



Economics & Policy for the Environment

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An Evaluation of the Socio-Economic Justification for Sediment Remediation in the St. Clair River Area of Concern

*April 1999 Final Report
(as amended for comments received December 2000)*

[The information and views presented in this report are those of the author and do not necessarily represent the view or position of Environment Canada or any other cooperating agencies.]

Acknowledgments

Recognition should be given to the number of people who have helped in assembling and interpreting the information in this report. Tom Muir and Karl Schaefer from Environment Canada and Gary Johnson from The Ontario Ministry of Environment were key, not only as project guides but also in providing feedback valuable guidance. The entire Bi-national Public Advisory Committee was extremely helpful in providing frank and sincere direction as to the potential benefits associated with remediation of the contaminated site in question. The Lambton Industrial Society was helpful in outlining likely cost information and loaning information material for my use.

Ian Orchard of Environment Canada provided valuable cost information and assisted in providing additional direction. Keith Brinkley from the Federal Department of Fisheries and Oceans (DFO) and Fern Fillion were extremely helpful in estimating recreational fisheries and wildlife non-consumptive benefits, respectively. Other Environment Canada and DFO staff at the Canada Centre for Inland Waters additional direction as did resources at the University of Windsor. Most others who helped with this report are referenced through footnotes throughout the paper. I apologize in advance if I have missed someone.

In addition, a big thank you goes to Jean Rivers, my partner, who read the paper several times and provided some very helpful editorial comments.

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Executive Summary

This study has two purposes. First it is intended to provide information about expected costs and benefits that would be involved should there be a decision to remediate contaminated sediment in the St. Clair River. Second, the study is intended to provide direction as to the kinds of information that is required to facilitate decision making at other Areas of Concern that also have contaminated sediment impairing beneficial uses.

Approximately 4500 cubic meters of sediment contaminated by mercury and organic chemicals is slowly migrating downstream and will ultimately accumulate in the Delta and Lake St. Clair and possibly further downstream, unless remediated. In addition, there is the danger of a potential incident, such as low water propeller wash or ice scour, that could send a significant amount of contaminants downstream. Although there is ongoing monitoring of St. Clair River water quality, a large escape of contaminated material can affect water quality, natural resources and possibly human health in the River, Delta and Lake for a considerable period of time.

The St. Clair River Remedial Action Plan is a bi-national effort and has been successful in eliminating all but seven impaired uses that were responsible for the nomination of the St. Clair River as an Area of Concern. Five of these seven relate to issues that cannot be resolved without remediation of the contaminated sediment. It is widely believed that the economic, as well as the environmental, well being of Sarnia and the Canadian side of the St. Clair River, Delta and Lake would be significantly enhanced by de-listing the Area of Concern.

Benefits would include increased economic activity associated with enhanced recreational opportunities for tourists as well as residents in the St. Clair area. Sports fishers, in particular, would be increasingly attracted to the St. Clair area - one of most productive fisheries in the Great Lakes basin. Guiding and fish permit sales form an important part of the income for residents of Walpole Island and these would be expected to increase as confidence in the quality of the environment is enhanced. Family disposable incomes on Walpole would be enhanced as purchased food could be replaced by more traditional wildlife and fish food sources for the Island population. Security of drinking water could be enhanced for Wallaceburg and Walpole residents. In general, ecosystem health, including that of humans, would be put less at risk of incidental exposure to toxic chemicals.

The returns to industry are less well understood, however, the potential liability of Chemical Valley industries and others for an accidental escape of contaminants would be reduced. Industrial and commercial property values are likely to be enhanced by the improvements in water quality and the environment and greater market opportunities for waterfront land should become available. In addition, the productive freshwater commercial fishery of the St. Clair area has been severely limited since 1970. The value of a renewed commercial fishery, particularly one that could, once again, safely

harvest higher valued fish species would provide significant benefits to the entire area community - although realization will depend on provincial fisheries policies. Sarnia has been allocating a million dollars a year to promote the area for enhanced economic development. De-listing of the St. Clair Area of Concern would make marketing Sarnia, as a place to build, work and live more successful, possibly allowing a reduction in the promotion costs per year. Finally, residential property values have been shown, elsewhere, to increase by as much as 12.5% solely as a result of environmental enhancements. Such a real increase in landholder wealth would be significant for the community.

Remediation of contaminated sediment in the St. Clair River would involve one of two options. One could carefully dredge the contaminated sediment to avoid escape of any material, de-watering the dredged material, and treating and disposing of the wastewater and dredged material. Alternatively, it has been suggested that material (textile cloth, stone and clay/sand) be placed over the contaminated site as a cap. Capping technology is not as well established as dredging and may be less reliable over time, but capping minimizes the risk of accidental escape of any material during remediation. Costs for either option are about the same at roughly three million dollars in total. Implementation of either option should be relatively short for the limited amount of material to be remediated.

This study has examined the potential costs and benefits based on existing information and concludes that a detailed benefit cost analysis would be of limited additional value to decision makers in the remedial action plan. The benefits are less clearly defined than costs, as is typical for environmental projects. However the potential exists for the benefits to exceed the total costs by a significant margin. In the author's view the potential benefits more than offset the costs of this project. It is doubtful that a more exhaustive examination would improve significantly on that determination. A benefits and costs scoping project, such as was done for the St. Clair, may be all that is required to facilitate decision making for other Areas of Concern with contaminated sediment impairing beneficial uses, particularly if costs are relatively small.

Although not addressed in the terms of reference for this study another key decision variable, besides socio-economic payback, should be considered in the future. A determination of the 'affordability' of a project is key to assisting decision makers to come to a relatively speedy conclusion as to project action. In the case of the St. Clair River contaminated sediment, \$3 million to remediate the project is a relatively small amount of money given the size of the community, the industrial tax base and the wealth of the industries in the area.

Introduction

1.1 Purpose and Objectives

Contaminated sediments are an environmental problem throughout the Great Lakes basin system including the St. Clair River. In general contaminated sediments are problematic throughout all of the 42 remaining environmental Areas of Concern of the Great Lakes and represent 11 of the 14 use impairments identified as restoration goals in the Great Lakes Water Quality Agreement (GLWQA).

Sediment cores taken from a narrow zone along the Canadian side of the St. Clair River have shown high concentrations of mercury, cadmium, lead, hexachlorobenzene (HCB), hexachlorobutadiene (HCBd), octachlorostyrene (OCS), and other chlorinated compounds. This contamination is a result of historical point source loadings from industrial sources on the Canadian side of the St. Clair River. Persistent toxic substances that have accumulated in this area may be responsible for 5 out of 7 current St. Clair River Area of Concern (AOC) beneficial use impairments, as defined by the GLWQA.

Further, since the St. Clair River system includes the River, the River Delta, and Lake St. Clair, the contamination and use impairments also impact on those downstream parts of the system. This contamination includes impacts to benthic organisms and bottom dwelling fish, and the possible accumulation and transfer of contaminants through the food chain resulting in effects on wildlife, birds and people. This has resulted in poor ecosystem health, including the establishment of fish consumption advisories that affect sport and other recreational fisheries.

Scientific studies have proven that sediment-bound chemicals pose a threat to organisms directly utilizing the sediments. Further, re-mobilization of in-place pollutants through natural events or adjacent shipping activities, including propeller wash or a shipping accident, poses an additional major environmental risk. Sediment re-suspension of fine sediment may see the export of contaminated substances to the Delta and deposits in the St. Clair flats and Lake St. Clair. This has contributed to fish consumption advisories for the Delta and Lake St. Clair and continues to retard recovery of these ecosystems.

This socio-economic study has two purposes. First, this study is intended to provide a socio-economic perspective to the discussion about the future of the remedial action plan (RAP) for the St. Clair River. In particular, this study is intended to help facilitate the discussion of dealing with sediment remediation, an environmental issue that is responsible for five of the remaining seven impaired uses in the St. Clair River Area of Concern (AOC). This study is intended to identify and explore potential costs and benefits that may result from remediation, however, it is not a traditional benefit-cost study and does not provide a quantified judgement of whether remediation should be undertaken. That is left to the reader and those involved in the discussion and

negotiation of remedial options.

A second purpose of this study is to provide a framework for analysis and discussion of the potential benefit and cost issues that are a consideration in other AOCs throughout the Great Lakes. The IJC and the parties to the Great Lakes Water Quality Agreement, through the 'SEDPAC' and other committees, are seeking direction as to whether and when remediation of contaminated sediment should be undertaken. This study of the costs and benefits associated with the St. Clair River is an initial step in helping to provide that direction.

1.2 The Nature of the Environmental Problem

The boundaries of the St. Clair River Area of Concern include the entire river from the Blue Water Bridge to the southern tip of Seaway Island, west to St. John's Marsh and east to include the north shore of Mitchell's Bay on Lake St. Clair. The St. Clair River flows approximately 64 kms in a southerly direction from the outflow of Lake Huron to Lake St. Clair and passes through seven channels that create the St. Clair Delta (also known as the St. Clair Flats). The width of the Rivers varies from 250 m and 1200 meters with flows between 4200 and 5500 cubic meters per second. There are a number of tributaries including Murphy Drain, Talfourd, Baby and Bowens Creeks in Ontario and the Black, Pine, and Belle Rivers in Michigan.

There are 21 industrial and two municipal waste sites near the St. Clair River in Ontario and six environmentally contaminated areas near river sites in Michigan. 72 deep injection wells are located in Michigan and 35 in Ontario. Although very little of the land bordering the River is forested, there are eight coastal wetlands on the River and another seven in the Delta. An extensive park network provides recreational amenities along both sides of the River.

A July 1998 study by McCorquodale, Tomczak and Haffner¹ reviewed an area of approximately 75,000 square metres (18 acres) just south of the City of Sarnia on the Canadian side of the St. Clair River. They found that "persistent toxic substances (including HCB (Hexachlorobenzene) and Mercury) that have already accumulated in bottom sediments, pose a hazard to the aquatic environment and its users (Persaud et al., 1993) and may, in part, be responsible for 5 out of 9² of the St. Clair River AOC beneficial use impairments as defined by the Great Lakes Water Quality Agreement (MOE, 1995). In addition, these contaminated sediments create a risk of being transported (over time or by accidental release) to the downstream lakes where as dispersed contaminants they will be virtually impossible to clean up (IJC, 1997).

¹ See John Alexander McCorquodale, et. al., Overview of Findings, Summary and Recommendations report.

² There were originally 10 impaired uses and only seven are considered to be outstanding at the time of this report.

In summary the authors established that:

- cytotoxicity and enzyme induction studies showed that the sediments are hazardous to benthic organisms;
- the total area of contaminated sediments is estimated to contain 400 kg of HCB and likely similar quantities of other chemicals including Mercury and HCBD;
- 20% of the 75,000 square metre study area - 4,500 cubic metres of the total volume of sediments (estimated at 23,000 cubic metres) is highly contaminated and requires remediation;
- up to 40% of these highly contaminated sediments could be gravel or other hard substrate that would not require treatment, leaving 60% or 2,700 cubic metres requiring treatment;
- ship effects account for a significant amount of the resuspension of fine sediments;
- water column concentration of HCB is less than 2-3 nanograms per litre and HCB is being exported from the area at a rate of 15 grams per day;
- the half life of contaminants in the area is approximately 20 years and if nothing were done, the rate of export (flux) of HCB would decrease by only 25% by the year 2010;
- implementation of capping or dredging of the 4,500 cubic metres of most contaminated sediments (an area of about 4 acres) would reduce this flux by 90% by the year 2010; and
- dredging would introduce a short term flux of chemicals from the site down River of approximately 1% of the dredged sediment, which represents up to four times the present HCB flux from the site during the time of dredging, and that capping would result in only a fraction of that loss.

