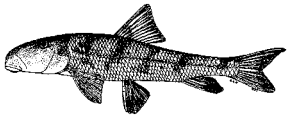
State of Ohio
Environmental Protection Agency

Division of Surface Water
Division of Drinking and Ground Waters

Surface and Ground Water Monitoring and Assessment Strategy

2005 - 2009



September 20, 2005

Bob Taft, Governor
Joseph P. Koncelik, Director

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Division of Surface Water
and
Division of Drinking and Ground Waters

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Acknowledgments

Ohio EPA's Surface and Ground Water Monitoring and Assessment Strategy has resulted from the many years of labor, research and experience accrued by numerous current and previous Ohio EPA Division of Surface Water and Division of Drinking and Ground Waters staff both in the Central and District Offices. This version of the Water Monitoring Strategy draws strongly on the previous edition coordinated and compiled by Chris Yoder. Contributors to this edition include: Paul Anderson, Robert Davic, Jeff DeShon, Michael Eggert, John Estenik, Gail Hesse, Christopher Kenah, AmyJo Klei, Julie Letterhos, John Mack, Mick Micacchion, Robert Miltner, Mylynda Shaskus, Chris Skalski, and Marc Smith. This strategy was coordinated and compiled by Jeff DeShon and Marc Smith.

Ohio EPA Surface and Ground Water Monitoring and Assessment Strategy

Introduction

This document presents a description of Ohio EPA's immediate and long-term water monitoring and assessment strategies. An attempt was made to closely follow the ten elements of a monitoring program framework described in the "Elements of a State Monitoring and Assessment Program" guidance document published by U.S.EPA in March, 2003. In each of the chapters which represent a separate element, applicable descriptions have been provided by water body type and/or water monitoring program component including the current effort, the desired state, and plans for reaching goals.

One of the goals of developing this water monitoring strategy is to promote integration of all the water monitoring programs and, in particular, integration between surface water and ground water monitoring. Ohio EPA recognizes the goals and objectives of a comprehensive strategy can not be achieved without recognizing the interconnection of surface and ground water. Ground water accounts for a significant portion of average annual stream flows in Ohio and surface water quality can be improved or impaired by ground water contributions. Clearly, it is not possible to achieve the goals of the Clean Water Act without characterizing and protecting both resources. The Division of Surface Water and the Division of Drinking and Ground Waters are committed to working together to identify opportunities for greater integration of the surface water and ground water monitoring programs.

Ohio's Water Resources

Ohio is a water rich state with more than 23,000 miles[1] of named and designated rivers and streams, a 451 mile border on the Ohio River, 447 publicly owned lakes, ponds, and reservoirs > 5 acres (118,963 total acres), and 312 miles of Lake Erie mainland and islands shoreline. Since 2002, Ohio EPA has endorsed a slightly larger estimate for the length of perennial streams (those having water year round) in Ohio - 29,357 miles[2]. The various water resource statistics for Ohio, the large rivers in Ohio and Ohio's Scenic River System are presented in Figures 1, 2 and 3, respectively.

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[1] Mileage figure for waters listed by Ohio Department of Natural Resources in *Gazetteer of Ohio Streams, 2nd edition* (Ohio DNR, 2001).

[2] An estimate prepared from a computer-digitized map of U.S. streams and rivers produced by the U.S. Geological Survey (USGS) known as the National Hydrography Dataset (NHD). The NHD is based upon the content of USGS Digital Line Graph (DLG) hydrography data integrated with reach-related information from the U.S. EPA Reach File Version 3 (RF3). http://nhd.usgs.gov/index.html

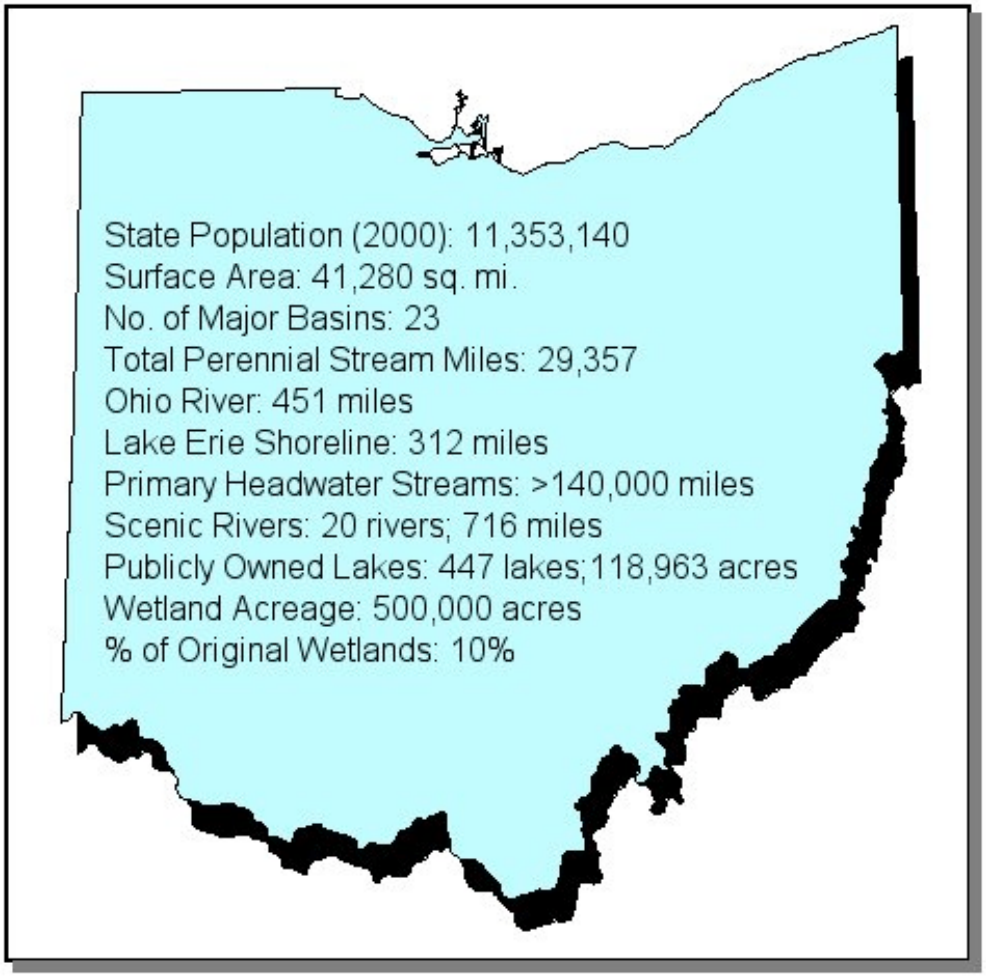

Figure 1. Ohio's water resource statistics.

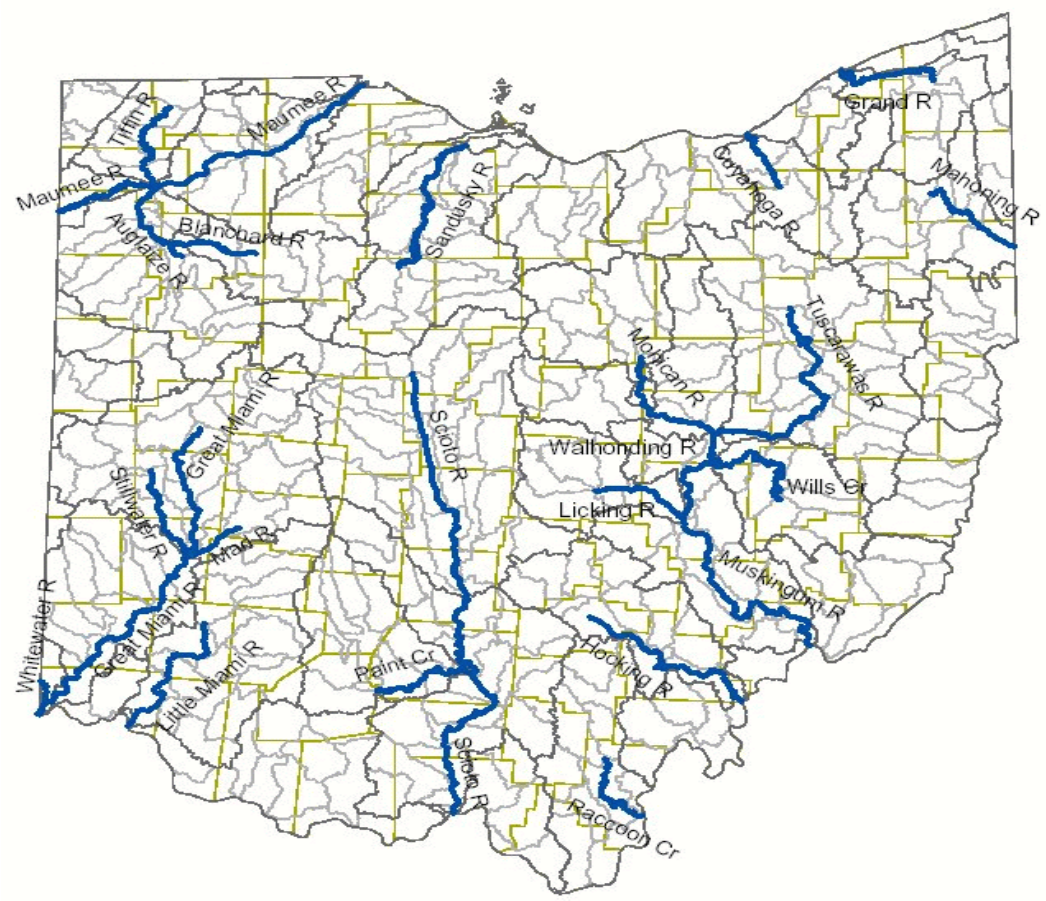

Figure 2. Ohio's large rivers with greater than 500 mi^2 of drainage area.

Figure 3. Ohio's Scenic River System.

The larger water bodies included in the preceding statistical summaries comprise the major aquatic resources that are used and enjoyed by Ohioans for water supplies, recreation and other purposes. The quality of these perennial streams and other larger water bodies is strongly influenced by the condition and quality of the small feeder streams, often called the headwaters. Approximately 27,550 miles of the nearly 57,000 miles of stream channels digitally mapped in Ohio are headwater streams. However, the digital maps currently available for Ohio do not include the smallest of headwater channels. Results of a special study of primary headwater streams (drainage areas less than 1 mi^2) place the estimate of primary headwaters between 146,000 to almost 250,000 miles (Ohio EPA, 2002). Some of these primary headwater streams are in fact perennial habitats for aquatic life that supply base flow in larger streams. This illustrates the importance of taking a holistic watershed perspective in water resource management.

Ohio‘s ground water resources are abundant and include three major aquifer types, unconsolidated sand and gravel, sandstone, and carbonate aquifers. The sand and gravel aquifers are superimposed on the bedrock and comprise Ohio’s most productive and sensitive aquifers. These buried valley aquifers are composed of bands of permeable unconsolidated sand and gravel (20 to 200 + feet thick) filling old river valleys which were cut by glacial meltwater and preglaical streams. The sandstone aquifer system is found throughout the eastern portion of Ohio. These aquifers are characterized by gently dipping strata of sandstone and shales, which yield moderate to high volumes of water. The carbonate bedrock aquifer is found in the western half of the state. These carbonates can be thick (up to 600 feet), and may yield over 500 gallons of water per minute in fractured zones with solution channels. Although ground water is abundant in Ohio, in areas where the bedrock is dominated by shales, the yield from wells is very limited.

Ohio is an economically important and diverse state with strong manufacturing and agricultural industries. Many of the historical patterns of environmental impact in Ohio are related to the geographical distribution of basic industries, land use, mineral resources, and population centers. Also important, however, is an understanding of Ohio’s geology, land form, land use, and other natural features as these determine the basic characteristics and ecological potential of streams and rivers. Ohio EPA bases the selection, development, and calibration of ecological, toxicological, and chemical/physical indicators on these factors. These are then employed via systematic ambient monitoring to provide information about existing environmental problems, threats to existing high quality waters, and successes in abating some past and current water pollution problems in Ohio’s surface waters.

I. U.S. EPA Water Monitoring Strategy Framework

The following outline abstracts the salient points from U.S. EPA (2003) that will be addressed in the body of the document.

A. Monitoring Program Strategy

USEPA's articulated goal for state programs:

The state has a comprehensive monitoring program strategy that serves all water quality management needs and addresses all State water, including all waterbody types (e.g., streams, rivers, lakes, Great Lakes, reservoirs, estuaries, coastal areas, wetlands, and groundwater).

B. Monitoring Objectives

USEPA's articulated goal for state programs:

The state has identified monitoring objectives critical to the design of a monitoring program that is efficient and effective in generating data that serve its management decision needs.

Highlighted objectives from the Clean Water Act include:

- Establishing, reviewing, and revising water quality standards (Section 303(c)).
- Determining water quality standards attainment (Section 305(b)).
- Identifying impaired waters (section 303(d)).
- Identifying causes and sources of water quality impairments (section 303(d), 305(b)).
- Supporting the implementation of water management programs (section 303, 314, 319, 402, etc.).
- Supporting the evaluation of program effectiveness (sections 303, 305, 402, 314, 319, etc.).

Additionally state programs that adequately meet the Clean water Act objectives should be able to answer the following questions:

1. What is the overall quality of waters in the State?
2. To what extent is water quality changing over time?
3. What are the problem areas and areas needing protection?
4. What level of protection is needed?
5. How effective are clean water projects and programs?

C. Monitoring Design

USEPA's articulated goal for state programs:

The state has an approach and rationale for selection of monitoring designs and sample sites that best serve its monitoring objectives.

D. Core and Supplemental Water Quality Indicators

USEPA's articulated goal for state programs:

Because limited resources affect the design of water quality monitoring programs, the State should use a tiered approach to monitoring that includes a core set of baseline indicators selected to represent each applicable designated use, plus supplemental indicators selected according to site-specific or project specific decision criteria.

E. Quality Assurance

USEPA's articulated goal for state programs:

Quality Management Plans and Quality Assurance Project Plans are developed, maintained, and peer reviewed in accordance with EPA policy to ensure the scientific validity of monitoring and laboratory activities.

F. Data Management

USEPA's articulated goal for state programs:

The State uses an accessible electronic data system for water quality, fish tissue, toxicity, sediment chemistry, habitat, and biological data (following appropriate metadata and State/Federal geo-locational standards) with timely data entry and public access.

G. Data Analysis/Assessment

USEPA's articulated goal for state programs:

The state has a methodology for assessing attainment of water quality standards based on analysis of various types of data (chemical, physical, biological, land use) from various sources, for all waterbody types and all State waters.

Additional guidance stated that the methodology should:

- Identify the required or likely sources of existing and available data and information and procedures for collecting or assembling it;
- Describe or reference requirements relating to data quality and representativeness, such as analytical precision, temporal and geographic representation, and metadata documentation needs;
- Include or reference procedures for evaluating the quality of datasets; and
- Explain data reduction procedures (e.g., statistical analyses) appropriate for comparing data to applicable water quality standards.

H. Reporting

USEPA's articulated goal for state programs:
The State produces timely and complete water quality reports and lists.

I. Programmatic Evaluation

USEPA's articulated goal for state programs:
The State, in consultation with its EPA Region, conducts periodic reviews of each aspect of its monitoring program to determine how well the program serves its water quality decision needs for all State waters, including all waterbody types.

J. General Support and Infrastructure Planning

USEPA's articulated goal for state programs:
The State identifies current and future monitoring resources it needs to fully implement its monitoring program strategy.

Major categories that should be addressed include:

- Staffing and Training
- Laboratory Resources
- Funding

II. Ohio EPA Water Monitoring and Assessment Programs

A. Monitoring and Assessment Program Descriptions

A.1 Wadeable Streams and Large Rivers

A.1.1 Watershed Biosurveys

Ohio EPA routinely conducts intensive biological and water quality surveys, or "biosurveys", on a systematic basis statewide. A biosurvey is an interdisciplinary monitoring effort coordinated on a waterbody specific or, more routinely, a watershed scale. Such efforts may involve a relatively simple setting focusing on a small watershed, one or two principal stressors, and 20 - 25 sampling sites or a much more complex effort including entire large river drainage basins, multiple and overlapping stressors, and 100+ sites. On a routine annual basis, Ohio EPA conducts fully integrated river and stream biosurveys in 20-25 U.S. Geological Survey 11-digit HUC-based Watershed Assessment Units (WAUs) and 2-3 Large River Assessment Units (LRAUs) with an aggregate total of 400 - 450 sampling sites. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as contact recreation and public drinking water supply, as well as human health concerns (fish consumption), are also addressed. The data gathered by a biosurvey is processed, evaluated, and synthesized in a biological and water quality Technical Support Document (TSD). The findings and conclusions of each biological and water quality TSD may factor into regulatory actions taken by Ohio EPA and are incorporated into Water Quality Permit Support Documents (WQPSDs), Total Maximum Daily Loads (TMDLs), State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the Ohio Integrated Water Quality Monitoring and Assessment Report (Sections 305[b] and 303[d] of the Clean Water Act).

Specific Ohio EPA water management programs and activities supported by data collected utilizing the integrated biosurvey approach and reported via the TSD include the CWA Section 305(b) reporting process, CWA Section 303(d) listing process (TMDL program), Water Quality Standards program (use designations, criteria refinements and modifications), Permitting program (NPDES permits, PTI requests, CSO regulation, stormwater management program), CWA Section 404/401 Water Quality Certification program, CWA Section 319 Nonpoint Source program, Lake Erie Area of Concern Remedial Action Plans (RAPs), hazardous waste site assessments (NRDA, CERCLA), and enforcement/litigation actions. A positive consequence of this type of sustained, routine, and standardized functional program support is a database and information resource which supports the ongoing water quality management effort in the aggregate. This includes the development of new and improved assessment tools, improved and

refined criteria, indicators development and use, concepts, policies, and rules. The critical concept is that by doing the level of monitoring and assessment that is required by the integrated biosurvey approach, the basic informational infrastructure needed to support the entire water quality management program is in place when the need for such support is realized.

A.1.2 Water Quality Modeling

Additional specialized monitoring, that includes wasteload allocation development and other water quality modeling surveys, is conducted annually to support the NPDES permitting program as well as the TMDL program. The former effort involves the development of Water Quality Based Effluent Limitations (WQBELs) for point sources while the latter activity involves development of watershed-scale point and nonpoint load allocations for pollutants impairing beneficial uses as identified through the watershed biosurveys. Monitoring for TMDL modeling usually takes place the year following the biosurvey while monitoring in support of WQBEL development occurs in advance of NPDES permit reissuance. Data collection for stream modeling surveys involves chemical, physical, and biological measurements. Submersible data loggers are used to collect hourly readings of pH, temperature, dissolved oxygen, and conductivity. Detailed sampling is used to address in-site waste stream assimilation and instream decay rates for nonconservative pollutant parameters. The surveys are conducted between the months of May and October depending upon ambient temperature and stream flow conditions. Oxygen model calibration and verification are completed using this database. In streams where simplified modeling is appropriate, sampling consists of composite and/or grab measurements, flow, diurnal dissolved oxygen measurements, and time of travel collected during a single survey. In complex modeling situations, stream flow, cross-sectional measurements, time of travel, composite chemical sampling, algal biomass and metabolism, diurnal dissolved oxygen, and sediment oxygen demand may be determined over a period of one to three days. Multiple surveys are required to fulfill the data requirements of the Qual2K dissolved oxygen model calibration and verification. Data collection required to calibrate watershed models (SWAT, GWLF) involves year-around monitoring of stream flows and water quality data at selected sites in the study areas, to supplement long term data that may be available at USGS gages in the watershed. Monthly (or more frequent) monitoring is required to define seasonal flow conditions and water quality fluctuations. Where no USGS gages are available, modeling staff may install and calibrate level recorders for extended periods (3 months or longer) to define the hydrologic regime and estimate streamflow during sampling events. In addition, the Modeling Section staff perform streamflow measurements at "sentinel" sites, where district staff collect monthly samples in support of the TMDL program. Procedures used to develop WQBELs and TMDLs have been promulgated in the Ohio WQS at Chapter 3745-2 of the Ohio Administrative Code. (http://www.epa.state.oh.us/dsw/rules/3745-2.html)

A.1.3 Fixed Station Networks

There are two monitoring networks maintained by DSW which qualify as fixed station networks: the National Ambient Water Quality Monitoring Network (NAWQMN) and the Regional Reference Sites network. The NAWQMN network represents the traditional fixed station design which dates to the 1950s. The network now consists of approximately 40 sites which are sampled monthly for field, oxygen demand, nutrient, and selected heavy metals chemical parameters. Biological sampling occasionally takes place at these sites, but at a reduced frequency depending on when watershed biosurveys are conducted. Ohio EPA district offices are responsible for the chemical/physical sampling and the Division of Surface Water Ecological Assessment Section is responsible for the biological sampling. The primary purpose of this network is to provide a long-term database for assessing changes through time. The analysis of trends takes place primarily when such sites are part of a watershed biosurvey and are often a component of a TMDL effort; the results are interpreted in that context. A portion of the NAWQMN network overlaps with the International Joint Commission (IJC) designated sites, addressing the data needs for assessing water quality conditions in Lake Erie and its major tributaries. The NAWQMN network also overlaps with the U.S. Geological Survey National Stream Quality Accounting Network (NASQAN) which is also comprised of a network of gaging stations and a limited number of four parameter continuous monitors.

