

	NIAGARA ON THE LAKE				NIAGARA FALLS		FORT ERIE		ST. CATHERINES
	1976	1978	1979	1980	1979	1980	1979	1980	1980
STRONTIUM 90		0.9 _B	0.7 _C	1.0 _D	0.6 _D	0.7 _D	0.7 _D	1.8 _D	0.3 _D
NITRATE	0.32 _A								
AMMONIA	0.04 _A								
ANTIMONY				<0.1 _E					
SULPHATE	26.6 _A								

SOURCE

- A - WATER SAMPLE AT NIAGARA ON THE LAKE WATER TREATMENT PLANT (IN P.P.M.)
BY ENVIRONMENT CANADA - CANADA CENTER FOR Inland Waters
- B - from 'Environmental Baseline Report of the Niagara River', Canada-Ontario
Review Board Report, June 1980, TABLE 'E'. (in pCi/l)
- C - Water Sample at Niagara on the Lake Water Treatment Plant ~~by~~ (in pCi/l)
By Water Resources Branch - Ontario Ministry of the Environment
- D - from 'Environmental Baseline Report of the Niagara River', November 1981 Update,
Canada-Ontario Review Board - Table 21c (in pCi/l)
- E - from 'Environmental Baseline Report of the Niagara River', November 1981 Update,
Canada-Ontario Review Board - Table 15 (in PPM). Note See attached
table for additional sample points.

Sulphate - SO_4

1975	-	25.0 mg/l
1976	-	25.3 mg/l
1977	-	24.7 mg/l
1978	-	24.4 mg/l
1979	-	24.5 mg/l
1980	-	24.7 mg/l
1981	-	23.0 mg/l

Nitrogen Total - Ammonia

1975	-	
76	-	.030 mg/l
77	-	.038 mg/l
78	-	.025 mg/l
79	-	.027 mg/l
80	-	.023 mg/l
81	-	.077 mg/l (Jan - March)

Nitrogen Total Kjeldahl

1975	-	.269 mg/l
1976	-	.276 mg/l
1977	-	.288 mg/l
1978	-	.239 mg/l
1979	-	.242 mg/l
1980	-	.260 mg/l
1981	-	.236 mg/l

Nitrogen Dissolved $\text{NO}_3 + \text{NO}_2$

1975	-	.146 mg/l
1976	-	.220 mg/l

1978 - .212 mg/l
1979 - .230 mg/l
1980 - .260 mg/l
1981 - .263 mg/l

No. 1 + No. 2
~~1975 - .263 mg/l~~
~~1976 -~~
~~1977 -~~
~~1978 -~~
~~1979 -~~
~~1980 -~~
~~1981 -~~

Table 4. Monthly Average Dissolved Major Ions Concentrations (mg/L), 1976

Month	pH*	Specific conductance†	Alk.	Ca	Mg	K	Na	Cl	SO ₄
January	8.09	312	96.2	40.0	8.4	1.4	11.3	22.8	26.7
February	7.94	315	94.5	39.9	8.3	1.4	10.9	23.1	26.5
March	8.07	306	92.1	37.8	7.8	1.3	10.5	20.4	26.4
April	8.07	301	90.8	36.4	7.8	1.3	10.2	20.6	25.3
May	8.22	302	94.2	37.0	8.0	1.3	10.3	21.1	25.0
June	8.15	315	89.3	37.2	7.9	1.3	10.5	21.7	24.6
July	8.10	296	94.0	37.5	7.7	1.3	10.2	20.7	24.1
August	8.35	305	90.6	38.2	7.8	1.3	10.0	20.8	24.5
September	8.22	306	90.9	37.4	8.0	1.3	10.3	21.5	25.2
October	8.18	305	92.8	38.5	8.1	1.3	10.0	20.2	25.5
November	8.06	306	93.6	40.1	8.2	1.3	10.2	22.3	25.1
December	8.04	310	93.9	39.2	8.2	1.3	10.9	23.4	25.0
Mean	8.12	306	92.6	38.3	8.0	1.3	10.4	21.5	25.3

*pH unit.

†Microsiemens per square centimetre.

Taken at the Niagara on the Lake water treatment plant intake.