The authors concluded that doing nothing “may not directly affect drinking water quality in the system but disturbance of the contaminated site by shipping, accidents and rare events can cause a significant pulse of chemical to be brought up into the water column. Most chemicals will be deposited in the Delta and a significant quantity will become incorporated into the food chain of the wetlands.”

The authors went on to recognize the extent of the problem by articulating the potential benefits from restoration of this area:

- Essentially meet all short and long term sediment, water and biota ‘yardsticks’ of the Remedial Action Plan and would represent a major step towards removing this site as an AOC;
- Yield economic and social benefits such as public confidence in the water supply and development opportunities;
- Accelerate recovery of the Delta so that fish consumption advisories for the St. Clair System can eventually be lifted or relaxed;
- Lower the risk of a serious accidental resuspension of a large amount of chemical as a result of such events as the propeller wash from an errant ship, a

- ship going aground, or an extreme natural event such as a large ice jam or anchor ice condition;
- Strengthen goodwill between the chemical industries of Sarnia and the down river communities; and
- make this site the model for other RAPs to follow or in the event of lack of action make this AOC a precedent for inaction in other seriously contaminated sites.

This July 1998 scientific study concludes by recommending action for the environmental problem. It is clear from this report that not taking action to remediate the contaminated sediment may pose an ongoing threat to human health and the environment and result in continued degradation of the ecosystem.

1.3 Impaired Uses

Any benefits from remediation of contaminated sediment are based on the assumption that remedial actions will ultimately allow the St. Clair River RAP to be concluded and the area to be de-listed as an Area of Concern.

The Great Lakes Water Quality Agreement³, as amended by Protocol and signed November 18, 1987 defines impaired uses under 'Annex 2' as:

- i] restrictions on fish and wildlife consumption;
- ii] tainting of fish and wildlife flavour;
- iii] degradation of fish and wildlife populations;
- iv] fish tumors or other deformities;
- v] bird or animal deformities or reproductive problems;
- vi] degradation of benthos;
- vii] restrictions on dredging activity;
- viii] eutrophication or undesirable algae;
- ix] restrictions on drinking water consumption. Or taste and odour problems;
- x] beach closings;
- xi] degradations of aesthetics;
- xii] added costs to agriculture or industry;
- xiii] degradation of phytoplankton and zooplankton populations; and
- xiv] loss of fish and wildlife habitat.

Ten impairments were recognized as problematic at the initial stage of the RAP, but since then three (tainting of fish and wildlife flavour, restrictions on drinking water consumption, and added costs to agriculture or industry) are being reported as meeting de-listing criteria⁴. Given that the issue of additional contaminated sediment removal is

³ International Joint Commission, United States and Canada. Great Lakes Water Quality Agreement of 1978 (revised) as amended by Protocol and signed November 18, 1987. (reprint) February 1994.

⁴ Nicolson, Michelle, L. [A Report to the Public on the Progress of the St. Clair River Clean Up]. December 1998.

the topic of this report there will be significant costs associated with that remediation if that is the final decision. Thus, in the view of the author, it may be premature to consider 'added costs to industry' as already meeting de-listing criteria. In fact, the progress report on the St. Clair River RAP fails to even mention contaminated sediment, although it does recommend reducing the use of or eliminating the Cole Drain.

Of the remaining seven impaired uses in the St. Clair River AOC there are currently five impaired uses associated with the contaminated sediment of the St. Clair Rivers AOC.

- **Restrictions on fish and wildlife consumption.** Mercury and PCBs are indicated as the reason for fish consumption advisories currently in effect on both the Canadian and US side of the River. .
- **Bird or animal deformities or reproductive problems.** Mouth part deformities occur in some chironomid species.
- **Degradation of benthos.** Degradation of benthos along the Ontario Shore line of the so called 'Chemical Valley' indicates bioaccumulation of various organic and inorganic chemicals.
- **Restrictions on dredging activities.** Metals and organic chemicals that exceed Ontario Ministry of the Environment guidelines for open water disposal of dredged sediments limit dredging that may be required for navigation and dredging in general.
- **Added costs to agriculture and industry.** Food processing industries in Ontario and a salt processing facility in Michigan have shut down their intakes in response to upstream spills. Costs have also been incurred for proper disposal of contaminated sediment removed from the River for construction purposes (retained for purposes of this report).

The remaining impairments that do not relate directly to the presence of contaminated sediment are the loss of fish and wildlife habitat, the frequency of beach closings and degradation of aesthetics. While it is conceivable that the Area of Concern might not be de-listed until all actions on beach closings and fish and wildlife habitat are adequately restored, there will likely be momentum to de-list following the remediation of sediment since it is possible that 5 impaired uses will be eliminated from that single action. In addition, if arguments and assurances can be accepted as to ensuring the implementation of the actions to eliminate the other impaired uses, the St. Clair River would a candidate for de-listing.

This study makes the assumption that remediation of the sediment is a necessary and (almost) sufficient condition to achieve de-listing. A resumption of full social economic and environmental benefits for Sarnia, Port Huron, the River, the Delta, the Lake and surrounding area is contingent on the remediation of the contaminated sediment in the St. Clair River.

1.4 The Analytical Framework

This study is intended to help with the decision about what to do about contaminated

sediment in the St. Clair River. In particular, three questions should be answered:

- What are the costs associated with a satisfactory clean up?
- What are the expected benefits from any clean up? and,
- Do the benefits exceed the costs and, thus, justify remediation on socio-economic grounds alone?

These are socio-economic questions about an environmental issue. In fact the nature of the problem has its roots in economics. The contaminated sediment in the St. Clair River is the end result of wasteful economic activity being conducted over a number of years. Society has learned, especially over the last decade, that pollution is the result of inefficient economic activities and that pollution prevention pays back returns to those who take the time and resources to reduce and eliminate waste. Pollution is as much an economic problem as it is an environmental issue. For this reason, it is reasonable to ask economists to participate in understanding the nature of pollution and in finding ways to evaluate and justify remediation.

In the absence of good socio-economic information, decisions could be still be made about whether or not and when to remediate. One should expect, based on historical responses to emergencies, that action would be imminent, even without an economic study, were human health in immediate danger or were there other potential catastrophic consequences associated with doing nothing. In fact, a 'de facto' decision has already been made to wait with sediment clean up until a report such as this one is available to further understanding of the economic implications of a clean up. This decision to wait in fact is a response to uncertain costs of remediation and even the more uncertain benefits.

The benefit cost analytical framework has potential to help parties come to a decision for action and can help in the question of environmental contamination of sediment in the St. Clair River. However, there is difficulty in applying benefit cost analysis to environmental problems, in general, and the St. Clair River in particular, because the quantified benefits are incommensurate with the costs for the most part. Many of the benefits are best described as intangible because they are not priced in the same markets as the costs and their values rarely expressed in financial terms. Other benefits may be entirely new or represent opportunities that do may not exist today. What ever the difficulty in quantification, these benefits are real and should be identified in the analysis.

A partial benefit cost analysis that identifies the 'hard' costs but largely ignores the mostly 'softer' benefits may bias the decision in favour of not remediating. In such a case the decision would be better made on other criteria than socio-economics.

1.4.1. Valuation and Quantification

Environmental benefits are difficult to quantify because the markets in which they are exchanged are less formalized or institutionalized and less well understood. For

example, recreational fishing in lakes and rivers is a benefit providing leisure and food for anglers. Yet, aside from the very low fishing licence fee and the associated outfitting costs, one can go fishing for free. Because fishing is a public good, it is provided to all residents, with a sizable public subsidy and essentially free of cost.

Are the benefits of recreational fishing a true reflection of the market price for it? Economists would say there is a sizable 'consumers surplus' (benefits in excess of what has to be paid) associated with recreational fishing that just doesn't appear in the national income accounts and so is not accurately valued for purposes of a benefit cost analysis. There are tools that have been developed to assist with getting the truer value of recreational fishing, bird watching and other non-consumptive activities in our society that may not appear as revenue (as in a company's income statement), but are still a valuable benefit to society.

One of these tools is 'hedonic pricing' where a good or service like a nature park is priced based on the value of its various attributes and statistical methods are then used to ascertain the total value of the good or service. However, perhaps the best known way of getting a value for the softer environmental benefits is to simply ask the question as is done with contingent value. Contingent value analysis has been developing over the last couple of decades as a way of better determining how a good would be valued as if a transparent market existed (thus contingent value). Asking people 'what they would be willing to pay for a new good or service' or 'what they would be willing to accept as compensation for the loss of a good or service' are two approaches to obtaining contingent valuation that provide totally different answers.

People associate much higher values for compensation for loss than they are willing to pay for the same new services. Extensive research⁵ indicates that the 'compensation' question is appropriate when one considers restoration of a loss, as for example, lost uses because of pollution. The 'willingness to pay' question is needed to value the benefits of a new good or service. In the case of the St. Clair River, had a contingent value analysis been part of this study, the compensation question would have been the more appropriate question to ask to determine contingent value, since the benefits to be restored have been lost over the years.

One of the challenges in trying to identify the benefits and costs of environmental issues, such as sediment remediation, is understanding the future and the past. Because pollution has affected lives and livelihoods in the past as well as into the future, the question of valuation is complicated. Economists want to regard every decision as a choice among options into the future and to be able to discount the past as a 'by-gone'. Yet the past has been important in determining the present and the future. In fact the benefits of remediation that may occur into the future are conditioned

⁵ See the draft paper on "Identifying the Economic Benefits of Contaminated Aquatic Sediment Cleanup" by D. N. Dewees for a more fuller discussion of Knetch and others on this subject.

by actions taken in history - thus making that history important in helping to value the future.

Losses are about the past while gains are about the future. That individuals value losses significantly differently than gains means that for any change in incomes, losses of economic welfare may be more significant than the equivalent amount of new benefits resulting from the change. Thus, restoration of losses should be more valuable and valued higher, other things being equal, than the development of new opportunities and estimates of the willingness of individuals to pay for the restoration of losses will understate the true worth of their restoration.

1.4.2. Practical Issues

Sarnia and the Canadian side of the St. Clair River have been experiencing relatively high unemployment and generally depressed economic activity since the recession of the early 1990s. The economic recession of the '90s was felt more severely in the St. Clair area than other industrial areas of Ontario, such as Hamilton, partly because of the nature of the demand for products from 'Chemical Valley', the severity of downsizing of the employee workforce and likely a number of other reasons, including perceptions of the environment.

The challenge in an economic study that will be forecasting benefits into the future, such as this one, is to discriminate between the benefits attributable to remedial action and the effects of any eventual economic recovery for that area. This can be very difficult to do for a number of reasons, especially since economic growth in the future will be a combination of the two factors. For example, the relative economic strength of the Canadian and US sides of the River reflect the differences in the two nations' general performance, with the US side being much stronger.⁶

The quest for relatively hard information with which to project into the future is made even more difficult for long term trending of activities such as fishing activities and fisheries catches, when the bio-economic data for these is not completely available. Estimates of demand for recreation and other environmentally dependant activities are typically non-existent or best guesses. Cost information for 'one-of-a-kind' remediation projects are unreliable at best and can be hopefully inaccurate at worst.

