MISSISSIPPI VALLEY CONSERVATION AUTHORITY CLEAN UP RURAL BEACHES PLAN (1993 - 1994)

Prepared for:

the
ONTARIO MINISTRY OF ENVIRONMENT AND ENERGY
and the
MISSISSIPPI VALLEY CONSERVATION AUTHORITY

Prepared by:

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Jim Craig	Leeds, Grenville and Lanark Health Unit
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EXECUTIVE SUMMARY

In response to concerns expressed by members of the public regarding numerous beach postings and perceived water quality deterioration of the Mississippi River, the Mississippi Valley Conservation Authority (MVCA) in conjunction with the Ministry of Environment and Energy (MOEE) initiated the Clean Up Rural Beaches (CURB) Program in 1992.

The Rural Beaches Study is completed, the study established a water quality and land use inventory data base through a detailed investigation of surface water quality. Investigations revealed sources and relative inputs of bacterial pollution and nutrients restricting the safe recreational use of public beaches along the Mississippi River.

Rural beaches in the Mississippi Valley play a vital role in providing enjoyment to residents and tourists. Throughout the summer months beaches along the river have been posted by the Health Unit, warning bathers of potential health risks due to unacceptable bacteria levels in the water. The summer of 1993 did not mark a change to this trend.

1993 HEALTH UNIT BEACH POSTINGS

Innisville North	8 Days
Innisville South	22 Days
Carleton Pl. Joseph St.	14 Days
Carleton Pl. Canoe Club	8 Days
Appleton	0
Blakeney	**
Almonte	0 Days
Pakenham	24 Days
Pakenham Bridge	**

* Health Unit did not monitor this site due to the Appleton Dam construction project during the summer of 1993.

** Health Unit sampled these sites only three times.

This report is a culmination of two years of water quality study and land use surveys. The study included the collection and analysis of 1,700 bacteriological samples and 900 nutrient-inorganic-physical samples. Land owner surveys were conducted at 50 establishments.

This CURB Plan is a remedial action plan unique to the Mississippi River watershed. The study results are applied to create the CURB model. The model is a standardized, mathematical modelling approach, that provides a prediction for the total bacteria load delivered to the beaches from all potential rural pollution sources. The CURB Plan incorporates the model to provide a framework for remedial projects and associated cost estimates in the following categories; cattle access restriction, manure management, milkhouse washwater disposal systems and private sewage systems. The following tables summarize the modelled percentage contributions from each source;

BACTERIA LOAD PERCENTAGE SUMMARY TABLE

SOURCE	Pakenham	Blakeney	Almonte	Appleton	Carleton Place	Innisville
			%			
Yard Runoff	6	9	9	6	7	9
Stack Runoff	12	11	14	6	9	11
Milkhouse Wash.	2	2	3	2	2	2
Cattle Access	43	34	42	11	26	32
Septic Systems	35	43	29	50	56	18
Manure Spreading	0	0	0	0	0	0
Urban Runoff	2	1	3	3	N/A	N/A
Gulls/Pigeons	N/A	N/A	N/A	22	N/A	28

AVERAGE BACTERIA LOAD PERCENTAGE SUMMARY FOR MVCA STUDY AREA

Pollution Source	Percentage Input
Septic Systems	39
Cattle Access	31
Stack Runoff	10
Barnyard Runoff	8
Gulls/Pigeons	8
Milkhouse Washwater	2
Urban Runoff	2
Manure Spreading	0

A total of 851 projects are eligible for assistance under the CURB Program. Total remedial costs to complete these projects are estimated at $11,033,000.00. This estimate is high due to the large number of manure piles without runoff containment and the large cost funding required to construct manure storage systems. From the total remedial costs, $5,136,000.00 may qualify for grant assistance over five years of implementation. The following table summarizes remedial costs for the study area.

REMEDIAL PROJECT COST BREAKDOWN

Remedial Projects	Number of Projects	Cost Estimates/ Project	Bacteria Reduction / Dollar	Eligible Funding	Percent Bacti Reduced
MSS	322	$25,000	9.3×10^{8}	$3,864,000	18 %
MWD	43	$ 7,000	2.4×10^{7}	$ 150,500	2 %
CAR	130	$ 4,200	2.3×10^{8}	$ 409,500	31 %
SDS	356	$ 6,000	3×10^{7}	$ 712,000	39 %
TOTALS	851	N/A	N/A	$5,136,000	* 90 %

MSS = Manure Storage Systems **MWD =** Milkhouse Washwater Disposal
CAR = Cattle Access Restriction **SDS =** Sewage Disposal Systems
* The remaining 10% is attributed to bacterial input from birds and urban storm water.

The table above, confirms that livestock access restriction projects remove the most bacteria for each dollar spent. This is followed by sewage disposal system installations and milkhouse washwater disposal systems. Promotion for grant funding will therefore be targeted towards projects in this order. However, applications requesting assistance to install manure storage systems will be given consideration by the Review Committee. Proximity to the beaches will be an important determining factor.

Education will continue to be an integral part of the program. A pro-active education and promotion initiative will focus on assisting rural residents to adopt conservative land use practices and to establish a site specific Water Quality Improvement Plan. By providing technical advice and financial assistance to property owners to undertake water quality improvement projects, long-term upgrading and protection of water quality can be achieved.

Acceptance of the CURB Plan by MOEE, permits the MVCA to work towards achieving the primary objective of the CURB Program; reduction of bacteria fm r1sources, sufficient to provide for the sa recreational use of the beaches in the study area.

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INTRODUCTION

Program History

Surface water quality in Ontario's lakes and rivers has long been a concern for private citizens and the government. In 1988 one-quarter of the reported beach closures were attributed to rural pollution sources. The Ministry of Environment and Energy responded to these beach closures by implementing the CURB Program, under the auspices of the Provincial Beaches Strategy. The program will provide $ 57 million to clean up rural beaches throughout Ontario, over ten years.

Program Objectives

The objectives of the CURB Program are to identify rural pollution sources impacting water quality at the beaches; promote local awareness of these problems in the rural community and provide detailed plans for implementing corrective measures on individual farms and residences.

These objectives are to be achieved through the preparation of a CURB Plan by the local Conservation Authority. The Mississippi Valley Conservation Authority's CURB Plan assesses the relative impact of each source and presents an implementation strategy for the most cost effective repair, of the rural beach pollution problems within the study area.

Program Study Area

The Mississippi Valley Conservation Authority's CURB study area is the middle reach of the Mississippi River. This encompasses fifty kilometres of the Mississippi River from Ferguson Falls to the Village of Pakenham (Figure 1). The study area includes nine public beaches monitored by the local Health Unit. The Blakeney Rapids swimming area was added to the Health Unit sampling program in 1993 and will likely continue to be monitored for the duration of the CURB Program. These beaches are located consecutively along the main river.

This reach of river is predominately flat with much of the shoreline and tributaries developed for agricultural or residential use. There are areas in the headwaters of several tributaries that, for the most part, remain undeveloped.

Within the study area there are two towns; Carleton Place and Almonte and four villages; Innisville, Appleton, Blakeney and Pakenham. The Town of Carleton Place is serviced by a secondary sewage treatment plant. This plant was upgraded and expanded in 1993. The effluent from the treatment plant is discharged into the Mississippi River immediately downstream of the Town of Carleton Place.

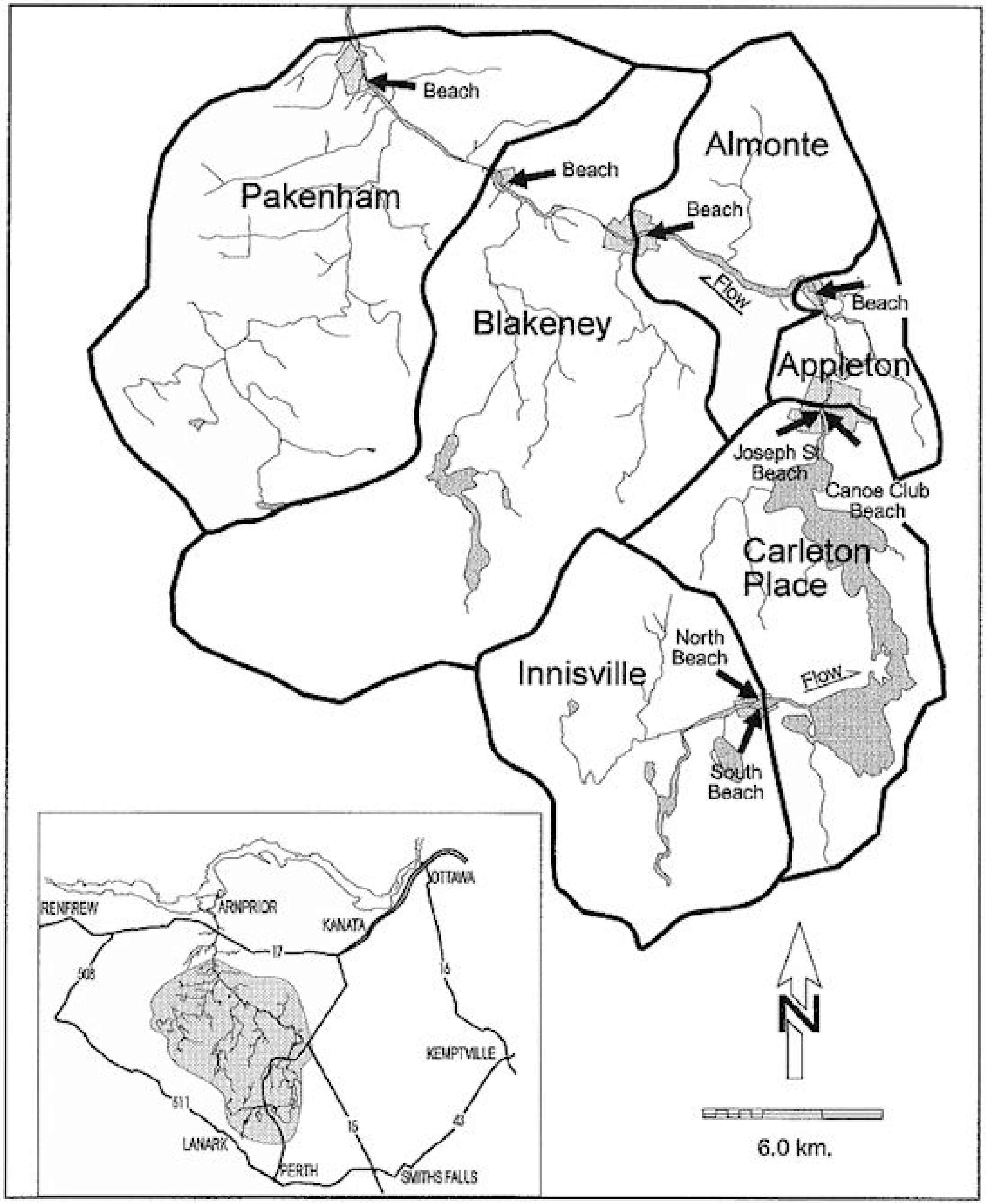


Figure 1: Clean Up Rural Beaches Study Area; Division by Sub-Watershed

The Town of Almonte is serviced by a multiple lagoon treatment system. This system discharges to the river twice a year, in early spring and late fall as per MOEE Certificate of Approval. The villages within the study area are serviced by private sewage disposal systems.

The study area is divided into six sub-watersheds outlined by the drainage basin to each beach (Figures 2-4). A CURB model was developed for each sub-watershed which represents the remedial action plan for each target beach. Sub-watershed division better reflects local land use practices and associated effects on water quality. It also allows for the fine tuning of CURB models unique to each sub-watershed.

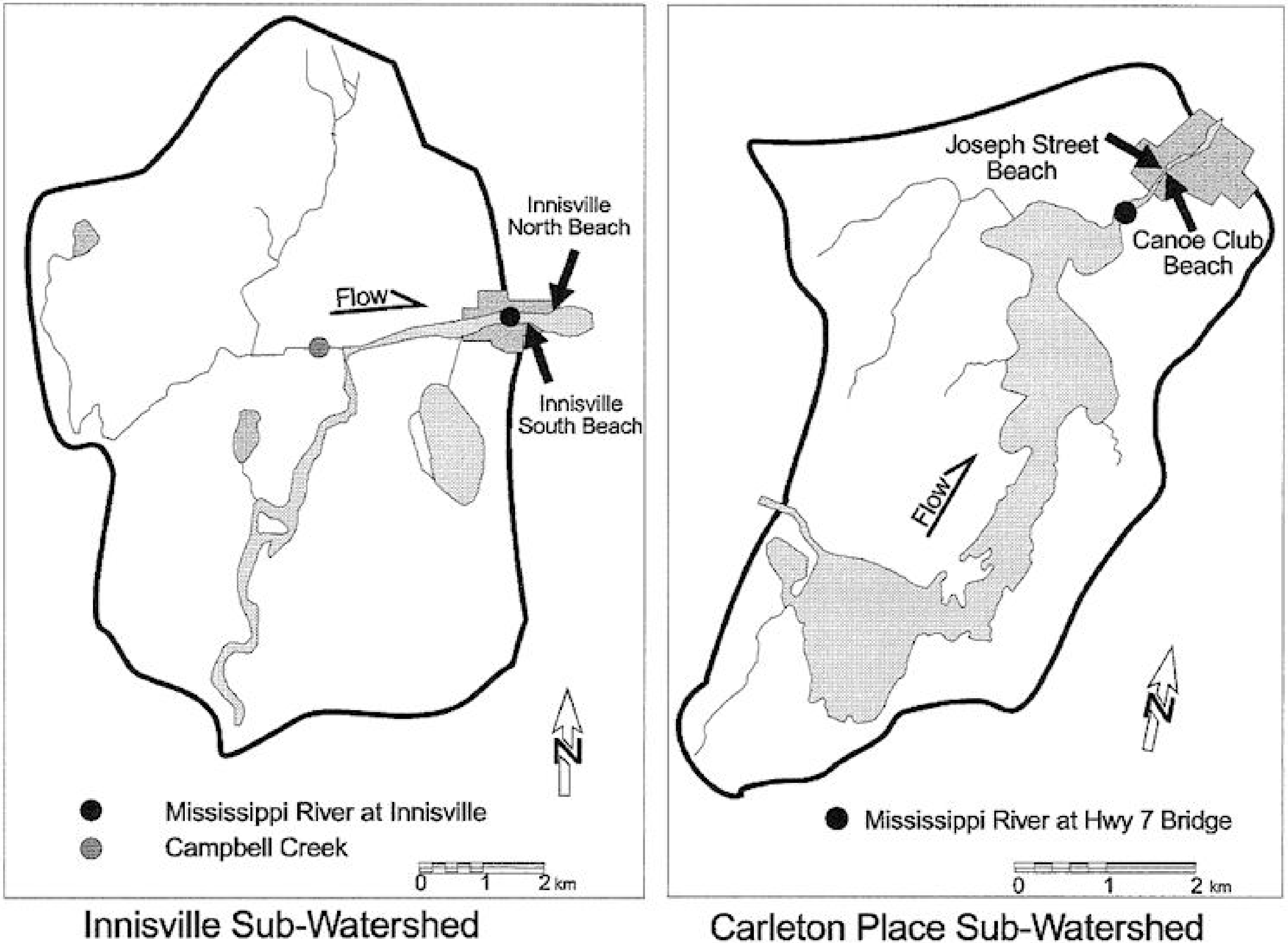
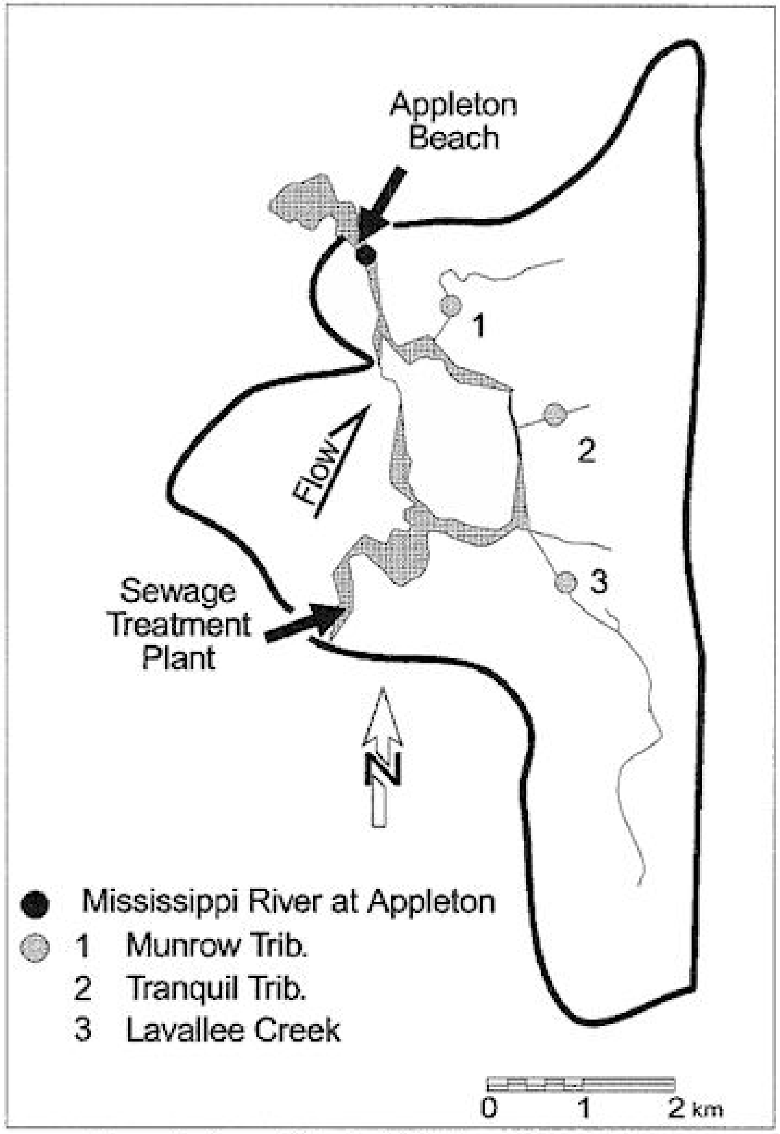
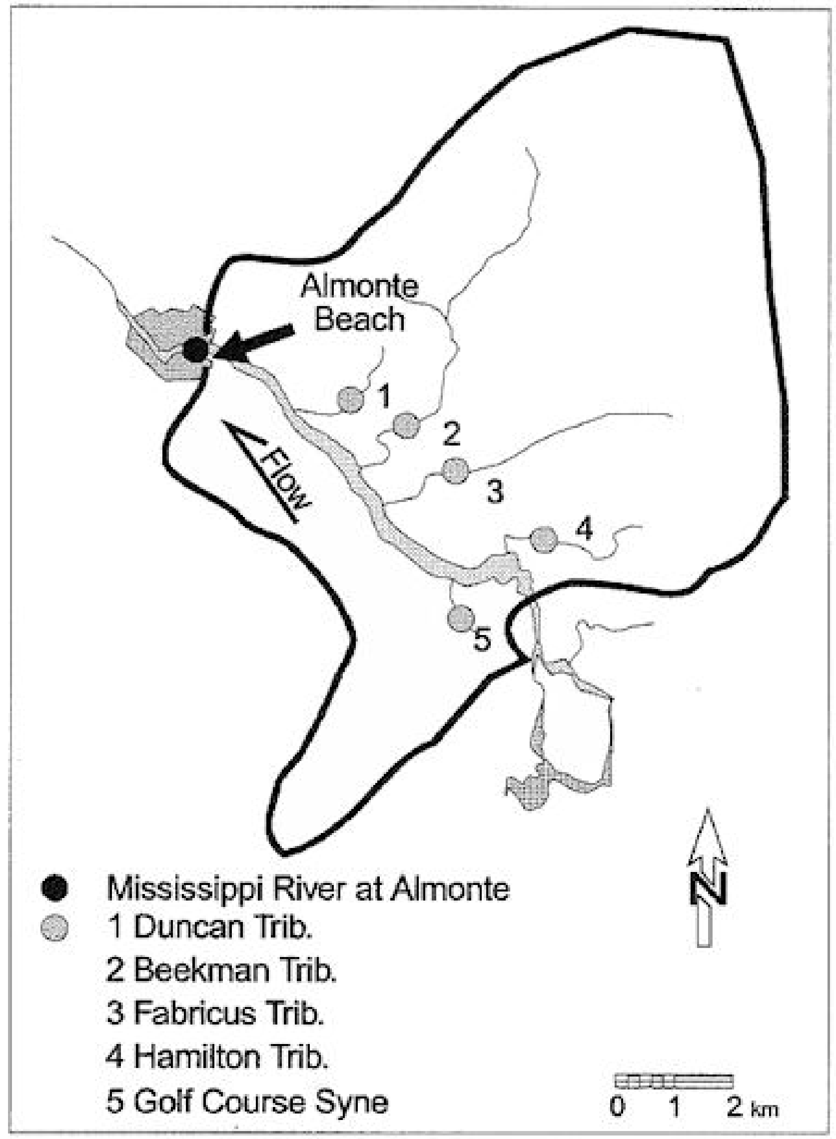


