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PROLOGUE

As is the case for all of recorded history, there remains a long and unbroken chain of events which preceded the St. Louis River System Remedial Action Plan. One of the most significant of these was the 1909 signing of the Boundary Waters Treaty between the United States and Great Britain [Canada was not a sovereign nation at this time]. The 1909 Boundary Waters Treaty established the International Joint Commission (IJC) as the bi-national organization responsible for the Great Lakes and other international boundary waters. The three principal responsibilities entrusted to IJC by the 1909 Treaty included the regulation of Great Lakes water levels, an obligation to carry out specific studies as requested by the parties, and as arbitrator for international water resource disputes. As one of its first responsibilities, IJC was asked to conduct a study of water quality problems resulting from discharges of raw sewage into the Great Lakes. IJC issued a report in 1919 that strongly recommended the establishment of a comprehensive treaty to combat such problems and to protect Great Lakes water quality. This recommendation was virtually ignored.

Degradation of the Great Lakes ecosystem proceeded for years before mounting scientific evidence and public pressure compelled the governments of the United States and Canada to enact the 1972 Water Quality Agreement. The circumstances that provoked this precedent setting action included wide spread and pervasive algae blooms in the lower Great Lakes, disease outbreaks attributable to discharges of raw sewage, and the devastating impact of the 1940s invasion of the sea lamprey on Great Lakes fisheries resources. These issues culminated in 1955 with the establishment of the Great Lakes Fisheries Commission (GLFC) and the 1972 signing of the Great Lakes Water Quality Agreement. Control of the sea lamprey served as the impetus for the 1955 establishment of GLFC. The 1972 Water Quality Agreement required that the governments take specific steps to reduce the discharge of conventional pollutants and signaled a commitment to reverse the progressive decline and deterioration of the Great Lakes ecosystem.

There were noticeable improvements in Great Lakes water quality following the implementation of the 1972 Water Quality Agreement. An estimated nine billion dollars was expended in controlling conventional pollutants by the upgrading or creation of waste water treatment plants. In the years following the signing of the 1972 Agreement, continued monitoring and research made it clear that toxic chemicals in the environment presented a threat equal or greater in significance than that posed by conventional pollutants. The gravity of this realization brought the signatories of the Water Quality Agreement together to amend the Agreement in 1978. The 1978 Agreement retained the essential components of the 1972 Agreement and added a new focus on toxic pollutants. After period of time, it became obvious that the amendments to the Agreement lacked an effective means of implementation. In 1987, the Agreement was modified to establish Remedial Action Plans (RAPs) as one of the principal mechanisms to implement provisions of the Agreement and to address the most severely impacted geographic areas around the Great Lakes Basin. The plans themselves are to embody a comprehensive ecosystem approach and to include substantial citizen participation.

EXECUTIVE SUMMARY

The Transformation and Legacy of the St. Louis River Area of Concern

Settlement and the consequent development of the lower St. Louis River and its watershed followed a pattern similar to other Great Lakes Areas of Concern (AOC). The shoreline and open waters of the river's mouth or estuary were transformed from a large, shallow, marshy area, to the slips and waterfront operations which make it one of the largest ports on the Great Lakes today. In this transformation, an estimated 3000 acres of open water and wetlands were filled and another 4000 acres of the harbor or estuary dredged. Other major hydrologic modifications included the development of 630 miles of drainage ditches in the western and central parts of the St. Louis River Watershed, the creation of a lake reservoir system, and the placement of five hydro-power dams in the river reach from the City of Cloquet, Minnesota to the upper reaches of the estuary. Each of these changes and many others have altered historic hydrologic conditions. Some of the known consequences of these physical alterations are manifested as barriers to fish movement, changes in flow regimes and aquatic habitats, and in the delivery of storm water and its associated pollutants.