In short, conducting an economic evaluation of the benefits and costs of environmental

⁶ It is worth noting that a predominant perspective in ecological economics is that improving the environment by conserving natural capital value and improving its quality increases the development potential and productive capacity of natural capital as a complement to other forms of capital. That means that enhancing the environment generally enhances the income earning and wealth making ability of society, particularly in the longer run. Thus, cleaning up the environment in an economic upturn can be safely considered to extend any general economic upturn and to moderate the effect of a recession.

projects, and sediment remediation in particular, is a very imperfect science. This paper discusses these and other issues involved in trying to present an objective framework for decision making with respect to remediating the contaminated sediments in the St. Clair River. Appendix A provides a more detailed discussion of the issues related to the application of benefit cost analysis to environmental projects.

1.4.3 This Study

This study is intended to provide more information about the benefits and costs of possible remediation of contaminated sediment in the St. Clair River. While no benefit cost indicators, such as a benefit cost ratio or net present value will be calculated from this information, the paper will discuss the cost and benefit information that might otherwise go into such a study.

This study is in support of the St. Clair River Remedial Action Plan (RAP). It was apparent during the benefit estimation phase of the study that the community is not of one mind on the need to remediate the contaminated sediment. Not everyone who discussed benefits were aware of the results of scientific studies on the sediment problem. However, in order to complete the study assumptions have had to be made about the nature of the problem and the likely outcome of any restorative actions.

The McCorquodale et. al. report has been understood by the author as dictating a need for remediation and that either approach to remediation will deliver relatively the same level of benefits. Further, it is generally accepted that sediment remediation is the major stumbling block to de-listing of the Area of Concern, since the other impaired uses are either already restored or have detailed plans that indicated their successful restoration. Thus, it is assumed that sediment remediation will result in both the de-listing of the Area of Concern and in resumption of impaired uses as a socio-economic benefit.

Benefits

2.1 Approach and Methodology

The benefits that may result from contaminated sediment remediation will be short and longer term. Some of the benefits following remediation will be dependent on ancillary economic decisions made to support greater use of the resource, such as developing enhanced tourism facilities. The benefits would be expected to be geographically dispersed throughout the area on both sides of the Canada-US border and in the rest of St. Clair basin and throughout the downstream Great Lakes. Some of the benefits may be manifested as increased income (either earned or retained) and others will be less tangible as in the form of additional emotional security, greater bi-national community cohesiveness, improved industry/community trust and co-operation, and the improved health of individuals and their communities in general.

This project's terms of reference did not include the acquisition of primary information, such as might be obtained through detailed surveys of potential beneficiaries from the

remediation of the Area of Concern. As expected there is little information that specifically addresses the potential positive or negative impacts of remediation for the St. Clair River. Some area residents, such as the Corporation of the Township of Sombra (Ontario), were concerned about the “possible escape of the contaminants” and forwarded written correspondence to that effect⁷.

Similar concerns about possible inadvertent releases of contaminants were voiced by residents of Walpole and Harsens Islands. It was not clear that they were fully aware of the analysis by McCorquodale and others at the time. A review of the 1996 partial remediation of the St. Clair River indicated that there had been “some short term adverse impacts on St. Clair River water quality” as a result of the remediation, although “no available drinking water levels or objectives for chlorinated aliphatics and aromatics and polychlorinated dibenzo-p-dioxins and dibenzofurans, or aquatic life acute toxicity thresholds were exceeded in any of the water samples collected.”⁸

The methodology for benefits assessment was to outline the potential areas in which benefits might be found following a remediation and to discuss how large these would have to be to justify remediation. A first step was to interview members of the St. Clair area community as to what they believed that the benefits would be. To achieve some level of consistency in approach a simple benefits survey form was used for the interviews. This was distributed to all those being interviewed and to BPAC members at the February 11 BPAC meeting.

⁷ See attached letter from Sombra Township.

⁸ See Kauss P.B. and P.C. Nettleton. [Impact of 1996 Cole Drain Area Contaminated Sediment Cleanup on St. Clair River Water Quality] Ontario Ministry of the Environment. Nov 23, 1998. page ii.

Exhibit 1 - Benefits Survey Form

To: St. Clair Binational Public Advisory Council (BPAC) Members

From: Ray Rivers

Subject: Benefits of St. Clair Contaminated Sediment Remediation

I have been contracted by Environment Canada to study the benefits and costs of the potential remediation of contaminated sediment on the Canadian side of the St. Clair River. In doing the study, I am seeking as much quantitative information on benefits as possible. However, I am also interested in qualitative information that individuals and the communities might be able to provide. To that end below is a survey that I am using as a guide in my meetings, with BPAC members and others, to help me gather this information.

Survey

1] How would site remediation affect you and your community:

- a] health issues
- b] recreation opportunities
- c] stress and social issues
- d] income and employment opportunities
- e] other quality of life aspects

2] Do you see any negative consequences from the remediation? How would you rate those compared to a clean up? Would remediation be worth the risk of possible escape of contaminants during a treatment?

3] Could you estimate any annual or one time cost savings (e.g. reduced monitoring) to you or your community? Would any annual savings increase over time after a clean up?

4] Could you estimate the dollar value of additional income or economic benefits that you or your community might realize as a result of remediation? Would these economic benefits increase over time?

5] Are there any other benefits that you could identify associated with remediation?

Ray Rivers
February 5, 1999

This approach is highly subjective and a personal interview was conducted, in addition, to facilitate a more consistent interpretation of what was being sought. However, the approach was less than satisfactory because many in the broader community were unaware or unconvinced of the full magnitude of the problem. Anticipating future benefits from a potential clean up was difficult for that reason. Clearly, there are not likely to be benefits that will result unless there is a problem to clean up.

The individuals selected for interview were recommended from the list of membership of the Binational Public Advisory Council (BPAC) by the RAP Coordinator⁹. In total 18 Binational Public Advisory Council members (BPAC) were contacted of which 13 Canadians and 6 Americans were approached and 9 Canadians and 3 Americans were interviewed in detail. This included representation from Wallaceburg, Walpole and

⁹ Gary Johnson, Ontario Ministry of the Environment.

Harsens Islands, Sarnia and area and Port Huron. Sectors covered included tourism, native people, municipal, fishery, education, conservation and environmental, business and industry and other citizens at large.

In addition officials of the Ministry of Environment and the real estate industry were contacted and interviewed at length. Others were invited to participate at the March BPAC meeting. Although a number of attempts were made, Dow Chemical company officials could not be contacted to arrange a meeting time or place and unfortunately were excluded from the interview process.

The interviews formed but one element of the benefits gathering exercise, in addition a number of references from the Stage 1 RAP document, and other information recommended by the Project Authority were reviewed to piece together elements of the benefits section of this report.

2.2 Recreational Benefits

Recreational benefits can be some of the most important restored uses in an area of concern affected by contaminated sediment. These include recreational fishing and hunting, bird and other nature enjoyment, recreational boating, swimming and other water contact sports and just passive nature appreciation. Recreational benefits result from the increased value of leisure time by individuals whether they have to pay for it or not. In addition, recreation is an important economic activity and generates income for individuals and provides potentially a major source of investment income for communities. Tourism and recreation are major industries for many communities right across North America.

Individuals don't directly pay the full cost or market value in order to go recreational fishing and other nature related recreational activities which makes the complete valuation of these activities problematic. As noted in Section 1, there are alternate ways to value recreational benefits within a benefit cost framework, although none of these are entirely satisfactory.

2.2.1 Recreational Fishing

Aquatic life in the River is diverse consisting of phytoplankton, zooplankton, benthic fauna, and numerous fish species. At least 46 species of fish spawn in the St. Clair River or Lake St. Clair and 91 species have been recorded as resident or migrants in the River and the Delta. Fishing is an important industry for the St. Clair River and area economy and a way of life for individuals as well as their communities.

Recreational fishing has emerged as more significant to the economy and society than was the commercial fisheries of earlier days, even though many valued species, such as lake trout, have had to be replaced by exotic cold water species of rainbow and brown trout and salmon. As a consequence of this shift, bait fishing is also becoming more important as a commercial activity to support recreational fishing. Recreational fishing on the Michigan side of the River, Delta and Lake amounted to almost 3 million

angler hours and 1.4 million fish in 1983-85. That means one fish for every two hours fishing. Ice anglers between 1977-1985 fished an average of 93,225 angler days and harvested almost 2,000 walleye, perch and bluegills annually.

The 1990 Survey of Recreational Fishing in Canada¹⁰ noted that over eight hundred thousand anglers, 85% from Canada, fished on the Great Lakes that year. That number declined dramatically by 1995 to just over half a million, although the percentage of residents was up to almost 90%. Over three quarters of these were male and they fished for over 7 million days (down from 11 in 1990) and averaged 13 days (down from 15 in 1990) per resident angler. In total these anglers caught 33 million fish in the Great lakes system in 1995 (down from 55 million in 1990) and kept 22 fish each of their catch (again down from 41 in 1990).

Great Lakes anglers each spent \$296¹¹ on average on durable goods in 1995, (down from \$608 in 1990. In addition they spent \$229 million on goods and services directly related to their fishing activities or over \$406 per angler (down from \$579 in 1995). They would have been willing to spend an additional \$137 million or \$248 per angler had the costs been higher - a 10% increase 1990.

Lake St. Clair statistics, which include the Detroit and St. Clair rivers had just over 30 thousand anglers in 1995 (versus 34,000 in 1990) with about 5% of these non-residents, each catching 210 fish per angler and keeping 97 or about half. Average investment in fishing equipment per angler was \$205 (1998 values) of which only a third could be attributed to fishing in the St. Clair area. Average angler expenses were \$388 (1998 value) each for all anglers with almost a third of the expenditures for food and lodging and about 10% for fishing supplies. Lake St. Clair was the third lowest area of the Great Lakes in terms of intensity of fishing activity at about a quarter of that on Lake Huron (Lake Erie and St. Lawrence were lower).

When asked about their willingness to pay even more for the fishing experience, anglers in Lake St. Clair had the second highest median values in the entire Great Lakes system. Just slightly ahead of their 1990 values St. Clair area fishers said they would have been willing to pay an additional \$12.42 per day for the fishing experience. In 1995 that would have totaled \$8 million 1998 dollars an increase of almost a million 1998 dollars from 1990, in spite of there being fewer fishers. Anglers across the Great Lakes note that they value relaxation and enjoying nature highest among the benefits of fishing where they do, but they also identified lack of pollutants in fish, water quality and

¹⁰ See [www.dfo-mpo.gc.ca] for more complete survey findings.

¹¹ Statistics Canada price deflators are used for 1990 and 1995 values to bring them to 1998.

natural beauty of the area as the key attributes that they seek in selecting fishing places.

Donald Cox¹², an employee of Bayer Inc, an avid angler and member of the Bluewater Anglers estimated that between 300 and 400 anglers per month fish for recreation on the River. Bluewater anglers operate a hatchery for salmon and rainbow trout to enhance fishing opportunities for anglers on the River and its tributaries. Walleye fishing is popular along the River and salmon and trout are also caught in bordering tributaries. He noted that anglers are comfortable consuming their catches and the annual derby is a big success. In fact one of the most popular fishing spots is the exact location of the infamous '1985 toxic blob'. While there are periodic tumors and deformities, these, he notes, have been determined by laboratory analysis to be attributed to bacterial infection rather than toxic mutagenic effects.

Tourist fishing has been limited for a number of reasons including limited infrastructure and possible attitudes about the environmental quality of the area, although it is difficult to know what people outside Sarnia think. Still, fishing quality is what matters and, according to Donald Cox, that means the potential of catching fish.

2.2.2 Other Recreational Benefits

Recreational boating has significant potential, particularly for trips into Lake Huron or further downstream along the River. No estimate has been attempted of the economic importance of this activity which includes sailing, board sailing and personal water craft, in addition to motor boats. The St. Clair River is a navigation channel and increasing amounts of new boating could well result in conflicts between fishers, the commercial navigation sector and pleasure boaters.

