MEASURING SUSTAINABLE DEVELOPMENT

APPLICATION OF THE GENUINE PROGRESS INDEX TO NOVA SCOTIA

The GPI Water Quality Accounts
Summary Report

NOVA SCOTIA'S WATER RESOURCE VALUES AND THE DAMAGE COSTS OF DECLINING WATER RESOURCES AND WATER QUALITY

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GPI *Atlantic*

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Executive Summary

The Earth's ecosystems are the source of all human goods and services, with water capital a key component of life itself. Unfortunately, we often take water availability and water quality for granted. But Canada's water supply is not exempt from potential shortages and degradation that have already afflicted parts of the world. David Schindler, one of the world's leading water experts, has warned that Canada's current levels of pollution, habitat destruction and climate warming "will compromise Canada's freshwater supplies so dramatically in the next 50 years that freshwater fisheries could disappear and drinking-water supplies will be in a state of crisis"(Nikiforuk 2000).

Current trends in water use and pollution threaten freshwater quality and availability, and the ecosystem health on which the human economy ultimately depends. Without a firm commitment to pollution prevention and control, and without the recognition of water values in our core benchmarks of progress, future generations may face a potentially irreversible crisis in a resource on which human survival and all other life forms depend. For this reason, an assessment of our water resources is one of the 22 central components of the Genuine Progress Index (GPI), enabling us to measure our progress in sustaining and improving the quality of this vital source of natural capital.

The GPI Natural Capital and Environmental Accounts aim to broaden our economic accounts to include natural resources and environmental assets. Natural assets or resources can be considered as natural capital. Just as we consider manufactured capital an asset in conventional economic indicators like the GDP, so we must account for the natural capital assets that are intrinsic to our very livelihood.

The GDP and related market statistics currently give no value to our natural capital assets. On the contrary, they actually record their depletion as gain, because they only count their "use value" when incorporated into industrial production and sold at the market price. Therefore, in our conventional accounts, the more trees, water and fish we consume, the faster the economy grows. The more pollution we have and the more we spend on clean-up, the more the GDP will grow. When GDP growth rates are misused as a measure of well-being and prosperity, they actually send the wrong message to policy-makers and the public about the health of our environment.

By contrast, the Genuine Progress Index recognizes that water resources have a wide range of social, economic and ecological values. Because these values are dependent on clean, healthy water, investment is also necessary to maintain and protect this vital natural asset. In the GPI, pollution is treated as a cost, not a gain, to the economy and society.

The Nova Scotia GPI Water Quality Account includes three main sections. Part I is a compilation of water quality indicators for the province, including drinking water quality, surface water quality, recreational water quality, wetlands, estuaries and coastal areas, and contaminated areas. Because resource benefits cannot always be accurately reflected monetarily, this first part of the GPI water quality account focuses only on physical indicators of key water quality issues.

Part II is a quantitative assessment of the economic value of Nova Scotia's water resources and water quality, including the costs due to losses in water-related ecosystem services and declines in water quality. Part two presents data on the value of water-related ecosystem services, defensive expenditures, pollution abatement costs, damage costs, restoration costs, and health costs. The study assesses the costs of halting the degradation of Nova Scotia's water capital and of protecting the flow of services from the province's water resources.

Part III is a detailed case study of the economic, environmental and social costs and benefits of wastewater treatment for Halifax Harbour, that demonstrates the utility of the GPI "full-cost accounting" approach to micro-level assessments of alternative investment options.

The development of comprehensive accounts should not be seen as a costly and draining exercise. Indeed, according to the U.S. Panel on Integrated Environmental and Economic Accounting, investing in more complete, accurate and timely data will yield a high economic return.

> "An investment in comprehensive economic accounts would benefit the nation because... better information allows both the public and private sectors to make better decisions." (Nordhaus and Kokkelenberg 1999)

Better physical and economic accounts including improved data on the interaction between the economy and the natural environment would help:

- refine regulatory tools, conservation policies and pollution control investments;
- improve the management of public lands by revealing the hidden subsidies to leasers that result from under-valuing the true worth of forests, rangelands and waters;
- structure tax penalties and financial incentives that would be passed on as more realistic prices that reflect the actual preservation or depletion of natural wealth; and
- assess the costs and benefits of measures to slow greenhouse warming.

