Economic Benefits of the Severn Sound Remedial Action Plan (1990-2002)

Cost Savings and Environmental Benefits

Final Draft

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EXECUTIVE SUMMARY

Implementation of the Severn Sound Remedial Action Plan (SSRAP) began in the early 1990s, supported by all levels of government and local partners. The SSRAP team coordinated a variety of measures including sewage treatment plant upgrades, agriculture source pollution control projects, storm water supply control, tree planting, shoreline rehabilitation, ecosystem monitoring and a public information service.

This study aims at monetizing the environmental benefits achieved by the SSRAP using damage cost assessment as an approach. Benefit transfer technique has been used for assessing some of the damage costs as well as the direct economic gains of environmental amenities generated or improved by the SSRAP.

One aspect that characterizes environmental benefits and their cost savings is that they are not realized only once, but they continue to occur every year. Therefore, while the cost of the project is a one-time incident, the value of the estimated environmental benefits accrues over the years, as long as they are conserved.

A comprehensive and detailed quantification of the physical achievements of the SSRAP projects was undertaken for the period 1990 -2002. This detailed statistical profile was necessary to conduct the economic valuation for these projects. Data needed to be sorted by project type, cost, output and year of implementation. The year was of vital importance in the economic analysis since it marks the beginning of accumulated cost savings.

Part one of the report presents the outcome of data sorting and syntheses for the physical quantification of achievements of the SSRAP. Starting with private sewage system upgrades, 69 projects were implemented from 1991 to the end of 2002 preventing 898 kg of Phosphorous (P) from entering waterways over this period.

Agricultural source pollution control included a number of activities. An area of 399 hectares (ha) of land was rehabilitated for riparian buffer strips improving a total of 105 km of stream length. By this, a total accumulated amount of 6,041 kg of P was prevented from entering streams over the period of the study. 67 cattle fencing projects were implemented restricting around 2,487 units of animals which prevented 453 kg of P over the period of the study. Six milkhouse management projects were implemented by the SSRAP preventing a total of 2,836 kg of P over the period. As for manure storage, a total of 13 tanks were installed preventing 4,649 kg of P from entering waterways. Eavestroughs installed were 12, preventing a total of 947 kg of P from polluting water over the period of the study.

With respect to soil erosion control, in addition to the measures implemented through streambank rehabilitation to reduce the off-site effects of soil erosion, an area of 7,575 ha of cropland was converted to conservation tillage.

The SSRAP has rehabilitated an area of 46.8 ha of wetlands, of which 10.1 ha was of created wetlands, while the rest was enhanced through planting activities. An area of 164 ha of uplands associated to wetlands was also rehabilitated.

The SSRAP has planted around 127,926 trees covering an area of 298.7 ha of land. This was mainly on retired areas along streambanks. Other planted areas of wetlands and uplands amounted to 210.9 ha.

Part two of the report presents the economic valuation for these achievements. Cost savings of wastewater treatment of P contamination through upgrading private sewage systems upgrade was estimated at an average of $1.1 million over the period 1990-2002. As for agriculture source pollution control projects, riparian buffer strips saved an average of $7.4 million of P treatment in wastewater, cattle restriction fencing projects saved $0.56 million, milkhouse wastewater management projects saved $3.5 million, eavestroughs saved $1.2 million, manure storage tanks saved $17.9 million and soil conservation saved $1.4 million of P wastewater treatment over the period of the study. Other cost savings for riparian buffer strips included $24,780 of sediment wastewater treatment, $2,774 of streambank maintenance and $13,925 of flood control.

On-site cost savings for soil erosion control was estimated for cropland areas conserved through conservation tillage. The estimated on-site cost savings of soil conserved through conservation tillage reached an accumulated average of $501,862.

The value of rehabilitated wetlands (both created and enhanced) was estimated at $1.3 million till the end of 2002. As for the economic value of carbon stored by tree planting activities, it was estimated at an average of $0.45 million over the twelve years of the study.

The total costs of SSRAP restoration projects presented in this study amounted to $2.2 million. Comparing the total estimated benefits to total costs, the cost-benefit ratio by end of year 2002 was calculated at 6.1 %, revealing the cost-effectiveness of these projects. Nevertheless, this is a not final or definitive result, as the benefits only cover a specific period and certain environmental aspects. A proper comparison for cost to benefit need to be made to all the benefits generated by these projects accumulated over the long term for these conserved environmental amenities.

Moreover, it is worth noting that the cost- benefit ratio diminishes over time as the environmental benefits accrue over the years, while costs remain constant. Even with increments of maintenance and monitoring costs for the restoration projects, this argument still holds as they are perceived minimal when compared to the large figures annually accumulated.

INTRODUCTION

1. Severn Sound Remedial Action Plan

Severn Sound is a group of bays located in southeastern Georgian Bay. The immediate watershed of the Sound covers an area of approximately 1000 km^2 (Stage 3 Report, 2002).

Severn Sound was listed as an Area of Concern by the IJC in 1987 because of problems stemming from nutrient enrichment. A remedial action plan was developed by the provincial and federal governments to improve water quality and maintain a healthy ecosystem in Severn Sound (Stage 2 Report, 1993).

The implementation of the Severn Sound RAP began in the early 1990s, supported by all levels of government and local partners. From its headquarters located at the Wye Marsh Wildlife Centre, the remedial actions implemented included: the improvement of sewage plant efficiency; the upgrading of private sewage systems; the reduction of stormwater supply; the reduction of agricultural sources and sources of erosion; the reduction of polluting marine activities; the protection and improvement of fish and wildlife habitat and the prevention of contamination (Stage 3 Report, 2002).

Remedial Action Plans have three stages: the first stage describes environmental conditions with an identification of problems; Stage 2 specifies the details of the remedial action plan in terms of actions, schedules, effectiveness, delisting objectives as well as a plan for monitoring; Stage 3 provides details of the status of restoration and delisting objectives set out in Stage 2. Out of the 43 areas of concerns on the Great Lakes, Severn Sound was only the second RAP to complete Stage 3.

After around 13 years of persistent efforts to achieve the RAP targets, a local celebration was held in June 2002 to announce the completion of RAP Stage 3 and the restoration of the Severn Sound ecosystem. This effort was considered as a *"model for other communities"* and its achievements as *"an example of civic engagement at its finest*." In January 2003, the Canadian Minister of the Environment and Minister of Foreign Affairs transmitted a letter to the International Joint Commission, formally announcing that Canada has removed Severn Sound from the list of Areas of Concern (SSEA Homepage).

2. Purpose and Scope of the Study

The purpose of this study is to monetize the environmental benefits achieved by the Severn Sound Remedial Action Plan (SSRAP) using damage cost assessment as an approach. It relies on the assumption that damage estimates are a measure of value (Barbier et. al., 1997). Benefit transfer technique will be used when needed for estimating "cost savings", as well as the direct economic gains of environmental amenities generated or improved by the RAP.

Due to time and information limitations of this study, it is not possible to monetize all the environmental benefits. Aspects that are monetized in this study are:

- Wastewater treatment cost savings of P prevented from entering streams by private septic upgrades and non-point source pollution projects (riparian buffer strips, cattle restriction fencing, milkhouse wastewater management, manure storage tanks, eavestroughs water diversion, and soil conservation)
- Sediment wastewater treatment cost savings for riparian buffer strips.
- Streambank maintenance and flood control cost savings of riparian buffer strips.
- On-site cost savings of soil conservation (conservation tillage)
- Value of rehabilitated wetlands
- Value of carbon stored by tree planting activities

An emphasis on the continuously accumulated benefits of the restoration projects is made in this study, where the cost-benefit ratio decreases over the years.

Therefore, the result of analysis here should not be taken as exhaustive, or definitive. Rather, it should be taken as indicative and illustrative.

Part One: Physical Quantification of Achievements

In order to assess the monetary value of the restoration activities undertaken by the SSRAP, a comprehensive and detailed quantification of the physical achievements of the restoration projects under the focus of this study is required.

In this part of the report, each restoration activity has been defined at a property level- when applicable- in terms of:

- Number of projects implemented
- Year of implementation of the project
- Physical output of the project (length of stream improved, area planted, etc.)
- Estimated amount of Phosphorous prevented by the project, both annual and accumulated
- Cost of the project

The period which this report covers is from the beginning of the SSRAP implementation (1990) till the delisting of the AOC (2002).

Data was provided by the Severn Sound Environmental Association (SSEA) staff. It was sorted and categorized by authors according to the aspects presented above.

