CANADA-NEWFOUNDLAND
WATER QUALITY MONITORING AGREEMENT

QUIDI VIDI BASIN
INTENSIVE SURVEY REPORT 1993

Surface Water Section
Water Resources Division
Department of Environment and Lands
St. John's, Newfoundland

Water Quality Branch
Inland Waters Directorate
Environment Canada
Moncton, New Brunswick

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CAT # EN37-107/3-1993E

ISBN # 0-662-24326-9

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Ecosystem Science Division
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Canada-Newfoundland Water Quality

Monitoring Agreement

Quidi Vidi Basin

Intensive Survey Report

1993

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March 1994

LETTER OF TRANSMITTAL

File # 1165-4/NF-1

Coordinating Committee
Canada-Newfoundland Water Quality Monitoring Agreement

Dear Member:

In August of 1993, a survey of the Quidi Vidi Basin was completed under the Canada-Newfoundland Water Quality Monitoring Agreement. This survey was a follow up to the 1990 survey in this basin and was expanded to include Virginia River. On behalf of the Technical Subcommittee members, it is our pleasure to submit to you the results of this survey.

Yours truly,

Joseph Pomeroy Environment Canada	Gerry Collins Nfld Dept. of Environment

Technical Subcommittee Members:

Dr. John Kingston, Newfoundland Dept. of Environment & Lands
Mr. Harold Bailey, Environment Canada

EXECUTIVE SUMMARY

In 1993 the Quidi Vidi watershed was chosen as the site for an Intensive Recurrent Survey under the Canada-Newfoundland Water Quality Monitoring Agreement. In 1990 a preliminary survey of this basin indicated the presence of elevated metals and organic contaminants (Pomeroy, Collins 1990). Because of these results, the present survey has analyzed numerous variables in the surface water, sediment, forage fish and sport size brown trout. The survey originated in the headwaters at Left Pond and Virginia Lake and sampled the watershed through to the Quidi Vidi Lake.

Results indicate that the watershed continues to receive deleterious substances as a result of development. The major inputs are sewage/wastewater, urban runoff, and combustion emissions. These inputs result in elevated ions, nutrients, and fecal coliforms in surface water and elevated metals and organic contaminants in sediment and biota.

Many of the organic contaminants and metals in sediment exceed guidelines for the protection of aquatic life.

Results suggest that some of the organic and metal contaminants are bioavailable to forage fish. The highest contaminant concentrations in forage fish seem to be related to high contaminant concentrations in habitat sediment. The highest contaminant concentrations in brown trout appear to be related to sewage/wastewater, and runoff inputs.

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ACKNOWLEDGEMENTS

The authors wish to thank Environment Canada's Environmental Quality Laboratory in Moncton for the analyses of samples, and the Newfoundland Public Health Laboratory (Leonard A. Miller Centre) in St. John's for the analysis of coliform in surface water.

Thanks is also extend to T. Bult, and S. Riley of Memorial University for the collection of the brown trout samples; J. Gibson of the Department of Fisheries and Oceans for aging the trout samples, and to Calvin Bakers, Howard Wells and Kelly Taylor of the Atmospheric Environmental Branch, Environment Canada in St. John's who supplied equipment, and collected numerous samples.

Special thanks to Louise Boulter of Environment Canada for word processing.

ABSTRACT

The Quidi Vidi Basin was surveyed in August of 1993 under the Canada-Newfoundland Water Quality Monitoring Agreement. This survey was a follow up to the 1990 Waterford River Quidi Vidi Basin Report. The 1993 report concentrated on the Quidi Vidi watershed and was implemented to check the presence of elevated metals and organic compounds reported in the previous report, and to assess the current conditions of this widely utilized watershed.

Analysis of sediment, sport and forage fish, and surface water for the presence of organic and inorganic compounds plus metals were used to study the aquatic environment.

Results indicate elevated ions and faecal coliform in surface water while metals and organic contaminants are generally low in surface water.

Organic contaminants and metals in sediment routinely exceed guidelines for protection of aquatic life.

Results for fish indicate that concentrations of PAHs in sediment may be bioavailable to forage fish. Contaminants in brown trout appear to be related to urban wastewater and runoff.

1.0 INTRODUCTION

In August of 1993 an intensive recurrent survey of the Quidi Vidi basin in the City of St. John's was completed under the Canada-Newfoundland Water Quality Monitoring Agreement. This survey was implemented as a follow up to the 1990 survey of the Waterford and Quidi Vidi Watersheds (Pomeroy, Collins 1990).

The Quidi Vidi basin (Maps 1,2) is located in the northeast section of the city. The basin traverses the core of St. John's, and only the upper portion of the headwaters remain relatively undeveloped. Quidi Vidi Lake is located 1.5 km north of St. John's harbour, and flows into the smaller Quidi Vidi harbour. Quidi Vidi Lake receives discharge from two major rivers. Virginia River is located to the north of Quidi Vidi Lake, and Rennies River, which drains Leary's Brook, is located to the west of the Lake. The combined catchment area is approximately 75 km^2.

A high percentage of the Quidi Vidi basin is developed and the river's proximity to the city has made it a convenient route to remove storm and sewage waste. Although the Leary's Brook - Rennies River system is impacted, a healthy brown trout population continues to grow.

Both watersheds have also been the main theme for the development of parks and multi-use recreation areas. The Rennies River watershed has a linear park trail along its banks and the Freshwater Resource Centre is located on Nagles Brook, adjacent Long Pond. Quidi Vidi Lake is a recreational area with the annual Regatta sporting event occurring each August.

This survey assessed the aquatic quality of the watershed and determined its present environmental condition. To meet these objectives, organic and inorganic variables of surface water, sediment, and fish throughout the basin were considered.

2.0 METHODOLOGY

The Quidi Vidi basin study was conducted in August 1993. Twenty-seven samples from the surface water, biota and sediment were collected to determine the aquatic quality of the watershed. Station descriptions are provided in Table 1.

2.1 Sampling Program

During the survey water samples were hand collected and analyzed for routine variables, organic compounds and coliform bacteria. The routine group consist of major ions, physical parameters, nutrients and total or extractable metals. The organic group consisted of selected polynuclear aromatic hydrocarbons (PAH), and polychlorinated biphenyls (PCBs). Quality control samples included field blank samples and internal laboratory quality control. Bacteriological samples included total and faecal coliform. These were analyzed at the Newfoundland Public Health Laboratory in St. John's.

Sediment samples were analyzed for particulate organic carbon and nitrogen, polychlorinated biphenyls, polynuclear aromatic hydrocarbons, total metals and particle size.

Biotic samples consisted of forage fish and adult brown trout. The forage fish are resident to a specific area within the watershed; whereas the brown trout are anadromous. This group was analyzed for extractable metals, percent lipid content, polychlorinated biphenyls, and polynuclear aromatic hydrocarbons. Analytical methodology for the analysis are described in the Analytical Methods Manual (WQB, 1979).

2.2 Field Methodology

Water samples were collected as discrete or triplicate grab samples in polyethylene or glass containers. Preparation of containers and sampling technique followed the protocol described in "Sampling for Water Quality" (Environment Canada, 1983). Bacterial analyses included total and faecal coliform. Sampling containers and analysis were provided by the Newfoundland Public Health Laboratory in St. John's.

Bottom sediments were sampled with a 26 cm x 26 cm Ekman dredge sampler, and then transferred to a plastic or stainless steel tray depending on the analysis requirements. At the centre of the grab sample, 2 cm of top sediment was removed with a stainless steel or plastic scoop, and placed in a similar bowl. Triplicate samples were prepared by repeating this procedure at least three times, homogenizing the samples and then dividing the sample into the required number of containers.

Samples for trace organic compounds and particle size analyses were placed in pre-washed aluminum foil trays with aluminum coated cardboard covers. Metals and organic particulate sample containers were placed in polyethylene sediment jars.

Forage fish were collected by walking a net along the shoreline. The fish were captured up to a depth of approximately 1 metre. Brown trout were captured using an electric current from an "electro fisher". This method allowed for individual selection and minimal damage. Analyses of forage fish was based on a whole body sample; whereas, only the muscle tissue was used from the trout. Containers for the fish samples were the same as sediment containers. Fish samples were analyzed for extractable metals and the same organic compounds as sediment.

Field quality assurance/quality control procedures were followed as outlined in Arseneault and Howell (1987).

3.0 RESULTS AND DISCUSSION

3.1 Leary's Brook

The watershed of Leary's Brook-Rennie's River is located to the east of Quidi Vidi Lake. The headwaters originate in the semi developed area which lies south of Windsor Lake and north of St. John's. The river flows through the City of St. John's and empties into Quidi Vidi Lake.

The basin overlies the geology of the Conception Group, which is composed of the Torbay and Drook Formations. The Torbay Formation is considered an extension of the Mistaken Point Formation. Towards the Harbour, the geology changes to the Signal Hill Group which is composed of the Blackhead, Flat Rock Cove, Cuckold, Cape Ballard, Quidi Vidi and Ferryland Head Formations (King 1984). The surficial geology is composed of thin vegetated till with numerous rock outcrops and small organic deposits.

3.1.1 Left Pond

Left Pond is located in the headwaters of Nagles Brook-Rennies River. The Pond is south of Windsor Lake and is one of three ponds located in this area. The discharge from these three ponds drain into Long Pond through Nagles Brook. The area surrounding Left Pond is relatively undeveloped except for a dirt road along its eastern perimeter. The Lake is shallow and vegetated. Surface water and sediment samples were collected in the Lake's midsection.

Surface Water:

The concentrations of surface water variables (Table 2) were the lowest found in the Quidi Vidi basin. A difference of one order of magnitude in variable concentrations was often found between this site and those sites in the lower sections of the basin. Specific conductance, as an example, was 31 μSie/cm in Left Pond and 209 μSie/cm in Leary's Brook.

The thin topsoil located in the area of Left Pond contributes few major ions to the surface water. Calcium which is usually associated with the acid neutralizing calcium-carbonate is present at 0.8 mg/L. In the lower sites, calcium concentrations range from 4.0 to 10 mg/L. The low concentration of carbonate results in an alkalinity of 0.7 mg/L. This low alkalinity provides minor acid neutralizing capacity. This factor combined with the high humic and fulvic acids result in the lowest pH of the survey, 6.0 pH units.

The wetland surrounding Left Pond provide 3.2 mg/L of dissolved organic carbon. The DOC concentrations are similar at all sites which indicate the large amount of wetland found in this area. Nutrient concentrations are low (0.01 mg/L nitrate, 0.005 phosphorus) which is likely a result of the higher amounts of vegetation and the absence of sewage and road runoff. The physical features of the surface water included a low turbidity of 0.4 JT units and a low colour of 5 relative units.

All the heavy metals were below the analytical detection limits. Iron and manganese concentrations were low, whereas aluminum was at 0.072 mg/L. Although the aluminum concentration is slightly below the 0.1 mg/L guideline for the protection of aquatic life, further interpretation indicates that the aluminum concentration is associated with the elevated DOC which acts as a ligand when present in elevated aluminum concentrations (CCREM, 1987). The guideline for aluminum refers to ionic or free aluminum. The concentration of aluminum in the sediment (Table 5) sample was 50 percent higher than concentrations found at the other sites (21600 mg/kg).

Sodium and chloride concentrations were 10 to 20 times lower than sites nearer Quidi Vidi Lake. Sodium was present at 4.2 mg/L and chloride at 6.1 mg/L.

The analyses of surface water for polynuclear aromatic hydrocarbons (PAHs) found all compounds to be below or at the analytical detection limit (Table 3). All concentrations were similar to those found in the trip blank quality control sample.

Sediment:

Sediment analyses included metals and organic compounds. The organic analysis (Table 4) indicated that in Left Pond, the PAH concentrations are amongst the lowest of the survey and below available guidelines (MacDonald et al. 1992). Of the PAHs the high molecular weight compounds were the most concentrated and the source is expected to be from the burning of fossil or wood fuels. Arochlor or total PCBs in Left Pond were 31 ng/g and this is the lowest concentrations found in the survey. The 1990 survey of the Quidi Vidi basin recorded the concentrations of PCBs as less than 77 ng/g which was the lowest detection limit available at the time.

Iron and manganese are similar to other sites in the basin, whereas aluminum is twice the concentrations found at other sites, and higher than concentrations found in other basins on the Avalon Peninsula (Roussel et al. 1991) (Table 5). The aluminum in Left Pond is likely elevated because of the thin topsoil, the acidic conditions and the high organic content. Copper was present at 22 mg/kg which is slightly above the 16 mg/kg "lowest effect level", whereas lead at 128 mg/kg is 4 to 5 times the 31 mg/kg "lowest effect level". The "severe effect level" for lead is 250 mg/kg (Persaud et al. 1992). The concentrations of copper and lead are similar to concentrations found in Mundy Pond (43 mg/kg, 330 mg/kg), and Beaver Pond (24 mg/kg, 79 mg/kg) of the Waterford River basin (Pomeroy, Collins, 1990). The similarity of concentrations may indicate a historic atmospheric input over this area. Nickel, and zinc were slightly below the guidelines.

Left Pond, Big Pond and Middle Pond make up the headwaters of Nagles Brook which drains into Long Pond. Nagles Brook flows through the City's Pippy Park and the only impact found in the 1990 study was a minor runoff of nutrients from lawn fertilizers (Pomeroy, Collins, 1990). A small section of Nagles Brook immediately above Long Pond has been developed into a public viewing fluvium. The placement of this facility appears to have had minor impact on the stream and it provides a valuable educational tool so that visitors can observe the aquatic communities of the local freshwater streams.

3.1.2 Leary's Brook

Leary's Brook originates south-west of Left Pond and flows into Long Pond, located on the university campus (Map 2). From the headwaters, the Brook flows through the north side of St. John's, and joins numerous tributaries such as Oxen Pond Brook and Yellow Marsh Stream. These tributaries flow through the City and as a result contain elevated concentrations of contaminants. Above Long Pond, Leary's Brook has been covered over to allow for the placement of roads and buildings. East of the Avalon Mall, the Brook resurfaces and flows along a major 4 lane highway, Prince Phillip Drive. Leary's Brook flows for 2 kilometres adjacent to Prince Phillip Drive and into Long Pond located on Memorial University Campus. During construction of the campus, Leary's Brook was re-routed. Originally, the stream bed flowed in an eastern semicircle, but the present route is to the west (See Site ZM0152 on Map 2).

Surface Water:

Above Long Pond, the Brook flows through a stillwater located in front of the University medical centre. This stillwater, site NF02ZM0152 (also written ZM0152), was sampled for surface water and sediment.

A comparison of water quality between Leary's Brook and Left Pond shows the impact development has upon a waterway. Left Pond is relatively non-impacted, whereas Leary's Brook receives storm and sewage runoff. All the ions in Leary's Brook increased considerably over concentrations found in Left Pond (Table 2). As a result, specific conductance was at 209 μSie/cm as compared to Left Pond's conductance of 31 μSie/cm. The continuous inputs along the basin maintained the specific conductance at a minimum of 200 μSie/cm.

Calcium concentrations were at 4.3 mg/L and the increase was reflected in an alkalinity of 6.1 mg/L, and a pH of 6.5 pH units. The presence of wetlands similar to those found at Left Pond are reflected in a DOC concentration of 3.4 mg/L. Silica concentration, which indicates the input of groundwater, was one magnitude higher than that of Left Pond (3.3 mg/L). Sodium and chloride concentrations were also higher than those found in Left Pond and the source is linked to continuous leachate from road-salt (Pomeroy, Collins, 1990). Sea salt undoubtedly contributes ions to the basin but the input is minor compared to contributions from the leachate. Elevated nitrate and phosphorus, and maximum counts of coliform, indicate the impact of storm and sewage runoffs. All the metals except zinc and copper were below the guidelines. Zinc was at the 0.03 mg/L guideline and copper was twice the 0.002 mg/L guideline (CCREM 1987). These elevated concentrations were the result of slow moving water and excessive sediment which create a prime environment for the absorption and settlement of contaminants from the upper parts of the basin. Any disturbance of the sediment would suspend the bound heavy metals. The high turbidity of 1.1 JT units indicates that sediment had been suspended in the water column.

The analysis of surface water for organic compounds detected only four compounds slightly above the detection limit (Table 3). Of those compounds, pyrene was present at 0.008 μg/L which is similar to concentrations found in Quidi Vidi Lake. Fluorene, a low molecular weight PAH, was slightly higher than the concentration found in Left Pond. The source is expected to be fossil fuel or wood combustion byproducts.

Sediment:

The sediment sample was collected in the mid-section of this slow flowing vegetated area. The sediment was thick and composed of approximately 53 percent silt. Because of the composition and the high organic content of the substrate, the presence of elevated compounds was expected. This area demonstrates the importance of these natural sinks in removing contaminants from the water column and reducing their bioavailability.

The analyses of sediment for PAHs found most concentrations above aquatic life protection guidelines (MacDonald et al. 1992). The concentrations were among the highest of the survey, but were still 50% less than concentrations in Quidi Vidi Lake (Table 4). The concentrations were higher than those found in Long Pond and this suggests that the PAHs are settling in this area as a result of the reeds and slow moving water. Naphthalene, which is representative of fuel was only one of two compounds found below the guidelines used for the assessment for Puget Sound Dredging Disposal Analysis (MacDonald et al. 1992). Naphthalene is volatile and was below the guideline (2000 ng/g maximum dredge level) at all sites. A ratio of naphthalene to phenanthrene indicates that these sediments do not contain fresh petroleum (Steinhauer, Boehm, 1991). Other 3 to 5 ring PAHs which indicate wood/fossil fuel combustion are elevated. These compounds were present above the screening dredge level, but below the maximum level (MacDonald et al. 1992). Phenanthrene at 1237 ng/g, pyrene at 2231 ng/g plus anthracene, perylene, and chysene are all one order of magnitude higher than concentrations found in Left Pond. The ratio of PAHs would suggest combustion as the likely source (Steinhauer, Boehm, 1991).

Total PCBs were found at 4480 ng/g. This concentration is lower than those found in Long Pond which is directly below this site. The PCB concentrations found in Leary's Brook and in Long Pond appear "patched", in that certain spots contain elevated concentrations and so sample concentrations are likely a reflection of sample site. Sediment analyses for metals found lower aluminum and manganese than in Left Pond (Table 5). Lead concentrations increased slightly and the elevated lead concentrations continue down to Quidi Vidi Lake. Chromium at 30 mg/kg was above the 26 mg/kg "lowest effect level", and zinc at 600 mg/kg was slightly below the "severe effect level" of 820 mg/kg (Persaud et al. 1992). The source of these metals is likely the numerous galvanized products used in the basin.

3.1.3 Long Pond

Long Pond is located on the University campus below the previously sampled site. The Pond is separated from Prince Phillip Drive by a parking lot, university buildings, and a narrow green belt. To the west of the Pond is Pippy Park. Nagles Brook flows through Pippy Park and into the north side of the Pond. A fluvarium is located slightly above the Pond on Nagles Brook.

Surface Water:

The Pond was sampled slightly below the inlet and above the outlet. The water quality samples indicate a specific conductance of 230 μSie/cm, and major ions concentrations which are similar to those found in Leary's Brook (Table 2). An increase in colour and dissolved organic carbon (DOC) is likely the result of the greater amount of decaying vegetation along the Pond's perimeter. The pH is at 6.6 pH units even though alkalinity has increased to 7.3 mg/L. The decrease of faecal coliform between the previous site and the outlet of Long Pond is expected to be from the dilution of bacteria in the Pond and also the absence of new input. The increase of total coliform is expected as a result of the larger amount of decaying vegetation. The slight decrease of nutrients is expected to result from uptake by vegetation.

The analyses of surface water for organic compounds found all compounds to be below the analytical detection limit (Table 3). The concentrations of PAHs in these samples were similar to those of the above site.

Sediment:

The sediment composition in Long Pond is similar to that found in the previous site. Long Pond also acts as a sink for contaminants flushed from Leary's Brook.

The two sediment samples collected in the Pond contain concentrations of PAHs which are lower than sediment at the site previously sampled, but still higher than the available screening level guidelines (MacDonald et al. 1992). The decrease in PAH concentrations indicate the effectiveness of a "sink" created by stillwaters in watersheds.

In the Pond, the concentrations of PAHs are lower at site ZM0139 (opposite Nagles Brook) than at site ZM0153 (at inlet of Leary's Brook) (Table 4). The decrease in concentrations from the inlet to outlet of the Pond is a result of the settling out of contaminants as they pass through the Pond.

In the sediment, the low molecular weight PAHs; naphthalene, acenaphthene, anthracene, fluorene and phenanthrene have low concentrations which indicate the absence of raw fossil fuels (Steinhauer, Boehm 1991). The higher molecular weight PAH concentrations are lower than concentrations found at the above site, but are still elevated above available screening guidelines (MacDonald et al. 1992). These compounds indicate that the source is from combustion. Between the stillwater on Leary's Brook to the outlet of Long Pond the concentrations of PAHs were decreasing which suggest that no new input of contaminants are entering the Pond. The source of PAHs were likely from the above stillwater and sediment bound compounds were being flushed into Long Pond during high discharge periods. Upon entering the Pond the suspended sediment settles out and so the Pond acts as a second contaminant sink on Leary's Brook. Although most compounds decreased or remained constant in concentrations, two compounds which increased significantly were dibenzo(a,h)anthracene and perylene. Dibenzo(a,h)anthracene was not found in the first site and this is likely an error because interference was recorded in other sites. Perylene increased three times from 474 ng/g to 1436 ng/g. Both these compounds are indications of fossil/wood combustion. Concentrations found in this survey are similar to concentrations found in the 1990 survey (Pomeroy, Collins 1990). PCBs were also elevated ranging from 9581 ng/g at the inlet and 12644 ng/g near the outlet. In 1990 the samples in this Pond contained concentrations in the range of 30000- 40000 ng/g at the inlet and 2000-3500 ng/g at the outlet. As in Leary's Brook these concentrations suggest the presence of hot spots in the Pond. Concentrations also seem to suggest the input of PCBs has ceased and future concentrations should decrease. The concentrations in Long Pond are up to nine times the highest concentration found in Quidi Vidi Lake.

There was a general decrease in the concentrations of metals in the sediment when compared to those in the Leary's Brook site and lower concentrations of heavy metals were also found at Long Pond's outlet (NF02ZM0139) (Table 5). Aluminum, manganese and iron were higher at the lower site and the increase may be the result of recently disturbed soils in Nagles Brook during construction of the fluvarium. Chromium at 15.4 mg/kg were below the 26 mg/kg guideline and 50 percent lower than concentrations found in Leary's Brook. Zinc, copper, and cadmium decreased slightly, but remained 4 to 5 times above the "lowest effect level" (Persaud et al., 1992). Lead increased 25 to 80 percent over the 200 mg/kg concentration found at the Leary's Brook site. The higher concentration of 380 mg/kg was found at the upper site. Its presence could be the result of numerous storms which have flushed historical lead bound sediment from the upper reaches of Leary's Brook.

Forage Fish:

Two forage fish samples were collected in Long Pond. Sample ZM0155 was collected on the northern shore 50 metres above confluence of Nagles Brook. This site was difficult to seine because of the rocky bottom. Five sweeps were made with 75 individual fish being collected. 85 to 90 percent of the sample were 20-30 mm long and 10-15 percent were 40-50 mm long.

The second sample, NF02ZM00154, was collected on the southern shore 50 metres above the recreation area. Again this area was rocky with heavy aquatic growth. Of the 75 individual fish, 90 percent were 20-30 mm long and 10 percent were 40-50 mm long.

Of the two samples, NF02ZM0154 contained 2.6 percent lipid whereas the second sample contained 1.67 percent. The percent of body lipid content did reflect upon the concentration of organic compounds. Because organic compounds are fat soluble the sample with the higher lipid content contained higher concentrations of PAHs. This was not the case with metals. Data in Table 6 indicates that the location of sample was more significant than lipid content.

