Ohio EPA Five-Year Surface Water Monitoring Strategy: 2000 - 2004

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FOREWORD

Statewide Biological and Water Quality Monitoring & Assessment
Ohio EPA routinely conducts biological and water quality surveys, or "biosurveys", on a systematic basis statewide. A biosurvey is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. Such efforts may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites or a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. Each year Ohio EPA conducts biosurveys in 10-15 different study areas with an aggregate total of 300-400 sampling sites. Biological, chemical, and physical monitoring and assessment techniques are employed in biosurveys in order to meet three major objectives: 1) determine the extent to which use designations assigned in the Ohio Water Quality Standards (WQS) are either attained or not attained; 2) determine if use designations assigned to a given water body are appropriate and attainable; and 3) determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices. The data gathered by a biosurvey is processed, evaluated, and synthesized in a biological and water quality report. The findings and conclusions of each biological and water quality study may factor into regulatory actions taken by Ohio EPA and are incorporated into Water Quality Permit Support Documents (WQPSDs), State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the Ohio Water Resource Inventory (305[b] report).

Five Year Basin Approach
In 1990 the Ohio EPA initiated an organized, sequential approach to monitoring and assessment termed the Five-Year Basin Approach. One of the principal objectives of this new approach was to better coordinate the collection of ambient monitoring data so that information and reports would be available in time to support water quality management activities such as the reissuance of NPDES permits and periodic revision of the Ohio water quality standards (WQS). The initial step in this process was to section the state into 25 different hydrologic units which represented aggregations of subbasins within the 23 major river basins previously delineated by Ohio EPA for the PEMSO system. The 25 hydrologic EPA districts. Thus within a given year, monitoring takes place within five of the

areas were each assigned to one of five basin years with respect to the five Ohio hydrologic areas *and* within each of the five Ohio EPA districts. Five years is required to complete the cycle of monitoring within each of the 25 hydrologic areas. Once the field monitoring is completed, data analysis and reporting takes place. The end product is termed a Technical Support Document (TSD) which contains the summary and integration of the biological, chemical, and physical assessments.

Ohio EPA's approach to surface water monitoring and management via the Five-Year Basin Approach essentially serves as an environmental feedback process taking "cues" from environmental indicators to effect needed changes or adjustments within water quality management. This hierarchy is essentially in place within the TSD process and represents, from a technical assessment and indicators framework standpoint, a watershed approach. The environmental indicators used in this process are categorized as stressor, exposure, and response indicators. *Stressor* indicators generally include activities that impact, but which may or may not degrade the environment. This includes point and nonpoint source loadings, land use changes, and other broad-scale influences that generally result from anthropogenic activities. *Exposure* indicators include chemical-specific, whole effluent toxicity, tissue residues, and biomarkers, each of which suggest or provide evidence of biological exposure to stressor agents. *Response* indicators include the direct measures of the status of use designations. For aquatic life uses the community and population response parameters that are represented by the biological indices that comprise Ohio EPA's biological criteria are the principal response indicators. For human body contact uses (*e.g.*, Primary Contact Recreation) fecal bacteria (*e.g.*, *E. Coli*, fecal coliforms) are the principal response indicators. The key to having a successful watershed approach is in using the different types of indicators within the roles that are the most appropriate for each. The inappropriate use of stressor and exposure indicators as substitutes for response indicators is at the root of the national problem of widely divergent 305(b) statistics reported between the States. This issue is discussed in the 1994 Ohio Water Resource Inventory (Ohio EPA 1995).

Monitoring for Status and Trends

An assessment of the impact of multiple sources on the receiving waters of a effluent, sediment, flows), biological (fish and macroinvertebrate assemblages), and

watershed includes an evaluation of the available chemical/physical (water column, habitat data which have been collected by Ohio EPA pursuant to the Five-Year Basin Approach. Other data which is evaluated includes, but is not limited to, NPDES permittee self-monitoring data, effluent and mixing zone bioassays conducted by Ohio EPA, the permittee, or U.S. EPA, spills data compiled by Ohio EPA, and fish kill information from the Ohio Division of Wildlife. The integration of this information into a report for each study area is accomplished via the TSD process. Besides reporting on status and trends for the applicable designated uses, the TSD also identifies and describes causal associations of use impairments with the predominant causes and sources of impairment. The completion of this process enables the structured use of the output from the TSD (*i.e.*, the assessment of water bodies) to support virtually any Ohio EPA program where surface water quality is a concern.

Technical Bulletin Series

The systematic monitoring and assessment of Ohio surface waters via the Five-Year Basin Approach since 1990, and overall since 1980, has produced a comprehensive database that can be used to address issues of statewide and program importance. As such, Ohio EPA periodically produces technical bulletins to provide an in-depth analysis of specific issues ranging from the validation of specific water quality criteria to process descriptions for tools such as the biological criteria. These analyses would not be possible without the systematic baseline monitoring and assessment which are an aggregate result of the Five-Year Basin Approach.

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ACKNOWLEDGEMENTS

The Five-Year Surface Water Monitoring Strategy was compiled from the many years of experience and work of numerous Ohio EPA, Division of Surface Water staff in the Central and District Offices. !!CONTRIBUTORS & REVIEWERS WILL BE ADDED IN FINAL!! The strategy was coordinated and compiled by Chris Yoder.

Chapter 1: The Role of Monitoring in Water Quality Management

1.1 Introduction

There is abundant evidence and appreciation that our air, land, and water resources are subject to a variety of effects of human activities on local, regional, national, and global scales. However, mere recognition that these effects can occur and that some are potentially detrimental is simply insufficient. The ability to measure the extent and severity of these effects and further understand the causes and sources of adverse effects is needed to construct accurate, effective, and proportionate management responses. Good environmental monitoring is the key to enabling this process.

Environmental monitoring is the systematic collection and evaluation of data about the chemical, physical, and biological quality of the environment and how external changes exerted both naturally and anthropogenically affect that quality (Cooly 1976). The pace of the latter has been greatly accelerated during the 20th century on local, regional, and even global scales. However, the mere recognition and cataloguing of such changes is insufficient for developing strategies to abate and manage the harmful activities.

Some estimate that more than $500 billion has been spent on water pollution abatement nationally since the early 1970s. Yet, with only a few exceptions, we have largely been unable to document the effectiveness of these expenditures in environmental terms (ITFM 1992). The reason may lie in the fact that only 0.2% of the amount spent on water pollution abatement has been devoted to ambient monitoring (ITFM 1992), clearly an inadequate amount. Our challenge then is to measure, characterize, and understand the significance of these changes and this is crucial to the effective management and protection of water resources. Good, comprehensive environmental monitoring is an indispensable component of achieving this goal (ITFM 1992).

Monitoring and assessment information, when based on a sufficiently comprehensive and rigorous system of environmental indicators, is integral to protecting human health, preserving and restoring ecosystem integrity, and sustaining a viable economy. Such a strategy is intended to achieve a better return on public and private investments in environmental protection and natural resources management. In short, more and better monitoring and assessment

information is needed to answer the fundamental questions that have been repeatedly asked about the condition of our water resources and shape the strategies needed to deal with both existing and emerging problems within the context of watershed-based management.

ITFM/NWQMC Recommendations

Monitoring plays a key role in the management of surface water resources by driving the progression of events from initial problem identification and characterization through the making of management decisions in such areas as pollution abatement and water quality management programs to the enforcement of laws and regulations. A long succession of federal laws and guidance have attempted to relate the purposes of water monitoring directly to management goals. Initial guidance for the coordination of federal water data acquisition activities date to that issued by the U.S. Bureau of the Budget in 1964. More recently the Intergovernmental Task Force on Monitoring Water Quality (ITFM) issued a series of reports (ITFM 1992, 1993) and a national strategy for water monitoring (ITFM 1995) which lead to the establishment of the National Water Quality Monitoring Council (NWQMC) in 1997. Simply stated, these latter efforts were aimed at revitalizing the role of monitoring in state and federal water quality management programs to provide the basic data and information needed to answer questions about the status and trends of water quality nationwide and guide the development of new water quality management activities.

Improving the current situation requires a strategy which has generally been provided by the ITFM and federal 106 monitoring guidance. According to the ITFM (1992), water monitoring has four major aspects:

Context

Monitoring should be the foundation of water resource policy making and management. This means that monitoring information should not only be available to managers and policy makers, but be sufficiently comprehensible and conclusive. A critical aspect is not just providing data and information, but an assessment of what that information means. This includes a determination of whether or not important criteria, standards, and other management requirements are being achieved and the degree (both quantitatively and qualitatively) to which any are being exceeded or abrogated. This process

requires the use of multiple classes of indicators, each functioning within their most appropriate role and in their proper relationship to each other.

Scope
Monitoring includes the following activities: articulating objectives; collecting, storing, and interpreting data; conversion of data to information; preparing assessments of the information (what does it mean?); communication of assessment results; and evaluation of management program performance. This organization allows water quality management programs to become more appropriately focused on the resource at issue, as opposed to the caretaking of administrative systems and processes. This fosters an approach of managing for results in the environment where administrative processes are tools to improve the environment, not an endpoint in themselves (Figure 1).

Scale
Monitoring includes all relevant scales such as site-specific investigations, regional descriptions and comparisons, and statewide summaries at various temporal scales. State monitoring strategies need to be constructed so that the same basic core data supports assessments at all of these scales. The specific designs, indicators, and assessment tools used must be tailored to the regional peculiarities in climate, soils, land use, geology, ecological resources, socioeconomic influences, and geography. Thus the indicators that are used need to be sufficiently developed and calibrated to reflect these influences and the scales at which the monitoring program must operate.

Objectives
Generally, monitoring objectives include: 1) defining status and trends; 2) identification of existing and emerging problems; 3) support of water quality management policy and program development; 4) evaluating program effectiveness; 5) responding to emergencies, and 6) continued development and improvement of the understanding of the basic chemical, physical, and biological processes that affect environmental quality.

Effective monitoring and, by extension, water quality management programs need the supporting infrastructure in terms of personnel and logistical support to carry out monitoring from a “cost-of-doing-business” standpoint. At this time the

proportion of a State water quality management program that should encompass all monitoring and assessment activities is estimated to range from 10-20% in terms of staffing and funding. This figure may vary by State depending on some of the variables described above.

