Sheboygan River Remedial Action Plan

A Plan to Clean Up Sheboygan Area Rivers and Harbor

October 1995

A Wisconsin Water Quality Management Program

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To the Reader

> "The Sheboygan River is one of the most beautiful rivers I have ever seen: water pure as crystal; a quick, sliding current; banks not deep but good water power at the falls,"
>
> *- Dr. Elisha Knowles in an 1845 letter to his wife, Olive, in Maine*
> *Courtesy of Roy Sebald (1992 pers. comm.)*

So impressed was Dr. Knowles with the Sheboygan River's "healthy soil, clear water and salubrious air," that he brought his family to the area and lived there for the rest of his life. We appreciate your interest in the quality of life in the Sheboygan River Basin. This Remedial Action Plan (RAP) for the Sheboygan River Area of Concern (AOC) describes what, why, and how area groups are working to improve that quality. This section is meant to help you understand and find your way around this report by briefly discussing these topics:

- Introduction
- Continuous Improvement
- Answering Your Questions
- Acknowledgements

Introduction

This report documents the progress made in RAP Stage 2 to recommend remedial actions. These actions, listed as RAP recommendations in Chapter 6, begin to address the RAP goals and objectives (Chapter 4) that were developed in Stage 1. It also describes strategies for implementing and evaluating these actions. Because this document lays the groundwork for remedial action, specifics about implementation are short term. Future remedial work will incorporate new technologies and knowledge from more intensive monitoring. Periodic progress reports will include details about this future work.

The RAP emphasizes an ecosystem approach to restoring polluted parts of Sheboygan River Basin waterways (all the water that eventually flows into the Sheboygan Harbor), because pollution sources are often located outside the polluted area. Participation at an individual level is key to RAP success. Public support is necessary to secure federal, state, and local funding; environmentally sound lifestyle choices are integral to lasting pollution prevention.

Continuous Improvement

Pollution sources will always exist. Therefore, the RAP must foster *continuous improvement.* As long as industries, residential development, and agriculture exist near Sheboygan River Basin waterways, the RAP must exist to identify and contain pollution from these sources.

Even after the RAP process is complete, the Wisconsin Department of Natural Resources (WDNR) has the obligation to protect and enhance the resources in the state. WDNR will continue with its mission:

> To protect and enhance our Natural Resources --
> our air, land and water;
> our wildlife, fish and forests.
>
> To provide a clean environment
> and a full range of outdoor opportunities.
>
> To insure the right of all Wisconsin citizens
> to use and enjoy these resources in
> their work and leisure.
>
> And in cooperation with all our citizens
> to consider the future
> and those who will follow us.

The work to restore the quality of the Sheboygan River Basin waterways is the immediate challenge ahead of us. To many people's credit, we have already made some progress. Once water quality is restored, RAP and WDNR efforts will continue in order to maintain this quality.

Answering Your Questions

As you read this plan, you may have general or specific questions. The table below and the table of contents on the next page are guides that may help you answer some of them.

Question	Refer to...
Where is a description of program "x"?	Index of Programs, Projects and Studies
What is a Remedial Action Plan (RAP)? Why is there a RAP?	Chapter 1: What is the RAP?
What is the extent of pollution in the Area of Concern (AOC)? Where is the AOC?	Chapter 2: Pollution in the Sheboygan River Basin
Where does the pollution come from?	Chapter 3: Sources of Pollution
What will we accomplish through the RAP?	Chapter 4: RAP Goals and Objectives
What RAP work is in progress?	Chapter 5: Reaching RAP Goals Through Existing Programs
What are the RAP's recommendations? Who developed them? How will they be implemented? funded?	Chapter 6: RAP Recommendations
How will someone evaluate RAP progress?	Chapter 7: Monitoring Strategy
How will the RAP implementation take place? How will groups avoid doubling efforts?	Chapter 8: Implementation Strategy
What do all these acronyms mean?!??	List of Acronyms

Acknowledgements

Many people have contributed information and comments in the development of the Sheboygan River Remedial Action Plan. Special thanks go to the Citizen's Advisory Committee and the staff of WDNR who were involved in the preparation and review of this document.

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List of Acronyms and Measurement Units

This section lists the acronyms that appear in this document and the words for which each stands. To find definitions of terms in this document, please see the Glossary on page GL-1.

Acronyms

208 PLANS	Areawide Water Quality Management Plans. Also known as Basin Plans.
A&M	Assessment and Monitoring (RAP recommendation)
ACP	Agricultural Conservation Program
AOC	Area of Concern
ARAR	Applicable and Relevant and Appropriate Requirement
ARCS	Assessment and Remediation of Contaminated Sediments (U.S. EPA Program)
BACT	Best Available Control Technology
BAT	Best Available Technology
BCT	Best Conventional Technology
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BPT	Best Practicable Technology
CAC	Citizen's Advisory Committee
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (a.k.a. Superfund)
COD	Chemical Oxygen Demand
CSO	Combined Sewer Overflow
DHSS	Department of Health and Social Services

DO	Dissolved Oxygen
DP	Demonstration Project (RAP recommendation)
EF	Enrichment Factors
FDA	Food and Drug Administration
FHA	Fish Health Assessment
FET	Federation of Environmental Technologists
GIS	Geographic Information System, an electronic mapping system
GLAD	Great Lakes Atmospheric Deposition database
GLFC	Great Lakes Fishery Commission
GLNPO	Great Lakes National Program Office (U.S. EPA)
HEC	Health Education Center of Wisconsin
I&E	Information and Education (RAP Recommendation)
IJC	International Joint Commission
LCC	Land Conservation Committee (of the county board)
LC_{50}	Concentration of a toxic substance in water which is lethal to 50% of the test population exposed to the toxic substance. *See Bioassay.*
LD_{50}	The dose (amount actually ingested by an organism) of a toxic substance which is lethal to 50% of the test population.
LMF	Lake Michigan Federation
LUST	Leaking Underground Storage Tanks
NH_3	Unionized ammonia
NH_3-N	Ammonia-Nitrogen
NH_4	Ammonium or ionized ammonia
NOAA	National Oceanic and Atmospheric Administration

NO_2	Nitrite
NO_3	Nitrate
NPDES	National Pollution Discharge Elimination System. Requires permits for wastewater discharges.
NPS	Nonpoint Source Pollution
NRCS	Natural Resource Conservation Service. Formerly known as the Soil Conservation Service.
O&G	Oil and Grease
O & M	Operation and Maintenance
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
POTW	Publicly Owned Treatment Works
PPM	Parts Per Million; a unit of measure for concentration.
PSA	Public Service Announcement
PRP	Potentially Responsible Party
QA/QC	Quality Assurance/Quality Control
RAP	Remedial Action Plan
RIC	RAP Implementation Committee
RI/FS	Remedial Investigation/Feasibility Study
RPC	Regional Planning Commission
RCRA	Resource Conservation and Recovery Act of 1976
SCWQTF	Sheboygan County Water Quality Task Force
SHWEC	UWEX Solid and Hazardous Waste Education Center
SIC	Standard Industrial Classification code

SMART	Sediment Management And Remediation Techniques (a program through the WDNR Bureau of Water Resources Management)
SO_2	Sulphur Dioxide
SOD	Sediment Oxygen Demand
SPMD	Semi-Permeable Membrane Device
SS	Suspended Solids
SSO	Sanitary Sewer Overflow
TAC	Technical Advisory Committee
TBD	To Be Determined
TKN	Total Kjeldahl Nitrogen: a measure of organic nitrogen
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TSCA	Toxic Substances Control Act, a federal law
TVS	Total Volatile Solids
U.S. ACOE	United States Army Corps of Engineers
U.S. EPA	U.S. Environmental Protection Agency
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service, U.S. Department of Interior.
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation. Used to determine the amount of sediment carried in runoff.
UWEX	University of Wisconsin-Extension
UWGB	University of Wisconsin - Green Bay
VOC	Volatile Organic Compound

WDATCP	Wisconsin Department of Agriculture, Trade and Consumer Protection
WDHSS	Wisconsin Department of Health and Social Services
WDILHR	Wisconsin Department of Industry, Labor and Human Relations
WDNR	Wisconsin Department of Natural Resources
WDOA	Wisconsin Department of Administration
WDOD	Wisconsin Department of Development
WDOT	Wisconsin Department of Transportation
WGNHS	Wisconsin Geologic and Natural History Survey
WLA	Waste Load Allocation
WPDES	Wisconsin Pollution Discharge Elimination System
WSLH	Wisconsin State Laboratory of Hygiene
WWTP	Wastewater Treatment Plant

Measurement Units

cfs	Cubic Feet Per Second, a measure of flow in streams
mgd	Million of Gallons Per Day; a measurement of water flow from wastewater treatment plants. 1 MGD = 1.55 cfs.
mg/L	Milligrams Per Liter; a unit of measure of concentration generally equivalent to parts per million.
ng/L	Nanograms Per Liter; a unit of measure for concentration generally equivalent to parts per trillion (ppt).
ppb	part per billion
ppm	part per million
ppt	part per trillion
mg/Kg	milligram per kilogram (equivalent to ppm)
µg/Kg	microgram per kilogram (equivalent to ppb)
ng/Kg	nanogram per kilogram (equivalent to ppt)
µg/L	microgram per liter (equivalent to ppb)

CHAPTER 1: What is the RAP?

This chapter defines the Remedial Action Plan (RAP) for the Sheboygan River Area of Concern (AOC). The Sheboygan River AOC is the part of the Sheboygan River Basin that is most polluted. The Sheboygan River Basin waterways include all waters that eventually flow into the Sheboygan River AOC. *For specific information about the Sheboygan River Basin and the boundaries of the Sheboygan River AOC, see a description of the Surface Waters on page 2-2.*

The first section of this chapter describes the history of the Sheboygan River Basin, detailing events and practices that contributed to its degradation and public concern for water quality. It then describes the purpose of the Remedial Action Plan (RAP), which the Wisconsin Department of Natural Resources (WDNR) and its stakeholders will implement to restore water quality. This second section details the legislation and requirements driving the RAP and describes its ecosystem approach, stages (or milestones), and documentation. Finally, there is a description of RAP progress to date. This chapter contains three sections:

- Sheboygan River Basin History
- RAP Purpose
- RAP Progress

Sheboygan River Basin History

This Sheboygan River Basin history describes the topics below. To see a historical record of management actions in the Sheboygan River Basin, see the table on page 1-4.

- Native American Inhabitants
- Settlers Arrive
- Harbor Construction and Dredging
- Today

Native American Inhabitants

The Native Americans living in the Sheboygan River Basin in the 17th century were comprised of small groups of Potawatomies, Chippewas, Ottowas, Winnebago, and Menominee. They settled many of their villages where streams discharged into lakes or near waterfalls. The mouths of the Sheboygan and Pigeon rivers were two such locations (Buchen, 1944).

Birch bark canoes were the chief means of conveyance for these original inhabitants of the Sheboygan River Basin. One version of the origin of the name *Sheboygan* is that the Native Americans applied it to the river, and that it means "a waterway or passage between lakes."

The shore of Lake Michigan supplied the Native Americans with whitefish that spawned in the shallow water near the shore each spring. Whole villages migrated in early spring from as far away as the Mississippi River to collect their season's supply of fish. As late as 1860, settlers observed this temporary, annual increase in Indian population. Isaac Ernisse, an old settler and fisherman, told Dr. Gerend that from 1850 to 1860, several hundred Chippewa came each spring and camped a mile west of the lake shore through August to fish the waters with their arrows (Buchen, 1944).

White explorers arrived in Wisconsin around 1630. Those that encountered the Sheboygan River Basin saw a dense virgin forest of pine and hardwoods. White settlers coveted the rich furs the country offered and the Native Americans desired goods of civilized manufacture; a system of bartering naturally developed. The first fur-trading post was established in Sheboygan County in 1795.

The fur trade and American settlement of the 17th and 18th centuries were responsible for greater changes in Indian life in the Sheboygan River Basin than those that had taken place over the preceding twelve thousand years (Mason, 1988).

Settlers Arrive
Information about settlers in the Sheboygan River Basin was provided in part by Roy Sebald.

In 1836, the Federal government took possession of the land in the Sheboygan River Basin, and the first permanent settlements were established. The first settlers were Yankees, descendants of Englishmen from the eastern states. Germans, Hollanders, and Irish followed in the 1840s.

Native Americans shared with the settlers methods to clear land with controlled fires, plant and cultivate crops, tap for maple sap and boil it down to sugar, and care for livestock. The area quickly became predominantly agricultural. Lumbering and fishing were the first two area industries.

Early settlers' letters to New England describing this "El Dorado of the West" soon encouraged others to join them. By the mid 1840s, land was in such high demand that land-hungry home seekers occupied or "squatted" on unappropriated tracts, expecting that congress would grant them the first right to buy.

"The Sheboygan River is one of the most beautiful rivers I have ever seen: water pure as crystal; a quick, sliding current; banks not deep but good water power at the falls," wrote Dr. Elisha Knowles in an 1845 letter to his wife, Olive, in Harmony, Maine. So impressed was Knowles with the "very healthy soil, clear water and salubrious air," that he brought his family to the area and lived there for the rest of his life.

Between 1845 and the beginning of the Civil War, Sheboygan welcomed thousands of foreign immigrants. In 1847, news of the tragedy on the *Phoenix* passenger ship shocked the world. The ship was en route from Buffalo to Chicago when it caught fire just before it reached Sheboygan. Most who lost their lives were immigrants from Holland nearing the end of a long journey to meet relatives and friends (Buchen, 1944).

As the population of the area increased, farms continued to dominate land uses. By the 1850s, there were eight lumbering mills on one stretch of the river near what is now Sheboygan Falls. Fish were among the first commercial products shipped from the area in the late 1800s. As early as 1845, four extensive fisheries were in operation at Sheboygan and vicinity. Sheboygan boasted a port that competed with Green Bay's as well as Milwaukee's. The harbor's activity reached its height in the 1870s. As railroads, with their all-year service, began to multiply in the late 1800s, Sheboygan's prominence as a shipping center began to dwindle.

The late 1800s saw the growth of the dairy and cheese industries and the birth of the furniture industry (Hildebrand, 1988). Sawmills on the rivers and the abundance of cut timber made for plentiful, cheap lumber to fuel the furniture industry; Sheboygan was soon referred to as "chair city."

Through two world wars and the depression, the municipalities on the Sheboygan River Basin grew and prospered. Industries like Borden, Johnsonville, Kohler and Mayline established themselves along the rivers as integral parts of municipalities. To accommodate growth, municipalities created wastewater treatment plants and implemented harbor construction and dredging projects.

Harbor Construction and Dredging

The first harbor improvements, constructed in 1852, consisted of parallel piers at the mouth of the Sheboygan River. The existing Federal navigation project at Sheboygan was authorized by the Rivers and Harbors Acts of 1866, 1907, 1927, 1954 and subsequent acts (U.S. ACOE, 1979). The first dredging occurred in 1867, providing a channel with a project depth of 12 feet and length of 320 feet. Minor construction and dredging continued through the 19th century.

The south pier saw completion in 1904. Construction of the north breakwater commenced in October 1913 and was completed in October 1931. Dredging of the existing turning basin was completed in 1931. Dredging of the entrance channel to current project depth was completed in July 1938. Present navigational features were completed in 1956. The Sheboygan harbor from Lake Michigan to Eighth Street, was dredged to project navigation depths (25 and 21 feet) by the U.S. Army Corps of Engineers between 1956 and 1969. In 1969, dredging was prohibited by the U.S. EPA and WDNR because of polluted sediment. There has been no dredging of the harbor, excluding the mouth, and no open water disposal of contaminated sediment since then.

In 1981, about 28,000 cubic yards of lake sand was removed from the harbor mouth and was used as fill for the industrial park in the City of Sheboygan. In 1984, about 26,600 cubic yards of lake sand was removed from the mouth and transported to the docks of The C. Reiss Coal Co. In 1985 and 1987, approximately 12,000 and 24,000 cubic yards of lake sand, respectively, were removed from the harbor mouth and used for beach nourishment south of the harbor (U.S. ACOE, 1987). Harbor mouth dredging was contracted for 1988, but was suspended because of lack of material. The last dredging operation by the U.S. ACOE was completed in 1991, where approximately 46,000 cubic yards of lake sand was removed from the harbor mouth and deposited for a beach nourishment project south of the harbor (Peterson, 1993). These dredging operations were conducted with WDNR approval.

A historical record of management actions in the Sheboygan River Basin, is listed on page 1-4.

Today

The population of the Sheboygan River Basin is approximately 118,000 people. The majority of people (about 81 percent) reside in incorporated areas, with most concentrated in the cities of Sheboygan, Sheboygan Falls, Kiel, and the Village of Kohler (WDNR, 1993). Population in the area continues to rise rapidly, and is expected to increase by approximately three percent per year over the next 20 years (Kaiser, 1989).

Today industrial, agricultural, and residential areas line the rivers of the Sheboygan River Basin. Agriculture is the dominant land use of the area, totaling 67 percent (WDNR, 1993).

Lake Michigan remains the open door to the basin, accommodating charter, sailing, fishing, and pleasure boats. Lakefront and harbor development has brought new life to the riverfront and harbor (Hildebrand, 1988). Businesses have taken over the fishing shanties from days gone by; several taverns, restaurants and gift shops are housed in replicas of early shanties along the banks of the harbor. The attraction for new business in Sheboygan is enhanced by Rotary Riverview Park. Located along the north bank of the Sheboygan River near Lake Michigan, the park consists of shelters near the river and terraced walkways leading to the water's edge as well as a boardwalk with slips for docking.

Table 1.1: Historical Record of Management Actions in the Sheboygan River Basin.

Date	Action	Impaired Use(s) Affecting
1956-1969	Sheboygan Harbor Navigational Dredging by the U.S. Army Corps of Engineers	Dredging Restrictions
1969	Dredging of Sheboygan Harbor halted due to U.S. EPA and WDNR's decision that prohibiting open water disposal of dredged material	Dredging Restrictions
1977	Federal ban on PCBs.	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities
1978	City of Sheboygan wastewater treatment plant upgraded, providing service for Kohler, Sheboygan Falls, and Sheboygan.	Fish and wildlife: -habitat degradation Recreational uses Eutrophication
1978	Fish consumption advisory established for AOC.	Fish and Wildlife: -consumption advisories -population declines Recreational use

Date	Action	Impaired Use(s) Affecting
1979	Tecumseh dike evacuated and replaced.	Fish and wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat
1980	Onion River watershed designated as a Priority Watershed by Wisconsin's Nonpoint Source Water Pollution Abatement Program.	Fish and Wildlife: -population declines -habitat degradation; Recreational use Eutrophication
1983	Kohler Company Landfill proposed to the U.S. EPA National Priorities List	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities
1984	Sheboygan River Water Quality Task Force formed.	all use impairments
1984	The Kohler Co. Landfill designated as a Federal Superfund site; consent order signed by Kohler Co.	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities
1985	Sheboygan River and Harbor proposed to the U.S. EPA National Priorities List	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat Recreational use Dredging Restrictions
1985	WDNR commits to develop a Remedial Action Plan (RAP) for the Sheboygan River AOC.	all use impairments
1985	Sheboygan River Watershed designated as a priority watershed under Wisconsin's Nonpoint Source Water Pollution Abatement Program.	Fish and Wildlife: -population declines -tumors and deformities Recreational use Eutrophication

Date	Action	Impaired Use(s) Affecting
1986	Sheboygan River and Harbor designated as a federal Superfund site. Three potentially responsible parties (PRPs) identified - Tecumseh Products Co., Kohler Co., and Thomas Industries. Consent order signed by Tecumseh Products Co.	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat Recreational use Dredging Restrictions
1986-1988	▪ Tecumseh Products Company agrees to undertake the Remedial Investigation/Feasibility Study ▪ Draft Remedial Investigation/Enhanced Screening Report Completed ▪ Most significant areas of PCB contamination identified in the upper Sheboygan River sediments ▪ Plan expeditiously developed to address removal of these PCB-contaminated sediment deposits	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat Recreational use Dredging Restrictions
1987	WDNR ceases fish stocking on the Sheboygan River because of high levels of PCBs found in river sediment, and fish tissue.	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities Recreational use
1987	Waterfowl consumption advisory established for AOC.	Wildlife: -consumption advisory -population declines Recreational use
1987	Sheboygan Harbor proposed for U.S. EPA's In-place Pollution Demonstration Project (ARCS Program).	Fish and Wildlife: -consumption advisories -population declines Recreational use Dredging restrictions
1989	U.S. ACOE proposed a limited dredge project to remove contaminated sediment; the report identifies 19 disposal sites within a ten mile radius of the harbor.	Fish and Wildlife: -consumption advisories Recreational use Dredging restrictions

Date	Action	Impaired Use(s) Affecting
01/89 to 06/89	▪ Tecumseh agrees to remove PCB contaminated sediments from the upper Sheboygan River ▪ Tecumseh begins construction of containment structure in which to safely store the sediments and conduct a treatability study of biodegradation ▪ Additional detailed sediment characterization of the upper river also completed; additional sediment deposits designated for removal	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat Recreational use Dredging Restrictions
11/89	Construction of containment structure and other activities completed; dredging operations begin to remove the PCB-contaminated sediments	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat Recreational use Dredging Restrictions
12/89 to 03/90	Winter shutdown due to adverse winter conditions	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat Recreational use Dredging Restrictions
03/90 to 09/90	▪ Dredging of PCB-contaminated sediments from uppermost reach of river completed; additional lesser-contaminated sediments were armored (capped) ▪ Several studies initiated including treatment technologies and transport modeling ▪ Determination made to remove additional highly contaminated sediment deposits from the next segment of the upper Sheboygan River	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat Recreational use Dredging Restrictions

Date	Action	Impaired Use(s) Affecting
08/90	Tecumseh agrees to remove these additional PCB-contaminated sediment deposits under a Removal Action, and store them temporarily in a tank to be built on its property until its ultimate deposition is determined in the final Record of Decision.	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat Recreational use Dredging Restrictions
1990	WDNR initiates an experimental fish stocking study for coho and steelhead salmon on the Sheboygan River.	Restrictions on Fish and Wildlife Consumption
1990	Diecast Corporation identified as potentially responsible party for Sheboygan River and Harbor Superfund site.	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat Recreational use Dredging Restrictions
Fall-Winter 1990/91	Design of the removal action is completed	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat Recreational use Dredging Restrictions
03/91 to 06/91	▪ Tank constructed and other activities completed to implement the action ▪ Sediment dredging initiated	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat Recreational use Dredging Restrictions
11/91	Removal Action completed	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat Recreational use Dredging Restrictions

Date	Action	Impaired Use(s) Affecting
03/93	Record of Decision for Kohler Landfill closure issued for source control operable unit (see page 3-15 for detailed information).	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat Recreational use Dredging Restrictions
04/93	Sheboygan County completes its first agricultural and household hazardous waste county-wide clean sweep	Fish and Wildlife: -consumption advisories -population declines -tumors and deformities -loss of habitat Recreational use Dredging Restrictions
10/93	Construction of Sheboygan Harbor Marina Complete	Degraded Aesthetics Recreational use
1995	WDNR completes experimental stocking study. Steelhead, coho and chinook salmon will be stocked in spring only. See completed report in Appendix H.	Fish and Wildlife: -consumption advisories Recreational use

RAP Purpose

A Remedial Action Plan (RAP) is being developed for each of the 43 Areas of Concern in the Great Lakes Basin, (?). Each area is degraded to the point that beneficial uses of the local waterways are impaired.

The RAP process begins with problem definition and continues until each impaired beneficial use is restored. A list of impaired uses is shown in Table 2.5 on page 2-12. In order to be lasting and effective, the RAP must be a program of continuous improvement, re-evaluating its course as new scientific information and technology becomes available. The WDNR has primary responsibility for developing the Sheboygan River Remedial Action Plan, with active participation by stakeholders.

The first subsection below describes the legislation and the legislative bodies, the U.S. EPA and IJC, driving the RAP program. The second subsection lists the IJC-defined RAP requirements. Next, the ecosystem approach emphasized in RAP work is described. Also described are the RAP stages and the role of RAP documentation.

- Legislation
- Requirements List
- Ecosystem Approach
- RAP Stages
- RAP Documentation

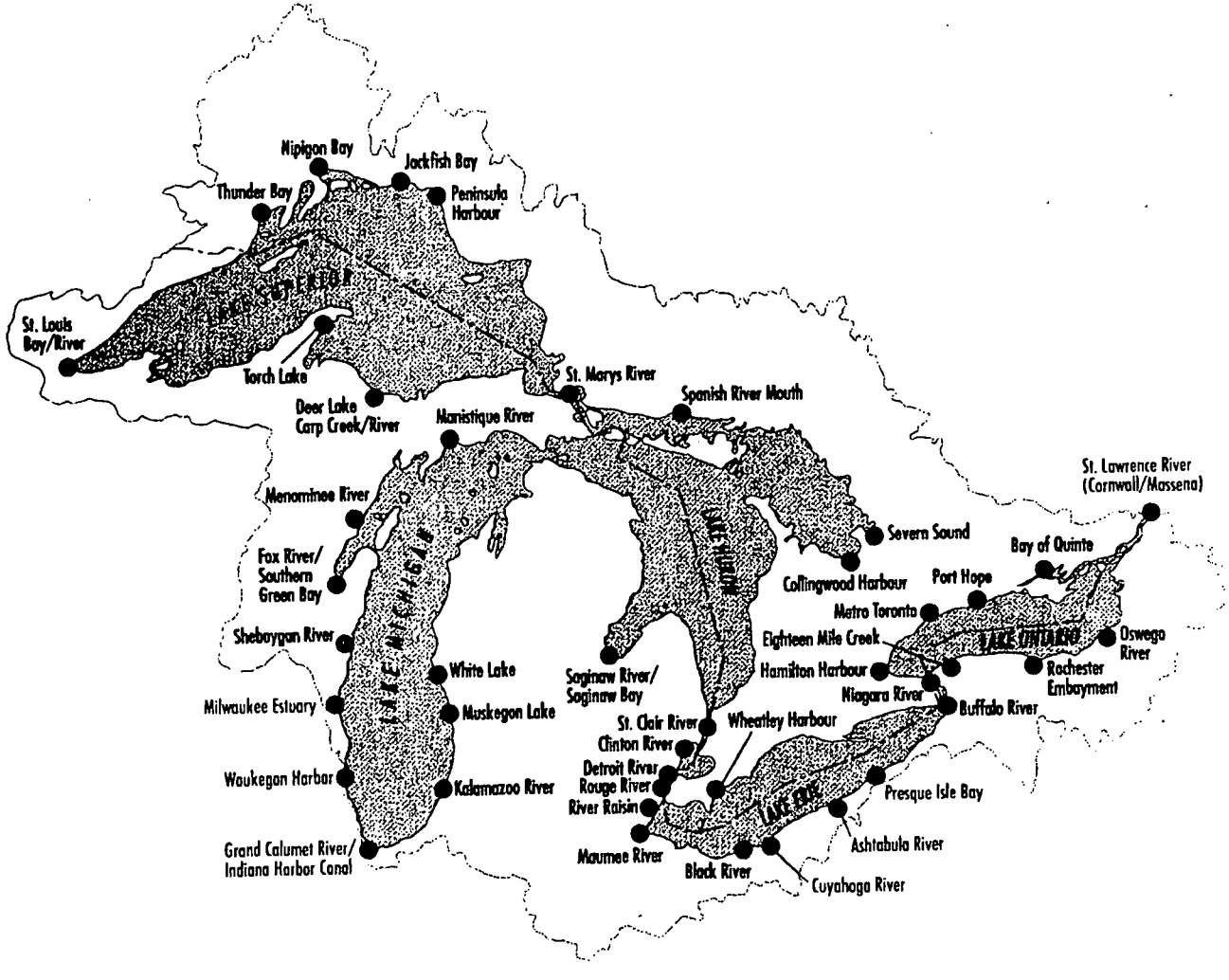


Figure 1.1: The 43 Great Lakes Areas of Concern; each is degraded to the point that beneficial uses are impaired (Water Environment Technology, June 1993).

Legislation

The United States and Canada signed the Great Lakes Water Quality Agreement in 1972. Amended in 1978 and 1987, the Agreement identifies specific goals and remedial objectives for improving water quality. A major focus is the clean-up of toxic "hot spots" or Areas of Concern (AOCs) in ports, harbors, and river mouths that empty into the Great Lakes. Forty-three AOCs, which are shown in Figure 1.1 on page 1-11, have been identified in the Great Lakes Basin by the International Joint Commission (IJC). The IJC advises Canada and the U.S. in resolving issues of water quality and quantity, pollution problems and border disputes in the Great Lakes. In addition to restoring these AOCs, the states and provinces, local governments and citizens living in these areas can insure that the cumulative effects of their actions will improve water quality throughout the Great Lakes region.

The IJC, United States Environmental Protection Agency (U.S. EPA), and the Wisconsin Department of Natural Resources (WDNR), have targeted the Sheboygan River AOC as one of the forty-three AOCs requiring remedial action. The work done in the Sheboygan River Basin is part of Wisconsin's area-wide water quality management plans which the WDNR prepares for the U.S. EPA under Section 208 of the Clean Water Act. The IJC developed the RAP program to address the remedial objectives of the Great Lakes Water Quality Agreement. These remedial objectives are embodied in the IJC RAP requirements, which are listed in Table 1.2 on page 1-13.

Requirements List

The RAP process for restoring beneficial uses of waterways in Areas of Concern involves meeting the requirements listed in the table below. The table lists the progress to date in the Sheboygan River on each requirement.

Table 1.2: RAP Requirements from the IJC and Progress Made in the Sheboygan River AOC.

RAP Step		Progress
1)	Quantitatively define the area's environmental problems, including the geographic extent of the area affected.	See Chapter 2, Pollution in the Sheboygan River Basin.*
2)	Identify which beneficial uses are impaired.	See page 2-12.
3)	Describe the causes of the problems and identify all known sources of pollution.	See Chapter 3, Sources of Pollution.*
4)	Identify remedial actions to restore impaired uses.	See Chapter 6, RAP Recommendations.
5)	Identify a schedule for implementing remedial actions.	RAP Recommendations listed in Chapter 6 will see implementation in the next 2-5 years. Also see Chapter 5, Reaching RAP Goals Through Existing Programs.
6)	Identify jurisdictions and agencies responsible for implementing and regulating remedial measures.	See description of RAP Implementation on page 8-1 and 8-2 . Also see "Leaders" listed in each RAP recommendation in Chapter 6.
7)	Describe the process for evaluating remedial program implementation and regulating remedial actions.	Described in Chapter 7, Monitoring Strategy.
8)	Describe the surveillance and monitoring activities that will be used to track program effectiveness and eventual confirmation that beneficial waterway uses have been restored.	Described in Chapter 7, Monitoring Strategy.

* Further monitoring, described in Chapter 7, Monitoring Strategy, will help to further quantify these items.

Ecosystem Approach

Each AOC is regarded as an ecosystem comprised of land, air, water, and all living things (including humans) to emphasize the interrelationships among these components. Incorporating this ecosystem approach means viewing organizations, government agencies, and stakeholders as equal members in a partnership to identify and solve environmental problems. Stakeholders are people who represent any public or private group that makes use of, has an impact on, or is affected by the Area of Concern. Sheboygan River AOC RAP solutions will reflect how all citizens, businesses, industries, and governments view the Sheboygan River AOC and its potential to be a centerpiece of an environmentally sustainable community.

RAP Stages

There are three RAP stages, listed below. Once restoration is well underway, plans for maintenance and protection of beneficial waterway uses must be considered.

Stage 1: Develop Goals and Objectives. (Initiated in 1987; completed in 1989)

Stage 2: Recommend and Implement Remedial Actions. (Initiated in 1990)

Stage 3: Evaluate Remedial Actions. (Initiated 1992)

These RAP stages provide milestones to facilitate the two-track process to implement RAPs. In the RAP Program document (IJC, 1991a), the IJC states

> "The Water Quality Board has recognized that implementing RAPs and restoring beneficial uses is a two-track process: 1) existing programs must be expedited and accelerated; and 2) the schedule of steps must be identified ... to determine actions beyond existing programs that are needed... Because this is a long term, iterative process, it is essential that a schedule of key action steps or *'milestones' be identified to measure progress in RAPS.*"

Developing a timeline for RAP activities is a difficult, if not impossible task. The implementation of the different projects and programs recommended in the RAP is dependent on the availability of funding. As noted above, the development of the goals and objectives got underway in 1987 and was completed in 1989. Since that time, various remedial actions have been recommended and some implemented. This document represents those developments. Stage 3 has also been in progress during the last few years, as already implemented projects are evaluated. Stage 3 will continue into the future long after all recommendations have been implemented.

RAP Documentation

RAP documents reflect progress made on RAP work. After the initial Stage II document is completed, subsequent RAP reports will be published regularly. These reports may be 1-2 year updates, individual project reports, and/or five year updates which follow Wisconsin river basin planning schedules.

RAP documents fulfill the reporting requirements of the 1990 Great Lakes Critical Programs Act, which states

> "'Remedial Action Plan' means a written document which embodies a systematic and comprehensive ecosystem approach to restoring and protecting the beneficial uses of areas in concern, in accordance with ... the Great Lakes Water Quality Agreement."

By following these guidelines, RAP documents will promote the efficiency, effectiveness, and endurance of RAP work. RAP documents also fulfill the IJC requirement that the WDNR provide a historical record of each step and consult the public throughout the plan.

RAP Progress

This section describes the purpose, development, and any results of each stage of the Sheboygan River RAP. For a list of specific IJC-defined RAP requirements and the progress on each, see Table 1.2 on page 1-13.

Stage 1: Develop Goals and Objectives

The purpose of Stage 1 is to define the problems of the Sheboygan River AOC and the sources of these problems in order to develop goals and objectives for the RAP.

Development

The goals and objectives for the Sheboygan River AOC were established based on the Clean Water Act and the Great Lakes Water Quality Agreement, state and federal water quality standards and the concerns of the public.

The Sheboygan County Water Quality Task Force (SCWQTF) served as the Citizen's Advisory Committee (CAC) for the development of Stage 1. The SCWQTF has been an information and education liaison between the public and environmental agencies since 1985. The SCWQTF is composed of representatives from local government, business, industry, environmental and citizen groups and other key constituencies.

An interagency Technical Advisory Committee (TAC) was utilized for review purposes. Members included representatives from Coastal Zone Management, the Department of Health and Social Services, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers and U.S. Environmental Protection Agency.

In the RAP planning process, public awareness was generated through several activities. A questionnaire was developed and distributed to solicit public involvement. This survey was developed by the SCWQTF and was also used in the development of the goals and objectives. Three public information meetings were conducted for the purpose of explaining the draft and obtaining input from citizens. A public hearing was conducted by WDNR in April of 1989 to review the final plan.

The Stage 1 RAP was reviewed by the IJC. The WDNR responded to the IJC review comments and the IJC officially accepted the plan as a Stage 1 document in 1990.

Results
The Stage 1 document contains these items:

1) A definition and detailed description of the environmental problems of the AOC, including the beneficial uses of the waterways that are impaired, the degree of impairment, and the geographical extent of the impairment.

2) A definition of the causes of the waterway use impairments, including a description of all known and potential sources of pollution.

3) Goals and objectives to remediate the Sheboygan River AOC and maintain its water quality.

Stage 2: Recommend and Implement Remedial Actions

The IJC requires that these components be included in Stage 2.

1) An evaluation of remedial measures in place.

2) An evaluation of alternative additional measures to restore beneficial uses.

3) A selection of additional remedial measures to restore beneficial uses and a schedule for their implementation.

4) An identification of the persons or agencies responsible for implementation of remedial measures.

Development
The SCWQTF served as the nucleus of a new and expanded CAC. Additional members were added to broaden citizen and organizational involvement in the development of Stage 2.

The CAC was divided into three work groups for addressing water quality, habitat and biota, and education. The work groups began the process of preparing recommendations by developing and evaluating a wide variety of alternative recommendations.

The CAC reviewed the selected recommended actions before they were included in this document. Citizens were invited to review and comment on draft recommendations at a public meeting in May 1994. Comments for this review were considered in preparation of this document.

Results
The Stage 2 document contains the following:

1) Updated information describing the environmental problems of the AOC, the use impairments and known and potential sources of pollution

2) Remedial measures already in place are included with a description of all known existing programs and activities that address many of the RAP goals and objectives

3) Specific recommendations for implementing projects and remedial measures to restore beneficial uses within the next two to five years

4) A comprehensive surveillance and monitoring strategy

5) A strategy for effectively implementing RAP recommendations by evaluating additional remedial actions and identifying persons and agencies responsible for the implementation

Stage 3: Evaluate Remedial Actions

In Stage 3, a RAP implementation committee will facilitate implementation and evaluation of remedial actions defined in Stage 2. Because evaluation involves comparing the effect of remediation to the pre-treated situation, Stage 3 work began at about the same time as Stage 2 in the form of monitoring.

Development
Forthcoming

Results
Forthcoming

CHAPTER 2: Pollution in the Sheboygan River Basin

The purpose of this chapter is to describe the characteristics of the Sheboygan River Area of Concern (AOC) in relation to its environmental setting, land use and the existing quality of water, sediment, aquatic organisms and wildlife. Emphasis is on problems in and near the AOC, however this chapter also identifies pollution problems in the upstream portions of the Sheboygan River Basin contributing to the existing conditions in the AOC.

Pollution is measured according to the IJC-developed criteria of impaired uses of waterways, listed on page 2-12. The following Sheboygan River AOC characteristics and impaired beneficial waterway uses are covered in this chapter.

- Pollutants of Concern
- Environmental Setting
- Water Uses
- Surface Water Quality Standards
- Impaired Uses in the AOC
- Unimpaired Uses of AOC Waterways

Pollutants of Concern

Following are the conventional and toxic pollutants known as "pollutants of concern" in the Sheboygan River Basin. The pollutants of concern were identified during preparation of the Stage I RAP (WDNR, 1989). Historical and recent data from monitoring and various studies have documented that these are the pollutants that most significantly affect the water quality of the AOC.

Conventional Pollutants

- Suspended solids
- Fecal coliform
- Phosphorus
- Nitrogen

Toxic Pollutants

- PCBs (polychlorinated biphenyls)
- Heavy metals: arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc
- PAHs (polycyclic aromatic hydrocarbons)

Environmental Setting

This section describes these Sheboygan River AOC environmental setting characteristics:

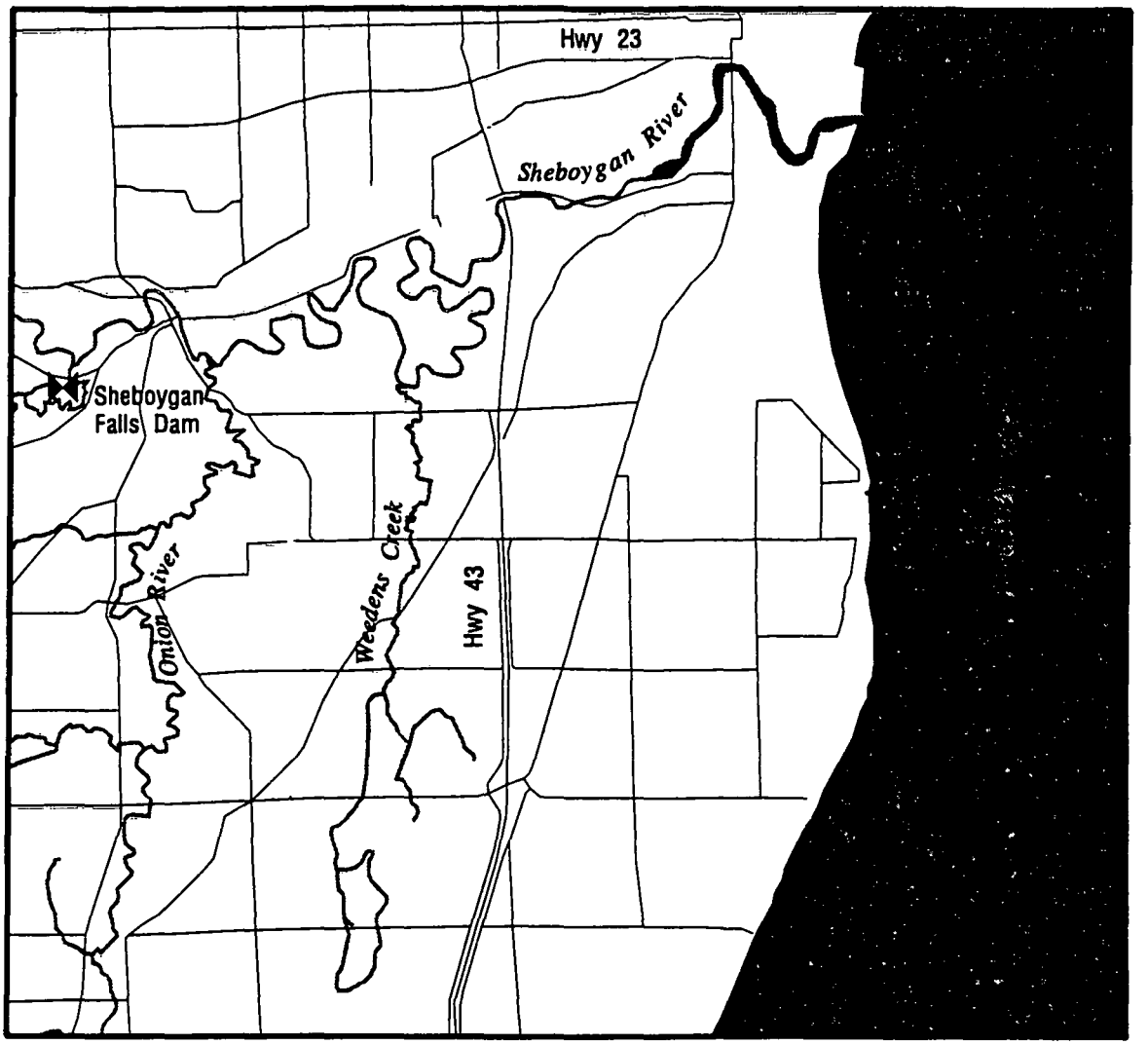
- Surface Waters
- Land Uses
- Climate and Topography
- Endangered and Threatened Species

Surface Waters

The Sheboygan River Area of Concern (AOC) encompasses the lower Sheboygan River downstream from the Sheboygan Falls Dam including the entire harbor and nearshore Lake Michigan. The AOC, shown in Figure 2.1 on page 2-3, serves as a sink for pollutants carried from three watersheds: the Sheboygan River, Mullet River and Onion River. The table below lists the towns, cities, and villages in each watershed.

Table 2.1: Cities, towns, and villages in each watershed of the Sheboygan River Basin.

Watershed	Cities (C), Towns (T), and Villages (V)	
Sheboygan River Watershed	Calvary (V) Dotyville (T) Elkhart Lake (V) Kiel (V) Kohler (V) Malone (T) Mt. Calvary (V)	Rockville (T) Sheboygan (C) Sheboygan Falls (C) St. Anna (T) St. Cloud (V) St. Peter (T)
Onion River Watershed	Cedar Grove (V) Gibbsville (T) Hingham (T) Oostburg (V) Waldo (V)	
Mullet River Watershed	Plymouth (C) Greenbush (V) Glenbulah (V)	



Wisconsin Department of Natural Resources
Bureau of Water Resources Management

Figure 2.1 Sheyboygan River Area of Concern

The entire Sheboygan River Basin with its watersheds is shown in Figure 2.2 on page 2-5. The Pigeon River, Black River, and Sauk-Sucker Creek Watersheds flow directly into Lake Michigan. The Onion and Mullet Rivers discharge to the Sheboygan River 13 and 17 miles upstream from its mouth, respectively. The total drainage area of these three watersheds is about 280 square miles. Appendix A lists the potential and existing biological uses of the streams in the Sheboygan River Basin. The table below lists stream miles, drainage area, tributaries, and other features of each watershed.

Table 2.2: Stream Miles, Drainage Area, and Features of Each Sheboygan River Basin Watershed.

Parameter	Sheboygan R. Watershed	Mullet R. Watershed	Onion R. Watershed
Mainstem Stream (miles)	173	79	62
Drainage Area (mi^2)	104.8	98	78
Tributaries	- Feldner's Creek - Gooseville Creek - Millhome Creek - Otter Creek - Schuett Creek - 23 unnamed creeks	- Belgium Creek - Mill Creek - 6 unnamed creeks	- Jackson - LaBudde - 6 unnamed creeks
Other Features	- 72 unnamed ditches - Elkhart Lake - Little Elkhart Lake - Cedar Lake - Wolf Lake - Wilke Lake - Sheboygan Marsh (14,000 acres)		- Crystal Lake - Mullet Lake - Little Elkhart Lake

The Sheboygan River Basin

-Geographical Features-

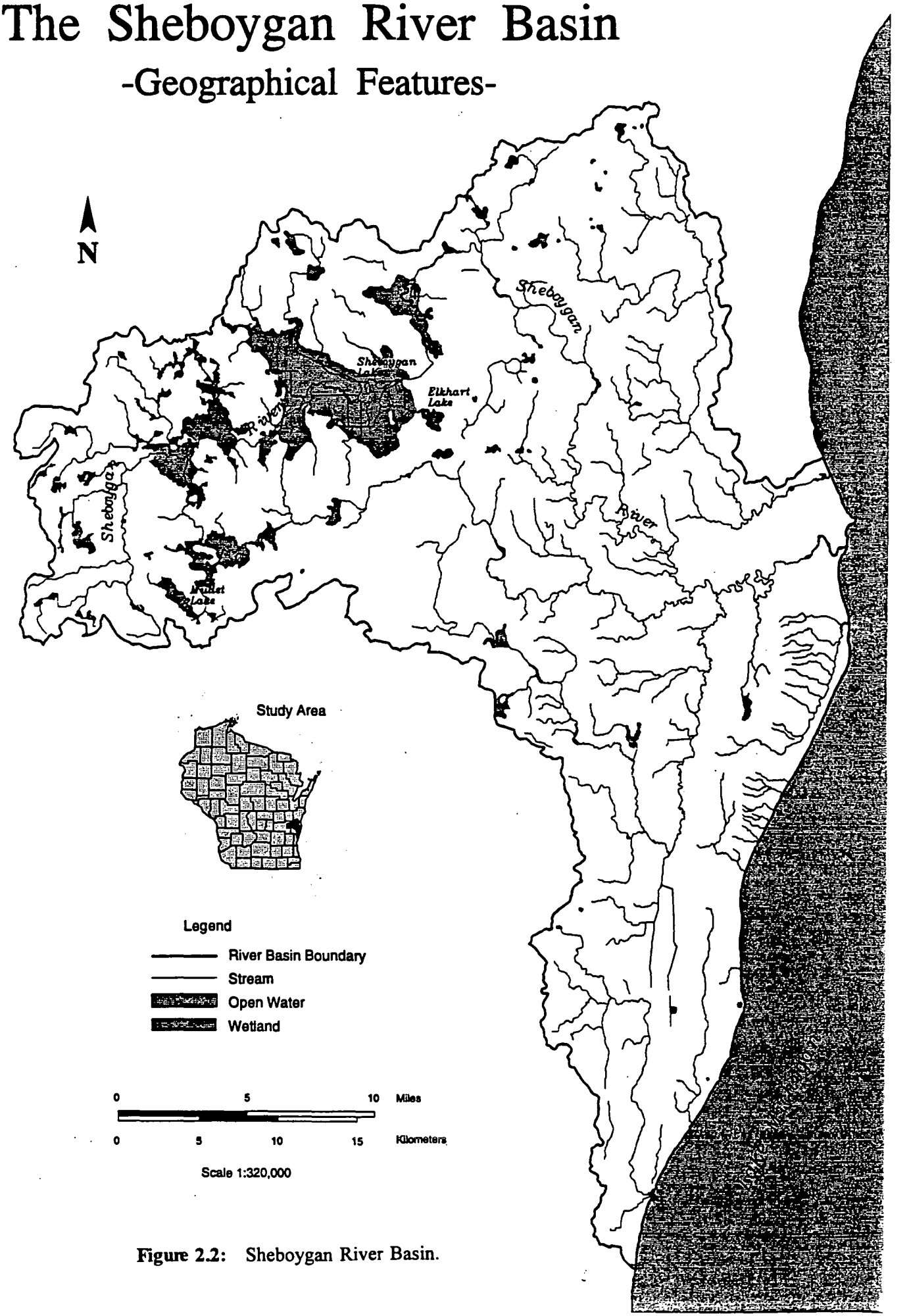


Figure 2.2: Sheboygan River Basin.

Land Uses

This section describes land uses of the Sheboygan River Watershed. The table below summarizes this information.

Land uses in the watershed are primarily rural. Agricultural uses and related open space accounts for 68 percent of the drainage area. Woodlands cover eight percent. Wetlands and surface waters account for another 15 percent.

Urban land uses occupy about 13, 900 acres, or nine percent of the watershed. About three-quarters of this urban land is in the Sheboygan metropolitan area. About one percent of the land in the watershed in under development.

Table 2.3: Land use in the Sheboygan River Watershed.
(Source: WDNR, 1993)

Land Use	Percent of Watershed
Agricultural	
pasture, grazed woodlot	1%
cropland	61%
grassland	5%
Woodland	8%
Urban and developing	9%
Wetlands and surface waters	15%

Land uses adjacent to the harbor consist of small boat facilities, parks, recreation areas, and industrial transportation. The City of Sheboygan is active in developing a commercial area along the north bank of the river and is in the process of constructing a marina along the Lake Michigan Shoreline. The area is developed around the old commercial fish shanties and includes many restaurants and shops.

Climate and Topography

Topography within the basin is generally irregular, consisting of low rounded hills to the west interrupted by narrow valleys and numerous wetlands. A central band of Kettle Moraine landscape divides the basin which grades into irregularly low, flat moraine landscape to the east. Local elevation varies from 50 to 150 feet depending on the observers' location within the basin. The slope of the basin tends toward the east and Lake Michigan but varies along individual stream reaches from 0 to 21 feet per mile. The average river gradient approaches 7 feet per mile.

Soil types vary within the basin. Soils to the west tend to be loamy and light textured, and grade into gravelly soils within the central portion of the basin. Soils in the eastern third of the Sheboygan River

basin are heavy clay soils that tend to have poor drainage but high fertility. Runoff of soil nutrients and animal pollutants is fostered by clay soils but is less likely to occur in porus sandy soils. It is the interaction of current and historical surface water runoff from agricultural, domestic, and industrial sources with materials discharged directly to the streams by municipal and industrial waste sources that produce the condition of the waters within the Sheboygan River Basin.

The climate in the Sheboygan River Basin is continental, characterized by moderate winters and warm summers; the average temperature is 19°F in January and 70.5°F in July. Temperatures within the eastern portion of the basin are moderated by Lake Michigan, which extends the growing season near the lakeshore. An average 29.4 inches of precipitation falls within the basin, either as snow or rain. For much of the winter, little of this precipitation runs off into the stream, but usually in March or April a heavy melt occurs and much of the accumulated snow swells the shallow winter stream.

Runoff and discharge within the basin is varied and tends to follow surface discharge and recharge features. Flow is sufficient within the lower reaches of the Sheboygan River main stem in the warm dry periods of the year. Sheboygan Lake, an impoundment located in the Broughton Sheboygan County Marsh Area, serves as both a reservoir and groundwater recharge feature within the river basin. The quantity of stream water in dry periods has a profound effect on the water quality of the basin, especially where waste sources discharge continuously to the stream regardless of the river flow.

Endangered and Threatened Species

Several species which have been designated "endangered", or whose continued existence is in jeopardy in the State of Wisconsin have been found in the Sheboygan River Basin. The queen snake (Regina septemvittata) has been observed in the Sheboygan River in the vicinity of the Kohler dams. The Sheboygan Marsh subwatershed supports the prairie white-fringed orchid (Platanthera leucophaea) - also a federally threatened species - and two Wisconsin species: the loggerhead shrike (Lanius ludovicianus) and Hudson Bay anemone (Anemone multifida).

Several state-designated threatened plant species that have been identified in the Sheboygan Marsh area include rams-head lady slipper (Cypridpedium arietinum), small round leaved orchid (Orchis rotundifolia), and marsh valerian (Valeriana sitchensis). Forked aster (Aster furcatus) has been observed near the Greendale Cemetery ravine in the City of Sheboygan.

Several species of special concern in Wisconsin occur in the Sheboygan River Basin. These are species about which some problem of abundance or distribution is suspected but not yet proved. The purpose of this category is to focus attention on certain species before they become endangered or threatened. The following are known to occur near the Sheboygan and Kiel marshes: white adder's mouth (Malaxix brachypoda), dragon sagewort (Artemisia dracunculus), American gromwell (Lithosperum latifolium), purple false oats (Trisetum melicoides), yellow gentian (Gentiana alba) and Cooper's hawk (Accipiter cooperii). One plant species of special concern, the hairy beardtongue (Penstemmon hirsutus) has been observed in the City of Sheboygan.

Water Uses

This section describes Sheboygan River AOC water uses: Recreation, Commercial Shipping, Fishing, Public Water Supply, and Waste Disposal.

Recreation

Noncontact recreation such as walking, jogging and bicycling occurs in parks along the river in Sheboygan and Sheboygan Falls. Much of the land near the river in the Village of Kohler is privately owned, limiting public access in that area.

The City of Sheboygan operates two public beaches for wading and swimming. They are located on Lake Michigan, north and south of the Sheboygan Harbor. Swimming is popular at a quarry in Jaycee Park, which is not located near the river. There are no public beaches located on the lower Sheboygan River or Harbor.