Nevertheless, the potential for Sarnia and other places along the River to become ports of call for the yacht crowd could result in expanded commercial enterprise for the City and the down river communities of the St. Clair. Although a clean up of the River and de-listing as an Area of Concern would undeniably make the River more attractive to boaters of all kinds, no estimate of this value has been provided in this report.

Swimming is much more limited than in the past as property rights and shore protection to prevent high water level damages have reduced access for bathers. In addition, inadequate storm and sewage treatment infrastructure poses difficulties that restrict swimming and other water sports and the enjoyment of the River in general. Expected improvements to sewage collection and treatment facilities on both sides of the River should lead to expanded opportunities for swimming, particularly in the wake of de-listing of the Area of Concern. No effort has been made to estimate the economic value of swimming and other water contact activities that might be enhanced by a remediation of the contaminated sediment.

¹² Personal communication Don Cox.

Animal hunting in the Chatham District as set out by the Ontario Ministry of Natural Resources included 1,500 big game, and about one hundred thousand each of small game, waterfowl and trapped animals in 1983. Michigan statistics on hunting indicates a fairly constant level of waterfowl hunters and hunter days from 1985 to 1989 at just under 50,000 hunters and 700,000 hunter days for the State. From 1961 to 1970 about 7% of all ducks harvested in Michigan were from the St. Clair County with that percentage increasing to 9% of a higher harvest level, almost doubling, for the ten year period 1976 to 1985¹³. Walpole Islanders earn significant revenues from guiding fishers and hunters on the island and in the Delta although they feel that they are constrained in their income by concerns about pollution. The St. Clair River is the most important hunting area in Michigan and duck hunting has been valued there at 2.3 million 1989 Us dollars (4 million '98 Can \$).

Finally passive nature recreation is a rapidly growing activity, and one that will become more important as our society continues to age. No attempt has been made to identify the potential additional socio-economic benefits that can result from increases in passive recreation, such as bird and animal watching, nature hiking and other relatively non-consumptive uses (although catch and release angling was covered under the previous section on recreational fishing. An extensive park network provides recreational amenities along both sides of the River.

2.3 Human Health and Benefits to Industry

Land uses adjacent to the St. Clair River include agriculture, urban, rural, industrial, native lands, recreation, forest and wetlands and waste disposal. 78% and 68% of the Ontario and Michigan portions respectively of the St. Clair River basin are dedicated to cash cropping, beef, dairy and swine operations and other farming. Approximately 170,000 people live in the basin with Ontario having slightly more than half. Most of the industry is concentrated between Sarnia and Corunna on the Canadian side of the River.

Petroleum, chemical, paper and salt production as well as significant thermal electric generation have situated by the River which with its high volume and flow rate of water is a major source of production water and an opportunity for wastewater discharge. Almost half of all manufacturing employment is with the chemical industries, a quarter in petroleum production, and 10% in metal products. Imperial Oil Ltd. was the leading employer with 1400 staff, followed by Bayer, NOVA and Dow at 770. Lambton has over 8200 acres of industrial land with prices that start at \$1000 and average \$5000 for fully serviced property.

¹³ Data obtained from the Stage 1 RAP Report.

Industry has found it very profitable to locate along the St. Clair River, and most of the larger operations in Sarnia, especially chemical companies, are branch operations of multi-national corporations. For example, Dow Corporation, which started operations in Sarnia in 1942, had worldwide sales of over \$20 billion (US) in 1996. Earnings per share of the almost quarter million shares for that year were \$7.71 and dividends of \$3.00 were paid representing a return on equity of 23.8%. Net income for common stockholders was \$1.9 billion dollars. Dow worldwide paid \$1,187 billion in taxes on its income.

With 39,000 employees, operating 14 global businesses and 121 manufacturing sites in 32 countries producing 3,500 products, Dow had worldwide property valued at \$24 billion (US). Dow's rest of world operations still indicate almost \$5 billion (US) in 1996 with \$7.5 billion (US) in identifiable assets and almost \$4 billion (US) in gross plant properties¹⁴. Dow is a generous charitable donor, including a charitable foundation, for its giving on community and environmental pursuits. For example Dow contributed \$3.7 million (US) for the construction of a community centre in The Netherlands in 1996.

No success was achieved in trying to ascertain whether and to what extent industrial land in Sarnia would benefit from higher demand prices as a result of an environmental clean up and de-listing of the area of concern. The size of the organizations and their landholding are significant and can exert considerable monopolistic pressure on the land market in Sarnia. That and the current lack of other economic opportunities for that land use, means that industrial land values in Sarnia will be less heavily influenced by a cleaner environment than other factors in the short run.

Interviews with industry representatives in Sarnia didn't provide any sense that a clean up would have much effect in influencing the value of their real estate holdings. Nevertheless, as 'brownfield'¹⁵ conversions become more common the potential opportunity value for these extensive prime waterfront holdings can be expected to increase.

The Sierra Club in their paper titled "Clean Lakes, Clean Jobs"¹⁶ claims that "...PCBs in Great Lakes fish cause more than 38,000 cancer cases and add from \$257 to \$513 per year in health costs for each Great Lakes resident.."and that "high fish and wildlife consumers - including Native Americans, African Americans, anglers, hunters, low-income and urban fishers - are at the greatest risk.." and "..have cancer risks as high as

¹⁴ Dow 1996 Annual Report, see also [www.dow.com].

¹⁵ A term associated with former industrial and other contaminated sites that offer the potential of reconversion to less environmentally damaging uses, such as parks or housing.

¹⁶ Peck, John, Brett Hulsey and Andrew Savagian. □Clean Lakes, Clean Jobs: A Case for Cleaning Up Contaminated Sediments□Sierra Club Great Lakes Program.

1 in 200 because of the large amount of contaminated fish they consume". The paper goes on to argue that "toxic pollution threatens approximately 89,000 fishing jobs and more than \$4 billion in commercial and sport fishing proceeds". No attempt has been made in this paper to assess whether remediation of contaminated sediments would prevent morbidity or mortality¹⁷ associated with the toxic substances in the sediment.

The Sierra Club¹⁸ estimates that almost 3 million jobs are at risk if sediment clean up in the Great Lakes is not undertaken and almost \$100 million dollars in resulting economic benefits are at risk throughout the Great Lakes because of the contaminated sediment, including 89,000 fishing jobs. Having just survived one of Sarnia's biggest recessions, none of the interviewees wanted to talk about the economy getting worse if the contaminated sediment was not cleaned up. Those who chose to vision outwards saw only improved economics times in keeping with the AOC being de-listed.

2.4 Community Development

While there has been a bit of an economic boom on the US side of the River, Sarnia and the Canadian side still are suffering the effects of the second biggest long term recession. Sarnia has organized a Council for Economic Renewal to assist it to getting to better economic development for the area. Sarnia had recently amalgamated with Lambton County to form the new municipality of Sarnia-Lambton. Sarnia has among the least costly housing and industrial land prices for larger municipalities in Ontario. It has a well educated labour force with particular strength in science and engineering. Sarnia-Lambton was ranked as having the lowest relative costs of doing business in ten US and Canadian cities in that part of the basin.

Sarnia-Lambton is a community that should be performing better. It has a population of about 130,000, and a labour force of just over 60,000, a decline from the 1991 high of 66,000. There were 51 companies, in 1991 which employed over 25 employees, more than 2,600 farming operations that produce over \$200 million annually. In addition, there are 80 recreational parks, 18 golf courses, 64 beaches and resorts, 25 daycare facilities, 3 hospitals, and 9 medical centers. Average per capita income for the County is around thirty thousand dollars while the average household income (1995) was just over \$50,000 per year. In that year 17% of the workforce was engaged in manufacturing, 12% in retail, 7% in construction, 6% in the education and accommodation sectors and 4% in government services. Nine and a half percent of the workforce was unemployed in that year.¹⁹ Nevertheless, total per capita retail sales in 1999 averaged over \$9000.

¹⁷ Tom Muir, personal communications, notes that there is supporting documentation from other studies for valuing a human life at \$ 5 million Canadian.

¹⁸ See Clean Lakes, Clean Jobs.

¹⁹ Sarnia Lambton Office of Economic Development. Sarnia Lambton Community Profile. October 1998.

The Sarnia-Lambton County government had 1997 expenditures of almost 100 million dollars, in addition to expenditures that were made in the lower tier governments²⁰. Sarnia, at over 50%, has the largest levy of all the lower tier municipalities. Of the total municipal assessment of over 7 billion dollars, about 80% is residential and farm land, the balance being industrial at 7% (550 million) and the balance being commercial.

The Sarnia-Lambton Council for Economic Renewal has increased spending to promote Sarnia to potential new developers and businesses from about a quarter million dollars a few years ago to over a million today. With unemployment above the national average of under 8%, Sarnia is far behind cities like Hamilton, for example, with less than a 5% unemployment rate. For all its efforts, many of which are working, a major problem is the pollution image that Sarnia has acquired and dearly would like to shed. De-listing would go a long way, it was felt, to removing that stigma and would enable a substantial push for business for the area.

The general property market along the Canadian side of the River has been depressed for a number of years, consistent with the downturn in the Sarnia and area job market. Following the introduction of free trade and the Canadian recession of 1990, market values plummeted and have not yet recovered to pre 1990 levels. Houses that once sold for close to a million are selling for less than half of that today. There is a general view that Toronto house buyers (for example) have a view of Sarnia as dirty and are not as active or interested here as they could be.

There are too many confounding factors to be able to pin point the potential economic effect of a cleaner environment on property values in the St. Clair River AOC to date, but it is believed that de-listing could result in significant new housing and business development interest which would translate into market improvement for property.

²⁰ Sarnia-Lambton is a two tier municipality with municipal governance responsibilities and expenditures split between the two tiers of government.

Environment Canada has examined the impacts of proximity to shoreline and a clean up of the environment in Hamilton Ontario and concluded that "Distance from the parks and distance from the waterfront had measurable and significant effects on property values in the West Harbourfront, and these effects became increasingly positive as Harbour clean up progressed"²¹ 12.5% of the aggregate 1996 residential property values in the study area was attributable to improvements in water quality while another 6% was due to the establishments of the Pier 4 and (Bayfront) parkland. However, the environmental impact is probably greater since it is unlikely the park would have been established in the absence of an environmental clean up. These increases were attributable to an increase in the value of the land associated with a cleaner environment and net of any general inflationary effects.

Removing the threat of contaminated sediment will enhance security among those that rely on or choose to consume fish and wildlife from the Area of Concern. In addition, security of drinking water sources from the River will be enhanced. De-listing of the area as an Area of Concern should help remove any negative view that is hindering investment and development of the area. Property values should increase significantly following de-listing because of the environmental improvements as well as the competition from greater investment.

Applying the 12.5% that was calculated for Hamilton to a portion of the 7 billion dollars in assessed property of Sarnia-Lambton would generate very positive financial benefits for land owners in the County. If only 1% of that assessment were located close to the waterfront that would be an increase in value of almost 9 million dollars. In fact less than half of a percentage point of the County's current assessment would have to increase in order for the properties²² to increase in value by 3 million dollars. Of course, rising property market value is a benefit if one wants to borrow against the property or to sell it and to the extent that it surpasses general price increases.

²¹ Environment Canada. "Rising Property Values on Hamilton's West Harbourfront: Effects of Environmental Restoration on Real Estate Prices". May 1998, Burlington Ontario.

²² Assuming that Ontario provincial "current value assessment" accurately reflects market values.

