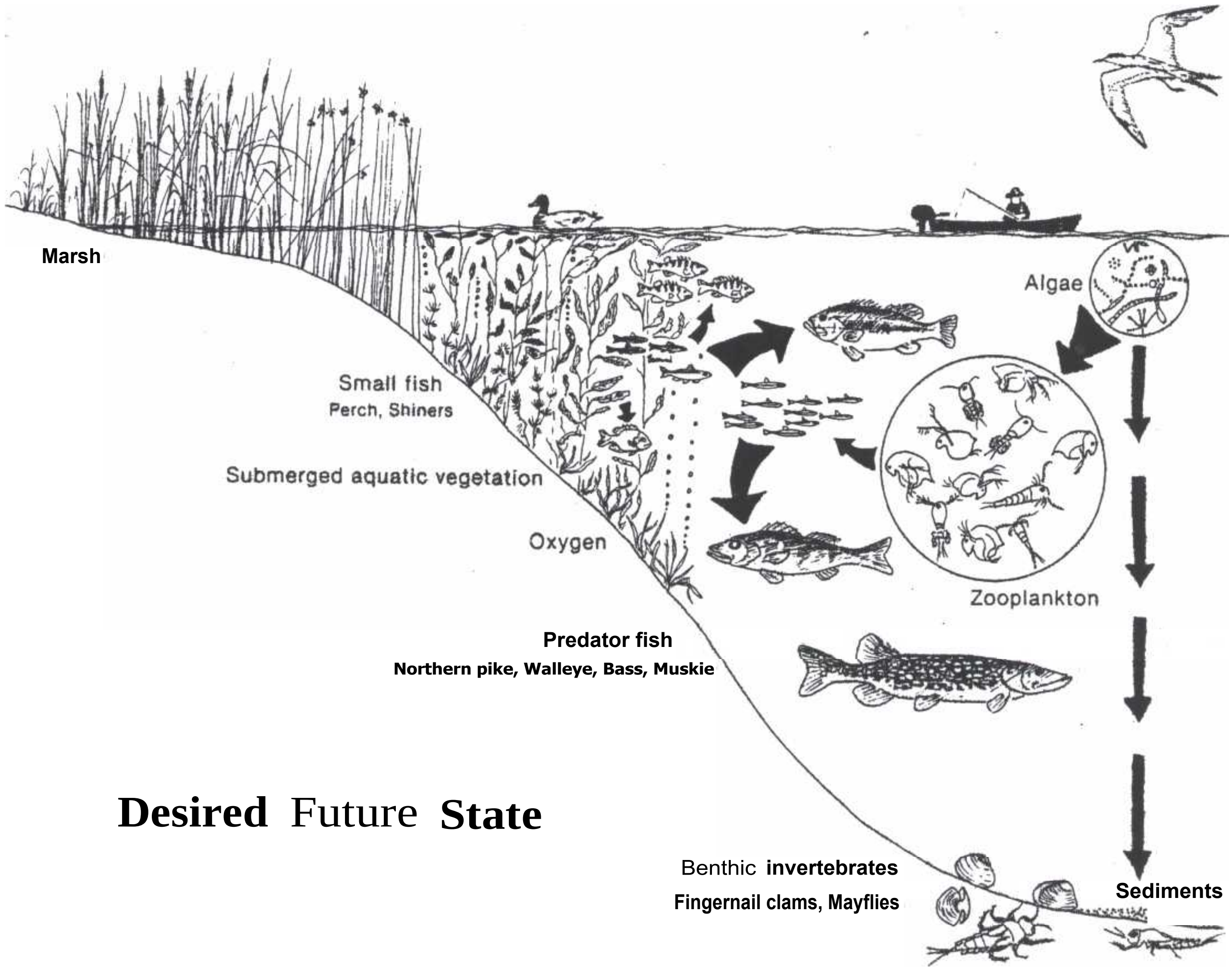
LOWER GREEN BAY REMEDIAL ACTION PLAN 1993 UPDATE

September 1993



LOWER GREEN BAY REMEDIAL ACTION

PLAN

1993 UPDATE

for the Lower Green Bay and Fox River

Area of Concern

Published by

Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, Wisconsin 53707

SEPTEMBER 1993

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LOWER GREEN BAY REMEDIAL ACTION PLAN UPDATE

for the Lower Green Bay and Fox River

Area of Concern

Developed by the Wisconsin Department
of Natural Resources in conjunction with
the Green Bay Remedial Action Plan
Public Advisory Committee

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Advisory Committees and WDNR program staff

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Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, Wisconsin 53707

September 1993

Lower Green Bay and Fox River
REMEDIAL ACTION PLAN

September 1993

To the Citizens of Northeastern Wisconsin and Other Interested Parties:

The Public Advisory Committee for the Lower Green Bay Remedial Action Plan is pleased to present you with this 1993 Update of the Lower Green Bay Remedial Action Plan (RAP). The RAP was adopted in February, 1988 and is a long-range strategy for restoring water quality and a full array of beneficial uses such as swimming and fishing to the lower Bay and Fox River ecosystem. Many water resource uses continue to be restricted or impaired primarily due to problems with excess algae; suspended solids and sedimentation; and toxics substances like PCBs, mercury and ammonia.

This report is intended to enhance, not replace the 1988 Remedial Action Plan. Advancements since 1988 in our knowledge about the problems and pollutant sources impacting lower Green Bay and the Fox River make this Plan Update necessary. The report summarizes current environmental conditions and updates the status of resource use impairments as documented by recent studies. Plan goals and objectives are expanded to reflect this new knowledge. Remedial actions taken or initiated since 1988 are listed, along with an estimation of their environmental results. Finally, the Plan Update identifies the priority issues which must be addressed over the long term to restore the ecosystem and lays out a timetable for actions to be taken during the next two years.

It is anticipated that this report will be used mainly by resource managers, planners and administrators of designated management agencies. Although the report is necessarily technical in nature, a general summary is provided for the layman reader.

The Plan Update was prepared by the Wisconsin Department of Natural Resources, Water Resources Management staff with information and assistance from the RAP Science and Technical Advisory Committee. Many organizations and recognized experts contributed substantively to this report. Previous drafts were reviewed and revised by the RAP Science and Technical Advisory Committee, the Public Advisory Committee, the Public Education and Participation Advisory Committee and Department staff.

The Public Advisory Committee approves of this Plan Update and hereby forwards it to the citizens of Wisconsin, appropriate governments, resource agencies and other interest groups for their consideration and input. Public participation and support have been mainstays of the Remedial Action Plan and will be essential for its full implementation.

The Public Advisory Committee believes this report will serve as a historical record of the state of the lower Green Ba and Fox River ecosystem and will further the efforts to improve and maintain these important w resources.

Sincerely,

Thomas D. Cuene

Thomas D. Cuene
Chairman, Public Advisory Committee

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EXECUTIVE S ARY

Purpose of the 1993 Plan Update

This report updates the **1988 Lower Green Bay Remedial Action Plan --** a long-range strategy for improving water quality and restoring the beneficial uses of Lower Green Bay and the Fox River by the year 2000. In the southern Bay and Fox River, persistent water quality problems impair the health of the ecosystem and restrict public uses such as swimming and fishing. A Great Lakes Water Quality Agreement between the United States and Canada recommends that the states and provinces prepare Remedial Action Plans (RAPs) that define corrective measures needed to restore the beneficial uses of 43 degraded "areas of concern" (AOC) on the Great Lakes. The 1988 Lower Green Bay Remedial Action Plan was the first RAP prepared in the Great Lakes basin; it was accepted by the International Joint Commission (IJC), the binational organization that oversees implementation of the Great Lakes Water Quality Agreement.

Since 1988, nearly three quarters of the RAP's 120 recommended actions have been initiated. Despite incremental improvements to prevent water pollution, restore habitats, improve public access, and further define the causes of impaired uses, none of the problems in the AOC have been completely solved. Recommendations are implemented sequentially -- the easiest have been started, the more difficult have yet to be implemented. Full implementation will carry us well beyond the year 2000.

Since 1988, the IJC has developed criteria for defining "impaired uses" and new guidelines for preparing RAPs in three stages: Stage I - Problem Identification; Stage II - Remedial Action; Stage III - Documentation of Restored Uses. A 1990 Great Lakes Critical Programs Act requires that RAPs be submitted by 1993. As actions are taken and new information becomes available, it will be necessary to review and revise the Lower Green Bay RAP. The RAP is intended to be a "living" document, responsive to the changing natural, social, and institutional environment.

This report updates, but does <u>not</u> replace, the 1988 RAP and its technical reports. The 1993 RAP fulfills the reporting requirements of the 1990 Critical Programs Act. Reports may be amendments, site-specific project reports, and/or updates which follow Wisconsin River Basin planning schedules. It is the first in a series of updates during remedial action implementation. This report updates the status and the geographic extent of environmental problems and impaired uses. It emphasizes that water quality in the AOC is the result of land uses and human activities in the large, 6640 square mile watershed, and that actions to restore the AOC also will benefit water-related resources throughout the Fox-Wolf River basins, including Lake Winnebago. The RAP goals and objectives are updated to reflect new understanding of the ecosystem. Actions taken to date, or in progress, and their environmental results are summarized. Environmental risk assessment is used to identify priority problems. Finally, the RAP Update outlines actions to be taken during 1993-1994 to continue implementation and further improve environmental conditions in the AOC.

The RAP is a community plan, prepared by the Wisconsin Department of Natural Resources in partnership with local governments, other agencies, businesses, and many interest groups -- agricultural, academic, environmental, conservation and recreational -- in the Fox-Wolf River Basin. The plan describes a shared vision of the future, or the Desired Future State. This vision includes a healthy River and Bay environment, providing water quality and habitat for balanced and productive wildlife and plant communities; sustainable and edible sport and commercial fisheries; water-based recreation opportunities; water quality that protects human health and wildlife from the effects of contaminants; balanced shoreline land uses; an economical water- and land-based transportation network that minimizes adverse environmental effects; and water discharge and runoff quality that sustain the Desired Future State.

<u>**Use Impairments and Their Causes**</u>

The AOC consists of the last seven miles of the Fox River below the De Pere dam and a 21 square mile area of southern Green Bay out to Point au Sable and Long Tail Point. The drainage area encompasses portions of eighteen counties in Wisconsin and 40 watersheds of the Upper Fox River, Wolf River, and Fox River basins including the largest inland lake in Wisconsin, Lake Winnebago, and its pool lakes. While water quality problems and public use restrictions are most severe in the AOC, water resources of the entire basin are affected by runoff pollution from urban and rural areas, municipal and industrial wastewater discharges, and degraded habitats.

The IJC has developed definitions for fourteen "use impairments" that, if documented, result in designation as a Great Lakes Area of Concern. Eleven use impairments are documented in the Lower Green Bay and Fox River AOC; two uses are suspected of being impaired; one use is judged to be unimpaired.

USE IMPAIRMENTS IN THE AREA OF CONCERN	**PRESENT**	**ABSENT**	**SUSPECTED**
Restrictions on Fish and Wildlife Consumption	X		
Tainting of Fish and Wildlife Flavor			X
Degraded Fish and Wildlife Populations	X		
Fish Tumors or Other Deformities			X
Bird or Animal Deformities or Reproductive Problems	X		
Degradation of Benthos	X		
Restrictions on Dredging Activities	X		
Eutrophication or Undesirable Algae	X		
Restrictions on Drinking Water Consumption or Taste and Odor Problems	X		
Beach Closings	X		
Degradation of Aesthetics	X		
Added Costs to Agriculture or Industry		X	
Degradation of Phytoplankton and Zooplankton Populations	X		
Loss of Fish and Wildlife Habitat	X		

Most of the use impairments are caused by excess phosphorus, suspended solids, toxic substances, and wetland losses.

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Phosphorus Enrichment and Eutrophication

Phosphorus is a plant nutrient which when present, even in small amounts, will stimulate algae production. Large amounts of phosphorus from land runoff and wastewater discharges in the basin cause an undesirable condition known as "eutrophication;" causing wide-spread negative impacts on the aquatic ecosystem and impairing many beneficial uses. Abundant algae growth creates a floating scum that interferes with public recreation. Algae growth blocks sunlight from penetrating through the water to support the growth of rooted aquatic plants that are valuable habitat for fish and food for most waterfowl. One of the most pronounced changes in the Lower Bay ecosystem is the virtual elimination of the submerged aquatic vegetation that once carpeted the shallows of the AOC.

As algae settle and decay, the bottom waters and sediments of the Bay can develop low dissolved oxygen and high ammonia concentrations; this can be fatal to more sensitive aquatic organisms like burrowing mayflies and fingernail clams. Before the 1950s, these invertebrates were abundant throughout the River and Bay; they provided valuable food for fish and waterfowl. As water quality has improved, there have been rare observations of burrowing mayflies (Hexagenia) and fingernail clams in the AOC. Occasional fish kills also are observed in commercial fishing nets during periods of low dissolved oxygen.

The AOC generally **meets** state bacteria standards for safe swimming, except after periods of wind that resuspend bacteria from bottom sediments or runoff that carries animal waste. The primary reason for unsafe conditions that restrict public swimming in the area is the poor water clarity, caused by a combination of algae and other suspended particles.

The problems and use impairments related to eutrophication and suspended solids are not restricted to the AOC; they are found throughout the Winnebago Pool lakes, the entire Fox River, and roughly the southern half of Green Bay.

Suspended Solids

Suspended solids in the water are a combination of algae, soil and other particles washed in from the watersheds or resuspended from the bottom sediments. Suspended solids result in poor water clarity for both submerged plant growth and sight-feeding fish. Poor water quality favors bottom-feeding rough fish like carp and bullheads over predatory sport fish like walleye and northern **pike.** Eventually suspended solids settle out, covering spawning beds, smothering fish eggs, degrading bottom habitat, and filling navigation channels.

Prior to 1985, an average of 458,000 cubic meters of sediment was dredged annually from the harbor and navigation channel. Because of the difficulty in siting dredge spoil disposal facilities, annual dredging has been limited to an average of 111,000 cubic meters at a cost of more than **$2** million per year. A backlog of navigational dredging has resulted. Concerns about the disposal of dredged material include loss of habitat, the effects of in-lake disposal facilities on water circulation and dissolved oxygen levels, and the potential release of toxic substances from contaminated sediments.

Toxic Substances

More than 100 potentially toxic substances have been identified in the water, fish, and sediments of the Fox River. Those substances known to exceed toxic water quality standards at times and to impair beneficial uses, include polychlorinated biphenyls (PCBs), mercury, and ammonia. Other chlorinated organic compounds, polycyclic aromatic hydrocarbons, heavy metals, and pesticides **are** known to be present, but their impacts have not been adequately assessed. These substances are not known to **be** present in sufficient quantities to be acutely or chronically toxic to aquatic life, but the subtle, long-term health effects from exposure to some toxic substances is poorly understood. Additionally, some compounds break down very slowly in the environment and may increase in concentration as they are passed up the food chain. In particular, PCBs are readily taken up by algae and other aquatic organisms and passed through the food chain, increasing in concentration by roughly 10,000 times--from 120 ppt in the water to 3-5 ppm in walleye.

Eleven species of fish as well as mallard ducks from the AOC are listed in a consumption advisory that warns people of the risks to human health from fish and ducks containing more than 2 ppm PCBs in the meat. Larger walleye occasionally exceed the 0.5 ppm mercury standard as well. Concentrations of PCBs in Fox River fish are declining slowly, and walleye smaller than 15 inches were removed from the consumption advisory in 1990 because of evidence that they do not exceed PCB or mercury health standards.

Studies of bottom-feeding fish and walleye from the AOC do not indicate an abnormal incidence of cancerous tumors, but further studies are warranted to examine fully the potential for fish tumors or other deformities. PCB-like compounds are suspected of causing most of the known reproductive problems in the fish-eating Forster's tern. Reproductive rates of Forster's terns in 1988 showed improvements over 1983 rates. It is believed that low river flows during 1988, a drought year, may have reduced PCB delivery from Fox River sediments to the AOC. However, it is too early to attribute increased reproductive success to lower toxicant levels.

Habitat Loss and Fish and Wildlife Populations

More than 90% of the coastal wetlands in the AOC have been lost to land filling, development, and high lake levels. Some losses are permanent and represent irreversible damage to the ecosystem. Other wetlands may become reestablished as water levels fluctuate naturally. According to 1989 state wetland maps there are roughly 5,000 acres of wetland remaining in the AOC . A majority of the beach, mud flat, and shallow water habitat has been degraded or lost because of shoreline filling for development and erosion control, and poor water clarity. Poor water clarity reduces the diversity of wetland plants and habitat types, resulting in lower numbers and diversity of aquatic insects and marsh nesting birds.

The fishery has improved in diversity and numbers since the 1970s when only a handful of the most pollution-tolerant species were found in the AOC. Water quality improvements, fish stocking, harvest management, and habitat creation have resulted in stable populations of 33 fish species, including a nationally renowned walleye fishery. Still, there are fewer species and numbers of top predator fish than desired, and a predominance of a few species of forage fish and rough fish.

Several kinds of terns are listed as Wisconsin endangered species because of their low numbers. Waterfowl use during spring and fall migration has declined from historic levels; this is attributed partly to a lack of preferred waterfowl foods like wild celery, fingernail clams, and snails. In addition, bald eagles, osprey, mink and otter within the Green Bay ecosystem may be adversely affected by toxic chemicals.

Exotic Species

A number of non-native (exotic) plants and animals have been introduced that may threaten native communities or result in negative impacts on the ecosystem. The carp, an exotic but long time resident of the AOC, has often been blamed for uprooting aquatic vegetation and causing water turbidity. However, poor water clarity is caused primarily by algae and suspended solids from land runoff or wind-related turbulence in the Bay. Unless these underlying reasons for poor water clarity are remedied, efforts to remove or control carp would have little or no effect.

The zebra mussel was first detected in Green Bay in 1991; it is expected to expand greatly in number over the next few years. The marble-size, barnacle-like mollusk colonizes almost any hard underwater structure including water intake pipes, boat hulls, harbor pilings, navigation buoys and commercial fishing gear. The economic impacts to area industries, power plants, and water utilities are mounting as devices and treatment systems are installed to keep zebra mussels out of intake pipes. The ecological effects of zebra mussels are largely unknown; however, their extraordinary ability to filter water for food particles could increase water clarity as has happened in western Lake Erie.

Ironically, as water quality has improved in the AOC, the parasitic sea lamprey has become a threat to the fishery of the Fox River. Sea lamprey require good quality streams to reproduce. If the sea lamprey became established in the Fox-Wolf River basin, they would be devastating to the upstream fisheries. A barrier to sea lamprey migration was constructed in 1988-89 at the Rapide Croche lock and dam on the Fox River, permanently closing the lock to navigation. Sea lamprey were first detected in the Fox River below the De Pere dam the following year, 1990.

Pollutant Sources and Loads

Within the large drainage area, there are many potential pollution sources that may contribute to the degraded conditions found in the AOC. Pollutant sources are divided into two categories -- point and nonpoint sources. Point sources are direct discharges or emissions to the environment from a point location such as a municipal or industrial wastewater discharge pipe. There are approximately 120 industrial and 66 municipal treatment facilities that have state permits to discharge wastewater to surface waters of the basin. Nonpoint or diffuse sources of pollution include runoff from eroding construction sites, croplands, barnyards, highways, parking lots, coal stockpiles, and other land uses, or they may be pollutant releases from contaminated soils or sediments. Contrary to popular belief, nonpoint sources contribute a much larger share of pollutants to the AOC than do point sources, although nonpoint sources are just beginning to be regulated and monitored.

An estimated 700,000 kg (1,540,000 lbs.) of phosphorus was delivered to the Fox River in 1990. Of that amount, municipal discharges from sewage treatment plants accounted for 95,000 kg (13%), net industrial discharges were 48,000 kg (7%), and nonpoint sources or watershed runoff contributed a minimum of 557,000 kg (80%). Municipal loads have been reduced by about 84% since the 1970s, when phosphorus limitations were imposed upon facilities discharging more than one million gallons of wastewater per day. Roughly one-half of the total phosphorus load to the Fox River comes from land runoff and discharges to Lake Winnebago and the Upper Fox and Wolf Rivers; together, these make up about 90% of the drainage area. The other half of the phosphorus load comes from the point discharges and tributaries to the Fox River basin which comprises about 10% of the drainage area. Therefore, the RAP objective of reducing phosphorus loading to the AOC by 50% cannot be achieved without addressing both point and nonpoint sources in the entire drainage basin.

Discharge monitoring reports for municipalities and industries in the entire basin showed approximately 143,000 kg (315,000 Ibs) of phosphorus, 4.3 million kg (9.5 million Ibs) of suspended solids, 4 million kg (8.8 million Ibs) of oxygen-demanding waste (BOD), and more than 90,000 kg (2 million Ibs) of ammonia in 1990. During 1981-83, the total suspended solids load to the AOC averaged 90 million kg (200 million Ibs). The vast majority of suspended solids in the system are related to nonpoint sources. Nonpoint source load estimates for other pollutants are not available for the entire basin.

Not all of the pollutants entering the Fox River are delivered to the AOC. Some pollutants are biodegraded. Some settle out along the way and are added to the sediments building up behind the dams or in backwater areas. Many toxic substances that have entered the Fox River over past decades have become trapped in sediment deposits. Fox River sediment deposits serve as a continuing pollutant source to downstream areas of the River, Green Bay and Lake Michigan.

The Green Bay Mass Balance Study, an $11 million research effort by the United States Environmental Protection Agency and a consortium of federal, state, and academic institutions estimated the sources, movement, and fate of PCBs in the Fox River and Green Bay system. There are an estimated 7-9 million cubic meters (m) of sediment containing more than 0.05 ppm PCB in the Fox River, with about 2 million m^3 upstream of the De Pere dam and 5-7 million m^3 in the River below the dam. PCB transport modeling indicates that approximately 90% of the PCB in the river water is due to sediment resuspension/settling. About 175 kg were resuspended and transported over the De Pere dam to the AOC in 1989-90. Another 95-100 kg was picked up from the River below the dam, amounting to a total of about 270 kg of PCB delivered to the Lower Bay from May 1989 to May

1990. Research results must be applied to management questions in order to reduce the impact of PCB contamination in the River and the Bay.

Atmospheric contributions to the entire Bay were estimated to be 2-16 kg per year. However, the Bay may be acting as a net source of PCB to the atmosphere rather than as a sink as PCBs volatilize from the water. Several landfills known to contain PCBs were found to be a negligible source to the adjacent River and Bay waters, presumably because of the low mobility of PCBs in groundwater. Discharges to the Fox River from municipalities and industries represented less that one percent of the total PCB load to the AOC.

Direct discharges of potentially toxic substances to the AOC are reported in a 1988 RAP technical report and in the Lake Michigan Lakewide Management Plan. Some estimates from ongoing Priority Watershed projects show that urban runoff may be a significant source of heavy metals like lead, zinc, and copper. Nonpoint sources of toxic substances to the system may include urban stormwater, uncovered coal and chemical stockpiles, deposition from atmospheric emissions, chemical spills, leaking landfills, or leaking underground storage tanks. From 1987 to 1991, there were 437 reported spills and 582 active cases of leaking petroleum product storage tanks in the Fox River basin.

Actions Taken Since the 1988 RAP and Their Environmental Results

The RAP has had a sustained implementation program since the 1988 Plan was adopted. RAP implementation committees -- currently a Public Advisory Committee, Science and Technical Advisory Committee, and Public Education and Participation Advisory Committee -- were established by the WDNR to represent stakeholder interests, promote RAP implementation, and provide ongoing guidance for the implementation program.

Since 1988, 38 of the 120 recommended remedial actions have been implemented. Another 57 have been initiated but need more effort, and 25 actions have had little or no progress. Many of the actions completed have been short-term, lower cost projects that demonstrate an immediate environmental result or institutional commitment to the RAP. Examples include nonpoint source management demonstration projects, voluntary reductions in phosphorus discharges by several large sewage treatment plants, and improvements in public access. Other actions set the stage for long-term, sustained programs needed to address the extensive problems of nonpoint source pollution and contaminated sediments. For example, several large-scale Priority Watershed projects have been initiated to provide nonpoint source management plans and an estimated $30 million in cost-sharing funds to local communities and landowners over the next 5 to 10 years.

Some local governments have adopted ordinances to require construction site erosion controls or to manage urban stormwater. New state and federal laws will expand these types of regulations to more communities in the basin, but the problems of urban and rural nonpoint source pollution are massive and will require further actions to achieve RAP objectives.

Statewide water and air toxic discharge rules are being implemented to reduce the loading of toxic substances and to prevent acute or chronic toxicity resulting from discharges. A new state rule will extend the present 1.0 ppm discharge limit for phosphorus to many industrial and smaller municipal dischargers in the state; this should result in an estimated 12% reduction of the point source load to the AOC. Four large municipal treatment plants are completing facility improvements to meet more stringent ammonia and chlorine limits, eliminate sewage bypassing, and improve sludge management. Two smaller municipal plants will be connecting to the Green Bay Metropolitan Sewerage District to eliminate problems with failing facilities. The total costs of these improvements will exceed $190 million.

Progress was made toward shifting the fishery biomass toward predator and sport species. Spotted muskellunge were reintroduced to the Lower Bay through annual stocking, beginning in 1989. Growth rates of the muskellunge appear to be very good, and natural reproduction may be expected by 1996. The 1991 year class of walleye in the AOC was very strong and should translate into higher numbers of adults in several years. Some increase in the population may be attributed to the creation of several rock spawning beds on the east shore of the Fox River. The population of walleye in the AOC is self-sustaining and has achieved the RAP goal of about 70,000 adults.

While progress has been made toward restoring uses of the AOC, and while industrial and municipal point source pollutant discharges have been reduced, no delisting criteria have been fully met. Loads of toxic contaminants from point sources appear to be largely controlled, but nonpoint sources, including contaminated sediments, are not reduced significantly from 1985 and are substantial, continuing pollutant sources to the AOC.

Implementation Priorities

Environmental Risk Assessment

An environmental risk assessment was conducted in 1991-92 to determine which environmental problems, or stressors, posed the greatest potential to harm human health, the ecosystem, the economic system, and/or the quality of life in the AOC. Stressors impacting the River and Bay ecosystem were ranked based on: 1) the degree to which a stressor contributes to use impairment; 2) the duration of the impacts; and 3) the capability to manage the stressor through pollution prevention or remediation activities. Those stressors judged to pose the greatest risk to the Lower Bay ecosystem were, in descending order: wetland/shoreland filling; exotic species invasions; persistent bioaccumulative organic substances (PCBs); heavy metals (mercury and lead); phosphorus loading; suspended solids loading; BOD loading; and nonpersistent toxic substances (ammonia).

The risk assessment showed that although nutrient and suspended solids loading have extensive and dramatic impacts on more beneficial uses than do other stressors, the duration of their impacts would be relatively short if the stressors were controlled and were relatively easy to prevent through cost-effective management practices. Conversely, persistent toxic substances have relatively fewer pronounced impacts on beneficial uses, but their risk is heightened by long-term persistence in the environment and the great difficulty in remediating the chemicals already present. Exotic species invasions and wetland/shoreland filling were judged to pose the greatest overall risk, because they cause permanent and widespread changes to the ecosystem and are virtually impossible to remediate. Although the relative ranking of stressors may change as understanding of the ecosystem evolves, the ability to identify and compare environmental risks will help to set priorities and target resources toward the most effective risk reduction strategies for the AOC.

Goals and Objectives

The RAP Update reconfirms the goals of the 1988 Plan with added emphasis on increasing biodiversity. An eighth goal has been added to ensure the sustainability of a restored and healthy environment through pollution prevention and the development of sustainable economies, resources, and facilities which support beneficial uses into the future. RAP objectives for water quality, habitat, and fish and wildlife populations were updated to reflect improved understanding of the ecosystem. Water quality objectives for toxic substances were added to reflect the present state standards. However, the plan also recognizes that a federal Great Lakes Water Quality Initiative will soon be proposed which, if adopted, will result in revised state criteria and standards for toxic substances.

The objectives represent measurable conditions which are indicators of ecosystem health and beneficial uses in the AOC. They were carefully integrated to ensure that each objective would support the plan's goals as well as the other objectives. For example, trophic state models for the AOC were used to define the inter-related phosphorus, chlorophyll, suspended solids, and water clarity objectives.

Priority Issues and the RAP Implementation Agenda for 1993-94

Recent research, the environmental risk assessment, and deliberations of the Science and Technical Advisory Committee were used to identify the priority issues for RAP implementation. They are: reduction of phosphorus and suspended solids loading to the Fox-Wolf basin and the AOC; development of a strategy for remediating contaminated sediments in the Fox River; protection and restoration of habitats; and community outreach to increase public awareness and support for remedial actions.

Management of phosphorus and suspended solids must take a basin-wide approach and must address both point and nonpoint sources from all three basins. Better information and decision models are needed to identify nonpoint source management priorities. A modeling and monitoring strategy is being developed to provide this information. Water quality standards for phosphorus are being developed by the WDNR which will provide additional authority to control both point and nonpoint sources. The RAP Public Advisory Committee will seek commitments from local governments in the basin to adopt a resolution and to implement actions that achieve a 50% reduction in both phosphorus and suspended solids loading. Additionally, a coalition of Great Lakes County Land Conservation Departments was recently formed, and the Public Advisory Committee will work with this group to identify and rank watersheds and nonpoint sources for pollution abatement projects.

Sediment resuspension and the PCB load transported to the AOC are primarily affected by river flows. During high flows, there is potential for massive scouring and movement of sediment and associated PCBs from the River to the Bay. In addition, surface sediment layers, which may have lower PCB concentrations may be scoured away, exposing sediments with higher concentrations of PCB. Transport into the Bay remains a concern because of the continued impact on fish and wildlife and the potential release of PCBs to the atmosphere through volatilization. Once PCBs reach the Bay, they are distributed over a large area and are virtually impossible to clean up. Strategies must be explored to determine the potential to remediate contaminated River sediments before they are dispersed to the Bay.

A RAP Science and Technical Advisory Committee Work Group is working with a Fox River Coalition of industries and local governments to develop a priority list of sediment deposits for future clean up. Together, the groups are recommending guidelines for clean up levels, criteria for site selection, and potential funding mechanisms. To build capabilities for sediment remediation, a demonstration project is being planned for Little Lake Butte des Mort at the head of the Fox River. A remedial investigation and feasibility study is being conducted to select the appropriate clean up technique. Hopefully, implementation will begin in late 1993.

Coastal wetlands located behind bulkhead lines may be threatened by future development. Bulkhead lines are legal boundaries, established by local ordinances and approved by the State, that provide shore owners the right to place fill or structures in the nearshore area out to the bulkhead line. Although federal wetland regulations still apply to these wetlands, state authorities are limited by the bulkhead line. Where fish and wildlife habitat exists behind bulkhead lines, the WDNR and RAP committees are seeking cooperation from local communities to rescind bulkhead lines.

A wetland enhancement project is being constructed on the west shore at Sensiba Wildlife Area, and another is being considered for Peter's Marsh. A colonial nesting waterbird management plan will be completed to outline population and habitat management needs.

Although the presence of exotic species in the AOC is considered a high priority risk to the environment, there is little that can be done to remediate the potential damages. Exotics like carp, ruffe, white perch, sea lamprey, zebra mussels, and purple loosestrife are now permanent components of the ecosystem and will have to be lived with. The focus must be placed on preventing new invasions or introductions of exotics through ballast water regulations on Great Lakes shipping or through other controls. Exotics will be monitored to track their population levels and, in particular, to assess the effectiveness of the sea lamprey barrier at Rapide Croche dam.

A number of ongoing public information and participation programs will be continued to keep citizens informed and involved in RAP implementation. The Adopt-a-Waterway monitoring project is being expanded to include more Green Bay area schools and students. An interactive, room-sized, water quality exhibit is being constructed at the new Green Bay boat launch to inform citizens about actions they can take to improve the AOC. A River/Bay Clean Up Day draws hundreds of volunteers each year to join in removing trash from the shores and marshes of the Fox River, East River, and Lower Bay. Pollution prevention by industries is being promoted through technical assistance, a Lake Michigan Federation workshop for pre-treatment industries that discharge to the Green Bay Sewerage District, and annual RAP Clean Bay Backer awards that recognize success stories.

The degree and extent of contamination and resource degradation in the AOC has resulted from nearly 100 years of land use changes and pollutant releases. There are no "quick fixes" to remediate the damages and restore full beneficial uses. Restoration will take decades of sustained commitment to pollution prevention, contaminant clean-up, habitat enhancement, better land use management, and facility redevelopment.

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ABBREVIATIONS FOUND IN THIS PLAN

AOC:	Area of Concern.
ASCS:	Agricultural Stabilization and Conservation Service of the U.S. Department of Agriculture.
BOD:	Biochemical Oxygen Demand.
CDF:	Confined Disposal Facility.
CFS:	Cubic Feet Per Second.
DO:	Dissolved Oxygen.
EPA:	United States Environmental Protection Agency.
FDA:	United States Food and Drug Administration.
GBMSD:	Green Bay Metropolitan Sewerage District.
GIS:	Geographic Information Systems.
GLNPO:	EPA Great Lakes National Program Office.
GLWQI:	Great Lakes Water Quality Initiative.
IJC:	International Joint Commission.
LCD:	Land Conservation District.
LLBM:	Little Lake Butte des Morts, Winnebago Co., WI.
MG/L:	Milligrams Per Liter; equals 1 part per million (ppm).
μG/L:	Microgram Per Liter; equals 1 part per billion (ppb).
MGD:	Million Gallons Per Day; a measurement of water flow.
MT:	Metric Tons.
N:	Number of Samples.
NEWWT:	North East Wisconsin Waters of Tomorrow.
NG/L:	Nanogram Per Liter; equals 1 part per Brillion (ppb).
NO_2:	Nitrogen Dioxide.
NOAA:	National Oceanic and Atmospheric Administration.

O&M:	Operation and Maintenance.
PAC:	Public Advisory Committee.
PAHs:	Polyaromatic Hydrocarbons.
PCBs:	Polychlorinated Biphenyls.
PEP:	Public Education and Participation Committee.
PG:	Picogram; one trillionth of a gram.
POTW:	Publicly Owned Treatment Works.
PPM:	Parts Per Million; mg/L, mg/kg, μg/g; a unit of measure of concentration.
RAP:	Remedial Action Plan.
SARA:	Superfund Amendments Reauthorization Act.
SCS:	Soil Conservation Service of the United States Department of Agriculture.
SO_2:	Sulfur Dioxide.
SOC:	Semivolatile Organic Chemicals.
STAC:	Science and Technical Advisory Committee.
STP:	Sewage Treatment Plant.
SWIS	Special Wetland Inventory Study.
TP:	Total Phosphorus.
TSS:	Total Suspended Solids.
USACOE:	United States Army Corps of Engineers.
USDA:	United States Department of Agriculture.
USFWS:	United State Fish and Wildlife Service, U. S. Department of Interior.
USGS:	United States Geological Survey.
UW-Extension:	University of Wisconsin-Cooperative Extension.
UW-Green Bay:	University of Wisconsin - Green Bay.
UW-Sea Grant:	University of Wisconsin Sea Grant Institute.
VOC:	Volatile Organic Compounds.
WDATCP:	Wisconsin Department of Agriculture, Trade and Consumer Protection.

WDHSS:	Wisconsin Department of Health and Social Services.
WDNR:	Wisconsin Department of Natural Resources.
WDOH:	Wisconsin Division of Health.
WPDES:	Wisconsin Pollutant Discharge Elimination System.
WPSC:	Wisconsin Public Service Corporation.
WWTP:	Wastewater Treatment Plant.

CHAPTER I
INTRODUCTION

REMEDIAL ACTION PLAN BACKGROUND

The Great Lakes Water Quality Agreement, signed by the United States and Canada in 1972 and amended in 1978 and 1987, identifies specific goals and remedial objectives for improving water quality by cleaning up persistently polluted trouble spots -- Areas of Concern (AOCs) -- in ports, harbors, and river mouths tributary to the Great Lakes. Forty-three AOCs have been identified in the Great Lakes Basin by the International Joint Commission (IJC), an organization that advises Canada and the United States and helps the two governments resolve issues of water quality and quantity, pollution problems, and border disputes in the Great Lakes (Figure 1). Annex 2 of the 1987 Water Quality Agreement recommends that states and provinces prepare Remedial Action Plans (RAPs) that define corrective measures to restore all beneficial uses to each AOC. The cumulative effects of local actions also are intended to improve water quality throughout the Great Lakes ecosystem.

The IJC, the United States Environmental Protection Agency (EPA) and the Wisconsin Department of Natural Resources (WDNR), have targeted Lower Green Bay and the Fox River downstream of the De Pere dam as a Great Lakes AOC needing remedial action (Figure 2). While the AOC exhibits severe problems, water quality conditions in the Lower Fox River and Lake Winnebago are also important concerns and, in fact, contribute substantially to the degraded conditions in the AOC and the rest of the Bay.

Under the 1987 amendments to the Water Quality Agreement, RAPs are to be submitted to the IJC in three stages: Stage I - Problem Identification; Stage II - Remedial Actions; and Stage III - Documentation of Restored Uses. Under the Critical Programs Act of 1990, the U.S. Congress specified that RAPs be incorporated into a statewide water quality management plan by January 1993.

FIGURE 1. FORTY-THREE AREAS OF CONCERN IDENTIFIED IN THE GREAT LAKES BASIN

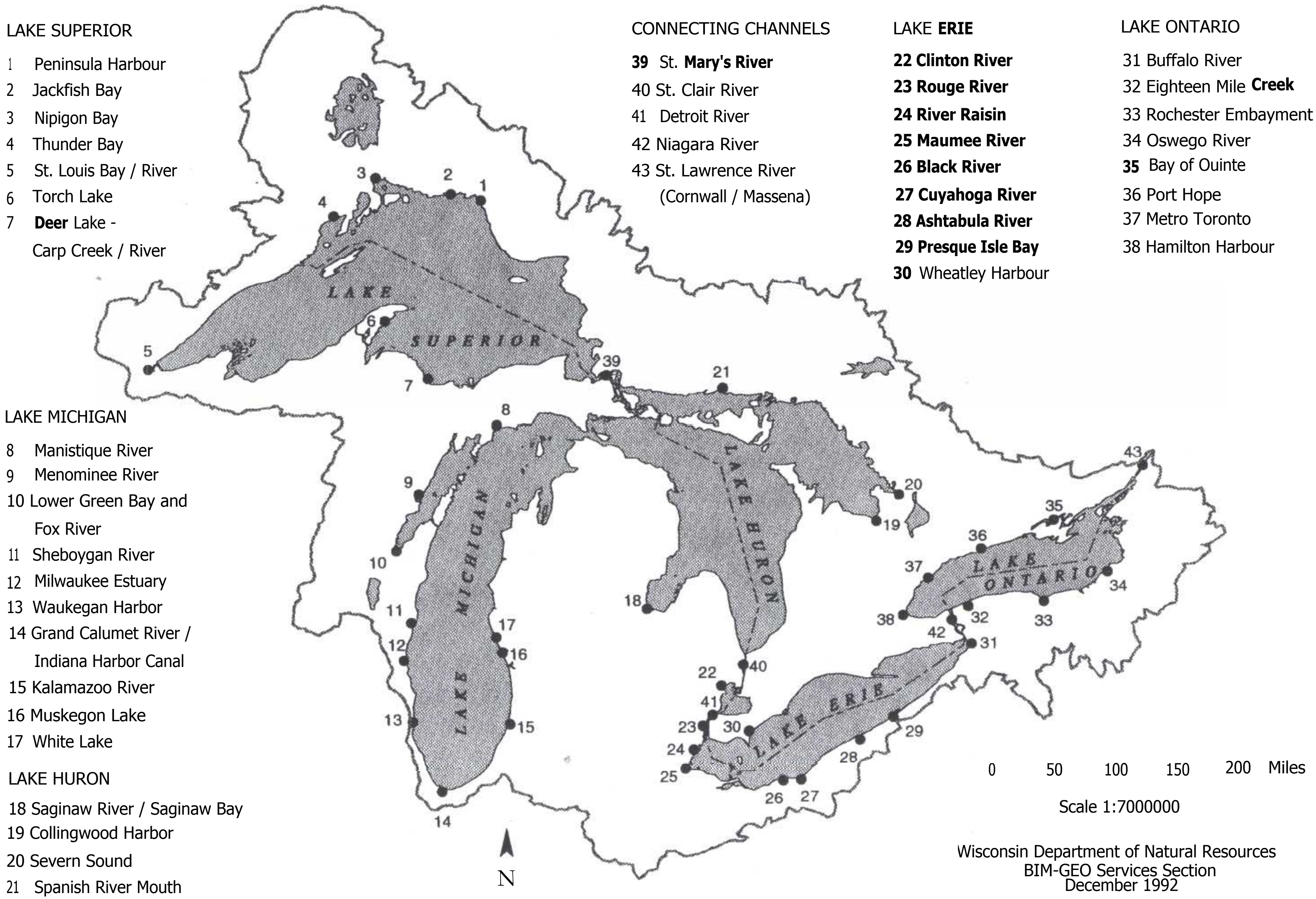
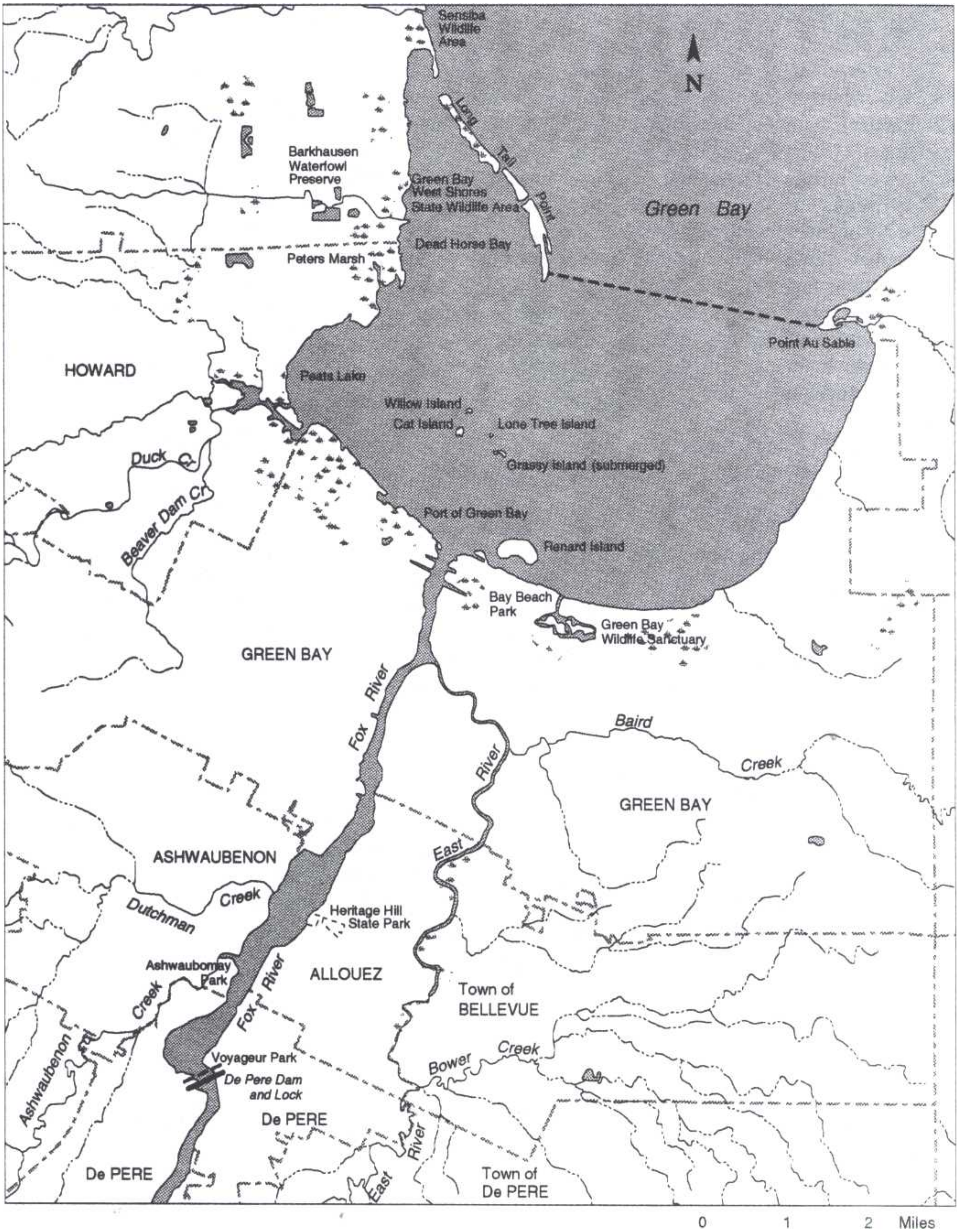


FIGURE 2. LOWER GREEN BAY AND FOX RIVER AREA OF CONCERN



Rivers and Streams

Intermittent Streams

Lakes and Ponds

Corporate Boundary

IJC Boundaries for the AOC

Wetlands

Scale 1:100000

Wisconsin Department of Natural Resources
BIM-GEO Services Section
December 1992

DEVELOPMENT AND STATUS OF THE 1988 RAP

The Lower Green Bay RAP was developed by the WDNR with extensive public involvement and input from other agencies, local governments, scientists, citizens, industries, and environmental groups. More than 75 people participated for two years on four technical advisory committees and a Citizen's Advisory Committee. The committees helped to define water resource problems and develop goals, objectives, and recommendations for the RAP. The plan was completed in late 1987 and adopted as part of Wisconsin's Water Quality Management Plan in February 1988. The Lower Green Bay RAP was the first plan written for an area of concern in the Great Lakes and the first to be reviewed and accepted by the IJC and EPA, prior to the definition of Stage I, II, and III RAPs. RAPs prepared since 1987 include: Stage I - problem identification; Stage II - identification and implementation of remedial and regulatory measures; and Stage III - documentation of restored beneficial uses.

The Lower Green Bay RAP consists of 14 documents (Appendix A, Table 1). The "1988 Lower Green Bay Remedial Action Plan" contains 120 recommendations under 16 Key Actions to restore water quality and the beneficial uses of Lower Green Bay and the Fox River. Since 1988, nearly two thirds of the plan's recommendations have been initiated. (See Chapter III - Part B: Remedial Actions Taken to Date or In Progress and Expected Environmental Results.) Many remedial measures require long-term programs that will take 10 years or more to implement fully. Other plan recommendations include research or monitoring to define further the causes of impaired uses and to track ecosystem change. As actions are taken and new information becomes available, it will be necessary to review and revise the Lower Green Bay RAP.

1993 PLAN PURPOSE

This report updates the 1988 RAP and associated technical reports for Lower Green Bay. The RAP is intended to be a living document, responsive to emerging information and the changing natural, social, and institutional environment. Under new federal guidance and the requirements of the 1990 Critical Programs Act, this update fulfills the 1993 reporting requirement.

PLAN SCOPE

This RAP update reviews changes in the Fox River and Lower Green Bay ecosystem resulting from citizen, industry, and government action over the past five years.

This report:

1. Reevaluates the environmental problems in the area and their geographical extent;

2. Summarizes actions taken to date, or in progress, and their environmental results;

3. Documents continuing problems related to excess nutrients and suspended solids, toxic contamination, and loss of fish and wildlife habitat;

4. Outlines actions to be taken during 1993-1994 to continue RAP implementation.

This update is not meant to replace the 1988 RAP, but focuses on three areas that are closely related and essential to achieving ecosystem improvements: reducing point and nonpoint source contributions of nutrients (primarily phosphorus) and suspended solids; remediating sediments contaminated by polychlorinated biphenyls (PCBs), mercury, and/or ammonia; and protecting and/or rehabilitating remaining coastal wetlands and other fish and wildlife habitats. The RAP also addresses changes with potential ecological significance, such as zebra mussel infestation of Green Bay.

Issue papers, project proposals and implementation schedules will be developed during 1993 to address these specific problems and will form the basis for annual reports to EPA.

1993 RAP PREPARATION AND CITIZEN INPUT

The 1993 RAP update was prepared with the guidance of the Green Bay RAP Public Advisory Committee (PAC), which includes citizens and representatives from state and federal agencies, state legislature, environmental, conservation and recreation organizations, agriculture, industry, and local government, and the Science and Technical Advisory Committee (STAC). The STAC, comprised of resource managers, researchers, and local experts, developed approaches to ecosystem management which the PAC could use in garnering public and political support for implementation. Social and economic scientists contributed to a larger vision of how clean-up could be accomplished. A third group, the Public Education and Participation Advisory Committee (PEP), also supported plan preparation through on-going education efforts throughout the AOC and drainage basin.

Additionally, because social and economic factors are important in the management of the Bay and River, a non-profit corporation called the North East Wisconsin Waters of Tomorrow (NEWWT) was established by local community leaders. Its goal is to bring together an analysis team of economists, engineers, and scientists to determine the most cost-effective actions to meet the goals of the RAP. Results from the analysis team will be available in subsequent RAP updates.

RELATIONSHIP TO OTHER PLANNING AND MANAGEMENT ACTIVITIES

This update builds on many past and ongoing efforts. Among these are the 1988 RAP, the Lake Winnebago Comprehensive Management Plan (LWCMP), Areawide Water Quality Management Plans for the Fox and Wolf River basins, Nonpoint Source Priority Watershed Plans, sewer service area plans, wastewater facility plans, Fox River wasteload allocation updates, and the West Shore Master Plan for wetland acquisition. Other related plans include local comprehensive land use plans and the Lower Fox River/Winnebago Pool Long-Range Plan for historic preservation, tourism and commercial development in the Fox River corridor; and the EPA Special Wetlands Inventory Study (SWIS).

Implementation of many RAP recommendations that affect the Upper Fox and Wolf River Basins is accomplished through the Upper Fox, Fox and Wolf River Basin Areawide Water Quality Management Plans and the LWCMP. Basin Plans make recommendations for municipal and industrial wastewater monitoring, facility planning and upgrading, and effluent limits, and these plans rank watersheds for nonpoint source management needs and priority watershed project selections.

Adopted by the WDNR in September 1989, the LWCMP has been endorsed by the County Boards of Calumet and Winnebago Counties, and by the Township and City of Omro[9]. The plan's goal to include 1000 square miles of watershed in the Nonpoint Source Pollution Abatement Program by the year 2000, will have a direct impact on the potential success of RAP recommendations. There are 15 watersheds identified as high priority in the LWCMP. At least nine more priority watershed projects will be needed to reach this goal. The plan calls for a 30% load reduction annually in total phosphorus from 680,000 kg to 454,000 kg (1.5 million to 1 million pounds) and a summertime ambient water concentration of 90 pg/L. Water clarity objectives are consistent with the RAP for a desired minimum of 1.7 m average summer Secchi disk depth reading. The summer chlorophyll objective is for < 30 pg/L chlorophyll a. In critical open water habitat areas, a suspended solids concentration objective is for no more than 10-12 mg/L. In addition to water quality goals, the plan includes recommendations for restoration of fish and wildlife populations and habitat and management of multiple uses. Development of the LWCMP goals and recommendations was integrated with RAP objectives through liaison between technical committees.

The East River Priority Watershed Plan details rural and urban land management needed to reduce nonpoint source pollution to East River tributaries and ultimately to Green Bay and Lake Michigan8[9]. Two other priority watershed plans for the Lake Winnebago East and Arrowhead/Rat River/Daggets Creek Watersheds have been completed, and together, the three watershed projects will provide cost-sharing incentives to landowners and municipalities in 6.5 percent of the basin [70]." The Areawide Water Quality Management plans identify and rank other watersheds in need of nonpoint source pollution abatement projects.

The Lake Michigan Lakewide Management Plan (LaMP) is a larger effort called for by the Great Lakes Water Quality Agreement (GLWQA) as amended by Protocol on November 18, 1987[87]. Its primary purpose is to identify and reduce loadings of "critical pollutants" in order to restore beneficial uses of the open lake waters.

While each RAP addresses impaired uses in a specific AOC, the LaMP goals pertain to the larger lake ecosystem and include:

1. Prohibiting increases in pollutant loadings over agreed upon specific limits set by the governments of Canada and the United States;

2. Serving as an important step toward virtual elimination of persistent toxic **substances, and** toward restoring and maintaining the chemical, physical, and **biological** integrity of the Great Lakes Basin Ecosystem; and

3. **Embodying a** systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses in open lake waters.

The EPA has responsibility for developing the LaMP in cooperation with other Federal agencies and with state and local authorities; it circulated a public review draft for comment in 1992.

RAP VISION - DESIRED FUTURE STATE

The 1993 RAP update builds on management efforts over the past 20 years which have improved water quality and fisheries. Despite past efforts, however, toxic contaminants still are found in fish and wildlife populations at levels that restrict human consumption or impair reproduction. Nutrients continue to cause excessive algae blooms, exacerbating the transfer of toxic organic substances through the food chain and contributing to fluctuations in trophic level dynamics. Habitat continues to be lost or degraded, and swimming is restricted.

The water resources of Green Bay have historically been responsible for the location, size, and character of the surrounding communities and industries. Although degraded, the waters attract tourism and continued growth to the region, and water quality remains critical to the local economy. While jobs are critical to families, their health and quality of life depend on a healthy and sustainable environment. The water's role as a disposal site has necessarily become more limited because of the threat from past and current contamination.

In 1990 the University of Wisconsin-Green Bay Center for Public Affairs conducted a survey throughout Brown County to determine citizen awareness and support for the RAP and public use of the water resources[4]. Substantial public awareness existed concerning environmental problems and was related to extensive recreational use of the River and Bay. While only one in five people surveyed had heard of the Green Bay RAP, nearly 90% supported its goals when described.

In the early stages of RAP planning, a Citizen's Advisory Committee and WDNR staff developed the "Desired Future State", a vision of the resource that people would like to have in the River and Bay. Presented below, the Desired Future State describes the attributes necessary to provide a full range of beneficial uses of the Lower Green Bay and Fox River AOC.

Recognizing, however, that only cooperative action throughout the entire Wolf, Upper Fox and Fox River Basins will enable us to achieve this vision, the Public Advisory Committee works consistently to involve citizens and government in the communities tributary to the AOC. In this way, achieving the Desired Future State will improve water resources and public benefits throughout the 6,641 square mile area which ultimately drains to the Bay and Lake Michigan.

Finally, the vision and the plan will help guide and focus federal, state, and local resources on actions which will have the greatest, and sometimes most immediate, benefit in restoring beneficial use to the AOC. The 1993 RAP is a road map for continued implementation.

THE CITIZENS' DESIRED FUTURE STATE OF THE LOWER GREEN BAY AND FOX RIVER ECOSYSTEM includes attaining, maintaining and continuing to evaluate the following*:

1. A healthy River and Bay environment providing water quality and habitat for balanced and productive wildlife and plant communities including a well-balanced, sustainable, and edible sport and commercial fishery.

2. Water-based recreation opportunities including:

   a. Accessible local swimming beaches on the Bay; and

   b. Adequate boating areas and facilities.

3. Fox River and Lower Green Bay water quality that protects human health and wildlife from effects of contaminants and meets water quality standards which could provide for drinkable water after standard treatment * *.

4. Balanced public and private shoreline usage including park, agricultural, commercial, residential, and industrial lands.

