RIDEAU LAKE
LAKESIDE VILLAGE WATER QUALITY STUDY
PHASE 1 FINAL REPORT 2003

Prepared for: Big Rideau Lake Association
By: Centre for Sustainable Watersheds

LAKESIDE VILLAGE SURFACE WATER QUALITY STUDY

PHASE 1: FINAL REPORT

(GMEF Project #1667)

Prepared by:

Centre for Sustainable Watersheds
Portland, Ontario

For:

Township of Rideau Lakes/ Big Rideau Lake Association

June 2003

Objective

The Lakeside Village Water Quality Study was initiated by Big Rideau Lake Association and its partners to understand the threats to water quality in the two most urbanized areas of the Rideau Lake, the villages of Portland and Rideau Ferry.

This report was written to supplement findings from the October 2001 Report and evaluate:

- Water quality sampling in storm conveyance systems in Portland and Rideau Ferry in the spring and summer of 2002
- Delineation of subwatersheds and estimate volume of flow during precipitation events based on average and maximum observed events
- An estimation of loading of TP into the urban bays
- Direction of future work

Background

Due to drought conditions in the summer of 2001, stormwater was difficult to monitor, and correlation to contamination from run-off could not be established. Near-shore testing did show average Total Phosphorus (TP) levels over 0.03 mg/L, the level at which Ontario Provincial Water Quality Objectives for aquatic health indicate may cause excessive plant growth and render these areas more sensitive to further nutrient loading. *E. coli* levels were below provincial guidelines but at an average 50 CFU/per 100 mL, the data indicates some source of fecal contamination. Stormwater source sites (conveyance systems, ditches, streams) showed high levels of both *E.coli* and TP, and higher than usual levels of TKN, TSS, NO2+NO3, COND, Alk and Cl (although the Rideau Ferry source site did not have high levels of Cl). The intensive sampling after the September 23rd 2001 rain event did not disclose any conclusive information relating to contamination from run-off. Details of the sampling can be found in Interim Report #2 (October 2001). After the 2001 sampling season, an extension was requested from the Federation of Canadian Municipalities to continue the monitoring program into the spring and summer of 2002 so that potential nutrient loading from rain events could be better evaluated.

2002 Work Plan

Project management for work in 2002 was carried out by the Centre for Sustainable Watersheds, (at that time a division of the Big Rideau Lake Association). Partner organizations also provided support and assistance in this study. As a Technical Advisory Committee, representatives from the Township of Rideau Lakes (Julie MacAdoo, Planner), the Township of Drummond/North Elmsley (Ray Scissons, Chief Building Official), the Rideau Valley Conservation Authority (Bruce Reid, Hydrologist) and Queen's University Department of Civil Engineering Stormwater Research Group (Dr. Bruce Anderson, Associate Professor; Joan Ng, MSc. Candidate; Grace Yungwirth, NSERC summer intern), Centre for Sustainable Watersheds (Erika Kiss, Water Quality Technician; Mark Sunohara, Information Management Manager; Sarah Rosolen, Project Advisor) met on April 10 2002 to evaluate the project study design for 2002 and provide input to project direction to further work.

The objective of the extension of this study was to identify and characterize effluent in storm conveyance systems, to complement the comprehensive sampling of water quality in the nearshore waters around the two villages in 2001. Run-off was evaluated during two rain events for each site. Due to the geographic distance between the two villages, it was not possible to monitor the same event for each village. At least 3 samples were taken for analysis of TP and *E. coli* for each event, and the amount of precipitation was measured and recorded.

The sub-watersheds of Portland and Rideau Ferry were delineated using a Digital Elevation Model (DEM- see Figures 1 and 2). Sampling sites were chosen based on the delineation, to be representative of each of the catchment areas. The volume of rain collected in each subwatershed was estimated based on catchment area and average measure of rainfall over 5 mm (16 mm) as well as maximum observed event (50 mm). TP loading from urban run-off was estimated based on the calculated volume and average TP concentrations.

