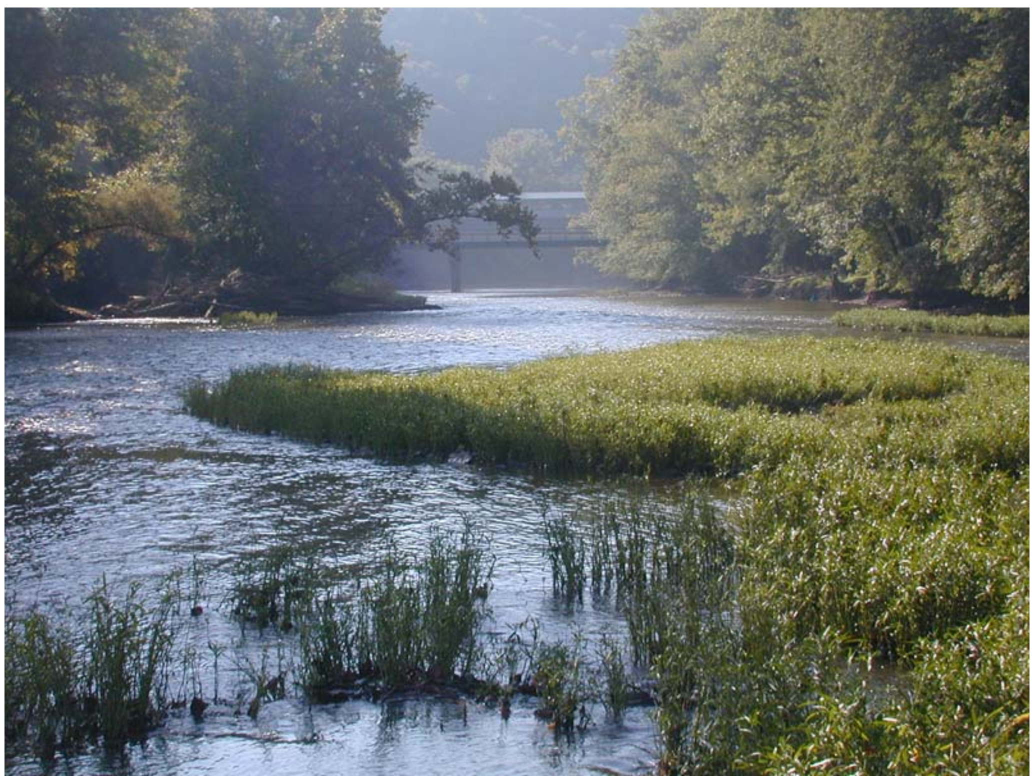
July 2011

Division of Drinking and Ground Waters
Division of Surface Water

Ohio EPA Surface and Ground Waters

Monitoring Strategy

2011 - 2015



OHIO EPA Technical Bulletin DSW/EAS/2011-4-1

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Ohio EPA Surface and Ground Waters Monitoring Strategy 2011 - 2015

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Ohio Environmental Protection Agency
Division of Surface Water
and
Division of Drinking and Ground Waters

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Acknowledgments

Ohio EPA's Surface and Ground Water Monitoring 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 Jeff DeShon and Marc Smith. Contributors to this edition include: Paul Anderson, Jeff DeShon, Michael Eggert, John Estenik, Gail Hesse, Christopher Kenah, AmyJo Klei, Mick Micacchion, Heather Raymond, Mylynda Shaskus, Bill Schumacher, and Chris Skalski. This strategy was coordinated and compiled by Jeff DeShon.

Ohio EPA Surface and Ground Waters Monitoring Strategy

Introduction

This document presents a description of Ohio EPA's immediate and long-term water monitoring 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 that goal.

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. The 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 all water 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 of named and designated rivers and streams, including 24 stream and river reaches designated as State Wild, Scenic, or Recreational Rivers (800+ cumulative miles). Ohio also includes a 451 mile border on the Ohio River, 447 publicly owned lakes, ponds, and reservoirs > 5 acres (118,963 total acres), and 290 miles of Lake Erie mainland and islands shoreline. Since 1994, Ohio EPA has endorsed a slightly larger estimate for the length of perennial streams (those having water year round) in Ohio - 29,412 miles. Originally, Ohio had about 5 million acres of wetlands, today the wetland resource is estimated at about 500,000 acres. The various water resource statistics for Ohio, the large rivers in Ohio, Ohio's Wild, Scenic, and Recreational River System, and the major aquifers of Ohio are presented in Table 1 and Figures 1, 2, and 3, respectively.

Table 1. Ohio's water resource statistics
(from 2010 Integrated Report).

	Value	Source	Scale
State population	11,536,504	2010 Census	
Land area	40,948 sq miles	2010 Census	
Rivers and streams			
Miles of named and designated streams	> 23,000	Ohio DNR[1]	1:24K
Total miles	58,343	NHD[2]	1:24K
Miles of perennial streams	29,412	NHD	1:24K
Miles of intermittent streams	28,931	NHD	1:24K
Miles of primary headwater streams	> 115,000	Ohio EPA[3]	
Miles of large rivers (draining more than 500 sq mi)	1,287	NHD	1:24K
Miles of principal streams (draining 50 to 500 sq mi)	4,474	NHD	1:24K
Border miles: Ohio River	451	USGS $7^{1/2}$' Maps	1:24K
Border miles: Lake Erie shoreline	290	USGS $7^{1/2}$' Maps	1:24K
Lakes/reservoirs/ponds			
Number of significant publicly owned lakes	447	Ohio DNR[4]	1:24K
Total acreage of significant publicly owned lakes	118,963	Ohio DNR[4]	1:24K
Wetlands			
Acreage	500,000	Ohio EPA[5]	$30m \times 30m$[7]
% of original wetlands	10%	Dahl[6]	

1 Mileage figure for waters listed by Ohio Department of Natural Resources (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.

3 An estimate prepared by Ohio State University for Ohio EPA and reported in “Field Evaluation Manual for Ohio’s Primary Headwater Habitat Streams” (Ohio EPA, 2002a).

4 Acreage figure for significant publicly owned lakes (> 5 acres) listed by Ohio Department of Natural Resources (1980).

5 Current acreage figure for wetlands listed based on totals from most recent National Wetland Inventory Maps as calculated by Ohio EPA.

6 Historic acres from “Dahl (1990).

7 LandSat Thematic Mapper Data.

Figure 1. Ohio's large rivers with greater than 500 mi^2 of drainage area.

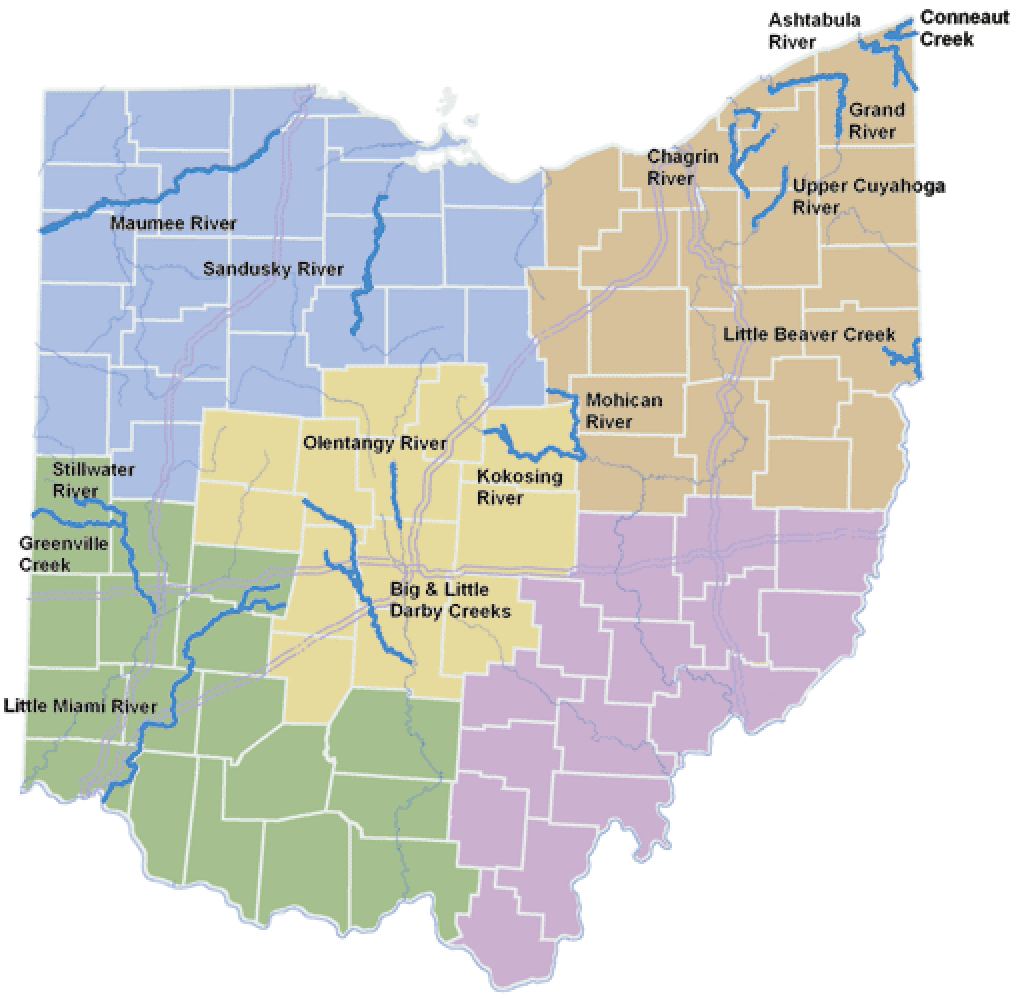

Figure 2. Ohio's Wild, Scenic, and Recreational River System.

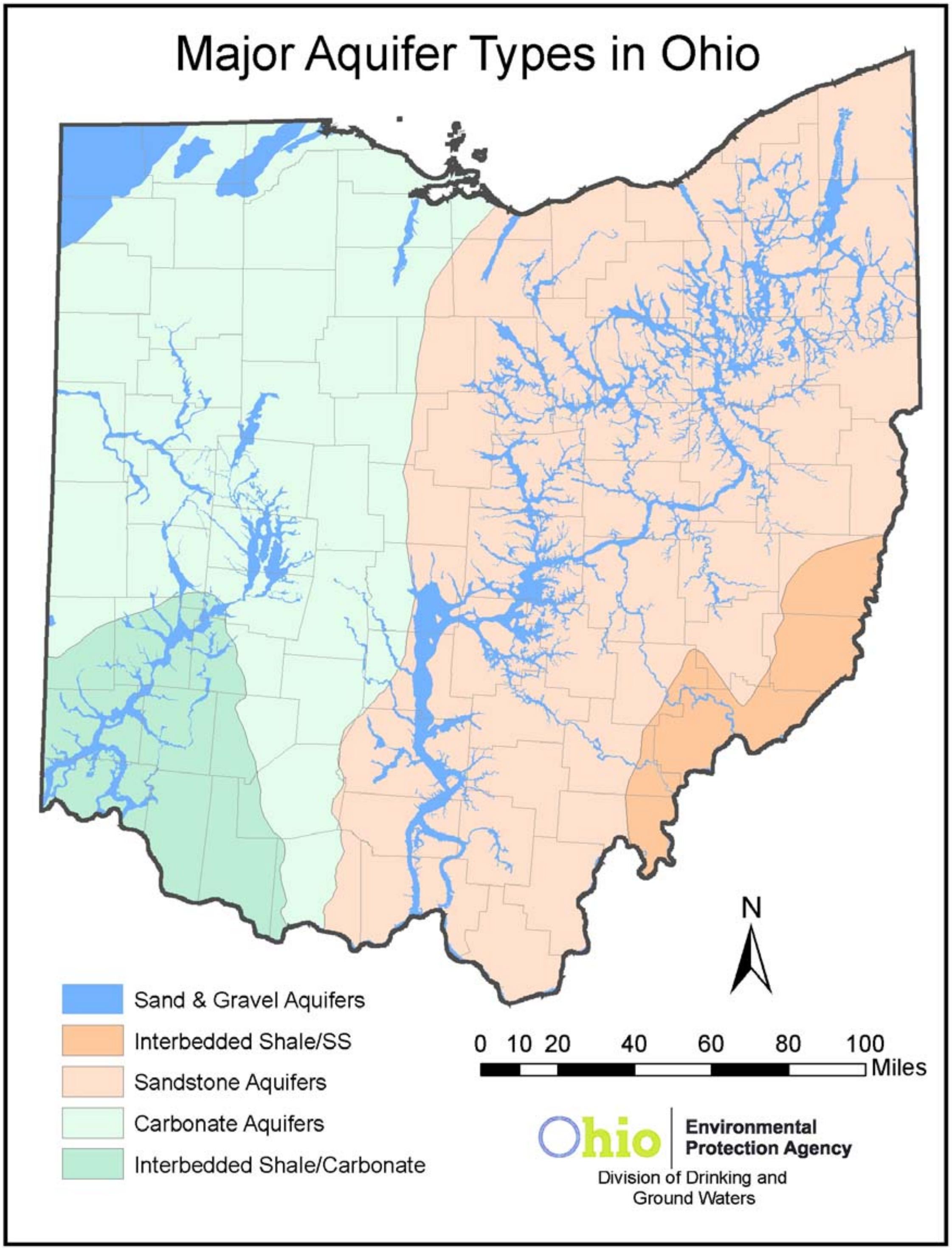

Figure 3. Ohio's Major Aquifers.

The larger water bodies included in the preceding statistical summaries do 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 30,000 miles of the over 61,000 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 2002a). 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 interbedded with shale, 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 and the sensitivity of the aquifers. 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

U.S. EPA'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

U.S. EPA'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

U.S. EPA'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

U.S. EPA'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

U.S. EPA'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

U.S. EPA'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

U.S. EPA'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

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

I. Programmatic Evaluation

U.S. EPA'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

U.S. EPA'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 Programs

A. Monitoring 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 90 - 110 U.S. Geological Survey 12-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 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 and Section 314 Clean Lakes programs, Lake Erie Area of Concern Remedial Action Plans (RAPs) and Great Lakes Restoration Initiative (GLRI) projects, 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. This demonstrates how this type of sustained approach is inherently anticipatory. Anticipatory monitoring and assessment is essential to maintaining and improving the overall water quality management process.