Figure 2: Innisville and Carleton Place Sub-watershed Maps



Appleton Sub-Watershed



Almonte Sub-Watershed

Figure 3: Appleton and Almonte Sub-watershed Maps

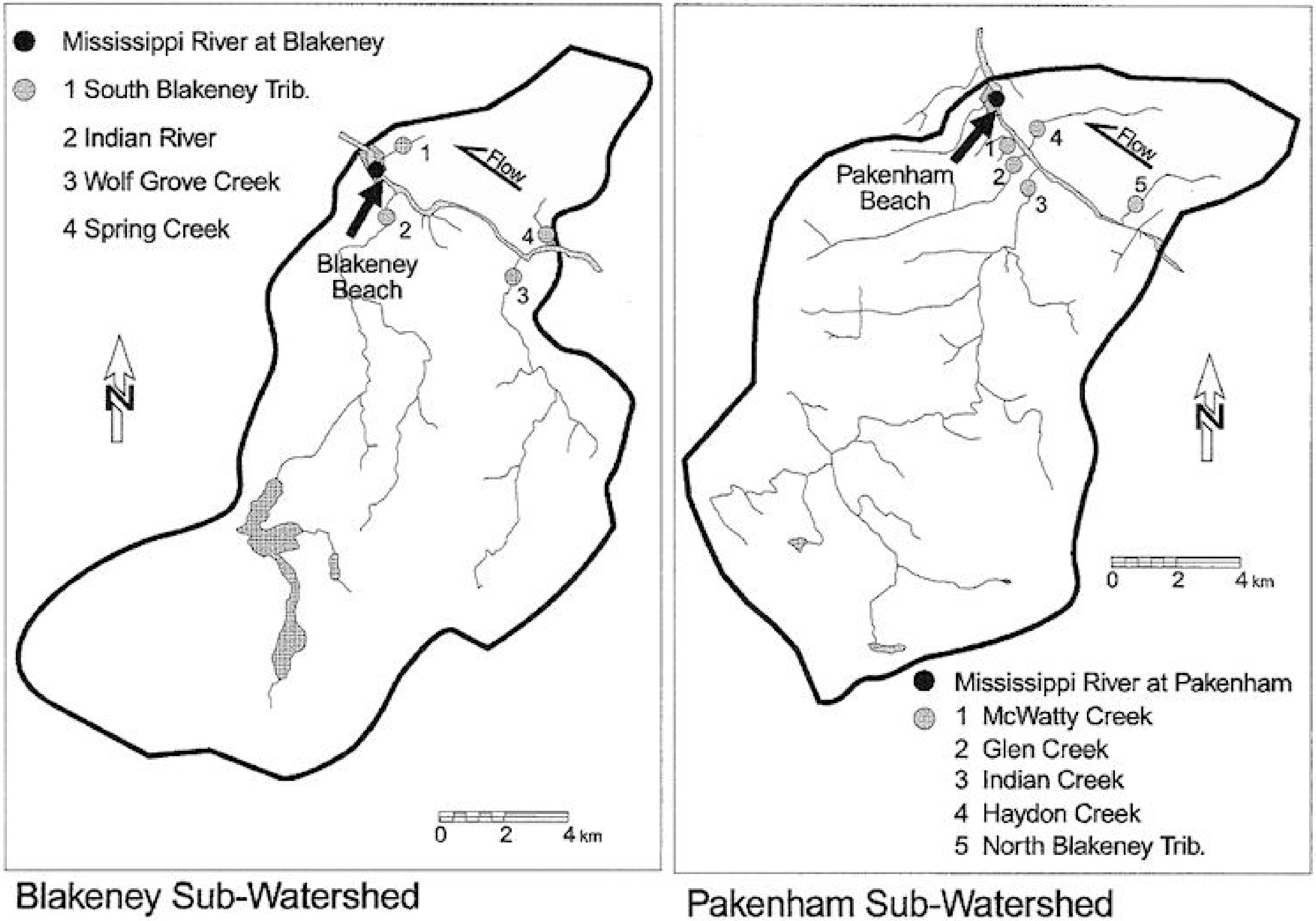


Figure 4: Blakeney and Pakenham Sub-watershed Maps

RURAL BEACHES STUDY

Water Quality Program

The MVCA has completed the second and final year of the Rural Beaches Study. Sufficient water quality data is now available to evaluate bacterial water quality within the study area. The Rural Beaches sampling program was completed based on the recommendations in the 1992 Rural Beaches Report. The most notable of these recommendations being:

1) That the monitoring of the Mississippi River, its tributaries and beaches be continued and the data base be expanded to attain wet and dry event sampling results.

2) That specific investigations be carried out to determine sources at identified areas of bacterial contamination.

Two years of study does not provide sufficient data to draw long-term projections on water quality. It does however, permit for generalizations in water quality trends to be established. The water quality program included the analysis of bacteria and physical-nutrient parameters. For the development of the CURB model, bacteria is evaluated in detail. This evaluation focuses on Fecal Coliform as there is limited *Escherichia coli* data from the first year of study. A review of phosphorus data is included in this analysis to evaluate the eutrophic state of the study area.

Sample Parameters

Indicator bacteria sampled for are Fecal Coliform (FC) and *Escherichia coli* (EC). Bacteriological samples were analyzed at set dilution rates of 1.0 ml and 10.0 ml for FC and 10.0 ml for EC. Bacteria levels do not exceed 10,000 FC /100 ml or 1,000 EC /100 ml because of these set dilutions. Smaller dilutions were specified by the sampler when investigating suspected sources.

Nutrient-inorganic-physical sample parameters include: Ammonia, Total Kjeldahl Nitrogen, Nitrate, Nitrite, Total Phosphorus, Dissolved Reactive Phosphorus, Chloride, pH, Conductivity and Turbidity.

Sample Sites

The sample season was eleven weeks in duration starting June 22 and ending August 31, 1993. Both the Mississippi River and the tributaries were sampled for bacteria and nutrients, providing a weekly overview of the river's health within the study area. Sample blanks were run on occasion as a means of determining sample integrity and technique.

The Mississippi River was sampled at seven bridge locations throughout the length of the study area. These sample points reflect water quality within close proximity to the beaches. Sample station monitoring on both sides of the river, provided an indication of patterns in immediate shoreline contamination. Tributary station sites remained the same as in the first year of study. Flow measurements were taken at the time of sampling.

Data Analysis

The analysis of the bacteria data incorporates geometric means and percentiles. The geometric mean is a statistical function that determines the average value for a wide range of values such as in bacterial sampling. Percentiles were used to determine the value at which a percentage of the database are found to be below the percentile. Unlike bacteria, the range of values for the physical-nutrient database is narrow. An arithmetic mean was therefore used to express the average values.

Mississippi River Overview

Bacterial Data

The same general trend that was observed in the river's profile during the first year of study prevailed into 1993. This trend depicts beaches under bacterial influence to be; Innisville, Carleton Place, Appleton and Pakenham, with improved water quality at Almonte. The Health Unit sampling program supports this trend, the majority of beach postings occurred at Innisville, Carleton Place and at Pakenham. Fecal Coliform geometric means are within the same order of magnitude as in the previous year of study (Figure 5). Bacteriological data for the 1993 sampling program is in Appendix A.

The summer of 1993 was typical in the amount and frequency of rainfall as opposed to 1992. This supports the theory that, the 1992 sampling program did experience unusually low bacteria counts because of excessive rainfall. This was supported through the MVCA's streamflow gauging network and extensive evaluations as outlined in the Year One Report. Therefore, results obtained in 1993 are more indicative of the water quality we might expect to experience under average climatic conditions (Figure 6).

Wet and dry event sampling was attained in this year of study. Sources of pollution in the Mississippi River are characterized as continuous or intermittent discharges, or point and non-point sources. Non-point sources are not easily identified, significant rainfall is the mode of transfer. The spreadsheet in Appendix B introduces the separation of rainfall event pollution for the main river. Rainfall event pollution was evident on: June 22, July 27, August 3, 12 and 24, 1993. Factors influencing event pollution such as turbidity, soil saturation, runoff and travel times were observed on these days.

The sample station at Ferguson Falls was established as a control site to confirm the water quality entering the study area, (Geometric Mean = 20). This station is not influenced by urban centres and the agricultural land base is limited. As in the previous year, bacterial quality was very good at this station.

Water quality declines considerably between Ferguson Falls and Innisville. Site specific investigations in 1993, of gulls and pigeons frequenting the shallow water at Innisville, confirms that these birds are a major contributor to local beach postings (MVCA 1993). The south side of the river recorded the highest levels. This sample site experienced FC levels greater than 180 FC/100 ml for 50% of the sampling season.

Mississippi Lake continues to contribute to the decrease of bacteria. This is likely attributed to the retention time of water within the lake. Refer to the Bacteria Transport Section for additional information. Percentiles for the sampling station at the outlet, indicate that bacteria levels were less than 20 FC /100 ml for 75% of the sample season. Health Unit data for the beaches located 1,500 meters downstream from the outlet of the lake, indicates the pollution source is within this 1,500 meter reach, (Canoe Club Geometric Mean = 37 and Joseph Street Geometric Mean = 27).

Bacterial pollution is evident for most of the sampling season at the Appleton station. Site specific investigations determined that the gulls contribute to bacteria levels (MVCA 1993). Appleton is also subject to influences from faulty septic systems and runoff from the agricultural land base.

Water quality at Almonte is improved over that of Appleton. Bacteria levels drop close to levels recorded at the Ferguson Falls control station. Numerous tributaries with high bacteria levels empty into the river within this stretch, however, an evaluation of travel times indicated that bacteria may die off prior to reaching the beach. Refer to the Bacteria Transport Section for additional information.

A decline in water quality begins at the Blakeney station (Geometric Mean = 32) and extends to Pakenham, (Geometric Mean = 31). The ratio between EC and FC is closest at Pakenham. This is confirmation that the pollution is fecal in origin. Furthermore, "RMOC laboratory staff have noticed the greatest amount of background growth of non-target coliforms from agricultural areas." [1] MVCA samples submitted from the Pakenham station displayed the largest quantity of background growth over other main river stations.

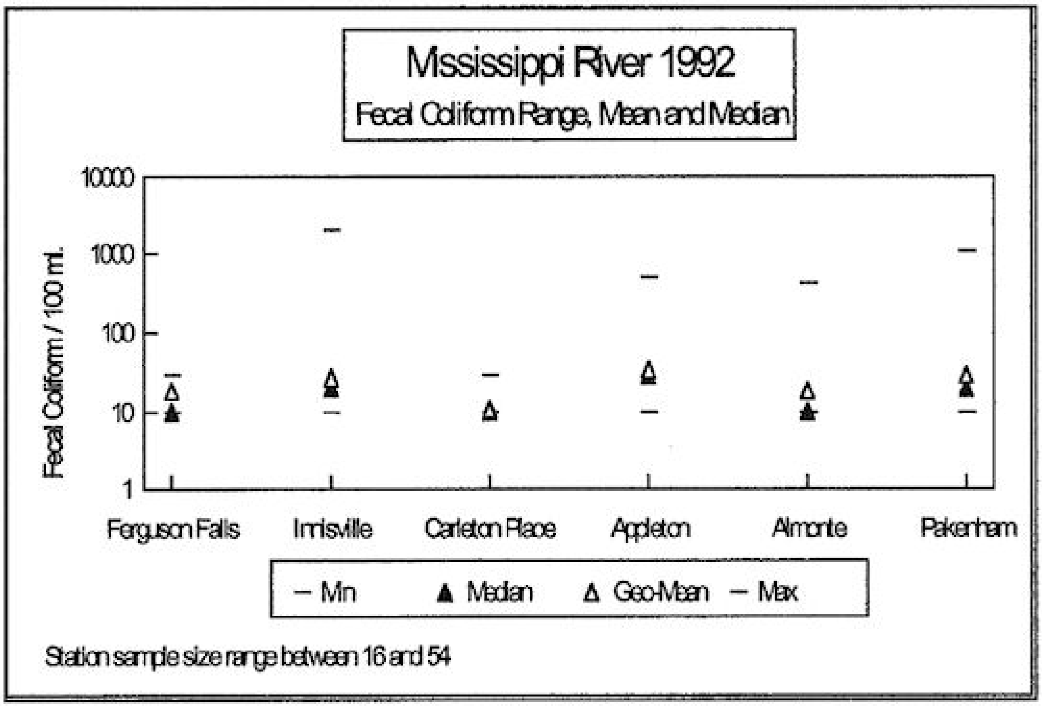


Figure 5: Mississippi River 1992 Fecal Coliform Results

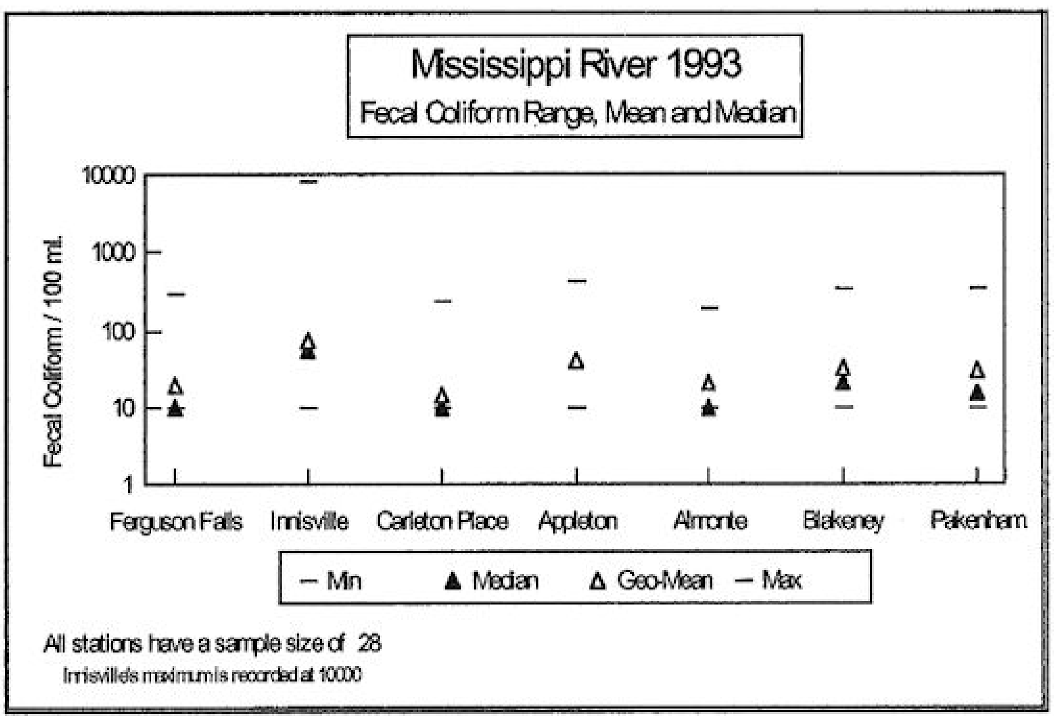


Figure 6: Mississippi River 1993 Fecal Coliform Results

Physical-nutrient Data

Ten parameters were analyzed in a nutrient inorganic-physical sample set. However, phosphorus is the only parameter presented in detail. Values for the remaining parameters can be found in Appendix C.

