Ohio Environmental Protection Agency

Surface and Ground Waters Monitoring Strategy

Little Miami R. Near Morrow @ Stubbs Mill Rd DST

Division of Surface Water
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Introduction

This document presents a description of Ohio EPA's immediate and long-term water monitoring strategies. It describes how Ohio is meeting the 10 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. Each of the chapters represent a separate element. Applicable descriptions have been provided by water body type and/or water monitoring program component including the current efforts, any aspirational goals, and potential plans for reaching those goals.

One of the goals of developing this water monitoring strategy is to promote integration of all the water monitoring programs and integration between surface water and drinking/ground water monitoring. Ohio EPA recognizes the goals and objectives of a comprehensive strategy cannot 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 (CWA) without characterizing and protecting all water resources. The Division of Surface Water (DSW) and the Division of Drinking and Ground Waters (DDAGW) are committed to working together to identify opportunities for greater integration of the surface water and drinking water monitoring programs.

Ohio's Water Resources

Ohio is a water-rich state, bounded on the south by the Ohio River and the north by Lake Erie. These water bodies, as well as thousands of miles of inland streams and rivers and thousands of acres of lakes and wetlands, contribute to the quality of life of Ohio's citizens. The size and scope of Ohio's water resources are outlined in Table 1.

The larger water bodies included in Table 1 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 28,900 miles of the more than 58,000 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. An evaluation of primary headwater streams (drainage areas less than one square mile) places the estimate of primary headwaters between 146,000 to almost 250,000 miles (Ohio EPA 2009). 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.

Table 1. Ohio's water resource statistics

Metric	Value	Source	Scale
State population	11,536,504	2010 Census[1]	
Land area (square miles)	40,861	2010 Census[2]	
Rivers and streams			
Miles of named and designated streams	>23,000	ODNR[3]	1:24K
Total miles	58,343	NHD[4]	1:24K
Miles of perennial streams	29,412	NHD[4]	1:24K
Miles of intermittent streams	28,931	NHD[4]	1:24K
Miles of primary headwater streams	>115,000	Ohio EPA[5]	
Miles of large rivers (draining more than 500 square miles)	1,248	NHD[4]	1:24K
Miles of principal streams (draining 50 to 500 square miles)	4,453	NHD[4]	1:24K
Border miles: Ohio River	451	USGS 7 1/2' Maps	1:24K
Lakes/Reservoirs			
Number of significant publicly owned lakes	447	ODNR[6]	1:24K
Total acreage of significant publicly owned lakes	118,963	ODNR[6]	1:24K
Border miles: Lake Erie shoreline	290	USGS 7 1/2' Maps	1:24K
Total acreage of Ohio's Lake Erie waters	2,283,680	NHD[4]	1:24K
Wetlands			
Acreage	507,057	Ohio EPA[7]	1:24K
Percent of original wetlands	10 percent	Dahl[8]	

1 Source: ***factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml***
2 Source: ***census.gov/geo/reference/state-area.html***
3 Mileage for waters listed by Ohio Department of Natural Resources (ODNR) in *Gazetteer of Ohio Streams*, 2nd edition (ODNR 2001).
4 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). ***nhd.usgs.gov/index.html***
5 An estimate prepared by The Ohio State University for Ohio EPA and reported in *Field Evaluation Manual for Ohio's Primary Headwater Habitat Streams* (Ohio EPA 2009).
6 Acreage for significant publicly owned lakes (> five acres) listed by ODNR in *Inventory of Ohio's Lakes* (ODNR 1980).
7 Acreage for wetlands listed by Ohio EPA in *Intensification of the National Wetland Condition Assessment for Ohio: Final Report* (Ohio EPA 2015).
8 Loss of historic wetlands in Ohio estimated to be 90 percent (Dahl, 1990).

The named streams and rivers that are readily recognized by the public are mostly those that drain more than 50 mi^2. There are 254 principal streams and large rivers in Ohio (comprising 5,679 linear stream miles). Figure 1 graphically depicts the extent of these stream and river miles within Ohio.

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. Equally important, however, is an understanding of Ohio's geology, landform, land use, and other natural features as these determine the basic characteristics and ecological potential of streams and rivers.

Ohio EPA bases the selection, development, and calibration of ecological, toxicological, and chemical/ physical indicators on these factors. These indicators are then used via systematic ambient monitoring to provide information about existing environmental problems; threats to existing high-quality waters; and successes in abating water pollution problems in Ohio's surface waters.

In Ohio, 15 river systems are included in the State Scenic Rivers Program, administered by the Ohio Department of Natural Resources (ODNR) (see Figure 2). Between 1970 and 2018, a little more than 676 miles were designated Scenic; 102 miles in four systems were designated Wild; and 79 miles in two systems were designated Recreational. Portions of three stream systems—the Little Miami, Little Beaver Creek, and Big and Little Darby Creek—are also included in the National Wild and Scenic System. The total Ohio stream miles included in the national designation is 207 miles. More information on Ohio's scenic rivers can be found at ***Ohio Department of Natural Resources Scenic River Program***.

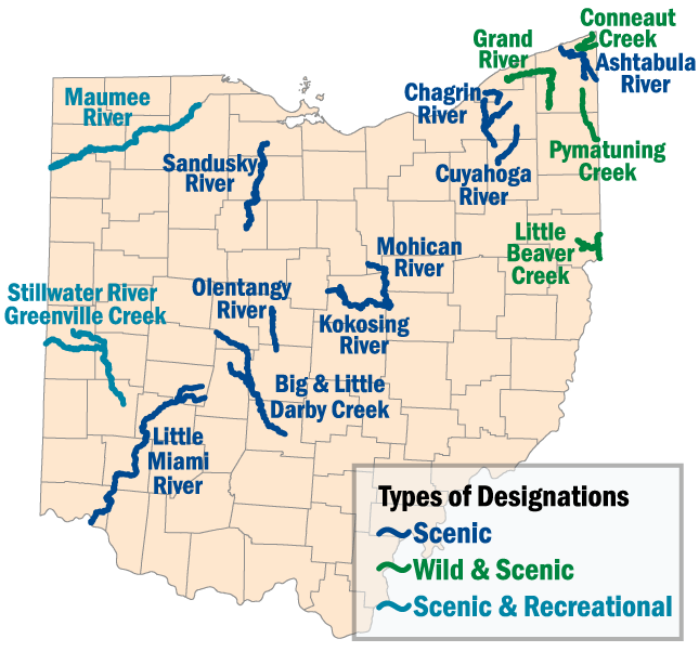

Figure 1 — Ohio Scenic River System
Source: ***ODNR Scenic Rivers Program***

Ohio has abundant ground water resources. Average rainfall ranges between 30 and 44 inches/year (increasing from northwest to southeast), which drives healthy stream flows. Infiltration of a small portion of this rainfall (3-16 inches) recharges the aquifers and keeps the streams flowing between rains. Ohio's aquifers can be divided into three major types as illustrated in Figure 3. The sand and gravel buried valley aquifers (in blue) are distributed through the state. The valleys filled by these sands and gravels are cut into sandstone and shale in the eastern half of the state (in tan) and into carbonate aquifers (in greens) in the western half.

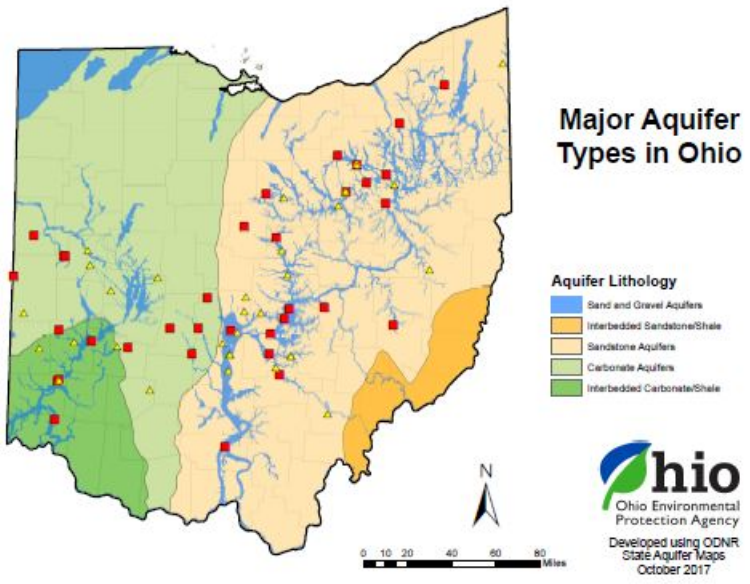

Figure 3 — Aquifer Types in Ohio modified from ODNR Glacial and Bedrock Aquifer Maps (ODNR, 2000; ***Groundwater Maps & Publications***).

The buried valley aquifers are productive aquifers. The sandstone and carbonate aquifers generally provide sufficient production for water wells except where dominated by shale, as in southwest and southeast Ohio. An Ohio EPA report, *Major Aquifers in Ohio and Associated Water Quality* (2015), provides more detailed descriptions of these aquifers.

I. U.S. EPA Water Monitoring Strategy Framework

The following outline abstracts the articulated goal for state programs and the salient points from U.S. EPA (2003). These 10 points are:

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

U.S. EPA's articulated goals are provided in each section. This document demonstrates how Ohio is meeting these goals.

II. Ohio EPA Water Monitoring Programs

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 (for example, streams, rivers, lakes, Great Lakes, reservoirs, estuaries, coastal areas, wetlands, and ground water).

Each year, Ohio EPA DSW collects data from streams and rivers in areas around the state. A total of 400 to 450 biological sampling events are examined, and each site is visited more than once. During these studies, Ohio EPA scientists collect chemical samples, examine and count fish and aquatic insects, and take measurements of the stream. There are three major objectives for the studies:

- to determine how the stream is doing compared to goals assigned in the ***Ohio Water Quality Standards (WQS)***;
- to determine if the goals assigned to the river or stream are appropriate and attainable; and
- to determine if the stream's condition has changed since the last time the stream was studied.

The data gathered by a field survey is processed, evaluated, and synthesized in a biological and water quality report. The findings and conclusions of each biological and water quality study 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***, the ***Ohio Water Resource Inventory*** (305[b] report), and WQS. This information also provides the basis for the list of impaired and threatened waters required by Section 303(d) of the CWA.

Additionally, Ohio EPA's DDAGW collects data on the state's drinking water supplies and ground water. The collaboration between the CWA and the Safe Drinking Water Act (SDWA) works to ensure public water systems produce safe drinking water using only conventional treatment, resulting in reduced financial cost to communities and minimized risk to human health. This data is used in determining public drinking water supply beneficial use. DDAGW also collects ambient ground water samples. This data characterizes ambient ground water quality conditions, identifies ground water contamination, and recommends strategies for preventing contamination.

A.1 Headwaters, Streams and Rivers

A.1.1 Aquatic Life Use

A.1.1.1 Comprehensive Watershed Surveys

Ohio EPA routinely conducts intensive biological and water quality surveys on a regular basis statewide. A comprehensive watershed survey is an interdisciplinary monitoring effort that examines the physical, chemical, and biological conditions of a stream to assess its designated use as prescribed in Ohio's WQS. Comprehensive watershed surveys are typically coordinated on a watershed scale but can also be waterbody specific. They can be relatively simple and focus on a small watershed with one or two principal stressors and a small number of sampling sites, or a much more complex effort including entire large river drainage basins with multiple and overlapping stressors and more than 100 sites. Sampling techniques are outlined in Ohio's ***biocriteria users' manuals***.