A.1.2 Water Quality Modeling

Additional specialized monitoring that includes water quality modeling surveys and wasteload allocation development is conducted annually to support the TMDL program and the NPDES permitting program. The former effort involves development of watershed-scale point and nonpoint load allocations for pollutants impairing beneficial uses as identified through the watershed biosurveys while the latter activity involves the development of water quality based effluent limitations (WQBELs) for point sources. 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. Comprehensive (i.e., watershed-wide) surveys using time-continuous, multi-parameter sensors of bulk chemistry are deployed to support the integrated biosurvey identified in A.1.1.

Data collection required to calibrate and validate watershed models involves year-around monitoring of stream flows and water quality data at selected sites in the study areas. Monthly (or more frequent) monitoring is typically required to define seasonal flow condition and water quality fluctuations. Enhanced spatial (e.g., sub-watershed) and temporal (e.g., rain event) monitoring frequency improves the definition of TMDL restoration scenarios. 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 stream flow conditions. Oxygen model calibration and verification are completed using these monitoring results. 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, time of travel, reaeration, composite chemical sampling, algal biomass and metabolism, and sediment oxygen demand may be determined over a period of one to four days. Multiple surveys are required to fulfill the data requirements of model calibration and verification. 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.ohio.gov/dsw/rules/3745_2.aspx)

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 quarterly for field, 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. The 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 gauging 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 stratified by Level 3 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 criteria, 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

The 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 many of the water quality impairments in Ohio's rivers and streams can be traced to impacts in the upper headwater reaches of watersheds. The current Ohio Water Quality Standards (Chapter 3745-1 in the Ohio Administrative Code) 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 and benthic macroinvertebrates that vary by ecoregion. However, experience has shown that the assessment techniques for biological integrity do not accurately measure ecological responses in the smallest headwater streams (<1 mi^2). This is reflective of the low level of fish species richness that naturally occurs in these systems, and the differences in species assemblages found in first and second order headwater systems. In addition, the use of Hester-Dendy artificial substrate samplers to sample benthic macroinvertebrates, as required by existing Ohio EPA 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) can be reliably used as biological assessment tools for the smallest headwater streams.

Since 2002, the Ohio EPA has changed the monitoring strategy from a stream-reach based assessment to a watershed-based attainment assessment for purposes of 303(d) listing and integrated reporting. Much of this sampling is designed to identify causes and sources of use impairment so that pollutant TMDLs can be developed. However, in the smallest headwater watersheds where the IBI and ICI cannot provide functional assessments of water quality impairment, it is nearly impossible to construct TMDLs since reliable measures of expected outcomes for beneficial aquatic life uses cannot be predicted.

To address these limitations in Ohio's monitoring strategy the Ohio EPA Division of Surface Water (DSW) conducted a survey of over 300 of the smallest headwater streams in the various ecoregions of Ohio from 1999 to 2002. 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. The Ohio EPA has coined the term "Primary Headwater Habitat" (PHWH) stream to distinguish these habitats from the current "headwater" stream definition as currently listed in the Ohio Water Quality Standards.

The results of the first phase of the PHWH stream project have now been finalized and made available to the public at the following DSW web page: http://www.epa.ohio.gov/dsw/wqs/headwaters/index.aspx. Available information 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, 2009a).

In general, the results of the survey indicate that three distinct types of biological communities are present within the spatial scale of PHWH streams, referred to as Class I stream, Class II, and Class III PHWH streams. 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 recharge, 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 a hydraulic connection to various types of ground waters, 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 incidence of cool and cold water benthic macroinvertebrate taxa; (2) reproducing populations of cold water adapted fish species (e.g. brook trout, mottled sculpins, brook stickleback, or redside dace); or (3) reproducing populations of salamander (amphibian) species from the Family Plethodontidae 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 experience perennial flow resulting from hydraulic connection to groundwater.

Class II PHWH streams are those habitats with hydrology connected to perched ground waters or wetland-lake surface water discharge. These streams experience warmer water temperatures in the summer, and often exhibit intermittent flow regimes. 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 the PHWH project was that diverse networks of biological communities are present in streams with very small drainage areas. The obvious implication of this finding is that approaches to water quality and land management issues must be appropriately scaled to reflect the diverse types of aquatic resources present. For example, the Ohio Water Quality Standards protect all “undesignated” streams in Ohio using the Warmwater Habitat chemical criteria. However, the results of the PHWH survey indicate that this approach is over-protective of ephemeral Class I PHWH streams, but may not be sufficiently protective of Class III PHWH streams where pollution-sensitive species are more likely to be found.

The primary use of the PHWH stream classification system in the water quality monitoring strategy currently is within the Section 401 water quality certification program. Primary Headwater Habitat classifications are used to determine the “existing aquatic life use” for small streams that are proposed to be modified under an Army Corps of Engineers Section 404 permit. Results of these assessments provide valuable data for anitdegradation decisions, and the determination of stream mitigation requirements relating to approved impacts. Ohio EPA has proposed the incorporation of the PHWH aquatic life uses into the State Water Quality Standards and the use of the classification scheme as a critical component of draft rules for stream mitigation. Both draft rules were open for comment through the Interested Party Review process, with comments due to Ohio EPA by June 6, 2011 (http://www.epa.ohio.gov/dsw/rules/overview_dec10.aspx).

Ohio EPA has developed and maintained a training program for PHWH assessment methods that serves agency staff; staff from other state, federal and local government agencies; colleges and universities; and environmental resource professionals. However, the ability to provide training and testing has been limited, and at current staffing the existing training strategy cannot meet demand. Ohio EPA plans to develop a web-based introductory PHWH training tool that can be used to reach more participants, with more intense follow-up field training available to those needing a higher level of qualification under Ohio's credible data law. It is hoped that this training approach can be implemented in the spring of 2011.

The PHWH classification system has been used by numerous agencies and academic institutions as a tool to classify small streams, provide resource inventories, and to correlate watershed-scale water quality information. For example, the Lake Soil and Water Conservation District (Lake County, Ohio) has used the PHWH classification system to map the existing biological potential of all PHWH streams for small watersheds in the county. This project has greatly assisted in efforts to develop appropriate land use planning and storm water management at the county level of government. Additional examples include: basic research efforts by scientists at The Ohio Agricultural Research and Development Center (the Ohio State University) to work with farmers to protect PHWH stream corridors that flow through agricultural lands; and use of PHWH assessments within the Cuyahoga Valley National Park to monitor effects of land use changes on park resources.

Finally, research has begun to enhance the methodologies for PHWH streams beyond basic classification of community type to assessment of attainment of water quality goals through the development of biological criteria. A PHWH Community Quality Index (CQI) for Class III PHWH streams has recently been developed that can provide a reliable measure of water quality impairment in these systems (Moore, 2009). Ohio EPA plans to conduct a study using the PHWH CQI methods to validate the applicability of the methodology as a measurement of water quality across all of the ecoregions in Ohio. In addition, the candidate study sites will be expanded to determine whether the same concepts can be applied to Class II PHWH streams.

A.3 Inland Lakes and Reservoirs

Ohio EPA's most recent past 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, 1997a). 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, 2004) indicated that the Agency will strive to include inland lakes and reservoirs in future monitoring activities. In 2005, Ohio EPA convened a workgroup to begin the process of defining a new inland lakes sampling program that would be linked to the TMDL program. Then in 2006, Ohio EPA prepared a White Paper detailing the new Inland Lakes Monitoring Program. This White Paper also included a lake definition that had not previously been included in our rules.

During the 2007 field season, Ohio EPA participated in the U.S. EPA-sponsored National Lakes Survey. Ohio was assigned 19 lakes that were selected through a probability-based random selection process. The effort served as a precursor for renewed lake sampling program in Ohio which officially started in the spring of 2008.

An important distinction between assessment of aquatic life uses of rivers and streams in Ohio versus lakes is that the former relies on biological monitoring and a comparison of those results to the biological criteria as the assessment tool. At this time, Ohio does not have biological criteria that apply to lakes. As a result, the assessment methodology for the lake habitat aquatic life use will rely solely on the results of water quality sampling and a comparison of the results to the applicable numeric Water Quality Standards criteria.

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 U.S. EPA/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 and focused on the nearshore, lacustuaries, and harbors. However, programs are underway to better assess these areas.

A.4.1 Remedial Action Plan (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 have developed 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 were presented in the 2004 update to the Lake Erie LaMP to provide a means of measuring the progress toward achieving the ecosystem objectives associated with the vision (U.S. EPA, 2004).

A.4.3 Lake Erie Coastal Wetlands

Lake Erie Coastal Marshes are a specific hydrogeomorphic (HGM) class of wetlands in Ohio. Coastal marshes include 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 (VIBI) for Ohio Wetlands.

A.4.4 Lake Erie Nearshore Monitoring Project

Ohio EPA was awarded a Great Lakes Restoration Initiative (GLRI) grant in 2010 to develop a comprehensive Lake Erie nearshore monitoring program. This project will design and implement a monitoring program for the Ohio Lake Erie nearshore zone (including bays, harbors and estuaries) that can be maintained on an annual basis. Annex 11 of the Great Lakes Water Quality Agreement recommends a comprehensive surveillance and monitoring program for the Great Lakes to evaluate water quality trends, assess the effectiveness of remedial programs, measure compliance with jurisdictional regulatory programs, identify emerging problems and support the development of remedial action plans and lakewide management plans. Such a program has existed with wide-ranging variability since it was first proposed more than 20 years ago.

The Lake Erie LaMP, the International Joint Commission, and the State of the Lakes Ecosystem Conference (SOLEC) initiative emphasize the importance of understanding what is happening in the nearshore as the mixing zone/buffer area between the pollutant loads from the watershed and the quality of the open lake. Sub-objective 4.3.3 of U.S. EPA's Strategic Plan is to "Improve the Health of the Great Lakes", but a monitoring program is needed to establish baselines and measure the improvements. The Great Lakes Regional Collaboration recognized the importance of monitoring in its section on Indicators and Information, and emphasized that monitoring needs to be done on a regular basis to measure progress toward the desired state. The Great Lakes Restoration Initiative recognized this need and called for funding an annual monitoring program under Program I.E.4 Annual Comprehensive Nearshore Monitoring Program in the FFY 2010 RFP. The results of such a program will allow the measurement of progress under a number of the other Great Lakes Restoration Initiative focus areas as well as existing programs under the Clean Water Act and Great Lakes Water Quality Agreement.

The nearshore area is the most utilized, visible, impacted and dynamic area of the lake, yet it has not been comprehensively assessed for Lake Erie since the 1978 and 1979 nearshore intensive survey. Since that time conditions in the lake have changed considerably. Implementation of Clean Water Act programs significantly decreased the loads of toxic chemicals, nutrients and sediment and resulted in a much improved Lake Erie ecosystem by the early 1980s. The invasion of dreissenids (zebra and quagga mussels) beginning in the late 1980s initiated dramatic changes in the internal dynamics of the lake affecting the food chain as well as water quality. In the mid 1990s, cyanobacteria (blue-green algae) blooms returned to the lake and have been increasing in temporal and spatial intensity ever since. These cyanobacterial blooms differ from those of the 1960s and 1970s as they are now composed largely of *Microcystis aeruginosa,* a toxin-producing species included under the Harmful Algal Blooms (HABs) umbrella. If present in high enough concentrations, these toxins can impact the health of humans and animals. Shoreline and shallow water growths of the filamentous algal species of *Lyngbya* and *Cladophora* are present at elevated nuisance levels in certain areas. It has also been documented that the tributary loads of dissolved reactive phosphorus and the concentrations of phosphorus in the lake have been increasing since the mid 1990s. Eutrophic conditions have returned.

It is likely that the changing water quality and the cyanobacterial and other algal blooms have also had an impact on the biological nearshore community. Monitoring for fish populations, plankton and water quality occurs at sites in the open lake, but current sampling programs do not assess the quality of the nearshore. In addition to the impacts on water quality from runoff, tributary flows and direct discharges, the nearshore habitat is impacted by shoreline development and wetland loss. The pressures of development have left approximately 85% of the shoreline in Ohio as armored in an unnatural state (Ohio DNR, 2010) so it is extremely important to identify and protect the remaining natural areas. Historically, the fish and habitat community in the nearshore have been assessed using methods developed by Ohio EPA (Thoma, 1999 and Ohio EPA, 2004), but most of the data are now more than 10 years old. The changes that have occurred over the last 10 years could indeed now support a fish community very different than what was measured previously.

A.5 <u>Ohio River</u>

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 detailed monitoring Standard Operating Procedures (SOPs) for the Ohio River which has been endorsed by member states and the federal government. These SOPs were 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 SOPs along with other ORSANCO information are available on their web site. (http://www.orsanco.org./)

A.6 Human Health (Fish Consumption)

Ohio has a comprehensive sport fish tissue monitoring program for fish consumption advisory and environmental contaminant tracking purposes. It addresses all applicable State waters, including streams, rivers, inland lakes and reservoirs, Lake Erie, and the Ohio River. The Ohio EPA and the Ohio Department of Natural Resources (Ohio DNR), together with input from the Ohio Department of Health, maintain a Sport Fish Consumption Advisory (SFCA) program that includes sample collection, laboratory analysis, data assessment, and public outreach. The monitoring strategy provides for sampling all of Ohio's river and stream 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. In the case of the Ohio River, the SFCA program relies on staff from ORSANCO for the collection of fish tissue samples. All 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 locations.
(http://www.epa.ohio.gov/dsw/fishadvisory/overview.aspx)
(http://www.epa.ohio.gov/dsw/fishadvisory/index.aspx)

A.7 Human Health (Contact Recreation)

A.7.1 Ohio's Recreation Water Quality Standards

Ohio recently completed its update to the Water Quality Standards (WQS) pertaining to the recreation use designation as anticipated in the previous version of this report. Updated rules were adopted on December 15, 2009 and became effective on March 15, 2010. They were approved by U.S. EPA on May 4, 2010.

The revised WQS continue to recognize a tiered system of recreation uses consisting of the Bathing Water (BW) use, Primary Contact Recreation (PCR) use, and Secondary Contact Recreation (SCR) use. However, the PCR use is now further subcategorized into Class A, Class B, and Class C waters, each of which has different applicable bacteria criteria. The three classes of PCR waters are differentiated by their potential frequency and intensity of primary contact recreation usage. PCR Class A waters potentially support frequent primary contact recreation activities and include lakes and streams featuring public access points that promote recreational activity. PCR Class C waters are primarily small, historically channelized ditches supporting infrequent recreational activity. PCR Class B waters support occasional primary contact recreation activity and the designation applies to all surface waters not meeting the definition of another recreation use.

