Assessment of the Lake Michigan Monitoring Inventory

A Report on the Lake Michigan Tributary Monitoring Project

Prepared by

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Executive Summary

Introduction

Through a cooperative agreement, the Great Lakes Commission worked with the U.S. Environmental Protection Agency (U.S. EPA) Region 5, and its partners in the Lake Michigan Lakewide Management Plan (LaMP) process, to assess existing monitoring efforts in the Lake Michigan basin and subwatersheds, including the ten Lake Michigan Areas of Concern (AOC) and four other tributary watersheds. This report is one of the outcomes of the project, and includes a comprehensive review of monitoring programs at the federal, state and local levels for the targeted watersheds; an analysis of gaps, inconsistencies and unmet needs; an assessment of the adequacy of existing efforts to support critical ecosystem indicators; and recommendations for addressing major monitoring needs, particularly those considered most important for lakewide management decision making. The report has also been used to inform members of the Lake Michigan Forum, local public advisory councils (PACs), and other stakeholders about identifying current, local monitoring efforts and establishing community-based monitoring programs.

Monitoring was broadly defined for this project to include not only traditional water quality parameters, but also habitat, wildlife, land use, nonpoint source pollution and other measures of ecosystem health. It is intended that the report and future project outcomes will provide U.S. EPA, the PACs and other stakeholders with important tools for developing their Remedial Action Plans (RAPs) and will enable them to engage their community in a valuable dialogue regarding the status of knowledge on their local watershed. Working closely with the states and tribal authorities, they will benefit from the exchange of information and the opportunity to enhance local participation in state-sponsored monitoring programs.

Project participants were responsible for conducting this assessment at the local level in their watersheds. This consisted primarily of implementing a survey of potential local monitoring organizations and conducting follow-up interviews. The Great Lakes Commission, in collaboration with the U.S. EPA and other agencies, assessed monitoring being conducted by state and federal agencies. The Commission then compiled the results of this collaborative effort into an inventory database, which was the basis for this report. Please see the methodology chapter for a background on project participants, as well as methods used to gain information to build the inventory.

Results

The results from an analysis of the monitoring inventory are organized along several lines. First, each tributary watershed is reviewed separately, with an additional chapter on open lake and basinwide monitoring. Watersheds for the following tributaries are covered in this report:

Grand Traverse Bay
White Lake
Muskegon Lake
Grand River
Kalamazoo River
St. Joseph River
Grand Calumet River
Waukegan Harbor
Milwaukee River and Estuary
Sheboygan River
Fox-Wolf River Basin
Door County
Menominee River
Manistique River

Within each of these chapters, findings from the inventory are presented in the following nine categories:

- LaMP pollutants
- Nutrients and bacteria
- Meteorological and flow monitoring
- Sediments
- Fish contaminants, fish health, and aquatic nuisance species
- Benthos monitoring
- Air monitoring
- Wildlife monitoring
- Land use

In addition to discussing findings for each of the watersheds, monitoring locations (where available) are also displayed for each watershed. The combination of database analysis and geographical analysis was designed to present the most complete assessment of monitoring within each watershed.

Following the open lake chapter, a more general analysis of monitoring coverage is presented in chapter 18, Overall Discussion. In this section, the monitoring infrastructure was analyzed for its ability to provide sufficient data for assessing the 70 Lake Michigan LaMP indicators. A qualitative rating is given to each LaMP indicator, based on the availability and specificity of monitoring related to the indicator.

Findings and Recommendations

The final section of this report centers on general issues that were uncovered throughout the course of research. There are three key areas under which the monitoring inventory provided valuable information and recommendations for improving overall monitoring in the Lake Michigan basin. These include data gaps and unmet needs; underutilized resources; and monitoring coordination and information sharing. Findings and recommendations within these areas are summarized below. More detail can be found in the last chapter of the report. For reference purposes, sections are labeled with letters and findings and recommendations are numbered.

A. Data Gaps and Unmet Needs

This report, and the inventory on which it is based, represent the first effort to account for the range of environmental monitoring in the Lake Michigan basin. The inventory represents the initial approach toward achieving this ambitious goal. It is a framework on which a more complete inventory will eventually be built.

(1) Finding: There are several gaps in the inventory that are listed below and throughout the report. While some of these gaps are areas that have not been well covered in the inventory, others may represent gaps in the monitoring coverage. At this point, it is difficult to tell which are gaps in the monitoring inventory and which are actual monitoring gaps. Further improvement of the inventory database is needed to better clarify this distinction.

(1.1) Recommendation: *Continue to update the inventory and expand data collection to include all tributaries.*

(2) Finding: There are several key monitoring areas where little information was received, but where more monitoring is believed to exist. These areas include monitoring for *E. coli*, fish population characteristics, aquatic nuisance species, benthic organisms, wildlife, and habitat.

(2.1) Recommendation: *Establish better lines of communication with state Departments of Natural Resources (DNR), U. S. Fsih and Wildlife Service (USFWS), U. S. Forestry Service (USFS), and U. S. Department of Agriculture (USDA).*

(2.2) Recommendation: *Better integrate habitat and wildlife monitoring with traditional water quality monitoring.*

(3) Finding: Another result of this initial approach to the monitoring inventory for the Lake Michigan basin was that much of the information included only general information about the geographic location of monitoring sites. Many organizations reported monitoring for parameters across a broad geographic area but did not include specific site references. Locational information is critical if the inventory is to be brought online in a geographically-searchable format.

(3.1) Recommendation: *Improve information on the geographic location of monitoring sites.*

(4) Finding: A further gap in the monitoring information obtained for this report, was the lack of complete and continuing coverage of Lake Michigan Mass Balance data. Data obtained for this report on the Lake Michigan Mass Balance Project was limited by the timing of the release of data to the public. However, information in the inventory database will be improved when the project is finalized. Additionally, the value of coordinated sampling data (as collected in the Mass Balance project) would be greatly enhanced by a repeat of the sampling event ten years following completion of the original sampling.

(4.1) Recommendation: *Initiate planning for a coordinated sampling event for ten years following the initial Mass Balance project, and share data and modeling results with the public in a timely fashion through numerous outlets.*

(5) Finding: This initial project specifically avoided attempting to collect information about university monitoring projects. However, some academic institutions conduct a number of important ongoing, long-term projects, and information on these projects should be included in the inventory. Other programs catalog the university work they fund. Closer ties need to be established with these programs and such efforts need to be expanded throughout the basin.

(5.1) Recommendation: *Include academic research and data collection efforts in future updates to the monitoring inventory.*

(6) Finding: While a number of LaMP pollutants, such as mercury and copper, are monitored extensively across the basin, it has been difficult to find monitoring information on some of the other pollutants. These under-monitored pollutants include all the emerging LaMP pollutants, along with DDT, HCBs, toxaphene, and PAHs.

(6.1) Recommendation: *Further examine the monitoring coverage of specific LaMP critical pollutants and emerging pollutants.*

B. Underutilized Resources

Along with the gaps in monitoring coverage identified in this project, some resources in the basin were also discovered that do not appear to be fully utilized. Monitoring is an area of environmental management that has often been underfunded in the past. Therefore, in order to achieve the most complete monitoring coverage possible, all available resources must work in concert.

(1) Finding: One of these underutilized resources is volunteer groups. Most of the volunteer groups currently engage in some form of monitoring, but often their efforts are not incorporated into state or regional monitoring plans, and the information collected is only reported internally or locally.

(1.1) Recommendation: *Take better advantage of relatively untapped volunteer monitoring resources.*

(2) Finding: Another group that is underutilized is local agencies. Examples of such agencies are health departments, conservation districts and planning agencies. In many cases, these agencies are already engaged in monitoring to serve their local needs.

(2.1) Recommendation: *Take better advantage of local agencies such as health departments, conservation districts and planning agencies.*

(3) Finding: To best capitalize on these underutilized resources, it is important that these local groups (both volunteer groups and local agencies) be linked into basinwide efforts, but at the same time retain their local focus and discretion.

(3.1) Recommendation: *Establish a better framework for bottom-up monitoring program linkages.*

(4) Finding: Part of the difficulty in using data collected at the local level is that there are few standards at the basinwide level to integrate data. The local focus of the data collection effort often will leave the data incompatible with other data from neighboring localities.

(4.1) Recommendation: *Standardize data collection and reporting*.

C. Monitoring Coordination and Information Sharing

The final issue area does not involve direct monitoring, but responds to the need to coordinate monitoring efforts. There are a wide array of organizations involved in monitoring at the federal, state and local levels. However, no single organization is responsible for planning, coordinating, or disseminating monitoring efforts for the entire Lake Michigan basin.

(1) Finding: A major coordination problem is the lack of a central source for monitoring information. The inventory that this report evaluates is the first step toward creating such a central source. However, this one-time inventory is currently not universally accessible and may quickly become dated if the database is not continually updated by monitoring organizations in the basin.

(1.1) Recommendation: *Encourage state, federal, tribal, and local agencies to report monitoring coverage and results to a meta-database with universal access.*

(1.2) Recommendation: *Develop an online database of monitoring information that is geographically-based, and content-searchable.*

(2) Finding: In general, organizations make most, if not all, decisions about their monitoring programs based on goals for their local coverage areas. Rarely does this area cover the entire Lake Michigan basin.

(2.1) Recommendation: *Develop and coordinate the implementation of comparable methods to collect indicator data in a coordinated network.*

Acknowledgments

The primary authors of this report were Ric Lawson of the Great Lakes Commission, and the Lake Michigan Tributary Monitoring Project participants from the 14 participating tributary watersheds around the Lake Michigan basin. Mr. Lawson compiled state and federal monitoring information; designed and analyzed the monitoring inventory survey and database; integrated all other information into this final report; and provided day-to-day project management. The project participants collected information on local monitoring programs in their watersheds; compiled this information for population of the inventory database; reported on their findings (much of which is included directly in this report); and provided review comments to Mr. Lawson. These project participants, and their respective watersheds, are as follows:

Chris Wright — Grand Traverse Bay
Susan Russell — Grand Traverse Bay
Kathy Evans — White Lake and Muskegon Lake
Dr. Janet Vail — Grand River
Melissa Welsh — Grand River
Bruce Merchant — Kalamazoo River
Andrew Laucher — Kalamazoo River
Al Smith — St. Joseph River
John Wuepper — St. Joseph River
Kathy Luther — Grand Calumet River
Dr. Greg Olyphant — Grand Calumet River
Susie Scheiber — Waukegan Harbor
Paul Geiselhart — Waukegan Harbor
Dr. Vicky Harris — Milwaukee, Sheboygan, and Menominee Rivers
Nate Hawley — Milwaukee, Sheboygan, and Menominee Rivers
Bruce Johnson — Fox-Wolf River Basin
Jim Pinkham — Fox-Wolf River Basin
Roy Aiken — Door County
Jim Anderson — Manistique River

Contact information for these individuals is included in Appendix B.

In addition to the authors, several individuals made important contributions to the development of the inventory and this report. Judy Beck, Lake Michigan Team Manager with U.S. EPA, Region 5, served as the technical contact. Through the U.S. EPA she provided funding for the project, as well as project guidance, federal contacts, and overall support of the project through the LaMP process. Matt Doss, Program Manager with the Great Lakes Commission, provided project leadership, oversight, administration, and extensive editorial and task support for all aspects of the project. Dr. Michael Donahue and Tom Crane with the Great Lakes Commission provided guidance and important contact information.

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1. Introduction and Background

Lake Michigan Background

Lake Michigan is the second largest Great Lake, by volume. The lake is 307 miles long and 118 miles wide, with an average depth of 279 feet and a maximum depth of 925 feet. The Lake Michigan drainage basin covers more than 45,000 square miles. The shoreline of the lake stretches 1,660 miles.

Lake Michigan flows into Lake Huron through the Straits of Mackinac. The flow rate into Lake Huron allows Lake Michigan to be recharged once every 100 years, which is considered a relatively slow recharge rate. The lake supports a unique ecology, with colder forested regions dominating the northern half of the basin, and more temperate, fertile regions in the southern section.

Lake Michigan is located entirely in the United States, which made it uniquely situated for this project. Four states border the lake – predominately Michigan to the east and north, and Wisconsin on the western shore. Indiana and Illinois make up the southern shore of the lake, and while a small proportion of the basin area exists in these states, these areas contain significant natural areas, and high population and pollution sources.

The Lake Michigan basin consists of a variety of land uses. About 44 percent of the land in the basin is taken up in agricultural production. Roughly 41 percent exists as managed or unmanaged forest land. Nine percent of the remaining land is divided up into residential units, with a variety of uses making up the remaining 6 percent of the basin.

Monitoring Relevance to the Lake Michigan LaMP

Pursuant to the 1987 protocol to the Great Lakes Water Quality Agreement (GLWQA), Lakewide Management Plans (LaMP) have been developed for four of the five Great Lakes. The Lake Michigan LaMP effort was led by the U.S. Environmental Protection Agency (U.S. EPA), Region 5, in cooperation with its partners in the states of Michigan, Indiana, Illinois and Wisconsin, the public and other federal and tribal agencies. Additionally, Remedial Action Plans (RAPs) are being prepared and updated for ten Lake Michigan tributaries designated as Areas of Concern by the parties to the GLWQA.

According to the 1987 protocol, "LaMPs shall embody a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses in ... open lake waters." The LaMP process involves setting goals to reduce toxics, improve habitat, and restore beneficial uses to the environment in the Lake Michigan basin. The RAPs follow a similar approach in specific geographic areas where significant pollution problems have impaired beneficial uses of the water body.

An additional feature of the LaMPs and RAPs is a strong emphasis on public consultation and local involvement. For the Lake Michigan LaMP, this is achieved through the Lake Michigan Forum, a broad-based stakeholder group with members from tribes, industry, environmental groups, local government agencies, community organizations, academia, recreational organizations, and the ten Lake Michigan AOCs. Public advisory councils (PACs) are the primary vehicle for facilitating public involvement in the AOCs. The PACs include broad representation from the AOC community and guide the RAP process at the local level.

While the original draft Lake Michigan LaMP focused strongly on toxic pollutants, the participating agencies and stakeholders recognized that other stressors contribute to impairments of the lake and the tributaries that feed into it. In response, the latest version of the LaMP expanded its scope to address a broader array of management issues, including loss of habitat and biodiversity and introduction of damaging exotic species. The year 2000 draft of the LaMP includes the results of a number of studies and monitoring efforts to determine the fate of pollutants entering the Lake, and how they move through air or water or sediments into the food chain.

A critical component of this broader approach will be a monitoring regime that is coordinated from one jurisdiction to another and sufficiently comprehensive to support the ecosystem indicators which inform management decisions. The Lake Michigan Mass Balance Study will provide important data on the amount of several critical pollutants entering the lake, their movement and how they are made available to fish and plant life. An outstanding need remains, however, to assess the status and scope of monitoring being conducted at the state and local levels on major tributaries to Lake Michigan; to develop a plan for coordinating and enhancing these efforts; and to address gaps and unmet needs in the collective monitoring and reporting regime that hamper decision making at all levels.

Project Goals

Through a cooperative agreement, the Great Lakes Commission worked with U.S. EPA Region 5, and its partners in the Lake Michigan LaMP process, to assess existing monitoring efforts in Lake Michigan basin and subwatersheds, including the ten AOCs and four other tributary watersheds. This report is one of the outcomes of the project. The report includes a comprehensive review of monitoring programs at the federal, state and local levels for the targeted watersheds; an analysis of gaps, inconsistencies and unmet needs; an assessment of the adequacy of existing efforts to support critical ecosystem indicators; and a plan for addressing major monitoring needs, particularly those considered most important for lakewide management decision making. The report has also been used in training members of the Lake Michigan Forum, PACs, and other stakeholders on determining current, local monitoring efforts and establishing community-based monitoring programs.

The project and report are consistent with the ecosystem approach of the LaMPs and RAPs as well as their emphasis on community involvement and participation. Monitoring has been viewed in the broadest sense, including not only traditional water quality parameters, but also habitat, wildlife, land use, nonpoint source pollution and other measures of ecosystem health. It is intended that the report and future project outcomes will provide the PACs and other stakeholders with important tools for developing their RAPs and will enable them to engage their community in a valuable dialogue regarding the status of knowledge on their local watershed.

Scope of the Assessment Effort

This report assesses monitoring efforts in the broadest sense, including not only traditional water quality parameters, but also habitat, wildlife, land use, nonpoint source pollution and other measures of ecosystem health. Project participants were responsible for conducting this assessment at the local level in their watersheds. There were fourteen major Lake Michigan tributaries selected for local analysis. The watersheds impacting these tributaries were selected as the base unit of analysis. These watersheds are illustrated in Figure 1. The Great Lakes Commission, in collaboration U.S. EPA and other agencies, assessed monitoring being conducted by state and federal agencies. Please see the methodology chapter for a background on project participants, as well as methods used to gain information to build the inventory.

Figure 1. Watersheds included in the Lake Michigan Monitoring Inventory.

Report Framework

This report is structured along the lines of a typical research report. This introduction is followed by a discussion of the methodologies used to collect the information in the inventory and this subsequent report. The methodology is followed by a series of chapters that present the project findings and inventory content. Summaries of inventory results from each of the fourteen tributaries included in this project are presented in the following categories:

- *LaMP pollutants:* This category includes substances classified as water quality pollutants at three levels. Critical pollutants are those that have been found to impair beneficial uses of the lake and its tributaries. Included in this category are polychlorinated biphenyls (PCB), dieldrin, chlordane, dichlorodiphenyltrichloroethane (DDT) and metabolites, mercury, and dioxins and furans. Pollutants of Concern are those toxic substances that are associated with local or regional use impairments. These include arsenic, cadmium, chromium, copper, cyanide, lead, zinc, hexachlorobenzene (HCB), toxaphene, and polynuclear aromatic hydrocarbons (PAH). Finally, Emerging Pollutants include those toxic

substances that have characteristics that indicate a potential to affect the physical or biological integrity of Lake Michigan. These include atrazine, selenium, and PCB substitute compounds.[1]

- *Nutrients and bacteria:* Nutrients, when present in high levels, can impair water bodies by encouraging the overproduction of algae and other plant life, leading to low oxygen levels and ultimately eutrophication. Several organisms which proliferate in high nutrient conditions include *E. coli* and coliform forms of bacteria. These bacteria can locally impair beneficial uses of water bodies.
- *Meteorological and flow monitoring:* Meteorological and flow monitoring represent two types of physical parameters that can be measured for water bodies. Meteorology (mostly relating to precipitation) and flow data help researchers develop water quality models, which have many uses, including source determination, Total Maximum Daily Load (TMDL) development, and other types of predictive modeling, to name just a few.
- *Sediments:* Contamination of bottom sediments is a common source of water quality impairment in AOCs in the Lake Michigan basin. Monitoring these sediments is important for determining the overall quality of a waterbody and its adjoining ecosystems.
- *Fish contaminants, fish health, and aquatic nuisance species:* Many species of fish in the basin take up chemical pollutants through the food web. Often, the effect is a bioaccumulation or concentration of pollutants within the fish tissue. This presents a significant health hazard to humans who consume this fish. Also, the health of fish populations in the lake and tributaries serves to indicate the health of the ecosystem to some degree. Nonindigenous Aquatic nuisance species can affect native aquatic species in a variety of ways. Monitoring of all these aspects of fish populations is important for tracking the health of life in the lake.
- *Benthos monitoring:* Similar to fish, there are a wide number of other organisms that exist deep within lakes and streams within the Lake Michigan basin. Many of these organisms are very sensitive to pollution and other aspects of a healthy aquatic system. Monitoring for the health and diversity of these species helps to determine the overall health of the aquatic ecosystem.
- *Air monitoring:* While monitoring the content of the air is an important task to determine intrinsic air quality, it is also important for tracking potential sources of water quality impairment. Much research is ongoing in the basin to determine how pollutants can be passed through the air to water bodies through air deposition.
- *Wildlife monitoring:* Any effort to track the health and quality of ecosystems must include some measure of the diversity and health of wildlife populations. Several types of public and private organizations are monitoring a variety of wildlife populations.
- *Land use:* One of the measures of human impact on the natural world is tracking the development of land. Changing the use of land from a naturally-controlled environment to agricultural production or urban or suburban habitation can have a wide range of impacts on the surrounding ecosystems. It is important to track these changes, along with measures of ecosystem health, to help determine the overall impacts from changes in land use.

In addition, each chapter begins with background about the watershed or region of focus, and ends with a local assessment of monitoring efforts. Both of these sections were written directly by the local project participants. Actual survey results will be made available for public use via a geographically-searchable Internet database, which is currently under development.

The tributary chapters are followed by a chapter assessing the monitoring coverage of the open lake and a discussion of state and federal monitoring programs which have a multiple watershed focus. This chapter is followed by a general discussion of the monitoring coverage in the Lake Michigan basin, focusing on gaps

[1]Definitions for LaMP pollutants were excerpted from the *Lake Michigan Lakewide Management Plan (LaMP 2000)*; U.S. EPA, 2000.

and unmet needs. The final chapter contains recommendations from the project participants, in consultation with numerous monitoring stakeholders, such as members of the Lake Michigan Monitoring Coordination Council.

2. Methodology

Attempting to take an inventory of all ecological monitoring efforts in a basin as wide in area as the Lake Michigan basin is a mammoth undertaking. Thousands of separate efforts may be ongoing, and few people outside project participants may be aware of many of them. Striving to become aware of all of these efforts is high goal — a goal that one cannot expect to achieve on the first attempt. We view the products of Lake Michigan Tributary Monitoring Project as comprising a foundation of a monitoring inventory. Over time, if the foundation is strong enough and enough people become aware of it, the inventory can be built upon so that it will eventually become complete. We envision the inventory as a dynamic product that should constantly be updated to reflect new discoveries and changes in monitoring efforts.

In this vein, the methods used to collect information and develop the inventory consisted of the following general elements:

- A two-tiered survey of potential monitoring organizations;
- Review and collection of supplemental or specific geographic monitoring information; and
- Development of an organizing framework for the inventory.

Monitoring Inventory Survey

A short survey (25 questions, 2 pages) was developed to solicit information about possible monitoring projects in the basin (See Appendix C for the survey). Questions in the survey ask respondents to provide information on a variety of characteristics about monitoring projects. Generally, these characteristics include basic contact information, locational information, indicators monitored, logistical information, quality assurance and controls, and staff and training information.

The survey was distributed on two levels – local and state/federal. In an effort to collect a greater amount and higher quality of local monitoring information, the Great Lakes Commission partnered with local groups in 14 key tributaries to Lake Michigan. The tributaries included all ten Areas of Concern (AOCs), as well as Grand Traverse Bay, Grand River, St. Joseph River, and Door County (see Appendix B for a list of project participants). The GLC conducted the survey of state, federal and other basinwide organizations.

Two workshops were conducted to provide training and technical assistance to project participants so that the survey could be administered as effectively as possible. At the first workshop, the survey, along with a set of supporting materials, was distributed to project participants. These materials were reviewed and subsequently adapted to reflect participant feedback. A process was established at the meeting, whereby participants committed to carry out the following steps:

- *Develop a contact list for delivering surveys.* Participants were encouraged to meet with their local advisory groups and develop a list of entities in the watersheds that might be conducting monitoring programs, including local municipalities, utilities, educational institutions, business/industry groups, environmental and conservation organizations and recreational groups among others.
- *Distribute surveys with informational materials.* Participants were subsequently sent a set of materials that could be tailored to their local area. Methods to encourage high response were also discussed.
- *Enter returned surveys into electronic format.* Participants were given a database template to be used for data entry. The final datasets were sent to the GLC for encorporation into the project database. The final database is being developed for public use on the Internet as a geographically-searchable database.
- *Follow up to encourage high response.* Several strategies were discussed to increase the response rate.

- *Report findings.* A framework and timeline were established for reporting on local survey results. These reports were submitted to the GLC for integration into this final report.
- *Final workshop.* A workshop was held to review the overall findings of the project and to share information and ideas about how local groups could build on the results in future projects.

A second meeting was held midway through the project to troubleshoot survey and reporting difficulties. The main difficulty was determined to be response rate. Following the meeting, GLC crafted a press release that the project participants adapted and sent out to local media outlets. This was used to create greater awareness of the project, thereby encouraging better response.

Local Methodologies

Each project participant tailored the general methodology to achieve the best results for their watersheds. The specific methodologies used by the project participants, along with general information about survey results, are provided below.

Grand Traverse Bay

Description of the Research Process

The purpose of this research project is to identify the overall state of ecosystem monitoring being conducted in the Grand Traverse Bay watershed. In addition to water quality monitoring, ecosystem monitoring includes collecting data on selected parameters that effect the biological, physical, chemical, and human health condition of the watershed**.** Parameters such as fish and wildlife habitat, wetland coverage, land use development patterns, construction of infrastructure, atmospheric deposition, climatic conditions, groundwater contamination, watershed hydrology, and others are useful in assessing the condition of a watershed.

Collaboration and Communication With Watershed Groups

The survey project was presented to the Grand Traverse Bay Water Quality Monitoring Team to solicit their support and assistance in identifying organizations to receive the survey. Promotion of the survey was also made at public meetings, monthly meetings with natural resource managers, monthly meetings with the Grand Traverse Regional Environmental Health Committee, and presentations about Grand Traverse Bay sponsored by Grand Traverse Bay Watershed Initiative (GTBWI).

Number of Entities Contacted and Number of Responses

The Grand Traverse Bay Watershed Monitoring Inventory Form was mailed to 96 selected organizations located in the Grand Traverse Bay Watershed.

Of the 96 organizations receiving the survey, 24 returned the survey. Of the 24 respondents, 17 administer a monitoring program.

Muskegon and White Lakes

Surveys were mailed to over 275 potential monitoring entities in the Muskegon and White Lake AOC/River Watersheds. All county level governments, drain commissions, health departments, road commissions and conservation districts were surveyed. Contacts with the PACs and other conservation organizations initially helped to form a mailing list of townships, planning commissions, schools, sport fishing/conservation and lake associations with an interest in water quality, habitat and environmental education projects. This mailing list was compiled and used in the survey. Through a network of conservation districts, individuals and organizations throughout the watershed, a list of individuals, businesses, city governments, schools and

university contacts was developed and used in the survey. Personal contacts, phone calls and follow up mailings were performed as more information became available.

Of the survey contacts made, 70 responses were received by the Muskegon Conservation District. Of these, 23 responded with monitoring information. Thirteen of these respondents were from the Muskegon Lake AOC/River Watershed and eight were from the White Lake AOC/River Watershed. A total of 47 respondents indicated that they did not perform any monitoring.

Four public meetings were held to support the RAPs and two newsletters were developed in conjunction with the Muskegon and White Lake Public Advisory Councils to raise awareness and solicit participation for this project. The newsletters were mailed and/or distributed to over 2000 members of the public. An additional survey mailing about the occurrence of "projects" in the Muskegon River Watershed was completed to supplement knowledge about activities and opportunities which could be useful to the Muskegon River Watershed Assembly. A meeting to discuss public involvement in contaminated sediments remediation will be held in the White Lake area as part of this project as well. An educational brochure about Muskegon County watersheds (Muskegon and White being the two largest) is also being developed to promote watershed awareness and public involvement opportunities.

Grand River

Research began with contacting Grand Valley State University-Water Resources Institute (GVSU-WRI) and obtaining mailing lists for different individuals involved in water related projects that were already known to the Institute. This proved to be the best resource since the Grand River does not have a public advisory council or committee established at the time of this study.

A list was also comprised from the Michigan Water Environment Association's 1998-99 membership directory. Surveys sent to these organizations were asked to provide information on monitoring that was above and beyond what they report for compliance purposes.

Contacts were obtained by searching through publications, reports, and news articles for individuals and groups that were in the media. Internet sites were also searched, but unfortunately most of the information found was outdated and websites did not give a good representation of the watershed as a whole. Another search method was the Know Your Watershed software published by Conservation Technology Information Center, which can be found at **http://www.ctic.purdue.edu/KYW/**. The information was obtained for local groups working within different watersheds. The publication date was in 1996, so some of the groups were no longer active. Other names came from individuals that completed the survey.

A total of 325 surveys were sent out in two bulk mailings. Additional surveys were mailed individually as more contacts were discovered. The University had 25 successful responses and 28 negative responses. The majority of surveys sent out were never returned. Inquiries were made by non-monitoring groups on the project, and results will be sent to them.

Kalamazoo River

In an effort to share responsibilities on this project, as well as avoid repetition of surveying, the Kalamazoo River Watershed Public Advisory Council (KRWPAC) partnered with a local project known as the Watershed Information Management Project (WIMP). This group seeks to compile monitoring data and store it in a publically accessible format. After several initial meetings with this group, it became evident that the decision making process between the two groups was preventing our project from commencing on schedule for our November 1, 1999 deadline. We decided to go ahead with our surveying efforts, and agree to share the information acquired with the WIMP group when the time had come.

Utilizing a mailing list obtained from the Michigan Department of Environmental Quality (MDEQ) for the Allegan Lake TMDL project, our first contact included a mailing of 272 surveys to the various contact persons on the list. Initial response yielded about 20 surveys. The surveys requested a two week turnaround time. At four weeks past the date they were mailed an intern conducted follow up calls. Most agencies did not respond to the surveys because they are not conducting any monitoring. We did receive a few surveys that were mailed or faxed back indicating that no monitoring efforts were taking place. The follow up calls did yield an additional four surveys.

A second mailing utilized a list obtained from the Kalamazoo Foundation, a private non-profit foundation that had recently held a Sustainable Community Watershed Conference. Using a list generated from those attending the conference, an additional 50 surveys were sent out. Response from this mailing yielded approximately five responses. Follow up calls did not yield any responses.

In early August, a press release was sent to the major newspapers in the Watershed as well as a few news-oriented radio stations. It is unclear as to how many of these publications actually ran the article. A few responses were received via phone, but these were general inquiry about the Watershed Council. No survey results were attained from the press release.

St. Joseph River

The first stage of the assessment was to identify various organizations that might be monitoring for information on the St. Joseph River watershed, either on water, land, wildlife or any other benchmark. Numerous telephone calls were made to speak with individuals involved in some kind of watershed monitoring. Newspapers serving all watershed counties except Berrien published the press release, proposed by the GLC. The next step was to utilize the survey form designed by the GLC/EPA. Telephone interviews were conducted with several individuals. If they did not return the survey form, the details of their programs were not made available. Comments from some of the organizations that did not return forms are included in the Excel spreadsheet under the comment column. A few personal interviews were conducted and these actually are most effective way to conduct surveys but time or lack of available resources did not permit this as a routine method. The names of the contacts are listed in the Excel spreadsheet even if they did not respond. The ones that responded with a completed form are designated in italics.

A total of about 40 organizations were contacted but only nine completed survey forms were returned. The organizations that were contacted included county health departments, wetland conservation groups, nature centers, volunteer “water watchers”, lake and stream association members, river environmental groups, “steelheaders”, county conservation offices, colleges and newspapers. The small number of returned forms reflects what appears to be a low level of formal programs that are in place that possess the discipline and resources required to monitor the parameters listed on the survey form. For example, only one organization, “Water Watcher”, of Indiana, reported monitoring Atrazine and Acetichlor.

Grand Calumet River

An initial list of likely monitoring organizations or contact people was constructed from the membership of the Citizens Advisory for the Remediation of the Environment (CARE) Committee, the Interagency Task Force on *E. coli* member lists, participants in the TMDL stakeholder process, and other local partnership efforts. The Indiana Department of Environmental Management (IDEM) Volunteer Monitoring Coordinator and the Indiana Department of Natural Resources Hoosier Riverwatch Coordinator was also consulted for a list of local participants in their volunteer water quality monitoring programs. The Riverwatch program did supply a list of past participants in their projects in Lake, Porter, and LaPorte County, Indiana. This information confirmed that in fact, no volunteer water quality or aquatic biota monitoring actually occurs in the Grand Calumet River system. This is most likely the result of the real or perceived dangers of exposing

volunteers to a waterbody with a large accumulation of highly contaminated sediments. Despite this limitation, a substantial list of contacts and organizations was constructed. Groups which might be collecting water quality data in other Lake Michigan tributaries and those which might collect other types of environmental information where added to the list. An internet search was conducted for local chapters of national organization such as Audubon and Sierra Club which might participate in bird and wildlife counting activities. Faculty members involved in ecological or environmental research at local universities were also included. In addition, lists of local governments such as park departments, water departments, and others were provided by the Northwest Indiana Regional Planning Commission. Most of the lists provided by others provided addresses only.

In addition to Internet and phone research, information about this project was presented at a number of local meetings and partnerships. Members of the CARE Committee, the Interagency Task Force on *E. Coli*, and the TMDL stakeholders were informed of the project and advised that they would likely be receiving surveys. Presentations and surveys where also distributed at the annual meeting of the Indiana Hub of the Great Lakes Aquatic Habitat Network, a consortium of local environmental organizations and individuals interested in environmental issues.

An initial mailing of letters, fact sheets, and surveys was distributed to 20 individuals and organizations. Since project funding was actually received by Indiana University as a member of the *E. Coli* Task Force, the letters where sent on Task Force letterhead and signed by Kathy Luther as the Task Force Co-Chair. No responses where received as a result of this initial mailing.

Limited follow up calling was done to those organizations known to be conducting monitoring. A total of two responses were received as a result of this calling effort. Because of earlier decisions regarding project funding, there was insufficient staff time dedicated to this project to permit more extensive calling efforts. Based on conversations with other project participants, 10 percent seems to be a fairly consistent response rate. Follow up phone calls indicated that many recipients did not consider the work they might be doing to be monitoring. This may be one reason for poor survey response rates.

After a mid-term Lake Michigan Tributary Monitoring Project participant meeting in Chicago revealed that GLC was having limited response from state and federal agencies, an effort was made to contact local branches ofsome of these agencies by phone and fax out surveys. Surveys where sent to the IDNR, to Illinois-Indiana Sea Grant, and the USGS Research Station at the Indiana Dunes National Lakeshore. No responses where received as a result of these surveys. IDEM completed survey forms for those partnerships and organizations for which IDEM is a substantial participant. Despite limited responses to surveys IDEM is confident that a comprehensive list of state agency efforts will capture most if not all ongoing water quality monitoring that is occurring in the Grand Calumet River and this Area of Concern. As a result staff time was largely dedicated to completing online the surveys for all IDEM monitoring programs.

Initially, IDEM believed that all information necessary for the Tributary Monitoring Project would be collected in the TMDL process. While this was not the case, some important data was discovered which might not have been learned from the survey project. Information was collected about data that National Pollutant Discharge Elimination System (NPDES) dischargers have collected during discrete time periods as part of special projects. This information is not part of ongoing continuous data collection efforts or any organized monitoring programs and so is not a good fit with the database format of this project. The information was included because it might be useful for any efforts to compile historical data. The regular monitoring of operations and outfalls which NPDES holders undertake as part of the regulatory requirements of their permits is not included in this report. However, it may be useful to remember that information of this type is collected regularly and reported to state agencies.

Waukegan Harbor
The following steps were implemented prior to contacting a company or agency:

- A press release was sent to all local newspapers. Lake County Chamber of Commerce Newsletter published the press release.
- Announcements of the survey were made at the Audubon Society, Waukegan Harbor Citizens Advisory Group, and Liberty Prairie Conservancy meetings.
- Networking was done by telephoning approximately 150 companies, agencies, schools, and lead contacts furnished by telephone contacts. For future reference of sources for information, a database of 52 contacts was developed. Some contacts expressed interest in being a part of future monitoring programs. There were eight surveys returned out of fourteen mailed.

Milwaukee River
Meetings were held with Wisconsin Department of Natural Resources (WDNR) staff, RAP leaders, and others to develop a list of stakeholders and managers working in the basin (DNR, County Land Conservation Departments, University of Wisconsin-Extension Offices, Non-Governmental Organizations (NGOs) etc.). Identified organizations were then contacted by telephone to describe the goals and objectives of the project. Some of the entities contacted provided valuable information regarding their monitoring activities and mentioned some other entities that should be contacted. In most cases however this was not the case, either the groups were no longer active or they were monitoring for compliance with state and federal regulations. In total, over 200 entities were contacted with only 63 actively monitoring. However, of the 63 active programs, only 16 were applicable and responded to this project. After further investigation it was apparent that many of the applicable programs were connected in some way or form to state agencies, mainly the DNR and UW-Extension.

Sheboygan River
A procedure similar to the one used for the Milwaukee River watershed was used to collect information on the Sheboygan River watershed. In total, over 100 entities were contacted with only 28 actively monitoring. However, of the 28 active programs, only 12 were applicable to this project, as many were subsets of a broader program. For example, Testing the Waters involves numerous schools, teachers, and students in the basin. After further investigation it was apparent that many of the applicable programs were connected in some way or form to state agencies, mainly the DNR and the UW-Extension.

The two largest and most active monitoring programs in the Sheboygan River Basin, Testing the Waters and the Pigeon River Water Action Volunteers (WAV), fit the trend previously mentioned. The DNR and the UW-Extension have played active roles in providing equipment and technical guidance for both programs. The Testing the Waters program incorporates local high school and middle school students to actively monitor various tributaries throughout the Sheboygan River Basin (Pigeon, Sheboygan, and Mullet River Watersheds). This program has been very successful, involving several schools over the past eight years. The WAV program, very similar to the Testing the Waters program, utilizes local citizens to monitor water quality. WAV monitoring teams consisted of either adult volunteers or school classes. In both cases, the DNR and UW-Extension provided the initial support and training to develop these programs, but now rely on their local team leaders (teachers and others) to facilitate the efforts. This initial involvement by the DNR and UW-Extension (training, quality control, and equipment) has provided the assurance that the data collected by Testing the Waters and WAV are deemed worthy for ecological assessment, as stated by various stakeholders.

Other smaller programs were also found monitoring in the Sheboygan River Basin. These programs or projects involved land trust and conservation offices, local colleges/universities, as well as a few industrial facilities.

Fox-Wolf Basin
Fox-Wolf Basin 2000 established a list of 131 individuals or entities thought to be conducting some kind of ongoing monitoring program in the basin. This list was derived from our database--focusing on agencies, organizations and university researchers. Additional contacts were provided through a Wisconsin Department of Natural Resources Water Action Volunteer (WAV) database.

Cover letters and survey forms were distributed to those for whom addresses were readily available. After waiting a few weeks, follow-up calls were made to selected contacts. Additional e-mail requests were made in early January prior to the compilation of this report. Seventeen responses were received from eight different individuals and entities. The lack of adequate monitoring in the Fox-Wolf basin has long been lamented by citizens and resource managers alike. However, it is likely there are additional monitoring programs being conducted in a Basin of this size. The limited response in this survey is believed to be more the result of FWB 2000 not having the staff or time available to be more diligent in making additional, repeated contacts.

Door County
Research as to the degree to which monitoring or collecting of data is done on a regular basis was conducted in three modes: personal contact; written communications to determine what, if any, monitoring was being done; and personal interviews with key personal in local and state agencies.

There are no specific nonprofit or volunteer watershed groups in the area, other than two lake associations.

Pursuant to 21 telephone and personal contact interviews, ten letters of inquiry were sent to local organizations and individuals. Personal contact interviews were conducted with three staff personal within the Department of Natural Resources, each with different areas of responsibility. Companies located in Sturgeon Bay's Industrial Park gave indications that their activities were not of a nature that monitoring would be a concern.

Menominee River
A procedure similar to the one used for the Milwaukee River watershed and Sheboygan River watershed was used to collect information on the Menominee River watershed. Many of the national environmental organizations (Isaac Walton League, Trout Unlimited, etc) had representatives or chapters in the basin, but were not actively monitoring at the present time. In total, over 50 organizations were contacted with only 8 actively monitoring. After reviewing the list with County Land Conservation managers and WDNR staff, it was apparent that the list was comprehensive.

Manistique River
Description of the research process
Schoolcraft County Economic Development Corporation coordinated research to determine groups, agencies, businesses, governmental entities, and individuals conducting research and monitoring within the Manistique River Watershed.

The following was the process used to collect data for this process:

1) List of potential contacts generated by the Corporation and Manistique River/Harbor Public Advisory Council.
2) Initial mailing sent to entire mailing list. Mailing included an introductory letter, background document describing basin-wide project, and a survey form. All three of these documents were developed by the Great Lakes Commission with comment by all partners.

3) Follow-up mailings of the same packets were delivered to new persons identified by respondents identified and contacted during step two.
4) Surveys returned to the Corporation were entered into the required Excel spreadsheet. Respondents were contacted for additional information if needed.
5) James Anderson met with Michael Tansy, chairperson of the Manistique River Watershed, and director of the Seney National Wildlife Refuge, and George Lyon with the Luce-Mackinac-Schoolcraft Soil and Water Conservation District office.
6) Telephone or personal contacts were made to recipients of the survey who did not respond to determine their level of monitoring activities within the Watershed.

Collaboration / communication with the public advisory council or other watershed groups

During the course of the research the Corporation worked with the Manistique River/Harbor Public Advisory Council to brainstorm monitoring activities occurring within the Watershed, and to develop an initial mailing list for the survey instrument.

The Corporation met with the lead staff person with the local Soil and Water Conservation office, and the chairperson of the organization and director of the Seney Wildlife Refuge to discuss their activities within the watershed. Both shared that beyond the activities of the Refuge, there are very few monitoring activities happening within the watershed. The response from the survey instrument verifies that the assessment made by Mr. Tansy and Mr. Lyon was correct.

Other outreach efforts

In addition to the above activities, a press release developed by the Great Lakes Commission was modified for local informational content, and sent to the local media including radio (WTIQ), and the local newspapers - *Pioneer Tribune* (Manistique / Schoolcraft County), *Munising News* (Alger County), and the *Newberry News* (Luce County). James Anderson, executive director provided updates and information at Corporation board meetings concerning the project which were covered by the media, and discussed the project during a quarterly half-hour interview on WTIQ AM 1490 Community Focus program.

Number of entities contracted and number of responses

Of the 34 surveys sent out, six (6) responses were received. George Lyon with the Soil and Water Conservation indicated that he did not believe either dam operator was involved with any monitoring activities.

General comments on results

Only five surveys were returned indicating that a rather large watershed has very little monitoring or coordination of conservation activities occurring within it. Further, the data returned indicated that most monitoring is for regulatory requirements, with some additional data collection beyond the required level. There does not appear to be any monitoring in terms of land use, soil, and very little monitoring of Fish and Biota / Wildlife beyond that of the Seney National Wildlife Refuge and the United States Department of Agriculture - Hiawatha National Forest.

In terms of the indicators being collected, all 18 indicators are being collected by at least one organization - City of Manistique, Department of Public Works. Further, most monitoring appears to be completed by paid staff who are trained in data collection methodology as well as quality assurance / quality control methods.

Further, the Corporation was surprised to find that only one of three universities in the region has any interest in conducting research within the watershed, and the only effort is driven primarily due to the contamination of the lower watershed with PCB's.

Federal and State Data Collection

The GLC was primarily responsible for collecting data from federal, state, and other organizations conducting monitoring programs basinwide. This was accomplished through two efforts — a survey, and supplemental data search. First, the GLC, in consultation with project participants and members of the Lake Michigan Monitoring Coordination Council (LMMCC), developed a list of federal and state entities that were likely to be conducting monitoring efforts in the basin (see Appendix D for the LMMCC membership list, and Appendix E for a list of survey contacts). In an effort to maintain efficiency, every effort was made to select specific contacts who could respond generally about monitoring programs in their agency, or who would collect information from relevant people in their agency. Follow up phone calls and e-mails were made to non-respondents to solicit a higher response rate. These phone calls led to further contacts (sometimes in other agencies), and additional surveys were distributed. In addition, the survey form was transformed into a web-based format to ease completion by respondents. This generated further responses, as agency contacts often asked multiple people within their agency to complete the web-based form. From an initial distribution of 72 surveys, the GLC received 27 responses. An accurate response rate cannot be calculated, since some agencies returned several surveys (some not directly solicited), while others returned none. The full database of survey responses (including local responses) can be obtained upon request.

The data received from the surveys was supplemented with information on monitoring collected through a general information search. This consisted of a general web review, as well as follow-up from conversations with agency and participant contacts. In many cases, the information collected through this method made it unnecessary to pursue further contacts with specific agencies. Several databases of monitoring information were discovered through this process. The most useful database was the *Better Assessment Science Integrating Point and Nonpoint Sources (BASINS)* system developed by Tetra Tech, Inc. for the U.S. EPA, Office of Water. This system consolidates a number of federal databases to allow easy extraction and use of ecological information on a watershed basis. Several datasets were used in the analysis for this report.

Datasets used to provide monitoring information for this report (including those extracted from BASINS and those obtained elsewhere, are included below. Where possible, dataset summaries are taken directly from metadata provided with the dataset.

The Storage and Retrieval (STORET) System
This dataset provided statistical summaries of water quality monitoring for 47 physical and chemical-related parameters. The parameter specific statistics were computed by station for five-year intervals from 1970 to 1994 and a three-year interval from 1995 to 1997. The data are contributed by a number of organizations including federal, state, interstate agencies, universities, contractors, individuals and water laboratories. Information was extracted from the STORET system for analysis of monitoring coverage for all LaMP pollutants, bacteria, nutrients, and some physical characteristics.

Permit Compliance System (PCS)
PCS is a national computerized management information system that automates entry, updating, and retrieval of National Pollutant Discharge Elimination System (NPDES) data and tracks permit issuance, permit limits and monitoring data, and other data pertaining to facilities regulated under the NPDES program. PCS records water-discharge permit data on more than 75,000 facilities nationwide.

The NPDES permit program regulates direct discharges from municipal and industrial wastewater treatment facilities that discharge into the navigable waters of the United States. Wastewater treatment facilities (also called "point sources") are issued NPDES permits regulating their discharge. Information on the point locations of sites reporting discharges from 1991 through 1996 were included in the analysis for this report.

Toxic Release Inventory (TRI)
This database contains data on annual estimated releases of over 300 toxic chemicals to air, water, and land by the manufacturing industry.

Industrial facilities provide the information, which includes the location of the facility where chemicals are manufactured, processed, or otherwise used; amounts of chemicals stored on-site; estimated quantities of chemicals released; on-site source reduction and recycling practices; and estimated amounts of chemicals transferred to treatment, recycling, or waste facilities.

The TRI data for chemical releases to land are limited to releases within the boundary of a facility. Releases to land include landfills; land treatment/application farming; and surface impoundments, such as topographic depressions, man-made excavations, or diked areas. Air releases are identified as either point source releases or as non-point (i.e. fugitive) releases, such as those occurring from vents, ducts, pipes, or any confined air stream. Surface water releases included discharges to rivers, lakes, streams, and other bodies of water. In addition, the database covers releases to underground injection wells (where chemicals are injected into the groundwater) and off-site transfers of chemicals to either publicly owned treatment works (POTWs) or any other disposal, treatment, storage, or recycling facility.

For use in the assessment for this report, information on the locations of facilities discharging pollutants through any of the above media streams from the years 1987 through 1995 were included.

National Sediment Inventory
This dataset describes the accumulation of chemical contaminants in river, lake, ocean, and estuary bottoms and includes a screening assessment of the potential for associated adverse effects on human and environmental health. The U.S. EPA evaluated more than 21,000 sampling stations nationwide using sediment chemistry data, chemical residue levels in edible tissue of aquatic organisms, and sediment toxicity data. Of the sampling stations evaluated, 5,521 stations were classified as Tier 1 (associated adverse effects are probable), 10,401 stations were classified as Tier 2 (associated adverse effects are possible, but expected infrequently), and 5,174 stations were classified as Tier 3 (no indication of associated adverse effects). Ninety-six watersheds were identified as areas of probable concern for sediment contamination. U.S. EPA believes that these watersheds represent the highest priority for further ecotoxicological assessments, risk analysis, temporal and spatial trend assessments, contaminant source evaluation, and management action because of the preponderance of evidence in these areas (although further evaluation is necessary). Also see the related report entitled the *Incidence and Severity of Sediment Contamination in Surface Waters of the United States, Volume 1, National Sediment Quality Survey* (EPA 823-R-97-006, **http://www.epa.gov/OST**) that was published in September 1997.

Stations monitoring for sediment chemistry data, chemical residue levels in edible tissue of aquatic organisms, and sediment toxicity data were used for the inventory. For this report, information on monitoring station locations, monitoring agency, and type of sampling conducted (i.e. sediment chemistry or biotoxicity/tissue residue).

U. S. Geological Survey Gage Stations
This dataset contains the locations and summary data from USGS stream gaging stations. The gage data were retrieved from the Gage File database. These stations are used primarily to collect continuous stream flow and water level information on target waterbodies. Only gage locations were used in this report.

Aerometric Information Retrieval System (AIRS)
The AIRS system inventories and summarizes air pollutant data from air monitoring stations throughout the United States. The system is funded and maintained by U.S. EPA Office of Air Quality Planning and Standards (OAQPS). The system contains information about and from stations that monitor the following criteria pollutants:

CO - carbon monoxide (gas)
NO2 - nitrogen dioxide (gas)
O3 - ozone (gas)
SO2 - sulfur dioxide (gas)
PB - lead (a constituent of particulate matter)
PM10 - particulate matter (particles smaller than 10 micrometers)

Additionally, AIRS data includes emissions estimates for two more pollutants:

PT - particulate matter (total, all particle sizes - reported in lieu of PM10)
VOC - volatile organic compounds (precursors that can lead to the formation of ground level ozone)

Data on site locations and pollutant monitored were extracted for use in this report.

National Oceanic and Atmospheric Administration (NOAA) Weather Stations and Weather Data Management (WDM) Sites
This data set provides a location map in ARCVIEW Shapefile format of weather stations and WDM stations for the entire United States and U. S. territories. The spatial data was prepared from the National Climatic Data Center Hourly Precipitation database available from EarthInfo, Inc. (**http://www.earthinfo.com/earthinfo/**). The shapefile is prepared and distributed by U.S. EPA regions or states. Information on site locations of weather stations was used for this report.

Fish and Wildlife Consumption Advisory Database
The 1996 update for the database, *Listing of Fish Consumption Advisories*, is now available from the U.S. Environmental Protection Agency. This database includes all available information describing state-, tribal-, and federally issued fish consumption advisories in the United States for the 50 states, the District of Columbia, and four U.S. Territories, and has been expanded to include the 12 Canadian provinces and territories. The database contains information provided to U.S. EPA by the states, tribes, and Canada as of December 1996. This includes advisories issued by several Native American tribes.

The number of advisories in the United States rose by 453 in 1996 to a total of 2,193 representing a 25 percent increase over 1995. The number of waterbodies under advisory represents 15 percent of the nation's total lake acres and 5 percent of the nation's total river miles. In addition, 100 percent of the Great Lakes waters and their connecting waters and a large portion of the nation's coastal waters are also under advisory. The number of advisories in the United States increased for four major contaminants (mercury, PCBs, chlordane, and DDT). In 1996, the U.S. EPA contacted health officials in Canada in an effort to identify fish consumption advisories in effect. In Canada, a total of 2,617 advisories were in effect in 1996. All of the Canadian advisories resulted from contamination from five pollutants: mercury, PCBs, dioxin/furans, toxaphene, and mirex. Ninety-six percent of all the advisories resulted from mercury contamination in fish tissues. In addition, 87 percent of the advisories were issued by the provinces of Ontario and Quebec. Information on the location of advisories, species affected, and flagged pollutants were used in this report.

Lake Michigan Mass Balance (LMMB) Monitoring Sites
This is an unpublished dataset that contains information on sites providing information for the Lake Michigan Mass Balance Project. Information includes locations, and purposes for sampling stations, project names and organizations, and indicators analyzed. The information is contained in three separate datasets, and linkages are based only on project names. Data quality is undefined. Information for this report was extracted from this dataset for monitoring locations, media and pollutants monitored, and organizations conducting the monitoring. The sample data itself has been quality assured and is available upon request from GLNPO.

National Water Quality Assessment Monitoring Sites (NAWQA)
This dataset includes the monitoring stations used in the Western Lake Michigan Drainages study unit for the NAWQA program. Information was collected through the study unit's online database, found through **http://wwwdwimdn.er.usgs.gov/nawqa/index.html**. Information included station identification, location, and flags for one of four types of monitoring conducted: surface water, ground water, sediment and tissue, and biological. More extensive data can also be obtained from this site, including parametric measurements.

Additional Federal/State Datasets

Several monitoring data sets were discovered just prior to final publication of this report. Discussion and general analysis of these sets have been included in the report, but in the interest of time, geographic analysis of monitoring site locations was not completed. Geographic locations of monitoring stations in these data sets will be included in the online version of the monitoring inventory when it is released. General information on these data sets are included below.

Regional Toxic Air Emissions Inventory
This is a multijurisdictional inventory of point, area, and mobile sources of toxic air emissions that have the potential to impact environmental quality in the Great Lakes basin. This initiative was undertaken through an intergovernmental partnership involving the eight Great Lakes states, the province of Ontario, and the U.S. Environmental Protection Agency (U.S. EPA). The objective of this ongoing initiative is to present researchers and policy makers with detailed, basin wide data on the source and emission levels of 82 toxic contaminants. Source and emission levels are projected by each state or province using the *Regional Air Pollutant Inventory Development System (RAPIDS).* The most recent inventory report uses 1996 data and can be found at: **http://www.glc.org/air/1996/1996.html**.

Integrated Atmospheric Deposition Network (IADN)
The Integrated Atmospheric Deposition Network is a joint effort of the United States and Canada to measure atmospheric deposition of toxic materials to the Great Lakes. This network includes a number of stations throughout the Great Lakes, but only one is found in the Lake Michigan basin at Sleeping Bear Dunes National Lakeshore. This station monitors for PCBs, chlorinated pesticides, PAHs, and trace metals in air and precipitation. This site was also included in the analysis of the Lake Michigan Mass Balance Project. Please see discussions on that program for more details.

Sea Lamprey Assessment
Through the Great Lakes Fishery Commission, the Sea Lamprey Integration Committee (SLIC) was established to monitor and control Sea Lamprey infestation throughout the Great Lakes. The Sea Lamprey Assessment Task Force within SLIC establishes plans for monitoring to assess the extent of infestation. In general, tributaries of the Great Lakes systematically are assessed for abundance of sea lamprey larvae (quantitative surveys) and distribution (qualitative surveys) to determine when and where lampricide

treatments are required and effectiveness of past treatments. Results of these assessments are published in annual reports.

***R/V Lake Guardian* Sampling**

The U.S. EPA's Great Lakes National Program Office (GLNPO) annually tours the Great Lakes and samples for phyto- and zooplankton at specified locations. The *R/V Lake Guardian* is used to conduct sampling tows at different depths to obtain data on changes in plankton populations. In addition, the vessel takes a set of standard baseline measurements including conductivity, temperature and depth.

Lakewide Assessment Plan for Lake Michigan Fish Communities

This plan was developed through the Great Lakes Fishery Commission (GLFC) by Departments of Natural Resources from Wisconsin, Michigan and Illinois, as well as the USFWS and USGS-BRD. The plan establishes guidelines for annual sampling of lake trout, chinook salmon, and burbot populations throughout Lake Michigan. For lake trout and burbot, six sampling sites are randomly selected from within eleven regions each year for a total of 66 sampling locations. For chinook salmon, randomly-selected sites are selected along the length (south to north) of the lake in the spring and summer, with 22 sites selected in each season.

Status and Trends of Prey Fish Populations in Lake Michigan, 1999

This report from the USGS Great Lakes Science Center details the monitoring and findings related to sampling of prey fish populations through 1999. The surveys are performed using standard 12-meter bottom trawls towed along contour at depths of 9 to 110 m at each of seven to nine index transects. Information is collected on abundance, species composition, population characteristics, and general fish health.

3. Inventory Results

The ultimate result of nearly one year's work by the GLC, 14 local tributary groups, and other stakeholders, this report represents an inventory of ecological monitoring projects throughout the Lake Michigan basin. The results that follow originate from two basic sources — the survey data, and a supplementary search of relevant datasets. All data is combined into analyses for each of the 14 tributaries, as well as one for the open waters of Lake Michigan.

General Survey Results

Altogether 334 surveys were returned from efforts made by local groups and the GLC. Agencies from all levels of government (federal, state, and local), as well as business, academic, and volunteer organizations from diverse regions of the basin participated in this survey, and added their information to the inventory. Of the responses, 63 percent of the projects primarily monitor water, 5 percent monitor land, 2 percent monitor air, 3 percent monitor soils, 18 percent primarily monitor biota or wildlife, and 9 percent primarily monitor other media (see Figure 2). See specific watershed chapters for discussions about general monitoring characteristics. The frequency of monitoring broke down as follows: daily – 6 percent, weekly – 8 percent, monthly – 10 percent, semiannually – 12 percent, annually – 16 percent, other – 48 percent. Projects staffed the monitoring as follows: paid staff – 65 percent, volunteers – 17 percent, students – 11 percent, other – 7 percent (see Figure 3). The number of staff on monitoring projects range from one to 1000, with the median equal to three people. Nearly 93 percent of the programs provide some sort of training to staff. Budgets for the monitoring projects surveyed range from zero to $12 million, with a median budget of $15,000. Nearly 63 percent reported that funding for the monitoring project was relatively reliable.