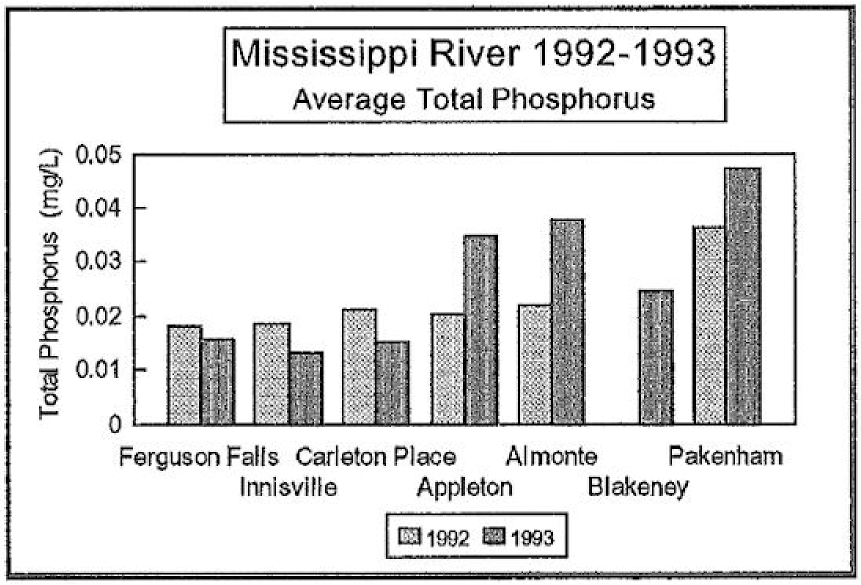


Figure 7

Phosphorus is a parameter closely associated to runoff from rural land use activities and sewage from urban treatment and private septic systems. Phosphorus is the leading cause of eutrophication of rivers and lakes. Analysis of phosphorus substantiates the bacteriological findings. Phosphorus was analyzed as total phosphorus and dissolved reactive phosphorus. This evaluation deals with total phosphorus, which is the sum of both soluble and particulate phosphorus.

Averages for the river stations differ over the previous year, (Figure 7). Although there is still the trend for levels to increase downstream, there is a small decrease in 1993 phosphorus levels upstream of the Town of Carleton Place. Concentrations increase at Appleton and this trend continues through to Pakenham. The Blakeney swimming area was not sampled in 1992, the Health Unit discontinued this location as a result of the Beach Management Protocol, however, sampling resumed in 1993 providing data to support the CURB Program. There is a period of regeneration at Blakeney. This may be attributed to the settling of sediment as the river velocity decreases as well as nutrient uptake by aquatic plant life.

The average concentration during 1993 for Appleton, Almonte and Pakenham exceeds " the provincial objective of 0.03 mg/L." [2] Phosphorus contributions at Appleton are attributed to soil erosion, overland runoff and faulty septic systems. The predominant soil type in this area is a well drained loam soil. Levels at Almonte are attributed to storm sewer discharge, as well as overland runoff. The predominant soil type in this area is a well drained loam and silty loam soil over sandstone or limestone. Phosphorus input at Pakenham is likely the result of soil erosion, overland runoff and faulty septic systems. The soil present is a well drained sandy loam soil over clay. This may be a factor influencing runoff from agricultural lands evident in this stretch of river.

Phosphorus input from the Carleton Place Sewage Treatment Plant and the Almonte Lagoons requires additional monitoring of effluent quality, following upgrades, in order to make a definitive statement.

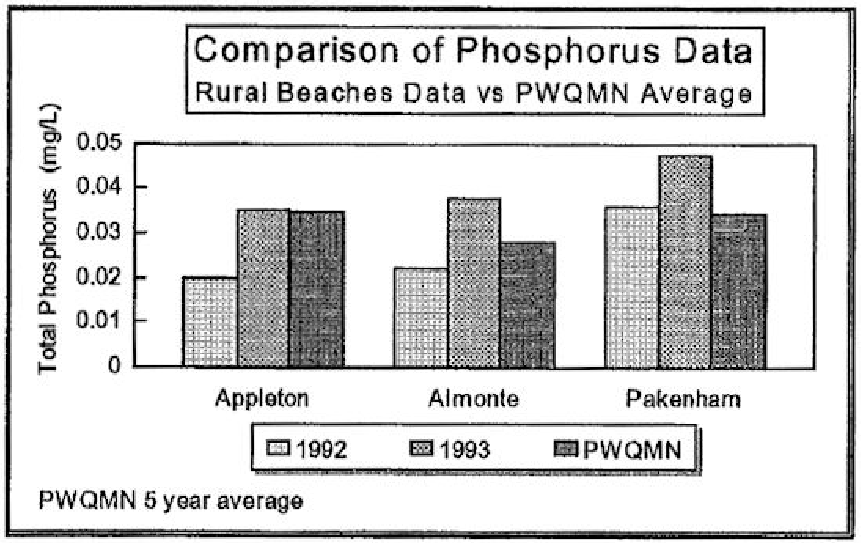


Figure 8

Figure 8 is a comparison of 1992-1993 Rural Beaches Study data and the Provincial Water Quality Monitoring Network (PWQMN) five year average. It shows an increase in phosphorus levels during the 1993 sampling season. Phosphorus levels in these sub-watersheds are expected to remain above the provincial guideline until abatement work or runoff control measures are initiated.

Tributaries Overview

Tributaries of the Mississippi River experience a varying range of bacterial contamination. At any given time, bacteria levels can exceed 1000-10000 FC /100 ml. Although these tributaries are under fecal contamination, the Mississippi River does not always show an obvious stress from this source. This is due to dilution as tributary water mixes with the greater volume of the river. There are many factors that influence each tributary and must be considered individually. Each tributary is a small watershed with its own characteristics relating to land use, precipitation and travel time. The volume of water that each contributes is important to determine the individual bacterial loads.

Geometric means for the bacteria results found in Appendix D demonstrate that the tributaries in the Blakeney and Pakenham sub-watersheds, have the greatest potential to impact on the river. This is contributing to bacteria levels at the Pakenham and Blakeney swimming areas. Haydons Creek, McWatty Tributary, and South Blakeney Tributary have displayed the highest maximums and means during two years of study. Larger tributaries such as Wolf Grove Creek, Indian River, and Indian Creek have lower bacteria levels in comparison to the other tributaries. Bacteriological data for the tributaries from the 1993 sampling season are found in Appendix D.

Beach Postings

There are nine public beaches monitored by the local Health Unit in the 1993 sampling season within the study area. Rural beaches in the Mississippi Valley play a vital role in providing recreational enjoyment to local residents and tourists. Unsafe water quality results in fewer tourists frequenting the beaches and decreased revenue for local businesses.

Health Officials collect a minimum of five samples at each beach as per the Ministry of Health Beach Management Protocol. The geometric mean is calculated. Health Officials consider posting beaches, warning of the risk to bathers, when "the geometric mean for *E. coli* bacteria exceed the Provincial Guideline of 100 E. coli bacteria /100 ml." [3] Table One lists the number of days beaches were posted from 1991 to 1993.

TABLE ONE : NUMBER OF DAYS BEACHES POSTED IN STUDY AREA

Beaches	1991	1992	1993
Innisville North	35	33	8
Innisville South	49	22	22
Joseph Street	0	7	14
Canoe Club	30	2	8
Appleton	15	0	
Almonte	0	7	0
Blakeney	***		**
Pakenham	**	0	27
Pakenham Bridge	0	**	**

* Health Unit did not monitor this site due to the Appleton Dam construction project during the summer of 1993.

** Health Unit sampled these sites only 3 times.

*** Health Unit posted a permanent sign at this site stating: **WARNING After Rainfall This River May Be Polluted, Persons Swimming Do So At Own Risk**

CURB MODEL DEVELOPMENT

Introduction

Rural Beaches Study results are applied to create the CURB model. The model is developed by incorporating water quantity measurements, water quality monitoring data and information from the land use survey. The primary objective of the CURB model is to provide a quantitative tool for CURB facilitators to measure bacteria load estimates, specific to the study area. The CURB Plan is based on the application of this model.

The CURB model is a mathematical modelling approach, standardized by the Ministry of Environment and Energy and conservation authorities. It is based on extensive research efforts from the cooperating agencies over the past ten years. In particular, efforts by the St. Clair Region, Upper Thames River and the Maitland Valley Conservation Authorities. As well, the model is based on efforts by Ecologistics Limited through the creation of the Pollution from Livestock Operations Predictor Model (PLOP).

The CURB model makes predictions for the quantity and transport of bacteria and phosphorus produced, its delivery to a watercourse and target beaches. Travel times and die-off rates are incorporated into the model. Historically, beaches in the study area are posted due to elevated bacteria levels, therefore, only the bacterial model is utilized.

In this report, a CURB model is developed for each sub-watershed. The number of beaches found in succession along the Mississippi River, made it impractical for one CURB model to apply to the study area. A model for each sub-watershed better represents the remedial action plan required for each target beach.

The model is modified to best reflect local conditions such as land use and topography which influence sources and delivery of bacteria. These conditions differ considerably between south western Ontario and south eastern Ontario. Subsequent review by the MVCA Steering Committee resulted in additional modifications to the basic model. The end result being a functional model unique to the MVCA study area.

Landowner Survey

Preliminary identification of bacterial and nutrient sources was accomplished by a windshield survey and water sampling program. Subsequent field inspections and landowner consultations provided information required to develop the CURB model. The landowner survey is a uniform approach to inventory and classify residential establishments and agricultural operations. Information obtained provides an estimate for the potential number of remedial projects required to improve water quality at the beaches.

There are 4,485 residential and agricultural establishments within the study area. Information was obtained from the tax roles for each municipality. Of this total, eighty-five percent of the establishments or 3,808 are residential or seasonal units and fifteen percent or 677 are farming establishments. Further ground truthing was necessary, to provide a breakdown of operational, non-operational and hobby farms. Table Two provides a summary of the farm units. Operational farms were further divided into three categories; beef, dairy or other. Table Three is a summary of the operational farm units.

TABLE TWO : Number Of Farms Per Sub-watershed

Subwatershed	Operational	Non-operation	Hobby
Pakenham	77 / 69%	29 / 26%	5 / 5%
Blakeney	104 / 55%	57 / 30%	28 /15%
Almonte	62 / 71%	19 / 22%	6 / 7%
Appleton	23 / 42%	23 / 42%	9 / 16%
Carleton Pl.	65 / 59%	36 / 32%	10 / 9%
Innisville	70 / 59%	38 / 32%	10 / 9%

TABLE THREE : Type Of Operational Farms Per Subwatershed

Subwatershed	Beef	Dairy	Other
Pakenham	53 / 69%	9 / 12%	15 / 19%
Blakeney	59 / 57%	19 / 18%	26 / 25%
Almonte	35 / 57%	10 /16%	17 / 27%
Appleton	9 / 39%	5 / 22%	9 / 39%
Carleton Pl.	61 / 55%	19 / 17%	31 / 28%
Innisville	65 / 55%	20 / 17%	33 / 28%

To summarize the study area, fifty-nine percent of the total farm units are operational while thirty-two percent are no longer in operation. Nine percent of the total farms are considered hobby farms. Fifty-five percent of the operational farms are beef operations, seventeen percent are dairy operations and twenty-seven percent are other or mixed farming units. These percentages are very close to those outlined in the 1992 Agricultural Statistics for Ontario Booklet for Lanark County. The study area encompasses a large percentage of Lanark County.

Twenty-seven percent miscellaneous or mixed farming units are small operations, mainly sheep, equine or mixed. Average livestock numbers are small in comparison to dairy and beef operations in the study area, therefore, these operations were not considered to have a significant pollution potential to warrant further evaluation.

A study of the equivalent animal units table developed by Ecologistics further supports this theory. Refer to Appendix E. Equivalent animal units is a concept adapted from the Agricultural Code of Practice. <u>It is based on the concentration and volume of manure produced per animal type.</u> It provides a convenient measurement for comparison purposes. The equivalent animal unit, for fecal coliform bacteria, for a beef cow is 1.04 and for a dairy cow is 1.62, the equivalent unit for a lamb is significantly lower; 0.02 and for a horse which is 0.013.

All establishments could not be surveyed in the time frame available. Therefore, a sample number of 28 farm sites and 22 residential sites were selected for a total of 50 on-site interviews. This represents a composite number, randomly selected throughout each sub-watershed. "Twenty-seven farm establishments surveyed achieves an estimated eighty-six percent confidence level." [4]

A survey form was created for residential establishments, it was adopted from the MOEE Cottage Pollution Control Program. A separate form was developed for farm operations, the design for this came from other CURB studies. A copy of each is found in Appendix F. Information obtained from the landowner survey is strictly confidential, only statistical information is used for model calculations.

Pollutant Sources

The CURB model incorporates bacterial pollutant sources rural and urban in origin. Rural pollution sources include; cattle access, barnyard runoff, manure storage runoff, manure spreading, milkhouse wastewater and private sewage disposal systems. The model accounts for gulls and pigeons as an input as well. Storm water runoff is the urban non-point source. All of these sources can have a negative impact on water quality.

Livestock access to a watercourse for the purposes of watering has been a traditional farming practice. There may be a reluctance within the agricultural community to alter this practice as it is economical and convenient. This practice can no longer be considered acceptable due to the negative impact on water quality and on herd health to cattle downstream. Cattle defecating in the water is a direct source of pollution, a direct input of concentrated bacteria and nutrients. Livestock erode the shoreline increasing runoff of bacteria and nutrients. " In pasture land, fencing off a stream is the greatest environmental improvement that can be made. It will improve water quality and wildlife habitat (including fish habitat)." [5]

Barnyard and manure storage areas can be a pollution source due to unobstructed precipitation resulting in runoff. This contaminated liquid runoff contains nitrogen and bacteria, if it reaches a watercourse there can be a significant negative impact on water quality. Eighty percent of the farms surveyed have manure stacks with no containment for runoff.

Effective manure management includes the efficient usage and spreading of manure. The correct volume and concentration of manure, incorporated in the correct time frame, under suitable conditions, is key to effective management. Winter manure spreading has been a traditional practice generally as a result of insufficient storage. Manure can be washed into a watercourse during spring thaw effecting water quality. As well, manure spreading too close to a watercourse can result in runoff to the watercourse following a rainfall event.

Milkhouse washwater contains phosphorus and bacteria detrimental to surface water quality. Numerous systems empty directly into a watercourse or indirectly through tile drains. Fifty percent of the dairy farms surveyed had insufficient treatment systems. Milk contained in washwater drainage pipes, provides an ideal growing medium for bacteria to multiply. Oxygen is required to decompose the bacteria once in the watercourse, this can rob fish of oxygen necessary to their survival.

Faulty, antiquated, improperly designed or maintained private sewage disposal systems have long been recognized as a potential source of harmful pathogens and phosphorus and to a lesser extent, nitrogen, ammonia and chloride. Eight percent of establishments surveyed within the study area, fall into this category.

Gulls and pigeons contribute bacteria to surface waters either by direct defecation, shoreline runoff or cleansing of roosting areas where these birds frequent. Within the study area, there are two sites in particular where birds exist in large numbers; Innisville and Appleton. Depending on the food consumed, fecal deposits from these birds can contain higher levels of FC and EC bacteria than that of humans.

There are other pollution sources not incorporated into the CURB model. Wildlife, other than gulls and pigeons has not been quantified. Extensive research and evaluations are required to include a wildlife algorithm. This was not feasible in the time frame available, however, other CURB studies have shown this input to be significantly lower in comparison to other rural sources. Though wildlife inputs are a natural source and uncontrollable, it is recognized as a minor contributing source.

As well, the model does not account for input resulting from soil erosion. Phosphorus attached to soil particles, is delivered to a watercourse by wind and rainfall. Streams can be clouded by sediment and contaminated by the leaching of fertilizers. Sediment build up in certain areas can also be detrimental to fish spawning beds.

Potential input from livestock other than cattle, was excluded. Swine, poultry, sheep and equine farms average only 1-3 percent of the total farms in Lanark County.[6] In light of this, potential input from these sources are not expected to be significant.

An algorithm for storm water runoff from urban centres was included in the model. Runoff carries feces from domestic pets and gulls, lawn fertilizers, as well as debris. This can be a source of nutrients and bacteria, and salt from winter road salting. There are methods to abate this pollution source, diversion to retention ponds or treatment through municipal sewage treatment plants, only where such plants have the capacity. Urban residents need to view storm sewers as small tributaries, even urban land use activities, however small the land base, can impact water quality.

An algorithm for urban point source pollution was not included in the CURB model, however, communications are ongoing with the treatment plant operators and effluent quality data has been made available to the Authority. "Due to recent upgrades at the Carleton Place Sewage Treatment Plant, effluent quality is expected to be within Ministry of Environment and Energy guidelines." [7] The Almonte Lagoon treatment facility is presently in the review process for proposed upgrades. Monitoring and evaluations following upgrades will continue throughout the program.

Bacteria Transport

When pathogenic enteric bacteria are excreted from a warm blooded host, bacterium are introduced to a more harsh environment. Bacterium are subject to various stresses that result in an increase in mortality rate. These environmental stresses include temperature, ultra violate radiation, predation, and nutrient availability. "Temperature is the parameter cited most often as exerting a major influence on the survival of enteric bacteria." Research from other CURB models have determined this mortality rate to be 0.03 log/hour.

Travel time is the length of time it takes for bacteria suspended in water to travel from the point of entry to a watercourse to a specified destination, a target beach. Velocity measurements were conducted for all tributaries sampled. The velocity for the reaches of the Mississippi River was taken from the MVCA's Hec II Hydraulic Modelling. Velocities utilized are for the average summer flow of 6.8 cubic meters per second.

The travel length of each tributary was calculated from the beginning of the tributary to the beach located downstream. Each portion of the travel length was multiplied by its respective velocity to determine a combined travel time to the beach. This was completed for each tributary sampled. Travel times were then averaged to determine the average travel time for each sub-watershed. These travel times multiplied by the die-off rate are used to determine the reduction in bacteria actually delivered to the beaches from the point of entry. Refer to Table Four for the travel times and Table Five for bacteria die-off for each sub-watershed.

TABLE FOUR: Travel Times For Each Sub-watershed

Pakenham	Blakeney	Almonte	Appleton	Carleton Place	Innisville
9 Hrs.	10 Hrs.	12.5 Hrs.	4.5 Hrs.	31 Hrs.	11.5 Hrs.

