Revised
Great Lakes and Environmental Assessment Section
Procedure #58

Water Chemistry Monitoring

This procedure describes the goals and the current structure of the statewide water chemistry monitoring activities. It identifies the sampling locations, sampling frequencies, and the parameters that are analyzed.

Introduction

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. Assessment of the environmental impacts of point and nonpoint source discharges, the latter being diverse and more difficult to measure, is critical. Because bioaccumulative chemicals (e.g., dioxins, polychlorinated biphenyls (PCBs), and mercury) can have serious impacts on aquatic systems when present at extremely low concentrations, monitoring techniques must be sophisticated and sensitive. Therefore, water quality monitoring activities must be expanded and improved to more effectively address changing environmental conditions and issues.

Past limitations in analytical quantification levels, as well as funding reductions, have restricted the overall effectiveness of the DEQ's water monitoring activities. The number of DEQ long-term water quality sites declined from over 100 in the late 1980s to just 13 on the Detroit River and eight on the Saginaw Bay in 1997. This reduction was noted in a 1995 report by the Auditor General, which stated that the Surface Water Quality Division (SWQD) does not have a monitoring program in place to evaluate overall water quality conditions in Michigan. Partly in response to these criticisms, and partly because of a DEQ commitment to develop a comprehensive monitoring plan, a report entitled "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (Strategy), was completed in January 1997. 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. Recent technological advances (i.e., low-level analytical techniques for metals and organics) now make it possible to collect high-quality water chemistry data at a reasonable cost.

In November 1998, the citizens of Michigan approved the Clean Michigan Initiative, a $675 million bond to clean up, protect, and enhance Michigan's environmental quality, natural resources, and infrastructure. Some of these funds were allocated for the implementation of the Strategy, including the water chemistry monitoring element.

Watershed Management Units

One objective of the enhanced water chemistry monitoring is to be consistent, to the extent possible, with existing DEQ programs and activities. Therefore, the DEQ will continue to use the existing five-year basin units defined by the National Pollutant Discharge Elimination System (NPDES) permitting program. This plan, consistent with the NPDES program, defines 45 watershed units based on drainage to the four Great Lakes (Figure 1). Thirty-one of these units have been selected for placement of water chemistry stations. Monitoring activities within the

watersheds include macroinvertebrate and fish evaluations, water chemistry, 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.

Description

The water chemistry monitoring element consists of several components that, in combination, provide data necessary to help achieve the Strategy's four goals:

- Assess the current status and condition of waters of the state and determine whether water 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.

Some fixed stations are monitored annually to assess spatial and temporal trends, while other stations are monitored at appropriate frequencies to evaluate program effectiveness, address specific issues of interest, or provide information for five-year watershed surveys. Water chemistry monitoring will be fully coordinated with the other elements in the Strategy, especially stream flow, inland lake quality, sediment chemistry, and biological integrity. The basic components of the water chemistry element are described below and are summarized in Appendix 1.

Bays and Connecting Channels

The primary goal for the Bays and Connecting Channel monitoring is to assess spatial and temporal trends. Therefore, these are fixed trend stations that are routinely monitored each year. A second specific goal for the Saginaw Bay monitoring is to determine whether the target phosphorus concentration of 0.015 milligrams per liter (mg/L), as defined in the Saginaw Bay Phosphorus Reduction Strategy, is being met. The connecting channel data, especially on the St. Mary's and Detroit Rivers, also are used to evaluate the effectiveness of Remedial Action Plan activities.

Saginaw Bay and Grand Traverse Bay represent water quality conditions resulting from interactions among land-use, point source and nonpoint sources of pollution, and geological and other natural influences in their respective watersheds. Saginaw Bay represents a largely agricultural, industrial, and urbanized watershed impacted by pesticides, nutrients, suspended solids, and other surface water contaminants typically associated with agriculture and urban runoff. Seven sites on Saginaw Bay are assessed, located at nearshore and offshore areas south of Point AuGres-Sand Point (Figures 2 and 3, Appendix 2). Grand Traverse Bay, on the other hand, represents a minimally impacted watershed that is experiencing increasing development. Four sites on Grand Traverse Bay are monitored, located at a northern and southern point in both the east and west arms (Figures 2 and 4, Appendix 2). Since 1998, the Grand Traverse Bay sites have been sampled three times per year (April, July, and October) for nutrients and conventionals, and once per year (October) for mercury, trace metals, and some organic compounds. From 1998-2000, Saginaw Bay was also sampled three times per year. Starting in 2001, Saginaw Bay samples have been collected from April through November and are analyzed for nutrients, conventionals, mercury, and trace metals.

