Large Volume Sampling at Six Lake Ontario Tributaries During 1997 and 1998: Project Synopsis and Summary of Selected Results

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Large Volume Sampling at Six Lake Ontario Tributaries During 1997 and 1998:

Project Synopsis and Summary of Selected Results

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Preface

This data summary report, which does not include any statistically-based interpretation or discussion, has been prepared as a means of communicating results of this sampling exercise to all interested parties as soon as possible. The anticipated audience would include government agency staff associated with water quality management and the development of the Lake Ontario Lakewide Management Plan (LaMP), as well as researchers examining the ecosystem effects of toxic substances (persistent trace organics) within the Lake Ontario drainage basin. This study was undertaken as a screening level exercise to identify those watersheds (if any) exhibiting cumulative evidence of contaminant sources within their entire drainage area and to illustrate the general relationship between land use and water quality. It was not designed to identify specific contaminant sources within watersheds. The distribution of these data is intended to encourage and accelerate additional data synthesis and analysis by federal and provincial agency staff and the research community. It is anticipated that subsequent analysis will include a more rigorous statistical examination of the relationships among land use, flow conditions, and contaminant concentrations, along with a comparison of water quality findings with biomonitoring data. The potential application of these data to the estimation of loadings will also be examined.

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1. INTRODUCTION

1.1 Background

A need to update and improve upon source, concentration, and loading information for persistent, bioaccumulative, trace organic contaminants (commonly referred to as "persistent organic pollutants" or "POPs") in tributaries flowing into Lake Ontario was identified by both the Ontario Ministry of the Environment (MOE) and Environment Canada (EC) during 1996. The Province requires this information to assess surface water quality in Ontario according to the policies and Provincial Water Quality Objectives (PWQOs)[1] and as part of the development of a Provincial Toxics Plan for Priority Substances. The Canadian federal and provincial governments, in conjunction with U.S. state and federal governments, have also identified a further need for improved concentration and loading data during the development of a Lakewide Management Plan for Lake Ontario.

The principal limitation on previous measurement of tributary concentrations of trace organic contaminants (and hence estimated loadings) has been the difficulty achieving sufficiently low level analytical detection limits for these substances. In particular, the routine MOE detection limit for total PCBs in water has been 20 ng/L (positive identification of a trace amount) or ten times higher for a positively quantified result. This has not compared favourably with the PWQO of 1.0 ng/L and has precluded an accurate assessment of water quality status for this ubiquitous substance. Detection limits for other contaminants such as organochlorine pesticides have been better than this, but still not sufficiently below PWQOs to allow a quantitative assessment of compliance. In addition, existing routine tributary monitoring efforts by MOE have tended to under-sample during high flow events, biassing estimates of contaminant loadings towards low flow conditions.

Tributary and sewer effluent sampling studies by MOE and Metro Toronto (now City of Toronto) along the Toronto Waterfront during the period 1990 to 1993 successfully employed large volume sampling during wet and dry weather events to improve estimates of trace organic contaminant concentrations and loadings. These experiences demonstrated the potential for success of a low-level detection monitoring project to address data deficiencies for Lake Ontario tributaries, and in the spring of 1997 a collaborative sampling program was established between the Environmental Conservation Branch at Environment Canada and the Environmental Monitoring and Reporting Branch at the Ontario Ministry of the Environment. The arrangement was designed to allow sampling under a range of flow conditions during the summer and fall of 1997, and the winter and spring of 1998.

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1 Water Management Policies, Guidelines Provincial Water Quality Objectives, 1995.

1.2 Objectives

Two of the principal objectives of the overall 1997/98 study were to:

(a) measure the ranges of contaminant concentrations under wet and dry conditions at a variety of Lake Ontario watersheds comprising a range of land uses near the point at which they flow into the lake and compare the results with PWQOs; and

(b) use the data to screen these watersheds for anomalies indicative of potentially significant contaminant sources and which could justify the need for follow-up source "track down" monitoring.

The data were also collected with a view to estimating contaminant loadings from the selected tributaries to Lake Ontario by using the concentration data in conjunction with flow data. Calculation of the uncertainty associated with these estimates is central to any such exercise since it is well documented that the confidence of such calculations would be limited by the relatively small number of samples available through this study. This analysis and discussion will be the focus of a separate report.

2. LAKE ONTARIO DRAINAGE BASIN AND SAMPLING LOCATIONS

2.1 Summary Description of Lake Ontario Basin

Lake Ontario is the last in the chain of Great Lakes and is the smallest Great Lake in terms of surface area (approximately 19,000 square kilometres) although its total volume of 1,640 cubic kilometres is over three times greater than that of Lake Erie. About 93% of the lake's water flows out through the St. Lawrence River and another 7% is lost through evaporation. The average "residence time" for water in the lake is approximately six years. On average, approximately 80% of the water flowing into Lake Ontario comes from Lake Erie via the Niagara River with the remaining flow coming from tributaries within the Lake Ontario watershed and from precipitation. With a watershed land area of approximately 64,000 km^2 (of which slightly less than half lies in Ontario), Lake Ontario has the highest ratio of watershed land area to lake surface area of all the Great Lakes. The total estimated tributary flow to the lake is approximately 860 $m^3 s^{-1}$ and is evenly divided between the Ontario and New York State portions of the lake's watershed at roughly 430 $m^3 s^{-1}$ each [2].

Although the peripheral upland areas of the Lake Ontario basin are forested, nearer the lake, the basin's climate and soil types support various agricultural activities (areas such as the Niagara region are highly specialized for growing fruits and vegetables) and urban areas with high population densities. The "Golden Horseshoe" extending from Cobourg in the east around the western end of Lake Ontario to St. Catharines and Niagara Falls is highly urbanized and industrialized and includes Metropolitan Toronto and the industrial centre of Hamilton.

2.2 Land Use and Pollution Sources

The extensive urban/industrial and rural/agricultural land use activity within the drainage area of Lake Ontario accounts for a range of pollutants entering tributaries and lakes from "point sources" (e.g. industrial and municipal effluent discharges) and "non-point sources" (e.g. diffuse runoff from urban or agricultural areas). These pollutants include suspended solids, dissolved solids, bacteria (not included in this study), nutrients, metals, and trace organic contaminants (including pesticides, PCBs, and a range of industrial organic chemical byproducts).

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[2] Information sources:

Lake Ontario Toxics Management Plan, A Report by the Lake Ontario Toxics Committee February 1989, Environment Canada, United States Environmental Protection Agency, Ontario Ministry of the Environment, New York State Department of Environmental Conservation.

The Great Lakes, An Environmental Atlas and Resource Book, Jointly produced by: Government of Canada and United States Environmental Protection Agency, Third Edition 1995.

The Lake Ontario Lakewide Management Plan, Stage 1: Problem Definition, Environment Canada, United States Environmental Protection Agency, Ontario Ministry of the Environment, New York State Department of Environmental Conservation, May 1998.

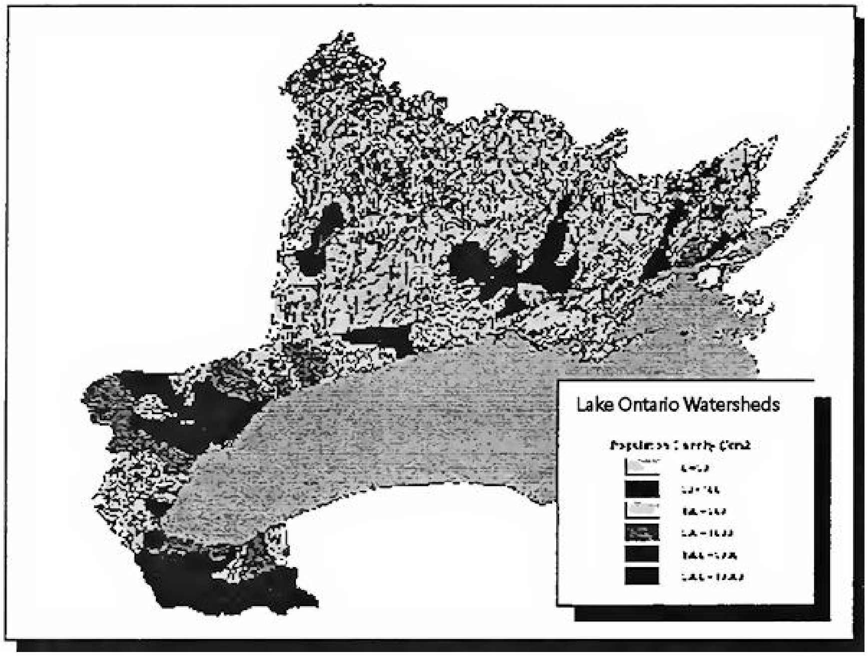

Figure 2.1: Population Densities in the Lake Ontario Drainage Basin

Spatial and temporal trends in water quality throughout this area of the province can often be linked to shifts in these land use patterns as well trends in contaminant loads from wastewater discharges (which have tended to decrease over the past 20 years).

Contaminants associated with urban runoff include polynuclear aromatic hydrocarbons (PAHs) which include benzo(a)pyrene (BaP), as well as metals and petroleum hydrocarbons. These contaminants are associated with vehicle exhaust, brake and tire wear, fuel and engine oil leaks or spills, and corrosion and are most prevalent in areas with high traffic densities. Other contaminants associated with roads and urban runoff include suspended solids, nutrients, pesticides and bacteria from sanitary sewer cross connections, infiltration from the sanitary sewer systems, accidental or deliberate spills to road side catch basins, chemical applications (fertilizers and pesticides), run off from commercial/industrial storage areas, and faecal material from wildlife and domestic animals.

Pollutants linked to rural and agricultural land uses can overlap with urban sources. Agricultural activities can contribute suspended solids from erosion and livestock access to waterways, nutrients from fertilizer and manure applications, and pesticides from run-off or drift during application. Sources of elevated bacteria can be liked to run-off from improper manure handling or inappropriate field applications, animal storage areas, faecal material from livestock. The relative impact of suspended solids, fertilizers and pesticides on rural streams can vary widely with the season and local farm practices but can be significant, particularly during the spring.

Not all pollutants are locally or recently generated. Many of the persistent "trace organic compounds" which are still being detected in the water, sediment, and biota of Lake Ontario and its tributaries are pesticides which have not been used in Ontario for decades, if ever. Present day sources may be hundreds or thousands of kilometres away, but deposition from long-range atmospheric transport combined with large tributary catchment areas can focus contaminants into tributary waters.

2.3 Description of Sampling Locations

Six tributaries in the Canadian portion of the Lake Ontario watershed were sampled over the period July 1997 to March 1998. These were: the Credit River, the Humber River, the Ganaraska River, the Trent River, Twenty Mile Creek, and Twelve Mile Creek (Figure 2.2). These tributaries were selected in order to cover the range of land use, watershed size, and average flows within the Lake Ontario drainage basin. Access to flow monitoring data and the potential for vandal-proof installation of automatic sampling equipment were other factors considered in the selection of tributaries and siting of sampling installations.

A summary of sampling locations, drainage basin areas, and annual average flows is presented in Table 2.1 to illustrate the range of tributary sizes covered by this study, and to provide an indication of the proportion of drainage basin area and flow from Ontario tributaries covered by the 1997/98 sampling program.

The large annual average flows from Twelve Mile Creek and the Trent River, and the extremely large drainage area associated with the Trent watershed, mean that the tributaries selected for sampling in 1997/98 cover approximately 80% of the Ontario tributary flows (excluding the Niagara River), and about 50 % of the Ontario watershed area.

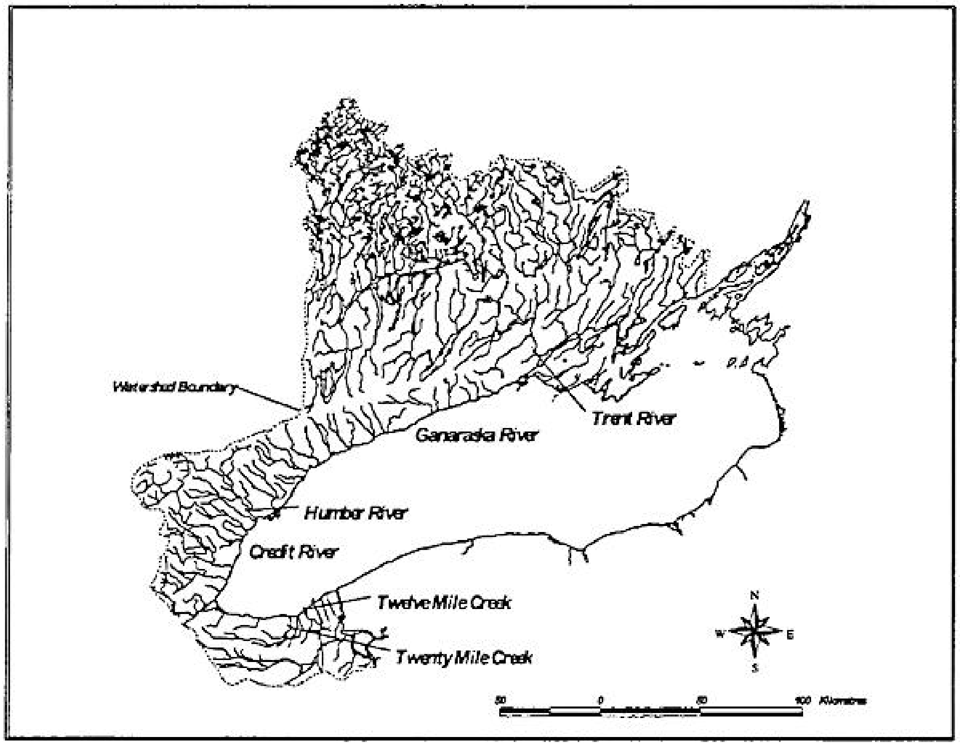

Figure 2.2: 1997/98 Tributary Toxics Monitoring Locations.

