Saugeen Valley
Rural Beaches Impact Study
of the Durham Subwatershed

Annual Report

for the period

August 1988 to March 1989

Prepared by

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for

The Ontario Ministry of the Environment

Southwestern Region

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SUMMARY

Although the Saugeen River has been known for high quality water, Durham reservoir beaches were dosed to swimming in 1987 due to bacterial contamination. The Saugeen Valley Rural Beaches Program, funded by the Ministry of the Environment, began in 1988 to address the problem of diffuse source pollution in the drainage area upstream of Durham.

The study watershed is made up of small to medium size farm operations utilizing pasturing systems and cropping areas where suitable. The rolling moraine topography leaves much land unsuitable for agriculture and remaining forested with some recreational usage.

A collection of watershed data base information was completed during the program year. Water quality evaluation revealed watercourses with considerable degradation due to agricultural land use practices. Other tributaries, unaffected by human activity, showed a high level of water quality which may be attainable throughout the subwatershed.

Because water quality information was only generated since the beginning of the program in August, the effect of contaminated springtime runoff on the river system has not been evaluated. The second year of the program will document spring and early summer flow conditions and qualities which relate directly to swimming season considerations.

Water quality analysis showed areas of concentrated agricultural activity to have correspondingly poor water quality. Sample analysis from station 6 on tributary A indicated the pollution potential of the surrounding pasture systems and emphasized the importance of further investigation of this part of the subwatershed.

Articles in local news media concerning the Beaches Program contributed to the interest shown by landowners contacted through the stream survey. These positive contacts will be increased and expanded in the second year of the study through a landowner information and education program.

Through these programs of field study, water quality evaluation and public relations, the first year of the Saugeen Valley Rural Beaches Program has established the groundwork for the remainder of the program.

RECOMMENDATIONS

The Saugeen Valley Conservation Authority has been involved in the Rural Beaches Study on the watershed of the Saugeen River upstream of the Durham reservoirs for the period of August of 1988 to March, 1989. During this period, a significant level of effort has resulted in not only the identification of possible source areas of direct negative impact on water quality but also on the generation of public contact with watershed residents.

It is recommended therefore that the Saugeen Valley Conservation Authority continue the Rural Beaches Program to further identify the sources of contamination with the long-range goal of controlling and/ or eliminating those sources.

It is also recommended that the public information and education program presently in the infant stage, be further developed to aid in the implementation of a remedial measures program.

Given the short period of investigation it is necessary to continue the study to confirm the results to date so that a practical, common sense remedial measures plan can be developed. Upon implementation, the ultimate objective of maintaining the recreational usage of the Durham beaches through the improvement of water quality will be realized.

1.0 INTRODUCTION

The Saugeen River has a reputation for high quality water with significant fisheries resources and recreational opportunities. Historically, water quality problems have not been present in this river basin to the extent that other rivers in south and southwestern Ontario have been affected. Over the past few years however, there have been indications that a gradual deterioration of the basin water quality is occurring.

In July, 1987 three beaches were closed on the Saugeen River due to unacceptable levels of fecal coliform bacteria. Of concern to the Authority is the maintenance of the water quality, particularly as it affects the recreational attributes of its park and more importantly, the health of its users.

This Beaches Project is part of the Provincial Rural Beaches Program, funded by the Ontario Ministry of the Environment and in association with the Ministry of Agriculture and Food and other Conservation Authorities.

The Provincial Rural Beaches Management Strategy was initiated by the Ministry of the Environment in 1985 in response to widespread swimming area closures due to bacterial contamination in southern Ontario. The program is expected to span at least 10 years for significant progress to be shown.

Watersheds chosen for study are those with beaches identified as having predominately agricultural practice impacts. The general approach is to proceed with low effort, low cost projects which produce immediate benefits while at the same time undertaking the complex long term watershed studies.

A major tool of the program is the Ministry of Agriculture and Food's cost sharing plan called the Ontario Soil Conservation and Environmental Protection Assistance Program. Under this program, grants are provided to farmers for the construction of approved manure handling systems and soil erosion controls.

With a range of research and practical projects on the go, the Beaches Program is dedicated to the development of a prioritized and logical plan of action to solve Provincial beach problems.

2.0 BACKGROUND

2.1 <u>The Durham Subwatershed</u>

The study area is a subwatershed of the Saugeen River, bounded by the hamlet of

Priceville in the east and the Town of Durham in the west. The main stream flows generally westward with a channel length of 28.5 km, draining an area of 121 square kilometers. The first census report of agricultural production in the area was in 1851. Figure 1 shows the location of the Durham subwatershed within the Saugeen watershed.

The basin is composed of portions of four townships; 78% being Glenelg Township with 9460 hectares, Artemesia Township with 18% or 2150 hectares, Proton Township with 3% or 310 hectares and Egremont Township with 1% or 160 hectares.

The Durham Subwatershed is fed by drainage from the headwater subwatershed of the main Saugeen River above Priceville which covers an area of 228 square kilometers. Entering the subwatershed at an elevation of 463 m, the river descends 120 m to the Durham reservoir before continuing on to the Lake Huron outlet at Southampton, over 100 km distant.

The average gradient of the river as it passes through the subwatershed is 0.45%. The topography and surficial geology of the main channel allow for rapid shallow flow over clean gravel to boulder size material. In many places, limestone bedrock forms the channel bed. Relative watercourse gradients are shown in figure 2, utilizing lines of equal stream elevation.

Five significant tributaries provide permanent flow to the main stream, three draining the north and two draining the south half of the watershed. Several intermittent streams play a varying role in river water quality, depending on season and location.

The topography is widely varying, with physiography composed of the Dundalk Till Plain and the Horseshoe Moraine. The physiography and distribution of surficial materials in the Durham Subwatershed are the result of the activities of the Georgian Bay ice lobe during the time of the Wisconsin glacial advance which ended some 10,000 years ago.

Underlain by bedrock of the Guelph formation, the drift thickness is variable, ranging from less than Im to at least 43m. Areas of less than 15m of drift generally parallel the course of the Saugeen River from Durham to Glenelg Centre. Bedrock outcrops also occur in these areas. A small area of less than im of drift is located in the vicinity of the Town of Durham.

The dominant soil type is the Pike Lake Loam. An agricultural breakdown by percent land area reveals 32% grassland, 13% small grains and 4% row crops. The forest cover in the subwatershed is 37%, with lowland mixed and upland hardwood being the dominant types. Artificial drainage is found on 2% of the subwatershed area, while 3.3% is wetland.

The basin is made up of four landscape types: the Markdale Rolling Plain; the Durham Rolling Plain; the Glenelg Gravelly Hills; and the Swampy Saugeen Flats. Figure 3 identifies the landscape types of the Durham subwatershed.

