Michigan Water Quality Monitoring

Strategy Update

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Water Bureau

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I. Monitoring Strategy

Environmental monitoring is an essential component of the Michigan Department of Environmental Quality (DEQ) mission. The DEQ recognizes that comprehensive water quality monitoring is necessary to improve natural resource management, maintain sustainable ecosystems, and protect public health. As described in the DEQ's 2004 Integrated Report, Michigan contains many miles of rivers, streams, and Great Lakes shoreline, as well as abundant acreage of inland lakes and wetlands (MDEQ 2004a). An effective monitoring program should support objective water quality decision-making at all levels of government, as well as inform the public about water quality conditions and changes. Because of a DEQ commitment to develop a monitoring plan, a report titled "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (Strategy), was completed in January 1997. This Strategy described the necessary monitoring activities for a comprehensive assessment of water quality in Michigan's surface waters, and has guided Michigan's monitoring program implementation. It consists of nine interrelated elements: fish contaminants, water chemistry, sediment chemistry, biological integrity, wildlife contaminants, bathing beaches, inland lake quality and eutrophication, stream flow, and volunteer monitoring. The Strategy specifically identifies four monitoring goals:

- Assess the current status and condition of waters of the state and determine whether water quality standards are being met;
- Measure spatial and temporal water quality trends;
- Evaluate the effectiveness of water quality prevention and protection programs; and
- Identify new and emerging water quality problems.

In November 1998, Michigan citizens approved the Clean Michigan Initiative (CMI), a $675 million bond to clean up, protect, and enhance Michigan's environmental quality, natural resources, and infrastructure. Some of this money, from the Clean Water Fund (CWF) portion of the CMI, was allocated for the implementation of the activities outlined in the Strategy. The result in recent years has been an increase of approximately $3 million per year for surface water quality monitoring (Figure 1).

The DEQ has decided to update the 1997 Strategy at this time based on an understanding that the Strategy was written at a time when resource constraints were quite severe. Funding and staffing resources devoted to water quality monitoring had dropped substantially between 1990 and 1997. The level of monitoring in Michigan declined accordingly and numerous reports were issued that criticized the DEQ for lacking an adequate monitoring program (Michigan Environmental Science Board 1993, Office of the Auditor General 1995, Michigan Pollution Prevention Task Force 1996). As a result, the Strategy was developed specifically to identify the activities, and the resources, needed to establish a comprehensive, state-of-the-art water quality monitoring program. The resource constraints have been greatly alleviated in recent years with annual appropriations of CMI funds since 2000, allowing for full implementation of the Strategy. However, the evolving nature of management and program needs, technology, and technical monitoring guidance/science requires a re-evaluation of our existing activities to ensure that we continue effective, comprehensive monitoring and to identify opportunities for improvement.

Another impetus for this update is a requirement by the United States Environmental Protection Agency (EPA) that States produce "a comprehensive monitoring program strategy that serves all water quality management needs and addresses all State waters, including all water body types. The monitoring program strategy is a long-term implementation plan and should include a timeline, not to exceed 10 years, for completing implementation of the strategy. It is important that the strategy be comprehensive in scope and identify the technical issues and resource needs that are currently impediments to an adequate monitoring program" (EPA 2003). Specifically, the EPA guidance recommends that a state monitoring program contain the following elements:

- Monitoring strategy
- Monitoring objectives
- Monitoring design
- Core and supplemental water quality indicators
- Quality assurance
- Data management
- Data analysis/assessment
- Reporting
- Programmatic evaluation
- General support and infrastructure planning

The purpose of this update is to 1) describe ongoing monitoring activities (including monitoring objectives, study design, indicators, data analysis, data management, and reporting); 2) identify potential future monitoring activities, to the extent possible; 3) identify program gaps and a timeline for addressing them; and 4) specify resource needs (staff, funding, and technical). To ensure consistency with EPA guidance, the format of this update is based on the elements listed above. Although this update provides a snapshot of the current status and needs of Michigan's water quality monitoring program, we understand that ensuring a state-of-the-art program is an ongoing, iterative process. As such, we welcome comments and input from a broad array of stakeholders, including agency managers and staff (federal and state), local governments, academia, the private sector, environmental organizations, and the general public. Indeed, the DEQ solicits monitoring suggestions from these stakeholders each year, prior to the field season (as described later in this document). This document serves as a current benchmark and does not preclude the DEQ from adding, eliminating, or modifying water quality monitoring activities as appropriate based on evolving needs and stakeholder input.

II. Monitoring Objectives

The four goals listed in the previous section served as the basis for developing the Strategy in 1997, and continue to guide monitoring program implementation. The Strategy also identified a series of specific objectives for each of the nine program elements. These objectives encompass those of the Clean Water Act, as well as several management questions necessary to meet state requirements and needs. In this update, we further spell out the objectives for the water quality monitoring program (Figure 2). Rather than listing objectives separately for each program element as in the 1997 Strategy, they are consolidated in this section, along with a brief description of the existing and planned monitoring activities that support each one. Michigan's

water quality monitoring program addresses all of these objectives. The descriptions below focus on monitoring activities either conducted or funded by DEQ. However, it should be noted that DEQ also uses available data from other entities to fulfill our monitoring objectives, when such data are of known, sufficient quality.

Table 1 summarizes the linkages between DEQ water quality monitoring activities and the goals and objectives listed below. Table 2 describes the implementation status of the many monitoring activities described in this section.

Goal: Assess the current status of waters of the state and determine whether water quality standards are being met

Objective: Determine water quality standards attainment

The information needed to support this objective includes biological data and/or chemical data (in water, sediments, and/or fish tissue). These data are used to assess attainment of standards for designated uses, including aquatic life, recreation, navigation, and industrial, agricultural, and public water supply. Each year, DEQ biologists conduct surveys in selected watersheds to identify waters that are and are not attaining standards. Watersheds are assessed according to a 5-year rotating basin design (see Study Design section below), with a target of assessing 80% of the river/stream miles in each watershed. The surveys consist of monitoring for a combination of biological (benthic invertebrates and/or fish), habitat, water, sediment, and fish tissue indicators in wadable streams. Aquatic macrophytes and algae also are assessed, primarily to determine whether nuisance plant levels are present. Historically, a targeted approach to site selection has been used, whereby sites were chosen for a specific reason (e.g. known/suspected contamination, evaluate program effectiveness, lack of data, etc.). In 2004, however, a probabilistic approach to site selection was tested in several watersheds and may be used in the future. Random site selection allows results to be extrapolated to unmonitored locations in the watershed. Available information and data from other federal, state, and local agencies also are used as appropriate to assist with these determinations.

Although the biological monitoring protocol for wadable streams was not developed specifically for use in headwater streams, it can be applied to these smaller waterbodies when there is sufficient gradient and water in the channel to create flow. However, this protocol clearly is not suitable for use in small headwater streams with little flow, either because of low gradient (i.e. "swampy" streams) and/or intermittent flow. Our understanding is that the EPA and the U.S. Geological Survey currently are testing assessment methods for small headwater streams. As these methods are developed and proven, the DEQ is willing to incorporate monitoring of small headwater streams into the watershed surveys. The timeframe for incorporation obviously depends on successful completion of the federal effort and resulting guidance. The DEQ provided a grant to Michigan State University to develop a biological and habitat assessment procedure for non-wadable rivers, and a draft protocol was completed in 2004. We will test this protocol in 2005 with the intent to incorporate non-wadable river monitoring into the 2006 watershed surveys.

The DEQ collects fish from selected locations each year to measure contaminant levels in tissues. If the concentration of any contaminant exceeds a Michigan Department of Community Health action level, then a consumption advisory is issued and the affected waterbody is determined to be in non-attainment with water quality standards.

Data collected from inland lakes each year by professional staff and trained volunteers are used to classify the lakes according to trophic status, per Section 314 of the Clean Water Act. Also, lakes with excessive eutrophication (i.e. hypereutrophic) and those otherwise determined to be non-attaining are identified in the Integrated 303(d)/305(b) Report (MDEQ 2004b).

Only limited monitoring of wetlands has been done by DEQ to support this objective. Wetland assessment more often takes the form of determining whether a site is classified as a wetland for permitting purposes, rather than actually assessing water quality within the wetland. However, DEQ has committed to producing a Monitoring and Assessment Strategy for Wetlands by May 31, 2005. This Strategy likely will include guidance for assessing water quality in wetlands.

Drinking water quality is monitored by municipal facilities for two primary objectives. The first is to evaluate the effectiveness and efficiency of the water treatment process. A second, related objective is to identify whether additional treatment is necessary to maintain compliance with drinking water standards. The resulting data are used to ensure public health protection in the drinking water system. Drinking water quality is monitored at non-community water systems to ensure the water meets applicable standards and to confirm the integrity of the source, treatment, storage, and distribution system to protect public health.

Special studies, within and outside of the 5-year rotating basin surveys, are conducted to identify waters that may not be attaining standards. One example is a comprehensive survey of Michigan rivers, streams, lakes, and impoundments (over 200 sites total over two years) to measure mercury concentration in the water column (Great Lakes Environmental Center 2003a). These types of projects are identified on an as needed basis, and are implemented for the appropriate length of time necessary to answer the question.

The DEQ awards grants each year to local health departments to monitor *E. coli* levels at Great Lakes and inland beaches, using federal BEACH Act and state CMI funds respectively. County health departments use the results to assess whether the full-body or partial body recreation designated uses are being attained and whether beach closings are necessary. Sampling procedures and allowable *E. coli* levels are defined in the Michigan Water Quality Standards. In addition, DEQ has awarded grants to local governments to measure *E. coli* levels in waters of interest and determine whether standards are being attained.

Data from trained volunteers also are sometimes used to assist with this objective. Volunteer data primarily are used as a screening tool to assist DEQ biologists with site selection in a watershed. If a volunteer finds many types of stoneflies, mayflies, and caddisflies (which are verified in a specimen jar), then we can conclude that a given stream is attaining standards.

The monitoring results generated in support of this objective are summarized in the DEQ's Integrated 303(d)/305(b) Report to EPA. Impaired waters are placed on the 303(d) list for the

development of Total Maximum Daily Loads (TMDLs). Data generated from grants awarded each year to local organizations for water quality monitoring, as well as volunteer data, are used as screening data to support this objective.

Objective: Identify causes and sources of water quality problems

During the watershed surveys described above, DEQ identifies known and/or suspected causes and sources of water quality problems. For waters listed as impaired, the TMDL development process requires extensive monitoring to document the cause(s) of impairment, identify the sources of the problem, and quantify the loads (more detail provided below). In addition to the watershed surveys, special monitoring studies are conducted as necessary to document water quality concerns and pinpoint potential sources.

Caged fish are routinely used to identify potential sources of bioaccumulative contaminants. Cages are placed at various locations along a river or within the watershed. After approximately four weeks, cages are retrieved and the fish tissues analyzed for the parameter(s) of interest. Concentration differences in fish among the cages, if such differences are found, can indicate potential contaminant sources, or at least in which part of the watershed the contaminants are found.

The DEQ provides funding each year to researchers at Michigan State University for an inland lake sediment coring project. By dating different slices of the sediment core, specific dates can be assigned to contaminant concentrations throughout the core. Analysis of sediments from multiple lakes throughout Michigan yields important clues about contaminant sources. If many lakes show a similar historical pattern for a contaminant, then a regional source (i.e. air deposition) is likely. If patterns vary among lakes, then local sources are likely.

Grants are awarded annually to local governments, universities, and nonprofit organizations to support local monitoring needs. Most of these grants have been used to measure contaminant levels of interest and the sources of the contaminants. Citizen volunteers also provide information to assist with this objective.

Goal: Measure spatial and temporal water quality trends

Objective: Compare water quality among waters throughout Michigan
Objective: Determine whether water quality is changing over time.

Effective spatial and temporal trend assessment requires consistent, long-term monitoring. Many ongoing monitoring activities address these objectives. The DEQ's ability to achieve these monitoring objectives was substantially reduced due to funding cuts during the 1990s. Therefore, water quality trend monitoring was identified as one of the primary goals in the 1997 Monitoring Strategy. When CMI funds became available in 2000, several monitoring activities identified in the Strategy were implemented to assess trends. All of the activities described below in this section are ongoing, long-term projects.

A total of 31 tributary sites (most near river mouths prior to discharge into the Great Lakes) are sampled annually for a suite of water quality parameters, including mercury, trace metals, nutrients, and ions. Preliminary sampling was conducted from 1998 to 2000, and full sampling under the current design began in 2001. The data will be used to measure temporal trends at these fixed-station locations, as well as to compare concentrations among sites. In addition to the fixed stations, the DEQ intends to initiate a probabilistic sampling design for water chemistry in 2005. Random site selection will allow the water chemistry data to be extrapolated statewide in support of these objectives.

As described previously, the DEQ works with researchers at Michigan State University to collect sediment cores each year from inland lakes. A total of 27 lakes have been sampled through 2004, and we expect a total of 35-40 lakes to be sampled overall. By dating different slices of the sediment core, specific dates can assigned to contaminant concentrations throughout the core. This project allows us to assess temporal trends in sediment accumulation rates in the sampled lakes, as well as compare concentrations among lakes.

The DEQ has established 26 fixed stations from which samples are repeatedly collected to measure temporal trends in bioaccumulative contaminants in fish tissues. A contractor was hired in 2002 to review this network and completed the review in 2003. The report issued a number of recommendations to improve our ability to detect trends (Exponent 2003). Some recommendations have already been implemented, and others are being considered (see Monitoring Design section below for more detail).

Since 1999, the DEQ has funded researchers at Michigan State and Clemson Universities to measure contaminant levels in bald eagle blood and feathers each year. Eaglets from selected nests have been monitored annually, while others have been sampled according to DEQ's 5-year rotating basin schedule. Samples are analyzed for PCBs, mercury, DDT, and a few other selected pesticides. Previous bald eagle contaminant data were collected in the late 1980s and early 1990s. Thus, the current effort allows the DEQ to measure temporal, as well as spatial, trends in contaminant levels.

The same researchers monitoring bald eagles also are assessing contaminant levels (PCBs, DDT, mercury) in herring gull eggs. This project complements and expands existing herring gull egg monitoring conducted by the Canadian Wildlife Service. The data are used for trend assessment of near-shore areas of the Great Lakes.

The DEQ is evaluating the feasibility of a biological trend monitoring project using a probabilistic sampling approach. This effort would supplement the ongoing biological assessment conducted during the watershed surveys. Some preliminary development work was conducted in 2004, as recommended in a report summarizing issues related to biological trend monitoring (Great Lakes Environmental Center 2003b). We expect to test a design in 2005 with full implementation to occur in 2006.

The DEQ provides funding to the U.S. Geological Survey (USGS) each year to monitor the trophic condition of inland lakes. Lakes are sampled in watersheds consistent with the 5-year

rotating basin schedule, and are selected randomly within each watershed. This approach will allow spatial and temporal comparisons of lake quality.

Finally, volunteers often monitor inland lakes and selected streams over multiple years. These results are used to measure water quality changes from year to year.

Goal: Evaluate the effectiveness of water quality prevention and protection programs

Objective: Support the implementation of water quality management programs, including the evaluation of program effectiveness

A substantial portion of the DEQ's monitoring effort is devoted to this objective. The programs supported by monitoring are listed below, along with a summary of applicable monitoring activities.

a) NPDES Permit Program

The 5-year rotational watershed assessments directly support the NPDES program. Watersheds are monitored two years prior to permit re-issuance to ensure that the monitoring data are considered during permit reviews. Monitoring staff, with input from NPDES staff, review the location of NPDES facilities and the permits to decide on sampling locations and parameters. Biological, water, and sediment samples are collected as appropriate. The biological data indicate whether NPDES facilities are affecting aquatic life, while water and sediment data are used to determine whether contaminant levels are elevated downstream from a facility outfall. Special studies also are conducted by DEQ and its contractors as needed to support the NPDES program. For facilities that discharge bioaccumulative contaminants of concern, especially mercury, fish and wildlife contaminant data support permit review. Finally, water quality data collected by local governments and non-profit organizations through DEQ grants also support NPDES activities.

Because the watershed surveys and special studies are planned and conducted by the same staff developing the water quality-based effluent limits (WQBELs) for all NPDES facilities in the watershed (with assistance from contractors as needed), the DEQ ensures that the monitoring data are used and directly support the NPDES program. Similarly, project managers for the local monitoring grant generally are assigned based on watershed (as well as expertise) such that the project manager often is the same person developing the WQBELs for NPDES permits in that watershed.

b) Nonpoint Source Program

Water quality data often are needed to document the need for, and subsequent improvement as a result of, the implementation of Best Management Practices. The specific information required depends upon the problem being addressed, but may include biological, chemical, or physical data. The DEQ recently completed a Nonpoint Source Environmental Monitoring Strategy (NPS Strategy) that explains in detail how monitoring is used to support nonpoint source efforts (MDEQ 2004b). Specifically, it describes how the DEQ's nonpoint source monitoring priorities

are set; how monitoring is used to track improvements in water quality following implementation of nonpoint source controls; and how the monitoring results are communicated and used in program decisions. The NPS Strategy divides nonpoint source monitoring into four broad categories, including statewide trend monitoring, problem identification monitoring, total maximum daily load (TMDL) development and effectiveness monitoring, and nonpoint source control effectiveness monitoring.

The NPS Strategy was reviewed by EPA, and it is available on DEQ's web site and in hard copy.

c) Clean Lakes Program

The DEQ works with the USGS to monitor the trophic status of selected public lakes each year throughout the state to fulfill Section 314 Clean Water Act requirements. Information on chemical (primarily nutrients) and physical (temperature, dissolved oxygen, pH) characteristics is generated. Lakes are randomly selected each year within watersheds consistent with the 5-year rotational basin cycle, allowing DEQ to make statistically valid statements about lake trophic status within each watershed, as well as throughout the state over a 5-year period. Volunteers also collect lake trophic data that support this program. The DEQ project manager on the USGS lake monitoring effort is the same person who oversees the inland lake volunteer monitoring. This helps to ensure that these two efforts are coordinated and complementary to the extent possible.

d) TMDL/303(d)

The DEQ conducts a number of special studies each year to support the development and implementation of TMDLs, as required by Section 303(d) of the Clean Water Act. DEQ carries out some of these monitoring activities, and DEQ contractors conduct others (using DEQ study designs and sampling procedures). DEQ has completed some TMDLs, has several under development, and has an extensive list of waters requiring TMDLs through 2017. Thus, TMDL support will continue to be a high DEQ monitoring priority for at least the next decade. For each TMDL, extensive monitoring is conducted to identify causes and sources of impairment(s) at non-attaining waters, to determine the assimilative capacity of the waterbody for the pollutant(s) of concern, and to evaluate the effectiveness of pollutant load reduction efforts during and after TMDL implementation. The EPA approves the list of waters on the 303(d) list, the schedule for TMDL development, and each specific TMDL developed by DEQ. Based on the fact that EPA has approved the 303(d) list, the development schedule, and all specific TMDLs submitted to date, the monitoring program is effectively supporting this effort.

e) Great Lakes Programs

Many of DEQ monitoring activities directly support Great Lakes programs, including Remedial Action Plans (RAPs), Lakewide Management Plans (LaMPs), and the SOLEC indicator process. These programs require information on the status of beneficial use impairments and contaminant loads and concentrations that contribute to the use impairments. The resulting data ultimately will be used to support the delisting process for beneficial use impairments. The tributary monitoring project allows for the calculation of contaminant loadings to Areas of Concern and

from the Michigan portion of the Great Lakes' watersheds. These data have been used to support RAPs, LaMPs, and the development of the Lake Michigan Mass Balance model. Annual sampling of the Great Lakes connecting channels, Saginaw Bay, and Grand Traverse Bay also supports these programs. In addition, the DEQ monitoring coordinator co-chairs the Lake Michigan Monitoring Coordination Council, which directly supports the Lake Michigan LaMP. Contaminant data from fish, bald eagles, and herring gull eggs directly support the SOLEC indicator process, as well as indicators identified by the individual LaMPs and RAPs. DEQ participates in a project to collect Great Lakes fish for contaminant analysis along with EPA, USGS, and other Great Lakes States. DEQ monitoring staff also have met with representatives of Michigan RAP Public Advisory Councils to identify monitoring opportunities to support beneficial use assessments and the delisting process. Finally, DEQ participates in the Great Lakes Wetlands Consortium.

f) Public Advisories

The DEQ monitoring program collects and summarizes data to provide the public with information about the suitability for eating fish and swimming at beaches. Each year, fish are collected from selected waterbodies (generally, though not always, consistent with the 5-year rotating basin schedule) and analyzed for a variety of bioaccumulative contaminants, including PCBs, mercury, DDT, and dioxins/furans. The results are used by the Department of Community Health as the basis for setting fish consumption advisories. In addition, local health departments, using federal, CMI, and/or local funds, collect samples each year to assess bacteria levels at Great Lakes and inland beaches. The data are used by the counties to determine whether beaches should be closed due to high *E. coli* levels, and all results are posted on DEQ's beach web site.

g) Conservation Reserve Enhancement Program

Michigan's Conservation Reserve Enhancement Program (CREP) was created to reduce sediment, phosphorus, and nitrogen loading to the Macatawa River, River Raisin, and Saginaw Bay watersheds. The CREP establishes financial incentives for landowners to install filter strips, riparian buffers, windbreaks, permanent vegetative cover on erosion-prone cropland near streams and exclusionary fencing for livestock; and restore wetlands and create shallow water areas for wildlife. Currently, CREP practices have been primarily implemented in the Saginaw Bay watershed, with 37,854 acres. The River Raisin and Macatawa River watersheds have 9,753 and 239 acres enrolled, respectively.

