Indiana Department of Environmental Management

Water Quality Monitoring Strategy

2022-2026

EXECUTIVE SUMMARY

The United States Environmental Protection Agency (U.S. EPA) recommends ten elements that states should include in their water monitoring strategies to meet prerequisites of the federal Clean Water Act (CWA) § 106 (U.S. EPA, 2003).

This *Indiana Water Quality Monitoring Strategy* (WQMS), *2022-2026* refines the previous *Indiana Water Quality Monitoring Strategy 2017-2021*. It was developed by an interdisciplinary work group comprised of staff from several programs within the Office of Water Quality (OWQ), including monitoring staff responsible for collecting the water quality data needed to meet Indiana Department of Environmental Management (IDEM) water management needs. The OWQ collects surface water quality, biological, and habitat data for the following purposes:

- To fulfill requirements of the CWA § 305(b), § 303(d) and § 314 to assess all waters of the state to determine if they are meeting their designated uses and to identify those waters that are not.
- To support OWQ programs including water quality standards (WQS) development, National Pollutant Discharge Elimination System (NPDES) permitting, and compliance.
- To support public health advisories and address emerging water quality issues.
- To support watershed planning and restoration activities.
- To determine water quality trends and to evaluate the performance of programs.
- To engage and support a volunteer monitoring network across the state.

The following monitoring programs are employed to achieve the above objectives:

- Probabilistic monitoring in one basin/year on a 9-year rotating basin cycle.
- Fixed Station monitoring at 165 sites across the state.
- Reference site monitoring to refine and validate measurements of biological integrity for aquatic life use assessments.
- Fish tissue contaminants monitoring on a 5-year rotating basin cycle.
- Targeted (watershed characterization) monitoring for Total Maximum Daily Load (TMDL) reassessments and development, watershed baseline planning, and performance measures determinations.
- Cyanobacteria monitoring of DNR operated swimming beaches at lakes/reservoirs around the state.
- Special studies such as remediation follow-up sampling and coolwater site monitoring.
- Thermal verification studies to characterize thermal plumes and biological communities in surface water near NPDES permitted facilities.
- Hoosier Riverwatch (HRW) program citizen volunteer monitoring.

This WQMS identifies key water quality monitoring objectives and the monitoring approaches used to collect the data necessary to meet them. The activities related to U.S. EPA priorities or requirements and those related to the protection of human health are ranked as IDEM's primary priorities. All others are ranked as secondary priorities based on resource constraints and other factors including the degree to which they meet the OWQ mission:

> *The OWQ mission is to monitor, protect, and improve Indiana's water quality to ensure its continued use as a drinking water source, habitat for wildlife, recreational resource, and economic asset.*

IDEM's WQMS is developed to facilitate an adaptive management process to ensure that the monitoring programs are providing the data required for IDEM program management as well as to meet emerging concerns. OWQ plans to revise the WQMS every five years and will evaluate its monitoring programs annually to determine what worked well and what was problematic in order to modify or improve logistics. IDEM will work with U.S. EPA to determine the appropriate timelines for formal review and approval of future revisions to this WQMS.

ACKNOWLEDGEMENTS

The annual review and evaluation of IDEM's water monitoring programs, which typically takes place in January, is well attended by IDEM staff from monitoring, laboratories, data management and quality assurance, as well as the other IDEM programs that use the data such as the Nonpoint Source and Total Maximum Daily Load programs. This edition of the WQMS reflects the revisions, refinements and decisions made through those meetings over the last five years as well as input from staff representing the NPDES permitting and modeling programs, Drinking Water, Wetlands and Stormwater programs.

Many thanks to the IDEM staff, agency partners, volunteer monitors, stakeholders, contractors, and U.S. EPA for their contributions to this WQMS.

LIST OF ACRONYMS

AIMS II: Assessment Information Management System Database II

ATTAINS: Assessment, TMDL Tracking and Implementation System

AUID: Assessment Unit Identification Code

BEACH: Beaches Environmental Assessment and Coastal Health

CALM: Consolidated Assessment and Listing Methodology

CFU: Colony forming units

CLP: Clean Lakes Program

CWA: Clean Water Act

DQA: Data Quality Assessment

DWB: Drinking Water Branch

***E. coli*:** *Escherichia coli*

EnPPA: Environmental Performance Partnership Agreement

FCA: Fish Consumption Advisory

DFW: Division of Fish and Wildlife

GIS: Geographic Information Systems

GWMN: Ground Water Monitoring Network

HUC: Hydrologic Unit Code

IBI: Index of Biotic Integrity

IDEM: Indiana Department of Environmental Management

IDNR: Indiana Department of Natural Resources

IGS: Indiana Geological Survey

IR: Indiana Integrated Water Monitoring and Assessment Report

IDOH: Indiana Department of Health

ITSI: Indiana Trophic State Index

IU/SPEA: Indiana University, School of Public and Environmental Affairs

MCL: Maximum Contaminant Level

MDL: Method Detection Limit

mIBI: Macroinvertebrate Index of Biotic Integrity

mL: milliliter

NHD: National Hydrography Dataset

NWQI: National Water Quality Initiative

NPDES: National Pollutant Discharge Elimination System

NPS: Nonpoint Source

NWI: National Wetland Inventory

OWQ: Office of Water Quality (at IDEM)

PCB: Polychlorinated Biphenyl

ppb: parts per billion

PWS: Public Water Supply

QA: Quality Assurance

QAPP: Quality Assurance Project Plan

QA/QC: Quality Assurance/Quality Control

QC: Quality Control

QHEI: Qualitative Habitat Evaluation Index

QMP: Quality Management Plan

SOP: Standard Operating Procedure

STORET: Storage and Retrieval Database

SDWA: Safe Drinking Water Act

TMDL: Total Maximum Daily Load

U.S. EPA: United States Environmental Protection Agency

USFWS: United States Fish & Wildlife Service

USGS: United States Geological Survey

WAPB: Watershed Assessment and Planning Branch

WQMS: Water Quality Monitoring Strategy

WQS: Water Quality Standards

WQX: Water Quality Exchange

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1 INTRODUCTION

The United States Environmental Protection Agency (U.S. EPA) recommends ten elements which states should include in their water monitoring framework to meet prerequisites of the federal Clean Water Act (CWA) § 106 (U.S. EPA, 2003). These elements are described here:

Monitoring Program Strategy – This document describes IDEM's comprehensive monitoring strategy for collecting the data and information needed to address its water quality management needs. Section 1 summarizes and provides the rationale for changes made to the *Indiana Water Quality Monitoring Strategy* (WQMS) 2017-2021.

Monitoring Objectives – Section 2 describes IDEM's water quality monitoring objectives that serve as the basis for its WQMS.

Monitoring Design – Section 3 describes the different monitoring designs that IDEM employs to meet its water quality management objectives.

Core and Supplemental Indicators – Section 4 describes the environmental indicators that are or can be monitored to help IDEM meet its water quality management objectives.

Quality Assurance – Section 5 describes IDEM's quality assurance and quality control processes for ensuring that the data collected to meet its water quality management needs are scientifically sound and valid.

Data Management – Section 6 describes IDEM's systems for managing water quality data and assessment information.

Analysis and Assessment – Section 7 describes how monitoring data are used to meet the water quality management needs identified in this WQMS.

Reporting – Section 8 describes how water quality monitoring data and analytical results are reported, including in IDEM's Integrated Water Monitoring and Assessment Report (IR) pursuant to CWA § 305(b) and § 303(d) and in other types of reports required by U.S. EPA.

Programmatic Evaluation – Section 9 provides a timeline for review and revision of IDEM's WQMS and describes the process by which IDEM Office of Water Quality (OWQ) will evaluate its effectiveness in meeting IDEM's water quality management needs.

General Support and Infrastructure Planning – Section 10 identifies current and future resources needed to fully implement the WQMS for meeting all of IDEM's water quality management needs.

Comprised of these ten elements, *IDEM's WQMS 2022 - 2026* provides a comprehensive approach to water quality monitoring for the next five years. Successful implementation of the WQMS is expected to result in data of the appropriate type and of sufficient quantity and quality necessary to meet the fundamental water quality management needs for all types of water resources in Indiana including streams, rivers, lakes, reservoirs, near-shore Lake Michigan, wetlands, and ground water.

The WQMS uses a watershed approach to prioritize monitoring activities to meet surface water quality management needs and acknowledges the nexus between surface water and ground water. Most of the surface water monitoring described herein is conducted by the Watershed Assessment and Planning Branch (WAPB), which includes several CWA programs and conducts a wide range of monitoring activities to meet the needs of the CWA and to a degree, the Safe Drinking Water Act (SDWA) programs implemented throughout the OWQ. Ground water monitoring is conducted by the Drinking Water Branch (DWB) to help meet the needs of the SDWA and to characterize surface water-ground water interactions.

1.1 PAST WATER MONITORING STRATEGIES

IDEM developed its first WQMS in 1995 to guide its monitoring efforts from 1996-2000 (IDEM, 1995). Although this WQMS was endorsed by U.S. EPA, IDEM found it necessary in 1998 to revise it earlier than originally intended in response to unforeseen reductions in staff and resources (IDEM, 1998). At that time, there was also a corresponding increase in monitoring needed for the development of TMDLs, which required a reallocation of staff and fiscal resources. IDEM revised its WQMS again in 2001 to cover the years 2001-2005. IDEM made no significant changes to its monitoring programs for this revision. When IDEM revised the WQMS for the years 2006-2010, it added information regarding wetlands and ground water and outlined a plan to address the water quality management needs associated with these water resources. The 2006 revision also included more information regarding core and supplemental indicators and methods for evaluating its monitoring programs (IDEM, 2006).

In its review of the 2006-2010 WQMS, U.S. EPA identified the need for a more specific plan for obtaining the data necessary to support IDEM's Nonpoint Source Program needs and to evaluate the effectiveness of the Nonpoint Source Program at reducing the effects of nonpoint source pollution to Indiana waters. U.S. EPA also cited a need for better inter-program coordination for the purposes of planning monitoring activities and to identify programmatic efficiencies that could result in data usable for multiple management objectives. With the WQMS 2011-2019, IDEM followed U.S. EPA's recommendations both in terms of the process

used to develop a comprehensive WQMS and the resulting changes in IDEM's water monitoring programs, which were both significant in scope and effective in addressing data gaps.

The 2017-2021 WQMS documented the revisions and modifications made to IDEM's monitoring programs from 2011-2016. It reflected the cumulative decisions made from the annual convening of a multidisciplinary work group that reviewed and reported on the logistics and findings from the previous year's monitoring programs to plan for the current year's monitoring projects.

1.2 DEVELOPMENT OF INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT'S WATER MONITORING STRATEGY FOR 2022-2026

This WQMS documents the revisions and modifications made to IDEM's monitoring programs since completion of the 2017-2021 WQMS. A multidisciplinary work group continues to meet annually to review and report on the logistics and findings from the previous year's monitoring programs in order to plan the current year's monitoring projects.

IDEM's WQMS is developed to facilitate the adaptive management necessary to ensure that it continues to meet OWQ's monitoring objectives, water quality management needs, and emerging concerns. Any significant revisions to the WQMS will be submitted to U.S. EPA for evaluation and comment prior to their implementation. IDEM will work with U.S. EPA to determine the appropriate timelines for such review and approval.

1.3 CHANGES TO IDEM'S MONITORING PROGRAMS

The key refinements from the *2017-2021 WQMS* include the following:

- Collection of dissolved metals and dissolved organic carbon (DOC) began at a different subset of 12 Fixed Station program sites which are identified on the map provided in Appendix 1.
- As noted in IDEM's 2022 Integrated Report Consolidated Assessment and Listing Methodology (CALM), the "metals converter" for total metals:dissolved metals will be used as a screening tool to indicate follow-up sampling for dissolved metals.
- As instituted in 2019, dissolved reactive phosphorus (DRP) will continue to be collected along with total phosphorus at the 12 sites in the Western Lake Erie Basin (WLEB) in accordance with Indiana's WLEB Domestic Action Plan.
- For the fish tissue program, PFAS was added, and pesticide parameters reduced.
- For the Probabilistic Monitoring Program, continuous dissolved oxygen and DRP will not be collected at a subset of sites until an analysis can be performed on their saliency for nutrient criteria development and/or determining nutrient reduction best management practices.
- IDEM is conducting a coolwater stream monitoring project from 2021-2022 to provide continuous stream temperature data with chemical, physical, and biological data from

reference and stressed coolwater streams throughout the State of Indiana. Sites selected from historical IDEM sites that had coolwater taxa, a mean stream summer temperature < 22 degrees Celsius, and considered reference or stressed based on land use evaluations. Data will be utilized to modify new biotic indices for accurate evaluations of macroinvertebrate and fish communities.

- IDEM will be calculating the Diatom Index of Biotic Integrity at probabilistic and reference sites to investigate the use of the diatom community structure for assessment of aquatic life use.
- IDEM will add three sites to the Stream Regional Monitoring Network following installation of equipment and monitor these sites annually to share the information with U.S. EPA.

2 MONITORING STRATEGY OBJECTIVES

The Indiana Department of Environmental Management's (IDEM's) role in the protection and restoration of its water resources is reflected in the Office of Water Quality (OWQ) mission to "monitor, protect, and improve Indiana's water quality to ensure its continued use as a drinking water source, habitat for wildlife, recreational resource and economic asset." The Watershed Assessment and Planning Branch (WAPB) plays a critical role in this mission by administering several federal Clean Water Act (CWA) programs and collecting the water quality data and information necessary to support these and other programs throughout the OWQ.

The WAPB's goals are to monitor, assess, and facilitate the protection and restoration of the designated uses of all waters of the state and to evaluate the effectiveness of our programs. The WAPB accomplishes this by:

- Conducting monitoring activities to provide water quality data that will support multiple water quality management and assessment needs of the OWQ CWA programs and, to the extent possible, the Safe Drinking Water Act (SDWA) programs which are not intended to regularly assess drinking water sources.
- Using the water quality data collected by WAPB monitoring programs to more effectively implement CWA programs and evaluate their effectiveness in protecting and restoring Indiana watersheds.
- Providing water quality data and information to support other water quality management programs in partnership with external customers and stakeholders.

IDEM's ground water monitoring activities are implemented by OWQ's Drinking Water Branch and are included in the WQMS to provide a comprehensive picture of all of OWQ's water monitoring activities.

2.1 WATER QUALITY MONITORING OBJECTIVES

IDEM's water quality monitoring objectives, which provide the basis for the water monitoring programs described in the WQMS are summarized in Table 1. Due to the diversity of Indiana's water resources and the management activities necessary to protect and restore them, IDEM must necessarily prioritize its limited resources to ensure that its critical water quality management needs are being met.

Some of the objectives shown reflect IDEM's decision-making processes while others reflect United State Environmental Protection Agency (U.S. EPA) environmental policy and priorities. All of them require water quality monitoring data. The activities related to U.S. EPA priorities or requirements and those related to the protection of human health are ranked as IDEM's primary priorities. All others are ranked as secondary priorities based on resource constraints and other factors including the degree to which they meet the OWQ mission. Secondary priorities are those that support but are not necessary to IDEM's ability to meet primary monitoring objectives and/or provide additional information to augment environmental decision making.

These priorities are also reflected in Table 1, and a key is provided to facilitate linking these monitoring objectives with the core and supplemental indicators (identified in Section 4 of this document) that are needed to meet them.

As shown in Table 1, OWQ's monitoring objectives may be met by one or more of the following three primary monitoring approaches:

Probabilistic Monitoring – Probabilistic monitoring employs a stratified random sampling design which accounts for Strahler stream order and provides data that the OWQ can use to make water quality assessments on two spatial scales. The probabilistic design allows OWQ to make statistically valid, unbiased and comprehensive assessments of the degree to which each basin as a whole is supporting its designated uses. OWQ also uses these data to make reach-specific assessments of the degree to which the individual streams or stream reaches sampled are supporting their designated uses as described in Indiana's water quality standards (WQS). Both types of water quality assessments meet key CWA objectives.

*Targeted Monitoring –*Unlike the probabilistic approach to monitoring, targeted monitoring designs involve the intentional selection of sampling locations based on the specific monitoring objective to be met. The data collected through these projects are used to answer specific questions and vary in terms of location, parameters, monitoring frequency, etc. While targeted monitoring approaches are designed to meet specific needs, they are leveraged where possible to meet multiple water monitoring objectives and the data may be used to make designated use assessments.

Fixed Station Monitoring – Albeit fixed station monitoring is also a targeted monitoring approach, for the purposes of the WQMS, fixed station monitoring is treated as a separate approach because unlike OWQ's other targeted monitoring designs, sampling locations typically do not change from year to year. However, it should be noted that dissolved metals and dissolved organic carbon will be sampled from at least 12 fixed station sites for a three year rotation and then new sites will be chosen for the next three year cycle. The data collected through the fixed station monitoring network are used for determining ambient water quality trends; for use in wasteload allocation models for NPDES permitting; and in limited application for making designated use assessments.

Table 1: OWQ's primary and secondary water quality monitoring objectives and the types of monitoring approaches needed to meet them

Key	Monitoring Objective	Priority	Probabilistic	Targeted	Fixed	Priority Rationale
A	**Conduct water quality assessments pursuant to CWA § 305(b) to support the development of Indiana's Integrated Report to U.S. EPA**	**Primary**	**X**	**X**	**X**	**Required for CWA § 106 funding**
B	**Development of Indiana's CWA § 303(d) List of Impaired Waters for Indiana's Integrated Report**	**Primary**	**X**	**X**	**X**	**Required for CWA § 106 funding**
C	**Develop Total Maximum Daily Loads to address impairments identified on Indiana's 303(d) list**	**Primary**	**X**	**X**	**X**	**Required for CWA § 106 funding**
D	**Determine trends and trophic status of Indiana's lakes and reservoirs under CWA § 314**	**Primary**	**X** +	**X**		**Required for CWA § 106 funding**
E	**Develop water quality criteria, including nutrient criteria for lakes and reservoirs, rivers and streams**	**Primary**	**X**	**X**		**Required for CWA § 106 funding**
F	**Support watershed planning and restoration efforts**	**Primary**	**X**	**X**	**X**	**Required for CWA § 319 funding and to meet performance measures in U.S. EPA's Strategic Plan**
G	**Identify water quality improvements accomplished by watershed restoration efforts funded through CWA programs**	**Primary**	**X** +	**X**	**X** + +	**Required to meet performance measures in U.S. EPA's Strategic Plan**
H	**Support the development of public health advisories related to the use of Indiana's water resources, including fish consumption advisories and recreational use advisories**	**Primary**		**X**		**Supports protection of human health**
I	**Determine ambient ground water quality and extent of contaminated areas**	**Primary**		**X**		**Supports protection of human health**

Key	Monitoring Objective	Priority	Probabilistic	Targeted	Fixed	Priority Rationale
J	**Support source water protection including both ground water and surface source water supplies**	**Primary**		**X**	**X**	**Supports protection of human health**
K	**Support development of National Pollutant Discharge Elimination System permit limits**	**Primary**	**X**	**X**	**X**	**Required for CWA § 106 funding**
L	**Responding to citizen complaints about activities that may be impacting private wells**	**Primary**		**X**		**Mandated by State Statute**
M	**Develop environmental indicators, including indices of biological integrity, for use in making water quality assessments**	**Secondary**	**X**	**X**		**Supports primary monitoring objectives (A-C, E)**
N	**Provide sampling support to other IDEM program areas as needed**	**Secondary**		**X**	**X**	**Supports primary monitoring objective (K)**
O	**Determine trends in water quality for the purposes of reporting to the Indiana Environmental Rules Board, U.S. EPA, and the public**	**Secondary**	**X**	**X**	**X**	**Augments environmental decision making; Supports primary monitoring objectives (A, D)**
P	**Support development of threatened and endangered species lists**	**Secondary**	**X**	**X**		**Augments environmental decision making**
Q	**Support the development of aquatic life uses**	**Secondary**	**X**			**Supports primary monitoring objectives (A-C, E, F)**
R	**Wetlands water quality monitoring**	**Secondary**	*****	*****	*****	**Augments environmental decision making**

+ Randomness has been incorporated in site selection.

