AN INVESTIGATION OF POSSIBLE WATER QUALITY SAMPLING SITES TO REPRESENT BASELINE CONDITIONS OF THE HURONTARIO ECOREGION

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Summary

A subjective investigation of 5 potential baseline water quality sampling sites for the Hurontario ecoregion was completed. The sites that have been proposed have satisfied two preconditions. One, that their drainage areas are the least impacted of those found in the ecoregion; and, secondly, that the drainage areas of the sites are representative of typical physical characteristics of the ecoregion. Such sites were then evaluated more closely through field investigation. An acceptable site will provide baseline values for physical and chemical water quality parameters.

This data will aid water quality interpretation in two respects. Firstly, it would help to form better assessments of the nature and magnitude of agricultural, industrial, and municipal impacts in water reaches of the ecoregion, rather than those made in isolation, in the absence of comparison with "pristine" sites. Secondly, this data would be appropriate for setting general goals for attainable conditions in impacted water reaches undergoing recovery or reclamation.

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1.0 Introduction

Possible sampling sites to represent the Hurontario ecoregion have been selected from the northeast section of the Saugeen watershed as this area is one of the least impacted in the ecoregion. These selected sites are evaluated with respect to the Saugeen watershed rather than the entire Hurontario ecoregion. Mapped physical parameters, such as physiography, erosion, geology, and soil associations, were unavailable at the ecoregion level. Representativeness was thus more readily evaluated on the watershed basis. The Saugeen watershed falls within ecodistricts 5, 7, and primarily 8 (Fig.1), of Hurontario. Ecodistrict 8 has been found to be one of the most representative ecodistricts of the ecoregion. (Warry, 1990) Ecodistrict 11 is equally representative, but its area has suffered much more impact, and thus baseline sampling sites there would be inappropriate. It should be noted that, while the proposed water quality sampling sites are representative of the whole Hurontario ecoregion, they are located entirely within the Saugeen River watershed, even though the entire ecoregion is much larger, made up of 9 ecodistricts, numbers 5 to 13. (Fig.1)

An interdisciplinary study by Wickware and Associates on the Saugeen River basin (1990) was used as a base to begin selecting baseline water quality sampling sites. They propose sampling for "pristine" water quality parameters in the upper reaches of the Rocky Saugeen sub-basin. This sub-basin was selected out of 8 watershed divisions altogether including the Lower Saugeen, Mill Creek, Willow Creek, Snake Creek, North Saugeen, South Saugeen, Teeswater, and the Rocky Saugeen. The Rocky Saugeen was determined to be the most desirable for baseline water quality sampling on the basis of: one, percentage of idle land; two, the magnitude of area drained; and three, the range of surficial deposits. The proximity of gauging stations to the sub-basin and the usefulness of existing water quality information for the sub-basin were also factors involved in the selection of the upper Rocky Saugeen by Wickware and Associates.

In this study, five areas were investigated with respect to the proportion of undeveloped versus developed land in their sub-basins. The extent to which they represent the general physical characteristics of the watershed was considered as well.

The greatest emphasis in site selection was placed on minimum impact; the least developed drainage areas were most desirable. Being the least developed, the proposed sampling areas are very small, each representing approximately 1 to 2 percent of the area of the watershed. Thus the conditions represented by these sites are limited in range, though all are typically found in the watershed.

The small sub-basins selected include Hamilton Creek, Black's Creek, Mountain Creek, Traverston Creek, and the creek draining the Black Lake area.

The approximate areas of the drainages are as follows:

Hamilton Creek	70 km^2
Black's Creek	50 km^2
Mountain Creek	30 km^2
Traverston Creek	40 km^2
Black Lake	20 km^2

The Saugeen watershed as a whole covers approximately 4000 km^2. (Fig.2)

Hamilton Creek (Fig.3) and Black's Creek (Fig.4), tributaries to North Saugeen and Rocky Saugeen rivers, have been examined in the field. Mountain Creek (Fig.5) and Traverston Creek (Fig.6) may be inappropriate for sampling purposes due to insufficient flow. These latter two creeks both flow into the Rocky Saugeen. The Black Lake area (Fig.7) flows into Camp Creek, and eventually into the main Saugeen River.

The desirability of the sub-basins as baseline water quality sampling areas was assessed as follows:

1. With respect to impact, the proportion of natural vegetation and the land use in the developed areas was evaluated. Any damming of the water reach, tile drainage of fields, or municipal drainage was noted, to be avoided when sampling.