The Great Lakes Connecting Channels (St. Mary's, St. Clair, and Detroit Rivers) are subject to intense commercial and industrial activity. These waters represent large watersheds also affected by interactions among land-use, point and nonpoint pollution sources, and geological and other natural influences. They serve as conduits for water quality impacts between the Great Lakes. A considerable amount of historical water chemistry data has been collected on the Detroit River, whereas relatively little historical data exist for the St. Mary's and St. Clair Rivers. The current sampling design was initiated in 1998. Six sites, consisting of the headwaters and mouth of the St. Mary's, St. Clair, and Detroit Rivers (Figure 2, Appendix 2), are monitored every year. The sites are sampled monthly during ice-free time periods (usually April through November). All samples are analyzed for mercury, trace metals, nutrients, and conventional parameters. At least one sample per year from each site is analyzed for PCB congeners and selected organics, such as base/neutrals and volatile organic compounds.

Intensive Sites

Like the Bays and Connecting Channels, intensive sites are part of the fixed station trend network and are routinely monitored each year. The primary goal for the intensive locations is to assess spatial and temporal trends. The data are also used to calculate chemical loadings from these rivers to the Great Lakes.

Beginning in the year 2000, six sites were designated as intensive sites. Intensive sites are sampled 12 times per year on a flow-stratified schedule, with approximately three-quarters of the samples collected during high-flow. High-flow is defined as one of the following: greater than 20 percent exceedance flow; an increase in stream flow of 100 percent above the preceding base flow condition; or an increase in stream flow following a long period of discharge at base flow and considered likely to produce a measurable change in the concentration of sampled parameters. These locations include the Au Sable, Clinton, Grand, Kalamazoo, Muskegon, and Saginaw Rivers (Figure 5, Appendix 2). The Saginaw River was not sampled in 2000, due to the extensive sediment remediation that took place there. It was first sampled in 2001. Intensive sites were selected based on large flow volumes and/or expected contaminant loads to the Great Lakes, except for the Au Sable River, which was chosen as a high-quality, background river. Data on contaminant concentrations and flow are collected from each river for loading calculations. For temporal trend analysis, measured loads are calculated using flow-normalized concentrations, to account for variation that may be due strictly to precipitation changes from year to year. All samples are analyzed for mercury, trace metals, nutrients, and conventional parameters. At least one sample per year from each intensive site is analyzed for PCB congeners and selected organic chemicals, such as base/neutrals and volatile organic compounds.

Integrator Sites

The integrator sites are also a part of the fixed station trend network and are monitored each year. The primary goal for the integrator locations is to assess spatial and temporal trends. Once every five years, the data from each integrator site are used to calculate chemical loadings.

The 25 integrator sites represent water quality conditions of major streams and rivers in large, heterogeneous basins (Figure 6, Appendix 2). Integrator sites generally are located near the outlet of large basins at or near flow gauging stations. Four integrator sites are located in the mid-reaches of the largest watersheds, including the St. Joe, Kalamazoo, Grand, and Muskegon Rivers. Integrator sites are sampled intensively on a staggered five-year rotation. Once every five years (consistent with the NPDES program), each integrator site is sampled 12 times on a

flow-stratified schedule identical to the intensive sites described above. Contaminant loads are calculated for these years. During the other four years in the five-year cycle, the integrator sites are sampled four times per year. These samples are prescheduled throughout the period from ice breakup to ice cover and may include samples during spring snowmelt and low flow. Trends are evaluated on the combined data sets. All samples are analyzed for mercury, trace metals, nutrients, and conventional parameters. At least one sample per year from each integrator site is analyzed for PCB congeners and selected organic chemicals, such as base/neutrals and volatile organic compounds.