There are several projects underway to evaluate the effectiveness of the CREP. Nutrient samples were collected in Carrow Creek (Clare County) to assess the effects of cattle exclusion. Pre-treatment data were collected from October 2001 through May of 2002. The barnyard and pasture treatments were completed in the fall of 2002 and the post treatment monitoring of Carrow Creek started in September of 2003. Channel morphology and biological parameters were monitored in the Sugar River (Clare County) to assess the effects of a cattle exclusion project, and storm event sampling was conducted in areas with CREP practices and without CREP practices to evaluate their effectiveness.

Monitoring of peak flood stage upstream and downstream of a proposed wetland restoration project on the Macatawa River continued in 2003. Peak flood stage data were collected upstream and downstream of the project prior to wetland restoration. Wetland restoration began under CREP beginning in summer of 2004.

Modeling tools are being used in conjunction with water quality monitoring to evaluate the effectiveness of CREP activities in Michigan. Watershed modeling tools are used to estimate pollutant loading reductions from CREP.

CREP monitoring activities are summarized in an annual report produced by a DEQ contractor.

h) Sanitary Sewer Overflows/Combined Sewer Overflows

There is continued concern about the release of untreated sewage from sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs) into surface waters and the potential for environmental and public health impacts. The DEQ has several monitoring activities to identify SSOs, CSOs, illicit connections, and leaking septic systems. For example, DEQ collects samples at locations where sewage releases are suspected. The samples are analyzed for bacteria. If bacteria numbers are indicative of untreated sewage, the matter is referred to DEQ district staff to identify the source(s), working in cooperation with the municipality and/or local health department. In addition, district staff routinely investigates potential sources in response to citizen complaints and evidence of untreated sewage release. During the 5-year rotating watershed surveys, biologists look for evidence of sewage discharge and refer findings to district staff for follow-up action.

A total of 20 TMDLs have been approved by EPA for Michigan waters with *E. coli* problems, through September 2004. Furthermore, several waters are being monitored, or will be monitored in the future, for *E. coli* to support the development of TMDLs.

Several water quality monitoring grants have been awarded to local governments or watershed groups in recent years to measure *E. coli* levels in water to identify potential sources of untreated sewage. The waters being monitored include the Saginaw, Shiawassee, Kalamazoo, Thornapple, and Boardman Rivers, as well as the Lake St. Clair watershed.

i) Compliance and Enforcement

Two full-time DEQ staffers collect effluent samples from NPDES facilities to evaluate compliance with permit limits. In addition, the DEQ has a toxicity laboratory that conducts acute and chronic whole effluent toxicity tests from selected facilities each year. WET tests usually are conducted consistent with the 5-year rotating basin schedule, such that facilities are tested two years prior to permit re-issuance.

The DEQ conducts special studies to support water quality enforcement actions. These studies may include water, sediment, biological, and/or toxicity sampling, depending on the specific issue. One example is the 2004 intensive monitoring of drains and rivers in Hillsdale County that are impacted by confined animal feeding operations, primarily via manure runoff from surrounding farm fields. Water quality monitoring in response to spills also is conducted. Monitoring activities to support enforcement actions are implemented as needed, and are always developed with input from Enforcement and Compliance staff.

j) Water Quality Standards/Criteria

The DEQ collects data to support human health, aquatic life, and wildlife criteria review and development. This includes the refinement and improvement of Michigan Water Quality Standards as appropriate, as well as the development of site-specific criteria where necessary. As one example, monitoring, aquatic toxicity testing, and modeling were performed in 2004 to support the development of a water quality criteria for copper in the surface waters of Michigan's Upper Peninsula. In addition, the DEQ collects data on nutrients in all waterbody types to support current efforts to develop nutrient criterion for lakes, reservoirs, rivers, and streams. Data on response variables such as algae and/or chlorophyll a are collected when appropriate. These data also will serve as the basis for efforts to develop nutrient guidelines or criteria for other waterbody types including wetlands and sensitive Great Lakes areas, if determined to be necessary in the future. As data needs are identified, the monitoring program is flexible enough to ensure that the necessary information is collected. This flexibility also applies to other potential criteria development needs that may be identified in the future.

k) Local Program Support

The DEQ provides grants to local governments, universities, and non-profit organizations each year for local water quality monitoring activities. The grants are often used to support local water quality protection and restoration programs, and to evaluate the effectiveness of these programs. Examples include sediment reductions from road crossing improvements and bank stabilization, elimination of illicit connections and CSOs, and land use changes/issues. Along with the grants, DEQ project managers provide technical assistance during work plan and quality assurance project plan development to ensure that the study design, collection and analytical methods, and data analysis meet project needs. The DEQ also solicits monitoring requests each year from DEQ and external customers, with some requesting monitoring activities to assist local programs. The development of watershed management plans also is supported by water quality monitoring efforts.

l) Groundwater Permits

The objective of the groundwater discharge permit program is to protect groundwater quality by preventing harmful chemical discharges. Thus, the primary monitoring objective for groundwater contamination investigations is to determine the extent and degree of private well impacts from point sources of contamination. Initial investigations generally are carried out by county health departments, with follow-up monitoring by the DEQ if necessary. This includes

the identification of parameters of concern, their concentrations, and the extent of the associated impacts.

m) Wetland Protection

To evaluate state efforts to protect, manage, and restore wetlands, the DEQ committed to develop a wetlands monitoring strategy using a grant from the EPA. The strategy will address monitoring needs (goals/objectives, design and methods, indicators, data analysis/use) necessary to assess status and trends related to wetland acreage as well as to conduct detailed evaluation of individual wetland sites required under Part 303 and Section 404 of the Clean Water Act. DEQ has discussed its overall approach to wetland monitoring and assessment with EPA. Based on EPA suggestion, the strategy is likely to include three tiers of assessment: a landscape scale (statewide inventories, watershed level planning and assessment, etc.); rapid assessment methods, such as the methods used in regulatory programs based on single site inspections; and intensive site investigations which are more parallel to the quantitative methods employed for traditional water monitoring.

The target date for completing the development of the wetland monitoring strategy is May 31, 2005.

n) Sediment Remediation

The DEQ often monitors the effectiveness of sediment remediation efforts. Monitoring activities can include the collection and analysis of caged fish, water samples, sediment samples, and/or toxicity testing. The monitoring frequently incorporates sampling before and after the sediment remediation. DEQ monitoring and sediment staff, along with external agency staff as appropriate, work together to ensure effective, coordinated monitoring projects.

Goal: Identify new and emerging water quality problems

Objective: Assess the potential of new chemicals to impact water quality and public health

The DEQ has the flexibility to analyze water, sediment, and fish/wildlife tissue samples for emerging contaminants as appropriate. This can be accommodated either by collecting an additional sample as part of an existing project or by means of a special study. Examples from recent years include methyl tert-butyl ether (MTBE), perfluorooctane sulfonate (PFOS), perchlorate, and polybrominated di-phenyl ethers (PBDEs).

Since 2003, the DEQ also has awarded grants totaling approximately $200,000 annually to local governments, universities, and nonprofit organizations to identify emerging issues of concern and assess potential impacts. Funded projects have included monitoring for antibiotics, pharmaceuticals, household personal care products, and PBDEs.

The results from these DEQ and local studies are provided to other DEQ program staff as appropriate, depending on known or suspected contaminant sources.

Objective: Identify the presence of nuisance aquatic species in Michigan waters, and their impact on water quality

During the watershed surveys, and in response to complaints/requests from the public, DEQ biologists look for the presence of aquatic nuisance species (ANS) in Michigan streams, rivers, and lakes. DEQ also participates in a regional work group designed to address ANS issues, including monitoring. This work group has compiled an inventory of ANS monitoring activities, and will be developing recommendations for further steps necessary to effectively respond to ANS issues. To the extent that these recommendations address improved monitoring, the DEQ will consider opportunities to incorporate these recommendations into its monitoring program.

Through the emerging issue grants, DEQ has funded projects to monitor for ANS and to assess their impacts on water quality. We expect to fund additional ANS-related projects in the future.

Gaps and Implementation Timelines

Some types of waterbodies are not currently monitored on a comprehensive basis. In most cases, efforts are underway to address these gaps as described below. In addition, DEQ is in the process of implementing a nonpoint source monitoring strategy to better evaluate the effectiveness of the nonpoint program.

- **Non-wadable rivers** - Biological assessment of large, non-wadable rivers primarily depends upon data collected by other agencies, particularly fish monitoring conducted by the Michigan DNR. Fish contaminant information also is available for some rivers. Using a grant from DEQ, Michigan State University researchers recently developed a draft procedure to qualitatively assess the benthic macroinvertebrate community and physical habitat in these systems. After testing the procedure in 2005, the DEQ will finalize it by April 2006 to allow staff to incorporate large river monitoring into the 5-year rotating basin surveys in 2006.

- **Wetlands** - Wetlands are not routinely assessed for water quality at present, except for occasional studies. However, the DEQ is committed to the development of a wetland monitoring strategy by May 31, 2005. We expect this strategy to address issues such as monitoring design, monitoring and assessment procedures, data analysis, data management, and reporting.

- **Headwater streams** - Limited monitoring of very small headwater streams occurs during the 5-year rotating basin watershed surveys. However, our current biological assessment procedure was not developed for small, low-gradient, "swampy" streams. It is our understanding that the U.S. Geological Survey and the EPA are currently developing and testing rapid assessment procedures for these types of waters. Once these procedures have been developed, tested, and shown to be accurate and efficient, the DEQ will further incorporate these waterbodies into routine monitoring plans. Implementation of this activity is dependent upon federal guidance and technical assistance; thus DEQ cannot commit to an exact implementation date.

- **Nonpoint source monitoring** - The DEQ recently produced a nonpoint source monitoring strategy (MDEQ 2004b), which was submitted to EPA in September 2004. This strategy describes in detail how the nonpoint source and the water quality monitoring programs will be coordinated to ensure that the needs of both are being met effectively and efficiently. The DEQ has committed to the full implementation of the nonpoint source environmental monitoring strategy within two years, by October 2006.

III. Monitoring Design

To meet the diverse objectives described in the previous section, the DEQ employs a number of designs within its monitoring program. Designs for the various monitoring activities are selected to ensure that management and programmatic needs are effectively addressed in an efficient manner. Each monitoring activity is reviewed at appropriate intervals to determine whether the resulting data are achieving agency objectives and to evaluate whether the study design can be improved. In general, DEQ monitoring activities fall under one or more of the following types of study design:

- 5-year Rotating Basin;
- Fixed Station;
- Probabilistic; and
- Targeted Sites/Special Studies.

These study designs, along with the associated monitoring activities and objectives, are described below in more detail, as well as in Figure 3 and Table 3. Study designs for some of the new projects described here are currently being developed. As these projects are implemented in the future and the study designs are refined, additional details will be provided in future updates. Appendix A contains summaries of the various monitoring program components described in this section. Detailed work plans for all of the activities are available upon request.

5-Year Rotating Basin

The 5-year rotating basin approach serves as the primary study design for assessing current water quality status and attainment of Michigan water quality standards. The data generated by this approach allow the DEQ to identify impaired and high quality waters, and to pinpoint causes and sources of impairment. Because watersheds are monitored two years prior to the re-issuance of NPDES permits within that watershed, this monitoring design directly supports the NPDES program. Some sites are selected within the targeted watersheds to evaluate the effectiveness of best management practices, thereby supporting the nonpoint source program (MDEQ 2004b). The basins are delineated by the 8-digit Hydrological Unit Code (HUC), and the schedule for watershed assessment over the 5-year cycle is shown in Figure 4. Since 1997, the DEQ has been assessing approximately 80% of river and stream miles in each watershed, through a combination of direct DEQ monitoring and the evaluation of available data generated by federal and other state agencies, tribes, local governments, and volunteers. This process is fully described in the DEQ's 2004 Integrated Report (MDEQ 2004a).

The number of sites monitored in each watershed varies based on many considerations, including basin size, waterbody characteristics, land use diversity, and the extent of sites with known or expected problems (contaminants, habitat degradation, flow modification, etc.). DEQ biologists and water quality modelers talk and/or meet with DEQ program (e.g. NPDES, nonpoint source) and district staff, as well as representatives from other federal, state, tribal, and local agencies, to assist with the selection of monitoring sites within a targeted watershed. During this process, the types of monitoring (biological, water, sediment, fish/wildlife contaminants, habitat, flow, visual assessment) that should occur at each site are identified. These watershed plans also take into consideration existing resource constraints (staff, funding, and equipment) that limit how much field work can be conducted in a given year.

Several monitoring activities are conducted consistent with the 5-year rotating basin design. Biological assessments, including benthic macroinvertebrate and fish community evaluations, habitat assessments, and other water quality studies are routinely conducted in streams and rivers during the watershed surveys. DEQ generally monitors biological community and habitat at a total of 500-600 sites per year, with most of these assessments occurring in wadable streams and rivers within the targeted watersheds. The resulting data are used to determine whether waters are achieving the designated use for aquatic life. Michigan State University, through a grant funded by DEQ, recently completed a draft biological and habitat assessment procedure for non-wadable rivers. This new procedure will allow DEQ to extend biological assessment coverage to larger rivers in 2006. Water and sediment samples also are collected as needed, and are analyzed for selected parameters depending on site-specific issues and concerns.

Although the monitoring conducted during these watershed surveys focuses primarily on perennial waters, intermittent and ephemeral streams frequently are assessed. In some cases, non-perennial sites are visited because they are erroneously identified as perennial in the National Hydrography Dataset. Non-perennial sites also are visited by DEQ staff to ensure adequate characterization of the entire watershed and to identify potential causes/sources of problems identified downstream. If flowing water is present at the time of the site visit, monitoring may include benthic invertebrates, fish, habitat, and/or the collection and analysis of water samples for parameters of interest. If the stream is dry or contains only isolated areas of standing water, the assessment is likely to include general habitat (e.g. riparian vegetation, surrounding land use, bottom substrate) and potential causes/sources of impairment (e.g. road crossing status, nonpoint source concerns, channelization, etc.).

Most of the fish tissue analyzed to support the fish consumption advisory process comes from fish collected in targeted watersheds, consistent with the 5-year rotating basin cycle. In addition, the bald eagle monitoring project focuses on eaglet blood and feathers collected from targeted watersheds, such that all watersheds with successfully reproducing eagles are assessed over the 5-year period for population and contaminant levels. In 2004, the study design was reviewed after five years of data collection. The 5-year rotating basin study design for the bald eagle project was maintained as statistical analyses indicated that the current design adequately characterizes statewide spatial and temporal trends.

Water quality data from inland lakes have been collected each year since 2001 to assess trophic conditions and support the Clean Lakes Program. Lakes are selected randomly each year in the

targeted watersheds, consistent with the 5-year rotating basin cycle. Approximately 730 lakes with public access will be sampled over 15 years. Between 2001 and 2004, 55-85 lakes were monitored each year. The assessment of lakes in targeted watersheds allows for the resulting data to more effectively support the NPDES permit program and the nonpoint source program, as well as to better fulfill various reporting requirements.

Fixed Station

The DEQ has a number of fixed stations from which data are routinely collected, primarily to assess temporal water quality trends at sites of particular interest. For example, water samples are collected from fixed stations including Saginaw Bay, Grand Traverse Bay, the three Great Lakes connecting channels (an upstream and downstream site on each), and 31 inland river sites (primarily near the mouth of major rivers). Site locations are displayed in Figure 5. These sites are sampled every year, although sample frequency varies at some sites from year to year. In addition to using the data to assess spatial and temporal trends, the tributary and Great Lakes connecting channel data are used to calculate contaminant loadings to the Great Lakes. Thus, this effort also supports the Remedial Action Plan and Lakewide Management Plan programs, as well as various Great Lakes indicator initiatives. A thorough description of this project is available from DEQ upon request.

A total of twenty-six fixed stations are routinely monitored as a component of the Fish Contaminant Monitoring Program (FCMP). These sites include a mix of river, inland lake, and Great Lakes stations (Figure 6). For environmental, resource, and logistical reasons, fish tissue often is a better endpoint than water for bioaccumulative contaminants. Whole fish tissues are analyzed for PCBs, mercury, and a suite of pesticides such as DDT, and the resulting data are used to evaluate temporal trends in contaminant levels in fish from specific locations.

The wildlife contaminant component of the monitoring program incorporates fixed stations. In addition to the 5-year basin sampling described above, some bald eagle nests are sampled annually. These include nests along the Great Lakes and connecting channels, where nesting success is highly variable, as well as 12 inland territories with consistently high productivity to track year-to-year variability of concentrations and to determine the sampling frequency needed to evaluate trends. Herring gull eggs are collected annually at up to eight fixed stations along the Great Lakes in Michigan, as a complement to the herring gull egg monitoring project conducted by the Canadian Wildlife Service (Figure 7). The resulting data are used to assess spatial and temporal trends in bioaccumulative contaminants in the Great Lakes.

Drinking water monitoring occurs at fixed stations, specifically at municipal drinking water treatment facilities and at sampling sites in the distribution system. Monitoring within a facility generally is conducted on the raw water as well as at various stages of the treatment process, including point(s) of entry to the distribution system. Each facility is also required to have a sampling plan that clearly identifies sampling locations and frequency for distribution system monitoring for coliform, chlorine residuals, disinfectant byproducts, lead, copper, etc. Non-community water systems monitor drinking water quality at raw water sample taps except for bacteriologic and lead/copper which are collected in the distribution system. Sampling locations are identified in a sample siting plan.

Most volunteer monitoring groups collect data from fixed stations each year. The Cooperative Lakes Monitoring Program (inland lakes) includes many lakes, both with and without public access, that are sampled every year for trophic indicators. Some of these lakes have been sampled annually for more than 20 years. Likewise, most volunteer organizations that monitor rivers and streams in specific watersheds have fixed stations that are sampled every year.

Probabilistic

The primary benefit of a probabilistic (random) monitoring design is that statistically valid conclusions about water quality can be made by sampling a relatively small number of sites from the target population (e.g. large inland lakes, wadable coldwater streams). Because sites are randomly chosen, results from the selected sites can be extrapolated to the entire population of sites. Thus, the EPA has encouraged states to consider incorporating probabilistic study designs into monitoring programs.

DEQ has utilized, or is considering using, this type of sampling design for some monitoring program components. Although biological surveys are conducted in watersheds consistent with the 5-year rotating basin, some biologists in 2004 randomly sampled river segments within targeted watersheds to assess the aquatic life designated use. Rivers in Michigan have been delineated into individual classifications called valley segments that are based on flow and temperature characteristics as related to groundwater and local geomorphology. The data will be used to assess attainment of water quality standards and temporal trends on a watershed basis. In addition, DEQ will implement a probabilistic design for water chemistry sampling in 2005 and biological assessment in 2006, based on recommendations provided by a contractor (Great Lakes Environmental Center 2003b). Although specific parameters/indicators have yet to be selected, the biological probabilistic monitoring design obviously will focus on the aquatic life designated use, while the water chemistry probability monitoring will provide information to support all designated uses (although see "Gaps and Implementation Timelines" section below for discussion on logistical issues related to assessing the recreation designated use).

Through a grant from DEQ, a contractor recently completed a comprehensive review of Michigan's FCMP, which included several recommendations for improving this activity (Exponent 2003). One recommendation was to consider a probabilistic design rather than fixed stations to improve our ability to detect spatial and temporal trends in fish contaminant levels. The DEQ is considering a probabilistic approach to assess mercury levels in fish from inland lakes as a component of the FCMP trend monitoring effort.

Water quality data from inland public access lakes are collected to assess trophic conditions and support the Clean Lakes Program. Lakes are selected randomly each year in the targeted watersheds, consistent with the 5-year rotating basin cycle. Random site selection within the targeted watersheds allows the trophic data to be extrapolated to all lakes in the targeted watersheds. After 15 years, a total of 730 inland lakes will be monitored.

Targeted Sites/Special Studies

The remainder of monitoring activities not listed under the previous study designs can be classified as special studies at targeted sites. These monitoring activities are conducted to address specific questions and issues and are performed by DEQ, contractors, or grantees. For example, the DEQ each year conducts a number of monitoring studies to support the development and implementation of TMDLs. In 2003, TMDL-related sampling was conducted on Lake Allegan, Lake Macatawa, Ford Lake, Belleville Lake, Paint Creek (Washtenaw County), Grand River, Belle River, McKinzie Creek, Grand River, Ecorse River, Little Black Creek, Black Creek, Malletts Creek, Swift Run, Stony Creek, Letts Creek, Black Creek, Duff Creek, Berry Drain, and the Belle River. In addition, *E. coli* monitoring was conducted on 15 waterbodies for TMDL development, with a total of 3,480 E. coli samples collected and analyzed.

The DEQ conducts targeted monitoring to support various water quality programs, including NPDES and nonpoint source. Examples of the former include monitoring for the development of a water effect ratio for copper in the Upper Peninsula and pre-monitoring in anticipation of potential mining activity. An example of the latter is intensive monitoring and modeling studies at selected locations to evaluate the effectiveness of best management practices implemented through the Conservation Reserve Enhancement Program (CREP). As mentioned previously, the DEQ recently completed development of a strategy that describes how the DEQ will monitor the effectiveness of nonpoint source activities. Groundwater monitoring is targeted to specific sites with groundwater permits, to assess potential impacts on private wells from these sites.