Table 2.1: Summary of Sampling Locations, Drainage Basin Areas, and Annual Average Flows for 1997/98 Tributary Sampling.

Tributary	Station Description	Latitude	Longitude	Approx. Area (km^2)	Annual Flow ($m^2 s^{-1}$)
Credit River	Mississauga Golf and Country Club	43° 32.574	79° 38.002	650	6.9
Humber	Lawrence Ave. (first two samples) Old Mill Road (subsequent samples)	43° 37.849	79° 28.232	900	6.2
Ganaraska	Sylvan Glen Road	43° 59.444	78° 19.695	250	3.2
Trent	South of Hwy. 401 (500 m)	44° 07.476	77° 35.513	12700	142
Twenty Mile Creek	Balls Falls	43° 08.014	79° 22.588	300	3
Twelve Mile Creek	South end of Martindale Pond	43° 11.913	79° 15.933	N.A. *	189
Totals				14800	353.3

* flow diversion from Lake Erie

3. *SURVEY METHODS*

3.1 Field Methods

Large-volume water sample were collected using ISCO automatic samplers with Teflon-lined polyethylene tubing intake lines to minimize contamination of samples. The intake lines were connected to stainless steel pre-filters situated at mid-depth and in the main flow of the tributary. The ISCO samplers were modified to split the flow from the sampler distribution arm into three stainless steel 19 litre containers. Two of the containers were prepared for trace organics analysis by the Environment Canada National Laboratory for Environmental Testing (NLET) using a modification of the protocol previously established for Great Lakes samples. The third sample container, which was used for trace metals, major ions and nutrients analyses, was fitted with a disposable laboratory grade polyethylene bag liner for submission to the MOE Laboratory Services Branch (LSB).

Sample containers were cleaned and prepared, and samples were handled and delivered, using standard protocols designed to minimize sample contamination and degradation. The use of sample blanks and spiked samples further ensured accuracy of the results.

At sites which were co-located with stream flow gauging stations, sampling was triggered by the stream gauge using programmed set-points. Sampling for other sites involved either on-site or project personnel collecting samples in response to events and flow information from remotely accessed stream gauges. Sampling targeted a range of flows covering base-flow levels as well as rainfall events and peak spring flows based on hydrograph data. At Twelve Mile Creek, however, where high flows from Lake Erie are uniformly controlled for power generation and where the influence of runoff from the local drainage basin is extremely small, event sampling was coordinated with nearby Twenty Mile Creek.

3.2 Laboratory Methods

Samples were analysed for a range of trace contaminants and "conventional" pollutants. These included organochlorine pesticides, total polychlorinated biphenyls (total PCBs as represented by a suite of 103 congeners or congener groupings), and polynuclear aromatic hydrocarbon compounds (PAHs). Trace metals (Al, Cr, Cd, Cu, Fe, Hg, Mn, Ni, Pb, Zn) and selected major ions and nutrients were also included. Bacteriological analyses were not carried out as part of this study.

Sample preparation of trace organic samples (two 19 litre containers) involved centrifugation followed by liquid-liquid extraction of the supernatant and extraction of the solid phase. The two extracts were recombined for total PCB and organochlorine analysis by GC/ECD, and PAH analysis by GC/MSD at NLET. Samples from the third container were analysed for nutrients (N and P) and metals using MOE standard methods (AAS, colourimetry, ICP/MS) by the LSB.

Each sample run for PCB analysis included analysis of a laboratory blank and all reported results have been blank corrected.

Table 3.1: Summary of Detection Limits and PWQOs for Trace Organics Sampled in 1997/98.

Substance	Detection Limit (ng/L)	PWQO ng/L)
Aldrin/dieldrin	0.05	1
Benzo(a)pyrene	0.1	210
Chlordane	0.05	60
DDT (total)	0.05	3
HCB	0.05	6.5
Mirex	0.05	1
Octachlorostyrene	0.05	—
PCBs (total)	0.10	1

Table 3.2: Summary of Detection Limits and PWQOs for Trace Metals, Suspended Solids, and Total Phosphorus Sampled in 1997/98.

Substance	Detection Limit (µg/L)	PWQO (µg/L)
Suspended Solids	500	—
Total Phosphorus	4	* 30.0
Total Kjeldahl Nitrogen	20	—
Aluminum (clay-free sample)	10	* 75.0
Chromium	0.5	100
Copper	1	5.0
Iran	20	300
Lead	5	* 5.0
Manganese	0.5	—
Mercury (filtered sample)	0.02	0.2
Nickel	2	25
Zinc	0.5	* 20.0

* indicates interim PWQO

4. SUMMARY OF SELECTED RESULTS

The following summary focuses on trace organic contaminants and metals. Suspended solids and nutrients have also been included for comparison (since they are routinely available pollution indicators from other monitoring programs). Given the commonly observed relationship between flow conditions and water quality, all data have been partitioned into "wet" and "dry" weather samples to ensure that among-station comparisons of contaminant concentrations are not biassed by differences in the proportion of "wet" (high flow) events available at each station. This partitioning was based on inspection of hydrograph data (except at Twelve Mile Creek where partitioning was based on the Twenty Mile Creek sampling dates).

4.1 Comparison with PWQOs

The frequencies with which water quality parameters were detected above their respective Provincial Water Quality Objectives (PWQOs) are presented in Table 4.1. No samples were detected above PWQOs for chromium, mercury, Mirex, hexachlorobenzene, benzo(a)pyrene, or any of the organochlorine pesticides (lindane, aldrin/dieldrin. chlordane, DDT, endrin, endosulfan) in either dry or wet weather samples. Total PCBs, however, were detected above the PWQO of 1.0 ng/L in all wet and dry weather samples. Cadmium, copper, iron, nickel, lead, zinc, and total phosphorus had detection frequencies greater than PWQOs ranging from 0% to 100% depending upon the location and weather.

4.2 Dry and Wet Weather Contaminant Concentrations

Median concentrations for total phosphorus (TP), metals (Al, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn), total PCBs, organochlorine pesticides, and the PAH benzo(a)pyrene (BaP) are summarized in Table 4.2. Selected contaminant concentration results, along with flow data, are also presented in Figures 4.1 to 4.11.

As expected, all tributaries exhibited a pattern of wet weather median concentrations of suspended solids (SS) exceeding dry weather median concentrations. Similarly, all tributaries other than the Trent River had wet weather total Kjeldahl Nitrogen (TKN) and TP medians which exceeded the dry weather medians, frequently by more than an order of magnitude. Wet weather TP concentrations exceeded the interim PWQO of 0.030 mg/L at all tributaries other than the Trent River. Twenty Mile Creek's dry weather median also exceeded the interim PWQO for TP.

With the exception of Cd and Cr, wet weather metal median concentrations also exceeded dry weather median concentrations. Median concentrations of Cd, Cu, Fe, Pb, and Zn were all detected above their respective PWQOs at two or more tributaries, generally in wet weather samples with the exception of Cd at the Ganaraska and Trent Rivers. Results for BaP showed a similar pattern to that of SS, nutrients, and metals, with wet weather median concentrations exceeding dry weather concentrations at all locations. Total PCBs were an exception to this pattern. Wet weather median concentrations of PCBs did not tend to exceed dry weather medians except at the Humber River.

Results for all other organochlorine compounds were varied, depending upon sample type and location. a-BHC, lindane (γ-BHC), α-endosulfan, β-endosulfan, α-chlordane, dieldrin, p,p-DDD (a DDT metabolite), and p,p-DDT were the most frequently detected, although they were always present at concentrations well below their respective PWQOs.

The Credit River was the only sampling location having dry and wet weather median concentrations of Mirex above the detection limit (0.01 ng L^{-1}) with values of 0.06 ng L^{-1} and 0.02 ng L^{-1} respectively (well below the PWQO of 1.0 ng L^{-1}).

Table 4.1 Frequency of Detection Greater than Provincial Water Quality Objectives (shown in parentheses).

STN	WET/ DRY	N	TP (30 mg/L)	Cd (0.5 μg/L)	Cr (100 μg/L)	Cu (5 μg/L)	Fe (300 μg/L)	Hg (0.2 μg/L)	Ni (25 pg/L)	Pb (5 pg/L)	Zn (20 μg/L)
CREDIT	DRY	8	25%	38%	0%	0%	13%	0%	0%	0%	0%
	WET	6	100%	33%	0%	83%	100%	0%	50%	83%	100%
HUMBER	DRY	5	40%	20%	0%	20%	20%	0%	0%	20%	20%
	WET	7	86%	57%	0%	100%	100%	0%	29%	100%	100%
GANARASKA	DRY	3	0%	67%	0%	0%	0%	0%	0%	0%	0%
	WET	9	89%	33%	0%	0%	56%	0%	33%	0%	0%
TRENT	DRY	4	25%	75%	0%	0%	0%	0%	0%	0%	0%
	WET	8	13%	50%	0%	0%	0%	0%	0%	0%	0%
20 MILE CR.	DRY	7	100%	14%	0%	0%	0%	0%	0%	0%	0%
	WET	6	100%	17%	0%	50%	83%	0%	0%	50%	67%
12 MILE CR.	DRY	6	33%	0%	0%	0%	0%	0%	0%	0%	0%
	WET	6	67%	0%	0%	0%	33%	0%	0%	0%	0%

STN	WET/ DRY	N	TPCB (1 ng/L)	Aldrin/ Dieldrin (1 ng/L)	LINDANE (10 ng/L)	Σ-Heptachlor (+epoxide)(1 ng/L)	Σ-chlordane (60 ng/L)	Σ-Endosulfan (3 ng/L)	Mirex (1 ng/L)	Σ-DDT (3 ng/L)	Endrin (2 ng/L)
CREDIT	DRY	8	100%	0%	0%	0%	0%	0%	0%	0%	0%
	WET	6	100%	0%	0%	0%	0%	0%	0%	0%	0%
HUMBER	DRY	5	100%	0%	0%	0%	0%	0%	0%	0%	0%
	WET	7	100%	0%	0%	0%	0%	0%	0%	0%	0%
GANARASKA	DRY	3	100%	0%	0%	0%	0%	0%	0%	0%	0%
	WET	9	100%	0%	0%	0%	0%	0%	0%	0%	0%
TRENT	DRY	4	100%	0%	0%	0%	0%	0%	0%	0%	0%
	WET	8	100%	0%	0%	0%	0%	0%	0%	0%	0%
20 MILE CR.	DRY	7	100%	0%	0%	0%	0%	0%	0%	0%	0%
	WET	6	100%	0%	0%	0%	0%	0%	0%	0%	0%
12 MILE CR.	DRY	6	100%	0%	0%	0%	0%	0%	0%	0%	0%
	WET	6	100%	0%	0%	0%	0%	0%	0%	0%	0%

STN	WET/ DRY	N	BaP (210 ng/L)	HCB (6.5 ng/L)	Methoxychlor (40 ng/L)
CREDIT	DRY	8	0%	0%	0%
	WET	6	0%	0%	0%
HUMBER	DRY	5	0%	0%	0%
	WET	7	0%	0%	0%
GANARASKA	DRY	3	0%	0%	0%
	WET	9	0%	0%	0%
TRENT	DRY	4	0%	0%	0%
	WET	8	0%	0%	0%
20 MILE CR.	DRY	7	0%	0%	0%
	WET	6	0%	0%	0%
12 MILE CR.	DRY	6	0%	0%	0%
	WET	6	0%	0%	0%

Table 4.2 Summary of Median Flows and Concentrations.

