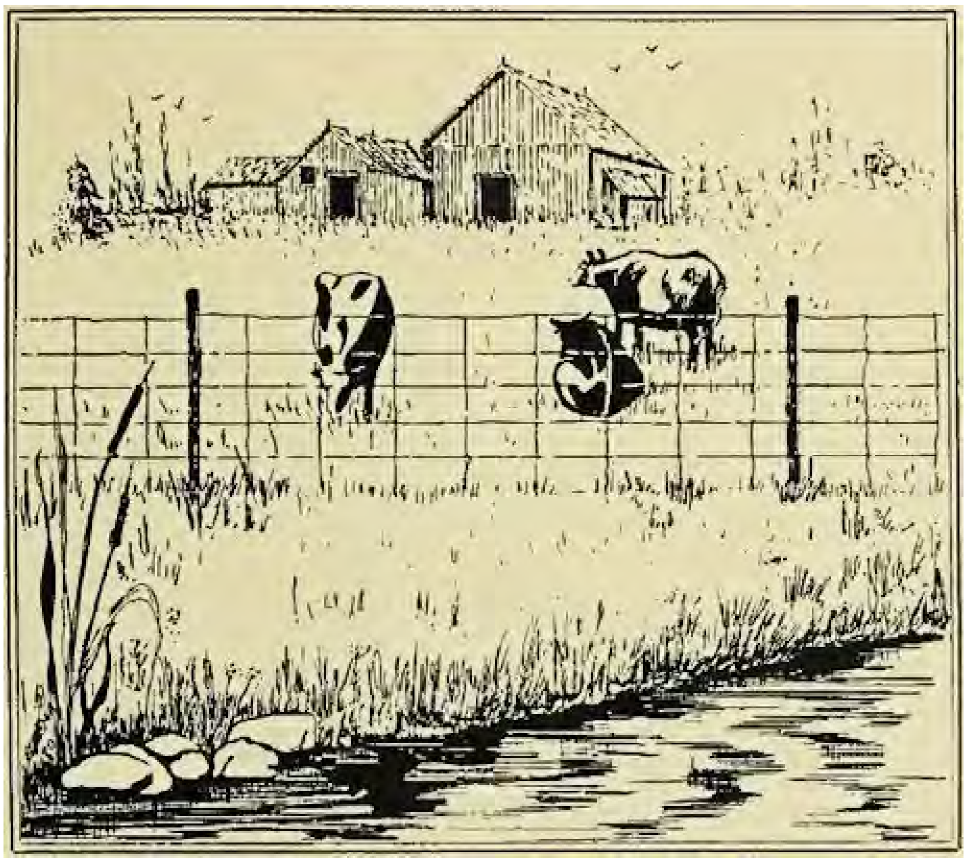
March 6, 2010

CLEAN UP RURAL BEACHES (CURB) PLAN

FOR THE BEAVERTON RIVER DRAINAGE BASIN



PRODUCED BY
THE LAKE SIMCOE REGION
CONSERVATION AUTHORITY

FOR THE ONTARIO MINISTRY OF THE ENVIRONMENT

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DISCLAIMER

FOREWORD

This report is one of a series produced under the Provincial Rural Beaches Program. The objective of the Program is to identify the relative impact of pollution sources, and develop a course of action leading to the restoration and long term maintenance of acceptable water quality at provincial rural beaches.

Significant enrichment and bacterial contamination in southern Ontario rivers and lakes originates from rural sources. The discharge of waste material to streams can result in elevated bacterial concentrations, nuisance algae blooms, fish kills, and present a potential health hazard to humans and livestock using the water. Watershed studies have found that a multitude of pollution sources and pathways may affect beaches in Ontario. These include:

1) Urban sanitary and stormwater runoff,
2) Direct livestock manure access to watercourses,
3) Inadequate manure management practices,
4) Direct discharge of milkhouse wastes,
5) Contaminated field tile systems, and
6) Faulty septic systems

The impact upon beaches of any of these sources, either singly or in combination, can range from a few days of elevated concentrations to complete seasonal closures.

Numerous beach closings in 1983 and 1984, drew public and government attention to the severity of this water quality problem. In 1985, the Ontario Ministry of the Environment's (MOE) Water Resources Branch formulated the Provincial Rural Beaches Strategy Program. Directed by the Provincial Rural Beaches Planning and Advisory Committee, it includes representatives from MOE, Ministry of Agriculture and Food (OMAF), and Ministry of Natural Resources (MNR).

With financial and technical assistance from the MOE, local Conservation Authorities carry out studies under the direction of a local technical steering committee. Chaired by an MOE regional staff, the committees typically include representation from OMAF, MNR, the Medical Officer of Health, Conservation Authority, the local Federation of Agriculture, and a local farmer. The chairs of the local committees assure communication between all the projects by participating on the Provincial Committee.

The primary objective of each local study is to identify the relative impact of pollution sources, their pathways to beaches, and to develop a Clean Up Rural Beaches (CURB) plan specific to the watershed upstream of each beach. The CURB plan develops remedial strategy options and respective cost estimates for each beach through:

1) Field inspections,
2) Farmer consultations,
3) Water quality monitoring, and
4) Basic mathematical modelling techniques.

Recommended actions will include both measures for specific beaches and broader scale Provincial measures based on cumulative results of component studies.

The following related research projects were also MOE funded and undertaken by various Conservation Authorities to improve our understanding of bacterial and nutrient dynamics:

1) *In-situ* bacterial survival studies determine longevity: in watercourses, offshore of beaches, in sediments, and in milkhouse washwater tiles.

2) Biotracer studies determine the speed and nature of travel for bacteria introduced into a watercourse.

3) A liquid manure spreading study examines bacterial movement through the soil column and exiting field tile drains.

4) A target sub-basin study evaluates the effectiveness of a watershed with comprehensive remedial measures.

Numerous demonstration farms have been established with the cooperation of local farmers to display innovative management practices. Research continues on their effectiveness at improving water quality.

Comments and/or questions on this report are welcome. Please send written comments to:

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CLEAN UP RURAL BEACHES

CURB PLAN - BEAVERTON RIVER DRAINAGE BASIN

1989

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CURB PLAN - BEAVERTON RIVER

Lake Simcoe Region Conservation Authority
Rural Beaches Impact Study

SUMMARY

The CURB (Clean Up Rural Beaches) Plan report is a document outlining the remedial projects required to improve water quality in the Beaverton River drainage basin. Water pollution resulting from various agricultural related contaminants has lead to beach closures in recent years. This has resulted in the impairment of the recreational potential of beaches on Lake Simcoe within close proximity of the river outfall.

The CURB Plan is based on extensive farm practice inventories, pollution delivery capability, manure management, water quality data and beach posting frequencies. Priorities were placed on projects in the remedial plan based on pollution severity, potential pollution reductions, cost of remediation and the type of pollution input wether continuous or discontinuous. Costs were calculated using 1988 information for labour and materials.

The result of the CURB study is a prioritized list of required remedial projects and / or changes in manure handling practices which will reduce the impact of agricultural practices on water quality of local rivers impacting on target beaches. These projects have been categorized into two groups based upon their cost efficiency relative to the potential reduction in water pollution. These groups are referred to as "Priority A" and "Priority B" projects.

Priority A projects include restrictive livestock access to surface waters and controlling the discharge of milk house wash water. Within the Beaverton River drainage basin there are 24 potential Priority A projects which can be implemented at a total cost of $132,588 (in 1988 dollars).

The Priority B projects will focus on manure storage and feedlots as well as improving manure spreading technique. There are 51 farm operations included in this category with project costs totalling $549,833 (in 1988 dollars).

If all remedial projects were completed in the Beaverton River, the result would achieve an 79% reduction of the pollution presently released by the identified farms. By combining the Priority A and Priority B groups, a total of 75 projects would be undertaken as part of the CURB Plan. The sum total of all these projects is $682,421 (as of 1988).

CURB PLAN - BEAVERTON RIVER

Lake Simcoe Region Conservation Authority
Rural Beaches Impact Study

FORWARD

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DISCLAIMER

The material presented in this report, both quantitative and qualitative, does not necessarily constitute policy or approved management priorities of the Lake Simcoe Region Conservation Authority. Interpretation and evaluation of the data and findings should not be based solely on this specific report. Instead they should be analyzed in light of other reports produced within the comprehensive framework of the Rural Beaches Impact Study.

ACKNOWLEDGEMENTS

The authors wish to express their appreciation to the members of the Rural Beaches Technical Committee for their time and effort throughout the Beaches study.

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1.0 LAKE SIMCOE RURAL BEACHES IMPACT STUDY

1.1 Introduction

The Lake Simcoe Rural Beaches Impact Study (LSRBIS) began on March 1, 1986 as part of the Ontario Ministry of the Environment's (MOE) Provincial Rural Beaches Management Strategy. The study was initiated in response to wide-spread beach postings occurring throughout the Lake Simcoe watershed thought to be resulting from agricultural land-use activities.

The study was designed to; identify major agricultural sources of faecal bacterial inputs to surface waters; determine the relative individual source pollution contributions, and; recommend cost effective remedial measures to reduce bacterial inputs to surface waters and thereby reduce or eliminate further beach postings.

Studies to date, have been limited to two sub-basins of the Lake Simcoe watershed, namely those of the Beaverton River and Pefferlaw Brook. The Pefferlaw Brook sub-basin was selected prior to this study as a pilot watershed due to it's high density of livestock and frequency of beach postings. Investigations of bacterial sources in the Beaverton River sub-basins were initiated during the summer of 1987 alongside continuing efforts in the Pefferlaw Brook sub-basin.

This report examines the manure management practices in the Beaverton River watershed and summarizes investigations into faecal pollution sources undertaken over the past two years of the study. It outlines the results and the methods used in the determination of:

- the identification of livestock operations potentially polluting surface waters
- the relative contributions from individual sources determined to be providing faecal pollution inputs to surface waters.
- remedial measures designed to reduce bacterial pollution from agriculture, the costs associated with them, and the proposed reduction of the bacterial pollution.
- the prioritization of remedial measures considered for implementation based on their cost effectiveness.
- the ranking of beach areas within the Beaverton River watershed to aid in prioritization of remedial projects.

The outcome of these results are intended to provided a framework for the implementation of remedial measures designed to achieve the study objectives. This framework includes an inventory of suggested remedial measures and their costs for each beach in the study area.

1.2 Methodology

In order to eliminate beach postings, individual source inputs must be reduced so that the faecal coliform geometric mean concentration, measured at a beach, is consistently below the MOE recreational water quality guideline. The following is the study methodology is presently being employed in the Beaverton River watersheds.

Step 1

The first step is to determine the relative individual contributions from faecal pollution sources in relation to beach postings. This requires that; a) individual sources of faecal inputs be identified. b) their relative pollution inputs to surface waters be quantified. and c) the changes in pollution severity due to in-stream processes, be assessed.

Step 2

Having obtained the above information, an estimate of the total pollution severity score can be determined by summing all of the scores from individual pollution sources. Further calculations to determine the effectiveness of different remedial strategies can be conducted by comparing total potential reductions with existing farm scores. Total reductions of at least seventy five percent in the pollution severity score should ensure significant reductions in beach postings.