5. An economical transportation network including both water and land-based systems which minimizes adverse environmental effects.

6. Point and nonpoint discharges and runoff consistent with the maintenance of the desired water quality future state.

* **Identified by the Lower Green Bay Remedial Action Plan Citizens Advisory Committee in 1987, and updated** by the Public **Advisory Committee in 1992.**

" While the RAP Toxic Substance Management and Citizen's Advisory Committees recommended the attainment of drinking water quality standards, they do not recommend that the AOC be used as a potable water source in the foreseeable future due to the unknown but potential human health impacts from exposure to multiple toxic substances present in low concentrations.

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CHAPTER II
STAGE I UPDATE - PROBLEM ASSESSMENT

PART A: THE SETTING

The following section describes the physical characteristics of the AOC. A review of the historical environmental impacts and management history is contained in the 1988 RAP". While the AOC is defined to include about 21 square miles of the southern part of Green Bay and the Fox River upstream to the De Pere dam, the geographical area having poor water quality is much greater. Throughout the report, you will find reference to the Fox-Wolf Basin. There are three major river basins that drain into the AOC (Figure 3). Restoring ecological health to the River and Bay will require solving pollution problems throughout the 6,641 square miles of the Upper Fox, the Fox, and the Wolf River basins, particularly with regard to excess nutrients and suspended solids. The Fox River between Lake Winnebago and Green Bay is popularly known as the "Lower Fox River"; however, the United States Geological Survey (USGS) and state hydrologic naming committee refer to it officially as the "Fox River," and that will be the convention for the remainder of the report.

<u>The Fox River Basin:</u> Waters from the Upper Fox River, Wolf River, and Winnebago Pool lakes empty into the Fox River at the outlet of Lake Winnebago and travel northeast 39 miles to Green Bay. The River is impounded by 12 dams, has 17 locks and is navigable on both sides of the Rapide Croche lock which is permanently closed to restrict sea lamprey <u>(Petromyzon marinus)</u> migration. The Fox has the appearance and characteristics of a large flowing river rather than a series of impoundments.

The basin includes portions of five counties and is home to more than 300,000 people in Brown, Calumet, Fond du Lac, Outagamie and Winnebago Counties. (Table 1). (Populations in the Upper Fox and Wolf River Basins are found in Appendix B, Table 1). Commercial activity includes a diverse industrial base dominated by the greatest concentration of pulp and paper mills in the world -- 20 mills on 39 miles of river. Productive dairy, cash grain, and vegetable farming comprise the agricultural sector contribution to economic vitality of the Fox Valley.

Figure 3. FOX-WOLF RIVER BASINS

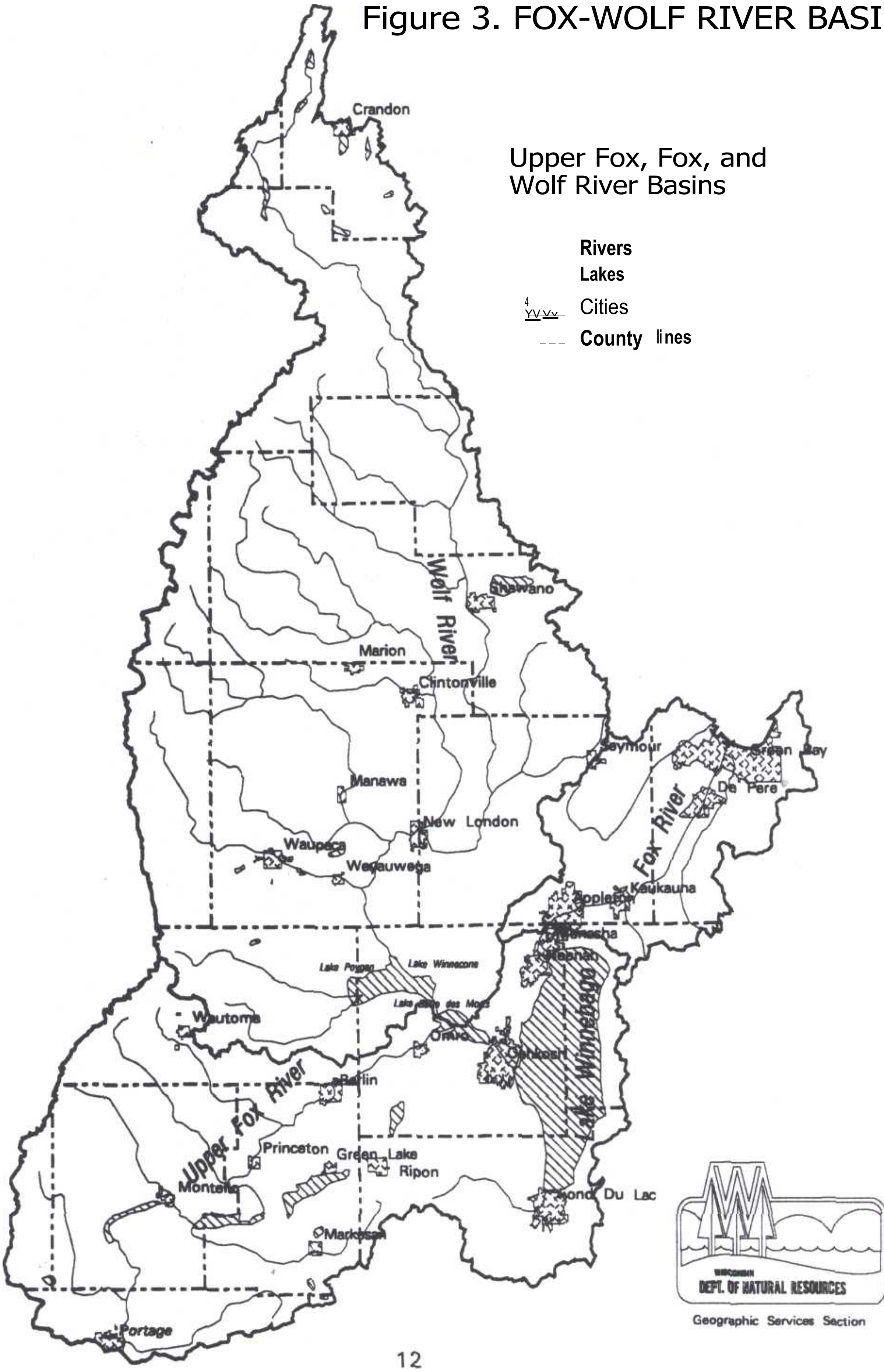


Table 1. Minor Civil Division Populations By County For the Fox River Basin -- 1990[1]

Minor Civil Division	City, Village or Township [2]	Population/County	
DE PERE	C	16,569	Brown
GREEN BAY	C	96,466	Brown
APPLETON	C	6,146	Calumet
APPLETON	C	56,177	Outagamie
KAUKAUNA	C	11,982	Outagamie
SEYMOUR	C	1,598	Outagamie
APPLETON	C	219	Winnebago
ALLOUEZ	V	14,431	Brown
ASHWAUBENON	V	16,376	Brown
HOWARD	V	9,744	Brown
WRIGHTSTOWN	V	1,262	Brown
SHERWOOD	V	92	Calumet
COMBINED LOCKS	V	2,190	Outagamie
KIMBERLY	V	5,406	Outagamie
LITTLE CHUTE	V	9,207	Outagamie
BELLEVUE	T	7,541	Brown
HOBART	T	4,284	Brown
FREEDOM	T	4,114	Outagamie
GRAND CHUTE	T	13,807	Outagamie
ONEIDA	T	3,722	Outagamie
MENASHA	T	3,451	Winnebago
SUBTOTAL		284,784	
Total of townships not listed:		21,559	
TOTAL		306,343	

[1] Source -- United States Census Bureau
[2] Only townships >2,500 are listed.

The AOC: The AOC includes the last seven miles of the Fox River from the De Pere Dam to the mouth and extends northeasterly up to an imaginary line crossing the Bay from Long Tail Point to Point au Sable (Figure 2). The bay portion of the AOC is generally 10 to 15 feet deep. In 1986 it contained two small islands, several other islands or shoals covered by high water, and a confined disposal facility for dredge spoils (Renard Isle, formerly known as Kidney Island). The western shore of the Lower Bay contains low lying areas of wetlands and sandy shores. The eastern shore is characterized generally by residential development along rocky shorelines.

The AOC is the part of the Bay and River where water quality has been most severely impacted by human activity. It has been used in past years for open water disposal of dredge spoils. High turbidity, sedimentation, frequent algal blooms, broad fluctuations in dissolved oxygen, degraded or destroyed wildlife, fish and plant populations, and adverse toxicant impacts have all been documented in the AOC with greater frequency than in any other part of the watershed and Bay. This is due mainly to land and water uses upstream in the AOC, but also due partly to the physical characteristics of the AOC itself, a shallow, rapidly recycling environment.

The Fox River from the De Pere Dam to the mouth has a low gradient and is channelized. It is flanked by urban and industrial development. Navigation extends from the Bay upriver to Fort Howard Paper Company via a shipping channel dredged to a depth of approximately 24 feet. Riparian land uses have changed somewhat in recent years. As water quality has improved, shoreland property values have risen, and previously neglected or undervalued parcels have been re-developed to provide new housing, office space, shopping and recreational/cultural facilities.

Green Bay: Water quality in the Bay and potentially Lake Michigan is impacted by pollutants from the AOC. Green Bay, including the southern bay within the AOC, is an elongated arm of Lake Michigan, partially separated from the lake by the Door County Peninsula. The Bay runs northeast from the Fox River's mouth for 1 19 miles and has a maximum width of 23 miles. It is relatively shallow, ranging from an average of 10 to 15 feet at the southern end to 120 feet at its deepest point.

Currents tend to flow counterclockwise in Green Bay as a whole. Water coming from the Fox River flows northeasterly up the eastern shore of the Lower Bay. Lake Michigan and northern Bay waters move southward along the western shore of the Bay.

Water quality and algae growth (often termed "productivity") in the Bay change dramatically from south to north. In the Lower Bay the water quality is poor and characterized by over-production of green and blue-green algae during the summer months. The level of productivity, or trophic status, is classified as hypereutrophic (extremely productive). Moving northward, water quality improves from eutrophic (very productive) to mesotrophic (moderately productive), and finally to oligotrophic (low productivity) near Lake Michigan as the water becomes clearer and production of green and blue-green algae decreases.

Since 1860, water levels in Green Bay and the Great Lakes basin as a whole have varied seven feet due to climatic variations. In 1986, water levels were at record high levels, and by 1989 had dropped nearly three feet. Both high and low water levels have significantly impacted fish, wildlife, and people within the Great Lakes region. The effect on wetland areas adjacent to Green Bay has been documented as part of the SWIS. Changing water levels alternately create and destroy wetlands, cause severe shoreline erosion and flooding, and can restrict navigation.

Additional adverse impacts, such as shoreline erosion, are caused by seiches at high water levels. Seiches are natural, short-term fluctuations in water levels due to wind, barometric pressure changes, and other localized physical factors. These conditions cause water in elongated basins like Green Bay to tilt or rock back and forth, raising the water levels at one end of the bay and lowering them at the other. Water levels rise and fall an average of six inches every eleven hours in Green Bay.

PART B: REVIEW OF ENVIRONMENTAL CONDITIONS AND IMPAIRED USES

INTRODUCTION

The IJC has **developed** guidelines to determine whether an area of the Great Lakes has water quality or habitat problems that restrict beneficial human or fish and wildlife uses. There are 14 "Impaired Uses". If impaired uses are documented by the guideline definitions, the area is listed as an AOC. Preparation and implementation of a RAP is then required to address these impairments.

Recommendations in a RAP are designed to restore impaired uses. Upon completion of **Stage** III - Documentation of Restored Beneficial Uses, an AOC can be "**delisted**". "Delisting" can occur even when a continuing impaired use exists, if it can be shown that a **beneficial** use can never be restored because of irreversible changes in the **ecosystem.**

The 1988 Lower Green **Bay** RAP was written prior to identification of the IJC listing/delisting guidelines. It defined the most pressing environmental problems in four technical reports: on biota and habitat; toxic substances; nutrients and eutrophication; and institutional concerns. Goals and objectives were established to correct the identified problems, and recommendations were made to implement key actions necessary to restore the ecosystem.

Eleven of the 14 IJC defined Impaired Uses have been identified in the Green Bay AOC (Table 2). Two impaired uses are suspected but have not been documented. This section describes the impact of pollutants or human activities on beneficial uses of the AOC and the current environmental conditions for each impaired use, highlighting changes since 1987.

Table 2. IJC Impaired Uses Identified in the Green Bay AOC - 1993

USE IMPAIRMENT	LISTING GUIDELINE	PRESENT	ABSENT	SUSPECTED
RESTRICTIONS ON FISH AND WILDLIFE CONSUMPTION	When contaminant levels in fish or wildlife populations exceed current standards, objectives or guidelines and 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, i.e. lipid-weight, contaminant concentrations in fish and wildlife will exceed lakewide or regional levels.	X		
TAINTING OF FISH AND WILDLIFE FLAVOR	When ambient water quality standards, objectives, or guidelines, for the anthropogenic substance(s) known to cause tainting, are being exceeded or survey results have identified tainting of fish or wildlife flavor.			X
DEGRADED FISH AND WILDLIFE POPULATIONS	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.	X		
FISH TUMORS OR OTHER DEFORMITIES	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.			X
BIRD OR ANIMAL DEFORMITIES OR REPRODUCTIVE PROBLEMS	When wildlife survey data confirm the presence of deformities (e.g. cross-bill syndrome) or other reproductive problems (e.g. egg-shell thinning) in sentinel wildlife species.	X		
DEGRADATION OF BENTHOS	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.	X		

Table 2. IJC Impaired Uses Identified in the Green Bay AOC - 1993

USE IMPAIRMENT	LISTING GUIDELINE	PRESENT	ABSENT	SUSPECTED
RESTRICTIONS ON DREDGING ACTIVITIES	When contaminants in sediments exceed standards, criteria, or guidelines such that there are restrictions on dredging or disposal activities.	X		
EUTROPHICATION OR UNDESIRABLE ALGAE	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.	X		
RESTRICTIONS ON DRINKING WATER CONSUMPTION OR TASTE AND ODOR PROBLEMS	When treated drinking 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 the standard treatment used in comparable portions of the Great Lakes which are not degraded, i.e. settling, coagulation, disinfection.	X		
BEACH CLOSINGS	When waters, which are commonly used for total-body contact or partial-body contact recreation, exceed standards, objectives, or guidelines for such use.	X		
DEGRADATION OF AESTHETICS	When any substance in water produces a persistent objectionable deposit, unnatural color or turbidity, or unnatural odor (e.g. oil slick, surface scum).	X		
ADDED COSTS TO AGRICULTURE OR INDUSTRY	When there are additional costs required to treat the water prior to use for agricultural purposes, i.e. including, but not limited to, livestock watering, irrigation and crop-spraying or industrial purposes, i.e. intended for commercial or industrial applications and noncontact food processing.		X	
DEGRADATION OF PHYTO PLANKTON AND ZOOPLANKTON POPULATIONS	When phytoplankton 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 fractionation bioassays) with appropriate quality assurance/quality controls confirm toxicity in ambient waters.	X		

Table 2. IJC Impaired Uses Identified in the Green Bay AOC - 1993

USE IMPAIRMENT	LISTING GUIDELINE	PRESENT	ABSENT	SUSPECTED
LOSS OF FISH AND WILDLIFE HABITAT	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.	X		

IMPAIRED USES

1. Restrictions on fish and wildlife consumption

There are consumption advisories for certain species of fish and waterfowl using waters in the AOC. The 1992 fish advisory pertains to the Fox River from its mouth to the De Pere Dam, and to Green Bay and its tributaries up to the first dam south of Marinette (Appendix C). PCBs have been the primary cause for fish consumption advisories in the AOC since 1976 and for the closure of the commercial carp fishery in 1984[73].

While mercury levels in the water column for most of the Fox River exceed the WDNR 2 ppt criteria for wild and domestic animals, the incidence of mercury contamination of larger fish from the Fox River is similar to that of inland lakes. Because the size-class and species of fish that may be contaminated with mercury are already listed under a PCB consumption advisory, no separate warning was issued. Contaminant sampling data for fish from the Fox River are found in Appendix D, Tables 1 and 2.

A waterfowl consumption advisory exists for mallard ducks using waters of the AOC and the Fox River between Lake Winnebago and the northeast city limits of Kaukauna[74]. Guidelines prepared by the Wisconsin Division of Health and the WDNR **base warnings on the** U.S. Food and Drug Administration's standard for 3 ppm PCB in poultry fat. Waterfowl from this area tested above 3 ppm, but are considered safe to eat if they are skinned and all fat is removed prior to cooking. Discarding drippings or stuffing is also recommended since they may retain fat that contains PCBs.

Having decreased by more than 95% since the late 1960's, PCB concentrations in direct discharges to the Fox River are now a negligible 1 to 2 kg per year (< 1 pound); **nevertheless,** the relative decline of PCBs in fish tissue has not kept pace. The reason is believed to be that substantial quantities of PCBs remaining in the sediments of the Fox River are reintroduced to the water column through sediment resuspension, bioperturbation, and diffusion, thus becoming available for uptake.

Changes since 1987: PCB concentrations in fish tissue have declined but continue to exceed consumption advisory levels. The fish consumption advisory remains in effect for walleyes (Stizostedion vitreum) over 15 inches and for northern pike (Esox lucius), white bass (Morone chrysops), white suckers (Catostomus commersoni), carp (Cvprinus carpio), drum (Aplodinotus grunniens), and channel catfish (Ictalurus punctatus). The advisory for walleyes less than 15 inches was removed in 1990. Declining PCB levels and tissue monitoring indicated that smaller walleyes do not exceed the 2 ppm PCB or 0.5 ppm mercury criteria.

Waterfowl consumption advisories continue for mallard ducks (Anas platvrhynchos).

The commercial carp fishery for human consumption remains closed because of PCB contamination. There is new interest in commercial carp harvest for products made from the skin and scales, but the flesh may not be sold for any use.

2. Tainting of fish and wildlife flavor

There have been no specific studies to document occurrence of this impaired use, but area anglers have occasionally reported problems with fish taste and odor. In a 1983 report of the Toxics Substances Task Force on the Fox River, resin acids, a component of pulp and paper mill effluent, were reported as possible precursors to alkyl phenols[80]. These compounds have been identified as causing off-flavors in fish studied on the Wisconsin River[22]. Chlorophenols which have been discharged in industrial and municipal effluent can also cause off-flavors.

Changes since 1987: Tainting remains a suspected, but unproven, impaired use. With the application of effluent treatment to all municipal and industrial wastewater discharges and the closing of most pulp mills on the Fox River, the likelihood of fish tainting has been greatly reduced.

3. Degraded fish and wildlife populations

Fish and wildlife populations have been altered through changes in habitat, impact from exotic species, and toxic chemicals, some of which bioaccumulate and affect reproductive success.

Species diversity has been reduced through overfishing of native fish populations, invasion of exotic species and poor water quality which particularly favors rough fish. There are fewer species and numbers of top predator fish -- northern pike and muskellunge (Esox masquinongy) -- and an over-abundance of rough fish -- carp, bullheads (Ameiurus spp) and white suckers. Additionally, the forage fish population is dominated by a few species, particularly gizzard shad (Dorosma cepedianum). Introduction of exotic species such as white perch (Morone americana) and ruffe (Gvmnocephalus cernuus) may further alter community composition. As water quality improves in the Lower Bay, sea lamprey are expected to increase and may populate previously uninfested streams. Fish kills were observed during August 1992 by commercial fishing operators in the Bay. Kills were likely due to oxygen deficits in bottom waters resulting from abundant algae decomposition[61].

While the system remains dramatically altered with less diversity in fish species than originally present, more than 33 fish species now observed in the River and Bay. Fish managers credit water quality improvements and management actions, such as setting quotas on commercial catches of yellow perch and bag limits on sport catches, for creating conditions that support many species. Fish stocking, water quality improvements, habitat creation and harvest management have achieved a self-sustaining walleye fishery that is nationally renowned, even though consumption advisories exist. Management of yellow perch (Perca flavescens), through adjustment of harvest regulations, has reestablished a sport fishery equal to the commercial fishery in Green Bay.

Certain wildlife populations in the AOC have been depleted to a degree that results in, or warrants, protection under the Wisconsin Endangered Resources program: common terns (Sterna hirundo), Forster's terns (Sterna fosteri) and Caspian terns (Sterna caspia). Attempting to nest in unsuitable locations such as the Renard Isle confined disposal facility has also contributed to reduced chick survival of these endangered species. Waterfowl use of the Lower Bay during spring and fall migration periods has declined from historic levels[14]; this is attributed to a lack of preferred foods including invertebrate species such as fingernail clams (Musculim lacustre) and snails (Mollusca gastrophoda), and submerged aquatic vegetation such as wild celery (Vallisneria americana). According to trappers surveyed in 1991, wild mink (Mustela vison) populations throughout marshes adjacent to the Bay were depressed[43]. The mink trappers' success ratio along an area within one mile of the Fox River and Green Bay shoreline was lower than any other area surveyed throughout Wisconsin. (A success ratio is developed by considering the number of trappers, number of mink trapped, and a success index equaling the amount of effort, number of traps, number of sets, etc.) In addition, bald eagles (Haliaeetus leucocephalus), osprey mink (Pandion haliaetus) and otter (Lutra canadensis) within the broader Green Bay ecosystem may have been affected adversely by toxic chemicals. Evidence supporting a causal relationship is neither direct nor necessarily from within the geographical boundaries of the AOC itself. The Fox River has become a wintering area for bald eagles. Between 25 and 30 eagles were observed using the river between the cities of Appleton and De Pere during the winter of 1992. Concern would be warranted if the birds are feeding on contaminated fish.

Contamination of wildlife inhabiting the Green Bay ecosystem was evident in the mid-1970's, although no direct toxic effects were detected[21,23]. A 1983 study of Forster's tern reproduction at a site within the AOC demonstrated a presumed linkage between PCBs and reduced fecundity[33]; later studies within the AOC have documented various physiological alterations consistent with toxic effects of PCBs[18,3]. On a broader scale, studies in northern Green Bay and adjacent parts of Lake Michigan have demonstrated a negative association of double-crested cormorant (Phalacrocorax auritus) egg hatchability with PCBs[82], even though attempts to establish a definite cause and effect relationship were unsuccessful.

There is a growing body of literature supporting use of wildlife populations as indicators of ecosystem health; it suggests that many of the aforementioned species are sentinels for toxic chemical effects, although conclusive linkages between such effects and chemicals remain elusive. Additionally, many of the affected species are migratory and pass through Green Bay between their wintering and breeding areas. Thus, individuals may experience harmful effects of local pollutants after leaving the AOC.

Changes since 1987: Sea lamprey were first detected in the AOC below the De Pere dam in 1990[10]. The threat of sea lamprey migration upstream into the Upper Fox River, Lake Winnebago and Wolf River systems was reduced by constructing a permanent barrier at the Rapide Croche dam.

Progress was made toward shifting fishery biomass toward predator and sport species. The 1991 year class of walleye in the AOC was very strong and should result in higher numbers of adults in several years. Some increase in population may be attributed to the creation of several rock spawning beds which provide habitat on the eastern shore of the Fox River. Management programs shifted from stocking to natural reproduction, resulting in a walleye population that is self-sustaining at about 70,000 adults. Spotted muskellunge were reintroduced to the AOC through stocking beginning in 1989. Growth rates appear to be very good. In September 1991, a 27 inch spotted muskellunge, the largest of this species seen to date, was captured during a fish survey on the Fox River. Adult reproduction is not expected until the spring of 1996.

Abundance of yellow perch in the AOC decreased from 1988 to 1990 and stabilized in 1991 because of changes in harvest regulations. Perch have spread into deeper bay waters than previously occupied, and abundance at depth intervals is being studied. This may lead to a modified population objective for the AOC. The population of white perch, an introduced species first observed in 1988, is rapidly increasing.

Nesting success of terns and gulls (Larus spp) within the AOC was very poor during the 1992 nesting season, but with no particular indication that this was linked to toxic chemicals. Instead, environmental variables probably intervened and chemical effects were obscured[59]. In 1991, 448 breeding pairs of common tern were found at sites on Lake Superior, Green Bay, Lake Winnebago and Lake Butte des Morts, representing a 13% increase over 1990. Forster's tern breeding pairs increased 12% from 1990 to 1991 (996 to 1,1 17), although the number of colonies, which foster successful reproduction decreased by two. Ninety-nine nesting platforms were installed on Lake Poygan in 1991 to provide suitable breeding habitat.

The status of the three endangered tern species within the AOC is still precarious and compromised by degraded habitat and, presumably, by the presence of toxic chemicals[59].

4. Fish tumors or other deformities

There have been few studies of deformities in fish populations. In addition to tumors, there are many types of deformities or impairments such as reproductive impairments and general health which could be examined.

Studies of benthic fish species from the Fox River below the De Pere dam in 1984 and 1988 indicated less than a two percent incidence of preneoplastic or neoplastic liver tumors in bullheads or suckers[3]. However, in order to determine more precisely the significance and frequency of neoplasms (potentially malignant altered cells or tissue mass) in a fish population, large scale studies would need to be conducted and all livers examined by histopathology.

A study of liver tumor frequencies in walleye and brown bullhead (Ameiurus nebulosus) from five sampling tributaries to the Great Lakes included the Fox and Menominee Rivers in Wisconsin[8]. Livers were examined visually, and suspect tissue was examined histopathologically. No liver neoplasms were found in brown bullhead from the Fox and Menominee Rivers even though polychlorinated aromatic compounds (PCDDs, PCDFs, non-ortho PCBs) were highest in Fox River sediment and the Fox and Menominee River brown bullhead. Arsenic was highest in the Menominee River sediment and fish. In general, walleye had a lower incidence of neoplasms than did brown bullhead in waters where both were collected. Only one liver neoplasm was found in 40 walleye examined from the Fox River. External neoplasms were seen in both black (Ameiurus melas) and brown bullhead, but 75 percent of the external lesions examined in brown bullhead were not cancerous. Researchers hypothesized that high concentrations of organochlorines might have inhibited PAH-induced carcinogenesis in bullheads.

Changes since 1987: There has been nothing to indicate that fish tumors have become any more prevalent than in 1987. WDNR fisheries managers have not observed visually apparent deformities in fish collected through monitoring studies, nor have they been observed in Fox River fish populations in the above referenced works. However, these studies are not conclusive, and no studies of "other deformities" have been conducted; therefore, fish tumors and or other deformities remain a suspected impaired use.

5. Bird or animal deformities or reproduction problems

Studies of various bird species indicate that contaminants continue to affect the reproductive capacity of some species in the AOC. Summaries of studies and historical data are contained in the 1987 Toxic Substances Management Technical Advisory Committee Report' and in the 1983 Toxics Task Force Report for the Lower Fox River'.

A 1983 study of the state endangered Forster's tern documented that egg hatchability and offspring viability of this fish-eating colonial waterbird on Lower Green Bay was impaired compared to a clean location upstream on Lake Poygan[34].

Eggs taken from terns at the Green Bay site had significantly lower hatchability, lower mean weight of chicks, higher liver-to-body weight ratios, and higher concentrations of 2,3,7,8 TCDD, HCDD, total PCDD, non-ortho PCBs and total PCBs than eggs from the Lake Poygan reference site.

High PCB levels have also been found in eggs of herring gulls (Larus argentatus), ring-billed gulls, common terns, and double-crested cormorants (Phalacrocorax auritus). Analysis of dead or sick black-crowned night herons (Nvcticorax nycticorax) found on Green Bay contained high levels of total PCBs, PCDDs, PCDFs, and non-ortho, and ortho' PCB congeners[33]. Liver enzyme levels of black-crowned night herons in the AOC indicated moderate exposure to enzyme-inducing toxic chemicals when samples from known polluted sites were compared to unpolluted sites in Texas and North Carolina [12]. The relationship between these physiological biomarkers and reproduction is not conclusively established, but it is presumed to be harmful. Studies of several avian species within the AOC have revealed reduced reproductive performance and related physiological changes consistent with PCB effects[18].

Studies of double-crested cormorants in the upper portion of the Bay and Lake Michigan have established that there is statistically significant reduced hatchability and increased incidence of structural deformities in this area when compared to a relatively uncontaminated reference area in Canada[35]. The rate of deformities had remained relatively constant to the present[58]. An additional valuable indicator species of wildlife reproductive status, the mink, has not been systematically studied within the AOC or Green Bay ecosystem.

While no studies have been conducted on the possible impact of PCBs on mink and otter in the Green Bay area, circumstantial evidence suggests that these mammals may be affected by contaminants in the Fox River/Green Bay ecosystem.

Changes since 1987: 1988 hatching success and fledging rates of Forster's terns appeared to be improved, compared to the 1983 study, because they were not statistically different from those of reference ("clean") populations. However, even though no overall reproductive effect was seen, Forster's tern and red-winged blackbird (Agelaius phoeniceus) chicks that died before fledging appeared to exhibit "wasting" indicative of toxicological effect [18]. Historical fluctuations in tern breeding pairs have paralleled changes in habitat caused by lake level fluctuations; these have been linked to the presence of persistent toxic substances in the environment, specifically PCBs. While PCB contaminant levels in Green Bay fish appear to have fallen slightly between 1977 and 1987, it is premature to attribute increased reproductive success of Forster's terns with lower toxicant levels [20].

6. Degradation of benthos

In 1988 benthic invertebrates (bottom dwelling invertebrates) in the AOC exhibited low diversity compared to the middle bay and comparatively low productivity.

Data collected in 1988 by the Institute of Paper Chemistry and WDNR at 60 stations between Lake Winnebago and Lower Green Bay indicated a benthic community structure dominated by worms (oligochaetes). There were only two stations where fly larvae (Diptera spp) constituted up to a third of organisms collected

A report prepared by a consortium of federal and university research agencies also found the benthic community of the Fox River and Lower Green Bay to have low species diversity in the summers of 1988 and 1989[3]. Samples of sediment and biota were collected from 13 sites in the Fox River below the De Pere dam and southern Green Bay to determine existing or potential impacts of sediment-associated contaminants on different ecosystem components. Compared to a reference site upstream on the East River, all of the Fox River and Green Bay sites exhibited relatively low benthic diversity; the only organisms consistently present were worms and midge larvae (chironomids). Also, total numbers of organisms were lower at the ten Fox River sites than at either the Green Bay or East River locations.

In the same effort, researchers also studied toxicity of sediment pore water to identify causative toxicants. Sediment pore water samples were used for toxicity tests on fathead minnows (Pimephales promelas) and zooplankton (Ceriodaphnia dubia). Pore water from all 10 of the Fox River sites was acutely toxic to both organisms. An important component of the observed toxicity appeared to be ammonia. Researchers reported toxicity to C. dubia was highly pH-dependent and that toxicity to C. dubia and P. promelas **was** highly correlated with ammonia concentration.

Other tests with C. dubia "further implicated ammonia as a primary causal toxicant in the Fox River pore water samples. The identification of ammonia, a compound formed in sediment through microbial activity, as an important toxicant is of significance not only for the Fox River and Green Bay, but potentially for other systems." Recent studies at other Great Lakes sites "also have implicated ammonia as a common sediment toxicant, particularly in eutrophic systems heavily polluted with contaminants such as metals and nonpolar organics. This suggests that normal microbial processes (e.g. nitrification) in these types of systems may be disrupted, due either to organic loading or selective toxicity, and indicates the need for further studies focused specifically upon evaluation of microbial community structure and function in these perturbed environments[55]."

In the eutrophic conditions of the Fox River and Lower Green Bay, the functional interrelationship of nonpoint source and point source contributions of excess phosphorus to the system and degradation of benthos appears evident. Ammonia may be present in sediments, not solely because of industrial or municipal wastewater discharges, but also because of algae which die and are incorporated into the sediment. Ammonia is generated as a by-product of decomposition.

Changes since 1987: The 1990 State of the Bay Report indicates that the number of benthic species, while still relatively limited in diversity, has risen from approximately 10 species found along both shores of Lower Green Bay in 1978 to 20 on the eastern shore and slightly more on the western shore[46,68]. In the Bay north of the AOC, diversity on the western shore area increased substantially from 20 to 35 species, but remained at around 20 species along the eastern shore. This suggests that benthos are still being influenced by Fox River water which flows up the eastern shore. Bottom substrate may also be a factor.

7. Restrictions on dredging activities

Dredging restrictions are considered an impaired use when contaminants in sediments exceed standards, criteria, or guidelines, such that there are restrictions on dredging or disposal activities.

Wisconsin considers dredged materials a pollutant and does not permit open water disposal of dredged sediment in adjacent Great Lakes waters. Additionally, the Detroit District of the United States Army Corps of Engineers (USACOE), in consultation with the EPA, has evaluated navigational dredge spoils against the 1977 EPA Guidelines and classified sediments as polluted and unsuitable for open water disposal[25]. Minimal maintenance dredging of Green Bay and the Fox River has taken place since 1988, because the current disposal site, Renard Isle, is near capacity, and its expansion is the subject of a case in the Wisconsin court of appeals.

The 1988 RAP recommended development of a 25-year dredge disposal plan and endorsed a comprehensive economic/environmental Harbor Study with cost/benefit components. A long-range sediment disposal plan is critical not only to continued navigational dredging, but also to successful remediation of contaminated sediments in the Fox River.

Changes since 1987: Dredging activities have been substantially reduced because of unresolved disposal issues. The 1988 RAP recommended a comprehensive harbor study to examine the overall economic and environmental impacts of the port and of alternative transportation modes. Brown County and the Bay Lake Regional Planning Commission are conducting an environmental and economic impact study (1993) of a model shift from shipping to rail and truck. The county also is expected to submit a proposal to the WDNR in 1993 to expand the Bay Port site for long-term dredge spoil disposal.

8. Eutrophication or undesirable algae

Nutrient enrichment of the Fox River and Lower Green Bay continues, leading to excess algal biomass. The AOC is considered to be "hypereutrophic", or extremely productive, because of high levels of the nutrient phosphorus which stimulates algae growth. The excessive amount of algae produced has many widespread impacts resulting in a number of use impairments, including restricted swimming, poor aesthetics, degradation of aquatic habitats, degradation of phytoplankton populations, degradation of fish and wildlife populations, and degradation of benthos. The negative effects of eutrophication are not restricted to the AOC, but are evident from lakes Poygan, Butte des Morts, Winneconne, and Winnebago down through the 'Fox River and out to the mid-bay near Chamber's Island.

Phosphorus is the nutrient that most controls algae growth in fresh water ecosystems. Algae productivity in the AOC is significantly correlated to annualized phosphorus loadings. Regression analysis by Dr. Paul Sager, UW-Green Bay, indicates that substantial phosphorus load reductions (40-50%) will be necessary before algae production (measured by chlorophyll a) and water clarity (measured by Secchi disk depth) are noticeably improved. Trophic conditions in the AOC are monitored by GBMSD annually and were surveyed for the entire Bay by WDNR and Green Bay Metropolitan Sewage District (GBMSD) in 1992.

Phosphorus inputs have decreased over the past two decades but remain high enough to be the primary factor in creating eutrophic conditions. The load of phosphorus from all municipal wastewater treatment plants on the Fox River has dropped from about 366,000 kg (805,000 Ibs) in 1971 to about 60,000 kg (133,000 Ibs) in 1992 because of regulations that require better phosphorus removal at larger sewage treatment plants and restrictions on phosphorus-containing detergents. In the same period, the average summer total phosphorus (TP) concentration in the AOC changed from about 200 Ng/L to 150 Ng/L [51]. Implementation of priority watershed projects in the basin is relatively recent, and while best management practices are being installed, it is too early to assess the effect of nonpoint source phosphorus load reductions. The Fox River discharged about 680,000 kg (1.5 million Ibs) of phosphorus to Green Bay in 1990.

Eutrophication effects include low light transmission levels in the waters of the AOC because of to great abundance of algae and other particulates. Consequently, growth of aquatic macrophytes, which would otherwise provide food and habitat for a variety of invertebrates, fishes, and waterfowl in the littoral zone, is limited.

Interactions between levels of the food chain (trophic dynamics) have been altered by the predominance of algae in the system, particularly blue-green algae. There has been a shift away from littoral and pelagial food chains toward the detrital food chain with a concurrent change in associated fishes and other aquatic life. There is a predominance of small, plankton-feeding fishes and bottom-feeding rough fishes, and a loss of predatory, sight-feeding fishes.

Much of the primary productivity in the form of blue-green algae is not utilized by the zooplankton and fish. The excess algae die and sink to the bottom, becoming part of the detritus (organic matter) in the sediment. As algae are decomposed by bacteria in the sediment, oxygen is taken out of the water, and ammonia and phosphorus are released. The concentrations of un-ionized ammonia in the sediments and bay water may reach toxic levels at times, impacting benthos and possibly fish. The phosphorus is released back to the water column, where it may be taken up to produce more algae.

Decomposition of the excess primary production can also lead to oxygen deficits in deeper regions of the middle bay where sedimentation rates are high. Under certain conditions of thermal stratification and internal seiche activity, anoxic waters from the mid-bay area may be transported to the lower bay. Previous work has documented distinct water mass movements in central Green Bay, presumably driven by large influxes of Lake Michigan water. One instance, documented in 1988 with continuous monitoring of in situ vertical water column profiles, showed characteristics of a water mass to include temperature < 10° C, dissolved oxygen < 2.0 mg/L and conductivity of 200-210 pmhos/cm[27]. This condition persisted for 17 days, until two days of strong, northeasterly winds broke up the stratification. This phenomenon could result in destruction of benthic organisms and fish kills. It is also important from a regulatory perspective, as incomplete identification of such an intrusion could be mistakenly viewed as the result of excess point or nonpoint discharges.

Changes since 1987: In the short time since 1987, one would not expect to see much change except for fluctuations characteristic of hypereutrophic systems. There appears to be no trend of improvement in the trophic state of the AOC since 1987, as measured by TP concentrations, chlorophyll a, and Secchi disk depth (Table 3). In fact, conditions worsened in the summers of 1991 and 1992, when blue-green algae blooms were heavy throughout the Lake Winnebago-Fox River-Green Bay system[50]. Although water clarity has not shown long-term trends of improvement, average summer Secchi disk depths in the AOC during 1986 and 1988 approached the RAP objective of 0.7 M. A very wet year, 1986 had high river flows and record stage levels, effectively diluting total phosphorus, while 1988 was a drought year with lower spring runoff and, thus, lower phosphorus inputs. The combination of increased water transparency and lower water levels during 1986 and 1988, however, was associated with re-establishment of submerged vegetation, particularly wild celery, a favorite food of waterfowl, along the western shore of the Bay north of the AOC[41].

Table 3. Measures of Trophic State in the Lower Green Bay Area of Concern

Year	T-Phos (pg/L)	Chl a (mg/m³)	Secchi (M)	D.O. [2] Avg. (mg/L)	D.O. [2] Min. (mg/L)	TSS (mg/L)	TS (mg/L)	NH3 (mg/L)
1986	120		0.71	8.1	2.3			0.091
1987	141		0.63	7.6	2.7			0.218
1988	138		0.66	7.8	3.7			0.096
1989	152	66	0.53	7.9	2.5			0.086
1990	148	55	0.52	8.4	5.6			0.113
1991	162	102	0.43	8.5	1.0	34	307	0.181

T-Phos = Total phosphorus
Chi a = Chlorophyll a, **green pigment** in **plants used** as an **indicator** of plant **and algae** productivity
Secchi = depth in meters at which a two-color disk can be **seen**
D.O. = Dissolved oxygen measured in milligrams per liter. The Department of Natural Resources considers **5** mg/I_ DO necessary for fish and **aquatic life.**
TSS = Total suspended solids
TS = Total solids
NH_3 = Ammonia

1) Data is uncorrected for phaeophytin, another plant pigment normally present.
2) Station **average** of readings at 1.0 meter intervals

Source: John Kennedy, GBMSD monitoring program. Values represent stations corresponding to the Lower Green Bay area of concern and coincide with historical stations used by Paul Sager, UW-Green Bay. Phosphorus and chlorophyll a data represent summer averages (June **-August) while other parameters** include entire **seasonal data base** (typically mid-May to mid-October).

9. <u>Restrictions on drinking water consumption or taste and odor problems</u>

The RAP Toxic Substance Management Technical Advisory Committee advised in its 1987 report that existing and potential use of the Bay and Lake Michigan as drinking water sources should be protected by maintaining and improving Fox River water quality[83]. At present, the Fox River is not suitable for drinking water supplies because of the unknown risks of substances toxic to human health, taste and odor problems, suspended solids, bacteria and viruses, color, low flow effect on water quality, and the high cost of water supply treatment.

<u>Changes since 1987:</u> Effective March 1, 1989, Chs. NR 105 and 106 established water quality criteria and methods for calculating Wisconsin Pollution Discharge Elimination System (WPDES) permit limits for toxic substances. The criteria were established to protect public health and welfare, the present and prospective use of all Wisconsin surface waters for public and private water supplies, and the propagation of fish and aquatic life, and of wild and domestic animal life. While NR 102.14 established taste and odor criteria, NR 105 also established how bioaccumulation factors used in deriving water quality criteria for toxic and organoleptic substances shall be determined. These criteria were established to protect human health from exposure to substances that are toxic and/or cause taste and odor problems in fish and drinking water sources, and that are applied to regulated point source dischargers. Regulation of nonpoint source contributions of

toxic and bioaccumulating substances has not been developed. Regulation of stormwater discharges, however, will begin to address this issue.

Historical degradation of the Fox River and Lower Bay have precluded their use for drinking water supplies because of varied water quality conditions. Current needs of the City of Green Bay are met primarily by pumping water from Lake Michigan, with limited backup pumping from several city wells. A number of communities to the north of Green Bay use the upper bay as a drinking water source. Consequently, while we recognize the unlikely restoration of this impaired use in the AOC, the RAP program also seeks to limit loading and transport of toxic substances into the outer bay.

10. <u>Beach closings</u>

Bay Beach, the only swimming beach on the southern shore of Green Bay, closed in 1943 because of excessive bacterial contamination. Additionally, excess sediment and algae cloud the water, making visibility difficult and waters less safe for swimming. State guidelines require that public swimming waters have a minimum 1.3 m of visibility as measured by Secchi disk depth. Current summer averages in the AOC are about 0.5 m. Observers report that sedimentation between Bay Beach and Renard Island is forming mud flats, further degrading swimming areas. Higher numbers of bacteria that may increase the risk of ear, skin, and intestinal infections, generally follow periods of rainfall or winds and are related to nonpoint source runoff and resuspension of bacteria from bottom sediments.

<u>Changes since 1987:</u> There has been no discernable increase in water clarity in the AOC. Fecal coliform numbers are measured weekly during the swimming season at a number of stations in the AOC by the Green Bay Health Department. In recent years, the number of bacteria and viruses in the Bay has decreased to levels which meet swimming standards for most of the summer, but these numbers are exceeded often enough to preclude designating swimming beaches on the Fox River and at Bay Beach[16].

Under Chapter NR 102 of the Wisconsin Administration Code which sets guidelines for determining suitability of surface water for recreational use, effluent cannot exceed fecal coliform counts of 400 colonies per 100 milliliters of discharge in more than 10 percent of the samples taken in any month. WPDES permits for all sewage treatment plants discharging to recreational use waters, i.e. the Fox River and Green Bay are being revised to enforce these guidelines as effluent limits. Under a 1992 WPDES permit revision for the GBMSD, the limit for fecal coliform bacteria will become more stringent. Other Public Owned Treatment Works (POTWs) along the Fox River are also in the process of permit revision for improved disinfection. Those facilities choosing to use chlorine for disinfection are also being required to install dechlorination equipment to meet more stringent state standards for residual chlorine.

11. Degradation of aesthetics

The IJC guidelines specify that when any substance in water produces a persistent, objectionable deposit, unnatural color or turbidity, or unnatural odor, the aesthetics have been degraded. An average of 90 million kg (200 million lbs) of total suspended solids (TSS) are delivered from the Fox River to the Bay each year. Coupled with **algal blooms** and turbidity created through wave action, the Lower Bay continues to be unacceptably turbid, and it occasionally has problems with odor caused by algal decomposition. This remains the prime reason for limited recreational **use.** Other odor problems in the AOC have been attributed to emissions from power generating facilities, industries, and wastewater treatment plants.

Changes since 1987: Changes in visual aesthetics of the water have been imperceptible due to continued influx of sediment and phosphorus resulting in turbidity and algae blooms.

12. Added costs **to** agriculture or industry

There is no evidence that use of water from the Fox River or Lower Green Bay for watering livestock, irrigating, or crop-spraying has generated increased pretreatment costs; neither have those costs increased for commercial or industrial use in applications such as noncontact food processing or cooling water. Therefore, this use is unimpaired.

Changes since 1987: None.

13. Degradation of **phytoplankton** and zooplankton populations

Excessive nutrient enrichment in the Lower Bay has stimulated changes in both phytoplankton and zooplankton populations. In response to high phosphorus concentrations, blue-green algae dominate (75%) the phytoplankton population, but they are a low quality food for zooplankton both in terms of size and palatability[49,52,53]. Zooplankton selectively feed on smaller-sized, higher-quality green algae. Additionally, because of shifts in population composition, the zooplankton population is dominated by small organisms with low grazing effectiveness **(cladocerans and** copepodes). These shifts are likely caused by plankton-eating fish, abundant in the Lower Bay, which prefer larger, higher food-quality plankton species[48]. As a result, on average, 80% of the primary production (algae) does not enter into the pelagial food web; instead it passes to the bottom sediments and decays.

Phytoplanktonic algae play a role in cycling toxic substances in the environment. Recent research on Green Bay indicates that a partitioning coefficient, which expresses the tendency for hydrophobic PCBs to adsorb to organic carbon in phytoplankton cells, ranges from 1 to 3 x 10^6 kg/L regardless of the PCB concentration in the water column". Because phytoplanktonic algae are made up of roughly 50% organic carbon, this means that every kilogram of organic carbon contains about 1 million times more PCB than a liter of surrounding water. Ambient Bay concentrations range from 120 ng/L at the Fox River mouth to 1 ng/L in the outer Bay; consequently, phytoplanktonic algae can have from 1 to 120 mg PCB/kg (ppm). As algae die and are incorporated into bottom sediments, they release PCB through decomposition by detrital organisms. This makes PCB available again to the food chain. Algae also release PCB through dissolution and decay in the water column itself. In deeper waters the second route becomes more important, as ungrazed algae are present in the water column longer before reaching the bottom and have more opportunity for direct release of PCBs.

Decay of excess algae can result in ammonia production which has been shown to have toxic effects on zooplankton and is suspected of degrading invertebrate populations[3].

Most PCB congeners generally are not regarded as being acutely toxic to phytoplankton themselves. Toxicity potentially can result from persistent commercial herbicides[32].

Changes since 1987: Surveys of phytoplankton species composition and the effect of light and zooplankton on biomass and productivity in Lower Green Bay have been conducted by students of Dr. Paul Sager of UW - Green Bay and Dr. Summner Richman of Lawrence University, Appleton, WI. Study results are unavailable at this writing.

14. Loss of fish and wildlife habitat

Disappearing wetlands caused by human activity and rising water levels, shoreline erosion and filling, and lack of underwater vegetation have resulted in the decline of bird nesting and fish spawning habitat in the Bay. Turbid water caused by suspended solids and overabundant algae reduces submerged aquatic plants and degrade habitat for underwater organisms such as snails and aquatic insects. These organisms are important food sources for fish and wildlife. Deposition of fine silt particles from tributaries, overland flow or resuspension and redistribution of bottom sediments in the Lower Bay also destroy fish spawning habitat. Loss of habitat jeopardizes endangered species in the area as well as other fish and wildlife, particularly waterfowl and marsh birds.

Bulkhead lines -- legal definitions of shorelines -- established by Brown County ordinance and approved by the WDNR, provide riparian owners with the right to fill or place solid structures up to such a line. Some of the last remaining wetlands in the AOC lie behind established bulkhead lines. The USACOE grants or denies wetland fill requests in such areas. Rescinding bulkhead lines **to protect** remaining wetlands would require an ordinance change by the civil division having jurisdiction and rescinding approval by the WDNR.

Changes since 1987: Eleven hundred feet of rock spawning habitat was constructed in 1990 and 1991 at three sites along the eastern bank of the Fox River downstream from De Pere.

Submerged aquatic vegetation has become reestablished along areas of the western shore just north of the AOC[41]. Recent research on the impacts of nutrients, sediment, and turbidity on coastal marsh habitat in Green Bay documented the link between nutrient and sediment pollution and the abundance of submerged aquatic vegetation and aquatic insects and birds". Results indicated that if a Secchi disk could be seen at 0.7 m water depth, as proposed by the 1988 RAP, the light environment would be suitable for reestablishment of wild celery, an important waterfowl food, in a large portion of the AOC.

Another factor affecting reestablishment of submerged aquatics, however, may be turbulence from wave action. In the same study, turbulence seemed to restrict plant growth in areas where light was sufficient. Comparison of water level fluctuation impacts between an undiked and a dike-protected marsh indicated a greater diversity and interspersion of plants, as well as a larger more diverse population of nesting birds, in the protected area. A study initiated in 1984 to characterize the emerging insect population of these marshes showed more insects, insect biomass, and insect taxa were found in the diked marsh, especially during late May and early June which is the peak period of nesting activity for marsh birds[42]. Additionally, it appears that a larger, more diverse nesting bird population is tied to a greater availability of insects during the nesting season. While these studies alone do not reflect changes in the ecosystem, they do provide an empirical basis for habitat improvement recommendations.

DISPOSAL OF NAVIGATIONAL DREDGE SPOILS

An average 176 ships per year have visited the Port of Green Bay since 1987[26]. Annual tonnage averages 1.75 million. The federally authorized channel is maintained to a navigational depth of 24 feet. Prior to 1985, an average of 458,000 m^3 (599,064 yds^3) of sediment was dredged from the harbor and channel each year. Because of limited disposal facilities for harbor dredge spoils, average annual dredging has dropped to about 111,000 m^3 (145,000 yd^3). The USACOE and Brown County have proposed to expand the existing confined disposal facility (CDF), Renard Isle, to meet spoil disposal needs for the next four years and possibly longer. As proposed, the USACOE would pay for dredging and the construction of the CDF, and the county would be responsible for operation and maintenance costs of the facility. The project is currently in litigation in the Wisconsin Court of Appeals. In the future, maintenance of the navigational channel may become increasingly a local responsibility.

Brown County, which operates the Port of Green Bay, has recently set an objective to dispose of approximately 392,000 m^3 (513,000 yd^3) of sediment at the Bay Port Disposal Site and Renard Isle during 1993, and to initiate a study of the environmental and economic impacts of shifting from shipping to other transportation modes.

A subcommittee of the Great Lakes Water Quality Board, as directed under Annex 7 of the Great Lakes Water Quality Agreement, has compiled information to allow for the evaluation of environmental effects resulting from dredging operations in the Great Lakes. The subcommittee addresses issues of dredging and disposal, as well as sediment management in areas of concern and in the overall Great Lakes ecosystem. The 1985-1989 Dredging Register, prepared by the Subcommittee, contains data on 95% of all dredging activities in the Great Lakes basin during this four-year period.

Perhaps the most notable aspect of the report is the substantial decrease, from the previous five-year period, in both the number of projects and the quantity of material disposed. There is also a consistent, decreasing trend, on an annual basis, in the total volume of material and number of projects over the past 10 years.

Reasons for this apparent decrease are not known, but they are probably a result of a combination of factors, including:

* Reduced sediment delivered to harbor and navigational channel areas, possibly resulting from the active control of erosion and/or decreased precipitation;

* Higher water levels, temporarily creating deeper navigational channels;

* Reduced shipping activity and the closing of some ports;

* Higher incidence of contaminated sediments, fewer options or more costly options for disposal, causing a more selective use of dredging.

Additionally, because of high cost, difficulties in the disposal of contaminated sediments, and the limitation of available space, few CDFs are being constructed, and a decrease in the use of confined disposal has been predicted. Confined disposal accounted for 52% of all disposal projects in 1980-1984 and 34% in 1985-1989.

A brief summary of the number and types of dredging/disposal projects in Green Bay is presented in Appendix E, Table 1.

EXOTICS

Carp: The carp, an exotic, but long-time resident of the system, remains abundant in the AOC. Its presence, however, has not precluded increased abundance of preferred fish species -- yellow perch, walleye, smallmouth bass (*Micropterus dolomieui*), etc. Much discussion has centered on the rose carp play in inhibiting the development of rooted aquatic macrophytes in the AOC. It has been suggested that a carp removal project be initiated to control or eradicate carp from the system as a means of achieving greater abundance of rooted macrophytes. **Eradication** is impossible in an open system like Green Bay, and control, at a significant level, would be inordinately expensive.

Although carp are acknowledged as a negative factor in reaching this goal, they are not considered, at this time, to be the major factor controlling the absence or presence of rooted macrophytes in the system. A greatly reduced photic zone, caused by high levels of suspended solids (sediment and plankton) inhibiting light penetration, reduces or eliminates the possibility of rooted aquatics establishing themselves in the AOC. Unless these underlying reasons for poor water clarity are addressed, carp removal would have little or no effect and would be less than cost-effective.

The commercial fishing **season** for carp is currently closed. Although harvesting carp can not be justified as a mechanism directed toward increasing the abundance of rooted aquatic macrophtyes or improving water clarity, carp harvest, for purposes other than human consumption, should be accommodated whenever those efforts do not adversely impact other biological communities.

Zebra Mussels: The invasion of the Great Lakes by the zebra mussel (*Dreissena polymorpha*) as the **potential** for a greater effect, in human terms, than the invasions of the parasitic sea lamprey, alewife, and all other exotic species in the lakes combined. The marble-size, barnacle-like freshwater mollusks colonize almost any underwater structure with a hard surface, including water intake pipes, boat hulls, harbor pilings, navigation buoys, and commercial fishing gear. Colony densities range up to hundreds of thousands per square yard. Virtually unknown in the Great Lakes in 1988, the mussel has spread throughout the lakes and is also present in inland rivers and lakes[31].

Ecological effects of zebra mussels are largely unknown; however, the extraordinary ability of the mollusk to filter up to one liter of water per day feeding on phytoplankton may alter the cycling of PCBs among water, sediment and other organisms. The effects zebra mussel filtering activity could have on water clarity in the Bay are unknown, but they are expected to increase water clarity as has occurred in western Lake Erie, Saginaw Bay, and southern Lake Michigan.

The zebra mussel was first detected in the waters of Green Bay in June 1991. Throughout the summer and fall of 1991, sightings of zebra mussels increased in frequency. By the end of the year, zebra mussels had been identified at numerous sites in the Lower Bay and within two water intakes of the Wisconsin Public Service Corporations's Pulliam Power Plant in the AOC.

Zebra mussels failed to expand in the AOC during the summer of 1992. Increased veliger (larval mussel) reproduction was observed in 1992, but settling of post-veligers declined by comparison with 1991. Few mussels have been found between the De Pere Dam and the Fox River mouth. Zebra mussel populations are expected to increase within the next two years.