Location of study area within the Saugeen Watershed

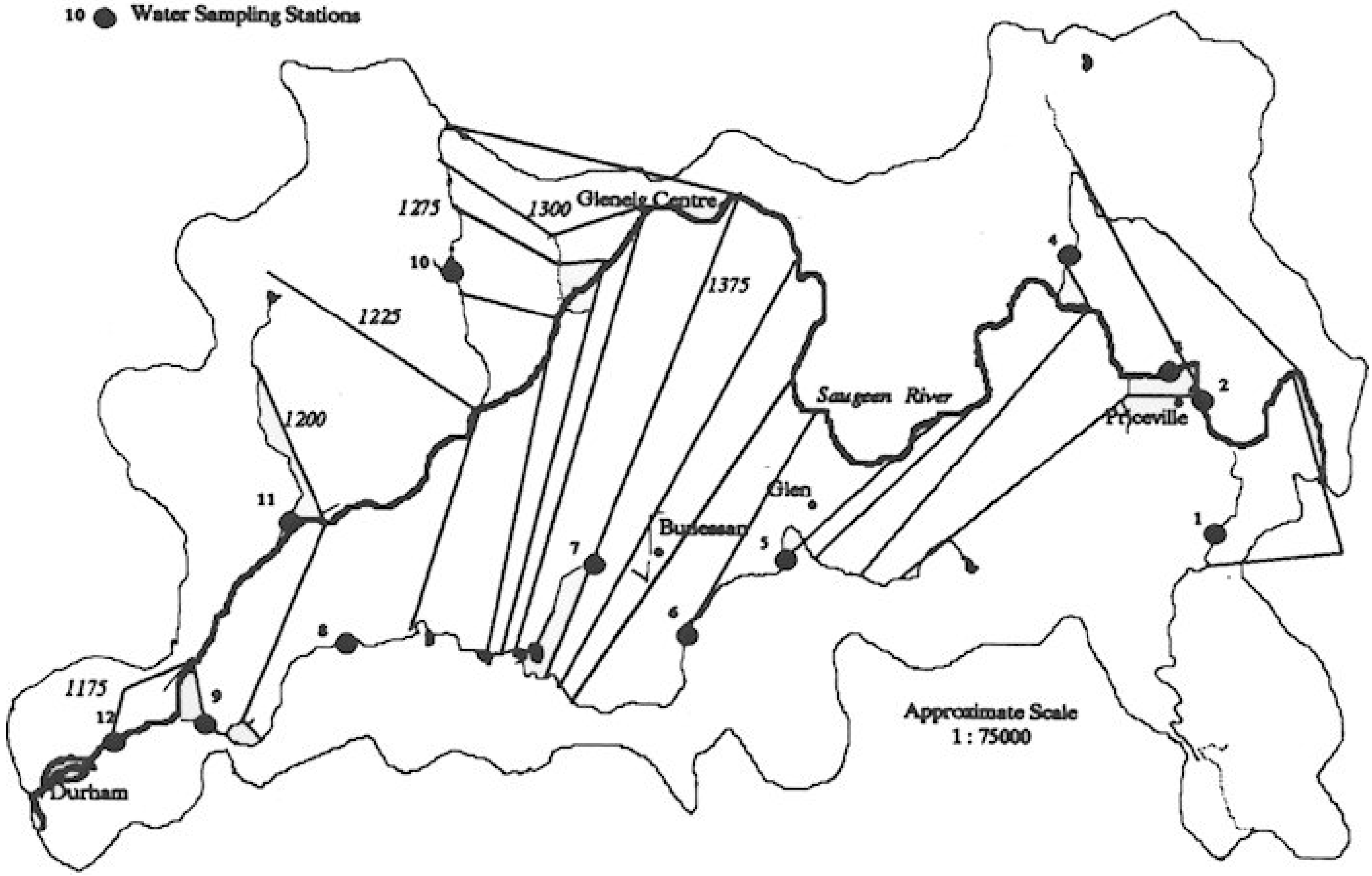


Figure 2: SAMPLE SITE LOCATION, 1988: Durham Subwatershed

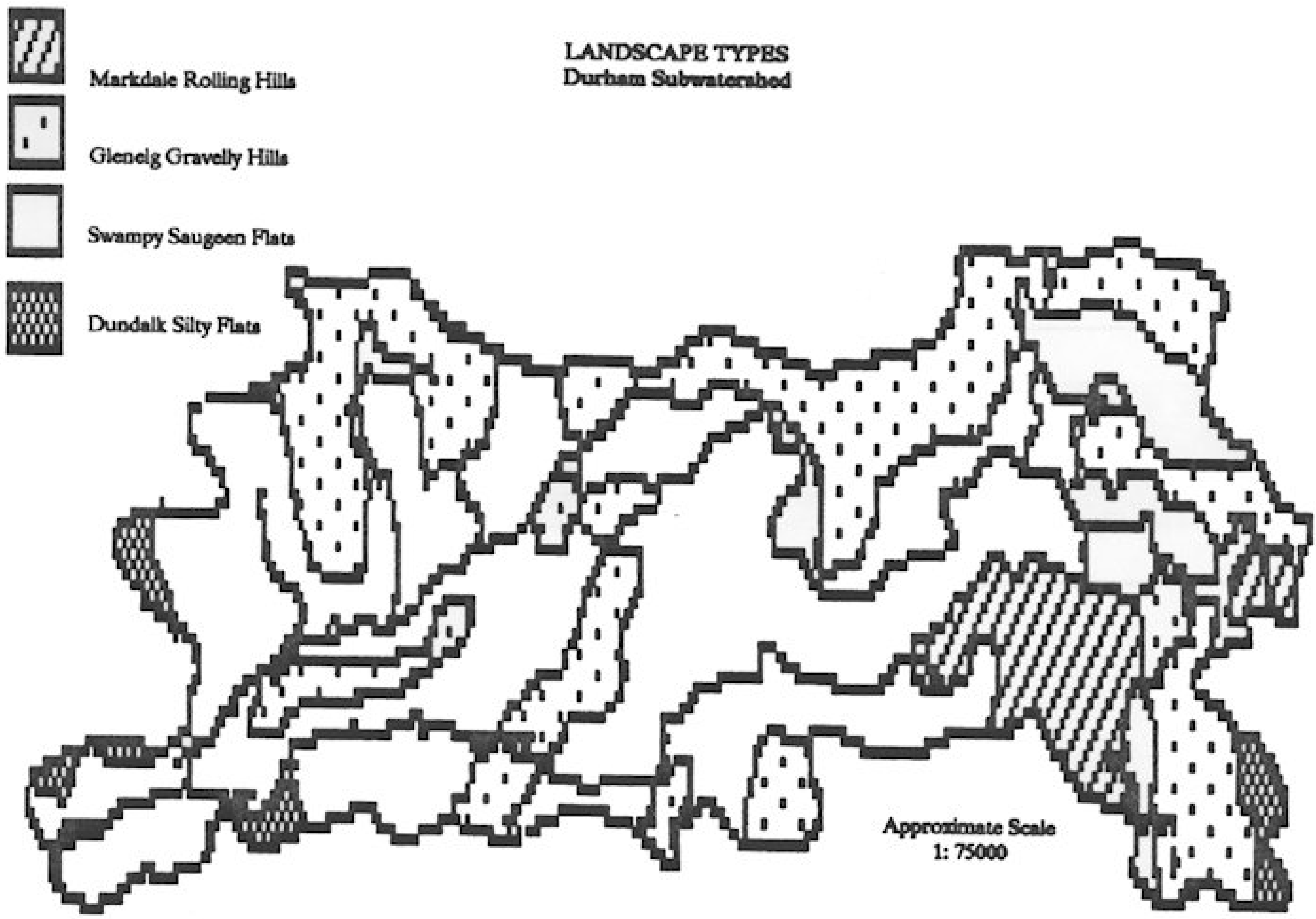


Figure 3: LANDSCAPE TYPES: Durham Subwatershed

3.0 OBJECTIVES

It is the objective of this program to address the problem of surface water quality deterioration caused by diffuse source contamination in the project area. Through the Beaches Program, the Authority hopes to maintain the recreational usage of the three beaches within the Durham Conservation Area with the identification of possible sources of contamination and the implementation of a remedial action/public education program.

The goal of the first phase of the Beaches Program is to establish a data base from which conclusions regarding water quality may be developed. The data base will include information relating to land use, agricultural activity, forest cover, land ownership, stream conditions and water quality.

4.0 METHODOLOGY

4.1 Water Quality Monitoring

Commencing on August 8, 1988, samples were taken twice weekly from 12 locations throughout the watershed. A total of 31 samples were collected from each of the regular stations along with numerous other random samples. The location of the stations in the subwatershed is shown on figure 4.

The selection of sample site locations was based upon the need to evaluate the quality of water entering the system from various source areas throughout the subwatershed. Tributary sampling locations were established at road crossings when possible and as close to the confluence with the Saugeen River as possible.

Additional sample sites were utilized as field observations indicated potential pollution sources and where additional documentation of conditions was necessary. Analysis was provided by the Ministry of the Environment Laboratory in London for bacterial and chemical components.

4.2 Stream Survey

Virtually all the watercourses within the study boundaries were surveyed on foot. Observations were made on surrounding land use, stream characteristics and the impact of local human activity.

A photobase map of the subwatershed at a scale of 1:5000 was assembled and utilized to record data and direct field work.

A landowner identification file was prepared for use in establishing contact with owners of streamside property. Assessment records from the municipal offices were utilized to relate names and addresses to lots and concessions.

4.3 Hydrology and Precipitation

Streamflow and precipitation were monitored for the study area through an automated gauge located just above the Durham Conservation Area and operated by the Flood Forecast Unit of the Authority.

Tributaries were evaluated for summer base flows using a pygmy flow meter. Streams with very low flows were described as having minimal discharge.

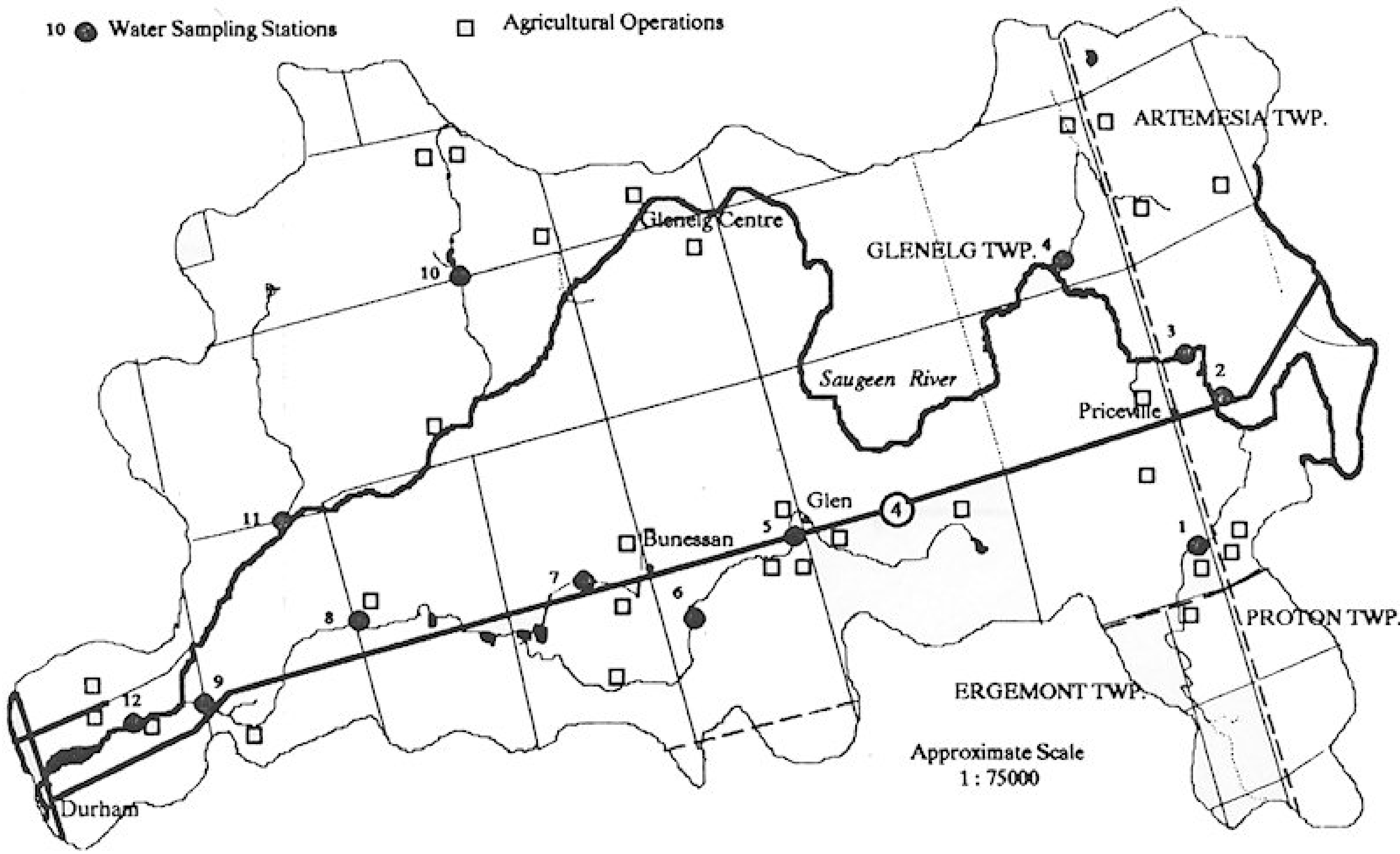


Figure 4: SAMPLE SITE LOCATION, 1988: Durham Subwatershed

5.0 OBSERVATIONS AND RESULTS

5.1 Water Quality

A total of 412 samples were collected throughout the sampling term. Analyses were completed for bacterial, chemical and physical parameters as listed in Appendix 1. Sample analysis data for each station are presented in figures 5 to 19.

Geometric means have been utilized to evaluate the bacterial parameters in order to decrease the effect of anomalous data. As presented, the data reflect combined wet and dry weather sampling for what can be assumed to be a period of moderate contaminant input, late summer and fall of 1988.