***Water monitoring objective is not addressed by current OWQ monitoring approaches/resources.**

++Two fixed station sites have been added for the National Water Quality Initiative through the Natural Resource Conservation Service.

2.1.1 CLEAN WATER ACT § 305(B) DESIGNATED USE ASSESSMENTS

§ 305(b)(1) of the federal CWA (33 U.S.C. 1315) requires states to monitor waters of the United States to determine the degree to which they support the beneficial uses for which they are designated in Indiana's WQS. This includes assessments of how well the water quality supports aquatic life, recreational uses, and human health based on comparison of the available data to the narrative and numeric criteria in Indiana's WQS. For the purposes of CWA § 305(b), Indiana's waters are assessed as either fully supporting of the designated use in question or impaired (i.e. the water does not fully support the use). The assessments are conducted in accordance with OWQ's Consolidated Assessment and Listing Methodology (CALM).

OWQ currently conducts CWA 305(b) assessments on rivers and streams, and CWA 314 assessments on lakes and reservoirs. Although Indiana's current WQS do not contain the water quality criteria necessary to support 305(b) water quality assessments of ground water and wetlands, the WQMS supports other monitoring activities aimed at protecting these important water resources.

To make its 305(b) water quality assessments, OWQ may consider data collected under most study designs provided that Indiana's WQS contain numeric criteria and/or IDEM has developed an assessment methodology to utilize the type of data in question. Given this, most of the water quality data collected by the Watershed Planning and Assessment Branch (WAPB), including data from its probabilistic, targeted, and fixed station monitoring activities are used to make CWA 305(b) assessments.

OWQ, in accordance with CWA § 303(d) IDEM solicits data from external organizations and partners for potential use in its CWA § 305(b) assessments. Numerous universities, municipalities, watershed groups and other grassroots organizations as well as individual citizens throughout the state participate in water monitoring activities at various scales. Many of these have indicated a strong and ongoing interest in providing OWQ with the water quality data they collect.

Toward that end, the External Data Framework (EDF) developed by the IDEM's OWQ and launched in 2015, provides a systematic, transparent and voluntary process for external organizations to submit their water quality data for consideration for use in various OWQ programs. The EDF accommodates data collected for rivers and streams as well as lakes and reservoirs. The EDF does not currently accept ground water monitoring data or data collected from wetlands because the database OWQ uses to store the data received and to facilitate its review is not currently designed for these types of water resources and/or the types of monitoring data that might be available for them.

The types of data OWQ accepts through the EDF include:

- General chemistry and physical properties (in and of surface water).
- Nutrients and other inorganic substances (in surface water).
- Metals (in surface water and fish tissue).
- Bacteria (in surface water).
- Algal toxins (in surface water).
- Pesticides (in surface water).
- Organic compounds (in surface water).
- Polychlorinated biphenyls (PCBs in surface water and fish tissue).
- Polycyclic aromatic hydrocarbons (PAHs in surface water).
- Dioxins (in fish tissue)
- Perfluorinated Chemicals (PFC in fish tissue)
- Aquatic biological communities (fish and macroinvertebrates).
- Habitat evaluations (for aquatic biological communities).

The EDF describes OWQ policy regarding the agency use of external data, the guidelines for submitting data and the technical assistance necessary to facilitate greater collaboration between OWQ and external parties. The EDF is a tiered system, based on U.S. EPA's graded approach to data quality, which recognizes that the quality of data should be commensurate with the intended use of those data. For example, regulatory decisions (Level 3) require the highest quality data – equivalent to that collected by IDEM OWQ – while the data quality requirements for non-regulatory uses (Levels 1 and 2) are not as stringent.

Although the EDF does not represent monitoring activities undertaken by OWQ, it is included in the WQMS based on its potential to provide additional water quality data for use in CWA § 305(b) water quality assessments and to inform the development of Indiana's CWA § 303(d) List of Impaired Waters, both of which are primary monitoring objectives of this WQMS. These data may also be used for trend analyses and to signal follow-up monitoring opportunities for the WAPB.

2.1.2 DEVELOPMENT OF THE CLEAN WATER ACT § 303(D) LIST OF IMPAIRED WATERS

Under § 303(d)(1)(A) of the CWA (33 U.S.C. 1313), states are required to list as impaired those waters, including rivers and streams, lakes and reservoirs, that are not supporting one or more of their designated uses and therefore require a TMDL. The impairments that appear on Indiana's 303(d) list are most often identified through OWQ's CWA 305(b) assessment process.

Impairments may also be identified through watershed characterization projects, which collect additional data to further characterize impairment in order to develop a TMDL or for watershed planning. The design of these projects and the additional data collected better define the

source and extent of impairment and commonly reveal additional impairments. Regardless of the process through which impairments are identified, they are all assessed in accordance with the CALM and consider all readily existing and available data. Therefore, this monitoring objective may be met by most all of the WAPB's monitoring programs and with data provided through partnerships with external partners.

2.1.3 TOTAL MAXIMUM DAILY LOAD DEVELOPMENT

The requirement to develop TMDLs comes from § 303(d)(1)(D) of the CWA (33 U.S.C. 1313). This monitoring objective relies primarily on OWQ's targeted monitoring efforts to provide the data necessary for TMDL development. However, the process considers all available data for the watershed, including data collected by OWQ's probabilistic and fixed station monitoring activities. Data are also solicited from interested parties external to IDEM. Load calculations in the TMDL are based only on water quality data that meet OWQ's data quality requirements.

2.1.4 CLEAN WATER ACT § 314 ASSESSMENTS OF TRENDS AND TROPHIC STATUS OF INDIANA LAKES AND RESERVOIRS

§ 314(a) of the CWA (33 U.S.C. 1324) requires states to assess the trophic status and trends of all publicly owned lakes in Indiana. IDEM meets this monitoring objective through a contractual agreement with the Indiana University School of Public and Environmental Affairs (IU/SPEA) to administer the Indiana Clean Lakes Program (CLP). In collaboration with OWQ, the IU/SPEA conducts the monitoring needed to meet IDEM's CWA 314 objectives and then provides the data to OWQ for use in its assessment processes.

2.1.5 SUPPORT FOR WATERSHED MANAGEMENT PLANNING AND RESTORATION ACTIVITIES

§ 319(h) of the CWA (33 U.S.C. 1329) provides funding for various types of projects that work to reduce nonpoint source water pollution. These funds are administered by OWQ's Nonpoint Source (NPS) Program, which provides grants to watershed groups and other organizations for watershed management planning and restoration activities. Watershed plans funded through CWA § 319 must:

- Identify the causes of impairment within their watershed(s), the sources and/or stressors driving them, and the load reductions or other activities needed to control them.
- Identify and prioritize the critical areas in need of implementation measures to reduce nonpoint source pollution.

- Include a monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against a set of defined criteria that can be used to determine whether loading reductions are being achieved and whether progress is being made toward attaining water quality standards.

These monitoring objectives are met with targeted monitoring data. However, for the purposes of identifying impairments within their watersheds, nonpoint source projects may also draw upon other types of data such as those available through OWQ's fixed station and probabilistic monitoring activities.

Watershed groups and other organizations participating in watershed planning and restoration activities may use data from any source, including, but not limited to, data collected by IDEM. Watershed groups commonly conduct their own monitoring. Any monitoring activities funded through IDEM's Nonpoint Source (NPS) Program must be conducted under a Quality Assurance Project Plan (QAPP) approved by OWQ's NPS Program prior to initiation of monitoring activities. Watershed groups typically use the most scientifically rigorous sampling and analytical methods their expertise and budget will allow, which can vary significantly from watershed group to watershed group. To provide additional support to watershed management planning activities, OWQ conducts watershed characterization monitoring for a limited number of NPS projects each funding year. IDEM's selection criteria is driven by where a TMDL is also planned for development or in a watershed with a drinking water reservoir and where the watershed group does not have the capacity to perform watershed characterization monitoring equivalent to IDEM's.

Watershed characterization studies employ a modified geometric design, which is described in more detail in §3.3.1. This design provides a robust data-set to support the decision making processes required by comprehensive watershed management planning, which characterizes the watershed and prioritizes areas in need of restoration. This monitoring also provides a valid baseline for later determining if improvements in water quality have been achieved as a result of any conservation or best management practices (BMPs) implemented in the watershed, helping IDEM meet some of the performance measures described in the following sections. Additionally, IDEM incorporates the data collected from this monitoring and other targeted monitoring projects into its statewide 305(b) assessments.

2.1.6 IDENTIFY WATER QUALITY IMPROVEMENTS ACCOMPLISHED BY WATERSHED RESTORATION EFFORTS FUNDED THROUGH CLEAN WATER ACT PROGRAMS

This monitoring objective comes from the FY 2023-2024 National Water Program Guidance issued by U.S. EPA (U.S. EPA, 2022), which defines the measures to be used to assess progress in meeting the goals outlined in its 2022-2026 EPA Strategic Plan. This guidance contains both

administrative and environmental performance measures for many of IDEM's CWA programs. IDEM's WQMS addresses those measures which require water quality monitoring data.

The *Number of primarily NPS-impaired waterbodies partially or fully restored by NPS program actions* performance measure is used for tracking how NPS restoration efforts are improving water quality. To meet this measure, OWQ must monitor to identify nonpoint source-impaired waters that have been improved as a result of watershed restoration efforts. IDEM determines where to monitor for this measure based on where there are BMPs funded through § 319 or other Indiana Conservation Partnership (ICP) programs that have been in place for five years or more, coupled with field observations, sampling data, or analyses of the AIMSII data that may indicate an improvement has occurred. The targeted monitoring design and parameters vary based on the original impairments, however; most involve ascertaining if there has been an improvement for aquatic life use. Success stories documented from monitoring for previous performance measure monitoring may be found here.

2.1.7 DEVELOPMENT OF PUBLIC HEALTH ADVISORIES

In Indiana, the responsibility to develop and issue public health advisories is delegated to the Indiana Department of Health (IDOH) and local health departments. Because the protection of human health is central to IDEM's mission, OWQ actively participates in the development of public health advisories regarding the use of Indiana's water resources.

OWQ conducts monitoring to provide water quality and other data needed for the development of fish consumption advisories and toxic algae alerts, both of which are issued through IDOH. IDEM also administers the Beaches Environmental Assessment and Coastal Health Act (BEACH Act) program in Indiana, which provides grants to municipalities to conduct bacterial water quality monitoring for the purpose of issuing swimming advisories for their beaches.

IDOH FISH CONSUMPTION ADVISORY (FCA) – The annual Indiana FCA is the product of the collaborative efforts of the IDOH, IDEM, and the Indiana Department of Natural Resources (IDNR). Much of the data used for its development is collected by IDEM OWQ's fish tissue monitoring program, and OWQ staff participates in the data analysis necessary to develop the FCA. The FCA is based on the statewide collection and analysis of fish samples for long-lasting contaminants found in fish tissue, such as polychlorinated biphenyls (PCBs), organochlorine pesticides, per- and polyfluoroalkyl substances, and/or heavy metals (e.g., mercury). The risks and benefits of eating fish, commercial fish advice and Indiana wild-caught fish consumption advice is found on the IDOH FCA web site Health: Environmental Public Health: Fish Consumption Guidelines.

TOXIC ALGAE ALERTS – IDEM's blue-green algae (cyanobacteria) monitoring program samples public access beaches at IDNR properties and analyzes those samples for the type and quantity of blue-green algae present and for the following toxins which may be produced by certain types of blue-green algae: microcystin, cylindrospermopsin (only done if the species that produce it are present), saxitoxin, and anatoxin-a. For protection of human health from exposure to the cyanobacteria and associated toxins, cyanobacteria will be compared to the World Health Organization (WHO), United States Environmental Protection Agency (EPA) and Ohio Department of Health (ODH) guidelines. Beach advisory signs are posted when cell counts are 100,000 cells/ml or higher. Swimming areas will stay on the high cell count alert until the cell counts fall below 100,000 cells/ml. Beach caution and closure alerts are based on the "Human Recreation" toxin thresholds. Cell counts, toxin thresholds and levels are found on the Blue-Green Algae web site www.idem.IN.gov/algae.

BEACH NOTIFICATIONS –IDEM provides BEACH Act funds to coastal communities to increase the frequency and/or maintain the current level of monitoring at their beaches. The federal BEACH Act program, administered by IDEM's Northwest Regional Office, provides multiple resources to local communities, allowing for equipment upgrades, supply purchases, and additional summer staff to collect and analyze samples. Bacteriological sampling and analyses of Indiana's 22 coastal beaches occurs 5-7 days per week.

2.1.8 DETERMINE GROUND WATER QUALITY AND EXTENT OF CONTAMINATED AREAS

§ 106(e) of the CWA (33 U.S.C. 1256) requires that in order to receive federal CWA § 106 funds, states must monitor water quality including "navigable waters and to the extent practicable, ground waters". In its guidance for CWA § 305(b) reporting, U.S. EPA also encourages states to include in their Integrated Water Monitoring and Assessment Reports a description of the nature and extent of ground water pollution and recommendations made by state plans or programs to maintain or improve ground water quality.

Public water supply is designated in Indiana's WQS as a beneficial use that must be protected and maintained. Characterizing ambient ground water quality is an important step in protecting its use as a drinking water resource as approximately 55 percent of Indiana's public water supplies (PWS) rely on ground water as their source of drinking water.

To provide the information necessary to more comprehensively address the full range of Indiana's water resource management needs, OWQ's Drinking Water Branch (DWB) used CWA § 106 Supplemental funds to initiate a pilot Ground Water Monitoring Network in 2008 to meet the following goals:

- Characterize the ambient quality of ground water in Indiana's different hydrogeologic settings and determine the nature, extent and sources of ground water quality contamination throughout the state;
- Gain a better understanding of ground water/surface water interactions including how point source and non-point source loading from ground water influences surface water quality and vice versa;
- Inform source water protection efforts by identifying geographic areas where water quality constituents represent a risk to human health and determining the extent to which human activities as well as naturally occurring geologic settings may be threatening drinking water supplies, particularly in source water protection areas aquifers which feed PWS well fields.

Since the 2008 pilot, IDEM has maintained the Ground Water Monitoring Network which provides a framework for assessing the status of Indiana's ground water resources and is augmented with information collected through OWQ's Fixed Station Monitoring Program and other surface water monitoring programs where possible to better understand the quality of Indiana's source water for PWSs. Together, these monitoring activities provide good indicators of both the current state of the water supply and the susceptibility of source water to contamination.

2.1.9 CITIZEN COMPLAINT MONITORING

IDEM does not have regulatory authority over private drinking water wells. However, many citizens rely on private wells for their drinking water, and Indiana Statute (IC 13-18-17-4) requires the Drinking Water Branch (DWB) in OWQ to implement a Private Well Complaint Response Program http://www.idem.IN.gov/cleanwater/information-about/groundwater-monitoring-and-source-water-protection/understanding-and-protecting-your-drinking-water. The DWB also provides homeowners information on how to protect their wells online at: https://www.epa.gov/privatewells. The Private Well Complaint Response Program receives complaints, investigates, and samples at-risk private water wells which are suspected of being contaminated by synthetic contaminants.

2.1.10 SUPPORT DEVELOPMENT OF NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT LIMITS

In 1975, U.S. EPA delegated IDEM with the authority to develop National Pollutant Discharge Elimination System (NPDES) permits under the CWA. The OWQ Permits Branch uses all available water quality data to conduct the water quality modeling for waste load allocations required to develop these permits. Frequently, this includes the data collected at WAPB fixed station monitoring sites. The long-term data can provide a temporal trend of baseline water

quality, aiding in the characterization of a stream receiving permitted effluent. The NPDES program may also utilize data collected through the WAPB's other monitoring activities to support this objective when appropriate.

2.1.11 PROVIDE SAMPLING SUPPORT TO OTHER INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT PROGRAM AREAS AS NEEDED

One of the WAPB's responsibilities is to provide monitoring and assessment assistance as needed to various program areas within OWQ and other IDEM offices. Requests for assistance might include sampling to support enforcement and compliance activities, to address a specific water quality complaint or concern, in response to spill or fish kill incidents, to determine effectiveness of remediation activities and to collect flow measurements for modeling purposes.

These requests are accommodated through the coordination and implementation of special studies, which are short-term, targeted monitoring projects designed to meet the unique needs of the program requesting the assistance. Because such requests are relatively infrequent, they are considered a secondary responsibility relative to other monitoring objectives outlined in the WQMS, and the necessary monitoring is generally worked into the WAPB's routine sampling activities as time and resources allow.

However, such requests do have the potential to become a primary objective based on the urgency of the issue for which monitoring support is requested, and depending on the scope of the issue at hand, special studies may require a temporary but significant reallocation of staff resources in order to respond appropriately and in a timely manner.

2.1.12 DEVELOP ENVIRONMENTAL INDICATORS TO SUPPORT WATER QUALITY ASSESSMENTS

STATE-WIDE DIATOM INDEX

U.S. EPA recommends the use of multiple biological indicators, which facilitate a "weight-of-evidence" approach to interpretation of biomonitoring results. This approach involves interpreting data from multiple sources to arrive at conclusions about an environmental system or stressors such as nutrients. Multiple lines of evidence utilizing more than one bio-indicator can be valuable in corroborating critical levels of nutrients to stream biota. IDEM has developed and currently employs two important biological indicators to make water quality assessments – fish communities and macroinvertebrate communities. Both assemblages have different advantages with regard to determining the overall health of the aquatic ecosystem as does the periphyton assemblage.

Studies have shown that algal community metrics are a more precise indicator of nutrient enrichment compared to other response variables such as fish and macroinvertebrate metrics. To evaluate whether this might be the case in Indiana and to support ongoing efforts to develop nutrient criteria, IDEM developed algal metrics for Indiana streams and rivers. IDEM has incorporated algal identification and enumeration into its routine probabilistic and reference site sampling activities to determine if periphyton diatom data will indicate a stronger correspondence with nutrients than has been found in the fish and macroinvertebrate data analyzed for this purpose. Conclusions of the analyses can be found in the StoryMap.