2. The representativeness of the sub-basins with respect to the Saugeen watershed was then assessed by the examination of other variables affecting water quality including physiography, erosion potential, geology, and soil associations. This assessment of representativeness at the watershed level was then extrapolated to the ecoregion level, as previously justified.

From the assessment of potential water quality sampling sites, the most preferable were recommended for field evaluation, ideally to provide data in the future for baseline conditions of the Hurontario ecoregion.

2.0 Impacts on Sites

These sites were initially selected on the grounds that the sub-basins they drain contain the maximum percentage of non-developed land in order to keep agricultural, municipal, and industrial impacts to a minimum.

These areas would be relatively free of the effects of fertilizers, pesticides, and herbicides from agriculture. Where agriculture does take place, pasture was deemed to have less impact on the water courses than cropland because of the absence of chemicals, although livestock feces was recognized as an important factor in eutrophication of water courses.

The Hamilton Creek, Black's Creek, Mountain Creek, and Black Lake area sub-basins were found to contain about 50 percent forest and scrub. Forests are immediately adjacent to the headlands of Hamilton Creek except for a small area of pasture. Black Creek's forests are adjacent to the basin's streams. Mountain Creek has some cropland adjacent to it about halfway down, in addition to forest. The sub-basin at Traverston Creek appeared to be made up of over 50 percent forest with only very small cropped areas existing and a small area of pasture reaching the creek. Pasture reaches the Black Lake sub-basin at its headwaters and also further down its reach. A correctional institution that is located at one branch of the Black Lake area's headwaters, as well as a railway running through this sub-basin, might prove to have negative impacts on water quality.

The Traverston Creek sub-basin seems the most desirable with respect to containing the smallest proportion of developed land.

Where land is developed, detailed land use information was available covering the Hamilton, Black's, Mountain, Traverston, and Black Lake sub-basins. (SVCA, Subwatershed Data) Values were available only specifically for the Black's Creek sub-basin. Generalizations follow for the four other creeks examined as they only cover portions of areas where specific information is available. Of the 5 sub-basins, forest typically covers the greatest proportion of land, followed by pasture, hay (legumes), small grains, hay (grass), row crops, and fallow land, respectively. Urban areas take up the smallest proportion of land in these areas.

Hamilton Creek and Black's Creek, unfortunately, were found to contain areas of tile drainage in their basins. Hamilton Creek would be best sampled upstream of Robson Lake, out of reach of the impact of a small area of tile drainage. (OMAF map 42-360, scale 1: 25 000) The possibility of Black's as a representative site for baseline conditions for the ecoregion was reduced, as this area of artificial drainage is at the stream's headwaters, draining approximately 14 hectares, at the municipality of Berkeley. (SVCA records)

3.0 Representativeness of the Sites

Black's Creek, Mountain Creek, Traverston Creek, and the Black Lake area fall within the delineation of ecodistrict 8. (Fig.1) Ecodistricts 8 and 11 have been determined to be the most representative of the Hurontario ecoregion by a presence/absence analysis of ecological characteristics which include area, elevation, relief, land/water ratio, landform, bedrock, soil, vegetation, drainage, and river system structure. (Warry, 1990)

Hamilton Creek was found very near the boundary of ecodistricts 7 and 8. (Fig.1) However, the ecodistrict boundaries were inaccurate when transferred from the low resolution 1: 2 000 000 map to higher resolution 1 : 50 000 maps. Ecodistrict 7 has been found to be relatively low in its general representation of Hurontario although it is representative in elevation, relief, land/water ratio, bedrock, unconsolidated surface expression, and drainage density. Ecodistrict 8 has been noted as being representative for consolidated surface expression, soil type, and river expression; as well as relief, land/water ratio, bedrock, unconsolidated surface expression, and drainage density. (Warry, 1990) Hamilton Creek lies in the transition zone between the districts 7 and 8. From available information, it should remain a candidate for sampling baseline water quality conditions as representative of the Hurontario ecoregion.

The characteristic physiography, geology, and soil associations were examined for the Saugeen watershed and proposed water quality sampling sites. The representativeness of suggested sites was evaluated based on these criteria.

3.1 Physiography

All potential sampling sites exhibit physiographic characteristics typical of the watershed. (Table 1) This includes spillways in central areas, and till plains throughout, as the major depositional landforms. Kame moraines, till moraines, and drumlins can also be found. Till moraines are the most common landform in the Hamilton Creek sub-basin, along with till plains at the creek's headwaters and spillways along the creek's reach. Spillways are the most common landform of the Black's Creek sub-basin, with till plains along the length of the stream, and drumlins in the north and northwest. Mountain, Traverston, and Black Lake sub-basins exhibit mostly spillways as well. The area drained by Mountain Creek also has drumlins throughout, along with some till plains; kame moraine occurs midway down the stream. Traverston also has kame moraines at the outer part of the upper reaches of the sub-basin. Black Lake exhibits kame moraines and till plains as well.