The DEQ conducts only minimal monitoring of wetlands at present, primarily because of a lack of guidance and assessment tools for these waters. Current wetlands monitoring is based on a targeted approach, often following complaints from the public or observations during watershed surveys. As mentioned above, the DEQ is in the process of producing a wetlands monitoring strategy which may incorporate other monitoring designs as appropriate. One approach being considered is tiered monitoring, which incorporates one or a combination of landscape assessment, on-site rapid wetland assessment, and intensive site assessment, depending on the monitoring objective. The wetland monitoring strategy should be completed by May 31, 2005.

The DEQ provides grants for local monitoring, emerging issue monitoring, and beach monitoring to local governments and organizations each year to support specific, targeted water quality monitoring projects. With regard to the total and partial body contact recreation, county health departments have primary responsibility in Michigan for beach monitoring. The DEQ provided almost $350,000 in grants in 2004 using federal BEACH Act and state Clean Michigan Initiative funds to county health departments for monitoring at Great Lakes beaches and inland beaches. As of July 2004, a total of 859 beaches have been identified in Michigan, including 405 public inland beaches and 454 Great Lakes beaches. Of these a total of 462 beaches (54%) were monitored in 2004, including 271 public inland beaches and 191 Great Lakes beaches. All counties that submitted proposals were funded, though not always at the full level requested. Whenever a location is found that does not meet the recreation designated use, the DEQ extensively monitors the site and develops a TMDL.

The DEQ is exploring the use of satellite imagery as a tool to assess the trophic status of inland lakes in Michigan. Wisconsin and Minnesota also are evaluating this method. If this approach proves to be effective and reliable, it would allow the DEQ to increase the number of public and private lakes that are monitored. The results of this ongoing evaluation will be provided in the next strategy update.

External Data Use

In addition to the monitoring activities conducted or funded by DEQ described above, information collected by other agencies and organizations is used as appropriate by the State to supplement DEQ data and to better meet the various monitoring objectives. Other organizations collecting useful information include EPA, USGS, U.S. Fish and Wildlife Service, Michigan DNR, county health departments/local governments, and volunteer organizations. The level of quality assurance associated with data collection and analysis is a critical factor in determining how DEQ uses external data. A detailed explanation of DEQ's process for external data use is provided in the 2004 Integrated Report to EPA (MDEQ 2004a).

Gaps and Implementation Timelines

EPA has indicated it expects states to assess 100% of all waterbody types for all designated uses. Despite having a comprehensive, multi-media monitoring program, the DEQ is not currently meeting this expectation. One reason is that DEQ believes that a monitoring program should encompass multiple objectives, beyond just documenting whether standards are attained and designated uses are met. Other monitoring goals are equally important, such as measuring trends, evaluating program effectiveness, and detecting emerging issues, and we encourage EPA to consider all of these when evaluating state monitoring programs. Nonetheless, the DEQ is committed to achieving the goal of assessing 100% of all waterbody types.

- **100% assessment of waters** - Because the ongoing public inland lake trophic monitoring project randomly selects lakes within targeted watersheds, 100% coverage of these waters will be achieved over a 5-year period. Because of difficulties with access and concerns about spending public funds on lakes without public access, the DEQ does not comprehensively monitor private lakes. Some private lakes are monitored by volunteers, and the use of satellite imagery is being considered as a means to assess trophic conditions in private (as well as public) lakes.

  In 2004, biologists incorporated probabilistic monitoring into the watershed survey designs. We expect this to continue in the future, and to achieve 100% coverage of wadable rivers and streams over a 5-year period. Because a draft non-wadable procedure has been developed and will be available for use in 2006, we expect that 100% of non-wadable rivers also will be assessed by 2010, using a probabilistic approach. Once federal agencies provide guidance for monitoring small headwater streams, these waters also will be incorporated into the watershed survey plans. Finally, the DEQ will be working with our contractor during 2005 to develop a monitoring protocol and study design for designated drains, with an ultimate goal of 100% assessment of these waters.

A wetland monitoring strategy will be completed by May 31, 2005. This strategy will address study design, such that all wetlands are assessed over a defined time period. Beginning in 2005, the DEQ will partner with the Michigan Natural Features Inventory to expand monitoring in the Great Lakes. Specifically, near-shore locations in Lake Michigan and Lake Superior will be randomly selected and sampled for benthic invertebrates, zooplankton, non-indigenous species, and water chemistry parameters. In 2006, a similar monitoring design will be implemented for the Michigan portions of Lake Huron and Lake Erie.

In addition to assessing 100% of waters in Michigan, the EPA also expects DEQ to assess all designated uses for these waters. For the drinking water designated use, 100% of drinking water sources/intakes are currently monitored by municipal facilities. Efforts to achieve 100% assessment of other designated uses include:

- **Aquatic life designated use** – Incorporating the study design modifications described above will ensure effective assessment of the aquatic life designated use. Biological monitoring by DEQ and/or the Michigan DNR is, or will be, fully incorporated into sampling of streams and rivers, inland lakes, wetlands, and the Great Lakes.

- **Recreation designated use** – With regard to the recreation designated use, approximately 54% of the public beaches (inland and Great Lakes) currently are monitored by county health departments, often through grants from the DEQ. To increase the percentage of beaches that are monitored, DEQ Director Steve Chester requested that EPA reconsider the allocation formula for BEACH Act funding in a June 3, 2004 letter to Mr. Benjamin Grumbles. We were informed on August 20, 2004 by Ms. Wendy Miller (Office of Science and Technology) that EPA has decided not to change the allocation at this time.

  As mentioned in the "Monitoring Design" section above, the DEQ is developing a probabilistic sampling design for biological assessment and water chemistry monitoring on inland rivers and streams. We intend to evaluate the logistical feasibility of including *E. coli* on the analytical parameter list by December 31, 2005. The value of adding *E. coli* as a parameter in a probabilistic sampling design is that it would allow for an assessment of the recreation designated use in 100% of the sampled waters. However, the short holding time (approximately 6 hours) makes getting samples from multiple locations to a laboratory in a timely fashion a substantial logistical challenge. A separate sampling run specifically for *E. coli* likely would be necessary and therefore would require additional resources (FTEs and/or dollars). Thus, we have to consider the costs and benefits of such a project, compared to other activities that could be implemented. The development of a rapid assessment method for *E. coli* would make the achievement of this goal more feasible.

The DEQ has many ongoing monitoring activities designed to measure spatial and temporal trends. Some additional trend monitoring efforts are being considered and/or developed:

- **Water chemistry trend monitoring** – To augment our existing fixed station water chemistry trend monitoring, we will implement a statewide probabilistic component to this project, beginning in 2005.

- **Fish contaminant trend monitoring** – Another potential addition to our trend monitoring efforts is the development of a probabilistic sampling design to assess mercury levels in fish from inland lakes. If a decision is made to proceed with this activity, implementation likely would begin in 2006.

- **Biological trend monitoring** – Given all of the chemical trend monitoring described previously, the DEQ also recognizes the importance of trend monitoring for biological communities. In 2001, the Michigan DNR began to implement a trend monitoring project for fish communities in streams, rivers, and inland lakes (MDNR 2003), incorporating both probabilistic and fixed station components. The DEQ recently provided a grant to the Great Lakes Environmental Center to review other state and federal biological trend monitoring projects, and to make recommendations for a biological trend monitoring program for benthic macroinvertebrates in Michigan. The report was completed in September 2003. Based on the recommendations, the DEQ conducted pilot testing during 2004, which will continue in 2005. We expect to have an initial probabilistic study design in place for the 2006 field season.

IV. Water Quality Indicators

The DEQ routinely collects biological, chemical, and physical/habitat data from a variety of water body types and media. These indicators are used to address the monitoring goals and objectives outlined in Section II. The list of core indicators collected by DEQ (Table 4) is consistent with, and goes beyond, the list of core indicators recommended in current EPA guidance (EPA 2003).

There is some variation in the types of indicators collected from different types of water bodies. For example, the DEQ has well-developed procedures for assessing fish and benthic macroinvertebrate communities in wadable rivers/streams. The latter are routinely sampled during surveys, whereas the former are assessed at a subset of sites partly due to time and resource constraints. We also have found that the benthic invertebrate community generally is more restrictive than fish when assessing aquatic life use attainment. A benthic invertebrate community assessment procedure for large, non-wadable rivers will be tested in 2005 and fully implemented in 2006. These biological indicators are the primary means for determining whether the aquatic life designated use is being attained. As one component of a biological trend monitoring study design, the DEQ is evaluating whether increased taxonomic resolution and larger sub-samples can improve the existing procedure by providing additional information on biological integrity (see Data Analysis and Assessment section below). During site visits, biologists also note the existence of nuisance algal or aquatic plant conditions.

In contrast, rapid biological assessment guidance is lacking for the Great Lakes and inland lakes. Biological monitoring in these water bodies often includes *E. coli*, which is used to evaluate the recreation designated use, and nuisance aquatic plant conditions or species. The DEQ produces data on macrophyte species, densities, and distribution when assessing lakes for aquatic nuisance control. The Michigan DNR monitors populations of recreationally or commercially important fish species from rivers/streams, inland lakes, and Great Lakes sites. The USGS conducts

qualitative macrophyte assessments as a component of the inland lake trophic monitoring. Beginning in 2005, the DEQ will initiate a project with the Michigan Natural Features Inventory to sample benthic invertebrates and zooplankton in multiple near-shore areas of the Great Lakes. The DEQ is willing and able to conduct more rigorous biological community assessment in inland lakes, but additional guidance is needed on sampling procedures and data analysis/interpretation.

The biological indicators to be used for wetland assessment will be identified in the wetland monitoring strategy. The primary biological indicator currently monitored is wetland vegetation. Indices of Biological Integrity (IBIs), which may include indicators such as plants, fish, benthic macroinvertebrates, and amphibians, are being developed by Michigan State University and Grand Valley State University in cooperation with DEQ and federal agencies. IBIs are currently being developed for many systems, including Great Lakes coastal wetlands, Lake Michigan drowned river mouth wetlands, inland forested depressional wetlands, and inland herbaceous depressional wetlands. These efforts have been supported through the EPA State Wetland Grant Program.

Chemical indicators are monitored in all water body types, including rivers/streams, inland lakes, Great Lakes, wetlands, and groundwater. They also are routinely measured in all media, including water, sediment, fish, and wildlife using clean sampling techniques and state-of-the-art analytical methods. Although chemical indicators are used to determine attainment with all designated uses, the suite of chemical indicators can vary depending on the monitoring objective(s) and water body type. For example, water samples are analyzed for mercury, trace metals, nutrients, and other parameters (e.g. chloride, total suspended solids) at all fixed station tributary locations for trend assessment. Routine water monitoring in lakes generally includes nutrients and parameters such as dissolved oxygen and chlorophyll a with the primary objective being to assess trophic status. Samples also are analyzed for other parameters (especially mercury) as necessary for specific studies. Sediments from inland lakes are monitored for PCBs, DDT, other pesticides, mercury, trace metals, and phosphorus. Sediment grab samples collected during watershed surveys and to support sediment remediation activities can be analyzed for a variety of parameters depending on the known and/or suspected sources of contamination. Obviously, the chemical indicators in fish and wildlife are those that bioaccumulate, and are important components of the DEQ's Great Lakes monitoring effort and the fish consumption advisory process.

Drinking water is monitored for process indicators and compliance indicators. Process indicators are those parameters for which specific standards do not exist or may not apply, but which provide information about the effectiveness and efficiency of the treatment process. These include chlorine, fluoride, phosphates, sodium, pH, hardness, alkalinity, and turbidity. Compliance indicators are those for which specific drinking water standards have been developed. These include lead, copper, arsenic, chlorine residuals, volatile organic compounds, *E. coli*, total coliforms, etc. The DEQ provides a monitoring schedule for these parameters to all drinking water treatment facilities. Local health departments under contract with DEQ provide a sampling schedule to all non-community water systems at least once every five years at the time of a sanitary survey or when the frequency is changed.

Physical habitat indicators are an important component of stream and river assessments. Along with evaluating biological indicators, DEQ staff routinely assess habitat in the stream channel and the immediate surrounding area (i.e. riparian habitat). Secchi depth/transparency and temperature are important measurements in inland lakes, Saginaw Bay, and Grand Traverse Bay. Land use also is a common physical indicator noted during monitoring activities and studies. Likewise, physical landscape characteristics are used to assess the presence of, as well as potential threats to, Michigan wetlands.

In addition to the core indicators listed above, supplemental indicators are added as needed to meet monitoring goals/objectives and program needs. When planning watershed surveys each year, DEQ monitoring staff meet with district and program staff to develop monitoring plans in specific watersheds. A letter also is sent each year to interested stakeholders to solicit monitoring recommendations and suggestions. This feedback is incorporated into monitoring plans to the extent feasible and practical. The result of this consultation process is that supplemental indicators are sometimes added to monitoring plans to meet specific objectives.

One example of a supplemental biological indicator is *Cryptosporidium*. *Cryptosporidium* is a protozoan parasite often found in domestic animals and which can infect humans. As a result, DEQ is working with researchers from Michigan State University to analyze water samples from waters used as drinking water sources collected near Confined Animal Feedlot Operations (CAFOs) for *Cryptosporidium*, in addition to many of the core biological and chemical indicators. Supplemental chemical indicators also are utilized at times, particularly in regards to the goal of identifying emerging chemicals. Past examples of supplemental chemical indicators measured in water, sediments, and/or fish tissue include PFOS, PBDE, MTBE, dioxins/furans, and cyanide. Detailed stream geomorphology studies also have been conducted, either by DEQ or contractors, to evaluate the effectiveness of nonpoint source projects. These monitoring studies often require the use of supplemental physical/habitat indicators, in additional to the core ones.

Gaps and Implementation Timelines

The DEQ collects data on a broad array of biological, chemical, and physical parameters. Many waterbody types are monitored (or will be monitored), as well as a variety of media including water, sediment, and fish/wildlife tissues. The indicators assessed depend upon the specific monitoring objective, and there is flexibility to sample new indicators as circumstances warrant.

- **Fish Community Assessment** – The EPA has indicated that states should routinely monitor at least two aquatic life communities among fish, benthic invertebrates, and algae. The DEQ currently monitors benthic invertebrates routinely, while fish are only sampled by DEQ at a subset of the sites. The DNR collects fish community data from numerous streams, rivers, and lakes and shares this information with DEQ. As a result, aquatic life data for both fish and benthic invertebrates often exist at sites, although the assessments may not occur at exactly the same time. Additional resources (FTEs, equipment) would be required to incorporate fish community assessments into all DEQ biological assessment sites (see "General Infrastructure and Resources" section below for need estimates).

- **Biological Assessment** – Between the DEQ and DNR, biological assessment is a routine component of state monitoring efforts in rivers, streams, and inland lakes. The primary indicator gap in DEQ's monitoring program is a lack of biological assessment in some other types of waters. However, plans are in place to address this gap in some waters. A wetland monitoring strategy will be completed by May 31, 2005, describing the study design and sampling methods for biological assessment of wetlands. The DEQ will fund the Michigan Natural Features Inventory to collect benthic invertebrate and zooplankton data from Great Lakes near shore areas in 2005 and likely in future years. The existing monitoring program can accommodate biological community assessment (e.g. fish, benthic macroinvertebrates) in inland lakes, but guidance on data assessment/interpretation from EPA or some other source is needed to ensure proper data use and reporting.

V. Quality Assurance

Quality assurance (QA) is an essential component of an effective water quality monitoring program and is necessary to ensure the scientific validity of monitoring activities, including planning, implementation, and assessment procedures for specific projects. The DEQ fully recognizes the importance of QA and strives to ensure that all monitoring data meet high standards of quality. In September 2001, the DEQ completed a Quality Assurance Resource Document (QARD), which was submitted to EPA. The QARD provides an overview of DEQ policies, practices, and procedures relating to QA for DEQ as a whole. In addition to the QARD, existing DEQ policies establish the need for written procedures and the review of the procedures, and specify when Quality Assurance Project Plans (QAPPs) are required.

For water quality monitoring, the Water Bureau has a Surface Water Quality Assurance Manual (MDNR 1994), which is periodically updated. It contains detailed standard operating procedures for water, sediment, and biological sampling of surface waters and point source discharges. Included in the manual are several Surface Water Assessment Section procedures related to water quality monitoring. The QA procedures used by the DEQ Environmental Laboratory also are described in the Manual. This process ensures that monitoring data collected to support various objectives and water quality programs are accurate and reliable.

In addition to the standard operating procedures and section procedures, the Water Bureau (in conjunction with contractors, as appropriate) develops QAPPs for water quality monitoring activities funded by federal funds and by Clean Michigan Initiative – Clean Water Fund monies. Indeed, the EPA requires states to develop QAPPs for federally-funded monitoring projects. Likewise, the Clean Water Fund Rules specify that QAPPs be developed and approved before monitoring can take place. Thus, these documents are available for all monitoring program elements, including water chemistry, sediment, chemistry, fish contaminants, wildlife contaminants, biological assessment, beach/*E. coli*, and inland lake monitoring.

The DEQ does not require each drinking water treatment facility to submit a specific monitoring QAPP. However, these facilities are required to use certified laboratories for any compliance monitoring. As part of the certification process, laboratories must demonstrate the use of standard protocols and incorporate quality assurance procedures such as blanks and spikes. The

laboratories also provide instructions with the sampling kits to ensure appropriate collection methods.

All organizations that receive DEQ grants for water quality monitoring are required to submit QAPPs and receive DEQ approval before sampling can begin. The type of projects include volunteer monitoring, local monitoring, emerging issue monitoring, beach monitoring, and Section 319 or CMI-funded nonpoint projects with a monitoring component. DEQ has a Section procedure for approving QAPPs (Appendix B). The guidance includes a document titled "Content Requirements for Quality Assurance Project Plans for Water Quality Monitoring Studies" which is distributed to grantees to facilitate the preparation of approvable QAPPs. Specifically, this document describes the QAPP format and content requirements (also included in Appendix B).

Gaps and Implementation Timelines

- **Quality Management Plan -** The DEQ is developing a Quality Management Plan (QMP) for EPA approval. The QMP will document how DEQ will plan, implement, and assess the effectiveness of our quality assurance/quality control operations, and will essentially replace the existing Quality Assurance Resource Document. We expect the QMP to be completed by the end of 2005.

VI. Data Management

The benefits of a water quality monitoring program are maximized when the data are effectively managed. An ideal data management system should contain all relevant information (raw data, metadata, and QA information), allow for relatively easy queries and retrieval, and be readily accessible to all data users, including the general public. Almost all water quality monitoring data are stored electronically, either in the federal Storage and Retrieval (STORET) system and/or in Microsoft Access databases developed by DEQ staff. Much of the data stored in internal Access databases are available to the public via the DEQ web site. However, some data are not yet publicly available except by specific request. The data management status of the various monitoring program components is described below in more detail, and summarized in Table 5.

All water chemistry data collected by DEQ and our contractors are uploaded to STORET within one year of collection. This includes all trend data collected at our tributary, connecting channel, and Great Lakes fixed stations, grab samples collected during the watershed surveys, and special studies and intensive monitoring conducted to support specific program needs. Indeed, DEQ has been a national leader among the states in entering water data into STORET. Thus, these data are available to the public. A copy of all analytical data produced by the DEQ Environmental Laboratory is sent directly to DEQ's data management coordinator to ensure prompt data entry. For data generated by other laboratories, DEQ project managers are responsible for providing the data as they become available to the data management coordinator for entry into STORET and/or DEQ databases. All fixed station trend data also are stored in an internal Access database, which is used by DEQ staff to create tables and figures used in the annual report. This database is not available to the general public, although DEQ does respond to specific information requests.

Once entered into the appropriate databases, the data can be analyzed and organized into tables and graphs to be used in annual/final reports.

Like the water chemistry data, all sediment chemistry data collected during the watershed surveys are entered into STORET within one year of collection. Some of these data are used to support sediment remediation activities. Historically, the sediment contaminant data collected and analyzed by contractors as part of remedial investigations and post-remediation monitoring were not entered into STORET or any internal databases. However, the DEQ currently is working to enter our available sediment data into STORET, and expect this process to be completed by December 31, 2005. The inland lake sediment trend data collected by Michigan State University investigators currently are not entered into STORET or any other database, although they are entered into an Excel spreadsheet and are available on request from DEQ. The difficulty with sediment core data is that several slices of the core are analyzed for contaminants, such that one core sample yields several analytical results for each of many parameters. DEQ is willing to enter these data into STORET, but will require technical assistance from EPA on the most efficient and practical way to accomplish this task. Once an approach is agreed upon, the DEQ will ensure that all inland lake sediment core data are entered into STORET within one year of the agreement.

DEQ has developed an Access database to store all of the fish contaminant data. This database was recently made available on the DEQ web site, making the fish contaminant data readily available to any interested party. It allows users to query the data by a number of criteria, including location, date, or contaminant. The database also is used by DEQ staff to create the tables and figures found in the annual Fish Contaminant Monitoring Report. The bald eagle contaminant data are entered into a database developed and maintained by the U.S. Fish and Wildlife Service. Data are available upon request, but the database is not accessible to the public. Neither the FCMP data nor the wildlife contaminant data are entered into STORET.