***Fecal coliform* (FC):** Figure 5 illustrates the maximum, minimum and geometric mean concentrations of fecal coliform bacteria for the 12 regular sampling stations in the study area. Nine of the 12 stations had geometric mean FC concentrations below the Ministry of the Environment objective for recreational water use. Concentrations ranged from a maximum of >1500 organisms per 100ml at stations 1 and 6, to a minimum of <4/100ml at stations 3, 4, 8, 9, 10, 11 and 12.

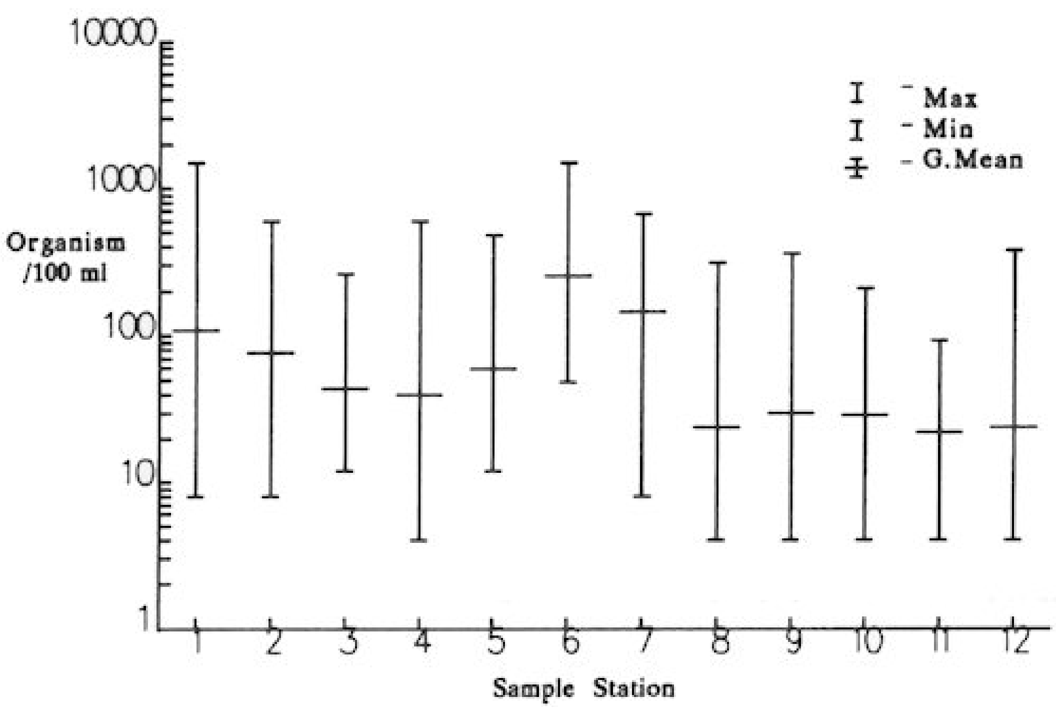


Figure 5: FECAL COLIFORM (FC): Max, Min and Geometric Mean Concentration (Aug.8 - Dec. 6, 1988).

The average geometric mean concentration for the watershed as sampled was 71/100ml.

As described, FC geometric mean concentrations exceeded the MOE recreational use guideline level at three sample sites. The three tributaries represented by these stations flow through areas of livestock production and reflect associated quality changes as compared to areas of less intensive agricultural activity. Samples from station 6 show generally the poorest bacterial water quality in the subwatershed, followed by those of stations 7 and 1.

Escherichia coli **(E. Coli)**: *E. coli* concentrations were proportionately similar to those of fecal coliform. Analysis results are shown on figure 6.

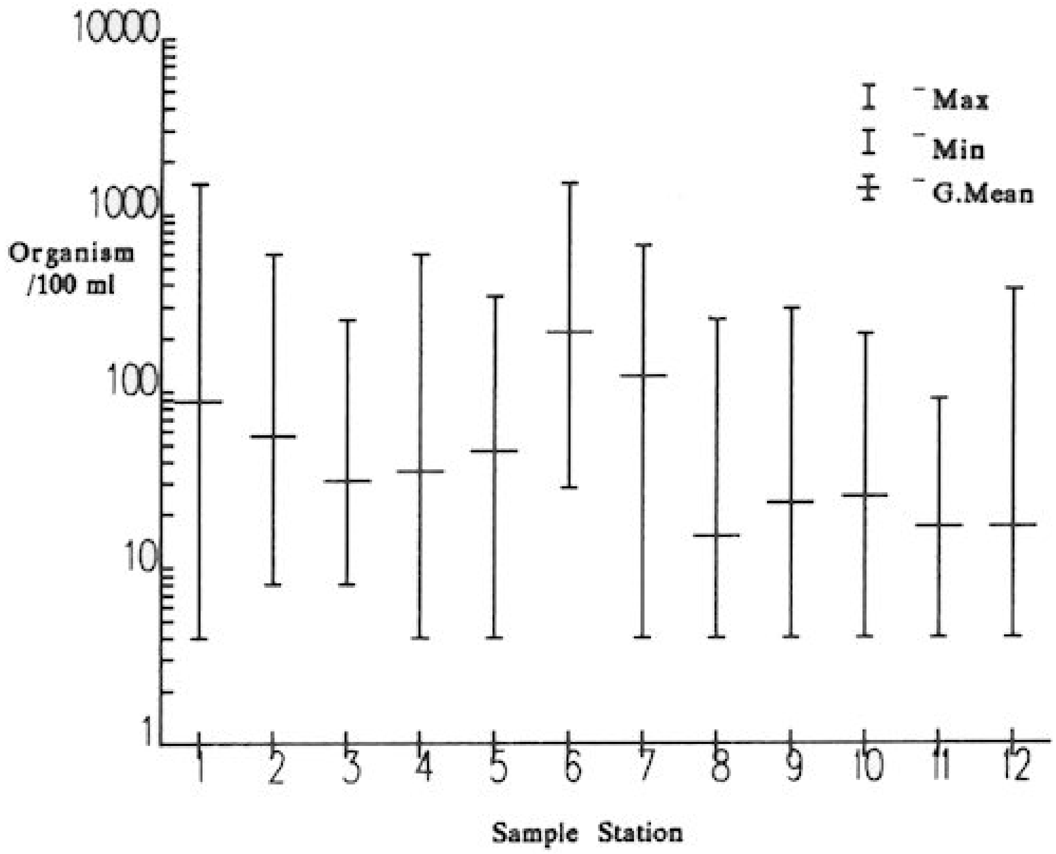


Figure 6: *ESCHERICHIA COLI* (E. COLI): Max, Min and Geometric Mean Concentration (Aug.8 - Dec. 6, 1988).

Fecal Streptococci (FS): Fecal streptococci are also pathogenic bacteria indicators. As described in Appendix 1, FS is known to be found in greater numbers in animal wastes than in those of human origin. FS are also known to be more resistant to sunlight inactivation than fecal coliform bacteria (Fujioka, 1982). Concentrations of FS observed during the study period, compared to FC levels show ratios consistent with waters impacted by animal wastes. Figure 7 illustrates the maximum, minimum and geometric mean concentrations.

Broad generalizations may be possible concerning source location relative to sampling site when considering FC/FS ratios and survival rates. Station 7 may illustrate these relationships by indicating a localized source of contamination.

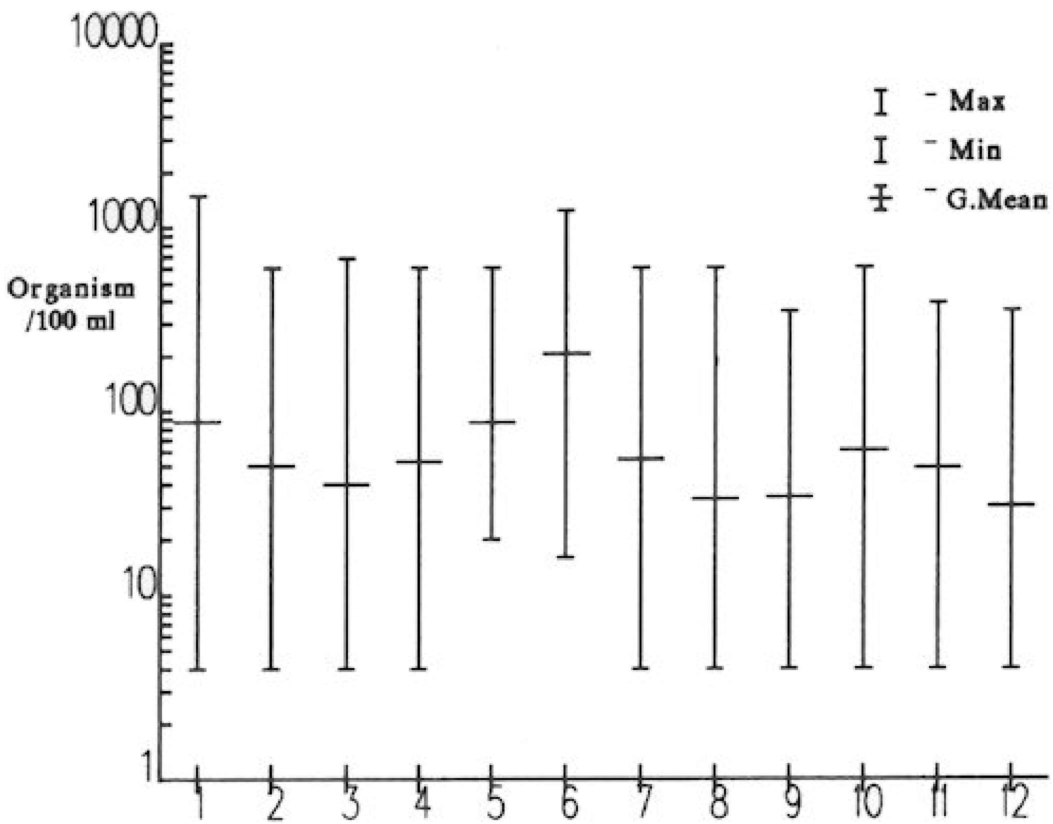


Figure 7: FECAL STREPTOCOCCI (FS): Max, Min and Geometric Mean Concentration (Aug,8 - Dec. 6, 1968).