Mountain Creek was judged to be the most representative site with respect to physiography.

3.2 Erosion Potential

Relative erosion potential of the main sub-basins of the Saugeen watershed was determined by the SVCA, based on soil type, slope, land use, and rainfall. (See table 2; from map of land-related erosion potential, scale 1: 285 714, SVCA Watershed Plan, figure 5) Hamilton Creek has relatively steep slopes (approximately 0.004 m/m). Black's Creek, Mountain Creek, and Traverston Creek exhibit moderate slopes relative to the watershed, at approximately 0.003 m/m. The slopes of the Black Lake area are significantly high for the watershed at an average of 0.009 m/m. (SVCA, Subwatershed Data) The other variables affecting erosion include land use, which has been discussed above, and soil associations, a discussion of which follows. Erosion potential, as found by the SVCA, is low relative to the watershed as a whole at Hamilton Creek, Black's Creek, and Black Lake. Mountain Creek has moderately low erosion potential, and Traverston Creek has moderate potential, relative to the watershed.

Traverston Creek was judged the most representative with respect to erosion potential.

3.3 Geology

The bedrock of the Saugeen watershed ranges in age from the Devonian to Silurian geologic time periods and is predominantly made up of sedimentary dolomite. (Table 3) The bedrock underlying all of the proposed water quality sampling sites is dolomite of the Guelph formation, formed in the middle to lower Silurian period. This is representative of the Saugeen.

All sites have equally representative bedrock geology.

3.4 Soil Associations

The soil associations found within the potential sampling sub-basins are typical of the Saugeen River watershed. (Table 4) Predominantly medium to sometimes coarse-textured soil formed on till is found, on slightly to exceedingly stony loam. This soil has good drainage and ranges from slightly acidic to neutral.

Hamilton Creek and Black's Creek have stony, neutral soils of the Brown Forest group. Mountain Creek's soils are predominantly medium-textured, Grey-Brown Podzols, which are slightly acidic. Traverston Creek and Black Lake have stony, neutral, Brown Forest soils which are more coarsely textured.

Hamilton Creek, Black's Creek, and Mountain Creek were thus found to be most representative with regard to soil associations, although all of the sub-basins represent the major soil associations found in the Saugeen River watershed as a whole.

4.0 Conclusions and Recommendations

Water quality sampling site selection has been limited to areas of the least possible human impact. As a result, small drainage areas have been chosen at the possible expense of greater representation of the Hurontario ecoregion as a whole. All areas exhibit conditions typical of the Saugeen watershed and Hurontario ecoregion, yet do not, obviously, cover a broad range of these conditions.

From the study of available maps and literature, Hamilton Creek was found to be the most preferable sub-basin (Table 5). A reconnaissance survey of the entire Saugeen watershed was performed in December 1990, and a follow-up survey targeting the recommended sites was completed in April, 1991.

Traverston Creek, and Mountain Creek were found to be relatively highly impacted in the upper reaches, with many ploughed fields, and ample evidence of erosion. The Camp Creek, and Black Lake sub-basins also had significant impacts, and in addition to this, there were not any suitable sites for sample collection.

The Black's Creek sub-basin was inappropriate for baseline sampling, because there is artificial municipal drainage from the town of Berkley, in the headwaters area.

The Hamilton Creek sub-basin was found to have two sites that were highly suitable, from the point of view of being able to collect samples year round. The upstream site was located on a regional road 1.5 km north of Lily Oak, and this small basin had an area of approximately 9 square kilometres. Hamilton Creek originates here from the outflow of two small ponds. The area was very representative of the Saugeen River basin as a whole, as it contained upland forest, abandoned fields, swamp, and marsh. The minimal farming that occurs involves marginal pasture land, at best. A potential problem with this site is that the creek is very wide where it crosses the road. The water course is divided between seven culverts of various diameters, and grade levels. It was thought at the time that this could create problems in measuring discharge at this site; otherwise these headwaters appeared to exhibit ideal conditions.