The biological community (fish, benthic macroinvertebrates) and physical habitat data collected during the watershed surveys or special studies are stored in an Access database maintained by DEQ. DEQ staff has access to the database to generate the biological survey and habitat data tables that are used in reports, and to review previous survey results. The database is not directly accessible to the public, but the biological and habitat data can be provided to the public upon request. DEQ is in the process of entering the biological community and physical habitat data into STORET, and we expect to have these data entered by December 31, 2005.

The DEQ has developed a beach monitoring database that is used to store all beach monitoring data collected by county health departments (primarily) throughout Michigan. The data, which are entered directly into the database by county health department staff, include *E. coli* levels at the monitored beaches as well as information on beach closings. This database is readily available to the public on the DEQ web site. As a requirement of receiving federal BEACH Act funds, the State must submit beach closing information to EPA for entry into the federal PRAWN database. In addition, data on *E. coli* concentrations are sent to EPA with a STORET number for entry into the Central Data Exchange, which are then entered into STORET.

The river/stream monitoring information collected by volunteer organizations are entered into an Access database that is accessible only to DEQ staff. The database is designed to capture benthic macroinvertebrate, habitat, and water chemistry data collected and analyzed by volunteers. DEQ staff currently enter the data manually into the database, which is not accessible to others outside DEQ or the general public. Data retrievals can be performed as requested. The lake data generated through the Cooperative Lakes Monitoring Program are not currently maintained electronically. The DEQ has recently entered into a contract with the Great Lakes Commission to administer the volunteer monitoring programs. One of the primary tasks for the contractor in 2005 is to develop a database to store the CLMP volunteer data. Another task is to make all of the volunteer data available to the public via the DEQ web site. This task should be completed by December 31, 2006. None of the stream or inland lake volunteer data are entered into STORET at this time.

Beginning in 2001, trophic data from approximately 80 lakes per year have been collected for DEQ by the USGS. The resulting data currently are entered into the USGS NWIS database, which is available to the public via the USGS web site. The DEQ intends to enter the data into the STORET database by December 31, 2005. Aquatic plant survey data are entered into Aquabase, a database used to maintain plant survey data and produce reports. This database is not available to the public.

The data collected by drinking water facilities are sent to DEQ district staff, generally in hard copy. After reviewing the data for any violations or problems, district staff enter violation and enforcement information into SDWIS/STATE. This database currently contains community water supply inventory and compliance information, and is the source of quarterly compliance reporting to U.S. EPA. This data system is accessible to all community drinking water staff, but not to the general public. However, once data are reported, EPA makes limited inventory and compliance data available to the public through a web site called EnviroFacts.

All sample results for noncommunity water sample results are retained in the WaterTrack Data system, which is a secure web-based application accessible to local health department contractor and DEQ staff. Violation determinations are made in WaterTrack by comparing required sampling frequency and results to the sample results in the database. Required reporting to EPA is done quarterly based on the WaterTrack data.

The DEQ has awarded a number of grants since 2001 to local organizations for water quality monitoring projects. The data produced from these projects were sometimes provided to DEQ electronically, sometimes only in hard copy. In either case, the data were not entered into STORET. The same is true of monitoring data collected using 319 nonpoint source grant funds. However, the DEQ recently committed to entering all data collected through CMI and 319 grants into STORET. Starting with the Fiscal Year 2004 grants, all grantees will be required to submit data in a STORET-compatible electronic format. This requirement will ensure that all monitoring data produced by grantees can seamlessly transfer into STORET. Existing data collected from previous CMI water quality monitoring grants (2001-2003) will be entered manually, with a target completion date of December 31, 2007.

Location information, primarily latitude/longitude, is now routinely collected by DEQ, contractors, and grantees. This information is included in the various data management systems to facilitate the use of Geographic Information System (GIS) technology for data analysis and map production. Other meta-data also are included in the databases.

The DEQ maintains a Water Quality Monitoring Reports database in Microsoft Access which is available to DEQ staff. Reports can be searched by water body name, county, hydrological unit code, or author. This database is not available to the public, although DEQ can provide information upon request.

The Water Body System (WBS) database has been used since the late 1980s to update various components required for the Clean Water Act Section 305(b) biennial monitoring report (Water Quality and Pollution Control In Michigan) provided to EPA. Since 1994, the WBS has been upgraded by the Water Bureau into a Microsoft Access environment. The database is continuously updated, but especially during the biennial review in the fall/winter period in preparation of the final report Section 305(b) report to U.S. EPA due April 1 of even years.

The DEQ Water Bureau is conducting a pilot project for the Department dealing with data management and communication. The pilot involves making better use of surface water quality ambient data for program support and decision-making, and communicating data and information more effectively to others through the internet. The pilot will focus on enhancing current data management systems, building new databases to contain data not currently available electronically, and linking them through a Geographic Information System. The exact nature and scope of the project is still being developed, but we expect to complete the pilot by September 30, 2005.

Beginning with the 1996 report review and database update, there has been an increased emphasis on the use of the database to develop a listing of Michigan water bodies that are not meeting Water Quality Standards and require a CWA Section 303(d) TMDL. The current data management system has been able to consolidate the information necessary to fulfill the reporting requirements of both Sections 303(d) and 305(b).

Based on staff reviews of available monitoring information for a given water body, summary sheets are completed by staff and entered into the WBS. Access to the raw database is restricted to a few key staff in order to maintain QA/QC on the database information but is available as read-only to DEQ staff. For each water body assessed, the database summarizes the findings from various monitoring data, as to whether WQS and designated use(s) support is met. Each assessed waterbody or reach is identified with a unique code and placed into an EPA/DEQ approved category system (Table 6).

The information in the database for each assessed water body includes station location descriptions, USGS National Hydrography Dataset indexing reach codes and coverage, latitude/longitude coordinates, and designated use(s) support determinations. The WBS information can be used with ArcView to depict either point or reach coverage for each water body in the database, thereby facilitating graphic representation. The WBS database can be used in conjunction with other GIS coverages including the Michigan Resource Information System

(MIRIS), National Hydrography Dataset (NHD), Digital Orthophotos, NPDES Management System database.

The DEQ has committed to working toward converting from the WBS to EPA's Assessment Database. The FY04 and FY05 DEQ work plans for the 106 grant specify that "Water Bureau staff, with assistance from EPA, will work toward using the EPA's new Assessment Database for the 2006 Integrated Report."

Gaps and Implementation Timelines

The lack of accessible databases for some water quality monitoring information is the biggest gap related to data management. Some data are entered into the federal STORET system, but other data are not. The necessary steps and target dates for STORET entry are summarized below:

- **Watershed sediment data** – New sediment data will be entered into STORET within one year of collection; historical sediment data available electronically will be entered into STORET by December 31, 2005; historical sediment data not available electronically will be entered as resources and priorities allow.

- **Inland lake sediment trend data** – Technical issues must be discussed with EPA about entering sediment core data into STORET; if these discussions indicate data entry is feasible technically, a target date will be set at that time based on level of data manipulation required.

- **Fish contaminant data** – Because these data are available to the public via a database on the DEQ web site, and due to the technical difficulties, entry of fish contaminant data into STORET is a low priority at this time and will be considered as other data management issues in this list are completed.

- **Wildlife contaminant data** – DEQ intends to develop a state database for this information by December 31, 2007. If technically feasible and resources allow, the DEQ will enter wildlife contaminant data into STORET by December 31, 2009.

- **Biological community data** – The DEQ is in the process of entering fish, benthic macroinvertebrate, and habitat data (back to 1990) into STORET. This process will be complete by December 31, 2005.

- **Volunteer monitoring data** – DEQ's first priority for these data is to develop a database for the inland lake volunteer data, to complement the existing state stream/river volunteer database. The volunteer data will be made available to the public on the DEQ web site by December 31, 2006. Volunteer data will be entered into STORET by December 31, 2007.

- **Inland lake trophic data** – DEQ will develop a state database for this information by December 31, 2005, and the data will be entered into STORET by December 31, 2006.

- **Nonpoint source/CMI monitoring grants** - Beginning in 2004, DEQ required monitoring and nonpoint source grantees to provide data electronically. These data will be entered into STORET within one year of receipt; historical data collected by CMI grantees will be entered into STORET by December 31, 2007.

- **EPA Assessment Database** – DEQ is working toward converting to this system for use in the 2006 Integrated Report.

VII. Data Analysis and Assessment

The DEQ uses an established methodology to assess the attainment status of waters against Michigan Water Quality Standards. This assessment approach ensures that all relevant information is consistently used to make water quality assessments for 305(b), 303(d), and other Clean Water Act purposes. It includes information on how data on Michigan's water bodies are obtained, assessed, and classified during the assessment process. An in-depth description of these considerations is provided in Appendix VI of the 2004 Integrated Report (MDEQ 2004).

In addition the to the assessment methodology used to determine whether water quality standards are being attained, other data analysis tools are used depending on the monitoring objective. Appropriate data analysis is performed for temporal and spatial trend assessment, program effectiveness assessment, and evaluation of emerging issues. The specific data analysis method(s) used for each monitoring activity is described in the project-specific QAPP, as well as in the final project report.

Facilities submit drinking water data to DEQ each month. DEQ district staff reviews all of the data to assess compliance with drinking water standards. DEQ staff also reviews the process monitoring data to ensure proper treatment is occurring. If the process data indicate a potential problem, or an exceedance of a drinking water standard, appropriate follow-up action will be taken (including regulatory action if needed). Local health departments routinely review non-community water supply sample results and track results that indicate potential violations of drinking water standards to insure proper follow up and public health protection. Most results are available in electronic format directly from the laboratories or are from local health department labs. This enables timely review of results and appropriate follow up oversight.

DEQ also uses data from other federal, state, tribal, and local agencies as appropriate to assess water quality conditions. Volunteer data also are evaluated, primarily as a screening tool to identify waters requiring further assessment. The use of external data depends in large part on the quality of sampling and analytical protocols as well as the level of quality assurance. Such decisions are made on a case-by-case basis.

Gaps and Implementation Timelines

- **Assessment methodology updates** - The DEQ has a well-defined process for analyzing data, as described above. DEQ will update this process as additional monitoring activities are implemented. For example, this process should include data analysis related to the recently completed nonpoint source monitoring strategy and the wetland monitoring strategy

scheduled for completion in May 2005. It also will incorporate additional biological assessment procedures as federal guidance is issued for additional waterbody types. This update will occur every two years, coinciding with the update to the Integrated Report.

- **Evaluate Procedure 51 assessment results** – As described under "Study Design", the DEQ will implement probabilistic monitoring for biological assessment in 2006, based on recommendations provided by a contractor (Great Lakes Environmental Center 2003b) and pilot testing in 2004 and 2005. One component of this assessment involves reviewing whether improved taxonomic resolution and larger sub-samples can improve the method's ability to distinguish aquatic life condition and trends. It may be possible to apply these more rigorous data analysis methods to marginal waters to better evaluate the level of impairment and ensure that aquatic life is appropriately protected. Although this evaluation will be an ongoing process, preliminary results will be available by July 2005. An initial design for the aquatic life trend procedure will be implemented during the 2005 field season. The results will be evaluated and the design finalized by 2006. The DEQ will then evaluate the feasibility of applying more rigorous data analysis methods to impacted and marginal waters to ensure protection of aquatic life.

VIII. Reporting

Reporting is an essential component of a comprehensive water quality monitoring program. The value of water quality data is greatly diminished if the data are not provided to potential users in a timely and effective manner. Therefore, the DEQ (sometimes via contractors and grantees) produces reports that summarize the results of all major water quality monitoring activities, many of which are available to the general public via the DEQ web site. Most of these reports include appendices that contain all of the raw data.

All of the reports produced by the DEQ and its contractors require the completion of a report distribution form before being finalized. The distribution form ensures that copies of the report are sent to all interested stakeholders, potentially including (but not limited to) NPDES program staff, nonpoint source staff, DEQ district staff, Michigan DNR – Fisheries Division, and appropriate federal and local agencies. The benefit of this process is the monitoring project manager must specifically identify the target audiences for the report, who actually receive the report rather than having to request a report that they may not even know about.

The DEQ produced a Section 305(b) and 303(d) Integrated Report in 2004 that summarizes the attainment status of Michigan waters, as required by EPA every other year. This report specifically identifies waters that are not attaining standards and therefore require the development of Total Maximum Daily Loads. It was submitted on schedule in April 2004 and the list of non-attaining waters was approved by EPA. The Integrated Report is available to the public on the DEQ web site. The next Integrated Report is due in 2006.

The reporting process for monitoring activities varies as appropriate. Annual reports are produced and made available on the DEQ web site for long-term monitoring projects that are routinely implemented every year, including:

- Water Chemistry Trend Monitoring (31 tributaries);
- Saginaw Bay/Grand Traverse Bay;
- Great Lakes Connecting Channels;
- Fish Contaminant Monitoring;
- Bald Eagle Contaminant Monitoring;
- Herring Gull Egg Monitoring;
- Inland Lake Sediment Contaminants; and
- Cooperative Lakes Monitoring Program (inland lake volunteer monitoring)

Other reports are generated at varying frequencies. For example, a report summarizing the results of the stream volunteer monitoring activities and results from 1998-2001 was completed in 2001 and is available on the DEQ web site (MDEQ 2002). A similar report covering the stream volunteer monitoring program from 2002-2004 will be completed in 2005. Likewise, the USGS currently is developing a report summarizing the first three years (2001-2003) of the inland lake water quality assessment project. The DEQ intends that future inland lake reports will be produced annually, and will be available on the web site. The limited wetland monitoring information generally is summarized in watershed survey reports. In addition, the DEQ reports annually on actions taken under the Michigan's state administered Section 404 program. We expect that additional wetland reporting needs will be identified in the upcoming wetland assessment strategy.

Staff biologists produce reports summarizing the results of the 5-year rotating basin surveys conducted each year in the targeted watersheds. These reports generally include biological, physical, water chemistry, and sediment chemistry data collected during the assessment. Additional data collected by other entities also may be incorporated. Starting in FY 2005, these reports also will include specific sections summarizing findings related to nonpoint source activities. The reports are provided to the target audiences as indicated on the report distribution form, and are entered into an internal Access database. The database allows DEQ staff to identify and locate any previous DEQ reports for a specified watershed, county, or author. All watershed reports are available to interested parties upon request; however, they are not currently available to the public on the DEQ web site.

An annual nonpoint source program report is produced by October 1 of each year by DEQ staff. Beginning in 2005, this report will include a section summarizing major findings from nonpoint source monitoring studies conducted by DEQ, citizen volunteers, and grantees. In addition, technical reports will be prepared by DEQ whenever special projects are completed. These projects could include multi-year intensive monitoring efforts intended to "showcase" the results of nonpoint source controls in a particular watershed. Nonpoint source reporting is described in more detail in DEQ's recently completed Nonpoint Source Environmental Monitoring Strategy (DEQ 2004a).

Drinking water facilities are required to submit monthly reports to the DEQ, which are reviewed by district staff. Certain acute health threats are required to be reported to DEQ immediately, such as the detection of fecal coliforms, *E. coli*, or nitrates above the Maximum Contaminant Level. Using these reports, the DEQ provides a quarterly report to EPA which lists the drinking water standards violations that occurred during that period. In addition, the DEQ produces an

annual compliance report for EPA. This compliance report is a summary of major drinking water violations that occurred during the year. Specifically, the report summarizes the parameters showing violations and how many violations occurred. This report is available on the DEQ web site or on request. The EPA uses these state annual reports to provide a nationwide report on drinking water violations. In the near future, drinking water laboratories will be able to report analytical data and water supplies can submit monthly operation reports to DEQ electronically through the Electronic Drinking Water Reporting (eDWR) system. This system may be accessed by authorized DEQ staff. It will not be available to the public, however.

Many project-specific reports are produced by DEQ grantees and contractors. Organizations receiving grants for volunteer, emerging issue, and local water quality monitoring grants are required to produce final project reports. In recent years, DEQ has requested electronic copies as well as hard copies of these reports. Likewise, our contractors carry out a wide range of monitoring tasks as directed and often write the final reports, with careful review by DEQ staff. These reports are provided directly to the target audiences, and are available to anyone upon request. They are not currently available on our web site.

The only grantees that do not routinely produce final project reports are the county health departments that receive grants for beach monitoring. However, all beach monitoring grantees are required to promptly enter their *E. coli* data into DEQ's beach monitoring database, which is available to the public on our web site. This reporting process meets the primary objective of this monitoring program, which is to make the data available to the public as quickly as possible.

Gaps and Implementation Timelines

- **Nonpoint source reporting** - The Nonpoint Source Monitoring Strategy was recently completed and submitted to the EPA (DEQ 2004b). This Strategy outlines the process to be used for reporting nonpoint source results to internal and external audiences. Beginning in FY 2005, reporting will include sections in watershed survey reports specifically describing nonpoint source-related monitoring, special technical reports on intensive monitoring studies, and an enhanced annual nonpoint source report summarizing major findings from nonpoint source monitoring studies.

- **Reporting of wetland monitoring results** – We expect that the wetland monitoring strategy will outline a process for generating reports and identifying audiences. The wetland monitoring strategy will be completed by May 31, 2005.

- **Integrated watershed reporting** - The DEQ's reporting process could be improved by consistent, integrated watershed reports. Existing watershed reports tend to focus on the biological community assessments, water and sediment grab samples, and perhaps fish contaminant data. Data from other sources, such as Michigan DNR and USGS, may or may not be incorporated. Likewise, some data collected by DEQ, including water chemistry fixed station, wildlife contaminants, inland lake sediment cores, and data collected in past surveys often are not referenced in the reports. Thus, DEQ recognizes the need to generate more comprehensive, integrated watershed reports. While the value of expanded reports is intuitive, the primary barrier to this approach is that it will substantially increase the amount

of staff time required to write the watershed reports. Limited staff and high work loads therefore become a major impediment. We already have committed to additional nonpoint source reporting in the watershed reports, as spelled out in the nonpoint source monitoring strategy. The DEQ is willing to explore the feasibility of expanding the watershed reports, and the additional resources that may be needed to accomplish this objective. A feasibility assessment, identifying options for reducing current barriers to expanded watershed reports as well as potential resource needs, will be completed by September 30, 2006.

IX. Program Evaluation

The DEQ has established a number of internal and external mechanisms to evaluate the water quality monitoring program on a regular basis. These mechanisms provide opportunities to ensure that activities are meeting the monitoring objectives and serving water quality decision needs. The timing and frequency of the program reviews range from monthly to every five years. Many projects have been modified and improved in response to the evaluation process.

Monitoring activities carried out by our contractor are reviewed monthly. The contractor submits monthly progress reports for each individual project. The progress report provides an opportunity for the DEQ project managers to review contractor activity each month. One potential drawback to contracting out some monitoring efforts is the potential to drift away from specified protocols and/or objectives. However, careful review of project-specific activities each month helps to ensure that the contractor is meeting DEQ needs and fulfilling expectations. Similarly, all organizations receiving water quality monitoring grants from DEQ are required to submit quarterly progress reports. Like the monthly contractor submittals, review of the quarterly reports by DEQ project managers allows frequent evaluation of project results, progress, and consistency with project needs and requirements.

Internal monitoring program reviews occur annually. Each year, the DEQ water quality monitoring coordinator develops an implementation plan. It includes a list of monitoring projects not implemented directly by DEQ staff, the funding allocated to each project, and a list of monitoring contracts and grants necessary to carry out the monitoring program. The implementation plan is reviewed and approved by all layers of management, including the DEQ Director. Although the monitoring strategy serves as the basis for the annual implementation plan, there is a great deal of flexibility in funding and/or activity levels within various program elements. Implementation plan development allows DEQ staff and management to identify new monitoring needs each year, determine which projects should be modified to better meet program objectives, and to eliminate projects whose objectives have already been met or otherwise are no longer necessary.

The DEQ biologists conducting the 5-year rotating basin surveys prepare monitoring study plans for the watersheds to be assessed each year. These include the monitoring objectives, sampling activities, and the staff/funding resources necessary to carry out the plan. The study plans are developed based on input from NPDES, nonpoint source, and other relevant program staff, district staff, Michigan DNR – Fisheries Division, volunteer monitors within the watershed, and other interested stakeholders whose suggestions are solicited via an annual letter requesting monitoring recommendations. The plans are then reviewed and approved by each biologist's

supervisor to ensure completeness and consistency. If the plan does not include clear recommendations from key internal and external customers, the supervisor will make sure that the biologist solicited ideas from those customers. During the development of the Integrated Report every two years, the DEQ also evaluates whether we are achieving our goal of assessing 80% of the river miles in each watershed.

The study designs for various monitoring activities are evaluated periodically as necessary. For example, the DEQ awarded a contract to Exponent Inc., which has extensive experience in statistics and fish contaminant monitoring, to review the trend component of the Fish Contaminant Monitoring Program (Exponent 2003). The report and a subsequent peer-review workshop were completed in April 2003, from which several recommendations were made to improve our ability to detect trends. Some of the recommendations have already been incorporated, and others are being considered. Likewise, the DEQ established a contract with the Great Lakes Environmental Center to assess the DEQ's existing biological monitoring effort, evaluate study designs used by other agencies and organizations to measure trends in benthic macroinvertebrate communities, and to make recommendations for a potential DEQ aquatic life trend monitoring effort. A report was finalized in September 2003 and the DEQ conducted a pilot study, as suggested by GLEC, during the 2004 field season (and continuing in 2005) to test some of the report recommendations. The DEQ expects to have a benthic macroinvertebrate trend monitoring project in place by the 2006 field season.