1.2 **Federal Requirements and Guidance**

Monitoring program requirements are generally articulated in the Water Quality Planning and Management regulations (40 CFR Part 130) as follows:

> 130.4 Water Quality Monitoring
>
> (a) In accordance with section 106(e)(1), States must establish appropriate monitoring methods and procedures (including biological monitoring) necessary to compile and analyze data on the quality of waters of the United States and, to the extent practicable, ground waters.
>
> . . . and,
>
> (b) The State's water monitoring program shall include the collection and analysis of physical, chemical, and biological data and quality assurance and control programs to assure scientifically valid data. The uses of these data include determining abatement and control priorities; developing and reviewing water quality standards, total maximum daily loads, wasteload allocations and load allocations; assessing compliance with National Pollutant Discharge Elimination System (NPDES) permits by dischargers; reporting information to the public through the section 305(b) report and reviewing site-specific monitoring efforts.

References to monitoring based information requirements and the implications of resulting assessments also appear in parts 130.5 (Continuous Planning Process), 130.6 (Water Quality Management Plans), 130.7 (Total Maximum Daily Loads), 130.8 (Water Quality Report), and 130.10 (State submittals to EPA).

As the State agency with delegated authority under the Clean Water Act, Ohio EPA must comply with federal requirements and guidelines issued by U.S. EPA. For monitoring and assessment activities, U.S. EPA issued guidance for the

development of State monitoring and assessment programs for awarding Section 106 and 604[b] grants in 1994 (U.S. EPA 1994). According to this guidance, States should provide a multi-year (preferably on a 5-year cycle) monitoring strategy with the 106 grant application. This strategy provides the framework for the Regional/State agreement on the annual monitoring workplan. The monitoring strategy should be consistent with and developed in support of related water quality management program goals. It should include a description of how the State will integrate ambient and program-specific monitoring such as nonpoint source assessments, lakes, wetlands, coastal waters, CSOs, stormwater, TMDLs, and 305(b)/303(d) reporting. The strategy should explicitly describe how these are integrated to provide the total body of information necessary to support water quality management programs.

Section 106/604(b) Monitoring Guidance

Revised monitoring guidance issued under sections 106 and 604(b) became available in October 1994 (U.S. EPA 1994) following a lengthy process. This was largely an outgrowth of the ITFM process which took place between 1991 and 1995 and which has been detailed in 3 reports (ITFM 1992, 1993, 1995). The 106/604(b) guidance updates and supersedes previous guidance published in 1984 by U.S. EPA, Region V (U.S. EPA 1984) and later by U.S. EPA in 1985 (U.S. EPA 1985). The 1994 strategy lists five key objectives for the monitoring program:

1) the identifications of impaired waters throughout the U.S.;
2) increasing the number of waters assessed by utilizing cost-effective techniques and methods appropriate to the condition of and goals for specific water bodies;
3) achieving greater comparability in parameters and methods to enable improved data sharing and geographical comparability;
4) using common indicators to report on the condition of the nation's waters; and,
5) improving information sharing with both public and private organizations and in the context of watersheds.

These were further allied with the theme of revitalizing State monitoring programs and reporting core information in a comparable manner.

Monitoring Strategy Goals

The overall goal of the 106/604(b) strategy is to develop and implement a surface and ground water monitoring strategy to help achieve the goals and objectives of the Clean Water Act (CWA) and other environmental initiatives. This requires the use of a mix of approaches that provide for the design, collection, measurement, storage, retrieval, assessment, and biological/ecological data necessary to efficiently and effectively meet the objectives of the strategy.

An acceptable State monitoring strategy includes the following purposes:

1) determining status and trends;
2) identifying causes and sources of impairment and threats and ranking in priority order;
3) designing and implementing water quality management programs;
4) determining program effectiveness; and,
5) responding to emergencies.

Implementing a State strategy consistent with these purposes should support the development and attainment of water quality standards (WQS), TMDL/303(d) listing and development, NPDES permitting, nonpoint source assessment and management, watershed and ecosystem protection, and the development and use of environmental indicators.

Design and Coverage

The goal of the U.S. EPA monitoring guidance is to assess all State waters (surface, ground, and coastal) on a periodic basis ranging from 4-10 and as negotiated between the Region and the State. The monitoring design(s) used by the State should consider the condition of and goals set for various waters and should include a mix of networks including synoptic surveys, fixed stations, intensive and screening level monitoring, and probabalistic monitoring. Many States already employ a five-year rotating basin design.

Data Collection and Methods

The major theme is to produce chemical, physical, and biological data of a known quality so as to enhance and improve comparisons across and between States and to make the data useable for data sharing purposes. A key issue in meeting this

objective of the federal guidance is to establish data quality objectives for each data or indicator type. Multiple indicators are to be used and should encompass chemical, physical, and biological measures and be relevant to the water quality management issues being assessed. Sampling locations should also be located consistently and in accordance with U.S. EPA's Locational Data Policy (U.S. EPA 1994).

Environmental Indicators

States are to identify specific environmental indicators to measure and use in reporting progress towards meeting identified program goals. This process requires an understanding of the most appropriate role of individual indicators and having mechanisms in place by which these indicators can be tracked and reported on a regular basis.

Data and Information Management

Data is to be stored in a manner so that it is easily retrieved, analyzed, and available for sharing between agencies and institutions. These data should also be entered or uploaded into the EPA STORET and Waterbody System (WBS) databases.

Analysis and Reporting

Reporting should take place, at a minimum, in accordance with the requirements and guidance issued for section 305(b) reports which includes using the WBS. Other reports should be produced and tailored to the State specific needs and audiences.

Reference Condition

Ecoregional reference conditions should be established for the analysis of water quality and biological data. This process is specifically recommended for the development of biological criteria and is useful for determining regional patterns in a host of environmental variables and indicators.

Collaboration

Monitoring activities should be conducted in coordination with existing and planned programs in other public and private organizations in order to maximize the benefits of data sharing.

EPA Water Indicators Initiative

Another important component of the overall approach to improving and revitalizing monitoring and assessment as an integral part of State water quality management has been the recent initiatives by U.S. EPA to institutionalize the use of environmental indicators. Increasing the usage of environmental indicators is an important goal of the U.S. EPA, Office of Water. EPA intends to change the way progress towards meeting Clean Water Act goals is measured and in how EPA conducts business with the States. EPA wishes to shift from what has become a singular reliance on administrative activity indicators ("bean counting") to a broader reliance on comprehensive environmental measures. EPA also believes that environmental indicators presents an opportunity for States to reduce the burden of EPA oversight. In exchange, an increased emphasis on environmental indicators and basic information gathering (i.e., ambient monitoring and assessment) is sought through the savings gained in reduced administrative requirements. The commitment of U.S. EPA to the concept of a comprehensive environmental indicators framework is exemplified by the following vision statement:

> "EPA will use environmental indicators, together with measures of activity accomplishments, to evaluate the success of our programs. Working in partnership with others, we will be able to report status and trends of U.S. and global environmental quality to the public, Congress, states, the regulated community, and the international community. National program managers will use environmental indicators to determine where their programs are achieving the desired environmental results, and where inadequate results indicate strategies need to be changed. Over time, as more complete data are reported, environmental indicators will become the Agency's primary means of reporting and evaluating success".

This also responded to the mandates of the Government Performance and Results Act (GPRA) which spurred the development of strategic goals by the Office of Water, national indicators for surface waters (U.S. EPA 1995a), a conceptual framework for using environmental information in decision-making (U.S. EPA 1995b), and the Environmental Performance Partnership Agreement concept. While these are critical first steps in addressing some of the previously mentioned

program deficiencies, there remain wide gaps between the U.S. EPA vision statement and the support that is provided for adequate State monitoring programs, particularly for bioassessments and biological criteria. Such criticisms are not new (*e.g.*, U.S. GAO 1986).

Related initiatives include the State Environmental Goals and Indicators Project (Berquist et al. 1995) and the ITFM effort. Each of these outlined partial frameworks for addressing deficiencies in water quality management. Taken together, these offer a more complete approach that should more effectively guide the better use of State, local, and Federal resources and hopefully lead to solutions for some of the remaining and much more complex water resource problems that are identified with improved monitoring and assessment efforts.

Adequate State Monitoring Program

The question of what constitutes an adequate State watershed monitoring and assessment program has yet to be fully articulated by U.S. EPA even though this is implicitly obvious from the growing list of programs which require this type of information. Successfully addressing this issue is key to resolving current deficiencies and inequities within and between State programs and questions about the reliability of State and national 305(b) reports and, by extension, 303)d) listings, nonpoint source and watershed management, and water quality standards.

Through a cooperative agreement between Ohio EPA and U.S. EPA, Yoder (1997) outlined the important elements and concepts of an adequate State watershed monitoring and assessment effort. This document relied principally on the recommendations of the ITFM process, EPA's environmental indicators initiative, and Ohio EPA's own experience in operating a consistently funded program for a period of 18 years. Elements of this document are detailed in section 3.

1.3 State Requirements and Guidance

Ohio EPA is a delegated State for CWA programs and as such is responsible for carrying out all water quality management activities which includes monitoring and assessment (40 CFR Part 130) and water quality standards (40CFR Part 131). Additionally, the Ohio Water Pollution Law (ORC 6111) and Ohio Administrative Code (OAC 3745) contain several provisions which at least indirectly relate to the use of monitoring and assessment information in support of agency management

activities for surface waters.

Ohio Water Pollution Law (ORC 6111)

The Ohio Water Pollution Law allows the Director to conduct studies, investigations, research, and demonstrations and disseminate findings related to the causes, prevention, and control of water pollution (*e.g.*, ORC 6111.03). In addition, other provisions of the law either require or allow the consideration of monitoring and assessment information in the administration and development of discharge permits, water quality standards, planning, and permits to install. References to comprehensive studies and water quality planning in ORC 6111.042 at least implicitly refer to the use of this type of information. Administrative rules contain more specific references to specific activities and indicators.

Ohio Administrative Code (OAC)

The Ohio WQS (OAC 3745-1) contain chemical-specific criteria which are expressed as numerical concentrations designed to prevent lethality, acute toxicity, and chronic effects to aquatic life, wildlife, and humans. Physical criteria are also included (*e.g.,* temperature) and are designed to prevent adverse effects to populations and communities of aquatic life. Biological criteria are numerical endpoints which are used to serve as attainment/non-attainment thresholds for the common warmwater habitat aquatic life use designations. Narrative provisions in the WQS set general standards for the overall condition of water bodies and aquatic life and wildlife. These criteria can functionally serve as environmental indicators either singly or as aggregate index measurements. As such, these provide the most direct targets by which monitoring provides the basic data to determine compliance. Further embedded within these criteria and associated concepts are the supporting information that is used to calibrate the applications of specific chemical, physical, and biological criteria. For example, the biological criteria are calibrated and derived based on a network of regional reference sites which are stratified by ecoregion, stream and river size, and other regional stratification elements. Reference thresholds have also been developed for chemical/physical parameters in the water column and bottom sediments for use in assessments. The emerging area of nutrient criteria development will require a similar approach. Monitoring and assessment is required not only to provide the basic data, but as a maintenance function since regionally-derived criteria are revisited on a 10 year cycle.