Issue Sites

Issue sites are chosen by the DEQ and the United States Geological Survey (USGS) to understand how specific activities or conditions affect water quality. Issue sites are a flexible component of the water chemistry program element that focuses on known or suspected problems, as well as emerging issues. There are no fixed station issue sites. Each year, the DEQ and the USGS prioritize data needs and choose issue sites accordingly. While data requirements focus on the NPDES-targeted basins, these sites may be anywhere in the state. Issue sites may be chosen to collect data prior to and after a nonpoint source project, assess the effects of land use on water quality, evaluate the impacts of pesticides and herbicides, and/or collect data on an emerging issue. Sites monitored for the development of Total Maximum Daily Loads (TMDLs) fall into this category. Depending upon the rationale for monitoring, an issue site may be monitored for one or a few years or perhaps for a longer time period. The suite of parameters collected at each indicator site varies based upon the issue being addressed. Current examples of issues that are being investigated include mercury levels in lakes and rivers/streams in Michigan and the effect of the Conservation Reserve Enhancement Program on water quality. Emerging chemicals of concern have been monitored at several locations, including methyl tert-butyl ether (MTBE; a gasoline additive) and perfluorooctane sulfonate (PFOS; used in ScothGard). In addition, extensive PCB monitoring will be conducted in selected watersheds to support future TMDL development efforts.

Minimally Impacted Sites

One minimally impacted site is located in each of the 31 watershed management units with an intensive or integrator station (Appendix 2). These sites are sampled once every five years, consistent with the NPDES five-year rotating basin schedule, to provide data on the best water quality that can be expected in each watershed. This information allows for a comparison of water chemistry data collected at other locations in a watershed to the minimally impacted site. It should be noted that the term "minimally impacted" varies by watershed. A minimally impacted site in the Rouge River Watershed differs from a minimally impacted site in the Au Sable River Watershed. These locations are sampled four times during the year for mercury, trace metals, conventionals, nutrients, and selected organic compounds.

Five-Year Basin Sampling

The SWQD biologists routinely collect water samples each year from many biological survey locations, as part of the five-year rotating basin assessments. These generally are one-time grab samples, and the parameters of interest most often include nutrients and conventional parameters. A small subset of these samples is analyzed for chemicals, such as metals and/or a variety of organic contaminants, as local conditions warrant. Samples are collected from sites identified by the biologists, and if appropriate several samples are collected during the year by the SWQD or consultants.

Grants to Local Governments

Starting in 2001, the DEQ makes grants available to local governments for water quality monitoring. These entities submit proposals that are evaluated by the DEQ. Proposals are selected based on defined criteria, including watershed priority, the parameter/issue(s) being addressed, cost, and amount of local match. We expect that these projects will produce data for many areas of the state.

One example of such a project is Lake St. Clair and its watershed. Monitoring for bacteria, nutrients, and metals in the Lake St. Clair Watershed is a priority for the Macomb County Health Department (County) and the DEQ to identify contaminant sources, particularly sanitary sewer overflows, combined sewer overflows, and illicit connections. The DEQ provided grants to the County in 1998 and 2000 for water quality monitoring. The County has monitored a number of locations in the Clinton River and Lake St. Clair (nearshore and open water) in 1998-2001. Additional testing will be conducted in areas not attaining water quality standards due to exceedences of *Escherichia coli*. These efforts will be linked with TMDL requirements. A number of waterbodies in Macomb County are not attaining standards due to high bacteria levels and associated beach closings. The development and implementation of TMDLs will require extensive monitoring of these waters and control measures to reduce pollutant inputs.

Other Sites

Samples are also taken at selected locations that are sampled for other elements of the monitoring strategy, including inland lake sediments, fish contaminants, and biological trends. The locations vary each year, and the parameter list varies on a site-specific basis.

Parameters

Data on nutrients (phosphorus, nitrogen, and ions) and conventional parameters (temperature, conductivity, suspended solids, pH, and dissolved oxygen) will be collected from all of the sites identified above. These are basic measures of water quality, and the DEQ and the USGS frequently receive requests for such information. In addition, these analyses are relatively inexpensive.