There are other cases where internal evaluations found gaps in, or impediments to, existing monitoring efforts and identified opportunities for improvement. In reviewing our biological assessment protocols, it became clear that non-wadable rivers were not being adequately assessed due to the lack of a refined, scientifically defensible assessment procedure. To remedy this, the DEQ provided a grant to Michigan State University scientists to develop a practical procedure for non-wadable rivers (Merritt et al. 2003). This report was completed in January 2004, and is being reviewed and tested by DEQ staff in 2005. We expect that the procedure will be available for use in 2006. In addition, internal evaluation indicated that the DEQ did not have sufficient staff to establish and facilitate the Michigan Clean Water Corps, a volunteer monitoring program established by Executive Order in September 2003. As a result, the DEQ solicited bids and selected a qualified organization to develop and administer this volunteer program.

In addition to the opportunities for internal program review described above, the monitoring coordinator and project managers always review final and/or annual reports, and communicate with data users, to ensure that monitoring goals and objectives are being met. For example, if it becomes clear during a specific project that there is too much variability to detect trends, then either the study design is modified to be more robust, the objectives are modified to be more realistic, or the project is discontinued altogether. This type of evaluation led to the study redesigns described above. Furthermore, if potential data users indicate that data are not readily available or effectively presented, we work with the user to eliminate any problems or barriers.

Mechanisms for external evaluation of, and input to, the monitoring program also have been established. The DEQ sends a letter to external stakeholders each year soliciting monitoring recommendations. Grants also are awarded annually to organizations for monitoring to support

local water quality concerns throughout Michigan. Taken together, these efforts provide an opportunity for all agencies and interested parties to ensure that DEQ monitoring activities are responsive to the needs of all stakeholders.

The Michigan Water Quality Monitoring Advisory Board (Board) was established in 1999 by Governor's Executive Order. Specifically, the Board was charged with the following:

1. Advise the Department on issues affecting the implementation of the Monitoring Strategy;
2. Advise the Department on the development of statistically sound sampling designs to collect various types of water quality data;
3. Advise the Department on appropriate methodologies for evaluating temporal and spatial water quality data;
4. Advise the Department on state-of-the-art data management and data communication techniques to ensure that water quality information is easily accessible and communicated in meaningful, understandable, and timely ways to intended audiences; and
5. Review and comment on the annual monitoring plans prepared by the Department to implement the Monitoring Strategy.

The Board consists of five appointed members with up to four year terms. Currently, the Board consists of representatives from the private sector (2), academia (1), conservation organization (1), and local government (1). All members have expertise in one or more areas of water quality monitoring. Meetings are generally held two-three times per year, with a specific topic of interest being selected for each meeting. Past meetings have included presentations and discussion on issues such as annual implementation plans, data management and communication, study design, nonpoint source effectiveness monitoring, and sampling design. The Board has provided guidance and suggestions that have improved the quality of the monitoring program.

The monitoring program has been audited twice, once in 2002 and again in 2003 by the state Office of the Auditor General. The first was an audit of all DEQ – Water Division (WD) programs while the second was an audit of all activities funded by the Clean Michigan Initiative. Both audits were extensive, with the auditors reviewing monitoring objectives, work plans, QAPPs, final reports/work products, data availability, and grant/contract paperwork. The final report for the DEQ – Water Division program audit had no negative findings on the monitoring program. In fact, the audit concluded that "The WD's monitoring program exceeds the common monitoring methods and analytical techniques commonly employed by most other states and federal agencies, which provides a broader coverage of water quality management issues. Staff and managers of other government agencies, such as the U.S. Fish and Wildlife Service, U.S. Geological Survey, and the U.S. EPA have praised Michigan's program for being comprehensive, scientifically sound, and above the standard water monitoring program." The only significant finding from the second audit of the water quality monitoring program was the lack of a formal procedure to approve QAPPs. That finding was addressed (prior to the release of the audit report) with the completion of a Section procedure for QAPP approval.

The monitoring locations, frequencies, and parameters for drinking water generally are well-defined and fixed by the water systems in consultation with district staff. The DEQ does develop an Annual Resource Deployment Plan, which identifies agency priorities for the coming year.

This Plan provides an opportunity for DEQ staff to ensure that drinking water monitoring activities are effectively targeted to maximize protection of public health. DEQ contracts with local health departments to implement and enforce Safe Drinking Water Act requirements for non-community water supplies. The DEQ Non-community Unit tracks violations by system and local health jurisdiction on a quarterly basis. DEQ Non-community staff access sample results and facility data in WaterTrack as needed to insure proper follow up and public health protection is provided when systems exceed drinking water standards. Annual evaluations are conducted on each local health department to assess compliance with contract requirements including maintaining acceptable compliance rates for the non-community water systems in their jurisdiction.

U.S. EPA has indicated that states should consider a full, detailed review of their monitoring programs at least once every five years, with EPA input, and that DEQ and EPA monitoring program staff could discuss specific issues once per year. The DEQ agrees that periodic reviews and Monitoring Strategy updates are necessary, and is willing to discuss the frequency, timing, and substance of future updates with EPA.

Gaps and Implementation Timelines

- **EPA/DEQ monitoring program review -** DEQ will work with EPA to develop a process and timeframe for program staff to discuss appropriate monitoring issues and to periodically review and update DEQ's monitoring strategy. The process and timelines will be developed by December 31, 2005.

X. General Support and Infrastructure

Current Resources

The DEQ supports water quality monitoring activities using a variety of state and federal funding sources. State funding sources include the General Fund and Clean Michigan Initiative funds, while federal grant funds include Sections 104b, 106, 205j, 319, and the BEACH Act. Approximately 15 full-time equivalencies (FTEs) were devoted to water quality monitoring in Fiscal Year (FY) 2004. This total includes almost 0.5 FTE for data management. The estimated breakdown of FTEs by funding source is:

State General Fund – 1.1
State CMI – 2.3
Federal 104b Grant – 1.4
Federal 106 Grant – 5.0
Federal 205j Grant – 2.0
Federal 319 Grant – 3.0
Federal BEACH Act – 0.1

A total of approximately 25 FTE positions are involved in the oversight of monitoring programs conducted by public drinking water systems. These positions are located in both the DEQ and local health departments. The DEQ positions oversee the monitoring programs conducted by

community public water systems, while those at local health departments oversee monitoring conducted by non-community public water systems. Local health departments are under contract for supervision of non-community systems. Activities that are performed by these positions include: sampling site plan review, notification of monitoring requirements, data entry and recordkeeping, public notification, compliance tracking, general compliance assistance and training, informal and formal enforcement, etc. Some functions may be performed in the field during surveillance and inspection visits. The annual funding for oversight of these contaminant specific monitoring programs is estimated to be $1.9 million, based on the costs per state and contract FTE (which includes local health departments).

In addition to FTEs, the DEQ receives funds for monitoring grants and contracts. From FY 2002-2004, the State Legislature appropriated $3 million per year from CMI bond funds specifically for water quality monitoring. A spending and implementation plan is prepared each year summarizing the grants and contracts that will be funded with these dollars. Depending on the number and scope of monitoring projects in a given year, the actual amount encumbered may be less than the $3 million appropriation. For example, approximately $2.5 million was encumbered in FY 2004. Any unencumbered monies revert back to the CMI bond fund to support monitoring projects in future years.

The DEQ also supports water quality monitoring activities through federal funds. In FY 2004, a total of $694,000 was allocated among 28 Section 319 grants to support nonpoint source-related monitoring. The DEQ receives approximately $279,000 of federal BEACH Act funds each year, which are passed along primarily to county health departments to monitor Great Lakes beaches. Additional federal funds are periodically provided to Michigan for specific water quality monitoring projects, such as TMDL monitoring support and the development of a site-specific water effects ratio for copper.

The DEQ Environmental Laboratory analyzes many of the water quality monitoring samples. The Environmental Laboratory is supported through state general funds. Of the total laboratory capacity, 40% is allocated to samples submitted by the Water Bureau. In dollar value, this equates to approximately $1.8 million. However, the Water Bureau only used about 50% of this capacity in Fiscal Year 2004, at $885,000. The Water Bureau also provides approximately $316,000 each year to the state Department of Community Health to analyze fish tissues for bioaccumulative contaminants.

Approximately $30,000 in federal and state funds was used to support travel expenses (including vehicles) in FY 2004. Another $35,000 was used to purchase equipment and supplies in support of water quality monitoring activities.

Additional Resource Needs

- **Staffing -** Additional FTEs and/or funding will be necessary to expand Michigan's water quality monitoring program and address the program gaps identified in this strategy update. The most efficient way to implement these additional activities would be through increased FTEs. However, even if the EPA provides increased 106 funding to DEQ to support these FTEs, the DEQ would have to request and receive approval to fill the positions. In the event

that FTE requests are denied, then implementation of additional monitoring would have to be carried out through contractual arrangements although the capacity of existing staff to manage additional projects and contracts is extremely limited. Currently, an FTE costs the state approximately $83,500. We estimate that approximately 7.5 additional FTEs are required to address the identified program gaps. Some monitoring projects are still being designed, or require guidance from EPA, so these estimates should be considered tentative at this time. This estimate also does not include FTEs that will be needed to implement the wetland monitoring strategy. That estimate will be provided separately when the wetland monitoring strategy is completed in May 2005.

Specifically, we estimate that approximately 2 FTEs will be necessary to implement the probabilistic monitoring projects that are being designed or considered. These include probabilistic sampling for biological communities (1 FTE), water chemistry (.5 FTE), and possibly mercury in fish tissues from inland lakes (.5 FTE). These FTEs would primarily be used for study design, sample collection, data analysis and reporting.

The EPA recommends that states routinely monitor two biological communities at all sites. The DEQ currently monitors benthic macroinvertebrate community at all biological survey sites, but fish community is only assessed at a subset of these locations. The DNR collects fish community data from many waters and shares this information with DEQ. As a result, aquatic life data for both fish and benthic invertebrates often exist at sites, although the assessments may not occur at exactly the same time. For DEQ to routinely collect fish community data at all sites, an estimated 2 additional FTEs would be required.

EPA has indicated that states should develop plans to assess all waterbody types. One type identified by EPA is small headwater streams, and it is our understanding that monitoring guidance for these systems is being developed by federal agencies. We estimate that 1 FTE would be required to fully assess headwater streams, which currently are not systematically monitored by DEQ. This estimate may change depending on the final federal monitoring guidance, and the level of effort identified in that guidance as necessary to accurately characterize headwater streams. As mentioned above, additional FTE estimates for fully assessing wetlands will be provided separately after May 2005.

The incorporation of *E. coli* into probabilistic monitoring projects being developed by DEQ likely would require an additional 0.5 FTE. Because of the extremely short holding time for these samples, a separate sampling visit to the selected sites almost certainly would be necessary. The benefit would be that a statewide assessment of the recreation designated use could be made.

Finally, we estimate that we will need 1 additional FTE for the data management issues identified in this strategy, and 1 additional FTE to produce the integrated watershed reports. The data management issues include development of some internal databases, making these databases accessible to the public on the DEQ web site, and entering data into STORET. The existing monitoring program, not to mention potential additional projects, generates a huge amount of data which makes data management a major undertaking. Similarly, the

production of watershed reports in which all monitoring data from a given watershed is incorporated and integrated will require a substantial increase in time and effort.

- **Training** – To fully meet the training needs of DEQ monitoring staff, we estimate that approximately $1000 per FTE per year is required. Given the current staffing level, that comes to $15,600 per year. If the FTE needs described above are met, then a corresponding increase in training funds would be required.

- **Equipment** – Additional equipment would be required to carry out some of the new monitoring activities described in this update. For example, EPA has indicated a desire for DEQ to assess fish communities at every biological survey station. In addition to the extra FTEs required for this activity, more fish shocking equipment (e.g. backpack shockers, stream shockers) would be needed. Increasing the number of FTEs also would carry equipment costs needed to support new FTEs, such as waders, rain gear, and perhaps boats and vehicles. Finally, more equipment would be needed to monitor the additional waterbodies and indicators described in this report (wetlands, headwater streams, biological monitoring in inland lakes).

  Although equipment cost estimates are difficult given the uncertainty about the number of additional FTEs and which new monitoring activities will be implemented, we estimate that approximately $60,000 would be needed in the first year to acquire the equipment needed for all of the activities. After the initial purchase, funding needs would be less in future years, primarily for maintenance and equipment updates.

- **Laboratory** – A primary laboratory-related need is method development. The DEQ encourages the EPA to promulgate analytical methods and/or minimum levels for chemicals such as PCBs, dioxins/furans, PBDEs, pesticides/herbicides, Cryptosporidium, microcystin, and pharmaceuticals. Rather than have every state laboratory expend staff time and money to gear up to analyze all of these chemicals, it may be more cost-efficient for the EPA to establish or certify select laboratories where such samples could be sent for analysis in a reasonable time and at an affordable cost.

  Additional funding also may be required, up to approximately $900,000 per year, for sample analysis. The DEQ laboratory is planning to implement a per sample charge in FY 2005, and the use of existing funds to pay for these laboratory costs will create a shortfall elsewhere.

- **Technical Assistance/Guidance** – In addition to FTEs, there are specific areas in which monitoring program development requires technical assistance or guidance development from EPA. Assistance from EPA likely will be needed to ensure the entry of certain project data into STORET. For example, the inland lake sediment core data may present a challenge because multiple layers of sediment from one core sample are analyzed. Likewise, the volunteer monitoring data are somewhat unique in terms of parameters and level of assessment, which may pose challenges for entry into STORET. Entry of wildlife contaminant data also may present challenges. Therefore, the DEQ will require ongoing assistance from EPA to ensure data entry into STORET. EPA has communicated an expectation that states assess 100% of small headwater streams. However, to our knowledge

validated procedures for assessing these waters have not been developed or approved by EPA. It is our understanding that the USGS and EPA are currently in the process of developing and testing such methods. Therefore, complete assessment of headwater streams is not likely until the technical guidance has been finalized and approved.

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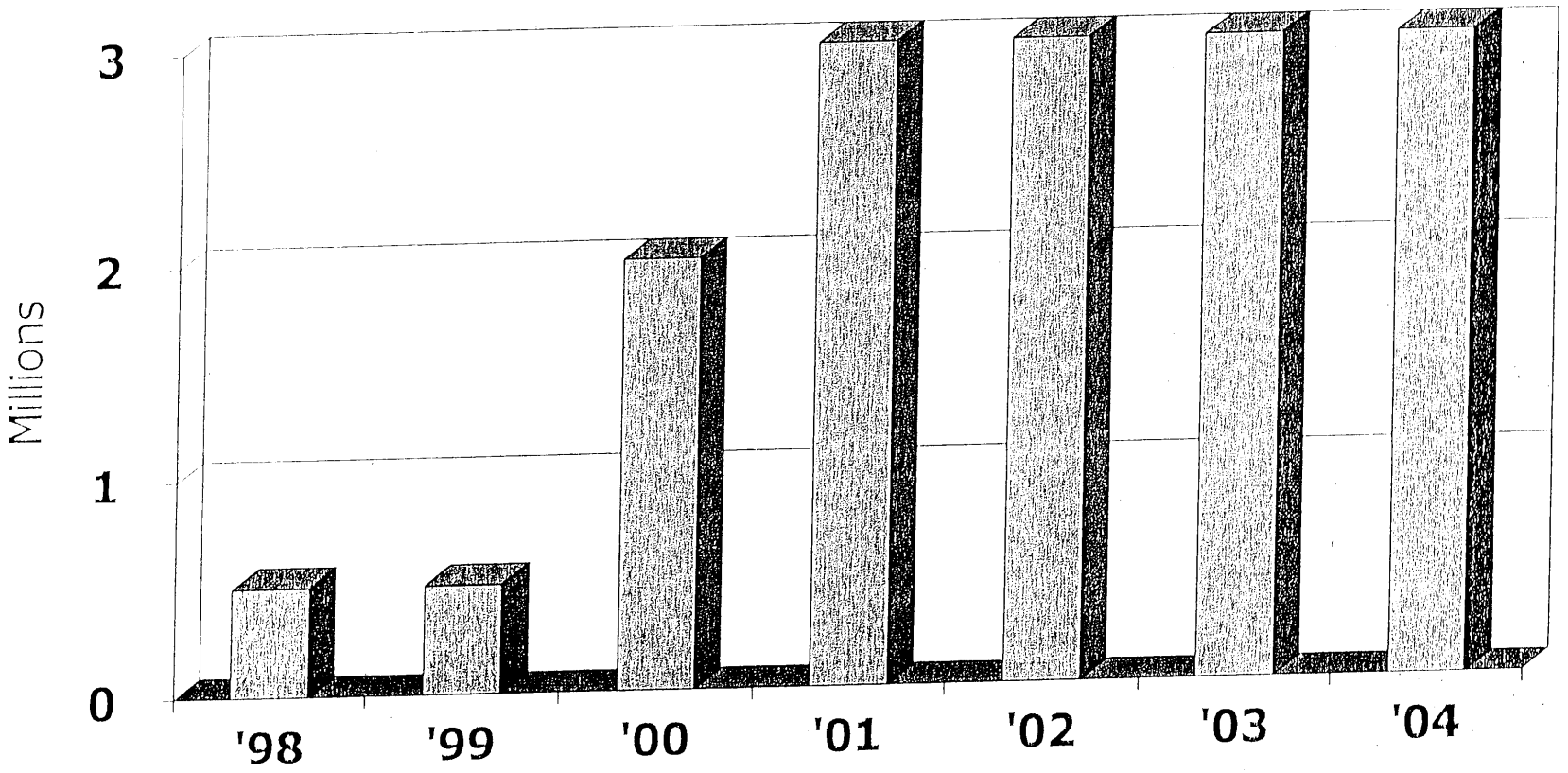
Figure 1. Funding Increase For Water Quality Monitoring



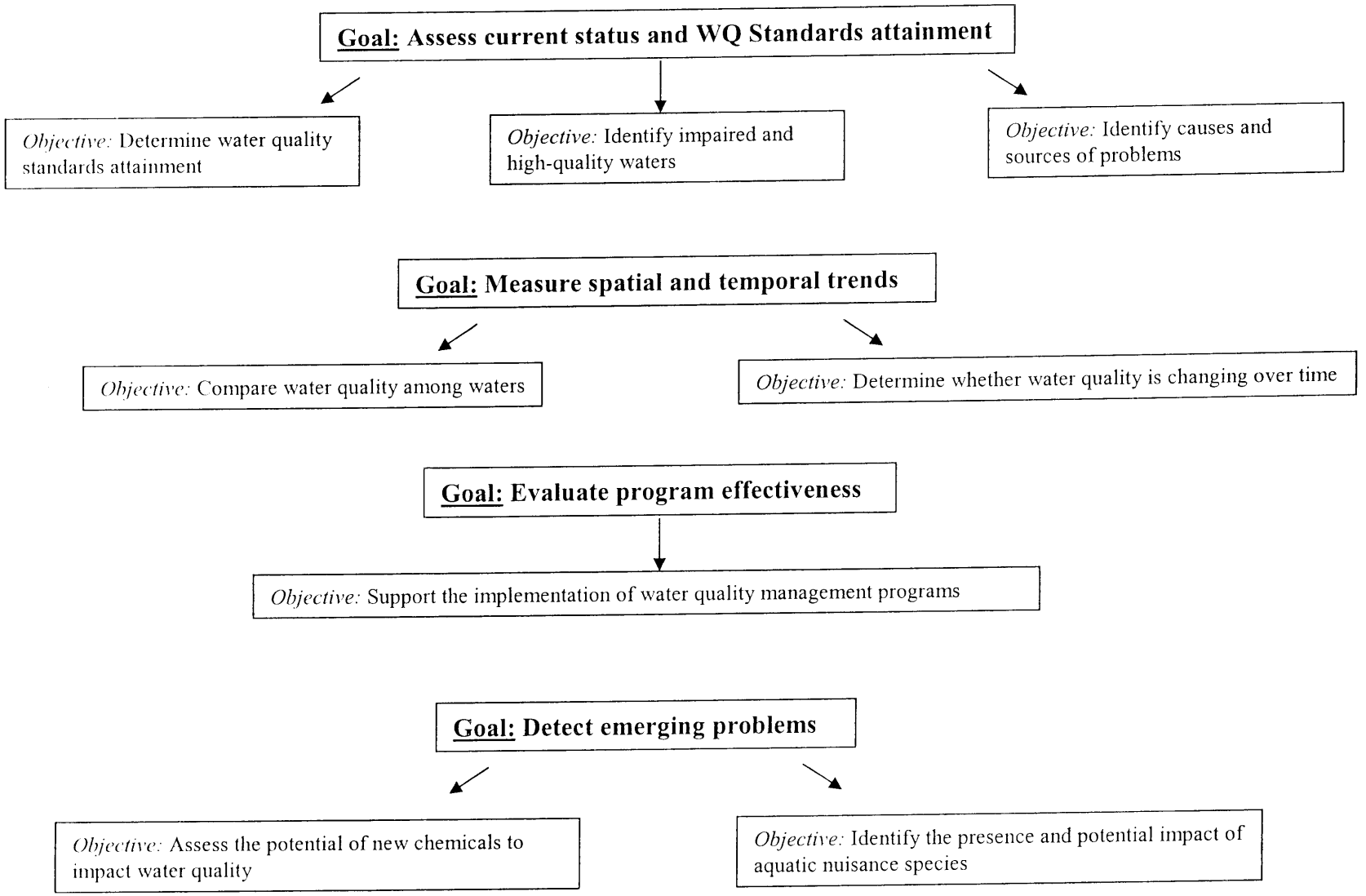


Figure 2. Water quality monitoring goals and objectives.