The St. Louis River has undergone a long history of degradation resulting from pollution. As a consequence of a 1928 - 1929 investigation, the Minnesota State Board of Health classified the river reach from the City of Cloquet to Lake Superior as "pollutional". A follow up study in 1948 confirmed the 1928 study's classification of the river and concluded that 20 years had elapsed with significant increases in waste discharges and no improvements in treatment. Oxygen deficiencies and sludge deposits in river bottom areas were commonplace at this time. Complaints of tainted fish flavor and fish kills were also frequent occurrences from the 1940's through 1970's. A 1967 fisheries potential study reported that "fish caught in the river reportedly have a very strong flavor and are scarcely edible without strong seasoning". Fish kills occurred at various intervals during late spring and summer from 1956 to 1980. Waste water treatment improvements in the 1980s alleviated most of the problems associated with discharges of conventional pollutants. Issues of toxic substances in the environment have since moved to the forefront of the public agenda, as evidenced by issuance of fish consumption advisories. Minnesota and Wisconsin issued fish consumption advisories for the presence of toxic residues in fish in the St. Louis River in 1985.

Major industrial and municipal discharges to the St. Louis River were occurring throughout the time frame when fish kills and tainting problems were commonplace. Industrial byproducts were discharged, as one example, from the a ravine/stream on the northern edge of the US Steel/Duluth Works Site to the St. Louis River for some 65 years. Wood products industries in Cloquet also discharged a variety of wastes to the river for over 75 years. These sources were joined by an agglomeration of industrial and municipal point sources from both Minnesota and Wisconsin that discharged into tributaries, slips, and at a multitude of locations in St. Louis or Superior Bay. Establishment of the Western Lake Superior Sanitary District in 1978 consolidated the Minnesota industrial and municipal dischargers into a single waste treatment plant and had a significant positive impact on river water quality. In the past, studies had characterized the lower St. Louis River as eutrophic. With the start up of the treatment plant, dissolved oxygen deficiencies and the frequency of violations diminished from 25% to less than 1% over the period of 1979-87. Another study estimated that total phosphorous loadings from nine former sewage treatment plants had been reduced by about 80%.

Where and What is the Area of Concern?

The St. Louis River System is varied and complex, and includes several major bays and tributaries. The term "St. Louis River System Area of Concern" is used to describe the geographic area being addressed by the RAP, without naming all of the individual regions and waterways it represents. The St. Louis River System RAP primarily focuses on the St. Louis River below Cloquet, including St. Louis Bay, Superior Bay, Allouez Bay and the lower Nemadji River. The 39 river miles of the St. Louis River between the City of Cloquet and its entrance to Lake Superior has been the region of most intense water uses, development, and industrial activities on the River throughout the period of settlement. The RAP also considers activities throughout the St. Louis and Nemadji River watersheds which affect water quality. Atmospheric sources which may originate beyond the watershed are also considered.

What Do We Know About Pollutant Sources in the Area of Concern?

A multitude of lingering historical problems and continuing sources of pollution contribute to the degradation of the aquatic ecosystem of the St. Louis River system. The significance of individual sources to the overall problems may never be truly known. These sources are largely and collectively responsible for the integrity of the lower river, including its contaminated fish and sediment.

Historical discharges have left continuing problems: sediments contaminated with mercury, PCBs, dioxins, polynuclear aromatic hydrocarbons (PAHs), and a variety of other metals and organic compounds. These contaminants have been found throughout sediments in the area of concern, although large regions have not been sampled. Certain areas have been identified as having particularly elevated levels of sediment contaminants:

- (1) The embayment that receives discharge from WLSSD, and historically received discharge from previous treatment plants in Duluth, MN;
- (2) The Interlake Superfund site vicinity in Duluth, MN;
- (3) The U.S. Steel Superfund site vicinity in Duluth, MN;
- (4) Newton Creek and Hog Island Inlet of Superior Bay in Superior, WI;
- (5) Crawford Creek wetland/Koppers Co. vicinity in Superior, WI.