STN	WET/ DRY	N	FLOW (CMS)	Susp. Sol (mg/L)	TKN (mg/L)	TP (mg/L	Al (μ/L)	Cd (μ/L)	Cr (μ/L)	Cu (μ/L)	Fe (μL)	Mn (μ/L)	Ni (μ/L)	Pb (μ/L)
CREDIT	DRY	8	3.59	6.00	0.43	0.014	59.30	0.00	4.74	2.56	93.45	10.24	0.00	0.00
	WET	6	19.50	184.00	1.60	0.370	720.50	0.00	2.81	8.45	1003.00	200.5	24.36	5.63
HUMBER	DRY	5	1.43	11.50	0.38	0.030	126.00	0.00	7.18	2.29	184.00	25.3	0.00	0.00
	WET	7	15.23	125.00	1.16	0.250	737.00	0.22	5.91	11.30	1200.00	181.00	3.85	8.71
GANARASKA	DRY	3	1.77	5.00	0.22	0.012	39.20	0.26	5.55	0.51	64.40	14.80	0.00	0.00
	WET	9	7.15	60.50	0.96	0110	218.00	0.00	3.28	1.30	411.00	68.60	0.00	0.00
TRENT	DRY	4	45.90	2.00	0.45	0.024	12.60	0.53	3.43	0.65	27.80	11.25	0.00	0.00
	WET	8	175.35	4.25	0.46	0.017	19.40	0.13	1.54	0.77	59.00	10.28	0.00	0.00
20 MILE CR.	DRY	7	0.08	4.00	0.72	0.086	77.30	0.00	3.53	1.44	92.90	52.60	2.90	0.00
	WET	6	30.65	194.00	2.35	0.760	1415.00	0.00	1.97	5.10	1105.00	123.70	4.43	2.87
12 MILE CR.	DRY	6	213.80	7.75	0.26	0.025	88.85	0.00	2.68	1.35	98.10	8.55	0.00	0.00
	WET	6	215.51	13.00	0.34	0.061	216.50	0.00	0.78	1.87	217.00	13.95	3.09	0.00

STN	WET/ DRY	N	FLOW (CMS)	Zn (μg/L)	PCB (ng/L)	BaP (ng/L)	TPAH (ng/L)	a-BHC (ng/L)	Lindane (ng/L)	Heptachlor (ng/L)	Aldrin (ng/L)	Heptchlor Epox. (ng/L)	γ-Chlordane (ng/L)	α-Endosulfan (ng/L)
CREDIT	DRY	8	3.59	5.72	4.2	0.66	22.25	0.06	0.15	0.00	0.00	0.03	0 00	0.03
	WET	6	19.50	31.10	2.9	5.36	119.20	0.28	0.36	0.00	0.00	0.01	0.00	0.22
HUMBER	DRY	5	1.43	4.54	4.2	1.03	32.70	0.13	0.10	0.00	0.00	0.00	0.00	0.04
	WET	7	15.23	43.80	5.4	22.15	271.06	0.39	0.29	0.00	0.00	0 02	0.02	0.17
GANARASKA	DRY	3	1.77	1.32	3.5	0.09	8.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	WET	9	7.15	5.06	3.2	0.15	18.05	0.17	0.09	0.00	0.00	0.00	0.00	0.03
TRENT	DRY	4	45.90	2.75	4.1	0.05	5.46	0.09	0.10	0.00	0.00	0 00	0.00	0.01
	WET	8	175.35	2.72	4.4	0	11.88	0.17	0.13	0.00	0.00	0.00	0.00	0.01
20 MILE CR.	DRY	7	0.08	4.28	4.2	0	11.97	0.07	0.09	0.00	0.00	0.00	0.00	0.02
	WET	6	30.65	28.30	2.4	0.34	25.69	0.32	0.36	0.00	0.00	0.02	0.00	0.12
12 MILE CR.	DRY	6	213.80	1.631	6.4	0.23	13.17	0.27	0.28	0.00	0.00	0.03	0.00	0.03
	WET	6	215.51	4.26	5.6	0.37	19.56	0.34	0.26	0.00	0.00	0.05	0.00	0.03

STN	WET/ DRY	N	FLOW (CMS)	α-Chlordane (ng/L)	Dieldrin (ng/L)	p,p-DDE (ng/L)	Endrin (ng/L)	p-Endoslfn (ng/L)	p,p-DDD (ng/L)	o,p-DDT (ng/L)	p,p-DDT (ng/L)	Methxychlr (ng/L)	Mirex (ng/L)	HCB (ng/L)
CREDIT	DRY	8	3.59	0.03	0.10	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.06	0.02
	WET	6	19.50	0.02	0.06	0.00	0.00	0.20	0.02	0.00	0.07	0.00	0.02	0.03
HUMBER	DRY	5	1.43	0.04	0.10	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.01
	WET	7	15.23	0.04	0.07	0.00	0.00	0.12	0.03	0.00	0.00	0.00	0.00	0.03
GANARASKA	DRY	3	1.77	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.01
	WET	9	7.15	0.00	0.20	0.00	0.00	0.03	0.05	0.00	0.14	0.00	0.00	0.02
TRENT	DRY	4	45.90	0.01	0.03	0.00	0.00	0.02	0.00	0.00	0.01	0.00	0.00	0.02
	WET	8	175.35	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
20 MILE CR.	DRY	7	0.08	0.01	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	WET	6	30.65	0.00	0.06	0.00	0.00	0.12	0.01	0.00	0.10	0.00	0.00	0.03
12 MILE CR.	DRY	6	213.80	0.02	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	WET	6	215.51	0.01	0.13	0.00	0.00	0.06	0.04	0.00	0.12	0.00	0.00	0.02

Note: Shaded Value Indicates Concentration Greater Than PWQO; "0.00" Indicates "Not Detected"

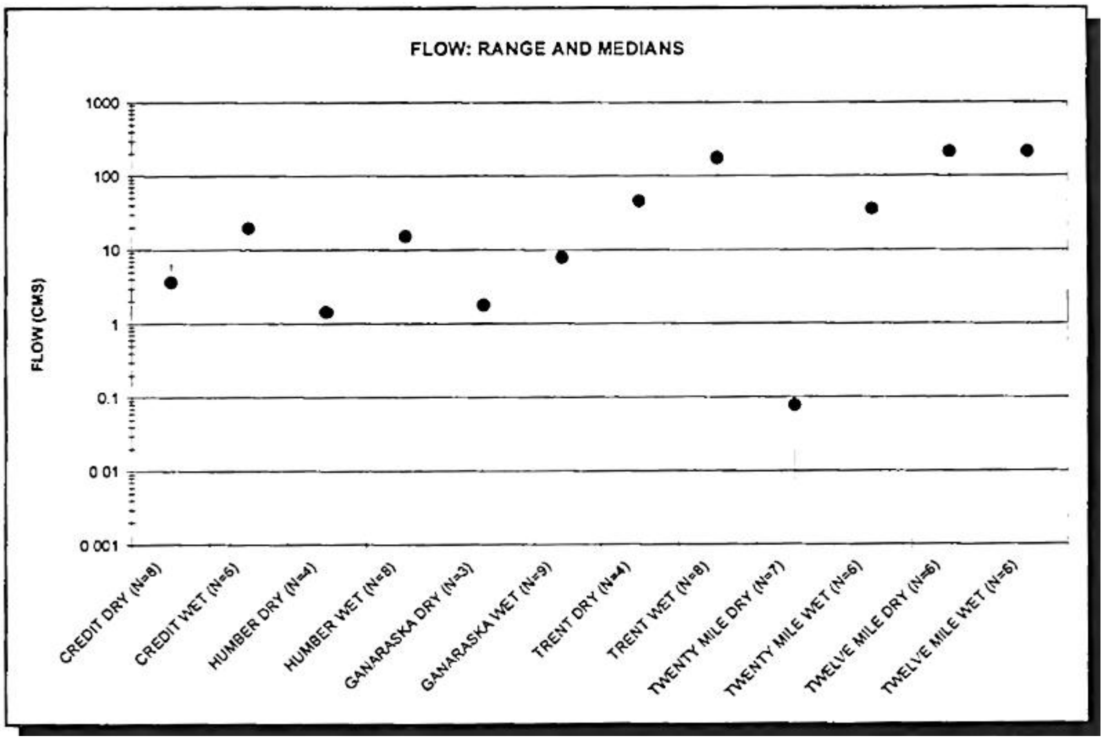

Figure 4.1: Range of Daily Flows Corresponding to 1997/98 Sampling Episodes.

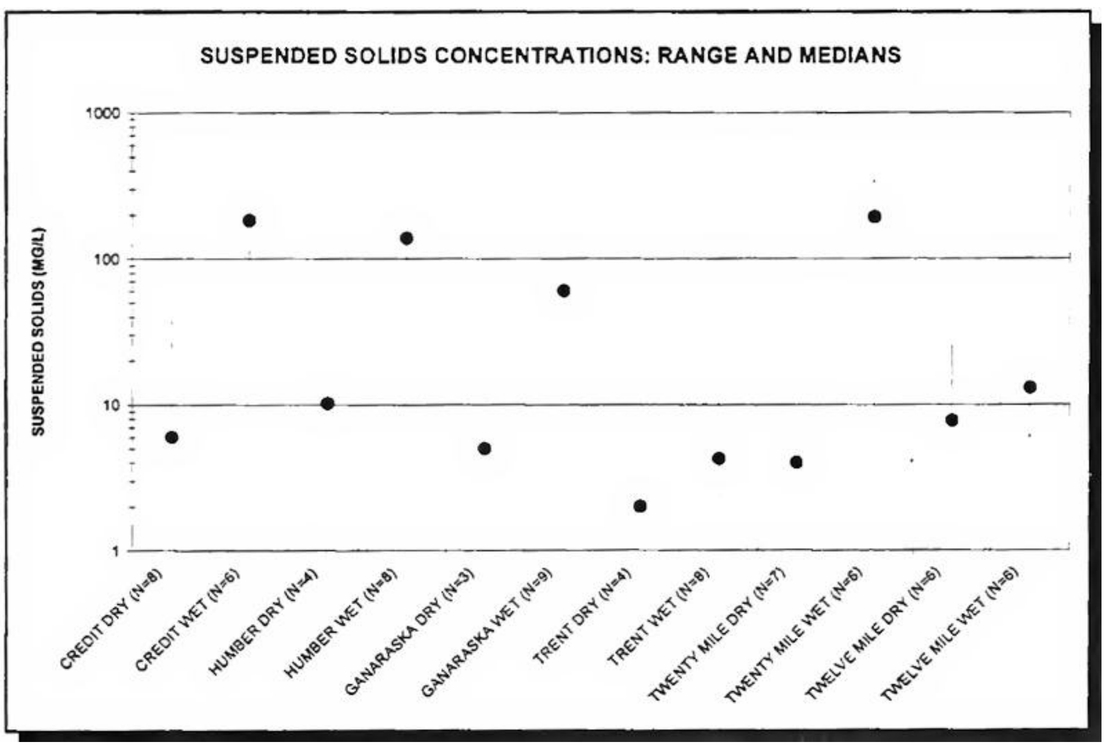

Figure 4.2: Range of Suspended Solids Concentrations Sampled During 1997/98.

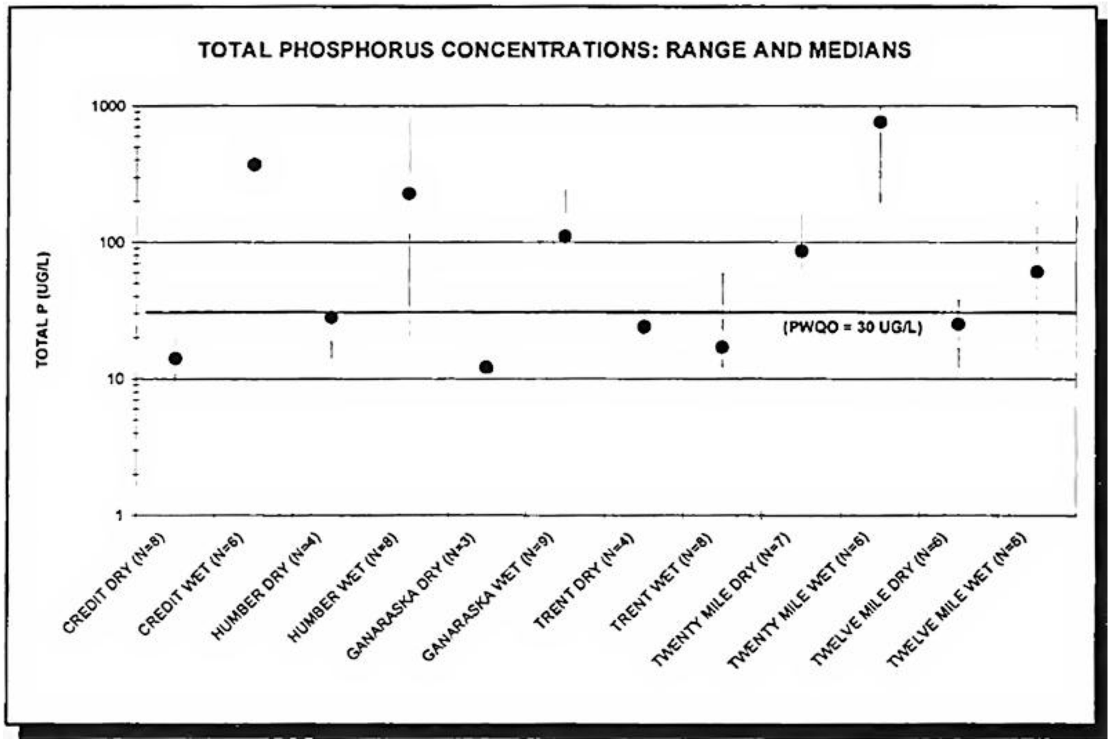

Figure 4.3: Range of Total Phosphorus Concentrations Sampled During 1997/98.