Economic impacts of the zebra mussel on Green Bay area industries, power plants and the Lake Michigan water intake facilities accrue as treatment and exclusion devices are installed. The Green Bay Water Utility, though located outside the AOC, draws water from a 27 mile long pipe to Lake Michigan; the Utility installed the first zebra mussel control project at a Wisconsin water utility in February 1992 at an approximate cost of $450,000. The Wisconsin Public Service Corporation's J.P. Pulliam Power Plant in Green Bay and Wisconsin Electric Power Company are among other facilities that have spent $200,000 - $800,000 on equipment and chlorination for zebra mussel control systems.

<u>White perch:</u> There has been a dramatic increase of another new species to the system since 1988. According to unpublished WDNR data from Lake Michigan creel surveys, fewer than 100 white perch were collected in 1988 surveys, compared to 21,000 caught by sport fisherman in 1991. Inhabiting many areas of Green Bay, the fish are most abundant in the Lower Bay along the east shore and in the Fox River. Similar in appearance to white bass, the newcomer can impact native species such as white bass and yellow perch through competition for available food sources. This is only a problem when food is limited. Other impacts may result from predation of larval fish forms.

WILDLIFE/HUMAN CONFLICTS

While the Lower Green Bay RAP is intended to preserve and enhance a diversity of wildlife in the AOC, there are public concerns with the large numbers of certain colonial nesting waterbirds -- double-crested cormorants and ring-billed gulls -- due to perceived conflicts with human uses. A management plan for colonial waterbirds is being prepared by the WDNR and UW-Green Bay [76]; it makes recommendations for both population enhancement and control.

Double-crested cormorants first nested in the AOC in 1969 and are a relatively recent addition to the Lower Bay's avifauna [39]. The number of cormorants declined statewide in the 1970s, which led to it being declared a state endangered species in 1978. A population recovery project in Lower Green Bay involved the construction of forty-five artificial nesting platforms on Cat Island in March 1978. Cormorants utilized the nesting platforms and other nearby islands, and they increased from 109 nesting pairs in 1979 to more than 1000 pairs in 1989 [40]

The large numbers of cormorants using Green Bay has raised concerns from fishermen and some fisheries' biologists that double-crested cormorants are competing with both sport and commercial fishermen for yellow perch, the most valued fishery in the Bay. The Lower Green Bay Colonial Waterbird Management Plan points out that past efforts to control cormorants was a contributing factor in the species' demise in the 1950s and 1960s in the Great Lakes Region. Green Bay area wildlife biologists have not recommended active management of the cormorant population [5, 59]. The nesting platforms are no longer functional, and no efforts are being made to enhance or control the population. The population size is expected to fluctuate naturally and is not believed to be a problem at this time.

The population of ring-billed gulls throughout the Great Lakes has been increasing dramatically in the last 25 years. Ringbills were absent from the Great Lakes early in this century and first appeared around 1926 near the Straits of Mackinac [37]. The population has been increasing dramatically ever since. Ring-billed gulls first nested in the AOC on Lone Tree Island in 1969. Their numbers have virtually exploded in the last ten years, during which time a colony on Renard Isle has grown from a few hundred in 1982 to 21,748 in 1989.

The proximity of Renard Isle to Bay Beach Amusement Park, a popular waterside recreation area, has led to increased contact and conflicts between ringbills and people. The Green Bay Health Department receives numerous complaints about gulls stealing picnic food and intimidating park users by their swooping, screeching, and defecating. The children's wading pool has been degraded by gull waste, and there are concerns for potential transmission of salmonella and histoplasmosis to humans [38]

The Green Bay Health Department requested in 1992 that the Animal and Plant Health Inspection Service (APHIS) develop and implement a plan to eliminate nuisance conditions and prevent potential health problems. However, for unknown reasons, the entire colony on Renard Isle was suddenly abandoned in summer of 1992, and the entire production of ringbills was lost

SHORELINE ACCESS AND AESTHETICS

Industrial uses which predominate along the shores of the Fox River and to a lesser degree the Lower Bay, limit public access to the water in several areas. These conditions do not encourage people to use the River, Bay, or downtown waterfront for recreational activities. Downtown businesses have not taken -- or are not able to take full advantage of the commercial value of an attractive waterfront. There is also inadequate access for shore users such as anglers, sunbathers, picnickers, and people who wish to hike or bike along the shore.

For the most part there is adequate boat access in the Lower Bay; however, several of the access sites need expanded capacity and improved facilities. Also, boat access along the east shore of the Bay is limited, and there is a demand for more marina facilities.

People and wildlife are often competing for the limited natural shoreland that remains. Much of the critical wetlands and other shore habitat for fish and wildlife have been destroyed. As water quality improves, there is increased demand for residential and recreational development along the shore.

<u>Changes since 1987:</u> A new boat launch was constructed in eastern De Pere, and the capacity and facilities of several boat access sites have been expanded and improved along the Fox River and in the Lower Bay. Available dockage for boats has been increased through expansion of private marinas on the Fox River. Boating access to the downtown commercial area has been improved also.

Opportunities for shore fishing, passive recreation, and biking, walking, and jogging along the water have increased due to park expansions and facility improvements along the Fox and East Rivers and Duck Creek. A Fox River Parkway and trail is partially completed and expected to link eventually with the East River Parkway. New shore fishing piers have been developed on the Fox River at De Pere and Green Bay and on Duck Creek.

Shoreline aesthetics have improved along river sections in downtown Green Bay and De Pere, especially where the Fox River Parkway and Voyageur Park have been expanded and landscaped. However, much of the industrial property along the Fox River remains aesthetically unattractive. Aesthetics are further degraded by unsightly debris and fill material deposited along shorelines and by the deterioration of old or abandoned buildings.

PART C: POLLUTANT SOURCES AND LOADS

The AOC is influenced by the 6,641 square mile drainage area of the Upper Fox, Fox and Wolf River **Basins.** Within these basins there are many potential pollution sources that may contribute to conditions found in the AOC. The data presented here pertain to **selected areas** within the Fox-Wolf River Basin, but they are not **comprehensive for the entire Basin.**

POINT SOURCES

Point source **discharges** from facilities throughout the Fox-Wolf River Basin are summarized below in Table 4. They include municipal and industrial wastewater **discharges.**

<u>Municipal and industrial wastewater treatment slants:</u> In the three basins draining to the AOC, 120 industries and 66 publicly owned treatment plants hold WPDES permits to discharge to surface water. There are no combined sewer overflows in the basin. There **are** 14 **paper** mills and 6 major municipal wastewater treatment facilities discharging directly to the 39 miles of Fox River from Lake Winnebago to the mouth (Figure 4). Five paper mills and two municipal treatment plants lie within the AOC.

Current **loads of phosphorus,** ammonia, suspended solids and biological oxygen demand from all discharges to the Upper Fox, Fox and Wolf Rivers are summarized in Appendix F, **Tables** 1-6.

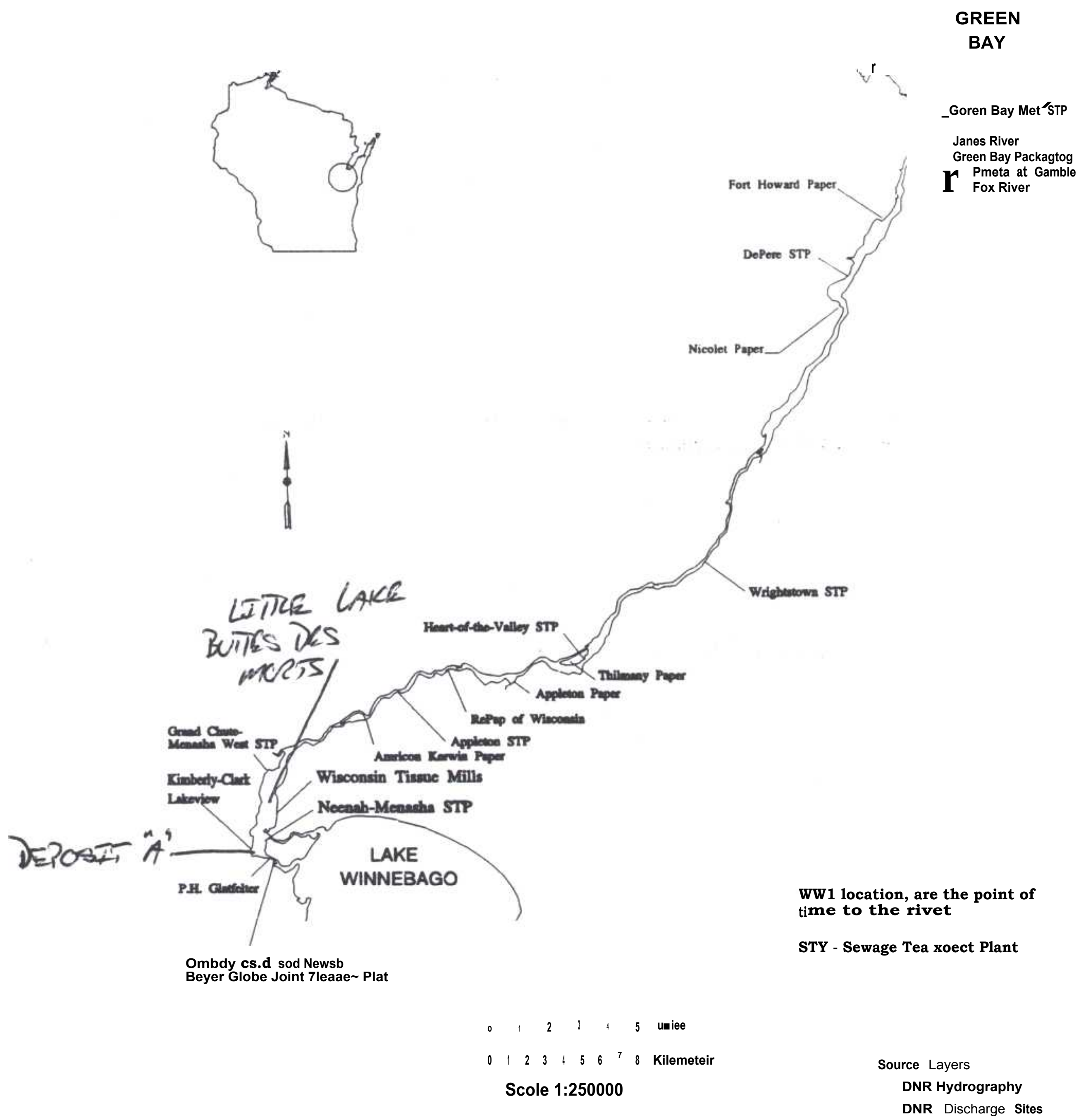
1985 municipal and industrial loads of metals, cyanide, dioxin, acid compounds, volatile **compounds, base** neutral compounds, pesticides, and PCBs discharged to the Fox River **are** found in the draft Lake Michigan Lakewide Management Plan [s']. As summary **reports** of 1986-1992 data become available, they will be included in subsequent RAP **updates.**

Table 4. 1990 Loads of Conventional Pollutants to the Fox-Wolf River Basin*

	Upper Fox Municipal WWTP kg/year	Upper Fox Industrial WWTP kg/year	Wolf Municipal WWTP kg/year	Wolf Industrial WWTP kg/year	Fox Municipal WWTP kg/year	Fox Industrial WWTP kg/year	Total for basin kg/year
Phosphorus	18,000	4,200	6,900	11,000	61,000	58,000	159,100
Suspended Solids	324,000	28,000	100,000	130,000	1,342,000	2,992,000	4,916,000
BOD	496,000	32,000	123,000	282,000	1,333,000	2,658,000	4,924,000
Ammonia	59,000	25	4,800	500	743,000	142,000	949,325

*Source - Discharge Monitoring Reports - WPDES permit system

Figure 4. OUTFALL LOCATIONS OF MAJOR. MUNICIPAL AND INDUSTRIAL DISCHARG13RS TO THE PDX RIVER



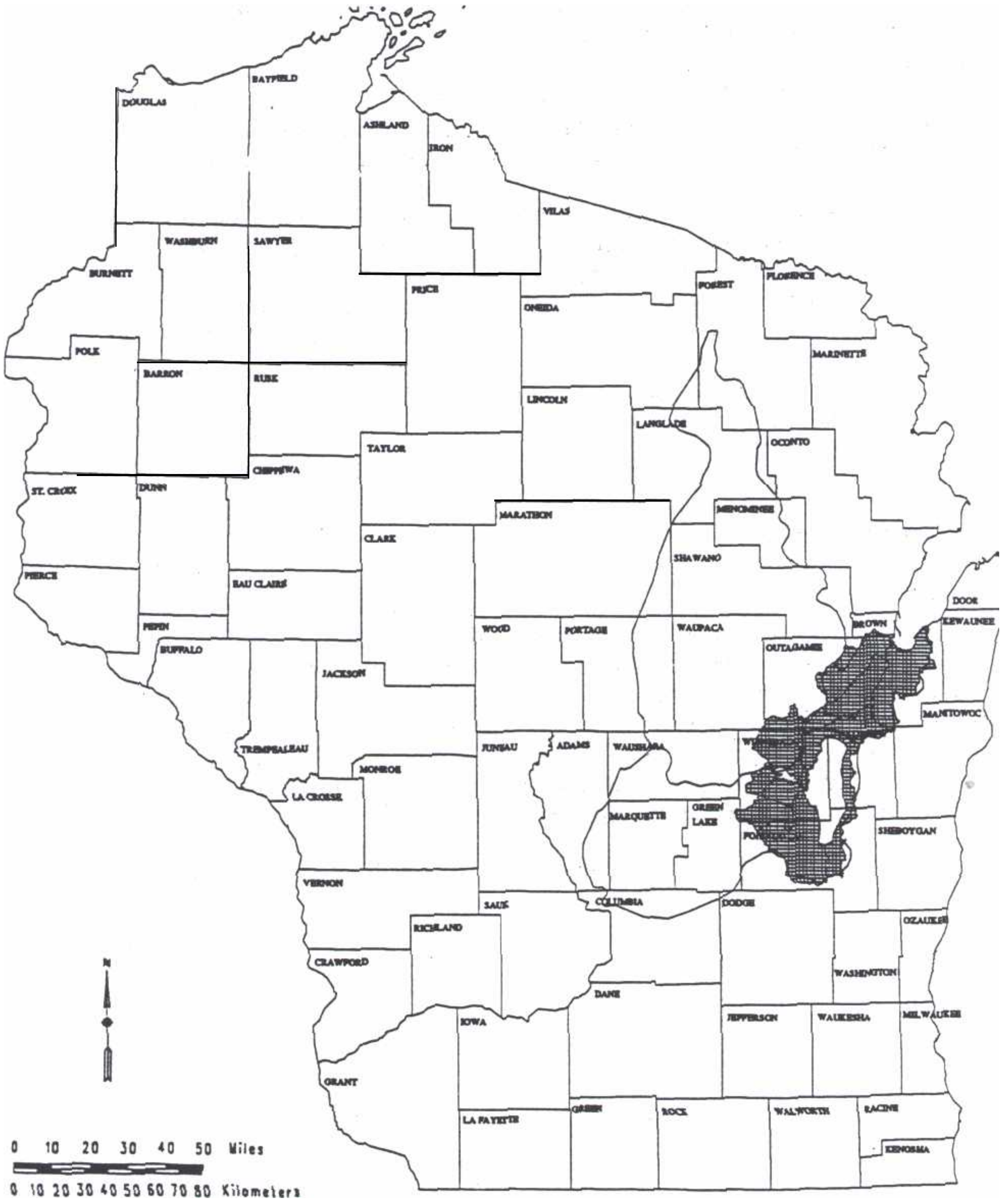
Biochemical Oxygen Demand: Biochemical oxygen demand (BOD) is a measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. BOD_5 is the biochemical oxygen demand measured in a five day test -- the greater the degree of pollution, the higher the BOD_5. High BOD can lead to a low oxygen level and adverse impacts on aquatic organisms. The NR 102 surface water quality standard is 5 mg/L (ppm) dissolved oxygen at all times in streams capable of supporting warmwater fish and aquatic life.

The Fox River is a wasteload allocated river, which means that wastewater dischargers are required to meet effluent limits more stringent than nationally applied categorical limits. A wasteload allocation is applied where the combined discharge of all facilities meets the categorical limits established by the EPA, but it exceeds the assimilative capacity of the receiving water. In such a case, point source reductions in BOD waste are required to achieve the surface water quality standards. The allocations are designed to meet the dissolved oxygen standard of five ppm in the River at all times. A two ppm dissolved oxygen water quality standard variance remains in effect for part of the AOC during the winter.

NONPOINT SOURCES

Runoff from urban and agricultural areas constitutes nonpoint sources of pollution to the AOC. There are 41 watersheds within the Fox and Wolf River Basins; six drain into the Fox River below LLBM. The Duck Creek watershed drains directly into the Lower Bay. Those watersheds believed to have the greatest potential to contribute phosphorus and sediment loads to the Bay are indicated with shading in Figure 5. However, other watersheds in the basin also contribute to the massive phosphorus and suspended solids loads to the system, and they may need to be addressed to reach a load reduction goal of 50 percent.

Figure 5. WATERSHEDS DELIVERING NONPOINT SOURCE POLLUTANTS TO GREEN BAY



Scale 1:2500000

11 Critical *Watersheds*

Additional Watersheds in *the Upper* Fox-Wolf River Basins

Source Layers:
DNR County Borders
DNR Watersheds

Land use in the Fox River Basin is approximately 69% agricultural, 13% urban, and 18% wooded or natural. A detailed inventory of critical areas contributing nonpoint source pollution is available for about 7% of the area.

Analysis of phosphorus, sediment, and heavy metal loading is included in three Priority Watershed Plans for watersheds within the basin; the East River, Lake Winnebago East and the Arrowhead/Rat River/Daggets Creek Watersheds'''. Rankings of other watersheds recommended for priority watershed planning in the 1988 RAP are included in the Upper Fox, Fox and Wolf River Basin Water Quality Management Plans[77,78,79].

<u>Sediment Loads:</u> Sediment loading to the Fox River and Green Bay can be attributed to numerous sources. Sources include cropland, unprotected streambanks, construction sites, both single family and multi-building sites, and street runoff.

The loads discussed here are attributed to the following:

* nonpoint source runoff from the East River Priority Watershed and tributaries draining directly into Lower Green Bay below the De Pere Dam;

* delivery of sediment from areas draining into Lake Winnebago and the Fox River above the De Pere dam ;

* tributary loadings to the Upper Fox and Wolf Rivers with ultimate delivery to the Fox River.

Sediment loading from the East River watershed is approximately 15,000 metric tons (MT)/year (17,000 tons/year) from both agricultural and urban areas. This figure includes estimates of construction site erosion, which can be 10 times higher than the average 7MT/ha/year (3 tons/acre/year) from rural cropland. An additional 9900 MT (11,000 tons/year) and 23,000 MT (25,000 tons/year) come from the Lake Winnebago East watershed and the Arrowhead/Rat River/Daggets Creek watershed, respectively. Because these latter watersheds drain to the Lake Winnebago and the Fox River above the De Pere dam their loads represent part of the 136,000 MT (150,000 tons) per year coming over the dam[29]. A portion of these sediment loads settles out and accumulates in Lake Winnebago and the Fox River behind the dams. Detailed assessments of other watersheds and funding assistance for implementation of sediment reduction practices must occur to reduce this tremendous sediment burden to the Fox River.

<u>Excess Nutrient/Phosphorus Loads:</u> Phosphorus loads from priority watersheds are estimated from inventories of barnyard runoff, placement and tonnage of winter spread manure, and urban stormwater runoff. Contributions to the Fox River system from three priority watersheds total about 25,700 kg/year (57,000 Ibs/year) (Table 5).

Table 5. Estimates of Phosphorus Contributions From Three Priority Watersheds in the Upper Fox and Fox River Basins

Watershed name	East River	Arrowhead/Rat River/Daggets Creek	Lake Winnebago East
	- - - - - kg phosphorus/year - - - - -		
Rural sources (barnyards)	1,870	17,600	1,000
Urban	5,000	0	700
Total	7,000	17,600	1,700

A more detailed estimate of nonpoint source loads of phosphorus from Lake Winnebago and the Fox River throughout the river system is part of the trophic state analysis currently underway by Dr. Paul Sager, UW-Green Bay. This work is described in Chapter IV, Part C. Algae, which develop in upstream areas, are a source of phosphorus to the entire system and must be considered in determining phosphorus loading to the Bay. This in turn means that phosphorus inputs to Lake Winnebago from all sources must be defined better.

<u>Other Urban Nonpoint Source Pollutants:</u> Loading of lead, zinc, and copper have been estimated for urban areas within priority watersheds. Because these estimates are based on types of land use which vary among cities, it is not possible to extrapolate to the entire Fox River Basin or Fox-Wolf River Basin for nonpoint source loadings of these metals [30]. However, loadings of lead, cadmium and PCB from nonpoint source runoff was estimated for the entire urban area that drains into the Fox River below the De Pere dam and Lower Green Bay [30]. The study included approximately 13,670 ha or 53 mile ^{2} comprised of 11,716 ha in the East River Priority Watershed, 1,954 ha within the Ashwaubenon Creek and Dutchman Creek watersheds, and 2,770 ha which drain directly into Green Bay. Annual lead loadings from the area were calculated at 2066 kg (4,555 Ibs), while cadmium loads were roughly 28.3 kg (62 Ibs). Researchers concluded that stormwater was a significant source of lead for the Fox River and Lower Green Bay, but expected loads to decrease as the use of leaded gasoline decreased. Cadmium loads did not appear significant.

To determine the significance of the urban area as a source of PCBs, researchers used a number of approaches. Initially, stormwater data collected in Milwaukee in 1973 and 1990 was extrapolated to similar urban land use areas in the Green Bay metropolitan area. The 1973 Milwaukee data extrapolation suggested that 10% of total PCB loading to Green Bay was from nonpoint source runoff. This unlikely high percentage lead to further study. In a second approach, sediment samples were collected from 10 sewer catch basins in May 1989, and the PCB residue concentrations were used to extrapolate from the catch basin drainage areas to the entire study area. Finally, the sediment load from urban areas within the study area was associated with PCB residue concentrations from the catch basins. Results of all approaches indicated that PCBs in urban stormwater runoff is not presently a significant source of PCBs to the Fox River. The maximum PCB concentration in urban stormwater runoff, using the catch basin approach and comparing it with 1990 PCB stormwater runoff data from Milwaukee, resulted in an estimated loading of about 1 kg/yr (2.2 Ibs)[30]

SPILLS

The area draining directly into the AOC is generally heavily urbanized, especially along the Fox River. Uncovered coal and chemical stock piles, petroleum tank farms, and many industrial lots are located next to the River. Under ss.144.01 Wisconsin Statutes, any release of hazardous substances must be reported to the WDNR immediately. Designated personnel make a response decision based on the type and amount of material and potential hazard to human health and wildlife. Large releases, or those with potential human health impacts, are managed by the Division of Emergency Government.

Spills are recorded in a data base, coded according to response action, and summarized twice annually. A code 1 indicates that no on-site investigation occurred by WDNR personnel as part of the Environmental Remedial Response Program. Code 2 indicates an on-site assessment was conducted to confirm release, identify potentially responsible parties, assess environmental harm, and direct a potentially responsible party to take action. Code 3 indicates that the WDNR hired a cleanup contractor and/or supervised cleanup.

From 1987 to 1991, there were 437 spills reported in the Fox River Basin. Action was taken on 262 incidents. Substances released included used motor oil, pesticide treated corn, diesel and gasoline fuel, ammonia, and a host of industrial chemicals.

There were 170 active clean up cases for spills or leaking underground storage tanks of non-petroleum related products in the Fox River Basin in 1992. Brown County had 65 cases, Calumet, 18; Outagamie, 44; and Winnebago, 43.

Active cases related to petroleum products handled through the WDNR Leaking Underground Storage Tank (LUST) program totalled 582 in 1992 with 207 in Brown County, 44 in Calumet, 167 in Outagamie, and 164 in Winnebago.

IN-PLACE POLLUTANTS/CONTAMINATED SEDIMENT AS A SOURCE

Fox River sediment deposits that are contaminated with PCBs and other pollutants serve as a continuing pollutant source to downstream reaches of the River, Green Bay, and Lake Michigan. Sediment-associated pollutants can be made accessible to the aquatic ecosystem through biological, hydrological, and chemical mechanisms. The accessibility of sediment-associated pollutants can cause adverse biological effects in the vicinity of the sediment deposit and produce a significant pollutant load to downstream reaches.

Although a number of contaminants have been associated with sediment deposits in the Fox River, this discussion focuses on PCBs. The significance of the AOC's sediment-derived loading of contaminants other than PCBs has not been studied in detail. In spite of this narrow discussion, it should be remembered that significant amounts of other contaminants may also be entering the AOC through release from upstream sediments.

Part of the 1988 RAP, "Key Action #4: Reduce Availability of Toxic Substances from Contaminated Sediments", recommended that the mass and availability of PCB and other contaminants in the River system be determined. There are an estimated 9 m^3 of sediment containing PCBs above 0.05 ppm between LLBM and the mouth of the Fox River. Estimates place 2 million m^3 upstream of the De Pere dam and 5-7 million m^3 in the River downstream of the dam. Clean-up levels for individual sites will be determined on a case-by-case basis. RAP advisory committees have not recommended Fox River clean-up criteria, nor are there federal or state sediment criteria established for PCBs. One benchmark established through a national study, however, indicates that biota are first adversely affected at concentrations of 0.05 ppm PCB[as]

Sediment transport modeling includes resuspension under various flow regimes related to rainfall events or dam gate settings. Modeling conducted upstream of the De Pere dam indicates that roughly 90% of the PCB in the water column is due to resuspension/settling of bottom sediment.

Refer to Chapter IV, Part C for a detailed discussion of Green Bay Mass Balance modeling results and issues regarding contaminated sediment.

ATMOSPHERIC DEPOSITION

Atmospheric deposition of PCBs and other toxic contaminants has been difficult to quantify. Limited data from the early 1980s indicated that atmospheric deposition contributed approximately 290 to 450 kg (640 to 990 pounds) per year total PCB to all of Lake Michigan[2]. Only a small portion of this load is likely to have fallen in the AOC because of its relatively small surface area.

As part of the Green Bay Mass Balance Study, atmospheric contributions of PCB to Green Bay were investigated in 1989. In a report to the U.S. EPA Great Lakes National Program Office, researchers concluded the rain/snow flux of PCBs to Green Bay to be 2-16 kg/yr, with 2.2 ± 1.7 ,ug/m^2/yr[13]. Researchers assumed a total bay surface area of 4200 km^2 and 80 cm/yr precipitation. No calculations were made specifically for the AOC.

Members of the same research team simultaneously collected air samples over land and over water to assess the air/water exchange of semivolatile organic chemicals (SOCs), using 85 PCBs as indicators. The abstract of an article submitted for publication states "...This data set is believed to be the first such comparison although the magnitude and direction of air/water exchange for SOCs is often estimated from air samples collected over land. The over water/over land differences were greatest where water PCB concentrations are the highest. Concentrations of total PCBs over the water were higher over the southern Bay (670 to 2200 pg/m^3). The over water vs. over land differences in southern Green Bay are due to an enrichment of the most volatile PCB congeners. A regression comparison of PCB congener distributions in air and in water collected at the same site and time suggests that this enrichment of PCBs is due to volatilization of the chemicals from the water of Green Bay. Our results suggest that the magnitude of chemical loss from contaminated waters and the effect of SOC volatilization on local atmospheric concentrations may be underestimated from shoreline measurements[24]." In fact, if atmospheric concentrations of SOCs over land and over water are significantly different, then water bodies influence regional and global atmospheric concentrations more strongly than previously was believed.

Researchers found atmospheric concentrations of PCBs measured over land and over water on the same day differed by as much as a factor of seven. Measurements were statistically different in the southern Bay, but not over land and water in central and northern Green Bay. Spatial and temporal trends among three sites along the eastern shore of the Bay were also investigated to determine if there was a seasonal pattern of PCB atmospheric inputs, or if north-south concentration gradients existed. No seasonal variation was detected, and while north/south differences were not evident over land, there was a clear gradient over water. Concentrations measured over the southern bay are one and one-half times higher than the total PCB concentrations measured in the north (average total PCB concentration and standard deviation measured at southern sites 600 $\pm$ 480 pg/m^3 versus 400 $\pm$ 180 pg/m^3 at northern sites).

A WDNR air toxics monitoring site is now located to the north of the Green Bay urban area and borders the Bay, and has been operational for one year. Analysis of collection filters has failed to detect any PCBs or pesticides although the recovery method demonstrated in the laboratory is working properly.

LANDFILLS

There are 16 abandoned landfills located within a quarter mile of the Fox River and Lower Green Bay[72]. Several of these have been monitored as part of the Green Bay Mass Balance Groundwater Monitoring Study[57]. Two sites, the abandoned

Military Avenue Municipal Incinerator Ash Landfill and the active Bayport Dredge Spoils Site, lie adjacent to each other and along the lower western shoreline of Green Bay. Their combined perimeter shoreline length is about 1.5 miles. They have replaced what was once natural wetland. A third site evaluated was the P.H. Glatfelter-Arrowhead Park Site Landfill at the southern end of LLBM in the City of Neenah. The study completes an assessment begun in 1990 on the potential contributions of lead, cadmium, and PCBs to Green Bay or LLBM.

The report concludes that groundwater is not adversely impacting surface water bodies adjacent to these waste sites with lead, cadmium, or PCBs. The study suggests that the greatest total PCB load from any of the landfills would not exceed 12.8 grams per year. PCB attenuation by soils was not considered in the study and would likely reduce PCB values significantly. Specific daily PCB loads to groundwater from each site were:

Military Avenue Site:	5.03×10^{-5} gm/day
Bayport Site:	1.27×10^{-5} gm/day
Glatfelter Site:	3.5×10^{-2} gm/day.

The study concludes that these concentrations are minimal compared to the lowest winter daily PCB loading concentrations of 30-100 gm/day measured in the Fox River below the De Pere dam, as reported in the 1990 Preliminary Report[57].

Additional groundwater and soil sampling has been conducted at the Bayport Site for complete organic and inorganic analyses as part of a superfund preremedial assessment, but results are not available at this time.

The 1988 RAP suggested additional land disposal sites were of possible concern: Wisconsin Public Service Corporation's (WPSC) ash disposal areas, and two former coal-gas plants that may have tar deposits. Contamination of groundwater, surface runoff, and direct exposure to wildlife through the food chain were of potential concern. All six existing monitoring wells at the WPSC's Ash Site were sampled in 1989. None of the samples indicated a lead, cadmium or PCB impact. PCBs would not normally be a likely contaminant from flyash. However, WPSC used oils contaminated with low levels of PCBs for boiler start-up. Data from testing in May 1988 was considered irrelevant because of quality control/quality assurance problems. Retesting in 1989 indicated PCBs and cadmium at detection level only and does not indicate any groundwater impact at this site. Samples confirm that cadmium and lead exist in the fill material, but they do not appear to be dissolved in groundwater. This is not unusual, because in many soils, lead has a very low mobility and cadmium a moderately low mobility. Potential surface water runoff problems were also evaluated and corrected.

in summary, while progress has been made toward restoring full uses of the AOC, and industrial and municipal point source pollutant discharges have been reduced, only one delisting criteria has been met fully. Furthermore, pollutant sources consist largely of nonpoint sources and contaminated sediment. Phosphorus reductions from point sources have not offset loads from nonpoint sources and Lake Winnebago sufficiently **to realize** a significant **environmental** improvement. Loads of toxic contaminants from new sources **appear** to be controlled, but accumulation in the aquatic environment from contaminated sediment and nonpoint sources are not reduced significantly compared to 1985 data.

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CHAPTER III .PROGRESS TOWARD REHABILITATION IN THE AREA OF CONCERN

INTRODUCTION

The Lower Green Bay and Fox River RAP has had a sustained implementation program since the plan was adopted in 1988. The program builds on existing plans and cooperation with other ongoing management programs to improve water quality, fish and wildlife resources, and public uses of the AOC. Related planning efforts are described in the 1988 RAP and in Chapter I of this report.

This chapter consists of three parts, which describe: A) the structure and function of the current RAP implementation program; B) actions taken or in progress to implement the 1988 RAP or achieve additional environmental improvement in the Fox River and Lower Green Bay; and C) pollution prevention activities that will help to prevent recontamination of remediated areas.

The chapter was developed through consultation with WDNR program managers, county agencies, and other public entities actively charged with carrying out restoration activities. It is a means of assessing progress and envisioning environmental results where there has been insufficient time for the system to respond to changing conditions. It is intended also to assist implementors in judging the effectiveness of implementing RAP recommendations, and to track costs where possible.

PART A: MANAGEMENT STRUCTURE FOR GREEN BAY REMEDIAL ACTION PLAN IMPLEMENTATION AND BASIN-WIDE WATER QUALITY MANAGEMENT

BACKGROUND

Like the Remedial Action Plan, the RAP implementation program has continued to evolve over the past six years. The WDNR is the designated lead agency for statewide water quality planning and management, and for the Green Bay Remedial Action Plan. The WDNR involved citizens, government agencies, elected officials, businesses, scientists, and other interest groups throughout the development of the RAP. Recognizing the importance of continued stakeholder participation in the implementation process, the WDNR created an interim Implementation Committee and six Technical Advisory Committees in spring 1988, shortly after the Green Bay RAP was approved by the State. The purpose of the interim committees was to initiate plan implementation, inform and involve the public, and recommend an appropriate structure for long-term management of RAP implementation. The implementation committees were active for about three years, until they completed recommendations for a revised management structure.

Several alternative management structures were explored by the interim Implementation Committee, including: 1) the creation of a Basin Authority or special purpose unit of government with authority to tax and regulate; 2) delegation of implementation coordination responsibilities to a regional planning commission, whose boundaries would be rearranged to coincide with basin boundaries; and 3) establishment of standing RAP implementation committees under the coordination of the WDNR. Several workshops were held by the Implementation Committee and facilitated by the U.W.-Center for Public Affairs, an independent contractor (with support from the Wisconsin Coastal Management Program), to identify and evaluate RAP management options. For reasons having to do with political feasibility, agency mandate and legitimacy, technical expertise, and resources, the Implementation Committee recommended that the WDNR maintain the lead role and establish several RAP advisory committees.

PRESENT INSTITUTIONAL STRUCTURE

Three standing committees - a Public Advisory Committee (PAC), a Science and Technical Advisory Committee (STAC), and a Public Education and Participation (PEP) Advisory Committee - were created by the WDNR in mid-1991 to represent stakeholder interests, promote implementation, and provide ongoing guidance for the Green Bay Remedial Action Plan implementation program. Members are appointed for three-year terms by the WDNR-Lake Michigan District Director. Membership of the committees is diverse and was designed specifically to include a balance of representatives from county and municipal government, municipal and industrial dischargers, environmental and conservation groups, recreation groups, agriculture, state legislature, resource management agencies, academia, media, and interested citizens.

Legislation was not required to create this management structure. Government and agency representatives participate voluntarily. Mandated responsibilities and authorities remain with the existing governments and agencies. No regulatory, policy-making, or taxing authority was delegated to the RAP advisory committees. They seek to achieve consensus, coordination and cooperation, and their interactions are characterized more by accommodation than confrontation, leading to agreements and recommendations. Their effectiveness in obtaining commitments to RAP implementation is influenced by public/private perceptions of legitimacy and reasonableness, and by the extent to which designated implementation organizations are involved in the process.

Financial support for the advisory committees is provided through a mix of funding from Brown County; Wisconsin General Program Revenues (GPR); Section 604(b) funding from the Clean Water Act appropriation; and federal, state and private grants. Staff support is supplied by the Brown County Planning Commission through contractual arrangements, and the WDNR.

The **MISSION** of the committees is to:

1. Advise the Department, other agencies, governments, private organizations, and citizens on RAP implementation priorities and coordination needs.

2. Promote cooperative efforts and an ecosystem approach to managing the River and Bay.

3. Seek implementation actions by designated lead agencies/organizations.

4. Represent the interests of citizens, business, government, and others whose cooperation will be needed to implement plan recommendations.

5. Build public awareness and support for the RAP.

Specific objectives of the committees are to:

1. Advise the WDNR and others on RAP implementation priorities and strategies including specific actions, timing, sources of funds, and other lead agency responsibilities.

2. Advise the WDNR on RAP updates or amendments, as needed.

3. Provide a forum for coordinating activities and resolving conflicts.

4. Review the implementation activities of designated lead agencies/organizations and provide a biennial progress report on RAP implementation and future priorities to the WDNR Secretary and the public.

5. Develop a strategy for getting and keeping the RAP on political agendas.

6. Provide for citizen input to the RAP.

7. Develop financial strategies and seek funds, grants, and agencies to implement **actions.**

8. Recommend staffing and a budget to support RAP committee activities.

Each year, the RAP advisory committees recommend implementation priorities and adopt work plans and a budget to guide implementation activities. Some of their priority activities and tasks for 1993 are included in Chapter IV of this report.

INTEGRATED RESOURCE MANAGEMENT IN THE FOX-WOLF RIVER BASINS

The WDNR-Lake Michigan District also created a Fox-Wolf Basin Integrated Management Team to coordinate internal planning, budgeting, and management activities within the basin. The Team consists of District administration, project managers, and program supervisors from each of the following projects in the basin:

Areawide Water Quality Management Plans
Lower Green Bay Remedial Action Plan
Lake Winnebago Comprehensive Management Plan
Nonpoint Source Priority Watershed Plans
Sewer Service Area Plans
Wasteload Allocation Updates
Dredging and Spoil Disposal

Objectives of the Integrated Management Team are to:

1. Identify WDNR program needs for the various projects and set basin-wide implementation priorities.
2. Coordinate project work planning with district programs, bureaus, and divisions.
3. Develop WDNR budget initiatives for basin projects.
4. Increase cross-program awareness of project implementation activities, timing, and needs, and maintain communication on priority issues.
5. Develop a mechanism for coordinated public education and participation efforts for basin projects.

RAP IMPLEMENTATION PROGRAM

Together the RAP advisory committees and the Integrated Management Team address a geographic area including the Wolf River, Upper Fox River, Winnebago Pool Lakes, and Fox River watersheds, and the waters of Lower Green Bay out to Point Au Sable and Long Tail Point.

The 1988 RAP established priorities and target dates for each of 120 recommendations organized under 16 Key Actions. At the onset of plan implementation, a critical path analysis identified the interdependencies between individual actions and the logical sequence and timing of implementation to achieve target dates and plan objectives. The critical path was updated annually by the RAP Implementation Committee and six technical advisory committees. The committees developed implementation strategies and annual work priorities based on the critical path analysis and plan recommendations.

These priority setting and work planning activities have been continued by the re-organized RAP advisory committees. The STAC and PEP committees identify annual implementation goals, objectives, and activities, and submit annual work plans to the PAC. The PAC sets overall direction, adds its own work plan to the package, holds an annual meeting, announced to the public, and approves the entire RAP work plan and a committee budget for the calendar year. The workplan is submitted to the WDNR as recommended yearly activities.

For the past two years, the advisory committees and RAP implementation program have focused most attention on several high priority issues: reduction of phosphorus and suspended solids loading to the Fox-Wolf system and the AOC; development of a strategy for remediating contaminated sediments in the Fox River; protection and restoration of lacustrine, palustrine and riverine habitats; and community outreach to increase public awareness and support for remedial actions. The committees carry out their mission and address implementation priorities through contacts with local governments, designated management agencies, and legislators. They seek consensus on management recommendations and promote remedial actions by the designated lead agencies/organizations.

Existing local, state, and federal programs and resources have been used wherever possible to implement RAP recommendations and achieve the desired objectives. The RAP also serves as a catalyst to develop new programs or reallocate funds. Where remedial programs and resources are lacking, the RAP committees strive to influence public policy and budget allocations. Implementation occurs with a variety of management tools, including regulations, cost-share incentives, pricing disincentives, and information/education to bring about reduced pollutant loadings and changes in consumer behavior.

PART B: REMEDIAL ACTIONS TAKEN TO DATE OR IN PROGRESS AND EXPECTED ENVIRONMENTAL RESULTS

The following information was compiled from WDNR program managers and local implementors, who have been active in RAP implementation since 1988.

Table 6 summarizes the progress on most of the high priority recommendations in the 1988 RAP. The environmental results of individual actions are often difficult to measure and may not be apparent for some years. The cumulative changes in environmental conditions of the AOC since 1987 are more fully described in Chapter II of this Update. Detailed descriptions of actions taken to date also may be found in the 1990, 1991, and forthcoming 1993 RAP Progress Reports.

Table 6. Remedial Actions Taken to Date or in Progress and Expected Environmental Results

I. ACTIONS TAKEN TO REDUCE TOXICITY IN THE ENVIRONMENT

A. ASSESSMENT OF SOURCES AND FATES OF TOXIC SUBSTANCES IN THE ENVIRONMENT

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
3.4-Identify and quantify all significant PCB Sources. 18.1-Complete mass balance study of toxic substances.	Municipal and industrial discharges, stormwater discharges, atmospheric deposition, landfill leachate, sediment **deposits** and tributary **loads have** been measured or estimated as part of the Green **Bay Mass Balance Study. Analysis was conducted at low levels of detection (ppt-ppq) and included some samples for PCB congeners. All samples have been taken and most analyses are completed. Results are expected to be released in 1993.**	**EPA** WDNR	**1989**	**1993**	Included as part of the Green **Bay** and Fox River Mass Balance Studies, 611 million - **EPA**	Will provide information about the relative importance of various PCB sources to the AOC which can be used to develop source control and sediment cleanup recommendations.
B. CONTAMINATED SEDIMENTS						
4.1-Determine mass and **availability of PCBs and other** contaminants in the river system.	Determined mass of PCBs, location and **volume** of **contaminated sediment** from Lake Winnebago to De Pare. Modeled fete and transport of PCBs in Fox River **and Green Bay** as part of **Mass** Balance Study.	WDNR	**1989**	**1993**	61,600,000 - WDNR 6 728,000 - **NOAA** 6 **420,000 - USGS** 6 130,000 - UW-Sea grant	Modeling results will be used in to assist in management decisions.
	Five Fox River sediment deposits were tested for **EPA** priority pollutants, acute and chronic toxicity and invertebrate population structure (tried assessment) and **compared** with a reference site.	WDNR	**1992**	**1993**	630,000	Results will be used to evaluate and rank deposits for potential clean up.
4.3-Establish Federal, state and local sediment remediation programs.	Legislature created the Sediment Management and **Remedial Techniques** Program (SMART) to identify contaminated sediment sites statewide, develop cleanup **criteria, conduct demonstration projects and coordinate sediment cleanup.**	WDNR	**1989**	**Ongoing**		Advance sediment remediation projects in Wisconsin.
	State Legislature passed Harbors and Bays Act Funding remedial action.	WDNR	**1990**	**Ongoing**	62.6 million/yr	Habitat restoration. Sediment cleanup.

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
	Feasibility study in progress for the Little Lake Butte des Morts ILLBM) Demonstration Project. Evaluating options for remediating a sediment deposit containing 18% of the PCB mass upstream of the De Pere dam. Pre-remediation monitoring conducted at LLBM.	WDNR, P.H. Glatfelter Co. WDNR, USFWS	1990 1992	March 1993 1993	0250,000 - WDNR for feasibility study $275,000 for FY '91-'92 - Coastal America $76,000 - EPA for design and engineering	Removal or isolation of 716 kg of PCB in LLBM.
	Assessment and Remediation of Contaminated Sediments Program (ARCS) - five year federal program to develop and test assessment and remedial action alternatives for contaminated sediments. Five ongoing demonstration projects in Great Lakes basin.	EPA-GLNPO	1989	1994	-	Assistance to state in applying technology to sediment remediation.
	Fox River Coalition - Cooperative effort of local industry, municipal, county, state and federal governments, and RAP advisors to set schedule of contaminated sediment remediation in the Fox River.	WDNR, Industry, Government	1992	Ongoing	-	Advance sediment remediation on the Lower Fox River.
C. POINT SOURCE DISCHARGES						
3.1-Complete rule adoption for water quality standards and associated effluent limit procedures for toxic substances. 3.8-Monitor and control discharge of bioaccumulating substances. 3.7-Recognize additive effects of toxics. 3.9-Use bioassays to monitor toxicity.	Water quality standards for toxic substances to protect human health, fish and aquatic life, and wild and domestic animals INR 106) and implementation procedures INR 106) were adopted in 1990. NR 106 and 106 are being implemented through WPDES discharge permits. Four industrial and one municipal permits in the basin now include monitoring requirements and effluents limits for toxic substances where necessary to meet water quality standards. Bioassays and whole effluent toxicity testing are also required. A recent court decision denied WDNR the authority to set mass limits for persistent bioaccumulative toxic substances not identified in NR 106 or without rule making.	WDNR	1986	1990 (Water Quality Standards reviewed every three years)	Rule development costs - low Implementation costs unknown	Standards and effluent limits are intended to protect human heath. fish and aquatic life and wildlife from acute and chronic toxicity associated with direct water discharges.

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
	EPA and the Great Lakes States are completing a Great Lakes Water Quality Initiative to establish uniform criteria and implementation procedures for state toxics programs. Wisconsin's water toxics rules will likely be revised based on the Great Lakes Water Quality Initiative.	EPA	1991	Expected 1993		Reduction in loading of toxic substances to the Great Lakes ecosystem.
3.2-Adopt antidegradation and mixing zone rules to protect Lower Green Bay.	A revised antidegradatlon policy MR 207) was enacted that provides protection from new discharges to Great Lakes waters. Policy is being implemented statewide and covers mixing zones for Great Lakes.	WDNR	1988	Rule enacted 1990	Low	New or increased discharges of toxic substances will be prohibited in most instances.
3.3-Adopt water quality standards and human health criteria for PCBs and other bioaccumulating substances.	State water quality standards (NR 105) for PCBs were revised to address total PCBs. Congener specific standards were proposed but not adopted due to lack of congener specific toxicity data. Water quality standards and effluent limits are now based on total PCBs instead of Aroclor mixtures. If the Great Lakes Water Quality initiative is adopted, Wisconsin rules would be revised and might incorporate criteria for PCB congeners.	WDNR	1990	1991	Low	The rule change is not known to have resulted in any reductions in existing discharges of PCBs; discharges already meet limits for total PCBs.
3.8 Evaluate and control ammonia toxicity.	Municipal Treatment Plant Upgrades:					
	Green Bay Metropolitan Sewerage District (GBMSD) is expanding and upgrading its facilities. Will meet new discharge limits set for ammonia, chlorine and organic waste, and potentially enhance treatment for P removal.	GBMSD	1990	September 1993	689 million - Total: 615 million - federal/state grant; $30 million - Wisconsin Fund loan; $24 million - local fees	Concentration of ammonia (NH3-N) will decline from an average of 8 ppm in 1990 to <1 ppm year round.
	City of Appleton completed plans to upgrade waste water treatment facility. Will increase capacity to remove ammonia, double capacity to prevent sewage bypassing during wet weather, reduce chlorine discharges and include a new sludge storage and treatment process.	City of Appleton	1990	Dec. 1993	689 million - Total: — $20 million - Wisconsin Fund Grants	Will reduce ammonia from the 1990 average of 19.5 ppm, eliminate sewage overflow and reduce chlorine discharges to the Fox River.

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
	The Heart of Valley Metropolitan **Sewerage** District (MSD) is **upgrading** to meet sludge **storage** needs and will be required to meet ammonia limits by May of **1995.** Heart of the Valley may seek an economic variance for a modified ammonia limit which could be achieved by their **present** facility. Also plan to conduct chronic toxicity testing to determine if ammonia is a problem.	Heart of the Valley **MSD**	1992	Sludge storage to be done in **1993,** Rest in **1996**		Meeting proposed ammonia limit could amount to approx. 60% reduction in ammonia discharge.
	Oneida Tribe **completed abandonment** of **old sewage** treatment facility and construction of new sewage collection system with connection to **GBMSD.**	Oneida Tribe	**1991**	1992	$1.5 million - Clean Water Fund Loan	Will eliminate **problems** with failing **STP and** onsite systems **and** improve of water quality in Duck Creek.
	Oshkosh is reviewing its sludge digestion process in order to meet new ammonia limits. Also completed plans for dechlorination.	City of Oshkosh	**1992** **1992**	May **1995** March **1994**	$14.3 million Clean Water fund $640,000 Loan	Will eliminate the potential for ammonia or chlorine toxicity in the effluent.
	Pulaski treatment facility plan for annexing to **GBMSD** is **approved.** Construction will **begin** in 1993. Will reconstruct lagoons for pretreatment to eliminate odors and **provide storage capacity.**	Village of Pulaski	**1991**	**1993-94**	$4.5 million - Clean Water Fund Loan	Water quality of Little Suamico River will improve.
D. AIR EMISSIONS						
11.11-Determine atmospheric deposition's contribution to toxic substances found in the Bay and River **and** establish **load** reductions.	Clean Air Act Amendments	**EPA**	**1990**	**Ongoing**	-	WI has achieved some reductions in air toxics through existing programs. Other reductions are pending implementations of the **CAA** and outcome of the **EPA** Great Waters Study. No specific numerical goals **have been established for individual AOCs.**
	Prototype air toxics monitoring program conducted at Bay Beach, Green **Bay,** Wisconsin.	WDNR	**1992**	Ongoing	-	Will assist in assessing **deposition** of **PCBs,** PAHs, pesticides **and non-volatile** metals in AOC.

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
	Air/water interface studies were conducted as part of the Green Bay Mass Balance Study to estimate volatilization of PCBs to the atmosphere.	EPA	1989	1992	.	Wet deposition of PCBs was estimated at 2-18 kg/year. Preliminary results of the Green Bay Mass Balance Study indicate that Green Bay acts as a source of PCBs to the atmosphere. Further research is needed on river-baylake atmospheric transfer of PCBs.

E. NONPOINT SOURCE RUNOFF

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
11.2-Evaluate and control urban stormwater discharges and runoff.	EPA Stormwater Regulations and WDNR Stormwater Permits for industries and municipalities.	EPA, WDNR	1992	Ongoing	Unknown	Purpose is to reduce pollutant loads from urban runoff including toxic substances, nutrients, sediments and BOD.
	East River Priority Watershed has an urban component which addresses stormwater discharges. See II. B. in this table.					Reduction in toxic substances from urban runoff into the East River.
11.1-Evaluate and control runoff of toxic substances from all watershed sources.	262 spills cleaned up in Fox River Basin.	WDNR, Responsible Parties	1987	Ongoing	Unknown	Prevent or reduce impact of spills to surface water and groundwater.
	Coal gasification sites identified and ranked for investigation and cleanup.	WDNR	1991		Low	
	Ongoing cleanup of leaking underground storage tanks. 682 underground storage tank cases in Lower Fox River Basin.	WDNR	1992	Ongoing	Unknown	Groundwater protection and cleanup to reduce potential for delivery of toxic substances to the AOC.

II. ACTIONS TAKEN TO REDUCE PHOSPHORUS (P) AND SUSPENDED SOLIDS

A. POINT SOURCES

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
1.1-Evaluate point source phosphorus loads and treatment plant capabilities, making reductions as soon as possible.	WDNR requested monitoring and reporting of net and total ortho phosphorus discharges by major industries which use Fox River water for processing. Net phosphorus monitoring and reporting is completed for most facilities.	Industries	1988	1990	Low	Information was used to update point source loads for this Update.

RAP RECOMMENDATION 1988	**ACTIONS TAKEN** OR INITIATED	**IMPLEMENTING AGENCY**	DATE INITIATED	**DATE COMPLETED**	**EXPENDITURE**	**EXPECTED ENVIRONMENTAL RESULTS**
	Three POTWs voluntarily reduced total P discharges and have evaluated capabilities to achieve P concentrations of 0.6 ppm or less (Green Bay MSD, De Pere STP, Neenah-Menasha STP). Green Bay MSD is continuing P reductions, while De Pere and Neenah-Menasha STPs have concluded feasibility studies which showed that achieving an effluent concentration of 0.6 ppm is possible at existing facilities. Reducing P discharges increased costs and sludge generation, handling and disposal needs. P removal has potential to remove some additional toxic': but may increase aluminum in effluent if alum is used for precipitant.	POTWs	1990	1991	– $0.50/ capita/yr; or an additional $60,000/yr for GBMSD	Total P discharges from Fox River POTWs decreased 8.6% from 1989 to 1990 while total flows increased by 15% (1990 also was an unusually wet year).
1.2-Establish phosphorus water quality standards.	Wisconsin adopted Administrative Rule NR 217 which extends the present 1.0 ppm total P effluent limit for large municipalities to many industries and smaller municipalities in the Great Lakes basin.	WDNR	1991	1992	Low	Conservative estimate for P reduction in Fox-Wolf Basin is 20,866 kg (46,000 lbs./yr.) or -12% of the point source load of P.
	Statewide rules for P Water Quality Standards are being developed and would allow establishment of site specific standards. The RAP recommended water quality standard for P in the AOC is 0.090 ppm (summer average). A technical advisory committee for P standards has been meetings since Feb., **1991.**	WDNR	1991	**Expected 1993-4**	Unknown	Will provide authority for requiring both point and nonpoint source reductions. Once passed, rules could allow more stringent P limits to be set for AOC.
1.3-Establish a wasteload allocation for phosphorus if necessary to achieve desired reductions.	Models are needed that describe the sources, movement and impacts of P in the Fox-Wolf-Winnebago system. No action will be taken until a P water quality standard is established. Watershed models for the basin are being developed by UW-GB and N.E.W. Waters of Tomorrow.	WDNR **UWGB** N.E.W.W.T.	1992	Ongoing	$150,000	Would allocate the necessary P reductions to meet water quality standards between point source discharges and nonpoint sources in the basin.

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
B. NONPOINT SOURCES						
1.4-Implement comprehensive management projects to reduce phosphorus loads and other pollutants from nonpoint sources in 11 targeted watersheds.	Priority Watershed Projects have been initiated in 6 of 11 recommended watersheds and provide cost-sharing and technical assistance to landowners and municipalities. Projects generally take 10 years to complete. Comprehensive management plans are prepared that Include specific goals for pollutant reductions and identify management practices needed to achieve goals.	WDNR, DATCP, Counties and Municipalities in the watersheds				If 75% landowner participation occurs then:
	Big Green Lake Watershed (99 ml') management plan implemented.	Green Lake County and Fond du Lac County LCDs	1981	1992	1.1 million	Protection of Big Green Lake
	East River Watershed (221 ml'): Management plan adopted and implementation is ongoing. 30 cost-share agreements signed.	Brown County LCD, Calumet County LCD, C. of Green Bay and De Pere, V. of Ashwaubenon and Allouez	1988	Expected 1999	For rural portion: $6.8 million (state share being $5.3 million). For the urban portion: $17 million (state share being $7 million).	P delivery to the AOC will be reduced by 70% and sediment delivery will be reduced by 50%.
	Lake Winnebago-East 190mi'): Management plan adopted and implementation is ongoing. 18 cost-share agreements signed and 2 land easements obtained.	Calumet LCD, Fond du Lac LCD	1989	Expected 2000	$2.6 million	P loadings to tributaries will be reduced by 40% and sediment by 50%.
	Arrowhead-Daggets Creeks (135 mi' I: Management plan adopted.	WDNR, DATCP, Winnebago LCD, Outagamie LCD	1990	Expected 2000	$2-3 million	Arrowhead-Daggets Creeks · P and sediment loads will be reduced by 60%.
	Neenah Creek Watershed (169 mi')	Adams, Marquette and Columbia County LCDs	1993	Expected 2001	-	Nonpoint Source inventories will determine necessary load reductions.
1.6-Seek innovative and alternative ways to achieve nonpoint source objectives in management programs.	Federal and state agricultural programs require cross-compliance with soil and water conservation plane for farmers seeking federal and state agricultural funds.	USDA & DATCP	1985	Ongoing	Unknown	Reduction In nonpoint sources of pollution in the AOC.