At each of these locations, a variety of polynuclear aromatic hydrocarbons and/or heavy metals (i.e., mercury, lead, arsenic, etc.) have been detected at elevated levels in bottom sediments. In addition, degraded communities of bottom dwelling organisms have been documented at the Interlake and Newton Creek/Hog Island Inlet sites. Contaminated sediments in the five areas listed above may act as sources of contaminants to the overall ecosystem of the lower river and estuary.

In addition to continuing contributions of contaminants from these sites, other established or potential pollutant sources include continuing industrial and municipal discharges and a significant number of major and minor landfills. Point source dischargers contribute a range of toxic and conventional pollutants to the St. Louis River Area of Concern. The major active discharges are the Western Lake Superior Sanitary District, the City of Superior, Murphy Oil and Superior Fiber Products. Annual loadings estimates of heavy metals and organic compounds from these sources range from undetectable to 11,000 pounds per year. Among the landfill sites are the Superior-Wisconsin Point Landfill, the Engineers Realty Landfill in Duluth, and the Potlatch Landfill in Cloquet, MN. In addition, a compilation of records for the last decade has shown continuing inputs of untreated sewage, industrial wastewater, and petroleum products through bypassing, spills, and other accidental releases.

Little quantitative information exists for the multitude of waterborne non-point sources of pollution delivered to the St. Louis River. Of these sources, groundwater and surface water represent two of the principal mechanisms for the transport of non-point sources of pollution. No systematic attempt has been undertaken to assess the significance of groundwater as a pollutant source, despite the existence of a number of contaminated sites within the drainage basin of the St. Louis River system. Investigations are generally carried out within the context of specific sites and focus on human health considerations.

The significance of the other principal transport mechanism, surface water, also remains poorly defined. There is a serious lack of data from the AOC's urban areas which quantify pollutant inputs from the 30 or so tributaries that drain the steep slopes of the City of Duluth and from the numerous small streams which dissect the semi-impermeable red clay region of Superior, Wisconsin. Most of what is known about non-point source pollution in the St. Louis River AOC is of general knowledge. For instance, constituents commonly identified in urban storm water by the U.S. Environmental Protection Agency's (EPA) National Urban Runoff Program (NURP) included sediment, nutrients, trace metals, hydrocarbons, and chlorides. It would be reasonable to expect the same range of pollutants in surface water runoff from the AOC. The significance of sediment loading is well illustrated by the 150,000 to 200,000 yds³ of sediment dredged annually from the Duluth-Superior Harbor. One half of this amount is believed to originate from the Nemadji River. The cost of managing this sediment is approximately \$7.00 per cubic yard.

Atmospheric deposition represents another important mechanism for the delivery of non-point source pollutants to Lake Superior and to a lesser degree, the AOC. Studies indicate that most long-range transport of air pollution to northern Minnesota, and presumably Lake Superior and the St. Louis River, originates from the Ohio River Valley, the St. Louis, Missouri region, and from the Texas/Louisiana oil and petro-chemical complexes. There are also 63 local sources which are authorized by the states of Minnesota and Wisconsin to emit particulates, lead, carbon dioxide, sulfur dioxide, nitrogen oxides, and/or total volatile organic compounds. Some of the substances emitted locally are considered toxic. Atmospheric deposition is believed to contribute less than 30% of the mercury found in the St. Louis River Estuary. The primary source of mercury is the wastewater discharge for the Western Lake Superior Sanitary District (WLSSD) facility. Due to the large surface area of Lake Superior, atmospheric deposition constitutes 88% of the PCB loadings. The contribution of PCBs to the St. Louis River has not been quantified. Sources of atmospheric PCBs include the WLSSD sludge incinerator, local waste oil burners, and distant emissions. There is very little information on atmospheric deposition of dioxin to the St. Louis River. While there are at least two local sources (WLSSD and Potlatch), much of the dioxin could originate from distant sources.

Summary of IJC's 14 Beneficial Use Categories in the St. Louis River AOC

The International Joint Commission developed 14 impaired use categories to designate Great Lakes Areas of Concern. Impaired use criteria, which are summarized on the following pages, provide a framework for the development of RAPs. Status of these categories serve as indicators of past actions and of the biological, physical, and chemical integrity of the resource. The impaired use categories and the goals of the RAP Citizens Advisory Committee will guide development of recommendations during Stage II. The ultimate goal of Stage II and its implementation being to restore impaired uses and to protect those unimpaired.