The lower Sheboygan River is navigable, but river traffic is restricted by the dams in Kohler and Sheboygan Falls. The Sheboygan Yacht Club is a private recreational resource in the harbor. Public boat access is available at many sites in Sheboygan. While sport and charter fishing occurs in the AOC, commercial fishing occurs outside of the AOC in the open waters of Lake Michigan. Open water duck hunting also occurs in the harbor during the fall.

Commercial Shipping

The Sheboygan Harbor is categorized as a diversified cargo port by the Wisconsin Department of Transportation. This means that the port receives more than one or two types of freight for use within the vicinity of the port. The C. Reiss Coal Co. is the primary handler of commercial cargo in the harbor.

Fishing

This section covers these topics: Species Diversity and Balance, Sport and Charter Fishing, and Commercial Fishing.

Species Diversity and Balance

Generally, there is a good diversity of sport fish in the river. However, the impoundments created by the Waelderhaus and River Bend Dams within the AOC are inhabited mainly by carp. This is due to the fact that dams and the resulting impoundments present barriers to fish movement, may create thermal pollution problems, and usually result in poor water quality because of chronic sediment and nutrient build-up (Pajak and Nelson, 1987). Rough fish such as carp replace game fish as sedimentation covers habitat with sediment and excessive plant growth (Marshall, 1988).

The major fish species that have been found in the lower Sheboygan River and Harbor are listed below. Interestingly, smallmouth bass populations downstream of the Sheboygan Falls Dam have increased dramatically since 1980. A relatively large population of smallmouth is also located upstream of the AOC (Nelson, 1993).

- alewife
- american smelt
- black crappie
- black bullhead
- carp
- channel catfish
- chinook salmon
- coho salmon
- common shiner
- gizzard shad
- lake whitefish
- northern pike
- rock bass
- round whitefish
- smallmouth bass
- trout: brook, brown, lake, and rainbow
- walleye
- white sucker
- white crappie
- yellow perch

Sport and Charter Fishing

The Charter Fishing schedule depends upon Sheboygan Harbor's periodic runs of lake trout and salmon. These two species comprise the majority of the charter anglers' catch. Appendix B lists charter angler effort hours and catch numbers and composition for the years between 1976 and 1992. Angler hours increased from about 6,000 hours to over 68,000 hours per year from 1976 to 1984; this is an average increase of about 35 percent per year. The angler hours began to decrease in 1988 at an average of about 16 percent per year through 1992. Similarly, catch increased from 1976 through 1987 and then steadily decreased until 1992. The earlier catch increase was due to annual river stocking; the recent decrease was probably due to a variety of factors including suspended stocking and reports of PCB and other contaminants in the fish.

Sport fishing begins in the spring for rainbow, brook, and brown trout. The summer months of June through August produce catches of brook and brown trout with coho and chinook salmon catches increasing during August. Catches of resident species such as yellow perch and smallmouth bass are also prevalent. Rough fish such as carp and sucker are also fished. September marks the beginning of the fall salmon run when coho and chinook begin to ascend the Sheboygan River to spawn. Rainbow and brown trout catches also increase in the fall. Late winter and spring produce runs of rainbow trout.

Stocking release sites are located within and outside of the Sheboygan Harbor. Annual stocking of coho and chinook salmon and rainbow trout has been done in the fall and spring within Sheboygan Harbor. Brook, brown, and lake trout are stocked at Lake Michigan sites in the spring and fall.

In 1969, the WDNR began annual creel surveys of Lake Michigan sport anglers at boat ramps, piers, shores, and tributary streams along the Wisconsin coast of the lake. Large scale trout and salmon stocking had begun just a few years earlier, setting the stage for an unprecedented Great Lakes sport fishery.

Commercial Fishing

Whitefish and perch catches near the Sheboygan Harbor were productive in 1987. Chubs are also commercially fished, but well off shore and outside of the AOC.

Lake whitefish are a valuable commercial fish and appear to be rebuilding their populations from an extreme low during the pre-lamprey control years prior to 1965. Offshore waters of Lake Michigan near Door County provide a spawning area for whitefish. The Sheboygan Harbor provides a nursery for these fish. Commercial fishing occurs just south of the harbor.

Commercial perch fishing has seen a significant increase approximately one half mile from the harbor mouth. Perch do not spawn in the harbor, but principally near offshore reefs and similar structures in 20 to 30 feet of water.

Public Water Supply

Municipal water supplies provide water to the homes of approximately 2.7 million people in Wisconsin. They also supply water to many public facilities such as mobile home parks, factories, schools and churches. In addition, there are many public facilities which have their own water supply. Any such water system, which regularly provides drinking water to 25 or more people per day, is considered a public water supply.

WDNR requires that public water supply facilities monitor for Primary Drinking Water Standards. Appendix C, Contaminants Monitored in Public Water Supply, lists these and other contaminants monitored in public water supplies. All community systems and all non-transient non-community systems (like factories and schools) monitor levels of bacteria, as well as a series of pesticides, volatile organic and miscellaneous compounds.

For most water supplies, monitoring for bacteria is conducted on a monthly basis. Nitrate samples are collected annually. Other contaminants are monitored on a three- to nine-year cycle, with the frequency being determined by the results of previous testing.

Standards and treatment requirements for human consumption are contained in Chapter NR 809 and 811, Wisconsin Administrative Codes for safe drinking water. When the results of a water sample exceed the Maximum Contaminant Level (MCL) established in the Safe Drinking Water Act, the water supply owner issues a Public Notice. The Public Notice contains information for water consumers about the nature and possible effects of the contamination as well as a phone number for more information.

The municipal water supply for the City of Sheboygan Falls, the Village of Kohler, and the City of Sheboygan is from Lake Michigan with an intake located north of the harbor approximately one mile out into the lake. The water supply facilities in these AOC communities comprise the Sheboygan Water Commission. Table 2.4 on page 2-11 lists the amounts of water provided by the Commission for industrial, residential, commercial, and public uses in each of these communities. The Sheboygan Water Commission provided over 4 million gallons of water to these communities in 1992.

Table 2.4: 1992 Public Water Supply Breakdown.
(Amounts in thousands of gallons)

Use	City of Sheboygan	Sheboygan Falls	Kohler
Residential	1,049,902	116,945	45,033
Commercial	396,649	23,108	8,545
Industrial	1,656,770	738,769	4,435
Public Authorities	72,978	7,492	503
City Total	3,176,299	886,314	58,516
Water Commission TOTAL	4,121,129		

Surface Water Quality Standards

Water quality standards form the basis for deriving water quality-based effluent limitations. These standards are helpful in making decisions related to discharge permitting, sewage treatment plant construction and funding, and resource management. Water quality standards for recreational use and public health and welfare apply to all the classified waters and designated uses.

The Sheboygan River AOC is classified as a Great Lakes water in Chapter NR 102.12 Wisconsin Administrative Code. Various reaches of the streams that feed into the AOC have different fish and aquatic use classifications as listed in Chapter NR 102.04 Wisconsin Administrative Code. Appendix A, Biological Uses of Streams in the Sheboygan River Basin, shows the current and potential biological uses of all perennial streams in the basin. It also lists factors that impair any potential biological uses of these streams.

The WDNR developed water quality criteria standards and procedures for calculating point source limits for toxic substances discharged to surface waters. Chapter NR 105 Wisconsin Administrative Code establishes numerical standards for fish and aquatic life, wildlife and human health for about 100 toxic substances. Chapter NR 106 Wisconsin Administrative Code establishes the methods to calculate effluent limits for point source dischargers to ensure water quality standards for toxic substances are met in surface waters.

Impaired Uses of AOC Waterways

The International Joint Commission (IJC) developed criteria of 14 uses of waterways that enter the Great Lakes (IJC, 1987). These criteria, known as beneficial waterway uses, are used to identify areas in need of a remedial action plan. By definition in the Great Lakes Water Quality Agreement of 1987, "impairment of beneficial use(s)" means a change in the chemical, physical or biological integrity of the Great Lakes system sufficient to impair any of these 14 waterway uses. This section discusses these impaired uses of the AOC in the order they are listed in Table 2.5, below.

For each AOC, the RAP must examine and document the extent of use impairments. Recommendations in the RAP must outline implementation strategies to eliminate identified use impairments. In order to remove these beneficial uses from the impaired list they must meet the delisting criteria, which are listed in Table 7.2 beginning on page 7-9.

Table 2.5: Impaired Waterway Uses Identified in the Sheboygan River AOC.

Use Impairment	Use is Impaired	Use is Unimpaired
Restrictions on Fish and Wildlife Consumption		
Fish	X	
Wildlife	X	
Tainting of Fish and Wildlife Flavor		X
Degradation of Fish and Wildlife Populations		
Fish	X	
Wildlife	X	
Fish Tumors or Other Deformities	X	
Bird or Animal Deformities or Reproduction Problems[1]	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/Recreational Restrictions		X
Degraded Aesthetics		X
Added Costs to Agriculture or Industry		X
Degradation of Phytoplankton and Zooplankton Population		
Phytoplankton	X	
Zooplankton	X	
Loss of Fish and Wildlife Habitat		
Fish Habitat	X	
Wildlife Habitat	X	

[1] Although no bird or animal deformities have been reported thus far in the AOC there is still a suspected impairment. Monitoring efforts will confirm or deny this in the future.

Restrictions on Fish and Wildlife Consumption

The WDNR uses the U.S. Food and Drug Administration (FDA) action levels and the Wisconsin Department of Health and Social Services (WDHSS) criteria to determine consumption advisories for fish and waterfowl. The FDA establishes "action levels" and "tolerance levels" to limit the concentration of contaminants in food sold for human or animal consumption. Wisconsin uses these standards as a basis for issuing health advice to the public. WDNR publishes this information twice each year in the "Health Guide for People Who Eat Sport Fish From Wisconsin Waters". Fish and waterfowl consumption advisories exist for several species found in the Sheboygan River AOC.

Fish and waterfowl consumption advisories are in effect for the Sheboygan River AOC. These advisories are a result of PCB levels in excess of two ppm in fish tissue and three ppm in waterfowl. Elevated levels of PCB in river sediment are contributing to the problem. The fish consumption advisory is based on data collected through 1993. The waterfowl consumption advisory is based on data collected through 1988.

Anglers are advised not to eat any resident fish (smallmouth bass, walleye, carp or panfish) caught in the Sheboygan River and to consult the fish advisory about consumption of trout and salmon. The WDNR completed an experimental stocking study (Chapter 5, page 5-9) for trout and salmon. Based on the results of the study, WDNR is resuming trout and salmon stocking on a limited basis in the Sheboygan River (see Appendix H for study report).

Degradation of Fish and Wildlife Populations

The lower Sheboygan River currently supports a diverse fish population. Recent surveys show smallmouth bass are abundant in the Sheboygan River system. Populations of trout and salmon are dependent on stocking. However, bioaccumulating contaminants in the food chain and sedimentation have the potential to negatively affect both the quantity and quality of individual fish populations and their forage base.

Populations of mink are well below what normally would be expected for the habitat available. Small mammal trapping by the WDNR in 1993 resulted in no mink being found in the AOC. Occasional mink are seen in this area, however, they are suspected to be transient individuals which probably are not breeding here (Katsma, 1994). Mink depend on a diet of fish and invertebrates, and may be accumulating contaminants from these food sources through the food chain (Patnode, 1995).

Fish Tumors or Other Deformities

Detailed studies of possible deformities in fish resident in the Sheboygan AOC have not been conducted. In 1992, a test of the usefulness of a procedure to assess the general health condition of wild fish was conducted on two species in the Sheboygan River. A report of this trial will be provided as soon as all lab results are completed. In order to provide meaningful information on the general health condition of a species, this assessment procedure needs to be conducted on the same species over several years. A fish health survey is proposed in Chapter 6 (page 6-11) to further assess effects of contaminants in fish.

Bird or Animal Deformities or Reproductive Problems

No deformities have been reported in any wildlife in the AOC. Reproductive problems are suspected with mink because of their low population levels and the high quality of available habitat. Studies have shown that mink reproduction has been severely reduced when exposed to PCBs. Food chain levels of PCBs are sufficient to cause reproductive failure in this species. Further study is proposed in a recommendation in Chapter 6 (page 6-15) to assess contaminant levels in wildlife tissues and to possibly confirm suspected impairments and deformities.

A study that examined four species of birds collected along the Sheboygan River from 1976 to 1980 revealed levels of PCBs associated with reproductive impairments (Heinz et al., 1984). The study concluded that birds feeding in the contaminated portions of the Sheboygan River may have been harmed by high PCB levels.

A biomonitoring project designed to assess the effects of PCB contamination on Sheboygan River wildlife was initiated in the summer of 1993 (Seeley, 1993). The first part, a small mammal study, determined species presence and abundance. Deer mice, meadow voles and eastern chipmunks were most abundant. Mink were also targeted, but none were caught. Only one set of mink tracks was found near a control site. Some specimens were collected for PCB tissue analysis (final results not yet available as of September, 1995). Future efforts will target waterfowl, reptiles and amphibians along the river.

Degradation of Benthos

Prior to 1989, benthic surveys on the Sheboygan River identified the area below the Roller Mills Dam (Sheboygan Falls) as being degraded. This determination was based on low species diversity, with the community dominated by pollution tolerant species. Since that time, it is evident that there are distinct differences in the benthic communities between the reaches above Sheboygan Falls and those within the AOC. However, this information is preliminary and continues to be evaluated. *(For more information, please see Chapter 7, Monitoring Strategy).*

A biotic index comparison of samples collected above the Roller Mills Dam (unaffected by PCB contamination) to samples collected just below the dam (area of highest PCB contamination) and further downstream into the City of Sheboygan (area containing lower sediment PCB concentrations) showed very little difference between sites. These invertebrate samples were collected for the Sheboygan River Nonpoint Source Priority Watershed project. Biotic index comparisons, however, do not determine the effects the contaminants in question (PCBs, metals) have on the benthic community, but instead measure the impact that organic enrichment has on this community. Specifically, these indices measure the organism's tolerance or intolerance to low levels of dissolved oxygen in the water column.

Restrictions on Dredging Activities

Dredging in the lower Sheboygan River and Inner Harbor is restricted because the sediment is contaminated with PCBs, PAHs, and heavy metals. Some deposits are considered heavily polluted according to U.S. EPA guidelines and Wisconsin draft sediment criteria. Although the Sheboygan Harbor is an U.S. Army Corps of Engineers (U.S. ACOE) certified port, no dredging for navigation purposes has been conducted since 1969 because of contaminated sediment disposal concerns. Limited dredging of the outer harbor was done in 1991 and again in spring and summer of 1992 by the U.S. ACOE to provide fill for a beach nourishment project.

Eutrophication and Undesirable Algae

Undesirable algae blooms occur in response to excess nutrients from agricultural and urban nonpoint pollution sources such as runoff from farm fields, fertilized yards, streets and construction sites.

Nutrient concentrations in the lower Sheboygan River and Harbor routinely exceed water quality criteria. Blooms of nuisance algae are occasionally seen. The major cause of eutrophication is nonpoint source pollution from upstream sources and developing urban areas.

Degradation of Zooplankton and Phytoplankton

In the Sheboygan River AOC, information assessing the attached aquatic plant community (periphyton) was collected in the late 1970s (WDNR, 1980). The species found are indicative of disturbed conditions. The periphyton community downstream of Kohler is highly productive. The community shifts towards greater tolerance of nutrient rich conditions. Biomass and density are the highest found in the Sheboygan River. High concentrations of nutrients from point and nonpoint sources are responsible. A RAP recommendation described in Chapter 6 aims at updating the phyto- and zooplankton community evaluation.

Loss of Fish and Wildlife Habitat

Although historic loss of habitat has occurred through development, the quality of wildlife habitat along the river in the AOC is good considering its proximity to urban areas. Upstream of the AOC, sufficient habitat exists along the Sheboygan River to support a low to moderate mink population, but few have been seen in recent years. High tissue PCB concentrations have probably caused reproductive failure in mink (Katsma, 1994).

Ongoing loss of instream habitat for fish and wildlife is occurring through sedimentation from streambank, farmland and construction site erosion. Dams on the river also contribute to degraded habitat in several ways. They alter river flow, increase the water temperature, cause the loss of important riffle areas, and restrict fish from moving upstream to spawn. Dams also cause the build up of sediment behind them which buries much of the fish cover and invertebrate habitat.

Unimpaired Uses of AOC Waterways

The following uses are considered unimpaired in the Sheboygan River AOC:

Tainting of Fish and Wildlife Flavor
Restrictions on Drinking Water Consumption or Taste and Odor Problems
Beach Closing/Recreational Restrictions
Degradation of Aesthetics
Added Costs to Agriculture or Industry

These river uses are either not applicable to the area (such as beach closings; there are no beaches to close), or they have not been found to be affected by the contamination within the AOC. The taste of fish and wildlife has not been noticeably tainted. There have been no drinking water restrictions or reports of taste or odor problems. Although subjective, river aesthetics have not been affected, and there is no additional costs to agriculture or industry due to the contamination.

CHAPTER 3: Sources of Pollution

This chapter describes the sources of pollution in the Sheboygan River AOC. The information in this document is updated and revised information presented in the Stage 1 RAP document.

Many sources contribute to the poor water quality in the Sheboygan River AOC. Page 2-1, Pollutants of Concern, lists the major pollutants of AOC water, biota, and sediment.

Chapter 2, Pollution in the Sheboygan River Basin, discusses the impaired uses of the AOC waterways (page 2-12). Table 3.1 on page 3-2 correlates these impaired uses with their likely causes and sources. In order to remove these uses from the impaired list they must meet the delisting criteria, which are listed in Table 7.2 on page 7-9.

The pollution sources in this chapter are described in the categories listed below. A brief summary precedes these descriptions.

- Summary of Pollution Sources
- Point Sources
- Nonpoint Sources
- Atmospheric Deposition
- Contaminated Sediments
- Contaminated Groundwater

Summary of Pollution Sources

Pollutants to the Sheboygan River AOC are contributed by both point (direct) and nonpoint (diffused) sources.

Point Sources — The most significant point sources of pollution are industrial discharges and sewage treatment plant discharges.

Nonpoint Sources — More than 50 percent of pollutants come from nonpoint sources. Rural nonpoint contaminants are primarily suspended solids and excessive nutrients. Urban nonpoint pollutants come primarily from construction site erosion and storm water runoff.

Atmospheric Deposition — Sources of air pollutants are numerous. Industries such as waste incinerators, power plants, and chemical manufacturers, as well as pesticide applications, paint, small engines (e.g. lawn mowers) and motor vehicles are all examples of manmade air pollution sources.

Contaminated Sediment — Contaminated waterway sediments are an end result of both point (direct) and nonpoint (diffuse) source pollution, and provide a significant amount of toxic contaminants to the AOC.

Contaminated Groundwater — Pollutants from some contaminated groundwater sites contribute toxic contaminants to the Sheboygan River.

Table 3.1: Suspected Causes and Sources of Impaired Uses in the Sheboygan River AOC.

Impaired Use	Likely Cause	Likely Sources of Pollution or Problem
Restrictions on fish and wildlife consumption	- High concentrations of PCBs	- Historic point and nonpoint source pollution - Contaminated sediment - Atmospheric deposition
Restrictions on waterfowl consumption	- High concentrations of PCBs	- Sources such as those listed for fish found throughout the flyways
Degradation of fish and wildlife populations (diversity and abundance)	- Poor ambient water quality (low dissolved oxygen) - Poor quality habitat resulting from excessive sedimentation and urban development along the rivers in the basin - Damming the river - Wetland destruction	- Point and nonpoint source pollution (primarily soil loss from construction site erosion and agriculture) - Physical habitat restraints and modifications (e.g. dams, channelization)
Fish tumors or other deformities	- Sediments contaminated with PAHs (e.g. fluoranthene, pyrene, benzo(a) anthracene, benzo(a)pyrene)	- Contaminated sediments - Spills - Point and nonpoint sources - Atmospheric deposition
Bird or animal deformities or reproduction problems	- Bioaccumulation of contaminants in tissues	- Historic point and nonpoint source pollution - Contaminated sediments
Degradation of benthos	- Contaminated sediment (see page 2-1 for pollutants of concern) - Poor ambient water quality - Poor quality habitat from excessive sedimentation	- Point and nonpoint source pollution (primarily soil loss from construction site erosion and agriculture) - Physical habitat restraints and modifications (e.g. dams, channelization)
Restrictions on dredging activities	- Elevated levels of PCBs and other toxic contaminants in sediment	- Historic point and nonpoint sources - Atmospheric deposition - Spills
Eutrophication or undesirable algae	- Excessive inputs of phosphorus and nitrogen - High water temperatures and stagnant water in impoundments	- Point source pollution - Nonpoint source pollution - Dams

Impaired Use	Likely Cause	Likely Sources of Pollution or Problem
Degraded phytoplankton and zooplankton populations	- Poor ambient water quality, e.g., high suspended solids concentrations	- Point source pollution - Nonpoint source pollution - Dams causing migration restrictions and leading to sedimentation - Contaminated sediment
Loss of fish and wildlife habitat	- Contamination of the water and sediment - Habitat construction (dams, channelization and concrete lining) - Excessive sedimentation	- Point source pollution - Nonpoint source pollution - Migration restrictions (e.g. dams) - Contaminated sediments - Excessive sedimentation

Point Sources

Described below are the following primary point sources for pollution in the Sheboygan River AOC.
- Municipal Wastewater Treatment Facilities
- AOC Industries
- Spills, Illegal Dumping, and the Improper Disposal of Household Hazardous Waste

Municipal Wastewater Treatment Facilities

Area wastewater treatment facilities are a major point source discharge in the AOC. Appendix D, Municipal Point Sources of Pollution in the Sheboygan River Basin, lists each facility, the water that receives its discharge, and WDNR's recommendations for improvement.

AOC Industries

Industries in the Sheboygan River Area of Concern are responsible for point and nonpoint source pollution to surface waters as well as groundwater. Appendix E, Industrial Point Sources of Pollution in the Sheboygan River Basin lists each source, the pollutant found in the discharge, and the stream to which it discharges.

Spills, Illegal Dumping, and the Improper Disposal of Household Hazardous Waste

Appendix F, Sheboygan River Basin Spills Report (1989-1993), lists the spills in the area recorded by the WDNR from 1986 to present. Below is a description of some of these point sources which can adversely affect the quality of waters in the AOC.

LUSTs

Leaking underground storage tanks have the capability of causing extensive groundwater and soil contamination. WDNR is currently investigating several cases in Sheboygan county to determine how they may be affecting groundwater, and in turn affecting surface water and

sediment.

Illegal Dumping

Waste oil has been banned from disposal in Wisconsin landfills since January 1, 1991. At present, towns and villages with fewer than 3,500 residents are not required to provide oil collection facilities. However, the residents and businesses in these areas are not exempt from having to properly dispose of their oil. To discourage illegal dumping, it is necessary to provide a central location where rural residents will be able to conveniently and properly dispose of their waste oil.

Improper Disposal of Household Hazardous Waste

The improper disposal of household hazardous waste may also be an additional source of pollutants to the AOC. Each year used motor oil, paints, and other household hazardous wastes are dumped on the ground or down storm sewers. In Wisconsin each year, "do-it-yourself" mechanics have the opportunity to recycle 3.5 to 4.5 million gallons of used oil each year. Instead, they dump approximately 80,000 gallons down storm sewers and another 2.4 million gallons on the ground (WDNR, 1991). Used oil contains lead, zinc, cadmium, chromium, arsenic and benzene; these substances are harmful to aquatic and terrestrial life and humans.

To address this problem, Sheboygan County held it's first county-wide agricultural and household hazardous waste "Clean Sweeps" on April 2 and April 3, 1993, respectively. Eighty-seven farmers and 907 urban residents disposed of hazardous waste at the designated collection center. Mark Leider, the County Planning Director, declared their first clean sweep a great success, after collecting more than 19,000 pounds of hazardous waste. A post clean sweep survey indicated strong support for future county-wide hazardous waste collection programs. A permanent household hazardous waste collection facility opened in January, 1995 in the City of Sheboygan. In addition, an informational brochure regarding the safe use and disposal of hazardous wastes was published by the Clean Sweep Committee. Additional agricultural "Clean Sweeps" are planned for the future.

Nonpoint Sources

Nonpoint sources of pollution are indirect sources of pollution like runoff from a barnyard or construction site erosion. These sources are significant contributors of sediment, nutrients, and other pollutants to the streams and lakes in the Sheboygan River Basin. These pollutants are contributing to the decline in water quality and degradation of aquatic habitats. Under certain conditions, they also may have localized adverse impacts on groundwater quality.

This section describes rural and urban nonpoint sources of pollution in the Sheboygan River Basin. It also describes the findings of the urban and rural nonpoint sources inventories conducted in the Sheboygan River Priority Watershed Plan (WDNR, 1993).

Rural Sources

The Sheboygan River Priority Watershed Plan inventory (WDNR, 1993) indicates that rural nonpoint source pollutants are significantly affecting stream and lake water quality in the Sheboygan River Basin. The priority watershed inventory, detailed below, investigated these rural nonpoint pollution sources:

- Barnyard Manure Runoff
- Upland Sediment
- Streambank Erosion
- Manure-Spreading Runoff

Barnyard Manure Runoff

Runoff that carries a variety of pollutants from livestock feeding, pasturing areas, and barnyards is a significant source of pollutants in the streams of the Sheboygan River Basin.

pollution	In the watershed, 219 livestock lots were identified as having runoff delivered to surface waters. These lots produce about 1000 pounds of phosphorus during a four-inch rainfall (10-year reoccurrence period). An additional 67 livestock lots are internally drained. The runoff waters from these lots do not reach a stream or lake. These sites require further investigation to determine their potential to contaminate groundwater.
reduction goals	The Priority Watershed Plan (WDNR, 1993) identifies 116 barnyards as targets for phosphorus reduction. Cost share agreements have been signed on 57 barnyards, which should result in a reduction of almost 500 pounds of phosphorus loading (during a four-inch rainfall).

Upland Sediment

Upland erosion, or erosion from fields that are not adjacent to streams, is the major source of sediments carried to surface waters. Intensive agricultural practices have allowed considerable amounts of eroded soil to reach streams, lakes, and wetlands in the Sheboygan River Watershed. Chemical fertilizers, herbicides, and pesticides are also carried along with runoff.

These sediments have blanketed the stream beds, filling in pools and riffles, and degraded reproductive habitat for cold and warm water fish species and associated fauna.

pollution

About 300,000 tons of soil erode annually from croplands, pastures, wood lot, grassland, and other rural upland lands. About four percent of this amount, or 13,500 tons/year, actually reach wetlands streams, or lakes in the watershed. The rest of the sediment settles out on fields or dry channels before reaching surface waters.

Croplands are the major source of upland sediment that reaches surface waters. Although this land use accounts for 65 percent of watershed land, it contributes 95 percent of sediment loading to surface waters.

The highest upland sediment delivery rates to watershed surface waters are in the Franklin, Wayside Park, Maple Corners, and Airport Subwatersheds of the Sheboygan River Watershed. These are located in Sheboygan County in the eastern part of the watershed. This area of the watershed contains the most cropland and is dominated by heavy clay soils, two factors which most likely account for the high sediment delivery rates.

reduction goals

The reduction goal for the total rural sediment loading, which includes both upland sediment and streambank erosion, is about 7,500 tons/year. About one-third, or 3,400 tons/year, is currently under contract for reduction. The cost sharing description in the Priority Watershed Code (Chapter NR 120, Wisconsin Administrative Code) is being revised to enhance the attractiveness of sign-up for sediment control.

Streambank Erosion

Streambank erosion is not a large source of sediment to surface waters in the Sheboygan River Basin (WDNR, 1993). It accounts for about four percent of total rural sediment loading to surface waters. Adjacent wetland drainage results in increased flow rates in the river which can lead to high rates of bank erosion. Of greater concern are the number of sites where the streambanks are trampled from cattle, which causes significant streambank habitat and stream bed degradation.

pollution

Seventy-six percent of the sediment from inventoried surface waters is from eroding streambanks in Weeden's Creek, located in the Wilson Subwatershed, and the Sheboygan River and its tributaries in the Airport and South Branch Watersheds. Stream-side and streambed habitat degradation resulting from cattle access were most prevalent along the south and north branches of the Sheboygan River in Fond du Lac County. Approximately seven miles of degraded habitat were inventoried along these reaches. The main stem of the Sheboygan River was not inventoried for streambank conditions in the Kohler and Oxbow Subwatersheds.

reduction goals — The reduction goal for the total rural sediment loading, which includes both upland sediment and streambank erosion, is about 7,500 tons/year. About one-third, or 3,400 tons/year, is currently under contract for reduction.

Manure-Spreading Runoff

The most significant water quality problems associated with land spreading of livestock manure occur when wastes are spread on "critical" areas and wastes spread during winter over frozen ground. For the purposes of this inventory, critical lands were defined as lands with a grade greater than six percent, soil types rated as flood prone, and soils with less than a 24 inch depth to bedrock. Inventory results indicate that almost 2,000 critical acres have manure spread on them each year.

pollution — The 285 livestock operations inventoried in the Sheboygan River Watershed produced about 176,600 tons of manure during the six-month period from late fall through mid-spring 1992. When cropland owners spread with manure when the soil is frozen, the potential for the manure runoff to reach surface water is greater.

About 7,000 acres in the watershed are needed to safely spread the manure generated from late fall through mid-spring. Together, the operators of livestock operations own enough suitable land (13,500 acres) to safely spread animal wastes. However, a combination of factors, including climate, soil condition, and proximity of croplands suitable for spreading, result in manure-spreading on critical areas. In addition, individual landowners may not have enough suitable land to properly spread manure.

reduction goals — The watershed control plan identified 1,992 acres of critical land that must be controlled in order to reduce the runoff the runoff of manure to surface water. Increase in manure storage cost sharing in 1991 is expected to increase landowner sign-up. Sheboygan County has made it a priority to improve the participation in this program. Over the last two years, the County has seen an increase in landowner sign-up due to that effort.

Urban Sources

Sheboygan River Basin urban land area may be small in comparison to rural land area; however, urban areas can contribute more pollutants on a per-acre basis because they have more impervious surfaces and are often connected to storm sewers which convey runoff directly to lakes and streams.

As the basin becomes increasingly urbanized, runoff volumes and peak stream flows increase. This is due to high amounts of impervious surfaces like parking lots, roads, and buildings which do not allow water to soak into the ground, instead conveying it to nearby waterways. This can lead to streams

with extreme, dynamic conditions. Dramatic fluctuations in temperature, flow rate, and chemistry limit water use by aquatic life as well as humans. At the same time, increasing impervious surfaces reduces the rate of groundwater recharge. This can greatly reduce the base stream flows, which are needed to sustain aquatic life during periods of low rainfall.

This section describes the aspects of urban nonpoint pollution listed below. Construction site erosion, the most critical source of sediment to surface waters, is covered in the last two subsections. The City of Sheboygan is in the process of developing and adopting a construction site erosion control ordinance as well as a city-wide storm water management plan. The other urban areas inventoried have no such provisions in place. Sheboygan has also experimented with urban control practices such as grass swales in selected developing residential areas.

- Urban Pollution Factors
  (Urban land use, storm water conveyance, urban housekeeping practices)
- Current Urban Pollutant Loads
- Future Urban Development

Urban Pollutant Factors

Urban runoff carries a wide array of pollutants including those listed below.

- Heavy metals (lead, copper, zinc, cadmium, or chromium)
- Toxic organic chemicals (PCBs, aromatic hydrocarbons, esters)
- Sediments (especially from construction sites)
- Nutrients
- Bacteria
- Pathogens
- Pesticides

The three major factors which affected the results of the WDNR inventory are urban land uses, storm water conveyance, and urban housekeeping practices. The results of the inventory are described in the Current Urban Pollutant Loads section beginning on page 3-9.

▸ **Urban Land Uses**

An urban land use inventory conducted in 1988 (WDNR, 1993) found that about 17.6 square miles of urban land exist in the Sheboygan River Watershed. The predominant uses in the urban areas are 41 percent open space and 35 percent residential.

▸ **Storm Water Conveyance**

Urban storm water reaches streams and lakes primarily through storm sewers, either separately or combined with grass swales or roadside ditches. Storm sewers transport the runoff rapidly with no treatment or filtering for pollutants before it enters surface waters.

Properly designed grass swales transport less runoff. Infiltration and vegetation remove some pollutants and larger conventionals, like leaves and grass, from runoff before it flows into streams or storm sewers.

- **Urban Housekeeping Practices**

Street sweeping practices affect the amount of pollutants accumulated on urban surfaces that actually reach streams via runoff. It does this by removing some of the particulate pollutants from street and parking lot surfaces before they are transported via runoff. The biggest benefit is realized by weekly sweeping of commercial and industrial areas during spring, summer, and fall.

Current Urban Pollutant Loads

Urban nonpoint pollution sources studied in the inventory include runoff from established commercial, industrial, institutional, freeways, and residential lands; and runoff from areas where new urbanization is anticipated. The WDNR inventory evaluated the amounts of sediment, phosphorus, and lead that reach area surface waters in order to characterize the sources and severity of pollution. Table 3.2 below gives the results of the inventory of these pollutants in the areas studied. Following the table is an interpretation of the results for each pollutant.

Table 3.2: Urban Inventory Results for Pollutant Loads (1988) (WDNR,1993).

Municipality	Current Area		Sediment Load*		Phosphorus Load		Lead Load	
	Acres	% total	tons/yr	% total	tons/yr	% total	tons/yr	% total
Kiel	703	6	218	6	0.14	6	0.14	5
Sheboygan Falls	1655	15	901	23	0.28	11	0.23	8
Kohler	2555	23	703	18	0.26	10	0.37	13
Sheboygan: Drainage to Sheboygan River	3864	34	1461	37	1.07	42	1.44	52
Drainage to L. Michigan	2502	22	659	17	0.77	31	0.59	21
TOTAL	11,279	100	3,942	101	2.52	100	2.77	99

* Includes construction site erosion.

- **Sediment**

Construction site erosion is the primary source of sediment that reaches surface waters from urban areas. Although construction sites constitute less than one percent of urban land in the watershed, they contribute nearly 70 percent of total sediment load from urban sources. This is based on a rate of 30 tons per acre per year to estimate the

sediment load from construction sites. Table 3.3 on page 3-10 gives the sediment pollution associated with each municipality in the inventory.

Table 3.3: Areas Under Construction and Associated Sediment Pollution (1988) (WDNR 1993).

Municipality	Area under construction (acres)	Sediment	
		tons	%[1]
Kiel	5	150	69
Kohler	19	570	81
Sheboygan Falls	26	777	86
Sheboygan	40	1200	57
TOTAL	90.00	2,697.00	Avg: 73.25

[1]percent sediment contributed by construction site erosion compared to all other land uses in the municipality.

- **Phosphorus and Lead**

Overall, contributions of phosphorus and lead to the Sheboygan River from urban areas are relatively low. Freeways, industrial areas, commercial areas, and high density residential areas are the greatest contributors of phosphorus and lead. The acreage for these uses is relatively low, even in the City of Sheboygan. However, as these types of land uses increase, increased levels of lead and other heavy metals may increase as well.

Medium density residential areas comprise 32 percent of the urban area and generates about 15 percent of the urban lead load. Such areas are significant sources of pesticides, bacteria, and household/ automotive products, which reach surface waters via storm sewers.

Future Urban Development

By the year 2010, urban land use will increase by an estimated 11 percent, or 1,300 acres (WDNR, 1993). Most of the urban growth in the watershed is expected to be residential, at 690 acres, with significant additions of industrial and commercial areas, at 537 acres.

Polluted runoff from new urban areas can further degrade stream water quality if storm water management controls are not incorporated during development. Annual sediment loads are expected to increase by more than 58 percent per year over 1988 levels. In 1988 construction erosion in the areas inventoried contributed about 2,700 tons of sediment of surface waters in the watershed. By 2010, this sediment loading is expected to increase to about 4,500 tons.

Atmospheric Deposition

Long-range atmospheric transport and deposition of heavy metals and organic compounds are of great concern to the agencies and people in the Great Lakes drainage basin. PCBs, PAHs, mercury and many other pollutants are released to the air from the source, after which they are often transported away from their source to another location. Finally, the pollutants are deposited to the land or into waterbodies. Whatever the source or the route, atmospheric deposition contributes contamination to both the AOC and Lake Michigan. Overall, scientists estimate that 35 to 50 percent of current yearly inputs of a variety of toxic chemicals to the Great Lakes may be from the air (U.S. EPA, 1994). However, the only air quality exceedances found in Southeastern Wisconsin are for the ozone standard.

The airborne contribution of pollutants specifically to the surface waters in the Sheboygan River AOC has not been quantified. Techniques for monitoring air deposition are in the developmental stage and are not consistently reliable (Chazin, 1992). Some specific data, detailed below, are available about ozone, the main component of smog. This section describes what is known about air deposition in Wisconsin and in the Sheboygan River Basin.

Wisconsin

Wisconsin's Air program regularly monitors 15 sites throughout the Southeast District for 6 criteria pollutants: particulates, sulfur dioxide, nitrogen dioxide, ozone, carbon monoxide and lead. The only exceedances found in Southeastern Wisconsin are for the ozone standard (WDNR, 1990). A six county area in southeastern Wisconsin exceeds the acceptable level for ozone. This region is included in a larger severe nonattainment area that covers metropolitan Chicago, northern Indiana and the entire southern Lake Michigan shoreline.

Ozone, the main component of smog, is formed from volatile organic compounds (VOCs) and nitrogen oxides (NO_x). VOCs come from paint thinners, vehicle exhaust, solvents and other petroleum based products. NO_x comes from emissions from vehicles, factories and utilities. Ground level ozone is formed when VOCs and NO_x combine and are chemically-activated by hot sunlight, posing a significant health risk for the elderly, young children and persons suffering from respiratory ailments.

Heavy industrial sources contribute only 16 percent of ozone forming pollutants. The larger sources of air pollutants are contributed by all individuals who drive motorized vehicles (e.g. trucks, automobiles, boats), paint outdoors, and operate machinery with small engines (e.g. lawn mowers). On hot days, cars contribute nearly 60 percent of the pollutants that form ozone in southeastern Wisconsin.

In order to keep track of industries emitting air pollutants, the WDNR's Air Management Program conducts an annual emission inventory of the more than 500 facilities in southeastern Wisconsin. The inventory includes information about the sources of pollution such as processes, boilers, or incinerators and any fuels associated with these sources. From the inventories, the WDNR is able to determine how much of the air resource is being consumed and to determine if the facility is in compliance with air regulations.

Sheboygan River Basin

In Sheboygan County, the WDNR regularly monitors for ozone, sulfur oxides (SO_x), particulates, lead, carbon monoxide and nitrogen oxides (NO_x) to determine ambient air quality. Currently, Sheboygan County exceeds current ambient air standards for ozone. It is considered a moderate nonattainment

area, which means the area is required to reduce 1990 VOC emissions by 15 percent by 1996 (Reynolds et al., 1992).

Deposition of airborne toxic substances may contribute to pollutant loads in the Sheboygan River. PCBs can enter the air through either the incomplete combustion of PCBs or from chlorinated organics used in many solvents and degreasers. Annual emissions of PCBs from the Sheboygan Incinerator were determined to be 0.08 pounds in 1990. This rate of emissions was not in compliance with the 1990 amendment of the Clean Air Act. Because the Sheboygan Incinerator was not able to come into compliance, it shut down in March 1992, as did many incinerators throughout the state.

Industrial air pollution sources also contribute to contaminant deposition. According to WDNR air management staff, eleven industries in the Sheboygan area contribute more than 100 tons of air emissions annually. No wet and dry deposition monitoring for airborne toxics has been initiated in Sheboygan County so the contribution of air emissions to pollutant loads in surface waters has not been fully assessed.

Contaminated Sediments

The contaminated sediments in the Sheboygan River AOC serve as a source as well as a sink for a variety of pollutants listed in Chapter 2 on page 2-1.

Sediments as a source of toxic contamination

Contaminated sediments in rivers and streams pose risks to the health of the ecosystem as well as potential risks to human health. After being deposited, the contaminated sediment acts as a sink and serves as a reservoir for future releases of the contaminant back to the water column. Therefore, sediments are a primary source of pollutants that travel through the food chain, accumulate in fish and other aquatic organisms, wildlife, and humans.

The rate at which contaminants from sediments are introduced into the food chain depends upon their availability to organisms. This is partially a function of the affinity between particular contaminants and the sediments to which they are adsorbed. This affinity differs among various chemicals and sediment types. Many contaminants tend to be held tightly to the organic matter and fine sized particles in the sediments. The degree to which contaminants are bound to sediments affects their release to the water column or sediment pore water where they are assimilated by organisms. Thus, equal concentrations of contaminants in different sediment types can vary widely in their toxicity to aquatic organisms (Burton, 1992).

Many natural mechanisms free toxic substances from sediments for uptake into the food chain. Bioavailability can change over time as it is affected by organic loadings and losses, temperature, pH and other environmental factors. Also, the natural interaction between water and bottom sediment, aquatic organisms moving through the sediments, floods scouring the river bottoms and human activities such as dredging, continually expose and free contaminant from the sediments. Some contaminated sediments have a harmful effect on the bottom dwelling communities in close contact with them. These communities are an important food source for numerous species of fish and wildlife. Their contamination leads to bioaccumulation of contaminants throughout the food chain (Landrum and Robbins, 1990).

Consumption of certain resident fish species in and upstream of the AOC and in Lake Michigan pose a public health risk (WDNR, 1993). Contaminants in sediment are thought to be a significant source of contamination in these fish. Human consumption of Lake Michigan fish contaminated with PCBs, for example, has been linked to neurological and behavioral abnormalities and decreased learning abilities in children (IJC, 1991b). Therefore, critical warning is given to pregnant and nursing women and young children to restrict consumption of certain Great Lakes fish. Unexpected harmful effects also occur in wildlife living in the Great Lakes Basin from exposure to toxicants in the food chain from a variety of sources including sediments (National Wildlife Federation, 1991).

Various publications (IJC 1990; 1991a-c; National Wildlife Federation, 1991) present evidence linking metals, synthetic organics, and petroleum and coal derived hydrocarbons in the Great Lakes ecosystem to lethal and sublethal effects in organisms including humans. Reproductive failure, population declines, developmental abnormalities, neurobehavioral deficiencies in offspring and genetic effects are observed in aquatic organisms and wildlife contaminated with certain toxicants. Adult and embryonic mortality, malignancy or carcinogenic effects, bioaccumulation of contaminants and subsequent biomagnification up through the food chain has been observed in contaminated wildlife. In addition, other more subtle biochemical and physiological changes are associated with contaminant exposure. These changes may reduce the ability of organisms to tolerate environmental changes, stress and disease.

Sheboygan River and Harbor Superfund Project

In 1985, the U.S. EPA designated the Sheboygan River and Harbor as a Superfund site by proposing it onto the National Priorities List. Tecumseh Products Company, Kohler Company, Thomas Industries, and more recently, Diecast Corporation have been identified as potentially responsible parties (PRPs), based on the fact that these companies generated or generate wastes containing PCBs lead, chromium, zinc and copper. In April 1986, Tecumseh Products Company signed a Consent Order with U.S. EPA and WDNR in which they agreed to conduct a Remedial Investigation (RI) and Feasibility Study (FS) for the site.

An assessment of sediment contamination has been completed through the Sheboygan River and Harbor Superfund Project (Blasland and Bouck, 1990a). The results of the RI are documented in the Remedial Investigation/Enhanced Screening Report (Blasland and Bouck, 1990a) which defined the extent of contamination in the river and harbor sediments, floodplain soils, and water, and evaluated the risks posed by the contaminants to human health. The highest concentrations of PCBs in sediment samples were found in the upper river portion from Sheboygan Falls to just downstream of the Riverbend Dam in Kohler. In this portion of the river, three sediment deposits with significantly higher PCB concentrations (between 890 and 4500 ppm) were identified and in 1989 were targeted for removal under a new phase of the project called the Alternative Specific Remedial Investigation (ASRI). In this phase, removal and treatability studies were conducted to aid in the evaluation of cleanup alternatives for the site (Blasland & Bouck 1990b). The dredging of these sediments took place from late 1989 through 1990.

The removal of PCB-contaminated sediment was completed in late 1990. Approximately 2,700 cubic yards of sediment were placed into a Confined Treatment Facility (CTF) to undergo a pilot-scale biodegradation treatability study. The CTF is located on Tecumseh's property in Sheboygan Falls. It contains four cells which were used to evaluate the ability to enhance biodegradation of PCBs in the sediment. This pilot study was done in conjunction with U.S. EPA's five-year study and

demonstration project called the Assessment and Remediation of Contaminated Sediments (ARCS) Program which is being administered by U.S. EPA's Great Lakes National Program Office (GLNPO). Under the ARCS Program, among other things, GLNPO demonstrated and evaluated the effectiveness of selected remedial treatment technologies at five priority AOCs, one of which was the Sheboygan AOC. In this study, U.S. EPA and Tecumseh's consultant developed a plan to manipulate the sediments in the CTF to enhance naturally occurring biodegradation, by adding nutrients and oxygen to the sediments in selected cells. The demonstration showed that the PCBs present in the sediments had already undergone a great deal of anaerobic dechlorination while in the river, but questions remain about developing a properly engineered system to deliver adequate amounts of oxygen to the sediments in order to break down the remaining partially dechlorinated PCB molecules (U.S. EPA, 1994). A final report on the results of the study is due in early 1995.

Other studies conducted under the ASRI included a pilot-scale treatability study of armoring PCB-contaminated sediment in-place. Five sediment areas were armored only. Four additional sediment areas were armored after dredging activities were unable to achieve acceptable PCB concentrations in the residual sediment after dredging. The armoring design consists of multiple layers of geotextile, run-of bank material, and cobbles with gabions (rock-filled cages) placed on top around the perimeter to hold everything in place. The objective of armoring is to prevent the migration downstream of the underlying PCB-containing sediment. Bench-scale treatability studies were also performed on various treatment technologies including solvent extraction, thermal extraction, and solidification. Sediment dredging, handling, and transport techniques were also evaluated in the ASRI. A final Report is due in 1995.

In 1990, U.S. EPA initiated a Removal Action for the purpose of removing an additional 2,700 cubic yards (approximately) of highly contaminated sediment that had been identified as posing significant risk to human health and the environment. Through another Consent Order which Tecumseh Products Company entered into with U.S. EPA in September 1990, these additional sediments were removed in 1991 and placed into a Sediment Management Facility (SMF). This is a large tank designed to temporarily store the sediments until a final disposal and/or treatment method is determined in the Record of Decision for the site.

The U.S. EPA has set a goal of issuing a recommendation for final site cleanup in a Proposed Plan in late 1995. Following a public meeting and a minimum 30-day public comment period, U.S. EPA will issue a Record of Decision announcing the selected remedy. Following that, the PRPs will be contacted and negotiations held to try and reach an agreement with them for the design and implementation of the selected remedy. Should they agree to undertake the cleanup, the design of the remedy would be initiated shortly thereafter.

Kohler Company Landfill Superfund Project

The Kohler Company Landfill was designated a Superfund Site in 1983 when it was proposed to the National Priority List. Kohler Company has operated the landfill since the early 1950s for disposal of foundry sand, cores and pottery waste. Cells were constructed at the landfill between 1950 and 1975 for the disposal of chrome plating sludges, enamel powder, hydraulic oils, solvents and paint wastes. To comply with State and Federal regulations requiring disposal of hazardous wastes at selected sites, Kohler Company closed these cells and filled them over with non-hazardous wastes.

In 1986 Kohler Company initiated a Remedial Investigation (RI). Completed in 1991, the RI was conducted to determine the nature and extent of contamination and to estimate the risks to the environment and human health. Results of the RI indicate that landfill wastes include volatile organic compounds (VOCs) including vinyl chloride, trichloroethane (TCE), and 1,2-dichlorethene (DCE); polynuclear aromatic hydrocarbons (PAHs); phenolic compounds; PCBs; and heavy metals including chromium, cadmium, lead, copper, antimony and zinc. Shallow groundwater beneath the site is contaminated with many of these compounds and flows into the Sheboygan River rather than underneath it (Geraghty and Miller, 1992). Surface water runoff and its associated sediments were historically found to contain semivolatile organic compounds (i.e. PAHs) and heavy metals.

The next step in the process was the Feasibility Study (FS). At that time, U.S. EPA divided the Superfund project into two phases called operable units in order to separately address wastes buried in the landfill and contaminated groundwater. The Source Control Operable Unit Feasibility Study was completed in September 1991 and examined cleanup alternatives addressing the landfill as a source of contaminants to the groundwater and Sheboygan River. The Source Control Record of Decision was signed in March 1992. The components of the selected remedy include closure of the landfill on an expedited schedule, placement of a multi-layer soil cap over the waste, and collection and treatment of leachate. The cost was estimated at $4.7 million. Kohler Company submitted the Source Control Remedial Design to WDNR in December, 1992. After receiving additional information from Kohler Company, WDNR issued a draft plan modification January 30, 1995.

The project is currently in the second operable unit under WDNR direction and oversight. At the direction of WDNR, Kohler Company submitted an Environmental Contamination Assessment and Remedial Alternatives Analysis report (Groundwater FS) in November, 1992, which evaluated cleanup alternatives for the contaminated groundwater. WDNR is requiring Kohler Company to submit a more complete evaluation of the groundwater remedial alternatives. Once this additional information has been received, WDNR will prepare a draft Record of Decision containing a recommended groundwater cleanup alternative for public comment.

Former Coal Gasification Site

While constructing a foundation for the boat docking facility between Center Street and New York Avenue along the east bank of the Sheboygan River, a dark, oily material was found in an excavation along the shoreline (Simon Hydro-Search, 1992). A potential source of this contamination is a former coal gasification operation located at this site. This plant was owned by the Wisconsin Public Service Corporation and in operation from 1872 until 1929. The facility manufactured gas used for lighting and heating as well as producing by-products which served as feedstocks for other chemical manufacturing operations (Simon Hydro-Search, 1992). Property owners since that time were Heilemann Brewing (1966-1977), Riverside Properties (1977-1980), Garton Properties (1980-1985),

Sheboygan Outboard Club (1985-present owners of island), and the City of Sheboygan (1985-present). The WDNR along with the City of Sheboygan and Wisconsin Public Service are in the process of determining the extent of the contamination.

Potential conditions at the former coal gasification plant site that may be sources of pollution to the Sheboygan River surface waters, and which lead to contaminated sediment, are storm water runoff from the site and contaminated groundwater influx.

Investigation Results

Results of the June 1992 investigation of water from the test pits dug on the site showed levels of arsenic, total cyanide and benzene above the state enforcement standard found in Chapter NR 140, Wisconsin Administrative Code (Simon Hydro-Search, 1992). Monitoring for total PAHs, cyanide, arsenic and nickel in both the soil and groundwater began in the spring of 1992 and are continuing.

The former coal gasification plant site is a possible source of PAHs detected in downstream sediments near the Pennsylvania Avenue Bridge (Blasland & Bouck, 1990a) and the Eighth Street Bridge (RMT, 1993). The table below shows how PAH levels increase at eight sites along the Sheboygan River, including the Eighth Street Bridge.

Table 3.4: PAH Levels in Sediment Upstream and Downstream of the former Coal Gasification Plant.
The lowest level at which negative effects on organisms become apparent, for PAHs is 2 ppm (Persaud et al., 1990).

Site	Total PAH Level (ppm)	Sample Depth	Source of Information (see bibliography)
Weedens Creek Tributary	< 0.1	surface sediment	Blasland & Bouck, 1990a
County Hwy. A	0.2	surface sediment	Blasland & Bouck, 1990a
Chicago Northwestern RR	0.7	surface sediment	Blasland & Bouck, 1990a
Kiwanis Park	2.0	surface sediment	Blasland & Bouck, 1990a
near former Coal Gasification Plant	4.0	surface sediment	Blasland & Bouck, 1990a
Pennsylvania Avenue Bridge	63.0	2'-4' sediment	Blasland & Bouck, 1990a
Eighth Street Bridge	5.0 - 97.0	0'-2' sediment	RMT, 1993
Average of Four Harbor samples	1.09	2'-4' sediment	Blasland & Bouck, 1990a

Although no sediment has been tested at the former coal gasification site to date, several soil test pits were excavated and analyzed for PAH levels. PAH concentrations in these pits ranged from non-detectable to 151.3 ppm. Other possible sources of PAHs in the river near the former coal gasification site could include storm water runoff from parking lots and other surfaces, motor oil poured down storm sewers, motor boat traffic on the river (the island in this area was historically used as a marina facility), and other point and nonpoint sources upstream.

What's Next?

To date, groundwater, soil, and sediment are continuing to be investigated at the former coal gasification plant site. Simon Hydro-Search (consultants for City of Sheboygan and Wisconsin Public Service Corp.) is performing further investigation in order to propose a remedial work plan. Under investigation are 1) the extent of ground-water impacts, 2) the extent of soil impacts, and 3) sources of contamination other than the coal gasification plant. WDNR will request that sediment sampling above and below the coal gasification plant site be included in this additional investigation.

The C. Reiss Coal Company

The C. Reiss Coal Company (a subsidiary of Koch Industries, Inc.) encompasses approximately 40 acres on the south bank at the mouth of the Sheboygan River. The site historically housed a coal storage facility and also includes nine above ground and two below underground storage tanks. Koch Industries voluntarily began investigations into possible soil and groundwater contamination at this site in 1992 in preparation for the future sale of the property. In June of 1992, a Phase I Environmental Assessment of the site was completed by STS Consultants Ltd. (STS). The purpose of the this study was to identify areas that may have potentially been impacted by the storage or handling of petroleum products or other chemicals. The results of the study indicated several potential sources of environmental contamination including above and below ground petroleum storage tanks, a fertilizer tank farm, previous electric power and veneer plants, and an off-site petroleum release (STS, 1992).

