Results of a Preliminary Water Quality Survey of the Eastern Portion of the Gaspereau-Black River Lake Watershed

Prepared By

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Kings County Wildlife Association
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1. Introduction

Increased pressure from recreational boating and fishing, cottage development, forestry operations and other activities in the Gaspereau-Black River Lake watershed has raised concerns as to the potential impact these activities may be having on water quality within the numerous lakes and streams within this system. To address these concerns, the Acadia Centre for Estuarine Research, at the request of the Kings County Wildlife Association, carried out a preliminary survey of water quality at a number of sites within this watershed. The Gaspereau-Black River Lake watershed includes 12 major lakes and headponds and many smaller lakes and streams. This survey concentrated on the eastern portion of the watershed which includes Gaspereau Lake, Salmontail Lake, Dean Chapter Lake, Murphy Lake, Little River Lake, Methals Lake and Black River Lake. The western portion of the watershed, which includes Lake George, Aylesford Lake, Loon Lake and Hardwood Lake, is currently being evaluated for water quality by the Municipality of Kings County (Horner Associates 1995). The primary objective of the survey was to obtain preliminary baseline data useful in determining if present levels of activity within the watershed are having significant impacts on water quality.

2. Methods

A total of 16 sites (Figure 1) were surveyed between 10-12 October 1995. The sites were chosen to represent the major basins of each lake (7 sites) and the major inlet and outlet streams from each lake (9 sites). With the exception of the stream outlet from Gaspereau Lake into the Whiterock Headpond, no samples were collected at or below Lumsden Pond since this area had been drained just prior to the survey for maintenance operations by the Nova Scotia Power Commission.

The parameters measured at each site (Table 1) included those most commonly analyzed for determination of water quality. Water samples collected from shallow sites within the inlet and outlet streams were obtained by immersing and filling the sample containers with as little disturbance of bottom sediments as possible. Lake samples were collected using a Van Dorn water sampler. Since there was never any indication of water column stratification at any of the sample sites within the lakes surveyed, all water samples were collected from mid-depth.

Sample analysis procedures were those commonly employed in limnological investigations (Wetzel and Likens 1991). Apparent and true color were determined by visual observation of water samples before and after filtration. Particulate matter concentrations were measured by oven drying and weighing samples that were filtered onto pre-weighed and pre-combusted Whatman GF/C filters. Particulate organic matter concentrations were determined by reweighing after combustion at 500 °C. Total phosphorous was determined by the ammonium molybdate method after oxidation by persulfate. Nitrate concentrations were determined by the cadmium reduction method using the Hach (1992) procedure. Fecal coliform determinations were carried out by the Valley Health Services laboratory of the Valley Regional Hospital, Kentville, N.S.

Table 1. Water quality parameters measured at each site.

Physical:
- Secchi Disk Depth
- Water Temperature Depth Profiles
- Suspended Particulate Matter (Total, Organic and Inorganic)

Chemical:
- Dissolved Oxygen
- Percent Dissolved Oxygen Saturation
- Conductivity
- Hardness (Total, Calcium and Magnesium)
- pH
- Alkalinity
- Total Phosphorous
- Dissolved Nitrate