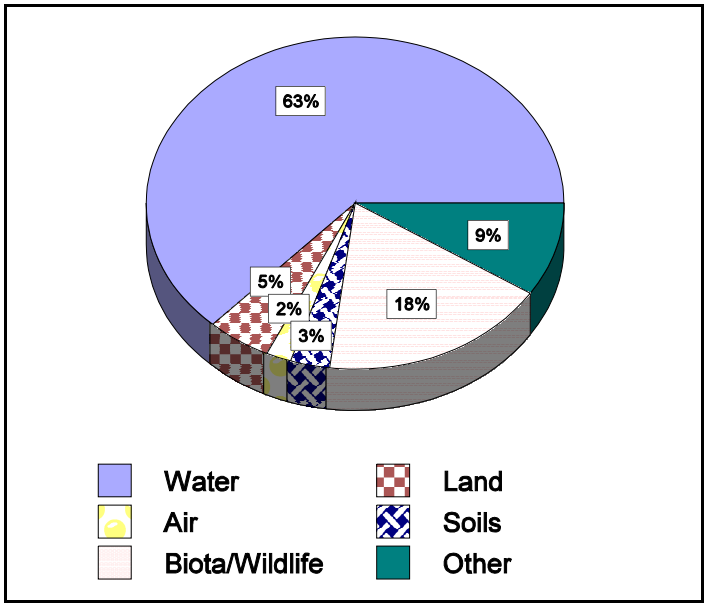

Figure 2. Proportion of survey responses by the primary medium monitored.

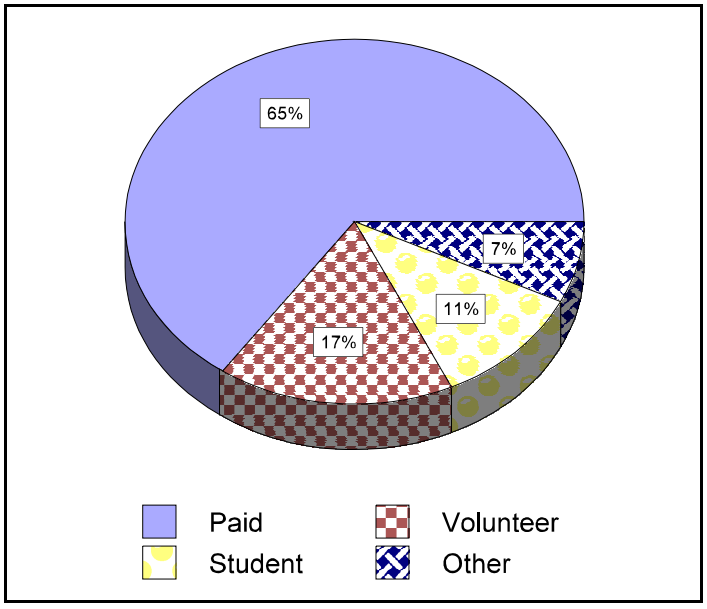

Figure 3. Proportion of survey responses by the type of monitoring staff.

Results Framework

The following chapters contain the analysis of inventory results for all 14 tributaries and the open waters of Lake Michigan, as well as generalized projects which cover multiple watersheds. The chapters are segmented as follows:

- Background
- LaMP pollutants
- Nutrients and bacteria
- Meteorological and flow monitoring
- Sediments
- Fish contaminants, fish health, and aquatic nuisance species
- Benthos monitoring
- Air monitoring
- Wildlife monitoring
- Land use
- Local assessment

Information in the background and local assessment sections was provided by the project participants, with editing by GLC to establish a continuity of flow. The other results-based sections contain integrated information from local project participant surveys, GLC surveys, and external datasets. Where possible, data is geographically displayed. However, each section discusses all monitoring projects, including those for which no specific geographic information was available.

4. Grand Traverse Bay

Background

The Grand Traverse Bay Watershed is located in northwest lower Michigan along the eastern shore of Lake Michigan. The Grand Traverse Bay Watershed is the drainage basin for Grand Traverse Bay and is 973 square miles. The two principal river systems are the Boardman River and the Elk River. The Elk River delivers 60 percent of the surface water flow, and the Boardman delivers 30 percent. The remaining 10 percent of surface water flow to Grand Traverse Bay comes from 13 small tributaries. Groundwater is the source for 95 percent of the tributary discharge to the bay.

The Grand Traverse Bay Watershed contains the following major drainage basins[1]:

Drainage Basin	Area (sq. miles)	Major Waterway
1. Elk River Chain of Lakes	491	Chain of Lakes
2. Boardman River	279	Boardman River
3. Mitchell Creek	14	Mitchell Creek
4. Acme Creek	13	Acme Creek
5. Tobeco Creek	10	Tobeco Creek
6. Yuba Creek	8	Yuba Creek
7. East Bay shoreline	55	Antrim Creek, springs, feeder streams
7. West Bay shoreline	73	9 small tributaries
8. Old Mission Peninsula	30	Springs and feeder streams
	973 sq. miles	

Total Drainage Basin Area (sq. miles):	973
Grand Traverse Bay Surface Water Area:	263

The area of the watershed (drainage basin) surrounding the bay relative to the bay's surface area is an important factor in assessing the impact from the watershed to the bay. The drainage basin / bay surface ratio for Grand Traverse Bay (973/263) is 3.7. For every square mile of the bay's surface area there is 3.7 square miles of watershed land surface.

Land use in the Grand Traverse Bay Watershed is predominately forest (49 percent) and agriculture (20 percent). The other land use cover types are open shrub/grasslands (15 percent), water (9 percent), wetlands (1 percent), and urban (6 percent).

Of the five counties located in the Grand Traverse Bay Watershed, Grand Traverse, Leelanau, and Antrim counties are "hot spots" of population growth in the Great Lakes region. Each county is forecasted to increase its population by 20 percent from 1988 - 2010. The counties throughout the Great Lakes basin expected to grow at the fastest rate are located almost exclusively on the shores of Lake Michigan and Lake Superior.

Status of Watershed Management Efforts in the Study Area

Of the eight major sub-basins in the Grand Traverse Bay Watershed, watershed protection plans have been developed for the following five sub-basins: Mitchell Creek, Acme Creek, Yuba Creek, Elk River Chain of Lakes, and Boardman River. A watershed protection plan will be developed for the West Bay basin along

eastern Leelanau County shoreline during 2000 - 2001. The following impacts and pollution sources have been identified for the sub-basins:

Mitchell Creek

Stormwater runoff from recreational, urban, industrial, and agricultural sites is potentially a large source of pollutant input to Mitchell Creek. Excess sedimentation is altering the fish community in Mitchell Creek due to loss of fish spawning beds and aquatic insect habitat. Thermal impacts to the waterway are occurring from loss of riparian shading, runoff from impervious surfaces, and poorly designed detention basins. Uncontrolled development of the basins critical recharge areas (wetland and upland) will impact the basin's hydrology and could result in negative economic and ecological consequences.

A watershed protection plan has been developed for the Mitchell Creek basin. Recommendations contained in the plan have been incorporated into land use master plans for Acme Township and East Bay Township located in the basin. Watershed protection projects implemented in the basin include construction of storm water retention basins, agricultural and golf course best management practices (BMPs) to protect water quality, and educational outreach to watershed homeowners.

Acme and Yuba Creeks

The most significant water quality and quantity impacts are from sedimentation, nutrient loading from golf courses, residential and agricultural lands, and storm water runoff from increased impervious surfaces. A watershed protection plan has been developed for the Acme Creek watershed.

Elk River Chain of Lakes

The major problems in this sub-basin include inadequate and poorly sited septic tanks and sewage pollution entering waterways and groundwater; loss of wetlands, natural areas, and open space; runoff from lawn fertilizers, golf courses, and agriculture; erosion and sediment from new construction and road stream crossings; and impacts from oil, gas, and brine wells, and leaking underground storage tanks. A watershed protection plan has been developed for the Elk River Chain of Lakes basin. Implementation projects include a shoreline survey of property along the Chain of Lakes to identify shoreline conditions and sources of nutrient loading, soil erosion control projects, and educational outreach to watershed residents.

Boardman River

More than 600 erosion sites have been identified along the 130 miles of the Boardman River riverbank. 100 sites have been stabilized to reduce sediment loading into the river. A survey of erosion sites along the Boardman River has been completed. Implementation projects include riverbank stabilization and restoration, sediment traps, fish habitat restoration, improvements to stream/road crossings, and educational outreach.

Grand Traverse Bay Watershed Initiative Water Quality Monitoring Plan

Representatives of GTBWI partner organizations involved with regular water quality monitoring efforts developed specific program outlines for each of the three principal water body types in the watershed: the bay, tributaries, and inland lakes. For each water body type, key parameters and programs goals have been identified.

Pollutants of Concern

Aquatic Monitoring

Figure 4 illustrates the coverage of water quality stations in the watershed that monitor for the LaMP pollutants of concern. This indicates that, of the pollutants of concern, mercury has the best coverage in the watershed. Mercury stations are located at the mouths of all the major Lake Michigan tributaries, as well as

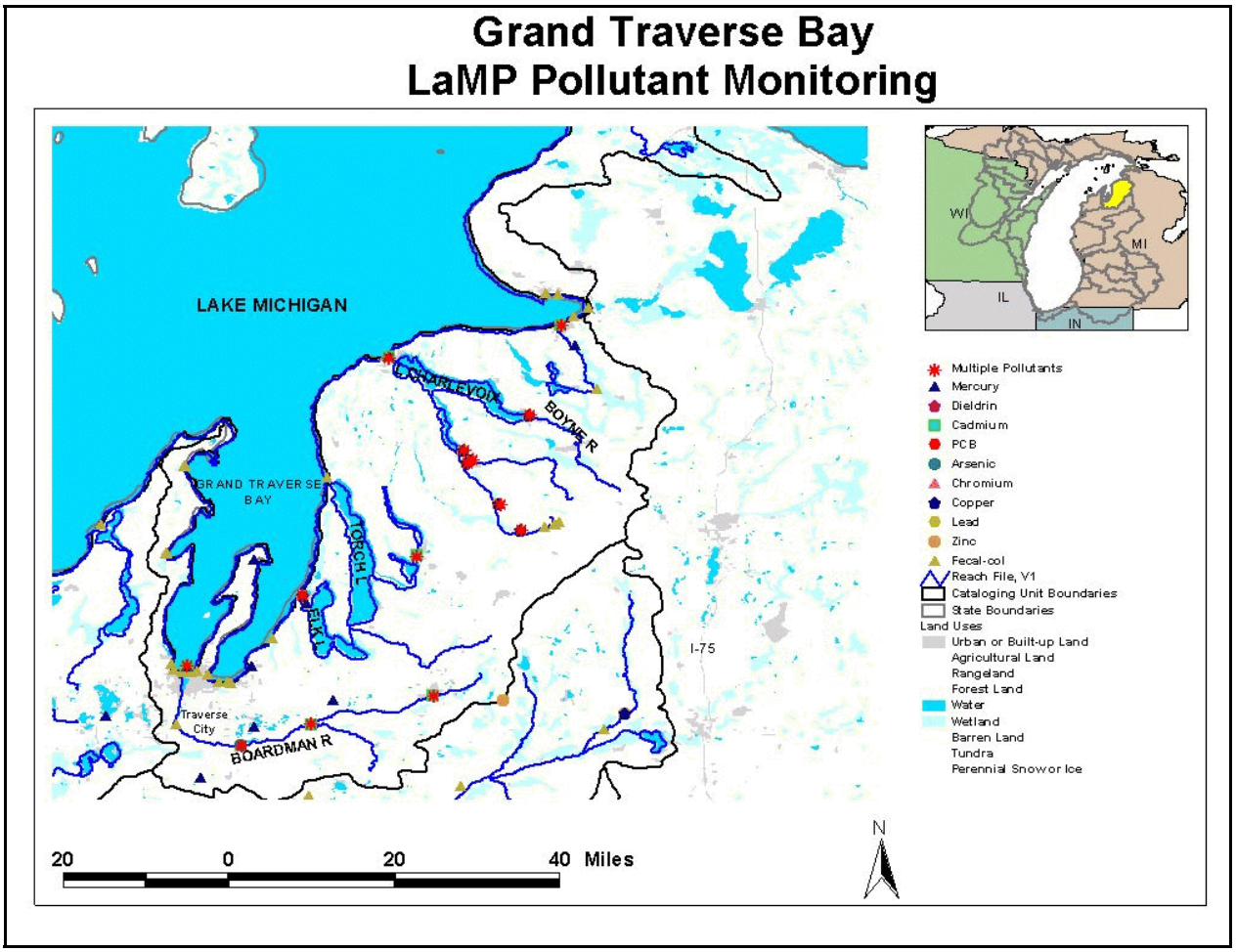

Figure 4. Grand Traverse Bay watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

along the Boardman River. Arsenic stations exist only on the Boardman River. Stations monitoring cadmium have coverage equal to that for mercury. Chromium is only monitored at the mouth of the Boardman. Copper and zinc stations are also located at the mouth of all major tributaries, as well as numerous locations upstream. Lead stations are located at the mouths of the Boardman and Charlevoix Rivers as well as upstream on both of those reaches. No stations were located for DDT, chlordane, dieldrin, PCB, dioxins, furans, HCB, toxaphene, PAHs, atrazine, or selenium.

Organizations monitoring for these pollutants include the Water Resources Division of the U.S. Geological Survey (mercury only) and the Michigan DEQ. Local surveying for this project focused on the main tributaries to the Grand Traverse Bay, while the more general analysis covered the entire Grand Traverse watershed. Several surveys were returned that indicated additional water quality monitoring is occurring, but none of these indicated monitoring for critical, concern, or emerging pollutants.

Pollutant Release Monitoring

An examination of Permit Compliance System and Toxic Release Inventory monitoring locations indicates a prevalence of monitoring for potential pollution sources in Traverse City at the mouth of the Boardman River (see Figure 5). However, only a few sources in the watershed reported releases of LaMP pollutants. The pollutants released from these sources include mercury, cadmium, chromium, copper, cyanide, lead, and zinc.

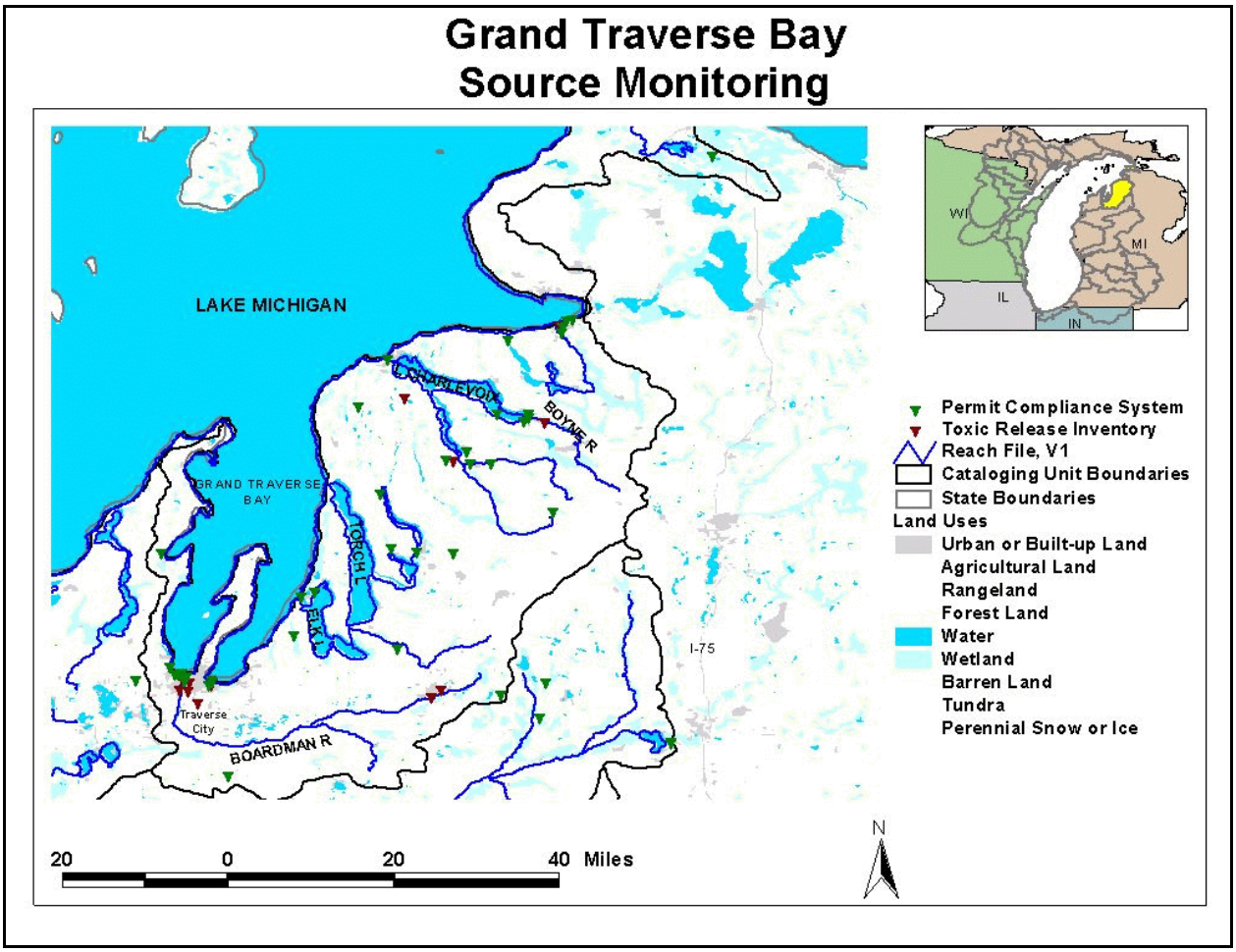

Figure 5. Grand Traverse Bay watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

Nutrients and Bacteria

Most of the additional water quality stations illustrated in Figure 4 measure for some form of nitrogen and phosphorus. These sites cover all the tributaries to Lake Michigan, as well as most of the upper stream reaches and inland lakes. Organizations monitoring for these nutrients include the BSFWD, the U.S. EPA, USGS-WRD, the Eastern Lake Survey, Grand Traverse Band of Ottawa and Chippewa Indians and MDEQ. In addition, our returned surveys indicated other groups were monitoring for nutrients, as well as several minerals, in the watershed.

An examination of the bacteria station database reveals that there is good monitoring coverage for fecal coliform, but not for *E. coli* (see Figure 4). Fecal coliform stations exist at all the major inputs to Grand Traverse Bay and greater Lake Michigan, as well as numerous locations along the Lake Michigan shore. There are also a number of stations upstream on the major tributaries in the watershed. Agencies collecting this fecal coliform data include BSFWD (4 stations), and MDEQ (50 stations). In addition, the Northwest Michigan Community Health Agency returned a survey indicating that they monitor for fecal coliform along beaches throughout the watershed. No *E. coli* stations were indicated in the national database, but one survey was returned indicating *E. coli* coverage. According to this survey, Michigan State University maintains

stations monitoring for *E. coli* on 80 streams in the watershed and 25 ground water wells in Grand Traverse County.

Meteorological and Flow Monitoring

USGS maintains four gage stations in the watershed to measure various physical characteristics of streams (see Figure 6). These are located at the mouth of the Elk, and on the Boardman, Jordan and Boyne Rivers. These stations measure flow rates and other physical qualities of the rivers. Our survey also indicated that there are several other groups in the watershed that monitor for physical stream conditions. Properties measured include stream discharge (flow), temperature, pH, alkalinity, dissolved oxygen, turbidity and bottom characteristics/habitat. Areas covered for these characteristics range from specific sites around Grand Traverse Bay to unspecified locations throughout the watershed.

Two NOAA weather stations were located in or near the watershed. An NCDC Weather Data Management station is located in Traverse City, and an additional station is located in the Fife Lake State Forest, just outside the watershed boundary. These stations measure continuous precipitation data, as well as other meteorological data. No returned surveys revealed further meteorological monitoring.

Sediments

Our examination of the National Sediment Inventory and surveys returned from throughout the basin reveal a lack of monitoring of sediments in this watershed or Grand Traverse Bay.

Fish Contaminants, Fish Health, and Aquatic Nuisance Species

As discussed earlier, we have been unable to find specific locational information (such as sampling locations) for programs monitoring fish populations, their health or tissue contaminants. However, surveys indicate that the Surface Water Quality Division of MDEQ conducts fish surveys at 26 trend sites throughout Michigan, and MDNR also conducts trend monitoring for fish species throughout Michigan's inlands lakes and streams. A search of the Fish and Wildlife Advisory database on Grand Traverse Bay, Charlevoix, Elk and Torch Lakes, and Boardman and Boyne Rivers revealed fish consumption advisories for Torch Lake. The advisories were all state issued and relate to mercury levels in smallmouth bass, walleye, sauger, and lake trout, as well as chlordane levels in lake trout.

Similarly, no programs we discovered claimed to be monitoring for aquatic nuisance species within the Grand Traverse Bay watershed.

Benthos Monitoring

No specific locational information was discovered for state or national programs monitoring benthic organisms. However, returned surveys suggest that several organizations are monitoring benthic organisms in the watershed. MDEQ lists a program that monitors for benthic health in inland waters throughout the state for long-term study. In addition, the Grand Traverse Bay Watershed Initiative monitors benthic organisms along the Grand Traverse Bay shoreline, and the office of the Grand Traverse County Drain Commissioner monitors benthics in sub-watersheds of East Grand Traverse Bay.

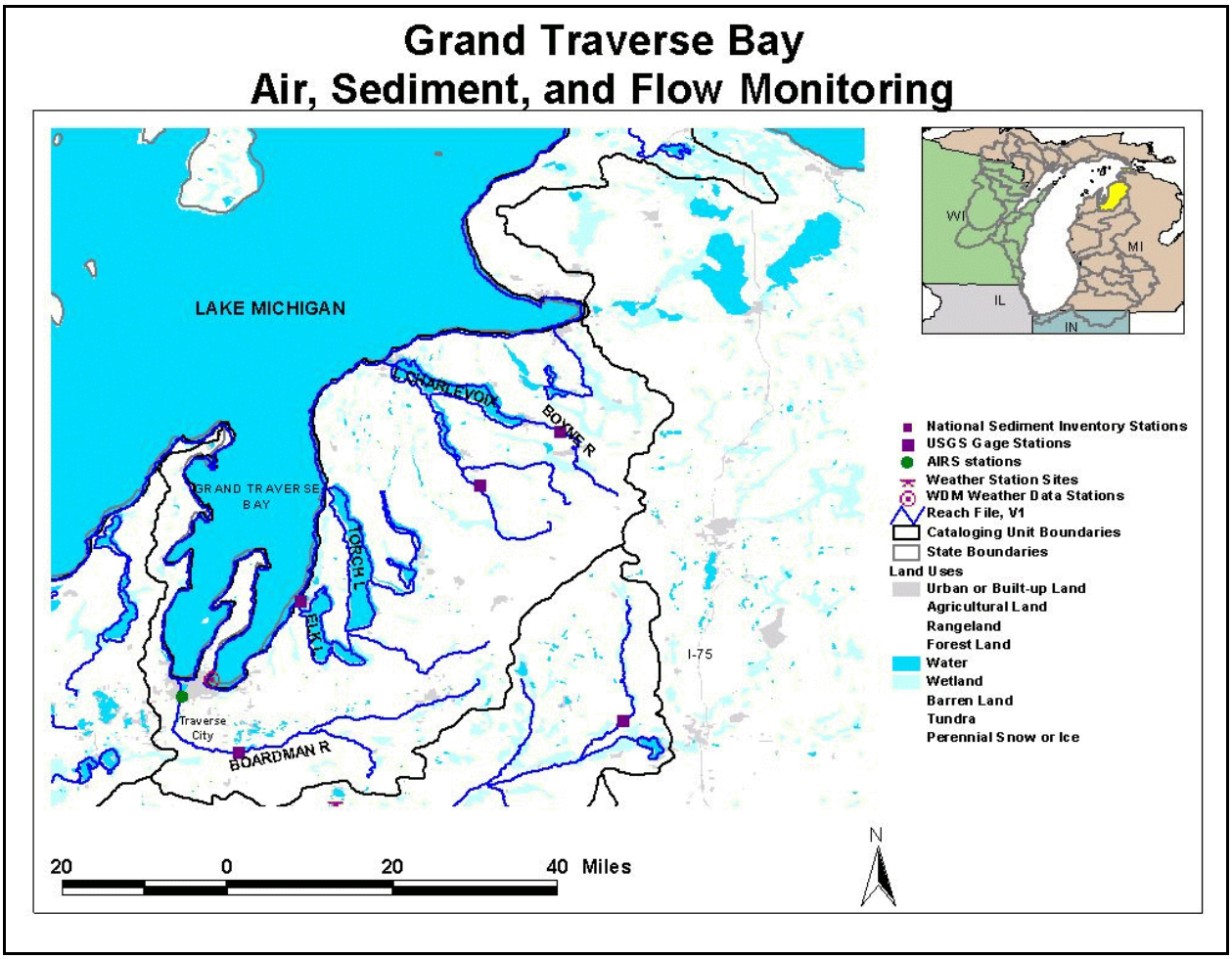

Figure 6. Grand Traverse Bay watershed with USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

Air Monitoring

Figure 6 illustrates the location of the one air monitoring station in the watershed, according to the AIRS database. This station is located in Traverse City and monitors for low-level ozone. A returned survey also indicates that the American Lung Association maintains a station monitoring low-level ozone in Traverse City. However, it is possible that this is the same station included in the AIRS database.

Wildlife Monitoring

Several organizations are likely monitoring specific wildlife species in the watershed. These include the USFWS, and the MDNR. However, USFWS did not return a survey, and the MDNR did not list species monitored. It is known, however, that MDNR monitors populations of game species throughout the state, and that MDNR and USFWS both monitor endangered species in a variety of locations. Additionally, the Grand Traverse Band of Ottawa and Chippewa indicate that they monitor wildlife populations and their habitat on their ceded territory in the watershed, and the Conservation Resource Alliance generally monitors wildlife corridors in the watershed.

Land Use

Developed (urbanized) and wetland land uses/landcovers for the watershed are displayed in the previous maps. The coverages illustrate that there is relatively little development throughout the Grand Traverse Bay watershed. The only substantial development is Traverse City. However, there are also smaller developments along the shores Lake Michigan, and other inland lakes and streams. The land-use maps also show extensive wetlands throughout the watershed. ? indicates that, while there are a number of monitoring stations located in inland lakes and along rivers and streams, there are few stations in wetlands.

Local Assessment

Use of Monitoring Results for Local Watershed Management
The use of monitoring results for local watershed management predominately occurs during the initial stages of developing a watershed protection plan. Monitoring data is typically collected and compiled during the natural resource inventory and assessment stages of watershed protection planning. The data is used to present the watershed's hydrology and identify impaired uses.

The Grand Traverse County Drain Commissioner's Office is collecting water quality data for purposes of conducting a comparative analysis of best management practices in two adjacent sub-basins in the Mitchell Creek watershed. The purpose of the study is to try and discern if implemented BMPs result in measurable improvements in water quality compared to a basin without similar BMPs.

Monitoring results are being used on a "project by project" basis within individual sub-basins in the Grand Traverse Bay Watershed. Examples of watershed projects may include remediation of a groundwater contamination site, soil erosion control at stream/road crossings, use of buffer strips along waterways or inland lake shoreline, soil erosion control at public access sites or stream banks, education purposes for student programs. Monitoring is also conducted by local agencies (health departments, water and wastewater treatment plants) to ensure public safety (safe drinking water, body contact at public swimming beaches) and meet wastewater discharge standards.

Monitoring Designated Use Impairments
There is limited ongoing monitoring of designated impaired uses. Groundwater pollution impairs the use of groundwater for potable water. Monitoring of tributaries and inland lakes primarily focuses on nutrient loading and the adverse impact on water quality and aquatic ecology. No ongoing monitoring of sediment loading and the loss of fish and aquatic insect habitat is being conducted. There is limited monitoring of public swimming beaches to record ambient bacterial levels in near shore waters. A comprehensive list of impaired uses by watershed basin and relevant monitoring has not been compiled.

Gaps and Needs of Monitoring Programs
There is a wide range in budgets, staff training, and application of monitoring results between respondents. Organizations such as power utilities and water treatment plants conduct monitoring as part of their daily operations and results are used for management purposes. Other monitoring programs are conducted and completed as part of a grant funded project. Some organizations conduct monitoring on a fee-for-service basis. Lake associations typically rely on trained volunteers to conduct water clarity readings and collect grab samples for analysis of total phosphorus. Lake associations will contract for services to have comprehensive monitoring conducted on their lake.

There is minimum monitoring of sediment loading to tributaries although sediment loading is a significant impairment to designated uses of waterways.

Duplicative Monitoring Programs
No duplicative monitoring programs were identified from the survey results. In a few cases respondents are monitoring similar waterways but different parameters. For example, on the Boardman River, the Grand Traverse Conservation District monitors erosion sites along the riverbank, students conduct field water quality test at selected river stations, Traverse City Light and Power monitors river flow, and Michigan State University is conducting field research on selected chemical and bacterial water quality parameters.

Utilization and Dissemination of Monitoring Results to Support Watershed Management
The monitoring results are used for specific research and project tasks. Monitoring results are currently being used in a limited manner to support ongoing watershed protection and implementation programs. Many private nonprofit organizations that conduct monitoring often have limited staff and financial resources to compile, analyze, and report the data in an ongoing and systematic manner.

Opportunities for Coordination of Monitoring Programs
The Grand Traverse Bay Watershed Initiative office schedules an annual meeting with representatives from organizations that conduct water quality monitoring in the basin. The meeting is an opportunity for exchange of program information and monitoring results. The meeting is held at the start of the year.

GTBWI is establishing a water quality database for historical and current water quality data. The database will contain data for Grand Traverse Bay, tributaries, and inland lakes. Data will be categorized according to the level of QA/QC used by the organization. Categories will consist of scientific, trained volunteers, and student collected data. The database will be integrated with geographical information systems software (GIS) and accessible over the Internet. It is hoped that as the database becomes operational it will foster greater coordination and networking among organizations conducting monitoring.

5. White Lake and Muskegon Lake

Background

This study area includes the Muskegon and White River watersheds in Michigan, with a focus on the Muskegon and White Lake Areas of Concern in Muskegon County. White Lake is a scenic, four square-mile drowned-river mouth lake in Muskegon County. It lies along the east shore of Lake Michigan and flows into Lake Michigan through a channel. White Lake was designated an AOC in 1985, primarily because of contaminated groundwater migrating to the lake from the site of the Occidental Chemical Corporation located less than a mile from the lake. The White Lake AOC is part of the White River watershed. The White River is the primary tributary to the lake, supplying over 95 percent of its water. The White River has approximately 121 miles of mainstream with many more miles of tributaries that comprise a 525 square-mile watershed. The river flows through Newaygo, Oceana and Muskegon Counties before emptying into White Lake. The White River has also been designated as a State Country-Scenic River under the Natural Rivers Act in 1975. Other tributaries to White Lake include Carlton Creek, Silver Creek, Buttermilk Creek, Pierson Creek, Bush Creek, Mill Pond Creek, Wildcat Creek, Birch Brook and Strawberry Creek.

In 1995, the White Lake RAP was updated with broad public involvement included in the process. The Public Advisory Council (PAC) and MDNR RAP Team identified the following impairments:

- Loss of Fish and Wildife Habitat
- Restrictions on fish and wildlife consumption
- Degradation of fish and wildlife populations
- Degradation of benthos
- Restrictions on dredging
- Restrictions on drinking water consumption – human health implications

In addition, eutrophication or undesirable algae, and degradation of aesthetics were identified as impairments by the PAC.

The Muskegon River watershed is 2,634 square-miles in area. The river begins as “Big Creek” in Roscommon County, 219 miles northeast of Muskegon Lake. The Muskegon is the second longest river in Michigan. It is considered a “cool-water river” which supports trout and salmon. However, thermal pollution is a leading threat to the Muskegon, potentially changing it from a “cool-water” river to a “warm-water” river. A major cause of thermal pollution in the Muskegon is from reservoirs created by dams. There are 95 government regulated dams in the river system. Sedimentation also causes thermal pollution and disturbs fish spawning areas as well. Causes of sedimentation in the Muskegon River include: lumbering practices in the 1800s, the flood of 1986, boat wakes, and development. The most severe erosion sites on the lower Muskegon river were surveyed by the Timberland Resource Conservation and Development Council in 1997. Through a partnership with the Muskegon Lake Public Advisory Council, the Muskegon River Watershed Assembly, the MDEQ’s Clean Michigan Initiative program, and other local sponsors, some of these sites will be restored in 2000.

Along with the river partnership, the Muskegon Lake PAC addresses impairments of Muskegon Lake AOC. In the 1960’s and early ‘70’s Muskegon Lake received millions of gallons of untreated wastewater, industrial discharges and spills from oil tankers and gas pipelines. Contaminated sediments and the loss of fish and wildlife habitat remain a serious problem for Muskegon Lake and some of its immediate tributaries. The south shoreline has been altered by logging companies and foundries that filled in marshes and wetlands with

sawdust, sand and slag. Even with these problems, the lake supports a thriving sport fishery and people continue to use the lake for recreation.

The AOC watersheds run alongside each other in Muskegon County and share other counties in their river watersheds. Many local governments and volunteer groups have an interest or jurisdiction in both the Muskegon and White Lake AOCs/watersheds. This project was carried out to cover both areas without duplication of the survey inquiries or mailings. The cover letters accompanying the surveys acknowledged whether the recipient was part of the White, Muskegon or both watersheds.

Status of Watershed Management Efforts in the Study Area

The Muskegon Conservation District carried out local surveying for this study area in conjunction with the Muskegon and White Lake AOC PACs and Muskegon River Watershed Assembly members. The Muskegon Conservation District is a partner in the White River Watershed Partnership and the Muskegon River Watershed Assembly. During the course of this project, several grant applications for non-point source planning, implementation and education funds were completed to implement recommendations of the Muskegon and White Lake AOC RAPs. The grant proposals will also meet the goals of the Muskegon River Watershed Assembly and the White River Watershed Partnership identified non-point source watershed projects. The White River Watershed Partnership formed several years ago (with the assistance of the

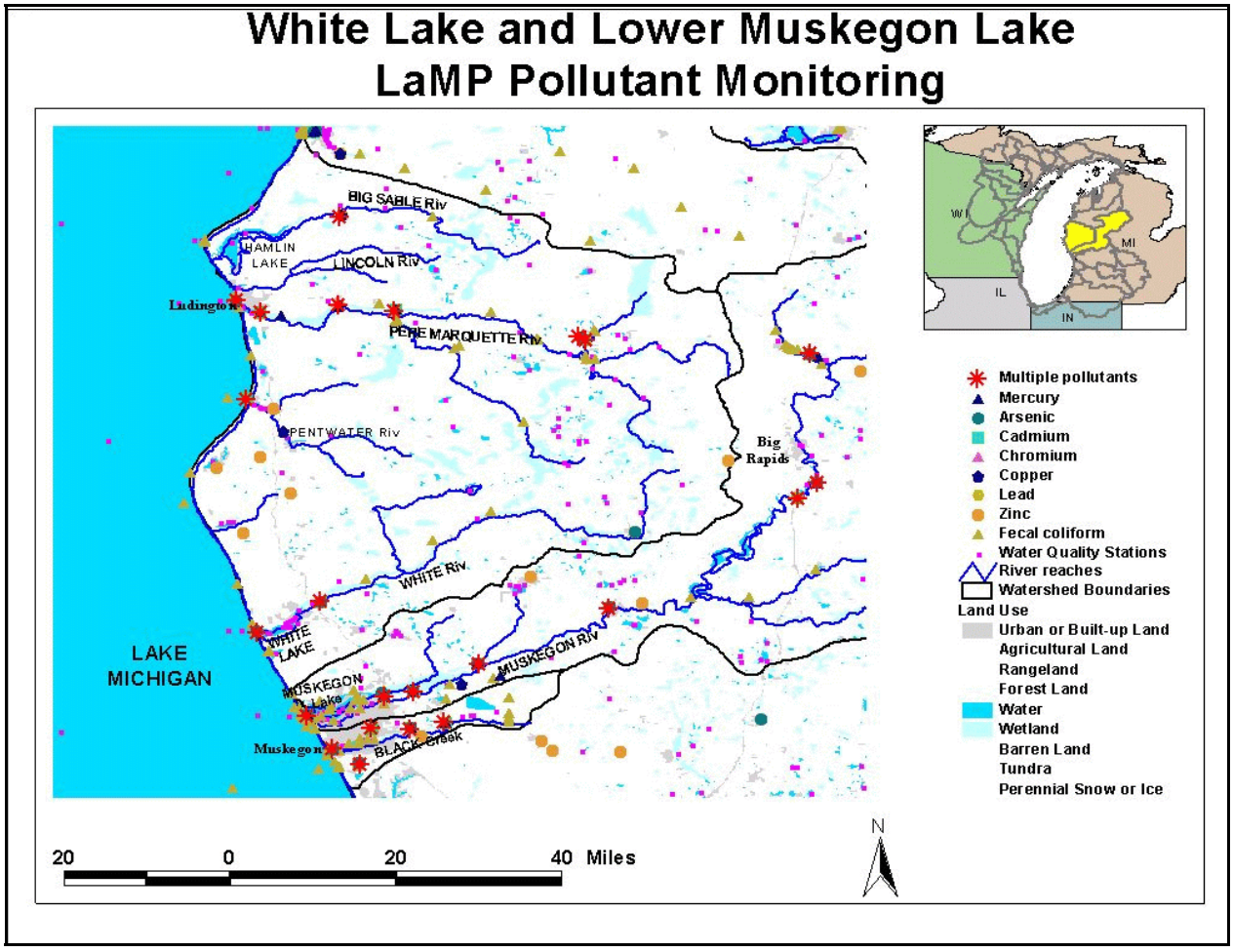

Figure 7. The western portion of White Lake and Muskegon Lake watersheds with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

Timberland Resource Conservation and Development Council). Members have met "as-needed" in order to carry out planning, streambank erosion surveys and implementation projects. The partnership includes representation from the White Lake PAC, local governments and conservation organizations. The Muskegon River Watershed Assembly was initiated two years ago and continues to meet regularly. Its membership is strong and continues to grow. Strong partnerships are in place to carry out watershed planning, monitoring, educational and implementation projects throughout both watersheds.

Pollutants of Concern

Aquatic Monitoring

Monitoring coverage for LaMP pollutants is shown in Figure 7 and Figure 8. These maps indicate that stations exist in the two watersheds for only one (mercury) of seven critical pollutants, six out of ten pollutants of concern, and none of the listed emerging pollutants. However, according to one survey, the Michigan Department of Agriculture maintains a Groundwater Stewardship Program which assists residents in monitoring their wells for atrazine, among other chemicals. Monitoring for mercury exists only on the Pere Marquette River, Black Creek and the lower and middle reaches of the Muskegon River. Stations exist

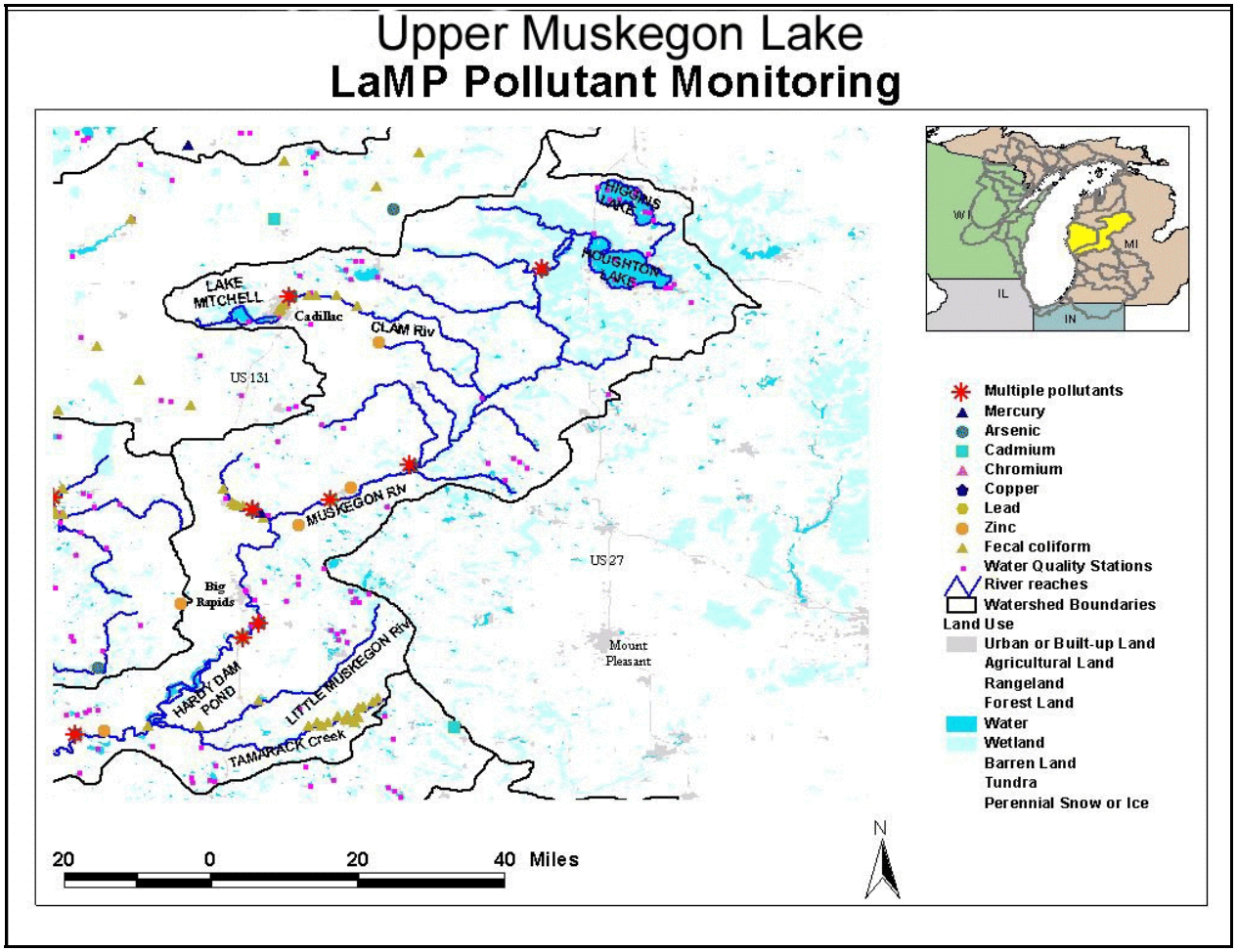

Figure 8. The eastern portion of the Muskegon Lake watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

on all the other major tributaries for the other pollutants monitored. Monitoring for zinc has the most extensive coverage in the two watersheds.

The Surface Water Quality Division within MDEQ maintains a majority of the stations monitoring for these pollutants. The only other organization monitoring for LaMP pollutants is the USGS-WRD. In addition, according to our surveys, Steel Middle School in Muskegon monitors for copper and chromium along Ryerson Creek (a tributary to Muskegon Lake), and the Muskegon Conservation District monitors for atrazine in and around Muskegon and White Lake AOCs.

Pollutant Release Monitoring

An examination of Permit Compliance System and Toxic Release Inventory reporting locations in the White and Muskegon River watersheds indicates clusters of monitoring for potential pollution sources in or near the urbanized centers of Muskegon, Ludington, Big Rapids and Cadillac (see Figure 9 and Figure 10). There are a number of other point source monitoring locations scattered throughout the watersheds, as well. However, only a small number of sources in the urban areas released LaMP pollutants into the watershed. Reported releases include mercury, DDT derivatives, arsenic, cadmium, chromium, copper, cyanide, lead, and zinc.

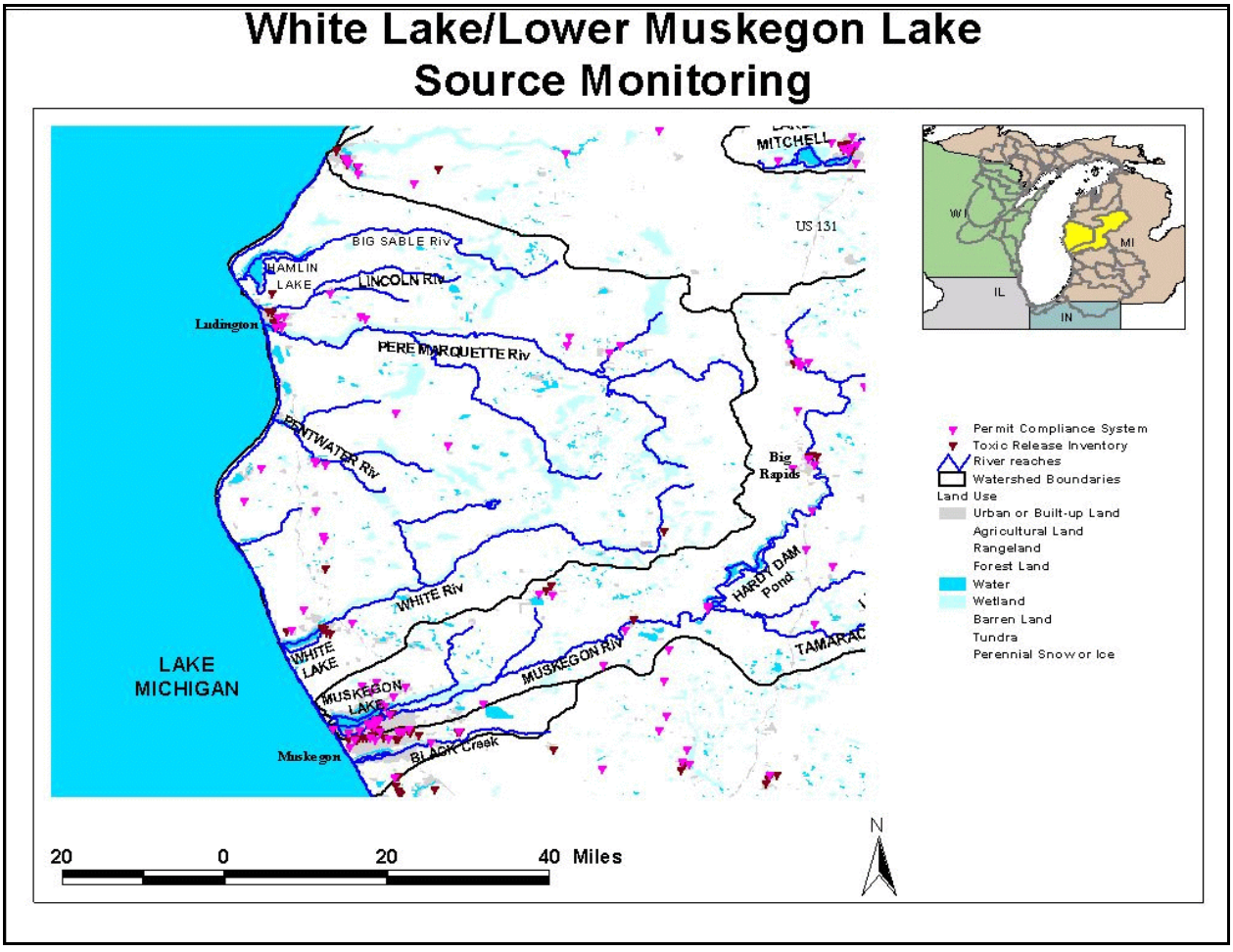

Figure 9. White Lake and Lower Muskegon Lake watersheds with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

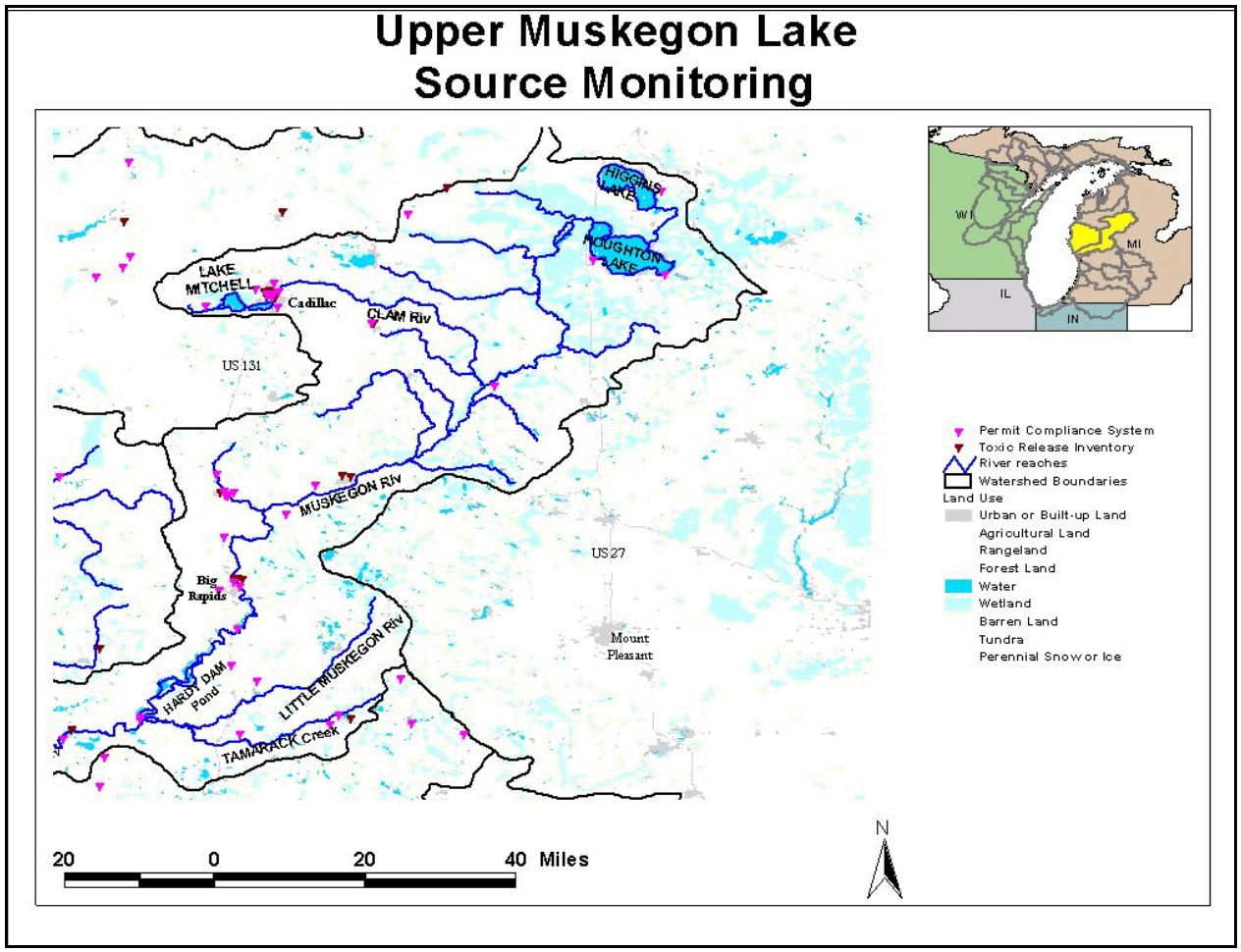

Figure 10. Upper Muskegon Lake watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

Nutrients and Bacteria

A vast majority of the 111 stations pictured in Figure 7 and Figure 8 monitor for some form of nitrogen and phosphorus, the chief nutrients impacting water quality. Over 70 percent of water quality monitoring stations measure phosphorus levels and 85 percent measure nitrogen levels. Thus, where monitoring stations exist, they are likely tracking nitrogen and phosphorus. However, the overall coverage of water quality monitoring stations indicates a gap in coverage of tributaries to the upper reaches of the Muskegon River. In addition to monitoring projects reporting through the STORET system, many of those within the White and Muskegon watersheds who responded to our survey are also monitoring for nitrogen and phosphorus.

No monitoring programs were reported to the STORET database for *E. coli* in either of the two watersheds. However, an educational project administered by Grand Valley State Water Resources Institute monitors *E. coli* in Muskegon Lake and in open Lake Michigan near Muskegon.

In contrast, fecal coliform is monitored extensively, especially along rivers in the lower sections of the watersheds. There is little coverage of the most upper reaches of the Muskegon River. Organizations monitoring for fecal coliform in the watersheds include MDNR, USGS-WRD, U.S. EPA (Region 5 – off

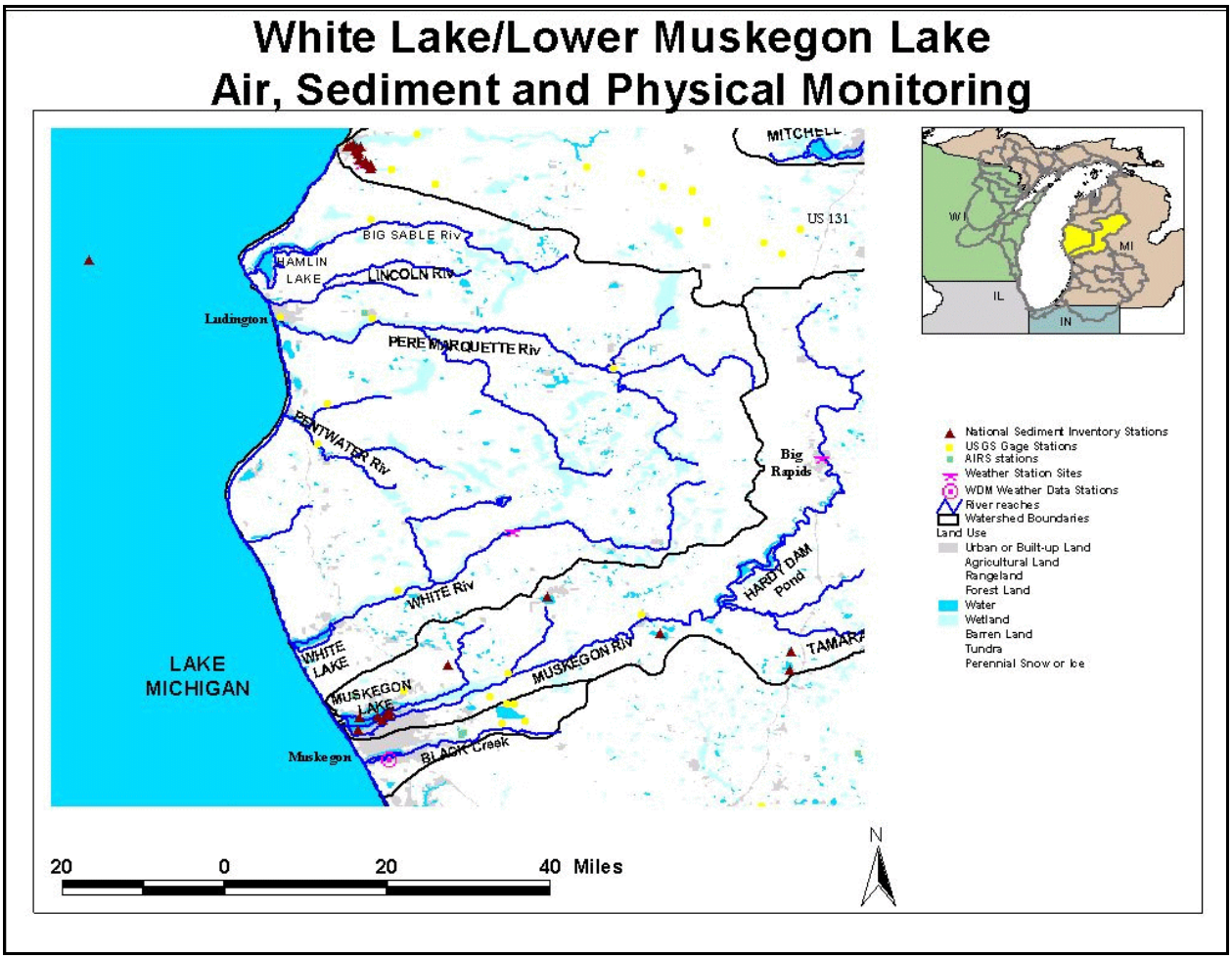

Figure 11. White Lake and Lower Muskegon Lake watersheds with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

shore sites only), USFS (Region 9), Muskegon Community College, Steel Middle School, Orchard View High School, and Whitehall High School.

Meteorological and Flow Monitoring

USGS maintains numerous gage stations in the watersheds to measure various physical characteristics of streams (see Figure 11 and Figure 12). All the major tributaries to Lake Michigan are covered with the exception of the Lincoln River. There is only one gage station on the White River, however. Our survey also indicated that there are several other groups in the watersheds that monitor for physical stream conditions. Properties measured include stream discharge (flow), temperature, pH, alkalinity, dissolved oxygen, biological oxygen demand, conductivity, clarity, turbidity, and water levels. Areas covered for these characteristics include specific sites scattered throughout the watersheds, as well as sections of counties that intersect the watersheds (including Mecosta, Newaygo, Oceana, and Muskegon counties). More focus was indicated in or near White Lake and Muskegon Lake AOCs.