As the year recorded by the SSEA for the implementation of the projects is the fiscal year (which falls between two years), the year of implementation was defined here as the latter year e.g. fiscal year 1992/1993 defined as year 1993. This was to ensure that the project has been fully implemented, marking the start of accumulated environmental benefits.

In a few cases, some projects did not have the year of implementation specified. The year 1997 was assumed by authors here as the midpoint or average year.

Projects that are presented and quantified in this section are only those that are economically assessed in the second part of this report. These include: upgrade of private sewage systems, control of agricultural sources, control sources of erosion, wetland rehabilitation and planting activities.

1.1 Upgrade of Private Sewage Systems

This activity involved the replacement of faulty or seriously substandard private sewage systems with properly operating systems according to Environmental Protection Act (EPA) Regulations. However, in order to ensure that the inspected systems, which were found satisfactory, did not fail in years after the inspection, private sewage systems were required to be inspected every three years (Stage 2 Report, 1993).

The Shoreline Pollution Control (Fertile Waters in Cottage Country) project in 1991 involved the systematic detection and correction of faulty private sewage systems in both shoreline residences and pleasure boats. Of approximately 3000 sewage systems surveyed, about 600 were found to require abatement. The abatement of these systems was completed (Stage 3 Report, 2002).

With the assistance of the Severn Sound CURB and Rural Non-Point Source Control projects, 69 failing septic systems that were having an impact on surface water quality were replaced.

Table (1.1) presents the number of septic projects implemented by year, cost by SSRAP and owner, and the amount of P prevented from entering the streams (kg/yr).

Table (1.1) No. of Septic Upgrades Implemented through the SSRAP (1992-2002) by Year, Cost and Amount of P Prevented from Entering Streams (kg/yr.)

Year	No. of Septic Projects	Cost (grant) ($)	Cost (owner) ($)	Total cost ($)	Annual P prevented (kg/yr)	Accumulated P Prevented (kg)
1992	0	0	0	0	0	0
1993	8	16,000	39,677	79,354	16	16
1994	9	16,230	25,911	51,822	18	34
1995	16	31,253	56,403	112,807	32	66
1996	6	12,000	25,107	50,213	12	78
1997	8	15,571	27,042	54,083	16	94
1998	2	4,000	8,532	17,064	4	98
1999	8	16,000	25,521	51,043	16	114
2000	4	7,830	21,755	43,510	8	122
2001	8	16,000	35,889	71,778	16	138
2002	0	0	0	0	0	138
Total	**69**	**134,884**	**265,837**	**531,673**	**138**	**898**

Source: SSEA staff, July, 2003.

The average grant cost of the septic upgrades amounted to $1,955 ranging from $1,162 to $2000. As for the costs incurred by owners, the average was $3,408 ranging from $1,162 to $11,273.

The amount of P prevented by the repair and upgrade of each failing system was estimated in the order of 2 kg/y. This is based on the assumption that the average per capita P contributed in a domestic dwelling is 0.8 kg/yr. (from a combination of sources (including sewage and wash water). Assuming 2.5 people per dwelling, the average P supply from a dwelling used year round could reach 2.0 kg/yr (Stage 2 Report, 1993).

According to the table above, year 1995 has experienced the highest number of septic upgrades (16 projects), preventing 32 kg of P from entering streams that year. The total number of septic projects undertaken over the period 1992 – 2002 is 69 projects. The total amount of annual P prevented from entering and polluting water over these years is 138 kg. However, the actual amount prevented should be seen accumulatively, since these faulty systems could have polluted water every year if they have not been repaired. Therefore, the total accumulated amount of P prevented from entering watercourses over these years is 898 kg.

1.2 Control of Agricultural Sources

Between a third and a half of the land draining from the south into Severn Sound is used for crop and livestock production (Stage 2 Report, 1993). Sources of P from agricultural activities were evaluated for the Severn Sound watersheds draining from the south. Estimation of P export from different land uses and slopes was based on Coleman, 1982 (Stage 2 Report, 1993).

A livestock survey was conducted by the RAP Team in 1990-91 of each farm in the Severn Sound area to determine livestock numbers, cattle access, manure handling practices and milkhouse wastewater handling in relation to water courses (Stage 2 Report, 1993). The effectiveness of remedial measures in reducing P load to the sound was reviewed by the RAP team and estimated for each measure based on assumptions documented in the Stage 2 Report. Site specificity was taken into consideration in the calculation of P discharge prevented for each project including nutrient (P) delivery to the main water body.

Non-point (agricultural) source pollution control in the SSRAP was undertaken through a number of programs. The Clean Up Rural Beaches (CURB) program conducted a number of management practices in the SSRAP for four years (1992-1995). Its activities included manure and milkhouse wastewater management, and erosion control projects. After the CURB was discontinued, the initiative was resumed in March 1996 through the Severn Sound Rural Non-Point Source Control Project (RNPSC). It provided technical and financial assistance to develop and implement plans to remediate the targeted practices (Stage 3 Report, 2002).

Moreover, a Tributary Rehabilitation Program has contributed to non-point source pollution control through a different set of activities. These activities included retiring riparian buffer strips, fencing cattle away from creeks and planting activities.

Detailed information on non-point source pollution control activities are provided in the following tables including the estimated amount of P prevented from entering the streams:

a) Stream Bank Rehabilitation

1) Riparian Buffer Strips

As the following table shows, the total area of riparian buffer strips retired since 1991 till 2002 is 399 ha. This has improved 105 km of stream. Years 1995 and 1999 experienced the highest areas retired. The total amount of P prevented from entering the streams was estimated by the SSEA staff accumulating to a total of 6,041 kg of P over the years specified.

Table (1.2) Riparian Buffer Strips Rehabilitated by the SSRAP (1991-2002) by Area, Stream Length Improved and Amount of P Prevented from Entering Streams (kg/yr.)

Year	Area of RBS retired (ha)	P prevented (kg)	Accumulated P Prevented (kg/yr)	Stream length improved (km)
1992	7	17	17	4
1993	33	78	95	7
1994	41	101	196	15
1995	70	171	367	15
1996	62	170	537	20
1997	18	43	579	10
1998	9	23	603	6
1999	70	206	809	18
2000	39	92	901	2
2001	4	12	913	0
2002	45	110	1,024	9
Total	**399**	**1,024**	**6,041**	**105**

2) Cattle Restricted Access Fencing

As table 1.3 shows, the number of cattle restricted access fencing projects over the period amounted to 67. Usually, the retirement of land at each property was also accompanied by livestock access restriction project if there were animals. A total of 2,487 animals were prevented from access to streams. The total amount of P prevented from entering the streams due to cattle access restriction was estimated by the SSEA staff, to be 453 kg over this period. Included in the cost of cattle restriction fencing were other access control projects (e.g. 20 alternate cattle crossing projects and 52 alternate water source projects).

Table (1.3) Cattle Fencing Projects Implemented by the SSRAP (1991-2002) by Number of Animal Units Fenced and Amount of P Prevented from Entering Streams (kg/yr.)

Year	No. of cattle fencing projects	No. of animal units fenced	P prevented (kg)	Accumulated P Prevented (kg/yr)
1992	2	76	1	1
1993	9	337	8	9
1994	7	272	8	17
1995	13	354	10	27
1996	12	574	17	44
1997	7	220	6	51
1998	5	155	4	54
1999	7	196	5	60
2000	1	10	0	60
2001	0	0	0	60
2002	4	293	9	69
Total	**67**	**2,487**	**69**	**453**

3) Total Cost of Streambank Rehabilitation Projects

The costs of all the above projects in streambank rehabilitation are presented in table 1.5. These costs also include some other habitat enhancement projects and tree planting activities. Landowner in-kind contributions are not included in these costs.

Table (1.4) Total Costs of Streambank Rehabilitation Projects Implemented by the SSRAP (1991-2002)

Year	1992	1993	1994	1995	1996	1997	1998	1999
Total Cost ($)	57,019	65,576	94,955	66,168	56,602	31,574	60,964	12,810

Year	2000	2001	2002	Total
Total Cost ($)	5,306	33,460	8,863	493,296

b) Milkhouse Wastewater Management

As table 1.5 shows, a total number of six milkhouse wastewater management projects were implemented during this period. Costs have been shared by the SSRAP and the owner (50% each). Amount of P prevented from entering the streams by these projects was estimated by the SSEA staff to be 391 kg. However, the accumulated total over the years amounted to 2,836 kg of P.

Table (1.5) No. of Milkhouse Wastewater Management Projects Implemented by SSRAP (1991-2002) by Cost and Amount of P Prevented from Entering Streams (kg/yr.)