Pseudomonas Aeruginosa (PsA): A potential health risk exists when the pathogenic organism PsA can be enumerated and frequently isolated from the water (MOE, 1978). A lower analysis limit of <4 org/100ml is accepted as defining natural background river water quality. As shown in figure 8, PsA was detected above background levels at stations 6, 9 and 12. Observations of PsA at stations 9 and 12 are significant because of their close proximity to the swimming areas.

The Grey-Owen Sound Health Unit confirmed having enumerated PsA on several previous occasions through routine sampling of the Durham reservoirs. This bacteria is known to be associated with human waste and a potential source would be faulty or inappropriately installed septic systems.

Free Ammonia (NH_3): In relation to the MOE water quality objective of <0.02 mg/L for the protection of aquatic life, concentrations of NH_3 in the subwatershed appear high. Stations 1, 6, 10 and 11 have mean levels exceeding the objective. Peak concentrations at stations 1 and 10 exceed 0.1 mg/L which may suggest recent organic pollution, either decaying plant material or animal waste. Figure 9 illustrates the statistical data for this parameter.

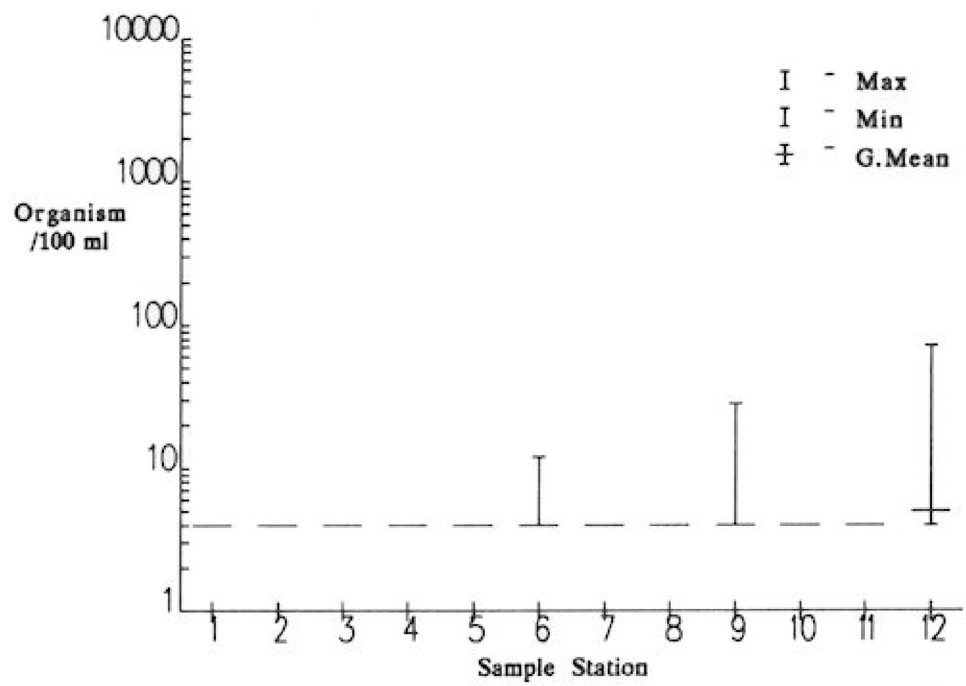


Figure 8: *PSEUDOMONAS AERUGINOSA* (PSA): Max, MM and Geometric Mean Concentration (Aug.8 - Dec. 6, 1988).

Total Kjeldahl Nitrogen (TKN): Most mean concentrations of TKN fell within the general range suggested by McNeely (1979) of between 0.1 and 0.3 mg/L for watercourses not affected by excessive organic inputs (Figure 10). The two exceptions were stations 1 and 10 with average levels exceeding this range, suggesting some form of higher organic input.

Nitrite (NO_2): Nitrite is seldom present in surface waters in significant concentrations. The presence of this component in concentrations greater than 0.001 mg/L can indicate active biological processes and therefor organic pollution.

All stations show a departure from the base level of 0.001 mg/L (Figure 11) during the study period. Stations 1 and 10 show sufficient fluctuations above the lower analysis limit of 0.01 mg/L, to produce a mean concentration of 0.02 mg/L.

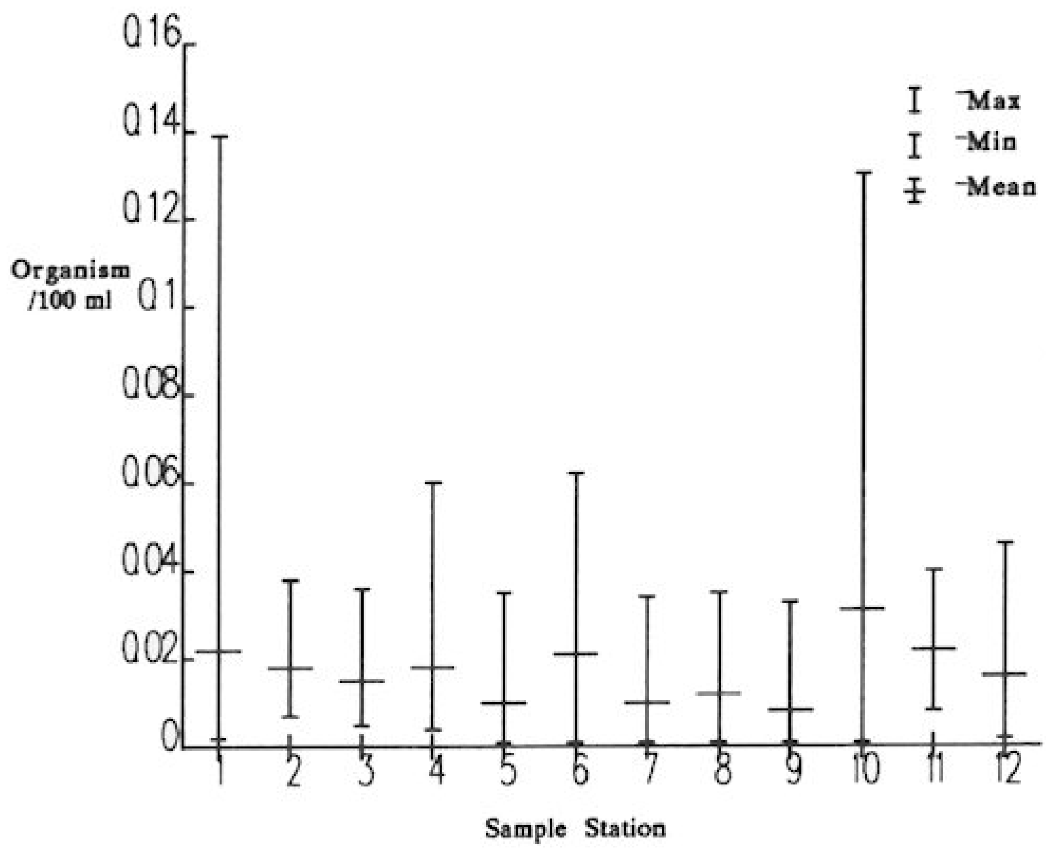


Figure 9: FREE AMMONIA (NH_3): Max, Min and Mean Concentration (Aug.8 - Dec. 6, 1988).

Nitrate (NO_3): Concentrations of NO_3 ranged from 0.1 to 1.6 mg/L, as shown in Figure 12. As NO_3 is seldom abundant in surface waters, elevated levels in the headwaters of tributary "A" (stations 5 and 7) are likely the result of percolating groundwater. The groundwater may have been contaminated by leaching fertilizers and probably results in increased NO_3 levels at downstream stations.

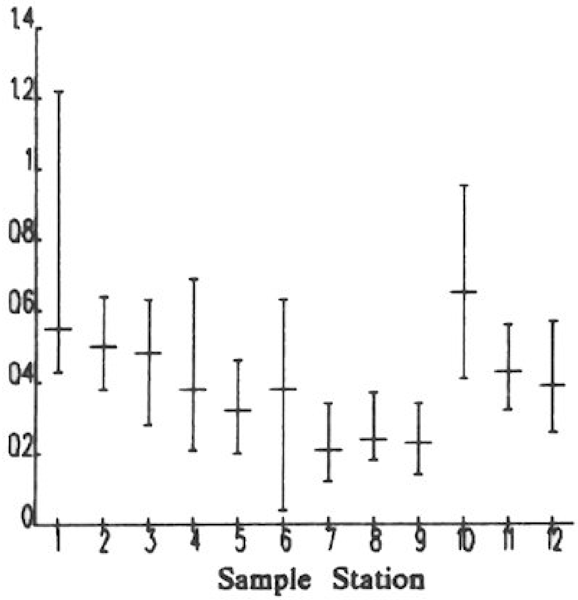


Figure 10: TOTAL KJELDAHL NITROGEN (TKN) - mg/L; Max, Min and Mean Concentration (Aug.8 - Dec. 6, 1988).

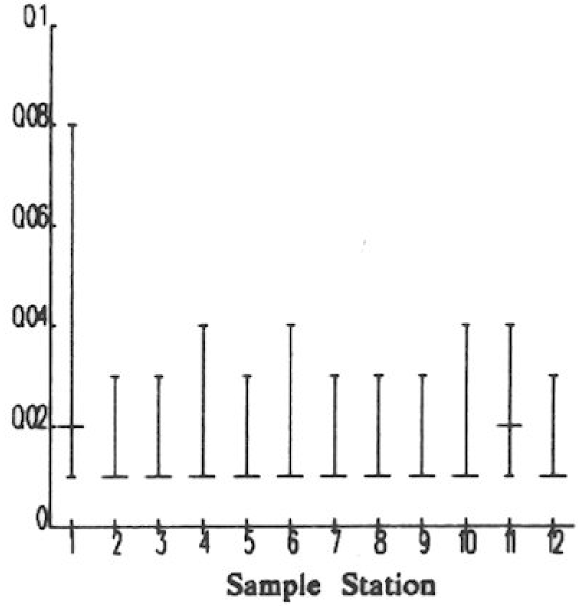


Figure 11: NITRITE (NO2) - mg/L Max, Min and Mean Concentration (Aug.8 - Dec. 6, 1988).