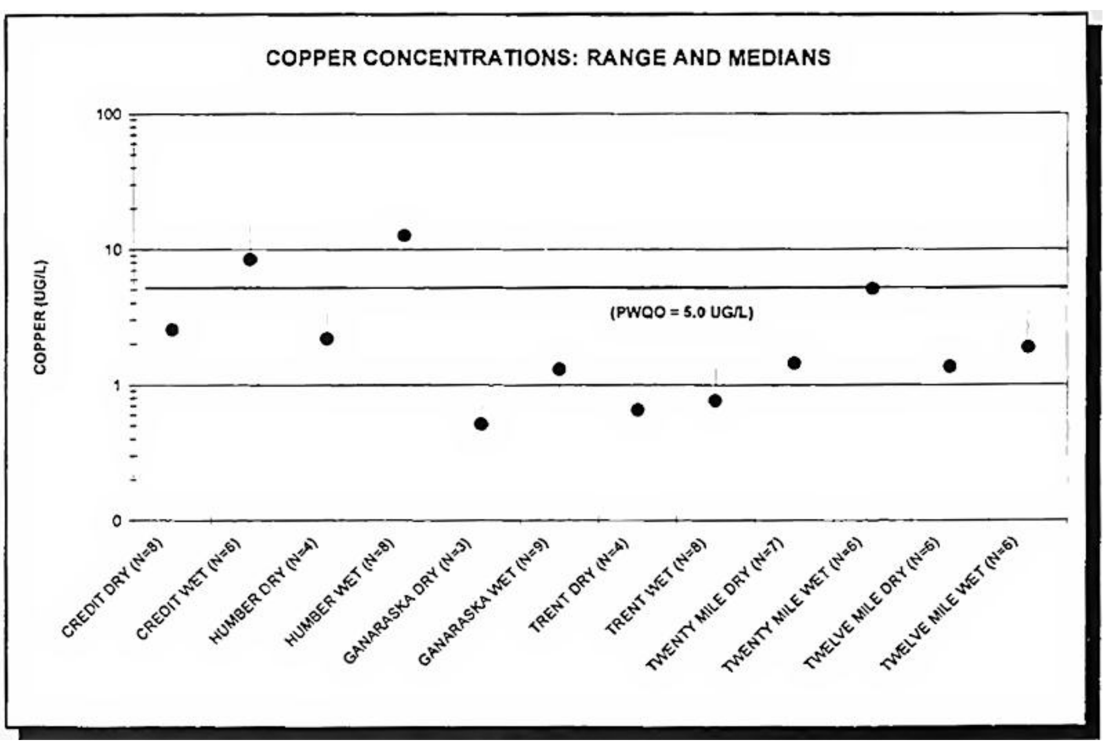

Figure 4.4: Range of Copper Concentrations Sampled During 1997/98.

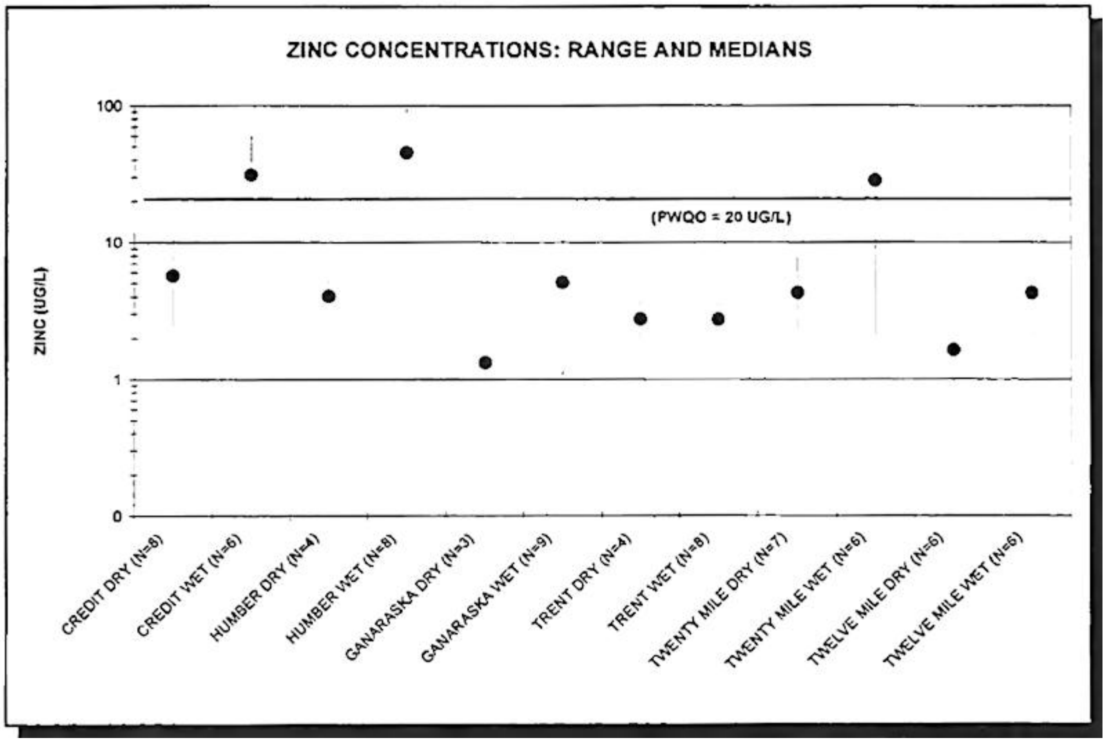

Figure 4.5: Range of Zinc Concentrations Sampled During 1997/98.

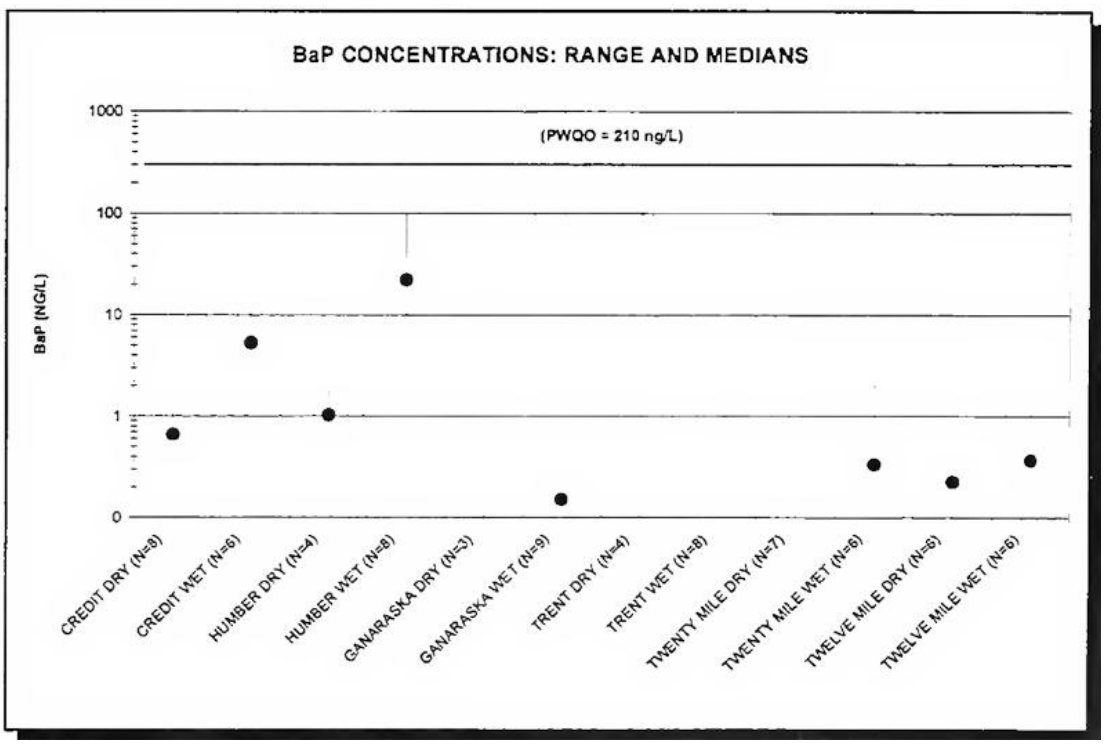

Figure 4.6: Range of Benzo(a)pyrene Concentrations Sampled During 1997/98.

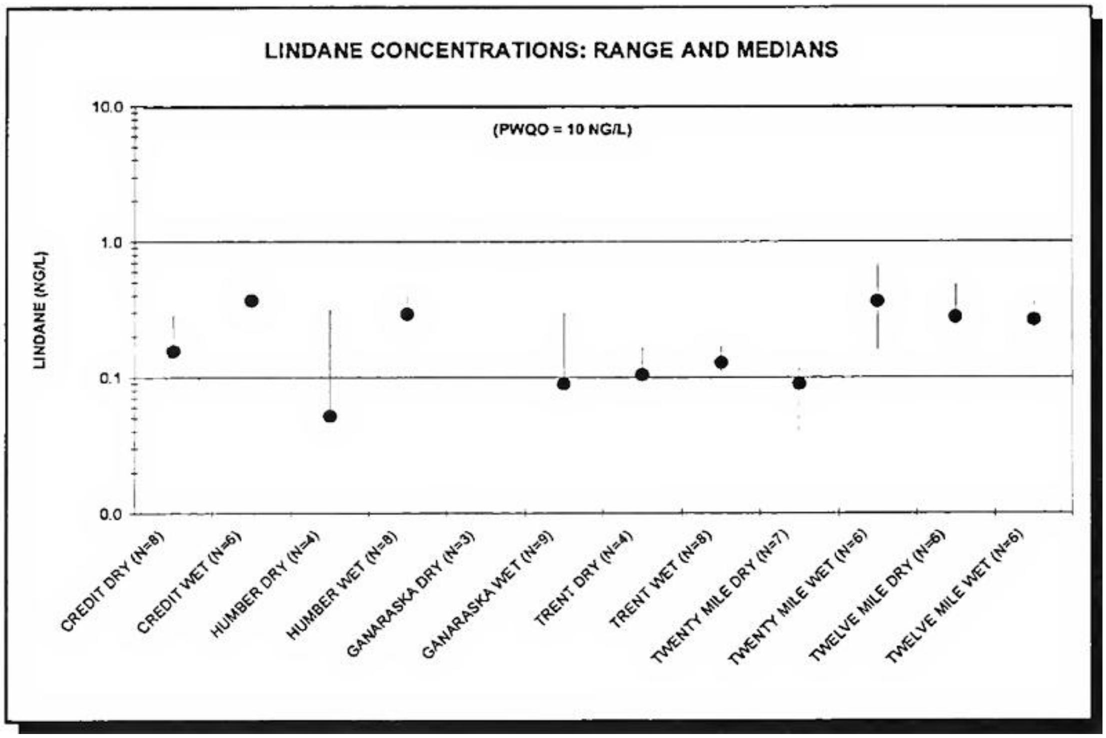

Figure 4.7: Range of Lindane Concentrations Sampled During 1997/98.