The bacteria criteria applicable to the recreation use were also revised in the WQS update in several respects, including removal of the fecal coliform criteria, increasing the averaging period for the geometric mean from a thirty day period to an entire recreation season, extending the period during which the criteria apply to October 31st in lieu of October 15th, and revising the numeric criteria applicable to each use and subclass as shown in Table 2.

These uses and the associated criteria are contained in OAC 3745-1-07. The recreation use is seasonal, lasting from May 1st through October 31st. The changes to Ohio's recreation use WQS have had implications on the monitoring program for bacteria as described below.

Table 2. Statewide numeric criteria for the protection of recreation uses. These criteria apply inside and outside the mixing zone at all times during the recreation season.

Recreation Use	*E. coli* (colony county per 100 ml)	
	Seasonal Geometric Mean	Single Sample Maximum[1]
Bathing Water	126	235[2]
Class A PCR	126	298
Class B PCR	161	523
Class C PCR	206	940
Secondary Contact	1030	1030

[1]Except as noted in footnote 2, these criteria shall not be exceeded in more than ten percent of the samples taken during any thirty-day period.
[2]This criterion shall be used for the issuance of beach and bathing water advisories.

A.7.2 Recreation Use Designations and Use Attainability Analysis (UAA)
Field evaluations for determining recreation use potential are typically performed as part of the watershed biosurvey program conducted annually from June 15th to October 31st. 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. All surface waters of the state are designated as PCR Class B unless otherwise designated as bathing waters, PCR Class A, PCR Class C, or secondary contact recreation.

Ohio's UAA process for recreation use designation determinations take into consideration factors such as water depth, adjacent land use, potential for use by children, and water body accessibility. Ohio developed a field data sheet to facilitate the collection of relevant data for use in assessing recreation use potential.

As previously described, Ohio updated its recreation use designation framework to account for differences in potential full body recreational activity. Those waters having the highest potential use intensity as a result of their promotion as recreational destinations such as scenic rivers, popular paddling streams, and public lakes are assigned the PCR Class A use designation, while those waters that likely support infrequent recreational activity are assigned a PCR Class C designation.

Modification of existing recreation use assessment study plan design took place following the revision of the WQS for the recreation use. The new study plan design, described in Section C.1.4, not only accounts for the WQS revisions but improves upon the Agency's ability to assess the quality of the Ohio's aquatic recreation resources for use in both the Integrated Water Quality Monitoring and Assessment Report and the Total Maximum Daily Load (TMDL) processes.

A.7.3 Recreation Water Quality Criteria
With the 2010 adoption of new recreation WQS, Ohio now relies exclusively on *Escherichia coli* (*E. coli)* as the indicator criteria for assessing recreational water quality. During the previous 20-year period, Ohio's WQS included criteria for both fecal coliform and *E. coli* bacteria indicators. Ohio's bacteria monitoring strategy historically focused on the collection of fecal coliform data. Ohio began collecting an increasing amount of *E. coli* data in addition to fecal coliform data in anticipation of the transition away from fecal coliform criteria to *E. coli* criteria. During this transition period, extra monitoring resources were utilized to collect data for both indicators as there was a fair amount of uncertainty regarding the adoption of the new recreation WQS in terms of both timing and ultimate content. As of the 2010 field season, water quality staff have been able to re-focus their monitoring resources on the *E. coli* indicator now that the fecal coliform indicator

has been formally dropped from Ohio's WQS. This has resulted in an easing of the over-extended usage of the Agency's DES laboratory capacity for microbiological analyses, which had become a major problem for the lab by 2009. Monitoring staff are now able to collect more *E. coli* samples per site since lab capacity is no longer being consumed by the submission of water samples for fecal coliform analysis. Additional *E. coli* data improve the statistical reliability upon which site geometric means are computed, which in turn improves the reliability of recreation use assessments.

Ohio's WQS include both a seasonal geometric mean criterion and a single sample maximum criterion for each recreation use designation. Previously, the geometric mean required the collection of a minimum of five samples within a thirty-day period. Logistical difficulties had often been encountered about the resources available to meet this type of sampling demand. The revised WQS expresses the geometric mean in terms of a recreation season period rather than the previous 30-day period. This revision provides more flexibility to staff in planning and conducting the sampling, and also fosters the ability to collect five or more samples at each sampling location identified in the sampling plans.

The Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (2009b) details the methodology used by field personnel in the collection of water samples for bacteria measurements. Further sampling guidelines were provided to monitoring staff in a May 2010 memo in an effort to ensure that monitoring objectives are achieved with respect to the bacteria data collected to support 303(d) listings, TMDLs, and the Integrated Report in light of the recently adopted recreation use WQS. Sampling issues covered included a variety of topics such as:

- Emphasis on sampling PCR Class A water bodies
- Specification of minimum sampling requirements
- Specification of sampling requirements in relation to flow condition, and
- Frequency of sampling and targets for sampling events per site.

In addition, OAC 3745-1-04 and Ohio EPA DSW Water Quality Standard Guidance #3 provide specific sampling detail used for the purpose of documenting public health nuisance conditions. 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 performs limited and variable monitoring of beaches at inland state parks. The ODH sampling procedures and sample results are available on their web site at www.odh.ohio.gov/odhPrograms/eh/bbeach/beachmon.aspx .

A.8 Human Health (Public Drinking Water Supply)
The 2010 Integrated Water Quality Report was the second reporting cycle to include assessments of the public drinking water supply (PDWS) beneficial use. Ohio has continued to look for connections between Clean Water Act and Safe Drinking Water Act activities and to leverage these programs to clean up and protect sources of drinking water for over seven million Ohioans. The PDWS assessment methodology was developed to evaluate surface waters used as drinking water sources 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 of public water systems using only *conventional* treatment to meet the finished water standards established by the Safe Drinking Water Act. 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). 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 is focusing initial assessment efforts and limited resources on water bodies currently serving as public drinking water sources. Sample collection for the PDWS use is coordinated with ongoing watershed biosurveys, Total Maximum Daily Load (TMDL) assessments, and Inland Lake surveys.

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 at that time. The wetland antidegradation rule (OAC 3745-1-54) created three categories of wetlands (low [poor], moderate [fair to good], and superior [excellent] ecological condition). 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 (ecological condition). These regulatory categories are now defined using actual measures of a wetland's biology and ecological services (functions).

Ohio EPA began working on the development of wetland biological criteria in 1996. To date, we have over 500 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 have been proposed using both plants and amphibians as indicator taxa. Plant TALUs use hydrogeomorphic class, dominant plant community and ecoregion as major classification variables while amphibian TALUs apply to forest and shrub depressional wetlands and are uniform across the state. In 2006 Ohio EPA introduced proposed rules that would modify wetland mitigation requirements as well as establish wetland tiered aquatic life uses and numeric biocriteria. However, that rulemaking received considerable opposition and is currently stalled. This rulemaking should be restarted given the importance of wetland TALUs to the monitoring process at Ohio EPA.

The Ohio Rapid Assessment Method for Wetlands version 5.0 (ORAM) was finalized on February 1, 2001 (Ohio EPA, 2001). Development of the ORAM began in 1996, alongside the development of wetland water quality standards. Development of wetland IBIs has paralleled this process. ORAM has been widely accepted for use in Ohio and is now the predominant assessment method for support of Section 401 Water Quality Certification and Isolated Wetland Permit wetland category determinations. It has been used as a model for numerous other rapid assessment methods across the country and a study of all existing wetland rapid assessment methods determined the ORAM as one of the best methods available (Fennessy et al. 2007). An updated User's Manual, involving minor revisions that would clarify the appropriate scoring protocols for numerous metrics, is planned.

Ohio EPA has evaluated mitigation wetland performance in five different studies dating back to 1995. The studies have included evaluation of mitigation wetland marshes in 2001-2002, an inventory and evaluation of all past 401 mitigation projects conducted in 2002-2004, detailed sampling and evaluation of 12 major Ohio wetland mitigation banks in 2003-2004, and a random sample of all individual wetland mitigation projects, stratified by age, in 2007. In 2009, as part of a larger wetland mitigation grant, a GIS model was developed to predict where high quality vernal pools exist and to identify adjacent locations with high potential for vernal pool restorations. Field verification has shown the model to be highly reliable and it is now being used as a tool to locate and develop better wetland mitigation projects. These studies have included detailed measurements of the biological and biogeochemical characteristics of mitigation wetlands and have allowed statistical evaluation of the overall ecological performance of mitigation wetlands in Ohio to be conducted. Data from both individual wetland mitigation projects and wetland mitigation banks have been compared to values from our natural wetland reference set. Products of these mitigation studies include standardized monitoring protocols, quantitative performance standards, and an evaluation of the feasibility of developing a mitigation ORAM. Results have shown that a rapid mitigation assessment method cannot replace more detailed monitoring. The Ohio Interagency Review Team public noticed the “Interagency Agreement on Wetland Mitigation Banking for Ohio” in early 2010. This comprehensive guide for the wetland banking process in Ohio contains many provisions, including quantitative, ecologically based performance standards, and a phased release schedule, based on achievement of ecological goals, that are direct products of Ohio EPA’s wetland monitoring program.

The Wetland Ecology Group in the past several years has conducted evaluations of the condition of wetlands in specific watersheds. In conjunction with EMAP (Environmental Monitoring and Assessment Program) in Corvallis, Oregon, Kenyon College, and the Cuyahoga RAP, we conducted monitoring to determine the overall condition of wetlands in the Cuyahoga River watershed in 2005. This project used a probabilistic, geospatially balanced, stratified random sample of all wetlands in the watershed. In all, 303 locales received reconnaissance, of which a resulting 243 wetlands were monitored. In 2006, we conducted a random sampling and reporting on the ecological condition of urban wetlands, located in watersheds predominantly within the I-270 outer belt in central Ohio (Columbus metropolitan area). In 2008, we followed up with a study that focused on the amphibian habitat functions of randomly selected urban wetlands, again within central Ohio. In 2008, we also monitored stream flow and nutrient levels in the Big Run Scioto River in central Ohio. This information will be paired with data on the stream fish and invertebrate IBIs, as well as information on the remaining wetland resource in the watershed, to report on the role wetlands play in this watershed’s water quality. Most recently, we have conducted monitoring of a representative set of randomly selected wetlands in two 10-digit HUCs in the middle Scioto River watershed. This monitoring is occurring at the same time as data on stream water quality is being collected by stream biologists. Information on the streams and wetlands, along with management recommendations, will be integrated into the TMDL process to evaluate the overall watershed water quality. In 2011, we will undertake Ohio’s portion of the National Wetland Condition Assessment (NWCA). Additionally, we have received a grant to conduct a statewide intensification of the NWCA over the years 2011 to 2013. We will be using both the national and Ohio methods to monitor these 50 to 60 sites. The results of this study will allow us to provide a report card on overall wetland condition on a statewide basis. In the future, we envision wetland monitoring being incorporated as an integral part of any watershed analysis Ohio EPA conducts.

The Wetland Ecology Group has provided substantial enforcement and litigation support during the past decade. This has included the Bainbridge, Sheldon's Marsh, Dorr/King, Countryside Estates, Riverside Commons, Harshman Road lawsuits and other appeals and enforcement cases. Our current funding sources allow for work defending or using the grant products in permit appeals and enforcement. Technical assistance, that relies heavily on the knowledge from our wetland monitoring, to 401 Coordinators and other parts of the Division and Agency for various projects and programs, occurs regularly, on an as needed and ad hoc basis, and accounts for a significant portion of our time.

Over 1000 people have attended ORAM trainings during the years 2002-2010. The two-day course has a full day of classroom instruction followed by a field day using the method to evaluate wetlands. An advanced wetland-focused botany course was taught with the cooperation of Ohio Department of Transportation (ODOT) staff during the mid 2000s on several occasions. This botany course, which was offered exclusively to Ohio EPA, ODOT and other resource agency staff, included field practicals and a final examination. This course greatly increased the wetland botanical expertise of participants and future sessions are being considered. Approximately 150 people have attended wetland biocriteria training during the years 2005-2010. The three-day course provides in-depth information on field, lab, desktop and computer methods to derive vegetation and amphibian IBI scores. Development of the wetland ICI is also discussed. Given the need to have a wetland permit staff with a high level of wetland expertise and the reliance on outside consultants and users in our wetland program, continuing to offer advanced training is essential to obtaining good information in wetland permit applications and to provide high quality permit reviews.

A.10 Ground Waters

The Ohio EPA Division of Drinking and Ground Waters (DDAGW) implements Ohio's Ground Water Quality Characterization Program (GWQCP) as a non-regulatory ground water monitoring program for Ohio. The 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 Quality Monitoring Program (AGWQMP); 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 AGWQMP 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 AGWQMP program currently collects raw (untreated) water samples at approximately 200 sites on a 6 to 18 month 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. In the mid 1990s, the program was evaluated and additional wells were included in the AGWQMP 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 active AGWQMP sites, roughly 92% are public water systems and the others are industrial, business, or residential wells. Of the active wells, 62% are in unconsolidated aquifers, 21% are in limestone aquifers, and 17% are in sandstone aquifers.

Special studies focus on specific sites with known or suspected ground water quality impacts and allow documentation of cause and effect relationships between land use and ground water contamination. Often the studies are directly associated with ground water impacts effecting or with potential to effect public or private water supplies. The insights gained are applied to similar hydrogeologic settings across the state and compliment the AGWQMP data.

B. Monitoring Objectives

U.S. EPA'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 <u>Wadeable Streams and Large Rivers</u>
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, agricultural best management practices, or TMDLs developed for identified pollutants causing impairment. More specific monitoring objectives for key beneficial uses and related discussion are detailed below.

B.1.1 <u>Aquatic Life Uses</u>
The primary objective of biological monitoring of resident fish and macroinvertebrate communities in wadeable streams and large rivers is to directly assess the biological integrity goal of the Clean Water Act. To this end, the 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.ohio.gov/dsw/rules/3745_1.aspx)

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, 1997b).

B.1.2 <u>Recreation Uses</u>

Ohio EPA's monitoring objectives for recreation uses are consistent with Clean Water Act monitoring objectives. Ohio completed a WQS rulemaking in 2010 that revised the recreation use designations and applicable criteria. Simultaneously, Ohio EPA revised its sampling plan for bacteria to not only account for the changes in the recreation WQS but also to accommodate changes made in recreation use support determinations as implemented in Ohio's 2010 Integrated Report. Changes to the sampling protocol used in the recreation use assessment methodology were made to ensure that the data collected provide sufficient information to determine use support at the assessment unit scale (HUC-12) along with any LRAUs and Class A PCR streams within a study area. In addition, the revised sampling protocol is designed to promote data collection for the most important recreational resources within a study area, to identify impairment and associated causes and sources, and to support modeling activities associated with the TMDL program.