Step 3

Step 3 involves the formulation of remedial measures and control options designed to achieve a reduction in the total pollution score significant enough to eliminate or reduce beach postings. For each pollution source identified an assessment of possible remedial measures, their cost, and estimated effectiveness must be examined. Benefit-cost analysis will be used in determining the prioritization of remedial measures. Only those measures which are cost effective will be considered for implementation.

Step 4

The final step is the production of a Remedial Action Plan that includes a framework for implementation. The plan will be designed to achieve the overall objective of the Rural Beaches Program, that being, the elimination of beach postings from faecal pollution. A total cost for the remedial actions necessary to reduce the bacteria concentration below the Provincial Water Quality Objective (PWQO) for each beach will be produced.

1.3 Agricultural Sources of Aquatic Pollution

With the advent of modern technology, the agricultural industry has undergone dramatic changes. Continuing economic pressure to produce more for less has forced farmers to adopt new farming methods and practices. Farm operations have become larger and more specialized in order to intensify production. Unfortunately, increased production has resulted in the concentrations of animal waste byproducts, in the form of manure and milkhouse wastes thereby increasing the potential for environmental problems.

Manure and milkhouse wash water contain significant amounts of bacteria and nutrients that can cause serious surface water quality degradation. Agricultural inputs of bacteria and nutrients can enter streams directly or within contaminated runoff water. Farm practices which contribute to faecal pollution include; livestock pasturing especially when there is access to a watercourse, tile drains contaminated by milkhouse wash water, and runoff from improper manure storage, feedlots, pastures, and manure spread fields.

Livestock access is certainly one of the most significant sources of faecal bacterial and nutrient contamination of surface waters. Until recently, livestock access was considered the most convenient method of watering livestock and a time honoured tradition amongst farmers. Unfortunately, when livestock have direct access to surface waters so do their waste byproducts which when deposited cause bacterial and nutrient contamination along with increasing the potential for herd health problems for livestock watering at the site or downstream.

Another major source of bacterial contamination is milkhouse wash water. According to recent studies (UTRCA, 1988) a large number of dairy operation surveyed in Southwestern Ontario had direct discharge from milkhouse to an open watercourse. Wash water from the milkhouse contains high levels of phosphorus, organic matter, and chlorine. Once the chlorine concentrations dissipate, the available nutrients and milk solids provide an ideal breeding ground for bacteria. Improper handling of milkhouse wash water may lead to the contamination of sub-surface tile drains can be a serious and continuous source of bacterial and nutrient pollution in the Beaverton River watershed.

Although not a continuous source, runoff from feedlots, inadequate manure storages, and manure spread fields, can deliver large quantities of bacteria and nutrients to receiving waters. This type of pollution requires the generation of surface runoff before contaminates can be transported to a watercourse. As a result the pollution from these practices is generally of a lower magnitude (even though animal waste accumulation is much greater, much less makes it to the watercourse). Factors influencing the significance of the pollution contribution from these farm practices include manure accumulation. the distance to a watercourse, the slope, the area contributing runoff, existing soil cover, and the intensity and magnitude of the runoff event.

2.0 BEAVERTON RIVER WATERSHED

2.1 THE STUDY AREA

The Beaverton River sub-basin is one of eight distinct sub-basins within the Lake Simcoe watershed (Figure 2.0). Located in the eastern most corner of the watershed, the Beaverton River and its tributaries drain an area of approximately 443 square kilometres or 15% of the total land area in the Lake Simcoe watershed. This region of the Lake Simcoe Watershed in noted for supporting numerous livestock farm operations. In addition, the Beaverton River drainage basin has a relatively high frequency of beach postings as a result of elevated faecal pollution levels.

2.2 Soils and Physiography

The Beaverton River sub-basin has three major physiographic units which are the result of glacial-fluvial action in the Wisconsin Ice Age. Physiographic unit boundaries correspond closely to areas of differing soil textural class found within the sub-basin (Figure 2.1).

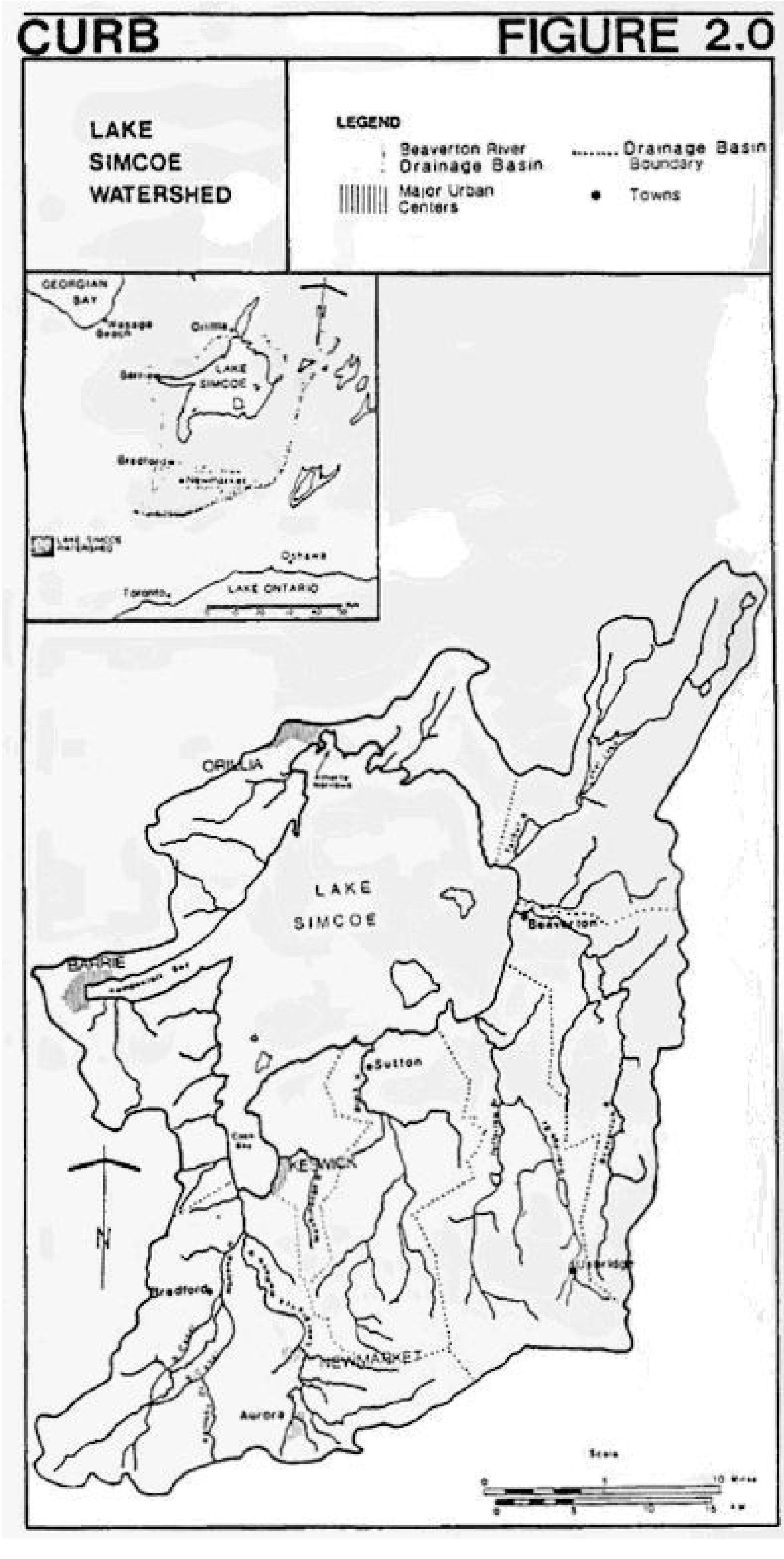
The most southern portion of the sub-basin is located in the Oak Ridges Moraine. The moraine accounts for approximately 4.5% of the total drainage area. Soils are coarse textured sandy loams with good drainage.

The Peterborough Drumlin Field is dominated by medium textured soils with organic deposits along the main branch of the Beaverton River and Vrooman Creek. The drumlin field lies between the Oak Ridges Moraine and the Simcoe Lowlands and comprises roughly 80.9% of the drainage area.

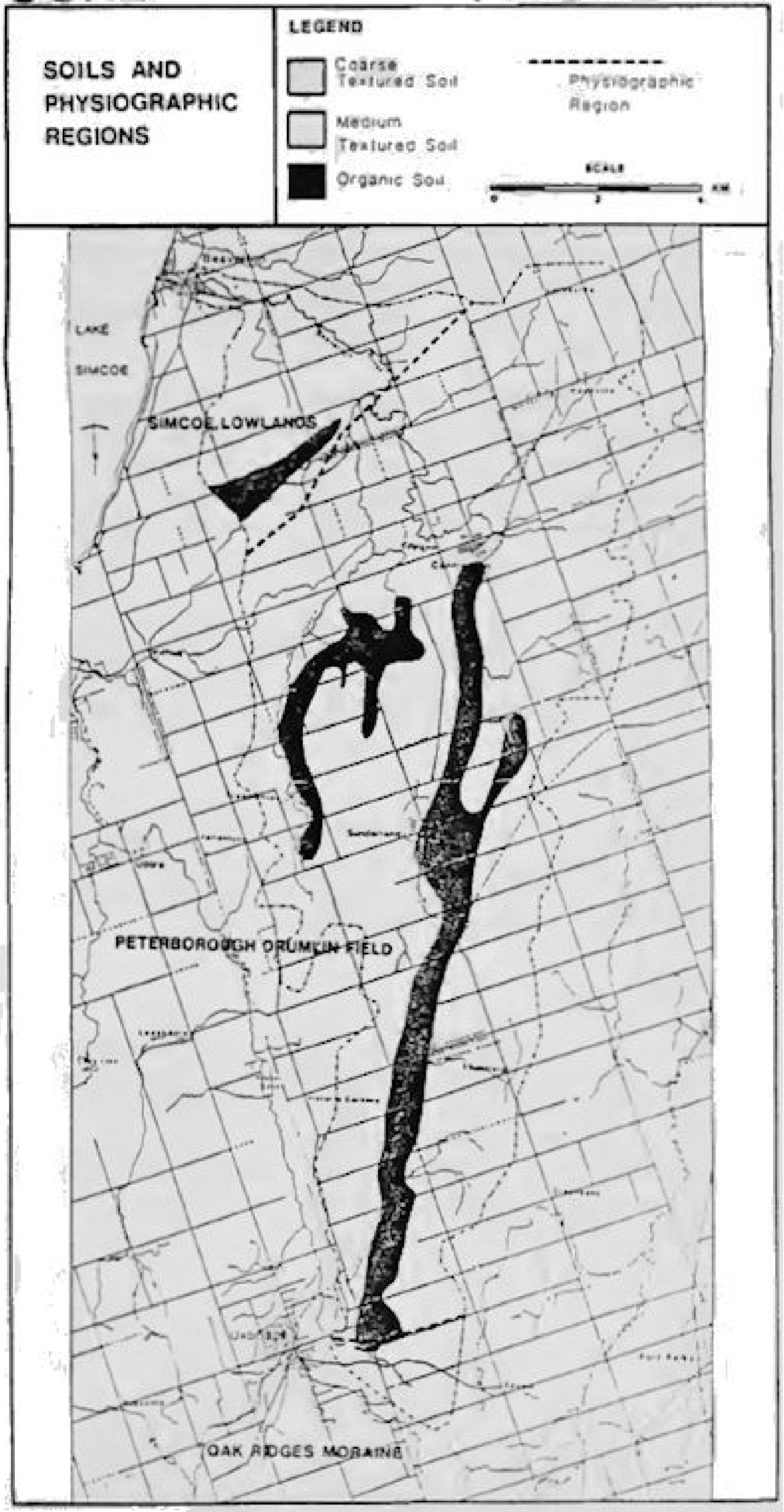
The Simcoe Lowlands contains nearly equal proportions of all three of the previously mentioned soil texture classes. This area is located between the Peterborough Drumlin Fields and Lake Simcoe. The lowland's area makes up the remaining 14.5% of the Beaverton River drainage basin.

