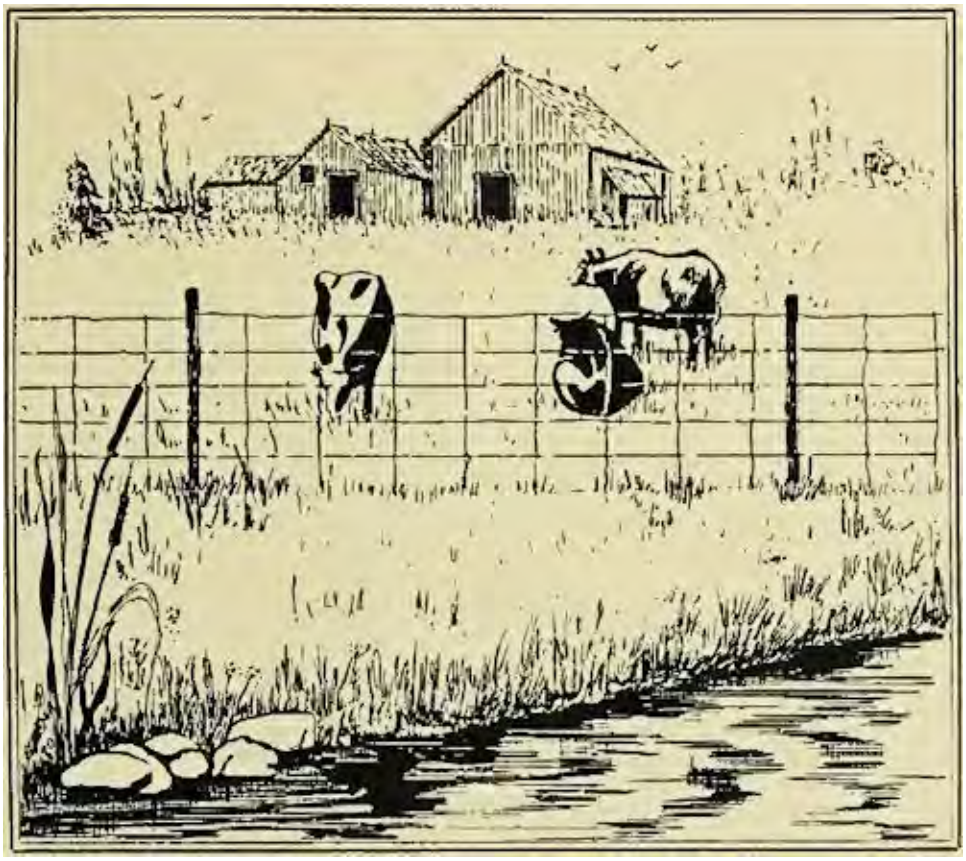
CLEAN UP RURAL BEACHES (CURB) PLAN

FOR THE BINBROOK RESERVOIR



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THE NIAGARA PENINSULA
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FOR THE ONTARIO MINISTRY OF THE ENVIRONMENT

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DISCLAIMER

This report has been reviewed by the local Technical Steering Committee and approved for publication. Approval does not necessarily signify that the contents reflect the position and/or policies of individual agencies.

FOREWORD

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

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

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

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

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

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

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

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

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

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

1) *In-situ* bacterial survival studies determine longevity: in watercourses, offshore of beaches, in sediments, and in milkhouse washwater tiles.
2) Biotracer studies determine the speed and nature of travel for bacteria introduced into a watercourse.
3) A liquid manure spreading study examines bacterial movement through the soil column and exiting field tile drains.
4) A target sub-basin study evaluates the effectiveness of a watershed with comprehensive remedial measures.

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

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

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Prepared for

Provincial Rural Beaches Planning and Advisory Committee
Ontario Ministry of the Environment

by

Kevin Laidley

April 1991

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The authority would like to express his appreciation to the following:

- To the livestock operators in the Binbrook Reservoir watershed for their cooperation throughout the study.

- To the Binbrook Reservoir Rural Beaches Study Technical Steering Committee which was comprised of representatives from the Niagara Peninsula Conservation Authority, Ontario Ministry of the Environment, Ontario Ministry of Agriculture and Food, Hamilton-Wentworth Federation of Agriculture and the Regional Municipality of Hamilton-Wentworth Department of Health Services. Their support, guidance and editorial reviews were greatly appreciated.

- To the staff and members of the Niagara Peninsula Conservation Authority for their support and assistance.

- To Millie Kukhta for her patience and skill in translating the author's handwriting into a legible report.

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EXECUTIVE SUMMARY

The purpose of the Clean Up Rural Beaches (CURB) plan is two-fold: to outline various options, and associated costs, of remediating bacterial inputs to the Welland River watershed upstream of the Binbrook Dam; and to outline a mechanism which will facilitate the implementation of socially and environmentally acceptable options for the improvement of recreational water quality in the Binbrook Reservoir Rural Beaches Study watershed and other rural watersheds within the jurisdictional boundary of the Niagara Peninsula Conservation Authority.

To achieve this purpose, the CURB plan outlines five implementation strategy options which can be categorized under three different attitudinal groups: a laissez-faire, or 'do nothing' attitude; a reactive, or 'deal with the symptoms' attitude; and a proactive, or 'deal with the sources' attitude.

The 'do nothing' strategy is the simplest to implement and has the lowest direct capital outlay. The environmental benefits to be derived from this approach, however, are negligible. In all likelihood, beach closings and algae blooms would continue and the aquatic ecosystem might be expected to degrade further.

The 'deal with the symptoms' strategy only addresses the issue of impaired water quality at the beach. It does not specifically address water quality concerns in other parts of the watershed.

Three strategies address the attitude of 'deal with the sources' and, as such, provide for wider ranging environmental benefits. Costs associated with these individual strategies range from $867,800 (for the complete control of livestock generated contamination on high priority livestock operations in the study watershed) to $1.63 million (for the remediation of non-compliance household septic systems throughout the study watershed).

To receive the most direct bacterial water quality benefits at the beach, certain components of strategy #2 should be considered as a first priority. Beach enhancement and maintenance (at an initial capital cost of $10,000 and annual capital maintenance costs of approximately $3,000) along with the management of gulls and waterfowl (at an initial capital cost of approximately $5,000) would provide for relatively low cost remedial measures which are likely to result in enhanced bacterial water quality at the beach.

For longer-term benefits, however, remediation of sites upstream from the beach will be required. Fencing of watercourses to restrict livestock access, in conjunction with a active riparian zone management program, is likely to provide for a wide range of ecosystem benefits and, as a result, should be second priority.

Concurred to the first and second priority components, other aspects of strategies 4 and 5 (along with erosion control measures such as conservation tillage and erosion control

structures) and the remediation of non-compliance domestic septic systems (strategy #3) should be initiated.

For optimum environmental benefits, a combination of implementation strategies 2, 3 and 5, at a cost of approximately $2.5 million, is suggested.

To facilitate the implementation of preferred strategies, and to provide for wider-ranging adoption of best management practices, a soil and water conservation program is recommended. The overall philosophy of the program is ecosystem sustainability through integrated resource management. Further, the program emphasizes planned change through a proactive, dynamic and integrated extension education program in partnership with watershed residents, community organizations, government organizations and other interested stakeholders.

The program recognizes that the enhancement of water quality is a complex issue that can best be achieved through the incorporation of an overall rural land stewardship concept. A variety of management practices must be promoted in a manner which is sensitive to the characteristics of the individual landowner and recognizes motivational factors which affect adoption rates.

The program must also utilize the strengths and ideas of the rural community, government agencies and other interested stakeholders. Co-partnerships should be enhanced, or developed, to make the best use of available resources.

A variety of educational, technical and financial assistance options should be available to address the varying needs of the rural community. Funding for the program through cost-sharing arrangements between local municipalities and provincial government agencies (such as OMAF, MOE, MNR and MOH) would ensure that both local and provincial interests were addressed.

Targeted financial assistance programs, in addition to existing broader-based financial assistance programs, would provide for more immediate environmental gains with least monetary expenditure. Co-ordination of these assistance programs between the funding agencies would enhance the efficiency of program delivery to the rural community.

An on-going evaluation process which analyzes long-term water quality trends, the rate of remedial practice adoption and changing land use practices throughout the watershed should be implemented to determine the effectiveness of the program at improving water quality.

1.0 INTRODUCTION

Since the early 1970's, the Binbrook Conservation Area has provided a number of recreational opportunities for its visitors. Many of these opportunities, such as swimming, windsurfing, boating and fishing, have been water-related.

During the summers of 1983, 1984 and 1985, the swimming beach at Binbrook was posted due to elevated bacterial concentrations. To make the beach suitable for swimming, the Niagara Peninsula Conservation Authority installed a chlorine curtain in 1986.

The curtain, while effective at improving bacterial water quality at the swimming beach, was expensive to operate and failed to address the larger problem of impaired water quality throughout the lake. Windsurfers and others utilizing recreational opportunities other than swimming were not protected by the action of the chlorine curtain. In addition, the turbidity of the water within the curtain was elevated, due to swimmer activity, to the point where the decreased water clarity was a hazard. The curtain remained in use for 2 swimming seasons.

In the years following, bacterial concentrations have remained high resulting in the posting of the beach for a portion of each summer.

In addition to bacterial concerns, the lake has experienced annual blue-green algae blooms. While not generally occurring until after the beach has been posted, the algae blooms cause sufficient aesthetic concerns and potential health risks that their presence could also result on the posting of the beach.