Year	No. of Milkhouse Projects	Total cost ($)	P prevented (kg)	Accumulated P Prevented (kg/yr)
1992	1	1,211	78	78
1993	2	3,887	80	158
1994	0	0	0	158
1995	0	0	0	158
1996	1	9,911	80	238
1997	1	11,370	78	316
1998	0	0	0	316
1999	0	0	0	316
2000	0	0	0	316
2001	1	12,960	75	391
2002	0	0	0	391
Total	**6**	**39,339**	**391**	**2,836**

c) Manure Storage Tanks

A total of 13 manure storage tanks were installed by the SSRAP over this period. Cost has also been shared by the SSRAP and the owner, but was restricted to a ceiling for the SSRAP, where the remaining was covered by the owner. The amount of P prevented from entering the streams by these projects was also estimated by the SSEA staff. The total accumulated amount of P prevented was 14,649 kg over the specified period.

Table (1.6) No. of Manure Tanks Installed by SSRAP (1991-2002) by Cost and Amount of P Prevented from Entering Streams (kg/yr.)

Year	No. of Manure Storage Tank Projects	Cost (grant) ($)	Cost (owner) ($)	Total cost ($)	P prevented (kg)	Accumulated P Prevented (kg/yr)
1992	1	4,237	4,237	8,474	159	159
1993	5	69,881	64,208	134,089	833	992
1994	0	0	0	0	0	992
1995	0	0	0	0	0	992
1996	0	0	0	0	0	992
1997	2	24,000	61,634	85,634	370	1,362

1998	0	0	0	0	0	1,362
1999	0	0	0	0	0	1,362
2000	3	32,364	33,599	65,963	550	1,912
2001	2	29,111	33,235	62,346	350	2,262
2002	0	0	0	0	0	2,262
Total	**13**	**159,592**	**196,913**	**356,505**	**2,262**	**14,649**

d) Eavestroughs Stormwater Diversion

As table (1.7) shows, twelve eavestroughs were installed by the SSRAP to divert stormwater from flowing across nutrient-rich farmyards. The total cost of installing these eavestroughs amounted to $31,141 which was shared between the SSRAP and the owner. The total amount of P prevented from entering streams by these projects was estimated by the SSEA staff to be 947 kg over the years specified.

Table (1.7) No. of Eavestroughs Installed for Stormwater Diversion by SSRAP (1991-2002) by Cost and Amount of P Prevented from Entering Streams (kg/yr.)

Year	No. of Eavestroughs	Cost (grant) ($)	Cost (owner) ($)	Total cost ($)	P prevented (kg)	Accumulated P Prevented (kg)
1992	1	212	213	425	72	72
1993	1	683	683	1,365	3	75
1994	3	2,213	2,213	4,426	7	82
1995	1	792	908	1,700	0	82
1996	1	1,362	1,422	2,783	2	84
1997	0	0	0	0	0	84
1998	0	0	0	0	0	84
1999	2	1,721	1,721	3,443	5	89
2000	3	2,605	2,761	5,366	7	96
2001	2	4,000	7,634	11,634	5	101
2002	0	0	0	0	0	101
Total	**12**	**13587**	**17554**	**31141**	**101**	**947**

1.3 Erosion Control

The Severn Sound Remedial Action Plan has implemented a wide range of activities to reduce sources of erosion. These activities included both on-site and off-site soil erosion control measures.

On-site soil erosion control activities included the implementation of projects on the cropland area to reduce soil loss from the farm land, where tillage equipment was converted to no-till, zone till, mulch till, or others.

Off-site control measures of soil erosion included stabilizing streambanks, planting vegetation buffer along waterways and using erosion control in ditches and waterways. These activities were undertaken under the tributary rehabilitation program mentioned above for non-point source pollution control.

1.3.1 On-site soil erosion control

The following table shows the area of cropland converted to conservation tillage by type of equipment. The no-till, zone till and soil savers were the dominant equipments used.

Table (1.8) Area of Cropland Conserved by Type of Tillage Equipment Converted to by the SSRAP (1991-2002)

Type of equipment converted to	Area of cropland (ha)
No-till	2,990
Zone Till	1,161
Mulch Till	93
Offset disc	472
Soil Saver	1,576
No till grain drill	735
Row cleaners/coulters	213
Rockflex disks-spring/Soil Saver-fall	190
Chisel plow	146
Total	**7,575**

Source: SSEA staff, July, 2003.

As for table 1.9, the area of cropland conserved is presented by the year the tillage project was implemented. The total amount of P reduced from export to Severn Sound each year has been estimated by the SSEA staff to be 2,386 kg.

Table (1.9) Area of Cropland Conserved by Year of Implementation through the SSRAP (1990 -2002)

Year	Area (ha)	Kg of P reduced
1990*	169	55
1991*	213	70
1992*	207	67
1993*	96	31
1994*	60	20
1995*	147	48
1996	68	28
1997	2279	675
1998	2123	508

1999	1584	431
2000	552	401
2001	78	53
2002	0	0
Total	**7575**	**2,386**

Source: SSEA staff, July, 2003.
* Data for P export reduction was estimated by author based on coefficients derived from available data.

1.3.2 Off-site soil erosion control
These activities were included in the streambank rehabilitation projects.

1.4 Wetland and Upland Rehabilitation

In the recent past, wetlands have received tremendous attention because of their value to local and regional landscapes (De Laney, 1995). Wetlands provide many valuable services such as improved water quality, groundwater recharge, shoreline anchoring, flood control, and support a diverse variety of fish, wildlife, and plants (Mahan et al, 2000).

The SSRAP has rehabilitated a number of wetlands. The total area of wetlands rehabilitated amount to 46.8 ha, of which 10.1ha were created and 36.7 ha were enhanced through planting activities.

The following table presents the wetland rehabilitation projects classified by year of implementation and area.

Table (1.10) Area of Wetlands Rehabilitated by the SSRAP (1991-2002)*

Year	**Area Rehabilitated (ha)**	***of which created (ha)***	***of which enhanced (ha)***
1998	0.0	0.0	0.0
1999	15.5	0.0	15.5
2000	10.1	10.1	0.0
2001	2.0	0.0	2.0
2002	19.2	0.0	19.2
Total	**46.8**	**10.1**	**36.7**

* Projects in this table do not include ponds and wetlands created for stormwater supply control. These were covered in section 1.3 above.
Source: SSEA Staff, August, 2003.

As for the cost of wetlands rehabilitation, table 1.12 presents these costs. In general, the landowner shares about half the cost, but some contribute more, as there usually is a ceiling for grants. The share is approximately 55% landowner, 45% other cash input. The landowners also usually contribute in-kind value to the project, which were not factored into these numbers.

Table (1.11) Cost of Wetland Rehabilitation Projects in the SSRAP (1991-2002)

Type of restoration	Cost of the project* ($)
Creation	47,018
Enhancement	24,865
Total	**71,883**

* Costs include money spent out (landowner cash plus other funding when applicable).
"In-kind" contributions by landowner and/or other agencies are not normally included. Some conservation agreement projects do not have a cost associated with them
Source: SSEA staff, August, 2003.

Table (1.12) Area of Upland Rehabilitated* by the SSRAP (1991-2002)

Year	Area Rehabilitated (ha)
1998	0.0
1999	12.7
2000	111.1
2001	21.3
2002	19.1
Total	**164.1**

*These are upland areas adjacent to rehabilitated wetlands.

1.5 Planting Activities

There is increasing appreciation of the vital role trees play whether in fish and wildlife habitat protection or in absorbing atmospheric carbon dioxide.

The SSRAP has implemented a number of planting activities whether in riparian buffer strips, wetlands or uplands.

Planting of riparian buffer strips included trees, shrubs and herbaceous vegetation. Tree species were mainly White Cedar, White Pine, White Spruce, High Bush Cranberry, Nannyberry, Red Osier Dogwood, and Silver Maple.

The total area of riparian buffer strips planted amounted to 298.7 hectares, and the total number of trees planted reached 127,906 trees. As the table below shows, year 1993 had the highest number of trees planted reaching 30,866 trees with 21 hectares of land planted.

Table (1.13) Planting Activities for Riparian Buffer Strips by No. of Trees and Area Planted in the SSRAP (1991-2002)

Year	No. of trees	Area planted (ha)
1992	0	0.0
1993	30,866	21.0
1994	9,258	26.3
1995	8,950	15.7
1996	7,595	29.3
1997	15,770	44.3
1998	16,959	34.7
1999	10,369	34.1
2000	6,628	26.4
2001	13,151	53.6
2002	8,360	13.3
Total	**127,906**	**298.7**

Wetland and upland planting included mainly planting vegetation in the wetland and/or banks immediately surrounding it. Usually this vegetation was emergent aquatic vegetation, wildflowers and some deciduous shrubs.