The criteria and process for developing water quality based limitations for discharges is detailed in OAC 3745-2. These were developed as part of the Great Lakes Water Quality Guidance (GLWQG) process and include rules for reasonable potential determinations, background chemical quality, mixing zone requirements, permit issuance conditioned on monitoring results, and procedures for whole effluent toxicity limits. Federal requirements for this are included in 40CFR Part 122.

Strategic Planning Process

In 1994 a Strategic Management Council was organized to develop and implement an action plan to arrive at an initial vision for the Strategic Management Process (Ohio EPA 1996a). The action plan included identification of customers and their requirements, an inventory of existing planning activities, and an update of the planning calendar initially developed at the senior staff retreat. Benchmarking with other planning processes was accomplished by reviewing numerous articles and publications regarding planning in general and case studies of governmental agencies in particular. The Strategic Management Process is a six-step process: 1) situation assessment; 2) strategic direction; 3) strategy development; 4) resource acquisition and allocation; 5) annual plans; and, 6) work schedules. Included among the long term goals of this process is that of increasing the number and miles of streams and rivers achieving swimmable/fishable goals from 50% to 75% by the year 2000. Tracking this goal is based on the data and information supplied by ambient surface water monitoring. In support of the long term goals, three strategic themes are prevalent in all the division/district/office plans. The themes are 1) Public and Community Involvement, 2) Quality Service Improvements, 3) Technical Assistance/Compliance and Outreach. These themes represent some of the "hows" the Agency will employ to achieve the long term goals.

The approach to implementing these themes within the surface water program is as follows:

- Improving and Protecting Water Resource Quality
- Watersheds
- Information Management
- Monitoring and Assessment

- Ohio EPA Quality Principles
- Communication, Legislative/Regulatory Efforts
- Tools (*e.g.,* permits, grants, GIS, enforcement actions, multi-stakeholder processes, pollution prevention, compliance assistance).

The Watershed approach is the coordinating framework for the management of water resources. Partnerships, which span all levels of government and involve both private and public entities, are key to designing and implementing watershed goals. The application of specific management tools (*e.g.,* permits, grants for local implementation techniques, enforcement actions, computer networking, data management, pollution prevention, nonpoint source pollution controls, stormwater prevention, etc.) is to be based on a comprehensive analysis of the water resource. The plan also calls for the consideration of new and innovative operations and technologies where they result in net water quality improvement including the development of alternative pollution control strategies as a means to attaining water quality standards. This may include, but is not limited to, pollutant trading, pollution prevention activities, pollution minimization plans, phased TMDLs (total maximum daily loads), compliance incentives, pooling and leverage of financial resources for implementation and supplemental environmental projects. The surface water programs are in the midst of a transition to a watershed management approach. In this approach the District Offices provide a critical connection to local and regional stakeholders and work directly with these partners by developing and supporting watershed approaches.

Monitoring and assessment is a critical component of the overall strategic management process within the Division of Surface Water. Specifically the plans states that DSW ". . . will maintain and build upon the successes of our *monitoring and assessment program* and other information management system components to produce the necessary environmental indicators of water resource quality and expand our universe of useful information". Furthermore this will be linked to the watershed geographic unit. DSW's information management systems will be improved and include internal data from categories and sources such as effluent quality and flow for point sources, compliance statistics, ambient chemical and biological data, locational data, and non-regulatory actions (*e.g.,* nonpoint grants)for more efficient and widespread use throughout DSW. Better use of external sources of data, *i.e.*, ODNR wetlands inventory, Nature works, etc. will be made.

The strategic plan calls for DSW to support and maintain the presently used monitoring and assessment tools and designs. In terms of monitoring and assessment output DSW will strive towards the goal of satisfying ambient monitoring and assessment demands to at least 80 percent of that identified annually. At the same time, there will be an effort to develop new monitoring and assessment tools and approaches with the goal of enhancing the Five-Year Basin Approach to attain the national goal of assessing 100 percent of surface water resources. Part of this will entail making use of monitoring data provided by other (non-Ohio EPA) institutions and organizations provided they meet data quality objectives and QA/QC requirements. Emphasis will be placed on encourage these groups to develop high quality and robust assessment capabilities that meet the appropriate data quality objectives.

This type of monitoring and assessment approach fosters management for water resource integrity which integrates chemical/physical variables, biotic factors, flow regime, habitat structure, and energy source. Management resources can then be focused on the principal causes and effects of impairment based on the results of monitoring and assessment. This includes responding to the conclusions and information in the Ohio Water Resource Inventory (305[b] report) and other synthesized data by adjusting programmatic and policy directions as needed. DSW is committed in the strategic management process to investigate and determine causes and sources of impairment, their relative magnitude, geographic variation, and any data and information gaps when characterizing them. This also includes supporting research and development to enhance understanding the causes of water resource impairments, problem discovery, trends, and the development of new and revised policies and procedures for emerging issues.

Finally, the information provided by monitoring and assessment will be used to build foundations which support needed legislation and regulations for accomplishing water resource improvements and implementation of the watershed approach. Using water quality assessment and program analysis, gaps and needs in legislation and regulations to address water resource management will be identified.

1.4 **Informational and Indicators Hierarchy**

An important outcome of the strategic planning and management process was the

need to make better use of existing and new environmental indicators. For surface waters, DSW completed an environmental indicators pilot project in association with U.S. EPA, Office of Water. This project was intended to test the national indicators for water that were then being considered and many of which were eventually adopted (U.S. EPA 1995a, 1995b). Increasing the use of environmental indicators is an important goal of the Office of Water. EPA intends to change the way progress towards meeting Clean Water Act goals is measured and in how EPA conducts business with the States. EPA wishes to shift from what has become a singular reliance on administrative activity indicators ("bean counting") to a broader reliance on comprehensive environmental measures. EPA also believes that environmental indicators presents an opportunity for States to reduce the burden of EPA oversight. In exchange, an increased emphasis on environmental indicators and basic information gathering (*i.e.*, ambient monitoring and assessment) is sought through the savings gained in reduced administrative requirements.

An environmental indicator is defined as ". . . a measurable feature which singly or in combination provides managerially and scientifically useful evidence of ecosystem quality, or reliable evidence of trends in quality." (ITFM 1995) This definition provides some of the underlying ground rules by which environmental indicators should be used. Indicators should not only have a firm basis in science, but have relevance to management needs and uses. Environmental indicators, when used within their most appropriate roles, provide the means by which water quality management programs can successfully link management actions to environmental results. This approach will be most successful when direct measures (as opposed to surrogates) are used to measure goals such as those embodied in the designated uses defined within State water quality standards.

Our vision for environmental indicators has resulted in the institutionalization of indicator usage throughout the water quality management process at Ohio EPA. This has resulted in better environmental communication, forecasting, policy making, program evaluation, and budget decisions. Furthermore, environmental indicators have become an integral component of environmental decision-making. This now supplements administrative activity measures (i.e., "bean counting"). Indicators have been accepted as objective measures of environmental quality, not necessarily as negative or positive sources of environmental information.

Environmental indicators are also becoming harmonized across all levels of government. This has been accomplished by focusing on the following areas:

1. Environmental communication: Indicators now provide legislators, the Governor's office, and other public officials with understandable end-points enabling better informed, more accountable decisions to be made. A natural shift towards decision-making based on environmental data and information occurred as the information base was developed and strengthened.

2. Environmental information management and data acquisition: Environmental indicators based on environmental data are relied upon as valid, science-based information in lieu of anecdotal sources. Environmental data is collected on a systematic basis to measure and characterize the quality of environmental resources in addition to the success of management programs. The information is available to develop cross-walks between data sources and environmental indicators and between all levels of government, private enterprise, and the public.

3. Public involvement and education: The public would become more involved in using environmental indicators at the front-end of the process to assist in identifying environmental benefits and values and at the back-end to review and comment on outputs and outcomes. Some data collection activities could also be enhanced by increased public involvement, particularly at the local watershed level.

4. Program evaluation: A front-end evaluation of water quality management program effectiveness based on environmental indicators would become more formalized and routine. An self-evaluation and oversight framework using indicators to measure the overall success of management programs would be in place.

5. Partnerships with the regulated community: Indicators would be tied to administrative fees and certification processes. The regulated community and the State would strive to increase regulatory flexibility in exchange for improving monitoring and assessment, and ultimately environmental indicators, while maintaining and improving environmental quality.

Much of the above is already envisioned in the Division of Surface Water strategic plan (Ohio EPA 1996a). One of the better examples is the Ohio 2001 goals for surface waters and the process for reporting on progress towards that goal via the Ohio Water Resource Inventory(305[b] report). Various components of an integrated set of environmental indicators have long been in place within the monitoring and assessment program and are evidenced in the many reports and evaluations completed each year. Efforts to improve the establishment of linkages between indicators of pollution source performance and ambient quality indicators are on-going. However, to achieve the full use and integration of environmental indicators in accordance with the vision statement will require some significant changes in which measures State water quality management programs value as the most meaningful indications of overall program success.

A Hierarchy of Environmental Indicators for Water

A carefully conceived ambient monitoring approach, using cost-effective indicators comprised of biological, chemical, and physical measures, can ensure that all relevant pollution sources are judged objectively on the basis of quantifiable environmental results. Such an approach simultaneously assures that indicators will be representative of the elements and processes of the five factors which determine water resource integrity. However, composite measures that reflect the status of water resource integrity must also be included. It is these types of indicators which have, until only recently, been missing from State and Federal programs.

The indicators hierarchy developed by U.S. EPA provides a robust organizational framework within which the use of environmental indicators should take place (Figure 1). This also offers a structured approach to assure that management programs are implemented and , if necessary, adjusted based on environmental feedback. A comprehensive ambient monitoring effort which includes indicators representative of key variables within the five factors which determine the integrity of the water resource (Figure 2) is essential to successfully implementing a true environmental indicators approach. For this approach to be successful, ambient monitoring must take place at the same scale at which management actions are being applied. For States this is at a local, waterbody-specific scale consistent with that delineated in the U.S. EPA Waterbody System Reach File 3

(*e.g.*, river or stream reach-specific). Such information provides the basis for other uses including the aggregation of information over broader geographical areas (*e.g.*, 305[b] reports, nonpoint source assessments, etc.).