Comprehensive watershed surveys are broken down into different informational collection efforts, biology which includes fish and macroinvertebrates, water chemistry, algae, habitat, and physical measurements. Different work groups within Ohio EPA cover these different collection efforts: biologists collect fish and macroinvertebrate samples and habitat data; district and modeling staff collect water chemistry and algae samples; and modeling staff collect physical measurements such as stream flow. The portion of the comprehensive watershed survey where biology (fish and macroinvertebrates) and habitat are collected is referred to as a biosurvey.

Ohio EPA is currently updating the study plan design for these biosurveys. The revised strategy includes a 12-year rotation to cover the entire state. The rotation will also include large rivers, wadeable streams and rivers, and headwaters probabilistic surveys. During the years of the probabilistic work, one or two targeted surveys will be conducted. In the years without probabilistic work, four targeted surveys will be conducted. An aggregate total of 400 to 450 biological sampling passes will be sampled in a year. While the principal focus of a biosurvey is on the status of the designated aquatic life use, the status of other beneficial uses such as contact recreation, public water supply, and human health (fish consumption) are also addressed. The data gathered by a biosurvey is processed, evaluated, and synthesized in a biological and water quality monitoring report, or technical support document (TSD). The findings and conclusions of each biological and water quality study 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 (CWA)]. The design of the probabilistic studies is described in more detail in Section A.1.1.4. The sampling techniques used are the same as Ohio's biosurveys.

The following Ohio EPA water management programs and activities use data collected through the integrated biosurvey approach:

- CWA Section 305(b) reporting process;
- CWA Section 303(d) listing process (TMDL program);
- CWA Section 303(c) establishing, reviewing, and revising Water Quality Standards (WQS);
- WQS program (use designations, criteria refinements, and modifications);
- Permitting program (NPDES permits, PTI requests, CSO regulation, storm water management program);
- CWA Section 404/401 Water Quality Certification program;
- CWA Section 319 Nonpoint Source and Section 314 Clean Lakes programs;
- Lake Erie Areas of Concern (AOCs) 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 that tracks 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. By conducting the level of monitoring and assessment 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 and essential to maintaining and improving the overall water quality management process.

A.1.1.2 Water Quality Monitoring

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 (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 (sub-watershed) and temporal (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 May and October depending on stream flow conditions. Dissolved 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 Ohio's WQS at Chapter 3745-2 of the Ohio Administrative Code (***epa.ohio.gov/static/Portals/35/rules/02-all_feb19.pdf***).

A.1.1.3 Fixed Station Networks

There are two monitoring networks maintained by Ohio EPA's Division of Surface Water (DSW) that qualify as fixed station networks: the National Ambient Water Quality Monitoring Network (NAWQMN) and the Regional Reference Sites network. The NAWQMN represents the traditional fixed station design that dates to the 1950s. Though somewhat fluid as of 2020, the network consists of 64 sites that 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. These sites are listed in Table 1 of the *Statewide Ambient Water Quality Monitoring Guidance V2.1* July 2, 2018. Ohio EPA district water quality staff are responsible for the collection of chemical/physical samples; whereas, biologists from the ecological assessment unit are responsible for collecting and analyzing biological samples. 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 for which the results are interpreted in that context. A portion of the NAWQMN overlaps with the International Joint Commission (IJC) designated sites, which addresses data needs for assessing water quality conditions in Lake Erie and its major tributaries. The NAWQMN also overlaps with the USGS National Stream Quality Accounting Network (NASQAN), which is also comprised of a network of gage 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's ecological assessment unit is primarily responsible for the design and implementation of this network.

A.1.1.4 Probabilistic Statewide Assessment

For statewide assessments, rivers and streams are divided into three sampling frames based on drainage area; specifically, headwaters (1-3.1 mi^2); wadeable streams (3.1-500 mi^2); and large rivers (500-10,000 mi^2). The large river frame totals approximately 1,387 miles of free-flowing waters. Given that species turnover is relatively gradual in large rivers, one sampling point can effectively represent several or more miles of the frame, such that it becomes feasible to census condition and attainment status for the entire frame by sampling at a rate of one sample per eight miles, or approximately 175 sites.

The stream network in the wadeable frame totals nearly 18,500 miles. Under the most optimistic assumptions (based on historic sampling densities and sampling rates to provide a condition assessment), it would take five biological crews approximately 10 years to complete one rotation of the frame if sampling to the exclusion of all other needs. Practice has shown that one rotation is more on the order of 20 years. That length of time has created a strong temporal and spatial bias in statewide condition estimates. To address this programmatic shortcoming, a probabilistic sample of approximately 360 locations will be used to provide an unbiased statewide estimate of condition and attainment status. The sampling will be conducted over two consecutive seasons, and will include the full complement of biological, chemical, and physical parameters.

The headwater frame totals roughly 13,370 miles. The streams in this frame (1-3.1 mi^2) have been historically underrepresented in the data, especially through the 1990s, due in part to the fact that reference expectations are not well established for fish assemblages within this class. More recent sampling, however, has shown that macroinvertebrate assemblages read the condition status in these small streams and appear to follow reference expectations drawn from larger waters as inferred by the similarity in slopes over drainage area drawn from quantile regressions applied to the reference and monitoring sites datasets. A probabilistic sample of approximately 150 sites will establish a baseline condition estimate and inform expectations for fish assemblages such that scoring or metric adjustments can be suggested for the fish IBI.

A.1.1.5 Primary Headwater Streams

Ohio EPA 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 WQS (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 as drainage areas approach and fall below 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. Consequently, 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. While the ICI is not applicable to any headwater streams, Ohio EPA routinely uses qualitative assessments resulting in narrative descriptions of macroinvertebrate community health as part of its aquatic life use assessments and aquatic life use designation recommendations.

In the smallest headwater watersheds, narrative assessments of the macroinvertebrate community can provide functional assessments of water quality impairment. Assessments of the physical habitat, fish, and amphibians can also provide useful information toward a comprehensive evaluation of overall health within the upper reaches of a watershed. Like larger stream reaches, these biological measures can be used to provide reliable measures of expected outcomes following a TMDL.

To address these limitations in Ohio's monitoring strategy, DSW conducted a survey of more than 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. Ohio EPA has coined the term primary headwater (PHW) stream to distinguish this subset of habitats from the current headwater stream definition as currently listed in the Ohio WQS.

The results of the first phase of the PHW stream project have now been finalized and made available to the public at ***epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/surface-water/reports-data/primary-headwater-streams-in-ohio***. 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, 2020).

In general, the results of the survey indicate that three distinct types of biological communities are present within the spatial scale of PHW streams, referred to as Class I, Class II, and Class III PHW 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 PHW 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 PHW streams, Class II and Class III streams have a hydraulic connection to various types of ground waters, either perched or represented by the deep ground water table. The biological conditions of Class III PHW streams indicate that they are connected to deep, cold, and perennial ground water flow, having at least one of the following biological signatures:

1) a high incidence of cool and coldwater benthic macroinvertebrate taxa;
2) reproducing populations of coldwater adapted fish species (for example, 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, coldwater 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 ground water.

Class II PHW 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 PHW streams lack the Class III vertebrate indicator groups (fish, amphibians), and have a low number of cool water adapted macroinvertebrates (<4 taxa). Class II PHW streams can maintain a diverse number of aquatic species adapted to either perennial warmwater or intermittent flow conditions.

Perhaps the most important general finding of the PHW 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 WQS protect all undesignated streams in Ohio using the warmwater habitat chemical criteria. However, the results of the PHW survey indicate that this approach is over-protective of ephemeral Class I PHW streams but may not be sufficiently protective of Class III PHW streams where pollution-sensitive species are more likely to be found.

The primary use of the PHW 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 characterize the relative quality and diversity of these small streams that are proposed to be modified under a U.S. Army Corps of Engineers Section 404 permit. Results of these assessments provide valuable data for antidegradation decisions, and the determination of stream mitigation requirements relating to approved impacts.

Research has begun to enhance the methodologies for PHW streams beyond basic classification of community type to assessment of attainment of water quality goals through the development of biological criteria. A PHW community quality index (CQI) for Class III PHW 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 PHW CQI methods to validate the applicability of the methodology as a measurement of water quality across all ecoregions in Ohio. In addition, the candidate study sites will be expanded to determine whether the same concepts can be applied to Class II PHW streams.

A.1.2 Recreation Use

A.1.2.1 Ohio's Recreation Water Quality Standards

Ohio completed its update to the WQS pertaining to the recreation use designation. Recreation uses were updated in 2016 to be consistent with U.S. EPA recreation criteria recommendations. Previously, primary contact recreation (PCR) was broken down into three categories. In 2016, PCR uses were combined into one category.

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. Bathing waters are heavily used for swimming during recreation season, particularly where a lifeguard or bathhouse facilities are present. Primary contact are waters that during the recreation season are suitable for one or more full-body contact recreation activities. All surface waters of the state are designated as PCR unless specifically designated in rule as bathing waters or SCR. Secondary contact are water that result in minimal exposure because they are rarely used, have restricted access or insufficient depth. See OAC 3745-1-07 for more detailed definitions.

The bacteria criteria applicable to recreation were revised in several ways. Instead of a seasonal geometric mean, the geomean employs a 90-averaging period from samples collected during the recreation season. The single sample maximum value has been replaced with a statistical threshold value (STV). This STV may not be exceeded by 10 percent of the samples taken in a 30-day period.

These uses and the associated criteria are contained in OAC 3745-1-37 (***epa.ohio.gov/static/Portals/35/rules/01-all_apr21.pdf?ver=Eaa7s8hOK8IRHn1XA8nXDA%3d%3d***). The recreation use is seasonal, lasting from May 1 through Oct. 31. These criteria apply inside and outside the mixing zone at all times during the recreation season. The changes to Ohio's recreation use WQS have had implications on the monitoring program for bacteria as described below.

A.1.2.2 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 15 to Oct. 31. Selection of waters needing UAA information is part of the study planning process. Obtaining the information needed for management decisions depends on good study planning. All surface waters of the state are designated as PCR unless otherwise designated as bathing waters or SCR in rule.

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.

A.1.2.3 Recreation Water Quality Criteria

Since 2010, Ohio has relied exclusively on *Escherichia coli* (*E. coli*) as the indicator criteria for assessing recreational water quality. Ohio's WQS include both a 90-day geometric mean and a statistical threshold value for each recreation use designation. Previously, the WQS expressed the geometric mean in terms of a recreation season period. The current WQS requires samples be taken in a 90-day period during the recreation season.

The *Surface Water Field Sampling Manual* (April 22, 2019) details the methodology used by field personnel in the collection of water samples for bacteria measurements.

In addition, OAC 3745-1-04 and 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 ODNR performs limited and variable monitoring of beaches at inland state parks. The ODH sampling procedures and sample results are available at ***https://odh.ohio.gov/wps/portal/gov/odh/know-our-programs/bathing-beach-monitoring/BeachGuard***.