The Regional Reference Sites network consists of biological (fish and macroinvertebrates), habitat, chemical/physical water quality, and sediment chemical sampling. There are approximately 450 sites located throughout the state with respect to ecoregion and stream size. The purpose of this network is to define reference condition for biological, chemical, and physical parameters and indicators. This in turn is used in the development of the biological criteria, refined chemical assessment thresholds, and other assessment indicators and thresholds. The Division of Surface Water Ecological Assessment Section is primarily responsible for the design and implementation of this network.

A.2 Primary Headwater Habitat Streams

Ohio EPA, as the State's lead water quality agency, monitors the conditions of Ohio's water resources. Results from numerous biological surveys over the past three decades indicate that the many impacts occur in the upper reaches of watersheds of larger streams where the headwaters are located. Current Ohio water quality standards define a "headwater stream" as a stream with a watershed less than or equal to 20 mi^2. These habitats have specific biological criteria for fish (IBI) and benthic macroinvertebrate (ICI) that vary by ecoregion. However, the concept of fish community integrity does not accurately reflect the low level of fish species richness that naturally occurs in the smallest headwater

streams (< 1 mi^2). In addition, the use of Hester-Dendy artificial substrate samplers to sample benthic macroinvertebrates, as required by the ICI protocol, is problematic in the smallest headwater streams due to lack of sufficient water depth. As a consequence, neither the fish based Index of Biotic Integrity (IBI) nor the Invertebrate Community Index (ICI) are appropriate biological assessment tools for the extreme headwater habitats of watersheds.

Furthermore, since 2002, Ohio EPA has shifted monitoring resources to include sampling at smaller watersheds within larger hydrologic units which Ohio EPA has termed Watershed Assessment Units (WAUs). Much of this sampling is geared to identification of causes and sources of use impairment so that pollutant TMDLs can be developed. However, in small watersheds where neither the IBI nor ICI has been thoroughly tested and callibrated, required TMDL assessments are nearly impossible to conduct since it is difficult to determine whether or not the water resource is impaired, especially for the aquatic life use.

Recognizing these limitations in Ohio's monitoring strategy, from 1999 to 2002, the Ohio EPA Division of Surface Water conducted a survey of over 300 of the smallest headwater streams in the various ecoregions of Ohio. This survey was restricted to streams having a catchment of less than 1.0 mi^2 or pools less than 40 cm deep under base flow conditions.

Ohio EPA has coined the term "primary headwater habitat" stream (PHWH) to distinguish these habitats from the current "headwater" stream definition currently defined in the Ohio Water Quality Standards (Chapter 3745-1 in the Ohio Administrative Code).

The results of the first phase of the primary headwater habitat stream project have now been finalized and made available to the public at the following DSW web page. (http://www.epa.state.oh.us/dsw/wqs/headwaters/index.html)

Information available includes various fact sheets on the importance of protecting small headwater stream habitats, a formal assessment manual to be used to sample these habitats, and technical reports on biological and physical conditions observed (Ohio EPA, 2002a, 2002b, 2002c, 2002d, and In Prep.).

In general, the results of the survey indicate that three distinct types of biological communities are present within the spatial scale of the primary headwater habitat, what Ohio EPA refers to Class I PHWH-stream, Class II, and Class III. The biological communities present in these various types of headwater habitats are highly dependent on complex interactions of hydrology, water temperature, stream flow, channel morphology, and type of stream bed substrate.

Class I PHWH-streams by definition are stream channels that are completely separated from ground water aquifers and thus only maintain water during or

immediately after precipitation events. Because Class I streams naturally have a dry channel they have low aquatic biological diversity.

In contrast to Class I-PHWH streams, Class II and Class III streams have hydraulic connection to various types of groundwaters, either perched or represented by the deep groundwater table. The biological conditions of Class III-PHWH streams indicate that they are connected to deep, cold, and perennial groundwater flow, having at least one of the following biological signatures (1) a high number of cool water benthic macroinvertebrate taxa, (2) cold water adapted fish species such as trout, mottled sculpins, and redside dace, or (3) salamander (amphibian) species with long-lived larval periods. The use of three different indicator taxa groups (cool water macroinvertebrates, cold water fish, salamander species with long-lived larval periods) allows for many different types of aquatic habitats to be identified that are connected to groundwater tables. Class II-PHWH streams are those habitats with hydrology connected to perched groundwaters and tend to be warmer in summer months. By definition, Class II PHWH-streams lack the Class III vertebrate indicator groups (fish, amphibians) and have a low number of cool water adapted macroinvertebrates (<3 taxa). Class II-PHWH streams can maintain a diverse number of aquatic species adapted to either perennial warm water or intermittent flow conditions.

Perhaps the most important general finding of this PHWH project is that a diverse network of biological communities are present at drainage areas of less than 1 sq. mi. and that uniform approaches to water quality and land management issues will not adequately protect the diverse types of aquatic resources present. For example, the current water quality standards in the OAC protect all “undesignated” streams in Ohio using the WarmWater Habitat chemical criteria. However, the results of the PHWH survey indicate that this approach is overprotective of ephemeral Class I- PHWH streams, and not protective of Class III streams that require perennial flowing cold to cool water to maintain their ecological integrity.

At present, Ohio EPA has applied the PHWH stream classification system (e.g., Class I, II, III) in the Section 401 water quality certification program to help determine the “existing aquatic life use” for PHWH streams that are proposed to be modified under an Army Corps of Engineers Section 404 permit. The classification system is also being used by the Lake County SWCD to map the existing biological potential of all PHWH streams for small watersheds. This project will greatly assist efforts for appropriate land use planning at the county level of government. Other uses include a Summit County zoning law that requires riparian protection for all PHWH streams, and a basic research effort by scientists at The Ohio State University, Agricultural Research Station, to work with farmers to protect PHWH stream corridors that flow through agricultural lands.

A.3 Inland Lakes and Reservoirs

Ohio EPA's most recent work to monitor and assess inland lakes and reservoirs began in 1989 with a Clean Water Act Section 314 Lake Water Quality Assessment grant that supported the monitoring and evaluation of 52 lakes. Various additional grants enabled the monitoring and evaluation of 89 more lakes through 1995. An analysis and determination of beneficial use status for many of Ohio's 447 significant public lakes (>5 acres in surface area and freely accessible to the citizens of Ohio) were presented in Volume 3 of the 1996 Ohio Water Resource Inventory (Ohio EPA, 1997b). As part of the 1996 Water Resource Inventory report, Ohio EPA applied a revised Lake Condition Index (LCI) (Davic and DeShon, 1989) to characterize overall inland lake and reservoir health and to assess beneficial use status. From 1996 to the present, Ohio EPA has monitored an additional 53 lakes, but LCI assessments have not been completed due to a lack of available resources. Additionally, the passage of HB 43 (Credible Data Law) requires that only Level 3 data of sufficient rigor be used to assess surface water regulatory issues, including beneficial use attainment decisions. Since some components of the LCI do not meet the Level 3 data requirement, its use in future lake assessments will be invalid unless significant revisions are made.

To the extent that many (perhaps most) natural inland lakes in Ohio have extensive wetland communities around their perimeters, or are shallow enough that the entire "lake" is a jurisdictional "wetland", Ohio EPA has developed, and is using in the context of its 401/404 program, techniques for assessing the condition and regulatory protection category of these waters. These tools include the Ohio Rapid Assessment Method for Wetlands v. 5.0 and the Vegetation Index of Biotic Integrity for Ohio Wetlands.

The Ohio 2004 Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2004a) indicated that the Agency will strive to include inland lakes and reservoirs in future monitoring activities. However, available resources continue to be inadequate to provide this need except for isolated instances including the use and assessment of external bacteriological data collected from Ohio State Park beaches which can be used to evaluate status of the designated Bathing Waters contact recreation use at the beach locations. When additional resources can be devoted to more extensive monitoring and assessment efforts, Ohio EPA intends to incorporate inland lake and reservoir evaluations of all designated uses into its overall watershed biosurvey assessment procedures. These procedures currently are used to identify and characterize pollutants and other issues impairing designated beneficial uses of streams and rivers within priority watersheds and for which results may require development and implementation of Total Maximum Daily Loads (TMDLs) and/or other watershed restoration activities. Current efforts are underway within the Division of Surface

Water to identify and permanently support staff dedicated to monitoring of Ohio's inland lakes and reservoirs.

A.4 Lake Erie - Open Waters, Nearshore, Lacustuaries, and Harbors

The Lake Erie program consists of Ohio EPA involvement in activities related to the multi-jurisdictional Lake Erie Lakewide Management Plan, Remedial Action Plans for the four Ohio Lake Erie Areas of Concern, various USEPA/GLNPO programs, the activities of the Ohio Lake Erie Office and other Great Lakes Regional initiatives. Monitoring and assessment activities conducted by Ohio EPA in Lake Erie and the lower tributaries have historically been very limited in scope. However, programs are underway to better assess these areas.

A.4.1 RAP Program

There are four Areas of Concern (AOC) in Ohio for which Remedial Action Plans (RAPs) are underway. These include: the lower Ashtabula River; the entire Black River watershed; the lower Cuyahoga River; and the Maumee AOC, which also contains several other tributaries that discharge directly to Lake Erie. Ohio EPA is responsible for ensuring RAPs are implemented in Ohio. Ohio's RAP Program focuses on the restoration of the fourteen beneficial use impairments (BUIs) listed in Annex 2 of the Great Lakes Water Quality Agreement (IJC, 1988). The RAPs take an ecosystem approach and are based in active public involvement. Since 1988, local communities have been working with federal and state agencies in partnership to make decisions, raise funds and implement the actions needed to restore Ohio's AOCs.

Each of Ohio's RAPs has been organized somewhat differently, depending on the unique characteristics of each AOC. These characteristics include: environmental problems in the AOC; sources and causes of the problems; available resources - both technical and financial; political climate; public interest; and the volunteer base. The ecosystem approach and public involvement have promoted a flexible and innovative process toward restoration, but one that has taken a long time. The RAPs require a comprehensive assessment of the problems, a plan to address the problems, implementation of the plan, and continuing monitoring to ensure that the AOCs are not re-contaminated and that the actions implemented have indeed restored all beneficial uses to the river. The RAPs rely heavily on monitoring already being conducted by Ohio EPA. However, monitoring or assessment related to individual projects in the AOCs is done as well.

The Great Lakes Water Quality Agreement lists 14 beneficial use impairments against which the health of the Great Lakes are to be measured which include:

- Restrictions on fish and wildlife consumption
- Tainting of fish and wildlife flavor
- Degraded fish and wildlife populations
- Fish tumors or other deformities
- Bird or animal deformities or reproductive problems
- Degradation of benthos
- Restrictions on dredging activities
- Eutrophication or undesirable algae
- Restrictions on drinking water consumption or taste and odor problems
- Beach closings
- Degradation of aesthetics
- Added costs to agriculture
- Degradation of phytoplankton and zooplankton, and
- Loss of fish and wildlife habitat.

The RAPs have completed BUI assessments, implemented many remedial actions, and are currently developing targets to determine when a beneficial use is no longer impaired.

A.4.2 Lakewide Management Plan (LaMP)

The development of Lakewide Management Plans (LaMPs) is another requirement of the Great Lake Water Quality Agreement. A LaMP is a comprehensive management plan to restore and protect the biological, physical and chemical integrity of the Great Lakes. The goal of the Lake Erie LaMP is to preserve, restore and protect the beneficial uses of the open waters of Lake Erie. The development of the Lake Erie LaMP can best be thought of as a problem solving process. The first step was to identify impairments and the causes and sources. Assessments have been completed for each of the BUIs listed previously. The second step was to define a vision for the desired future state of the lake and the general actions needed to achieve it. Indicators are currently under development to provide a means of measuring the progress toward achieving the ecosystem objectives associated with achieving the vision (USEPA and Environment Canada, 2004).

A.4.3 Lake Erie Coastal Wetlands

Lake Erie Coastal Marshes are a specific hydrogeomorphic (HGM) class of wetlands in Ohio. Coastal marshes included open and closed embayments, river mouth wetlands, and managed, unmanaged and failed diked wetlands. Ohio EPA has evaluated, developed and adapted assessment techniques, originally developed for inland wetlands, for use in Lake Erie Coastal Marshes. These tools include the Ohio Rapid Assessment Method for Wetlands v. 5.0 and the Vegetation Index of Biotic Integrity for Ohio Wetlands.

A.5 Ohio River

Since 1948, the Ohio River Valley Water Sanitation Commission (ORSANCO) and its member states have cooperated to improve water quality in the Ohio River Basin so that the river and its tributaries can be used for drinking water, industrial supplies, and recreational purposes; and can support healthy and diverse aquatic communities. ORSANCO operates monitoring programs to check for pollutants and toxins that may interfere with specific uses of the river, and conducts special studies to address emerging water quality issues. ORSANCO was established on June 30, 1948, to control and abate pollution in the Ohio River Basin. ORSANCO is an interstate commission representing eight states and the federal government. Member states include Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia, and West Virginia. ORSANCO operates programs to improve water quality in the Ohio River and its tributaries including: setting waste water discharge standards; performing biological assessments; monitoring for the chemical and physical properties of the waterways; and conducting special surveys and studies. ORSANCO also coordinates emergency response activities for spills or accidental discharges to the river, and promotes public participation in programs such as the Ohio River Sweep, RiverWatchers Volunteer Monitoring Program, and Friends of the Ohio.

As a member to the Commission, the State of Ohio and the Ohio Environmental Protection Agency support ORSANCO activities, including monitoring of the Ohio River mainstem, by providing funding based on state population and miles of Ohio River shoreline. As such, monitoring activities on the Ohio River are coordinated and conducted by ORSANCO staff or its contractors. ORSANCO has developed a detailed monitoring strategy for the Ohio River which has been endorsed by member states and the federal government (ORSANCO, 2005). This document was developed under the guidance and oversight of several committees and subcommittees of ORSANCO which are composed of scientists and technical staff from state environmental and natural resource agencies and various federal agencies. The document is available at the following web location. (http://www.orsanco.org./)

A.6 Human Health (Fish Consumption)

Ohio has a comprehensive monitoring program for fish consumption advisory purposes. It addresses all applicable State waters, including streams, rivers, inland lakes and reservoirs, Lake Erie, and the Ohio River. Ohio EPA and the Ohio Department of Natural Resources (Ohio DNR), together with input from the Ohio Department of Health, maintain a fish consumption advisory program that includes sample collection, laboratory analysis, data assessment, and public outreach. The monitoring strategy provides for sampling all of Ohio's drainage basins greater than 50 square miles, and all of Ohio's public inland lakes and reservoirs greater than 5 surface acres, at least once every ten years. Priority

water bodies such as Lake Erie, the Ohio River, and some more highly fished and/or highly contaminated areas such as the major tributaries to Lake Erie, portions of the Ohio River, and some of the larger sport fishing lakes are sampled on a five-year cycle. The collected samples are analyzed for priority pollutants, including several metals, PCBs, and a number of pesticides. The results are analyzed and reported to the public on a yearly basis. A thorough description of the program and the latest advisory information can be found at the following web location.
(http://www.epa.state.oh.us/dsw/fishadvisory/index.html)

A.7 Human Health (Contact Recreation)

A.7.1 Ohio's Recreation Water Quality Standards

Ohio's Water Quality Standards (WQS) recognize a tiered system of recreational uses consisting of the Bathing Water (BW) use, Primary Contact Recreation (PCR) use, and Secondary Contact Recreation (SCR) use. These uses and the associated criteria are contained in OAC 3745-1-07. The recreation use is seasonal, lasting from May 1st to October 15th. Ohio's WQS utilize a set of dual criteria consisting of two indicator types: fecal coliform and *E. coli*. It is only necessary to meet the criteria associated with one of these two indicators in order for the waterbody to be considered in attainment of its recreational use designation.

USEPA's Office of the Inspector General conducted an audit of the WQS program in 1998. The 1999 audit report noted only one significant deficiency in the WQS program, which was Ohio's failure to update its bacteria criteria to be consistent with the 1986 federal recommendations for bacteria. Ohio was included in a federal rulemaking published on November 16, 2004, that made Ohio's coastal recreation waters consistent with federal requirements under the 2000 BEACH Act from USEPA's perspective. This rulemaking eliminated the dual criteria currently in place for Lake Erie, leaving only USEPA's 1986 *E. coli* criteria. Monitoring for *E. coli* will continue as it is currently performed (four times per week between Memorial Day and Labor Day). However, posting decisions will be based upon exceedance of the single sample maximum of 235 rather than exceedance of a 5-sample running geometric mean of 126. Ohio's WQS program anticipates making changes to the state's bacteria criteria in the near future. These changes will, in turn, have implications on the monitoring program for bacteria.

A.7.2 Recreation Use Designations and Use Attainability Analysis (UAA)

Field evaluations for determining recreational use potential are typically performed as part of the watershed biosurvey program conducted from June 15th to October 15th. Selection of waters needing UAA information is part of the study planning process. Obtaining the information needed for management decisions is dependent on good study planning. When UAA information is not collected, waters are assigned the Primary Contact Recreation use.

Differentiating between the PCR and SCR uses has historically revolved around the issue of water depth. Water bodies having an average depth of three feet over a 100ft^2 area have been deemed "swimmable/full body contact" and assigned a PCR use whereas water bodies not having this depth have been considered "wadeable/partial body contact" and therefore assigned the SCR use designation. Ohio EPA Policy DSW-0700.008 (Ohio EPA, 1999a) describes in further detail the methodologies Ohio has typically used to make recreational use decisions. During Ohio EPA's 2002 use designation rulemaking, USEPA Region V expressed concern over the Ohio's recreational UAA process stating that Ohio EPA's use attainability analysis used in justifying the secondary contact recreation use was inadequate because it was too narrowly focused on water depth alone, failing to account for other factors important in determining recreational use potential. Furthermore, USEPA stated that "physical factors alone do not provide sufficient justification for removing or failing to designate a primary contact recreation use". In response, Ohio has begun to incorporate other factors such as adjacent land uses, potential for use by children, and accessibility in addition to water depth as factors to consider during the UAA. Ohio has developed a new field data sheet to facilitate the collection of pertinent data for use in the use designation process.

Ohio plans to reconstruct its recreational use designation platform in the future to better account for the multitude of factors necessary for making appropriate recreation use designation decisions. There is also a recognized need for the use framework to be able to deal with wet weather situations as well. Modification of existing UAA guidance and study plan design will happen after the revised recreation use rule changes are adopted.

A.7.3 Recreation Water Quality Criteria

The applicable criteria include both the fecal coliform and *E. coli* bacteria indicators, with these dual indicators being in place since 1990. Ohio's bacteria monitoring strategy has historically focused on the collection of fecal coliform data. Recently, however, Ohio has been collecting data on both indicators in anticipation of a switch away from fecal coliform to the exclusive use of *E. coli* criteria. During this transition period, extra monitoring resources are utilized. Ohio's WQS generally include both a geometric mean criterion and a "not to exceed" criterion for each indicator type (there is no geometric mean criterion for the SCR use). The geometric mean requires the collection of a minimum of five samples within a thirty-day period. Concerns have always been raised about the resources available to meet this type of sampling demand. In an effort to address this concern, memos were distributed in the spring of 2003 to field staff providing guidance on conducting bacteria sampling. In addition, OAC 3745-1-04 and Ohio EPA DSW Water Quality Standard Guidance #3 provides specific detail for sampling methods and monitoring for the documentation of public health

nuisance conditions. The Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (2003) provides details regarding bacteria sampling methodology used by field personnel in the collection of water samples for bacteria measurements. Finally, the Ohio Department of Health (ODH), in cooperation with various county health departments, monitors Lake Erie coastal beaches for bacteria (*E. coli*) while the Ohio Department of Natural Resources does some limited and variable monitoring of beaches at inland state parks. The ODH sampling procedures and sample results are available on their web site. (http://www.odh.state.oh.us/ODHPrograms/beach/beachmain.htm)

A.8 Human Health (Public Drinking Water Supply)

In 2002, Ohio EPA initiated development of an assessment methodology for the Public Drinking Water Supply (PDWS) beneficial use required under Section 305(b) of the Clean Water Act. Previously, it was believed that water quality standards designed to protect the aquatic life uses were comprehensive enough to be protective of the PDWS use. However, several water bodies in Ohio were identified where the aquatic life use assessment failed to identify source water conditions which required additional treatment and expenditures by a public water system. This approach maximizes protection efforts by employing the authority of the Clean Water Act to prevent contamination of source waters while minimizing the risk to human health and violations of standards set forth in the Safe Drinking Water Act (SDWA).