2.3 Drainage

The Beaverton River has an average annual discharge of approximately 3 cubic metres per second. The headwaters of the river originate in the Oak Ridges Moraine. The river also drains parts of the Peterborough Drumlin Field and the Simcoe lowlands. The river has two branches, the main branch, referred to as the Beaverton River. drains the east side of the watershed and the largest of it's tributaries, the Vrooman Creek. drains an area to the west. The Vrooman Creek does not extend as far south as the main branch.


CURB
FIGURE 2.0
LAKE
SIMCOE
WATERSHED
LEGEND
Beaverton River
Drainage Basin
Drainage Basin
Boundary
Major Urban
Centers
Towns
GEORGIAN
BAY
Orillia
LAKE
SIMCOE
Barrie
Bradford
Newmarket
Oshawa
Toronto
LAKE ONTARIO
ORILLIA
LAKE
SIMCOE
Beaverton
BARRIE
Sutton
KESWICK
N
Bradford
NEWMARKET
Aurora
Scale

CURB FIGURE 2.1



Two smaller tributaries also enter the river and the creek, one is located 2 km north of Cannington on the Beaverton River, while the other is located approximately on the Vrooman Creek 1.5 km south west of the river confluence.

The total length of the Beaverton River from headwaters to mouth is approximately 66.5 kilometres. The headwaters are at an elevation of 310 metres above mean sea level (a.m.s.l.) dropping to roughly 218.85 metres a.m.s.l. The river flows into Lake Simcoe between Beaverton North Beach and Beaverton South Beach. Before reaching the lake the river flows from the Cannington urban area which is a distance of 24.5 kilometres. At the midpoint between Beaverton and Cannington enters the main tributary, Vrooman Creek (Figure 2.2).

The confluence of the Beaverton River and Vrooman Creek is located 13 kilometres north of the Cannington urban area. The Beaverton River upstream of the confluence drains an area of approximately 23.5 square kilometres. Immediately above the confluence, the river flows through mainly agrarian land until it reaches the urban area of the town of Beaverton. The hamlets of Argyle, Lornville, Woodville, Manilla, Blackwater, Saintfield and Vroomanton are also within the watershed.

The Vrooman Creek drains an area of approximately 83 square kilometres. It flows approximately 18 km dropping from the headwaters 259 metres a.m.s.l. to 243 metres a.m.s.l. at the confluence of the Beaverton River. At the headwaters of the creek lies a swamp with a surface area of approximately 0.2 square kilometres.

2.4 Land Use

Land use within the 407 square kilometre Beaverton River drainage basin is predominantly agricultural. Approximately 71 % of the watersheds total land area is farmland. Only 0.54 % of the land is urbanized. The remaining 27.5 % is in its natural state, idle, used for transportation corridors or aggregate extraction.

2.4.1 Agriculture

The Beaverton River drainage basin supports approximately 631 farms the majority of which are livestock operations. Statistics Canada census data on numbers of livestock in 1981 were mapped during the LSEMS study (LSEMS Technical Report. A.6, 1985). These maps indicate higher than average livestock and poultry densities in the Beaverton River drainage basin compared to the remaining Lake Simcoe sub-basins. Cropping activities in the Beaverton River watershed are dominated by the cultivation of row crops, small grains, and hay.

CURB **FIGURE 2.2**

BEAVERTON
RIVER
WATERSHED

LEGEND

Watershed Boundary

SCALE

0 2 4 KM

2.4.2 Built-up Areas

The major urban centre in the Beaverton River Watershed is the Town of Beaverton in addition to the smaller towns of Cannington and Sunderland. Other communities include the hamlets of Argyle, Lornville, Woodville, Manila, Blackwater, and Saintfield.

The largest urban centre, Beaverton, has an estimated population of 2,200. Beaverton has two small manufacturing industries, one produces car parts, the other provides fabricating and welding services. The storm and sanitary sewer system of the town are completely separate. Stormwater is discharged directly to the Beaverton River. The sanitary and industrial water is treated at an extended aeration plant with a 0.382 MiGD capacity.

The second largest urban centre, Cannington, has an estimated population of 2000. The town supports three industries. These industries include a heavy metal manufacturing company which produces augurs and belts for ships, a food processing operation and thirdly, a glass manufacturer.

Residential dwellings within the immediate urban area are connected to a sanitary sewage system utilizing an extended aeration system with a 0.235 MiGD capacity. Cannington's treated sewage is discharged directly into the Beaverton River.

The third largest centre, Sunderland, has an estimated population of 800. This town supports tertiary industry providing services for the surrounding rural community. The town is on the municipality's sanitary sewage and storm water system. The sanitary system has a capacity of 0.16 MiGD and also utilizes extended aeration treatment.

The remaining hamlets consist of small groups of homes and services such as schools, churches, and retail operations. Houses in these areas use private septic systems for sanitary waste disposal. The numbers of storm sewers servicing these areas are very limited.

3.0 BEACH AREAS IN THE BEAVERTON RIVER

3.1 Introduction

Lake Simcoe offers a number of recreational opportunities throughout the summer. Swimming has been identified as the most popular activity of tourists visiting the Lake Simcoe area (LSEMS, 1985). There are approximately 150 beaches in the Lake Simcoe watershed of which roughly half (72) are within the Conservation Authority's area of jurisdiction. Five are found within the Beaverton River sub-basin, all of which are located on the shore of Lake Simcoe in close proximity to the river mouth (Figure 3.0).

Information was collected on each beach of the Beaverton River sub-basin with regard to the history of beach postings and data on aquatic, physiographic and socio-economic conditions. The data was used to identify beach sites requiring attention and estimate the individual recreational value of each beach in order to prioritize remedial measures.

3.2 Beach Postings

Beaches in the Beaverton River sub-basing are posted by the Durham Region Municipal Health Unit when faecal coliform concentrations exceed the Ministry of the Environment and the Ministry of Health's recreation PWQO of 100 organisms/100 mL (Appendix A: Criteria For Beach Closure). The health risk to bathers is associated with pathogens which include bacteria, protozoa, fungi and viruses in the water. Exposure can result in ear, eye and throat infections along with intestinal diseases.

Information regarding beach postings in the Beaverton River sub-basin was compiled from the local health unit records . Between 1986 and 1988, two of the five beaches in the Beaverton River drainage basin were posted due to high faecal coliform counts (B. Stroughan, pers. comm., 1988). The placarded beaches are the Beaverton North and Beaverton South locations (Figure 3.0). The number of beach postings and their duration are illustrated in Table 3.0. These two beach sites are located at the mouth of the Beaverton River. For the purpose of the CURB plan only the beaches with a history of beach posting due to bacterial pollution will be discussed in detail.

CURB **FIGURE 3.0**

Beach Postings In The Beaverton River Drainage Basin

LEGEND

▲ 1 Beaverton North Beach

▲ 2 Beaverton South Beach

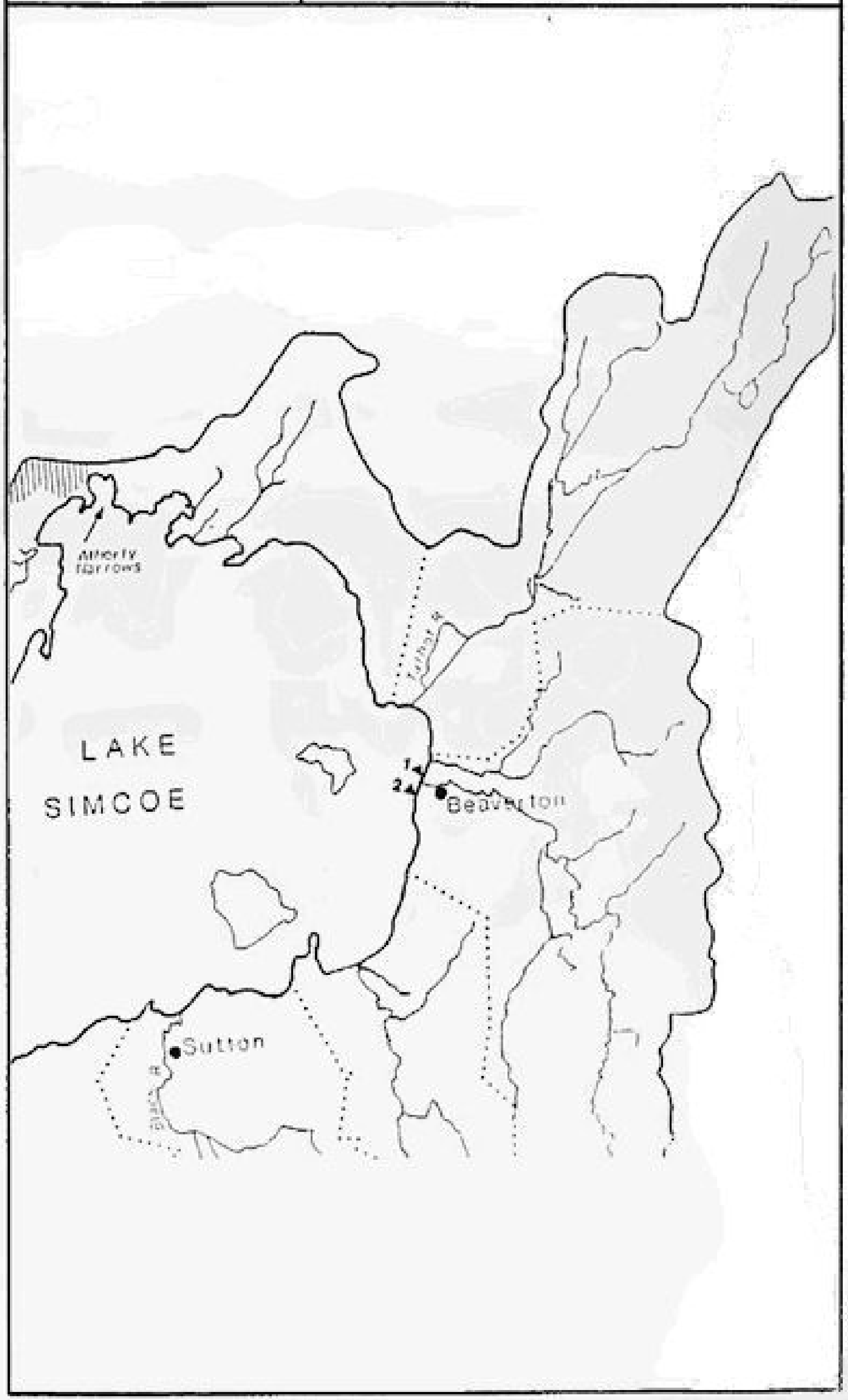


Table 3.0: Beach Posting in the Beaverton River Drainage Basin During The Period June 1 to September 1 (1986 - 1988)