IJC Impaired Use Criteria Summary for the St. Louis River AOC

Impairment Identified in AOC		
IJC Criteria	Reason	Comments
Fish Consumption Advisories	Advisories issued by MN and WI	PCBs, dioxin, mercury
Degraded Fish Populations	Impact of ruffe (exotic fish species)	-
Degraded Wildlife Populations	Decline in threatened and endangered Species	-
Fish Tumors and Other Deformities	Observations in 1991 (harbor) and 1985 (Crawford Creek)	Data on incidence of tumors and deformities needed
Degradation of Benthos	Documented at Stryker Bay/Hog Island Inlet	Surveys are needed to document extent of problem in AOC
Restrictions on Dredging	Contaminated sediment	Data lacking for many parts of the AOC
Excessive Loading of Sediments and Nutrients to Lake Superior ¹	High Sediment/Nutrient Load from AOC	-
Beach Closings/Body Contact	Sewage bypasses	Probable site specific bacterial problems from bypasses, spills, etc.
Degradation of Aesthetics	Aesthetics of water degraded by oily materials at Stryker Bay/Interlake and at Hog Island/Newton Creek	Other areas may have aesthetic impairment
Loss of Fish and Wildlife Habitat	Documented loss of habitat at Stryker Bay and Hog Island due to Contamination	Continuing loss of physical habitat limits population
Impairment Not Clear		
Fish Tainting	Historical problem, currently conflicting evidence	Clarify existence or extent of fish tainting in Stage II
Bird or Animal Deformities or Reproductive Problems	Low reproductive success in common terns - reasons not clear. Potential factors include toxics, competition, physical habitat loss.	Additional data on toxics in terns and other species needed.

IJC Impaired Use Criteria Summary for the St. Louis River AOC

Not Impaired Currently		
Wildlife Consumption Advisories	No advisories issued	Limited data
Restrictions on Drinking Water Consumption	Drinking water not taken from AOC	Concerns for spills
Eutrophication or Undesirable Algae ²	High nutrient levels, but no clear evidence of eutrophication	High nutrient loading to Lake Superior is of concern
Added Costs to Agriculture or Industry	No impairment currently	Zebra Mussel could cause problems
Degradation of Phytoplankton and Zooplankton	No evidence of impairment	Future impairment possible due to exotics (BC and Zebra Mussel)

¹ Adaptation of Eutrophication Criteria to Fit Local Conditions

²IJC Eutrophication Criterion not Impaired, see "Excessive Loadings" Criterion

Restrictions on Fish Consumption

IJC Listing Criteria: When contaminant levels in fish or wildlife populations exceed current standards, objectives, guidelines, or public health advisories are in effect for human consumption of fish or wildlife. Contaminant levels in fish and wildlife must be due to contaminant input from the watershed.

Is the Beneficial Use Impaired? -Yes

The states of Wisconsin and Minnesota issue fish consumption advisories for Lake Superior and the St. Louis River. Advisories are issued for the presence of mercury, dioxin, and polychlorinated biphenyls (PCBs) in fish tissue. Fish tissue residues of mercury and PCBs also exceed the .5 mg/kg and .1 mg/kg standards established in the 1978 Great Lakes Water Quality Agreement for the protection of aquatic life and fish consuming birds.

Degraded Fish and Wildlife Populations

IJC Listing Criteria: When fish and wildlife management programs have identified degraded fish or wildlife populations due to a cause within the watershed. In addition, this use will be considered impaired when relevant, field validated, fish or wildlife bioassays with appropriate quality assurance/quality controls confirm significant toxicity from water column or sediment contaminants.