The PDWS use assessment methodology was developed to evaluate surface waters used as source water for Ohio public water systems and to identify those waters of poor quality which adversely impact operation of the treatment plants. Development of PDWS water quality standards are based on the objective that public water systems using *conventional* treatment could meet the finished water standards established by the Safe Drinking Water Act. Identification of impaired waters will allow Ohio EPA, local watershed groups and local communities to focus attention and resources on improving the source water quality, ultimately resulting in reduced risk to human health and reduced treatment costs for communities. Additionally, source water quality data will assist communities with watershed planning and protection efforts through contaminant trend analysis and evaluation of best management practices (BMPs) effectiveness.

Ohio EPA will employ a tiered assessment approach, beginning with active surface water intakes serving public water systems. All other water bodies with PDWS use designations will eventually be assessed. Although this beneficial use designation applies to a 500-yard zone surrounding the intakes, the attainment determination will apply to the entire Watershed or Large River Assessment Unit. For public water systems with intakes located in multiple assessment units, separate assessments will be completed for each intake.

A.9 Wetlands

Ohio EPA has a developed a comprehensive strategy for monitoring the quality of wetlands throughout the state of Ohio. Major steps in the process towards establishment of wetland water quality standards are as follows.

Ohio EPA adopted Wetland Water Quality Standards on May 1, 1998. The wetland water quality standards specify narrative criteria for wetlands. All wetlands are assigned to the "wetland designated use." More detailed uses and numeric biological criteria were not proposed since the data to support them had not been collected. The wetland antidegradation rule (OAC 3745-1-54) created three categories of wetlands (low, medium, and high quality). State legislation was enacted in 2001 for the regulation of impacts to isolated wetlands which no longer fall under federal jurisdiction. The isolated wetland law also assigns wetlands three antidegradation categories based on their quality. We are now defining these regulatory categories using actual measures of a wetland's biology and functions.

Ohio EPA began working on the development of wetland biological criteria in 1996. To date, Ohio has over 200 points in the wetland data set. Plant and amphibian IBIs (Vegetation IBI or VIBI, AMPHIBI) have been developed and are being refined. Tiered Aquatic Life Uses (TALUs) for Wetlands were initially proposed in November 2001. These uses were refined and vegetation and amphibian TALUs are included in a Water Quality Standards rulemaking package currently under review. Macroinvertebrate assemblages will also be used to define wetland TALUs.

The Ohio Rapid Assessment Method for Wetlands (ORAM v. 5.0) was finalized on February 1, 2001. Development of the ORAM began in 1996 and paralleled the development of Wetland IBIs. This method has been widely accepted for use in Ohio. The National Park Service is using it as a screening tool in the Cuyahoga Valley National Park. Portions of the method have been adapted for use by researchers in New York and Minnesota and it is being considered for use in California and other states. A recent study of all existing wetland rapid assessment methods chose ORAM v. 5.0 has one of the best methods available. An updated User's Manual, minor revisions for a v. 5.1, and an updated Score Calibration Report are being planned.

Ohio EPA first evaluated mitigation wetland performance in a 1995 study. A very detailed study of the biological and biogeochemical characteristics of natural marshes versus mitigation wetland marshes was performed during 2001-2002 in conjunction with researchers at Kenyon College and Ohio State University. Products of this project include standardized monitoring protocols, quantitative performance standards, and an evaluation of the feasibility of developing a

mitigation ORAM. Preliminary results suggest that a rapid mitigation assessment cannot replace detailed monitoring although it may be usable in conjunction with detailed monitoring. Ohio EPA completed an inventory of all past 401 mitigation projects in 2002-2004. A random sample of this inventory with detailed biological and chemical sampling is planned for 2006-2007. This will allow statistical evaluation of the overall ecological performance of mitigation wetlands in Ohio to be done. Finally, detailed sampling and evaluation of all wetland mitigation banks in Ohio was performed in 2003-2004.

In conjunction with EMAP (Environmental Monitoring and Assessment Program) in Corvallis, Oregon, Kenyon College, and the Cuyahoga RAP, a project that will evaluate the overall condition of wetlands in the Cuyahoga River watershed has commenced. This project uses a probabilistic sampling design. Over 400 wetlands were assessed during spring and summer 2005 and final field work will be completed during the fall.

The Wetland Ecology Group provided substantial litigation support during the Bainbridge lawsuits in 2001 and continues to be involved with other appeals. Our current Wetland Grant allows for work “defending” or using the grant products in permit appeals and enforcement to be funded by the grant. Technical assistance to 401 Coordinators on various projects occurs regularly on an as needed and ad hoc basis.

Over 300 people have attended ORAM training during the years 2002-2005. An advanced wetland focused botany course was taught with the cooperation of ODOT staff in the spring and summers of 2003 and 2004. Over 30 people attended the botany course which includes field practicals and a final examination. Fifty people attended wetland biocriteria training during the fall 2004 and another 40 individuals are scheduled for the training during the fall 2005. The course provides indepth information on field, lab and desktop methods to derive vegetation and amphibian IBI scores. Development of the wetland ICI will also be discussed. Given the reliance on outside consultants and users in our wetland program, continued and advanced training is essential to obtain good information in wetland permit applications.

In 2006, information will be gathered on urban wetlands in central Ohio. The range of wetland assessment methods Ohio EPA has available will be run on a random sample of all wetlands within the I-270 corridor. This data will allow comparisons between natural wetlands and wetlands influenced by an urban setting. The data will also be used to identify those urban wetlands that are performing valuable functions and target them for protection.

A.10 Ground Water

The Ohio EPA Division of Drinking and Ground Waters (DDAGW) maintains Ohio's Ground Water Quality Characterization Program (GWQCP) as a non-regulatory, ground water monitoring program for Ohio. This program focuses on collecting raw water samples and complements compliance program ground water sampling. The Ground Water Quality Characterization Program (GWQCP) includes two primary elements:

- Ambient Ground Water Monitoring Program (AGWMP); and
- Special Studies.

The purpose of these efforts is to characterize general ground water quality conditions in Ohio to enhance water resource planning and protection activities. In general terms, the AGWMP focuses on statewide and regional scales and the special studies focus on local scales. These efforts complement compliance ground water sampling completed by permitted facilities. These data support Ohio EPA-DDAGW's mission to protect human health and the environment by characterizing and protecting ground water quality and by helping to ensure that Ohio's public water systems provide adequate supplies of safe drinking water.

The AGWMP program currently collects raw (untreated) water samples at 200 sites on a semi-annual sampling schedule with the objective of characterizing the major aquifers in the state. This program was established in1973 to measure seasonal and annual water quality changes in the State's major aquifers. The number of wells sampled varied significantly through the 1970s and 1980s. In the mid 1990s, the program was evaluated and additional wells were included in the AGWMP to improve the geographic distribution and to provide better representation of the three primary aquifers in Ohio. The long sampling history of many of these wells is particularly valuable for documenting water quality trends at specific locations. Of the total sites, roughly 95% are public water systems and roughly 5% are industrial, business, or residential wells. Of the active wells, 62% are in unconsolidated aquifers, 22% are in limestone aquifers, and 16% are in sandstone aquifers.

B. Monitoring Objectives

USEPA's articulated goal for state programs:
The state has identified monitoring objectives critical to the design of a monitoring program that is efficient and effective in generating data that serve its management decision needs.

Descriptions of Ohio EPA Water Program Monitoring Objectives
Ohio EPA has identified monitoring objectives which are used to design our monitoring program. This program is efficient and effective in generating data that serve our management decision needs for many water resource types and beneficial uses. There are, however, shortfalls that will be addressed within this document.

General monitoring objectives for Ohio's different water body types support programmatic needs including: 1) determining status and trends of Ohio waters; 2) identifying causes and sources of impairment and threats and ranking in priority order; 3) identifying existing and emerging problems; 4) supporting water quality management policy and program development; 5) evaluating program effectiveness; 6) responding to emergencies, and 7) developing and improving the understanding of the basic chemical, physical, and biological processes that affect environmental quality.

B.1 Wadeable Streams and Large Rivers
Biological, chemical, and/or physical monitoring and assessment techniques are employed in watershed biosurveys and fixed station networks in order to meet four major objectives in addition to those listed above. These include 1) determining the extent to which beneficial use designations assigned in the Ohio Water Quality Standards are either attained or not attained; 2) determining if use designations assigned to a given water body are appropriate and attainable (Use Attainability Analysis protocols); 3) monitoring previously unassessed watersheds, and 4) determining if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls, NPS agricultural and urban best management practices (as guided by the Nonpoint Source - Section 319 Program Evaluation Framework; Ohio EPA, 2004b), or Section 303(d) TMDLs developed for identified pollutants causing beneficial use impairment. Ohio EPA is committed to integrating NPS Program activities with the agency's current statewide watershed biosurvey program, particularly the long-term monitoring plan/TMDL schedule. This will allow continued predictive capabilities to accurately identify the number of watersheds impaired significantly by NPS. This will also facilitate identification of those watersheds that have fully

or partially recovered as a result of local preservation and restoration efforts. The watershed biosurvey program will also be used at the sub-basin level to specifically assist with identifying NPS problem areas including cause and impairment source relationships and/or threats, helping to develop detailed watershed restoration and preservation plans, and evaluating local project effectiveness. More specific monitoring objectives for key beneficial uses and related discussion are detailed below.

B.1.1 Aquatic Life Uses

The primary objective of biological monitoring of resident fish and macro-invertebrate communities in wadeable streams and large rivers is to directly assess the biological integrity goal of the Clean Water Act. To this end, Ohio EPA developed a tiered framework of aquatic life uses and associated biological criteria which have been promulgated in the Ohio Water Quality Standards (Chapter 3745-1 of the Ohio Administrative Code). (http://www.epa.state.oh.us/dsw/wqs/criteria.html)

The most innovative aspect of this effort was the incorporation of standardized biological field and laboratory analysis protocols coupled with development of bioassessment indices and subsequent derivation of biological criteria callibrated against least impacted ecoregional reference sites.

In applications of the Ohio WQS to the management of water resource issues in Ohio's wadeable streams and large rivers, the aquatic life use criteria frequently result in the most stringent protection and restoration requirements, hence their emphasis in watershed biosurveys and biological and water quality TSDs. Also, an emphasis on protecting for aquatic life generally results in water quality suitable for all uses. The five different aquatic life uses currently defined in the Ohio WQS are described as follows.

> *Warmwater Habitat (WWH)* - this use designation defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams; *this use represents the principal restoration target for the majority of water resource management efforts in Ohio.*
>
> *Exceptional Warmwater Habitat (EWH)* - this use designation is reserved for waters which support "unusual and exceptional" assemblages of aquatic organisms which are characterized by a high diversity of species, particularly those which are highly intolerant and/or rare, threatened, endangered, or special status (*i.e.,* declining species); *this designation represents a protection goal for water resource management efforts dealing with Ohio's best water resources.*

Coldwater Habitat (CWH) - this use is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic "runs" of salmonids during the spring, summer, and/or fall.

Modified Warmwater Habitat (MWH) - this use applies to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable *and where the activities have been sanctioned and permitted by state or federal law;* the representative aquatic assemblages are generally composed of species which are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor quality habitat.

Limited Resource Water (LRW) - this use applies to small streams (usually <3 mi.^{2} drainage area) and other water courses which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported; such waterways generally include small streams in extensively urbanized areas, those which lie in watersheds with extensive drainage modifications, those which completely lack water on a recurring annual basis (*i.e.,* true ephemeral streams), or other irretrievably altered waterways.

Chemical, physical, and/or biological criteria are generally assigned to each use designation in accordance with the broad goals defined by each. As such the system of use designations employed in the Ohio WQS constitutes a "tiered" approach in that varying and graduated levels of protection are provided by each. This hierarchy is especially apparent for parameters such as dissolved oxygen, ammonia-nitrogen, temperature, and the biological criteria. For other parameters, such as heavy metals, the technology to construct an equally graduated set of criteria has been lacking; thus, the same water quality criteria may apply to two or three different use designations. However, with the adoption of dissolved metals criteria as a result of the Great Lake Water Quality Agreement, "equivalency" with a tiered system of criteria for metals is effectively achieved whenever the biocriteria derived total recoverable thresholds are used to develop the wasteload allocation (Ohio EPA, 1997).

B.1.2 Recreation Uses

Ohio EPA's monitoring objectives for recreational uses are congruent with Clean Water Act monitoring objectives. An attempt is made in all waterbodies sampled where recreational beneficial uses are applicable to perform use attainability

analyses to assign appropriate uses, determine use attainment status, identify impairments, determine causes and sources of impairment, support TMDL efforts, etc. Ohio EPA Policy DSW-0700.008 (Ohio EPA, 1999a) describes in detail the methodologies Ohio has historically used to make recreational use decisions. However, concern expressed by USEPA Region V during Ohio EPA's 2002 use designation rulemaking over the Ohio's recreational UAA process has led Ohio to incorporate additional factors such as adjacent land uses, potential for use by children, and accessibility to water depth as factors to consider during the UAA process. One of Ohio's monitoring objectives has therefore become reconstruction of its recreational use designation platform to account for the multitude of factors related to making appropriate recreation use designation decisions. The use framework will also be altered to deal with wet weather situations as well. Modification of existing UAA guidance and study plan design will happen after the revised recreation use rule changes are adopted.

B.1.3 Public Drinking Water Supply Use

The primary objective for monitoring of waters designated for the Public Drinking Water Supply (PDWS) use is to identify areas and specific causes of impairment. Ohio is currently developing water quality standards and assessment methodology for this beneficial use and would utilize the first few years of monitoring data to evaluate and refine the methodology. Source water monitoring data will be used in addition to public water system compliance data collected and submitted to Ohio EPA to fulfill Safe Drinking Water Act requirements. Monitoring will be conducted in areas where insufficient source water data exists or additional water quality data is required to confirm suspected impairment, and in conjunction with Ohio EPA's routine watershed biosurveys.

B.1.4 Fish Consumption

The primary objective of the fish consumption advisory program is to provide meaningful information to the citizens of Ohio regarding the safety of consuming fish caught from Ohio's surface waters including inland streams, large rivers, lakes, reservoirs, the Ohio River, and Lake Erie. Beginning with the 2004 Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2004a), a second objective of data generated for the fish consumption advisory program was developed. In this case, protocols were established to determine impairment status of a water body based on fish tissue analytical data. Basically, if a water body has a fish consumption advisory in effect due to PCBs or specific organochlorine pesticides (one meal per month or more restrictive), an impairment for fish consumption was indicated and the water body listed accordingly. Similarly, for mercury, if a water body has an advisory due to fish tissue contamination at or in excess of 350 parts per billion mercury (one meal per month advisory or more restrictive), the water body was listed as impaired for fish consumption due to the advisory.

B.2 Inland Lakes and Reservoirs

The Ohio EPA inland lakes and reservoirs monitoring program was last active during the late 1980s and early 1990s and was funded by several CWA Section 314 Lake Water Quality Assessment grants received by Ohio EPA which resulted in 141 lakes being sampled between 1988 and 1995.

Objectives of the monitoring program during this time frame were as follows.

- to improve Ohio's ability to classify lakes, to identify impaired and threatened lakes, and to establish consistent databases for future assessments of trends in lake water quality and

- to determine overall water quality, lake trophic state, and status of beneficial uses (aquatic life, recreation, water supply, fish consumption, and flood control).

B.3 Lake Erie - Open Waters, Nearshore, Lacustuaries, and Harbors

For the open waters of Lake Erie, Ohio largely relies on the bi-national monitoring done by USEPA-GLNPO and Environment Canada. Ohio EPA's monitoring efforts in Lake Erie have focused on its drowned river mouths (lacustuaries) with special emphasis on the four AOCs in Ohio for which RAPs are underway and the nearshore areas along the mainland coastline and around the Bass Islands. Ohio EPA has developed monitoring objectives which largely support its management needs to protect the water resource quality of Lake Erie. These monitoring objectives strongly reflect Ohio EPA's involvement in the multi-jurisdictional Lake Erie Lakewide Management Plan, RAP program, various USEPA/GLNPO programs, the activities of the Ohio Lake Erie Office and other Great Lakes Regional initiatives. Specific objectives for the various programs are provided below.

B.3.1 RAP Program

There are four AOCs in Ohio for which RAPs are underway. These include: the lower Ashtabula River; the entire Black River watershed; the lower Cuyahoga River; and the Maumee AOC, which also contains several other tributaries that discharge directly to Lake Erie.

The Great Lakes Water Quality Agreement lists 14 beneficial use impairments (BUIs) against which the health of the Great Lakes and the RAPs are to be measured. The 14 BUIs were previously listed in Section A.4.1. Based on initial guidance from the IJC (IJC, 1991), Ohio EPA has finalized targets and milestones for determining when a BUI is no longer impaired (Ohio EPA, 2005a). Monitoring objectives for AOCs address determining the status of each of the BUIs. Each of the RAPs has completed an assessment of the BUIs in their

AOCs and is using the Ohio EPA delisting targets as the baseline for further customizing targets that may be more appropriate for the conditions in that AOC.

B.3.2 Lakewide Management Plan (LaMP)

The development of Lakewide Management Plans (LaMPs) is another requirement of the Great Lake Water Quality Agreement. A LaMP is a comprehensive management plan to restore and protect the biological, physical and chemical integrity of the Great Lakes. The monitoring objectives of the LaMP are served by the BUI assessments described above. The role of the states in implementing the LaMP is to improve land use and river discharges that are impacting the lake. Therefore, Ohio EPA monitoring objectives are largely reflective of the monitoring objectives for the Lake Erie tributary streams and shoreline.

B.3.3. Other Lake Erie Programs

The State of Ohio has developed a Lake Erie Quality Index (LEQI) (Ohio Lake Erie Commission, 2004) used to periodically measure the state of the lake as related to the quality of life it provides to Ohio citizens and visitors to the Lake Erie area. To support the LEQI, the state has adopted the Lake Erie Protection and Restoration Plan (Ohio Lake Erie Commission, 2000). Monitoring objectives are to measure the progress of the activities listed in the Protection and Restoration Plan, and translate the results of this progress into updates to the LEQI.

B.4 Ohio River

Monitoring objectives for the Ohio River mainstem are documented in ORSANCO (2005).

B.5 Wetlands

Wetlands are being evaluated on an individual basis as they are proposed for impacts through Section 401 or Isolated Wetland Permit applications. Work is just beginning on doing assessments of wetlands at a watershed level. Most watersheds have thousands of individual wetlands which makes monitoring and assessment of each wetland impractical. What is being tested instead is choosing and assessing a representative sample and then based on those results making statements about the overall condition of wetlands in a watershed.

To date, monitoring and assessment of wetlands in Ohio has focused on the development of assessment methods for use in the Section 401/404 permit program and the evaluation of the mitigation wetlands in Ohio. While Tiered Aquatic Life Uses have been proposed, these have not yet been incorporated into rule, although to the extent that reference wetland data sets are used to define existing antidegradation categories already specified in Ohio's wetland

rules since 1998, the antidegradation categories are equivalent to rule-based TALUs. The pilot wetland condition assessment project in the Cuyahoga River watershed that is being funded by a Wetland Program Development grant will provide the technical and statistical procedures for doing watershed scale ambient condition assessment of Ohio's wetlands.

The final step will be to perform a fully integrated assessment of both wetlands and flowing waters (streams, rivers) in a watershed. This will involve the inclusion of ambient wetland assessments as part of Ohio EPA's routine intensive biological and water quality surveys, or "biosurveys", on a systematic basis statewide. Such an integrated biosurvey would be a an interdisciplinary monitoring effort coordinated on a watershed scale. Such efforts may involve a relatively simple setting focusing on a small watershed or a much more complex effort including entire large river drainage basins and multiple and overlapping stressors. Wetlands would be included in the routine, annual, biosurveys Ohio EPA already conducts in 20-25 U.S. Geological Survey 11-digit HUC-based Watershed Assessment Units (WAUs) and 2-3 Large River Assessment Units (LRAUs.