Results
Portland

Catchment basins for Portland are shown in Figure 1 and predicted volumes (m^3) during rain events, based on land area and amount of precipitation (average and maximum observed) are shown in Table 1. There are 6 main subwatersheds representing the catchment area draining into Portland Bay.

Table 1: Predicted area and associated volume of flow during an average rain event over 5mm as well as the maximum observed event

ID	LOCATION (Subwatershed)	Monitoring Sites	Area (km2)	Precipitation volume-16mm (m3)	Precipitation volume-50mm (m3)
1	hwy15_colborne	NA	0.11	1800	5500
2	Queen	QW	0.088	1400	4400
3	Campb_colborne	CAM	0.043	700	2100
4	StMary_Main	SW, MW	0.057	900	2800
5	Campbell_N	NA	0.0042	70	200
6	hwy15	HWY	0.39	6300	19600

** NA – no stormwater conveyance system sampling site available*

While the subwatersheds were roughly delineated using the existing elevation data, more detailed data would increase accuracy of the calculation. Improved elevation data, as well as a detailed inventory of land use/cover would improve estimates of stormwater run-off and is suggested as part of the extension project in 2003.

Currently there are no guidelines regulating stormwater discharge, although water quality objectives for effluent discharge may be applied to stormwater. MOE mandates a limit of 1 mg/L TP for all wastewater treatment outflows along the Rideau waterway (MOE 1994), however these guidelines do not consider the effects of loading into areas that already show high levels of nutrients. TP loading, the amount of TP discharged during a rain event (average and maximum observed), as well as concentrations are shown in Table 2. *E. coli* counts are shown in Table 3.

Table 2: TP concentrations (mg/L) in stormwater, associated loading (g) from each catchment area and receiving water concentrations (mg/L)

Subwatershed	Sampling Site	Number Samples	Average TP in stormwater (mg/L)	Receiving water TP (mg/L)*	TP loading (grams)	
					16 mm event	50 mm event
2- Queen	Queen/Water	6	0.17	0.046	240	750
3- Campb_colborne	Campbell St.	6	0.19	0.052	130	840
4 – StMary_Main	St. Mary's /Water	6	0.21	0.038	190	590

4 – StMary_Main	Main/Water	6	0.22	0.012	200	620
6 -hwy15	Highway	6	0.12	0.025	760	2400

* See Interim Report #2 for details

While TP concentrations in the stormwater outflow were generally lower than the provincial sewage outflow guidelines, loading into the bay may still be significant (130 – 760 g during an average event), given the volumes of flow channelled by the storm conveyance systems and the high levels of TP already present at the outfalls.

Table 3: *E. coli* counts in stormwater and receiving water (CFU/100 mL)

Subwatershed	Sampling Site	Number Samples	*E .coli* in stormwater (CFU/100mL)	Receiving water *E. coli* (CFU/100 mL)*
2- Queen	Queen/Water	6	240**	48
3- Campb_colborne	Campbell St.	6	356***	17
4 – StMary_Main	St. Mary's /Water	6	>400	47
4 – StMary_Main	Main/Water	6	>400	58
6 -hwy15	Highway	6	>400	94

* See Interim Report #2 for details
** 3 out of 6 samples were over 400 CFU/100 mL
*** 5 out of 6 samples were over 400 CFU/100 mL

Although it is difficult to correlate *E. coli* in storm conveyance systems to levels in the ambient water surrounding the outlets, the levels in the conveyance systems were generally over 400 CFU/100 mL and the levels observed in the nearshore waters, while not over the guidelines, indicated some contamination.

Problematic to the stormwater system in Portland is that two of the outfalls discharge directly to village beaches and also near residential housing. Only one of the beaches, Campbell Street Beach is assessed regularly (weekly) for *E. coli*, and this site was posted on one occasion during the summer of 2002 (815 CFU geometric mean).