A.1.3 Public Drinking Water Supply

The *2020 Integrated Water Quality Monitoring and Assessment Report* (IR) was the seventh reporting cycle to include assessments of the public drinking water supply (PDWS) beneficial use. Ohio continues to look for connections between CWA and SDWA activities and to leverage these programs to clean up and protect drinking water sources. The PDWS assessment methodology was first presented in the 2006 IR and updates to the methodology were included in subsequent IRs. This approach evaluates surface waters used as drinking water sources and identifies areas and specific causes of impairments. The PDWS WQS are designed to protect source water quality to the extent that public water systems can meet the finished water SDWA standards using only conventional treatment, as defined for PDWS beneficial use (Ohio Administrative Code rule 3745-1-07). This approach maximizes protection efforts by employing the authority of the CWA to prevent contamination of source waters while minimizing the risk to human health and violations of standards set forth in the SDWA. Identification of impaired waters allows Ohio EPA, state and local government, 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.

DSW monitoring is focused 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.1.4 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. Ohio EPA and ODNR, together with input from ODH, 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 five surface acres, at least once every ten years. Priority water bodies such as Lake Erie and the Ohio River are sampled annually, while some highly fished and/or highly contaminated areas such as the major tributaries to Lake Erie 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 the Ohio River Valley Water Sanitation Commission (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 ***odh.ohio.gov/wps/portal/gov/odh/know-our-programs/ohio-sport-fish-consumption-advisory.***

A.2 Inland Lakes and Reservoirs

Ohio EPA's work to assess lakes began in 1989 with a CWA Section 314 Lake Water Quality Assessment grant that supported the evaluation of 52 lakes. Various additional grants enabled the evaluation of 89 more lakes through 1995. An analysis and determination of beneficial use status for 447 public lakes (greater than five acres in surface area) was presented in Volume 3 of the 1982 through 1996 Ohio Water Resource Inventories [305(b) report]. In those reports, Ohio EPA developed a lake condition index (LCI) using multiple metrics to characterize overall lake health which was applied to designated uses as well as general CWA fishable and swimmable goals.

Ohio EPA began researching ways to re-establish an inland lakes monitoring program in 2005. During the 2007 field season, Ohio EPA participated in the U.S. EPA-sponsored National Lakes Assessment (NLA). Ohio was assigned 19 lakes that were selected through a probability-based random selection process. The effort served as a precursor for a renewed lake sampling program in Ohio. Ohio EPA again participated in a second round of NLA sampling in 2012 at 16 additional lakes.

Between 2012 and 2017, Ohio EPA monitored 50 additional inland lakes that had not been previously assessed. Also, two additional lakes (Grand Lake St. Marys and Buckeye Lake) have been assessed on a routine basis as part of a special study.

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 (ORAM) and the Vegetation Index of Biotic Integrity (VIBI) for Ohio Wetlands.

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. Ohio does not have biological criteria that apply to lakes. As a result, the assessment methodology for the aquatic life use will rely solely on the results of chemical water quality sampling and a comparison of the results to the applicable numeric chemical criteria. This is an important difference to the weight-of-evidence approach traditionally used by Ohio EPA utilizing biocriteria for the assessment of

rivers and streams. Ohio EPA currently monitors select inland lakes using the strategy described in Section B.1.

A.3 Lake Erie – Rivers, Harbors, Shoreline and Open Waters

Ohio's Lake Erie programs are founded in the Great Lakes Water Quality Agreement (GLWQA). The GLWQA is a commitment between the United States and Canada to address key environmental health issues in the Great Lakes basin. The agreement has 10 annexes that focus on specific issues. Annex 1 focuses on areas of concern (AOC). These are sites identified as highly contaminated. Ohio EPA collaborates with the Ohio Lake Erie Commission (OLEC) to manage and restore AOC sites. Annex 2 focuses on lakewide action and management plans (LAMPs). This is a multi-jurisdictional effort between U.S. EPA and its member states and Environment and Climate Change Canada and its member province. Annex 4 focuses on nutrients and led to the development of a U.S. Action Plan and Ohio Domestic Action Plan for Lake Erie. Annex 10 focuses on monitoring and surveillance. These programs provide support for the monitoring activities.

Ohio EPA annually conducts water quality monitoring in the lake from spring-fall. Data collected are used, in part, to satisfy Ohio's CWA Section 303(d) requirements to identify waters that are impaired for various beneficial uses. The agency also participates in planning for comprehensive science and monitoring initiative (CSMI) surveys. These intensive surveys are led by U.S. EPA's Great Lakes National Program Office (GLNPO) and done in each of the Great Lakes on a five-year rotation. U.S. EPA also leads national aquatic resource surveys (NARS) on a five-year rotation. As a part of the NARS, Ohio EPA completed sampling for Lake Erie in the 2020 national coastal conditions assessment (NCCA). These monitoring activities feed data and results back into the various programs of the GLWQA and the state.

A.3.1 Areas of Concern (AOC) Program

Annex 1 identifies 14 beneficial use impairments (BUIs), defined as a reduction in chemical, physical, or biological integrity. Ohio's AOC program focuses on their restoration. Those BUIs include:

- BUI 1: Restrictions on fish and wildlife consumption
- BUI 2: Tainting of fish and wildlife flavor
- BUI 3: Degraded fish and wildlife populations
- BUI 4: Fish tumors or other deformities
- BUI 5: Bird or animal deformities or reproductive problems
- BUI 6: Degradation of benthos
- BUI 7: Restrictions on dredging activities
- BUI 8: Eutrophication or undesirable algae
- BUI 9: Restrictions on drinking water consumption or taste and odor problems
- BUI 10: Beach closings
- BUI 11: Degradation of aesthetics
- BUI 12: Added costs to agriculture or Industry
- BUI 13: Degradation of phytoplankton and zooplankton populations
- BUI 14: Loss of fish and wildlife habitat

There are four AOCs in Ohio. These include: 1) the lower two miles of the Ashtabula River; 2) the lower portion of the Black River; 3) the lower 46.5 miles of the Cuyahoga River, including all tributaries and the adjacent shoreline; and 4) the lower 22 miles of the Maumee River, including several adjacent watersheds that discharge directly to Maumee Bay and Lake Erie.

Annex 1 requires development of Remedial Action Plans (RAPs) to identify the BUIs and their causes, development of criteria for restoration of the beneficial uses, implementation of remedial measures/management actions, monitoring of the effectiveness of those actions and confirmation that restoration of beneficial uses has been achieved. Ohio established statewide BUI restoration targets to identify when a beneficial use is no longer impaired.

Restoration of Ohio's four AOC sites involves a great deal of collaboration between federal, state, and local partners including a public advisory committee for each AOC.

In coordination with Ohio EPA, the local advisory committees (or their predecessors) have completed the initial assessment of impairments to beneficial uses (stage 1 reports), identified sources, defined remediation and restoration needs (stage 2 reports) and prepared status reports. Projects have been implemented to better define impairments and sources, remediate problems, restore habitat, remove contaminated sediments, and outline plans for strategic action.

Ohio's AOC program has transitioned from active planning to implementation and BUI evaluation when actions are completed. The AOC program annually identifies BUIs for assessment, evaluation, or removal based on the progress of cleanup and restoration activities in each AOC.

A.3.2 Lakewide Action and Management Plan (LAMP)

The development of LAMPs is another requirement of the Great Lake Water Quality Agreement (Annex 2). 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 is to identify impairments. Next, the causes and sources are listed. Finally, actions are identified for the parties and their partners to take to meet their goals. Assessments have been completed using the State of the Great Lakes (SOGL) indicators, most recently in 2019. The second step was to define a vision for the desired future state of the lake and the general actions needed to achieve it, which are provided in the Lake Erie LAMP (2019).

A.3.3 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 ORAM and the VIBI for Ohio Wetlands. The H2Ohio Wetland Monitoring Program being facilitated by ODNR and the academic Lake Erie and Aquatic Research Network (LEARN). Ohio EPA is involved in this effort via its technical and management advisory boards. For more information please see the following website: ***https://h2.ohio.gov/natural-resources/***

A.3.4 Lake Erie Monitoring Program

Ohio EPA started an annual Lake Erie monitoring program in 2014. Methods were developed during a three-year project funded by the Great Lakes Restoration Initiative (GLRI) from 2011-2013. The program includes an assessment of mayfly populations in the Western Basin, an evaluation of water quality conditions and phytoplankton community composition at fixed ambient stations across the lake, and an assessment of dissolved oxygen conditions in the hypolimnion of the Central Basin.

A.4 Ohio River

Since 1948, 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 Ohio EPA 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 - ***orsanco.org***.

A.5 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 toward establishment of wetland WQS are as follows.

Ohio EPA adopted wetland WQS on May 1, 1998. The wetland WQS 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).

The *Ohio Rapid Assessment Method for Wetlands version 5.0* (ORAM) was finalized on Feb. 1, 2001 (Ohio EPA, 2001). 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. 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.

Data from both individual wetland mitigation projects and wetland mitigation banks have been compared to values from Ohio's 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 (Ohio IRT) 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 Ohio IRT will be re-public noticing new guidance for wetland mitigation and in-lieu fee projects in Ohio in 2020.

A.6 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 drinking water sampling. The 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 a local scale. These data support 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 210 sites on either a 6-, 18-, or 36-month sampling schedule with the objective of characterizing the major aquifers in the state. This program was established in 1973 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 94 percent are public water systems and the others are industrial, business, or residential wells. Of the active wells, 65 percent are in unconsolidated aquifers, 20 percent are in limestone aquifers, and 15 percent 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 affecting or with potential to affect public or private water supplies. The insights gained are applied to similar hydrogeologic settings across the state and complement 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.

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; 7) developing and refining WQS, and 8) developing and improving the understanding of the basic chemical, physical, and biological processes that affect environmental quality.

B.1 Surface Waters (Headwaters, Streams, Rivers, and Inland Lakes/Reservoirs)

Each year, Ohio EPA collects data from a fixed station network in streams and rivers around the state. Additionally, total of 400 to 450 biological sampling passes are examined and each site is visited more than once. During these studies, Ohio EPA scientists collect chemical samples, examine and count fish and aquatic insects, and take measurements of the stream. There are four major objectives for the studies:

- To determine how the stream is doing compared to goals assigned in the Ohio ***Water Quality Standards (WQS)***;
- To identify the source of pollutants and recommendations for improvement;
- To determine if the goals assigned to the river or stream are appropriate and attainable; and
- To determine if the stream's condition has changed since the last time the stream was studied.

The four major objectives for the current inland lakes monitoring program 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.

More specific monitoring objectives for key beneficial uses and related discussion are detailed below.

B.1.1 Aquatic Life Use

B.1.1.1 Watershed Biosurveys

The primary objective of biological monitoring of resident fish and macroinvertebrate communities in streams and large rivers is to directly assess the biological integrity goal of the CWA. To this end, Ohio EPA developed a tiered framework of aquatic life uses and associated biological criteria that have been promulgated in Ohio's WQS (Chapter 3745-1 of the Ohio Administrative Code), found at ***epa.ohio.gov/static/Portals/35/rules/water_body_index.pdf***.

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 calibrated against least impacted ecoregional reference sites.