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
	State legislation is proposed (SB 44) that would require landowners who do not voluntarily participate in priority watershed projects to install necessary management practices at their own expense if determined to cause water quality degradation.	DATCP & WDNR WI Legislature	1992	Ongoing	Unknown	Would improve participation in nonpoint source management projects and reduce runoff pollution in critical areas.
	East River Water Quality Demonstration Project evaluates management practices to reduce commercial fertilizer use and milkhouse waste runoff.	SCS UW-Ext.	1991	Ongoing		Fifty landowners cut phosphorus use in 1992 by 80,000 lbs.
1.6-Require and use construction erosion and stormwater runoff controls.	De Pere Detention Ponds - Two stormwater detention ponds were completed in the City of De Pere as part of a demonstration project for the East River Priority Watershed.	City of De Pere	1989	1991	WDNR cost-share contribution ~$220,000	Reduction in urban nonpoint source pollutant loads to the East River and AOC.
	State model ordinances have been developed for construction site erosion control and storm water runoff. The following local governments in the AOC are considering or have adopted construction erosion ordinances: Brown County (ordinances under development in 1992); City of Green Bay (passed ordinance in 1991); City of De Pere (passed ordinance in 1992); Village of Allouez (passed ordinance in 1992); Village of Pulaski (developing ordinance in 1992) and Village of Ashwaubenon (passed ordinance in 1991).	Municipalities Counties Towns		See "Actions Taken" column	Most management practices are low cost although enforcement may cost the counties approximately $20-40,000/yr.	Construction erosion is believed to be a substantial source of sediment and potentially nutrients to the AOC although it is not known how much reduction will be achieved specifically through these ordinances.
	New state legislation will make local ordinances mandatory for construction of 1-2 family homes. Construction erosion control ordinances are now required of local governments participating in new priority watershed projects. Lack of local enforcement is a concern.		1992	Ongoing	Unknown	
	EPA now requires that a Notice of Intent to Discharge be filed with WDNR for all construction sites > 5 acres and that a construction erosion control and stormwater plan be submitted.	EPA, WDNR		Ongoing	Unknown	

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
1.7-Require shoreland buffer strips and green strips using shoreland zoning, easements or other land use controls.	Shoreland wetland zoning exists statewide and provides some protection to wetlands adjacent to streams and lakes. However, maintenance of natural vegetation adjacent to surface waters is not required statewide.	Municipalities Counties Towns	1980 and 1983	Ongoing	Low	Preservation of wetlands and maintenance of buffer strips will reduce shoreland erosion and help filter pollutants from land runoff. In Brown County as of Feb., 1993, 108,665 feet of stream shoreline were protected from livestock; an estimated 80,000 tons of soil erosion was prevented. 76 property owners cooperated, fixing what is estimated to be 65% of the problems caused by livestock in streams. Degraded streambanks have recovered quickly.
	Brown County has expanded its shoreland/floodplain zoning ordinance to require setbacks from perennial streams for agricultural land uses that impact water quality, including 35 ft. for row crops and 16.5 ft. for livestock pasture or barnyards. Over half of Brown County farms now fence livestock away from streams. The new ordinance will cover most of the rest of the farms. ASCS, Farmland Preservation tax credits, or priority watershed cost-sharing helps pay for streambank fencing.	Brown County LCD, ASCS	1991	Ongoing	$42,000 - cost share funds $18,000 landowners (as of Feb., '93)	
	DATCP is developing a state model ordinance to exclude livestock from streams. Model ordinances will be considered for state law.	DATCP	1992	1993	Low	
1.8-Adopt animal waste management ordinances and uses best management practices.	All counties in the Fox/Wolf basin except Waushara County have adopted animal waste management ordinances. However, some county ordinances adopted prior to 1988 do not regulate waste spreading. 58 animal waste management applications processed in the Fox-Wolf River Basin. 63 waste management plans prepared.	Counties	1985 1990 1990	Ongoing	Unknown	Ordinances intended primarily to protect groundwater quality although ordinances which cover waste utilization will reduce the runoff of animal waste to surface waters. The impacts have not been quantified.
	Farmland Preservation program for Brown County requires cattle to be fenced out of streams. 129,250 acres enrolled in Brown County program.	Brown County LCD		Ongoing		Reduction in erosion and nutrients entering Brown County waterways.

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
	The Water Quality Demonstration Project - East River - is one of sixteen pilot projects nationally to demonstrate technology for reducing surface and groundwater contamination from agricultural activities. Hosts on-farm demonstrations and funds the implementation of some best management practices.	SCS, UW-Extension	1990	1994	~$1,250,000 is a conservative estimate for whole project	Will result in a better informed agricultural community and increased installation of best management practices to reduce nonpoint source pollution.
2.1-Include additional land in Conservation Reserve Program.	The Federal Conservation Reserve Program has been changed to expand eligibility to cropped lands adjacent to streams. Additional enrollments have allowed more agricultural land to enter the program. Regional enrollment: Brown County - 1300 acres Calumet County - 5000 acres Fond du Lac County - 700 acres Outagamie County - 5000 acres Winnebago County - 10,400 acres	SCS	1989	Ongoing	Unknown	Reduced soil erosion and sediment delivery to the AOC will result in greater water clarity, increased submerged vegetation, improved stream and spawning habitat, and reduced sedimentation in navigational channels.
III. ACTIONS TO MAINTAIN ADEQUATE DISSOLVED OXYGEN						
5.2-Continue to periodically review and revise wasteload allocations on the Fox River.	By law the BOD Wasteload Allocation for Fox River must be reviewed and refined every 5 years. Most recent review was in 1990.	WDNR, Industries, POTWs	1977	1985 with periodic revisions	Estimated $300 million 1972-1985 to upgrade municipal and industrial wastewater treatment plants	Further restricts BOD discharges so dissolved oxygen levels are maintained and protected during low flow and high water temperature seasons.
IV. ACTIONS TAKEN TO INCREASE PREDATOR FISH AND CONTROL PROBLEM FISH						
8.4-Re-introduce muskies to Lower Bay as water quality improves.	Musky fingerlings released to river and Bay: 10,000 in 1989; 1,283 in 1990; 2,624 in 1991; and 2,259 in 1992.	WDNR, local musky clubs	1989	Ongoing	$4,500 - WDNR $24,775 - local donation	Increase in spotted musky, a top predator fish and reduction in over abundant forage fishes.
8.1-Continue and expand walleye management program.	1,100 feet of rock spawning habitat for walleye constructed at three Fox River sites.	WDNR, City of De Pere	1990	1990	$35,000 - WDNR $9,000 - City of De Pere	Increase walleye and other fish spawning habitat.
	Walleye sport regulations enacted to restrict harvest.	WDNR	1989	1989	Unknown	Protect current walleye stock and increase future walleye population.
8.2-Continue yellow perch management program and complete research projects.	Sport and commercial regulations enacted to increase yellow perch population.	WDNR	1991	Ongoing	Unknown	Stabilize yellow perch population.

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
7.1-Complete program to prevent sea lamprey migration into the Fox-Wolf River basin and Lake Winnebago.	Permanent barrier to sea lamprey migration constructed at Rapide Croche Dam.	WDNR, U.S. Army Corps of Engineers, USFWS Sea Lamprey Control Unit	1987	1988	$120,000 Great Lakes Fishery Commission	Sea lamprey have since been detected at De Pere dam. Barrier will prevent infestation upstream into Fox-Wolf-Winnebago system where population management would be impossible.
7.4-Evaluate potential for white perch to impact the Green Bay Fishery.	Survey of exotic white perch conducted.	WDNR	1990	1992	$3,000 - WDNR	Measure white peroh abundance in order to determine potential impacts of this exotic species to the AOC.
V. ACTIONS TAKEN TO PROTECT WETLANDS AND MANAGE HABITAT						
8.1-Continue acquisition of west shore wetlands.	Land Acquisition: 166 acres within the boundaries of West Shore Wildlife Area and 113 acres just north of Duck Creek.	WDNR	1948	Ongoing	$100,000	Program provides relatively permanent protection for critical west shore habitats.
6.2-Establish goals for wetland and other habitat protection and use existing authorities to achieve them.	Special Wetland Inventory Study to map critical coastal wetlands is being conducted on Green Bay. Field work completed. Being digitized by WDNR Wetland office.	EPA, USFWS, WDNR	1990 field work started	1992 field work completed; report expected in July 1993	$180,000	More accurate information for protection of critical wetlands and fluctuating coastal wetlands.
	GIS was used to map fish and wildlife habitats, wetlands under both low and high lake levels, bulkhead lines, recreational access/facilities, public ownership, and other resources of the AOC.	Bay-Lake Regional Planning, RAP Technical Committees	Oct. 1990	Sept. 1991	$16,088 Bay-Lakes Regional Planning Commission: $12,600 WI Coastal Management Program	Maps used to set goals and priorities for habitat protection.
6.3-Continue adoption and strict enforcement of local wetland zoning.	Shoreland/wetland zoning regulations have been adopted by all counties and municipalities in the basin and offer some protection for wetlands in the shoreland zone.	WDNR, Counties and Municipalities	1980	1990 ongoing enforcement	Unknown	Offers some protection from development of wetlands in the shoreland zone (wetlands within 300' of a navigable stream or 1000' of a lake).
6.4-Consider additional wetland protection measures.	Administrative rules to establish water quality standards for wetlands have been approved (NR 103). The rules have the potential to protect wetland habitat from activities that would result In water quality impacts. No NR 103 actions have occurred in AOC to date.	WDNR	1990	1992	Low	NR 103 is intended to protect water quality from degradation, not habitat. The potential benefits to habitat are unknown.
6.6-Encourage private wetland preservation.	20 private pothole wetlands restored in the Fox River basin (10.6 acres)	USFWS, WDNR, SCS				Increase in wetland habitat for migratory waterfowl.

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
6.6-Change bulkhead lines as necessary to protect habitat.	Field surveys conducted to assess littoral/wetland habitats that may be threatened by development behind bulkhead lines.	RAP STAC-Biota and Habitat Work Group, Municipalities, WDNR	June 1992	Oct. 1992	Low	Surveys will be used to request bulkhead line changes in AOC, where necessary to protect wetland habitat.
6.9-Develop and use habitat enhancement methods.	Administrative rules for the Priority Watershed Program (NR 120) were revised and make best management practices that provide habitat as well as reduce nonpoint source pollution eligible for cost-sharing under the program.	WDNR		Nov. **1989**	Low	Will provide cost-share incentives for protecting and restoring fish and wildlife habitats in the priority watersheds of the Fox-Wolf basin.
VI. ACTIONS TAKEN TO MONITOR ECOSYSTEM CHANGES						
15.2-Increase fish and wildlife tissue monitoring to evaluate trends.	Fish and wildlife from the River and Bay are periodically sampled for contaminants like PCBs, mercury, and pesticides. Green Bay Mass Balance research included fish tissue monitoring.	WDNR WDNR, **EPA**	1977 1990	Ongoing **1992**	$13,000- AOC in 1992 $13,000 - above De **Pere**	Monitors the incidence and concentration of toxic substances that may be of concern to human health. Results **are used** to **update** public fish consumption advisories and assess long term trends. Trends continue to show slow declines in PCB levels in fish.
16.4-Monitor trophic **statue.**	Trophic state conditions are surveyed annually in the AOC during May-Sept. Trophic conditions in the whole Bay were surveyed at long-term trend stations.	**GBMSD** WDNR, **GBMSD**	1988 May 1992	Ongoing Oct. **1992**	$46,000/yr $60,000	Information used to develop trophic state models for AOC and to track water quality response to nutrient and solids loading. **Assess** the impact of nutrient and solids **loading** to AOC on water quality and trophic conditions in the entire Bay.
15.7-Monitor endangered tern species population trend° reproductive success in PCC	Study of Forster's terns hatching, fledging and growth rates.	UW-Green Bay, **EPA**	1988	1989	$60,000	Results indicate that Forster's terns are sensitive to dioxin-like PCB congeners. 1988 hatching rates were improved over 1983. **Fledging** and growth rates revealed higher mortality than control populations.
16.8-Continue monitori n i population trends and h~ a	Fish populations in the Bay and River are surveyed for relative abundance and young of the year.	WDNR	**1988**	Ongoing	$160.000 since 1988	Tracks changes in fish community structure as management actions are taken and monitors abundance of exotic fish species.
15.9-Continue to monit, ^thic (bottom dwelling) organ	Zebra mussels and their larval stage (veligers) are monitored in the Bay, Fox River and Lake Winnebago.	UW-Sea Grant	1990	Ongoing	$1,000/yr	Both veligers and adult mussels have been found in the AOC.

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
	Benthic invertebrate populations of the River and Bay are surveyed periodically (every 6 yrsl to track population changes in response to water quality changes.	Integrated **Paper** Services **supported** by industry (formerly institute for paper chemistry), WDNR	1970s	Ongoing	Unknown	Benthic **macroinvertebretes** are **good indicators** of environmental **change.** Surveys show continuing trends of **improvement** but also show areas of persistent problems.
15.10-Periodically map rooted aquatic plants in the Bay.	Surveys of **submerged** aquatic plants **revealed** beds of wild celery, a desired waterfowl food, along the west shore north of AOC.	UW-Green Bay	1988	**1990**	$34,000	Study defined relationship of water clarity to growth of **submerged** aquatic vegetation.
16.11-Survey public attitudes on River **and Bay** issues. 1 **5.12-Periodically** measure people's use of *the Bay* and River.	Public **perceptions** of water quality, public use and willingness to pay for remedial actions were surveyed in Brown County.	UW-Green Bay, Center for Public Affairs	**1989**	**1990**	$25,000 - WI Coastal Management **Program** $25,000 UW-GB. WDNR	Survey showed substantial public use of the River and Bay, perception of poor *water* quality, general support (90%) for **RAP goals, and** a willingness to *pay* for actions that result in restored uses (ave. $32 per household).
1 5.13-Collect and update socioeconomic and demographic information that will help in assessment of management options for the Bay and River.	A **cost-effectiveness** study of alternative remedial actions under future socioeconomic and **demographic** conditions is being conducted.	N.E.W. Waters for Tomorrow (non-profit)	**1992**	1993 for first cut analysis	$160,000	Will provide an **assessment** of future **economic/public use conditions and cost-effectiveness** for use in selecting remedial actions.
VII. ACTIONS TAKEN TO IMPROVE PUBLIC ACCESS AND RECREATIONAL OPPORTUNITIES						
1 4.1-Evaluate and upgrade boat launch facilities. 1 4.4-Develop shoreline fishing facilities, 1 4.5-Protect and develop **recreational and environmental** corridors.	Green Bay Metro Boat Launch near the mouth of the Fox River **expanded and upgraded** to provide 8 new launch lanes/docks, a **comfort/education facility, and expanded** parking. Fishing pier is planned.	City of Green Bay, Green Bey Metropolitan Sewerage District	**1991**	**Expected 1993**	$391,000-WDNR $391,000-City of Green **Bay** **$113,500-GBMSD** (comfort facility)	Increased opportunity for water-based recreation and other public uses in the AOC. Public use is related to public support for **environmental** protection and restoration.
	Access site near the mouth of Duck Creek i**mproved.** Includes **boat** launch, **handicapped-accessible** fishing pier and picnic **area.** Nature **boardwalk** will **be completed** in winter of 1993.	Village of Howard	1 **991**	**Expected 1993**	**683,000-WDNR** $83.000-Village of **Howard** $6000-Brown County **Sportmen's** Alliance	
	Fox Point-a new six **lane boat** launch was built on the east side of the **Fox** River in De Pare.	City of De Pere	**1988**	**1991**	6930,000-WDNR $26,000-City of De Pere	

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
	Improvements to Voyager Park in De Pere - included shoreline fish facilities with **handicapped accessible areas, expanded park** trails and construction of two fish spawning reefs.	City of De Pere	1989	1992	$58,000-WDNR 827,000-De Pere	
	East River Parkway expansion continues. Land acquisition planned in Village of Bellevue. Trails and fishing platforms added in Village of Allouez.	Communities along East River.	1970's	Ongoing	$33,000-WDNR (for trails and fishing platforms in Allouez in 1992) 8260,000 in WDNR grants since 1970's	
	Boarding dock **added** at Ashwaubenon Creek boat launch.	Village of Ashwaubenon	1992	1992	8900-WDNR	
	Suamico boat launch **upgraded** to include improved parking lot, four lane launch, comfort facility, shoreline fishing.	Brown County	1990	1991	$197,000-WDNR	
	Land acquisition for open space along Bay Beach continues.	WDNR	1970s	Ongoing	8800,000-WDNR	

VIII. ACTIONS TAKEN TO IMPROVE PUBLIC AWARENESS PARTICIPATION AND SUPPORT FOR RIVER AND BAY RESTORATION

13.2-Develop public information programs. 13.3-Develop public education programs.	Adopt-a-Waterway, a water-quality pilot project was tested with 10 teachers from the Green Bay school system. Students test the water quality of area streams in fall and spring.	University of Wisconsin Extension, Public Education and Participation Committee, Green Bay area schools	1990	Ongoing	84,000 annually to maintain present level of participation. 1990-91 pilot program funded by: $1,000-Natural Resources Foundation $1,000-Walmart Foundation 82,100-Brown County Conservation Alliance 8400-Green Bay Chamber of Commerce 8500-RAP Public Advisory Committee (PAC)	Improved public awareness of and support for Fox River/Green Bay restoration. Expect to increase individual actions to reduce water pollution.

RAP RECOMMENDATION 1988	ACTIONS TAKEN OR INITIATED	IMPLEMENTING AGENCY	DATE INITIATED	DATE COMPLETED	EXPENDITURE	EXPECTED ENVIRONMENTAL RESULTS
	"Clean Bay Backer" Awards - annual awards given to a citizen, local government, school/youth group, civic organization and business for exemplary efforts which aid in River/Bay restoration or public awareness of River/Bay issues.	PEP Committee	1990	Annual Event	$1,000/yr RAP-PAC	
	RAP and nonpoint source education exhibit at Green Bay Metro Boat Launch has been designed by the PEP Committee.	PEP Committee	1991	Expected 1993	610,000 EPA 416,000 WDNR 4 6,000 RAP-PAC Space has been provided by Green Bay Metropolitan Sewerage District and the City of Green Bay.	
	The "State of the Bay" report was published in 1990 and is currently being updated to focus on nonpoint source pollution and contaminated sediments.	UW-Green Bay, Institute for Land and Water Studies.	1989 1992	1990 - First Edition 1993 - Update	621,000 - WI Coastal Management Program UW-GB 830,000 - RAP-PAC, Fort Howard Corporation and others	
	Host a RAP exhibit at area expositions like the Home and Garden Show and Sports Fishing Show.	UW-Extension, PEP Committee	1990	Annual	6400- UW-Extension	
	River/Bay Cleanup Day - annual event for volunteers to collect trash along the River and Bay shores.	PEP Committee, Wisconsin Public Service, Fox Valley Sierra Club and others.	1989	Annual	$300/yr Wisconsin Public Service, RAP-PEP and others.	

PART C: POLLUTION PREVENTION ACTIVITIES IN PROGRESS

Pollution prevention is defined as the use of material processes, practices, products, or planning which reduce, eliminate, or avoid the generation of pollutants. There are three major modes of reducing pollution effects on the environment: pollution prevention, pollution control, and pollution remediation. Traditionally, regulatory agencies, such as state natural resource agencies, have relied on pollution control or "end-of-pipe" measures to control the release of pollutants into the environment. Pollution remediation measures are used to mitigate the effects of pollutants after they have been released into the environment.

Pollution prevention focuses, instead, on eliminating or reducing the use, generation, or release of pollutants, hazardous substances, and wastes at the source. Preventive approaches reduce the use of hazardous and nonhazardous chemicals that produce pollution, and minimize the transfer of pollution from one environmental medium to another (e.g. water to air).

LOCAL INITIATIVES

In the Green Bay AOC, efforts are underway by the WDNR, citizen advisors, U.W. Extension, and the County Land Conservation agencies to promote the use of pollution prevention strategies. Members of the STAC developed a survey of 134 industries in the five county area of the Fox River Basin to assess the types of pollution prevention activities in use and to recognize exemplary pollution prevention efforts through nomination for a Clean Bay Backer Award. The Awards are given annually to a business, community, organization, citizen, and school/youth group that has taken positive action during the year to help implement the Lower Green Bay and Fox River RAP.

The survey consisted of eight brief questions about the company, its past pollution problems, and its present pollution prevention activities. It was sent to the chief executive officer of industries which are required to report annual toxic releases and to selected companies from 21 industrial categories.

The percentage of responses to the survey was extremely low. Only six percent of the companies responded, submitting a total of eleven possibilities for consideration for the Clean Bay Backer Award. Follow-up contacts failed to increase the number of responses. Perhaps a lack of time to respond to surveys and confusion about the concept of pollution preventior resulted in the low response.

Regardless, it is clear that on-going pollution prevention activities must be made more visible, and that new initiatives are needed if the shift from clean-up to prevention is to occur on a large scale.

The committee nominated two of the eleven submissions for the Clean Bay Backer Award; both were in the Business and Industry category -- Astro Industries, a member of the electroplating industry, and Krueger International, a metal office furniture manufacturer. Those two, as well as others that excel in the area of Pollution Prevention, will be recognized in an article in the Wisconsin Natural Resources magazine. The article's intention is to publicize and stimulate outstanding pollution prevention activities.

RAP Committees will continue to work with the WDNR and other agencies to develop a technology transfer network so that successful approaches can be implemented by other businesses and industries throughout the Fox River Basin and upstream areas.

Local Government Assistance: EPA shares its resources to help launch pollution prevention initiatives in state and local entities. EPA is supporting Wisconsin's effort to develop a statewide pollution prevention strategy and integrate pollution prevention into all environmental quality programs. It will foster technology transfer, innovative approaches, and financial assistance for hazardous waste reduction, particularly among small and medium-sized businesses. The program will promote pollution prevention as the best way of complying with new toxic air and water quality regulations.

Local Non-Government Assistance: The Lake Michigan Federation, with support from a Great Lakes Protection Fund grant, is currently working on a pollution prevention project involving several **sewerage** districts in the Lake Michigan region. Goals of the project are to provide information exchange among the Districts themselves, to develop and disseminate public educational materials, and to host a series of workshops for Pretreatment Program industries, which are those that must treat wastewater to remove or reduce toxic materials before discharging to POTW.

FEDERAL STRATEGY

Efforts in the AOC and surrounding Fox-Wolf Basin are supported by efforts at the federal and state level. The following federal and state information was obtained, in part, from the Waste Reduction Institute for Training and Applications Research Corporation on contract with the EPA.

When Congress passed the Pollution Prevention Act of 1990, it marked a new federal attitude toward environmental protection. While much improvement on the environment has been achieved by environmental regulation governing individual media, it is now well understood that pollution undergoes cross-media transfers and stems from dispersed, non-point sources. Therefore, preventing pollution from the start is the ideal way to minimize or remove threats to the environment.

The Pollution Prevention Act 1990 declares pollution prevention to be a national policy and establishes a hierarchy of environmental management whereby pollution should be prevented or reduced at the source whenever feasible. Where pollution cannot be prevented, it should be recycled in an environmentally sound manner. Where there are no feasible prevention or recycling opportunities, pollution should be treated. Disposal should be used as a last resort. The EPA is charged with promoting pollution prevention as the preferred approach to enhancing environmental protection and reducing environmental risks. This has been a tremendous undertaking for this agency, because the multi-media approaches required to prevent pollution differ so greatly from the EPA's traditional methods of end-of-pipe pollution control. Nevertheless, the EPA has made pollution prevention one of its highest priorities.

33/50 Project. EPA Region V is working towards the objectives of the 33/50 project, a national EPA voluntary pollution prevention initiative aimed to reduce the emissions of 17 different toxic chemicals from industrial sources. The goal of the 33/50 project is to reduce aggregate environmental releases to all media from industrial facilities of these targeted chemicals, as measured by the Toxic Release Inventory as a baseline, by 33% by the end of 1992 and at least 50% by the end of 1995.

STATE STRATEGIES

The state funds two programs designed to approach directly pollution prevention issues and has authorized the formation of an advisory board composed of various industry, government, and interest group representatives. All these efforts are supported by specific pollution prevention legislation, 1989 Wisconsin Act 325. This act creates state statutes related to reducing the use and release of hazardous substances, toxic pollutants, and hazardous waste. It also provides Hazardous Waste Pollution Prevention Audit grants which provide up to $2,500 with a 50% match from the industry applicant. These audits are to be used to identify processes that reduce the production of hazardous waste and identify pollution prevention options. The combination of services offered by these programs cover the range of those usually available to those involved in exploring pollution prevention opportunities.

The Hazardous Pollution Prevention Board is the guiding force behind hazardous pollution prevention in the state. Made up of a variety of public and private sector specialists, the Board recommends educational priorities, provides advice to various state departments and groups, and reports to the Governor and the Legislature regarding the progress of the state's pollution prevention efforts. The Board also awards Hazardous Pollution Prevention Audit Grants in an attempt to assist interested businesses discover pollution prevention opportunities on their production lines.

The WDNR also contributes to the state's pollution prevention effort through the Office of Pollution Prevention and the Hazardous Waste Minimization Program. As part of the state's regulatory structure, the Office is responsible for training state regulatory personnel regarding pollution prevention issues. The Hazardous Waste Minimization Program operates an information clearing house and a limited technical assistance program; it sponsors outreach workshops for industry, and publishes a newsletter concerning pollution prevention issues.

The newest element of the state's pollution prevention effort is the Solid and Hazardous Waste Education Center. As part of the University of Wisconsin-Extension, the Center's staff is able to draw on the extensive resources available through the University in answering technical assistance questions. The Center's pollution prevention program strives to provide Wisconsin's businesses and local governments with the training and technical support necessary to initiate programs that will result in reducing the generation of hazardous wastes and the release of toxic substances to the air, water, and land. As the Center's reputation grows with state businesses, it hopes to make a positive impact on technological transfer and innovation as they relate to pollution prevention. It will take the WDNR's Office of Pollution Prevention and the Center time to assemble and distribute the data available to those concerned. The provision of effective technical assistance will also depend upon the Center's ability to access experienced pollution prevention personnel.

In Wisconsin, as in most states, the success of pollution prevention efforts will hinge on the state legislature's continued funding of the programs in place. Although the various services available in the state seem to be distributed with a minimum amount of duplication, greater funding is **necessary** to expand services. If pollution prevention is to be an alternative or a supplement to regulatory programs, then the resources necessary to reach all sectors of industry and agriculture must be made available to public or private entities engaged in pollution prevention education.

CHAPTER SUMMARY

More than three quarters of the 120 remedial actions recommended in the 1988 RAP have been implemented or are in progress. Thirty-eight actions are completed or are being carried out through established, ongoing programs. Another fifty-seven actions have been initiated, and twenty-five actions have had little or no progress.

Many of the actions completed have been short-term, lower-cost projects that demonstrated an immediate environmental result or institutional commitment to the

RAP (e.g. sewage treatment plant reductions in phosphorus discharges and public access improvements). Other actions set the stage for long-term, sustained programs needed to address the extensive problems of nonpoint source pollution and toxic substances contamination (e.g. priority watershed projects and regulations for toxic substance discharges/emissions). Still other actions involve monitoring and research programs to further define use impairments or their causes, evaluate management alternatives, and/or track ecosystem changes as implementation progresses (eg. the Green Bay and Fox River Mass Balance Studies, NEWWT cost-effectiveness analysis, and trophic state monitoring).

Some actions, such as adoption of state water quality standards for PCBs or passage of the Clean Air Act amendments, would have occurred without the RAP. Other action, such as passage of a streambank livestock exclusion ordinance in Brown County is a prime example of a local entity (the Brown County Land Conservation Department) taking the initiative to implement RAP recommendations. Most actions taken to date have been initiated by the organizations participating directly on the RAP advisory committees or located in the immediate vicinity of the AOC. More effort is needed to expand implementation activities by local governments upstream in the Fox-Wolf River basin.

While point source discharges of pollutants, including toxic substances, are increasingly controlled through regulations, nonpoint source and in-place pollutants remain largely uncontrolled and continue to impair the Fox River and Lower Green Bay. To achieve the large reductions heeded in nutrient and suspended solids loadings, and to reduce the nonpoint contributions of toxic substances, more aggressive and wide-spread controls of both rural and urban nonpoint sources are necessary.

The degree and extent of contamination and resource degradation in the AOC has resulted from nearly 100 years of land use changes and pollutant releases. There are no "quick fixes" to remediate the damages and restore beneficial uses. Full restoration will take decades of sustained commitment to pollution prevention, contaminant clean-up, habitat enhancement, better land management and facility redevelopment. This commitment is sought through continued involvement of stakeholder groups, inter- and intra-agency coordination, political contacts, and public education and information programs.

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CHAPTER IV
1993-1994 - IMPLEMENTATION AGENDA

INTRODUCTION

This Chapter describes a rationale for selecting remedial actions; it presents updated goals and objectives which are the basis for continued implementation of the RAP, and it outlines a course of action for **1993-1994.**

Part A presents the results of a **1991-1992** EPA-supported workshop on Green Bay Environmental Risk Assessment. **Workshop participants** identified those environmental problems/stressors that **pose** the **greatest** risk to the Green Bay ecosystem.

Part B presents updated goals for the AOC and watersheds throughout the Fox-Wolf Basin. Specific objectives are presented for the most pressing environmental issues faced in the AOC: water quality protection and improvement, habitat enhancement and restoration, fish and wildlife management, and the maximum levels of toxic substances **allowable** to protect human, fish, and wildlife health and reproduction.

Part C presents a more in-depth description of several key issues which the RAP program, its advisory committees, the WDNR, **and** other implementing agencies plan to address during 1993. It contains **generalized** work plans that outline the best approaches to achieve nutrient reductions, **clean-up** of Fox River sediment, and habitat protection and restoration. These work plans identify likely implementors. This section does not present detailed, updated recommendations, timetables, or costs. Detailed project **proposals** developed during the year will be included in a 1994 report to the EPA.

PART A: ENVIRONMENTAL RISK AND IMPLEMENTATION PRIORITIES

ENVIRONMENTAL RISK ASSESSMENT

Environmental risk assessment is useful in setting priorities for remedial actions in the AOC. Environmental risk may be defined as the potential harm to human health, the structure and function of the ecosystem, the economic system, and/or the quality of human life.

Strategies for environmental protection and pollution prevention should be targeted at high-risk stressors and should be based on those actions which offer the greatest opportunities for risk reduction.

The Science Advisory Board of the EPA has recommended that risk reduction strategies become the centerpiece of environmental management, and that environmental risk assessment be based on a more comprehensive, ecological approach than the traditional human health risk assessment [85].

Stresses on the River and Bay ecosystem due to human and natural influences have been identified through the 1988 RAP and previous studies [6]. The primary stressors affecting the Green Bay ecosystem were identified as:

* nutrient (phosphorus) loading
* suspended solids loading
* persistent, bioaccumulative chlorinated organic compounds, i.e. PCBs
* heavy metals, i.e. Hg, Pb, Cu, Cr, Cd, Zn, As
* nonpersistent toxic substances, i.e. ammonia
* BOD (biological oxygen demand) loading
* exotic species invasions
* wetland/shoreland filling
* fish and wildlife harvest
* loss/degradation of habitats
* bacteria
* poor aesthetics

To identify which of these pose the greatest environmental risk to Green Bay, a case study was conducted in 1991-92 by the University of Wisconsin-Green Bay Institute for Land and Water Studies and the U.S. EPA [19]. A methodology was developed for the study in which people with extensive knowledge of the Green Bay ecosystem assigned environmental risk values to ecosystem stressors based on 1) the degree to which a particular stressor contributes to impaired uses; 2) the duration of the impacts, or length of time required for the ecosystem to recover beneficial uses after the stressor is reduced/eliminated; 3) the capability (technological and economic) to manage the stressor through preventive actions; and 4) the capability (technological and economic) to manage the stressor in the environment through remedial actions, i.e. clean-up. Socio/political feasibility was excluded from the analysis.

After reaching group consensus on appropriate risk values, mathematical analyses were used to integrate the results of the assessments for stressor impact, impact duration, and manageability. Stressors were ranked in order of their relative risk to the Green Bay ecosystem.

The integrated assessment of environmental risk to the Green Bay ecosystem resulted in the following ranking of stressors:

Relative Risk	Rank	Environmental Stressor
Greatest Risk	1	Wetland/Shoreland Filling
	1	Exotic Species Invasions
	2	Persistent Bioaccumulative Organic Substances
	3	Heavy Metal Contaminants
	4	Nutrient Loading
	5	Suspended Solids Loading
	6	Biochemical Oxygen Demand Loading
	7	Nonpersistent Toxic Substances

The case study for Green Bay leads to several conclusions: stressors that have large impacts, result in long-term or irreversible alteration of the ecosystem, and are difficult to remediate pose the greatest environmental risk; therefore, wetland and shoreland filling, exotic species invasions, and persistent bioaccumulative organic chemicals are high priority candidates for preventive management strategies. The stressors judged to have the greatest present impacts on the Lower Green Bay ecosystem, namely phosphorus and suspended solids loading, are relatively short-lived and manageable. BOD loading, which is popularly believed to have been resolved, remains a significant present day stress on the Lower Bay and Fox River. Small-scale problems, such as individual nonpoint sources of pollutants and isolated wetland fills, can be magnified into large-scale problems at the ecosystem level.

The results of the risk assessment workshop have implications for implementing the Lower Green Bay and Fox River Remedial Action Plan and restoring beneficial uses of the Green Bay ecosystem. An improved ability to identify and compare environmental risks will help to set priorities and target resources at the most effective risk reduction strategies for Green Bay. The relative risk of particular stressors may change, however, as understanding of the Bay ecosystem evolves. Further, RAP monitoring and surveillance programs should be designed to assess, compare, and track the reduction of stressors and environmental risks.

COST-EFFECTIVE RISK REDUCTION

Once the most important environmental risks are identified, it will be prudent to seek the most effective, yet economical, risk reduction strategies. There are limited resources to carry out remedial actions, and decisions regarding resource allocations should be based not only on programmatic mandates but aiso on risk reduction priorities and cost-effectiveness.

The environmental risk assessment for Green Bay and the RAP have identified those stressors which pose the greatest risk to the River and Bay ecosystem. There are a large number of alternative remedial and preventive actions that may be taken to relieve stresses and reduce environmental risk. The next task is to identify which mix of actions will achieve the greatest risk reduction and meet the appropriate objectives and standards for the least cost.

A cost-effectiveness analysis of remedial and preventive management strategies for the Green Bay RAP is being carried out by a multi-disciplinary team under the direction of an independent, nonprofit organization, NEWWT. The analysis is designed: 1) to describe the existing and potential future economic conditions and societal demands for resource uses in the AOC; 2) to examine the effectiveness and costs of various management alternatives for protecting remaining wetland habitats in the AOC and for reducing inputs of high risk pollutants, primarily phosphorus, suspended solids, and PCBs; and 3) to estimate the uncertainties of the variables involved and their implications for the analysis.

A first-cut analysis is expected to be completed in the summer of 1993 and will be available to the RAP advisory committee and the WDNR. The analysis may prove useful to implementing agencies, local governments, and others in selecting the best combination of remedial and preventive actions that achieve RAP goals and objectives. The study is intended to add another dimension to the Green Bay RAP -- that of cost-effectiveness -- and to provide additional information useful for making resource management, policy and budget decisions. The results of the first year's efforts will be used to define the need for and scope of additional analyses.

PART B: GOALS AND OBJECTIVES

The following section provides revised goals and objectives from the 1988 RAP. While the goals and objectives are tailored for Lower Green Bay and the Fox River AOC, they are also intended to restore water quality and beneficial uses of all local watersheds in the Upper Fox, Fox and Wolf River Basins. Revised goals reflect an emphasis on increasing the diversity of fish and wildlife species, including cost-effectiveness as a measure of successful RAP implementation and protecting environmental improvements through pollution prevention and ecologically sound development.

Numerous objectives were revised or added, based on greater knowledge of the Lower Green Bay and Fox River ecosystem (Tables 8-10). Some qualitative objectives in the 1988 RAP are expressed here with numerical guidelines particularly regarding toxic substances in water, sediment, fish, and wildlife. Quantifying objectives will improve our ability to track progress as implementation continues.

Revisions to RAP objectives reflect the most up-to-date findings and best professional judgement of knowledgeable experts and experienced managers. We expect, however, that objectives will be refined if necessary to maintain progress toward achieving RAP goals (Table 7).

Table 7. Eight primary goals for restoring Lower **Green Bay and the Fox River".**
1. ENHANCE AND PROTECT MULTIPLE USES OF THE BAY AND RIVER WHICH INCLUDE RESTORING SWIMMING AND AN EDIBLE FISHERY. Existing uses to enhance and protect include fish and aquatic life, wildlife, endangered species, boating, swimming and other water sports, sport and commercial fishing, hunting, agriculture, commercial navigation, industry, and aesthetic and scenic enjoyment.
2. DEVELOP A BLEND OF PUBLIC AND PRIVATE SHORELINE USES THAT INCLUDES ADEQUATE PUBLIC ACCESS. These include trails and parkways for people to use and enjoy, accessible local swimming beaches on the Bay, and adequate boating areas and facilities. They also include natural areas and environmental corridors to protect important wildlife and fishery habitat, and commercial developments that build upon and enhance the value of downtown waterfronts. Other shoreline uses include residential, agricultural, industrial, and aesthetically pleasing viewsheds.
3. PROVIDE SUITABLE AND SUFFICIENT HABITAT TO ENHANCE AND SUSTAIN A DIVERSITY OF WILDLIFE IN THE BAY AND RIVER. Wildlife includes spring and fall migratory diving and dabbling ducks, nesting common and Forster's Terns and other colonial water birds, marsh nesting species, seasonally occurring raptors, resident dabbling ducks, resident aquatic fur bearers, resident and migratory shore birds, and amphibians and reptiles.
4. ESTABLISH A SELF-SUSTAINING, BALANCED AND DIVERSIFIED, EDIBLE FISH COMMUNITY. This includes increasing and/or maintaining sport or commercial species in particular, walleye, yellow perch, northern pike, and muskellunge populations as a dominant part of the biomass, plus other valued fish, such as channel catfish, white bass, lake sturgeon, smallmouth bass, and black crappies. This also includes encouraging forage species such as emerald shiner, spottail shiner, trout-perch, and darters which are an integral part of the fish community. There are a variety of other fish species present which should also be included in a balanced fish community. These species are listed in Appendix A of the (1987) Biota and Habitat Technical Advisory Committee Report.
5. IMPROVE THE WATER QUALITY AND TROPHIC STATE OF THE AREA OF CONCERN TO RELIEVE ECOLOGICAL STRESSES AND SUPPORT A FULL RANGE OF PUBLIC USES. Specific improvements to achieve include: increased water clarity; increased submerged aquatic vegetation in the photic zone; increased populations of desirable aquatic invertebrates, fish and waterfowl; decreased frequency and biomass of algae blooms; reduced sedimentation to decrease the need for maintenance dredging and improve spawning habitat; increased fish production relative to algae production; reduced frequency and distribution of low dissolved oxygen; reduced magnitude of system fluctuations (i.e., dissolved oxygen, algae blooms, and perch populations); and water quality suitable for swimming.

6. ACHIEVE AND MAINTAIN WATER QUALITY THAT PROTECTS THE ECOSYSTEM FROM THE ADVERSE EFFECTS OF TOXIC SUBSTANCES ON SHORELINE AND AQUATIC VEGETATION, FISH, AQUATIC LIFE AND WILDLIFE UTILIZING THE AQUATIC RESOURCES, AND PROTECTS HUMAN HEALTH.

Reduce the loading of toxic substances from all sources to the Fox-Wolf Basin and Lower Green Bay. Reduce concentrations of toxic substances in the water column and bottom sediments to levels where:

a. The most stringent state and/or federal fish and game consumption advisory levels are met;

b. Human health is protected from all water associated exposure routes;

c. Adverse effects on aquatic and terrestrial biota are virtually eliminated; and

d. Other beneficial uses of the water are not impaired.

7. DEVELOP A MANAGEMENT STRATEGY AND ORGANIZATIONAL STRUCTURE THAT WILL COORDINATE PUBLIC AND PRIVATE EFFORTS TO IMPROVE AND PROTECT THE NATURAL RESOURCES, AND CONSIDER COST-EFFECTIVENESS, WHENEVER POSSIBLE, AS A PRIMARY MEASURE OF SUCH EFFORTS.

This should be done while protecting the public trust, providing for multiple uses, minimizing conflicts, recognizing the needs of the diverse populace while considering minority views and improving the overall quality of life of citizens of the Green Bay area and northeastern Wisconsin.

8. ENSURE THE SUSTAINABILITY OF A RESTORED AND HEALTHY ENVIRONMENT THROUGH POLLUTION PREVENTION AND THE DEVELOPMENT OF ECONOMIES, RESOURCES AND FACILITIES THAT WILL SUPPORT THE BENEFICIAL USES OF THE WATER RESOURCE INTO THE FUTURE.

It is far more cost effective to prevent pollution and environmental damage than to repair damages and restore resources later. Pollution prevention and a sustainable environment should be cornerstones of all new developments and the repair/replacement of existing facilities and infrastructure in the basin. The environmental costs of actions should be integrated into economic decision-making to ensure the sustainability of the resource base.

* Goals are numbered for convenience in referencing them and do not reflect a priority order.

Objectives: The following objectives were revised by the RAP Science and Technical Advisory Committee's Habitat and Biota workgroup and the WDNR water resources management, fisheries management and wildlife management programs' staff.

(Table 8. Water Quality and Habitat Objectives for Lower Green Bay and the Fox River

Objective	Parameter to Measure	Desired Concentration or Level	Where and When	Comments	Information Source
WATER QUALITY					
Maintain adequate oxygen to support fish and aquatic life.	Dissolved oxygen	Minimum: 5 mg/L (ppm)	Everywhere, all times	Need at least 5 mg/L at all times. Generally being met, however there is a 2 mg/L (ppm) winter water quality **standard** variance in the Lower Bay.	Wis. State Adm. **Code** NR 102
Increase water clarity to provide for safe swimming	Secchi disk depth	Average: 1.3m	Lower Bay, growing season	State guidelines suggest 4 feet (1.3 m) needed for safe swimming. Achieved by reducing suspended sediment **and algae.** Current average is 1.6 feet (0.5 m). 2.3 ft.	(Sager and GBMSD, unpublished **data)**
Increase water clarity to increase rooted aquatic vegetation	Secchi disk depth	0.7 m		(0.7 m) is minimum clarity needed to re-establish rooted aquatic vegetation that reduce sediment resuspension.	(McAllister 1991) (Richman et al. 1987)
Reduce algae to improve water clarity and reduce nuisance conditions.	Chlorophyll-a	Average: 25 pg/L (ppm)	Lower Bay, growing season	Current summer average is 60 pg/L. The frequency and biomass of blue-green **algae blooms** should be reduced. Achieved by reducing **phosphorus** concentrations.	(Richman et al. 1984) (Sager personal communication).
Reduce total phosphorus concentrations and loads to reduce algae.	Total phosphorus	Average: 90 pg/L To be determined	Lower Bay, growing season	The current summer average is 150 pg/L. Current loads are 700,000 kg/yr. Objective requires a 50% reduction in annual areal loads.	(Richman et al. 1987) (Sager personal communication).
Reduce suspended solids loads to reduce sedimentation, increase water clarity and improve aquatic habitat.	Total suspended solids	Average: 10 mg/L	Lower Bay, growing season	Current **load** is in excess of 96 million kg (200 million **pounds)** per year. Objective requires a 50% reduction.	(Bannerman et al. 1984)

Table 8. Water Quality and Habitat Objectives for Lower Green Bay and the Fox River					
Objective	Parameter to Measure	Desired Concentration or Level	Where and When	Comments	Information Source
Reduce bacteria levels to meet state standards for swimming and recreational use.	Membrane filter fecal coliform count	Should not exceed a geometric mean of 200 per 100 ml in at least 5 samples per month or exceed 400 per 100 ml in >10% of samples taken in a month.	Everywhere, growing season	Current state standard to provide for safe swimming.	Wis. Adm. Code NR 102
HABITAT					
Maintain lacustrine, palustrine and riverine wetlands	Acres of wetlands contiguous to shoreland zone in AOC (300' from river and 1000' from Lakeshore)	Minimum: To be Determined	During low water **levels along bay** shore in Area of Concern	May be refined based on further analysis of EPA SWIS study *which* used 1938-39 SCS photos for low water wetland conditions. GIS mapping for RAP by BLRPC (See Fig. V3) **used** air **photos** for low water wetlands inventory. WDNR **1989** state wetlands was used for SWIS and RAP GIS monitoring of high water conditions.	WDNR 1964 Wetlands Survey,
		Minimum: To be Determined	During high water levels **along bay shore** in Area of Concern		WDNR **1989** State Wetlands Inventory
		To be determined	Fox River, East River and Duck Creek	Wetlands behind bulkhead lines may be threatened.	
Increase submergent vegetation.	Area of lake **bottom** in photic zone to a depth of 1.3 meters (Secchi disk).	To be determined	Along Shore in AOC	Area will vary with **duration** of change in lake levels.	(McAllister 1991)

Table 8. Water Quality and Habitat Objectives for Lower Green Bay and the Fox River

Objective	Parameter to Measure	Desired Concentration or Level	Where and When	Comments	Information Source
Protect shorebird habitat.	Length of unconsolidated shoreline.	To be determined.	Fox River and Lower Bay AOC and tributaries	Habitat is unconsolidated shoreline (sand and mud) with periodic inundation, and will vary greatly with changing water levels.	(Erdman and Jacobs 1991)
Protect other important habitat for fish, aquatic life, wildlife, and endangered species.		To be determined.	AOC and tributaries		

'Table 9. Fish and Wildlife Population Objectives for Lower Green Bay and the Fox River

Objective	Desired Annual Population	Desired Population Density	Comments	Information Source
BIRDS				
Maintain Forster's tern populations.	Average: 400-600 nesting pairs Minimum: 50 nesting pairs in AOC and along West Shore north to Peshtigo Point	Produce 1 fledged chick per nesting pair	State endangered species. Minimum numbers during high water periods when less nesting habitat is available.	(Harris and Trick 1979), (Trick 1982) and (Mosman)
Maintain common tern populations.	Average: 200 nesting pairs Minimum: 100 nesting pairs		State endangered species. Minimum would be during high water periods when less nesting habitat is available.	(Sharf 1978), (Ludwig 1962) and (Erdman per. corm)
Track cormorant population levels.	Average: 600 nesting pairs Minimum: To be determined		Formerly on state threatened species list. Population now re-established and no management is needed.	(Bahti per. corn.), (Harris 1988) and (Ludwig 1984)
Support more dabbling ducks.	Minimum: 5,000 peak concentration		Similar numbers were observed in fall of 1978 and represent the minimum desired population during migration.	(Garsow 1978) (U.S. F&WS 1979)
		Average: Produce 1 duck per acre brood water.	Brood water is marsh area with less than 24 inches water and 50% emergent vegetation and 50% open water.	(Bahti per. corn.)
Support more diving ducks.	Average:2 million duck use days in AOC and along West Shore north to Peshtigo Point		This is twice the numbers observed in 1978. Includes larger area than AOC because population information is not available for the AOC alone.	(Garsow 1978) (U.S. F&WS 1979)
Maintain a diversity of marsh nesting birds.		Minimum: 15 nesting pairs per acre habitat	Habitat is persistent emergent vegetation. Currently 14 species nesting in Sensiba.	(Harris unpub. data) (Post and Seals 1991)
Maintain a balance (species richness and evenness) of colonial nesting birds.				(Erdman 1981)

Table 9. Fish and Wildlife Population Objectives for Lower Green Bay and the Fox River				
Objective	Desired Annual Population	Desired Population Density	Comments	Information Source
WILDLIFE				
Maintain muskrat populations.		Average: 15 muskrats per acre habitat	Habitat is emergent vegetation where there is sufficient water depths to prevent complete freezing. Habitat and population will vary with water levels.	
Maintain mink population		Average: 1 mink per 60 acres habitat	Habitat is wooded areas adjacent to lakes and marshes.	
Other wildlife	To be determined	To be determined	Studies needed to determine objectives for other wildlife and nongame species.	
FISH				
Achieve desired walleye population.	Average: 70,000 adults (approx.) Population will fluctuate with year class strength	7 adults per acre	Harvest is close to 5,000/year now. Population is protected through sport harvest regulations.	(Oglesby, Leach and Forney 1987) (WDNR Fish Mgt. Ref. Book)
Achieve desired yellow perch populations and age classes.		Average of 2000 yearlings and older perch (at least 5 age classes) per trawl hour (Aug. ave.) at index sites	Population is protected through sport and commercial harvest regulations.	(Belonger, WDNR) Green Bay index trawl data
Achieve desired northern pike populations.	Average: 20,000 adults	2 adults per acre	Present levels are believ4d to be below desired.	(WDNR Fish Mgt. Ref. Book)
Achieve desired muskellunge populations.	Average: 3,000 adults	1 adult per 3 acres	Population of spotted muskellunge being established by stocking in Green Bay.	(WDNR Fish Mgt. Ref. Book)

*Desired annual populations are long term averages and individual species populations will exhibit natural fluctuations.

(Table 9. Fish and Wildlife Population Objectives for Lower Green Bay and the Fox River

Objective	Desired Annual Population	Desired Population Density	Comments	Information Source
Restore centrarchid (panfish) populations.	To be determined	To be determined		
Protect against infestations of sea lamprey	**No sea lamprey above Rapid Croche dam**		**Sea lamprey barrier constructed at Rapid Croche dam on Fox River. If substantial reproduction** is noted in the lower river, future action will be required.	WDNR Fisheries Management
Shift fishery biomass to increased predator and sport species.		Biomass Range: 90 to 140 kg (200 to **300 pounds) of predatory fish per acre.** **Predator/Prey ratio range: 1/10 to** 1/20.	**This objective describes and quantifies a positive change in biomass that reflects increasing food chain efficiency and a shift to a balanced and more desirable fishery. Biomass may decrease** if **productivity changes but the predator/prey ratio should be maintained**	
OTHER AQUATIC LIFE				
Develop a diverse community of pollution intolerant benthic organisms including:		**Average:** 3,000-**4,000 organisms per sq. meter**	**These are based on numbers of pollution intolerant organisms observed historically in 1939. Numbers represent population densities expected in silt-silty sand sediments. R** = River, B = **Bay**	**(Garsow 1978),** (Howmiller 1971), (Marken 1982) **and (U.S.** F&WS **1979)**
Hexagenia (burrowing mayfly)		**Average: 400-500 per** m^2 (R)		
Fingernail clams		Average: 500-1,000 **per** m^2 **(B)**		
Snails		Average: 250-500 per m^2 **(B)**		
Mayflies and Caddisflies		Average: 250-500 per m^2 (R)		

Table 9. Fish and Wildlife Population Objectives for Lower Green Bay and the Fox River

Objective	Desired Annual Population	Desired Population Density	Comments	Information Source
Shift the **carbon transfer** efficiency **of lower Bay to** that **of mid-Bay** which will **decrease** the **amount of algae channelled into** the **detrital food** chain **and increase** energy channelled **into** the **pelagic food chain.**				**Smith and Magnuson, 1990**[89]

The following explanations will help you interpret Table 11 -- "Numerical Objectives for Toxic Materials". The table was developed by a STAC, ad hoc workgroup on toxics, in conjunction with WDNR staff from fisheries and wildlife management, and standards and monitoring programs. It is the philosophy of the RAP advisory committees that criteria should be applied that will protect the most sensitive species in an ecosystem, because organisms at higher trophic levels also will be protected.

More than 100 potentially toxic chemicals have been identified in the water column of the Fox River/Lower Green Bay area [60]. At least twenty of these appear on the EPA's priority pollutant list [75]. In this list the federal government identifies chemical compounds and classes of compounds which, at some predetermined level may pose unacceptable risks to the environment or humans.

The toxic chemicals known or suspected to exist in the AOC were organized in 1987 by the Toxic Substances Management Technical Advisory Committee into three major categories:

Chemicals in Group A, polychlorinated organic compounds, (e.g., PCBs, dioxins, furans), are toxicologically related and are suspected of causing most of the reproductive problems in fish and wildlife species in the area.

Group B consists of substances known to be acutely toxic to aquatic life in the quantities presently in the system. At this time ammonia, mercury, and lead are included in this group.

Group C compounds include other heavy metals, pesticides (e.g., DDT), polycyclic aromatic hydrocarbons or PAHs (e.g., fluoranthene), volatile hydrocarbons (e.g., dichloromethane), PCB substitute compounds (e.g., isopropylbiphenyl), and those compounds detected, but unidentified, during laboratory analyses of samples from various portions of the ecosystem. The impacts of this group of chemicals, in the concentrations present, have not been adequately assessed.

Water quality and sediment sampling is carried out by the WDNR, Green Bay MSD, and municipal and industrial wastewater dischargers to identify contaminants and to detect trends in the Fox River and Lower Bay.

Water quality data collected by EPA, USGS, and WDNR from 1987 to 1992 indicates that concentrations of metals, except for mercury and in two instances cyanide, chlorides, and un-ionized ammonia, do not exceed water quality criterion (Appendix G, Table 1). Data collected during 1989-1990 by the USGS and WDNR as part of the Green Bay Mass Balance Study show that PCBs exceeded water quality criterion for human health, with summertime concentrations averaging about 60-80 ng/L at De Pere and 40-50 ng/L at Appleton. Detailed reporting of PCBs and other organic compound concentrations is available from GBMSD in its 1990 River/Bay water Quality Monitoring Program Summary [50]

Mercury levels in the water column for most of the Fox River exceed the WDNR's criteria for wildlife of 2 ppt. Surface water concentrations range from less than 2 ng/L (ppt) at Lake Winnebago to 60 ng/L just upstream from the De Pere dam [15].

Sediment sampling by a number of researchers since 1977 indicate mercury concentrations increase from 0.05 mg/kg ppm just north of Doty Island in LLBM to a detection level as high as 10.4 ppm behind the De Pere dam. Downstream of the De Pere dam, concentrations have been sampled from 0.08 to 3.48 ppm. Concentrations in the Bay, primarily in the navigation channel, range from 0.4 - 1.08 ppm. Several samples outside the navigation channel had concentrations below 0.3 ppm [47].

Direct discharges of PCBs have declined by more than 95% since the mid-70's because of improved wastewater treatment and the attrition of PCB containing products made prior to the 1977 ban on use of PCBs, i.e., carbonless copy paper, plasticizers, and hydraulic fluids. Contaminated sediment is the major source of continued loading of PCBs to the water column and food chain.

Table 10 contains numerical standards for toxic substance in surface waters. Criteria established by NR 105 are applied by law to protect human health, wildlife health, and fish and aquatic life. These are listed under Water Column Objectives.