The organic analyses indicated that many PAHs were below the analytical limit and probably do not represent a threat to fish survival. The higher PAH concentrations were measured in fish captured at the inlet to Long Pond (ZM0154) rather than at the outlet (ZM0155). Fish at the inlet contained the highest lipid content. The highest PAH concentrations in sediment were also found at the pond's inlet.

It is interesting to note that some of the PAH concentrations in the forage fish from Long Pond are higher than some of the PAH concentrations from fish in Quidi Vidi Lake, even though PAH concentrations from Quidi Vidi Lake sediment are higher. This difference is due to the fact that forage fish in Quidi Vidi Lake were collected near the sandy shore, while the sediment was collected in the deep mid-section of the lake where forage fish do not inhabit. Because Long Pond is long and shallow, the fish live over the organic sediment and so ingest more contaminants.

Concentrations of PCBs in the forage fish at both sites in Long Pond were almost identical, even though lipid concentrations were different. The values of PCBs, however, were one order of magnitude higher than at other survey sites, undoubtedly due to the fact that Long Pond had the highest concentrations of PCB contaminated sediment in the survey. The expected source is the developed areas on Leary's Brook.

The pattern of high metals in fish coinciding with high levels in sediment was also observed. Metal concentrations in forage fish tended to be higher at the outlet of the pond.

Concentrations of metals found in fish in Long Pond are similar to concentrations found in a unpublished study by Bailey (1995 Unpublished data) in which 137 samples from across Atlantic Canada were analyzed for concentrations of metals.

3.2 Rennies River

Rennies River flows from the outlet of Long Pond to Quidi Vidi Lake. This section of the Leary's Brook-Rennies River watershed flows through the oldest sections of St. John's. The perimeter of the River is separated from development by a walking park.

Brown Trout

To determine the environmental impact upon the brown trout population, samples were collected in Rennies River and in Virginia River. Below Long Pond, 6 trout samples were collected (NF02ZM0173). The samples were collected using an electrical shocking device and a net. The lengths of the fish ranged between 20.5 to 30.5 cm , and the weight ranged between 105 to 306 grams. For the analyses of brown trout, only muscle tissue was used. The lipid content of the trout ranged in the 1 percent area. The last sample in this group in Table 6 lists the sample as having a lipid content of 0.05 percent. This percent is likely a mistake because this sample has the highest concentrations of PAHs in the group and so the lipid content should also be the highest. Only 5 PAH compounds were detected in this sample. The concentrations were the lowest of the brown trout samples. This could be a result of the time spent in the freshwater or perhaps the trout are living in flowing water. The concentrations of PCBs were also low. Metals were slightly elevated compared to salmonoid species from 3 Labrador headwater lakes (Lockerbie, 1987).

The concentrations in relation to forage fish are lower and the reasons for the differences are expected to be the difference in lipid content of tissue analyzed (whole body analyses of forage fish, muscle only for brown trout), the different feeding habits and the site specificity of the forage fish.

3.2.1 Rennies River - Kent's Pond Tributary

Kent's Pond tributary enters Rennies River 100 metres below Long Pond. The tributary is composed of two branches. The west branch originates near the Pippy Park Campground, and the east branch originates in Kent's Pond. The Pond is located in a small green belt area and is surrounded by thick vegetation and mature trees. Surface water and sediment samples were collected above the Pond's outlet (NF02ZM0135). These samples were collected in triplicate as part of the quality control procedures.

Surface Water:

The concentrations of inorganic variables within the surface water triplicate sample were within the acceptable 10 percent range (Table 2). The counts from the coliform samples were widely spread ranging from 10 to 120 count per 100 mL. These samples were collected at the same time, but only the sample with the count of 10 was analyzed in the required 6 hour time frame. Because the two samples which had the higher counts were analyzed 24 hours after collection, and the 6 hour sample should have been highest, the lower count is expected to be unreliable. The source of the faecal coliform is expected to be from birds or storm runoff in the headwaters. The total coliform counts in the samples ranged between 260 and 400/100 mL.

The nutrients in the Pond are similar to those found in Left Pond. Physically the water is clear with low turbidity and pH of 7.2. The 10.0 mg/L calcium is reflected in a 16.5 mg/L alkalinity, which is the highest of the survey. All the major ions are double those of other sites and this is reflected in the conductance of 569 μSie/cm. The major source of the ions is expected to be from the sedimentary shale and siltstone. Minor inputs are expected from seawater spray. All heavy metals were below the detection limits.

The surface water sample analyzed for organic compounds found all compounds were below the analytical detection limits, and the concentrations were similar to those in the trip blank sample (Table 3).

Sediment:

The sediment analysis for organic compounds was also collected as a triplicate sample (Table 4). The data indicate that the concentrations are acceptable for all compounds except dibenzo (a,h)anthracene. For this compound, the second sample was found to contain four times the concentrations of the other two. The detection of this compound has been problematic in other samples and should be considered with caution.

The PAH data indicate that the concentrations found in Kent's Pond are below available guidelines and similar to concentrations found in Virginia Pond. The concentration of PCBs ranged between 135 ng/g to 293 ng/g. This range is one magnitude higher than Left Pond, but two magnitudes lower than concentrations found in Long Pond. The 1993 concentrations are similar to the 77 to 208 ng/g found in the 1990 survey.

The sediment analysis for metals detected elevated concentrations of nickel, copper, zinc, cadmium and lead (Table 5). Nickel and cadmium were slightly above the "lowest effect Level" guideline (Persaud et al. 1992), whereas zinc, copper and lead were near the "severe effect level". The source of the zinc is expected to be from galvanized culverts in the headwaters. The lead source is likely historical, being from the lead used in auto fuels. Copper is used in many products and one source cannot be identified as the major contributor.

Forage Fish:

A forage fish sample was collected 50 metres east of the outlet on the southern shore of Kents Pond. Three sweeps of the seine produced 200 forage fish. 85-90 percent of samples ranged between 20-30 mm and the rest fell into the 40-50 mm range. The larger fish were divided between metal and organic samples.

The concentrations of PAHs found in forage fish in Kent's Pond are listed in Table 6. Naphthalene was the lowest value found in the forage fish samples. Many of the compounds were below the analytical detection limit. The concentrations of detected compounds were generally low compared to most of the other sites. Total PCBs were below the analytical detection limit.

The concentrations of metals are similar to values at other sites in the basin and similar to concentrations found by Bailey (1995 Unpublished data) in Atlantic Canada.

3.2.2 Rennies River - Kings Bridge

Brown Trout

Two samples of trout were collected for analysis. The first sample consisted of two fish that were collected 100 metres upstream of Kings Bridge Road (ZM0157). The lengths of the fish ranged between 33- 39 cm and the weight ranged between 374 to 657 grams.

The second sample was collected adjacent to an outfall near the stadium and 200 metres above Quidi Vidi Lake (ZM158). This sample consisted of four fish which ranged between 28 - 34.5 cm and weighed between 239 - 418 grams.

Concentrations of PAHs found in these two samples were generally much higher than concentrations found in brown trout in other parts of the study area, particularly trout captured farther upstream. Naphthalene concentrations, in particular, were very high. They were one order of magnitude higher than other samples, with one value reaching a concentrations of 263 ng/g. This was two orders of magnitude higher than most of the other samples in the study area. This fish weighed 657 grams, one of the biggest fish caught in the survey. Sample ZM0157 was captured downstream in Kellys Brook outfall, while sample ZM0158 was captured below another major outfall farther downstream. These outfalls may have been responsible for the high PAH values as a result of oils and gasoline discharges. PCB values are similar to most other samples in the study.

The concentrations of metals were similar to other samples collected in the survey, and slightly higher than metals reported for Labrador Lakes (Lockerbie, 1987). Mercury concentrations were the lowest found in the brown trout samples.

3.2.3 <u>Rennies River Long Term Surface Water</u>

Rennies River, site NF02ZM0016 has been sampled monthly since 1986 above Carnell Drive Bridge as part of the Canada-Newfoundland Water Quality Monitoring Agreement. The 1986 to 1990 surface water data on this site was discussed in the 1990 Waterford and Quidi Vidi Watersheds Survey Report. Since the last report data up to 1994 has been approved and selected water quality variables will be discussed (Table 8).

Surface Water:

The pH of Rennies River fluctuates between 6.2 to 6.9 depending upon the alkalinity and rain event. Alkalinity ranges between 4.9 during spring snow thaw to 12.9 mg/L during summer to fall when groundwater supplies most of the stream flow. Specific conductance (Figure 1) has remained similar to other years although there is an absence of large runoffs. Sodium and chloride from road salt leachate and sea salt are the main ions which maintain the elevated conductance. Conductance ranges between 200 to 1000 μSie/cm as compared to 31 for Left Pond. Total phosphorus concentrations during 1987 to 1990-91 ranged between 0.01 to 0.07 mg/L. In the later years the concentrations appear to be decreasing, dropping periodically to more appropriate concentrations of 0.006 mg/L concentrations. The decrease could be a result of fewer products on the market containing phosphates. Phosphorus concentrations in Rennies River are similar to those found in Virginia River (Figure 2). Nitrate concentrations have remained stable over the years of collection which is expected as sewage and storm runoff continues to enter this River (Figure 2). Lead and copper concentrations (Figures 3,4) have decreased over the sample period. The high discharge periods during spring and fall have lower concentrations of heavy metals. This indicates that the sediment being flushed out of the river contains lower amounts of lead and copper. This decrease would suggest lower amounts are entering the rivers. Zinc continues to be elevated because of its presence in galvanized culverts used in road construction. Similar concentrations are found in Rennies and Virginia River. Although concentrations of zinc are above the 0.03 mg/L guideline (CCREM 1987), such peaks occur during high flow and are usually bound with sediment. Other heavy metals are below the guidelines.

3.3 Virginia River Basin

The Virginia River lies north-west of Quidi Vidi Lake and directly north of Leary's Brook - Rennies River (Map 2). The system is approximately 8 kilometres long with Virginia Lake located at the midpoint. The headwaters are located south of Windsor Lake. To the north and east of this system are the subdivisions of Penetanguishene and Rickett's Bridge. The geology consist of the Drook Formation with a surficial geology of vegetated and stony till interspersed with organic deposits.

3.3.1 Virginia Lake

Virginia Lake is situated 2.5 kilometres north of Quidi Vidi Lake between Torbay Road and Logy Bay Road. The areas to the south and west are developed with subdivisions, whereas the eastern shore is developed minimally. The lake is approximately 330 metres wide by 1 kilometre long. On the eastern shore of the lake an outcropping of land partially divides the lake into an upper and lower section. The inlet and outlet are located in the lower section. Two sample sites were chosen in the lake. In the upper section at midpoint (ZM0160), and in the lower (ZM0159)section between the inlet and outlet.

Surface Water:

The surface water at the two sites in Virginia Lake both have a pH of 6.9, conductance of 242 μSie/cm and alkalinity of 12.8 mg/L. The physical and biological variables of the surface water are higher in the lower section than in the upper section. The turbidity at site ZM0159 is twice that of the upper site as a result of the inlet current carrying sediment into the water column. The source of elevated phosphorus is likely from algae or urban runoff.

All organic contaminants in the surface water were below detection limits, and similar to concentrations found in the trip blank.

Sediment:

The substrate of the upper sample collected in Virginia Pond was composed of 66 percent silt. This type of composition is desired for the complexing of organic compounds and metals. The analysis of sediment for PAHs found concentrations were lower at site ZM0160 than at site ZM0159, which is next to the outlet. The higher concentrations at ZM0159 are expected because the inlet of the Virginia River and the outlet of the Lake are situated in the southern section. All inputs from Virginia River would enter the Lake and settle at or near site ZM0159. The northern site is subjected only to the input of storm drains from the local subdivisions. The concentrations found at site ZM0160 are similar to concentrations found in Left Pond.

The concentrations of PAHs varied in range with the lower values found in the low molecular weight compounds. Only phenanthrene and chrysene are slightly above the available guidelines. The concentrations indicate the presence of PAHs from fossil/wood combustion. Such compounds would be expected in this residential zone. Total PCBs were elevated at both sites compared to the background station, but were fairly low compared to most of the other sites.

Many of the metal concentrations in sediment were lower than those found in Kents Pond and this may be a result of lack of atmospheric input. The concentrations of metals in Virginia Lake were similar at the two sites. Copper, zinc, cadmium, and lead were above the "lowest effect level", and 50 percent lower than the "severe effect level" (Persaud et al. 1992). The concentration of lead was 90 and 110 mg/kg, which were the lowest concentrations found in the survey. Similar low concentrations were found in 1990 (Pomeroy, Collins 1990).

Forage Fish:

Two forage fish samples were collected in Virginia Lake. Sample ZM0161 was collected in a shallow cove at the outlet of the Lake. There is a concrete dam at the outlet and the sample was collected above this. Sample ZM0162 was collected along the shore in the upper section of the Lake. Several sweeps with a seining net were taken just up shore from a storm pipe. Several PAH compounds were below the analytical detection limit in the two forage fish samples. Of the two samples, the fish collected nearest the outlet contained the higher concentrations. Table 4 lists the concentrations of PAHs in sediment and the data shows that the outlet also has concentrations of PAHs 2 to 4 times the upper site. The outlet site of the Lake is adjacent to the inlet and any organic compounds entering the Lake would settle in the area of the outlet. The upper site is located in a cove and the only input would be from a storm line which originates in a recent sub-division. As in the other sites the compounds detected were naphthalene, fluoranthene, phenanthrene and pyrene at the outlet sample. Naphthalene was present in concentrations above Kent's Pond, but was 50 percent of the concentrations found in Long Pond. The other compounds were lower than found at other sites. The source of these compounds is likely burning of fossil fuels. The concentrations of PCBs were also higher than that found in Kent's Pond and one order of magnitude lower than that found in Long Pond. The concentration of PCBs is also related to sediment concentrations. PCB in sediment in Virginia Lake is 3 times higher than that found in Kent's Pond and 1 to 2 orders of magnitude lower than concentrations found in Long Pond.

The concentrations of metals in the forage fish sample (Table 7) indicate that the upper site sample (ZM0162) are similar to the other sites. The lower sample adjacent to the outlet has concentrations higher than the other sites and some metals are elevated by one order of magnitude.

Sample ZM0162, which was collected in the upper cove contains metal concentrations in forage fish which are similar to those found in other smaller sized ponds. But some concentrations are up to 50 percent higher than those found in Quidi Vidi Lake, even though metals in sediment are similar. In this case the reason for the difference is that the sediment sample and the forage fish sample in Quidi Vidi Lake are taken from different areas. In the forage fish sample adjacent to the outlet, the concentrations for aluminum is 666 mg/kg and for iron is 673 mg/kg. These are one order of magnitude above other sites even though the concentrations found in the sediment are only slightly higher. Elevated concentrations of other metals were also found and the reason for the difference is expected to be that the fish live over the sediment and ingest larger quantities. The zinc concentration was the same at all sites and this may be the result of the use of galvanized culverts throughout the basin.

3.3.2 Virginia River Below Logy Bay Road

After leaving Virginia Lake, the River flows along a golf course for approximately 1 kilometre and then flows 0.5 kilometre into Quidi Vidi Lake. At the Logy Bay Road bridge, four Brown trout were collected (ZM0148). This site was heavily vegetated as a result of planting by the local river protection group.

Brown Trout:

Brown trout were collected from Virginia River above and below the bridge on Logy Bay Road (ZM0148). The trout were collected by an electrical shocking device and dip netted into a plastic pail. The sample consisted of 7 fish divided into four groups. The weight of the fish ranged between 148 - 224 grams and the length ranged between 24.5 to 27.5 cms.

Seven PAH compounds were detected in the samples. The concentrations were low in comparison to the brown trout captured on the lower part of Rennies River and similar to concentrations found below Long Pond. The second sample contained a lipid content of 5 percent and also contained the higher concentrations of contaminants. The low concentrations in this group of fish is related to the area of capture. The fish were collected in a good flowing stream which had large mats of plants growing from the stream. This area was likely the least impacted of the sites sampled. PCBs were below the analytical detection limit.

The concentrations of metals varied somewhat with most metal concentrations being similar to those in Rennies River samples. Elevated zinc, iron and mercury were present in the last two samples collected at this site. The concentrations are similar to those found in the lower Virginia River so there is a possibility that these fish would have recently travelled upstream.

The lower sample (ZM0014) of brown trout were collected between Quidi Vidi Lake and the Boulevard Bridge. The sample consisted of seven fish divided into four groups. The length ranged between 27 to 36.5 cm and the weight ranged between 188 to 504 grams. The lipid content of these fish ranged between 1.5 to 2.67 percent. The seven PAH compounds found in other samples were also detected in this sample. The concentrations are similar to concentrations found at the Logy Bay bridge site and are sometimes below the magnitude of samples from Rennies River. Elevated zinc is likely related to the use of galvanized material from road construction. PCBs were detected at low concentrations similar to those at the Rennies River site.

3.3.3 Virginia River Long Term Water Quality Data

Virginia River has been sampled monthly since 1986 under the Canada-Newfoundland Water Quality Monitoring Agreement. The water quality of this site was discussed in the 1990 Waterford and Quidi Vidi Watershed Survey Report (Pomeroy, Collins 1990). The data presented in this report will include selected variables up to March 1994.

Surface Water:

Virginia River is very similar to Rennies River in water quality. The specific conductance normally fluctuates between 300 and 1000 μSie/cm. During periods of high discharge conductance reaches 3700 μSie/cm (Figure 1). The high conductance is a result of road salt runoff and sea salt deposition. The input of road salt occurs as a quick concentrated spike during the winter season and as a leachate which is continuous throughout the year. The leachate is a major source of ions which causes the conductance to remain above 250 μSie/cm. The pH of the water ranges between 6.2 to 7.5 units. The alkalinity usually ranges between 6.0 and 20 mg/L. Phosphorus has remained stable over the sample period with lower concentrations occurring in the latter years (Figure 2). As with the case in Rennies River, the phosphorus concentrations may be a result of lower amounts of phosphate containing products being used. The nitrate concentrations have steadily increased during 1987 to 1994 (Figure 2). The increase indicates additional inputs of sewage or fertilizers. Concentrations in Virginia River now exceed those found in Rennies River.

The concentrations of copper and lead have remained steady overall, but the fewer number of peaks suggests a decrease in the concentrations present in sediment in the rivers.(Figures 3,4). The concentration of zinc has remained elevated and steady during the sample period and during high discharge surpassed the 0.03 mg/L guideline (CCREM 1987) (Figure 4). As in Rennies River the use of galvanized products will cause concentrations to remain high. The concentrations of metals present are expected to be bound to sediment and not readily available to biota.

3.4 Quidi Vidi Lake

Virginia River flows into the north side of Quidi Vidi lake, and Leary's Brook-Rennies River flows in the western end (Map 2). The lake is approximately 1.5 kilometres long and 500 metres wide. The outlet is located at the east end, and flows 200 metres into Quidi Vidi Harbour.

Surface Water:

Samples were collected at four sites. The first site was located 300 metres from the inlet of Rennies River, the second 500 metres, the third 800 metres, and the fourth 1.3 kilometres, or slightly above the Lake's outlet (Table 2).

The second sample, NF02ZM0164, was collected in triplicate as part of the quality control. The triplicate samples are acceptable with all variable concentrations except colour and coliform counts falling within the 10 percent range of variability. The colour ranges from 15 relative units at Rennies River inlet to 35 at Quidi Vidi Lake outlet. The coliform counts are higher at the Rennies River inlet and decrease by 50 percent at the second station. High inputs of sewage to Rennies River from tributaries like Kelly's Brook cause elevated counts of coliform in Quidi Vidi Lake (Pomeroy, Collins 1990).

Overall the water quality of the lake consists of lightly coloured water with a low turbidity of 1.2 JT units, and a DOC of 3.5 mg/L. The pH is 7.0 units and the alkalinity is 13.7 mg/L, providing ample buffering capacity. Nutrients are slightly elevated although no heavy metals were present.

The analysis of organic compounds in the surface water found a few PAH compounds at the analytical detection limit (Table 3). Only pyrene was detected at the analytical detection limit at all four sites. The concentrations ranged between 0.006-0.009 μg/L, which is slightly higher than the L 0.003 μg/L in the blank sample.

Sediment:

Quidi Vidi Lake contains the highest concentrations of metals and organic compounds in this survey (Table 4). The sources of contaminants are Rennies River and Virginia River. During high discharge, sediment and associated compounds are flushed from the Rivers and settle in the Lake. Because the discharge carries with it the finest sediment, the sample composition consisted of 50 percent silt and 36 percent clay.

The second site in the Lake, NF02ZM0164, was collected as a triplicate quality control sample. Of the three samples analyzed for organic compounds, the first will not be used because the concentrations were outside the accepted 10% range of variability. Based on the two remaining samples, only dibenzo(a,h)anthracene and indeno(1,2,3-cd) pyrene are not acceptable. Dibenzo(a,h)anthracene concentrations have not been acceptable at most stations due to interference in its detection (Table 4). The metal concentrations are all within the acceptable 10 percent range (Table 5).

The organic analyses show that the concentrations of PAHs at the first site (ZM0163) are almost double those at the second site (ZM0164). From the second site the concentrations gradually decrease towards the outlet. The concentration gradient indicates that most of the contaminants are coming from Rennies River.

Naphthalene was present at concentrations ranging between 111 to 150 ng/g. These concentrations are below the 210 ng/g dredge disposal guideline used in the Puget Sound Dredged Disposal Analyses 1989 (MacDonald et al. 1992), and 5 times concentrations found at the other sites. The presence of naphthalene indicates that raw fuel from street runoff has entered the Lake. Phenanthrene is 10 times the 320 guideline and 30 times the concentrations found in Left Pond. The highest concentrations of PAHs occurred in the high molecular weight compounds which are produced from the combustion of fossil fuels and wood fuels. Fluoranthene (1780-7258 ng/g), phenanthrene (850-3745 ng/g), benzo(a)anthracene (730-2674 ng/g), and pyrene (1840-6739 ng/g) are examples of the concentrations found in the sediment. The concentrations of most of the high molecular weight compounds are one magnitude above the guidelines used for dredge disposal in Puget Sound (MacDonald et al. 1992). These compounds are insoluble in water with a high affinity for sediment and biota. As a result of these properties the compounds quickly adhere to sediment and settle after entering the Lake. Although the concentrations of the PAHs are above guidelines, these compounds are quickly metabolized and eliminated by organisms. Bioaccumulation is considered short-term (CCREM, 1987). The source of these PAHs is likely home heating systems and car exhaust.

Total PCBs concentrations ranged from 573 to 1141 ng/g. These concentrations are one order of magnitude above those found in Left Pond, but one order of magnitude below concentrations found in Leary's Brook and the inlet of Long Pond. The source of the PCBs in Quidi Vidi Lake is likely the same as that for Long Pond. A release of oil containing PCBs above Long Pond may have been carried to Quidi Vidi Lake or sediment bound PCBs were likely flushed through Rennies River to the Lake. A continuous source of PCBs does not appear to be present and concentrations should continue to decrease over the years.

The metal analyses of the sediment show a general decrease in concentrations from the inlet of Rennies River to the Lake's outlet.

Between Long Pond and the first site in Quidi Vidi Lake there is numerous sources of metals from sewage/storm drains. Chromium increases from 11.6 mg/kg to 32.7 mg/kg, copper from 73 to 128, zinc from 510 to 730 mg/kg, and lead from 250 to 410 mg/kg. At site ZM0163, copper and lead surpass the "severe effects level" guideline (Persaud et al. 1992) of 110 mg/kg and 250 mg/kg. Zinc (720 mg/kg) is slightly below the "severe effect level" of 820 mg/kg.