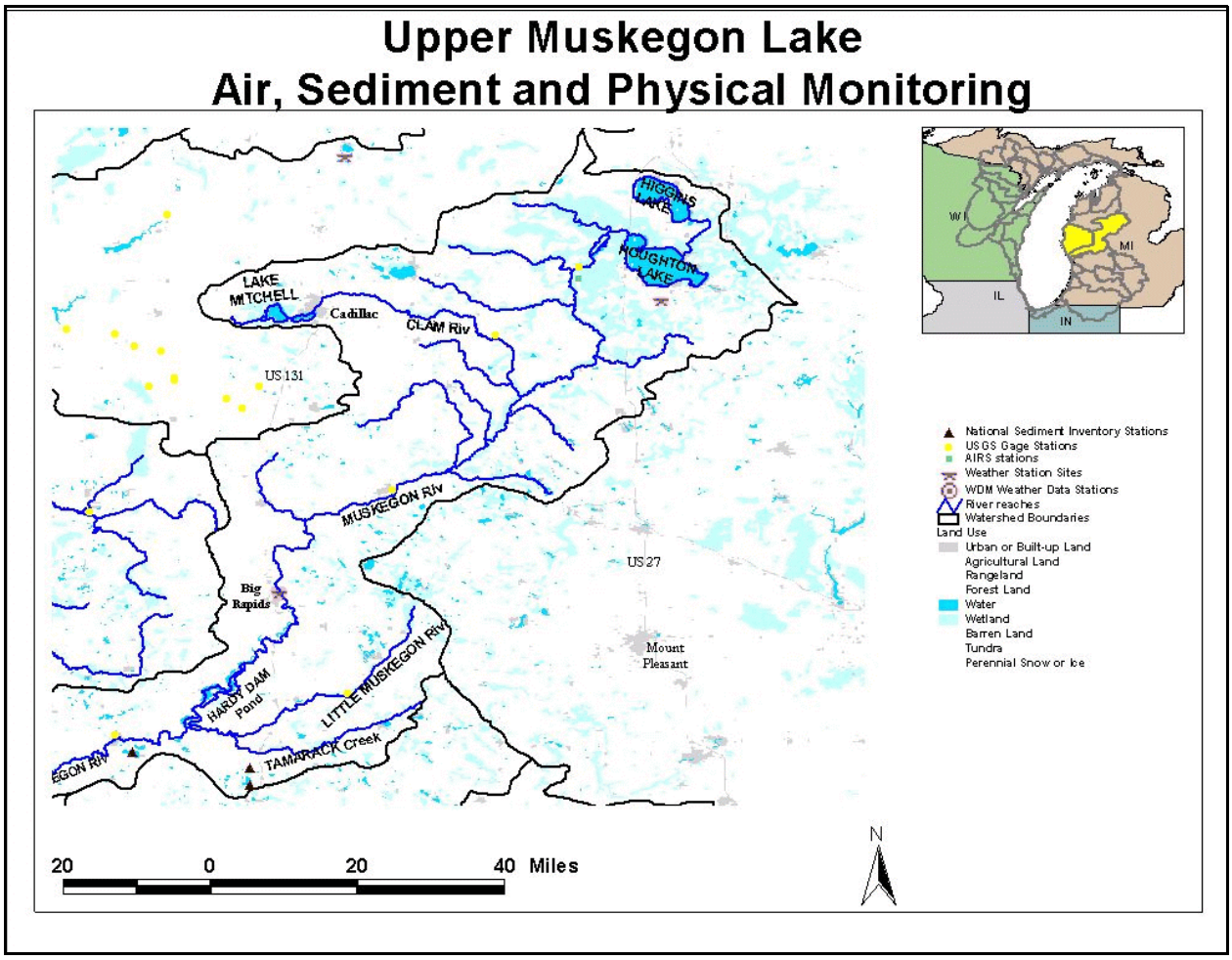

Figure 12. Upper Muskegon Lake watershed with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

One NOAA weather station exists in the White Lake watershed, while three are located in the Muskegon Lake watershed. These stations are located near Hesperia, along the White River, and at the Muskegon airport, in Big Rapids, and in the Houghton Lake State Forest. These stations measure continuous precipitation data, as well as other meteorological data. No returned surveys revealed further meteorological monitoring.

Sediments

Thirteen National Sediment Inventory sites can be found within Lake Muskegon, the Muskegon River, and in tributaries to the Muskegon (see Figure 11 and Figure 12). There are no sites located in the White Lake watershed or in other parts of the Muskegon Lake watershed. The locations within Muskegon Lake are administered by the U.S. EPA, Region 5 through their Great Lakes Surveillance Branch or as part of the National Bioaccumulation Study. Upstream locations are administered by the MDEQ Surface Water Quality Division. Of the 13 sites, ten monitor sediment chemistry. The remaining three monitor benthic organism tissue, discussed below.

Fish Contaminants, Fish Health, and Aquatic Nuisance Species

As discussed earlier, we have been unable to find specific locational information (such as sampling locations) for programs monitoring fish populations or their health. However, the National Sediment Inventory contains three sites that monitor for fish tissue contaminants in the Muskegon Lake watershed. Two of the sites are near the eastern shore of Muskegon Lake and the other is located on Cedar Creek, a tributary to the Muskegon River. The tissue at these sites is assessed for human health impacts. All three sites are maintained as part of the National Bioaccumulation Study.

However, surveys indicate that the Surface Water Quality Division of MDEQ conducts fish surveys at 26 trend sites throughout Michigan, and MDNR also conducts trend monitoring for fish species throughout Michigan's inlands lakes and streams. A search of the Fish and Wildlife Advisory database on Muskegon Lake, Muskegon River, White Lake, White River, and the Pere Marquette River revealed a fish consumption advisoriy for White Lake. The advisory was state issued and relates to PCB and chlordane levels in common carp.

Similarly, no programs we discovered claimed to be monitoring for aquatic nuisance species within the White Lake or Muskegon Lake watersheds.

Benthos Monitoring

No specific locational information was discovered for state or national programs monitoring benthic organisms. However, returned surveys suggest that several organizations are monitoring benthic organisms in the watershed. MDEQ lists a program that monitors for benthic health in inland waters throughout the state for long-term study. In addition, the Tri Lakes Association monitors benthic organisms in the Tri Lakes in Morton Township, and the office of the Grand Valley State University Water Resource Institute, through an educational program monitors benthics in Muskegon Lake and Lake Michigan outside of Muskegon.

Air Monitoring

Figure 11 and Figure 12 illustrate the location of the three air monitoring stations in the watershed, according to the U.S. EPA's AIRS database. This stations are located east of Muskegon, along the Pere Marquette River, and west of Houghton Lake. The stations monitor for low-level ozone, particulate matter, and lead.

Wildlife Monitoring

While we received no specific information from the USFWS, we learned that a local habitat biologist working for the MDNR (N.K. Kalejs) conducts various migratory waterfowl and other wildlife surveys across Muskegon, Newago, Ottawa and Kent Counties. It is also known, that MDNR monitors populations of game species throughout the state, and that MDNR and USFWS both monitor endangered species in a variety of locations. Additionally, while the Muskegon River Watershed Assembly, Ferris State University, and the Muskegon Conservation District all report to conduct some general habitat assessments, no other organizations reported to be monitoring for wildlife species.

Land Use

Developed (urbanized) and wetland land uses/landcovers for the watersheds are displayed in the previous maps. There appears to be relatively little development throughout the White and Muskegon Lake

watersheds. The main urbanized areas include Muskegon, Ludington, Big Rapids, and Cadillac. A large portion of the landscape in these watersheds is publicly managed forest land including Manistee National Forest across much of the White Lake watershed, and the Pere Marquette and Au Sable State Forests in the upper portion of the Muskegon Lake watershed.

The land-use maps show extensive wetlands throughout the upper portion of the Muskegon Lake watershed, especially west of Higgins and Houghton Lakes. Almost no monitoring is conducted in these upland forested wetlands.

Local Assessment

The Muskegon Conservation District has used the results of grant funded water quality monitoring, streambank erosion surveys and habitat assessments in developing RAP and watershed management implementation programs. Most of the educator's volunteer water quality monitoring data has been used for educational purposes, however most of these educators had related service learning and watershed conservation enhancement projects incorporated in their curriculum. Ten respondents indicated that their purpose was education, with eight indicating that their purpose was project/implementation related. An additional five respondents, whose purpose served both education and implementation, indicated an association with the AOCs or recommendations of the RAPs.

Recommendation: Clearer linkages should be made to help identify volunteer monitoring purposes with the goals of the RAPs and LaMPs in the Muskegon and White Lake AOC/River Watersheds and to the Michigan Department of Environmental Quality's Strategic Monitoring Plan.

Budgets were reported as not reliable in eight of the "educational purpose" monitoring projects. The Michigan Inland Lakes and Streams Association, Ravenna Conservation Club, and Grand Valley State University reported reliable funding for educational purposes. The schools, conservation districts and extension programs that coordinate monitoring and project implementation reported unreliable funding. They reported that supplies and materials were relatively easy to obtain through community-based contributions or grants, compared to a budget for staff to maintain and expand these programs. The result is a lack of promotion and expansion of this type of monitoring.

Recommendation: Create linkages between monitoring groups to provide models for the sustainable funding of Adopt-A-Watershed program coordinators.

Information is available to support RAP and other watershed management efforts, however, there is no central location to electronically distribute the data. Most of the volunteer-gathered data or grant-funded studies are being used to develop projects by the same educators, volunteeers and organizations who coordinated the initial studies. The general public would find it difficult to access this information unless they became involved in local watershed management activities, PACs or watershed organizations.

Recommendation: Create a central database or electronic media repository to distribute information beyond what EPA's STORET system has completed. Information should be available even if it does not meet QA/QC standards. For example, the public should be able to go to an electronic site and determine how TMDL water bodies were selected.

Duplicative monitoring efforts were not found as a result of this study. However, there is a risk of future duplication due to a lack of communication between organizations and volunteer groups. Volunteers have resource and time constraints and do not want to duplicate an agency's or another organization's efforts.

There seems to be the perception that some duplication is occurring at the state level however. Apparently there is a lack of communication/information sharing between agencies/divisions with similar goals.

There are opportunities for more coordination of monitoring programs to further the goals of RAPs and LaMPs. Each state and watershed – especially where there are active partnering organizations – would benefit from more timely information and data sharing. In the Muskegon and White River watersheds, several organizations have come together to support the PACs and the watershed organizations. A central repository or electronic site with partner information, studies, and monitoring results would be helpful.

Difficulties in Getting Information

A second mailing to the original survey list was made for those who did not initially respond by the deadline. However, after the first mailing, most responses were from those who did not do any monitoring. Most respondents who phoned were referring us to a more appropriate party to collect information. Follow up calls and mailings were performed to several parties based on input from initial respondents and PAC members. Based on input from the Muskegon River Watershed Assembly, a third mailing was sent to solicit information on "projects" being coordinated in the Muskegon River watershed. The cover letters were designed to explain the project in terms best suited to the sector being surveyed. It is unknown whether or not this helped get responses. All business' who responded indicated they did not do any monitoring above and beyond that which is required for legal compliance.

6. Grand River

Background

From Jackson to Grand Haven winding 256 miles, the Grand River is Michigan's longest river encompassing 19 counties and having 12 major tributaries. Although several cities impact the river through point sources, a majority of the Grand River Watershed is used for agricultural purposes (53 percent), and thus non-point sources become a major concern. Furthermore, this watershed is an important factor when looking at the overall status of Lake Michigan, because the Grand River watershed makes up around thirteen percent of the total Lake Michigan Watershed.

Historically, both the Grand Rapids and Lansing areas were known for large-scale metal finishing and plating industries that contributed significant amounts of heavy metals to the environment due to ineffective waste water treatment. Other impacts have included discharges from a large tannery in the Grand Haven area and wood processing facilities throughout the lower region of the Grand River. Most of these point sources have addressed this problem by updating waste water treatment systems, however, many of the historic pollutants may remain in the river system.

According to Dr. Rick Rediske of Grand Valley State University Water Resources Institute, recent studies of the 12 major tributaries of Lake Michigan have found the Grand River to be one of the most significant contributors of contaminant loading into Lake Michigan. Preliminary results of the Lake Michigan Mass Balance Study have found that the Grand River is the largest tributary source to Lake Michigan for lead, DDT compounds and atrazine and the second largest source for mercury.

The Grand River's past and present connection to point and non-point source contaminants make it an important tributary for continued monitoring when developing a LaMP for Lake Michigan. Tributary management and monitoring are key factors in addressing health concerns for the watershed.

Pollutants of Concern

Aquatic Monitoring

Monitoring coverage for LaMP pollutants reported into the STORET system is shown in Figure 13 and Figure 14. These maps indicate that stations exist in for only one (mercury) of seven critical pollutants, six out of ten pollutants of concern, and none of the listed emerging pollutants. Monitoring for mercury is focused on the Grand itself in the lower watershed, and on the Looking Glass River and Grand River near Jackson in the upper watershed. Little coverage exists for the tributaries to the Grand in the lower watershed. Coverage of the other pollutants is fairly broad, though focused in the Grand mainstem.

The Surface Water Quality Division within MDEQ maintains a majority of the stations monitoring for these pollutants. The other organizations monitoring for LaMP pollutants include the USGS-WRD, and the U.S. EPA, Region 5 (Great Lakes Surveillance and Clean Lakes Programs).

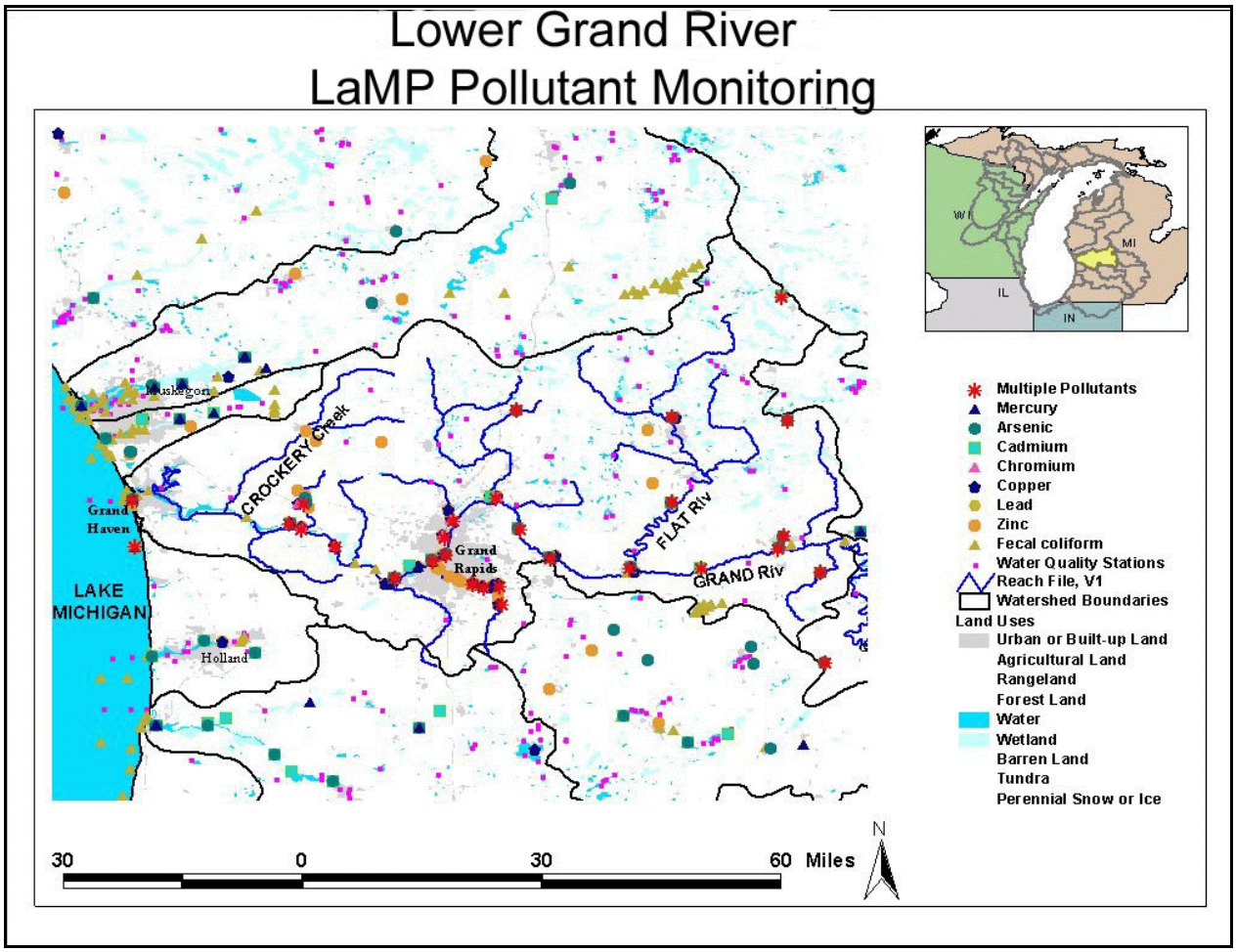

Figure 13. The lower Grand River watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

In addition, our surveys show that there are several organizations which monitor specifically in the Grand River watershed for LaMP pollutants. All eighteen pollutants are covered by at least one organization. These organizations include Water Treatment Plants for the cities of St. Louis, Jackson, Lansing, Mason, and Wyoming, the Grand Haven Board of Power and Light, GZA Geo Environmental, Superior Environmental Corp. Therefore, it is likely that there are organizations monitoring PCBs, dieldrin, chlordane, DDT, dioxins/furans, HCB, toxaphene, PAHs, atrazine, and selenium. From our information, however, we are unable to determine specifically where this monitoring is being conducted. Some of the monitoring also includes groundwater monitoring.

Pollutant Release Monitoring

An examination of Permit Compliance System and Toxic Release Inventory reporting locations in the Grand River watershed indicates a large number of monitoring locations for potential pollution sources throughout the watershed. Many of these are clustered along the Grand (see Figure 15 and Figure 16).

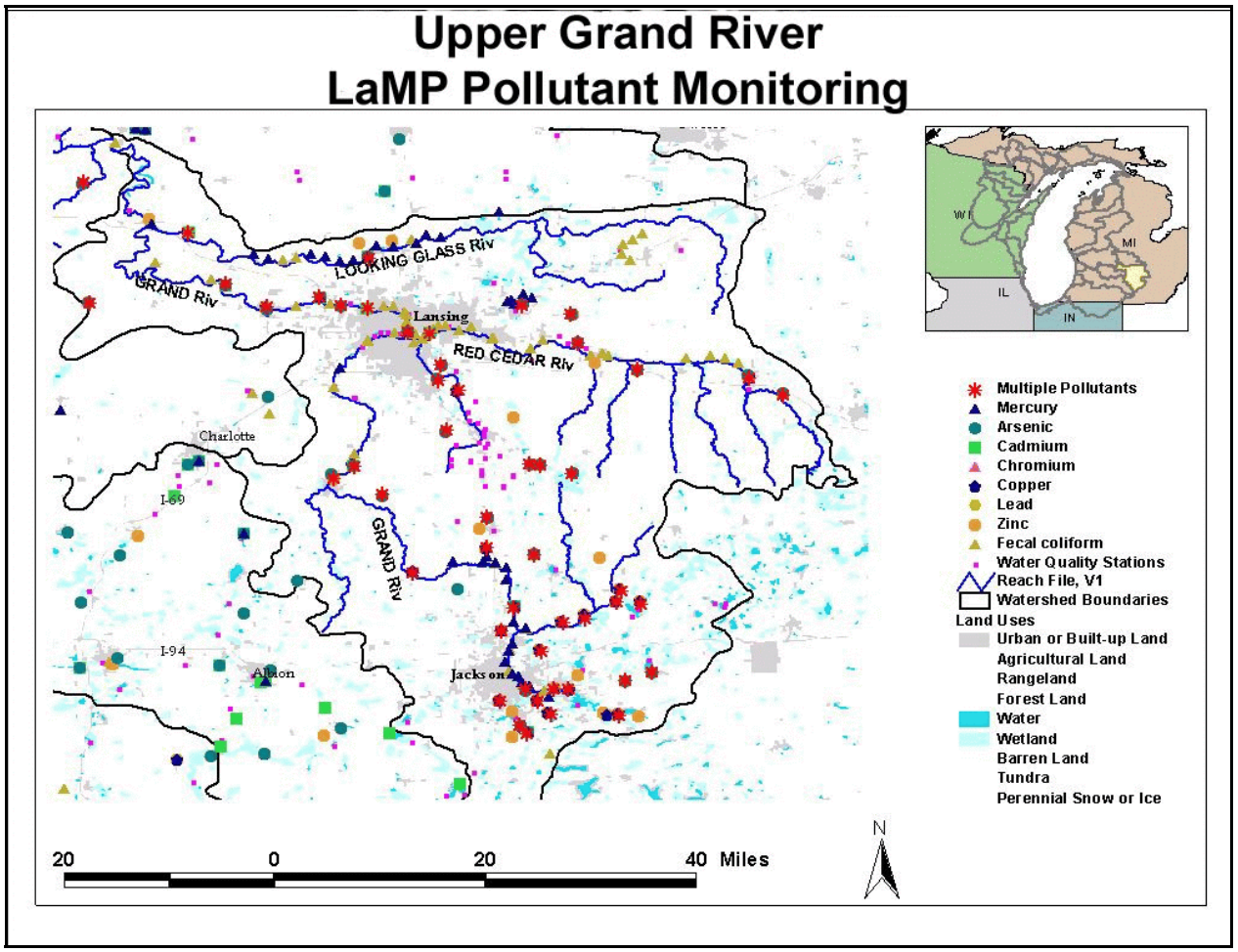

Figure 14. The upper Grand River watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

Nutrients and Bacteria

As with the other watersheds, a vast majority of the more than 300 water quality stations pictured in Figure 13 and Figure 14 monitor for some form of nitrogen and phosphorus, the chief nutrients impacting water quality. Thus, where monitoring stations exist, they are likely tracking nitrogen and phosphorus. This is especially important in a watershed dominated by agriculture the way the Grand River watershed is. As with other stations in this watershed, there is a focus on the Grand River. In addition to these sites, several water treatment plants monitor nutrients and bacteria at their outfall to the Grand, but this is not necessarily monitoring on the river. Also, a few of the returned surveys indicated that they monitor for nutrients in general, though specific indicators were not listed.

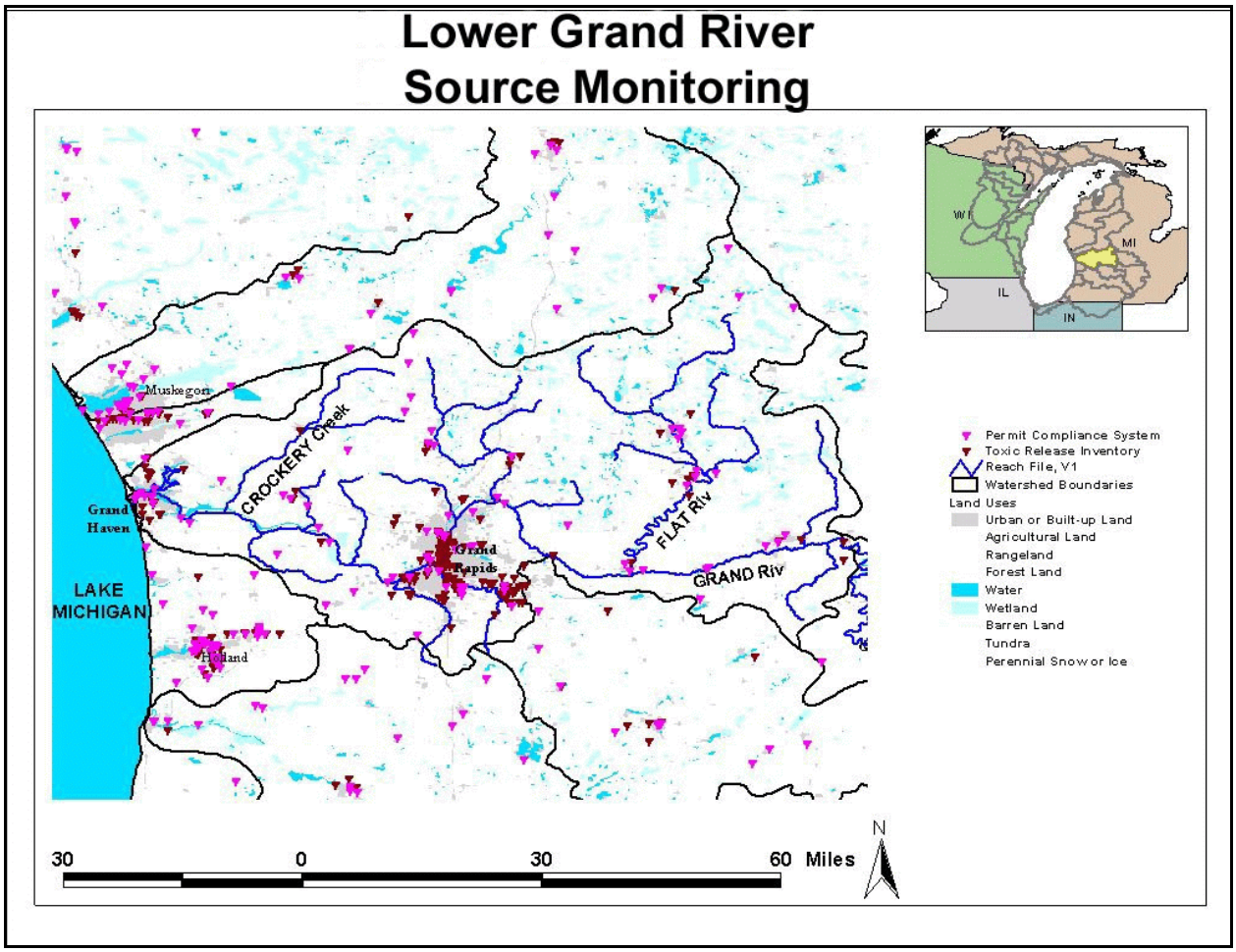

Figure 15. Lower Grand River watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

No monitoring programs were reported to the STORET database for *E. coli* in the watershed. However, the Ingham County Health Department monitors for *E. coli* in and around Lansing. Kent County Health Department monitors for conformance with bacteria body contact standards, but they did not declare which specific indicators are monitored.

Fecal coliform is monitored extensively, especially along the Grand, Looking Glass, and Red Cedar Rivers. There is little coverage of lower tributaries to the Grand, however. Organizations monitoring for fecal coliform in the watersheds include MDEQ, USGS-WRD, and a program within the Woldumar Nature Center.

Meteorological and Flow Monitoring

USGS maintains a number of gage stations in the watershed to measure flow rates and various other physical characteristics of streams (see Figure 17 and Figure 18). The upper Grand is especially well-covered, but the lower watershed has much more disperse coverage. Crockery Creek and the Grand's outflow into Lake Michigan are not covered by gage stations at all.

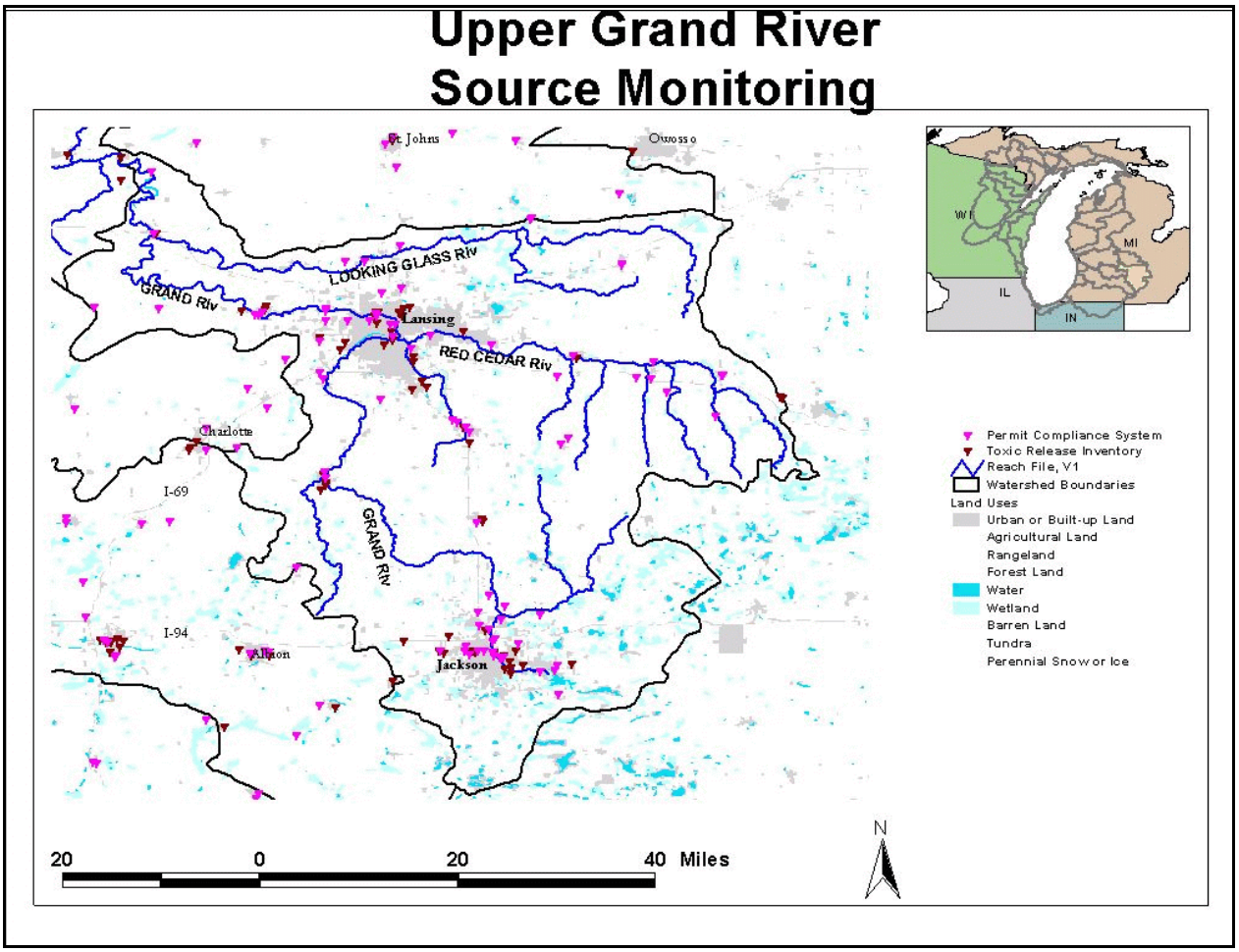

Figure 16. Upper Grand River watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

Our survey also indicated that there are several other groups in the watershed that monitor physical stream conditions. Properties measured include stream discharge (flow), temperature, pH, alkalinity, chlorophyll, dissolved oxygen, biological oxygen demand, suspended solids, conductivity, clarity, turbidity, and water levels. Areas covered for these characteristics range throughout the watershed.

Three NOAA weather stations exists in or near the Grand River watershed. These stations are located southeast of Grand Rapids (on the watershed border), at the Lansing airport, and in Jackson. These stations measure continuous precipitation data, as well as other meteorological data. It was also indicated by one survey that there may be further precipitation monitoring in the watershed (as well as other watersheds) by the National Weather Service for the purpose of local forecasting and storm tracking.

Sediments

There exist eighteen National Sediment Inventory sites within the Grand River watershed (see Figure 17 and Figure 18). A cluster of eleven stations have been placed on the Grand downstream of Grand Rapids, while the other seven are dispersed throughout the watershed. All sites are administered by the MDEQ Surface Water Quality Division. All sites monitor sediment chemistry to assess human health impact as well as aquatic life impacts. The remaining three monitor benthic organism tissue, discussed below.

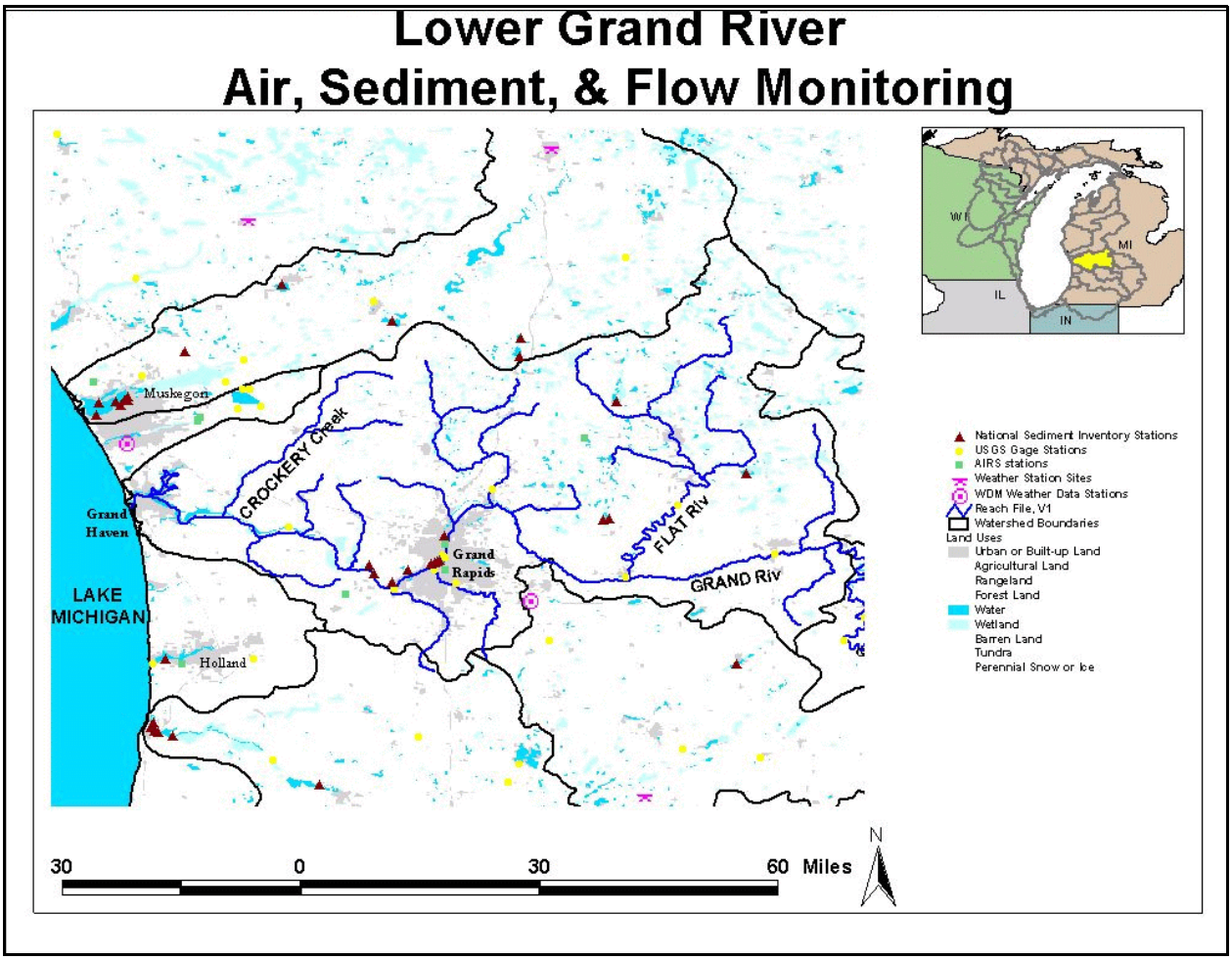

Figure 17. Lower Grand River watershed with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

Fish Contaminants, Fish Health, and Aquatic Nuisance Species

As discussed earlier, we have been unable to find specific locational information (such as sampling locations) for programs monitoring fish populations or their health. There are statewide programs in existence, but these are discussed in the overall findings discussion.

However, a search of the Fish and Wildlife Advisory database on Grand River, Flat River, Looking Glass River, and Red Cedar River revealed a fish consumption advisory for a portion of the Grand River downstream from Grand Ledge (west of Lansing). The advisory was state issued and relates to PCB levels in common carp.

No programs we discovered claimed to be monitoring for aquatic nuisance species specifically within the Grand River watersheds. Refer to the overall discussion of Lake Michigan monitoring for a discussion about programs that cover multiple tributary watersheds.

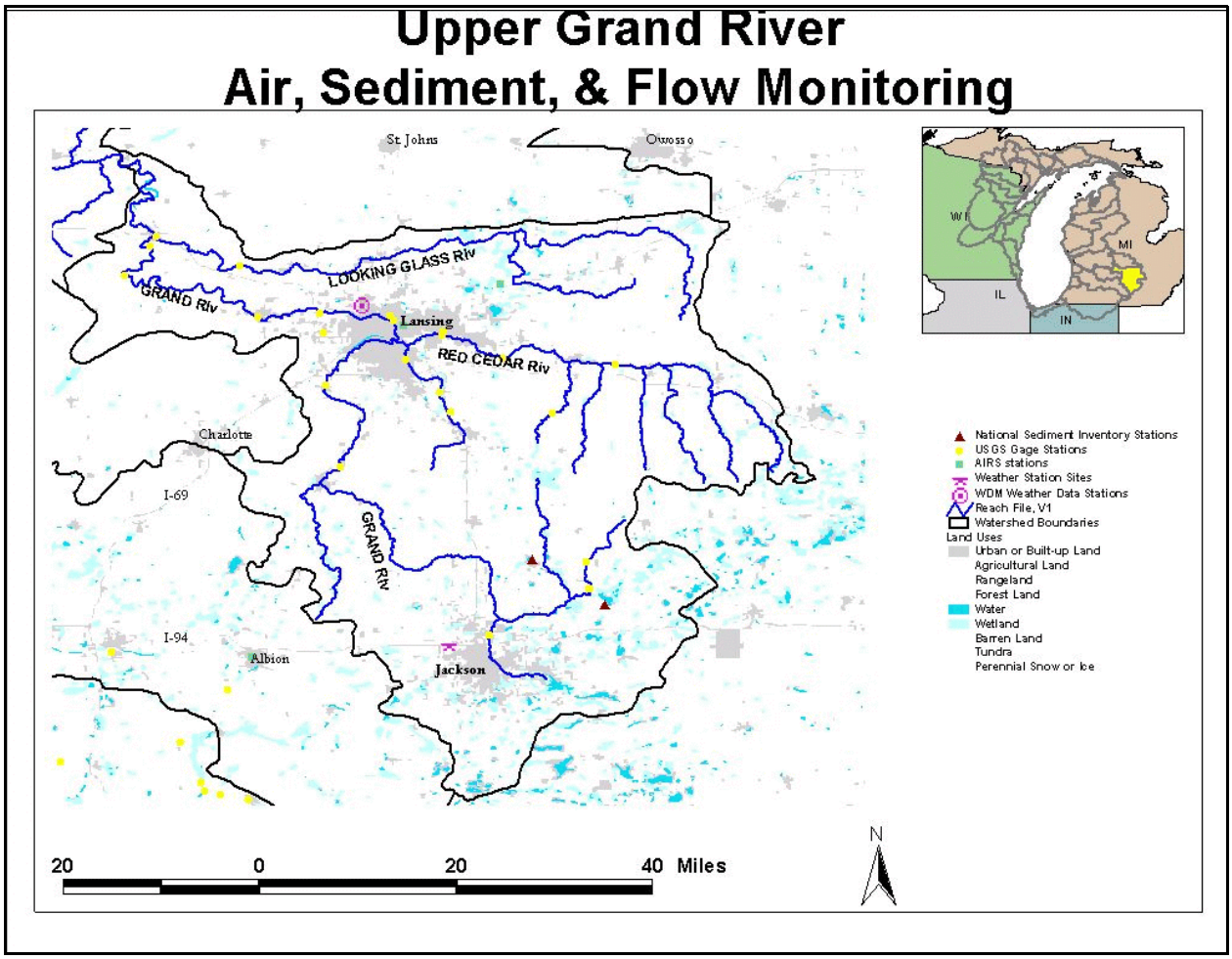

Figure 18. Upper Grand River watershed with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

Benthos Monitoring

No specific locational information was discovered for state or national programs monitoring benthic organisms. However, returned surveys suggest that several organizations are monitoring benthic organisms in the watershed, among others. These are discussed in the overall discussion of Lake Michigan monitoring.

Air Monitoring

Figure 17 and Figure 18 illustrate the locations of the eleven air monitoring stations in the watershed, according to the U.S. EPA's AIRS database. There is a cluster of seven stations around Grand Rapids, and the other four are located around the watershed – two in the lower watershed and two in the upper. The stations monitor for low-level ozone, particulate matter, carbon monoxide, sulphur dioxide, and lead.

Wildlife Monitoring

According to our surveys, two groups conduct wildlife monitoring of some form in the watershed. The Howard Christensen Nature Center conducts various flora and fauna surveys around the center, near Kent City. Resource Management Group, Inc. conducts a limited study of endangered and threatened species use. There are other organizations monitoring wildlife species in the Grand River watershed and others. These are discussed in the overall discussion of Lake Michigan monitoring.

Land Use

There are several large urbanized centers in the watershed, including Grand Rapids, Lansing, and Jackson. Much of the rest of the watershed is managed as agricultural land. There are also several sections of dispersed wetlands in the watershed. These can be found in the headwater region of the Flat River, and in the headwater region of the Grand, east of Jackson. While there is little monitoring in the Flat River wetlands, pollutant monitoring east of Jackson appears to be quite extensive.

In addition, the NRCS conducts some limited wetland monitoring near mud creek, including soil loss, sediment delivery, wildlife habitat, and acres of wetlands restored. The Muskegon County Land Use Task Force also monitors to determine trends in land use change.

Local Assessment

The Grand River Watershed at this time does not have a Remedial Action Plan nor local watershed management efforts within the watershed. Depending on the state and federal monitoring coverage, the importance of local monitoring in this watershed may be vital.

Most of the responses to surveys did not appear to be duplicated by other groups. All had a different purpose for collecting information, though a lot of the groups tend to gather data on similar parameters and/or use the same techniques for methodologies. Other observations made from the surveys were that the major portion of data is gathered by paid staff or students, chemical and physical characteristics were the two most studied parameters in this watershed, and most of the data were gathered on a weekly basis. Nearly all of the survey participants are collecting data in water or on land, and 80 percent do not monitor for any of the LaMP indicators. All of the data are stored indefinitely by all survey participants, with the exception of a few wastewater treatment plants.

There appears to be some coordination between groups such as the West Michigan Environmental Action Council and Adopt-A-Stream, Michigan State University and the Ingham County Health Department, and Grand Valley State University and Horizions. Opportunities for coordination might be found between Thornapple River Watershed and Mud Creek and the groups whose main purpose is to educate students on how to perform water-monitoring tests.

Organizations contacted that did not respond but likely are directly or indirectly monitoring the Grand River include:

- Grand River Expedition 2000—Verlen Kruger 517-323-2139
- Les Toth—Ottawa Environmental Health (bacteria study) 616-393-5645
- Chis Clampitt—Nature Conservancy 517-332-1741
- Beth Vineyard—Neighborhood Wetland Monitors 616-261-3422.

7. Kalamazoo River

Background

The Kalamazoo River watershed is located in the southwest portion of Michigan's Lower Peninsula. It drains approximately 2,020 square miles in ten counties: Allegan, Barry, Calhoun, Eaton, Hillsdale, Jackson, Kalamazoo, Kent, Ottawa, and Van Buren. Geographically, the watershed is about 162 miles long and varies in width from 11 to 29 miles. The Kalamazoo River watershed is contained entirely within the Michigan/Indiana till plains ecoregion. Characteristics of this region include irregular plains (mix of relatively level lands and rolling hills and valleys), potential natural vegetation of oak, hickory, beech, and maple, land use of cropland with pasture, woodland, and forest, and gray-brown podzolic soils.

There are about 2,450 lakes and ponds totaling 37,500 acres scattered across the watershed, ranging in size from Gun Lake (Allegan/Barry Counties) at 2,611 acres to numerous small ponds. There are 52 lakes or impoundments of 100 acres or more in size.

The North and South branches of the Kalamazoo River originate within a few miles of each other. The North Branch originates in Farewell and Pine Hills lakes in southern Jackson County and the South Branches rises in marshy areas south of Moscow in northeastern Hillsdale County. The two branches join at Albion, forming the mainstream, which flows northwesterly for approximately 123 miles before entering Lake Michigan near Saugatuck. Along the way, the river flows through several municipalities, including Marshall, Battle Creek, Augusta, Galesburg, Comstock, Kalamazoo, Parchment, Plainwell, Otsego, Allegan and Saugatuck.

There are numerous tributaries and drains that discharge into the Kalamazoo River. The North Branch above Concord is a small, clear-water stream that varies in size from ten feet wide by four inches deep below Farewell Lake, to 35 feet wide by one foot deep above the Concord impoundment. The bottom type, in general, through this stretch of stream is sand with some areas of gravel.

The South Branch from Homer to Albion is a larger river averaging 40 feet wide by 18 inches deep in the upper areas to 70 feet wide by two feet deep in the lower areas. There are a few flat areas in marsh situations where the river may widen up to 100 feet and the water is quite shallow (eight inches or less). Bottom types are mostly sands and gravel with some rubble and boulders in the riffle areas.

More than half the length of the mainstream between Albion and Ceresco (east of Marshall) is impounded or heavily developed in the cities of Albion and Marshall. The mainstream of the Kalamazoo River from Ceresco to the southwestern edge of Battle Creek flows through scenic natural areas and includes several islands. The river is about 80-100 feet wide and averages 1-2 feet deep. The river bottom has many areas of gravel and aquatic weeds. Through Battle Creek and adjacent suburbs, the river is almost entirely within developed areas. The Fort Custer Recreation area is in the area between Battle Creek and Augusta.

From Augusta to Galesburg there is little development, except in the villages. The river is wide and deep, averaging 110 feet wide and four feet deep. Low stream banks are well vegetated with soft maple, willow, and ash. Between Galesburg and Comstock, the river flows into Morrow Pond, an impoundment created by the Brice E. Morrow power plant dam. From this point, the river flows through more urbanized areas of Kalamazoo. From Kalamazoo, the river flows north through natural and agricultural areas to Plainwell. With the river gradient increasing to 2.6 feet per mile between Plainwell and Allegan, five dams were constructed in this stretch of the river (three have since been partially removed).

From Allegan the river flows into Lake Allegan behind the Calkins power dam. From there it flows through the wildest section of the river, Allegan State Game Area. A major tributary, the Rabbit River, enters the Kalamazoo a few miles upstream from Lake Kalamazoo. Near the mouth of the Kalamazoo River there are extensive marshlands. The Kalamazoo River outlets to Lake Michigan at Saugatuck through a constructed channel.

Status of Watershed Management Efforts in the Study Area

Current management efforts in the Kalamazoo River watershed are concentrated primarily in the Kalamazoo River AOC. The RAP for the Kalamazoo River AOC is the primary management plan in the watershed. In addition to the RAP, a group of affiliated entities are developing a Total Maximum Daily Load (TMDL) report on Lake Allegan. As a requirement of the federal Clean Water Act, a TMDL project has been initiated for the Kalamazoo River/Lake Allegan to reduce phosphorus concentrations in the lake to meet water quality standards. The MDEQ has initiated efforts to determine what the "capacity" of this water body is for phosphorus. The project is scheduled to be submitted to the EPA by Dec 31, 1999.

Davis Creek is a highly modified water course located in the center of Kalamazoo County. The Creek drains about 10,000 acres of an urbanizing fringe and the older, industrial core of the community. Having been largely abandoned and forgotten in recent years, the creek emerged as a public concern when the Nonpoint

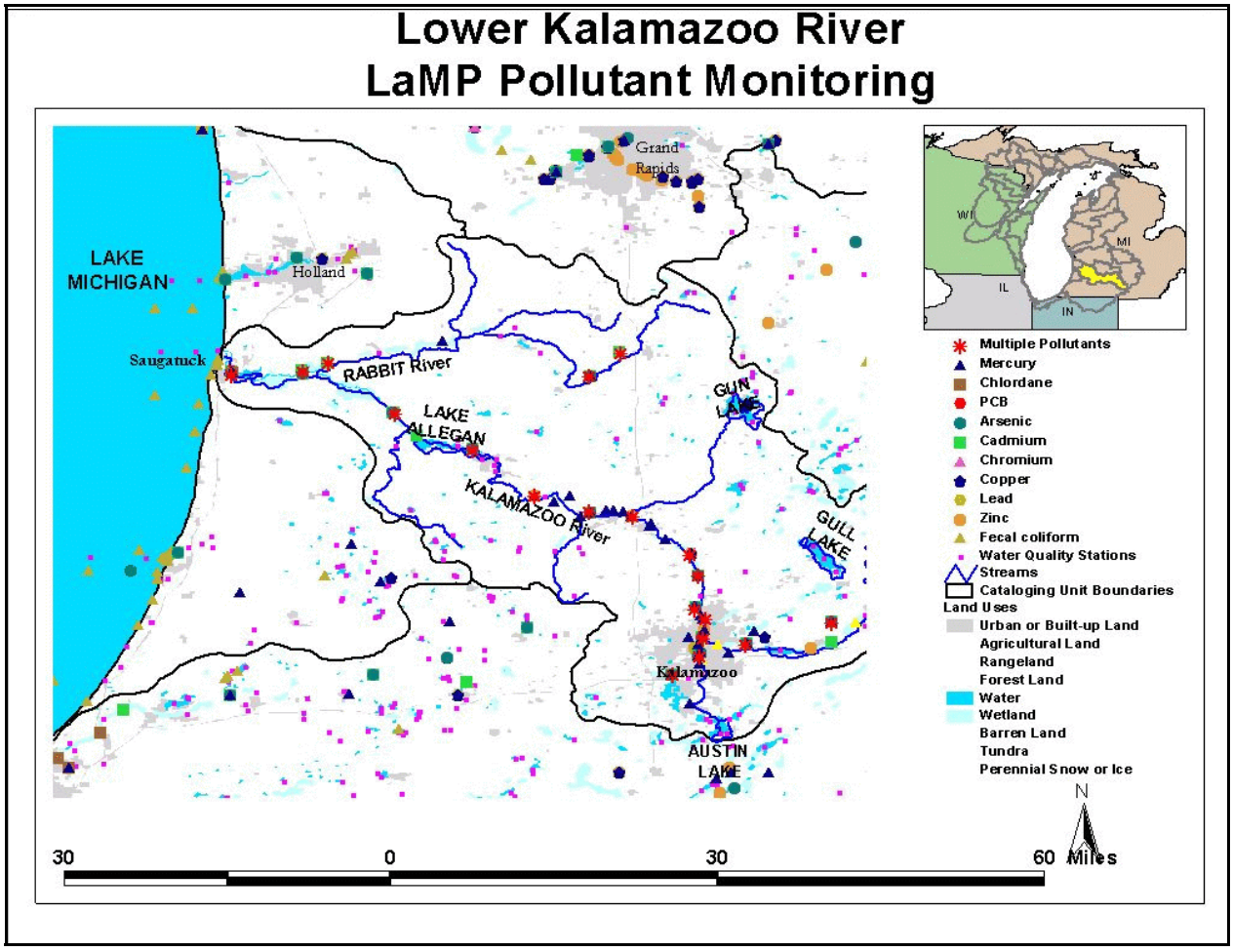

Figure 19. The lower Kalamazoo River watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

Source Pollution Advisory Committee of the Forum of Greater Kalamazoo identified Davis Creek as one of the most polluted creeks in Kalamazoo County. This identification was accomplished by a local-led, volunteer effort to collect and analyze water samples from all major tributaries to the Kalamazoo River within Kalamazoo County.

Ultimately, scores of local individuals, dozens of agencies and business representatives participated in developing the Davis Creek Water Management Plan (1996). In 1997 a grant ($300,000 over 3-years) was awarded to the Davis Creek Watershed Steering Committee to implement some of the 48 action items recommended in the plan. The implementation work tasks have focused upon public education, citizen stewardship, community partnerships and the installation of demonstration best management practices (BMPs) to reduce nonpoint source pollution.

The Little Rabbit River Watershed has received a grant to implement BMP's in a mostly agricultural area. A project has been completed for the Lower Rabbit River, and a new project has just been approved for the Upper Rabbit River. This project will continue to research and implement BMP's in the basin.

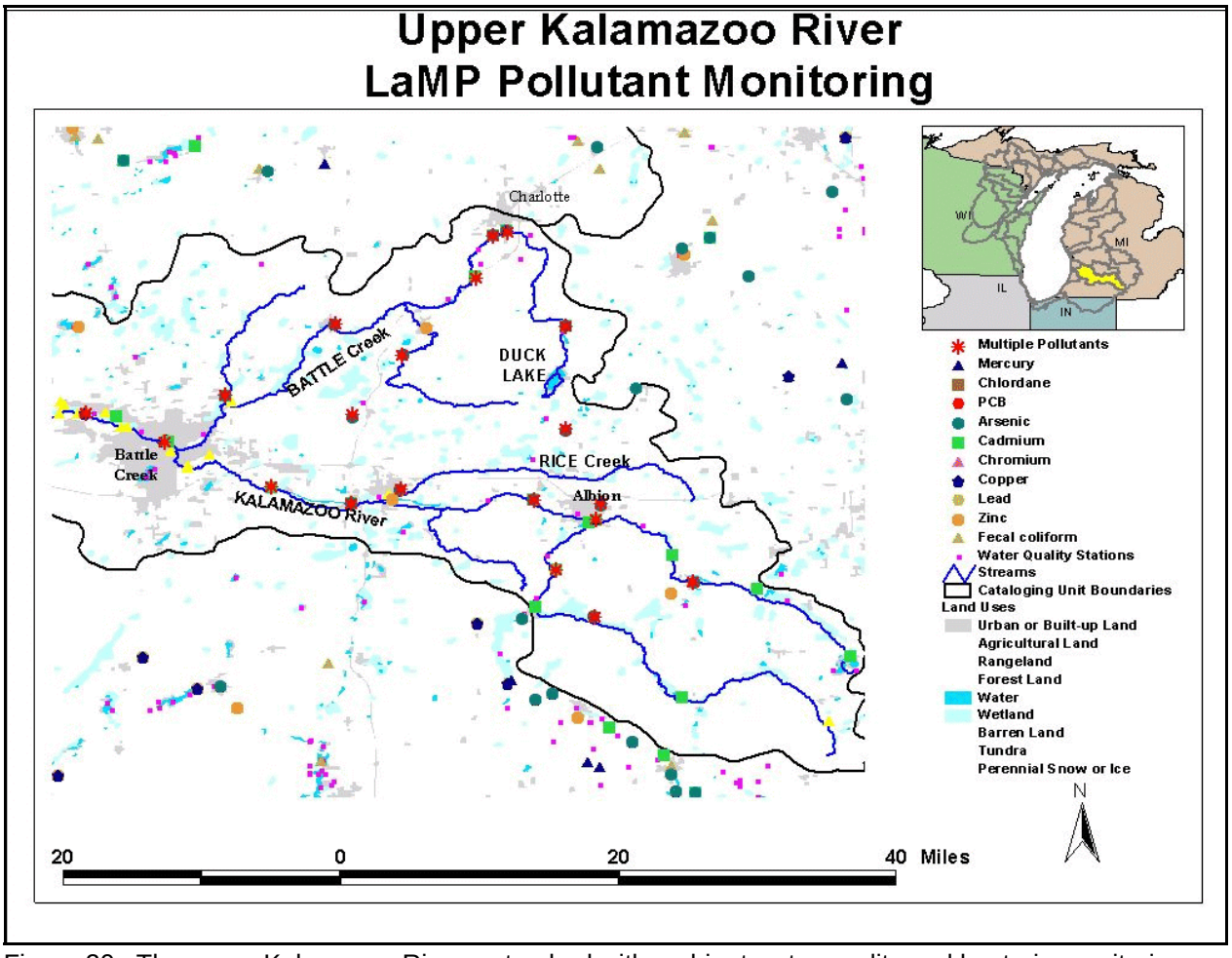

Figure 20. The upper Kalamazoo River watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

Pollutants of Concern

Aquatic Monitoring

Monitoring coverage for LaMP pollutants reported into the STORET system is shown in Figure 19 and Figure 20. These maps indicate that stations exist in for three (mercury, chlordane, and PCBs) of seven critical pollutants, six out of ten pollutants of concern, and none of the listed emerging pollutants. Monitoring for mercury is focused on the lower section of the Kalamazoo, between Battle Creek and Lake Allegan, with a few other stations in other locations off the Kalamazoo and one site in Saugatuck, upstream of the outfall to Lake Michigan. Chlordane is monitored by USGS-WRD at the same Saugatuck station listed above. PCBs are monitored at the Saugatuck station and in Kalamazoo at the confluence of Portage Creek and the Kalamazoo River. Stations monitoring pollutants of concern are dispersed liberally throughout the watershed, focusing on the Kalamazoo and Battle Creek, with the exception of chromium, which is monitored in only four locations on the lower Kalamazoo and two locations on Battle Creek. All of the stations monitoring for these pollutants are maintained by either MDEQ or USGS-WRD.

In addition, our surveys show that there are several organizations which monitor specifically in the Kalamazoo River watershed for LaMP pollutants. All eighteen pollutants are covered by at least one organization. These organizations include Water Treatment Plant for the city of Allegan, the Barry-Eaton District Health Department, Menasha Corporation, Parker Hannifin Brass Division, Pharmacia & Upjohn Company, and Woods Lake Association. Therefore, there are organizations monitoring PCBs, dieldrin, chlordane, DDT, dioxins/furans, HCB, toxaphene, PAHs, atrazine, and selenium. From our information, however, we are unable at this time to determine specifically where this monitoring is being conducted. The Barry-Eaton District Health Department, Environmental Health and Laboratory Services Bureau of HSD, and MDEQ are also conducting groundwater monitoring at a variety of locations, though not a fixed locations. The Pharmacia & Upjohn Company monitors groundwater at fixed locations around a single site.

Pollutant Release Monitoring

An examination of Permit Compliance System and Toxic Release Inventory reporting locations in the Grand River watershed indicates a large number of potential pollution sources throughout the watershed and especially along the Kalamazoo (see Figure 21 and Figure 22). Clusters of point sources exist upstream of Lake Allegan, and throughout Otsego, Plainwell, Kalamazoo, Battle Creek, Marshall, and Albion.

Nutrients and Bacteria

As with the other watersheds, a vast majority of the more than 200 water quality stations pictured in Figure 19 and Figure 20 monitor for some form of nitrogen and phosphorus, the chief nutrients impacting water quality. Thus, where monitoring stations exist, they are likely tracking nitrogen and phosphorus. As with other stations in this watershed, there is a focus on the lower section of the Kalamazoo. Outside these monitoring stations, several other groups are monitoring nutrients in the watershed.

No programs monitoring for *E. coli* in the watershed were reported to the STORET database. However, the Woods Lake Association monitors for *E. coli* in Woods Lake, and the Barry-Eaton District Health Department monitors wells for undefined bacterial contamination.