The following table presents the area of wetland and upland planted by the SSRAP. The total area planted reaches 210.9 ha of land.

Table (1.14) Wetland and Upland Planting by Area Planted in the SSRAP (1991-2002)

Year	Area planted (ha)
1997	0.00
1998	0.00
1999	28.16
2000	121.23
2001	23.28
2002	38.23
Total	**210.90**

Part Two: Monetary Benefits of the Restoration Projects

2.1 Approach

The approach in estimating the monetary benefits in this study is based on damage cost assessment "cost savings" of the remediation projects. Benefit transfer technique was used to assess some of these cost savings as well as evaluate other environmental amenities generated or improved by the SSRAP.

a) Damage cost assessment

Based on the assumption that damage estimates are a measure of value (Barbier et. al., 1997), "damage costs avoided" here were estimated using wastewater/sewage treatment costs as a replacement. These wastewater treatment costs were calculated at a marginal unit for TP which acts as a proxy for the whole suite of processes used to treat sewage effluent.

Damage caused by agricultural sources is manifested in loading animal fecal matter to stream water, soil particles or sediment, nutrients (including fertilizers), pesticides, and some microbial loading. These all have a damaging effect on the receiving water-body and downstream causing turbidity and sedimentation in waterways and reservoirs as well as excess algal growth or water "eutrophication" due to nutrient enrichment.

One measure of the cost savings or damage costs avoided, associated with the remediation projects, is asking how, and at what cost, the water quality deterioration could be prevented by treating water from these pollutants (Tejani and Muir, 2003).

TP was used as a proxy for the whole suite of processes to treat water. The amount of TP prevented from entering the streams through remediation activities was calculated by the SSEA staff and presented in part one of this report. The assumptions and methodology of estimating these TP amounts are documented in the stage 2 report of the SSRAP. As noted earlier (in part one of this report), site specificity was taken into consideration in calculating P discharge prevented for each project, including nutrient (P) delivery to the main water body.

The marginal cost for TP wastewater treatment was calculated for Sewage Treatment Plants in the Severn Sound Area. Annual capital costs of upgrading were amortized for these sewage treatment plants. According to these calculations, the \$/kg of P wastewater treatment ranges from \$343 to \$1,761. Calculations are presented in appendix B of this report, with all underlying assumptions.

b) Benefit transfer

Benefit transfer refers to the use of existing benefit estimates in a different but similar context, compared with the original study that generated the benefit estimates (Bergstorm and de Civita, 1999). Although this technique is subject to a number of conceptual and empirical limitations, it is widely applied by government agencies as input into economic assessments of public policies and projects (Bergstorm and de Civita, 1999).

Transferred benefits are utilized for assessing avoided damage cost estimates or “cost savings”, as well as direct economic gains of environmental amenities generated or improved by the SSRAP.

In this study, benefit transfer was used to assess the following:

- Wastewater treatment cost savings of prevented sediment through riparian buffer strip projects.
- Streambank maintenance cost savings
- Flood control cost savings
- On-site cost savings of conservation tillage
- Value of created and enhanced wetlands
- Value of carbon stored through planting activities

Many of the benefits transferred in this report were based on the literature reviewed by Tejani and Muir (2003), which was conducted to assess the monetary benefits of the Hamilton Halton Watershed Stewardship Program (1994-2002).

2.2 Wastewater Treatment Cost Savings of the SSRAP Remediation Projects

Based on the above rationale for calculating wastewater treatment costs of P as a replacement or “avoided damage cost”, the following formula was used:

$$\textbf{WTCS} = \textbf{PP} * \textbf{WTC}$$

Where:
WTCS: wastewater treatment cost savings.
PP: amount of prevented P accumulated each year.
WTC: wastewater treatment costs for P per kg ($343 - $1761).

This was calculated for all the remediation activities presented in part one of this report. Table 2.1 presents the outcome of these calculations:

Table (2.1) Wastewater Treatment Cost Savings of Phosphorous Prevented from Entering Streams by the Remediation Projects Implemented by the SSRAP (1990-2002)

	1992		1993		1994		1995	
Project	**Min ($)**	**Max ($)**	**Min ($)**	**Max ($)**	**Min ($)**	**Max ($)**	**Min ($)**	**Max ($)**
Private sewage systems	0	0	5,486	28,170	11,658	59,861	22,629	116,201
Riparian buffer strips	5,781	29,684	32,490	166,836	67,113	344,624	125,864	646,306

Cattle Restricted Accesss fencing	329	1,690	3,141	16,127	5,863	30,107	9,395	48,241
Milkhouse wastewater management	26,744	137,328	54,174	278,178	54,174	278,178	54,174	278,178
Manure tank storage	54,516	279,938	340,127	1,746,534	340,127	1,746,534	340,127	1,746,534
Eavestrough Stormwater Diversion	24,687	126,765	25,544	131,166	27,944	143,490	27,944	143,490
Conservation tillage*	2,312	11,872	3,386	17,389	4,059	20,843	5,701	29,273
Total	**114,369**	**587,278**	**464,348**	**2,384,401**	**510,938**	**2,623,637**	**585,834**	**3,008,223**

	1996		**1997**		**2000**		**2001**	
Project	**Min ($)**	**Max ($)**	**Min ($)**	**Max ($)**	**Min ($)**	**Max ($)**	**Min ($)**	**Max ($)**
Private sewage systems	26,744	137,328	32,230	165,498	33,601	172,541	39,087	200,711
Riparian buffer strips	184,046	945,065	198,669	1,020,156	206,723	1,061,513	277,399	1,424,429
Cattle Restricted Accesss fencing	15,134	77,714	17,339	89,035	18,659	95,813	20,535	105,443
Milkhouse wastewater management	81,603	419,027	108,347	556,356	108,347	556,356	108,347	556,356
Manure tank storage	340,127	1,746,534	466,989	2,397,964	466,989	2,397,964	466,989	2,397,964
Eavestrough Stormwater Diversion	28,767	147,716	28,767	147,716	28,767	147,716	30,413	156,167
Conservation tillage*	6,645	34,122	29,772	152,875	47,202	242,377	61,987	318,301
Total	**683,067**	**3,507,507**	**882,113**	**4,529,599**	**910,289**	**4,674,279**	**1,004,757**	**5,159,370**

	2000		**2001**		**2002**		**Total**	
Project	**Min ($)**	**Max ($)**	**Min ($)**	**Max ($)**	**Min ($)**	**Max ($)**	**Min ($)**	**Max ($)**
Private sewage systems	41,830	214,796	47,316	242,965	47,316	242,965	307,898	1,581,036

Riparian buffer strips	308,923	1,586,300	313,188	1,608,203	350,993	1,802,328	2,071,191	10,635,444
Cattle Restricted Accesss fencing	20,634	105,954	20,634	105,954	23,562	120,990	155,224	797,068
Milkhouse wastewater management	108,347	556,356	134,062	688,402	134,062	688,402	972,380	4,993,116
Manure tank storage	655,568	3,366,304	775,573	3,982,521	775,573	3,982,521	5,022,709	25,791,313
Eavestrough Stormwater Diversion	32,881	168,843	34,527	177,294	34,527	177,294	324,767	1,667,659
Conservation tillage*	75,727	388,854	77,550	398,213	77,550	398,213	391,890	2,012,333
Total	**1,243,910**	**6,387,407**	**1,402,850**	**7,203,553**	**1,443,583**	**7,412,715**	**9,246,059**	**47,477,968**

* Only 10% of accumulated prevented amount of TP was considered in conservation tillage projects (advised by Keith Sherman but cannot reference him)

Table (2.2) Average Wastewater Treatment Cost Savings of Phosphorous Prevented from Entering Streams by the Remediation Projects Implemented by the SSRAP (1990-2002)

Project	1992 ($)	1993 ($)	1994 ($)	1995 ($)
Private sewage systems	0	19,571	41,588	80,730
Riparian buffer strips	20,623	115,909	239,425	449,017
Cattle Restricted Accesss fencing	1,174	11,204	20,916	33,515
Milkhouse wastewater management	95,408	193,262	193,262	193,262
Manure tank storage	194,486	1,213,395	1,213,395	1,213,395
Eavestrough Stormwater Diversion	88,069	91,127	99,689	99,689
Conservation tillage	8,248	12,081	14,480	20,337
Total	**408,008**	**1,656,549**	**1,822,756**	**2,089,946**
Project	**1996 ($)**	**1997 ($)**	**1998 ($)**	**1999 ($)**
Private sewage systems	95,408	114,979	119,872	139,443
Riparian buffer strips	656,579	708,747	737,480	989,614
Cattle Restricted Accesss fencing	53,991	61,856	66,565	73,256