CURB Algorithms Equations

The CURB model is based on eight algorithms. "Each algorithm in this CURB model is based on a series of assumptions in combination with actual experimental data." [8] Algorithms employed calculate the bacteria load delivered to the beaches from sources identified through water quality monitoring and land use surveys. The algorithms predict bacteria loading on a source specific basis. The algorithms were developed through consultations with the Steering Committee to best reflect local conditions unique to the study area. The following are algorithms developed for the Mississippi Valley Conservation Authority study area, for further explanation and clarification of terms refer to Appendix G.

1 **CATTLE ACCESS ALGORITHM =**

Concentration of Defecation x Equivalent Animal Units x

Probability of Defecation x Access Events / Day x

No. of Animals x No. of Days

2 **BARNYARD RUNOFF ALGORITHM =**

Concentration of Runoff x Number of Farms

x Volume of Runoff x Delivery

3 **MANURE STACK RUNOFF ALGORITHM =**

Concentration of Runoff x Number of Farms

x Volume of Runoff x Delivery

4 **SEPTIC SYSTEM IMPACT ALGORITHM =**

Concentration x Volume/Person/Day x No. of Days x Population

x Failure Rate x Delivery

5 **MILKHOUSE WASTEWATER ALGORITHM =**

Concentration of Bacteria x Volume/Animal/Day x No. of Animals

x Discharge Days x Delivery

6 **SPRING AND SUMMER MANURE SPREADING ALGORITHM =**

Volume Spread x Concentration x Storage Die-off x

Field Decay x Delivery

7 **URBAN NON-POINT SOURCE ALGORITHM =**

Load/Hectare x Urban Area x Die-Off

8 GULLS AND PIGEONS ALGORITHM =

Concentration of Gull Feces + Concentration of Pigeon Feces x

Amount of Feces/Bird/Day x No. of Birds x Delivery x

No. of Days

Predictions

The estimated bacteria load from the algorithms for potential rural sources, are added together providing a total load delivered to each beach. These bacterial load estimate percentages are determined for bacteria load from each source. Tables Five and Six outline CURB model results.

TABLE FIVE : BACTERIA LOAD COMPARISON TABLE

	PAKENHAM		BLAKENEY		ALMONTE		APPLETON		CARLETON PLACE		INNISVILLE	
SOURCE	Bacteria	Percent	Bacteria	Percent	Bacteria	Percent	Bacteria	Percent	Bacteria	Percent	Bacteria	Percent
Cattle Access	$2.4x10^{13}$	43 %	$2.7x10^{13}$	34%	$1.6x10^{13}$	42 %	$4.1x10^{12}$	11 %	$2.8x10^{13}$	26 %	$2.9x10^{13}$	32 %
Barnyard Runoff	$3.6x10^{12}$	6 %	$7.2x10^{12}$	9 %	$3.6x10^{12}$	9 %	$2.0x10^{12}$	6 %	$7.3x10^{12}$	7 %	$7.6x10^{12}$	9 %
Stack Runoff	$6.5x10^{12}$	12 %	$8.7x10^{12}$	11 %	$5.3x10^{12}$	14 %	$2.0x10^{12}$	6 %	$9.4x10^{12}$	9 %	$9.8x10^{12}$	11 %
Septic Systems	$1.9x10^{13}$	35 %	$3.4x10^{13}$	43 %	$1.1x10^{13}$	29 %	$1.8x10^{13}$	50 %	$6.1x10^{13}$	56 %	$1.6x10^{13}$	18 %
Milk House Wastes	$8.1x10^{11}$	2 %	$1.7x10^{12}$	2 %	$9.0x10^{11}$	3 %	$4.5x10^{11}$	2 %	$1.7x10^{12}$	2 %	$1.8x10^{12}$	2 %
Manure Spread	$4.9X10^{4}$	0	$6.7X10^{4}$	0	$3.8x10^{4}$	0	$2.4x10^{3}$	0	$6.8x10^{4}$	0	$7.2x10^{4}$	0
Urban Runoff	$8.8x10^{11}$	2 %	$5.5x10^{11}$	1 %	$1.3x10^{12}$	3 %	$9.6x10^{11}$	3 %	N/A	0	N/A	0
Gulls/ Pigeons	N/A	0	N/A	0	N/A	0	$7.9x10^{12}$	22 %	N/A	0	$2.5x10^{13}$	28 %
Model Total	$5.5X10^{13}$	100 %	$7.9x10^{13}$	100 %	$3.8x10^{13}$	100 %	$3.6x10^{13}$	100 %	$1.1x10^{14}$	100 %	$8.9x10^{13}$	100 %
Bacteria Die Off	$1.5X10^{13}$		$2.6X10^{13}$		$1.4X10^{13}$		$4.9X10^{12}$		$1.0X10^{14}$		$3.1X10^{13}$	
Model Total After Die-Off	$4.0X10^{13}$		$5.3X10^{13}$		$2.4X10^{13}$		$3.1X10^{13}$		$1.0X10^{13}$		$5.8X10^{13}$	
Sample Program Total	$1.8x10^{13}$		$1.8x10^{13}$		$1.1x10^{13}$		$2.2x10^{13}$		$8.0x10^{12}$		$5.0x10^{13}$	

TABLE SIX : Bacteria Load Percentage Summary For Study Area

Pollution Source	Percentage Input
Septic Systems	39
Cattle Access	31
Stack Runoff	10
Barnyard Runoff	8
Gulls/Pigeons	8
Milkhouse Washwater	2
Urban Runoff	2
Manure Spreading	0

Septic systems rank as the greatest source of bacteria in the Blakeney, Almonte and Carleton Place sub-watersheds. Cattle access rank as the most significant source of bacteria in the Pakenham, Almonte and Innisville sub-watersheds. Barnyard and manure stack runoff contributes on average, nine percent of the bacterial input throughout the study area. Milkhouse washwater is two percent of potential rural sources. Based on the algorithm results, manure spreading when compared to other rural sources, did not appear to have a significant impact on water quality at beaches in the study area. However, localized water quality impairment incidents may occur as a result from improper spreading practices. Urban runoff contributes two percent of the bacterial input. Gulls and pigeons are considered a substantial input at Innisville and Appleton.

Limitations

The CURB Plan adopts the model results to provide a guideline for remedial project cost estimates in the following categories; cattle access restriction, manure management, milkhouse washwater disposal systems, private sewage systems.

The CURB model uses algorithms based on a series of assumptions combined with actual data. Therefore, algorithms provide data useful for making generalizations only. In light of this, information can not be used for site specific classifications. The model includes ground truthing and windshield survey work. It is the task of the CURB facilitator to effectively decipher all information and data existing and researched, to provide an accurate picture of the land use activities affecting water quality at each beach. This is essential to develop an effective and accurate implementation strategy.

CURB RECOMMENDATIONS

Verification

The Rural Beaches Study provided water quality and quantity data to calculate an actual total bacteria load to each beach. Calculations applied in the CURB model provide a numeric prediction for the same loading. Comparing these load predictions is verification of CURB estimates, refer to Table Seven. If load calculations are within the same magnitude, a reasonable confidence level is achieved. Application of the model provides a prediction for the bacterial load from potential rural pollution sources and urban non-point sources. The difference in magnitude for results in the Carleton Place sub-watershed is attributed to the retention time of water within Mississippi Lake. Refer to the Bacteria Transport Section for additional information.

TABLE SEVEN: Sample Program And Algorithm Bacteria Load Comparison Table For Each Sub-watershed

	Pakenham	Blakeney	Almonte	Appleton	Carleton Place	Innisville
Actual Total Load	$6.7 X10^{13}$	$1.1 X10^{14}$	$2.6 X10^{13}$	$5.4 X10^{13}$	$1.0 X 10^{13}$	$6.8 X 10^{13}$
CURB Model Predicted Load	$5.5 X 10^{13}$	$7.9 X 10^{13}$	$3.8 X 10^{13}$	$3.6 X 10^{13}$	$1.0 X 10^{14}$	$8.9 X 10^{13}$
% Difference	18%	28 %	46 %	33 %	900 %	31 %

Cost Effectiveness

Table Eight outlines the potential number of projects required to clean up targeted beaches within the sub-watersheds, assuming one hundred percent landowner participation. Information supporting this table is obtained from the land use survey findings and agricultural statistics for Ontario. Eighty percent of manure stacks within the study area do not have containment for runoff. Fifty percent of the dairy operations did not adequately treat milkhouse wastes. Thirty percent of farming operations allow cattle direct access to a watercourse. Eight percent of establishments surveyed had failed sewage disposal systems.

TABLE EIGHT: Potential Number Of Remedial Projects For Each Sub-watershed

Projects	Pakenham	Blakeney	Almonte	Appleton	Carleton Place	Innisville
MSS	62	83	50	19	52	56
MWD	5	10	5	3	10	10
CAR	25	33	20	8	21	23
SDS	43	78	24	39	138	34
TOTALS	**135**	**204**	**99**	**69**	**221**	**123**

MSS = Manure Storage Systems
CAR = Cattle Access Restriction
MWD = Milkhouse Washwater Disposal
SDS = Sewage Disposal Systems

Table Nine outlines the average capital cost for remedial projects under the CURB Program. The average is calculated from three estimates obtained from local contractors or manufacturers. The average capital cost is the average cost for various sizes and types of systems for each category. The cattle access restriction estimate includes alternate watering devices but does not include costing for cattle crossings, therefore this figure will be higher for sites requiring crossings.

TABLE NINE: Remedial Project Cost Estimates

PROJECT	AVE. CAPITAL COST
Manure Storage Systems	$ 25,000.00
Milkhouse Washwater Disposal	$ 7,000.00
Cattle Access Restriction	Fencing = $ 2,700.00 Alternate Watering = $ 1,500.00 Total = $ 4,200.00
Sewage Disposal Systems	$ 6,000.00

Manure storage facilities rank lowest due to the large capital required for such projects. One manure storage facility can be installed rectifying one pollution problem at one site. The same capital will complete approximately six cattle restriction projects with alternate watering devices. Cattle access is a concentrated direct source. Improper manure storage is influenced by numerous factors; proximity to the watercourse, soil types, precipitation and by volume and concentration of manure.

Cost estimates for remedial projects have undergone scrutiny to determine where dollars are best spent to improve water quality at the beaches. Bacteria reduction per dollar is calculated for each source / sub-watershed using the following formula: **estimated bacteria load divided by the total cost.** Total cost / source = the average cost multiplied by the potential number of projects. Table Ten outlines the bacteria reduction per remedial project dollar spent.

TABLE TEN: Bacteria Reduction / Dollar For Each Sub-watershed

Source	Pakenham	Blakeney	Almonte	Appleton	Carleton Place	Innisville
CAR	2.3×10^8	2.0×10^8	1.9×10^8	1.2×10^8	3.2×10^8	3.0×10^8
SDS	7.4×10^7	7.3×10^7	7.7×10^7	7.7×10^7	7.4×10^7	7.9×10^7
MWD	2.3×10^7	2.4×10^7	2.6×10^7	2.2×10^7	2.4×10^7	2.6×10^7
MSS	6.5×10^6	7.7×10^8	7.1×10^8	8.4×10^6	1.3×10^7	1.3×10^7

MSS = Manure Storage Systems
MWD = Milkhouse Washwater Disposal
CAR = Cattle Access Restriction
SDS = Sewage Disposal Systems

From Table Ten it is evident that cattle access restriction projects result in the greatest reduction of bacteria per dollar spent. This is followed by sewage disposal systems and milkhouse washwater disposal systems.

In summary, monies are more effectively allocated to cattle access restriction projects. This must be qualified however, proximity and delivery of bacteria to the beach from a given source, may be a more definitive factor. Windshield surveys and ground truthing must be included in determining cost effectiveness.

Implementation Strategy

The Implementation Strategy will outline which remedial projects (cattle access, manure management, milkhouse washwater disposal systems, or sewage disposal systems), should be given funding priority in the five year CURB implementation phase. The Implementation Strategy will outline specific remedial projects to be installed in close upstream proximity to each beach. Completion of remedial projects as outlined in the strategy could remove bacteria sufficient to keep levels below 100 fecal coliforms/100ml at beaches cited throughout the swimming season.

A complete review of algorithm results and cost effectiveness for remedial projects was conducted on a sub-watershed basis. It is recommended that remedial project funding be given priority within the funding target zone. The **funding target zone** is defined as; the shoreline and areas draining into the Mississippi River and the tributaries within close upstream proximity to a target beach. The average travel time for each sub-watershed, with the exception of Carleton Place, is less than twenty-four hours, refer to the Bacteria Transport Section. Therefore, all of the CURB watershed is eligible for grant funding, however, remedial projects installed at sites in the target zone will result in the greatest reduction in bacteria for monies spent.

Estimates outlined in the Implementation Strategy are based on the following assumptions:

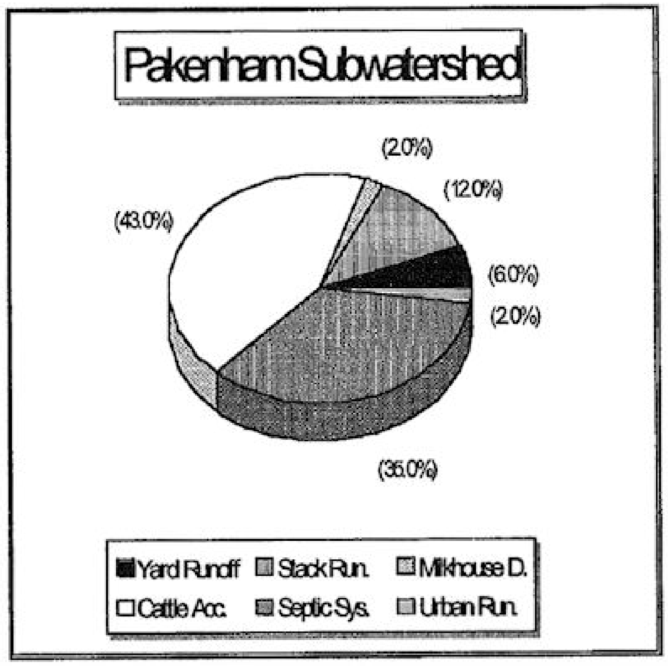
1) One hundred percent landowner participation at establishments with the greatest potential to pollute.
2) Appropriate remedial projects be installed at sites within close upstream proximity to each beach, the funding target zone.

These assumptions provide the best case scenario, it is unrealistic however, that this will be accomplished. Therefore, grant funding forthcoming from MOEE should reflect this addition. It is recommended the Review Committee institute a prioritization scale for grant funding allocation based on the implementation strategy.

By reviewing the maximum fecal coliform bacterial levels presented in Appendix A, it is possible to determine the percentage reduction of bacteria required to ensure the maximum bacteria level will remain below 100 FC per 100 ml for the swimming season. This percentage of bacteria reduction value is compared to the percentage of actual bacteria contributed by rural sources. **"Maximum Bacteria Count" minus the "Standard" (100) divided by the "Maximum Bacteria Count" equals the "Percentage of bacteria reduction value".**

Pakenham Sub-watershed:

The Pakenham sub-watershed includes a nine kilometre stretch of the Mississippi River. Swimming programs have been curtailed due to numerous beach postings. There are five main tributaries emptying into the river within this reach. The land base close to the river and to the east is mainly flat with a well drained silty loam soil over clay loam. The land use is mainly agricultural with residential and seasonal development. In light of the soil types and phosphorus levels recorded in the two years of study, phosphorus retention projects, in particular shoreline revegetation, are necessary in addition to bacterial abatement projects.



The following table outlines which projects should be given greatest priority.

TABLE ELEVEN: Project Priority Table For The Pakenham Sub-watershed

% Bacti Reduction Req'd. to maintain levels less than 100 FC/100ml	Total Reduction of Each Req'd. (% Bacti Reduction x Actual Bacti load from sampling program)	No. of Estimated Projects Required from Land Use Inventory	Bacteria Removed FC/100ml Completion of Remedial Projects Outlined	Total Estimated Costs	Total Costs Eligible for Funding
72 %	1.3 x 10^{13}	4 **MSS**	6.5 x 10^{11}	$100,000	$40,000
		1 MWD	1.6 x 10^{11}	$ 7,000	$ 3,500
		10 **CAR**	9.7 x 10^{12}	$42,000	$31,500
		7 **SDS**	3.1 x 10^{12}	$42,000	$14,000
72%	**1.3 x 10^{13}**	**22**	**1.3 x 10^{13}**	**$191,000**	**$89,000**

MSS = Manure Storage Systems
MWD = Milkhouse Washwater Disposal
CAR = Cattle Access Restriction
SDS = Sewage Disposal Systems

Installation of projects outlined above within the funding target zone, could remove approximately 72% of the bacteria delivered to the Pakenham beach at an estimated cost of $191,000.00. Manure storage systems constitute 18% of the total remedial projects required, milkhouse washwater disposal projects 4%, cattle access restriction projects 45 % and sewage systems 32%. These percentages are close to the percentage contributions of bacteria to the beaches outlined in the CURB model.

It is recommended these projects be given highest priority in this sub-watershed. The MVCA recognizes that not all owners of establishments with the highest pollution potential within the target zone, will participate in the program.

Blakeney Sub-watershed:

The Blakeney sub-watershed includes a six kilometre stretch of the Mississippi River. A sign reading, "WARNING after rainfall this river may be polluted, persons swimming do so at own risk", is permanently posted at the public swimming area. There are four tributaries emptying into the river within this reach. The land base close to the river is gently sloping with a well drained silty loam soil over clay loam. The land use is mainly agricultural with residential and seasonal development. The following table outlines which projects should be given greatest priority.