Rideau Ferry

Assessment of the topography and urban lay-out of Rideau Ferry made the catchment basin modelling difficult, as most of the urban watersheds drained directly to the lake (overland flow) and not through the storm conveyance system (see Figure 2). Overland flow is difficult to monitor, but the impact is also more diffused. The development in this village is relatively dense along the shore, and otherwise is not built up.

Stormwater is collected along the highway in Rideau Ferry, and discharges on the edge of the residential area of the village. The catchment area contributing to this outfall is large and does not represent the dense development along the shore, therefore the loading at this outfall is not representative of the loading from high development along the shoreline. Again, more detailed

elevation data as well as land cover information would be useful to accurately predict the catchment area and stormwater flow.

Results from sampling for TP - concentration and loading at the outlet of each of the basins, as well as estimated loading are shown in Table 5.

Table 4: Predicted area and associated volume of flow during an average rain event over 5mm as well as the maximum observed event

LOCATION (Subwatershed)	Area (km^2)	Volume of Precipitation per event (m^3)	
		16mm event	50 mm event
hwy15	0.39	6300	19,600

Table 5: TP concentrations (mg/L) and associated loading (g) from each catchment area, *E.coli* (CFU/100 mL)

Parameter	Number Samples	Average concentration stormwater	Receiving water*	TP loading (grams)	
				16 mm event	50 mm event
TP (mg/L)	3	0.15	0.025	950	2940
E. coli (CFU/100 mL)	3	>400	9	N/A	N/A

Again, TP concentrations in the stormwater outflow were lower than the provincial sewage outflow guidelines and levels in the surrounding water near the outlet suggested nutrient enrichment. This bay also experiences heavy boat traffic and correlation to stormwater run-off contamination would be difficult. Nevertheless, loading into the bay may still be significant, given the volumes of flow channelled by the storm conveyance systems.

Summary & Recommendations

Portland

The village of Portland has a large catchment area that contributes to nutrient and pathogen loading to its bay during rain events. Contaminants in the stormwater conveyance systems come from highway run-off as well as residential lawn and paved roads. Given the high boat traffic, recreational use and high levels of nutrients already present in the bay, this loading may be significant.

There are several stormwater Best Management Practices (BMPs) that could be implemented to help reduce run-off and contamination in the run-off. A description of recommended BMPs was provided with Interim Report #2 in 2001, *Catalogue of Best Management Practices (BMPs) for Stormwater Management on Big Rideau Lake*.

The conveyance system infrastructure, 4 discharges in the village below the highway, would make centralized treatment of the stormwater from the area below the highway difficult. However, as the stormwater from the highway is conveyed in swales to a single discharge and in this location there is a potential to divert this flow and treat it in a detention pond, constructed wetland, filter or reduce run-off with an infiltration swale.

The lay-out of the village below the highway slopes towards the lake, and when water levels in the lake are high the stormwater conveyance system backs up, making modifications or treatment options difficult. Treatment could be improved by introducing a maintenance schedule on the existing stormwater catch basins. During the survey, it was observed that all of the basins were full with sediments, reducing their ability to settle sediments introduced in the stormwater flow. Catch basin inserts (adsorbent stormwater filters) can be used to reduce contaminants in stormwater, however, these are an expensive option and require more maintenance. There are swales conveying stormwater to the infrastructure in the village, and these could be engineered to improve infiltration, and thus reduce run-off. The approved extension of this study is currently in progress to examine the impacts of stormwater infiltration on septic system performance (see Further Work).

Two of the stormwater outlets discharge directly to public beaches. These two conveyance systems could be targeted for catch basin inserts.

Stormwater run-off from individual homes could be reduced with landowner education on the impacts of stormwater and BMPs they could implement on their properties. Incentives have been offered by municipalities to encourage landowners to adopt stormwater BMPs such as rainbarrels, rainwater gardens, cisterns, infiltration, or vegetated buffers for homeowners living along the shoreline or on a slope. Such a program could be considered for the residents of Portland, or other residents living along the shoreline.