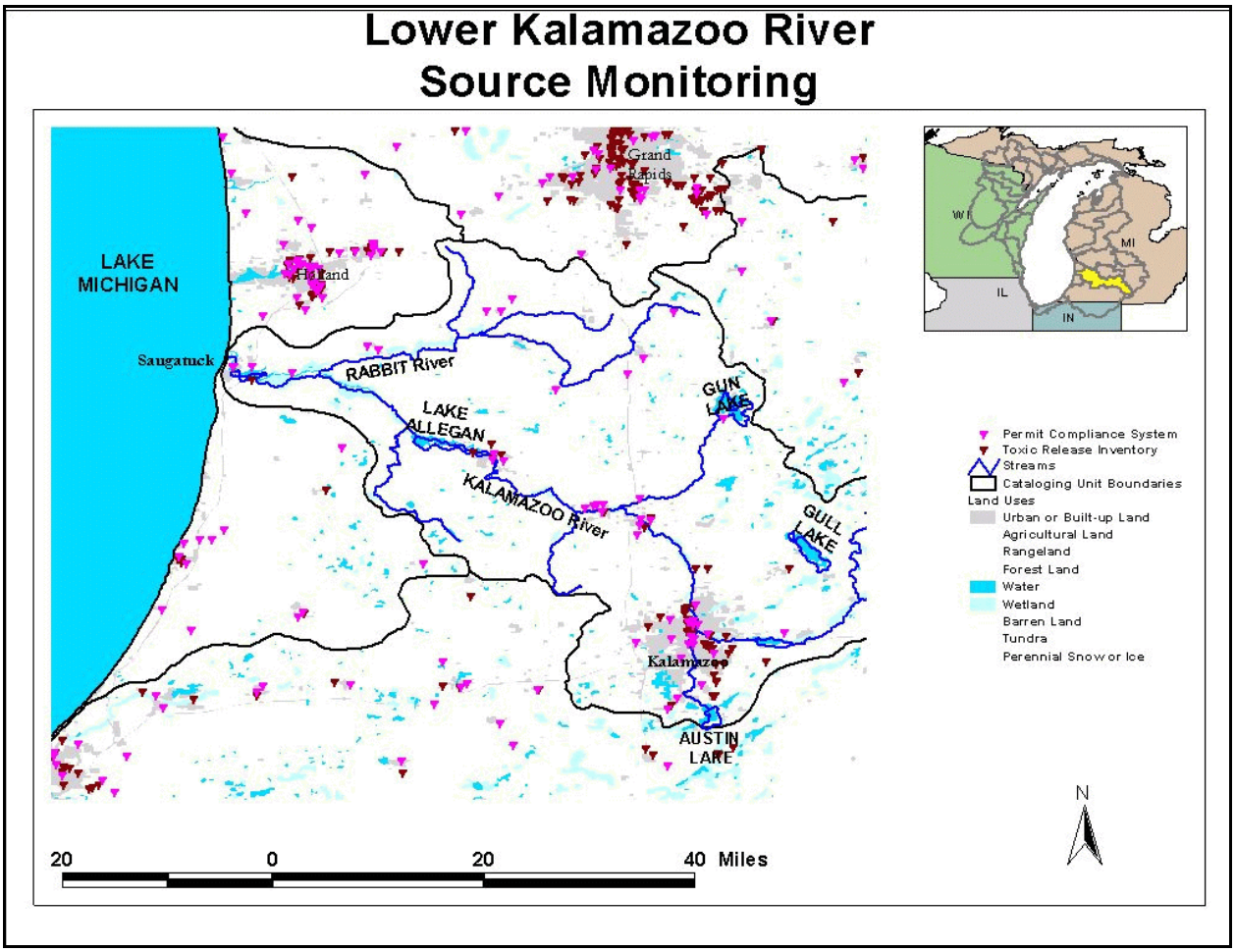

Figure 21. Lower Kalamazoo River watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

Fecal coliform is monitored extensively, especially along the Kalamazoo, Battle Creek and the Rabbit River. However, there is no coverage of the Gun River, the Rice Creek and some other tributaries to the Kalamazoo. Organizations monitoring for fecal coliform in the watersheds include MDEQ and USGS-WRD.

Meteorological and Flow Monitoring

USGS maintains a number of gage stations in the watershed to measure flow rates and various other physical characteristics of streams (see Figure 23 and Figure 24). The middle section of the Kalamazoo is especially well-covered, but many of the tributaries to the river lack stations.

Our survey also indicated that there are several other groups in the watershed that monitor physical stream conditions. Properties measured include stream discharge (flow), temperature, pH, alkalinity, chlorophyll, dissolved oxygen, biological oxygen demand, suspended solids, conductivity, clarity, turbidity, and water levels. Areas covered for these characteristics range throughout the watershed.

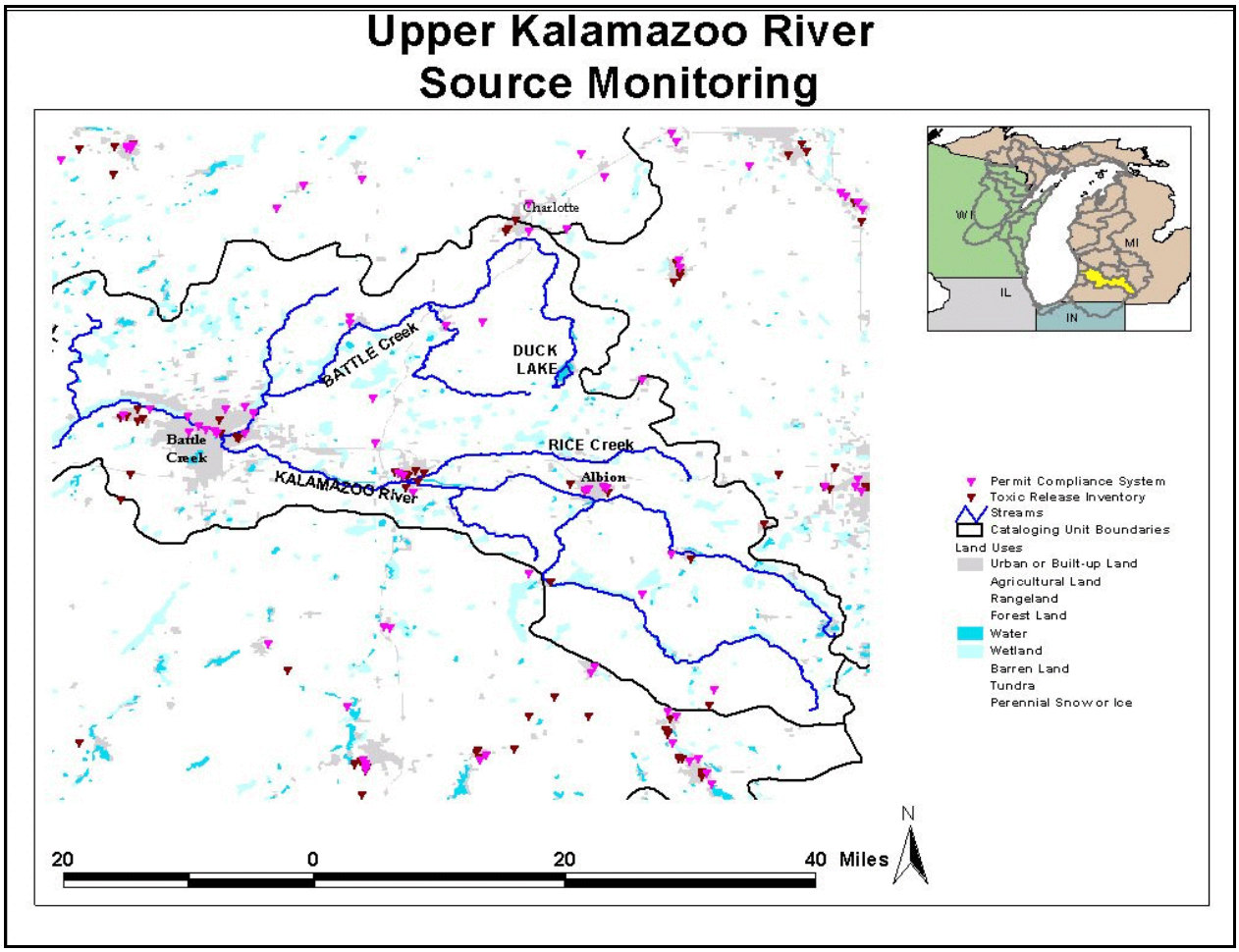

Figure 22. Upper Kalamazoo River watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

One NOAA weather station exists in the Kalamazoo watershed and several others are relatively nearby. The station within the watershed is located on the shore of Gull Lake. Nearby stations are located in Grand Rapids, Jackson, South Haven, and Lansing. These stations measure continuous precipitation data, as well as other meteorological data.

Sediments

There exist fifteen National Sediment Inventory sites within the Kalamazoo River watershed (see Figure 23 and Figure 24). There are clusters of stations at Saugatuck and Kalamazoo. These sites are administered by the MDEQ, USGS-WRD, and U.S. EPA, Region 5. Fifteen of the sites monitor sediment chemistry to assess human health and aquatic life impacts. The other two monitor benthic organism tissue, discussed below. In addition, Michigan Township Services of Allegan Township conducts site inspections for erosion and sedimentation permits issued by the drain commissioner.

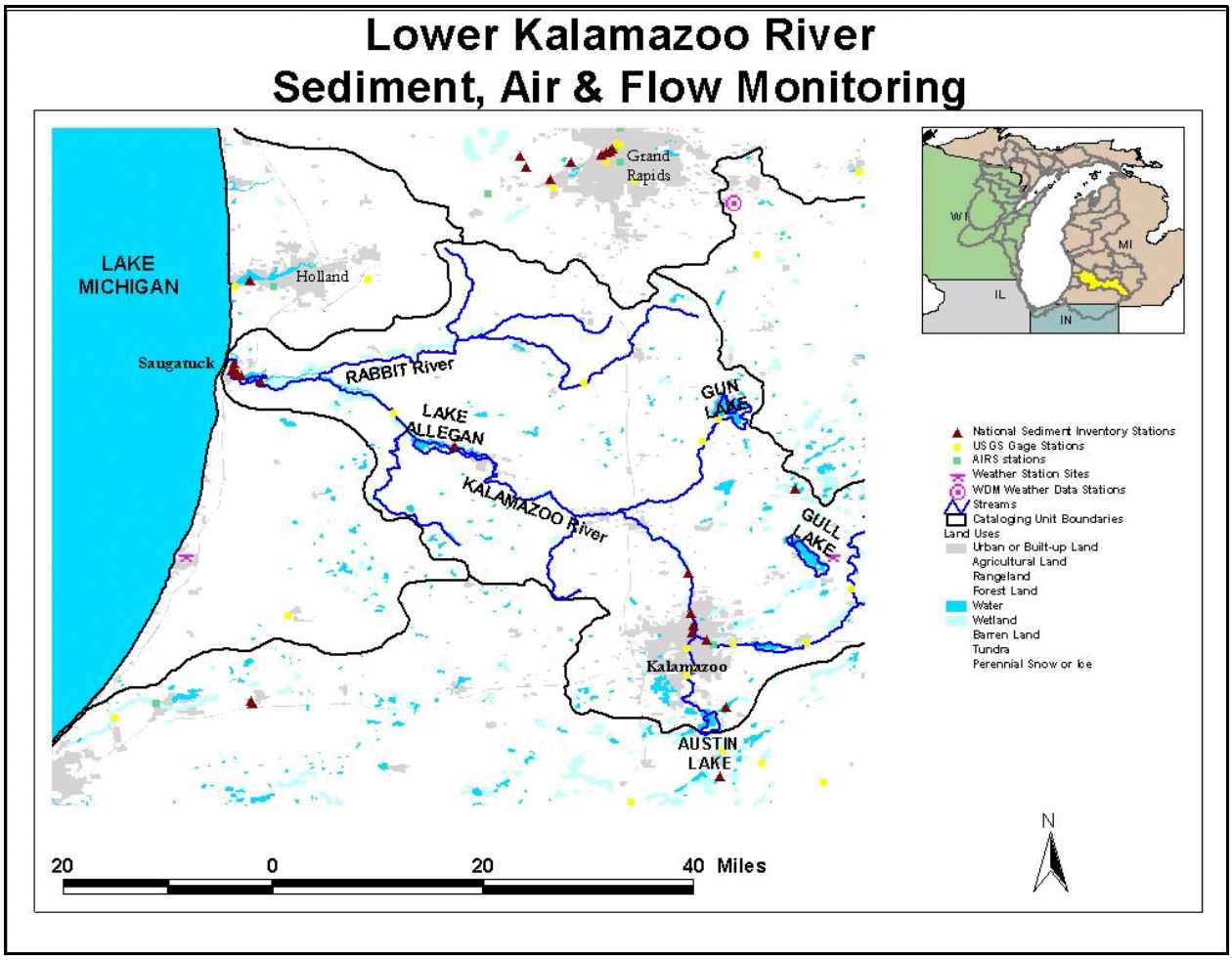

Figure 23. Lower Kalamazoo River watershed with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

Fish Contaminants, Fish Health, and Aquatic Nuisance Species

As discussed earlier, we have been unable to find specific locational information (such as sampling locations) for programs monitoring fish populations or their health. However, one survey indicated that the Fisheries Division of MDNR monitors characteristics of Brook Trout in Silver Creek. There are other statewide programs in existence, but these are discussed in the overall findings discussion. National Sediment Inventory lists two stations that monitor fish tissue for bottom contamination. These are located on Lake Allegan and in Saugatuck, and are administered by U.S. EPA, Region 5.

A search of the Fish and Wildlife Advisory database on all major Kalamazoo watershed waterbodies revealed fish consumption advisories for three sections of the Kalamazoo River — covering the entire reach from Battle Creek to Lake Michigan. The advisories were state issued and related to PCB levels in most fish species, specifically including bass, carp, catfish, white suckers, and pike.

No programs we discovered claimed to be monitoring for aquatic nuisance species specifically within the Kalamazoo River watershed. Refer to the overall discussion of Lake Michigan monitoring for a discussion

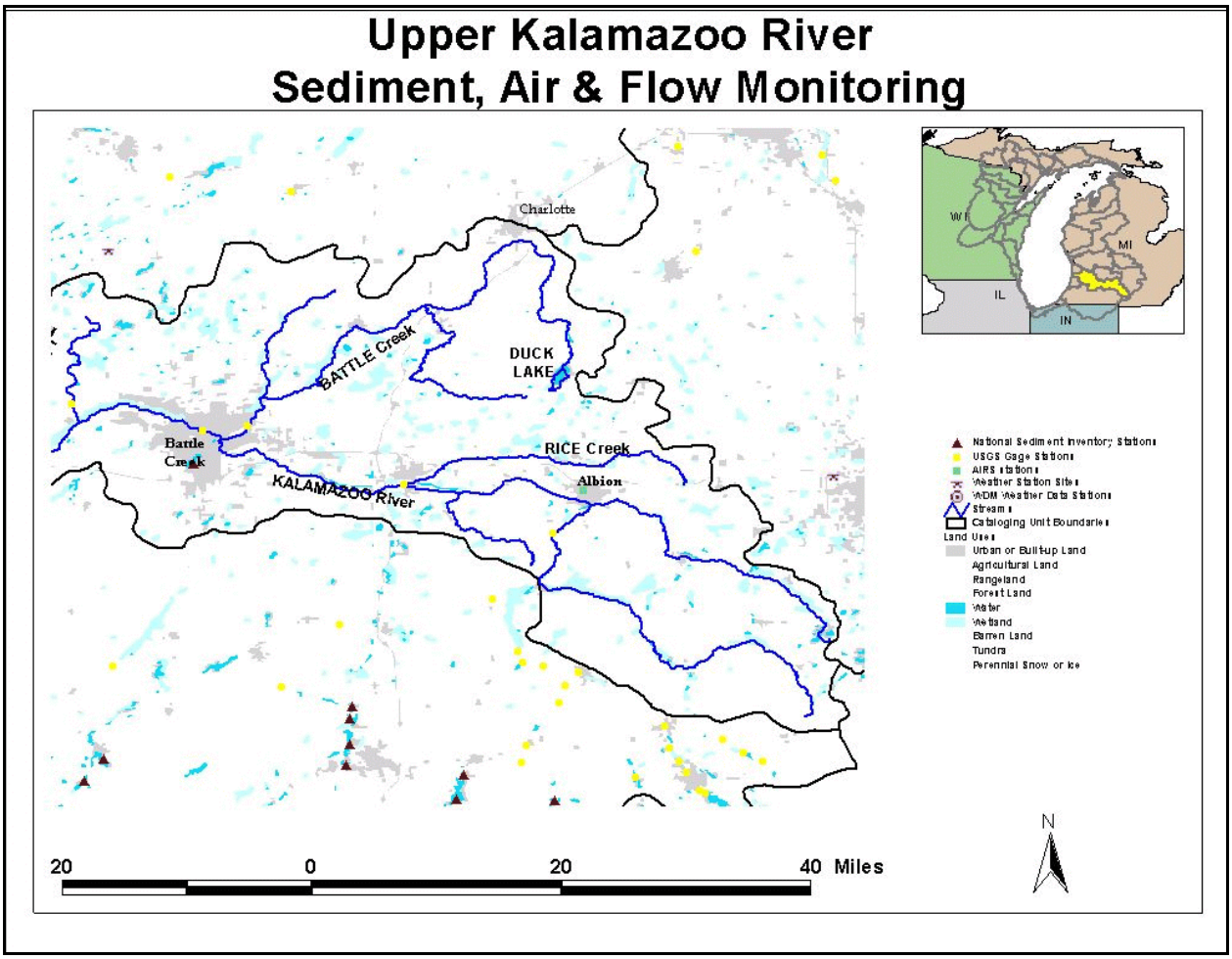

Figure 24. Upper Kalamazoo River watershed with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

about programs that cover multiple tributary watersheds. We were able to locate the Binder Park Zoological Society, Inc., which administers a program that monitors purple loostrife, a terrestrial nuisance species.

Benthos Monitoring

No specific locational information was discovered for state or national programs monitoring benthic organisms. However, returned surveys indicate that Binder Park Zoological Society, Inc. monitors macroinvertebrates on the Kalamazoo near Barnum Creek, and the Allegan Conservation District samples macroinvertebrates in the Rabbit River watershed. Other organizations may be monitoring benthic organisms generally in the watershed, among others. These are discussed in the overall discussion of Lake Michigan monitoring.

Air Monitoring

Figure 23 and Figure 24 illustrate the locations of the two air monitoring stations in the watershed, according to the U.S. EPA's AIRS database. The station in Kalamazoo monitors for low-level ozone, while the station

in Albion monitors for particulate matter. In addition, the Pharmacia and Upjohn Company conducts some undefined air monitoring around their plant site.

Wildlife Monitoring

According to our surveys, two groups conduct wildlife monitoring of some form in the watershed. Michigan State University, in partnership with MDNR monitors the abundance and distribution of Canada Geese and the Trumpeter Swan, as well as the overall abundance and diversity wildlife on university lands, in St. Joseph, Kalamazoo, Calhoun, and Barry Counties. Western Michigan University conducts undefined wildlife monitoring in the lower Kalamazoo watershed. There are other organizations monitoring wildlife species in the Kalamazoo River watershed and others. These are discussed in the overall discussion of Lake Michigan monitoring.

Land Use

There are several urban centers in the watershed, including Kalamazoo, Battle Creek, and Albion. In addition, there are several smaller developments in the watershed. Much of the rest of the watershed is managed as agricultural land. There are also several sections of dispersed wetlands in the watershed. These can be found in a region around Gull Lake and around the headwaters of the Kalamazoo River. There is relatively little monitoring in these wetlands.

In addition, the MSU's Kellogg Biological Station monitors water levels of some wetlands around Gull Lake. The Binder Park Zoological Society, Inc. monitors land use changes around Barnum Creek.

Local Assessment

When the Kalamazoo River AOC PAC developed the RAP for the Kalamazoo River, some monitoring data was used. However, most of this data was historical data from the MDNR and MDEQ and not part of any ongoing monitoring efforts. The development of the RAP did not initiate any ongoing monitoring projects either. When compiling this data, some of it was readily available from the state and federal agencies, while some was difficult to obtain. An example of a data source that took over a year to be delivered was an Angler Survey generated by the Michigan Department of Community Health.

The gaps that exist in monitoring resources are varied and abundant. For example, comprehensive monitoring could help us to identify NPS pollution. The current monitoring has provided a better picture of point source pollution rather than NPS.

Additionally, we need to know more about the extent of PCB contamination in the watershed and river. Specifically, PCB levels in the marshes, wetlands, and floodplains downstream of the operable units in the Superfund AOC. Debate as to what amount of monitoring needs to be performed is a present issue. Emerging issues include the ongoing monitoring of the PCB landfill sites. These sites were created as part of the cleanup efforts that occurred because of the Superfund process. It is important that these remedial measures do not become another source of contamination in the future.

In the case of monitoring efforts that may be duplicative, it does not appear that any efforts have overlaps. The data gained in this survey process will be used in conjunction with another project that will be focused on disseminating the information to better support watershed management efforts. The WIMP group, associated with the GEM regional center at Western Michigan University has recieved a grant to begin

compiling and warehousing data associated with the watershed. As their work continues, the access of this data will become more readily accessible.

In addition to the more formal monitoring efforts detailed in this report, there are many other additional, less formal monitoring efforts within the area. Several communities, including the cities of Kalamazoo and Portage and several of the incorporated townships and villages, have initiated comprehensive planning activities for their areas. These activities have included various land use planning initiatives that also evaluate current land uses and projections for the future. The general nature and large volume of material involved with these planning activities make it impractical to include in this report. The Kalamazoo River Watershed Council continues to be involved in several of these efforts and will continue to monitor such activities and provide input that is protective of river water quality.

A considerable amount of effort is currently underway regarding the newly enacted federal Phase II Storm Water regulations. Nine municipalities in Kalamazoo County (with several other municipalities in adjoining counties) will be required to comply with these new regulations. Several informal monitoring efforts are already underway with more significant and formal efforts planned over the next several years. The KRWC is also directly involved with these efforts and will continue to monitor and provide input as needed.

8. St. Joseph River

Background

The St. Joseph River rises in Baw Beese Lake, Hillsdale County, Hillsdale, Michigan. It enters Lake Michigan at St. Joseph, Michigan. The route environs, and many ecosystem measures of the St. Joseph River are described well in *St. Joseph River Assessment* by Jay K Wesly and Joan E. Duffy at the Michigan Department of Natural Resources Fisheries Division (August 1998).

The local assessment of the watershed for this project, focused on programs that were at the volunteer and local level, although overlap between volunteer efforts and agency-funded programs was evident. It is obvious that any watershed management effort is a multifaceted endeavor that includes, not only disciplined characterization of water, but education, unification of efforts, financial resources and sustainable pursuit of long term goals.

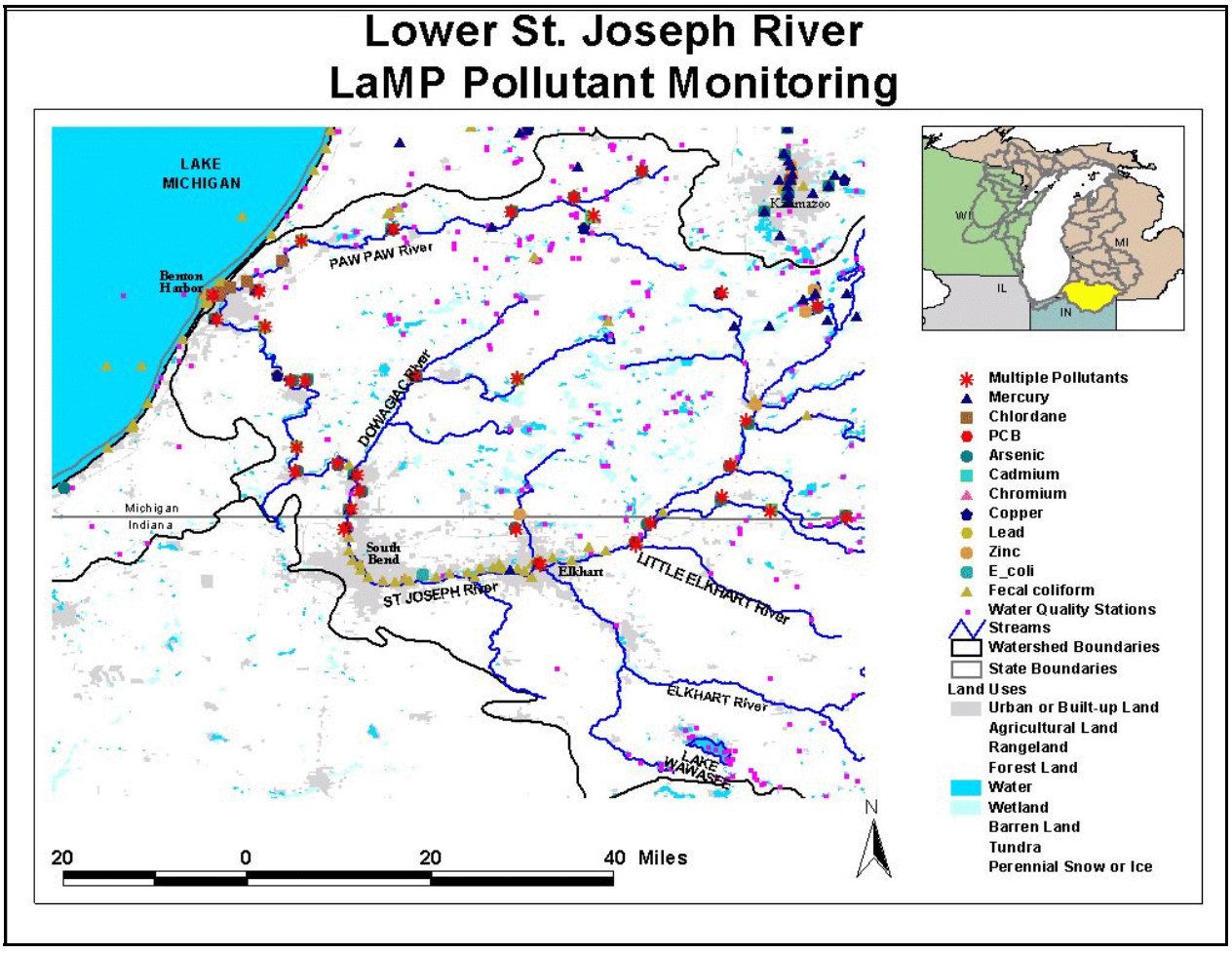

Figure 25. The lower St. Joseph River watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

Status of Watershed Management Efforts in the Study Area

While overall effectiveness of St. Joseph River watershed management monitoring efforts vary, some programs offer special reason for optimism and it seems that provisions should be made for them to develop further.

Pollutants of Concern

Aquatic Monitoring

Monitoring coverage for LaMP pollutants reported into the STORET system is shown in Figure 25 and Figure 26. These maps indicate that stations exist in for three (mercury, chlordane, and PCBs) of seven critical pollutants, six out of ten pollutants of concern, and none of the listed emerging pollutants. Monitoring for mercury is scant, with stations clustered around Portage River, Flowerfield Creek, the Paw Paw River, and the headwaters and lower section of the St. Joseph River. Chlordane is monitored by MDEQ along the lowest section of the Paw Paw and at the outfall to Lake Michigan in Benton Harbor. PCBs are monitored at the Lake Michigan outfall, as well as three other points along the lower St. Joseph River. Stations monitoring pollutants of concern are dispersed liberally throughout the northern portion of the watershed, with a large cluster of stations along the headwaters of the St. Joseph. Chromium is an exception,

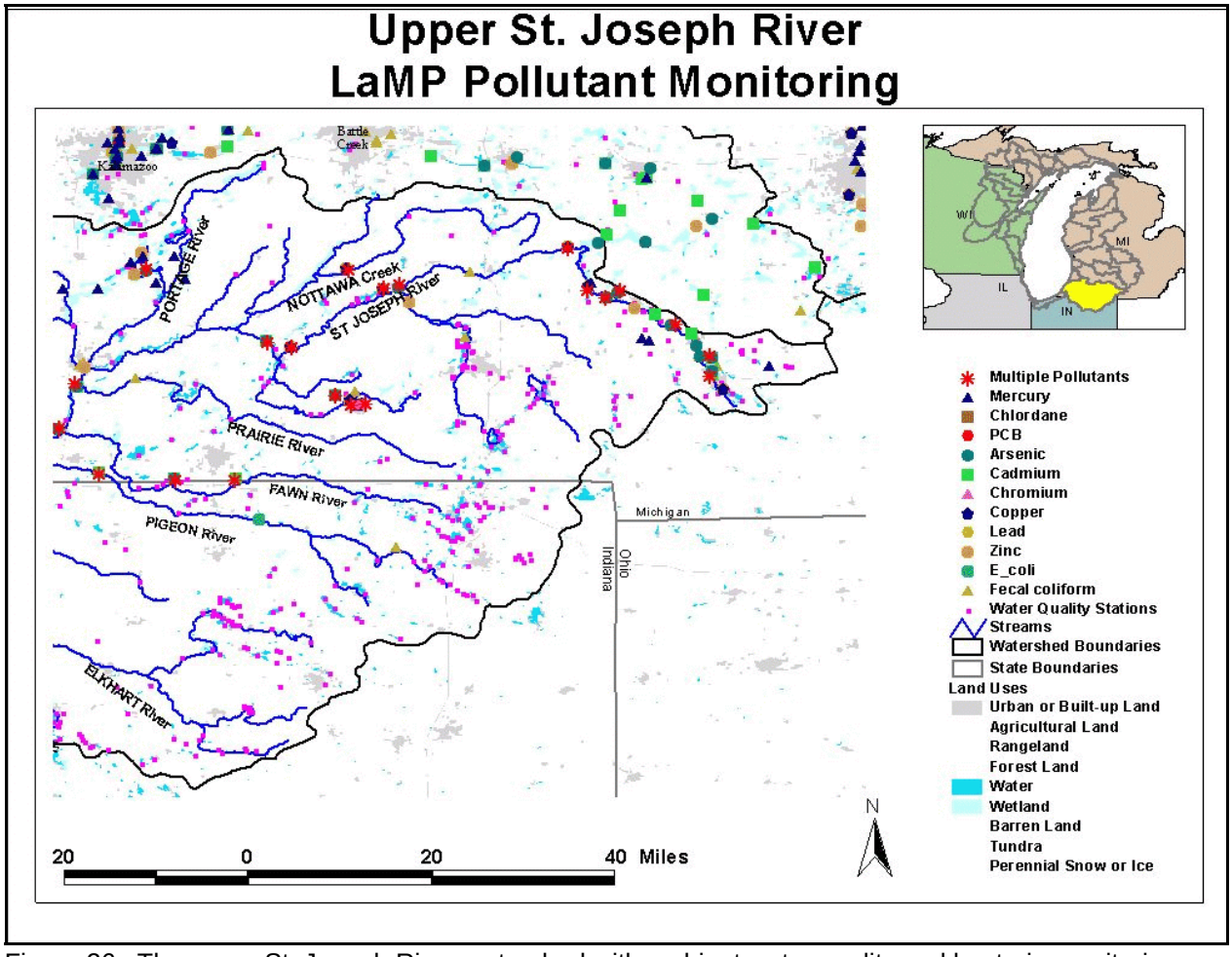

Figure 26. The upper St. Joseph River watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

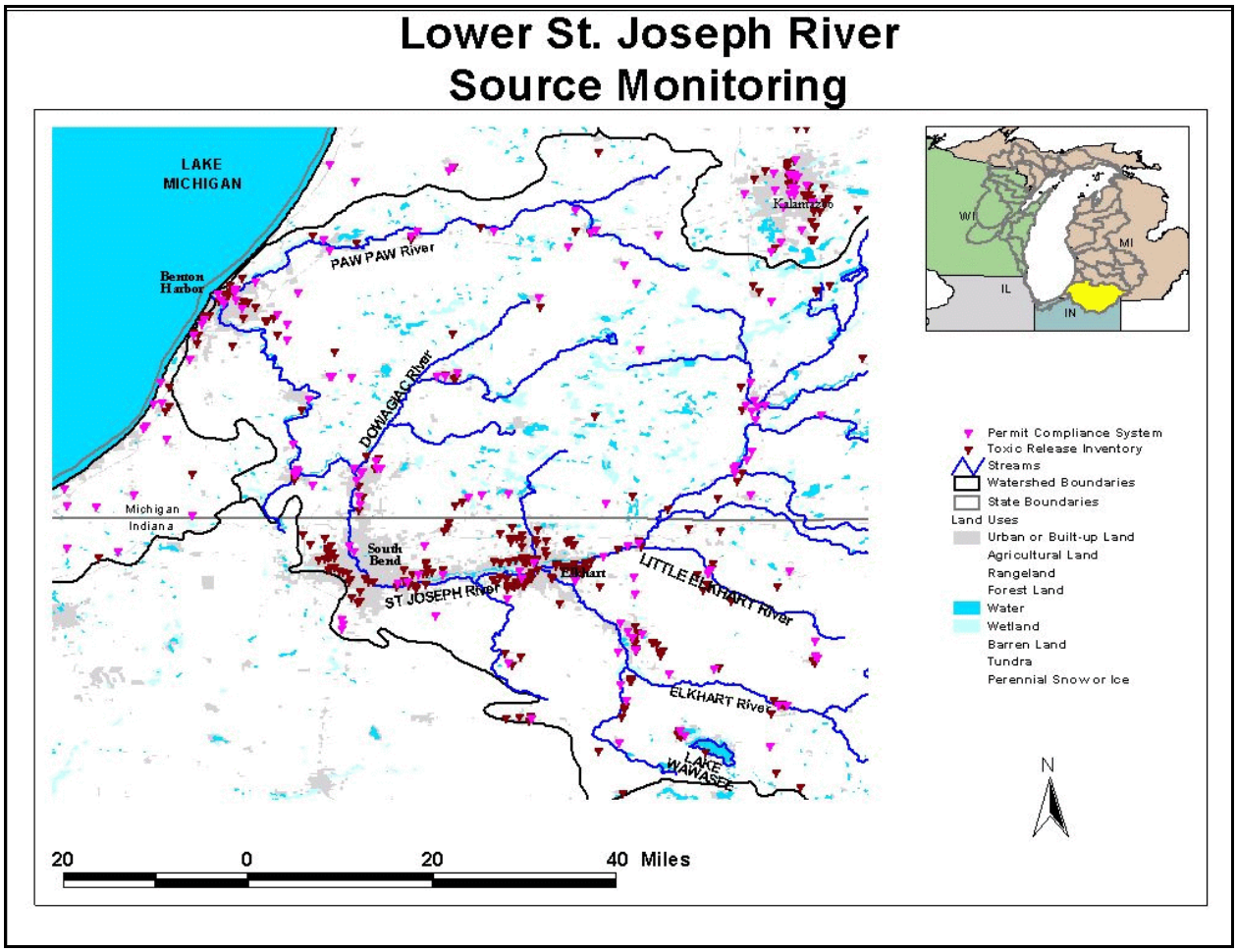

Figure 27. Lower St. Joseph River watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

as it is monitored in only nine locations in the watershed. The STORET database shows very limited monitoring within the portion of the watershed within Indiana, though this is likely due to minimal reporting into the system by Indiana agencies. The stations monitoring for LaMP pollutants are maintained by MDEQ, the Indiana Department of Environmental Management (IDEM) or USGS-WRD.

In addition, a survey was returned by Water Watchers which indicated that they monitor for atrazine throughout the Indiana portion of the St. Joseph watershed. Michigan State University also monitors atrazine in a small section of the watershed. Finally, the St. Joseph River and Galien River Soil Conservation District monitors a number of drinking water wells in Berrien and Cass Counties for unspecified contaminants.

Pollutant Release Monitoring

An examination of Permit Compliance System and Toxic Release Inventory reporting locations in the St. Joseph River watershed indicates a large number of monitoring locations for potential pollution sources throughout the watershed (see Figure 27 and Figure 28). Clusters these monitoring points exist along the Lake Michigan shore, as well as surrounding South Bend and Elkhart.

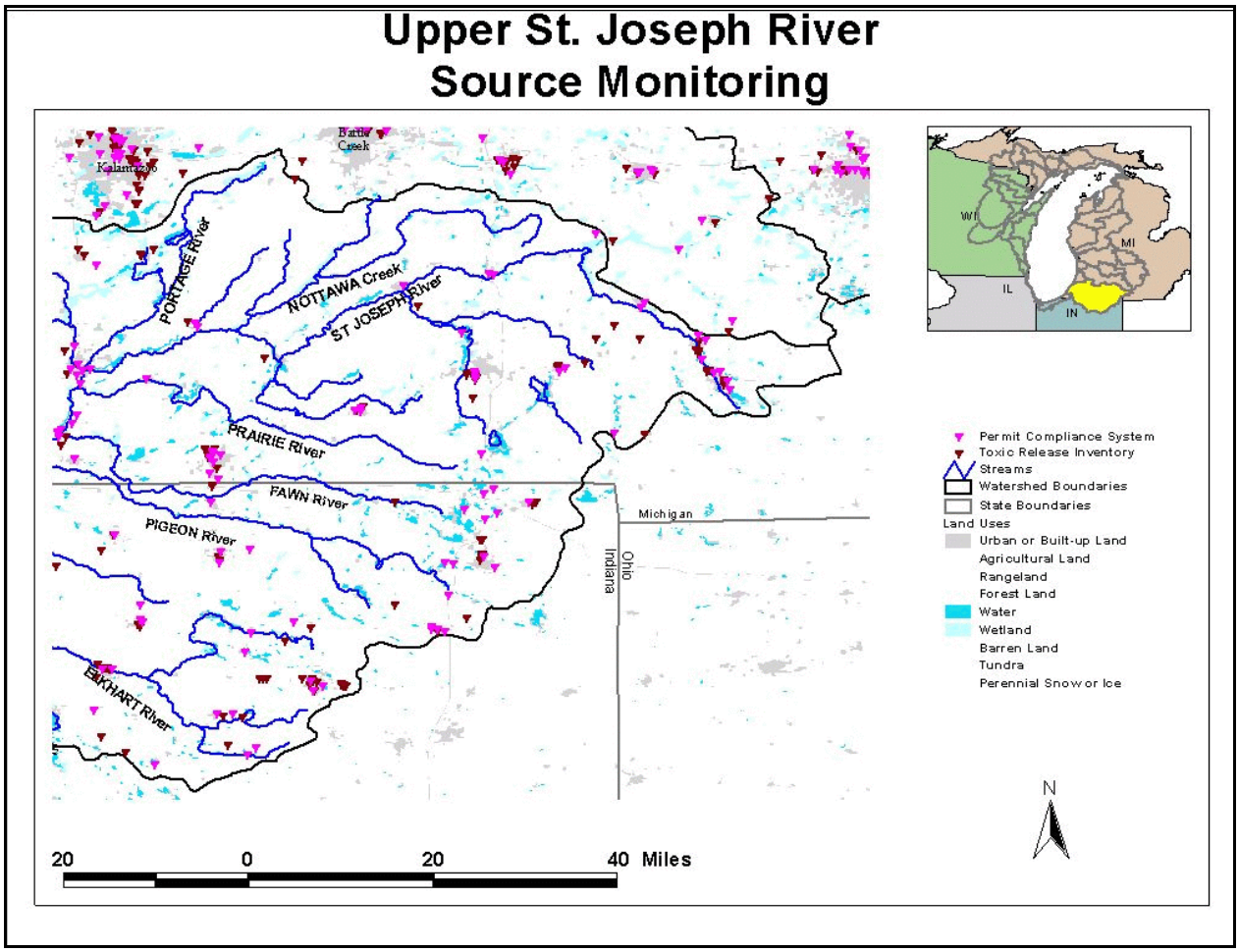

Figure 28. Upper St. Joseph River watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

Nutrients and Bacteria

There are nearly 700 water quality monitoring stations within the St. Joseph River watershed listed in the STORET system. A vast majority of these stations (shown in Figure 25 and Figure 26) monitor for some form of nitrogen and phosphorus, the chief nutrients impacting water quality. Thus, where monitoring stations exist, they are likely tracking nitrogen and phosphorus. The numerous stations are well-dispersed throughout the watershed with only a few gaps in coverage. The most significant of these gaps is the lower section of the Elkhart River. Outside these monitoring stations, Lake Michigan College and Michigan State University are both monitoring nitrogen and phosphorus levels in the watershed.

Five stations report to monitor for *E. coli* in the watershed – four along the St. Joseph and one on the Pigeon River (all within Indiana). All five stations are maintained by IDEM. Contrary to *E. coli* coverage, monitoring for fecal coliform is quite extensive throughout most of the watershed, especially at the outfall to Lake Michigan. The one exception to this is the complete lack of coverage of the Elkhart River and its tributaries. Organizations monitoring for fecal coliform in the watersheds include MDEQ, IDEM, USGS-WRD, and Lake Michigan University. The Berrien County Health Department also indicated that they monitor bathing beaches for "microbiologicals."

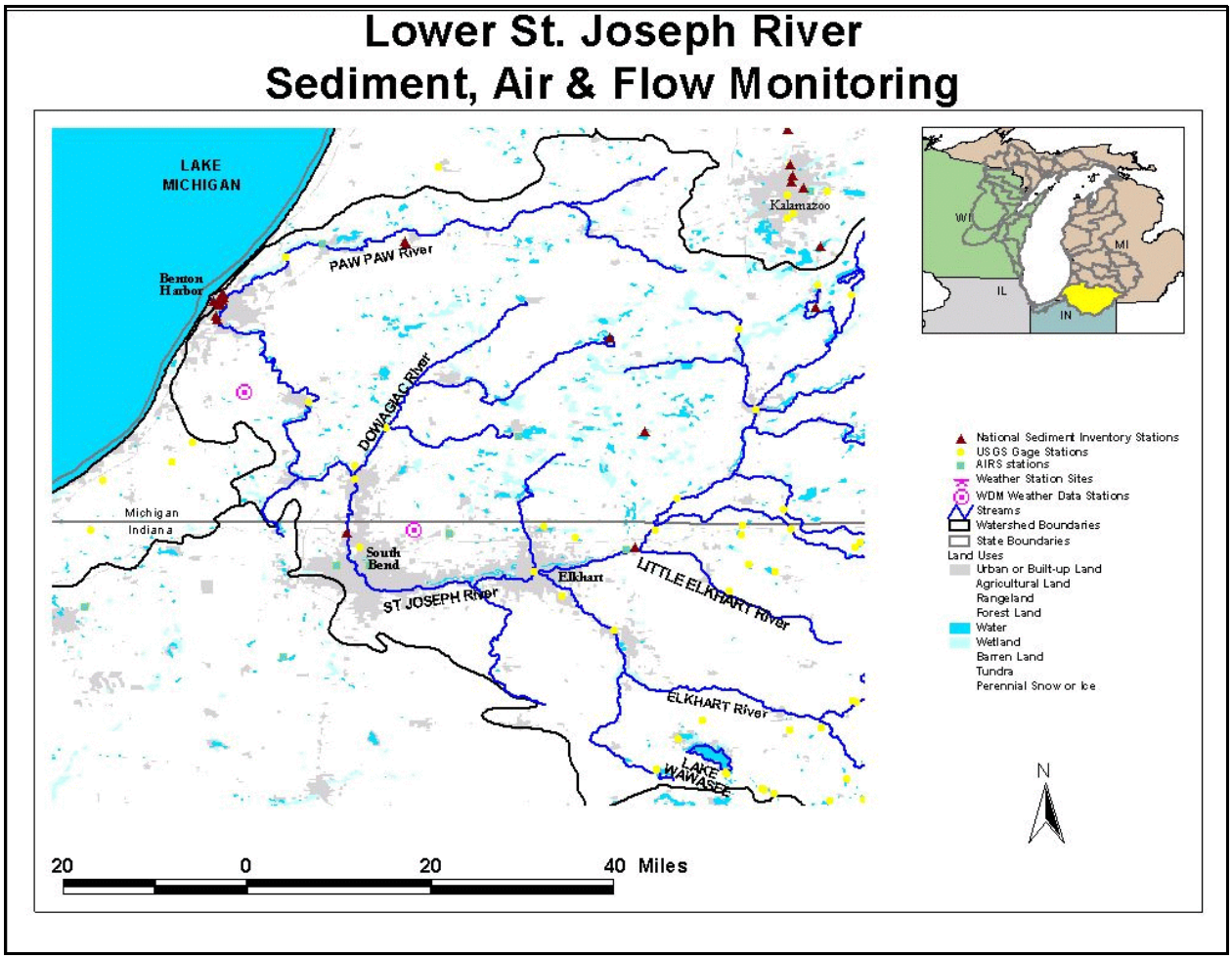

Figure 29. Lower St. Joseph River watershed with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

Meteorological and Flow Monitoring

USGS maintains a number of gage stations in the watershed to measure flow rates and various other physical characteristics of streams (see Figure 29 and Figure 30). A station is located on nearly all major rivers and streams in the watershed, however, the Paw Paw River contains only one station.

A program at Lake Michigan College also monitors physical stream conditions. Properties measured include pH, dissolved oxygen, suspended solids, and turbidity. The area covered was not included.

Two NOAA weather station are located in the St. Joseph watershed. One station is located in Berrien Springs, while the other is outside of South Bend. These stations measure continuous precipitation data, as well as other meteorological data.

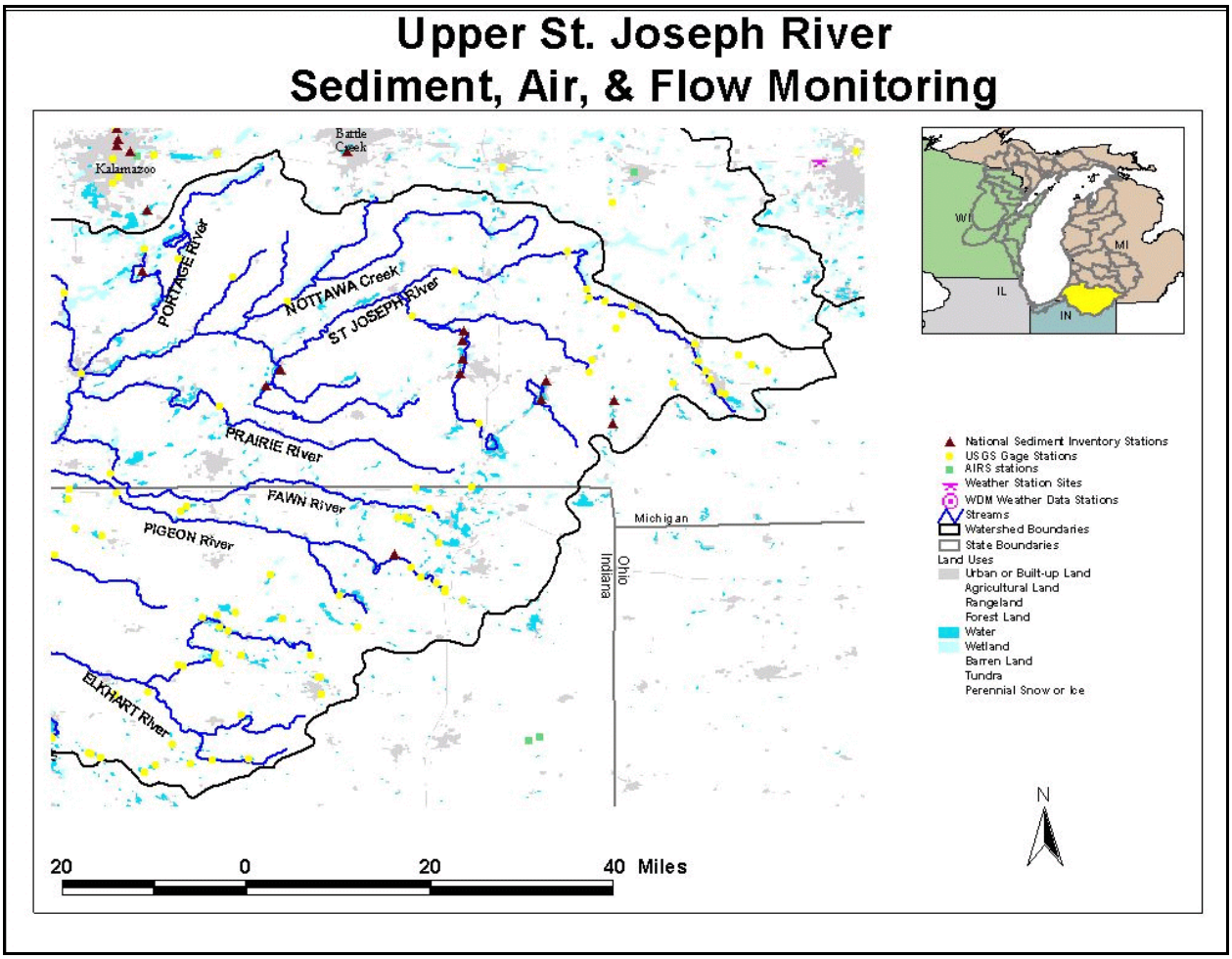

Figure 30. Upper St. Joseph River watershed with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

Sediments

There exist 33 National Sediment Inventory sites within the St. Joseph River watershed (see Figure 29 and Figure 30). There are clusters of stations at the outfall to Lake Michigan at Benton Harbor, and along the Coldwater River. These sites are administered by the MDEQ, IDEM, and U.S. EPA, Region 5. Thirty of the sites monitor sediment chemistry to assess human health and aquatic life impacts. The other three monitor benthic organism tissue, discussed below.

Fish Contaminants, Fish Health, and Aquatic Nuisance Species

As discussed earlier, we have been unable to find specific locational information (such as sampling locations) for programs monitoring fish populations or their health. There are statewide programs in existence, but these are discussed in the overall findings discussion. The National Sediment Inventory lists three stations that monitor fish tissue for bottom contamination. These are located on the St. Joseph and Pigeon Rivers, and are administered by IDEM.

A search of the Fish and Wildlife Advisory database on all major St. Joseph waterbodies revealed fish consumption advisories for seven locations in the watershed. Advisories had been issued for Pigeon Creek, Lake Wawasee, Portage Creek, Elhart River, and three sections of the St. Joseph River. The advisories were state issued and related to PCB and mercury levels in a wide variety of fish species.

No programs we discovered claimed to be monitoring for aquatic nuisance species specifically within the St. Joseph River watershed. Refer to the overall discussion of Lake Michigan monitoring for a discussion about programs that cover multiple tributary watersheds.

Benthos Monitoring

No specific locational information was discovered for state or national programs monitoring benthic organisms. However, the Friends of the St. Joseph indicated that they monitor benthic invertebrates throughout the watershed. Other organizations may be monitoring benthic organisms generally in the watershed, among others. These are discussed in the overall discussion of Lake Michigan monitoring.

Air Monitoring

Figure 29 and Figure 30 illustrate the locations of the ten air monitoring stations in the watershed, according to the U.S. EPA's AIRS database. All stations can be found in the western half of the watershed. The stations monitor for low-level ozone, particulate matter, and nitrogen dioxide.

Wildlife Monitoring

According to our surveys, three groups conduct wildlife monitoring of some form in the watershed. The Sarett Nature Center monitors birds and frogs near their center, and the Fernwood Nature Center monitors birds, mammals, and reptiles near theirs. In addition, the Wetlands Conservation Association tracks birds, reptiles, amphibians, and all endangered species in wetlands in several subwatersheds. There are other organizations monitoring wildlife species in the St. Joseph River watershed and others. These are discussed in the overall discussion of Lake Michigan monitoring.

Land Use

There are two major urban centers in the watershed — Benton Harbor, Michigan and South Bend to Elkhart, Indiana. In addition, there are several smaller developments in the watershed. Much of the rest of the watershed is managed as agricultural land. There are also several sections of wetland area in the watershed. These can be found in a region south of the Paw Paw River and north of the St. Joseph, and around the headwaters of the St. Joseph River and other tributaries (the eastern border of the watershed). There are numerous water quality monitoring stations within or near these wetlands, though few monitor for LaMP pollutants. In addition, the Wetlands Conservation Association tracks a variety of characteristics for wetlands in several subwatersheds in the basin.

Local Assessment

Based on the previous results, it appears that admirable and valuable contributions to the health of the St. Joseph watershed have been made and will continue to be made. It also seems that there are not significant monitoring resources being applied to address concerns regarding pollutants such as atrazine, mercury and perhaps others. However, the Parties to the Great Lakes Water Quality Agreement have determined that an

AOC designation for the St. Joseph watershed is not warranted. This puts the watershed at a disadvantage when competing for limited monitoring funding. The recent EPA mass balance study suggests that atrazine inputs from the St. Joseph River are high and require more analysis at the watershed level. This monitoring and analysis should be pursued with or without AOC designation.

Development pressures are obvious along the river especially in Berrien County with new housing developments occurring along the riverbanks. Riverfront property owners are reportedly not willing to participate in use of their property for "environmental use." However, it also has been shown that once the value of the flora and fauna of the river bottom land is explained, property owners can become appreciative of the unique qualities offered by the river environs. (Personal communication, Sarett Nature Center, Benton Township, MI.)

There are a considerable number of rather diverse organizations that have, at one time or another, spent considerable time and energy to provide St. Joseph River ecosystem studies. There seems to be an "army" of workers that work more or less independently. Overall effectiveness might be increased by watershed-wide unification of efforts into a long term managed plan consisting of well-defined objectives.

It was obvious that some programs directly involved with St. Joseph watershed monitoring contained a strong proprietary aspect that prevented sharing of information and this privacy preference was honored. These organizations are not identified further in this discussion.

Land Conservancies and Nature Centers

There are a number of positive findings in this assessment. For example, Sarett Nature Center, Benton Township, has acquired over 800 acres of land in the Paw Paw River area. The Paw Paw River flows into the St. Joseph River near Lake Michigan. This land, as part of the St. Joseph River watershed, will be preserved and protected in the future and used for diverse environmental education of a large number of individuals of all ages. This 800-acre island of environmental success has shown the advantage of pursuit of admirable long-term goals. Bird, plant, reptile and amphibian histories are available for over 25 years, but no water monitoring results are available. While 800 acres is a small parcel in the context of the larger watershed, it is quite an accomplishment when considering that this small nature center survives as an independent organization.

Similarly, the Southwestern Michigan Land Conservancy has acquired over 1000 acres within the last few years. Some, but not all of this land is in the St. Joseph River watershed, but it illustrates that obtaining land or the development rights serves the long term objective of ecosystem preservation. Land conservancy efforts are reportedly increasing in activity across the country. These efforts usually involve outright gifts of land to a conservancy or transfer of the development rights to the conservancy. Conservation easements are then placed on the land for future preservation of the ecosystem.

Fernwood Nature Center is located on the banks of the St. Joseph River near Niles, Michigan. Indigenous spring wildflowers are numerous and it has also maintained long term records of bird and animal life. It offers a diverse program of environmental education.

Love Creek Nature Center and County Park is located on Love Creek in Berrien Springs. Active programs in environmental education are on-going.

Water/River Monitoring
Certain types of effective monitoring assessments were found, or will begin soon, but it was not apparent that these programs have had time to develop into active watershed management in the form of "stabilizing", "corrective" or "progressive"actions. Volunteer or local programs that were designed to consistently, periodically and reliably monitor watershed health parameters over time that then have led to corrective or progressive action on the watershed were not evident in this survey. Programs such as Water Watchers appear to have had extensive river water monitoring in the past, but whether this work has lead to corrective or remedial action would require further research.

Friends of the St. Joseph River has begun an ambitious program, in conjunction with the MDEQ, to assess the benthic invertebrate population over the whole St. Joseph River watershed. This program will utilize the help of schools and other interested volunteers.

More than one organization has sponsored river cleanups. While river cleanups can't address contaminants such pesticides, heavy metals or herbicides, they can be valuable contributions of to watershed stewardship in this area. Friends of the St. Joseph River, the Hillsdale Rotary Club, Michiana Steel Headers and others participate in these cleanups. A clean landscape and riverscape comments strongly on feelings of the residents toward their home environment.

Considering the Michigan counties of Hillsdale, Calhoun, Branch, St. Joseph, Cass, and Berrien, as well as the Indiana counties of Elkhart and St. Joseph, only Berrien County responded to the survey to report any kind of water monitoring. The monitoring by Berrien County was related to bathing and swimming standards. While the Indiana DEM, Water Watchers and others monitor the river and lakes for various parameters in Indiana, it appears that little funding from the municipalities in the watershed is available for on-going analysis or monitoring of the St. Joseph River and its tributaries. It appears that these municipalities might monitor the river water for E. coli occasionally during periods of heavy rain, flooding, or unusual weather, but no consistent monitoring of any kind was reported in survey responses from the health departments of these counties.

Wetlands
Wetlands conservation is the goal of The Wetlands Conservation Association. Admirably, the goal of this organization is to maintain the integrity of wetlands.

Newspapers
Newspaper personnel seem to know the community and can point to groups that have been involved in environmental activities in the past. Most of the newspapers contacted were very willing to offer publicity for the watershed projects. For example, one of the Rotary Clubs along the St. Joseph River watershed had been involved in several river cleanups. This originally low-visibility project was bolstered interest and enthusiasm of other river cleanup groups created by media coverage. Interaction with newspapers was a positive experience and illustrate that newspapers and other media outlet should be utilized more in the future.

County Conservation Groups
Conservation groups seem to have a communications link with farmers and can offer advice on pesticide use, farming practices and land use – factors that can be important in pesticide and herbicide runoff. The St. Joseph River and Galien River Soil Conservation District offices provide these services.