The study marks the first ever assessment in Canada of the full value of a province's water resources, and pulls together vast quantities of published and unpublished information from a wide range of federal, provincial and municipal sources.

[1] The GPI water quality study is the first in a series of natural resource accounts to be released in the coming months by GPI Atlantic, as part of the Nova Scotia Genuine Progress Index, a new measure of well-being and sustainable development.

Results from this GPI Water Quality Account show that more Nova Scotians have clean and healthy drinking water than they did 15 years ago, but the quality of the province's rivers, lakes

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Databases and information in GPI Water study are from: Environment Canada, Department of Fisheries and Oceans, Statistics Canada, Health Canada, NS Department of Environment, NS Department of Natural Resources, NS Department of Transportation and Public Works, NS Department of Municipal Affairs, Halifax Regional Municipality, Halifax Regional Water Commission, Soil and Conservation Society of Metro Halifax, North American Commission for Environmental Cooperation, and a variety of academic and independent research studies.

and coastal waters has declined. The province's water resources provide a wealth of benefits to Nova Scotia worth more than $11 billion a year, including drinking and industrial water supply, recreation, waste treatment, food production, nutrient cycling, erosion control, and other vital ecosystem services.

The study found a 3.2 percentage point improvement from 1987 to 1998 in municipal water samples that were free from coliform bacteria; a 33% improvement in the percentage of Nova Scotia's population with drinking water conforming to national health guidelines; and a 17% improvement in water complying with aesthetic objectives. Two municipal water supplies still have lead above the maximum acceptable concentration, and 3% of municipal water samples showed the presence of coliform bacteria that could cause health problems.

Still, more than one third of Nova Scotians don't trust their drinking water and spend an estimated $265 a year per household on bottled water and water filtration systems, injecting $32.8 million a year into the provincial economy. In the GPI, unlike measures of progress based on the GDP, this infusion of spending is not regarded as economic gain nor as a signal of well-being. Rather, if more Nova Scotians trusted their drinking water, they would realize major savings.

But while drinking water quality has actually improved, the province's wetlands, rivers, lakes, and coastal waters are in decline, causing hidden damage to the economy, and threatening the well-being of future generations. Nova Scotia's rivers have suffered more from acid rain than any other province, and only 20% of the province's former salmon rivers still have healthy fish stocks. Atlantic salmon are extinct in 22% of NS rivers, 31% have only "remnant" populations, and another 25% have depleted stocks. In 1999, only 22 of Nova Scotia's 72 salmon rivers were still open to recreational salmon angling.

Since 1985, the number of brook trout caught in the province has dropped by half, likely because of previous over-fishing, acid rain, and sedimentation of stream beds due to logging, agriculture and development. The GPI report estimated a loss to Nova Scotia of $22 million over 10 years due to the decline in recreational fishing. As well, the closing of the commercial salmon fishery has cost the federal government another $1 million to buy back licenses.

Along the coast, the number of shellfish closures, due mostly to bacteriological contamination, has more than doubled in the last 15 years, at an annual estimated cost of $8 million a year in lost revenues. In the last four years alone, the closed shellfish area has increased by 38%.

Metro lakes are faring no better, with nearly one-quarter "aging" and dying rapidly due to high concentrations of phosphorus, nitrogen and other nutrients that come from fertilizer run-off, and from households, agriculture and forestry. Four metro lakes are already classified as "eutrophic," meaning that nutrient levels are so high that dissolved oxygen levels have been significantly reduced, and another seven are "mesotrophic," with intermediate levels of nutrients and oxygen. When oxygen is depleted, fish and other aquatic organisms die.

But the highest costs are the most hidden ones, with wetland loss due to development costing Nova Scotia an estimated $2.3 billion a year in lost ecological services. Wetlands are among the

most productive ecosystems in the world. They perform a host of incredibly valuable functions, including waste and nutrient cycling; protection against erosion, floods and storms; water purification; and food production. They are one of the richest known wildlife habitats and an essential link in the food chain.