Based on the results of the Phase I study, Koch Industries requested STS to perform a Phase II Subsurface Contamination Assessment. This study consisted of digging 32 test pits in July 1992 to characterize subsurface soil and groundwater conditions. Soil and groundwater samples were collected from these pits and field screened and/or laboratory analyzed for suspected petroleum contamination. Results confirmed the presence of contaminated soil and groundwater at four areas of the site. These sites included property located west of S. Eighth Street in the vicinity of a previous underground storage tank installation, The C. Reiss Coal Company's petroleum tank farm and loading racks, and along oil intake piping (STS, 1993).

Phase III of the investigation of this site was conducted and finalized in April of 1993. The purpose of this phase was to further define the extent of contamination vertically and laterally by installing groundwater monitoring wells, and to make recommendations for remediation. Soil and groundwater samples were collected and submitted for laboratory analyses for petroleum volatile organic compounds, gasoline range organic compounds, diesel range organic compounds, polynuclear aromatic hydrocarbons, total recoverable petroleum hydrocarbons, and lead. Levels of these compounds varied depending on the location on the property and the media analyzed (STS, 1993). Full results and suggested remedial actions can be found in the document entitled "Phase III Contamination Assessment and Remedial Action Plan" (STS, 1993).

During a July 1992 bulk storage tank inspection, the Department of Agriculture, Trade, and Consumer Protection (DATCP) noticed spots of dead vegetation in the areas of a vessel off-loading area along the Sheboygan River and a fertilizer tank farm. DATCP inspectors collected samples of soil and rainwater from the site containment area which indicated elevated levels of fertilizer in the form of nitrates in the soil and rainwater. Phosphate was also observed in the rainwater sample for the containment area. Additional investigation into this contamination is being pursued (STS, 1994). Work plans to delineate the fertilizer impacts and the off-site petroleum plume were submitted by STS to the WDNR and DATCP in September 1994 and are currently being reviewed.

Contaminated Groundwater

Many types of pollutants may be transported to surface waters via the groundwater system. Toxic organic substances and metals are the major contaminants of concern in groundwater. The groundwater throughout the entire basin has not been sufficiently monitored to determine the overall contribution of contaminated groundwater to the Sheboygan River AOC.

CHAPTER 4: RAP Goals and Objectives

The goals and objectives outlined in this chapter describe the "desired future state" of the Sheboygan River ecosystem which reflect environmental, recreational and human health concerns. The goals were developed during Stage 1 and remain unchanged for Stage 2. In order to address all concerns in a detailed manner, the Stage 1 objectives were modified to provide the needed detail without changing the original intent.

The goals are listed below. Following is a description of the purpose and the development of the goals. Finally, there is a list of objectives and rationale for each goal.

List of Goals

Goal 1: Protect the ecosystem (including humans, wildlife, fish and other organisms) from the adverse effects (on the reproduction, survival, and health of individuals, and the integrity of interspecies relationships) of toxic substances.

Goal 2: Maintain and enhance a diverse community of terrestrial and aquatic life and their necessary habitat.

Goal 3: Control eutrophication (nutrient enrichment of water), and sediment loadings to the Sheboygan River for the protection of Lake Michigan.

Goal 4: Restore the river so that it is of recreational quality from its source to Lake Michigan. . .

Purpose

The goals and objectives provide the criteria for evaluating the short- and long-term pollution abatement and resource management decisions needed to clean up the Sheboygan River and Harbor. These goals and objectives identify a high quality river system so that the discharge of any or all persistent toxic substances be virtually eliminated (Revised Great Lakes Water Quality Agreement of 1978, 1987). As goals are achieved and the ecosystem is systematically restored, impaired uses in the Sheboygan River AOC will be delisted according to the IJC's delisting guidelines (see page 7-9).

The objectives provide specific guidance on the conditions that should be met if the goals are to be achieved. Objectives are listed under the applicable goal, however, in many cases objectives will apply to more than one goal.

Development

The Citizen's Advisory Committee developed the goals for the Sheboygan AOC based upon the goals and objectives of the Clean Water Act, Water Quality Agreement, state and federal water quality standards, and the concerns of the public and the Sheboygan County Water Quality Task Force. A public survey, developed by the Task Force helped area citizens to learn about public concerns.

This plan's goals describe a desired ecosystem that is a necessary compromise between the extremes of full restoration to presettlement conditions and allowing existing conditions (impaired uses). Environmental, economic, and recreational concerns are addressed by these goals.

The goals and objectives draw upon the legal mandates of the Clean Water Act, the Great Lakes Water Quality Agreement and the environmental protection and resource management authority established by state statutes. In the interest of coordinating a unified pollution abatement effort, they take into consideration ongoing activities such as the nonpoint source pollution abatement and areawide water quality management plans for the Sheboygan River Watershed. The RAP is not limited to only working with established programs; new and innovative initiatives will also be considered.

Objectives and Rationale

This section lists the objectives and states the rationale for each goal of the Sheboygan River RAP.

Goal 1: Protect the ecosystem (including humans, wildlife, fish and other organisms) from the adverse effects (on the reproduction, survival, and health of individuals, and the integrity of interspecies relationships) of toxic substances.

Objectives

A) Significantly reduce inputs, with the goal of virtual elimination of persistent toxic substances to the Sheboygan River from all point and nonpoint sources.

B) Improve water and sediment quality to the extent that aquatic and terrestrial organisms are not adversely affected either through direct contact with contaminants or by consuming other contaminated organisms.

C) Eliminate the need for fish and wildlife consumption advisories.

D) Improve sediment quality so that, if dredging is necessary, disposal is not restricted because of contaminants.

E) Once the desired levels of water and sediment quality are achieved, maintain these through a program that encompasses an effective monitoring strategy along with a strong anti-pollution policy.

F) Increase public and private sector understanding of the sources of pollution, and encourage implementation and participation in pollution prevention and abatement programs.

Rationale

Goal 1 focuses on reducing inputs of toxic pollutants to the Great Lakes. It is the policy of the Great Lakes Water Quality Agreement (amended 1987) that: "The discharge of toxic substances in toxic amounts be prohibited and the discharge of any or all persistent toxic substances be virtually eliminated." In Wisconsin, discharges of toxic substances are currently regulated by Chapter NR 105, 106 and 207, Wisconsin Administrative Code. While dischargers cannot be forced through current regulations to virtually eliminate their discharges of toxic substances, they are encouraged to do so voluntarily. Another important aspect of this goal addresses protection of aquatic and terrestrial organisms and humans from the adverse effects of exposure (through the food chain or direct contact) to toxic substances. Once inputs of toxic substances are reduced or eliminated, it is crucial that monitoring and education continue so that these problems do not reoccur.

Goal 2: Maintain and enhance a diverse community of terrestrial and aquatic life and their

necessary habitat.

Objectives

A) Maintain a diverse resident fishery and, with attainment of the toxic objectives, establish seasonal runs of coho, chinook and salmon.

B) Restore and protect the diversity and abundance of the benthic invertebrate, zooplankton, phytoplankton and aquatic macrophyte communities.

C) Protect and restore natural areas (green spaces) along the waterway and enhance habitat for all aquatic and terrestrial communities.

D) Restore degraded wetlands which help to maintain water quality and provide important habitat for fish and wildlife populations.

E) Coordinate with existing programs and promote new efforts to involve the public in the physical clean-up of the river and any other projects to improve habitat and water quality.

Rationale

This goal stresses the importance of restoring and maintaining diverse communities of aquatic and terrestrial organisms and their associated habitat. Strongly encouraging public participation in restoring habitat and keeping the waterway clean will foster an awareness of the place of humans in the ecosystem.

Goal 3: Control eutrophication (nutrient enrichment of water), and sediment loadings to the Sheboygan River for the protection of Lake Michigan.

Objectives

A) Continue to control nutrient inputs to the Sheboygan River and nearshore areas of Lake Michigan to meet the goals of the Great Lakes Water Quality Agreement and to reduce occurrence of undesirable algae in the marina and other nearshore areas.

B) Reduce suspended solids concentrations in the Sheboygan River to meet a mean concentration of 25 mg/L during 90 percent of the time and reduce bedload (solids transported and deposited along the river bottom) by 50 to 75 percent.

C) Protect natural areas along the waterway and restore areas where banks are unstable to prevent erosion into the river.

D) Enhance public understanding of nonpoint source issues and encourage participation to support this goal.

E) Encourage understanding and active support of nonpoint source, pollution prevention and abatement programs among public officials.

Rationale

The negative impacts of excessive nutrient and sediment loadings are addressed in this third goal. An education component stresses the importance of knowledgeable citizens and local officials in addressing nonpoint source pollution issues.

Goal 4: Restore the river so that it is of recreational quality from its source to Lake Michigan.

Objectives

A) Reduce bacteria levels in the Sheboygan, Onion and Mullet Rivers to meet state recreational use standards.

B) Provide adequate public access and recreational facilities.

C) Develop a sense of stewardship, in both the public and private sectors, to improve and maintain water quality in the Sheboygan River so that all may realize and enjoy its recreational potential.

Rationale

The objectives of this last goal strive to enhance the recreational potential of the Sheboygan River so that all may enjoy its use. It is crucial to instill a sense of stewardship in the public and private sectors so once all objectives are realized, degradation of the ecosystem will not reoccur.

CHAPTER 5: Reaching RAP Goals Through Existing Programs

While the RAP serves to initiate remedial actions, it also works to unify remediation initiatives by combining efforts with existing programs. This chapter describes these ongoing programs that are working to restore the waterway quality of the Sheboygan River AOC.

According to the International Joint Commission (1991), several billion dollars have been spent since 1988 on remedial actions by local, state and federal programs that are already in place in the Great Lakes Basin. Continuing and improving such programs in the Sheboygan River Basin will prove essential in helping the RAP achieve its goals.

A description of each program and how it works toward RAP goals is provided in these sections:

- Recognizing Progress of Local Efforts
- Resource Management
- Pollution Abatement and Prevention
- Regulatory Programs

Recognizing Progress

The Sheboygan River RAP would like to recognize the following programs for having made considerable progress toward the goals of the RAP.

Sheboygan County Conservation Association (page 5-1)
Sheboygan County Water Quality Task Force (page 5-2)
Clean Sweep Programs (page 5-2)
Testing the Waters (page 5-2)
Nonpoint Source Water Pollution Abatement Program (page 5-3)
Assessment and Remediation of Contaminated Sediments (ARCS) Program (page 5-5)
Sheboygan River and Harbor Superfund Project (page 3-13)
Kohler Company Landfill Superfund Project (page 3-15)

Sheboygan County Conservation Association

The Sheboygan County Conservation Association celebrated its 50th anniversary in 1994. Thirty clubs representing approximately three thousand members currently comprise this alliance. Two delegates from each club attend the monthly meeting, which is held the third Wednesday of every month.

The Association complements their interest in harvesting wildlife with their active role in improving the environment for humans as well as wildlife. The funds for various association projects come from an annual banquet which has an attendance of 750 supporters. Appendix G, Sheboygan County Conservation Association Projects, lists the recent activities made possible by donor participation and sports person involvement.

The Association had these initial objectives:
- Coordinate work of the individual clubs in the county
- Encourage and promote conservation and sportsman work
- Promote better feelings between farmers, landowners, and sportsmen
- Cooperate with other conservation and sportsmen clubs
- Assist our state and national conservation and wildlife departments

Through the years, the Association adopted additional objectives. Some examples of educational programs the Association promotes are college scholarships, "Trees for Tomorrow Camp" sponsorship for high school students, middle and high school essay contests, and the annual White Tail night with speakers and seminars. The recent formation of the habitat and legislative committees gave way these activities:
- Planting the Jilin pheasant in Sheboygan and Ozaukee Counties (in cooperation with the Ozaukee Chapter of Wings Over Wisconsin)
- Establishing food plots for the pheasant and other wildlife
- Placing underwater forests and fish cribs in Elkhart Lake (with assistance from the WDNR)
- Increasing communication of concerns to WDNR and other government offices

Sheboygan County Water Quality Task Force

The Sheboygan County Water Quality Task Force was created in 1984 to explore possible clean up solutions and to coordinate restoration efforts for the Sheboygan River and Harbor. Task Force members include representatives from industry, government, fishing and conservation groups and the general public. The Task Force acts as an information and education liaison between the public and state and federal environmental agencies.

Clean Sweep Programs

Sheboygan County's first county-wide agricultural and household hazardous waste "Clean Sweeps" were held on April 2 and April 3, 1993, respectively. Eighty-seven farmers and 907 urban residents disposed of hazardous waste at the designated collection center. The first clean sweep was declared a great success, after collecting more than 19,000 pounds of hazardous waste. A post clean sweep survey indicated strong support for future county-wide hazardous waste collection programs.

A permanent household hazardous waste collection facility opened in January, 1995 in the City of Sheboygan. This facility was open a few days a week January through June, and provided Sheboygan County residents the opportunity to safely dispose of their hazardous household wastes. In addition, an informational brochure regarding the safe use and disposal of hazardous wastes was published for county residents this year. This pamphlet also addressed the issues of reusing and recycling certain household materials. Another successful county-wide agricultural "Clean Sweep" was held in April, 1995. This year 52 farmers participated, disposing of over 11,500 pounds of hazardous materials.

Testing the Waters

The Testing the Waters Program involves students monitoring local waterways to educate them about protecting and improving the environment. The program involves about 12 middle and high schools in Sheboygan County. Each year students and teachers involved in the program participate in a spring training session. Each fall, students report results of their testing at an all day Conservation

Congress. The representatives at this year's spring training program developed a standardized report format so information can be compared between rivers.

Following are the program objectives:

1) Provide training for teachers and students in riverine system ecology, Sheboygan River issues and intervention strategies to improve the watershed and the quality of life within the watershed.

2) Establish a network of high schools and middle schools collecting and reporting water quality data with a standardized format and an annual watershed forum.

3) Develop students who are knowledgeable of local environmental issues, competent in using scientific equipment and research methods and aware of potential careers in science, computer science and natural resources.

4) Develop a citizenry who is able to take active and responsible steps in resolving complex socio-environmental issues.

Nonpoint Source Water Pollution Abatement Program

Wisconsin's nationally renowned Nonpoint Source (NPS) Pollution Abatement Program continues to be an integral part of water quality restoration in the Sheboygan River AOC. The NPS Program was established in 1978 by the state legislature. Its purpose is to improve and protect the quality of streams, lakes, wetlands and groundwater by reducing pollutants from urban and rural nonpoint sources.

Sheboygan County contains 52 percent of the Sheboygan River Watershed. As of September 1995 over $2 million had been committed by the state to fund the counties and municipalities portion of the program. The funds go toward administration assistance to the counties and municipalities and implementation of environmentally conscious practices.

WHAT? Nonpoint sources include eroding agricultural lands, eroding streambanks and roadsides, runoff from livestock wastes, erosion from developing urban areas and runoff from established urban areas. Pollutants from nonpoint sources are carried to the surface water or groundwater via rainfall runoff, and snow melt.

WHO? The Program is administered by the WDNR and the Department of Agriculture, Trade, and Consumer Protection (DATCP). It focuses on critical hydrologic units called priority watersheds. The program is implemented through priority watershed projects for which a plan has been prepared.

WHERE? The Sheboygan River mainstem was designated a priority watershed in 1990. The RAP recommendations SA9 and SA10 beginning on page 6-48 is to have the Mullet River and the Pigeon River designated as priority watersheds.

HOW? Implementation is by local units of government. Water quality improvement is achieved through voluntary implementation of nonpoint source controls (best

management practices) and adoption of ordinances. Landowners, land renters, counties, cities, villages, towns, sanitary districts, lake districts, and regional planning commissions are eligible to participate. The program is divided into two parts: rural and urban.

Rural

More than 130 rural landowners have committed to spend over $1 million on best management practices (BMPs) to protect the river. These practices include barnyard control and manure storage systems, which will control nutrient and bacteria runoff from over 3,000 critical acres into the river. Farmers will also install fencing to keep cattle out of streams. In addition to these practices being implemented, three wetland restoration projects have completed in the area.

Urban

The Cities of Sheboygan and Sheboygan Falls and the Village of Kohler have all been active addressing nonpoint source pollution. Below is a brief explanation of some of their activities.

The City of Sheboygan has been addressing its urban nonpoint source pollution since 1992. Grant monies totaling $1.5 million have been allocated to the City from the WDNR's Nonpoint Water Pollution Abatement Program for their efforts. Much of the money has been directed towards the development of the Kohler Memorial Drive wet detention pond. This project is being developed to control heavily polluted runoff from a 326 acre drainage basin that is completely developed with industrial, commercial and residential establishments. The City is currently negotiating with Sheboygan County for purchasing the land where the pond will be located.

Other projects the City of Sheboygan is involved with include developing of a city-wide storm water management plan and designing and constructing of the Thomas Industries/Zimbal Farm wet detention ponds.

The Village of Kohler has completed a storm water management plan for Ravine Park Creek, which covered 750 acres. The Village subsequently completed a streambank project as recommended by the plan, which stabilized 1,000 feet of eroding streambank.

The City of Sheboygan Falls constructed the Bemis storm water wet detention pond. This pond was a demonstration project which cost approximately $60,000.

Assessment and Remediation of Contaminated Sediments (ARCS) Program

The Sheboygan River AOC was one of five AOCs selected for a 5-year study and demonstration project relating to the control and removal of contaminated sediments from the Great Lakes through the ARCS Program. This program is being coordinated and conducted by the U.S. EPA's Great Lakes National Program Office (GLNPO). A primary goal of the ARCS Program was to develop an integrated, comprehensive approach to assessing the extent and severity of sediment contamination, assessing the risks associated with that contamination, and selecting appropriate remedial responses in order to help support the implementation of RAPs (U.S. EPA, 1994). A pilot-scale demonstration project through the program studied bioremediation of the contaminated sediments in conjunction with Superfund activities being conducted by Tecumseh Products Company. (For more information on this study, please see "Sheboygan River and Harbor Superfund Project" on page 3-13.)

A risk assessment focusing on baseline human health risks resulting from exposure to sediment-derived contaminants at the Sheboygan River was also performed through the ARCS Program. The conclusions of the study are presented below (U.S. EPA, 1993).

"The results of this baseline human health risk assessment indicate that fish consumption should be avoided from the Sheboygan River AOC. In addition, dermal exposure to floodplain soils appears to be of marginal concern under the reasonable maximum exposure scenario. The results of this risk assessment are not directly comparable to the human health endangerment assessment given in the RI/ES report because different exposure parameters were often used. However, some generalizations can be made between the two risk assessments.

- PCBs accounted for most (or all) of the carcinogenic risk.
- Concentrations of PCBs in fish tissue collected from the Sheboygan River have decreased over the past 10 years. Although the carcinogenic risk for the typical exposure scenario has decreased by one to two orders of magnitude compared to the RI/FS endangerment assessment, the estimated risk levels still warrant a fish advisory for the AOC.
- The RI/ES report indicated that the noncarcinogenic risk from either consuming fish or dermally exposing the feet to river bank soils was not significant. Likewise, if heavy metals had been measured in the fish and soil samples used in this risk assessment, the noncarcinogenic risks would probably have been below a level of concern."

Resource Management

Resource management is an integral part of pollution monitoring, remediation, and prevention. Described below are the programs that strive to understand and improve conditions of Sheboygan River Basin waterways.

- Water Resources Management Programs
- Fisheries Management Program (WDNR)
- Wildlife Management Program (WDNR)
- Lake Michigan Lakewide Management Plan

Water Resources Management Programs

The Water Resources Management Program in the WDNR's Southeast District has a variety of responsibilities including: monitoring, conducting field investigations, areawide water quality plan updates, nonpoint source appraisals, and special studies. Described below are these water resources management programs:

- Surface Water Monitoring Program
- Sediment Management and Remedial Techniques (SMART) Program
- Fish Contaminant Monitoring for Consumption Advisories
- Experimental Fish Stocking in the Sheboygan River
- Tecumseh Pilot Studies Monitoring
- Otter Creek Evaluation Demonstration

Surface Water Monitoring Program

The purpose of the WDNR's surface water monitoring program is to provide the information required to meet water quality requirements set by the Natural Resources Board. The table below lists the objectives the program strives to achieve through various types of monitoring.

Table 5.1: Surface Water Monitoring Program Objectives.

Monitoring	Objective(s)
Condition Monitoring	- Characterize water conditions, uses, trends - Identify problem areas
Assessment Monitoring	- Identify pollution sources - Identify water management needs
Evaluation Monitoring	- Evaluate effectiveness of water quality management actions according to state standards and impaired uses of waterways

With Wisconsin's success managing point source effects on surface waters, more emphasis has been placed in recent years on other water quality problems such as toxic substances in water, sediment and biota, and nonpoint sources of pollution.

The WDNR's water quality monitoring program has evolved from assessing water quality based on single indicators, to a more integrated approach that evaluates the effects of specific discharges and substances on the entire aquatic ecosystem. This ecosystem approach complements the RAP's goals. While highest priority for monitoring is assessing effects of toxic substances and nonpoint source pollution, other monitoring activities such as surface water use classifications continue.

WDNR Water Quality Management Plans, updated every five years, address the water quality issues and problems in a given river basin. WDNR uses these basin plans for these purposes:

- Select priority watersheds and lakes for the Wisconsin Nonpoint Source Water Pollution Abatement Program
- Identify monitoring needs in the basin
- Note streams that need to be classified
- Identify lake monitoring needs
- Identify feasible projects that would improve water quality

Sediment Management And Remedial Techniques (SMART) Program

In 1989 the State Legislature recognized the need to address the issue of contaminated sediment by appropriating $240,000 annually to begin work in this field. The goal of the SMART Program is to restore surface waters which have been impaired or damaged by contaminated sediments. Activities to achieve this goal include: identification of the nature and extent of contamination, investigation of remedial measure options, implementation of effective remedial actions, development of sediment quality criteria, and monitoring the restoration of the resource. Proper remediation will assure that contaminated sediments no longer pose a threat to human health and aquatic life.

The responsibility for developing Wisconsin's overall sediment management program strategy has been assigned to the Surface Water Standards and Monitoring Section, Bureau of Water Resources Management. Since 1989, the Department's sediment management activities have increased. The SMART team is involved in a wide variety of activities including those described below.

1) Developing a comprehensive sediment management guidance document which will deal with the assessment and remediation of contaminated sediment, as well as related institutional and legal issues. The document will eventually contain sediment quality criteria, standard operating procedures for sediment sampling and monitoring, methods for performing ecological and human health risk assessments, engineering aspects of remediation design plans and feasibility studies of remedial alternatives, and a ranking system for prioritizing sites.

2) Compiling a statewide inventory of sites needing remedial action. Staff will conduct a statewide survey to identify sites that have, or potentially have, contaminated sediments. This will be accomplished in part through the basin assessment/basin planning process. Additionally, a scoring system will be developed to rank sites for

additional data collection, feasibility studies, and remediation.

3) Reviewing sediment quality in AOCs and developing sediment management options for the five remedial action plans in the state.

4) Tracking and commenting on developments from the U.S. EPA's Assessment and Remediation of Contaminated Sediment (ARCS) Program, as well as coordinating WDNR activities with the U.S. EPA, U.S. ACOE, NOAA, USGS and the Fish and Wildlife Service.

5) Conducting four sediment remediation demonstration projects in the state:

Starkweather Creek (Madison): Dredged 17,000 cubic yards of mercury-contaminated sediment; reshaped and stabilized the streambank; restored fish and wildlife habitat.

Cedar Creek (Cedarburg): Includes plans to model the amount of PCB being transported from sediment hot spots to the Milwaukee River and harbor, conduct a feasibility study of remedial alternatives.

North Avenue Dam Feasibility Study (Milwaukee): The feasibility study evaluated management alternatives relating to the retention, partial or complete removal of the dam. In addition, the environmental, economic and social benefits and effects of these alternatives were quantified.

Little Lake Butte des Morts (Neenah): Includes plans to conduct a feasibility study of remedial options for removing or isolating a 67,000 cubic yard deposit of soft sediment containing 3600 pounds of PCB, select the best overall environmental solution, and implement clean up in 1995.

Fish Contaminant Monitoring for Consumption Advisories

An updated sport fish consumption advisory was issued in April 1994. The advice lists species and sizes of sport fish containing contaminant levels that may pose a risk to humans if eaten in certain quantities. The Wisconsin Department of Health and Social Services (WDHSS) and the WDNR has updated the advisory each April and October since its inception in 1976. Fish from more than 235 Wisconsin lakes and rivers are covered by the advisory.

In the Sheboygan River, from the dam at Sheboygan Falls to the Coast Guard station at the City of Sheboygan, sport fish with PCB consumption advisories include these species: bluegill, brook trout, brown trout, carp, catfish, chinook salmon, coho salmon, crappie, northern pike, rainbow trout, rock bass, smallmouth bass, and walleye.

PCB levels in resident fish species continue to routinely exceed the advisory tolerance level. Contaminant concentrations range from 2-3 ppm in crappies and other panfish, 4 ppm for walleye and smallmouth bass, and up to 36.9 ppm in carp. The advisory lists most resident fish species in the "Do Not Eat" category.

WDHSS establishes appropriate health advice after reviewing fish contaminant test results with the

WDNR. To test fish contaminant levels, WDNR staff begin by collecting 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 the skin left on) are finely ground, placed in labeled jars, frozen and sent to a laboratory for contaminant analysis. WDNR records show that PCB levels in Lake Michigan fish have dropped more than 80 percent in the last decade.

Experimental Fish Stocking in the Sheboygan River

In 1986, the Department suspended stocking of trout and salmon after it was discovered that the stocked fish were accumulating high levels of PCBs before leaving the river. In 1990, WDNR initiated an experimental stocking study of trout and salmon in the Sheboygan River. The purpose of the study is to determine the effect of this short term, high exposure effect on the overall PCB level in adult, catchable size salmon which spend most of their life in the lake. Data from the study have been examined. Based on these results the Department made the decision to stock trout and salmon into the Sheboygan River in the spring only. When stocked in the spring, the fish spend very little time in the Sheboygan River before they migrate to the lake. See Appendix H for the completed report.

Pilot Study Monitoring

Please see information included in Chapter 7, Monitoring Strategy.

Otter Creek Evaluation Demonstration

Otter Creek was selected as an evaluation monitoring site for the Sheboygan River Priority Watershed Project. The creek was selected:

- Because of its manageable size, the stream's water quality problems and sources of pollution could be readily identified;
- The involvement of just three landowners would ensure stream improvements;
- The stream has the potential to respond quickly to the implementation of best management practices (BMPs). The stream isn't "dead", but is in fair to good condition.

The monitoring will document:

a) a decrease in sediment loading to the stream,
b) a reduction in bacteria and nutrient inputs to the stream,
c) improved in stream and near stream (riparian) habitats.

Chemical (water chemistry), physical (e.g. flow, habitat) and biological (e.g. fish and invertebrate) monitoring is being used for the project. Three years of pre-implementation monitoring data were

collected between 1991 and 1993. Post-implementation monitoring will begin following installation of best management practices (1996 or 1997).

The information that is collected will be used to:

a) gauge the success of the Sheboygan River Priority Watershed project on a local scale,

b) identify the effects/improvements of implementation of BMPs to the aquatic community, and

c) provide a reference for other priority watershed projects to show the benefits of implementing BMPs to the aquatic community.

WDNR Water Resources Biologists are currently analyzing the results of the pre-implementation monitoring.

Fisheries Management Program

The WDNR's Fisheries Management Program is responsible for protecting, maintaining and enhancing Wisconsin's fisheries and the habitat that sustains them. Program activities include conducting resource surveys to identify critical habitat and fish populations for environmental impact assessments, developing waste load allocations and reviewing permits. Other program activities are implementing and evaluating fishing regulations, developing habitat and stocking warm and cold water species, including Great Lakes trout and salmon. An important program component is the acquisition, development and maintenance of public access and fishing areas. Public education, management participation and the promotion of resource stewardship comprise the focus of public involvement in the fisheries program.

Pigeon River LUNKERS Project
This project was an effort to increase the quantity and quality of habitat in the Pigeon River for trout and salmon. LUNKERS structures provide bank cover, create overhangs, and give the streambank greater stability and protection from erosion.

Fisheries Management and RAP Goals
The objectives of the Fisheries' Strategic Plan, the Wisconsin Great Lakes Plans, Integrated Resource Management Plans and the goals of the Great Lakes Fish Community will be represented in RAP planning process. WDNR staff will work to ensure consistency among RAP goals, Fisheries Management goals and other Great Lakes Programs such as the Great Lakes Water Quality Agreement and Lakewide Management Plans. The RAP will work to unify the objectives of these programs.

Wildlife Management Program

The focus of the WDNR's Wildlife Management Program is to maintain healthy life systems for wildlife populations. The maintenance or restoration of healthy wildlife populations at AOCs are important aspects of the overall management program in the Bureau of Wildlife Management.

The Wildlife Management Program protects and enhances wildlife habitat on state and private lands. Lands are purchased to protect, restore, and develop wildlife-related recreation. The program operates over 440,000 acres of wildlife property in the state. The program manages wildlife populations by setting, implementing, and evaluating regulations based on population monitoring and surveys. Population management includes restoring viable populations of wildlife in Wisconsin. Wild turkeys were recently restored in the state and efforts are currently underway to bring back viable populations of pheasants. Wildlife management has led the way to the restoration of endangered and threatened species like osprey, bald eagles, trumpeter swans, peregrine falcons, and prairie chickens. The program is also involved in these activities:

- Water regulations permit and environmental assessment reviews
- Leasing private lands for hunting, public education, and wildlife damage and nuisance control
- Monitoring wildlife for environmental contaminants.

Wildlife toxicology
The wildlife toxicology program was initiated to identify problems, assess remediation progress, and protect wildlife consumers and wildlife health. Wildlife disease surveillance, diagnosis, and suppression minimize the risk of disease outbreak in wildlife populations.

Habitat management programs related to water quality in the basin

Habitat restoration initiatives related to watershed enhancement include wetland restorations and grassland restorations. Over 100 wetlands have been restored within the basin in cooperation with the U.S. Fish and Wildlife Service and Soil Conservation Service. These restorations provide wildlife habitat and improve water quality through sediment and nutrient retention and attenuations of flow rates. Grassland restoration within the basin has been primarily through the Federal Farm Bill Conservation Reserve Program as well as through WDNR-led cooperative projects for improvement of grassland and wetland wildlife habitat.

WDNR assisted the Fish and Wildlife Service in establishing several waterfowl production areas (WPAs) in Ozaukee County (Town of Belgium). As land is acquired, these areas will have wetlands restored and grasslands or other permanent cover established.

The Sheboygan Marsh is managed in cooperation with Sheboygan County to maintain fish and wildlife habitat and related recreation. Water level management is conducted to maintain aquatic vegetation within this restored wetland basin. Maintaining emergent vegetation provides wildlife habitat and improves water quality as well. Management of water levels at both Kiel Marsh Wildlife Area and Sheboygan Marsh moderate water flows and helps reduce in-stream erosion.

Lake Michigan Lakewide Management Plan

Lake Michigan was the first site chosen by the U.S. EPA, as part of the 1990 Great Lakes Critical Programs Act, to develop and implement a Lakewide Management Plan (LaMP). The LaMP is meant to identify lakewide problems, quantify loads of pollutants, identify sources of those loads and implement control strategies to reduce or eliminate the loads of toxic substances to Lake Michigan. The second draft of the Lake Michigan LaMP was released for review in Fall 1993.

The U.S. EPA is working in conjunction with federal, state, tribal and local agencies, the public, and the regulated community to direct existing programs and establish new programs as a part of the LaMP. The LaMP and the RAP complement each other's goals. The RAP targets the reduction or virtual elimination of pollutants causing problems in Great Lakes rivers and harbors, while the LaMP targets reduction of pollutants affecting the entire lake. The LaMP has two primary environmental objectives:

1) To achieve specific reductions in the release and deposition of pollutants in the Lake Michigan ecosystem on established time tables and to isolate, treat, and/or remove contaminated sediments to levels that provide:

   - Water quality and sediments capable of sustaining communities of sensitive living resources (aquatic or terrestrial); and

   - Drinking water, fish, and wildlife which pose minimal risks upon human or wildlife consumption.

2) To virtually eliminate the release of persistent, toxic, and/or bioaccumulative pollutants within the Lake Michigan Basin in order to prevent any further degradation of Lake Michigan and to avoid costly remedial actions in the future.

Pollution Abatement and Prevention

Pollution abatement and prevention are a high priority for all 43 RAPs in both the United States and Canada. Many programs are working on the federal, state and local level to encourage pollution abatement and prevention activities in all aspects of our society. Below is a brief description of some of these activities.

Federal and State Involvement

This section describes the federal and state involvement in pollution abatement and prevention. More specifically, it describes the U.S. Pollution Prevention Act and Wisconsin's Pollution Prevention Management Groups.

U.S. Pollution Prevention Act

The 1990 Pollution Prevention Act set forth a national policy aimed at controlling pollution by means of reducing pollutants at the source or prior to generation. Section 6602(b) of the act outlines the "pollution prevention hierarchy," or preferred methods of controlling pollution:

> "...pollution should be prevented or reduced at the source whenever feasible; in an environmentally safe manner, whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner."

Pollution prevention programs seek to prevent contamination through source reduction. Section 6603(5) of the Pollution Prevention Act provides a definition of source reduction as any practice that:

1) Reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and

2) Reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.

Wisconsin's Pollution Prevention Management Groups

Pollution prevention in Wisconsin is managed by three bodies: the Hazardous Pollution Prevention Board, the WDNR's Hazardous Waste Minimization Program, and the Solid and Hazardous Waste Education Center. In addition, the Department of Development administers Hazardous Pollution Prevention Audit Grants to promote voluntary pollution prevention by business and industry.

▸ **Hazardous Pollution Prevention Board**
Established by the Wisconsin Legislature, the Hazardous Pollution Prevention Board advises various state departments and agencies, recommends educational priorities, and reports pollution prevention efforts to interested branches of state government.

The Board works with the University of Wisconsin-Extension to identify the educational components necessary to a non-regulatory pollution prevention technical assistance program. These components relate to volume and toxicity of hazardous substances, classes of toxic pollutants and hazardous materials produced, questions of compliance, the potential for hazardous pollution prevention, and anticipated shortfalls in hazardous waste treatment.

▸ **WDNR Hazardous Waste Minimization Program and Office of Pollution Prevention**
WDNR 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 of Pollution Prevention is responsible for training state regulatory personnel for pollution prevention issues. The office is also responsible for creating a focus for multimedia policy development, recognizing businesses for pollution prevention successes and identifying pollution prevention reporting and environmental needs. The Hazardous Waste Minimization Program operates an information clearing house including over 150 pollution prevention publications and a limited technical assistance program, sponsors outreach workshops for industry and publishes a newsletter concerning pollution prevention issues.

Supplemental to the above education efforts, the office has set up an information depository and technical assistance program in cooperation with the University of Wisconsin-Extension (UWEX) Solid and Hazardous Waste Education Center (described below). This Pollution Prevention Information Clearinghouse is designed to educate pollution generators and regulators about solutions to general and technical problems that impede effective pollution prevention.

▸ **UW-Extension Solid and Hazardous Waste Education Center**
The Solid and Hazardous Waste Education Center (SHWEC) is a free, non-regulatory educational program established under the authority of Wisconsin Act 335 by the state legislature and administered by UWEX. SHWEC provides information and assistance to help industry, business, local government, and citizens meet regulatory mandates, reduce waste volumes and protect the environment. The Center's programs, described below, are funded by the Wisconsin legislature and available grant funding. Through these programs, SHWEC reaches large and diverse audiences. The Pollution Prevention and Integrated Waste Management Programs, for example, have reached several thousands of people state wide.

Educational Outreach Programs provide a forum for SHWEC pollution prevention specialists to assist industry, business, municipalities, and government agencies in finding ways to achieve source elimination, substitution or reduction of toxic releases and hazardous wastes. Assistance comes in the form of seminars, presentations, and technical assistance.

Pollution Prevention Programs inform interested individuals such as residents,

manufacturers, regulators, waste water treatment practitioners and local governments about pollution prevention methods. Topics include pollution prevention measures for processes such as metal finishing, paints and coatings, machine and fabrication, cleaning and degreasing operations and service industries such as dry cleaning and vehicle maintenance and repair.

SHWEC specialists provide technical assistance through non-regulatory on-site pollution prevention assessments and through detailed literature searches to address specific process or problematic requests. In the last half of 1992 over 25 entities in southeast Wisconsin requested specific technical assistance through on-site assessments or by telephone consultation. Requests for detailed assistance are expected to increase as more small businesses become aware of this free non-regulatory program.

The Integrated Waste Management Program provides educational programming for municipalities, businesses and consumers on recycling topics including legal and technical issues. Information is provided for individuals, municipalities and businesses on waste processing technologies such as yard waste composting, solid waste composting, waste-to-energy and material recovery facilities and the legal and technical aspects of landfill siting and operation.

▸ **DOD Hazardous Pollution Prevention Audit Grant Program**

The Department of Development's (DOD's) Hazardous Pollution Prevention Audit Grant Program encourages business and industry to evaluate their hazardous waste generating processes in order to target pollution prevention opportunities.

Grant applicants must pay up to 50 percent of the cost of the waste audit, identify the auditor and report to the state a summary of the audit findings within 60 days after completion of the audit. Grants are limited to $2,500 or half the cost of the audit, whichever is less. Grant recipients must also develop and implement a plan that uses the information from the audit to revise waste management practices.

DOD staff members are responsible for providing a copy of each application to the Hazardous Pollution Prevention Board, which awards the grants. The DOD is also responsible for evaluating applications, making the actual grant application and reviewing the audit and implementation summaries submitted by the recipients. When evaluating grant applications, DOD staff consider the following criteria:

- The applicant's ability and willingness, both technically and financially, to implement hazardous pollution prevention methods
- The volume and toxicity of hazardous substances, toxic pollutants and hazardous waste used or produced by the applicant
- The secondary uses of the information gained from specific applicants hazardous pollution prevention audit
- The legislature's directive to provide grants to a variety of industries

U.S. EPA - 33/50 Program

The U.S. EPA's 33/50 program is a nation-wide voluntary pollution prevention initiative which began in February 1991, aimed at reducing emissions of toxic chemicals from industrial sources. The program targets 17 chemical groups for reduction:

- Benzene
- Cadmium and cadmium compounds
- Carbon tetrachloride
- Chloroform (trichloromethane)
- Chromium and chromium compounds
- Cyanide compounds and hydrogen cyanide
- Lead and lead compounds
- Mercury and mercury compounds
- Methylene chloride (dichloromethane)
- Methyl ethyl ketone
- Methyl isobutyl ketone
- Nickel and nickel compounds
- Tetrachloroethylene (perchloroethylene)
- Toluene
- 1,1,1, trichloroethane (methyl chloroform)
- Trichloroethylene
- Xylene (all xylenes)

The program is taking a multi-media approach (air, water, land) to reduce the release of the 17 toxic chemical compounds by major dischargers by an aggregate of 33 percent in 1992, and a 50 percent reduction by 1995. The Toxics Release Inventory (TRI) will be used to track these reductions using 1988 data as a baseline. The program aims to achieve these targeted reductions through encouraging industry to further develop its pollution prevention activities.

According to the baseline data, 1.4 billion pounds of the targeted chemicals were either released to the environment or transferred off-site to waste management facilities in 1988. The aim is to reduce this figure to 700 million pounds by 1995.

The U.S. EPA sent letters to CEOs of companies emitting the largest quantities of the targeted chemicals in mid 1991, inviting their companies to join this voluntary program. In Wisconsin, approximately 224 industries were contacted. Of the industries contacted in the state, 35 (as of March 1992) agreed to voluntarily decrease their emissions as set forth in the 33/50 program (Nowakowski, 1992). The U.S. EPA estimates that by 1995, companies in Wisconsin will eliminate emission of 10.5 million lbs/year (of the 35.1 million lbs/year currently emitted) of the 17 targeted chemicals.

Regulatory Programs

Regulatory initiatives are a necessary part of reducing and eliminating the amounts of toxic pollutants from entering our waterways. These initiatives, combined with voluntary compliance, will enable us to meet RAP goals.

- Wastewater Management Program (WDNR)
- Solid and Hazardous Waste Management Program (WDNR)
- Water Regulation and Zoning Program (WDNR)
- Air Management Program (WDNR)
- Superfund Program (U.S. EPA)

Wastewater Management Program

The mission of the WDNR's Wastewater Management Program is to protect, maintain and improve the chemical, physical and biological quality of state waters. The WDNR manages present and potential point sources of discharge and related sludges toward that end. The program has these goals:

- Protect public health
- Safeguard fish, aquatic life, scenic and ecological values
- Enhance the urban and rural uses of water by regulation and control of point source discharges

At the WDNR Southeast District, wastewater is divided into Industrial and Municipal Wastewater Programs, which are described below.

Industrial Wastewater

Industrial **direct** discharges to Wisconsin ground and surface waters are regulated through WDNR's Wisconsin Pollution Discharge Elimination System (WPDES) permits. There are two types of WPDES permits: a specific permit for an individual discharge and a general permit for discharge that falls into a particular category. To date, WDNR's Southeast District has issued about 150 specific permits and about 600 general permits.

Industrial **indirect** discharges to publicly owned treatment works (POTW) are regulated by WDNR's pretreatment program. Industries discharging to POTWs with a design flow of greater than 5 MGD (million gallons per day) are administered pretreatment permits. These pretreatment permits are administered by the POTW (wastewater treatment plant) receiving the discharge. Industries discharging to POTWs with a design flow of less than 5 MGD (million gallons per day) are administered pretreatment permits by the WDNR. To date, about 270 Southeast District industries have been administered pretreatment permits by POTWs and about 50 by the WDNR. Industries wishing to discharge directly to surface water must be able to meet state water quality standards in their effluent. As with municipal WWTPs, monitoring requirements are included in WPDES permits and are based on an analysis of discharge from the facility.

Federal regulations requiring storm water permits for certain categories of industrial and municipal discharges became effective November 1990. The regulations emphasize the use of "source area control" best management practices to prevent contaminants from getting into storm water. The

WDNR is the authority for storm water permitting in Wisconsin, and is in the process of developing permit rules for municipalities and industries. The permit rules for industries will classify industries as high-priority or low-priority polluters. WDNR expects to have the codes approved for industrial permits in 1995.

Once an industry receives a storm water permit, it has 36 months to comply with the following four steps:
1) Perform storm water self-audit
2) Develop and obtain approval of a compliance plan
3) Install best management practice
4) Establish ongoing monitoring practices.

Municipal Wastewater

Municipal wastewater discharges are regulated through the Wisconsin Pollution Discharge Elimination System (WPDES). WDNR drafts and issues permits for a period of five years to treatment plants. Municipal permits are expected to come out in four to five years.

Treatment plants conduct initial effluent sampling and report their results to WDNR before they can receive a permit. Effluent limits are based on daily, weekly and monthly averages of discharge. Monitoring requirements are also included in WPDES permits and are based on an analysis of discharge from the facilities.

Most facilities with permits are required to send monthly reports indicating their monitoring results to the WDNR for review. In addition to this monthly reporting, municipalities must report annually to the state. The purpose of these reports is to provide the community, as well as the WDNR, with an assessment of the current conditions of the wastewater treatment plant and the collection system.

Solid and Hazardous Waste Management Program

The Solid and Hazardous Waste Management Program at Southeast District has four organizational sections:
- Hazardous Waste Management
- Solid Waste Management
- Emergency and Remedial Response
- Recycling

Hazardous Waste Management

The function of the Hazardous Waste Program is to ensure that hazardous waste generators and transporters, as well as treatment, storage and disposal facilities are complying with regulations so that contamination (e.g. of soil and groundwater) from hazardous waste does not occur. Hazardous waste regulations are found in Chapter NR 600-685 of the Wisconsin Administrative Code.

The Southeast District Hazardous Waste Program is responsible for licensing hazardous waste

transporters and treatment/storage/disposal facilities, conducting site inspections of facilities where hazardous waste is managed (e.g. transporters, treatment and storage facilities), and responding to complaints. The program also coordinates remedial measures and offers a Technical Assistance Program to prevent pollution.

Remedial measures A remedial aspect is included in this program. If site contamination (e.g. soil, groundwater) is found, the WDNR can require the facility to undergo closure until the contamination is addressed. Included in closure plans are proposals for cleaning up the contamination.

Pollution prevention Pollution prevention is another important aspect of the Hazardous Waste program. The Hazardous Waste Minimization Technical Assistance Program is discussed in the Wisconsin Pollution Prevention Management Groups section on page 5-13. It provides general information on waste minimization for all generators and specifically targets three categories:

1) Electroplaters and metal finishers
2) Auto repair and body shops
3) Local governments, universities and trade schools

Solid Waste Management

The Solid Waste Management Program (Chapter NR 502, Wisconsin Administrative Code) is responsible for licensing and overseeing solid waste disposal facilities (e.g. landfills) and storage facilities and for reviewing initial site reports, feasibility reports and in-field conditions reports: plans of operation, site construction documentation, closure plans, and land spreading plans and modifications. The program is also responsible for licensing and oversight for solid waste transportation, transfer, incinerators, air curtain destructors, processing, wood burning, one time disposal and small demolition facilities, as well as implementation of the state's infectious waste program.

The goal of the program is to ensure that efficient, nuisance-free and environmentally acceptable solid waste management procedures are practiced so that they do not have a detrimental effect on wetlands, critical habitat areas, and surface and ground water quality. During the operation of a landfill and prior to closure, assessment and monitoring must be conducted. If contamination is found, remedial measures must be taken to correct the problems.

Environmental Response and Repair

The Environmental Response and Repair Program at the Southeast District WDNR is responsible for the implementation of the state's environmental repair programs and corresponding federal programs described below.

The Leaking Underground Storage Tank (LUST) Program provides federal resources and authority to clean up petroleum leaks and spills from underground storage tanks.

The Superfund Program provides federal resources and authority to respond directly to releases (or threatened releases) of hazardous substances that could endanger human health or the environment (see Superfund Program description on page 5-23).

The Wisconsin Environmental Repair Program utilizes state resources provided through the Environmental Fund (EF) to correct environmental damage problems which are not eligible for remedial action under the Superfund Program.

The WDNR operates a Hazardous Substance Spill Program under the authority of s. 144.76, WI Statutes. When a spill (or discharge) occurs, the WDNR's primary role is to protect the environment. The party responsible for the spill is required to undertake the cleanup action deemed necessary by the WDNR. If the identity of the responsible party is unknown, the WDNR is authorized to take the necessary action to return the environment, as nearly as possible, to its condition prior to the spill.

The Abandoned Container Program (s.144.77 WI Statutes) requires responsible parties to properly monitor and maintain containers of hazardous substances. If the WDNR determines that a container containing a hazardous substance is not being adequately monitored and maintained, the WDNR has the authority to take the action it deems necessary under the circumstances. Such action is usually limited to cases constituting an imminent threat to public health, safety, welfare, or the environment and typically consists of repackaging of the hazardous material, or removal and disposal.

The Environmental Response and Repair (State Superfund) Program is administered by the WDNR under the authority of s. 144.442, WI Statutes. The WDNR may use the authority of this statute to undertake environmental response and repair actions or enter into contracts with any person to take such action. The WDNR is authorized to seek recovery of its environmental response and repair costs from any responsible party if: the responsible party should have known that the disposal was likely to result in or cause contamination; if the responsible party violated any legally applicable requirement and the violation caused or contributed to the contamination; or if the responsible party's actions caused or contributed to the contamination and would result in liability under common law in effect at the time the disposal occurred.

Recycling

The function of the Recycling Program is to implement and administer the State of Wisconsin's "Recycling Law" (Wisconsin Act 335, 1990). The law is a broad statute that will change the state's throw-away habits. The purpose of the Recycling Program is to reduce the use of landfills and incinerators, and emphasize waste reduction, reuse, recycling and composting methods.

The Recycling Program has numerous pollution prevention related goals:

1) Recycle 25 percent of solid waste by 1995
2) Recycle 30 to 40 percent of solid waste by 2000
3) Involve 100 percent of the state's population in the recycling program by 1995
4) Provide convenient yard composting and oil collection facilities for all residents by 1995
5) Require 40 percent recycled paper content in paper products purchased by governments agencies by 1995.

6) Require newspapers to contain 45 percent recycled paper content by 2001.
7) Require plastic containers to contain 10 percent recycled plastic content by 1995.
8) Expand use of tires, glass, paper mill sludge, wastepaper, and ash in road construction.

The program works with the Department of Development (DOD) and the Wisconsin Housing and Economic Development Authority (WHEDA) to provide businesses economic assistance; DATCP to establish labeling standards and monitor market entry of new or existing recyclable products; and DILHR to modify commercial building codes to require building owners to allocate space for recycling.

By 1995, all communities which receive state recycling grants will be required to define and measure their solid waste stream, recyclables generated, and residual materials landfilled. This will enable the WDNR to closely monitor recycling and landfill activities and work with communities to reduce waste generation and illegal disposal.

Ninety percent of the communities in SED (65 percent state-wide) already participate in the Grant Program, which provides monies to responsible units for recycling and yard composting activities. Eight-hundred communities state-wide have started or plan to start a recycling program in the near future.

Currently, the City of Sheboygan, the City of Sheboygan Falls and the Village of Kohler all have mandatory curbside recycling collection. Sheboygan also has several sites where residents can drop off recyclables. In addition, drop-off sites for compost materials and wood are available in the area.

Water Regulation and Zoning Program (WDNR)

The Water Regulation and Zoning Program protects public rights and interests in surface waters by providing the services listed below. Permits are required for these types of projects: grading, utility crossings, ponds within 500 feet of a water body, culverts, and outfall structures into a water body.

- Protection of the public trust in navigable waters through the regulation of certain physical alterations in and near navigable lakes and streams
- Oversight of local zoning of shoreland areas near navigable waters to protect water quality, natural scenic beauty, and wildlife and fish habitat
- Oversight of local zoning of identified flood hazard areas
- Regulation and inspection of new and existing dams
- Mapping and taking inventory of wetlands

Specific functions of the WDNR Southeast District program include:

Water Regulation. In the Southeast District, about 800 permit applications are received annually and reviewed by program staff. An additional 1500 to 2000 informal inquiries are received each year which do not proceed to a formal decision because they are not in compliance with state law. Some activities requiring permits include: dredging, grading, channel changes, diversions, and dam construction, operation and maintenance. Over 95 percent of the formal applications are granted, although the majority have been modified from the original proposal to conform to state law. Statewide, staff respond to approximately 300 inquiries regarding the U. S. Army Corps of Engineers' Section 10 and Section 404 permit programs.

Shoreland Zoning. Assistance is provided to counties to effectively administer zoning ordinances applying to areas near navigable lakes and streams. Seventy counties have both the "basic" shoreland and shoreland/wetland ordinances in place. In the Sheboygan River Basin, Sheboygan County is the only county with a basic shoreland ordinance. Most basin cities and villages (at least ten) have adopted wetland protection zoning ordinances; Sheboygan, Fond du Lac, Manitowoc, and Ozaukee Counties also have shoreland/wetland ordinances.

Dam Safety. This inspection program examines dams each year and provides substantial follow-up with dam owners who need to make repairs or take some other major action to improve safety of their dams. In the Sheboygan River Basin, there are 18 dams. Inspections have led to three repairs; none have been removed.

In 1990, staff were added to administer a grant program to assist municipalities in funding the cost of repair of their dams. Efforts are being made to increase the inspection staffing to meet the statutory requirement to inspect about 115 large dams each year statewide, a substantial increase above the current 50 inspected each year. Inspections are also made upon complaint that a dam is potentially unsafe.

Floodplain Zoning. Assistance is provided to communities in effectively administering their ordinances. Sheboygan, Fond du Lac, Manitowoc, and Ozaukee Counties and at least six basin cities and villages have floodplain zoning ordinances that meet or exceed minimum state standards. Communities are also assisted in meeting requirements of the National Flood Insurance Program.

Wetlands Inventory. Final Wisconsin Wetland Inventory maps have been completed for the entire state and have been issued to all counties and to most cities and villages which have wetlands in the shoreland areas. Wetland maps are being updated to reflect natural and human-caused changes. With existing funding, maps can only be updated on an average of once every 20 years. Efforts are being made to secure sufficient funds to change this interval to an average of 10 years.

Air Management Program (WDNR)

The Southeast District Air Management Monitoring Section measures actual concentrations of pollutants in the ambient air. The section monitors continuously for ozone, sulfur dioxide, nitrogen oxides, and carbon monoxide at several locations throughout the district. When an exceedance of a National Ambient Air Quality Standard (NAAQS) is measured, the Engineering section is assigned to determine responsibility for the exceedance.

The compliance units are responsible for evaluating whether the air pollution sources in the southeast district are in compliance with applicable Natural Resources Administrative Codes. The permitting unit is responsible for processing new source permits.

The Clean Air Act amendments of 1990 included regulations on hazardous air emissions. The Federal law requires the U.S. EPA to develop emission limitations for some 200 compounds over the next 10 years. The SED Air Management program will continue to carry out the hazardous air compound rules effective in October 1988 and phase in the U.S. EPA regulations as they are promulgated. By effectively implementing the Clean Air Act Amendments, the Air Management Program is doing its part in helping to achieve the goals of the RAP by ensuring industry compliance with the hazardous air emission reduction goals.