In applications of Ohio's WQS to the management of water resource issues in Ohio's 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 technical support documents (TSDs). Also, an emphasis on protecting for aquatic life generally results in water quality suitable for all beneficial uses. The five different aquatic life uses currently defined in Ohio's 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 and are characterized by a high diversity of species, particularly those that 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. Currently, all inland lakes, except for upground reservoirs, are listed as EWH. Upground reservoirs are listed as WWH.
- Coldwater habitat (CWH) - this use is intended for waters that are capable of supporting populations of native coldwater fish and associated vertebrate and invertebrate organisms and plants on an annual basis. It also applies to streams that are stocked with salmonids with the intent of providing a put-and-take fishery on a year-round basis as sanctioned by the Ohio Department of Natural Resources, Division of Wildlife. This use should not be confused with the Seasonal Salmonid Habitat (SSH) aquatic life use, which applies to Lake Erie tributaries that support periodic runs of salmonids during the spring, summer and/or fall.
- Modified warmwater habitat (MWH) - this use applies to streams and rivers that 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 tolerant of low dissolved oxygen, silt, nutrient enrichment and poor quality habitat.
- Limited resource water (LRW) - this use applies to water courses that have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported. Such waterways generally include streams affected by acid mine drainage[1] and/or are regularly subjected to small drainageway maintenance[2].

[1] Acid mine drainage - these are surface waters with sustained pH values below 4.1 s.u. or with intermittently acidic conditions combined with severe streambed siltation and have a demonstrated biological performance below that of the modified warmwater habitat biological criteria.

[2] Small drainageway maintenance - these are highly modified surface water drainageways (usually less than three square miles in drainage area) that do not possess the stream morphology and habitat characteristics necessary to support any other aquatic life habitat use. The potential for habitat improvements must be precluded due to regular stream channel maintenance required for drainage purposes.

Chemical, physical and/or biological criteria are generally assigned to each use designation. The system of use designation employed in Ohio's WQS constitutes a tiered approach in that varying and graduated levels of protection are provided. This hierarchy is especially apparent for parameters such as dissolved oxygen, ammonia-nitrogen, temperature, and 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 aquatic life use designations. However, with the adoption of dissolved metals criteria as a result of the GLWQA, 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). The water quality and fixed station network monitoring would use these same objectives.

For inland lakes, water chemistry samples are taken to determine if specific chemical concentrations are present in exceedance for the applicable chemical criteria for ALU. Currently, Ohio does not have biocriteria for these waterbodies.

B.1.1.4 Probabilistic Statewide Assessment

There are several inter-related objectives for the large river survey. The survey is intended to provide an estimate of the condition and attainment status of the entire frame. Note that condition status refers to position on the disturbance gradient and can be interpreted through observed biological assemblages or measured water quality. Attainment status is specific to whether observed biological assemblages meet established numeric (or narrative) criteria. When biological assemblages fail to attain numeric criteria, the intersection of biological and water quality condition helps identify the causative factors. Thus, the overall objective is to characterize the large river frame in terms of the overall disturbance gradient, and identify stressors limiting biological condition. Also note that because the sampling density represents a virtual census, the survey will provide specificity with respect to stressors limiting particular reaches, and thus provide information for both 305(b) and 303(d) reporting. Additionally, an outcome accomplished by characterizing the status of the frame at a given point in time is to establish a baseline for future comparisons. Establishing that baseline can be thought of as an implicit objective. A separate objective is to characterize the status of contaminant levels in fish tissue.

The objectives for the wadeable frame are essentially the same as that for the large river frame; however, the because the wadeable frame is being sampled probabilistically, the estimates will apply to the population. Thus, major stressors identified will be acting at the population level.

The objectives for the headwater frame are to estimate condition status, identify major stressors acting at the population level, and provide data to help inform expectations for fish assemblages within the headwater frame.

B.1.1.5 Primary Headwater Streams

Primary headwater streams are quite small, less than 1.0 mi^2 drainage area. Many of them are not represented with blue lines on USGS 1:24,000 quadrangle maps, although almost all of them are visible and marked on county soil maps. These streams are usually not identified or assigned beneficial uses in the Ohio WQS, but there are exceptions. In fact, every stream within the WQS has a segment near its origin where the drainage area drops down into the PHW range. The sampling methods, and concurrent biological and habitat indices now used by Ohio EPA to classify waterways for existing water quality (for example, 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 principal 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 Rapid Assessment Method (ORAM) sampling methods used to classify jurisdictional wetlands (Ohio EPA, 2001).

The *Field Evaluation Manual for Ohio's Primary Headwater Streams* (Ohio EPA, 2020) 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 anti-degradation protocols needed to protect the native fauna of any primary headwater stream.

B.1.2 Recreation Uses

Ohio EPA's monitoring objectives for recreation uses are consistent with CWA 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 streams that are more heavily used for recreation 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 Public Drinking Water Supply Use

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. The current PDWS assessment in the 2020 IR identifies the need for additional data to complete nitrate and pesticide evaluations (sufficient data for only 53 percent of assessment units for nitrate indicator and only 30 percent for pesticides).

While there is sufficient data to assess algae (cyanotoxin) indicator due to compliance monitoring at public water systems (see OAC rule 3745-90), more than half of the assessment units are impaired or on the watch list for this indicator. The combined lack of data for some indications and high occurrence of cyanotoxins supports continued efforts to monitor at public drinking water intakes. 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 (SFCA 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 the impairment status of a water body based on fish tissue analytical data. These calculations assume a certain level of consumption, which is used to calculate safe tissue concentrations of chlordane, dichlorodiphenyltrichloroethane (DDT), hexachlorobenzene, mercury, mirex, and total polychlorinated biphenyl. These calculated concentrations are compared to concentrations from collected fish tissue samples. If the sample concentrations are greater than the calculated values, then the waterbody is listed as impaired. A more detailed description of the data analysis and assessment procedures is available in the *2020 Integrated Water Quality Monitoring and Assessment Report* at ***epa.ohio.gov/static/Portals/35/tmdl/2020intreport/2020_SectionE.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 WQS for the purposes of making TMDL determinations.

B.2 Lake Erie – Rivers, Harbors, Shoreline and Open Waters

Ohio EPA's watershed biosurvey and Lake Erie monitoring programs generate much of the river and harbor data used to evaluate AOC beneficial uses. Ohio EPA monitoring data from the Lake Erie shoreline and open water supports CWA reporting requirements such as 305(b) and 303(d). Ohio also relies on R/V Lake Guardian data generated by GLNPO. The harmful algae bloom (HAB) forecast done by the National Oceanic and Atmospheric Administration (NOAA) is also being used to assess open waters. Specific objectives for the various programs are provided below.

B.2.1 AOC Program

Monitoring objectives for the AOC program address the status of each of the BUIs and the corresponding target. The data may also be used as the baseline to further customize targets that may be more appropriate for the conditions of an individual AOC.

B.2.2 GLWQA: State of the Great Lakes Indicators

The development of a suite of SOGL indicators is another requirement of the Great Lakes Water Quality Agreement of 2012. The monitoring objectives of SOGL are served in part by the BUI assessments described above. Ohio EPA monitoring objectives are largely reflective of SOGL monitoring objectives for the Lake Erie tributary streams and shoreline. This information is also used to support evaluation of the Lake Erie LAMP.

B.2.3 Lake Erie Monitoring Program for 303(d) Assessment

Ohio waters of Lake Erie are divided into seven segments or Lake Erie assessment units (LEAUs). For each of the seven assessment units the status of aquatic life, recreation, public water supply, human health, and recreation beneficial uses are evaluated for CWA Section 303(d) list of impaired waters purposes (the Central basin shoreline assessment unit has no public drinking water supply intakes in its area, therefore that use is not assessed in this unit). Results are summarized in the *Integrated Water Quality Monitoring and Assessment Report*.

B.2.4 Other Lake Erie Programs

To describe state actions to protect and restore Lake Erie, the state is required in statute to adopt the *Lake Erie Protection and Restoration Plan* (Ohio Lake Erie Commission, 2020). Monitoring objectives are to measure the progress of the activities listed in the protection and restoration plan and track the results of these actions. 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 using a suite of indicators to describe its ecological and economic condition. The most recent update to the plan was completed in 2020 and an update of the LEQI is underway during 2020. These programs are found at:
https://lakeerie.ohio.gov/wps/portal/gov/lec/planning-and-priorities/01-protection-and-restoration-plan/01-protection-and-restoration-plan

B.3 Ohio River

Monitoring objectives for the Ohio River mainstem are documented in ORSANCO standard operating procedures documents at ***orsanco.org***.

B.4 Wetlands

Wetlands continue to be evaluated on an individual basis as they are proposed for impacts through Section 401 water quality certification or isolated wetland permit applications or when that information is needed for other uses. While tiered aquatic life uses (TALU) 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.

Overall, the goals of Ohio EPA's wetland monitoring program include:

- the ability to document the ambient quality of any wetland for regulatory or non-regulatory purposes;
- evaluate the performance of permittee responsible wetland mitigation projects and wetland mitigation banks;
- develop tools to identify locations that have high potential for successful restoration of lost wetland resources;
- report on the condition of wetlands from a watershed, or other geospatial, prospective; and
- 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.5 Ground Waters

The primary objective of the AGWQMP 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 from special studies is stored, along with AGWQMP data, in a specifically designed water quality database. These data can then be transferred to U.S. EPA's STORET Data Warehouse via the Water Quality Exchange (WQX).

In September 2019, Governor Mike DeWine created an inter-agency workgroup to address the emerging issue of PFAS in Ohio. In his announcement, he directed Ohio EPA and ODH to work together on developing a statewide action plan to address potential threats to both public and private drinking water systems. Accordingly, Ohio EPA is coordinating the sampling of nearly 1,500 public water systems statewide for these emerging drinking water contaminants. This sampling program has a significant ground water component. For ground water based PWSs, both a distribution water sample as well as raw (untreated) water sample is to be collected at each system. The PFAS action plan is available at ***epa.ohio.gov/wps/portal/gov/epa/monitor-pollution/pollution-issues/per-and-polyfluoroalkyl-substances-pfas***.

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.

C.1 Surface Waters (Headwaters, Streams, Rivers, and Inland Lakes/Reservoirs)

C.1.1 Watershed Biosurveys

Ohio EPA adopted as basic watershed assessment units the USGS 11-digit hydrologic unit (HUC-11) of which there were 331 delineated within Ohio. However, in practice, TMDLs were effectively being implemented with projects operating at the USGS 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*, 1,538 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 drainage area), large river assessment units (LRAUs) were developed to report independently on these large water bodies since they are unique in their importance and cannot 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, 45 LRAUs have been established for the 30 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 Integrated Water Quality Monitoring and Assessment Report (***epa.ohio.gov/static/Portals/35/tmdl/2020intreport/2020_SectionG.pdf***).

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 (for example, 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), two to five 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 storm water 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.

Probabilistic sampling design will use the drainage area to determine the statewide assessments design. The sampling methods are the same as the biosurveys.

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 temporal distribution of 10 sampling events collected during the summer months (multiple or single year). Key water quality parameters sampled include total phosphorus, total nitrogen, chlorophyll a, Secchi depth, ammonia, dissolved oxygen, pH, total dissolved solids, algal toxins, and various metals such as lead, mercury, and copper. Details of the sampling protocol are outlined in Appendix I of the *Surface Water Field Sampling Manual*, available online at ***epa.ohio.gov/static/Portals/35/inland_lakes/Inland_Lake_Sampling_Manual_2019_update_final_031819.pdf?ver=2019-11-26-142257-620***.

The monitoring design and sample site selection process for assessing aquatic life use in inland lakes/reservoirs is based on obtaining sufficient information to determine if the inland lake is meeting the WQS chemical criteria. The lakes have use designations assigned in rule. Ohio EPA currently has limited resources to monitor inland lakes. 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.