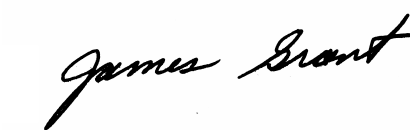
Total mercury and trace metals (cadmium, chromium, copper, lead, nickel, and zinc) will also be measured at most of the sites, except perhaps at some of the issue sites that are specifically chosen for other reasons. Samples will not routinely be analyzed for dissolved metals, given that such analysis adds additional expense and that sample collection for dissolved metals is more time-consuming. The DEQ recently completed a project establishing ratios of total and dissolved metals in several Michigan rivers. This information can be used to convert total metal concentrations to dissolved concentrations if necessary. In addition, if data for total metals concentrations indicate possible exceedance of water quality standards, then follow-up sampling using dissolved techniques can be conducted.

Each year, at least one sample from the connecting channels, intensive sites, integrator sites, and minimally impacted sites are collected and analyzed for PCBs using state-of-the-art techniques. More frequent PCB samples are collected as needed at some locations. Extensive sampling in 1998 and 1999 for other organics, such as base neutrals and methyl-tertiary-butyl ether, from several rivers were almost all below detection. Therefore, only one sample per year from each location is analyzed for these substances as a spot check. Pesticide/herbicide analyses may be conducted at selected sites, most likely at issue sites.

Data are reviewed each year to determine whether additional parameters should be added, removed, or analyzed at a greater or lesser frequency. An intricate part of the water chemistry monitoring element is the development and use of indicators to reduce cost. To identify statistically valid indicators, historical and new data will be examined. If feasible, lower cost indicator parameters will be substituted in future sampling.

Data Management and Reporting

Data management and reporting are integral parts of the water chemistry monitoring element. All water chemistry data will be entered into the Storage and Retrieval System database. Data from the Bays and Connecting Channels are compiled into an annual trend report, as are the data from the intensive, integrator, and minimally impacted sites. The information from the issue sites are summarized in individual reports as appropriate. Data collected as part of the five-year basin sampling are summarized in Great Lakes and Environmental Assessment Section biosurvey reports. Data collected as part of TMDL sampling are summarized in individual reports prepared for each waterbody for which TMDLs are developed. The data also are used in preparation of the state's Section 305(b) report. Each local government that receives a grant for water quality monitoring is required to produce a final report at the conclusion of the project.

Approved:  Date: 5/1/02

APPENDIX 1
Water Chemistry Monitoring Components

Bays

Saginaw Bay (seven locations)
Grand Traverse Bay (four locations)

These stations were sampled three times per year (April, July, and October) from 1998-2000. This continues at Grand Traverse Bay. Monthly samples have been collected from Saginaw Bay since 2001.

Connecting Channels

St. Mary's River (upstream and downstream)
St. Clair River (upstream and downstream)
Detroit River (upstream and downstream)

These stations are sampled monthly during the open water portion of each year.

Intensive Sites

AuSable River
Clinton River
Grand River
Kalamazoo River
Muskegon River
Saginaw River

Stations are sampled near their mouths 12 times annually, on a flow-stratified schedule to calculate loads.

Integrator Sites

Ontonagon River	Muskegon River (upper)	Cass River
Sturgeon River	Grand River (upper)	Flint River
Tahquamenon River	Kalamazoo River	Shiawassee River
Menominee River	St. Joe River (upper/lower)	Tittabawassee River
Escanaba River	Raisin River	Thunder Bay River
Manistique River	Huron River	Cheboygan River
Pine River (Mackinac County)	Rouge River	Manistee River
Pere Marquette River	Black River (St. Clair County)	Boardman River

Each site is sampled 12 times per year once in a five-year cycle (during its basin year). In the other four years, a site is sampled four times per year.

Issue Sites

Sites and sampling frequency are determined each year.

Minimally Impacted Sites

Bigelow Creek (Muskegon River; 2001)
Evergreen Creek (Cass River; 2001)
Grand River (Grand River; 2001)
Pokagon Creek (Lower St. Joe River; 2001)
Tioga River (Sturgeon River; 2001)
Huron River (Huron River; 2002)
Perry Creek (Au Sable River; 2002)
Paint River (Menominee River; 2002)
West Branch Tittabawassee River (Tittabawassee River; 2002)

Minimally impacted sites for the 2003 to 2005 intensive and integrator watersheds will be selected prior to each field season.

Stations will be sampled four times per year.

Five-Year Basin

Locations and sampling frequency are identified each year in the target watersheds (consistent with the five-year basin cycle).