The public can call their WDNR district office and obtain prerecorded reports on the current air quality in the southeast district. The monitoring section is responsible for updating the recorded messages on a daily basis. The monitoring section has also been involved in a special study concerning the effects of Lake Michigan on localized meteorological conditions along the lake shore and the atmospheric transport of ozone precursors into and out of the district.

Superfund Program (U.S. EPA)

The Superfund program, officially known as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) was enacted by the federal government in 1980 and amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA). The National Contingency Plan (NCP) is the regulation that implements CERCLA. The goal is to select and implement remedies that protect human health and the environment, that maintain protection over time, and that minimize untreated waste. U.S. EPA believes that treating waste is the best method for achieving long term protection. The NCP promotes use of innovative technologies in order to bolster development of new methods to ensure long-term protection.

U.S. EPA uncovers potential hazardous waste problems through many sources including reports from states, communities, businesses, the U.S. Coast Guard, and citizen reports to the National Response Center's 24 hour hotline (1-800-424-8802). Most long-standing hazardous waste sites took years to develop. Cleaning them up to protect people and environments is also a lengthy and painstaking process.

Each Superfund site is unique. Hence, there is no general, all-purpose solution to Superfund site clean up. The NCP has a set of ground rules for selecting Superfund cleanup actions which include:

- Overall protection of human health and the environment;
- Compliance with other Federal and State environmental laws;

- Long-term effectiveness and permanence;
- A preference for reduction of waste toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Feasibility of implementation;
- Cost;
- State acceptance; and
- Community acceptance.

The major steps in the Superfund process are:

* **Remedial Investigation (RI)/ Feasibility Study (FS):** The RI/FS consists of detailed studies to assess what contaminants are present and their extent, an evaluation of potential and actual risks to human health and the environment, and an identification and evaluation of potential cleanup alternatives to address the problem. In addition, treatability studies may be done in order to determine which cleanup methods may be most effective.

* **Selection of Remedy and Record of Decision:** The lead agency (U.S. EPA or State agency) will propose a cleanup option, in a document called the Proposed Plan, to the public for a minimum 30-day public comment period. A public meeting is also held to present the recommendation, answer questions, and take public comments. At the end of the public comment period, the Record of Decision is completed, documenting the selected remedy and the basis for it. A Responsiveness summary is included which provides a response to the public comments.

* **Remedial Design (RD)/ Remedial Action (RA):** The RD consists of the detailed engineering plans and specifications for construction and implementing the cleanup. The RA is the construction phase and consists of the actual implementation of the remedy.

* **Operation and Maintenance (O&M):** O&M is defined as those activities required for maintaining the effectiveness of the cleanup action. The O&M phase begins once the remedy has achieved the remediation goals and objectives defined in the ROD for non-groundwater remedies. For groundwater remedies, the first ten years of pumping and treating the groundwater are considered part of the RA; the time thereafter needed to achieve the cleanup objectives are considered O&M. O&M is required when waste is left on the site and may include periodic inspections and maintenance of waste containment measures, long-term air or water monitoring, groundwater and/or leachate collection and treatment, etc.

* **Site Completion/Deletion:** The site completion phase follows the implementation of all appropriate remedial actions and the attainment of the cleanup objectives defined in the ROD. In addition, the site is determined to be protective of human health and the environment across all pathways of exposure.

  A site may be deleted from the NPL when no further response is appropriate, such as when all appropriate remedial actions have been implemented. The deletion process includes the publication of a Notice of Intent to Delete in the Federal Register and local newspaper(s), and a 30-day public comment period. Following public comment, a final decision is made and published in the Federal Register.

  The potentially responsible parties (PRPs) for a site may enter into a legal agreement with the U.S. EPA and or the State Agency to conduct the RI/FS and/or the RD/RA and O&M. If a

settlement cannot be reached with the PRPs within specified periods of time, or if they are unwilling, or there are no viable PRPs, Superfund monies may be expended to conduct these Superfund activities.

For a complete description of the two Superfund sites located within the AOC, please see Chapter 3.

CHAPTER 6: RAP Recommendations

The 29 recommendations presented here were derived from a list of suggested actions developed by the work groups described on page 6-5. The recommendations are grouped according to activity type: Assessment and Monitoring (A&M), Specific Actions (SA), and Information and Education (I&E). Many of these recommendations are implementable in a 2 to 5 year period.

As funding for these projects is secured and programs are set in place, we will learn more about what it will take to restore and maintain Sheboygan River basin waterways. Subsequent recommendations will materialize to address these newly identified needs. The RAP Implementation Committee (RIC), described on page 8-1, will work to coordinate and unify all restoration efforts.

The first section of this chapter provides a table that summarizes the recommendations. The second section describes how the work groups developed these recommendations. The last two sections provide a description of each recommendation.

- Summary of Recommendations
- Recommendation Development by Work Groups
- Recommendations with an AOC Focus
- Recommendations With a Basin-wide Focus

Summary of Recommendations

An asterisk (*) signifies that progress has already been made.

Table 6.1: Summary of RAP Recommendations.

Recommendation	Leaders	Est. Cost	Page No.
RECOMMENDATIONS WITH AN AOC FOCUS			
A&M 1: Conduct Water Quality Monitoring*	WDNR	$23,400/yr	6-6
A&M 2: Conduct Macroinvertebrate Populations Analysis*	WDNR, UW-Stevens Point	$11,400/yr	6-8
A&M 3: Conduct Fish Community Evaluations*	WDNR	$64,960/yr	6-9
A&M 4: Conduct Fish Health Assessment*	WDNR	$20,000/yr	6-11
A&M 5: Assess Fish Tissue Contamination*	WDNR	to be determined	6-13
A&M 6: Assess Wildlife Tissue Contamination	WDNR	to be determined	6-15
A&M 7: Conduct Wildlife Health Assessment	WDNR	$30,000/yr	6-17
A&M 8: Monitor Bioaccumulative Toxicants	WDNR	$80,000	6-19
A&M 9: Develop a Sediment GIS*	WDNR	$67,000	6-21
A&M 10: Assess PCB Congener and PAH Contamination and Toxicity in the Sheboygan AOC	WDNR	$80,000	6-23
A&M 11: Conduct Phytoplankton/Zooplankton Degradation Assessment	WDNR	$50,000	6-25
SA 1: Expedite Implementation of Superfund Records of Decision	Superfund, Responsible Parties, WDNR	unknown	6-27
SA 2: Develop Protective Zoning for Shoreland Wetlands	Local municipalities	unknown	6-29
SA 3: Evaluate/Implement Removal of River Bend and Walderhaus Dams	WDNR, Area Conservation Assns.	$35,000 - $80,000	6-31

Recommendation	Leaders	Est. Cost	Page No.
SA 4: Develop/Implement/Enforce Erosion Control Ordinances*	WDNR; UWEX; local municipalities	$100,000/yr	6-33
SA 5: Implement a Storm water Management Plan for the City of Sheboygan*	City of Sheboygan; WDNR	$2.7 million	6-35
SA 6: Clean Up Contaminated Sediment*	Superfund; Responsible parties; WDNR	to be determined	6-38
I&E 1: Install Environmental Awareness Signs*	UWEX	$210/sign	6-40
I&E 2: Increase Awareness of Fish Consumption Advisory*	WDNR; UWEX; DHSS	$2,500	6-42
RECOMMENDATIONS WITH A BASIN WIDE FOCUS			
SA 7: Protect and Restore Critical Wetlands Tributary to the Sheboygan River*	WDNR, NRCS	$24,000	6-44
SA 8: Pursue Additional Funding for Nonpoint Projects on the Onion River	Sheb. Cty LCD; WDNR; Sheb. Cty Conservation Association	$4 million	6-46
SA 9: Recommend the Mullet River as a Large Scale Priority Watershed Project	Sheb. Cty LCD; WDNR; DATCP; Sheb. Cty Conservation Association	$6.4 million	6-48
SA 10: Recommend the Pigeon River as a Large Scale Priority Watershed Project*	Sheb. Cty LCDt; WDNR; DATCP; Sheboygan Cty Conservation Association	$6.4 million	6-50
I&E 3: Establish a Water Quality Awards Program	Sheboygan Cty Conservation Association; SCWQTF; RAP Implementation Committee	$200/yr	6-52

Recommendation	Leaders	Est. Cost	Page No.
I&E 4: Strengthen Community Participation in the Sheboygan River Priority Watershed Project*	RAP Implementation Committee; Sheb.Cty LCD; citizens' organizations; WDNR; UWEX	unknown	6-54
I&E 5: Conduct Stormsewer Stenciling Program	Maywood; UWEX; WDNR	in kind	6-56
I&E 6: Encourage Responsible Vehicle Waste Oil and Antifreeze Disposal*	RAP CAC; Sheboygan Cty Conservation Association; Sheboygan Cty Interfaith Environmental Committee; SCWQTF; WDNR	$2,500	6-58
I&E 7: Develop Sheboygan River Basin Awareness Program*	WDNR; SCWQTF; Maywood; Sheb. River Priority Watershed Project; Sheboygan Cty Conservation Association; Sheboygan Cty Schools	$24,500	6-60
I&E 8: Continue Testing the Waters Program*	Maywood; Riveredge; WDNR; area schools	$2,700 / school	6-62

Recommendation Development by Work Groups

The three work groups described below were formed to develop suggested actions to restore impaired uses in the Sheboygan River and Harbor. The work groups met to define the causes and sources of impaired uses, and suggest remedial actions. The recommendations included in this chapter were developed from these suggested actions, which were evaluated and prioritized by the Citizen's Advisory Committee for selection. Further recommended actions will materialize into future recommendations as more projects are implemented and more is understood about the most efficient and lasting ways to restore the Sheboygan River and Harbor.

The Water Quality Work Group involved representatives from local environmental organizations, federal, state and local agencies, area businesses, local schools, and concerned citizens. The work group members analyzed the causes and sources of water quality impairments in the AOC and developed a course of action to assess and remedy the problems associated with degraded water quality.

The Biota Work Group included biologists and ecologists from WDNR, agency representatives, concerned members of local environmental organizations and area schools and businesses. Recommendations developed by this group were aimed at restoring habitat for fish and wildlife populations in the AOC. The group focused on site-specific restoration of physical habitat and land as well as resource management policies for fish and wildlife.

The Information and Education Work Group consisted of local school, business, community and government representatives. The group developed education program recommendations to educate citizens throughout the Sheboygan River Basin about environmental quality and pollution prevention.

Recommendations with an AOC Focus

The recommendations included in this section are those with a focus on the Sheboygan River Area of Concern (AOC). To avoid confusion, all assessment and monitoring recommendations are included in this section, but some may be applied basin-wide.

Assessment and Monitoring Recommendations

The following recommendations involve assessment and monitoring. Adequate monitoring will enable us to make informed, cost- and resource-effective decisions during remediation. By measuring water quality before, during and after RAP work, we can measure our progress.

A&M 1: Conduct Water Quality Monitoring*

Conduct water column monitoring to identify loadings of critical pollutants, identify water quality variables known to influence the bioavailability or toxicity of pollutants, and detect loadings of compounds that other monitoring efforts have identified as causes for concern.

Rationale

Benefits

- Identify sources of pollutants to the AOC.
- Quantify water quality variables known to influence bioavailability or toxicity of pollutants.
- Provide information for long-term trend analysis.
- Provide water quality data necessary for evaluating effectiveness of remedial actions.

Use Impairments Addressed

All

Cost and Funding

Item	Estimated Cost	Funding Options
Sample Collection	$3,000/yr	-GLNPO (U.S. U.S. EPA) - State RAP funding
Lab Analysis	$20,400/yr	

Implementation

Leader(s)

WDNR.

Short-term Steps

1) Compile all existing water quality data for the Sheboygan River Basin.
2) Select sites for water quality monitoring to coordinate with other monitoring efforts (sediment, macroinvertebrate studies).
3) Monitor the following aspects of water quality.

a) Water quality variables; measure at 4 sites, during high and low flow conditions:

- Dissolved oxygen
- Volatile solids
- chlorophyll a
- Alkalinity
- pH
- Chlorides
- Total Suspended Solids
- Total Organic Carbon
- Fecal coliform
- Hardness
- BOD_5

b) Nutrients (sample with water quality variables, above)

- Total Phosphorus
- Soluble Phosphorus (ortho)
- Nitrogen (TKN, NH_3, Nitrite, Nitrate)
- Soluble Silica

c) Water column metals (low level technique, total recoverable); measure at 4 sites, during high and low flow conditions:

Cd	Cr and Cr^{+6}
Cu	Zn
Pb	Ni
As	Cn
Se	Ag

d) Critical pollutants PCBs and PAHs; measure at 4 sites, during high and low flow conditions.

Long-term Steps

4) Execute monitoring plan (Step 3) annually.
5) Evaluate water quality monitoring program and modify, when appropriate, toward measuring continuous improvement.

Progress*

Step 1)	In progress.
Step 2)	Ongoing.
Step 3)	Most parameters listed in parts a) and b) were monitored through the Sheboygan River Basin Water Quality Monitoring in 1994.

Related Existing Activities

- See the WDNR Water Resources Management Programs on page 5-6.
- See Sheboygan River and Harbor and Kohler Landfill Superfund program descriptions beginning on page 3-13.

A&M 2: Conduct Macroinvertebrate Population Analysis*

Assess benthic macroinvertebrate populations throughout the AOC annually. More specifically, evaluate benthic invertebrate community population structure and biomass.

Rationale

Benefits
- Identify long term changes in water and sediment quality.
- Provide criteria for delisting the AOC use impairment "degradation of benthos."

Impaired Uses Addressed
- Degradation of benthos

Cost and Funding

Items	Estimated Cost	Funding
Sample collection by two people	$2400/week	Options: - U.S. EPA funding - RAP funding
Sample processing and identification	$7500 (25 samples @ $300/sample)	
QA/QC (20%)	$1500	

NOTE: Cost is dependent upon the number of samples that need analysis.

Implementation

Leader(s)
WDNR, UW-Stevens Point (for analysis of macroinvertebrate communities), and other contracted laboratories.

Short-term Steps
1) Obtain funding.
2) Identify sampling locations. (Control site could be any location upstream of the confluence with the Mullet River.)
3) Collect benthic grab samples, and deploy Hester-Dendy artificial substrate samplers.
4) Process samples, key invertebrates to the species level.

Long-term Steps
5) Track long term trends.
6) Statistically compare sample compositions to reference site or control site conditions for delisting purposes.

Progress*

Step 1) In progress (submitted proposal to Great Lakes National Program Office for funding consideration).

Steps 2-3) Preliminary, non-quantitative sampling was done as part of intensive monitoring. Future recommendations will be made after sample analysis.

Related Existing Activities

- WDNR's supplemental monitoring in the Sheboygan River AOC.

A&M 3: Conduct Fish Community Evaluations*

Conduct standardized long-term monitoring of fish community composition as an indicator of overall health and integrity of the fish community. Monitor species occurrence and relative abundance over time to assess the cumulative effects of all the factors affecting the fish community.

This monitoring involves conducting an evaluation of the fish community each year for three years to establish conditions from which to judge improvement. After the baseline is established, conduct monitoring during the basin assessment year, with follow-up sampling in intermittent years. Conduct sampling at two to six stations throughout the AOC and appropriate control/reference sites (located upstream of the Sheboygan Falls Dam). Stations should represent important or major habitat types within the AOC.

Rationale

Benefits

- Provide information to assess the viability of resident fish populations.
- Better quantify impairment of fish community.
- Provide long-term trend monitoring data.
- Provide information to assess the overall effect of improvements in habitat, water quality, sediment quality and other factors.

Impaired Uses Addressed

- Degradation of fish and wildlife populations.
- Loss of fish and wildlife habitat.

Cost and Funding

Items	Estimated Cost	Funding
SHORT TERM		
Fish community monitoring	$64,960 per year for three years	Options: - U.S. EPA special project funding - Great Lakes funding
LONG TERM		
Revisit every 5 years to assess trends	$64,960 per year	see above

Implementation

Leader(s)
WDNR.

Short-term Steps

1) Obtain funding.
2) Design monitoring protocol (sampling locations, gear, etc.).
3) Measure the following community variables of the collected fish.

- Number of species collected
- Number of individuals collected (catch per unit effort)

4) Determine community richness, diversity, and evenness from collected information.
5) Conduct follow-up sampling in intermittent years as needed.

Long-Term Steps

7) Assess effectiveness of methods used and make necessary modifications.
8) Continue monitoring to determine long-term fish community trends.
9) Delist use impairments according to delisting criteria when warranted. *See IJC Delisting Criteria on page 7-9.*

Progress*

Step 1) Ongoing.
Step 2) In progress.

Related Existing Activities

- Fisheries management monitoring of Great Lakes fish.
- Fish tissue contaminant monitoring of sport fish.
- Fish health assessment, A&M 4

A&M 4: Conduct Fish Health Assessment*

Conduct fish health assessments (FHAs) on selected species in the AOC.

Rationale

Benefits

- Provide information where none currently exists on the general health status of resident AOC fish to more precisely quantify use impairments.
- Provide insight to the causes of fish kills and poor fish health.
- Provide long-term trend monitoring data.

Impaired Uses Addressed

- Degradation of fish and wildlife populations.
- Fish tumors or other deformities.

Cost and Funding

Items	Estimated Cost	Funding
SHORT TERM		
Basin year fish health survey	$20,000 per year	Funding is available through the Bureau of Fisheries Management for a portion of the study. This project is contingent upon getting needed additional funding and assistance from area fish managers.
LONG TERM		
Continue each basin year (5 year schedule)	$20,000 per year	see above

Implementation

Leader(s)
WDNR.

Short-term Steps

1) Obtain funding.
2) Select representative species for fish community evaluation.
3) Catch fish for FHA; coordinate with fish tissue collections for contaminant analysis on page 6-13, 6-15.
4) Perform FHA on 30 individuals per species within the AOC as well as 30

individuals per species collected at reference sites. Measure the following:

General Variables
Length; Width; Age; Sex; External and internal rating of gross visual characteristics of skin, fin, gill, operculum, pseudobranch, thymus, eye, body, cavity, visceral fat, liver, spleen, gallbladder, kidney, stomach, intestine, etc.; Liver somatic index (% liver vs total visceral weight).

Blood Variables
Hematocrit; Leucocrit; Serum protein.

Fish Histopathology
Take tissue samples for histopathological examinations of any visually observable liver and skin lesions. Prepare slides and send to a registered histopathologist for examination.

5) Excise livers from a random subsample of individuals and prepare for histopathology analysis.

Long-term Steps
6) If a significant incidence of tumors is noted, propose additional surveys or studies to specifically address presence and extent of tumors.
7) Evaluate first round of FHA and modify protocol if needed for best results.
8) Continue long-term trend FHA and delist impaired waterway uses when appropriate. *See IJC Delisting Criteria on page 7-9.*

Progress*

Step 1)	Funding is available through the Bureau of Fish Management for a portion of the study per year.
Step 2)	In progress.

Related Existing Activities

- WDNR's fish kill investigations, which are currently performed on an as needed basis.

A&M 5: Assess Fish Tissue Contamination*

Conduct an intensive fish contaminant assessment every 5 years, following the state's Basin Assessment Schedule. Coordinate this effort with health and community structure assessments. This effort will help to evaluate sort-term bioaccumulation potentials and also compliment the WDNR's fish contaminant program to ensure the full utilization of limited monitoring monies.

Rationale

Benefits
- Track and evaluate contaminant trends in the ecosystem.
- Evaluate the effectiveness of environmental programs.
- Track progress toward delisting "Restrictions on Fish Consumption" as an impaired waterway use.

Use Impairments Addressed
- Restrictions on fish consumption

Cost and Funding

Items	Estimated Cost	Funding
SHORT TERM		
Sample collection	To be determined	Options: - Great Lakes funding - RAP funding - U.S. EPA (GLNPO)
Sample analysis	$1250/sample	
LONG TERM		
Sample collection	To be determined	Options: - Great Lakes funding - RAP funding - U.S. EPA (GLNPO)
Sample analysis	$1250/sample	

NOTE: Cost is dependent upon the number of samples that need analysis.

Implementation

Leader(s)
WDNR.

Short Term
1) Coordinate with the health assessment, described on page 6-11.
2) Conduct analysis at 2 locations: riverine site and harbor site.

3) Analyze these fish parameters:
   - Fish of each resident species (i.e. smallmouth bass).
   - Age class I+ and IV+ (or oldest class present insignificant numbers) .
   - Whole fish for each species and fillets for sport fish species.

4) Analyze fish for the following contaminants: mercury, PCBs, DDT, chlordane, dieldrin, PAHs and lipid content.

Long Term

5) Coordinate effort with the annual population survey, described on page 6-9.
6) Conduct analysis at two locations: riverine site and harbor site
7) Analyze fish for these parameters:
   - Age class I+
   - Forage and sport fish species
   - Whole fish for each species and fillets for sport fish species
8) Continue Analysis for the contaminants listed in Step 4.

Progress*

Step 1) Completed for white suckers in summer of 1994.
Step 2) Completed summer of 1994.
Step 3) Complete.
Step 4) In progress.

Related Existing Activities

- Current Fish Contaminant Monitoring for Sport Fish.
- Proposed Fish Community Structure on page 6-9.
- Proposed Fish Health Assessment on page 6-11.
- Proposed Recommendation to Increase Awareness of Fish Consumption Advisories on page 6-42.
- See WDNR Water Resources Management Programs on page 5-6.

A&M 6: Assess Wildlife Tissue Contamination

Develop and conduct a long-term wildlife monitoring program. Various techniques are available and others are becoming available to determine tissue concentrations of toxicants in wildlife, and to measure physiological responses to contaminant exposure in wildlife.

Rationale

Benefits

- Track and evaluate contaminant trends in the ecosystem.
- Evaluate the effectiveness of environmental programs.
- Track progress toward delisting "Restrictions on Wildlife Consumption" as an impaired use.

Use Impairments Addressed

- Restrictions on wildlife consumption
- Bird or animal deformities or reproduction problems

Cost and Funding

Items	Estimated Cost	Funding
SHORT TERM		
Sample collection	to be determined	Options: - Great Lakes funding - RAP funding - U.S. EPA (GLNPO)
Sample analysis	$100 to $1250/sample depending on analysis	
LONG TERM		
Sample collection	to be determined	Options: - Great Lakes funding - RAP funding - U.S. EPA (GLNPO)
Sample analysis	$100 to $1250/sample depending on analysis	

NOTE: Cost is dependent upon the number of samples that need analysis.

Implementation

Leader(s)
WDNR, Bureau of Wildlife Management.

Short Term
1) Obtain funding.
2) Determine target species and design sampling strategy.
3) Evaluate information to determine contaminant trends, and possible links to reproductive problems, tumors or deformities.

Long Term
1) Validate and correlate exposure biomarkers to reduce reliance on costly contaminant tissue determinations. Possible techniques (Patnode, 1995) include:
    a.) liver enzyme assays
    b.) porphyrin profiles
    c.) DNA damage assays
    d.) carbon and nitrogen isotope assessment
    e.) other techniques as they become available

Progress
Wildlife Management staff have collected small mammals for tissue analysis from different sites along the Sheboygan River.

Related Existing Activities

- WDNR's (Wildlife Management) Wildlife Biomonitoring Project on the Sheboygan River.

A&M 7: Conduct Wildlife Health Assessment

Conduct wildlife health assessments on selected species in the AOC. Compare to species found in areas not affected by bioaccumulative contaminants.

Rationale

Benefits

- Provide important baseline information on the general health of wildlife species found in and near the AOC
- Determine indicators of wildlife health for long-term trend monitoring

Use Impairments Addressed

- Degradation of wildlife populations
- Loss of wildlife habitat
- Restriction on wildlife consumption

Cost and Funding

Items	Estimated Cost	Funding
SHORT TERM		
Baseline Health Assessment	$30,000 per year	-Wildlife Management Contaminant Monitoring - EPA (GLNPO) - USFWS (Partnerships for Wildlife Program) -WDNR Great Lakes Funding - Great Lakes Protection Fund
LONG TERM		
Periodic Update (5-year schedule)	$30,000 per update	see above

Implementation

Leader(s)
WDNR

Short Term Steps
1) Obtain funding.
2) Select representative species for mammals, birds, amphibians and reptiles
3) Collect tissues for contaminant analysis
4) Monitor reproduction
5) Conduct habitat assessment
6) Collect samples for health assessment
   a. general: weight, age, sex, organ weights, bone weights, lengths and diameters
   b. blood: complete blood cell count, immune function assays, hormone concentrations, serum proteins
   c. histology: observable tumors/lesions, gonads, uteri, liver, kidney
   d. biochemistry: liver enzyme assays, hormone receptor assays

Long- Term Steps
7) If significant problems identified in screening assays, assessment would be modified to target effects and identify probable causes
8) Continue long-term monitoring on 5-year schedule to identify improvements in health in response to remediation efforts

Progress
Step 1: Funding currently being sought from Great Lakes Protection Fund for steps 3-6 for mink
Step 2: In progress
Step 3: Funding available for waterfowl contaminant analysis
In progress for mink in Sheboygan River basin

Related Existing Activities

- Waterfowl Consumption Advisory monitoring scheduled for 1995

A&M 8: Monitor Bioaccumulative Toxicants*

Determine the bioavailability of toxic substances (PCBs and PAHs and heavy metals), and bioaccumulation potential of PCBs to fish and other aquatic organisms in the Sheboygan River AOC. Collect benthic invertebrates, crayfish and fish species (one forage and one top predator), and employ semipermeable membrane devices (SPMDs) to monitor trends and availability of toxicants (wildlife species may also be collected to address possible effects on wildlife). The data from this monitoring will help identify possible sources (i.e. tributaries, in-place pollutants) of toxicants, and provide baseline information for long-term trend monitoring.

Rationale

Benefits

- Determine the relative bioavailability of toxicants to aquatic organisms between stream segments.
- Locate potential toxic sediment deposits.
- Monitor long term trends in contamination.
- Identify potential sources (secondary tributaries, in-place sediment deposits, point sources) of pollution and evaluate their relative importance.
- Compare the cost effectiveness and accuracy of environmental analysis tools.
- Provide a post-remediation evaluation of the effectiveness of the remedial actions completed to date.

Impaired Uses Addressed

- Restrictions on fish and waterfowl consumption
- Restrictions on dredging activities
- Degradation of benthos
- Degradation of fish populations
- Degradation of phytoplankton and zooplankton populations

Cost and Funding

Items	Estimated Cost	Funding
Sample collection	-SPMDs - $480/day -Macroinvert collection $2400 (2 people @ 1 week) -fish collection $3800 (3 people @ 1 week)	Options: - Great Lakes/RAP funding - U.S. EPA GLNPO funding
Lab analysis	-SPMDs- $550/sample -fish contaminants - $1250/sample -macroinvert analysis- $1250/sample -crayfish analysis - $1250/sample	

NOTE: Cost is dependent upon the number of samples that need analysis.

Implementation

Leader(s)
WDNR, Water Resources and Fisheries Management Sections

Short-term Steps
1) Obtain funding.
2) Choose 5 sites within the Sheboygan River AOC.
3) Expose SPMDs for specific length of time. Collect fish, invertebrates, and crayfish.
4) Analyze samples for the following toxicants: PCBs (total and congener specific); PAHs; and heavy metals.

Long-term Steps
5) Variance and regression analyses will be employed to detect significant differences and correlations among the data collected for each methodology.
6) Use environmental data assess the bioavailability of toxicants in the environment.

Progress*
Steps 1-3) Complete.

Related Existing Activities

- Lincoln Creek Storm water study in the Milwaukee River Basin.
- WDNR mussel bioaccumulation study in the Sheboygan River.
- Crayfish monitoring/ food chain analysis in the Sheboygan River.

A&M 9: Develop a Sediment Geographic Information System (GIS)*

Develop a data base to track historical data, as well as data generated from current and future sediment assessment projects. The data base will be used to develop sediment contour maps of the system and analyze data to determine significant depositional areas on which to focus future efforts.

Rationale

Benefits

- Display sediment data for use by decision makers and environmental planners.
- Utilize system as a tool to analyze existing sediment data and data generated by historic and current environmental assessment projects like the ongoing Superfund activities.

Impaired Uses Addressed

- Restrictions of fish and wildlife consumption
- Restrictions on dredging activities
- Loss of fish habitat

Cost and Funding

Items	Estimated Cost	Funding
SHORT TERM		
GIS system development; Data entry; Data analysis	$67,000	- Great Lakes/RAP funding - GLNPO (U.S. EPA)
LONG TERM		
Data entry/ analysis as data are collected	TBD	

Implementation

Leader(s)
WDNR.

Short-term Steps

1) Purchase computers and software.
2) WDNR develops system
3) Enter existing sediment data into system.
4) Utilize data management system to analyze information to date, and identify data deficiencies.

Long-term Steps

5) Fill data gaps.
6) Continually update system with new information from ongoing programs and assessment projects.
7) Utilize system to assist advisory groups in furthering sediment related remedial decisions.

Progress*

Step 1)	Complete.
Step 2)	Complete.
Step 3)	In progress.

Related Existing Activities

- Sediment GIS currently underway in the Milwaukee Estuary AOC

A&M 10: Assess PCB Congener and PAH Contamination and Toxicity in the Sheboygan AOC

This assessment will characterize sediment contamination and its biological and toxicological effects in the Sheboygan River AOC. This characterization will provide support for ongoing and potential additional efforts for contaminated sediment remediation. Proposed sediment assessments in the AOC must consider the role of Superfund and ERP efforts for investigating and remediating the system. Assessment needs not currently being addressed through these programs include:

- evaluating PCB congener (including coplanar congeners) distribution over the river's length (to expand upon the information developed through the Superfund process)
- investigating PAH distribution in the lower portion of the river (to expand on information developed from ERP's investigation of the manufactured gas plant site on the lower river)
- assessing benthic community health and sediment toxicity to improve understanding of the effects of contaminants in the aquatic ecosystem of the AOC.

Rationale

Benefits

- Characterize the nature and extent of sediment contamination in the Sheboygan River AOC, the first step in sediment remediation.
- Provide data to assess whether current measures to remediate/contain sediment are adequate to protect the ecosystem from toxic contamination.
- Provide data to generate estimates of contaminated sediment transport into Lake Michigan.
- Provide data to calculate biota-sediment bioaccumulation factors to determine the availability of contaminants to the food chain.

Use Impairments Addressed

- Restrictions on fish and wildlife consumption
- Restrictions on dredging activities
- Bird or animal deformities or reproduction problems

Cost and Funding

Items	Estimated Cost	Funding Options
PCB congener, PAH, TOC analysis of sediment cores and traps	$1250 per sample, per site	- GLNPO - WDNR
Benthic community analysis	-coordinate collection & identification with A&M 2 - approx. $12,000/year	
Sediment toxicity testing	$1600 per sample, per site	

NOTE: Cost is dependent upon the number of samples that need analysis.

Implementation

Leader(s)
WDNR

Short-term Steps

1) Obtain funding.
2) Collect and analyze cores as described below.
   a) Assess the extent of PAH contamination in the lower reaches of the Sheboygan River, near and below the abandoned coal gasification site.
   b) Conduct congener specific PCB analysis throughout the river, focusing on impoundments behind dams.
   c) Analyze sediment for TOC.
   d) Conduct sediment toxicity testing.
3) Collect and analyze sediment traps (same as steps 2b, 2c and 2d above)
4) Analyze benthic community structure (coordinate with A&M 2 where possible)
5) Map concentrations of contaminants in the Sheboygan River with a sediment GIS, as described in the recommendation on page 6-21, 6-23.

Long-term Steps

6) Use data generated to assess the adequacy of sediment remediation projects in the Sheboygan River.
7) Identify any additional clean-up needed to restore aquatic ecosystem.

Progress

Step 1) In progress: partial funding secured for collection and analysis of sediment cores. This includes money for steps 2 a, b, and c, and step 4.

Related Existing Activities

- Sheboygan River and Harbor Superfund Project
- WDNR's supplemental monitoring in Sheboygan River
- Recommendation for the monitoring of bioaccumulative toxicants

A&M 11: Conduct Phytoplankton/Zooplankton Degradation Assessment

Collect phytoplankton and zooplankton samples for identification and data analysis. This work will reveal the degree to which phytoplankton and zooplankton populations are degraded, signifying an impaired beneficial use of the waterway.

To date, the degradation of the phytoplankton and zooplankton population use impairment has not been adequately defined. A thorough understanding of these important elements of the aquatic food chain is vital to effectively manage our water resources.

Rationale

Benefits
- Provide information to establish baseline conditions of plankton and better define this impaired beneficial use.
- Provide data to facilitate long-term trend monitoring
- Provide information to use plankton as water quality indicators

Impaired Uses Addressed
- Degradation of phytoplankton and zooplankton populations
- Eutrophication or undesirable algae

Cost and Funding

Items	Estimated Cost	Funding
SHORT TERM		
Collect and analyze plankton samples during basin assessment year	$25,000	-RAP Funding -GLNPO
LONG TERM		
Continue data collection on 5 year schedule	$25,000	see above

Implementation

Leader(s)
WDNR

Short term Steps
1) Obtain funding
2) Determine sample sites and number of samples needed for analysis
3) Collect samples during basin assessment year
4) Analyze data and determine use impairments

Long-term Steps

5) Use information gathered to determine the causes of the impairment
6) Continue data collection on 5 year basin assessment schedule
7) Use data to develop indicators of water quality for long-term trend monitoring

Related Existing Activities

- WDNR's water quality monitoring during Sheboygan River Basin Assessment year.

Specific Action Recommendations

The following recommendations outline actions other than monitoring and education to help meet RAP goals.

SA 1: Expedite Implementation of Superfund Records of Decision

Two active Superfund sites are located within the Sheboygan River Area of Concern: 1) Sheboygan River and Harbor, and 2) Kohler Company Landfill. Both sites are in different stages of site clean up. Many of the public have expressed concerns that these projects are moving more slowly than they should.

With the help of two technical assistance grants, the public will become better informed about the status of the Superfund sites, and will be better able to express concerns and apply pressure where it is needed to effect prompt action. This recommendation outlines actions that should be taken to expedite clean up of these two sites.

1. The Sheboygan River and Harbor

The U.S. EPA has set a goal for issuing a proposed plan for final site clean up for late 1995. Many delays have caused the modification of previous schedules. The following actions are recommended:

a. U.S. EPA, WDNR and Tecumseh Products Corporation should mutually agree and adhere to a firm schedule leading to a record of decision. This schedule should be made publicly available and a process established for U.S. EPA and WDNR to provide regular status reports to the public.

b. The public should be kept informed of all Superfund activities, and be given the opportunity for input on a regular basis.

c. The public has the responsibility for commenting on all Superfund materials presented for public comment and to attend public meetings to have concerns addressed. If the public feels that the length of a comment period is insufficient, a request can be made to U.S. EPA to extend the comment period.

2. Kohler Company Landfill

The U.S. EPA gave the Wisconsin Department of Natural Resources the lead on this Superfund site after it was divided into two operable units. The ROD was issued for the first unit (the Source Control Unit) in March, 1992. The components of the selected remedy include closure of the landfill on an expedited schedule, placement of a multi-layer soil cap over the waste, and collection and treatment of leachate. Kohler Company is in the process of implementing the remedy with WDNR oversight. U.S. EPA provides technical support to WDNR as requested.

Kohler Company is in the process of completing a feasibility study of potential groundwater remedial actions in a report called: "Environmental Contamination Assessment/Remedial Action Alternatives." Once completed, WDNR (in consultation with U.S.EPA) will determine a recommended remedial action to address the groundwater and issue a Proposed Plan for public

review and hold a public comment period.

The following actions are recommended:

a. WDNR should work with Kohler Company to expedite closure of as much of the current operating landfill as possible. This will involve developing and following a firm schedule.

b. WDNR and Kohler Company should mutually agree and adhere to a firm schedule leading to a record of decision for the groundwater operable unit.

c. WDNR should have regular communication with the public regarding progress on this Superfund site.

d. BT^2 should hold regular public meetings to keep the public informed about this project and also to best represent the public's interests regarding this site.

e. RAP participants, concerned citizens, representatives and others must exercise their right to off comment during public comment periods.

f. The public has the responsibility for encouraging the responsible parties and WDNR to expedite implementation of the proposed plan and subsequent record of decision for this site.

Related Existing Activities For more detailed information about these Superfund sites, please see pages 3-13, 5-23.

SA 2: Develop Protective Zoning for Shoreland Wetlands

Sheboygan AOC municipalities should adopt protective zoning for wetlands within the shoreland zone along the Sheboygan River. This land is designated as an environmental corridor; however, this land is not protected by zoning unless the zoning is specifically adopted by the governing municipality.

Current protection for wetlands in the AOC consists of shoreland zoning ordinances administered by Sheboygan County, the City of Sheboygan and the Village of Kohler. As of January 1995, the City of Sheboygan Falls is in the process of developing their shoreland wetland zoning ordinance.

Ordinances implemented by the County and the City of Sheboygan protect wetlands that are in the shoreland zone which is within 300 feet of the ordinary high water mark of the River or to the floodplain boundary (whichever distance is greater) and within 1000 feet of a lake, pond, or flowage. These ordinances are in compliance with state mandated local zoning. The Sheboygan County ordinance protects wetlands of any size in the shoreland zone while the State mandate only requires protection of wetlands greater than five acres. Wetlands within this zone cannot be altered unless it is demonstrated the alteration will not have a significant adverse effect on wetland functions. Wetlands outside of the shoreland zone are not protected under local zoning.

Rationale

Benefits
-Prohibit environmentally incompatible development in the corridor.
-Preserve needed greenspace and habitat, which acts as a pollution buffer for the Sheboygan River.
-Protect wetlands within the shoreland zone

Impaired Uses Addressed
-Degradation of benthos
-Loss of fish and wildlife habitat
-Degradation of fish and wildlife populations

Cost and Funding

The shoreland wetland ordinances can be adopted through existing channels.

Implementation

Leader(s)
City of Sheboygan Falls; Village of Kohler; Sheboygan County; Bay Lake Regional Planning Commission; WDNR.

Short-term Steps
1) Municipalities develop a protective zoning ordinance for shoreland wetlands and present it to their respective councils.
2) Municipalities adopt shoreland wetland zoning ordinance.

Long-term Steps
3) Evaluate effectiveness of ordinances.

Progress*	
Step 1)	Complete for Sheboygan County, the City of Sheboygan and the Village of Kohler. In progress for the City of Sheboygan Falls.
Step 2)	Complete for Sheboygan County, the City of Sheboygan, and the Village of Kohler.

Related Existing Activities-Sheboygan County and City of Sheboygan Shoreland Wetland Zoning Ordinances.

SA 3: Evaluate/Implement Removal of River Bend and Walderhaus Dams

Conduct a feasibility study to evaluate the possibility of partial or total removal of the River Bend and Walderhaus Dams from the Sheboygan River. Implement the recommendations suggested in the feasibility study.

Dams create an impoundment, or a retention pond, just upstream of the dam, which contributes to the degradation of a river's water and ecosystem quality. Because of their frequent proximity to public parks, the impoundments are often valued locally for uses like ice skating or aesthetic qualities. The ecological impact of impoundments, however, presents barriers to fish movement, may create thermal pollution problems, and usually result in poor water quality because of chronic sediment and nutrient build-up (Pajak and Nelson, 1987). Rough fish such as carp replace game fish as sedimentation reduces habitat. Reduced current and the resulting sedimentation promotes excessive aquatic plant growth, which can impede recreational uses like swimming and fishing and degrade aesthetics (Marshall, 1988).

Shallow impoundments, given sufficient retention time, act as pollutant "sinks" (McIntosh, et. al., 1978). The pollutant contents on the bottom sediment are often several orders of magnitude greater that of the overlying water. When the sediments are disturbed, these pollutants can again be released into the water column.

Dam removal should not be initiated before PCB contaminated sediment can be remediated or sufficiently stabilized to prevent downstream transport.

Rationale

Benefits

-Improve water quality by increasing flow velocities and decreasing sediment accumulation at the dam sites.
-Improve waterway aesthetics.
-Increase the scope and quality of the habitat for area aquatic life.
-Increase sport fishing opportunities.

Impairments Addressed

-Restrictions on fish and wildlife consumption
-Degradation of fish and wildlife populations
-Degradation of benthos
-Loss of fish and wildlife habitat

Cost and Funding

Item	Estimated Cost	Funding Options
LONG TERM		
Feasibility/ design	$5000	- WDNR/Great Lakes/ RAP funding - Area Conservation Associations - Kohler Company
Dam Removal	$30,000 - $75,000[1]	
Impoundment rehabilitation	TBD	

[1] based on previous dam removal costs.

Implementation

Leader(s)
Area Conservation Associations, WDNR

Short-term Steps
1) Remediate and/or stabilize contaminated sediment areas that will be affected by dam removal.
2) Hire an environmental engineering firm to conduct the feasibility study and propose removal alternatives.
3) Kohler Company implements removal alternative with funding assistance.

Long-term Steps
3) Monitor changes in water and habitat quality.

Progress
NA

Related Existing Activities

Milwaukee River Basin Dam Removals:
-Woolen Mills Dam (concrete) removal
-Funk's Dam removal

SA 4: Develop/Implement/Enforce Erosion Control Ordinances*

Encourage Sheboygan River Basin municipalities to adopt and enforce construction site erosion control ordinances. Focus on areas that are seeing a lot of growth like the Cities of Sheboygan and Sheboygan Falls, the Village of Kohler and the Town of Sheboygan. Significant construction site erosion problems exist in these fast-growing municipalities. Sediment levels in urban runoff were 26 times higher than those from regulated municipal wastewater treatment plants, according to studies by the Natural Resources Defense Council (Jensen, 1988).

These municipalities are eligible for nonpoint funding assistance to hire and train erosion control staff. WDNR has a model ordinance that can be customized for specific cities, towns, and villages, depending upon their needs.

Rationale

Benefits
-Reduce sediment load to Sheboygan River Basin waters from urban nonpoint sources.
-Improve fish and wildlife habitat.

Impaired Uses Addressed
-Degradation of fish and wildlife populations
-Degradation of benthos
-Loss of fish and wildlife habitat
-Eutrophication or undesirable algae

Cost and Funding

Item	Estimated Cost	Funding
SHORT TERM		
Erosion control ordinance staff training and enforcement: 2.5 people @ $40,000/year	$100,000/ year	- State nonpoint funding (during the Sheboygan River Watershed Priority Watershed Program eligibility)

Implementation

Leader(s)
WDNR; UWEX; local municipalities.

Short-term Steps
1) Municipalities develop and adopt the ordinance with guidance from WDNR.

Long-term Steps
2) Municipalities continue to enforce ordinance effectively.

Progress

Step 1) Complete for the Village of Kohler. The Village has adopted and is enforcing a construction site erosion control ordinance consistent with the state model.
In progress for the Cities of Sheboygan and Sheboygan Falls. They are currently developing a construction site erosion control ordinance.

Step 2) Ongoing for the Village of Kohler.

Related Existing Activities

-About 40 Southeast District municipalities have adopted and enforce construction site erosion control ordinances.

SA 5: Implement a Storm Water Management Plan for the City of Sheboygan*

Create and implement a comprehensive storm water management plan for the city to identify potential methods to control storm water runoff. The Priority Watershed Plan has identified urban storm water as a major source of urban runoff to the Sheboygan River.

The nonpoint pollutant runoff generated from a major storm can be significant. A single storm event can generate most of the pollutants that enter a lake in a given year (Jensen, 1988). The table below lists the concentrations of pollutants in storm water runoff based on samples collected in Milwaukee, but this can be indicative of most urbanized areas. The concentration of many storm water pollutants is high enough to exceed water quality criteria in Chapter NR 105, Wisconsin Administrative Code, criteria on which many point discharge permits are based (Bannermann, 1993).

Table 6.1: Concentrations of Pollutants in Storm Water Runoff.
Urban data based on samples collected in Milwaukee from 1980-82 for the National Urban Runoff Program. Little Menomonee River data based on samples collected from 1976-79 for the Menomonee River Watershed Study.

Source Area	Suspended Solids (mg/L)	Total Phosphorus (mg/L)	Total Lead (mg/L)
Commercial	186	0.30	0.52
High Density Residential	174	0.46	0.32
Med. Density Residential	94	0.25	0.11
L. Menomonee (Agricultural)	241	0.57	0.06

Rationale

Benefits
-Reduce the amount of contaminants and sediment entering the Sheboygan River.
-Improve fish and wildlife habitat.
-Reduce toxicity to fish and wildlife.

Impaired Uses Addressed
-Restrictions on fish and wildlife consumption
-Degradation of fish and wildlife populations
-Degradation of benthos
-Restrictions on dredging activities
-Loss of fish and wildlife habitat

Cost and Funding

Item	Estimated Cost	Funding
SHORT TERM		
Plan	$173,000	- $86,000 from WDNR - $87,000 from City of Sheboygan
5 acre wet detention basin (includes land acquisition)	$2,500,000[1]	The City of Sheboygan will receive $1.2 million from the Sheboygan River Priority Watershed Program to construct this basin

[1] based on RUST Environment and Infrastructure Report, 1992.

Implementation

Leader(s)
City of Sheboygan; WDNR.

Short-term Steps
1) Obtain funding.
2) Hire a consulting firm.
3) Take an inventory of the situation:
   a) Obtain existing city data.
   b) Perform an exploratory field survey.
   c) Delineate the watersheds affected by storm water.
   d) Establish hydrologic-hydraulic parameters and summarize these parameters in a table.
   e) Document inventory findings.
4) Form a citizen storm water advisory committee.
5) Perform hydrologic-hydraulic analysis.
6) Develop alternative storm water management plans that identify source reduction and summarize costs.
7) City reviews alternatives.
8) Alternatives review meeting with statewide advisory committee, the City of Sheboygan, WDNR, and RUST. Select a recommended Basin Facility Plan.
9) RUST submits 15 copies of Basin Facility Plan for review by the City and WDNR.
10) RUST presents Basin Facility Plan to City committees and the Council.
11) RUST distributes final Report.
12) RUST implements Basin Facility Plan.

Long-term Steps
1) Continue implementing Phase I recommendations.

2) Finalize Phase II and begin implementation.
3) Continue to request state funding assistance for storm water management plan implementation.

Progress*

Steps 1-8) Complete for Phase I. Also, a grant was recently received for additional implementation projects in the Phase I area.
Phase II has since been recommended since the inception of this recommendation. Phase II expands the study area to include the entire City of Sheboygan. This phase of the project will be getting underway in the near future as funding has already been secured. ($59,000 from the City of Sheboygan and $6,000 from the WDNR.)

Related Existing Activities

-Deer Creek Watershed in the City of New Berlin.
-Meadowbrook Watershed in the Village of Grafton.
-Hasmer Lake Drainage Area in the Village of Jackson.
-Districts 2,4, and 7 in the City of Cedar Creek.
-East Side Drainage Basin in the City of Mequon.
-Village-wide study in the Village of Fredonia.

SA 6: Clean Up Contaminated Sediment*

Ensure that contaminated sediment problems in the AOC are remediated. Sediment remediation should be consistent with RAP goals.

Rationale

Benefits
-Improve water and ecosystem quality.
-Eliminate fish and wildlife consumption advisory.
-Eliminate contaminated sediments as a source of pollution to the Sheboygan River Basin waters.

Impairments Addressed
All

Cost and Funding

Remediation costs and schedules will be determined through the Superfund process.

Implementation

Leader(s)
Responsible Parties; WDNR.

Short-term Steps
1) Complete feasibility study which develops and evaluates potential cleanup alternatives.
2) Prepare and release the Proposed Plan which provides the Agencies' recommended clean up option.
3) Hold a 30 day comment period to invite public comments on Proposed Plan. Public meeting held during this period.
4) Complete Record of Decision and respond to comments.
5) Hold negotiations with potentially responsible parties for conductance of design and implementation of selected remedy.
6) Design remedy.
7) Implement clean up.

Long-term Steps
8) Evaluate effectiveness of clean up through long-term monitoring.
9) Implement subsequent remediation if evaluation deems necessary.

Progress*
Step 1) Tecumseh Products Company is conducting a feasibility study to consider the following remedial technologies for the Sheboygan River and Harbor Superfund Site:
-In-situ remediation: e.g. biodegradation, armoring, immobilization.
-Sediment removal: e.g. dredging, excavation.
-Dewatering: e.g. filtration, centrifuge, gravity settling.
-On-site treatment: e.g. extraction, PCB destruction, immobilization.

-Off-site management: e.g. confined disposal facility.
-Residuals management: e.g. solid waste landfill, off-site incineration, aqueous PCB destruction, PCB absorption.

Related Existing Activities

-Sheboygan River and Harbor Superfund Project
-Kohler Company Landfill Superfund Project

Information and Education Recommendations

The following recommendations outline steps that should be taken to educate all who affect and are affected by the Sheboygan River. A well informed public is essential for improving the quality of the Sheboygan River.

I&E 1: Install Environmental Awareness Signs*

Develop and install environmental action and awareness signs at locations where they are accessible to citizens and AOC waterway users. Sign topics will include contaminants in the river; food chains and fish advisories; nonpoint source pollution; and citizen pollution prevention techniques.

Rationale

Benefits
-Educate the public about water quality issues.
-Promote wise use of the riverine and Great Lakes coastal environment.
-Increase citizen involvement in decisions affecting the rivers and Great Lakes.
-Encourage individual responsibility for cleaning up and restoring AOC waterways.

Impaired Uses Addressed
All

Cost and Funding

Item	Estimated Cost	Funding
SHORT TERM		
Sign creation/ installation	$210/sign	- Nonpoint Program (Sheboygan River Priority Watershed Project)
LONG TERM		
Maintenance/ replacement	$210/sign	

Implementation

Leader(s)
UWEX

Short-term Steps
1)Identify target audiences: a) citizens who are not reached through formal education and b) waterfront amenities users.
2)Designate posting locations for signs.
3)Develop sign material.
4)Hire contractor to construct signs.

5)Install signs.
6)Notify public of signs.

Long-term Steps
7)Maintain signs.

Progress*
Steps 1-6)The Sheboygan River Priority Watershed Project has *completed* site-specific interpretive signs for placement throughout the watershed. In the Sheboygan area, signs will be posted at these locations:
-Rochester Park (Sheboygan Falls)
-River Park (Sheboygan Falls)
-Esslingen Park
-Kiwanis Park
-Deland Park
-Near the riverwalk at Riverfront Drive

Related Existing Activities

-Educational component of WDNR Southeast District's Priority Watershed Programs.
-Sheboygan River Water Quality Education Campaign

I&E 2: Increase Awareness of Fish and Waterfowl Consumption Advisory*

Increase awareness of fish and waterfowl consumption advisories, focusing on non-fishing consumers (those who do not fish but consume fish caught in the Sheboygan River Basin) and non-English speaking public. In 1992, a series of workshops targeted area Hmong anglers and fish consumers. The activities of these workshops, listed below, should be continued and expanded.

1)Translate consumption advisory and fish preparation information for foreign-speaking anglers.
2)Increase distribution of the advisory and post it in strategic locations.
3)Offer workshops as needed.

Rationale

Benefits
-Increase knowledge among fish and waterfowl eaters of their contaminants and water quality.
-Reduce the risk of health problems due to consuming contaminated fish and waterfowl by teaching anglers and hunters proper preparation techniques.

Impairments Addressed
-Restrictions on fish and wildlife consumption

Cost and Funding

Item	Estimated Cost	Funding Options
SHORT TERM		
Print 1500 info packets and maps	$1000	- local funding - RAP funding - US DHSS grants
Mail 1500 packets (+ map)	$1500 ($4125)	

Implementation

Leader(s)
WDNR; UWEX; DHSS.

Short-term Steps
1) Identify target audiences.
2) Translate advisory as necessary.
3) Post signs and provide advisory in locations accessible to target audience.
4) Conduct public workshops to publicize and demonstrate the best methods to clean and prepare fish to decrease the risk of exposure to contamination.

Long-term Steps

5) Evaluate project and make recommendations for future actions and expansion.

Progress*

1) A successful workshop for Hmong anglers was given in Summer of 1992. The next step is to identify new target audiences.

Related Existing Activities

-WDNR project in Sheboygan targeting Hmong anglers.

Recommendations with a Basin-Wide Focus

SA 7: Protect and Restore Critical Wetlands Tributary to the Sheboygan River*

Protect and restore wetlands tributary to the Sheboygan River by land acquisition, easements and restoration. Past wetland drainage activities (ditching, subsurface tiles) drastically reduced the distribution and abundance of shallow water wetlands. Wetland losses not only limit wildlife habitat and wildlife populations, but also lead to water quality deterioration and flooding.

Using a survey, inventory wetland data according to type and status. Use this data to compile a list of wetlands that are most critical to protect and/or restore.

Consider land acquisition, zoning and easements to protect the wetlands in critical danger of degradation; work with landowners to ensure protection. Select wetland restoration alternatives for critical degraded areas.

Rationale

Benefits
-Reduce flooding through attenuation of storm water.
-Reduce sedimentation and nutrient flow to rivers and Lake Michigan.
-Improve recharge of shallow aquifers.
-Protect wildlife habitat and water quality in area wetlands.
-Ensure that the most critical wetlands are identified and slated for restoration and protection.