Biological:
- Chlorophyll *a*
- Fecal Coliform Bacteria

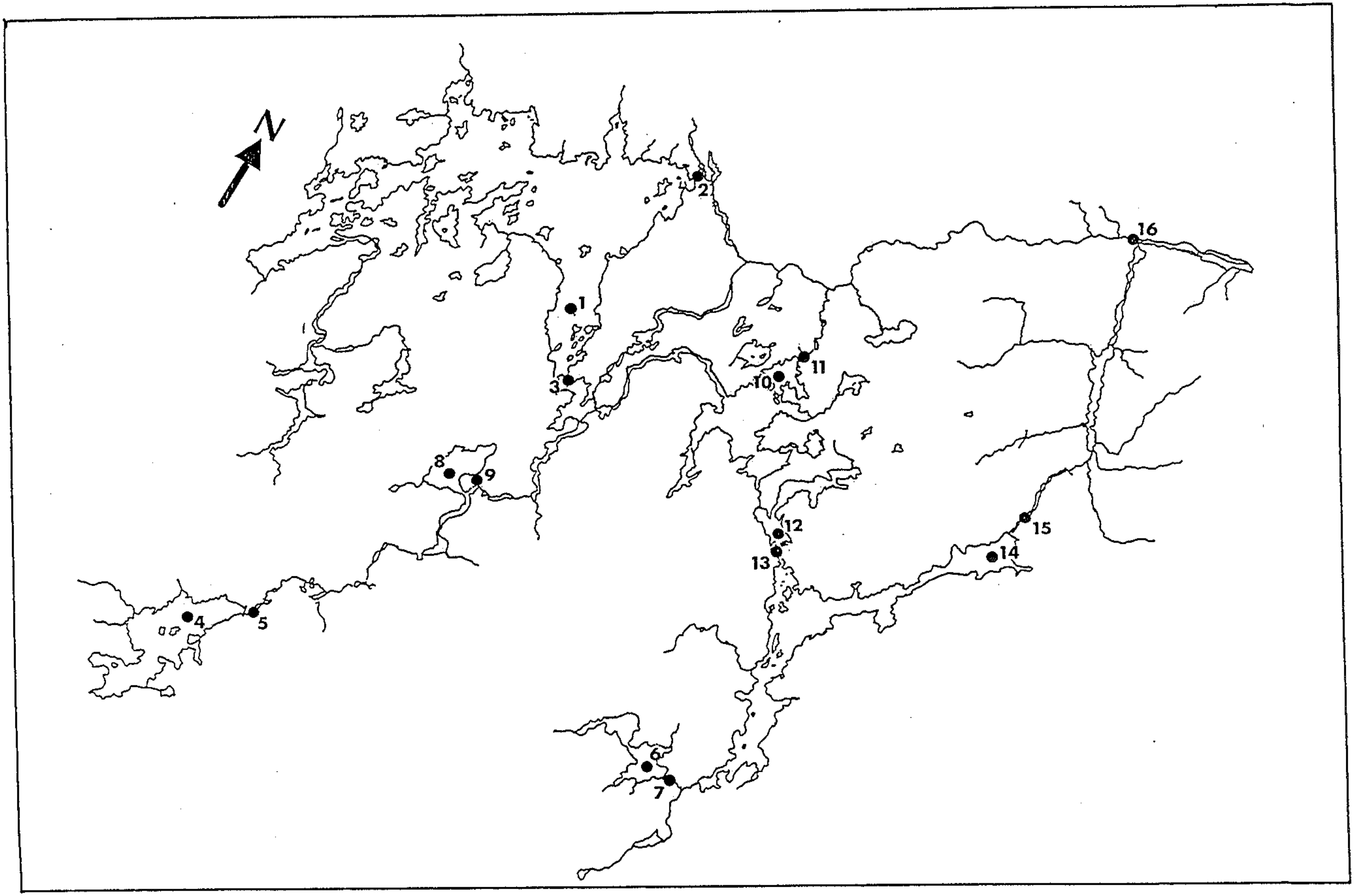

Figure 1. Location of sampling sites.

3. Results

The results of the survey are summarized in Table 2. Appendix I contains a summary of sampling locations, times and weather and other conditions at the time of sampling. Appendix II contains some guidelines useful in interpretation of the data.

Water clarity, as indicated by the Secchi disk depths and color observations, was quite good at most of the sites surveyed. Secchi disk depths were generally greater than 2.5 meters and there was little evidence of any color resulting from high algae or suspended sediment concentrations. The values for suspended particulate matter concentration were also very low, usually less than 10 mg/l, and in most cases consisted of about equal amounts of inorganic and organic matter. The latter observation suggests that during the sampling period there was little evidence of significant sediment input as a result of soil erosion. The one site showing a somewhat depressed water clarity was the main basin of Dean Chapter Lake (site 6) which had a Secchi depth reading of only 1.4 meters.. It is difficult to determine the source of the reduced water clarity at this site since both the apparent and true color measurements indicated a green color. A green apparent color that is removed during determination of true color would ordinarily suggest high algal concentrations. However, the color remained after filtration which suggests its source is something other than algal material.

All of the lakes and streams surveyed are very dilute in terms of their chemistry. Conductivity values were all less than 50 μsei/cm at all sites except the outlet of Black River Lake (site 15). Total hardness values were also very low, generally less than 10 mg/l except for two samples, one collected at the outlet from Black River Lake (site 15) and one collected form the inlet of White Rock headpond (site 16), both of which were greater than 10 mg/l. The higher values measured for both conductivity and total hardness at the Black River lake outlet may be related to the fact that this site, which is a man-made canal, was essentially drained at the time of survey, contained very little water and had a considerably reduced flow. At all sites most of the hardness is due to calcium as opposed to magnesium. Total alkalinity values are also low but the relatively high pH measured at all sites (generally greater than 5.5) indicates that there is currently sufficient alkalinity in this system to prevent it from becoming seriously acidified as a result of acid precipitation.