Finally, successful educational programs have been implemented in larger municipalities across the country and through the United States, to help teach residents about the impacts of lawn and car maintenance as well as pet waste management on water quality. Such a program could be readily adapted to serve rural areas, where septic systems are involved and wells can also be impacted.

Rideau Ferry

As discussed, the stormwater collected in Rideau Ferry is largely run-off from the highway. This flow could be treated by installation of a filter or wetland prior to discharge to a the lake. The remainder of the stormwater in Rideau Ferry is overland flow. As with Portland, an educational program targeted to shoreline residents could reduce overland flow as well as the contaminants carried in the stormwater.

This report presents a unique assessment of the impacts of stormwater run-off from two lakeside villages as well as the feasibility of mitigation strategies for this type of run-off. Given the growing development on lakes and lakeside villages, stormwater discharge can present a serious threat to water quality. Where stormwater is discharged directly to a water body, stormwater management should be a priority in Official Plans and considered in development applications. Further, in rural areas, where wells and septic systems come in to play, evaluation of stormwater BMPs that promote infiltration should be considered, as they may affect performance of septic systems, or introduce contamination to wells. Education programs for landowners should be adapted to suit the unique issues involved with rural and lakeside villages.

Because Portland is a lakeside village, septic systems may be an important source of surface water contamination, especially during storm events. Higher water levels and/or increased groundwater movement during rain events may cause nutrients and pathogens to 'flush' through the system more quickly, with not enough time for sufficient treatment. This problem may be paramount in more densely populated areas on lakes, with smaller lots and more septic systems, and more people relying on clean water resources for drinking and recreational uses.

Further Work

While the existing elevation data does allow identification of rough catchment basins, better resolution is required to create a digital elevation model for predicting quantities of stormwater flow and associated loading. An elevation survey is underway to help gather more accurate detail. A comprehensive land cover assessment in the village will also help predict the fate of the stormwater (i.e. infiltration or run-off).

The Stormwater Research Group at Queen's University (Department of Civil Engineering) has partnered in the extension of this project. In the summer of 2002 it developed and distributed a comprehensive landowner survey to help learn more about the water management in the village (including # residents, water use & conservation, wastewater treatment system type and age, as well as stormwater management strategies). They propose that more work needs to be done to evaluate the feasibility of stormwater BMPs, especially in rural villages with wells and septic systems, with particular interest to infiltration applications, and how they may impact on septic system performance and well water quality. This project will examine various on-site

stormwater BMPs by modelling impacts of these systems on groundwater flows as well as concentrations of contaminants in the subsurface during rain events. Results from this study will contribute to recommendations for on-site stormwater management in rural villages.