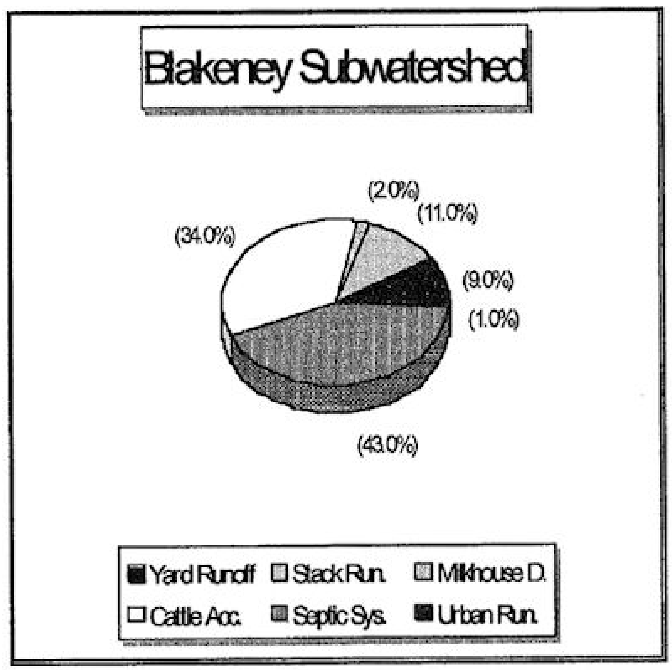


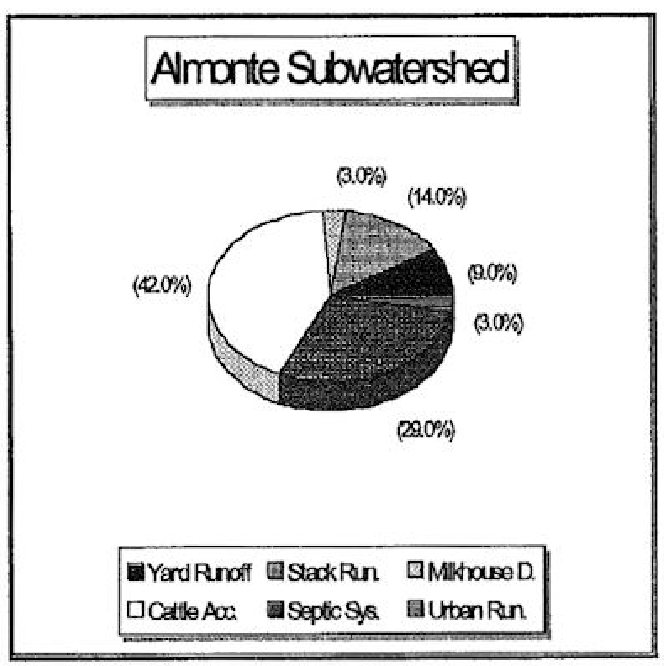
TABLE TWELVE: Project Priority Table For The Blakeney Sub-watershed

% Bacti Reduction Req'd. to maintain levels less than 100 FC/100ml.	Total Reduction of Bacti Req'd, (% Bacti Reduction x Actual Bacti load from sampling program)	No. of Estimated Projects Required from Land Use Inventory	Bacteria Removed by the Completion of Remedial Projects Outlined	Total Estimated Costs	Total Costs Eligible for Funding
71 %	1.3×10^{13}	5 **MSS**	9.7×10^{11}	$ 125,000	$ 60,000
		1 **MWD**	1.7×10^{11}	$ 7,000	$ 2,500
		8 **CAR**	6.7×10^{12}	$ 33,600	$ 25,200
		10 **SDS**	4.4×10^{12}	$ 60,000	$ 20,000
71 %	$\mathbf{1.3 \times 10^{13}}$	**24**	$\mathbf{1.3 \times 10^{13}}$	**$ 225,600**	**$107,700**

MSS = Manure Storage Systems
MWD = Milkhouse Washwater Disposal
CAR = Cattle Access Restriction
SDS = Sewage Disposal Systems

Installation of projects outlined above within the funding target zone, could remove approximately 71% of the bacteria delivered to the Blakeney swimming area for an estimated cost of $ 225,600.00. Manure storage systems make up 20 % of the total remedial projects required, milkhouse washwater disposal projects 4 %, cattle access restriction projects 34 % and sewage systems 42 %. These percentages are close to the percentage contributions of bacteria to the beaches as outlined in the CURB model.

It is recommended these projects be given highest priority in this sub-watershed. The MVCA recognizes that not all owner's of establishments with the highest pollution potential within the target zone, will participate in the program.



Almonte Sub-watershed:

The Almonte sub-watershed includes a seven kilometre stretch of the Mississippi River. There are five tributaries emptying into the river within this reach. The land base close to the river is gently sloping with a well drained loam soil, as well, there is a large wetland on the east side. The land use is mainly agricultural with residential and seasonal development.

The following table outlines which projects should be given greatest priority.

TABLE THIRTEEN: Project Priority Table For The Almonte Sub-watershed

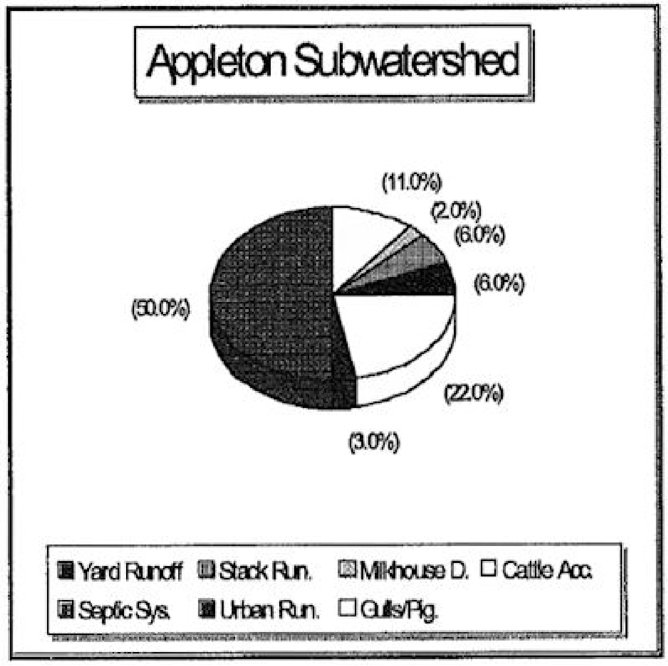
% Bacti Reduction Req'd. to maintain levels less than 100 FC/100ml	Total Reduction of Bacti Req'd. (% Bacti Reduction x Actual Bacti load from sampling program)	No. of Estimated Projects Required from Land Use Inventory	Bacteria Removed by the Completion of Remedial Projects Outlined	Total Estimated Costs	Total Costs Eligible for Funding
48 %	5.3×10^{12}	2 **MSS**	3.9×10^{11}	$ 50,000	$ 24,000
		1 MWD	1.7×10^{11}	$ 7,000	$ 2,500
		4 **CAR**	3.4×10^{12}	$16,800	$ 12,600
		3 **SDS**	1.3×10^{12}	$18,000	$ 6,000
48 %	$\mathbf{5.3 \times 10^{12}}$	**10**	$\mathbf{5.3 \times 10^{12}}$	**$ 91,800**	**$ 45,100**

MSS = Manure Storage Systems
MWD = Milkhouse Washwater Disposal
CAR = Cattle Access Restriction
SDS = Sewage Disposal Systems

Installation of projects outlined above within the funding target zone, could remove approximately 48% of the bacteria delivered to the Almonte beach. This reduction in bacteria is required to maintain levels below 100 FC/100 ml. The estimated cost to achieve this is $ 91,800.00. Manure storage systems make up 20 % of the total remedial projects required, milkhouse washwater disposal projects 10 %, cattle access restriction projects 40% and sewage systems 30%. These percentages are close to the percentage contributions of bacteria to the beaches as outlined in the CURB model.

It is recommended these projects be given highest priority in this sub-watershed. The MVCA recognizes that not all owners of establishments with the highest pollution potential within the target zone, will participate in the program.

Appleton Sub-watershed:

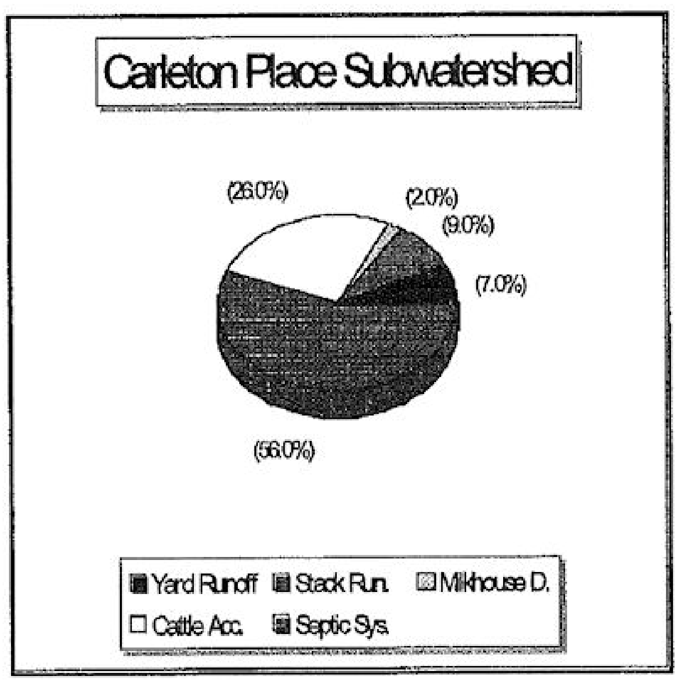


The Appleton sub-watershed includes an eight kilometre stretch of the Mississippi River. There are three tributaries emptying into the river within this reach. The land base close to the river is gently sloping with a loam soil. The land use is agricultural mixed with residential development within the village of Appleton.

Algorithm results show that gulls contribute approximately 22% of the bacteria in this sub-watershed. The CURB Program does not provide funding for reducing bacteria loads from wildlife. Reconstruction of the Appleton Dam will be completed in 1994. Water levels in this section of the river may be altered, this may discourage the gulls from using this area. The gull population will continue to be monitored at this site.

Septic systems were cited as the major contributing source of bacteria, therefore a large portion of remedial grant funding should go to these projects. Additional septic surveys will be conducted in the target zone to increase awareness of the program to encourage abatement work. To a lesser extent remedial funding should be eligible to landowners to conduct cattle access restriction projects, manure storage systems and milkhouse washwater disposal systems within the target zone.

Carleton Place Sub-watershed:

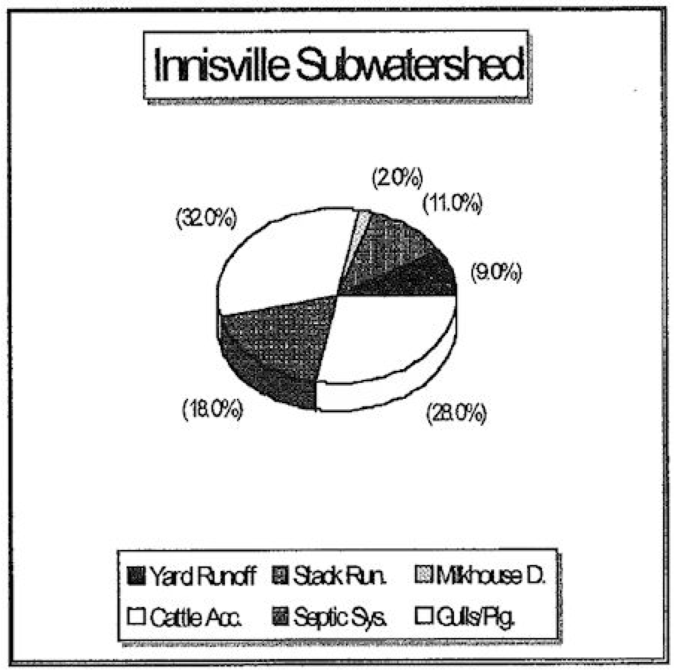


The Carleton Place sub-watershed is a unique sub-watershed within the study area. This sub-watershed encompasses Mississippi Lake. The water sampling program concluded that bacteria exiting the lake is less than that entering. Bacterial reduction through the lake is occurring because of the extended travel time of thirty-one hours resulting in die-off of bacteria.

The CURB model, based on the land use survey, concludes rural non-point source contributions enter the river in this sub-watershed. The bacteria, however, is having a minimal affect at the Carleton Place beach as the bacteria does not survive travel to the beach. Bacterial influences enter the river between the outlet of the lake and the beaches. Development in this stretch is mainly urban, the CURB Program does not provide funding for reducing bacteria loads from this source.

It is recommended that funding be available to property owners in this sub-watershed. However, funding be given a less priority than in other sub-watersheds, unless a site specific pollution source is considered a significant environmental hazard.

Innisville Sub-watershed:



The Innisville sub-watershed is a unique sub-watershed as well taking in an eight kilometre stretch of the Mississippi River. The CURB model again identifies that rural non-point sources are contributing significant bacteria loads to the river. Gulls and pigeons contribute approximately 28% of the bacterial load. Water quality investigations directed at the bird population show that the gulls and pigeons are having a greater influence than shown by the CURB model. This may be explained by the close proximity of the birds to the beaches.

For implementation of the CURB Program, it is recommended that funding for all remedial projects be available to property owners in this sub-watershed. However, funding be a lower priority than other sub-watersheds, unless a site specific pollution source is considered a significant environmental hazard.

Qualifier:

The funding estimates in the implementation strategy are significantly less than the original maximum projected costs, as outlined in the 'Cost Effectiveness' section. This is because the implementation strategy recommends only the most cost effective projects be completed.

Recommendations

1) That the MVCA move into implementation of the CURB Program. This will institute the remedial action plan as outlined in the implementation strategy in this CURB Plan.

2) That the MVCA continue base line monitoring of the Mississippi River.

3) That the MVCA conduct water sampling prior to and following implementation of remedial projects in order to establish the level of bacteria reduction by the installation of such projects.

4) That the MVCA monitor the storm sewers adjacent to the Joseph Street and Canoe Club beaches in Carleton Place to determine the full impact from this source.

5) That the Health Unit sample the Blakeney swimming area more frequently due to its popularity.

6) That the MVCA encourage Drummond Township to direct recreational activities to the North Beach at Innisville as opposed to the South Beach.

7) That the MVCA efforts focus on promotion of remedial grant funding for establishments within the target areas as outlined in the implementation strategy.

8) That the MVCA develop a proactive information and education program to inform residents of the importance of clean water, the benefits of adopting environmentally friendly land use and alternative waste management practices.

9) That the MVCA work jointly with the Ontario Ministry Agriculture and Food and Rural Affairs and the Ontario Soil and Crop Association to provide environmental land use extension services to landowners in an effort to encourage remedial options to reduce bacteria and nutrients entering the Mississippi River.

10) That the MVCA continue to encourage the agricultural community to participate in the Environmental Farm Plan initiative.

11) That the MVCA develop a fact sheet aimed at educating residents in small towns and urban centres within the study area, regarding storm water runoff impacts on water quality and methods to reduce this impact.

12) That the MVCA work in partnership with the Ministry of Natural Resources to open discussion regarding methods to reduce bacterial influences at Innisville and Appleton from gulls and pigeons.

FOOTNOTES

1 Personal Conversation, Regional Municipality of Ottawa-Carleton Environmental Centre Laboratory Staff, 1993.

2 Water Management Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment, 1984. Ministry of the Environment.

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4 Personal Conversation, Kimberly Rollins, Natural Resource Economist Department of Agriculture and Business, 1993.

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6 Agriculture Statistics for Ontario 1992. Ontario Ministry of Agriculture and Food.

7 Personal Conversation, Jeff Demarche, Acting Superintendent - Carleton Place Sewage Treatment Plant, 1994

8 CURB Report 1988. Upper Thames River Conservation Authority

9 Water Quality Implications of Cattle Grazing on a Semi-Arid Watershed in Southeastern Utah 1976. Buckhouse, J.C. and G. F. Gifford.

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APPENDIX A

Mississippi River Stations

Escherichia Coli / 100 ml

	Ferguson Falls		Innisvillle		Carleton Place		Appleton		Almonte		Blakeney		Pakenham	
Date	L	R	L	R	L	R	L	R	L	R	L	R	L	R
JUNE 22	200	200	200	160	160	110	10	10	20	20	20	20	410	390
JUNE 29	10	10	10	10	10	10	10	10	10	10	10	10	10	10
JULY 6	10	10	10	10	10	10	10	10	10	10	10	20	10	10
JULY 13	10	10	10	10	10	10	20	10	10	10	20	20	80	40
JULY 20	10	10	10	10	10	10	20	10	10	10	10	10	10	10
JULY 27	10	10	40	60	10	10	130	80	80	70	30	30	70	70
JULY 29	10	20	10	10	10	10	10	40	10	10	10	20	10	10
AUG 3	10	10	10	10	10	10	50	20	10	10	40	30	220	190
AUG 10	10	10	1000	10	10	10	10	10	10	10	10	10	20	10
AUG 12	10	10	10	10	10	10	20	10	10	10	30	30	20	10
AUG 17	10	20	1000	10	10	10	10	20	440	10	10	10	470	10
AUG 24	30	10	300	20	10	10	50	40	40	10	20	60	10	30
AUG 31	10	10	280	10	10	10	10	10	10	10	10	20	10	10
MAX	200	200	1000	160	160	110	130	80	80	70	40	60	470	390
GEO-MEAN	14	14	48	15	12	12	18	16	15	12	15	19	34	23

Mississippi River Stations

Fecal Coliform / 100 ml

	Ferguson Falls		Innisvillle		Carleton Place		Appleton		Almonte		Blakeney		Pakenham	
Date	L	R	L	R	L	R	L	R	L	R	L	R	L	R
JUNE 22	280	290	230	230	150	240	10	10	20	10	60	20	210	350
JUNE 29	10	10	10	20	10	10	50	10	10	20	20	10	10	10
JULY 6	20	10	100	10	10	10	10	40	10	10	20	20	10	10
JULY 13	10	20	20	10	10	10	10	30	10	10	20	20	50	70
JULY 20	10	10	20	10	10	10	20	20	10	'10	40	10	10	10
JULY 27	10	10	210	100	10	10	430	100	70	50	20	40	180	120
JULY 29	10	10	30	50	10	10	70	50	30	10	70	20	10	20
AUG 3	10	10	60	20	10	10	30	30	10	10	70	40	140	160
AUG 10	10	10	2500	20	10	20	30	10	10	10	10	10	10	10
AUG 12	210	200	180	170	60	30	340	350	190	190	340	160	330	140
AUG 17	40	30	10000	10	10	10	50	40	30	10	30	60	30	40
AUG 24	30	10	490	20	10	20	90	40	60	10	150	70	40	10
AUG 31	10	20	560	20	10	10	110	50	20	40	20	20	10	10
MAX	280	290	10000	230	150	240	430	350	190	190	340	160	330	350
GEO-MEAN	21	20	159	28	14	15	46	35	22	17	40	27	35	33