To address the issue of beach closures, the Conservation Authority, through funding from the Ministry of, the Environment's Provincial Rural Beaches Management Strategy, initiated the Binbrook Reservoir Rural Beaches Study in 1987. The overall goals of the study are:

- To locate the most significant sources of indicator species of bacteria which impact the beach at the Binbrook Conservation Area; and
- To reduce the levels of bacteria, phosphorus and sediment entering the Binbrook Reservoir through public awareness and cost-sharing programs.

Since 1987, the study has focused on improving the recreational water quality in the reservoir by addressing agriculture-related sources of bacterial contamination to the Welland River watershed upstream of the Binbrook Dam. Primary bacterial contamination sources addressed to date are those from livestock operations. Examples of such inputs are livestock access to watercourses, improper disposal of milkhouse washwater, inadequate manure storage and runoff containment facilities and undesirable manure application practices.

Other bacterial inputs identified, but addressed to a much lesser extent, are inadequate septic systems and birds, such as gulls and waterfowl.

Soil erosion, while recognized as a primary contributor of phosphorus and sediment to the watercourse, was also addressed to a lesser degree.

1.1 Clean Up Rural Beaches (CURB) Plan Description

The Clean Up Rural Beaches (CURB) plan represents the end product of the Binbrook Reservoir Rural Beaches Study activities for the period 1987 to 1990. The purpose of the CURB plan is two-fold:

1) To outline various options, and associated costs, of remediating bacterial inputs to the Welland River watershed upstream of the Binbrook Dam; and

2) To outline a mechanism which will facilitate the implementation of socially and environmentally acceptable options for the improvement of recreational water quality in the Binbrook Reservoir Rural Beaches Study watershed and other rural watersheds within the jurisdictional boundary of the Niagara Peninsula Conservation Authority.

To achieve this purpose, the CURB plan outlines various implementation strategy options ranging from 'do nothing' to the 'complete' remediation of bacterial contamination from livestock operations and private households throughout the watershed. In addition, a conceptualized soil and water conservation program, designed to facilitate the enhancement of rural water quality, is presented.

2.0 BINBROOK RESERVOIR WATERSHED

The Binbrook Reservoir watershed, located at the western end of the Niagara Peninsula Conservation Authority's jurisdictional area, covers an area of approximately 4,140 hectares in the Township of Glanbrook and Town of Ancaster in the Regional Municipality of Hamilton-Wentworth (Figures 1 and 2).

The watershed is predominantly agricultural with sections of strip development along major roads. The village of Mount Hope and the Hamilton Civic Airport are both located within the watershed.

In the 1970's attendance at the Binbrook Conservation Area was recorded as being as high as over 70,000 visitors per summer. Camping and other recreational activities flourished for the first decade of operations at the Conservation Area.

In 1983 and 1984 the swimming beach was posted for approximately 2 weeks during the summer due to elevated levels of fecal coliform bacteria in the water. In 1985, the beach was posted for most of the summer: Attendance at the Conservation Area dropped dramatically throughout this period.

To make the beach area suitable for swimming, the Conservation Authority installed a chlorine curtain in 1986 and again in 1987. Attendance, however, did not recover. Records for this period show that paid visitors numbered less than 9,000 per year. Camping at the Conservation Area was discontinued. Two full-time staff working out of Binbrook were reassigned.

Since 1988, the Conservation Area has operated as a day use area, utilizing casual employees. There has been no admission charge to the park. Clearly, great economic difficulties have occurred at Binbrook during the last decade. These economic hardships are

likely to have been felt by not only the Conservation Authority but also local merchants.

The Binbrook Reservoir Rural Beaches Study has monitored summer time water quality throughout the watershed since 1987. Three complete summers (May - September) have been monitored (1988, 1989 and 1990). Figure 3 shows the location of 6 sampling stations where comparative water quality data is available for the period 1988 to 1990.

Figure 4 illustrates that the bacterial water quality throughout the watershed has generally been unacceptable for recreational use of water over the three summers. Evidence of this has been the posting of the swimming beach at the Conservation Area during either the last week of July (1988) or the first week of August (1989 and 1990).

The aesthetics of the water in the study area is diminished due to very turbid conditions and the abundance of algae growth. All six sampling stations have reported mean total phosphorus concentrations exceeding the Ministry of the Environment guideline for the avoidance of excessive aquatic plant and algae growth (Figure 5). Blue-green algae blooms have been an annual occurrence at the Binbrook- Reservoir.

Another recurring situation is the presence of anoxic conditions in the bottom waters of the reservoir. This condition, along with the high turbidity levels which prohibit sunlight penetration to any significant depth through the water, severely limits the biological integrity and potential fisheries of the reservoir.

An improvement in the water quality of the Binbrook Reservoir watershed would result in many benefits to local residents, the aquatic ecosystem and the general public. Since this watershed is the headwaters of the Welland River, any improvement in water quality would also be a benefit to downstream water users throughout the remaining Welland River watershed.

Within the study watershed, 28 livestock operations were identified (as of 1990). Of these, 22 were deemed as having a high potential to impact on the water quality at the Binbrook Reservoir.