9. Grand Calumet River

Background

The primary study area for this watershed was the Grand Calumet River/Indiana Harbor Canal Area of Concern. This area is located in northern Lake County, Indiana. It includes the Grand Calumet River, the Indiana Harbor Canal, Lake County portions of nearshore Lake Michigan, and Indiana portions of Wolf Lake. The Grand Calumet River watershed is difficult to define due to extensive historical ditching, filling, and sewering. The approximate size of the systems drainage basin is 67 square miles. The surveying efforts for the project focused on the Area of Concern. The larger watershed that encompasses Grand Calumet River includes the Grand Calumet and Little Calumet Rivers as well as the entire Indiana shoreline on Lake Michigan. Other tributaries in this larger watershed include the Galien River, Salt Creek and Deep River. This watershed is referred to as the Little Calumet-Galien watershed, and we will distinguish between references to the Grand Calumet River and the Little Calumet-Galien watershed. While local surveys focused only on the AOC, this report also evaluates monitoring projects found in the larger watershed.

Status of Watershed Management Efforts in the Study Area

Watershed Management efforts in the AOC have arisen out of the RAP process. Sub-watershed management plans have been created for the Wolf Lake Area and for the Grand Calumet Lagoons. Additionally several best management practices for reducing nonpoint source pollution have been installed at several locations throughout the system. Projects to build BMPs, explore greenway development, educate the public, inform private land owners and encourage watershed coordination have been sponsored throughout the AOC. Participants have included the Hammond Parks Department, the Hammond Department of Environmental Management, the Gary Parks Department, the City of East Chicago, the Natural Resource and Conservation Service, the Grand Cal Task Force, and the Indiana Toll Road Authority.

The RAP has provided a framework for cooperation and watershed management in this politically and naturally complex region. Unfortunately, implementation of watershed management principles remains fragmented across the jurisdictions of the cities and sanitary districts of Gary, Hammond, and East Chicago. Because of the highly industrial and urban nature of the watershed, regulatory permitting and remediation programs tend to receive more focus by the RAP than watershed planning and management activities.

Pollutants of Concern

Aquatic Monitoring

Monitoring coverage for LaMP pollutants reported into the STORET system is shown in Figure 31. These maps indicate that stations exist for two (mercury and PCBs) of seven critical pollutants, six out of ten pollutants of concern, and none of the listed emerging pollutants. Monitoring for all pollutants is heavy along the Lake Michigan shore and at the outfalls to the lake, but the coverage is quite sparse upstream. Three of the four major streams in the watershed (Deep River, Galien River, and Salt Creek) have almost a complete lack of monitoring activity, except at their outfalls. The stations monitoring for LaMP pollutants are maintained by MDEQ, IDEM, Illinois Environmental Protection Agnecy (IEPA), U.S. U.S. EPA (3 programs), the U. S. Army Corps of Engineers (COE), USGS-WRD, Purdue University, or the Chicago Metropolitan Sanitary District.

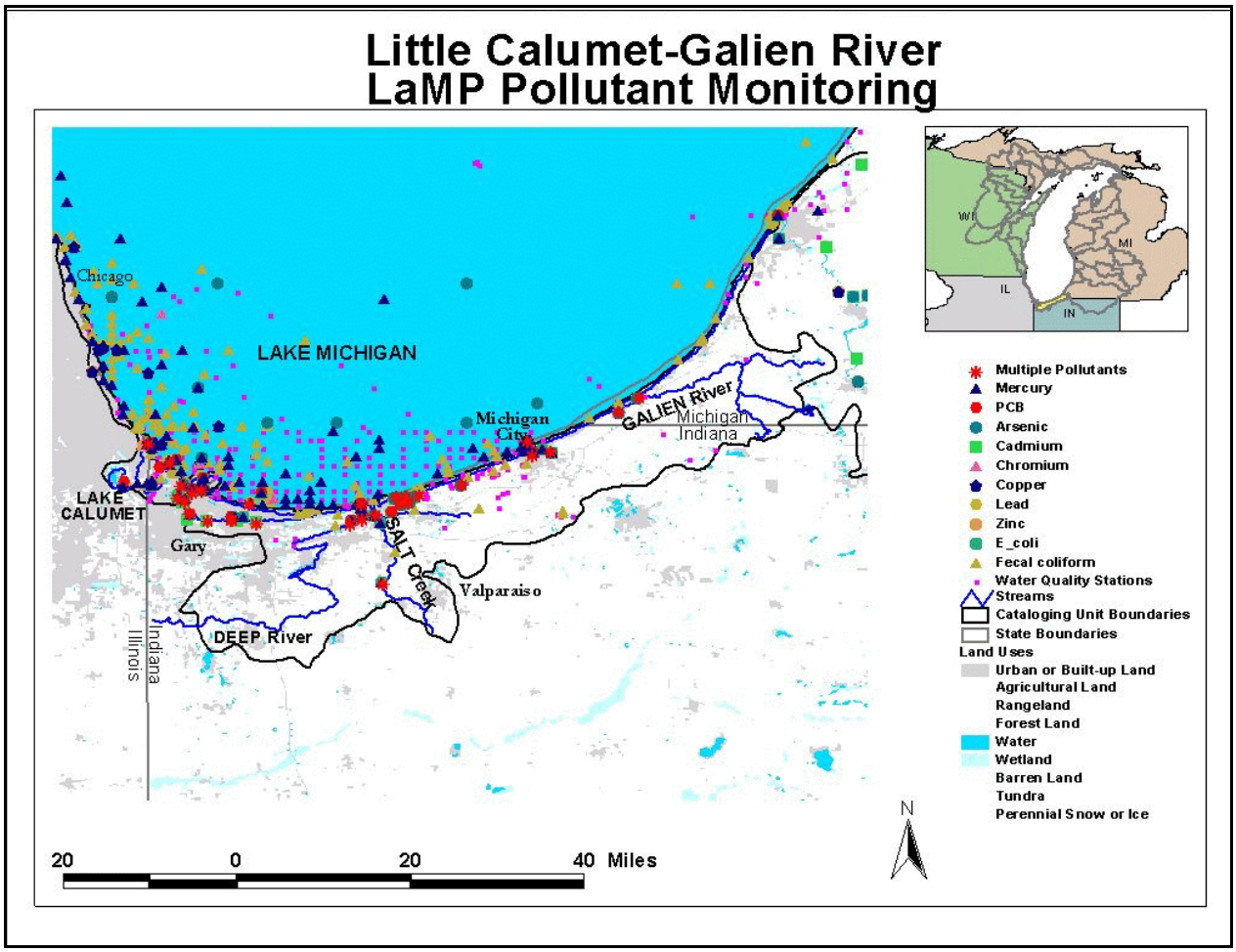

Figure 31. The Little Calumet-Galien watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

In addition, surveys indicate that the Office of Water within IDEM monitors for all LaMP pollutants with the exceptions of dioxins/furans, and atrazine. This monitoring includes over 100 stations within Lake Michigan watersheds within Indiana.

Pollutant Release Monitoring

An examination of Permit Compliance System and Toxic Release Inventory reporting locations in the Little Calumet-Galien watershed indicates a large number of potential pollution sources throughout the watershed (see Figure 32). This includes nearly 100 potential point sources in the Lake Calumet-Gary region alone. Other clusters of point sources can be found along Salt Creek, and around Michigan City, Indiana.

Nutrients and Bacteria

There are nearly 250 water quality monitoring stations within the Little Calumet-Galien watershed listed in the STORET system. A vast majority of these stations (shown in Figure 31) monitor for some form of nitrogen and phosphorus, the chief nutrients impacting water quality. Thus, where monitoring stations exist, they are likely tracking nitrogen and phosphorus. The majority of the stations in the watershed are located along the Lake Michigan shoreline. Very few stations exist inland from the lake shore.

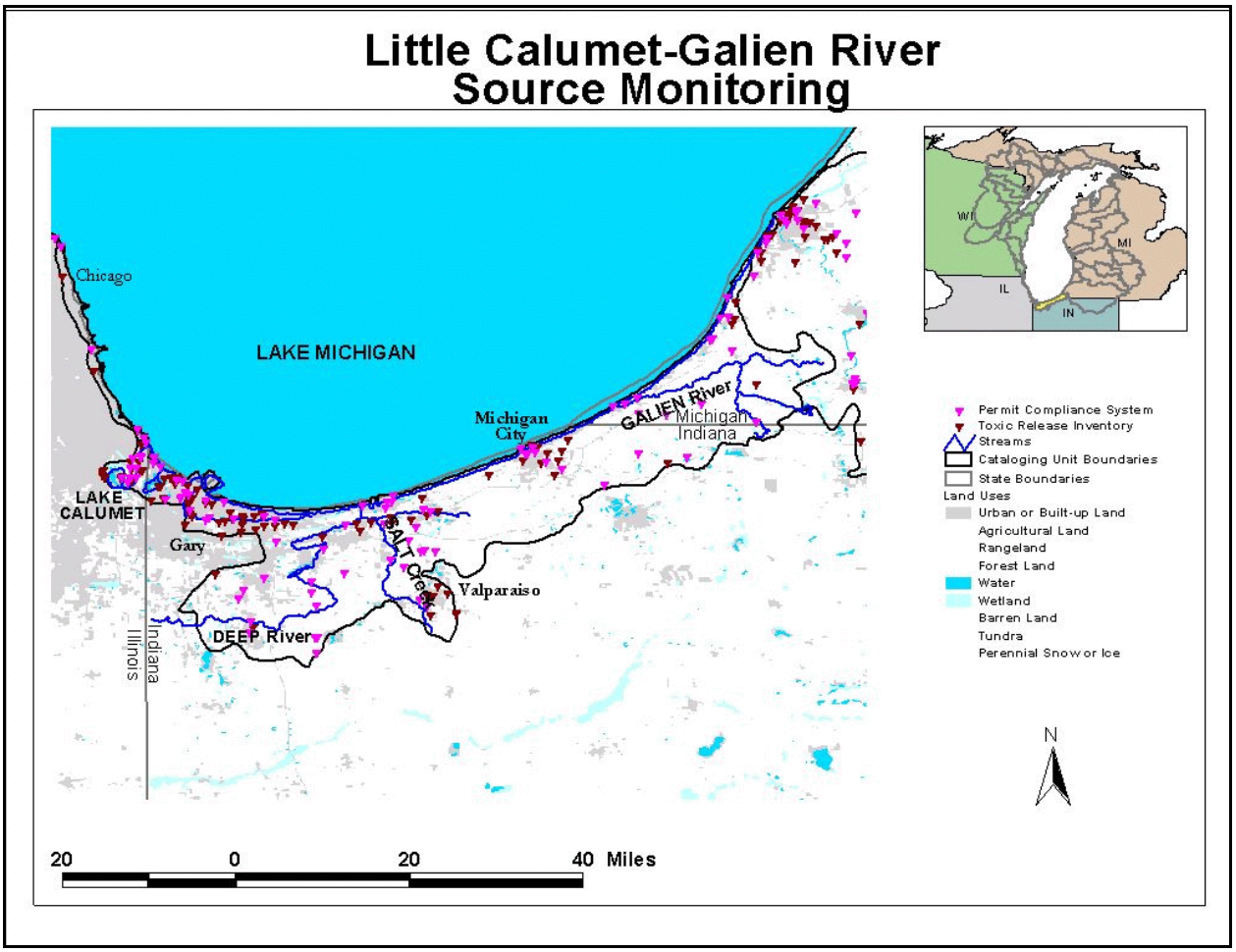

Figure 32. Little Calumet-Galien watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

Seventeen stations report to monitor for *E. coli* in the watershed – most clustered in Gary, Michigan City, and at the lower reaches of the Deep River and Salt Creek. All 17 stations are maintained by IDEM. IDEM also reports that they monitor *E. coli* at 80 sites in Lake Michigan watersheds in general. Monitoring for fecal coliform is significantly more extensive. Greater than 100 stations can be found throughout the watershed. As with other monitoring coverage in the watershed, monitoring of fecal coliform levels is clustered along the Lake Michigan shore and at outfalls to the lake. No stations exist in upstream reaches of either the Deep River or Galien River. Organizations monitoring for fecal coliform in the watersheds include MDEQ, IDEM, IEPA, USGS-WRD, U.S. EPA, COE, and Chicago MSD.

Meteorological and Flow Monitoring

USGS maintains 15 gage stations in the watershed to measure flow rates and various other physical characteristics of streams (see Figure 33). Gage stations are located on all major rivers and streams in the watershed.

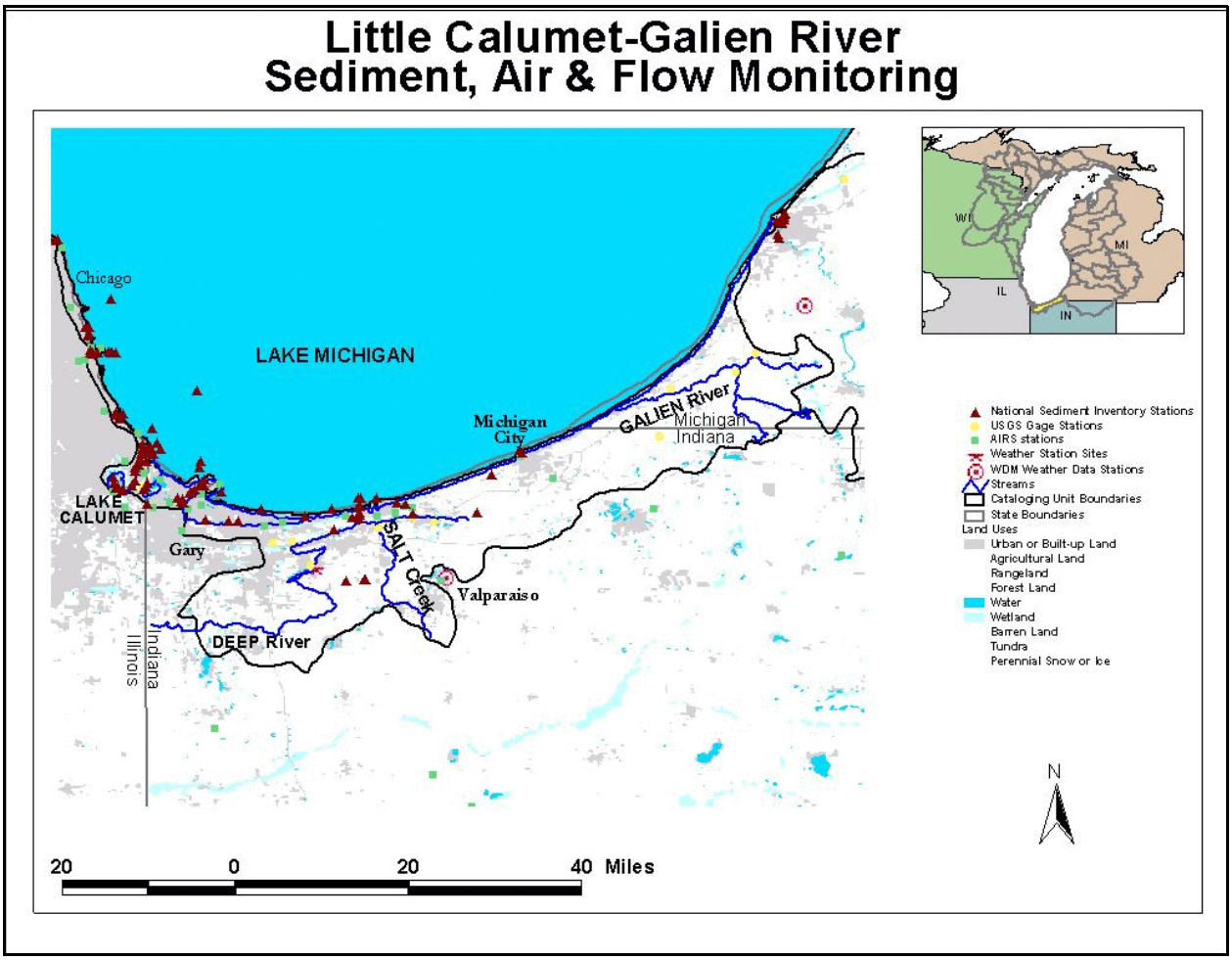

Figure 33. Little Calumet-Galien watershed with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

IDEM also reported that they monitor numerous physical properties in streams throughout Indiana's Lake Michigan watersheds. Properties measured include temperature, pH, alkalinity, conductivity, dissolved oxygen, chemical and biological oxygen demand, suspended solids, hardness, and turbidity.

One NOAA weather station is located in the Little Calumet-Galien watershed, and two others are just outside its boundaries. The station inside the watershed is located in Hobart, while the stations outside the watershed are located in Valparaiso and Berrien Springs. These stations measure continuous precipitation data, as well as other meteorological data.

Sediments

There are 84 National Sediment Inventory sites within the Little Calumet-Galien watershed (see Figure 33). Most of these sites are located in Lake Calumet, along the Grand Calumet River, and in and around Gary. These sites are administered by the IDEM, IEPA, USGS-WRD, COE, and U.S. EPA. All but eight of the sites monitor sediment chemistry to assess human health and aquatic life impacts. A total of 12 sites monitor benthic organism tissue, discussed below.

Fish Contaminants, Fish Health, and Aquatic Nuisance Species

As discussed earlier, we have been unable to find specific locational information (such as sampling locations) for programs monitoring fish populations or their health. There are statewide programs in existence, but these are discussed in the overall findings discussion. The National Sediment Inventory lists 12 stations that monitor fish tissue for bottom contamination. These are located throughout several areas of the watershed, and are administered by IDEM and U.S. U.S. EPA. IDEM specifically indicates that they monitor fish tissue a numerous undefined locations. At the same time IDEM monitors species, trophic composition, feeding and reproductive guilds, and fish condition and health.

A search of the Fish and Wildlife Advisory database on all major Little Calumet-Galien waterbodies revealed fish consumption advisories for three locations in the watershed. Advisories had been issued for the Grand Calumet River, Galien River, and Salt Creek. The advisories were state issued, covered all fish species and related to PCB, mercury, and chlordane levels.

No programs we discovered claimed to be monitoring for aquatic nuisance species specifically within the Little Calumet-Galien watershed. Refer to the overall discussion of Lake Michigan monitoring for a discussion about programs that cover multiple tributary watersheds.

Benthos Monitoring

No specific locational information was discovered for state or national programs monitoring benthic organisms. However, IDEM reports that they collect macroinvertebrate data (including community composition, and structural and functional integrity) in numerous locations throughout Indiana's Lake Michigan watersheds. Other organizations may be monitoring benthic organisms generally in the watershed, among others. These are discussed in the overall discussion of Lake Michigan monitoring.

Air Monitoring

Figure 33 illustrates the locations of the 65 air monitoring stations in or within five miles of the watershed, according to the U.S. EPA's AIRS database. A majority of the stations are clustered in the Lake Calumet-Gary region. The stations monitor for seven of eight indicators in the database, including low-level ozone, particulate matter, nitrogen dioxide, carbon monoxide, sulfur dioxide, and lead.

Wildlife Monitoring

According to our surveys, one group conducts wildlife monitoring of some form in the watershed. The Save the Dunes Conservation Fund monitors a variety of indicators of birds species health in the Miller Woods section of the Indiana Dunes National Lakeshore, near Gary. There are other organizations monitoring wildlife species in the Little Calumet-Galien watershed and others. These are discussed in the overall discussion of Lake Michigan monitoring.

Land Use

A substantial portion of the watershed exists as developed or urbanized land. This includes the major industrial city of Gary as well as Michigan City, and a portion of South Chicago. Much of the rest of the watershed is managed as agricultural land. There are relatively few sections of wetland area in the

watershed, though there are some around Lake Calumet. These wetlands are surrounded by highly developed land. These wetlands appear to be heavily monitored.

Local Assessment

Monitoring results generated by the various programs of the IDEM, OWM Assessment Branch, have been used in developing the RAP. In particular, the monitoring information has helped the RAP to identify sediment remediation as a high priority for the AOC. Monitoring results have also been used by IDEM to develop the 303(d) list and to begin the TMDL process. The Grand Calumet TMDL has been given a high priority and early scheduling largely as a result of the RAP. Other monitoring efforts are the results of recommendations of the RAP. The formation of the E. coli Task Force and continuation of its monitoring efforts is partly driven by the AOC's beach closure beneficial use impairment. In addition to the monitoring results reported in this survey, IDEM believes that additional information collection is occurring by other RAP partners that did not get reported in the surveys. The Nature Conservancy and Shirley Heinze Fund have many acres of properties that they preserve and maintain. These organizations collect information on their properties to inform their management decisions. The Indiana DNR has recently completed a study updating the Indiana Natural Heritage Database for the region. However, this type of data is often collected in short term or intermittent fashion. This may be why surveys on monitoring programs where not completed. However, this information is shared and utilized in the RAP process through the participation of experts from these organizations.

In the Grand Calumet AOC, there appears to be significantly more information available regarding some beneficial use impairments than others. For example, while IDEM has been collecting fish tissue data for years, some impairments were listed based short term historical studies or anecdotal evidence. Many of these have no current regular monitoring program in place. This could make monitoring progress and delisting difficult. This project found no evidence of monitoring programs in place which would regularly detect changes in BUI 5: Bird or Animal Deformities or Reproductive Problems, BUI 8: Eutrophication, BUI 11: Degradation of Aesthetics, BUI 12: Added Costs to Agriculture and Industry, or BUI 13: Degradation of Phytoplankton and Zooplankton Populations.

In general federal and state monitoring programs have been the primary information sources for the RAP. For the most part, this information has been made available for the RAP. Availability difficulties sometimes arise when data is being collected related to specific enforcement cases. Legal processes can delay public access to this information. Quality assurance procedures set up by agencies to ensure the validity of data can also delay its dissemination to the end users.

Other information sharing problems are geographic, much historical data is kept in Indianapolis in paper files. This makes it difficult for the Northwest Indiana public to access this information. Much of this information has been shared with EPA and is in the STORET database, however this system has not been easily accessible to the public in the past. Conversion of STORET to an internet based system should improve access to this data.

Due to the high levels of contamination in the sediment of the Grand Calumet River, volunteer monitoring efforts in the AOC have been virtually non-existent. However, IDEM is aware that several school programs have participated in volunteer monitoring in other Lake Michigan tributaries in Indiana. However, tracking down the contact persons for these programs has proven difficult. The Hoosier River Watch Program, housed at the Indiana DNR is in the process of developing a web site which will enable better coordination and sharing of data by participants in volunteer monitoring programs. This will also help the data be more accessible for watershed planning efforts in the region.

In general, further development of the internet as a tool for data dissemination has tremendous potential to improve utilization of data which is currently collected by federal and state agencies. GIS tools also present great opportunities to make data more understandable and useable for watershed planning and management. However, legal concerns, quality assurance procedures, staff and budget constraints may result in delays in posting results of current monitoring efforts. Costs to convert existing monitoring records into internet accessible databases may be prohibitive, and are unlikely to be high priorities for public agencies under strict fiscal constraints.

Local agencies, private organizations, non-profits, and the general public participating in monitoring projects have even greater obstacles to overcome. Many of these organizations are ill equipped for online data sharing and access. The E. coli Task Force developed a Volunteer Monitoring Network which collects and analyzes watershed samples for e. coli on a weekly basis during the summer months. Participants in this network are local health departments, sanitary districts, POTWs, industries, and state and federal parks. Many of these organizations were not equipped with modern computers or internet access when the project started. Some of these agencies have since upgraded their capabilities, but some continue to fax hand written data sheets to IDEM or EPA staff. The Task Force is in the process of applying for an EMPACT grant to obtain computers and internet access to those agencies. At the same time, EPA is working to establish an internet database. This will enable Network members to share data. Eventually it will also provide the public with access to recent bacteria sampling results in their area. If the internet is to be the mechanism governments use to share information with each other and the public, then greater investment must be made to ensure that all partners have equipment and training to access this new technology.

A terrific opportunity for better coordination of informational resources exists in state and federal agency management of data received from outside partners and the regulated community. In Indiana, IDEM is making great strides to try and make its monitoring data more available. However, little is currently being done to make data submitted by the regulated communities usable. For example, through the TMDL process we have learned that NPDES regulated dischargers have submitted vast quantities of data to IDEM through monthly reports, daily monitoring records, permit renewal applications, and special projects. Once received at IDEM, this data is reviewed for permit compliance, and monthly data is entered into the Permit Compliance System Database. However, other data is simply filed and eventually stored on microfiche. This maybe the case in other states as well. Working on the TMDL, we have found it is often easier to ask the permittees for electronic copies of this data again than to try and extract it from our own filerooms. The daily monitoring records of industrial and municipal dischargers could provide valuable clues to the sources of loadings measured and modeled in the Lake Michigan Mass Balance. This information will be critical to future efforts to reduce pollutant loadings to Lake Michigan. Agencies have it, but it is not in a usable format at the current time.

Conclusions

This project has not collected as much information about ongoing monitoring programs in the area of concern as was initially hoped. One obvious cause of this problem was an initial misinterpretation on the part of IDEM as the goals of the project. However, other important lessons were also learned.

Future efforts might do well to focus on the distinctions between ongoing monitoring programs and short term data collection projects. Large quantities of information may be gathered by academic researchers, consultants, and others during short term projects. Much of this information may not be captured by a survey about monitoring. Also, a better ability to adapt the survey into the jargon of different fields may have resulted in more responses. Monitoring tends to be a term associated with more closely with chemical sampling than other areas of data collection.

Finally, there is a critical distinction that could be made between two types of problems related to monitoring. The focus of this project has been on discovering what monitoring is occurring with an eye to future coordination of these efforts. Many of the problems identified through research on this project seemed to revolve around data sharing. These two issues are separate, but intertwined. Improving data sharing capabilities may be first key step in moving toward better coordinated monitoring.

10. Waukegan Harbor

Background

This unique study area includes the Waukegan Harbor and the two branches of the Waukegan River that flow into Lake Michigan south of the harbor. It includes the north branch west to Yeoman Park and the south branch west to Lincoln Avenue.

The Waukegan AOC is located in Lake County, Illinois, on the west shore of Lake Michigan. There is also an Expanded Study Area (ESA) bounded by Dead River on the north, a bluff line which parallels Sheridan Road on the west, the southern boundary of the former U.S. Steel Property on the south, and the nearshore waters of Lake Michigan on the east. The ESA was added to explore additional concerns of the citizens beyond the AOC.

A natural inlet and portions of adjacent wetlands were filled to form the present shape of the harbor. Waukegan Harbor consists of approximately 1.2 km^2 of industrial, commercial, municipal and open/vacant lands. The watershed of the Waukegan ESA contains the Waukegan River drainage basin, the North Ditch drainage basin and other nearshore areas which drain to Lake Michigan.[2]

Status of Watershed Management Efforts in the Study Area

The Waukegan Harbor Citizens Advisory Group was organized in August, 1990, to help citizens and business leaders concerned about the harbor environment develop plans to identify and clean up contaminated harbor properties. The CAG is composed of business, fishing, recreation, environmental, government, and other interested groups and individuals. They formed a partnership with the Illinois Environmental Protection Agency to develop a two-part plan, the Waukegan Harbor Remedial Action Plan, detailing use impairments and how these impairments could be restored through a cooperative effort. In July 1999 the Stage III Report[3] was completed. This report is the most complete compendium and analysis of monitoring information for Waukegan Harbor. Considerable monitoring information exists for the Waukegan Harbor and Waukegan River Watershed area. Most monitoring information supports a project or specific investigation to resolve a problem.

Pollutants of Concern

Aquatic Monitoring

Monitoring coverage for LaMP pollutants reported into the STORET system is shown in Figure 34. The map indicates that there is very little coverage of LaMP pollutant monitoring in the AOC region. Stations exist for two (mercury and dieldrin) of seven critical pollutants, four out of ten pollutants of concern, and none of the listed emerging pollutants. However, the only monitoring close to Waukegan Harbor is for arsenic. There is no monitoring for these pollutants on Waukegan River. Organizations monitoring for LaMP pollutants in the region include IEPA, and U.S. EPA.

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[2]Excerpted in part from the Waukegan Harbor AOC website (http://www.epa.gov/glnpo/aoc/waukegan.html).

[3]*Final Stage III Report, Waukegan Harbor Remedial Action Plan*, Illinois Environmental Protection Agency, July 1999.

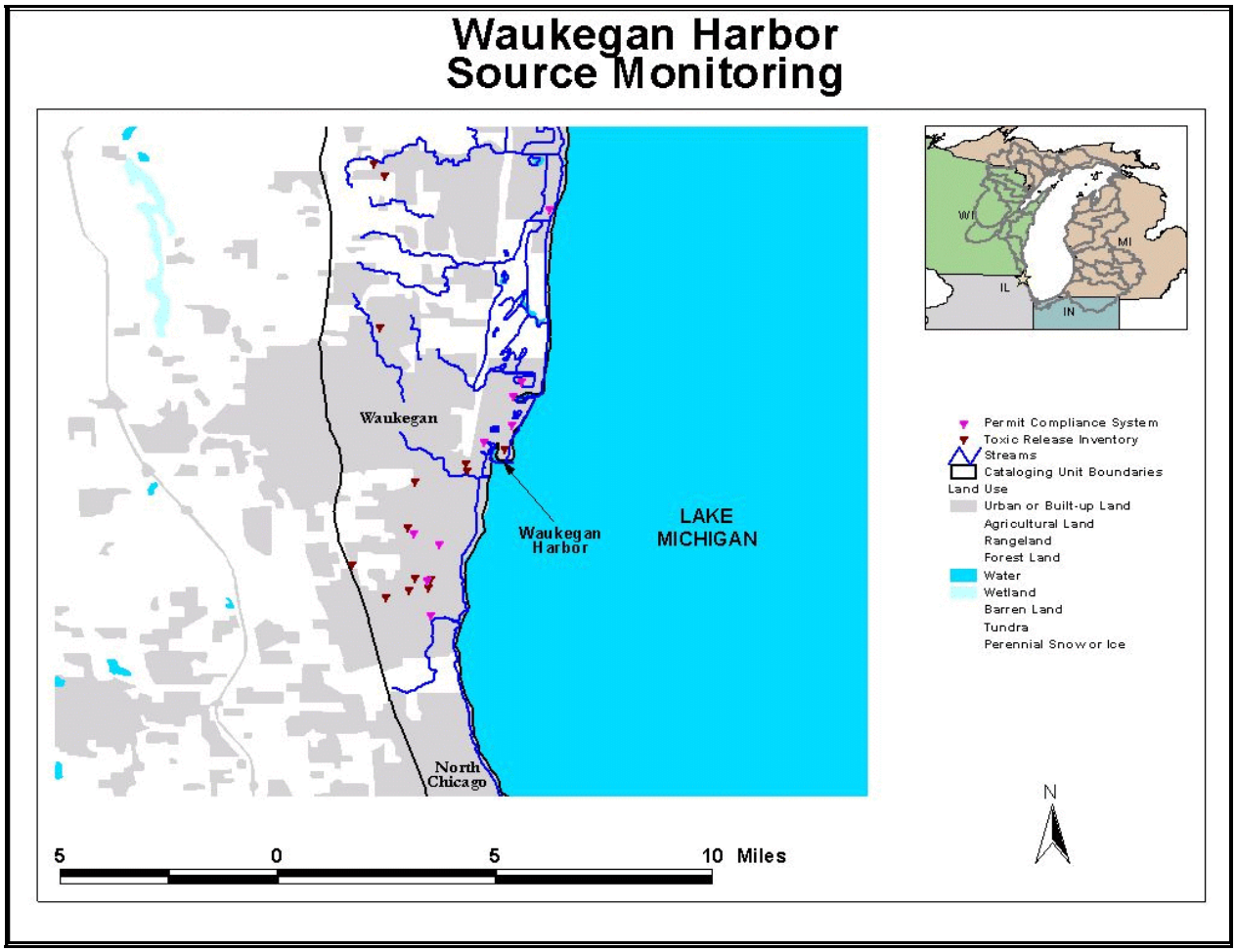

Figure 35. Waukegan Harbor AOC with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

Figure 34. The Waukegan Harbor AOC with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

In addition, surveys indicate that three other organizations monitor LaMP pollutants in the AOC to some extent. The Outboard Marine Corporation and the Illinois State Water Survey monitor PCBs at sites throughout the AOC, while EJ&E Railway Company monitors groundwater for mercury, lead, cadmium, zinc, and chromium at a site adjacent to the Waukegan River.

Pollutant Release Monitoring

An examination of Permit Compliance System and Toxic Release Inventory reporting locations in the Waukegan Harbor AOC indicates a number of potential pollution sources near the harbor and along Waukegan River as well (see Figure 35).

Nutrients and Bacteria

The IEPA maintains 22 water quality monitoring stations within the Waukegan Harbor AOC, as listed in the STORET system. Nearly all of these stations (shown in Figure 34) monitor for some form of nitrogen and phosphorus, the chief nutrients impacting water quality. Stations are located all around Waukegan Harbor as well as along the Waukegan River.

Prior to the year 2000, no stations report to monitor for *E. coli* in the watershed. Currently, some county health departments favor using fecal coliform over *E. coli*. Monitoring for fecal coliform is significantly

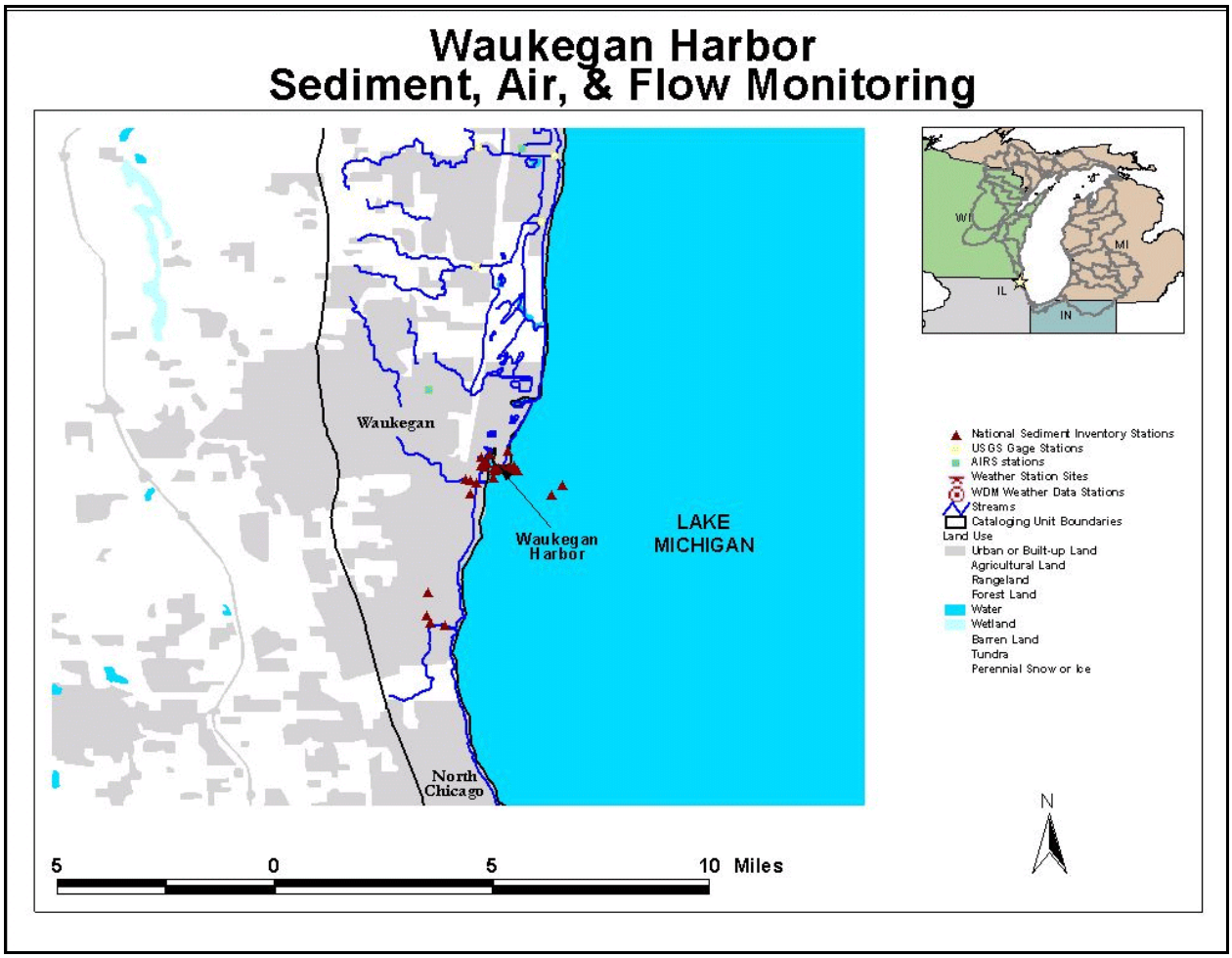

Figure 36. Waukegan Harbor AOC with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

more extensive. IEPA maintains 16 stations around Waukegan Harbor and along the Waukegan River that track this bacteria. In addition, the North Shore Sanitary District conducts bacteria counts at locations along Waukegan's beaches, and the Lake County Health Department monitors fecal coliform at several locations along Illinois beaches and along several unspecified rivers.

Meteorological and Flow Monitoring

USGS maintains a number of gage stations in the area to measure flow rates and various other physical characteristics of streams (see Figure 36). However, none of these stations are located in the AOC.

IEPA monitors numerous physical properties of Waukegan Harbor and River. Properties measured include temperature, pH, alkalinity, dissolved oxygen, biological oxygen demand, suspended solids, hardness, and conductance. The Outboard Marine Corporation, EJ&E Railway Company, and the Illinois Ecowatch Network also monitor several of these characteristics at their locations.

There are no NOAA weather stations located in the Waukegan Harbor AOC.

Sediments

There are 26 National Sediment Inventory sites located around Waukegan Harbor (see Figure 36). Most of these sites are administered by the COE, but some are also administered by IEPA, and U.S. EPA. All but one of the sites monitor sediment chemistry to assess human health and aquatic life impacts. The other site monitors benthic organism tissue, discussed below.

Fish Contaminants, Fish Health, and Aquatic Nuisance Species

As discussed earlier, we have been unable to find specific locational information (such as sampling locations) for programs monitoring fish populations or their health. There are statewide programs in existence, but these are discussed in the overall findings discussion. The National Sediment Inventory lists one station that monitors fish tissue for bottom contamination in Waukegan Harbor. This station is administered by U.S. EPA. Two additional agencies monitor fish characteristics in the AOC. The Illinois Natural History Survey measures abundance of near shore fishes, and the Illinois Department of Natural Resources conducts the Waukegan River Fish Inventory.

A search of the Fish and Wildlife Advisory database on Waukegan Harbor and River, but no fish consumption advisories were listed. The Stage III RAP reports that fish advisories specific to Waukegan Harbor were lifted in February 1997. Fish consumption advisories are now no different than those for Lake Michigan as a whole. (See Stage III RAP, Section 2.1.1 for more details).

No programs we discovered claimed to be monitoring for aquatic nuisance species specifically within the Waukegan Harbor AOC. Refer to the overall discussion of Lake Michigan monitoring for a discussion about programs that cover multiple tributary watersheds.

Benthos Monitoring

No specific locational information was discovered for state or national programs monitoring benthic organisms. Other organizations may be monitoring benthic organisms generally in the area. These are discussed in the overall discussion of Lake Michigan monitoring. The Stage III RAP lists a number of benthic studies conducted in the AOC from between 1972 through 1996. Please refer to Section 2.1.6 of that document for more information.

Air Monitoring

Figure 36 depicts the single air monitoring station located in Waukegan, according to the U.S. EPA's AIRS database. That station monitors low-level ozone for the area. In addition, the Northeast Illinois Planning Commission (NIPC) studies the potential contributions of air contaminants to water pollution in the six county area of northeastern Illinois.

Wildlife Monitoring

According to our surveys, one group conducts wildlife monitoring of some form in the watershed. Bird Studies Canada tracks Marsh Bird and Amphibian Communities in the Waukegan Harbor AOC. There are other organizations monitoring wildlife species in the state. These are discussed in the overall discussion of Lake Michigan monitoring.

Land Use

The AOC is almost entirely composed of urbanized land. Parts of Waukegan Harbor existed as wetland in the past, however these were altered to form the current configuration of the harbor. Within the AOC, the Metropolitan Water Reclamation District conducts a land-use runoff sampling program. The Lake County Storm Water Management Commission (http://www.co.lake.il.us/smc/) conducts the Lake Michigan Watershed Assessment of Uses And Use Impairments. The Northeastern Illinois Planning Commission (NIPC — http://www.nipc.cog.il.us) conducts on-going land use studies of the surrounding region. Others studying land use in the Waukegan Harbor AOC include Sanborn Map and Publishing Co., Limited, Consoer, Townsend and Associates, Inc., the North Shore Sanitary District, the Lake County Storm Water Management Commission, and NIPC.

Local Assessment

The above referenced items have been used in developing the RAP. The Waukegan RAP, Stages 1 and 2 referenced one monitoring program that is not reported in this document. That is the North Shore Sanitary District Investigation into the Source of Elevated Coliform Bacteria Counts at Waukegan Beaches which is now monitored by the Lake County Health Department.

As an overview, the IEPA and the USEPA developed site specific monitoring/testing programs to address problems in the Waukegan Harbor and River areas. Prior to 1990 there were few monitoring programs addressing problems in the AOC. The Northeastern Illinois Planning Commission (NIPC) formerly had several water quality and stormwater management assessments and evaluations. The starting point seems to be the U.S. Environmental Protection Agency (USEPA), 1977 Guidelines for the Pollution Classification of Great Lakes Harbor Sediments, U.S. Environmental Protection Agency, Region V, Chicago, IL April 1977. However, there were few consistent monitoring programs until the Waukegan RAP was initiated.

Federal and state monitoring programs have been adequate, timely (but often delayed, usually because of funding) and accessible because of the Waukegan RAP. The Plan agreed to by the IEPA, U.S. EPA and Corps of Engineers and the Waukegan Harbor CAG identified properties to be remediated along with the Harbor, and initiated a monitoring plan to work in solving AOC problems. The RAP focused the problems, and with the tenacity of the IEPA in a partnership with the Waukegan Harbor CAG methodically planned and coordinated the monitoring requirements.

Local monitoring programs have been ongoing (Lake County Health Department), but new initiatives are needed such as consistent Waukegan River water quality monitoring and bringing adjacent properties up to code for allowable discharges.

Delays in funding the monitoring programs have stretched the time to completion of studies and programs to restore impaired uses, though they have not delayed completion of the RAP documents. This has led to a considerable degree of frustration for the CAG, and resulted in the CAG initiating political action directed to responsible county, state and federal officials.

The monitoring information for the five Impaired Uses identified in the RAP has generally been available but sometimes delayed due to funding. The CAG, because of its close working relationship with the IEPA, is able to request updated monitoring information on specific Impaired Uses and receive it in a timely manner. Also, the state provides many reference documents such as the Stage III RAP.

Some of the unmet /upcoming needs for the Waukegan Harbor and River watershed are:

- A plan for future monitoring programs for restored AOC properties and the harbor.
- Increased Harbor and River wetland monitoring and restoration.
- Non-point pollution such as the potential coming from "peaker" power plants being proposed for various locations in Lake County and west.
- The above itemized monitoring responses indicate specific and different niches occupied by the various respondents. The need exists for integration of their federal and state EPA monitoring data with those currently being obtained by private organizations and other governmental entities.
- With the planned restoration of Waukegan Harbor and properties and with the proposed restoration of the downtown area, there are emerging issues that will require change in types of monitoring. Future monitoring programs will change from being reactive to a known problem to proactive or preventive. Monitoring results are the indicators that a neighborhood is safe and a strong economic incentive for future investors and developers. There may occur a new kind of support for watershed management if, for example, a local organization such as a school or environmental group actively participates in planning future restoration and new uses such as walkways and/or bike trails for the improvement of these community resources. "Ownership" of the solution by local residents could offer the best benefits to the groups' interests. One of the purposes of the RAP is to include these local needs.

Monitoring information can be better utilized and disseminated if the information is included in links to many websites so that groups can see timely reporting of the results of their efforts and coordinate them in order to avoid duplication.

Coordination and expansion opportunities exist with the following organizations:

- **Lake County Stormwater Management Commission** has the professional staff, computer databases including GIS for watershed planning, training, and implementation of programs.
- **Shimer College, Waukegan, IL** Don Rose, President (expressed interest in college becoming involved in monitoring programs).
- **Waukegan High School, Waukegan, IL** Rob Allen, Science Chair (expressed interest in a high school monitoring program).

Other Comments
Some of the information gathered from contacts through this project are as follows.

1) Bird Watchers consider Waukegan Harbor one of the best areas in the state for birding.

2) Two birdwatch contacts listed in the database have a significant amount of bird information regarding bird sightings in the harbor including the annual "Christmas Bird Count." Unfortunately they did not respond to the survey request.

3) Waukegan Harbor's sediment test sample information is stored in the basement of the Waukegan Harbor Port Authority.

4) According to Lake County Wetland Inventory there are 29.5 wetland acres in the Waukegan River watershed. The net amount of floodplains, wetlands, and greenways is 599 acres according to NIPC 1990 statistics.

5) One of the outreaches that should be considered is a speakers' bureau which will consist of experts who will be available to present the Waukegan Harbor Success Story to the many groups in the area which are constantly seeking speakers for their programs.

11. Milwaukee River and Estuary

Background

The Milwaukee River basin covers approximately 850 square miles including portions of Milwaukee, Waukesha, Washington, Ozaukee, Dodge, Sheboygan, and Fond du Lac counties. There are six watersheds that comprise the Milwaukee River basin — the East-West, North, and South Branches of the Milwaukee River, along with the Menomonee River, and the Kinnickinnic River. The surface waters in the Basin include 430 miles of perennial streams, 60,000 acres of wetlands and 87 lakes and ponds that are five acres or larger. Over 1.5 million people reside within the drainage area in 14 cities, 23 villages, and 31 townships. Although not the largest, the Milwaukee River basin is by far the most populated basin that flows directly into Lake Michigan. The most densely populated area is located within the drainage basin of the Milwaukee Estuary and contributes a disproportional amount pollution, leading to its designation as an Area of Concern (AOC). The AOC is located within the following boundaries: the lower Milwaukee River downstream of the North Avenue Dam, the lower Menomonee River downstream of 35th Street, the lower Kinnickinnic River downstream of Chase Avenue, the inner and outer Milwaukee harbor, and the near shore waters of Lake Michigan.

Glacial deposits superimposed on underlying bedrock formed the topography of the Milwaukee River basin. There is a general slope downward from the north and west to the south and east, with elevation ranging from 1,360 to 580 feet above mean sea level. Physiography is typical of rolling ground moraine, although surface drainage networks are generally well connected, leaving relatively few areas of the watershed that are internally drained.

Recreation in the Milwaukee River basin below the North Avenue Dam is limited to boating and fishing due to physical barriers and poor water quality, which restrict swimming and wading. However above the North Avenue Dam many people enjoy walking, running, and bicycling on the extensive trails along the river. There are also many places for people to fish, especially during the spring and fall runs of salmonids, which occur as far upriver as the Theinsville Impoundment. Canoeing and rowing in this river basin also have been popular recreational activities in the past.

Pollution, from both conventional and toxic contaminants, has been a major concern within the Milwaukee Estuary. Conventional pollutants (such as phosphorus and suspended solids) have created eutrophic conditions inducing excessive algae blooms, and resulting in decreased dissolved oxygen and fish kills. Toxic pollutants (metals and organic chemicals) from the area's industry also have contributed to intermittent fish kills. It has been reported in the past that average metal concentrations at stations throughout the AOC exceeded chronic ambient water quality standards for cadmium and lead. The remaining areas of the Milwaukee River basin are experiencing problems with increases in urban and agricultural nonpoint source pollution and habitat alteration, due to the increasing urban sprawl and development.

The biota in both the Milwaukee Estuary and the rest of the Milwaukee River basin are adversely affected by poor water quality, habitat alteration (dams, lack of vegetation, etc.), and eutrophication. Low dissolved oxygen levels, habitat alteration, excessive amounts of nutrients and high water temperatures have all had a dramatic impact on limiting the abundance and diversity of the flora and fauna within the Milwaukee Estuary. Therefore, the biota in this system are characterized by a disproportionately high abundance of pollutant tolerant species. Generally, the remaining areas of the Milwaukee River basin do not experience the gross pollution that is found in the Estuary. However, due to the increase in urban development and the

high percentage of land in agricultural production, the remaining parts of the watershed are experiencing an increase in environmental perturbations.

Many of the local monitoring programs contacted in the Milwaukee River basin seem to be indirectly or directly connected with state (WDNR) and/or federal organizations. In general, funding and/or technical assistance is provided by state or federal agencies to initiate programs. As the programs progress, more responsibility is shifted from state and federal agencies to locally-based groups (Water Action Volunteers (WAV) and Testing the Waters). Many of the monitoring programs utilize adult volunteers and students, stressing environmental education. There are also a fair number of programs that have been created in the public health sector. The City of Milwaukee Health Department and the 16th Street Community Health Center have both been active in monitoring water quality at beaches and other recreational areas within the basin. Overall the Milwaukee River basin is home to a diverse range of monitoring activities assessing land use, habitat modification, biota, and water quality.

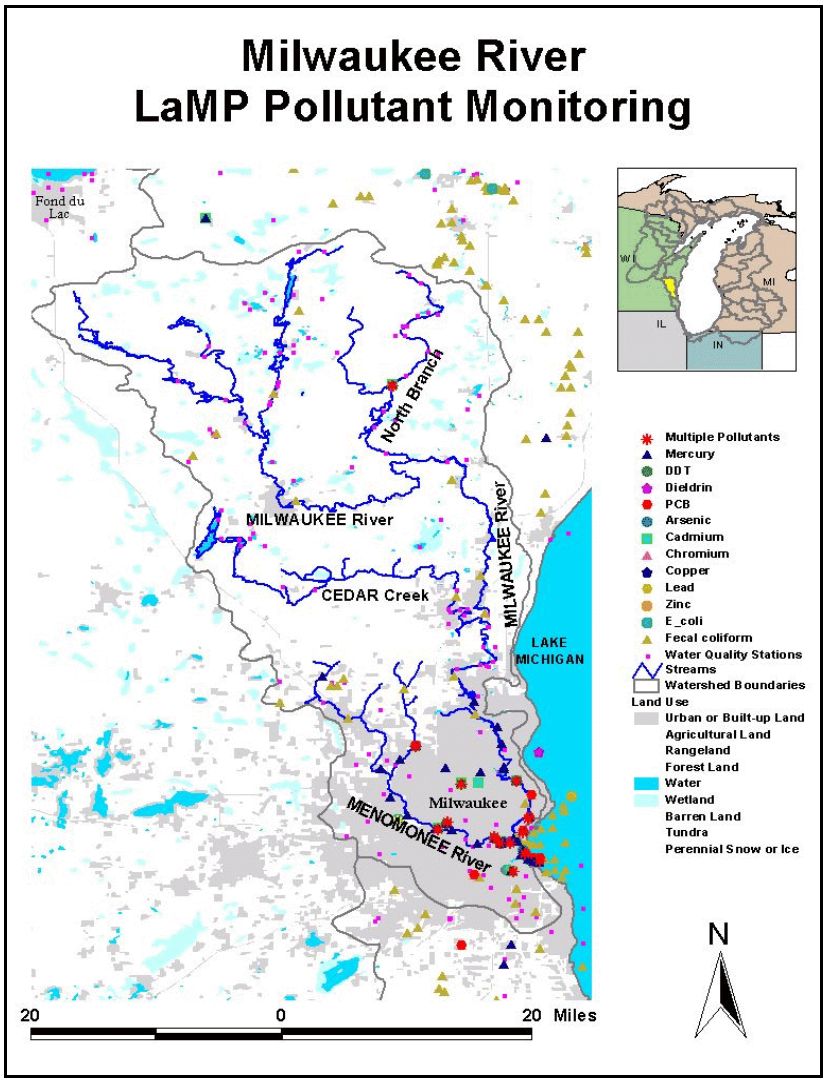

Figure 37. The Milwaukee River watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

Pollutants of Concern

Aquatic Monitoring

Monitoring coverage for LaMP pollutants reported into the STORET system is shown in Figure 37. These maps indicate that stations exist for four (mercury, DDT, dieldrin, and PCBs) of seven critical pollutants, six out of ten pollutants of concern, and none of the listed emerging pollutants. Monitoring for all pollutants is fairly extensive throughout Milwaukee (along both the Milwaukee and Menomonee Rivers), but monitoring coverage is mostly absent in the rest of the watershed. There is no LaMP pollutant monitoring at all along Cedar Creek or the south branches of the Milwaukee River. Therefore, while the Milwaukee Estuary AOC is well-covered, the watershed itself is not. The stations monitoring for LaMP pollutants are maintained by the Wisconsin Department of Natural Resources (WDNR), U.S. EPA, COE, and USGS-WRD (both NAWQA and baseline monitoring).

In addition, surveys indicate that there are other organizations monitoring LaMP pollutants in the watershed. These organizations are tracking PCBs, mercury, lead,

cadmium, copper, zinc, chromium, arsenic, cyanide, PAHs, and selenium. The organizations include Homestead High School, the Milwaukee Metropolitan Sewage District (MMSD), Milwaukee County Environmental Services, the City of Milwaukee, and the Wisconsin Electric Power Company. Monitoring coverage ranges from specific point locations to general regions throughout the watershed.

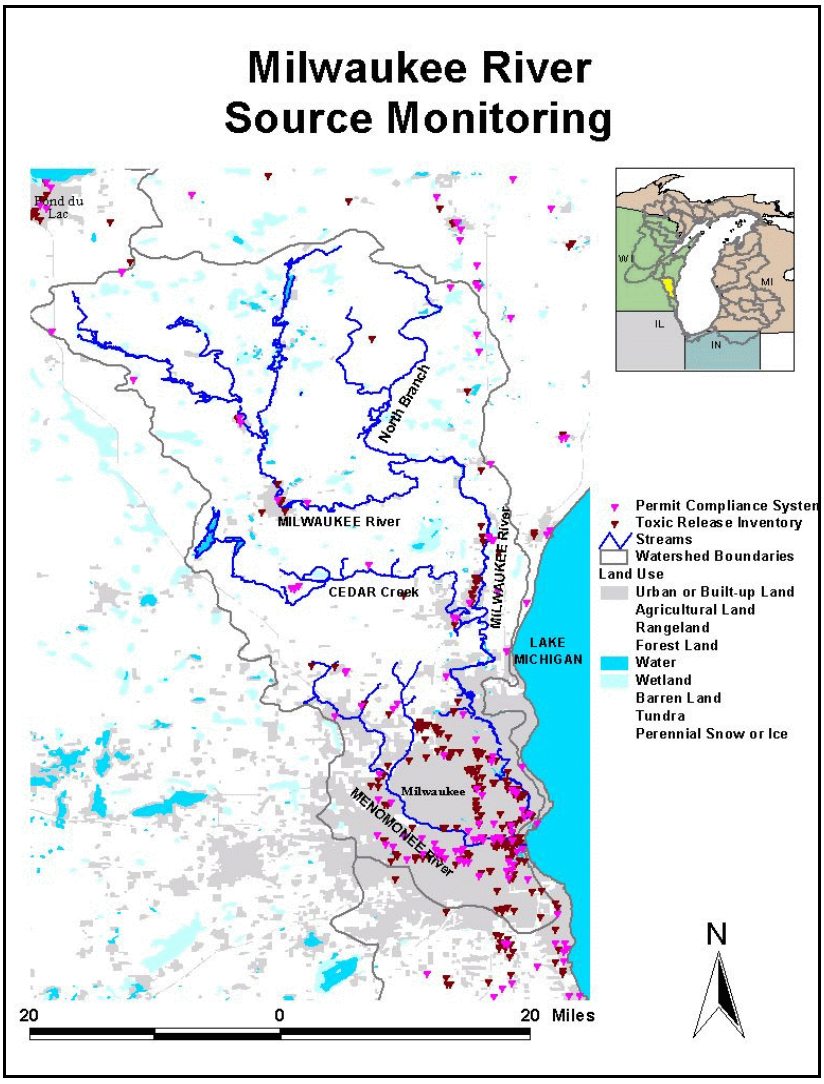

Figure 38. Milwaukee River watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

Pollutant Release Monitoring

An examination of Permit Compliance System and Toxic Release Inventory reporting locations in the Milwaukee River watershed indicates a large number of monitoring locations for potential pollution sources in the watershed (see Figure 38). The vast majority of these locations are in the Milwaukee urban area, though there is also a cluster of along the middle section of the Milwaukee River.

Nutrients and Bacteria

There are roughly 230 water quality monitoring stations within the Milwaukee River watershed listed in the STORET system. These stations are maintained by WDNR, U.S. EPA, COE, and USGS-WRD. A vast majority of the stations (shown in Figure 37) monitor for some form of nitrogen and phosphorus, the chief nutrients impacting water quality. Thus, where monitoring stations exist, they are likely tracking nitrogen and phosphorus. The stations are dispersed fairly evenly throughout the watershed, though there is a greater density of stations in the Milwaukee Estuary. In addition, Homestead High School tracks nitrogen and phosphorus levels at a point in the Milwaukee River.

Four stations in the watershed report to monitor for *E. coli* – all within the Milwaukee metropolitan area. All four stations are maintained by WDNR. Monitoring for fecal coliform is more extensive. More than 70 stations can be found throughout the watershed. The vast majority of fecal coliform monitoring sites are located within the Milwaukee metropolitan area. Few stations exist along the upper branches of the Milwaukee River or along Cedar Creek. Organizations monitoring for fecal coliform in the watersheds include WDNR, USGS-WRD, U.S. EPA, and COE. In addition, the City of Milwaukee Health Department monitors undefined microbiologicals in Milwaukee County and Racine.