APPENDIX B

Mississippi River Stations

Fecal Coliform / 100 ml

	Ferguson Falls		Innisvillle		Carleton Place		Appleton		Almonte		Blakeney		Pakenham	
	L	R	L	R	L	R	L	R	L	R	L	R	L	R
JUNE 22	280	290	230	230	150	240	10	10	20	10	60	20	210	350
JUNE 29	10	10	10	20	10	10	50	10	10	20	20	10	10	10
JULY 6	20	10	100	10	10	10	10	40	10	10	20	20	10	10
JULY 13	10	20	20	10	10	10	10	30	10	10	20	20	50	70
JULY 20	10	10	20	10	10	10	20	20	10	10	40	10	10	10
JULY 27	10	10	210	100	10	10	430	100	70	50	20	40	180	120
JULY 29	10	10	30	50	10	10	70	50	30	10	70	20	10	20
AUG 3	10	10	60	20	10	10	30	30	10	10	70	40	140	160
AUG 10	10	10	2500	20	10	20	30	10	10	10	10	10	10	10
AUG 12	210	200	180	170	60	30	340	350	190	190	340	160	330	140
AUG 17	40	30	10000	10	10	10	50	40	30	10	30	60	30	40
AUG 24	30	10	490	20	10	20	90	40	60	10	150	70	40	10
AUG 31	10	20	560	20	10	10	110	50	20	40	20	20	10	10

APPENDIX C

Mississippi River Stations

Total Phosphorus (mg/L)

Date	Ferguson Falls	Innisvillle	Carleton Place	Appleton	Almonte	Blakeney	Pakenham
JUNE 22	0.015	0.024	0.018	0.030	0.050	0.031	0.039
JUNE 29							
JULY 6	0.008	0.005		0.013	0.010	0.017	0.020
JULY 8							
JULY 13	0.009	0.010	0.004	0.005	0.012	0.017	0.020
JULY 15							
JULY 20	0.014	0.008	0.006	0.015	0.014	0.011	0.011
JULY 27	0.013	0.016	0.010	0.010		0.015	0.017
JULY 29							
AUG 3	0.016	0.016	0.012	0.186	0.178	0.062	0.270
AUG 10	0.012	0.022	0.022	0.022	0.016	0.024	0.042
AUG 12							
AUG 17	0.010	0.008	0.026	0.034	0.020	0.024	0.022
AUG 24	0.052	0.012	0.022	0.020	0.026	0.028	0.016
AUG 31	0.010	0.010	0.014	0.014	0.014	0.016	0.014
AVERAGE	0.016	0.013	0.015	0.035	0.038	0.025	0.047
STD. DEV.	0.013	0.006	0.008	0.054	0.054	0.015	0.079
MAX	0.052	0.024	0.026	0.186	0.178	0.062	0.270

Mississippi River Stations

Dissolved Reactive Phosphorus (mg/L)

Date	Ferguson Falls	Innisvillle	Carleton Place	Appleton	Almonte	Blakeney	Pakenham
JUNE 22	0.002	0.002	0.002	0.002	0.004	0.005	0.003
JUNE 29							
JULY 6	0.002	0.002	0.002	0.002	0.002	0.002	0.002
JULY 8							
JULY 13	0.002	0.002	0.002	0.002	0.002	0.002	0.003
JULY 15							
JULY 20	0.002	0.002	0.002	0.002	0.002	0.002	0.002
JULY 27	0.002	0.003	0.002	0.002		0.002	0.003
JULY 29							
AUG 3	0.002	0.002	0.002	0.002	0.002	0.002	0.006
AUG 10	0.010	0.010	0.006	0.010	0.008	0.006	0.006
AUG 12							
AUG 17							
AUG 24	0.004	0.004	0.004	0.004	0.004	0.004	0.008
AVERAGE	0.003	0.003	0.003	0.003	0.003	0.003	0.004
STD. DEV.	0.003	0.003	0.001	0.003	0.002	0.002	0.002
MAX	0.010	0.010	0.006	0.010	0.008	0.006	0.008

Mississippi River Stations

Nitrate (mg/L)

Date	Ferguson Falls	Innisvillle	Carleton Place	Appleton	Almonte	Blakeney	Pakenham
JUNE 22	0.02	0.02	0.02	0.11	0.12	0.14	0.20
JUNE 29							
JULY 6	0.02	0.02	0.02	0.02	0.02	0.02	0.25
JULY 8							
JULY 13	0.02	0.02	0.02	0.02	0.02	0.02	0.02
JULY 15							
JULY 20	0.02	0.02	0.02	0.02	0.02	0.02	0.02
JULY 27	0.02	0.02	0.02	0.03		0.02	0.02
JULY 29							
AUG 3	0.02	0.02	0.02	0.02	0.02	0.02	0.02
AUG 10	0.02	0.02	0.02	0.02	0.02	0.02	0.02
AUG 12							
AUG 17							
AUG 24	0.02	0.02	0.02	0.04	0.02	0.02	0.02
AVERAGE	0.02	0.02	0.02	0.03	0.03	0.04	0.07
STD. DEV.	0.00	0.00	0.00	0.03	0.04	0.04	0.10
MAX	0.02	0.02	0.02	0.11	0.12	0.14	0.25

Mississippi River Stations

Nitrite (mg/L)

	Ferguson Falls	Innisvillle	Carleton Place	Appleton	Almonte	Blakeney	Pakenham
Date							
JUNE 22	0.003	0.004	0.002	0.007	0.007	0.006	0.008
JUNE 29							
JULY 6	0.002	0.002	0.002	0.004	0.003	0.003	0.003
JULY 8							
JULY 13	0.002	0.002	0.002	0.002	0.002	0.002	0.002
JULY 15							
JULY 20	0.002	0.002	0.002	0.005	0.003	0.002	0.002
JULY 27	0.002	0.002	0.002	0.008		0.002	0.003
JULY 29							
AUG 3	0.002	0.002	0.002	0.004	0.002	0.002	0.004
AUG 10	0.006	0.002	0.002	0.006	0.002	0.002	0.002
AUG 12							
AUG 17							
AUG 24	0.002	0.002	0.002	0.002	0.002	0.002	0.002
AVERAGE	0.003	0.002	0.002	0.005	0.003	0.003	0.003
STD. DEV.	0.001	0.001	0.000	0.002	0.002	0.001	0.002
MAX	0.006	0.004	0.002	0.008	0.007	0.006	0.008

Mississippi River Stations

Total Kjeldahl Nitrogen(mg/L)

Date	Ferguson Falls	Innisvillle	Carleton Place	Appleton	Almonte	Blakeney	Pakenham
JUNE 22	0.38	0.53	0.52	0.61	0.80	0.60	0.68
JUNE 29							
JULY 6	0.39	0.36	0.55	0.61	0.51	0.50	0.39
JULY 8							
JULY 13	0.45	0.42	0.43	0.47	0.48	0.47	0.49
JULY 15							
JULY 20	0.45	0.42	0.50	0.50	0.60	0.53	0.52
JULY 27	0.44	0.39	0.48	0.42		0.49	0.49
JULY 29							
AUG 3	0.45	0.37	0.46	0.68	0.70	0.56	0.72
AUG 10	0.41	0.48	0.58	0.44	0.51	0.43	0.51
AUG 12							
AUG 17							
AUG 24	0.45	0.38	0.64	0.55	0.63	0.55	0.48
AVERAGE	0.43	0.42	0.52	0.53	0.60	0.51	0.53
STD. DEV.	0.03	0.06	0.07	0.09	0.12	0.05	0.11
MAX	0.45	0.53	0.64	0.68	0.80	0.60	0.72

Mississippi River Stations

Un-Ionized Ammonia (mg/L)

Date	Ferguson Falls	Innisvillle	Carleton Place	Appleton	Almonte	Blakeney	Pakenham
JUNE 22	0.000376	0.000376	0.001104	0.001200	0.000376	0.000376	0.000412
JUNE 29							
JULY 6	0.000252	0.000396	0.000936	0.000468	0.000540	0.000468	0.000540
JULY 8							
JULY 13	0.000582	0.000582	0.001948	0.000974	0.000989	0.002386	0.001270
JULY 15							
JULY 20	0.000412	0.000440	0.001298	0.001298	0.000690	0.000690	0.000690
JULY 27	0.000707	0.000707	0.002429	0.001946		0.001381	
JULY 29							
AUG 3	0.000372	0.000440	0.001846	0.000974	0.001116	0.000732	0.000732
AUG 10	0.002032	0.001760	0.002071	0.002071	0.005844	0.002196	0.002922
AUG 12							
AUG 17							
AUG 24	0.000412	0.000474	0.001214	0.001214	0.000770	0.000948	0.000649
AVERAGE	0.000643	0.000647	0.001606	0.001268	0.001475	0.001147	0.001031
STD. DEV.	0.000578	0.000463	0.000537	0.000525	0.001943	0.000771	0.000876
MAX	0.002032	0.004760	0.002429	0.002071	0.005844	0.002386	0.002922

Mississippi River Stations

Chloride (mg/L)

Date	Ferguson Falls	Innisvillle	Carleton Place	Appleton	Almonte	Blakeney	Pakenham
JUNE 22	7.0	7.4	7.7	8.3	9.4	9.3	8.3
JUNE 29							
JULY 6	5.5	5.4	6.3	6.8	6.7	6.8	7.1
JULY8							
JULY 13	5.3	5.0	6.0	6.4	7.9	8.1	7.0
JULY 15							
JULY 20	6.7	7.2	7.0	6.9	6.9	7.3	7.6
JULY 27	4.1	3.9	4.7	5.2		5.5	5.6
JULY 29							
AUG 3	4.4	4.4	5.2	5.7	5.7	5.9	6.1
AUG 10	7.5	4.3	5.2	5.6	5.7	5.8	6.0
AUG12							
AUG 17							
AUG 24	7.3	7.3	7.7	7.8	7.8	8.2	8.3
AVERAGE	6.0	5.6	6.2	6.6	7.2	7.1	7.0
STD. DEV.	1.3	1.5	1.2	1.1	1.3	1.4	1.0
MAX	7.5	7.4	7.7	8.3	9.4	9.3	8.3

Mississippi River Stations

Conductivity (µmho/cm)

Date	Ferguson Falls	Innisvillle	Carleton Place	Appleton	Almonte	Blakeney	Pakenham
JUNE 22	190	196	208	229	245	250	242
JUNE 29							
JULY 6	188	186	206	210	215	223	222
JULY 8							
JULY 13	183	185	207	212	217	226	229
JULY 15							
JULY 20	166	168	206	210	210	214	216
JULY 27	161	161	202	203		212	216
JULY 29							
AUG 3	161	162	198	203	206	212	214
AUG 10	159	160	201	203	206	211	214
AUG 12							
AUG 17							
AUG 24	162	160	196	199	207	215	219
AVERAGE	171	172	203	209	215	220	221
STD. DEV.	13	14	4	9	14	13	10
MAX	190	196	207	229	245	250	242

Mississippi River Stations

Turbidity (F.T.U.)

Date	Ferguson Falls	Innisvillle	Carleton Place	Appleton	Almonte	Blakeney	Pakenham
JUNE 22	1.07	1.00	1.70	1.85	1.15	1.60	5.15
JUNE 29							
JULY 6	0.88	0.73	0.67	0.69	0.91	0.90	1.50
JULY 8							
JULY 13	0.64	0.64	0.50	0.58	0.60	0.90	2.00
JULY 15							
JULY 20	0.96	1.25	1.20	1.13	1.35	1.45	2.15
JULY 27	0.60	0.53	0.58	0.61		0.68	1.40
JULY 29							
AUG 3	0.52	0.59	0.61	0.64	0.71	1.00	4.80
AUG 10	0.72	0.86	0.86	0.90	0.79	1.00	1.40
AUG 12							
AUG 17							
AUG 24	0.50	0.47	0.55	0.75	0.65	0.75	0.75
AVERAGE	0.74	0.76	0.83	0.89	0.88	1.04	2.39
STD. DEV.	0.21	0.27	0.42	0.43	0.28	0.32	1.65
MAX	1.07	1.25	1.70	1.85	1.35	1.60	5.15

Tributary Stations

Total Phosphorus (mg/L)

Date	Lavallee	Tranquil	Monroe	Beekman	Spring	Wolf Grove	Indian River	S. Blakeney	N. Blakeney	Indian Creek	Glen	Haydons	McWatty
JUNE 22	0.13	0.07			0.04			0.06		0.05	0.03		0.70
JUNE 29													
JULY 6	0.09	0.13			0.02			0.04		0.04	0.01		0.11
JULY 8													
JULY 13	0.08	0.16			0.07		0.02	0.03		0.03	0.04		0.33
JULY 15		0.30							0.03				0.13
JULY 20	0.10				0.02		0.01	0.03		0.03	0.01		0.08
JULY 27	0.14	0.21	0.04	0.08		0.07	0.03	0.10	0.02	0.04	0.03	0.32	0.28
JULY 29													
AUG 3	0.17				0.36		0.30	0.42		0.72	0.58		4.00
AUG 10	0.08				0.05		0.05	0.07		0.04	0.03		0.12
AUG 12													
AUG 17			0.04				0.03	0.04			0.03		
AUG 24	0.23				0.02	0.06	0.01	0.12		0.03	0.03	1.40	0.36
AVERAGE	0.13	0.17	0.04	0.08	0.08	0.06	0.07	0.10	0.03	0.12	0.09	0.86	0.68
STD. DEV.	0.05	0.09	0.00	0.00	0.12	0.00	0.10	0.12	0.01	024	0.19	0.76	1.26
MAX	0.23	0.30	0.04	0.08	0.36	0.07	0.30	0.42	0.03	0.72	0.58	1.40	4.00

Tributary Stations

Dissolved Reactive Phosphorus (mg/L)

Date	Lavallee	Tranquil	Monroe	Beekman	Spring	Wolf Grove	Indian River	S. Blakeney	N. Blakeney	Indian Creek	Glen	Haydons	McWatty
JUNE 22	0.059		0.030		0.010			0.006		0.009	0.008		0.066
JUNE 29													
JULY 6	0.046	0.098			0.004			0.003		0.007	0.004		0.080
JULY 8													
JULY 13	0.060	0.120			0.010		0.008	0.012		0.014	0.010		0.120
JULY 15		0.110							0.002				0.030
JULY 20	0.038				0.002		0.004	0.002		0.004	0.004		0.046
JULY 27	0.052	0.160	0.003	0.048		0.038	0.016	0.022	0.004	0.014	0.008	0.210	0.110
JULY 29													
AUG 3	0.026				0.002		0.002	0.010		0.008	0.002		0.082
AUG 10	0.024				0.006		0.004	0.004		0.006	0.006		0.024
AUG 12													
AUG 17			0.004				0.002	0.008			0.006		
AUG 24	0.060				0.016	0.034	0.002	0.040		0.012	0.008	1.200	0.320
AVERAGE	0.046	0.104	0.004	0.048	0.007	0.036	0.005	0.012	0.003	0.009	0.006	0.705	0.098
STD. DEV.	0.015	0.047	0.001	0.000	0.005	0.003	0.005	0.012	0.001	0.004	0.003	0.700	0.090
MAX	0.060	0.160	0.004	0.048	0.016	0.038	0.016	0.040	0.004	0.014	0.010	1.200	0.320

Tributary Stations

Nitrate (mg/L)

Date	Lavallee	Tranquil	Monroe	Beekman	Spring	Wolf Grove	Indian River	S. Blakeney	N. Blakeney	Indian Creek	Glen	Haydons	McWatty
JUNE 22	0.07	0.13			0.06			0.89		0.08	0.06		0.20
JUNE 29													
JULY 6	0.02	0.05			0.02			0.69		0.06	0.06		0.02
JULY8													
JULY 13	0.02	0.09			0.40		0.02	0.39		0.04	0.04		0.10
JULY 15		0.04							0.02				0.04
JULY 20	0.02				0.02		0.02	0.47		0.04	0.08		0.02
JULY 27	0.02	0.11	0.24	0.02		0.05	0.02	0.41	0.02	0.05	0.17	0.63	0.21
JULY 29													
AUG 3	0.02				0.02		0.02	0.37		0.21	0.06		0.16
AUG 10	0.02				0.02		0.02	0.16		0.02	0.02		0.02
AUG 12													
AUG 17			0.13				0.02	0.09			0.06		
AUG 24	0.02				0.54	0.13	0.02	0.37		0.04	0.02	0.87	0.09
AVERAGE	0.03	0.08	0.19	0.02	0.15	0.09	0.02	0.43	0.02	0.07	0.06	0;75	0.10
STD. DEV.	0.02	0.04	0.08	0.00	0.22	0.06	0.00	0.24	0.00	0.06	0.04	0.17	0.08
MAX	0.07	0.13	0.24	0.02	0.54	0.13	0.02	0.89	0.02	0.21	0.17	0.87	0.21

Tributary Stations

Nitrite (mg/L)

Date	Lavallee	Tranquil	Monroe	Beekman	Spring	Wolf Grove	Indian River	S. Blakeney	N. Blakeney	Indian Creek	Glen	Haydons	McWatty
JUNE 22	0.006	0.010			0.006			0.008		0.006	0.007		0.024
JUNE 29													
JULY 6	0.004	0.032			0.007			0.060		0.005	0.004		0.018
JULY 8													
JULY 13	0.002	0.032			0.004		0.002	0.008		0.002	0.002		0.120
JULY 15		0.098							0.002				0.016
JULY 20	0.004				0.004		0.002	0.010		0.004	0.004		0.020
JULY 27	0.012	0.130	0.064	0.016		0.012	0.004	0.006	0.006	0.010	0.006	0.072	0.014
JULY 29													
AUG 3	0.004				0.004		0.002	0.010		0.010	0.004		0.022
AUG 10	0.002				0.004		0.002	0.002		0.004	0.002		0.014
AUG 12													
AUG 17			0.014				0.002	0.006			0.004		
AUG 24	0.004				0.016	0.006	0.002	0.008		0.002	0.006	0.046	0.028
AVERAGE	0.005	0.060	0.039	0.016	0.006	0.009	0.002	0.013	0.004	0.005	0.004	0.059	0.031
STD. DEV.	0.003	0.051	0.035		0.004	0.004	0.001	0.018	0.003	0.003	0.002	0.018	0.034
MAX	0.012	0.130	0.064	0.016	0.016	0.012	0.004	0.060	0.006	0.010	0.007	0.072	0.120