Also listed are criteria developed under the Great Lakes Water Quality Initiative (GLWQI) described below. These values may or may not become law through a five year process of public hearings, adoption, and state adherence. The State of Wisconsin will be required to update its water quality standards to be consistent with these guidelines within two years from the date of enactment. Affected rules would be NR 105, 106 and 207. The GLWQI guidelines are presented here for your information because if adopted, state criteria may become much more stringent in some cases. This has economic implications for municipal and industrial wastewater discharges. The criteria represent current scientific thinking regarding the levels of toxic substances necessary to protect organisms at all trophic levels. Whether the GLWQI values could practicably be achieved, and whether there are variations in ecosystem interactions that would warrant differential application, will be points of discussion.

Other values listed in Table 10 should also be considered guidelines and have not been adopted by the State of Wisconsin.

The numerical objectives listed are derived from the following sources:

1. <u>Wisconsin Administrative Code:</u>
   Chapter NR 105, entitled "Surface Water Quality Criteria for Toxic Substances," is designed to "establish water quality criteria and methods for developing criteria for toxic substances to protect public health and welfare, the present and prospective use of all surface waters for public and private water supplies, and the propagation of fish and aquatic life and wild and domestic

animal life. This chapter also establishes how bioaccumulation factors used in deriving water quality criteria for toxic and organoleptic substances shall be determined. Water quality criteria are a component of surface water quality standards. This chapter and Chs. NR 102, 104, 106, 107 and 207 constitute quality standards for the surface waters of Wisconsin."

2. Wisconsin Division of Health (WDOH):
The WDOH provides **recommendations** for the annual fish and wildlife consumption advisories for the protection of human health.

3. The Great Lakes Water Quality Initiative (GLWQI):
The GLWQI is a joint, multi-state/EPA program developed to ensure state adoption of consistent, protective water quality standards throughout the Great Lakes Basin. It is required as part of the Great Lakes Critical Programs Act of 1990. The GLWQI **was** published in the Federal Register in April 1993 for a 180 day public comment period. When adopted, the states would have two years to adopt rules consistent with the GLWQI guidelines. These guidelines would further the goal of the Clean Water Act and the Great Lakes Water Quality Agreement to restore, maintain, and protect the waters of this particularly valuable and sensitive ecosystem.

   More current toxicity data were used in the development of the GLWQI, and this often accounts for numerical differences between objectives of the GLWQI and NR 105. Specifically, the bioaccumulation factors used in the GLWQI are generally the same or higher (more stringent criteria may result) than those values used by Wisconsin for two reasons: more field and laboratory data have been generated since Wisconsin's values were derived; and food-chain multipliers have been incorporated which account for bioaccumulation at different trophic levels. The bioaccumulation factor values used in the GLWQI have been determined from laboratory and field data summarized by the EPA Environmental Research Laboratory in Duluth, Minnesota.

4. U.S. Food and Drug Administration (FDA):
The FDA sets **standards** for human health consumption of food products.

5. U.S. Department of Agriculture (USDA):
The USDA enforces the standards set by FDA and provides guidelines for establishing standards in part, through its National Residue Program.

Considerations to note for each of the media discussed in Table 10 follow:

WATER COLUMN OBJECTIVES

Human Health

NR 105 Standards

PCB - The Fox River is classified as being capable of supporting warm water sport fish **and** has **a** human cancer **criterion of** 0.49 **ng/L.**

- Green Bay supports Great Lakes community aquatic species; therefore, the standard of 0.15 ng/L PCB in the water column is in effect.

2,3,7,8 - TCDD - 2,3,7,8-tetrachlorodibenzo-p-dioxin is the most toxic form of the dioxin-like compounds for which there are criteria. Criteria pertain to public water supplies with Great Lakes fish and aquatic life communities.

4,4'- DDT and metabolites - There are no specific criteria for metabolites with respect to human health. DDE and other metabolites are considered in establishing NR 105 and GLWQI wildlife health criteria.

Ammonia - This substance does not bioaccumulate, so there is no danger to humans or wildlife through consumption of fish.

Mercury - Listed are human threshold criteria for all public water supplies.

Lead - The water column human threshold criteria is the drinking water standard and equals the maximum contaminant level allowable in water.

<u>Wildlife Health</u>

2,3,7,8 - TCDD - There is a proposed criterion for the GLWQI, but none currently in NR 105. All criteria for wildlife protection are based on chronic endpoints for reproduction, not on cancer as for human health protection. Only recently have data become available to calculate a wildlife criterion for TCDD. These data may be used in the future to develop NR 105 criteria.

Lead - NR 105

The water column is not a likely source of wildlife health impacts from lead, therefore, there are no criteria.

<u>Fish and Aquatic Life</u>

PCB and 2,3,7,8-TCDD - There are no established criteria available. Criteria are being developed by the EPA-Duluth Environmental Research Laboratory.

Ammonia - Un-ionized ammonia (NH_3) is the principal toxic form of ammonia. Effluent limits are determined for ammonia-nitrogen (NH_3-N) and pH in discharges to surface waters classified for fish and aquatic life. From un-ionized ammonia criteria set forth in "Quality Criteria for Water" (EPA, 1976), also known as the "Red Book", conversion to total NH_3-N can be made if the instream temperature and pH are known, or calculated using upstream and effluent values. The converted total NH_3-N standard is an instream concentration; therefore, an effluent limitation on a discharge may be determined by back-calculating to an outfall, using the design effluent discharge rate and design stream flow.

The "Red Book" criterion for un-ionized ammonia (as NH_3) is 0.02 mg/L. The ratio of molecular weights between nitrogen and ammonia (N vs. NH_3) is 14/17 or 0.82. Therefore, the un-ionized NH_3-N standard would be 0.02 mg/L x 0.82, or 0.016

mg/L (as N). A report titled "Rationale for the Development of an Un-ionized Ammonia Criteria for Aquatic Life in Wisconsin" (Schuettpelz and Harpt, 1980) concluded that the "Red Book" criterion does not accurately reflect application to representative warmwater species. Based on a composite analysis of bioassay results, literature review, and EPA data evaluation procedures, alternative un-ionized ammonia and NH_3-N criteria were developed for warmwater sportfish streams, waters not classified as trout streams. These criteria are 2.5 times the "Red Book" values, as listed below:

Stream Classification	NH_3 (mg/L)	NH_3 -N (mg/L
Coldwater (trout stream)	0.02	0.016
Warmwater sportfish	.05	0.04

These criteria serve as the basis for determination of instream standards for total ammonia and NH_3-N.

Lead - NR 105

The acute toxicity of lead varies according to water hardness as shown below: thus, the criteria to protect against acutely toxic effects also varies. On average, the acute toxicity criteria for lead for the Fox River is 345 pg/L based on a long-term average river hardness of 175 ppm ($CaCO_3$).

The chronic toxicity of lead also varies with water hardness. The criterion to protect against chronic toxic affects is on average 20.6 pg/L based on 175 ppm calcium carbonate ($CaCO_3$).

Lead Criteria

Hardness (ppm $CaCO_3$)	Acute Toxicity Criteria	Chronic Toxicity Criteria
100	169.06	10.09
105	179.90	10.73
110	190.87	11.39
115	201.99	12.05
120	213.23	12.72
125	224.61	13.40
130	236.10	14.09
135	247.72	14.78
140	259.46	15.48
145	271.32	16.19
150	283.28	16.90
155	295.36	17.62
160	307.54	18.35
165	319.82	19.08
170	332.21	19.82
175	344.70	20.57
180	357.29	21.32

FISH TISSUE OBJECTIVES

Human Health

The FDA, WDOH, and WDNR prepare a semi-annual fish consumption advisory to protect human health.

PCB - The FDA limit of 2 ppm in fish filet tissue is based on a combination of toxicological and economic factors. Economic considerations raise the value.

Wildlife Health

States generally do not have fish tissue criteria or objectives to protect wildlife which consume fish, although the calculation of fish tissue objective levels can be a useful tool for assessing wildlife exposure and health effects attributable to toxic substances.

Under the framework of the GLWQI, the United States and Canada are presently comparing their thresholds for wildlife protection. Efforts are underway in Canada to develop an acceptable procedure for calculating fish tissue levels that are protective of wildlife. Since the proposed GLWQI incorporates the United States' thinking on water quality criteria for wildlife protection, these criteria have to be converted first to fish tissue levels for direct comparison with the Canadian method.

There are two possible ways to calculate fish tissue objective levels from the GLWQI wildlife criteria documents. The most straight-forward way is to take the water quality criterion for each chemical and multiply it by the geometric mean of the bioaccumulation factors (BAF) that were used in calculating the criterion. The second way is to take the No Adverse Effect Level (NOAEL) value for each criterion, multiply it by the species sensitivity factor (SSF), then make it specific to each representative species by multiplying this value by the species' weight, and dividing it by the species' food consumption value. If the latter method is used, it is necessary to take the geometric mean of the avian or mammalian derived tissue levels in order to determine the final fish tissue level protective of wildlife for each chemical. Consequently, the two methods result in the same values.

It is not appropriate simply to take the lowest calculated fish tissue level for any representative species. This would add an additional level of safety that cannot be easily justified and would not follow the intent of the GLWQI. (Calculations follow).

WILDLIFE TISSUE OBJECTIVES

Human Health

PCB - The FDA "tolerance level" for PCBs in poultry is 3 ppm on a fat basis, (ppm wet weight multiplied by 100 percent then divided by the percentage of fat). The Federal Register states that poultry, with levels higher than 3 ppm on a fat basis, may not be sold commercially or used in interstate commerce . Waterfowl placed on the WDNR consumption advisory, i.e., mallard ducks from selected reaches of the Fox River or Green Bay, contained levels higher than 3 ppm.

DDT - The USDA action level is that concentration of DDT and its metabolites in the fat of poultry, cattle, sheep/goats, swine, and horses that precludes the sale or transfer of meat products.

Wildlife Health

With regard to which values to use for wildlife tissue levels that are protective of wildlife that consume other wildlife, i.e. eagles may eat gulls, the WDNR recommends using fish tissue values as default values, until more appropriate bioaccumulation values exist from which to calculate such numbers.

CALCULATING FISH TISSUE LEVELS FOR WILDLIFE PROTECTION

Method1

Water Quality Criterion x = *Fish* ***Tissue Objective***

Method 2

NOAEL x SSF x = **Fish Tissue Objective**
food consumption

DDT & METABOLITES

1. *0.75 pg/L x a = 1.3 µg/kg*

2. eagle 2.54 pg/kg
osprey 1.41 pg/kg geometric mean = 1.3 pg/kg
kingfisher 0.56 pg/kg

PCBs

1. 15 *pg/Lx 134* = *7.7* x10' *4kg*

2. otter 27 pg/kg geometric mean = 23 pg/kg
mink 20 pg/kg

2,3,7,8-TCDD

8.5x10^{-3} *pgrLx* ^{3} *=7.7x10" µg/kg*

2. otter 8.9 x 10' pg/kg geometric mean =
mink 6.7 x 10' pg/kg 7.7 x 10' pg/kg

MERCURY (including methvlmercurv)

180 pal_ *x* ^{s} ***BAFs = 14*** *4g/kg*

2. kingfisher 6.4 pg/kg
osprey 16 pg/kg geometric mean = 14 pg/kg
eagle 29 pg/kg

NOAEL No Adverse Effect Level
SSF Species Safety Factor
BAF **Bioaccumulating** Factor
WT **Bioaccumulation Factor**

Note: fish tissue objectives for wildlife are obviously lower than for human health protection. Several factors contribute to this difference, the main one being that wildlife exposure comes from the consumption of whole fish which is the primary dietary component. In contrast, human exposure and risk characterization is based on the consumption of skinned, filleted and cooked fish, which form only a portion of an individual's diet.

Table 10. Green Bay Remedial Action Plan Numerical Objectives For Toxic Materials							
MEDIA	PCB	DIOXIN	DDT & METABOLITES	AMMONIA	MERCURY	LEAD	INFORMATION SOURCES
Objective: Reduce toxic contaminants in the water column to levels that meet the most stringent state and/or federal consumption advisory levels and protect human health, wildlife, and fish and aquatic life and their reproduction.							
WATER COLUMN OBJECTIVES FOR: Human Health Fox River	0.49 ng/L	**2,3,7,8-TODD** 9.7×10^{-5} ng/L	4,4'-DDT 0.14 ng/L	NA'	79 ng/L"	5×10^{4} ng/L°	NR105 Human Cancer Criteria
Green Bay	0.15 ng/L	3×10^{-5} ng/L	0.43 ng/L		79 ng/L	5×10^{4} ng/L	
Wildlife Health	3.0 ng/L	See text	0.015 ng/L	NA	2.0 ng/L	NA	NR 105 Wild and Domestic Animal Criteria
Fish and Aquatic Life	Not presently available	Not presently available	4,4'-DDT 0.43 ng/L	Warm water species NH_3 5 x 10' ng/L NH, -N 4 x 10' ng/L Cold water **species** NH_3 2 x 10' ng/L NH, -N 1.6 x 10` ng/L	1.53 x 10' ng/L	**3.45** $\times 10^{5}$ ng/L	NR 105 Acute Toxicity Criteria Lead value **recalculated** using Fox River long term average hardness of 175 ppm $CaCO_3$
				NR 102 and internal documents		20.6 x 10' ng/L	NR 105 Chronic Toxicity
'NA - not applicable "NR 105 establishes a human threshold for these substances because they are not carcinogenic.							

Table 10. Green Bay Remedial Action Plan Numerical Objectives For Toxic Materials

MEDIA	PCB	DIOXIN	DDT & METABOLITES	AMMONIA	MERCURY	LEAD	INFORMATION SOURCES
Objective: Reduce toxic contaminants in fish tissue to levels that protect humans, birds, and animals which consume them and which protect reproductive success.							
FISH TISSUE OBJECTIVES FOR: Human Health (consumption - fish filets)	FDA 2.0 X 10^3 pg/kg	.01 pg/kg	5 x 10^3 pg/kg	NA	DNR 500 pg/kg	NA	FDA, WDHSS and WDNR
Wildlife Health (consumption - whole fish)	Not presently available.						
Fish and Aquatic Life Health (consumption)	Not presently available.						
Objective: Reduce toxic contaminants in wildlife tissue to levels which protect human and wildlife health and do not impair reproductive success.							
WILDLIFE TISSUE OBJECTIVES FOR: Human Health (consumption)	3 x 10^3 **pg/kg**	0.1 pg/kg	5 x 10 pg/kg	NA	Not presently **available** **Not** presently **available**	10 pg/kg guideline	FDA **lipid basis** **USDA action level for residues** in **meat products**
Wildlife Health (consumption)	**See fish tissue objectives for wildlife health. Precise** bioaccumulation values for wildlife consumption of other non-fish wildlife **are** not **available.**						

Table 10. Green Bay Remedial Action Plan Numerical Objectives For Toxic Materials

MEDIA	PCB	DIOXIN	DDT & METABOLITES	AMMONIA	MERCURY	LEAD	INFORMATION SOURCES
Objective: Reduce toxic contaminants in sediment or the release from sediment to levels which are not acutely or chronically toxic to fish and aquatic life or humans and wildlife which consume them.							
SEDIMENT OBJECTIVES FOR: Human Health (consumption) Wildlife Health Fish and Aquatic Life Health	Not presently available						
ANTICIPATED CRITERIA TO BE PUBLISHED IN THE PROPOSED GREAT LAKES INITIATIVE, APRIL 1993.[c]							
WATER COLUMN OBJECTIVES FOR: Human Health	0.003 ng/L	1×10^{-5} ng/L	0.06 ng/L	NA	2.0 ng/L	Not presently available	Proposed Great Lakes Initiative
Wildlife Health	0.015 ng/L	8.5×10^{-6} ng/L	7.5×10^{-4} ng/L	NA	0.18 ng/L	NA	Proposed Great Lakes Initiative
FISH TISSUE OBJECTIVES FOR: Wildlife Health (consumption - whole fish)	23 μg/kg	7.7×10^{-4} μg/kg	1.3 μg/kg	NA	14 μg/kg	NA	Calculated from proposed Great Lakes Initiative chemical criteria documents for wildlife protection

[a]NA - not applicable
[b]NR 105 establishes a human threshold for these substances because they are not carcinogenic.
[c]Values may change through the public review process.

PART C: PRIORITY ISSUES AND 1993-1994 RECOMMENDED ACTIONS

For the past two years, the WDNR RAP implementation program and the advisory committees have focused most attention on several high priority issues: reduction of phosphorus and suspended solids loading to the Fox-Wolf system and the AOC; development of a strategy for remediating contaminated sediments in the Fox River; protection and restoration of lacustrine, palustrine, and riverine habitats; and community outreach to increase public awareness and support for remedial actions. This section describes these four priority issues in greater depth and outlines implementation activities for 1993-94.

Following a discussion of each issue is a generalized workplan which outlines the approach to be followed by RAP implementors, advisory committees, and WDNR program managers.

A key to abbreviations found in Tables 14, 18, 19, and 20 is provided below for your convenience.

AOC	Area of Concern
EPA	Environmental Protection Agency
FM	WDNR Fisheries Management Program
GBMBS	Green Bay Mass Balance Study
GBMSD	Green Bay Metropolitan Sewerage District
LCD	Land Conservation Department
LLBM	Little Lake Butte des Morts
LMD	Lake Michigan District
NEWWT	N.E.W. Waters of Tomorrow
P2	Pollution Prevention
PAC	RAP Public Advisory Committee
PEP	RAP Public Education and Participation Advisory Committee
RAP	Remedial Action Plan
STAC	RAP Science and Technical Advisory Committee
SW	WDNR Solid Waste Program
UW-EXT	University of Wisconsin Extension
WDNR	Wisconsin Department of Natural Resources
WM	WDNR Wildlife Management Program
WPS	Wisconsin Public Service Corporation
WRM	WDNR Water Resources Management Program

NUTRIENT AND SUSPENDED SOLIDS REDUCTIONS

The Wolf and Upper Fox Rivers, Lake Winnebago and its tributaries drain about 1.3 million hectares (5,000 square miles) of land and contribute about 50% of the total phosphorus load to the Fox River system. The Fox River, which drains an additional 414,000 hectares (1,600 square miles), contributes roughly another 50%.

Lake Winnebago and its tributaries funnel about 360,000 kg (790,000 lbs) of phosphorus to the Fox River system and Lower Green Bay, according to data collected in 1990. A reduction in phosphorus loading to the Bay from the Fox River is recommended in the 1988 RAP. The goals are to achieve a reduction in total algal biomass, a decrease in the proportion of blue-green algae, and improved water clarity, all of which depend on reducing phosphorus loading.

The 1993 RAP objective -- achieving a 50% reduction in total phosphorus loading to the AOC -- cannot be achieved without addressing phosphorus inputs from Lake Winnebago, as well as other inputs to the Fox River. Efforts to restore the Bay must move upstream and address Lake Winnebago as a large source of phosphorus.

Results of Trophic State Monitoring: Recent research has shed new light on phosphorus loadings in the Fox River and Green Bay. Dr. Paul Sager of the University of Wisconsin-Green Bay, who has studied the trophic dynamics and productivity of the Bay for more than 20 years, attempted to fit water quality data from 1970 to 1991 to a phosphorus loading model. It proved to be a poor fit for the Fox River and Green Bay system. However, new insights about phosphorus loadings in the AOC were gained, with important implications for how restoration efforts in the Fox River and Green Bay should proceed.

In most lake systems high water flows are associated with low phosphorus concentrations because of dilution. Logically, if phosphorus levels entering the Fox River system were low, then phosphorus concentrations in the AOC should also be low. However, in Lower Green Bay, just the opposite was found. At high water flows, high phosphorus concentrations were found. And when phosphorus inputs to the Bay were low, concentrations of phosphorus remained high.

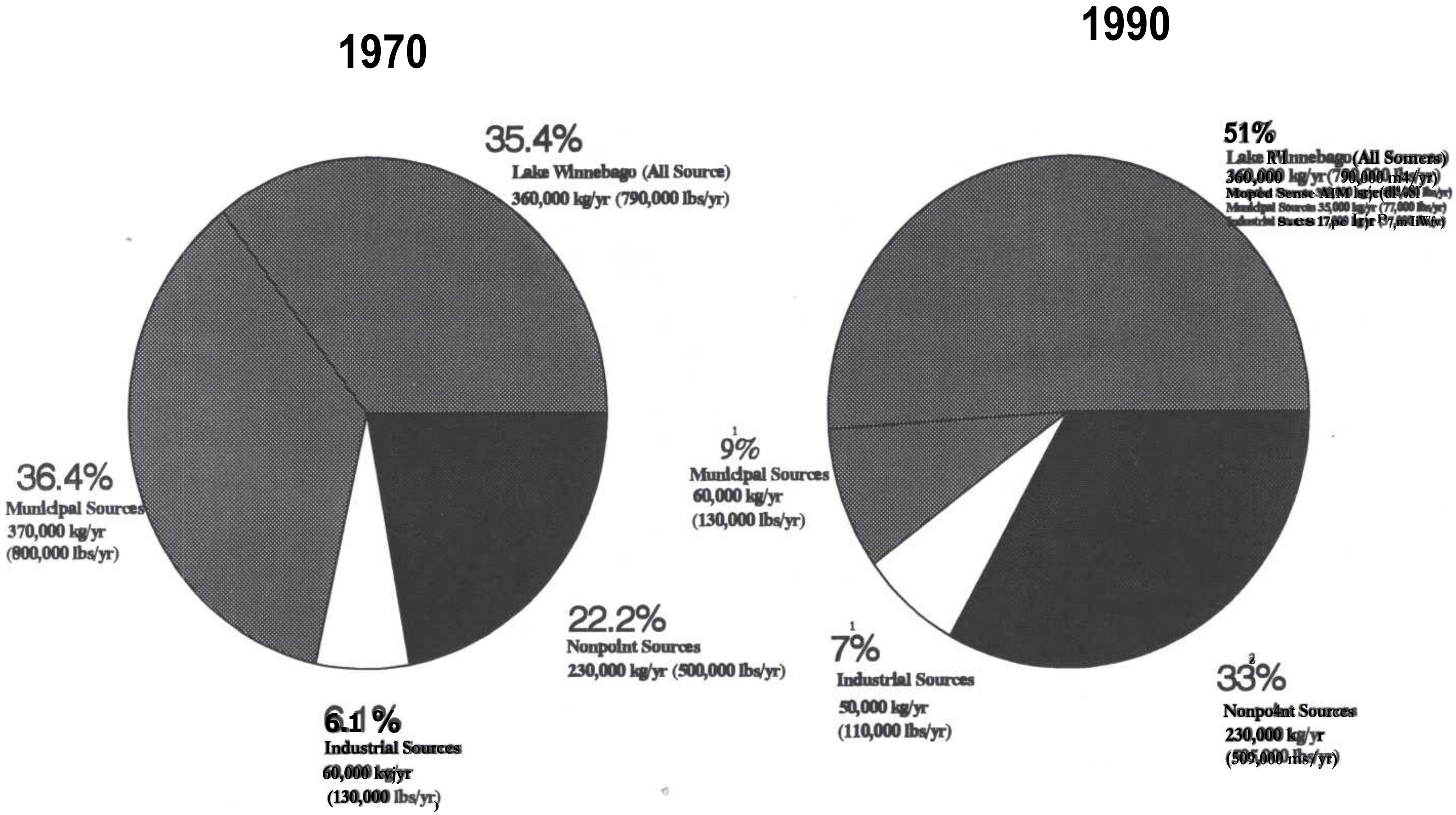
Ambient phosphorus concentrations (summer average) in Lower Green Bay have a lower level of variability than the external loadings. This suggests that a substantial internal loading of phosphorus from bottom sediments buffers the impact of variations in external loadings. The effect is to create a lag time between external load reduction and ambient concentrations.

Evidence of Lag Time: This lag time is demonstrated by data collected in the Bay before, during and after municipal sewage treatment plants significantly reduced phosphorus discharge. Between 1970 and 1990, municipal treatment plants reduced their phosphorus discharges by 84% or 300,000 kg/yr (660,000 Ibs/yr). The data are incomplete, but they indicate that although the reductions occurred in the mid-1970s, the ambient levels of total phosphorus (TP) in the Lower Bay did not show a reduction for approximately five years. The mean value for phosphorus concentrations in the Lower Bay AOC for 1982-91 shows that the 84% reduction in phosphorus discharges from municipal treatment plants resulted in a 28% reduction in TP concentrations in the Bay.

Estimates of Phosphorus Sources: Using phosphorus data from 1990, Dr. Sager developed an updated estimate for sources of phosphorus (P) to the Fox River and the AOC (Figure 6). The sources include the Fox River Basin and discharge from Lake Winnebago, which receives its phosphorus load from the Upper Fox and Wolf River Basins. A breakdown by industrial, municipal, and nonpoint sources in the Fox River Basin indicates about 16% comes from point sources. Gross industrial discharge is about 50,000 kg per year. Some industries, however, report that about 18,000 kg annually is removed from influent. Because methods of estimating the amount of phosphorus removed varies, and some wastewater is sent to municipal POTWs for treatment, net discharge is probably greater than 23,000 kg.

Point sources account for about 14% of the total phosphorus discharge from Lake Winnebago. Most of the phosphorus entering and discharged from Lake Winnebago is from rural and urban nonpoint sources[51].

Esti mates of Total Phosphorus Loads to the Fox River



11990Midst's i kg Data

2 Fefimete t r u st Seger nod WI n 1975

The annual values for phosphorus loadings between 1980-91 from Lake Winnebago showed little variation between years. The reduction of phosphorus loads from municipal treatment plants in the Fox River Basin is evident when 1970 data and 1990 data are compared (Figures 6). The nonpoint source load estimate to the Fox River reflects no change between 1970 and 1990, because a refined estimate is not available at this time. More data are needed to increase confidence in and to refine the nonpoint source load estimate, and to determine the relative loads from various tributaries to the Upper Fox, Wolf and Fox Rivers. Additionally, researchers need a better understanding of phosphorus and particle cycling throughout the system.

Relative Importance of Algae and Suspended Sediment to Water Clarity: The rationale for the objective of a 50% reduction in total phosphorus load to the AOC is the need to reduce algae in the system and to improve water clarity. Excess phosphorus causes algae blooms, particularly of blue-green algae which are not very palatable to many forms of zooplankton. Algae also significantly reduce water clarity and may, by the process of decay, lower dissolved oxygen levels. Poor water clarity prevents the growth of submerged aquatic vegetation which is essential habitat and food for invertebrates, fish, and wildlife. Poor water clarity also limits recreational swimming in the Fox River and Lower Bay. Both living algae (biotic particles) and other non-living suspended matter (abiotic particles) block light transmission through water, reducing water clarity and causing unappealing murky conditions.

In order to update water quality objectives, scientists on the RAP STAC have examined the relationship between water clarity (as measured by Secchi disk depth) and corresponding concentrations of TSS and chlorophyll a . TSS is a measure of particulates in the water column affecting water clarity, and chlorophyll a is a measure of algae abundance. The relationships between these measures of trophic conditions are presented in a series of regression models which are based on extensive data collected in the AOC (Tables 11 , 12 and 13)[64].

Table 11. Relationship Between Water Clarity and Total Suspended Solids and Chlorophyll a Concentrations.

Log Secchi = 0.825 -0.850 log TSS		Log Secchi = 0.923 - 0.718 log Chlor	
Secchi (m)	TSS (Ng/L)	Secchi (m)	Chlor (pg/L)
0.30	40	0.31	100
0.32	35	0.38	75
0.37	30	0.44	60
0.52	20	0.50	50
0.94	10	0.73	30
1.70	5	0.97	20
		1.60	10
R^2 = 83.9% F = 1122 p<0.00, n =217 **Source:** GBMSD data summer 1991		R^2 = 88%, F = 490 p<0.00 n=214 **Source:** UW - Green Bay data, 1982	

Table 12. Prediction of Algae Concentrations Given Chlorophyll a and Total Phosphorus Concentrations.

Log Chlor = - 0.956 + 1.21 log Total Phosphorus		
Chlor (Ng/L)	TP (Ng/L)	% Blue Green Algae'
67	200	74
48	150	67
29	100	56
20	75	48

R^2 = 75.3%, F = 650, p<0.000, n = 214

Data Source: *UW-Green* **Bay,** Sager

' Based on the model by Trimbe and Prepas, 1987

The depth at which a Secchi disk can be seen correlates well with decreasing TSS (R^2 = 83.9%) and chlorophyll concentrations (R^2 = 88%).

These relationships for the Bay are statistically significant. Current average Secchi disk depth is 0.5 m and TSS is 20-25 ,ug/L, which is quite similar to what the first regression equation predicts. Chlorophyll a concentrations average around 50 pg/L, while phosphorus averages 150 pg/L. Blue-green algae averages about 75%.

A regression analysis of the relationship of Secchi transparency to the abiotic component of total suspended solids and Chlorophyll a was also examined (Table 13).

Table 13. Effect of Abiotic Solids and Chlorophyll a on Secchi Transparency

Log Secchi = 0.499 - 0.363 log Abiotic Solids - 0.187 log Chlorophyll a.
R^2 = 62.5%, F 56.6, p<0.000, n = 71
Data sources: TSS - Green Bay Metropolitan Sewerage District; TSS and Secchi depth from UW - Green Bay

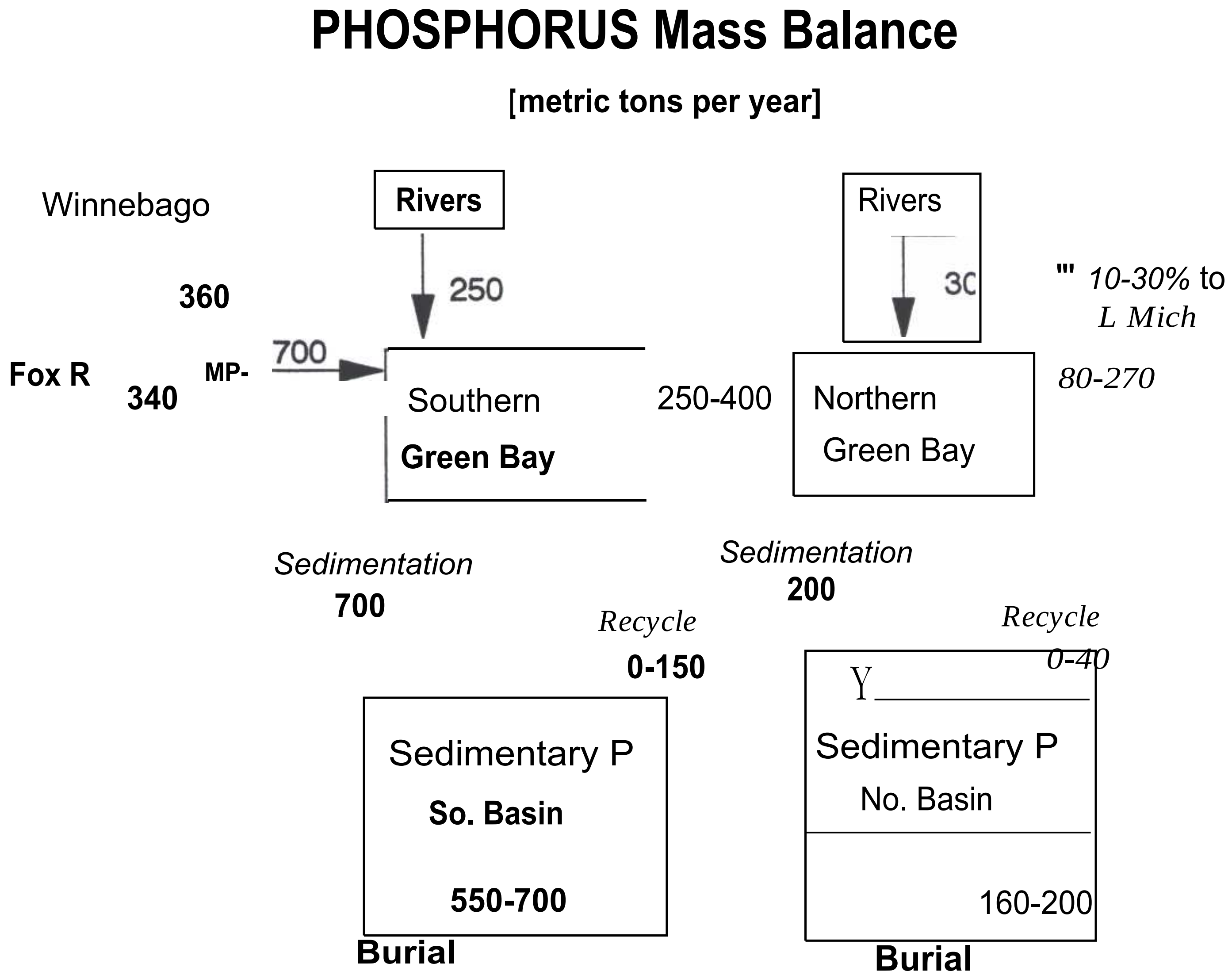
These results indicate that biotic and abiotic solids (algae and sediment) are of approximately equal importance in determining water clarity in Lower Green Bay. While preliminary, the implications of these results are very important for restoration efforts. Improvement in water clarity can be achieved via phosphorus reductions, but greater improvement may be realized with decreases in abiotic solid loadings, i.e. total suspended solids in addition to phosphorus. The range of data used to formulate the model was narrow, but it can be improved with additional data collection. These results also suggest that both phosphorus and total suspended solids need to be addressed. If only the sediment load were reduced, then conditions for algae growth would actually be improved by better light availability.

<u>Significance for Lake Michigan:</u> The analyses show that water quality in the AOC is closely connected to Lake Winnebago water quality. Restoration efforts must focus on the whole watershed as one ecosystem.

Research underway by Dr. Val Klump of the University of Wisconsin-Milwaukee Center for Great Lakes Studies, indicates that phosphorus loads in this watershed have far-reaching effects. His research addresses nutrient cycling in Green Bay, including phosphorus sedimentation, recycling, and burial in the depositional areas of the Bay. In sediments from north of Long Tail and Au Sable Points to near Chambers Island, particles are rapidly deposited to the sediments where at least 70% of the particulate phosphorus is permanently buried in the sediments.

Estimates of phosphorus input and burial to sediments throughout this southern basin of the Bay have been derived from direct measurements, sediment accumulation rates, and the phosphorus content of sediments. When combined with the Sager loading estimates given earlier (Figure 6), these data allow the construction of a simple phosphorus mass balance for the Green Bay system (Figure 7).

Figure 8. Phosphorus Budget for Green Bay



Current estimates indicate that — 360 metric tons (1 MT = 1000 kg) of phosphorus enter Green Bay from Lake Winnebago annually. To this, an additional 340 MT is added between Lake Winnebago and the mouth of the Fox River, giving an annual load at the mouth of the Fox of 700 MT. To this is added an additional estimated 250 MT from the Menominee, Oconto, and Peshtigo Rivers, yielding a total estimated tributary load to southern Green Bay of — 950 MT/yr. Deposition and burial can account for — 550-700 MT/yr, leaving an estimated 250-400 MT that is unaccounted for. This mass balance residual is presumably transported out of southern Green Bay and into the northern basin north of Chambers Island. Here rivers add an additional estimated 30 MT/yr (Escanaba River). Phosphorus removal by sedimentation and burial is not well quantified for northern Green Bay, but a rough estimate for burial is 160-200 MT annually. The net result is that of the estimated 980 MT of phosphorus entering Green Bay annually, burial, or removal within the Bay, can account for 70-90% of this input, leaving an estimated 10-30% entering Lake Michigan[28].

This phosphorus budget suggests that the phosphorus loading to the AOC is not just a local problem, but has implications for upper Green Bay and Lake Michigan, a resource of international importance.

The geographic focus for RAP implementation must expand beyond the boundaries of the AOC. Not only must Lake Winnebago be addressed if the ecosystem is to improve, but the implications of the watershed's phosphorus problem for Lake Michigan adds urgency to restoration actions. Solving Green Bay's phosphorus problems will benefit a much greater region than traditionally assumed.

In summary, recent research indicates that management actions for the AOC:

1) Must have an ecosystem-wide approach.

2) Must address phosphorus loads to Lake Winnebago from its tributaries.

3) Must tackle both phosphorus loads and sediment loads for greater water clarity results.

4) Have implications for trophic conditions in upper Green Bay and Lake Michigan.

Specific activities to be carried out in 1993-94 are found in Table 14.

Table 14. 1993-1994 Actions to Address Excess Nutrients and Suspended Solids

GOAL: Reduce the negative effects on water quality in the Area of Concern, due to excess phosphorus and suspended solids.

OBJECTIVE 1: Develop a cooperative mechanism among local units of government, academia, and stage agencies to reduce phosphorus loading to the Fox River and Green Bay.

	ACTIVITY/TASK	IMPLEMENTING AGENCY	START DATE
1.	Generate a white paper on current loadings, sources and impacts of phosphorus and suspended solids to the AOC including recommended management actions. This document will be used to enlist management agencies, local government in upstream counties and legislators in efforts to reduce inputs.	WDNR, RAP PAC, RAP STAC, Waupaca, Winnebago, Calumet, Fond du Lac, and Outagamie Counties	2/93
2.	Institute mandatory animal waste utilization plans at the County level.		
3.	Enact shoreland zoning and livestock exclusion ordinances based on the DATCP model ordinance.	All Counties	10/93
4.	Pursue adoption and enforcement of construction erosion control ordinance in all cities and villages of the Fox-Wolf Basin.	PAC, Local Government	6/93
5.	Pursue state legislation for mandatory construction site erosion control.	PAC	9/93
6.	Identify appropriate models and monitoring needs to adequately define sources, loads and transport of phosphorus and suspended solids in the Fox-Wolf-Winnebago-Green Bay system under various management scenarios.	WDNR, RAP STAC, NEWWT	3/93
	a. Identify appropriate watershed and lake models.		
	b. Develop monitoring plans and project proposals.	WDNR, RAP STAC	6/93

	ACTIVITY/TASK	IMPLEMENTING AGENCY	START DATE
7.	Work with county LCDs to identify and rank watersheds and nonpoint sources for targeted management leg. priority watershed projects or regulations).	WDNR, RAP STAG	4/93
8.	Establish timetable for selection of priority watershed projects in Calumet, Fond du Lac, Outagamie Winnebago and Waupaca Counties.	PAC, County Government, LCDs, WDNR	5/93
9.	Advise the DNR and Phosphorus Ambient Standards Technical Advisory Committee on appropriate water quality standards for the AOC.	RAP PAC & STAC	4/93
10.	Update and seek implementation of the RAP Monitoring and Research Plan.		
	a. Review and update appropriate portions of the RAP Monitoring and Research Plan.	RAP STAC	3/93

FOX RIVER SEDIMENT REMEDIATION

The issue of contaminated sediment clean up is multi-faceted, encompassing planning, technical, political, and economic aspects. Several of the issues are highlighted below.

Green Bav Mass Balance Study: The Green Bay Mass Balance Study was initiated in 1986 to accurately model contaminant transport through multiple media using mass conservation principles. Essentially, a "mass balance" determines whether the quantities of contaminants entering the Green Bay system, minus quantities stored, transformed, or degraded within the system, would equal the quantities leaving the system. Fifty-five individuals from the EPA, USGS, National Oceanic and Atmospheric Administration (NOAA), WDNR and a host of academic institutions endeavored to account for PCBs, dieldrin, cadmium and lead in the sediment, water column, and air of the Fox River and Green Bay system. In initial screenings, detectable levels of dieldrin and cadmium were too low to warrant further study. To date, analysis of fish tissue for lead concentrations has not been completed and no study results are available. PCB transport was estimated through five independent but interrelated computer models: sediment and PCB transport from LLBM to the De Pere dam, PCB transport from the De Pere dam to the mouth of the River, fine scale sediment transport from the De Pere dam to the River mouth, a Bay toxics model and a food chain model. Results regarding PCBs have been presented to EPA but they represent preliminary findings, as completed reports will not be available until October 1993. Consequently, all data and results are subject to change.

Many of the results and analyses presented here are based on the work of WDNR and USGS. These agencies cooperated to collect data and develop a sediment and PCB transport model for the River from LLBM to the De Pere dam.

PCBs adsorb strongly to organic carbon. They are hydrophobic compounds. This means they are not readily soluble in water and have an affinity for biological lipids and organic carbon associated with sediment. Partitioning, diffusion, advective pumping, resuspension and settling of sediments through bioperturbation and river currents make PCBs potentially available to water column organisms. Benthic invertebrates may take up PCBs from sediment pore water or from ingestion of particulate matter, detritus, or food items. Benthic invertebrates and emerging insects are potential biotic pathways for transferring sediment associated PCBs to upper food chain levels in the aquatic and terrestrial ecosystems.

Sediment core data were collected from May 1989 to May 1990, from 318 sites between LLBM and the De Pere Dam (Table 15). These data were analyzed during development of the sediment transport model and included conditions under a 5-year flow event. Results indicate that about 175 kg (386 Ibs/yr) of PCBs were resuspended and transported over the De Pere dam during that year. Confidence in this estimate is increased by reviewing results of a 1984 Master's of Science thesis by Edwin Marti. He estimated a PCB loading to the Bay of approximately 520 kg/yr (1146 Ibs/yr)[38]. Preliminary modeling projections predict that transport of PCBs over the De Pere dam would reduce by half every 5-7 years. Back calculating from 175 kg/yr (386 Ibs/yr) in 1990, and assuming no load from the downstream portion of the river, loading to Green Bay would have been about 700 kg/yr (1543 Ibs/yr) , roughly Marti's estimate.

Downstream of the dam, sampling conducted by the WDNR for the Green Bay Mass Balance Project included 37 gravity cores and 35 deep cores (Table 16). Gravity cores penetrate to the depth possible through the force of gravity alone, while deep cores require added force to drive the sampling probe to the desired depth. Average depth of gravity cores was 0.50 m (1.6 ft). Deep core sample depths were typically 7 m, but they ranged from 1 to 11 meters. Each deep core was segmented into 0.69 m (2.5 ft) sections and analyzed for PCB and physical parameters.

Figures 8 - 11 depict locations of soft sediment deposits and deep core sampling.

Under low to normal flow conditions, the PCB load transported over the dam is a good first approximation of the load exported at the mouth of the river. An average flow for the Fox River is 4,252 cubic feet per second (cfs). Of more significance than the average flow, however, is the frequency of higher discharge flow events with greater scouring potential. USGS compiles flood-frequency characteristics of Wisconsin streams, which gives the average occurrence of various river discharges (Table 17). Recognize, however, that the frequency of any flow event can vary.

Table 17. Fox River Discharge (cfs) for Indicated Recurrence Interval, Wrightstown, WI '

Station name	Flow Recurrence Interval (Years)							
	2	5	10	25	50	100	Std E.,~	WRC skew
Fox River at Rapide Croche Dam, near Wrightstown, WI	12,700	17,000	19,200	21,600	23,000	24,200	6.7	-.768

'cfs - cubic feet per second
Source: USGS Flood Frequency Characteristics of Wisconsin Streams. Water Resource Investigative Report.

Table 15. Estimates of Contaminated Sediment Between Little Lake Butte des Morts and the De Pere Dam on the Fox River.

Deposit	Sediment Surface Area (m^2)	Percent of Total Area	Contamin. Sediment Volume (m^3) > .05ppm	Percent of Total Volume	Est. PCB Mass (Kg)	Percent of Total Mass	PCB Mass/ Sed. Vol. g/m^3
A	154,050	2.04	56,702	2.74	716	18.43	12.6
B	101,133	1.34	10,283	0.50	1	0.02	0.1
C	112,148	1.48	30,685	1.48	117	3.01	3.8
POG	110,954	1.47	16,907	0.82	254	6.54	15.0
D	548,843	7.26	158,737	7.66	315	8.12	2.0
E	1,703,519	22.52	405,925	19.60	538	13.85	1.3
F	150,551	1.99	39,446	1.90	7	0.19	0.2
G	40,520	0.54	4,825	0.23	1	0.02	0.1
H	6,428	0.08	1,093	0.05	2	0.05	1.6
	23,815	0.31	3,334	0.16	1	0.03	0.3
J	26,351	0.35	5,270	0.25	0	0.01	0.1
K	5,348	0.07	856	0.04	0	0.00	0.2
L	10,663	0.14	1,599	0.08	0	0.01	0.2
M	10,334	0.14	1,963	0.09	1	0.02	0.3
N	25,441	0.34	13,386	0.65	160	4.11	11.9
O	19,756	0.26	4,337	0.21	3	0.07	0.7
P	45,914	0.61	27,824	1.34	69	1.79	2.5
Q	4,723	0.06	2,489	0.12	8	0.20	3.1
R	7,536	0.10	0	0.00	0	0.00	0.0
S	165,873	2.19	15,944	0.77	4	0.10	0.2
T	21,055	0.28	14,993	0.72	23	0.59	1.5
U	16,003	0.21	1,920	0.09	1	0.02	0.5
V	25,168	0.33	9,854	0.48	6	0.14	0.6
W	692,621	9.16	146,732	7.08	63	1.63	0.4

Table 15 Continued:

Deposit *	Sediment Surface Area (m^2)	Percent of Total Area	Contamin. Sediment Volume (m^3) > .05ppm	Percent of Total Volume	**Est. PCB Mass (Kg)**	Percent of Total Mass	PCB Mass/ Sed. Vol. g/m^3
X	210,540	2.78	42,363	2.05	58	1.50	1.4
Y	30,768	0.41	4,307	0.21	1	0.03	0.2
Z	23,790	0.31	2,617	0.13	1	0.01	0.2
AA	6,042	0.08	0	0.00	0	0.0	0.0
BB	14,027	0.19	1,964	0.09	0	0.01	0.1
CC	124,258	1.64	7,725	0.37	2	0.05	0.3
DD	173,836	2.30	23,247	1.12	19	0.49	0.8
EE(22)	507,244	6.71	129,661	6.26	70	1.80	0.5
EE(23)	670,519	8.86	210,147	10.15	300	7.72	1.4
EE(24)	730,787	9.66	174,951	8.45	368	9.47	2.1
EE(25)	358,007	4.73	165,334	7.98	**143**	3.68	0.9
EE(26)	355,865	4.70	100,543	4.85	178	4.57	1.8
EE(27)	200,043	2.64	89,983	4.34	230	5.93	2.6
FF	6,658	0.09	3,063	0.15	9	0.23	2.9
GG	65,876	0.87	51,478	2.49	114	2.92	2.2
HH	56,959	0.75	88,711	4.28	103	2.65	1.2
Totals	7,563,954	100.00	2,071,198	100.00	3,886	100.00	1.9

Data are ordered by location in river beginning upstream at Little Lake Butte des Morts.

Source: WDNR/USGS data collection April 1989 - 1990.

Table 16. Estimates of Contaminated Sediment Between the De Pere Dam and the mouth **of the Fox River.**

Deep* Core	Sediment Surface Area (m^2)	**Percent** of Total **Area**	Contam. Sediment Volume (m^3) > .05ppm	Percent of Total Volume	Est. PCB Mass (Kg)	Percent of Total Mass	PCB Mass/ Sed. Vol. g/m^3
1 FRB08	323,287	6.22	193,972	2.70	74	0.17	0.4
1 FRB01	129,608	2.49	447,148	6.22	4,578	10.25	10.2
2FRB27	139,313	2.68	167,176	2.32	33	0.07	0.2
2FRB25	83,829	1.61	0	0.00	0	0.00	
2FRB23	85,513	1.65	50,453	0.70	**5**	0.01	0.1
2FRB26	109,994	2.12	52,797	0.73	87	0.19	1.6
2FRB24	71,698	1.38	45,170	0.63	2	0.00	0.0
2FRB22	174,265	3.35	287,537	4.00	3,266	7.31	11.4
2FRB21	180,879	3.48	113,954	1.58	182	0.41	1.6
2FRB20	241,804	4.65	145,082	2.02	348	0.78	2.4
2FRB19	225,336	**4.34**	0	0.00	0	0.00	
2FRB17	157,988	3.04	197,485	2.75	2,067	4.63	10.5
2FRB18	188,274	3.62	114,847	1.6	276	0.62	2.4
2FRB16	252,835	4.87	796,430	11.07	6,154	13.78	7.7
2FRB15	233,770	4.50	140,262	1.95	174	0.39	1.2
2FRB13	204,563	3.94	513,453	7.14	1,358	3.04	2.6
2FRB12	213,971	4.12	139,081	1.93	106	0.24	0.8
2FRB14	73,301	1.41	45,447	0.63	184	0.41	4.0
2FRB01	178,219	3.43	969,511	13.48	8,129	18.21	8.4
2FRB02	144,676	2.78	**135,995**	1.89	925	2.07	6.8
2FRB03	74,579	1.44	0	0.00	0	0.00	
1 FRB02	108,962	2.10	71,915	1.00	25	0.06	0.3
1 FRB03	260,443	5.01	179,706	2.50	3	0.01	0.0
1 FRB06	114,381	2.20	0	0.00	0	0.00	
1 FRB07	60,376	1.16	23,547	0.33	66	0.15	2.8

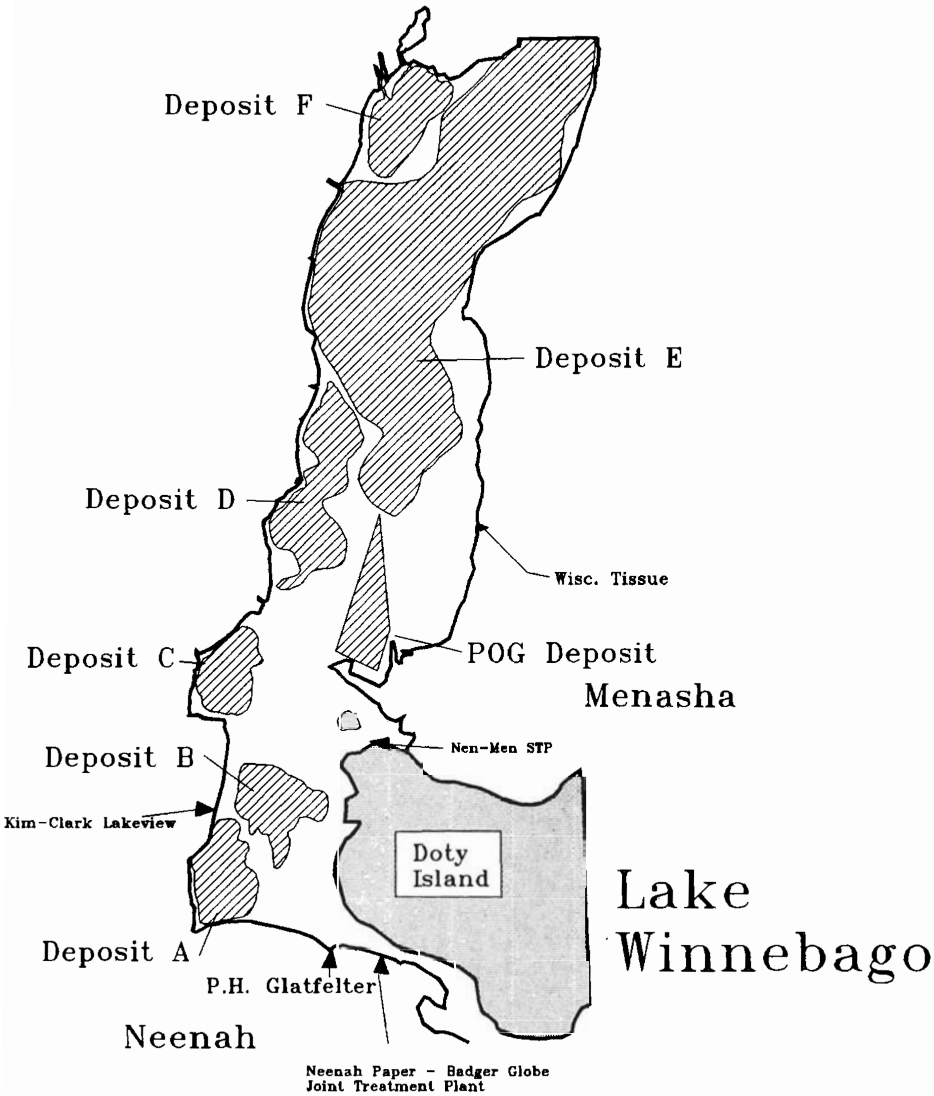
Table 16 Continued

Deep' Core	Sediment Surface Area (m^2)	Percent of Total Area	Contamin. Sediment Volume (m^3) > .05ppm	Percent of Total Volume	Est. **PCB Mass (Kg)**	Percent of Total Mass	PCB Mass/ Sed. Vol. g/m3
2FRB04	36,610	0.70	19,037	0.26	8	0.02	0.4
2FRB05	64,716	1.25	80,248	1.12	1,581	3.54	19.7
2FRB06	144,497	2.78	741,270	10.30	6,263	14.03	8.4
2FRB11	101,117	1.95	178,977	2.49	1,422	3.18	7.9
2FRB07	153,929	2.96	277,072	3.85	1,347	3.02	4.9
2FRB08	133,852	2.58	80,311	1.12	32	0.07	0.4
2FRB09	158,327	3.05	612,725	8.52	4,846	10.85	7.9
1FRB04	165,540	3.19	0	0.00	0	0.00	
2FRB10	136,723	2.63	226,960	3.15	292	0.65	1.3
1FRB05	69,126	1.33	46,547	2.04	817	1.83	5.6
Totals	5,196,301	100.00	7,194,115	100.00	44,650	100.00	

Data are ordered by location in river beginning upstream at the De Pere Dam.