The third and fourth sites collected in Quidi Vidi Lake are below Virginia River, but low concentrations suggest that the input from Virginia River is minor. The only metal to increase at the lower end of the Lake was zinc. At 880 mg/kg the concentration is above the "severe effects level". The source is likely galvanized culverts used throughout the Virginia River basin.

Forage Fish:

Six forage fish samples were collected in Quidi Vidi Lake. Samples NF02ZM0167, and ZM0168 were collected on the north side of the Lake west of Virginia River. Samples ZM0169, ZM0170 were collected on the north side of the lake east of Virginia River. Samples ZM0171, ZM0172 were collected on the south shore. The samples were collected along the sandy shoreline. The sediment samples were collected in the middle of the Lake in a substrate which consisted of silt and clay. The differing sampling areas cause the concentrations of metals and organic compounds in each matrix to not correspond.

In the forage fish samples collected in Quidi Vidi Lake, 9 PAH compounds were detected. Samples from the lower end of the Lake have lower concentrations. The concentration gradient is likely the result of contaminants settling in the upper areas of the Lake. Rennies River has been identified as a major source of contaminants and so samples at the outlet would be expected to contain higher concentrations of organics and metals. Generally the concentrations of PAHs in the forage fish from Quidi Vidi Lake are higher than those found in Kent's Pond, Virginia Lake, and at the outlet of Long Pond, but up to five times lower than those found in the sample of fish from the inlet of Long Pond. The sediment at the inlet of Long Pond consist of contaminants from Leary's Brook which settles in the immediate area, and here forage fish are in close contact with substrate.

The concentrations of PCBs in forage fish at all sites in the Lake were comparable to most other sites in the basin. When compared to Long Pond, concentrations are one order of magnitude lower.

Heavy metal concentrations were similar to those found in the sample adjacent to the outlet of Long Pond (ZM0155) and to concentrations found in Kent's Pond and Virginia Lake. Nickel, arsenic and mercury were all below concentrations Bailey found in Atlantic Canada (Bailey 1995 Unpublished data).

3.4.1 Quidi Vidi Lake Outlet Long Term Water Quality Data

Water quality data has been collected at the outlet of Quidi Vidi Lake since 1986 under the Canada-Newfoundland Water Quality Monitoring Agreement. The data from this site was discussed in the 1990 Waterford and Quidi Vidi Watershed Survey Report

(Pomeroy, Collins 1990). In this current report, selected water quality variables for the period of 1986 to 1994 will be discussed.

Surface Water:

Quidi Vidi Lake receives water from Rennies River and Virginia River. All contaminants which enter the rivers eventually settle in the Lake. Some contaminants such as organic compounds are flushed directly into the Lake where they are adsorbed onto sediment and settle. Other contaminants are adsorbed onto sediment in the Rivers and settle there. This sediment is flushed into the Lake during high discharge and settles out. The lake has become a final trap for contaminants and prevents them from entering the Harbour. The surface water quality which leaves Quidi Vidi Lake has specific conductance similar to the rivers except during high discharge periods. At peak flow, the conductance at the outlet can be 30 percent that found in the rivers (Figure 1). Alkalinity at 4 to 11 mg/L is slightly lower than found in the rivers, but pH levels are similar at approximately 6.4 to 7.3 units. Copper and lead concentrations are similar to concentrations in rivers. Lead concentrations (Figure 3) increase slightly in the 1994 period and this is likely a result of sediment being mixed into the water column during a storm. Elevated concentrations also occurred in Rennies River during this period which would suggest a surge of sediment travelled through the system and out of the Lake. Zinc concentrations range between 0.01 to .065 mg/L, which is similar to concentrations in the rivers (Figure 5). There appears to be a sufficient amount of zinc in the water column that settlement has a minimal affect on concentrations.

4.0 QUALITY CONTROL/QUALITY ASSURANCE

To establish a degree of credibility when producing concentration data, a project must include verifiable quality control/quality assurance procedures (QA/QC) for the field collection and laboratory analytical practices. As part of this survey, triplicate and blank samples for surface water and triplicate samples for sediment were collected. These procedures can indicate contamination, and/or the reliability of sampling and analytical methods. The field quality control augments the laboratory practices of QA/QC which are routine in the Environmental Quality Laboratory of Environment Canada.

4.1 Triplicate Samples - Surface Water - Sediment

Sequential triplicate samples are three sets of samples from one location collected in sequence. The resulting data from this quality control procedure should indicate sampling representativeness, sample contamination, and/or data management problems. A general guideline used by Roussel et al. (1991a), suggests that triplicate sample results should not vary by more than 10 percent.

Triplicate surface water samples were collected in Kent's Pond (NF02ZM0135), and in Quidi Vidi Lake (NF02ZM0164) (Table 2). Both sites show that all the variables are within or slightly above the 10 percent standard. These samples indicate that concentrations provided in the report are representative of environmental concentrations.

The sediment triplicate samples were also collected in Kent's Pond (NF02ZM0135), and in Quidi Vidi Lake (NF02ZM0164) (Table 4). The triplicate sample of PAHs and metals in Quidi Vidi Lake (NF02ZM0164) were satisfactory in concentrations. Most of the variables were within the 10 percent range and only a few PAHs produced one of the three samples outside this range. In these cases the environmental concentration were based on the two closest.

In the Kent's Pond triplicate, NF02ZM0135, the metals were acceptable and the PAHs produced two samples within 10 percent concentration agreement and the other sample was 10 times higher. The reason for this difference is unknown but a dilution problem is suspected. Because of the difference, the PAHs concentrations were based on two samples.

4.2 Blank and Spiked Samples - Surface Water - Routine Analysis

Field and laboratory spikes and blanks were used for the analysis of major ions and metals. Blanks consist of distilled water where one is transported to the field and the other is left in the laboratory. The spike is similar except known amounts of major ions and metals are added. These Q.C. samples should verify if bottles have been contaminated, and also the cleanliness of bottles.

Table 11 shows the results of the analysis. The laboratory and trip spike produced concentrations either identical or within an acceptable range. This indicates that the variables were not adversely affected by the travel and conditions of the field work. The blank samples also produced identical concentrations except for conductance and dissolved organic carbon. The conductance was 1.0 μSie/cm in the laboratory sample and 6.1 in the trip or field sample. The only other variable not in agreement was DOC which was 1.2 mg/L in the trip blank and less than 0.5 in the laboratory blank. The DOC must have caused the increase in conductance and the only explanation would be a problem with the distilled water or a filter which let a small amount of DOC through the system. Overall the samples indicate that contamination and breakdown of variables is a insignificant problem.

4.3 Blanks - Surface Water - Organic Analysis

The blank sample consists of distilled laboratory water. This sample is used to determine contamination. Sample NFO2ZM0163 (Table 3) produced all concentrations below the analytical detection limit which indicates the absence of a contamination problem.

5.0 CONCLUSION

Surface Water:

Surface water concentrations of routine variables were low at the background station in Left Pond (NF02ZM0151), while metals and organic parameters were at or below analytical detection limits. Water quality deteriorates in other parts of the watershed. Major ions show considerable increases compared to the background station and are frequently one to two orders of magnitude higher. Increases in sodium and chloride are related to road salting and continuous leachate throughout the year.

Elevated nutrient and faecal concentrations throughout the system are related to storm and sewage runoff. Recreational guidelines for faecal bacteria were exceeded at only two locations, but other reports have indicated much more extensive bacterial contamination (Pomeroy and Collins 1990).

Metals concentrations are frequently below detection limits throughout the watershed and those metals which are detected are generally similar to background concentrations. Organic compounds are generally below detection limits.

Sediment:

PAHs and PCBs at the background station were generally the lowest in the survey and were below available guidelines.

Quidi Vidi Lake contained the highest concentrations of PAHs in the survey. The concentrations of most of the high molecular weight compounds are one order of magnitude above guidelines used for dredge disposal in Puget Sound (MacDonald et al. 1992). Although the PAHs are above guidelines, the compounds are quickly metabolized and eliminated by organisms. PAHs were also high in Leary's Pond. Most of these measurements were also above aquatic life protection guidelines. PAHs in Long Pond were lower than Leary's Pond, but were still above guidelines. PAHs in Kent's Pond and Virginia Lake were similar, with only a few compounds above guidelines in Virginia Lake. Contaminant sources are likely emissions from home heating systems and car exhaust.

Elevated concentrations of PCBs in relation to other surveyed sites were observed at Long Pond and Leary's Pond. The highest concentrations were measured at Long Pond. PCBs were elevated at Quidi Vidi Lake as well, but were one to two orders of magnitude lower than Long Pond.

Most metal concentrations at the background station were also generally the lowest in the survey. Metals such as chromium, copper, zinc, cadmium and lead were elevated throughout other areas of the watershed. Quidi Vidi Lake contained some of the highest metal's concentrations. Long Pond, Virginia Lake, and Kent's Pond generally contained lower concentrations than Quidi Vidi Lake. Some guidelines for metals in sediment were exceeded at every station in the watershed. Galvanized culverts, storm runoff, and sewage are likely sources of metals.

Biota:

Forage fish and brown trout samples were collected in both Rennies River and Virginia River. The forage fish samples contained higher concentrations of organic contaminants and metals in comparison to the brown trout. The reasons for the difference is that the analyses of forage fish included the whole body whereas in brown trout only muscle tissue was analyzed. Also, forage fish feed and live in shallow water which tend to be a sink for contaminants.

No guidelines exist to assess the health risks associated with contaminants in fish in a survey such as the current Quidi Vidi Survey. (There does exist a set of Canadian Guidelines for several Chemical Contaminants in Fish and Fish Products. Sampling is based on a minimum of five units which are representative of a lot, and results from this survey may not be applicable to this criteria). However, none of these guidelines were exceeded in this survey.

Most PAH compounds in fish were below analytical detection limits. Naphthalene, fluoranthene, phenanthrene, acenaphthene, pyrene, and anthracene were the only compounds consistently detected.

Some of the results suggest that contaminants in sediment may be bioavailable for forage fish. Availability of contaminants is likely a function of concentration of contaminant in the sediment and location of forage fish in relation to the sediment. The highest concentrations of PAHs were generally observed in forage fish caught in Quidi Vidi Lake. Quidi Vidi Lake also contained the highest concentration of PAH in sediment (the high concentration of contaminants in fish in Quidi Vidi Lake may have been due to local point sources as the forage fish probably do not inhabit the deep areas where the sediment was collected). The highest concentrations of metals in forage fish were observed in Quidi Vidi Lake and Virginia Lake. Quidi Vidi Lake contained the highest concentrations of metals in sediment. Concentrations of metals in sediment in Quidi Vidi Lake exhibit a gradient with the concentrations decreasing from east to west. Contaminants in forage fish from the lake also show the same concentration gradient.

High concentrations of PAHs were also observed in forage fish in Long Pond, where PAH concentrations were also elevated. The highest concentrations of PCBs were observed in forage fish from Long Pond, the site of the highest PCB in sediment concentrations.

Sediment/forage fish tissue concentration relationships were also observed in different locations in the same lake. High concentrations of PAHs and metals in sediment at the inlet of Long Pond, compared to the outlet, corresponded with high concentrations of PAHs and metals in forage fish samples from the inlet of Long Pond. Organic contaminants were higher in sediment at the inlet of Virginia Lake compared to the outlet. The forage fish from the lake showed the same pattern of higher concentrations at the inlet compared to the outlet.

Metal concentrations in forage fish are generally comparable to results from an unpublished study by Bailey (1995 Unpublished data).

Brown trout, unlike forage fish, are much more mobile and tend to travel throughout various parts of the watershed. All samples of brown trout were captured in flowing water where sediment samples were not collected. Therefore, it is difficult to establish relationships between contaminant concentrations in sediment and contaminant concentrations in brown trout.

The highest concentration of organic contaminants in brown trout was observed at stations ZM0157 and ZM0158 on Rennies River. ZM0157 is located downstream of Kellys Brook, and ZM0158 located adjacent to another major outfall. These outfalls have often been implicated in gasoline and oil spills. The lowest organic compound concentrations were observed in brown trout at a station just upstream of this area.

Metals concentrations were generally elevated compared to results reported for salmonoids from lakes in Labrador (Lockerbie, 1987).

6.0 RECOMMENDATIONS

Future studies should investigate the following:

1) Analysis of dissolved heavy metals during high and low discharge to determine the concentration of variables becoming redissolved and bioavailable and to determine the loadings to the Harbour.

2) Conduct a study on the effects of contaminants present in bottom sediments, benthic communities and bottom dwelling fish in selected watersheds.

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TABLE 1

LIST OF STATIONS SAMPLED DURING THE 1993

QUIDI VIDI BASIN RECURRENT SURVEY

	STATION #	DESCRIPTION
1.	00NF02ZM0014	Lat. 47°35'02" Long. 52°41'29" Virginia River 30 m upstream of the Boulevard Bridge near outlet into Quidi Vidi Lake, St. John's
2.	00NF02ZM0015	Lat. 47°35'02" Long. 52°40'51" Quidi Vidi Lake outlet from the Boulevard Bridge, St. John's
3.	01NF02ZM0135	Lat. 47°35'23" Long. 52°43'31" Kent's Pond 10 m above pond's outlet, St. John's
4.	01NF02ZM0139	Lat. 47°34'50" Long. 52°43'58" Long Pond, 10 m below Nagles Hill Brook inlet to pond, St. John's
5.	01NF02ZM0148	Lat. 47°35'45" Long. 52°41'51" Virginia River, 100 m below Logy Bay Road, St. John's
6.	01NF02ZM0151	Lat. 47°34'54" Long. 52°45'58" Left Pond at Midpoint at Pond's Widest Section
7.	01NF02ZM0152	Lat. 47°34'16" Long. 52°44'25" Pond in front of the Memorial University Health Science Centre
8.	01NF02ZM0153	Lat. 47°34'37" Long. 52°44'15" Long Pond, 30 m East of Leary's Brook inlet, St. John's
9.	01NF02ZM0154	Lat. 47°34'37" Long. 52°44'04" Long Pond, on Southerly Shore - 250 m East of Confluence of Rennies River, St. John's
10.	01NF02ZM0155	Lat. 47°34'44" Long 52°44'00" Long Pond, Northshore 75 m west of Nagles Hill Brook
11.	01NF02ZM0156	Lat. 47°35'12" Long. 52°43'44" Kent's Pond, on Southerly Shore, 50 m East of Outflow to Rennies River, St. John's

12.	00NF02ZM0157	Lat. 47°34'31" Long. 52°42'16" Rennies River, 100 m Upstream of Kings Bridge Road, St. John's
13.	00NF02ZM0158	Lat. 47°34'38" Long. 52°42'12" Rennies River, at Walking Bridge - 200 m above confluence with Quidi Vidi Lake, St. John's
14.	01NF02ZM0159	Lat. 47°36'20" Long. 52°42'17" Virginia Lake, 300 m East of Virginia River Inlet at Mid-point in Southern Basin, St. John's
15.	01NF02ZM0160	Lat. 47°36'34" Long. 52°41'56" Virginia Lake, at Mid-point in the Lake's Northern Basin, St. John's
16.	01NF02ZM0161	Lat. 47°36'14" Long. 52°42'15" Virginia Lake, at the Outlet flowing to Virginia River above Concrete Dam
17.	01NF02ZM0162	Lat. 47°36'38" Long. 52°41'56" Virginia Lake, on the North Shore of the Northern Basin Opposite the Neck of Land in the Centre of the Lake
18.	00NF02ZM0163	Lat. 47°34'44" Long. 52°41'53" Quidi Vidi Lake, 300 m from the Inlet from Rennies River at Midpoint
19.	00NF02ZM0164	Lat. 47°34'49" Long. 52°41'43" Quidi Vidi Lake, 500 m below Rennies River inlet at the Lake's Mid-point - Slightly below the Boat House located on the South Shore
20.	00NF02ZM0165	Lat. 47°34'51" Long. 52°41'28" Quidi Vidi Lake, 800 m Downstream of Rennies River at Mid-point - Slightly above Virginia River Inlet
21.	00NF02ZM0166	Lat. 47°35'00" Long. 52°41'10" Quidi Vidi Lake, 1300 m Downstream of Rennies River Inlet at Lake Mid-point Opposite South Cover before Lake's outflow
22.	00NF02ZM0167	Lat. 47°34'41" Long. 52°42'02" Quidi Vidi Lake, at Shoreline at Western End of Lake 50 m North of Confluence of Rennies River, St. John's

23.	01NF02ZM0168	Lat. 47°34'52" Long. 52°41'48" Quidi Vidi Lake, on Northerly Shore across Lake from Large Boathouse, St. John's
24.	01NF02ZM0169	Lat. 47°34'58" Long. 52°41'24" Quidi Vidi Lake, on Northerly Shore 50 m East of Confluence of Virginia River, St. John's
25.	01NF02ZM0170	Lat. 47°35'03" Long. 52°40'56" Quidi Vidi Lake, at Easterly Shore 50 m North of Outlet, St. John's
26.	01NF02ZM0171	Lat. 47°34'44" Long. 52°41'41" Quidi Vidi Lake, along South Shore 100 metres East of the Boathouse
27.	01NF02ZM0172	Lat. 47°34'53" Long. 52°41'05" Quidi Vidi Lake, on Southerly Shore at Cove, 1 km East of Boathouse
28.	00NF02ZM0173	Lat. 47°34'44" Long. 52°43'40" Rennies River, approximately 100 m below Long Pond, St. John's

TABLE 2
SURFACE WATER QUALITY DATA FROM THE 1993 QUIDI VIDI BASIN
INTENSIVE SURVEY REPORT

STATION NUMBER	SAMPLE DATE	APPARENT COLOUR REL. UNITS	SPECIFIC CONDUCTANCE USIE/CM	TURBIDITY JT UNITS	DISSOLVED ORG. CARBON MG/L	NITRATE UNFILTERED MG/L	TOTAL NITROGEN MG/L	ALKALINITY GRAN MG/L	PH PH UNITS
LEFT PD									
NF02ZM0151	25-AUG-93	5	31	0.4	3.2	L .0100	0.11	0.7	6.0
LEARY'S BK									
NF02ZM0152	26-AUG-93	15	209	1.1	3.4	0.08	0.40	6.1	6.5
LONG PD									
NF02ZM0153	25-AUG-93	30	230	0.8	4.0	0.04	0.42	7.3	6.6
NF02ZM0139	25-AUG-93	25	229	0.6	3.6	0.04	0.33	7.2	6.6
KENT'S PD									
NF02ZM0135	25-AUG-93	10	568	0.9	3.1	L .0100	0.21	16.5	7.2
NF02ZM0135	25-AUG-93	5	569	0.9	2.8	L .0100	0.21	16.5	7.2
NF02ZM0135	25-AUG-93	5	568	0.9	3.0	L .0100	0.20	16.3	7.2
VIRGIN LK									
NF02ZM0160	26-AUG-93	15	233	0.7	3.9	0.06	0.41	13.0	6.9
NF02ZM0159	26-AUG-93	10	242	1.8	4.0	0.06	0.37	12.8	6.9
QUIDI V LK									
NF02ZM0163	24-AUG-93	15	351	1.2	3.4	0.50	0.56	13.5	7.0
NF02ZM0164	24-AUG-93	20	351	1.3	3.2	0.50	0.59	13.5	7.1
NF02ZM0164	24-AUG-93	20	352	1.3	3.5	0.44	0.59	13.5	7.0
NF02ZM0164	24-AUG-93	15	349	1.2	3.2	0.47	0.64	13.5	7.0
NF02ZM0165	24-AUG-93	35	351	1.2	3.6	0.46	0.55	13.7	7.1
NF02ZM0166	24-AUG-93	30	351	1.2	3.2	0.46	0.55	13.5	7.1

TABLE 2

SURFACE WATER QUALITY DATA FROM THE 1993 QUIDI VIDI BASIN INTENSIVE SURVEY REPORT

DISSOLVED SODIUM MG/L	DISSOLVED MAGNESIUM MG/L	EXTRACT ALUMINUM MG/L	SILICA MG/L	TOTAL PHOSPHORUS MG/L	DISSOLVED SULPHATE MG/L	DISSOLVED CHLORIDE MG/L	DISSOLVED POTASSIUM MG/L	DISSOLVED CALCIUM MG/L	EXTRACT MANGANESE MG/L	EXTRACT IRON MG/L
4.2	0.37	0.072	0.27	0.005	3.1	6.1	0.18	0.8	0.02	0.06
36.0	0.79	0.083	3.30	0.020	6.2	50.0	0.90	4.3	0.16	0.48
39.0	0.98	0.062	2.40	0.016	5.9	60.0	0.84	4.8	0.19	0.68
39.0	0.98	0.063	2.20	0.015	6.1	55.0	0.86	4.4	0.18	0.65
103.0	2.20	0.010	1.60	0.011	10.0	169.0	1.70	9.9	0.03	0.54
101.0	2.10	0.010	1.60	0.012	9.8	150.0	1.80	10.0	0.03	0.52
102.0	2.00	0.010	1.60	0.008	9.8	150.0	1.80	10.0	0.03	0.54
36.0	1.80	0.057	0.32	0.023	8.6	60.0	1.20	6.5	0.18	0.19
39.0	1.70	0.083	0.55	0.029	9.1	60.0	1.20	7.0	0.15	0.29
61.0	1.60	0.025	0.24	0.011	9.6	85.0	1.30	8.1	0.15	0.48
60.0	1.70	0.025	0.13	0.006	8.0	85.0	1.30	8.3	0.14	0.45
60.0	1.70	0.024	0.17	0.010	9.2	92.0	1.30	8.6	0.13	0.44
60.0	1.70	0.026	0.29	0.010	9.2	92.0	1.20	8.6	0.13	0.45
62.0	1.70	0.026	0.24	0.010	9.2	92.0	1.30	8.8	0.11	0.41
61.0	1.70	0.023	0.17	0.010	9.2	93.0	1.30	8.6	0.12	0.38

TABLE 2
SURFACE WATER QUALITY DATA FROM THE 1993 QUIDI VIDI BASIN
INTENSIVE SURVEY REPORT

EXTRACT COPPER MG/L	EXTRACT ZINC MG/L	TOTAL ARSENIC MG/L	TOTAL COLIFORM No./100ML	FECAL COLIFORM No./100ML	EXTRACT CADMIUM MG/L	EXTRACT MERCURY UG/L	EXTRACT LEAD MG/L
L .0020	L .0100	L .0005	140	L10	L .0010	L .0200	L .0020
0.005	0.03	L .0005	G1600	G600	L .0010	L .0200	L .0020
0.003	0.02	L .0005	780	150	L .0010	L .0200	L .0020
0.003	0.01	L .0005	960	90	L .0010	L .0200	L .0020
L .0020	L .0100	L .0005	400	80	L .0010	L .0200	L .0020
L .0020	L .0100	L .0005	320	10	L .0010	L .0200	L .0020
L .0020	L .0100	L .0005	260	120	L .0010	L .0200	L .0020
0.002	L .0100	L .0005	640	L10	L .0010	L .0200	L .0020
L .0020	0.01	L .0005	1580	140	L .0010	L .0200	L .0020
0.003	0.01	L .0005	840	220	L .0010	L .0200	L .0020
0.003	0.01	L .0005	920	130	L .0010	L .0200	L .0020
0.003	0.01	L .0005			L .0010	L .0200	L .0020
0.003	0.01	L .0005			L .0010	L .0200	L .0020
0.003	0.01	L .0005	640	60	L .0010	L .0200	L .0020
0.003	0.01	L .0005	640	100	L .0010	L .0200	L .0020

TABLE 3

SURFACE WATER CONCENTRATIONS (UG/L) OF PAH'S - POLYNUCLEAR AROMATIC HYDROCARBONS IN THE 1993 QUIDI VIDI BASIN INTENSIVE SURVEY REPORT