Tributary Stations

Total Kjeldahl Nitrogen (mg/L)

Date	Lavallee	Tranquil	Monroe	Beekman	Spring	Wolf Grove	Indian River	S. Blakeney	N. Blakeney	Indian Creek	Glen	Haydons	McWatty
JUNE 22	1.05	0.70			1.50			0.75		0.82	0.56		0.70
JUNE 29													
JULY 6	1.10	0.71			1.20			1.70		0.75	0.49		0.50
JULY 8													
JULY 13	1.15	0.68			1.45		0.58	0.36		0.75	0.84		1.10
JULY 15		1.20							0.59				0.10
JULY 20	1.70				0.84		0.68	0.45		0.80	0.49		0.54
JULY 27	1.60	0.90	0.51	0.65		0.71	0.63	0.75	0.63	0.73	0.41	1.10	0.63
JULY 29													
AUG 3	1.60				0.58		0.65	0.57		0.89	0.33		0.04
AUG 10	1.45				0.90		0.66	0.52		0.78	0.37		0.55
AUG 12													
AUG 17			0.61				0.60	0.40			0.47		
AUG 24	1.65				0.32	0.90	0.60	0.73		0.72	0.50	0.95	0.18
AVERAGE	1.41	0.84	0.56	0.65	0.97	0.81	0.63	0.69	0.61	0.78	0.50	1.63	0.48
STD. DEV.	0.27	0.22	0.07		0.44	0.13	0.04	0.41	0.03	0.06	0.15	0.11	0.33
MAX	1.70	1.20	0.61	0.65	1.50	0.90	0.68	1.70	0.63	0.89	0.84	1.10	1.10

Tributary Stations

Chloride (mg/L)

Date	Lavallee	Tranquil	Monroe	Beekman	Spring	Wolf Grove	Indian River	S. Blakeney	N. Blakeney	Indian Creek	Glen	Haydons	McWatty
JUNE 22	22.5	62.3			9.4			6.7		5.9	3.6		13.6
JUNE 29													
JULY 6	45.4	76.6			23.6			8.5		3.8	3.9		11.8
JULY 8													
JULY 13	53.7	74.3			20.4		8.8	6.5		3.4	3.5		15.1
JULY 15		82.8							10.3				14.7
JULY 20	57.7				88.2		9.2	6.5		4.6	4.6		18.6
JULY 27	54.8	129.0	14.9	17.4		18.2	7.9	6.5	10.2	3.0	3.0	20.4	14.0
JULY 29													
AUG 3	63.2				46.8		7.5	6.6		4.2	2.9		14.1
AUG 10	66.9				74.7		7.8	6.5		3.7	3.1		31.9
AUG 12													
AUG 17			21.8				9.5	7.7			3.6		
AUG 24	44.9				17.6	17.6	8.7	11.5		6.5	5.0	21.1	23.4
AVERAGE	51.1	85.0	18.4	17.4	40.1	17.9	8.5	7.4	10.3	4.4	3.7	20.8	17.5
STD. DEV.	13.9	25.7	4.9	0.0	30.7	0.4	0.8	1.7	0.1	1.2	0.7	0.5	6.4
MAX	66.9	129.0	21.8	17.4	88.2	18.2	9.5	11.5	10.3	6.5	5.0	21.1	31.9

Tributary Stations

Conductivity (µmho/cm)

Date	Lavallee	Tranquil	Monroe	Beekman	Spring	Wolf Grove	Indian River	S. Blakeney	N. Blakeney	Indian Creek	Glen	Haydons	McWatty
JUNE 22	495	788			517			502		189	203		406
JUNE 29													
JULY 6	591	847			574			564		188	252		396
JULY 8													
JULY 13	642	863			622		291	512		192	140		421
JULY 15		860							469				438
JULY 20	217				780		297	542		196	254		519
JULY 27	599	1040	415	574		496	300	556	450	214	277	567	495
JULY 29													
AUG 3	634				517		282	592		241	279		411
AUG 10	646				631		286	525		228	284		675
AUG12													
AUG 17			615				306	537			281		
AUG 24	629				346	493	273	567		251		292	550
AVERAGE	557	880	515	574	570	495	291	544	460	212	246	430	479
STD. DEV.	146	95	141	0	133	2	11	29	13	25	51	194	92
MAX	646	1040	615	574	780	496	306	592	469	251	284	567	675

Tributary Stations

Turbidity (F.T.U.)

Date	Lavallee	Tranquil	Monroe	Beekman	Spring	Wolf Grove	Indian River	S. Blakeney	N. Blakeney	Indian Creek	Glen	Haydons	McWatty
JUNE 22	2.30	1.50			1.80			7.60		5.00	4.00		33.00
JUNE 29													
JULY 6	1.50	2.10			2.50			8.30		4.70	3.50		36.00
JULY 8													
JULY 13	1.50	5.50			3.50		1.90	6.90		4.40	5.80		130.00
JULY 15		4.10							2.10				36.00
JULY 20	2.00				0.96		1.90	4.70		4.70	6.30		25.00
JULY 27	2.00	1.50	6.70	4.20		4.10	1.20	20.00	1.10	5.00	6.50	25.00	58.00
JULY 29													
AUG 3	3.00				1.30		1.50	6.20		6.50	3.60		79.00
AUG 10	1.60				2.50		1.20	16.00		3.20	3.00		35.00
AUG 12													
AUG 17			2.20				0.50	4.40			0.55		
AUG 24	1.20				1.40	3.20	0.85	31.00		1.90	4.30	54.00	35.00
AVERAGE	1.89	2.94	4.45	4.20	1.99	3.65	1.29	11.68	1.60	4.43	4.17	39.50	51.89
STD. DEV.	0.57	1.79	3.18		0.89	0.64	0.52	8.97	0.71	1.36	1.87	20.51	33.59
MAX	3.00	5.50	6.70	4.20	3.50	4.10	1.90	31.00	2.10	6.50	6.50	54.00	130.00

APPENDIX D

Tributary Stations

Escherichia Coli / 100 ml

Date	Lavallee	Tranquil	Monroe	Beekman	Spring	Wolf Grove	Indian River	S. Blakeney	N. Blakeney	Indian Creek	Glen	Haydons	McWatty
JUNE 22	410	1000			230			840		530	230		1000
JUNE 29	20	170			20			490		30	40		1000
JULY 6	10	400			230					10	270		610
JULY 8	10	570											
JULY 13	10	70			300		50	820		110	390		1000
JULY 15									70				
JULY 20	120				710		30	610					1000
JULY 27	410	1000	730	480		1000	190	1000	500	180	990	1000	1000
AUG 3	80				660		880	1000			750		1000
AUG 10	70				360		20	170		60	470		800
AUG 12	190				820		40	1000		260	1000		1000
AUG 17	320		140	330		180	60	260	20		130	10	
AUG 19	1000		50	20		50	10		1000	20	570	400	
AUG 24	1000	1000	260	170	1000	1000	150	1000	150	60	1000	3800	6000
AUG 31	1000		170	650	840	430	40	1000	380	30	1000	1000	340
MAX	1000	1000	730	650	1000	1000	880	1000	1000	530	1000	3800	6000
GEO MEAN	121	430	187	204	360	329	61	652	185	67	414	433	1000

Tributary Stations

Fecal Coliform / 100 ml

Date	Lavallee	Tranquil	Monroe	Beekman	Spring	Wolf Grove	Indian River	S. Blakeney	N. Blakeney	Indian Creek	Glen	Haydons	McWatty
JUNE 22	390	3900			290'			1400		670	290		3800
JUNE 29	30	290			20			690		110	70		2700
JULY 6	30	540			260			10000		70	440		960
JULY 8	20	2700											
JULY 13	10	270			500		60	1200		210	930		3200
JULY15									140				930
JULY 20	120				630		40	470		10	230		1100
JULY 27			4700	4200		10	370	10000	730	250	2700	10000	10000
AUG 3	180				1600		80	2500		2600	1400		3900
AUG 10	90				300		110	330		30	690		2400
AUG 12	1100				4600		100	10000		1100	3300		10000
AUG 17	800		360	400		180	190	180	70		350		50
AUG 19	6300		90	70		90	70		1000	30	260	200	
AUG 24	3600	2200	450	320	6700	2200	190	10000	310	70	6700	2100	3400
AUG 31	3500		160	2100	1700	750		2300	290	110	2300	4200	2700
MAX	6300	3900	4700	4200	6700	2200	370	10000	1000	2600	6700	10000	10000
GEO MEAN	242	997	406	602	642	193	108	1873	294	139	748	2049	2082

APPENDIX E

EQUIVALENT ANIMAL UNITS

ANIMAL TYPE	WEIGHT (kg)	PHOSPHORUS EAU	FECAL COLIFORM EAU
Beef Cow	455	1.04	1.04
Slaughter Cow	455	1.00	1.00
Yearling Beef (Feeder)	365	0.78	0.71
Beef Calf	180	0.53	0.48
Dairy Cow		1.50	1.62
Young Dairy/heifer	318	0.75	0.71
Dairy Calf	136	0.46	0.36
Sow/boar		0.60*	
Feeder Pig	22-90	0.40	
Sheep	45	0.17	0.02
Turkey	4.5	0.03	0.03
Chicken/duck	1.8	0.02	
Horse	455	1.20	0.013

* Ecologistics, 1988

APPENDIX F

Mississippi Valley Conservation Authority

RURAL BEACHES PROGRAM

Agricultural Landowner Questionnaire

P.O. BOX 268, LANARK, ONTARIO, K0G 1K0 - (613) 259-2421

Date: ____________________
Name: ____________________
Address: ____________________
Township: ____________________
Phone: ____________________
Rent: ________ Own: ________

Assessment #: ____________________
Flight Lines ____________________
Longitude: ____________________
Latitude: ____________________
Lot: __________ Conc: __________

Operation Specifics

1. Type of Operation:

LIVESTOCK	NUMBER	DETAILS
A. Dairy	________	________
B. Beef	________	Cow / Calf or Feedlot
C. Swine	________	Weaners/Sows & Litters Dry Sows / Finishers
D. Poultry	________	________
E. Sheep	________	________
F. Horse	________	________
G. Other	________	________

Manure Management

2. Type of Manure: Solid: __________
Semi-Solid: __________ Liquid: __________

3. Type of Manure Storage System:

Solid Manure

A. Pad: Concrete: ________ Earthen: ________ Covered: ________
B: Pad Dimensions: ____________________
C: Pad Capacity: ____________________
D: Walls: Concrete: ________ Earthen: ________ Wood: ________
E: Wall Dimensions: ____________________
F: Capacity: ____________________
G: Runoff: Pond: ________ Tank: ________ Other: ________ None: ________
H: Setbacks: Watercourse ________ Wells: ________
I: Days of Manure Storage: ____________________

or

Liquid Manure

A: Tank: Covered: ________ Ingrade: ________ Above-Grade: ________
B: Tank Dimensions: ____________________
C: Tank Capacity: ____________________
D: Setbacks: Watercourse ________ Tile Drains ________ Wells ________
E: Earthen Lagoon: Dimensions: ____________________
F: Earthen Lagoon: Capacity: ____________________
G: Setbacks: Watercourse ________ Tile Drains ________ Wells ________
H: Days of Manure Storage: ____________________

4. Transport Factors: Manure Storage to Receiving Waters:

A: Soil Type: Sand__________ Sandy Loam_____ Silt Loam______ Clay Loam______ Clay __________ Organic________

Soil Cover ___________ % Slope______________ Slope Length__________

5. General:

A: Barnyard Runoff Collected: Yes___________ No___________

B: Barnyard Runoff Diverted To: Storage________ Other_________

C: Eavestroughing on Buildings: Yes___________ No___________

D: Eavestroughing Diverted To: Yard_______ Manure Storage________ Tile Drains_______

E: Barnyard Setbacks: Watercourse_____ Tile Drains_____ Wells_____

F: Barn Specifics: Number _________

G: Barn Dimensions: 1)__________________ 2)__________________ 3)__________________

6. Feedlot/Exercise Yard:

A: Specifics: Type: Concrete____________ Earthen____________ Covered____________ Other____________

B: Livestock Type and Number:
Dairy_________ Beef__________ Swine_________ Other__________

C: Yard Runoff Diverted: Yes_______________ No_______________

D: Directed To: Ditch________ Manure Storage________ Other________

E: Setbacks: Watercourse________ Tile Drains________ Wells________

F: Number Months In Use:________ Number Cleanouts Per Year________

7. Manure Application

A: Time Of Application: Spring____ Summer____ Fall____ Winter____

B: Incorporation Rate: 1 Day______ 1 - 3 Days______ > 3 Days______

C: Estimated Rate Of Application:_________ Gallons or Tons /Acre

D: Soil Tested: Yes__________ No___________ Frequency___________

E: Manure Tested: Yes________ No___________ Frequency___________

F: Transport Factors: Field To Receiving Waters

	FIELD #1	FIELD #2	FIELD #3
Setbacks:	______	______	______
% Soil Cover:	______	______	______
% Slope:	______	______	______
Slope Length:	______	______	______
Soil Type:	______	______	______

Milkhouse Washwater

A: Wastes Drain To: Surface__________ Drainage Ditch___________
Manure Storage______________ Holding Tank______________
Septic Tank & Tile Field______________ Other______________

B: Rinse Prior To Washing Pipeline: Yes__________ No__________

C: Disposal Of Rinse Water:______________________________

Pasture Management

A: Watering Presently Available: ______________________
B: Is the Watercourse Fenced?: Yes ____________ No ____________
B: If Yes, Type of Buffer Strip: ____________ Width ____________
C: Livestock Type and Number In Pasture:
Dairy ________ Beef ________ Swine ________ Other ________
D: Watercourse Access Footage: ______________________
E: Type of Access: Limited ____________ Unlimited ____________

G: Additional Comments: ______________________
____

Household Sewage Disposal System

A: Type of System: Septic Tank ____ Size ________ Age ________
Tile Field ____ Size ________ Age ________
Holding Tank ____ Size ________ Age ________
Other ______________________
B: Disposal of Grey Water: Septic System ____________
Leaching Pit ______ On Surface ______ Drainage Ditch ______
C: Number of Bedrooms: ______________________
D: Was The System Approved: ____________ Year: ____________
E: Setbacks: Watercourse ______ Tile Drains ______ Wells ______
F: Potable Water Supply: ______________________
G: Washroom Facilities In the Barn: ______________________
H: Type of Disposal: ______________________
____

General

8. Have you done any major improvements in the past five years? (for example to: drainage, fencing, expansion)
____
____
____

9. Have you introduced conservation farming practices into your general routine in the last five years? (for example: fencing, grassed waterways, strip farming)
____
____

11. Would you be interested in participating in an assistance program to establish conservation measures on your farm?
____
____

12. What land use activities do you feel affect water quality in the Mississippi River?
____
____
____
____

Property Sketch

Survey Form Completed By: ______________________________

Ministry of the Environment
Ontario

RURAL POLLUTION CONTROL

STABLISHMENT IDENTITY

KE OR RIVER No. | ESTABLISHMENT SURVEY No. | ASSESSMENT NO.

STABLISHMENT DESCRIPTION

RD No. 01 | HYDRO METER No. | DATE OF INSPECTION DAY MONTH YEAR | LOT SIZE | UNIT OF LOT SIZE SQ. FT. ACRES | USE | No. OF OCCUPANTS AVERAGE MAXIMUM | No. BEDROOMS | ESTABLISHMENT TYPE

ACCESSIBLE BY ROAD Yes No

NAME OF ROAD

USE
1 SUMMER ONLY
2 YEAR ROUND
3 SUMMER/OCCASIONAL WINTER
4 PREDOMINANT WINTER
5 NOT IN USE—CLOSED
6 UNDER CONSTRUCTION

TYPE OF ESTABLISHMENT
01 PRIVATE COTTAGE
02 CABIN ESTABLISHMENT
03 COTTAGE ESTABLISHMENT
04 CAMP
05 PICNIC AREA/PUBLIC PARK
06 MARINA
07 HOTEL/MOTEL
08 RESTAURANT
09 STORE
10 FARMHOUSE
11 CLUB
12 INDUSTRIAL
13 BOATHOUSE
14 PERMANENT HOME
15 CAMPGROUND/ TRAILER PARK
16 OTHER

STABLISHMENT OWNER

TLE | INITIALS | SURNAME

TELEPHONE No.