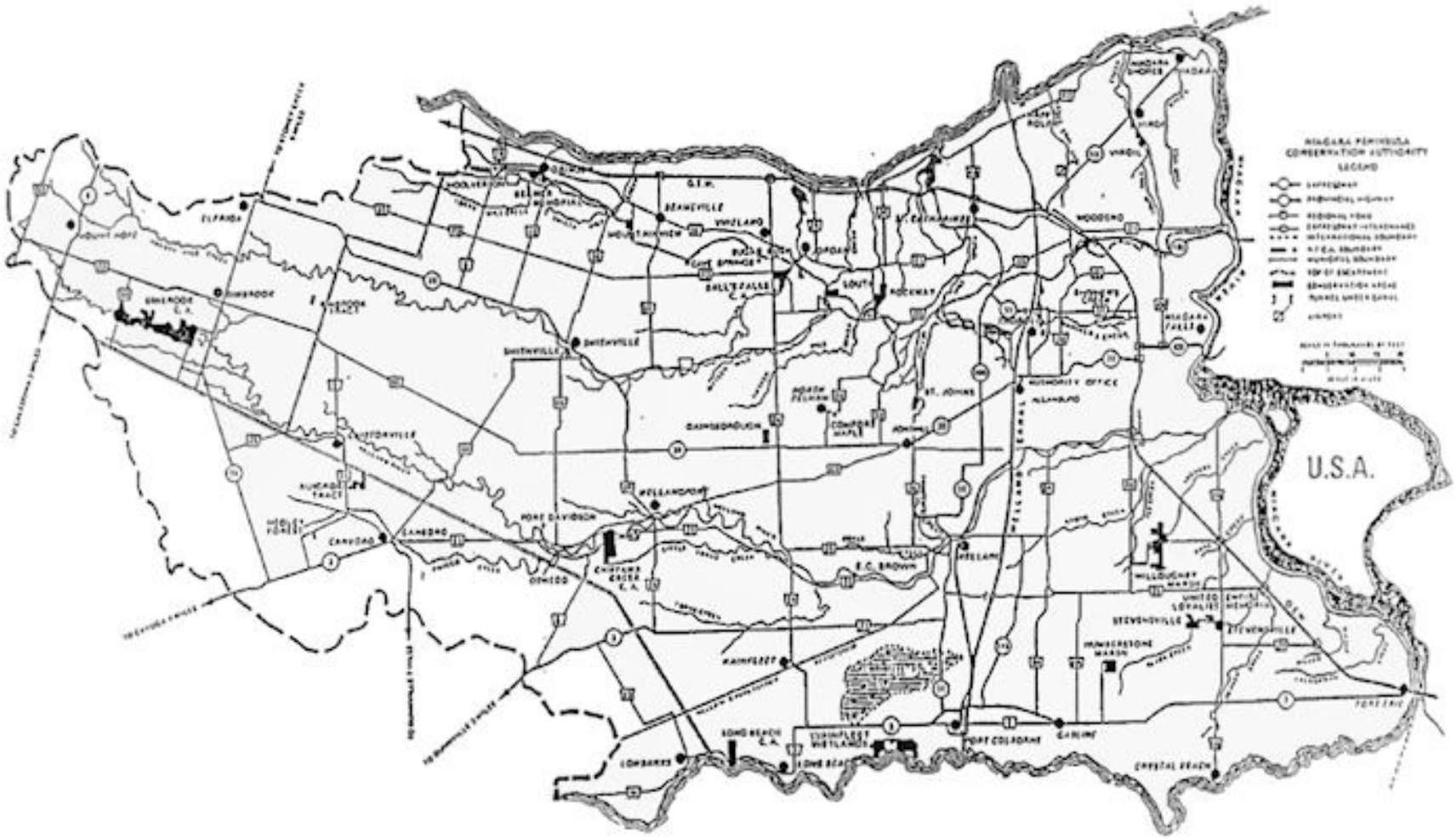

Figure 1: N.P.C.A. Area of Jurisdiction

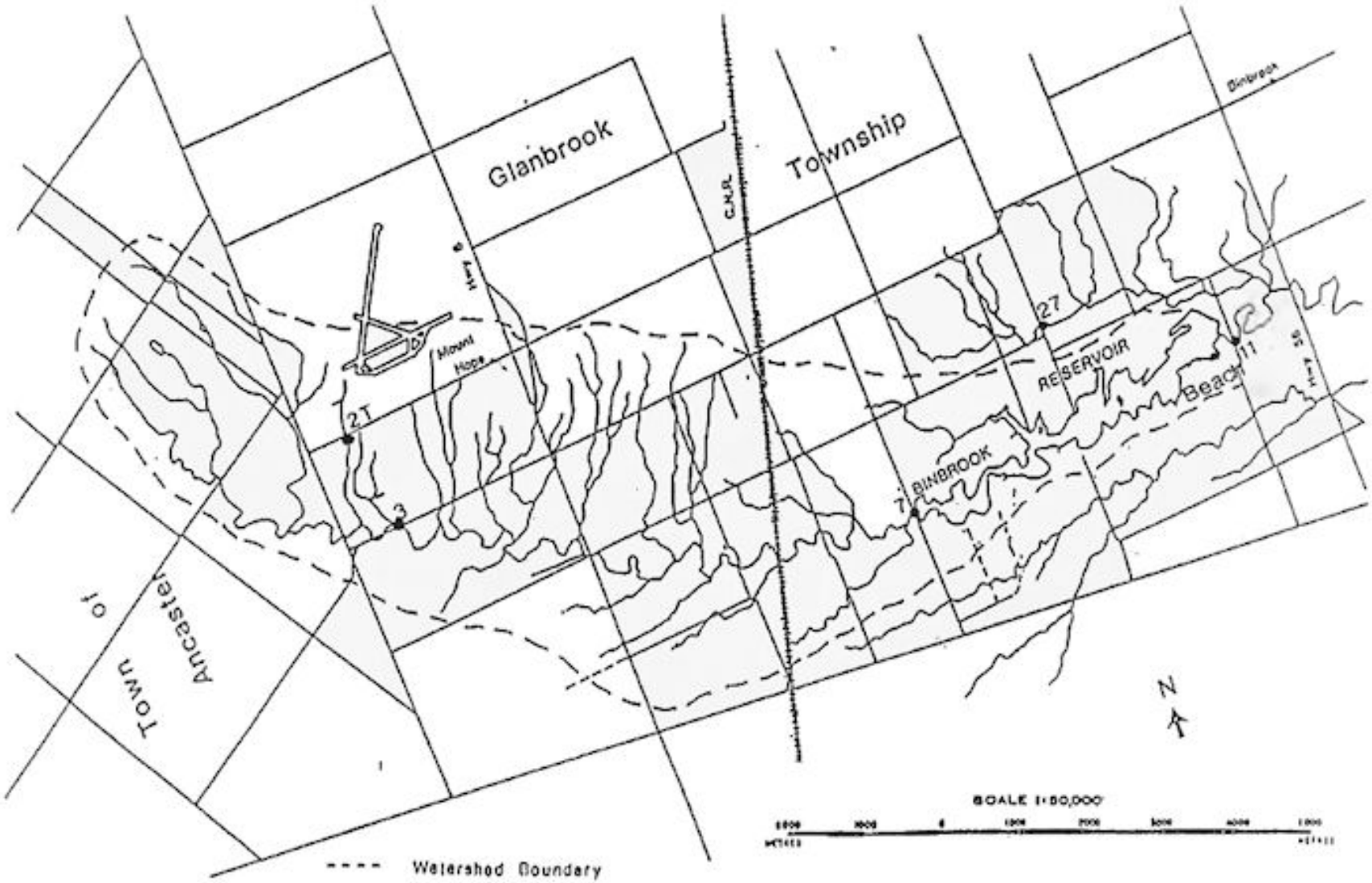

Figure 2: Binbrook Reservoir Watershed

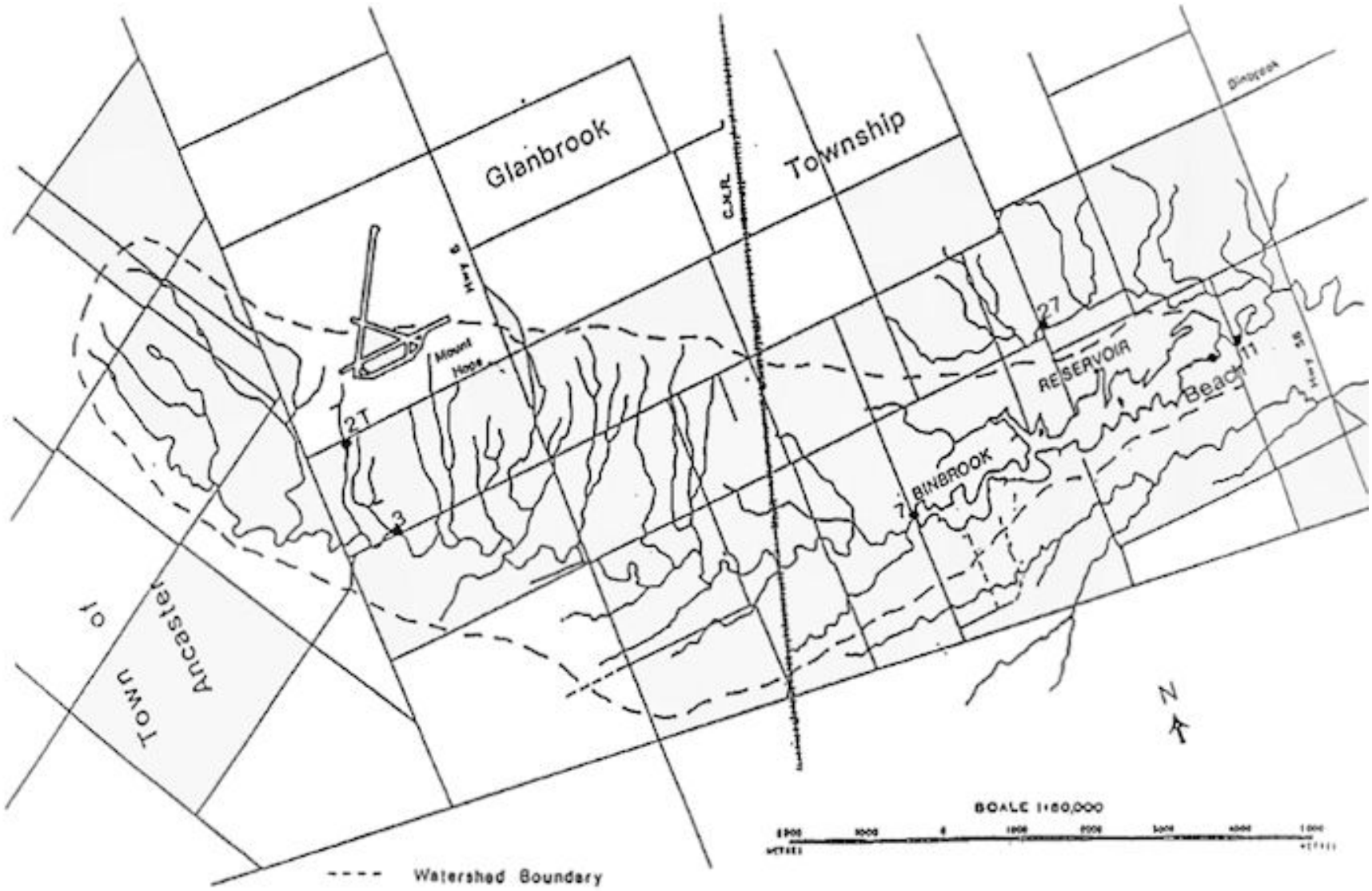

Figure 3: Location of Sampling Stations For Comparative Water Quality Data, 1988 - 1990

Figure 4: Comparison of Mean Fecal Coliform Concentrations - 1988 to 1990

	Mean Fecal Coliform (bacteria/100 mL)		
Sampling Station	1988	1989	1990
2T	539	466	619
3	132	397	604
7	117	196	78
West Side of Beach	95	126	109
Centre Beach	93	359	156
East Side of Beach	155	134	115
11	272	99	145
27	20518	3615	4962

* Guideline: less than 100 FC/100 mL

Figure 5: Comparison of Mean Total Phosphorus Concentrations - 1988 to 1990

	Mean Total Phosphorus (mg/L)		
Sampling Station	1988	1989	1990
2T	0.08	0.11	0.08
3	0.28	0.77	0.08
7	0.25	0.22	0.18
Beach	0.04	0.04	0.04
11	0.08	0.06	0.06
27	0.38	0.31	0.16

* Objective: less than 0.03 mg/L

3.0 IMPLEMENTATION STRATEGY OPTIONS

Five implementation strategies are identified as options to address the water quality concern at the Binbrook Reservoir swimming beach. The various strategy options are intended to focus on various levels of remediation of bacterial contamination at the beach. The five strategies are summarized as follows:

1. Do nothing.

2. Alteration of beach and/or reservoir situations.

3. Remediation of non-compliance household septic systems throughout the study watershed.

4. Complete control of livestock generated contamination on high priority livestock operations in the study watershed.

5. Complete control of livestock generated contamination on all livestock operations in the study watershed.

The first three strategies outline the. costs associated with options for the remediation of non-agricultural sources. Strategies 4 and 5 deal with agricultural contamination sources.

For the purposes of the CURB plan, the following agricultural remedial actions were assumed to be capable of providing complete control of livestock generated contamination and, therefore, were used in the derivation of implementation strategy costs: restricted livestock access to watercourses, proper disposal of milkhouse washwater and appropriately sized manure storage facilities (including containment for runoff from the storage and, if necessary, the barnyard). Other potential agricultural contamination sources, such as soil erosion and improper manure application, are recognized as important however were not priced. In many cases, remediation of these concerns is best achieved through management practices and not, necessarily, capital works.

Information derived from farm surveys was utilized to calculate CURB estimates. The length of fencing required for restricting livestock access to watercourses was measured during farm visits. Determination of the need for alternate watering sources and stream crossings was also based on information from farm visits. Temporary fencing was deemed to be the most practical means of fencing the watercourses. Due to the substantial variations in water levels observed and the severity of ice conditions in the spring it was determined (and confirmed with local farm operators' experiences) that permanent fencing was not a viable option. If permanent fencing were to be utilized it would need to be erected far from the watercourse and, in many cases, remove virtually all of the pasture from production. This situation was seen as totally unacceptable by the livestock operators.