Is the Beneficial Use Impaired? -Yes

During the period of severe organic pollution before 1979, fish populations were degraded and fish kills were common. Fish populations have been recovering from that era because of improvements in wastewater treatment. However, fish populations are now adversely affected by the proliferation of the ruffe, an exotic species first found in the AOC in 1987. Other exotics threaten fish populations. The potential effects of toxic substances on fish population health in the AOC is largely unknown. Continuing loss of physical habitat also threatens populations. The loss of wetland habitat and the infestation of the exotic plant, purple loosestrife, have the potential to cause declining fish and wildlife populations. Little population data is available

for wildlife with the exception of colonial nesting birds in the AOC. Populations of the common tern and the piping plover (threatened and endangered species) have declined probably due to a combination of local and regional factors.

Fish Tumors and Other Deformities

IJC Listing Criteria: When the incidence rates of fish tumors or other deformities exceed rates at unimpacted control sites or when survey data confirm the presence of neoplastic or preneoplastic liver tumors in bullheads or suckers.

Is the Beneficial Use Impaired? -Yes

Observations suggest that fish tumors and deformities represent an impaired use in the St. Louis River estuary. However, at present, there are no studies which document the incidence rates of tumors in fish. Additional work is needed to fully determine the incidence of fish tumors and deformities in the AOC.

Degradation of Benthos

IJC Listing Criteria: When the benthic macroinvertebrate community structure significantly diverges from unimpacted control sites of comparable physical and chemical characteristics. In addition, this use will be considered impaired when toxicity (as defined by relevant, field validated, bioassays with appropriate quality assurance/quality controls) of sediment associated contaminants at a site is significantly higher than controls.

Is the Beneficial Use Impaired? -Yes

Degradation of benthos has been documented in two areas: Stryker Bay/Interlake Superfund Site, and Newton Creek/Hog Island Inlet of Superior Bay. Investigations conducted in 1989-1991 indicate degraded benthos in these areas. Macroinvertebrate surveys in Stryker Bay show a marked paucity in numbers and diversity. In Newton Creek/Hog Island Inlet, tests have demonstrated sediment toxicity to benthic organisms. Although contaminated sediments may be causing degradation in other river areas, no system-wide benthic studies have been conducted.

Restrictions on Dredging

IJC Listing Criteria: When contaminants in sediments exceed standards, criteria, or guidelines such that there are restrictions on dredging or disposal activities.

Is the Beneficial Use Impaired? -Yes

Restrictions on dredging is a use that can be clearly identified as impaired in the St. Louis River AOC. Sediments in many parts of the AOC exceed guidelines developed by regulatory agencies to characterize in-place sediments and contain a variety of toxic, bio-accumulative contaminants which have been shown to cause adverse effects to aquatic and terrestrial organisms. Serious economic and social consequences are also imposed upon some resource users through special dredging requirements and obligations for long term sediment containment.

Excessive Loading of Sediment and Nutrients to Lake Superior

Listing Criteria: Adaptation of IJC criteria to fit local conditions.

Is the Beneficial Use Impaired -Yes

Despite high levels of phosphorous in AOC waters, little evidence exists of widespread or pervasive water quality problems associated with eutrophication. Algal growth may be suppressed in the lower St. Louis River by persistent turbidity and its consequent light limitations. Nonetheless, these excessive loadings of this phosphorous and sediment to Lake Superior remain a concern. Excessive loadings of sediment and nutrients to Lake Superior are of importance to fish habitat and the trophic status of littoral and/or near shore areas.

Beach Closings, Body Contact

IJC Listing Criteria: When waters, which are commonly used for total body contact recreation, exceed standards, objectives, or guidelines for such use.

Is the Beneficial Use Impaired? -Yes

Water quality data indicate that improvements have occurred in bacterial contamination levels since the 1970s. Episodic sources such as sewage bypasses and marine traffic, however, continue to represent sources of localized bacterial contamination. Body contact recreation is considered impaired because of documented sewage bypasses into the St. Louis River system from Wisconsin and Minnesota sources.