Milkhouse wastewater management	291,117	386,525	386,525	386,525
Manure tank storage	1,213,395	1,665,971	1,665,971	1,665,971
Eavestrough Stormwater Diversion	102,625	102,625	102,625	108,496
Conservation tillage	23,706	106,209	168,390	221,138
Total	**2,436,820**	**3,146,913**	**3,247,428**	**3,584,442**
Project	**2000 ($)**	**2001 ($)**	**2002 ($)**	**Total ($)**
Private sewage systems	149,228	168,799	168,799	1,098,416
Riparian buffer strips	1,102,073	1,117,289	1,252,157	7,388,913
Cattle Restricted Accesss fencing	73,611	73,611	84,057	553,758
Milkhouse wastewater management	386,525	478,263	478,263	3,468,939
Manure tank storage	2,338,720	2,766,833	2,766,833	17,918,365
Eavestrough Stormwater Diversion	117,303	123,174	123,174	1,158,596
Conservation tillage	270,154	276,657	276,657	1,398,057
Total	**4,437,614**	**5,004,627**	**5,149,940**	**32,985,043**

2.3 Other Cost Savings for Riparian Buffer Strips

2.3.1 Wastewater treatment cost savings of sediment

Vegetated filter strips contribute substantially in preventing sediment from entering waterways. Some literature suggests that the effectiveness of riparian buffer strips reaches 90% in reducing sediment load.

Wall, Bos and Marshall, 1996 developed an empirical relationship between P and suspended solid loadings in the Canadian Great Lakes basin. Annual loadings of suspended solids and total P were collected from agricultural surface water quality studies carried out in Ontario. Various study factors such as plot, field, and watershed sizes, as well as methods, loadings and references were documented and annual loading values were plotted.

In order to estimate the amount of prevented sediment by riparian buffer strips using estimates made for P in the Severn Sound AOC, studies of watersheds geographically relevant to the Severn Sound area were selected. Black Creek at Sutton watershed was the closest in characteristics to the watersheds in Severn Sound area. The ratio of P to suspended solids for Black Creek ranged from (4.2-6.4) kg/ton. A coefficient ranging from 0.16 to 0 0.24 was derived to estimate prevented amounts of sediment based on the amounts of P prevented from entering the streams through the use of riparian buffer strips As for the $/tonne value of wastewater treatment for sediment, values from Ducks Unlimited, 2001 were used for this regard, which ranged from 9.34 – 28.02 ($/t).

Using the formula for wastewater treatment cost savings with the appropriate values for sediment, the annual cost savings of prevented sediment were calculated in table (2.7) below.

Table (2.3) Wastewater Treatment Cost Savings of Sediment Prevented from Entering Streams by Riparian Buffer Strips Rehabilitated in the SSRAP (1991 – 2002)

	Accumulated Annuals of Sediment (kg/yr.)				Wastewater Treatment Cost Savings ($/kg/yr.)		
Year	**Min**	**Max**	**Average**		**Min**	**Max**	**Average**
1992	2,651	4,053	3,352	25	114	69	2,651
1993	14,899	22,779	18,839	139	638	389	14,899
1994	30,777	47,053	38,915	287	1,318	803	30,777
1995	57,719	88,243	72,981	539	2,473	1,506	57,719
1996	84,399	129,034	106,717	788	3,616	2,202	84,399
1997	91,105	139,286	115,196	851	3,903	2,377	91,105
1998	94,799	144,933	119,866	885	4,061	2,473	94,799
1999	127,209	194,483	160,846	1,188	5,449	3,319	127,209
2000	141,665	216,584	179,125	1,323	6,069	3,696	141,665
2001	143,621	219,575	181,598	1,341	6,152	3,747	143,621
2002	160,958	246,079	203,518	1,503	6,895	4,199	160,958
Totals	**949,802**	**1,452,101**	**1,200,951**	**8,871**	**40,688**	**24,780**	**949,802**

2.3.2 Streambank maintenance cost savings

When soil is eroded from fields, a portion of this sediment will be deposited in roadside ditches and other conveyance structures and reduces capacity of reservoirs and storage facilities within the watershed. This impact can reduce the effectiveness of these structures and increase the likelihood of flood events (Ducks Unlimited, 2001).

The maintenance cost of removing sediment is presented in the table below totaling to $2.31 per tonne.

Indicator	**Maintenance cost of removing sediment ($/tonne)**
Cost of ditch maintenance	$0.69
Cost of maintaining water storage	$1.62

reservoirs	
Total dredging cost	$2.31

Note: Values are in 2000 $.
Source: Ducks Unlimited, 2001.

To calculate the streambank maintenance cost savings, the following formula was used:

SMCS = TDC * PA

Where:

SMCS: streambank maintenance cost savings
TDC: total dredging costs
PA: prevented amounts of sediment (tones)
The following table presents the results of the calculations over the specified period.

Table (2.4) Streambank Maintenance Cost Savings due to Riparian Buffer Strips Rehabilitated in the SSRAP (1991-2002)

Year	Min ($)	Max ($)	Average ($)
1992	6	9	11
1993	34	53	61
1994	71	109	125
1995	133	204	235
1996	195	298	344
1997	210	322	371
1998	219	335	386
1999	294	449	518
2000	327	500	577
2001	332	507	585
2002	372	568	656
Totals	**2,194**	**3,354**	**2,774**

2.3.3 Flood control cost savings

Decreased frequency and intensity in flooding caused by riparian buffer strips are estimated by $2.10 - $7.50 / ha. This value represents changes in hydrology due to decreased sedimentation of water conveyance and diminished flow during peak runoff periods (Ducks Unlimited, 2001).

Therefore, flood control cost savings due to the rehabilitation of riparian buffer strips was calculated as:

FCCS = ABS * ($2.10 to $7.50)

Where:

FCCS: flood control cost savings
ABS: area of buffer strips (ha) rehabilitated by year.

Table 2.5 demonstrates the results of these calculations.

Table (2.5) Accumulated Flood Control Cost Savings due to Riparian Buffer Strips Rehabilitated in the SSRAP (1991-2002)

Year	Min ($)	Max ($)	Average ($)
1992	15	54	34
1993	85	387	236
1994	172	785	478
1995	318	1,456	887
1996	449	2,055	1,252
1997	487	2,225	1,356
1998	506	2,314	1,410
1999	653	2,986	1,820
2000	735	3,358	2,046
2001	743	3,397	2,070
2002	838	3,833	2,336
Totals	**5,001**	**22,848**	**13,925**

2.3 Cost Savings of Soil Erosion Control

On-Site Damage Assessment

Loss of crop yields is considered to be the most important on-site impact of soil erosion. The direct approach to estimating the on-site costs of soil erosion is to quantify yield losses attributable to soil erosion and value those using market prices (Vieth, Gunatilake and Cox, 2000).

Such an estimate is unique to the characteristics of each farm including (field activity, purchased input price, crop practice, farm management, slope, climate etc). However, it is unfeasible in practice to conduct a site-specific study for every field in order to estimate accurate on-site losses of soil degradation.

In a study cited by Furtan and Husseini, 1997, the Science Council of Canada (1986) indicates that annual losses associated with soil degradation exceed $20-$25 per hectare of agricultural land in Canada.

The value above of $20-$25/ha which is the estimated annual loss associated with soil degradation was used to assess cost savings of conservation tillage projects as follows:

OFCSCT = ($20-$25) * ha of cropland conserved

Where:
OFCSCT: on-farm cost savings of conservation tillage.

However, no information is available whether farmlands have continued to adopt the conservation tillage practice in subsequent years. Therefore, cost savings were calculated for two different scenarios; farms did not use conservation tillage in later years (min), and farms used conservation tillage in all subsequent years (max).

The following table presents the outcome of the calculations.

Table (2.6) Cost Savings of Tillage Projects on Croplands by SSRAP (1990 – 2002)

Year	Min ($)	Max ($)	Average ($)
1990	3,370	4,213	3,791
1991	4,268	9,548	6,908
1992	4,132	14,713	9,422
1993	1,920	17,113	9,516
1994	1,202	18,615	9,909
1995	2,934	22,283	12,608
1996	1,366	23,990	12,678
1997	45,576	80,960	63,268
1998	42,462	134,038	88,250
1999	31,676	173,633	102,654
2000	11,040	187,433	99,236
2001	1,552	189,373	95,462
2002	0	189,373	94,686
Totals	**151,498**	**852,225**	**501,862**

Off-Site Damage Assessment
This aspect has already been covered under wastewater treatment cost savings – tillage projects.