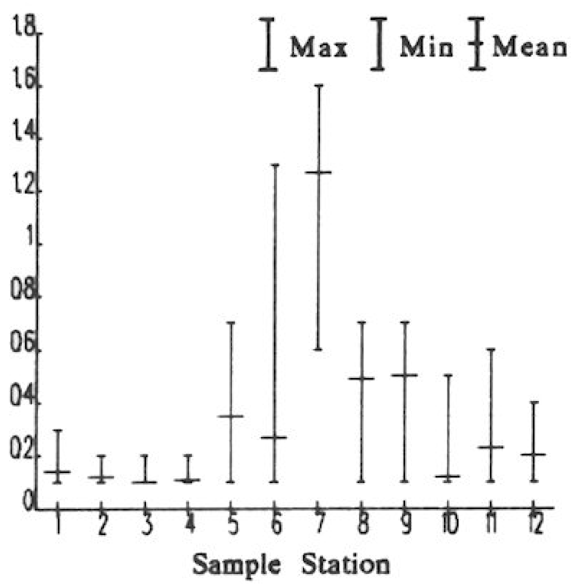


Figure 12: NITRATE (NO3) - mg/L Max, Min and Mean Concentration (Aug.8 - Dec. 6, 1988).

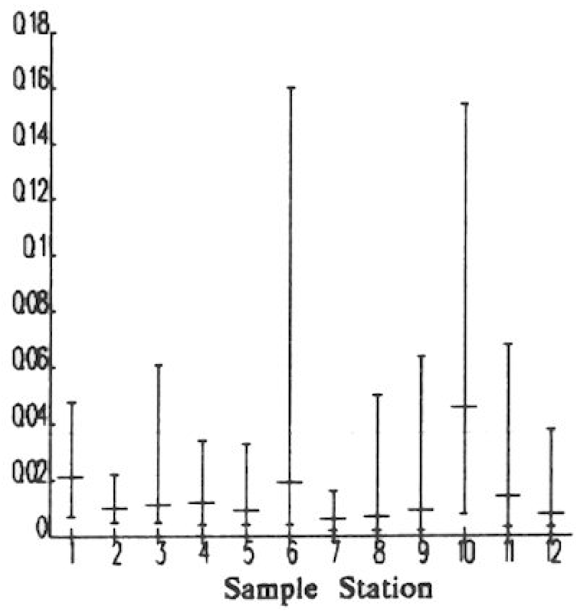


Figure 13: TOTAL PHOSPHORUS - mg/L Max, Min and Mean Concentration (Aug.8 - Dec. 6, 1988).

Total Phosphorus (TP): An MOE guideline maximum concentration of 0.03 mg/L has been established for the prevention of nuisance plant growth. Station 10 had average concentrations in exceedance of the guideline.

This station is located on a sluggish stream that originates in an area of agricultural drainage, subsequently flowing through a wetland where some of the phosphorus could be generated through plant processes. Further sampling is required to determine the effect of the agricultural drainage on the stream. Figure 13 shows concentrations for all stations.

Soluble Reactive Phosphorus (RP): Station 10 showed the highest concentration of RP, along with station 1. Agricultural activity may be involved with fluctuations at these stations though station 10 may possibly be influenced by wetlands. Other station concentrations were low and showed little variance (Figure 14).

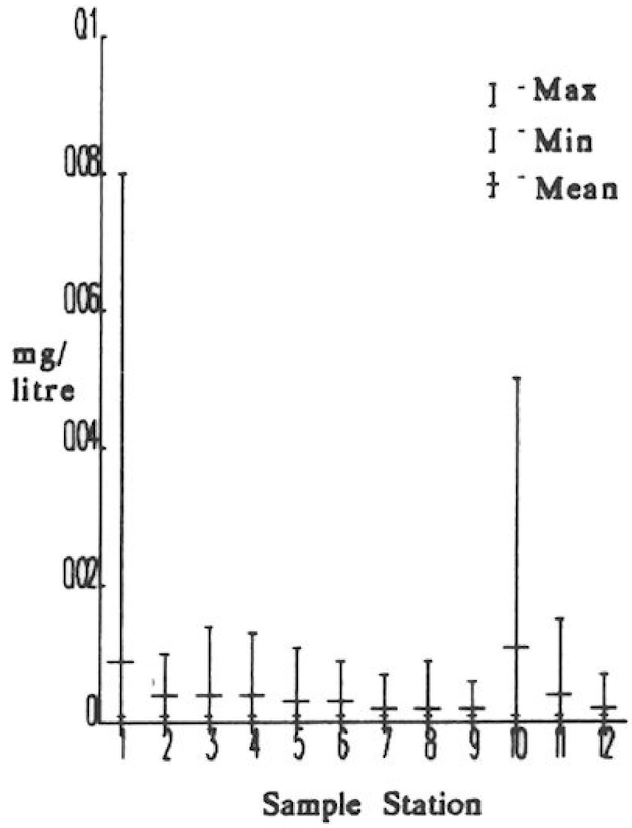


Figure 14: REACTIVE PHOSPHORUS
Max, Min and Mean Concentration
(Aug.8 - Dec- 6, 1988).

pH: The MOE Water Quality Objective (1978) range for pH is 6.5-8.5. Average pH levels for the 12 stations were within the required range as described by figure 15.

Turbidity: Turbidity levels were generally low, ranging from 0.26 to 6.0 formazin turbidity units (FTU) (figure 16). An exception was station 6 which reached 18.6 FTU in late August. Station 6 also had the highest average turbidity, due to livestock activity upstream. Least turbid conditions were found at station 11 which represents a watercourse in its natural state.

Chloride: Chloride concentrations ranged from a low of 0.01 mg/L at station 4 to 20.47 mg/L at station 2. As shown in figure 17, average levels ranged between 2.59 mg/L at station 4 to 17.06 mg/L at station 7.

The higher concentrations at stations 2 and 7 may be a result of the application of chloride in de-icing operations on Highway 4. Though above background levels for the watershed, these concentrations are well below the 250 mg/L guideline criteria set by the MOE for public water sources.

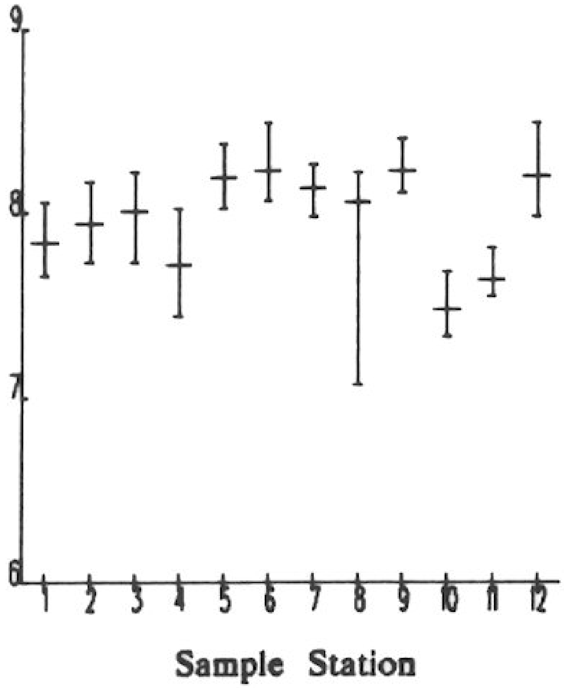


Figure 15: pH - pH units
Max, Min and Mean
(Aug.8 - Dec. 6, 1988).

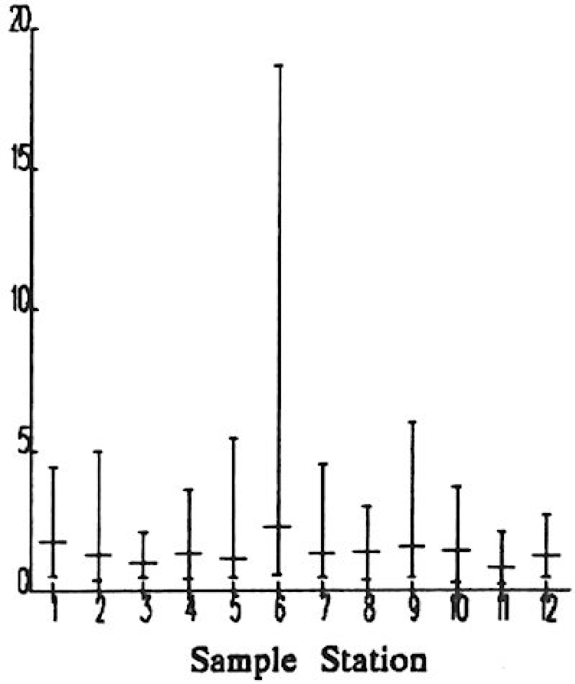


Figure 16: TURBIDITY - Formazin Units
Max, Min and Mean
(Aug.8 - Dec. 6, 1988).

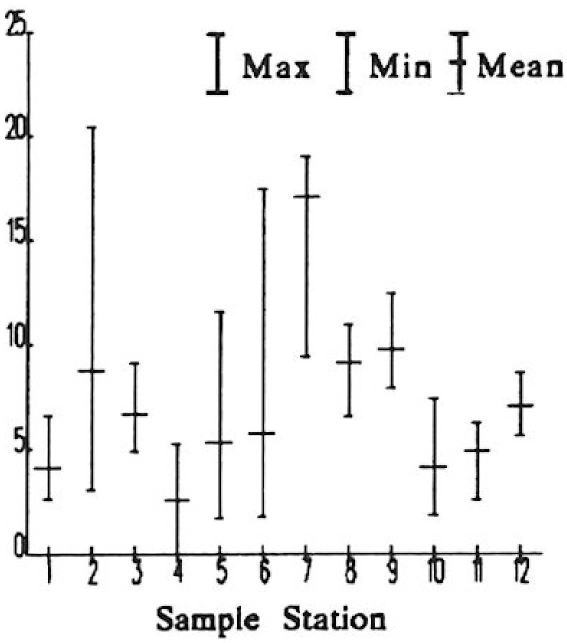


Figure 17: CHLORIDE - mg/L
Max, Min and Mean
(Aug.8 - Dec. 6, 1988).