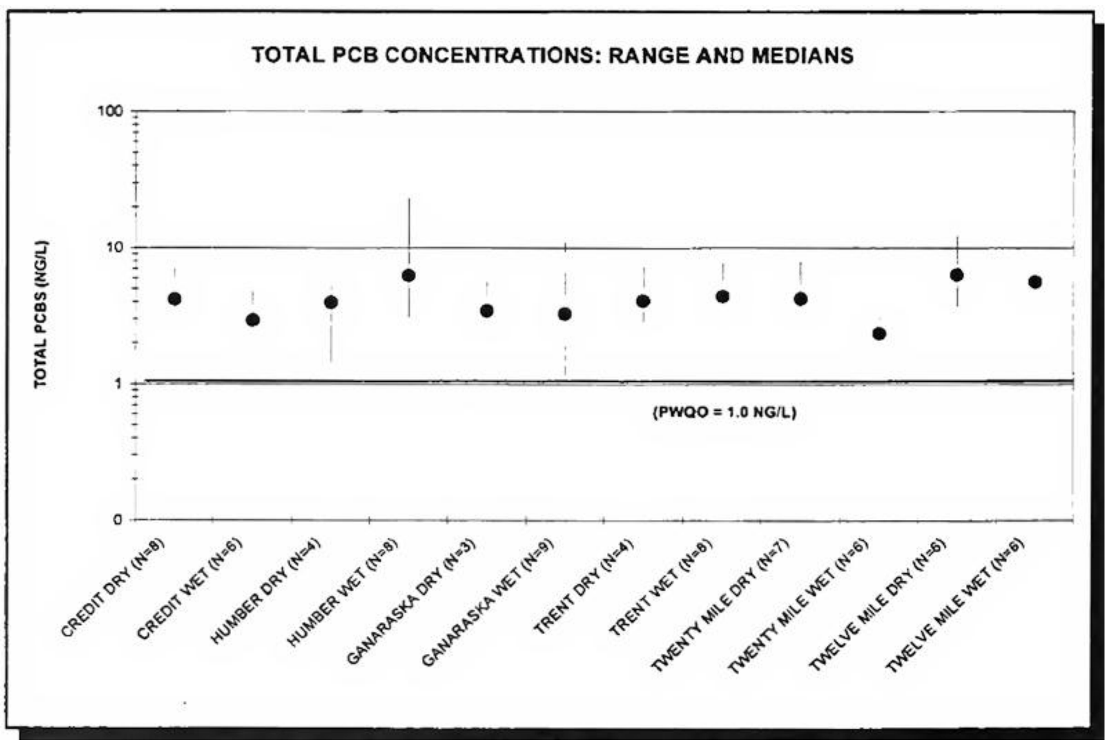

Figure 4.8: Range of Total PCB Concentrations Sampled During 1997/98.

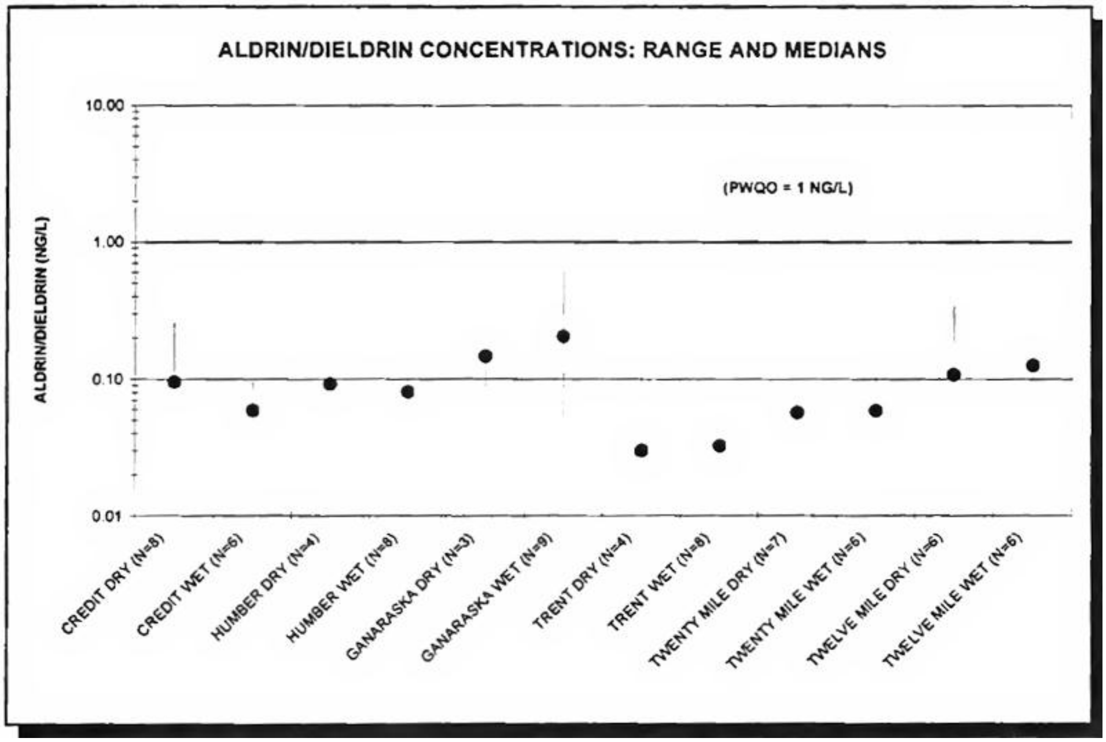

Figure 4.9: Range of Aldrin/Dieldrin Concentrations Sampled During 1997/98.

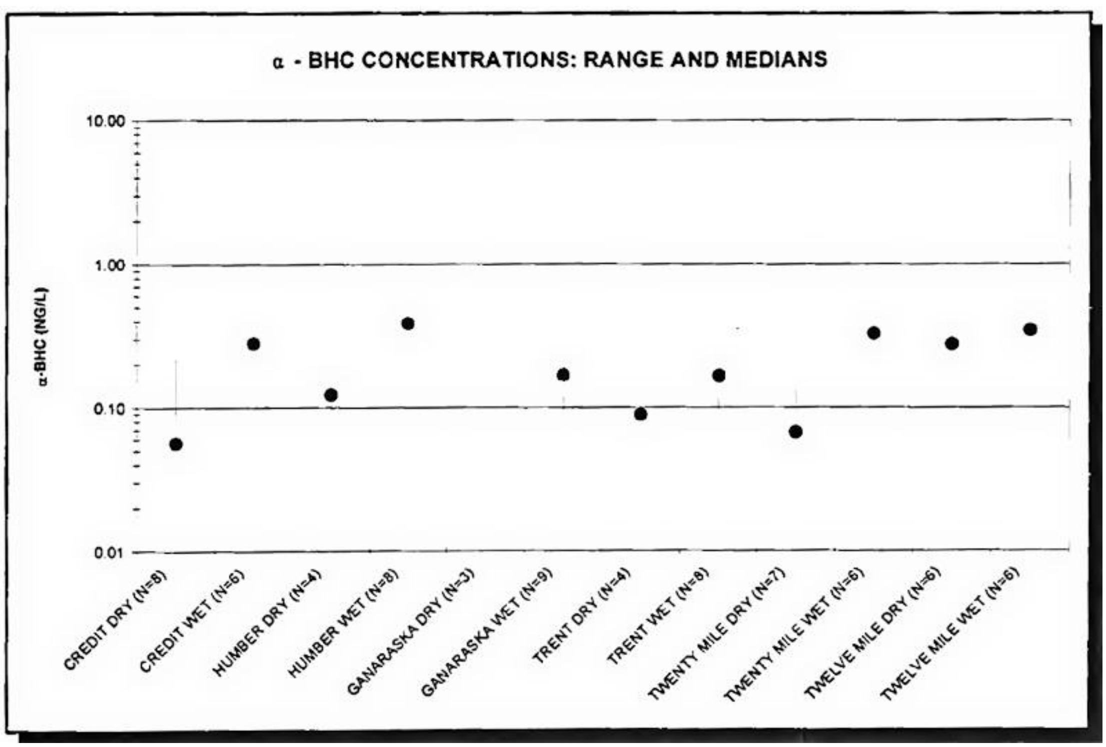

Figure 4.10: Range of α- BHC Concentrations Sampled During 1997/98.

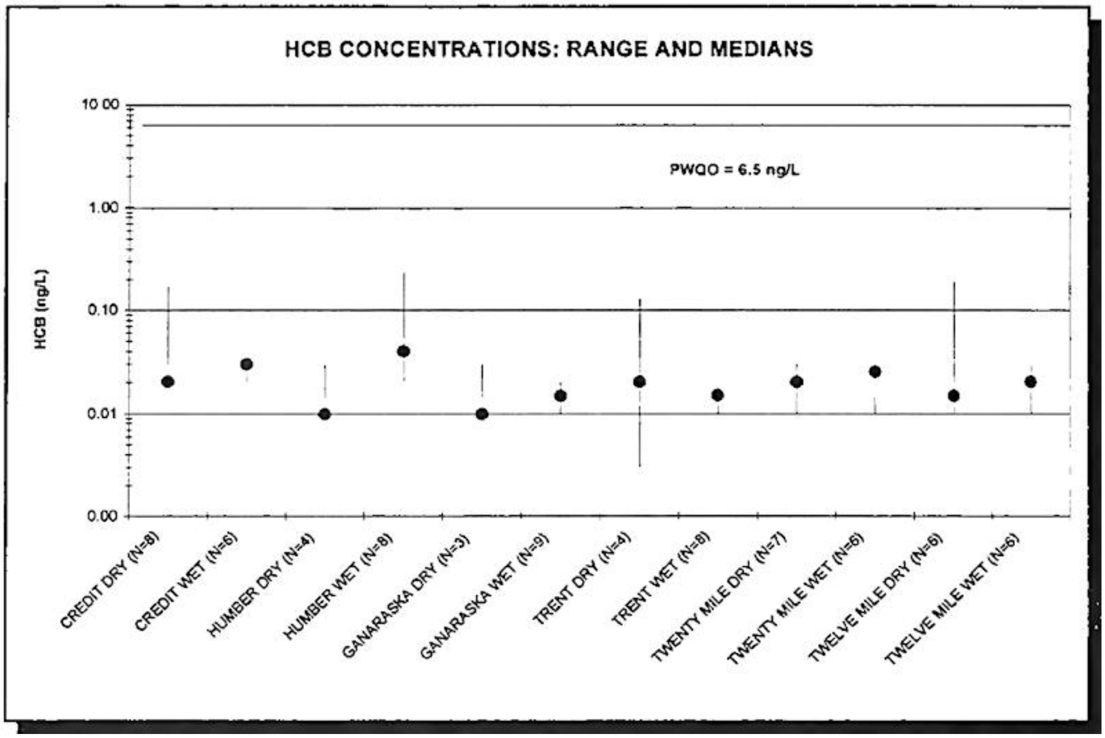

Figure 4.11: Range of HCB Concentrations Sampled During 1997/98.

5. CONCLUSIONS AND RECOMMENDATIONS

1. The similarity in ranges of total PCB concentrations across the range of land use types at monitored watersheds suggests a relatively uniform tributary background for the Lake Ontario drainage basin which may be attributable to both atmospheric deposition of PCBs and its ubiquitous presence at sites throughout the drainage basin.

2. The general tendency for wet weather total PCB median concentrations to be lower than (or similar to) dry weather medians may be a genuine reflection of dilution by rain or it may be an artifact of the relatively small number of samples available for analysis in this study. If it is dilution, this would suggest the existence of local dry weather sources (i.e point sources);

3. Although concentrations of total DDT are well below the PWQO of 3.0 ng/L, the frequent detection of the p,p-DDT isomer across all monitored tributaries implies that there may still be local sources of DDT within these drainage basins. These low concentrations may reflect the current use of the organochlorine pesticide Dicofol which is manufactured from DDT (technical grade Dicofol contains less than 0.1% DDT) and which is used on a wide variety of fruit, vegetable, ornamental and field crops. It may also reflect soil residues from legal applications of DDT since detection of DDT in soil does not necessarily indicate new use [3];

4. The elevated median concentrations of Mirex at the Credit River resulted from the higher frequency of detection at this location relative to other tributaries, and may be indicative of a historical source in this watershed;

5. The influence of highways, urban land use and high population density is apparent with median concentrations of the BaP, Cu, Pb, and Zn at the Credit River and Humber River markedly greater than those at other sampling locations;

6. Further analysis of available PCB congener group data, additional event-based sampling, and examination of sediment, tissue, and atmospheric data will be required to estimate the relative significance of local sources contributing to the pervasive detection of total PCBs at concentrations greater than 1.0 ng/L in these six Lake Ontario watersheds [4];

7. An optimal survey design (e.g. sampling frequency, spatial distribution, list of contaminants) for future monitoring will vary depending upon specific objectives and associated data requirements. For this reason follow-up monitoring plans must be based on a thorough discussion of information needs. Priorities could include "track down" monitoring, improved event-based sampling for loading calculations, or an improved analysis of the relationships between land use and contaminant types.

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[3] California Department of Food and Agriculture 1985: *Agricultural Sources of DDT residues in California's Environment.*

[4] It should be noted that trend data from Lake Ontario juvenile forage fish and sportfish monitoring indicate that exposure in the nearshore waters of Lake Ontario has declined by more than 80% over the past twenty years, and open-lake water quality data from the USEPA indicate ambient concentrations consistently below the PWQO of 1.0 ng/L.