Source: WDNR/USGS data collection April 1989-1990

FIGURE 8 LOCATIONS OF SOFT SEDIMENT DEPOSITS IN LITTLE LAKE BUTTE DES MORTS (LLBDM)



PCB Mass Estimates	
Deposit A	716 Kg
Deposit B	1 Kg
Deposit C	117 Kg
Deposit D	315 Kg
Deposit E	538 Kg
Deposit F	7 Kg
POG Deposit	254 Kg
LLBDM Total	1949 Kg

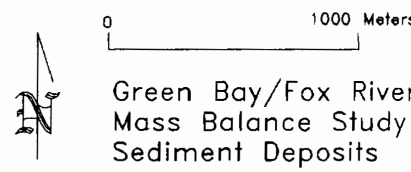
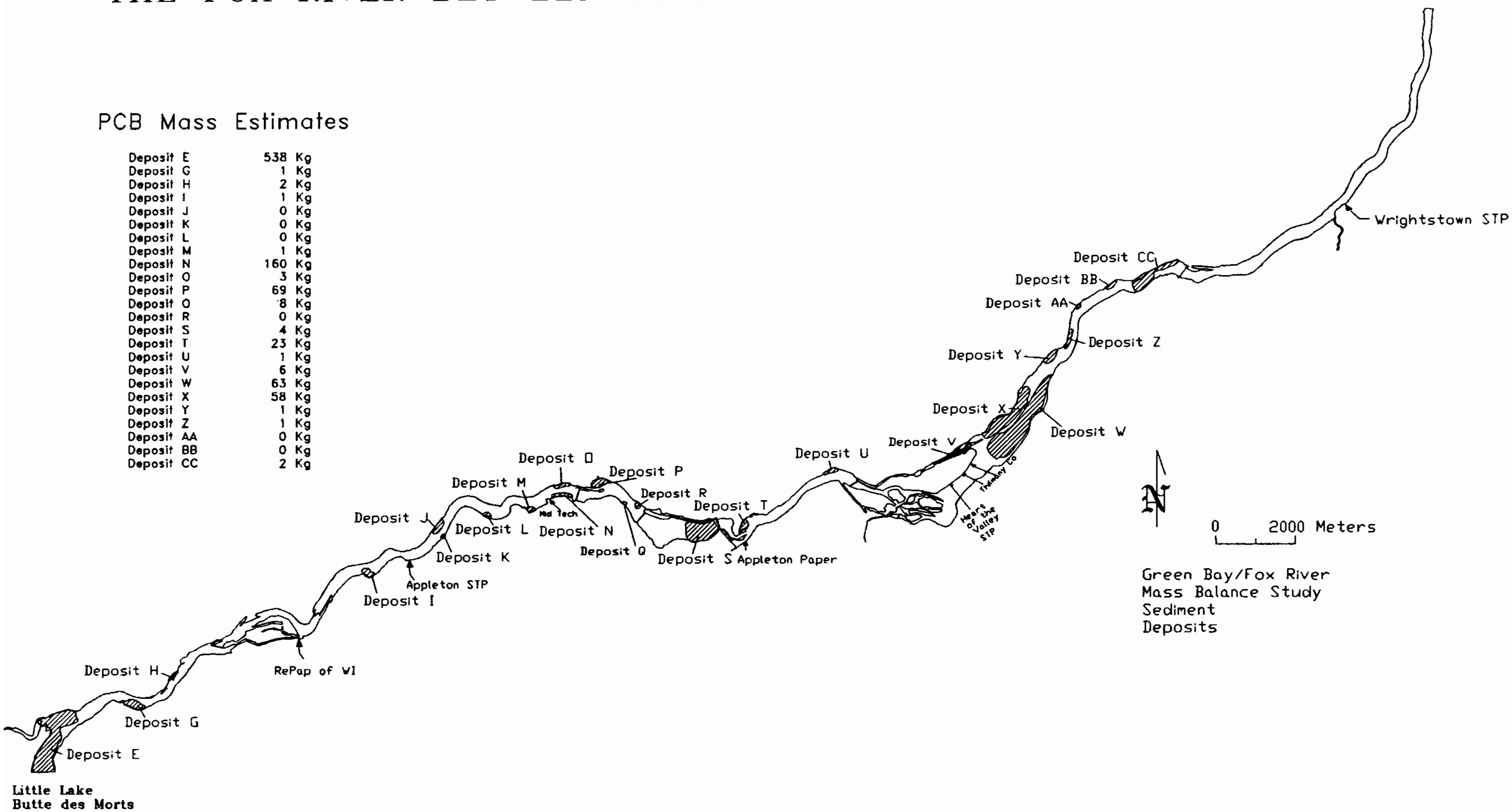


FIGURE 9 LOCATIONS OF SOFT SEDIMENT DEPOSITS IN THE FOX RIVER BETWEEN LLBDM AND WRIGHTSTOWN

PCB Mass Estimates

Deposit E	538 Kg
Deposit G	1 Kg
Deposit H	2 Kg
Deposit I	1 Kg
Deposit J	0 Kg
Deposit K	0 Kg
Deposit L	0 Kg
Deposit M	1 Kg
Deposit N	160 Kg
Deposit O	3 Kg
Deposit P	69 Kg
Deposit Q	8 Kg
Deposit R	0 Kg
Deposit S	4 Kg
Deposit T	23 Kg
Deposit U	1 Kg
Deposit V	6 Kg
Deposit W	63 Kg
Deposit X	58 Kg
Deposit Y	1 Kg
Deposit Z	1 Kg
Deposit AA	0 Kg
Deposit BB	0 Kg
Deposit CC	2 Kg



Green Bay/Fox River
Mass Balance Study
Sediment
Deposits

FIGURE 10 LOCATIONS OF SOFT SEDIMENT DEPOSITS IN THE FOX RIVER BETWEEN WRIGHTSTOWN AND THE DEPERE DAM

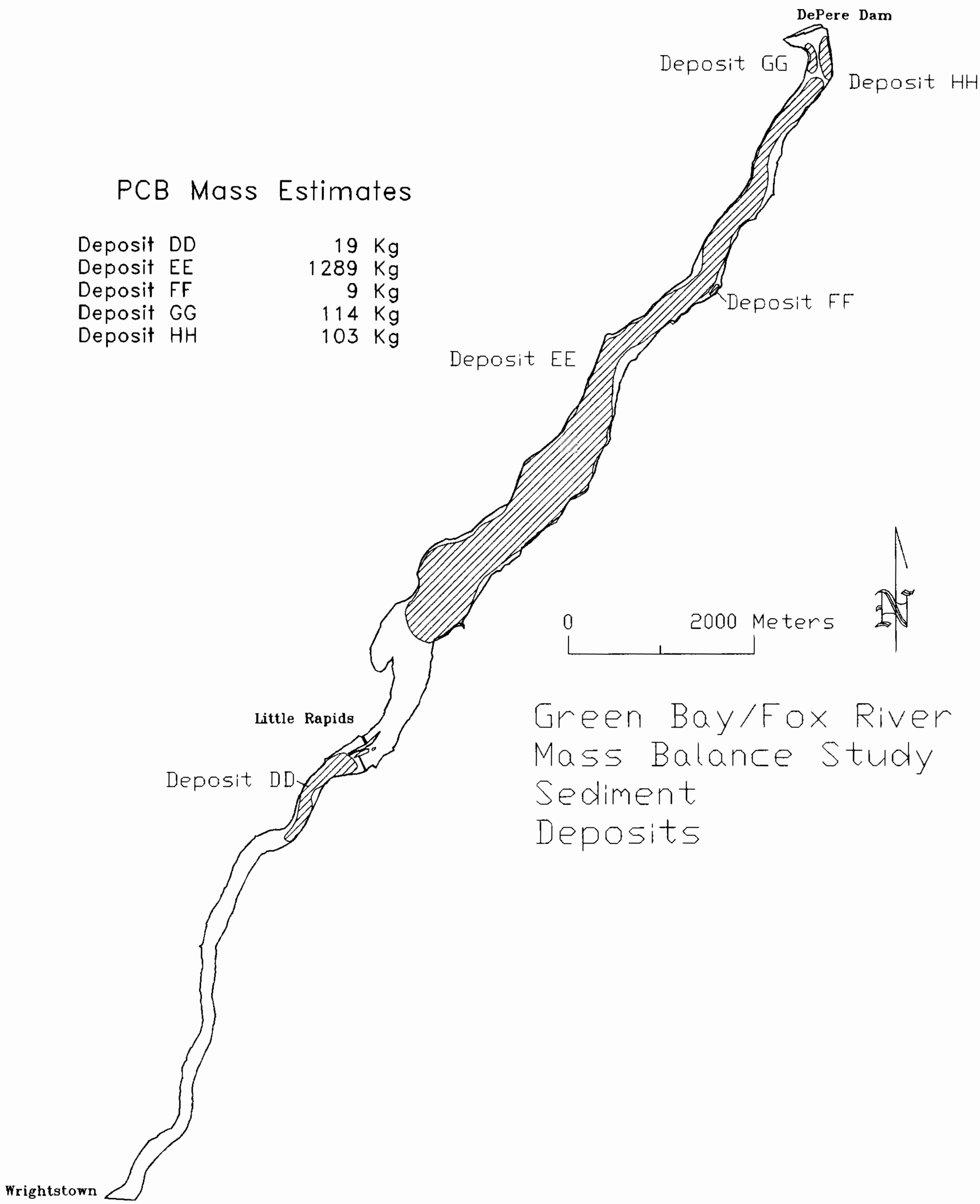
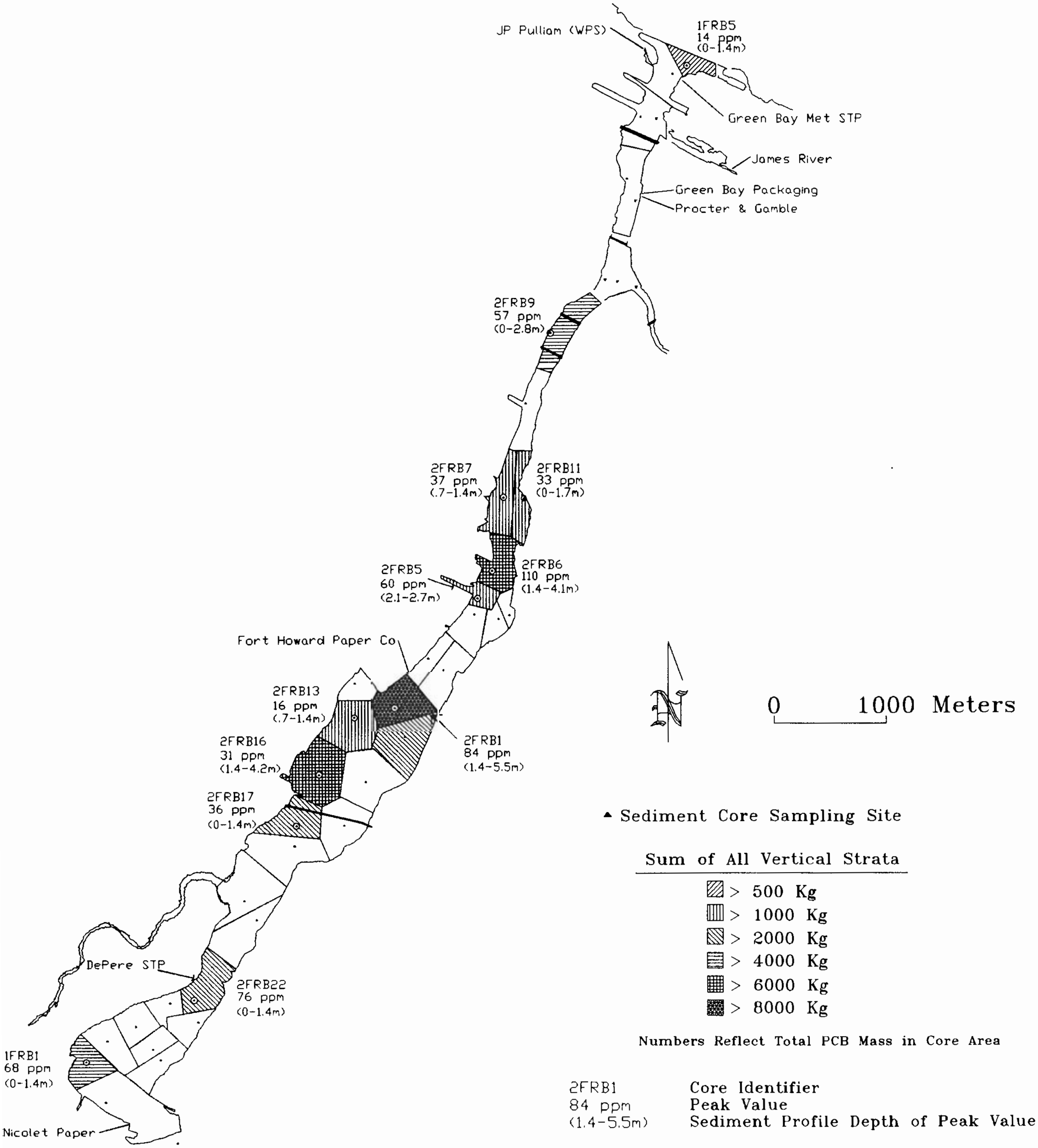


FIGURE 11

1989 SEDIMENT SAMPLING LOCATIONS AND ESTIMATES OF PCB MASS PER AREA BETWEEN THE DE PERE DAM AND MOUTH OF THE FOX RIVER[a]



a Area Estimated by Intersecting Bisects

The highest flow peaks recorded occurred in 1952 - discharge of 24,000 cfs, and 1960 - 23,400 cfs. Regardless of flow, there is a continual exchange of sediment between the water column and the river bed, with some PCB being deposited and picked up during the seven mile journey from the De Pere dam to the mouth.

One environmental danger lies in the potential of a large flow event such as the 100 year flood, to expose and transport PCBs that are buried relatively deeply in sediment deposits. Under the conditions of a large flow event, surface sediment layers that generally have lower concentrations of PCBs than underlying strata, could be scoured away, moving not only PCB laden sediment out into the Bay but also exposing a sediment surface with higher PCBs. After contaminated sediment has been deposited in the Bay, it becomes spread out over such a large area, that it is virtually impossible to clean up. The ecological impacts, however, continue. Storm events, Bay water intrusions, and pronounced winds all effect resuspension and, consequently, PCB loading at the mouth of the river.

Preliminary estimates from data collected as part of the Green Bay Mass Balance Study, from May 1989 - May 1990, by researchers at the EPA's Large Lakes Research Station, are that approximately 270 kg PCB (600 Ibs) were exported to the Bay at the mouth of the Fox River during the year of data collection. Modeling efforts for the downstream portion of the river indicate that approximately 100 out of 270 kg PCB were picked up between the De Pere dam and the mouth of the river and were contributed to the net load into the Bay.

Modeling projections, which couple sediment and PCB transport from the Fox River with food chain effects in Green Bay, will be available in late 1993.

The Little Lake Butte des Morts (LLBM) Contaminated Sediment Demonstration Project: The LLBM demonstration is part of a statewide effort to address contaminated sediment. In addition to the five AOCs for which Wisconsin is developing or assisting with Remedial Action Plans, the WDNR has identified approximately 50 other sites in Wisconsin with contaminated sediment. These sites include inland lakes, tributary streams to Lakes Michigan and Superior, and the Mississippi and Wisconsin Rivers. The statewide program to clean up river and lake sediments contaminated with toxic or hazardous substances is called the Sediment Management and Remedial Techniques (SMART) program. It is intended to restore the quality of waters damaged by contaminated bottom sediments.

Because scientists and resource managers are still learning to deal with contaminated sediments, demonstration projects that allow testing of sediment clean-up methods are an important part of the SMART program. The LLBM contaminated sediment project is one of the first of these demonstrations in the state.

In recognition of the WDNR's efforts to address these problems, a consortium of federal agencies, collectively referred to as Coastal America, chose the LLBM project as the Great Lakes Region's candidate to receive $300,000 in funding for the fiscal year ending September 30, 1992. Wisconsin is the only state that has the lead on any of the Coastal America funded projects. The ability to continue to attract Federal funding and programmatic assistance depends in part on what we learn from the demonstration projects of the State's SMART program.

The LLBM demonstration will be conducted at a site called "Deposit A", which lies in the southwest corner of the Lake. The deposit is about 40 acres in size, with approximately 63,000 cubic yards of the contaminated sediment. The deposit contains approximately 716 kg (1,500 lbs.) of PCBs--or about 18 per cent of the total mass of PCBs in the Fox River between Neenah-Menasha and De Pere.

Because PCBs continually escape from this sediment "hotspot", removing or containing them is vital to the continuing recovery of the Fox River. Modeling from the Green Bay Mass Balance Study indicates that transport of PCBs from Deposit A is most likely to occur under conditions of a large flow of water down the Neenah Slough. If no action is taken at Deposit A, and no large runoff event increases flow down the Slough, modeling predictions indicate that about 74% of the PCBs still will be contained in the deposit after 25 years. This indicates that the impact on benthic organisms, fish, and waterfowl will continue for decades if remediation does not occur.

The deposit is located in a shallow part of the lake where the water is only two to four feet deep. The contaminated sediment is two to three feet thick, but most of the PCBs are found in a layer about a foot thick, beginning a few inches below the surface of the deposit. The average PCB concentration in Deposit A is 33.4 ppm, but the contaminant is not evenly distributed across the deposit. Samples from individual locations within Deposit A contain PCB concentrations ranging from less than .05 ppm to as high as 223 ppm.

Test results indicate that the PCBs in Deposit A most closely resemble Aroclor 1242, a type of PCB produced for use in carbonless copy paper. Because portions of the deposit contain PCB concentrations higher than 50 ppm, the material must legally be classified as a hazardous waste, and as such, will be regulated under the federal Toxic Substances Control Act.

The LLBM remedial demonstration project is being conducted in three phases.

1. The first phase, a remedial investigation and feasibility study, began *in May* 1991. The WDNR contracted with EWI Engineering Associates, *Inc., now* Woodward Clyde Consultants, a Middleton, WI consulting firm, to carry o■)t tm. x of the work.

In its contract, EWI was asked to investigate Deposit A in detail, to evaluate methods that could be used to clean up or isolate the contaminants, and to recommend what it believed to be the most environmentally sound and cost-effective way to deal with the deposit.

The Wisconsin Paper Council conducted a shadow study, and in June 1992 representatives met with the WDNR to review details of the report prepared by Blasland, Bouck & Lee consultants. Recognizing that a small fraction of contaminants in the LLBM demonstration site, Deposit A, may be from nonpoint sources, the WDNR approach has been to enlist project assistance from interested, potentially responsible parties, and not to pursue litigation. Paper Council members maintain that voluntary participation in remediation projects necessitates that the feasibility studies include components specified in the Comprehensive Environmental Response Compensation and Liability Act of 1980 (P.L. 96-510) (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986. (P.L. 99-499). To that end, the first phase of the project was extended to permit representatives or consultants of the P.H. Glatfelter Company to prepare those elements of a feasibility study that meet minimum criteria resulting in a CERCLA-quality cleanup, keeping in mind that the WDNR demonstration goals may be more stringent. This effort might also strengthen the technical merit of the project and along with public comment, might facilitate selection of a final remedial alternative. At the time of this writing three options are under investigation: in-place armoring; construction, over Deposit A, of a confined disposal facility with the capacity to receive sediment from other locations; and dry excavation and landfilling. A cooperative schedule with P.H. Glatfelter to complete a feasibility study has been implemented, and a public informational meeting will be held in the fall of 1993 to discuss these or other options.

2. In the second phase of the project, the WDNR will contract with an engineering firm to carry out pre-design studies and develop the final engineering designs, plans, and specifications necessary for the clean-up demonstration project. This phase should be completed by the fall of 1993.

3. Finally, the WDNR will contract with an engineering and construction firm to actually implement the clean-up. This third phase is expected to begin late fall 1993 or spring 1994.

The investigation and design phases are being funded by the SMART program and through grants from the Coastal America Program. The actual clean-up will be much more expensive. A variety of funding sources could be used for the final phase, including state and federal funds and contributions from local government and industry.

<u>Fox River Coalition:</u> In an effort to broaden participation in voluntary cleanup of the Fox River, Wisconsin Paper Council representatives, county, city and village government officials, municipal treatment plant directors, liaisons from RAP committees, and representatives from the WDNR, formed a coalition. The goal of the "Coalition" is "to develop a process for private/public participation in determining cleanup levels, cost-effective methods, funding mechanisms and timetables for sediment remediation." As remediation projects proceed, it will

become necessary to call for participation by other parties such as the USFWS, the USACOE, and the Port of Green Bay.

To date, the Coalition has sponsored a subgroup to review existing data and to **determine a** rationale for selecting remediation sites. Over twenty considerations were identified as being important to prioritizing contaminated deposits and work continues to obtain necessary data and develop a selection process. Paper industry and RAP committee members have worked together in this effort with substantial progress since September 1992.

Two issues have emerged from this process: Unavailability of data or modeling capabilities from the Green Bay Mass Balance Study downstream of the De Pere dam, and the establishment of clean up criteria.

1. Modeling Capabilities: Under the terms of Mass Balance Study contracts with independent researchers, modeling results and computer programs will be finalized and deposited with the EPA at the Large Lakes Research Station in Grosse Ile, Michigan by June 1993. As there are five models, each developed somewhat differently, coupling them to run a hypothetical management scenario is not a simple task. A year of WDNR staff time would be needed to obtain the downstream models and develop the expertise to use them. The implications of this are that information is limited regarding downstream PCB and sediment transport information which would be useful in completing a remediation schedule for the Fox River. At issue are funding of researchers to facilitate model coupling, and allocation of resources to research versus remediation efforts. Fine scale modeling for deposits outside the main current of the River may be another approach to obtaining site specific information for use in management decisions. Additional research on sediment resuspension under varying flow conditions could also help to focus remediation efforts. The EPA is currently funding such work by Dr. Wilbur Lick of UC-Santa Barbara.

2. Sediment Criteria: No specific standards or criteria for sediment contamination have been established by EPA or the State of Wisconsin at this writing; however, Chapter NR 105 of the Wisconsin Administrative Code establishes surface water criteria for toxic substances to protect public health and welfare, the present and prospective use of all surface waters for public and private water supplies, and the propagation of fish and aquatic life and wild and domestic animal life. The WDNR develops site-specific clean up criteria that will protect water quality criteria established in NR 105. For PCBs for example, water column criteria to protect wild and domestic animals is 3 ppt. The human cancer criterion for non-public water supplies for Great Lakes aquatic communities is 0.15 ppt and for warm water sport fish communities, 0.49 ppt.

In determining sediment clean-up levels, WDNR considers and uses a number of approaches that relate concentrations of contaminants in sediment to biological effects and the need to protect all biotic components of the aquatic system. Some of the approaches are based on partitioning models which express the tendency for hydrophobic PCBs to partition to other phases of the environment in which they exist. Some of the partitioning models used are:

1) Equilibrium Partitioning (EqP) based on partitioning of a particular Aroclor between organic carbon in the sediment and sediment pore water;

2) Calculation of PCB sediment quality criteria based on partitioning of PCB between organic carbon in the sediment and lipids in fish tissue;

3) Calculation of PCB sediment quality criteria based on partitioning of PCB from the sediment to the water column and subsequent bioconcentration into lipids of fish tissue.

A number of assumptions have to be made in using these partitioning models, such as:

1) the whole system reaches equilibrium (sediment organic carbon-sediment pore water-overlying water column-fish lipids);

2) the system is closed (or once released from the sediment to the overlying water column, residence time is relatively long, mixing and dilution is small, and such factors as bioperturbation, advective pumping, bed porosity, and depth of contamination in sediment contribute to release of PCBs);

3) a site-specific sediment criteria can be calculated that if maintained, will prevent exceeding acceptable water quality or fish tissue residue levels.

Until federal or state criteria are established by rule, the WDNR will look to groups such as the Fox River Coalition and RAP STAC for input and endorsement of approaches that will enable sediment remediation to proceed.

<u>Navigational Dredge Disposal:</u> Since 1988 the USACOE, Brown County, the Public Intervenor's Office, and the WDNR have been embroiled in a stalemated controversy about whether or not to expand the existing confined disposal facility in Lower Green Bay, Renard Isle. At the heart of the controversy is disagreement over computer modeling of the impact on dissolved oxygen in the Bay from an expanded facility. Meanwhile, navigational dredging has been limited, and we have gained greater knowledge about the level of contamination in bottom sediments.

Two issues must be resolved; determining the long-term maintenance and viability of the Port, and whether there is a political solution to the stalemate between the

Public Intervenor's Office and Brown County that will result in an acceptable disposal alternative for dredge spoils. Lastly, how navigational dredging and remedial dredging can be coordinated will become an important economic consideration as projects are developed, and public and private sector funding is called for.

The USACOE has been authorized through the Water Resources Development Act to dredge for environmental reasons and to provide assistance for Great Lakes AOC remediation projects. While no funding was allocated to provide such assistance, there are cost sharing provisions for dredging areas adjacent to the navigation channel. Since some of the estimated nine million cubic meters of contaminated sediment in the Fox River lie outside the channel, USACOE's technical assistance could be beneficial to the Green Bay AOC if dredging is the remedial option of choice.

As discussed, developing a sediment remediation strategy is proceeding on a number of fronts. Coordinated action among local, state, and federal agencies, and the private sector as outlined in Table 18 is the key to moving ahead with sediment cleanup in the Fox River.

Table 18. 1993-1994 Actions to Eliminate Toxicity From Contaminated Sediment

GOAL: Develop a written schedule to complete assessments and remediate sediments contaminated with PCBs, mercury, other toxic materials or degraded by ammonia toxicity, and prevent the re-contamination of remediated areas.

OBJECTIVE 1: Evaluate existing information to determine the need for further sediment sampling and biomonitoring.

	ACTIVITY/TASK	IMPLEMENTING AGENCY	START DATE
	Compile sediment sampling data for organic pollutants, metals, and other contaminants specifically PCBs, mercury and lead, DDT and its metabolites and 2,3,7,8 -TCDD.	WDNR, GBMSD, INDUSTRY	3/93
2.	Assess results of the EPA Green Bay Mass Balance Study results and recommend applications of the contaminant transport and fate models.	WDNR, RAP STAC	3/93
3.	Advise WDNR on pollutant screening sites for 1993 monitoring season.	RAP STAC, FRC	3/93
4.	Map soft sediment deposits downstream of the De Pere dam, and coordinate sediment transport data gathering.	RAP PAC & STAC, FRC, WDNR, USACOE, USEPA	4/93
5.	Track Brown County environmental assessment of a Harbor modal shift study and recommend PAC involvement as possible in forming long-range dredge spoil disposal plans.	RAP STAC, WDNR	**3/93**

OBJECTIVE 2: Develop guidelines for sediment clean up levels and criteria for sequencing remediation.

ACTIVITY/TASK	IMPLEMENTING AGENCY	START DATE
1. Work with the Fox River Coalition to develop a matrix of decision criteria.	WDNR, RAP STAC	3/93
2. Review WDNR procedures for determining site-specific cleanup levels for PCBs.	RAP STAC, FRC	3/93
3. Assist in writing rationale for site selection.	RAP STAC, FRC WDNR	4/93
4. Develop a priority list of sediment deposits for clean up.	RAP STAC, FRC, WDNR, USACOE	6/93

OBJECTIVE 3: Apply sediment clean-up criteria to a review of remedial options likely to be applicable to the Fox River and Lower Green Bay System and determine a timeframe for implementation.

ACTIVITY/TASK	IMPLEMENTING AGENCY	START DATE
Identify past or current sources of contaminants.	WDNR, RAP STAC, FRC	6/93
Identify regulatory and non-regulatory control measures and recommend source controls.	WDNR, FRC, RAP STAC & PAC	8/93
Review case histories and results of demonstration projects to establish criteria by which to select remedial options.	WDNR, RAP STAC, FRC	8/93
Develop remedial options applicable and available for use in the Fox River and Green Bay.	FRC, RAP STAC, WDNR	9/93
Assist in identifying potential consulting engineers to contract for site-remediation	FRC, PAC	3/93
Coordinate with the FRC, STAC and PAC to recommend a clean-up schedule for the Fox River.	RAP STAC, WDNR	8/93
Develop an equitable, dependable and easily administered financing mechanism using public and private sources to fund sediment remediation.	RAP PAC, FRC, WDNR	3/93

HABITAT PROTECTION AND RESTORATION

The Biota and Habitat Work Group of the RAP STAC conducted field surveillance of Fox River shoreland and littoral habitats on June 11, 1992. The following summarizes its findings and recommended actions for 1993-1994.

The shallow aquatic (littoral) and shoreland (riparian) habitats of the Lower Green Bay and Fox River AOC have been substantially altered and degraded over the past one hundred years. Most wetlands have been filled or diked; natural, unconsolidated shorelines have been buried under rock riprap or metal sheet piling and fill; shorelands are permanently altered by development; and shallow, littoral habitat has been lost to sedimentation, channelization and dredging. In addition, poor water quality and clarity degrade aquatic habitat. Despite these losses, a mosaic of habitat still exists and sustains a diversity of birds, mammals, amphibians, reptiles, fish, and other aquatic life. The remaining habitat should be protected and restored or rehabilitated where possible.

Much of the remaining habitat is located behind bulkhead lines -- legal boundaries established in the 1960s and 1970s which ceded state authorities over shorelands and wetlands to communities and riparian property owners. State permits are not required for filling or modifying shorelands out to the bulkhead line, although federal authorities remain intact, through Section 404/10 permits issued by the USCOE. Considerable shoreland habitat in the area of concern is threatened by the potential for filling, dredging, or other alteration behind existing bulkhead lines (Figure 12).

For discussion purposes, the riverine corridor in the AOC of concern is divided into four segments:

Segment I is defined as the river reach from the De Pere dam -- the southern boundary of the AOC -- to the Interstate Highway 172 bridge. This corridor is occupied by a number of parks and recreation facilities, as well as residential and other developments. A substantial portion of the shoreline has not yet been altered or filled. There are no bulkhead lines in this segment, with the exception of a small area granted to the Brown County Fairgrounds for shoreline stabilization.

The eastern shore is characterized by low, sandy shorelines with areas of wetland vegetation and occasional riprap (revetments of large, loose rocks used to protect the streambanks from erosion). Three areas have been enhanced with graded rock to provide gravel beds for fish spawning (two at Voyageur Park and one at the new Fox Point boat landing). The River below the dam is scoured of sediment and provides additional rock and gravel habitat. Much of the River's western shore has been riprapped to protect against shoreline erosion, although there are areas of wetland and natural, unconsolidated shoreline.

Segment 2 is the reach between Interstate Highway 172 and the Mason Street Bridge. The eastern shore is flanked by primarily residential lands with riprap or shallow, sandy shorelines. The western shore is mostly industrialized, with riprap or metal sheet piling and fill along the shoreline. Port industries in particular have reduced littoral habitat by driving vertical sheets of steel into the riverbed and filling in behind them to create parallel docking space for ships.

East shore habitats and aesthetics are being degraded by dumping of broken pavement, concrete blocks, bricks and other construction debris. Wetlands remain adjacent to the National Railroad Museum on the western shore and west of St. Joseph Street on the eastern shore, although the latter wetland was isolated from the River by a permitted fill and may be threatened by shoreline filling and parking lot expansion.

Segment 3 is the reach between the Mason Street and Tower Drive bridges. This corridor is mostly channelized and flanked by intensely developed and industrialized shorelines. Sheet piling and rip rap are common on the shoreline. The river is dredged to maintain a 24 ft shipping channel and turning basin, and little natural shoreline remains. Shorelines which are altered by sheet piling and filling provide little or no littoral habitat.

Segment 4 is defined as the reach north of the Tower Drive (I-43) Bridge, extending beyond the Fox River mouth to include the adjacent southern shore of Lower Green Bay. Wetland habitat persists in several areas -- under the Tower Drive Bridge on the western shore of the Fox River, inside the slough adjacent to Green Bay Packaging on the eastern shore, along the northeast shore of the river mouth, and adjacent to the Bayport Industrial Park landfill (previously Atkinson's Marsh). A variety of fish and wildlife currently use or have the potential to use these wetlands. In addition, many fish species use the rocky shorelines for spawning. The remaining wetlands are degraded by adjacent land uses and are threatened by new or expanded developments.

Green Bay Remedial Action Plan Area of Concern

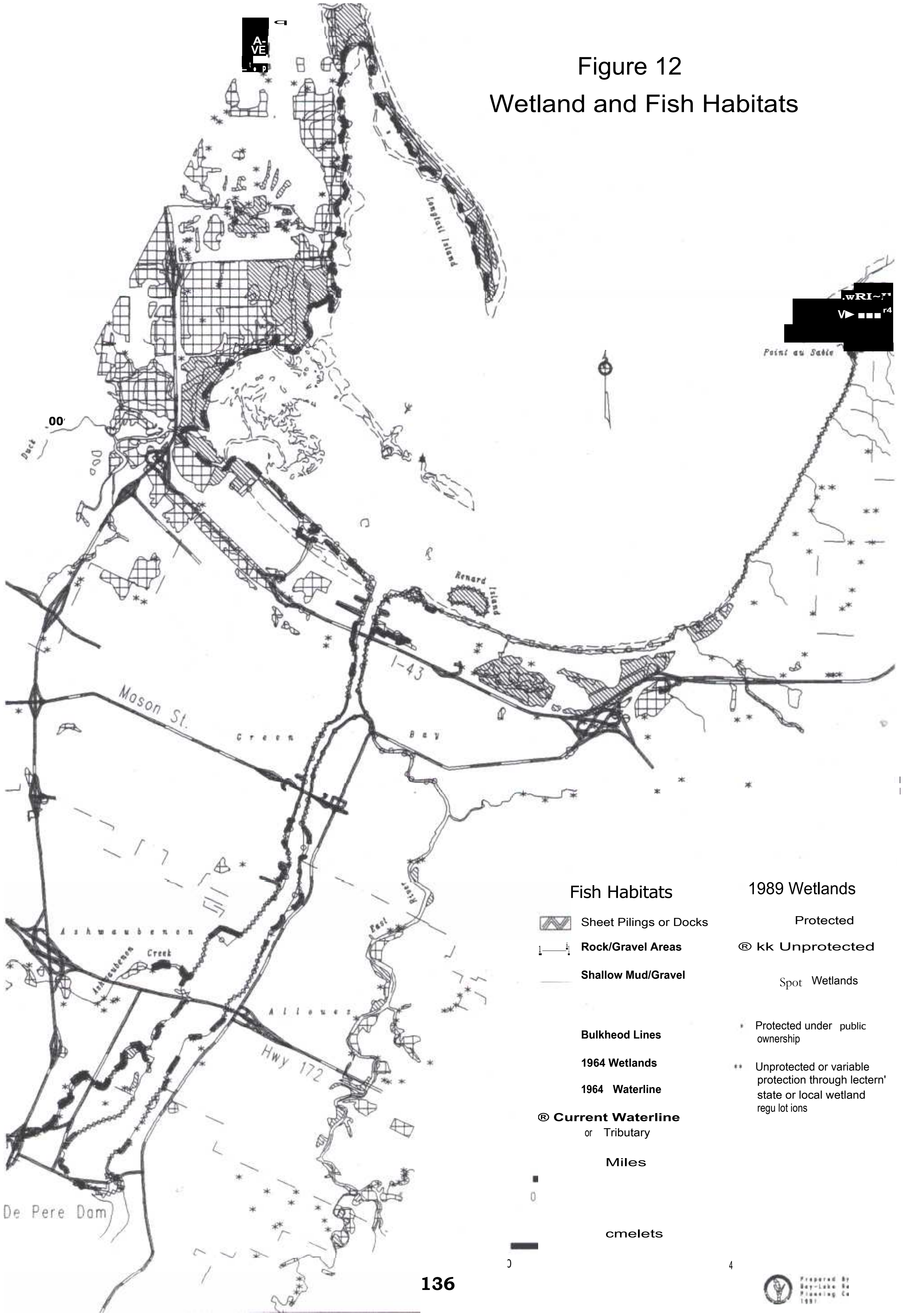


Table 19. 1993-1994 Actions to Restore Biota and Habitat

GOAL: Protect, restore and/or enhance fish and wildlife habitats and populations in the area of concern.

OBJECTIVE 1: Protect remaining habitats.

	ACTIVITY/TASK	IMPLEMENTING AGENCY	START DATE
1.	Identify and quantify remaining wetlands as outlined in GIS maps and the EPA Special Wetlands Inventory Study (SWIS1•	RAP STAC, WDNR	Expected completion 4/93
2.	Identify and quantify aquatic and upland habitat and natural and unconsolidated shoreline under private and public ownership.	RAP STAC, WDNR	3/93
3.	Evaluate effectiveness of current habitat protection measures and programs.	RAP STAC, WDNR	5/93
4.	Review and develop recommendations for additional protection including changes to bulkhead lines.	RAP STAC, WDNR	3/93
5.	Preserve the littoral zone where shoreline stabilization or redevelopment are necessary by using graded rock where possible. Consult with WDNR Fisheries Management and/or US Fish and Wildlife Service on creating habitat.	Riparian owners Brown County, City of Green Bay, WDNR, USFWS, USACOE	3/93
6.	Update the West Shore Wetlands management Plan for wetland acquisition and consider acquisition and fill removal in wetlands near the west end of the 1-43 frontage road in the Duck Creek delta.	WDNR	6/93
7.	Pursue funding for a Special Area Management Plan and seek a local sponsor to implement it.	USFWS	6/93
8.	Examine status and potential of Green Bay as a National Marine Sanctuary.	RAP PAC, Brown County, City of Green Bay, WDNR	6/93

ACTIVITY/TASK	IMPLEMENTING AGENCY	START DATE
9. Discourage filling to existing bulkhead lines except where necessary for water-dependent development.	USFWS, USACOE, WDNR	3/93
10. Grant no new bulkhead lines in the AOC unless it can be shown that they are in the public interest and will conform as nearly as practical to the existing shoreline.	WDNR	3/93
11. Rescind or modify bulkhead lines between Hwy 172 and the Mason Street Bridge. Evaluate exceptions for existing development on a case-by-case basis.	City of Green Bay Village of Allouez	6/93
12. Rescind bulkhead lines in selected areas between and including 143 and the southern shoreline of Green Bay; specifically areas under the Tower Drive Bridge, in the east shore slough and along the southern shore of the Bay beyond existing dikes.	City of Green Bay WDNR	6/93
13. Discontinue debris disposal along the Fox River shoreline.	Village of Allouez and other local governments	3/93
14. Acquire and develop the railroad right-of-way along the east shore of the Fox River as a recreational trail and corridor preserved in a natural state.	Brown County and/or Cities of Green Bay and De Pere and Village of Allouez	6/93
15. Develop comprehensive shoreland zoning plans that protect fish and wildlife habitat, provide for a recreational corridor and public access, and allow for environmentally sound recreational, industrial, commercial and residential development.	Counties and municipalities	1/94

OBJECTIVE 2: Develop recommendations for habitat restoration/enhancement.

ACTIVITY/TASK	RESPONSIBLE GROUP	START DATE
Complete recommendations, implementation strategies and proposals for habitat restoration projects.	RAP STAC	4/93
Identify potential sources of funds for proposals such as Bay Estuary Program Funding for AOC habitat restoration.	RAP STAC & PAC, WDNR, USFWS	5/93
Develop a feasibility study for diking Peter's marsh and enhancing wetland habitat.	USFWS	4/93
Develop a feasibility study for converting wetlands immediately northeast of the Fox River mouth into a public wildlife preserve.	USFWS, WDNR, Brown County	4/94
Evaluate potential for wetland habitat restoration on the state prison property adjacent to Hwy 172.	WDNR FM & WM Programs	4/93
Form a task group to evaluate potential for managing the Atkinson marsh and other remaining wetlands in the 143 corridor and Bayport landfill complex for wildlife habitat.	RAP PAC & STAC, Brown County, City of Green Bay, Village of Howard	5/94

OBJECTIVE 3: Update and revise RAP recommendations for managing exotic species and other fish and wildlife populations.

ACTIVITY/TASK	RESPONSIBLE GROUP	START DATE
1. Develop recommendations for species management, particularly colonial nesting birds, bald eagles and gulls.	RAP STAC & PAC	4/93
2. Evaluate stocking predator fish to reduce the numbers of smaller plankton-eating fish as a complimentary strategy to phosphorus reductions in an effort to restore a more effective composition of zooplankton.	WDNR, USFWS WDNR FM, RAP STAC	1/94

COMMUNITY OUTREACH

Table 20 was developed primarily as the intended work plan of the Green Bay RAP Public Advisory Committee.

Table 20. 1993-1994 Actions to Build Momentum for Green Bay Remedial Action Plan Implementation

GOAL 1: Seek implementation actions by designated lead agencies and promote a coordinated, ecosystem approach to managing the Fox River and Green Bay.

OBJECTIVE 1: Develop financial strategies and seek funds, grants, and agencies/organizations to implement remedial actions.

	ACTIVITY/TASK	RESPONSIBLE GROUP	START DATE
	Promote cooperative, voluntary efforts to fund the Little Lake Butte des Mort contaminated sediment remediation demonstration project.	PAC, WDNR, FRC	9/93
	Cooperate with the Fox River Coalition and other entities to develop a financing strategy for Fox River contaminated sediment remediation.	RAP PAC	6/93
3	Promote increased state funding for additional Priority Watershed Projects.	RAP PAC	4/93
4	Develop a list of RAP projects (completed, ongoing, and future), identify expenditures and future costs, incorporate into annual reports to EPA and publicize locally.	RAP, PAC & PEP, WDNR	3/93
5	Coordinate RAP Committee fund raising efforts	RAP PAC	As needed
6.	Identify annual priorities for Great Lakes Project funding.	RAP PAC & STAC	5/93
7	Identify funding sources or project sponsors for the Adopt-a-Waterway program	RAP STAC & PAC	As appropriate

OBJECTIVE 2: Promote point and nonpoint source pollution prevention actions by communities, citizens and industries in the Fox-Wolf River basin including the voluntary use of, or change to, low or non-polluting processes and raw materials and changes in consumer behavior.

	ACTIVITY/TASK	**RESPONSIBLE GROUP**	START DATE
1.	Identify and encourage appropriate individuals to hold a summer institute for high school and grade school teachers using EPA grant funds to promote consumer behavioral changes	RAP STAC, Bionet, UW-GB Center for Public Affairs	3/93
2.	Identify and work with agricultural organizations to expand pollution prevention knowledge and activities in the agricultural sector.	RAP PAC, STAC & PEP, LMD-WDNR	On-going
3.	Develop a means of disseminating proven pollution prevention techniques for local industry.	RAP PAC, STAC, & PEP, WDNR	3/93
4.	Develop a feature article for the Wisconsin Natural Resources Magazine on statewide pollution prevention with emphasis on the Green Bay area.	WDNR - Office of Pollution Prevention, LMD-WDNR RAP PEP	3/93
5.	Enlist Chambers of Commerce to include a monthly paragraph on pollution prevention activities in newsletters.	Brown, Calumet, Fond du Lac, Outagamie, Winnebago Counties, RAP STAC & PEP	3/93
6.	Use the SARA data base or other reporting mechanisms to identify industries, municipalities, and nonpoint sources to target with Pollution Prevention initiatives as a means of evaluating and preventing cross media contamination in the Fox-Wolf Basin.	RAP STAC, WDNR	6/93
7.	Evaluate potential for an urban "Clean Sweep" for business and industry.	RAP PEP, PAC	12/93
8.	Encourage municipal and volunteer groups to increase distribution of recycling information to small businesses. Use educational materials on proper disposal of hazardous waste, alternative products and safe handling. Post information in the workplace whenever possible	RAP PEP, PAC, WDNR, Business and Industry	6/93

	ACTIVITY/TASK	RESPONSIBLE GROUP	START DATE
9.	Assist in encouraging participation in the 1993 Brown County agricultural clean sweep and encourage other counties in the Fox-Wolf Basin to conduct similar efforts	RAP PAC	3/93

OBJECTIVE 3: Advise the Department, other agencies, governments, private organizations and citizens on Stage II RAP Update.

	ACTIVITY/TASK	RESPONSIBLE GROUP	START DATE
1.	Develop a Biennial Progress Report Summary.	RAP PAC, PEP, LMD-WDNR	4/93
2.	Sponsor public informational meetings on implementation projects.	RAP PAC, LMD-WDNR	6/93

OBJECTIVE 4: Develop a strategy for getting and keeping the RAP on political agendas.

	ACTIVITY/TASK	RESPONSIBLE GROUP	START DATE
1.	Monitor progress and comment on relative state and federal legislation and codes (i.e., Clean Water Act Re-authorization, Great Lakes initiatives, NPS bills, phosphorus standards).	PAC	As appropriate
2.	Periodically brief legislators and elected officials on implementation needs and progress.	RAP PAC	As appropriate

OBJECTIVE 5: Coordinate efforts with other organizations seeking to manage water resources of the Area of Concern.

ACTIVITY/TASK	RESPONSIBLE GROUP	START DATE
1. Provide technical advice to the North East Wisconsin Waters of Tomorrow cost-effective Analysis Team.	RAP STAC & PAC, LMD-WDNR	As appropriate
2. Maintain liaison with the Fox River Coalition.	RAP PAC & STAC	As appropriate
3. Review and comment on drafts of the Brown County Comprehensive Plan Update.	RAP PAC	As appropriate
4. Obtain information and prepare issue papers with recommendations for the WDNR, other implementors and the EPA.	RAP PAC	6/93
5. Identify annual priorities and update appropriate portions of the RAP Monitoring and Research Plan and pursue funding and personnel to implement the plan.	RAP PAC & STAC	4/93

OBJECTIVE 6: Identify opportunities for sustainable re-development projects which will improve water quality.

	ACTIVITY/TASK	RESPONSIBLE GROUP	START DATE
1.	Monitor Federal priorities for re-development through economic stimulation programs. Encourage local initiatives to identify such opportunities.	RAP PAC	As appropriate

GOAL 2: Promote the goals of the RAP through public information and education and provide opportunities for public participation in project development and implementation.

OBJECTIVE 1: Target RAP education and participation projects for special groups (i.e., schools, businesses, industry, conservation groups and civic organizations.

	ACTIVITY/TASK	RESPONSIBLE GROUP	START DATE
1.	Conduct annual in-service workshops for teachers, involved in the Adopt-a-Waterway program help to develop teaching teams and evaluate success of the pilot project	RAP PEP, STAC & PAC	4/93
2.	Continue the Clean **Bay** Backer Awards recognition program.	RAP PEP & PAC	10/93
3.	Coordinate sponsorship of annual River/Bay Clean Up Day.	RAP PEP WPS	3/93

OBJECTIVE 2: Provide RAP information to Fox-Wolf River Basin residents to increase public awareness and involvement.

ACTIVITY/TASK	RESPONSIBLE GROUP	START DATE
Sponsor annual RAP display at Home and Garden Show and ECO-FAIR.	RAP PEP, UW-EXT	3/93
Develop and coordinate Green Bay Boat Launch Environmental Education Center construction.	RAP PEP	3/93
Plan elements to update the portable RAP Display.	RAP PEP	6/93
Assist Neville Public Museum and GBMSD to prepare a water quality exhibit.	RAP PEP	6/93
Promote media coverage for RAP activities through mass advertising, radio and television public service announcements, and video and slide presentations.	RAP PEP	6/93

OBJECTIVE 3: Develop a network of volunteers for ongoing RAP/PEP programs that includes industry, the public and special interest groups.

ACTIVITY/TASK	RESPONSIBLE GROUP	START DATE
1. Schedule informational meetings with local municipal and business leaders on their role in RAP implementation activities.	RAP PEP & PAC, WDNR	03/93
2. Identify and promote activities which provide opportunities for public participation and volunteerism.	RAP PEP	07/93

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CHAPTER V
CONCLUSIONS

Successful implementation of the Remedial Action Plan will hinge upon timely, coordinated action by a multiplicity of public and private institutions, agencies, interest groups, and individual citizens. No one agency or group has the capability to implement all the recommendations in the RAP. Under the guidance of the WDNR, and in concert with program work-planning, actions identified here and in the 1988 RAP will be implemented through cooperative effort with local government, industry, and citizen groups.

This document is not intended to define all the actions necessary to reach RAP goals and restore beneficial uses to the Fox River and Lower Green Bay, but to outline interim steps toward those ends.

Increased Understanding of the Ecosystem

A number of studies have contributed, or will contribute to understanding and managing the River and Bay ecosystem. Mass balance studies of the sources, transport, and fate of toxic organic substances (PCBs) and the characterization of contaminated sediments in the Fox River will allow for more detailed remediation planning and implementation over the next few years. Trophic state analyses have led to re-evaluation and revision of RAP objectives for phosphorus, suspended solids, and chlorophyll that may be used to establish waterbody-specific water quality standards for the AOC. The increasing body of knowledge on ecotoxicology provided the basis for development of State surface water quality standards and effluent limits for toxic substances and, more recently, for proposed toxic substance criteria in the GLWQI. State standards and the proposed GLWQI criteria will provide the measures of progress in reducing toxic substances in the AOC. Coupled with socio-economic and cost-effectiveness information, these and other studies will enhance management efforts and form the basis for future RAP updates.

Impaired Use Status

Despite progress, the Fox River and Green Bay AOC cannot fully support beneficial uses of the resource. Eleven o` the fourteen L1C-defined beneficial uses remain impaired, and another two are suspected of being impaired. Added costs to agriculture or industry from using AOC waters, fish taste or odor' problems, and the presence of tumors or other deformities in fish and wildlife remain unsubstantiated. Given the ongoing work to assess contaminated sediment, including fish tissue monitoring, it seems likely that surficial tumors or other deformities will be documented if they are present. While the remaining 11 impaired uses will require much effort and many resources to restore, documenting suspected impaired uses is unlikely to become an early priority.

The primary causes of remaining problems in the AOC are excess phosphorus, suspended solids, ammonia, bioaccumulating toxic substances from sediment, and the destruction or degradation of fish and wildlife habitat. While it is popularly believed that BOD loading is no longer a problem because of the implementation of a wasteload allocation that restricts municipal and industrial discharges, BOD remains a significant pollutant in the AOC. There are periodic episodes of low dissolved oxygen in the River and Bay that may be attributed to a combination of point source loads and hypereutrophic conditions.

An environmental risk assessment has pointed to the above stressors, in addition to exotic species invasions, as the most pressing environmental problems posing the greatest ecological risk to the AOC and Green Bay.

Progress

Increased restrictions on conventional and toxic substance discharges, substantial investments in municipal and industrial wastewater treatment, several large-scale nonpoint source management projects, clean-up of numerous small hazardous or toxic waste spills, fish population management, and other remedial actions have controlled sources of some pollutants and activities adversely impacting the AOC.

Point source discharges of total phosphorus declined by 83% during the mid-1970s when effluent limits went into effect for POTWs discharging more than 1 MGD. Municipal and industrial discharges now account for less than 20% of the total phosphorus load to the Fox River. New regulations that extend phosphorus discharge limits to smaller POTWs and industries are expected to further decrease point source loads by 20,900 kg/yr (46,100 Ibs/yr), or about 5% of the total load. The remaining 80% of the present load may be attributed primarily to nonpoint source inputs from the 6600 mi^2 basin with 48% entering the Fox River from Lake Winnebago and its upstream tributaries. RAP implementation efforts must, therefore, move upstream to address nonpoint sources of pollution.

Similarly, point source discharges of PCBs and mercury have dramatically declined in the past decade. Direct discharges of PCBs now account for less than one percent of the present load to the AOC. Urban runoff, atmospheric deposition, and landfill leachate account for similarly small contributions of PCBs.

The vast majority of PCBs (> 95%), mercury and other potentially toxic contaminants are delivered to the water column from the reservoir of contaminated sediment in the Fox River. The length of time that PCBs will continue to restrict public consumption of fish and ducks and impair the health and reproduction of wildlife and aquatic life will depend on the capability to manage those sediments.

This capability will be tested by the Little Lake Butte des Morts sediment remediation demonstration project and by the Fox River Coalition's efforts to build political good will and to secure funding for future cleanup.

There is a diverse array of habitats that remain in the AOC, although many have been degraded by poor water quality and incompatible land uses. Top priority must be given to protecting remaining habitats from irreversible destruction while continuing to enhance and/or restore degraded habitats.

While progress has been made on three-quarters of the 1988 RAP recommendations, it is too early to measure the environmental results of most actions. Lake Winnebago, the Fox River sediments, and the Lower Bay contain large reservoirs of pollutants that will continue to impact the AOC, even after point and nonpoint source inputs have been reduced to target levels. There is a significant lag time, perhaps five years or more, before the ecosystem in this vast watershed responds to pollutant load reductions. The aquatic sediments serve as sources, sinks, and capacitors for nutrients and toxic contaminants.

Implementation Agenda

Watershed models and a better understanding of the transport and fate of nutrients and suspended solids are needed to improve phosphorus and suspended solids reduction strategies.

Public education and voluntary cost-share programs, while beneficial, have been insufficient to stem the massive influx of nonpoint source pollutants to the basin. Management efforts must be extended to include regulatory measures as well. It will take numerous incremental actions by landowners, businesses, state and federal agencies and the more than 100 units of local government in the basin to realize improved water quality through reductions of nutrient and suspended solids. During the coming year, RAP advisory committee members and WDNR managers will carry this message to local governments throughout the Fox-Wolf River Basin.

Pollution nravantinn tarhnningy and information will **bo dissominatod** to agrioulturo and industry to continue to stem the influx of toxic substances to the ecosystem. Sediment remediation demonstrations nationwide and in Wisconsin will provide experience that can be applied to selected sites on the Fox River. Additional assessment and modeling of specific soft sediment deposits will also help in making cost-effective management decisions regarding sediment cleanup.

Management efforts will promote increased biodiversity and complex food webs that are characteristic of a healthy and sustainable ecosystem. This will require protecting the most sensitive species in the ecosystem, as well as taking strong political action to preserve or restore shoreline and wetland habitat.

In the years ahead, the issues listed above should receive high priority for program planning, budgeting, grant selection, and legislative actions. A prerequisite for keeping the RAP high on political and agency agendas will be a well-informed and supportive public. Recent opinion surveys showed that the overwhelming majority of Brown County residents were supportive of RAP goals when these goals were described to them but only 20% of respondents were familiar with the RAP. Continuing public education and participation programs will be needed to create the public support, political will, resources, and sustained commitments needed over many years to achieve RAP implementation and restoration of beneficial uses to the AOC.

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APPENDIX A

Table 1. Reference Guide to Lower Green Bay and Fox River Remedial Action Plan Documents

The Lower Green Bay and Fox River Remedial Action Plan is a collection of documents developed from the deliberations of advisory committees/stakeholder groups and the Wisconsin Department of Natural Resources RAP team. As new information and implementation tools become available, the plan will continue to evolve through periodic updates and progress reports. The following table is a reference list of existing Plan documents and a useful guide for locating desired RAP information.

RAP Document	Date Published	Contents
Scope of Study, Lower Green Bay and Adjacent Fox River Remedial Action Plan Draft Report, WDNR.	1986	Plan of study for preparing the Remedial Action Plan.
Biota and Habitat Management Technical Advisory Committee Report: Lower Green Bay Remedial Action Plan, WDNR, 102pp.	1987	Descriptions of wildlife, fish, other aquatic life and habitats in the area of concern; detailed problem assessments and use impairments; goals, objectives and their rationale; evaluation of alternative management actions; and recommendations of the Technical Advisory Committee.
Nutrient and Eutrophication Management Technical Advisory Committee Report, Lower Green Bay Remedial Action Plan, WDNR 117 pp.	1987	Descriptions of water quality and trophic conditions (e.g. algae production); detailed problem assessments and use impairments due to phosphorus, suspended solids, biological oxygen demand and bacteria/viruses; estimates of present (1982) and future (2000) phosphorus loads from point and nonpoint sources; evaluation of alternative management actions; and recommendations of the Technical Advisory Committee.
Toxic Substances Management Technical Advisory Committee Report, Lower Green Bay Remedial Action Plan, WDNR, 108 pp.	1987	Identification and assessment of toxic substances found in fish, wildlife, water and sediments of the area of concern; descriptions of known or suspected impacts; potential sources of toxic chemicals; recommended goals and objectives; management recommendations and their rationale.
Institutional Technical Advisory Committee Report: Lower Green Bay Remedial Action Plan, WDNR, 117 pp.	1988	Assessment of public use, land use, demographics and management responsibilities for the AOC; goals and objectives; evaluation of alternative actions and institutional arrangements; and recommendations for public access, recreation and plan implementation.
Key Actions to Restore Beneficial Uses of the Lower Green Bay Area of Concern: A Summary Report, UW-Sea Grant Institute and WDNR, 31 pp.	1987	Results of a workshop to organize the various plan recommendations into categories--key actions--and identify their relationship to beneficial uses.
Citizen Comments and Suggestions, Lower Green Bay Technical Advisory Committee Reports, WDNR, 37 pp.	1987	Summary of written and oral comments received during public review and informational meetings on the RAP Technical Advisory Committee Reports.