STATION NUMBER	SAMPLE DATE	NAPHTHA LENE UG/L	1-ACE NAPTHTENE UG/L	FLUOR ENE UG/L	PHENAN THRENE UG/L	FLUOR ANTHENE UG/L	BENZO(B) FLUORAN THENE UG/L	BENZO(K) FLUORAN THENE UG/L
LEFT PD								
NF02ZM0151	25-AUG-93	L .0290	L .0100	L .0090	0.006	L .0030	L .0012	L .0006
LEARY'S BK								
NF02ZM0152	26-AUG-93	L .0300	L .0110	0.013	L .0080	0.003	0.0013	L .0007
LONG PD								
NF02ZM0153	25-AUG-93	L .0280	L .0100	L .0070	L .0080	L .0030	L .0014	L .0007
NF02ZM0139	25-AUG-93	L .0210	L .0080	L .0080	L .0050	L .0020	L .0009	L .0005
KENTS PD								
NF02ZM0135	25-AUG-93	L .0190	L .0070	L .0070	L .0050	L .0020	L .0008	L .0040
NF02ZM0135	25-AUG-93	L .0190	L .0070	L .0070	L .0050	L .0020	L .0009	L .0005
NF02ZM0135	25-AUG-93	L .0200	L .0070	L .0070	L .0050	L .0020	L .0008	L .0004
VIRGIN LK								
NF02ZM0160	26-AUG-93	L .0210	L .0070	L .0070	L .0050	L .0020	L .0009	L .0005
NF02ZM0159	26-AUG-93	L .0200	L .0070	L .0070	L .0050	L .0020	L .0008	L .0004
QUIDI V LK								
NF02ZM0163	24-AUG-93	L .0280	L .0100	0.006	L .0070	0.002	L .0012	L .0006
NF02ZM0164	24-AUG-93	L .0240	L .0080	L .0070	L .0060	L .0020	0.0010	L .0005
NF02ZM0165	24-AUG-93	L .0270	L .0100	L .0080	L .0070	0.002	0.0008	0.0005
NF02ZM0166	24-AUG-93	L .0270	L .0100	L .0080	L .0070	L .0020	L .0011	L .0004
TRIP BLK								
NF02ZM0163	24-AUG-93	L .0210	L .0070	L .0070	L .0060	L .0020	L .0008	L .0004

TABLE 3

SURFACE WATER CONCENTRATIONS (UG/L) OF PAH'S - POLYNUCLEAR AROMATIC HYDROCARBONS IN THE 1993 QUIDI VIDI BASIN INTENSIVE SURVEY REPORT

BENZO(GHI) PERYLENE UG/L	ANTHRA CENE UG/L	BENZO(A) ANTHRA CENE UG/L	DIBENZO(AH) ANTHRACENE UG/L	PYRENE UG/L	BENZO(A) PYRENE UG/L	INDENO (123-CD) PYRENE UG/L
L .0070	L .0280	L .0020	L .0024	L .0040	L .0012	L .0060
L .0070	L .0300	L .0020	L .0026	0.0080	L .0013	L .0070
L .0080	L .0330	L .0020	L .0029	L .0050	L .0013	L .0080
L .0050	L .0200	L .0010	L .0020	L .0030	L .0009	L .0050
L .0050	L .0180	L .0010	L .0018	L .0030	L .0008	L .0050
L .0050	L .0180	L .0010	L .0020	L .0030	L .0009	L .0050
L .0050	L .0190	L .0010	L .0020	L .0030	L .0008	L .0050
L .0050	L .0200	L .0010	L .0019	L .0030	L .0009	L .0050
L .0050	L .0190	L .0010	L .0018	L .0030	L .0008	L .0050
L .0070	L .0028	L .0020	L .0024	0.0090	L .0012	L .0060
L .0050	0.021	L .0010	L .0018	0.0086	L .0009	L .0050
L .0060	L .0270	L .0020	L .0024	0.0070	0.0007	L .0060
L .0060	0.014	L .0020	L .0024	0.0060	L .0008	L .0060
L .0050	L .0190	L .0010	L .0018	L .0030	L .0008	L .0050

TABLE 4
CONCENTRATIONS OF PAHS - POLYNUCLEAR AROMATIC HYDROCARBONS (NG/G)
AND PCB'S - POLYCHLORINATED BIPHENYLS (NG/G) IN SEDIMENT PLUS THE
PERCENTAGES OF SEDIMENT SIZE, AND ORGANIC CONTENT FROM SAMPLES
COLLECTED FOR THE 1993 QUIDI VIDI BASIN INTENSIVE SURVEY REPORT

STATION	SAMPLE DATE	NAPHTH ALENE	FLUOR ANTHENE	PHEN ANTH RENE	1 ACE NAPH THENE	BENZO(B) FLUORAN THENE	BENZO(K) FLUORAN THENE	BENZO(A) PYRENE	BENZO(A) ANTHRA CENE	DIBENZO (AH) CENE	ANTHRA	FLUOR ENE
1 LEFT PD												
2 NF02ZM0151	25-AUG-93	25	337	135	7	265	88	145	93		0	13
3 LEARY'S PD												
4 NF02ZM0152	26-AUG-93	37	3013	1237	101	1445	851	1463	779		236	145
5 LONG PD												
6 NF02ZM0153	25-AUG-93	24	1133	570	29	1093	532	1065	511		0	43
7 NF02ZM0139	25-AUG-93	22	1063	533	21	804	458	796	505		164	40
8 KENT'S PD												
9 NF02ZM0135	25-AUG-93	26	906	580	39	1137	268	427	572		84	63
10 NF02ZM0135	25-AUG-93	22	800	503	33	1034	250	435	584		447	54
11 NF02ZM0135	25-AUG-93	21	748	461	34	663	272	401	363		87	55
12 VIRGIN LK												
13 NF02ZM0159	26-AUG-93	20	608	403	38	392	215	351	267		0	49
14 NF02ZM0160	27-AUG-93	12	240	98	7	165	40	96	78		27	11
15 QUIDI V LK												
16 NF02ZM0163	24-AUG-93	127	7258	3745	335	4266	1771	-34	2674		605	456
17 NF02ZM0164	24-AUG-93	112	4353	2196	238	2647	1282	1788	1608		450	347
18 NF02ZM0164	24-AUG-93	150	4498	2300	302	3122	1439	-25	1670		601	401
19 NF02ZM0164	24-AUG-93	135	4453	2207	283	2900	1576	-25	1480	**in**		398
20 NF02ZM0165	24-AUG-93	-	3954	2043	-	2405	945	1410	1285	-		-
21 NF02ZM0166	24-AUG-93	-	1780	850	-	1585	705	1020	730	-		-

TABLE 4
CONCENTRATIONS OF PAHS - POLYNUCLEAR AROMATIC HYDROCARBONS (NG/G) AND PCB'S - POLYCHLORINATED BIPHENYLS (NG/G) IN SEDIMENT PLUS THE PERCENTAGES OF SEDIMENT SIZE, AND ORGANIC CONTENT FROM SAMPLES COLLECTED FOR THE 1993 QUIDI VIDI BASIN INTENSIVE SURVEY REPORT

STATION	PYRENE	BENZO(GH I) PERY LENE	INDENO(12 3-CD) PYRENE	CHRY SENE	ANTHRA CENE	PERY LENE	BENZO(E) PYRENE	AROCLOR	TOTAL INORG CARBON %	PARTIC ORGANIC CARBON %	PARTIC ORGANIC NITORGEN %
1 LEFT PD											
2 NF02ZM0151	374	173	179	148	14	136	134	30.00			
3 LEARY'S PD											
4 NF02ZM0152	2231	1164	1183	1176	281	414	1441	4480.00	0.64	7.16	0.50
5 LONG PD											
6 NF02ZM0153	1456	917	851	847	69	475	830	9580.00	0.01	8.12	0.58
7 NF02ZM0139	997	746	708	666	83	1436	718	12640	0.15	6.69	0.53
8 KENT'S PD											
9 NF02ZM0135	902	247	426	394	69	99	244	140.00			
10 NF02ZM0135	862	313	306	373	63	133	329	290.00			
11 NF02ZM0135	866	142	402	430	69	188	452	110.00			
12 VIRGIN LK											
13 NF02ZM0159	443	315	327	348	72	221	343	640.00	0.47	5.91	0.60
14 NF02ZM0160	227	113	79	114	16	1211	89	180.00	0.02	8.88	0.86
15 QUIDI V LK											
16 NF02ZM0163	6739	3325	2567	3372	745	1041	-32	570.00	1.13	7.95	0.52
17 NF02ZM0164	4348	-25	-20	2187	488	839	1849	910.00	0.21	8.28	0.54
18 NF02ZM0164	4480	183	2446	2223	539	-23	-24	830.00	0.26	8.40	0.56
19 NF02ZM0164	4390	216	-20	2060	391	-23	-24	450.00	0.43	8.20	0.53
20 NF02ZM0165	3390	1415	1540	1820	390	531	1400	1120.00	0.35	6.94	0.51
21 NF02ZM0166	1840	1150	1230	1040	-	394	892	1140.00	0.31	6.53	0.48

TABLE 4

CONCENTRATIONS OF PAHS - POLYNUCLEAR AROMATIC HYDROCARBONS (NG/G) AND PCB'S - POLYCHLORINATED BIPHENYLS (NG/G) IN SEDIMENT PLUS THE PERCENTAGES OF SEDIMENT SIZE, AND ORGANIC CONTENT FROM SAMPLES COLLECTED FOR THE 1993 QUIDI VIDI BASIN INTENSIVE SURVEY REPORT

STATION	SEDIMENT SIZE-SAND (%)	SEDIMENT SIZE-SILT (%)	SEDIMENT SIZE-CLAY (%)
1 LEFT PD			
2 NF02ZM0151			
3 LEARY'S PD			
4 NF02ZM0152	39.6	52.7	7.7
5 LONG PD			
6 NF02ZM0153	17.8	58.6	23.6
7 NF02ZM0139	22.8	49.2	28.0
8 KENT'S PD			
9 NF02ZM0135			
10 NF02ZM0135			
11 NF02ZM0135			
12 VIRGIN LK			
13 NF02ZM0159			
14 NF02ZM0160	6.0	65.6	28.4
15 QUIDI V LK			
16 NF02ZM0163	14.0	67.7	18.3
17 NF02ZM0164			
18 NF02ZM0164			
19 NF02ZM0164			
20 NF02ZM0165			
21 NF02ZM0166	5.0	59.0	36.0

TABLE 5
CONCENTRATIONS OF NONRESIDUAL AND TOTAL METALS (MG/KG) IN SEDIMENT FROM THE 1993 QUIDI VIDI BASIN INTENSIVE SURVEY REPORT

STATION NO	SAMPLE DATE	SAMPLE TIME	NONRESID ALUMINUM	NONRESID CHROMIUM	NONRESID MANGANESE	NONRESID IRON	NONRESID NICKEL	NONRESID COPPER	NONRESID ZINC	NONRESID ARSENIC
LEFT PD										
NF02ZM0151	25-AUG-93	1210	21600	3.4	3760	20000	14	22	76	0.95
LEARY'S BK										
NF02ZM0152	26-AUG-93	1000	11600	30.3	1200	20000	14	136	600	0.91
LONG PD										
NF02ZM0153	25-AUG-93	925	12400	15.4	810	26000	11	104	550	0.83
NF02ZM0139	25-AUG-93	1030	12880	11.6	1600	30000	11	73	510	0.90
KENTS PD										
NF02ZM0135	25-AUG-93	1400	11200	12.3	3920	26000	26	96	730	1.70
NF02ZM0135	25-AUG-93	1405	10840	8.6	4000	26000	26	101	710	1.50
NF02ZM0135	25-AUG-93	1410	10640	8.6	4000	27000	25	100	690	1.70
QUIDI V LK										
NF02ZM0163	24-AUG-93	1300	9240	32.7	640	39000	14	164	720	0.98
NF02ZM0164	24-AUG-93	1400	11200	32.5	770	35000	14	128	710	0.95
NF02ZM0164	24-AUG-93	1405	11120	30.9	790	36000	15	132	710	0.89
NF02ZM0164	24-AUG-93	1410	10800	28.8	820	35000	15	136	720	1.00
VIRGIN LK										
NF02ZM0160	27-AUG-93	1140	11640	11.3	5200	30000	11	22	420	0.91
NF02ZM0159	26-AUG-93	1115	11000	14.5	2000	26000	10	32	490	0.87
QUIDI V LK										
NF02ZM0165	24-AUG-93	1550	12000	21.2	870	26000	15	104	880	1.00
NF02ZM0166	24-AUG-93	1615	12720	18.8	930	27000	15	98	740	0.91

TABLE 5

CONCENTRATIONS OF NONRESIDUAL AND TOTAL METALS (MG/KG) IN SEDIMENT FROM THE 1993 QUIDI VIDI BASIN INTENSIVE SURVEY REPORT

NONRESID CADMIUM		TOTAL MERCURY	NONRESID LEAD
0.8		0.02	128
2.4	L	.0200	200
2.2		0.02	380
1.5		0.03	250
3.6	L	.0200	410
3.4	L	.0200	340
2.9	L	.0200	360
2.2	L	.0200	410
1.9	L	.0200	470
2.0		0.02	420
2.0	L	.0200	440
0.7	L	.0200	110
0.9	L	.0200	90
2.1		0.02	360
1.6		0.02	370

TABLE 6

THE CONENTRATIONS OF PAH's - POLYNUCLEAR AROMATIC HYDROCARBONS (NG/G) AND THE LIPID PERCENTAGE IN FORAGE FISH AND BROWN TROUT COLLECTED FOR THE 1993 QUIDI VIDI BASIN INTENSIVE SURVEY REPORT

STATION NUMBER	FISH TYPE	NUMBER IN SAMPLE	LENGTH cm	WEIGTH	AGE ESTIMATED	SAMPLE DATE	NAPHTH ALENE	FLUORAN THENE	PHENAN THRENE
1 LONG PD	FORAGE F								
2 NF02ZM0154		75	2-5			25-AUG-93	2.700	12.700	26.200
3 NF02ZM0155		75	1-3			25-AUG-93	1.580	4.500	3.620
4 RENNIE R	BRWN TROUT								
5 NF02ZM0173		1	30.5	306.1	3+	06-OCT-93	2.200	0.417	1.400
6 NF02ZM0173		2	25/24	190/183	4+	06-OCT-93	1.190	0.554	1.620
7 NF02ZM0173		2	24/24.5	130/161	4+	06-OCT-93	0.840	L .5630	1.990
8 NF02ZM0173		1	27.0	250.0	4+	06-OCT-93	0.911	L .6510	1.230
9 NF02ZM0173		2	26/24	180/148	4+	06-OCT-93	0.839	L .6030	1.190
10 NF02ZM0173		3	23/21/20.5	131/105/101		06-OCT-93	3.410	1.120	2.400
11 KENTS PD	FORAGE F								
12 NF02ZM0156		200	2-5			25-AUG-93	0.293	3.140	5.250
13 RENNIES R	BRWN TROUT								
14 NF02ZM0157		1	33.0	374.0		26-AUG-93	6.930	0.617	2.650
15 NF02ZM0157		1	39.0	657.0		26-AUG-93	263.000	2.770	10.200
16 RENNIES R	BRWN TROUT								
17 NF02ZM0158		1	32.0	372.0		26-AUG-93	37.300	2.350	5.370
18 NF02ZM0158		1	28.0	249.0		26-AUG-93	36.200	2.950	4.870
19 NF02ZM0158		1	27.0	239.0		26-AUG-93	37.500	5.590	14.000
20 NF02ZM0158		1	34.5	418.0		26-AUG-93	14.800	2.410	5.880
21 VIRGIN LK	FORAGE F								
22 NF02ZM0162		65	4-5			26-AUG-93	0.923	0.710	0.527
23 NF02ZM0161		65	4-5			26-AUG-93	0.923	1.890	1.960
24 VIRGIN R	BRWN TROUT								
25 NF02ZM0148		1	27.0	224.0	5+	25-AUG-93	4.140	0.935	1.750
26 NF02ZM0148		2	25.5/24.5	166/164	3+/3+	25-AUG-93	8.360	2.040	3.590
27 NF02ZM0148		2	25.5/27.5	173/185		25-AUG-93	4.810	1.180	2.870
28 NF02ZM0148		2	26.5/24.5	158/148		25-AUG-93	4.680	1.150	2.510
29 VIRGIN R	BRWN TROUT								
30 NF02ZM0014		1	36.5	504.0	4+	25-AUG-93	3.330	1.410	5.730
31 NF02ZM0014						25-AUG-93	3.380	0.615	6.600
32 NF02ZM0014		1	33.0	365.0	5+	25-AUG-93	4.120	L .7360	5.740
33 NF02ZM0014		2	28/28	225/226	4+/3+	25-AUG-93	2.910	1.870	4.140
34 NF02ZM0014		2	27/28	191/188		25-AUG-93	2.500	L 1.3100	2.160
35 QUIDI V LK	FORAGE F								
36 NF02ZM0167		75	4-5			24-AUG-93	7.720	7.490	5.080
37 NF02ZM0167		75	4-5			24-AUG-93	5.240	7.210	5.610
38 NF02ZM0167		75	4-5			24-AUG-93	3.990	5.920	3.750

TABLE 6
THE CONENTRATIONS OF PAH's - POLYNUCLEAR AROMATIC HYDROCARBONS (NG/G) AND THE LIPID PERCENTAGE IN FORAGE FISH AND BROWN TROUT COLLECTED FOR THE 1993 QUIDI VIDI BASIN INTENSIVE SURVEY REPORT

STATION NUMBER	ACENAPH THENE	BENZO(B) FLUORAN THENE	BENZO(K) FLUORAN THENE	BENZO(A) PYRENE	BENZO(A) ANTHRA CENE	DIBENZO(A H) ANTHRA CENE	DIBENZO(A, H) ANTHRA CENE	FLUORENE
1 LONG PD								
2 NF02ZM0154	5.410	L 1.8900	L 1.8800	L 1.8900	L 2.0600	L1.82	L 1.8200	6.38
3 NF02ZM0155	L 1.7500	L 1.3300	L 1.3200	L 1.3300	L 1.4600	L1.28	L 1.2800	L 1.7700
4 RENNIE R								
5 NF02ZM0173	L .6750	L .4580	L .4610	L .4570	L .4660	L.383	L .3830	L .6280
6 NF02ZM0173	L .6410	L .4860	L .4890	L .4860	L .4670	L.407	L .4070	L .5960
7 NF02ZM0173	L .9480	L .6600	L .6640	L .6600	L .7150	L.553	L .5530	L .8820
8 NF02ZM0173	L 1.0900	L .7840	L .7890	L .7830	L .7780	L.656	L .6560	L 1.0100
9 NF02ZM0173	L .9350	L .7040	L .7080	L .7030	L .7100	L.589	L .5890	L .8700
10 NF02ZM0173	1.650	L .7470	L .7510	L .7460	L .7340	L.625	L .6250	L .9150
11 KENTS PD								
12 NF02ZM0156	2.450	L 1.2400	L 1.2300	L 1.2500	L 1.2800	L1.2	L 1.2000	L 1.5300
13 RENNIES R								
14 NF02ZM0157	3.800	L .7430	L .7470	L .7420	L .7460	0.763	0.763	4.66
15 NF02ZM0157	17.900	L .4230	L .4250	L .4220	L .4550	L.354	L .3540	14.70
16 RENNIES R								
17 NF02ZM0158	8.200	L .5660	L .4840	L .5760	L .5610	L.491	L .4910	5.54
18 NF02ZM0158	7.410	L .5740	L .4910	L .5830	L .5650	L.497	L .4970	5.71
19 NF02ZM0158	22.500	L .4970	L .4250	L .5050	L .5110	L.431	L .4310	16.90
20 NF02ZM0158	7.500	L .6830	L .5850	L .6950	L .6750	L.592	L .5920	4.77
21 VIRGIN LK								
22 NF02ZM0162	L .8120	L .6140	L .5790	L .6380	L .6010	L.575	L .5750	L .7380
23 NF02ZM0161	L .8120	L .6140	L .5790	L .6380	L .6010	L.575	L .5750	L .7380
24 VIRGIN R								
25 NF02ZM0148	0.918	L .4980	L .4670	L .4890	L .5170	L.404	L .4040	1.64
26 NF02ZM0148	2.560	L .4950	L .4650	L .4860	L .5680	L.402	L .4020	2.38
27 NF02ZM0148	0.895	L .5180	L .4850	L .5080	L .5520	L.42	L .4200	2.05
28 NF02ZM0148	0.953	L .5610	L .5260	L .5510	L .5700	L.456	L .4560	1.21
29 VIRGIN R								
30 NF02ZM0014	2.830	L .5630	L .5280	L .5520	L .6280	L.457	L .4570	2.31
31 NF02ZM0014	1.960	L .5920	L .5550	L .5820	L .6910	L.481	L .4810	3.07
32 NF02ZM0014	2.150	L .6320	L .5410	L .6430	L .7220	L.548	L .5480	1.98
33 NF02ZM0014	1.360	L .6700	L .5730	L .6820	L .6250	L.581	L .5810	1.98
34 NF02ZM0014	L 2.4400	L 2.6200	L 2.6400	L 2.6200	L 2.1800	L2.2	L 2.2000	L 2.2700
35 QUIDI V LK								
36 NF02ZM0167	3.100	L .6130	L .5780	L .6370	L .6000	L.574	L .5740	4.22
37 NF02ZM0167	3.150	L .6150	L .5800	L .6390	L .6210	L.575	L .5750	3.67
38 NF02ZM0167	2.400	L .5340	L .5040	L .5550	L .5760	L.5	L .5000	2.79

TABLE 6

THE CONENTRATIONS OF PAH's - POLYNUCLEAR AROMATIC HYDROCARBONS (NG/G) AND THE LIPID PERCENTAGE IN FORAGE FISH AND BROWN TROUT COLLECTED FOR THE 1993 QUIDI VIDI BASIN INTENSIVE SURVEY REPORT

STATION NUMBER	PYRENE	BENZO(GH I)PERY LENE	INDENO(123 CD)PYRENE	CHRYSENE	ANTHRA CENE	AROCLOR	LIPIDS (%)
1 LONG PD							
2 NF02ZM0154	15.400	L 1.6000	L 1.8400	L 1.8200	6.190	2.957	2.67
3 NF02ZM0155	3.190	L 1.1200	L 1.2900	L 1.2800	2.450	2.913	1.67
4 RENNIE R							
5 NF02ZM0173	0.649	L .3690	L .4740	L .4120	0.689	0.199	1.33
6 NF02ZM0173	L .3940	L .3920	L .5030	L .4140	0.469	L.012	1.17
7 NF02ZM0173	0.620	L .5330	L .6830	L .6470	0.680	0.172	1.00
8 NF02ZM0173	L .6610	L .6330	L .8110	L .6750	L .6770	0.100	0.83
9 NF02ZM0173	0.781	L .5680	L .7280	L .6330	L .6280	0.160	1.17
10 NF02ZM0173	1.710	L .6030	L .7730	L .6500	1.650	L.012	0.05
11 KENTS PD							
12 NF02ZM0156	1.280	L 1.0500	L 1.2100	L 1.1700	L 1.1500	L.11	1.50
13 RENNIES R							
14 NF02ZM0157	L .6030	1.1	L .7690	L .6590	1.070	0.225	1.83
15 NF02ZM0157	1.930	L .3410	L .4370	L .4160	3.510	0.101	4.67
16 RENNIES R							
17 NF02ZM0158	0.622	L .4400	L .5390	L .4460	0.870	0.111	3.50
18 NF02ZM0158	1.180	L .4460	L .5460	L .4480	0.849	L.011	3.33
19 NF02ZM0158	1.990	L .3860	L .4730	L .4330	3.570	0.207	3.83
20 NF02ZM0158	0.840	L .5310	L .6510	L .4660	0.626	0.211	3.00
21 VIRGIN LK							
22 NF02ZM0162	L .5000	L .5280	L .6370	L .4780	L .4880	0.346	3.65
23 NF02ZM0161	1.720	L .5280	L .6370	L .4780	L .4880	0.535	2.33
24 VIRGIN R							
25 NF02ZM0148	0.462	L .3860	L .4720	L .3680	1.010	L.011	1.83
26 NF02ZM0148	0.572	L .3850	L .4700	L .4250	1.040	L.01	5.00
27 NF02ZM0148	0.672	L .4020	L .4910	L .3990	0.524	L.011	2.50
28 NF02ZM0148	0.927	L .4350	L .5320	L .3810	0.518	L.011	2.33
29 VIRGIN R							
30 NF02ZM0014	0.701	L .4370	L .5340	L .3740	0.311	0.663	2.50
31 NF02ZM0014	0.559	L .4600	L .5620	L .3700	1.180	1.067	2.67
32 NF02ZM0014	L .4420	L .4910	L .6020	L .4170	0.524	0.184	1.82
33 NF02ZM0014	0.560	L .5210	L .6380	L .4380	0.668	0.096	1.50
34 NF02ZM0014	1.930	L 2.1200	L 2.7100	L 1.9000	2.350	0.320	2.17
35 QUIDI V LK							
36 NF02ZM0167	6.070	L .5270	L .6360	L .4770	2.110	0.138	2.17
37 NF02ZM0167	7.310	L .5290	L .6380	L .5010	2.440	0.147	2.33
38 NF02ZM0167	4.280	L .4600	L .5540	L .4580	1.860	0.253	2.33