	Duration of Beach Postings (Days)			
Beach	1986	1987	1988	Total
Beaverton North	8	28	0	36
Beaverton South	0	21	0	21

3.3 Cost Of Lost Recreational Opportunities

During the period 1986 to 1988, the Beaverton River drainage basin suffered a loss of recreational dollars as a result of beach closure. These beaches, the number of posted days and their associated total lost recreational dollars are displayed in Table 3.1. The cost of lost recreational opportunity was calculated by first determining the number of people per front metre of beach and then converting this to the beach carrying capacity (Appendix B: "M.O.E. Methodology of Calculating Beach Carrying Capacity"). This figure was adjusted to the number of days of beach closure and then multiplied against an expenditure factor representing the average money spent by a beach user. In 198S dollars this amount was equal to an average $20 per person per beach use occasion in Southern Ontario (M.O.E., 1987). This cost is the collective economic loss to all participants in the local recreational industry. Although the Ministry of the Environment has determined that S20 is representative of the amount spent by individual beach users, it is used in this report for comparative purposes only. A more accurate cost of lost recreational dollars for the beaches in the Lake Simcoe area would require the expenditure of time and money beyond the scope of this study.

The total lost recreational dollars in the Beaverton River drainage basin between 1986 and 1988 was $177,120. Beaverton North beach had the highest total lost cost of $116,640. with Beaverton South beach losing a total of $60,480. These high dollar figures are indicative of the frequency of beach closures and the popularity of these beaches. The estimated cost of lost recreational opportunity can be combined with beach rank to aid in the efficient use of remedial funding.

Table 3.1: Lost Recreation Dollars In The Beaverton River Drainage Basin

Beach Area	Total Days of Beach Closure	Cost Of Lost Recreation Dollars
Beaverton North	36	116,640
Beaverton South	21	60,480

3.4 Beach Ranking

During the summer of 1988 a detailed inventory of beach sites was conducted to evaluate site characteristics (Appendix C: "Methodology of Beach Ranking"). The findings of this study were used to create a ranking of all the beaches in the south Lake Simcoe area, together with their potential level of use. From the results a prioritized list of beach locations in the Beaverton River was established. The five beaches, in rank order, are Beaverton North, Fair Glen, Beaverton South and Sunrise.

The beach ranking results were based upon measured determinants evaluating aquatic conditions, physiographic factors and developmental amenities. Together, these characteristics were used to calculate a beach score as an assessment of the beach value (Table 3.2). The aquatic features alone are not always the best characteristics to judge the overall desirability of a beach. In Beaverton River, it is apparent that the preferred beaches, as indicated by score, are influenced by developmental factors instead of just physical characteristics of the site. Developmental scores are highest for the best ranked beaches which shows the importance of such features as stores and playgrounds.

Table 3.2: Beach Determinant Scores And Rank

Beach Areas	Determinants Aquatic	Physio-graphic	Development Management	Beach Rank
Beaverton North	52	75	35	1
Fair Glen	80	60	15	2
Beaverton South	44	45	55	3
Sunrise Beach	62	11	10	4

These scores are representative of overall beach value, which influences the recreational demand placed upon the particular site. Judging from these beach scores, the CURB plan should address remediation which would improve water quality at beach sites in order from highest to lowest ranked beach . The results would allow the most active beaches and those perceived to be of highest value to be kept in a condition suitable for recreational use.

3.5 Beach Descriptions

3.5.1 Beaverton North Beach

Beaverton North beach is located in the Town of Beaverton at the mouth of the Beaverton River were it empties into Lake Simcoe. This river drains an area extensively used for agricultural purposes, particularly livestock operations. As such, the waters of the Beaverton River are often polluted by faecal contamination. The Beaverton North beach was ranked 11 out of 59 beaches within the south Lake Simcoe area. This sand beach is approximately 112 metres long and includes picnic tables and portable toilets. The geographical location of the beach at the harbour mouth makes it very accessible to local residents and as a result is used extensively throughout the summer.

Aquatic Determinants

This beach site exhibits typical aquatic characteristics associated with the eastern shore of Lake Simcoe. The beach composition consists of sand and course sand, with some intermittent gravel bars sorted by wave action (prevailing west winds). The construction of a breakwall protecting the harbour mouth has caused detrital material accumulate at the south end of the beach. This beach site does, at times, encounter wind blown weed mats which wash up on shore. These weed mats, and the detrital accumulation, can impair the aesthetic quality of the Beaverton North Beach.

Physiographic Determinants

Beaverton North beach is a sand and gravel beach stretching approximately 112 metres long by 14 metres wide. This site has a low shore angle at 2% with a gently sloping wet beach. The beach perimeter is crescent shaped owing to the effect of the breakwall on sediment deposition and near shore current deflection.

Development and Management Determinants

Many development amenities exist close the Beaverton North beach site because of the proximity to the Town of Beaverton. Variety stores cater to most needs of the daily beach user, while local restaurants can attend to the out of town visitors. In addition, the beach provides picnic tables, washroom facilities and limited parking.

3.5.2 Beaverton South Beach

The Beaverton South beach is located across the harbour from the north beach. It is a popular swimming area for local residents and cottagers alike. The beach is bounded by a breakwall and path to viewing area at the end of the breakwall. This site is also a popular sport fishing area.

Aquatic Determinants

Water clarity at this beach site is excellent, aiding to its aesthetic appeal and to water safety. Water quality is, at times, degraded by the presence of aquatic weeds and algae. On occasion the beach must be raked of accumulated aquatic plants which have washed ashore.

Physiographic Determinants

Beaverton South beach is moderately large by Lake Simcoe standards being roughly WO metres long and 20 metres wide with a large park area behind the beach. The beach composition is a mix of gravel and cobble material. Beach slope is approximately 3% with an extended shallow entry towards deeper water.

Development and management Determinants

The close proximity of the beach to the town of Beaverton provides access to numerous services including stores, restaurants and other amenities. Specific beach facilities include a parking lot, picnic tables, washrooms and a change room. In addition, a snack-bar is located at the beach.

4.0 METHODS OF SOURCE ASSESSMENT

4.1 Introduction

Faecal pollution origins can be categorized into natural or man-made sources. In the Beaverton River sub-basin, the natural source contribution to water quality degradation are insignificant when compared to inputs from man-made sources. Urban, industrial, and agricultural activities are undoubtedly responsible for the largest percentages of the faecal pollution entering surface waters in populated areas.

The intent of the Lake Simcoe Rural Beaches Impact Program is to address surface water quality problems originating from agricultural sources of faecal contamination. Contamination of surface water by urban and industrial sources of faecal pollution are to be addressed through other MOE initiatives such as the Municipal Industrial Strategy for Abatement (MISA) program.

4.2 Bacterial Source Identification

Intensive on site investigations were required to determine whether the operational practices of livestock farms contribute to bacterial contamination of surface waters. The large number of livestock operations and size of the Beaverton River watershed render an investigation of this scale impractical. In order to limit the number of farm visits and ensure that all problem areas were identified, a methodology to target farm visits was devised.[1]

Air photograph Interpretation

The first step in the identification of problem livestock operations involved the use of air photographs to locate all livestock and poultry operations within the Beaverton drainage basin. Livestock and poultry operations were identified using interpretive techniques employed in earlier studies (Ryan, 1982; and Baliant, 1982). A total of 476 farms were identified of which 127 were determined to contribute faecal pollution to the waterways of the Beaverton River. Livestock operation locations were mapped on to 1:50.000 scale topographic sheets for later use.

Sediment Delivery Capability

The second step in the methodology to target farm visits utilized the development and use of sediment capability maps after the Land's Directorate (Snell. 1984). These maps were produced onto 1:50,000 mylar sheets and display a land area's tendency to generate

1. The methodology was based, in part, on previous work completed by Upper Thames River and the Ausable-Bayfield Conservation Authorities.

runoff and contaminate surface waters. These maps were then overlaid onto the topographic sheets depicting the location of livestock farms. Farm operations which were located in high and moderate sediment delivery areas were targeted for future investigations, operations located in low sediment delivery capability areas were not to be given further consideration.

Targeting of Farm Visits

Livestock operations which received a high or moderate rank were targeted for detailed site assessment. The greatest reduction of harmful inputs are likely to be achieved at these locations. Low ranked farms are not expected to contribute to faecal contamination, however, to ensure that the methodology used in targeting farm visits is accurate, a number of low ranked farms will be randomly visited. Overall, the total number of detailed investigations required was reduced significantly by 349 farm operations from 476 to 127.

Detailed Source Assessment

Site inspections of livestock operations previously targeted in the Beaverton River were completed and the results entered into a database for further use. A total of 127 farm visits were made, 40 to farms which had received a high pollution potential ranking, and 87 to farms classified to have a moderate pollution potential (Figure 4.0).

During site inspections the individual livestock operation's manure storage and handling practices were examined and discussed in detail, along with milkhouse waste disposal and livestock watering methods. An example of a survey sheet and the type of information collected can be found in Appendix D. The information was collected to further evaluate the contribution from individual livestock and poultry farms to faecal pollution and surface water quality degradation.

4.3 Pollution Severity Scoring Methodology

The objectives of the pollution severity scoring methodology were to:

1) Measure the relative faecal pollution contributions originating from all aspects of a livestock farm's manure storage and management practices.

2) Calculate reductions in faecal contamination resulting from the initiation of remedial measures associated with changes to the existing manure storage and management practices.

3) Estimate the costs of suggested remedial measures and using the associated reduction in pollution score calculate a cost per unit reduction so that remedial measures may be ranked based on their cost-effectiveness.