RAP Document	Date Published	Contents
Lower Green Bay Remedial Action Plan, WDNR, 319 pp.	1988	Review of the environmental setting, problems and their sources; relationship of RAP to other planning and management programs; Citizen's Desired Future State; plan goals and objectives; key actions and final recommendations to restore beneficial uses; implementation strategy, schedule and costs.
Citizen Comments and Suggestions: Lower Green Bay Remedial Action Plan, Public Review Draft, WDNR, 34 pp.	1988	Summary of written and oral comments received during public review and public hearings on the draft Remedial Action Plan.
The Green Bay Remedial Action Plan Summary, WDNR, 17 pp.	1991	A popularized summary of the plan describing environmental problems, key actions and high priority recommendations to restore beneficial uses of the river and bay.
Estimated Loading of Toxic Substances to the Lower Fox River from Point Sources, WDNR, 62 pp.	1988	Estimates of annual loadings of toxic substances to the Fox River from major municipal and industrial discharges; and an evaluation of the potential environmental implications and fates of toxic substances found in the discharges.
Lower Fox River and Green Bay Harbor PCB Sediment Sampling Data, WDNR, 33 pp.	1988	Summary of PCB sediment sampling data for the Lower Fox River and Lower Bay.
Lower Green Bay Remedial Action Plan - First Annual Progress Report, UW-Green Bay Center for Public Affairs, 50 pp.	1989	Description of institutional arrangements and committee structure for RAP implementation; and progress toward implementing plan recommendations.
Remedial Action Plan 1990 Progress Report for Green Bay and the Fox River, UW-Green Bay Center for Public Affairs, 51 pp.	1990	Summary of actions taken by agencies, industries, governments and others to implement plan recommendations; activities and future directions of the RAP Implementation Committees; and a listing of priority actions and their costs.

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APPENDIX B

Table 1. Minor Civil Division Populations By County And River Basin For The Upper Fox And Wolf River Basins -- 1990'

Minor Civil Division	City, Village or Townships*	Population/County		River Basin
APPLETON	C	2,929	Calumet	Upper Fox River
MENASHA	C	73	Calumet	Upper Fox River
PORTAGE	C	4,750	Columbia	Upper Fox River
FOND DU LAC	C	37,757	Fond du Lac	Upper Fox River
RIPON	C	7,241	Fond du Lac	Upper Fox River
BERLIN	C	5,304	Green Lake	Upper Fox River
GREEN LAKE	C	1,064	Green Lake	Upper Fox River
MARKESAN	C	1,496	Green Lake	Upper Fox River
PRINCETON	C	1,458	Green Lake	Upper Fox River
MONTELLO	C	1,329	Marquette	Upper Fox River
APPLETON	C	0	Outagamie	Upper Fox River
BERLIN	C	67	Waushara	Upper Fox River
WAUTOMA	C	1,784	Waushara	Upper Fox River
APPLETON	C	224	Winnebago	Upper Fox River
MENASHA	C	14,638	Winnebago	Upper Fox River
NEENAH	C	23,219	Winnebago	Upper Fox River
OMRO	C	2,836	Winnebago	Upper Fox River
OSHKOSH	C	55,006	Winnebago	Upper Fox River
SHERWOOD	V	745	Calumet	Upper Fox River
STOCKBRIDGE	V	579	Calumet	Upper Fox River
FRIESLAND	V	261	Columbia	Upper Fox River
PARDEEVILLE	V	1,628	Columbia	Upper Fox River
EDEN	V	610	Fond du Lac	Upper Fox River
FAIRWATER	V	302	Fond du Lac	Upper Fox River
NORTH FOND DU LAC	V	4,292	Fond du Lac	Upper Fox River
OAKFIELD	V	1,003	Fond du Lac	Upper Fox River
ROSENDALE	V	777	Fond du Lac	Upper Fox River
KINGSTON	V	346	Green Lake	Upper Fox River
MARQUETTE	V	182	Green Lake	Upper Fox River
ENDEAVOR	V	316	Marquette	Upper Fox River
NESHKORO	V	384	Marquette	Upper Fox River
OXFORD	V	499	Marquette	Upper Fox River

Table 1.	Minor Civil Division Populations By County And River Basin For The Upper Fox And Wolf River Basins -- 1990[1]		
Minor Civil Division	City, Village or Townships[2]	Population/County	River Basin
WESTFIELD	V	1,125 Marquette	Upper Fox River
COLOMA	V	383 Waushara	Upper Fox River
LOHRVILLE	V	111 Waushara	Upper Fox River
REDGRANITE	V	58 Waushara	Upper Fox River
W1NNECONNE	V	695 Winnebago	Upper Fox River
MENASHA	T	10,524 Winnebago	Upper Fox River
NEENAH	T	2,691 Winnebago	Upper Fox River
SUBTOTAL		196,607	
CRANDON	C	1,590 Forest	Wolf River
NEW LONDON	C	1,337 Outagamie	Wolf River
SEYMOUR	C	1,184 Outagamie	Wolf River
SHAWANO	C	7,598 Shawano	Wolf River
CLINTONVILLE	C	4,351 Waupaca	Wolf River
MANAWA	C	1,169 Waupaca	Wolf River
MARION	C	1,242 Waupaca	Wolf River
NEW LONDON	C	5,321 Waupaca	Wolf River
WAUPACA	C	**4,957** Waupaca	Wolf River
WEYAUWEGA	C	1,665 Waupaca	Wolf River
WHITE LAKE	V	304 Langlade	Wolf River
BIRNAMWOOD	V	6 Marathon	Wolf River
ELDERON	V	175 Marathon	Wolf River
BEAR CREEK	V	418 Outagamie	Wolf River
BLACK CREEK	V	1,152 Outagamie	Wolf River
HORTONVILLE	V	2,029 Outagamie	Wolf River
NICHOLS	V	254 Outagamie	Wolf River
SHIOCTON	V	913 Outagamie	Wolf River
MAHERST	V	792 Portage	Wolf River
AMHERST JUNCTION	V	269 Portage	Wolf River
NELSONVILLE	V	171 Portage	Wolf River
ROSHOLT	V	512 Portage	Wolf River
ANIWA	V	31 Shawano	Wolf River
BIRNAMWOOD	V	687 Shawano	Wolf River

Table 1.	Minor Civil Division Populations By County And River Basin For The Upper Fox And Wolf River Basins -- 1990'			
Minor Civil Division	City, Village or Townships	Population/County		River Basin
BOUNDUEL	V	1,210	Shawano	Wolf River
BOWLER	V	279	Shawano	Wolf River
CECIL	V	**373**	**Shawano**	Wolf River
ELAND	V	247	Shawano	Wolf River
GRESHAM	V	**515**	**Shawano**	Wolf River
MATTOON	V	431	Shawano	Wolf River
TIGERTON	V	**815**	**Shawano**	Wolf River
WITTENBERG	V	1,145	Shawano	Wolf River
BIG FALLS	V	75	**Waupaca**	Wolf River
EMBARRASS	V	**461**	**Waupaca**	Wolf River
FREMONT	V	**632**	**Waupaca**	Wolf River
IOLA	V	1,125	**Waupaca**	Wolf River
OGDENSBURG	V	220	Waupaca	Wolf River
SCANDINAVIA	V	**298**	**Waupaca**	Wolf River
LOHRVILLE	V	257	Waushara	Wolf River
REDGRANITE	V	**951**	**Waushara**	Wolf River
WILD ROSE	V	676	Waushara	Wolf River
WINNECONNE	V	**1,364**	**Winnebago**	Wolf River
MENOMINEE	T	3,521	Menominee	Wolf River
GREENVILLE	T	**3,156**	**Outagamie**	Wolf River
WESCOTT	T	**3,085**	Shawano	Wolf River
FARMINGTON	T	3,602	Waupaca	Wolf River
SUBTOTAL		62,565		
Total of townships not listed:		**83,188**		
UPPER FOX-WOLF BASIN TOTAL		**402,442**		

' Source -- United States Census Bureau
[2] Townships > 2500

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APPENDIX C Excerpts from the 1992 Health Guide for People who Eat Sport Fish From Wisconsin Waters

HEALTH GUIDE to Eating Wisconsin Sport Fish

October 1992

Important heatth information

This guide provides anglers and consumers with advice for eating Wisconsin sport fish which contain unhealthy levels of environmental contaminants. To protect your health, use this guide to choose which sizes and species of Wisconsin sport fish contain the lowest contaminant levels.

The guide covers fish in the Great Lakes and Mississippi River as well as fish caught from inland lakes and rivers.

Wisconsin's fish advisory is revised each April and October to provide consumers with up-to-date health information. The guide is produced as a public health service by the Wisconsin Department of Natural Resources (DNR) and the Department of Health and Social Services (H&SS). Wisconsin has issued a fish advisory since 1976.

Fish sampling

DNR staff collect fish using nets or electroshocking devices. The fish are wrapped, labeled, frozen and shipped to an agency laboratory in Madison, where they are thawed and filleted. Fillets (with skin left on) are finely ground, placed in labeled jars, frozen and sent to a laboratory for contaminant analysis. H&SS establishes appropriate health advice after reviewing fish contaminant test results with DNR. The agencies then issue this advice to the public.

Note: Whole fish are **not** used as the basis for Wisconsin's sport fish consumption advisory, as some people mistakenly believe.

Fish testing sites

Wisconsin's fish collection and testing program is frequently adjusted to meet changing needs. New lakes and rivers are tested each year, along with some previously-tested waters to determine trends in contaminant levels.

Nearly 15,000 lakes are located within Wisconsin, which also features thousands of miles of rivers and streams as well as Lakes Michigan and Superior and the Mississippi River. Since it is too expensive for the state to test fish from every Wisconsin water, the state focuses its sampling program in:

4.4 waters where there is a known or suspected pollution source

lakes that may be susceptible to mercury contamination

popular angling waters

waters where long-term contaminant trends in fish are being observed.

Citizens are welcome to contact the DNR to find out whether fish from a particular water have been tested. Call or write the DNR Bureau of Water Resources Management, P.O. Box 7921, Madison, WI 53707, (608) 267-7610 or contact DNR district offices in Spooner, Rhinelander, Green Bay, Milwaukee, Fitchburg (Dane County) and Eau Claire.

Contaminants found in fish

Wisconsin tests sport fish for the following contaminants (see box): PCBs (polychlorinated biphenyls), DDT, toxaphene, chlordane, dieldrin, mercury and dioxin. Health standards or action levels have been established for each of these substances. Wisconsin uses these standards as a basis for issuing health advice to the public and recommends ways to reduce exposure to contaminated sport fish.

Contaminant residues in sport fish vary in concentration depending on fish species, size, age, fat content, diet, location and type of contaminant. For example, large, old Jake trout in Lake Michigan are high in fat and contain relatively high PCB levels (PCBs accumulate in fat). In contrast, smaller, leaner, shorter-lived species such as perch contain very low or undetectable PCB levels.

Inland Wisconsin sport fish are much more likely to contain mercury than Great Lakes or Mississippi River sport fish, which are more likely to contain PCBs. Walleyes and other larger, older predator fish often contain relatively high mercury levels compared to smaller, younger fish of the same species and from the same lake or river.

Other known fish contaminants, such as toxaphene, dieldrin and DDT, are not as commonly found in Wisconsin sport fish as PCBs and mercury.

Health risks

PCBs and mercury pose different health threats to humans.

PCBs

High consumption of PCB-contaminated sport fish has been linked to developmental and growth problems in infants born to women who regularly ate contaminated fish.

PCBs also are suspected of posing a long-term risk of cancer to people who regularly eat fish that contain PCBs.

PCBs stay stored in body fat many years, and may not pose a health risk for years after exposure. Follow the advice in this Health Guide to minimize lifetime build-up of PCBs that might be present in sport fish, regardless of your age, sex or physical status.

Mercury, unlike PCBs, poses a short-term health risk to people who frequently eat fish that contain this contaminant. The human health effects of mercury are better known than for PCBs. Mercury affects the human nervous system, and thus can harm your ability to feel, see, taste and move.

Because the human body can eliminate mercury over time, occasional fish eaters face a lower health risk than people who frequently eat mercury-contaminated fish. Human fetuses and pregnant women, however, are more sensitive to mercury than other adults. Whatever your age or physical status, follow the fish advisory recommendations to protect yourself from mercury exposure.

Contaminant trends

By testing the same species and size of fish at the same place over many years, scientists can observe trends in environmental contaminant levels. In some cases, the information can be used to pinpoint pollution sources so actions can be taken to control these problems.

One trend already is evident as a result of Wisconsin's fish monitoring program: PCB levels in Lake Michigan sport fish declined 80 percent during the 1980s.

Environmental protection efforts underway

Wisconsin has regulations in place which limit the discharge of PCBs, mercury and other toxic substances into the air or water. Wisconsin also has rules to limit the air pollutants which produce acid rain. Acid rain in Wisconsin lakes may increase mercury uptake in sport fish. Improving air quality will help control this problem.

The state also is studying how to manage contaminated sediment to reduce the uptake of contaminants by sport fish. Clean-up efforts are being planned or are underway at many sites, particularly along the Great Lakes.

PCB FACTS

- Generally found in the Great Lakes, their tributaries and Mississippi River
- PCBs once used as fire retardants and in many other products
- PCB production banned in 1976 to protect public health, but PCBs still widely distributed in the environment
- Highest PCB levels in Wisconsin usually found in the largest salmon, lake trout and carp from Green Bay, Lake Michigan and tributaries
- PCBs build up in the fat of fish, birds, humans and other organisms
- Panfish (perch, etc.) usually contain low or undetectable PCB levels
- PCBs are a suspected animal carcinogen; research shows PCBs impair reproduction in some animals
- PCBs linked to developmental and growth problems in children born to women who regularly ate Great Lakes fish
- AVOID EXPOSURE TO PCBs by eating smaller, leaner fish; remove all traces of skin and fat before cooking (fat holds the PCBs). If you're pregnant, nursing an infant or under 15, avoid eating some fish (see guide for specific advice).

MERCURY FACTS

- Generally found in inland Wisconsin lakes and some rivers
- Emitted from coal-burning, paint and mixed-waste incineration, or discharged in pre-1970s industrial wastewater effluent. Acid rain may release mercury into lakewater and contaminate sport fisheries.
- Converted by bacteria dwelling in lake sediment into a chemical form readily absorbed by fish
- Highest levels found in large, old walleyes in lakes from all parts of the state; high levels found less frequently in larger northem pike and largemouth bass
- Panfish (bluegill, perch, rock bass, crappie) generally contain low or undetectable levels
- Mercury is stored in the fillet, or muscle, portion of a fish, not the fat; removing fat or skin from these fish will not lower mercury levels
- Mercury harms the human central nervous system; may affect body movement and senses of touch, taste and sight
- Health effects generally reversible if mild exposure hafted; human body can eliminate half its mercury burden every 70 days
- AVOID EXPOSURE TO MERCURY by following advice in this Health Guide, especially if you are pregnant, under 15 or frequently eat sport fish that might contain mercury. Remember that in general, panfish contain lower mercury levels than large, predator fish.

U.S. Food & Drug Administration and Wisconsin Division of Health Standards for Contaminants Commonly Found in Sport Fish

PCBs............2 parts per million (ppm)	Dieldrin..........0.3 ppm
DDT..............5 ppm	Mercury.........0.5 ppm
Toxaphene ...5 ppm	Dioxin.............10 parts per trillion
Chlordane ....0.3 ppm	

SOURCE: Wisconsin Division of Health and Wisconsin Department of Natural Resources October, 1992

Health guide for people who eat sport fish from Wisconsin waters

This publication explains which sport fish species in Wisconsin lakes and rivers do not meet health standards for a number of toxic pollutants. It describes health precautions you should consider before you decide to eat fish you've caught from waters where contaminants pose a problem.

It's important to note that this guide features.two different sets of health advice: one for fish contaminated with PCBs and pesticide (pages 4 - 7), and another for fish contaminated with mercury (pages 8 through 15). Generally, people who should take the most precautions are children aged 15 or less and women who intend to have children.

PCB and pesticide contamination in fish

	Group 1 These fish pose the lowest health risk.	**Group 2** Women and children should not eat these fish.	**Group 3** No one should eat these fish.
	See page 7 for specific health advice on **each** group of fish.		
LAKE MICHIGAN	Lake trout up to 20" Coho salmon up to 26" Chinook salmon up to 21" Brook trout Rainbow trout Pink salmon Smelt Perch	Lake trout 20 to 23" **Coho** salmon **over** 26" Chinook salmon 21 to 32" Brown trout up to 23"	Lake trout over 23"" Chinook salmon over 32" Brown trout over 23" Carp Catfish
GREEN BAY south of Marinette and its tributaries (except the Lower Fox River), including the **Menominee, Oconto, and Peshtigo Rivers,** from their mouths up to the first dam	Rainbow trout up to 22" Chinook salmon up to 25" Brook trout up to 15" Smallmouth bass Northern pike up to 28" Walleye up to 20" Perch Brown trout up to 12" Bullhead White sucker	Splake up to 16"	Rainbow trout over 22" Chinook salmon over 25" Brown trout over 12" Brook trout over 15" Carp" Splake over 16" Northern pike over 28" Walleye over 20"" White bass
PESHTIGO RIVER from its mouth at Green Bay up to the Peshtigo Dam			Sturgeon
LOWER FOX RIVER from its mouth at Green Bay up to the DePere Dam	Walleye up to 15"	Northern pike White sucker Walleye 15 to 18"	White bass" Walleye over 18" Carp" Drum" Channel Catfish"
LOWER FOX RIVER from the DePere Dam up to the Neenah-Menasha Dam	Walleye up to 15" White bass Northern pike Perch White sucker	Walleyes over 15" Bullheads	Carp over 17"
EAST AND WEST TWIN **RIVERS** from their mouths up to the first dam NOTE: Follow Lake Michigan advisory above for trout and salmon.	Perch Northern pike Crappie Smallmouth bass		Carp Catfish"
MANITOWOC RIVER from its mouth up to the dam at Clarks Mills	NOTE: Follow Lake Michigan advisory above for trout and salmon.		Catfish"
MANITOWOC RIVER and its tributaries from Chilton to Clarks Mills (including the Pine Creek and Killsnake River			All Species

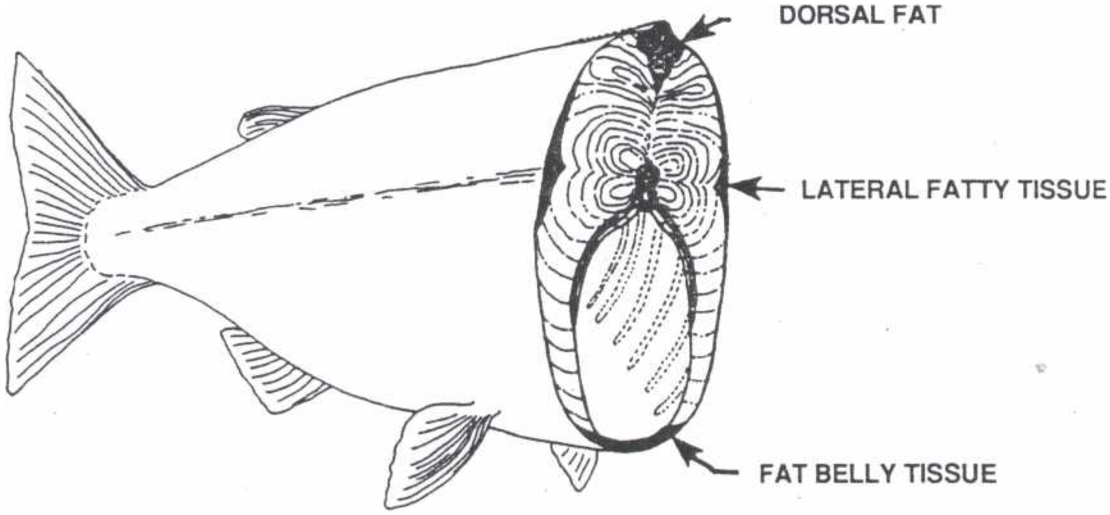
PCB and pesticide contamination in fish	**Group 1** These fish pose the lowest health risk.	**Group 2** Women and children should not **eat** these fish.	**Group 3** No one should eat these fish.
	See page 7 **for specific** health **advice** on each group of fish.		
SHEBOYGAN RIVER in **Sheboygan** County from the dam at Sheboygan Falls to the Coast Guard station in the City of Sheboygan, including **Greendale and Weedens Creek**	Coho salmon up to 26" Chinook salmon up to 21'	Rainbow trout Brook trout Coho salmon over 26" Chinook salmon 21 to 32"	Bluegill Crappie Rock bass' Carp' Smallmouth bass° Walleye' Northern pike' Brown trout Catfish' Chinook salmon 32 to 35" Chinook salmon over 35""
MILWAUKEE RIVER in Milwaukee County (includes **Milwaukee Harbor)** from its mouth up to the North Avenue dam, including the **Kinnickinnic and Menomonee Rivers** NOTE: Follow Lake Michigan advisory on previous page for trout and salmon.	Perch		Crappie Northern pike Carp' Redhorse Smallmouth bass White Sucker
MILWAUKEE RIVER from the North Avenue dam in Milwaukee County upstream to the Lime Kiln Dam at Grafton (Ozaukee County)	Rock bass up to 8.5'	Redhorse	Northern pike Carp
CEDAR CREEK from the Milwaukee River up to bridge Road in the Village of Cedarburg including Zeunert Pond			All species'
ROOT RIVER in Racine County from its mouth upstream to the Horlick Dam in the City of Racine	Carp up to 21" NOTE: Follow Lake Michigan advisory on previous page for trout and salmon.		Carp over 21
PIKE RIVER in Kenosha County from its mouth up to Carthage College in the City of Kenosha	NOTE: Follow Lake Michigan Advisory on previous page for trout and salmon.	Carp	
LAKE SUPERIOR NOTE: Also **see** advice for mercury-contaminated **walleye** in the St. Louis River, Douglas County, page 5.	Lake trout up to 30' Siscowett under 20"		Lake trout over 30" Siscowett over 20"
UPPER FOX RIVER above Swan Lake in Columbia County downstream to Portage			Carp
UPPER FOX RIVER from Portage in Columbia County north to but not including Buffalo Lake	Northern pike	Crappies Bullheads	Largemouth bass Carp
BIG GREEN LAKE in Green Lake County	Lake trout under 32" Carp		Lake trout over 32"
WISCONSIN RIVER from the Nekoosa Dam to the Petenwell Dam (Petenwell Flowage)			Carp White bass

PCB and pesticide contamination in fish	**Group 1** These fish pose the lowest health risk.	**Group 2** Women and children should not eat these fish.	**Group 3** No one should eat these fish.
	See page 7 for specific health advice on each group of fish.		
WISCONSIN RIVER from the Petenwell Dam to Castle Rock Dam (Castle Rock Flowage)			Carp
WISCONSIN RIVER at Wisconsin Dells to the Prairie du Sac Dam (includes Lake Wisconsin)	See advice on mercury-contaminated fish in the Wisconsin River on pages 8 through 14 under Adams, Juneau, Lincoln, Sauk, and Wood Counties.	**Lake** sturgeon	
ST. CROIX RIVER from Stillwater, Minnesota, to the Mississippi River at Prescott, Wisconsin	Drum White **bass** Carp up to 26" Walleye Flathead catfish up to 26" Sauger **Buffalo** up to 23" NOTE: Also **see additional** advice for mercury-contaminated fish in the St. Croix River under Douglas, Pierce, Polk, and St. Croix Counties, pages 10 through 13.		Channel catfish Buffalo over 23" Carp over 26" Flathead catfish over 26"
MISSISSIPPI RIVER off Pierce and Pepin Counties from Prescott down to and including Lake Pepin (Pools 3 and 4). -	Drum Walleye Sauger White bass up to 13" Flathead catfish up to 30" Buffalo up to 18" (Pool 3) Buffalo up to 20" (Pool 4) Channel catfish up to 16" (Pool 3) Channel catfish up to 21" (Pool 4) Carp up to 21"	Channel catfish 16" to 23" (Pool 3) Channel catfish 21" to 23" (Pool 4)	White bass over 13" Buffalo over 18" (Pool 3) Buffalo over 20" (Pool 4) Flathead catfish over 30" Channel catfish over 23" Carp over 21"
MISSISSIPPI RIVER from below the dam at Alma to the dam at **Trempealeau** (Pools 5, 5A, and 6)	Flathead catfish Carp up to 24" Channel catfish up to 21" Buffalo Drum Walleye Sauger White bass	Carp over 24' Channel catfish 21 to 25"	Channel catfish over 25"
MISSISSIPPI RIVER from below the dam at Trempealeau to the dam at Lynxville (Pools 7, 8, 9, 10 and 11)	Buffalo **Walleye** Crappie Flathead catfish Channel catfish up to 24" Drum White bass Carp	Channel catfish over 24"	

HEALTH ADVICE for the charts on pages 4 - 6

GROUP 1:	Contaminant levels in 10 percent or less of tested Group 1 fish are higher than one or more health standards. EATING GROUP 1 FISH POSES THE LOWEST HEALTH RISK. Trim fat and skin from Group 1 fish before cooking and eating them.
GROUP 2:	Contaminant levels in more than 10 percent but less than 50 percent of tested Group 2 fish are higher than one or more health standards. CHILDREN UNDER 15, AND WOMEN OF CHILDBEARING AGE SHOULD NOT EAT GROUP 2 FISH. You should also limit your overall consumption of other Group 2 fish, and trim skin and fat from these fish before cooking and eating them. (NOTE: See specific health advice for mercury-contaminated fish in the Petenwell Flowage and Lake Superior elsewhere in this publication.
GROUP 3:	Contaminant levels in 50 percent or more of tested Group 3 fish are higher than one or more health standards. NO ONE SHOULD EAT GROUP 3 FISH.

'Ninety percent or more of Group 3 fish marked with an asterisk (') contain contaminant levels higher than one or more health standards.



COOKING, CLEANING, AND EATING P(_'R-CONTAMINATFD FISH

PCBs and many pesticides usually build up in a fish's fat deposits and just underneath the skin rather than in muscle tissue. By removing the fat and skin before you cook and eat these fish (see directions below), you can reduce PCB and pesticide levels, though not always enough to meet health standards.

To reduce PCBs in fish you catch:

Remove all skin.

« Cut away the dark fat on top of the fish along its backbone.

« Slice off fat belly meat along the bottom of the fish.

Cut away the dark, V-shaped wedge of fat located along the lateral line on each side of the fish.

Bake or broil skinned, trimmed fish on a rack or grill so more fat drips off. Discard any drippings.

« Fish may also be cooked in liquids, but discard the resulting broth.

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APPENDIX D

Table 1. PCBs and Mercury in Fish Fillets from Little Lake Butte des Morts to De Pere Dam

Species	Sample Date	Length (in)	Weight (kg)	PCB (ppm)	Mercury (ppm)
Walleye	09/04/85	12.9	0.29	0.52	
		13.1	0.31	0.36	
		13.8	0.38	0.25	
		14.8	0.45	1.20	
		15.0	0.48	0.85	
		18.0	0.70	1.50	0.52
		18.8	1.03	2.30	0.60
	09/05/85	12.4	0.24	<0.20	
		12.4	0.29	0.58	
		14.5	0.39	0.38	
		19.9	0.90	0.94	0.24
		20.7	1.37	0.68	0.18
		21.5	1.45	0.60	
	09/03/86	15.4	0.51	1.80	0.46
		15.6	0.56	0.63	0.14
		18.5	0.85	1.70	0.33
	09/04/86	13.1	0.40	0.64	
		13.7	0.40	0.24	
		13.8	0.45	0.59	
		19.2	1.15	1.10	0.08
		20.5	1.36	0.94	0.16
	09/02/87	16.4	0.70	0.25	
		19.1	0.95	<0.20	
Northern Pike	09/04/85	17.3	0.55	0.49	
		26.2	1.80	0.40	
	09/05/85	29.5	2.30	1.20	
		31.6	3.15	1.60	
		32.2	3.55	1.00	

Table 1. PCBs and Mercury in Fish Fillets from Little Lake Butte des Morts to De Pere Dam

		Length	Weight	PCB	Mercury
White Bass	09/05/85	9.9	0.20	0.28	
		10.0	0.20	0.29	
		10.3	0.23	<0.20	
	09/04/86	10.2	0.25	0.26	
		10.7	0.26	2.20	
		11.0	0.26	0.31	
Yellow Perch	09/05/85	6.9	0.08	<0.20	
		7.5	0.08	<0.20	
		7.7	0.10	<0.20	
Carp	09/04/85	17.1	0.80	0.89	
		17.2	0.92	6.30	
		17.6	1.02	5.80	
	09/05/85	16.1	0.68	0.72	
		22.2	2.15	1.10	
		26.8	3.90	1.50	
	09/03/86	16.9	0.85	0.75	
		17.8	0.95	2.50	
	09/04/86	18.7	1.45	1.80	
		20.2	1.70	3.80	
		21.1	1.96	3.80	
	09/02/87	21.7	2.00	8.80	
		21.9	2.05	2.50	
		23.7	2.90	6.80	
	09/03/87	19.2	1.60	31.00	
		20.8	1.90	16.00	
		22.8	2.02	12.00	
		24.2	2.10	1.60	

Source: WDNR Bureau of Water Resources Contaminant Monitoring Program. 1992.

Table 2. **PCBs and Mercury** in Fish **Fillets From the** De **Pere Dam** to **the mouth** of the Fox River

Species	**Sample Date**	**Length (in)**	**Weight (kg)**	**PCB (ppm)**	**Mercury (ppm)**
Walleye	8/1/85	14.50	0.50	1.60	
		15.00	0.46	2.00	
		15.75	0.58	1.60	
		17.25	0.91	2.90	0.27
		18.00	0.96	1.20	0.25
		19.50	1.17	1.20	0.34
	10/6/86	19.00	1.06	2.10	0.48
		21.00	1.45	2.10	0.57
		23.50	2.39	1.60	0.78
	5/11/87	19.30	1.14	2.30	
		20.50	1.41	3.10	
		22.00	1.93	0.38	
		27.50	2.96	0.75	
		21.30	1.25	2.30	0.13
		22.30	2.16	1.90	0.58
		12.25	0.26	0.36	0.40
		15.30	0.54	1.70	

Table 2.	PCBs and Mercury in **Fish Fillets From the** De Pere Dam to the mouth of the Fox River

Species	Sample Date	Length (in)	Weight (kg)	PCB (ppm)	Mercury (ppm)
		9.90	0.13	0.47	
	5/18/87	13.80	0.40	0.12	
	5/22/87	8.60	0.08	0.51	
		13.00	0.34	0.76	
		15.50	0.65	0.88	
	4/28/88	19.88	1.29	1.20	
		21.88	1.57	1.90	
		22.88	2.14	2.30	
Northern Pike	5/11/87	16.30	0.35	0.44	
		26.00	1.51	1.50	
		24.25	1.44	1.80	
	5/18/87	16.50	0.40	0.80	
		18.25	0.56	0.40	0.08
		20.15	0.82	0.53	
		22.30	0.96	2.40	
		25.30	1.44	2.80	0.26

Table 2. **PCBs** and Mercury in Fish Fillets From the De Pere Dam to the mouth of the Fox River

Species	Sample Date	Length (in)	Weight (kg)	PCB Ippm)	Mercury Ippm)
		28.50	2.50	2.40	0.28
		30.80	2.92	1.60	0.38
	5/12/88	31.50	3.08	1.00	
	5/13/88	23.83	1.05	1.10	
		26.75	1.98	0.66	
White **Bass**	8/1 /85	9.25	0.16	1.90	
		11.00	0.22	6.50	
		12.50	0.50	6.50	
	5/4/87	5.80	0.03	3.80	
		7.80	0.06	1.20	
		9.80	0.17	2.60	
		11.30	0.22	2.50	
		11.90	0.36	3.00	
		13.00	0.51	0.19	
	5/11 /87	10.65	0.25	1.80	
		13.00	0.56	4.50	
		13.50	0.60	3.80	

Table 2. PCBs and Mercury in Fish Fillets From the De Pere Dam to the mouth of the Fox River

Species	Sample Date	Length (in)	Weight (kg)	PCB (ppm)	Mercury (ppm)
		15.30	0.83	8.40	
		12.75	0.47	4.60	
		14.30	0.74	5.80	
Sheepshead	5/11/87	15.80	0.86	3.30	
		10.60	0.32	1.00	
		10.53	0.15	0.82	
		5.56	0.03	2.90	
		14.30	0.56	1.20	
		15.05	0.68	2.90	
		18.10	1.40	4.60	
		18.90	1.60	3.60	
		20.00	2.20	3.70	
		17.80	1.43	1.10	
		19.50	1.60	3.60	
Channel Catfish	5/4/87	15.80	0.51	3.20	
		27.00	3.10	8.00	
	5/6/87	14.50	0.44	6.20	

Table 2. PCBs and Mercury in Fish Fillets From the De Pere Dam to the mouth of the Fox River

Species	Sample Date	Length (in)	Weight (kg)	PCB (ppm)	Mercury (ppm)
	5/11 /87	23.50	2.68	3.10	
		21.50	1.38	6.00	
		25.50	2.24	4.00	
		16.50	0.59	14.00	
		20.00	1.26	13.00	
	5/15/87	24.40	2.41	9.40	0.28
	5/18/87	11.70	0.20	2.30	
	5/20/88	26.13	3.08	1.70	
		21.33	1.47	3.90	
	6/1 /88	7.50	0.05	0.84	
		8.50	0.08	1.20	
		9.25	0.10	1.70	
Flathead Catfish	5/20/88	22.75	2.43		
		27.00	3.66	1.20	
Black Bullhead	5/1 1 /87	9.03	0.18	0.47	
		9.25	0.18	0.22	

Table 2. PCBs and Mercury in Fish Fillets From the De Pere Dam to the mouth of the Fox River

Species	Sample Date	Length (in)	Weight (kg)	PCB (ppm)	Mercury (ppm)
		10.00	0.20	1.80	
	5/15/87	7.62	0.09	0.64	
Rock Bass	5/11/87	7.33	0.18	0.62	
		8.25	0.17	0.43	
	5/15/87	8.23	0.22	0.45	
		8.50	0.27	0.43	
Black Crappie	4/29/87	6.50	0.07	0.37	
		7.40	0.11	0.40	
		8.70	0.16	0.76	
		9.20	0.19	1.30	
		10.00	0.30	0.62	
Carp	10/6/86	18.13	1.31	21.00	0.08
		19.20	1.50	6.40	
		19.20	1.50	8.80	
		19.70	1.65	50.00	
	8/1/85	20.25	1.67	3.10	
		23.00	2.17	3.70	
		16.50	0.97	12.00	
Gizzard Shad	10/6/86	6.22	2.31	5.90	<0.03

Table 2. PCBs and Mercury in Fish Fillets From the De Pere Dam to the mouth of the Fox River

Species	Sample Date	Length (in)	Weight (kg)	PCB (ppm)	Mercury (ppm)
Alewife	5/27/87	7.50	0.05	3.10	
White Sucker	8/1 /85	14.50	0.55	0.80	
		14.75	0.53	1.50	
		16.25	0.68	3.70	
	5/7/87	12.20	0.34	0.51	
		14.65	0.56	1.50	
		15.87	0.60	1.60	
		17.40	0.50	1.30	
		18.93	0.54	1.20	
	10/25/89	17.20	0.89	1.60	
	10/26/89	16.10	0.88	1.90	
		17.30	1.02	0.54	
		9.40	0.14	0.20	
		9.50	0.14	0.23	

Source: WDNR Bureau of Water Resources Contaminant Monitoring Program. 1992.

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APPENDIX E

(Table 1. Dredging Activities Report

Project: GREEN BAY
Jurisdiction: Wisconsin
Basin: Michigan

Calendar Year: 1985.	Beginning Date: 85/7/3	Ending Date: 85/9/2 Maximum depth (Meters): 7.9
Equipment: Bucket Total Quantity (M**3): 78186. Dredging Cost ($/M 3): 7.27 Disposal Method: Confined		Pay Quantity (M**3): 78186. CDF Cost ($/M**3): 6.05
Calendar Year: 1985	Beginning Date: 85/10/23	Ending Date: 86/5/1 Maximum depth (Meters): 7.3
Equipment: Bucket Total Quantity (M ** 3): 91964. Dredging Cost ($/M**3): 11.98 Disposal Method: Confined		Pay Quantity (M ** 3): 91964. CDF Cost (S/M**3): 6.05
Calendar Year: 1986	Beginning Date: 86/9/2	Ending Date: 87/5/1 Maximum depth (Meters): 7.9
Equipment: Bucket Total Quantity (M**3): 51087. Dredging Cost ($/M**3): 14.39 Disposal Method: Confined		Pay Quantity (M**3): 51087. CDF Cost ($/M**3): 6.05
Calendar Year: 1987	Beginning Date: 87/9/14	Ending Date: 87/11/17 Maximum depth (Meters): 7.9
Equipment: Bucket Total Quantity (M**3): 87359. Dredging Cost ($/M**3): 11.86 Disposal Method: Confined		Pay Quantity (M**3): 87359. CDF Cost ($/M**3): 6.05
Calendar Year: 1987	Beginning Date: 87/10/17	Ending Date: 88/10/26 Maximum depth (Meters): 7.6
Equipment: Bucket Total Quantity (M**3): 120161. Dredging Cost (S/M **3): 14.37 Disposal Method: Confined		Pay Quantity (M**3): 120161. CDF Cost ($/M**3): 6.05
Calendar Year: 1988	Beginning Date: 88/8/15	Ending Date: 89/6/2 Maximum depth (Meters): 8.1
Equipment: Bucket Total Quantity (M**3): 127823. Dredging Cost ($/M ** 3): 11.96 Disposal Method: Confined		Pay Quantity (M**3): 127823. CDF Cost ($/M **3): 6.05
Calendar Year: 1989	Beginning Date: 89/10/16	Ending Date: 89/11/14 Maximum depth (Meters): 7.9
Equipment: Bucket Total Quantity (M 3): 37830. Dredging Cost ($/M**3): 13.40 Disposal Method: Confined		Pay Quantity (M 3): 37830. CDF Cost ($/M**3): 6.05

Key:
- **Calendar Year - Indicates broadly the time** of **the dredging**
- Beginning **and Ending Date - Reported data range** of **when** dredging was **performed**
- Location - listed **as** the 'Project.'
- Maximum Depth - dredging occurred at variable levels
- Equipment - dredging equipment used
- Total Quantity - The total quantity of **dredged material** in **Cubic Meters** of **Placed** Material ICMPMI
- **Pay** Quantity - Amount of **material approved land paid for)** in **CMPM**
- **Dredging** Cost - Actual **cost of dredging**
- Disposal Method
- Latitude/Longitude - When material **was** not **placed** in a confined **disposal** facility, the location where the material **was placed** is indicated
- **CDF Cost - Cost per CMPM** in a CDF
- Percent Confined - When it could be determined what percent of the **dredged material was placed** in a CDF, the information is **provided.**

ource: 1986-1989 Great Lakes Water Quality Board Dredging Register. Data source, USACOE.

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APPENDIX F

THE FOLLOWING TEST DESCRIBES HOW APPENDIX F TABLES 1-6 WERE DEVELOPED:

Procedures Used for Calculating 1990 Loads of Phosphorus, Ammonia, Suspended Solids, and Biological Oxygen Demand

In calculating point source nutrient loads, two different data bases were used. The primary data source was the Discharge Monitoring Reports (DMRs) and the secondary basis for information was NR 101 reports.

All active dischargers under the Wisconsin Pollutant Discharge Elimination System (WPDES) are required to submit DMRs on a monthly basis. DMRs are essentially an account of discharge for each outfall for various parameters as specified in the WPDES permit and is presented as average daily concentration (mg/L) or average daily load (lbs) in combination with flow (MGD or GPD). Calculating total annual loads from DMR data is a stepwise process. First, monthly loads were determined. If the data were presented in mg/L, then multiplying the average daily flow by average daily concentration by a conversion factor (8.34) yields an average daily load in pounds. The formula is represented by [CONCENTRATION (mg/L) x FLOW (mgd) x 8.34 = QUANTITY (lbs/day)]. The number of pounds was then multiplied by the number of days in the month to determine the average monthly load.

If the DMR data were presented in pounds, then multiplying the average daily load by the number of days in the month gives average monthly load. The average daily concentration was back-calculated using the formula [(AVERAGE lbs/day)/(AVERAGE MGD x 8.34) = AVERAGE mg/L].

Next, total annual loads were determined by summing the average monthly loads. The average annual concentration was calculated by averaging the monthly concentrations.

If DMR data were not available, then information from NR 101 reports was used. NR 101 requires that any industrial facility discharging more than 10,000 gallons per day of wastewater, which contains at least one of the substances listed in NR 101, report annually and pay a fee based on the "quality" of the wastewater. The data are presented as average and maximum concentration (mg/L) and load (lbs/day) along with flow in million gallons per day (MGD). Total annual load in pounds is simply calculated by multiplying the given average daily load by 365.

Several assumptions were made in determining total annual loads. First, the annual concentration was determined for outfalls only when they were discharging. If an outfall only discharges seasonally, then the concentration only takes into account those months for which it was discharging. Secondly, if a discharger has more than one outfall then the annual flow and load are summed for each outfall and presented as one total number. The reported concentration is the highest value of all outfalls. Next, some of the dischargers only reported maximum daily values and no average daily values. in these cases, the reported maximum daily value was used. Furthermore, municipalities often are not required to report effluent flows. Where this was the case, total influent flows were used. Lastly, due to the fact that reported effluent flows can vary as much as 20%, the reported annual loads are just an estimate.

Many of the WPDES permits do not require industries to report net (effluent subtract influent) loading values. Therefore, most of the reported values in the table are total loads and are not adjusted to reflect the make-up of the process water before it is used in manufacturing. Several industries treat in-take water prior to utilizing it in manufacturing and actually remove many of the associated impurities. The sources of in-take water can include river, well, and municipal water. Because the methods of calculating net loads are not standardized across industries, only gross loads are reported here.

Table 1. Annual Industrial Loading to Surface Waters of the Fox River Basin -- 1990

Facility Name	Permit #	Receiving Waters	Flow MGD	Total-P mg/L	Total-P lbs	Suspended Solids mg/L	Suspended Solids lbs	BOD-5 mg/L	BOD-5 lbs	Ammonia(NH3-N) mg/L	Ammonia(NH3-N) lbs
Aid Assn For Lutherans	0039420	Fox River via Apple Creek	0.0004								
Akrosil Cooperation	0001155(G)	Fox River	0.219'					2.50	1679		
American Nat'l Can Menasha	0026999	Fox River	0.444	1.23	1692			1.80'	2847	0.31	86
American Nat'l Can Neenah	0030163	Fox River	0.026	0.26	21	2.78	197				
Amoco Oil Co-Green Bay	0026603(G)	Fox River	0.110'			24.00	7300				
AMP! Morning Glory Farms	0039993	Fox River via storm sewer	0.280	2.00'	1825	8.00	6935	2.18	989		
Appleton Papers Inc. Lksmill	0000990(M)	Fox River	5.587	1.07	15665	30.83	499902	24.21	387387	2.16	37128
Atlas Warehouse and Cold Sto	0033871	Ellis Creek	2.736								
Beloit Manhattan Inc	0032671	Neenah Slough	0.119			3.05	1037				
Citgo Petroleum Company	0026298(G)	Fox River	0.002	0.10	37	15.00	6388	3.00	1278		
Culligan Water Conditioning-GB	0038989(G)	Fox River	0.0001'			0.0003'	110				
De Pere High School	0040860	East River	0.0002								
Eilers Cheese Factory	0027472	Devil River via unk trib									
Fabco Equipment Inc	0046612	Fox River	0.0007								
Foremost Whey Prod-Div Coop	0001228	Fox River--NCCW outfall 2	0.096					12.52	1050		
		Fox River--NCCW outfall 3	0.132					1.06	137		
		TOTAL LBS for Foremost Whey		0.19	66	35.00	4015		1187		
Fort Howard Paper Company	0001848(M)	Fox River	15.779	0.43	20056	19.82	942662	13.72	662589	2.63	66175
Galloway Company	0027553	Neenah Sl via Monroe st sewer	0.379'								
Green Bay Food Co	0037702	Fox River	0.061			4.00'	1314	4.33	740		
Green Bay Packaging Inc.	0000973(M)	Fox River	2.050	0.23	267	36.47	238797	33.90	208129	0.31	361

Facility Name	Permit #	Receiving Waters	Flow MGD	Total-P mg/L	Total-P lbs	Suspended Solids mg/L	Suspended Solids lbs	800-5 mg/L	800-5 lbs	Ammonia(NH3-N) mg/L	Ammonia(NH3-N) lbs
Green Bay Terminal Corp	0045357	Green Bay via storm sewers	0.006								
James River Corporation GB	0001261(M)	Lower Fox R and East R	7.264	0.09	2056	21.64	479242	24.56	547099		
James River Corp Menasha	0045608	US Canal	0.000'								
James River Corp Neenah	0030147	Fox River	0.129'	2.40'	1241						
James R Corp-Neenah Tech Center	0027081(G)	Neenah Slough	0.000'								
K L M Foods Inc	0045080	Little Suamico R) outfall 1	0.016					7.07	180		
		via un trib) outfall 2	0.015					18175.50	276934		
		TOTAL LBS for K L M Foods							277114		
Kerwin Paper Co Riverside Corp	0000591(M)	Fox River	0.607	0.19'	548	146.58	262742	165.82	302873		
Kimberly Clark Lakeview GB	0000680(M)	Fox River	2.100	0.05	333	2.44	15512	45.86	291021	0.36	735
Kim. Clark Corp Dev Fac. So.	0045136	Neenah Slough via storm sewer	0-055								
Kimberly Clark NP BG WWTP	0037842(M)	Fox River	3.390	0.04	445	6.72	67884	5.97	59966	0.61	3285
Kim. Clark Corp Main Office	0027871	Little Lk Butte des Morts	0.031			14.43	1359	12.64	1203		
Larsen Company GB	0000451	Fox River-outfall 2	.306			4.46	1281	2.98	3064		
		Fox River-outfall 3	.029			7.58	398	3.00	121		
		Fox River-outfall 4	0.091					3.08	407		
		TOTAL LBS for Larsen Company					1680		3592		
M-I Drilling Fluids-Appleton		Fox River	0.131'			2.32'	1082				
Mead Corp. Gilbert Paper	0000302	Fox River	0.144'								
Menasha Elec. and Water Util	0027707	Fox River	12.104								
Mercury Marine Plant #33	0047619	Fox River									
Midtec Paper Corp. Kimberly	0000698(M)	Fox River	11.884	0.89	32813	15.09	542428	11.99	428285	1.12	40592
Nicolet Paper Company	0001473(M)	Fox River	2.807	0.12	517	26.99	239258	76.71	669365	2.98	18120
P.H. Glatfelter-Bergstrom	0001121(M)	Little Lake Butte Des Morts	4.368	0.97	12706	44.09	584836	32.23	426975	8.38	75096

Facility Name	Permit #	Receiving Waters	Flow	Total-P		Suspended Solids		BOD-5		Ammonia(NH3-N)	
			MGD	mg/L	lbs	mg/L	lbs	mg/L	lbs	mg/L	lbs
Proctor & Gamble Fox R Plant	0001031(M)	Fox River	3.667	0.06	589	19.04	213074	25.17	280684	0.18	489
Provimi Veal	0044628	Duck Cr via un trib	0.045	7.00'	2026	40.63	5425	24.30	3207		
Renco Machine Box O Matic	0047783	Fox River									
Rich Products Corp-Appleton	0038342(G)	Mud Creek	0.302'	0.10'	91						
Schreiber Foods Inc	0004499	Fond du Lac R West Branch	0.079	0.02'	4	2.00'	511				
Stokley USA Inc Appleton	0040339	Fox River via storm sewer	0.025					8.49	225		
Stokley USA Inc Green Bay	0034274	East River									
Stowe Woodward Co		Fox River	0.017			2.70'	1387				
Super Value Stores Inc	0043923	Dutchman's Cr via storm sewers	0.004								
Thilmany Pulp & Paper Co.	0000825(M)	Fox River-sec. trmt pit dis.	18.458	0.37	20499	22.49	1267331	14.74	829331	1.00	56005
		Fox River-condenser cool water	3.027			14.00	36396	2.75	7099		
		Fox River-NCCW	2.713			17.25	49772	4.25	7007		
		Fox River-NCCW/Seal water	0.290			19.00	5669	3.00	890		
		Fox River-NCCW yard+roof dr.	0.187			19.50	4050	3.25	672		
		TOTAL LBS for Thilmany			20499		1363218		844998		56005
US Army Corps of Engineers	0044792	Lake Michigan									
White Clover Dairy Kaukauna	0027197	Plum Creek via un trib	0.096	1.90'	913	8.16	2379	4.35	1270		
White Clover Dairy Sherwood	0027201	Kankapot Cr via un trib	0.168	3.40'	1606	119.00	153665	27.21	11503		
WI Protective Coatings	0048241	Fox River									
WI Public Service Pulliam	0000965(M)	Fox River-outfall 1	1.396			9.03	38620				
		Fox River-outfall 2	1.292			4.47	18586				
		Fox River-outfall 3	1.296			13.27	81398				
		Fox River-outfall 4	2.150			10.58	73591				
		TOTAL LBS for Pulliam		0.004	2916		212195	0.10	44457		
WI Tissue Mills	0037389(M)	L Lk Butte Des Morts-new WWTS	2.623	0.78	5189	56.76	450812	33.87	276625	1.96	7499
		L Lk Butte Des Morts-old WWTS	2.280	0.77	4360	44.37	289124	19.82	121603	3.49	15684
		TOTAL LBS for WI Tissue Mills			9549		739936		398228		23183

TOTAL FOR FOX RIVER BASIN	Total-P	Suspended Solids	BOD-5	Ammonia(NN3-N)
	128480 LBS	6596468 LBS	5858889 LBS	321254 LBS

based on NR 101 reports

M - major discharger (discharges over 1,000,000 gallons per day

G - general permittee (as defined by WPDES guidelines

Table 2. Annual Industrial Loading to Surface Waters of the Upper Fox River Basin -- 1990

Facility Name	Permit #	Receiving Waters	Flow MGD	Total-P mg/L	Total-P lbs	Suspended Solids mg/L	Suspended Solids lbs	BOD-5 mg/L	BOD-5 lbs	Ammonia(NH3-N) mg/L	Ammonia(NH3-N) lbs
Allen Creek Trout Farm	0046949	Allen Creek									
AMPI-Portage		Fox River	0.022'	0.02'	2	1.00	88	1.00'	88		
Bemis-Curwood		Lake Winnebago	0.014'			1.20	73				
Berlin Foundry-McQuay Corp	0001147(G)	Fox River	0.497'	0.20'	303	4.00'	6051	5.00	7563		
Castle Pierce Printing	0001520	Lake Butte des Morts	0.002	1.70'	18	9.76	74	5.80	42		
Chicago-N'western Transportation	0026310(G)	Fireberg Creek	0.0001	0.15	0	2.00	1	6.00	2		
Culligan Water Conditioning	0045063(G)	Lake Winnebago	0.089	0.02	1	1.88'	511				
Del Monte Foods Plant 116	0027448	Grand River and groundwater	0.383	0.37'	599	5.00'	7300	4.76	2294		
4 X Corporation-Green Lake	0042251	Puchyan River via un ditch	0.001			8.56	22				
Friday Canning-Eden	0000485	De Neveu Creek--outfall 1	0.006			117.00	182	81.00	126	35.00	54
		De Neveu Creek--outfall 2	0.009					8.50	97		
		TOTAL LBS for Eden Plant					182		222		54
Friday Canning-Markesan	0027529	Grand River	0.100	12.20	3723	24.09	7333	11.18	3402		
Friday Canning-Oakfield	0002267	Campground Creek and grndwater	0.027	0.34'	29	9.50'	840	5.60	166		
Galloway West Co Fond du Lac	0000132	W Br Fond du Lac R & grndwater	0.238	0.40	292	4.00'	2920				
Kimberly Clark W Off Cmplx	0041157	Fox River via un creek	0.100								
Larsen Comp Fairwater Plant	0002666	Grand River and groundwater	0.000								
Mercury Marine Plant 64	0047759	Fox River	0.060								
Mercury Marine Plant 64	0040029	Fox River	0.0035'			5.50'	168	13.00'	402		
Mercury Marine Plant #6	0000981	Lake Winnebago	0.072			11.75	847				
Merc Mar Hickory St Complex	0040011	W Br Fond du Lac River	0.136'					2.10	876		
Mercy Medical Center-Oshkosh	0043052	Lake Winnebago	0.086'	7.10'	1241	144.00'	24820	309.00	53655		

Facility Name	Permit #	Receiving Waters	Flow MGD	Total-P mg/L	Total-P lbs	Suspended Solids mg/L	Suspended Solids lbs	BOD-5 mg/L	BOD-5 lbs	Aninonia(NH3-N) mg/L	Aninonia(NH3-N) lbs
Merwin Oil Company	0048216	Fond du Lac River									
National By Products-Berlin	0038083	Fox River via trib & grndwater	1.688								
Pillsbury Green Giant-Ripon	0001163	Silver Creek and groundwater	0.283	1.80'	2117	6.30'	7355	2.56	941		
Scott Worldwide Food Service		Lake Winnebago	0.810'	0.35	876						
Tuscarora Plastic Inc	0055328	Fox River	0.090	0.08	40	3.00	1460				
Vulcan Materials-Oshkosh	0001201(G)	Fox River	0.130	0.23	91	5.00	2008				

TOTAL FOR UPPER FOX RIVER BASIN	Total-P	Suspended Solids	BOO-5	Anmonia(NH3-N)
	9332 LBS	62050 LBS	69653 LBS	54 LBS

based on NR 101 reports

M - major discharger (discharges over 1,000,000 gallons per day
G - general permittee (as defined by WPDES guidelines

Table 3. Annual Industrial Loading to Surface Waters of the Wolf River Basin -- 1990

Facility Name	Permit #	Receiving Waters	Flow MGD	Total-P mg/L	Total-P lbs	Suspended Solids mg/L	Suspended Solids lbs	BOD-5 mg/L	BOD-5 lbs	Ammonia(NH3-N) mg/L	Ammonia(NH3-N) lbs
Alto Dairy Black Creek	0027596	Black Creek via storm sewer	0.149			2.40	1095	5.33	2417		
AMPI Morn Glory Farms-Wittenberg	0029513	Tiger Creek and groundwater	0.125	2.10'	128	6.00'	365	5.01	2022		
Beatrice Cheese-North Osborn	0033031	Black Creek	0.109					15.98	5432		
Bemis-Curwood	0000647(G)	Wolf River	0.641'	0.02'	44	1.80'	4088				
Flanagan Brothers Inc	0050407	Bear Creek and groundwater	0.000'								
Fremont Company	0000281	Black Creek-stabiliz. pond	0.102			148.70	7106	97.73	4860		
		Black Creek-CCW	0.026					8.47	348		
		TOTAL LBS for Fremont Company		1.00'	438		7106		5208		
FWD Corp	0034690	Pigeon River	0.006	2.60	44	6.87	115	5.69	96		
Galloway West Co-New London	0000159	Wolf River and groundwater	0.204	0.06'	77			3.01	1814		
Hillshire Farm Co-Div Sara Lee	0023094	Wolf River via tributary	0.858	2.99	7639	37.79	94242	9.60	24232	0.07	172
Isaar Cheese Inc	0034797	Suamico River	0.0008								
Larsen Company Hortonville Plant	0070777	Black Otter Cr and groundwater	0.327			93.87	66262	32.50	24228		
		Black Otter Cr and groundwater	0.075					4.17	841		
		TOTAL LBS for Larsen Company		5.40	4745		66262		25069		
Manawa Water Dept Well 3	0038636	Little Wolf River	0.003								
Ripon Pickle Co-Redgranite	0043435	Willow Creek and groundwater	0.000'								
Seymour Canning Co	0027634	Black Cr via un trib & grndwtr	0.014					4.15	152		
			0.010					4.50	88		
		TOTAL LBS for Seymour Canning							240		
Shawano Paper Little Rapids Corp	0001341(M)	Wolf River	1.460	1.50'	9417	16.57	71658	117.76	522366		
Shiocton Kraut Co Inc	0070441	Wolf River and groundwater	0.008					6.90	113		
Twelve Corners Cheese Factory	0043851	Duck Cr via dr ditch & grndwtr	0.005								