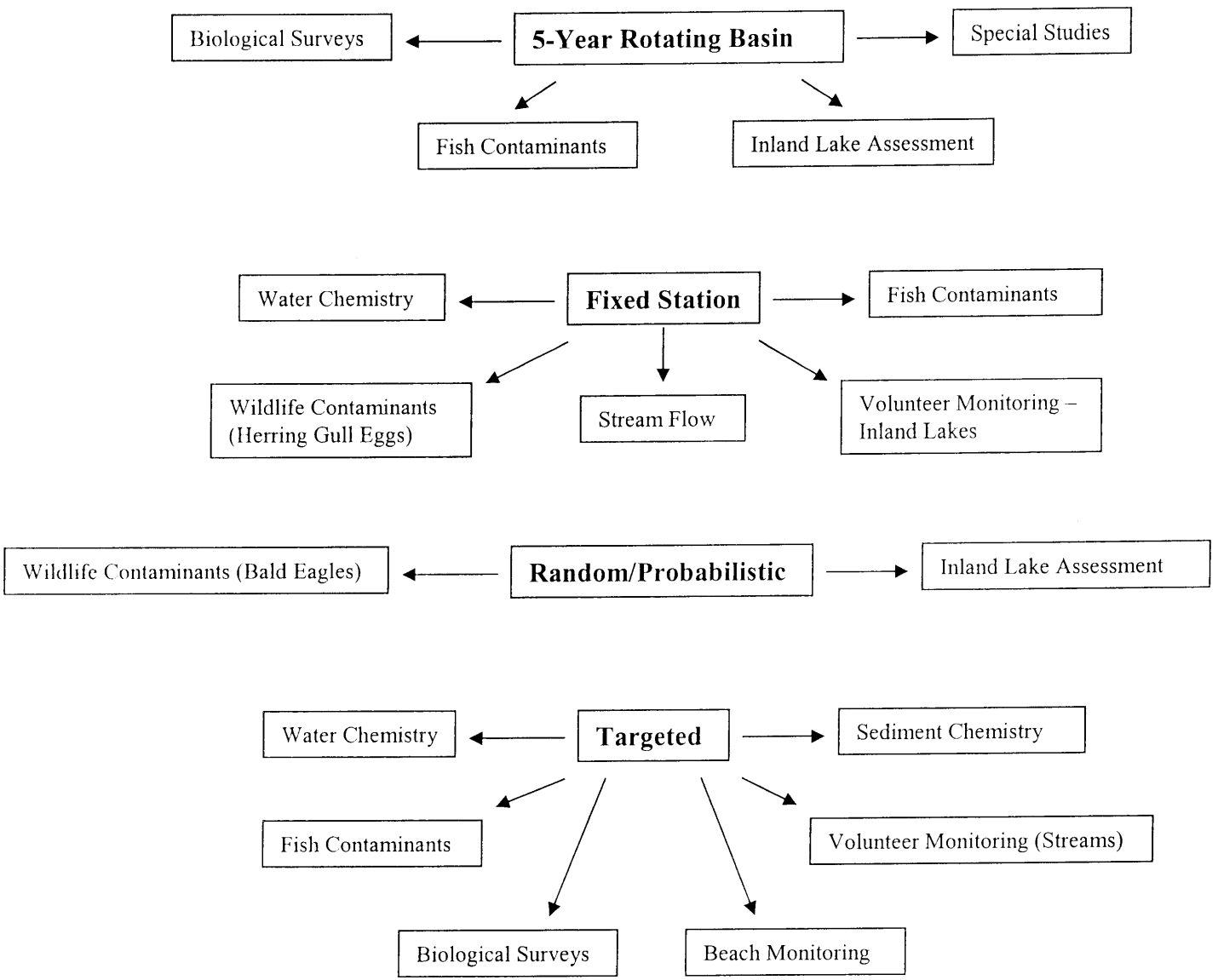


Figure 3. Study designs currently used for water quality monitoring elements.

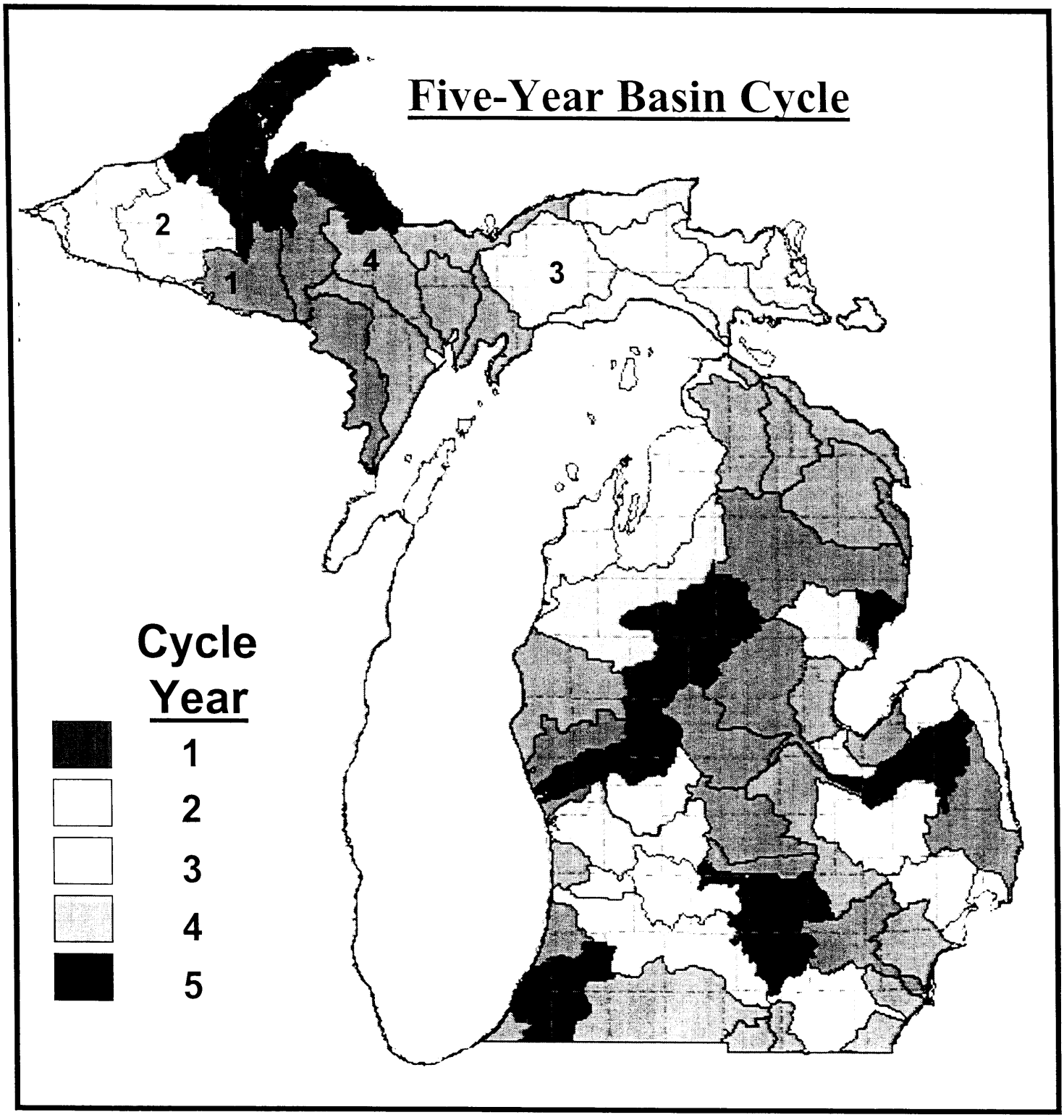
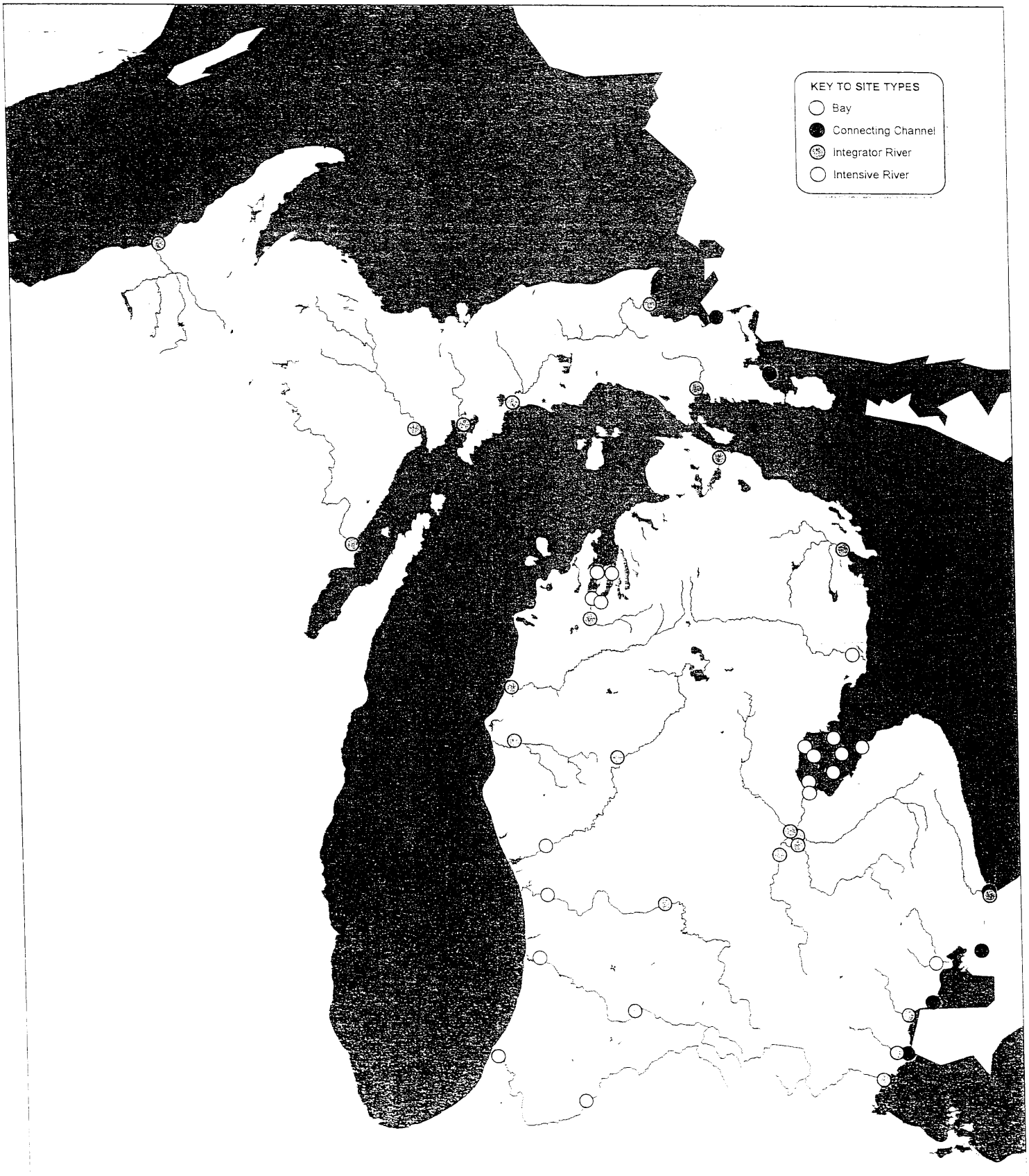


Figure 4. Five-Year Watershed Assessment Cycle

Figure 5

Water chemistry trend monitoring locations in Michigan (Bay, Connecting Channel, Intensive, and Integrator types).



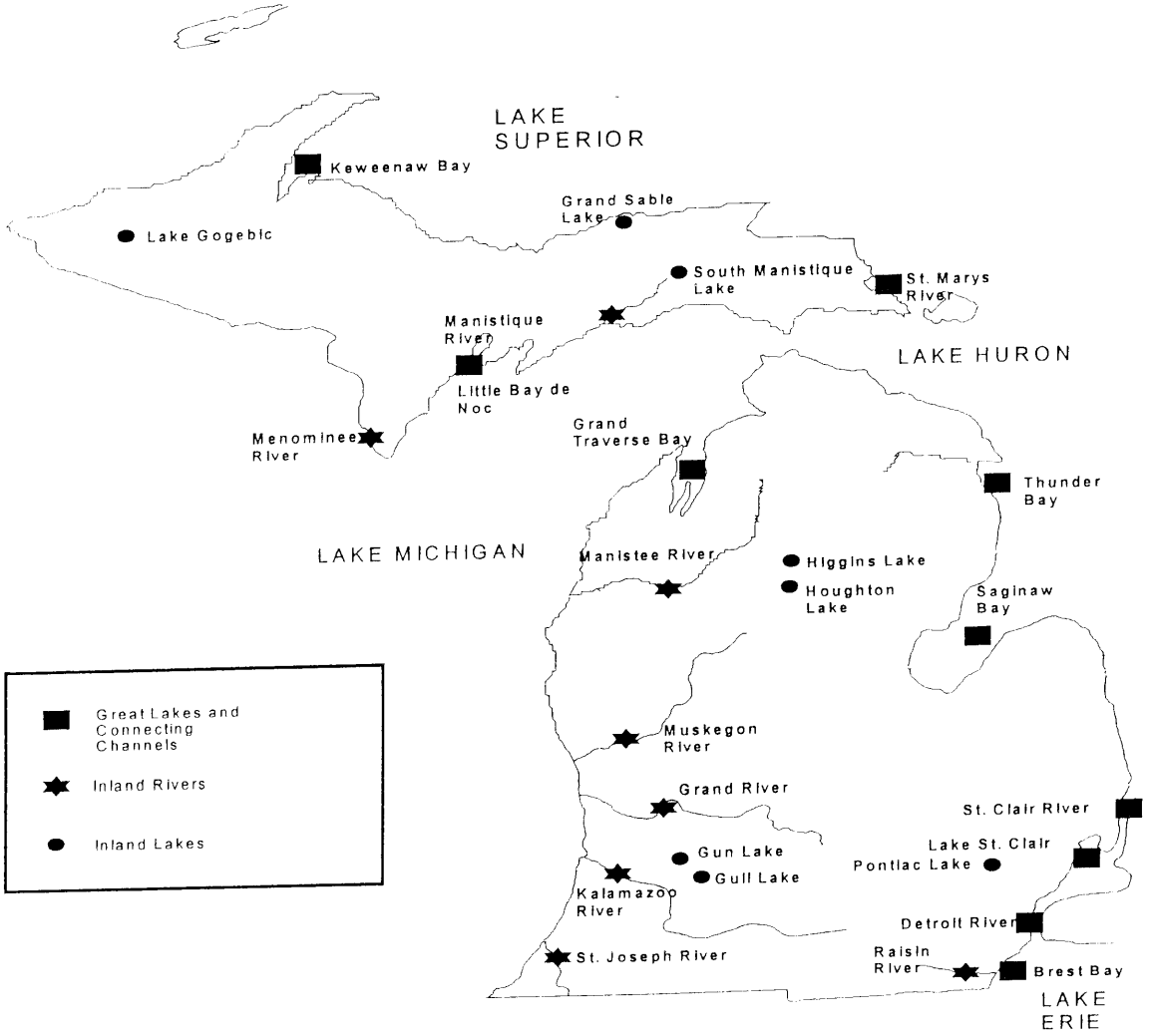


Figure 6. **Michigan Fish Contaminant Monitoring Program whole-fish trend monitoring sites.**

Figure 7. Locations of Herring Gull Annual Monitoring Colonies

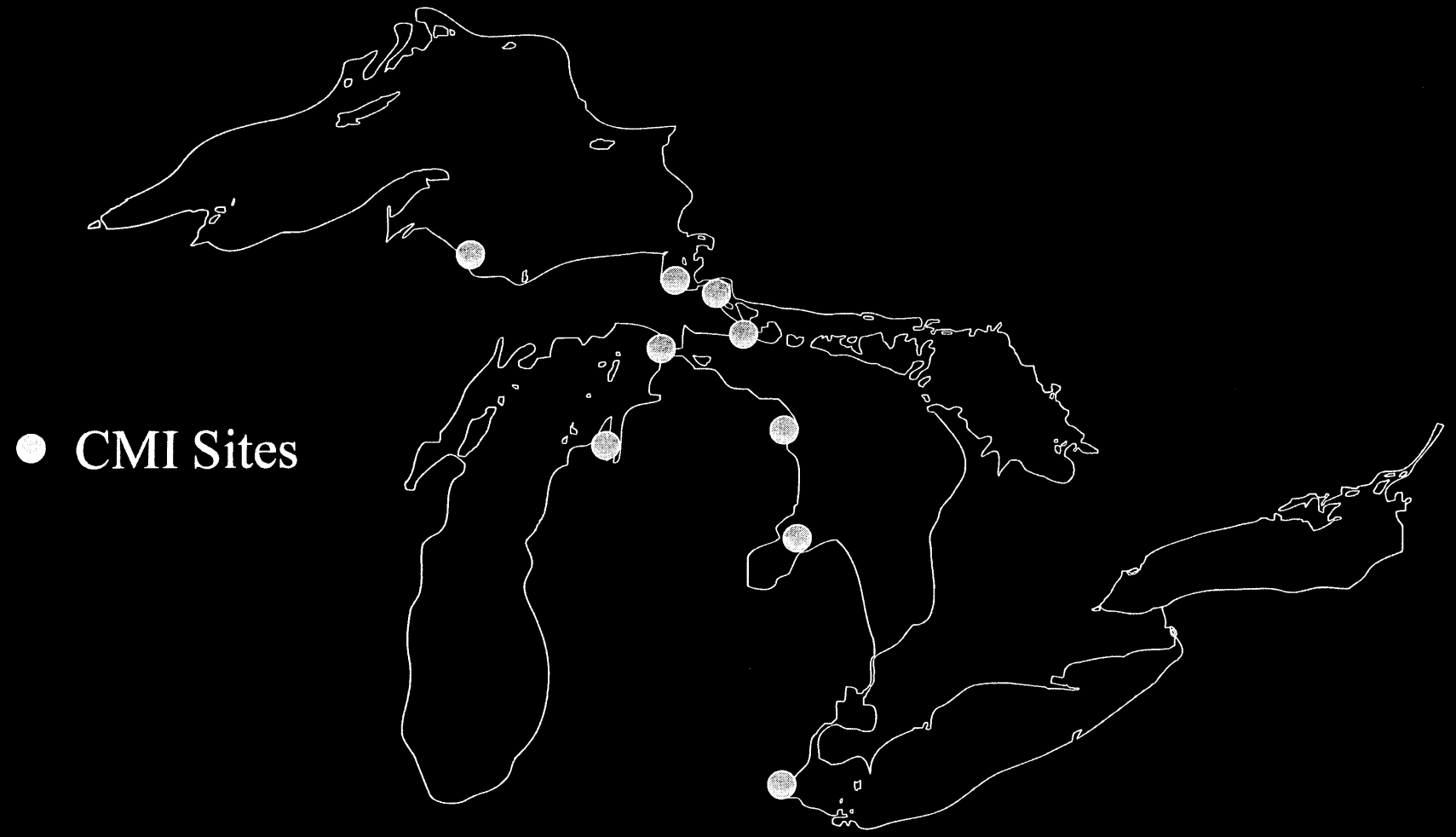


Table 1. Relationship of monitoring activities to water quality management program area.

Monitoring Activity	Trend	Program Effectiveness/Support								WQS				Emerging Issue
		NPDES	Nonpoint Source	Clean Lakes	Great Lakes	Local Programs	Wetland	Drinking Water	Groundwater	Attain. Status	TMDL	Causes/ Sources	Compliance/ Enforcement	
Water Chemistry – Fixed Station Trend	1	2	2		1					1				2
Water Chemistry – Probabilistic Trend	1	2	2							1				
Targeted Water Assessment Studies		1	1	1	1		1	1	1	1	1	1	1	1
Inland Lake Sediment Trend	1			2								1		
Targeted Sediment Assessment		1			1					2			1	2
Biological Assessment	P	1	2	1	P	2	2			1	1	1	2	
Fish Contaminants	1	1	2	2	1					1		1	2	2
Wildlife Contaminants	1				1									P
Inland Lake Assessment	2			1						1	2			
Beach Monitoring/ *E. coli* Source ID			2		1	1		1		1	1	1		
Stream Flow		1								2	1			
Volunteer Monitoring	2	1	1	1		2				2		2		
WQ Monitoring Grants		2	2	2		1				2		1		1
Special Studies		1	1	1	1	2	1	1	1		1	1	1	
Nonpoint Source Monitoring Strategy	2		1			1				1		1	2	
Wetland Monitoring Strategy							1			1			2	

1 = Design objective; 2 = Secondary use; P = Planned/future use

Table 2. Status of DEQ water quality monitoring activities.