APPENDIX A-1:

Data Listing for Station 89

Credit River

APPENDIX A-1: Data Listing for the Credit River

STN#	DATE	TIME	FLOW (CMS)	SS (mg/L)	TKN (mg/L)	TP (mg/L)	Al (µg/L)	Cd (µg/L)	Cr (µg/L)
89	970724	915	3.69	4.0	0.400	0.014	70	2.3	6.1
89	970810	1045	3.30	4.0	0.380	0.014	46	nd	5.8
89	970916	0	3.49	2.5	0.440	0.008	32	nd	5.3
89	970916	1430	3,49	2.0	0.400	0.008	21	nd	4.4
89	970920	1115	**6.07**	81.0	0.700	0.076	324	1.2	2.5
89	970925	1600	3.78	8.0	0.520	0.014	101	0.2	3.9
89	971015	1515	3.30	13.0	0.420	0.016	48	nd	1.4
89	971027	1145	**11.38**	341.0	3.300	0.470	717	0.3	16.0
89	971121	1600	6.48	18.0	0.560	0.036	85	nd	5.0
89	980108	1230	**22.50**	208.0	1.900	0.440	959	nd	5.4
89	980219	1430	**10.20**	160.0	1.400	0.350	1150	nd	4.2
89	980310	1115	**23.50**	149.0	1.560	0.296	498	nd	0.7
89	980319	1349	**16.50**	255.0	1.600	0.350	724	0.2	1.4
89	980327	1115	**37.70**	76.5	1.600	0.390	690	nd	0.9

STN#	DATE	TIME	Cu (µg/L)	Fe (µg/L)	Mn (µg/L)	Ni (µg/L)	Pb (µg/L)	Zn (µg/L)	TPCB (ng/L)
89	970724	915	2.3	81.9	12.30	nd	nd	6.0	7.0
89	970810	1045	2,0	56.3	6.64	nd	nd	2.3	2.1
89	970916	0	4.2	44.7	3.20	nd	nd	5.4	4.1
89	970916	1430	2.1	35	2.79	nd	nd	2.8	4.2
89	970920	1115	4.6	419	66.10	nd	nd	14.0	4.1
89	970925	1600	2.8	105	8.18	nd	nd	6.0	3.4
89	971015	1515	2.2	128	15.80	nd	nd	2.9	6.3
89	971027	1145	17.5	966	580.00	3	9	60.0	3.6
89	971121	1600	4.9	180	33.90	nd	nd	9.4	5.2
89	980108	1230	7.8	1110	270.00	3	5	27.9	4.8
89	980219	1430	9.1	1140	169.00	6	6	33.6	4.1
89	980310	1115	4.8	862	131.00	43	nd	20.5	1.4
89	980319	1349	9.2	917	143.00	46	7	52.3	2.3
89	980327	1115	6.9	1040	232.00	51	5	28.6	2.2

NOTE: unfiltered total mercury results were all below the detection limit of 0.02 µg/L and have not been included
In this table wet weather flows are shown in bold.

APPENDIX A-1: Data Listing for the Credit River

STN#	DATE	TIME	BAP (ng/L)	TPAH (ng/L)	α-BHC (ng/L)	Lindane (ng/L)	Heptachlor (ng/L)	Aldrin (ng/L)	Heptachlor Epox. (ng/L)
89	970724	915	0.56	26.9	0.15	0.27	nd	nd	0.12
89	970810	1045	0.27	13.0	nd	nd	nd	nd	nd
89	970916	0	nd	16.2	0.01	0.05	nd	nd	0.02
89	970916	1430	0.23	11.4	nd	0.15	nd	nd	0.04
89	970920	1115	6.63	154.8	0.24	0.29	nd	nd	0.05
89	970925	1600	1.09	231.5	0,13	0.16	nd	nd	0.04
89	971015	1515	0.75	22.5	nd	0.17	nd	nd	nd
89	971027	1145	4.35	67.0	0.21	nd	nd	nd	nd
89	971121	1600	0.75	22.0	0.10	0.11	nd	nd	0.01
89	980108	1230	5.54	129.2	0.32	0.42	nd	nd	0.03
89	980219	1430	5.17	123.0	0.33	0.37	nd	nd	0.03
89	980310	1115	2.04	48.4	0.12	0.29	nd	nd	nd
89	980319	1349	13.3	404.5	0.45	0.35	nd	nd	0.02
89	980327	1115	6.04	115.4	0.24	0.46	nd	nd	nd

STN#	DATE	TIME	Γ-chlordane (ng/L)	α- Endosulfan (ng/L)	α- Chlordane (ng/L)	Dieldrin (ng/L)	p,p-DDE (ng/L)	Endrin (ng/L)	β-Endosulfan (ng/L)
89	970724	915	0.13	0.03	0.11	0.26	nd	0.22	0.08
89	970810	1045	nd	nd	0.17	nd	nd	nd	nd
89	970916	0	nd	0.01	0.01	0.09	nd	nd	nd
89	970916	1430	nd	0.04	0.01	0.10	nd	nd	nd
89	970920	1115	0.03	0.40	0.05	0.12	nd	nd	0.24
89	970925	1600	nd	0.08	0.02	0.07	nd	nd	0.06
89	971015	1515	nd	nd	0.05	0.10	nd	nd	nd
89	971027	1145	nd	nd	nd	0.05	nd	nd	0.04
89	971121	1600	nd	0.03	0.02	nd	nd	nd	nd
89	980108	1230	0.03	0.36	0.03	0.07	0.02	nd	0.29
89	980219	1430	nd	0.69	0.01	0.06	0.04	nd	0.46
89	980310	1115	nd	0.07	0.02	0.04	nd	nd	0.11
89	980319	1349	nd	0.28	0.02	0.05	nd	nd	0.25
89	980327	1115	nd	0.17	0.03	0.10	nd	nd	0.15

APPENDIX A-1: Data Listing for the Credit River

STN#	DATE	TIME	p,p-DDD (ng/L)	o,p-DDT (ng/L)	p,p-DDT (ng/L)	Methoxychlor (ng/L)	Mirex (ng/L)	HCB (ng/L)	OCS (ng/L)
89	970724	915	0.56	nd	0.54	nd	0.35	0.17	nd
89	970810	1045	nd	nd	nd	nd	nd	nd	nd
89	970916	0	nd	nd	nd	nd	0.01	0.01	nd
89	970916	1430	0.02	nd	0.00	nd	0.01	0.02	nd
89	970920	1115	0.05	nd	0.05	nd	0.69	0.02	nd
89	970925	1600	0.01	nd	nd	nd	0.03	0.02	nd
89	971015	1515	0.02	nd	nd	nd	0.08	0.03	nd
89	971027	1145	0.08	nd	nd	nd	0.18	0.04	nd
89	971121	1600	0.05	nd	nd	nd	0.09	0.02	nd
89	980108	1230	0.04	nd	0.08	0.11	0.02	0.03	nd
89	980219	1430	0.02	nd	0.07	nd	nd	0.03	nd
89	980310	1115	nd	nd	nd	nd	nd	0.02	nd
89	980319	1349	nd	nd	0.09	0.13	0.01	0.04	nd
89	980327	1115	0.03	nd	0.08	nd	0.02	0.02	nd

APPENDIX A-2:

Data Listing for Station 90

Humber River

APPENDIX A-2: Data Listing for the Humber River

STN#	DATE	TIME	FLOW (CMS)	SS (mg/L)	TKN (mg/L)	TP (mg/L)	Al (µg/L)	Cd (µg/L)	Cr (µg/L)
90	970724	1230	1.47	16.50	0.36	0.04	126.00	nd	7.18
90	970809	1700	1.20	7.50	0.34	0.03	60.00	nd	5.99
90	970821	1020	**8.25**	125.00	1.16	0.20	633.00	0.3	5.95
90	970908	1230	1.97	11.50	0.54	0.03	164.00	nd	4.63
90	970910	1330	**5.01**	153.00	0.62	0.07	801.00	0.3	8.00
90	971016	1115	1.39	9.00	0.38	0.01	38.30	nd	9.26
90	971027	1330	**7.63**	84.00	1.00	0.18	592.00	nd	5.91
90	971121	1530	**3.23**	23.50	0.34	0.02	331.00	nd	2.60
90	980108	1311	**22.30**	118.00	1.10	0.25	1090.00	nd	6.17
90	980219	1220	**62.60**	495.00	2.50	0.79	1530.00	0.2	22.40
90	980319	1455	**42.90**	239.00	1.44	0.34	737.00	0.6	2.75
90	980327	1230	**59.50**	849.00	2.50	0.92	1070.00	0.2	1.16

STN#	DATE	TIME	Cu (µg/L)	Fe (µg/L)	Mn (µg/L)	Ni (µg/L)	Pb (µg/L)	Zn (µg/L)	TPCB (ng/L)
90	970724	1230	2.10	184	28.90	nd	nd	4.54	5.3
90	970809	1700	1.74	124	24.00	nd	nd	2.65	1.4
90	970821	1020	13.90	1200	189.00	4	10	57.20	9.1
90	970908	1230	3.49	272	25.30	2	nd	6.76	4.2
90	970910	1330	18.70	1840	227.00	5	17	66.00	23.3
90	971016	1115	2.29	151	13.90	nd	nd	3.56	3.7
90	971027	1330	9.30	1250	135.00	3	7	36.20	5.1
90	971121	1530	11.30	573	68.40	3	7	30.50	5.4
90	980108	1311	10.70	1850	181.00	4	9	43.80	7.1
90	980219	1220	14.10	2840	402.00	11	11	46.40	9.8
90	980319	1455	17.70	950	119.00	54	20	97.10	5.4
90	980327	1230	9.24	1190	322.00	84	6	35.90	3.1

NOTE: unfiltered total mercury results were all below the detection limit of 0.02 µg/L and have not been included in this table wet weather flows are shown In bold.

APPENDIX A-2: Data Listing for the Humber River

STN#	DATE	TIME	BAP (ng/L)	TPAH (ng/L)	α-BHC (ng/L)	Lindane (ng/L)	Heptachlor (ng/L)	Aldrin (ng/L)	Heptachlor Epox. (ng/L)
90	970724	1230	1.24	42.8	0.12	0.10	nd	nd	nd
90	970809	1700	0.75	29.9	nd	nd	nd	nd	nd
90	970821	1020	30.7	498.9	0.25	0.40	nd	nd	0.06
90	970908	1230	1.89	32.7	0.21	0.32	nd	nd	0.01
90	970910	1330	98.7	1303.8	0.35	0.30	nd	nd	nd
90	971016	1115	0.81	13.0	0.13	nd	nd	nd	0.02
90	971027	1330	5.50	146.2	0.88	nd	nd	nd	nd
90	971121	1530	6.20	187 8	0.38	0.34	nd	nd	0.02
90	980108	1311	11.41	271.1	0.42	0.22	nd	nd	0.03
90	980219	1220	32.4	532.7	0.39	0.28	nd	nd	0.02
90	980319	1455	97.5	1878.7	0.45	0.31	nd	nd	0.07
90	980327	1230	13.6	255.8	0.21	0.29	nd	nd	nd

STN#	DATE	TIME	Γ-chlordane (ng/L)	α- Endosulfan (ng/L)	α- Chlordane (ng/L)	Dieldrin (ng/L)	p,p-DDE (ng/L)	Endrin (ng/L)	β-Endosulfan (ng/L)
90	970724	1230	nd	0.10	0.04	0.13	nd	nd	0.04
90	970809	1700	nd	nd	0.05	nd	nd	nd	nd
90	970821	1020	0.09	0.41	0.15	0.18	nd	nd	0.44
90	970908	1230	0.05	0.04	0.03	0.08	nd	nd	nd
90	970910	1330	0.44	0.69	0.44	0.44	nd	nd	0.64
90	971016	1115	nd	0.04	0.04	0.10	nd	nd	0.06
90	971027	1330	0.01	0.42	0.03	0.06	nd	nd	0.38
90	971121	1530	0.02	0.05	nd	0.04	nd	0.04	0.02
90	980108	1311	0.04	0.24	0.04	0.11	0.01	nd	0.24
90	980219	1220	0.02	015	0.05	0.06	0.03	nd	nd
90	980319	1455	0.09	0.17	0.14	0.09	nd	nd	nd
90	980327	1230	nd	0.10	nd	0.07	nd	nd	0.12

APPENDIX A-2: Data Listing for the Humber River.