Considerable effort has been made to incorporate the preferred farm management options of the individual farmers into the CURB. As in the case with fencing, farm operators were asked what their preferred manure management system would be if existing manure storage problems were to be remediated. Only one of the operators preferred a totally liquid system. All others stated that they would prefer to remain with a solid, or semi-solid, manure system even if it meant that a liquid runoff containment tank was part of the system. Manure storages for each individual operation were sized for 300 days storage and costs were estimated accordingly.

In the case of dairy operations, it was assumed that all milkhouse washwater would be added to the manure storage system. Systems were sized to accommodate all washwater during the 300 day period.

Costs used in the CURB estimates are based on discussions with local contractors/suppliers. Estimates for fencing axe based on material costs only, not installed costs. Estimates for manure storages are for the storage only and do not include transfer piping, transfer pumps, excavation, backfilling, spreading equipment or post-construction landscaping. Costs used for circular concrete tanks are variable based on tank size.

Some of the unit costs used to derive CURB estimates are as follows:

- Concrete pad for manure storages	$23.68/sq.m.	($2.20/sq.ft.)
- Concrete walls for manure storages (8 inches thick x 4 feet high)	$91.86/m	($28.00/ft.)
- Safety fence for manure storages (chain link)	$47.08/m	($14.35/ft.)
- Electric fence	$2.62/m	($0.80/ft.)
- Stream crossing	$4,000.00	
- Alternative watering source	$1,500.00	
- Household septic system	$5,000.00	

All CURB estimates exclude the cost of permits, long-term maintenance and any applicable taxes. CURB estimates can be considered to be very conservative. Only capital cost estimates are included. There has been no attempt to estimate the annual, or long-term, costs associated with program delivery.

Implementation strategy number 2 deals with the alteration of beach and/or reservoir situations. While some costs estimates are included with this option, it is assumed that these cost will be largely absorbed by the Conservation Authority.

3.1 Strategy #1 - Do nothing

The do nothing, or status quo, strategy does not propose any remedial measure and, as a result, does not have direct implementation costs.

With this strategy, the associated environmental benefits, at best, equal the direct implementation costs ... none. In all likelihood, however, the result of the 'do nothing' strategy will be further degradation of water quality in the watershed. Beach postings and annual algae blooms are likely to continue. Unfavourable aesthetics, further degradation of the aquatic ecosystem and continued health risks to water users are 'costs' which are associated with the acceptance and implementation of this strategy.

3.2 Strategy #2 - Alteration of the beach and/or reservoir situations

Strategy #2 deals with the symptoms of degraded water quality at the beach. It is, at least partially, a `band-aid' approach and only addresses the issue of impaired water quality at the beach.

This strategy, while not completely without merit, has been used by the Conservation Authority in the past. It is best suited to improving swimming opportunities in the short-term while longer term options are being implemented. A number of measures might be considered as components of this strategy.

A. Beach enhancement and maintenance

Water quality monitoring results have shown that the shallow waters near shore often exhibit high concentrations of fecal coliform bacteria due to contamination by waterfowl and the swimmers themselves (MOE, 1984).

Providing a daily beach maintenance program, such as removing bird dropping, litter, algae and other 'foreign material', will improve beach aesthetics and reduce potential contamination. Raking or harrowing the beach area will keep beach sand dry, 'fluffy' and will help expose any bacteria to the ultraviolet light of the sun. Ultraviolet will destroy the exposed bacteria.

Additions of clean sand to the beach each year will also improve aesthetics and reduce possible water contamination due to bacteria in the beach sediment. This practice was once part of the regular maintenance at the Binbrook Conservation Area but, in recent years, has been curtailed.

To bring the condition of the beach back to a desirable condition, it is estimated that approximately 40 to 50 loads of sand would be required. At approximately $200 per load, initial costs for beach enhancement would range from $8,000 to $10,000. Annual costs of sand replacement, following initial enhancement, are estimated at $2,000 to $3,000.

Since the daily maintenance associated with the beach could be incorporated into the duties of Conservation Area staff, annual maintenance costs are expected to be minimal.

B. Installation of a swimming curtain and chlorination system

A measure previous utilized by the Conservation Authority to provide safe swimming opportunities was the installation of a swimming curtain and chlorination system. The curtain, while effective at improving bacterial water quality at the swimming beach, failed to provide protection for windsurfers and other water users away from the beach area. In addition, the turbidity of water within the curtain was elevated, due to swimmers activity, to the point where the decreased water clarity was a swimming hazard.

While the system was effective at ensuring that the beach remained open all summer, it provided an 'artificial' environment for swimmers. It was, essentially, a pool within a lake. This 'poor, however, had a sand beach and sand bottom.

Another drawback of the chlorination system was that it had to be installed and removed at the beginning and end of each swimming season, respectively. Once removed, the curtain had to be stored and the chlorination pumps needed to be sent away for expensive servicing.

Based on 1985/1986 dollars, the cost of the curtain and chlorination system was approximately $70,000. Annual operating costs were $10,000 to $12,000.

Since the chlorine distribution system is essentially still intact, the costs of resurrecting this method of beach alteration would be significantly lower than outlined above.

C. Management of gulls and waterfowl

Surveys of gull and waterfowl numbers, and their location on the Binbrook Reservoir, have suggested that bacterial contamination of the swimming beach area from birds may be significant (Laidley, 1991). This, along with the previously referenced report indicating that near shore waters often exhibit high concentrations of fecal coliform bacteria due to contamination from waterfowl and swimmers (MOE, 1984), indicates that the management of gulls and waterfowl at the Binbrook Conservation Area may be an effective mechanism for improving bacterial water quality at the beach. Preferably methods could be devised so that these birds would be encouraged to spend their time away from the beach area, and yet, still be free to co-habitate with Conservation Area users.

There are essentially two different types of birds utilizing the beach area. Each is likely to require different management techniques.

Each year there are a number of geese which nest within the Conservation Area. This activity has been 'encouraged' by the Conservation Authority as part of its fish and wildlife program. The reservoir, and surrounding area, provides good habitat for nesting waterfowl.

Geese are grazing birds and are often seen in the day use area of the Conservation Area feeding on the grassy area maintained by Authority staff. The easiest access to this grass from the water is the beach. As a result, the geese tend to congregate at, or near, the beach area for portions of the day. The result is a large amount of droppings being deposited on, or near, the beach.

To help alleviate this problem, alternate grazing *areas* (away from the beach) should be provided to the geese. These areas will need to be maintained a grass will require regular cutting) and easy access for the geese, from the water, will be necessary. Initially, methods designed to encourage the geese to use these areas will be required. The provision of an abundant food source at non-threatening locations around the reservoir may reduce the frequency of the geese using the beach area. Additionally, suitable natural (or artificial) nesting habitat near these new areas may further encourage their usage by the geese.

Estimated costs for providing alternate grazing areas for geese are minimal. Initially, some grading of the shoreline, to allow easy access for the geese, may be required. In addition, the seeding of a suitable hardy grass mixture would be desirable. Regular maintenance of these areas could be incorporated into the daily duties of Conservation Area staff.

For gulls, the most appropriate and economical remediation measure may be the construction of a 'bird screen over the beach and swimming area. This method has been employed by a number of organizations, including the Grand River, Hamilton Region and Halton Region Conservation Authorities.

The initial material and installation costs of a bird screen are estimated at $3,000 to $5,000. Screen maintenance could also be incorporated into the daily duties of park staff. The screen would need to be installed each spring and removed at the end of each park season.

3.3 Strategy #3: Remediation of non-compliance household septic systems throughout the study watershed

Sanitary surveys conducted by the Regional Municipality of Hamilton-Wentworth Department of Health Services indicate that 70% of household septic systems surveyed in the study watershed failed to comply with regulations (Laidley, 1991). The main reason for noncompliance was grey water bypassing the septic system and directly entering roadside ditches.

Both 'grey water' and 'black water' are serious risks to water quality and human health as they contain high concentrations of fecal bacteria. Water quality monitoring in a part of the watershed where grey water bypasses are known to occur show geometric mean fecal bacteria concentrations over 205 times higher than the MOE guideline for recreational use of water (Laidley, 1989).

Information from topographic maps shows that there are 465 households in the Binbrook Reservoir watershed. If 70% of these (326) are assumed to have faulty septic systems, the potential for water quality degradation is vast. RemediatIon of these systems would provide for greatly improved bacterial and chemical water quality (faulty septic systems also contain high concentrations of phosphorus). The result would be safer water for recreational uses and less available phosphorus to promote algae growth.

The estimated cost of repairing a household septic system is $5,000. The total estimated cost of remediating 326 non-compliance septic systems throughout the watershed is $1,630,000.

3.4 Strategy #4: Complete control of livestock generated contamination on high priority livestock operations in the study watershed

The objective of strategy #4 is to completely control livestock generated contamination on high priority livestock operations in the watershed. Complete control is assumed if livestock access to watercourses is restricted and appropriately sized manure storage facilities are in place and on daily farms, milkhouse washwater is disposed of in an proper fashion (the CURB plan assumes that washwater is added to an appropriately sized manure storage).

Twenty-two high priority farms have been identified in the watershed. Twenty-two upgraded manure storage facilities (including, where appropriate, provisions for milkhouse washwater disposal and sizing to accommodate barnyard runoff) are required. In addition, on 7 of these farms, approximately 5,370 metres of fencing is needed to restrict livestock access to the watercourses. Seven stream crossings and 4 alternative watering sources are also required.