Ohio EPA relies on the tiered indicators approach in attempting to link the results of administrative activities with true environmental measures. This integrated framework relies on the hierarchical continuum of administrative and true environmental indicators. This framework was initially developed by U.S. EPA (1990a) as part of the original process for developing environmental indicators. The framework includes six "levels" of indicators as follows:

- Level 1 - actions taken by regulatory agencies (*e.g.*, permitting, enforcement, grants);
- Level 2 - responses by the regulated community (*e.g.*, construction of treatment works, pollution prevention);
- Level 3 - changes in discharged quantities (*e.g.*, pollutant loadings);
- Level 4 - changes in ambient conditions (*e.g.*, water quality, habitat);
- Level 5 - changes in uptake and/or assimilation (*e.g.*, tissue contamination,biomarkers, assimilative capacity); and,
- Level 6 - changes in health, ecology, or other effects (*e.g.*, ecological condition, pathogenicity).

In this process the results of administrative activities (levels 1 and 2) are followed by changes in pollutant loadings and ambient water quality (levels 3, 4, and 5), all of which leads to measurable environmental "results" (level 6). The process is multi-directional with the level 6 indicators providing overall feedback about the completeness and accuracy of the process through the preceding levels. While this illustration uses point source terms, the process is adaptable to nonpoint sources and media other than surface waters.

The specific information that is generally available to Ohio EPA is indicated for each level (Figure 1). Some of these are highly developed and calibrated, some are inherently qualitative, some are in various stages of ongoing refinement, and others are in the initial stages of definition and development. The further refinement of

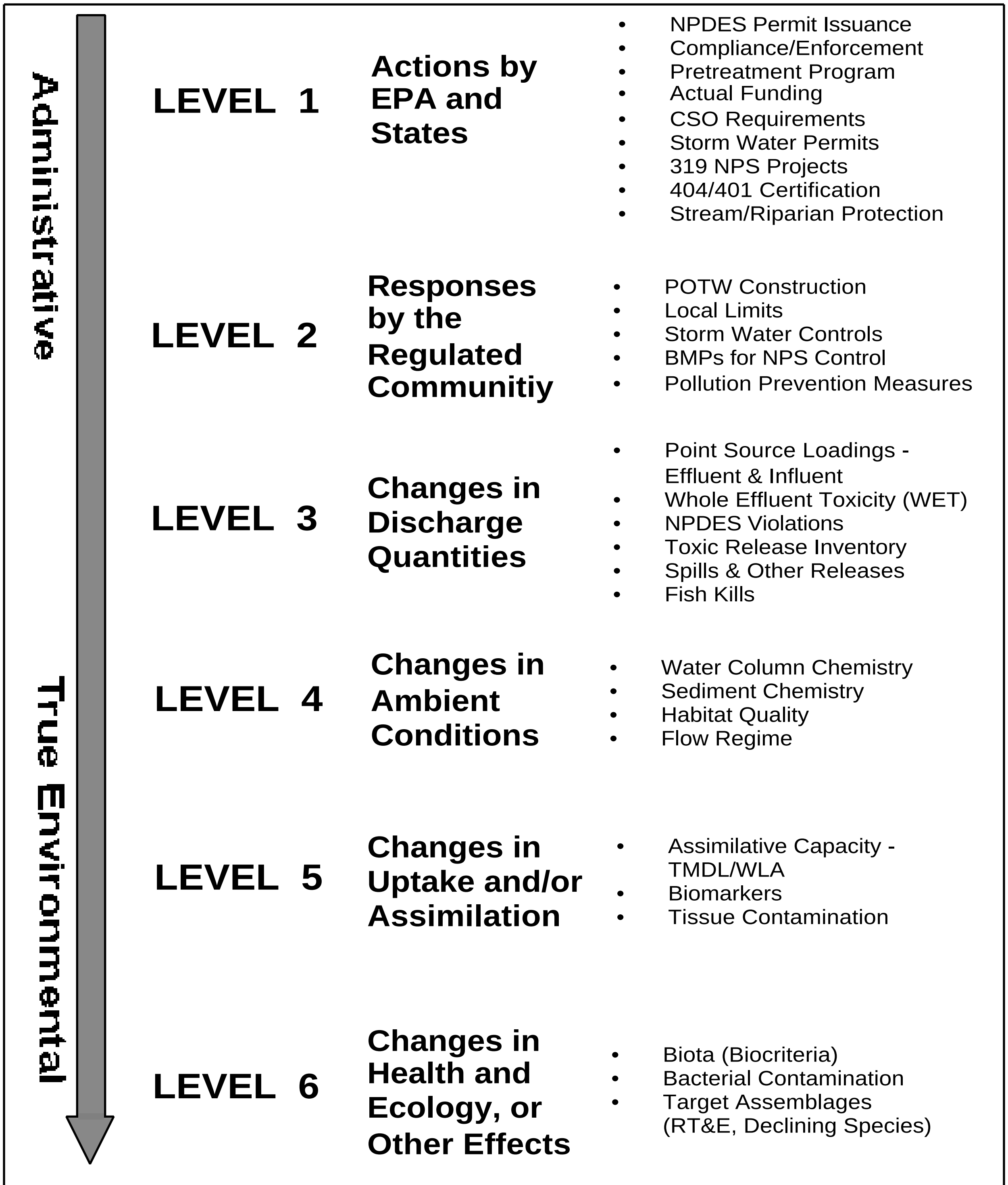

Figure 1. Hierarchy of administrative and environmental indicators which is used by Ohio EPA for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995b).

the supporting data sources for each indicator level can be incorporated as each is developed. Thus the hierarchy serves a dual role as an information tracking device and a feedback mechanism. For example, we can now begin to ascertain the aggregate effect of the billions of dollars spent on water pollution control since the early 1970s by comparing the implementation of level 1 administrative actions (*e.g.*, funding, permitting) with quantifiable measures of environmental condition (level 6). This hierarchy is conceptually comparable to the pressure-state-response paradigm frequently cited as part of the sustainable development framework (U.S. EPA 1995b), and the GPRA model of output and outcomes.

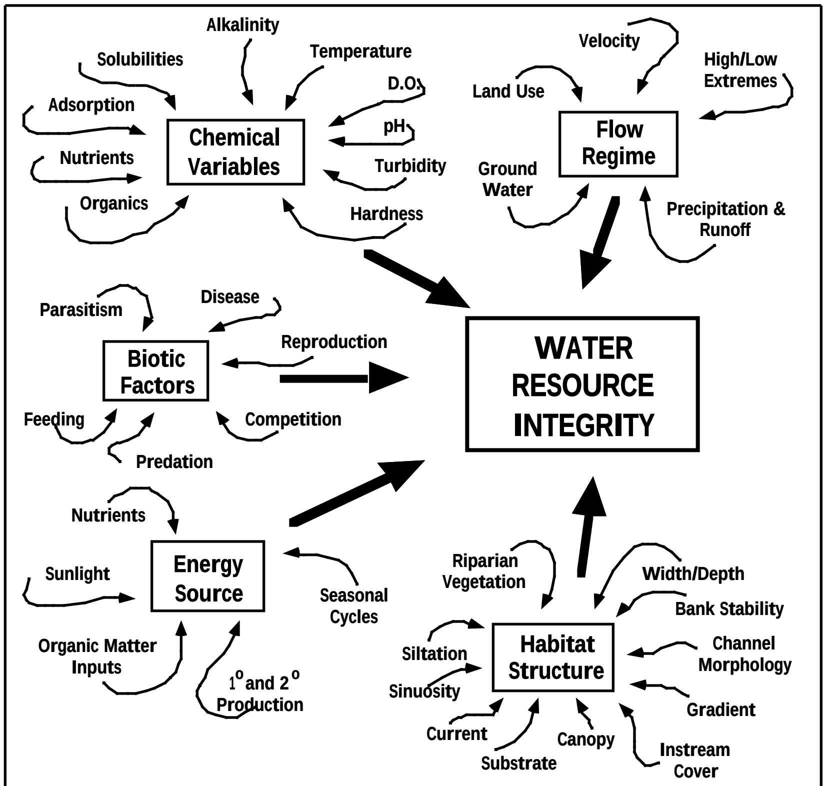

Figure 2. The five major factors which determine the integrity of the water resource (modified after Karr et al. 1986). Environmental indicators are chosen to represent important variables and the composite condition of the water resource.

Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators (Figure 1) similar to that developed by the U.S. EPA Environmental Monitoring and Assessment Program (EMAP; U.S. EPA 1991a). Stressor indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges, land use effects, and habitat modifications (level 3). Exposure indicators are those which measure the apparent effects of stressors and can include chemical water quality criteria, whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of

biological exposure to a stressor or bioaccumulative agent (levels 4 and 5). Response indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of biological community and population response that are represented here by the biological indices which comprise the Ohio EPA biological criteria (level 6). Other response indicators include target assemblages (*e.g.*, rare, threatened, endangered, special status, and declining species) or bacterial levels which serve as surrogates for recreational use designations. All of these indicators represent the essential technical elements for watershed-based management approaches.

The key is to use the different indicators within the roles which are most appropriate for each. Historically, this has not always been done. Previous comparisons of chemical and biological indicator frameworks (Ohio EPA 1990; Yoder and Rankin 1997) illustrate a national problem - the inappropriate use of stressor and exposure indicators as substitutes for response indicators. States which do not have well developed biological indicators still must report on the status of their waters to U.S. EPA. Unfortunately, the most readily available information usually consists of stressor or exposure indicators which leads to their substitutionary use. Response indicators are inherently better at evaluating attainment of designated uses which are the basis of State water quality standards. An example is relying on biological community measures to evaluate designated aquatic life uses in lieu of elevating chemical data into this role. More accurately portraying the condition of the nation's aquatic resources depends much on the wider development and use of response indicators.

Indicator Information Matrix

As part of the surface water indicators pilot an evaluation of the ease of obtaining and completeness of each indicator was made (Table 1). This illustrates that the information available for each indicator is not equivalent and points to where improvements need to be made in both information management and indicators development.

The most readily accessible and complete data were from the level 6 ambient bioassessment indicators and some level 5 indicators. These are stored in the Ohio ECOS system which is not yet accessible to non-Ohio EPA users except by request. The level 3 and 4 indicators for effluent quality and ambient water quality were

Table 1. Summary of current data storage, ease of access, completeness of the database, and type of data presentation made in the surface water indicators pilot completed by Ohio EPA (1998).