Facility Name	Permit #	Receiving Waters	Flow	Total-P		Suspended Solids		800-5		Ammonia(NH3-N)	
			MGD	mg/L	lbs	mg/L	lbs	mg/L	lbs	mg/L	lbs
Vlasic Foods Inc-Bonduel	0039322	Shiocton River	0.160	2.20	937	42.63	13157	22.04	7172	0.96	295
Waupaca Foundry Inc Plant No 1	0026379	Waupaca River	0.818	0.028	60	1.00	2157	3.69'	7953		
Waupaca Foundry Inc Plant No 283	0055930	Waupaca River	0.419	0.064	102	6.24	8875				
Weyauwega Milk Products	0001449	Waupaca River and groundwater	0.276			9.66	7868	8.78	7210		
Weyauwega Star Dairy	0039527	Lake Weyauwega and groundwater									
WI DNR Langlade Rearing Station	0022748	Dalton Creek and groundwater	1.422			0.75	3947	1.80'	10724		
WI DNR Wild Rose Fish Hatchery	0022756	Pine River and groundwater	2.538	0.08	215	2.75	6558			0.26	647

TOTAL FOR WOLF RIVER BASIN	Total-P	Suspended Solids	80D-5	Ammonia(NH3-N)
	23845	287493	622068	1114
	LBS	LBS	LBS	LBS

based on NR 101 reports

M - major discharger (discharges over 1,000,000 gallons per day

G - general permittee (as defined by WPDES guidelines

Table 4. Annual Municipal Loading to Surface Waters of the Fox River Basin -- 1990 '

Facility Name	Permit #''	Receiving Waters	Flow MGD	Total-P mg/L	Total-P lbs	Suspended Solids mg/L	Suspended Solids lbs	BOD-5 mg/L	BOD-5 lbs	Ammonia(NH3-N) mg/L	Ammonia(NH3-N) lbs
Appleton City	0023221(M)	Fox River	13.100	0.71	28000	18.67	757052			19.51	752057
De Pere City	0023787(M)	Fox River	4.188	0.54	6398	2.05	23495	10.59	123959	6.49	74207
Freedom Elementary School	0030384	Duck Creek	0.003			11.83	87	11.72	89		
Freedom Sanitary District 1	0020842	Duck Creek	0.142			6.96	3008	7.54	3247	0.10	43
Grand Chute Menasha West	0024686(M)	Little Lk Butte Des Morts	3.780	0.76	8615	15.08	173267	15.42	178372		
Green Bay Met	0020991(M)	Green Bay via Fox R	33.750	0.58	58899	17.50	1760870	20.92	2114816	8.08	812037
Heart of the Valley Met	0031232(M)	Fox River	4.688	0.78	11044	6.58	102844	21.33	311976		
Holland Town San. Dist.	0028207	Plum Creek via trib	0.168	2.92	1473	7.25	3643	5.92	2948		
Neenah-Menasha Sewerage	0026085(M)	Fox R Menasha Canal	8.233	0.69	17307	4.67	125614	7.67	193876		
Royal Scot San. Dist.	0020931	Vincent Pt. Ck via Pol. Pond	0.053			5.42	898	23.57	3902		
		Vincent Pt. Ck via Icr. Pond	0.072			11.48	4364	7.12	2964		
		TOTAL LBS for Royal Scot					5262		6866		
Wrightstown San. Dist. # 1	0022438	East River via Unk Creek	0.064			5.42	1044	6.17	1177	1.53	288
Wrightstown San. Dist. 2	0022357	East River via Birch Creek	0.001			8.59	26	12.09	37		
Wrightstown Sewer & Water	0022497	Fox River	0.142	5.50	2240	3.91	1650	4.24	1815		
TOTAL FOR FOX RIVER BASIN				Total-P	133976 LBS	Suspended Solids	2957862 LBS	BOD-5	2939178 LBS	Ammonia(NH3-N)	1638632 LBS

' based on NR 101 reports
** - facility is a general permittee as defined by WPDES guidelines unless otherwise noted
M - major discharger (dischargers over 1,000,000 gallons per day)

Table 5. Annual Municipal Loading to Surface Waters of the Upper Fox River Basin -- 1990

Facility Name	Permit IC	Receiving Waters	Flow MGD	Total-P mg/L	Total-P lbs	Suspended Solids mg/L	Suspended Solids lbs	BOD-5 mg/L	BOD-5 lbs	Ammonia(NH3-N) mg/L	Ammonia(NH3-N) lbs
Berlin City	0021229(M)	Fox River	0.699	0.61	1281	3.00	6365	8.50	17234		
Collins Truck Service	0022969	Lk Butte des Morts via trib	0.003			6.17	62	7.33	74		
Cong St Agnes Nazareth Heights	0028240	De Neveu Creek	0.015			19.57	511	13.57	360		
Eden Village	0030716	De Neveu Creek	0.088			14.83	4021	11.67	3157	0.38	119
Edison Estates Mobile Home Park	0028126	Lake Butte des Morts via trib	0.024			6.75	484	7.50	540		
Fairwater Village	0021440	Grand River via trib	0.090			51.57	8295	22.29	3572	2.79	260
Fond du Lac City	0023990(M)	Lake Winnebago	7.278	0.71	15840	12.00	269714	19.08	430083	6.49	126131
Friesland Village	0031780	Grand River	0.011			18.80	290	8.80	120		
Green Lake City	0021776	Puchyan Creek	0.183			11.08	5801	16.75	9468		
Kingston Village	0036421	Grand River	0.023			42.50	2975	32.00	2310		
Lakeview MHP Bieck Management	0030732	Lake Winnebago via drn ditch	0.020			6.58	405	7.75	478		
Markesan City	0024619	Grand River	0.279			5.42	4553	6.42	5171	0.38	172
Montello City	0024813	Fox River	0.152			7.42	3319	11.58	5225		
Oakfield Village	0024988	Fond du Lac R via Campground	0.174			12.50	6939	11.08	5898	2.27	565
Omro City	0025011	Fox River	0.513	0.41	639	3.52	5607	4.24	6547		
Oshkosh City	0025038(M)	Fox River	14.286	0.44	19316	7.83	364243	12.67	548893		
Oxford Village	0032077	Neenah Creek	0.040			11.58	1195	8.33	1083		
Princeton City	0022055	Fox River	0.206			12.75	8270	19.42	12568		
Ridgeway Country Club Inc	0030643	drainage ditch	0.002			9.42	55	10.08	60		
Ripon City	0021032(M)	Silver Creek	1.566	0.74	3495	1.48	8079	5.67	26738	0.46	2233
Rosendale Village	0028428	W Branch Fond du Lac River	0.089			16.17	4657	9.83	2689	1.16	350
Silver Lake Sanitary District	0061301	White River	0.070	0.48	94	10.17	2071	10.92	2375	12.83	1241

Facility Name	Permit #''	Receiving Waters	Flow MGD	Total-P mg/L	Total-P lbs	Suspended Solids mg/L	Suspended Solids lbs	600 5 mg/L	600 5 lbs	Ammonia(NH3 N) mg/L	Ammonia(NH3 N) lbs
Stockbridge Village	0021393	Mud Creek	0.031			8.20	649	18.10	1514		
Westfield Village	0022250	Westfield Creek	0.212			9.92	6424	10.00	6842		
Winneconne Butte des Morts SD #1	0032492	Lake Butte des Morts									

TOTAL FOR UPPER FOX RIVER BASIN	Total-P	Suspended Solids	Boo-5	Ammonia(NH3-N)
	40665	714984	1092999	131072
	LBS	LBS	LBS	

' based on NR 101 reports
** - facility is a general permittee as defined by WPDES guidelines unless otherwise noted
M - major discharger (dischargers over 1,000,000 gallons per day)

Table 6. Annual Municipal Loading to Surface Waters of the Wolf River Basin -- 1990

Facility Name	Permit #''	Receiving Waters	Flow MGD	Total-P mg/L	Total-P lbs	Suspended Solids mg/L	Suspended Solids lbs	BOO-5 mg/L	BOO-5 lbs	Ammonia(NH3-N) mg/L	Ammonia(NH3-N) lbs
Amherst Village	0023213	Tomorrow River	0.097			13.08	3888	23.83	7002		
Bear Creek Village	0028061	Bear Creek	0.025			6.63	492	9.42	705	0.21	16
Birnamwood Village	0022691	Railroad Creek via un wetland	0.057			12.75	2323	18.92	3304	10.44	1827
Black Creek Village	0021041	Black Creek	0.265	2.22	1769	11.08	8913	10.50	8572	6.60	5348
Bonduel Village	0023426	Shiocton River W Branch	0.083			6.20	1506	6.88	1686	2.76	670
Bowler Village	0021237	Embarrass River North Branch									
Caroline Sanitary District 1	0022829	Embarrass River	0.019								
Clintonville City	0021466(M)	Pigeon River	0.662	0.66	1311	3.86	7566	6.21	11720	0.82	1574
Dale Sanitary District 1	0030830	Rat River via dry run	0.039			18.03	2717	19.12	2736		
Elcho Sanitary District #1	0029726	Wolf River via tributary	0.329			12.83	3823				
Embarrass Village	0023949	Embarrass River	0.111			16.58	5582	11.33	3874		
Fremont Village	0026158	Wolf River	0.068			39.34	7986	34.07	6939		
Gresham Village	0022781	Red River	0.055			16.00	2738	14.81	2540		
Hortonville Village	0022896	Wolf River	0.189	3.58	1908	6.33	3647	6.85	3684		
Iola Village	0021717	Little Wolf River S Branch	0.131			7.32	2913	16.31	6487		
Larsen Winchester San Dist	0031925	Arrowhead Creek	0.143			14.90	462	8.70	337		
Manawa City	0020869	Little Wolf River	0.146			6.33	2759	9.50	4110		
Maple Lane Health Care Center	0029718	Long Lake via unk wetland	0.202			3.00	152	1.60	81		
Marion City	0020770	Pigeon River	0.243			4.08	2928	6.25	4522	0.83	594
New London City	0024929(M)	Wolf River-effluent	0.812	0.77	1883	7.33	17914	13.25	31840		

Facility Name	Permit #'	Receiving Waters	Flow MGD	Total-P mg/L	Total-P lbs	Suspended Solids mg/L	Suspended Solids lbs	BOD-5 mg/L	BOD-5 lbs	Aamonia(NH3-N) mg/L	Aamonia(NH3-N) lbs
Nichols Village	0020508	Shiocton River	0.026			12.51	1027	15.19	1139		
North Lk Poygan San District	0036251	Lake Poygan	0.018			6.50	381	8.33	466		
North Lk Poygan San District	0035475	Lake Poygan									
Poy Sippi Sanitary District	0031691	Pine River	0.028			15.50	1374	16.00	1450		
Poygan Poysippi San District 1	0035513	Lake Poygan	0.015					7.30	22		
Redgranite Village	0020729	Willow Creek	0.084			20.17	5426	22.08	5668		
Seymour City	0021768	Black Creek	0.461	0.25	359	1.22	1734	1.49	1929	0.10	136
Shiocton Village	0028100	Wolf River	0.054			5.51	865	13.34	2033		
Stephensville San District #1	0032531	Bear Creek	0.007			10.69	238	6.65	136	0.38	8
Tigerton Village	0022349	Embarrass River S Branch	0.068			9.02	1943	9.61	1894		
Waupaca City	0030490	Waupaca River	0.661	0.86	1740	20.67	41332	22.83	41419		
Weyauwega City	0020923	Waupaca River	0.253	2.59	2044	9.82	6878	7.91	5008		
Wild Rose Village	0060071	Lower Pine Rvr and groundwate	0.114	2.54	895	15.17	5415	15.50	5256	1.49	286
Winneconne Village	0021938	Wolf River	0.389	0.37	414	6.33	7457	5.78	6218		
Wittenberg Village	0028444	Embarrass River Middle Branch	0.730			16.74	47759	21.35	49370	1.67	133
Wolf Treatment Plant	0028452(M)	Wolf River	1.565	0.60	2906	4.33	21075	10.25	49085		

TOTAL FOR WOLF RIVER BASIN	Total-P	Suspended Solids	BOD-5	Ammonia(NH3-N)
	15230 LBS	221213 LBS	271232 LBS	10592 LBS

' based on NR 101 reports
** - facility is a general permittee as defined by WPDES guidelines unless otherwise noted
M - major discharger (dischargers over 1,000,000 gallons per day)

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APPENDIX G

Table 1. Summary of Ambient Water Quality Data for the Fox River		
LOCATION:	**Lake Winnebago outlet (Neenah / Menasha, 1/87 - 6/92)**	
PARAMETER	MEAN CONC.	WQ CRITERION
Chlorides	12.6 mg/L	230 mg/L
Un-ionized **ammonia** Nitrogen	0.0032 mg/L	0.04 mg/L
Total Hardness	184 ppm	
Lead	**0.56 pg/L**	21.9 **µg/L**
LOCATION:	Little Lake Butte des Morts (1991 Low-Level Metals Study)	
PARAMETER	MEAN CONC.	WQ CRITERION
Total Hardness	185 ppm (Appleton value)	
Cadmium	**0.0246 pg/L**	0.94 **V8/**L
Copper	1.34 **µg/L**	20.6 pg/L
Lead	1.45 pg/L	22.1 µg/L
Mercury	6.12 ng/L	2.0 ng/L
Zinc	3.47 **yg/L**	83.5 pg/L
LOCATION:	**Appleton (1/87 - 6/92)**	
PARAMETER	MEAN CONC.	WQ CRITERION
Chlorides	16.0 mg/L	230 mg/L
Un-ionized Ammonia Nitrogen	0.0043 mg/L	0.04 mg/L
Total Hardness	185 ppm	
LOCATIONN:	**Wrightstown (10/86 - 9/91)**	
PARAMETER	MEAN CONC.	WQ CRITERION
Chlorides	18.5 mg/L	230 mg/L
Total Hardness	185 ppm"	
Arsenic	0.5 mg/L	50 pg/L
Beryllium	0.063 mg/L	
Cadmium	**0.3 pg/L**	0.94 µg/L
Chromium	0.3 µg/L	9.74 pg/L (Cr'")
Copper	1.5 **pg/L**	20.6 pg/L
Iron	0.01 mg/L	1.0 mg/L
Lead	1.0 pg/L	22.1 µg/L
Mercury	20 ng/L°	2 ng/L
Nickel	0.65 yg/L	111 µg/L
Selenium	not detected (@ 1 µg/L)	7.07 pg/L
Zinc	8.3 pg/L	83.5 µg/:.
LOCATION:	**De Pere Dam (1/87 - 6/92)**	
PARAMETER	MEAN CONC.	WQ CRITERION
Chlorides	19.6 mg/L	230 mg/L

Table 1. Summary of Ambient Water Quality Data for the Fox River		
LOCATION:	Lake Winnebago outlet (Neenah / Menasha, 1/87 - 6/92)	
PARAMETER	MEAN CONC.	WQ CRITERION
Un-ionized Ammonia Nitrogen	0.0066 mg/L	0.04 mg/L
Total Hardness	175 ppm	
Cyanide	5.7 µg/L°	4.96 yg/L
Lead	0.71 pg/L	20.6 µg/L

'Mean concentrations are compared to criterion of NR 105 or EPA. Criterion listed is the lowest value available under NR 105.

°Since criteria for some metals vary with water hardness, the mean hardness value used to generate criteria is included.

'Mercury value is average of two out of twenty samples taken quarterly over this period (March 1988 = at level of detection; June 1988 approx. 20 ng/L.)

'Monthly sampling since July 1990. Value is average of two detects(11/91, 4/92).

Source: Jim Schmidt WDNR Bureau Water Resources Management, Madison, WI
Table prepared from EPA, USGS, and WDNR data collected 1987-92.

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APPENDIX H

GLOSSARY

ACUTE TOXICITY:

Any poisonous effect produced by a single short-term exposure to a chemical that results in a rapid onset of severe symptoms.

ADDITIVITY:

The characteristic property of a mixture of toxicants that exhibit a cumulative toxic effect equal to the arithmetic sum of the individual toxicants.

ADVANCED WASTEWATER TREATMENT:

The highest level of wastewater treatment for municipal treatment systems. It requires removal of all but 10 parts per million of suspended solids and biological oxygen and/or 50% of the total nitrogen. Advanced wastewater treatment is also known as "tertiary treatment."

ADVECTION:

Direct transport of a unit of water from one point to another as in stream flow.

AGRICULTURAL CONSERVATION PROGRAM (ACP):

A federal cost-sharing program to help landowners install measures to conserve soil and water resources. ACP is administered by the USDA ASCS through county ACP committees.

AIR POLLUTION:

Contamination of the atmosphere by human activities.

ALGAE:

A group of microscopic, photosynthetic water plants. Algae give off oxygen during the day as a product of photosynthesis and consume oxygen during the night as a result of respiration. Thus, algae effect the oxygen content of water. Nutrient-enriched water increases algae growth.

AMBIENT:

The encompassing environment.

AMMONIA:

A form of nitrogen (NH_3) found in human and animal wastes. Ammonia can be toxic to aquatic life in its un-ionized form.

ANAEROBIC OR ANOXIC:

Without oxygen.

AREA OF CONCERN (AOC):

Areas of the Great Lakes identified by the International Joint Commission (IJC) as having serious water pollution problems.

AREAWIDE WATER QUALITY MANAGEMENT PLANS (208 PLANS):

A plan to document water quality conditions in a drainage basin and make recommendations to protect and improve basin water quality. Each basin in Wisconsin must have a plan prepared for it, according to section 208 of the Clean Water Act.

ANTIDEGRADATION:

A policy which states that water quality will not be lowered below background levels unless justified by economic and social development considerations. Wisconsin's antidegradation policy is currently being revised to make it more specific and to meet EPA guidelines.

ASSIMILATIVE CAPACITY:

The ability of a water body to purify itself of pollutants.

AVAILABILITY:

The degree to which toxic substances or other pollutants that are present in sediments or elsewhere in the ecosystem are available to affect or be taken up by organisms. Some pollutants may be "bound up" or unavailable because they are attached to clay particles or are buried by sediment. The amount of oxygen, pH, temperature and other conditions in the water can affect availability.

BACTERIA:

Single-cell, microscopic organisms. Some can cause disease, and some are important in the stabilization of organic wastes.

BASIN PLAN:

See "Areawide Water Quality Management Plan".

BENTHIC ORGANISMS (BENTHOS):

The organisms living in or on the bottom of a lake or stream.

BEST MANAGEMENT PRACTICE (BMP):

The most effective, practical measures to control nonpoint sources of pollutants that runoff from land surfaces.

BIOACCUMULATION:

The uptake and retention of substances by an organism from its surrounding medium and from its food. Chemicals move through the food chain and tend to end up at higher concentrations in organisms at the upper end of the food chain such as predator fish, or in people or birds that eat these fish.

BIOASSAY STUDY:

A test for pollutant toxicity. Tanks of fish or other organisms are exposed to varying doses of treatment plant effluent; lethal doses of pollutants in the effluent are thus determined.

BIOAVAILABILITY:

A pollutant or other chemical is in a physical or chemical form that permits it to be eaten, breathed, or otherwise absorbed by living things.

BIOCHEMICAL OXYGEN DEMAND (BOD):

A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. BOD_5 is the biochemical oxygen demand measured in a five day test. The greater the degree of pollution, the higher the BOD_5.

BIODEGRADABLE:

Waste which can be broken down by bacteria into basic elements. Most organic wastes such as food remains and paper are biodegradable.

BIOPERTURBATION:

Turbidity caused by fish or bottom dwelling organisms which stir up sediment in the search for food, spawning sites, etc.

BIOTA:

All living organisms that exist in an area.

BUFFER STRIPS:

Strips of grass or other erosion-resisting vegetation between disturbed areas and a stream or lake.

BULKHEAD LINES:

Legally established boundaries which indicate how far into a stream or lake an adjacent property owner has the right to fill. Many of these lines were established many years ago and allow substantial filling of the bed of the River and Bay. Other environmental laws may limit filling to some degree.

CARCINOGENIC:

A chemical capable of causing cancer.

CATEGORICAL LIMITS:

All point source discharges are required to provide a basic level of treatment. For municipal wastewater treatment plants this is secondary treatment (30 mg/I effluent limits for SS and BOD). For industry the level is dependent on the type of industry and the level of production. More stringent effluent limits are required, if necessary to meet water quality standards.

CHLORINATION:

The application of chlorine to wastewater to disinfect it and kill bacteria and other organisms.

CHLORORGANIC COMPOUNDS (CHLORORGANICS):

A class of chemicals which contain chlorine, carbon and hydrocarbon. Generally refers to pesticides and herbicides that can be toxic. Examples include PCBs and pesticides such as DDT and dieldrin.

CHLOROPHYLL a:

A green pigment in plants used as an indicator of plant and algae productivity.

CHRONIC TOXICITY:

The effects of long-term exposure of organisms to concentrations of a toxic chemical that are not lethal is injurious or debilitating to an organism in one or more ways. An example of the effect of chronic toxicity could be reduced reproductive success.

CLEAN WATER ACT:

See "Public Law 92-500."

COMBINED SEWERS:

A wastewater collection system that carries both sanitary sewage and stormwater runoff. During dry weather, combined sewers carry only wastewater to the treatment plant; during heavy rainfall, the sewer becomes swollen with stormwater. Because the treatment plant cannot process the excess flow, untreated sewage is discharged to the plant's receiving waters, i.e., combined sewer outflow.

CONFINED DISPOSAL FACILITY (CDF):

A structure built for the containment and disposal of dredged material.

CONGENERS:

Chemical compounds that have the same molecular composition, but have different molecular structures and formula. For example, the congeners of PCB have chlorine located at different spots on the molecule. These differences can cause differences in the properties and toxicity of the congeners.

CONSERVATION TILLAGE:

Planting row crops while disturbing the soil only slightly. In this way a protective layer of plant residue stays in the surface; erosion is decreased.

CONSUMPTION ADVISORY:

A health warning issued by WDNR and WDHSS that recommends that people limit the fish they eat from some rivers and lakes based on the levels of toxic contaminants found in the fish.

CONTAMINANT:

Some material that has been added to water that is not normally present. This is different from a pollutant, as a pollutant suggests that there is too much of the material present.

CONVENTIONAL POLLUTANTS:

Refers to suspended solids, fecal coliforms, biochemical oxygen demand, and pH, as opposed to toxic pollutants.

COST-EFFECTIVE:

A level of treatment or management with the greatest incremental benefit for the money spent.

CRITERIA:

See water quality standard criteria.

DDT:

A chlorinated hydrocarbon insecticide that has been banned because of its persistence in the environment.

DIOXIN(2,3,7,8-tetra-chloro-dibenzo-p-dioxin):

A chlorinated organic chemical which is highly toxic.

DIFFUSION:

The transport of a substance in a medium when a concentration difference is the cause of the transport.

DISINFECTION:

A chemical or physical process that kills organism that cause disease. Chlorine is often used to disinfect wastewater.

DISSOLVED OXYGEN (DO):

Oxygen dissolved in water. Low levels of dissolved oxygen cause bad smelling water and threaten fish survival. Low levels of dissolved oxygen are often due to inadequate wastewater treatment. The Department of Natural Resources considers 5 ppm DO necessary for fish and aquatic life.

DREDGING:

Removal of sediment from the bottom of water bodies.

ECOSYSTEM:

The interacting system of a biological community and its nonliving surrounding.

EFFLUENT:

Solid, liquid or gas wastes (byproducts) which are disposed on land, in water or in air. As used in the RAP generally means wastewater discharges.

EFFLUENT LIMITS:

The Department of Natural Resources issues WPDES permits that establish the maximum amount of pollutant that can be discharged to a receiving stream. Limits depend on the pollutant involved and the water quality standards that apply for the receiving waters.

EMISSION:

A direct (smokestack particles) or indirect (busy shopping center parking lot) release of any contaminant into the air.

ENVIRONMENTAL PROTECTION AGENCY (USEPA):

The federal agency responsible for enforcing federal environmental regulations. The Environmental Protection Agency delegates some of its responsibilities for water, air and solid waste pollution control to state agencies.

ENVIRONMENTAL REPAIR FUND:

A fund established by the Wisconsin Legislature to deal with abandoned landfills.

EPIDEMIOLOGY:

The science that studies statistical relationships between patterns of disease and the occurrence of possible causing or contributing factors.

EROSION:

The wearing away of the land surface by wind or water.

EUTROPHIC:

Refers to a nutrient-rich lake. Large amounts of algae and weeds characterize a eutrophic lake (see also, "Oligotrophic" and "Mesotrophic").

EUTROPHICATION:

The process of nutrient enrichment of a lake loading to increased production of aquatic organisms. Eutrophication can be accelerated by human activity such as agriculture and improper waste disposal.

FACILITY PLAN:

A preliminary planning and engineering document which identifies alternative solutions to a community's wastewater treatment problems.

FECAL COLIFORM:

A group of bacteria used to indicate the presence of other bacteria that cause disease. The number of coliform is particularly important when water is used for drinking and swimming.

FISHABLE AND SWIMMABLE:

Refers to the water quality goal set for the nation's surface waters by Congress in the Clean Water Act. All waters were to meet this goal by 1984.

FLUORANTHENE:

A polyaromatic hydrocarbon (PAH) with toxic properties.

FLY ASH:

Particulates emitted from coal burning and other combustion, such as wood burning, and exited into the air from stacks, or more likely, collected by electrostatic precipitators.

FOOD CHAIN:

A sequence of organisms in which each uses the next as a food source.

FORSTER'S TERN:

A bird that is an endangered species in Wisconsin.

FURANS (2,3,7,8-tetra-chloro-dibenzofurans):

A chlorinated organic compound which is highly toxic.

GREEN STRIPS:

See buffer strip.

GROUNDWATER:

Underground water-bearing areas generally within the boundaries of a watershed, which fill internal passageways of porous geologic formations (aquifers) with water which flows in response to gravity and pressure. Often used by the source of water for communities and industries.

HABITAT:

The place or type of site where a plant or animal naturally lives and grows.

HALF-LIFE:

The amount of time required for half of a particular pollutant to degrade (change to another chemical form) in the environment, so that only half of the amount of the original pollutant is left in the environment.

HEAVY METALS:

Metals present in municipal and industrial wastes that pose long-term environmental hazards if not properly disposed. Heavy metals can contaminate ground and surface waters, fish and other food stuffs. The metals of most concern are: arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium and zinc (see also separate listings of these metals for their health effects).

HERBICIDE:

A type of pesticide that is specifically designed to kill plants and can also be toxic to other organisms.

HYDROCARBONS:

Any of a large family of chemicals containing carbon and hydrogen in various combinations.

HYPEREUTROPHIC:

Refers to a lake with excessive fertility. Extreme algae blooms and low dissolved oxygen are characteristic.

INCINERATOR:

A furnace designed to burn wastes or contaminated materials.

INFLUENT:

Influent for an industry would be the river water that the plant intakes for use in its processing. Influent to a municipal treatment plant is untreated wastewater.

IN-PLACE POLLUTION:

As used in the 1988 RAP refers to pollution from contaminated sediments.

INTERNATIONAL JOINT COMMISSION (IJC):

An agency formed by the United States and Canada to guide management of the Great Lakes and resolve border issues.

ISOPROPYLBIPHENYL:

A chemical compound used as a substitute for PCB.

LACUSTRINE:

Of, relating to, or growing in lakes.

LANDFILL:

A conventional sanitary landfill is "a land disposal site employing an engineered method of disposing of solid wastes on land in a manner that minimizes environmental hazards by spreading solid wastes in thin layers, compacting the wastes to the smallest practical volume, and applying cover materials at the end of each operating day." Hazardous wastes frequently require various types of pretreatment before they are disposed of, i.e., neutralization, chemical fixation, encapsulation. Neutralizing and disposing of wastes should be considered a last resort. Repurifying and reusing waste materials or recycling them for another use may be less costly.

LC_{50}:

Lethal concentration for 50% of the test population exposed to a toxic substance.

LD_{50}:

Lethal dose for 50% of the test population exposed to a toxic substance.

LEACHATE:

The contaminated liquid which seeps from a pile or cell of solid materials and which contains water, dissolved and decomposing solids. Leachate may enter the groundwater and contaminate or inking water supplies.

LITTORAL ZONE:

The area in a lake or bay that extends from the shore just upland from the influence of waves to where light penetration is barely sufficient for rooted aquatic plants to grow.

LOAD:

The total amount of materials or pollutants reaching a given local.

MACROPHYTE:

A rooted aquatic plant.

MASS:

The amount of material a substance contains after measured by its weight (in a gravitational field).

MASS BALANCE:

A study that examines all parts of the ecosystem to determine the amount of toxic or other pollutant present, its sources, and the processes by which the chemical moves through the ecosystem.

MESOTROPHIC:

Refers to a moderately fertile nutrient level of a lake between the oligotrophic and eutrophic levels. (See also "Eutrophic" and "Oligotrophic.")

MILLIGRAMS PER LITER (mg/L):

A measure of the concentration of substance in water. For most pollution measurement this is the equivalent to "parts per million".

MITIGATION:

The effort to lessen the damages caused, by modifying a project, providing alternatives, compensating for losses, or replacing lost values.

MIXING ZONE:

The portion of a stream or lake in which effluent is allowed to mix with the receiving water. The size of the area depends on the volume and flow of the discharge and receiving water. For streams the mixing zone is one-third of the lowest flow that occurs once every 10 years for a seven day period.

NONPOINT SOURCE POLLUTION (NPS):

Pollution whose sources cannot be traced to a single point such as a municipal or industrial wastewater treatment plant discharge pipe. Nonpoint sources include eroding farmland and construction sites, urban streets, and barnyards. Pollutants from these sources reach water bodies in runoff, which can best be controlled by proper land management.

OLIGOTROPHIC:

Refers to an unproductive and nutrient-poor lake. Such lakes typically have very clear water. (See also "Eutrophic" and "Mesotrophic.")

OUTFALL:

The mouth of a sewer, drain, or pipe where effluent from a wastewater treatment plant is discharged.

PALUSTRINE:

A plant which lives or thrives in marshy habitat; a habitat which consists of marshes.

PATHOGEN:

Any infective agent capable of producing disease; may be a virus, bacterium, protozoan, etc.

PARTITIONING:

To divide into parts or shares. Used in this report to describe the division of hydrophobic compounds into lipid and aqueous phases in the environment.

PELAGIC:

Referring to open water portion of a lake.

PERSISTENT:

A pollutant that takes a long time to break down or be rendered harmless in the environment. Under the Great Lakes Water Quality Agreement, a persistent pollutant is one with a half-life of eight weeks or longer.

PESTICIDE:

Any chemical agent used for control of specific organisms, such as insecticides, herbicides, fungicides, etc.

pH:

A measure of acidity or alkalinity, expressed on a logarithmic scale of 0 to 14, with 7 being neutral and 0 being most acid, and 14 most alkaline.

PHENOLS:

Organic compounds that are the byproducts of petroleum refining, textile, dye, and resin manufacture. Low concentrations can cause taste and odor problems in fish. Higher concentration can be toxic to fish and aquatic life.

PHOSPHORUS:

A nutrient that when reaching lakes in excess amounts can lead to over fertile conditions and algae blooms.

PHOTIC ZONE:

The area in a lake or bay lying away from the shore where light penetrates until it is about 1 percent of that at the surface. Water layers are well mixed in the photic zone.

PLANKTON:

Tiny plants and animals that live in water.

POINT SOURCES:

Sources of pollution that have discrete discharges, usually from a pipe or outfall.

POLLUTION:

The presence of materials or energy whose nature, location, or quantity produces undesired environmental effects.

POLYCHLORINATED BIPHENYLS (PCBs):

A group of 209 compounds, PCBs have been manufactured since 1929 for such common uses as electrical insulation and heating/cooling equipment, because they resist wear and chemical breakdown. Although banned in 1979 because of their toxicity, they have been detected on air, land and water, and recent surveys have found PCBs in every section for the country, even those remote from PCB manufacturers.

POLYCHLORINATED ORGANIC COMPOUNDS:

A group of toxic chemicals which contains several chlorine atoms.

PRETREATMENT:

A partial wastewater treatment required from some industries. Pretreatment removes some types of industrial pollutants before the wastewater is discharged to a municipal wastewater treatment plant.

PRIORITY POLLUTANT:

A list of toxic chemicals identified by the federal government because of their potential impact in the environment and human health. Major discharges are required to monitor for all or some of these chemicals when their WPDES permits are reissued.

PRIORITY WATERSHED:

A drainage area about 100,000 acres in size selected to receive Wisconsin Fund money to help pay the cost of controlling nonpoint source pollution. Because money is limited, only watersheds where problems are critical, control is practical, and cooperation is likely are selected for funding.

PRODUCTIVITY:

A measure of the amount of living matter which is supported by an environment over a specific period of time. Often described in terms of algae production for a lake.

PUBLIC LAW 92-500 (CLEAN WATER ACT):

The federal law that set national policy for improving and protecting the quality of the nation's waters. The law set a timetable for the cleanup of the nation's waters and stated that they are to be fishable and swimmable. This also required all discharges of pollutants to obtain a permit and meet the conditions of the permit. To accomplish this pollution cleanup billions of dollars have been made available to help communities pay the cost of building sewage treatment facilities. Amendments in the Clean Water Act were made in 1977 by passage of Public Law 95-217, and in 1987.

PUBLIC PARTICIPATION:

The active involvement of interested and affected citizens in governmental decision-making.

PUBLICLY OWNED TREATMENT WORKS (POTW):

A wastewater treatment plan owned by a city, village or other unit of government.

RAP:

See Remedial Action Plan.

RECYCLING:

The process by which waste materials are transformed into new products.

REMEDIAL ACTION PLAN:

A plan designed to restore beneficial uses to a Great Lakes Area of Concern.

RESOURCE CONSERVATION AND RECOVERY ACT OF 1976 (RCRA):

This federal law amends the Solid Waste Disposal Act of 1965 and expands on the Resource Recovery Act of 1970 to provide a program which regulates hazardous wastes, to eliminate open dumping and to promote solid waste management programs.

RIPRAP:

Broken rock, cobbles, or boulders placed on the bank of a stream to protect it against erosion.

RISK ASSESSMENT:

Techniques for systematically measuring and estimating the likely health effects, environmental impacts and other results of releasing or discharging specified amounts of pollutants.

RULE:

Refers to Wisconsin administrative rules. See Wisconsin Administrative Code.

RUNOFF:

Water from rain, snow melt, or irrigation that flows over the ground surface and returns to streams. Runoff can collect pollutants from air or land and carry them to receiving waters.

SECCHI DEPTH:

A white disk usually 20 cm in diameter is used to measure water transparency. It is lowered until it disappears from sight then slowly raised until it is just visible again. The distance halfway between the points of disappearance and reappearance of the disk is **taken as the** Secchi depth.

SECONDARY IMPACTS:

The indirect effects that an action can have on the health of the ecosystem or the economy.

SECONDARY TREATMENT:

Two-stage wastewater treatment that allows the coarse particles to settle out, as in primary treatment, followed by biological breakdowns of the remaining impurities. Secondary treatment commonly removes 90% of the impurities. Sometimes "secondary treatment" refers simply to the biological part of the treatment process.

SEDIMENT:

Soil particles suspended in and carried by water as a result of erosion.

SEICHES:

Changes in water levels due to the tipping of water in an elongated lake basin whereby water is raised in one end of the basin and lowered in the other.

SEPTIC SYSTEM:

Sewage treatment and disposal for homes not connected to sewer lines. Usually the system includes a tank and drain field. Solids settle to the bottom of the tank; liquid percolates through the drain field.

SLUDGE:

A byproduct of wastewater treatment; waste solids suspended in water.

SOLID WASTE:

Unwanted or discharged material with insufficient liquid to be free flowing.

STANDARDS:

See water quality standards.

STORM SEWERS:

A system of sewers that collect and transport rain and snow runoff. In areas that have separated sewers, such stormwater is not mixed with sanitary sewage.

SUPERFUND:

A federal program which provides for cleanup of major hazardous landfills and land disposal areas.

SUSPENDED SOLIDS (SS):

Small particles of solid pollutants suspended in water.

SYNERGISM:

The characteristic property of a mixture of toxicants that exhibits a greater-than-additive cumulative toxic effect.

TACS:

Technical advisory committees that assist in the development of Remedial Action Plans.

TERTIARY TREATMENT:

See advanced wastewater treatment.

TOP-DOWN MANAGEMENT:

A management theory that uses biomanipulation, specifically the stocking of predator species of fish to improve water quality.

TOTAL MAXIMUM DAILY LOADS:

The maximum amount of a pollutant that can be discharged into a stream without causing a violation of water quality standards.

TOXIC:

An adjective that describes a substance which is poisonous, or can kill or injure a person or plants and animals upon direct contact or long-term exposure. (Also, see toxic substance.)

TOXIC SUBSTANCE:

A chemical or mixture of chemicals which through sufficient exposure, or ingestion, inhalation of assimilation by an organism, either directly from the environment or indirectly by ingestion through the food chain, will, on the basis of available information cause death, disease, behavioral of immunologic abnormalities, cancer, genetic mutations, or development of physiological malfunctions, including malfunctions in reproduction or physical deformations, in organisms or their offspring.

TOXICANT:

See toxic substance.

TOXICITY:

The degree of danger posed by a toxic a substance to animal or plant life. Also see acute toxicity, chronic toxicity and additivity.

TOXICITY REDUCTION EVALUATION:

A requirement for a discharger that the causes of toxicity in an effluent be determined and measures taken to eliminate the toxicity. The measures may be treatment, product substitution, chemical use reduction or other actions that will achieve the desired result.

TREATMENT PLANT:

See wastewater treatment plant.

TROPHIC STATUS:

The level of growth or productivity of a lake as measured by phosphorus content, algae abundance, and depth of light penetration.

TURBIDITY:

Lack of water clarity. Turbidity is usually closely related to the amount of suspended solids in water.

UNIVERSITY OF WISCONSIN-EXTENSION (UWEX):

A special outreach, education branch of the University of Wisconsin System.

VARIANCE:

Government permission for a delay or exception in the application of a given law, ordinance, or regulation. Also, see water quality standard variance.

VOLATILE:

Any substance that evaporates at a low temperature.

WASTELOAD ALLOCATION:

Division of the amount of waste a stream can assimilate among the various dischargers to a stream. Results in the limit on the amount (in pounds) of a chemical or biological constituent discharged from a wastewater treatment plant to a water body.

WASTEWATER:

Water that has become contaminated as a byproduct of some human activity. Wastewater includes sewage, washwater, and the water-borne wastes of industrial processes.

WASTE:

Unwanted materials left over from manufacturing processes, refuse from places of human habitation, or animal habitation.

WASTEWATER TREATMENT PLANT:

A facility for purifying wastewater. Modern wastewater treatment plants are capable of removing 95% of organic pollutants.

WATER QUALITY AGREEMENT:

The Great Lakes Water Quality agreement was initially signed by Canada and the United States in 1972, and was subsequently revised in 1978 and 1987. It proves guidance for the management of water quality, specifically phosphorus and toxics, in the Great Lakes.

WATER QUALITY LIMITED SEGMENT:

A section of river where water quality standards will not be met if only categorical effluent standards are met.

WATER QUALITY CRITERIA:

A measure of the physical, chemical or biological characteristics of a water body necessary to protect and maintain different water uses (fish and aquatic life, swimming, etc.).

WATER QUALITY STANDARDS:

The legal basis and determination of the use of a water body and the water quality criteria, physical, chemical, or biological characteristics of a water body, that must be met to make it suitable for the specified use.

WATER QUALITY STANDARD VARIANCE:

When natural conditions of a water body preclude meeting all conditions necessary to maintain full fish and aquatic life and swimming a variance may be granted.

WATERSHED:

The land area that drains into a lake or river.

WETLANDS:

Those areas that are inundates or saturated by surface or groundwater at a frequency and duration sufficient to support a variety of vegetative or aquatic life. Wetland vegetation requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas.

WISCONSIN ADMINISTRATIVE CODE:

The set of rules written and used by state agencies to implement state statutes. Administrative codes are subject to public hearing and have the force of law.

WISCONSIN NONPOINT SOURCE WATER POLLUTION ABATEMENT GRANT PROGRAM:

A state cost-share program established by the State Legislature in 1978 to help pay the costs of controlling nonpoint source pollution. It is also known as the nonpoint source element of the Wisconsin Fund or the Priority Watershed Program.

WISCONSIN POLLUTANT DISCHARGE ELIMINATION SYSTEM (WPDES):

A permit system to monitor and control the point source discharges of wastewater in Wisconsin. Dischargers are required to have a permit and meet the conditions it specifies.

ZOOPLANKTON:

Tiny aquatic animals that fish feed upon.

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APPENDIX I LITERATURE CITED

Text
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APPENDIX J

Public Comment and Suggestions
Lower Green Bay Remedial Action Plan
Public Review Draft

Introduction

A public hearing on the Green Bay Remedial Action Plan Update was held June 1, 1993 at the Green Bay Wildlife Sanctuary. Draft plans were distributed to over 100 people and were made available in 60 libraries statewide one month prior to the meeting. The 7:00 p.m. meeting was attended by approximately 30 people including representatives of national and local news media.

Six people made formal public comment. Written comment was received from five sources in additional to internal WDNR review comments.

Comments largely fell into three categories: implementation efficiency; technical detail; and consistency with International Joint Commission guidelines for Stage II Remedial Action Plans.

A summary of verbal comments is presented in Part A. Part B details written comments and how they were addressed.

PART A: SUMMARY OF COMMENTS

Efficiency of Implementation

* Expand the AOC to include entire basin. Need to show communities upstream how their activities are affecting the waters downstream.

* Begin tougher regulations, tougher legislation, and more pollution prevention activities.

* Need a better defined financial plan for implementation.

* Increase attention on the funding mechanism.

* Ask the Fox River Coalition (a coalition of Fox Valley industry and government, state, and federal agencies) to take the next steps in funding some of the clean up of the sediments.

* Need to continue discussing the role the polluters have in the financing of clean up activities. Funding of clean up projects is essential and those contaminating the AOC should have a larger role in the clean up.

* Reduce the amount of contaminants that are being dumped into the AOC, especially persistent and bioaccumulative ones. Need to clean up PCBs as well.

* Combine the Public Advisory Committee and the Science and Technical Advisory Committee. The separation of committees delays action and intimidates the public into believing the issues are too complex and should be left to the experts.

Technical Detail

* Need to focus on all RAP issues, including toxics and Pollution Prevention.

* Loads of toxic contaminants from point sources cannot be "largely controlled" as stated in the plan because water toxic rules NR 105 and NR 106 specifically allow acutely and chronically toxic mixing zones downstream from discharge pipes.

Consistency with IJC guidelines for Stage II RAPs

Identification of the persons or agencies responsible for implementation.

* Responsibility of the communities, not just industry and government to help regarding the implementation of clean up projects.

* Require the community to get active in the RAP activities. They need to recognize and support other agencies and organizations that are working to benefit the community.

* Increased attention on community outreach programs to get, and keep the community involved in the cleaning up process. Need to take more real steps with the community.

* Need to improve the general awareness of the RAP process.

* RAP committees should have more public visibility. The committees need to play a larger role in the public eye, to get the RAP the attention that it needs and deserves.

* Political pressure needs to be placed on government officials for funding and support of the implementation processes.

* Communication with political representatives is essential. Politicians are aware of the RAP process, but are cautious to get involved until they find out what the public support is. We need to send letters and make telephone calls to let representatives know that communities are in support of the RAP process, the clean up projects that are ongoing, and the need for funding for these clean up projects.

* Push for support of the Great Lakes Water Quality Initiative. It has the potential to reduce as much as 80 percent of the toxic pollutants discharged into the Great Lakes. Round two will address the non-point source issues.

* One individual can have an effect on water quality. The Green Bay East River Water Quality Demonstration Project worked with 50 farmers in the East River Watershed to cut phosphorus fertilizer applications by about 80,000 pounds for the year. This not only reduced the amount of phosphorus in the water, but also cut the farmers expenses by 13 dollars per acre.

(Selection of additional remedial measures to restore beneficial uses and a schedule for their implementation)

* This is not truly **a Stage** II Update. It **doesn't have** enough of the information that a Stage II needs as far as who is going to do what and when are they going to do it.

* GBMSD recommends that the plan update include some statements about the ongoing Stage II development and the effort to fulfill the requirements of the IJC and EPA.

PART B: WRITTEN COMMENT AND RESPONSE

SOURCE	COMMENT	RESPONSE
Paul Baumgart, STAC member	Two Secchi disk depth objectives are reported in Table 8.	Pg. 86. The STAC decided to maintain two numbers, because each refers to restoration of a different impaired use. The 0.7 m minimum Secchi disk depth objective is necessary to increase rooted macrophyte production which in turn may help improve water clarity. The 1.4 m objective is desired to restore swimming.
	Refer to current navigational dredging as "substantially reduced" rather than "minimal".	Pg.26 Par 4. Change made
	NR 106 establishes procedures used to implement NR 105 which establishes WPDES permit limits for toxic substances.	Pg.29 Make reference to NR 106.
	Pulliam Power Plant is not the correct name for this facility.	Pg.36. Name will be listed as Wisconsin Public Service Corporations's J.P. Pulliam Power Plant in Green Bay.
	Net phosphorous loading estimates from point industrial sources should not be included in the RAP Update because they are is generally insufficient to reliably establish net loads. The STAC should revisit this issue prior to final plan publication.	The STAC decided to acknowledge that some industries remove phosphorous from influent, but have limited confidence in net load estimates.

SOURCE	COMMENT	RESPONSE
G. Knapp- Urban and Regional Planning. Univ. of IL and L. Smith, Social Change and Development, UW-Green Bay	Brown County has an unprecedented opportunity for 'converting knowledge reflected in the Remedial Action Plan into action, through integration with the Brown County Comprehensive Land Use Plan. Combining the regulatory powers of the WDNR and land use authority of Brown County to implement both the RAP and the Comprehensive Plan would set an example for other municipal and county governments and is imperative for successful implementation of RAP objectives.	Opportunities like this are precisely the means for achieving ecosystem improvements. WDNR representatives participate in the Comprehensive Land Use Plan(ning) currently underway. Public involvement to encourage integration of objectives is a good idea.
PEP Committee	The name "Remedial Action Plan" has no meaning to the general public. Forward a request to the IJC to rename the local effort the "Clean Bay Backer" Plan.	The idea of increasing educational effectiveness with a recognizable and friendly slogan is a sound marketing principle. The idea will be discussed with the RAP Public Advisory Committee and appropriate WDNR managers. Regardless of the name, agencies, businesses and individuals throughout the Fox Wolf Basin must be able to use the Plan as a basis for action to restore and protect the ecosystem.
USEPA Region V	Add SWIS to list of abbreviations used in plan	Added
	Add the Special Wetlands Inventory Study (SWIS) into discussion under "Relationship to Other Planning and Management Activities".	Added

SOURCE	COMMENT	RESPONSE
	Add reference to SWIS mapping of wetlands under low and high lake levels.	Pg.14, Par.1, Sentence 4: "The effect on wetland areas adjacent to Green Bay has been documented as part of the Special Wetlands Inventory Study".
	Reposition or remove reference to "atmospheric deposition (air pollution)" under discussion of Point Sources.	Pg. 39, Par.3, "Atmospheric..." removed.
	Clarify discussion of conventional pollutant loads from municipal and industrial point sources.	Pg.39, Par. 4 revised and Table 4 expanded to reflect all loads from the Fox-Wolf River Basin.
	List specific, numerical goals under "Expected Environmental Results" of the Clean Air Act Amendments.	Pg.60, Section D "Will depend on Federal rules..." will be changed to "WI has achieved some reductions in air toxics through existing programs. Other reductions are pending implementation of the CAA and outcome of EPA Great Waters Study. No specific numerical goals have been established for individual AOCs."
	State that the conclusion that Green Bay is a source of PCBs to the atmosphere is based on preliminary data.	Pg.60, Section D "Green Bay acts..." Statement will read Preliminary results of Mass Balance Study indicate, that Green Bay acts as a net source of PCBs to the atmosphere."
	Correct information regarding the SWIS	Pg.69, RAP rec. 6.2. The SWIS report is expected in July 1993, cost $180,000 and is "an informational tool for protection of critical wetlands and fluctuating coastal wetlands."

SOURCE	COMMENT	RESPONSE
	Add information to habitat table	Pg.87, Maintain.. wetlands. Comment column will read "May be refined based on further analysis of EPA SWIS Study which defined low water wetland aerial extent based on SCS photos from 1938-39. GIS mapping by Bay Lake Reg. Plng Commission used 1964 air photos for low water wetlands inventory (See Fig. 13). WDNR 1989 State Wetlands inventory was used for SWIS and RAP GIS mapping of high water conditions.
	Reword purpose of **Green Bay Mass Balance** Study	Pg.116. Reword to read " The Green Bay Mass Balance Study was initiated in 1989 1986 (per WDNR) to accurately model contaminant transport through multiple media using mass conservation principles. Essentially, a "mass balance" determines if the contaminants entering minus...equal quantities leaving".
	Note that the **SWIS maps are based on WDNR Wisconsin Wetland Inventory maps.**	Pg. 138. Noted. No change in report.
	Discuss interim conclusions of the **Green Bay Mass Balance modeling** work.	Pg. 126. The citizens' Science and Technical Advisory Committee and WDNR managers prefer to report "peer reviewed" results after release in October 1993. Modeling projections will be included in a "Contaminated Sediment Strategy for the Fox River and Green Bay" to be developed as part of the 1993-94 workplan.

SOURCE	COMMENT	RESPONSE
	Provide more guidance on approaches to selecting sediment clean up levels.	This type of information will be developed and presented during the 1993-94 workplan.
	Provide more detail on options considered during the Remedial Investigation/ Feasibility Study for Little Lake Butte des Morts.	Pg.128 Par.1. Last sentence will be reworded to read "At the time of this writing three options are under investigation: in-place armoring, construction of a confined disposal facility (CDF) over Deposit A with the capacity to receive contaminated sediment from other locations, and "dry excavation" of Deposit A. A cooperative schedule with P.H. Glatfelter to complete a FS has been implemented and a public informational meeting will be held in the Fall, 1993 to discuss these or other options."

SOURCE	COMMENT	RESPONSE
	Discuss pursuing Natural Resource Damage Assessments (NRDA) as a "tool for remediating habitat, as well as fisheries and wildlife populations."	NRDA's are a labor intensive monitoring and surveying method to calculate the dollar value of an injury to natural resources sustained by the discharge or release of a toxic or hazardous substance. The assessment calculates the lost value due to the release based on magnitude of the injury and perception of value to the public. The information can be used to obtain a damage award or settlement in which funds recovered are used to acquire equivalent lands, replace or restore the injured resources. At present, the WDNR has allocated resources to other types of monitoring to document the extent of impaired uses and improvements due to RAP implementation.
	Address disposal of dredge spoils in greater detail.	This issue will be addressed during implementation of the 1993-94 workplan.
	Address consistency between the RAP and appropriate Water Quality Management Plans and a schedule for revising WQMs.	We consider RAPs to be a supplement to the State Water Quality Management Plans and they will be submitted to EPA as such.
	Consider whether the RAP meets requirements of 40 CFR 130.7 and submit for approval as a Total Maximum Daily Load (TMDL) under 40 CFR 130.7 (d)	The RAP should not, at this time be viewed as a complete submittal in consideration of the requirements of 40 CFR 130.7. We will continue to evaluate the basin loading system as part of the RAP process and when appropriate submit it for federal review and approval.

SOURCE	COMMENT	RESPONSE
	Link each remedial action to the specific pollutant and load reduction necessary to achieve RAP goals.	Individual project scopes of work will incorporate this type of information as developed through the 1993-94 workplan.
	Assess the Lake Winnebago Comprehensive Management Plan as a TMDL.	The Lake Winnebago Comprehensive Management Plan does not satisfy all of the requirements of 40CFR 130.7 at this time.
	Correct the scientific name for osprey.	Pg.21 Use Pandion haliatus and correct typographical error "osprey mink".
	Augment the Update with critical path tables developed in 1988 and discuss how actions taken to date relate to original recommendations, how events and accruing knowledge may have modified the interdependence of the recommendations and the Key Actions since 1988 and the resulting impacts on future years' directions.	While we agree such a reporting would help to describe progress in the context of original recommendations, we elected to list as concisely as possible which recommendations had been addressed since 1988. The sixteen Key Actions and 120 recommendations of the RAP prioritized in unpublished tables continue to guide WDNR biennial workplans, RAP Coordinators' activities and implementation with advisory committee assistance. To accommodate future contextual progress reports we focused the 1993 Update around four issues in which simplified biennial workplans can be used to document project-result linkages.
WDNR-LMD	Add information on gulls and motorists.	Pg.37. Information will be added that gulls searching for food have been killed in traffic along East Shore drive.

SOURCE	COMMENT	RESPONSE
	Add information on creating a better nesting location to entice colonial nesting birds away from Renard Isle	Pg.21 Par. 1 Add second sentence "Attempting to nest in unsuitable locations such as the Renard Isle CDF has contributed to reduced survival of chicks of these endangered species."
Fort Howard Corporation	Under column entitled "Expected Environmental Result"for the Little Lake Butte des Morts project should contain reference to the possibility of capping the deposit or portion thereof as a remedial action alternative.	Pg. 57 Noted: Isolation included capping, removal, in place stabilization etc.
	Add reference and detail regarding the case study conducted by UWGB Institute for Land and Water Studies and the U.S. EPA.	Pg. 80 reference added to text.
	Reference to department's "planned revisions" to the classification of rivers, should be deleted. Document should only mention specific authorized department actions, or make recommendations with respect to other actions.	Pg. 96 Reference deleted
	Second sentence of the first entry in the "comment" column of Table 8 on page 86 regarding dissolved oxygen levels should be deleted.	Pg. 86 Table 8 first entry under "comment" column sentence "May need higher when fish spawn." will be deleted.
	All references to the Great Lakes Initiative including incorporation of the GLI water quality criteria should be deleted since this initiative is only proposed by US EPA at the time.	Pg 95, 103, etc. Committee voted to retain discussion of the Great Lakes Water Quality Initiative.