Table 5. Monthly Average Dissolved Major Ions Concentrations (mg/L), 1977

Month	pH*	Specific conductance†	Alk.	Ca	Mg	K	Na	Cl	SO ₄
January	7.97	322	95.5	38.0	8.3	1.3	10.6	23.6	25.4
February	8.03	322	93.8	39.7	8.2	1.4	11.4	24.7	26.0
March	8.03	318	91.8	38.4	7.8	1.4	11.2	23.9	25.5
April	8.11	300	87.9	36.4	7.6	1.4	10.2	21.9	23.9
May	8.25	306	89.4	36.5	7.8	1.4	10.5	22.6	24.2
June	8.20	312	92.6	37.0	7.9	1.3	10.6	22.2	24.3
July	8.14	304	91.9	36.6	7.8	1.4	10.7	22.9	24.0
August	8.32	303	88.8	36.8	8.0	1.4	10.6	20.7	25.1
September	8.29	307	91.3	37.1	7.8	1.4	10.4	20.2	24.4
October	8.28	309	91.0	37.3	7.9	1.4	10.4	21.8	23.9
November	8.25	309	92.5	36.9	8.2	1.5	10.5	20.8	24.5
December	8.11	309	92.2	36.8	8.1	1.5	10.6	21.7	24.9
Mean	9.17	309	91.3	37.3	7.9	1.4	10.6	22.2	24.6

*pH unit.

†Microsiemens per square centimetre.

Changes in major ions were also obvious from 1976 to 1977. Mean annual concentrations for calcium, magnesium and sulphate were all lower in value, while sodium and chloride were higher. The annual mean calcium concentration in 1976 was 38.2 mg/L compared with 37.3 mg/L in 1977. The annual average magnesium concentration was 8.0 mg/L in 1976 and 7.9 mg/L in 1977, and sulphate, which measured 25.3 mg/L in 1976, was 24.6 mg/L in 1977. In contrast, sodium increased by 0.2 mg/L from 10.4 mg/L in 1976 to 10.6 mg/L in 1977. Chloride showed an increase of 0.7 mg/L (21.5 mg/L to 22.2 mg/L) during the same period. Changes in potassium concentration are within the detection limit of the method. These changes,

although small in magnitude, are detectable and considered to be real. Trend analysis by calculating linear correlation coefficients on 12-month moving averages indicated the level of significance is high (Table 3).

The decrease in calcium, magnesium and sulphate concentrations from 1976 to 1977 and the increase of sodium and chloride concentrations seem to indicate that the two groups of ions may have different mechanisms of transport and origins. Most dissolved minerals, which originate from weathering of bedrock, are carried into water bodies by runoff within the whole drainage basin. Thus their sources are diffuse and their loading is dependent

Table 1. Number of Water Samples Collected from August 1975

Month	1975		1976	
	Nutrients		Major ions	
January			26	
February			19	
March			25	4
April			30	3
May			23	5
June			22	4
July			27	3
August			25	4
September	31	4	30	4
October	30	5	22	5
November	31	4	20	4
December	30	5	28	3
Total	31	22	297	4
	153		48	329

Table 2. Monthly Average Phosphorus and Nitrogen Concentrations (mg/L), 1976-1977

Month	1976				1977			
	TP	TKN	NO ₃	TN	TP	TKN	NO ₃	
January	0.022	0.272	0.297	0.576	0.018	0.274	0.191	
February	0.022	0.255	0.295	0.551	0.019	0.289	0.216	
March	0.025	0.294	0.322	0.616	0.023	0.282	0.233	
April	0.029	0.284	0.343	0.624	0.022	0.324	0.240	
May	0.023	0.318	0.315	0.639	0.021	0.291	0.188	
June	0.019	0.229	0.296	0.522	0.018	0.328	0.158	
July	0.018	0.239	0.177	0.419	0.018	0.292	0.148	
August	0.024	0.278	0.139	0.372	0.015	0.302	0.108	
September	0.014	0.286	0.085	0.409	0.033	0.280	0.101	
October	0.018	0.306	0.108	0.486	0.020	0.228	0.108	
November	0.029	0.298	0.188	0.440	0.021	0.278	0.136	
December	0.035	0.254	0.181		0.040		0.278	
Mean	0.023	0.276	0.220	0.497	0.022	0.288	0.173	0.460

TKN- Total Kjeldahl nitrogen.

Phosphorus

The time plot for total phosphorus concentration in the lower Niagara River is shown in Figure 4. This figure displays a seasonal cycle and some rapid and large fluctuations which are indicated by the sharp peaks in the diagram. Such random fluctuations in total phosphorus concentration would make detection of any real significant changes in total phosphorus concentration difficult. The observed seasonal cycle of phosphorus, lower values in summer and fall and higher in winter and spring, is consistent with observations made in 1974 and 1975. This pattern is probably closely related to the nutrient cycles in Lake Erie where the formation of nutrient-depleted epilimnetic

water in the summer creates a partition of nutrients between surface and bottom water. Lake turnover in the fall mixes epilimnetic and hypolimnetic water and the isothermal condition in winter tends to raise the phosphorus concentration in the whole water column.