Higher assessment also means increased tax potential for the community since those with increased new wealth are now candidates for increased property taxes²³. Increasing property values for Hamilton as a result of improved environmental conditions resulted in an additional \$560,000 in new annual property tax revenue in Hamilton for 1996. The landholders have increased the value of their holdings and the community, in this case has shared in the economic benefit. Similar benefits could be ascribed for municipalities down from the River, in the Delta and even around Lake St. Clair.

Water quality has been improving and local angling seems to be the major sources of growth for the recreational sector as this cleaning up has been occurring. One interviewee noted that there is more angling and eating than ever. Still, it was noted by several persons that were interviewed, and in 'Vision 2020' for Sarnia²⁴, that there is still a negative perception outside of Sarnia. This negative perception is, apparently, not as strong in the US and thus the benefits from remediation can be expected to be largely on the Canadian side of the River. This view is in part a result of the lingering impression created by the so called 'blob' almost 15 years ago and the fact that the St. Clair River is an environmental Area of Concern.

Greg Michaud, RAP²⁵ coordinator for Waukegan Harbor Illinois speaks passionately about the direction which that Area of Concern has taken since a decision was made to complete the environmental dredging of the Harbour. Sediment remediation enabled a lifting of the local fish consumption advisories and brought a new interest in the Harbour from existing residents and a new interest from investors and developers. Harbour use for commercial shipping has increased but so too has pleasure crafts. Greg notes that "every slip is now filled up". The Chamber of Commerce is excited about the new interest in the community which runs against the trend of continuing socio-economic erosion in city centers and an economic boom in the sprawling suburbs. Greg expects that application for de-listing is not far away.

The US side of the St. Clair River has seen increased housing and other development, partly driven by the US economic boom. In contrast to Sarnia some of the property with the highest values is along the River in Port Huron, where there seems to be a very positive sense about the River. It was the view of US residents of the area that most

²³ Rising property prices only for those near the water may have income distribution implications since those with increased assessments will be expected to pay a greater portion of the municipal tax bill under Ontario's 'actual assessment system', while others will need to pay less as a result. That may or may not be desirable from an socio-economic perspective.

²⁴Sarnia-Lambton Council for Economic Renewal. □ Vision 2020: The First Step - A Strategy for Economic Renewal in Lambton County□ November 1995.

²⁵ Greg Michaud, personal communications.

people felt that environmental issues were in hand. There was a general view from Port Huron that the area's environment is already clean, although there is also an ongoing need to get it better.

2.5 Food Fisheries and Aboriginal Communities

The Chippewa of Sarnia Band Reserve and the Walpole Island First Nations Indian Reserve are the two major Native Indian communities in the basin. Walpole Island is of particular importance in this study because of the high degree of dependance on the water environment. Walpole residents operate a community farm and some localized industrial activity in craft production but are heavily dependant on tourist guiding, hunting, fishing and trapping for food and income. Of the over 14,000 hectares that comprises Walpole, about a third is used for agriculture and the balance for housing and wetlands.

The wetlands are a major source of income for the population of Walpole and compete with agriculture. A 1991 study of the Island's economy²⁶ indicated the value of income derived from marshlands at 1.5 million dollars (\$2 million 1998), including the value of purchased food potentially displaced by hunting and fishing. Buying food further reduces the disposable income of Island residents and has social impacts as a result. Half the farming on the island is by native islanders and the balance rented out at \$160 per acre. The marshland is also a great source of potential income for trapping by residents and also for professional guiding of tourist hunters and anglers. Fishers are licensed at \$32 per season and hunters (300/year) at \$25 per day.

Although there are fish consumption advisories for the area the population of Walpole still relies heavily on fish and game for their food. 86% of all residents of Walpole Island consume fish, 79% duck, 56% muskrat, 29% squirrel and rabbit, and other animals in lesser amounts. In the one hundred years since 1873, over 30% of the wetlands in the Delta have been lost which has impacted both the supply of fish and wildlife, and also the cleansing ability of nature that Walpole inhabitants believe are critical to remediate contaminated water and restore ecosystem health.

There is a concern that contaminated sediment is much more widespread than just below the Cole Drain, since so much of the traditional culture is bound up with the environment. Island residents are just as concerned about sediments further down river or in the Delta and believe that a broader clean up is also required. Island residents typically are using more processed foods and bottled water because of concerns they have about the pollutants in the water, regardless of source.

²⁶ See Lynne Elliot and George Mulamoottil. Agricultural and Marsh Land Uses ON Walpole Island: Profit Comparisons.

Walpole offers potential for naturalists. It was estimated that 150 visited Walpole in 1989, although other locations, such as, Point Pelee National Park on Lake Erie attract half a million visitors a year at an economic value of almost \$40 million (1998 Can). Of course, fishing, hunting and trapping are more than income and food to Island residents since they are also an inherent part of the aboriginal culture and essential for cultural survival. This traditional way of life has been interrupted by pollution and healing is felt to be required. In fact, Walpole has offered to hold a healing circle for the St. Clair RAP - a circle on "the sustainable development of the River".

2.6 Reduced Liability - An Insurance Against the Future

Liability is a big and growing issue with respect to industrial activities and the environment. Society and our legal system have generally been slow to demand compensation for damages in response to the environmental and human health consequences of industrial pollution. However, the metal plating industry in Ontario claims that it was unable to get bank financing in the early '90s using property as collateral because of bankers concerns over potentially contaminated land in that industry.

The Exxon ship that ran aground in Alaska in 1989 demonstrated that awards can be made against polluters for lack of due diligence and in favour of restoring the environment²⁷. Under terms of an October 9, 1991 US District Court decision, Exxon agreed to pay \$900 million over 10 years for the costs of clean up, damage assessment and legal costs in addition to restoration of the ecosystem. Governments may also claim an additional \$100 million to restore resources that suffered a substantial loss but as yet undetermined at the time of the decision.

The complexities of environmental law and the processes required to ensure adequate damage awards are topics of their own and much larger than can be dealt with here. However, liability and insurance are potential costs to those that may be exposing the environment and humans to risk. Consequently, actions that can reduce that risk are a benefit to all of society, including industry. Considering the value of an insurance premium that would be required to protect a company or society from claims is another potential way to estimate the benefit of a cleanup, once the risk has been estimated.

Remediating the sediments in the St. Clair River will reduce potential risk and harm. Insurance is purchased to ensure that sufficient financial resources are available to provide for the costs of dealing with the consequences of that harm. There is a difference between general or blanket insurance (where a number of risks are covered by a policy) and specified policies (where only a specified peril is identified). One selects specified perils when there is a greater probability of occurrence and usually at a higher premium. Insurance against harm for the St. Clair would be a specified peril with a quantified risk of occurrence and an, as yet, uncertain cost of potential harm. In fact,

²⁷ See [www.oilspill.state.ak.us] for details.

it might be more instructive to estimate the potential harm from the risk of contaminant release than to identify the potential benefits of a clean up.

Identifying the expected value of that peril would go a long way towards helping with decision making for those who might end up paying for the remediation. For example, historical releases of mercury to the St. Clair system completely devastated the sizable commercial fisheries that had been operating for generations in Lake St. Clair and the connecting channels. In 1969, the last complete year of harvesting prior to closure from mercury contamination, almost a million pounds of fish of various species were landed generating income of 1.5 million 1998 dollars. By comparison, the fishery in Lake St. Clair was about as valuable as that in Lake Ontario and slightly smaller than that in lakes Huron and Superior. Economic spin offs to the local community and Ontario in general would amplify the 1.5 million to much higher levels. That is because much of the income would have been going to smaller communities where unemployment is higher and spending leakages lower. Selected fisheries in Lake Erie and Lake Ontario were also closed because of mercury contamination.

So what is an appropriate amount of insurance that would be required to manage the present day risk of environmental damage? Three other factors also need to be considered in viewing the risk question. First since the sediment is not monitored, the impact of the damage might be more severe than if down river communities were able to shut down water treatments plants as they are prepared to do when industrial spills occur. Human populations would be at risk unknowingly. Second, since there is an ongoing migration of the contaminants that pose a threat to restoration of the ecosystem claims might be broader than just for an occurrence. Third, since the danger is known, quantified and preventable, any settlement might need to consider the question of diligence and might result in punitive additional levies to any claim.

The very best insurance against the occurrence of a major escape is sediment remediation. Homeowners pay in excess of \$300 per year for general household insurance, depending on the policy and value of the property and over a thousand dollars, depending on driving history for automobile insurance. A fifty year old male non-smoker could pay \$30 dollars or more a month to insure himself for \$50,000 and a smoker might pay up to a 50% specified peril premium to cover his higher risk associated with smoking. Clearly the premium would need to be based on the actual risk and potential payout.

COSTS

3.1 Cost of Clean Up

The choices for remediation include either 'in situ' capping with clean fill or the removal, treatment and disposal of the sediment material. Currently there are no official estimates available for the cost of either of these remediation options for the St. Clair River. Thus, any cost estimates presented in this study are preliminary and will need to

be verified when an actual decision is made to proceed with the remediation. By way of comparison, the costs for the clean up of contaminated sediment in Collingwood Harbour, the first RAP AOC to be de-listed, were just slightly in excess of one million dollars in 1993²⁸ and that cleaned up almost twice the amount of sediment (8000 cubic meters) that is in the St. Clair.

3.2 Dredging

The Ontario Centre for Environmental Technology Advancement and Environment Canada have enumerated a number of experiences of dredging activity across North America and globally. This data base, called SEDTEC, includes a range of costs for the various technologies and sites in which clean up has already taken place. The data base includes fully developed technologies as well as bench scale illustrations. The following table outlines some optional technologies and costs.

**Table 1
Selected Dredging Technologies**

Technology	Origin/Development	Application	Costs (\$US/cu m)
REACT hopper overflow hydraulic	Bench scale - Canada	Nearshore or in harbours hydraulic pumping - <i>mining dredge</i>	\$15
Consolidated De-watering	Commercial - Canada	Low turbidity hydraulic - <i>environmental dredge</i>	\$200
Eriksson Sediment	Pilot Scale - Canada - applied in Wheatley Harbour	Freezing encapsulation of sediment - <i>environmental dredge</i>	\$200
Great Lakes Clean Up Fund using Amphibex, Amphibious dredge	Normrock Industries, Terrebonne Que. Canada	Welland Rivers clean up - using a barge mounted with a hydraulic pumping bucket - <i>navigational dredge</i>	\$27.91 including treatment and \$14.40 for dredging only
Sanexen Vacuum Clam Dredge	Full scale demonstration - Canada	Barge mounted hydraulically mounted calm on a swivelled arm - <i>environmental dredge</i>	\$50

Source - SEDTEC²⁹

The range of costs (in \$US) per cubic meter runs from \$14 to \$200 depending on the potential application. Navigational (and water bed mining) represent the lower end of

²⁸ Information available off the internet at [<http://www.IJC.org/boards/wqb/cases/collingwood/collingwood.html>].

²⁹ See references for SEDTEC

the cost scale while environmental dredging is far more expensive. In addition, the \$200 estimates are still either bench scale or hypothetical. A partial clean up of the site was conducted in 1996 in which 170 cubic meters of highly contaminated material was dredged, using a sophisticated 'cable arm dredge' by Dow Corporation at a cost reported to be in the order of \$400,000, supposedly excluding the costs of de-watering, treatment and disposal. An official report of this clean up was not available and these values are based on verbal estimates. The cost would have exceeded \$2000 per cubic meter if the reports are accurate, although this was very much an experimental and thus costly effort.