STN#	DATE	TIME	p,p-DDD (ng/L)	o,p-DDT (ng/L)	p,p-DDT (ng/L)	Methoxychlor (ng/L)	Mirex (ng/L)	HCB (ng/L)	OCS (ng/L)
90	970724	1230	nd	nd	nd	nd	nd	0.03	nd
90	970809	1700	nd	nd	nd	nd	nd	nd	nd
90	970821	1020	0.30	nd	nd	nd	nd	0.05	nd
90	970908	1230	nd	nd	0.03	nd	nd	0.01	nd
90	970910	1330	nd	nd	nd	nd	nd	0.05	nd
90	971016	1115	nd	nd	nd	nd	nd	0.01	nd
90	971027	1330	0.03	nd	nd	nd	nd	0.03	nd
90	971121	1530	nd	nd	nd	nd	nd	0.03	nd
90	980108	1311	nd	nd	0.02	nd	nd	0.03	nd
90	980219	1220	0.10	nd	0.10	nd	nd	0.23	nd
90	980319	1455	0.11	nd	0.31	0.11	nd	0.06	nd
90	980327	1230	0.01	nd	nd	nd	nd	0.02	nd

APPENDIX A-3:

Data Listing for Station 91

Ganaraska River

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APPENDIX A-3: Data Listing for the Ganaraska River

STN#	DATE	TIME	FLOW (CMS)	SS (mg/L)	TKN (mg/L)	TP (mg/L)	Al (µg/L)	Cd (µg/L)	Cr (µg/L)
91	970724	1500	1.77	4.00	0.24	0.03	41.10	0.3	6.43
91	970809	1400	1.62	5.00	0.22	0.01	36.80	nd	5.55
91	970911	1100	**5.05**	36.50	0.66	0.09	127.00	0.9	5.12
91	970929	1400	7.15	28.50	0.46	0.05	105.00	0.9	4.02
91	971020	1540	2.11	5.00	0.22	0.01	39.20	0.3	4.56
91	971029	1520	**7.60**	60.50	0.60	0.08	218.00	0 2	0.73
91	971121	1400	**4.08**	17.50	0.36	0.03	69.60	nd	15.80
91	980108	336	**19.20**	127.00	1.44	0.30	567.00	nd	3.28
91	980219	1355	**8.62**	72.50	0.96	0.15	397.00	nd	16.40
91	980310	1320	**7 (est.)**	134.00	1.16	0.31	456.00	nd	0.70
91	980320	1330	**6.76**	33.50	1.16	0.11	10.00	nd	1.97
91	980327	1030	**16.50**	108.00	1.36	0.30	557.00	nd	0.71

STN#	DATE	TIME	Cu (µg/L)	Fe (µg/L)	Mn (µg/L)	Ni (µg/L)	Pb (µg/L)	Zn (µg/L)	TPCB (ng/L)
91	970724	1500	0.51	47.3	14.80	nd	nd	1.62	5.6
91	970809	1400	0.50	64.4	13.60	nd	nd	1.21	2.1
91	970911	1100	1.30	236	46.80	nd	nd	2,81	11.2
91	970929	1400	2.01	196	51.10	nd	nd	6.15	34
91	971020	1540	0.82	102	15.50	nd	nd	1.32	3.5
91	971029	1520	1.07	411	68.60	nd	nd	3.39	1.7
91	971121	1400	0.50	149	26.40	nd	nd	1.18	3.4
91	980108	336	1.61	553	143.00	nd	nd	5.96	5.1
91	980219	1355	1.30	611	79.10	4	nd	5.06	3.2
91	980310	1320	1.62	779	90.20	38	nd	9.68	---
91	980320	1330	0.67	20	0.50	37	nd	1.07	1.1
91	980327	1030	1.82	730	117.00	37	nd	10.80	2.3

NOTE: unfiltered total mercury results were all below the detection limit of 0.02 µg/L and have not been included in this table
wet weather flows are shown In bold

APPENDIX A-3: Data Listing for the Ganaraska River

STN#	DATE	TIME	BAP (ng/L)	TPAH (ng/L)	α-BHC (ng/L)	Lindane (ng/L)	Heptachlor (ng/L)	Aldrin (ng/L)	Heptachlor Epox. (ng/L)
91	970724	1500	0.09	12.0	0.05	0.04	nd	nd	nd
91	970809	1400	0.12	8.2	nd	nd	nd	nd	nd
91	970911	1100	0.37	57.2	0.06	0.08	nd	nd	nd
91	970929	1400	0.19	6.5	0.04	0.09	nd	nd	nd
91	971020	1540	nd	2.1	nd	nd	nd	nd	nd
91	971029	1520	nd	10.5	0.19	0.12	nd	nd	nd
91	971121	1400	0.11	15.3	0.07	nd	nd	nd	nd
91	980108	336	0.25	20.8	0.14	0.09	nd	nd	0.02
91	980219	1355	0.22	5.7	0.25	nd	nd	nd	0.01
91	980320	1330	nd	26.9	0.28	0.17	nd	nd	nd
91	980327	1030	nd	25.1	0.25	0.30	nd	nd	nd

STN#	DATE	TIME	Γ-chlordane (ng/L)	α- Endosulfan (ng/L)	α- Chlordane (ng/L)	Dieldrin (ng/L)	p,p-DDE (ng/L)	Endrin (ng/L)	β-Endosulfan (ng/L)
91	970724	1500	nd	0.03	nd	0.17	nd	nd	0.04
91	970809	1400	nd	nd	nd	0.15	nd	nd	nd
91	970911	1100	nd	0.05	nd	0.23	nd	0.01	0.07
91	970929	1400	nd	0.03	0.01	0.12	nd	nd	nd
91	971020	1540	nd	nd	0.04	0.09	nd	nd	nd
91	971029	1520	nd	0.04	nd	0.07	nd	nd	0.06
91	971121	1400	nd	nd	0.01	0.03	nd	nd	nd
91	980108	336	nd	nd	nd	0.62	0.03	nd	nd
91	980219	1355	nd	0.04	nd	0.18	0.02	nd	0.09
91	980320	1330	nd	0.05	nd	0.32	nd	nd	0.08
91	980327	1030	nd	nd	nd	0.59	nd	nd	nd

APPENDIX A-3: Data Listing for the Ganaraska River

STN#	DATE	TIME	p,p-DDD (ng/L)	o,p-DDT (ng/L)	p,p-DDT (ng/L)	Methoxychlor (ng/L)	Mirex (ng/L)	HCB (ng/L)	OCS (ng/L)
91	970724	1500	0.13	nd	0.21	nd	nd	0.03	nd
91	970809	1400	nd	nd	0.43	nd	nd	nd	nd
91	970911	1100	0.16	nd	0.15	nd	nd	0.02	nd
91	970929	1400	0.27	nd	0.26	nd	0.01	0.02	nd
91	971020	1540	nd	nd	nd	nd	nd	0.01	nd
91	971029	1520	0.04	nd	nd	nd	0.01	0.01	nd
91	971121	1400	0.06	nd	0.13	nd	0.02	0.02	nd
91	980108	336	nd	nd	0.57	0.04	0.00	0.01	nd
91	980219	1355	0.05	nd	0.42	nd	nd	0.02	nd
91	980320	1330	0.03	nd	nd	nd	0.00	0.01	nd
91	980327	1030	0.06	nd	nd	nd	nd	0.01	nd

APPENDIX A-4:

Data Listing for Station 92

Trent River

APPENDIX A-4: Data Listing for the Trent River

STN#	DATE	TIME	FLOW (CMS)	SS (mg/L)	TKN (mg/L)	TP (mg/L)	Al (µg/L)	Cd (µg/L)	Cr (µg/L)
92	970724	1800	28.8	1.50	0.44	0.03	14.20	nd	3.61
92	970809	1200	37.8	3.00	0.46	0.03	13.90	14.0	3.25
92	970822	1500	54.0	2.00	0.86	0.02	10.00	0.5	5.06
92	970911	1100	56.2	2.00	0.44	0.02	11.30	0.5	1.07
92	971001	1400	**123.5**	2.00	0.50	0.02	15.20	0.5	2.66
92	971029	1230	**74.3**	4.00	0.50	0.02	23.60	0.3	0.50
92	971029	1415	**79.5**	2.00	0.50	0.01	13.50	0.7	4.84
92	971121	0	**123.7**	2.00	0.42	0.01	12.80	0.9	5.05
92	980108	1700	**341.0**	16.50	0.60	0.06	160.00	nd	2.57
92	980303	1428	**319.0**	4.50	0.40	0.02	34.00	nd	0.50
92	980320	1500	**227.0**	11.00	0.38	0.02	12.40	nd	0.50
92	980327	1425	**287.0**	8.00	0.34	0.02	27.90	nd	0.50

STN#	DATE	TIME	Cu (µg/L)	Fe (µg/L)	Mn (µg/L)	Ni (µg/L)	Pb (µg/L)	Zn (µg/L)	TPCB (ng/L)
92	970724	1800	0.50	20	14.70	nd	nd	2.43	3.6
92	970809	1200	0.64	39.4	12.60	nd	nd	3.97	4.6
92	970822	1500	0.67	20	0.50	nd	nd	1.90	7.3
92	970911	1100	0.75	35.6	9.89	nd	nd	3.06	2.8
92	971001	1400	1.35	43.1	8.86	nd	nd	3.18	4.2
92	971029	1230	1.00	81.7	19.00	nd	nd	2.39	3.6
92	971029	1415	0.76	58.7	12.20	nd	nd	1.81	2.8
92	971121	0	1.35	34.4	8.01	nd	nd	4.18	5.3
92	980108	1700	0.78	234	48.40	nd	nd	3.04	7.7
92	980303	1428	0.68	88.4	11.70	23	nd	1.61	4.6
92	980320	1500	0.67	48.2	5.10	23	nd	3.55	1.8
92	980327	1425	0.65	59.3	7.31	25	nd	1.58	5.1

NOTE: unfiltered total mercury results were all below the detection limit of 0.02 µg/L and have not been Included in this table
wet weather flows are shown in bold

APPENDIX A-4: Data Listing for the Trent River.

STN#	DATE	TIME	BAP (ng/L)	TPAH (ng/L)	α-BHC (ng/L)	Lindane (ng/L)	Heptachlor (ng/L)	Aldrin (ng/L)	Heptachlor Epox. (ng/L)
92	970724	1800	nd	5.8	0.13	0.22	nd	nd	0.13
92	970809	1200	0.10	4.8	0.06	0.09	nd	nd	0.01
92	970822	1500	nd	15.8	0.05	0.09	nd	nd	nd
92	970911	1100	0.27	5.2	0.11	0.12	nd	nd	nd
92	971001	1400	nd	1.6	0.14	0.11	nd	nd	na
92	971029	1230	0.12	10.8	0.08	0.12	nd	nd	nd
92	971029	1415	nd	6.4	0.13	0.11	nd	nd	nd
92	971121	0	nd	6.3	0.19	0.14	nd	nd	nd
92	980108	1700	0.66	26.7	0.22	0.17	nd	nd	nd
92	980303	1428	nd	22.5	0.14	0.11	nd	nd	0.01
92	980320	1500	nd	13.0	0.22	0.17	nd	nd	nd
92	980327	1425	0.43	21.4	0.19	0.15	nd	nd	nd

STN#	DATE	TIME	Γ-chlordane (ng/L)	α- Endosulfan (ng/L)	α- Chlordane (ng/L)	Dieldrin (ng/L)	p,p-DDE (ng/L)	Endrin (ng/L)	β-Endosulfan (ng/L)
92	970724	1800	0.10	0.16	0.07	0.23	nd	0.27	0.08
92	970809	1200	nd	0.01	nd	0.03	nd	nd	0.04
92	970822	1500	nd	0.01	0.02	0.03	nd	nd	nd
92	970911	1100	0.01	0.01	0.00	0.02	nd	nd	nd
92	971001	1400	nd	nd	0.01	0.05	nd	nd	nd
92	971029	1230	nd	nd	nd	0.02	nd	nd	nd
92	971029	1415	nd	0.02	0.01	0.01	nd	nd	0.02
92	971121	0	nd	nd	nd	0.02	nd	nd	nd
92	980108	1700	nd	nd	nd	0.04	0.01	nd	nd
92	980303	1428	nd	0.09	nd	0.03	nd	nd	0.08
92	980320	1500	nd	0.03	nd	0.04	nd	nd	0.04
92	980327	1425	nd	0.02	nd	0.05	nd	nd	nd

APPENDIX A-4: Data Listing for the Trent River.

STN#	DATE	TIME	p,p-DDD (ng/L)	o,p-DDT (ng/L)	p,p-DDT (ng/L)	Methoxychlor (ng/L)	Mirex (ng/L)	HCB (ng/L)	OCS (ng/L)
92	970724	1800	0.50	nd	0.49	nd	0.37	0.13	nd
92	970809	1200	nd	nd	0.03	nd	nd	0.02	nd
92	970822	1500	nd	nd	nd	nd	nd	0.02	nd
92	970911	1100	nd	nd	nd	nd	nd	0.00	nd
92	971001	1400	nd	nd	nd	nd	nd	0.01	nd
92	971029	1230	nd	nd	nd	nd	nd	0.01	nd
92	971029	1415	nd	nd	nd	nd	nd	0.01	nd
92	971121	0	nd	nd	nd	nd	nd	0.01	nd
92	980108	1700	nd	nd	0.02	nd	0.00	0.02	nd
92	980303	1428	0.01	nd	0.01	nd	nd	0.02	nd
92	980320	1500	nd	nd	0.02	nd	nd	0.02	nd
92	980327	1425	nd	nd	nd	nd	nd	0.02	nd

APPENDIX A-5:

Data Listing for Station 93

Twenty Mile Creek

APPENDIX A-5: Data Listing for Twenty Mile Creek.