B.6 Ground Water

The primary objective of the Ambient Ground Water Monitoring Program is to provide statewide ground water quality data (raw water) for the major aquifers in Ohio. The AGWMP places a priority on collecting data from public water systems. Water samples collected by the public water systems for compliance purposes are collected from distribution samples (treated water); consequently, the raw water AGWMP data are valuable resource data distinct from the compliance data. These AGWMP data are used to characterize the water quality in the major aquifers across the state, to help identify sensitive ground water settings, to document long-term trends in ground water quality, and to provide water quality data to help implement compliance programs. AGWMP sampling generally includes the deeper, more productive aquifers. These aquifers are not representative of the shallow, and consequently, the most sensitive aquifers in the state.

The AGWMP data is supplemented with data collected for special studies. Special studies are topical or site-specific sampling programs of short duration with the objective of answering specific questions, such as identifying cause and effect relationships and identifying areas of impacted ground water. Special studies, by their site-specific nature, generally focus on the more sensitive, shallow aquifers. The objective of the study is well defined and a sampling plan template has been generated to ensure internal review to improve sampling design and to capture a critical set of hydrogeologic data elements so the analytical data can be captured in STORET.

C. Monitoring Design

USEPA's articulated goal for state programs:
The state has an approach and rationale for selection of monitoring designs and sample sites that best serve its monitoring objectives.

Descriptions of Ohio EPA Water Program Monitoring Designs

C.1 Wadeable Streams and Large Rivers

C.1.1 Watershed Biosurveys

In 1990, Ohio EPA initiated an organized, sequential approach to monitoring and assessment termed the Five-Year Basin Approach. One of the principal objectives of this new approach was to better coordinate the collection of ambient stream and river monitoring data so that information and reports would be available in time to support water quality management activities such as the reissuance of NPDES permits, development of watershed TMDLs, and periodic revision of the Ohio Water Quality Standards (WQS). The initial step in this process was to section the state into 25 different hydrologic units which represented aggregations of subbasins within the 23 major river basins previously delineated by Ohio EPA for the Planning and Engineering Data Management System for Ohio (PEMSO) system. The 25 hydrologic units are roughly distributed equally among the five Ohio EPA districts. Within a given year, monitoring takes place within five of the areas, one in each of the five Ohio EPA districts. Thus, five years is required to complete the cycle of monitoring within each of the 25 hydrologic areas.

Further refinement of the Five-Year Basin design occurred in the early 2000s in response to the Ohio EPA decision to embark on a progressive watershed-based monitoring, assessment, and reporting approach to facilitate the collection of data to support development of TMDLs impairing beneficial uses using the 12-Step TMDL Process (Ohio EPA, 1999b). To this end, Ohio EPA adopted as basic watershed assessment units the U.S. Geological Survey 11-digit Hydrologic Unit (HUC-11) of which there are 331 delineated within Ohio. The HUC-11 assessment units are of practical size for development, management, and implementation of effective TMDLs and, as such, serve as the basic biosurvey design for this high priority program activity.

To facilitate individual site selection and provide for comprehensive watershed coverage, Ohio EPA initiated a process in 1998 coined geometric site selection to identify sampling locations in HUC-11 WAUs targeted for intensive monitoring and where identification of beneficial use impairments is needed in anticipation of

TMDL development for pollutants. Site selection within the watershed is driven by a stratification of the watershed based on a sequential, systematic halving of drainage area such that a census of all streams within the watershed down to a prescribed drainage area size are selected for sampling. For example, a 160 mi^2 watershed would have all stream reaches identified at the 160 mi^2, 80 mi^2, 40 mi^2, 20 mi^2, 10 mi^2, and 5 mi^2 drainage areas. Sampling locations which best match these drainage areas are used in combination with other longitudinally relevant sites (e.g., those bracketing point sources, regional reference sites, historical mainstem sites, etc.) to adequately assess the watershed. For the typical HUC-11 WAU in Ohio (approximately 125 mi^2 watershed size), 20 to 25 sampling locations will be targeted with this approach; this provides coverage of one site for about every 5 mi^2 of watershed size (an area roughly bounded by 2.2 miles on a side). More traditional site selection protocols are used to establish LRAU sampling locations including location of point sources, confluence of major tributaries, longitudinal extent of urban areas, wet weather stormwater or combined sewer discharge points, regional reference sites, historical sampling locations, other geographically relevant points, and other locations of known site-specific interest. Some of the principal benefits of using the geometric design are the ability to economize sampling resources on a watershed scale, development of a stratified database, and the enhanced ability to capture previously unassessed streams. This approach has been particularly useful for watersheds that are targeted for TMDL development in that unassessed waters and outdated assessments can be resolved just prior to TMDL development.

C.1.2 Fixed Station Networks

Current fixed station networks include:

1) National Ambient Water Quality Monitoring Network (NAWQMN)/State Monthly Fixed Station Network
   The principal objective of the NAWQMN/State fixed station network is to measure general progress towards achieving national water quality goals. The network was established in 1974 using guidance provided by U.S. EPA. Formerly, this network included approximately 150 sites statewide. Currently, there are 56 sites of which 39 are NAWQMN stations. Seven (7) of these stations, along with 6 additional locations, also serve as IJC sites and are located near the mouths of the 12 major Lake Erie tributaries. Each site is sampled monthly for physical and chemical constituents and provides a database that spans nearly 30 years.

2) U.S. Geological Survey (USGS)/Ohio EPA Cooperative Network
   The Ohio EPA/USGS cooperative program includes the operation of 25 fixed gaging stations. These stations provide continuous flow data and are coordinated with the NAWQMN and State Monthly monitoring stations. The Ohio EPA/USGS Cooperative Network also includes eleven (11)

continuous water quality recorders which provide data for four (4) parameters; dissolved oxygen (D.O.), pH, temperature, and specific conductance. USGS samples and reports data at 9 National Stream Quality Accounting Network (NASQAN) stations in Ohio. Sampling for physical and chemical constituents is conducted quarterly. This network supplements the NAWQMN and State Monthly fixed station networks.

3) Lake Erie Monitoring and IJC Programs
Ohio EPA conducts ambient monitoring at thirteen (13) sites near the mouths of major Lake Erie tributaries. Seven of these sites are also part of the NAWQMN/State Monthly network described above. An additional six sites constitutes the IJC network to provide annual tributary loading data on nutrient and toxic substances, calculated by the IJC or USEPA.

Fish tissue is also collected periodically by Ohio EPA from river mouth, harbor, and nearshore areas during intensive biosurveys and in connection with RAPs in the AOCs. Ohio EPA used to collect water samples at five Lake Erie intakes as representative of ambient lake conditions. All intake sampling was discontinued by 2001 as results were routinely below detection limits. All water quality monitoring of open lake waters is done by USEPA-GLNPO or Environment Canada.

C.1.3 Sentinel Site Design Pilot

An innovative monitoring design approach has recently been implemented in one Ohio EPA district that modifies the monitoring frequency at NAWQMN sites and applies the resource savings to fixed station monitoring in advance of scheduled watershed biosurveys. This approach evolved from the recognition that a fundamental drawback to the existing integrated biosurvey design is the paucity of water chemistry and bacteriological data collected under varying flow conditions available to develop water quality models and TMDLs for pollutants identified as causes of non-attainment of recreation and aquatic life uses. This is a result of focusing sampling activities upon summertime low flow periods when the stress to aquatic biological communities is believed to be greatest. The lack of adequate flow and water quality data often results in the need for additional field work to collect the information needed for modeling efforts following the biological sampling season, or requires that models be developed from incomplete data sets.

In an effort to address this problem in the face of static available personnel resources, the Ohio EPA Northeast District Office (NEDO) has piloted a “sentinel site” approach to develop watershed based data sets over an annual period and varying climatic and flow conditions. The sentinel site sampling network is designed to work in conjunction with the wider ranging low flow period sampling

campaigns used to determine attainment status within the study watersheds. The resulting data set is then capable of both supporting the analysis of causes and sources of any observed non-attainment and of supporting water quality modeling efforts where TMDLs are determined to be necessary.

The sampling effort for sentinel sites selected within targeted watersheds is designed using the following guidelines.

- Sampling frequencies for NAWQMN sites within NEDO have been reduced to once per quarter rather than once per month. Evaluation of data sets from NAWQMN sites indicates that this reduction in sampling frequency does not appreciably diminish the power of trend analysis for water chemistry at these sites.
- Sampling frequencies for sentinel sites are twice per quarter for one year. Sampling begins in October prior to the year in which the integrated biosurvey will be conducted under Ohio's TMDL monitoring schedule.
- The number of sentinel sites selected is limited to those which can be sampled using the same level of effort as previously used to monitor the NAWQMN sites.
- Sentinel sites are selected to provide data useful in long-term trend analysis and water quality modeling. Sites selected include all USGS gage locations, as well as representative stream sampling locations throughout the watershed or along LRAU reaches capable of supplying adequate water quality data for modeling efforts. Based upon recommendations from the Modeling Section of the Division of Surface Water, sentinel site stream sampling locations are restricted to sites with upstream watershed areas of 30 mi^2 or greater since these sites provide the most useful data for model development.
- Where possible, sentinel sites are selected based upon the availability of historical data that can be used to provide information for trend analysis.
- Where possible, gaging marks are established at sentinel sites so that gage height:stream flow relationships can be developed. Periodic flow measurements are taken in the streams near the sentinel site locations to develop predictive relationships for flow based upon water depth. The stream flow information collected during the sampling period can then be used to develop flow relationships for the basin for water quality modeling efforts.

If proved reliable in providing cost effective, meaningful data for TMDL development, it is anticipated that this approach will be expanded to all districts in Ohio and used, wherever practical, to enhance the biosurvey data collection capabilities of district water quality staff.

C.1.4 Recreation Uses

The monitoring design and sample site selection process for recreation uses largely follow the same design and sample site selection process pursued for water chemistry sites in the Five Year Rotating Basin Approach and the TMDL Monitoring Efforts since they are largely one and the same. Typically that has been a judgmental, targeted design augmented with a geometric drainage area design. This permits not only the ability to exactly determine impairments and causes and sources for particular waterbodies, but also permits generalization to sampling sites of a particular drainage area.

C.1.5 Public Drinking Water Supply Use

The design for PDWS monitoring will vary from site to site based on the amount of data needed and whether the sampling is part of another Ohio EPA water quality survey, primarily a DSW-led watershed biosurvey. Sampling sites are selected within the designated use areas or immediately upstream in order to monitor source water quality. The applicability of available compliance data (treated water) will factor significantly in the monitoring design. Source water data will be collected at least every five years in order to provide a reasonably current assessment of source water quality conditions.

The monitoring design will also consider the seasonal nature of key water quality indicators in the source water. For example, pesticides concentrations are the highest from early spring to late summer so sampling will be concentrated during this time frame to capture peak contaminant concentrations. The PDWS Use assessment methodology will provide specific sampling requirements.

C.1.6 Fish Consumption

Ohio's fish consumption advisory program was designed to provide information on the safety or risk associated with consuming fish from publicly owned or managed waterbodies. The monitoring design initially targeted larger waterbodies or waterbodies felt or documented to support higher fishing pressure. As these waterbodies were sampled sampling shifted to smaller waterbodies and those felt to support less fishing pressure. Virtually the entire state has been sampled within the last ten years down to a drainage area of 50 square miles for rivers and streams and fifty acres and greater for ponds, lakes and reservoirs. With the majority of the state sampled at least once, the monitoring design has changed with sample site selection shifting to include a variety of other factors in the site selection process including TMDL survey locations, previous sampling sites, potential public fishing locations, potential contaminated areas, and age of existing data among others. Integral to the monitoring design was the decision to select species and size classes of fish available in specific water bodies that were most likely to be consumed by sport fishers. Ohio believes this approach is efficient in covering most areas and most

fish that would be consumed by sport fishers. A detailed description of the sport fish consumption advisory monitoring design is available (Ohio EPA; 2004c, 2005a).

C.2 Inland Lakes and Reservoirs

Each of the 141 lakes monitored between 1988 and 1995 was sampled at one or more locations (based on lake size) three times during the sampling season, once in the spring and twice in midsummer/early fall. At each location, water column samples were collected at the surface and near the bottom and were analyzed for nutrients, heavy metals, and miscellaneous other parameters. Additionally, full water column profiles of basic field parameters (temperature, dissolved oxygen, pH, and conductivity) were collected on each visit. One sediment grab sample was collected at one location in each lake during the spring sampling run. Sediment samples were analyzed for nutrients (phosphorus) and metals; additionally, priority pollutant organochlorine pesticides, PCBs, cyanide, ammonia, % total solids, % volatile solids, % moisture, and particle size were collected at selected lakes. At the sediment sampling locations in select water supply lakes, upper and lower water column samples were analyzed for organochlorine pesticides and PCBs. In addition to the chemical sampling listed above, duplicate samples for plankton chlorophyll-a were collected at each surface location during each summer sampling run and Secchi depth measurements were taken during all visits.

C.3 Lake Erie - Open Waters, Nearshore, Lacustuaries, and Harbors

For the open waters of the lake, Ohio EPA relies on the water quality monitoring done by U.S. EPA-GLNPO and Environment Canada. A network of sites has been established and sampled for many years for nutrients, metals, organics and a number of other physical, chemical and biological components. In 1996 and 1997, Ohio ran a pilot program to sample selected historical sites in the nearshore areas of the western and central basin. Historical sampling locations were reviewed to choose the fewest number of sites most representative of the designated nearshore reaches. Lack of funding ended the program. Over about a 10-year period, Ohio EPA developed sampling methodologies and collected fish and macroinvertebrate data along the nearshore, in the harbors, from lacustuaries and around the Bass Islands in the western basin. Sampling reaches were selected to cover all the habitat types in these areas, and eventually ended up with complete coverage. Field assessment protocols and calibrated biological indices have been developed for fish in the nearshore, lacustuaries and harbors (Thoma, 1999). Macroinvertebrate field assessment protocols and preliminary indices were developed for the nearshore, lacustuaries and harbors (Ohio EPA, undated draft). Ohio EPA works with the RAP committees to help design sampling programs for a number of project needs. Some projects have included characterizing sediment, monitoring the

presence/movement of larval fish, and tracking bacteria and water quality levels. All data is collected with the intent of being able to measure progress toward restoration of beneficial uses.

C.4 Ohio River

The Monitoring Design for the Ohio River mainstem is documented in ORSANCO (2005).

C.5 Wetlands

While assessment of wetland condition at a watershed level is beginning, to date, most work on wetlands has involved monitoring of reference sites to develop biological indices and other wetland assessment tools. The reference sites chosen have been from all ecoregions, hydrogeomorphic settings and vegetation types. Additionally, wetlands have been chosen that represent the entire range of disturbance from those that are relatively intact to those that are severely degraded. As discussed above, ambient wetland condition assessments will be included as part of Ohio EPA's routine intensive biological and water quality surveys, or "biosurveys", on a systematic basis statewide. This will initially be on a limited basis until necessary resources can be provided.

C.6 Ground Water

The AGWMP program to sample raw water (untreated) was originally established in1973 to measure seasonal and annual water quality changes in the State's major aquifers. As the program evolved, additional wells were included in the AGWMP to improve the geographic distribution and to provide better representation of the primary aquifers in Ohio. The well location design is not random or probabilistic; rather ,wells have been selected on a combination of geographic distribution, geologic setting, and practical considerations, including the potential for long-term sampling. The AGWMP Operation Procedures Document includes a section on the selection criteria for new wells. This document is available at the following web site. (http://www.epa.state.oh.us/ddagw/wqcharpr.html)

The monitoring design for special studies is extremely flexible and is selected to address the site-specific objective of the study. The sampling plan requires internal review in order to ensure that the monitoring approach is appropriate for answering the site-specific questions.

D. Core and Supplemental Water Quality Indicators

USEPA's articulated goal for state programs:
Because limited resources affect the design of water quality monitoring programs, the State should use a tiered approach to monitoring that includes a core set of baseline indicators selected to represent each applicable designated use, plus supplemental indicators selected according to site-specific or project specific decision criteria.

Descriptions of Ohio EPA Water Program Core and Supplemental Water Quality Indicators

D.1 Surface Waters

D.1.1 Water Quality Indicators - General

Ohio uses a wide variety of core and selected supplemental indicators to evaluate water and sediment chemistry, physical habitat, toxicology and aquatic biological community performance. Although there is considerable overlap, the indicators are tailored for each water body type being evaluated (Tables 1 and 2). In concert with appropriate monitoring design, the core indicators permit assessing water resource quality and determination of use attainment status, the level of impairment and the assigning of causes and sources of impairment. The core indicator list is augmented with supplemental indicators when appropriate, typically when knowledge or suspicion of the presence of an additional parameter(s) warrants inclusion. More explicit discussion of the decision criteria for use of supplemental indicators within specific program areas is provided below.

Another set of indicators that merits discussion and allocation of resources to develop includes data on the characteristics of the contributing watershed. Success in the TMDL process increasingly hinges upon shifting land use practices towards those yielding fewer stressors and at a lower rate. Knowledge of the characteristics of the contributing watershed and its changes over time is therefore key. GIS capability is integral to the successful incorporation of that data into the water resource evaluation process. Ohio EPA is working to develop GIS hardware capability; however, there is no specific initiative to enhance GIS expertise and broaden water program support. Development of this skill set among staff currently depends on personal interest and initiative.

Table 1. Ohio EPA's water quality indicators for general designated use categories for lotic water bodies.

Core and Supplemental Water Quality Indicators				
Water Body Type	Aquatic Life and Wildlife	Recreation	Public Drinking Water Supply	Fish Consumption
Core Indicators				
Wadeable Streams and Large Rivers	Biota - condition of fish and macroinvertebrate communities (IBI, ICI, MIwb, contributing metrics) Water Chemistry - dissolved oxygen - temperature - conductivity - pH - nutrients (P & N) - metals - other conventional parameters Habitat - QHEI (instream and riparian habitat assessment) - flow	Pathogen Indicators - *E. coli* and fecal coliform Physical Conditions - flow - depth - surface area - location Recreation - observed activity - indirect evidence	Biota - *Cryptosporidium* Water Chemistry - nitrate - pesticides - primary SDWA MCL contaminants	Contaminants - mercury - heavy metals - halogenated pesticides - DDT & metabolites - PCBs
Primary Headwater Habitat Streams	Biota - condition of amphibian community, Headwater Habitat Macroinvertebrate Field Evaluation Index (HHMFEI) Water Chemistry - as above Habitat - Headwater Habitat Evaluation Index (HHEI)	As above	As above	Generally not applicable

Table 1. (Continued)				
Great Rivers (i.e., Ohio River)	Biota - Ohio River Fish Index (ORFIn), contributing metrics Habitat - Ohio River Habitat Index, contributing metrics	See wadeable and boatable list	See wadeable and boatable list	See wadeable and boatable list
Supplemental Indicators				
All Lotic Water Body Types	- ambient toxicity - sediment toxicity - other chemicals of concern in the water column or sediment - health of organisms	- other chemicals of concern in water column or sediment - hazardous chemicals - aesthetics	- other chemicals of concern - algae - taste and odor	- other chemicals of concern in water column or sediment (eg.,chlordane, Mirex, PFOA, SAS, etc.)

Table 2. Ohio EPA's water quality indicators for general designated use categories for lentic water bodies.