Impaired Uses Addressed
-Degradation of fish and wildlife populations
-Eutrophication or undesirable algae
-Loss of fish and wildlife habitat

Cost and Funding

Items	Estimated Cost	Funding Options
SHORT TERM		
Restore 20 wetlands (about 1.5 acres ea)	$800/acre = $24,000	- NRCS - UWFWS - WDNR ▪ Great Lakes/RAP funding ▪ Section 319 funding - Wisconsin Coastal Zone Management funding

Implementation

Leader(s)
WDNR; Natural Resource Conservation Service (NRCS)

Short-term Steps
1) WDNR continues survey with local assistance from NRCS.
2) WDNR obtains funding for restoration work.
3) Prioritize wetlands according to need for protection and restoration.
4) Slate wetlands most critical for protection through land acquisition, easement or zoning.
5) Identify target sites for restoration in Sheboygan and Ozaukee Counties.
6) Implement restoration:
   a) Conduct site surveys to complete construction plans.
   b) Obtain competitive bids from private contractors.
   c) Select contractor(s); begin restoration work.

Long-term Steps
7) Maintain prioritized list of wetlands, and continue to take protective and restorative actions for the most critical wetlands when feasible.

Progress*
1) In progress.
5) Many sites in Sheboygan County have been targeted for restoration.

Related Existing Activities

- Southeast District WDNR's current wetland restoration efforts with NRCS.

SA 8: Pursue Additional Funding for Nonpoint Projects on the Onion River

Pursue additional funding for nonpoint pollution control projects on the Onion River. The Onion River was a Priority Watershed Project that was completed in 1989. The participation rate for landowner projects, however, fell far short of expectations. The Onion River is still significantly affected by nonpoint pollution, which also contributes to pollution levels in the Sheboygan River. Additional best management practices (BMPs) are needed in this area to reduce the runoff from farms and other areas. Examples of BMPs possible for implementation include barnyard runoff control systems, manure storage facilities, reduced tillage practices, streambank stabilization, shoreline buffers, and critical area stabilization.

Revisiting this nonpoint project to fund cost sharing projects would help control nonpoint pollution. Federal funding may be available for new cost sharing projects. Revision of administrative code NR 120 gives a provision to revisit critical areas.

Rationale

Benefits
- Reduce nonpoint pollution in the Onion and Sheboygan Rivers.
- Improve water quality and in-stream habitat.

Impaired Uses Addressed
- Restrictions on fish and wildlife consumption
- Degradation of fish and wildlife populations
- Degradation of benthos
- Restrictions on dredging activities
- Eutrophication or undesirable algae
- Loss of fish and wildlife habitat

Cost and Funding

Item	Estimated Cost	Funding Options
SHORT TERM		
Rural Implementation	$2,000,000	- WDNR - Federal 319 funds - Landowners (cost-share) - Coastal Zone Management
Urban Implementation	$2,000,000	Options: - WDNR - UWEX - Soil Conservation Service - Municipalities (cost-share)

Implementation

Leader(s)

Sheboygan County Land Conservation Department; WDNR; Sheboygan County Conservation Association.

Short-term Steps

1) Establish a list of nonpoint cost share projects to revisit as well as new projects.
2) Solicit funding.
3) Sign up landowners.
4) Monitor projects.

Long-term Steps

5) Establish a long term plan for continuous nonpoint pollution control.

Progress

This project is contingent on funding availability and subsequent adoption of revised Chapter NR 120, Wisconsin Administrative Code by the counties in the watershed for critical sites enforcement.

Related Existing Activities

- The Sheboygan County Conservation Association has allocated $10,000 to increase cost share to landowners for implementation of BMPs that will protect and restore streambanks for the Sheboygan River Priority Watershed project.

SA 9: Recommend the Mullet River as a Large Scale Priority Watershed Project*

Recommend that the Mullet River be designated as a large scale Priority Watershed Project under the Nonpoint Source Pollution Abatement Program. The Mullet River is a major source of sediment, nutrients, and bacteria that are contributing to eutrophication, sedimentation and siltation problems in the Sheboygan River. The high local support for this project will lend to local assistance during implementation.

Rationale

Benefits

- Provide cost sharing of land management practices to reduce nonpoint source pollution.
- Educate the public about nonpoint source pollution issues.
- Improve water quality and in stream habitat.

Impaired Uses Addressed

- Restrictions on fish and wildlife consumption
- Degradation of fish and wildlife populations
- Degradation of benthos
- Restrictions on dredging activities
- Eutrophication or undesirable algae
- Loss of fish and wildlife habitat

Cost and Funding

Item	Estimated Cost	Funding Options
SHORT TERM		
Rural Implementation	$4,200,000[1]	- WDNR - DATCP - Landowners (cost-share)
Urban Implementation	$2,250,000[1]	- WDNR - UWEX - NRCS - Municipalities (cost-share)

[1] Based on estimates made for the Sheboygan River Priority Watershed.

Implementation

Leader(s)

Sheboygan County Land Conservation Department; WDNR; Department of Agriculture, Trade and Consumer Protection (DATCP); Sheboygan County Conservation Association.

Short-term Steps

1) Propose the Mullet River for a large scale Priority Watershed Project in the next update of the Sheboygan River Basin Areawide Water Quality Management Plan Update (1994).
2) Determine the ability and willingness of the Sheboygan County Land Conservation Department to administer the rural portion of the priority watershed project.
3) The RAP Implementation Committee should work with the Sheboygan County LCD and other interested groups to deliver the proposal at the next NPS selection committee meeting, which will be held in spring 1994. The extent of local as well as agency participation will be deciding factors as the project undergoes consideration.

Long-term Steps

4) Once the Mullet River has been designated as a large scale Priority Watershed Project, maintain a high level of local support throughout the eight year implementation period.

Progress*

Step 1) Complete; applications were sent to Sheboygan County to solicit a proposal for Priority Watershed designation for 1999.

Related Existing Activities

- The Sheboygan County Conservation Assoc. has allocated $10,000 to increase cost share to landowners for implementation of BMPs that will protect and restore streambanks for the Sheboygan River Priority Watershed project.

SA 10: Recommend the Pigeon River as a Large Scale Priority Watershed Project*

Recommend that the Pigeon River be designated as a large scale Priority Watershed Project under the Nonpoint Source Pollution Abatement Program. The Pigeon River contributes significant amounts of sediment, nutrients, and bacteria to Lake Michigan.

Rationale

Benefits

- Provide cost sharing of land management practices to reduce nonpoint source pollution.
- Educate the public about nonpoint source pollution issues.
- Improve water quality and in-stream habitat.

Impaired Uses Addressed

- Restrictions on fish and wildlife consumption
- Degradation of fish and wildlife populations
- Degradation of benthos
- Restrictions on dredging activities
- Eutrophication or undesirable algae
- Loss of fish and wildlife habitat

Cost and Funding

Item	Estimated Cost	Funding
SHORT TERM		
Rural Implementation	$4,200,000[1]	Options: - WDNR - DATCP - Landowners (cost-share)
Urban Implementation	$2,250,000[1]	Options: - WDNR - UWEX - NRCS - Municipalities (cost-share)

[1] Based on estimates made for the Sheboygan River Priority Watershed.

Implementation

Leader(s)

Sheboygan County Land Conservation Department; WDNR; Department of Agriculture, Trade and Consumer Protection (DATCP); Sheboygan County Conservation Association.

Short-term Steps

1) Propose the Pigeon River for a large scale Priority Watershed Project in the next update of the Sheboygan River Basin Area Wide Water Quality Management Plan Update (1994).
2) Determine the ability and willingness of the Sheboygan County Land Conservation District to administer the rural portion of the priority watershed project.
3) The RAP Implementation Committee should work with the Sheboygan County LCD and other interested groups to deliver the proposal at the next NPS selection committee meeting, which will be held in spring 1994. The extent of local as well as agency participation will be deciding factors as the project undergoes consideration.

Long-term Steps

4) Once the Pigeon River has been designated as a large scale Priority Watershed Project, maintain a high level of local support throughout the eight year implementation period.

Progress*

Step 1) Complete; the Pigeon River has been designated by the DATCP Land and Water Conservation Board to be selected as a Priority Watershed beginning in 1999. This is dependent upon nonpoint source program funding.

Related Existing Activities

- The Sheboygan County Conservation Assoc. has allocated $10,000 to increase cost share to landowners for implementation of BMPs that will protect and restore streambanks for the Sheboygan River Priority Watershed project.

I&E 3: Establish a Water Quality Awards Program

Establish a yearly awards program for water quality efforts in the Sheboygan River Basin. Awards should be established for local community and environmental groups, industry, local government, and private citizens. Present awards at a local meeting of the Sheboygan County Conservation Association. The focus of the recommendation is to provide recognition for groups and individuals that are taking action to improve water quality in their community. Examples of these activities could include businesses implementing a pollution prevention program or minimizing their discharge; school, scout or other groups participating in clean sweeps and testing the waters; or individuals taking initiatives to actively improve water quality. Publicity of these events will encourage others to take part in actions to improve water quality.

Rationale

Benefits

- Increase awareness of efforts by various groups to improve water quality.
- Recognize groups that are improving water quality.
- Provide incentive for other groups to implement activities.
- Increase media coverage of water quality issues.

Impaired Uses Addressed

All

Cost and Funding

Item	Estimated Cost	Funding
Clean Water Award plaque for display for each of four categories	$50/award; x 4 awards = $200 per year.	Options: - Sheboygan County Conservation Association - Local businesses - Sheboygan County Water Quality Task Force

Implementation

Leader(s)

Sheboygan County Conservation Association; Sheboygan County Water Quality Task Force; RAP Implementation Committee.

Short-term Steps

1) Create an awards committee.
2) Committee designates awards and criteria for awards.
3) Committee advertises for nominations.
4) Committee accepts nominations.
5) Committee designates awards and notifies press.
6) Committee holds awards ceremony in conjunction with a Sheboygan County Conservation Association meeting.

Long-term Steps

7) Perform annually.

Progress
NA

Related Existing Activities

- "Clean Bay Backer" award in Green Bay.
- WDNR's monthly pollution prevention awards.

I&E 4: Strengthen Community Participation in the Sheboygan River Priority Watershed Project*

Solicit participation from citizens and local organizations in the Sheboygan River Priority Watershed. Involve citizens in identifying problem areas and assisting in signing up landowners. Recruit members of conservation organizations like the Wisconsin Conservation Corps (WCC) to help with fencing and erosion control projects.

Rationale

Benefits

- Improved water and habitat quality.
- Promote community stewardship of the Sheboygan River Priority Watershed Project.
- Through volunteer assistance, maximize results from existing funding.

Impaired Uses Addressed

- Restrictions on fish and wildlife consumption
- Degradation of fish and wildlife populations
- Degradation of benthos
- Restrictions on dredging activities
- Eutrophication or undesirable algae
- Loss of fish and wildlife habitat

Cost and Funding

Most of these activities can be completed with in-kind support of volunteers and funding from the Nonpoint Priority Watershed and Stewardship Programs.

Implementation

Leader(s)

RAP Implementation Committee; Sheboygan County Land Conservation Department (LCD); Citizen organizations; WDNR; UWEX.

Short-term Steps

1) Involve citizens in activities to assist the project by creating an information and education speakers' bureau consisting of local and state environmental experts to speak to interested groups. Coordinate this effort with the Sheboygan Watershed Citizen's Advisory Committee.

   TOPICS: Urban Water Quality Issues
   Rural Water Quality Issues
   AUDIENCES: schools, sportsmen' groups, conservation groups.

2) Encourage funding from private groups and county sources to be used as matching funds to increase state cost-share funding to a maximum of 80 percent.
3) Encourage the Pigeon River's selection as a Priority Watershed Program (page 6-50).
4) Encourage citizens to write letters to legislators telling them of their awareness of the need for rural and urban water quality education and implementation programs.

5) Organize and educate citizen groups; establish a time frame for landowner

contacts.

NOTE: Rural landowners must sign up by May 1995 to be part of the Priority Watershed Project. Practices will be implemented within five years after sign-up.

6) Recruit members of conservation organizations like the Wisconsin Conservation Corps (WCC) to help with fencing and erosion control projects.

Long-term Steps

7) Continue to encourage nonpoint pollution control practices in other areas.

Progress*

Step 2) Sheboygan County Conservation Associations allocated $10,000 to increase cost-sharing for streambank protection projects.

Related Existing Activities

- Current Sheboygan River Priority Watershed Education Component.

I&E 5: Conduct Storm Sewer Stenciling Program

Involve community groups in stenciling storm sewers to discourage dumping of wastes such as motor oil, paint, antifreeze, pet waste, fertilizers, and pesticides into storm sewers. Currently, many urban residents dump such wastes down storm sewers because they incorrectly believe that these sewers will carry waste to sewage treatment plants before discharge to local waterways. Communities in other states have successfully used storm sewer stenciling to largely dispel this misconception.

Rationale

Benefits

- Educate urban residents about storm sewers, and that they drain to nearby waterways.
- Discourage dumping of waste products into storm sewers.
- Improve water quality, appearance, aquatic habitat, and use of urban tributaries to the harbor.

Impaired Uses Addressed

- Restrictions on fish and wildlife consumption
- Degradation of fish and wildlife populations
- Degradation of benthos
- Restrictions on dredging activities
- Eutrophication or undesirable algae
- Loss of fish and wildlife habitat

Cost and Funding

Item	Estimated Cost	Funding Options
SHORT TERM		
Storm sewer stenciling coordination	in kind	- Maywood Environmental Education Center, Cooperative Extension
Paint, buckets, brushes, door hangers, safety vests for visibility	in kind	Options: - Donations - Stenciling group
Stencils, door hangers	in kind	- UWEX

Implementation

Leader(s)

Maywood; UWEX; RAP Implementation Committee; other interested groups.

Short-term Steps

1) Identify prospective stencilers, like scouts, school groups, environmental groups.
2) Locate sewers to be stenciled.

3) Obtain permission from local municipal governments for stenciling.
4) Hold stenciling training.
5) Distribute sewer stenciling kits.

Long-term Steps
6) Make plans to expand program.

Progress
NA

Related Existing Activities

- Successful stenciling program in Howard's Grove
- Well-established LMF Shorekeeper's Programs in Chicago and Muskegon, MI
- Statewide Adopt-A-Stream Program
- LMF's Beach Sweeps

I&E 6: Encourage Responsible Vehicle Waste Oil and Antifreeze Disposal*

Provide informational materials and technical assistance to disposers of vehicle oil and antifreeze. Disposal of such waste into landfills and storm sewers contaminates ground water and streams. Project focus is to educate disposers about improper disposal effects, proper disposal methods, and recycling options. While oil disposal into landfills has been banned since 1991, antifreeze disposal has not.

Rationale

Benefits

- Reduce discharge of vehicle oil and antifreeze into storm and sanitary sewers or landfills, which contaminates groundwater and streams.
- Educate the public about proper disposal of these wastes.
- Improve water quality.

Impaired Uses Addressed

- Restrictions on fish and wildlife consumption
- Degradation of fish and wildlife populations
- Degradation of benthos
- Restrictions on dredging activities
- Eutrophication or undesirable algae
- Loss of fish and wildlife habitat

Cost and Funding

Item	Estimated Cost	Funding
SHORT TERM		
Educational fact sheet (Step 2); initial printing and distribution	$2000	Options: - RAP/Great Lakes funding - Local business and industry - Educational grants - Nonpoint source education funding
LONG TERM		
Update educational fact sheet	$500	Options: - RAP/Great Lakes funding - Local business and industry - Educational grants

Implementation

Leader(s)

RAP Implementation Committee; Sierra Club - Algonquin Shores Group; Izaak Walton League; Sheboygan County Conservation Association; Sheboygan County Water Quality Task Force; WDNR.

Short-term Steps

1) Identify target audiences, e.g.: do-it-yourselfers; auto repair shops; auto and truck dealerships; farm implement dealers and manufacturers; technical school students.
2) Prepare and distribute a fact sheet to target audiences about improper disposal effects and proper disposal methods, as well as disposal site locations and hours, e.g. post in stores where people buy oil/antifreeze.
3) Educate antifreeze consumers on the benefits of using antifreeze mixtures that are composed primarily of propylene glycol. This is a virtually non-toxic alternative to ethylene glycol and eliminates the need for special disposal.
4) Create an incentive for auto repair shops to collect and/or recycle oil and antifreeze.
5) Provide adequate, accessible facilities for residents to recycle their waste oil and antifreeze. Distribute a list of facilities.
6) If needed, contract with a firm to recycle oil and antifreeze. Encourage garages to buy recycling equipment.
7) Develop radio PSAs to encourage oil and antifreeze recycling. Include a list of recycling centers and garages that recycle to area residents.
8) Encourage banning the disposal of antifreeze in landfills.

Long-term Steps

9) Evaluate efforts and recommend future actions.

Progress*

Steps 1,2,3,5 and 7) All or part of these steps have been accomplished through the Sheboygan County Clean Sweep Program, the permanent household hazardous waste facility in Sheboygan, and an informational "tablet" distributed to area residents.

Related Existing Activities

- Many local municipalities and auto repair shops already provide disposal and recycling facilities.
- Sheboygan County Clean Sweep Program
- Sheboygan River Water Quality Educational Campaign

I&E 7: Develop Sheboygan River Basin Awareness Program*

Develop and implement a comprehensive Sheboygan River Basin awareness program to educate school and youth groups and the general public about the complexity of water quality issues. The program could integrate the education component of the Sheboygan River Priority Watershed project, which has a rural focus, with proposed RAP education objectives to work with schools and the urban sector. The program would include these projects:

- Portable, interpretive water quality display, which could be housed at Maywood Environmental Center when not in use at an event.
- Sheboygan River Basin Water Quality Resource Guide and one-day in-service to aid school districts and teachers in planning curricula with an environmental focus in conjunction with the Testing the Waters Program (pages 5-2, 6-62).
- Annual basin-wide public officials tour to increase awareness among participants of NPS and RAP issues.
- Five copies of a Sheboygan River Basin slide show with narrative tape for use by various area groups.

Rationale

Benefits

- Promote local support for recommended remedial actions.
- Improve citizens' understanding of the scope and interdependence of problems affecting the Sheboygan River Basin.
- Increase public and private participation in implementing remedial actions.
- Increase visibility of water quality issues.

Impaired Uses Addressed

All

Cost and Funding

Item	Estimated Cost	Funding
SHORT TERM		
Interpretive display: research, construction, materials.	$11000	Options: - WDNR/Great Lakes/ RAP funding - Coastal Zone Management - Education Grants - Private local sponsors
Resource Guide and inservice -artwork -development: staff -time, materials, printing - in-service training	 $2000 $2000 $3000 $500	
Public officials tour	$3000	
Slide show: 5 copies w/ narrative tape	$3000	

Implementation

Leader(s)

WDNR; Maywood Environmental Education Center; Sheboygan River Priority Watershed Project; Sheboygan County Conservation Association; Sheboygan County Schools.

Short-term Steps

1) Secure funding for each project.
2) Contract with Maywood to develop teachers resource guide and interpretive water quality exhibit.
3) Modify existing UWEX fact sheets from the nonpoint program so they are specific to the Sheboygan River Basin.
4) Create slide show and publicize to local interest groups and the media.
5) Organize the basin-wide public officials tour in conjunction with the Sheboygan River Priority Watershed Project.

Long-term Steps

6) Evaluate and make recommendations for future.

Progress*

Step 1-2)	Complete.
Steps 3-5)	In progress.

Related Existing Activities

- Water Action Volunteers Program (Statewide)

I&E 8: Continue Testing the Waters Program*

Establish a public/private consortium under the title of "Testing the Waters: Linking Students and the Water Through Technology." The Sheboygan program could benefit from the experience of the Milwaukee Consortium. Program will include these components:

1) Annual two-day fall training workshop to teach students and teachers about riverine system ecology, issues, intervention strategies, and data collection of nine water quality parameters.
2) Computer network between schools to support communication of water quality parameters.
3) Spring student congress to report results and share water quality ideas.
4) Encouragement of student to involve the community in a Water Action Volunteers project
5) Resource guide for middle and high school students providing water quality information.

Rationale

Benefits

- Increase teacher and student awareness, knowledge, and skills regarding water quality.
- Demonstrate effect of rural, urban, and suburban areas upon water quality.
- Increase awareness of nonpoint source pollution problems and solutions.
- Increase awareness among students of environmental careers.

Impaired Uses Addressed

All

Cost and Funding

Item	Estimated Cost	Funding
SHORT TERM		
Pilot project: includes kits; resource guide; printing	$2000/ school	- Coastal Zone Grants - Educational Grants - Local sponsors
Create and distribute Water Action Volunteers Packet	in- kind	- WDNR (create) - Maywood Center - Sheboygan County Cons. Association
LONG TERM		
TOTAL continuation fee: Workshop ($100/ school) Computer network ($120/ school) Student congress ($140/ 7 people)	$700/ school	Options: - Coastal Zone Management Grants - Local environmental groups or businesses
Lake Project, including boat rental	$700/school+ boat rental fees	

Implementation

Leader(s)
Maywood Environmental Education Center; area schools.

Short-term Steps
1) Form a formal consortium with members from area schools and members from leader groups (above) to guide the project.
2) Designate an organization responsible for linking the schools participating in the program. Riveredge Nature Center or the Maywood Environmental Education Center would be good candidates because they could obtain grant money for the program.
3) Obtain funding and sponsors for pilot program.
4) Contact schools from rural, urban, and suburban areas to identify interested schools.
5) Develop fall training workshop and spring student congress.
6) Develop computer network of schools monitoring Sheboygan, Onion, and Mullet rivers for nine water quality parameters, which will support communication of water quality testing results.
7) Develop resource guide.

Long-term Steps
8) Reinstate funding for project continuation.
9) Continue workshop, computer network, monitoring bus services, and student congress.

Progress*
3) About 12 schools already participate in the program.
5) Fall training and spring congress is ongoing.

Related Existing Activities

- Ongoing Testing the Waters Program in Sheboygan River Basin.
- Ongoing Testing the Waters Program in Milwaukee River Basin.

CHAPTER 7: Monitoring Strategy

This chapter describes the strategy for monitoring Sheboygan River Basin waterways. The monitoring strategy provides a framework for evaluating the biological, chemical and physical characteristics of these waterways with respect to ecosystem integrity and designated beneficial uses.

The goal of this plan is to lay the foundation for monitoring efforts that have been identified as high priority, given the available data to date. Data collected via this monitoring strategy will help us achieve these objectives:

1) More precisely delineate impaired uses of Sheboygan River Basin waterways.

2) Provide information to make more informed policy and management decisions (e.g. setting program priorities).

3) Document trends and status of waterways, leading to a proactive approach to pollution control.

4) Maximize the cost effectiveness and efficiency of RAP implementation.

5) Evaluate the effectiveness of RAP work.

This monitoring strategy will give us the information needed to implement actions to move us toward achieving RAP goals (Chapter 4). It will also enable us to gain knowledge that may transfer to other RAPs in Wisconsin or other states.

The monitoring strategy approach has evolved from a reactive, site-focused approach to a proactive one that encompasses ecosystem considerations. This shift will enable scientists to move from a qualitative to a quantitative assessment of waterway pollution.

Such an integrated approach ensures that environmental data will be collected and managed with efficiency, lending to informed decision-making and the use of cost effective practices. Scientists, for example, will collect data for multiple uses, rather than for one project at a time. Additionally, more precise assessments will lead to more efficient use of resources for remedial work. Scientists can determine, for example, areas that do not require treatment.

The strategy must remain flexible, responding to new situations, advances in knowledge, and new technologies. As the knowledge of the complexities of the Sheboygan River Basin waterways has evolved, so has the challenge to manage them in a way that balances environmental protection with human uses. This section discusses how the monitoring strategy approach has evolved to better address this challenge. It also describes the schedule and method for data collection as well as the importance of reference sites. Finally, delisting impaired waterway uses, the ultimate goal of RAP monitoring, is discussed.

Monitoring and RAP Goals

The monitoring strategy described in the next section will produce data that gives us a way to measure water quality restoration and maintenance activities. In this way, monitoring is integral to achieving RAP goals (Chapter 4). This section describes the role that monitoring plays in each of the following restoration steps.

- Describe recent monitoring efforts
- Define additional data needs
- Evaluate implementation of recommendations and existing programs
- Delist use impairments
- Maintain unimpaired waterway uses

Recent Monitoring Efforts

Many monitoring efforts are underway in the Sheboygan River Basin for assessing current conditions, evaluating program implementation activities, and assessing ambient water quality. The efforts targeting the AOC will be described here. For specific information regarding basin-wide water quality monitoring activities, please see Chapter 5, *Reaching RAP Goals Through Existing Programs.* Current monitoring activities described in this section include:

Overview of WDNR's Sheboygan River PCB Monitoring Activities

- Pilot Study Monitoring
  - Sediment transport study
  - Mussel bioaccumulation study
  - Benthic Invertebrate Community Assessment
- Study of PCB accumulation by salmonine smolts and adults

Superfund Monitoring Activities

WDNR's Sheboygan River PCB Monitoring Activities

Pilot Study Monitoring

In 1985, Tecumseh Products Company, one of four PRPs for the Sheboygan River and Harbor Superfund Site, agreed to conduct a Remedial Investigation/Feasibility Study on the Sheboygan River to delineate the nature and extent of contamination associated with activities at the Tecumseh site. This study also set out to identify remedial measures for mitigating potential human health or environmental risks associated with the PCBs and other toxicants related to this particular site. Tecumseh then proposed an Alternative Specific Remedial Investigation (ASRI) to further evaluate potential remedial technologies for the site through bench-scale and pilot studies. (See Superfund Monitoring Activities, page 7-4, for further information.) Among others, these technologies included *in situ* bioremediation using an armoring technique, and biodegradation of removed sediments in an on-site treatment facility. The studies also identified three sites in the upper river that had significantly higher PCB concentrations. The sediment from these areas was subsequently removed and placed in the pilot confined treatment facility (CTF).

The WDNR developed a monitoring strategy to:

1) measure the effectiveness of these new technologies for reducing the bioavailability of PCBs to aquatic organisms,
2) measure the impact, if any, that instream sediment remediation activities (barge movement, installation and removal of geomembrane curtains) had on the resuspension of PCBs into the water column, and
3) document the current status of the Sheboygan River's invertebrate community, and identify any PCB related impacts to this community.

This monitoring strategy consists of both pre- and post-pilot studies remedial work data collections. To date, WDNR staff have collected both the pre-remedial and post-pilot studies remedial data (Aartila, 1994). The final report of this study will be added as an amendment to the RAP when available.

WDNR's monitoring strategy consists of:

- Sediment Transport Studies
- Mussel Bioaccumulation Studies
- Benthic Invertebrate Community Assessments

Sediment Transport Study

Sediment traps were set at nine locations to collect suspended sediments during spring high flow periods, during low flow periods and during instream remedial work. These sites document background low flow and storm event (high flow) contaminated sediment transport within the most highly contaminated areas of the river, and the movement of sediment from this area to the lower reaches of the river (where sediment PCB concentrations are lower). The sediment trap information is to qualitatively define sediment contaminant transport in the river, and is not a quantitative measure of sediment movement. Samples are analyzed for total PCBs and total organic carbon. Samples from three of the sites are also being analyzed for individual PCB congeners. This study is ongoing.

Mussel Bioaccumulation Studies

Mussels indigenous to the Sheboygan River were collected from three sites on the river (one upstream control and two sites within the contaminated segment), and analyzed for PCBs and lipid content. A second phase of this study consisted of collecting and marking mussels from an upstream control site and transplanting them at two contaminated downstream sites. After being exposed for one year, approximately ten percent of the transplanted mussels were recollected from each site and analyzed for PCBs. Preliminary findings show that PCB concentrations were similar between indigenous mussels collected before the remedial actions began, and those transplanted mussels exposed after remedial actions were complete. A final report on the findings will be added as an adendum to the RAP when published.

Benthic Invertebrate Community Assessment

The benthic invertebrate communities from two distinct habitats on the Sheboygan River are being used to assess the impact that PCBs may be having on the river. The two habitat types being

sampled are:

Riffle Community - Kick net and "cobble" samples were collected from a control site and two impacted sites in the Sheboygan River to measure the impact of waterborne PCBs on the invertebrate community.

Depositional Zones - Core samples from six depositional sites with varying PCB contaminant levels have been collected to measure the impact that sediment-borne contaminants have on the invertebrates that live within the bottom sediments (embenthic community). Sample collection is complete. Sample analysis is ongoing.

Study of PCB Accumulation Study in Salmonine Smolts and Adults

In 1990, WDNR initiated an experimental stocking study of trout and salmon in the Sheboygan River. The study was designed to determine the effects of PCB contamination on the overall levels in sub-adult and adult salmonines that were stocked in rivers of varying PCB contamination. The results from the study have shown that: 1) salmonines stocked in the Sheboygan River in fall accumulate significantly higher levels of PCBs before out-migration, than those at the other two rivers; 2) sub-adult and adult coho salmon caught in fall 1993 in the Sheboygan River contained the same level of PCBs as sub-adult and adults returning to the Root River; 3) sub-adult and adult steelhead caught in the fall of 1993 in the Sheboygan River contained similar levels of PCBs as fish returning to the Root and Pigeon Rivers; and 4) all fillet samples from sub-adult and adult fish analyzed to date have PCB concentrations below 2.0 ppm (Eggold and Amrhein, 1994). Based on these results the Department made the decision to begin spring-only trout and salmon stocking in the Sheboygan River. See Appendix H for the final report.

Superfund Monitoring Activities

Tecumseh Products Company, one of four PRPs for the Sheboygan River and Harbor Superfund Site, has conducted an extensive monitoring program as part of their Superfund activities. The activities listed below are outlined in the Alternative Specific Remedial Investigation (ASRI) Final Work Plan / QAPP for the Sheboygan River and Harbor by Tecumseh Products Company (Blasland & Bouck, 1990b). The final results of the ASRI are not yet available. They are expected to be finalized by early 1996 and added to the Superfund repository at Mead Public Library in Sheboygan.

1. Supplemental reconnaissance and sediment sampling
2. Design and construction of the pilot confined treatment facility (CTF)
3. Removal and armoring of sediments
4. Water column and biological monitoring
   a. Pre-construction monitoring; water column and caged fish
   b. Construction monitoring; water column and caged fish
   c. Post-construction monitoring; water column and caged fish
5. Pilot treatability studies
6. Bench-scale treatability studies
7. Supplemental investigations

Define Additional Data Needs

The most efficient use of limited funds for monitoring in the Sheboygan River Basin is to pool and coordinate existing data from data collection efforts of all involved agencies, such as the USGS, the WDNR, and the U.S. EPA. See Chapter 5, Reaching RAP Goals Through Existing Programs, for a description of ongoing basin-wide monitoring activities. The process has begun to assemble and analyze this data to identify additional monitoring needs. Cooperation among all data collectors and users is essential.

Given our present knowledge of the Sheboygan River, monitoring efforts should focus on the following priority areas:

- Evaluate various locations to be used as control and reference sites for the AOC (described below).
- Collect data to assess the role contaminated sediments play in the AOC from a biological standpoint (i.e. how they affect aquatic life, wildlife, and humans).
- Collect needed data to better define use impairments (problem assessment).
- Develop appropriate criteria for delisting impaired uses.
- Collect information to gauge effectiveness of clean up efforts (long-term trend).

As technology changes and our knowledge of the Sheboygan River system increases, monitoring priorities will evolve. Table 7.1 on page 7-6 lists the recommendations for monitoring in the Sheboygan River Basin.

First and foremost, information about relatively unaffected but similar sites is needed in order to gauge the effectiveness of implementation of management practices to improve the Sheboygan River ecosystem. The section below describes the use of reference sites and possible sites to compare to the Sheboygan River.

Reference Sites

Generally, a reference site is a relatively unaffected site, with features similar to the study area. The critical variables for selecting a reference site are dependent on the study.

Upstream reaches well above the AOC, as well as streams and harbors from other river basins, will be monitored to represent the range of habitat types found in the Sheboygan River Basin. Sites will be selected to provide information for more than one AOC, if possible. For the Sheboygan River Basin, reference sites could include the Sheboygan River upstream of the Roller Mills dam in Sheboygan Falls, the Pigeon River, and the Kewaunee River and Harbor. The Kewaunee harbor is proposed as a reference site because it may represent a less polluted major harbor. Other reference sites to compare with the rest of the basin should also be selected. While reference sites may not represent the desired end point for the RAPs, they provide a comparison to a harbor system that has ongoing urban effects, but minimal toxic pollutants like PCBs, PAHs and heavy metals. An additional consideration will be to compare AOC data to all other AOCs as clean-up actions proceed. This will enable a relative comparison of how the systems respond to different implementation projects.

Table 7.1 Monitoring Recommendations for the Sheboygan River Remedial Action Plan

Recommendation (from Chapter 6)	Impaired Uses Addressed	Data type (e.g. problem assessment, long-term trend, etc)	Emphasis (AOC, or Basin-wide)
A&M 1: Water Quality Monitoring (page 6-6)	All	-problem assessment -long-term trend	AOC and Basin-wide (as needed)
A&M 2: Macroinvertebrate population analysis (page 6-8)	-degradation of benthos	-problem assessment -long-term trend	AOC
A&M 3: Conduct Fish Community Evaluations (page 6-9)	-degradation of fish populations	-long-term trend	AOC
A&M 4: Conduct Fish Health Assessment (page 6-11)	-degradation of fish populations -fish tumors or deformities	-problem assessment -long-term trend	AOC
A&M 5: Assess Fish Tissue Contamination (page 6-13)	-restrictions on fish consumption	-problem assessment -long-term trend	AOC
A&M 6: Assess Wildlife Tissue Contamination (page 6-15)	-restrictions on wildlife consumption	-problem assessment -long-term trend	AOC

Recommendation (from Chapter 6)	Impaired Uses Addressed	Data type (e.g. problem assessment, long-term trend, etc)	Emphasis (AOC, or Basin-wide)
A&M 7: Conduct Wildlife Health Assessment (page 6-17)	-degradation of wildlife populations -wildlife tumors or deformities	-problem assessment -long-term trend	AOC
A&M 8: Monitor Bioaccumulative toxicants (page 6-19)	-restrictions on fish and wildlife consumption -restrictions on dredging activities -degradation of benthos -degradation of fish and wildlife populations -degradation of phytoplankton and zooplankton populations.	-problem assessment -long-term trend	AOC
A&M 9: Develop a Sediment GIS (page 6-21)	-restrictions on fish and wildlife consumption -restrictions on dredging activities -loss of fish habitat	-problem assessment -long-term trend	AOC
A&M 10: Assess PCB congener and PAH contamination and toxicity in the Sheboygan AOC (page 6-23)	-restrictions on fish and wildlife consumption -restrictions on dredging activities -bird or animal deformities or reproduction problems -degradation of fish and wildlife populations	-problem assessment -long-term trend	AOC
A&M 11: Phytoplankton/Zooplankton Degradation Assessment (pg 6-25)	-eutrophication or undesirable algae -degradation of phytoplankton and zooplankton	-problem assessment -long-term trend	AOC

Delist Use Impairments

When is restoration complete? Restoring the quality of a waterway means delisting all of its impaired uses.

Table 7.2 is a guide to measuring and attaining restoration progress. It lists each use impairment, the corresponding IJC delisting guidelines, and monitoring requirements. Information gathered from monitoring will provide the needed basis from which to make decisions regarding delisting use impairments. These criteria may be quantitative and/or qualitative. Many criteria are quantitative, giving an accepted numerical level for a contaminant. Qualitative criteria, like best professional judgement, are prevalent as well.

Table 7.2: Delisting Criteria and Monitoring Requirements.

Use Impairment	IJC Delisting Guideline	Monitoring Requirements
Restrictions on fish and wildlife consumption	When contaminant levels in fish and wildlife populations do not exceed current standards, objectives or guidelines, and public health advisories are not in effect for human consumption of fish or wildlife.	Fish collections for contaminant analysis, including fillets and whole fish (see A&M 5).
Degradation of fish and wildlife populations	When environmental conditions support healthy, self-sustaining communities of desired fish and wildlife at predetermined levels of abundance that would be expected from the amount and quality of suitable physical, chemical and biological habitat present. In the absence of community structure data, this use will be considered restored when fish and wildlife bioassays confirm no significant toxicity from water column or sediment contaminants.	-Conduct fish community assessment (A&M 3); -Conduct fish health assessment (A&M 4); -Test sediment toxicity (A&M 10).
Fish tumors or other deformities	When the incidence rates of fish tumors or other deformities do not exceed rates at unaffected control sites and when survey data confirm the absence of neoplastic or pre-neoplastic liver tumors in bullheads or suckers.	-Conduct fish health assessment (A&M 4); -Test sediment toxicity (A&M 10).
Bird or animal deformities or reproductive problems	When the incidence rates of deformities or reproductive problems in sentinel wildlife species do not exceed background levels in inland control populations.	-Conduct wildlife health assessment (A&M 7); -Test sediment toxicity (A&M 10).
Degradation of benthos	When the benthic macroinvertebrate community structure does not significantly diverge from unaffected control sites of comparable physical and chemical characteristics. Further, in the absence of community structure data, this use will be considered restored when toxicity of sediment-associated contaminants is not significantly higher than controls.	-Test Sediment toxicity (A&M 10); -Conduct Macroinvertebrate population analysis (A&M 2); -Monitor bioaccumulative toxicants (A&M 8).

Use Impairment	IJC Delisting Guideline	Monitoring Requirements
Restrictions on dredging activities	When contaminants in sediment do not exceed standards, criteria or guidelines such that they are restrictions on dredging or disposal activities.	Collect sediment quality data via bulk chemistry testing. Test for critical pollutants (PCBs and PAHs) and metals (A&M 10).
Eutrophication or undesirable algae	When there are no 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.	-Collect water quality data consisting of: water temperature, dissolved oxygen, turbidity, conductivity, hardness, nutrients, Chlorophyll a, and solids (A&M 1); -Assess phytoplankton and zooplankton populations (A&M 11).
Degradation of phytoplankton and zooplankton populations	When phytoplankton and zooplankton community structure does not significantly diverge from unaffected control sites of comparable physical and chemical characteristics. Further, in the absence of community structure data, this use will be considered restored when phytoplankton and zooplankton bioassays confirm no significant toxicity in ambient waters.	-Assess phytoplankton and zooplankton populations (A&M 11); -Test sediment toxicity (A&M 10).
Loss of fish and wildlife habitat	When the amount and quality of physical, chemical, and biological habitat required to meet fish and wildlife management goals have been achieved and protected.	-Collect information on fish and wildlife habitat as part of other fish and wildlife monitoring projects (e.g. A&M 3; 4; 5; 6 and 7).

Maintain Unimpaired Waterway Uses

Once Sheboygan River Basin water quality is restored, monitoring will assure maintenance of that quality. Regular monitoring, as described in the monitoring strategy below, will reveal future waterway degradation in a timely manner. This will allow for proactive actions and minimal remedial action, once again, saving time and money.

Monitoring Strategy

The strategy described below is a plan for thoroughly monitoring AOC waterways to support water quality restoration and maintenance. Many of the efforts outlined when completed for the first time will contribute to, or furnish, the data necessary to establish baseline and/or pre-remediation conditions. Some revisions and adjustment can be made along the way; however, a complete reevaluation (using existing data) of the components should be done every 5 years to determine its continued inclusion in the surveillance and monitoring effort. It should be noted that this strategy has been developed for all Wisconsin AOCs. This strategy recommends monitoring the following components for all Wisconsin AOCs, but has been modified, where appropriate, for the Sheboygan AOC to take into account ongoing efforts.

- Water Quality
- Ambient Water Column Toxicity
- Sediment
- Fish Community
- Fish Tissue Contamination
- Wildlife Community and Tissue Contamination

Several efforts listed above will provide data to evaluate emerging problems. Where feasible, monitoring programs should be coordinated (e.g. use of similar sampling and reference sites) in order to collect information that will be most useful for characterizing the Sheboygan River. In addition to these efforts, semi-permeable membrane devices (SPMDs) will be deployed to screen the AOC and upstream river segments for bioaccumulative pollutants. SPMDs will be deployed at five sites within the Sheboygan AOC. Location of these sites are to be determined, and could be used to evaluate potential sources (secondary tributaries, point sources, in place sediment deposits) of bioaccumulative pollutants. *Also see the RAP recommendation A&M 8 on page 6-19.*

Water Quality

Water column monitoring efforts will be undertaken primarily to identify (not necessarily quantify) loadings of critical pollutants, water quality variables known to influence the bioavailability or toxicity of pollutants, and to detect loadings of compounds that other efforts have identified as causes for concern. Four fixed station sites will be monitored in the AOC yearly, as described in the RAP recommendation A&M 1 on page 6-6.

Coordination with existing data collection activities will provide the necessary data with minimal additional effort. However, where specific data are not currently generated, initial efforts will focus on support, coordination, and if necessary augmentation of existing programs to obtain the missing information.

Ambient Water Column Toxicity

Chronic toxicity will be evaluated annually to assess the additive, synergistic and antagonistic effects of point and nonpoint source inputs and chemicals released from sediment deposits. Testing will use the species *Ceriodaphnia dubia* and fathead minnows (*Pimephales promelas*) and should include both low and high flow periods. Provisions to attempt identification of toxicants accounting for observed chronic toxicity are to be included. If chronic toxicity is observed, the U.S. EPA's chronic toxicity evaluation procedures will be employed to begin determination of causative compounds.

One potential source for ambient water toxicity data is the current WPDES biomonitoring program. Each discharger that is required to conduct chronic toxicity testing on their discharge must include a receiving water control exposure. This data is easily assembled and could be substituted where sufficient data exists.

Sediment

Sediment toxicity assessments will be conducted for purposes of detecting the effects of the complex interactions between chemicals present in the system and chemicals not typically analyzed. A test battery includes chronic exposure with *Chironomus tentans* and an acute exposure of *Hyalella azteca*. Endpoints to be evaluated include survival for both species with biomass production and mentum deformity for *C. tentans*.

Representative (or continual) depositional zones will be identified in order to continually evaluate changes in sediment quality resulting from downstream transport. Sediment traps will be analyzed for critical pollutants and particle size every 3 years. More frequent analyses may be appropriate immediately prior to and following remediation of contaminated sediment sites.

Benthic invertebrate populations will be assessed throughout the AOC during the basin assessment year. Benthic invertebrate community population structure and biomass are to be evaluated. If species from the *Chironomus* genus are present, incidence of mentum deformities will be assessed as part of the species identification process. Invertebrate samples will include benthic grabs collected using standardized procedures. In addition, Hester-Dendy artificial substrate samplers will be deployed at each site for characterization of the epi-benthic community. *See RAP recommendation A&M 2 on page 6-8.*

Fish Community

Degraded fish populations and fish consumption advisories are identified use impairments in the AOC. The first evidence of identifiable contaminant associated stress in fish populations is often exhibited in changes in fish community structure (composition and populations) and the overall health of specific populations or individuals. Recognizing the significance and importance of the fish community in each AOC, the following activities provide the necessary data to continually assess the status of the fish community and adjust activities in response to observed changes. *See RAP recommendation A&M 3 on page 6-9.*

Community Structure

An evaluation of the fish community will be conducted yearly for 3 years in order to get baseline information. After baseline conditions are determined, fish community evaluations will be conducted during the basin assessment year (5-year rotating schedule). Sampling will be conducted at two to six stations per AOC. Stations will represent important or major habitat types within the AOC. From this information, basic measures of community richness, diversity, and evenness will be determined and assessed for changes over time using appropriate techniques.

Fish Health Assessment

A Fish Health Assessment (FHA) will be conducted on the selected resident species during fish community evaluation sampling. FHA is a standardized procedure to assess the general health of a population using a necropsy procedure on live caught fish. The general health of one or two representative resident species will be examined in the Sheboygan AOC. *See RAP recommendation A&M 4 on page 6-11.*

Fish Tissue Contamination

This monitoring effort will provide these items:

- data to evaluate the short-term bioavailability of bioaccumulating toxic substances,
- data to evaluate contaminant levels in respect to the fish consumption advisory and potential food chain magnification,
- identification of substances present in fish tissue that have not previously been identified, and
- data helpful in identifying potential sources of contamination (congener specific PCBs).

This effort is an intensive fish contaminant assessment following the state's Basin Assessment Schedule. It will also be coordinated with the fish health and community structure assessments. The first of these will be coordinated with the health assessment conducted during the basin assessment year. The tissue analysis will be conducted on both whole fish for each species and fillets for the designated sport fish species. *See RAP recommendation A&M 5 on page 6-13 for further detail.*

Wildlife Community and Tissue Contamination

The evaluation of wildlife within the AOC, as with fish, will take on many directions. Wildlife to be studied include small mammals, birds, reptiles and amphibians. Population inventories will be accomplished by estimating population sizes and age structures through mark/recapture techniques. Wildlife habitat, and loss thereof, will be evaluated and compared with population information. Habitat improvement projects will also be developed.

Wildlife health and reproductive success will be monitored including offspring survival and/or deformities. Biomonitoring techniques will be used to assess the effect of floodplain and river contamination on the wildlife. For a representative species from each wildlife class, some specimens collected for the population assessment will also be used to evaluate tissue condition (e.g. presence or absence of tumors, etc.), and contaminant levels (e.g. PCBs). Contaminant concentrations in waterfowl will be determined during each basin-assessment year to re-evaluate the restrictions on human consumption. See recommendations A&M 6 and A&M 7 beginning on page 6-15.

CHAPTER 8: Implementation Strategy

Improving the quality of the Sheboygan River Basin will require a long-term commitment from all levels of government and local interest groups as well as area citizens. RAP implementation must promote such involvement at a feasible pace, allowing results to materialize one step at a time.

This step-by-step implementation will pivot on RAP recommendations. The current RAP recommendations are listed in Table 6.1 on page 6-2. These recommendations, most of which are implementable in two to five years, will be important steps toward basin restoration. These are not the first steps towards restoration; many projects that are underway are described in *Chapter 5, Reaching RAP Goals Through Existing Programs*. Furthermore, recommendations will continue to materialize as more is understood about the most efficient and lasting ways to restore the Sheboygan River and Harbor.

This chapter describes the following aspects of the RAP implementation strategy.
- RAP Implementation Committee (RIC)
- Implementation Steps
- Implementation Focus
- Who will pay for environmental clean-up?
- Implementation Status

Restoring and protecting the Sheboygan River Basin requires cooperation from all Sheboygan River Basin citizens, governments, and businesses. Monetary support alone, although important, does not ensure RAP success. Ultimately, successful implementation of this plan will depend on the willingness of the basin's citizens to voluntarily change the way we lead our lives.

RAP Implementation Committee (RIC)

Although WDNR's RAP Coordinators have responsibility for overseeing RAP implementation (developing plan updates, tracking progress), restoration of the AOC will require cooperation from all Sheboygan River Basin stakeholders. As the RAP moves into the implementation phase, RAP Coordinators will call for formation of a RAP Implementation Committee (RIC).

The RAP Implementation Committee will be the driving force behind implementing RAP recommendations. Once a recommendation materializes, the RIC will take action to transform the recommendation into a project according to the implementation steps described on page 8-2. Members of the RIC should represent the groups listed below. RIC diverse membership will foster a unified approach toward AOC restoration.

- County and municipal government
- Municipal and industrial dischargers
- Environmental and conservation groups
- Recreational groups

- Agriculture
- State legislature
- Resource management agencies
- Universities
- Media
- Interested citizens
- Local schools and educators

In other states, RAP implementation committees have established themselves as non-profit organizations to make themselves more eligible for funding from foundations, state and federal grant programs, corporations, and individuals. Such organizations assist the RAP by managing funds for RAP programs; coordinating participation among communities; and encouraging public awareness and appreciation of RAP efforts. An existing non-profit agency could apply for grants for RAP projects; this may be a more efficient alternative.

Implementation Steps

Achieving RAP goals and objectives requires both continuing support of existing programs and rigorous implementation of new initiatives. RAP recommendations are the vehicle through which the RAP Implementation Committee and RAP Coordinators can guide RAP implementation. More specifically, the RIC and the RAP Coordinators will regularly implement the steps listed below to ensure that RAP recommendations address basin needs.

1) Assemble all known data into a database to determine baseline conditions and help decide future steps.

2) Employ the *implementation focus* described on page 8-3 to identify and prioritize water quality improvement needs in the Sheboygan River Basin.

3) Keep abreast of existing program activities and objectives in order to promote unity and avoid overlap between programs.

4) Propose recommendations to address water quality improvement needs.

5) Transform recommendations into actions by obtaining sponsors and funding.

6) Provide assistance to sponsors of recommendations as they develop project objectives, budgets, and implementation strategies.

7) Distribute an annual report describing RAP progress to Sheboygan River Basin stakeholders, general public representatives, and government officials.

Implementation Focus

The RAP implementation strategy must focus on the major pollution sources as well as public information and education. It must also embody an ecosystem approach. RAP implementors must apply these criteria when formulating RAP recommendations.

Major Pollution Sources

The major pollution sources the RAP shall focus on are contaminated sediment, point and nonpoint sources of pollution.

Contaminated Sediment

Currently, the primary mechanism in place for contaminated sediment remediation in the Sheboygan River is through the Superfund program. RAP committees will provide an effective means to coordinate public input to Superfund projects. Local interest and concern will play an essential role in sediment remediation through the Superfund program.

WDNR is developing sediment quality criteria, which will undergo consideration during formulation of Superfund Record of Decisions (RODs), the "remedy" for a site. If implementation of the ROD is not sufficient to restore beneficial uses, WDNR will explore other clean-up mechanisms, like RAP implementation grants, the Great Lakes Protection Fund, and grants from U.S. EPA's Great Lakes National Program Office.

Nonpoint Source Pollution

The Sheboygan River Priority Watershed Project, supported primarily by the WDNR and the County Land Conservation Department, funds and supports implementation of nonpoint source projects in the AOC. One such project is the comprehensive urban storm water plan under development for the City of Sheboygan. This work is funded through the priority watershed project and a federal RAP planning assistance grant.

The following RAP objectives target reduction of nonpoint source pollution:

- Increase public awareness and participation in the Sheboygan River Priority Watershed Project (see RAP recommendation I&E 4 on page 6-54).
- Strive to secure funding for rural and urban nonpoint source management and demonstration projects.
- Seek designation of the Mullet and Pigeon Rivers as a Priority Watershed Projects (see RAP recommendations SA 8 on page 6-46, 6-48 and SA 9 on page 6-48.

Ecosystem Approach

Pollution does not recognize political boundaries. Following suit, RAP funding and implementation should extend beyond political boundaries to reflect the AOC's watershed

boundaries. For example, upstream sources of pollution contribute significant amounts of pollutants to the AOC. Therefore, successful environmental clean-up must target pollution and pollution sources throughout the basin.

Such an "ecosystem approach" to environmental clean-up recognizes the interrelationships between organisms, including humans, and the interacting elements of the water, air, and land in the Sheboygan River Basin. The ecosystem approach attempts to integrate environmental programs to attain a common goal. The RAP represents an unprecedented opportunity to apply an ecosystem approach to environmental restoration.

Public Information and Education

An effective public outreach and participation program must be an integral part of RAP implementation. Providing the public with information about clean-up benefits is necessary to generate political support for the RAP. This "political will" is key at the federal, state, and local levels to secure funding in support of restoration activities. Whenever possible, the benefits of AOC restoration must be visible and quantified. Improvement in fish and wildlife populations or elimination of consumption advisories, for example, will have the most success in generating public support.

Information and education programs should inform citizens of environmentally sound choices. Decisions about what products to purchase, how to tend lawns, and how they get to work, have effects that can only change if citizen choices and lifestyles change. Therefore, the most important outreach efforts for the long-term future success of the RAP may well be those directed at children (Eiger and McAvoy, 1992).

Pollution prevention methods should be highlighted as a necessary and cost effective way to reduce environmental degradation.

Finally, a successful public outreach strategy for the RAP requires a multi-media approach. A survey done for the Green Bay RAP showed that newspapers are more effective than public meetings, brochures, fact sheets, or videos as tools for reaching a large number of people (Glassner et al., 1991). Television and radio advertisements reach the largest audience, but their high cost may be limiting.

Who Will Pay for Environmental Clean-up?

Who will pay for environmental clean-up? There are three primary funding options: 1) polluter pays, 2) beneficiary pays, or 3) general revenues.

To obtain funding, the funding procurer will first attempt to identify a polluter. This option is preferable because the party responsible for the pollution pays to clean it up. The two Superfund projects in the AOC, for example, have identified Potentially Responsible Parties.

If the procurer can not identify a polluter, they must then attempt to identify a beneficiary of the remedial work. In the case that neither a polluter or beneficiary can be identified, the funding procurer then must consider general revenues.

There is not always a clear distinction between the polluter and the beneficiary. For example, boaters are both polluters and beneficiaries; they contribute to surface water pollution, and benefit from clean-up efforts. A funding option that imposes a fee on boaters combines these options, drawing funding from the polluter and beneficiary. In some cases, it may also be necessary to investigate the contribution of historical polluters in the basin.

Implementation Status

A description of RAP progress begins on page 1-15.

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GLOSSARY

This glossary defines technical terms and describes concepts and organizations named in this document. *Also see the List of Acronyms at the beginning of the document.*

Abatement — Actions which will capture and retain, or treat the pollutant at or near the point of origin, prohibiting its downstream transport. It also includes all actions which capture, treat, or otherwise control the contaminant after it has been introduced into the sewers, drainage-ways, waterways, or sediments.

Aerosol contamination — Contaminants dispersed in a suspension of fine particles or droplets such as can result from the spraying of pesticides or paints, etc.

Action Level — Concentration of a contaminant in fish or wildlife which would trigger issuance of a Fish or Wildlife Consumption Advisory.

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 demand and/or 50% of the total nitrogen. Advanced wastewater treatment is also known as "tertiary treatment."