The second site had a drainage area of approximately 50 square kilometres, and included the basin north of Lily Oak. It was below an abandoned dam, that is 2 kms downstream of Robson Lake. There is an ideal place to sample, 100 m downstream of the dam, where the river crosses a dead end secondary road. The potential problem at this site is that there are a number of cottages upstream on Connell's, Hines, and Robson Lakes, which may contribute sewage inputs. In addition, there is a dwelling immediately upstream of the sampling site between the road and the dam.

A final reconnaissance of the two Hamilton Creek sites was undertaken with Water Survey Canada personnel in August, 1991. It was felt that the many culverts at the upstream site north of Lily Oak, make it totally unsuitable for the installation of a gauging station. Discharge information is required for the calculation of loadings, so this site was rejected.

The downstream site below Robson Lake was thought to have very good potential in terms of being suitable for measuring water quantity. In fact, the remains of the old dam structure may act as a suitable control for the hydrometric station, greatly reducing installation costs.

After discussion with the residents of the house adjacent to the site, it was found that they use the creek as their source of drinking water, and it is tested regularly for bacti. All tests have come back negative to date, so it is unlikely there are any significant impacts from the cottages upstream, or for that matter the adjacent dwelling itself. The owners noted that the septic bed is located as far as possible from the creek, and it drains away from the creek bed.

On the basis of the literature review, mapping exercise, field reconnaissance observations, and information from local residents, it was decided that this site on Hamilton Creek, downstream of Robson Lake, is the most suitable for representing "pristine" conditions in the Saugeen River basin.

This station will provide baseline data, that will be compared with information collected at future impacted sites elsewhere in the Saugeen River basin.

Table 1. Physiography of the Saugeen watershed and potential sampling sites.

	MAJOR	OTHER	MINOR
SAUGEEN WATERSHED	spillways till plains	kame moraines till moraines drumlins	clay (NW) sand plains (NW) eskers peat & muck

	MAJOR	OTHER	RANKING (4 = most representative, 1 = least representative)
HAMILTON CREEK	till moraines	till plains spillways	1
BLACK'S CREEK	spillways	till plains drumlins (N & NW)	3
MOUNTAIN CREEK	spillways	drumlins till plains kame moraines	4
TRAVERSTON CREEK	spillways	kame moraines	2
BLACK LAKE	spillways	kame moraines till plains	3

Table 2. Erosion in the Saugeen watershed and potential sampling sites.

	SLOPE (RELATIVE TO WATERSHED)	EROSION POTENTIAL	RANKING OF EROSION POTENTIAL (2 = most representative, 1 = least representative)
HAMILTON CREEK	steep	low	1
BLACK'S CREEK	moderate	low	1
MOUNTAIN CREEK	moderate	moderately high	1
TRAVERSTON CREEK	moderate	moderate	2
BLACK LAKE	n/a	low	1

Table 3. Bedrock geology of the Saugeen watershed and potential sampling sites.

	AGE	FORMATION / ROCK TYPE
SAUGEEN WATERSHED	Devonian to Silurian	dolomite predominantly
HAMILTON CREEK	Middle & Lower Silurian	Guelph Formation / dolomite
BLACK'S CREEK	"	"
MOUNTAIN CREEK	"	"
TRAVERSTON CREEK	"	"
BLACK LAKE	"	"

Table 4. Soil associations of the Saugeen watershed and potential sampling sites.

	SAUGEEN WATERSHED	HAMILTON CREEK	BLACK'S CREEK	MOUNTAIN CREEK	TRAVERSTON CREEK	BLACK LAKE
TEXTURE	medium to coarse	medium stony	medium stony	medium few stones	medium &coarse stony	medium & coarse stony
PARENT MATERIAL	till (loam)	till	till	till	stony till	stony till
MAJOR SOIL GREAT GROUP	GBP BF	BF	BF	GBP	BF	BF
DRAINAGE	good	good	good	good	good	good
SURFACE REACTION	slightly acid to neutral	neutral	neutral	slightly acidic	neutral	neutral
RANKING	-	2	2	2	1	1

note: 2 = most representative, 1 = least representative
GBP = Grey Brown Podzolic
BF = Brown Forest

Table 5. Ranking of the sites by physical characteristics.

(3 = most substantially representative, 2 = most representative, 1 = representative)

	HAMILTON CREEK	BLACK'S CREEK	MOUNTAIN CREEK	TRAVERSTON CREEK	BLACK LAKE
PHYSIOGRAPHY	0	1	2	0	1
EROSION POTENTIAL	1	1	1	2	1
SOIL ASSOCIATION	1	1	1	0	0
AREA	2	1	0	0	0
LAND USE	2	0	1	3	1
SUM	6	4	5	5	3

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