Degradation of Aesthetics

IJC Listing Criteria: When any substance in water produces a persistent objectionable deposit, unnatural color or turbidity, or unnatural odor (e.g., oil slick, surface scum).

Is the Beneficial Use Impaired? -Yes

Visual inspections and complaint logs maintained by both states confirm that aesthetic values are degraded in a number of areas in the St. Louis River Area of Concern. Oils slicks have been repeatedly observed in Hog Island Inlet and in Stryker Embayment at the Interlake Steel Superfund Site. These areas and others should be systematically identified and addressed through remediation or separate riparian actions.

Loss of Fish and Wildlife Habitat

IJC Listing Criteria: When fish and wildlife management goals have not been met as a result of loss of fish and wildlife habitat due to a perturbation in the physical, chemical, or biological integrity of the Boundary Waters, including wetlands.

Is the Beneficial Use Impaired? -Yes

In the past, fish habitat in the estuary was degraded because of impaired water quality. Currently, contaminated sediments may cause habitat degradation in several areas of the river system. Habitat degradation due to sediment contamination has been documented in two areas: Stryker Bay (Interlake Superfund site vicinity), and Newton Creek/Hog Island Inlet of Superior Bay. High rates of sedimentation in the estuary during the twentieth century, with ensuing turbidity and reduced light penetration, may limit macrophyte growth and therefore limit fish and wildlife habitat. Habitat loss due to sedimentation has not been documented for specific areas. Wetland habitat is being degraded due to the infestation of purple loosestrife. Fish and wildlife populations have not yet been noticeably affected by this infestation, but the potential exists if the loosestrife continues to spread.

The St. Louis River estuary has relatively large areas of undeveloped shoreline and wetland habitats, compared with many other Great Lakes Areas of Concern. Protection of these habitats is important to the stability of fish and wildlife communities. Critical habitats for some important fish and wildlife species have been identified and should be protected from loss through development or other degradation. Identification of important and critical habitats in the river system will be a continuing activity through the RAP and other planning efforts.

Tainting of Fish and Wildlife Flavor

IJC Listing Criteria: When ambient water quality standards, objectives, or guidelines, for the anthropogenic substance(s) known to cause tainting, are being exceeded or when survey results have identified tainting of fish or wildlife flavor.

Is the Beneficial Use Impaired? -Impairment Not Clear

Informal surveys of fisheries personnel and area game wardens indicate that fish tainting problems are no longer pervasive and wide-spread. A fish tasting study and survey conducted in the 1980s, however, raises questions as to whether this problem was simply transferred from upper river sites, where paper mill wastes were formerly discharged, to areas near the mixing zone of the Western Lake Superior Sanitary District waste treatment plant. This study compared fish trapped near the treatment plant outfall with those from upper river sites and other parts of the estuary. Fish tasting participants judged the upper river fish to be of better flavor than those from St. Louis Bay. To determine the present day status of fish tainting problems in the St. Louis River, a study of a similar nature should be undertaken.

Bird and Animal Deformities or Reproductive Problems

Is the Beneficial Use Impaired? -Impairment not Clear

With the exception of colonial nesting birds, there is little population data available to characterize wildlife in the Area of Concern. The common tern, whose populations have been extensively monitoring in the harbor, have experienced less than desirable reproductive success. At this time, however, there is no evidence to tie the population decline to toxic contaminants or a degraded food supply. Additional study of wildlife populations, with a particular emphasis on eagles and terns, is needed along with information on toxic substance residues in species with aquatic based diets.

Restrictions on Wildlife Consumption

IJC Listing Criteria: When contaminant levels in fish or wildlife populations exceed current standards, objectives, guidelines, or public health advisories are in effect for human consumption of fish or wildlife. Contaminant levels in fish and wildlife must be due to contaminant input from the watershed.

Is the Beneficial Use Impaired? -Not Impaired Currently

No wildlife consumption advisories are in effect or under consideration for any portion of the St. Louis River AOC. There exists concern, nonetheless, that wildlife are exposed to and may be bioaccumulating the same range of contaminants found in area sediments and fish.