STN#	DATE	TIME	FLOW (CMS)	SS (mg/L)	TKN (mg/L)	TP (mg/L)	Al (µg/L)	Cd (µg/L)	Cr (µg/L)
93	970725	900	0.058	8.50	1.00	0.16	118.00	nd	5.58
93	970810	1300	0.002	1.00	1.00	0.15	71.60	0.2	5.31
93	970909	1430	0.050	2.50	0.72	0.06	38.60	nd	1.33
93	970929	1100	0.143	6.00	0.72	0.07	77.30	nd	2.15
93	971004	2300	0.152	7.00	1.60	0.16	82.00	nd	3.53
93	971009	1000	0.146	4.00	0.68	0.09	86.60	nd	3.69
93	971016	1100	0 078	2.50	0.66	0.08	34.50	nd	0.50
93	971027	0	**0.5 (est.)**	4.00	0.76	0.19	94.80	nd	0.50
93	971122	1430	**3.270**	77.50	2.00	0.39	852.00	0.8	9.97
93	980108	1116	**59.000**	299.00	3.40	0.98	2470.00	nd	2.43
93	980219	1645	**35.100**	279.00	2.50	0.76	2510.00	nd	8.08
93	980320	911	**26.200**	109.00	3.20	0.76	1310.00	nd	1.50
93	980327	850	**83.900**	349.00	2.20	0.91	1520.00	nd	1.37

STN#	DATE	TIME	Cu (µg/L)	Fe (µg/L)	Mn (µg/L)	Ni (µg/L)	Pb (µg/L)	Zn (µg/L)	TPCB (ng/L)
93	970725	900	1.40	159	153.00	nd	nd	6.45	7.9
93	970810	1300	1.11	99.1	97.30	nd	nd	3.02	1.5
93	970909	1430	1.44	51.2	22.30	3	nd	3.03	5.1
93	970929	1100	1.55	92.9	67.40	3	nd	7.73	3.0
93	971004	2300	1.49	94.4	52.60	4	nd	4.66	4.5
93	971009	1000	1.68	90.9	50.40	3	nd	4.28	2.5
93	971016	1100	1.33	61.8	25.00	nd	nd	1.54	4.2
93	971027	0	1.57	120	19.00	nd	nd	2.00	3.1
93	971122	1430	4.07	866	261.00	3	nd	17.70	2.7
93	980108	1116	6.21	1030	165.00	3	6	42.30	3.0
93	980219	1645	5.64	1800	88.40	5	7	28.40	1.7
93	980320	911	4.95	1180	45.20	20	nd	28.20	2.0
93	980327	850	5.25	1270	159.00	14	6	38.00	1.9

NOTE: unfiltered total mercury results were all below the detection limit of 0.02 µg/L and have not been included in this table
wet weather flows are shown in bold

APPENDIX A-5: Data Listing for Twenty Mile Creek.

STN#	DATE	TIME	BAP (ng/L)	TPAH (ng/L)	α-BHC (ng/L)	Lindane (ng/L)	Heptachlor (ng/L)	Aldrin (ng/L)	Heptachlor Epox. (ng/L)
93	970725	900	nd	15.1	0.05	0.05	nd	nd	nd
93	970810	1300	0.23	9.7	0.07	0.09	nd	nd	nd
93	970909	1430	nd	31.1	0.02	0.04	nd	nd	nd
93	970929	1100	0.15	3.5	0.11	0.11	nd	nd	0.01
93	971004	2300	nd	4.1	0.13	0.12	nd	nd	nd
93	971009	1000	0.09	12.0	0.09	0.08	nd	nd	nd
93	971016	1100	nd	17.6	0.03	0.10	nd	nd	nd
93	971027	0	nd	9.0	0.35	0.16	nd	nd	nd
93	971122	1430	nd	6.8	0.14	0.27	nd	nd	0.01
93	980108	1116	nd	23.1	0,11	0.20	nd	nd	0.03
93	980219	1645	0.67	28.2	0.39	0.45	nd	nd	0.03
93	980320	911	0.91	32.3	0.30	0.68	nd	nd	0.02
93	980327	850	2.05	53.4	0.35	0 66	nd	nd	0.04

STN#	DATE	TIME	Γ-chlordane (ng/L)	α- Endosulfan (ng/L)	α- Chlordane (ng/L)	Dieldrin (ng/L)	p,p-DDE (ng/L)	Endrin (ng/L)	β-Endosulfan (ng/L)
93	970725	900	nd	0.20	0.02	0.06	nd	nd	0.03
93	970810	1300	nd	0.02	nd	0.06	nd	nd	nd
93	970909	1430	nd	0.05	0.01	0.04	nd	nd	nd
93	970929	1100	nd	0.02	0.01	0.06	nd	nd	nd
93	971004	2300	nd	0.04	0.01	0.08	nd	nd	nd
93	971009	1000	nd	nd	0.01	0.05	nd	nd	nd
93	971016	1100	nd	nd	nd	0.03	nd	nd	nd
93	971027	0	nd	0.03	0.01	0.03	nd	nd	nd
93	971122	1430	nd	0.02	0.01	0.04	nd	nd	nd
93	980108	1116	nd	0.05	nd	0.04	0.13	nd	0.08
93	980219	1645	nd	0.31	nd	0.09	nd	nd	0.22
93	980320	911	nd	0.22	nd	0.08	nd	nd	0.20
93	980327	850	nd	0.18	nd	0.13	nd	nd	0.16

APPENDIX A-5: Data Listing for Twenty Mile Creek.

STN#	DATE	TIME	p,p-DDD (ng/L)	o,p-DDT (ng/L)	p,p-DDT (ng/L)	Methoxychlor (ng/L)	Mirex (ng/L)	HCB (ng/L)	OCS (ng/L)
93	970725	900	nd	nd	0.05	nd	nd	0.03	nd
93	970810	1300	nd	nd	0.05	nd	nd	0.02	nd
93	970909	1430	nd	nd	nd	nd	nd	0.02	nd
93	970929	1100	nd	nd	nd	nd	nd	0.01	nd
93	971004	2300	nd	nd	nd	nd	nd	0.02	nd
93	971009	1000	nd	nd	nd	nd	nd	0.02	nd
93	971016	1100	nd	nd	nd	nd	nd	0.01	nd
93	971027	0	0.01	nd	nd	nd	0.00	0.01	nd
93	971122	1430	0.01	nd	0.03	nd	0.00	0.01	nd
93	980108	1116	0.02	nd	0.31	nd	0.00	0.02	nd
93	980219	1645	nd	nd	0.11	nd	nd	0.03	nd
93	980320	911	nd	nd	0.09	nd	nd	0.03	nd
93	980327	850	0.01	nd	0.10	nd	nd	0.03	nd

APPENDIX A-6:

Data Listing for Station 94

Twelve Mile Creek

APPENDIX A-6: Data Listing for Twelve Mile Creek.

STN#	DATE	TIME	FLOW (CMS)	SS (mg/L)	TKN (mg/L)	TP (mg/L)	Al (µg/L)	Cd (µg/L)	Cr (µg/L)
94	970725	1100	189.4	25.50	0.30	0.04	157.00	nd	3.27
94	970810	1545	85.7	4.50	0.26	0.03	93.80	nd	3.68
94	970909	1230	218.0	6.00	0.26	0.02	83.70	nd	3.07
94	970929	1400	216.6	12.50	0.32	0.03	84.80	nd	2.28
94	971009	1230	213.0	9.50	0.24	0.02	92.90	nd	2.21
94	971016	1315	214.6	5.00	0.26	0.01	62.70	nd	0.50
94	971027	1610	**213.0**	9.50	0.26	0.02	106.00	nd	0.50
94	971122	1430	**134.7**	11.00	0.40	0.06	188.00	nd	8.22
94	980108	1015	**226.3**	207.00	0.84	0.22	634.00	nd	1.86
94	980219	1800	**219.6**	15.00	0.36	0.06	353.00	nd	1.05
94	980320	1003	**218.0**	5.00	0.32	0.02	103.00	nd	0.50
94	980327	945	**209.5**	200.00	0.30	0.08	245.00	nd	0.50

STN#	DATE	TIME	Cu (µg/L)	Fe (µg/L)	Mn (µg/L)	Ni (µg/L)	Pb (µg/L)	Zn (µg/L)	TPCB (ng/L)
94	970725	1100	1.53	229	17.50	nd	nd	3.97	10.7
94	970810	1545	1.22	87.7	8.42	nd	nd	1.63	7.9
94	970909	1230	1.46	96.3	8.67	nd	nd	1.62	12.3
94	970929	1400	1.44	114	12.20	nd	nd	1.70	3.7
94	971009	1230	1.20	85.3	8.08	nd	nd	1.39	4.1
94	971016	1315	1.26	99.9	5.75	nd	nd	0.60	4.9
94	971027	1610	1.62	175	10.50	nd	nd	1.57	4.7
94	971122	1430	2.08	175	14.90	nd	nd	5.37	6.5
94	980108	1015	3.97	597	111.00	2	nd	10.20	8.1
94	980219	1800	1.84	322	13.00	4	nd	3.38	6.5
94	980320	1003	1.53	112	5.09	21	nd	3.11	2.4
94	980327	945	1.89	259	17.50	21	nd	5.14	2.5

NOTE: unfiltered total mercury results were all below the detection limit of 0.02 µg/L and have not been Included In this table
wet weather flows are shown in bold

APPENDIX A-6: Data Listing for Twelve Mile Creek.

STN#	DATE	TIME	BAP (ng/L)	TPAH (ng/L)	α-BHC (ng/L)	Lindane (ng/L)	Heptachlor (ng/L)	Aldrin (ng/L)	Heptachlor Epox. (ng/L)
94	970725	1100	0.47	17.7	0.41	0.48	nd	nd	0.16
94	970810	1545	0.25	9.3	0.24	0.28	nd	nd	nd
94	970909	1230	0.20	33.8	0.14	0.23	nd	nd	0.01
94	970929	1400	0.12	8.1	0.25	0.28	nd	nd	0.04
94	971009	1230	0.26	9.4	0.30	0.28	nd	nd	0.04
94	971016	1315	0.09	17.0	0.29	0.25	nd	nd	0.03
94	971027	1610	nd	1.6	0.31	0.23	nd	nd	0.04
94	971122	1430	nd	15.9	0.35	0.28	nd	nd	0.03
94	980108	1015	1.52	51.0	0.25	0.24	nd	nd	0.07
94	980219	1800	0.18	4.0	0.34	0.25	nd	nd	0.06
94	980320	1003	0.55	23.2	0.37	0.33	nd	nd	0.03
94	980327	945	3.11	71.3	0.46	0.36	nd	nd	0.06

STN#	DATE	TIME	Γ-chlordane (ng/L)	α- Endosulfan (ng/L)	α- Chlordane (ng/L)	Dieldrin (ng/L)	p,p-DDE (ng/L)	Endrin (ng/L)	β-Endosulfan (ng/L)
94	970725	1100	0.15	0.20	0.10	0.34	nd	0.26	0.08
94	970810	1545	nd	nd	nd	0.10	nd	nd	nd
94	970909	1230	rd	0.03	nd	0.08	nd	nd	nd
94	970929	1400	nd	0.05	0.01	0.11	nd	nd	nd
94	971009	1230	nd	0.03	0.02	0.11	nd	nd	nd
94	971016	1315	nd	0.03	0.03	0.11	nd	nd	nd
94	971027	1610	nd	0.02	nd	0.09	nd	0.01	0.06
94	971122	1430	nd	0.03	0.01	0.10	nd	nd	0.02
94	980108	1015	0.05	0.08	0.05	0.18	0.17	nd	0.16
94	980219	1800	0.01	nd	0.01	0.12	0.11	nd	nd
94	980320	1003	nd	0.04	nd	0.13	nd	nd	0.06
94	980327	945	nd	0.16	0.07	0.16	nd	nd	0.13

APPENDIX A-6: Data Listing for Twelve Mile Creek.

STN#	DATE	TIME	p,p-DDD (ng/L)	o,p-DDT (ng/L)	p,p-DDT (ng/L)	Methoxychlor (ng/L)	Mirex (ng/L)	HCB (ng/L)	OCS (ng/L)
94	970725	1100	0.60	nd	0.61	nd	0.39	0.19	nd
94	970810	1545	nd	nd	0.05	nd	nd	0,02	nd
94	970909	1230	nd	nd	nd	nd	nd	0.01	nd
94	970929	1400	nd	nd	nd	nd	nd	0.01	nd
94	971009	1230	nd	nd	nd	nd	nd	0.01	nd
94	971016	1315	nd	nd	nd	nd	nd	0.02	nd
94	971027	1610	nd	nd	nd	nd	nd	0.01	nd
94	971122	1430	0.02	nd	0.01	nd	0.00	0.01	nd
94	980108	1015	0.13	nd	0.41	0.02	0.00	0.03	nd
94	980219	1800	0.06	nd	0.22	nd	nd	0.02	nd
94	980320	1003	nd	nd	0.03	nd	nd	0.02	nd
94	980327	945	0.11	nd	0.22	0.05	nd	0.03	nd