If we lose the benefits of natural, functioning ecosystems, not only do we lose habitat and species diversity, we also have to cope with the loss in ecosystem services by investing in expensive waste treatment and water purification plants, and engineering projects to control erosion and flood damage. Currently the loss of wetland services is invisible in our economic accounts, and we count the cost of expenditures to compensate for these lost services as a gain to the economy. This is bad accounting. We have to recognize, appreciate and *value* nature's vital and irreplaceable life-support services.

The GPI report notes that Nova Scotia has lost 62% of its saltwater wetlands and 17% of its freshwater wetlands since colonization, and it urges immediate conservation measures to prevent further loss.

The GPI report also estimates that Nova Scotia's uncut forested watersheds provide $2,750 per hectare in services per year protecting water supply, -- filtering and intercepting water, controlling run-off, and removing air pollutants. The estimate is based on what it would cost to replace those services with man-made water filtration plants and storm-water retention systems if the forests were clear-cut.

One positive trend noted in the GPI report is a significant reduction in contaminants in pulp and paper mill effluent as a result of federal government regulations implemented in 1992, with all five major Nova Scotia mills now averaging 99% compliance with federal standards. The GPI report recommends further regulation including lowering acceptable carbon dioxide levels below 100 mg/litre using aeration or pH adjustment, in order to reduce contaminants that still cause stress to fish.

The GPI study also details the value of Nova Scotia's water resources for recreation ($150 million a year); investments needed for improvements in wastewater disposal ($532 million) and municipal water supply upgrades ($136 million); water pollution abatement and control expenditures ($180 million); contaminated well claims ($548,000 a year); and a range of other water resource values and pollution costs.

The GPI report has 15 recommendations to the province to protect and conserve the value of Nova Scotia's water resources, including greater source control to reduce toxic discharges to harbours, rivers and lakes; investments in wetland restoration, watershed protection, sewage and water supply upgrades, and salmon habitat restoration; and the explicit recognition of water resource values and pollution costs in the province's core economic accounts.

At a time of budget cuts, we need to keep in mind the investments necessary to maintain our water resources. If water values are not protected, and if adequate investment in sewage treatment, pollution control and conservation are not made, then damage costs and water intake costs will definitely increase, and future generations will be faced with significant costs.

Following earlier cuts, the Nova Scotia Department of Environment has had its 2000-2001 slashed by 16% to $13.1 million from $15.6 million the previous year, making essential inspection, monitoring and enforcement more difficult. The GPI report contains a section, referring to the Walkerton tragedy, that details the costs of inadequate monitoring and enforcement of drinking water quality, and warns that "disinvestment in environmental protection produces major costs to society and the economy."

The GPI Water Quality account is the first in a suite of GPI natural resource accounts to be released later this year, on which GPI Atlantic researchers have been working for more than two years. In the coming months, GPI Atlantic will release its greenhouse gas account for Nova Scotia; an ecological footprint analysis for the province; natural capital accounts for forests, fisheries, and soils and agriculture; an air quality component, and a full-cost accounting analysis of different modes of transportation in Nova Scotia.

GPI reports to date have focused on social components of the Genuine Progress Index, including the value of voluntary work, the value of unpaid household work, the cost of crime in Nova Scotia, and several population health indicators. Work is also currently proceeding on other social and economic indicators in the GPI.

Funding for the GPI Water Quality Account was provided by Environment Canada, Halifax Regional Municipality, and the Halifax Regional Water Commission, with in-kind support from the Nova Scotia Department of Environment and the Clean Nova Scotia Foundation.