B.1.3 <u>Public Drinking Water Supply Use</u>

The primary objective for monitoring of waters designated with the PDWS use is to identify areas and specific causes of impairment. For those areas previously designated as impaired, sampling may help identify the effectiveness of any implemented reservoir or watershed management actions and identify if the impairment can be delisted. Based on the results from the first two cycles of PDWS assessment and a 2009 Ohio EPA survey which queried Ohio public water systems on the occurrence of algal blooms and impact on water treatment, development of additional PDWS criteria capturing impacts due to algae is needed. The 2008 and 2010 PDWS assessments also identified a lack of pesticide data at or near public water supply intakes. Ohio also intends to evaluate the available pesticide data and consider designated PDWS impairments when determining the SDWA compliance monitoring schedules for pesticides in finished water. These schedules are currently based on finished water pesticide levels only. When possible, monitoring data will be prioritized for collection 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 sport fish tissue monitoring program is to protect and enhance public health by giving technically sound, practical advice about the risks and benefits of consuming sport fish caught from Ohio's surface waters including inland streams, large rivers, lakes, reservoirs, the Ohio River, and Lake Erie (Sport Fish Consumption Advisory program). Beginning with the 2004 Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2004), a second objective of data generated for the sport fish tissue monitoring 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 week 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. A more detailed description of the data analysis and assessment procedures is available in the 2010 Integrated Water Quality Monitoring and Assessment Report (http://www.epa.ohio.gov/portals/35/tmdl/2010IntReport/Section_E.pdf).

Specific goals of the sport fish tissue monitoring program include:

- the analyses of fish fillet and whole body samples (and other wildlife samples on occasion for specific purposes) to determine the potential for human health and environmental effects associated with elevated levels of chemical contaminants;

- to establish a comprehensive, historical database to evaluate contaminant concentrations, which affect the issuance or removal of human health fish consumption advisories and/or environmental impact assessments;
- to identify the extent and magnitude of chemical contaminants in fish to enable anglers to make informed decisions about where to fish and safely consume their catch; and
- to prioritize water bodies based on impaired fish consumption use as determined by the water quality standards for the purposes of making TMDL determinations.

B.2 Primary Headwater Habitats

Primary headwater streams are quite small, less than 1.0 mi^2 drainage area. Many of them would not show up as blue lines on USGS 1:24,000 quadrangle maps, although almost all of them would be visible and marked on county soil maps. These streams are not often defined or assigned beneficial uses in the Ohio Water Quality Standards. The sampling methods, and concurrent biological and habitat indices now used by Ohio EPA to classify waterways for existing water quality (e.g., IBI, ICI, QHEI) are oriented toward larger streams. Because these "index of biotic integrity" assessment systems are watershed size dependent, they often cannot be used to identify the well-being of the native fauna that survive and reproduce in small headwater stream ecosystems. In the absence of comparable measures of stream quality for extreme headwaters, government agencies responsible for protection of water resource integrity may appear to be arbitrary if they seek to approve or deny a permit or certification application to lower water quality in primary headwater streams. The principle objective of the stream classification methodology developed for primary headwater habitat streams is to help fill that void, in a manner similar to the Ohio EPA (ORAM) sampling methods now being used to classify jurisdictional wetlands. The Field Evaluation Manual for Ohio's Primary Headwater Habitat Streams (Ohio EPA, 2009a) outlines a predictable three-tiered protocol that can be used to conduct rapid assessment of headwater stream quality. The lowest level of field effort is a relatively rapid habitat evaluation procedure known as the "Headwater Habitat Evaluation Index" (HHEI). It is based on three physical measurements that have been found to correlate well with biological measures of stream quality. Two levels of biological assessment, one at an order-family level of taxonomic identification, the second to genus-species, provide flexibility in reaching a final objective decision on the appropriate aquatic life use designation needed to protect the native fauna of any primary headwater stream.

B.3 Inland Lakes and Reservoirs

The Ohio EPA inland lakes and reservoirs monitoring program during the late 1980s and early 1990s was funded by several CWA Section 314 Lake Water

Quality Assessment grants received by the 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).

The objectives for the current Inland Lakes Monitoring program which commenced active sampling during 2008 are:

- to track status and trends of lake quality,
- to determine attainment status of beneficial uses,
- to identify causes and sources of impaired uses, and
- to recommend actions for improving water quality in impaired lakes.

B.4 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 U.S. EPA-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 U.S. EPA/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.4.1 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 drafted targets and milestones for determining when a BUI is no longer impaired (Ohio EPA, 2008a). 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.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 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.4.3 Lake Erie Nearshore Monitoring Project

Beginning in 2011, a comprehensive monitoring program will be developed to establish the baseline chemical, physical and biological conditions of the Ohio Lake Erie nearshore. The program is designed as a three-year cycle to adequately define the environmental baseline in these dynamic areas. The experience and information gathered in the first three-year cycle of this program will be used as the basis to fully incorporate an annual Lake Erie nearshore monitoring program into the State of Ohio's monitoring and assessment program. The project will initially build on the 2010 National Coastal Assessment framework by adding ambient sites and additional parameters. Subsequent years will focus on harbors, bays, lacustuaries, and expanded coverage with the addition of more sites.

B.4.4 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.5 Ohio River

Monitoring objectives for the Ohio River mainstem are documented in ORSANCO Standard Operating Procedures documents.
(http://www.orsanco.org./)

B.6 Wetlands

Wetlands continue to be evaluated on an individual basis as they are proposed for impacts through Section 401 or Isolated Wetland Permit applications or when that information is needed for other uses. While Tiered Aquatic Life Uses have been proposed, these have not been incorporated into rule. However, 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. We also continue to monitor wetland mitigation projects to report on their success toward meeting performance standards and to determine where improvements can be made regarding wetland restoration locations, planning, construction and management.

Over the past five years we have completed, or are in the process of conducting, four assessments of wetlands at a watershed level. These studies have included integrated biosurveys where interdisciplinary monitoring efforts are coordinated on a watershed basis. The collective experiences of our monitoring studies have advanced the methods of incorporating wetlands into determinations of overall watershed health. Since most watersheds have thousands of individual wetlands, monitoring and assessment of each wetland in the watershed is impractical. Therefore, we have taken an approach of choosing and assessing a representative sample of the wetlands in the watershed. Based on those results we have been able to make meaningful statements about the overall condition of wetlands in the studied watersheds.

Overall, the goals of the Ohio EPA wetland monitoring program include the following: 1) the ability to document the ambient quality of any wetland for regulatory or non-regulatory purposes, 2) evaluate the performance of permittee responsible wetland mitigation projects and wetland mitigation banks, 3) develop tools to identify locations that have high potential for successful restoration of lost wetland resources, 4) report on the condition of wetlands from a watershed, or other geospatial, prospective, and 5) incorporate data about the population of wetlands occupying a watershed into the water quality determinations for those watersheds to be included in TMDLs, Integrated Reports and other assessments of watershed water quality.

B.7 Ground Waters

The primary objective of the Ambient Ground Water Quality Monitoring Program is to provide statewide ground water quality data (raw water) for the major aquifers in Ohio. The AGWQMP 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 AGWQMP data are valuable resource data distinct from the compliance data. These AGWQMP data are used to characterize the water quality in the major aquifers across the state, to help identify sensitive hydrogeologic settings, to document long-term trends in ground water quality, and to provide water quality data to help implement compliance programs. AGWQMP sampling includes deeper, more productive aquifers used by public water systems. However these aquifers are not necessarily representative of the shallow, most vulnerable or sensitive portion of the major aquifers in the state. The majority of ground water monitoring that is conducted in shallow aquifers is associated with regulatory compliance monitoring for hazardous waste, solid waste or various environmental clean-up programs.

The AGWQMP 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 is developed to ensure valid sampling design and to capture a critical set of hydrogeologic data elements. The analytical data can also be stored in a water quality database and transferred to U.S. EPA’s STORET Data Warehouse via the Water Quality Exchange (WQX).

C. Monitoring Design

U.S. EPA'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 the 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, with an aggregate total of 400-500 sampling locations. 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, 1999). 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 were 331 delineated within Ohio. The HUC-11 assessment units were thought to be of practical size for development, management, and implementation of effective TMDLs and, as such, served as the basic biosurvey design for this high priority program activity through 2007. However, in practice, TMDLs were effectively being implemented with projects operating at the U.S. Geological Survey 12-digit Hydrologic Unit (HUC-12) scale. Thus, beginning with the 2008 survey year and as reported in the 2010 Integrated Water Quality Monitoring and Assessment Report, 1538 HUC-12 watershed assessment units (WAUs) became the primary reporting unit for watershed survey monitoring and assessment and TMDL development and implementation.

The HUC-12 WAU scale is used to categorize and assess stream and river sites draining watersheds up to 500 mi^2. For Ohio's largest rivers greater than 500 mi^2, large river assessment units (LRAUs) were developed to report independently on these large water bodies since they are unique in their importance and can not be readily included and effectively assessed in small HUC-12 watersheds. At this size, rivers generally are impacted more by the character of and activity in the accumulated drainage area and less by what is happening adjacent to the channel (i.e., on the stream bank) or the immediate adjacent landscape. Currently, 38 LRAUs have been established for the 23 largest rivers in Ohio. More detail on the assessment of Ohio's HUC-12 WAUs and LRAUs can be found in the aquatic life assessment methodology section of the 2010 Integrated Water Quality Monitoring and Assessment Report. http://www.epa.ohio.gov/portals/35/tmdl/2010IntReport/Section_G.pdf

To facilitate individual site selection and provide for comprehensive watershed coverage, the Ohio EPA initiated a process in 1998 coined geometric site selection to identify sampling locations in HUC-11 (and now HUC-12) WAUs targeted for intensive monitoring and where identification of beneficial use impairments is needed in anticipation of TMDL development for pollutants. Site selection within a biosurvey 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-12 WAU in Ohio (approximately 25 mi^2 watershed size), 2 to 5 sampling locations are targeted with this approach; this provides coverage of one site for about every 5-10 mi^2 of watershed size (an area roughly bounded by 2.2-3.2 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 52 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 was historically sampled monthly for physical and chemical constituents although most are now sampled on a quarterly basis. Many of these sites provide a database that spans nearly 30 years.

2) Cooperative Stream Gaging Network
   The Ohio EPA, U.S. Geological Survey, Ohio DNR, and Ohio Water Development Authority 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 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
   The 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 U.S. EPA.

   Fish tissue is also collected periodically by the Ohio EPA from river mouth, harbor, and nearshore areas during intensive biosurveys and in connection with RAPs in the AOCs. Ohio EPA historically collected 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 U.S. EPA-GLNPO or Environment Canada.

C.1.3 Sentinel Site Design

An innovative monitoring design approach has been implemented in each Ohio EPA district office 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 Division of Surface Water has implemented 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 each district office 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.

C.1.4 Recreation Uses

Ohio's Five Year Rotating Basin Approach and the TMDL monitoring schedule define the watersheds in which sampling activity takes place annually. A study plan is developed in the spring for each basin to be surveyed during the summer that involves staff from the central office, district offices, and ecological assessment office. Staff from a variety of disciplines participate in the study plan development.

The monitoring design and sample site selection process for assessing the recreation use is based primarily on the objective of obtaining sufficient information to determine whether the applicable geometric mean *E. coli* criteria are being attained and to identify causes/sources of nonattainment where it is documented. Sampling is conducted to provide information to support TMDL development. As such, a goal of the sampling is to collect a sufficient number of samples at each site in order to provide a statistically meaningful determination of the geometric mean *E. coli* content at each site sampled. Generally, the goal is to collect a minimum of five valid samples during the course of the recreation season. A subset sites, called sentinel sites, within the study area is sampled 10-15 times under a variety of flow regimes conducive to recreation to support modeling efforts and assist in bacteria source identification in support of TMDL development.

A primary goal in site selection is to target adequate coverage of those surface waters within a study area that have the highest potential recreation use activity such as and Class A PCR and LRAUs within the study area. These streams and rivers are promoted recreation resources having numerous public access points and may have additional facilities as well, such as public parking areas and camping facilities. Some have canoe liveries operating along them. The monitoring objective for these streams and rivers is to conduct sampling at multiple points spaced ever 5-7 river miles. In addition, all assessment units (HUC 12 scale) within the study area are targeted such that at least one site is sampled, generally toward the downstream end of the assessment unit, so that data are available to support attainment determinations in the Integrated Report.

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, such as DSW's watershed biosurveys. Sampling sites are selected within the designated use areas or immediately upstream of the drinking water intake. The applicability of available compliance data (treated water) will also factor in the monitoring design. Ideally, 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 provides specific sampling requirements.

In order to achieve an acceptable degree of confidence for beneficial use decisions based on numerical chemical criteria, Ohio established minimum sample count and temporal requirements. These were described in the PDWS assessment methodology section of the 2006 Integrated Report (http://www.epa.ohio.gov/portals/35/tmdl/2006IntReport/IR06_app_C_PDWSmethodology.pdf). However, until the lack of pesticide data is addressed, it will be difficult to fully evaluate Ohio waters for the PDWS beneficial use.

C.1.6 Fish Consumption

Ohio's sport fish tissue monitoring program was initially designed to provide information on the safety or risk associated with consuming fish from publicly owned or managed water bodies. The monitoring design targeted larger water bodies or water bodies determined or documented to support higher fishing pressure. As these water bodies were sampled, sampling shifted to smaller water bodies and those likely supporting 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 five acres and greater for lakes, ponds, 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. More detailed information on the sport fish tissue monitoring program monitoring design can be found at the following web link:
(http://www.epa.ohio.gov/portals/35/fishadvisory/FishAdvisoryProcedure10.pdf).

C.2 Primary Headwater Habitat Streams

Generally speaking, monitoring design for sampling PHWH streams is determined on a site-specific basis to meet the needs of specific projects or regulatory situations that potentially impact this stream type. Detailed protocols and procedures for designing a study and sampling PHWH streams are available in the Field Evaluation Manual for Ohio's Primary Headwater Habitat Streams (Ohio EPA, 2009a). Sampling of PHWH streams occurs for a variety of reasons, including, but not limited to, the following:

- to delineate the total number and total linear feet of different classes (I, II, III, or modified PHWH classes) of primary headwater streams present within a specified property boundary (*e.g.*, as required for a CWA Section 401 water quality certification);
- to delineate the relative number and percentage of PHWH stream types that may be impacted by extensive road building, pipeline, or power line projects that may affect many numerous potential PHWH streams;
- to determine the existing aquatic life use (primary headwater or another tiered aquatic life use) and assign the appropriate class of primary headwater if necessary when considering NPDES permit applications or CWA section 401 water quality certifications;
- to determine if a wastewater discharge, or other environmental alteration, is having a significant impact on the chemistry and/or biology of a primary headwater stream; and
- as a standardized evaluation protocol used in association with land use planning, stormwater management, or scientific surveys related to PHWH streams.