TABLE 6

THE CONENTRATIONS OF PAH's - POLYNUCLEAR AROMATIC HYDROCARBONS (NG/G) AND THE LIPID PERCENTAGE IN FORAGE FISH AND BROWN TROUT COLLECTED FOR THE 1993 QUIDI VIDI BASIN INTENSIVE SURVEY REPORT

STATION NUMBER	FISH TYPE	NUMBER IN SAMPLE	LENGTH cm	WEIGTH	AGE ESTIMATED	SAMPLE DATE	NAPHTH ALENE	FLUORAN THENE	PHENAN THRENE
39 NF02ZM0168		150	4-5			24-AUG-93	2.270	6.610	3.230
40 NF02ZM0171		65	4-5			24-AUG-93	5.210	5.100	3.690
41 NF02ZM0169		65	4-5			24-AUG-93	4.890	6.070	3.050
42 NF02ZM0172		65	4-5			24-AUG-93	4.210	3.570	1.900
43 NF02ZM0170		65	4-5			24-AUG-93	3.790	3.090	3.430

STATION NUMBER	ACENAPH THENE	BENZO(B) FLUORAN THENE	BENZO(K) FLUORAN THENE	BENZO(A) PYRENE	BENZO(A) ANTHRA CENE	DIBENZO(A H) ANTHRA CENE	DIBENZO(A. H) ANTHRA CENE	FLUORENE
39 NF02ZM0168	1.050	L .6060	L .5710	L .6300	L .6090	L.567	L .5670	1.49
40 NF02ZM0171	1.170	L .6470	L .6380	L .6740	L .7330	L.619	L .6190	L .8160
41 NF02ZM0169	1.990	L .7340	L .7250	L .7650	L .7420	L.703	L .7030	L .9050
42 NF02ZM0172	L .9120	L .6820	L .6730	L .7110	L .7190	L.653	L .6530	L .8510
43 NF02ZM0170	1.150	L .7190	L .7090	L .7490	L .7210	L.688	L .6880	L .7740

STATION NUMBER	PYRENE	BENZO(GH I) PERY LENE	INDENO(123 CD) PYRENE	CHRYSENE	ANTHRA CENE	AROCLOR	LIPIDS (%)
39 NF02ZM0168	7.320	L .5210	L .6290	L .4940	1.250	0.320	2.00
40 NF02ZM0171	7.650	L .5960	L .7180	L .6290	1.340	L.011	1.67
41 NF02ZM0169	6.220	L .6760	L .8150	L .6260	1.690	0.204	1.50
42 NF02ZM0172	3.730	L .6280	L .7570	L .6100	1.290	0.278	1.99
43 NF02ZM0170	3.910	L .6620	L .7980	L .6060	1.050	0.221	2.17

TABLE 7
THE CONCENTRATIONS OF EXTRACTABLE METALS (MG/kG) IN FORAGE FISH AND BROWN TROUT COLLECTED FOR THE 1993 QUIDI VIDI BASIN INTENSIVE SURVEY REPORT
(INCLUDED: SUMMARY RESULTS OF METALS FOUND IN FORAGE FISH IN ATLANTIC CANADA BY BAILEY (UNPUBLISHED DATA))

	STATION NUMBER	FISH TYPE	NUMBER IN SAMPLE	LENGTH cm	WEIGHT gm	AGE ESTIMATED	SAMPLE DATE		EXTRACT ALUMINUM		EXTRACT CHROMIUM
1	LONG PD	FORAGE F									
2	NF02ZM0154		75	2-5			25-AUG-93		44.12	L	.5000
3	NF02ZM0155		75	1-3			25-AUG-93		74.00	L	.5000
4	RENNIE R	BRWN TROUT									
5	NF02ZM0173		1	30.5	30.5	3+	06-OCT-93	L	5.0000	L	.5000
6	NF02ZM0173		2	25/24	190/183	4+	06-OCT-93	L	5.0000	L	.5000
7	NF02ZM0173		2	24/24.5	130/161	4+	06-OCT-93	L	5.0000	L	.5000
8	NF02ZM0173		1	27.0	250.0	4+	06-OCT-93	L	5.0000	L	.5000
9	NF02ZM0173		2	26/24	180/148	4+	06-OCT-93	L	5.0000	L	.5000
10	NF02ZM0173		3	23/21/20.5	131/105/101		06-OCT-93	L	5.0000	L	.5000
11	KENT PD	FORAGE F									
12	NF02ZM0156		200	2-5			25-AUG-93		30.00	L	.5000
13	RENNIE R	BRWN TROUT									
14	NF02ZM0157		1	33.0	374.0		26-AUG-93		10.00	L	.5000
15	NF02ZM0157		1	39.0	657.0		26-AUG-93	L	5.0000	L	.5000
16	RENNIE R	BRWN TROUT									
17	NF02ZM0158		1	32.0	372.0		26-AUG-93	L	5.0000	L	.5000
18	NF02ZM0158		1	28.0	249.0		26-AUG-93	L	5.0000	L	.5000
19	NF02ZM0158		1	27.0	239.0		26-AUG-93		8.24	L	.5000
20	NF02ZM0158		1	34.5	418.0		26-AUG-93		5.60	L	.5000
21	VIRGIN LK	FORAGE F									
22	NF02ZM0162		65	4-5			26-AUG-93		61.80	L	.5000
23	NF02ZM0161		65	4-5			26-AUG-93		666.67		0.68
24	VIRGIN R	BROWN TROUT									
25	NF02ZM0148		1	27.0	224.0	5+	25-AUG-93	L	5.0000	L	.5000
26	NF02ZM0148		2	25.5/24.5	166/164	3+/3+	25-AUG-93	L	5.0000	L	.5000
27	NF02ZM0148		2	25.5/27.5	173/185		25-AUG-93		6.76	L	.5000
28	NF02ZM0148		2	26.5/24.5	158/148		25-AUG-93	L	5.0000	L	.5000
29	VIRGIN R	BRMN TROUT									
30	NF02ZM0014		1	36.5	504.0	4+	25-AUG-93	L	5.0000	L	.5000
31	NF02ZM0014						25-AUG-93	L	5.0000	L	.5000
32	NF02ZM0014		1	33.0	365.0	5+	25-AUG-93	L	5.0000	L	.5000
33	NF02ZM0014		2	28/28	225/226	4+/3+	25-AUG-93	L	5.0000	L	.5000
34	NF02ZM0014		2	27/28	191/188		25-AUG-93	L	5.0000	L	.5000
35	QUIDI V LK	FORAGE F									
36	NF02ZM0167		75	4-5			24-AUG-93		24.90	L	.5000

TABLE 7
THE CONCENTRATIONS OF EXTRACTABLE METALS (MG/kG) IN FORAGE FISH
AND BROWN TROUT COLLECTED FOR THE 1993 QUIDI VIDI BASIN
INTENSIVE SURVEY REPORT
(INCLUDED: SUMMARY RESULTS OF METALS FOUND IN FORAGE FISH
IN ATLANTIC CANADA BY BAILEY (UNPUBLISHED DATA))

	EXTRACT IRON	EXTRACT NICKEL	EXTRACT COPPER	EXTRACT ZINC	EXTRACT ARSENIC	EXTRACT CADMIUM	EXTRACT MERCURY	EXTRACT LEAD
1								
2	76.76	0.050	2.35	42.16	0.039	0.069	0.019	0.290
3	149.00	0.068	2.20	50.60	0.055	0.057	L .0200	0.270
4								
5	6.60	0.050	1.00	10.20	0.015	L .0250	0.059	L.05
6	4.00	L .0500	0.70	8.30	L .0100	L .0250	0.095	L.05
7	4.00	0.050	0.50	9.40	L .0100	0.033	0.100	0.063
8	7.90	0.050	1.10	9.30	L .0100	L .0250	0.093	L.05
9	5.50	0.090	0.60	8.00	L .0100	0.047	0.070	L.05
10	6.20	0.068	0.60	9.00	0.013	0.035	0.140	0.058
11								
12	78.20	L .0500	1.90	51.40	0.015	0.054	0.020	0.190
13								
14	6.50	0.050	0.50	9.90	0.025	L .0250	0.146	L.05
15	7.00	L .0500	1.10	8.80	0.035	L .0250	0.120	0.070
16								
17	6.00	0.053	1.10	9.30	0.040	L .0250	0.080	0.100
18	5.39	L .0500	0.69	10.29	0.020	L .0240	0.050	L.05
19	8.43	L .0500	0.49	9.90	0.022	0.029	0.073	0.083
20	9.60	L .0500	0.60	7.90	0.020	L .0250	0.045	L.05
21								
22	97.00	0.068	1.80	52.90	0.025	L .0250	0.086	0.100
23	673.53	*TC**	2.94	80.69	0.074	0.054	0.017	INT
24								
25	5.10	L .0500	0.50	9.10	L .0100	L .0250	0.079	L.05
26	6.40	L .0500	0.70	9.70	L .0100	L .0250	0.095	0.050
27	9.80	L .0500	0.98	20.00	0.012	L .0240	0.218	0.061
28	18.90	L .0500	0.80	19.80	0.018	L .0250	0.200	0.100
29								
30	2.60	L .0500	0.24	7.30	L .0100	L .0240	0.230	L.05
31	1.90	L .0500	0.30	5.00	L .0100	L .0250	0.235	L.05
32	3.20	L .0500	0.30	15.70	L .0100	L .0250	0.186	L.05
33	5.60	L .0500	1.00	10.00	0.013	L .0250	0.061	L.05
34	5.90	L .0500	1.00	20.20	L .0100	L .0250	0.146	L.05
35								
36	49.20	L .0500	2.70	55.40	0.022	0.077	0.055	0.140

TABLE 7

THE CONCENTRATIONS OF EXTRACTABLE METALS (MG/kG) IN FORAGE FISH AND BROWN TROUT COLLECTED FOR THE 1993 QUIDI VIDI BASIN INTENSIVE SURVEY REPORT

(INCLUDED: SUMMARY RESULTS OF METALS FOUND IN FORAGE FISH IN ATLANTIC CANADA BY BAILEY (UNPUBLISHED DATA))

	STATION NUMBER	FISH TYPE	NUMBER IN SAMPLE	LENGTH cm	WEIGHT gm	AGE ESTIMATED	SAMPLE DATE	EXTRACT ALUMINUM	EXTRACT CHROMIUM
37	NF02ZM0167		75	4-5			24-AUG-93	38.10	L .5000
38	NF02ZM0167		75	4-5			24-AUG-93	21.73	L .5000
39	NF02ZM0168		150	4-5			24-AUG-93	19.61	L .5000
40	NF02ZM0171		65	4-5			24-AUG-93	19.22	L .5000
41	NF02ZM0169		65	4-5			24-AUG-93	30.61	L .5000
42	NF02ZM0172		65	4-5			24-AUG-93	24.85	L .5000
43	NF02ZM0170		65	4-5			24-AUG-93	35.92	L .5000
44	ATLANTIC	SAMPLE	137						
45	MAXIMUM	FORAGE FISH							12.60
46	MINIMUM								0.17
47	MEAN								0.68

	EXTRACT IRON	EXTRACT NICKEL	EXTRACT COPPER	EXTRACT ZINC	EXTRACT ARSENIC	EXTRACT CADMIUM	EXTRACT MERCURY	EXTRACT LEAD
37	78.70	0.050	2.90	55.00	0.022	0.075	0.014	0.280
38	58.57	L .0500	2.86	43.06	0.017	0.059	0.020	0.200
39	41.76	L .0500	2.45	41.37	0.018	0.076	0.021	0.210
40	51.08	0.050	2.75	53.92	0.040	0.088	0.020	0.310
41	56.43	L .0500	1.73	50.87	0.017	0.092	0.025	0.180
42	63.00	0.050	2.00	47.70	0.019	0.054	L .0200	0.160
43	63.57	L .0500	2.45	53.88	0.017	0.053	0.021	0.200
44								
45		6.000	11.50	93.00	2.700	0.270	0.400	2.900
46		L.05	0.34	9.10	L.001	L0.02	L.02	0.040
47		0.330	2.60	39.90	0.065	0.040	0.090	0.180

TABLE 8
SURFACE WATER QUALITY DATA FROM THE OUTLET OF RENNIES RIVER
(NF02ZM0016) DURING THE PERIOD 1986 TO 1994

	SAMPLE DATE	SPECIFIC CONDUCTANCE USIE/CM	TURBIDITY JT UNITS	TOTAL ALKALINITY MG/L	PH PH UNITS	DISSOLVED SODIUM MG/L	DISSOLVED SULPHATE MG/L	DISSOLVED CHLORIDE MG/L	DISSOLVED CALCIUM MG/L	TOTAL ALUMINUM MG/L
1	17-OCT-86	280.0	0.17	8.4	6.22	41.2	7.80	69.8	7.64	0.070
2	28-NOV-86	309.0	0.62	6.2	6.62	47.9	10.90	79.3	6.80	0.181
3	23-DEC-86	378.0	0.11	9.7	6.48	58.2	10.70	93.1		0.078
4	29-JAN-87	1012.0	0.48	8.5	6.95	166.0	15.20	259.0	11.10	0.044
5	23-FEB-87	524.9	0.71	8.4	6.60	84.5	11.20	136.0	10.50	0.124
6	27-MAR-87	720.0	0.97	7.6	6.49	117.0	13.00	195.0	13.20	0.241
7	24-APR-87	241.2	0.50	4.9	6.58	35.1	7.80	58.5	5.20	0.130
8	20-MAY-87	339.0	0.66	7.5	6.65	51.7	8.50	85.2	8.22	0.092
9	11-JUN-87	406.0	0.70	8.9	6.80	60.0	9.40	113.0	10.00	0.034
10	09-JUL-87	404.0	0.23	9.9	6.52	60.8	9.50	104.0	10.48	0.041
11	20-AUG-87	453.0	0.50	11.5	6.61	66.6	9.40	111.0	11.80	0.038
12	22-SEP-87	411.0	0.16	11.0	6.52	60.2	9.70	106.0	10.80	0.020
13	22-OCT-87	378.0	3.20	12.9	6.43	56.0	10.30	91.8	10.80	0.073
14	23-NOV-87	257.0	0.45	5.7	6.38	39.4	10.00	61.1	5.81	0.142
15	22-DEC-87	492.0	0.80	9.5	6.67	79.7	11.20	127.0	8.85	0.085
16	27-JAN-88	981.0	1.50	6.5	6.61	163.0	16.60	261.0	14.70	0.117
17	29-FEB-88	369.0	0.65	4.3	6.32	60.5	8.90	96.6	7.15	0.152
18	28-MAR-88	536.0	0.87	5.7	6.50	92.8	11.10	143.0	9.15	0.116
19	29-APR-88	418.0	0.63	6.6	6.55	70.0	9.80	110.0	7.95	0.090
20	30-MAY-88	450.0	0.45	13.2	6.75	67.9	10.10	117.0	11.40	0.075
21	21-JUN-88	363.0	0.45	8.1	6.59	54.9	8.30	92.4	8.73	0.046
22	15-JUL-88	346.8	0.54	10.4	6.55	53.3	8.20	90.4	8.62	0.057
23	10-AUG-88	420.0	0.18	12.4	6.57	64.3	7.50	110.0	10.70	0.027
24	13-SEP-88	372.0	0.48	10.7	6.59	57.8	8.20	98.3	8.76	0.037
25	11-OCT-88	302.0	0.22	8.4	6.51	50.7	7.50	77.2	7.26	0.061
26	10-NOV-88	272.0	0.70	9.5	6.67	40.2	8.90	67.7	6.69	0.111
27	13-DEC-88	382.0	0.00	10.2	6.68	58.6	9.40	95.8	7.92	0.075
28	04-JAN-89	2813.0	1.50	10.0	6.85	537.0	31.80	824.0	20.80	0.102
29	07-FEB-89	1937.0	1.00	10.2	6.58	360.0	29.20	571.0	20.50	0.141
30	06-MAR-89	3850.0	2.20	8.5	6.22	598.0	18.50	923.0	17.10	0.355
31	10-APR-89	707.0	0.40	5.4	6.16	119.0	12.30	197.0	11.30	0.103
32	04-MAY-89	406.0	0.60	4.3	6.48	65.8	8.00	111.0	8.31	0.125
33	05-JUN-89	502.0	0.70	8.9	6.69	78.7	8.30	139.0	11.40	0.052
34	06-JUL-89	541.0	0.50	8.6	6.94	84.1	8.94	148.0	13.00	0.043
35	04-AUG-89	557.0	0.39	10.6	6.93	86.5	8.40	152.0	14.10	0.025
36	08-SEP-89	550.0	0.50	11.0	7.30	84.7	8.70	147.0	13.90	0.030
37	05-OCT-89	450.0	0.31	8.4	6.65	68.7	8.60	117.0	10.31	0.041
38	06-NOV-89	418.0	0.65	8.0	6.66	65.5	8.10	111.0	9.86	0.038
39	05-DEC-89	333.0	2.80	3.3	6.29	52.5	9.60	86.1	6.32	0.217

TABLE 8

SURFACE WATER QUALITY DATA FROM THE OUTLET OF RENNIES RIVER (NF02ZM0016) DURING THE PERIOD 1986 TO 1994

	TOTAL COPPER MG/L	TOTAL ZINC MG/L	DISSOLVED MERCURY UG/L	TOTAL LEAD MG/L	NITRATE UNFILTERED MG/L	TOTAL PHOSPHORUS MG/L
1	0.0019	0.0156	0.020	0.0015	0.037	0.0187
2	0.0039	0.0320	0.020	0.0026	0.417	0.0199
3	0.0043	0.0364	0.020	0.0016	0.481	0.0250
4	0.0036	0.0334	0.020	0.0028	0.419	0.0210
5	0.0027	0.0294	0.020	0.0032	0.381	0.0292
6	0.0044	0.0530	0.020	0.0082	0.433	0.0257
7	0.0017	0.0168	0.020	0.0012	0.167	0.0168
8	0.0035	0.0143	0.020	0.0010	0.245	0.0178
9	0.0160	0.0100	0.020	0.0020	0.340	0.0270
10	0.0032	0.0125	0.020	0.0005	0.309	0.0128
11	0.0070	0.0127	0.020	0.0019	0.456	0.0254
12	0.0059	0.0110	0.020	0.0012	0.434	0.0216
13	0.0074	0.0287	0.010	0.0065	0.325	0.0357
14	0.0033	0.0300	0.010	0.0020	0.365	0.0225
15	0.0033	0.0249	0.010	0.0026	0.477	0.0250
16	0.0058	0.0744	0.010	0.0046	0.522	0.0233
17	0.0030	0.0347	0.010	0.0014	0.359	0.0131
18	0.0025	0.0315	0.010	0.0014	0.290	0.0184
19	0.0019	0.0187	0.010	0.0012	0.230	0.0121
20	0.0040	0.0153	0.010	0.0028	0.300	0.0488
21	0.0042	0.0121	0.010	0.0004	0.160	0.0302
22	0.0029	0.0123	0.010	0.0012	0.270	0.0286
23	0.0022	0.0067	0.010	0.0011	0.580	0.0177
24	0.0025	0.0111	0.010	0.0012	0.410	0.0222
25	0.0030	0.0137	0.010	0.0008	0.380	0.0286
26	0.0032	0.0194	0.010	0.0014	0.420	0.0214
27	0.0024	0.0194	0.090	0.0017	0.660	0.0215
28	0.0128	0.0469	0.050	0.0026	0.390	0.0196
29	0.0040	0.0475	0.030	0.0038	0.380	0.0148
30	0.0079	0.0736	0.030	0.0113	0.310	0.0343
31	0.0018	0.0354	0.010	0.0013	0.320	0.0140
32	0.0023	0.0206	0.050	0.0017	0.150	0.0157
33	0.0028	0.0225	0.030	0.0003	0.230	0.0148
34	0.0026	0.0149	0.010	0.0008	0.310	0.0201
35	0.0022	0.0128	0.010	0.0002	0.360	0.0160
36	0.0026	0.0113	0.010	0.0003	0.610	0.0178
37	0.0028	0.0151	0.010	0.0008	0.220	0.0262
38	0.0015	0.0125	0.010	0.0002	0.360	0.0140
39	0.0029	0.0462	0.030	0.0021	0.500	0.0219