SUMMARY OF RESULTS

PART I: WATER QUALITY CRITERIA AND INDICATORS

Water Pollution Releases and Transfers in Nova Scotia	The total water pollutants released and transferred increased by 16.5%, from 708,981 kg in 1996 to 826,061 in 1997 (CEC 1999).
Percent of Nova Scotia's Population on Municipal Water Supplies that Conform to the Guidelines for Canadian Drinking Water Quality (GCDWQ) for Aesthetic and Health Standards	Using 1996 water quality data, 14 municipal water supplies (18%) of a total of 78 province-wide, serving 65% of the total municipal population in the province, did not meet one or more aesthetic objectives of the GCDWQ. In terms of health-related criteria, 8 of the 78 municipal water supplies (10%), serving 16% of the total municipal population in the province did not comply with one or two of MACs; 6 supplies exceeded the MAC for turbidity, and 2 supplies exceeded the criteria for lead. The percent of Nova Scotia's population served by municipal water supplies that comply with the aesthetic objectives and health-related criteria of the GCDWQ increased by 16.7% and by 33% respectively, between 1986 and 1996.
Percent of Nova Scotia's Municipal Water Supply Samples that Conform to the GCDWQ for Bacteriological Content	In terms of bacteriological content, water quality has improved with a 3.2 percentage point increase in municipal samples detecting zero coliforms from 1987 to 1998.
Percent of Nova Scotia's Population on Municipal Water Supplies Meeting the GCDWQ Interim Maximum Acceptable Concentration for Trihalomethane Compounds	The percent of Nova Scotia's population served by municipal water supplies with THMs above present IMAC was about 38.7% in 1989. This percentage decreased to an average of 20% between 1990 and 1994. Most recently, average preliminary results from testing in September 1999, January 2000, and Spring 2000 indicate that approximately 14% of the municipal population served by municipal water supplies may be affected by THM levels above the IMAC of 100 micrograms/litre.
Area of Land Under Water Supply Watershed Protection Strategies	31% of water supplies are either designated as Protected Water Areas or have a comprehensive water supply protection strategy in place. The GPI goal is the designation of protected water areas for 100% of the province's water supply watersheds.
Pesticide Concentrations in Private Wells in Agricultural Areas	There is no comprehensive programme for monitoring private well water quality in the province. A 1989 study in King's County indicated that of the 102 wells

	sampled, zero exceeded maximum acceptable concentrations (MACs) for pesticides tested. Atrazine and its degradation products were detected most frequently in 33 (32.4%) of the wells tested. Eight wells (19%) had more than one pesticide detected, with a maximum total pesticide concentration in one well of 2.19 micrograms/litre. Presently, there is no guideline for total pesticides in the GCDWQ.
Private Wells with Nitrate Concentrations Above the GCDWQ	In 1985, a province-wide study found approximately 7% of the wells on record had nitrate levels above MAC of 10 mg/L. (Note: the study indicates that the database tended to include wells sampled only when there was a suspected problem in the well's water quality.)
Contamination of Private Wells from Road Salt	The annual number of well claims to the NSDTPW for private wells contaminated by road salt runoff increased from 13 in 1989 to 34 in 1999.
Acid Deposition Affecting Rivers and Lakes in Nova Scotia	A study of 202 of lakes in Eastern Canada, reporting on sampling since the early 1980s, indicates that: · 33% have reduced levels of acidity; · 56% have shown no change; and, · 11% have become more acidic. However, the least improvement has occurred in Atlantic Canada. Atlantic salmon, an indicator species, are extinct in 22% of Nova Scotia's rivers; 25% of the province's rivers have depleted stocks; 31% of rivers have remnant populations; and, 20% of Nova Scotia's rivers have experienced no significant effect.The problem of acidic deposition is amplified in Atlantic Canada because our ecosystems are very sensitive to acid inputs. The critical load for much of the region is less than 8 kg/hectare/year, while the critical load target for reductions is set at less than 12 kg/hectare/year. Projections indicate that the Atlantic region will continue to receive deposition greater than 8 kg/hectare/year even after the legislated emission reductions are complete.
Wild Atlantic Salmon Population Trends	Over the past thirty years, Atlantic salmon returning each year to spawn in their natal rivers in eastern North America have declined by 75%, or from 1.5 million to only about 350,000; Canada's wild Atlantic salmon runs have declined by 80% during the past 25 years. In 1998, only 21 of the 71 Canadian index Atlantic salmon rivers met their minimum spawning targets.