While the goal of any dredging activity is to remove sediment without disturbing and suspending surrounding material, there is a marked difference in techniques and costs between dredging for navigational purposes (where contaminated sediment is not a concern) and dredging for environmental purposes. A soon to be published paper by Paul Henshaw from the University of Windsor, develops a cost model for dredging and notes that "... environmental dredging projects generally have slower production rates and therefore higher costs. The slower production rates may be due to debris removal, lower cutterhead speeds, shallower cuts, delays due to sediment treatment, decontamination of equipment, and more stringent health and safety requirements, all of which are related to reducing worker and environmental exposure to contaminants"³⁰

The authors go on to explain that a detailed cost estimate of an environmental dredging would require prior knowledge of the equipment to be used and the methods of transporting, treating and disposing of dredged material, in addition to prices for labour, fuel, etc.. Since this information is not currently available the estimates made herein are preliminary and crude at best. However, the costs should be closer in the range that has typically accompanied environmental dredging. However, using an estimate based on the extremely high costs for the 1996 clean up would be inappropriate since those costs are way out of line with other environmental projects. There are likely significant economies of scale that would come into play in a total dredging of the 4500 cubic meters of candidate contaminated sediment remaining in place in the St. Clair River.

Assuming that the upper end SEDTEC estimates of \$200 (US) per cubic meter are in line with what would be required to accomplish dredging of the candidate site, this would amount to \$900,000 (US). Additional costs for de-watering and treatment of contaminated wastewater and disposal are very much contingent on the technology employed and the choices made for treatment and disposal. Doubling the dredging estimate to allow for these costs would result in an overall estimate of 1.8 million dollars (US) or roughly \$2.7 million (Canadian). This is consistent with 'off the cuff' estimates by Alex McCorquodale³¹ and others in the course of discussions with BPAC members.

³⁰ Paul F. Henshaw, Steven Cervi and J. Alex McCorquodale. [A Simple Cost Estimator for Environmental Dredging in the Great Lakes] (draft report to be submitted for journal publication).

³¹ Personal communications Feb 18, 1999.

Phil Keillor³², Coastal Engineering specialist at the Sea Grant College, University of Wisconsin reported that his study of dredging indicated an average cost of about \$25 per cubic meter including dredging and disposal would apply to 'normal' navigational dredging. He developed the following table of potential costs associated with the remediation for the Milwaukee Harbor Estuary, Wisconsin based on his own research as well as that of several other sources of information.

Table 2
Potential For Remediation at Reasonable Unit Cost
Milwaukee Harbor Estuary, Wisconsin

Description	Estimated Cost Range (1991 US \$ per Cubic Meter)
'Reasonable cost' classification, de-watering, treatment	\$17 - \$199
Separation, de-watering (low cost limit)	\$6 - \$44
Soil washing	\$76 - \$132
Inexpensive treatment	\$14 - \$69
Expensive treatment	\$277 - \$693
Extraction (low cost Limit)	\$40 - \$268
Bio-degradation (low cost limit)	\$39 - \$181
Chemical destruction of organics (low cost limit)	\$34 - \$945
Thermal processes (low cost limit)	\$70 - \$257
Solidification/Stabilization (low cost limit)	\$33 - \$158

From Keillor, Philip J., Obstacles to Remediation of Contaminated Soils and Sediments in North America at Reasonable Cost

³² Personal communications March 5, 1998, also see J Philip Keillor. [Obstacles to Remediation of Contaminated Soils and Sediments in North America at Reasonable Cost]. 1993 Technological Institute of the Royal Flemish Society of Engineers. Proceedings of the CATS II Congress: Characterization and Treatment of Contaminated Dredged Material, November 15-17, 1993, Antwerp, Belgium.

Keillor felt that \$200 (US) per cubic meter for environmental dredging, treatment and disposal might be optimistic or low end while the \$450 (US) per cubic meter, the assumed cost in this study, would be pessimistic or high. The higher estimate will be used as a point of reference for this report as a conservative measure.

3.3 Capping

Experience with environmental capping is growing and capping has been used in areas such as the Hamilton Harbour Remedial Action Plan but rarely in aggressively flowing water as would be the case with the area of contamination of the St. Clair River. Thus different technologies would likely be required for this kind of remedial action. A capping was initiated in the Detroit River in 1998 to protect the Windsor-Detroit tunnel, the top of which had become exposed to potential damage and destruction from river current and shipping activity. The application of large and medium stone to an area, roughly 120 feet by 4000 feet (approximately 43,000 square meters), about half the area of the contaminated site on the St. Clair cost \$2.8 million (US).

Application of a 'geotextile' fabric covering to the area before placement of the stone cap was considered and rejected as unnecessary for the tunnel capping project, but might be required if capping were to be considered for an area of contaminated sediment. This would especially be helpful in ensuring durability of the capping technology, making it, perhaps, a viable long term alternative to dredging. The area being capped would be closer to the surface and lying closer to shore may require less cap cover than the tunnel, thus compensating for the added cost of the geotextile and the larger area.

A 'ball park' estimate of the cost of capping for the St. Clair contamination was in the order of \$2 million (US) or \$3 million (Canadian).³³ In the absence of more detailed exploration of specific technologies, the approximate costs of capping or dredging appear to be roughly similar and less than \$3 million. The final determination of an option may have more to do with issues, such as long term efficacy, prevention of short term hazard from dredging, availability of acceptable dredgate disposal sites and any long term liability associated with the remedial action.

Analysis

4.1 Overview

The purposes of this report are to provide socio-economic information on the issue of sediment remediation in the St. Clair River suitable for decision making by those responsible for implementation of the St. Clair River RAP and to discuss the relevance of the issues raised in the St. Clair for other RAP sites considering sediment restoration options.

³³ Personal communications, Alex McCorquodale, Feb 18, 1999.

A number of assumptions have needed to be made in developing this study. First, the report by Haffner and McCorquodale that indicated the existing ongoing escape of contaminants and the risk of accidental high dose escape has served as the scientific basis for other assumptions. Second, it is assumed that five of the outstanding 7 impaired uses relate to the contaminated sediment at issue and that remediation would restore these beneficial uses. Third, it is further assumed that the St. Clair River RAP could apply to be de-listed as an Area of Concern, and that de-listing is possible since the two impaired uses are being implemented or have detailed implementation plans outlining when they will be complete.

A reasonable upper limit estimate of the costs of either dredging and treating 4500 cubic meters of contaminated sediment or of capping the area with protective cover is three million 1998 Canadian dollars. There are also a number of benefits that can be expected as a result of remediation. These include enhancement in the quality of recreational opportunities, the potential human health implications, benefits to industry, additional community development, improved security for food fisheries, other wildlife as food sources, and other aspects of aboriginal lives and livelihood, and a reduced risk of downstream catastrophic impacts associated with potential release of contaminated sediment and the ensuing liability.

4.2 Putting The Benefits Into Context

If a formal benefit cost analysis were possible for this subject, the answer would be simple. The net present value of benefits or the benefit cost ratio would be greater than zero and one respectively. However, even if the benefit cost indicators were clearly positive, and thus clearly justifying remediation, there would still need to be discussion about who pays. Since the benefits will flow to a number of different entities there might be discussion about who should have to pay - the polluter or the beneficiaries of a clean up. However, that is not the topic of this paper.

The estimated cost of remediation, whether by 'in situ' capping or dredging and treatment of the dredgate is estimated to be about \$3 million (Can). From a purely economic perspective, thus, there needs to be at least \$3 million worth of benefits to justify any remedial action. The determination of the type of remediation selected and the timing, however, may be influenced by other than pure economic factors, such as, the relative security from downstream contamination during dredging, the feasibility of any of the technology, and the sustainability of the remediation actions, since there appear to be little difference in cost between the options. No attempt has been made in this report to identify parties responsible for the problem or to specify the preferred remediation option.

As long as the contaminated sediment continues to serve as a source for export and migration of toxic contaminants downstream to the Delta and Lake St. Clair, it is unlikely that the AOC will be able to apply for and receive de-listing. There are currently only two remaining non-sediment related impaired uses: the loss of fish and wildlife habitat

and the frequency of beach closings. Discussion with Ontario Ministry of Environment officials and others indicated that management plans and other developments were being put in place to ensure that remedial actions would be able to meet these respective de-listing criteria. The remaining five de-listing criteria associated with contaminated sediment, however, will not likely be removed until the sediment is remediated in some way. From an economic perspective, only \$3 million dollars in benefits, over any number of appropriately discounted years, is would be required to justify the anticipated costs of remediation.

4.2.1 The Community

The 3 million dollars required for sediment clean up is the equivalent of a one time fee of 23 dollars from every resident of Lambton County or approximately \$15 (Can) from the residents on both sides of the River. From a community perspective, the Sarnia and St. Clair area would require a one time investment of about \$100 per household to be able to justify making that community 'a former environmental hot spot' - this in a community where the average household income is greater than \$50,000 per year.

It is important to note that the Sarnia-Lambton Council for Economic Renewal spends over a million dollars annually to improve the image of the area and attract new residents. The conservatively estimated cost for sediment remediation for the St. Clair River would be the equivalent of three years of Sarnia-Lambton's current million dollar budget for economic development. The remediation would amount to 3 percent of the municipality of Sarnia-Lambton's 1997 annual expenditures, and about half of a ten thousandth of the assessment of the County.

De-listing would be expected to lead to an improved market of homes sales and new urban development. How much property values might increase is speculative and will depend on other factors as well. However, applying the same level of improvement in market values that"seen co-incidental with environmental improvement in Hamilton would lead to an 18.5% increase in aggregate residential property values. On a house worth a hundred thousand dollars that would amount to an increase over a number of years of \$18,500.00. It would be extremely optimistic to apply that increase in housing prices to a single remedial action, however, anything approaching that amount of increase would be a very good return on investment for the expected \$100 per household equivalent costs that remediation should require.

The Walpole community and those who rely on fishing and wildlife for recreation or food would be significantly better off following remediation. While it is difficult to place a value on these benefits, there should be no doubt that a cleaner environment will attract more visitors and enhance the earnings of Walpole residents, significantly, for guiding and fish licenses. In addition, the community will be able to reduce its need to purchase non traditional food. The economic spin offs of tourism are well known. There can be little doubt of the direction of the benefits from a remediation for this sector, even in the absence of a detailed study. Of course, it takes more than a clean environment to se

the spin offs materialize - infrastructure is also required.

4.2.2 Industry

From an industrial perspective, the full cost of remediation is the equivalent of only one hundred thousandth of the world wide 1996 sales revenue of the Dow Chemical Company, for example, which is only the fourth largest industrial organization operating in Sarnia. That would also translate to less than one cent for every one of the \$2.59 (US) common shares issued by Dow in 1996. Dow worldwide information is used for illustration, since the Canadian Sarnia operations information was not readily available.

The degree to which cleaning up the contaminated sediment would be a direct benefit to Dow or other industrial organization on the St. Clair River is unclear. At the least, removing the contaminated sediment would reduce any liability that one might at some time assign to the industries that contributed to the problem. It is not known how much any of these companies pay for insurance or to what extent their liability coverage would be reduced by this action. Over a long enough period of time \$3 million does not seem like a very large amount of industrial liability insurance given the risks.

The loss of commercial fishing as a result of mercury contamination, also one of the toxic substances in the sediment under question, cost Lake St. Clair a viable commercial fishery that was worth a million and a half dollars annually in 1998 terms.³⁴ Given the nature of the pollutant, it may be some time before that fishery could return. However, one of the benefits of remedial action for the sediment in the St. Clair River is the potential to restore that use - at least in principle and for purposes of quantification. The spin offs from re-establishing a commercial fishery would be significant although only a portion of the landed sales figure is value added and thus a net benefit for purposes of this study. Unfortunately, determining value added for the St. Clair fishery of yesteryear is a very difficult task. One could, however, assume 20%, for example, and estimate a net annual commercial fishery benefit about a third of a million 1998 dollars.