SUPPORT DEVELOPMENT OF THREATENED AND ENDANGERED SPECIES LISTS

The United States Fish and Wildlife Service (USFWS) works with the IDNR Division of Fish and Wildlife (DFW) to develop and maintain the threatened and endangered species list required under the Federal Endangered Species Act. Although IDEM has no regulatory responsibility in the development of these lists, OWQ routinely communicates with the USFWS and IDNR DFW whenever threatened or endangered species are identified as a result of its regular biological sampling activities.

Occasionally, opportunities arise to leverage funds for the purposes of conducting biological monitoring in support of this and other monitoring objectives. The data provided through such collaborative efforts are mutually beneficial to all agencies involved. The USFWS and IDNR use the data to develop and maintain their threatened and endangered species lists, a secondary monitoring objective for IDEM.

COOLWATER STREAM MONITORING

The main objective of the coolwater stream monitoring project is to provide continuous stream temperature data with chemical, physical, and biological data from reference and stressed coolwater streams throughout the state. Indiana is required to assess the status of all waters of the state as supporting or nonsupporting for their designated use. "…surface waters of the state…will be capable of supporting" a "well-balanced, warm water aquatic community" [327 IAC 2-1-3]; however, there are coolwater aquatic communities that must be evaluated as well. Currently, the Index of Biotic Integrity (IBI) used for assessment is only calibrated for warm water streams, which could result in false impairments.

Sites were selected from historical IDEM sites that had coolwater taxa, a mean stream summer temperature < 22 degrees Celsius, and considered reference or stressed based on land use evaluations. Out of 138 potential sites, a total of 90 sites with nearly an equal number of reference and stressed sites were randomly selected for each sampling year (2021 and 2022).

Sampling began in April 2021 and continues through October 2022. Laboratory processing and data analysis for the project will continue through spring of 2023. Data will be utilized to modify

new biotic indices for accurate evaluations of macroinvertebrate and fish communities and further develop tools that accurately evaluate biological assemblages' expectations to fully support aquatic life use based on naturally occurring stream temperature variation.

STREAM REGIONAL MONITORING NETWORK

IDEM will establish three sites for the Stream Regional Monitoring Network to track changes in biology, habitat, and water chemistry at high quality sites over time with changes in thermal and hydrological conditions. Data from these sites can be used for IDEM's Integrated Report, refinement of water quality criteria based on natural conditions, and exploring ecosystem responses and recovery from extreme weather events.

2.1.13 DETERMINE AND ANALYZE TRENDS IN WATER QUALITY

Developing better trend information for surface waters is critical to OWQ's ability to describe whether water quality conditions in Indiana are improving. Furthermore, with the increasing emphasis on accountability at the federal level regarding OWQ's federally funded water programs, trend analyses provide another measure of CWA programs' success.

FIXED STATION MONITORING

The determination of statistically valid trends requires long-term commitments to water quality monitoring. IDEM's Fixed Station Monitoring Program (FSMP) represents its longest running program; indeed, the FSMP commenced in 1957 nearly three decades before IDEM was an agency. The FSMP has since grown from 49 to 165 sites with monthly monitoring sampling for a broad suite of parameters. In 2014, USGS published its *Water Quality in Indiana: Trends in Concentrations of Selected Nutrients, Metals, and Ions in Streams, 2000-2010*, which was made possible through a CWA § 106 Supplemental grant from U.S. EPA. The abstract from this scientific investigation states:

"Water quality in Indiana streams generally improved during the 2000–10 study period, based on trends in selected nutrients, metals, and ions. This study combined water-quality data from the Indiana Fixed Station Monitoring Program (FSMP) with streamflow data from nearby U.S. Geological Survey stream gages. A parametric time-series model, QWTREND, was used to develop streamflow-adjusted constituent concentrations, to adjust for seasonal variance and serial correlation, and to identify trends independent of streamflow-related variability. This study examined 7,345 water samples from 57 FSMP sites for 11 years. Concentration trends were analyzed for 12 constituents—the nutrients nitrate, organic nitrogen, and total phosphorus; suspended solids; the metals copper, iron, lead, and zinc; the ions chloride, and sulfate together with hardness as a measure of the calcium carbonate ion; and dissolved solids."

WAPB used FSMP data to analyze trends from 2011-2020 using the QWTREND model as in the previous trend analysis. The results can be found here.

CYANOBACTERIA MONITORING PROGRAM

While a statistical analysis has not been applied to the data from the Cyanobacteria Monitoring Program, the WAPB has developed histograms of species count, composition and toxins since 2012, the year the program transitioned from the CWA § 106 Supplemental project and became integrated into IDEM's WQMS. These graphs are found in Appendix 1.

While several IDEM staff are proficient with statistical analyses, staff turnover with the requisite shifting of resources has delayed much of the in-house analyses of different data-sets collected over the past few years.

CONTAMINANTS MONITORING

Fish tissue monitoring serves as an important indicator of contaminated sediments and water quality problems. The collection of fish tissue also enables state agencies to detect levels of pollutants in fish tissue that may be harmful to human consumers. The Indiana monitoring program began in the late 1970s and when the long-term data is examined, fish tissue concentrations for several pollutants have decreased over time. For example, levels of Dieldrin, DDT, and Chlordane in Indiana fish have been steadily decreasing since the 1980s. This class of organochlorine pesticides were used as insecticides for agriculture, lawns, termites, and to control insect carrying diseases. All three chemicals were phased out of use by the late 1980s, but remained persistent in the environment due to their bioaccumulative properties. Although some pesticides continue to be detected in Indiana fish, concentrations have decreased greatly and no longer drive fish consumption advisories. Long term trends of organochlorine pesticides in fish tissue is included in Appendix 1.

3 MONITORING DESIGN

For a list of current work plans for various monitoring programs visit IDEM's Surface Water Monitoring website.

3.1 MONITORING AT SITES SELECTED BY PROBABILISTIC DESIGN

This monitoring design allows for a cost-effective and statistically valid assessment of overall water quality of rivers and streams within each major river basin in Indiana using a nine-year rotating basin approach (Figure 1). This approach divides Indiana into nine river basins, with one basin sampled per field season. The probabilistic design involves sample site selection using a stratified random distribution weighted by Strahler stream order. Sites are selected by

U.S. EPA National Health and Environmental Effects Research Laboratory in Corvallis, Oregon. This statistical method requires sampling 38-50 locations within a given basin. The results are extrapolated to characterize water quality conditions for the entire basin. Over time, the data may be used to identify emerging trends in basin-wide water quality conditions.

The probabilistic monitoring design gathers a variety of biotic and abiotic parameters including the following:

- General water chemistry, dissolved metals, and nutrients collected three times (over three sampling events) from April through November.
- Diatoms collected during one sampling event from August through November.
- Ambient *E. coli* concentrations with field chemistry collected once each week for five consecutive weeks April through October.
- Macroinvertebrate community including insects, crayfish, and mollusks collected once mid-July through October.
- Fish community collected once June through mid-October.
- Habitat evaluations completed with fish and macroinvertebrate sampling.

The probabilistic monitoring design provides the information needed to assess the extent to which Indiana's rivers and streams support their designated aquatic life and full body contact recreational uses. More specifically, the results of this type of sampling provide information for the IDEM OWQ's *Integrated Water Monitoring and Assessment Report*, total maximum daily load (TMDL) development, development of nonpoint source plans, and some types of trend analyses. Data collected using a probabilistic design may also be used to identify potential compliance issues which may need further sampling. Various outside organizations, contractors, and government agencies also use these data.

National Aquatic Resource Surveys

Beginning in 2000, the U.S. EPA created the National Aquatic Resource Surveys (NARS) program to assess the quality of the nation's coastal waters, lakes and reservoirs, rivers and streams, and wetlands using a probabilistic (or random) design and consistent sampling methodologies. While the NARS survey design, sampling methodologies, and assessments may be appropriate for a nationwide assessment of water quality, IDEM had already invested resources in developing collection procedures and indices of biotic integrity for fish and macroinvertebrate communities in streams and rivers as well as an assessment methodology for aquatic life use appropriate for the State of Indiana.

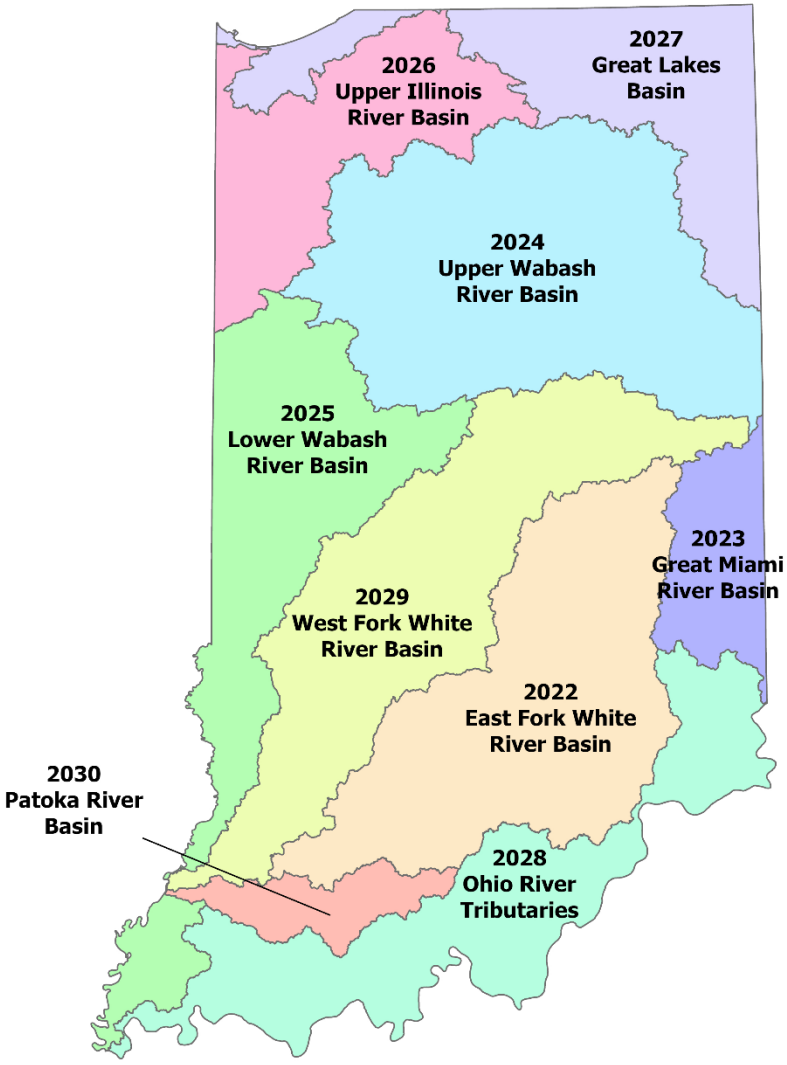
IDEM has conducted probabilistic surveys of Indiana streams since 1996 to provide a comprehensive assessment of aquatic life and recreational use. Currently IDEM is in its fifth cycle of a rotating basin approach; therefore, IDEM has not participated in the National Rivers

and Streams Assessment (NRSA), instead asking for Associated Program Support which directs funding for monitoring and lab work in Indiana to a U.S. EPA contractor. While not actively participating in NRSA, IDEM has referenced the NRSA field and lab operations manuals, site evaluation guidelines, and Quality Assurance Project Plans. IDEM experimented with the macroinvertebrate sampling methodology in Indiana streams and is investigating adoption of a modified method whereby macroinvertebrates are collected via kick and jab in multiple habitats at transects within a larger stream reach and subsampled in the laboratory to 300 organism picks rather than using IDEM's current multi-habitat sample collection in 50 meters followed by a 15-minute pick in the field. IDEM has also reviewed definitions and guidance on site evaluations and written a Quality Assurance Program Plan for Biological Community and Habitat Measurements given examples in the NRSA QAPP.

The Indiana Clean Lakes Program through Indiana University and IDEM has conducted probabilistic surveys of Indiana lakes since 2010 to calculate the Carlson Trophic State Index (TSI) for Clean Water Act (CWA) Section 314, 305(b), and 303(d) assessments and listing processes. Chemical and physical parameters are collected with plankton; however, IDEM has not invested many resources in developing collection procedures and assessment methodologies for fish, macroinvertebrates, macrophytes, and habitat in lakes; thus, IDEM contracted the Indiana Clean Lakes Program to conduct a state intensification whereby 50 lakes rather than 25 are sampled following the National Lakes Assessment (NLA) survey design and sampling methodology in 2007, 2012, 2017, and 2022. Results from participating in the NLA include the percent of total target population of Indiana lakes attaining numeric thresholds for key indicators of trophic state, ecological health, and recreation produced with 95% confidence level and an analysis to assess how widespread key stressors are for Indiana lakes and trends over the years.

IDEM does not have the staff expertise or resources to participate in the National Coastal Condition Assessment or National Wetland Condition Assessment ; thus, IDEM asked U.S. EPA for Associated Program Support. However, many other useful tools have been developed through NARS: Survey Design Tool, Mobile Data Entry Application, NARS Rapid Data Extraction and Reporting Tool, and NARS Population Estimate Calculation Tool. IDEM is looking forward to learning from those tools and trying to incorporate similar tools into Indiana's monitoring strategy and reporting.

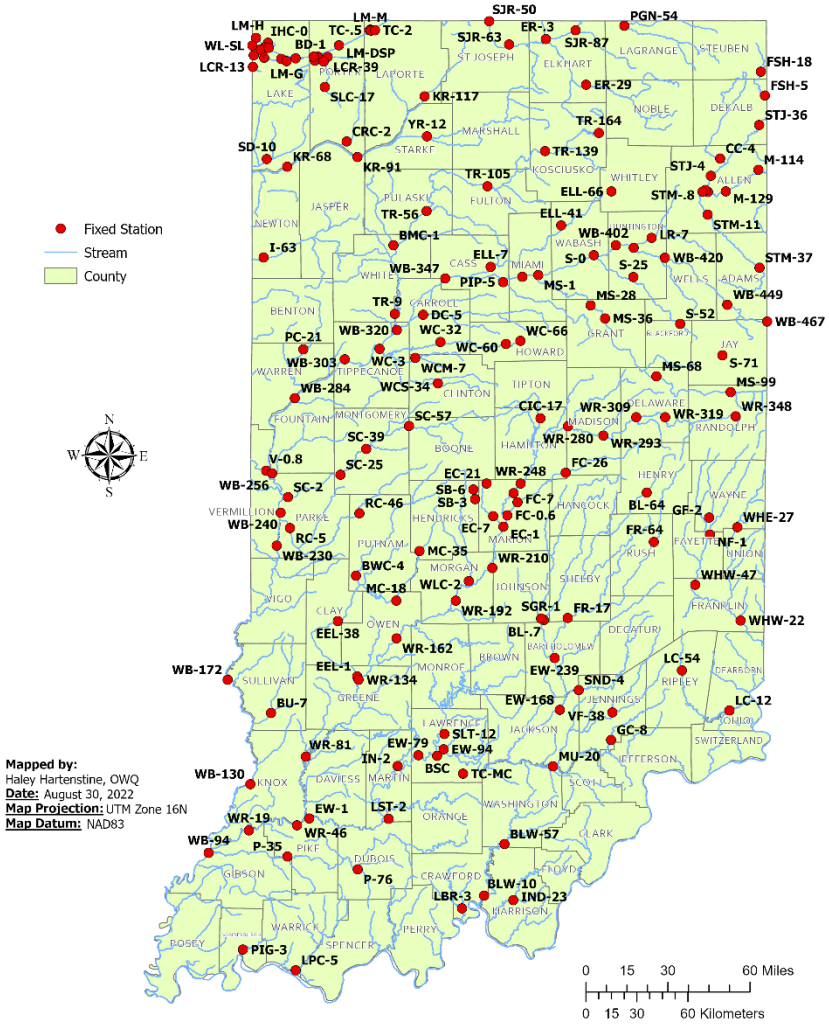
Figure 1. IDEM's nine-year rotating basin monitoring schedule for 2022-2030.



3.2 MONITORING AT FIXED STATIONS

IDEM's statewide Fixed Station Monitoring Program (FSMP) was established in 1957 with 49 sites located upstream and downstream of major wastewater treatment outfalls and near drinking water intakes. Since that time, sampling has increased to 165 sites statewide (Figure 2). This program collects monthly water quality samples to provide basic ambient water quality data for assessment of the major rivers of Indiana.

Figure 2. Fixed Station Monitoring Sites



In addition to providing data for the CWA purposes of water quality assessments, development of TMDLs, and providing data to calibrate and verify waste load allocations for NPDES permits, these data can be used to determine long-term water quality trends. Monitoring at municipal drinking water intakes occurs at a subset of sites on Lake Michigan.

The following parameters are collected:

- General water chemistry, total metals with dissolved metals collected at a subset of 12 sites across the state that represent different ecoregions, and nutrients.
- Field chemistry, *E. coli*, and conditions coding.
- Organics/pesticides at select sites and drinking water intakes.

3.3 MONITORING AT TARGETED LOCATIONS

OWQ's targeted monitoring designs provide data used to meet a number of the primary monitoring objectives identified in Table 1. Sampling occurs on different geospatial scales from entire basins to small watersheds. The sampling site selection is what makes this type of sampling different from others listed in the WQMS. Sites and study areas are specifically selected based on known impairments, historical information, permitted dischargers, land use, watershed group focus areas, and other factors relevant to the monitoring objective for which the monitoring is to be conducted. Sampling projects and sites change annually and may occur anywhere in the state, depending on their specific monitoring objectives. The targeted monitoring design allows for gathering a variety of biotic and abiotic information including bacteriological, fish and macroinvertebrate community measures, fish contaminant levels, in-stream and riparian habitat measures, and physical and chemical water chemistry parameters.

3.3.1 WATERSHED CHARACTERIZATION MONITORING

Watershed characterization monitoring provides valuable data for the purposes of TMDL development and CWA § 319 watershed management planning. This intensive monitoring design allows for future comparisons to evaluate changes in the water quality within the watershed(s) studied. Selecting a spatial monitoring design with sufficient sampling density to accurately characterize water quality conditions is a critical step in the process of developing an adequate local scale watershed study.

For its watershed characterization studies, OWQ uses a modified geometric site selection process in order to get the necessary spatial representation of the entire study area. Sites within a watershed are selected based on a geometric progression of drainage areas starting with the area at the mouth of the mainstem stream and working upstream through the tributaries to the headwaters (sites ≥ 5 square miles). Monitoring sites are then "snapped" to

the nearest bridge with additional sites located at pour points and, to the extent possible, sites of concern to the stakeholders.

Study areas are selected based upon TMDL development needs and where there is a successful CWA § 319 planning grant application. Due to staffing and laboratory constraints, one watershed characterization study will be conducted per year commencing in the fall (usually November). The watershed characterization monitoring project provides physical, chemical, and bacteriological data collected monthly for twelve months at the pour points and for the rest of the sites, April through October, which constitutes the recreational season. Biological data are collected once per year at each of the sites.