2.4 Economic Benefits of Wetlands Rehabilitated

In order to calculate the monetary value of rehabilitated wetlands, it is necessary to distinguish created from enhanced wetlands. It is assumed that the creation of wetlands is creating the whole economic value of wetland functions. Enhanced wetlands however, have already existed, but are expected to increase in value by the enhancement of their functions. Therefore, it is an overestimation to consider that the whole benefit value was generated by the RAP. Rather, it is only the extent by which the functions were enhanced that needs to be evaluated.

Costanza and his colleagues (1997) estimated the value of wetlands to be $23,218 (US$14,785) per hectare per year (cited by Turner et al., 2000). Accordingly, annual benefits of wetlands created and enhanced by SSRAP since 1991 till 2002 were calculated as follows:

AECW = ACW (ha/yr.)* $23,218

Where:
AECW: annual economic value of wetlands created
ACW: Area of wetlands created (ha) by year

and

AEEW = AEW (ha/yr.)* $23,218 * 50%

Where:
AEEW: annual economic value of wetlands enhanced
AEW: Area of wetlands enhanced (ha) by year

It is assumed here, that enhanced wetlands were only 50% of their value prior to enhancement. By their rehabilitation, and the enhancement of their functions, they became their full economic value.

The following table presents the annual calculations.

Table (2.7) Annual Monetary Value of Wetlands Rehabilitated by the SSRAP (1991-2002)

Year	Value of wetlands created ($)	Value of wetlands enhanced ($)	Total ($)	Accumulated Value ($)
1998	0	0	0	0
1999	0	179,473	179,473	179,473
2000	234,499	464	234,964	414,437
2001	0	23,218	23,218	437,655
2002	0	222,542	222,542	660,197
Total	**234,499**	**425,698**	**660,197**	**1,320,394**

2.5 Economic Benefits of Planting Activities - Carbon Storage Estimated Values

Carbon storage calculations were done based on a user -friendly guide prepared for the Ontario Ministry of Environment for the commonly planted tree species in Ontario. This guide has provided information and charts on carbon storage amounts (t/ha/yr.) by type of tree species, quality, age and previous land use. Tree species in this guide relevant to the SSRAP were White Pine and White Spruce. Carbon storage calculations were done to each of these tree species, from age 1 to 100 years. Annual increments in carbon stored were calculated for each year by subtracting from the carbon stored at each year the amount calculated for the previous one. In order to account for all possible scenarios (tree species, quality and previous land use), a range was designed to include the lowest possible amount of carbon stored as a lower bound, and the maximum possible amount as an upper bound at each year of age. Appendix C provides the detailed calculations of carbon storage ranges used. Instructions and charts used for these calculations are found in the guide prepared by Woodrising Consultancy Inc. for the Ontario Ministry of Environment, 2001.

According to these calculations, the following ranges were constructed:

Table (2.8) Carbon Storage Ranges for Relevant Tree Species to the SSRAP (Annual Increments of Carbon Stored)

Age of Tree (yrs)	Min (t/ha/yr.)	Max (t/ha/yr.)
1	45.60	46.03
2	0.00	0.43
3	0.00	0.43
4	0.00	0.43
5	0.00	0.43
6	0.00	3.37
7	1.00	1.43
8	0.00	2.37
9	1.00	1.43
10	0.00	0.43
11	0.00	1.43
12	1.00	1.43
15	0.00	7.22
20	5.00	11.85
25	3.00	14.85
50	41.00	62.25
100	64.00	85.50

The ranges from the above table give the minimum and maximum amount of carbon stored by a hectare of planted area, starting from age 1 till 100 years of age. As illustrated in the table, when trees are at age 1 year, the total amount of carbon stored in a hectare of land by trees, roots, surface litter, root litter and soil, ranges from 45.6 to 46.03 t, depending on the type of tree species, quality and previous land use. Increments in carbon stored in years 2-15 are quite minimal reaching a maximum of 7.22 t of carbon per hectare in year 15. However, carbon storage increments grow faster as trees get older and older reaching 41 to 62.25 t at 50 years and 64 to 85.50 t at 100 years of age.

From these ranges, it was possible to calculate the carbon storage amounts for the areas planted by SSRAP (1991-2002). Areas planted used for calculation were only those of riparian buffer strips (presented in table (1.13) in part 1 of this report). The reason for excluding the areas of wetland and upland planted in this calculation is the type of vegetation they were planted with (emergent aquatic vegetation, wildflowers and some deciduous shrubs). These species are not available in the MOE chart for estimating carbon stored. Therefore, carbon storage amount is underestimated here.

The following table presents the carbon storage amounts calculated for the period (1991-2002). The total value represents the accumulated amount of carbon storage since 1991 till 2002 of all planted areas during this period (only those for riparian buffer strips).

Table (2.9) Annual Carbon Storage Amounts of Planted Areas by the SSRAP (1991-2002)

Year	Min (tonne)	Max (tonne)	Average (tonne)
1992	0	0	0
1993	958	967	962
1994	1,199	1,217	1,208
1995	716	741	728
1996	1,336	1,373	1,355
1997	2,020	2,077	2,048
1998	1,582	1,700	1,641
1999	1,576	1,734	1,655
2000	1,230	1,404	1,317
2001	2,481	2,733	2,607
2002	662	949	806
Total	**13,760**	**14,895**	**14,328**

The amounts expressed for each year here, represent the amount of carbon stored by areas newly planted, as well as the amount of carbon stored by previously planted areas. Converting these carbon amounts to dollar values, the monetary value of 1 tonne of carbon/ha/year is calculated at $31.4 (US$20)[1]. The following table presents these calculations.

[1] Based on Tejani and Muir, 2003.

Table (2.10) Annual Monetary Value of Carbon Stored by SSRAP Planting Activities (1991-2002)

Year	Min ($)	Max ($)	Average($)
1992	0	0	0
1993	30,076	30,359	30,217
1994	37,666	38,233	37,950
1995	22,485	23,264	22,875
1996	41,963	43,137	42,550
1997	63,445	65,218	64,332
1998	49,696	53,388	51,542
1999	49,496	54,461	51,979
2000	38,635	44,100	41,368
2001	77,917	85,841	81,879
2002	20,794	29,804	25,299
Total	**432,173**	**467,806**	**449,989**

Summary and Conclusions

Achievements of the restoration activities of the SSRAP were sorted, quantified and monetized based on a "cost-saving" approach. Other environmental benefits were evaluated based benefit transfer technique; namely for the value of wetlands and carbon stored per tonne.

Due to restrictions of time and data availability, this study covered only those aspects that could be readily evaluated. Therefore, estimated values here are by no means exhaustive or definitive. Moreover, as indicated earlier, monetary benefits of environmental amenities are not realized only once the project is implemented, but they continue to produce benefits (goods and services) every year. The monetary benefits presented in this study cover the twelve-year period of the beginning of the SSRAP in 1990 to the end of 2002. The long-term benefits that accumulate over the years of these conserved environmental amenities are not included. Therefore, while the cost of the project is a one-time incident, the value of the estimated environmental benefits accrues over the years, as long as they are conserved.

Despite the potential for over or under estimating the value of an environmental improvement, many economists argue that the alternative of assuming no value for environmental benefits is potentially more misleading.

The following table presents a synthesis of the monetary benefits of the restoration projects evaluated in the SSRAP as well as their total costs.

Table (3.1) Total Cost Savings and Monetary Benefits Generated by the SSRAP Compared to Costs of the Rehabilitation Projects (1991-2002)

Restoration Activity	Min ($)	Max ($)	Average 2002 ($)	Total costs ($)*
Wastewater treatment cost savings	**9,246,059**	**47,477,968**	**32,985,043**	**2,086,807**
Septic tank upgrades	307,898	1,581,036	1,098,416	400,721
Riparian Buffer Strip P savings	2,071,191	10,635,444	7,388,913	493296
Cattle restricted access fencing	155,224	797,068	553,758	
Milkhouse wastewater management	972,380	4,993,116	3,468,939	39,339
Eavestrough stormwater diversion	324,767	1,667,659	1,158,596	31141
Manure storage tank construction	5,022,709	25,791,313	17,918,365	356,505
Soil Conservation (Tillage)	391,890	2,012,333	1,398,057	765,804
Other cost savings of riparian buffer strips	**16,067**	**66,891**	**41,479**	
Riparian Buffer Strip Sediment savings	8,871	40,688	24,780	
Streambank Maintenance	2,194	3,354	2,774	
Flood Control	5,001	22,848	13,925	
On-site cost savings of conservation tillage	**151,498**	**852,225**	**501,862**	

Carbon storage	**432,173**	**467,806**	**449,989**	
Wetlands	**1,320,394**	**1,320,394**	**1,320,394**	**71,883**
Total	**11,166,190**	**50,185,284**	**35,298,767**	**2,158,690**
Cost-benefit (%)			**6.1%**	

* Includes both government and owner costs.
** Covers all streambank rehabilitation projects including cattle access restriction.
*** Cost of tree planting is included in non-point source pollution control cost.