C.1.1.2 Primary Headwater Streams

Monitoring design for sampling PHW 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 PHH streams are available in the *Field Evaluation Manual for Ohio's Primary Headwater Habitat Streams* (Ohio EPA, 2009a). Sampling of PHW 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 PHW classes) of primary headwater streams present within a specified property boundary (for example, as required for a CWA Section 401 water quality certification);
- to delineate the relative number and percentage of PHW stream types that may be impacted by extensive road building, pipeline, or power line projects that may affect many numerous potential PHW 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;
- as a standardized evaluation protocol used in association with land use planning, storm water management, or scientific surveys related to PHH streams; and
- to survey and catalog aquatic resources within protected areas such as parks, preserves, and wildlife areas.

In the first situation above, all PHW 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 PHW channels will be crossed can be used to quickly estimate the relative percentage of different PHW classes that will potentially be impacted by various project routes across the landscape.

In the third situation, a multiple number (three to five) of discrete 200-foot stream reach assessments should be conducted along the length of the mainstem PHW channel. Areas of recent habitat modification should be avoided in these types of PHW 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.1.2 Recreation Uses

In 2019, Ohio implemented a new aquatic life use monitoring strategy to include a mixture of probabilistic and targeted surveys. A study plan is developed in the spring for each basin to be surveyed during the summer that involves staff from Ohio EPA's assessment and modeling section. 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 sufficient samples at each site 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 within a 90-day window during of the recreation season.

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 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 every five to seven 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.

If a lake or reservoir within the basin area supports open-water recreational activities (for example, waterskiing, boating) and if no current level 3 credible data is being collected by any other entity, a sample to be analyzed for *E. coli* bacteria should be collected. Additional samples will be collected from the surface as close to any designated swimming beach as possible. If no such beach exists, then bacteria should be collected near the boat ramp or other places with reasonable potential for human contact with water. Specific sampling locations and sampling frequencies should be listed in the lake-specific sampling plan.

C.1.3 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 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, pesticide concentrations are the highest from early spring to late summer so sampling will be concentrated during this time frame to capture peak contaminant concentrations. Similarly, it is important to capture high flow events, particularly during spring and fall that are concomitant with peak nitrate and pesticide concentrations. For PDWS lakes and reservoirs with known stratification or seasonal turnover, the preferred data collection location was either the raw water intake line or in the lake at the same depth or zone as the raw water intake screen(s). Surface sampling data collected at the intake may be utilized if no other raw water data were available. 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 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, the critical sampling time for cyanotoxins is late spring through fall (May to November). The PDWS use assessment methodology provides specific sampling requirements.

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* (***epa.ohio.gov/static/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.1.4 Human Health (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 10 years down to a drainage area of 50 mi^2 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 ***odh.ohio.gov/wps/portal/gov/odh/know-our-programs/ohio-sport-fish-consumption-advisory***.

C.2 Lake Erie – Open Waters, Nearshore, Lacustuaries, and Harbors

C.2.1 AOC Program

Beneficial use impairment (BUI) status for AOCs is determined through the assessment and evaluation of conditions based upon AOC restoration targets established by Ohio EPA and the Ohio AOC program. Monitoring and assessment of BUIs are conducted through existing Ohio EPA monitoring activities and specific BUI assessments in partnership with federal, state, and local entities consistent with Ohio EPA methodologies and data collection protocols.

C.2.2 State of the Great Lakes (SOGL) Indicators

The governments of Canada and the United States, together with their many agreement partners including Ohio, have established a set of nine overarching indicators of ecosystem health supported by 45 science-based sub-indicators. More than 200 government and non-government Great Lakes scientists and other experts analyze available data and assess each indicator. Ohio provides information to assist in this effort as requested.

C.2.3 Lake Erie – Rivers, Harbors, Shoreline and Open Waters 303(d) Assessment

C.2.3.1 Lake Erie – Rivers, Harbors, Shoreline and Open Waters 303(d) Aquatic Life Use

Determining aquatic life use status for Lake Erie has proven to be problematic. Indices developed for watershed biosurveys do not translate well to rivers that are influenced by Lake Erie water levels. These unique habitats are often called lacustuaries or fresh-water estuaries.

In previous years, 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 status of the Lake Erie shoreline and islands is currently evaluated using fish community assessment targets for the Lake Erie IBI and MIwb based on night electrofishing at sites included in the four shoreline LEAUs: Lake Erie western basin shoreline (including Maumee Bay); Lake Erie Sandusky basin shoreline; Lake Erie central basin shoreline; and Lake Erie islands shoreline. All available fish data are collected within 100 meters of the mainland, bay, or island shoreline. Status of LEAUs are determined by the percentage of sites in narrative full attainment of biological targets (scaled to prevailing shoreline habitat type) and where sufficient and current biosurvey data were available.

Ohio EPA is currently undertaking efforts to reexamine the existing assessment methods for the aquatic life use of the shoreline LEAUs. New methods to assess the three open-water LEAUs are also being developed. It is expected that biological indicators such as phytoplankton density and/or concentrations of chlorophyll-α will likely be key assessment parameters for the new open water method. Ohio EPA is partnering with the Ohio Sea Grant for development of these methods. This will pull in relevant resources from the academic community.

C.2.3.2 Lake Erie – Rivers, Harbors, Shoreline and Open Waters 303(d) Recreation Use

Recreation use status for the shoreline assessment units is based on *Escherichia coliform* (*E. coli*) data from public bathing beaches that is provided by ODH. There are 65 public beaches located in Ohio's eight coastal counties.

Recreation use impairment due to harmful algal blooms are also considered for western Lake Erie waters. With considerable effort from NOAA and several university partners, Ohio has developed a method for assessing the western basin open water, Sandusky open water and central basin open water LEAUs in lieu of federal targets. This method relies on MODIS (Moderate Resolution Imaging Spectroradiometer) and Sentinel-3 series satellite data to characterize the intensity and spatial coverage of HABs. The impairment results from these methods are applied to the adjacent shoreline LEAUs due to their proximity to the open waters.

C.2.3.3 Lake Erie – Rivers, Harbors, Shoreline and Open Waters 303(d) Public Drinking Water Use

Public drinking water is assessed by examining monitoring data collected by water systems in the LEAUs. Starting June 1, 2016, Ohio public water systems are required to conduct routine monitoring for microcystins and cyanobacteria, greatly increasing the data available to assess the algae indicator. Sufficient data were available to list all AUs in Lake Erie with drinking water intakes, including: western basin shoreline and open water; Sandusky basin shoreline and open water; central basin open waters. Additionally, the western basin open water LEAU is on the public drinking water pesticide indicator impairment water list.

C.2.3.4 Lake Erie – Rivers, Harbors, Shoreline and Open Waters 303(d) Human Health Use (Fish Consumption)

Ohio EPA and ODNR collect fish tissue data to determine the human health-fish consumption beneficial use. A fish consumption advisory is determined based on the quantity of a chemical in fish, such as micrograms of chemical per kilogram of fish tissue (µg/kg). The same chemical data analysis is used for LEAU as for wadable streams and large rivers, see section C.1.4.

C.2.4 Other Lake Erie Programs

Data collection methods and parameters monitored for the U.S. EPA NARS NCCA effort are determined by U.S. EPA. Ohio EPA collected data from Ohio's portion of Lake Erie for the 2020 survey. U.S. EPA provided training and supplies to Ohio EPA as well as the proper documentation needed for this sampling effort.

C.3 Ohio River

The monitoring design for the Ohio River mainstem is documented in ORSANCO standard operating procedures documents (***orsanco.org***).

C.4 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 are 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.5 Ground Waters

The AGWMP was originally established in 1973 to measure seasonal and annual water quality changes in the State's major aquifers. In the mid-1990s, additional wells were added to improve the geographic distribution and to provide better representation of the primary aquifers in Ohio. The well location design is not random, gridded, 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 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. A special studies sampling plan template requires internal review 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.

D.1 Surface Waters

D.1.1 Water Quality Indicators - General

Surface waters consist of both lotic and lentic water bodies. Lotic water bodies are systems that contain flowing water, such as streams and rivers. Lentic water bodies are systems that contain still waters, such as lakes, wetlands, and vernal pools. Both core and supplemental indicators are used for assessment of both types of water bodies. 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 targeted and probabilistic surveys which has been melded with the TMDL program in Ohio. However, spills or some other violation may necessitate more expeditious sampling to characterize impact. Water quality core and supplemental indicators for each type of water body are listed in Tables 3 and 4.

Table 3. Ohio EPA's water quality indicators for general designated use categories for lotic water bodies.

Water Body Type	Core and Supplemental Water Quality Indicators Aquatic Life and Wildlife	Recreation	Public Drinking Water Supply	Fish Consumption
Core Indicators				
Headwaters, Streams and Rivers	Biota – condition of fish and macroinvertebrate communities (IBI, ICI, MIwb, contributing metrics) Water Chemistry – dissolved oxygen – temperature – conductivity – pH – nutrients (P and 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 – Cyanotoxins	Contaminants – mercury – heavy metals – halogenated pesticides – DDT and metabolites – PCBs
Primary Headwater Streams	Biota – condition of amphibian and fish community, Headwater Habitat Macroinvertebrate Field Evaluation Index (HHMFEI) and/or Qual macro 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 headwaters, streams, and rivers list	Same as headwaters, streams, and rivers list	Same as headwaters, streams, and 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, cyanobacteria, and cyanotoxin production genes – taste and odor – total organic carbon – total dissolved solids – chloride	– other chemicals of concern in water column or sediment (eg.,chlordane, Mirex, SAS, etc.)

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-a	Pathogen Indicators – *E. coli* bacteria – Algal toxins 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 – cyanotoxins	Contaminants – mercury – heavy metals – halogenated pesticides – DDT and metabolites – PCBs
Lake Erie Open Lake, Nearshore, and Lacustuaries	– Lake Erie Quality Index (and 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 (and component metrics) Pathogen indicators – *E. coli* bacteria Physical conditions – location – Secchi depth Recreation – bathing beaches – remote sensing via satellite data interpreted by NOAA's cyanobacteria Index – observed activity – indirect evidence	As above	– Lake Erie Quality Index (and component metrics) Contaminants – mercury – heavy metals – halogenated pesticides – DDT and metabolites – PCBs

Core and Supplemental Water Quality Indicators				
Water Body Type	**Aquatic Life and Wildlife**	**Contact Recreation**	**Public Drinking Water Supply**	**Fish Consumption**
Wetlands	Biota – condition of the vascular plant and amphibian communities (VIBI, AmphIBI, contributing metrics) Water Chemistry – pH – temperature – TSS and TDS – TOC – metals – hardness – chlorine – nutrients – turbidity Soil Chemistry – percent 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

Core and Supplemental Water Quality Indicators				
Water Body Type	**Aquatic Life and Wildlife**	**Contact Recreation**	**Public Drinking Water Supply**	**Fish Consumption**
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, and cyanotoxin production genes – taste and odor	– other chemicals of concern in water column or sediment (eg. SAS) – algal toxins
Lake Erie Open Lake, Nearshore, and Lacustuaries	– AOC BUI restoration targets – SOGL indicators – phytoplankton – zooplankton – sediment nutrients, metals, BNAs, PCBs	– AOC BUI restoration targets – SOGL indicators	As above and – AOC BUI restoration targets – SOGL indicators	– AOC BUI restoration targets – SOGL indicators
Ground Waters	Not applicable	Not applicable	<u>Water Chemistry</u> - chloride/bromide ratio - nitrate isotopes	Not applicable

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 watershed stressor data into the water resource evaluation process, and Ohio EPA continues to incorporate new geospatial analysis tools to meet that goal.