	Nova Scotia's rivers have experienced the greatest impact in Canada in terms of the percentage of fish habitat affected by acid rain. In 1999, only 22 of Nova Scotia's 72 salmon rivers were open to recreational salmon angling. A recent study undertaken in New Brunswick discovered that nonylphenols, which are found in pesticides, urban runoff and sewage effluents, many plastics, and industrial and domestic detergents have caused gender 'confusion' and developmental irregularities in Atlantic salmon. In addition, increased sediment loads to rivers due to agriculture, forestry activities, and development have negatively affected aquatic habitat and fish populations.
Brook Trout Populations	Since 1985, the number of brook trout caught in the province has declined from 2.6 million to 1.3 million (50% decrease)
Wastewater Contaminant Contribution from Pulp and Paper Mills	In 1992, the federal government amended the Pulp and Paper Effluent Regulations under the authority of the Fisheries Act. As a result, both TSS and BOD in the effluent of pulp and paper mills have dramatically decreased since 1995. All five mills in Nova Scotia have significantly decreased TSS and BOD levels. Mill effluent compliance in relation to the LC50 standard has increased from 58.7%, in 1995, to 98.7% in 1998. However, meeting this goal does not mean that mill effluents are 100% contaminant-free, nor does it ensure that there are no cumulative or chronic impacts on the ecosystem. There is evidence that fish still exhibit signs of distress when exposed to effluent from an oxygen activated sludge treatment plant when levels of carbon dioxide are greater than 100 mg/litre. Mills using these treatment systems have carbon dioxide levels of 48 to 251 mg/litre in their effluent.
Trends in Beach Closures due to High Bacterial and Parasitic Levels	Beach closure data and information records have not been consistently maintained in Nova Scotia. Limited information has been collected by informally surveying the Nova Scotia Department of Environment district offices. Thus, no trends in closures are available at this time. However, closures do occur each year in the province.
Eutrophication of Lakes	Lake sampling, in 1991, of 51 lakes in the Halifax-Dartmouth Metro area indicated that four lakes were eutrophic (7.8%), nine lakes were mesotrophic (17.6%), and the remainder were all oligotrophic (74.5%).

	Nine lakes in King's County were monitored between 1993 and 1999 for trophic state indicators (i.e. total phosphorus, chlorophyll, and transparency). Results indicated a slight increase in nutrient concentrations over time, but all lakes either remained oligotrophic or were approaching mesotrophic conditions. There is no comprehensive water quality database which addresses the trophic status of lakes throughout the province. Site-specific or region-specific surveys have been undertaken where significant development pressures have been identified This is currently a significant data gap because we are unable to make a comprehensive assessment of the trophic status trends of Nova Scotia's lakes.
Recreational Fishing Trends	The number of recreational fish caught has dramatically and steadily declined since 1975, with the most dramatic decline in the 1990s. Between 1975 and 1995, the total number of recreational fish retained declined by nearly 5 million fish, or about 70%. The total recreational catch declined by nearly 1.7 million fish, or 45%, between 1990 and 1995 alone. The angler effort (i.e. the number of days spent fishing per year), has also declined from 1.5 million days, in 1980, to 1.2 million in 1995, the lowest number in two decades. Total recreational fishing expenditures were approximately $24 million to $25 million from 1975 to 1990, followed by a decline of $5.5 million between 1990 and 1995.
Areas closed to shellfishing	Nova Scotia has the highest number of closed shellfishing areas in all the Atlantic provinces, accounting for about half the Maritime regional total. The number of shellfish closures has more than doubled in the last 15 years. The area closed has increased by 264 sq. km. over the past 4 years, a 38% increase in a very short period of time.
Area of Wetland Lost since Colonization	Approximately 17% of Nova Scotia's freshwater wetlands, and 62% of the province's saltwater wetlands have disappeared. Overall, 20.5% of original area covered by freshwater and saltwater wetlands has been lost since colonization in Nova Scotia; a loss of about 75,000 hectares.