In the first situation above, all PHWH streams on the property should be mapped and delineated using 200 foot stream reach assessments. In the second situation, photographs and Headwater Habitat Evaluation Index (HHEI) evaluations at discrete locations where PHWH channels will be crossed can be used to quickly estimate the relative percentage of different PHWH classes that will potentially be impacted by various project routes across the landscape. In the third situation, a multiple number (3-5) of discrete 200 foot stream reach assessments should be conducted along the length of the mainstem PHWH channel. Areas of recent habitat modification should be avoided in these types of PHWH assessments. In the fourth situation, 200 foot stream reaches should be identified upstream (reference site) and downstream from the wastewater discharge, or source of impact. Potential chemical impacts should be evaluated against water quality criteria found in OAC Chapter 3745-1. Potential biological impacts should be evaluated using the sample methods found in the field manual. In the final example, study plans should incorporate sufficient coverage of streams to accomplish the data quality objectives and scale of resolution necessary to meet the goals of the study in question.

C.3 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.

In the new Inland Lakes Monitoring program, Ohio EPA has implemented a sampling strategy that focuses on evaluating the water quality conditions present in the epilimnion of lakes. The sampling target consists of an even distribution of a total of ten sampling events divided over a two-year period and collected during the summer months. Key water quality parameters sampled include total phosphorus, total nitrogen, chlorophyll a, secchi depth, ammonia, dissolved oxygen, pH, total dissolved solids, and various metals such as lead, mercury, and copper. Details of the sampling protocol are outlined in the following document, available on Ohio EPA's web page at: http://www.epa.ohio.gov/portals/35/inland_lakes/Lake%20Sampling%20ProceduresFinal42910.pdf .

Ohio EPA currently has resources to monitor approximately 5-10 lakes per year. Priority is being placed on lakes used for public drinking water or used heavily for recreation and suspected of being impaired for either of those uses. Secondary priorities not being addressed because of limited resources include developing a more robust sampling program, expanding to a wider variety of lakes, exploring the use of remote sensing in the screening of water quality in lakes, and attempting to track water quality changes in lakes that might be attributed to Section 319 funding and other watershed water quality improvement efforts.

C.4 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 with a Lake Erie Protection Fund grant for the nearshore, lacustuaries and harbors (Ohio EPA, undated draft).

The GLRI funded grant received in 2010 will be based on a three year monitoring design. In an initial project prior to the official start of the GLRI nearshore monitoring effort, Ohio EPA participated in the U.S. EPA National Coastal Assessment (NCA). This involved sampling at 26 sites in Ohio waters chosen by U.S. EPA for a select set of parameters. Ohio EPA also covered four NCA sites in Pennsylvania. Ohio EPA added the collection of phytoplankton and zooplankton samples to the NCA sampling protocol under this proposal. Ohio EPA also initiated an ambient monitoring site network at 10 sites with four sampling events during 2010. Ambient sites were sampled for trophic state parameters (nutrients, chlorophyll, etc.), water column metals, plankton, and sediment samples for nutrients, as well as a standard array of physical measurements (profile). In order to provide data with respect to sediment nutrient re-suspension potential, sediment samples were collected from all sites sampled in 2010 (both NCA and ambient sites) for total phosphorus and ammonia-nitrogen analysis. The Ohio Division of Wildlife (ODNR) and USGS will sample at 10 nearshore sites for fish communities and habitat in 2010 using the electro-fishing methodology developed by Ohio EPA (Thoma 1999).

The second year of the monitoring plan will focus on lacustuaries, bays and harbors. Approximately 40 sites will be sampled covering the Portage River lacustuary, Sandusky Bay, Old Woman Creek, Black River lacustuary, Lorain harbor, Grand River lacustuary, Fairport Harbor, Ashtabula River lacustuary, Ashtabula harbor, Conneaut Creek lacustuary, and Conneaut harbor. This will amount to 12 harbor/bay sites and 28 lacustuary sites. The ambient sites will not be sampled this year, although physical profiles may be taken at them if time and weather permit. Not all of the major Ohio tributaries will be sampled in this second year.

The sampling protocols and routine will be worked out first at some of the less complicated sites before it is applied to highly complex/impacted sites such as the Cuyahoga River, Maumee River and Maumee Bay. A number of special projects and research efforts are underway in the Maumee area and reviewing the results of those efforts will be needed prior to designing the best sampling regime for an annual program in this area. All of the major tributaries will be included as part of the long-term annual monitoring program that will be developed as a result of this grant.

In addition to the water chemistry and physical profiles, all sites will be assessed for fish communities, habitat, macroinvertebrates, and periphyton. Periphyton and plankton diatoms will be collected and analyzed to assess their usefulness in the development of an additional biological index that could be used as another assessment tool, particularly in areas where the macroinvertebrate ICI is not effective. The periphyton/diatom work will be done in collaboration with Dr. Gerald Sgro (John Carroll University) who has been involved in the development of diatom periphyton indicators under the Great Lakes Environmental Indicators (GLEI) effort. Sediment samples will be collected and analyzed for nutrients, metals, BNAs and PCBs. Water samples in these areas will also be analyzed for *E. coli* in order to determine the appropriate recreational use designation and the beneficial use attainment status for these areas. The Ohio Division of Wildlife and U.S. Geological Survey will conduct the shoreline sampling while Ohio EPA will cover the estuary and harbor areas.

In the third year of the project, the primary focus of the assessment work will be sampling and analysis of lake benthos. Ambient sites will be revisited four times, following the protocols developed in year 1. We plan to collect zoobenthos samples from 39 sites that have historically been surveyed to follow the abundance of *Hexagenia*, a keystone species in the ecology of the lake. Field profiles, water chemistry, chlorophyll a, sediment metals and nutrients, phytoplankton and zooplankton samples will also be collected. The fish community sampling along the nearshore will be repeated and expanded. The draft list of the anticipated number and type of samples and their respective sampling years is presented below. A more detailed list is provided in the attachments.

The sampling of fish communities in these areas requires the use of different methods than those used for rivers or the open lake waters. This project will utilize the methods developed by Ohio EPA (Thoma 1999). Daytime electroshocking will be done in the high turbidity locations (estuaries and bays) while night time electroshocking will be done in the higher light locations along the Lake Erie shoreline. 500 meter transects parallel to the shore will be sampled. Sites will be chosen based on geomorphic and anthropogenic influences and generally cover the same locations defined by Thoma (1999). Physical profiles and water chemistry samples will be collected at these sites as well. Aquatic habitat classification data as developed by Ohio EPA (Ohio EPA, 2010a) will be collected at each sampling site. The nearshore fish sampling done in 2011 and 2012 will be more intensive than that done in 2010 in order to determine if any changes in methodology are needed and to better define a plan for long term annual monitoring. The use of additional sampling gear (in addition to electroshocking) may be done if needed to better characterize the nearshore fish community. This shoreline work will be done in depths generally less than 5 feet.

Due to the extremely high heterogeneity of substrates in the nearshore of Lake Erie, additional high resolution substrate distribution information will be collected at sampling stations and other shoreline locations. This work will be done by the Ohio Division of Wildlife and U.S. Geological Survey.

C.5 Ohio River

The Monitoring Design for the Ohio River mainstem is documented in ORSANCO Standard Operating Procedures documents.
(http://www.orsanco.org./)

C.6 Wetlands

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.

C.7 Ground Waters

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. In the mid 1990s, additional wells were added to the AGWQMP 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 accessibility and the potential for long-term sampling. The AGWMP Operation Procedures Document, currently being updated, includes a section on the selection criteria for new wells.

The monitoring design for special studies is extremely flexible and is selected to address the site-specific objective of the study. A special studies sampling plan template requires internal review in order to ensure that the monitoring approach is appropriate for answering site-specific questions and that critical data for applying the study results to other areas of the state are collected.

D. Core and Supplemental Water Quality Indicators

U.S. EPA'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 3 and 4). 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 3. 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* bacteria 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

Great Rivers (i.e., Ohio River)	Biota - Ohio River Fish Index (ORFIn), contributing metrics Habitat - Ohio River Habitat Index, contributing metrics	Same as wadeable streams and large rivers list	Same as wadeable streams and large rivers list	Same as wadeable streams and large rivers 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 - total organic carbon - total dissolved solids - chloride	- other chemicals of concern in water column or sediment (eg.,chlordane, Mirex, PFOA, SAS, etc.)

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 recreation use 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 the source 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, algal toxins, taste and odor, and other chemicals of concern (e.g. total organic carbon, total dissolved solids, chloride) 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 pharmaceuticals and other pathogens.

D.1.2.4 Fish Consumption

The selection of supplemental indicators for fish tissue consumption results from several different avenues. 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. Ohio EPA attempts to identify the magnitude and the extent of the contaminant in various matrices including tissue. Ohio EPA 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, Ohio EPA 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.

Table 4. 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	- Water Chemistry - vertical profiles of DO, pH, temperature, and conductivity - surface and bottom grabs for conventional parameters, metals - chlorophyll	- Pathogen Indicators - *E. coli* bacteria 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	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 and macroinvertebrate communities (lacustuary and Lake Erie IBI, MIwb, lacustuary ICI, contributing metrics) Water Chemistry - vertical profiles of DO, pH, temperature, and conductivity - surface and bottom grabs for conventional parameters, metals - chlorophyll	- Lake Erie Quality Index (& component metrics) Pathogen indicators - *E. coli* bacteria 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

Wetlands	Biota - condition of the vascular plant and amphibian communities (VIBI, AmphIBI, 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 **NOTE:** Water soil chemistry data is collected from each reference wetland to provide baseline information on wetland chemistry to develop ambient standards General Condition - ORAM 5.0: measures intactness of wetland and surrounding land use features	Pathogen Indicators - *E. coli* bacteria Physical conditions - depth - surface area - location Recreation - observed activity - indirect evidence	Generally not applicable	Generally not applicable

Ground Waters	Not applicable	Not applicable	Water Chemistry - field parameters(5) - 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, cyanobacteria - taste and odor	- other chemicals of concern in water column or sediment (eg., PFOA, SAS) - algal toxins
Lake Erie Open Lake, Nearshore, and Lacustuaries	- RAP delisting targets - LaMP indicators - phytoplankton - zooplankton - sediment nutrients, metals, BNAs, PCBs	- RAP delisting targets - LaMP indicators	As above and - RAP delisting targets - LaMP indicators	- RAP delisting targets - LaMP indicators
Ground Waters	Not applicable	Not applicable	Water Chemistry - chloride/bromide ratio - nitrate isotopes	Not applicable

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 be included under the Ohio EPA core indicators. These should also fall under supplemental.

D.2 Ground Waters

The AGWQMP 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 AGWQMP is providing valuable results. 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 of contamination; however, additional parameters are included if their addition enhances the application of the study conclusions to similar geologic settings in the state. The majority of the special studies have focused on pathogen or nutrient contamination in shallow ground waters. This combination of parameter selection approaches, for the AGWQMP and special studies, constitutes a tiered approach.

For assessing ground water quality in Ohio, core indicators for impairments include various inorganic and organic parameters which are shown to be useful in documenting naturally occurring or anthropogenic contaminants of concern. Arsenic, iron, manganese, sulfate and total dissolved solids are the core indicators most often associated with naturally occurring causes (i.e. geologic or geochemical conditions) which cause impairments. Nitrate and chloride are core indicators that are often associated with anthropogenic causes (e.g. fertilizers, sewage, salt, brine) but occur naturally in lower concentrations in the environment. Volatile organic chemicals (e.g. vinyl chloride, trichloroethylene) and pesticides (although rarely detected in Ohio's ground water) are core indicators associated with anthropogenic sources (e.g. industrial, commercial or agricultural chemicals). Supplemental indicators that can identify sources of ground water contamination include chloride/bromide ratio and nitrate isotopes.

E. Quality Assurance

U.S. EPA'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: 1) an introduction (i.e., a general description of the project and relevant background information); 2) project objectives (descriptive DQOs);
3) the identification of methods used in the project, either by reference (U.S. EPA methods and/or methods identified in DSW or DES methods manuals), or described if not included in the identified methods manuals; 4) the identification of numerical DQOs; 5) the identification of staff project responsibilities; and 6) a tentative schedule that identifies key project target dates and 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 *Guidance for Quality Assurance Project Plans* (U.S. EPA, 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:
1) a detailed description of all of the contractor's products (deliverables) to be reported to the Ohio EPA, 2) the contractor's submittal deadline for the final report, 3) the contractor's methods, standard operating procedures (SOPs) and DQOs, and 4) the contractor's project contact name, telephone number and address.

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 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 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 cannot 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 objectives/priorities, and if there are an adequate budget, personnel, equipment, Agency space (as required), and a realistic schedule for the project's completion. DSW management will give final approval of identified funding source(s) and level(s) for the project.

E.1.6 DSW Technical Staff Responsibilities

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), both descriptive and numerical 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 6-7 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 36 ongoing programs that either generate data, or require data to be generated and submitted to the Division. Seventeen of these programs are involved with environmental assessment. Fifteen of the programs that deal with environmental assessment directly involve DSW and require DSW QAPPs and DSW QA/QC oversight. The fifteen programs include: Watershed Biosurveys, Fixed Station Monitoring (NAWQMN), Water Quality Modeling, Wasteload Allocation, TMDLs, DERR Support, Animal Tissue Monitoring, Grant Funded Non-Wetland Projects, Grant Funded Wetland Ecology, Primary Headwater Stream Evaluations, Lake Erie and Inland Lake/Reservoir Assessments, Watershed Section 319 projects, Credible Data projects, and 208 Section Water Quality Plans.

Historically, DSW has used the QAPP review procedure described above in three programs: Watershed Biosurveys (one special project), Grant Funded Wetland Ecology Program and the Lake Erie Program. The generic biosurvey QAPP will be modified, as necessary, depending upon specific project objectives (descriptive DQOs) and limitations (numerical DQOs).