Meteorological and Flow Monitoring

USGS maintains 27 gage stations in the watershed to measure flow rates and various other physical characteristics of streams (see Figure 39). Some of these stations have been used for physical and chemical monitoring through the NAWQA program. Gage stations are located on all major rivers and streams in the watershed.

Other organizations monitor numerous physical properties in streams throughout the watershed. Organizations include Wisconsin Electric Power Company, Trinity Luthern School, University of Wisconsin-Milwaukee, and Homestead High School. Properties measured include flow rates, temperature, pH, alkalinity, conductivity, dissolved oxygen, biological oxygen demand, suspended solids, conductivity, hardness, and turbidity.

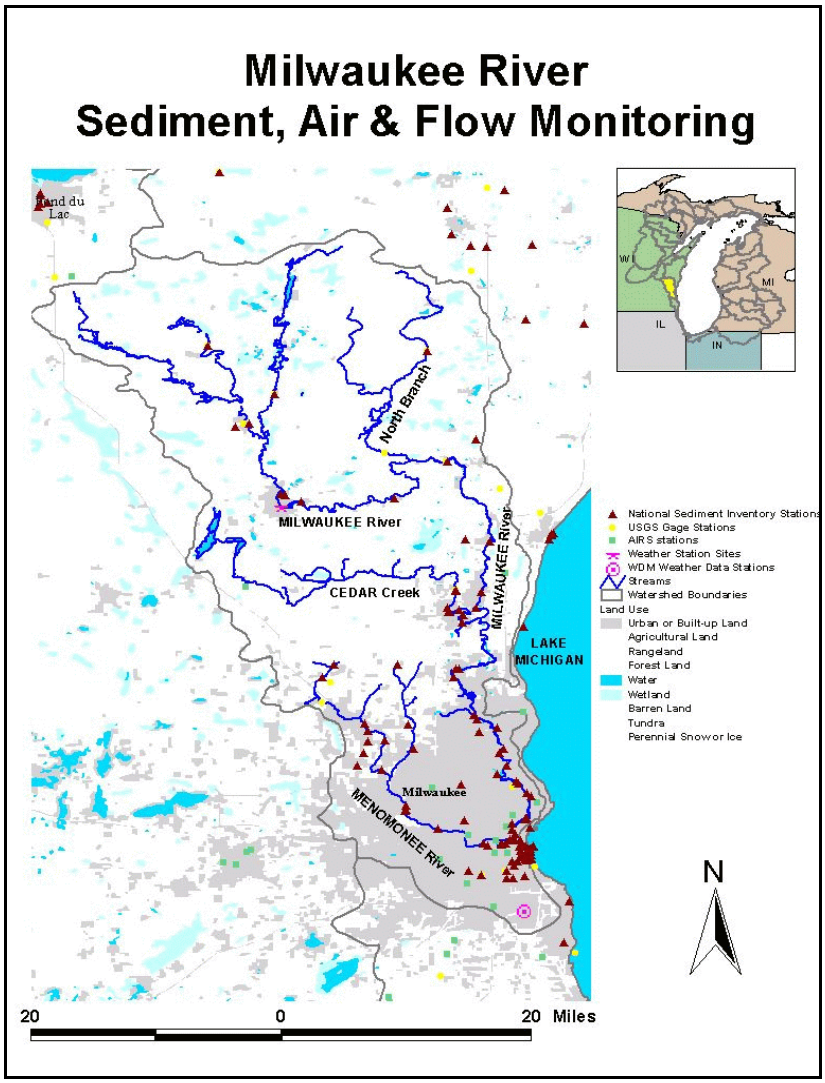

Figure 39. Milwaukee River watershed with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

Two NOAA weather stations are located in the Milwaukee watershed. These stations are located at the Milwaukee airport and in West Bend. These stations measure continuous precipitation data, as well as other meteorological data.

Sediments

There are 114 National Sediment Inventory sites within the Milwaukee River watershed (see Figure 39). Most of these sites are located in or near Milwaukee Estuary. These sites are administered by WDNR, USGS-WRD, and U.S. EPA. Seventy-five of the sites monitor sediment chemistry to assess human health and aquatic life impacts. A total of 39 sites monitor benthic organism tissue, discussed below.

Fish Contaminants, Fish Health, and Aquatic Nuisance Species

As discussed earlier, we have been unable to find specific locational information (such as sampling locations) for programs monitoring fish populations or their health. There are statewide programs in existence, but these are discussed in the overall findings discussion. The

National Sediment Inventory lists 39 stations that monitor fish tissue for bottom contamination. These are located in waters throughout the watershed, and are administered by WDNR and U.S. EPA. In addition, the University of Wisconsin-Milwaukee monitors fish and invertebrate characteristics in waters within Milwaukee, and USGS maintained NAWQA stations in several locations.

A search of the Fish and Wildlife Advisory database on all major Milwaukee waterbodies revealed fish consumption advisories for a large segment of the Milwaukee River, from the estuary to above the Newburg Dam. Advisories along this segment were state issued, covered a number of fish species and related to PCB levels.

No programs we discovered claimed to be monitoring for aquatic nuisance species specifically within the Milwaukee River watershed. Refer to the overall discussion of Lake Michigan monitoring for a discussion about programs that cover multiple tributary watersheds.

Benthos Monitoring

Several state and national programs exist to monitor benthic organisms, however, no specific locational information was provided for these programs. Other organizations may also be monitoring benthic organisms generally in this watershed and others. These are discussed in the overall discussion of Lake Michigan monitoring (see NAWQA discussion, for example).

Air Monitoring

Figure 39 illustrates the locations of the 27 air monitoring stations in the watershed, according to the U.S. EPA's AIRS database. A majority of the stations are clustered in the Milwaukee metropolitan area. The stations monitor for seven of eight indicators in the database, including low-level ozone, particulate matter (two types), nitrogen dioxide, carbon monoxide, sulfur dioxide, and lead.

Wildlife Monitoring

According to our surveys, four groups conduct wildlife monitoring of some form in the watershed. The Anita and Jacob Koenen Land Preserve tracks the presence of unnamed species in their preserve. The Milwaukee Audubon Society conducts an annual bird count within a 15-mile radius of the central city. Bird Studies Canada tracks populations of amphibians and birds within a number of wetlands in the watershed. Finally, the Wehr Nature Center tracks bird populations within the center. There are other organizations monitoring wildlife species in the Milwaukee River watershed and others. These are discussed in the overall discussion of Lake Michigan monitoring.

Land Use

Generally the land uses in this basin are rural occupying roughly 75 percent, with agricultural uses making up approximately 48 percent. The urban land uses in the drainage Basin are represented by residential use (12 percent), transportation and utilities (9 percent), while the other urban land uses total less than 5 percent of the Basin. A high percentage of the urban land uses, of course, are found in the densely populated greater Milwaukee area. Little monitoring occurs in the northern wetlands of the Milwaukee River watershed.

Local Assessment

The Milwaukee River basin, encompassing the largest metropolitan area in the state, tends to be the most actively monitored basin. This may reflect that population has an augmenting effect on monitoring. However, the Milwaukee River basin had a low response rate to the monitoring questionnaire. Some of the larger nature centers and municipalities did not respond after repeated efforts.

On a more positive note the Milwaukee River basin is monitored by over 33 schools through the Testing the Waters program, which started in 1989. Initially all of these schools were asked to submit a survey regarding their efforts, however after further analysis it was evident that the Riveredge Nature Center was coordinating the entire effort and that a survey from them would suffice. Land managers in this basin consider the information gathered by the Testing the Waters programs to be worthy and reliable. In many cases monitoring projects are created to investigate special needs and concerns. Once these needs and concerns are addressed, the monitoring program ceases. However, the Testing the Waters program allows land managers to obtain a basin-wide view of water quality over a longer temporal scale. The web site for the Marquette University High School (**http://www.muhs.edu/links/riverstudies/ttw.html**) is an excellent source for more information about this program. The Testing the Waters program has been especially important in supporting the RAP, by identifying water quality problems, tracking them over a long period, and by assessing the effectiveness of restoration efforts.

The WAV program compliments not only the Testing the Waters programs, but many other programs regarding the monitoring of water quality. In the Milwaukee River watershed, the WAV program utilizes adult volunteers to sample everything from chemical to physical properties in watershed tributaries. This is an important program in that it allows nature centers with limited staff and resources to take on fairly large projects, the Urban Ecology Center being a perfect example.

Another major component of the Milwaukee River basin is monitoring for compliance. A number of industries and corporations were contacted, but after further review it was found that these entities were reporting all of their results to state (DNR) and/or federal (EPA) agencies and therefore were not surveyed individually.

Yet another area of focus in the Milwaukee basin concerns public health issues. Two large monitoring programs were found to be monitoring beach water quality and promoting pollution education. These two organizations are also working on an environmental health project to limit the public's exposure to potentially hazardous chemicals in the water column.

Although the Milwaukee River watershed is home to a very large population, a high percentage of land still remains quite rural in character, especially in the northern areas of the basin. Water quality tends to degrade as one progress from north to south. This also follows a trend seen in monitoring, that simply indicates that as we move from north to south there is an increase in monitoring efforts. This trend might be present because there are simply more people to participate in monitoring programs or that monitoring programs are focused on areas with the most severe water quality problems.

Overall the monitoring programs ongoing in the Milwaukee River basin seem to reflect the environmental concerns identified in the RAP. The local monitoring mosaic for this watershed is developing a baseline database that will allow resource managers to predict changes, assess management activities, and identify emerging concerns. The communication and collaboration between groups is also a strong component of Milwaukee monitoring programs and the WAV, 16th Street Community Health Center, and Testing the Waters programs are excellent examples.

12. Sheboygan River

Background

The Sheboygan River basin encompasses approximately 615 square miles of land in Sheboygan, Ozaukee, Fond du Lac, Calumet and Manitowoc Counties. The following six watersheds compose this basin: the Mullet and Onion River watersheds, which drain directly into the Sheboygan River, and the Black, Sauk, Pigeon, and Sucker River Watersheds, which drain directly into Lake Michigan. Altogether, the Sheboygan River basin contains 21 lakes and six river impoundments greater than 10 acres.

The topography of the Sheboygan River basin varies. Low rounded hills interrupted by narrow valleys and numerous wetlands are found in the western portions. A central band of Kettle Moraine landscape divides the basin, which grades into irregularly low, flat moraine landscape to east. The local elevation varies between 50 and 150 feet, generating an average river gradient that approaches seven feet per mile. The soils in this basin tend to be quite loamy and light textured in the west, gravelly in the central areas, with heavy clay soils in the east. These heavy clay soils are often very fertile, but with a low permeability, which promotes runoff of soil and animal waste.

Recreational use of this basin varies for each locality or region. In the eastern regions, non-contact recreation such as, jogging, walking, and bicycling is popular in many of the parks in Sheboygan and Sheboygan Falls. The beaches and near shore waters in the Sheboygan area are also popular spots for wading and swimming. However, due to the extensive amount of privately owned river frontage around the city of Kohler, these activities are sometimes restricted. Generally, there is a good diversity of sport fish, especially in the low reaches of this basin. However, dam and impoundment areas around the cities of Sheboygan, Sheboygan Falls and Kohler present barriers to fish movement, and usually result in poor water quality because of the chronic sediment and nutrient build-up. The western portion of this basin is a popular area for hunting and fishing due to its high density of wetlands and surface waters (lakes).

Runoff from both specific and diffuse sources, contaminated sediment, habitat modifications (such as channelization and dams) have degraded water quality throughout the Sheboygan River basin. Construction site erosion and impervious surfaces (roads, roofs, parking lots) are generating threats to water quality, especially in the eastern portions, as the Sheboygan River basin grows increasingly urban.

Pollutants of Concern

Aquatic Monitoring

Monitoring coverage for LaMP pollutants reported into the STORET system is shown in Figure 40. These maps indicate that stations exist for two (mercury and dieldrin) of seven critical pollutants, six out of ten pollutants of concern, and none of the listed emerging pollutants. Monitoring for all pollutants is quite sparse throughout the watershed. LaMP pollutants are only monitored at four locations on the Sheboygan River, and one location on each of the Manitowoc and Sauk Rivers, as well as a few near shore stations in Lake Michigan. The stations monitoring for LaMP pollutants are maintained by the WDNR, U.S. EPA, USGS-WRD, and the Electric Power Research Institute (EPRI) (offshore sites only).

In addition, surveys indicate that there are two other organizations monitoring LaMP pollutants in the watershed. These organizations are tracking PCBs, mercury, cadmium, copper, zinc, chromium, arsenic, and

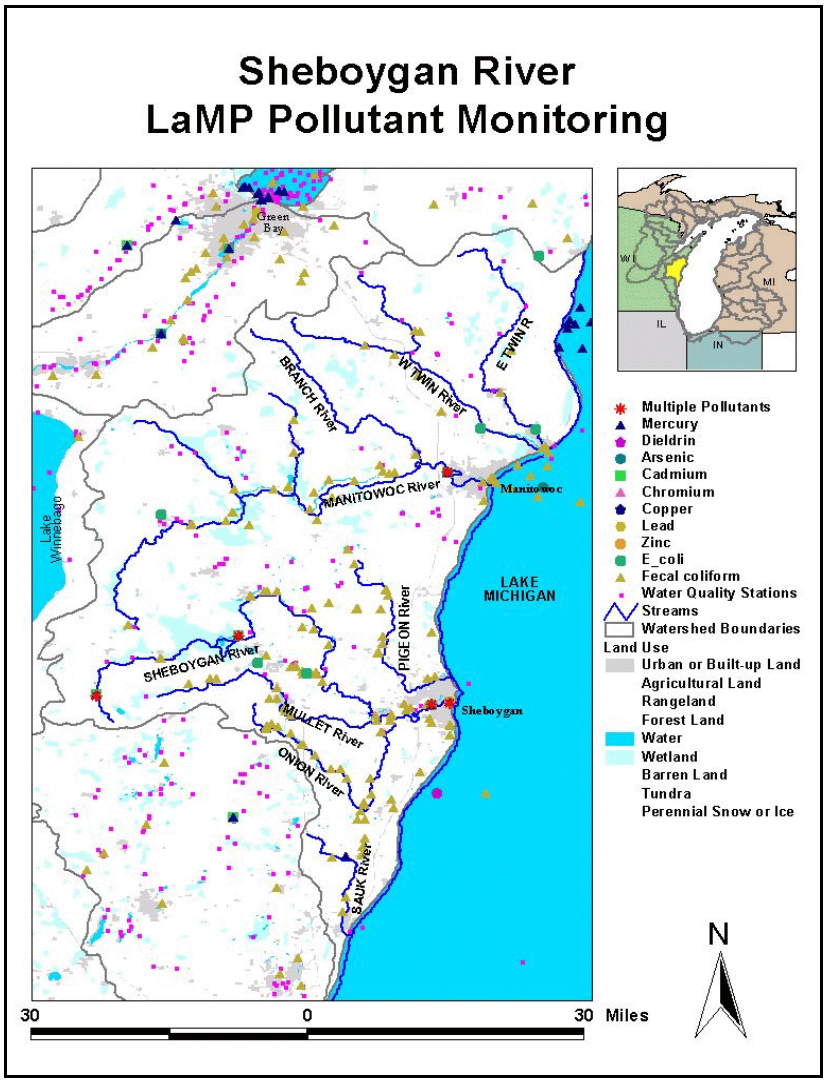

Figure 40. The Sheboygan River watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

cyanide. The organizations include Lakeland College and Tecumseh Products Company. Both maintain sites on the Sheboygan River.

Pollutant Release Monitoring
Despite the lack of monitoring for LaMP pollutants, an examination of Permit Compliance System and Toxic Release Inventory reporting locations in the Sheboygan River watershed indicates a large number of monitoring locations for potential pollution sources in the watershed (see Figure 41). Though these monitoring locations are dispersed throughout the watershed, clusters can be found in the cities of Sheboygan and Manitowoc.

Nutrients and Bacteria

Contrary to the small number of LaMP pollutant monitoring stations in the basin, there are nearly 250 water quality monitoring stations within the Sheboygan River watershed listed in the STORET system. These stations are maintained by WDNR, U.S. EPA, COE, USGS-WRD, and EPRI. A vast majority of the stations (shown in Figure 40) monitor for some form of nitrogen and phosphorus, the chief nutrients impacting water quality. Thus, where monitoring stations exist, they are likely tracking nitrogen and phosphorus. The stations are dispersed fairly evenly throughout the watershed. In addition, Sheboygan Falls Middle School tracks nitrogen and phosphorus levels at points along the Sheboygan River.

Six stations in the watershed monitor for *E. coli*. Each station is in a different region of the watershed. All stations are maintained by WDNR. Monitoring for fecal coliform is more extensive. Nearly 170 stations can be found throughout the watershed. These stations are distributed throughout the watershed, though there is a higher density in the Sheboygan River subwatershed. Organizations monitoring for fecal coliform in the watersheds include WDNR, USGS-WRD, U.S. EPA, and COE.

Meteorological and Flow Monitoring

USGS maintains 16 gage stations in the watershed to measure flow rates and various other physical characteristics of streams (see Figure 42). Gage stations are located on all major rivers and streams in the

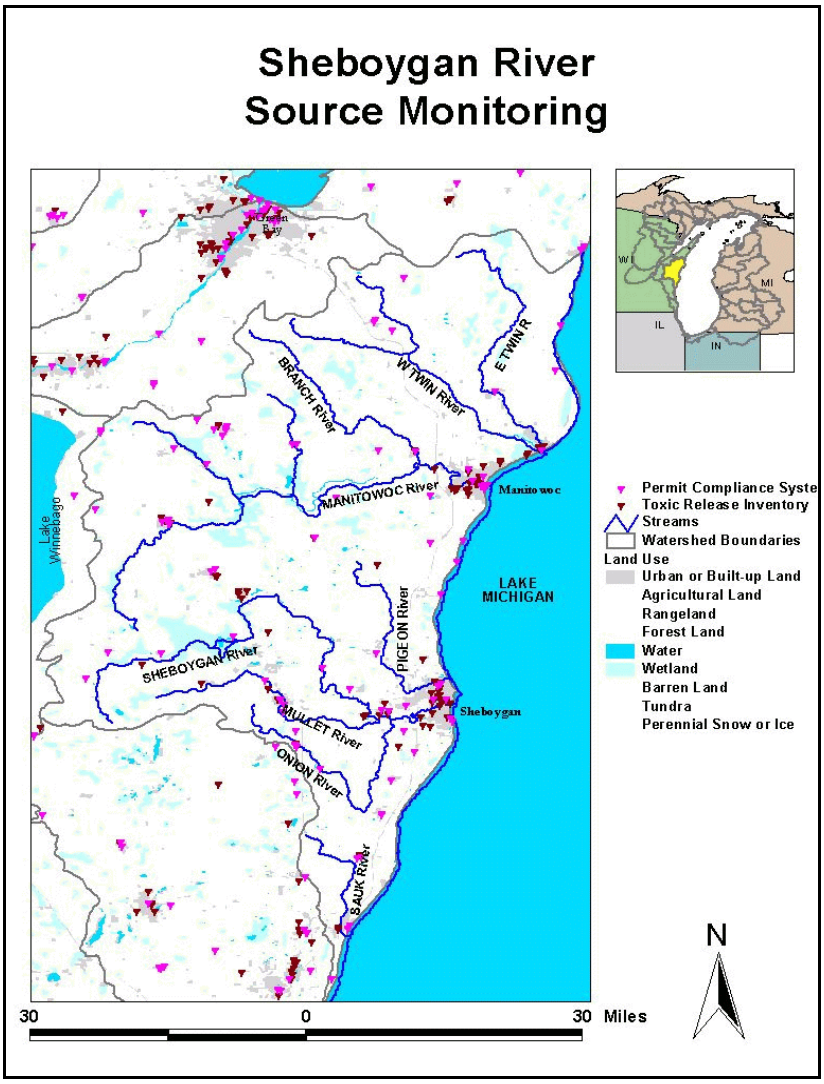

Figure 41. Sheboygan River watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

watershed. Additionally, two other organizations monitor physical properties in the watershed. The Sheboygan Falls Middle School monitors sites along the Sheboygan River, the Pigeon River Priority Watershed WAV monitors the Pigeon River. Properties measured include temperature, pH, dissolved oxygen, total suspended solids and carbon dioxide as well as rainfall.

There are no NOAA weather stations located in the Sheboygan River watershed. Two stations are located within a few miles of the watershed, however. These stations are located in West Bend and south of Green Bay. These stations measure continuous precipitation data, as well as other meteorological data.

Sediments

There are 82 National Sediment Inventory sites within the Sheboygan River watershed (see Figure 42). Sites are located on all major rivers in the watershed. These sites are administered by WDNR, USGS-WRD, and U.S. EPA. A total of 52 sites monitor sediment chemistry to assess human health and aquatic life impacts. Thirty of the sites monitor benthic organism tissue, discussed below.

Fish Contaminants, Fish Health, and Aquatic Nuisance Species

As discussed earlier, we have been unable to find specific locational information (such as sampling locations) for programs monitoring fish populations or their health. There are statewide programs in existence, but these are discussed in the overall findings discussion. The National Sediment Inventory lists 30 stations that monitor fish tissue for contamination found in bottom sediments. These are located in waters throughout the watershed with a specific focus on a region along the Sheboygan River near the Superfund site. These monitoring sites are administered by WDNR and U.S. EPA. In addition, Tecumseh Products monitors smallmouth bass and white suckers in a region along the Sheboygan River.

A search of the Fish and Wildlife Advisory database on all major Sheboygan waterbodies revealed fish consumption advisories for eight reaches in the watershed. Advisories have been issued for sections of the

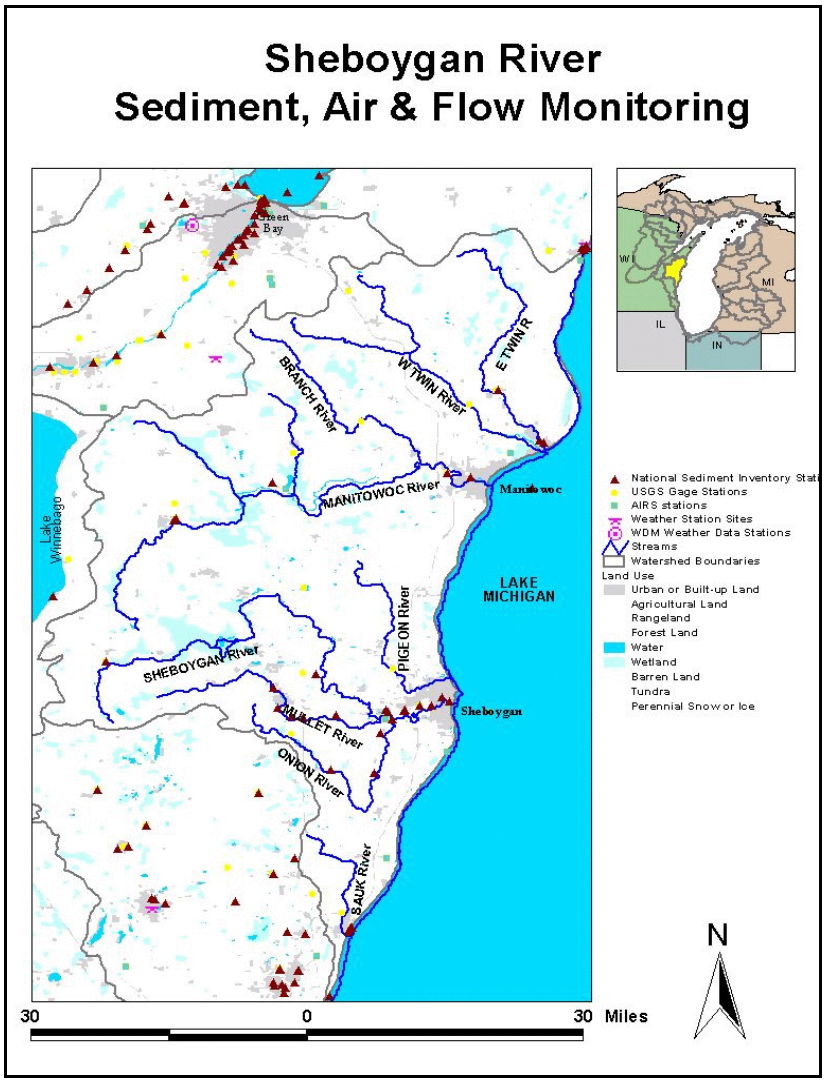

Figure 42. Sheboygan River watershed with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

Sheboygan, Manitowoc, and Twin (East and West) Rivers. The advisories were all state issued and covered a number of fish species. All advisories were related to PCB levels, and the advisory for the Sheboygan River was also due to mercury levels.

No programs we discovered claimed to be monitoring for aquatic nuisance species specifically within the Sheboygan River watershed. Refer to the overall discussion of Lake Michigan monitoring for a discussion about programs that cover multiple tributary watersheds.

Benthos Monitoring

No specific locational information was discovered for state or national programs monitoring benthic organisms. However, Lakeland College reports monitoring benthic organisms in the Sheboygan River. Other organizations may be monitoring benthic organisms generally in the watershed, among others. These are discussed in the overall discussion of Lake Michigan monitoring.

Air Monitoring

Figure 39 illustrates the locations of the seven air monitoring stations in the watershed, according to the U.S. EPA's AIRS database. These stations are located along the Lake Michigan shoreline. The stations monitor for low-level ozone and nitrogen dioxide.

Wildlife Monitoring

Our surveys did not show any groups monitoring wildlife in the watershed. There are organizations, however, monitoring wildlife species beyond the Sheboygan River watershed. These are discussed in the overall discussion of Lake Michigan monitoring.

Land Use

Generally the land uses in this basin are rural or agriculture in nature occupying roughly 68 percent. Natural areas are the second most dominant land use, woodlands and wetlands covering eight and 15 percent respectively. Urban land uses encompass the rest of the land area with in the basin totaling 13,900 acres or nine percent. The Sheboygan Basin contains 15 cities, towns and villages, including the major urban areas, Sheboygan, Sheboygan Falls, and Kohler, WI (RAP, 1995). Within the watershed, Glacier Resource Conservation and Development tracks a variety of metrics related to several test agricultural BMPs to reduce nutrient and pesticide runoff. Also, the University of Wisconsin-Sheboygan administers a project to monitor long-term change in a hemlock forest south of Sheboygan. Finally, the Sheboygan Area Land Conservancy, Inc., measures crop land loss and other consequences of sprawl in Sheboygan, Fond du Lac, Calumet, and Manitowoc counties.

Local Assessment

Many of the monitoring programs discovered in the Sheboygan River basin are indirectly or directly connected with state and/or federal organizations (such as the WDNR). In general, funding or technical assistance is provided initially by state or federal agencies to start programs, and, as the program progresses, more responsibility is shifted from state and federal agencies to local based groups (e.g. WAV and Testing the Waters). Many of the monitoring programs utilize volunteers and students, stressing environmental education. Generally, many of the local groups contacted perceive that watershed management efforts have slowed considerably due to indecisiveness in defining the best management plan for the basin.

13. Fox-Wolf River Basin

Background

The Fox-Wolf River basin of Northeast Wisconsin is a 6,400 square mile drainage area with three distinct sub-basins: the Wolf River, the Upper Fox and Lower Fox River. The Wolf and Upper Fox Rivers drain south and east (respectively) into the Lake Winnebago "pool" lakes and then north through the Lower Fox River to the bay of Green Bay. The Fox-Wolf Basin is the largest drainage basin to Lake Michigan and the third largest to the Great Lakes.

For purposes of this report, the discussion will address all three sub-basins and Lake Winnebago. However, the graphic display and majority of the discussion will focus on the Lower Fox River watershed. Lower Green Bay is also part of the AOC in this area, however, the bay is assessed as part of greater Lake Michigan Open Water chapter. Please see that chapter for further information.

Status of Watershed Management Efforts in the Study Area

Watershed management in the Fox-Wolf basin is conducted under a variety of program initiatives – primarily Wisconsin's Nonpoint Source Pollution Abatement Program (a.k.a. the Priority Watershed Program) and the Wisconsin Pollution Discharge Elimination System program. Ten of the basin's 41 watersheds have been identified as priority watersheds. County Land Conservation Departments are provided with state funds for staff and overhead to conduct watershed inventories, develop management plans, contact landowners, and offer cost-share funds to install BMPs.

Funds are also available to other local units of government in urban or urbanizing areas of the watershed. Recently, this program has undergone a re-design which has yet to be completed. No additional watersheds are expected to be selected under the new program, but efforts will continue through local governments on a more limited scope and time frame.

Many other local, state and federal initiatives work on some component of watershed management in the Fox-Wolf basin, too numerous to mention in this introduction. Initiatives range in function from voluntary cost-share programs to local ordinances to state and federal permitting. A recent reorganization of the Department of Natural Resources has established geographic management units (GMUs) designed to better coordinate programs and involve all agencies and individuals. GMU (or Basin) Partner Teams have been established in the Upper Fox, Lower Fox and Wolf River Basins.

Pollutants of Concern

Aquatic Monitoring

Monitoring coverage for LaMP pollutants reported into the STORET system is shown in Figure 43. This maps indicates that stations exist for two (mercury and PCBs) of seven critical pollutants, six out of ten pollutants of concern, and none of the listed emerging pollutants. Monitoring for all pollutants is relatively light compared to other watersheds in this analysis. The monitoring is heaviest along the lowest section of the Fox River where it flows out into Green Bay. There are 12 stations monitoring mercury at our near the Fox River outfall, while there are 28 stations for the rest of the Fox-Wolf basin (four in the Lower Fox, three at the entrance and exit of the Fox River to Lake Winnebago, three in the Upper Fox, and 18 in the Wolf River watershed). Ten PCB stations have been placed along the Lower Fox, with one on the shore of Lake

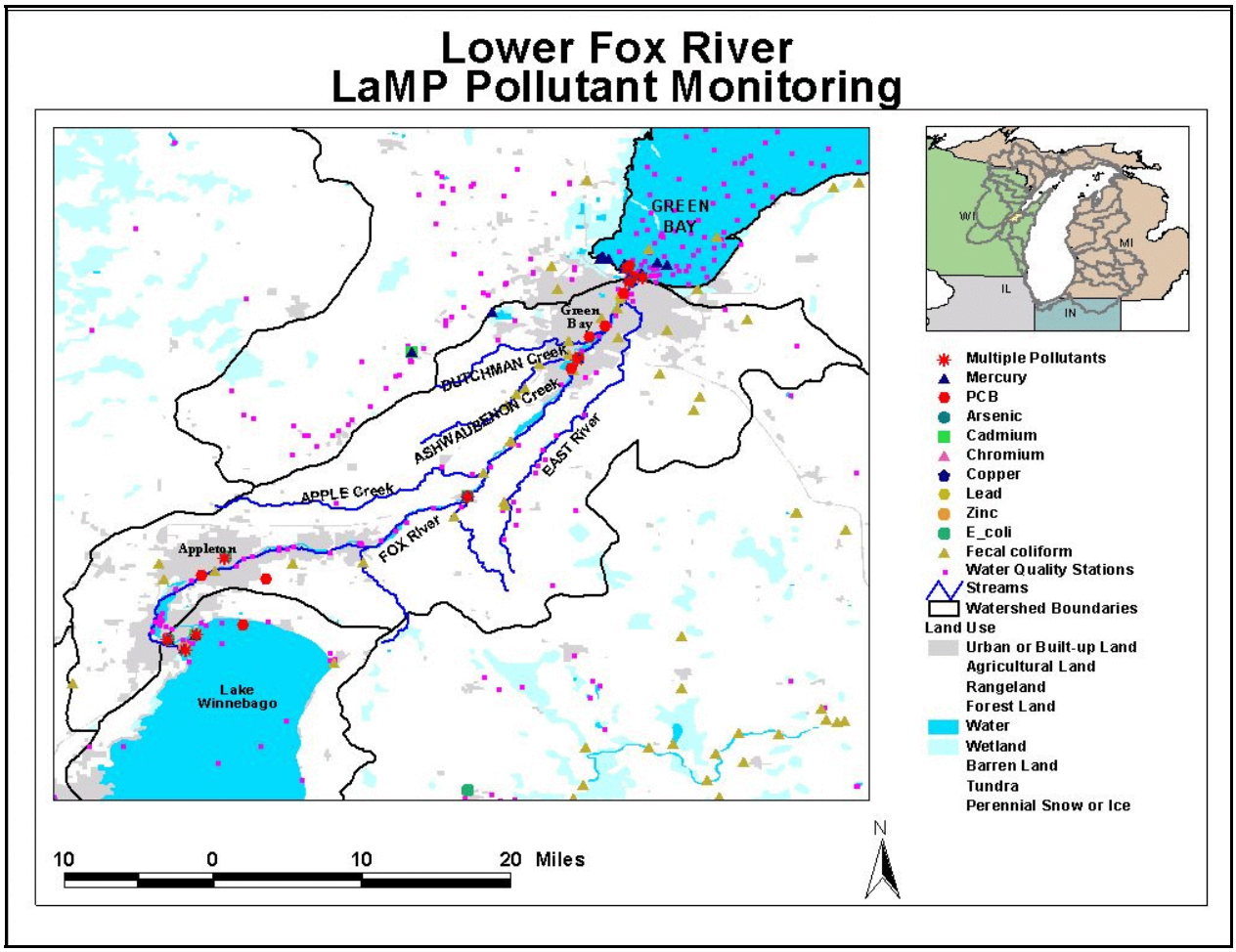

Figure 43. The Lower Fox River watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

Winnebago. The stations monitoring for LaMP pollutants are maintained by WDNR, U.S. EPA (3 programs), COE, USGS-WRD (NAWQA and baseline stations), or EPRI.

In addition, surveys indicate that the Green Bay MSD monitors for all LaMP pollutants with the exceptions of dioxins/furans, hexachlorobenzene, PAHs, and atrazine. This monitoring is conducted on the Lower Fox River at its outflow to Green Bay. Also, the University of Wisconsin-Stevens Point tracks atrazine in the Tomorrow-Waupaca River watershed.

Pollutant Release Monitoring

An examination of Permit Compliance System and Toxic Release Inventory reporting locations in the Fox-Wolf basin indicates a large number of monitoring locations for potential pollution sources throughout the basin (see Figure 44). Clusters of these locations can be found all along the Lower Fox River, as well as in Oshkosh on the western shore of Lake Winnebago, in Fond du Lac on the south shore, and on the shore of Shawano Lake in the Wolf River watershed.

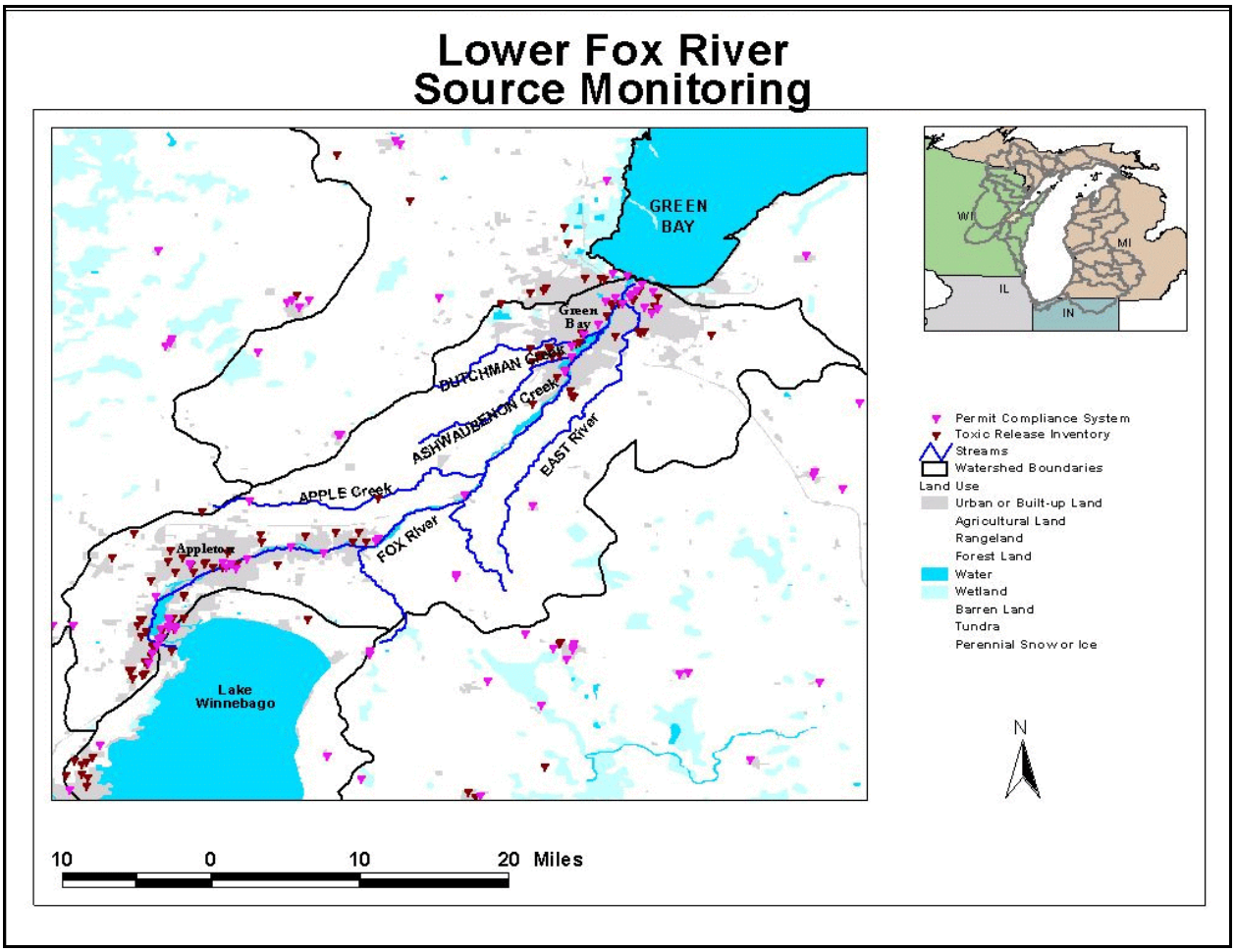

Figure 44. Lower Fox River watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

Nutrients and Bacteria

There are more than 120 water quality monitoring stations within the Lower Fox River watershed listed in the STORET system. An additional 720 stations are located throughout the remaining watersheds in the Fox-Wolf basin. Also, there are a large number of stations in the near shore region of Green Bay. A vast majority of these stations (shown in Figure 43) monitor for some form of nitrogen and phosphorus, the chief nutrients impacting water quality. Thus, where monitoring stations exist, they are likely tracking nitrogen and phosphorus. The density of stations is greater at the Fox River outfall to Green Bay, but the rest of the stations are distributed fairly evenly throughout the basin. According to our surveys, there are several other organizations in the basin monitoring for nutrients. These include the Brown County Land Conservation Department, the University of Wisconsin-Stevens Point, the Green Bay MSD, Waupaca County Land Conservation Department, University of Wisconsin-Milwaukee, Green Bay RAP, and Green Bay Public Schools WAV.

Eleven stations monitor *E. coli* in the Fox-Wolf basin — three in the Lower Fox, six in the Upper Fox (including three on Lake Butte Des Morts), and two in the Wolf watershed. All 11 stations are maintained by WDNR. Monitoring for fecal coliform is significantly more extensive. About 120 stations can be found throughout the basin. As with other monitoring coverage in the basin, monitoring of fecal coliform levels is

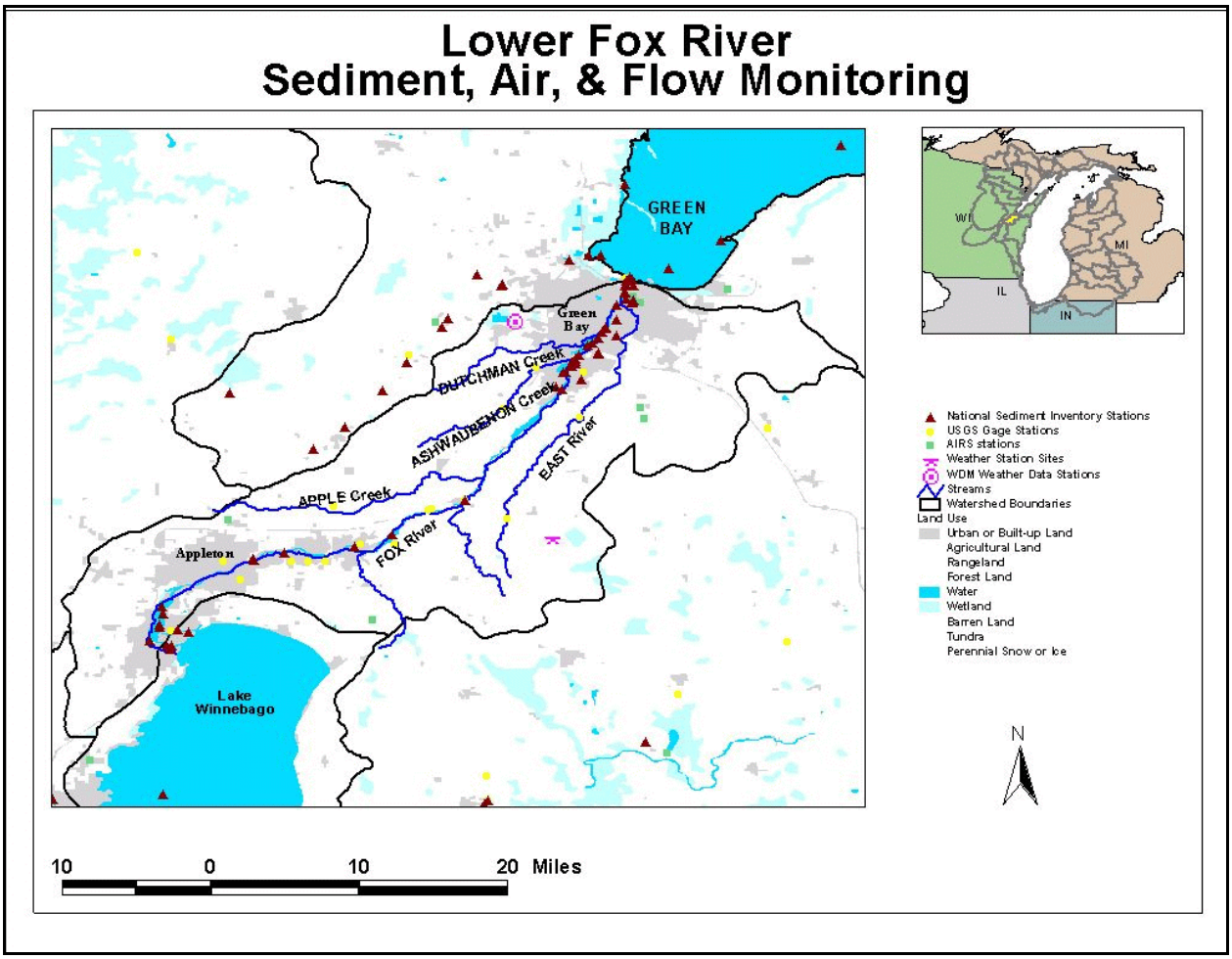

Figure 45. Lower Fox River watershed with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

clustered near Green Bay. However, there are numerous stations distributed throughout the rest of the basin. Organizations monitoring for fecal coliform in the watersheds include WDNR, USGS-WRD, U.S. EPA, and the U.S. Forest Service (USFS). In addition, two other organizations report through surveys to monitor bacteria in the basin. These include Brown County Land Conservation Department and Brown County Health Department.

Meteorological and Flow Monitoring

USGS maintains 85 gage stations throughout the Fox-Wolf basin to measure flow rates and various other physical characteristics of streams (see Figure 45). Some of these stations have been used for physical and chemical monitoring through the NAWQA program. Gage stations are located on all major rivers and streams in the watershed.

Several organizations also reported that they monitor numerous physical properties in streams in the basin. These include the Brown County Land Conservation Department, WDNR, the Oneida Tribe of Indians, and Green Bay MSD. Paper mills also monitor physical properties through their Industry Rivers Study

Committee. Physical properties measured by all these organizations include stream flow, temperature, pH, dissolved oxygen, biological oxygen demand, chlorophyll, suspended solids, and turbidity.

Three NOAA weather stations are located in the Fox-Wolf basin, and one other station is located just outside the northern boundary of the Wolf watershed. The stations inside the watershed are located within and south of Green Bay in the Lower Fox, and in New London in the southern portion of the Wolf watershed. The station north of the Wolf is located at the Laona Ranger Station in the Nicolet National Forest. These stations measure continuous precipitation data, as well as other meteorological data.

Sediments

There are 97 National Sediment Inventory sites within the Fox-Wolf basin (see Figure 45). The sites are clustered along the Lower Fox, at the inlets and outlets of the "pool" lakes, and along the Red River in the Wolf watershed. Other sites are located more randomly throughout the watersheds in the basin. These sites are administered by the WDNR, USGS-WRD, and U.S. EPA. Some of these sites are involved in cooperative projects between USGS-WRD, WDNR, and Oneida and Menominee Tribes, involving PCB sediment remediation, agricultural BMPs, and trace elements from the Crandon Mine. The Green Bay MSD also reports to conduct some sediment sampling. About 50 of the sites monitor sediment chemistry to assess human health and aquatic life impacts. A total of 48 sites monitor benthic organism tissue, discussed below.

Fish Contaminants, Fish Health, and Aquatic Nuisance Species

As discussed earlier, we have been unable to find specific locational information (i.e. sampling locations) for programs monitoring fish populations or their health. There are statewide programs in existence, but these are discussed in the overall findings discussion. The National Sediment Inventory lists 48 stations that monitor fish tissue to assess the impacts of sediment contamination. These are located throughout the basin, and are administered by WDNR and the U.S. EPA. USGS also maintained NAWQA stations in the basin to examine fish tissue. Two organizations also conduct fish habitat assessments. These include WDNR and the Oneida Tribe of Indians.

A search of the Fish and Wildlife Advisory database on all major Fow-Wolf basin waterbodies revealed fish consumption advisories for nine locations in the basin. Advisories had been issued for six sections of the Fox River, all of the Lake Winnebago "pool" lakes, Shawano Lake, and a section of the Wolf River. In addition, fish advisories have been issued for most of Green Bay. The advisories were all state issued, covered a variety of fish species and related to PCB and mercury levels.

One program was discovered to be monitoring for zebra mussels within the Fox-Wolf basin. The WDNR monitors zebra mussel veligers in the Fox River. Refer to the overall discussion of Lake Michigan monitoring for a discussion about programs that cover multiple tributary watersheds.

Benthos Monitoring

No specific locational information was discovered for state or national programs monitoring benthic organisms. However, several organizations report that they collect macroinvertebrate data (including community composition, and structural and functional integrity) in numerous locations in the basin. These organizations include WDNR (for the Index of Biotic Integrity (IBI)), Brown County Land Conservation Department, Integrated Paper Services, Inc. Other organizations may be monitoring benthic organisms generally in the watershed, among others. These are discussed in the overall discussion of Lake Michigan monitoring (see the NAWQA discussion, for example).

Air Monitoring

Figure 45 illustrates the locations of the 13 air monitoring stations in the basin, according to the U.S. EPA's AIRS database. The stations are distributed evenly throughout the basin. The stations monitor for three of eight indicators in the database, including low-level ozone, particulate matter, and sulfur dioxide.

Wildlife Monitoring

Several organizations are monitoring wildlife in the basin. The Northeast Wisconsin Audubon cunducts an annual bird count; the University of Wisconsin-Green Bay Richer Museum monitors colonial nesting birds; Long Point Bird Observatory monitors breeding marsh birds and amphibians at a couple of sites; and Barkhausen and Green Bay Wildlife Sanctuaries track various bird populations. In addition, there are organizations monitoring wildlife species in the basin on a more regional basis. These are discussed in the overall discussion of Lake Michigan monitoring.

Land Use

The Lower Fox watershed consists of a large portion of urbanized land with relatively few wetlands. Large developments include Green Bay, Appleton, Menasha, Oshkosh, Neenah and Fond du Lac. A substantial portion of the rest of the basin does exist as wetlands. Large wetland areas can be found throughout the Wolf watershed, especially around the headwaters of the Wolf River. The wetlands are not extensively monitored, except in the Wolf headwaters.

Local Assessment

One of the best examples of monitoring data put to beneficial use is "The State of the Bay: A Watershed Perspective" produced by UW-Green Bay's Bud Harris. This very simple, graphicly based format has been an exceptional education tool in a variety of contexts. Dr. Harris is initiating, with Fox/Wolf Basin 2000 assistance, a Strategic Data Acquisition Task Force to help expand monitoring coordination, improve data analysis and guide future activity.

From the perspective of a non-profit watershed alliance (Fox/Wolf Basin 2000), there are several important points to be made with regard to monitoring in the Fox-Wolf basin. First, where data is collected and disseminated, it has been particularly helpful in making the case for enhanced watershed management efforts as well as adding to the understanding of watershed functions and conditions. However, there is likely a large amount of monitoring that was not discovered through this project. Further efforts need to be made to complete the Fox-Wolf basin content in the monitoring database.

When the data collection is not coordinated from a geographic perspective consistently over the years, the ability to effectively manage resources on a watershed basis is lost. Evidence of this is found in this statement taken from the Lake Winnebago Comprehensive Management Plan compiled by the Wisconsin Department of Natural Resources in 1989:

> "There are no current ongoing programs in DNR or other agencies to collect the short- or long-term information necessary to allow adequate assessment of any efforts to reduce nutrient or sediment loading."

Granted, there are some monitoring programs designed to help resource managers, for example the "Single Sites Program" initiated by the WDNR and assisted by USGS. However, according to an observation made

by a WDNR employee during a recent Fox-Wolf Basin Strategic Data Acquisition Task Force meeting, WDNR's current "Baseline Monitoring Program" is constrained by U.S. EPA guidelines for data collection in support of Clean Water Act Section 305(b) reports — guidelines that may not be conducive to monitoring to understand ecosystems, evaluate programs or enhance watershed resource management.

Fox-Wolf Basin 2000's own experience in the Pigeon River Watershed (Wolf sub-basin) provides an example. Data collected on the watershed and its impoundment were somewhat scattered among a variety of locations and program files. When brought together, the information was helpful in developing an understanding of the condition of the watershed and the history leading to those conditions. Two data points 20 years apart suggested an annual sedimentation rate in the impoundment near the outlet of the watershed. But because little assessment was done upstream of the impoundment in that time, interpretations of the problem ranged from blaming eroded stream banks to poor farmland management to a golf course upstream to shoreline erosion on the impoundment itself. While those arguments ensued, many citizens responded to additional monitoring efforts by calling for action in the place of monitoring. One recent action, at a cost of about $100,000, was a series of highly visible shoreline stabilization projects that will do little to address the upstream soil and nutrient inputs.

It should also be noted that the information that was derived from the limited data available in the Piegeon River Watershed paralleled some of the "gut" feelings of long-time users or managers of the resource. This suggests anecdotal data and information also needs to be recorded and made accessible. However, this gives rise to another limitation we have encountered – the "quality" of data. The state has a Self-Help Monitoring Program and a Water Action Volunteer Program that encourages citizens to collect basic data (water clarity, phosphorus concentrations and temperature, for example). Efforts to expand such activity have been met with staunch criticism because the data collected would not be reliable and could not meet the rigors of quality assurance and control. Indeed, the uncertainty of anecdotal or non-professionally gathered data have made it easy for those asked to change land use practices or behaviors to question whether they are really the problem.

Another limitation has to do with the measurement of the efficacy of nonpoint source best management practices (BMPs) on a broader (subwatershed or catchment) scale. Much of the research available on BMPs was done in very narrowly defined contexts, which creates a lot of uncertainty when applying pollution reduction efficacy on a broader scale. Little, if any, of the studies look at long term efficiency – how well a practice performs after several years or what kind of maintenance needs and costs can be expected. In addition, literature reviews generally provide a broad range of efficacy estimates. For example, nutrient and sediment reduction rates of 5-90 percent were reported in studies assessing the effectiveness of vegetative filter strips (or buffers). Paired watershed study-designs have been proposed (and implemented in some areas) to address this deficiency. However, they are longer term, a bit unwieldy in garnering adequate participation and quite costly to conduct.

Several observations have been made in the past that there is plenty of data, but little information. The current movement in the Fox-Wolf basin to develop a coordinated monitoring framework is indicative of the inadequate quantity of data, quality of analysis and availability of information necessary to improve watershed management activity.

14. Door County

Background

The study area, Door County, is located in northeast Wisconsin and lies entirely on the Door Peninsula in the Door-Kewaunee watershed. The peninsula is bordered by Lake Michigan on one side and Green Bay on the other. The geology of the peninsula is comprised primarily of dominantly Silurian-aged dolomite. This fractured, calcareous bedrock is easily modified by the dissolution of the bedrock into karst features. These karst features, combined with the relatively thin soil layer found through much of the peninsula, create a high potential for groundwater and surface water contamination.

Status of Watershed Management Efforts in the Study Area

The nature of the geology has been a concern for soil and water conservationists. In particular, these concerns have in large part been at the heart of many of the initiatives and projects of the county's Soil and Water Conservation Department (SWCD). Additionally, the Wisconsin Department of Natural Resources developed a *Water Quality Management Plan* in March of 1995 serving as a guide to water resource activities with a focus on the Door-Kewaunee watershed. Initiatives of the SWCD and the WDNR remain in place as part of a comprehensive watershed management program. These have been the more visible efforts at resource management on the peninsula.

Pollutants of Concern

Aquatic Monitoring

Monitoring coverage for LaMP pollutants reported into the STORET system is shown in Figure 46. As should be obvious from the map, there appears to be no monitoring of LaMP pollutants on the penninsula. In total, there are only 57 water quality monitoring stations in the entire peninsular watershed.

Pollutant Release Monitoring

An examination of Permit Compliance System and Toxic Release Inventory reporting locations in Door County indicates only a few monitoring locations for potential pollution sources throughout the county (see Figure 47). There are now distinct clusters of these locations.

Nutrients and Bacteria

As mentioned previously, there are 57 water quality monitoring stations within the Door-Kewaunee watershed listed in the STORET system. Several others can be found around the peninsula in Green Bay and Lake Michigan. A vast majority of these stations (shown in Figure 46) monitor for some form of nitrogen and phosphorus, the chief nutrients impacting water quality. Thus, where monitoring stations exist, they are likely tracking nitrogen and phosphorus. The stations are distributed fairly evenly across the peninsula. These stations are maintained by WDNR, U.S. EPA, and USGS-WRD. According to our surveys, the Village of Ephraim WWTP monitors phosphorus inputs into Green Bay. The Fish Creek Watershed Study Committee may also be conducting some nutrient tracking along Fish Creek. Additionally, the Door County Sanitation Department monitors ground water for unspecified contamination.

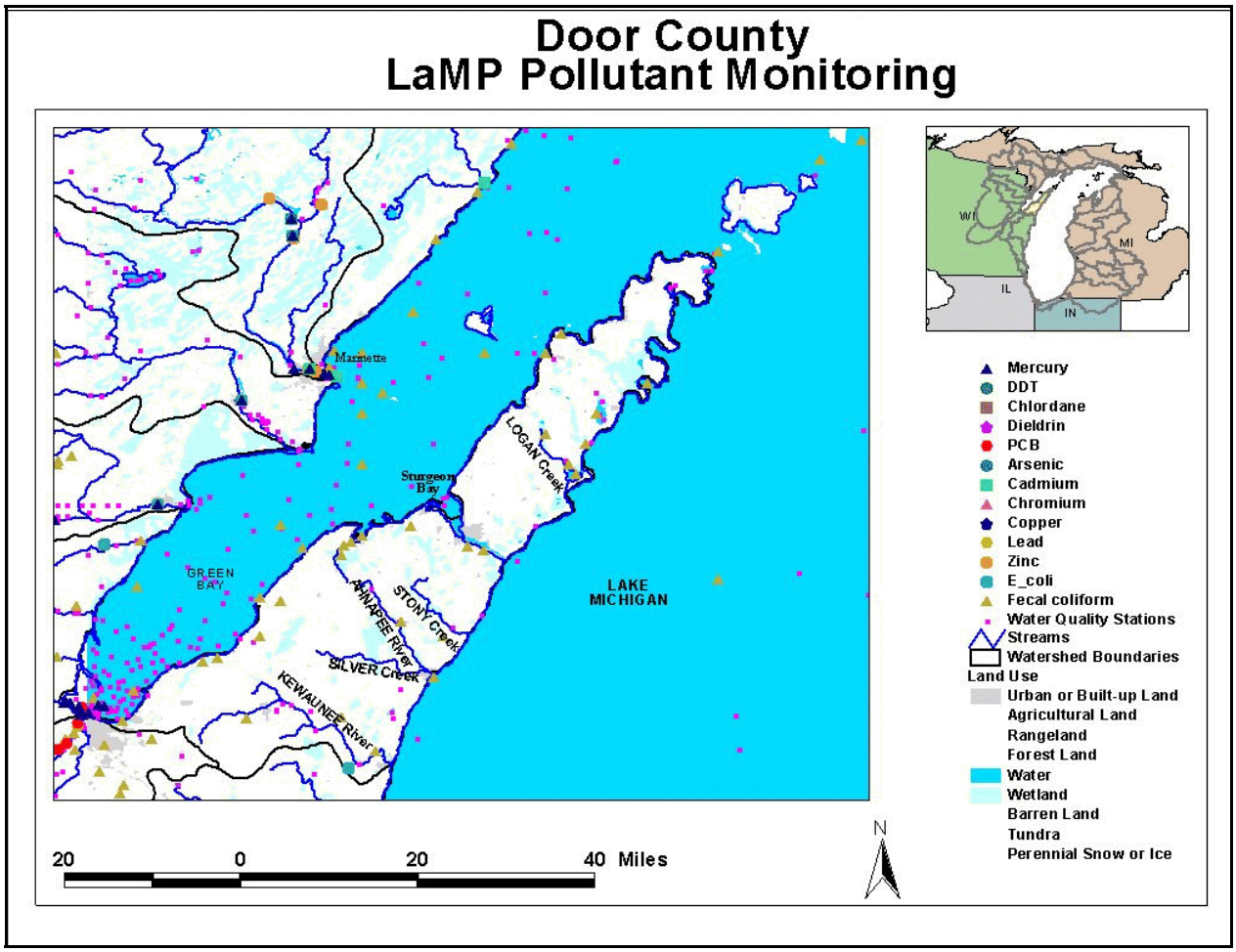

Figure 46. The Door-Kewaunee watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

One station monitors *E. coli* in the watershed on the Kewanee River. The station is maintained by WDNR. Monitoring for fecal coliform is significantly more extensive. About 29 stations can be found throughout the watershed. Most of the stations are located along the shoreline, but there are a number of stations distributed throughout the rest of the peninsula. WDNR maintains all the fecal coliform monitoring stations in the watershed.