Area of Wetland Restored or Rehabilitated in Nova Scotia	Several agencies in Nova Scotia have participated in wetland restoration projects, including Ducks Unlimited, Canadian Wildlife Service, Nova Scotia Natural Resources and Eastern Habitat Joint Venture Data on wetland restoration are available in files at the NSDNR but there are no resources to pull the information together at this time. However, the latest inventory of wetlands in the province includes restored wetlands.
Number and Area of Contaminated Sites in Nova Scotia	There are a total of 375 contaminated sites in Nova Scotia. Of this total, 72 have been re-classified as medium low, medium, and high risk sites based on the CCME scoring system Of the 72 sites, high risk contaminated areas account for 4% of contaminated areas (23 hectares); medium risk sites account for 83% of contaminated areas (473 hectares); and, medium low risk sites account for 13% (73 hectares).

Part II: WATER VALUES AND THE COSTS OF WATER POLLUTION AND WATER QUALITY DECLINE

WATER VALUES	
Preliminary Estimate of Nova Scotia's Water Resource Values	**Nova Scotia's wetlands contribute at least $7.9 billion in valuable ecological services each year, plus up to $22.8 million or an average of at least $12.5 million in additional economic value. The province's lakes and rivers contribute at least $3.1 billion per year more in ecosystem services**. The estimates are based on preliminary information only, and therefore are only a starting point for assigning economic value to the ecological goods and services provided by the world's ecosystems.
Water-based Value of a Forested Watershed	Based on replacement values, the estimated net benefit of a restored watershed is at least **$2,587/hectare/year[2].** In addition, the estimated value of a forested watershed in terms of the forest's interception of water and control of runoff is at least **$86/hectare/year [3]; and** the estimated value of a forested watershed for its removal of air pollutants is **$75/hectare/year.**
Water-Based Recreation Value	The total expenditure on water-based recreational activity in Nova Scotia, by Canadians, is estimated at **$106.2 million per year.** The additional economic value, based on "willingness to pay" estimates, for water-based recreation above the total expenditures is **$43.8 million/year. Thus, the total direct expenditures plus the economic value that is placed on the enjoyment of participating in water-based recreation by Canadians is estimated at $150 million per year in Nova Scotia.** This does not include expenditures by foreign tourists.
DEFENSIVE EXPENDITURES	
Cost to Improve Municipal Wastewater Disposal	**$444.8 million (1997$)** is needed for identified sewage system projects due to deficiencies (including HRM and Industrial Cape Breton). This cost is a crude surrogate measure of the costs of untreated wastewater disposal to the Nova Scotia environment. In other words, this is the necessary investment to stop further degradation as well as restoration of the respective water resources. If investments are made, the benefits of lowered

[2] This is a conservative estimate because it includes the capital costs of replacing this lost forest function through construction of a filtration plant. It does not include the on-going costs of operating the filtration plant, an estimated US$300 million per year.

[3] This is a conservative estimate because it includes only the capital cost of replacing this lost forest function, but not the operating and maintenance costs for the man-made retention structures.