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 Agricultural Stabilization and Conservation Service of the U.S. Department of Agriculture through the Agricultural Conservation Program.

Air Pollution — Contamination of the atmosphere by human activities, such as manufacturing and automobile emissions.

Algae (a.k.a. Phytoplankton) — A group of 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. Nutrient-enriched water increases algae growth.

Alkalinity	The measure of the quantity and kinds of compounds present which collectively shift the pH to the alkaline or basic side of neutrality.
Ammonia	A form of nitrogen (NH_3) is unionized ammonia found in human and animal wastes. Ammonia is toxic to aquatic life depending upon pH, temperature and ionic strength of the water. Ammonium (NH_4) is ionized ammonia found in human and animal waste.
Anaerobic	Without oxygen.
Antagonism	Interaction of two or more substances such that the action of any one of them lessened.
Antidegradation	A policy which states that water quality will not be lowered below background levels unless justified by economic and social development considerations.
Area of Concern	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 according to section 208 of the Clean Water Act.
Armoring	A remedial technology aimed at keeping contaminated sediment in place in the river or on the bank by covering it with several layers of materials including geotextile fabrics and gabions filled with large rocks.
Arochlor	A Monsanto Chemical Company trade name for various types of PCBs. Presented as a four digit number with the first two digits listing the number of carbons in the biphenyl molecule, while the last two digits represent the weight percentage of chlorine atoms.
Arsenic	A highly poisonous heavy metal having three allotropic forms. Use of arsenic and its compounds includes insecticides, weed killers and alloys.
Assimilative Capacity	The ability of a water body to purify itself of pollutants without detriment to fish and aquatic life or other beneficial uses of the water body.
Atmospheric Deposition	Pollutants/contaminants associated with particulate deposition resulting from air emissions and long distance atmospheric transport that either

	settles directly onto the surface water or indirectly onto land surfaces and then transported to the water body with storm water runoff.
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 water conditions my affect availability.
Background Levels	Levels or concentrations of a substance which would occur naturally.
Bacteria	Single-cell, microscopic organisms. Some can cause disease, and some are important in the stabilization of organic wastes.
Balanced Community	A community that supports an abundant and usually diverse population of forage fish, game fish, and other aquatic biota (zooplankton, phytoplankton, macroinvertebrates).
Basin	*See Drainage Basin.*
Basin Plan	*See Areawide Water Quality Management Plan.*
Bathymetric Survey	An investigation to measure the depths of water or sediment in water bodies (i.e. rivers, lakes and oceans).
Beneficial Uses	Uses that maintain the chemical, physical and biological integrity of an ecosystem.
Benthic Organisms (Benthos)	The organisms living in or on the bottom of a lake or stream.
Best Available Technology (BAT)	Effluent and air emission limitations guidelines and standards that represent the best existing performance in an industrial category.
Best Management Practice (BMP)	The most effective, practical measures to control nonpoint sources of pollutants that run off from land surfaces.
Best Practicable Control Technology (BPT)	Effluent and air emission limitations guidelines and standards that are based on the average of the best existing performance by facilities within an industrial category.
Bioaccumulation	The uptake and retention of substances by an organism 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 A test for pollutant toxicity in which the responses of aquatic organisms are used to detect or measure the presence or effect of one or more substances, wastes, or environmental factors, alone or in combination.

Bioavailability 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.

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. Carbonaceous BOD is the result of the same test conducted in a shorter time period. The greater the degree of pollution by organic matter the higher the BOD.

Bioconcentration The process by which there is a net accumulation of a chemical directly from water or sediment into aquatic organisms resulting from simultaneous uptake (e.g. by gill or epithelial tissue) and elimination (contrast with bioaccumulation which is a function of the food chain).

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

Biomonitoring *See Bioassay.*

Bioremediation The management and use of existing microorganisms to break down and destroy organic contaminants present in the sediment.

Bioturbation The movement and metabolism of benthic invertebrates in sediments which can affect the flux of nutrients/contaminants to the water column.

Biota All living organisms that exist in an area, e.g. bacteria, plants, animals.

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

Bulkhead Lines Legally established lines 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 a river or bay. Other environmental laws may limit filling to some degree.
Carcinogenic	The ability of a chemical to cause cancer.
Categorical Limits	The basic level of treatment required for all point source discharges. For municipal wastewater treatment plants this is secondary treatment (30 mg/l effluent limits for SS and BOD). For industry the level is dependent on the type of industry and the level of production. Effluent limits more stringent than categorical may be required if necessary to meet water quality standards.
Chlordane	A non-water soluble, oily, toxic compound used as an insecticide.
Chlorination	The application of chlorine to wastewater to kill bacteria and other organisms.
Chlororganic Compounds (Chlororganics)	A class of chemicals which contain chlorine, carbon and hydrogen. Generally refers to pesticides and herbicides that can be toxic. Examples include PCB's 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	Injurious or debilitating effects of long-term exposure of nonlethal toxic chemicals to organisms. An example of the effect of chronic toxicity could be reduced reproductive success.
Circle of Poison Legislation	Federal legislation proposed to eliminate or reduce the export of pesticides banned in the U.S. in order to prevent their return in or on goods imported to this country.
Clean Sweep Programs	Local community efforts to collect old or unwanted household products which are toxic or contain contaminants (i.e. pesticides, fertilizers, paint, oil, gasoline, etc.). Toxic products, once collected, are taken to an appropriate facility for proper disposal.
Clean Water Act	*See Public Law 92-500.*

Combined Sewers	A wastewater collection system that carries both sanitary sewage and storm water runoff. During dry weather, combined sewers carry only sanitary sewage to the treatment plant.
Combined Sewer Overflow (CSO)	During heavy rainfall, combined sewers become swollen with storm water and sewage. If the treatment plant cannot process the added flow, untreated sewage is discharged to surface waters via a treatment plant bypass known as a combined sewer overflow.
Compliance Maintenance	A Wastewater Program that identifies actions municipal treatment facilities should take to ensure they continue to meet existing and future effluent limits.
Confined Disposal Facility (CDF)	A structure built for the containment and disposal of contaminated 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. Therefore, a protective layer of plant residue stays in the surface and erosion is decreased.
Consumption Advisory	A health warning issued by a public agency that recommends people limit the fish they eat from some rivers and lakes based on levels of toxic substances found in the fish.
Contaminant	Some substance that has been added to water that is not normally present. Even in low concentrations contaminants such as pesticides, PCBs, and heavy metals have detrimental effects on biota. This is different from a pollutant, as a pollutant suggests that there is too much of the substance present.
Control Site	The area in a study which is relatively unaffected by the conditions in question (eg. pollutants, contaminants) and to which the other area(s) of the study are compared.
Conventional Pollutant	Refers to suspended solids, fecal coliform, biochemical oxygen demand, and pH as opposed to toxic pollutants.
Criteria	*See Water Quality Criteria.*

DDT	A chlorinated hydrocarbon insecticide that has been banned because of its persistence in the environment.
Delisting	The act of removing a use impairment.
Designated Management Agencies	Any agency designated by an Areawide Water Quality Management Plan to implement specific plan recommendations. This may be done through direct activities of the designated management agency or through delegation to other agencies or units of government.
Detention Basins	Holding ponds for temporary storage of storm water where sediments are allowed to settle out before discharge into receiving waters; usually used in association with construction sites or areas of land disturbance.
Dieldrin	A non-water soluble, solid toxic compound used as an insecticide.
Dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin)	A chlorinated organic chemical which is highly toxic. Paper manufacturers are the major industries that contribute dioxins to the environment.
Disinfection	A physical or chemical process that kills organisms which cause disease. Chlorine is often used to disinfect wastewater.
Dissolved Oxygen (DO)	Oxygen dissolved in water. Low levels of dissolved oxygen threaten the survival of aquatic life. Low levels of dissolved oxygen are often due to inadequate wastewater treatment. The Wisconsin Department of Natural Resources considers 5 ppm DO necessary to support a balanced community of fish and aquatic life.
Drainage Basin	The area of land from which water drains into a major water body, e.g. Sheboygan River Basin, Great Lakes Basin, Lake Michigan Basin.
Dredging	Removal of sediment from the bottom of water bodies.
Ecosystem	The interacting system of a biological community and its nonliving surroundings.
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 — These establish the maximum amount of a pollutant that can be discharged to a receiving stream. Limits depend on the pollutants involved, the water quality standards that apply for the receiving waters, and the characteristics of the receiving water.

Emission — A direct (smokestack particles) or indirect (busy shipping center parking lot) release of any contaminant into the air.

Endangered Resource — A natural resource, usually plant or animal, whose population has been sufficiently depleted to consider it in danger of extinction. Such resources should be closely monitored and protected by state environmental agencies.

Endangered Species — A species on the Wisconsin Endangered Species list is any whose continued existence as a viable component of the state's wild animals or wild plants is designated by the WDNR to be in danger of extinction on the basis of scientific evidence.

Environmental Corridor — Environmentally sensitive areas within sewer service areas which are not eligible for sewer development. Environmental corridors may include wetlands, shorelands, floodways and floodplains, groundwater recharge areas, and other sensitive areas.

Environmental Protection Agency (U.S. EPA) — 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 (ERF) — A fund established by the Wisconsin Legislature to deal with abandoned landfills and other sites (e.g. dry cleaning facilities, chrome-plating shops, etc.) that have caused soil and groundwater contamination. Funding is only used when there is not a cooperative party.

Epidemiology — The study of diseases as they affect populations rather than individuals. Factors evaluated include the distribution and incidence of a disease, mortality and morbidity rates, and the relationship of climate, age, sex, race, and other factors. U.S. EPA uses such data to establish national air quality standards.

Erosion — The action by which the surface of the land is worn away by wind or water and the soil and associated materials are transported elsewhere.

Estuary — An area where the river's mouth meets a larger water body and the currents mix.

Eutrophic	Refers to a nutrient-rich lake or stream. Large amounts of algae and aquatic plants characterize a eutrophic water body. *See also Oligotrophic and Mesotrophic.*
Eutrophication	The process of nutrient enrichment of a water body. Eutrophication can be accelerated by human activity such as agriculture and improper waste disposal.
Facility Plan	A preliminary planning and engineering document that identifies alternative solutions to a community's wastewater treatment problems.
Feasibility Study	A study conducted to determine what plan of action would be the most beneficial and practical to pursue.
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.
Floodplain	A flat area which borders one or both sides of river channel and which is periodically covered with floodwater during intervals of bank overflow.
Fluoranthene	A specific 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. Also known as a food web.
Furan (2,3,7,8-tetra-chloro-dibenzofuran)	A chlorinated organic compound which is highly toxic.
Groundwater	Underground water-bearing areas generally within the boundaries of a watershed, which fill internal passageways of porus geologic formations (aquifers) with water which flows in response to gravity and pressure. Often used as the source of water for communities and industries.
Groundwater Standards	Numerical standards for substances of health or welfare concern which consist of an enforcement standard and a preventive action limit (PAL) - the PAL being a percentage of the enforcement standard which indicates a problem may be developing.

Habitat	The place or type of site where a plant or animal naturally lives and grows.
Hardness	A measure of the dissolved salts in the water (eg. calcium sulfate, bicarbonate).
Heavy Metals	A group of metals which may be present in municipal and industrial wastes that pose long-term environmental hazards if not properly disposed. Some heavy metals are also found in storm water runoff and pesticides and herbicides. Heavy metals can contaminate ground and surface waters, fish and food. The metals of highest concern are: arsenic, cadmium, chromium, copper, lead, mercury, selenium and zinc.
Herbicide	A type of pesticide that is specifically designed to kill plants and can also be toxic to other organisms.
Hydraulic Fractionation	A process used in sediment remediation where the fine fraction containing most of the contaminants is separated out in order to reduce the volume of material to treated or disposed (ie. hydrocyclone separators).
Hydrocarbons	Any of a large class of chemicals containing carbon and hydrogen in a virtually infinite number of combinations.
Hypereutrophic	Refers to a lake with excessive fertility. Extreme algae blooms and low dissolved oxygen are characteristics.
Illegal/Unauthorized Discharges	Contributions of pollutants/contaminants to the AOC as a result of intentional and/or unlawful discharge or dumping.
Impervious	Something which does not allow water to pass through it.
Impoundment	The pond, lake or area of relatively slow moving water located behind and caused by a dam in a stream or river.
Incineration	Reduction of waste materials through combustion. When used by the water quality subcommittee, the term implies the inclusion of environmentally sound air quality controls and ash disposal for each incineration facility.
Indigenous	A species which is native to an area, occurring there naturally and not having been introduced from another area.

Influent — Influent for an industry would be the river water that the plant intakes for its use in processing. Influent to a municipal treatment plant is untreated wastewater.

In-place Pollution — As used in the RAP refers to pollution from contaminated sediments. These sediments are polluted from past discharges from municipal and industrial sources.

In situ — Latin term meaning "happening in its original place."

International Joint Commission (IJC) — An agency formed by the United States and Canada to guide management of the Great Lakes and resolve border issues, particularly water quality issues.

Isopropylbiphenyl — A chemical compound used as a substitute for PCB.

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."

LC_{50} — Lethal concentration for 50 percent of the test population exposed to a toxic substance.

LC_{50} — Lethal dose for 50 percent of the test population exposed to a toxic substance.

Leachate — The contaminated liquid which seeps through a landfill or other material and contains water, dissolved and decomposing solids. Leachate may enter the groundwater and contaminate drinking water supplies.

Lipid — Any of various substances that include fats and waxes and related and derived compounds and with proteins and carbohydrates constitute the principal structural components of living cells. This is where many contaminants such as PCBs are stored and accumulated in the body.

Littoral — The shallow potion of a lake bottom extending from the shoreline to the open water. Most emergent vegetation and attached aquatic plants are located in the littoral zone.

Load — The total amount of materials or pollutants reaching a given water body.

Macroinvertebrates Animals without a vertebral column and which are visible to the unaided eye.

Macrophyte A rooted aquatic plant.

Marginal Use A use that cannot support a fishery or a balanced community of aquatic organisms because of natural conditions (physical, chemical, biological or human activities).

Mass Balance A study that examines all parts of the ecosystem to determine the amount of toxic or other pollutants present, their sources, and the processes by which the pollutant 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.*

Mitigation The effort to lessen the damages caused. Mitigation can be accomplished 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.

Monitoring Programs to monitor or quantify the existence, transport, effect, and remediation of pollutant/contaminants. Evaluation monitoring assesses the effectiveness of remedial actions.

National Pollutant Discharge Elimination System (NPDES) A federal permit system to monitor and control the point source dischargers of wastewater. Dischargers are required to have a discharge permit and meet the conditions it specifies.

Naturally Occurring Sources of pollutants/contaminants that are widely distributed throughout the natural environment and are a result of or are caused by natural processes or phenomena. The contribution of these pollutants/contaminants can be made worse by human activities.

Natural Resource A material source of wealth, such as air, water, land, or their amenities, that occurs in a natural state.

Neoplasm An aberration of cells; a tumor.

Nitrate

NO_3, nitrate, is a major nutrient for plant growth. Certain species of bacteria, blue-green algae and other microbiota occurring in water can extract nitrogen from air and water and then convert it into nitrate in the process known as nitrification. The nitrification process utilizes dissolved oxygen in the conversion of ammonia to nitrate. High nitrification rates can severely deplete the dissolved oxygen content of water. Sources of nitrate in surface water include domestic wastewater, leaching from soil, barnyard or feed lot runoff, and industrial wastewater discharges.

Nitrite

NO_2, nitrite, can be toxic to warm-blooded animals when it reacts with hemoglobin to produce methemoglobin, which impairs oxygen transport in the bloodstream. Nitrites are the intermediate product of nitrification and are usually found in low concentration in the natural environment.

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.

Non-Point Sources

Includes all spatially dispersed sources of pollutants/contaminants including water from rain, snow melt, or irrigation that flows over the ground surface and returns to the surface water. Storm water discharge points are included in this category.

Nucleus

The central part around which others are grouped. The portion of a living cell which houses the essential elements for growth, reproduction, etc.

Nutrients

Substances such as nitrogen or phosphorus which are necessary for and therefore promote the growth of plants and algae.

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 wastewater effluent is discharged.

pH

The pH scale is a range of numbers from 0 to 14. Values from 0 through six indicate acidity, with 0 being most acid, and values from eight through 14 indicate alkalinity, with 14 being most alkaline (basic). A pH of seven is neutral.

Pathogen A virus, bacteria or other infective agent capable of producing disease.

Pelagic Refers to the open water portion of a lake.

Perennial That which lasts throughout the year.

Persistent Toxic Substances Persistent toxic substances are not easily broken down by natural processes in the environment. These substances tend to accumulate and are consumed by many parts of the food chain. As organisms eat these substances, either with sediment, water or through other species, the toxics accumulate in their tissues and magnify, or bioaccumulate. *Also see definition for toxic substances.*

Pesticide Any chemical agent used for control of specific organisms, such as insecticides, herbicides, fungicides, etc.

Phenols Organic compounds that are byproducts of petroleum refining, textile, dye, and resin manufacturing. High concentrations can cause taste and odor problems in fish. Higher concentrations can be toxic to fish and aquatic life.

Phosphorus A nutrient that in excess amounts in lakes and streams can lead to over fertile (eutrophic) conditions and algae blooms.

Phototoxicity Refers to chemicals/contaminants (such as PAHs) which increase in toxicity to aquatic organisms when exposed to light.

Phytoplankton *See Algae.*

Plankton Tiny plants (phytoplankton or algae) and animals (zooplankton) that live in the water column. Note that attached algae and invertebrates are not plankton.

Point Sources Sources of pollution that have discrete discharges, usually from a pipe or outfall. These sources include, but are not limited to, all spatially concentrated sources of pollutants/contaminants, including all present and historically permitted WPDES wastewater discharge points. Combined Sewer Overflows (CSO's) are included in this category while storm water discharge points are not.

Pollution The presence of materials or energy whose nature, location, or quantity produces undesired environmental effects.

Pollution Prevention Changes in processes or raw materials that reduce or eliminate the use or production of hazardous substances, toxic pollutants and hazardous

waste. This does not include incineration, changes in the manner of release of a hazardous substance, recycling of a substance outside of the process or treatment of that substance after the completion of the process.

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 1977, because of their persistence in the environment, they have been detected in air, soil and water, and recent surveys have found PCBs in every section of the country, even those remote from PCB manufacturers and users.

Polycyclic Aromatic Hydrocarbons (PAH)

PAHs are the result of incomplete combustion or organic compounds due to insufficient oxygen and are associated with oils and greases and other components derived from petroleum products which may end up in sediments and be measured as a component of oil and grease. Examples of compounds in the PAH group include benzo(a) anthracene, benzo(b) fluoranthene, benzo(a) pyrene, chrysene, phenanthrene, and pyrene.

Pretreatment

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

Toxic chemicals identified by the federal government because of their potential adverse effect on the environment and/or human health. Major discharges are required to monitor for all or some of these chemicals when their WPDES permits are reissued (referred to as a 2C screening).

Priority Watershed

A drainage area selected to receive Wisconsin fund money to help pay the cost of controlling nonpoint sources of pollution through implementation of Best Management Practices (BMPs). Because money is limited, the watersheds selected for funding are those where problems are critical, control is practical, and cooperation is likely.

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 pollutant dischargers 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 to the Clean Water Act were made in 1977, 1981 and 1989. It is currently up for reauthorization.
Publicly Owned Treatment Works (POTW)	A wastewater treatment plan owned by a city, village or other unit of government.
Qualitative	Pertaining to or concerned with quality or qualities; a subjective measure.
Quantitative	Relating to or involving the measurement of quantity or amount.
Recycling	The process by which waste materials are transformed into new products.
Remedial	Tending to remedy something, to restore to natural conditions, to correct or improve.
Remedial Action Plan (RAP)	A plan designed to restore all beneficial uses to a Great Lakes Area of Concern.
Remedial Investigation/ Feasibility Study (RI/FS)	An investigation of problems and assessment of management options conducted as part of a superfund project.
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.
Retention Basins	Holding ponds where water is not discharged except by means of evaporation, infiltration, or emergency bypass.
Riprap	Broken rock, cobbles, or boulders placed on the bank of a stream to protect it against erosion by hydraulic forces.
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 directly or via storm sewers.
Sanitary District	A special-purpose unit of government providing sanitary service in its

	jurisdictional area. A town sanitary district is created by order of either the town board or the Dept. of Natural Resources. The sanitary district is a designated management agency for collection systems. Each district has three commissioners who plan, construct and maintain a system of water supply, solid waste collection, and disposal of sewage including drainage improvements, sanitary sewers, surface sewers or storm water sewers. The commissioner performs a special assessment which is funded by residents of the sanitary district.
Sanitary Sewer Overflows (SSOs)	Overflows of sewer systems that carry sanitary sewage. Overflows occur when sewers cannot handle the flow and relief valves allow discharges to surface waters.
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	Particles suspended in and carried by water as a result of erosion, street runoff, etc. Particles are deposited in areas where the water flow is slowed (e.g. bends in streams, harbors, wetlands, lakes).
Sediment Oxygen Demand (SOD)	A measure of the amount of dissolved oxygen demand by sediment reactions. The SOD can have a significant influence on the amount of dissolved oxygen available in the water column.
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 as a result of being pushed by strong winds. Also known as "wind tide."
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.
Sewer Service Area	An area presently served or anticipated to be served by a sewage collection system.
Sludge	A byproduct of wastewater treatment; waste solids suspended in water.
Solid Waste	Unwanted or discharged material with insufficient liquid to be free flowing.
SPMD	Semipermeable Membrane Device - a water quality monitoring tool

consisting of a specific neutral lipid spread into a thin film inside a sealed polyethylene layflat tube. Lipophilic chemicals in the water permeate the thin wall of the tubing and partition into the lipid where they are concentrated similar to the way in which aquatic organisms would take up the substance. The lipid inside the tubing can then be analyzed for certain contaminants.

Spills Contributions of pollutants/contaminants to the AOC as a result of accidental spillage, or improper transport and handling practices and procedures.

Standard Industrial Classification (SIC) The United States SIC (Standard Industrial Classification) numbering system was developed to classify all firms by type of activity to facilitate compilation and presentation of data for uniformity and comparability. The 4-digit number defines the specific Industry within a Sub-Group. The first three digits represent the Sub-Group within a Major Group. The first two digits indicate the Major Group.

Example:
- SIC-35 is the Major Group Number for Machinery Except Electrical.
- 353 is the Sub-Group Number for Construction, Mining and Materials Handling and Equipment.
- 3537 is the Industry Number for industrial trucks, tractors, trailers and stackers.

Standards *See Water Quality Standards.*

Stakeholder A stakeholder of an Area of Concern is an individual or a public or private group that makes use of, has an impact on, or is affected by the Area of Concern.

Storm Sewers A system of sewers that collect and transport rain and snow runoff from streets, parking lots, etc. These sewers drain directly to surface waters.

Storm water Water and subsequent runoff generated by precipitation which often contains materials found on streets, parking lots, lawns, fields, etc. such as oil, antifreeze, gasoline, soil, litter, pet wastes, fertilizers, pesticides, leaves and grass clippings.

Superfund A federal program administered by the U.S. EPA which provides for cleanup of major hazardous waste landfills and land disposal areas.

Suspended Solids (SS) Small particles of solid matter suspended in water. Cloudy or turbid water is due to the presence of suspended solids in the form of silt or clay particles. These particles may carry pollutants adsorbed to the particle surfaces.

Synergism The characteristic property of a mixture of toxic substances that exhibits a greater-than-additive cumulative toxic effect.

Taxa Groups of classified organisms.

Tertiary Treatment *See Advanced Wastewater Treatment.*

Terrestrial Those species which live on the land as opposed to in the water.

Threatened A species on the Wisconsin Threatened Species list is one which appears likely, within the foreseeable future, on the basis of scientific evidence, to become endangered.

Total Maximum Daily Loads (TMDLs) The maximum amount of a pollutant that can be discharged into a stream without causing a violation of water quality standards.

Total Organic Carbon (TOC) One of several chemical variables used to measure the enrichment of sediment with organic materials. TOC levels can affect the bioavailability of organic contaminants.

Toxaphene A chlorinated, water insoluble solid used as and insecticide and rodenticide.

Toxic Screening The process used in the Areawide Water Quality Management Plans which may affect water quality or treatment plant performance and provide management recommendations for the control for these substances.

Toxic Substance A substance which can cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological or reproductive malfunctions or physical deformities in any organism or its offspring or a substance which can become poisonous after concentration in the food chain or in combination with other substances.

Toxicity The degree of danger posed by a toxic substance to animal or plant life. Also see acute toxicity, chronic toxicity and additivity.

Toxicity Reduction Evaluation For a discharger, it is required that causes of toxicity in an effluent be determined and that measures be taken to eliminate the toxicity. The measures may be treatment, product substitution, chemical use

reduction or other actions achieving the desired result.

Treatment Plant — *See wastewater treatment plant.*

Tributaries — Those streams, creeks or rivers which flow into a larger river or body of water.

Trophic Status — The level of growth or productivity of a lake as measured by nutrient concentration, algal biomass and depth of light penetration. The major categories of trophic status are oligotrophic, mesotrophic, eutrophic, and hypereutrophic.

Turbidity — Turbidity is the lack of water clarity usually closely related to the amount of suspended solids in water.

Utility District — Provide services such as highway, sewers, sidewalks, lighting and water for fire protection to towns, villages, and 3rd and 4th class cities who may establish a utility district. The funding is provided by district property taxes. The utility district could be a designated management agency for their collection systems.

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 vaporizes at a relatively low temperature.

Wasteload Allocation — Division of the amount of waste a stream can assimilate among the various dischargers to the stream. This results in a limit on the amount (in pounds) of a chemical or biological constituent discharged from a wastewater treatment plant to a water body. A water quality model may be used to calculate allowable loadings, which vary seasonally due to flow. *See Assimilative Capacity.*

Wastewater — Water that has become contaminated as a byproduct of some human activity. Wastewater includes sewage, washwater and the waterborne wastes of industrial processes.

Wastewater Treatment Plant — A facility for purifying wastewater. Modern wastewater treatment plants may be capable of removing 95% of organic pollutants.

Water Column — A vertical area within a body of water reaching from the surface of the water to the bed of the river or lake.

Water Quality — The Great Lakes Water Quality agreement was initially signed by

Agreement	Canada and the United States in 1972 and was subsequently revised in 1978 and 1987. It provides guidance for the management of water quality, specifically phosphorus and toxicants in the Great Lakes.
Water Quality Criteria	Measures 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 Limited Segment	A section of river where water quality standards will not be met if only categorical effluent limits are met.
Water Quality Standards	The legal basis and determination of the use or potential uses of a water body and the water quality criteria, physical, chemical, or biological characteristics of a water body, that must be maintained to keep 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, or tributaries thereof.
Wetlands	Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support specific types of vegetative or aquatic life. Wetland vegetation requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes and bogs.
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 are enforceable.
Wisconsin Pollutant Discharge Elimination System (WPDES)	A permit system to monitor and control the point source dischargers of wastewater in Wisconsin. Dischargers are required to have a discharge permit and meet the conditions it specifies. This program is delegated to the state from the federal NPDES program.
Zooplankton	Minute, free-floating or weakly swimming aquatic animals in streams or lakes. They form an important food supply for larger aquatic animals.

APPENDIX A: Biological Uses of Streams in the Sheboygan River Basin

The following table lists the current and potential uses aquatic life has for all perennial streams in the Sheboygan River Basin. It also lists factors that impair any potential biological uses of these streams. Use the key below to read the table.

Biological Uses Key

GL	Great Lakes communities This subcategory includes Lake Superior, Lake Michigan, and Green Bay including all bays, arms and inlets thereof. This also includes those tributaries which serve as a spawning area of anadromous fish species.
COLD	Cold Water communities This subcategory includes surface waters, except those in GL, capable of supporting a community of cold water fish and other aquatic life, or of serving as a spawning are for cold water fish species. This subcategory includes, but is not restricted to, surface waters identified as trout water by the WDNR.
WWSF	Warm Water Sport Fish communities This subcategory includes surface waters capable of supporting a community of warm water sport fish or serving as a spawning area for warm water sport fish.
WWFF	Warm Water Forage Fish Communities This subcategory includes surface waters capable of supporting an abundant diverse community of forage fish and other aquatic life.
LFF	Limited Forage Fish communities (intermediate surface waters) This subcategory includes surface waters of limited capacity and naturally poor water quality or habitat. These surface waters are capable of supporting only a limited community of forage fish and other aquatic life.
LAL	Limited Aquatic Life (marginal surface waters) This subcategory includes surface waters of severely limited capacity and naturally poor water quality or habitat. These surface waters are capable of supporting only a limited community of aquatic life.

Table A.1: Biological Uses of Streams in the Sheboygan River Basin.
(Source: Sheboygan River Basin Water Quality Management Plan, 1994)

Stream Name	Length (miles)	Biological Use		Supporting Potential Use (FULL, PART, NOT, THR)	Use Problems	
		Existing use	Potential Use		Source	Impact
Sauk-Sucker Creek Watershed (SH01)						
Sauk Creek	15	WWSF[e]	WWSF	NOT	- Nonpoint sources - Hydraulic modification	- Stream flow fluctuations - Turbidity - Sedimentation - Ditched
Sucker Creek	10	WWSF[e]	WWSF	NOT	- Nonpoint sources - Hydrologic modification	- Stream flow fluctuations - Turbidity - Sedimentation - Ditched
4 Unnamed Streams	11					

Stream Name	Length (miles)	Biological Use		Supporting Potential Use (FULL, PART, NOT, THR)	Use Problems	
		Existing use	Potential Use		Source	Impact
Black River Watershed (SH02)						
Barr Creek	3.0	LFF[e]	LFF	PART	- Nonpoint sources - Municipal point source	- Turbidity - Ammonia toxicity - Sedimentation - Dissolved Oxygen
Black River, Segment 1	1.6	LFF[e]	LFF	PART	- Municipal point source - Nonpoint sources	- Sedimentation
Black River, Segment 2	9.4	LAL[e]	LFF	PART	- Municipal point source - Nonpoint sources	- Sedimentation
Fisherman's Creek	2.0	WWFF[e]	WWFF	PART	- Urban storm water runoff - Hydrologic modification - Streambank erosion, - Ditched - Landfill	- Sedimentation - Stream flow fluctuations
2 Unnamed Streams	2.0					

Stream Name	Length (miles)	Biological Use		Supporting Potential Use (FULL, PART, NOT, THR)	Use Problems	
		Existing use	Potential Use		Source	Impact
Sheboygan River Watershed (SH03)						
Feldner's Creek	1.8	COLD[b] Class II	COLD Class II	PART	- Nonpoint sources - Hydrologic modification - Streambank pasturing	- Sedimentation - Stream flow fluctuations - Turbidity
Gooseville Creek	6.3	WWFF[a]	WWFF	PART	- Nonpoint sources, - Ditched	- Sedimentation
Millhome Creek	1.7	COLD[b] Class I	COLD Class I	PART	- Nonpoint sources - Streambank pasturing - Hydrologic modification - Ditched	- Sedimentation - Turbidity
Otter Creek	4.2	WWSF[a]	WWSF	PART	- Nonpoint sources - Streambank pasturing - Ditched - Streambank erosion - Barnyard or exercise lot runoff	- Sedimentation - Bacteriological contamination - Nutrient enrichment - Temperature fluctuation - Ammonia toxicity
Schuett Creek	0.4	COLD[b] Class I	COLD Class I	PART	- Streambank pasturing	- Sedimentation - Turbidity
Sheboygan River Seg. 1	9.9	WWSF[a]	WWSF	PART	- Urban storm water runoff, - Industrial point source discharge - Roadside erosion - Hydrologic modification - Nonpoint sources	- Turbidity - Toxicity problems - Sedimentation - PCB bioaccumulation

Stream Name	Length (miles)	Biological Use		Supporting Potential Use (FULL, PART, NOT, THR)	Use Problems	
		Existing use	Potential Use		Source	Impact
Sheboygan River Seg. 2	5.3	WWSF[a]	WWSF	PART	- Urban storm water runoff - Nonpoint sources - Industrial point source discharge - Hydrologic modification	- Stream flow fluctuations - Sedimentation - Fish migration interference - PCB bioaccumulation - Toxicity problems
Sheboygan River Seg. 3	29.8	WWSF[a]	WWSF	PART	- Nonpoint sources	- Sedimentation - Turbidity
Sheboygan River Seg. 4	22.7	WWSF[a]	WWSF	PART	- Municipal point source - Hydrologic modification	- Dissolved Oxygen - Fish migration interference
Sheboygan River Seg. 5	12.7	WWSF[a]	WWSF	PART	- Streambank pasturing - Cropland erosion - Streambank erosion	- Turbidity - Sedimentation
Weedens Creek	5.9	WWSF[a]	WWSF	PART	- Nonpoint sources - Hydrologic modification - Cropland erosion - Industrial point source discharge	- Turbidity - Stream flow fluctuations - Nutrient enrichment - Sedimentation
Unnamed Trib. to Sheboygan River (T15N, R23E, S30)	2.5	LAL[c]	LAL	PART	- Nonpoint sources - Industrial point source discharge - Hydrologic modification	- Turbidity - Sedimentation - Toxicity problems
29 Unnamed Streams	27.0					

Stream Name	Length (miles)	Biological Use		Supporting Potential Use (FULL, PART, NOT, THR)	Use Problems	
		Existing use	Potential Use		Source	Impact
Onion River Watershed (SH04)						
W. Branch of Belgium Creek	6.0	LFF[a]	WWFF	NOT	- Industrial point source discharge - Municipal point source - Hydrologic modification	- Stream flow fluctuations - Dissolved Oxygen - Ammonia toxicity
E. Branch of Belgium Creek	4.0	LAL[c]	LAL	PART	- Industrial point source discharge - Municipal point source - Hydrologic modification	- Stream flow fluctuations - Dissolved Oxygen - Ammonia
Mill Creek	2.0	COLD[b] Class II	COLD Class I	PART	- Hydrologic modification - Nonpoint sources	- Temperature fluctuation - Sedimentation
Ben Nutt Creek		COLD Class II	COLD Class I	NOT	- Hydrologic modification - Ditched	- Temperature fluctuation - Stream flow fluctuations
Onion River Seg. 1	31.9	WWSF[a]	WWSF	PART	- Nonpoint sources - Industrial point source discharge - Municipal point source - Hydrologic modification	- Turbidity - Sedimentation
Onion River Seg. 2	12.1	COLD[b] Class II	COLD - Class 1	PART	- Nonpoint sources - Hydrologic modification	- Temperature fluctuation - Sedimentation

Stream Name	Length (miles)	Biological Use		Supporting Potential Use (FULL, PART, NOT, THR)	Use Problems	
		Existing use	Potential Use		Source	Impact
Unnamed Trib. to Belgium Creek (T12N, R22E, S4)		WWFF[c]	WWFF	PART	- Nonpoint sources - Hydrologic modification	- Stream flow fluctuations - Dissolved Oxygen - Sedimentation
Unnamed Trib. to Onion River (T14N, R22E, S13)		LFF[b]	WWFF	NOT	- Nonpoint sources - Municipal point source - Hydrologic modification - Industrial point source discharge	- Sedimentation - Industrial point source discharge
8 Unnamed Trib.						

Stream Name	Length (miles)	Biological Use		Supporting Potential Use (FULL, PART, NOT, THR)	Use Problems	
		Existing use	Potential Use		Source	Impact
Mullet River Watershed (SH05)						
Jackson Creek	1.8	COLD[b] Class II	COLD Class I	PART	- Nonpoint sources	- Sedimentation
LaBudde Creek Seg. 1	3.2	COLD[b] Class II	COLD Class II	PART	- Nonpoint sources	- Sedimentation
LaBudde Creek Seg.2	1.9	COLD[b] Class I	COLD Class I	THR	- Industrial point source discharge	
Mullet River Seg. 1	6.9	WWSF[c]	WWSF	PART	- Nonpoint sources - Municipal point source	- Turbidity - Temperature fluctuation - Sedimentation - Fish migration interference
Mullet River Seg. 2	5.2	WWSF[c]	WWSF	PART	- Nonpoint sources - Industrial point source discharge	- Turbidity - Temperature fluctuation - Sedimentation - Fish migration interference
Mullet River Seg. 3	2.2	WWSF[c]	WWSF	PART	- Nonpoint sources	- Turbidity - Temperature fluctuation - Sedimentation - Fish migration interference
Mullet River Seg. 4	3.8	WWSF[c]	WWSF	PART	- Urban storm water runoff - Hydrologic modification	- Turbidity - Temperature fluctuation - Stream flow fluctuations - Sedimentation - Fish migration interference

Stream Name	Length (miles)	Biological Use		Supporting Potential Use (FULL, PART, NOT, THR)	Use Problems	
		Existing use	Potential Use		Source	Impact
Mullet River Seg. 5	4.9	COLD[b] Class II	COLD Class II	PART	- Nonpoint sources - Hydrologic modification - Industrial point source discharge - Urban storm water runoff	- Turbidity - Temperature fluctuation - Stream flow fluctuations - Sedimentation - Fish migration interference
Mullet River Seg. 6	16.7	WWSF[c]	WWSF	PART	- Nonpoint sources - Hydrologic modification	- Stream flow fluctuations - Temperature fluctuation - Fish migration interference - Sedimentation
9 Unnamed Trib.	15					

Stream Name	Length (miles)	Biological Use		Supporting Potential Use (FULL, PART, NOT, THR)	Use Problems	
		Existing use	Potential Use		Source	Impact
Pigeon River Watershed (SH06)						
Fisher Creek	4.4	LFF[c]	WWFF	NOT	- Nonpoint sources - Municipal point source - Hydrologic modification	- Turbidity - Sedimentation
Meeme River	11.9	WWSF[c]	WWSF	PART	- Cropland erosion - Streambank erosion	- Turbidity - Sedimentation
Pigeon River Seg. 1	18.1	WWSF[c]	WWSF	PART	- Hydrologic modification - Cropland erosion - Streambank erosion - Municipal point source	- Turbidity - Sedimentation
Pigeon River	11.9	WWSF[c]	WWSF	PART	- Hydrologic modification	- Turbidity- Sedimentation
Unnamed Creek Jetzer's Outlet Seg. 1	3.6	LFF[c]	WWFF	NOT	- Nonpoint sources - Municipal point source	- Turbidity - Sedimentation
Unnamed Creek Jetzer's Outlet Seg. 2	1.8	LAL[c]	LFF	PART	- Nonpoint sources - Municipal point source	- Turbidity - Sedimentation
10 Unnamed Trib.	18					

[a]A formal use classification (COLD, WWSF, WWFF) published by WDNR.
[b]Trout stream identified in Wisconsin Trout Streams (WDNR, 1980b)
[c]A formal use classification published by WDNR and correctly listed in Chapter NR 104, Wisconsin Administrative Code.
[d]A formal use classification published by WDNR and incorrectly listed in Chapter NR 104, Wisconsin Administrative Code.
[e]Recent studies or professional judgement of a fish manager or biologist indicate this is the biological use the stream is meeting or has potential to meet.

APPENDIX B: Sheboygan Charter Fishery Effort, Catch Rate, and Catch

Table B.1: Sheboygan Charter Fishery Effort, Catch Rate, and Catch.
(Eggold, 1992)

Year	Angler Hours	Fish per Angler Hour	Catch Totals					
			Brown Trout	Rainbow Trout	Coho Salmon	Lake Trout	Chinook Salmon	Total Fish
1976	6,142	.25	32	284	504	273	470	1,563
1977	9,374	.27	41	482	934	358	768	2,583
1978	7,748	.28	154	381	351	424	778	2,088
1979	13,137	.22	124	362	571	601	1,344	3,002
1980	16,381	.31	172	191	2,019	433	2,213	5,028
1981	22,137	.24	225	383	995	903	2,926	5,432
1982	35,860	.24	342	214	1,572	1,628	4,683	8,439
1983	54,136	.31	580	396	1,180	8,650	6,077	16,883
1984	68,200	.32	538	811	6,379	5,999	7,829	21,556
1985	65,851	.31	1,276	961	3,947	4,063	9,964	20,211
1986	68,677	.34	1,040	1,154	5,286	4,893	11,337	23,710
1987	63,483	.38	1,449	2,878	4,309	4,266	10,963	23,865
1988	75,690	.30	1,332	6,166	3,721	6,341	5,221	22,781
1989	60,532	.30	1,055	3,665	2,344	6,409	4,860	18,333
1990	48,129	.27	504	1,999	1,121	6,360	3,000	12,984
1991	41,143	.31	1,075	2,033	938	5,261	3,389	12,696
1992	36,833	.26	1,117	2,300	778	3,353	1,995	9,543

APPENDIX C: Contaminants Monitored in Public Water Supply

This Appendix is comprised of three tables that list the following contaminants:
- Primary Contaminants Monitored in Communities and Non-Transient Supplies
- Additional Primary Contaminant Monitoring for Community Supplies
- Secondary Drinking Water Contaminants

Table C.1: Primary Contaminants Monitored in Communities and Non-Transient Supplies.

These contaminants are monitored for health-related reasons. In most cases, you can not see, smell, or taste these contaminants.

Category	Contaminants	
Coliform Bacteria	Total Coliform Fecal Coliform	
Pesticides/ PCBs	Alachlor Aldicarb Aldicarb sulfoxide Aldicarb sulfone Atrazine Carbofuran Chlordane Dibromochloropropane 2, 4-D Ethylene Dibromide	Heptachlor Heptachlor Epoxide Lindane Methoxychlor Polychlorinated Biphenyls Pentachlorophenol Toxaphene 2,4,5-TP Acrylamide Epichlorohydrin
Volatile Organic Compounds (VOCs)	Benzene Carbon Tetrachloride p-Dichlorobenzene 1,2 Dichlorobenzene o-Dichlorobenzene cis-1,2-Dichloroethylene trans-1,2-Dichloroethylene 1,2-Dichloropropane Ethylbenzene	1,1-Dichloroethylene 1,1,1-Trichloroethane Trichloroethylene Vinyl Chloride Monochlorobenzene Styrene Tetrachloroethylene Toluene Xylenes
Other Regulated Compounds	Turbidity Lead Copper	

Category	Contaminants	
Unregulated Compounds	Sulfate Aldrin Butachlor Carbaryl Dicamba Dieldrin	3-Hydroxycarbofuran Methmyl Metolachlor Metribuzin Picloram

Table C.2: Additional Primary Contaminant Monitoring for Community Supplies

In addition to the list of contaminants in the previous table, community water supplies are required to monitor for the compounds listed below.

Category	Contaminants	
Inorganic Compounds	Asbestos Barium Cadmium Arsenic Chromium	Mercury Nitrate Nitrite Selenium Fluoride
Radionuclides	Beta particle and photon activity[1] Gross alpha particle activity[1] Radium 226/228 Radon Uranium	
Surface Water Treatment Rule	Giardia lamblia Legionella Heterotrophic Plant Count Viruses Cryptosporidium	
Other	Total Trihalomethanes (TTHMs)[2]	

[1] applies to surface water systems serving >100,000 people
[2] applies to systems serving > 10,000 people

Table C.3: Secondary Drinking Water Contaminants

Water supplies which exceed Secondary Drinking Water Standards are not hazardous to health, but may be objectionable to many people. These substances may cause undesirable aesthetic effects, such as staining, bad taste, or bad odor.

Contaminants	
Chloride	Iron
Color	Manganese
Copper	Odor
Corrosivity	Sulfate
Fluoride	Total dissolved solids
Foaming agents	Zinc
Hydrogen sulfide	

APPENDIX D: Municipal Point Sources of Pollution in the Sheboygan River Basin

Table D.1 lists the municipal point sources of pollution in the Sheboygan River Basin. For each source, the table lists the water that receives its discharge, the year built or last upgraded, and recommendations for improvement. *For more information about point source pollution, see page 3-3.*

These are descriptions of the recommendations for improvement:

Disinfection	Community upgrades the wastewater treatment plant disinfection system.
Plant Upgrade	Community upgrades wastewater treatment plant according to the WPDES permit compliance schedule.
Infiltration/Inflow	Community corrects infiltration and inflow problems in the sewer system.
Effluent Limit Review	WDNR reviews the effluent limits for the facility prior to next permit reissuance.
Flow Metering	Community installs new flow metering to record flow of influent and effluent at the wastewater treatment plant.
None	Wastewater treatment process needs no improvement.
Other	Wastewater treatment process needs improvement other than those above.

Table D.1: Municipal Point Sources of Pollution in the Sheboygan River Basin
(Sheboygan River Basin Water Quality Management Plan; WDNR, 1994)

Treatment Facility City (C); Town (T); Village (V)	**Receiving Water**	**Year Built or Last Upgraded**	**Recommendations**
Belgium (V)	Belgium Creek	1985	Other
Cedar Grove (V)	Barr Creek via unnamed tributary	1979	Effluent Limit Review
Gibbsville (V)	Onion River	1978	Other
Howards Grove (V)	Pigeon River	1980	Other

Treatment Facility City (C); Town (T); Village (V)	**Receiving Water**	**Year Built or Last Upgraded**	**Recommendations**
Kiel (C)	Sheboygan River	1983	Other
Lakeland College	Fisher Creek via unnamed tributary	1957	Plant Upgrade
Liberty (T), Sanitary District #1	Groundwater of Meeme River Watershed	1981	None
Mount Calvary (V)	Sheboygan River via unnamed tributary	1972	Plant Upgrade
Northern Moraine Utility commission	Groundwater of Mullet River Watershed	1976	Other
Onion River Sewage Commission	Onion River, segment #1	1993	None
Oostburg (V)	Black River	1981	Other
Plymouth (C)	Mullet River	1978	None
Port Washington (C)	Lake Michigan	1990	None
Sheboygan (C)	Lake Michigan	1979	Other
Sheboygan County Comprehensive Health Center	Onion River	1967	Other
St. Cloud (V)	Sheboygan River	1990	Other
Waldo (V)	Onion River	1963	Effluent Limit Review

APPENDIX E: Industrial Point Sources of Pollution in the Sheboygan River Basin

Table E.1 lists the industrial point sources of pollution in the Sheboygan River Basin. For each source, the table lists the water that receives its discharge, the type of pollutant found in the discharge, and the watershed in which the industry resides. *For more information about point source pollution, see page 3-3.*

Table E.1: Industrial Point Sources of Pollution in the Sheboygan River Basin
(Sheboygan River Basin Water Quality Management Plan; WDNR, 1994)
(Baumann, 1987)

Industry, Primary Activity	Pollutant Type (SIC): Pollutants	Receiving Water	Watershed
A A Lawn Furniture, furniture mfg.	household furniture (2511): Zn	Sheboygan River	Sheboygan River
Allis Chalmers, lawn equipment mfg.	farm/garden machinery (3524): CN-, Cr, Cu, Pb, Ni, Zn, Phenols	Sauk Creek via unnamed ditch	Sauk and Sucker
Ametek, plastic mfg.	miscellaneous plastic products (3079): see SIC Code Summary (Baumann, 1987)	Sheboygan River	Sheboygan River
Austin Gray Iron, foundry	iron and steel foundries (3321): see SIC Code Summary (Baumann, 1987)	Sheboygan River	Sheboygan River
Baker Cheese Factory, cheese mfg.	dairy products (2022): Pb, Zn, Phenols	Groundwater	Mullet River

Industry, Primary Activity	Pollutant Type (SIC): Pollutants	Receiving Water	Watershed
Bemis Manufacturing Main Plant, plastic mfg.	nonferrous rolling and drawing (3354): see SIC Code Summary (Baumann, 1987)	Sheboygan River	Sheboygan River
Bemis Manufacturing Plant D, plastic mfg.	miscellaneous plastic products (3081): see SIC Code Summary (Baumann, 1987)	Sheboygan River via storm sewer	Sheboygan River
Borden Inc., cheese mfg.	dairy products (2022): Pb, Zn, Phenols	Mullet River via drainage ditch	Mullet River
C. Reiss Coal, coal storage and sales	none sampled (5052)	Sheboygan River via storm sewer	Sheboygan River
Cedar Valley Cheese, cheese mfg.	dairy products (2022): Pb, Zn, Phenols	Groundwater	Sauk and Sucker
City of Sheboygan DPW, dredging	samples not available (4469)	Lake Michigan	Sheboygan River
Clevepak, fiber container mfg.	paperboard containers and boxes (2655): see SIC Code Summary (Baumann, 1987)	Mullet River via storm sewer	Mullet River
Cousin Components, plastics mfg.	miscellaneous plastic products (3079): see SIC Code Summary (Baumann, 1987)	Sheboygan River	Sheboygan River
Crafted Plastics, plastics mfg.	miscellaneous plastic products (3079): see SIC Code Summary (Baumann, 1987)	Sheboygan River	Sheboygan River

Industry, Primary Activity	Pollutant Type (SIC): Pollutants	Receiving Water	Watershed
Crystal Lake Crushed Stone, concrete mfg.	none sampled (3281)	Groundwater	Mullet River
Dirske Oil, oil storage	fabricated structural metal products (3443): CN^-, Cd, Cr, Cu, Pb, Ni, Zn, Phenols	Black River	Black River
Fiedler Processing Plant, packing co.	meat products (2011): Zn, Phenols	Groundwater	Onion River
J.L. French Co., aluminum die casting	nonferrous foundries (3361): see SIC Code Summary (Baumann, 1987)	Lake Michigan via storm sewer	Black River
Gibbsville Cheese, cheese mfg.	dairy products (2022): Pb, Zn, Phenols	Groundwater	Onion River
Harris and Gallob Inc., chrome metal plating	metal services (3471): CN^-, Cd, Cr, Cu, Pb, Ni, Zn, Ag	Belgium Creek	Onion River
Hydraulic Tools, welding equipment mfg.	none sampled (3548)	Sheboygan River via storm sewer	Sheboygan River
Intercommunity Incinerator, garbage incineration	plumbing and heating, except electric (3433): CN^-, Cd, Cr, Cu, Pb, Ni, Zn, Phenols	Un Lagoon and Groundwater	Sheboygan River
Jitram Extrusions, plastics mfg.	miscellaneous plastic products (3079): see SIC Code Summary (Baumann, 1987)	Sheboygan River	Sheboygan River
Johnsonville Foods, sausage mfg.	meat products (2013): Zn, Phenols	Sheboygan River	Sheboygan River

Industry, Primary Activity	Pollutant Type (SIC): Pollutants	Receiving Water	Watershed
Kohler Co., pluming fixture mfg.	metal services (3471): CN^-, Cd, Cr, Cu, Pb, Ni, Zn	Sheboygan River	Sheboygan River
Kohler General Corp., industrial machinery mfg.	special industry machinery (3553): Cr, Pb	Sheboygan River	Sheboygan River
Larsen Co. Waldo Plant, vegetable processing	preserved fruits and vegetables (2033): Cr, Cu, Zn, Phenols	Onion River via unnamed tributary	Onion River
Larsen Co. Cedar Grove Plant, vegetable processing	preserved fruits and vegetables (2033): Cr, Cu, Zn, Phenols	Barr Creek	Black River
Lakeside Packing Co., packaging co.	preserved fruits and vegetables (2033): Cr, Cu, Zn, Phenols	Belgium Creek	Onion River
Lindows & Wilbert Vault Inc., cement production	NA	Groundwater and Storm Sewers	Sheboygan River
Mayline Comp., furniture mfg.	office furniture (2521): Cr, Zn	Sheboygan River via storm sewer	Sheboygan River
Old WI Sausage Co., sausage mfg.	meat products (2013): Zn, Phenols	Sheboygan River	Sheboygan River
Old WI Sausage Co., sausage mfg.	meat products (2013): Zn, Phenols	Sheboygan River	Sheboygan River
Plastics Engineering Co. Geele Ave Plant, plastics mfg.	miscellaneous plastic products (3079): see SIC Code Summary (Baumann, 1987)	Sheboygan River	Sheboygan River

Industry, Primary Activity	Pollutant Type (SIC): Pollutants	Receiving Water	Watershed
Plastics Engineering Co. 15th St. Plant, plastics mfg.	plastics, materials, synthetics (2821): see SIC Code Summary (Baumann, 1987)	Lake Michigan	Sheboygan River
Polar Ware Co., stainless steel finishing	miscellaneous fabricated metal products (3499): CN^-, Cr, Cu, Pb, Ni, Zn, Phenols	Sheboygan River	Sheboygan River
Poly Vinyl, plastics mfg.	plastics, materials, synthetics (2820): see SIC Code Summary (Baumann, 1987)	Sheboygan River via un tributary	Sheboygan River
Port Washington Utility, iron filtering	samples not available (4941)	Lake Michigan	Sauk and Sucker
R Way Furniture, furniture mfg.	office furniture (2520): Cr, Zn	Sheboygan River via storm sewer	Sheboygan River
Rockline Inc., coffee filter mfg	miscellaneous converted paper products (2649): see SIC Code Summary (Baumann, 1987)	Sheboygan River via storm sewer	Sheboygan River
S&R Cheese Co. Plymouth, cheese mfg.	paints and allied products (2851): see SIC Code Summary (Baumann, 1987)	Mullet River via storm sewer	Mullet River
S&R Cheese Co. Bamford, cheese mfg.	dairy products (2022): Pb, Zn, Phenols	Sheboygan River via storm sewer	Sheboygan River
Sargento Cheese, cheese mfg.	dairy products (2022): Pb, Zn, Phenols	Jackson Creek via drainage ditch	Mullet River

Industry, Primary Activity	Pollutant Type (SIC): Pollutants	Receiving Water	Watershed
Sargento Cheese Elkart Lake, cheese mfg.	dairy products (2022): Pb, Zn, Phenols	Sheboygan River	Sheboygan River
Schneider Cheese, cheese mfg.	dairy products (2022): Pb, Zn, Phenols	Groundwater	Onion River
Schrier Malting, barley malting	beverages (2083): Cr, Cu, Pb, Zn, Phenols	Sheboygan River	Sheboygan River
Service Ice, ice storage	refrigeration and service machinery (3585): CN^-, Cd, Cr, Cu Pb, Hg, Ni, Zn, Phenols	Sheboygan River	Sheboygan River
Sheboygan Concrete Co., concrete mfg.	none sampled (3281)	Sheboygan River via storm sewer	Sheboygan River
Sheboygan Paint, paint mfg	paints and allied products (2851): see SIC Code Summary (Baumann, 1987)rniture (2515): Zn	Sheboygan River	Sheboygan River
Springtime Beverages, distilled water bottling	beverages (2086): Cr, Cu, Pb, Zn, Phenols	Lake Michigan	Sheboygan River
Steinhardt Bros. Fur Farms, animal feed	miscellaneous manufacturers (3999): CN^-, As, Cd, Cr, Ni, Zn, Phenols	Mullet River via unnamed tributary	Mullet River
Tecumseh Products, aluminum die	nonferrous foundries (3361): see SIC Code Summary (Baumann, 1987)	Sheboygan River	Sheboygan River

Industry, Primary Activity	Pollutant Type (SIC): Pollutants	Receiving Water	Watershed
Thomas Ind. Plant 1, paint spraying equipment mfg.	general industry machinery (3563): Cr, Cu, Pb, Zn, Phenols	Sheboygan River	Sheboygan River
Thomas Ind. Plant 2, paint spraying equipment mfg.	general industry machinery (3563): Cr, Cu, Pb, Zn, Phenols	Black River	Black River
Tupper Cheese Co., cheese mfg	dairy products (2022): Pb, Zn, Phenols	Mullet River	Mullet River
Vander Vaart Brick, ready mix concrete products	none sampled (3273)	Sheboygan River	Sheboygan River
Verifine Dairy, dairy product mfg.	dairy products (2021): Pb, Zn, Phenols	Sheboygan River via storm sewer	Sheboygan River
Vinyl Plastics, plastics mfg.	plastics, materials, and synthetics (2820): see SIC Code Summary (Baumann, 1987)	Lake Michigan	Sheboygan River
Vollrath Co., stainless steel mfg.	iron and steel foundries (3325): see SIC Code Summary (Baumann, 1987)	Sheboygan River via storm sewer	Sheboygan River
Waltry Industries, aluminum foundry	nonferrous foundries (3365): see SIC Code Summary (Baumann, 1987)	Lake Michigan	Sheboygan River
Willman Industries, foundry	iron and steel foundries (3321): see SIC Code Summary (Baumann, 1987)	Barr Creek via tributary	Black River

Industry, Primary Activity	Pollutant Type (SIC): Pollutants	Receiving Water	Watershed
WEPCO of Port Washington, electricity	electric services (4911): Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Se, Tl, Ni, Zn	Lake Michigan	Sauk and Sucker
WI Power and Light Edgewater Plant, electricity	electric services (4911): Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Se, Tl, Ni, Zn	Lake Michigan	Black River

APPENDIX F: WDNR Spills List (1986-1992)

Table F.1: WDNR Spills List (1986-1992).