IF PERSON INTERVIEWED IS NOT OWNER, NAME

AILING ADDRESS

RD No. 02 | OWNER'S PERMANENT MAILING ADDRESS

CLASSIFICATION

PRELIMINARY | FINAL

1 SATISFACTORY
2 SATISFACTORY PERFORMANCE
3 SERIOUSLY SUBSTANDARD
4 NUISANCE (WASH WATER)
5 NUISANCE (TOILET, SOLID WASTE)
6 DIRECT POLLUTER
7 UNCLASSIFIED TEMPORARILY
8 UNCLASSIFIED

INITIALS

ESCRIPTION OF FACILITIES

RD No. 03

FIXTURES & APPLIANCES												TOILETS										
BATHROOM WASH BASIN	DISHPAN	BATH WITH SHOWER	BATH	STALL SHOWER	KITCHEN SINK	AUTOMATIC DISHWASHER	WASHING MACHINE (Wringer)	WASHING MACHINE (Auto.)	LAUNDRY TUB	GARBAGE GRINDER	STANDARD FLUSH	URINAL	LOW VOLUME FLUSH	PIT PRIVY	VAULT PRIVY	AQUA PRIVY (Pail & dry)	INCIN. TOILET—GAS	INCIN. TOILET—ELECT.	CHEMICAL TOILET	OTHER (Specify)		
QUANTITY																						

SLOPE OF LOT GROUND: 0-5% (Flat) | 5-10% (Moderate) | 10-20% (Mod. Steep) | >20% (Steep)

MOE 1079 5/76

RINKING WATER

SOURCE PRIMARY OTHER | SOURCE IF IMPORTED | TREATMENT PRIMARY OTHER | LAUNDRY DONE AT COTTAGE YES NO | PIPED WATER YES NO | REFUSE PRIMARY OTHER

DRINKING WATER SOURCE
LAKE
COTTAGE DUG WELL
COTTAGE DRILLED WELL
4 CISTERN FOR RAINWATER
5 MUNICIPAL
6 OTHER (SPECIFY)

DRINKING WATER TREATMENT
1 NONE
2 BOILED OR FILTERED AND BOILED
3 FILTERED
4 DISINFECTED BY CHLORINE
5 DISINFECTED BY OTHER MEANS
6 FILTERED AND DISINFECTED BY CHLORINE
7 FILTERED AND DISINFECTED BY OTHER MEANS
8 OTHER (SPECIFY)

REFUSE
1 TO MUNICIPAL DUMP
2 TO LOCAL DUMP
3 TAKEN HOME
4 DEPOSITED IN LAKE
5 DEPOSITED ELSEWHERE
6 BURIED ON LOT
7 BURNED/INCINERATED
8 OTHER (SPECIFY)

PTIC TANKS

ID No

4

17

TANK No	CAPACITY: LIQUID	CAPACITY: TOTAL	CAPACITY: GALLONS	YEAR INSTALLED	LAST YEAR CLEANED	MATERIAL	APPROVAL	APPROV. AGENCY
18	19		21	25	27	29	30	31
42	43		45	49	51	53	54	55

MATERIAL	APPROVAL	APP. AGENCY
1 CONCRETE 2 STEEL 3 FIBERGLASS 4 CONC. BLOCK 5 OTHER (SPECIFY)	1 NO REFERRAL 2 REFERRAL, NOT YET APPROVED 3 NOT APPROVED 4 APPROVED	1 HEALTH UNIT 2 MIN. OF ENV 3 MUNICIPAL

TILE FIELDS

FIELD No.	TOTAL LENGTH OF TILES (FT.)	DISTANCE BETWEEN LINES (FT.)	HEIGHT ABOVE LAKE (FT.)
32	33	37	39
56	57	61	63

COMMENTS

05

/ALUATION OF SYSTEM

RD No

6

17

DISTANCE TO:

1. ALL MEASUREMENTS ARE SHORTEST DISTANCES
2. MEASUREMENT FROM POINT OF WASTE DISCHARGE ON GROUND SURFACE

SYSTEM No	SYSTEM TYPE	LAKE OR RIVER (FEET)	STREAM ON OR ABUTTING LOT (FEET)	DRINKING WELL (FEET)	BUILDING (FEET)	PROPERTY BOUNDARY (FEET)	TYPE OF WASTE: TOILET	BATHTUB, SHOWER, BATHROOM WASH BASIN	KITCHEN	LAUNDRY	UNKNOWN	CONST-RUCTION: POOR	INFERIOR MATERIALS	UNKNOWN CONSTRUCTION	OPER'N: SYSTEM OVERLOADED	SYSTEM ABUSED	UNKNOWN OPERATION	PERF.: FIRST	SECOND	SYSTEM CLASSIFICATION
9	10	21	24	27	30	32	34					39			42			45		

PERFORMANCE

1 POLLUTING DRINKING WELL
2 POLLUTING GROUND WATER
3 PONDING
4 EFFLUENT SURFACING
5 EFFLUENT BREAKING OUT
6 LEAKING
7 BAD ODOURS
8 NOT VERMIN PROOF

01 SEPTIC TANK 02 TILE FIELD 03 ON GROUND SURFACE	04 INTO LAKE/RIVER 05 LEACHING PIT 06 PIT PRIVY	07 CESSPOOL 08 HOLDING TANK 09 LAGOON	10 MUNICIPAL 11 REFUSE 12 OTHER (SPECIFY)

SOIL PROFILE

CARD No

07

16 17

SOIL TYPES	
1 ORGANIC 2 GRAVEL 3 SAND	4 SILT 5 CLAY

HOLE 1 (IN TILE FIELD IF ONE EXISTS)

	SOIL STRATUM (FT.)	MAINLY COMPOSED OF	WITH CONSIDERABLE AMOUNT OF	MINOR AMOUNT OF
FIRST	18	20	21	22
NEXT	23	25	26	27
NEXT	28	30	31	32
NEXT	33	35	36	37

HOLE 2 (IN TILE FIELD IF ONE EXISTS)

	SOIL STRATUM (FT.)	MAINLY COMPOSED OF	WITH CONSIDERABLE AMOUNT OF	MINOR AMOUNT OF
FIRST	42	44	45	46
NEXT	47	49	50	51
NEXT	52	54	55	56
NEXT	57	59	60	61

38 / 40 DEPTH TO IMPERVIOUS LAYER OR DEPTH TO GROUND WATER 62 / 64

SOIL DEPTH RANGE OVER WHOLE PROPERTY FT. 66 TO FT. 68

SOIL IS NATURAL 70 FILL 71

INSUFFICIENT SOIL 72

UNSUITABLE SOIL 73

RECOMMENDED ACTION AND COMMENTS (BY SUPERVISOR)

CARD No

08

16 17

CARD No.

09

16 17

20

50

20

50

ESTABLISHMENT IDENTITY

LAKE OR RIVER No. 1 6

ESTABLISHMENT SURVEY No. 7 11

Ministry of the Environment
Ontario

RURAL Pollution Control - Sketch

Name(s) of Inspector(s)	Establishment Survey No.	Lake ☐ River ☐

Note Bore Hole Thus ⊕ Note Probe Location Thus X

Remarks Summary of findings and reason(s) for classification (by Inspector)

APPENDIX G

CATTLE ACCESS ALGORITHM =

Concentration of Defecation x Equivalent Animal Units x
1 2
Probability of Defecation x Access Events / Day x
3 4
No. of Animals x No. of Days
5 6

Values apply to the Pakenham Subwatershed:

1	Concentration of Defecation	8.9×10^{8} EC / Defecation
2	Equivalent Animal Units	1.04 / Beef Cow
3	Probability of Defecation	18 %
4	Access Events / Day	2.5 / Day
5	Number of Animals	628 Beef Cows
6	Number of Days	92 Days

$8.9 \times 10^{8} \times 1.04 \times 0.18 \times 2.5 \times 628 \times 92 = 2.4 \times 10^{13}$

Clarification of Terms:

1 Concentration of Defecation is an assumed value derived from research work. done by the St. Clair Region Conservation Authority in 1991. The value is the collection of E. coli bacteria, on average, existing in any defecation.

2 Equivalent Animal Units is an assumed value taken from the Pollution from Livestock Operation Predictor (PLOP) Model. This model was developed by Ecologistics Limited for MOEE in 1988. This unit is for beef cattle only.

3 Source Dermal 1982

4 Source Dermal 1982

5 Number of Animals is for beef cattle only this was agreed by the Steering Committee. It is assumed dairy cattle will be provided water at the barn. Thirty-two % of the farms surveyed have direct access to a watercourse as the only source of water. The average beef herd size is 37, therefore, 32 % x no. of beef farms (53)x 37 = number of animals.

6 The number of days is for the swimming season only.

BARNYARD RUNOFF ALGORITHM =

Concentration of Runoff x Number of Farms x
1 2

Volume of Runoff x Delivery
3 4

Values apply to the Pakenham Subwatershed:

1	Concentration of Runoff	Assumed 7.5×10^9 EC/ha/mm
2	Number of Farms	Number of Dairy Farms with Barnyard Runoff is 9
3	Volume of Runoff	Average barnyard area 0.414 ha x Total annual precipitation 270 mm x Assumed runoff is 60 % of total precipitation
4	Delivery	Assumed 80 %

$$7.5 \times 10^9 \times 9 \times (0.414 \times 270 \times 0.60) \times 0.80 = 3.6 \times 10^{12}$$

Clarification of Terms:

1 Concentration of Runoff is an assumed value of 7.5×10^9 E. coli bacteria per hectare per mm of rainfall. This value is based on documented research by the Maitland Valley Conservation Authority in 1989.

2 To best reflect local farming practices only dairy operations are included in this algorithm. It is agreed upon with the Steering Committee that beef cattle are put out to pasture during the swimming season, in this area. Ninety-three percent of the farms surveyed have barnyards without proper containment for runoff. Therefore, 93 of the total number of dairy farms in the subwatershed equals the total number of dairy farms with barnyard runoff.

3 Volume of Runoff is calculated by taking the average dairy yard area of 0.414 hectare, multiplied by the total precipitation in the 92 day swimming season. Mulitiply this by 60 percent, this is calculated into the algorithm because it is assumed, runoff from the barnyard is 60 percent of the precipitation. This calculation is based on findings by Coote and Hore in 1978.

4 Delivery is an assumed rate of 80 % delivery to a watercourse. This is based on research by the Maitland Valley Conservation Authority in 1989.

MANURE STACK RUNOFF ALGORITHM =

Concentration of Runoff x Number of Farms x
1 2

Volume of Runoff x Delivery
3 4

Values apply to the Pakenham Subwatershed:

1 Concentration of Runoff	Assumed 7.5×10^9 EC/ha/mm
2 Number of Farms	Number of Farms with Manure Stacks with Runoff is 62
3 Volume of Runoff	Average Manure Stack Area is 0.108 ha x Total Annual Precipitation 270 mm x Assumed Runoff is 60 % of Total Precipitation
4 Delivery	Assumed 80 %

$$\mathbf{7.5 \times 10^9 \times 62 \times (0.108 \times 270 \times 0.60) \times 0.80 = 9.35 \times 10^{12}}$$

Clarification of Terms:

1 Concentration of Runoff is an assumed value of 7.5×10^9 E. coli bacteria per hectare per mm of rainfall. This value is based on documented research by the Maitland Valley Conservation Authority in 1989.

2 To best reflect local farming practices the total number of farms with manure stacks, with runoff are used in this algorithm. Eighty percent of farms surveyed have manure stacks with no containment for runoff. It is agreed upon between the Authority and the Ministry of Agriculture and Food representative, that, although manure stack areas may not be in full use, in this area, during the swimming season, the soil beneath each remain heavily saturated with nutrients and ' bacteria available for runoff, therefore all types of operations are included.

3 Volume of Runoff is calculated by taking the average manure stack area multiplied by the total precipitation in the 92 day swimming season. Multiply this by 60 percent, this is calculated into the algorithm because it is assumed, runoff from the barnyard is 60 percent of the precipitation. This calculation is based on findings by Coote and Hore in 1978.

4 Delivery is an assumed rate of 80 % delivery to a watercourse. This is based on research by the Maitland Valley Conservation Authority in 1989.

SEPTIC SYSTEM IMPACT ALGORITHM =

Concentration x Volume/Person/Day x No. of Days x Population
1 2 3 4

x Failure Rate x Delivery
5 6

Values apply to the Pakenham Subwatershed:

1	Concentration	Assumed 1.0×10^7 EC/L of effluent
2	Volume/Person/Day	Assumed 300 L/Day
3	No. of Days	92 Days
4	Population	548 homes x 3.2 persons/household
5	Failure Rate	8 % Failure rate or illegal bypasses
6	Delivery	50 % Potential rate of delivery to watercourse

$1.0 \times 10^7 \times 300 \times 92 \times 548 \times 3.2 \times 0.08 \times 0.50 = 1.94 \times 10^{13}$

Clarification of Terms:

1 Concentration is an assumed value of 1.0×10^7 E.coli bacteria per litre of effluent. This value is based on documented research by the Maitland Valley Conservation Authority.

2 Volume/Person/Day is estimated at 300 Litres per day based on research done by the Upper Thames Conservation Authority in 1991.

3 Number of Days is for the swimming season only, June 1-Aug.31.

4 Rural Population is calculated by adding the number of residential sites plus the number of farms and cottages multiplied by an average of 3.2 persons per establishment.

5 There are differing opinions as to the correct septic system Failure Rate in a given area, therefore, it was decided to use the percentage of failed systems found from residential and farm surveys within the study area (8%). A failed system is defined as one that is ponding, effluent is leaching out of the bed or one that is seriously substandard by current design criteria. This system has the potential to pollute.

6 A 50 per cent Delivery rate is the approximate percentage of total volume reaching a watercourse from a failed system or illegal bypass. This was agreed by the Health Unit Representative on the Steering Committee.

MILKHOUSE WASTEWATER ALGORITHM =

Concentration of Bacteria x Volume/Animal/Day x No. of Animals
1 2 3
x Discharge Days x Delivery
4 5

Values apply to the Pakenham Subwatershed:

1	Concentration of Bacteria	2000 FC/L
2	Volume/Animal/Day	25 L
3	No. of Animals	351 Cows
4	Discharge Days	92 Days
5	Delivery	50000 %

2000 x 25 x 351 x 92 x 500 = 8.1 x 1.0^{11}

Clarification of Terms:

1 Concentration of Bacteria is an assumed value of 2,000 Fecal Coliforms per Litre. This value is based on research done by the St. Clair Region Conservation Authority in 1991.

2 Volume/Animal/Day of Milkhouse Waste generated is an assumed value of 25 Litres. This value is based on research done by the Upper Thames Conservation Authority in 1989.

3 Number of Animals is derived by multiplying one half of the average dairy herd size, by the number of dairy farms. One half of the average herd size is assumed since only half a herd is normally milked at one time. The total number of dairy farms in the Pakenham subwatershed is 9. The average dairy herd size is 78, this divided in half and multiplied by 9 farms equals 351 milking cows.

4 Discharge Days is based on the swimming season only, therefore, the value used is 92 days. This period is from June 1 to August 31.

5 Delivery is an assumed rate of 50,000 % delivery to a watercourse. This is based on research work done by the Upper Thames Conservation Authority in 1989. A higher than average percentage takes into account the ideal growing medium within milkhouse wastes for bacteria to multiply.

SPRING AND SUMMER MANURE SPREADING ALGORITHM =

Volume Spread x Concentration x Storage Die-off x
1 2 3
Field Decay x Delivery
4 5

Values apply to the Pakenham Subwatershed:

1	Volume Spread	8,943 m^3
2	Concentration	5.0×10^{11} FC/m^3
3	Storage Die-off	1.0×10^{-9} FC
4	Field Decay	$10^{-0.066 \times 10} = 0.22$
5	Delivery	0.05

$8{,}943 \times 5.0 \times 10^{11} \times 1.0 \times 10^{-9} \times 0.22 \times 0.05 = 4.9 \times 10^{4}$

Clarification of Terms:

1 Volume Spread is determined by calculating the following equation on a sub-watershed basis: No. of Animals x Volume of Manure/Animal/Day x No. of Days x % Spreading in Spring and Summer. The total number of animals is based on survey findings. The average dairy herd size is 78 and the average beef herd size is 42. The total number of animals is 2,928. The volume of manure/animal/day is taken directly from the Manure Production Table produced in 1991 by the St. Clair Region Conservation Authority. The average is calculated for beef and dairy cows (0.046 m^3). The number of days is 166 days, this is based on the manure storage period starting November 1 and ending April 15. Percentage spreading in spring and summer is 40 percent, this is taken directly from the land use survey. Therefore, Volume Spread = 2,928 x 0.046 x 166 x 0.40 = 8,943 m^3.

2 Concentration for cattle is taken from the Average Fecal Coliform Densities in Animal Feces Table produced in 1991 by the St. Clair Region Conservation Authority.

3 Storage Die-Off is calculated utilizing a formula produced by Kress and Gifford, Fecal Coliform Release from Cattle Fecal Deposits Article, February 1984. (Log y = 7.69 - 2.88 Log x) where 'x' is the average storage time, this is taken as half the storage days of 166. Log y = 7.69 - 2.88 x log 83, Log y = 2.16, the inverse of this is 1.45 x10^2. The starting concentration of manure is an assumed value, utilized in earlier calculations of 5.0×10^{11} FC and the concentration after 83 days is 1.45×10^2, therefore, die-off is 9 orders of magnitude in 83 days or 1.0×10^{-9} fecal coliforms.

4 Field Decay calculation is taken from the St. Clair Region Conservation Authority CURB Plan. It is equal to 10^{-kt}, where K is a constant of 0.066. This figure is taken from the model produced by Ecologistics in 1988. T=time in number of days between rainfall events. For the MVCA study area this is 10, ($10^{-0.066 \times 10} = 0.22$) . Therefore, field decay is 22 percent.

5 Delivery is an assumed value of 5 percent based on the model produced by Ecologistics in 1988.

URBAN NON-POINT SOURCE ALGORITHM =

Load/Hectare x Urban Area x Die-Off
1 2 3

Values apply to the Pakenham Subwatershed:

1	Load/Hectare	3.1×10^{10} EC/ha
2	Urban Area	28.4 ha
3	Die-Off	Not Applicable

$$3.1 \times 10^{10} \times 28.4 = 8.8 \times 10^{11}$$

Clarification of Terms:

1 Load/Hectare is an assumed value. Storm sewer discharge draining each hectare of land will contain 3.1×10^{10} E. coli bacteria. This figure is based on storm sewer research by Marsalek et al in 1985 and Marsalek in 1978.

2 Urban Area is in hectares.

3 Die-Off is calculated only to urban areas situated greater than one kilometer upstream from a beach sampling station. Research through other CURB Programs has determined this rate to be 0.03 logs/hour x Travel Time, a CURB Program in particular is the Maitland Valley Conservation Authority.

GULLS AND PIGEONS ALGORITHM =

(Concentration of Gull Feces + Concentration of Pigeon Feces) x.
1 2
(Amount of Feces/Gull/Day + Amount of Feces/Pigeon/Day) x
3 4
(No. of Gulls + No. of Pigeons) x Delivery x No. Days
5 6 7 8

For the Innisville Subwatershed:

1	Concentration of Gull Feces	1.9×10^{8}
2	Concentration of Pigeon Feces	3.2×10^{8}
3	Amount of Feces/Gull/Day	18.1 grams
4	Amount of Feces/Pigeon/Day	12.0 grams
5	No. of Gulls	50
6	No. of Pigeons	50
7	Deliver	assumed 25%
8	Number of Days	92 (swimming season only)

Values for the above with the exception of number days and number of birds is taken from the Tri-Authority CURB Plan 1992.