Monitoring Activity	Ongoing	Development/Testing	Under Consideration	No Activity
Water Chemistry Fixed Station Trend	X			
Water Chemistry Probabilistic Trend			X	
Targeted Water Assessment Studies	X			
Inland Lake Sediment Trend	X			
Targeted Sediment Assessment	X			
Biological Assessment – Wadable Streams	X			
Biological Assessment – Non-wadable Rivers		X		
Biological Assessment – Headwater Streams				X
Biological Assessment – Inland Lakes	X			
Biological Assessment – Great Lakes		X		
Biological Trend Assessment		X		
Fish Contaminants – Fixed Station Trend	X			
Fish Contaminants – Probabilistic Trend			X	
Fish Contaminants – Consumption Advisories	X			
Fish Contaminants – Caged Fish (Source ID)	X			
Wildlife Contaminants – Bald Eagle Trends	X			
Wildlife Contaminants – Herring Gull Trends	X			
Inland Lake Assessment	X			
Beach Monitoring Grants – Great Lakes	X			
Beach Monitoring Grants – Inland Beaches	X			
Stream Flow Measurement	X			
Volunteer Monitoring – Streams/Rivers	X			
Volunteer Monitoring – Inland Lakes	X			
Local Monitoring Grants	X			
Emerging Issue Monitoring Grants	X			
Special Studies (project-specific objectives)	X			
Nonpoint Source Monitoring Strategy	X			
Wetland Monitoring Strategy		X		

Table 3. Designs used for DEQ water quality monitoring activities.

Monitoring Activity	Rotating Basin	Fixed Station	Probabilistic	Targeted
Water Chemistry Fixed Station Trend		X		
Water Chemistry Probabilistic Trend			P	
Targeted Water Assessment Studies				X
Inland Lake Sediment Trend				X
Targeted Sediment Assessment				X
Biological Assessment – Wadable Streams	X			
Biological Assessment – Non-wadable Rivers	X			
Biological Assessment – Inland Lakes	X			X
Biological Assessment – Great Lakes			P	
Biological Trend Assessment			P	
Fish Contaminants – Fixed Station Trend		X		
Fish Contaminants – Probabilistic Trend			P	
Fish Contaminants – Consumption Advisories	X			
Fish Contaminants – Caged Fish (Source ID)	X			X
Wildlife Contaminants – Bald Eagle Trends			X	
Wildlife Contaminants – Herring Gull Trends		X		
Inland Lake Assessment	X		X	
Beach Monitoring Grants – Great Lakes				X
Beach Monitoring Grants – Inland Beaches				X
Stream Flow Measurement		X		
Volunteer Monitoring – Streams/Rivers				X
Volunteer Monitoring – Inland Lakes		X		
Local Monitoring Grants				X
Emerging Issue Monitoring Grants				X
Special Studies (project-specific objectives)	X	X	X	X
Nonpoint Source Monitoring Strategy				
Wetland Monitoring Strategy	P			P

X = Existing activity
P = Planned activity

Table 4. Core water quality indicators.

	Aquatic Life	Recreation	Drinking Water	Fish/Wildlife Consumption
Biological	Benthic invertebrate community; Fish community; Nuisance algal/aquatic plant conditions; Vegetation (wetlands); Amphibians (potentially for wetlands)	E. coli; Nuisance algal/aquatic plant conditions	E. coli; Coliform	Fish trophic status (predator, bottom-feeder); Fish length/weight; Percent fat
Chemical	PCB congeners; DDT; Mercury; Lead; Chromium; Copper; Cadmium; Nickel; Zinc; Phosphorus; TKN; NH3; Nitrate; Total suspended solids; Chloride; Hardness; Dissolved oxygen; pH	Chlorophyll a; Phosphorus; TKN; NH3; Nitrate; Metals	Metals; Arsenic; Cyanide; Volatile organic compounds; Chlorine residual; Pesticides/herbicides; Total organic carbon; Trihalomethanes; Nitrate; Nitrite; Fluoride; Sodium	PCB congeners; PBBs; DDT/DDD/DDE; Chlordane; Dieldrin; Aldrin; Mirex; Heptachlor; Lindane; Hexachlorobenzene; Octachlorostyrene; Toxaphene; Mercury
Physical/Habitat	Flow; Habitat assessment; Channel morphology; Temperature; Land use	Secchi depth; Land use	Turbidity	Land use

Table 5. Status of data management for DEQ monitoring activities. All data are available from DEQ upon request. References to public access concern whether the public can access the DEQ database independently. N/A = Not applicable.

Activity	DEQ Database	Target Date for Data Entry	Public Access To Internal Database	Entered Into STORET	Target Date for STORET Entry
Water Chemistry Trend Monitoring Project	Access	Within 1 year of collection	No	Yes	Ongoing
Watershed Survey – Water and Sediment Data	No	N/A	N/A	Yes	Ongoing
Inland Lake Sediment Cores	No	None	N/A	No	1 year after EPA/DEQ agreement on process
Biological Community	Access	Within 1 year of collection	No	In process	December 31, 2005
Fish Contaminants	Access	Within 1 year of collection	Yes	No	
Wildlife Contaminants	No	N/A	N/A	No	
Beach Monitoring	Access	Within 1 day of collection	Yes	Yes	Ongoing
Inland Lakes	No	N/A	N/A	No	December 31, 2005
Volunteer Monitoring	Streams–Access Lakes-no	Within 6 months of collection	No	No	December 31, 2006
CMI/319 Monitoring Grant Data	No	N/A	N/A	Yes, starting in FY 2004	Historical data – 12/31/06 FY 2004 and later – within 1 year of grantee final report

Table 6. Water Quality Standards attainment category system.

Category	Description
1	All designated uses met.
2	Some uses are met but there is insufficient data to determine if all remaining uses are met.
3	Insufficient data to determine whether any uses are met (Further assessment required).
4a	WQS Nonattained (USEPA approved TMDL but unverified WQS restoration).
4b	WQS Nonattained (Other corrective action used but unverified WQS restoration).
4c	WQS Nonattained (Impairment not caused by a pollutant).
5	Water is impaired or threatened and a TMDL is needed.

Appendix A

Water Chemistry Monitoring

In 1997, the Department of Environmental Quality (DEQ) completed a report entitled "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (Strategy). This Strategy describes the monitoring activities that are necessary for a comprehensive assessment of water quality in Michigan's surface waters. One element of the Strategy is expanded and improved water chemistry monitoring.

Historically, funding reductions as well as limitations in analytical quantification levels have restricted the overall effectiveness of the DEQ water chemistry monitoring efforts. The number of long-term water quality sites assessed by DEQ declined from over 100 in the late 1980's to just 13 on the Detroit River and 8 on Saginaw Bay in 1997. However, the passage of the Clean Michigan Initiative in 1998, and subsequent appropriations by the State Legislature since Fiscal Year 2000, has resulted in a substantial funding increase for the implementation of the Strategy, which includes several water chemistry monitoring activities. In addition, recent technological advances, especially low-level analytical techniques for metals and organic chemicals, now make it possible to collect high-quality water chemistry data that are directly relevant to priority environmental issues at a reasonable cost.

The enhanced water chemistry monitoring is consistent with existing DEQ programs and activities. For example, the DEQ uses the existing 5-year basin units defined by the NPDES permitting program, which includes 45 watershed units based on drainage to the four Great Lakes. Monitoring activities in each watershed include not only water chemistry, but also macroinvertebrate and fish community evaluations, fish and wildlife contaminant studies, and sediment chemistry. Integrating the enhanced water chemistry monitoring with the other activities, within the framework of the five-year permitting cycle, will ensure that the monitoring is closely linked with other DEQ programs and contributes to resource management decisions.

The specific objectives of water chemistry monitoring are to:

1. Determine whether surface waters are suitable for aquatic life, wildlife and human health, based on water quality standards.

2. Determine whether surface waters are safe for agricultural use.

3. Determine whether nutrients are present in surface waters at levels capable of stimulating the growth of nuisance aquatic plants/algae/slimes.

4. Determine whether water quality is changing with time.

5. Provide data to support Total Maximum Daily Load (TMDL) development, the NPDES permit program and venting groundwater mixing zone determinations.

6. Evaluate the effectiveness of DEQ programs in protecting water quality from conventional and toxic pollutants.

7. Identify waters that are high quality, as well as those that are not meeting standards.

8. Identify new chemicals that impair, or have the potential to impair, waters of the state.

The water chemistry element consists of several components that, in combination, provide data necessary to achieve these objectives. These include:

- Fixed station trend (Saginaw & Grand Traverse Bays, connecting channels, 31 inland rivers);
- Watershed surveys (consistent with the 5-year basin cycle);
- Minimally impacted sites;
- Issue sites (TMDLs, nonpoint source issues, statewide mercury assessment, etc.); and
- Annual grants to local governments through a Grant Application Package (GAP) process.

Water samples generally are analyzed for nutrients, conventional parameters (temperature, conductivity, suspended solids, pH, dissolved oxygen), total mercury, and trace metals (cadmium, chromium, copper, lead, nickel, zinc). A much smaller number of samples are analyzed for organic contaminants such as PCBs and base neutrals. Other parameters may be included as appropriate at specific locations. Data are reviewed each year to determine whether additional parameters should be added, removed, or analyzed at a greater or lesser frequency.

All water chemistry data are entered into the STORET database. Fixed station trend data are summarized in an annual trend report produced by the SWQD. Data collected as part of the 5-year watershed surveys are summarized in watershed reports. Data collected as part of TMDL sampling will be summarized in individual reports prepared for each applicable waterbody.

For more information about the water chemistry monitoring element, contact Christine Aiello at (517) 241-7504 or aielloc@michigan.gov

Sediment Chemistry Monitoring

In 1997, the Department of Environmental Quality (DEQ) completed a report entitled "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (Strategy). This Strategy describes the monitoring activities that are necessary for a comprehensive assessment of water quality in Michigan's surface waters. One element of the Strategy is sediment chemistry monitoring.

The sediment chemistry monitoring activities are consistent with existing DEQ programs. For example, the DEQ uses the existing 5-year basin units defined by the NPDES permitting program, which includes 45 watershed units based on drainage to the four Great Lakes. Monitoring activities in each watershed include not only sediment chemistry, but also aquatic life community evaluations, fish and wildlife contaminant studies, and water chemistry. Integrating the sediment chemistry monitoring with the other activities, within the framework of the five-year permitting cycle, will ensure that the monitoring is closely linked with other DEQ programs and contributes to resource management decisions.

The specific objectives of sediment chemistry monitoring are to:

1. Determine the chemical character of sediments in waters of the state, and whether sediment contaminant levels are changing over time.

2. Identify priority locations for sediment remediation activities in Michigan.

3. Determine background sediment chemical character of waters of the state.

4. Determine whether new chemicals are accumulating in sediments.

5. Evaluate the overall effectiveness of the NPDES permit program in reducing contaminant levels in sediments.

The sediment chemistry element consists of two components that, in combination, provide data necessary to achieve these objectives. These include:

- Inland lake trends; and
- Watershed surveys (consistent with the 5-year basin cycle);

For the inland lake trends component, approximately 30 lakes will be assessed over several years. Through 2001, a total of 14 lakes have been monitored. Sediment samples are analyzed for total mercury, trace metals (cadmium, chromium, copper, lead, nickel, zinc), total PCBs, and organochlorine pesticides such as DDT. Inland lake trend data are summarized in annual reports produced by Dr. Dave Long of Michigan State University, and reviewed and approved by DEQ-SWQD.

Sediment samples collected as part of the watershed surveys are analyzed for a variety of parameters, based on local conditions and known/suspected sources. Data collected as part of the 5-year watershed surveys are summarized in watershed reports, and are entered into the STORET database. Sediment data also have been collected from several reference sites throughout Michigan, and these data are summarized in a report available to the public.

For more information about the inland lake trend monitoring, contact Sarah Walsh at (517) 373-4699 or walshs@michigan.gov.

For more information about the watershed and reference sediment sampling, contact Michael Alexander @ (517) 335-4189 or alexandm@michigan.gov.

Fish Contaminant Monitoring

In 1997, the Department of Environmental Quality (DEQ) completed a report entitled "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (Strategy). This Strategy describes the monitoring activities that are necessary for a comprehensive assessment of water quality in Michigan's surface waters. One element of the Strategy is expanded and improved fish contaminant monitoring.

The Michigan Fish Contaminant Monitoring Project (FCMP) has been in existence since 1980. Prior to 1986, fish contaminant monitoring studies were conducted primarily to address specific problems. In 1986, the FCMP was redesigned to allow a better assessment of chemical contamination in fish from the state's surface waters. Fish contaminant data are used to determine whether fish from waters of the state are safe for human and wildlife consumption, and as a surrogate measure of bioaccumulative contaminants in surface water.

The enhanced FCMP is consistent with existing DEQ programs and activities. For example, the DEQ uses the existing 5-year basin units defined by the NPDES permitting program, which includes 45 watershed units based on drainage to the four Great Lakes. Monitoring activities in each watershed include not only fish contaminants, but also macroinvertebrate and fish community evaluations, water chemistry, wildlife contaminant studies, and sediment chemistry. Integrating the FCMP with the other activities, within the framework of the five-year permitting cycle, will ensure that the monitoring is closely linked with other DEQ programs and contributes to resource management decisions.

The specific objectives of the FCMP are to:

1. Determine whether fish from the waters of the state are safe for human consumption.

2. Measure whole fish contamination concentrations in the waters of the state.

3. Assess whether contaminant levels in fish are changing with time.

4. Assist in the identification of waters that may exceed standards and target additional monitoring activities.

5. Evaluate the overall effectiveness of DEQ programs in reducing contaminant levels in fish.

6. Identify waters of the state that are high quality.

7. Determine if new chemicals are bioaccumulating in fish from Michigan waters.

The FCMP element consists of several components that, in combination, provide data necessary to achieve these objectives. These include:

- Edible fish portion monitoring to support the establishment or delisting of fish consumption advisories;
- Native whole fish trend monitoring;
- A contract with Exponent, Inc. to expand and improve the state's fish trend monitoring network; and
- Caged fish monitoring for source problem identification.

Fish tissues are analyzed for bioaccumulative contaminants of concern. These include mercury, PCBs, chlorinated pesticides (e.g. DDT/DDE/DDD), dioxins, and furans. More recently, some fish tissues have been analyzed for polybrominated biphenyl ethers (PBDEs) and perfluorooctane sulfonate (PFOS). Data are reviewed each year to determine whether there are additional new parameters of concern for which the fish should be analyzed.

All fish contaminant data are maintained in a Microsoft Access database. The information is summarized in an annual report produced by the Surface Water Quality Division.

For more information about the fish contaminant monitoring element, contact Bob Day at (517) 335-3314 or dayrm@michigan.gov

Biological Integrity and Physical Habitat Monitoring

In 1997, the Department of Environmental Quality (DEQ) completed a report entitled "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (Strategy). This Strategy describes the monitoring activities that are necessary for a comprehensive assessment of water quality in Michigan's surface waters. One element of the Strategy is expanded and improved monitoring of biological integrity and physical habitat.

This element includes all monitoring conducted for fish and benthic invertebrate community structure, nuisance aquatic plants, algae, and slimes, and assessment of physical habitat. Because biological communities integrate the cumulative effects of multiple environmental stresses, this element is an important tool for evaluating water quality. The DEQ's goal in conducting the watershed surveys is to assess 80% of the stream and river miles in Michigan over a 5-year period.

The enhanced biological integrity and physical habitat monitoring is consistent with existing DEQ programs and activities. For example, the DEQ uses the existing 5-year basin units defined by the NPDES permitting program, which includes 45 watershed units based on drainage to the four Great Lakes. Monitoring activities in each watershed include not only biological integrity, but also fish and wildlife contaminant studies, water chemistry, and sediment chemistry. Integrating the enhanced biological monitoring with the other activities, within the framework of the five-year permitting cycle, will ensure that the monitoring is closely linked with other DEQ programs and contributes to resource management decisions.

The specific objectives of biological integrity and physical habitat monitoring are to:

1. Determine whether waters of the state are attaining standards for aquatic life.

2. Assess the biological integrity of the waters of the state.

3. Determine the extent to which sedimentation in surface waters is impacting indigenous aquatic life.

4. Determine whether the biological integrity of surface waters is changing with time.

5. Assess the effectiveness of Best Management Practices and other restoration efforts in protecting and/or restoring biological integrity and physical habitat.

6. Evaluate the overall effectiveness of DEQ programs in protecting the biological integrity of surface waters.

7. Identify waters that are high quality, as well as those that are not meeting standards.

8. Identify the waters of the state that are impacted by nuisance aquatic plants, algae, and bacterial slimes.

The biological integrity and physical habitat element consists of several components that, in combination, provide data necessary to achieve these objectives. These include:

- Watershed surveys (consistent with the 5-year basin cycle);
- Development of a rapid assessment procedure for nonwadable rivers; and
- Development of a trend monitoring procedure for biological communities.

Rapid, qualitative biological assessments of wadable streams and rivers are conducted using the Great Lakes and Environmental Assessment Section Procedure 51, which compares fish and benthic invertebrate communities at a site to the communities that are expected at an un-impacted, or reference, site. This is a key tool used by DEQ to determine whether waterbodies are attaining Michigan Water Quality Standards. However, this procedure cannot be used on nonwadable rivers. Therefore, the DEQ established a contract with Michigan State University scientists to develop a procedure for assessing aquatic communities in nonwadable rivers. This project is scheduled for completion in December 2002.

Because Procedure 51 is meant to be a qualitative, rapid assessment tool, the DEQ established a contract with the Great Lakes Environmental Center to develop a statistically valid sample design and procedure for detection of trends using benthic macroinvertebrates. This project is scheduled for completion in January 2003.

All biological community data are entered into a DEQ Microsoft Access database. Biological and habitat data collected as part of the 5-year watershed surveys are summarized in watershed reports. The list of these reports is accessible to the public via a link below. Final reports will be prepared for the nonwadable river rapid assessment procedure and the biological community trend monitoring procedure, when these projects are completed. These reports also will be accessible from this site.

For more information about the watershed surveys and reports, contact Kevin Goodwin at (517) 335-4185 or goodwink@michigan.gov

For more information about the rapid assessment procedure for nonwadable rivers and the trend monitoring procedure for biological communities, contact Jeff Cooper at (517) 335-6968 or cooperjc@michigan.gov

Wildlife Contaminant Monitoring

In 1997, the Department of Environmental Quality (DEQ) completed a report entitled "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (Strategy). This Strategy describes the monitoring activities that are necessary for a comprehensive assessment of water quality in Michigan's surface waters. One element of the Strategy is wildlife contaminant monitoring.

Many persistent contaminants occur in the Great Lakes ecosystem at biologically relevant concentrations, but may not be quantifiable in water using cost- or time-effective techniques. Concentrations of contaminants in wildlife tissues may be quantified more readily. Because fish-eating wildlife and humans share a common aquatic food web, are subject to the mechanisms of trophic transfer, share similar complex physiologies, and suffer adverse effects controlled through a similar mechanism, wildlife can be used to make qualitative statements of risk to humans.

Wildlife can serve as a 'first alert' biological tool to detect changes in environmental quality and the potential for adverse health effects. Wildlife play an important role in monitoring water quality and ecosystem health and can be used to monitor for spatial and temporal trends in contaminant concentrations. Specific life stages may be sampled to provide discrete time units for determination of temporal trends. Specific geographic regions or watersheds may be targeted for the determination of spatial trends.

The wildlife contaminant activities are consistent with existing DEQ programs and activities. For example, the DEQ uses the existing 5-year basin units defined by the NPDES permitting program, which includes 45 watershed units based on drainage to the four Great Lakes. Monitoring activities in each watershed include not only wildlife contaminants, but also macroinvertebrate and fish community evaluations, water chemistry, fish contaminants, and sediment chemistry. Integrating the wildlife contaminant monitoring with the other activities, within the framework of the five-year permitting cycle, will ensure that it is closely linked with other DEQ programs and contributes to resource management decisions.

The specific objectives of the wildlife contaminant monitoring are to:

1. Determine contaminant levels in wildlife that may be exposed to contaminants from surface waters of the state.

2. Assess whether contaminant levels in fish are changing with time.

3. Assist in the identification of waters that may exceed standards and target additional monitoring activities.

4. Evaluate the overall effectiveness of DEQ programs in protecting wildlife from toxic contaminants.

5. Assist the Department of Community Health in the establishment or removal of wildlife consumption advisories.

6. Determine whether new chemicals are bioaccumulating in wildlife.

The wildlife contaminant monitoring element currently consists of two components that, in combination, provide data necessary to achieve these objectives. These include:

- Bald eagles; and
- Herring gull eggs.

The bald eagle project began in 1999 and has continued each year since then. Sample collection and analysis for the herring gull eggs will begin in 2002. Wildlife are analyzed for bioaccumulative contaminants of concern, including mercury, PCBs, and chlorinated pesticides (e.g. DDT/DDE/DDD). Data are reviewed each year to determine whether there are additional new parameters of concern for which wildlife should be analyzed.

All wildlife contaminant data will be maintained in a Microsoft Access database, which currently is under development. The bald eagle data are summarized in an annual report produced by the Surface Water Quality Division and scientists from Michigan State University and Clemson University.

For more information about the Wildlife Contaminant monitoring element, contact Dennis Bush at (517) 335-3308 or bushdm@michigan.gov

Beach Monitoring

In 1997, the Department of Environmental Quality (DEQ) completed a report entitled "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (Strategy). This Strategy describes the monitoring activities that are necessary for a comprehensive assessment of water quality in Michigan's surface waters. One element of the Strategy is improved support for public beach monitoring.