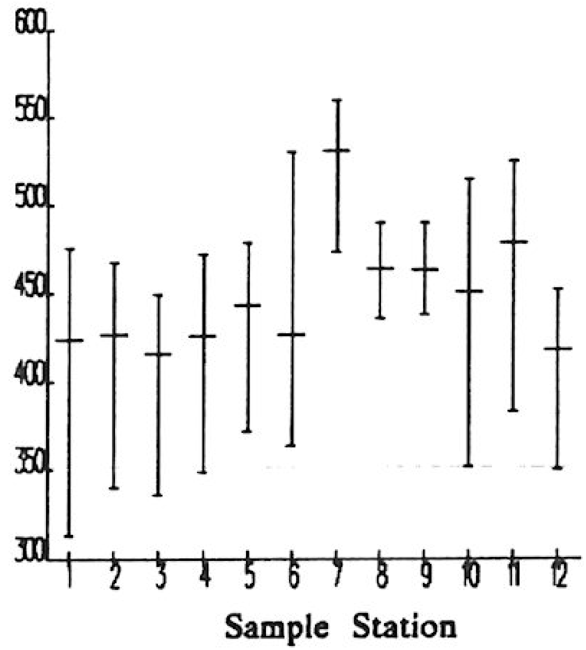


Figure 18: CONDUCTIVITY - µmho/cm
Max, Min and Mean
(Aug.8 - Dec. 6, 1988).

Conductivity: Conductivity levels, which relate to the concentration of dissolved solids, ranged from a low of 313 µmho/cm at station 1 to a high of 560 µmho/cm at station 7. Low mean levels occurred on main stream stations with station 3 having the lowest average level of 416 µmho/cm. The high average of 531 µmho/cm was recorded at station 7 (figure 18).

Elevated conductivity levels in tributary samples and particularly those from station 7 are probably a result of concentrations of chloride, nitrate, phosphate or combinations thereof.

Temperature: Though unrelated to bathing water quality, temperature is an important component of stream character and relevant to fish and wildlife concerns.

Most notable is the narrow range and low average temperature of station 7. This is a result of the stream having considerable flow and being spring-sourced in a relatively undisturbed forested area. High peak temperatures were observed at stations 6 and 10, relating to the open nature of the stream channels and the influence of agricultural drainage operations. Temperature ranges are illustrated in figure 19.

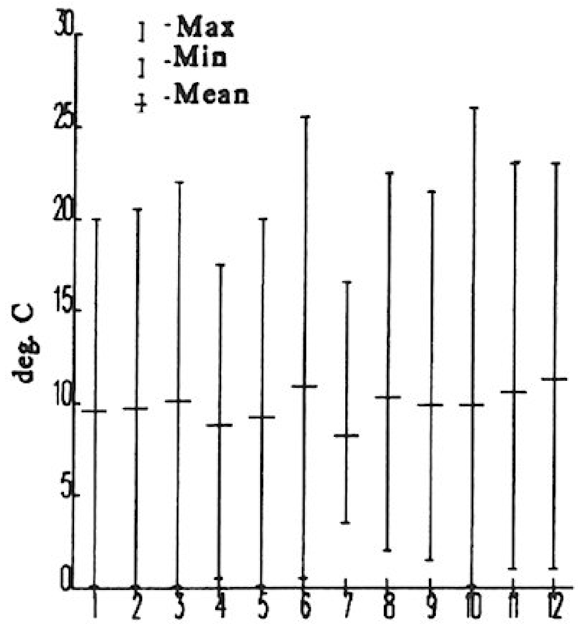


Figure 19: TEMPERATURE
Max, Min and Mean
(Aug.8 - Dec. 6, 1988).

5.2 Stream Survey

As part of the first stage of the Rural Beaches Program, a walking survey was undertaken to evaluate the physical nature of the subwatershed drainage system and adjacent lands within 150 m of a watercourse. Farm operations were also evaluated during the field survey for pollution potential based on proximity of farm buildings and access of livestock to streams, livestock type and management practice. A list of 33 landowners was assembled by referencing locations of activities with pollution potential to owner lists on township assessment roles. These locations are marked 'agricultural operations' on figure 20 and are targeted for further contact.

Stream characteristics, riparian land use and the impacts of human activity were considered as they apply to water quality. This section provides a brief summary of the field observations for each component of the drainage network, labeled main Saugeen channel and tributaries A to E.

Main Saugeen Channel (station 2.12): The main channel is 26.5 km in length with a base flow in August, 1988 of 0.36 cm as measured at the Durham gauging station. The river channel is stable and resists erosion, being generally composed of gravelly materials or in places, bounded by bedrock. Flow in the main channel is for the most part shallow and rapid, with a substrate of clean stone, cobble and boulder size material.

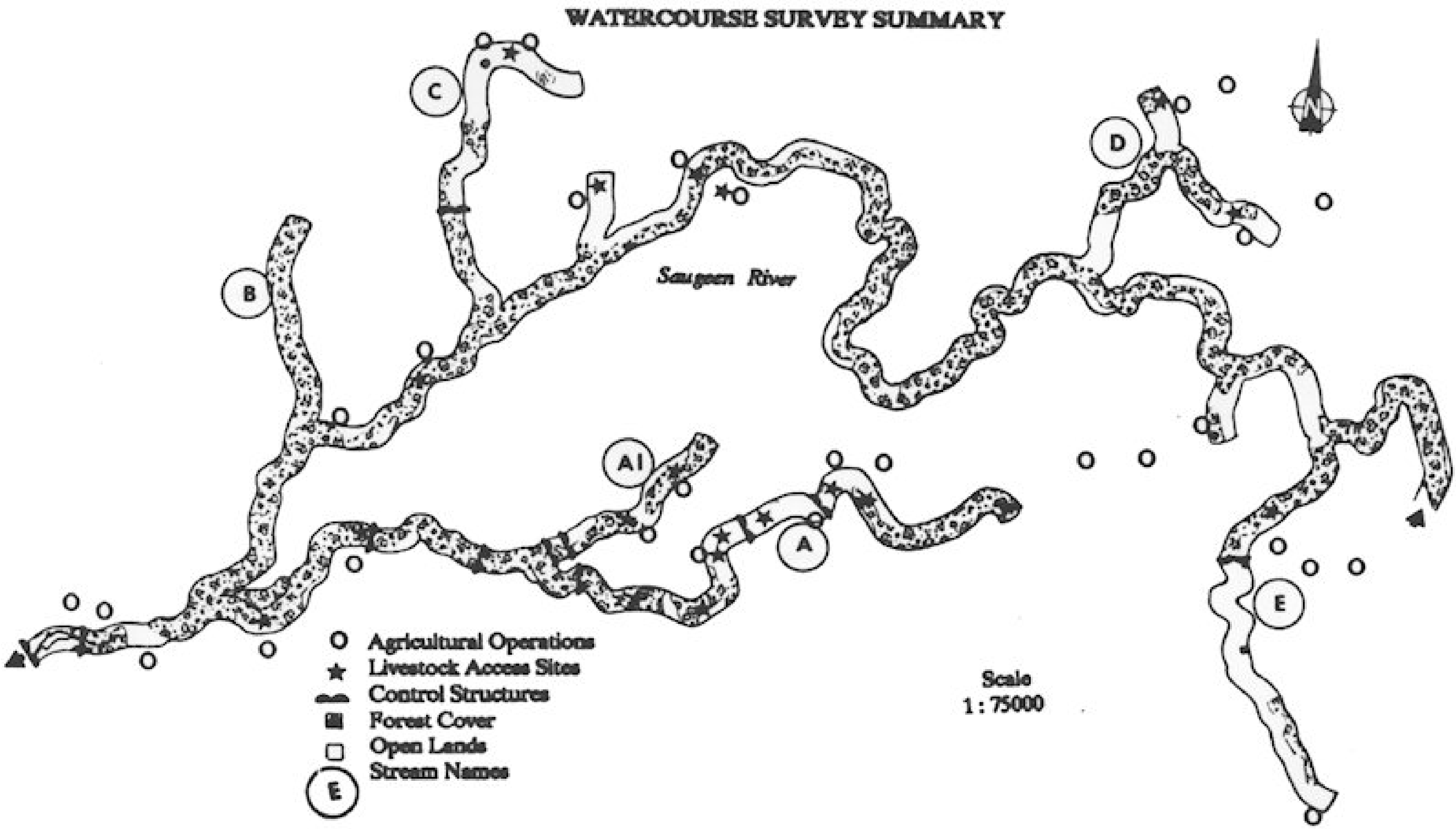


Figure 20: WATERCOURSE SURVEY SUMMARY

The riparian area is often very rugged with steep, hilly topography. Alternately, low and wet banks support dense growths of coniferous trees. Utilization of these areas has been difficult and subsequently the river banks remain largely forested.

Because the riparian areas are mostly unsuitable for agricultural purposes, pasturing systems have been developed at a distance from the river. As a result, livestock accesses for watering are less common along the main channel in this subwatershed than others of the Saugeen system. Only three sites of open livestock access were evaluated during the field study period.

Many farms located a distance from the river have seasonal flow channels that drain contaminated runoff to the main channel in quantities that vary throughout the year. These locations have been included in the program records for further contact.

Tributary A (station 5,6,8,9): With a length of 14.25 km and a base flow of 0.267 cm in late August, this watercourse has great significance for summer season water quality in the Durham reservoirs. The stream originates in an area of mixed lowland forest wetlands with minimal human influence in the upper reaches.

The adverse effects of unrestricted pasturing are evident near the Glen sideroad (station 5) and intensify downstream. The stream at station 5 is cold, clear and fast flowing with a gravel-rubble substrate. Major influences downstream of this point are beef cattle pasturing systems and winter housing with unrestricted access to the watercourse. Two farm ponds with domestic waterfowl and stock watering uses and unrestricted access by a great number of other animals including horses, buffalo, llamas and fallow deer also contribute to the degradation.

The stream is poor in quality at station 6 with increased temperature, mud substrate and varying turbidity. Artificial channelization is evident in this area. A further decrease in water quality was noted downstream where flow is through a barnyard in which large numbers of beef cattle are concentrated for the winter. Serious effects of spring runoff are expected from this area.

Downstream from the intensely utilized area around station 6, flow is through mixed forest and some varying wetlands. Two more cattle access sites were encountered, each providing water for large beef cattle herds.

Quantity and quality of flow is considerably increased after confluence with the A1 tributary. Downstream from this point, landuse is largely recreational and seasonal residential with two large ponds and a campground in this coniferous forest area. Some pasture land is also in use, and two sites of unrestricted access were encountered with expected effects on water quality.

Station 9 provides water quality data for the stream at Highway 4 before convergence with the Saugeen River, just above the Durham reservoirs.

Tributary A1 (Station 7): This stream measures 3km in length and has a late August base flow of 0.14 cm. Being spring-sourced in an area of coniferous forest with little or no human influence, the headwaters of this stream are of importance to the subwatershed.