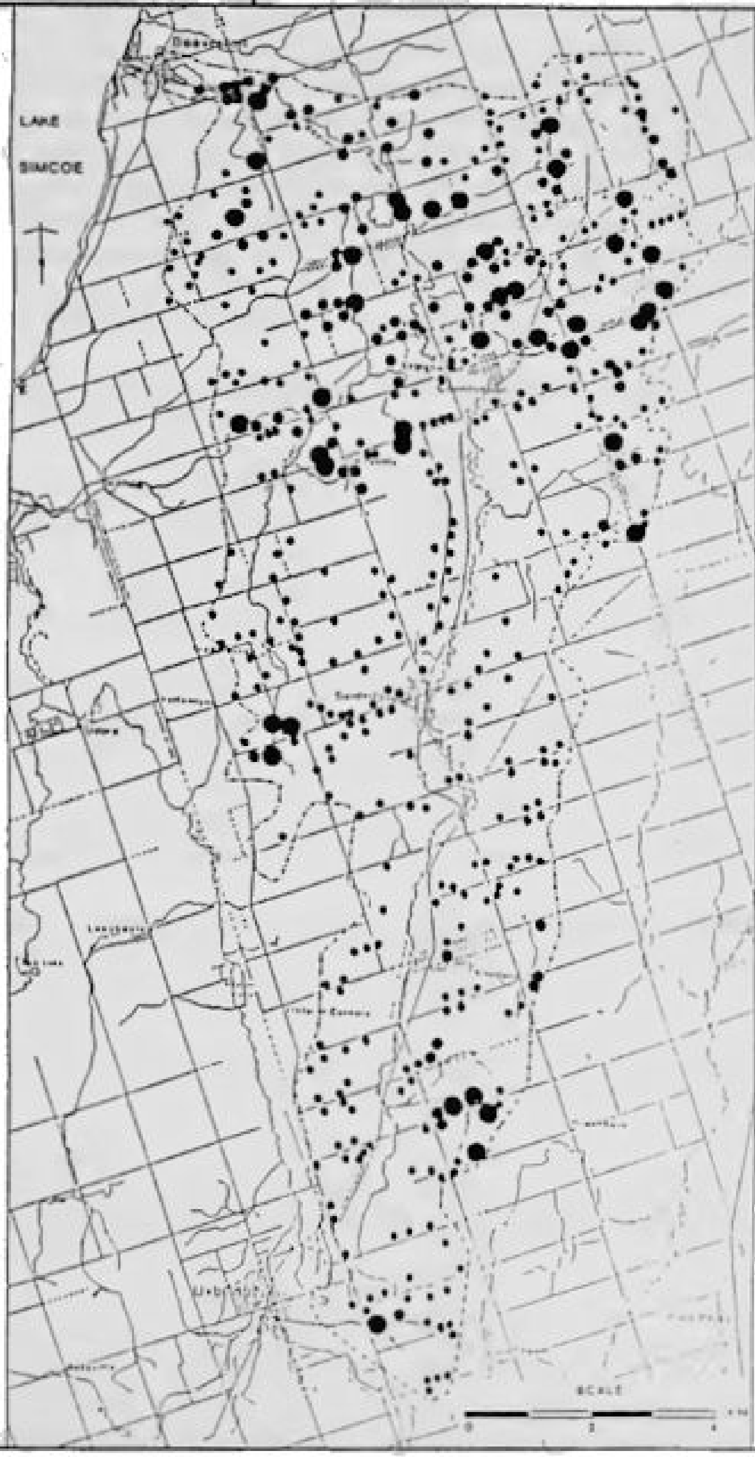
CURB **FIGURE 4.0**

FARM POLLUTION POTENTIAL

BEAVERTON RIVER

LEGEND

FARM RANKING
- ● HIGH
- • MODERATE
- · LOW



The following is a brief description of the Pollution Severity Scoring Methodology which was developed for farm evaluations. Software for the methodology has been programmed in basic language and is available upon request.

4.3.1 Calculating Pollution Severity Scores

Daily Bacteria Production Per Day

The first step in the determination of farm scores is to calculate the relative concentration of *Escherichia coli* (E. coli) bacteria produced per day for each individual livestock operation. Documentation concerning the concentration of E. coli in animal waste was more readily available than similar information for faecal coliforms therefore E. coli was selected for use in the calculations (Seyfried, Young and Harris, 1987). It is important to note that E. coli is a specific type of faecal coliform and responsible for approximately 90% of the faecal coliform reported in the Beaverton River water column. Relative bacteria concentrations per individual livestock species are listed below.

Relative Bacteria Concentrations Produced Per Day

Beef	1.3×10^{10} E. coli
Dairy	1.8×10^{10} E. coli
Sheep	2.9×10^{10} E. coli
Poultry	7.6×10^{10} E. coli
Horse	1.5×10^{10} E. coli
Pig	4.4×10^{10} E. coli

The priority scoring computer program will allow up to 3 different types of livestock to be reported, with the calculation of the number of bacteria produced can be simply stated as;

$$\text{Number Bacteria} = \Sigma\,(\text{relative bacteria}^{1} \times \text{number of animals}^{1}) + (\text{relative bacteria}^{2} \times \text{number of animals}^{2}) + (\text{relative bacteria}^{3} \times \text{number of animals}^{3})$$

The final product is a number which represents the total bacteria production per day for all livestock present on the farm operation.

Assessment of Transport Factors

The evaluation of transport factors is another procedure completed during the assessment of individual manure storage and management practices. Information concerning the percent slope, slope length, soil texture, and soil cover must be collected for the assessment of manure storages, pasture, feedlots, and manure spread fields. These factors, when considered together, produce a measure of runoff ability which can be used to indicate overland bacterial transport (Snell, 1985). The slope of a pasture or field is scored according to the runoff velocity generated as a function of the angular measure of the land. Higher scores represent increased runoff velocity in conjunction with greater slope angle. The volume of overland flow will increase as the fetch, or runoff length, increases. For this reason slope length scores are higher for longer fetch areas. Soil texture can affect the volume of runoff by its permeability and erodibility characteristics. Therefore soil texture is scored according to its overall ability to restrict runoff generation. Low scores indicate soils of low runoff production, and high scores relate to increased runoff generation. Vegetation can arrest erosion and reduce runoff on pasture land. Soil cover scores reflect this by increasing with decrease in vegetation cover.

The equation used to calculate transport is listed below and was developed by the Lands Directorate in Guelph (Snell, 1985).

Transport = (Slope + Slope Length + Soil Texture + Soil Cover)
Factor

Transport factors can range dramatically depending upon the site conditions. The following examples exemplify how results may vary due to various site conditions:

Site One has the following conditions:

- a % slope between >15 and <=30
- a slope length between >60 metres and < =75 metres
- a soil texture class described as clay loam
- a percent soil cover of < =20

Transport Factor = 4.2 (Site One)

Site Two has the exact same conditions with one exception:

- a % slope between >0.5 and <=2

Transport Factor = 1.6 (Site Two)

The result of the scoring of transport factors produces an overall runoff ability ranking and is linked to all of the rating procedures except milkhouse wash waster disposal.

Rating Manure Storage

This section offers a scoring system to assess farm manure storage facilities. Essentially. it differentiates storages which are liable to allow contaminated runoff or manure spills to enter surface receiving waters. A poor storage facility will receive a much higher score than one which is built to acceptable standards. Manure storage systems receive the following rankings based on their construction, and distance to the nearest watercourse:

Solid/Liquid Storage

if storage is a bare yard then	ms = 5	(worst case scenario)
if storage is a cement pad	ms = 4	
if storage is a pit	ms = 2	
if storage is a tank	ms = 1	(best case scenario)

Runoff Collection

if storage is covered then	ms = ms - 1
if storage has a runoff pond	ms = ms - 1
if storage has a liner	ms = ms - 1
if storage has retaining walls	ms = ms - 1
if storage receives runoff from yard or roofs	ms = ms + 1
if animal capacity exceeds present storage	ms = ms + 2

Transport Factor

if storage is yard or pad and distance to the watercourse < 120 metres adjust for transport factor

ms = ms + (transport factor)

The following is an example of the assessment procedure with Manure Storage. One representative of a poor storage and Manure Storage Two representing an acceptable storage.

Example 1: Manure Storage One

Solid/Liquid Storage

- has a bare yard	ms = 5

Runoff Collection

- storage is not covered	(no adjustment)
- storage has no pond	(no adjustment)
- storage is not lined	(no adjustment)
- no retaining wall	(no adjustment)
- storage receives runoff	ms = 5 + 1 ms =6
- storage at capacity	(no adjustment)

Transport Factor

- storage location (5)	ms = 6 + 5 ms = 11

Manure Storage Factor = 11

<u>Example 2:</u>	Manure Storage Two	
	Solid/Liquid Storage	
	- has a pad	ms = 4
	Runoff Collection	
	- storage is not covered	(no adjustment)
	- has a pond	ms = 4 - 1
		ms =3
	- storage is lined	ms = 3 - 1
		ms =2
	- has retaining walls	ms = 2 - 1
		ms = 1
	- no runoff received	(no adjustment)
	- storage at capacity	(no adjustment)
	Transport Factor	
	- storage location (5)	ms = 1 + 5
		ms =6
	<u>Manure Storage Factor = 6</u>	

Note that Example 2 still receives a score although not as large as Example 1. This is because the storage is still in close proximity to a watercourse and a potential spill would result in a significant amount of bacterial contamination and surface water degradation.

Rating Milkhouse Wash Water Waste Disposal

Milkhouse wash water waste disposal was examined since contamination of tile drains can contribute significant amounts of bacteria and phosphorus directly to ditches and streams. If disposed of properly milkhouse wash water receives a score of zero. Disposal systems which are considered acceptable include; holding tanks, septic tanks with weeping bed systems, treatment trenches and manure storage. Where milkhouse wash water is directly discharge through a tile drain, milkhouse wash water evaluation receives an automatic receives a score of ten.

Milkhouse Wash Water Disposal System

<u>Acceptable Systems</u>

- expanded Manure Storage Capacity	Mhouse = 0
- Holding Tank	Mhouse = 0
- Treatment Trench	Mhouse = 0
- Septic and Weeping Bed	Mhouse = 0

Unacceptable Systems

- Tile Drain Mhouse = 10

Rating Livestock Access

Pasture practices are included in the calculation of the farm score. Any access that livestock have to a watercourse pose a potential risk of bacterial contamination via direct faecal inputs from the animals themselves. Direct access earns the highest score for pasture practices at ten. When livestock do not have direct access to a watercourse, but are within 120 metres of a stream or ditch, then overland transport factors must be considered. The transport factor is calculated to adjust the pasture score according to site specific conditions. The assessment is shown below;

Livestock Access

- if livestock have access to surface waters	Past = 10
- if livestock access is restricted and is located > 120 metres from surface waters	Past = 0
- if livestock access is restricted but located < 120 metres from surface waters	Past = (Transport Factor)

Rating Manure Spreading Practices

Runoff generated on manure spread fields can ultimately wash soil and manure into ditches and streams contributing to serious water quality problems. The time of year application occurs can determine the vulnerability of surrounding watercourses to contamination. The worst case scenario is manure spreading during winter months while the ground is frozen. Come spring melt much of the manure and faecal bacteria can be transported by runoff to nearby waterways. Application of manure in spring, summer or fall also pose a risk to bordering waterways if manure is not incorporated into the soil. Transport factors of the manure spread field strongly influence it's ability to generate runoff therefore transport is reflected in the manure spreading practice scoring methodology. Other improper spreading practices such as spreading to close to a watercourse or over application were not assessed at this time. Scoring criteria for manure spreading practices are as follows;

Manure Spreading Practices

- if manure is spread in winter months	mfield = 10
- if manure spread field is < 120 metres to a watercourse	mfield = (transport factor)
- if manure spread field is > 120 metres to a watercourse	mfield = 0

Calculating the Final Pollution Severity Score

The calculation of the final pollution severity score combines all of the above mentioned practices into one equation producing a total pollution severity score based on the entire farm's storage and manure management practices. The equation is as follows:

Final Pollution Severity Score = Number of Bacteria Produced per Day x Σ of the integers ms, past, mfield, mhouse

4.3.2 Calculating Reductions Resulting from Remediation

The calculation of reductions in pollution severity score resulting from the initiation of remedial measures is accomplished by simply repeating the scoring methodology procedure and substituting the proposed remedial measures into the data base replacing the manure management practices originally utilized on the farm. This revised score can then be subtracted from the original pollution severity score to yield the overall farm reduction in faecal pollution. Proposed remedial measures included 200 day manure storage with runoff collection, milkhouse wash water treatment systems, restricting livestock access, the planting of buffer strips, above water stream crossings, and alternate watering facilities.