The water quality data collected through the watershed characterization monitoring provides the data needed to identify the sources and extent of impairment for TMDL development and for local watershed groups to designate critical areas and management decisions for their watershed management plans. The rigor of this monitoring design supports future performance measures monitoring to determine if improvements in water quality have occurred due to management and BMP implementation.

3.3.2 MONITORING TO IDENTIFY CHANGES IN WATER QUALITY

PERFORMANCE MEASURES MONITORING- Performance measures monitoring to identify changes in water quality is conducted in areas where there is reason to believe improvements may have occurred due to activities such as the implementation of point source and nonpoint BMPs, hydrological restoration, riparian restoration and/or wetland mitigation and restoration.

Generally, study areas are selected based on where watershed management plans (WMPs) have been implemented and where BMPs have had sufficient time to provide a measurable effect on water quality. Sufficient time is determined by the BMP and pollutant involved. Different BMPs have different lag times associated with their pollution reduction effectiveness (e.g. cover crops must grow in but they take less time to grow in than a woody riparian buffer). In addition, some pollutants must be flushed from the system over time (e.g. sediment on a streambed, phosphorus that has accumulated in a lake system) and take longer to see a reduction than others (for instance, E. coli contributed from cattle in a stream disappears almost instantaneously when cattle are fenced out of the stream). Therefore, how quickly a change may be seen in a stream system will be determined on a case-by-case basis. However, IDEM does not currently have the resources to assess whether or how well BMPs have been maintained over time. Our current contracts require that vegetative BMPs be maintained for 5 years (except for cover crops, which are an annual practice) and structural practices must be maintained for 10 years.

In addition to the practices installed through CWA § 319 or via implementation of a TMDL, IDEM consults with the Indiana Conservation Partnership (ICP) to identify watersheds where various Farm Bill, Clean Water Indiana, and Lake and River Enhancement cost-share funds have been used. These are mapped at the 12-digit scale and the IDEM § 319 Watershed Specialist provides further insight on activities, including social indicators, within the watershed. Analyses of AIMSII data are also completed for indications that an improvement has occurred. Performance measures monitoring is conducted on previously impaired segments. The specific parameters to be monitored and the number of sampling sites vary depending on the type and spatial extent of the original impairment. Segments may be sampled for general chemistry and nutrients, bacteria, and/or fish and macro-invertebrate communities depending on the type of impairment(s) identified.

The number of samples collected at each site and the sample frequency is consistent with the minimum data requirements described in IDEM's CALM for the listing and delisting of impairments on the 303(d) list.

3.3.3 MONITORING TO SUPPORT DEVELOPMENT OF PUBLIC HEALTH ADVISORIES

CONTAMINANTS MONITORING – Fish tissue contaminant analysis is a widely used method of monitoring and assessing environmental contaminants and their bioavailability as concentrations of some contaminants may be greater in tissues than in water because of bio-concentration, bioaccumulation, or bio-magnification. Tissue contaminant monitoring gives insight into exposure levels and allows IDEM to better understand the complexities of contaminant distribution, fate, and effects. Fish tissue contaminant monitoring has been a regular part of the Watershed Assessment and Planning Branch (WAPB) activities since the early 1970s with the then Indiana State Board of Health Division of Water Pollution. This program was incorporated into the five year rotating basin methodology of the 1996 Surface Water Quality Monitoring Strategy (SWQMS) in 1997. All sites are targeted, which has provided the benefits of a stable monitoring network.

Included in this monitoring is a 23-site "core" network located at FSMP sites on larger rivers coming into the State, exiting the State, or in key metropolitan reaches where sampling began in the late 1970s in cooperation with the U.S. EPA. In addition to these 23 sites, other sites are selected based on historical environmental problems, water body access, use for fishing, and recommendations for monitoring by other agencies and programs. Additionally, IDEM accepts fish tissue samples collected by other agencies, such as the IDNR samples from Lake Michigan, for analyses. On average, sampling occurs at approximately 30-40 sites annually with an average of 5-6 fish tissue samples collected per site. Most samples are prepared from the edible portion (skin-on or skin-off fillets) of fish.

Standard monitoring parameters on all samples include the following:

- Cadmium.
- Lead.
- Mercury.
- Selenium.
- Total Polychlorinated Biphenyls (PCBs).
- Analyses are done for PFAS, Organochlorine Pesticides, and other compounds on a portion of these samples.

Data from the Fish Tissue Contaminants Monitoring program helps support the efforts of a variety of water management decisions throughout IDEM and among other agencies. These include the following:

- Aquatic Life Use Support (ALUS) status for fish consumption in the 303(d) List of Impaired Waters.
- The Indiana Fish Consumption Advisory.
- The U.S. EPA National Fish Contaminants Program.
- The Office of Land Quality- Site Investigations, Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Resource Conservation Recovery Act (RCRA) clean-up efforts.
- The Natural Resources Damage Assessment (NRDA) Program.
- Understanding impacts to aquatic communities from the toxic effects of bio-accumulating compounds of concern.
- Understanding the health risks to humans and wildlife of eating fish.
- Understanding long term trends of contaminants in fish.

To better understand the concentrations of PFAS in Indiana, some sites are selected based on their location to a potential PFAS source, like airports, wastewater treatment plants, or other industrial sources. The addition of these sites includes previously un-sampled stream reaches for assessment of other contaminants like PCBs and methylmercury, while also collecting new data on PFAS concentrations. This sampling will continue to increase the number of stream miles assessed. In addition IDEM:

- Continues sampling at major reservoirs in the State.
- Continues sampling at the longstanding “core” monitoring locations.
- Continues annual sampling for Lake Michigan.
- Continues sampling at stream reaches in relation to historically significant PCB sources.

CYANOBACTERIA AND MICROCYSTIN MONITORING –Cyanobacteria are common constituents of algal communities in lakes and many are known to produce potent toxins, which are now

recognized as a potentially serious threat to human health. Through a CWA § 106 Supplemental grant awarded by the U.S. EPA, IDEM built its internal capacity regarding identification and enumeration of cyanobacteria and the laboratory analysis of the microcystin toxin. This was quality assured by Indiana University, Purdue University Indianapolis over a two-year period and then cyanobacteria monitoring was incorporated into IDEM's budget and WQMS in 2012.

IDEM's cyanobacteria monitoring program is conducted statewide at IDNR public access beaches and analyzes those samples for the type and quantity of cyanobacteria present and for the following toxins which may be produced by certain types of cyanobacteria: microcystin, cylindrospermopsin, saxitoxin and anatoxin-a.

For protection of human health from exposure to the cyanobacteria and associated toxins, cyanobacteria will be compared to the World Health Organization (WHO), United States Environmental Protection Agency (EPA) and Ohio Department of Health (ODH) guidelines. Beach advisory signs are posted when cell counts are 100,000 cells/ml or higher. Swimming areas will stay on the high cell count alert until the cell counts fall below 100,000 cells/ml. Beach caution and closure alerts are based on the "Human Recreation" toxin thresholds. Cell counts, toxin thresholds and levels are found on the Blue-Green Algae web site www.idem.IN.gov/algae.

Summary histograms from the cyanobacteria monitoring program over the last five years are found in Appendix 1.

3.3.4 SPECIAL STUDIES

THERMAL VERIFICATION MONITORING (design developed in 2015)- In accordance with 327 IAC 5-7 and CWA § 316(a), NPDES dischargers may request alternative thermal effluent limitations (ATEL) for a discharge based on a demonstration that the proposed effluent limitations for temperature are more stringent than necessary for the protection and propagation of the receiving waterbody's balanced, indigenous community (BIC) or balanced indigenous population (BIP) of shellfish, fish, and wildlife in and on the body of water. This means that a new or existing discharger may request an ATEL to the thermal effluent limitations otherwise imposed by IDEM based on the water quality criteria for the receiving waterbody or the technology standards, using the results from a demonstration study they implement.

The objective of monitoring point source discharge thermal plumes is to independently determine if impairments are occurring to the biological communities downstream of the thermal discharge outfalls on rivers and lakes. This monitoring effort documents the current downstream discharge conditions, determines zones of recovery of biological communities, and establishes the instantaneous pattern of the outfall thermal discharge plume by gathering

biological (fish and macroinvertebrate), chemical, and habitat quality data. For determination of "no harm" to BIC, sampling is conducted on up to three (3) sites per year for fish community and one site for macroinvertebrate community (weather, environmental, and health and safety conditions permitting) during the period of the discharger's NPDES permit. The information gathered from these studies support NPDES industrial permit decision making processes for the issuance of ATELs for permitted thermal discharges.

REFERENCE SITE MONITORING - IDEM worked with U.S. EPA and Tetra Tech, a contractor, in March 2015 to develop a framework and criteria for reference site selection for evaluating an Index of Biotic Integrity (IBI). Reference sites are located in areas with the least amount of anthropogenic disturbance and are considered the most natural remaining areas within a specified geographic boundary. Candidate sites are chosen based on abiotic factors such as land use, water chemistry and in-stream physical habitat that function as potential stressors to the biotic components (i.e. fish/macroinvertebrate/diatom communities) of the stream or river ecosystem.

The primary filter used in selecting reference sites is land use criteria such as percent of agricultural or urban areas, impervious surface area, human population density and distribution, road density and crossings, proportion of active mining activities, proportion of protected lands, and proximity to permitted facilities, confined feeding operations, and Superfund sites. In altered watersheds, chemical and in-stream physical habitat data may be used as a secondary filter to select reference sites and develop biological expectations for "least disturbed condition" (best available condition given widespread disturbance) rather than "minimally disturbed condition" (nearly absent human disturbance) or "historical condition" (prior to major industrialization, urbanization, and intense agricultural practices) (Stoddard et. al. 2006).

IDEM provided Tetra Tech with 1458 sites previously sampled for fish and/or macroinvertebrates between 2003 and 2013 for possible reference site selection. Using land use factors as the primary filter, Tetra Tech provided a list of 324 reference sites. IDEM narrowed down the list further by using in-stream chemical and physical data as a secondary filter. A minimum of 20 reference sites is required in each of the natural environmental gradient classifications (ecoregion, stream size, etc.) to develop linear regression models showing change in biological assemblage structure given certain explanatory variables. Increasing the number of reference sites will reduce variability in calibrating the IBI and in setting biological criteria thresholds (U.S. EPA 2013, Tetra Tech personal communication). Based on the spatial distribution of the sites and available resources, IDEM will conduct site reconnaissance and sampling of reference sites with the goal of at least 20 reference sites each

year over the next 10 years to refine biological indices, water quality criteria, and possibly develop other assessment indicators and thresholds.

The objective of the Reference Site Monitoring Program is to provide physical, chemical, and biological data from reference sites that will be used to develop/refine the IBI for aquatic assemblages (including diatoms, macroinvertebrates, and fish) as well as biological criteria for aquatic life use assessments. The IBI is composed of 12 biological assemblage characteristics or metrics that assess the aquatic communities' structural, compositional, and functional integrity. Different IBI metrics may be used depending on variables such as what part of the State is being sampled (ecoregion) and the size of stream (drainage area). The 12 different metrics can score 0, 1, 3, or 5, which represents the deviation from expected community structure (i.e. 5 = no deviation from expectations, 0 = severe deviation from expected community structure). The total score can range from 0 (severe disturbance) to 60 (excellent, comparable to "least impacted" conditions).

Ideally, reference sites will be sampled at least once every 10 years to monitor for changes in the biological expectations for "least disturbed condition" and possible revisions to biological criteria. Sampling at reference sites includes a minimum of two biological communities (fish, macroinvertebrates, and/or diatoms), habitat evaluations, and at least in-situ water chemistry (ideally laboratory water chemistry parameters, algal biomass, and flow are also sampled as resources allow).

MONITORING ASSISTANCE REQUESTED BY OTHER IDEM PROGRAM AREAS – Special studies are conducted for the purposes of providing monitoring assistance to other IDEM program areas when needed. The designs and parameters of special studies vary significantly based on the objective. When they are foreseen, such as with a CERCLA remediation site or for obtaining data to assist with water quality standards development, planning begins the preceding year and logistics are determined during the annual monitoring program review. Given resource constraints, it may be necessary to cut back on another targeted program in order to conduct the special study.

Infrequently, there will be an urgent, unforeseen sampling need such as in the case of a large scale fish kill. In such a case, resources are diverted from those targeted projects that do not have human health or recreation as their primary objective. All efforts are made to ensure sampling is sustained for probabilistic monitoring to provide data for water quality assessments.

3.3.5 LAKES MONITORING

The Clean Lakes Program (CLP) is administered for IDEM by Indiana University School of Public and Environmental Affairs (IU/SPEA) through a grant from OWQ's Nonpoint Source Program and includes two primary but different monitoring components. IU/SPEA staff and students conduct the majority of the monitoring for the CLP and administer a volunteer monitoring program through which additional monitoring is conducted by a corps of trained citizen volunteers.

Lakes monitored by IU/SPEA are selected randomly from a population of 320 lakes throughout Indiana which are greater than five acres in surface area and which have a publicly accessible boat launching area.

IU/SPEA samples approximately 80 lakes per year during July and August to capture the period of thermal stratification when lentic water quality is poorest. The following parameters are measured at each site:

- Temperature and DO profiles are taken at one meter intervals.
- Secchi disk transparency.
- Number of meters at one percent light level.
- Percent light transmission at 1.5 meters.
- Phytoplankton species distribution with 2-meter integrated sampler.
- Zooplankton species distributed through the full water column with a 50 micron tow net.
- Epilimnetic and hypolimnetic samples for:
    - soluble phosphorus
    - total phosphorus
    - total Kjeldahl nitrogen
    - Ammonia
    - nitrate nitrogen
    - pH
    - Alkalinity
    - Conductivity
    - epilimnetic samples for chlorophyll *a*

IDEM uses these data for CWA § 314 assessment purposes to calculate the Carlson's Trophic State Index (TSI) described in the CALM. More information on the CLP may be found at: https://clp.indiana.edu/

The primary objective of the volunteer component of the CLP is to engage Indiana's citizens in gathering quality scientific data from both public and private lakes. In this program, volunteers are trained to monitor water clarity at more than 100 lakes around the state. The data collected

by these volunteers are used for assessment purposes as well as for trophic state index calculations.

CLP volunteers take Secchi disk measurements every two weeks at the same site in the lake each time, generally over the deepest part of the lake. They are also asked to note the color of the lake and to evaluate the recreational potential and physical appearance of the lake.

Volunteers submit their data to IU/SPEA using pre-paid postage cards or may enter their data electronically on the CLP website. The monitoring conducted by CLP volunteers is targeted to their particular lake(s) of interest and may include both public and private lakes.

In addition to their regular monitoring, approximately 40 of the more experienced volunteers sample Chlorophyll *a* and total phosphorous once a month during the summer, typically May through August. Samples are frozen and shipped overnight to IU/SPEA for analysis by CLP staff. Additionally, IU/SPEA expanded the volunteer program in 2016 to include the identification of macrophytes and aquatic invasive species, including Zebra mussels. More information may be found at: https://clp.indiana.edu/volunteer-data/index.html

3.3.6 HOOSIER RIVERWATCH VOLUNTEER MONITORING PROGRAM

Since 1994, Hoosier Riverwatch (HRW) has engaged Indiana citizens in becoming active stewards of Indiana's valuable water resources through its hands-on water quality education and volunteer stream monitoring program. In 2012, the HRW program transferred from the IDNR to IDEM, bringing with it a coordinator position and skilled volunteer trainers. The statewide Hoosier Riverwatch volunteer network is robust, with over 4,000 trained stream monitors and 25 active certified instructors.

Following an eight-hour basic training workshop, participants are qualified to conduct habitat and biological surveys of their local streams. Monitoring activities include collecting and identifying small stream macroinvertebrates and determining the physical and chemical characteristics of the stream. Macroinvertebrates are generally identified to Order, but in some situations they are identified to Family when possible. The data that volunteers collect and input to the HRW online database can be used to determine the health of streams and how they are changing over time. The online database is a powerful tool for visualizing, graphing, searching, and downloading a variety of stream data collected by HRW volunteers who have entered data collected at over 2,100 river and stream sites across Indiana. The release of the updated HRW database in the fall of 2015 included a portal for the External Data Framework (EDF), which can be accessed at: http://www.hoosierriverwatch.com/portal/

3.3.7 GROUND WATER MONITORING

OWQ is employing a phased approach to its ground water monitoring. In 2008, the IDEM Drinking Water Branch, Ground Water Section conducted the inaugural field sampling of the statewide Ground Water Monitoring Network (GWMN). The overall goals of the project at its inception were to determine general ground water quality across the state, the effect of ground water on the quality of surface waters, and how source water and drinking water supplies can best be protected by utilizing data derived from a comprehensive approach to assessment and monitoring.

Achieving these goals involved first sampling ground water across the state to statistically establish background ground water quality levels in distinct hydrogeologically defined settings of the state. Once statistically-established ambient ground water conditions were established for the state, comparison between ground water and surface water data may be made and hypotheses concerning ground water/surface water interactions can be formulated and tested. To reach the goals of the GWMN, the following steps were determined:

- Collect ground water samples from public water supply (PWS) wells and private residential wells within distinct hydrogeologic areas of the state with the overall goal to determine the quality of ground water in the state's aquifers.
- Identify and expand sampling in areas with notable contamination.
- Practice continual improvement adjusting the GWMN as necessary to best fit resources (monetary/field support) and data gap needs.