Prior to reaching station 7, the stream is influenced by contamination from two livestock operations. Observed degradations were from the effect of cattle access for watering purposes but seasonal contamination from winter confinement area runoff is anticipated.

The effect of pollution from the drainage area of this stream may be seasonally buffered by the effect of two large artificial ponds which increase the transport time for the delivery of bacteria to the reservoirs at Durham. Timely spring flow sampling will be necessary to determine the significance of this stream as a contaminant source.

Tributary B (station 11): A base flow of 0.018 cm was measured in late August for this 3.25 km long stream. High quality water sampled at station 11 reflected the predominately natural state of this tributary.

The riparian zone is almost entirely forested with coniferous species which form a natural buffer from runoff contaminants. Some fairly open wetland areas form the middle section of the stream with populations of muskrat and beaver evident.

Some retired pasture was noted in the headwater area but no livestock activity was observed during the field survey.

Tributary C (station 10): Though 5.5 km in length, the extended dry conditions experienced in August produced a minimal base flow.

The headwater area is the Edwards Municipal Drain which was last excavated in 1968. Land use is mainly pasture and hay crops with some cattle access and associated water quality influences.

A large wetland area was encountered in the lower section of the stream with slowed flow and increased temperatures. The wetland no doubt improves water quality to the main stream by attenuating bacteria and nutrient loadings during the summer season.

Tributary D (station 4): Measuring 4 km in length, this stream produced minimal base flow in late August of the study period. Sections near the upper reaches were channelized and open to access by pasturing cattle. Pasture systems with some cereal crops characterize in the upper riparian area.

The stream is buffered for much of its length by scrub vegetation along low, wet edges. A large beaver complex with associated ponds and wetlands influenced the character of the stream during the study period. Downstream from the wetland to the confluence with the Saugeen River are areas of coniferous regrowth and brush as well as some lands being currently used for hay crops.

Tributary E (station 1): This stream is 6 km in length and produces a minimal base flow in August. The origin of the watercourse is in a largely open agriculture area. The main riparian land use is hay cropping though some fields were in disuse at the time of the survey.

Livestock access effects were observed only at the top end of the upper section. Flow from the upper agricultural area drains north through a coniferous plantation to a large artificial pond. From the pond to the main Saugeen channel, flow is through primarily mixed forest to a large wetland area near the confluence. Cattle access adversely effects the water quality in this section at two points above station 1.

5.3 Hydrology and Precipitation

When considering non-point source pollution, hydrological and meteorological conditions are important factors in determining water quality response. Precipitation, as recorded at the Durham gauging station, is illustrated in figure 21 for the interval August 8 to December 6, 1988. Data for this period was isolated to show conditions corresponding to the term of the sampling program.

The influence of wet weather on water quality was apparent in the watershed. Figure 22 illustrates the percentage exceedance of the MOE recreational criteria during wet weather as compared to dry weather for all samples. Dry weather samples were those having no rainfall influence for the previous two days while wet weather samples were those collected on a day of rain or if >5 mm fell on the previous day.

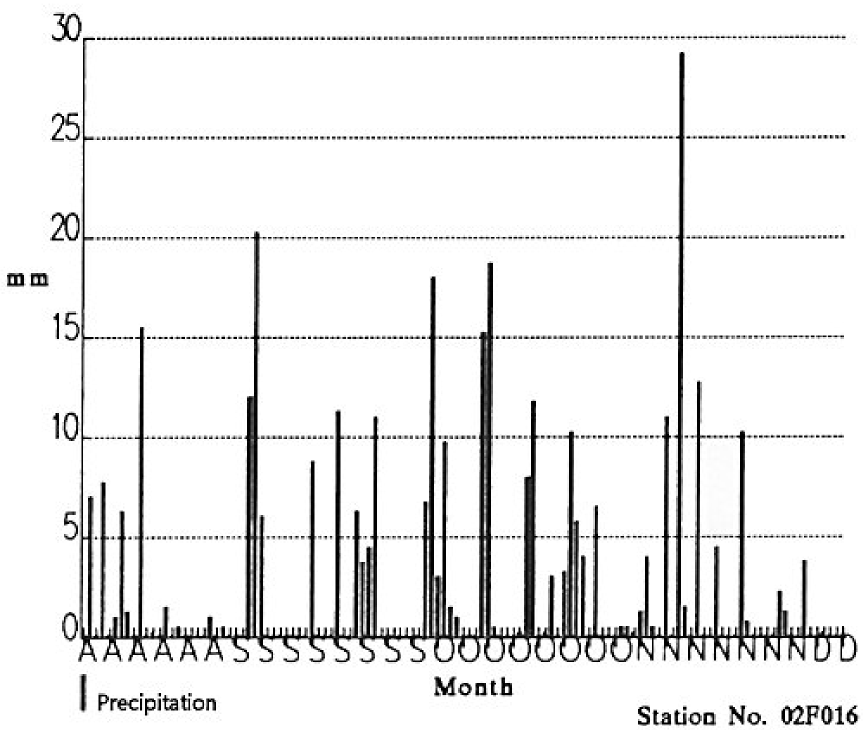


Figure 21: RECORDED PRECIPITATION, Durham Precip. Station.

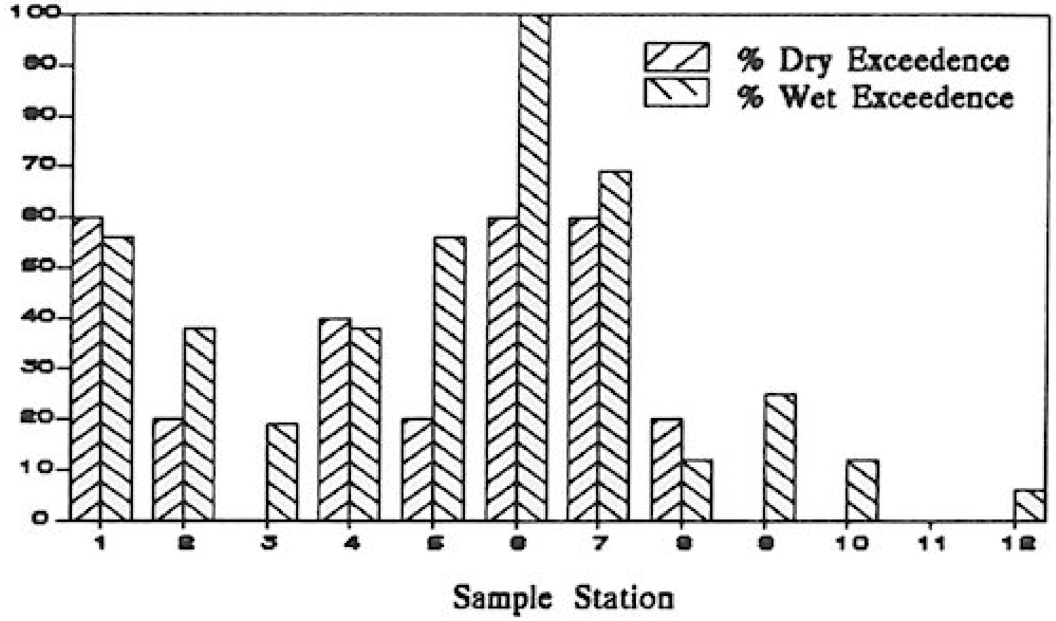


Figure 22: SAUGEEN RIVER FC ANALYSIS.

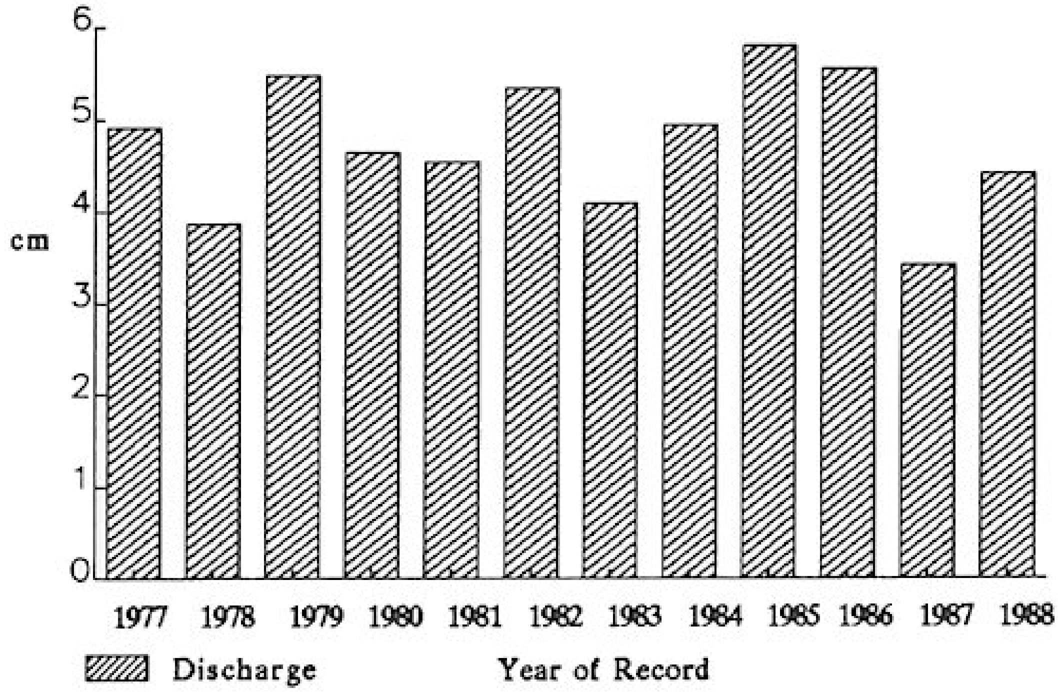


Figure 23: MEAN ANNUAL DISCHARGE, Saugeen River above Durham.

During the summer of 1988, unusually low streamflow conditions occurred in many watersheds in southern Ontario. Saugeen River discharge as recorded at Walkerton, was less than half the mean monthly level for June, based on 72 years of records. Figure 23 illustrates the mean annual discharge for the study area in 1988 to be that of an average year, despite the summer drought conditions, based on the past 11 years of data at the Durham gauge.

As much as 90 percent of pollutant loads are transported during runoff events. These events include overland flow during storms and melt events. Base loads occur during periods of base flow conditions.