An earlier study by Acres³⁵ of the socio-economic profile of The Area of Concern indicated that in 1990 there were over 6000 jobs or 10% of the county labour force reliant on tourism. Clearly, expanded tourism would have beneficial effects on employment. It was further noted that the local population increases by 15 to 20% as a

³⁴ Although it is difficult to jump from one time period to another, it should be a comfort to the know that the landing of all Ontario landing was essentially the same in 1969 and twenty years later in 1989 (28.7 vs 25.6 tonnes) although prices for these landings jumped from \$34 million to almost \$60 million when converted to 1998 values. The Ontario Ministry of Natural Resources has indicated that reopening a full scale commercial fishery on the St. Clair would be a lower priority than increasing recreational fishing in that area..

³⁵ See Acres 1990.

result of this tourism. In 1989 there were almost 2000 slip rentals indicating the extent of interest in pleasure crafting and the investment and associated employment.

4.2.3 Recreation

Lack of St. Clair specific information has prevented quantification of the value of potential benefits for recreational boating, hunting, bird watching and other passive recreational activities associated with a healthier environment. However there is substantial historical and current information over extent of and the demand and supply of recreational fishing. That this sector has involved expenditures associated with the St. Clair area of almost 12 million dollars in addition to a sizable investment in fishing equipment in 1995, in the middle of Ontario's economic recession. Further, there were 30,000 fishers in 1995 who were prepared to pay an additional \$8 million dollars collectively, a true benefit measure for the St. Clair recreational fishery. That this amount had increased by almost 15 % since 1990 is symbolic of the growing interest and economic value that fishers place on the activity.

In 1995, the St. Clair area accounted for just under 9% of all recreational fishing effort in the Great Lakes. Were a de-listing of the Area of Concern responsible for increasing that activity with new fishers by just 10%, to a tenth of the fishing activity in the Great Lakes system, that should result in an increase in fishery direct expenditures of over 1 million dollars a year for the St. Clair area and an increase in fishery capital investment of over half a million. This 1.5 million dollars of new spending on fishing for Lake St. Clair and area at an assumed 20% value added level would yield net benefits of a third of a million dollars annually to the economy. In fact this value would likely be much higher if new entrant were to be attracted to recreational fishing since many would be expected to outfit with entirely new equipment.

Extrapolating consumer surplus measures, such as the willingness to pay is problematic, without a great deal more information relating factors such as crowding and fish availability into the equation. Clearly if an additional ten percent more fishers increased crowding on the lake and solitude was a key determinant of the quality of the fishing experience, these factors could end up canceling each other out. However, there should be no question that reducing fish consumption advisories for the Lake St. Clair area would serve to enhance the quality of fishing and the economic value fishers attach to fishing. This value cannot be assessed without a detailed contingent value survey and analysis.

4.3 Totaling Benefits and Costs

An attempt at reconciling potential benefits and likely costs is presented in the tables below. This tables are for illustration purposes and the reader is discouraged from adding up the numbers since, among other things, the values may apply to various time periods. Also, the tables include a column that subjectively assesses a degree of confidence in the values.

**Table 3
Costs of Sediment Remediation in the St. Clair River**

Potential Cost Item	Likely Cost	Confidence* in Costs Values	Explanation
1. Dredging, de-watering, treating waste water and disposal of dredgate	\$2.7 million based on high end of current experience costs	good - due to experience in environmental dredging	4500 cubic meters to be removed with minimal downstream escape
2. Capping site with textile, stone and sand	\$3 million based on other experiences with caps	reduced - since this is relatively new technology	Unproven technology for this application and may not be sustainable

*subjective valuation by author

**Table 4
Benefits of Sediment Remediation leading to De-listing in the St. Clair River**

Potential Benefit Items	Likely Benefit	Confidence* in Benefits Values	Explanation
1. Health Benefits	Improved security of living in area and eating local food and fish, drinking or contacting water	a large range exists depending on probability of major contaminant escape	Anxiety of becoming sick from consumption of fish wildlife and drinking water may cause health problems.
2. Aboriginal Community	Improved security of food and water \$ 120,000 per year saving	good - community is suffering from clearly current impacts and benefits should be realizable	A very serious concern exists about upstream pollution sources and is believed to influence the incomes and expenses of residents
	Income from guiding and other local sources have potential to increase by up to half again - \$500,000 per year.	good - potential is clear for potential income	De-listing should encourage more interest in wildlife and guiding income for Walpole
2. Industry	Return of commercial fishery worth \$0.3 million per year with \$150 million economic impact	good - mainly as an opportunity cost since the commercial fishery is unlikely to re-open	Re-entry of participants would have significant economic benefits - only a portion of the landed value is added value
	Reducing Chemical Valley industries' liability	small - then potential value here depends on future legal action	Lack of information prevents a realistic assessment of this potential benefit category

Potential Benefit Items	Likely Benefit	Confidence* in Benefits Values	Explanation
	Property Values - not estimated although it is likely that demand will increase by more potential users	good - evidence is that values should increase, even for brownfield properties	Market will be positively influenced by improvements in related real estate markets
3. Community	Reduced need for area promotion and greater payback - \$1 million per year	moderate - promotion will still be required but result should be more cost-effective	Over a million dollars spent in part to counter negative image of Sarnia
	Increases of 12.5% for residential and commercial property in proximity with water - perhaps others as well	good - evidence is sound that values should increase	Millions of dollars potential to restore property market but this will be co-dependant on other factors
3. Recreation	Passive recreation increasing quality - significant potential but not directly estimated.	good - there is strong support for the increasing value of nature related recreation	Hard to quantify without local contingent value or other analytical method
	Increase in hunting and value of hunted products - not quantified	low - other factors, including game policies, will influence of hunting activity	Hard to quantify without direct valuation tool
	Increase in fishing activity and quality of fishing 0.3 million per year in value added if fishing increased to 10% of Great Lakes totals	moderate -other factors will influence although this area has great potential	Expected increase of activity should lead to increase expenditures and quality of fishing - needs quantification by survey

*subjective valuation by author

4.4 Costs and Benefits Over Time

The distribution of costs and benefits over time and among parties is as important a consideration as the cost and benefit numbers themselves. The discount rate in a benefit cost analysis means 'benefit now and pay for it later'. The determination of a positive net present value can very much hinge on when the costs and benefits are distributed over the number of years of the project.

Sediment remediation in the St. Clair is cast much like a classical capital type project. The costs are up front and the benefits of remediation and de-listing will follow over a much longer period of time and for ever. A high discount rate would bias the analysis toward not proceeding with a clean up while a low discount rate would promote an early

clean up. Although a detailed discussion on discounting for time cannot be accommodated in this paper, suffice it to say that there are some principles that argue for a low or perhaps even a negative discount rate.

An additional complication is the issue of inter-temporal justice, stemming from the work of the World Commission on Environment and Development report "Our Common Future"³⁶ which promotes the idea that sustainability means that the ability of future generations to meet their needs are not impaired by this generation meeting its needs. That is unattainable on a planet with finite resources when cost and benefit streams differ over time and the longer lasting stream of benefits are discounted. Not discounting the future equalizes the difference between costs today and benefits tomorrow and places the present and future generations on the same footing - a level playing ground. Early remediation would have an impact on the benefits, since the stream of benefits would start earlier and be that much greater. In addition, given that there is an ongoing escape of the contaminants, earlier remediation would also result in a higher value of total benefits, since any impacts of escape would be eliminated.

The benefits and costs are distributed among different individuals regardless of how they are to be allocated over time. Either continued leakage or an accidental escape of contaminants would impact the Delta and ultimately Lake St. Clair as well as all those downstream from the contaminated site. Wallaceburg, which gets its drinking water from the River will benefit in the assurance that it will not face an known or unexpected contaminant loading into its drinking water. Like Wallaceburg, Walpole Island receives its drinking water from the River. In addition, Walpole Island would likely be one of the major beneficiaries given its reliance on fish and wildlife for both food and as a tourism industry.

Recreational fishers will benefit and eventually those who would want to rebuild a commercial fishery might as well. Anglers and hunters would have a new security about the food they eat or at least the food that they expect to get on future hunts. If property values increase generally all property holders would benefit and particularly those near the water on both sides of the River. All ages will benefit from the remediation although children who eat fish are perhaps at greater risk of exposure to chemical contamination and would benefit more. And the younger generation would be the big beneficiaries of a cleaner environment in their life times and for the legacy of their offspring.

The World Commission on Environment and Development in 1987 concluded that sustainable development involved this generation ensuring that the needs of future generations are able to be met, just as this generation meets its. Clearly, remediation of this site would ensure that the generation to follow this one can do so without an environmental legacy of the magnitude of the contaminated sediment in the St. Clair River. An argument for sustainability is that harm done by one generation should not be

³⁶ See Brundtland. [Our Common Future].

left to the following generation to clean up or suffer losses as a result. Inter-temporal socio-economic or environmental justice would argue that it is the responsibility of this generation to deal with this generation's messes, such as contaminated sediment.

Summary and Conclusions

This study had two purposes from the outset. First, it was to provide more information about the costs and benefits of sediment remediation in the St. Clair River. Attempts were made to quantify both the benefits and the costs by using existing information. For the most part, the quantification of benefits is incomplete. However, considering the benefits that were given a first level identification it is clear that they are potentially significant. That is particularly true given the relatively small amount of costs for an effective remediation.

Further characterization of the benefits would no doubt reveal even greater potential value from remediation if they were subjected to a more detailed and direct analysis. A quick tally of benefits will identify at least 3 million dollars worth of benefits that could be expected to occur over the next few years. For example, were housing prices to better reflect the values associated with proximity to a clean water resource, both landholders wealth and municipal tax revenues could be expected to increase significantly, easily surpassing that amount.

Sarnia currently spends a million dollars a year, roughly one third of the cost of clean up on promotion for the area. It might be able to achieve the same results with only half that budget, or double its results with the same budget, it could rationalize the remediation costs in 6 years.. In any case, the costs of remediation amount to no more than a one time cost of a hundred dollars per household. This might be a sound investment to rid Sarnia of the current environmental stigma and serve as an insurance against future disasters from accidental release of the contaminants.

Chemical Valley industry, that is responsible for the problem, would likely see an increase in higher property values, although the biggest benefit would be in reducing their longer term liability and in improving and solidifying the image of this vital industry as good corporate citizens and stewards of the environment. Anglers, hunters and those reliant on food from the water or who drink the water will have greater security in knowing that their environment is a safer one. For the aboriginal inhabitants of Walpole Island they would benefit not only from safer food supply and expanded income from guiding, but also in ensuring that their cultural heritage is being protected.

The quality of fishing is important to anglers who place a very high socio-economic value on this recreational pursuit - that means having fish to catch and knowing that they are safe to eat. Fishers have noted a considerable willingness to pay for the fishing experience in excess of what it costs them. Clearly they would be willing to pay much more if safety of the fish were enhanced. Increased sports fishing activity and

other recreational activity will result in greater economic benefits to the community as fishers spend more in the surrounding communities.