Remedial cost estimates for strategy #4 are as follows:

Manure and milkhouse washwater storages (22)		$634,800
Fencing of watercourse (5,376m x $2.62/m)		14,085
Stream crossings (7 x $4,000)		28,000
Alternative watering sources (4 x $1,500)		6,000
Total for high priority farms		$682,885
Average for high priority farms	approximately	$ 31,040

3.5 Strategy #5: Complete control of livestock generated contamination on all livestock operations in the study watershed

Strategy #5 deals with the complete control of livestock generated contamination on 22 high priority farm as well as from 6 lower priority farms.

A total of 28 livestock operations are located within the Binbrook Reservoir watershed. Twenty-eight Manure storages, 5,864 metres of streamside fencing, 8 stream crossings and 4 alternative watering sources are required for complete remediation of livestock generated contamination throughout the entire watershed.

Remedial cost estimates for strategy #5 are as follows:

Manure and milkhouse washwater storages (28)		$814,400
Fencing of watercourse (5,864m x $2.62/m)		15,360
Stream crossings (8 x $4,000)		32,000
Alternative watering sources (4 x $1,500)		6,000
Total for all farms		$867,760
Average for all farms	approximately	$ 30,990

3.6 Summary of Implementation Strategy Options

The five strategies presented represent various options for addressing the problem of beach posting due to elevated fecal coliform bacteria. They should not be seen as ultimate paths for remediation but only as alternatives. Within the 5 strategies, three attitudes can be extracted: laissez-faire, or 'do nothing' attitude; a reactive, or 'deal with the symptoms', attitude; and a proactive, or 'deal with the sources' attitude. Costs and benefits can be attributed to each of these attitudes.

The 'do nothing' approach (strategy #1) is the simplest to implement and has the lowest direct capital outlay...do nothing and spend nothing. The environmental benefits to be derived from this approach, at best, will equal the direct implementation costs. In all likelihood, the benefits to be derived will, in fact, be negative as water quality and the aquatic ecosystem might be expected to degrade further. Beach postings and algae blooms are likely to continue under this scenario.

While environmental benefits and direct implementation costs associated with *this* strategy are both negligible, there may be opportunity costs attributed to this approach.

The 'deal with the symptoms' approach (strategy #2) is largely reactionary in nature. While it is partially a 'band-aid' approach, there are some aspects of the strategy that address sources of contamination (birds). This, however, is only partially proactive since the birds still contribute to the contamination problem (however, away from the beach area).

If the only objective of the CURB is to provide for a non-posted swimming beach, then the adoption of strategy #2 appears to be most appropriate and cost effective. The installation of a swimming curtain and chlorination system provides for safe swimming conditions (with respect to bacteria), has a relatively low capital cost and a reasonable annual operating cost. It does not, however, provide benefits to other recreational water users GI windsurfers) and does not enhance downstream water quality.

If the CURB goes beyond only providing for safe swimming opportunities and encompasses an ecosystem type of approach, then the benefits of strategy #2 are quickly eroded. It does not benefit the aquatic ecosystem and, may in fact, be detrimental due to the addition of chlorine into the water.

Strategies 3, 4 and 5 are proactive and aim at dealing with sources of bacterial contamination. Each deals with some of the bacterial contamination sources and, by themselves, may improve recreational water quality enough to prevent beach posting.

For optimum benefits, the most desirable situation would be one that combines options 2, 3 and 5. Short-term (band-aid') benefits can be gained by providing for swimming as per option #2. Longer-term, watershed wide benefits will be achieved through strategies 3 and 5.

Discounting the costs of strategy #2, which are assumed to be borne by the Conservation Authority, the cost of watershed wide benefits as per strategy options 3 and 5 is approximately $2.5 million. The vast majority of this cost, $1.63 million (or 65%) is for the remediation of faulty household septic systems.

The costs of implementing complete control of bacterial contamination throughout the watershed are relatively high. Costs to control livestock generated contamination in the watershed represent approximately 35% of the total.

The improvement of water quality is a complex issue that involves many components. To provide for optimal benefits, a comprehensive program must address these components in a proactive, dynamic and integrated manner. The following section presents a conceptualized soil and water conservation program, having rural *water* quality as its focus, for consideration.

4.0 A SOIL AND WATER CONSERVATION PLANNER

The Pollution from Land Use Activities Reference Group (PLUARG) studies of the 1970's illustrated that agriculture was a contributor to the degradation of rural watercourses. Since PLUARG, a number of government programs have addressed the management of soil, manure and pesticides. Recent examples include the Ontario Soil Conservation and Environmental Protection Assistance Programs (OSCEPAP and OSCEPAP II), the Soil and Water Environmental Enhancement Program (SWEEP), the Land Stewardship Programs (LSP and LSPII), the National Soil Conservation Program (NSCP) and the Rural Beaches Strategy. Central to each of these programs has been the encouragement of specific management practices through technical and/or financial assistance.

The 1972 Niagara Peninsula Conservation Report also recognized agricultural practices as a concern to the quality of water in streams throughout the Niagara Peninsula. Many of the concerns outlined in the Report remain as concerns in the 1990's.

A program to improve water quality involves a number of interrelated aspects which must be addressed. Many factors impact on rural water quality. The quality of water, in turn, influences other biological systems. In short, when considering the development of a program to protect/enhance rural water quality, the larger ecosystem relationships must not be overlooked.

Healthy soil and water ecosystems serve as the base for many of our other natural resources (i.e. fish, wildlife, forests). Together, the management of these various resources constitute the stewardship of rural land as depicted in Figure 6. A soil and water conservation program, then, might be seen as the base for good rural land stewardship and a springboard to further environmental programming.

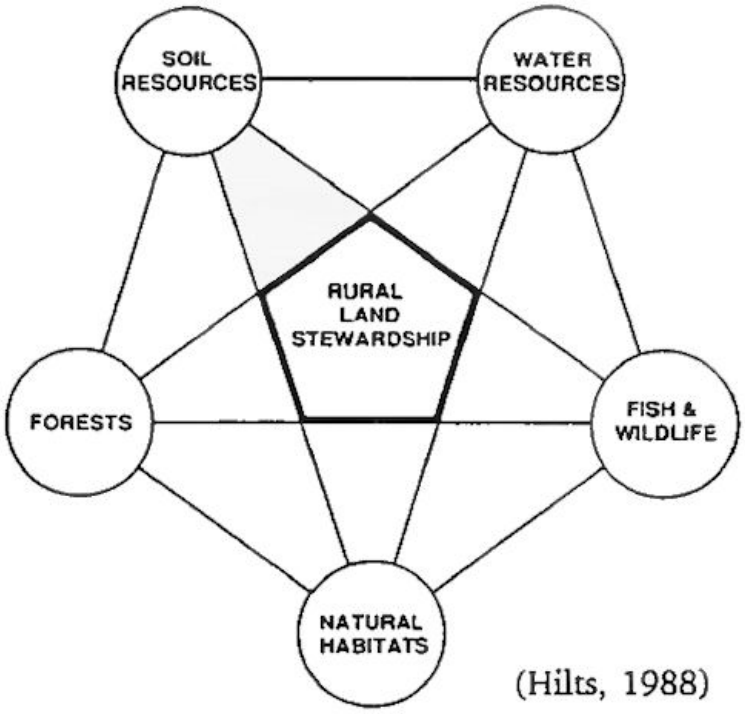

Figure 6: A Concept of Rural Land Stewardship

Conservation Authorities, by their mandate, are well suited to providing a lead role in integrated resource management. They are organized on the basis of hydrological units thereby presenting a unique opportunity to integrate the management of the various resources to provide for optimum water quality enhancement and protection.

The Niagara Peninsula Conservation Authority's Rural Water Quality Program has focused primarily on reducing the impact of livestock and manure management practices on the water quality of the Binbrook Reservoir watershed. While the program was successful in increasing overall awareness and interest in water quality concerns resulting from these management practices, it was unable to fully integrate the numerous on-farm management practices which, if implemented as part of a comprehensive conservation farm program, would preserve or enhance rural land resources.

Since a large proportion of the rural landscape in the Niagara Peninsula is agricultural in nature, and since healthy soil and water ecosystems provide the base for many other natural resources, it follows that an agricultural soil and water conservation program could act as a catalyst to the stewardship of rural lands throughout the Peninsula. Such a program would provide benefits not only to the agricultural community but to all watershed residents.

4.1 Program Philosophy and Goals

The overall philosophy of the program is ecosystem sustainability through integrated resource management. By adopting the principle of ecosystem protection and enhancement, the program will envelop societal, environmental and economic concerns.

In these times of increased societal awareness and demands for a quality environment, it is particularly important that an agricultural extension program face, and meet the challenges of a system in which agricultural production and the preservation of natural resources are integrated. Both the farm and non-farm communities must work together to achieve the desired outcome.

As major rural landowners, the farm community must make even greater efforts to ensure that operations on their farms do not negatively impact on the environment. Livestock and crop management practices must become more environmentally responsible. Management of wetlands, forests and streams must be further incorporated into the overall farm management plan. The aesthetic appearance of the agricultural landscape, especially in the eyes of the non-farm community, should be enhanced to portray a 'greener' and 'environmentally friendly' atmosphere. All of those measures are likely to be demanded by society. The challenge will be to have widespread adoption of these measures while, at the same time, maintaining economic viability on the farm.

The non-farm community has an important role to play in the adoption of such a program. As 'consumers' of the rural environment, we must all recognize that there are costs involved in preserving this commodity. Many manufacturing industries are able to incorporate the costs of environmental protection into their products. At the same time, society deems environmental protection important enough to further provide financial assistance, to these same industries, for the improvement of environmental protection measures. If the farm community is to implement more environmental protection measures as part of the normal operations of the farm, and for the benefit of society as a whole, then financial assistance should be provided to the farm community as it is to industry.