Data Component/ Indicator Level	**Data Stor-age:**	**Ease of Obtaining Data:**	**Data Complete-ness:**	**Data Presentation:**
LEVEL 1: Actions by EPA/State				
NPDES History	Main-frame	❸	●	Box & Whisker plots w/ line overlays
Compliance Actions	Main-frame	❸	◗	Bar Graph
Pretreatment Approvals/Reviews	Paper	❺	❍	Box & Whisker plots w/ line overlays
Grant Funding	Paper & Elec-tronic	❹	❍	Data not presented*
CSO Requirements	Paper	❹	❍	Data not presented* **Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:**
Storm Water Permits	**Main-frame**	❸	❍	**Data not presented***
319 NPS Projects	**Elec-tronic**	❶	●	**Data not presented***
404/401 Permit Actions	**Elec-tronic**	❶	◗	**Data not presented***
Local Stream Protection Actions	**Paper**	❺	❍	**Data not presented***

Data Component/ Indicator Level	Data Storage:	Ease of Obtaining Data:	Data Completeness:	Data Presentation:
LEVEL 2: Responses by Regulated Entities				**Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:** **Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:**
Local Limits	**Paper**	❺	◗	**Box & Whisker plots w/ line overlays** **Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:**
POTW Construction	**Electronic**	❹	❍	**Data not presented*** **Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:**
Storm Water Controls	**Mainframe**	❸	❍	**Data not presented***
BMPs for Erosion	**Paper & Electronic**	❸	●	**Column Plots & Table**
BMPs for Nutrients	**Paper**	❸	●	**Column Plots & Tables**

Data Component/ Indicator Level	**Data Stor-age:**	**Ease of Obtaining Data:**	**Data Complete-ness:**	**Data Presentation:**
				Data Component/ Indicator LevelData Storage:Ease of Obtaining Data:Data Completeness: **Data Presentation:**
LEVEL 3: Changes in Discharged Quantities				
Point Source Loadings - Effluent	Main-frame	❷	●	Box & Whisker plots
Point Source Loadings - Influent	Main-frame	❷	◗	Box & Whisker plots
Whole Effluent Toxicity	Paper & Elec-tronic	❸	❍	Scatter Plots **Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:**
NPDES Violations	**Main-frame**	❷	◗	**Bar Graphs** **Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:**
Toxic Release Inventory	**Main-frame**	❷	◗	**Data not presented*** **Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:**

Data Component/ Indicator Level	**Data Storage:**	**Ease of Obtaining Data:**	**Data Completeness:**	**Data Presentation:**
Spills	**Mainframe**	❸	●	**Bar Graph**
Fish Kills	**Mainframe**	❷	●	**Table** **Data Component/ Indicator LevelData Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:**
				Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness: **Data Presentation:**
LEVEL 4: Changes in Ambient Conditions				
Water Column Chemistry	Mainframe & Paper	❸	●	Box & Whisker Plots, Scatter Plots, Line and Bar graphs, Table **Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:**
Sediment Chemistry	**Mainframe & Paper**	❷	❍	**Line and Bar Graphs**
Habitat Quality	**Mainframe**	❶	●	**Table**

Data Component/ Indicator Level	**Data Stor-age:**	**Ease of Obtaining Data:**	**Data Complete-ness:**	**Data Presentation:**
LEVEL 5: Changes in Assimilation/Uptake				
Assimilative Capacity	Calcu-lated	N/A	N/A	Line and Bar Graphs **Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:** **Data Component/ Indicator LevelData Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:**
Biomarkers	**Elec-tronic**	❶	◗	**Data not presented***
Tissue Contamination	**Elec-tronic**	❶	●	**Bar Graph & Table**
				Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness: **Data Presentation:**
LEVEL 6: Changes in Health, Ecology, Other Effects				**Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:**

Data Component/ Indicator Level	Data Stor-age:	Ease of Obtaining Data:	Data Complete-ness:	Data Presentation:
Bacterial Contamination	**Main-frame**	❶	●	**Line Graph & Scatter Plot**
Biota	**Main-frame**	❶	●	**Scatter Plots** **Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:**
Target Assemblages	**Main-frame**	❶	●	**Table**
OTHER: Public Water Supply Related				**Data Component/ Indicator LevelData Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:**
Waterborne Disease Outbreaks	**Elec-tronic**	❺	❍	**Data not presented*** **Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:** **Data Component/ Indicator Level Data Storage:Ease of Obtaining Data:Data Completeness:** **Data Presentation:**

Data Component/ Indicator Level	Data Storage:	Ease of Obtaining Data:	Data Completeness:	Data Presentation:
Exceedence of Drinking Water Standards	**Electronic & Paper**	❸	◗	**Bar Graphs, Box & Whisker Plots, Table, Scatter Plots**
Waters Meeting PWS WQS	**Electronic & Paper**	❸	◗	**Bar Graphs, Box & Whisker Plots, Tables**

*** Inadequate or otherwise potentially misleading data were not graphically summarized.**

KEY:
Ease of Obtaining Data
Factors considered include location of data (internal or external sources), mode of data storage (paper, electronic database, mainframe database), skill and knowledge required to access the data (mainframe, special contacts) and type of information associated with the data (applicable location, date, data type, etc.).

Symbols:
- ❶ Data is readily accessible from a PC or by request.
- ❷ Data is accessible, but some additional steps are required to access data.
- ❸ Data is accessible, but obtaining it requires more steps and difficulty.
- ❹ Data requires substantial effort to obtain.
- ❺ Data very difficult to obtain.

Data Completeness
Factors considered include consistency and representation of data collection and reporting.

Symbols:
- ● Data is standardized and consistent, sufficient data was available for analysis.
- ◗ Data somewhat consistent, but additional information was needed.
- ❍ Data not standardized or consistent, much additional information was needed.

generally accessible, but each of the electronic systems (LEAPS and STORET) can be difficult to access. Improvements in both systems are forthcoming. The most difficult to access and incomplete databases were those associated with the level 1 and 2 categories and owe to these being in non-electronic storage. Improvements in the data management structures for each of these indicators is needed before a fully functioning system of indicators can exist.

Chapter 2: Water Quality Management Program Information Needs

2.1 **Introduction**

State water pollution control agencies function as custodians of water quality management under the Federal Water Pollution Control Act (*i.e.*, Clean Water Act [CWA]). This role is delegated by U.S. EPA to qualifying States which then have the obligation to develop and maintain water quality standards, issue NPDES permits, lead in the development of basin-wide water quality management plans, and monitor the effectiveness of the overall water quality management program. Ohio EPA is delegated by U.S. EPA for water quality management programs and activities required by the Clean Water Act. As such, there are a host of information needs associated with these programs which are described in the following subsections.

Basic Information Gathering Approach/*Rotating Basin Assessment Process*

Ohio EPA utilizes a rotating basin approach as the principal monitoring and assessment design in support of surface water quality management objectives. Other networks are in place or have been used in the past, but these are generally done within the context of the rotating basin design. This approach is the baseline data and information generating framework -- all data and information needed to meet water quality management objectives emanates from this approach.

Although a basin/watershed design has been used as part of the monitoring and assessment program since the late 1970s, it was in 1990 that the rotating basin design was formalized and integrated with key water quality management programs. The approach was known then as the Five-Year Basin Approach to Monitoring and NPDES Permit Reissuance.

The Five-Year Basin Approach better organized the previous approach to planning for and conducting watershed level assessments that had been in place since the late 1970s. One of the principal objectives of this new approach was to better coordinate the collection of ambient monitoring data so that information and assessments would be available in time to support the reissuance of NPDES permits and later, for many of the emerging watershed based management needs. The process by which data collection and assessments are accomplished is a biological and water quality survey.

A biological and water quality survey, or "biosurvey", is an interdisciplinary monitoring effort coordinated on a water body specific or watershed scale. This effort may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites up to a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. Each year DSW conducts biosurveys in 6-12 different study areas with an aggregate total of 300-500 sampling sites.

DSW employs biological, chemical, and physical monitoring and assessment techniques in biosurveys in order to meet three major objectives:

1) determine the extent to which use designations assigned in the Ohio Water Quality Standards (WQS) are either attained or not attained;

2) determine if use designations assigned to a given water body are appropriate and attainable; and,

3) determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices.

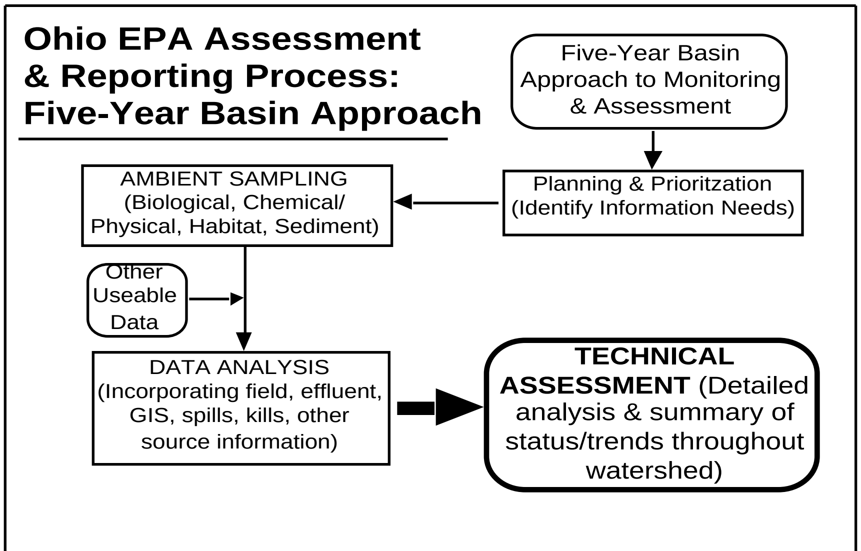

Figure 3. The five-year basin assessment process from planning and prioritization, sampling, data analysis, assessment, and reporting. The technical assessment is the basis for all other uses of the monitoring and assessment information including findings, conclusions, and recommendations.