Core and Supplemental Water Quality Indicators				
Water Body Type	Aquatic Life and Wildlife	Contact Recreation	Public Drinking Water Supply	Fish Consumption
Core Indicators				
Inland Lakes and Reservoirs	- Lake Condition Index (& component metrics) Water Chemistry - vertical profiles of DO, pH, temperature, and conductivity - surface and bottom grabs for conventional parameters, metals - chlorophyll	- Lake Condition Index (& component metrics) Pathogen Indicators - *E. coli* and fecal coliform Physical conditions - depth - surface area - location - Secchi depth Recreation - bathing beaches - observed activity - indirect evidence	Biota - *Cryptosporidium* Water Chemistry - nitrate - pesticides - primary SDWA MCL contaminants	- Lake Condition Index (& component metrics) Contaminants - mercury - heavy metals - halogenated pesticides - DDT & metabolites - PCBs
Lake Erie Open Lake, Nearshore, and Lacustuaries	- Lake Erie Quality Index (& component metrics) Biota - condition of fish / macroinvertebrate communities (lacustuary and Lake Erie IBI, MIwb, lacustuary and nearshore ICI, contributing metrics) Water Chemistry - nutrients - vertical profiles of DO, pH, temperature, and conductivity	- Lake Erie Quality Index (& component metrics) Pathogen indicators - *E. coli* and fecal coliform Physical conditions - location - Secchi depth Recreation - bathing beaches - observed activity - indirect evidence	- As above	- Lake Erie Quality Index (& component metrics) Contaminants - mercury - heavy metals - halogenated pesticides - DDT & metabolites - PCBs

Table 2. (Continued)				
Wetlands	Biota - condition of the vascular plant, amphibian, and macroinvertebrate communities (VIBI, AmphIBI, WICI, contributing metrics) Water Chemistry - pH - temperature - TSS & TDS - TOC - metals - hardness - chlorine - nutrients - turbidity Soil Chemistry - % solids - particle size - pH - TOC - metals - ammonia - total phosphorus General Condition - ORAM 5.0: measures intactness within wetland and surrounding land use features	Pathogen Indicators - *E. coli* and fecal coliform Physical conditions - depth - surface area - location Recreation - observed activity - indirect evidence	Generally not applicable	Generally not applicable

Table 2. (Continued)				
Ground Water	Not applicable	Not applicable	Water Chemistry - field parameters(3) - inorganic parameters(29) - organic parameters(60)	Not applicable
Supplemental Indicators				
Inland Lakes and Reservoirs	- phytoplankton - zooplankton - water column toxicity - sediment chemistry (nutrients, metals, ammonia, organics)/toxicity - other chemicals of concern in the water column or sediment - health of organisms	- other chemicals of concern in water column or sediment - hazardous chemicals - aesthetics	- other chemicals of concern - algae - taste and odor	- other chemicals of concern in water column or sediment (eg., PFOA, SAS)
Lake Erie Open Lake, Nearshore, and Lacustuaries	- RAP delisting targets - LaMP indicators	- RAP delisting targets - LaMP indicators	As above and - RAP delisting targets - LaMP indicators	- RAP delisting targets - LaMP indicators

D.1.2 Supplemental Indicator Selection - Lotic Water Bodies

D.1.2.1 Aquatic Life Uses

The selection of supplemental indicators typically occurs during the watershed biosurvey study planning process. Once the decision to survey a particular watershed has been finalized and a study team leader picked, that person will solicit information from all Ohio EPA program offices. Appropriate contacts will be requested to search their files for location of facilities, potential stressors released, routes of exposure, known or suspected magnitude of the problem(s), spills, legacy problems, etc. During the study planning meeting, participants will decide, among other things, the need to augment the parameter list with chemicals or compounds not found on the core analytical list. This decision may balance upon the perceived magnitude and severity of the problem, the ability of the Ohio EPA analytical laboratory to analyze for those parameters, the cost of the testing (especially if an outside laboratory must be used), the ability to compare the results against a WQS criterion or reference range and other factors.

D.1.2.2 Recreation Uses

The selection of supplemental indicators for the recreational uses typically has arisen from a knowledge or suspicion of contamination in the sediment that might warrant a dermal contact advisory. Spills or the observation of leachate breakouts from landfills are two other examples that might result in a shift in parameter coverage that would result in changes in recommendations for the recreation use. Again, most sampling is accommodated during the five-year rotating basin approach which has been melded with the TMDL program in Ohio. However, spills or some other egregious violation may necessitate more expeditious sampling to characterize impact.

D.1.2.3 Public Drinking Water Supply Use

Indicator selection was driven by the PDWS use definition that these waters, with conventional treatment, will be suitable for human intake and meet federal regulations for drinking water. Conventional treatment is expected to result in safe drinking water by removing most contaminants from the source water. However, conventional treatment may be ineffective for certain contaminants at any level (i.e. nitrates) and some contaminants if present in source water at elevated levels (i.e. pesticides). Selection was based on the following: human health impacts, availability of established water quality standards, availability of reliable data, impact of parameter on water treatment process and costs, and ability of the agency to conduct future sampling.

Supplemental indicators used to assess the PDWS use may include algae, taste and odor, and other chemicals of concern in the water column. Additionally, there are a number of indicators which will be reevaluated in the future as new research and water quality data become available, including toxic algae, pharmaceuticals, and other pathogens.

D.1.2.4 Fish Consumption

The selection of supplemental indicators for fish tissue consumption is driven by several different considerations. Chemical parameters are added to our tissue monitoring list of chemicals as needed. The selection may be based upon environmental monitoring data (e.g., high PAHs, total mercury, phthalates, or SAS concentrations found in sediment), entity or DSW effluent data (e.g., total mercury, SAS, phthalates, etc.), Superfund or RCRA site consultant and Agency monitoring data, or chemicals identified on "chemicals of concern" lists identified by U.S. EPA, other federal agencies, or other states.

Tissue chemical monitoring results are initially generated as screening data. The DSW attempts to identify the magnitude and the extent of the contaminant in various matrices including tissue. The DSW may also select a chemical based upon perceived risk to human health (ingestion route of exposure), or to the environment (wildlife impacts and/or environmental sinks that become sources of impact). If there are human health concerns and a known reference dose, the DSW will go beyond generating screening data and attempt to generate enough data to perform a fish consumption risk assessment, with the issuance of a consumption advisory if needed.

D.1.3 Supplemental Indicator Selection - Lentic Water Bodies

The selection of supplemental indicators typically occurs during the planning process for the desired activity. During the planning process, key participants decide, among other things, the need to augment the parameter list with chemicals or compounds not found on the core analytical list. This decision may balance upon the perceived magnitude and severity of the problem, the ability of the Ohio EPA analytical laboratory to analyze for those parameters, the cost of the testing (especially if an outside laboratory must be used), the ability to compare the results against a WQS criterion or reference range and other factors.

The restoration of Lake Erie AOCs is based on achieving the targets that allow an AOC to be delisted. Ohio EPA has developed a set of delisting targets for each of the BUIs. These targets are largely based on other previously

established core indicators that are used in other Ohio EPA monitoring and assessment programs. However, for the purposes of this report, the delisting targets should be considered supplemental indicators. Likewise for the Lake Erie LaMP, indicators are currently under development to measure the quality/trends of the environmental quality of the lake. Because the LaMP is a multi-jurisdictional effort, it is probable that many of the indicators selected may not ultimately be included as Ohio EPA core indicators but rather fall under the supplemental indicators category.

D.2 Ground Water

The AGWMP analyzes for a suite of 29 inorganic parameters plus 5 field parameters and 60 organic parameters. The suite of inorganic parameters includes most of the inorganic parameters with maximum contaminant levels (MCLs) and secondary maximum contaminant levels (SMCLs). The organic suite includes all the volatile organic compounds with MCLs. Frequently, discussions center on the addition of parameters to the analyte list. As a result of the long sampling history at many sites, trend analysis of the AGWMP is providing valuable results. Consequently, if a new parameter is added, the program makes a commitment to maintain the parameter as a long-term addition. Parameter lists for special studies are selected on a site-specific basis to target specific sources. This combination of parameter selection approaches, for the AGWMP and special studies, constitutes a tiered approach.

E. Quality Assurance

USEPA's articulated goal for state programs:
Quality Management Plans and Quality Assurance Project Plans are developed, maintained, and peer reviewed in accordance with EPA policy to ensure the scientific validity of monitoring and laboratory activities.

Descriptions of Ohio EPA Water Program Quality Assurance Practices

E.1 Division of Surface Water

Prior to 2002, the Division of Surface Water (DSW) was required to submit project Quality Assurance Project Plans (QAPPs) to U.S. EPA for review and approval before initiating an environmental data collection project. Since 2002, DSW was delegated the responsibility for reviewing and approving DSW project QAPPs internally. The following discussion describes the DSW procedures for QAPP review and approval, and identifies various responsibilities for the process.

E.1.1 General Procedures and Requirements

DSW projects involving the collection and submittal of environmental data require an internal DSW project QAPP review and approval. Project QAPPs require a project title, date and identification of the project manager. The QAPP text includes: an introduction (i.e., a general description of the project and relevant background information); project objectives; the identification of methods used in the project, either by reference (U.S. EPA methods and/or methods identified in the DSW's or the DES' methods manuals), or described if not included in the identified methods manuals; the identification of staff project responsibilities; and a tentative schedule that identifies key project target dates, which includes a project completion date. Field studies must report data quality objectives (DQOs) for physical, chemical and certain biological data. A list of parameters and their DQOs must be included as a QAPP appendix. (For additional information or details, see: EPA Guidance for Quality Assurance Project Plans - EPA QA/G-5; EPA/600/R-98/018, February 1998)

If a contractor is to participate in the project, the contractor's contract must be attached as a QAPP appendix. The following information must be included: A detailed description of all of the contractor's products (deliverables) reported to Ohio EPA and the contractor's submittal deadline for report submittal. The contractor's methods, standard operating procedures (SOPs) and DQOs must also be included. The contractor's project contact's name, telephone number and address must be included.

E.1.2 Project Manager Responsibilities

The project manager, or a designee, is responsible for designing the project and submitting six copies of the project draft QAPP to the Division's acting Data Quality Manager (DQM) through the Manager of the Standards and Technical Support Section of the Division of Surface Water. All outside funding sources, grant identification numbers, requirements (e.g., grant objectives), deadlines and requested funding levels must be identified in a cover memo with the project draft QAPP submittal. A copy of the grant for which the QAPP was written must also be attached. The project manager must submit a DSW approved project QAPP to the funding source and fulfill all requirements for outside funding, when applicable.

The project manager is responsible for writing any outside contractor contracts, and seeing to it that all contracts are properly processed according to Agency policy. The project manager is responsible for coordinating all project participants, receiving contract billing statements and seeing to it that all statements are processed according to Division policy (if applicable), receipt and a review of all data (including all sampling and analytical SOP information reported and data QA/QC review), and reviewing and accepting any report once all contractual requirements have been met. The manager's review should insure that all contractual obligations were fulfilled by the contractor and the data and report meet the contract's requirements.

The project manager is responsible for addressing any deficiencies, clarifying, correcting, or revising all problem areas and concerns identified in reviewers' comments, and resubmitting a corrected QAPP to the DSW's DQM for final approval.

If a DSW project is approved as a result of the DSW QAPP review and approval process, the project manager is responsible for organizing and coordinating the project activities among Ohio EPA staff and project participants, and completing and submitting a final project report.

E.1.3 Data Quality Manager (DQM) Responsibilities

The DQM is responsible for the oversight and coordination of the DSW's QAPP review and approval process. All reviewers' comments are summarized, and any deficiencies, requirements, or recommendations for project approval are identified in a QAPP review report submitted to the project manager and the appropriate section manager.

A corrected, final QAPP may be returned to the QAPP reviewers for final review and comment. If all conditions for project approval are met, the DQM sends a project approval memo to the project manager and the appropriate section manager. A final DQM QAPP review and status report will be sent to the DSW Chief.

E.1.4 DSW QAPP Review Procedure

All DSW QAPPs will be evaluated by a team of DSW staff composed of two DSW managers (a section manager and a higher level manager), and three technical staff with at least one field staff member participating in each QAPP review and approval. The QAPP review team will review the QAPP to determine if the project is scientifically sound and that all DSW guidelines, procedures and methods have been followed.

Each member of both groups (managerial and technical) will submit their findings to the DQM to be integrated in a final draft QAPP review report. Each review team member can unconditionally approve, conditionally approve, approve with reservation, or deny QAPP proposals. All reasons for a review team member's QAPP decision not to unconditionally approve the QAPP must be clearly stated.

The DQM may organize a meeting with the DSW management staff, the QAPP review team and the project manager to discuss and resolve any outstanding issues that can not be agreed upon through the QAPP review process.

E.1.5 DSW Management Responsibilities

The DSW management group's QAPP review objectives are to determine if the project meets the DSW's objectives/priorities, and if there are an adequate budget, personnel, equipment, Agency space (as required) and a realistic schedule for the project's completion. The DSW's management will give final approval of identified funding source(s) and level(s) for the project.

E.1.6 DSW Technical Staff Responsibilies

The DSW technical group's QAPP review objectives are to determine if the project reflects good and appropriate science, and to determine if there are any problems with the proposed procedures or methods, which include defined Data Quality Objectives (DQOs) where appropriate, to achieve the objectives identified in the proposal. U.S. EPA's guidelines will be the primary technical foundation used in this process. The reviewers should determine if the proposed schedule to complete the project and finalize any project results is realistic.

E.1.7 QAPP Reviews of Follow-up QAPPS submitted for Ongoing Projects
Occasionally, projects continue for multiple years. The original project may be slightly modified, and a modified project QAPP may be submitted for DQM review. Continuing the original project with different locations identified for monitoring, or identifying a selection of new monitoring locations based upon different selecting criteria are two examples. The DQM may review the submitted "new" QAPP to verify the proposed changes without involving additional DSW staff. The addition of any modified or new proposed methods may be copied and circulated to selected staff for staff input (i.e., review with comments). A formal QAPP review as previously described involving 6 to 7 DSW staff representing management and technical review is not required once the original proposal QAPP has been reviewed according to the previously described procedure.

E.1.8 Existing Division of Surface Water Monitoring Programs and the QAPP Process
DSW has 30 ongoing programs that either generate data, or require data to be generated and submitted to the Division. Fourteen of these programs are involved with environmental assessment. Ten of the programs that deal with environmental assessment directly involve the DSW and require DSW QAPPs and DSW QA/QC oversight. The ten programs include: Watershed Biosurveys, Fixed Station Monitoring Program (NAWQMN), Modeling/Wasteload Allocation/TMDLs, DERR Support, Animal Tissue Monitoring Program, Grant Funded Non-wetland Projects, Grant Funded Wetland Projects, Primary Headwater Stream Evaluation Project, Lake Erie Program and the Inland Lake/Reservoir Assessment Program.

DSW has used the QAPP review procedure described above in three programs: Watershed Biosurveys (one special project), Grant Funded Wetland Projects (four projects) and the Lake Erie Program (one project). Other ongoing monitoring programs listed have not used the QAPP procedure as described by U.S. EPA. The DSW uses individual project plans in place of a QAPP. The major difference between the Division's project plan and a QAPP is that a QAPP includes analytical method, matrix and analyte specific "Action Levels" identified for analytes. The DSW intends to develop a generic QAPP for all of its monitoring programs during late 2004 or early 2005. The generic QAPP will be modified, as necessary, depending upon specific project objectives and limitations. Therefore, the Division's current use of a project plan procedure will evolve into a QAPP procedure as described by U.S. EPA.

E.1.9 DSW Quality Management Plan (QMP)

DSW's updated Quality Management Plan (QMP) is scheduled to be submitted to U.S. EPA in June 2005. The Division's QMP is made up of two parts: Part 1 includes the following sections: Introduction, Description of Management and Organization, Quality Systems and Description, Personnel Qualifications and Training, Procurement of Items and Services, Documentation and Records, Computer Hardware and Software, Planning, Implementation of Work Processes, Assessment and Response, Quality Improvement, and Appendices. Part 2 is the test of a document titled "The Ohio Environmental Protection Agency: Division of Surface Water's Data Generation and Management Procedures Audit." All DSW staff had an opportunity to participate in the Division's Data Generation and Management Audit. The Audit Document was distributed to all DSW staff for a final review and comment. This document evaluates and tracks how the Division generates, evaluates, receives, reviews, reports and manages data in its 30 data generating programs.

E.2 Division of Drinking and Ground Waters

Ohio's Ground Water Quality Characterization Program honors the divisions commitment to use effective QA/QC procedures for data collection and documentation and recognizes the importance of accurate data for sound scientific and regulatory decisions as outlined in the Division of Drinking and Ground Waters Quality Management Plan. The core document for quality assurance for the AGWMP is the Operating Procedures Document (OPD), which provides extensive documentation for program processes including:

- Program objectives, description, and history;
- Program site documentation and parameter lists;
- Sample collection and field analysis;
- Ohio EPA Division of Environmental Services laboratory procedures (refers to DES SOPs and quality assurance documents); and
- Data management procedures (under revision to incorporate STORET) including QA/QC.

The OPD is updated as needed and is referenced multiple times in the division QMP. An End-of-Round report is completed after each semi-annual sampling round to ensure that the QA/QC of all new AGWMP data is completed. Special studies can refer to pertinent sections of the OPD sample collection and data management procedures as part of their quality plan. The project justification and sampling plan for the ground water quality special studies procedure document was produced to ensure that special study sampling plans are well designed and properly documented.

F. Data Management

USEPA's articulated goal for state programs:
The State uses an accessible electronic data system for water quality, fish tissue, toxicity, sediment chemistry, habitat, and biological data (following appropriate metadata and State/Federal geo-locational standards) with timely data entry and public access.

Descriptions of Ohio EPA Water Program Monitoring Data Management

F.1 Surface Water Data
The Division of Surface Water (DSW) is currently developing a new electronic monitoring and assessment database system called EA^3 (Ecological Assessment and Analysis Application). This new system will be replacing the existing Ohio ECOS database that has biological, fish tissue, sediment chemistry, and habitat data from Ohio's rivers, streams, inland lakes and reservoirs, and wetlands. Portions of the Ohio ECOS databases date back as far as the late 1960s and have significant historical importance.

The new system will support all surface water quality monitoring functions performed by Ohio EPA. The EA^3 system will be designed as a web-based application using the JAVA interface. The system will utilize the US EPA STORET database structure insuring that the data is stored in a consistent format that can be shared internally and externally. Ohio plans on rolling out the first phase of the EA^3 system before the 2005 sampling season. Additional phases of the application will include surface water chemistry and wetland data.

The major functions for the EA^3 system are:

- Data Entry/Verification/Review/Approval
- Assessment Indices Analysis and Calculation
- Reporting
- Site Recognition and Reconciliation
- Data Conversion

Data captured by DSW on field sheets is usually entered into the database after the field season is completed. The EA^3 system is being designed with a review and approval process that ensures the quality of the data entered is accurate.

Assessment Indices have been developed by Ohio EPA for surface waters for determining the relative health of a particular waterbody. Currently these calculations are triggered manually and are captured in a non-normalized structure within the existing Ohio ECOS databases. The new application will calculate the assessment indices from the monitoring data and automatically determine attainment. It is our intent to submit this assessment data to the USEPA.

The new system is expected to be able to interface with graphical GIS mapping software. For data in the new EA^3 application to work properly in STORET and for consistency in reporting, the current structure for identification of sampling stations is being completely redesigned. The new identification process will follow the STORET station model. A unique identifier along with a latitude/longitude location are now required for any surface water sampling location.

Additionally it is planned that all data from the existing monitoring databases will be converted into the new EA^3 system. Data conversion is critical to the functionality of the new system. The transformation of data into a standard format meeting US EPA STORET standards and old data summarized in different formats are just a few of the complexities that will need to be handled as part of the new application development.

F.2 Ground Water Data

Prior to 1992 AGWMP data were stored in paper files. In 1992, in order to increase data availability and to improve data analysis capabilities, efforts were initiated to incorporate AGWMP well and sample information into an electronic database. The goal was to receive, process, and preserve the water quality data electronically. In 2001, AGWMP staff evaluated options for updating the GWQCP database (FoxPro program) and concluded that the best alternative was to utilize the U.S. EPA STORET database as the primary database for ground water quality data. AGWMP data was migrated in 2004. Supplemental user tables (SEAGATE) were developed to manage the AGWMP sampling program and standard reports are being developed for the STORET and SEAGATE data. By 2006, STORET will be our primary database for housing, managing, and reporting AGWMP and special study data. Data management procedures will be described in the Operating Procedures Document.

G. Data Analysis/Assessment

USEPA's articulated goal for state programs:
The state has a methodology for assessing attainment of water quality standards based on analysis of various types of data (chemical, physical, biological, land use) from various sources, for all waterbody types and all State waters.

Descriptions of Ohio EPA Water Program Monitoring Data Analysis/Assessment

G.1 Wadeable Streams and Large Rivers
G.1.1 Aquatic Life Uses
Ohio EPA incorporated biological criteria into the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) regulations in February 1990 (effective May 1990). These criteria consist of numeric values for the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), both of which are based on fish assemblage data, and the Invertebrate Community Index (ICI), which is based on macroinvertebrate assemblage data. Criteria for each index are specified for each of Ohio's five ecoregions (as described by Omernik 1987), and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the existing chemical and whole effluent toxicity evaluation methods and criteria, figure prominently in the monitoring and assessment of Ohio's surface water resources.

The following documents support the use of biological criteria by outlining the rationale for using biological information, the methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results (Ohio EPA, 1987a, 1987b, 1989b, 1989c, and 1990; Rankin, 1989). Since the publication of the preceding guidance documents, the following new publications by Ohio EPA have become available. These publications should also be consulted as they represent the latest information and analyses used by Ohio EPA to implement the biological criteria (DeShon, 1995; Rankin, 1995; Yoder and Rankin, 1995a, 1995b, and 1995c; Yoder, 1995).

A carefully conceived ambient monitoring approach, using cost-effective indicators comprised of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. This

integrated approach is outlined in Figure 4 and includes a hierarchical continuum from administrative to true environmental indicators. The six "levels" of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6) changes in health, ecology, or other effects (ecological condition, pathogens). In this process the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). Thus, the aggregate effect of billions of dollars spent on water pollution control since the early 1970s can now be determined with quantifiable measures of environmental condition.

Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. *Stressor* indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. *Exposure* indicators are those which measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise Ohio's biological criteria. Other response indicators could include target assemblages, *i.e.,* rare, threatened, endangered, special status, and declining species or bacterial levels which serve as surrogates for the recreational uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each.