	contaminant additions such as improved shellfishery, beaches, aesthetics, and an improved marine environment, will be realized.
Cost to Improve Domestic Wastewater Disposal	**$86.9 million (1997$)** is the estimated cost to develop wastewater treatment facilities to improve wastewater disposal and reduce impacts on aquatic ecosystems. This estimate represents a surrogate value for the negative impacts of insufficient on-site sewage systems in Nova Scotia. In other words, this is the investment needed to prevent a further decline in the value of our water resources, and to reverse damage already incurred.
Government Pollution Abatement and Control (PAC) Expenditure	**On average, $106 million/year was spent by municipalities in Nova Scotia on water-related PAC expenditures, and $27.8 million/year was spent by the Nova Scotia provincial government on water-related PAC expenditures.** Nova Scotia's government expenditures on PAC increased by $15.4 million between 1991 and 1994. Most of the increase in expenditures occurred at the local level. Municipal government expenditures on PAC increased by approximately $30.6 million, whereas provincial government PAC expenditures declined by $15.2 million.
Pollution Abatement and Control (PAC) Expenditures in the Business Sector	On average, the business sector in Nova Scotia spent an average of $51.0 million/year, in 1995 and 1996, on PAC; **$46.3 million** on water-related PAC, and $4.6 million on air-related PAC. · 69% spent on end-of-the-pipe processes, · 13% on environmental monitoring, · 8% on reclamation and decommissioning, and · 5% on PAC integrated processes.
Percent Contribution by the Public and Business Sector in PAC	· local government contributed over half of all PAC expenditures (59%; $116.5 million), · industry contributed approximately 26% ($51 million), · provincial government contributed 15% ($30.5 million).
Prevention and Protection Expenditures in the Business Sector	**The business sector in Nova Scotia spent an average of $7.6 million/year on prevention and protection expenditures. However, there is a declining trend in expenditures.** Expenditures declined by $4.1 million, or 42% between 1995 and 1996.
Inspection, Monitoring and Enforcement Expenditure	**The total annual expenditure can be estimated at approximately $4.8 million. However, the annual amount is dependent on the Department of Environment's budget.**

WATER INTAKE COSTS	
Industrial Water Intake Treatment Expenditure	**Nova Scotia industry spends an average of $3.2 million/year on water intake treatment costs.**
Municipal Water Supply Expenditure	**The total estimated municipal expenditure on Nova Scotia's drinking water is approximately $8.1 million/year, including:** $7.5 million per year for drinking water treatment, $214,770 per year for water monitoring and analysis, and $322,160 per year for watershed protection, in Nova Scotia.
Costs to Improve Municipal and On-site Water Supply	The estimated cost for upgrades for municipal water supplies is **$114.5 million,** and a further 14 on-site communities require water supply improvements at an estimated cost of over **$21.2 million (1997$); a total of $135.7 million.**
Private Defensive Expenditures for Drinking Water	Nova Scotians spend an estimated **$4.2 million/year on home water filtration for drinking;** residents who drink bottled water regularly spend an estimated **$28 million/year** on bottled water; **a total of $32.8 million (1997$) per year, 1.6% of total annual food expenditure.**

DAMAGE COSTS DUE TO WATER QUALITY DECLINE AND RESOURCE LOSS	
MARKET-RELATED IMPACTS	
Cost of Well Claims due to Road Salt Contamination	The total cost paid by the provincial government for well claims due to salt contamination averages about **$548,000 per year**.
Cost of Shellfishery Closures	**As of August 1999, the economic cost of closed shellfish areas is estimated at $8.0 million/year. The cumulative total economic losses over the time period 1940 to 1994 is estimated at $155 million.**
NON-MARKET IMPACTS	
Cost of Beach Closures	The five year cumulative cost of the, so-far incomplete, list of beach closures in the province can be estimated at **$103,000 for closures that have occurred over the past 5 years. In addition, the cost of closures that are reportedly annual occurrences is estimated at $56,000 per year.**
Historical Value of Atlantic Salmon Fishing in Nova Scotia	**The total value of the salmon recreational catch was approximately $3.1 million per year in the 1980s.** The total cost to the Federal government to buy back the commercial licences was **$1 million**.
Recreational fishing in Nova Scotia	**It is estimated that over the past decade there may well have been a loss of $22 million in revenues in Nova Scotia due to a decline in recreational fishing.**

RESTORATION COSTS	
Restoration of salmon rivers	**The cost of mitigating acidification in the southwestern region of Nova Scotia is $227.5 million to $250.3 million.** Presently, there is no estimate for the area of acidified salmon habitat in other regions of Nova Scotia, which means that this estimate is only a percentage of the total restoration cost. **In Nova Scotia, it is estimated that as a result of 718,068 volunteer hours, approximately $8.6 million is contributed to the restoration of the acidified Atlantic salmon habitat, per year.** **Thus, the tallied restoration cost, which is not yet complete, is estimated at about $238.9 million in liming costs, and approximately $8.6 million per year in volunteer hours.**
Costs due to Wetland Loss	**The 50-year cumulative cost of lost ecosystem services due to wetland losses since colonization, is at least $77 billion (1997$).** **The on-going total annual cost of lost ecosystem services due to loss of Nova Scotia's wetlands is at least $2.3 billion per year.**
HEALTH IMPACTS	
Cost of Water-Related/Water-Borne Illness	The average annual cost of giardia and campylobacter in Nova Scotia is **$3 million per year**.