TABLE 8
SURFACE WATER QUALITY DATA FROM THE OUTLET OF RENNIES RIVER
(NF02ZM0016) DURING THE PERIOD 1986 TO 1994

	SAMPLE DATE	SPECIFIC CONDUCTANCE USIE/CM	TURBIDITY JT UNITS	TOTAL ALKALINITY MG/L	PH PH UNITS	DISSOLVED SODIUM MG/L	DISSOLVED SULPHATE MG/L	DISSOLVED CHLORIDE MG/L	DISSOLVED CALCIUM MG/L	TOTAL ALUMINUM MG/L
40	08-JAN-90	1623.0	1.00	8.2	6.31	296.0	16.00	490.0	15.30	0.130
41	12-FEB-90	515.0	0.98	3.9	6.42	84.7	10.20	137.0	8.49	0.139
42	06-MAR-90	492.0	1.10	5.8	6.54	79.4	8.80	133.0	8.99	0.122
43	03-APR-90	760.0	0.38	8.1	6.82	123.0	16.40	216.0	14.90	0.058
44	11-MAY-90	573.0	0.64	4.5	6.22	92.2	11.00	22.0	11.00	0.090
45	06-JUN-90	416.0	0.99	5.2	6.17	66.6	9.00	114.0	8.52	0.219
46	04-JUL-90	492.0	0.84	10.3	6.88	76.3	9.40	132.0	10.90	0.064
47	14-AUG-90	630.0	0.95	13.9	7.64	94.4	9.20	174.0	15.20	0.030
48	12-SEP-90	463.0	0.85	9.2	6.72	71.2	9.50	121.0	10.30	0.040
49	05-OCT-90	293.0	1.40	7.0	6.29	46.3	10.40	66.7	6.58	0.184
50	19-NOV-90	471.0	0.90	9.8	6.13	76.4	11.30	124.0	8.60	0.106
51	06-DEC-90	424.0	1.50	7.7	6.77	68.5	12.10	108.0	7.98	0.182
52	07-JAN-91	736.0	0.75	9.4	6.76	123.0	13.60	205.0	10.50	0.059
53	07-FEB-91	1443.0	0.60	9.5	6.81	258.0	22.10	378.0	16.30	0.158
54	04-APR-91	628.0	12.00	6.7	6.72	108.0	11.40	175.0	11.00	0.131
55	03-MAY-91	412.0	0.55	6.4	6.77	65.1	8.20	112.0	7.95	0.088
56	06-JUN-91	354.0	5.25	7.8	6.29	56.9	8.40	90.8	7.40	0.245
57	08-JUL-91	529.0	0.75	9.7	6.76	81.5	9.70	138.0	12.00	0.030
58	05-AUG-91	414.0	1.00	9.6	6.61	66.3	8.60	106.0	9.20	0.070
59	06-SEP-91	474.0	0.87	12.4	6.37	72.6	9.10	122.0	10.90	0.082
60	04-OCT-91	293.0	5.25	8.0	6.79	43.5	7.00	71.8	6.66	0.392
61	06-NOV-91	260.0	22.40	7.1	6.91	38.8	7.50	63.7	5.44	0.166
62	04-DEC-91	567.0	0.67	10.3	6.92	96.2	10.10	140.0	8.02	0.106
63	08-JAN-92	525.0	8.00	6.5	6.82	86.2	12.30	139.0	7.64	0.191
64	07-FEB-92	920.0	0.91	10.1	6.47	155.0	18.20	241.0	12.60	0.071
65	06-MAR-92	936.0	0.85	10.0	6.64	159.0	16.10	256.0	14.10	0.074
66	08-APR-92	1176.0	5.30	7.4	6.31	209.0	2.00	326.0	10.90	0.218
67	13-MAY-92	333.0	0.55	5.6	6.35	52.5	9.00	83.1	6.20	0.106
68	04-JUN-92	501.0	0.90	11.5	6.41	78.5	9.60	126.0	10.70	0.060
69	10-JUL-92	343.0	14.80	11.2	6.41	52.6	7.70	79.1	7.90	0.512
70	05-AUG-92	484.0	0.50	13.0	6.92	75.2	9.00	123.0	10.60	0.060
71	08-SEP-92	486.0	0.93	13.5	6.91	74.9	8.90	124.0	10.60	0.036
72	13-OCT-92	38.2	4.20	8.7	6.66	41.9	9.10	211.0	6.22	0.090
73	06-NOV-92	306.0	4.50	9.2	6.98	46.8	8.40	72.0	6.60	0.095
74	08-DEC-92	681.0	4.60	9.5	6.83	114.0	12.40	174.0	9.08	0.156
75	08-APR-93	678.0	0.65	8.9	6.72	110.0	12.10	194.0	12.30	0.051
76	04-JUN-93	500.0	0.98	9.5	6.81	78.4	10.00	132.0	9.45	0.066
77	06-JUL-93	257.0	0.82	6.6	6.67	39.5	8.80	56.3	4.92	0.184
78	05-AUG-93	386.0	0.80	12.4	6.94	61.7	10.00	102.0	8.05	0.084

TABLE 8

SURFACE WATER QUALITY DATA FROM THE OUTLET OF RENNIES RIVER (NF02ZM0016) DURING THE PERIOD 1986 TO 1994

	TOTAL COPPER MG/L	TOTAL ZINC MG/L	DISSOLVED MERCURY UG/L	TOTAL LEAD MG/L	NITRATE UNFILTERED MG/L	TOTAL PHOSPHORUS MG/L
40	0.0040	0.0431	0.010	0.0032	0.400	0.0296
41	0.0024	0.0388	0.010	0.0017	0.360	0.0170
42	0.0026	0.0293	0.010	0.0007	0.860	0.0135
43	0.0024	0.0330	0.010	0.0002	0.590	0.0201
44	0.0019	0.0257	0.010	0.0002	0.370	0.0143
45	0.0035	0.0223	0.010	0.0017	0.550	0.0287
46	0.0024	0.0121	0.010	0.0002	0.360	0.0155
47	0.0025	0.0102	0.010	0.0003	0.910	0.0155
48	0.0029	0.0121	0.010	0.0008	0.340	0.0173
49	0.0036	0.0228	0.010	0.0009	0.660	0.0132
50	0.0026	0.0224	0.010	0.0008	0.500	0.0361
51	0.0055	0.0309	0.010	0.0027	0.510	0.0180
52	0.0032	0.0219	0.010	0.0002	0.730	0.0114
53	0.0050	0.0575	0.010	0.0015	0.480	0.0202
54	0.0026	0.0362	0.010	0.0005	0.440	0.0168
55	0.0020	0.0281	0.100	0.0004	0.270	0.0029
56	0.0058	0.0334	0.010	0.0035	0.290	0.0269
57	0.0027	0.0111	0.010	0.0003	0.680	0.0307
58	0.0031	0.0190	0.010	0.0008	0.360	0.0198
59	0.0037	0.0146	0.010	0.0007	0.530	0.0174
60	0.0114	0.0507	0.010	0.0104	0.310	0.0798
61			0.010		0.380	0.0193
62			0.010		0.710	0.0135
63	0.0045	0.0432	0.010	0.0032	0.380	0.0065
64	0.0027	0.0395	0.010	0.0003	0.470	0.0106
65	0.0035	0.0462	0.010	0.0004	0.490	0.0068
66	0.0049	0.0500	0.006	0.0025	0.400	0.0062
67	0.0019	0.0164	0.005	0.0002	0.220	0.0063
68	0.0025	0.0101	0.005	0.0006	0.670	0.0133
69	0.0119	0.0565	0.005	0.0100	0.620	0.0071
70	0.0026	0.0115	0.005	0.0011	0.540	0.0081
71	0.0024	0.0093	0.007	0.0007	0.490	0.0145
72	0.0020	0.0186	0.005	0.0002	0.480	0.0117
73	0.0027	0.0172	0.005	0.0006	0.440	0.0147
74	0.0047	0.0401	0.005	0.0021	0.740	0.0065
75	0.0025	0.0323	0.006	0.0003	0.540	0.0147
76	0.0036	0.0147	0.005	0.0008	0.320	0.0058
77	0.0034	0.0238	0.005	0.0011	0.340	0.0131
78	0.0031	0.0126	0.010	0.0007	0.450	0.0163

TABLE 8
SURFACE WATER QUALITY DATA FROM THE OUTLET OF RENNIES RIVER
(NF02ZM0016) DURING THE PERIOD 1986 TO 1994

	SAMPLE DATE	SPECIFIC CONDUCTANCE USIE/CM	TURBIDITY JT UNITS	TOTAL ALKALINITY MG/L	PH PH UNITS	DISSOLVED SODIUM MG/L	DISSOLVED SULPHATE MG/L	DISSOLVED CHLORIDE MG/L	DISSOLVED CALCIUM MG/L	TOTAL ALUMINUM MG/L
79	14-SEP-93	376.0	0.85	13.7	6.19	57.5	11.60	91.5	8.30	0.044
80	05-OCT-93	277.0	0.80	9.0	6.60	41.2	8.20	68.5	5.90	0.091
81	09-NOV-93	228.0	0.80	8.9	6.65	34.4	8.20	52.9	4.84	0.105
82	07-DEC-93	314.0	4.20	7.9	6.95	50.0	9.00	96.6	5.70	0.106
83	07-JAN-94	650.0	0.95	8.0	6.75	108.0		178.0	9.30	0.078
84	03-FEB-94	641.0	0.92	11.0	6.78	101.0	11.10	174.0	10.40	0.063
85	07-MAR-94	1047.0	1.10	6.2	6.42	183.0	17.50	304.0	13.40	0.134

	TOTAL COPPER MG/L	TOTAL ZINC MG/L	DISSOLVED MERCURY UG/L	TOTAL LEAD MG/L	NITRATE UNFILTERED MG/L	TOTAL PHOSPHORUS MG/L
79	0.0049	0.0117	0.008	0.0009	0.410	0.0157
80	0.0043	0.0150	0.026	0.0012	0.470	0.0090
81	0.0045	0.0167	0.018	0.0006	0.560	0.0091
82	0.0039	0.0229	0.008	0.0012	0.460	0.0124
83	0.0046	0.0349	0.005	0.0011	0.020	0.0129
84	0.0031	0.0295	0.006	0.0007	0.510	0.0079
85	0.0062	0.0620	0.009	0.0027	0.450	0.0114

TABLE 9
SURFACE WATER QUALITY DATA FROM THE OUTLET OF VIRGINIA RIVER
(NF02ZM0014) DURING THE PERIOD OF 1986 TO 1994

	SAMPLE DATE	SPECIFIC CONDUCTANCE USIE/CM	TURBIDITY JT UNITS	TOTAL ALKALINITY MG/L	PH PH UNITS	DISSOLVED SODIUM MG/L	DISSOLVED SULPHATE MG/L	DISSOLVED CHLORIDE MG/L	DISSOLVED CALCIUM MG/L	TOTAL ALUMINUM MG/L
1	17-OCT-86	354.7	0.18	14.50	6.52	50.1	11.9	86.40	10.40	0.032
2	28-NOV-86	327.6	0.78	9.10	6.70	48.7	13.1	78.75	8.07	0.136
3	23-DEC-86	386.5	0.15	11.30	6.80	55.6	12.9	91.70	10.30	0.073
4	29-JAN-87	727.5	0.29	11.10	7.08	105.0	14.3	183.00	13.60	0.068
5	23-FEB-87	664.3	0.37	12.30	7.19	97.7	13.6	168.00	16.90	0.060
6	27-MAR-87	828.7	0.73	8.90	6.76	130.0	14.5	226.00	18.20	0.159
7	24-APR-87	292.7	0.46	6.50	6.73	40.4	9.5	71.10	7.00	0.114
8	20-MAY-87	408.0	0.33	10.30	6.87	58.8	11.4	101.00	11.00	0.065
9	11-JUN-87	431.0	0.60	11.70	6.70	60.0	12.2	114.00	12.00	0.038
10	09-JUL-87	475.0	0.53	14.50	6.99	69.0	13.1	116.00	13.40	0.039
11	20-AUG-87	526.0	0.42	24.60	7.16	77.9	12.8	101.00	16.60	0.037
12	22-SEP-87	533.0	0.12	17.70	6.75	76.7	14.0	137.00	15.70	0.022
13	22-OCT-87	481.0	0.90	15.70	6.71	68.7	13.7	115.00	14.30	0.046
14	23-NOV-87	444.0	0.56	13.90	6.34	68.5	14.2	105.00	10.10	0.161
15	22-DEC-87	467.0	0.56	11.10	6.79	75.0	14.4	115.00	10.80	0.060
16	27-JAN-88	914.0	0.94	12.30	6.90	141.0	16.9	241.00	19.50	0.112
17	24-FEB-88	481.0	4.30	7.50	6.45	76.6	12.9	125.00	9.92	0.458
18	28-MAR-88	494.0	0.69	7.60	6.83	76.3	11.6	124.00	11.40	0.094
19	29-APR-88	521.0	0.50	8.20	6.86	84.4	12.6	138.00	11.50	0.072
20	30-MAY-88	552.0	0.19	11.60	6.85	81.8	13.5	145.00	14.40	0.048
21	21-JUN-88	466.0	0.26	12.80	6.95	69.1	11.8	120.00	12.30	0.047
22	15-JUL-88	475.5	0.39	16.80	6.90	70.7	11.7	121.00	13.20	0.028
23	10-AUG-88	492.0	0.18	16.30	6.72	78.9	10.9	128.00	13.80	0.021
24	08-SEP-88	528.0	0.20	19.20	6.74	84.6	12.5	138.00	15.00	0.019
25	11-OCT-88	388.0	0.21	13.00	6.61	59.2	10.9	97.10	10.60	0.035
26	10-NOV-88	405.0	0.48	13.50	7.00	62.6	12.8	102.00	9.36	0.091
27	13-DEC-88	522.0	0.00	12.70	6.80	79.7	14.6	131.00	11.20	0.059
28	05-JAN-89	3734.0	0.33	8.80	6.72	692.0	56.1	1070.00	32.80	0.389
29	07-FEB-89	862.0	0.45	12.60	6.67	141.0	18.5	242.00	19.10	0.049
30	06-MAR-89	1410.0	0.90	9.60	6.31	173.0	17.9	298.00	20.00	0.107
31	10-APR-89	624.0	0.40	7.10	6.44	99.5	12.3	170.00	13.40	0.137
32	04-MAY-89	583.0	0.50	7.60	6.47	89.6	11.8	154.00	13.40	0.096
33	05-JUN-89	613.0	0.50	11.70	6.83	93.2	12.0	167.00	16.20	0.045
34	06-JUL-89	755.0	0.50	12.60	7.54	113.0	14.5	204.00	20.90	0.029
35	04-AUG-89	724.0	0.17	16.80	7.43	108.0	13.6	199.00	20.70	0.015
36	08-SEP-89	760.0	0.15	16.40	7.51	114.0	15.1	206.00	21.50	0.013
37	05-OCT-89	830.0	0.51	17.30	6.65	133.0	13.4	223.00	17.10	0.096
38	06-NOV-89	525.0	0.57	13.20	6.89	78.3	13.1	137.00	15.00	0.044
39	05-DEC-89	486.0	4.90	7.30	6.62	74.9	14.0	123.00	10.50	0.370

TABLE 9
SURFACE WATER QUALITY DATA FROM THE OUTLET OF VIRGINIA RIVER
(NF02ZM0014) DURING THE PERIOD OF 1986 TO 1994

	SAMPLE DATE	SPECIFIC CONDUCTANCE USIE/CM	TURBIDITY JT UNITS	TOTAL ALKALINITY MG/L	PH PH UNITS	DISSOLVED SODIUM MG/L	DISSOLVED SULPHATE MG/L	DISSOLVED CHLORIDE MG/L	DISSOLVED CALCIUM MG/L	TOTAL ALUMINUM MG/L
40	08-JAN-90	986.0	0.65	10.20	6.46	153.0	17.7	267.00	18.90	0.078
41	12-FEB-90	681.0	2.40	5.70	6.68	108.0	15.0	185.00	13.20	0.214
42	06-MAR-90	701.0	1.50	7.30	6.58	113.0	11.9	194.00	13.80	0.145
43	03-APR-90	1090.0	0.27	10.50	6.75	173.0	18.1	315.00	24.10	0.066
44	11-MAY-90	763.0	0.50	6.90	6.38	120.0	15.4	22.00	16.70	0.110
45	06-JUN-90	587.0	1.60	4.30	6.56	94.4	13.3	162.00	11.30	0.214
46	04-JUL-90	599.0	0.96	13.90	7.03	90.9	13.3	160.00	14.40	0.063
47	14-AUG-90	812.0	0.39	18.40	6.99	121.0	15.5	220.00	21.20	0.040
48	12-SEP-90	608.0	0.73	20.00	7.55	90.1	12.6	157.00	16.20	0.044
49	05-OCT-90	399.0	2.50	13.00	6.25	60.9	14.0	98.70	9.93	0.163
50	19-NOV-90	534.0	0.68	42.70	6.46	83.9	16.1	142.00	11.50	0.093
51	06-DEC-90	613.0	4.30	12.60	6.85	100.0	16.7	163.00	11.30	0.315
52	07-JAN-91	623.0	0.60	14.60	6.71	95.6	19.3	155.00	14.30	0.058
53	07-FEB-91	974.0	0.35	15.60	6.82	155.0	20.1	273.00	20.30	0.050
54	04-APR-91	752.0	14.00	9.20	6.77	124.0	14.3	205.00	15.00	0.199
55	03-MAY-91	609.0	0.57	9.40	6.72	97.4	13.3	166.00	12.80	0.084
56	06-JUN-91	534.0	4.20	9.90	6.61	83.8	13.3	141.00	11.40	0.171
57	08-JUL-91	711.0	0.52	12.20	6.81	108.0	14.8	185.00	16.90	0.025
58	05-AUG-91	511.0	0.70	16.90	6.55	79.4	12.5	129.00	13.60	0.062
59	06-SEP-91	617.0	0.35	18.70	6.59	92.4	13.1	162.00	15.80	0.030
60	04-OCT-91	548.0	0.63	6.96	6.96	83.1	12.5	142.00	12.70	0.047
61	06-NOV-91	511.0	34.00	12.70	6.95	80.7	11.8	130.00	8.33	0.474
62	04-DEC-91	535.0	0.58	14.10	6.73	84.5	15.8	122.00	10.80	0.083
63	08-JAN-92	895.0	60.00	11.60	6.85	149.0	18.6	270.00	12.60	0.434
64	07-FEB-92	1128.0	0.63	14.00	6.32	182.0	20.9	294.00	20.00	0.077
65	06-MAR-92	1155.0	1.00	12.80	6.56	187.0	20.5	314.00	22.40	0.101
66	08-APR-92	2398.0	9.80	10.00	6.19	445.0	2.0	666.00	17.50	0.290
67	13-MAY-92	484.0	0.45	8.50	6.30	74.9	17.0	124.00	10.10	0.088
68	04-JUN-92	729.0	3.70	10.60	6.27	114.0	14.9	202.00	15.70	0.089
69	10-JUL-92	472.0	0.56	14.00	6.69	72.2	12.1	115.00	10.80	0.091
70	05-AUG-92	594.0	0.60	17.60	6.86	90.4	13.7	151.00	13.90	0.090
71	08-SEP-92	624.0	0.57	18.30	6.85	95.2	13.9	155.00	14.80	0.038
72	13-OCT-92	287.0	0.85	13.40	6.47	69.1	14.9	114.00	10.70	0.081
73	06-NOV-92	470.0	4.10	13.80	7.17	72.6	14.3	116.00	11.00	0.149
74	08-DEC-92	659.0	0.86	14.10	7.06	102.0	16.0	160.00	13.00	0.062
75	12-MAY-93	572.0	1.00	10.30	7.08	89.4	14.6	159.00	12.20	0.061
76	04-JUN-93	615.0	0.63	10.70	7.26	94.8	13.4	163.00	13.50	0.057
77	06-JUL-93	352.0	0.75	11.90	7.04	52.8		86.60	8.30	0.126
78	05-AUG-93	482.0	0.85	16.40	7.52	76.5	14.3	125.00	11.10	0.063

TABLE 9

SURFACE WATER QUALITY DATA FROM THE OUTLET OF VIRGINIA RIVER (NF02ZM0014) DURING THE PERIOD OF 1986 TO 1994

	TOTAL COPPER MG/L	TOTAL ZINC MG/L	DISSOLVED MERCURY UG/L	TOTAL LEAD MG/L	NITRATE UNFILTERED MG/L	TOTAL PHOSPHORUS MG/L
1	0.0013	0.0250	0.020	0.0003	0.006	0.0211
2	0.0019	0.0418	0.020	0.0013	0.520	0.0267
3	0.0034	0.0448	0.020	0.0007	0.803	0.0273
4	0.0036	0.0458	0.020	0.0061	0.644	0.0249
5	0.0019	0.0552	0.020	0.0021	0.494	0.0214
6	0.0034	0.0773	0.020	0.0032	0.664	0.0225
7	0.0018	0.0273	0.020	0.0005	0.362	0.0236
8	0.0021	0.0260	0.020	0.0010	0.460	0.0123
9	0.0140	0.0100	0.020	0.0020	0.250	0.0280
10	0.0063	0.0241	0.020	0.0002	0.581	0.0285
11	0.0074	0.0379	0.020	0.0011	0.605	0.0233
12	0.0044	0.0232	0.020	0.0007	0.586	0.0216
13	0.0021	0.0186	0.010	0.0013	0.675	0.0265
14	0.0025	0.0364	0.010	0.0023	0.508	0.0300
15	0.0022	0.0344	0.010	0.0011	0.725	0.0176
16	0.0037	0.0828	0.010	0.0024	0.652	0.0334
17	0.0063	0.0697	0.010	0.0079	0.605	0.0547
18	0.0019	0.0439	0.020	0.0007	0.420	0.0208
19	0.0015	0.0299	0.030	0.0004	0.420	0.0123
20	0.0015	0.0238	0.020	0.0002	0.600	0.0187
21	0.0023	0.0216	0.020	0.0002	0.470	0.0276
22	0.0036	0.0145	0.010	0.0003	0.670	0.0249
23	0.0023	0.0104	0.010	0.0002	0.440	0.0233
24	0.0014	0.0121	0.010	0.0002	0.580	0.0204
25	0.0017	0.0213	0.010	0.0002	0.510	0.0227
26	0.0021	0.0323	0.020	0.0012	0.630	0.0253
27	0.0017	0.0298	0.010	0.0002	0.810	0.0220
28	0.0066	0.1350	0.020	0.0059	0.580	0.0422
29	0.0025	0.0536	0.020	0.0002	0.830	0.0224
30	0.0025	0.0607	0.020	0.0014	0.740	0.0275
31	0.0023	0.0438	0.010	0.0007	0.520	0.0193
32	0.0023	0.0243	0.010	0.0002	0.230	0.0334
33	0.0018	0.0237	0.020	0.0002	0.480	0.0238
34	0.0016	0.0172	0.010	0.0002	0.770	0.0168
35	0.0015	0.0119	0.010	0.0002	0.800	0.0213
36	0.0019	0.0121	0.010	0.0002	1.070	0.0232
37	0.0021	0.0234	0.040	0.0002	0.520	0.0313
38	0.0008	0.0161	0.010	0.0002	0.660	0.0263
39	0.0027	0.0686	0.010	0.0026	0.970	0.0328

TABLE 9

SURFACE WATER QUALITY DATA FROM THE OUTLET OF VIRGINIA RIVER (NF02ZM0014) DURING THE PERIOD OF 1986 TO 1994

	TOTAL COPPER MG/L	TOTAL ZINC MG/L	DISSOLVED MERCURY UG/L	TOTAL LEAD MG/L	NITRATE UNFILTERED MG/L	TOTAL PHOSPHORUS MG/L
40	0.0019	0.0531	0.010	0.0002	1.040	0.0173
41	0.0024	0.0653	0.010	0.0011	0.640	0.0254
42	0.0024	0.0536	0.010	0.0011	0.640	0.0239
43	0.0022	0.0461	0.020	0.0002	0.820	0.0198
44	0.0021	0.0236	0.020	0.0008	0.540	0.0210
45	0.0031	0.0311	0.020	0.0011	0.460	0.0369
46	0.0022	0.0128	0.010	0.0002	0.700	0.0215
47	0.0018	0.0061	0.010	0.0002	1.040	0.0218
48	0.0025	0.0222	0.010	0.0002	0.530	0.0257
49	0.0028	0.0330	0.010	0.0006	1.260	0.0273
50	0.0023	0.0262	0.010	0.0003	0.850	0.0217
51	0.0040	0.0426	0.010	0.0024	0.740	0.0344
52	0.0034	0.0342	0.010	0.0002	1.270	0.0252
53	0.0026	0.0431	0.010	0.0002	0.900	0.0133
54	0.0023	0.0577	0.040	0.0002	0.690	0.0183
55	0.0018	0.0188	0.010	0.0002	0.440	0.0116
56	0.0033	0.0301	0.010	0.0005	0.590	0.0266
57	0.0017	0.0082	0.010	0.0002	0.680	0.0148
58	0.0023	0.0205	0.010	0.0002	0.560	0.0230
59	0.0016	0.0105	0.010	0.0002	0.720	0.0183
60	0.0018	0.0122	0.010	0.0002	0.660	0.0270
61			0.010		0.580	0.0224
62			0.010		1.200	0.0320
63	0.0049	0.0612	0.010	0.0034	0.600	0.0406
64	0.0020	0.0517	0.010	0.0002	0.780	0.0144
65	0.0025	0.0340	0.010	0.0003	0.870	0.0157
66	0.0044	0.0715	0.010	0.0012	0.930	0.0098
67	0.0018	0.0125	0.005	0.0002	0.410	0.0103
68	0.0025	0.0087	0.005	0.0002	0.710	0.0201
69	0.0026	0.0224	0.005	0.0004	0.610	0.0191
70	0.0021	0.0149	0.005	0.0006	0.640	0.0158
71	0.0017	0.0054	0.005	0.0002	0.690	0.0181
72	0.0020	0.0231	0.005	0.0002	0.730	0.0208
73	0.0026	0.0176	0.005	0.0007	0.860	0.0256
74	0.0025	0.0351	0.005	0.0011	0.960	0.0070
75	0.0058	0.0141	0.005	0.0002	0.700	0.0132
76	0.0022	0.0066	0.005	0.0002	0.430	0.0075
77	0.0029	0.0249	0.010	0.0005	0.680	0.0175
78	0.0026	0.0098	0.012	0.0002	0.790	0.0210