D.1.2 Supplemental Indicator Selection - Lotic and Lentic 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 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. The recreation use sampling is performed in conjunction with Ohio's biosurveys.

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 (nitrates) and some contaminants if present in source water at elevated levels (pesticides) or in dissolved/extracellular form (cyanotoxins). Selection was based on the following: human health impacts; availability of established WQS; 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/cyanobacteria, cyanotoxin production genes (based on cyanobacteria screening/qPCR analysis), taste and odor, and other chemicals of concern (for example, total organic carbon, total dissolved solids, chloride) in the water column. Additionally, there are several 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 (for example, high PAHs, total mercury, phthalates, or SAS concentrations found in sediment), entity or DSW effluent data (for example, 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.

D.1.3 Supplemental Indicator Selection – Lake Erie Specific

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 Ohio EPA's 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 Ohio's AOCs is based on achieving the BUI restoration targets goals, so that all BUIs can be removed and the AOC delisted. Ohio EPA has developed a set of BUI restoration targets for each of the 14 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 BUI restoration targets should be considered supplemental indicators. Likewise, for the next Lake Erie SOGL effort, indicators are currently under development to measure the quality/trends of the environmental quality of the lake. Because the SOGL 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 31 inorganic parameters plus five field parameters and 60 organic parameters (VOCs). 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. Most 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 that 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 (geologic or geochemical conditions) that cause impairments. Nitrate and chloride are core indicators that are often associated with anthropogenic causes (for example, fertilizers, sewage, salt, brine) but occur naturally in lower concentrations in the environment. Volatile organic chemicals (for example, vinyl chloride, trichloroethylene) and pesticides (although rarely detected in Ohio's ground water) are core indicators associated with anthropogenic sources (for example, 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 U.S. EPA policy to ensure the scientific validity of monitoring and laboratory activities.

E.1 Division of Surface Water

Prior to 2002, 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. The QAPP also 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 (a general description of the project and relevant background information);
2) project objectives (descriptive data quality objectives {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 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) detailed description 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 Ohio EPA's standards and technical support section. All outside funding sources, grant identification numbers, requirements (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 ensure 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 reviewer's 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 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 (review with comments). A formal QAPP review as previously described involving six to seven 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 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 Section 208 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) was submitted to U.S. EPA in 2018. 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 text of *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 audit. The 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 using 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 DDAGW QMP. 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 SOPs;
- Ohio EPA Division of Environmental Services (DES) laboratory procedures (refers to DES SOPs and quality assurance documents); and
- data management procedures including QA/QC.

The OPD clarifies the data processing requirements as data flow from DES laboratory to ingestion into the GWQCP ground water database. The entire QA/QC process is documented in the AGWQMP QAPP, which ensures that QA/QC procedures are handled appropriately. 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 as set forth in the QAPP. 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.

E.2.1 Public Drinking Water Beneficial Use

All data used for PDWS beneficial use attainment determinations must meet Ohio's level 3 credible data criteria and ensure quality data. Data qualifies for this level if collected by certified collectors and analyzed according to specified laboratory protocols or is submitted to Ohio EPA to fulfill permit requirements.

PDWS attainment determinations based on small sample sets present several challenges. The small sample set may fail to identify an exceedance of a water quality standard, resulting in a determination of attainment when in fact an area is impaired. Statistical confidence in the determination decision is also reduced.

To address these concerns, the assessment looks at multiple lines of evidence including several sources of water quality data and treatment plant information. The attainment decision target sample size is 20 samples collected within the past five years. This sample count will provide sufficient power to detect exceedances of greater than or equal to 15 percent above the criterion with a Type I error of 0.15.

Ohio EPA has limited resources for source water sampling. Therefore, attainment determinations may be concluded with a minimum of 10 samples if these samples represent the critical period when the contaminant is typically detected. Attainment decisions may also be made with less than the required sample count when there is overwhelming evidence of impairment, such as a large single sample exceedance of nitrate or microcystins (verified with a repeat sample). Details on the evaluation methodology are provided in the integrated report and described in the PDWS assessment methodology section (***epa.ohio.gov/static/Portals/35/tmdl/2006IntReport/IR06_app_C_PDWSmethodology.pdf***).

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.

F.1 Surface Water Data

DSW uses an electronic monitoring and assessment database system called EA^3 (Ecological Assessment and Analysis Application). EA^3 has biological, water chemistry, sediment chemistry, and habitat data from Ohio's rivers, streams, inland lakes, reservoirs, and wetlands. Records in EA^3 date back to 1974 for biology and 1999 for chemistry.

This system supports all surface water quality monitoring functions performed by Ohio EPA. The EA^3 system is designed as a web-based application using a JAVA interface, with all data being stored in an Oracle database. The system is compatible with the U.S. EPA database structure ensuring that the data is stored in a consistent format that can be shared internally and externally.

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. Chemistry data is imported once it is analyzed and approved by the appropriate laboratory. 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. EA^3 calculates the assessment indices from the monitoring data and aggregates them by site and project. Since 2005, assessment summaries have been entered and stored in EA^3, from which they can be compiled for the biennial Integrated Report and submitted to U.S. EPA's ATTAINS database.

Fish tissue data is maintained outside of EA³ in separate spreadsheets that are updated annually. Records date back to 1969, though data wasn't consistently and systematically collected until 1992. Much like biological and chemical data in EA³, data on field sheets is entered into the spreadsheets post-field season and chemical concentration data is imported once it is approved by the appropriate laboratory. Fish tissue data is used to calculate consumption advisories, assess human health impairments, and summarize current and historical trends in technical support documents.

Wetland vegetation and amphibian data is managed outside of EA³ in separate spreadsheets. Field data sheets are post processed and transferred into digital datasheets at the end of each field season. Digital spreadsheets are stored outside of EA³ with the intent of entering all spreadsheets into the database annually. A backlog of data is waiting to be entered. Field staff are working to remove this backlog and ensure all wetland vegetation data is stored within the EA³ system. Wetland vegetation sampling using the VIBI began in 1996 and has continued up to the present. The wetland ecology group has sampled more than 600 wetlands in Ohio. This data is used to support the 401 permits program, wetland mitigation standards, and provide general condition assessments of Ohio wetlands.

Continuous water quality data is also maintained outside of EA³ in spreadsheets or text files, depending on equipment type. Work is ongoing to develop and implement a relational database for this data.

F.2 Ground Waters Data

In July 2015, a new ground water quality database was implemented to house all AGWQMP and special study data. This database system (Ground Water Quality Characterization Program (GWQCP)) is web-based and allows staff to flow data electronically from DES (the laboratory) into GWQCP, with separate procedures for uploading, verifying, and approving new data. Additionally, GWQCP houses facility, well, hydrogeologic information and other facility meta-data for the AGWQMP and special studies. GWQCP runs in parallel with DSW's EA³ database, but they are independent applications. Data reports that query and return requested data are available for staff to interact with the database. Data analysis procedures are in place 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 have been updated in the AGWQMP operating procedures document to document the data management system and its usage.

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.

F.3 Public Drinking Waters Data

The data used to assess the PDWS beneficial use includes public water system compliance monitoring, treated and raw water quality data, and ambient (stream and lake) water quality data. Treated water quality data were obtained from the Safe Drinking Water Information System (SDWIS) database, which contains all SDWA compliance data submitted to DDAGW by Ohio public water systems and their certified laboratories. Raw water quality data from samples collected near intakes were obtained from DSW's ambient monitoring database and level 3 credible data collected and submitted by level 3 qualified data collectors. Water quality data were requested and obtained from the Syngenta Crop Protection, Inc. Atrazine Monitoring Program. Additional raw water quality data were collected by DDAGW at intake locations and cyanotoxin data were retrieved from Ohio EPA's harmful algal bloom database.

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.

G.1 Surface Waters (Headwater, Streams, Rivers, and Inland Lakes/Reservoirs)

G.1.1 Aquatic Life Uses

Biological criteria incorporated into Ohio's WQS (Ohio Administrative Code 3745-1) in February 1990 (effective May 1990) consist of numeric values for the IBI and MIwb, both of which are based on fish assemblage data; and the ICI, which is based on macroinvertebrate assemblage data. Index criteria 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.

DSW is considering new ALU standards for inland lake use designations. Currently, the chemical parameters ammonia, dissolved oxygen, pH, total dissolved solids, and various metals were analyzed and reported in the most recent *2020 Integrated Report*. Statewide water quality outside mixing zone average (OMZA) criteria for these parameters are summarized in Table 35-1 of the Ohio WQS rule 3745- 1-35 of the Ohio Administrative Code (***epa.ohio.gov/static/Portals/35/rules/01-all_apr21.pdf?ver=Eaa7s8hOK8IRHn1XA8nXDA%3d%3d***). Other important parameters for assessing lake condition include causative nutrient parameters (for example, total phosphorus, total nitrogen) and biological response variables (Secchi depth, chlorophyll-a). Additionally, U.S. EPA released *Draft Ambient Water Quality Criteria Recommendations for Lakes and Reservoirs of the Conterminous United States* in 2020, which Ohio EPA plans to review and evaluate.

In 2020, Ohio EPA in conjunction with ODH and ODNR finalized a ***Harmful Algal Bloom Response Strategy for Recreational Waters***, which details a unified statewide approach to addressing harmful algal blooms in Ohio's recreational waters, including inland lakes.

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 and statistical threshold value listed in the Ohio WQS.

G.1.3 Public Drinking Water Supply Use

Water quality data collected to assess the PDWS use will be compared to WQS 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 WQS. 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 WQS 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 WQS 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 (***epa.ohio.gov/static/Portals/35/tmdl/Study%20Plan/2021-FishFieldCollectionManual.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 WQS can be found in the *2020 Integrated Water Quality Monitoring and Assessment Report* (***epa.ohio.gov/static/Portals/35/tmdl/2020intreport/2020_SectionE.pdf***).

G.2 Lake Erie - Open Waters, Nearshore, Lacustuaries, and Harbors

G.2.1. 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 (lacustuaries). The field work for this effort was largely completed in 1997. Working versions of an IBI for the fish community and the 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 AOC and LAMP programs also used these criteria to assess the status of their areas.

As noted in Section C.2.3.1, Ohio EPA is currently working with the Ohio Sea Grant to redevelop these aquatic life use assessments. This work is currently ongoing. New assessments and data management will result in this effort.

G.2.2 Lake Erie Quality Index

The Ohio Lake Erie Commission produces a report called the *Lake Erie Protection and Restoration Plan* that maps out Ohio's long-term strategy for improving the condition of the lake. The most recent plan was issued in March 2020.

The *State of the Lake Report - Lake Erie Quality Index* is periodically released by the Ohio Lake Erie Commission. This document reports on the present condition of the Ohio waters of Lake Erie, using indicators and metrics deemed most important and understandable to the Ohio public. With input from the public, various lake experts, and State agencies, the quality index accomplishes the following objectives: 1) determining what is essential to know about Lake Erie; 2) designing effective measuring systems for these essential factors; and, 3) establishing goals and scoring systems that allow for critical and easily understandable evaluations of progress. The last quality index report was released in 2004 (Ohio Lake Erie Commission, 2004).