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
06-27-86	Lake Michigan off Terry Andrea State Park			Oil	
06-27-86	Highway 28 & Monroe Street		Eugene Perronne, Cascade	Diesel Fuel	12 gal
07-15-86	North of Sunset Road	Sheboygan	Aniceto Gargia	Diesel Fuel	50 gal
09-25-86	444 Highland Drive	Kohler	Kohler Co.	PCB	20 gal
09-26-86	Sheboygan River			Road Run Off	2 gal
09-27-86	Lake Bank - Block North of North Avenue	Sheboygan	City of Sheboygan	Raw Sewage	
10-18-86	.03 Miles North of Highway 28 on Highway 43 South Bound		P & K Transfer Lines, Green Bay	Diesel Fuel	40 gal
10-31-86	Sewer Outfall	Sheboygan	E. H. Wolf & Sons, Inc., Slinger	Diesel Fuel	50 gal
11-20-86	Highland Drive	Kohler	Kohler Co.	Oil	500 gal

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
11-29-86	546 North Depot Street	Waldo	Norbert Hintz	2 Fuel Oil	49 gal
11-3-86	12 West Main Street	Plymouth	Level Valley Dairy, West Bend	Whey	7000 lbs
12-08-86	South Bound off Ramp Highway 43/42		James D. Dumke, Iron Mountain, MI	Diesel Fuel	100 gal
01-21-87	Kohler Co.	Sheboygan	Kohler Co.	6 Fuel Oil	300 gal
02-09-87	North of the Foundry	Kohler	Kohler Co.	Diesel Fuel	50 gal
02-24-87	Highway 57 and Onion River			Petroleum Product	
03-13-87	3016 Business Highway 42	Sheboygan	Conoco, Inc.	6 Fuel Oil	11340 gal
04-01-87	1409 Michigan Avenue	Sheboygan	Lee Leonard Auto Doctors	Fuel Oil	
04-09-87	Depot Street	Waldo	Gene Miller Trucking	Drain Oil	12 gal
05-12-87	Flowing Downstream near Sheboygan Falls	Sheboygan		Red Discoloration	
05-14-87	Highway 57 and County PP		Gilson Brothers Co., Plymouth	Unknown	
06-01-87	Business 42 just North of North Avenue	Sheboygan	Harren Equipment, Willingboro, NJ	2 Diesel Fuel	75 gal

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
07-31-87	100 yards down River 8th Street Bridge		Dennis Teetzen, Sheboygan	Gasoline	100 gal
07-31-87	Sheboygan River	Sheboygan		Gasoline	100 gal
08-29-87	Sheboygan River		Charter Vessel	Gasoline	
10-13-87	County Trunk Highway PP at On Ramp North Bound to Highway 43		Buteyn Excavating and Grading, Sheboygan	Diesel Fuel	2 gal
10-17-87	North of Village Limits - 3rd Street		Norbert Hintz, Waldo	Fuel Oil	150 gal
10-26-87	506 Wisconsin Street	Adell	Geoffrey Michael, Adell	Gasoline	
10-27-87		Adell		Gasoline	
11-10-87	Sheboygan River at Virginia Avenue			Paint Product	
01-28-88	Kohler Wastewater Plant	Kohler	Kohler Co., Kohler	Oil	
02-29-88	2732 North 15th Street	Sheboygan	Plastics Engineering Co.	Methanol	55 gal
03-14-88	802 South Street	Plymouth	Borden's Co.	Vegetable Oil	4800 lbs
03-16-88	1925 North 4th Street and 2112 North 6th Street	Sheboygan	Quality Street Oil	2 Fuel Oil	35 gal

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
03-25-88	434 Monroe Street	Sheboygan Falls	Frontier Pet Inc.	Petroleum Heating Oil	100 gal
05-13-88	824 County Trunk Highway Rural Route - East of Palmer Road	Cedar Grove	Manuel Casarez	Liquid Asphalt	100 gal
05-19-88	.25 Mile West of Mentink Road North County A		Robert Lammers, Oostburg	Ammonia	620 gal
05-23-88	Highway 32 and Highway 28 Intersection		Amoco Tank Truck, Okachee	Unleaded Gas	20 gal
06-05-88	5 Miles East of Sheboygan Harbor	Sheboygan		Diesel Fuel	
07-15-88	Sheboygan River	Sheboygan		Run Off	5 gal
07-26-88	Kohler Co. Plant	Kohler	Kohler Co., Kohler	Nickel Solution	2000 gal
07-26-88	Division Street	Plymouth	CPS Florstar, Milwaukee	2 Diesel Fuel	50 gal
08-04-88	1523 North 29th Street - 1610 North 28th Street	Sheboygan	Wisconsin Power & Light, Fond du Lac	PCB Oil	3 gal
08-23-88	1.5 Blocks West of Sheboygan River	Sheboygan	General Split	Aqueous Pigment Dispersion	45 gal
08-29-88	Broadway - Walnut Intersection	Sheboygan Falls	Goldsmith Painting & Cleaning	Diesel Fuel	100 gal

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
10-06-88	County Trunk Highway V - 1 Mile West of Highway 43		Aldridge Chemical, Sheboygan Falls	Borontri-fluoride	40 lbs
10-25-88	Highway 42 and Playbird Road		Wisconsin DOT, Green Bay	Hydraulic Oil	50 gal
11-06-88	County Trunk Highway F West of Highview Road		Alan Thull, West Bend	Unknown	
11-16-88	.5 Miles West of 23 on Gerber Lake Road			Creosote	1 gal
11-17-88	.10 Miles North of K on Highway 43			Blue Barrel	1 gal
11-22-88	.2 Miles East of Little Elk Road on Key Stone			Creosote	
11-27-88	Highway 57 - South of Highway 18		Hanefeld Brothers, Inc., Burnett	Diesel Fuel	200 gal
11-29-88	Village of Kohler	Kohler		Petroleum	
12-11-88	Highway V 1.25 Miles West of Highway 43	Sheboygan Falls	Aldrich Chemical Co.	Dilute Wastewater	250,000 gal
01-03-89	Generating Station	Sheboygan	Edgewater Generating Station	Chem Link Dusbloc 150	550 gal
01-04-89	934 North Water Street	Sheboygan	Verifine Products Co.	2 Diesel Fuel	250 gal

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
01-20-89	Highway 43 North at Rowe Road	Howards Grove	B & A Express, Bronwood Corporation, IL	Diesel Fuel	300 gal
01-21-89	Kohler Truck Scale	Kohler	Aloha Freightways, Addison, IL	Diesel Fuel	75 gal
03-04-89	Highway 67 between Golf Course Road and County Trunk Highway JJ		Kramer Trucking, Waldo	Diesel Fuel	
03-09-89	Kohler Andrae State Park	Adell	Adell Coop	Diesel Fuel	30 gal
04-03-89	632 Center Street	Sheboygan	Media Graphics	Nitric Acid Mix With Oil	3 gal
04-04-89	County TT	Sheboygan Falls	Sheboygan Falls Coop	Malathion	5 gal
04-21-89	Northeast Corner Pen Avenue and North Water Street	Sheboygan	Ken Budget Auto Sales	Diesel Fuel	5 gal
05-19-89	Sheboygan River	Sheboygan		Gasoline	1 gal
06-29-89	820 Wood Lake Road	Kohler	Quality State Oil	Unleaded Gasoline	500 gal
06-30-89	1410 North 15th Street	Sheboygan	Mike Mahnke	Oil	
07-26-89	Sheboygan River, 1 Mile of Street	Sheboygan		Titasoft-DB	110 gal

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
08-18-89	419 Illinois Avenue	Sheboygan	Thomas Industries	Mold Release, Tramp Oil	
08-21-89	County Highway LS Eisner Avenue	Sheboygan	Wisconsin Public Service Corporation	Natural Gas	
08-23-89	Highway 43 From County Highway PP to County Highway V	Sheboygan		Diesel Fuel	
09-02-89	1/2 Mile East of Snake Road on North Side FF	Elkhart Lake	Michael J. Hecker, Plymouth	Gasoline	15 gal
09-03-89	North End Stock Car Track, County Fairground	Plymouth	Norbert Hintz, Waldo	Octane, Gas	60 gal
09-12-89	300 Yards Northwest of Highway 144 and Silver Creek	Random Lake	Lakeside Packing Co.	Corn Wash Waste, Water	4500 gal
09-14-89	Onion River at County Trunk Highway G Bridge	Cedar Grove	Roy Teunnisen Farms	Corn Silage Juice	
10-08-89	Storms Sewer Outlet, Rochester Field	Sheboygan		Unknown	
10-16-89	Lake Michigan	Sheboygan	Plastics Engineering Co.	Phenol and Formaldehyde	5000 gal
10-24-89	Elkhart Lake Elementary School	Elkhart Lake	Waldridge Construction	Natural Gas	

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
11-14-89	West of KK on Hartman Road	Oostberg		Oily Substance	
11-27-89	Pigeon River at Village Park	Howard Grove		Petroleum	
12-21-89	444 Highland Drive	Kohler	Kohler Co.	Diesel Oil	125 gal
01-11-90	On Kohler Grounds at Kohler	Kohler	Kohler Co.	Diesel Fuel	50 gal
01-11-90	Highway 43 at Highway PP	Kohler		Diesel Fuel	50 gal
01-17-90	Mall Building - 444 Highland Drive	Kohler	Kohler Co.	Hydraulic Oil	50 gal
01-18-90	Kohler Plant - Northeast Corner	Kohler	Kohler Co.	Hydraulic Oil	40 gal
01-21-90	Mink Creek	Boltonville		Brown Foam	
02-07-90	444 Highland Drive	Kohler	Kohler Co.	Machine Coolant	55 gal
03-27-90	Sheboygan River - East Bank	Sheboygan		White Cure	50 gal
04-20-90	Creek Behind 3731 Bonnie Court	Sheboygan		Gasoline	
04-21-90	State Highway 57 and Onion River	Waldo		Paint	
04-26-90	.3 West of Highway 43 on PP	Sheboygan	Musson Brothers	Diesel Fuel	10 gal
05-21-90	444 Highland Drive	Kohler	Kohler Co.	Hydraulic Fluid	5 gal
05-25-90	72A Park Avenue	Sheboygan	Sheboygan Water Utility	Chlorine	
06-05-90	444 Highland Drive	Kohler	Kohler Co.	Mineral Oil	5 gal

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
07-19-90	2806 North 15th Street	Sheboygan	Polarware Co.	Ammonia	1950 lbs
07-19-90	444 Highland Drive	Kohler	Kohler Co.	Paint Solvent	10 gal
07-28-90	South Side City of Sheboygan	Sheboygan		Natural Gas	
07-30-90	Fishermans Creek - Highway OK on County PP	Sheboygan		Unknown	
08-03-90	Sheboygan River - 1011 Illinois Avenue	Sheboygan		Oil/Gas Base	
10-10-90	South Yard Southeast Corner Die Cast Building	Sheboygan	Kohler Co.	Diesel Fuel	30 gal
10-17-90	.5 Mile South of County A - Intersection of Highway A and 128	Kohler	Wisconsin Test Drilling	Hydraulic Oil	15 gal
10-27-90	Lake Michigan - 823 Commerce Street	Sheboygan		Diesel Fuel or Fuel Oil	
11-01-90	444 Highway Drive - South Yard	Kohler	Kohler Co.	Used Oil	55 gal
11-07-90	36th Place East of 38th and 300A South of Main	Sheboygan	Sheboygan Sports Club Inc.	Oil Filters	
11-09-90	Black River - Dirkse Oil Co. on North 10th	Oostburg	Dirkse Oil Co.	Gasoline	300 gal
01-21-91	444 Highland Drive	Kohler	Kohler Co.	Hydraulic Oil	50 gal

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
02-08-91	Engine Plant	Kohler	Kohler Co.	Gasoline	
03-27-91	Lake Michigan	Sheboygan	Wisconsin Power & Light	Coal Dust	
04-06-91	6700 Block National Avenue	West Allis	E & K Hazardous Waste Materials	Waste Tooling Oil	50 gal
04-09-91	444 Highland Drive	Kohler	Kohler Co.	2 Diesel Fuel	5 gal
04-11-91	Diesel Fuel Station on North Side of Foundry	Kohler	Kohler Co.	2 Diesel Fuel	10 gal
04-13-91	In Basement Ammonia Compressor Room	Plymouth	Borden Incorporated	Ammonia	400 lbs
04-15-91	444 Highland Drive - Sheboygan River	Kohler	Kohler Co.	Diesel Fuel	15 gal
04-17-91	444 Highland Drive - Sheboygan River	Kohler	Kohler Co.	Brass Cleaner	300 gal
04-19-91	2905 Paine Ave	Sheboygan	E & K Hazardous Waste Service	Diesel Fuel	50 gal
04-19-91	County Trunk Highway C between Willow Road and Highway 57	Sheboygan	Wisconsin Public Service	Natural Gas	
04-27-91	County Trunk Highway LS and Garton Road	Kohler	Kohler Co.	Gasoline	63 gal

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
05-01-91	444 Highland Drive	Kohler	Kohler Co.	Diesel Fuel	2 gal
05-06-91	430 1st Street	Random Lake	Cenex Service Station	Premium Unleaded Gasoline	10 gal
05-11-91	Highway 57 and County Highway C	Sheboygan		Corrosive	
05-13-91	706 Allen St.	Random Lake	Lake Side Packing	Ammonia	
05-14-91	Diesel Pump at 444 Highland Dr.	Kohler	Kohler Co.	Diesel Fuel	1 gal
05-22-91	444 Highland Dr.	Kohler	Kohler Co.	Hydraulic Oil	100 gal
05-30-91	Highway 43 at Highway 23	Sheboygan	Spieglvogel Inc.	Diesel Fuel	100 gal
06-24-91	Highway 42 and Pigeon River Bridge	Sheboygan	Eugene A Kunstman Sr.	Diesel Fuel	50 gal
07-12-91	2905 Paine Ave	Sheboygan	E&K Hazardous Waste Service	2 Diesel Fuel	10 gal
07-22-91	1300 Center Ave	Sheboygan	Ryan Oil Co.	Propane	
07-25-91	Sheboygan Power Plant	Sheboygan	Wisconsin Power and Electric	Transformer Oil	735 gal
08-05-91	County O 25 East of Willow Road	Sheboygan Falls	George Tomlinson	Gasoline	55 gal

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
08-06-91	Highway 32 and County Trunk Highway V	Sheboygan		Fuel Oil	60 gal
08-06-91	444 Highland Dr.	Kohler	Kohler Co.	Chromic Acid	20 gal
08-28-91	Riverside Facility	Sheboygan Falls	Johnsonville Foods	Ammonia	
09-08-91	Sheboygan River South of Coast Guard Station	Sheboygan	Andrie Inc.	2 Fuel Oil	10 gal
10-09-91	714 Indiana Ave.	Sheboygan	Sheboygan Cold Storage	Ammonia	
10-14-91	444 Highland Drive - on paved area	Kohler	Kohler Co.	Diesel Fuel	1 gal
11-11-91	444 Highland Drive	Kohler	Kohler Co.	Diesel Fuel	
11-12-91	444 Highland Drive	Kohler	Kohler Co.	Metal Finishing Waste Water	20 gal
11-13-91	444 Highland Drive	Kohler	Kohler Co.	Elevator Hydraulic Fluid	88 gal
11-14-91	Sheboygan River - Commerce Street	Sheboygan		Fuel Oil	
11-20-91	1236 North 18th Street	Sheboygan	Volrath Co.	Phosphoric Phosphate	3 gal
11-24-91	Highway 42 South of Milwaukee	Plymouth	Glacier Transiert and Storage	Diesel Fuel	100 gal

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
12-02-91	N132 MM I43	Sheboygan	D.K. Leonard Trucking	Diesel Fuel	75 gal
12-04-91	444 Highland Drive - Kohler Co.	Kohler	Miller Compressing	Hydraulic Oil	30 gal
12-09-91	444 Highland Drive	Kohler	Kohler Co.	Wastewater	200 gal
12-19-91	4024 Street Highway 42	Sheboygan		Fuel	20 gal
12-20-91	Highway 42 South of Manitowoc County Line	Erdman	Clark Carthage	Diesel Fuel	100 gal
01-13-92	Near Gas Station on Site	Kohler	Kohler Co.	Unleaded Gasoline	20 gal
02-03-92	Highway 57 and County Trunk Highway A	Adell		Diesel Fuel	50 gal
02-10-92	County A and Gibbons Road - Southeast Corner	Sheboygan	Rathjen Green Houses	Fertilizer 30-10-10	
02-21-92	North Side of Facility - 444 Highland Drive	Kohler	Kohler Co.	Oil	
02-21-92	Southwest Corner of Facility - 444 Highland Drive	Kohler	Kohler Co.	Hydraulic Oil	1 gal
03-18-92	Inside Trailer	Random Lake	Hyman Freightways	Dyfonate	15 gal
03-23-92	444 Highland Drive	Kohler	Kohler Co.	Waste Enamel Powder	55 gal

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
04-04-92	444 Highland Drive	Kohler	Kohler Co.	Enamel Powder	
05-02-92	444 Highland Drive - East Side of Mill Building	Kohler	Kohler Co.	Waste Enamel	2MIS
05-02-92	Decontamination Pad at Facility	Sheboygan Falls	Tecumseh Products	PCB Sludge	60 gal
05-08-92	Treatment Lagoon - 444 Highland Drive	Kohler	Kohler	Oil	20 gal
05-09-92	444 Highland Drive	Sheboygan	Gus Holman Co.	Hydraulic Fluid	5 gal
05-12-92	Northeast Corner of Foundry Building	Kohler	Kohler Co.	Hydraulic Fluid	25 gal
06-01-92	2732 North 15th Street	Sheboygan	Plastics Engineering	Methyl Alcohol	40 gal
06-03-92	2905 Paine Avenue	Sheboygan	E & K Hazardous Waste	Hydraulic Oil	30 gal
06-05-92	802 South Street	Plymouth	Bordens Inc.	Ammonia	10 lbs
06-14-92	802 South Street	Plymouth	Bordens Inc.	Ammonia	10 lbs
06-18-92	Railroad Car Unloading Area Southwest Mill Building	Kohler	Kohler Co.	Soda Ash	200 lbs
07-21-92	444 Highland Drive - East End of North Yard	Kohler	Kohler Co.	Gear Oil	4 gal
07-23-92	Highway A	Adell	Ecochem	Waste Water	40 gal

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
07-23-92	Highway 28 and Taylor Drive	Sheboygan	E & K Halvin - Jon Herrmann	Hydraulic Oil	50 gal
07-28-92	444 Highland Drive	Kohler	Kohler Co.	Hydraulic Oil	80 gal
08-09-92	802 South Street	Plymouth	Borden	Ammonia	25 lbs
08-14-92	Corner of Geeley and Calumet	Sheboygan	Quality State Oil	Diesel Fuel	70 gal
08-14-92	Sheboygan River	Sheboygan Falls	Tecumseh	Machining Coolant	20 gal
08-14-92	North Side of Brass Water Treatment Building	Kohler	Kohler Co.	Electro-plating Waste	1 gal
08-20-92	1410 Erie Street	Sheboygan	Midas Muffler	Brake Fluid	
09-14-92	740 South Commerce Street	Sheboygan	R-Way Furniture Co.	Transformer Oil	5 gal
09-24-92	Corner County A and EE	Wilson	Random Lake Coop	Triplet & Water	400 gal
09-24-92	Kohler County by South Gate	Sheboygan	Kohler Co.	Sludge	
10-28-92	Sheboygan River - County J	Sheboygan	Johnsonville Foods	Waste Water 95%	80,000 gal
11-09-92	North Side of Brass Building	Kohler	Kohler Co.	Brass Polishing Lint	
11-10-92	Sheboygan River - 3300 Block University Drive	Sheboygan	Kathleen P. Peters	Unleaded Gasoline	20 gal

Date	Spill Location	Spill City	Potential Responsible Party	Type Substance	Quantity & Unit
11-27-92	1108 South Wildwood Road	Sheboygan	Zavrl Auto Salvage	Gasoline	

APPENDIX G: Sheboygan County Conservation Association Projects

Following are the conservation projects in Sheboygan County that were made possible by donor participation and sports persons involvement through the Sheboygan County Conservation Association.

Year	Project	Funds Allocated
1983-84	Funds provided for previous projects (not listed)	$34,302
1985	Dredged for boat ramp in Gerber Lake	$480
1985	Supplied TV monitors and VCRs for safety programs	$1199
1985-88	Relocated pheasant pens to Maywood	$13,252
1985-91	Supplied seedlings, owl mounting, and owl-nest boxes for Howards Grove HS agricultural classes, Arboretumfor hands-on learning in an outdoor lab	$1071
1985-92	Annual Natural Resources Scholarship	$3500
1985-89	Sheboygan Area Water Quality Task Force	$10,000
1986	Advanced Hunter Education Pilot Study	$2416
1986	Little Elkhart Lake aerator expenses	$145
1986	Landowner/Land user Study and GRIP Program	$1973
1986	Blacktop public boat landing and parking area at Crystal Lake	$2893
1986	Materials for handicapped fishing pier at public boat landing on Jetzer's Lake	$299
1986	Little Elkhart Lake overflow system	$2000
1986	Land purchase: 37 acres of Sheboygan County Marsh	$12,464
1986	Land purchase: 40 acres of Sheboygan County Marsh	$7000
1987-89	Trees for Tomorrow Natural Resources Camp and Teacher Scholarship	$1314
1987	Sheboygan River clean-up	$570
1988	Funding for switch grass seed in Northern Unit of the Kettle Moraine State Forest	$1500

1988	Wild Turkey Survey in Northern Unit of the Kettle Moraine State Forest	$4000
1989	Outdoor Skill Center construction on Sheboygan County Fairgrounds	$12,800
1989	Pager for car-killed deer salvage at Sheboygan County Sheriff's Department	$392
1989	Sheboygan River Bass Survey	$1200
1989	Land purchase: 138 acres in the town of Sherman	$49,157
1989	Explorer Post Sponsorship	$297
1989	Access landing along Sheboygan River	$992
1989-92	Funds for Plymouth Ducks Unlimited	$771
1990	Funds toward Kiel Marsh Restoration Project	$300
1990	Funds for Maywood Environmental Center	$1000
1990	Blacktop public boat landing and parking area at Little Elkhart Lake	$880
1990	Purchased weed-cutter and rakes for County Lakes	$280
1990-91	Master-Plan Development, Outdoor Skills Center	$3000
1991-92	Creel-census survey on Rainbow stocking	$400
1991-92	Outdoor Skill Center Pilot Program	$14,500
1992-93	Restoring Ben-Nutt Creek	$2700
1992-93	1992 Scholarship	$500
1992-93	Sheboygan Falls HS Fish Rearing Pond	$2000
1992-93	Plymouth HS Fish Pond	$2000
1992-93	Jilin Pheasants Program	$3500
1992-93	Sheboygan County HS Essay Contest	$266
1992-93	Wisconsin Conservation Corps (supplies for new crew)	$1050
TOTAL funds allocated as of 01/6/93		$196,073

APPENDIX H: Sheboygan River Experimental Fish Stocking Study Report

PCB accumulation by salmonid smolts and adults and its effect on stocking policies

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Abstract. - In 1987, the Wisconsin Department of Natural Resources suspended stocking of salmonids in the Sheboygan River, a Lake Michigan tributary in southeastern Wisconsin and an Environmental Protection Agency Superfund site, because of contamination with polychlorinated biphenyls (PCBs). To determine levels of PCB uptake on stocked salmonids, we (1) measured PCB levels in steelhead Oncorhyncus mykiss and coho salmon Oncorhyncus kisutch smolts stocked in the Sheboygan River and compared these data with fish from two reference locations; (2) measured PCB levels in returning adult steelhead and coho salmon after residence in Lake Michigan from those plants; and (3) produced decisions regarding the proper stocking policy for the Sheboygan River in the future. Uniquely finclipped hatchery raised fish were stocked in the Sheboygan River and two other Lake Michigan tributaries (Pigeon and Root rivers). Smolts were collected, homogenized and analyzed (whole body), monthly until out-migration. Returning sub-adults and adults were analyzed as skin-on fillets and whole body. Sheboygan River smolts stocked in the fall accumulated higher PCB concentrations than smolts stocked in other rivers and those stocked in the spring. Total PCB concentrations in fillets of sub-adult and adult coho salmon and sub-adult and adult steelhead from the Sheboygan River did not significantly differ from sub-adults and adults returning to the reference rivers. None of the returning sub-adult and adult fillet samples exceeded the U.S. Food and Drug Administration tolerance level for PCBs of 2.0 ppm (parts per million). Lipid normalized PCB concentrations were significantly different for both sub-adult and adult coho salmon based on stocking location. Study results indicated that the PCB concentrations of smolts are not representative of the PCB concentrations in adult fillet samples. Therefore, we recommend the Sheboygan River be stocked with 135,000 chinook salmon, 55,000 coho salmon and 22,000 steelhead or 100% of the Sheboygan County quota for each species.

Introduction

Since their introduction in 1930 (Penning 1930), polychlorinated biphenyls (PCBs) were widely used in various industrial applications. However, due to increasing concerns about potential health and environmental effects, PCB use was markedly reduced in the 1970s. PCBs have been linked to decreased egg hatchability and high chick mortality in peregrine falcons (Risebrough et al. 1968), reproductive impairment of wild birds (Harris et al. 1985; Heinz et al. 1985) and reproductive complications in mink (Aulerich et al. 1971). All commercial PCB mixtures tested have been shown to cause reproductive and developmental effects in laboratory animals (ATSDR; 1989). Although toxicological studies have not directly linked human health problems with the ingestion of PCB contaminated fish, the U.S. Food and Drug Administration (FDA), in 1973, set tolerance levels that limited the allowable PCB concentrations in edible portion of fish to 5.0 ppm (Masnado, 1987). In 1977, the FDA proposed to lower the level in fish and shellfish from 5.0 to 2.0 ppm, which was finally established in 1984. Further research into fish consumption effects on humans has focused on reproductive effects and infant developmental delays (Anderson et al. 1993).

The Sheboygan River in southeastern Wisconsin is one of the major tributaries to Lake Michigan. The river originates about 75 km west of the city of Sheboygan. While the upper 49 km of river flow through primarily agricultural areas, the last 24 km are dominated by an urban environment, with the river flowing through the cities of Sheboygan Falls, Kohler, and Sheboygan. The Sheboygan River has a wide variety of native sport fish species including smallmouth bass Micropterus dolomieui, walleye Stizostedion vitreum vitreum, and channel

catfish Ictalurus puntatus (Nelson, Wisconsin Department of Natural Resources, personal communication). Since the early 1970's, the Sheboygan River has been used as a major stocking site for semelparous fish species such as chinook salmon Oncorhynchus tshawytscha, coho salmon O. kisutch, and steelhead O. mykiss.

The Wisconsin Department of Natural Resources (WDNR) has monitored contaminants in a variety of fish species from the Sheboygan Harbor since 1975. At that time salmonids from the harbor were found to contain PCB levels similar to those in fish sampled at other locations along Wisconsin's Lake Michigan coast. In 1977, the Department sampled resident fish farther upstream at Kiwanis Park in the city of Sheboygan. Levels ranged from 26 ppm to 750 ppm PCB. Confirmatory samples, which were analyzed in 1978, indicated concentrations from 8.3 to 241 ppm (Kleinert et al. 1978).

Because these levels were well in excess of the FDA guideline, the Department of Natural Resources and Division of Health issued an advisory recommending that no one eat any fish from the Sheboygan River downstream of Sheboygan Falls. It was subsequently discovered that Tecumseh Die-Casting Products was responsible for placing granular oil adsorbent material adjacent to the Sheboygan River (Kleinert et al. 1978). This was determined to be a significant source of PCBs to the lower river. Tecumseh was ordered to excavate the PCB containing materials from along the river. Despite the excavation of PCB-containing materials, and more recent Environmental Protection Agency (EPA) Superfund activities to remove some of the PCB sediment "hot-spots", concentrations in resident fish still average 2.4 to 42 ppm (Blasland and

Bouck, 1993).

Historically, the use of the Sheboygan River as a stocking site for trout and salmon played a key role in the success of the Lake Michigan management program in that area. In 1987, the Department of Natural Resources banned the stocking of trout and salmon in the Sheboygan River. This decision was made based on several studies. DeVault et. al (1988) reported that concentrations of PCBs in fall run coho salmon taken from the Sheboygan River were significantly higher than other Lake Michigan samples in 1983 and 1984. A 1985 study of PCB contamination in trout and salmon from the Wisconsin waters of Lake Michigan indicated that brook Salvelinus fontinalis, brown Salmo trutta and rainbow trout allegedly stocked in the Sheboygan River 2-3 months prior to sampling contained peak PCB concentrations of 4.0 (brook trout), 3.7 (brown trout) and 5.0 (rainbow trout) ppm (Masnado 1987). Samples of small (4.5-6.5 - inch) coho salmon collected from the Sheboygan River in spring 1986 contained PCB concentrations as high as 5.1 ppm in whole fish (WDNR, unpublished data).

Unfortunately, none of the above studies were designed to address the effects of PCB uptake by young and harvestable fish stocked in the Sheboygan River. For example, (1) baseline contaminant levels in the fish prior to stocking were not determined; (2) fish were not marked, making it impossible to know for certain where the stock originated; (3) coho salmon are currently stocked as accelerated-growth fall fingerlings while the coho salmon collected in 1986 were stocked as yearlings; (4) sample sizes were extremely small in both studies (12 rainbow trout in the 1985 study; 14 pre-smolt coho salmon in the 1986 sampling); and (5) neither the

1985 nor the 1986 sampling included time series information needed to analyze the contribution of contaminant uptake during stream residence.

Therefore, a carefully planned study that includes collection of a thorough time series of stocked fish was needed to assess the contribution of river PCBs to total body burdens and more importantly fillet concentrations in harvestable fish. To provide such a time series, sampling should cover the period before stocking, time of stream residence and intervals throughout the adult life stage. The purpose of this study was to determine the relative contribution of PCB uptake during an early lifestage to the overall body burden of PCBs in adult fish measuring both total and lipid normalized PCB concentrations. More specifically, the study determined whether PCB accumulation in salmonid species warrants a continued ban on stocking fish into that system. To accomplish these objectives, the Department chose to monitor trout and salmon from two other sites, the Pigeon River which has no known source of PCB contaminated sediments, and the Root River which is a major stocking site and has relatively low levels of PCB sediment contamination compared to the test site. Specifically the study: (1) measured PCB levels in steelhead and coho salmon smolts stocked in the Sheboygan, Pigeon and Root Rivers to determine uptake prior to out-migration and thus assess the effectiveness of clean-up efforts in the Sheboygan River; (2) measured PCB levels in returning adult steelhead and coho salmon fillets from those plants to determine the relative contribution of lakewide versus river PCB uptake; and (3) ultimately, provided decisions regarding the stocking policy in the Sheboygan River and in other areas of known contamination.

Study Areas

In this study, we collected fish from three separate rivers. The Sheboygan River, a tributary to Lake Michigan, is located in southeastern Wisconsin (87° 45′ W by 43° 45′ N). The river originates about 75 km west of the city of Sheboygan. The lower 24 km of the river contain sediments contaminated by PCBs ranging from 0.05 to 4,500 ppm. We collected fish from 16 stream km of the Sheboygan River, beginning at the mouth of the river, located in the city of Sheboygan (Figure 1), upstream to the Waelderhaus Dam, located in the River Wildlife area in Kohler, Wisconsin. This stretch consisted of many riffles and pools meandering through rural areas upstream to urban areas downstream. Most collections occurred three to six km upstream of the mouth of the river at the junction of Highway 43 and Lower Falls Road (Figure 1).

The Pigeon River, a tributary to Lake Michigan, was chosen based on its proximity to the Sheboygan River and origin in the same major watershed (Figure 1) and because it has no known source of PCBs. Fish were collected at specific sections from Highway Y downstream to Lake Shore Drive. Because of narrow stream widths and poor access, suitable sample areas downstream from Lake Shore Drive could not be sampled. The sampled section consisted of many riffles and pools running through rural farmland and city parks. Most of the collections occurred at the junction of Highway Y and Highway 42.

The Root River, also a tributary to Lake Michigan, is located 195 km south of the Sheboygan River in Racine County (87° 45′ W by 42° 45′ N)(Figure 1). The Root River is heavily stocked with salmonids and has been extensively surveyed. The river originates 97 km north in

Milwaukee County. Fish were collected from the mouth to the Horlick Dam at Highway 38 and Rapids Drive in the city of Racine. Most of the river runs through urban areas; however, several parks and a golf course provide riverine habitat and riparian areas next to the river. All of the salmonid collections were made below the Horlick Dam and other accessible areas downstream.

Methods

Stocking Design

The original stocking design stated that 20,000 to 25,000 steelhead yearlings and 75,000 coho salmon fingerlings were to be marked with year-class specific finclips and stocked into the Sheboygan River for three years (1990-1993). The Pigeon River and Root River were added as reference rivers in 1991 when 40,000 marked steelhead were stocked in the Pigeon River and 28,500 coho salmon were stocked in the Root River (Table 1). Coho salmon and steelhead were chosen because of historically lower levels of PCBs than those found in chinook salmon and brown trout, Stocking numbers were based on availability and WDNR Lake Michigan Steelhead Fishery Management Plan (LMSFMP; 1988). Skamania, Chambers Creek and Ganaraska steelhead strains were used in the study. For a complete description see LMSFMP (1988). Because of shortfalls in production of both steelhead and coho salmon, the actual numbers of fish stocked varied by year and location. Based on preliminary data from fish planted in 1990 and 1991, chinook salmon and steelhead were stocked in the Sheboygan River in 1994, with plans to stock chinook and coho salmon and steelhead in the Sheboygan River in 1995. The plan to continue stocking fish will be determined based on data contained in this study.

Sampling Design

In order to properly identify fish originally stocked in the rivers, year-class-specific and site-specific finclips were used to mark fish in each river system (Table 1; Figure 2). Of the fish that were collected, those with easily discernible finclips were retained for analyses.

For each plant, 50-100 fish were collected from the hatchery just prior to stocking and were sent for PCB analysis. Subsequent electrofishing surveys collected 50 fish/month for analysis from each group of stocked fish during their initial stream residence period. For fall fingerling steelhead and fall fingerling coho salmon, this included the months November to May but for spring yearling steelhead only April and May. For returning sub-adult and adult fish, 25 individuals were collected from each group, each year throughout their life stage. These returns came from electrofishing surveys. For example, coho salmon were sampled from time of stocking in October through out migration in May (50-fish samples/month), as sub-adults that fall (25-fish samples) and as adults the following fall (25-fish sample). Steelhead were sampled from time of stocking through out migration (50 fish/month), as sub-adults (25 fish) and adults (25 fish). Once captured, fish were immediately placed on ice. WDNR personnel wrapped the fish in aluminum foil, freezer paper, then labeled, froze and transported them to the Bureau of Water Resources in Madison for analysis.

Electrofishing Surveys

Fish were collected by either a boom shocker boat or stream shocker. The boom shocker boat was a 18-foot aluminum boat powered by a 50hp Mariner outboard motor. An AC generator

produced 200 volts that were converted to a pulsed DC current producing 12-16 amperes of power. Two booms extending from the front of the boat deliver the current into the water. The stream shocker consisted of a 6 foot fiberglass boat with a AC generator which produced 240 volts. A transformer converted the 240 volts into a pulsed DC current with 6-8 amperes of power. Two hand held probes delivered the current into the water.

PCB Analysis

Preparation of the fish for PCB analysis was conducted by the Bureau of Water Resources and the actual PCB analysis was conducted at the Wisconsin Laboratory of Hygiene (WLH) in Madison, Wisconsin. Composite samples of 10 whole fish per composite were used to analyze smolts. Both skin-on fillets and whole fish samples of sub-adult and adult fish were analyzed individually (i.e. fillet and fillet plus remaining whole body sample).

Skin-on fillets were removed from each fish following U.S. Food and Drug Administration procedures (Masnado 1987). A homogeneous subsample of tissue was taken from each fillet and frozen before laboratory analysis. Column extractions, gel permeation chromatography, silica gel absorption chromatography and gas chromatography procedures were described in Miller et al. (1993). These procedures and other analyses were conducted according to methods specified in Wisconsin State Laboratory of Hygiene manuals (1980 and 1991).

Statistical Analysis

The Kolmogorov-Smirnov test (with Lilliefors' correction) was conducted to test data for

normality of the estimated underlying population. To test for homogeneity of the variances, the Spearman rank correlation between the absolute values of the residuals and the observed value of the dependent variable were computed. Analysis of variance (ANOVA) was used to test the null hypothesis that PCB concentrations from fish in the Sheboygan River do not differ from those in the Pigeon and Root Rivers. The ANOVA's were conducted on smolt, sub-adult, and adult total PCB concentrations and lipid normalized PCB concentrations separately. Steelhead strains were also analyzed separately unless no significant differences could be detected. Alpha levels (α) were set to 0.05 for all statistical tests. Post-hoc evaluation of significant differences was completed using a Student-Newmann-Keuls' (S-N-K) test. All statistical computations were made using SIGMASTAT by Jandel Scientific. To derive numeric values for analytical results of samples below the laboratory detection limit, a random number from zero to one, drawn from a uniform distribution, was multiplied by the detection limit. This was only done for smolt samples, because all adults had detectable PCB levels.

Results

Stocking Success

Stocking of both steelhead and coho salmon into the Sheboygan, Pigeon and Root Rivers proceeded according to the study design (Table 1). Except for the stocking of fall fingerling steelhead in the Sheboygan (1990 and 1992) and Pigeon Rivers (1991) and coho salmon in the Root River in 1994, each plant was duplicated in at least two rivers (Table 1). This design will allow direct comparison of PCB concentrations in these fish among the rivers.

Sampling Success

For fish planted in fall, collection of smolts during stream residence before out-migration was successful. Fifty individuals/month/plant were collected for a minimum of 3 months regardless of species (Table 2). For spring stocked fish, sampling for smolts was less successful. Usually 50 fish were collected the month after stocking but for several plants no collection could be made (i.e. spring 1992 stockings).

Sub-adult and adult fish collection varied by year, stocking location and species. Collections of both sub-adult and adult coho salmon were extremely successful especially in the Sheboygan and Root Rivers. Collection of Chambers Creek and Ganaraska strains of steelhead was successful in both the Sheboygan and Root Rivers but less successful in the Pigeon River. Collections of Skamania steelhead have been poor to date, primarily because this strain does not return to the river until they are age 3 and older.

Steelhead Smolts

Smolt samples from the 1990 steelhead stocking in the Sheboygan River indicate uptake of PCBs by fingerling steelhead (Figure 3). Whole fish samples from the hatchery in October, 1990 before stocking were below detectable limits (<0.20 ppm) but one month later averaged 1.38 ppm (Figure 3). Mean PCB concentrations were similar the next month but were significantly higher the following spring, after the smolts overwintered, averaging 6.13 ppm in May 1991.

Whole fish samples taken from fall stocked fingerling steelhead (1991) in the Pigeon River had

PCB concentrations below detectable limits (0.20 ppm) for November through April but averaged 0.27 ppm in the May sample (Figure 4). Steelhead from the same year-class were stocked as yearlings in the Sheboygan and Root Rivers in the spring of 1992. These fish left the rivers and except for samples taken in the hatchery no other smolts could be collected (Figure 4).

Steelhead Adults

Twenty-five adult fish from the 1992 Sheboygan River stocking were collected after they had spent two summers in the lake; the average skin-on fillet PCB concentrations in these fish was 0.618 ppm (N=25) (Figure 4). Pigeon River stocked steelhead from the same year-class but stocked in the fall of 1991 had average fillet PCB levels of 0.719 ppm (N=7). Root River steelhead from the same year-class averaged 0.536 ppm PCB in skin-on fillets (N=8). To test for significant differences among the age 2 steelhead, a one-way ANOVA was run. No significant difference in PCB fillet concentrations among the three groups (P=0.376) was found.

No age 1 or 2 steelhead from the 1990 Sheboygan River stocking were collected but several age 3 fish were captured and analyzed. Fillet PCB concentrations from these fish averaged 0.99 ppm but consisted of only four samples (Figure 3). Because this stocking and collection were not duplicated in any other river, statistical tests could not be performed.

Coho Salmon Smolts

Coho salmon samples from the 1991 Sheboygan River stocking had a similar PCB trend to the fingerling steelhead stocked the previous year (Table 2). Whole fish hatchery samples contained

undetectable levels of PCBs but after one month in the river smolts averaged 0.84 ppm (Figure 5). Mean PCB concentrations increased to about 1.80 ppm in January, March and April and 2.54 ppm in May. Coho salmon smolt PCB concentrations from the 1992 Sheboygan River stocking mirrored those found in the 1991 coho salmon samples. Hatchery samples contained undetectable levels of PCBs but after 3 months in the river the levels had increased to 1.7 ppm (Figure 6). Mean PCB levels continued to increase and were 4.1 ppm in April and 3.1 ppm in May. PCB levels from coho salmon stocked in the Pigeon River in 1992 had undetectable levels from the time of stocking through December. Refinement in the analysis procedure at the State Laboratory of Hygiene allowed the detection limit to drop from 0.20 ppm to 0.04 ppm which led to the detection of PCBs in coho salmon smolts sampled in April. These fish averaged 0.11 ppm PCB (Figure 6). Root River stocked coho salmon (1992) contained low levels of PCBs from the time of stocking (September, 0.067 ppm) to out migration (April, 0.44 ppm) (Figure 6).

Coho Salmon Sub-adults

Twenty-five sub-adult coho salmon were collected from the first coho salmon stocking which occurred in the fall of 1991 in the Sheboygan River. The average fillet PCB concentration was 0.60 ppm. No comparable year-class data were collected in either of the reference rivers.

However, nine sub-adult coho salmon were collected the following fall from the 1992 stocking in the Sheboygan River. These fish had fillet PCB concentrations of 0.33 ppm. No sub-adult fish were collected from the Pigeon River but twenty-two sub-adults were collected from the Root River from this same year-class. Average fillet PCB levels were 0.15 ppm. An unpaired t-test

was run on the sub-adult fish collected from the Sheboygan and Root Rivers. These data failed to pass the normality test (P=0.0005) so a Mann-Whitney rank sum test was performed. There was no statistically significant difference in PCB fillet concentrations between these two groups (P=0.0709).

Coho Salmon Adults

Twenty-five adult coho salmon were collected from the Sheboygan and Root Rivers from plants made in the fall of 1991. The average fillet PCB concentrations were 0.733 ppm and 0.771 ppm, respectively (Figure 5). An unpaired t-test detected no significant difference in PCB fillet concentrations between the two groups of adult coho salmon (P=0.5824).

Lipid normalized data

Fillet values

Fillet samples from adult coho salmon and steelhead were normalized for lipid content according to the equation: PCB Concentration / % Lipid and are shown in Table 4. Lipid normalized concentrations in adult coho salmon fillets from the Root and Sheboygan Rivers (from fall 1991 stockings) were 0.187 and 0.264 ppm. respectively. The lipid normalized fillet values were significantly different from one another (P = 0.0013). No other coho salmon sub-adult or adult fillets showed significant differences. Adult steelhead collected from the Sheboygan, Root and Pigeon Rivers (from fall 1991 and spring 1992 stockings) contained 0.0779, 0.0689 and 0.0933 ppm, respectively. The lipid normalized fillet values from these fish were not significantly different from one another (P = 0.2992).

Whole fish values

Whole fish lipid normalized concentrations for adult coho salmon (from fall 1991 stocking) were 0.161 and 0.237 ppm for the Sheboygan and Root River respectively (Table 5). Similar with fillets, the lipid normalized PCB concentrations for whole fish were significantly different ($P = 0.0009$). Sub-adult coho salmon (from fall 1992 stocking) contained lipid normalized whole fish values of 0.1386 (Sheboygan River) and 0.0881 ppm (Root River). These data were also significantly different ($P=0.0126$). Steelhead whole fish lipid normalized concentrations for the Sheboygan, Root and Pigeon Rivers (from fall 1991 and spring 1992 stockings) were 0.053, 0.0599 and 0.0632 ppm respectively. No significant differences were detected among these steelhead collected in the Root, Pigeon and Sheboygan Rivers ($P = 0.4692$).

Discussion

Based on elevated PCB levels observed in fish collected from the Sheboygan River and growing concerns about PCBs and their toxicity to humans, fish stocking in the Sheboygan River was halted in 1987. There were three reasons for eliminating stocking. Masnado (1987) found that brook, brown and rainbow trout smolts stocked only 2-3 months prior to collection contained peak PCB concentrations of 4.0, 3.7 and 5.0 ppm respectively. Secondly, samples of small coho salmon (4.5-6.5 inches) collected from the Sheboygan River in the spring of 1986 contained PCB concentrations as high as 5.1 ppm. Thirdly, DeVault et al (1988) reported that PCB concentrations in fall run coho salmon from the Sheboygan River were significantly higher than other Lake Michigan samples from 1983 and 1984. However, in these studies: (1) fish were not finclipped; (2) sample sizes were small; and (3) a complete time series from smolt to adult of the

same year-class was not collected. This study was designed to generate data that addressed the deficiencies in the previous data sets and provide information to re-evaluate stocking decisions for the Sheboygan River through comparisons with the other Lake Michigan tributaries.

Smolts

Fish stocked in fall into the Sheboygan River do concentrate PCBs in their tissues. PCB levels found in both fall stocked steelhead and coho salmon in the Sheboygan River were similar to levels observed in a previous study (Masnado 1987). Fall stocked steelhead accumulate PCBs rapidly, averaging 6.13 ppm after 8 months in the river (Figure 3). Masnado (1987) found PCBs in steelhead averaged 3.6 ppm from June samples after the fish had been in the Sheboygan River for 8 to 9 months. In comparison, steelhead stocked in fall in the Pigeon River had PCB concentrations below detectable levels until the May sample, which averaged 0.27 ppm (Figure 4). The detection of PCBs from fish stocked into the Pigeon River is very important. Historically, there is no known source of PCB contamination in the river. Deposition through atmospheric events may be responsible for the detectable levels in these stocked fish, signifying the importance of PCB remediation at all PCB contaminated sites, not only those found in the Sheboygan River.

Fall stocked coho salmon had lower PCB concentrations than steelhead. For the 1991 and 1992 stockings in the Sheboygan River, PCB concentrations in May samples were 2.54 ppm and 3.06 ppm, respectively.

Despite initially high levels in smolts, PCB accumulation during stream residence apparently did not contribute significantly to PCB levels in adults, as discussed below. Initially high PCB levels in smolts were apparently diluted due to their high growth rates and rapid accumulation of new tissue (Jensen et al. 1982). For example, an 8 g steelhead was collected in May from the fall 1990 Sheboygan River stocking, a PCB concentration of 6.9 ug of PCB / g of tissue was measured.

Therefore, the total body burden of PCBs currently in its system would be 55.2 ug (6.9 ug/g * 8g) based on equation 1. If this steelhead did not subsequently accumulate any more PCBs

$$PCB\ (ug) = measured\ PCB\ (ug/g)\ concentration * weight\ of\ fish\ (g) \quad (1)$$

$$measured\ PCB\ (ug/g)\ concentration = \frac{PCB\ (ug)}{weight\ of\ fish\ (g)} \quad (2)$$

then returned to the river at age 3 at about 12 pounds, based on equation 2, the expected measured adult whole fish PCB concentration would be 0.010 ug/g (55.2 ug / 12 lbs * 454 g/lb). Data from this study show that returning adult fish contain substantially higher levels than would be expected if no further uptake occurred. Returning adults from the 1990 fall stocking in the Sheboygan River averaged 0.99±0.23 ug/g fillet PCB concentrations. These fish are accumulating additional PCBs during their lake residence, which certainly occurs for not only Sheboygan River

stocked fish but fish from all stocking locations. These data show that the uptake of PCBs as smolts contributes minimally to PCB levels in adult fish.

In another example, an adult steelhead from the fall 1990 stocking weighed 5.18 kg with a fillet PCB concentration of 1.2 ug/g. Total micrograms of PCBs from this skin-on fillet sample was calculated at 6216 ug (1.2 ug/g * 5180 g). PCB levels from May smolt samples from this year-class averaged 70.5 ug. This suggests that the contribution of PCB uptake during the smolt stream residence stage is only 1.1% of the PCB concentration in the adult fillet (70.5 g / 6216 g). Therefore, 98.9% of the PCB contamination in the sample comes from their residence in Lake Michigan. Additionally, 98.9% may be an underestimation because smolts are analyzed using whole body samples while adults are analyzed using skin-on fillets. Total PCB concentration in smolts can be calculated while total adult PCB concentration is based on skin-on fillets. Analysis of some whole body sub-adult coho salmon and steelhead samples revealed significantly higher PCB concentrations than skin-on fillet PCB concentrations (Wilcoxon signed rank test: $P=0.00905$ coho salmon, $p<0.0001$ steelhead). This suggests that the PCB body burden based on adult whole fish samples is higher than the body burden calculated using PCB concentrations in skin-on fillet samples. Consequently, the contribution of PCB uptake as smolts during stream residence to adult whole body PCB levels (e.g. adult whole fish samples) would be even less than 1.0%.

Adults

Of the adults collected, none of the fillets have tested above the FDA tolerance limit of 2.0

ppm total PCBs. Wisconsin's **current** Health Guide (Wisconsin Department of Natural Resources and Division of Health 1994) states that if 90% or more of the numbers tested for a given species falls below the FDA tolerance limit, these species should be put in Group 1 (these fish pose the lowest health risk). Data from this study show that both coho salmon and steelhead of any size should be placed in Group 1. The current advisory places coho salmon > 26" and steelhead in Group 2 (women and children should not eat these fish).

Fall stocked steelhead have exhibited the highest PCB levels of all adults collected, averaging 0.99±0.23 ppm in skin-on fillet samples (Figure 3). However, these are age 3 fish, one year older than any other fish collected. Comparisons among the same year classes show that average PCB concentrations do not significantly differ among adult steelhead, sub-adult and adult coho salmon planted in the three rivers. Additionally, samples collected from Lake Michigan for coho salmon and steelhead have similar fillet PCB concentrations to fish collected for this study (Table 3). Based on the above example, most of the PCB uptake is occurring in the main basin of Lake Michigan. Upon entering the aquatic environment, PCBs adhere to suspended particulate matter and bottom sediments because of their extremely low solubility in water (Crump-Wiesner et al. 1973). These trapped PCBs are a huge reservoir for contamination and have been a long term source of PCBs in Lake Michigan and other aquatic ecosystems (Hammond et al. 1972). According to Snarski and Puglisi (1976), fish sampled may be accumulating the majority of PCB contamination through bioconcentration and biomagnification of the PCBs present in the main lake basin of Lake Michigan with the primary source of PCBs for these salmonids being their diet (biomagnification). Until PCBs currently in the sediment biodegrade or are removed from the

aquatic system, uptake via biomagnification will continue to be a problem for all Lake Michigan fish species.