Dissolved oxygen concentrations and percent oxygen saturation values were well above levels that would be cause for concern except for one sample collected at the outlet of Murphy Lake (site 9). The value of percent oxygen saturation at this site was only 61.1 percent. This value is near the critical value of 50 percent saturation and is probably a result of the low water level and reduced water flow observed at the time of sample collection.

Chlorophyll *a* values for the main basin of each lake were generally less than 5 μ g/l which suggests that the lakes have low productivities and are not characterized by high algal concentrations. An exception to this was the main basin of Salmontail Lake (site 4) which had a chlorophyll *a* concentration of 6.4 μg/l. Although this value is still below what would be expected for a system receiving elevated nutrient inputs, it is high compared to other systems in this watershed.

Total phosphorus values were also low, generally less than 5 μg/l, at all sites except the main basin and outlet of Salmontail Lake. This further suggests that some process is making greater amounts of phosphorous available in this part of the watershed. This could be related either to some activity occurring within the drainage area of this lake, or, perhaps because of its shallow nature (water depth at the time of the survey was only about 2 meters), may have resulted from resuspension of bottom sediments since it was very windy at the time of sampling.

The exceptionally high value of total phosphorus reported for the main basin of Little River Lake (site 10) is probably in error since concentrations at the inlet and outlet of this lake (sites 9 and 11 respectively) were among the lowest reported.

Nitrate levels were in all cases very low and below the limit of detection of the measurement procedure used. Fecal coliform numbers per 100 ml were less than 10 at all sites except for the outlet of Murphy lake (site 9) which had a value of 26. Both the nitrate and coliform data indicate there is little reason to believe that significant amounts of sewage runoff were present at any of the sites examined during the period of the survey.

4. Discussion

The results of this preliminary survey suggest that water quality in this system has not seriously deteriorated as a result of the present levels of development and activity within the watershed. The primary indicators of water quality, chlorophyll *a*, phosphate, nitrate and coliform numbers, are generally within levels indicative of naturally unimpacted water bodies. A possible exception is Salmontail Lake which exhibited relatively high levels of chlorophyll *a* and phosphate concentrations. Further study is required to determine if this is a result of activities within the drainage area of this lake, or a natural condition resulting from the particular characteristics of the lake itself.

It is important to note, however, that the time during which this survey was conducted was in all probably the least appropriate time to detect any deterioration of water quality since the systems were unstratified and recently flushed as a result of fall rains and water drawdown associated with power generation. A more opportune time to carry out a survey of this sort would be during late summer when the lakes are stratified, particularly if they have not undergone recent drawndowns. Under these conditions nutrient loading by phosphates and nitrates could lead to enhanced algal growth and lowered dissolved oxygen levels in the deeper basins of the lakes. It should also be noted that this survey did not adequately determine if these systems were impacted by siltation arising as a result of soil erosion within the drainage basin. This would require a concerted and coordinated sampling effort at the major inlets of each lake during, or immediately after, a period of significant rainfall.

It is recommended that a sampling program similar to that presented here be carried out during late summer in order to provide a more complete evaluation of water quality within this portion of the Gaspereau-Black River Lake watershed. In addition, a complimentary sampling program should be carried out to more fully evaluate the extent of soil erosion impacts within this watershed.

Table 2. Summary of data collected.

Site	Secchi Depth (m)	Apparent Color	True Color	Surface Water Temp. (°C)	Surface Water Cond. (*u*sie/cm)	pH	Total Hardness (mg /l)	Calcium Hardness (mg /l)	Magnesium Hardness (mg/l)	Total Alkalinity (mg /l)
1	2.6	clear	clear	12.2	19	5.93	9.6	4.0	5.6	1.81
2		clear	clear	10.8	19	5.39	6.4	6.4	0.0	1.90
3		clear	clear	10.9	20	5.03	6.6	4.4	2.2	1.55
4		light brown	light brown	11.5	22	5.79	5.2	5.2	0.0	2.67
5		light brown	light brown	11.0	20	6.31	7.2	4.6	2.6	2.65
6	1.4	light green	light green	11.1	21	5.98	6.2	6.2	0.0	2.58
7		light green	clear	10.1	25	5.65	9.8	7.8	2.0	2.65
8	2.7	clear	clear	11.4	42	6.21	8.2	7.0	1.2	1.38
9		clear	clear	11.6	46	5.59	9.6	8.0	1.6	3.51
10	2.9	clear	clear	11.8	22	5.79	4.2	4.2	0.0	0.00
11		clear	clear	12.0	22	5.69	5.2	5.2	0.0	0.55
12	2.6	clear	clear	12.1	24	5.57	5.8	5.4	0.4	0.00
13		clear	clear	11.8	22	5.65	6.0	6.0	0.0	0.00
14	2.4	clear	clear	12.0	24	5.71	5.0	5.0	0.0	0.94
15		clear	clear	10.5	75	5.91	13.2	11.0	2.2	8.01
16		clear	clear	9.3	21	6.04	23.2	8.4	14.8	5.90