Water Quality Account - 1st Data Release

A) WATER VALUES (IF WATER RESOURCES ARE ECOLOGICALLY SOUND)	
Lakes and rivers	at least **$3.1 billion/year** in ecosystem services
Wetlands - freshwater and saltwater	1) at least **$7.9 billion/year** in ecosystem services
	2) a minimum of **$12.5 million** in economic value
Forested Watershed Water-based Value	1) at least **$2,587/hectare/year** for water filtration
	2) at least **$75/hectare/year** for removal of air pollutants
	3) at least **$86/hectare/ year** for interception of water and control of runoff
	Total: $2,748/hectare/year
Water-based Recreation	**$150 million/year**
Historical Atlantic Salmon Recreational Fishing	**$3.1 million/year**
TOTAL VALUES	**Total water ecosystem values $11.2 billion/year** (excludes the economic value for wetlands based on WTP, $12.5 million, and the Atlantic Salmon recreational fishing value, $3.1 million per year because of possible double-counting with the water-based recreation value.
	Total forested watershed water-based value $2,748/ha/year (here for reference, but not included in the total above)

B) DEFENSIVE EXPENDITURES	
- TO AVOID CONTAMINATION OF WATER	
Investment Necessary for Improvements for Wastewater Disposal	**$531.7 million**
Pollution Abatement and Control (PAC)	**$180 million/year**
Prevention and Protection	**$7.6 million/year**
Inspection, Monitoring and Enforcement	**$4.8 million/year** (depending on NSDOE total budget; e.g. declined between 1998/9 and 1999/2000)
TOTAL	**$192.4 million/year, plus necessary capital investment of $531.7 million**
C) WATER INTAKE COSTS	
INCREASE WHEN A (WATER VALUES) OR B (DEFENSIVE EXP.) DECREASE	
Municipal Water Supply	**$8.1 million/year** in operating costs (provincial expenditure for treatment, monitoring and protection, based on HRM's expenditure; necessary investment for upgrades $114.5 million in capital costs)
Household Water Filtering and Bottled Water	at least **$32.8 million/year**
Industrial Water Intake	**$3.2 million/year**
Domestic On-Site Community Water Supply	**unknown**, however, a capital investment of at least $21.2 million is needed for upgrades
TOTAL	**$44.1 million/year in operating costs, plus a necessary capital investment of $126.7 million**
D) COSTS INCURRED DUE TO A LOSS IN WATER RESOURCE VALUE AND WATER QUALITY DECLINE	
1) DAMAGE COSTS	
Contaminated Well Claims	**$548,000/year**

Shellfishery Closures	**$8 million/year; plus cumulative cost of $155 million** 1940 to1994
Beach Closures	at least **$56,000 per year; plus $103,000** over the past 5 years
Atlantic Salmon Fishing	**$1 million**
Recreational Fishing	**$2.2 million/year**
Wetlands	**$2.3 billion/year, plus cumulative loss of $77 billion**
TOTAL	**$2.31 billion/year, plus $77.18 billion in cumulative losses over 50 years due to wetland losses**
2) RESTORATION COSTS	
Atlantic Salmon Rivers	**$8.6 million/year, plus $238.9 million** for southwestern region
3) HEALTH COSTS	
Water-Related Illness	at least **$3 million/year**
ALL COSTS DUE TO DECLINE IN WATER VALUES AND/OR INSUFFICIENT INVESTMENT IN DEFENSIVE EXPENDITURES	**$2.32 billion/year IN DAMAGE, RESTORATION AND HEALTH COSTS;**