Describing the causes and sources associated with observed impairments revealed by the biological criteria and linking this with pollution sources involves an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus, the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators.

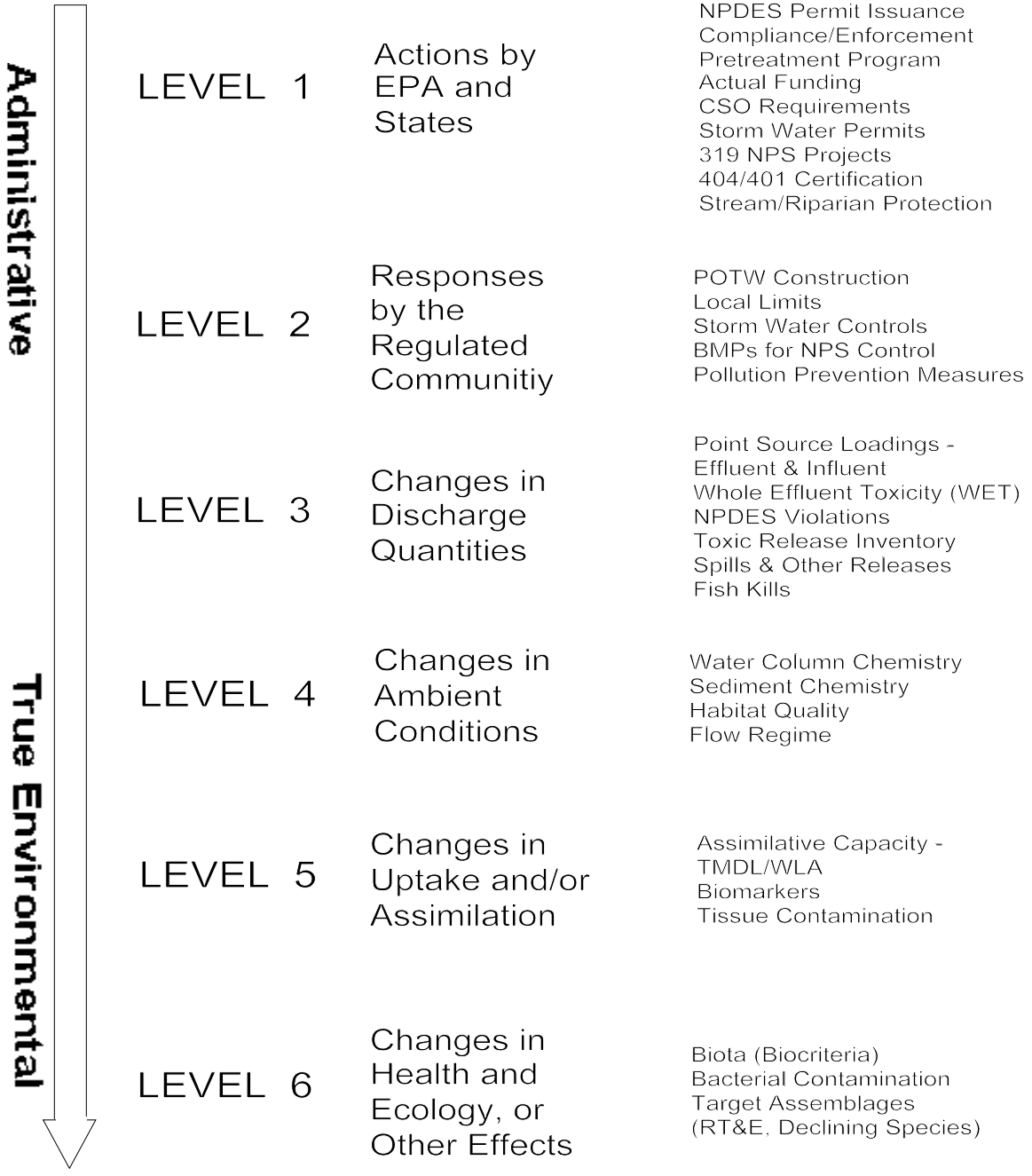

Figure 4. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995).

G.1.2 Recreation Uses

Bacteria data are used to assess the attainment of recreational uses in all waters with a designated Bathing Waters, Primary Contact Recreation (PCR), or Secondary Contact Recreation (SCR) use. Attainment decisions are based upon a comparison to the bacteria criteria within the Ohio Water Quality Standards, which currently contain both the fecal coliform and *E. coli* indicators. Ohio has recently begun to move away from using the fecal coliform indicator. For example, Ohio now uses only *E. coli* data in making decisions to post warning signs on lake Erie beaches when the Bathing Waters criterion is exceeded. Ohio anticipates drafting rules to cover definitions of recreation use categories, indicator bacteria (*E. coli*) and wet weather applicability in 2005. Completion of this task will ultimately result in a change in how recreational uses of waterbodies in Ohio are assessed, with an anticipation that there will be a transition away from the fecal coliform indicator to the *E. coli* indicator. Continued monitoring of both indicators results in duplicate effort with little added value in return. In addition, completion and implementation of the State's Credible Data rules should enable Ohio to make recreational use assessments using a more robust data set by enhancing the State's ability to gather and use bacteria data generated externally.

G.1.3 Public Drinking Water Supply Use

Water quality data collected to assess the PDWS use as applied to all designated Public Water Supply (PWS) waters will be compared to water quality standards newly developed for this use. Detailed assessment methodology is currently under development. Water quality data from the most recent five years will be evaluated and levels of impairment will be based on exceedances of water quality standards. Source water quality trend analysis will be used to identify areas in which to focus additional/future sampling. Additionally, development of a source water quality database could assist in evaluating the effectiveness of best management practices (BMPs) implemented in the source water protection area.

G.1.4 Fish Consumption

Fish tissue data from all waters are used to assess attainment of human health water quality standards in two ways. First, fish tissue contaminant levels are used to calculate the approximate contaminant concentrations in water. This provides an indirect measurement of whether Ohio Water Quality Standards human health criteria are being met. Second, as one of three primary goals of making Ohio's waters fishable, swimmable, and drinkable, fish tissue data are a direct measurement of the progress being made toward the goal of making all of Ohio's waters fishable.

Ohio has fish tissue data dating back to the early 1970s, and consistent, annual data dating back to the early 1990s. These data are stored in an electronic database, and new data continue to be collected and added yearly. The procedures for collecting the data are detailed in Ohio's Fish Collection Guidance Manual (Ohio EPA, 2004c). Data quality requirements and evaluation procedures, analytical methods and procedures, temporal and geographic representation, and statistical analyses can be found in Ohio EPA (2005b and 2005c). Equations and procedures for relating fish tissue contaminant levels to Water Quality Standards human health criteria and making status determinations can be found in the 2004 Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2004a).

G.2 Inland Lakes and Reservoirs

Prior to the inland lakes and reservoirs assessments conducted by Ohio EPA from 1988 to 1995, monitoring in Ohio was primarily focused on sampling to determine lake trophic state using the Carlson Trophic State Index (TSI, Carlson, 1977). This index classifies lakes into trophic categories ranging from oligotrophic (nutrient poor) to hypereutrophic (nutrient rich) using three basic parameters - chlorophyll, phosphorus, and Secchi disk transparency.

Passage of the 1987 amendments to the Clean Water Act required each State to expand assessment of lake water quality beyond the concept of nutrient enrichment (i.e. trophic state) to include topics such as violations of water quality standards, attainment of designated uses, and identification of lakes threatened by nonpoint and point sources of pollution. In order to comply with these new federal mandates, Ohio EPA developed a multiparameter lake assessment process called the Ohio Lake Condition Index (Ohio LCI, Davic and DeShon 1989). The Ohio LCI, as revised in 1992 (Ohio EPA, 1992) and 1996 (Ohio EPA, 1997), was used to assess the overall ecosystem condition of Ohio's inland lakes and reservoirs. The revised LCI used information gathered from 14 different parameters to allow a holistic assessment of the overall condition of the lake ecosystem. Calculation of the LCI scores for inland lakes and reservoirs sampled between 1988 and 1995 were used to: 1) determine if Ohio's public lakes are meeting Clean Water Act goals of fishable and swimmable waters, (2) determine the extent that Ohio's lakes are meeting designated uses under Ohio Water Quality Standards, (3) document temporal changes in the status of lake water quality, and (4) classify the overall ecosystem condition of Ohio's inland lakes.

G.3 Lake Erie - Open Waters, Nearshore, Lacustuaries, and Harbors

G.3.1. Bioassessment and Biocriteria Development

In 1993, Ohio EPA initiated the development of biological assessment methods and biological criteria for the Lake Erie nearshore and the inundated mouths of rivers and harbors (*i.e.,* lacustuaries). The field work for this effort was largely completed in 1997. Working versions of an Index of Biotic Integrity (IBI) for the fish community and the Invertebrate Community Index (ICI) were developed as a result (Thoma, 1999 and Ohio EPA, undated draft). These tools and databases allowed a preliminary assessment of the tributary mouth/harbor areas and the nearshore which was included in the 2004 Ohio Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2004a). The RAPs and LaMP also used these criteria to assess the status of their areas.

G.3.2 Lake Erie Quality Index

In 1998, a document entitled *State of the Lake Report/1998/Lake Erie Quality Index* was released by the Ohio Lake Erie Commission (1998). This document reported on the present condition of the Ohio waters of Lake Erie, using indicators and metrics that were deemed most important and understandable to the Ohio public. The motivation behind compiling the *Quality Index* was the realization that there were no adequate benchmarks to monitor and evaluate progress towards restoring the lake. There were also many parameters for which precise goals had not been established. With input from the public, various lake experts, and State agencies, the *Quality Index* accomplished the following objectives: 1) determined what is essential to know about Lake Erie; 2) designed effective measuring systems for these essential factors; and, 3) established goals and scoring systems that would allow for critical and easily understandable evaluations of progress. A revised, updated *Quality Index* report has been released (Ohio Lake Erie Commission, 2004).

The *Quality Index* did not address what needs to be done to achieve the established environmental, recreational, and economic goals it identified. The Ohio Lake Erie Commission (2000) initiated a follow-up effort called the *Lake Erie Protection and Restoration Plan*, that mapped out a long-term strategy for achieving the goals presented in the *Quality Index* and ensure future improvements to Lake Erie. The Plan would focus on the various metrics established in the *Quality Index,* catalogue all current efforts underway, and identify the additional initiatives and resources necessary to achieve the *Quality Index* goals and objectives. Progress reports were prepared in 2002 and 2004.

All Ohio Lake Erie Commission reports are available on their web site. (http://www.epa.state.oh.us/oleo/reports/leqi/leqi2004/leqiz.htm)

G.4 Ohio River

Details of Data Analysis/Assessment for monitoring in the Ohio River are documented in ORSANCO (2005).

G.5 Wetlands

Currently, there is only one wetland designated use, “wetland”. However, the current rules define three antidegradation categories for wetlands. In reality the antidegradation categories operate in much the same fashion as uses. We have developed proven tools that allow us to evaluate and assign any wetland to the appropriate antidegradation category. These tools include vegetation and amphibian IBI scores, soil and water chemistry analysis, and rapid assessment method scores. Wetland condition will be reported as deviation from numeric, wetland-specific Tiered Aquatic Life Uses. Condition can be reported for individual wetlands but will more typically involve reporting condition of wetlands on some geographic basis, e.g. 14- or 11-digit HUCs, as part of a larger biosurvey of that watershed’s waters.

G.6 Ground Water

Ohio does not have general ground water quality standards, so ground water attainment decisions are not made outside of compliance programs. Comparisons to MCL concentrations, however, are useful benchmarks. Consequently, the general water quality data analysis is not used to identify areas of non-attainment, but these data are used for characterizing the ground water quality in the major aquifers in Ohio and for trend analysis to document sensitive hydrogeologic settings within the state. The incorporation of Geographic Information System (GIS) technology also contributed to much improved data analysis, as documented by the improvement of the ground water sections of the Ohio Water Resource Inventory reports generated in 1996, 1998, 2000, and 2002.

H. Reporting

USEPA's articulated goal for state programs:
The State produces timely and complete water quality reports and lists.

Descriptions of Ohio EPA Water Program Monitoring Reporting

The Ohio EPA Division of Surface Water website provides links to many of the reports generated by staff and referenced in the following discussion. An index of the division's technical reports and publications can be found at the following URL. http://www.epa.state.oh.us/dsw/formspubs.html

H.1 Wadeable Streams and Large Rivers

H.1.1 Aquatic Life Uses

The Ohio EPA Division of Surface Water has a stellar record for producing biological and water quality Technical Support Documents (TSDs) which summarize the results of 1-2 years of intensive biological (fish and benthic macroinvertebrate communities), chemical, physical, habitat, and sediment sampling on a watershed scale. Attainment status of aquatic life uses are presented as well as causes and sources of impairment. Keying into the findings of the intensive survey and the TSD, sampling to support water quality modeling is subsequently undertaken. A TMDL report is then developed using results from both sampling efforts. These reports are submitted to U.S. EPA Region V according to a 15-year schedule. Deviations to that schedule are negotiated with U.S. EPA if there are to be any significant and justifiable delays.

The findings and conclusions of each biological and water quality TSD may factor into regulatory actions taken by Ohio EPA and are incorporated into Water Quality Permit Support Documents (WQPSDs), Total Maximum Daily Loads (TMDLs), State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the Ohio Integrated Water Quality Monitoring and Assessment Report (Sections 305[b] and 303[d] of the Clean Water Act). Specific Ohio EPA water management programs and activities supported by data collected utilizing the integrated biosurvey approach and reported via the TSD include the CWA Section 305(b) reporting process, CWA Section 303(d) listing process (TMDL program), Water Quality Standards program (use designations, criteria refinements and modifications), Permitting program (NPDES permits, PTI requests, CSO regulation, stormwater management program), CWA Section 404/401 Water Quality Certification program, CWA Section 319 Nonpoint Source

program, Lake Erie Area of Concern Remedial Action Plans (RAPs), hazardous waste site assessments (NRDA, CERCLA), and enforcement/litigation actions.

Watershed biosurvey study plans, final TSDs, and other requested documents are submitted to U.S. EPA annually and a comprehensive Integrated Water Quality Monitoring and Assessment Report (fulfilling CWA Section 305b and 303d requirements) is compiled every two years incorporating data from the last ten years of watershed biosurveys as well as any ancillary or specialized sampling that was conducted over that time period.

H.1.2 Primary Headwater Habitat Streams

Sampling, and, consequently, reporting on the quality of Primary Headwater Habitat streams, is currently inextricably linked to the 401/404 permitting process. Sampling, aside from the initial investigative studies, generally results from a submittal of a 401 permit to alter or fill a Primary Headwater Habitat stream channel. Reporting typically provides a classification of the stream segment and an estimate of the impact associated with the proposed project. The Primary Headwater Habitat stream uses are currently not incorporated in the Ohio Water Quality Standards but have been used to establish the existing use.

H.1.3 Recreation Uses

Results of bacteria monitoring are typically reported in Technical Support Documents and TMDL reports. The Agency has increased the intensity of its bacteria sampling in the last couple of field seasons in an attempt to generate sufficient data to provide a more direct comparison to the geometric mean criteria, which require a minimum of five samples collected within a 30-day period. While this sampling effort is not possible for every stream sampled, the goal is to collect enough data on larger mainstem water bodies that typically have greater recreational usage while still collecting sufficient bacteria samples in tributary streams to provide support for TMDLs. In addition, development and implementation of the Ohio's Credible Data rules will allow the State to more readily tap into external data for use in its publications.

H.1.4. Public Drinking Water Supply Use

Summaries of the PDWS assessments and impairment determinations will be published in the biennial Integrated Water Quality Monitoring and Assessment Report. Detailed reports will be grouped by watershed (HUC-8 level) and published on a continuous basis as they are completed.

H.1.5 Fish Consumption

The results of the fish tissue collections are published annually in February or March in the form of new fish consumption advisories. The fish tissue data are also incorporated into the Integrated Water Quality Monitoring and Assessment Report, published biannually typically in the manner of impairments. More in depth analysis of patterns, trends, etc. of the accumulated database although desired has not been possible since the mid 1990s. Recent addition of a fulltime human health risk assessor to the Division of Surface Water staff may permit a more exhaustive analysis of the data to coincide with the generation of the Integrated Report. Current sport fish consumption advisory information for Ohio can be found at the following website.
http://www.epa.state.oh.us/dsw/fishadvisory/index.html

H.2 Inland Lakes and Reservoirs

Historically, results of lake monitoring activities in Ohio have been reported as summaries and detailed appendices in Ohio Water Resource Inventory - Lakes reports and, for Lake Water Quality Assessment grants in the late 1980s to mid 1990s, through individual reports submitted to fulfill grant requirements. Summaries of trophic state assessments and Trophic State Index (TSI) scores for all lakes sampled by Ohio EPA from 1973 to 1995 were last reported in Ohio EPA (1997; Appendix C). Summary results of the revised Ohio Lake Condition Index (LCI) assessments for lakes sampled between 1988 and 1995 were reported in Ohio EPA (1997; Appendix H).

H.3 Lake Erie - Open Waters, Nearshore, Lacustuaries, and Harbors

Every two years the Lake Erie LaMP is updated with new information, progress, emerging issues and a projected work plan for the next two years. Included in the Lake Erie LaMP is an update on the progress and achievements of the RAPs. The RAPs also provide information to update the AOC web pages maintained by U.S. EPA/GLNPO. Several of the RAPs prepare annual activities and accomplishments reports. The Ohio Lake Erie Commission prepares a progress report on the Lake Erie Protection and Restoration Plan every two years. The Lake Erie Quality Index is updated on a 5-6 year interval, depending upon available resources.

H.4 Ohio River

Details of Reporting for monitoring in the Ohio River are documented in ORSANCO (2005).

H.5 Wetlands

Currently, reporting of wetland condition has occurred in only a general format. Basically, just a few paragraphs about general statewide wetland trends is included in the Integrated Water Quality Monitoring and Assessment Report. Wetlands have not been included on the 303d list and whether listing is appropriate for wetlands continues to be debated on a national level. Wetland condition will be reported as deviation from numeric, wetland-specific Tiered Aquatic Life Uses. Condition can be reported for individual wetlands but will more typically involve reporting condition of wetlands on some geographic basis, e.g. 14- or 11-digit HUCs as part of a larger watershed biosurvey.

H.6 Ground Water

STORET data will be submitted to the STORET Warehouse on a quarterly basis. The AGWMP data, in conjunction with drinking water compliance data, is used to produce ground water chapters for CWA Section 305(b) Ground Water reports. In addition, various reports, maps, and presentations using ground water quality data are available on DDAGW's Ground Water Quality web site. (www.epa.state.oh.us/ddagw/wqcharpr.html)

GWQCP staff are working to focus more effort on identifying ground water quality impacts in the future. This will serve as another approach for identifying sensitive aquifers as a means to help direct ground water protection activities to priority areas.

I. Programmatic Evaluation

USEPA's articulated goal for state programs:
The State, in consultation with its EPA Region, conducts periodic reviews of each aspect of its monitoring program to determine how well the program serves its water quality decision needs for all State waters, including all waterbody types.

Descriptions of Ohio EPA Water Program Monitoring Programmatic Evaluation

A joint U.S. EPA Region 5 and Ohio EPA review of Ohio EPA's monitoring and assessment program occurred in a November, 2003 two-day meeting. Current Ohio EPA monitoring programs were assessed against the "Elements of a State Monitoring and Assessment Program" guidance document. A draft document entitled "Review of Ohio's Monitoring and Assessment Program" was provided to Ohio in late December, 2003. The Region 5 review of Ohio's program utilized a draft set of criteria that were developed by U.S. EPA's Regional Monitoring Coordinators. This document will provide the framework for future review and evaluation of Ohio EPA monitoring programs and it is anticipated that program reviews by U.S. EPA will continue on a regular, if not annual, basis. More detailed descriptions of programmatic evaluations/reviews of specific programs or program components are provided below.

I.1 Wadeable Streams and Large Rivers - Bioassessment Component
A joint U.S. EPA Region 5, Ohio EPA Division of Surface Water, and U.S. EPA consultant review of Ohio EPA's monitoring and assessment program occurred in January, 2002. The purpose of the meeting and subsequent consultant efforts was to provide an initial assessment of the current status of the monitoring and assessment program in Ohio and initiate a process to determine what is needed to improve the capacity and quality of the program. This review specifically emphasized the biological assessment of aquatic life uses, and the review of the Ohio EPA monitoring program focused on the ability of the bioassessment component to support the integrated assessment of status and trends, reporting, and other primary water quality management programs. Results of the Ohio review were included in a consultant report along with detailed assessments of all other Region 5 states' bioassessment programs (Yoder, 2004). It is envisioned that the bioassessment review along with other issues within this strategy document will provide a framework for additional programmatic discussion and evaluation both internal to Ohio EPA and to external parties including U.S. EPA.