Table 2. Summary of data collected (continued).

Site	Dissolved Oxygen (mg/l)	Dissolved Oxygen Sat. (%)	Total Particulate Matter (mg/l)	Particulate Organic Matter (mg/l)	Particulate Inorganic Matter (mg/l)	Particulate Organic Matter (%)	Total Phosphorus (µg/l)	Nitrate (mg/l)	Chlor *a* (µg/l)	Fecal Coliforms (#/100 ml)
1	9.32	86.6	2.12	1.25	0.87	58.8	0.35	<0.10	3.9	2
2	9.12	82.3	2.67	1.51	1.16	56.5	0.35	<0.10	4.1	0
3	9.28	83.9	1.86	1.76	0.10	94.7	0.00	<0.10	12.0	6
4	9.06	83.0	9.80	5.40	4.4	55.1	16.90	<0.10	6.4	10
5	8.50	77.0	8.20	4.60	3.60	56.1	16.89	<0.10	11.6	4
6	9.74	88.4	1.60	1.20	0.40	75.0	1.57	<0.10	3.5	0
7	7.98	70.9	3.00	1.25	1.75	41.7	0.35	<0.10	3.7	0
8	9.74	89.0	2.37	1.37	1.00	57.9	1.11	<0.10	1.4	2
9	6.66	61.1	1.00	0.75	0.25	75.0	0.00	<0.10	1.2	26
10	9.10	83.9	0.70	0.50	0.20	71.4	24.10	<0.10	3.0	0
11	9.20	85.2	1.12	0.75	0.37	66.7	0.19	<0.10	2.4	2
12	7.94	73.7	1.37	1.13	0.25	81.8	0.35	<0.10	2.3	10
13	8.80	81.1	1.50	0.75	0.75	50.0	1.73	<0.10	1.3	2
14	8.82	81.6	1.25	1.13	0.12	90.0	1.27	<0.10	1.7	4
15	10.48	93.9	2.25	2.00	0.25	88.9	2.34	<0.10	16.3	0
16	10.70	93.4	1.61	1.01	0.60	62.5	0.19	<0.10	0.3	3

5. References

Hach. 1992. Hach water quality handbook, 2nd.ed. Hach Co.

Horner Associates Ltd. 1995. Lake carrying capacities and proposed shoreline development policies. Report to Municipality of County of Kings.100p.

Wetzel, R.G. and G.E. Likens. 1991. Limnological analyses, 2nd ed. Springer-Verlag.

APPENDIX I

Summary of sampling locations, times, weather and other conditions at time of sampling.

Site 1. Main Basin of Gaspereau Lake.
Date: 10 October 1995
Time: 1525
Weather: 14 °C with 100% cloud cover; no wind.
Samples collected from the lake by boat.
Water level in the lake was low (621.5 ft. on the water level gauge on the dam above the canal).

Site 2. Outlet of Gaspereau Lake into Gaspereau River.
Date: 10 October 1995
Time: 1130
Weather: 14 °C with 100% cloud cover; no wind.
Samples collected from shore just above the Lane Mills Fish Ladder.

Site 3. Outlet of Gaspereau Lake into the canal to Little River Lake.
Date: 10 October 1995
Time: 1200
Weather: 13 °C with 100% cloud cover; no wind.
Samples collected from shore just below the Highway 12 bridge; little or no flow from Gaspereau Lake into the canal.

Site 4. Main Basin of Salmontail Lake.
Date: 11 October 1995
Time; 1445
Weather: 14 °C with 100% cloud cover; strong wind.
Samples collected from the lake by boat.
Water level in the lake was low (estimated as 749 ft. on the water level gauge on the dam - the bottom of the gauge reads 752 ft.); maximum depth observed in the lake was less than 2 m.