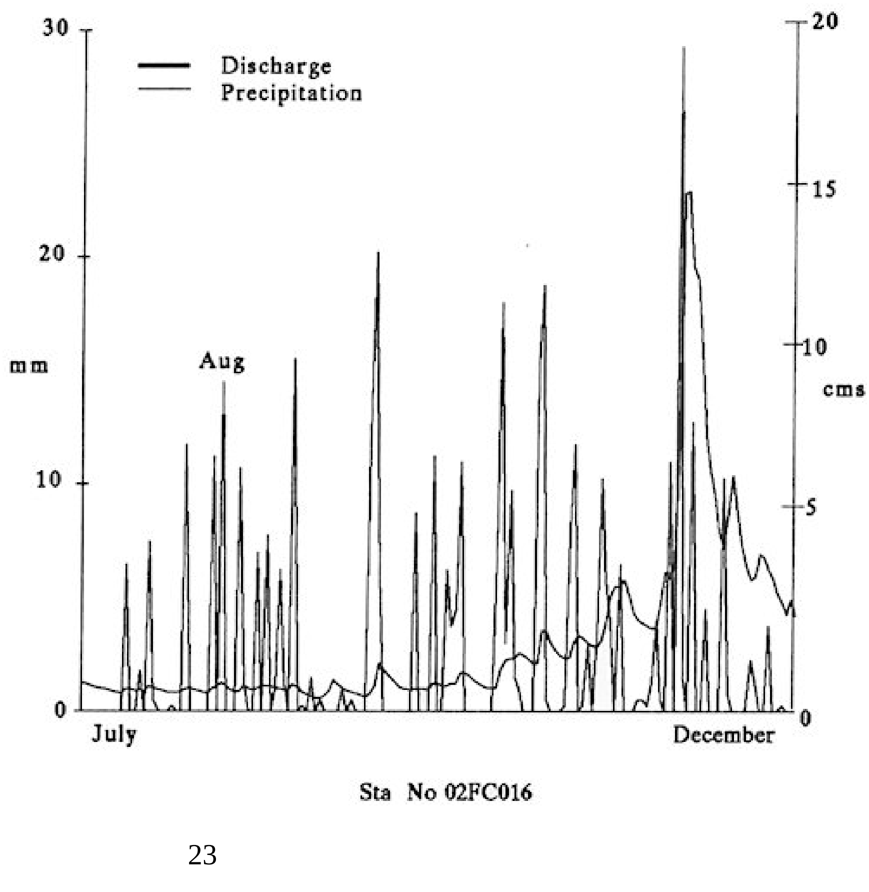
Summer "low flow" stream conditions were evaluated using a pygmy current meter for the tributary sample stations and through the Authority operated gauging station at Durham for the main channel flow.

The tributary described by Station 1 drains largely open areas of low topographic relief and at times produced only intermittent flows during the study period. Tributary "A" is by far the most important in the subwatershed in terms of quality and quantity of flow.

Figure 24 compares precipitation to discharge as measured at the Durham gauging station. The quantity of flow is dependent upon the amount, frequency, duration and pattern of precipitation. The associated water quality is in turn dependent upon the effect of many contaminant sources and transport mechanisms. This hydrograph shows a responsive watershed, consistent with the geomorphology of the area. Data for the month of July precedes the initial date of sampling but is included for comparison with early study data.

Figure 24:

PRECIPITATION/DISCHARGE, Saugeen River at Durham1988.



Mathematical modeling techniques are now being tested to estimate water quality and quantity resulting from non point source flows from areas of known land use. Though there are acceptable models for materials transport such as those predicted soil losses, water quality is much more complex and difficult to predetermine.

6.0 CONCLUSIONS

The study results have shown a relatively high quality of water in the Durham subwatershed system. The Saugeen River is one of the few remaining watercourses in the southwestern region that has been able to retain reliably good water quality, however large fluctuations in water temperature and low flow conditions combined with increasing contaminant loads will have detrimental effects.

The observations made in this report are based on data collected in the late summer and fall of a season of non-typical hot, dry weather. Spring and early summer conditions which may be more relevant to the swimming area problem were not observed during the 1988 program. Past studies have shown that the bulk of material (including pollutants) is transported in a river system during a short period of time during spring or storm flow conditions. Shock loads of contaminated runoff from winter livestock confinement areas may combine with disturbed sediments to deliver poor quality water to downstream reservoirs.

From 12 stations on the subwatershed, over 400 water samples were collected for analysis between August 8 and December 6, 1988. Nine of the 12 stations were within the MOE recreational use criteria for fecal coliform concentrations more than half the time. The highest FC count observed during the sampling period was >1500 org/100ml at station number 1 in mid-August while some of the best water quality was observed at station 12 on the main river just above the swimming areas.

Potential source areas were recorded with 33 landowners being identified for future public relations work. The placement of these farming operations in relation to the swimming areas is very important as the main channel and some significant tributaries have fairly steep gradients; in some areas offering fast delivery of contaminants to the in-stream swimming areas. Conversely, contaminants are also retained and attenuated in many natural and artificial pondings upstream of the swimming areas. This natural purification of contaminated water is realised through predation by other microorganisms and the destruction of bacteria by ultraviolet radiation.

The most significant source of fecal bacteria to the system is through the practice of allowing livestock access to watercourses. Of concern also are the PsA observations just upstream of the swimming areas. Many domestic septic systems in the immediate area may have to be investigated, including the Authority systems at the conservation area campground.

7.0 REFERENCES

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8.0 APPENDICES

Glossary of Analysis Parameters

Bacteria:

Fecal Coliform - bacteriological water quality indicator (bacteria whose densities in water can be related quantitatively to the presence of sewage or fecal matter and therefore to the risk of contracting a disease from the pathogens contained therein).
- potential health hazard exists if fecal coliform geometric mean density for a series of samples exceeds 100 organisms per 100ml.

Fecal Streptococci - water quality indicator.
- used in conjunction with fecal coliform as an indicator of the nature of fecal source
- if fecal coliform : fecal streptococci is >4; origin human in nature.
- if fecal coliform : fecal streptococci is <0.7; non-human origin.

Escherichia Coli (E. coli) - usually (not always) of fecal origin.
- pathogenic serological types.

Pseudomonas Aeruginosa - a pathogenic organism.
- potential health hazard exists when organisms can be enumerated and frequently isolated from the water (any number above the background level <4).

Chemical Parameters

Free Ammonia (NH_3) - often of vegetable origin and without hygenic significance.
- concentrations in excess of 0.10 mg/L renders the water suspect of recent pollution (manure).

Nitrate (NO_3) - the end product of aerobic stabilization of organic nitrogen; hence occurs in polluted waters that have undergone self-purification or aerobic treatment processes.
- occur in percolating ground waters as a result of excessive applications of fertilizer.
- seldom abundant in surface waters as photosynthetic process in plants constantly utilize nitrates and convert them to organic nitrate in plant cells.
- infant methoglobinemia may be a risk with drinking water in excess of 10 mg/L.

Nitrite (NO_2) - formed by the action of bacteria upon ammonia (generally)

and organic nitrogen - quickly oxidized to nitrates so seldom present in surface waters in significant concentrations.
- in conjunction with ammonia and nitrate, nitrites are often indicative of pollution.
- indicative of active biological processes in water.

Total Kjeldahl (organic nitrogen + ammonia)
- indicator of pollution.
- contributes to eutrophication at elevated concentrations
- MOE objective of 0.5 mg/L.

Un-ionized Ammonia
- concentrations should not exceed 0.02 mg/L for protection of aquatic life.
- percentages of unionized ammonia in aqueous ammonia solution for different temperature and pH conditions can be determined using MOE Water Management chart.

Total Phosphorus
- essential nutrient for plant and animal growth.
- passes through cycles of decomposition and plant growth.
- combines directly with many elements.
- found in water from soil erosion, fertilizers and detergents.
- MOE objective for the prevention of excessive plant growth in rivers and streams is less than 0.03 mg/L.
- concentrations greater than 0.2 mg/L may indicate that some phosphorus of sewage origin is present.

Soluble Phosphorus
- phosphorus in solution.
- characteristics as above.

pH
- measures acid/base balance in solution.
- MOE guideline range to be maintained 6.5 - 8.5.

Chloride
- found in all natural waters.
- may be of natural mineral origin, road salt application, human or animal sewage or industrial effluents.
- no MOE guideline but concentrations at or above 400 mg/L may be harmful to trout.

Physical Parameters

Conductivity
- expression of water's ability to conduct electrical current.
- increases with concentration of dissolved solids.
- dissolved solids consist mainly of carbonates, bicarbonates, chlorides, sulphates and phosphates - may indicate pollution from irrigation drainage.

Turbidity	-	relates to amount of suspended sediment in water.
	-	linked to the measure of many pollutants as suspended particles serve as transport mechanisms.
Temperature	-	important part of stream character relating to lack or abundance of shade, channel nature and other influences.
	-	quality factor for fish and wildlife concerns.

Sample Site Information

<u>Example</u>

Sample Station 3

Location: upstream side of bridge on Glenelg-Artemesia Township Road, 0.8 km north of Highway No. 4.
- 25 km above the Durham Reservoir.

Description: 20 m upstream of the bridge where rifle stretch enters pool.
- private residence on north side of river with streamside area maintained as a lawn.

Physical Conditions: local soils identified as Brisbane loam.
- surficial material is alluvium, mainly gravel with sand and silt.
- topography is rolling hill.
- forestry consists of mixed lowland species with coniferous types dominant.

Stream Conditions: flow is rapid and shallow over cobble to gravel size material.
- substrate is clean and generally sediment free.
- aquatic vegetation is limited to a few patches of coontail.

Bacterial Chemical and Physical Sample Analysis Parameter

Microbiological Parameters:	AKA:	Unit of Measure:
Fecal Coliform *	F C	org/100ml
Fecal *Streptococci*	FS	org/100ml
Escherichia Coli	E. coli	org/100ml
Pseudomonas Aeruginosa **	PsA	org/100ml
Chemical Parameters:		
Free Ammonia	NH3	mg/L
Total Kjeldahl Nitrogen	TKN	mg/L
Nitrite	NO2	mg/L
Nitrate	NO3	mg/L
Total Phosphorus ***	TP	mg/L
Soluble Phosphorus	RP	mg/L
Physical Parameters:		
pH	pH	pH units
Turbidity	Turb	formazin units
Conductivity	Cond	µmho/cm
Temperature	Temp	deg. C

MOE Guideline Levels

*	100 org/100ml
**	0 org/100ml
***	0.03 mg/L