Restrictions on Drinking Water Consumption or Taste and Odor Problems

IJC Listing Criteria: When treated water supplies are impacted to the extent that: 1) densities of disease-causing organisms or concentrations of hazardous or toxic chemicals or radioactive substances exceed human health standards, objectives or guidelines; 2) taste and odor problems are present; or 3) treatment needed to make raw water suitable for drinking is beyond comparable portions of the Great Lakes which are not degraded (i.e. settling, coagulation, disinfection).

Is the Beneficial Use Impaired? -Not Impaired Currently

There are no restrictions on drinking water consumption or reports of taste and odor problems attributable to drinking water supplies in the St. Louis River AOC. At least two conditions help explain this situation: 1) area communities do not rely on the lower St. Louis River as a water supply source; and 2) neither Wisconsin or Minnesota classify the St. Louis River as a water supply source for human consumption. Nonetheless, there are several notable historical events which demonstrate the precarious nature of surface water drinking supplies in general. One of these events, which was an outbreak of typhoid fever in 1895, prompted officials in Duluth, Minnesota to move their water intake away from the harbor to its present location further up the north shore of Lake Superior. The 1970s discovery of asbestos fibers in the drinking water supply of Duluth was another event which required officials to provide emergency water supplies and resulted in the construction of the City of Duluth's Lakewood Pumping Station. A number of people continue to express concern about the potential for water supply contamination by spills, sewage bypasses, and chemical discharges.

Eutrophication and Undesirable Algae

IJC Listing Criteria: When there are persistent water quality problems (e.g., dissolved oxygen depletion of bottom waters, nuisance algal blooms or accumulation, decreased water clarity, etc.) attributed to cultural eutrophication.

Is the Beneficial Use Impaired? -Not Impaired Currently

The St. Louis estuary was characterized as eutrophic prior to the improvements in wastewater treatment in the late 1970's. Since that time, many indicators of trophic status have shown improvements. The loading of phosphorus to the estuary from point sources was reduced substantially. Despite the reductions in point source loadings, phosphorus concentrations in the estuary remain at levels where eutrophic conditions might be expected. However, algal biomass in the estuary has been similar to levels found in mesotrophic or oligotrophic waters. Reduced light penetration due to turbidity and color may be a limiting factor for algal growth in the estuary. The high sedimentation rate as well as the high phosphorus concentrations measured in the estuary point to the need for further work to ascertain the effects of non-point source loadings to the system and to Lake Superior.

Added Costs to Agriculture and Industry

IJC Listing Criteria: Where there are additional costs required to treat the water prior to use for agricultural purposes (i.e. intended for commercial or industrial applications and non-contact food processing).

Is the Beneficial Use Impaired? -Not Impaired Currently

At the present time, there are no adverse impacts or special costs incurred by industrial users of surface water in the St. Louis River Area of Concern. At least two arguments help explain this situation: 1) the only major industrial use of the river water is for non-contact cooling waters; and 2) Lake Superior provides an alternative water supply which is both inexpensive and of outstanding quality. The effects of exotics species such as the zebra mussel and sewage bypasses or spills are several issues of potential concern.

Degradation of Phytoplankton and Zooplankton Populations

IJC Listing Criteria: When phytoplankton or zooplankton community structure significantly diverges from unimpacted control sites of comparable physical and chemical characteristics. In addition, this use will be considered impaired when relevant, field validated, phytoplankton or zooplankton bioassays (e.g. Ceriodaphnia; algal fractional bioassays) with appropriate quality assurance/quality controls confirm toxicity in ambient waters.

Is the Beneficial Use Impaired? -Not Impaired Currently

*The information available on phytoplankton and zooplankton communities does not suggest that they are currently degraded. Exotic species, particularly the zebra mussel (*Dreissena polymorpha*) and the spiny water flea (*Bythotrephes cederstroemi*), threaten plankton populations. This situation, in turn, affects the fish populations that make use of zooplankton as a food source during their juvenile life stages.*

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