Figure 1: Subwatersheds and Sampling Sites in the Village of Portland

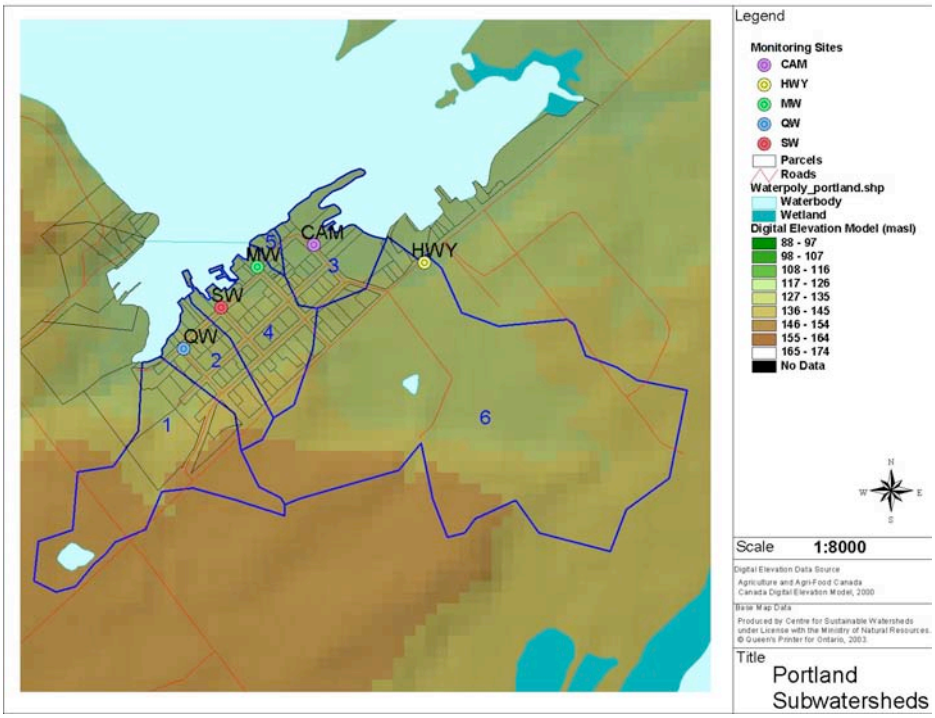
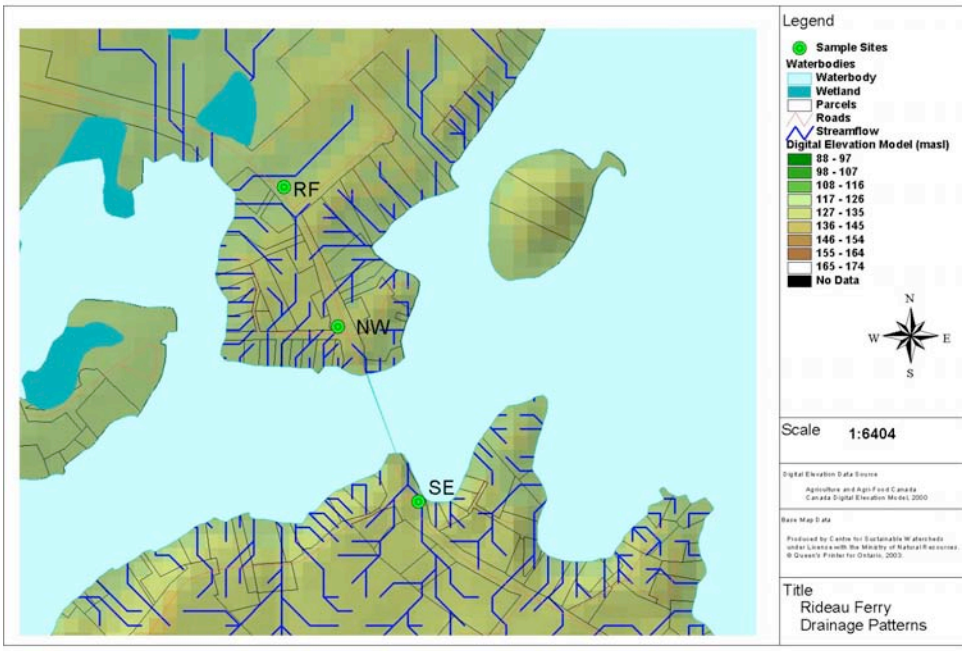


Figure 2: Drainage and Sampling Site in Rideau Ferry


RF
NW
SE
Legend
Sample Sites
Waterbodies
Waterbody
Wetland
Parcels
Roads
Streamflow
Digital Elevation Model (masl)
88 - 97
98 - 107
108 - 116
117 - 126
127 - 135
136 - 145
146 - 154
155 - 164
165 - 174
No Data
N
W
E
S
Scale 1:6404
Digital Elevation Data Source
Agriculture and Agri-Food Canada
Canada Digital Elevation Model, 2000
Base Map Data
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Title
Rideau Ferry
Drainage Patterns