Mean phosphorus concentrations for 1976 and 1977 were 0.023 mg/L and 0.022 mg/L, respectively (Table 2). Unlike dissolved major ions (to be discussed later), phosphorus concentration seemed to be unrelated to linear correlation coefficient. Trend analysis of the average concentration were least

Table 3. Ninety Percent Confidence Mean Concentration Limits for Lower Niagara, 1974

Parameter	July 17-19	August 20-22	October 1-3	November 12-14	December 3-5
pH	—	7.98-8.01	8.22-8.31	7.76-7.86	8.14-8.24
Conductance ($\mu\text{mho}/\text{cm}^2$)	—	301-304	329-331	310-314	312-313
Orthophosphate (mg/l)	.003-.004	.002-.003	.002-.002	.006-.008	.007-.008
Total P (mg/l)	.017-.020	.016-.017	.021-.021	.021-.023	.023-.024
TFP (mg/l)	.009-.011	.007-.008	.007-.008	.010-.011	.012-.013
TKN (mg/l)	.206-.226	.199-.210	.271-.287	.298-.328	.268-.288
NO_3, NO_2 (mg/l)	.261-.267	.104-.108	.076-.079	.133-.140	.166-.170
Total N (mg/l)	.470-.490	.305-.316	.347-.366	.433-.464	.436-.457
NH_3 (mg/l)	.028-.029	.024-.024	.033-.035	.040-.043	.047-.049
SiO_2 (mg/l)	.222-.228	.287-.295	.134-.167	.124-.138	.107-.120
Ca (mg/l)	37.75-38.02	37.76-37.98	—	38.65-38.88	38.87-39.04
Mg (mg/l)	8.36-8.36	7.67-7.87	—	—	8.07-8.09
K (mg/l)	1.10-1.12	1.32-1.35	—	1.40-1.40	1.30-1.31
Na (mg/l)	10.92-11.00	10.52-10.65	—	10.48-10.54	10.29-10.34
Cl (mg/l)	23.13-23.30	23.29-23.50	—	21.84-22.57	22.41-22.71
SO_4 (mg/l)	26.27-26.83	26.08-26.25	—	24.61-24.77	25.07-25.23
Alkalinity (mg/l)	92.53-93.23	93.70-94.31	—	94.69-95.31	95.54-96.26

Table 4. Mean Concentrations for Niagara River Survey, 1974

Parameter	July 17-19	August 20-22	October 1-3	November 13-14	December 3-5
Temperature ($^{\circ}\text{C}$)	22.2	23.0	15.3	10.3	4.6
pH	—	7.99	8.27	7.81	8.19
Conductance ($\mu\text{mho}/\text{cm}^2$)	—	303	330	312	312
Orthophosphate (mg/l)	0.003	0.002	0.002	0.007	0.007
Total P (mg/l)	0.018	0.016	0.021	0.022	0.024
TFP (mg/l)	0.010	0.008	0.008	0.011	0.012
TKN (mg/l)	0.216	0.205	0.279	0.313	0.278
NO_3, NO_2 (mg/l)	0.264	0.106	0.077	0.136	0.168
Total N (mg/l)	0.480	0.310	0.356	0.449	0.446
NH_3 (mg/l)	0.028	0.024	0.034	0.041	0.048
SiO_2 (mg/l)	0.225	0.291	0.150	0.131	0.114
Ca (mg/l)	37.88	37.87	—	38.76	38.96
Mg (mg/l)	8.37	7.77	—	—	8.08
K (mg/l)	1.11	1.33	—	1.40	1.31
Na (mg/l)	10.96	10.58	—	10.51	10.32
Cl (mg/l)	23.22	23.39	—	22.21	22.56
SO_4 (mg/l)	26.55	26.16	—	24.69	25.15
Alk. (mg/l)	92.88	94.00	—	95.00	95.9