Meteorological and Flow Monitoring

USGS maintains five gage stations throughout the Door-Kewaunee watershed to measure flow rates and various other physical characteristics of streams (see Figure 48). All gage stations are located on the Lake Michigan side of the watershed. In addition, the Village of Ephraim WWTP monitors suspended solids near their output into Green Bay.

One NOAA weather station is located on the peninsula. The station is located in Kewaunee at the southeastern corner of the watershed. NOAA stations measure continuous precipitation data, as well as other meteorological data.

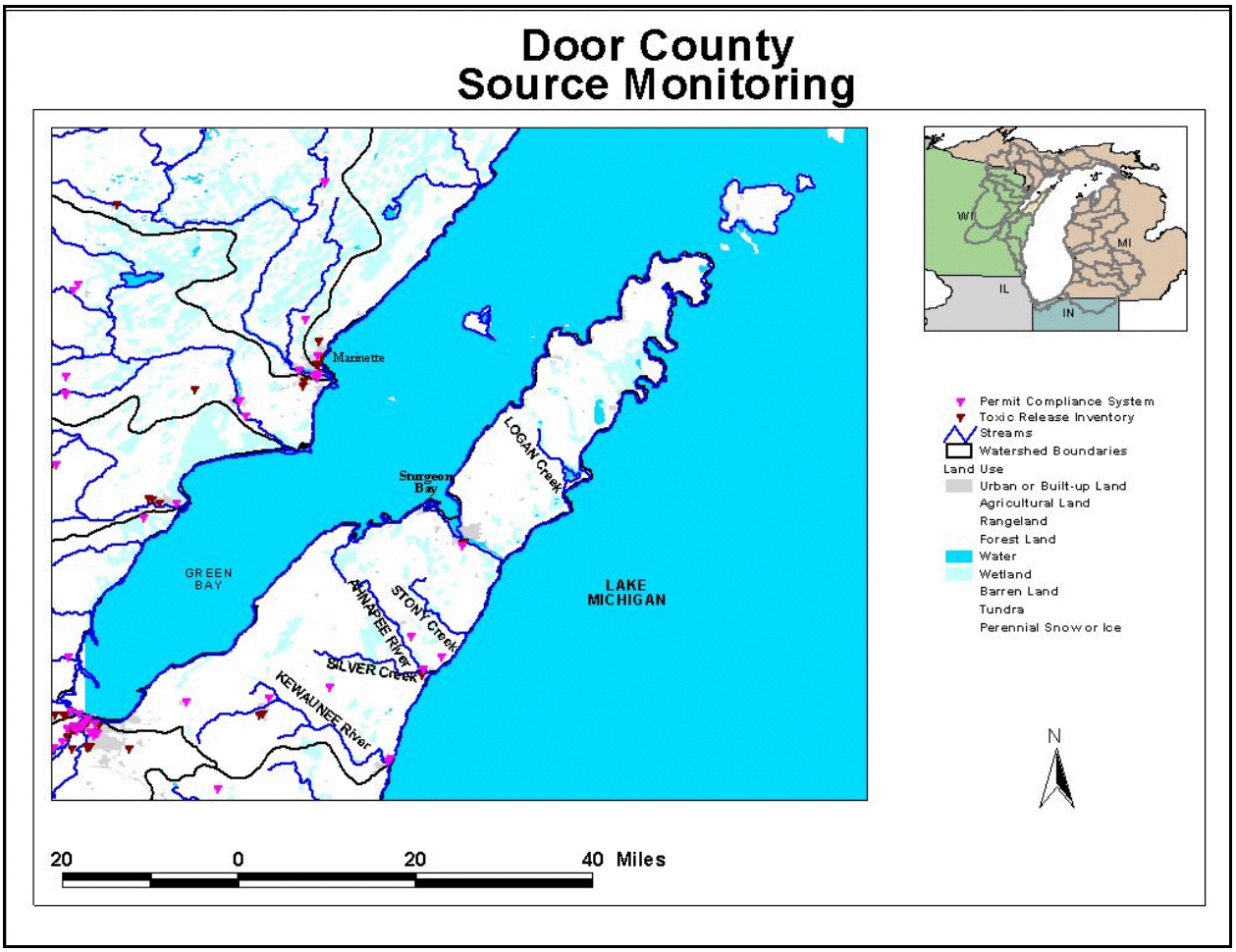

Figure 47. Door-Kewaunee watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

Sediments

There are 20 National Sediment Inventory sites within the watershed (see Figure 48). A cluster of sites are located in Sturgeon Bay and the rest are distributed along the shoreline around the peninsula. These sites are all administered by the WDNR. About half of the sites monitor sediment chemistry to assess human health and aquatic life impacts. A total of 11 sites monitor benthic organism tissue, discussed below.

Fish Contaminants, Fish Health, and Aquatic Nuisance Species

As discussed earlier, we have been unable to find specific locational information (such as sampling locations) for programs monitoring fish populations or their health. There are statewide programs in existence, but these are discussed in the overall findings discussion. The National Sediment Inventory lists 11 stations that monitor fish tissue for bottom contamination. These are located throughout the basin, and are administered by the WDNR.

A search of the Fish and Wildlife Advisory database on all major Door County waterbodies revealed fish consumption advisories for two locations in the basin. Advisories had been issued for the Kewaunee River,

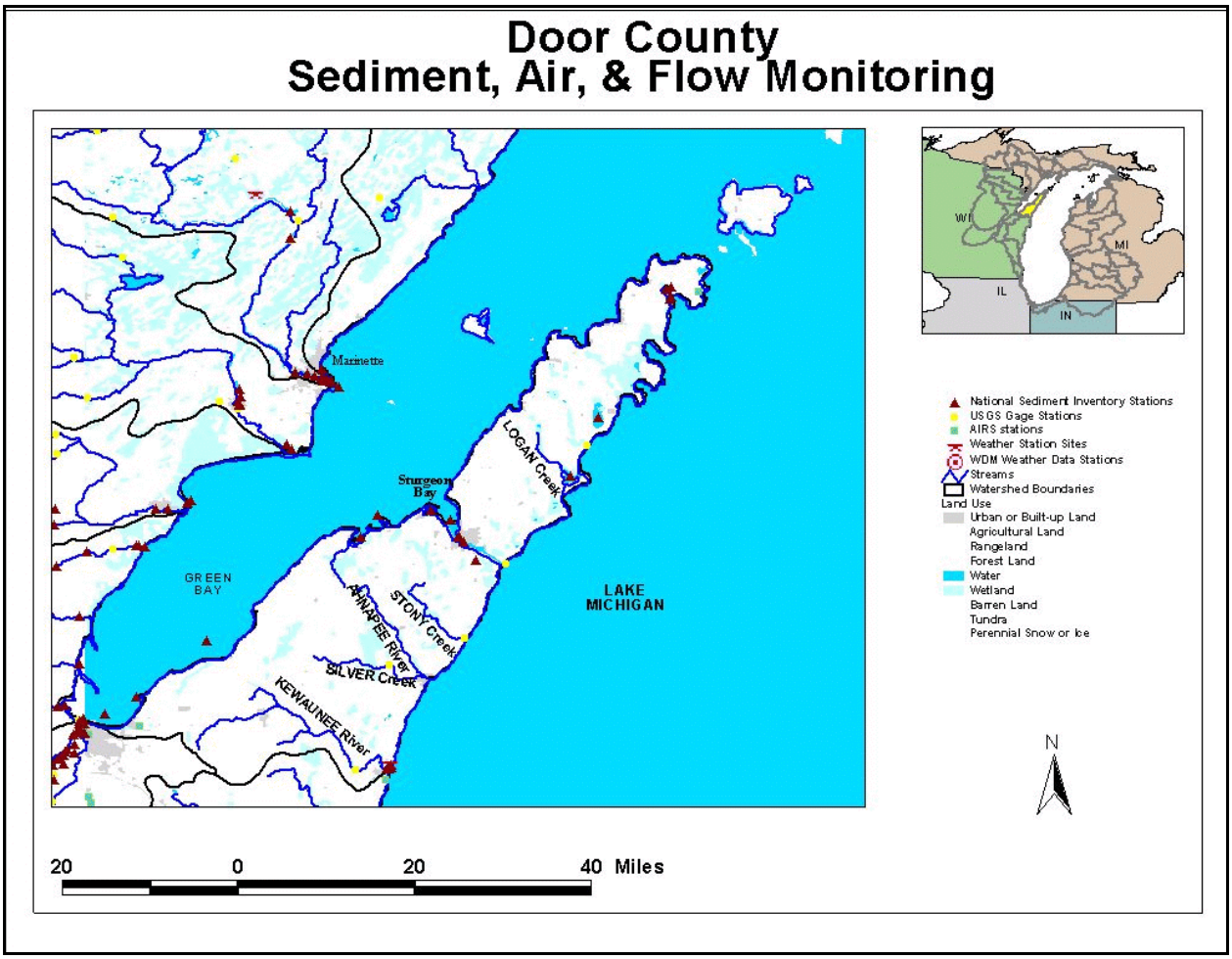

Figure 48. Door-Kewaunee watershed with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

and the Ahnapee River. The advisories were all state issued, covered a variety of fish species and related to PCB levels.

No programs were discovered to be monitoring for aquatic nuisance species within the watershed. Refer to the overall discussion of Lake Michigan monitoring for a discussion about programs that cover multiple tributary watersheds.

Benthos Monitoring

No specific locational information was discovered for state or national programs monitoring benthic organisms. Several organizations may be monitoring benthic organisms generally in the watershed, among others. These are discussed in the overall discussion of Lake Michigan monitoring.

Air Monitoring

Figure 48 illustrates the locations of the two air monitoring stations on the peninsula, according to the U.S. EPA's AIRS database. One station is paced at the far western border of the watershed, while the other is on the easternmost tip of the peninsula. Both stations monitor low-level ozone.

Wildlife Monitoring

One private citizen reports to be monitoring wildlife abundance at an unspecified site on the peninsula. There are other organizations monitoring wildlife species generally throughout the Lake Michigan basin. These are discussed in the overall discussion of Lake Michigan monitoring.

Land Use

Many large wetland areas exist across the peninsula. The Lower Fox watershed consists of a large portion of urbanized land with relatively few wetlands. The wetlands are not extensively monitored by water quality stations. The only urbanized development in the watershed is Sturgeon Bay. Most of the watershed consists of agricultural and forest lands.

Local Assessment

Three of the seven area watersheds are designated as Priority Watershed Projects and continue to receive attention through multiple state and local programs designed to reduce water pollution. These programs include nutrient and pest management, soil erosion, and pollution abatement cost-share programs. Door County recently prepared a *Land and Water Resource Management Plan* setting goals and objectives in moving toward improved management of the landscape and protection of water and other natural resources in the county.

The *Water Quality Management Plan* developed for the Door-Kewaunee Basin (1995) identified a number of problem areas and offered a number of recommendations, many of which are in process of implementation. However, a comprehensive area-wide monitoring initiative involving broad collaboration between volunteer organizations and local and state agencies may prove to be a possibility in light of the increasing pressures of development.

Duplication of monitoring efforts does not appear to be an issue, but rather the issue is one of a consistent set of monitoring programs directed toward lakes and streams.

There are several particular areas where attention could be beneficial:

- Improvement in data collection from water quality sampling and well drilling operations, wherein data could be assembled in a form that would allow for qualitative and quantitative analysis on a county-wide basis.

- Creation of additional lake associations, whose members and volunteers could institute regular water monitoring programs. Preliminary work is in process to organize additional lake associations and energize the two that exist to help develop monitoring programs similar to others throughout the state. The Wisconsin Association of Lakes is the reference source for this work.

- The most significant of emerging issues focus on growth and development and the implication toward development pressure from the planned expansion of Highway 42-57. This highway runs from Green Bay to Sturgeon Bay, and is planned for expansion from the current two lane road to a four lane divided highway.

- Collaborative partnerships such as the Door County Stewardship Council offer opportunities to enhance coordination of long-term monitoring programs.

- The Stewardship Council is working to develop coherent strategies that leverage the resources of all local and state agencies and some federal agencies. While we are moving toward cooperative relationships with various organizations, including local governments, a number of people foresee opportunities for coordinated programs that will leverage current standard or routine programs. One missing piece is for the council activities to bridge connections to neighborhood and Lake Associations that would generate an increased interest in watershed protection issues.

15. Menominee River

Background

The Menominee River forms the boundary between Wisconsin and the Upper Peninsula of Michigan in Marinette, Florence, Forest, Vilias, Menominee, Dickinson, and Iron counties. The Menominee system is comprised of a number of large and small tributaries, the major tributaries being the Michigamme, Brule, Pike, Paint, Iron and Sturgeon Rivers. The Menominee originates at the confluence of the Michigamme and Brule Rivers and flows approximately 115 miles to the east towards the waters of Green Bay. The total basin is approximately 4,070 square miles with 2,618 square miles located in Michigan and 1,452 square miles located in Wisconsin.

The topography in the Menominee River basin was formed and heavily altered by periodic glaciation, the most recent of which was the Wisconsin period- 10,000-20,000 years ago. The region is characterized by lakes, glacial plains, end moraines, and poorly integrated east to west drainage. Bedrock outcrops and moraine deposits in the northern river basin create a more rugged terrain with a maximum elevation of 1300 feet, giving the basin a gradient of approximately five feet per mile. Due to extensive amount of glacial activity, the Menominee basin consists mostly of sand and gravel called outwash which is underlain by dolomite. Some of the developed areas are constructed on man-made soils that were deposited during the lumbering boom around the turn of the century. These man-made soils are composed of sawdust and waste wood that was discarded and then overlain with sand or topsoil as the building surface. These unstable soils have subjected many structures with excessive settling and alignment shifting. Furthermore, the prevalent Roscommon soils and some of the marshy soils have also caused some problems due to their corrosive nature.

The status of local monitoring efforts in the Menominee River basin tends to revolve around compliance. In fact, of the eight entities found to be actively monitoring on the local level, five were monitoring for compliance purposes. However, there are habitat monitoring programs that will be discussed in further detail in the following sections.

Status of Watershed Management Efforts in the Study Area

The lower reaches of the Menominee River have been subjected to a high amount of pollution from industries over the years and now this watershed is identified as an Area of Concern. Since 1934, the Ansul facility has been the site of fire suppressant and agricultural herbicide products. The herbicidal products produced a salt byproduct that was 2 percent arsenic by weight that was stored in uncovered, unlined waste piles. Remediation began after the WDNR required Ansul to monitor arsenic discharges by issuing a consent decree. The U.S. EPA ordered Ansul to remove 15,000 yards of contaminated sediment in 1997.

Pollutants of Concern

Aquatic Monitoring

Monitoring coverage for LaMP pollutants reported into the STORET system is shown in Figure 49. This map indicates that stations exist for one (mercury) of seven critical pollutants, seven out of ten pollutants of concern, and none of the listed emerging pollutants. Monitoring for all pollutants is relatively light compared to other AOC watersheds in this report. The monitoring is almost exclusive to the Menominee River, with intense coverage at its outfall to Green Bay. There are a few sites on the Popple River, however. There are

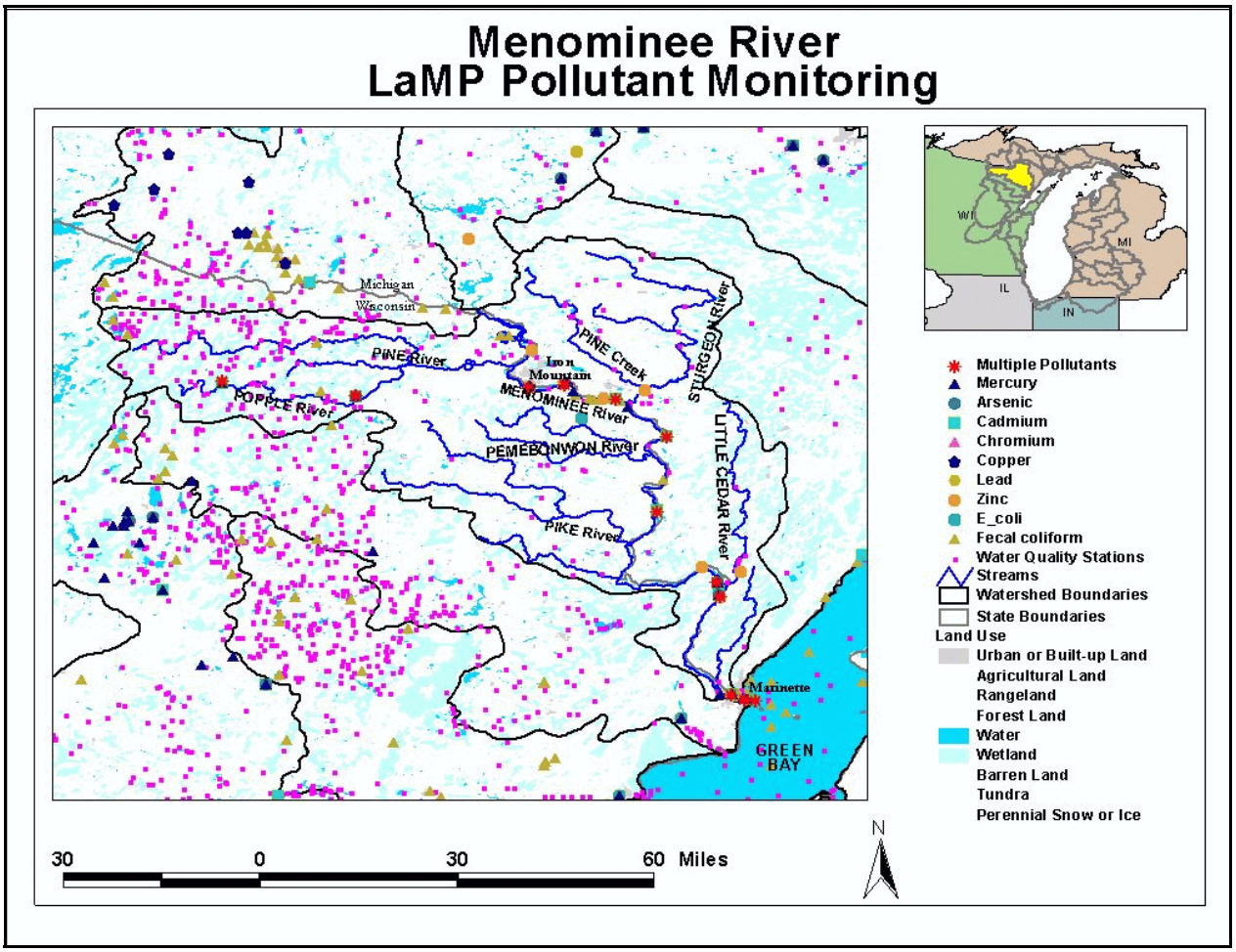

Figure 49. The Menominee River watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

12 stations monitoring mercury, with four at our near the Menominee outfall. The stations monitoring for LaMP pollutants are maintained by WDNR, MDEQ, and USGS-WRD (NAWQA and baseline stations).

In addition, surveys indicate that two organizations conduct some LaMP pollutant monitoring. The Wisconsin Electric Power Company conducts some limited monitoring for all but cyanide, PAHs, and atrazine at their 13 hydroelectric sites along the Menominee. Ansul, Inc. monitors for arsenic in the groundwater for a RCRA remediation site in the watershed.

Pollutant Release Monitoring

An examination of Permit Compliance System and Toxic Release Inventory reporting locations in the Menominee River watershed indicates a relatively small number of monitoring locations for potential pollution sources throughout the basin (see Figure 50). The locations are clustered around Marinette and Iron Mountain.

Nutrients and Bacteria

There are nearly 300 water quality monitoring stations within the Menominee River watershed listed in the STORET system. A vast majority of these stations (shown in Figure 49) monitor for some form of nitrogen

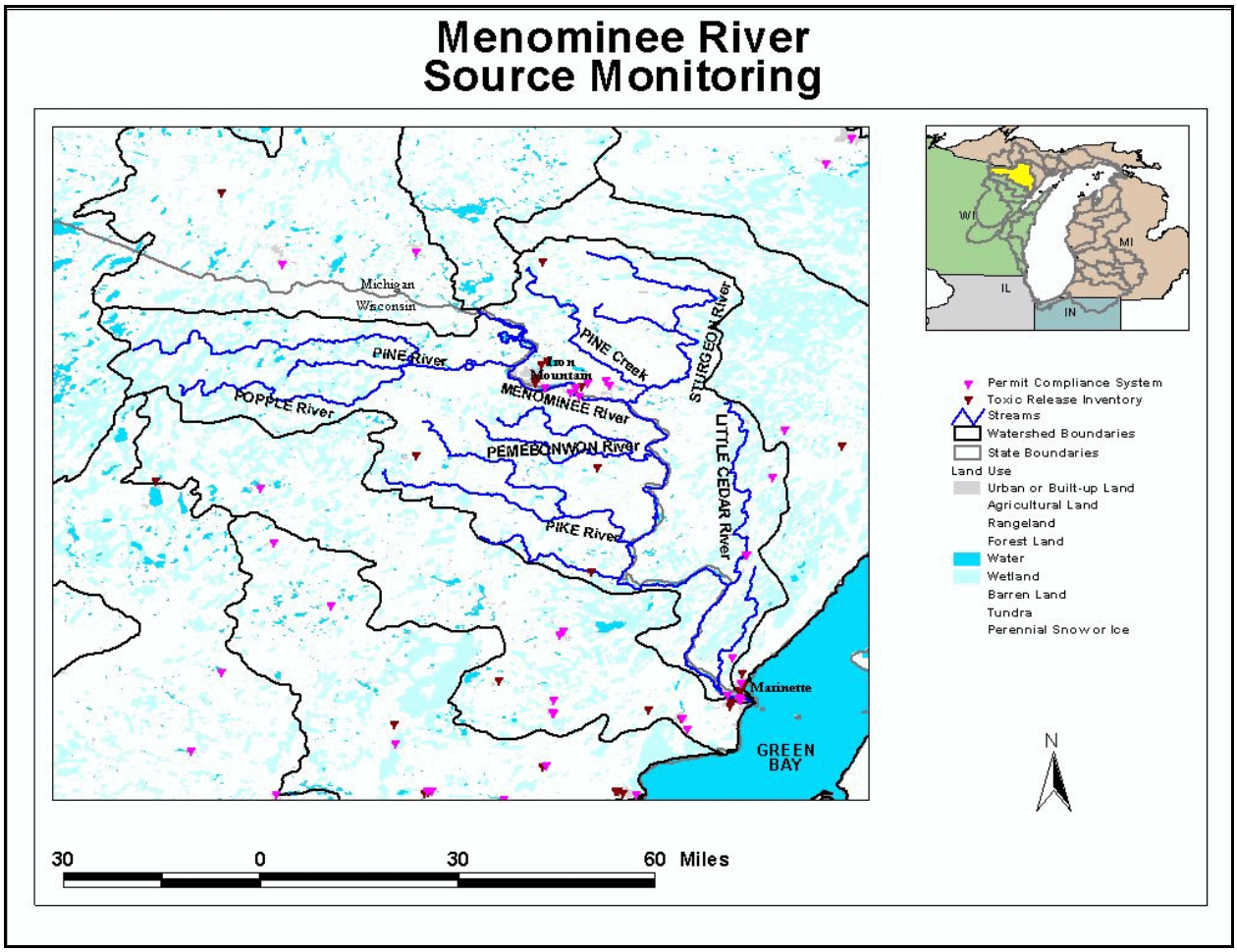

Figure 50. Menominee River watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

and phosphorus, the chief nutrients impacting water quality. Thus, where monitoring stations exist, they are likely tracking nitrogen and phosphorus. The density of stations is greater along the Menominee and also within the Nicolet National Forest in the westernmost section of the watershed. These stations are maintained by WDNR, MDEQ, USGS-WRD, U.S. EPA, and USFS. According to our surveys, there is one other organization in the basin that may be monitoring for nutrients. Champion International Corp. monitors its waste water effluent for unnamed pollutants.

Two stations monitor *E. coli* in the Menominee River watershed. Both are located on the Menominee, just south of Iron Mountain. Both stations are maintained by WDNR. Monitoring for fecal coliform is more extensive. About 35 stations can be found throughout the watershed. As with other monitoring coverage in the watershed, monitoring of fecal coliform levels is clustered along the Menominee, with greater density at Marinette and Iron Mountain. However, there are a few stations distributed throughout the rest of the basin. Organizations monitoring for fecal coliform in the watersheds include WDNR, MDEQ, USGS-WRD, and USFS.

Meteorological and Flow Monitoring

USGS maintains 29 gage stations throughout the Menominee River watershed to measure flow rates and various other physical characteristics of streams (see Figure 51). Some of these stations have been used for physical and chemical monitoring through the NAWQA program. Gage stations are located on most major rivers and streams in the watershed.

One organization (Consolidated Papers Inc.) reported that they continuously monitor pH, dissolved oxygen, and temperature along three miles of the Menominee. In addition, North American Hydro, Inc. monitors water levels of the Menominee at Marinette. Also, most of the water quality stations illustrated in Figure 49 monitor a range of physical characteristics.

One NOAA weather station is located in the Menominee River watershed, and one other station is located just outside the boundary of the watershed. The station inside the watershed is located in Stephenson, just north of the Menominee. The station outside the basin is located at the Laona Ranger Station in the Nicolet National Forest, about nine miles south of the watershed boundary. These stations measure continuous precipitation data, as well as other meteorological data.

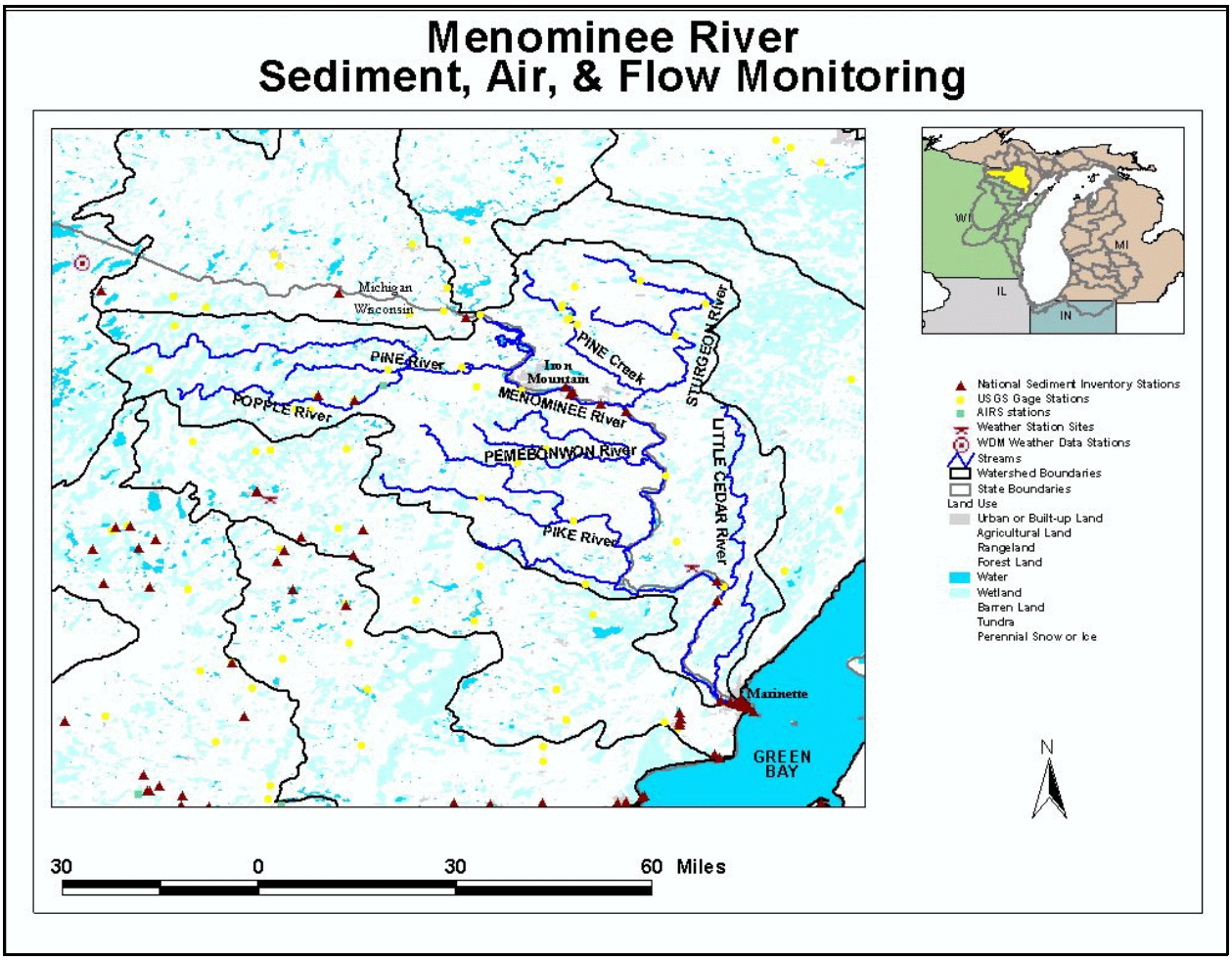

Figure 51. Menominee River watershed with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

Sediments

There are 21 National Sediment Inventory sites within the Menominee River watershed (see Figure 51). The sites are clustered along the Menominee, specifically at the outfall to Green Bay and downstream of Iron Mountain. These sites are administered by the WDNR, USGS-WRD, and U.S. EPA. About 13 of the sites monitor sediment chemistry to assess human health and aquatic life impacts. A total of eight sites monitor benthic organism tissue, discussed below.

Fish Contaminants, Fish Health, and Aquatic Nuisance Species

As discussed earlier, we have been unable to find specific locational information (such as sampling locations) for programs monitoring fish populations or their health. There are statewide programs in existence, but these are discussed in the overall findings discussion. The National Sediment Inventory lists eight stations that monitor fish tissue for bottom contamination. These are located at various points along the Menominee, and are administered by WDNR and the U.S. EPA. USGS also maintained several NAWQA stations in the watershed to monitor fish tissue.

A search of the Fish and Wildlife Advisory database on all major Menominee basin waterbodies revealed fish consumption advisories for eight locations along the Menominee River. The advisories were all state issued, covered a variety of fish species and related to PCB, dioxin, and mercury levels.

We did not discover any programs monitoring for aquatic nuisance species within the Menominee River watershed. Refer to the overall discussion of Lake Michigan monitoring for a discussion about programs that cover multiple tributary watersheds.

Benthos Monitoring

No specific locational information was discovered for state or national programs monitoring benthic organisms. Some organizations may be monitoring benthic organisms generally in the watershed, among others. These are discussed in the overall discussion of Lake Michigan monitoring (see NAWQA discussion, for example).

Air Monitoring

Figure 51 illustrates the location of the single air monitoring station in the basin, according to the U.S. EPA's AIRS database. The station is located on the Popple River at Florence. The station monitors low-level ozone.

Wildlife Monitoring

Bird Studies Canada conducts ongoing monitoring of amphibian and bird populations in marshes in the watershed. However, there are organizations monitoring wildlife species in the basin along with others. These are discussed in the overall discussion of Lake Michigan monitoring.

Land Use

Land use in this basin is primarily forested and agricultural, with only two major urban areas located on the lower Menominee River, Iron Mountain, MI and Marinette, WI. There are extensive wetlands in many areas

of the watershed. These wetlands are most prevalent in the western lobe of the watershed, and in the Little Cedar River subwatershed. Since the western wetlands are in the Nicolet National Forest, they are monitored quite extensively by the USFS. Also, Marinette County Land and Water Conservation Department monitors county shorelines for zoning purposes.

Local Assessment

The monitoring efforts in the Menominee River basin are focused primarily on remediation and compliance type activities. These types of activities are necessary, according to the RAP, for improving the water quality in the Menominee AOC. Such impaired uses as the restriction of fish and wildlife consumption, degraded wildlife populations, degraded benthos, and various public health concerns all have ties back to industrial polluters. It is therefore safe to say that monitoring activities in the Menominee area have been relatively successful in meeting the needs and suggestions stated in the RAP.

Most of the responsibility is placed on state and/or federal agencies when dealing with environmental concerns. The WDNR and MDEQ have together been working on implementing the RAP. According to the U.S. EPA web site (http://www.epa.gov/glnpo/aoc/lowmeno/index.html), a Citizens' Advisory Committee and a Technical Advisory Committee was formed to help develop the RAP document by mobilizing public support, increasing awareness, and conducting data and problem analysis. However, little evidence was found pertaining to public awareness and involvement through volunteers, especially when compared to other basins in the area. The UW-Extension project was the only one found to involve a substantial amount of local volunteers from the Menominee basin.

Education and awareness have provided the backbone for many environmental programs nationwide. Actively involving the public in monitoring programs allows resource managers to produce cost-effective data, while enhancing the environmental awareness of the community involved. These programs have often sparked the interest of surrounding communities and they too have jumped on the "environmental band wagon." So why the lack of public involvement in the Menominee basin? The lack of public involvement may be related to the remoteness of the basin and the lack of program promotion.

The Menominee River basin is located in a relatively "clean" area of the states of Michigan and Wisconsin. Even though the AOC is a highly degraded system, the local population is able to find pristine forested and wildlife areas only a short-drive away. Also, a high percentage of the local population is found working for these industrial polluters and relies on the industrial presence for their livelihood.

To promote a successful environmental monitoring strategy within the basin, the focus should be on the youth of the area. A Testing the Waters program would a great start to actively involve school children, while introducing the issue to their parents. It is important not to force public participation, but to create a program that would be attractive and conducive for people to get involved. It should be noted that this is an extremely slow process, often taking years to establish.

16. Manistique River

Background

The Manistique River Watershed includes the majority of Schoolcraft County and portions of Luce, Mackinac, Alger, and Delta Counties. The area encompasses approximately 1,461 square miles.

Watershed Breakdown by County

County	Area (Acres)	Sq. Miles	percent of Watershed
Schoolcraft	666,880	1,042	71
Alger	135,040	211	15
Mackinac	55,680	87	6
Luce	54,400	85	6
Delta	23,040	36	2

The river originates in the Manistique Lake in Luce County and flows southwestward across Schoolcraft County to Manistique where it empties into Lake Michigan. The majority of the tributaries flow southeast across Schoolcraft County to join the main stream. The major tributaries are the Indian River, West Branch, Driggs, Fox, Duck, and Little Dick Creeks.

Status of Watershed Management Efforts in the Study Area

It is the opinion of the Schoolcraft County Economic Development Corporation that activities concerning monitoring and management of the Manistique River Watershed lack coordination, depth, and sustainability. Although, activities such as streambank stabilization and monitoring of environmental conditions are occurring, there appears to be little coordination between stakeholder groups. Further, the Manistique River Watershed Partnership appears to depend heavily on the activities of the United States Fish and Wildlife Servics - Seney Wildlife Refuge to accomplish many of its goals.

Pollutants of Concern

Aquatic Monitoring

Monitoring coverage for LaMP pollutants reported into the STORET system is shown in Figure 52. This map indicates that stations exist for one (mercury) of seven critical pollutants, seven out of ten pollutants of concern, and none of the listed emerging pollutants. Only four stations monitor these pollutants in the watershed. All four stations are located on the Manistique River, with three stations near its outfall to Lake Michigan in the town of Manistique. USGS-WRD maintains two of the stations in Manistique, and MDEQ maintains the other Manistique station as well as the upstream station.

In addition, surveys indicate that three additional organizations conduct some LaMP pollutant monitoring. The City of Manistique monitors the effluent from their WWTP for all LaMP pollutants. Northern Michigan

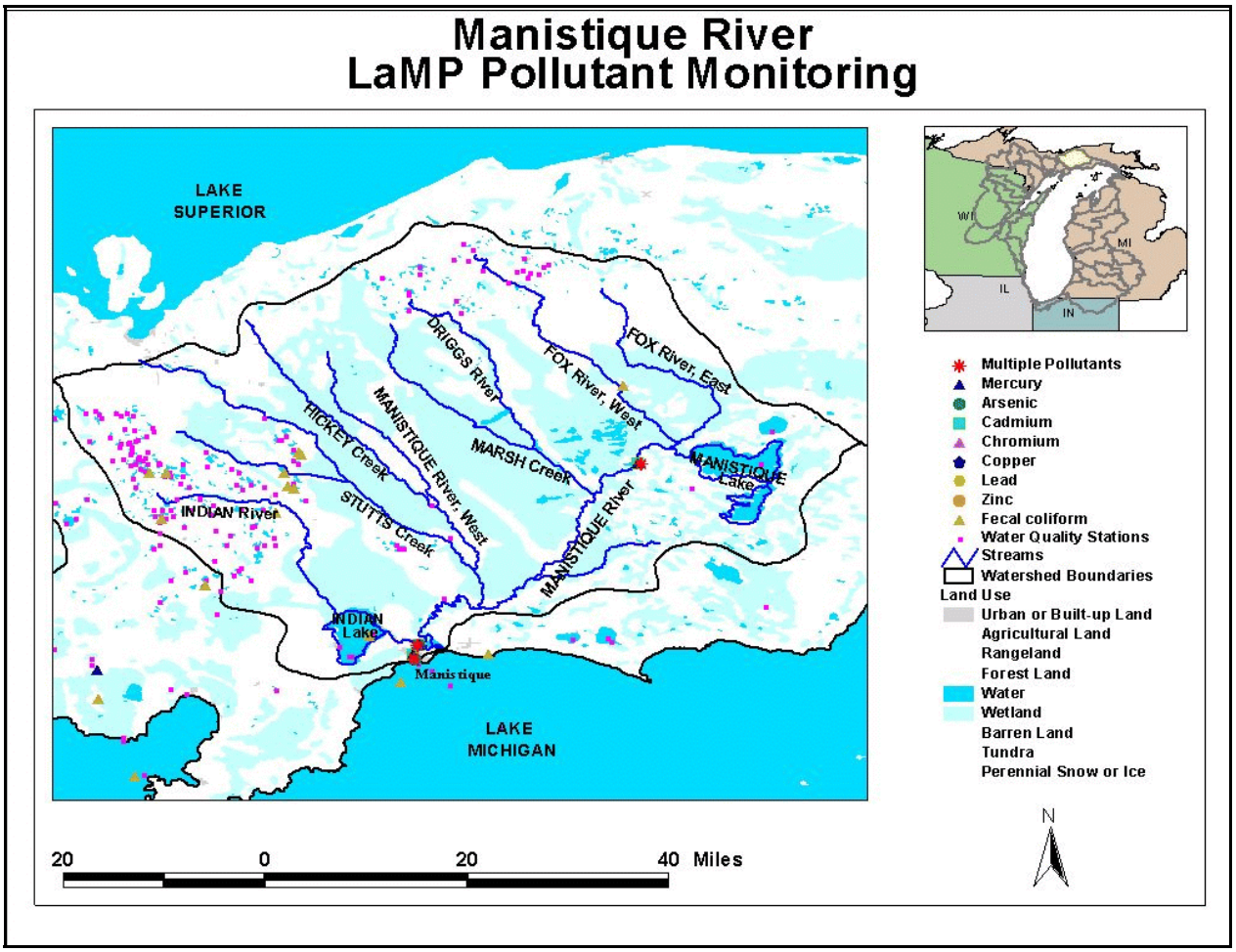

Figure 52. The Manistique River watershed with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

University monitors bottom fish tissue for PCBs in the Manistique River. Finally, Manistique Papers, Inc. monitor intakes from the Manistique for lead, copper, and zinc contamination.

Pollutant Release Monitoring

An examination of Permit Compliance System and Toxic Release Inventory reporting locations in the Manistique River watershed indicates only two monitoring locations for potential pollution sources in the watershed. Both are located at the outfall of the Manistique River to Lake Michigan (see Figure 53). These locations are Manistique Papers, Inc., and the Manistique WWTP. Past releases from Manistique Papers include copper, lead, silver, zinc, and phosphorus. Releases from the WWTP include mercury, chlorine, nitrogen, and phosphorus.

Nutrients and Bacteria

There are over 150 water quality monitoring stations within the Manistique River watershed listed in the STORET system. Clusters of stations can be found at the Manistique River outfall, and within the Hiawatha National Forest in the western part of the watershed. A vast majority of these stations (shown in Figure 52) monitor for some form of nitrogen and phosphorus, the chief nutrients impacting water quality. Thus, where

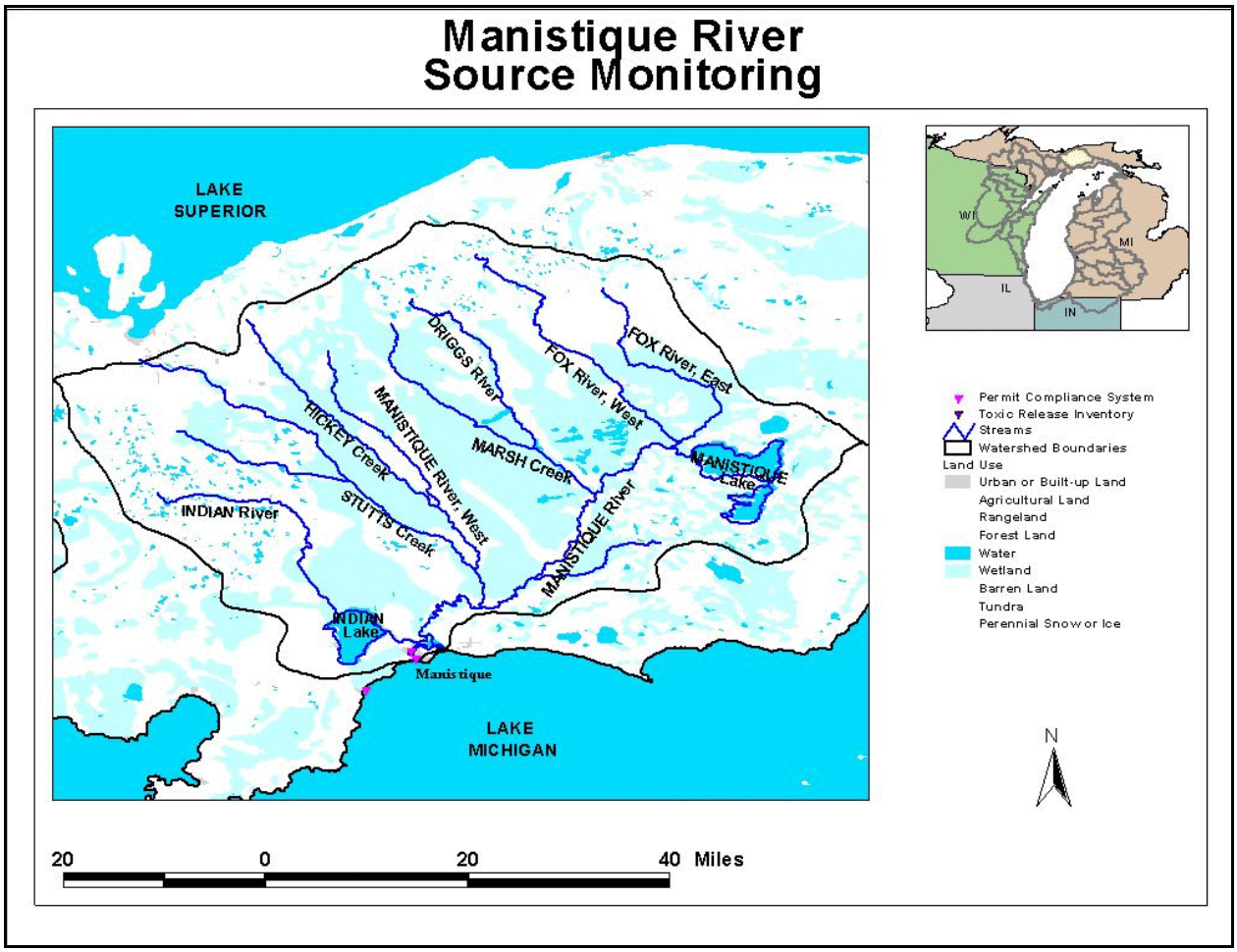

Figure 53. Manistique River watershed with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

monitoring stations exist, they are likely tracking nitrogen and phosphorus. These stations are maintained by MDEQ, USGS-WRD, U.S. EPA, and USFS.

No stations could be found that monitor *E. coli* in the Manistique River watershed. Contrarily, monitoring for fecal coliform is quite prevalent. About 14 stations can be found throughout the watershed. Monitoring of fecal coliform levels occurs along the Manistique, in the West branch of the Fox River, in Indian Lake, and within the Hiawatha National Forest. Organizations monitoring for fecal coliform in the watersheds include MDEQ and USFS.

Meteorological and Flow Monitoring

USGS maintains 13 gage stations throughout the Manistique River watershed to measure flow rates and various other physical characteristics of streams (see Figure 54). Gage stations are located on the Manistique, Fox (West branch), and Indian Rivers.

One organization (the City of Manistique) reported that they monitor temperature, pH, biological oxygen demand, color, and hardness in parts of the Manistique and Indian Rivers. In addition, the Schoolcraft

County Drain Commissioner monitors water levels in Indian Lake and Indian River. Further, most of the water quality stations illustrated in Figure 52 monitor a range of physical characteristics.

No NOAA weather stations are located in the Manistique River watershed. The closest stations are more than 25 miles away from the nearest watershed boundary. The closest stations are located at Fayette Sack Bay, southeast of Manistique, and on Beaver Island, in Lake Michigan. These stations measure continuous precipitation data, as well as other meteorological data.

Sediments

There are 10 National Sediment Inventory sites within the Manistique River watershed (see Figure 54). All sites are clustered at the outfall of the Manistique River. These sites are administered by the U.S. EPA. All of the sites monitor sediment chemistry to assess human health and aquatic life impacts. In addition, Northern Michigan University monitors sediments and fish tissue in the Manistique River for PCB contamination.

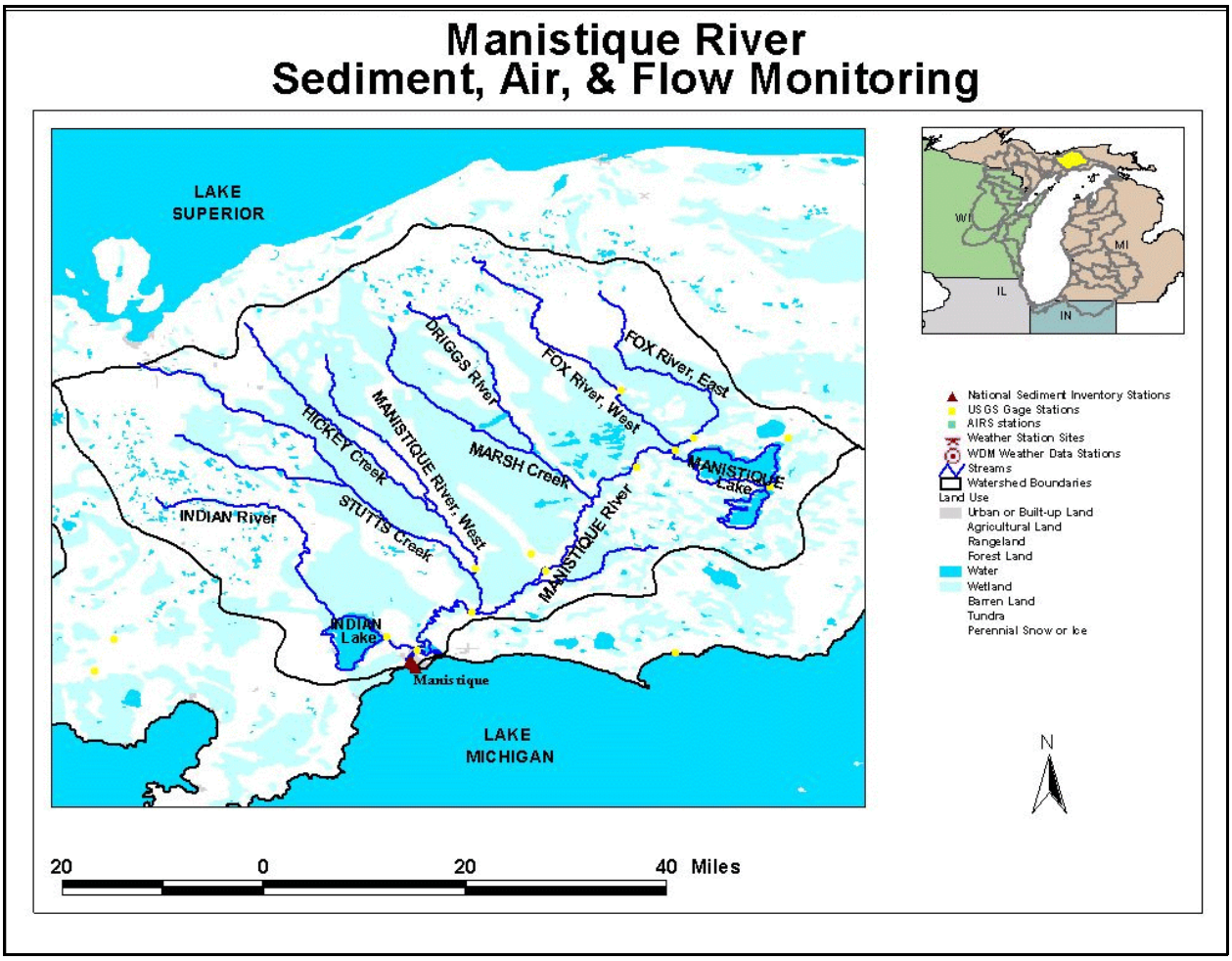

Figure 54. Manistique River watershed with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

Fish Contaminants, Fish Health, and Aquatic Nuisance Species

As discussed earlier, we have been unable to find specific locational information (such as sampling locations) for programs monitoring fish populations or their health. There are statewide programs in existence, but these are discussed in the overall findings discussion. The National Sediment Inventory does not list any stations that monitor fish tissue for bottom contamination. However, USFS indicates that they monitor sport fish populations and habitat within the Hiawatha National Forest.

A search of the Fish and Wildlife Advisory database on all major Manistique basin waterbodies revealed fish consumption advisories for two locations along the Manistique River. The advisories were all state issued, and related to PCB levels in common carp, and mercury levels in northern pike.

We did not discover any programs monitoring for aquatic nuisance species within the Manistique River watershed. Refer to the overall discussion of Lake Michigan monitoring for a discussion about programs that cover multiple tributary watersheds.

Benthos Monitoring

No specific locational information was discovered for state or national programs monitoring benthic organisms. Some organizations may be monitoring benthic organisms generally in the watershed, among others. These are discussed in the overall discussion of Lake Michigan monitoring.

Air Monitoring

Figure 54 illustrates no air monitoring stations in the basin, according to the U.S. EPA's AIRS database. However, the U.S. Fish and Wildlife Service (USFWS) is beginning a program to monitor air within the Seney National Wildlife Refuge for a variety of characteristics.

Wildlife Monitoring

The USFWS monitors an undefined list of species within the Seney National Wildlife Refuge. Ohter organizations may be monitoring wildlife species generally in the basin along with others. These are discussed in the overall discussion of Lake Michigan monitoring.

Land Use

The majority of the watershed is undeveloped with the primary use of forest and wetlands. More than 58 percent of the watershed is owned by the state or federal government, and another sixteen percent by industry or forest corporations. 26 percent of the forest land is in private ownership. Public forest lands include the Hiawatha National Forest, the Seney National Wildlife Refuge, and the Lake Superior State Forest. Land uses within the watershed consist of 93 percent forest land, 2 percent agricultural, and 5 percent other uses. Monitoring is heaviest in the Hiawatha National Forest. No special emphasis appears to be placed on wetlands.

Local Assessment

Monitoring activities and their relationship to RAP and watershed management activities
Research conducted by Dr. David Kingston, Department of Chemistry, Northern Michigan University was used in the development of the current Remedial Action Plan developed by the Michigan Department of Environmental Quality (February 20, 1997).

Adequacy, timeliness, and accessibility of monitoring data and research
There are five beneficial use impairments to the Manistique River:

1. Restrictions on Fish and Wildlife Consumption

Data is being collected by Dr. Kingston, as well as the U.S. EPA as they continue remediation activities. The Public Advisory Council and the City of Manistique have both commented that data is slow in returning to the community.

2. Degradation of Benthos

With the exception of EPA monitoring of saw dust removal while dredging, there appears to be no monitoring of the surface sawdust - particularly along the beach and other exposed areas.

3. Loss of Fish and Wildlife Habitat

At this time, beyond that of Dr. Kingston no monitoring is happening within the AOC in regards to this impairment. The Manistique River Watershed Partnership is currently conducting some strategic planning and grant writing. One of the projects they hope to work on includes restoration of fish habitat.

The Seney Wildlife Refuge and the Watershed Partnership completed an inventory of the watershed in 1995. Since then they have conducted two projects: stream-bank stabilization of the Driggs and Fox Rivers.

4. Restrictions on Dredging Activities

Once the U.S. EPA completes its dredging project, the ban on dredging should be lifted.

5. Potential Restrictions on Body Contact (Beach Closings)

The City of Manistique is currently upgrading its waste water treatment facilities, including an increase in capacity. Further, the City of Manistique is under order to eliminate combined storm / sanitary overflows which cause a discharge into the watershed. The City of Manistique is monitoring their activities and discharges into the watershed as required by their permitting. All work on the city sewer is subject to NPDES permit compliance monitoring.

In addition, the RAP notes two additional areas that may require further study to determine if they are impaired uses:

- Degraded fish and wildlife populations; and
- Bird or animal deformities or reproductive problems.

Dr. Kingston, and state and federal agencies appear to be the only individual(s), agencies monitoring data that would provide data for this possible impaired use.

Gaps in watershed monitoring activities
The only areas where there is active monitoring in the Manistique River and watershed are in the AOC and the Seney National Wildlife Refuge. Although the Watershed Partnership has plans for fish restocking programs and further streambank stabilization, currently there is not additional monitoring occurring within the watershed.

In addition, there does not seem to be any coordination of monitoring activities or sharing of information between these groups. Dr. Kingston has stated that at this time he is concerned about the release of his research data and will determine each request individually, beyond the data that he has published in journals.

Duplication in monitoring efforts
No duplication appears to be occurring, with little monitoring happening overall.

Improving utilization of existing monitoring activities
As the remediation of the AOC continues, the Manistique River / Harbor PAC will need to work to coordinate the existing research activities and new monitoring activities that will fill existing gaps to show that impaired uses to the AOC are being addressed and corrected.

Coordinating monitoring activities
The Schoolcraft County Economic Development Corporation recommends that the Manistique River and Harbor PAC and the Manistique River Watershed Partnership work together to develop a system that allows for the sharing of monitored data and address commonality, and devise a new and improved system to conduct monitoring within the watershed, allowing for better research and management in the watershed.

17. Lake Michigan Open Water and Basinwide Monitoring

Background

Many monitoring programs, especially those administered at the federal and state level, are established to cover more than one watershed in the basin. While all monitoring must take place at a specific geographic location, when information about those locations is absent, rather than attempting to divide multi-watershed programs up by watershed, it is more clear to discuss them in general across the whole basin. In addition, there are a number of programs that monitor the open waters of Lake Michigan. These have been set up to establish baseline information on the environmental health of the lake itself.

This chapter is organized in a way similar to the previous tributary chapters, with sections that cover the various types of ecological monitoring. In addition, two special programs are covered separately: the Lake Michigan Mass Balance Project and the National Water Quality Assessment Program.