All Ohio Lake Erie Commission reports are available at ***https://lakeerie.ohio.gov/wps/portal/gov/lec/planning-and-priorities.***

G.3 Ohio River

Details of Data Analysis/Assessment for monitoring in the Ohio River are documented in ORSANCO Standard Operating Procedures documents at ***orsanco.org***.

G.4 Wetlands

Currently, there is only one wetland designated use, wetland. However, the current rules define three antidegradation categories for wetlands. 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 TALU. Condition can be reported for individual wetlands but will more typically involve reporting condition of wetlands on some geographic basis (for example, 12- or 10-digit HUCs as part of a larger watershed biosurvey).

G.5 Ground Waters

Ohio does not have general ground WQS, so ground water attainment decisions use SDWA primary or secondary MCL concentrations as benchmarks. This is also consistent with the Ohio's WQS applied to the public water supply beneficial use, which are based on federal MCLs.

In Section M (An Overview of Ground Water Quality in Ohio) of the *Ohio 2020 Integrated Water Quality Monitoring and Assessment Report*, MCLs are used to identify public water supply or AGWQMP wells in watch list (>50 percent MCL to MCL) or impaired categories (>MCL) by indicator chemical and major aquifer type. In addition, both short-term and life-time health advisory levels (HALs) as well as action levels (ALs) for lead and copper are assessed. Evaluation 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 uses the previous decade of data for assessing the quality of ground water in Ohio in the integrated report process. This longer period has been selected to increase the confidence in the analysis due to the infrequency of sample collection at many public water system wells (for example, 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.

H. Reporting

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

H.1 Surface Waters (Headwater, Streams, Rivers, and Inland Lakes/Reservoirs)

H.1.1 Aquatic Life Uses

DSW produces a biological and water quality report that summarizes the results of data collected during the biosurvey. This report includes the aquatic life use attainment status – a determination of whether the stream is in attainment of Ohio's WQS. If the stream is determined to be in non-attainment of Ohio's WQS, then the possible causes and sources of impairment are also included. Following the publication of the biological and water quality study report a loading analysis plan is developed from which a water quality

model is prepared and, ultimately, TMDLs are established. These reports are submitted to U.S. EPA Region V for approval.

Ohio EPA also prepares an *Integrated Water Quality Monitoring and Assessment Report* that satisfies the CWA requirements for both Section 305(b) for biennial reports on the condition of the State's waters; and Section 303(d) for a prioritized list of impaired waters. The integrated report is based on the previous two field seasons' sampling data and incorporates data from the last 10 years of watershed biosurveys as well as any ancillary or specialized sampling that was conducted over that time period. The integrated report indicates the general condition of Ohio's waters and identifies waters that are not meeting water quality goals. For each impaired water, Ohio EPA typically prepares a TMDL analysis.

The results from the large river survey will be summarized and reported in the same way, and will satisfy reporting requirements for sections 305(b) and 303(d). The results from the wading and headwater surveys will be summarized and reported under section 305(b). Results, analyses, novel findings, implications, and emergent knowledge from each survey will be detailed in technical reports and scientific journals.

The current inland lakes monitoring program is reporting inland lake monitoring data in the Ohio *Integrated Water Quality Monitoring and Assessment Report*. In the 2020 report, Ohio EPA listed lake beneficial use impairments for recreation, public drinking water supply, and human health (via fish tissue). Other reporting includes lake snapshots for each lake sampled in years past, which are fact sheet summaries of sampling data and assessments of lake beneficial uses. Additionally, formal lake reports for 15 inland lakes sampled between 2015-2017 have been completed and will be available through Ohio's biological and water quality monitoring reports at ***epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/surface-water/reports-data/biological-and-water-quality-report-index***.

In the future, the plan is to link them through an interactive GIS map. Finally, there are several targeted inland lake planning efforts and lake management plans both completed and ongoing at ***Buckeye Lake*** (2013), ***Grand Lake St. Marys*** (ongoing), ***Kiser Lake*** (2016), ***Lake Alma*** (2016), Harsha Lake, and Tappan Lake.

Indexes to approved biological and water quality reports are available at ***epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/surface-water/reports-data/biological-and-water-quality-report-index***.

More information about the TMDL program is available at ***epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/surface-water/reports-data/total-maximum-daily-load-tmdl-program***.

More information about the integrated report is available at ***epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/surface-water/reports-data/ohio-integrated-water-quality-monitoring-and-assessment-report***.

H.1.2 Recreation Uses

Results of bacteria monitoring are typically reported in technical support documents and TMDL reports. The Agency typically targets a minimum goal of five samples collected at each site sampled during the recreation season to generate sufficient data to provide a direct comparison to the geometric mean criteria. 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 (for example, PCR and LRAU) 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 WAU scale. If five samples are not

collected, DSW notes insufficient data. Results of Ohio's bacteria monitoring and recreation use attainment statistics are also summarized every other year in Section F of Ohio's *Integrated Water Quality Monitoring and Assessment Report* (***epa.ohio.gov/static/Portals/35/tmdl/2020intreport/2020_SectionF.pdf***).

H.1.3. 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.1.4 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 ***https://odh.ohio.gov/wps/portal/gov/odh/know-our-programs/Ohio-Sport-Fish-Consumption-Advisory***.

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 ***epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/surface-water/reports-data/ohio-integrated-water-quality-monitoring-and-assessment-report***.

H.1.5 Primary Headwater Streams

There are two primary needs with respect to sampling and reporting regarding the quality of PHW streams: research and development of assessment techniques and as a regulatory function associated with the 401/404 permitting process. As discussed in Sections A.1.1.5 and J.2.1.5 of this document, 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 PHW streams. With respect to the 401 water quality certification process, data related to PHW streams generally accompanies a submittal of a 404/401 permit application to fill a stream channel. Although specific PHW stream uses are currently not incorporated in the Ohio WQS, the data is used to establish relative quality for antidegradation review purposes. Classification of potentially affected PHW 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 occasionally conduct sampling of PHW streams incorporated in permit applications to verify the data submitted by applicants.

H.2 Lake Erie - Open Waters, Nearshore, Lacustuaries, and Harbors

H.2.1 Lake Erie - Areas of Concern

The Lake Erie LAMP provides updates on the progress and achievements of the AOCs through the U.S. EPA website (***epa.gov/greatlakes/lake-erie-lamps-and-associated-reports***).

The AOCs provide information to update AOC web pages maintained by U.S. EPA/GLNPO, as requested. Reports are available through the Ohio AOC program website (***lakeerie.ohio.gov/wps/portal/gov/lec/programs-and-projects/areas-of-concern/01-program+overview***) or related links provided on the program website.

H.2.2 Lake Erie – State of Great Lakes (SOGL)

The state of the Great Lakes indicators (SOGL) report is published by the Governments of Canada and the United States. Together with their many Agreement partners including Ohio, these entities have established a set of nine overarching indicators of ecosystem health supported by 45 science-based sub-indicators. To create this report, more than 200 government and non-government Great Lakes scientists and other experts analyze available data and assess each indicator. The *2019 State of the Great Lakes Highlights Report* is available at ***https://binational.net/***.

H.2.3 Lake Erie – 303(d) Assessment

The status of the various beneficial uses for the LEAUs are published biannually in the *Ohio Integrated Water Quality Monitoring and Assessment Report* at ***epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/surface-water/reports-data/ohio-integrated-water-quality-monitoring-and-assessment-report***.

H.2.4 Other Lake Erie Programs

The Ohio Lake Erie Commission prepares or updates the Lake Erie Protection and Restoration Plan every year as required by statute. The Lake Erie Quality Index is updated periodically, depending upon available resources and interest. The next Lake Erie Quality Index should be available in 2021. More information is available at ***lakeerie.ohio.gov/wps/portal/gov/lec/planning-and-priorities/01-protection-and-restoration-plan/01-protection-and-restoration-plan***.

U.S. EPA will report the results from the NARS 2020 NCCA assessment of Lake Erie without the assistance of Ohio EPA. Based on previous NARS assessments, it takes about five years from when the sampling occurs until the results are published at ***epa.gov/national-aquatic-resource-surveys/ncca***.

H.3 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 ***orsanco.org/publications/***.

H.4 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 303(d) 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 TALU.

H.5 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. Technical reports, along with an associated fact sheet, are being produced to highlight various ground water constituents of concern as well as broad ground water topics. Most of these reports, as well as maps and presentations using ground water quality data are available on DDAGW's ground water quality website at ***epa.ohio.gov/wps/portal/gov/epa/divisions-and-offices/drinking-ground-and-waters/source-water-protection-and-underground-injection-control-%28uic%29/ground-water-quality-characterization-program***.

I. Programmatic Evaluation

U.S. EPA's articulated goal for state programs: The State, in consultation with its U.S. 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.

In December 2018, Ohio EPA began a review of its entire water quality monitoring program. This document will provide the framework for future review and evaluation of Ohio EPA monitoring programs. More detailed descriptions of programmatic evaluations/reviews of specific programs or program components are provided below.

I.1 Headwaters, Streams and Rivers - Bioassessment Component

Ohio EPA emphasizes the biological assessment of aquatic life uses to support the integrated assessment of status and trends, reporting, and other primary water quality management programs. It is envisioned that the bioassessment review along with other issues within this strategy document will provide a framework for additional programmatic discussion and evaluation both internal to Ohio EPA and to external parties including U.S. EPA.

I.2 Fish Consumption

Ohio consults periodically with a U.S. EPA Region V coordinator, as well as other organizations involved with the collection and assessment of fish tissue data including GLNPO, ORSANCO, and ad hoc Great Lakes committees, regarding 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 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 application.

I.4 Ground Water

DDAGW evaluates the AGWQMP at least annually to determine whether changes in sample stations or parameters will be beneficial. The AGWQMP QAPP is developed, as part of the Ohio EPA QMP, to organize the QA/QC processes for the AGWQMP. QA/QC training is developed from the QAPP to ensure that field staff and office staff have the tools, SOPs, and procedures in place to maintain quality in the gathering and processing of ground water data. 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 meetings 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, district management is requested participate 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, staff continually evaluate ways to improve the monitoring programs.

CWA Section 106 work plan, annual reports, and grant program reviews provide communication with U.S. EPA regarding the effectiveness of our program. DDAGW 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 plans 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.

J.1 Current Monitoring and Assessment Resources

Table 5 details Ohio EPA's Division of Surface Water SFY 2020 resources dedicated to surface water monitoring and assessment programs as compared to other surface water program areas (for example, permitting, compliance). Monitoring and assessment reporting categories represent most program areas which have been discussed in detail in previous sections of this document. The categories in Table 5 with monitoring and assessment duties are:

- 401/isolated wetlands work;
- Lake Erie work;
- fish tissue work;
- 319 work;
- TMDL work; and
- water quality work.

Ohio EPA's Division of Environmental Services (DES) provides in-house analytical services to both DSW and DDAGW. DES is funded through Agency fees.

DSW's monitoring and assessment funding is provided through a few sources. The bulk of the monitoring work is funded through Ohio EPA's 319 grant funding. Other sources include the state's 106 grant, NPDES permit fees, and the state's solid waste tipping fees.