The Michigan Water Quality Standards (WQS) contain numerical criteria for *E. coli* as an indicator of the potential human health risk from partial and total body contact recreation, which is a designated use of the waters of the state. Although the public bathing beach section of the Public Health Code references the WQS, the Code does not authorize the state to monitor beaches. Furthermore, the Code states that local health departments may test and otherwise evaluate the quality of the water at public beaches. The authority to close public beaches also rests with the local health departments. The DEQ's primary role is to compile data to evaluate overall water quality, and to support local health departments who use the information to assess the need for beach closings.

The specific objectives of the beach monitoring element are to:

1. Support county health departments in determining whether waters of the state are safe for total body contact recreation.

2. Evaluate the effectiveness of DEQ programs in protecting waters of the state from bacteria/*E. coli* contamination.

3. Develop and maintain a database into which counties can enter their beach monitoring data, and which the public can access for the latest information.

The beach monitoring element consists of two components that, in combination, provide data necessary to achieve these objectives. These include:

- Annual grants awarded through a Grant Application Package (GAP); and
- Development and maintenance of a statewide beach database.

Grants are awarded to local governments/county health departments each year to monitor public beaches. Special emphasis is placed on beaches along the Great Lakes and/or in state parks. On average, a total of approximately $150,000 is made available for grants. The grants are meant to serve as seed money to help local governments establish or expand beach monitoring activities. The database has been developed and is available on the DEQ web site. Counties enter data directly into the database.

For more information about the beach monitoring element, contact Shannon Briggs at (517) 335-1214 or briggssl@michigan.gov

Volunteer Monitoring in Streams and Rivers

In 1997, the Department of Environmental Quality (DEQ) completed a report entitled "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (Strategy). This Strategy describes the monitoring activities that are necessary for a comprehensive assessment of water quality in Michigan's surface waters. One element of the Strategy is volunteer monitoring of streams.

Many volunteer organizations collected water quality information from Michigan streams and rivers in the past. However, the DEQ did not have a program in place to use the data and ensure that volunteers were properly trained. Therefore, in 1998 the DEQ developed volunteer monitoring procedures and forms for wadable streams to ensure that volunteer data were consistent and useful for DEQ. To date, DEQ-supported volunteer monitoring has focused on benthic macroinvertebrate community and physical habitat. However, the DEQ is willing to work with volunteers on other types of monitoring, including water chemistry and bacteria.

The specific objectives of the volunteer monitoring element are to:

1. Produce quality-assured data that can be used by DEQ biologists as a screening tool to identify sites where more detailed assessment by the Department is needed.
2. Develop and maintain a database into which volunteer data can be stored and maintained.
3. Generate/foster public awareness, stewardship and surveillance of Michigan surface waters.

Grants are awarded to volunteer organizations through a Grant Application Package (GAP) process to monitor wadable streams and rivers. Since 1998, $50,000 has been made available for grants each year. The grants serve as seed money to help organizations establish volunteer monitoring activities. DEQ staff provides training to all funded volunteer groups. The training includes classroom and field instruction. In the classroom, volunteers are introduced to the survey forms, sampling procedures and logistics and shown examples of different types of habitat characteristics (substrate, riparian vegetation, riffles and pools, etc.) that they may encounter. The majority of classroom time is spent teaching volunteers to identify macroinvertebrates. The volunteers also learn how benthic invertebrates reflect water quality, and which taxa are most sensitive to stream degradation. During the field portion of the training, volunteers visit a stream to assess stream habitat and collect/identify invertebrates.

DEQ staff provide other technical assistance to volunteers, including site selection advice, quality assurance procedures, database maintenance, additional training, and presentations at meetings. The first annual Volunteer Monitoring Report was completed in 2002. A report entitled "The Use of Volunteer Monitoring Data: Benefits and Constraints" also is available.

For more information about stream volunteer monitoring, contact Gary Kohlhepp at 517-335-1289 or kohlhepg@michigan.gov

Appendix B

Revised
Great Lakes and Environmental Assessment Section
Procedure #88

Quality Assurance Project Plan Review Process

All grantees or vendors receiving federal or state monies for the purpose of conducting water quality monitoring are required to prepare quality assurance project plans (QAPPs). A QAPP is a written document that provides the framework for how environmental data will be collected to achieve specific project objectives and describes the procedures that will be implemented to obtain data of known and adequate quality. The QAPP must be prepared by the grantee/vendor (or their consultant) and approved by the Michigan Department of Environmental Quality (DEQ) prior to sample collection and analysis.

This procedure is designed to guide staff in fulfilling their QAPP review and approval/rejection responsibilities consistent with the Surface Water Quality Division's (SWQD's) "Procedure for Reviewing the Monitoring Aspects of Nonpoint Source Applications and Contracts." These responsibilities include:

- Coordinate the entire QAPP review and approval/rejection process.
- Review QAPP elements relating to ambient surface water biological, chemical, or toxicological monitoring.
- Solicit technical support from other DEQ divisions or SWQD sections needed to effectively review QAPP elements relating to illicit connection, hydrology/flow, groundwater, or specific Best Management Practice (BMP) performance monitoring.
- Approve or reject QAPPs.
- Provide the Budget and Administration Unit with copies of approved QAPPs and the corresponding QAPP approval memos.

QAPP Content Requirements

Three different sources of funding support water quality monitoring activities that require the development of QAPPs: federal Clean Michigan Initiative (CMI)-Nonpoint Source (NPS), CMI-Clean Water Fund (CWF), and Clean Water Act, Section 319. One of the "Terms and Conditions" in all signed water quality monitoring-related contracts between the DEQ and grantees/vendors is "Quality Assurance." The Quality Assurance contract term and condition requires the grantee/vendor:

> "...to submit a document for DEQ (or EPA) approval which describes the Grantee's organizational structure and operational measures related to environmental measurements or data generation sufficient to produce data of quality adequate to meet project objectives. The document will address procedures to plan, implement, and assess the effectiveness of the Grantee's QA/QC activities..."

The only administrative rule authority relating to QAPPs for any of the above funding sources is provided in Rule 14 (quality assurance for monitoring activities) of the Part 88, Water Pollution Prevention and Monitoring, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (Act 451). This rule also provides general guidance for grantees (or vendors) concerning the required elements of a QAPP.

To provide additional guidance to grantees (or vendors) relative to what constitutes an acceptable QAPP, the SWQD prepared the document entitled "Content Requirements for Quality Assurance Project Plans for Water Quality Monitoring Studies" (QAPP Content Guidance Document, Appendix A). If a grantee (or vendor) submits a QAPP for a CMI-CWF, CMI-NPS, or federal 319 grant supported water quality monitoring activity that satisfies the content requirements identified in the above document, then the QAPP shall be considered acceptable and in fulfillment of the "Quality Assurance" contract term and condition and, in the case of a CMI-CWF project, in fulfillment of Rule 14(2) of the Part 88 rules.

Review of Quality Assurance Project Plans

Step 1. The SWQD Project Administrator receives the draft QAPP from the grantee/vendor.

Step 2. The Project Administrator shall review the QAPP to determine if the monitoring activities described in the QAPP are consistent with the Project Work Plan.

If the QAPP includes monitoring activities that are inconsistent with the Project Work Plan, the Project Administrator shall identify the inconsistencies and return the QAPP, with a list of the inconsistencies, to the grantee/vendor for revision.

If the QAPP is consistent with the Project Work Plan, the Project Administrator shall submit the QAPP and a copy of the contract to the Chief of GLEAS for review.

Step 3. The Water Quality Appraisal Unit (North or South) Chief receives the QAPP and the contract from the Section Chief. The Unit Chief shall log and assign the QAPP review request to an appropriate staff person in their unit.

Step 4. GLEAS staff shall review the QAPP and contract and determine whether monitoring activities are being proposed by the grantee/vendor that require technical review by other DEQ divisions or other SWQD sections.

GLEAS shall review all QAPP elements relating to ambient surface water biological, toxicological, and chemical monitoring. QAPP elements for other types of monitoring need to be reviewed by other DEQ Divisions or other SWQD sections as indicated below:

a. QAPP elements for illicit connection monitoring shall be reviewed by SWQD district staff. The review requests should be sent to the appropriate District Supervisor.
b. QAPP elements for hydrology and flow monitoring shall be reviewed by the Land and Water Management Division (LWMD) of the DEQ. The review requests should be sent to the Chief of the Hydrologic Studies Unit of the LWMD.
c. QAPP elements for groundwater monitoring shall be reviewed by the Drinking Water and Radiological Protection Division (DWRPD) of the DEQ. The review requests should be sent to the Chief of the Field Operations Section of the DWRPD.

d. QAPP elements for specific BMP performance monitoring shall be reviewed by the SWQD Nonpoint Source (NPS) Unit staff. The review requests should be sent to the NPS Unit Chief. GLEAS staff will assist on reviewing the ambient monitoring aspects of BMP performance evaluations.

If technical review of the QAPP by DEQ divisions or SWQD sections not listed above is considered necessary, staff should consult with their Unit Chief to determine what type of assistance is needed, who should supply the assistance, and how that assistance should be solicited.

Step 5. If outside technical support is not needed, GLEAS staff shall review the draft QAPP and determine whether or not it satisfies all the requirements of the QAPP Content Guidance Document.

Step 6. After comparing the draft QAPP with the QAPP Content Guidance Document and after considering comments received from other DEQ divisions or SWQD sections, GLEAS staff shall determine whether a recommendation to approve or reject the QAPP shall be made to the GLEAS Unit Chief.

Approval of QAPPs

Step 1. GLEAS staff shall prepare a draft QAPP approval memo to the SWQD Project Administrator from their Unit Chief. An example QAPP approval memo is provided in Appendix B.

Step 2. The GLEAS Unit Chief shall review the draft QAPP approval memo for acceptability and discuss any recommended changes with staff.

Step 3. GLEAS staff shall make any necessary changes to the QAPP approval memo and submit it to the Unit Secretary for final typing and distribution.

Step 4. The Unit Secretary shall finalize the QAPP approval memo, obtain the Unit Chief's signature, and send it to the Project Administrator. Copies of the memo shall be sent to:

a. GLEAS Grants File.
b. GLEAS staff assigned to review the QAPP.
c. Any non-GLEAS staff who assisted with the QAPP review.
d. SWQD Budget and Administration Unit.

Copies of the approved QAPP shall be sent to the Budget and Administration Unit. In cases where a GLEAS staff person is the Project Administrator, a copy of the approved QAPP shall also be sent to the GLEAS Grants File.

Step 5. The Project Administrator shall send a letter to the grantee/vendor relaying the GLEAS Unit Chief's decision to approve the QAPP.

Inadequate QAPPs

Step 1. GLEAS staff shall prepare a draft QAPP rejection memo (Appendix C) to the SWQD Project Administrator from the GLEAS Unit Chief. This memo shall include:

a. A statement that GLEAS has reviewed the QAPP (date) submitted by the grantee/vendor.

b. A list and brief description of the QAPP's deficiencies.

c. A statement that GLEAS cannot approve the QAPP until the listed deficiencies are corrected by the grantee/vendor.

Step 2. The GLEAS Unit Chief shall review the draft QAPP rejection memo for acceptability and discuss any recommended changes with staff and, as appropriate, the Section Chief.

Step 3. GLEAS staff shall make any necessary changes required to finalize the QAPP rejection memo and submit it to the Unit Secretary for final typing and distribution.

Step 4. The Unit Secretary shall finalize the QAPP rejection memo, obtain the Unit Chief's signature, and send it to the Project Administrator. Copies of the memo shall also be sent to:

a. GLEAS Grants File
b. GLEAS staff assigned to review the QAPP
c. Any non-GLEAS staff who assisted with the QAPP review.

Step 5. After receiving the QAPP rejection memo, the Project Administrator shall send a letter to the grantee/vendor relaying the GLEAS Unit Chief's decision to not approve the QAPP. This letter shall also list the QAPP deficiencies and invite the grantee/vendor to make the necessary corrections and resubmit the QAPP for SWQD review.

Correspondence Filing

All GLEAS correspondence generated in the QAPP review and approval process shall be filed in the GLEAS Grants file.

Approved: James Grant Date: 5/1/02

Content Requirements for Quality Assurance Project Plans for Water Quality Monitoring Studies

All grantees receiving federal or state monies for the purpose of conducting water quality monitoring, as part of their nonpoint source (NPS) project are required to prepare a quality assurance project plan (QAPP). A QAPP is a written document that provides the framework for how environmental data will be collected to achieve specific project objectives and describes the procedures that will be implemented to obtain data of known and adequate quality. The QAPP must be prepared by the grantee (or their consultant) and approved by the Michigan Department of Environmental Quality (DEQ), Surface Water Quality Division, prior to sample collection and analysis. This document has been prepared to facilitate the preparation of approvable QAPPs for water quality monitoring studies. The use of this document is intended to improve the quality of draft QAPPs so that minimal revisions are necessary.

Elements of a QAPP

There are 12 elements of a QAPP. These elements are:

- A description of the elements that make up the project and the person(s) responsible for carrying out the project.
- Quality assurance objectives for measurement data.
- Sampling procedures.
- Sample custody procedures.
- Equipment calibration procedures and frequency.
- Analytical procedures.
- Internal quality control checks.
- Data reduction, validation, and reporting.
- Performance and system audits to verify adherence to quality assurance/quality control programs.
- Preventative maintenance on equipment and instrumentation.
- Data quality assessment.
- Corrective action for analytical and field equipment problems and quality assurance/quality control noncompliance problems.

Description of the Elements that Make Up the Project and the Person(s) Responsible for Carrying Out the Project

This section of the QAPP shall include a brief description of the NPS project, a description of the water quality monitoring to be performed as part of the NPS project, and the specific water quality-related questions to be answered by the water quality monitoring project.

> *Example:*
>
> *Buffer strips will be installed along a one-mile segment of the target stream, between Garner Road and Cook Road in Dallas Township, to minimize nutrient runoff from adjoining agricultural land. Water chemistry monitoring, focusing on total phosphorus, will be done in the target stream at sampling points upstream and downstream of the stream segment targeted for best management practice implementation. The monitoring results will be used to determine whether or not the buffer strips are effective in minimizing (at least a 75 percent decrease) phosphorus loading to the target stream.*

This section of the QAPP shall also contain the following items, including the addresses of each organization involved in the project:

1. Management Responsibilities – All managers and their respective responsibilities shall be listed. This includes the grantee and subcontractors.

2. Field Responsibilities – All field sampling personnel and their respective responsibilities shall be listed.

3. Laboratory Responsibilities – The identity of any laboratories and key laboratory staff associated with the project shall be listed. The location of the laboratory (city and state) and the analytes and matrices that will be tested at each laboratory shall be included.

4. Corrective Action – Project personnel responsible for initiating, developing, approving, and implementing corrective actions shall be listed.

Quality Assurance Objectives for Measurement Data

This section of the QAPP shall include the data quality objectives and requirements used to decide whether or not data are acceptable to use in the final report/project summary. Data quality objectives/requirements shall be listed for each parameter or parameter group being analyzed.

Example:

If the total mercury concentration in a trip or field blank is greater than or equal to 0.5 nanograms per liter, or greater than one-fifth of the sample concentration, whichever is higher, the associated sample result is an estimate.

Sampling Procedures

This section of the QAPP shall include a list and description of sampling methods that will be used to monitor different water quality parameters, as part of the monitoring project. If a United States Environmental Protection Agency EPA approved sampling method is used to monitor a given parameter, then the grantee (or subcontractor) may just reference the EPA method number and a full description of the sampling method does not need to be provided.

Example:

Total mercury water samples will be collected from Freeman Creek once a month for a period of 12 months according to EPA Method 1669.

Sample Custody Procedures

This QAPP element is only required when the grantee considers it necessary to maintain a chain of custody for water quality data produced by the monitoring project.

This section of the QAPP shall include a description of the process or procedure that will be used by the grantee (or subcontractors) to document that samples collected and analyzed as a part of

the monitoring project were always in a state of custody. Chain of custody is accomplished through a combination of field and laboratory records that demonstrate possession and transfer of custody.

Equipment Calibration Procedures and Frequency

This section of the QAPP shall include a description of the calibration procedures and the frequency with which these procedures will be performed for field instruments.

Each calibration procedure shall also include the acceptance criteria and the conditions that will require recalibration. The accuracy of the calibration standards used must be properly documented.

Example:

The pH meter will be standardized using a three buffer system. The buffers shall have pH levels of 4, 7, and 10 standard units. The standardization will follow the suggested procedure outlined in the user's manual specific to this meter. The meter will be standardized at least daily and the slope of the "reading vs. standard" graph should be between 90 and 105 percent. A slope outside this range means recalibration.

Analytical Procedures

This section of the QAPP shall include a list of parameters to be analyzed as part of the water quality monitoring project. The parameter list should also include the following:

- Frequency and time frame of sampling.
- Description of the analytical method for each parameter.

If the analytical method is an EPA approved method, then the grantee (or subcontractor) may just reference the EPA method number and a full description is not necessary.

Example:

Total mercury water samples will be analyzed using EPA Method 1631.

Quality Control Checks

This section of the QAPP shall describe all specific quality control checks to be used by the grantee (or subcontractor) to assess the adequacy of field and laboratory analyses associated with

the monitoring study. Field quality control checks are measures to assess the quality of the field procedures used in obtaining, handling, or analyzing samples. Laboratory quality control checks are measures used to assess the quality of the data resulting from the analytical procedures. The frequency of the quality control checks to be performed should be included in the description. Some examples of quality control checks include:

- Method blanks are generated within the laboratory by passing clean matrix through all the analytical method steps, and are used to assess contamination resulting from laboratory procedures.

- Surrogate spikes are compounds similar to the target analyte but not normally found in environmental samples that are added to each sample to assess the accuracy of the analytical procedures.

- Trip blanks are used to monitor contamination introduced via vapor phase into samples. Trip blanks are provided by the lab and are transported unopened to the field, returned from the field in a cooler with regular samples, and then delivered/shipped to the lab in the same manner as regular samples.

- Field blanks are used to monitor contamination introduced into samples by collection and handling procedures. A field blank is generated at the sample collection site by filling an empty sample bottle with reagent water.

- Field replicates are used to assess the consistency and precision of field sampling and analytical processes. A field replicate is collected by filling a second sample container within 15 minutes of the first sample, from the same source as the first sample and using identical procedures.

Example:

Trip blanks, field blanks, and field replicates will be used as quality control checks when sampling the water column for metals as part of the Brandywhine River monitoring project.

Trip blanks will be used to monitor potential contamination via the vapor phase into samples. The blanks will be provided by the lab, transported unopened to the field, returned from the field in a cooler with the regular samples, and delivered/shipped to the lab in the same manner as the regular samples. The trip blanks will be collected at a frequency of one per every 20 regular samples taken.

Field blanks will be used to monitor potential contamination introduced into the samples by collection and handling procedures. The blank will be generated at the sample collection site by filling an empty sampling bottle with reagent water. The blank will be returned from the field in a cooler with the regular samples and delivered/shipped to the lab in the same manner as the regular samples. The field blanks will be collected at a frequency of one per every 20 regular samples taken.

Field replicates will be used to assess the consistency and precision of field sampling and analytical procedures. The replicate will be collected by filling a second sample container within 15 minutes of the first sample, from the same source as the first sample and using identical procedures. The replicate will be returned from the field in a cooler with the regular samples and delivered/shipped to the lab in the same manner as the regular samples. The field replicates will be collected at a frequency of one per every 10 regular samples taken.

Data Reduction, Validation, and Reporting

This section of the QAPP shall include a description of the techniques that the grantee (or subcontractor) will use to manage, analyze, and interpret the water quality data produced by the monitoring project. A description of the data reporting actions that the grantee (or subcontractor) intends to take to communicate the data to the DEQ and other interested parties should also be provided. Specific types of information that should be provided in this section of the QAPP include:

- Any equations used to determine whether or not data are acceptable.
- Any statistical methods used to determine data significance.
- Any equations used to determine whether or not data meet the quality assurance objectives/requirements of the monitoring project.
- Database management software (i.e., Access) that will be used to store and analyze the water quality data.
- An outline and timeline for the draft and final reports to be prepared for the water quality monitoring project.

Performance and System Audits to Verify Adherence to Quality Assurance/Quality Control Programs

This section of the QAPP shall describe the performance and system audits that will be used to verify that the quality assurance/quality control program is strictly followed by the appropriate personnel during the field activities (e.g., sample collection, preservation, and transportation) and laboratory activities (e.g., sample preparation, instrument calibration, sample analysis, data validation, and final evidence documentation). The frequency of the performance and system audits shall also be identified.

Preventative Maintenance on Equipment and Instrumentation

Maintenance procedures for any water quality sampling or analytical equipment to be used by the grantee (or subcontractor) as part of the monitoring project, such as thermometers, pH, and conductivity meters, shall be described in this section of the QAPP.

Data Quality Assessment

This section of the QAPP shall include the data quality assessment process that will be used to assess the scientific and statistical quality of the data collected. This section shall describe how the data will be inspected for technical problems and for statistical significance. Methods used to evaluate the data statistically to verify assumptions (i.e., distribution and independence) shall be described.

Corrective Action for Analytical and Field Equipment Problems and Quality Assurance/Quality Control Noncompliance Problems

This section of the QAPP shall include a description of the corrective action process that will be used by the grantee (or subcontractor) to identify, recommend, approve, and implement measures to manage circumstances requiring a deviation from the approved QAPP. Corrective actions can be required during field activities, laboratory analyses, data validation, and data assessment. All corrective actions should be documented in a record book.