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 2011. 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,” (the DSW’s Self-Audit Report). All DSW staff have an opportunity to participate in the Division’s Data Generation and Management Audit. The Audit Document is 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 36 data generating programs.

E.2 Division of Drinking and Ground Waters

Ohio’s Ground Water Quality Characterization Program is committed 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 AGWQMP 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 including QA/QC.

The OPD is currently being updated to accommodate changes in the program including the development of a new water quality database to replace STORET for managing DDAGW ground water quality data. The procedures are also being updated to ensure consistency with USGS’s National Framework for Ground Water Monitoring in the United States, June 2009. An End-of-Round report is completed after each semi-annual sampling round to ensure that the QA/QC of all new AGWQMP data is completed. Special ground water studies refer to pertinent sections of the OPD sample collection and data management procedures as part of their quality plan. A ground water quality special studies procedure document was produced to ensure sampling plans are well designed and properly documented.

F. Data Management

U.S. EPA'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) deployed the first phase of a new electronic monitoring and assessment database system called EA^3 (Ecological Assessment and Analysis Application) in 2005. This new system will ultimately replace the existing Ohio ECOS database when it is fully functional. ECOS 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. This historical data will be uploaded to the EA^3 database.

The new system will support all surface water quality monitoring functions performed by Ohio EPA. The EA^3 system is designed as a web-based application using the JAVA interface. The system is compatible with the U.S. EPA database structure insuring that the data is stored in a consistent format that can be shared internally and externally. 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 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 water body. Currently these calculations are triggered manually and are captured in a non-normalized structure within the existing Ohio ECOS databases. The new application calculates the assessment indices from the monitoring data and, with further planned database enhancements, will automatically determine attainment status of site beneficial uses. It is our intent to submit this assessment data to U.S. EPA.

The new system is expected to be able to interface with graphical GIS mapping software. A unique identifier along with a latitude/longitude location are now required for any surface water sampling location.

F.2 Ground Waters Data

STORET has been the main database used for storing DDAGW ground water quality data. Supplemental facility and hydrogeologic information are managed in a related database, SEAGATE. Standard reports were developed to retrieve data from STORET and SEAGATE. With the federal decision to stop supporting state's local version of STORET and shift to WQX as the data upload vehicle, Ohio EPA initiated development of a new web based database management system, Ground Water Quality Characterization Program (GWQCP), to house facility, well, hydrogeologic information and ground water quality data for the AGWQMP and special studies. GWQCP is being developed in parallel with Division of Surface Water's EA^3 database, but they will be independent applications. Development of the database will be completed in 2011 and all data currently stored in STORET and SEAGATE will be transferred to the new database. Pending completion of the new database system, new reports and data analysis procedures will be developed to aid in production of the End of Round QA/QC reports and assessment of the data for the biennial Integrated Water Quality Report. Data management procedures will be updated in the AGWQMP Operating Procedures Document upon completion of the data management system.

AGWQMP data is provided to the public in various documents and data formats. Summaries of information have been prepared and included in Integrated Water Quality Monitoring and Assessment Reports. Individual ground water quality data summaries and chemical trend analysis for each well in the AGWQMP is published on the Agency's web site.

G. Data Analysis/Assessment

U.S. EPA'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 and the promulgation of the biocriteria in the Ohio Water Quality Standards, the following new publications by the Ohio EPA have become available. These publications should also be consulted as they represent the latest information and analyses used by the Ohio EPA to implement the biological criteria (DeShon, 1995; Rankin, 1995; Yoder and Rankin, 1995a, 1995b, and 1995c; Yoder, 1995; Ohio EPA, 2008b; Ohio EPA, 2008c).

G.1.2 Recreation Uses
Bacteria data are used to assess the attainment of the designated recreation use. Attainment decisions are based upon a comparison to the *E. coli* geometric mean criteria listed in the Ohio Water Quality Standards.

G.1.3 Public Drinking Water Supply Use

Water quality data collected to assess the PDWS use will be compared to water quality standards as described in the PDWS assessment methodology. Water quality data from the most recent five years will be evaluated and levels of impairment will be based on exceedance of water quality standards. Data will also be assessed to identify waters that meet "watch list" conditions. Source waters will be placed on the "watch list" where water quality is impacted but not at a level that indicates impairment. Source water quality trend analysis will be used to identify areas in which to focus additional/future sampling.

G.1.4 Fish Consumption

Fish tissue data are used to assess attainment of 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 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 and analyzing the data are detailed in the sport fish tissue monitoring program protocol:
(http://www.epa.ohio.gov/portals/35/fishadvisory/FishAdvisoryProcedure10.pdf).

Data quality requirements and evaluation procedures, analytical methods and procedures, temporal and geographic representation, and statistical analyses can also be found in the linked document. Equations and procedures for relating fish tissue contaminant levels to Water Quality Standards criteria can be found in the 2010 Integrated Water Quality Monitoring and Assessment Report
(http://www.epa.ohio.gov/portals/35/tmdl/2010IntReport/Section_E.pdf).

G.2 Inland Lakes and Reservoirs

Prior to the inland lakes and reservoirs assessments conducted by the 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, the 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, 1997a), 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.

With the development of the current Inland Lakes Monitoring Program in 2008, came the decision to revise the aquatic life use beneficial use designation for lakes. Many of Ohio's largest recreational lakes are managed for sport fish by Ohio DNR, and the current default designation of Exceptional Warmwater Habitat (EWH) for lakes in the Ohio Water Quality Standards does not equate to the presence of exceptional communities, especially for fish. Ohio DNR manages sport fisheries to achieve fisheries objectives and not biological diversity in these largely artificial habitats. All sport fish populations within a lake represent potential fishing opportunities; therefore, the term "impairment" is inapplicable if it is based on fish community diversity or structure. It is most efficient for Ohio EPA to concentrate on assessment of fish tissue consumption, public water supply, and recreational bacteria contamination issues, rather than sport fishing for use attainment decisions, and defer to Ohio DNR on the future determination of whether or not specific populations of game fish are fully attaining their recreational potential. In support of the new Inland Lakes Monitoring Program, there are a number of important revisions proposed for the Ohio Water Quality Standards (OAC 3745-1-07).

Revisions to Ohio's WQS that would change the aquatic life use from EWH to Lake Habitat (LH) are in progress. A primary reason for this revision is that in Ohio, a suite of biological criteria apply to river and stream aquatic life uses, whereas no biocriteria apply to lakes. The current EWH language for lakes in the

Ohio WQS dates from the 1970s, well before Ohio EPA established biological criteria now used to assess the primary aquatic life uses (EWH, WWH, MWH) for streams and rivers. Ohio EPA has no program in place, nor is any planned, to develop biological criteria for lakes; thus, the term “exceptional” as applied to streams and rivers to protect aquatic life is not scientifically valid for inland lakes and reservoirs. The numeric chemical criteria to protect the LH use will remain the same as the criteria to protect the EWH use that currently applies to lakes, with a suite of nutrient criteria added. A set of numeric criteria that apply to all surface waters for the protection of aquatic life, regardless of specific use designation, will also apply to inland lakes and are referred to as “base aquatic life use criteria” in the proposed WQS rules. The base aquatic life use criteria will be the same aquatic life numeric criteria that currently apply to lakes. Examples include various metals such as copper, lead, and cadmium as well as organic chemicals such as benzene and phenol. Specific details concerning the revisions to the water quality standards rules can be reviewed on Ohio EPA’s web page at the following address:
http://www.epa.ohio.gov/dsw/rules/draft_wqs_aug08.aspx.

Although not part of lake assessment procedures at this time, Harmful Algal Blooms (HABs) have received significant attention in recent years. In 2008, a HAB workgroup consisting of representatives of state and federal agencies, academia and volunteers was formed. Ohio Department of Natural Resources (ODNR), Ohio Department of Health (ODH) and Ohio EPA developed the State of Ohio Initiative to Address HABs in Ohio’s Inland Lakes and Lake Erie and a state-wide algal toxin sampling program. The initiative consists of four phases: outreach and education, issuing advisories, tracking/ reporting/ verification, and predicting/ surveillance. Additional details about the initiative may be viewed on Ohio EPA’s web page at the following address:
http://www.epa.ohio.gov/LinkClick.aspx?fileticket=uGXAJmwPz8A%3d&tabid=3897.

Microcystin toxin testing results from the 2007 National Lake Survey were released in late April 2009. Ohio EPA follow-up testing in May 2009 found 48-82 ppb from five sample locations in Grand Lake, Ohio’s largest inland lake. This prompted Ohio EPA, Ohio DNR, and ODH to post Water Quality Advisory signs at the three state park beaches and boat ramps at Grand Lake on the Friday before Memorial Day. In addition, because the lake is the source water for the City of Celina public water supply, testing of the finished water began to determine if microcystin would be detected in the finished water. Microcystin levels in the raw water remained above the WHO 20 ppb recreational threshold throughout the recreational season. Finished water is evaluated weekly by the Celina public water supply and there have been no detections of microcystin.

Also in 2009, Ohio EPA, Ohio DNR, and ODH monitored four canal lakes with similar nutrient impact issues for microcystin toxin. Ohio EPA sampled other lakes either because of known algal blooms in the past, because the lake was part of a larger investigation, or because of National Lake Survey results.

In 2010, Ohio EPA formally incorporated HAB monitoring and algal toxin testing into the Inland Lakes Monitoring program. A phytoplankton sample was collected in the first and fifth sampling run. If most of the phytoplankton consisted of cyanobacteria that could potentially produce toxins, then the frozen algal toxin sample was analyzed.

Also in 2010, Ohio had a significant number of HAB blooms and various types of algal toxins in inland lakes across the state and Lake Erie. Most of these were reported by Ohio DNR at state park lakes. The Ohio Department of Health determined that there were 48 illnesses (probable or suspect) associated with exposure to algal toxins. In addition, there were at least 5 dog deaths attributed to algal toxin exposure. A significant amount of resources from Ohio EPA, Ohio DNR and ODH were utilized to follow-up with monitoring and water quality advisory posting. In 2010, Ohio EPA's plan was to follow-up on HAB reports from other agencies and the public. The focus of monitoring was on public lakes with heavy recreation or a water supply lake. The heaviest biomass located at the point of major public contact was sampled and analyzed for algal toxins. This represents the potential worst-case-scenario for human and animal exposure.

Ohio EPA continues to consider if and how HABs and algal toxins will figure in determining impairments of the Recreation and Public Drinking Water Supply uses in future inland lake and reservoir assessments.

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 and subsequent Ohio Integrated Water Quality Monitoring and Assessment Reports (Ohio EPA, 2004, 2006, 2008d, 2010b). 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, 2004, and 2006 and a significant update to the restoration plan was completed in 2008.

All Ohio Lake Erie Commission reports are available on their web site. (http://www.lakeerie.ohio.gov/Reports.aspx)

G.4 Ohio River
Details of Data Analysis/Assessment for monitoring in the Ohio River are documented in ORSANCO Standard Operating Procedures documents. (http://www.orsanco.org./)

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.*, 12- or 10-digit HUCs as part of a larger watershed biosurvey).

G.6 <u>Ground Waters</u>

Ohio does not have general ground water quality standards, so ground water attainment decisions use Safe Drinking Water Act primary or secondary maximum contaminant limits (MCL) concentrations as benchmarks. This is also consistent with the Ohio's water quality standards applied to the public water supply beneficial use which are based on the federal MCLs.

In Section N (An Overview of Ground Water Quality in Ohio) of the Ohio 2010 Integrated Water Quality Monitoring and Assessment Report, MCLs are used to identify public water supply or AGWQMP wells in watch list (>50% MCL to MCL) or impaired categories (>MCL) by indicator chemical and major aquifer type. Assessment of both the public water supply and AGWQMP data will continue in future Integrated Reports and it is likely that the data analysis methods will be refined during the process. The state will use ten years of data for assessing the quality of ground water in Ohio. The longer period of time has been selected to increase the confidence in the analysis due to the infrequency of sample collection at many public water system wells (e.g. one sample every three years).

Geochemical data analysis is used to characterize differences in ground water quality between major aquifers in Ohio and for trend analysis to document sensitive hydrogeologic settings within the state.

H. Reporting

U.S. EPA'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

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 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 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. Indexes to available TSDs and TMDLs are available at the following web locations.
TSDs: (http://www.epa.ohio.gov/dsw/document_index/psdindx.aspx)
TMDLs: (http://www.epa.ohio.gov/dsw/tmdl/index.aspx#TMDL_Projects)

Updates to the Integrated Water Quality Monitoring and Assessment Report (fulfilling CWA Section 305b and 303d requirements) are submitted to U.S. EPA based on the previous two field seasons' sampling data via a comprehensive Integrated Report which is compiled every two years and incorporates data from the last ten years of watershed biosurveys as well as any ancillary or specialized sampling that was conducted over that time period. Recent Integrated Water Quality Monitoring and Assessment Reports are available from the following web location. (http://www.epa.ohio.gov/dsw/tmdl/OhioIntegratedReport.aspx)

H.1.2 Primary Headwater Habitat Streams
There are two primary needs with respect to sampling and reporting regarding the quality of Primary Headwater Habitat (PHWH) streams: research and development of assessment techniques and as a regulatory function associated with the 401/404 permitting process. As discussed in Sections A.2 and J.2.1.5 of this document, the Ohio EPA continues to conduct monitoring to validate current assessment procedures and to study the potential for the application of biological

water quality criteria to PHWH streams. With respect to the 401 Water Quality Certification process, data related to PHWH streams generally accompanies a submittal of a 404/401 permit application to alter or fill a stream channel. Although the PHWH stream uses are currently not incorporated in the Ohio Water Quality Standards, the data is used to establish existing beneficial uses for antidegradation review purposes. Classification of potentially affected PHWH streams is also commonly used to determine appropriate stream mitigation requirements, if applicable. Reporting typically provides a classification of the stream segment and an estimate of the impact associated with the proposed project. Agency personnel often conduct sampling of PHWH streams incorporated in permit applications in order to verify the data submitted by applicants.

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 order to generate sufficient data to provide a direct comparison to the geometric mean criteria, typically targeting a minimum goal of five samples collected at each site sampled during the recreation season. While this sampling effort may not always be feasible at every sampling location, the goal is to collect enough data on larger mainstem water bodies (e.g, Class A PCR and Large River Assessment Units) that typically have greater recreational usage while still collecting sufficient bacteria samples in tributary streams to provide support for TMDLs and to provide data for assessments at the 12-digit HUC Watershed Assessment Unit scale. Results of Ohio's bacteria monitoring and recreation use attainment statistics are also summarized every other year in the Ohio Integrated Water Quality Monitoring and Assessment Report.