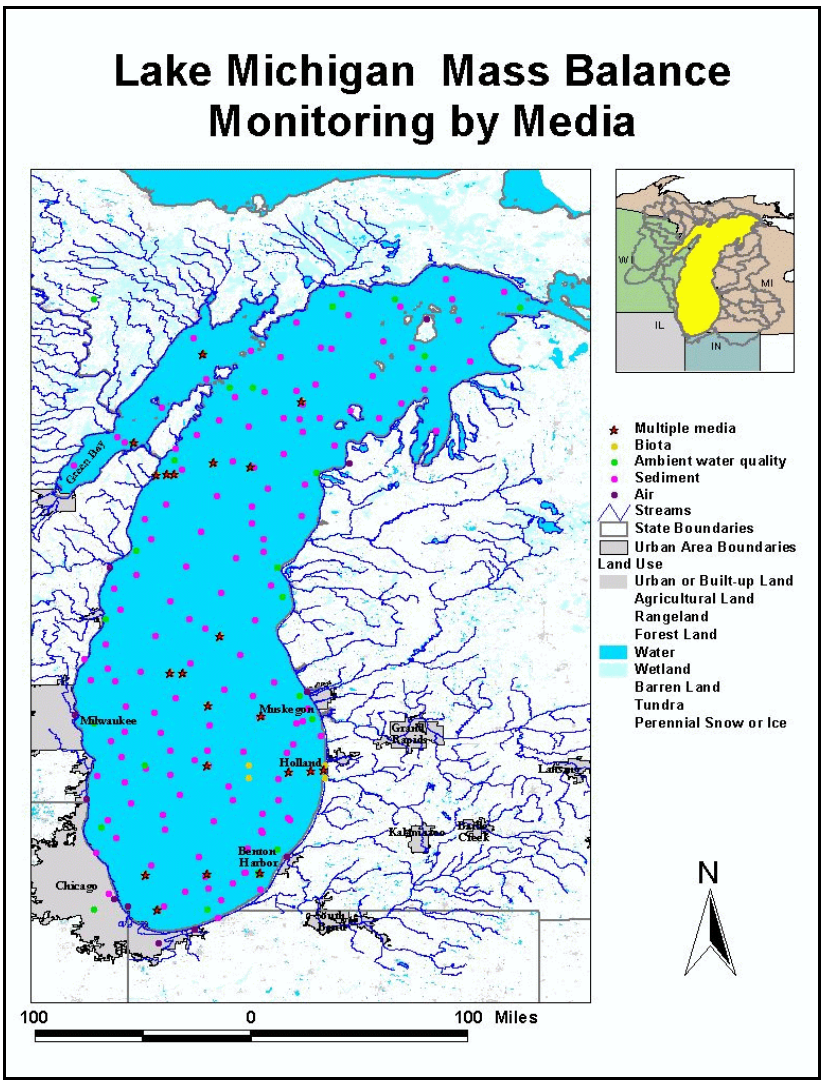

Figure 55. Lake Michigan with Lake Michigan Mass Balance project monitoring stations shown by media monitored.

Lake Michigan Mass Balance Project

The Lake Michigan Mass Balance study is a project funded and primarily administered by U.S. EPA's Great Lakes National Program Office (GLNPO). Begun in 1994 and completed in 1999, the study is based on the principle of conservation of mass. This principle states that all inputs or additions (in this case pollutants) into a system must be equivalent to the amount of the element exiting or being taken up by the system. The project is an attempt to accurately model the the cycle, from input to exit, of several important pollutants. It is a short-term study and not intended to provide long-term baseline information.

The project is focusing on four major chemicals: mercury, PCBs, atrazine, and trans-nonachlor (a pesticide). The purpose of the study is to determine the origination, fate, and transport of these chemicals into, through, and out of Lake Michigan. The objectives are to identify relative

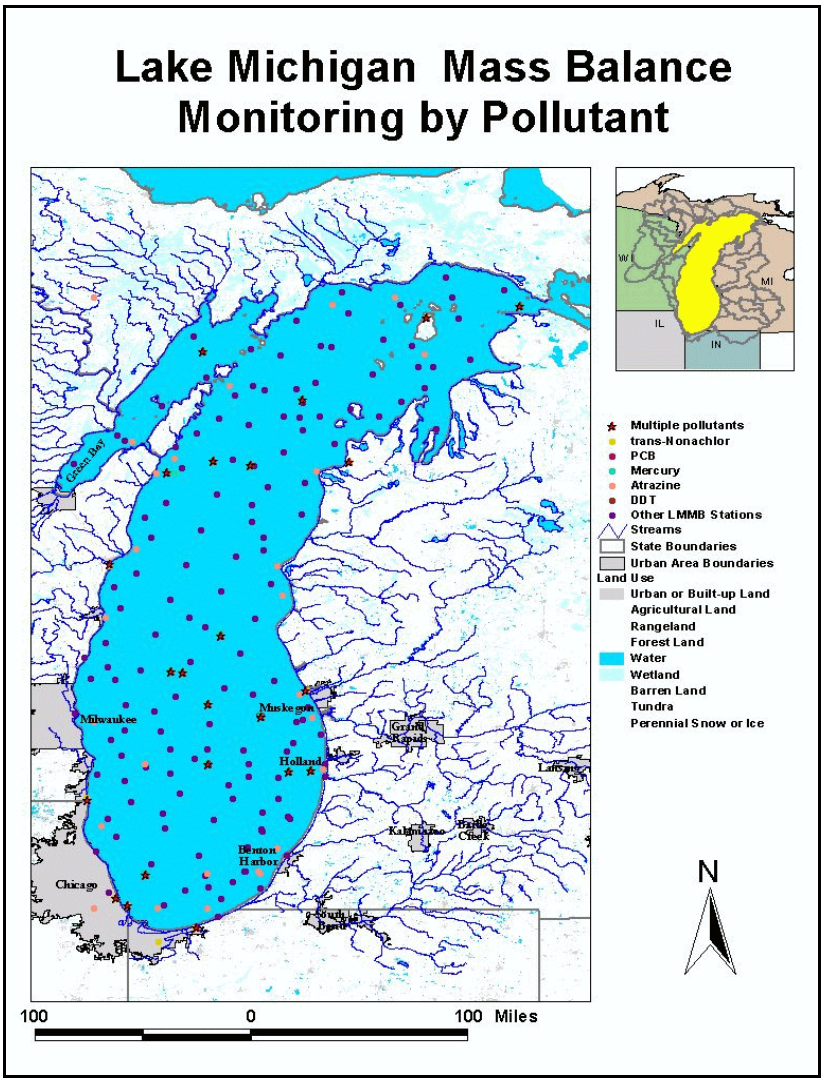

Figure 56. Lake Michigan with Lake Michigan Mass Balance project monitoring stations shown by pollutant monitored.

pollutant loads from rivers, air deposition, and sediment resuspension, and to predict the benefits associated with reducing loads.[4] For more information on the Lake Michigan Mass Balance Project, go to the project website at **http://www.epa.gov/glnpo/lmmb/**.

The key to the success of this project is accurate monitoring. Monitoring in the project has helped to establish a baseline and validate the models being developed. The Lake Michigan Mass Balance monitoring stations are displayed by the media monitored in Figure 55 and by the pollutants monitored in Figure 56. It should be noted that not all monitoring efforts under this project are displayed, as the information collected on the Lake Michigan Mass Balance project is still preliminary. Every attempt has been made to accurately describe the monitoring efforts under this project.

Efforts within the Mass Balance project have been put forth to monitor four media: ambient water quality, sediment, biota, and air. Under this project, there are about 45 stations monitoring water quality on the open lake. Organizations involved in this monitoring include the U.S. EPA (GLNPO and Environmental Research Lab – Duluth), the Battelle Marine Science Lab, University of Maryland Chesapeake Biological Lab, and Rutgers University (Department of Environmental Science).

Over 130 stations on the open lake monitor bottom sediments. Organizations conducting this monitoring include the U.S. EPA (Large Lakes Research Station) and NOAA (Great Lakes Environmental Research Lab). Nearly 20 stations monitor biota in the lake. The only information available about these stations indicates that plankton is monitored for mercury. However, there are several projects listed that are not geographically linked. These programs monitor fish diets, PCB levels, primary productivity, zooplankton, and plankton and invertebrate PCBs. The monitoring displayed on the map is conducted by the University of Minnesota (Soils Science Department), and the University of Michigan (School of Public Health).

[4]Lake Michigan Mass Balance Project home page, <**http://www.epa.gov/glnpo/lmmb/index.html**>, as of January 11, 2000 revision.

There are just over 25 stations on or near Lake Michigan that focus on monitoring air. These stations measure concentrations of a number of components including atrazine, nutrients, PCBs, and mercury. Organizations maintaining air monitoring stations include U.S. EPA (GLNPO), Rutgers University (Department of Environmental Science), Grace Analytical, Indiana University (School of Public and Environmental Affairs), University of Michigan (Air Quality Lab), Illinois Institute of Technology, and the Illinois State Water Survey.

As stated previously, monitoring efforts under the Lake Michigan Mass Balance project focus primarily on PCBs, mercury, DDT, atrazine, and trans-nonachlor. It appears that only eight of the stations monitor PCBs. All monitor the air for this chemical. All the organizations that participate in air monitoring (listed above), monitor for PCBs. There are a number of other programs that monitor PCBs, but are not geographically-linked. These programs monitor PCBs in lake water, in fish tissue, in sediment, as well as in plankton and invertebrates. About 19 stations are located lakewide that monitor mercury, but there are certainly more that are not geographically-linked. Organizations monitoring mercury include many of the organizations listed above, as well as MDNR, WDNR, USGS-WRD, and University of Wisconsin (Water Chemistry Lab). Only one station is listed to be monitoring DDT located at Sleeping Bear Dunes. This station is maintained by U.S. EPA (GLNPO). Nearly 50 stations are monitoring lake atrazine. Organizations involved in this monitoring are too numerous to list, but include most of the organizations listed previously.

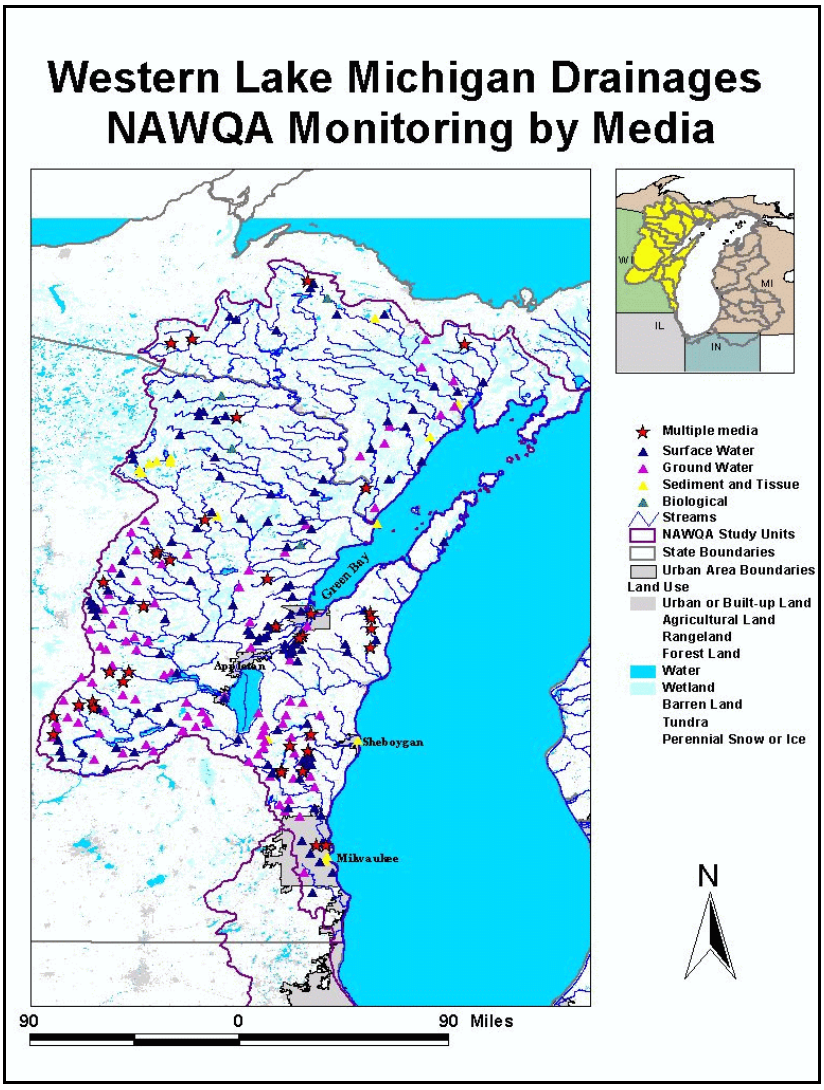

Figure 57. Western Lake Michigan Drainages study unit with NAWQA monitoring stations shown by media monitored.

The remaining stations monitor a large suite of pollutants. These include nutrients such a nitrogen and phosphorus, metals, other chemicals, and a number of physical characteristics. Little information is available about specifics in this area at this time.

National Water Quality Assessment (NAWQA) Program

The National Water Quality Assessment (NAWQA) Program is designed to describe the status and trends in the quality of the Nation's ground- and surface-water resources and to gain a better understanding of the factors that impact the quality of these resources. As part of the program, investigations are

conducted in 59 "study units." Ultimately, the purpose is to provide a framework for national and regional water quality assessment.[5]

Within these study units, several water quality parameters are monitored in both surface water and ground water. General parameter types include pesticides, volatile organic chemicals, nutrients, and trace elements. Bottom sediments, fish tissue, and aquatic organisms are also monitored. Study units rotate through a 3- to 5-year period of intensive data collection and analysis, followed by a 5- to 6-year periods of less intensive study and monitoring.

One of these study units is the "Western Lake Michigan Drainages." Data was collected intensively in this study unit from 1993 through 1995, and is currently in a "low phase" or period of lower intensity monitoring. Planning has begun for the next phase of high intensity monitoring. Data is collected mostly through USGS monitoring stations. While USGS monitoring stations are mapped along with other monitoring stations throughout this report, the NAWQA specific stations are depicted in Figure 57. The map shows monitoring stations by media monitored. These media include surface water (various physical and chemical water parameters), ground water, sediment and tissue (bottom sediment chemistry and organic tissue chemistry), and biological (benthic organisms). More information, including access to the study unit data can be found at **http://wwwdwimdn.er.usgs.gov/nawqa/** .

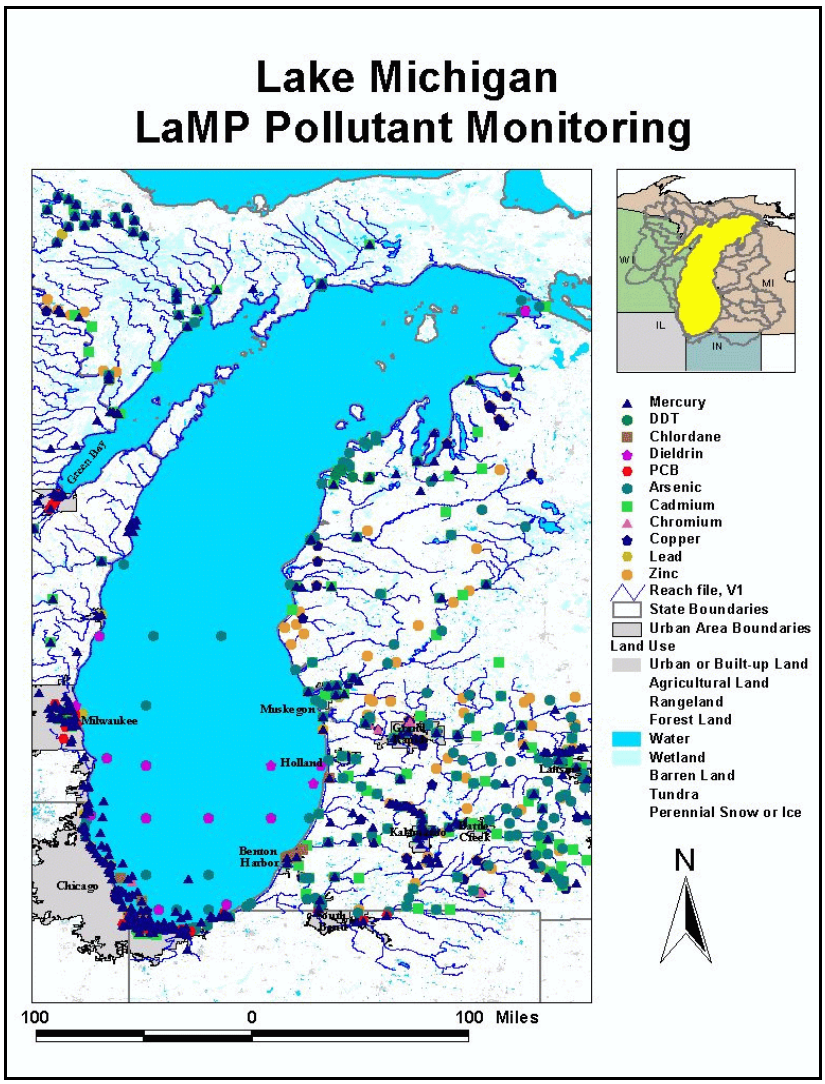

Figure 58. Lake Michigan with LaMP pollutant monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

Pollutants of Concern

Aquatic Monitoring

Monitoring coverage for LaMP pollutants reported in the STORET system is shown in Figure 58. This map indicates that stations exist for all of the seven critical pollutants, seven out of ten pollutants of concern, and none of the listed emerging pollutants.

[5]Program description was taken from the U.S. Geological Survey's NAWQA website (**http://water.usgs.gov/nawqa/**), as of June 15, 2000.

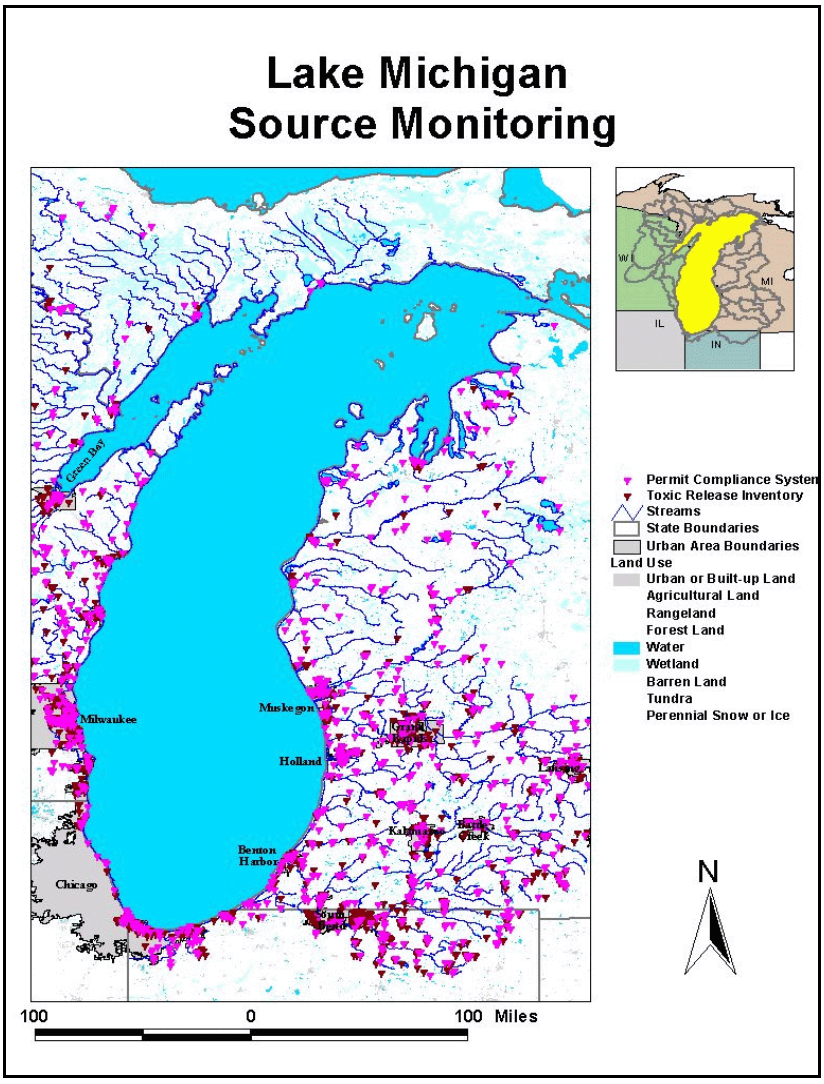

Figure 59. Lake Michigan with pollutant sources from the Permit Compliance System and Toxic Release Inventory databases indicated.

Most of the mercury stations are located in nearshore environments in the southernmost portion of the lake. Stations are also heavily clustered near Chicago and Milwaukee. Outside of LMMB stations, there are no stations monitoring mercury in the middle of the lake. DDT is not monitored in the open lake, but is monitored in two inland areas: Sleeping Bear Dunes on the northeastern shore, and in Milwaukee. Chlordane is monitored in a couple of nearshore locations off of Chicago, as well as inland locations at the outfalls of the Kalamazoo and St. Joseph rivers. Dieldrin is monitored in a number of open water locations across the southern portion of Lake Michigan, as well as near the Straits of Mackinac and a couple of nearshore locations near Milwaukee and Chicago. PCBs are monitored in a number of inland and nearshore locations including Green Bay, Milwaukee, Chicago, Benton Harbor, South Bend, Kalamazoo, as well as at the outfall of the Kalamazoo River and at the Straits of Mackinac.

Other LaMP pollutants are monitored at numerous inland locations, as well as open water locations in southern sections of the lake, and in the Straits of Mackinac. A large concentration of monitoring locations are located near the Chicago metropolitan area.

In addition, surveys indicate that there are organizations that monitor for all LaMP pollutants across the Lake Michigan basin. MDEQ, IDEM, IEPA, and WDNR monitor all LaMP pollutants at locations throughout their respective states. USGS-WRD also monitors sediment and sediment quality in locations throughout western Lake Michigan drainages as part of the NAWQA program, as well as at various specific locations associated with specific cooperative project activities. COE monitors for all LaMP pollutants in sediment samples from most major Lake Michigan harbors and federal navigation channels. Finally, many waste water treatment plants are monitoring for LaMP pollutants at inflows and outflows from their facilities.

Pollutant Release Monitoring

An examination of Permit Compliance System and Toxic Release Inventory reporting locations indicates that there are no open water point sources in Lake Michigan (see Figure 59). However, there are a vast number of

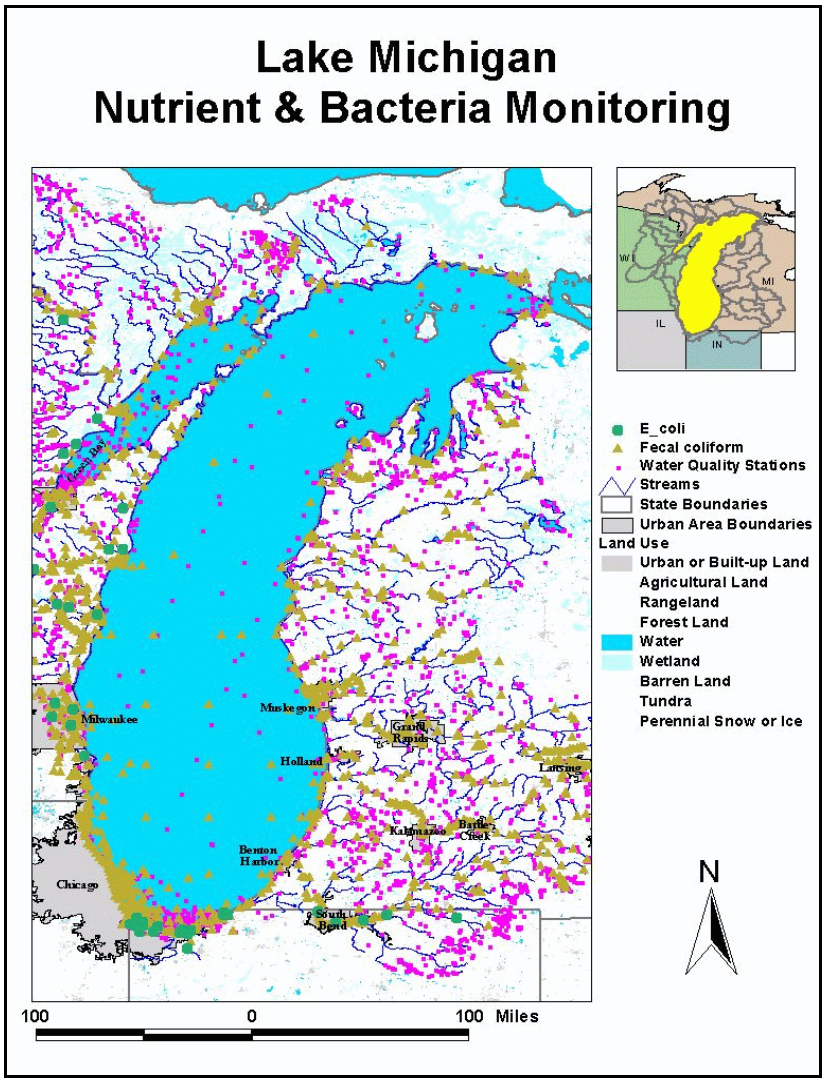

Figure 60. Lake Michigan with ambient water quality and bacteria monitoring stations from U.S. EPA's STORET system displayed by indicators measured.

sites located around the lake in inland locations. Please see the tributary chapters for more specific information.

Nutrients and Bacteria

There are a number of water quality monitoring stations located in open water locations in Lake Michigan, as listed in the STORET system. Nearly 870 stations are listed for the lake, though the vast majority of these are in nearshore locations. Green Bay is well covered, as are the Straits of Mackinac, and the waters outside of Chicago. A vast majority of these stations (shown in Figure 60) monitor for some form of nitrogen and phosphorus, the chief nutrients impacting water quality. Thus, where monitoring stations exist, they are likely tracking nitrogen and phosphorus. A large number of organizations maintain these stations across the lake.

Our surveys indicate that a number of other organizations and programs monitor nutrients widely across the Lake Michigan basin. These organizations include Save the Dunes Conservation Fund, Michigan Lake and Stream Associations, Cooperative Lakes Monitoring Program (CLMP – a MDEQ program), and Tip of the Mitt Watershed Council.

There are a number of stations that monitor *E. coli* throughout the Lake Michigan basin. However, all of these stations are located in inland areas. Please see the tributary chapters for specific information. In addition, our surveys indicate that Save the Dunes Conservation Fund monitors *E. coli* widely across the basin.

Monitoring for fecal coliform is quite prevalent throughout inland, nearshore and open water locations. Nearly 350 stations can be found in the lake, though most are nearshore locations. A large cluster of fecal coliform stations can be found outside of Chicago, but other stations are dispersed fairly evenly across the lake. Organizations monitoring for fecal coliform in the lake include U.S. EPA, USGS-WRD, COE, the International Joint Commission ((IJC), at the Straits of Mackinaw), MDEQ, IDEM, IEPA, WDNR, and Muskegon Community College.

Meteorological and Flow Monitoring

USGS maintains a large number of gage stations throughout the Lake Michigan basin, but none in the waters of the lake (see Figure 54). Information on these gaging stations can be obtained through USGS district web sites, which can be found by through **http://waterdata.usgs.gov/nwis-w/US/** . Please also see the tributary chapters for a discussion on the coverage of these stations.

Our surveys indicate that a number of organizations monitor most physical characteristics of streams and rivers widely across the basin. These organizations include Save the Dunes Conservation Fund, Cooperative Lakes Monitoring Program (CLMP), and Tip of the Mitt Watershed Council. Further, most of the water quality stations illustrated in Figure 60 monitor a range of physical characteristics.

A number of NOAA weather stations are located in the Lake Michigan basin, but only two are found within the lake itself. These two stations are located in the open lake between Chicago and Milwaukee, and on Beaver Island in the north part of the lake. These stations measure continuous precipitation data, as well as other meteorological data. NOAA (GLERL) also monitors a number of other physical characteristics in Lake Michigan. Some of these characteristics include ice cover, temperature, and currents.

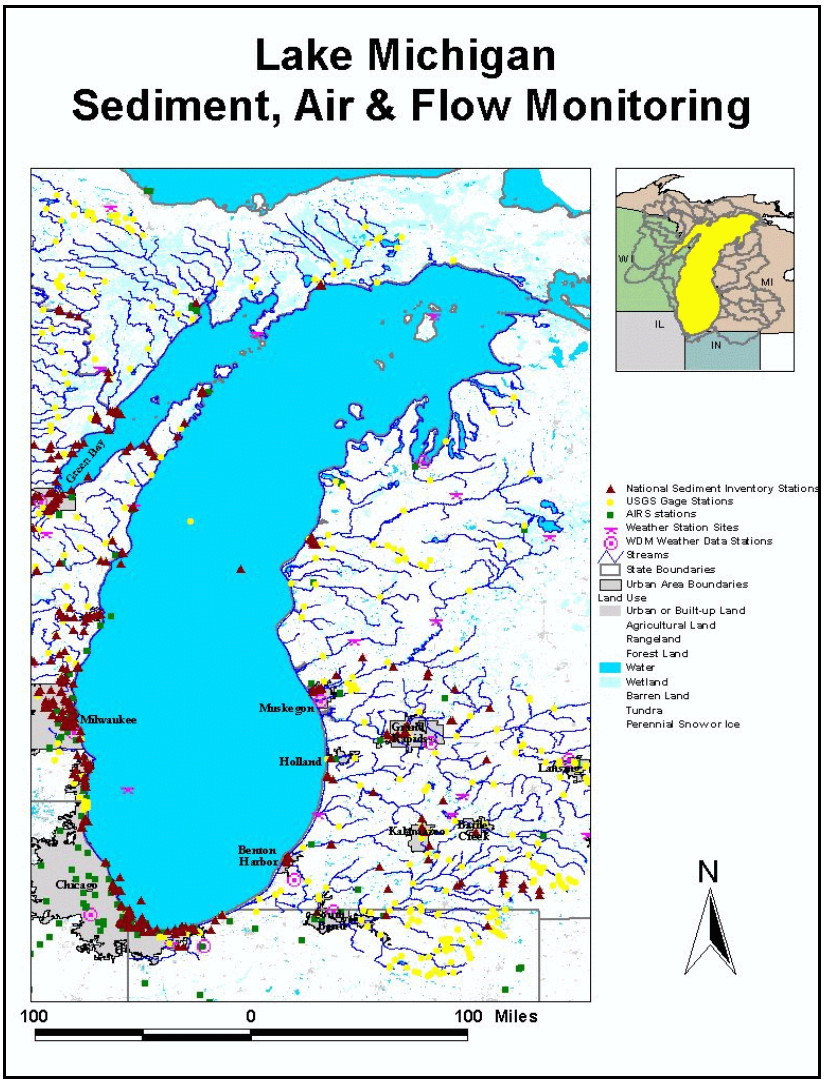

Figure 61. Lake Michigan with National Sediment Inventory stations, USGS gage stations, U.S. EPA's Aerometric Information Retrieval System (AIRS) stations, and NOAA weather stations indicated.

Sediments

There are 86 National Sediment Inventory sites listed as existing in Lake Michigan (see Figure 61). However, most of these sites are nearshore. Only one site can truly be considered an open water station. Overall, Lake Michigan sites are administered by the U.S. EPA, USGS, COE, WDNR, IEPA, IDEM, and MDEQ. About 74 of the sites monitor sediment chemistry to assess human health and aquatic life impacts, with 14 sites monitoring fish tissue. In addition, our surveys indicate that several organizations sample sediments widely throughout the Lake Michigan basin. COE monitors sediments for numerous contaminants in most major harbors and navigation channels throughout the basin. MDEQ monitors sediments in a number of lakes and waterways throughout Michigan.

Fish Contaminants, Fish Health, and Aquatic Nuisance Species

A *Lakewide Assessment Plan for Lake Michigan Fish Communities* has been established through the Great Lakes Fishery Commission to monitor the abundance, population characteristics, and general health of lake trout, chinook salmon, and burbot. Sampling sites for the assessment of these species are selected randomly each year and cover the entire open lake.

Creel surveys are conducted for predator species (including yellow perch) as well, though the data from these surveys are somewhat fragmented among different state agencies. Work is being done through the Great Lakes Fishery Commission to coordinate these surveys. States also conduct a census of sport fishing harvests. Data is reported lakewide through the GLFC - Lake Michigan Committee, though the extent of the census coverage is unknown at this time.

The USGS-BRD assesses the populations of forage fish using hydroacoustics and trawls. The trawls are conducted along seven to nine index transects at depths of 9 to 110 meters. The seven common index transects include Manistique, Frankfort, Ludington, and Saugatuck, Michigan; Waukegan, Illinois; and Port Washington and Sturgeon Bay, Wisconsin. Information on abundance, species composition, population characteristics, and general health are collected. See **http://www.glsc.usgs.gov/science/monitoring/** for more details.

The National Sediment Inventory lists 14 stations that monitor fish tissue for bottom contamination. These sites are located outside of Chicago and Milwaukee, in Green Bay, and in the open lake. The stations are maintained by U.S. EPA, WDNR, and MDEQ. In addition, USGS-WRD collects fish contaminant, fish population, and habitat information at a number of sites.

Our surveys indicate that several additional organizations widely monitor fish populations, habitat and contamination widely throughout the basin. These organizations include USGS-WRD, MDEQ, IDEM, Illinois DNR, and Michigan State University.

A search of the Fish and Wildlife Advisory database revealed 16 fish consumption advisories for Lake Michigan and Green Bay. The advisories were all federally issued, and were related to PCB, chlordane, or mercury levels in a number of fish species.

While we were unable to gain specific geographic information about programs monitoring aquatic nuisance species, our surveys indicate that several organizations are monitoring these species widely throughout the basin. The U.S. FWS, along with several other agencies are working together through the Sea Lamprey Integration Committee (SLIC) to assess the presence of sea lamprey larvae in tributaries to Lake Michigan (as well as the other Great Lakes). Larval surveys are conducted in over 60 tributaries to the lake annually. Tip of the Mitt Watershed Council monitors zebra mussels in locations in the northern lower peninsula of Michigan.

The Great Lakes National Program Office's *R/V Lake Guardian* conducts a series of annual samples of phyto- and zooplankton at several specific locations in Lake Michigan. Samples are collected at different depths to gauge changes in plankton populations. As of 1997, the vessel sampled at twelve locations.

Benthos Monitoring

No specific locational information was discovered for state or national programs monitoring benthic organisms. However, our surveys indicate that a number of organizations monitor information widely across

the basin. These organizations include Michigan Lake and Stream Associations, Inc., USGS, CLMP, NOAA (GLERL), and Michigan State University. Some of the indicators measured include macroinvertebrate, phyto- and zooplankton populations, contamination of macroinvertebrates, and algae.

Air Monitoring

Figure 61 illustrates a large number of air monitoring stations in the basin, according to the U.S. EPA's AIRS database. However, the only station located on Lake Michigan is a mobile station located on the Badger Car Ferry originating out of Sheboygan, Wisconsin. That station monitors low-level ozone.

Wildlife Monitoring

While wildlife is specific to land, and therefore not monitored in open waters of Lake Michigan, there are organizations that monitor wildlife more widely in the basin beyond specific tributaries. Bird Studies Canada maintains a volunteer network to monitor wetlands throughout the Great Lakes Basin for birds and calling amphibians. Wisconsin Breeding Bird Atlas develops a dataset on a variety of characteristics on breeding birds in Wisconsin. Michigan DNR monitors numerous game and nongame species, as well as others including waterfowl, throughout Michigan. Finally, it is known that DNRs in Indiana, Illinois, and Wisconsin, as well as USFWS, all monitor wildlife species, including endangered species, though none returned surveys to provide us with more specific information.

18. Overall Discussion

Monitoring to Support LaMP Indicators

One of the main purposes of this project is to determine if the current monitoring coverage is sufficient to support indicators proposed in the Lake Michigan LaMP. The findings and understanding gained through this project were applied to each of these indicators and a simple assessment of each was made. The LaMP describes a set of indicators in three categories — state indicators, which together describe the state of the ecosystem; pressure indicators, which describe pressures and possible causes of ecosystem degredation; and human activity indicators, which describe human activities that may lead to positive ecosystem impacts. The table on the following pages (Table 1) lists only the state and pressure indicators, since these are the ones this report addresses. In the table, each relevant open water, nearshore, human health, land use, and coastal wetlands indicator is listed, along with a rating for the ability of the current monitoring infrastructure to provide sufficient data to assess the indicator. The rating does not reflect any assessment of the infrastructure in place to consolidate, coordinate, or assess the monitoring data across the Lake Michigan basin, nor does the rating represent an assessment of actual data for the indicator. The following scale is used:

Rating	Meaning
A	Monitoring programs prevalent; geographic coverage extensive; characteristics measured are relevant to the indicator.
B	Monitoring programs prevalent; geographic coverage contains major gaps; characteristics measured are relevant.
C	Monitoring programs prevalent; geographic coverage unknown; characteristics measured are relevant.
D	Some monitoring programs known to exist; geographic coverage unknown; characteristics measured are relevant.
E	Some monitoring programs known to exist; geographic coverage unknown; characteristics measured may not be relevant or specific to indicator.
F	Monitoring coverage nonexistent.
NA	Not enough information to form an assessment.

This assessment is admittedly subjective. It is a first attempt at assessing monitoring sufficiency, and is meant to be used as a launching point for further discussion. The ratings reflect the information collected for this report. It is likely that some monitoring programs were missed by the inventory and information on others may be incomplete. The ratings thus reflect the absence of complete information on such programs. The indicators are ordered by rating.

Table 1. Assessment of Monitoring Infrastructure for Tracking LaMP State and Pressure Indicators		
LaMP Indicator	**Rating**	**Comments**
Wastewater pollution	A	
Air quality	A	Small number of air quality indicators are extensively monitored.
Concentration of contaminants in sediment cores	A	
Phosphorus concentrations and loadings	A	Phosphorus concentrations well monitored; point sources well covered; non-point source loadings being modeled.
Incidents of boil-water advisories	A	
Drinking water quality (chemical and microbial)	A	
Stream flow and sediment discharge	A	Stream flow well monitored. Sediment discharge monitored to a limited extent.
Atmospheric visibility	A	
Wastewater pollution	A	
Sea lamprey	A	Extensive basinwide monitoring. Assessment by USFWS through Great Lakes Fishery Commission.
Coliform levels of nearshore recreational waters	A	
Economic prosperity	A	Wide array of indicators of economic prosperity.
Global warming: ice duration on the Great Lakes	A	
Concentrations of contaminants in offshore waters	B	LMMB coverage mostly. Limited to a few contaminants.
Contaminant exchange between media: air to water and water to sediment	B	LMMB coverage only. Limited to a few contaminants.
E. coli levels in nearshore recreational waters	B	
Nitrates and total phosphorus into coastal waters	B	Nutrient monitoring in some wetlands is lacking.
Wetland area by type	B	Wetland delineation generally defined. More specific definition in progress.
Benthos diversity and abundance	B	Benthos monitoring coverage fluctuates across watersheds.
Contaminants in fish (including edible and recreational fish and young of year spot-tail shiners)	B	Much of northern tributaries not monitored except at outflows to Lake Michigan.
Atmospheric deposition of toxic chemicals	B	LMMB coverage only known monitoring – limited to nearshore.
Phytoplankton populations	B	12 locations sampled annually by GLNPO.
Zooplankton populations	B	12 locations sampled annually by GLNPO.
Fish community health	B	Lakewide assessment coordinated through the GLFC - Lake Michigan Committee.

Table 1. Assessment of Monitoring Infrastructure for Tracking LaMP State and Pressure Indicators		
LaMP Indicator	**Rating**	**Comments**
Salmon and trout	B	Lakewide assessment through the GLFC - Lake Michigan Committee.
Preyfish populations	B	Annual Lakewide coverage by USGS, Great Lakes Science Center.
Acid rain	C	
Threatened species	C	
Water consumption	C	
Lake trout and scud	C	Lakewide assessment of lake trout through the GLFC; extent of coverage of scud information unknown.
Sport fishing	C	Sport harvest census programs conducted by each state and reported lakewide through the GLFC, though extent of coverage unknown.
Nearshore species diversity and stability	D	Some monitoring of populations. Extent of diversity and stability assessments unknown.
Breeding bird diversity and abundance	D	
Contaminants affecting productivity of bald eagle	D	
Aquatic habitat	D	Few programs discovered. Limited to specific sites within watersheds.
Wetland-dependent bird diversity and abundance	D	Some basinwide programs in existence.
Deformities, Erosion of fins, Lesions, and Tumors (DELT) in fish	D	
Amphibian diversity and abundance	D	Some monitoring in wetlands.
Nearshore plant and wildlife problem species	D	Some monitoring of invasive species. Full coverage unknown.
Contaminant in colonial nesting waterbirds	D	
Presence, abundance, and expansion of invasive plants	E	Some programs monitoring purple loosestrife on a limited basis.
Extent and quality of nearshore natural land cover	E	Land cover monitoring complete. Quality monitoring unknown.
Nearshore land use intensity	E	Land use coverage complete, though intensity of use is unknown.
Habitat fragmentation	E	Land use/land cover monitoring complete; habitat delineation coverage unknown; fragmentation analysis unknown.
Urban density	E	Extent of urban land use well monitored by satellite data. Density monitoring unknown.
Native unionid mussels	E	Many programs monitoring macroinvertebrates, but specificity to unionid mussels unknown.

Table 1. Assessment of Monitoring Infrastructure for Tracking LaMP State and Pressure Indicators		
LaMP Indicator	**Rating**	**Comments**
Habitat adjacent to coastal wetlands	E	Land cover monitored by satellite. Extent of habitat delineation unknown.
Invertebrate community health	E	Invertebrate monitoring programs exist, but extent of coverage and community health specificity unknown.
Sediment available for coastal nourishment	NA	
Water level fluctuations	NA	
Energy consumption	NA	
Artificial coastal structures	NA	
Mass transportation	NA	
Area, quality, and protection of special lakeshore communities	NA	
Extent of hardened shoreline	NA	
Extent and quality of nearshore natural land cover	NA	
Gain in restored wetland area by type	NA	
Land conversion	NA	
Susceptibility (source water assessments)	NA	
Area, quality, and protection of special lakeshore communities	NA	
Sediment flowing into coastal waters and wetlands	NA	
Aesthetics	NA	
Incidents of water-borne disease outbreaks	NA	
Solid waste generation	NA	
Chemical contaminants in human tissue	NA	
Global warming: number of extreme storms	NA	
Global warming: first emergence of water lilies in coastal wetlands	NA	
Contaminants in snapping turtle eggs	NA	
Contaminants affecting the American otter	NA	
Sediment, land, and water habitat	NA	

19. Findings and Recommendations

The final section of this report centers on general issues that were uncovered throughout the course of research. There are three key areas under which the monitoring inventory provided valuable information and recommendations for improving overall monitoring in the Lake Michigan basin. These include data gaps and unmet needs; underutilized resources; and monitoring coordination and information sharing. Findings are summarized below for these areas, followed by recommendations for improving monitoring infrastructure and use. For reference purposes, sections are labeled with letters and findings and recommendations are numbered.

A. Data Gaps and Unmet Needs

This report, and the inventory on which it is based, represent the first effort to account for the range of environmental monitoring in the Lake Michigan basin. The inventory represents the initial approach toward achieving this ambitious goal. It is a framework on which a more complete inventory will eventually be built.

(1) Finding: There are several gaps in the inventory that are listed below and throughout the report. While some of these gaps are areas that have not been well covered in the inventory, others may represent gaps in the monitoring coverage. At this point, it is difficult to tell which are gaps in the monitoring inventory and which are actual monitoring gaps. Further improvement of the inventory database is needed to better clarify this distinction.

(1.1) Recommendation: *Continue to update the inventory and expand data collection to include all tributaries.* Fourteen tributaries were covered extensively in this project. The update should carry out the same research process with the other tributary watersheds in the basin.

(2) Finding: There are several key monitoring areas where little information was received, but where more monitoring is believed to exist. These areas include monitoring for *E. coli*, fish population characteristics, aquatic nuisance species, benthic organisms, wildlife, and habitat. We received some information about *E. coli* monitoring from county health departments and other local agencies, but believe more local agencies conduct such monitoring. For the other areas, we have some evidence to believe that state Departments of Natural Resources and federal agencies such as the U.S. Fish and Wildlife Service, U.S. Forest Service, and U.S. Department of Agriculture conduct monitoring programs in these areas. We received limited information about efforts made in specific watersheds by these agencies, but most of this information came from indirect sources. It is important that these agencies supply more complete information on their monitoring efforts to improve the overall completeness inventory.

(2.1) Recommendation: *Establish better lines of communication with state DNRs, USFWS, USFS, and USDA.* Further work needs to be carried out in order to obtain information from these agencies on their monitoring programs. This will fill in some of the major gaps in the inventory database.

(2.2) Recommendation: *Better integrate habitat and wildlife monitoring with traditional water quality monitoring.* One of the most difficult tasks needed to complete the monitoring inventory was to convince natural resource agencies that wildlife and habitat monitoring should be included in the inventory along with more traditional water quality monitoring. Agencies conducting monitoring in these areas must develop a better understanding of how all monitoring information can fit together so that policy makers, residents, and other stakeholders have access to a complete database of environmental monitoring information.

(3) Finding: Another result of this initial approach to the monitoring inventory for the Lake Michigan basin was that much of the information included only general information about the geographic location of monitoring sites. Many organizations reported monitoring for parameters across a broad geographic area but did not include specific site references. Locational information is critical if the inventory is to be brought online in a geographically-searchable format.

(3.1) Recommendation: *Improve information on the geographic location of monitoring sites.* This is especially true for monitoring programs at the local level. This will require extensive follow-up communication with those who originally reported into the inventory database.

(4) Finding: A further gap in the monitoring information obtained for this report, was the lack of complete and continuing coverage of Lake Michigan Mass Balance data. The Mass Balance project was a first of its kind sampling event designed to collect data across several variables in a coordinated fashion. The information produced by a project of this magnitude is valuable throughout the monitoring community. However, a project as large and complex as the Mass Balance project requires substantial time to collect, verify, validate, integrate, analyze, and report on the data. At the time the research for this report was conducted, most of the data from the Mass Balance project was not readily available for public consumption. Therefore, information contained in this report on sampling within the Lake Michigan Mass Balance project is incomplete and limited mostly to sampling location and general sampling focus. The data collected for the project has been quality assured, and, when released, will be more detailed. When these results are released, they will be added to the online version of the inventory database. Additionally, the value of coordinated sampling data (as collected in the Mass Balance project) would be greatly enhanced by a repeat of the sampling event ten years following completion of the original sampling.

(4.1) Recommendation: *Initiate planning for a coordinated sampling event for ten years following the initial Mass Balance project, and share data and modeling results with the public in a timely fashion through numerous outlets.*

(5) Finding: This initial project specifically avoided attempting to collect information about university monitoring projects. There were two reasons for this. First, much academic research is conducted in one-time, short-term projects, and therefore does not meet the need for baseline information and ongoing monitoring. Second, universities are complex environments with numerous independent research projects being conducted across each campus. However, some academic institutions conduct a number of important ongoing, long-term projects, and information on these projects should be included in the inventory. Sea Grant programs and other institutes catalog the university work they fund. Closer ties need to be established with these programs and such efforts need to be expanded throughout the basin.

(5.1) Recommendation: *Include academic research and data collection efforts in future updates to the monitoring inventory.*

(6) Finding: While a number of LaMP pollutants, such as mercury and copper, are monitored extensively across the basin, it has been difficult to find monitoring information on some of the other pollutants. These under-monitored pollutants include all the emerging LaMP pollutants, along with DDT, HCBs, toxaphene, and PAHs. The need for monitoring of these pollutants should be clarified.

(6.1) Recommendation: *Further examine the monitoring coverage of specific LaMP critical pollutants and emerging pollutants.*

B. Underutilized Resources

Along with the gaps in monitoring coverage identified in this project, some resources in the basin were also discovered that do not appear to be fully utilized. Monitoring is an area of environmental management that has often been underfunded in the past. Therefore, in order to achieve the most complete monitoring coverage possible, one must take advantage of all available resources. If resources, such as monitoring personnel, go unutilized, then some aspects of a complete monitoring coverage must be sacrificed. To avoid such a sacrifice, creative methods must be used to combine these underutilized resources with other monitoring programs.

(1) Finding: One of these underutilized resources is volunteer groups. These groups represent a vast pool of potential data collection personnel. Most of the volunteer groups currently engage in some form of monitoring, but often their efforts are not incorporated into state or regional monitoring plans, and the information collected is only reported internally or locally. These volunteers need to be better enabled to contribute to regional monitoring efforts. The challenge lies in preparing volunteers to collect environmental information in such a way that it is both accurate and relevant to regional needs, and of sufficient quality to be useful for resource managers and policy makers.

(1.1) Recommendation: *Take better advantage of relatively untapped volunteer monitoring resources.*

(2) Finding: Another group that is underutilized is local agencies. Examples of such agencies are health departments, conservation districts, and planning agencies. In many cases, these agencies are already engaged in monitoring to serve their local needs. Most of the agencies employ professionals trained to accurately monitor environmental parameters. These groups were discovered sporadically in the process of constructing the monitoring inventory. Several health departments reported monitoring of surface and ground waters for *E. coli*, coliform, and other contaminants of special interest to public health officials. Conservation districts may individually be monitoring for a number of parameters related to nonpoint source pollution, general water quality, or other issues. Planning agencies or commissions track population, mass transportation status and other land use characteristics for planning and funding purposes. It is likely that other similar agencies are also conducting monitoring programs. Information on these programs needs to be incorporated into the inventory. Also, there is an opportunity to link these agencies into basinwide monitoring efforts.

(2.1) Recommendation: *Take better advantage of local agencies such as health departments, conservation districts and planning agencies.*

(3) Finding: To best capitalize on these underutilized resources, it is important that these local groups (both volunteer groups and local agencies) be linked into basinwide efforts, but at the same time retain their local focus and discretion. Much of the energy that maintains these groups arises from a focus on local problems. While this is important, the value of their data to the larger basin is often overlooked. Linkages need to be made between local groups throughout the basin. However, such a basinwide focus needs to incorporate local data collectors in a way that is locally-driven.

(3.1) Recommendation: *Establish a better framework for bottom-up monitoring program linkages.*

(4) Finding: Part of the difficulty in using data collected at the local level is that there are few standards at the basinwide level to knit the data together. The local focus of the data collection effort often will leave the data incompatible with other data from neighboring localities. In order to use locally-driven data, the aspects of the collection and reporting processes need to be standardized across the basin. This standardization will

make local monitoring results more widely usable and allow for aggregation and analysis across the basin as a whole.

(4.1) Recommendation: *Standardize data collection and reporting.*

C. Monitoring Coordination and Information Sharing

The final issue area does not involve direct monitoring, but responds to the need to coordinate monitoring efforts. As should be obvious from this report, there are a wide array of organizations involved in monitoring at the federal, state and local levels. However, no single organization is responsible for planning, coordinating, or disseminating monitoring efforts for the entire Lake Michigan basin. In the absence of a single organization, a council of organizations has formed to take on this task — the Lake Michigan Monitoring Coordination Council. The council's task — to coordinate monitoring efforts for basinwide goals — is a difficult one. However, several steps could be taken to improve the prospects of this coordination.

(1) Finding: A major coordination problem is the lack of a central source for monitoring information. The inventory that this report evaluates is the first step toward creating such a central source. However, this one-time inventory is currently not universally accessible and may quickly become dated if the database is not continually updated by monitoring organizations in the basin. Therefore, these monitoring organizations need to be encouraged to report on their monitoring projects continually into a universally-accessible database. This database should contain proper metadata about the monitoring program and the data that is reported. Eventually, this database should directly link to monitoring data, wherever possible. The database should be developed for the Internet and allow for the metadata to be searched geographically and by metadata content.

(1.1) Recommendation: *Encourage state, federal, tribal, and local agencies to report monitoring coverage and results to a meta-database with universal access.*

(1.2) Recommendation: *Develop an online database of monitoring information that is geographically-based, and content-searchable.*

(2) Finding: Beyond creating and reporting to a shared database of monitoring program information, it would be most effective to link monitoring programs into a coordinated network. As it is, organizations make most, if not all, decisions about their monitoring programs based on goals for their local coverage area. Rarely does this area cover the entire Lake Michigan basin. Without a coordinated network, basinwide goals may go unmet. Several actions must be taken to make sure this network can successfully address basinwide goals. First, the network must contain all the necessary components for complete coverage. This means that common indicators need to be agreed upon for the basin, and all organizations monitoring for indicator data need to be included in the network. State of the Lake Ecosystem Conference (SOLEC) and LaMP indicators have already been established and should be adapted or condensed for use in the network. After this, a set of standard methods should be established for monitoring the agreed upon indicators within the basin. Standard methods will ensure that data is comparable and able to be combined for analysis across the basin.

(2.1) Recommendation: *Develop and coordinate the implementation of comparable methods to collect indicator data in a coordinated network.*

Appendix A.

Acronyms and Glossary

AOC	Area of Concern
AIRS	U.S. EPA's Aerometric Information Retrieval System
BMP	Best Management Practice
BSFWD	Bureau of Sport Fisheries and Wildlife Data
CLMP	Cooperative Lakes Management Program
COE	U.S. Army Corps of Engineers
EPRI	Electric Power Research Institute
GLC	Great Lakes Commission
GLFC	Great Lakes Fishery Commission
GLNPO	Great Lakes National Program Office
GLERL	Great Lakes Environmental Research Laboratory
IDEM	Indiana Department of Environmental Management
IEPA	Illinois Environmental Protection Agency
IJC	International Joint Commission
LMMCC	Lake Michigan Monitoring Coordination Council
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
MMSD	Milwaukee Metropolitan Sewage District
MSD	Metropolitan Sanitary District or Metropolitan Sewage District
NCDC	National Climatic Data Center
NIPC	Northeast Illinois Planning Commission
RAP	Remedial Action Plan
SLIC	Sea Lamprey Integration Committee
TMDL	Total Maximum Daily Load
U.S. EPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service

USGS-WRD	U.S. Geological Survey – Water Resources Division
WAV	Water Action Volunteers
WDNR	Wisconsin Department of Natural Resources
WWTP	Waste-water treatment plant

Appendix B.

Lake Michigan Tributary Monitoring Project Participants

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Appendix C.

Lake Michigan Monitoring Inventory Form

Following is the form that was distributed to organizations thought to be possibly conducting monitoring programs. The form was slightly tailored for use in local areas. A web-based form was also developed to enhance return rates. This form can currently be found at: http://www.glc.org/projects/lamps/monitor.html.

Lake Michigan Monitoring Inventory Form

The following form is intended to provide us with an inventory of federal and state agency monitoring programs in the Lake Michigan Basin. Please complete this form to the best of your ability, indicating the monitoring efforts that your agency currently undertakes, and return it to us as soon as possible. If you conduct more than one monitoring effort, please copy and complete a separate form for each program. This should take less than 20 minutes to complete.

General Information

The questions below will provide us with important background on your organization and monitoring efforts and may eventually result in greater use of your monitoring results.

1) Please provide your primary contact information.

Name: _____

Organization: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Phone: _____ Fax: _____

E-mail: _____ Website: _____

Watersheds covered: _____

_____

2) Who is the manager for the monitoring program?

_____

3) Briefly describe the overall purpose or goal of the monitoring/information collection effort.

_____

_____

4) Approximately, when did the monitoring program begin? (month / year) _____/_____

Monitoring Information

The following questions ask about specific details of your monitoring program. They will help us understand what is being done in your area to monitor the health of the ecosystem.

5) As specifically as possible, please describe the boundary of the location or geographic scope of your monitoring effort (e.g., named or numbered river reach, watershed, county or township boundary, latitude/longitude). Please include as much descriptive information as possible.

_____

_____

6) Medium being monitored:

❑ Water ❑ Land ❑ Air ❑ Soil ❑ Biota/Wildlife ❑ Other (specify: _____)

7) Please select the category that best fits the type of information being collected.

- ❑ Chemical (e.g. pH, BOD, mercury, phosphorus, PCBs)
- ❑ Microbiological (e.g. bacteria or other microbial organisms)
- ❑ Fish or aquatic invertebrates
- ❑ Other wildlife (e.g. turtles, beavers, deer, etc)
- ❑ Physical characteristics (e.g. hydrology, habitat, geology, soil, vegetation, forests, wetlands)
- ❑ Land uses (e.g. urbanized, agricultural, residential, industrial, brownfields sites)
- ❑ Other (specify: _____)

8) Do you collect data on any of the following? ❑ PCBs ❑ Dieldrin ❑ Chlordane

❑ DDT	❑ Lead	❑ Zinc	❑ Cyanide	❑ PAHs	❑ None of the above
❑ Mercury	❑ Cadmium	❑ Chromium	❑ Hexachlorobenzene	❑ Atrazine	
❑ Dioxins/Furans	❑ Copper	❑ Arsenic	❑ Toxaphene	❑ Selenium	

9) Please give a specific description of any other information being collected (i.e. list specific indicators measured).

_____

_____

10) How often is the information collected?

❑ Daily ❑ Weekly ❑ Monthly ❑ Semiannually ❑ Annually ❑ Other (specify: _____)

Program Information

We need some final information about your monitoring program so that we can assess the extent and needs for monitoring funding and training.

11) Please list the name or type of any standardized methodology used (e.g. EPA guidelines, standard methods texts, or kit procedures).

_____

12) Please list any standardized quality assurance or quality control procedures that are followed.

_____

_____

13) Select the classification that best describes the individuals who collect monitoring data.

❑ Paid staff ❑ Volunteers ❑ Students ❑ Other (specify: _____)

14) How many staff or volunteers participate in the monitoring project, on average? _____

15) Was training provided to data gatherers? ❑ Yes ❑ No

16) If yes, who provided the training? _____

17) Where is the monitoring data reported and stored (e.g., which office or agency)?

_____

18) Which format is used to store the data (i.e., which electronic format or software is used, or is it stored in a hard copy format)?

_____

19) Is the data stored indefinitely? ❑ Yes ❑ No

20) If no, how long is the information stored? _____

21) How is the monitoring data ultimately used (e.g. in Remedial Action Plans, educational materials, research, watershed planning, regulatory compliance)?

_____

_____

22) (Optional) Please list the approximate annual budget for the monitoring effort. $_____.00

23) Is this funding ongoing and reliable? ❑ Yes ❑ No

24) Please list any other parameters that you would like to monitor or other areas that you feel need additional monitoring in your region.

_____

_____

25) Please provide us with any other relevant information that you think would give us a more complete understanding of your monitoring efforts. Feel free to append any additional documentation that you think would be helpful.

_____

_____

_____

Thank you for your assistance.
Your input will help us better determine the scope and need for monitoring efforts in the Lake Michigan basin.

When completed, please return this form by mail or fax, to:

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