Table 5. Full-Time Equivalents (FTEs) spread by Division of Surface Water (DSW) program area (from the DSW SFY 2020 Time Accounting System)

Program Area	DSW Ecological Assessment Unit	DSW Operations - Central Office	DSW District Operations	Total
401/Isolated Wetlands Work		10.14	5.48	16.53
Agricultural Work		1.72	0.12	1.84
Lake Erie Work	1.59	1.78	3.7	7.08
Fish Tissue Work	0.51	0.69		1.2
319 Work	0.45	2.7		3.17
NPDES Work	0.84	20.63	47.5	73.6
PTI Work		1.88	15.91	17.96
Sludge Work		2.28	1.64	4.18
Storm Water Work		3.74	9.41	13.73
TMDL Work	6.94	0.67	4.38	12.02
Water Quality Work	12.01	7.85	9.91	30.99
Pool/Gen Admin Work		8.46	7.55	16.17
Total	22.34	62.54	105.6	198.47

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.

J.2.1 Headwaters, Streams and Rivers

J.2.1.1 Watershed Biosurveys

Table 7 provides an update on the attainment status of Lake Erie and Ohio's headwaters rivers and streams. 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.

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.

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 (sub-watershed) and temporally (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 timeline 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. Include this work in study planning for targeted basin surveys.
Maintaining sufficient capacity to provide comprehensive watershed biosurveys within a 12-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 headwaters, streams, and rivers on a 12-year sampling rotation. The positions for the fifth crew have been delayed due to the COVID pandemic.
Biocriteria revision and recalibration	Review, revise, and recalibrate Ohio's bioassessment indices and stream and 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.

Monitoring and Assessment Program Deficiency	Action Steps	Implementation Steps
Protection and assessment of Ohio's primary headwater (PHW) streams	Conduct basic research to adopt a concept of ecological integrity for Class III and Class II PHW streams.	This project would require Ohio EPA biologists to determine reference conditions for PHW biological communities in the different ecoregions of Ohio. It is estimated that a minimum of 50 PHW 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 2020 funded with core water quality money supplemented with federal 106 supplemental grants. Inland lakes and reservoirs are added in to targeted watershed surveys as needed.
Integration of wetlands monitoring program with watershed biosurvey program *(Aspirational)*	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.	Reviewing the proposed water quality nutrient criteria for aquatic life proposed by U.S. EPA after the National Lake Assessment.
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.

Monitoring and Assessment Program Deficiency	Action Steps	Implementation Steps
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 (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.	Sensitive aquifer monitoring will be better incorporated into the AGWQMP through adding more transient, non-community PWS wells, which tend to be shallower than community PWS wells. Specific wells can be identified using statewide data bases with ground water quality data, DDAGW's aquifer sensitivity analysis, and input from Drinking Water staff.
Surface water/ground water (SW/GW) interaction study planning *(Aspirational)*	Develop a study plan to determine how SW/GW interactions impact public drinking water supply impairments. The future sampling and planning efforts can be used to inform source water protection plans, TMDLs and 9-element planning work.	Surface and ground water staff need to identify specific areas in Ohio where SW/GW interaction has programmatic impact, (for example, TMDL and source water protection implementation). Initially, the effort to study SW/GW interaction will utilize surface and ground water staff in a pilot planning effort (for example, the Mad River watershed). Grant funds may be secured to support some special planning activities. The sampling effort could then be incorporated in the targeted basin survey work. Long-term needs are difficult to determine; however, at least one additional FTE is needed to identify and coordinate opportunities to study integration of SW/GW interaction.

Table 7 Summary of aquatic life use assessment for Ohio's WAUs1, LRAUs and LEAUs: 2002-2020 IR cycles.

IR Cycle	2002 (1991-2000)	2004 (1993-2002)	2006 (1995-2004)	2008 (1997-2006)	2010 (1999-2008)	2012 (2001-2010)	2014 (2003-2012)	2016 (2005-2014)	2018 (2007-2016)	2020 (2009-2018)
HUC11 WAUs (331)										
No. AUs Assessed (% of total)	224 (68%)	225 (68%)	212 (64%)	218 (66%)	221 (67%)	-	-	-	-	-
No. Sites Assessed	3,272	3,620	3,785	4,030	4,200	-	-	-	-	-
Average AU Scores										
Full Attainment	**46.6**	**48.3**	**52.5**	**54.7**	**58.5**	-	-	-	-	-
Partial Attainment	25.2	23.6	22.6	22.4	21.2	-	-	-	-	-
Non-Attainment	28.2	28.1	24.9	22.9	20.3	-	-	-	-	-
HUC12 WAUs (1538)										
No. AUs Assessed (% of total)[2]	-	-	-	-	999 (65%)	908 (59%)	933 (61%)	983 (64%)	1,007 (65.5%)	838 (54.5%)
No. Sites Assessed	-	-	-	-	4200	3867	3876	3875	3911	3533
Average AU Score[3]	-	-	-	-	**56.7**	**57.7**	**59.2**	**61.5**	**64.2**	**64.3**
% Sites Full Attainment	-	-	-	-	55.1	57.0	57.8	59.3	61.8	61.2
% Sites Partial Attainment	-	-	-	-	20.0	21.6	22.3	20.7	19.7	19.9
% Sites Non-Attainment	-	-	-	-	24.9	21.4	19.9	20.0	18.5	19.0
LRAUs (23 rivers/38 AUs totaling 1247.54 Miles)										
No. Rivers/AUs Assessed[4]	22	21	17	16	18/30	18/31	22/37	23/38	23/38	23/38
No. Sites Assessed	422	425	374	278	265	312	332	358	370	364
No. Miles Assessed (% of total)	905 (70%)	918 (71%)	873 (68%)	850 (66%)	852 (69%)	984 (80%)	1,147 (92%)	1,216 (98%)	1,243 (99.7%)	1,243 (99.7%)
% Miles Full Attainment	**62.5**	**64.0**	**76.8**	**78.7**	**93.1**	**89.0**	**89.2**	**87.4**	**87.5**	**88.2**
% Miles Partial Attainment	23.0	21.4	15.1	13.9	5.5	7.5	6.3	8.7	8.8	8.2
% Miles Non-Attainment	14.5	14.6	8.1	7.4	1.4	3.5	4.5	3.9	3.7	3.6
LEAUs (4[5])										
No. AUs Assessed	3	3	3	3	3	3	3	3	4[5]	4
No. Sites Assessed[6]	92	111	93	49	34	23	38	45	47	35
% Sites Full Attainment	**12.0**	**18.0**	**19.4**	**10.2**	**14.7**	**30.4**	**13.2**	**13.3**	**17.0**	**35.4[7]**
% Sites Partial Attainment	13.0	14.4	16.1	22.4	17.7	30.4	34.2	31.1	25.5	22.9[7]
% Sites Non-Attainment	75.0	67.6	64.5	67.4	67.6	39.2	52.6	55.6	57.5	41.6[7]

[1] WAUs for the IR 2002-2010 cycles were based on HUC11s; WAUs transitioned to HUC12s for cycles beginning with 2010.

[2] 2010 statistics based on direct assessment of HUC12 AUs with data collected between 2005 and 2008 (n=545) and HUC11 extrapolated assessment of HUC12 AUs with data collected between 1998 and 2004 (n=454).

[3] Statistic based on the average of available AU scores with up-to-date or acceptable data, derived as explained in Section G2.2.

[4] LRAUs are assessed using data back to 2003 in statistics for IR cycles 2014-2020.

[5] For the 2018 IR, LEAUs were refined to distinguish the Sandusky Bay shorelines and open water as a transition area between the western and central basins, resulting in four shoreline units that were assessed for aquatic life use.

[6] Data for Lake Erie shoreline sites used in the 2002-2012 IR cycles were generally collected between 1993 and 2002; for the 2014-2020 IRs, data were collected 2011-2018.

[7] Percentages are calculated upon number of sampling events in full attainment, partial attainment and non-attainment. Data are not grouped by site.

J.2.1.2 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 streams and rivers in Ohio. These sites were established based on results from the period 1981 – 1989. The goal is to resample approximately 10 percent of the reference sites each year. 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 (IBI and ICI) and provide the database from which ecoregional biological criteria are derived.

Continued resampling at the rate of 10 percent 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) has not yet been accomplished due to resource constraints

J.2.1.3 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 percent of the assessment units and for the pesticide indicator in only 13 percent 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.2.1.4 Fish Consumption

Currently, Ohio EPA, ODNR, and ODH actively participate in the sport fish tissue monitoring and consumption advisory programs. ODH contributes resources by calculating consumption advisories from tissue concentration data and conducting public outreach. ODNR contributes resources for tissue sample collection. Ohio EPA is responsible for sample collection, data maintenance, and analytical services other than the consumption advisory. 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.2.1.5 Primary Headwater Streams

This project entails the collection of biological, habitat, and basic water quality data from reference streams in each of Ohio's five ecoregions using a randomized site selection to determine reference conditions to support development of assessment methods, biological criteria, and use designations for primary headwaters in Ohio. Primary headwaters are operationally defined as streams that drain one square mile of land or less but may vary in size depending on stream features such as gradient. It is estimated that a minimum of 50 PHW reference stations for both Class II and Class III would need to be sampled in each ecoregion. 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.

J.2.2 Inland Lakes and Reservoirs

J.2.2.1 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 five percent 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 (for example, 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 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 more than 100 percent devoted to high priority stream and river watershed assessments.

The adoption of an Ohio EPA inland lakes monitoring program may be coupled to a program to monitor the nearshore waters of Lake Erie. 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. 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 Lake Erie

Ohio EPA's Lake Erie monitoring currently focuses on three areas annually in the spring through fall. Benthic mayfly larvae population collections occur in the spring. Due to the sparsity of mayfly larvae found in the Lake Erie's Central Basin, this monitoring has focused on the Western Basin and Sandusky Sub-Basin in recent years. The second monitoring group includes water quality and phytoplankton community composition collected at fixed ambient sites throughout the Ohio's Lake Erie near-shore monthly or more often. Finally, Ohio EPA collects four dissolved oxygen/hypoxia transects from the coast to Ohio's boarders in the Central Basin. Efforts are made to collect all four transects on the same day and to partner with transect(s) collected by Pennsylvania in that state's waters.

J.2.4 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 ***orsanco.org/programs***.

J.2.5 Wetlands

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.2.6 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 Section 106 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.

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

AGWQMP Data Gap Coverage: AGWMP sampling successfully covers the deeper and more productive aquifers common to Ohio's community public water systems. However, the AGWQMP does not sufficiently assess the shallow more dynamic transient non-community (TNC) wells. A strong case can be made to include more shallow wells drawing from sensitive aquifers by expanding the number of AGWQMP TNC wells A recent query of DDAGW's SDWIS data base revealed that, from 2019 through the present, TNC systems have been collectively issued approximately three times as many water quality NOVs as have community systems. Candidate TNC wells could be identified by using the statewide knowledge developed from DDAGW's sensitive aquifer analysis, the RCRA, SDWIS, EA3, and Heidelberg (private owner nitrate)

databases, and input from drinking water staff. This effort could be a moderate expansion of the existing AGWQMP configuration, or it could pair with a reasonable contraction of the current AGWQMP model.

J.2.7 Surface Water - Ground Water Interaction Study Planning 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.

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