TABLE 9
SURFACE WATER QUALITY DATA FROM THE OUTLET OF VIRGINIA RIVER
(NF02ZM0014) DURING THE PERIOD OF 1986 TO 1994

	SAMPLE DATE	SPECIFIC CONDUCTANCE USIE/CM	TURBIDITY JT UNITS	TOTAL ALKALINITY MG/L	PH PH UNITS	DISSOLVED SODIUM MG/L	DISSOLVED SULPHATE MG/L	DISSOLVED CHLORIDE MG/L	DISSOLVED CALCIUM MG/L	TOTAL ALUMINUM MG/L
79	14-SEP-93	502.0	0.47	18.10	7.09	76.7	14.4	123.00	12.10	0.032
80	05-OCT-93	413.0	0.65	20.60	7.10	59.9	13.8	100.00	11.20	0.075
81	09-NOV-93	423.0	0.85	14.50	7.01	64.1	13.9	219.00	8.31	0.101
82	07-DEC-93	488.0	4.40	15.30	7.12	74.7	13.9	129.00	10.40	0.082
83	07-JAN-94	778.0	0.84	14.50	7.02	124.0	28.4	243.00	15.00	0.076
84	03-FEB-94	825.0	0.60	12.20	6.93	132.0	14.7	226.00	15.50	0.055
85	07-MAR-94	1069.0	0.99	14.70	6.91	183.0	18.5	321.00	19.30	0.065

	TOTAL COPPER MG/L	TOTAL ZINC MG/L	DISSOLVED MERCURY UG/L	TOTAL LEAD MG/L	NITRATE UNFILTERED MG/L	TOTAL PHOSPHORUS MG/L
79	0.0036	0.0099	0.008	0.0002	0.940	0.0197
80	0.0029	0.0158	0.014	0.0002	0.700	0.0170
81	0.0031	0.0270	0.023	0.0002	0.970	0.0125
82	0.0031	0.0239	0.014	0.0003	0.750	0.0277
83	0.0027	0.0321	0.005	0.0003	0.970	0.0173
84	0.0024	0.0394	0.014	0.0004	1.030	0.0102
85	0.0031	0.0608	0.008	0.0002	0.680	0.0133

TABLE 10

SURFACE WATER QUALITY DATA FROM THE OUTLET OF QUIDI VIDI LAKE (NF02ZM0015) DURING THE PERIOD 1986 TO 1994

	SAMPLE DATE	SPECIFIC CONDUCTANCE USIE/CM	TURBIDITY JT UNITS	TOTAL ALKALINITY MG/L	PH PH UNITS	DISSOLVED SODIUM MG/L	DISSOLVED SULPHATE MG/L	DISSOLVED CHLORIDE MG/L	DISSOLVED CALCIUM MG/L	TOTAL ALUMINUM MG/L
1	17-OCT-86	290.4	0.18	9.3	6.65	41.40	9.60	70.6	8.30	0.046
2	28-NOV-86	436.0	0.68	7.3	6.64	69.60	13.40	109.6	8.36	0.155
3	23-DEC-86	521.9	0.09	10.0	6.49	82.20	14.10	137.8	10.10	0.124
4	29-JAN-87	759.7	0.53	9.2	6.89	118.00	16.50	191.0	12.10	0.062
5	23-FEB-87	730.0	0.49	8.6	6.94	117.00	13.70	188.0	12.70	0.072
6	27-MAR-87	679.0	0.80	6.1	6.48	110.00	12.90	187.0	12.20	0.180
7	24-APR-87	321.2	0.66	5.2	6.62	47.70	9.20	80.9	6.60	0.148
8	20-MAY-87	293.0	0.32	7.0	6.54	43.20	8.60	72.6	6.92	0.093
9	11-JUN-87	342.0	0.21	7.9	6.80	51.40	8.80	87.1	8.21	0.035
10	20-AUG-87	422.0	0.35	12.9	6.93	64.97	9.60	106.0	11.10	0.038
11	22-SEP-87	424.0	0.13	13.1	6.72	62.30	10.50	110.0	12.00	0.030
12	22-OCT-87	428.0	0.90	11.8	6.86	64.90	10.90	106.0	11.90	0.014
13	23-NOV-87	389.0	0.28	10.1	6.72	60.70	10.60	98.8	9.21	0.097
14	22-DEC-87	528.0	1.10	8.9	6.68	90.40	13.00	131.0	8.52	0.109
15	27-JAN-88	859.0	1.30	11.0	6.74	140.00	16.80	231.0	14.20	0.066
16	29-FEB-88	512.0	1.90	4.6	6.33	86.30	11.10	135.0	8.24	0.241
17	28-MAR-88	707.0	0.97	7.5	6.76	129.00	14.00	188.0	11.50	0.135
18	29-APR-88	489.0	1.40	5.6	6.73	80.50	11.70	130.0	8.61	0.124
19	30-MAY-88	399.0	0.31	7.8	6.80	67.30	10.70	101.0	9.13	0.035
20	21-JUN-88	378.0	0.28	8.8	6.78	60.50	9.70	97.2	8.86	0.026
21	15-JUL-88	365.0	0.35	11.4	6.59	64.70	9.20	94.0	8.97	0.018
22	10-AUG-88	393.0	0.18	12.2	6.55	60.70	7.50	104.0	9.80	0.014
23	13-SEP-88	406.0	0.38	13.1	6.64	70.10	9.10	106.0	10.20	0.052
24	11-OCT-88	389.0	0.15	12.9	6.56	60.70	8.20	101.0	9.68	0.024
25	10-NOV-88	340.0	5.00	10.6	6.83	51.50	10.30	86.7	8.55	0.107
26	13-DEC-88	423.0	0.00	10.2	6.76	65.00	11.60	105.0	8.49	0.104
27	05-JAN-89	802.0	1.30	10.2	7.19	145.00	16.80	219.0	12.40	0.061
28	08-FEB-89	859.0	0.70	11.0	6.56	148.00	16.40	243.0	14.50	0.051
29	06-MAR-89	1284.0	1.00	8.4	6.27	174.00	17.80	284.0	14.60	0.117
30	10-APR-89	910.0	0.80	7.5	6.37	158.00	14.40	246.0	12.50	0.148
31	04-MAY-89	627.0	0.85	6.5	6.46	98.90	10.90	164.0	11.40	0.252
32	05-JUN-89	574.0	1.00	8.4	6.72	92.00	10.40	159.0	12.30	0.031
33	06-JUL-89	553.0	0.50	8.9	7.32	86.80	9.87	151.0	12.40	0.026
34	04-AUG-89	535.0	0.35	9.9	7.06	82.50	8.90	144.0	13.10	0.015
35	08-SEP-89	549.0	0.40	11.0	7.16	84.90	9.70	146.0	13.50	0.006
36	05-OCT-89	527.0	0.92	10.8	6.72	81.10	9.70	139.0	13.40	0.040
37	06-NOV-89	480.0	1.05	9.6	6.89	74.90	9.30	128.0	12.10	0.048
38	05-DEC-89	589.0	4.50	8.2	6.59	95.90	12.30	159.0	10.60	0.222
39	08-JAN-90	819.0	0.98	7.3	6.37	138.00	15.60	227.0	14.10	0.111

TABLE 10

SURFACE WATER QUALITY DATA FROM THE OUTLET OF QUIDI VIDI LAKE (NF02ZM0015) DURING THE PERIOD 1986 TO 1994

	TOTAL COPPER MG/L	TOTAL ZINC MG/L	DISSOLVED MERCURY UG/L	TOTAL LEAD MG/L	NITRATE UNFILTERED MG/L	TOTAL PHOSPHORUS MG/L
1	0.0018	0.0197	0.020	0.0010	0.272	0.0122
2	0.0025	0.0388	0.020	0.0032	0.407	0.0211
3	0.0057	0.0407	0.020	0.0042	0.504	0.0212
4	0.0031	0.0484	0.020	0.0061	0.497	0.0193
5	0.0019	0.0421	0.020	0.0007	0.436	0.0168
6	0.0033	0.0570	0.020	0.0036	0.432	0.0183
7	0.0019	0.0257	0.020	0.0013	0.293	0.0165
8	0.0037	0.0202	0.020	0.0015	0.243	0.0122
9	0.0079	0.0137	0.020	0.0011	0.230	0.0137
10	0.0053	0.0069	0.020	0.0006	0.259	0.0123
11	0.0036	0.0086	0.020	0.0013	0.316	0.0114
12	0.0045	0.0093	0.010	0.0016	0.339	0.0100
13	0.0022	0.0271	0.010	0.0013	0.448	0.0163
14	0.0033	0.0324	0.010	0.0024	0.473	0.0153
15	0.0044	0.0426	0.010	0.0025	0.505	0.0186
16	0.0039	0.0473	0.010	0.0035	0.473	0.0221
17	0.0030	0.0415	0.010	0.0010	0.410	0.0170
18	0.0021	0.0297		0.0009	0.310	0.0102
19	0.0020	0.0195	0.010	0.0006	0.270	0.0144
20	0.0025	0.0140	0.010	0.0002	0.200	0.0096
21	0.0026	0.0119	0.010	0.0007	0.240	0.0108
22	0.0023	0.0086	0.010	0.0010	0.270	0.0082
23	0.0018	0.0080	0.010	0.0012	0.280	0.0156
24	0.0019	0.0073	0.010	0.0003	0.300	0.0146
25	0.0026	0.0231	0.010	0.0004	0.280	0.0197
26	0.0047	0.0294	0.010	0.0013	0.450	0.0145
27	0.0030	0.0384	0.010	0.0010	0.480	0.0164
28	0.0024	0.0434	0.020	0.0007	0.530	0.0123
29	0.0030	0.0508	0.010	0.0009	0.450	0.0181
30	0.0046	0.0458	0.010	0.0013	0.350	0.0201
31	0.0023	0.0343	0.010	0.0033	0.210	0.0225
32	0.0025	0.0218	0.010	0.0004	0.210	0.0100
33	0.0018	0.0153	0.010	0.0002	0.260	0.0092
34	0.0031	0.0121	0.010	0.0002	0.290	0.0127
35	0.0018	0.0069	0.010	0.0002	0.700	0.0068
36	0.0018	0.0076	0.010	0.0002	0.380	0.0123
37	0.0018	0.0153	0.010	0.0002	0.360	0.0140
38	0.0035	0.0387	0.010	0.0024	0.500	0.0235
39	0.0025	0.0497	0.010	0.0005	0.530	0.0210

TABLE 10
SURFACE WATER QUALITY DATA FROM THE OUTLET OF QUIDI VIDI LAKE
(NF02ZM0015) DURING THE PERIOD 1986 TO 1994

	SAMPLE DATE	SPECIFIC CONDUCTANCE USIE/CM	TURBIDITY JT UNITS	TOTAL ALKALINITY MG/L	PH PH UNITS	DISSOLVED SODIUM MG/L	DISSOLVED SULPHATE MG/L	DISSOLVED CHLORIDE MG/L	DISSOLVED CALCIUM MG/L	TOTAL ALUMINUM MG/L
40	12-FEB-90	884.0	4.40	6.2	6.40	153.00	17.40	246.0	13.40	0.317
41	06-MAR-90	725.0	1.70	6.0	6.48	124.00	11.50	202.0	10.60	0.251
42	03-APR-90	1052.0	0.60	7.9	6.44	178.00	16.80	291.0	15.90	0.084
43	11-MAY-90	764.0	0.58	6.0	6.65	122.00	14.10	222.0	14.40	0.081
44	06-JUN-90	461.0	0.84	3.1	6.51	74.00	11.00	128.0	10.10	0.109
45	04-JUL-90	450.0	0.65	8.1	6.69	69.50	9.50	120.0	9.93	0.043
46	14-AUG-90	533.0	0.81	10.4	6.81	80.50	9.50	146.0	12.50	0.041
47	12-SEP-90	518.0	1.70	12.4	6.93	78.60	10.80	135.0	12.20	0.067
48	05-OCT-90	353.0	1.80	9.5	6.30	54.80	9.70	91.7	8.36	0.140
49	19-NOV-90	554.0	1.20	9.2	6.07	91.80	12.70	161.0	9.20	0.093
50	06-DEC-90	605.0	2.40	9.9	6.73	101.00	14.10	164.0	10.00	0.227
51	07-JAN-91	495.0	1.40	9.5	6.50	79.30	14.20	129.0	9.37	0.080
52	07-FEB-91	847.0	0.55	11.0	6.69	146.00	16.80	213.0	12.90	0.070
53	04-APR-91	773.0	0.80	7.5	6.63	135.00	14.00	212.0	11.70	0.165
54	03-MAY-91	542.0	1.40	7.8	6.51	87.50	10.30	149.0	9.65	0.126
55	06-JUN-91	439.0	0.92	7.0	6.50	69.20	10.40	115.0	8.54	0.089
56	08-JUL-91	487.0	0.77	9.4	6.92	75.00	10.60	126.0	10.40	0.016
57	05-AUG-91	494.0	1.00	12.2	6.35	79.10	11.30	130.0	11.00	0.031
58	06-SEP-91	487.0	0.75	11.8	6.50	73.30	9.90	122.0	10.80	0.017
59	04-OCT-91	460.0	3.43	6.9	6.90	69.90	9.40	124.0	10.10	0.035
60	06-NOV-91	350.0	8.60	9.9	6.80	52.40	9.30	85.2	7.36	0.166
61	04-DEC-91	316.0	1.00	10.2	6.72	48.40	10.20	71.8	7.01	0.105
62	08-JAN-92	579.0	48.00	10.2	6.46	93.60	13.70	152.0	9.50	0.214
63	05-FEB-92	913.0	0.77	12.0	6.23	151.00	20.90	245.0	13.20	0.084
64	06-MAR-92	1177.0	0.61	9.7	6.26	198.00	19.10	317.0	15.90	0.058
65	03-APR-92	605.0	0.58	5.6	6.05	99.40	2.00	159.0	9.70	0.162
66	13-MAY-92	414.0	5.80	5.8	6.01	65.10	17.00	105.0	7.30	0.123
67	04-JUN-92	434.0	0.78	8.2	7.70	69.70	9.40	113.0	8.50	0.059
68	10-JUL-92	372.0	1.00	8.4	6.61	56.90	7.70	88.9	8.10	0.067
69	05-AUG-92	410.0	0.52	12.1	6.99	62.80	9.40	105.0	8.80	0.045
70	08-SEP-92	449.0	0.88	12.8	6.44	69.90	10.30	104.0	9.97	0.044
71	13-OCT-92	471.0	1.00	10.5	6.36	47.10	9.50	76.9	7.09	0.096
72	06-NOV-92	331.0	3.90	10.2	6.99	50.40	9.80	81.8	7.30	0.069
73	08-DEC-92	583.0	7.40	11.1	6.97	94.90	12.50	147.0	9.37	0.112
74	08-APR-93	779.0	0.79	9.1	6.57	129.00	13.90	216.0	13.30	0.064
75	12-MAY-93	488.0	1.88	6.8	6.66	79.20	12.10	138.0	8.84	0.081
76	06-JUL-93	333.0	0.90	8.0	6.77	50.30	9.60	84.8	7.02	0.101
77	05-AUG-93	352.0	3.20	11.2	7.04	55.70	10.80	91.9	7.74	0.053
78	14-SEP-93	388.0	4.70	14.1	6.90	58.80	9.50	92.6	8.85	0.028

TABLE 10

SURFACE WATER QUALITY DATA FROM THE OUTLET OF QUIDI VIDI LAKE (NF02ZM0015) DURING THE PERIOD 1986 TO 1994

	TOTAL COPPER MG/L	TOTAL ZINC MG/L	DISSOLVED MERCURY UG/L	TOTAL LEAD MG/L	NITRATE UNFILTERED MG/L	TOTAL PHOSPHORUS MG/L
40	0.0039	0.0590	0.010	0.0030	0.420	0.0223
41	0.0036	0.0464	0.010	0.0026	0.360	0.0294
42	0.0029	0.0499	0.010	0.0002	0.520	0.0203
43	0.0020	0.0388	0.010	0.0002	0.420	0.0145
44	0.0021	0.0312	0.020	0.0003	0.530	0.0146
45	0.0026	0.0187	0.010	0.0006	0.380	0.0123
46	0.0019	0.0077	0.020	0.0002	0.390	0.0069
47	0.0024	0.0091	0.010	0.0003	0.330	0.0136
48	0.0030	0.0229	0.010	0.0010	0.680	0.0153
49	0.0027	0.0277	0.010	0.0005	0.520	0.0065
50	0.0032	0.0311	0.010	0.0013	0.540	0.0166
51	0.0029	0.0292	0.010	0.0005	0.720	0.0109
52	0.0029	0.0461	0.010	0.0003	0.560	0.0139
53	0.0029	0.0499	0.010	0.0009	0.450	0.0188
54	0.0024	0.0344	0.030	0.0006	0.340	0.0061
55	0.0024	0.0264	0.010	0.0002	0.370	0.0124
56	0.0023	0.0157	0.010	0.0002	0.320	0.0121
57	0.0028	0.0162	0.010	0.0002	0.310	0.0118
58	0.0019	0.0082	0.010	0.0002	0.360	0.0074
59	0.0019	0.0071	0.010	0.0003	0.340	0.0177
60			0.010		0.440	0.0103
61			0.010		0.570	0.0057
62	0.0030	0.0375	0.010	0.0010	0.570	0.0069
63	0.0031	0.0415	0.010	0.0005	0.580	0.0094
64	0.0028	0.0479	0.010	0.0002	0.540	0.0046
65	0.0028	0.0451	0.011	0.0009	0.460	0.0070
66	0.0022	0.0252	0.005	0.0003	0.330	0.0076
67	0.0022	0.0187	0.005	0.0004	0.280	0.0073
68	0.0028	0.0197	0.005	0.0004	0.310	0.0059
69	0.0023	0.0135	0.007	0.0008	0.300	0.0043
70	0.0024	0.0056	0.006	0.0005	0.650	0.0085
71	0.0023	0.0217	0.005	0.0005	0.440	0.0113
72	0.0025	0.0189	0.005	0.0005	0.500	0.0106
73	0.0035	0.0291	0.005	0.0016	0.550	0.0070
74	0.0029	0.0416	0.005	0.0003	0.530	0.0154
75	0.0025	0.0279	0.005	0.0004	0.480	0.0098
76	0.0031	0.0225	0.016	0.0005	0.390	0.0126
77	0.0026	0.0117	0.069	0.0005	0.380	0.0130
78	0.0026	0.0087	0.012	0.0004	0.400	0.0109

TABLE 10
SURFACE WATER QUALITY DATA FROM THE OUTLET OF QUIDI VIDI LAKE
(NF02ZM0015) DURING THE PERIOD 1986 TO 1994

	SAMPLE DATE	SPECIFIC CONDUCTANCE USIE/CM	TURBIDITY JT UNITS	TOTAL ALKALINITY MG/L	PH PH UNITS	DISSOLVED SODIUM MG/L	DISSOLVED SULPHATE MG/L	DISSOLVED CHLORIDE MG/L	DISSOLVED CALCIUM MG/L	TOTAL ALUMINUM MG/L
79	05-OCT-93	386.0	0.41	13.2	6.85	55.50	11.40	96.3	8.85	0.042
80	10-NOV-93	311.0	0.64	10.6	6.64	52.40	9.80	78.4	6.24	0.095
81	07-DEC-93	456.0	4.40	12.2	7.02	74.10	11.20	115.0	7.80	0.079
82	06-JAN-94	541.0	0.89	10.7	6.76	87.50		141.0	9.20	0.070
83	03-FEB-94	824.0	0.71	9.7	6.59	140.00	15.40	228.0	12.30	0.059
84	07-MAR-94	1225.0	1.20	9.3	6.54	218.00	22.30	376.0	16.70	0.062

	TOTAL COPPER MG/L	TOTAL ZINC MG/L	DISSOLVED MERCURY UG/L	TOTAL LEAD MG/L	NITRATE UNFILTERED MG/L	TOTAL PHOSPHORUS MG/L
79	0.0030	0.0081	0.012	0.0003	0.490	0.0092
80	0.0038	0.0205	0.025	0.0006	0.570	0.0106
81	0.0036	0.0228	0.020	0.0007	0.720	0.0115
82	0.0032	0.0262	0.005	0.0007	0.640	0.0127
83	0.0029	0.0449	0.005	0.0008	0.040	0.0062
84	0.0043	0.0618	0.013	0.0009	0.560	0.0099

TABLE 11
SURFACE WATER QUALITY CONTROL TRIP AND LABORATORY BLANK
AND SPIKE SAMPLES FOR THE 1993 QUIDI VIDI BASIN INTENSIVE
SURVEY REPORT

	SAMPLE DATE	APPARENT COLOUR REL. UNITS	SPECIFIC CONDUCTANCE USIE/CM	TURBIDITY JT UNITS	DISSOLVED ORG. CARB. MG/L	NITRATE UNFILTERED MG/L	TOTAL NITROGEN MG/L	ALKALINITY GRAN MG/L	PH PH UNITS
TRIP BLK	10-AUG-93	L 5.0000	6.1	0.2	1.2	L .0100	L .0100	-0.3	5.1
TRIP SPK	10-AUG-93	L 5.0000	38.0	0.2	1.1	0.28	0.53	-0.3	5.3
LAB SPK	10-AUG-93	L 5.0000	38.0	0.1	1.1	0.08	0.50	-0.3	5.3
LAB BLK	10-AUG-93	L 5.0000	1.0	0.1	L .5000	L .0100	L .0100	-0.1	5.6

	DISSOLVED SODIUM MG/L	DISSOLVED MAGNESIUM MG/L	EXTRACT ALUMINUM MG/L	SILICA MG/L	TOTAL PHOSPHORUS MG/L	DISSOLVED SULPHATE MG/L	DISSOLVED CHLORIDE MG/L	DISSOLVED POTASSIUM MG/L
TRIP BLK	L .0500	L .1000	L .0100	L .1000	L .0010	L .0100	L .5000	0.05
TRIP SPK	2.4	0.21	0.11	L .1000	0.021	5.3	5.9	0.76
LAB SPK	2.4	0.14	0.11	L .1000	0.022	5.3	5.8	0.76
LAB BLK	L .0500	L .1000	L .0100	L .1000	L .0010	L .5000	L .5000	L .0500

	DISSOLVED CALCIUM MG/L	EXTRACT MANGANESE MG/L	EXTRACT COPPER MG/L	EXTRACT ZINC MG/L	TOTAL ARSENIC MG/L	EXTRACT CADMIUM MG/L	EXTRACT MERCURY UG/L	EXTRACT LEAD MG/L
TRIP BLK	0.4	L .0100	L .0020	L .0100	L .0005	L .0010	L .0200	L .0020
TRIP SPK	2.0	0.1	0.010	0.11	0.0050	0.010	L .0200	0.01
LAB SPK	1.8	0.1	0.011	0.11	0.0051	0.011	0.05	0.01
LAB BLK	L .1000	L .0100	L .0020	L .0100	L .0005	L .0010	L .0200	L .0020