The data gathered in a biosurvey is processed, evaluated, and synthesized in one of several assessment reports or outputs (Figure 3). This can range from a

Comprehensive, integrated watershed report to the summaries compiled for the waterbody system (WBS) in support of 305(b) reporting and extended products (*e.g.*, 303[d] list). Each assessment also addresses any recommendations for revisions to WQS, future monitoring needs, problem discovery, or other actions which may be needed to resolve impairments of or threats to designated uses. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as recreation and water supply, as well as human health concerns, are also addressed. As such the findings and conclusions of a biological and water quality assessment factor into the various water quality management activities of Ohio EPA (*e.g.*, NPDES permits, Director's Orders, the Ohio Water Quality Standards [OAC 3745-1]) and are eventually incorporated into Water Quality Permit Support Documents (WQPSDs), State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, the Ohio Water Resource Inventory (305[b] report), the 303[d] list of impaired and threatened waters, and virtually any program where surface water quality is a concern. Figure 4 outlines the major Ohio EPA programs that are supported by the basin assessment process.

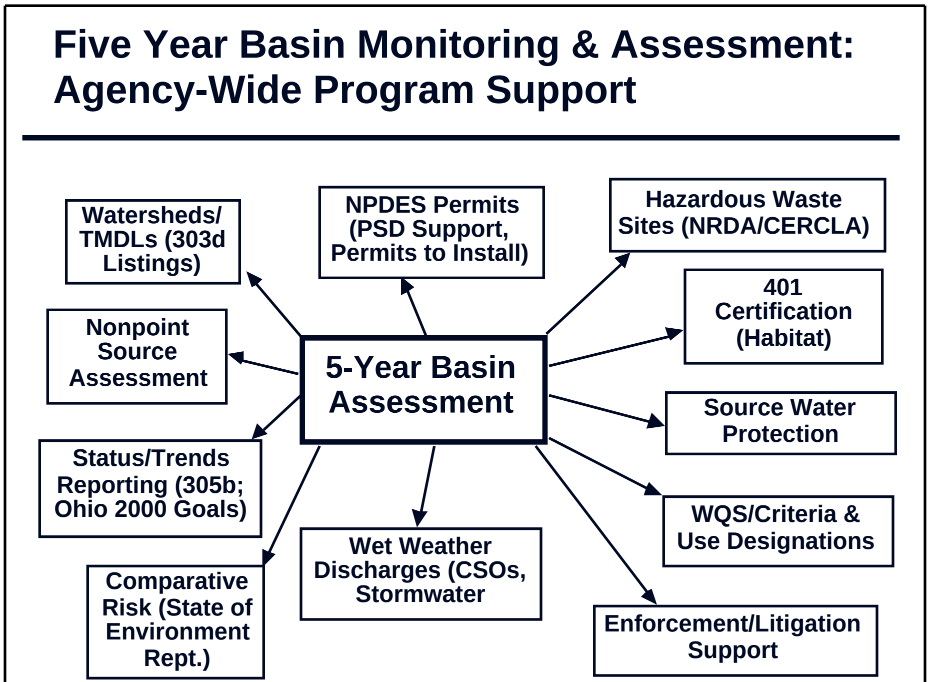

Figure 4. Agency-wide program support provided by five year basin assessments.

Functional support provided by individual basin assessments for specific water quality management activities is summarized in Figure 5. These include the

support of the 305(b) reporting process, TMDLs/303(d) listing, revising water quality standards (*i.e.*, use designations, criteria refinements and modifications), and NPDES permit support. Support is also provided for other programs including site-specific 404/401 reviews, 319 projects, and enforcement actions. A positive consequence of this type of sustained, routine, and standardized functional program support is a database and information resource which supports the ongoing water quality management effort in the aggregate (Figure 6). This includes the development of new and improved assessment tools, improved and refined criteria, indicators development and use, concepts, policies, and rules. The critical concept is that by doing the level of monitoring and assessment that is required by the intensive basin approach, the basic informational infrastructure needed to support the entire water quality management program is in place when the need for such support is realized. This demonstrates how this type of sustained approach is inherently anticipatory. Anticipatory monitoring and assessment is essential to maintaining and improving the

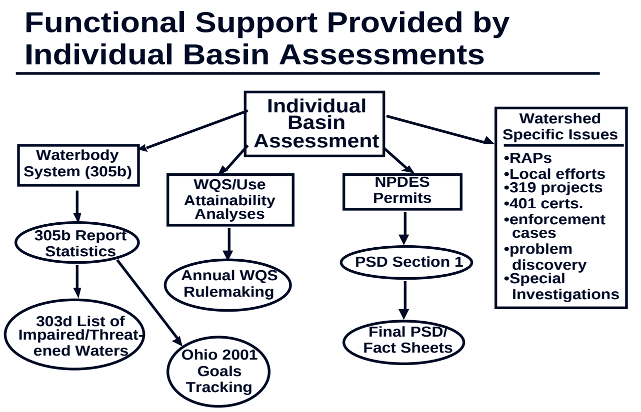

Figure 5. Functional water quality program support provided by the five-year basin assessment process emphasizing direct support of the 305(b) report, TMDL/303(d) listing process, water quality standards revisions, and water quality permit support documents in support of NPDES permit reissuance.

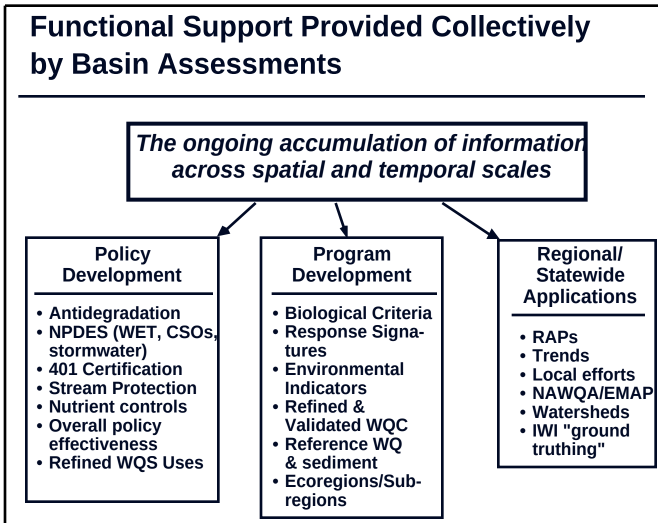

Figure 6. Functional water quality program support provided by the five-year basin assessment process emphasizing collective support for components of the overall water quality management process including specific programs and the development of tools, criteria, concepts, procedures, policy, and rules.

overall water quality management process.

2.2 **Water Quality Standards**

Water quality standards are codified in Chapter 3745-1 of the Ohio Administrative Code to establish minimum water quality requirements for all surface waters of the State. The purpose of WQS are to protect public health and welfare and to enhance, improve and maintain water quality as provided under the laws of the State of Ohio (ORC 6111.041) and the federal Clean Water Act. The Ohio WQS consist of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the goals specified by each use designation. Use designations consist of two broad groups, aquatic life and non-aquatic life uses.

Designated Aquatic Life Uses

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

1) *Warmwater Habitat (WWH)* - this use designation defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams; *this use represents the principal restoration target for the majority of water resource management efforts in Ohio.*

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

3) *Coldwater Habitat (CWH)* - this use is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round

basis which is further sanctioned by the Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic "runs" of salmonids during the spring, summer, and/or fall.

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

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

Chemical, physical, and/or biological criteria are generally assigned to each use designation in accordance with the broad goals defined by each. As such the system of use designations employed in the Ohio WQS constitutes a "tiered" approach in that varying and graduated levels of protection are provided by each. This hierarchy is especially apparent for parameters such as dissolved oxygen, ammonia-nitrogen, temperature, and the biological criteria (Figure 7). For other parameters such as heavy metals, the technology to construct an equally graduated set of criteria has been lacking, thus the same water quality criteria may apply to two or three different use designations. However, with the adoption of dissolved metals criteria as a result of the GLWQG, "equivalency" with a tiered system of criteria for metals is effectively achieved whenever the biocriteria derived total recoverable thresholds (Ohio EPA 1997a) are used to develop the wasteload allocation.

Ohio Water Quality Standards: Non-Aquatic Life Uses

In addition to assessing the appropriateness and status of aquatic life uses, each biological and water quality survey also addresses non-aquatic life uses such as recreation, water supply, and human health concerns as appropriate. The recreation uses most applicable to rivers and streams are the Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR) uses. The criterion for designating the PCR use is simply having a water depth of at least one meter over an area of at least 100 square feet or where canoeing is a feasible activity. If a water body is too small and shallow to meet either criterion the SCR use applies. The attainment status of PCR and SCR is determined using bacterial indicators (*e.g.*, fecal coliforms, *E. coli)* and the criteria for each are specified in the Ohio WQS.

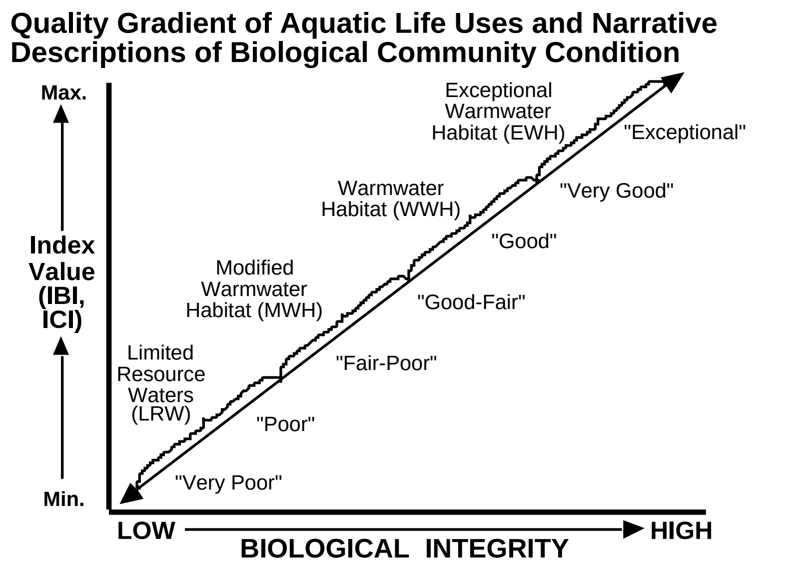

Figure 7. Graphical depiction of the system of tiered aquatic life uses in the Ohio WQS against a gradient of environmental quality ("biological integrity") and the scale of measurement ("biological criteria").

Water supply uses include Public Water Supply (PWS), Agricultural Water Supply (AWS), and Industrial Water Supply (IWS). Public Water Supplies are simply defined as segments within 500 yards of a potable water supply or food processing industry intake (subject to changes in the SWAP program; see subsection 2.9). The Agricultural Water Supply (AWS) and Industrial Water Supply (IWS) use designations generally apply to all waters unless it can be clearly shown that they are not applicable. An example of this would be an urban area where livestock watering or pasturing does not take place, thus the AWS use would be removed after a use attainability analysis. Chemical criteria are specified in the Ohio WQS for each use and attainment status is based primarily on chemical-specific indicators. Human health concerns are additionally addressed with fish tissue data,

but any consumption advisories are issued by the Ohio Department of Health are detailed in other documents.