I.2 Fish Consumption

Ohio consults periodically with a U.S. EPA Region V coordinator, as well as other organizations involved with the collection and assessment of fish tissue data including GLNPO, ORSANCO, and ad hoc Great Lakes committees, in regard to how fish consumption advisories are developed and issued.

I.3 Wetlands

The Wetland Program has focused on development of tools that assess wetland condition. Now that some tools are available for use, the focus is shifting to using the tools to assess wetlands for the differing needs of a comprehensive water monitoring program. Grant work has been funded by U.S. EPA and this has been instrumental in aiding Ohio EPA in the development of these tools. Part of that process has included guidance toward development of tools that will serve the decisions that need to be made about wetlands and how to best fit them into a comprehensive water monitoring program. Periodic reviews occur as U.S. EPA considers and approves Ohio EPA Wetland Program Development Grant applications.

I.4 Ground Water

The End-of-Round Report is completed for each sampling round as a final QA/QC process. This report is used to evaluate the effectiveness of standard procedures and to identify issues for discussion. These issues are discussed at the semi-annual AGWMP meetings scheduled at the beginning of each sampling round. If procedures need to be adjusted, or special situations are identified, the district office coordinators and central office staff develop a consensus for what changes need to occur for the next sampling round. These meeting are also used to discuss programmatic directions or needs for additional ground water monitoring. If programmatic issues are the dominant topic at an AGWMP meeting, the district ground water supervisors are requested participate in this meeting in order to broaden the perspectives expressed in the discussion. In this manner, the ground water staff are continually discussing ways to improve the ground water monitoring program. The 106 work plans, quarterly, and annual reports provide communication with the U.S. EPA about the program directions. New ideas are incorporated into 106 work plans as time, priorities, and budgets allow.

J. General Support and Infrastructure Planning

USEPA's articulated goal for state programs:
The State identifies current and future monitoring resources it needs to fully implement its monitoring program strategy.

Descriptions of Ohio EPA Water Program Monitoring General Support and Infrastructure Planning

J.1 Current Monitoring and Assessment Resources
Table 3 details projected Ohio EPA/Division of Surface Water SFY 2006 resources dedicated to surface water monitoring and assessment programs as compared to other surface water program areas (*e.g.*, permitting, compliance, etc.). Monitoring and assessment reporting categories represent most program areas which have been discussed in detail in previous sections of this document.

J.2 Future Monitoring and Assessment Resource Shortfalls
Detailed descriptions of identified monitoring and assessment resource shortfalls for specific programs or program components are provided below. A summary of shortfalls with action steps, short-term schedule, and long-term needs is compiled in Table 4.

J.2.1 Wadeable Streams and Large Rivers
J.2.1.1 Watershed Biosurveys
Statistics from the 2004 Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2004a) detailed the surface water monitoring effort of Ohio EPA over the last 10 years in Ohio's 331 11-digit HUC Watershed Assessment Units (WAUs) and 23 Large River Assessment Units (LRAUs). For the time period spanning 1993 - 2002, 225 (68.0%) of WAUs had sufficient sample site coverage to adequately assess status of aquatic life uses within the assessment unit. Equally, over 72% of LRAU miles (across 21 of 23 LRAUs) were assessed for aquatic life use status. In addition to individual watershed reporting, aggregated statistics from these assessment units were used to compile statewide statistics on aquatic life use attainment and non-attainment. While the level of effort and coverage over this ten-year period was assumed to have provided a sufficient amount of data to characterize statewide surface water condition, the ability to rely on this assumption in the near future is problematic. Projections for up-to-date and adequate data coverage in WAUs and LRAUs, based on existing Ohio EPA resources and scheduled watershed biosurveys (Ohio EPA, 2004a; Appendix B.3), show a significant decline in statewide

Table 3. Full-Time Equivalents (FTEs) spread by Division of Surface Water (DSW) program area (from the DSW SFY 2006 Annual Work Plan).

DSW Program Area	Total DSW FTEs	Monitoring and Assessment Reporting Categories (FTEs)				Total M&A FTEs
		Fish Tissue	Wetlands	TMDLs	General Water Quality/Other	
Cleanup / Remediation	**1.9**				1.1	**1.1**
Compliance	**30.8**			0.1	0.5	**0.6**
Enforcement	**4.7**					
Environmental Monitoring	**19.4**	0.4	2.8	13.3	2.6	**19.1**
General Administration (Includes Data Mgmt.)	**46.5**	0.4	0.1	5.6	4.9	**11.0**
Grants and Loans	**3.8**					
Outreach	**21.7**	0.1	0.1	2.0	1.4	**3.6**
Permits, Licenses, Plan Approvals & Certifications	**55.2**			5.2		**5.2**
Rules, Policies & Legislation	**6.0**				0.7	**0.7**
Technical Review / Technical Analysis	**21.4**	0.4	0.5	9.4	2.8	**13.1**
Leave	**33.3**	0.1	0.4	6.2	3.0	**9.7**
Total	**242.8**	**1.4**	**3.9**	**45.7**	**17.0**	**64.1**

coverage over the next two reporting cycles (Table 5). This is primarily due to the fact that peak monitoring years within the Division of Surface Water occurred from about 1994-1997. As data collected during this timeframe reaches the 10 - year threshold, it is excluded from the assessment database which is used to determine watershed condition and statewide statistics. Current monitoring and assessment resources are increasing slightly and should continue to do so over the next biennium.

Table 4. Listing of Ohio EPA Surface and Ground Water Monitoring and Assessment Program Deficiencies, Action Steps, Short-Term Schedule, and Projected Long-Term Needs.

Monitoring and Assessment Program Shortfall	**Action Steps**	**Short-Term Schedule and *Projected Long-Term Needs***
Diminishing Capacity to Provide Watershed Biosurvey Assessments Within a 10-Year Sampling Rotation Schedule	Increase the no. of field crews dedicated to watershed biosurveys to ensure adequate, up-to-date monitoring data for all water quality management programs; investigate the feasibility of initiating a probabilistic design to more efficiently provide monitoring data for specific assessment and reporting needs.	One additional new biological field crew (2 FTEs) will be available for the 2006 field season. This will increase capacity from 4 to 5 field crews and increase the annual site allocation by about 25%. *An additional 3 biological field crews (6 FTEs) and 7 to 8 FTEs of water quality staff at district offices (plus increased seasonal intern support) will be needed to provide 100% sampling coverage of Ohio's wadeable streams and large rivers on a 10-year sampling rotation using <u>current</u> survey protocols. Use of a probabilistic design to streamline certain monitoring needs and provide accurate statewide beneficial use attainment statistics for wadeable streams and large rivers will require one dedicated biological field crew and commensurate support from district water quality staff.*
Credible Data Program Implementation	Adequately staff this new mandated program to ensure no resource loss to existing monitoring and assessment programs.	One new FTE will be hired in FY2006 to oversee the program in the preliminary stages of implementation. *It is anticipated that up to an additional 2 FTEs will be needed to meet the demands of the program as State of Ohio agencies initiate mandatory submittals of monitoring data and volunteer institutions, groups, and individuals begin to more widely participate in the program.*

Table 4. (Continued)		
Biocriteria Revision and Recalibration	Review, revise, and recalibrate Ohio's bioassessment indices and wadeable streams and large river biocriteria based on resampling of Ohio's reference site network from 1990 - 2004.	Contractual support is provided in the FY2006 budget and is projected in the FY2007 budget to meet this need. *When completed, the next planned review, revision, and recalibration should not be necessary until 2015 at the earliest.*
Protection and Assessment of Ohio's Primary Headwater Habitat (PHWH) Streams	Incorporate PHWH aquatic life uses into the Ohio Water Quality Standards, promulgate chemical WQS criteria, and develop and implement bioassessment protocols, indices, and biocriteria.	The PHWH stream classification system is included in the new rules on requirements for mitigation of stream and wetland impacts under the Section 401 certification program. A draft of these rules will be released for public input during the fall, 2005. *Further development and inclusion of the PHWH classification system of aquatic life uses in the Water Quality Standards is contingent upon the successful introduction of this concept into the referenced rules.*
Revitalization of Inland Lakes and Reservoirs Monitoring and Assessment Program and Integration with the Watershed Biosurvey Program	Dedicate resources and develop and implement an inland lakes and reservoirs monitoring effort with eventual integration into the watershed biosurvey program.	A DSW lakes team has formed and is meeting on a regular basis to strategize lake monitoring and assessment proposals built on a tiered structure of increasing complexity and resource needs. The final proposals and recommendations will be presented to DSW management during the fall, 2005. *Ultimate resource needs will be determined by the tier chosen for implementation, but estimates range from 1-3 FTEs (plus 4.5 FTEs seasonal intern support) at the minimal monitoring tier to 7 FTEs (plus 4.5 FTEs seasonal intern support) at the highest resource tier.*

Table 4. (Continued)		
Monitoring and Assessment of the Lake Erie Nearshore, Harbors, and Open Waters	Investigate the feasibility of restoring resources dedicated to monitoring and asssessment of Lake Erie.	Pursue grants to continue bioassessment methods refinement for the Lake Erie nearshore and harbors with the goal of eventual incorporation of biocriteria into the WQS. With more attention being placed on the status of the Great Lakes, particularly by the Great Lakes Regional Collaboration, it will be particularly important to be able to measure progress. This will be difficult to do without the tools to monitor and assess current and future condition. *For the long-term, Ohio EPA should strive to incorporate routine Lake Erie nearshore and lacustuary monitoring as a component of the inland stream and river monitoring schedule.*
Integration of Wetlands Monitoring Program with Watershed Biosurvey Program	Incorporate monitoring and assessment of wetlands into annual watershed biosurveys using sampling methods and procedures and bioassessment indices developed for Ohio wetlands over the last 10 years.	Promulgation of wetland tiered aquatic life uses and numeric biocriteria based on wetland vegetation (VIBI) and amphibians (AmphIBI) is part of the five-year review of Ohio's 401 certification and wetland WQS rules. A draft of these rules will be released for public input during the fall, 2005. *Long-term needs focus on incorporating the wetland monitoring component (a blend of targeted and probabilistic designs) into the watershed biosurvey program and identifying the additional resources necessary to accomplish this. A preliminary estimate of up to 8 wetland field crews (13 new FTEs plus seasonal intern support) will be needed to fully unite the wetlands program with the long-term vision of the watershed biosurvey program.*

Table 4. (Continued)

Revised Contact Recreation Uses and Criteria	Update the Ohio Water Quality Standards contact recreation criteria for bacteria.	Draft rule language has been prepared and is under internal review by DSW. Revised rule language is projected to be available for public input by the end of 2005; proposed rules will be filed in 2006 and may be effective in 2006. Analytical costs should be lowered with implementation of the revised rules (*i.e.*, *E. coli* only rather than both *E. coli* and fecal coliform analyses).
Nutrient Water Quality Standards Criteria for Inland Lakes and Reservoirs	Develop, propose and adopt WQS criteria for nutrients in Ohio's inland lakes and reservoirs.	Available data for Ohio's inland lakes and reservoirs are being analyzed by the DSW lakes team. Revised lake uses, nutrient criteria development, and draft rules are projected for 2006 with new rules projected to be filed, adopted, and effective in 2007.
Nutrient Water Quality Standards Criteria for Wadeable Streams and Large Rivers	Develop, propose and adopt WQS criteria for nutrients in Ohio's wadeable streams and large rivers.	Field monitoring data will continue to be collected through 2006. Data assessment, criteria development, and draft rules are projected to be completed during 2007. New rules are projected to be filed, adopted, and effective in 2008.
Public Drinking Water Supply Monitoring and Assessment Protocols	Develop and implement procedures to assess the Public Drinking Water Supply beneficial use for surface water sources.	An assessment methodology is being prepared for the 2006 Integrated Water Quality Monitoring and Assessment Report which will include pilot assessments for selected public drinking water supplies. Needed revisions to the methodology will be made and assessments of all Ohio surface water public drinking water supplies will be completed for the 2008 Integrated Report.

Table 4. (Continued)		
Analytical Constraints to Monitor Emerging Contaminants	Determine mechanisms to enhance the analytical capability to provide analyses of emerging surface and ground water contaminants (*e.g.*, EDCs, new age pesticides).	Before the 2006 field season, initiate discussions with the Ohio EPA Division of Environmental Services to determine their ability to provide analytical support for desired parameters which will be infrequently or sporadically requested. As an option, investigate the possibility of establishing long-term contractual services with qualified external laboratories with the appropriate analytical expertise. Identify the necessary resources to implement either option.
Surface Water / Ground Water (SW/GW) Interaction	Identify opportunities for documentation of SW/GW interaction.	Surface and ground water staff need to identify specific areas in Ohio where SW/GW interaction has programmatic impact, *e.g.*, TMDL assessment and GW Rule implementation. Initially, the effort to study SW/GW interaction will utilize surface and ground water staff in special studies. Grant funds may be secured to support some special study activities. *Long-term needs are difficult to determine; however, at least one additional FTE is needed to identify and coordinate opportunities to study integration of SW/GW interaction.*

Table 5. Actual and Projected Statewide Aquatic Life Use Assessment: Integrated Report (IR) Cycles 2002 - 2008

	IR Cycle			
	2002 (Actual)	**2004 (Actual)**	**2006 (Projected)**	**2008 (Projected)**
Assessment Years	1991-2000	1993-2002	1995-2004	1997-2006
Watershed AUs				
No. WAUs Assessed	224	225	205	194
% Total Assessed (N=331)	67.7%	68.0%	61.9%	58.6%
Large River AUs				
No. LRAUs Assessed	22	21	17	15
% Total Assessed (N=23)	95.7%	91.3%	73.9%	65.2%
Total Miles Assessed	915.3	918.0	823.2	687.5
% Total Miles Assessed (N=1284.8)	71.2%	71.5%	64.1%	53.5%

While progress will continue to be made on TMDL development based on the Integrated Report schedule, it is readily apparent that the ability to adequately address the issue of statewide statistics (attainment and non-attainment) will likely be compromised with less and less up-to-date and comprehensive coverage of the state's watersheds. In addition, since the Integrated Report monitoring schedule will be directing existing resources into new watersheds needing new TMDL development over, at least, the next 8-10 years, it will be a serious challenge to find resources to follow-up in watersheds where TMDLs or other restoration options have already been implemented. While external sources should be capable of providing some data on progress of restoration measures in watersheds (Credible Data Level 2 efforts), the ultimate decision on success of TMDLs and other watershed restoration activities will likely fall primarily on Ohio EPA's ability to provide robust follow-up surveys to document changes in the status of aquatic life and other beneficial uses. This will seriously challenge monitoring resources if they continue at existing levels. A desirable scenario would be to dedicate new monitoring resources to this targeted follow-up effort. Additionally, these resources could be used to implement a statewide probabilistic monitoring design to more accurately address the issue of beneficial use status at the state and regional level. This concept is discussed in more detail below.

J.2.1.2 Probabilistic Survey Design Concept

To measure various aspects of any population, one needs to either census it entirely or draw a random sample from it. The advantage of a census is that it provides a complete picture; however, a large population census is costly and may not be feasible. A probability sample has the advantage of being less costly than a census, and provides an accurate estimate of the population with known precision. A non-uniform probability sample is a type of randomized study where a certain aspect of a population can be sampled more frequently, or a rare feature of a given population can be assigned a greater chance of being sampled.

For a statewide monitoring program, the type of sampling design depends on the questions one wants answered. Specifically, an estimate of the condition of the state's surface waters, with a high degree of accuracy and precision, can be estimated by randomly sampling ~ 300 locations statewide. These samples can be drawn as a resurvey of historic sites, or from a spatially stratified grid (Figures 5 and 6). A random sample of historic sites has the disadvantage that it repeats any existing spatial bias in the data set, in this case for southwestern and northeastern Ohio.

Using the HUC-14 watershed as a spatial grid has several advantages. It is robust enough to allow for comparisons to historic data, and it will build a spatially unbiased data set over time. Also, the HUC-14s provide a framework for non-uniform sampling to capture aquatic life use stressors that are not distributed randomly across the state. For example, industrial-scale animal feeding operations (AFOs) are concentrated in Darke and Mercer Counties of Ohio. Figure 7 shows a non-uniform probabilistic draw of 100 HUC-14s where HUCs containing AFOs were between 10 and 200 times more likely to be drawn depending on the number of AFOs that each contained (the redder the color, the more AFOs, blue denotes no AFOs). Lastly, using the HUC-14 as a spatial grid has, in a sense, a built in weighting for drainage area because the HUCs are nested within a hierarchical framework. The distribution of drainage areas drawn will mimic the distribution from recent historic data.

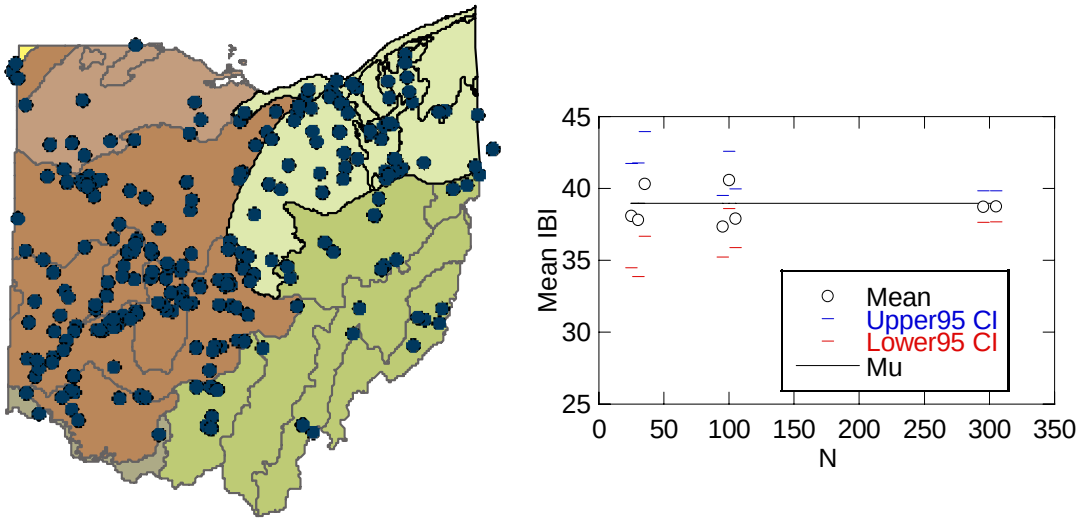

Figure 5. Estimates of mean IBI scores from random samples of recent (the last decade) historic sites drawn from the Ohio EPA database compared to the population mean of all IBI scores (the solid line in the right panel) for the same period.

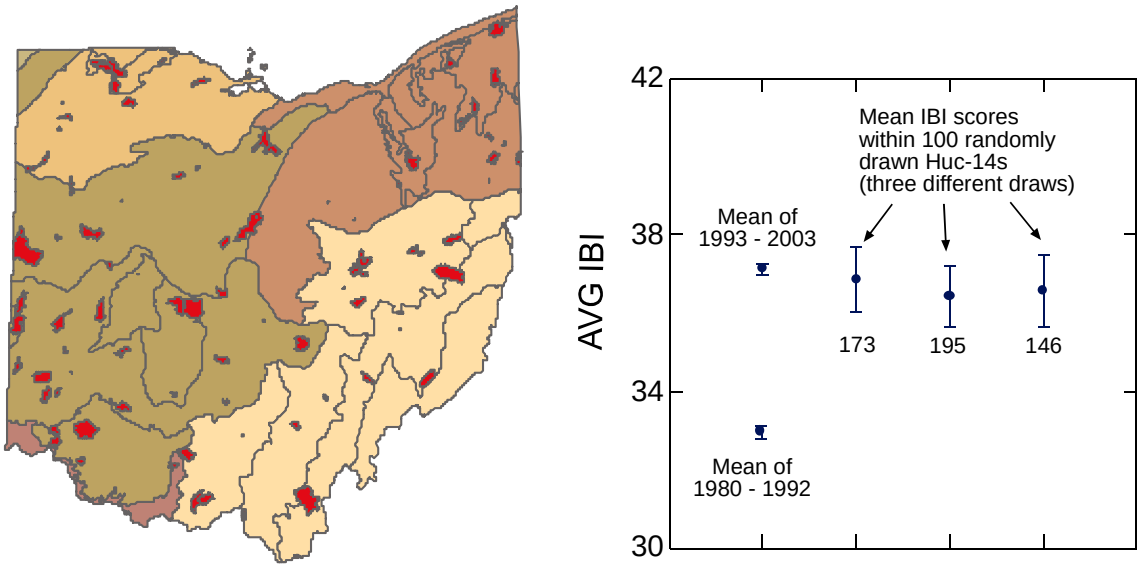

Figure 6. An example of 100 randomly drawn HUC-14s (left panel), and mean IBI scores from recent data (1993 - 2003) within three different runs compared to historic mean IBI scores from two time periods. IBI sample sizes for the HUC-14 draws are shown below their respective means.