As the table above shows, the total monetary value of these restoration projects is estimated at an average of $35,298,767 by end of year 2002.

The total costs of SSRAP restoration projects (1991-2002) covered in this report amount to $2,158,690. The cost-benefit ratio as of end of 2002 is only 6.1 %. This reflects the cost effectiveness of these projects.

To reiterate, these are not final or definitive results, as these benefits address only some of the economic gains generated by the RAP. Other aspects that were not economically assessed in this report include:

- Value of improved habitat (riparian, aquatic and terrestrial).
- Other cost savings of cattle fencing (streambank stability and herd health)
- Real estate gains due to the increase in property values
- Recreational benefits (including fishing, swimming, etc.).
- Health benefits and cost savings.

Moreover, the above results only cover a specific period of time. A proper comparison for cost to benefit need to be made to the total long-term benefits accumulated over the years of the conserved environmental amenities, as long as they are preserved.

As the environmental benefits accrue over the years, while costs are constant, the cost-benefit ratio diminishes over time approaching zero. Practically speaking, cost does not remain constant as there could be maintenance and monitoring costs for the restoration projects. However, these cost increments are perceived minimal when compared to the large figures annually accumulated. Therefore, over the long run, the cost benefit ratio is expected to continue declining to a very small figure (approaching zero).

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Appendices

Appendix A- Wetland and Upland Restoration Projects in the Severn Sound RAP (1991-2002)

Project ID	Watershed	Project Type*	Date Initiated-Completed	Cost	Wetlands		Upland	
					Rehab (ha)	Protected (ha)	Rehab (ha)	Protected (ha)
W1	Severn River	C	Nov98	$300	0	10.13	0	20.34
W2	Penetang Bay	PEB	Jan99-Dec99	$3,464	14.18	0	6.08	0
W3	North River	FPH	Sep98-Oct99	$15,701	1.28	0	6.62	0
W4	Coldwater River	C	Mar00	$300	0	10.13	0	67.84
W5	Wye River	OPH	1999-Mar00	$8,357	0.61	0	2.79	0
W6	Hog River	C	Dec99	$300	0	8.1	0	10.94
W7	Coldwater River	C	Dec99	$300	0	12.29	0	21.77
W8	Sturgeon River	OPH	Sep99-Nov00	$10,421	2.02	0	44.55	0
W9	Wye River	OPHE	Aug99-Dec00	$15,300	6.08	0	33.62	0
W10	Hog River	OPH	Aug99-May00	$5,600	0.3	0	0.91	0
W11	Lafontaine Creek	OPH	Aug99-Dec00	$7,340	1.13	0	29.22	0
W12	Severn River	C	Aug00	$300	0	48.6	0	72.9
W13	Sturgeon River	C	Dec00	$0	0	1	0	5
W14	Hog River	P	Jan01-May01	$1,500	1	0	20.28	0
W15	North River	P	Feb01-Aug01	$800	1	0	1	0
W16	North River	CE	Jan01-Nov01	$300	0	23	0	6
W17	Sturgeon River	C	Apr01	$0	0	6.5	0	5
W18	Coldwater River	C	Aug01	$0	0	2.5	0	3
W19	Coldwater River	C	Mar02	$0	0	1	0	7
W20	Hog River	C	May02	$0	0	1.5	0	2
W21	Little Lake	P	Jan02-Sep02	$1,000	2	0	1	0
W22	Midland Harbour	P	ongoing	$0	1	0	1	0
W23	Hog River	P	Jul02	$400	8.1	0	10.94	0

W24	Hog River	P	Jan01-Jul02	$2,000	9.07	0	7.12	0
Total					**47.77**	**124.75**	**165.13**	**221.79**

*Project type:
O=open water cell creation
P=planting
H=habitat structure (e.g. nest boxes)
B=biological control of Purple Loosestrife
E=educational signage
F=fencing
C=conservation agreement (Low Security-verbal/handshake agreements)

Appendix B- Performance of the Severn Sound Sewage Treatment Plants, and calculation of unit cost ($/kg) for TP wastewater treatment

Table (B.1) Severn Sound Sewage Treatment Plants' (STP's) Performance

Plant	**Pre-RAP Design Flow**	**Pre-RAP Effluent (TP) (mg/L)**	**Pre-RAP P Load**	**Target(1) Effluent (TP)**	**2003 Design Flow (2)**	**P.Load without Upgrade (3)**	**P.Load with Upgrades (4)**
	(m3/d)	**(mg/L)**	**(kg/y)**	**(mg/L)**	**(m3/d)**	**(kg/y)**	**(kg/y)**
Penetang							
Main St	3,000	0.58	552	0.1	4546	1,660	166
Fox St	1,500	0.47	215	0.1	1515	553	55
Penetang MHC	568	0.19	20	0.3	568	39	39
Midland	13,638	0.72	2,944	0.3	15680	4,124	1,718
Elmvale	750	3.5	1,750	0.1	1512	1,933	55
Port McNicol	1,045	0.32	88	0.15	2400	438	131
Victoria Harb.	2,363	0.12	27	0.15	2363	259	129
Coldwater	545	3.55	526	0.25	920	1,193	84
Port Severn				0.3	702	817	77
Totals	**23,409**		**6,121**		**30,206**	**11,017**	**2,456**

Source: SSRAP coordinator, August, 2003.

1- SSRAP target equivalent to Certificate of Approval objective for total phosphorus
2- From Certificate of Approval mean daily flow except Coldwater is from design brief (plant upgrade under construction)
3- Assumes old effluent requirement and new design flow
4- Current performance assuming target met and new design flow achieved

Table (B.1 cont'd) Severn Sound Sewage Treatment Plants' (STP's) Performance

Plant	Red. in P Loads (5)	Current P Load (6)	Year Upgrade Brought on-line	Total Project Cost
	(Kg/y)	(Kg/y)	On-line	($000s)
Penetang				
Main St (7)	1,494	112	1994	4,600
Fox St (7)	498	25	1995	1,500
Penetang MHC (7)	0	39	N/A	0
Midland (7)	2,405	789	1996	8,270
Elmvale (7)	1,878	32	1989	7,000
Port McNicol	307	44	2001	6,013
Victoria Harb.	129	104	N/A	0
Coldwater (7)(8)	1,109	50	2004	750
Port Severn	741	60	1998	5,800
Totals	**8,561**	**1,255**	**11,973**	**33,933**

Source: SSRAP coordinator, August, 2003.

5- P. reduction is the difference between "P.Load without" and "P.Load with" upgrade
6- From 2000, 2001, 2002 plant monitoring results or latest available
7- Improved performance also achieved through plant optimization training
8- Coldwater sewage plant under upgrade, performance will not change from existing

Table (B.2) Estimated Total Annual Costs of STPs* in Severn Sound and Marginal Cost of P Treatment ($/kg)

STP	Total Project Cost (1) ($000s)	Loan Amount (1) ($000s)	Grant Amount (1) ($000s)	Annual Capital Cost (1) ($000s)	O & M Costs (2) ($000s)	Total Annual Capital Cost (3) ($000s)	$/kg of P (4)	Interest Rate (5) %	Years of Amortization (5)
Penetang									
Main St	4,600	2,300	2300	611	59	670	**448**	9%	10
Fox St	1,500	750	750	210	81	291	**563**	9%	10
Penetang MHC	0	---	---	---	---	---	---	---	---
Midland	8,270	5400	2,870	730	445	1174	**474**	6%	18
Elmvale	7,000	4,200	2800	599	72	671	**343**	6%	18
Port McNicol	6,013	3300	2,713	507	56	563	**1761**	6%	18
Victoria Harb.	---	---	---	---	---	---	---	---	---
Port Severn	5,800	3,480	2320	65	194	259	**345**	6%	18

* Data for Coldwater STP was not included since its upgrade has not yet been brought online.
(1) Relevant townships were contacted to verify the basis for amortizing their loans. Part of the capital cost was indicated as a grant, which was treated differently in calculating annual payments (i. e. amount was evenly distributed over years without interest).
(2) Operational and maintenance cost was estimated based on Zegarac, 1994.
(3) Total annual cost = annual capital cost + operational and maintenance cost.
(4) This was calculated as the total annual cost divided by the reduction in P load (kg) in table B.1 above (difference between P load with upgrade and P load without upgrade).
(5) This information was obtained from treasury departments of townships (Penetang, Midland, and Port McNicol). Data for other townships was estimated based on collected data.