Site 5. Outlet of Salmontail Lake.
Date: 10 October 1995
Time: 1230
Weather: 12 °C with 100% cloud cover; no wind.
Samples collected from shore just below the dam by the lake.

Site 6. Main Basin of Dean Chapter Lake.
Date: 11 October 1995
Time; 1115
Weather: 14 °C with 100% cloud cover; strong wind.
Samples collected from the lake by boat.
Water level in the lake was low (603.5 ft. on the water level gauge on the dam).

Site 7. Outlet of Dean Chapter Lake.
Date: 11 October 1995
Time: 1030
Weather: 14 °C with 90% cloud cover; strong breeze.
Samples collected from shore just below the dam by the lake.
Very low flow through the outlet.

Site 8. Main Basin Of Murphy Lake.
Date: 11 October 1995
Time; 1330
Weather: 14 °C with 100% cloud cover; strong wind.
Samples collected from the lake by boat.
Water level in the lake appeared normal.

Site 9. Outlet of Murphy Lake.
Date: 11 October 1995
Time; 1400
Weather: 14 °C with 100% cloud cover; strong wind.
Samples collected just above the bridge.
Very low (<1 L/sec) flow through outlet.

Site 10. Main Basin of Little River Lake.
Date: 12 October 1995
Time; 1240
Weather: 14 °C with 100% cloud cover and intermittent showers; strong breeze.
Samples collected from the lake by boat.
Water level appeared normal.

Site 11. Outlet of Little River Lake into Little River.
Date: 12 October 1995
Time; 1220
Weather: 14 °C with 100% cloud cover and intermittent showers; strong breeze.
Samples collected from shore just below the dam.
Flows were abnormally high at the time of sampling as water was being let down this passage to fill the White Rock Headpond.

Site 12. Main Basin of Methals Lake.
Date: 12 October 1995
Time; 1130
Weather: 14 °C with 100% cloud cover and intermittent showers; strong breeze.
Samples collected from the lake by boat.
Water level appeared normal.

Site 13. Outlet of Methals Lake into Black River Lake.
Date: 12 October 1995
Time; 1110
Weather: 12 °C with 100% cloud cover and intermittent showers; strong breeze.
Samples collected from walkway on the downstream side of power station; there was no flow through this passage at the time of sampling.

Site 14. Main Basin of Black River Lake.
Date: 12 October 1995
Time; 1015
Weather: 12 °C with 100% cloud cover and intermittent showers; strong breeze.
Samples collected from the lake by boat.
Water level appeared normal.

Site 15. Outlet of Black River Lake into canal towards Lumdsen Pond.
Date: 12 October 1995
Time; 1050
Weather: 12 °C with 100% cloud cover and intermittent showers; strong breeze.
Samples collected from shore just below the power station.
Water level very low; little or no flow through the canal at the time of sampling.

Site 16. Outlet of Gaspereau River into White Rock headpond.
Date: 12 October 1995
Time: 1030
Weather: 14 °C and sunny; no wind.
Samples collected from the Highway bridge.

APPENDIX II

Guidelines for Data Interpretation

Secchi Disk Depth - A Secchi Disk is a small white and black disk that is lowered into the water until it can no longer be seen. The depth at which the disk disappears provides information on water clarity which depends on the kind and amount of dissolved and particulate material in the water body. Extremely turbid waters may have Secchi depths less than 1 meter while very clear waters have Secchi depths greater than 10 meters. Readings between 2 and 5 m are typical of Nova Scotia lakes.

Apparent Color and True Color - The color of a water body depends primarily on two factors; the kinds of particulate substances suspended in the water and the kinds of substances dissolved in the water. The color that results from suspended materials is called apparent color and the color caused by dissolved substances is called true color. Apparent color is caused by such things as microscopic algae and clay and silt particles. True color is usually caused by various substances leached from the soil within the watershed, especially decomposition products of plants, which are then carried into the stream or lake as runoff.

Conductivity - Conductivity is a measure of the amount of dissolved salts present in a water body. It is measured with a meter that determines the water's ability to conduct electricity - the higher the salt content the greater the conductivity. Conductivity values less than 100 µsei/cm generally indicate soft water, values between 100-300 moderately hard water, and values greater than 300 hard water.

Hardness - Hardness is related to conductivity but is a more direct measure of the amount of dissolved calcium and magnesium, the major salts that cause hardness, present in a water body. Total hardness values are expressed as mg/l of calcium carbonate equivalents and can range from as low as near 0 mg/l for very soft water to greater than 5000 mg/l for very hard waters. Generally, values less than 50 mg/l indicate soft water, values between 50 and 100 moderately hard water and values greater than 100 hard water.

pH - pH is a measure of the acidity of a liquid. Values of pH can range between 0 and 14. pH values less than 7 indicate acidic conditions and values greater than 7 indicate basic conditions. pH values below 5 indicate potentially harmful acidic conditions and are a cause for concern.