4.3.3 Estimating the Cost of Remedial Measures

Cost estimates were calculated for each component of a livestock operations manure storage and management practices where a reduction in the pollution severity score could be achieved. Costs for materials and labour were based on information collected from the Ministry of Agriculture and Food (Fleming, 1988) and local fencing contractors.

Total costs for manure storage varied for each operation as did costs estimates for restricting livestock access based on the individual operations requirements. Accurate cost estimates for milkhouse wash water treatment systems were not available therefore it was suggested that an estimated cost of $3,000.00 be used (Fleming, 1988). Cost estimates for manure spreading were not determined due to inadequacies in the survey data collected.

4.3.2 Calculating the Delta/Cost Ratio

The delta/cost ratio is defined as the product of a simple calculation where the estimated cost of a remedial measure is divided by the proposed reduction in pollution severity score. The result represents the cost per unit reduction in pollution severity score which could be achieved through implementation of the specific remedial measure. The ratio was used to prioritize remedial measures for implementation and is essential in the formulation of the CURB Remedial Plans.

4.4 Bacterial Source Significance

Bacterial contamination of surface water associated with agriculture land use is specific to livestock farming and occurs through the mismanagement of livestock wastes and milkhouse wash water. Bacteria can enter surface waters directly through the discharge of urine, faeces, and wash water, and indirectly, as contaminated runoff. It is important to dissociate between the two when assessing the relative impact of their contributions to surface water quality degradation.

Direct source inputs are considered the most significant agricultural sources of bacterial contamination, with inputs occurring continuously and discharged directly to surface waters. Subsequently, farm practices providing direct inputs have be given the highest priority within the CURB ranking for remediation. Farm practices providing direct inputs include livestock access, and faulty milkhouse waste water disposal systems and have been classified as Priority A Projects requiring immediate attention.

Indirect source inputs are generally a less significant contributor to surface water quality degradation than direct source inputs, requiring rainfall or snowmelt events to generate the runoff necessary to transport bacteria. As a result these sources while still significant contributors to bacterial contamination, have been classified as Priority B Projects requiring immediate attention after Priority A Projects have been addressed. Farm practices which provide indirect source inputs include runoff from manure storage, feedlots, manure storage and pastures.

5.0 SUMMARY OF SOURCE ASSESSMENT

5.1 Introduction

Individual farm source assessment provides information on faecal pollution severity scores and the intensity of a source input. The degree of pollution indicated by the score of an impacting farm will be in proportion to the amount and type of manure management practices used as part of the operation. These scores are adjusted by the implementation of available remedial measures used to correct the pollution hazard. The result is a figure representing the potential reduction in the pollution severity score. From the suggested remedial measures, a total cost of farm rehabilitation is calculated and presented for each sub-basin.

5..2 Beaverton River Sub-Basin (North and South Beached

The North and South Beaverton Beaches are located on the shore of Lake Simcoe at the mouth of the Beaverton River. Periodic beach postings during the summers of 1986 and 1987 lead to an investigation of faecal pollution sources in the Beaverton River drainage Basin. Using the pollution severity ranking methodology the pollution score for individual farms was calculated in order to evaluate the impact on the watercourse.

The result of the farm inventories indicated that the total score of these farm operations was estimated at approximately 3,092,087. It was observed that a single livestock operation was found to contribute to more than half of the sub-basin total, scoring 1,600.000 pollution units or roughly 52% of the total. This was sharply contrasted by the lowest score for a single operation which was only 300 pollution units. The average pollution severity score for livestock operations in the Beaverton drainage basin was calculated to be roughly 55,216 pollution severity units. The disparity which exists between farm pollution scores shows that careful consideration of farm remedial plans can net large reductions in bacterial inputs.

Figure 5.0 displays the distribution of the total pollution severity scores in relation to improper manure storage and other mismanaged practices within the Beaverton River drainage basin. Improper manure spreading or application accounts for the largest contribution to the total pollution severity score estimated at 2,121,903 units or 69% of the total. It is significant to note that one poultry operation was found to account for 75% of the total manure spreading severity score alone. Manure storage scored the second highest total accounting for 19% of the total score or 595,950 pollution severity units. Livestock access accounted for another 10% of the total, scoring approximately 315.669 pollution units. The remaining 2% of the pollution severity score can be attributed to inoperative milkhouse waste disposal systems which scored 58,565 pollution units.

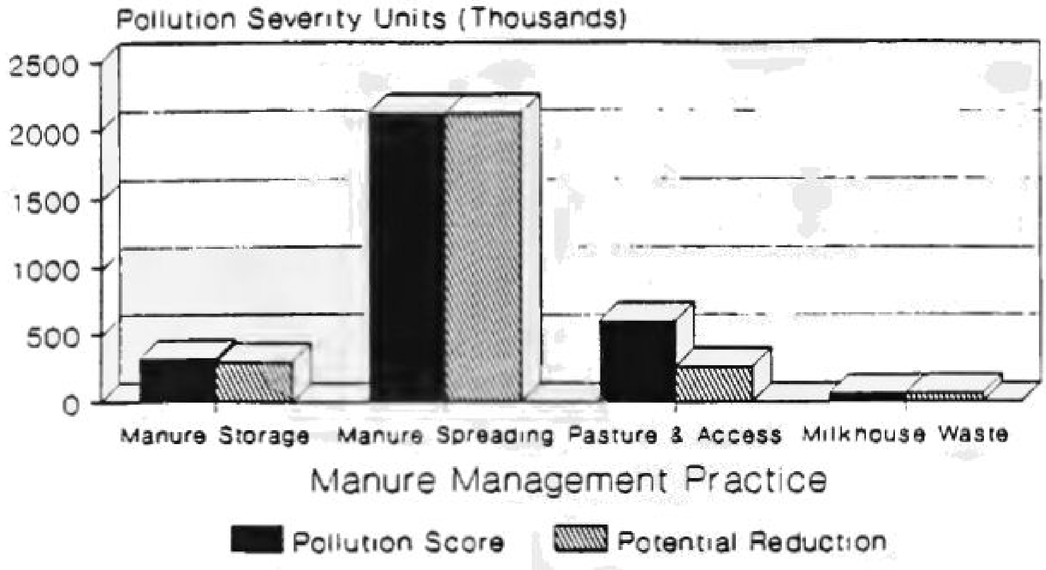


Figure 5.0: Beaverton River Drainage Basin Pollution Severity Score And Potential Reductions

It has been estimated that a 79% reduction amounting to 2,456,365 pollution units can be achieved should livestock farmers in the Beaverton River drainage basin improve upon existing manure storage and the adoption of better manure management practices (Figure 5.0). The largest reduction in the pollution severity score can be accomplished by educating farmers within the watershed concerning the proper application of manure. An estimated 1,832,231 pollution units or approximately 75% of the total reduction obtainable can be attributed to improper manure application. The next largest reduction in the pollution severity score involves the construction of new manure storage systems or modifications to existing systems. It has been estimated that a reduction of 12% or 289,916 pollution units is obtainable through these remedial works. Further reductions of 11% or 275,970 can be achieved through the elimination of livestock access and creation of buffer strips to control pasture runoff and 2% or 58,248 pollution units through construction of approved milkhouse waste disposal systems.

The cost associated with the proposed remedial measures are shown in Figure 5.1. The total cost of remedial measures in the Beaverton River drainage basin have been estimated at $682,421. The construction of manure storage accounts for roughly 80% of the total cost or $549,833. Remedial measures designed to control pasture runoff and eliminate livestock assess will cost an additional $120,588 or 18% of the overall cost. The remaining 2% of costs or $12,000 involves the construction of approved milkhouse waste disposal systems.

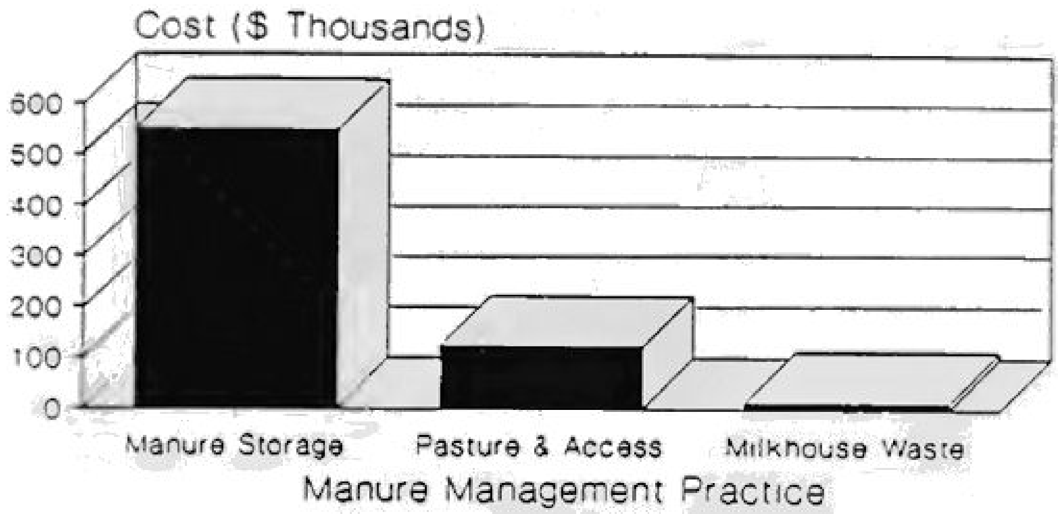


Figure 5.1: Cost of Remedial Measures In The Beaverton River Drainage Basin

Comparing the cost of remedial measures versus the estimated reduction in the pollution severity score it appears that upgrading milkhouse waste disposal systems is the most cost beneficial. The cost/reduction ratio for thise remedial measures was estimated at $0.21 per pollution severity unit reduction. Controlling pasture runoff and eliminating livestock access to streams was the next most cost effective remedial measure with a cost reduction ratio of $0.44. The construction of manure storage had the highest cost/reduction ratio of $1.90 per unit indication it was the least cost effective. Manure spreading practices do not have an associated cost/reduction ratio because cost estimates for manure spreading were not calculated. The prescribed remedial measure requires a change in the application practice not the construction of a capital words project. However, convincing farmers to adopt new and improved manure spreading practices could account for the largest reduction in the pollution severity score, approximately 75% of the total reduction obtainable (Figure 5.2).