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. Ohio EPA TMDL and watershed reports will also address the current status of the PDWS beneficial use for all active intakes located within the study area.

H.1.5 Fish Consumption

The results of the sport fish tissue monitoring collections are published annually in February or March in the form of new fish consumption advisories with updates published to the following web site:
(http://www.epa.ohio.gov/dsw/fishadvisory/index.aspx).

The fish tissue data are also incorporated into the Integrated Water Quality Monitoring and Assessment Report, published biennially, and are used to determine impairment status of the Human Health (Fish Consumption) beneficial use in Ohio water bodies. Assessments include more in depth analysis of patterns, trends, etc. of the accumulated data base. The most recent Integrated Water Quality Monitoring and Assessment report can be accessed at the following web location:
(http://www.epa.ohio.gov/dsw/tmdl/OhioIntegratedReport.aspx).

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 the Ohio EPA from 1973 to 1995 were last reported in Ohio EPA (1997a; 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 (1997a; Appendix H).

The current Inland Lakes Monitoring Program is reporting inland lake monitoring data in the Ohio Integrated Water Quality Monitoring and Assessment Report. In the 2010 report, Ohio EPA listed lake beneficial use impairments for Recreation, Public Drinking Water Supply, and Human Health (via fish tissue) and introduced the use assessment procedures for the proposed Lake Habitat aquatic life use. Other reporting includes Lake Snapshots for each lake sampled which are fact sheet summaries of sampling data and assessments of lake beneficial uses. These Lake Snapshots will be placed on the Ohio EPA Inland Lakes web site once the Lake Habitat aquatic life use and associated inland lake and reservoir nutrient criteria are adopted into the Ohio Water Quality Standards rules.

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

Detailed reports of chemical, physical, bacteriological, and biological monitoring of the Ohio River main stem and selected major tributaries are available from the ORSANCO website at the following location.
(http://www.orsanco.org./index.php/publicationsdocs)

H.5 Wetlands

Currently, reporting of wetland condition occurs on a watershed basis. Results of studies of wetlands in the Cuyahoga Watershed have appeared in the Integrated Water Quality Monitoring and Assessment Report and we will continue to report on a watershed basis when data are available. Wetlands have not been included on the 303d list and whether large scale listings are appropriate for wetlands continues to be debated on a national level. Wetland condition will be reported as attainment or deviation from numeric, wetland-specific Tiered Aquatic Life Uses.

H.6 Ground Water

The AGWMP data, in conjunction with public drinking water compliance data, will continue to be used to produce the ground water section of the Ohio Integrated Water Quality Monitoring and Assessment Report. In addition, summary reports will be completed in a timely manner for all special studies and various reports, maps, and presentations using ground water quality data are available on DDAGW's Ground Water Quality web site:
(http://www.epa.ohio.gov/ddagw/gwqcp.aspx).

Ohio's ambient ground water quality data is provided to U.S. EPA via the WQX Warehouse on a semi-annual basis.

I. Programmatic Evaluation

U.S. EPA'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 <u>Wadeable Streams and Large Rivers - Bioassessment Component</u>
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. A follow-up bioassessment program review was completed by a U.S. EPA Region 5 consultant in June, 2007. This review, along with those for other Region 5 states, is included in a report under review by U.S. EPA and Region 5 states (Yoder, 2011).

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 surface water monitoring program. Grant work has been funded by U.S. EPA and this has been instrumental in aiding the 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 surface water monitoring program. Periodic reviews occur as U.S. EPA considers and approves Ohio EPA Wetland Program Development Grant applications.

I.4 Ground Water

DDAGW evaluates the AGWQMP at least annually to determine whether changes in sample stations or parameters will be beneficial. 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 semi-annual AGWQMP 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.

Special study work plans are reviewed by appropriate central office and district office staff to assure the sampling accomplishes the water quality objectives of the special study. Based on these discussions, ground water program staff continually evaluate ways to improve the monitoring programs.

CWA Section 106 work plan, annual reports and grant program reviews provide communication with the U.S. EPA regarding the effectiveness of our program. The Ground Water Program continues to incorporate new ideas into our data analysis and use the data to support other agency programs wherever possible. Recommendations for new monitoring programs or initiatives are incorporated into annual CWA Section 106 Ground Water Section Work Plan as time, priorities, and budgets allow.

J. General Support and Infrastructure Planning

U.S. EPA'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 5 details Ohio EPA/Division of Surface Water SFY 2010 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 Monitoring and Assessment Resource Deficiencies
A summary of deficiencies with action steps and implementation steps is compiled in Table 6. Some of the implementation steps, particularly those requiring additional FTEs, are unlikely to be fully met into the foreseeable future given Ohio's budget limitations. However, it is anticipated that implementing the indicated action steps will allow for adequate monitoring and assessment of all Ohio EPA surface and ground waters program areas and provide data directed at restoration and protection of Ohio's water resources and beneficial uses. More detailed descriptions for some of the identified monitoring and assessment resource deficiencies for specific programs or program components are provided below.

Table 5. Full-Time Equivalents (FTEs) spread by Division of Surface Water (DSW) program area (from the DSW SFY 2010 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	**0.1**				0.1	**0.1**
Compliance	**28.3**			0.4	0.7	**1.1**
Enforcement	**9.0**			0.2	0.3	**0.5**
Environmental Monitoring	**21.8**	0.3	1.3	17.3	2.7	**21.6**
General Administration (Includes Data Mgmt.)	**34.4**	0.4	0.1	4.3	6.4	**11.2**
Grants and Loans	**4.1**				0.1	**0.1**
Outreach	**19.0**		0.1	2.9	2.1	**5.1**
Permits, Licenses, Plan Approvals & Certifications	**51.5**				1.5	**1.5**
Rules, Policies & Legislation	**7.6**			0.1	2.3	**2.4**
Technical Review / Technical Analysis	**21.5**	0.3	0.5	13.7	3.5	**18.0**
Leave	**36.3**	0.1	0.4	6.8	4.2	**11.5**
Total	**233.6**	**1.1**	**2.4**	**45.7**	**23.9**	**73.1**

Table 6. Listing of Ohio EPA Surface and Ground Waters Monitoring and Assessment Program Deficiencies, Action Steps, and Implementation Steps.

Monitoring and Assessment Program Deficiency	Action Steps	Implementation Steps
Improve ability to define TMDL restoration scenarios that reduce load and wasteload allocations in a spatially (e.g., sub-watershed) and temporally (e.g., seasonal) explicit manner [TMDL Implementation Phase].	Allow one continuation year of specific TMDL projects to design and implement restoration scenario using modeling techniques. No additional staff but extension of time-line for TMDL completion needed.	Revisit TMDL schedule and extend length for specific projects that are likely to deploy restoration scenarios. Project selection depends on local stakeholder activity, relative mix of non-point and point sources of impairment, position in drainage network, etc. Increase training resources to better equip staff with these skills.
Follow-up monitoring to ensure 1) installation of restoration scenario actually occurred, and 2) restoration scenario is helping to meet water quality goal (TMDL Validation Phase).	Allow time in ensuing years for validation monitoring. May need to increase number of field crews (1-2 crews) for follow-up monitoring. Explore extending eligible length of student intern employment or seek temporary worker status.	Evaluate feasibility of re-assigning some staff to start follow-up monitoring. Extended TMDL timeline (identified above) combined with increased length of seasonal staff employment should meet monitoring need without additional FTEs.

Maintaining Sufficient Capacity to Provide Comprehensive Watershed Biosurveys Within a 10-Year Sampling Rotation Schedule	Maintain a core number of field crews dedicated to watershed biosurveys to ensure adequate, up-to-date monitoring data for all water quality management programs.	Full-time and seasonal staffing levels in support of five biological field crews should be maintained at a minimum to meet resource demands necessary to provide 65-70% sampling coverage of Ohio's wadeable streams and large rivers on a 10-year sampling rotation. This would require one additional FTE to replace a staff position lost to retirement in 2010.
Implementation of an Algal Bio-Indicator in Monitoring and Assessment Efforts	Investigate the feasibility and efficacy of incorporating an algal indicator in routine watershed biosurvey assessments.	Secure funding to provide contractual laboratory support to process algal samples collected from pilot biosurvey watersheds; use the data and existing algal assessment indices to gauge the effectiveness of the algal indicator as a complimentary assessment tool to use with standard fish and macroinvertebrate protocols. If determined that an algal component provides sufficient value, an additional two FTEs of laboratory sample analysis support will be needed to fully incorporate the algal indicator component into the watershed biosurvey program.

Biocriteria Revision and Recalibration	Review, revise, and recalibrate Ohio's bioassessment indices and wadeable stream and large river biocriteria based on resampling of Ohio's reference site network.	Expand on the results of two contractual projects completed in 2008 and 2010 which incorporated new reference data in the calibration of existing bioassessment indices as well as provided the foundational basis for potential continuous scoring bioassessment indices. Determine the effect of the recalibration on existing WQS criteria and propose changes if necessary. Investigate the feasibility of incorporating the new continuous scoring bioassessment indices, including the efficacy of using revised or replacement index metrics, to further refine the discriminatory capability of Ohio's bioassessment indices.
Protection and Assessment of Ohio's Primary Headwater Habitat (PHWH) Streams	Conduct basic research to adopt a concept of "ecological integrity" for Class III and Class II PHWH streams.	This project would require Ohio EPA biologists to determine reference conditions for PHWH biological communities in the different ecoregions of Ohio. It is estimated 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. Staff time estimated at two FTEs per year would need to be allocated for both field sampling and identification of benthic macroinvertebrate species over a two-year period in addition to time for data analysis and writing final reports.

Inland Lakes and Reservoirs Monitoring and Assessment Program and Integration with the Watershed Biosurvey Program	Dedicate resources and expand monitoring efforts to provide assessment of significant Ohio inland lakes and reservoirs as part of the watershed biosurvey program.	A DSW lakes team, formed in the mid 2000s, strategized and developed lake monitoring and assessment proposals built on a tiered structure of increasing complexity and resource needs. The final proposals and recommendations were presented to DSW management during the fall, 2005, and a minimal program based on existing staff resources was selected and has been implemented through 2010 funded with core water quality money supplemented with federal 106 supplemental grants
Harmful Algal Bloom Monitoring Program	Work with Ohio Department of Health and Ohio Department of Natural Resources in developing a unified state monitoring, reporting, and advisory program.	A standardized approach to collecting phytoplankton and algal toxin samples, data sharing, and issuing water quality advisories will be completed in spring, 2011. In 2010, Ohio EPA used NOAA satellite imagery to track cyanobacteria blooms along the Lake Erie shoreline in the vicinity of drinking water intakes and public beaches. Longer term goals are to use remote sensing to monitor some inland lakes by 2012 and investigate opportunities to create phytoplankton or algal toxin indicators of impairment in lakes and streams by 2014.

Monitoring and Assessment of Lake Erie Lacustuary, Harbor, and Nearshore Waters	Build on the 2010 GLRI grant which provided funding for three years dedicated to monitoring and asssessment of Lake Erie.	Pursue additional GLRI or other grants to continue biological and water quality monitoring and assessment for Lake Erie lacustuary, harbor, and nearshore waters with the goal of eventual incorporation of biocriteria into the WQS. With more attention being placed on the status of the Great Lakes, 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 and the funding to carry out the monitoring. For the long-term, Ohio EPA should strive to incorporate routine Lake Erie lacustuary, harbor, and nearshore monitoring as a component of the inland stream and river monitoring as Lake Erie tributaries are scheduled.
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 15 years.	Wetland Ecology Group reports have included wetland tiered aquatic life uses and numeric biocriteria based on wetland vegetation (VIBI) and amphibians (AmphIBI). 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. An estimate of two new FTEs and supporting seasonal staff should allow for select wetland monitoring in a number of watersheds on a rotating basis.
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 were released for public input in December 2010 and were open for interested party review until June 6, 2011.

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 for large rivers through 2011; initial assessment of results is underway. Data assessment, criteria development, and draft rules for streams and small rivers are projected to be completed in early 2011. New rules are projected to be filed, adopted, and effective in 2012.
Public Drinking Water Supply Monitoring and Assessment Protocols	Enhance and implement procedures to assess the Public Drinking Water Supply beneficial use for surface water sources.	Field monitoring and assessment of the PDWS use will continue with updates provided in Ohio's Integrated Reports. Human health criteria should be established for algal toxins and any other chemicals of concern in drinking water for the protection of the PDWS beneficial use. Long-term needs focus on obtaining sufficient pesticide and nitrate data at drinking water intakes (may also include algal toxin data).
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).	Continue discussions with 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.

Sensitivity of shallow aquifers	The AGWQMP does not adequately assess the vulnerability of the most sensitive aquifers in the State.	Special studies generally focus on sensitive aquifers and the Ground Water Rule development of the Hydrogeologic Sensitivity Assessment for PWS with detected E. coli will identify areas of sensitive aquifers. Resources limit the options for developing a sensitive aquifer monitoring program. A likely approach is to utilize data from existing programs that identify ground water impacts in shallow aquifers.
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.

J.2.1 Wadeable Streams and Large Rivers

J.2.1.1 Watershed Biosurveys

The 2005 Ohio EPA Surface and Ground Waters Monitoring Strategy document provided projections of likely coverage statistics for the future 2006 and 2008 Integrated Report cycles and concluded that significant declines were likely. As indicated in Table 7, these declines did not occur and coverage remained stable or increased slightly based on the 2006 and 2008 reports. This was accomplished by prudent selection of watershed survey sites and the availability of extra monitoring capacity to support some additional work. The challenge for the next several years will be to continue to make progress on watershed monitoring to support TMDL development while at the same time being able to begin follow-up survey work in watersheds where TMDLs have been completed and are in various stages of implementation. This latter activity will be crucial in documenting success of watershed efforts and in being able to show that positive water quality trends are continuing in Ohio streams and rivers. It is not anticipated at this time that resources will increase and they may likely decline as senior staff begin to retire.