2.3 Permitting, Enforcement, and Compliance

The issuance of NPDES permits is one of the most important surface water quality management programs in terms of ability to effect pollution control and terms of resources required to operate a statewide program. Major activities include permit issuance and reissuance, monitoring compliance, performing inspections, and taking enforcement actions when this is deemed necessary. Monitoring and assessment supports all of these functions as follows:

1) Validation and revision, if necessary, of designated uses and anitdegradation tiers thereby assuring that the appropriate water quality and biological criteria are used in the development of water quality based effluent limits and assessment of compliance both in the effluent and the receiving waters;

2) Validation and revision, if necessary, of water quality criteria used to develop a wasteload allocation (WLA) based on reviews of existing toxicological information, regional reference data and information, and biological criteria relationships on a statewide or regional basis;

3) Demonstration of the extent and severity of impairment, if any, in the immediate receiving waters including mixing zone, near field , and far field effects; such information in conjunction with other environmental indicators provides reasonable estimates of associated cause and effect relationships; and,

4) Demonstrating the overall effectiveness of the aggregate approach to permitting, compliance, and enforcement in terms of resource quality and trends in that quality on a local, regional, and statewide basis.

NPDES Permit Program

Whenever a municipality, industry, or other entity wishes to discharge water to a surface water of the State, they must first obtain a permit from the Ohio EPA Division of Surface Water (DSW). This permit is called a National Pollutant Discharge Elimination System (NPDES) permit. NPDES permits regulate

wastewater discharges by limiting the quantities of pollutants to be discharged and imposing monitoring requirements and other conditions. The limits and/or requirements in the permit help ensure compliance with the Ohio Water Quality Standards and federal regulations, all of which were written to protect public health and the aquatic environment.

There are two types of NPDES permits; individual and general. An individual NPDES permit is unique to each facility. The limitations and requirements in an individual permit are based on the facility's operations, type and amount of discharge, and receiving stream, among other factors.

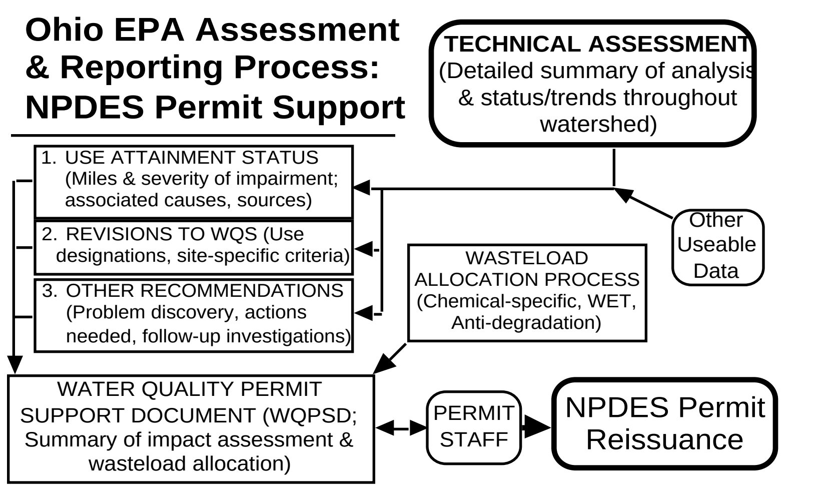

Figure 8. Process for completing water quality permit support documents (PSD) in support of NPDES permit issuance and reissuance.

Permit Support Documents

A permit support document (PSD) is a summary of a receiving water impact assessment based on a biosurvey and the wasteload allocation. The three sections which comprise a PSD include Section 1: Impact on Receiving Waters, Section 2: Wasteload Allocation Modelling, and Section 3: Conclusions. For some permit issues the PSD may be comprised of Section 2 only where a relevant assessment of the receiving water is lacking. Section 1 is completed for approximately one-half of the PSDs produced in a year. The availability of Section 1 information is addressed ahead of permit drafting and reissuance as part of the basin survey planning and prioritization process.

Monitoring and assessment information is a vital contribution to the PSD process, both for the receiving water impact assessment and the wastelaod allocation. The process and flow of information is depicted in Figure 8. The recommendations in the PSD are used by the permit writer in drafting a NPDES permit for issuance or

reissuance.

Enforcement Support

Monitoring and assessment for enforcement support can take place in a number of different ways and designs from the collection of grab effluent and ambient samples over a few hours or days to longer term investigations involving biological, habitat, and water quality sampling over many months or years. However, the purpose remains the same, to document the extent and severity of any violations of permit terms and conditions and the Ohio WQS. There are many recent and ongoing examples of the latter of which the ongoing effort to document the recovery of Leading Creek from the Ohio Coal Co. Meigs Mine #31 spill of 1994 and compliance with the recovery endpoints established (Ohio EPA 1995).

Compliance Evaluation and Support

Compliance monitoring and evaluation include the following objectives:

- determine compliance with NPDES permit terms and conditions;
- validation of monthly operating reports submitted by permit holders; and,
- information base for supporting enforcement actions.

Data submitted by permitted entities is included in a monthly operating report (MOR) and is entered into the Surface Water Information Management System (SWIMS) which only recently replaced the Liquid Effluent Analysis Processing System (LEAPS). U.S. EPA coordinates a reference sample quality assurance program for all major discharges. Major and significant minor permits have the highest priority for compliance sampling and inspections. Activities of the compliance monitoring program include review and evaluation of MORs, compliance evaluation inspections (CEI), compliance sampling inspections (CSI), performance audit inspections (PAI), toxics sampling inspections (TSI), diagnostic inspections (DI), and legal support inspections (LSI).

DSW also operates a significant program to provide direct technical assistance to municipalities in an effort to achieve long term compliance. The Municipal Assistance Program is a cooperative effort between Ohio EPA and municipalities to bring wastewater treatment plants into compliance and maintain compliance. In this program Ohio EPA serves as a facilitator, providing innovative and cost-

effective methods of improving plant performance and is directed at non-capital improvements.

2.4 Section 305(b) Reporting Process

Within DSW, EAU is responsible for completion of the section 305(b) report with support provided via the Five Year Basin Approach by other sections and units. This report is one of several possible outcomes of the Five-Year Basin Approach (Figures 4 and 5). The issues of planning, sampling, data quality objectives, QA/QC, and assessment of results is addressed via the Five-Year Basin Approach process.

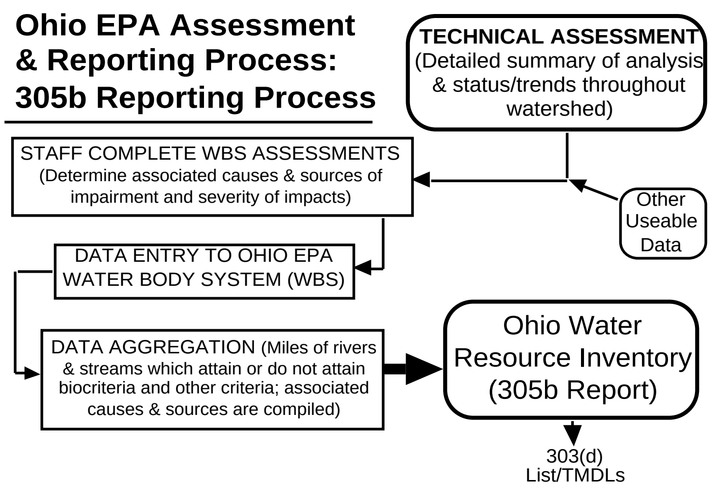

Figure 9. Process for completing the Ohio Water Resource Inventory (305[b] Report).

The Ohio Water Resource Inventory (305[b] report) is produced biennially by DSW. The report consists of a summary and fact sheets, four volumes (rivers & streams, fish contaminants, lakes, and ground water), and an appendix containing various required lists and a compilation of the Waterbody System (WBS). The WBS is an electronic database which contains the basic assessment information for specific waterbody segments which is aggregated in different ways to produce the text portions of the 305(b) report. The WBS is updated on an annual basis.

The 305(b) reporting process emanates from the basin approach and allied technical assessment process (Figure 9). The basin assessment information is used to complete WBS work sheets on which various states of impairment and threats are delineated along with associated causes and sources using codes established by U.S. EPA (Figure 10a). A brief narrative summary of the results within each waterbody segment is also produced and contained within the WBS database (Figure 10b). The WBS summaries are reviewed and approved by the EAU manager prior to entry into the WBS database which is part of Ohio ECOS.

Entries are then proofread for accuracy.

The 305(b) process provides the basic information on which progress towards various Clean Water Act goals is ascertained. A forecast analysis is used to both track past progress in restoring impaired designated uses and project future conditions. This information has been used to set strategic goals for the water programs and is a focus of strategic planning for the water quality management process.

2.5 **Total Maximum Daily Loads (TMDL)/Section 303(d) Listing**

One of the more important outcomes of the 305(b) assessment process is the compilation of the section 303(d) list of impaired waters. This list is essentially a product of the 305(b) impaired and threatened waters gained from the WBS. The severity of the impairment is also expressed when this is relevant and the body of information is then available for use in priority rankings and TMDL development scheduling. The 303(d) list is updated as required by U.S. EPA and incorporates new information via the Five-Year Basin Approach. The approach was changed in 1999 moving basin surveys two years in advance of TMDL development. This was done to allow more time to revise the 303(d) list based on the findings of the basin assessment and to permit TMDL specific field work to take place one year in advance of TMDL development.