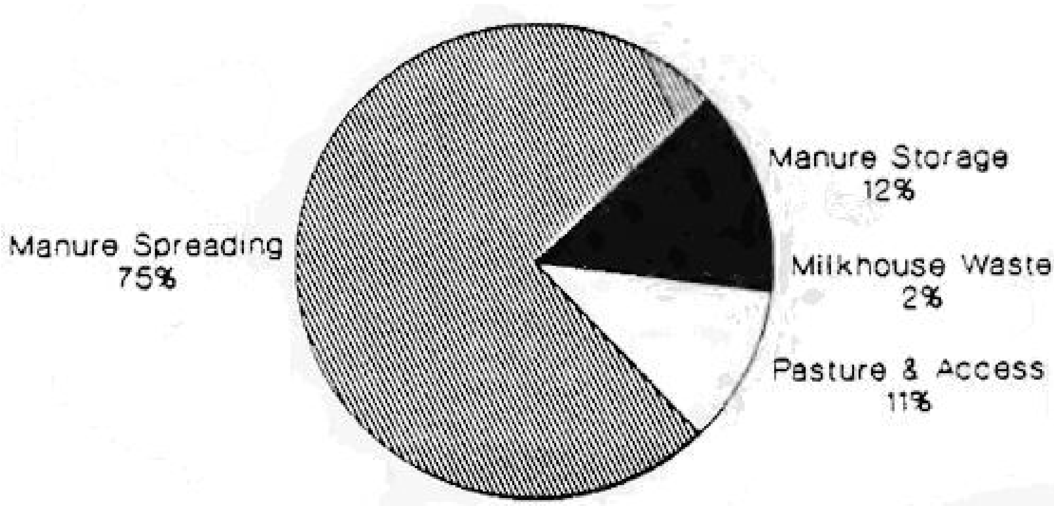


Figure 5.2: Pollution Reduction Per Manure Management Practice

A survey conducted in 1986 of farmers in the Beaverton River drainage basin (LSRBIS, 1986) indicate that few if any farmers actual had their manure and soil tested to determine manure application rates. The reasons farmers suggested for not calculating application rates included; the inconvenience involved with sending samples away, the time required for analysis, and their inability to calculate application rates given the results. Due to the significant reduction obtainable from reduced manure application, a program to better educate farmers concerning the proper method of applying manure and chemical fertilizers should be undertaken. The best economical approach to reduce agriculturally related bacterial input to surface waters, while still significantly improving the regions water quality include the following:

1. Improve manure management by controlling manure spreading and pasture runoff.

2. Upgrade existing manure storage facilities.

3. Eliminate in-stream watering of livestock by installing alternate watering devices.

4. Repair or construct new milkhouse waste disposal systems on farms presently with sub-standard equipment.

5.a) Prepare and implement a method of educating farmers on soil and manure testing programs and on how to interpret the results obtained from these tests.

b) Alternatively, it is recommended that a mobile laboratory be used to service communities within the watershed and provide on-the-spot manure and soil testing.

If these manure management methods can be adopted, the resulting reduction in bacterial pollution in area waterways will improve water quality at local beaches.

6.0 CLEAN UP RURAL BEACHES REMEDIAL PLAN

6.1 Introduction

The purpose of the Clean Up Rural Beaches (CURB) Remedial Plan is to provide a framework for the implementation of proposed remedial works. Significant reductions in the total pollution severity scores of problem beach areas can be achieved through the initiation of selected remedial measures. Each of the proposed remedial measures have been examined in terms of the relative reduction in pollution severity score, cost involved, and ease of implementation. From this has evolved a scheduling of remediation works into Priority A and Priority B projects. These divisions in addition to the beach ranking methodology, allow the formulation of a remedial management plan which can best achieve the objectives of the Lake Simcoe Rural Beaches Impact Study.

6.2 Proposed Remedial Measures for Priority A Projects

Remedial measures associated with Priority A Projects include restricting livestock access to surface waters and controlling the discharge of milkhouse wash water. These forms of remediation are; a) the most significant in improving water quality, b) most cost effective, recording the lowest cost per unit reduction ratios, and c) the most acceptable to the farm community requiring only modest capital expenditures. As a result, funding allocated towards the implementation of the CURB Remedial Plan would best be spent addressing these farm practices.

Livestock Access

Allowing livestock access to rivers and streams has been a convenient means of water livestock, however, faeces and urine produced can be discharged directly to surface waters contributing to bacterial and nutrient contamination. In addition to bacterial contamination, livestock access contributes to other stream degradation problems including streambank erosion, stream siltation and loss of aquatic habitat.

Suggested remedial measures include the total restriction of livestock from the stream or ditch using pagewire, high tension, or electric fence. Often the stream or ditch divides a pasture, in these instances fence must be installed on both sides and an appropriate above water crossing constructed. Fencing should be kept a moderate distance away from the stream or ditch so that vegetation can be established to produce a buffer strip which will reduce faecal contamination originating from pasture runoff. The planting of shrubs and trees within the buffered zone is encouraged as it will stabilize the streambank and provide shade to enhance the aquatic ecosystem. Alternate water facilities for livestock are necessary. A number of techniques can be employed to provide water to livestock utilizing surface water or ground water from existing wells.

Milkhouse Wastewater

Tile effluent contaminated by milkhouse wash water has been found to contain high concentrations of bacteria. Preliminary evidence indicates that the tile drains provide an environment conducive to bacteria growth (UTRCA, 1987). Livestock watering downstream of drain outlets are potentially exposed to a greater range of pathogenic organisms which can degrade herd health, and cost farmers through reduced productivity and veterinarian bills. In addition to bacteria, wash water also contains high concentrations of phosphorus which promotes the growth of algae and aquatic plants.

Suggested remedial measures include the treatment of milkhouse wash water using existing manure storage system, the construction of a milkhouse wash water holding tank and/or treatment trench. If wash water is to be rerouted to a manure storage it should be checked to ensure that the storage has the capacity to handle the additional daily waste input. The utilization of treatment trenches is another popular method of controlling milkhouse wash water, however this technique is provisional on existing soil and drainage conditions and should not be employed in heavy poorly drained soils. Holding tanks can be used regardless of the soil or drainage conditions, but, like manure storage require a large amount of maintenance.

6.3 Proposed Remedial Measures for Priority B Projects

Remedial measures associated with Priority B Projects includes construction of approved 200 day manure storages, capable of storing manure waste, rainwater and runoff generated from feedlots during that time period. The construction of these remedial measures generally do less for improving water quality than Priority A Projects since surface water contamination only occurs when a rainfall or snowmelt events produce the runoff necessary to transport bacteria. Subsequently, Priority B farms are less significant contributors of bacterial contamination and should be addressed only after Priority A Projects have been completed. Implementation of Priority B Projects will be limited since construction of manure storage and runoff collection devices are not widely accepted within the farm community due to the high cost involved and present economical environment.

Manure Storage and Feedlots

Manure storage systems consist of a cement pad with retaining walls for solid wastes and either a cement covered tank, cement tank, or clay lined pit to collect liquid waste and runoff. Feedlots can be incorporated into these systems however runoff devices must be sized accordingly in relation to the feedlot surface area to provide a minimum of 200 days accumulation. Manure storage systems are costly requiring large capital investments along with some maintenance, but it should be stressed to farmers that there are commercial benefits besides those dealing strictly with pollution. For example, the fertilizer value of stored manure is greater than when nutrients are lost to runoff water. Also. proper timing of manure spreading ensures that the manure is fully utilized.

Manure Spreading Practices

Promotion of acceptable manure spreading practices were considered within the framework of the CURB Remedial Plan as a Priority B Project. No attempts were made to estimate costs associated with correcting improper manure spreading practices (spreading to close to a stream or ditch, not incorporating manure after surface application, and winter spreading). Changing these practices does not involve a cost to the farm operator with the exception of manure over-application and winter spreading necessitated by inadequate storage. In these cases, the reduction in the farm pollution score from improved manure application is included in the reduction and costs associated with manure storage.

6.4 Selection of Remedial Measures

Using the Pollution Severity Ranking System (see chapter 3.0) manure storage and management practices for individual livestock operations were assessed along with the estimated reductions obtainable through the initiation of remedial measures. Costs associated with each remedial measure were also determined and used to calculate the cost per unit reduction in the pollution severity score. Referred to as the Delta\Cost Ratio, this assessment procedure has provided a means for ordering the remedial measures within their Priority A or B designation to ensure the greatest reduction in faecal pollution for the least amount of capital expenditure. Where several remedial measures have been proposed for a single farm practice (ie. manure storage), the most cost effective has been selected.

As might be expected, not all landowners agree with proposed remediation, or are in a position to participate in a program of improved manure management benefiting regional water quality. For this reason the use of the delta/cost ratio can not always be adhered to. As a result it becomes probable that less cost effective projects may be undertaken in response to landowner interest and ability to meet the requirements of the financing programs. Under these circumstances the beach ranking methodology will be used to determine the order of project completion for works with a less effective delta/cost ratio. This will allow recreationally significant beach area to receive priority attention in the form of water quality remedial works.

6.4.1 Beaverton River Priority A Projects

There are a total of 40 Priority A projects within the Beaverton River drainage basin. Completing these projects would yield a total reduction of 334,535 pollution units and would cost a total of $132,588. All of the projects involve fencing work and or pasture modifications. Table 6.0 summarizes the reduction, cost, and delta cost associated with the remedial work needed for each individual farm.

TABLE 6.0: Priority A Projects Beaverton River Drainage Basin

FARM #	REMEDIAL MEASURE	REDUCTION IN SCORE	PROPOSED COST	DELTA /COST
S1409	PASTURE	875	0	0
B1005	PASTURE	2865	0	0
E110	PASTURE	1989	0	0
S1204	PASTURE	51	0	0
M1204	PASTURE	451	0	0
B1219	PASTURE	20	0	0
B821	PASTURE	438	0	0
M1001	PASTURE	6309	0	0
E204	PASTURE	3060	0	0
B1324	PASTURE	2067	0	0
B604	PASTURE	23040	2828	0.122743
B1311	PASTURE	18720	2664	0.142307
B1008	PASTURE	34960	5124	0.146567
B1313	MHWASTE	18000	3000	0.166666
B1005	MHWASTE	16200	3000	0.185185
B1210	MHWASTE	16200	3000	0.185185
B1112	PASTURE	20160	3812	0.189087
B1210	PASTURE	12960	2631	0.203009
T118	PASTURE	14400	3418	0.237361
T124	PASTURE	13680	3812	0.278654
B1204	PASTURE	17280	5124	0.296527
T122	MHWASTE	8165	3000	0.367421
M1302	PASTURE	16443	6436	0.391412
B1313	PASTURE	14400	6436	0.446944
T119	PASTURE	6496	3156	0.485837
S1312	PASTURE	5760	3025	0.525173
S803	PASTURE	14400	7748	0.538055
B811	PASTURE	10400	5780	0.555769
M1106	PASTURE	9100	5124	0.563076
B1222	PASTURE	3120	3418	1.095512
E205	PASTURE	4160	4796	1.152884
B1220	PASTURE	3048	3812	1.250656
B1316	PASTURE	2144	3156	1.472014
B1409	PASTURE	2392	4468	1.867892
B1309	PASTURE	1248	2624	2.102564
T116	PASTURE	3528	7748	2.196145
B1211	PASTURE	1094	2500	2.285191
B1315	PASTURE	1368	3484	2.546783
T115	PASTURE	1464	4468	3.051912
M1508	PASTURE	2080	12996	6.248076
n=40	TOTALS	334535	132588	

6.4.3 Beaverton River Priority B Projects

A total of 51 farms in the Beaverton River drainage basin are classified as Priority B projects. If all requested remedial work is completed a total reduction of 289,916 pollution units can be achieved at total cost of $549,833. All these projects involve improvements to manure storage practices. Table 6.1 summarizes the respective reduction, cost, and delta cost associated with the remedial work required for each individual farm.