Appendix C- Carbon storage calculations for tree species planted by the SSRAP

1) White Pine Tree Species

Age (yrs)	Previous use	Trees & roots (t/ha)		Surface litter (t/ha)		Root litter and soil (t/ha)		Total (t/ha)		Annual increment (t/ha)	
		Med	Good	Med	Good	Med	Good	Med	Good	Med	Good
1	Agr	6	6	2.6	2.6	37.3	37.4	45.9	46.0	45.9	46.0
2	Agr	6	6	2.7	2.8	37.4	37.5	46.1	46.3	0.3	0.4
3	Agr	6	6	2.9	3.1	37.5	37.7	46.4	46.7	0.3	0.4
4	Agr	6	6	3.0	3.3	37.6	37.8	46.6	47.1	0.3	0.4
5	Agr	6	6	3.2	3.5	37.7	38.0	46.9	47.5	0.3	0.4
6	Agr	6	9	3.4	3.7	37.8	38.1	47.2	50.8	0.3	3.4
7	Agr	7	10	3.5	3.9	37.9	38.3	48.4	52.2	1.3	1.4
8	Agr	7	12	3.7	4.2	38.0	38.4	48.7	54.6	0.3	2.4
9	Agr	8	12	3.8	4.4	38.1	38.6	49.9	54.9	1.3	0.4
10	Agr	8	12	4.0	4.6	38.2	38.7	50.2	55.3	0.3	0.4
11	Agr	8	13	4.2	4.8	38.3	38.9	50.5	56.7	0.3	1.4
12	Agr	9	14	4.3	5.0	38.4	39.0	51.7	58.0	1.3	1.4
15	Agr	12	17	4.8	5.7	38.7	39.5	55.5	62.2	5.6	7.2
20	Agr	19	27	5.6	6.8	39.2	40.2	63.8	74.0	8.3	11.9
25	Agr	24	40	6.4	7.9	39.7	41.0	70.1	88.9	6.3	14.9
50	Agr	66	93	10.4	13.4	42.2	44.7	118.6	151.1	48.5	62.3
100	Agr	118	160	18.4	24.4	47.2	52.2	183.6	236.6	65.0	85.5
1	NonAgr	6	6	2.4	2.4	37.2	37.2	45.6	45.6	45.6	45.6
2	NonAgr	6	6	2.4	2.4	37.2	37.2	45.6	45.6	0.0	0.0
3	NonAgr	6	6	2.4	2.4	37.2	37.2	45.6	45.6	0.0	0.0
4	NonAgr	6	6	2.4	2.4	37.2	37.2	45.6	45.6	0.0	0.0
5	NonAgr	6	6	2.4	2.4	37.2	37.2	45.6	45.6	0.0	0.0
6	NonAgr	6	9	2.4	2.4	37.2	37.2	45.6	48.6	0.0	3.0
7	NonAgr	7	10	2.4	2.4	37.2	37.2	46.6	49.6	1.0	1.0
8	NonAgr	7	12	2.4	2.4	37.2	37.2	46.6	51.6	0.0	2.0
9	NonAgr	8	12	2.4	2.4	37.2	37.2	47.6	51.6	1.0	0.0
10	NonAgr	8	12	2.4	2.4	37.2	37.2	47.6	51.6	0.0	0.0
11	NonAgr	8	13	2.4	2.4	37.2	37.2	47.6	52.6	0.0	1.0
12	NonAgr	9	14	2.4	2.4	37.2	37.2	48.6	53.6	1.0	1.0
15	NonAgr	12	17	2.4	2.4	37.2	37.2	51.6	56.6	4.0	5.0
20	NonAgr	19	27	2.4	2.4	37.2	37.2	58.6	66.6	7.0	10.0
25	NonAgr	24	40	2.4	2.4	37.2	37.2	63.6	79.6	5.0	13.0
50	NonAgr	66	93	10.4	13.4	42.2	44.7	118.6	151.1	55.0	71.5
100	NonAgr	118	160	18.4	24.4	47.2	52.2	183.6	236.6	65.0	85.5

2) White Spruce Tree Species

Age	Previous use	Trees & roots (t/ha)		Surface litter (t/ha)		Root litter and soil (t/ha)		Total (t/ha)		Annual increment (t/ha)	
		Med	Good	Med	Good	Med	Good	Med	Good	Med	Good
1	Agr	6	6	2.6	2.7	37.3	37.4	45.9	46.0	45.9	46.0
2	Agr	6	6	2.8	2.9	37.5	37.5	46.3	46.5	0.3	0.4
3	Agr	6	6	3.0	3.2	37.6	37.7	46.6	46.9	0.3	0.4
4	Agr	6	6	3.2	3.4	37.8	37.9	47.0	47.3	0.3	0.4
5	Agr	6	6	3.4	3.7	37.9	38.1	47.3	47.8	0.3	0.4
6	Agr	6	6	3.6	4.0	38.0	38.2	47.6	48.2	0.3	0.4
7	Agr	7	7	3.8	4.2	38.2	38.4	49.0	49.6	1.3	1.4
8	Agr	7	7	4.0	4.5	38.3	38.6	49.3	50.0	0.3	0.4
9	Agr	8	8	4.2	4.7	38.5	38.7	50.7	51.5	1.3	1.4
10	Agr	8	8	4.4	5.0	38.6	38.9	51.0	51.9	0.3	0.4
11	Agr	8	9	4.6	5.3	38.7	39.1	51.3	53.3	0.3	1.4
12	Agr	9	10	4.8	5.5	38.9	39.2	52.7	54.8	1.3	1.4
15	Agr	8	12	5.4	6.3	39.3	39.8	52.7	58.1	2.0	6.6
20	Agr	13	18	6.4	7.6	40.0	40.6	59.4	66.2	6.7	8.2
25	Agr	16	20	7.4	8.9	40.7	41.5	64.1	70.4	4.7	4.1
50	Agr	40	56	12.4	15.4	44.2	45.7	96.6	117.1	32.5	46.8
100	Agr	87	113	22.4	28.4	51.2	54.2	160.6	195.6	64.0	78.5
1	NonAgr	6	6	2.4	2.4	37.2	37.2	45.6	45.6	45.6	45.6
2	NonAgr	6	6	2.4	2.4	37.2	37.2	45.6	45.6	0.0	0.0
3	NonAgr	6	6	2.4	2.4	37.2	37.2	45.6	45.6	0.0	0.0
4	NonAgr	6	6	2.4	2.4	37.2	37.2	45.6	45.6	0.0	0.0
5	NonAgr	6	6	2.4	2.4	37.2	37.2	45.6	45.6	0.0	0.0
6	NonAgr	6	6	2.4	2.4	37.2	37.2	45.6	45.6	0.0	0.0
7	NonAgr	7	7	2.4	2.4	37.2	37.2	46.6	46.6	1.0	1.0
8	NonAgr	7	7	2.4	2.4	37.2	37.2	46.6	46.6	0.0	0.0
9	NonAgr	8	8	2.4	2.4	37.2	37.2	47.6	47.6	1.0	1.0
10	NonAgr	8	8	2.4	2.4	37.2	37.2	47.6	47.6	0.0	0.0
11	NonAgr	8	9	2.4	2.4	37.2	37.2	47.6	48.6	0.0	1.0
12	NonAgr	9	10	2.4	2.4	37.2	37.2	48.6	49.6	1.0	1.0
15	NonAgr	8	12	2.4	2.4	37.2	37.2	47.6	51.6	0.0	4.0
20	NonAgr	13	18	2.4	2.4	37.2	37.2	52.6	57.6	5.0	6.0
25	NonAgr	16	20	2.4	2.4	37.2	37.2	55.6	59.6	3.0	2.0
50	NonAgr	40	56	12.4	15.4	44.2	45.7	96.6	117.1	41.0	57.5
100	NonAgr	87	113	22.4	28.4	51.2	54.2	160.6	195.6	64.0	78.5