Both the rural farm and non-farm communities must ensure that domestic sewage is disposed of in a proper manner. Septic systems must not be overlooked when considering sound environmental protection measures in the rural community. Individual homeowners must maintain responsibility for a properly functioning septic system to treat household septic wastes, including grey water.

As a long-term goal, the soil and water conservation program aims to protect, enhance and sustain soil and water resources within the Binbrook Reservoir Rural Beaches Study watershed and other rural watersheds within the jurisdictional boundary of the Niagara Peninsula Conservation Authority.

To achieve this long-term goal, a shorter term goal has been established; to promote the adoption of rural land management and waste management practices which are conducive to the sustained use of rural soil and water resources. This shorter term goal maintains with it the concept of sustainability of soil and water resources and, by extension, soil and water ecosystems.

Specific rural land management and waste management practices which will be promoted as part of the program are described in a later section of this report.

4.2 Program Approach

The desired outcome of the overall program is the improvement of rural water quality. Water quality, therefore, must be central to both the program and the program approach.

To effectively achieve its long term goal, the program must facilitate attitudinal change. While it is recognized that this type of change is not achieved over-night, it is essential if long-lasting benefits are to be realized. Change must be planned if it is to have positive benefits. It cannot just be 'allowed to happen.

For maximum effectiveness, change should be achieved through a systematic program planning process which analyzes the situation, identifies needs, sets priorities, states objectives, inventories available resources, selects methods for implementation and provides for ongoing evaluation.

The program approach, therefore, must emphasize planned change through a proactive, dynamic and integrated extension education program in partnership with watershed residents, community organizations, government organizations and other interested stakeholders. The proactive approach allows the program to be taken to watershed residents and organizations rather than waiting for them to come to the program (a reactionary approach). This is important if contaminants are to be controlled at their source (proactive) rather than trying to deal with them after they have entered the watercourse (reactive), It is also an important component in increasing awareness of water quality issues and remediation.

Furthermore, the program should be dynamic to allow for 'realignment' in response to societal changes and varying circumstances. It should also be an education program that utilizes input from local residents and community organizations various government agencies and other interested stakeholders. The program should stress local participation since it is the local residents who are 'basic units of change' and are most directly affected.

Following from this, a water quality focused program, since it impacts on a number of different societal groups, will need to be co-operative and integrated with the activities of these groups.

To effectively facilitate long term attitudinal change, the program must recognize the need for education, technical and financial assistance components. Education and technical assistance are key elements throughout the diffusion/adoption process while financial assistance is likely to be most needed as an incentive to assist in the adoption of a particular practice. As various practices are accepted into the farm management plan, the need for financial incentives to adopt another new practice may be diminished as the farm operator recognizes the merits of the practice to his/her operation.

Recognizing that the program has as its focus water quality improvement of rural watercourses, there may be merit in targeting financial assistance to areas where improved rural land stewardship practices are most likely to directly result in improved in-stream water quality. This does not imply that similar assistance should not be available for areas removed from streams. The same practices which are likely to lead to sustained water quality in streams are beneficial in the improvement and preservation of soil ecosystems, natural habitats for wildlife and other rural land stewardship components. For the purposes of a water quality program however, the largest 'immediate' return on financial investment is likely to be achieved through targeting available financial resources. These Immediate' improvements can then be utilized and managed in an educational program and monitored

over the long-term to illustrate the benefits of an integrated program.

4.3 Administrative Considerations

The phrase "water respects no political boundaries" is often quoted and should be carefully considered with respect to the administration of a water quality program. Many government agencies (for example, Ministry of the Environment, Ministry of Natural Resources, Ministry of Agriculture and Food, Ministry of Health, Environment Canada, Agriculture Canada and Fisheries and Oceans), industries, Conservation Authorities, private and community organizations, special interest groups and individuals are all recognized as having a vested interest in water quality. In many instances, the group or agency is primarily concerned with a specific aspect of the water quality issue. For example, the Ministry of Health is primarily concerned with public health while a particular industry may be primarily concerned with the quality of water as it relates to a specific use in the manufacturing process.

Often, the operational units of a particular group is determined by political boundaries. In the case of a government agency, for instance, two separate administrative offices may be responsible for program implementation at different points along and watercourse. These different offices may have identified different 'local priorities' (based on the defined political boundaries) and, as a result, program implementation may not be consistent at all points along the watercourse.

Water does, however, respect watershed boundaries. It would be logical then that an agency, structured on a watershed basis, be identified as the lead delivery agent of a rural water quality program.

Considering the three basic principles of the Conservation Authority movement

(management of renewable natural resources on a watershed basis; local initiative and involvement; and financial partnership between municipal and financial partnership between municipal and provincial governments), the Niagara Peninsula Conservation Authority is seen as the appropriate lead agency for the delivery of program water quality focused program in the Niagara Peninsula. Through the Conservation Authorities Act the N.P.C.A. is able to enter into agreements with various agencies and administer programs on their behalf.

Over the past few years, the N.P.C.A.'s Rural Water Quality Program has become increasingly recognized by the rural community as being committed to soil and water conservation. As a result, a growing rapport with farmers, farm organizations, government agencies and individuals is currently in place. Direct co-operative working relationships between the Authority and local offices of the Ministries of Agriculture and Food and Natural Resources, as well as local Soil and Crop Improvement Associations, have also been established through this program. Since 1987, the N.P.C.A. and Ministry of the Environment have entered into agreements to address water quality concerns through the Rural Beaches Program.

The Authority is also active in other aspects of rural land stewardship. Existing programs include water management (through flood and valley system erosion control, flood forecasting, flood plain mapping, resources planning and regulation programming), public education, fish and wildlife and forestry. The Authority is also involved in providing for recreational opportunities related, in part, to water.

With this multitude of existing programs, opportunities exist for the integration of various programs to maximize resource management benefits in an ecosystem approach. These opportunities can be enhanced through the involvement of government and local community agencies.

Currently, the N.P.C.A. has one staff person specific to the Rural Water Quality Program. This position is one which takes a comprehensive approach to the issue of rural water quality. The approach encompasses data collection, information and education; program planning, implementation and evaluation; and extension and technical services. The position might best be described as 'a specialist at integrating a broad array of resources management issues'. Considerable time is devoted to networking with other resource management specialists and facilitating resource management activities from various groups and agencies for delivery to the rural community.

The current level of staffing should be expanded to 2 staff to allow for a proactive and integrated soil and water conservation program throughout the entire N.P.C.A. jurisdictional watershed. In addition, existing co-partnerships with the Ministries of Agriculture and Food, Natural Resources and the Environment, and local Soil and Crop Improvement Associations, should be maintained and enhanced. Co-partnership arrangements with other local community organizations and government agencies having a vested interest in the rural water quality in the Niagara Peninsula should be sought and established.

Funding for the soil and water conservation program should be provided through cost-sharing arrangements between local municipalities and provincial government agencies (MOE, OMAF, MOH and MNR). Such an arrangement would ensure that both local and provincial interests are committed to the protection, enhancement and sustainable management of soil and water resources ecosystems in the Niagara Peninsula.

While the day-to-day operations and administration of the program would be through the Conservation Authority, a steering committee, comprised of members from both government and non-government agencies, should provide overall program direction. Such an approach has worked well for the Rural Beaches Program. At least one half of the steering committee should be 'non-government' members. This will ensure that both local

organizations and government agencies have input into the planning and development of the program.

4.4 Program Components

A number of rural land management and waste management practices having the potential to impact on rural water quality have been identified. By remediating existing inadequate situations and managing all practices with an ecosystem perspective, long-term environmental rewards will be realized.

Many of the practices are directly complimentary. Some practices will have an impact on the improvement of bacterial water quality. Others will have large roles to play in the reduction of sediment loading to watercourses. Often, a specific practice will have multiple benefits. All are important components in a comprehensive approach to improved rural water quality and rural land stewardship.

4.4.1 Manure Management

Livestock manure, properly managed, can be a valuable resource generated from the farming operation. It can supply a significant portion of the nutrients required for crop production and, due to its organic matter content, can improve the tilth, structure and permeability of soil.

For maximum efficiency, manure needs to be properly stored and applied to the land in a manner which optimizes nutrient availability. Such management also minimizes the potential negative environmental impacts of manure on stream water quality.

Essentially, there are two separate components to manure management; storage and application.

A. Manure storage

Manure storages should be designed to completely contain at least 200 days of manure production and associated precipitation. By containing both the solid and liquid portions of the manure, environmental impacts are minimized and manure nutrients are retained for field application. Where appropriate, runoff from barnyards should be contained within the manure storage facilities. On dairy farms, milkhouses washwater can also be added to the storage. In all cases, the farm operator should ensure that his/her manure storage is sized appropriately.

The CURB provides cost estimates for manure storages having 300 days of storage capacity. By assuming this size of storage, the CURB allows for greater manure management flexibility with respect to timing of manure application. This is especially desirable on the clay soils which are typical of the study area.

Properly designed manure storages are very effective at reducing the environmental impact potential of livestock farms on the water quality of streams. In addition, they improve the overall sanitation of the farm and provide the opportunity for utilization of manure resources at appropriate times of the year.

The main drawback of manure storages is their initial capital cost. Manure storages represented the largest 'agricultural cost' identified by CURB ($814,400). On average, the cost of a 300 day capacity, solid manure system designed to contain manure, runoff from the manure, barnyard runoff and, if applicable, milkhouse washwater was approximately $30,990.

B. Manure application

A second, and equally important aspect of manure management, is manure application. Timing, rate and method are all key aspects of manure application.