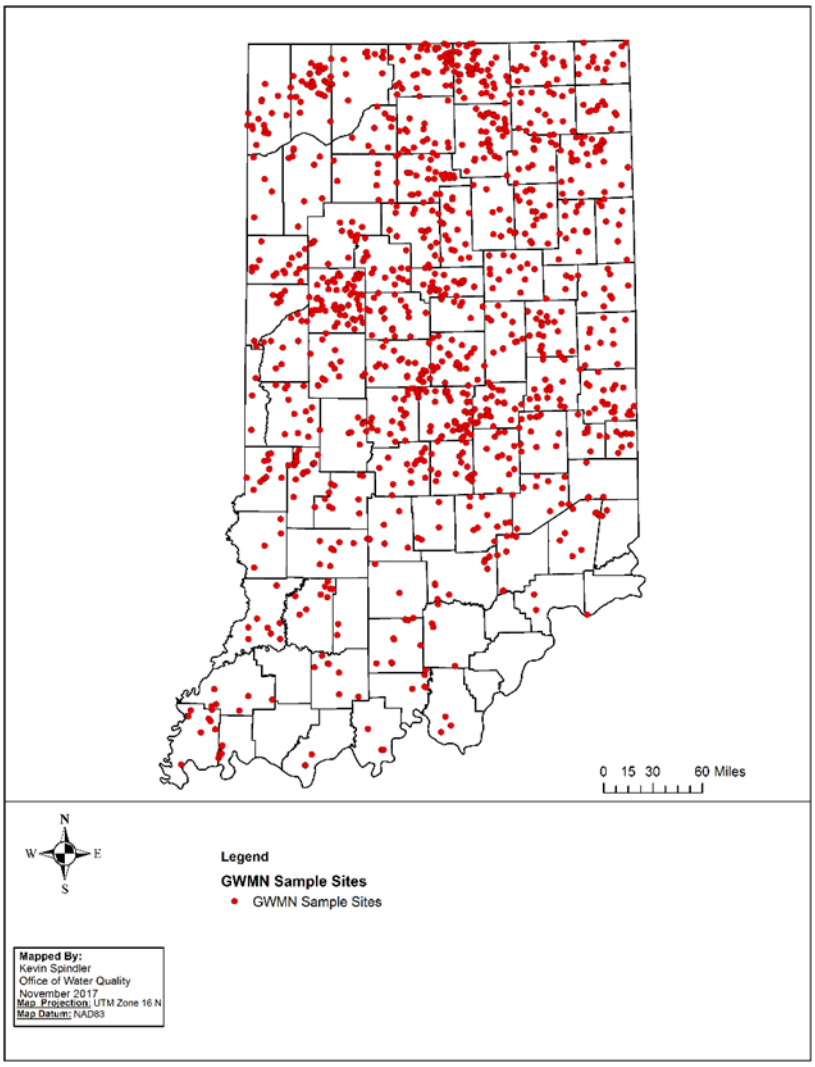
A statistically-based random, stratified sampling WQMS was developed and commenced in 2013. To date, three full rounds of statistically-based sampling have been completed. Nearly 1200 samples have been collected from unique sites (small public water supplies and private drinking water wells) across the entire State of Indiana based on hydrogeologic settings.

In 2016, IDEM released the 2016 Ground Water Monitoring Network Summary and Results Report detailing the first round of statistically-based sampling. From these data, it is possible to make general statements about ground water quality in Indiana. The ground water type across the state is generally dominated by calcium and bicarbonate, with varying amounts of sodium and sulfate. Nitrates were detected across the state, with higher concentrations generally observed in highly sensitive aquifers under oxidizing redox conditions. Arsenic was found above the Safe Drinking Water Act Maximum Contaminant Level (MCL) in 11% of the samples. The data suggests a statistical link between Arsenic concentrations and aquifers of glacial till origin under reducing redox conditions. Although few pesticides were detected in their parent form, degraded forms of Acetochlor, Alachlor, and Metolachlor were observed in more than 17% of the samples collected, indicating that these compounds are persistent in ground water.

During the 2017 and 2018 sampling seasons, residential sites that showed high levels of arsenic in previous sampling events were resampled to determine the chemical species of arsenic in the ground water. It is important to determine the ratio of Arsenic (V) to Arsenic (III) (which is more mobile and toxic) under various aquifer conditions so that effective treatment systems to remove the Arsenic can be designed. The study found that approximately 80% of the arsenic found in Indiana ground water is in the form of Arsenic (III). With this information, IDEM can begin to geochemically map aquifer units across large areas and determine specific areas, aquifers, and geochemical conditions that might be at risk to contain high levels of Arsenic.

In 2020 and 2021, approximately 362 of the sites previously sampled during the initial rounds of sampling were resampled to address anion-cation charge balance issues. Processing of this data is ongoing. After these issues are resolved, IDEM will produce a full report on GWMN findings and release the dataset to the public via the IDEM website.

Figure 3: Sites sampled for the Ground Water Monitoring Network.



3.3.8 WETLANDS MONITORING

OWQ uses a rapid classification system for isolated wetlands, providing an on-the-ground assessment methodology for determining a given wetland's classification for regulatory purposes. The IDEM Wetlands program has developed a Wetlands Program Plan that outlines goals and objectives to improve the overall effectiveness of the program. Many of these goals and objectives may not be achievable with current program staff, but could be pursued through grants and partnering with universities, organizations, and the public. One element contained in the Wetlands Program Plan is development of an enhanced tracking system with a new electronic public facing portal.

4 CORE AND SUPPLEMENTAL WATER QUALITY INDICATORS

Core and supplemental water quality indicators include physical, chemical, toxicological, biological, and ecological indicators that can be used to meet Indiana Department of Environmental Management's (IDEM's) water quality monitoring objectives. The United States Environmental Protection Agency (U.S. EPA) defines "core" indicators specifically as those which can be used to assess water quality standards (WQS) attainment through a state's designated use assessment under Clean Water Act (CWA) § 305(b) and "supplemental" indicators as those used to address more specific questions such as determining the source of impairment, or screening for a specific pollutant of concern (U.S. EPA, 2003).

For the purposes of the *2022-2026 Water Quality Monitoring Strategy* (WQMS), the Office of Water Quality (OWQ) defines core and supplemental indicators differently within the context of water quality monitoring objectives. For example, while pathogen indicators are useful in determining whether a waterbody supports recreational uses, they have no value in determining whether or not fish caught from that same waterbody may be safely consumed. Designated use assessments and providing data for the development of fish consumption advisories are both examples of different, but primary water quality monitoring objectives that IDEM's WQMS is intended to address. Thus, OWQ considers "core" indicators to be those which are critical to meeting the specific water quality monitoring objective for which they are monitored, while "supplemental" indicators are additional indicators that provide valuable information, but are not necessary in order to meet the water quality monitoring objective.

This section describes core and supplemental indicators used by IDEM, how they are linked to the monitoring designs described in section 3, and how they facilitate meeting the monitoring objectives identified in section 2 of the WQMS.

4.1 PHYSICAL AND CHEMICAL INDICATORS MEASURED IN THE FIELD

Core and supplemental indicators measured in the field are shown in Table 2. Core indicators of in-situ water quality conditions are measured using a calibrated multi-probe unit. Field verification of multi-probe measurements is conducted weekly by each sampling team. When measurements with the multi-probe indicate potentially impaired conditions, supplemental measurements of dissolved oxygen, pH, and temperature are taken with portable meters.

Table 2: Core and supplemental indicators of physical surface water quality conditions

Indicator	Monitoring Objective(s) from Table 1 (pp. 9 & 10)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Discharge (stream flow)	**C,F**	**G**		**X**	**X**
Dissolved Oxygen	**A,B,C,D,E,F,G,J,K**		**X**	**X**	**X**
Percent Saturation	**A,B,C,D,E,G,J,K**	**F**	**X**	**X**	**X**
Conductivity	**A,B,C,D,E, G,J,K**	**F**	**X**	**X**	**X**
pH	**A,B,C,D,E,F,G,J,K**		**X**	**X**	**X**
Turbidity	**A,B,C,D,E G,J,K**	**F**	**X**	**X**	**X**
Temperature	**A,B,C,D,E G,J,K**	**F**	**X**	**X**	**X**
Oxidation-reduction potential (Eh)	**I**		**X**	**X**	

4.2 CHEMICAL INDICATORS ANALYZED IN THE LABORATORY

The core and supplemental chemicals in water samples collected for laboratory analysis are shown in Table 3. These indicators include general chemical parameters and nutrient parameters, which are known to have toxic and other detrimental effects on aquatic organisms. Chemical indicators provide important information regarding the chemical constituents of the waterbody sampled and are used to identify pollutants that may be present in the water column and the effect that chemical conditions may be having on the aquatic community. Nutrient indicators are also critical for the development of nutrient criteria.

Table 3: Core and supplemental indicators of general chemical surface water quality conditions

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Alkalinity	**F,G,J,K,O**	**C**	**X**	**X**	**X**
Total Solids	**G,J,K,O**	**C ,F**	**X**	**X**	**X**
Suspended Solids	**F,G,J,K,O**	**C**	**X**	**X**	**X**
Dissolved Solids	**G,J,K,O**	**F**	**X**	**X**	**X**
Sulfate	**A,B,C,G,J,K,O**	**F**	**X**	**X**	**X**
Chloride	**A,B,C,G,J,K,O**	**F**	**X**	**X**	**X**
Hardness	**A,B,C,G,J,K,O**	**F**	**X**	**X**	**X**
Total Kjeldahl Nitrogen (TKN)	**E,F,G,J,K,M,O**	**F**	**X**	**X**	**X**
Ammonia (NH3-N)	**A,B,C,E,F,G,J,K,M,O**	**F**	**X**	**X**	**X**
Nitrate-Nitrite (NO2+NO3)	**A,B,C,E,F,G,J,K,M,O**		**X**	**X**	**X**
Total Phosphorus	**A,B,C,F,G,J,K,O**		**X**	**X**	**X**
Total Organic Carbon (TOC)	**G,J,K,O**	**F**	**X**	**X**	**X**
Chemical Oxygen Demand (COD)	**G,J,K,O**	**F**	**X**	**X**	**X**

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Total Metals	**G,J,K,O**	**F**			**X**
Dissolved Metals	**A,B,C,E,G,J,K,O**	**F**	**X**	**X**	**X**
Total Cyanide	**G,J,K,O**	**F**	**X**	**X**	**X**
Free Cyanide	**A,B,C,G,J,K,O**	**F**	**X**	**X**	**X**

4.3 BACTERIOLOGICAL AND TOXICOLOGICAL INDICATORS

Core and supplemental bacteriological and toxicological indicators are used to identify environmental conditions that pose a potential risk to human health.

4.3.1 BACTERIOLOGICAL INDICATORS

IDEM conducts routine monitoring for *E. coli* as an indicator of fecal contamination, which can contain a number of different enteropathogens which can cause gastrointestinal diseases in humans and which are also disseminated through the fecal contamination of water. Many of these organisms are difficult to detect making them poor indicators of water quality with regard to human contact.

E. coli, which is normally a nonpathogenic intestinal organism of warm-blooded animals, is used as an indicator because it easier to test for and is relatively more abundant by comparison to enteropathogens in a given water sample. Given this, using *E. coli* as an indicator allows for a margin of safety with regard to disease causing organisms that may be present in surface waters.

E. coli is IDEM's primary bacteriological indicator (Table 4) and is measured in surface water samples collected for laboratory analysis in order to determine the human health risks associated with exposure to pathogenic microbes present in the water.

Table 4: Core indicator of bacteriological water quality conditions that may pose a potential risk to human health

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Escherichia coli	**A,B,C,F,G,H,J,O**		**X**	**X**	**X**

4.3.2 ALGAL TOXINS

Cyanobacteria (blue-green algae) are common constituents of algal communities in surface waters. Many types of cyanobacteria are known to produce algal toxins, which pose a potentially serious threat to human health. However, much remains to be learned about the environmental conditions under which algal toxins are produced and the cumulative or synergistic effects of other irritants that may be present in surface waters. Additional factors include the varying sensitivities of humans and animals exposed to the toxins.

For public health advisories, IDEM's Cyanobacteria Monitoring Program is conducted statewide at select IDNR public access beaches and analyzes those samples for the type and quantity of cyanobacteria present and for the following toxins which may be produced by certain types of cyanobacteria: microcystin, cylindrospermopsin (only done if species that produce it are present), saxitoxin and anatoxin-a.

Table 5: Core indicators of the potential human health risks associated with algal levels in recreational lakes

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Microcystin	**E,H,J,M,O**			**X**	
Cylindrospermopsin	**E,H,J,M,O**			**X**	
Anatoxin-a	**E,H,J,M,O**			**X**	
Saxitoxin	**E,H,J,M,O**			**X**	
Cyanobacteria density	**E,H,M,O**			**X**	

4.3.3 FISH TISSUE AND SEDIMENT CONTAMINANTS

Bioaccumulative chemicals of concern are measured in the edible tissues of fish caught from surface waters to indicate the potential health risks associated with fish consumption. Sediment indicators augment this information. Both fish tissue samples and sediment samples are analyzed in the laboratory.

The fish tissue indicators in Table 6 are used to determine the risks associated with fish consumption and to calculate consumption rates that are safe. Many of these pollutants occur in such low concentrations in the water column that they are usually below analytical detection limits. However, over time, they may accumulate in fish tissue to levels that are easily measured. Therefore, fish tissue results may also be used as indicators of pollutants that may be present in the waterbody at very low levels that would not be detected in water samples.

Supplemental fish tissue indicators may be analyzed when industrial, municipal, or other pollution is suspected, or if a core indicator shows a certain type of impairment. Fish tissue sampling continues to evolve over time as public concern regarding new and emerging contaminants in the environment grows. If OWQ decides in the future to investigate other contaminants of concern, the core and supplemental indicators identified in the WQMS will be modified accordingly.

Table 6: Core supplemental indicators of bioaccumulative pollutants of concern in fish tissue

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Total Polychlorinated Biphenyls (PCB)	**A,B,H,O**			**X**	
Metals (including mercury)*	**A,B,H,O**			**X**	
Organochlorine Pesticides*		**A,B,H,O**		**X**	
Polycyclic Aromatic Hydrocarbons*		**A,B,H,O**		**X**	
Polybrominated Diphenyl Ethers*		**A,B,H,O**		**X**	
PCB Congeners*		**A,B,H,O**		**X**	
Polychlorinated Dioxins and Furans*		**A,B,H,O**		**X**	
Semi-volatile organic compounds *		**A,B,H,O**		**X**	
Per- and Polyfluoroalkyl Substances *		**A,B,H,O**		**X**	

***The specific parameters included in this group of indicators are identified in IDEM's quality assurance project plan for surface water monitoring (IDEM, 2017).**

When analytical resources are available, sediment sampling is conducted in conjunction with fish tissue sampling in order to determine possible contaminant sources. Bioaccumulating contaminants in sediments are strongly associated with levels found in fish and can aid in determining the potential origins and extent of contamination. Results for the sediment indicators shown in Table 7 are used to supplement the fish tissue information.

Table 7: Core and supplemental indicators of bioaccumulative pollutants of concern in sediment

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Polycyclic Aromatic Hydrocarbons*		**A,B,H,O**		**X**	
Simultaneously Extracted Metals*		**A,B,H,O**		**X**	
Organochlorine Pesticides*		**A,B,H,O**		**X**	
PCB Aroclors*		**A,B,H,O**		**X**	
Semi-volatile organic compounds*		**A,B,H,O**		**X**	
Volatile organic compounds*		**A,B,H,O**		**X**	
PCB Congeners*		**A,B,H,O**		**X**	
Cyanide		**A,B,H,O**		**X**	

*** The specific parameters included in this group of indicators are identified in IDEM's quality assurance project plan for surface water monitoring (IDEM, 2017).**

4.4 BIOLOGICAL AND OTHER ECOLOGICAL INDICATORS

4.4.1 FISH COMMUNITY ASSESSMENT

OWQ conducts fish community sampling to determine the biological integrity of Indiana's rivers and streams. The Index of Biotic Integrity (IBI) is composed of 12 metrics that when analyzed together can be used to assess the community's species and trophic composition (feeding and reproductive guilds) and fish condition and health (Table 8). The total IBI score, integrity class and attributes help define fish community characteristics. Separate metrics have been developed based on drainage area for headwater streams (< 20 square miles), wadable rivers (20-1000 square miles), and great rivers (>1000 square miles). Additional scoring modifications exist for the Wabash River. All of the indicators shown in Table 8 are identified as "core" because they represent the metrics required for the calculation of the IBI. Appendix 1 provides a list of Indiana fish species and attributes used to calculate the fish IBI.

Table 8: Core fish community indicators

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Number of Species	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Number of Native Species	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Darter/Madtom/Sculpin Species Count	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Number of Darter Species	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Number of Minnow Species	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Percent Large River Individuals	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Percent Headwater Individuals	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Number of Sunfish Species	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Number of Centrarchid Species	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Number of Salmonid Species	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Number of Sucker Species	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Number of Round-Bodied Sucker Species	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Number of Sensitive Species	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Percent Tolerant Individuals	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Percent Omnivore Individuals	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Percent Insectivore Individuals	**A,B,F,G,M,O,P,Q**		**X**	**X**	

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Percent Pioneer Individuals	A,B,F,G,M,O,P,Q		X	X	
Percent Carnivore Individuals	A,B,F,G,M,O,P,Q		X	X	
Total Number of Individuals (CPUE)	A,B,F,G,M,O,P,Q		X	X	
Total Number of Individuals (CPUE) less gizzard shad	A,B,F,G,M,O,P,Q		X	X	
Percent Simple Lithophilic Individuals	A,B,F,G,M,O,P,Q		X	X	
Percent Individuals with Deformities, Eroded Fins, Lesions, Tumors	A,B,F,G,M,O,P,Q		X	X	

4.4.2 MACROINVERTEBRATE COMMUNITY ASSESSMENT

In addition to fish community sampling, OWQ conducts macroinvertebrate community sampling to determine the biological integrity of rivers and streams. The level of taxonomic resolution used in the identification of macroinvertebrates depends in large part on the condition (instar and physical condition) of the specimens and the availability of taxonomic resources that are comprehensive and appropriate for Indiana's fauna. Specimens are generally identified to the “lowest practical" taxonomic level. OWQ’s multi-habitat macroinvertebrate Index of Biotic Integrity (mIBI) is composed of 12 metrics that measure taxa richness, feeding and habitat preferences and tolerance to environmental stressors (Table 9). The total mIBI score, integrity class and attributes help define macroinvertebrate community characteristics. All of the indicators shown in Table 9 are identified as “core” because they represent the metrics required for the calculation of the multi-habitat mIBI. For more information on the mIBI, look in IDEM’s October 2020 QAPP for Biological Community and Habitat Measurements Appendix 2. IDEM Macroinvertebrate Community Assessments for Aquatic Life Use.

Table 9: Core macroinvertebrate community indicators

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Number of Taxa	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Number of Individuals	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Number of Ephemeroptera, Plecoptera, Trichoptera (EPT) Taxa	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Percent Orthocladiinae and Tanytarsini	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Percent Non-insects Minus Crayfish	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Number of Diptera Taxa	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Percent Intolerant Individuals	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Percent Tolerant Individuals	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Percent Predator Individuals	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Percent Shredders and Scrapers	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Percent Collector-Filterers	**A,B,F,G,M,O,P,Q**		**X**	**X**	
Percent Sprawlers	**A,B,F,G,M,O,P,Q**		**X**	**X**	

4.4.3 QUALITATIVE HABITAT EVALUATION INDEX

OWQ uses the Qualitative Habitat Evaluation Index (QHEI) to assess habitat quality at sites where the fish community and or resident macroinvertebrate community are sampled. The QHEI is a physical habitat index designed to provide an empirical, quantified evaluation of the general macrohabitat characteristics that are important to fish and macroinvertebrate communities. Habitat information is recorded and used to determine the score of six metrics describing the substrate, instream cover, channel morphology, bank erosion and riparian zone, pool/glide and riffle/run quality, and gradient (Table 10). The indicators identified as core represent the metrics required for the calculation of QHEI. Supplemental indicators are used to

provide additional information that is not necessary for the calculation of the QHEI but is used to augment the information it provides.