The commercial fishery that once vied with others for prominence in the Great Lakes and was wiped out because of mercury pollution, might be in a position to eventually re-open and provide employment and livelihood to those living around the River and Lake. Were a commercial fishery allowed to be re-established in St. Clair it might generate at least the one and a half million 1998 dollars of gross landed value that it did historically. The total economic impact of a commercial fishery, estimated by the industry, would make that about one hundred and fifty million for comparable catch levels as in the past. Of course the Province would need to decide on the desirability of re-commencing a serious commercial fishery.

The security of water supply for Wallaceburg and Walpole Island is a very important issues to the residents of these communities. Walpole residents are estimated to spend over \$10,000 a month on bottled water and alternative food. In addition the Walpole Island community earns a substantial income from wildlife and fisheries guiding and licensing and the current income of about three quarters of a million dollars could be increased substantially, perhaps even doubling should the St. Clair area become better recognized as a quality fishing and wildlife area.

\$ 3 million dollars was seem as an upper end or conservative estimate by all of the experts that were talked to regarding dredging and capping. Clearly more money could always be spent and spent wisely. Curtaining of the area would increase the cost but enhance safety.. It is unfortunate that the information on the partial dredging effort a couple of years earlier was not made available for this paper. Although that was a pilot dredging, it would have helped provide a sounder baseline for decisions on the future.

In the end the decision that must be made (to clean up or not) will be based on a complex set of criteria and not just a single indicator such as a benefit cost ratio. This paper has tried to help that process by scoping cost and benefit categories and by identifying levels of confidence around any estimates. The potential benefits are significant in relation to the costs. That should drive the next step in decision making.

More research could always help to better refine the information provided, although it is doubtful that it would be worth spending a significant amount of money for valuation tools such as a thorough contingent value study. This is especially the case given the relatively low estimate of the costs of remediation for the St. Clair. In the course of research on this project Professor Phil Keillor³⁷ noted that a contingent value analysis had been conducted for the Fox River sediment clean up justification.

³⁷ Personal communications. A copy of the study was not available as it has yet to be written up for a learned journal and peer reviewed.

Although the results of that analysis have not yet been published, there was apparently a net benefits value that exceeded the costs of sediment remediation even though a willingness to pay question was asked. Even greater benefit values would have been demonstrated had a willingness to accept compensation question been asked as was discussed elsewhere in this report. The values that could be ascertained from a contingent value questionnaire would be expected to, also, exceed the estimated \$3 million costs.

Tom Muir from Environment Canada has suggested that most willingness to pay studies of this kind end up with estimates of \$ 25 to \$50 per person. Assuming that this range applied to the St. Clair area between three and ten million dollars would be the willingness to pay benefit , depending on the geographical boundaries of the area, and whether to include the US as well as the Canadian side of the area. Since the pollution has already resulted in impaired uses, the issue here is 'harm avoidance' not investment. As is noted elsewhere in the paper, the appropriate measure for estimating the value of restoration should be the willingness to accept compensation for the loss, a value that is considerably in excess of the 3 to 10 million value estimate here.

The second purpose of this paper is to provide a framework to assist with decision making in other contaminated sediment sites throughout the Great Lakes. A traditional benefit cost study is not appropriate for this kind of decision making issue. Quantifying benefits and discounting are major philosophical problems that make benefit cost analysis undesirable as an environmental decision making tool. Additional quantification through 'hedonic', 'contingent value' or other techniques would provide extra confidence that remediation is the smart socio-economic thing to do. However, the higher cost for this additional research would probably not be economically justified.

The framework used here to identify benefits and costs can help the decision makers with finding consensus and coming to terms with how, when and who pays for the clean up. This study demonstrates the potential **payback**; that is, that the potential benefits are at least in the same order or magnitude, if not greater, than the costs. Nevertheless, the RAP participants and the community will need to further discuss and resolve another issue not explicitly discussed here. That is the question of **affordability** - that those responsible for the clean up are able to fund the costs.

Appendix A

The Benefit Cost Framework

The most common analytical instrument for economic decision making is 'classical' benefit cost analysis.³⁸ This analytical tool has its origins in the evaluation of capital

³⁸ Classical benefit cost analysis (or cost benefit analysis) involves fully quantifying the costs and benefits over the years of an investment project and discounting these to a present value to derive net present value, benefit cost ratio, net payback period or internal rate of return.

intensive investment projects. The annual project costs over a number of years are discounted using an interest rate and compared with the discounted stream of annual benefits that can be expected from the investment. Benefit cost analysis is most applicable as an evaluation technique when all the potential benefits and costs can be quantified with relative certainty. Comparing the stream of fully valued benefits and costs, discounted to their present value sums, allows the analyst to derive a benefit-cost ratio, a net present value of benefits, an internal rate of return and a payback period - all of which provide valuable information about investment decisions.

Although benefit cost analysis has been tried extensively in the public sector for non-investment decisions, it has been proven of lessor unequivocal value than its application to private sector investment analysis. Many decision makers have preferred to utilize 'cost-effectiveness' analysis where only the discounted cost streams among options are compared to determine the relative 'cost effectiveness' of various options to achieving a common target or goal. Cost effectiveness has been used extensively by decision makers in the military and other public sector program areas where credible benefit quantification is difficult, if not impossible or where the goals are clear and desirable.

A recent article by Holly Stallworth from the United States Environmental Protection Agency, "The Cost-Benefit Paradigm for Environmental Protection - An Economist's Perspective on Methodological, Theoretical and Ethical Problems"³⁹ discusses the US experience in attempting to apply classical benefit cost analysis to public sector environmental decisions. US Executive Order 12291 under the Reagan and Bush Administrations and Order 12866 under President Clinton call for the extensive use of benefit cost analysis for all major environmental program expenditures. Stallworth contends that this has been dis-functional to US environmental policy.

Environmental benefits often include so-called 'intangibles' that, typically, can only be partially quantified or in some cases are not quantifiable at all. Thus, Stallworth notes that an asymmetry develops between poorly quantified benefits and the more readily identified costs giving a bias away from public investment in the environment and a bias to projects with more concretely quantified benefits as opposed to those where quantification is more difficult.

The Stallworth discussion raises the issue of the utility of benefit cost analysis for environmental projects or whether these projects would not be better considered using a more cursory cost-effectiveness approach. The issue is whether a project should be ignored just because it cannot be easily and completely quantified. This and other issues that detract from any advantages of benefit cost analysis are considered in the balance of this section

Benefit Cost Framework Issues

³⁹ See Stallworth.

- **Public Goods**

Public goods exist because the marketplace of buyers and sellers for these goods is either highly imperfect or fails to exist. Stallworth draws a comparison to the environment and notes that significant expenditures are made on the recognized 'public good' of defense without mandatory quantification of the benefits of these expenditures or a classical benefit cost analysis. Rather, cost effectiveness is used. Since the goal of national defense is a given for society, analysis can be focused on delivering acceptable levels of security at different costs.

National defense is required to prevent harm and loss of sovereignty. In this regard defense expenditures provides insurance against future harm. This insurance or harm-avoided goal is inherently different from maximizing the so-called 'utility' of consumers that underpins much of traditional economic theory. The 'harm avoided' approach that is used in decisions of national defense is the same challenge that faces analysts and decision makers of environmental protection and restoration.

Environmental protection is as much a public good as is national defense. Other evaluation instruments including simulation analysis, risk assessment, community impact and attitude surveys, contingent valuation, hedonic and travel cost analysis are frequently used by economists to assist in better understanding the consequences of investing in the environment. In the absence of clearly quantified benefits these tools provided valuable information for decision makers.

- **The Discount Rate**

Discount rates are used in benefit cost analysis (BCA) to equate the present value of a future benefit stream to the present costs of an investment - to provide a common numeraire. The discount rate used in business analysis is related to the most common business borrowing interest rates. This rate represents the opportunity cost of private capital or the cost of foregoing consumption today to enjoy it tomorrow. Public sector decisions that have tried to use a BCA have typically used a lower than private sector discount rate to reflect the lower opportunity costs of public monies as is seen, for example, in the reduced borrowing costs for public institutions over private ones.

A second difficulty rests with the notion of applying a discount rate to an area of the economy where markets do not exist. For example restoring a wetland may provide a greater level of benefits tomorrow than it does today. In this case a discount rate would bias the analysis against the project. Sustainable development⁴⁰ is an environmental concept that holds that the needs of future generations are as important as those of those of today. If the opportunity cost of environmental goods in the future is as great as it is today the appropriate discount rate is zero and using positive discount rates to reduce benefits out into the future would be inappropriate. The argument for a zero (or

⁴⁰ See Brundtland.

even negative) discount rate removes one of the major features of BCA and thus reduces its usefulness for environmental projects.

- **Public Goods and Externalities**

Public goods, since the days of Adam Smith, are features that must be provided for the public good. Traditionally, governments have provided these but with the emerging 're-engineering' of government goals and objectives and the progress of globalization government, in the nineteen nineties, has in turn come to expect the burgeoning private sector to assume a greater role in the provision of public goods. This is especially true in the area of the environment where a long standing policy of polluter pay⁴¹ is gaining new meaning given the fiscal inability of governments to pay for environmental clean up with taxpayer dollars.

While in theory even the private sector BCA was to include the external costs⁴² (externalities) of an investment, this was rarely the case. Decisions that involve externalities usually found them difficult to quantify and/or since externalities are by definition external and not a direct cost of benefit they are ignored, regardless of the costs and benefits they might impose. In the case of environmental externalities, these have quite often required subsequent clean up, to restore the public good, paid by both private and public organizations. Contaminated sediment in the St. Clair River is an environmental externality of private sector processes that are being considered for remedial action.

- **Willingness to Pay and to Accept Compensation for Intangibles**

Where goods and services are not traded, they typically have no price and cannot be quantified using market prices. Since the market for these intangibles cannot be observed in dollar terms these goods and services are termed intangible. Since they are not defined in dollar numeraire, economists and others have tried to quantify them using a variety of techniques. Contingent valuation⁴³ is one approach whereby values are estimated by observing the responses to supposedly unbiased questions regarding how much one would be willing to pay to acquire a good or service and how much one would require as compensation to have it taken away from them.

⁴¹ The polluter pay principle has been endorsed by most governments although this concept has not always been strictly applied. For example, orphan contaminated sites receive public funding for decommissioning. In addition, RAPs, many of which are a consequence of private sector pollution are funded largely by governments.

⁴² External costs are those that occur as a consequence of a project - are not of direct consideration. For example, a highway construction project involves direct costs of construction, land purchase etc, but it also may result in external costs of air pollution, noise and increased health care costs from accidents as well as the external benefits of increased net economic activity from the investment and time saved for those using road transit.

⁴³ See Dewees for more detail.

There is a significant and consistent difference in the responses to these two questions. People value the loss of an existing benefits at a much higher level than they themselves would be willing to pay to acquire it in the first place. This is not irrational human behaviour but rather epitomizes how humans value goods and services, placing a premium on loss to which they have attached a sense of implied property rights. Thus, in respect of environmental benefits over which much of the contingent value analyses have been conducted, the insurance or harm-avoided preference of society reflects much higher value than they would may be required to restore an environmental loss. Some economists have inferred this preference for preservation reflects a combination of existence value and other non-use as well as use values⁴⁴.

Stallworth in her treatise quotes Adam Smith as he discussed the concept of value..” The word VALUE, it is to be observed, has two different meanings, and sometimes expresses the utility of some particular object, and sometimes the power of purchasing other goods... The one may be called ‘value in use’, the other, ‘value in exchange’. The things which have the greatest value in use have frequently little or no value in exchange; and on the contrary, those which have the greatest value in exchange have frequently little or no value in use.⁴⁵

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⁴⁴ See Dewees.

⁴⁵ Wealth of Nations Bk 1, Ch 4, 1776.

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