Proper timing of manure application can reduce the chances of manure having a negative environmental impact and can maximize the nutrient benefits to crops. Manure should not be spread on frozen ground since the potential for runoff is high as is the loss of nitrogen to the atmosphere. Also, spreading in wet conditions should be avoided as both runoff potential and soil compaction potential are high under such circumstances.

Rate of application is also an important consideration. Very few of the farm operators surveyed as part of the Binbrook Reservoir Rural Beaches Study knew how much manure was being applied to their land. Similarly, few knew the nutrient content of the manure or what the 'average' manure nutrient content was for the type of livestock that was on their farm.

For effective management, manure should be applied at a specific rate following consideration of available manure nutrients, soil fertility and crop requirements. Soil and manure sampling should be conducted regularly. In addition, manure spreading equipment should be calibrated so that the rate of manure application can be matched to manure and soil sampling results and the nutrient requirements of the crop. Over-application is not only economically unfavourable but can be an environmental hazard.

The method of manure application is an important management tool. Soil injection, or the immediate incorporation of manure into the soil, increases the nutrient availability of manure while reducing both the potential for runoff and the risk of complaints due to odours.

Costs associated with manure application are largely attitudinal. The main associated monetary cost is for the manure spreading equipment which will need to be matched to the type of manure which is being handled on the farm i.e. solid, semi-solid or liquid). In nearly all cases, provisions will need to be made for spreading some liquids. The decision as to whether to purchase liquid manure spreading equipment, or to have the liquids applied by a custom operator, is one that should be carefully considered on an individual farm basis.

4.4.2 Proper Handling of Milkhouse Washwater

Improperly handled milkhouse washwater can be a major source of bacterial and phosphorus contamination to rural watercourses. In the Rural Beaches study watershed, only 1 of 15 dairy operations had a method of handling milkhouse washwater which could be described as adequate.

Currently, there are two accepted methods of handling this water. The first method is through a sediment tank and treatment trench system similar to that used for household septic systems. Presently. these systems are receiving 'mixed reviews' and have been found to have low efficiency on impermeable soils. Initial cost for a treatment trench system is approximately $3,000-$5,000. In addition, the sediment tank requires regular pumping (typically, 1 or 2 times per *year).* The cost per pumping is estimated at approximately $150 (Miller *et al*, 1987).

The addition of milkhouse washwater to a properly designed and sized manure storage appears to be the most practical, and economical, method in the study watershed. Because of the low permeability of soils in the area, the sediment tank and treatment trench system is seen as unreliable. Furthermore, with the addition of the washwater to the manure storage, the nutrient value of the washwater can be utilized for crop production. Generally, the cost of installing a separate liquid storage exclusively for the containment of milkhouse washwater is prohibitive.

4.4.3 Restricting Livestock Access to Watercourses

Unrestricted livestock access to watercourses has been shown to have a detrimental impact on the quality of water in a stream (Laidley, 1989 and Laidley, 1991). Livestock, if allowed access to a watercourse, trample streambanks (making them more susceptible to erosion), defecate and urinate directly into the stream and can destroy fish habitat.

A practical, effective and cost-efficient means of reducing such impacts on a watercourse is to fence the stream to restrict livestock access. Along the 13.4 km (approximately) section of the Welland River, upstream of the Binbrook Reservoir, 9 livestock access sites were noted requiring approximately 5.9 km of fencing.

If a stream is fenced, and the livestock had been utilizing the stream for watering, an alternative watering source will be required. If the pasture is adjacent to the barn and the quantity of water available at the barn is adequate, the preferred option is to water the livestock from the barn. If, however, its necessary to use the strearn as a water source, provisions should be made to pump the water from the stream to the livestock. Common methods of pumping water to livestock are through the use of electric powered pumps, solar powered pumps or nose pumps. Within the study watershed, 4 alternative watering devices were deemed necessary.

It may also be desirable to provide crossings to permit pasturing of both sides of the watercourse or to allow machinery access across the stream. While the most desirable type of crossing would be one that did not permit livestock contact with the water (as in a culvert crossing), low level crossings are often the most practical alternative.

This is the case within the study watershed (where it was estimated that 8 crossings would be required). Due to ice conditions in the spring and widely fluctuating water levels

throughout the year, it was decided, in consultation with local farmers, that low level crossings would be most feasible. For the same reasons, electric fencing was preferred.

The estimated cost for providing 8 low level crossings, 4 alternative watering devices and 5,860 metres of electric fencing is approximately $53,400. The perceived benefits resulting from this fencing include reduced sediment, phosphorus and bacterial loading to the watercourse; improved streambank stability; less risk of spreading waterborne diseases from one herd to another; improved fisheries habitat and reduced risk of livestock injuries resulting from uneven footing in, or near, streams. Due to the multi-beneficial nature of this program component, the fencing of watercourses to restrict livestock access should be a high priority.

Even with this multitude of benefits to be derived from fencing watercourses, farmers in the area appear reluctant to accept the practice. Historically, livestock drinking directly from streams has been a common, and inexpensive, means of providing water. In addition, all of the pasture, including streambanks, was available for grazing. Fencing is perceived by farmers as being inconvenient, resulting in a loss of valuable pasture and an unnecessary expense. It represents a major change in pasture management and in their historical socio-cultural beliefs.

4.4.4 Domestic Septic Systems

Properly sized and functioning domestic septic systems are an effective means of treating household septic wastes. Such wastes include not only those from toilets, but laundry washwater and water from bathtubs, showers and sinks. Left unchecked, these wastes can pose a severe risk to water quality and human health.

Sanitary surveys conducted in the study watershed by the Regional Municipality of

Hamilton-Wentworth Department of Health Services revealed that 70% of households surveyed had illegal laundry waste disposals (Laidley, 1991). By extrapolating this survey data to the entire study watershed, it is estimated that approximately 326 households would require remediation of septic systems. Assuming that remediation would cost approximately $5,000 per household, the total estimated cost to eliminate water quality concerns associated with septic system would be $1.63 million.

4.4.5 Erosion Control

The control of soil erosion from agricultural operations provides for numerous benefits not only to water quality but to the productivity of the farm enterprise. Eroded soil, when it enters a watercourse, can have serious detrimental effects on the aquatic ecosystem. The resulting increase in suspended sediments can decrease the aesthetics of the stream and make it unsuitable for a number of species of fish. In addition, the sediment, when it settles out of suspension, can cover fish spawning beds thereby jeopardizing future generations of fish.

Soils also can act as a transport mechanism for a number of contaminants. Phosphorus, bacteria and some pesticides are known to adhere to soil particles and can enter a watercourse via soil erosion.

Once soil has entered a watercourse, it is no longer available for field crop production. Valuable top soil and crop inputs such as pesticides and fertilizer are lost from production areas. The resulting reduction in crop yield and economic return per unit of land can be substantial.

A number of proven erosion control techniques are available for adoption by the farm operator. Tillage practices (such as contour plowing and minimum tillage and no-till) and 40

cropping practices (such as crop rotations and the use of cover crops) are examples of such techniques. Structures, including grassed waterways, water and sediment control basins and others, are effective and common on many farms throughout the province.

While techniques of soil erosion control are well known in the agricultural community, there are still many areas within the study watershed experiencing soil losses greater than what could be considered as reasonable for sustaining productivity. In some cases, the land is of such a fragile nature that permanent retirement from agricultural production should be considered. In others, the establishment of windbreaks would reduce soil loss due to wind erosion and provide for improved landscape aesthetics.

Watercourses in the study watershed, and generally throughout the Niagara Peninsula have high concentrations of suspended sediments. While some of this can be expected as naturally occurring, there is much visual evidence that significant proportions can be attributed to overland erosion and streambank erosion.

Sediment loading from streambank erosion should not be overlooked. Remediation of actively eroding sites can save valuable cropland for the farmer and will result in enhanced water quality.

While not a priority of the Rural Beaches study, erosion was recognized as an important contributor to water quality degradation. Efforts to remediate this contaminant source should be enhanced.

4.4.6 Riparian Zone Management

Tied closely to erosion control and fencing of watercourses riparian zone management. The maintaining of a vegetated zone, including shrubs and trees, can enhance

water quality by controlling erosion and providing a filter for any overland runoff. In addition, fish and wildlife habitat can be enhanced through such attention. Overall aesthetics of the landscape and a positive image of the rural community are other important benefits derived from riparian management.

4.4.7 Vegetated Buffer Strips

Vegetated buffer strips can be used as simple, economic means by which soil erosion and the contamination of watercourses from overland runoff can be curtailed. When used within the riparian zone, they help maintain the integrity of the streambank and can provide valuable habitat and corridors for wildlife. When utilized around the outside of a field, the buffer strip can be used to turn equipment thereby reducing soil compaction on the cropped portion of the field. If planted to forages, the buffer can be also utilized to grow hay for livestock.

Many watercourses throughout the Niagara Peninsula could benefit from the establishment and maintenance of permanent buffer strips. Active promotion, and subsequent adoption, of this low cost remedial measure is likely to pay large dividends to many components of the rural land stewardship model.

4.4.8 Woodlot and Wetland Management

The conservation and management of woodlots and wetlands are important aspects of rural land stewardship. Both provide for water quality and fish and wildlife benefits. A well managed woodlot can also reap economic rewards for the landowner. Equally as important, the image of the agricultural community could be greatly enhanced by the preservation of woodlots and remaining wetlands. For some rural residents, tax advantages, through the Conservation Land Tax Reduction Program, could be realized through such actions.

4.5 Program Delivery

The delivery of a soil and water conservation program to rural residents is a multi-facetted undertaking which must consider various factors which affect the adoption process. One of the greatest impediments to the adoption of practices which will improve water quality is that the monetary costs of implementing the practice are typically borne by certain individuals (in the case of many of those previously described, the farmers) while the benefits are accrued by society as a whole.