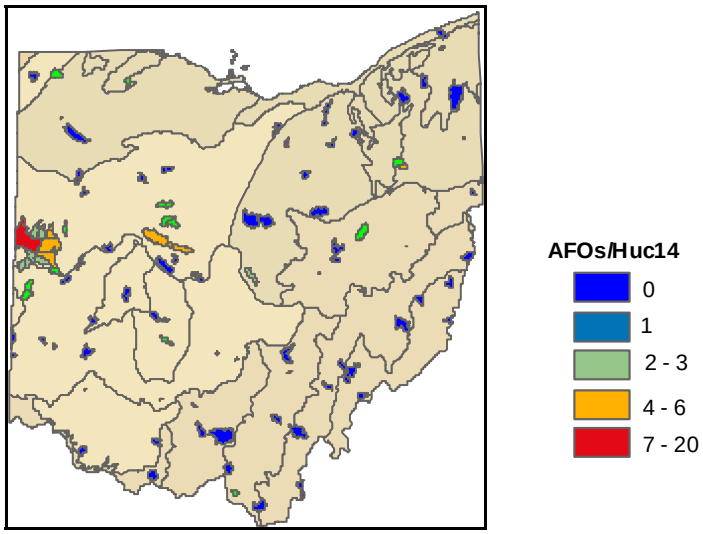

Figure 7. An example of a non-uniform probabilistic draw of 100 HUC-14s where the HUCs containing NPDES permitted AFOs were between 10 and 200 times more likely to be drawn than a HUC-14 lacking permitted AFOs. The HUC-14s were weighted by ten times the number of AFOs that each contained.

J.2.1.3 Credible Data Rules Implementation

The Ohio General Assembly passed HB 43 in 2003 which mandates that Ohio EPA develop and administer a new water quality monitoring program for the classification and repository of credible data collected by other state agencies and third parties. While administrative rules for this program are still in preparation, it is evident that additional database management and staff time for review of the credentials for qualified data collectors and of the data submitted will become a significant new demand for monitoring program resources in the SFYs 2006 and 2007 biennium budget and all future budgets. Specifically, administering the credible data program will require the review of study plans for data collection submitted by organizations and citizens, the verification of the data to determine its classification, and managing all data submitted by other state agencies. This work is expected to ultimately consume at least 3 FTEs. One FTE has been committed to this program during SFY 2006 and the position is in the process of being filled.

J.2.1.4 Biological Criteria Recalibration

Ohio EPA conducts biological (fish and macroinvertebrates) and chemical/physical sampling periodically at sites in the regional reference site network (approximately 450 sites) established for wadeable streams and large rivers in Ohio. These sites were established based on results from the period 1981 - 1989 and continue to be sampled in connection with watershed biosurveys following the Ohio EPA 5-year Basin Approach and the monitoring schedule detailed in the 2004 Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2004a; Appendix B.3). The goal is to resample approximately 10% of the reference sites each year. Additionally, approximately 100 sites are scheduled to be resampled for sediment chemistry. This database provides background information about regional expectations for biological community performance and chemical/physical water quality at least impacted reference sites. Regional reference sites are important in the derivation of the Ohio EPA biological criteria in that they “drive” the calibration of the multi-metric evaluation tools (eg., IBI and ICI) and provide the database from which ecoregional biological criteria are derived. Continued resampling at the rate of 10% of the sites per year is necessary to keep track of any changes in background biological community performance. This provides the opportunity to make periodic adjustments to the calibration of the multimetric indices, the biological criteria, or both. However, the biocriteria review (including metric and criteria recalibration and revision, if necessary), which was originally intended to be completed early in the 2000s using the resampled reference data collected between 1990 and 1999, has not yet been accomplished due to resource

constraints. As such, Ohio EPA has targeted contractual resources in its SFY 2006 and SFY 2007 budgets to undertake this task. A Request for Proposal (RFP) will be developed during SFY 2006 based on committed resources. An additional RFP will be available during SFY 2007 if resources are allocated.

J.2.1.5 Primary Headwater Habitat Streams

The future of the Primary Headwater Habitat (PHWH) stream project provides for a number of options.

1) To incorporate the PHWH stream classification system into the Ohio EPA future "stream mitigation" rule for the Section 401 Water Quality Certification program. This proposed rule is now in final draft form and should be released to the public for review within the next 12 months.

2) The adoption of specific aquatic life designated uses in OAC Section 3745-1 for the various PHWH stream classes (I, II, III), with each class receiving unique chemical specific water quality criteria to protect their ecological integrity. In general, this would equate to the following system: Class I streams protected using LRW chemical criteria, Class II streams protected using WWH chemical criteria, and Class III streams protected using CWH criteria.

3) Conduct basic research to adopt a concept of "ecological integrity" for Class III and Class II Primary Headwater Habitat streams. This would allow for "impaired" PHWH streams to be identified and thus included in TMDL assessments. Such a project would require Ohio EPA biologists to determine "reference conditions" for PHWH biological communities in the different ecoregions of Ohio. A specific set of physical and biological metrics would need to be measured to determine the natural structure and function of both Class II and Class III habitats, and how these metrics deviate from the norm under different levels of impact from chemical pollution, land use, loss of riparian habitat, siltation from construction site runoff, and modification of hydrology. This project would require the type of funding, monitoring effort and staff commitment now being used by the DSW Wetland Assessment Section to determine the concept of ecological integrity for various categories of wetlands in Ohio. It is not unreasonable to suggest that a minimum of 50 PHWH reference stations for both Class II and Class III would need to be sampled in each of the four major ecoregions of Ohio. This sampling effort would require a total of 400 reference stream stations to be sampled seasonally for at least a two year

period. Staff time would need to be allocated for both field sampling and identification of benthic macroinvertebrate species during this two-year period in addition to time for data analysis and writing final reports. Funding for this project could be obtained by applying for a three-year monitoring grant from the NSF and/or US EPA.

J.2.1.6 Recreation Uses

District staff, which collect most of the Agency's bacteria data, will be involved in future revisions to the recreational water quality standards to help ensure that monitoring resources are considered before making any rule revisions. Additional bacteria data resources may be tapped through the implementation of the Credible Data rules. Elimination of the dual bacteria indicators should provide additional resources to collect *E. coli* data.

J.2.1.7 Public Drinking Water Supply Use

As Ohio EPA prepares to move from the developmental to implementation phase of assessment protocols for the PDWS use, it is clear the most significant obstacle is availability of financial and personnel resources. Resources would be most efficiently utilized when source water sampling can be combined with other ongoing and larger-scale sampling efforts. However, due to the seasonal occurrence of the core indicator contaminants and the distribution of public water system intakes across the state, it may be necessary to develop a separate source water sampling program. Additional funding and resource options are under consideration.

J.2.1.8 Fish Consumption

Currently, Ohio EPA, Ohio DNR, and the Ohio Department of Health actively participate in the fish consumption advisory program. Additionally, the Ohio Department of Health contributes resources by conducting public outreach. The Ohio DNR contributes resources both for outreach and for tissue sample collection. Ohio EPA is the primary agency responsible for issuing fish consumption advisories, providing public outreach, sample collection, data maintenance, and analytical services. Funding for most of the fish consumption advisory activities comes from the state's General Revenue Fund.

Currently, the fish consumption advisory program is in the process of developing a strategy to determine fish contaminant trends in Ohio's major waters, Lake Erie and the Ohio River. This strategy will address questions regarding the safety of fish consumption, how contaminant levels in fish are changing over time, problem areas for fish contamination in those water bodies, and the effectiveness of cleanup and pollution prevention strategies for PCBs and mercury.

J.2.2 Inland Lakes and Reservoirs

A serious deficiency in Ohio EPA's surface water monitoring effort is the lack of a state inland lake and reservoir program that assesses water quality and identifies protection needs. Many of Ohio's 400+ publicly owned lakes and reservoirs have multiple recreation uses in addition to their functions as public water supplies, flood control structures, or unique ecological resources. In many of these lakes, upland watershed contributions to the lake ecosystem introduce an array of both point and nonpoint sources of pollution. These multi-media loadings (especially nutrients, pathogens, and sediment) create water quality impacts posing significant risks to human health, aquatic life, and the economic viability of the recreation resource. Historical state inland lake and reservoir monitoring activities relied on federal CWA Section 314 funding and the availability of matching state funds. As the targeted 314 federal funds disappeared in the mid 1990s, states were encouraged to utilize 5% of CWA Section 319 money to fund their lake monitoring efforts. However, the success of this endeavor in Ohio has been extremely limited because most of the available 319 funding is being used to support development of watershed TMDLs for pollutants impairing beneficial uses of streams and rivers. While implementation of upland stream and river TMDLs should certainly provide a secondary benefit to those lakes and reservoirs in the watershed (i.e., decreased loadings of nutrients, pathogens, and sediment), there is a growing need to establish baseline lake condition, determine long-term benefits of upland watershed TMDLs, and identify other lake and reservoir problems that are unique to the water body and in need of attention. The Clean Water Act requires States to report to the U.S. EPA on the status and trends of lake water quality; however, the most recent inland lake summary report submitted by Ohio EPA was for the 1996 Water Resource Inventory report. The most obvious way to jump start a state lakes program would be to incorporate baseline monitoring of lakes and reservoirs within the context of the watershed biosurvey design. However, while some attempts have been made, this has been difficult to put into routine practice because of limited resources that are already 100%+ devoted to high priority stream and river watershed assessments.

From 1988 to 1995, Ohio EPA applied the Ohio Lake Condition Index (LCI) approach to document the aquatic life and recreational use attainment status for public lakes and reservoirs under federal CWA Sections 305(b) and 314 reporting requirements. However, recent passage of the Credible Data Bill in Ohio (OAC 6111.50 to 6111.56) has invalidated some components of the LCI approach since these do not meet the rigor of Level 3 data. This, thus, leaves a void in the ability of Ohio EPA to identify impaired public lakes and reservoirs that

would require a lake-specific TMDL to restore designated aquatic life, public drinking water, and recreational uses.

Acknowledging this program deficiency, the Division of Surface Water, in the spring of 2005, reconvened its lakes team which had been inactive since the late 1990s. The primary goal of the team is to develop resource-based scenarios for dedicated lakes program funding. It will also address a revision of lake beneficial uses as well as the assessment methodologies used to determine attainment status of those uses. Additionally, the DSW has committed to basic lake and reservoir monitoring to be commenced during the 2005 field season at selected water bodies within watershed biosurvey basins. As such, monitoring has been initiated in several Ohio lakes and reservoirs located in the Blanchard River basin, the Yellow Creek basin, the Salt Creek basin, and the Fourmile Creek basin.

Based on lakes team discussions, a minimal inland lake and reservoir monitoring program, focused on conducting basic lake trophic state assessments using a probability-based design, will require the commitment of one new full-time coordinating position, additional district office summer interns, and some monitoring support from existing district office staff. This dedicated staffing would also provide technical support, advocacy, and guidance to existing and future volunteer monitoring networks across Ohio. Availability of additional staffing resources will allow for an increased level of monitoring.

Ohio EPA envisions a statewide volunteer monitoring program as an integral component to a successful inland lake and reservoir program. An active volunteer program at the local level can assist in some basic lake data collection activities (most efficiently and reliably as Level 2 Qualified Data Collectors per ORC 6111.50 to 6111.56) as well as provide an excellent opportunity for public education on the quality of the lake resource and the need for water quality protection. Volunteers will be particularly useful in monitoring needs that take place after watershed TMDL implementation and/or other watershed restoration activities have occurred. Such volunteer input can provide continual progress reports on the status of restoration activities that would otherwise be difficult to accomplish with Ohio EPA resources devoted elsewhere to new watershed projects. The Ohio Lake Management Society (OLMS) has conducted a citizen lake monitoring program in Ohio for the past ten years and would be an obvious stakeholder organization for a collaborative lake monitoring program with Ohio EPA. Local involvement is pivotal in facilitating local action for remedial activities to restore impaired beneficial uses in lakes and reservoirs.

J.2.3 Lake Erie

Monitoring and assessment support for Lake Erie programs decreased significantly in early 2004 with the loss of a key staff person partially dedicated to Lake Erie nearshore, harbor, and lacustuary monitoring and assessment. As such, current and future monitoring with existing resources will be relegated to overlap activities related to watershed biosurveys occurring in Lake Erie watersheds. Monitoring directly related to existing Lake Erie programs will mostly involve stream, river, and lacustuary sampling in the four RAP watersheds as specified in the Integrated Report monitoring schedule (Ohio EPA, 2004a; Appendix B.3). At this time, there is no monitoring envisioned for Lake Erie harbors, the nearshore, or open waters. Repercussions of this decreased monitoring activity will be most felt in the ability to update the Lake Erie Quality Index, especially for those metrics which relied upon biological data collected by Ohio EPA. Being able to report on the achievement of designated uses in the Integrated Report will be lost and the large gap in knowing anything that is happening in the nearshore zone will remain.

J.2.4 Ohio River

Details of General Support and Infrastructure Planning for monitoring in the Ohio River are documented in ORSANCO (2005).

J.2.5 Wetlands

As discussed above, to date, the Wetlands Program has focused on the development of tools that assess wetland condition. Now that some of these tools have been developed and are available for use, the program's focus is shifting towards using the tools to assess wetlands for the variety of needs of a comprehensive water monitoring program. Grant work has been funded by U.S. EPA and they have been instrumental in aiding us in the development of these tools.

The next step for Ohio EPA will be to perform a fully integrated assessment of both wetlands and flowing waters (streams, rivers) in a watershed. This will mean assessment of ambient wetland condition will be included on a routine basis of with the intensive biological and water quality surveys of streams and rivers already being performed by Ohio EPA. The main limitations on full inclusion of wetlands in Ohio's already well established monitoring and assessment program are lack of implementation funding, too few wetland-dedicated sampling personnel, and, at least partially, not having wetland tiered aquatic life uses specified in rule. The lack of wetland TALUs will be remedied by a rulemaking funded during the next Wetland Program Development grant cycle.

However, as discussed above, the current wetland antidegradation categories presently function as *de facto* TALUs given that they are defined by Ohio EPA's reference wetland data sets.

Virtually all of Ohio EPA's wetland program elements have been developed using project-based Wetland Program Development grants. Full incorporation of wetland monitoring into Ohio EPA's already established watershed biosurvey process will require funding such activities with an alternative source. Such funding would provide the necessary resources to hire additional wetland dedicated sampling staff.

J.2.6 Ground Water

The discussions outlined in the Programmatic Evaluation section have been held regularly since 1994 to identify program directions and activities consistent with DDAGW needs and 106 grant requirements. The 106 work plan and budget identifies current activities and resources. Staffing levels are stable and unlikely to increase. The agency has training programs in place and, if staff identify specialized training relevant to ground water quality monitoring, procedures to request such training are in place. The largest resource issue currently facing the ground water quality monitoring program is access to laboratory resources. The laboratory budget has been cut multiple times with state budget cuts and the current laboratory budget is at a level that will almost certainly be exceeded in SFY 2005.

Potential innovations to the ground water monitoring program include the following.

- Ground Water Probabilistic Monitoring Design: AGWMP sampling generally includes the deeper more productive aquifers. However, these aquifers are not the most sensitive aquifers. A strong case can be made to include more shallow wells located in sensitive aquifers by expanding the number of transient non-community (TNC) wells included in the AGWMP. A probabilistic design could be used in selecting the TNC wells using the statewide knowledge developed about sensitive aquifers. The AGWMP program is at a point where all the AGWMP wells should be evaluated to determine where water quality is stable so that sampling intervals can be expanded from 6 months to 18 months. This will free up analytical budget and time for sample collection at additional wells. The addition of new wells could be selected to maintain broad geographic distribution, to include an increased number of bedrock wells, or to expand the AGWMP to include more shallow wells in sensitive aquifers. The

decision about which option, or combination of options, to choose needs to be presented to the AGWMP workgroup.

- New Parameters: The Ohio EPA Division of Environmental Services (DES) provides high quality data, but our ability to add new parameters is very limited due to the production nature of the DES lab. DDAGW needs to identify a lab or labs that can be used for analysis of emerging parameters for both surface water and ground water monitoring in sensitive situations. This includes the need for standing contracts and resources to pay for limited analyses of emerging parameters.

J.2.7 Surface Water - Ground Water Interaction Strategy

The hydrologic cycle clearly indicates the importance of surface water - ground water interaction; however, the difference in flow rates of surface water and ground water makes it difficult to combine monitoring programs for these resources. The strategy to integrate the surface water and ground water monitoring programs is to focus on areas where surface water and ground water interaction significantly impact one another. These are the areas where the differences in flow rates converge. Some good examples include the following.

- At low flow, ground water comprises up to 75% of the Mad River's volumetric base flow.

- In southeast Ohio, discharges from abandoned mines cause impairment to streams.

- In sensitive aquifers, such as karst or buried valley aquifers, rapid recharge to ground water can transport contaminants that impact water quality.

- Well fields located close to rivers are designed to induce surface water infiltration.

To achieve the goals of the Clean Water Act, Ohio EPA needs to understand the interaction of surface water and ground water in hydrologic settings where rapid exchange between surface water and ground water occurs. To be effective, a water quality monitoring strategy must account for this interaction and the water quality impacts each resource can have on the other. The Division of Surface Water and the Division of Drinking and Ground Waters are committed to working together to identify opportunities for greater integration of the surface water and

ground water monitoring programs. Considering U.S. EPA's ten elements of a monitoring program, the following describe a potential strategy to implement a program to assess ground water - surface water interactions in Ohio.

Monitoring Objectives: The primary objective of monitoring surface water and ground water interactions is to better understand these interactions in hydrologic settings where rapid exchange between surface water and ground water occurs. In particular, monitoring efforts should focus on areas where the interaction has the potential to impair water resources. Knowledge about the rate of exchange of water between surface water and ground water will significantly benefit surface water and ground water modeling efforts.

Monitoring Design: Monitoring design should focus on specific areas where surface water and ground water interact. Water resource uses that provide potential for this interaction, with practical applications for protecting water quality, include:

- Characterization of stream base flow contributions from ground water;
- Study riverbank filtration to understand the effectiveness of natural filtration of pathogens associated with induced recharge of surface water;
- Design pathogen migration studies to evaluate the effectiveness of natural filtration processes for removing pathogens in aquifers;
- Study the influence of surface water quality on river bank filtration processes;
- Evaluate the influence of high surface water recharge on water quality in sensitive aquifers including karst, thin till over bedrock, and buried valley aquifers;
- Correlate areas of high ground water discharge to surface water quality; and
- Study small watersheds over sensitive aquifers to evaluate cause and effect relationships between land use and ground water quality.

The integration of surface water - ground water interaction into monitoring plans will provide information to evaluate sustainability of Ohio water resources.

Core and Supplemental Water Quality Indicators: The water quality indicators selected for individual surface water -ground water interaction studies will be a combination of surface water and ground water indicators best suited for meeting the objectives of the specific study.

Quality Assurance: A Surface Water - Ground Water Interaction Program should be supported by general QA/QC procedures comparable to those used in the individual programs.

Data Management: A Surface Water - Ground Water Interaction Program should be supported by general data management procedures comparable to those used in the individual programs; data and results should be incorporated into STORET if possible.

Data Analysis/Assessment: The objective of data analysis tools should be to evaluate surface water - ground water interactions and to identify ways to protect water resources of the state. Existing water quality standards could be applied, but no assessment parameters or water quality standards are established for surface water - ground water interaction. The primary benefit of such an analysis should be expanding knowledge of the flux between surface water and ground water, of contaminant transport loads, and of filtration of contaminants and pathogens associated with this interaction.

Reporting: Results of special studies should be incorporated into updates to the Integrated Water Quality Monitoring and Assessment Report, the ground water chapter of the CWA Section 305(b) report, and appropriate Technical Support Documents (TSDs). The initial focus of reporting results should apply the knowledge of surface water - ground water interaction to protecting Ohio's water resources.

Programmatic Evaluation: It is not clear how the surface water - ground water interaction monitoring should be evaluated in the long-term. Initially, however, most of the sampling should be organized on a special/local study structure and the monitoring judged on how well the study meets the sampling plan objectives.

General Support and Infrastructure Planning: The preliminary nature of the surface water - ground water interaction monitoring makes the general level of support difficult to identify beyond the fact that additional resources, staff time and analytical costs will be needed. What level will be needed is largely a function of how quickly the Division of Surface Water and Division of Drinking and Ground Waters identify opportunities for monitoring surface water and ground water interactions.

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