Alkalinity - Alkalinity is a measure of the buffering capacity (ability to resist change in pH) of a water body. Water bodies having a low alkalinity have little ability to neutralize acids and are very susceptible to acidic inputs such as acid precipitation. Water bodies having alkalinity values less than 10 mg/l have little buffering capacity, those having values between 10 and 100 moderate buffering capacity and those above 100 good buffering capacity.

Dissolved Oxygen and Percent Oxygen Saturation - The amount of dissolved oxygen present provides important information on the suitability of a water body to support aquatic organisms. It is one of the most sensitive indicators of water quality. Equally important is the percent oxygen saturation which depends on water temperature as well as the amount of dissolved oxygen present. Generally, dissolved oxygen concentrations below 3-4 mg/l are lethal for most fish and many other aquatic organisms. Percent saturation values above 80 generally indicate healthy conditions. Values less than 50 percent saturation are cause for concern.

Suspended Particulate Matter - Measurement of suspended particulate matter provides information on the amount of particulate material in a water body. Particulate materials are diverse in origin and may consist of soils that have washed into the water through land erosion (inorganic particulate matter), materials resuspended from the bottom of a stream or lake, as well as microscopic organisms such as algae and bacteria (organic particulate matter). Particulate matter levels than 10 mg/l are about normal for clear waters. Levels between 10-25 mg/l indicate moderate suspended particulate matter concentrations and levels above 50 mg/l indicate particularly high concentrations.

Chlorophyll *a* - Chlorophyll *a* is the pigment that gives plants their green color. Measurement of the amount of chlorophyll a in a water body provides an estimate of the quantity of plant material present which is closely related to the level of productivity of the water body. Very often, when water quality deteriorates as a result of high nutrient inputs, the productivity of the system increases leading to heavy blooms of algae (microscopic plants). In some cases this can lead to depletion of oxygen if the plants die and sink into the bottom waters. In severe instances this depletion of oxygen can result in the build up of toxic substances such as hydrogen sulfide and ammonia. Chlorophyll *a* values generally range from less than 1 to as high as 30 µg/l. Values less than 3 µg/l generally indicate relatively unproductive waters, values between 3 and 10 µg/l moderately productive waters, and values above 10 µg/l very productive waters.

Total Phosphorous - Phosphorous is a major micronutrient required for the growth of plants. In aquatic ecosystems it is often the nutrient that limits the growth of algae. Excessive inputs of phosphate often leads to blooms of algae and results in deterioration of water quality. Common sources of excess phosphate include run off from human sewage, animal manures and farm and lawn fertilizers. The amount of phosphorous that can be assimilated by a water body before water quality is severely impacted depends on a number of factors, particularly the degree of water column stratification and flushing rate of the water body. However, rough guidelines often used to determine the concentrations that may result in impacts on water quality are: less than 10 µg/l - little impact; between 10 and 20 µg/l - moderate impact; greater than 20 µg/l - high impact.

Nitrate - Nitrate is also a major plant micronutrient that can limit the growth of algae and result in rapid plant growth when supplied to a water body in excessive amounts. Potential sources of this nutrient are the same as for phosphorous, but it is particularly abundant in sewage and manures and is sometimes used as an indicator of contamination from these sources. Rough guidelines used to determine the concentrations that may impact water quality are: less than 0.5 mg/l - little impact; between 0.5 and 2 mg/l - moderate impact; values greater than 2 mg/l - high impact.

Fecal Coliform Bacteria - Coliform bacteria are bacteria that are common in the intestines of warm-blooded animals. Although they are not toxic in themselves, they are an indicator of the presence of fecal material that may contain organisms potentially harmful to humans. In aquatic ecosystems coliforms often originate from poorly treated human sewage. They may also originate, however, from run-off from farm feedlots and pastures, and even from wild waterfowl such as ducks. Acceptable fecal coliform numbers depends on the proposed use of the water. Limits for various uses as proposed in the Canadian Water Quality Guidelines are: drinking water for humans - 0 per 100 ml; drinking water for livestock - 20 to 50 per 100 ml; irrigation of produce for human consumption - 100 per 100 ml; recreation (e.g. swimming, board sailing) - 200 per ml.