One method removing this impediment would be to legislate change. While this method may appear like a simple solution, it has with it many aspects which, generally, make it the least preferred option when dealing with agricultural practices. First, the legislation of change, if not accompanied by large-scale subsidy programs, would likely mean that the economic burden associated with the change would likely fall entirely to the farm operator. For many farmers, the viability of their business may be diminished to the point where they would have to leave the industry. For others, it would mean that the price of their product would need to be increased to offset this cost-of-production increase. Such an increase in food prices may not be acceptable to the consumer. Other factors relating to competitiveness in the global economy would also come into play unless similar required change was uniformly distributed throughout the world marketplace.

Legislative change might also be considered as 'forced attitudinal change'. While attitudinal change is typically conducive to the further adoption of other practices, 'forced change' may, in fact, result in a situation where individuals and less likely to voluntarily adopt new ideas.

A much preferred option is to provide incentives for farmers to ease the transition from one management practice to another. Through this method, the costs of improving water quality are shared by those who accrue the benefits. Also, this option provides a better mechanism for various elements of sociological change to occur thereby resulting in long-term attitudinal change and commitment to the concept of improving water quality through improved farm management practices in general, not just through the change in one practice.

A number of motivational factors affect the rate at which a particular remedial measure will be adopted. Some farmers will accept a practice regardless of what their neighbours do, or of the economic benefit. Others will wait until the majority of his/her peers have been using the practices for some time before trying it.

While the characteristics of individuals is an important factor in determining how quickly a given practice will be adopted (if at all), the relative speed with which a practice is adopted is partially dependent on the characteristics of the practice itself. Bohlen, *et al* (1961) identified five characteristics affecting the rate of adoption: cost and economic returns, complexity, compatibility, visibility and divisibility. When delivering an extension program, recognition of these characteristics, and subsequent development of appropriate extension methodology, can increase the acceptance and rate of adoption of a particular practice.

Practices which produce reasonable returns for dollars invested tend to be adopted more rapidly than those yielding lower, or no, returns. In addition, practices which produce quick returns on investments will likely be accepted sooner than those in which returns are not expected for many years. This does not mean, however, that the acceptability of practice is strictly a function of economic cost/benefit analysis. If a particular practice is perceived as having a relative advantage over a previous practice (in terms of prestige, convenience,

economics or any attribute), then adoption is likely (Lamble, 1984). By increasing a remedial measure's perceived relative advantage, by offering financial incentives or by other means, the rate of adoption is likely to be enhanced.

Practices that are relatively simple to use and understand will, typically, be adopted more readily than practices which are perceived as being complex in nature. Past experience can greatly influence a farmer's perception of complexity. If similar ideas have been adopted in the past, then a new practice may not appear to be complicated or complex. The farmer will have been 'through the process of change' before and, by virtue of that experience, subsequent adoption of new practices will be 'simplified'. If the farmer initially perceives a practice to be too complex, efforts must be made to provide enough information and/or technical assistance to help simplify the practice, thereby increasing its chances of being adopted.

Visibility is important in the adoption process. Practices which have easily observable methods of operation and easily observable results are more readily adopted than practices which are not easily observed. Demonstration sites can be valuable tools in highlighting a particular practice.

Divisibility, or the ability to try a practice on a limited scale rather than an "all-or-nothing" basis, increases the rate of adoption. Many farmers are reluctant to expend financial resources and time on a practice without trying it on a small scale first. Again, demonstration sites provide a mechanism by which small scale trials can be compared to existing practices on the farm. Alternatively, observation of an "all-or-nothing" practice on another individual's fans provides the opportunity to 'test' the practice without committing personal resources. Divisibility has been a proven mechanism in the promotion of conservation tillage and new seed varieties.

If a new practice is consistent with existing socio-cultural values and with existing practices, the likelihood of its adoption is enhanced. From a program delivery perspective, it is important to emphasize how the new practice compliments existing practices.

A combination of information dissemination, education, extension services, financial assistance and, if absolutely required, legislation should be presented to encourage the adoption of remedial measures which will enhance water quality and lead to improved rural land stewardship. Throughout the process, the realization of immediate, positive benefits should be sought while, at the same time, long-term attitudinal change and the integration of various programming (both within the Conservation Authority and through co-partnership arrangements) to provide for maximum resource management benefits should remain paramount.

The dissemination of resource management information pertaining to rural land stewardship and, in particular, the conservation of healthy soil and water ecosystems can be achieved through a variety of techniques. Utilization of mass contact techniques such as media releases, displays and through the production and distribution of brochures and factsheets are all proven methods of increasing public awareness. Targeted contacts through rural organizations, the farm press and rural weekly newspapers could be used to provide updates of new technologies, and other desired information, to the primary audience of the program; the rural residents within the Conservation Authority's jurisdictional watershed. Information networks already established through the Conservation Authority, and government agencies such the Ministries of Agriculture and Food and Natural Resources, should be utilized.

Educational opportunities such as workshops, demonstration sites and tours should be developed and widely publicized. Workshops/demonstration days covering topics such as manure spreader calibration and tillage equipment comparisons should be developed

along with appropriate resource materials. Tours to illustrate various remedial options would allow participants to try out the practice' on someone else's farm and evaluate the merits of the practice for their own situation. By touring a number of demonstration sites, each showing different remedial options, adoption of favourable practices is likely to be enhanced.

A network of demonstration sites should be established, throughout the Niagara Peninsula to illustrate practical, working remedial options. A number of these desirable options already exist on farms in the area and, as a result, negligible costs would be involved with establishing a self-guiding tour package. The same sites used for the self-guiding tours, in which information would be supplied by peers (not government staff), could be utilized for organized tours.

As a major landholder in the Niagara Peninsula, the Conservation Authority should take the lead in establishing demonstrations on Authority-owned lands. Potential demonstrations could include streambank erosion control measures (through both bioengineering and more traditional engineering designs), woodlot management, windbreaks, erosion control structures such as grassed waterways, fish and wildlife habitat enhancement, riparian zone management and the retirement of fragile lands, especially through the planting of trees. Such demonstrations would not only solidify and demonstrate the Conservation Authority's commitment to integrated resource management but would serve to increase the profile of the Authority in the community.

Exploration of alternative remedial options should also be part of the program. Trials relating to alternative methods milkhouse washwater treatment, composting of livestock manure, viability of hybrid willows as windbreaks on clay soils and the effectiveness of various bioengineering techniques for erosion control are examples of options which might be explored. Such exploration provides excellent opportunities for the establishment of co-partnership arrangements with government agencies and rural organizations. Both

environmental and economic parameters should be evaluated.

Extension services should promote available financial assistance programs relating to remedial options to encourage their adoption. Staff should have a working knowledge of programs such as the Conservation Land Tax Reduction Program, Land Stewardship II, the National Soil Conservation Program, the Community Fisheries Involvement Program and the Community Wildlife Involvement Program. In addition, related Conservation Authority programs such as the Private Lands Tree Planting program should be promoted.

Technical assistance should also be available through the Soil and Water Conservation Program. Assistance with respect to the various remediation options should be readily available. The integration of expertise from within the Authority and its co-partners can provide a team of specialists to advise clients. Emphasis should be on providing practical, economically-sound alternatives that provide for one, and preferable a multitude of, environmentally acceptable resource management benefits.

Targeted financial assistance programs, in addition to broader-based financial assistance programs, should be developed-to provide for more immediate environmental 'gains' with least monetary expenditure. Targeting financial assistance to areas near watercourses will facilitate the remediation of existing problems and, hopefully, will result in fairly immediate environmental gains. These, in turn, could be utilized as demonstrations, through the broad-based program, which should be aimed at encouraging positive attitudinal change in both near-water and not so-near-water areas of the province. Co-ordination of these financial assistance programs between the funding agencies (for example, the Ministries of Agriculture and Food and the Environment) should ensure efficient program delivery to the rural community.

The level of financial assistance should be such that it will be an incentive for the adoption of remedial options especially those which are perceived to have little, if any, return on investment i.e. manure storages), while, at the same time, ensuring some financial commitment on the part of the landowner. Grant rates in the range of 66% - 75% to a maximum of $20,000 have been suggested by some local farm operators as being sufficient incentive to adopt certain remedial measures.

Should a landowner receive funding for the adoption of a remedial measure, a standard agreement to ensure the care and proper maintenance of the measure should be mandatory to protect the public investment. The agreement should stipulate that the measure with remain in place, and be properly maintained, for a specified period of time. Default of the agreement should result in the repayment of the public's contribution to the project.

Conservation easements should be examined as an option to encourage the permanent retirement of land. Such a mechanism might be particularly appropriate in cases where landowners are reluctant to fence livestock from streams because a large proportion of their pasture would be taken out of production. Compensation for this lost production could be achieved through conservation easement agreements.

Legislation of change should only used as a 'last resort' to influence the adoption of remedial measures. In many instances, legislation is already in place but has, to this point, not been widely enforced.

4.6 Program Evaluation

The ultimate evaluation of the success of a water quality focused program is a measured improvement in the quality of the water. As a result, an on-going baseline water

quality monitoring program should be established in the study watershed to monitor water quality trends. Emphasis should be on bacteria, phosphorus, nitrogen and suspended sediment parameters.

In parts of the Niagara Peninsula outside of the study watershed, data from the Provincial Water Quality Monitoring Network could be used to monitor water quality trends.

In addition, a method of monitoring the adoption of remedial measures should be developed and updated regularly. In this way, changes in management can be compared to water quality data and determinations made as to the success of the implemented remedial measures at improving water quality.

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