Table 10: Core and supplemental habitat indicators

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Substrate: Predominant Substrate in Pool and Riffle, Number of Substrates, % Total Substrates, Number of Best Substrate Types, Origin, Silt Cover, and Embeddedness	**F,G,O,Q**	**A,B**	**X**	**X**	
Instreams Cover: Type of Instream Cover, Amount of Instream Cover, % Total Instream Cover	**F,G,O,Q**	**A,B**	**X**	**X**	
Channel Morphology: Sinuosity, Development of Pool/Riffle/Run Habitats, Channelization, Stability,	**F,G,O,Q**	**A,B**	**X**	**X**	
Riparian Zone and Bank Erosion: Riparian Width, Floodplain Quality, Bank Erosion	**F,G,O,Q**	**A,B**	**X**	**X**	
Pool/Glide Quality: Maximum Pool Depth, Morphology of Pool vs. Riffle Width, Pool/Riffle/Run Current Velocity	**F,G,O,Q**	**A,B**	**X**	**X**	
Riffle/Run Quality: Riffle Depth, Run Depth, Riffle/Run Substrate, Riffle/Run Embeddedness	**F,G,O,Q**	**A,B**	**X**	**X**	
Gradient: Gradient (feet/mile), Drainage Area (square miles)	**F,G,O,Q**	**A,B**	**X**	**X**	
Major Suspected Impacts	**Q**	**A,B,F,G,O**	**X**	**X**	
Subjective and Aesthetic Rating		**A,B,F,G,O,Q**	**X**	**X**	
Canopy Cover		**A,B,F,G,O,Q**	**X**	**X**	
Percent Riffle		**A,B,F,G,O,Q**	**X**	**X**	
Percent Run		**A,B,F,G,O,Q**	**X**	**X**	
Percent Glide		**A,B,F,G,O,Q**	**X**	**X**	
Percent Pool		**A,B,F,G,O,Q**	**X**	**X**	
Stream Drawing		**A,B,F,G,O,Q**	**X**	**X**	

4.4.4 ALGAL COMMUNITY ASSESSMENT

Algal communities are sampled from lakes, rivers, and streams to fulfill different monitoring objectives. OWQ's algal monitoring focuses on two important components of algal biomass in surface waters, Chlorophyll *a* and diatoms (Table 11). Chlorophyll *a* is collected as a measure of algal biomass from phytoplankton which is needed for the development of nutrient water quality criteria for lakes. Diatom community sampling provides the information necessary to develop algal metrics to be used as a line of evidence in the development of nutrient criteria for rivers and streams.

In an effort to develop algal metrics for Indiana streams and rivers, IDEM includes algal identification and enumeration as part of its probabilistic and reference site sampling activities, collecting diatom samples. Studies have shown that algal community metrics often are a more precise indicator of nutrient enrichment compared to other response variables. One goal of this monitoring is to determine which circumstances periphyton diatom data indicate a stronger correspondence with nutrients than fish or invertebrate metrics do. Using data collected from this project, IDEM developed algal metrics which may be used to support and potentially enhance nutrient criteria development for Indiana's rivers and streams.

Table 11: Core and supplemental indicators of the presence of algal communities in surface waters

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Chlorophyll *a*	**E**	**A,B,M,O**	**X**		
Diatoms	**E**	**M**	**X**	**X**	

4.4.5 CARLSON'S TROPHIC STATE INDEX

IDEM's lakes sampling includes a comprehensive set of parameters to allow for various analyses of Indiana's lakes and reservoirs. For the assessments of trophic status, IDEM uses the Carlson's Trophic State Index (TSI). The Carlson TSI score is a measure of algal biomass that can be calculated for three variables, Secchi depth (SD), total phosphorus (TP), and Chlorophyll *a* (CHL). All three can be used as independent indicators of the amount of algal biomass present in the waterbody – the trophic state of the lake or reservoir in question. Unlike TP, which may or may not be a limiting factor in algal production, CHL concentration provides a more direct measure of phytoplankton abundance and is not affected by non-algal turbidity like Secchi depth can be. For the purposes of its CWA 314 assessments, IDEM uses only the TSI for CHL for trophic state classification. However, because divergent results for a given lake allow for comparisons that

can yield additional insights into how different components of a lake's ecosystem might be functioning, IDEM includes all three trophic scores in its reporting where possible.

Table 12: Core and supplemental indicators of lake trophic status

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Chlorophyll *a*	**A,B,D,E,F,O**			**X**	
Total Phosphorus		**A,B,D,E,F,O**		**X**	
Soluble Phosphorus		**A,B,D,E,F,O**		**X**	
Secchi Depth (Light Penetration)		**A,B,D,E,F,O**		**X**	
Organic Nitrogen		**A,B,D,E,F,O**		**X**	
Nitrate		**A,B,D,E,F,O**		**X**	
Ammonia		**A,B,D,E,F,O**		**X**	
Dissolved Oxygen (percent saturation at 5 foot depth)		**A,B,D,E,F,O**		**X**	
Dissolved Oxygen (percent of measured water column with at least 0.1 ppm)		**A,B,D,E,F,O**		**X**	
Light Transmission		**A,B,D,E,F,O**		**X**	
Total Plankton		**A,B,D,E,F,O**		**X**	
Blue-green Algae Percent		**A,B,D,E,F,O**		**X**	
Alkalinity		**A,B.D,E,F,O**		**X**	
Conductivity		**A,B.D,E,F,O**		**X**	
Total Suspended Solids		**A,B.D,E,F,O**		**X**	
Volatile Suspended Solids		**A,B.D,E,F,O**		**X**	
Land Use		**A,B.D,E,F,O**		**X**	

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
One Percent Light Level		**A,B,D,E,F,O**		**X**	
pH		**A,B,D,E,F,O**		**X**	
Temperature Profile		**A,B,D,E,F,O**		**X**	
Microcystin		**H**		**X**	

4.5 GROUND WATER INDICATORS

The core ground water indicators monitored through OWQ's Ground Water Monitoring Network (GWMN) include organic and inorganic parameters for which Safe Drinking Water Act maximum contaminant levels (MCLs) exist and which are most likely to affect surface water quality in streams impacted by ground water and surface water interactions (Table 13). Supplemental indicators are selected on a site-specific basis depending on the particular needs of the study to be undertaken. Supplemental indicators are usually monitored in areas known or suspected to be impacted by specific pollutants or other substances.

Table 13: Core and supplemental indicators of ground water quality

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Dissolved Metals (including dissolved arsenic)*	**A,B,I,J,O**			**X**	
Bromate	**A,B,I,J,O**			**X**	
Bromide	**A,B,I,J,O**			**X**	

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Chlorate	**A,B,I,J,O**			**X**	
Dissolved Metals (including dissolved arsenic)*	**A,B,I,J,O**			**X**	
Bromate	**A,B,I,J,O**			**X**	
Bromide	**A,B,I,J,O**			**X**	
Chloride	**A,B,I,J,O**			**X**	
Chlorite	**A,B,I,J,O**			**X**	
Fluoride	**A,B,I,J,O**			**X**	
Nitrogen, Nitrate	**A,B,I,J,O**			**X**	
Phosphorous, Ortho	**A,B,I,J,O**			**X**	
Sulfate	**A,B,I,J,O**			**X**	
Nitrate + Nitrite	**A,B,I,J,O**			**X**	
Dibromo-3-chloropropanes*		**A,B,I,J,O**		**X**	
Chlorinated Acids*		**A,B,I,J,O**		**X**	
Volatile Organic Compounds*		**A,B,I,J,O**		**X**	
(Amenomethyl) Phosphonic acid		**A,B,I,J,O**		**X**	
Phosphonic acid (Glyphosate)		**A,B,I,J,O**		**X**	
Unregulated Pesticide Degradates*		**A,B,I,J,O**		**X**	
Turfgrass Pesticides*	**A,B,I,J,O**			**X**	

Indicator	Monitoring Objective(s) from Table 1 (pp. 21-22)		Probabilistic	Targeted	Fixed Station
	Core	Supplemental			
Synthetic Organic Compounds*	**A,B,I,J,O**			**X**	
Alkalinity	**A,B,I,J,O**			**X**	

***The specific parameters included in this group of indicators are identified in OWQ's standard operating procedures for the GWMN (IDEM, 2010).**

5 QUALITY ASSURANCE

The United State Environmental Protection Agency (U.S. EPA) requires that any state delegated with the authority to implement federal programs and receiving federal funds must have a quality management plan (QMP). A QMP ensures the proper planning, implementation, and assessment of the state's quality assurance (QA) and quality control (QC) measures. The Indiana Department of Environmental Management's (IDEM's) QMP was initially approved by U.S. EPA in 1999. Revised first in 2005 and then again in 2012, the QMP serves as an Agency-wide umbrella structure and revised most recently in 2022. The revised Quality Assurance Project Plan (QAPP) for the Watershed Assessment and Planning Branch (WAPB) is currently under review.

5.1 QUALITY ASSURANCE OF OFFICE OF WATER QUALITY'S SURFACE WATER MONITORING PROGRAMS

OWQ's quality assurance project plan (QAPP) for surface water quality monitoring provides a measurement of environmental data quality and ensures that the data collected are validated and legally defensible for use in regulatory decision-making processes.

The surface water QAPP describes the quality assurance/quality control (QA/QC) methods, techniques, tools, protocols and other requirements necessary to ensure the collection of precise, accurate, and complete environmental data.

5.1.1 FIELD QA/QC

All sampling is conducted according to standard operating procedures (SOPs) to ensure collection methods are reproducible and data are representative of the media. QC checks employed by WAPB staff in the field include equipment calibrations with reference standards, collection of field duplicates and matrix spike/matrix spike duplicate samples, duplicate

samples, and field blanks. SOPs are stored electronically on IDEM's computer network and are available to all staff.

As part of its External Data Framework, the WAPB has developed both a *General Guidance* and a *Technical Guidance* for secondary data collection QA/QC and how to submit those data. Additionally, *Monitoring Water in Indiana: Choices for Nonpoint Source and Other Watershed Projects* is a monitoring manual written by Purdue University in 2012 under a CWA § 319 grant that provides the protocols, parameters, and resources to consider when designing a sampling program. *The Hoosier Riverwatch Volunteer Stream Monitoring Training Manual* was updated in 2022 and is another valuable resource for ensuring sampling QA/QC. These online catalogs of monitoring protocols support greater data sharing by providing external organizations the information they need to enhance the comparability of their data to the data collected by the WAPB.

5.1.2 LABORATORY QUALITY ASSURANCE/QUALITY CONTROL

OWQ's surface water QAPP also identifies in contracts the QC checks that must be used in IDEM's contracted laboratories that analyze samples collected by the WAPB. Such QC checks include instrument calibration and/or verification, laboratory duplicates and matrix spike/matrix spike duplicates samples, method blanks, the use of external standards, laboratory control samples, and surrogates, serial dilution, and interference checks.

5.1.3 DATA QUALITY REVIEW

The QAPP serves as a guide for QA/QC review by OWQ's contract laboratories and the staff charged with reviewing the analytical results they provide to ensure they meet the data quality requirements of the monitoring objective(s) for which the samples were collected.

Staff reviews all laboratory data reports to determine laboratory compliance with U.S. EPA approved methods and that the QA/QC procedures as prescribed in the QAPP have been followed for individual parameters. As part of the review process, a data quality assessment (DQA) level is assigned to each report to indicate the usability of the results. These DQA levels also provide the foundation for the data quality acceptance criteria for water quality data submitted through OWQ's External Data Framework (EDF):

Level 1 Screening Data – Results are usually generated onsite and have no QC checks. Analytical results that contain numbers with no corresponding QC checks, precision or accuracy information, or detection limit calculations are included in this category. Level 1 data are usable for pre-surveys and for preliminary rapid assessment.

Level 2 Field Analysis Data – Data are recorded in the field or laboratory on calibrated or standardized equipment. Field duplicates are measured on a regular periodic basis. Calculations may be done in the field or later at the office. Analytical results, which have limited QC checks, are included in this category. Detection limits and ranges have been set for each analysis. Information regarding QC checks for field or laboratory results is useable for estimating precision, accuracy, and completeness of the data set. Level 2 data are used independently for rapid assessment and preliminary decisions.

Level 3 Laboratory Analytical Data – Analytical results include QC check samples for each batch of samples from which precision, accuracy, and completeness can be determined. Method detection limits have been determined using 40 CFR Part 136 Appendix B. For contract laboratories, all reporting information required in the laboratory contract, and in the surface water QAPP is included in the analytical data reports. Raw data, chromatograms, spectrograms, and bench sheets are not included as part of the analytical report, but are maintained by the contract laboratory for easy retrieval and review. Data can be elevated from DQA Level 3 to DQA Level 4 if this information is included in the data report and the QC data are reported using U.S. EPA Contract Laboratory Program forms or format. Level 3 data are considered complete and legally defensible for regulatory decision-making.

Level 4 Enforcement Data – Analytical results, for the most part, meet U.S. EPA Contract Laboratory Program requirements for data analysis, contract required quantification limits and validation procedures. QC data are reported using U.S. EPA Contract Laboratory Program forms and/or format. Raw data, chromatograms, spectrograms, and bench sheets are included as part of the analytical report. All reporting information required in the laboratory contract and OWQ's surface water QAPP is included in the analytical data reports. Level 4 data are considered complete and legally quantitative in value for the purposes of regulatory decision-making and enforcement.

5.1.4 TIMELINES FOR QUALITY ASSURANCE PROJECT PLAN REVIEW AND STANDARD OPERATING PROCEDURE DEVELOPMENT/REVISION

IDEM's *Agency Wide Quality Management Plan* was revised in 2022. The WAPB Surface Water QAPP was revised in 2017and is currently under review for a 2022 update. It addresses the changes made to IDEM's surface water quality monitoring programs over the last five years.

SOPs are reviewed periodically and revised when necessary to reflect changes in monitoring and/or analytical procedures. OWQ develops and revises existing SOPs as needed to incorporate the changes described in the WQMS.

5.2 QUALITY ASSURANCE OF CLEAN LAKES PROGRAM MONITORING

Clean Lakes Program (CLP) monitoring is guided by two separate QAPPs, one for sampling and analyses conducted by Indiana University School of Public and Environmental Affairs (IU/SPEA), which was updated for the lake water quality monitoring 2022 sampling season, and another for the volunteer monitoring supported through the CLP. The CLP is currently funded through OWQ's Nonpoint Source Program, which requires that both QAPPs be reviewed and revised prior to the initiation of sampling activities under each new grant cycle. Both QAPPs are provided to IU/SPEA students, staff, and CLP volunteers to guide their monitoring. IU/SPEA has also developed a volunteer monitoring manual and training videos to serve as SOPs for CLP volunteers.

5.3 QUALITY ASSURANCE FOR HOOSIER RIVERWATCH MONITORING

The manual for the Hoosier Riverwatch (HRW) program was revised in 2022 to run in conjunction with the External Data Framework (EDF) noted in the following section.

5.4 QUALITY ASSURANCE FOR EXTERNAL DATA MONITORING

Secondary data are collected by external organizations for many different reasons and decision-making purposes; thus, the data quality objectives and QAPPS, if applicable, for those projects are specific to the monitoring project. IDEM provides general and technical guidance on the documentation that must be submitted with an organization's data that follows a tiered approach for data use and that is represented in Appendix 1 of the *EDF Technical Guidance*.

5.5 QUALITY ASSURANCE OF OFFICE OF WATER QUALITY'S GROUND WATER MONITORING NETWORK

The ground water monitoring activities discussed in the WQMS are covered in the sub-QMP for the Drinking Water Branch (IDEM, 2009). The specific procedures for implementing them are described in the *Statewide Ground Water Monitoring Network SOP* (IDEM, 2020). All data collected through the Ground Water Monitoring Network (GWMN) are analyzed by contract laboratories. The project manager is responsible for ensuring that monitoring procedures are correctly implemented and that the SOP is followed. Data quality review is conducted by the project chemist who determines if the data conforms to the QA/QC standards.

6 DATA MANAGEMENT

The Indiana Department of Environmental Management (IDEM) Office of Water Quality (OWQ) relies primarily on three databases to manage the data collected by its surface water monitoring programs – the United States Environmental Protection Agency (U.S. EPA) Assessment and TMDL Tracking and Implementation System (ATTAINS), the IDEM Assessment Information Management System (AIMSII), and the U.S. EPA Water Quality Portal (WQP)

databases. These databases are necessary to accurately organize water quality data, store it securely, and to make the data easily available to IDEM staff and other customers for use in various applications. They also enhance data quality by simplifying electronic data submission to reduce human error and by simplifying various quality assurance (QA) and quality control (QC) processes. Data from OWQ's ground water monitoring programs, Clean Lakes Program (CLP), and the Hoosier Riverwatch program monitoring programs are stored in separate databases administered by their respective programs. Volunteer monitoring data from the Hoosier Riverwatch program is not uploaded to WQX.

6.1 OFFICE OF WATER QUALITY'S ASSESSMENT INFORMATION MANAGEMENT SYSTEM DATABASE

The AIMSII database serves as a central repository for nearly all of the data collected by the Watershed Planning and Assessment Branch (WAPB) surface water quality monitoring programs. Water quality information stored in the AIMSII database is used for tracking water quality assessment data and designated use attainment, cataloguing impairments, and tracking causes and sources of impairment. All data in AIMS is uploaded to WQX.

Deployed over the IDEM Extranet for better accessibility throughout the agency, AIMSII, is a web-based front-end application that allows access to the data tables in which water monitoring results and other information are stored and facilitates project planning and data quality assurance, analysis and reporting. AIMSII stores results for physical and chemical surface water parameters, fish community data (both the index of biological integrity scores and individual metrics), macroinvertebrate community data (both the macroinvertebrate index of biological integrity scores and individual metrics), bacteriological data, habitat information, fish tissue contaminant data, and sediment contaminant data. These data can be retrieved in a variety of ways including by location (latitude/longitude, decimal degrees or Universal Transverse Mercator) sample collection date, waterbody name, hydrologic unit code, county, ecoregion, etc. The web front-end application for AIMSII was developed to assist staff in all phases of project implementation from the planning stage through data analysis and reporting. The application utilizes a Microsoft.Net web application to access data that are stored in Oracle tables.

In addition to efficient data storage and retrieval, AIMSII provides a structure to assist in conducting QA analysis of data that is entered into the database. A number of specific steps have been incorporated into OWQ's information management process and, where possible, have been built into the AIMSII application. This includes procedures and formats for the following:

- Data entry and QC standards for overall data quality assessment. Data quality assessment to define precision and accuracy of results. Data and information dissemination and related documentation.
- Data reduction (scores and other metrics as environmental indicators).
- Standards for use of data in reports (using known data quality assessment for each project).

6.1.1 MANAGEMENT OF NONPOINT SOURCE GRANT PROJECT DATA AND DATA SUBMITTED THROUGH OFFICE OF WATER QUALITY'S EXTERNAL DATA FRAMEWORK

The AIMSII database also includes the ability to integrate nonpoint source monitoring data collected by external organizations for projects funded through IDEM's Nonpoint Source Program and others interested in submitting their data through the External Data Framework (EDF). The ability to integrate data from multiple sources allows OWQ to better support internal and external data requests by providing a more comprehensive set of data, which is accurately characterized in terms of its data quality and appropriateness for various uses.