TABLE 6.1: Priority B Projects Beaverton River Drainage Basin

FARM #	REMEDIAL MEASURE	REDUCTION IN SCORE	PROPOSED COST	DELTA /COST
S1204	storage	120	5516	0.021754
S1313	storage	975	14223	0.068550
B603	storage	546	7242	0.075393
B1204	storage	4320	32945	0.131127
M1508	storage	520	3751	0.138629
T115	storage	732	5060	0.144664
B1202	storage	5400	33893	0.159324
B1313	storage	3600	21821	0.164978
B1203	storage	2730	14903	0.183184
B1309	storage	624	3402	0.183421
B1219	storage	848	4404	0.192552
S803	storage	3600	18538	0.194195
B1316	storage	1072	5516	0.194343
B1321	storage	1800	9096	0.197889
B1315	storage	684	3402	0.201058
B1311	storage	4680	22626	0.206841
B1211	storage	1950	8931	0.218340
T124	storage	5130	22321	0.229828
M1002	storage	715	3107	0.230125
B1210	storage	4860	20863	0.232948
B726	storage	1040	4404	0.236148
M1204	storage	1040	4404	0.236148
B821	storage	1040	4404	0.236148
B1409	storage	1196	5060	0.236363
B1220	storage	1524	6240	0.244230
B501	storage	4107	16814	0.244260
B1222	storage	1560	6240	0.25
B1112	storage	5040	19400	0.259793
E110	storage	2340	8549	0.273716
M1003	storage	1365	4949	0.275813
B1122	storage	2080	7530	0.276228
T118	storage	5760	20122	0.286253
B1308	storage	3744	12432	0.301158
T122	storage	2430	7866	0.308924

TABLE 6.1 (Continued): Priority B Projects Beaverton River Drainage Basin

FARM #	REMEDIAL MEASURE	REDUCTION IN SCORE	PROPOSED COST	DELTA /COST
S1409	storage	1560	4938	0.315917
M1106	storage	5200	16056	0.323866
B811	storage	3900	9835	0.396542
T116	storage	784	1621	0.483652
B1005	storage	4860	9658	0.503209
B1404	storage	8720	16814	0.518615
B1324	storage	4768	6240	0.764102
B1008	storage	8740	9530	0.917103
E204	storage	3600	3600	1
M1001	storage	10100	8367	1.207123
B1223	storage	11460	9254	1.238383
B1405	storage	8200	6240	1.314102
B1208	storage	3520	2511	1.401831
T501	storage	39684	25877	1.533562
T119	storage	3248	1448	2.243093
T308	storage	52800	19575	2.697318
B1413	storage	39600	8295	4.773960
n=51	TOTALS	289916	549833	

6.5 Manure Spreading Control and Management

As a source of enteric bacteria, manure spreading can pose a significant hazard to surface water quality. Faecal coliform bacteria can easily be carried in overland flow during a precipitation event, surface runoff over frozen land and in snowmelt. Restrictions governing the time of manure application and the distance it is spread from a watercourse are solutions to the associated pollution problem. As such, it might be expected that a manure spreading management program would be determined as a first priority endeavour. Yet manure spreading was not previously included in the priority organization of manure management practices. The reasons for this are as follows. First, as a manure management practice, the solution to manure spreading leading to aquatic pollution would include a no cost education program of promoting environmentally safe manure application. As a no cost incentive, it does not require a ranking within framework of priority cash allocation. In addition, the cause of poor spreading practices. particularly during winter months, often hinges on inadequate manure storage facilities. lt. for example, a farm operation does not have sufficient storage capacity to collect the animal waste it produces, an alternate means of disposal is required. The common solution is to spread regardless of season or field conditions.

A conflict arises on how manure spreading, as a management practice, should be designated with regard to the overall CURB plan implementation. As demonstrated above, it can either be a problem involving a no cost solution, or one which is indicative of a much larger and very expensive manure storage problem. It is suggested that to improve this management practice, that an individual farm evaluation be preformed to determine the source of the manure spreading concern. In cases where proper manure spreading technique is in question, then farmer education can be used to inform the farm operator of the benefits of proper manure spreading. If, however, the problem lies in an under-sized manure storage facility, then a system upgrade will be necessary. In this circumstance the project would be classified as a Priority B project due to the high expense of designing and installing an appropriate replacement manure storage system.

In the Beaverton River drainage basin manure spreading accounts for 2,121,903 pollution severity units (Figure 6.4). Through the adoption of better manure management practices (ie. 200 day manure storages and no winter spreading etc.) and environmentally sound manure application, this pollution hazard can be eliminated.

TABLE 6.2: Manure Spreading In The Beaverton River Drainage Basin

FARM #	MANURE SPREAD
S1204	90
B1309	312
B1315	349
B1219	424
M1204	520
M1508	520
B1316	547
B1409	569
B1222	741
T116	784
M1003	901
E205	1040
B1211	1287
T119	1543
B603	1806
E110	2340
T122	2381
B1208	2640
B1203	2739
B811	2808
T124	3420
S803	3600

TABLE 6.2 (Continued): Manure Spreading In The Beaverton River Drainage Basin

FARM #		MANURE SPREAD
E204		3600
B1220		3810
B1405		4162
M1302		4792
B1210		4860
B1122		5200
B1202		5400
B1204		6242
B1324		11955
M1106		13000
T118		14400
B1005		16200
B1313		18000
B1311		23400
B1112		25175
M1001		25250
T501		38096
B1008		43656
B1322		48400
T308		174944
T205		1600000
n=43	TOTAL	2121903

Unfortunately, no system of enforcement is available to regulate manure spreading activities, nor is there a strategy to oversee the continuation of suggested remedial practices. This increases the demand on the successful use of education to inform farmers of the necessity to manage their farm operation as an efficient business which is also environmentally conscious.

6.6 Implementation Responsibilities and Funding Mechanism

Reducing agricultural pollution is ultimately the responsibility of the farmer, however. recognizing the present economic environment it is unlikely that operators will be able to initiate the suggested remedial measures without financial assistance. If we consider the contribution of the farmer to his community and the overall environmental benefits to be achieved through wise farm management, a moral question exists; should the farmer be responsible for the total cost of remediation necessary to improve the local and regional water quality.

If serious action is to be taken to initiate the Pefferlaw Brook CURB Remedial Plan a government assistance is required. The Conservation Authority could provide an excellent vehicle in which to deliver the program to the farm community, however, under present funding restraints diffuse source pollution control programs are not considered core programs and as such are not funded. Therefore, some source of funding is required, both for staffing and for the initiation of projects in the field.

Future financing programs would likely involve a cost sharing approach which would aid the farmer and insure the continued vigilance in project maintenance. A cost sharing ratio of 75% assistance and 25% landowner contribution may be sufficient to entice a reasonable level of participation in a program aimed at improving the regional water quality. As an assistance program using public funding, it should be noted that the advantage of reducing the pollution in the aquatic environment benefits proportionately a large number of people.

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APPENDIX: A

CRITERIA FOR BEACH CLOSURE
(AS SET BY THE LOCAL HEALTH UNIT)

Durham Region Health Unit:

The Durham Region Health Unit samples from June to September, taking samples twice a week. Ten individual samples are taken during each sample run. If all twenty samples exceed 100 fecal coliforms per 100 mL the beach is posted. To re-open the beach, one full week of samples (20 samples) must be below 100 bacteria per 100 mL.

APPENDIX: B

METHODOLOGY OF CALCULATING BEACH CARRYING CAPACITY

Beach carrying capacity was a critical factor in evaluating the overall beach value as a recreational resource, not only for use by the public, but also in terms of economic benefit to the local service industry. The procedure of estimating beach capacity used a space standard for the number of people per unit of length of beach. This was done on the basis of a matrix of wet beach and dry beach width categories (Ministry of the Environment, 1987). The beach carrying capacity matrix for various wet and dry beach widths is listed below.

People per front metre of beach*:

wet beach	dry beach width (m)					
width (m)	<5	5-10	10-20	20-40	40-80	>80
<5	0.56	1.31	1.31	1.31	1.31	1.31
5-10**	0.56	1.77	3.51	4.10	4.10	4.10
10-20	0.56	1.77	3.51	7.02	8.20	8.20
20-40	0.56	1.77	3.51	7.02	13.35	16.40
40-80	0.56	1.77	3.51	7.02	13.35	17.59
>80	0.56	1.77	3.51	7.02	13.35	17.59

* From M.O.E., 1987.

** all beaches surveyed had at least 5-10 metres wet beach.

APPENDIX: C

METHODOLOGY OF BEACH RANKING

For the purpose of the Beach Ranking Methodology, a beach is defined as a strip of shoreline with the physiographic, climatic, access, and ownership attributes necessary to accommodate both contact and non-contact recreational activities associated with a waterfront. Certain criteria have been set-out to evaluate a beach site as to its suitability as a recreational resource. These criteria were first defined in the Ministry Of The Environments "Beach Use and Environmental Quality in Ontario" (1987) handbook and has since been modified for use in this report. The criteria have been divided into three determinant sections, namely; aquatic, physiographic, development and management. Listed below are the score values appointed to each of the individual characteristics. These factors were evaluated for each beach during the summer months of 1988. The scored results lead to the rank ordering of the beaches from high (best), to low (worst) as previously listed in Chapter 3.

Aquatic Determinants

Determinants	Rating	Score
Colour, Weeds,	1	0
Odour, Algae,	2	2
Oil Scum, Debris	3	5
	4	10
	5	15

Physiographic Determinants

Carrying Capacity (Beach Width/Beach Length)	#People	Score
	<10	1
	10-25	5
	26-50	10
	51-100	15
	101-500	25
	501-1000	35
	>1000	50

Beach Composition	Material	Score
	organic	1
	cobble	5
	gravel	10
	sand/gravel/cobble	15
	sand	25

Bottom Composition	Material	Score
	organic	1
	cobble	5
	gravel	10
	sand/gravel/cobble	15
	sand	25

Development and Management Determinants

Parking	Lot Size	Score
	0	0
	1-25	5
	26-50	10
	51-100	15
	>100	0

Admission	Cost	Score
	>$7	1
	$4-$7	2
	$1-$3	5
	0	10

Washrooms	Present	Score
	No	0
	Yes	10

Picnic Areas	Present	Score
	No	0
	Yes	10

Variety Stores	Present	Score
	No	0
	Yes	10

APPENDIX D

FARM SURVEY SHEET

Archivist Note - Survey too faded in copy to reproduce