*Taken at Niagara on the
Lake water treatment
plant intake.*

APPENDIX B

TABLE B-1 SAMPLING LOCATIONS IN UPPER NIAGARA RIVER

RANGE	STATION	DIST. FROM LEFT BANK LOOKING DOWNSTREAM	LANDMARK
← 19.5 E width 3800' depending	A	500'	Upstream from North Grand Is. Bridge
	B	1400'	
	C	2300'	
	D	3200'	
23.3 E width 2500'	A	600'	Off Stoney Pt. Road Grand Is. N.Y.
	B	1100'	
	C	1600'	
	D	2100'	
20.5 W width 2500'	A	500'	2000' Upstream from Navy Island
	B	1000'	
	C	1500'	
	D	2200'	
31.0 E width 2500'	A	500'	Off Blue Water Marina Grand Is. N.Y.
	B	1000'	
	C	1500'	
	D	2000'	
26.7 W width 2200'	A	440'	6000' downstream from Niagara Parks Comm. Marina
	B	880'	
	C	1320'	
	D	1760'	
36.0 width 2600'	A	500'	Under Tower Transmission line downstream from Peace Bridge, Fort Erie
	B	1000'	
	C	1500'	
	D	2000'	

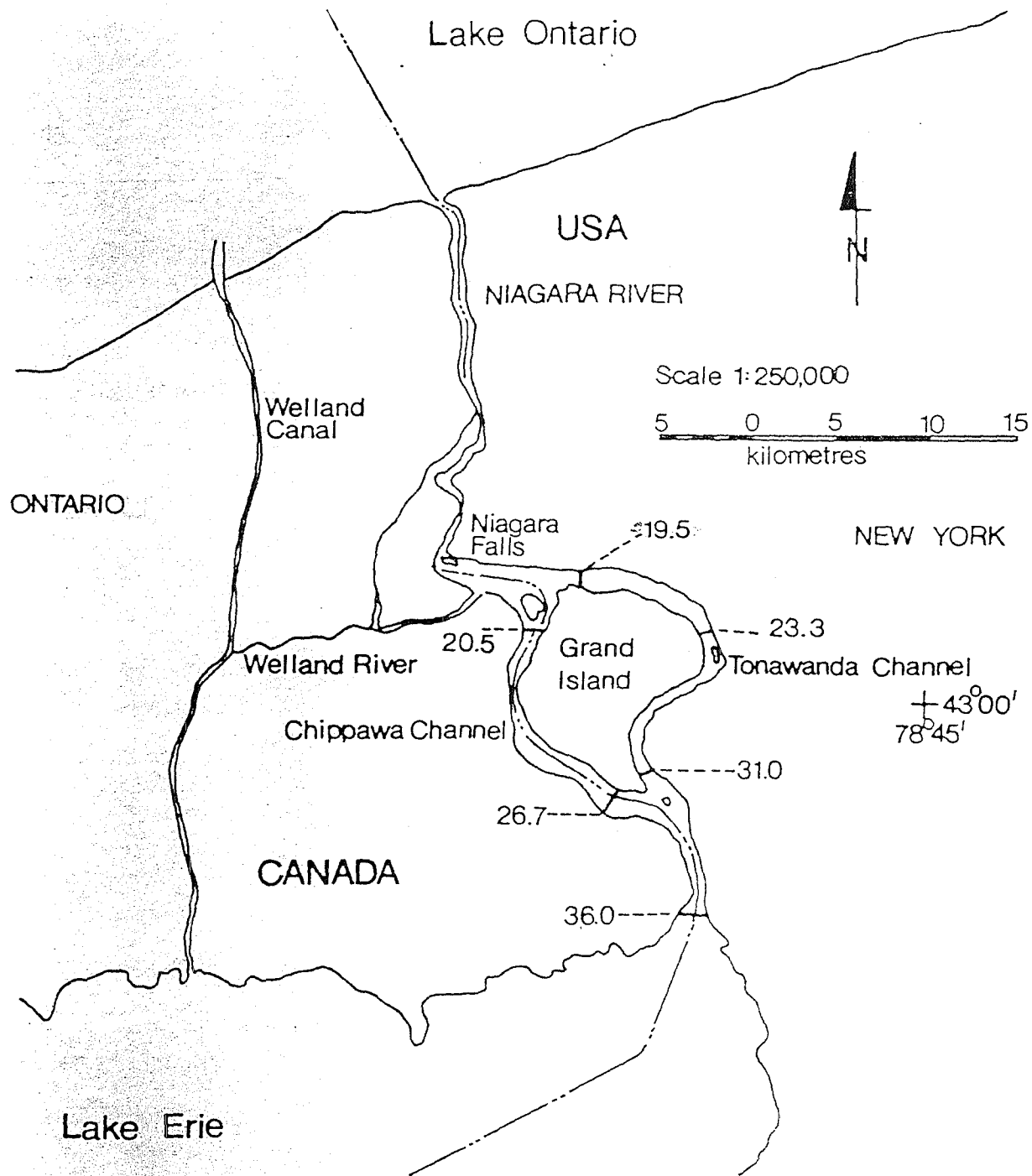


Figure 1. SAMPLING LOCATIONS ON THE UPPER NIAGARA RIVER

TABLE B-6

SUMMARY OF 1975 AND 1979 UPPER NIAGARA RIVER ANNUAL
MEAN NUTRIENTS DATA (mg/L)