	EXTRACT IRON MG/L
TRIP BLK	L .0020
TRIP SPK	0.021
LAB SPK	0.022
LAB BLK	L .0020

FIGURE 1
SPECIFIC CONDUCTANCE (USIE/CM) AT RENNIES RIVER, VIRGINIA RIVER, AND QUIDI VIDI LAKE OUTLET DURING 1987 TO 1994

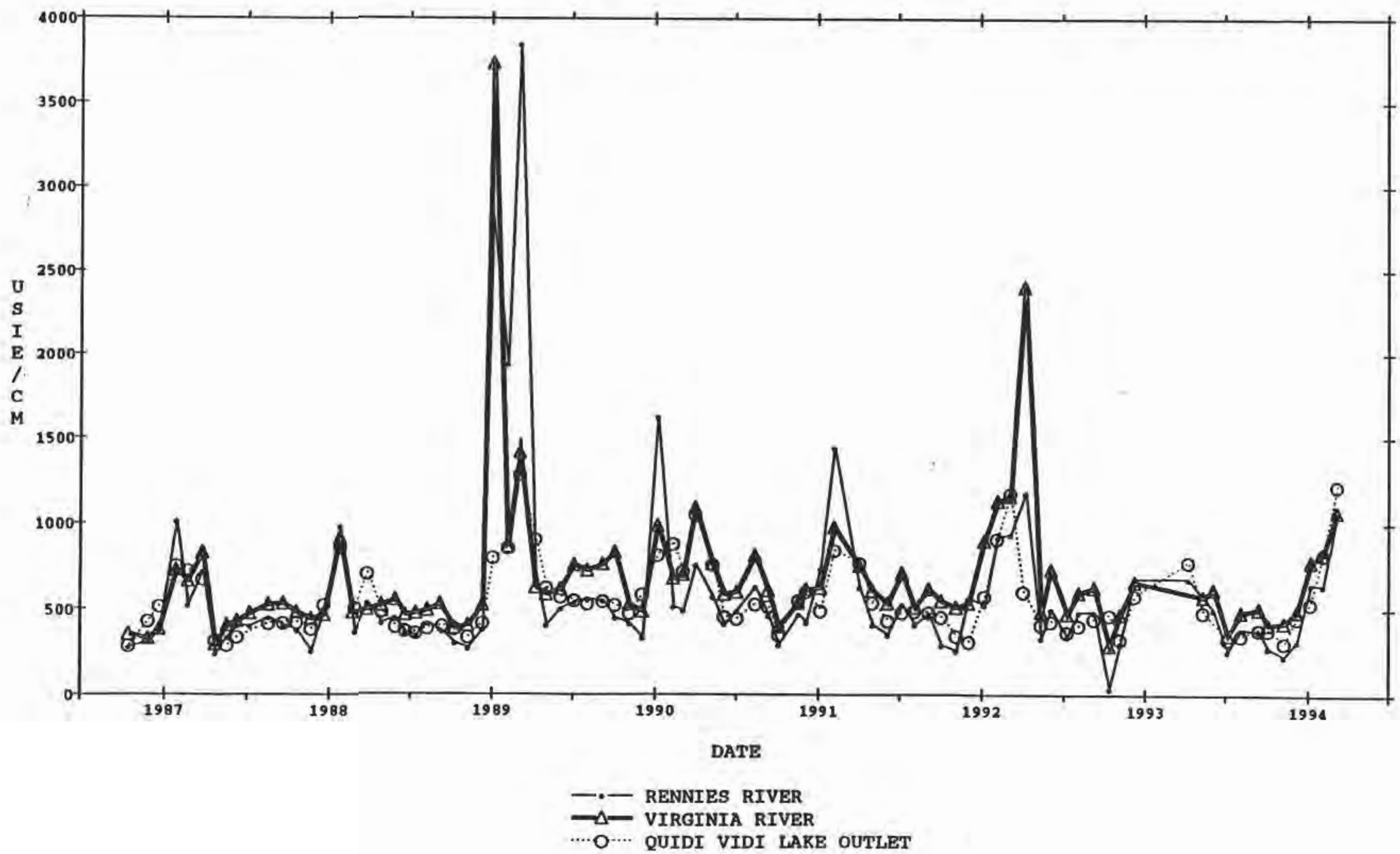


FIGURE 2

CONCENTRATIONS OF UNFILTERED NITRATE (MG/L) AND TOTAL PHOSPHORUS (MG/L) IN RENNIES RIVER AND VIRGINIA RIVER DURING 1987 TO 1994

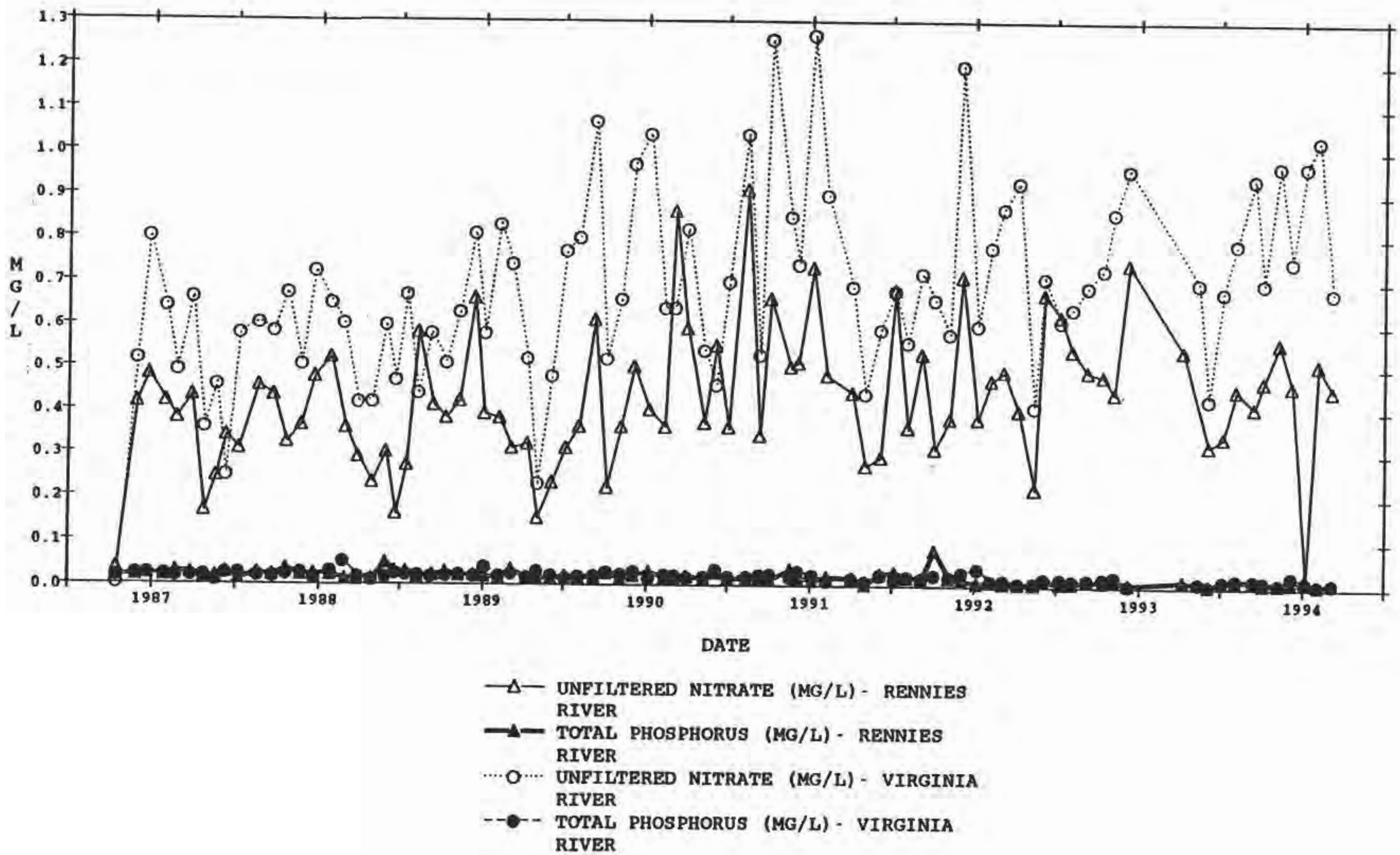


FIGURE 3
CONCENTRATIONS OF TOTAL LEAD (MG/L) IN RENNIES RIVER, VIRGINIA RIVER AND AT THE OUTLET OF QUIDI VIDI LAKE DURING 1987 TO 1994

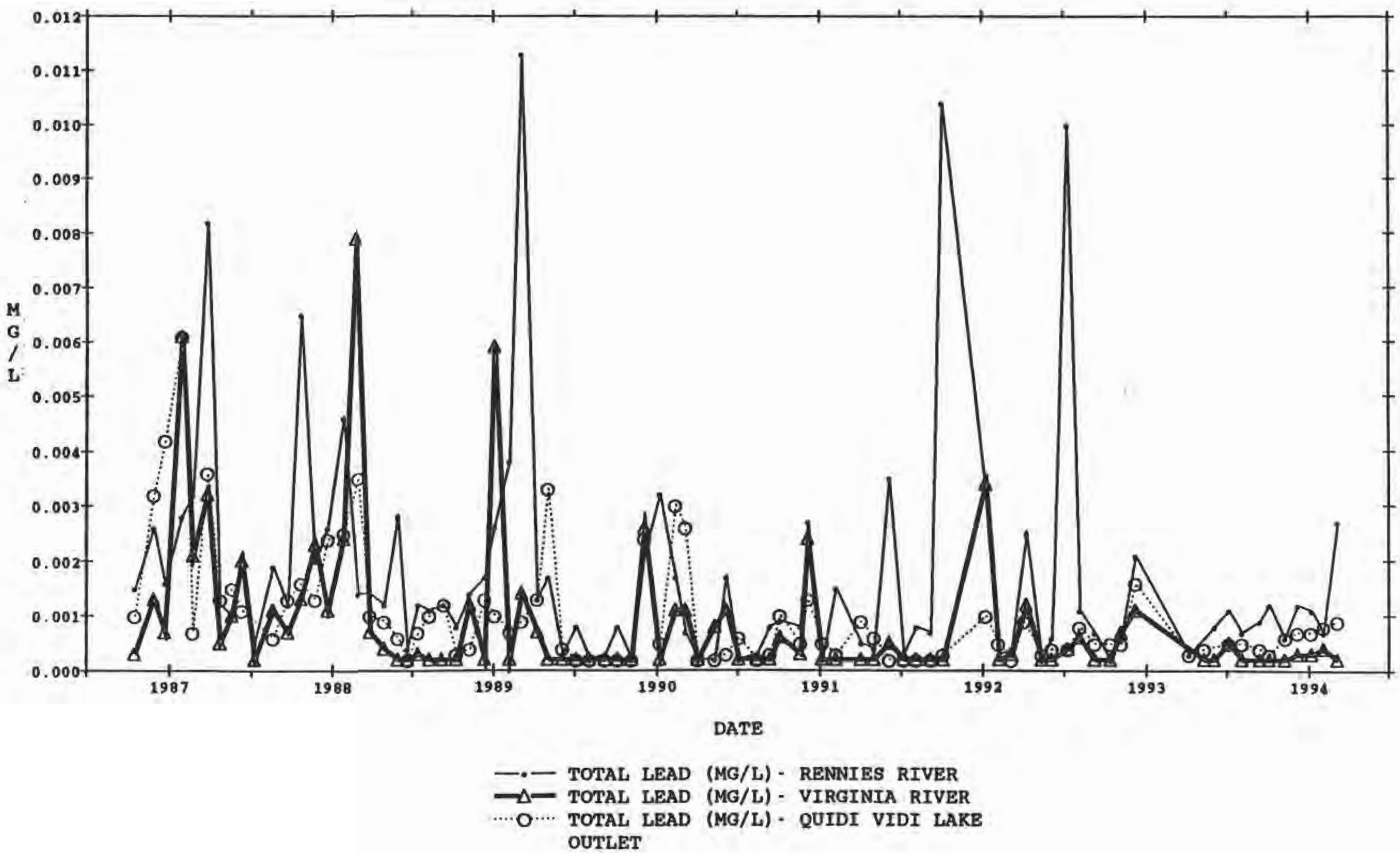


FIGURE 4
THE CONCENTRATIONS OF TOTAL COPPER AND ZINC (MG/L) AT RENNIES RIVER AND VIRGINIA RIVER DURING 1987 TO 1994

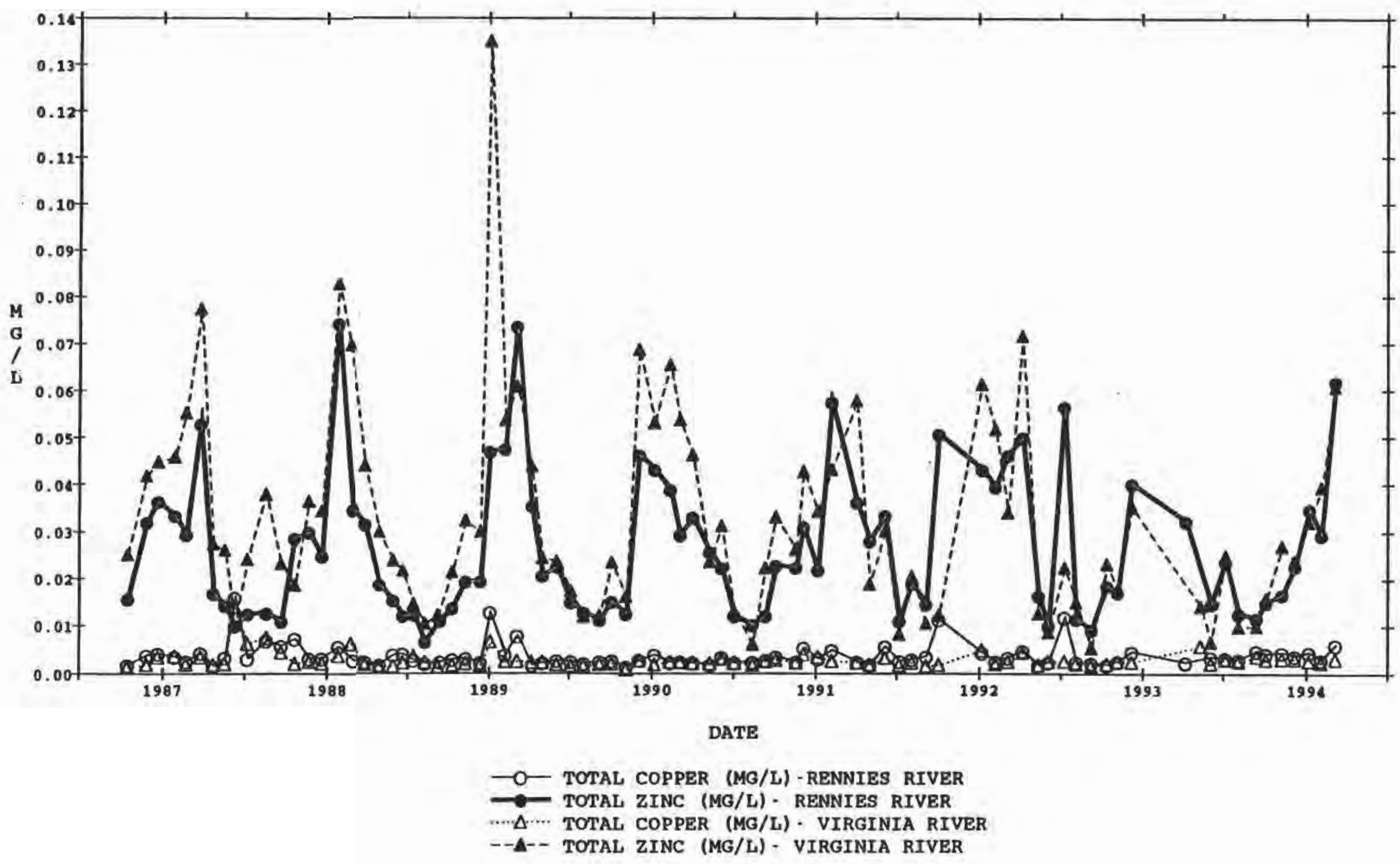
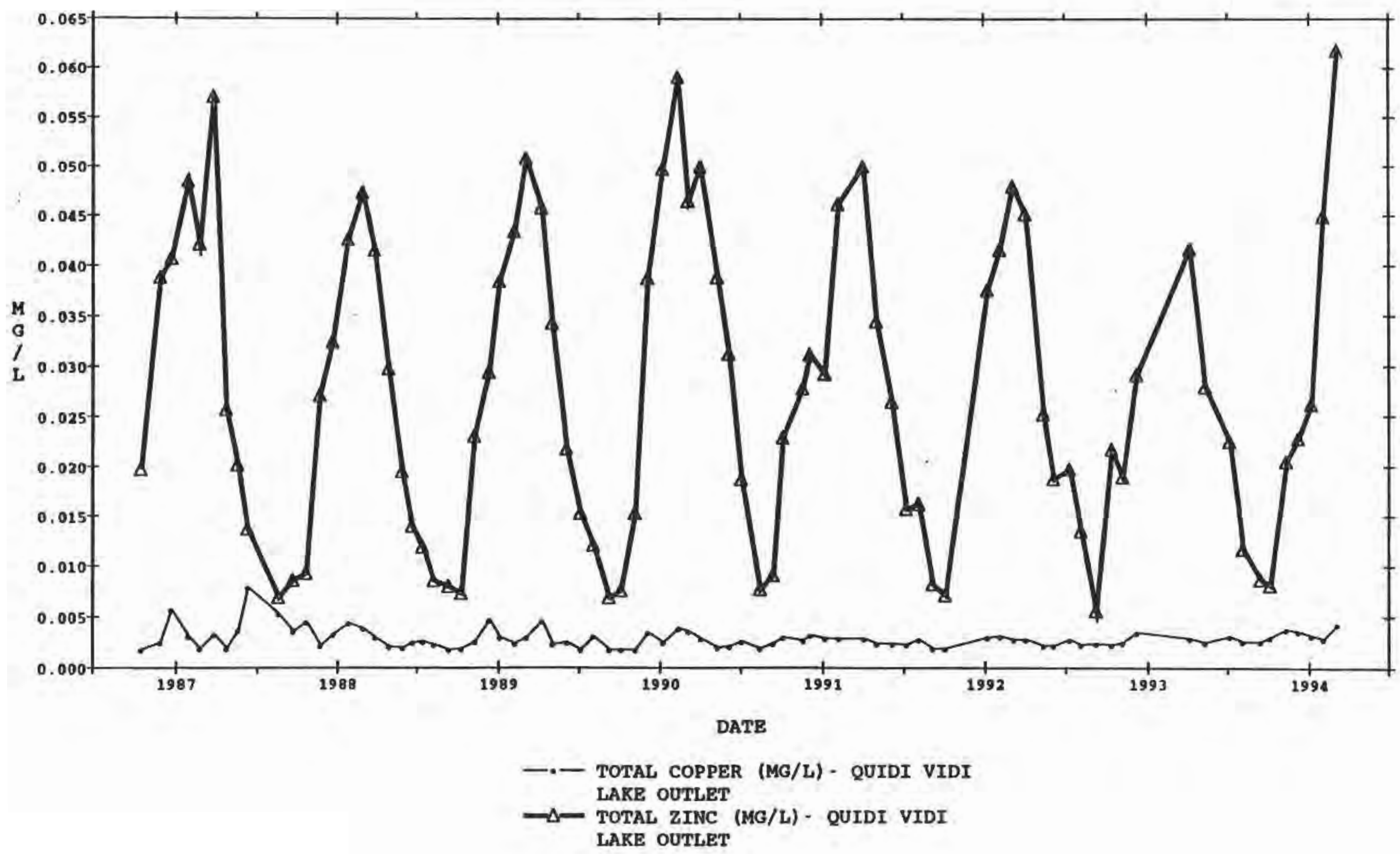
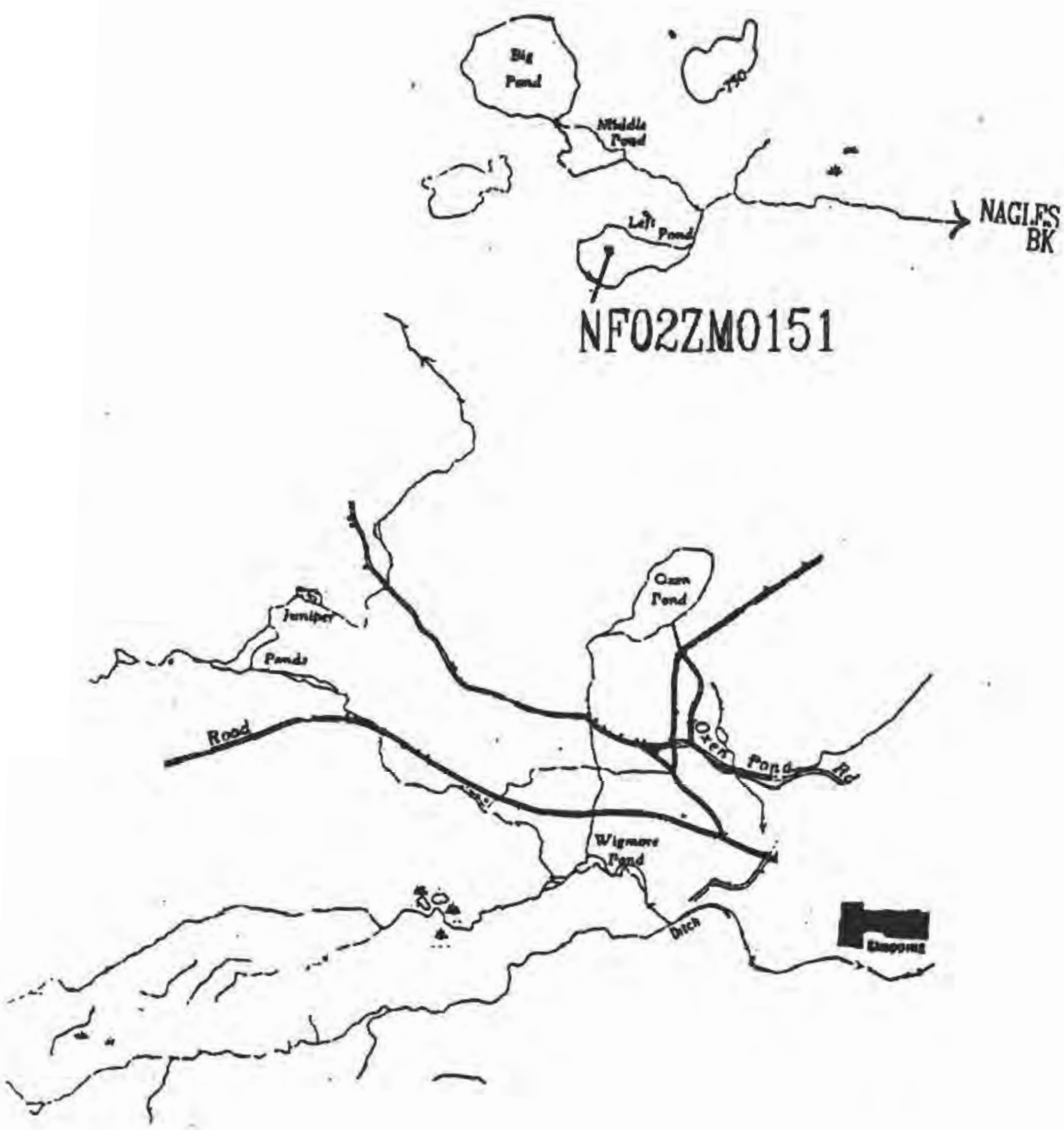


FIGURE 5
THE CONCENTRATIONS OF TOTAL COPPER AND ZINC (MG/L) AT THE OUTLET OF QUIDI VIDI LAKE DURING THE PERIOD OF 1987 TO 1994



MAP 1
WESTERN SECTION OF
QUIDI VIDI BASIN



MAP 2
EASTERN SECTION OF QUIDI VIDI BASIN

(ALL STATION NUMBERS PRECEED BY NF02)