While actual fillet PCB concentrations do not differ by stocking site, lipid normalized PCB concentrations for both whole fish and fillets did show significant differences in coho salmon (Tables 4 & 5) between stocking sites. For adult coho salmon (fall 1991 stockings) both the lipid normalized fillet and whole fish PCB concentrations were significantly higher in Root River coho salmon but for sub-adult coho salmon (fall 1992 stocking) lipid normalized whole fish PCB concentrations were significantly higher in Sheboygan River coho salmon. Based on equations (1) and (2), total micrograms of PCBs in smolts accounts for 26% and 3.9% of the total micrograms found in sub-adult and adult coho salmon fillet samples, respectively (Figure 7). This indicates that the PCBs taken up in the Sheboygan River may have contributed significantly to the levels found in sub-adult coho salmon (lipid normalized). Due to growth dilution, this percentage drops in adult coho salmon and does not then contribute significantly to the overall levels in these fish.

Fisheries managers are responsible for providing cost effective recreational fishing and safe, edible fish. Data from this study suggest that despite sediment PCB contamination in the Sheboygan River and subsequent elevated PCB concentrations in smolts, PCB concentrations in fillets of returning sub-adult and adult fish stocked in the Sheboygan River did not significantly differ from fish stocked in other rivers. Therefore, stocking decisions can be made on the basis of factors other than PCB sediment concentrations. This allows fisheries managers to stock fish

at the best location (e.g. river) and time of year. In most cases this is in a tributary to Lake Michigan in the spring. Not only does this provide maximum survival of stocked fish before out migration but it also maximizes the return of the fish to this area during the spawning runs.

Management Implications

The purpose of this study was to determine the effects of PCB uptake during various life stages on the overall levels of PCBs in catchable size fish and to answer important questions about the differences in fish contamination levels before and after clean-up efforts. The study results show that: (1) sub-adult and adult coho salmon returning in fall 1993 in the Sheboygan River contained similar levels of PCBs in fillets as sub-adults and adults returning to the Root River; (2) sub-adult and adult steelhead returning in the fall of 1993 in the Sheboygan River contained similar levels of PCBs in fillets to fish returning to the Root and Pigeon Rivers; (3) all fillet samples from sub-adult and adult fish had PCB concentrations below the 2.0 ppm FDA tolerance limit; (4) salmonids stocked in the Sheboygan River in fall accumulate significantly higher levels of PCBs in whole body tissue before out-migration, than salmonids stocked in the other two rivers, but this accumulation does not contribute significantly to adult fish PCB fillet concentrations.

Both steelhead and coho salmon stocked in fall accumulated very high levels of PCBs comparable to other studies (Masnado 1987). Fish that reside in the river for longer periods of time bioaccumulate higher levels of PCBs than fish that spend shorter periods of time in the river (Figures 2-5). In 1990, a study was initiated to attempt to track PCB levels in resident species.

The study called for a transplant of yearling smallmouth bass from above Sheboygan Falls dam into a contaminated site between River Bend and Walderhaus dams. The smallmouth bass were found to have accumulated PCBs to an average of 8.8 ppm (whole fish) after one month of exposure and 15.3 ppm (whole fish) after two months. Unfortunately, none of the clipped smallmouth bass could be found after that time. However, it does demonstrate substantial availability and accumulation of PCBs in this portion of the river.

Preliminary data from resident fish collected in 1994 indicate fish that are exposed to the PCBs over their lifetime are still accumulating the contaminant to relatively high levels. Available data is summarized below.

Species(n)	PCB Range	Average
Walleye (6)	0.87 - 7.7 ppm	3.38 ppm
N Pike (7)	0.35 - 11.0 ppm	3.92 ppm
Rock Bass (2)	1.70 - 2.10 ppm	1.90 ppm

Because not all data is available for resident species collected in 1994, comparisons are difficult. However, northern pike and walleye collected from the Sheboygan River from 1984-1988 contained PCBs ranging from 2.0 to 12 ppm and 0.75 - 32 ppm respectively. These concentrations are within the range of PCB levels found in the 1994 samples.

Several important decisions can be made from these data: 1) stocking of trout and salmon on a non-experimental basis should be limited to spring stockings. This drastically reduces the fish's

exposure to PCBs and subsequent exposure of indigenous predators to these smolts; and 2) bioaccumulation of PCBs by smolts is very rapid and reach very high levels (6.13 ppm steelhead, 2.54 ppm and 3.1 ppm coho salmon). Analysis of variance and Kruskal-Wallis one way ANOVA on rank tests were conducted on selected smolt collections. Coho salmon smolts collected in April 1993 (Figure 6) from the Sheboygan River were significantly different from those collected in the Pigeon and Root Rivers for both whole fish PCB concentrations and lipid normalized whole fish PCB concentrations (PCBs Sheboygan vs Pigeon - $P = 0.0357$ and Sheboygan vs Root - $P = 0.0001$; Lipid normalized PCBs Sheboygan vs Pigeon - $P = 0.0357$ and Sheboygan vs Root - $P = 0.0357$) (Figure 8). Steelhead collected in April 1991 from the Sheboygan River (Figure 3) and steelhead collected in April 1992 from the Pigeon River (Figure 4) were significantly different for both whole fish PCB concentrations and lipid normalized whole fish PCB concentrations (PCBs $P = 0.0159$ and Lipid normalized PCBs $P = 0.0159$) (Figure 8). This indicates that PCBs are still a problem in the Sheboygan River and uptake by smolts through contaminated sediments exists in the same order of magnitude present in other studies (Masnado 1987, WDNR, unpublished data). Therefore, subsequent plants of fall fingerlings on an experimental basis may be useful as an indicator of clean-up effort effectiveness in the Sheboygan River.

Based on the data that have shown that both coho salmon and steelhead stocked in the Sheboygan River have similar sub-adult and adult PCB concentrations as other rivers, chinook salmon should be stocked back into the Sheboygan River. Although no chinook salmon PCB concentration data were generated as part of this study, the study species are sufficiently similar

to chinook salmon (i.e. life histories). It is unlikely that returning adult chinook salmon stocked as smolts in the Sheboygan River will have fillet PCB levels higher than chinook salmon stocked elsewhere on Lake Michigan. Chinook salmon are stocked in early May as fingerlings and within several weeks leave the Sheboygan River system. Thus uptake of PCBs and PCB concentration in smolt tissue will be lower than those found in coho salmon and steelhead. Additionally, chinook salmon are important to the Lake Michigan fishery, usually comprising 30% of the salmon and trout harvest. Normally, 130,000 to 140,000 chinook salmon are stocked in the Sheboygan area. Before the ban, the full quota was stocked in the river but since 1986, chinook salmon were planted in the Pigeon River and/or Sheboygan harbor. We are confident that adult chinook salmon planted and caught in the Sheboygan River will not pose any more of a health risk than those caught elsewhere. Therefore, it is recommended that the full 135,00 chinook salmon quota for Sheboygan County be stocked into the Sheboygan River starting in 1995.

Based on data generated from this study, coho salmon should be stocked back into the Sheboygan River starting in 1995. Since the data were very conclusive as to the PCB levels in smolts and sub-adults and adults and the relative contribution of PCBs from the river and lake, coho salmon do not need to be marked in the following years. This means that about 55,000 coho salmon should be stocked annually into the Sheboygan River.

Steelhead data show that adults returning to the Sheboygan River do not contain higher PCB concentrations than those returning to other rivers. During this study, the Sheboygan River received its full quota of steelhead as outlined in the LMSFMP (1988) at about 22,000 fish

annually. We recommend that this level be continued and that subsequent plants not be finclipped. We have stocked three year-classes of fish in the rivers. Any additional information needed to address the effects of PCB levels on repeat spawners can adequately be answered using these year-classes.

The resumption of salmon and trout stocking in the Sheboygan River should not be construed as an endorsement of the river's water or sediment quality. Of continuing concern are the resident fish species that cannot leave the Sheboygan River system and routinely achieve PCB levels in excess of the FDA's tolerance level of 2.0 ppm. Continuation of the Superfund process to remediate the contaminated sediments is warranted.

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Table 1. Sheboygan River PCB study design showing fish marked for stocking in 1990-1994. Description in parentheses denotes strain and finclip for steelhead and finclip for coho and chinook salmon.

DATE	SHEBOYGAN RIVER	PIGEON RIVER	ROOT RIVER
Fall 1990	41,000 Steelhead (C-RV)	-	-
Fall 1991	65,000 Coho (ARV)	40,000 Steelhead (C-LV)	28,500 Coho (no clip)
Spring 1992	22,000 Steelhead (C-LPRV, S-RPLV)	6,500 Steelhead (G-RMRP)	110,670 Steelhead (G-ARV,C-LM,S-RM)
Fall 1992	50,000 Coho (ALV) 40,000 Steelhead (C-ABV)	24,000 Coho (RMLV)	33,000 Coho (RPLV)
Spring 1993	22,000 Steelhead (C-LMRV, S-LMLV)	6,500 Steelhead (G-LMLP)	101,000 Steelhead (G-ALV,C-ALM,S-ARM)
Spring 1994	22,000 Steelhead (C-LMRP, S-RMRP) 65,000 Chinook (RM)	6,500 Steelhead (C-BV)	100,000 Steelhead (G-LV,C-LM,S-RM) 50,000 Coho (LP) 100,000 Chinook (LP)

C = Chambers Creek, S = Skamania, G = Ganaraska
A=adipose fin
RM=right maxillary bone
LM=left maxillary bone
RP=right pectoral fin
LP=left pectoral fin
RV=right ventral fin
LV=left ventral fin
BV=both ventral fins

Table 2. Number of fish collected by location and species as both smolts and adults. Shaded rows indicate stockings that were analyzed for this paper. RBT = steelhead, CHK = chinook, CC = Chambers Creek, GN = Ganaraska, SK = Skamania, SPR = spring, 1+ = one summer spent in the lake, 2+ = two summers spent in the lake, 3+ = three summers spent in the lake. See Table 1 and Figure 2 for finclip descriptions.

				SMOLTS (BEFORE OUT MIGRATION)									ADULTS		
Species /Strain	Finclip	Stocking Date	Location	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	1+	2+	3+
FALL STOCKED															
RBT/CC	RV	Fall 90	Sheb. R		95	51	59			36	40	30			6
RBT/CC	LV	Fall 91	Pigeon R			100		50		53	50	50		12	
Coho	ARV	Fall 91	Sheb. R		100	51		22		50	50	50	25	25	
Coho	nc	Fall 91	Root R											25	
Coho	ALV	Fall 92	Sheb. R	50	50	41	13				15	50	9		
RBT/CC	ABV	Fall 92	Sheb. R		50	50	50				2	28			
Coho	RMLV	Fall 92	Pigeon R	50	50	50	50				50	50			
Coho	RPLV	Fall 92	Root R	50	50	50	50	50	50		50		22		
SPRING STOCKED															
RBT/CC	LPRV	Spr 92	Sheb. R								50			25	
RBT/SK	RPLV	Spr 92	Sheb. R								50			1	
RBT/GN	RMRP	Spr 92	Pigeon R								50		3	10	
RBT/SK	RM	Spr 92	Root R								45				
RBT/CC	LM	Spr 92	Root R								50		15	26	
RBT/GN	ARV	Spr 92	Root R								50		25	26	
RBT/SK	LMLV	Spr 93	Sheb. R								50	50			
RBT/CC	LMRV	Spr 93	Sheb. R								50	50	4		
RBT/GN	LMLP	Spr 93	Pigeon R								50	50	1		
RBT/SK	ARM	Spr 93	Root R								50	50			
RBT/CC	ALM	Spr 93	Root R								50	50	4		
RBT/GN	ALV	Spr 93	Root R								50	50	25		
RBT/CC	LMRP	Spr 94	Sheb. R							25	50	50			
RBT/GN	RMRP	Spr 94	Sheb. R							25	50	50			
CHK	RM	Spr 94	Sheb. R									50			
RBT/GN	BV	Spr 94	Pigeon R							25	50	50			
RBT/GN	LV	Spr 94	Root R							25	50	50			
RBT/CC	LM	Spr 94	Root R							25	50	50			
RBT/SK	RM	Spr 94	Root R							25	10	50			
CHK	LP	Spr 94	Root R									50			

Table 3. Coho salmon and steelhead fillet PCB concentrations from Lake Michigan.

Year	Number	Mean PCB ppm	Standard Deviation
Coho Salmon			
1985	39	0.99	0.595
1990	10	0.83	0.251
1992	8	0.78	0.285
Steelhead			
1985	18	1.13	1.38
1990	9	0.61	0.327
1992	6	0.44	0.191

Table 4. Lipid normalized fillet PCB concentrations for adult coho salmon (fall 1991 stockings) and steelhead (fall 1991 and spring 1992 stockings).

Site	Ave. Lipid Normalized PCB Concentration (ppm)	
	Coho	**Steelhead**
Sheboygan River	0.187 ppm[a]	0.0779 ppm[a]
Root River	0.264 ppm[b]	0.0689 ppm[a]
Pigeon River		0.0933 ppm[a]

Letters (a & b) represent statistical similarity or difference

Table 5. Lipid normalized whole fish PCB concentrations for sub-adult and adult coho salmon (fall 1991 and fall 1992 stockings) and adult steelhead (fall 1991 and spring 1992 stockings).

Site	Ave. Lipid Normalized PCB Concentration (ppm)		
	Coho Salmon (fall 1992) sub-adults	**Coho Salmon (fall 1991) adults**	**Steelhead**
Sheboygan River	0.1386 ppm[a]	0.161[a]	0.0530 ppm[a]
Root River	0.0881 ppm[b]	0.237[b]	0.0599 ppm[a]
Pigeon River			0.0632 ppm[a]

Letters (a & b) represent statistical similarity or difference

Figure 1. Map of Wisconsin showing the location of Sheboygan and Racine and the three study rivers.

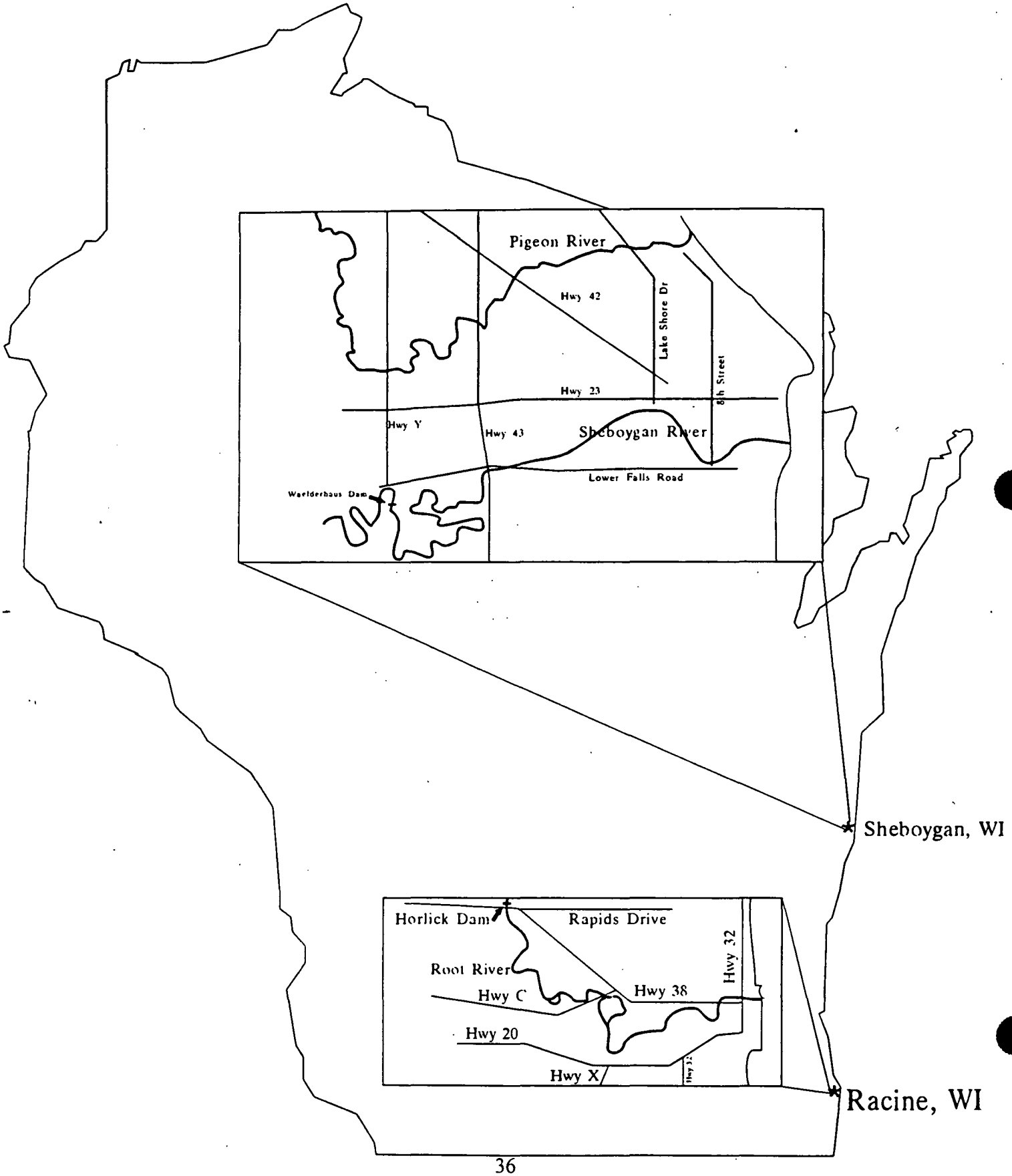


Figure 2. Fins and mouth parts clipped to mark steelhead, coho and chinook salmon in the Sheboygan, Pigeon and Root Rivers from 1990-1994.

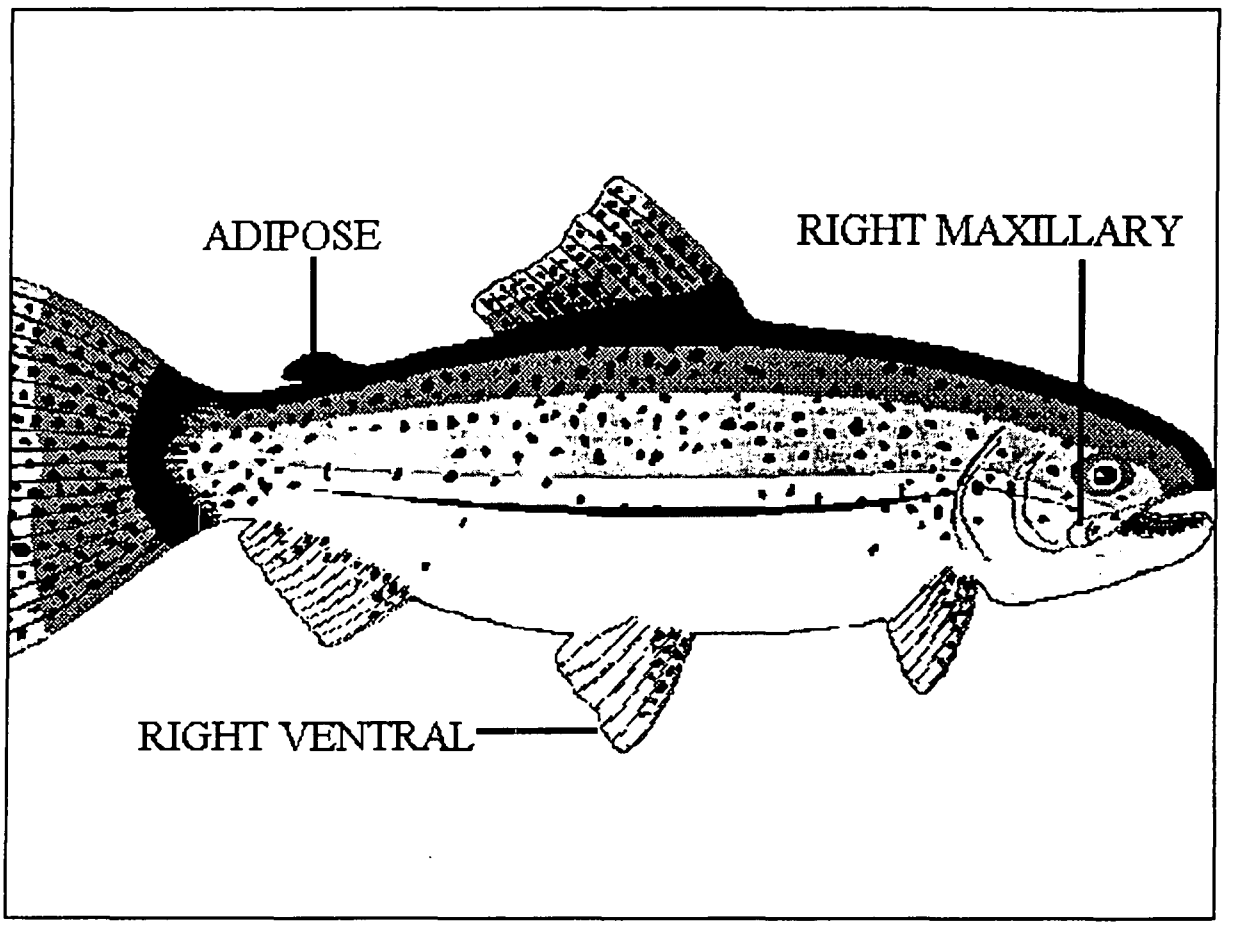


Figure 3. Steelhead PCB results from the fall 1990 stocking in the Sheboygan River. Error bars denote ± 1 sd.

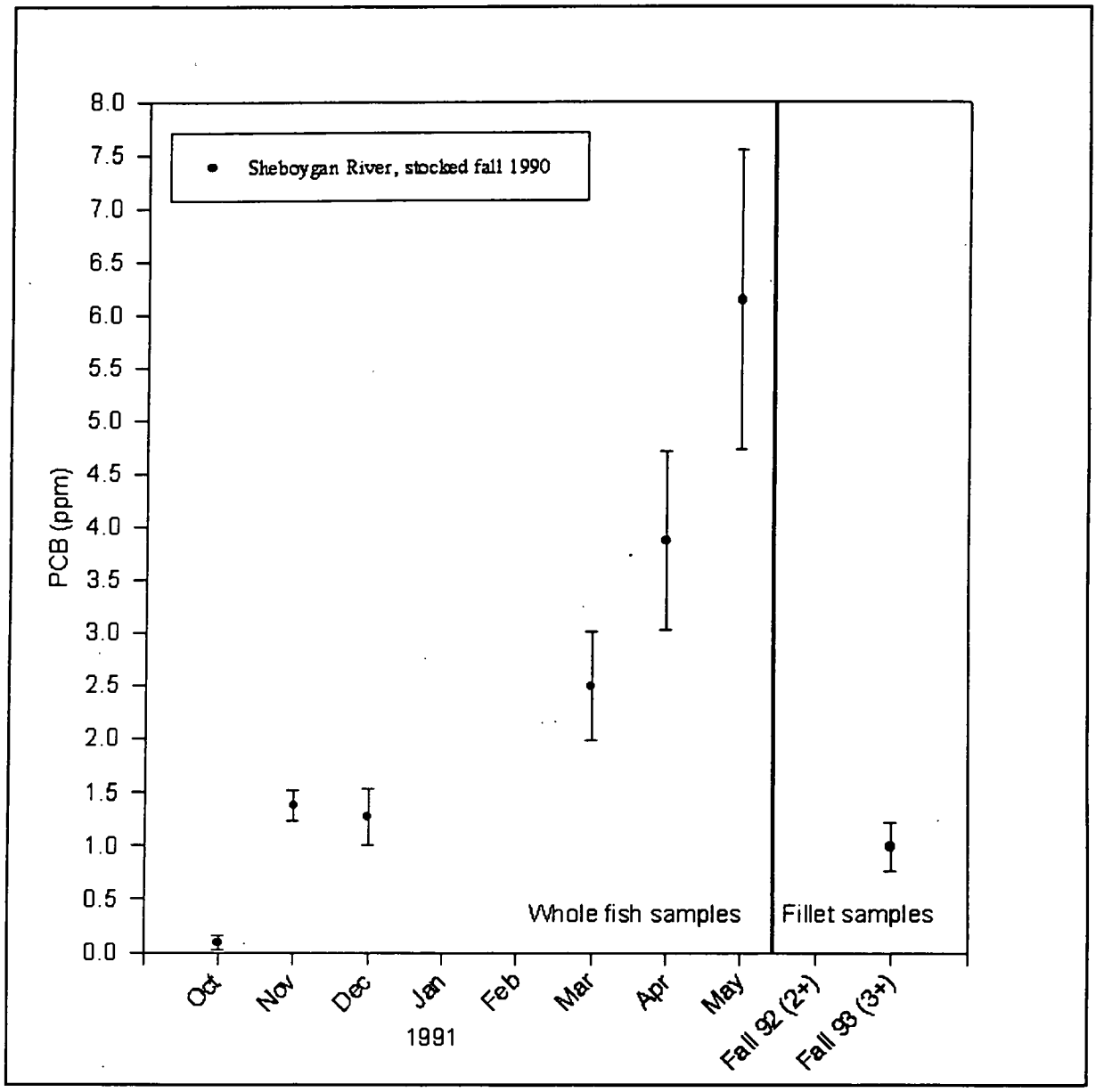


Figure 4. Steelhead PCB results from the fall 1991 stocking in the Pigeon River and spring 1992 stocking in the Sheboygan and Root Rivers. Error bars denote ± 1 sd. ns = no significant difference.

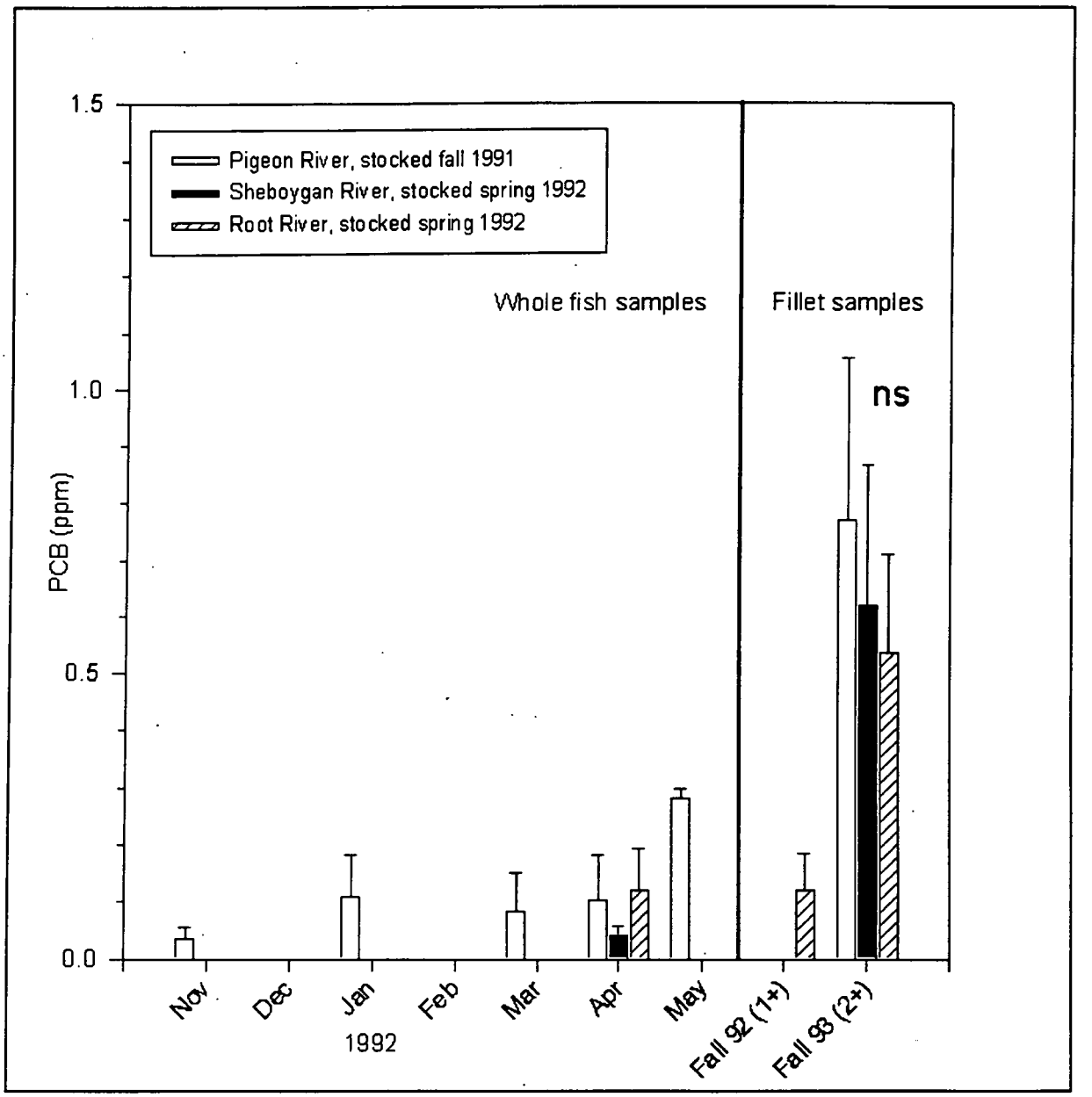


Figure 5. Coho salmon PCB results from the fall 1991 stocking in the Sheboygan and Root Rivers. Error bars denote ± 1 sd. ns = no significant difference.

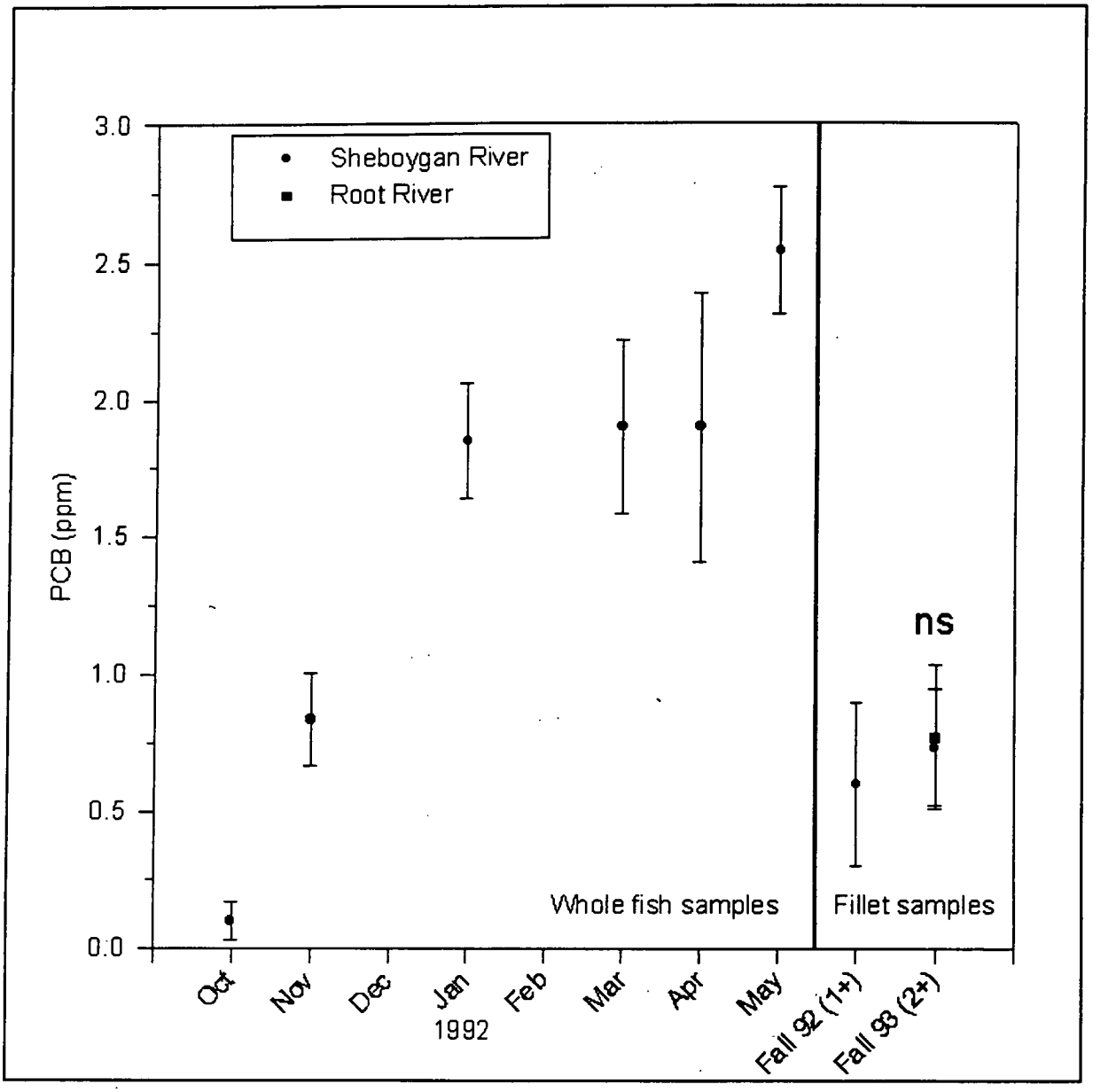


Figure 6. Coho salmon PCB results from the fall 1992 stocking in the Sheboygan, Pigeon and Root Rivers. Error bars denote ± 1 sd. ns = no significant difference.

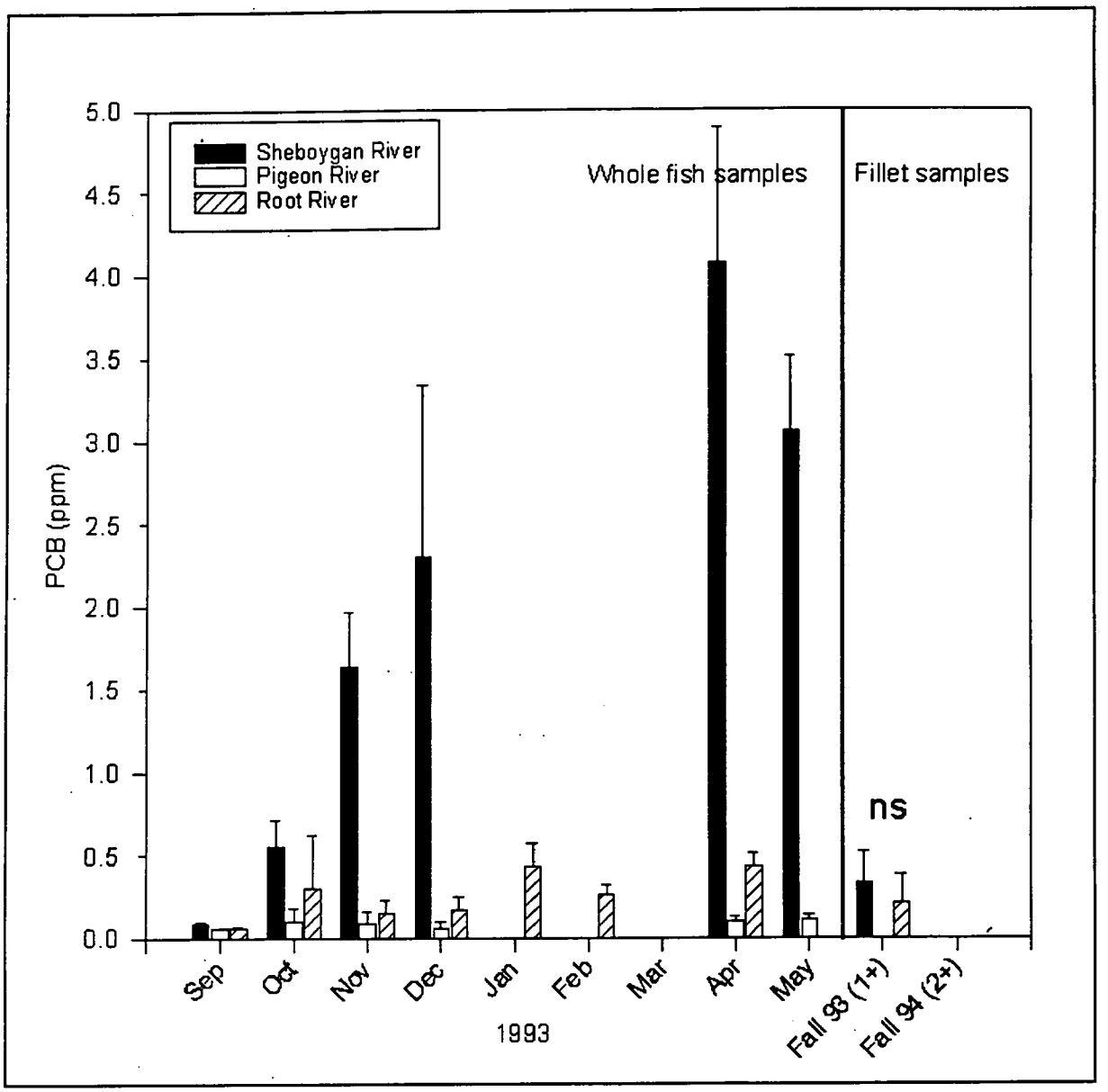


Figure 7. Coho salmon from the Sheboygan River showing river vs lake PCB contributions and total PCBs (ppm) from those samples. Percentages indicate the % contribution of river PCBs (ug) to the overall PCBs (ug). Error bars denote ± 1 sd.

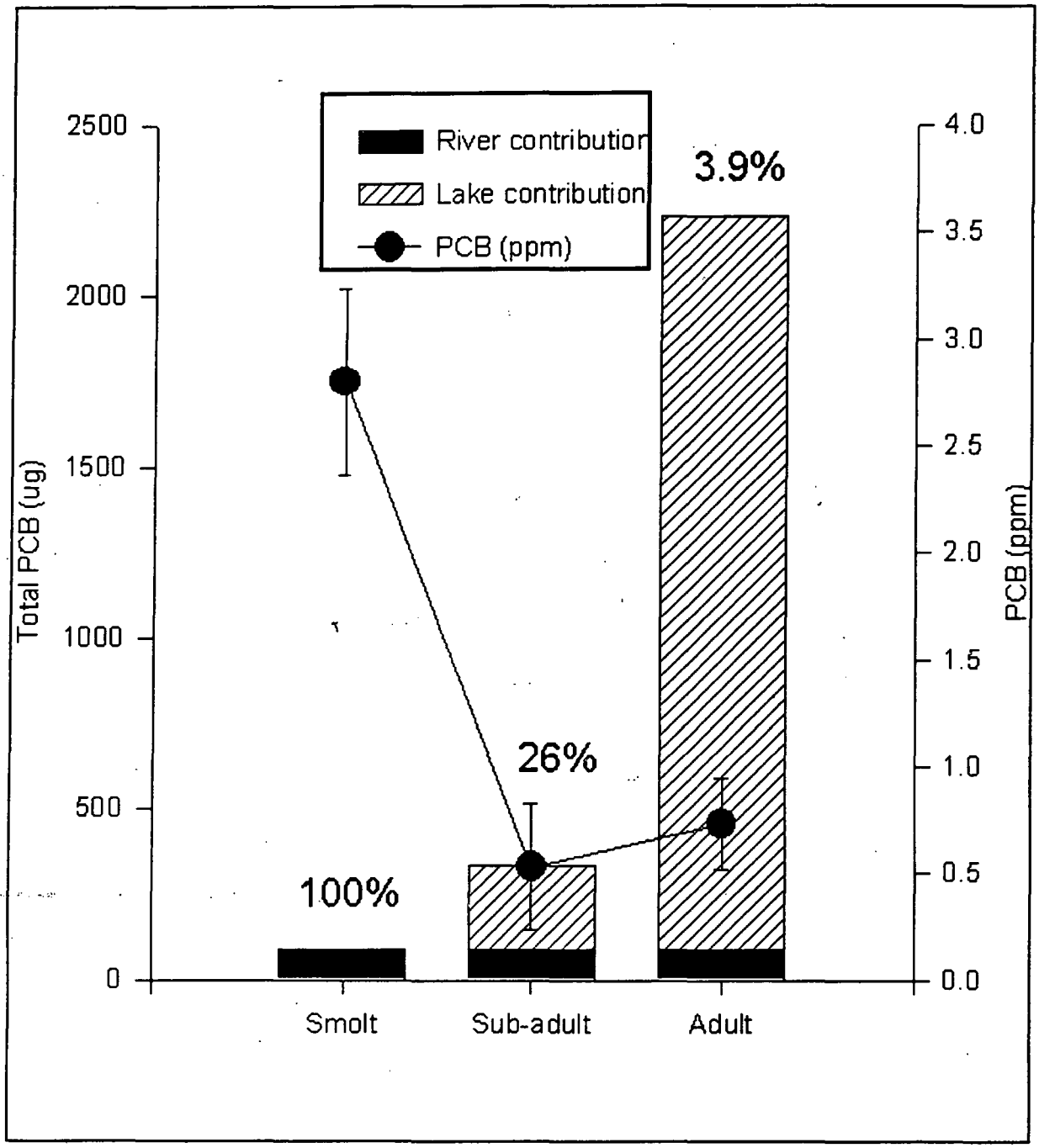
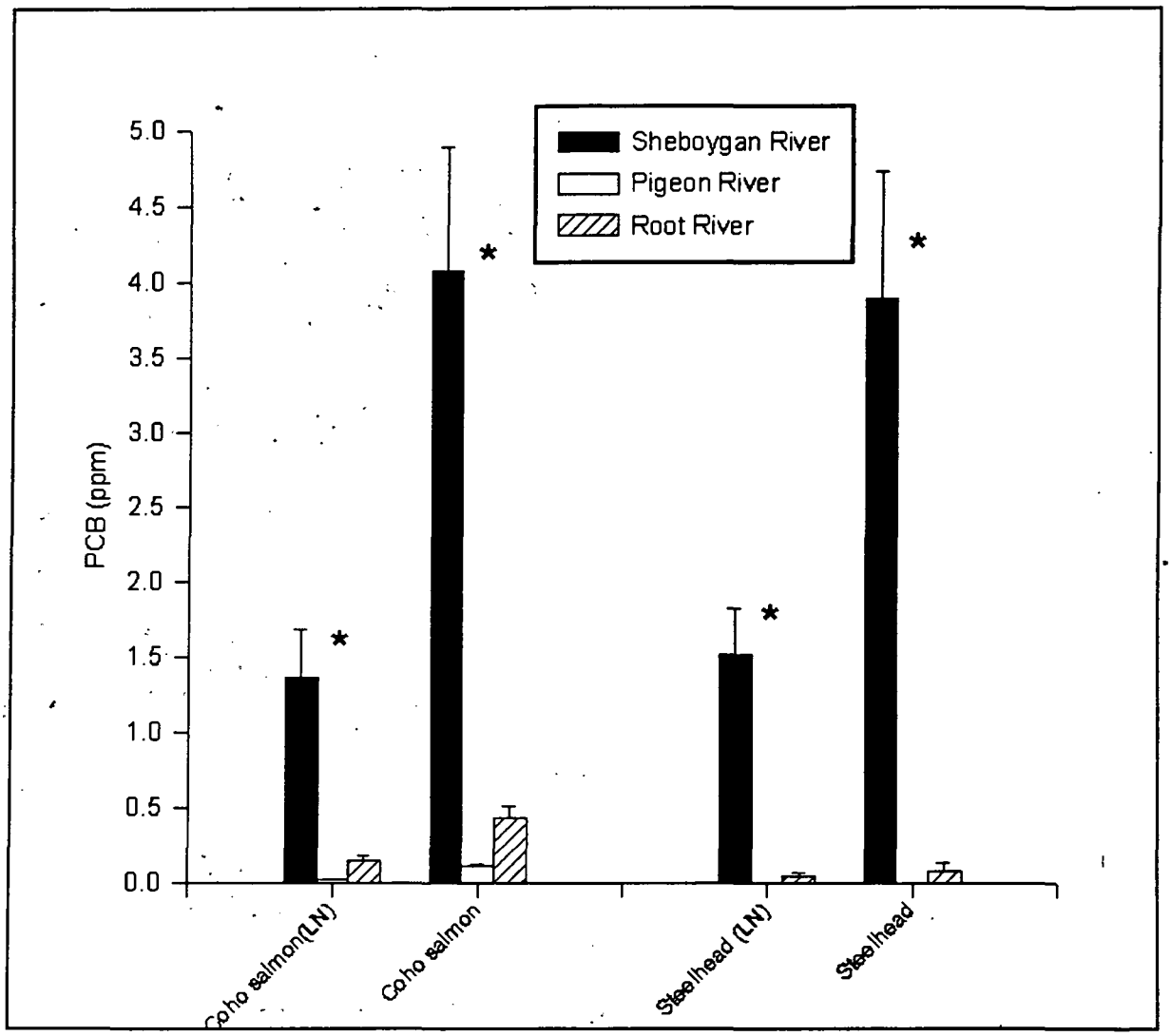
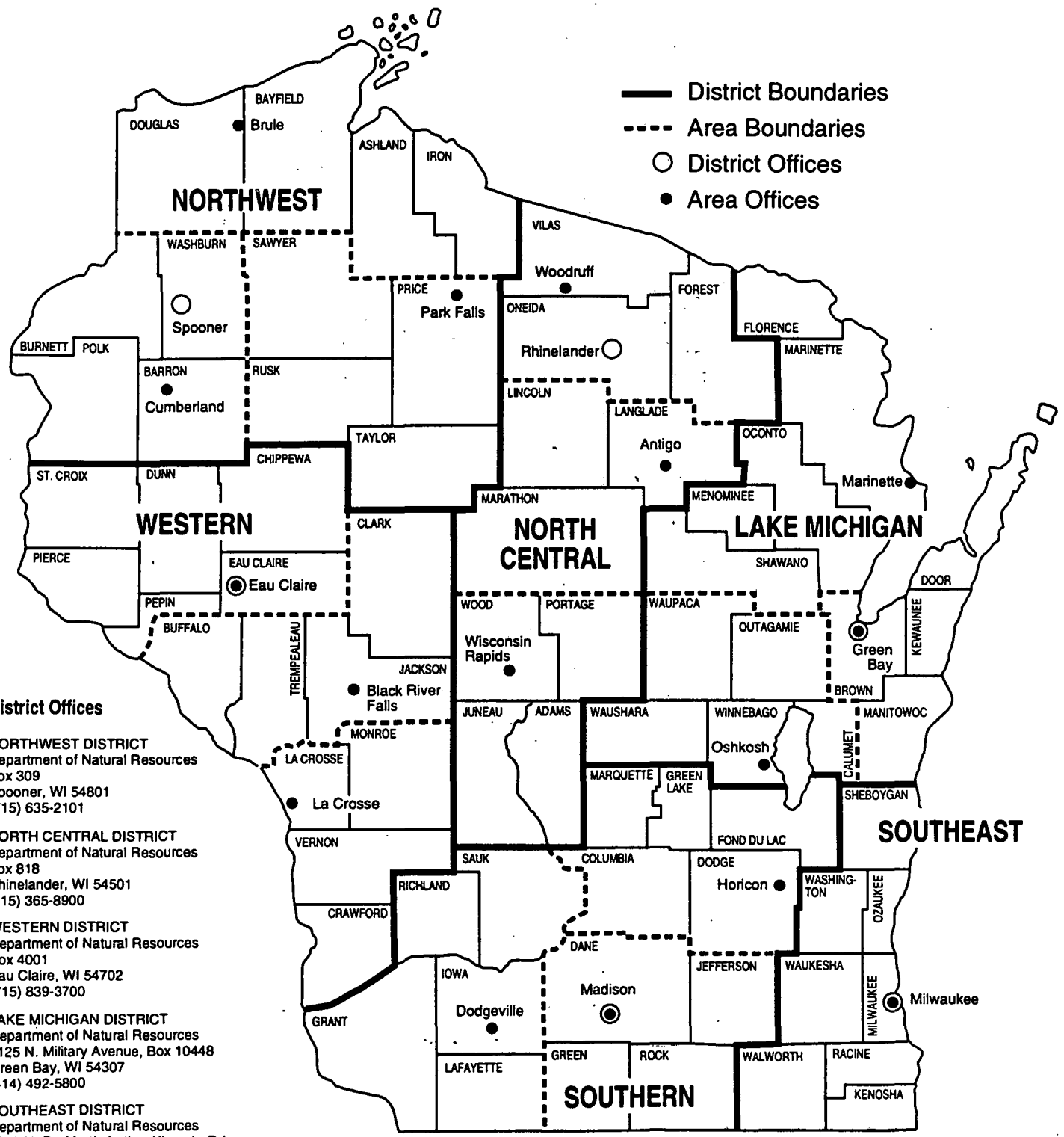


Figure 8. Coho salmon and steelhead smolts from the Sheboygan, Pigeon and Root Rivers. ns = no significant difference, * = significant difference, LN = lipid normalized data. Error bars denote ± 1 sd.



DNR Field Districts and Areas



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SOUTHERN DISTRICT
Department of Natural Resources
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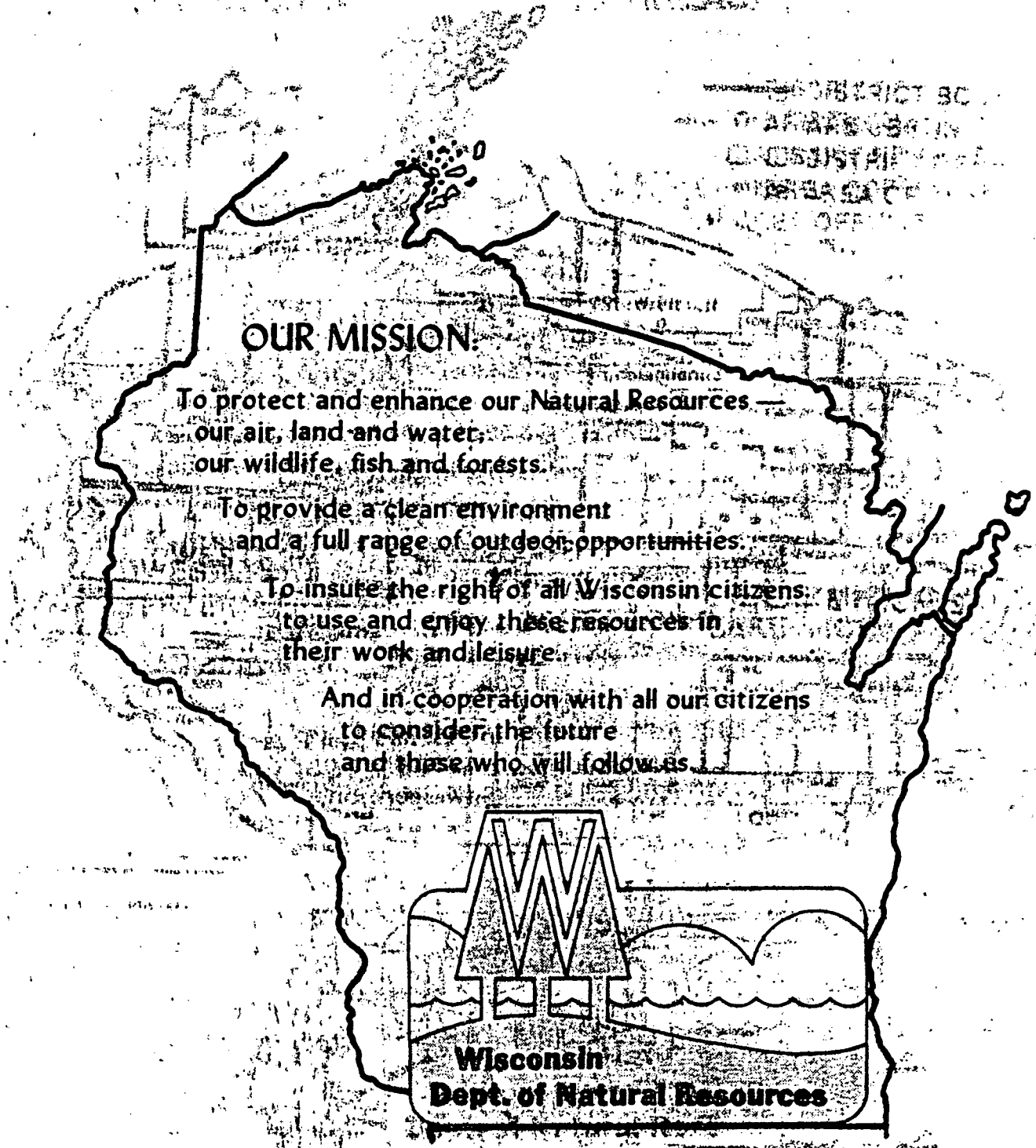
REV 7/95


OUR MISSION:
To protect and enhance our Natural Resources —
our air, land and water;
our wildlife, fish and forests.
To provide a clean environment
and a full range of outdoor opportunities.
To insure the right of all Wisconsin citizens
to use and enjoy these resources in
their work and leisure.
And in cooperation with all our citizens
to consider the future
and those who will follow us.
Wisconsin
Dept. of Natural Resources