The nonpoint source function of AIMSII supports the internal data management needs associated with OWQ's EDF and serves as an important component of the guidance that external organizations can receive. The templates developed for nonpoint source data submission can be used by any external organization to standardize its project metadata, which describes the data it will collect, and its water quality data for submission through the EDF. Providing such documentation helps external organizations ensure that the data they collect are of known quality, enhancing the usability of the data and creating new opportunities for collaboration.

6.2 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY'S WATER QUALITY EXCHANGE DATABASE

Data generated and collected by the WAPB are submitted to the IDEM Water Quality Exchange Node (WQX) for direct transmission to U.S. EPA's Water Quality Exchange (WQX) database. Transmission to U.S. EPA's Storage and Retrieval (STORET) database was discontinued with the decommissioning of the database in 2018. Data on the WQX database is retrievable through the Water Quality Portal (WQP) which is the premier source of discrete water quality data in the United States and beyond. Uploads occur no less than monthly. WQX facilitates IDEM's compliance with reporting requirements of PL 92-500 Clean Water Act (CWA) and IDEM's Environmental Performance Partnership Agreement with U.S. EPA.

6.3 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY'S ASSESSMENT AND TOTAL MAXIMUM DAILY LOAD TRACKING AND IMPLEMENTATION

ATTAINS is a specialized database developed by U.S. EPA for states to store information related to their CWA § 305(b) and 303(d) assessment and listing decisions and their CWA § 314 assessments. ATTAINS is a companion database to AIMSII - AIMSII stores water quality monitoring data while ATTAINS stores assessment decisions based on those data. OWQ uses ATTAINS to organize this information for the purposes of developing its Integrated Water Monitoring and Assessment Report and 303(d) List of Impaired Waters. U.S. EPA uses this information to incorporate Indiana's water quality assessment information into its national water quality assessment database and to prepare its CWA 305(b) comprehensive report to Congress.

A critical component in OWQ's management of CWA assessment information is its Reach Index. OWQ developed its Reach Index based on the USGS National Hydrography Dataset (NHD) [1]. Through the reach indexing process, OWQ assigns every waterbody that appears on the NHD for Indiana unique assessment unit identification (AUID) codes, which define the extent of the waterbody that is considered representative for the purposes of water quality assessments. The AUID codes in Indiana's Reach index allow OWQ to "key" the waterbody assessment information stored in ATTAINS to their geographical location. This facilitates mapping Indiana's 305(b) assessments and 303(d) listings using geospatial information systems software and incorporation of this information into U.S. EPA's national databases including products like How's My Waterway. In 2015, OWQ completed its revision of the Reach Index at the high resolution 1:24,000 scale, which facilitates more representative water quality assessments.

6.4 CLEAN LAKES PROGRAM DATA MANAGEMENT

Currently Clean Lakes Program (CLP) data are stored in a database managed by Indiana University Paul H. O'Neill School of Environmental Affairs which administers the program for IDEM under a CWA § 319 grant. These data are provided to IDEM regularly for the purposes of making its CWA assessments, which are then entered into ATTAINS.

IDEM incorporates some of the CLP data submitted to IDEM into its AIMSII database and has worked with the CLP to achieve a higher data quality assessment level.

6.5 OFFICE OF WATER QUALITY'S GROUND WATER MONITORING NETWORK DATABASE

[1] The NHD is a database created by U.S. EPA and the U.S. Geological Survey that provides a comprehensive coverage of hydrographic data for the United States. It uniquely identifies and interconnects the stream segments that comprise the nation's surface water drainage system and contains information for other common surface waterbodies such as lakes, reservoirs, estuaries, and coastlines.

Results from ground water sampling conducted through OWQ's Ground Water Monitoring Network and Private Well Complaint Response Program are currently entered into the Ground Water Monitoring Network database. This is a Microsoft Access database developed by OWQ and maintained by staff in OWQ's Ground Water Section. When resources become available, OWQ plans to put this database online to facilitate downloading of the data. In order to ensure the security of public and private drinking water supplies, results are associated with estimated locations only.

7 DATA ANALYSIS AND ASSESSMENT

All water monitoring data collected will be interpreted to meet the monitoring objectives identified in Table 1 of the Water Quality Monitoring Strategy (WQMS).

7.1 CLEAN WATER ACT § 305(B) DESIGNATED USE ASSESSMENTS AND DEVELOPMENT OF INDIANA'S 303(D) LIST OF IMPAIRED WATERS

The Office of Water Quality (OWQ) Clean Water Act (CWA) § 305(b) designated use assessments and the development of its § 303(d) List of Impaired Waters are guided by the agency's Consolidated Assessment and Listing Methodology (CALM). Almost all of the water quality data collected by the Watershed Assessment and Planning Branch (WAPB) can be used to support CWA 305(b) assessments. The data are compared to the narrative and numeric water quality criteria articulated in Indiana's water quality standards to determine the extent to which the waterbody supports its designated uses. Waters that fail to meet the designated use assessed are placed on the 303(d) List of Impaired waters.

7.2 CLEAN WATER ACT § 314 ASSESSMENTS OF LAKE TRENDS AND TROPHIC STATE

IDEM's lakes sampling includes a comprehensive set of parameters to allow for various analyses of Indiana's lakes and reservoirs. For the assessments of trophic status, IDEM uses the Carlson's Trophic State Index (TSI). The Carlson TSI score is a measure of algal biomass that can be calculated for three variables, Secchi depth (SD), total phosphorus (TP), and Chlorophyll-*a* (CHL). All three can be used as independent indicators of the amount of algal biomass present in the waterbody – the trophic state of the lake or reservoir in question. Unlike TP, which may or may not be a limiting factor in algal production, CHL concentration provides a more direct measure of phytoplankton abundance and is not affected by non-algal turbidity like Secchi depth can be. For the purposes of its CWA 314 assessments, IDEM uses only the TSI for CHL for trophic state classification. However, because divergent results for a given lake allow for comparisons that can yield additional insights into how different components of a lake's ecosystem might be functioning, IDEM includes all three trophic scores in its reporting where

possible. OWQ's methods for calculating the Carlson TSI score and using this score to assign a trophic status and determine trends in trophic status are described in its CALM.

7.3 TOTAL MAXIMUM DAILY LOAD (TMDL) DEVELOPMENT

Data collected for TMDL development are used in conjunction with continuous flow data, which is typically obtained from the nearest USGS gaging station, to develop flow and load duration curves.

Flow duration curves display the cumulative frequency of distribution of the daily flow for the period of record. The flow duration curve relates flow values measured at the monitoring station to the percent of time that those values are met or exceeded. Flow duration curves are transformed into load duration curves by multiplying the flow values along the curve by applicable water quality criteria values for the pollutant in question and appropriate conversion factors.

Pollutant loads are estimated from the water quality monitoring data as the product of the pollutant concentrations, instantaneous flows measured at the time of sample collection, and appropriate conversion factors. In order to identify the plotting position of each calculated load, the recurrence interval of each instantaneous flow measurement is defined. Water quality pollutant monitoring data are plotted on the same graph as the load duration curve which provides a graphical display of the water quality conditions in the waterbody. The pollutant monitoring data points that are above the target line exceed the water quality criteria, and those that fall below the target line meet the applicable water quality criteria.

7.4 MEASUREMENT OF CLEAN WATER ACT GRANT PROGRAM PERFORMANCE

Most of the performance measures outlined in the United States Environmental Protection Agency's (U.S. EPA's) *Strategic Plan for 2022-2026* require that OWQ's CWA grant programs achieve measurable improvements in water quality as demonstrated by the removal of one or more impairments from the state's 303(d) list. Therefore, the data collected for the purposes of measuring OWQ's grant program performance are analyzed in the same manner as data collected for the purposes of making CWA 305(b) designated use assessments and developing the 303(d) list, which is described in OWQ's CALM. Waters that are identified through these monitoring activities as meeting the applicable water quality criteria for the parameter(s) originally impaired may be removed from the 303(d) list and considered a measure of success subject to the criteria outlined in U.S. EPA's Strategic Plan and summarized in § 2.1.6 of the WQMS.

7.5 DETERMINATION OF WATER QUALITY TRENDS

7.5.1 TRENDS IN FISH TISSUE CONTAMINANTS

The WAPB maintains an extensive fish contaminants database that allows for trend assessment at many different levels of resolution, local to statewide. In order to maintain the levels of resolution, adequate data collection on an annual basis is necessary. Fish tissue concentrations are compared to numerous established state and national benchmarks. Increases and decreases of these benchmark exceedances across time are indicators of trends. Numerous species are utilized as indictors in building weight-of-evidence trends in contaminants. Graphic and tabular methods of displaying and interpreting data are used in order to analyze trends temporally and spatially. These trends are also used to determine how to allocate limited analytical resources.

7.5.2 TRENDS IN WATER CHEMISTRY COLLECTED AT FIXED STATIONS

An analysis of total phosphorus data at fixed station sites in the Western Lake Erie Basin from 2008-2015 was performed by staff. The first exercise was to graph concentration (no flow data) trends. Then, an analysis was done to ascertain flow weighted mean concentrations in order to inform the development of Indiana's Domestic Action Plan under the Great Lakes Water Quality Agreement, Nutrients Annex 4. This analysis employed both the load duration curve and the United States Geological Survey (USGS) Load Estimator (LOADEST) models as well as the Purdue University LOADEST interface and the USGS desktop application. The resultant map has been useful in determining the sub-watersheds with the highest total phosphorus loads. More staff trained on the use of these models will accelerate state-wide characterization of nutrient loads for the *State Nutrient Reduction Strategy* and to prioritize nutrient reduction implementation efforts. In 2019, staff expanded on this analysis by determining time weighted and flow weighted mean concentrations at all fixed station sites in the state using data from 2009-2018. Parameters were expanded and included total phosphorus, total nitrogen, and total suspended solids. Resulting concentrations and maps help inform on areas of the state with the greatest contributions of nutrients and sediment.

A 2013 analysis of fixed station data by USGS (made possible by a CWA Supplemental 106 grant) entitled *Water Quality in Indiana: Trends in Concentrations of Selected Nutrients, Metals, and Ions in Streams, 2000–10* was published in 2014. This study combined water quality data

from the Indiana Fixed Station Monitoring Program (FSMP) with streamflow data from nearby USGS streamgages. A parametric time-series model, QWTREND, was used to develop streamflow-adjusted constituent concentrations, to adjust for seasonal variance and serial correlation, and to identify trends independent of streamflow-related variability. This study examined 7,345 water samples from 57 FSMP sites for 11 years. Concentration trends were analyzed for 12 constituents—the nutrients nitrate, organic nitrogen, and phosphorus; suspended solids; the metals copper, iron, lead, and zinc; the ions chloride and sulfate together with hardness as a measure of the calcium carbonate ion; and dissolved solids.

WAPB used FSMP data to analyze trends from 2011-2020 using QWTREND. The results can be found here.

7.6 DEVELOPMENT OF PUBLIC HEALTH ADVISORIES

7.6.1 RECREATIONAL USE ADVISORIES

TOXIC CYANOBACTERIA ALERTS – The cyanobacteria and cyanotoxin data collected through IDEM are used by the IDOH Epidemiology Resource Center: Harmful Algal Blooms to provide general information on harmful algal blooms, as well as up-to-date information on testing sites. The Indiana Department of Natural Resources (IDNR) uses the data to educate swimmers and boaters of possible high levels of blue-green algae at a selection of Indiana's reservoirs and lakes. For protection of human health from exposure to the cyanobacteria and associated toxins, cyanobacteria will be compared to the World Health Organization (WHO), United States Environmental Protection Agency (EPA) and Ohio Department of Health (ODH) guidelines. WHO guidelines recommend using an action level of 100,000 cells/ml to post beach advisory signs. Swimming areas will stay on the high cell count alert until the cell counts fall below 100,000 cells/ml. Beach caution and closure alerts are based on the "Human Recreation" toxin thresholds. Cell counts, toxin thresholds and levels are found on the Blue-Green Algae web site http://www.in.gov/idem/algae/.

BEACH CLOSURES – The funds IDEM provides Lake Michigan coastal communities from the Beaches Environmental Assessment and Coastal Health (BEACH) Act are used to monitor public beaches and post public health advisories. Water samples are analyzed for *E. coli*, a core indicator of disease-causing organisms, using either a 16-18 hour test or a 24-hour test. If a water sample concentration exceeds the 235 colony forming units per 100 mL (the state single sample maximum criterion for *E. coli*), the beach manager must take action by either posting an advisory or closing the beach. These data may also be used by organizations outside of IDEM to develop predictive models.

7.6.2 FISH CONSUMPTION ADVISORIES

The fish tissue contaminants data collected through IDEM are used by the Indiana Department of Health (IDOH) to advise the public on safe fish consumption of recreationally caught and commercial fish. This is an annual collaborative effort of IDEM, IDOH, and the IDNR with support from Purdue University. Fish tissue data are analyzed to determine the amounts of fish that are safe to consume, which depends on the species, size, and location of where the fish are caught. Indiana's sport fish advisories are currently based on levels of polychlorinated biphenyls, mercury, and PFAS found in fish tissue. During the last four decades more than 5,500 fish tissue samples have been analyzed for polychlorinated biphenyls, pesticides, and heavy metals of concern.

The decision-making criteria used to develop the Fish Consumption Advisory (FCA) was agreed upon and revised in 2016 by the Indiana interagency fish consumption advisory workgroup. The protocols are based in part on protocols documented in the Great Lakes Sport Fish Advisory Task Force published in 1993, the subsequent addenda for mercury, which was finalized in 2007, and the Best Practice for Perfluorooctane Sulfonate (PFOS) Guidelines.

7.7 GROUND WATER AND SOURCE WATER

Currently, data collected through OWQ's Ground Water Monitoring Network are analyzed by comparing results to Safe Drinking Water Act maximum contaminant levels. Statistical analyses include statewide intra-well comparisons, trends in ground water quality within and among different aquifers and across hydrogeologic settings. OWQ uses modeling to further analyze areas where ground water contamination is identified. In areas where sufficient surface water data exists, modeling may also be used to characterize surface water and ground water interactions.

8 REPORTING

8.1 INTEGRATED REPORTING

The Clean Water Act (CWA) § 305(b) requires states to make water quality assessments and provide water quality reports to the United States Environmental Protection Agency (U.S. EPA) and § 303(d) requires states to submit a list of impaired waters to U.S. EPA. Since 2002, in accordance with U.S. EPA guidance, the products from both of these processes, 305(b) water quality assessments and the 303(d) List of Impaired Waters, have been combined into one report for submission to U.S. EPA.

The Integrated Water Monitoring and Assessment Report (IR) contains the comprehensive results of many of the Indiana Department of Environmental Management (IDEM) water quality assessments made for the purpose of CWA § 305(b) and identifies waters that are fully supporting and those that are not supporting their designated uses as defined in Indiana's water quality standards. Those that are not supporting are considered impaired and are placed on the 303(d) List of Impaired Waters. The Office of Water Quality (OWQ) processes for water quality assessment and listing are described in detail in its Consolidated Assessment and Listing Methodology (CALM).

OWQ submits the entire IR, including the 303(d) list, to U.S. EPA every two years. OWQ also excerpts the 303(d) list and supporting materials from the IR and submits them separately to U.S. EPA to facilitate the federal review and approval process required specifically for the 303(d) component of the report.

The IR is published on IDEM's website at: http://www.idem.IN.gov/nps/watershed-assessment/water-quality-assessments-and-reporting/integrated-water-monitoring-and-assessment-report/

8.2 TOTAL MAXIMUM DAILY LOAD (TMDL) REPORTS

TMDL reports are developed to meet the requirements of CWA § 303(d) and contain a quantitative assessment of water quality problems, contributing sources, and load reductions or control actions needed to restore and protect the designated uses of individual waterbodies. Load duration curves are used to help determine pollutant loads and sources.

The TMDL reports to be developed each year are guided by IDEM's *TMDL Program Priority Framework.* In consultation with U.S. EPA, IDEM develops a candidate pool of potential TMDL waters on which to focus for each cycle of the Clean Water Action Section 303(d) Program Vision and then refines those commitments on a 2-year timeframe according to local group capacity to implement. These TMDL commitments are included in the Environmental Performance Partnership Agreement (EnPPA) between the U.S. EPA and IDEM. The TMDL development schedule is included with IDEM's IR submission every two years and specifies the TMDLs that will be completed over the next two-year cycle. TMDL reports can be used by watershed groups, state and local officials, municipalities, and others in their water quality restoration efforts whether they are implementing the measures provided in the TMDL or in their watershed improvement plans or evaluating the status of water bodies where TMDLs or nonpoint source projects have been conducted. All TMDL reports completed or in progress are available online at: http://www.idem.IN.gov/nps/resources/total-maximum-daily-load-reports/

8.3 U.S. EPA STRATEGIC PLAN PERFORMANCE MEASURE REPORTS

OWQ's Watershed Assessment and Planning Branch (WAPB) develops reports to meet U.S. EPA's performance measures for its CWA programs:

- The *Number of primarily NPS-impaired waterbodies partially or fully restored by NPS program actions* performance measure shows how NPS restoration efforts are improving water quality. To meet this measure, OWQ must identify nonpoint source-impaired waters that have been improved as a result of watershed restoration efforts.

Performance measures reports are posted on the website and may be found at: http://www.idem.IN.gov/nps/what-is-nonpoint-source-pollution/make-a-real-difference/

8.4 REPORTING THROUGH PARTNERING AGENCIES

8.4.1 INDIANA DEPARTMENT OF HEALTH FISH CONSUMPTION ADVISORIES

The Indiana Fish Consumption Advisory (FCA) is issued annually by the Indiana Department of Health (IDOH) based on data provided from IDEM OWQ's fish tissue monitoring activities.

The development of the FCA is a collaborative, interagency effort. IDEM collects and manages the majority of the data. The Indiana Department of Natural Resources (IDNR) has been instrumental in the collection of fish tissue samples from Lake Michigan and a number of inland lakes where special studies have been conducted. The decision-making criteria used to develop the FCA was agreed upon and revised in 2016 by the Indiana interagency fish consumption advisory workgroup. The protocols are based in part on protocols documented in the Great Lakes Sport Fish Advisory Task Force published in 1993 and subsequent addenda for mercury, which was finalized in 2007. The statewide FCA is published online at: https://secure.in.gov/health/eph/fish-consumption-advisory/

8.4.2 REPORTING ON CYANOBACTERIA AND ALGAL TOXINS

IDEM, the IDNR, the IDOH, and the Board of Animal Health (BOAH) partner to provide information about cyanobacteria and algal toxins in Indiana lakes. The IDEM website found at https://www.in.gov/idem/algae/ is updated weekly during the sampling season to provide information about blue-green algae levels at the IDNR lakes that IDEM samples. The IDEM video, Sampling Blue-green Algae, explains how IDEM staff samples the IDNR swimming beaches.