Table 7. Actual and Projected Statewide Aquatic Life Use Assessment: Integrated Report (IR) Cycles 2002 - 2008[1]

IR Cycle	2002 (Actual)	2004 (Actual)	2006 (Projected/ Actual)	2008 (Projected/ Actual)
Assessment Years	1991-2000	1993-2002	1995-2004	1997-2006
Watershed HUC-11 AUs				
No. WAUs Assessed	224	225	205/212	194/218
% Total Assessed (N=331)	67.7%	68.0%	61.9%/64.0%	58.6%/65.9%
Large River AUs				
No. LRAUs Assessed	22	21	17/17	15/16
% Total Assessed (N=23)	95.7%	91.3%	73.9%/73.9%	65.2%/69.6%
Total Miles Assessed	915.3	918.0	823.2/873.0	687.5/850.0
% Total Miles Assessed (N=1284.8)	71.2%	71.5%	64.1%/67.9%	53.5%/66.2%

[1] Actual data are those reported in the Ohio 2008 Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2008d). Projected data for the 2006 and 2008 IR cycles were taken from the last Ohio EPA Surface and Ground Waters Monitoring Strategy (Ohio EPA, 2005).

While external sources should be capable of providing some data on progress of restoration measures in watersheds (Credible Data Level 2 and Level 3 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 or decline. A desirable scenario would be to dedicate new monitoring resources to this targeted follow-up effort.

J.2.1.2 Implementation of an Algal Bio-Indicator

Nutrients are a major cause of water body impairment in Ohio. Currently non-point source pollutants, specifically nutrients, are one of the largest challenges that Ohio has in protecting water quality. According to the Ohio 2010 Integrated Report, excessive nutrients are one of the top five causes of impairment for the aquatic life use in streams for the period 1999 through 2008. With the development and adoption of nutrient criteria, the work in abating excess nutrients will increase.

There will be a need for tools for monitoring the nutrient status as well as identifying nutrient related problems in surface waters. The development of algae as a bio-indicator and the development of an algae IBI would help standardize the process of detecting excess nutrients in surface waters, both lakes and streams. Algae sampling would likely provide a very cost effective way to document current conditions of enrichment and show trends over time in response to nutrient management efforts.

In the United States, certain organism groups, such as macroinvertebrates and fish, have traditionally been used to monitor water quality, whereas algae have not been used extensively. This is probably for a couple of reasons. Most water quality managers are more familiar with the former, and naturally have tended to use what is familiar. Secondly, standardized methods and analysis for macroinvertebrates and fish have tended to be developed quicker than that for algae (Stevenson pers. com. 2010). However, in the past 15-20 years that has changed and now robust methods and analytical techniques for monitoring algae have largely been developed (The Academy of Natural Sciences 2002; KY Division of Water 2008, 2009a, 2009b, 2009c; Stevenson, pers. com. 2010).

Algae have a large potential to assist in indicating water quality changes for Ohio's waters. There are numerous reasons for this potential (McCormick and Cairns 1994; Stevenson and Smol 2003) including:

- Diatoms and other algae groups tend to respond readily to nutrient enrichment;
- Filamentous algae and diatoms tell a different, yet complimentary, part of the story than do fish and macroinvertebrate assemblages;
- Algae are present and play an ecologic important role in most aquatic systems and, as such, are an important part of aquatic environmental health;
- Many algae species are very sensitive to changes in the aquatic environment and to a large number of stressors. This and their diversification of habitats help provide for a more sensitive, quicker, earlier, and more precise indicator of nutrient change than found with macroinvertebrates and fish. They can act as the "canary in the mine" providing early warnings about changes in the health of aquatic ecosystems;
- Sampling and analysis of algae is relatively inexpensive when compared with other organisms/groups commonly sampled; and
- Algae can be used for the analysis of past water quality conditions.

Although algae have use as bio-indicators for many aspects of streams and other waterbodies, they probably work best with several variables in that they react most readily to changes in pH, acidity, and nutrients. There are relatively quick dynamic changes in algal communities and individual populations with changes in nutrient status (e.g., change in diatom assemblages and/or numbers responding to different levels of bio-available P). However, like other biological groups, the response would be different depending on region and hydromorphic features.

Algae, whether as benthic algae or plankton, serve as the basis of aquatic food webs. Since their entire lifespan is spent in the water, they, along with other organisms such as macroinvertebrates and fish, can serve as valuable indicators of water quality. In streams, diatom assemblages, along with other algae, have a direct and rapid response to water quality changes where often early and subtle changes can be noted (Stevenson and Bahls 1999; Stevenson et al. 2010). For streams and small rivers, periphytic diatoms from substrates are usually sampled, whereas with larger rivers, plankton also becomes informative. Changes in the diatom communities and specific taxonomic groups, as well as an understanding of threshold responses along environmental gradients in different ecoregions, can be used in the development of multimetric indices for use in algal bioassessments (Stevenson and Bahls 1999; Stevenson and Rollins 2006; Stevenson et al. 2010). Periphyton protocols may be used by themselves, but there is the potential for increased effectiveness when combined with other biological groups. Habitat and macroinvertebrate data in particular are useful because of their close connection with periphyton in stream ecosystems (Stevenson et al. 2010).

Algae also have the potential of being important bio-indicators for lakes and wetlands. There is a large potential for assessing algal assemblages in lakes using a combination of plankton, periphyton, sedimentary diatoms and remote sensing (Stevenson pers. com. 2010). Algae have also been found to have importance in wetland bioassessment. Algae in wetlands are found in diverse groups, and have known responses to environmental factors, all which lend them to use in multivariate statistics and the development of multimetric indices (Wang et al. 2006).

Fortunately, there is a rich legacy of using algae for bioassessment in streams, lakes, and wetlands. Many government agencies throughout the world use or have used algae as bioindicators (e.g., parts of Europe have a long history of using algae in bioassessment since the early part of the last century)(Stevenson et al. 2010). A number of states including Kentucky, Maine, Montana, and Oklahoma have developed periphyton bioassessment programs including the development of multimetric indices. Other states (e.g., California) are exploring the possibility of developing periphyton programs (Southern CA Coastal Water Research Project, 2010). Kentucky has developed numerous SOPs regarding algae bioassessment (KY Division of Water 2008, 2009a, 2009b, 2009c). In addition, there is a large amount of literature and research regarding algae as indicators (Bellinger and Sigee, 2010; Stevenson and Smol, 2003). All of the above indicate that, if Ohio is interested in developing algae as a bioindicator, it doesn't have to "reinvent the wheel".

J.2.1.3 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 2010 Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2010b; Section L5). 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. While much of the groundwork for reassessment and recallibration of the biocriteria was accomplished with 2008 and 2010 contracts, successful completion of this effort, up to and including a Water Quality Standards rulemaking revision, will be contingent on resources being allocated and approved for this task in a future state biennium budget.

J.2.1.4 Public Drinking Water Supply Use

As reported in Ohio's 2010 Integrated Report, sufficient data were available to complete evaluation of the nitrate indicator in 34% of the assessment units and for the pesticide indicator in only 13% of the assessment units. Three waters were identified as impaired due to nitrate and five were impaired due to elevated atrazine. Ohio must continue to utilize all existing water quality monitoring efforts and consider other sources of data. Without additional funding dedicated to collection of monitoring data at PDWS locations, it will be difficult to obtain the data necessary to complete assessments for all locations where the PDWS use applies.

J.2.1.5 Fish Consumption

Currently, the Ohio EPA, the Ohio DNR, and the Ohio Department of Health actively participate in the sport fish tissue monitoring and consumption advisory programs. 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. The 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 Primary Headwater Habitat Streams

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

1) 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 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. Incorporation of the PHWH aquatic life use is included in draft rules currently available for interested party review until June 6, 2011. (http://www.epa.ohio.gov/dsw/rules/draft_wqs_dec10.aspx)

2) Incorporation of the PHWH stream classification system into a stream antidegradation and mitigation rule for the Section 401 Water Quality Certification program. Draft rules have been circulated for interested party review, with a comment deadline of June 6, 2011. (http://www.epa.ohio.gov/dsw/rules/draft_stream_mitigation_dec10.aspx)

3) Conduct basic research to adopt a concept of "ecological integrity" for Class III and Class II PHWH streams. This study would test whether the PHWH Community Quality Index (Moore, 2009) can be reliably used as a measure of water quality attainment on a state-wide basis. Potentially, this assessment tool would allow the Ohio EPA to identify impaired PHWH streams and include them in the TMDL development process. This 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 PHWH streams, 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 estimated 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. Staff time would need to be allocated for both field sampling and identification of benthic macroinvertebrate species over a two-year period in addition to time for data analysis and writing final reports.

J.2.3 Inland Lakes and Reservoirs

J.2.3.1 Inland Lakes and Reservoirs Monitoring Program

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, the 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.

The 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.

The adoption of an Ohio EPA inland lakes monitoring program may be coupled to a program to monitor the nearshore waters of Lake Erie. The current lack of a full-time Lake Erie nearshore monitoring and assessment program is another deficiency that has been identified in the current DSW statewide monitoring effort. The nearshore area is the primary spot where the impacts of land use and discharges to the lake is seen, but there is no regular long-term monitoring program. Lake Erie is a valuable water resource used for recreation and a source of public drinking water for millions of Ohio citizens. Using a full time staff person to conduct sampling in both inland lakes and Lake Erie would be a cost effective and beneficial use of staff time to provide data for lake water resources. The commitment of one new full-time position, access to district office summer interns, and some monitoring support from existing district office staff would provide a minimum level of effort to revitalize an Ohio EPA inland lake and reservoir program. This dedicated staffing would also provide technical support, advocacy, and guidance to existing and future volunteer monitoring networks across Ohio. Obviously, this monitoring effort would also require funds to purchase a boat and trailer, sampling equipment, field meters, supplies, and computer hardware and software to facilitate data collection, assessment, and reporting.

J.2.3.2 Harmful Algal Bloom Monitoring Program

Ohio experienced a large outbreak of HABs in public and private lakes, and Lake Erie in 2010. The Ohio State University Extension office reported 200 confirmed HABs in private ponds, and Ohio EPA, in cooperation with Ohio Department of Natural Resources and Ohio Department of Health posted water quality advisory signs at 19 State park beaches. Two of those advisories were No Contact Advisories at Grand Lake St. Marys and Cutler Lake in Blue Rock State Park. Considerable economic impacts were reported at Grand Lake St. Marys where two communities rely on tourism for economic viability. The public water supply for Celina is located at the west end of Grand Lake St. Marys. The finished water has continuously been free of microcystin since weekly testing began in 2009.

Microcystin, cylindrospermopsin, saxitoxin and anatoxin-a were detected at different lakes. Each of these toxins were detected at Grand Lake St. Marys where microcystin levels exceeded 2,000 ppb. One lake at a children’s camp in Bellefontaine had microcystin levels of 1,000 ppb which was connected to 19 human illnesses. The Ohio Department of Health determined there were a total of 41 probable human illnesses, 8 suspect human illnesses, and 5 dog deaths attributed to exposure to algal toxins statewide in 2010. The finished water at the City of Akron public water supply had 0.6 ppb microcystin in their finished water on May 6, 2010.

Lake Erie western basin and water supply intakes and finished water were tested in 2010. The Maumee Bay State Park beach had 570 ppb microcystin on August 18, 2010, which initiated a Water Quality Advisory at that beach. Two of the eleven public water supply systems had low levels of microcsytin in their finished water – Carroll Township (0.16 ppb) and Oregon (0.23 ppb).

Ohio EPA worked with NOAA in evaluating HAB bloom concentrations along Lake Erie to determine where sampling efforts should be focused with respect to public beaches and drinking water intakes. This collaboration will continue in 2011 and beyond. NOAA will be coming to Ohio in May, 2011, to instruct state personnel on remote sensing interpretation to facilitate coordination and communication with NOAA and the public.

There were numerous HAB presentations given to a variety of stakeholders in 2010. These included presentations to the Ohio Academy of Science, Ohio Lake Management Society, Ohio Environmental Health Association, and the Water Management Association of Ohio.

Ohio EPA participated in instructing a two-day workshop at Stone Laboratory on "Dealing with Cyanobacteria, Algal Toxins, and Taste and Odor Compounds". This workshop primarily focused on the needs of public water supply operators and lake managers and will be offered again in 2011.

Wright State University professor emeritus Dr. Wayne Carmichael will be conducting a two-day workshop for State personnel in May, 2011, to help state agencies develop capacity for cyanobacteria identification and cell counting.

J.2.4 Lake Erie

Monitoring 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. As such, monitoring with existing resources has been relegated to overlap activities related to watershed biosurveys occurring in Lake Erie watersheds. Monitoring directly related to existing Lake Erie programs has mostly involved stream, river, and lacustuary sampling in the four RAP watersheds as these watersheds are monitored according to Integrated Report monitoring schedules.

In 2010, Ohio EPA successfully secured funding from the Great Lakes Restoration Initiative to implement a nearshore monitoring program. Early efforts for a nearshore monitoring program were developed in the late 1990s and early 2000s but never fully implemented due to limited resources. The GLRI funding will build upon this work and support the design and implementation of a comprehensive monitoring program for the Ohio Lake Erie nearshore zone (including bays, harbors and lacustuaries). This work will also build upon Ohio's participation in the U.S. EPA National Coastal Assessment work completed in 2010. The GLRI funding will support three field seasons of data collection. As a component of this project, Ohio EPA will partner with the Ohio Department of Natural Resources and several Ohio universities for a cooperative program with standardized sampling methods to provide a comprehensive assessment of Lake Erie nearshore waters. Ohio EPA intends to solicit ongoing funding beyond the three year GLRI support.

J.2.5 Ohio River
Details of General Support and Infrastructure Planning for monitoring and other related programs in the Ohio River are available from the ORSANCO website at the following location.
(http://www.orsanco.org/programs)

J.2.6 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 surface 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.

Ohio EPA has begun to perform a fully integrated assessment of both wetlands and flowing waters (streams, rivers) in a watershed. This involves assessment of ambient wetland condition which will be included on a routine basis 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. 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 biosurvey process will require funding such activities with non-development grant monies. Such monies would provide the funding necessary to hire additional wetland dedicated sampling staff.

J.2.7 Ground Waters
The discussions outlined in the Programmatic Evaluation section (I.4) have been held regularly since 1994 to identify program directions and activities consistent with DDAGW needs and CWA 106 grant requirements. This grant is the core to implementing the Ground Water Quality Characterization Program in Ohio. The annual CWA Section106 work plan and budget identifies current activities and resources. Staffing levels are stable and unlikely to increase but current state

budget concerns create uncertainty for monitoring programs. The largest resource issue currently facing the Ground Water Quality Characterization Program is access to laboratory resources. The DDAGW laboratory budget was previously reduced and if reduced any further, will affect the level of ambient ground water monitoring completed on an annual basis.

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. .

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

J.2.8 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 ground water quality.

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

To achieve the goals of the Clean Water Act, the 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 will be provided to U.S. EPA via the WQX Warehouse.

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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