RANGE	PARAMETER	STATION							
		A		B		C		D	
		1975	1979	1975	1979	1975	1979	1975	1979
20.5	TP	.017	.017	.017	.017	.020	.016	.019	.016
	TFP	.007	.008	.007	.009	.008	.008	.007	.008
	SRP	.002	.002	.002	.002	.001	.002	.002	.003
	TN	.392	.449	.393	.452	.396	.473	.400	.484
	TKN	.254	.286	.255	.281	.258	.298	.261	.302
	NO ₃	.138	.163	.138	.171	.137	.175	.139	.182
	NH ₃	.013	.014	.014	.014	.013	.014	.016	.011
	PN	.065	.067	.072	.067	.076	.068	.080	.076
	DOC	2.5	2.1	2.7	2.1	2.6	2.1	2.6	2.1
	POC	.536	.404	.593	.386	.597	.394	.634	.444
	SiO ₂	.195	.132	.179	.142	.189	.132	.227	.143
23.3	TP	.019	.018	.020	.019	.023	.025	.031	.033
	TFP	.008	.007	.007	.009	.009	.010	.014	.015
	SRP	.002	.002	.002	.003	.003	.004	.005	.007
	TN	.413	.472	.433	.502	.445	.539	.512	.633
	TKN	.261	.288	.277	.307	.286	.332	.343	.404
	NO ₃	.152	.184	.155	.195	.159	.207	.169	.229
	NH ₃	.016	.015	.021	.021	.033	.032	.084	.067
	PN	.092	.071	.104	.079	.096	.082	.113	.093
	DOC	2.8	2.1	2.6	2.1	2.5	2.1	2.8	2.2
	POC	.699	.424	.715	.461	.756	.509	.877	.606
	SiO ₂	.220	.173	.228	.218	.267	.275	.339	.278
26.7	TP	.016	.017	.015	.017	.016	.017	.015	.017
	TFP	.008	.007	.007	.009	.006	.007	.006	.008
	SRP	.003	.002	.003	.002	.003	.002	.002	.002
	TN	.383	.441	.382	.437	.401	.449	.389	.458
	TKN	.248	.280	.247	.269	.261	.276	.253	.278
	NO ₃	.134	.161	.135	.168	.140	.173	.136	.180
	NH ₃	.015	.012	.013	.011	.012	.010	.013	.013
	PN	.077	.068	.073	.065	.078	.065	.084	.068
	DOC	3.0	2.1	2.6	2.1	2.5	2.1	2.6	2.1
	POC	.629	.386	.579	.383	.632	.376	.610	.393
	SiO ₂	.184	.138	.170	.145	.180	.143	.193	.142

TABLE B-7

SUMMARY OF 1975 AND 1979 UPPER NIAGARA RIVER
ANNUAL MEAN MAJOR IONS DATA (mg/L)

*Sample location
↑ see map.*

YEAR	RANGE	T-ALK	Ca	Mg	PARAMETER K	Na	Cl	SO ₄
1975	20.5	91.9	37.3	8.1	1.3	10.0	20.6	25.1
	26.7	92.2	37.4	8.1	1.3	10.0	20.6	25.3
	36.0	92.0	37.1	8.1	1.3	9.9	20.6	25.0
	23.3	91.2	37.2	8.1	1.3	10.1	20.7	25.6
	31.0	91.9	37.1	8.1	1.3	10.1	20.8	23.9
1979	20.5	91.8	35.8	8.0	1.3	10.0	20.3	23.7
	26.7	91.5	35.8	8.0	1.3	9.9	20.4	23.8
	36.0	91.8	35.8	8.0	1.3	9.9	20.5	23.3
	23.3	92.9	36.2	8.0	1.3	10.5	21.0	24.7
	31.0	91.9	35.9	8.0	1.3	10.3	21.0	23.9
	19.5	91.9	35.8	8.1	1.4	10.6	21.2	24.5