The public can check the status of the IDNR lakes that IDEM samples at the IDNR website for the specific property. This update may also include results for other lakes sampled by other entities wishing to post on this site. Links to IDEM's sampling results and laboratory tests as well as links to other websites such as the World Health Organization, the United States Geological

Survey (USGS) Kansas Water Science Center, and assorted information available through other states are available on IDEM's website.

8.5 BEACHES ENVIRONMENTAL ASSESSMENT AND COASTAL HEALTH ACT REPORTS

Funding from the federal Beaches Environmental Assessment and Coastal Health (BEACH) Act was used to develop Beach*Alert*. This portal contains information about Indiana's coastal and inland beaches. *BeachAlert* provides information about beach advisories, closures, sampling schedules, *E.* coli testing results, beach signage and beach amenities. IDEM works with local organizations to perform water quality monitoring and notification activities at participating beaches. Any sample result that exceeds Indiana's recreational water quality standard of 235 cfu/100ml requires the local beach manager to post an alert.

Local beach managers use the results of their BEACH Act funded monitoring activities to notify the public of potential risk by posting state-approved beach advisories or beach water closure signs at their beaches.

IDEM also provides Indiana's Lake Michigan shoreline beach communities with kiosks to display the beach advisory signs in addition to relevant information on the causes and risks associated with *E. coli* contamination.

8.6 LAKES MONITORING REPORTS

In addition to providing data to OWQ for its assessment and reporting processes, Indiana University School of Public and Environmental Affairs (IU/SPEA) develops Indiana Lake Water Quality Assessment Reports approximately every four years, which are published on the IU/SPEA Clean Lakes Program website.

8.7 GROUND WATER REPORTS

In 2016, IDEM released the 2016 Ground Water Monitoring Network Summary and Results Report, which details the first round of statistically-based sampling. From this data, it is possible to make general statements about ground water quality in Indiana.

The primary reporting mechanism for OWQ's ground water monitoring data is OWQ's IR. In accordance with U.S. EPA guidance, OWQ provides a summary of its ground water monitoring data and a discussion of the results in the IR every two years. Major sources of contamination are discussed along with OWQ's ground water protection efforts.

In addition to incorporating ground water monitoring results into the IR, results for sites sampled through the Private Well Complaint Response program are provided to the homeowners requesting the sampling along with additional information to help them understand the results and better protect their wells.

8.8 HOOSIER RIVERWATCH (HRW) REPORTS

The HRW program publishes a quarterly newsletter that reports on the various volunteer monitoring workshops across the state, the type of workshop and the demographics of the workshop. The first newsletter in the calendar year typically provides an annual recap of the previous year. The HRW website is found at www.idem.IN.gov/riverwatch. The data collected from volunteer monitors are entered into the HRW database, which can be searched at: http://www.hoosierriverwatch.com/

8.9 FACT SHEETS

Fact sheets have been developed for WAPB programs that support the Water Quality Monitoring Strategy (WQMS). These provide program specific information for OWQ's monitoring activities including monitoring objectives, participants, description, specific products, technical notes, and contact information. Fact sheets are updated as time allows and will be developed for all the new monitoring activities described in the WQMS.

8.10 WATER QUALITY DATA REQUESTS

In addition to reporting data internally to IDEM programs that request it, OWQ routinely receives requests from external parties for water quality data stored in the AIMSII database and assessment information stored in ATTAINS. Such requests are initiated primarily through email correspondence.

Approximately 100 water quality data requests are filled per year where data are provided in either spreadsheet or database file format. Other requests often require only an acknowledgement of the existence of data. Requests are normally filled within three to four business days. IDEM also refers requesters to the WQP.

OWQ receives approximately 30-40 requests for assessment information each year, which are typically filled within two weeks of the initial request. For these requests, a report is generated from ATTAINS and is sent to the requester along with additional explanatory information as needed.

8.11 OTHER REPORTS

Data generated as a result of special studies may be reported in National Pollutant Discharge Elimination System (NPDES) Permit or modeling documents, Office of Land Quality *Remediation Sites Reports*, compliance or enforcement documents or included in data requests. All data are furnished to the requesting program area after the data set has been verified by the OWQ's quality assurance process. Where appropriate, a report is prepared that summarizes and presents the data with comments and analysis.

9 PROGRAM EVALUATION

9.1 OFFICE OF WATER QUALITY'S APPROACH TO EVALUATING ITS MONITORING PROGRAMS AND WATER QUALITY MONITORING STRATEGY (WQMS)

In January or early February each year, the Watershed Assessment and Planning Branch (WAPB) conducts an annual review of its previous year's monitoring programs with field monitoring staff, laboratory staff, QA/QC and data management staff, and TMDL and NPS program staff as well as the WAPB management team and technical specialists. The WAPB reviews the monitoring projects to discuss what worked, challenges/difficulties, data gaps, and to determine if any changes are needed for the upcoming field season projects, which are identified and put into the annual monitoring matrix. Logistics for field, lab, and data management as well as monitoring designs are standard topics and there are often several bigger picture or policy issues that are addressed. The decisions from the meeting(s) are documented and stored on IDEM's internal SharePoint site and communicated to senior staff.

IDEM will share the outcomes of the annual review with United States Environmental Protection Agency (U.S. EPA). Any significant proposed changes to monitoring designs will be discussed with U.S. EPA and incorporated into the WQMS, which IDEM will seek to make web-based with the accompanying annual project work plans.

9.2 FUTURE ENDEAVORS

<u>Investigating changes in aquatic life use assessment methodology using macroinvertebrate and fish communities</u>

Modernization of the fish and macroinvertebrate indices of biotic integrity was completed in March 2017 using reference sites and new data to develop new IBI metrics and new scaling for the IBI (0-100 rather than 0-60). For the new fish IBI, the metrics are dependent on sampling methodology (wadeable or non-wadeable) and stream size (drainage area and gradient). For the new macroinvertebrate IBI, the metrics are dependent on ecoregion and watershed. Biological Condition Gradient (BCG) models were developed for fish in November 2016 and macroinvertebrates in March 2017. The BCG is a conceptual model which describes how the biota of aquatic habitats are expected to change in response to increasing levels of human influence that tend to degrade the natural properties of those habitats. For BCG levels 1-6, level 1 represents the biota in a highly natural, undisturbed condition; level 6 at the other end of the gradient represents highly degraded (i.e., unnatural) biota. The BCG Level can be used as another assessment tool (in addition to the IBI) to detect measurable changes in the aquatic biota at various increments of human stress and provide a precise way to detect degradation. IDEM will investigate revisions to the Consolidated Assessment Listing Methodology for aquatic life use based on the combination of the new IBI and BCG.

Stream Regional Monitoring Network (RMN)

IDEM will add three sites to the Stream Regional Monitoring Network following installation of equipment and monitor these sites annually to share the information with U.S. EPA. IDEM purchased 6 HOBO Water Temperature Pro v2 Data Loggers and 3 MicroRX Weather Stations for this project.

Electronic Field Data Entry

WAPB uses an accessible electronic data system (AIMS II) for site information, water quality, fish tissue, toxicity, sediment chemistry, habitat, and biological data; however, portions of the site reconnaissance, water quality, biological, and habitat data are written on data sheets in the field and then entered manually as time allows in the office. To address timely data entry for data management, WAPB is proposing to use FFY22-23 Monitoring Initiative Funds to develop a data entry mobile application on tablets for entering field results in the AIMS II database. The project will enhance Indiana's monitoring strategy by maximizing the efficiency by which data are entered into the AIMS II database and reducing staff time for data entry and quality control; thus, granting staff additional time to investigate changes to monitoring designs, indicators, and sampling methodologies; conduct analyses of data; and produce written reports of data collected.

Monitoring in the Western Lake Erie Basin (WLEB) to Further Characterize Phosphorous Loading Sources

The Maumee River

Indiana's Domestic Action Plan to reduce phosphorus loading to the WLEB proposes using the existing United States Geological Survey (USGS) monitoring site at Antwerp, Ohio to determine its progress in meeting the spring- time flow weighted mean concentration (FWMC) target load of 0.23 mg/L total phosphorus and 0.05 mg/L dissolved reactive phosphorus on the Maumee River as it flows out of Indiana. This site was chosen versus a site on the border as hydrological modifications upstream of the border in Indiana render the Antwerp site more representative of Indiana's nutrient contribution. IDEM, the Ohio Environmental Protection Agency, the USGS, and the U.S. EPA are working together to create a long-term monitoring network within the Lake Erie Basin that will provide a more robust, consistent water quality data set.

The St. Mary's River

IDEM contracted the USGS to install an auto-sampler and monitor the St. Mary's River just prior to its confluence with the St. Joseph River to form the Maumee in order to determine the sources and extent of sediment and nutrient loading. The data collected from this monitoring will help inform management decisions in the watershed. As the monitoring protocols are further developed by the Annex 4 Monitoring Task Group, IDEM will work with its various partners to enhance monitoring in the WLEB.

Dissolved Reactive Phosphorus (DRP)

IDEM secured laboratory equipment for IDOH to use for DRP analyses. Lower detection limits are achievable with this new instrument, resulting in a more robust dataset. WAPB staff collect DRP at 12 fixed station sites in the WLEB.

Monitoring to Determine Sediment and Nutrient Loads Entering and Leaving Indiana via Major Rivers and Tributaries

IDEM has participated on the Indiana Water Monitoring Council's (InWMC) Optimization Task Group to analyze the existing monitoring network across the State of Indiana to determine monitoring gaps and redundancies in order to optimize limited monitoring resources. Some of the gaps identified from that exercise are continuous flow data at a number of the network sites on or near the border and the lack of monitoring stations, particularly in the western and southern parts of the state to determine sediment and nutrient loads entering and leaving Indiana. Over the next few years, IDEM will work with the InWMC to identify the most critical locations for monitoring and help seek resources to install stream flow gages and auto-samplers or supergages.

Monitoring gaps

IDEM is working with EPA and Tetra Tech to identify coolwater streams in Indiana and modify new biological indices for coolwater streams. Temperature logger data, water chemistry and biological assemblages were collected from 90 sites around the State. Following data collection and interpretation, new biotic indices will need to be modified to accurately evaluate biological assemblage expectations for coolwater streams.

IDEM is partnering with the Indiana State Chemist Office to analyze neonicotinoids as part of an RCPP project, Blue River Indian Creek. WAPB would be interested in incorporating routine sampling and analyses for neonicotinoids for a subset of Fixed Station sites, if the State Chemist Office and IDOH are willing and able to be partners with IDEM to determine laboratory methods and holding times. Funding and staff resources could be a barrier.

IDEM has a goal of installing three weather stations with cameras for the Stream Regional Monitoring Network in 2023. In fact, two stations have already been set up and are collecting data. Consideration will be given to participating in the Lake Regional Monitoring Network in the future if funding and staffing resources are available.

IDEM plans to continue to make updates to the Cyanobacteria Monitoring Program. WAPB will explore the feasibility of determining cyanobacteria biovolume, qPCR analysis, and moving to a two tier warning system. Staff resources and funding could be barriers along with buy-in from partner agencies.

10 GENERAL SUPPORT AND INFRASTRUCTURE PLANNING

The Watershed Assessment and Planning Branch has instituted efficiencies that enable the branch to better meet more of its primary water monitoring objectives within current resource restraints.

10.1 CURRENT STAFF RESOURCES

The creation of a single branch combining the efforts of nonpoint source pollution prevention, watershed management, surface water quality monitoring, laboratory activities and quality assurance/quality control functions has facilitated greater opportunities for cross-training and synchronization between programs for more efficient work.

The WAPB has 42 full-time equivalents. Of those FTEs, 22 are dedicated to accomplishing the work of this WQMS: 18 are dedicated to sample collection and identification, 1 for laboratory work, and another 2.5 for quality assurance/ quality control (QA/QC) of the data and to manage lab contracts. The current employees have a broad range of skills as well as specific areas of expertise that successfully execute branch tasks and strive to continuously improve the logistics of the work as well as the deliverables.

10.2 CURRENT LABORATORY SUPPORT AND OFFICE OF WATER QUALITY LABORATORY RESOURCES

Laboratory support for the surface water and ground water chemistry samples and fish tissue samples the Office of Water Quality (OWQ) collects comes from a combination of contract laboratories, in-house lab support, and state agency lab support.

Surface water chemistry samples and fish tissue samples are collected and delivered to certified laboratories under contract with the State of Indiana according to the WAPB quality control measures. Analytical support for fixed station monitoring is provided at no cost to IDEM through a memorandum of agreement with the IDOH. This relationship is reciprocal. OWQ contributes a significant amount of fish tissue data to the development of the IDOH fish consumption advisory each year, the analytical costs of which are covered by OWQ's Laboratory Services Contract Fund. Additionally, OWQ purchased for IDOH additional analytical equipment for dissolved reactive phosphorus (DRP) with detection ability for reportable limits of 0.05 mg/L. The WAPB currently operates three laboratories as well as two mobile *E. coli* labs. OWQ also dedicates resources to the calibration and maintenance of water quality monitoring equipment.

The WAPB's bacteriology laboratory is used to analyze most of the *E. coli* samples collected through the WAPB's various monitoring activities and is augmented by two mobile *E. coli* laboratories, in which sample analyses can be conducted while in the field.

The WAPB's biological laboratory consists of three separate, smaller laboratories, one in which fish samples are processed and identified, another where macroinvertebrate samples are processed and identified, and another for cyanobacteria enumeration, identification and toxin analysis.

10.3 CURRENT FUNDING SOURCES

OWQ relies on a variety of funding sources and services provided by partnering agencies to support its monitoring activities, including:

- CWA § 106 Grant Funds.
- CWA § 319 Grant Funds.
- State Laboratory Services Contract Fund.
- CWA § 106 Supplemental Grant Funds.
- CWA § 205(j) Grant Funds.

10.3.1 CLEAN WATER ACT § 106 FUNDS

Federal Clean Water Act (CWA) § 106 funds are granted to IDEM by the U.S. EPA, and are based on IDEM's Environmental Performance Partnership Agreement (EnPPA) with U.S. EPA, which is renewed every two years. Indiana's CWA § 106 varies from year to year based on the federal congressional budget and is augmented by monies from the state's dedicated funds, which are added as match for the federal funds received.

CWA § 106 funds provide the primary support for many OWQ programs including those that conduct water quality monitoring as well as other programs that do not. OWQ allocates the largest portion of the CWA § 106 funds received to support surface water programs with the remaining funds allocated to ground water programs. The majority of both allocations are used to pay salaries of staff in various OWQ programs while the remaining funds pay for training, travel, equipment and supplies related primarily to OWQ's monitoring activities.

10.3.2 CLEAN WATER ACT § 319 GRANT FUNDS

Federal CWA § 319 funds are granted to IDEM by U.S. EPA for the purposes of addressing Indiana's nonpoint source pollution issues. This funding source has remained relatively stable over the past few years, with approximately $3.4 million annually for which Indiana provides 40 percent match. Approximately $1.1 million per year covers administrative costs including the salaries of staff that administer the nonpoint source grant programs, with the remaining $2.3 million passed through for local watershed planning and implementation efforts. Funds are passed to external organizations for implementation of approved watershed management plans (WMPs) and for restoration activities. Two monitoring programs, the Hoosier Riverwatch and the Clean Lakes Program are funded through the 319 grant program.

10.3.3 LABORATORY SERVICES CONTRACT FUND

OWQ's Laboratory Services Contract Fund comes from funds dedicated by the Indiana State Legislature to support environmental monitoring activities. This funding, amounting to approximately $875,000 annually continues to provide critical support for OWQ's surface and ground water monitoring activities.

The Laboratory Services Contract Fund is used primarily to pay for analytical work done by contract laboratories and is shared among all IDEM offices that use contract laboratories for analytical services. The funds allocated to OWQ are shared between the WAPB and the Drinking Water Branch (DWB). With this fund, the WAPB finances contract lab services such as:

- Probabilistic monitoring chemistry analysis.
- Targeted monitoring chemistry analysis.
- Fish tissue and sediment contaminants analysis.

The DWB uses its share of these funds to cover the analytical cost of samples collected through its Ground Water Monitoring Network, its Private Well Complaint Response Program and some special projects.

10.3.4 CLEAN WATER ACT SUPPLEMENTAL 106 GRANT FUNDS

Each budget cycle, U.S. EPA sets aside a portion of the total CWA § 106 Funds awarded by Congress. This appropriation is passed through to states as CWA §106 Supplemental Grant Funds, which are typically awarded as one- to two-year grants to support state monitoring activities.

The WAPB and DWB coordinate to develop proposals for these funds which commonly include different projects to enhance their respective monitoring programs. OWQ uses Supplemental

106 funds to support a number of activities identified in the previous WQMS as gaps or areas requiring improvement.

10.3.5 CLEAN WATER ACT § 205(J) GRANT FUNDS

CWA § 205(j) allows states to reserve up to one percent of their annual Clean Water State Revolving Fund Loan Program Capitalization Grant allocation for water quality management planning activities. These funds are awarded to OWQ as a grant, of which 40 percent must be offered as state grants to regional planning organizations. The remaining 60 percent of these funds may be either passed through as grants to external organizations or used internally by OWQ for projects that support water quality assessment and planning projects. IDEM has used the money for water quality monitoring and water quality database enhancements. CWA § 205(j) allocations vary from year to year in the range of $325,000 - $350,000.

10.3.6 SERVICES PROVIDED BY PARTNERING AGENCIES

The value of sample analysis done by the IDOH for both surface water and ground water projects is great as it provides the WAPB with the ability to complete year-round monitoring to develop watershed characterizations and water quality trends across the state. IDNR collects fish tissue from Lake Michigan for the contaminant's program and also provides valuable data quality assurance/quality control support to OWQ by allowing one of its aquatic biologists to perform voucher checks for 10% of the fish community samples collected by the WAPB.

10.4 FUTURE NEEDS

This WQMS reflects IDEM's commitment to implement efficiencies in both logistics and monitoring designs to collect high quality data that are usable for multiple management objectives including the following actions:

- Cross-training staff to work in several program areas, for example on field sampling crews and in the laboratories;
- Organizing monitoring logistics for optimal resource allocation and for quick redeployment;
- Using data from the various monitoring programs and projects to address multiple CWA program objectives and for program management decisions; and
- Implementing the External Data Framework to make CWA § 305(b) water quality assessments, to inform the development of Indiana's CWA § 303(d) List of Impaired

Waters, to determine trends, and to help identify where WAPB follow-up monitoring might be warranted.

10.4.1 TRAINING NEEDS

Many efficiencies have been realized since the creation of the WAPB. Paramount to the efficiencies achieved has been the cross-training of staff and assignment of staff to projects based on their skills, experience and interest. Cross-training has included:

- Total maximum daily load development.
- Water quality assessments.
- Statistical data analysis and water quality modeling.
- Watershed planning and management.
- Biological monitoring.
- Water chemistry monitoring.
- Data quality review processes.
- Laboratory analytical methods.
- Macroinvertebrate processing and identification.
- Diatom identification and enumeration.
- Analysis of 316 (b) (entrainment/entrapment) reports submitted by NPDES permittees.

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