Ohio EPA committed to a 15-year TMDL development process in 1998. Based on the 303(d) list at that time, the schedule was organized by watershed unit and in coordination with the Five-Year Basin Approach (Figure 11). Ohio EPA has chartered an internal workgroup to assess how the Agency might address and comply with the Total Maximum Daily Load (TMDL) requirements of the Clean Water Act. To accomplish this task the Ohio EPA TMDL Workgroup has been divided into subteams. Each subteam has been asked to examine a specific part of the TMDL process. The subteams are looking at listing, restoration target development, implementation of measures to achieve the restoration targets, and validation that achievement of restoration targets has occurred.A three phased approach has been devised to accomplish the goals of the workgroup. Phase one was dedicated to taking an inventory of *tools that currently exist* and can be used to

River Code: 20-001 River Segment: Black River, RM 15.65 to mouth

Waterbody ID#: OH86 2 URM: 15.65 LRM: 0.00 Length: 15.65 * Initials: RJM

Aquatic Life Use: WWH Date of Assessment: (MM/YY): 04/99

Dates of Data Collection: (MM/YY) 07/97 to 10/97

TYPES OF DATA AVAILABLE: FISH: X BUG: X CHEM: X

Assessment Types: ☐ 720 Other:

Miles:

Uses:	Recommended Use Change? (Y/N)	Supported	Threatened	Partial Support	Non-Support	Not Attainable	Unassessed
Aquatic Life:	☐	3.7		4.2	7.7		
Recreation:	☐						

Biological Integrity Narrative:	Excellent	Good:	Fair:	Poor:	Very Poor:
		3.7	4.2	0.9	6.8

Significant Aquatic Contamination:

Causes (w/Magnitude) of Partial or Non Support:

Cause/Mag - Miles			Cause/Mag - Miles			Cause/Mag - Miles			Cause/Mag - Miles			Cause/Mag - Miles		
0900	H	7.7	1200	H	11.9	2400	M	6.0						

Sources (w/Magnitude) of Partial or Non Support:

	Source/Mag - Miles			Source/Mag - Miles			Source/Mag - Miles			Source/Mag - Miles			Source/Mag - Miles		
Major Categ.	0000	H	11.9	0000	M	6.0									
Subcategory	0210	H	7.7	0210	M	6.0									
Subcategory	0400	H	11.9	0110	M	6.0									
Subcategory				0400	M	6.0									

Toxic Parameters Measured (That May Not Be Electonically Accessible at EAU)

Code:	Pollutant
☒ 4	***Organics (Effluent)***
☐ 8	***Pesticides (Effluent)***
☒ 12	***Metals (Effluent)***
☐ 14	***Oth. Inorganics (Effluent)***
☒ 15	***Toxicity Testing (Water Column)***
☒ 16	***Toxicity Testing (Sediment)***
☐ 17	***Toxicity Testing (Effluent)***

Estimate of Miles of Segment Covered by Toxic Monitoring: 5.0

TSD Planned or in Progress?(Y/N) Y Estimated Completion Date: (M/Y) 04/99

Data Compiled for this Assessment Includes:

X Use Attainment Table
X OHEI Matrix
X WQS Use Designation Matrix w/Rec. use changes
X Chemical Criteria Exceedance Table
X Chemical Data Summary
X Sediment Chemistry Table
X Spill Summary
X Fish Kill
X Fish Sampling Results Summary
X Macroinvertebrate Results Summary
__ Other (Specify)
X PSD

Date Printed: *03/31/99*

Figure 10a. Front page of a waterbody system (WBS) work sheet which is completed by the staff making the assessment and in accordance with the process outline in Figure 9. This information is recorded in the WBS and used to develop 305(b) statistics and products.

Narrative Summary/Additional Information

Are you recommending an Aquatic Life Use change? - YES **X** - NO
New Use LRW MWH WWH EWH
Other:_______

If a portion of the segment is currently meeting its use, but you feel that this use is threatened, briefly describe this threat:

Is any of the impact observed caused by priority organic pollutants:? **X** - YES - NO
If so briefly describe the source of these pollutants and the extent of the problem:

Historic and residual PAH contamination from coking facilities in the lower river

Trend in the segment (more than one year of data)
(Improving) **S**table **D**eclining

Does this site need future monitoring?
X - YES - NO

Was data from outside of Ohio EPA used?
X - YES - NO
List Sources:

Dr. Paul Bauman, USGS/OSU
Dr. Allan Burton, Wright State U.

Signficant Point Sources Present in Segment:

NPDES	Name
3PD00034	City of Elyria WWTP
3ID00028	USS/Kobe Steel
3PE00005	City of Lorain Eastside WWTTP

Signficant Nonpoint Sources in Segment:

Name	Description
USS Kobe	Slag Piles
D2	Landfill

Summary Narrative Description of Status/ Causes/Sources in Segment [If you can't fit it in this box, then you've written too much!]

Pollutant loadings in the lacustrine portion of the river contribute to anoxia. Residual and current sources of toxics including metals and PAHs continue to impair aquatic life in the Black River.

CSOs and SSOs in Elyria contribute to the impairment in the free flowing section of the mainstem, as well as contribute organic loading to the lacustrine portion.

Figure 10b. Back page of a waterbody system (WBS) work sheet which is completed by the staff making the assessment and in accordance with the process outline in Figure 9. This information supplements the coding on the front side and is entered into the WBS as important supporting information.

list, develop, implement, and validate the TMDL process in Ohio. Phase two has involved bench marking with other regulatory agencies, watershed projects, remedial action programs, as well as to draw on internal staff experience to document how the TMDL process *could be* implemented in Ohio. The objective of phase two is to report on “what could be” with respect to each of the individual elements of the TMDL process. To accomplish this task the workgroup divided into subteams. Each subteam examined a specific part of the TMDL process: **listing**, restoration target **development**, **implementation** of measures to achieve the restoration targets, and **validation** that achievement of restoration targets has occurred. In developing a list of options the agency may wish to pursue, constraints such as a current lack of statutory authority, agency resources, etc. have not yet been considered. The third and final phase will focus on developing recommendations for Ohio EPA management on how the TMDL requirements of the Clean Water Act *should be* met in Ohio.

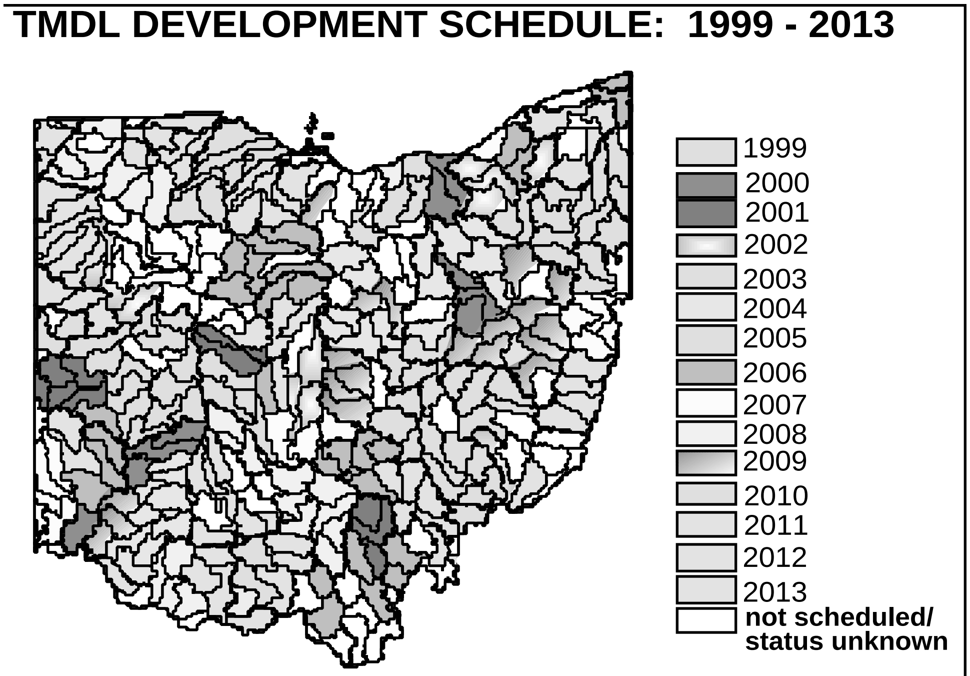

Figure 11. Schedule for development of TMDLs developed by Ohio EPA in 1998 showing subbasins and watersheds by TMDL year. Five-year basin and TMDL field work takes place two and one years prior.

The monitoring and assessment needs of the TMDL process are in line with the Five-Year Basin Approach and the continuing development of environmental indicators. Regarding the latter, the development of indicators to measure interim

progress towards meeting TMDL benchmarks is being emphasized.

2.6 **401 Water Quality Certification Process**

Any activity that results in the discharge of dredged or fill material into the waters of the U.S., regardless of whether on private or public property, must obtain a Section 404 permit from the U.S. Army Corps of Engineers (Corps) and a Section 401 Water Quality Certification (WQC) from the state, the latter of which is administered by DSW. Projects which may lead to more than de minimis impacts generally require a site-specific review and may further require monitoring and assessment information to be collected and/or evaluated. In many cases, site-specific assessments consist of a habitat assessment up to biological assessment in streams and rivers and wetlands. Standard Ohio EPA methods are followed in each case.

2.7 **Nonpoint Source Assessment and Management/Watersheds**

The Ohio Environmental Protection Agency (Ohio EPA) is the designated state water quality management agency responsible for administering the Clean Water Act (CWA) Section 319 program in Ohio. In a broad context, NPS pollution control is a part of the Ohio EPA surface water quality program. However, NPS pollution control is administered as a distinct program because of the manner in which the federal CWA addresses the issue. Under CWA Section 319, the Ohio NPS Program emphasizes education, technical assistance, financial incentives and voluntary actions as opposed to regulatory mandates or permits. The success of the Ohio NPS Program to date is attributed to the fact that it is a program based on innovation, voluntary compliance, is geographically focused and involves a multitude of local, state and federal agencies working toward a common water quality goal.

Nonpoint Source Assessment

Throughout Ohio, federal, State and local agencies are implementing NPS pollution control projects. The majority of these projects are implemented at the local level with technical support from federal and state agencies. These projects represent an investment of approximately $22 million of federal, state and local funds being used to address NPS water quality issues. Each year, DSW applies for and receives CWA Section 319 funding from U.S. EPA for NPS implementation and demonstration projects in Ohio. Education, innovation, cost-sharing and voluntary compliance

with locally developed watershed management plans are the cornerstones of Ohio's NPS program.

The Ohio NPS program relies heavily on watershed management plans to address water quality problems. These plans emphasize: identification of the nature, extent, and cause of water quality problems; development of an implementation plan; implementation of BMPs; education and evaluation. The watershed management plans are developed locally with input and support from Ohio EPA, Ohio Department of Natural Resources (ODNR), Natural Resources Conservation Service (NRCS) and other agencies.

Ohio EPA's role in NPS pollution control is:

1) identify adverse water resource impacts and threats caused by NPS pollution;
2) document water resource improvements resulting from implementation of BMPs;
3) provide education and financial incentives to implement NPS pollution controls;
4) sustain a viable voluntary program for managing NPS water quality problems;
5) maintain effective communication and coordination with all agencies, groups and individuals interested in NPS pollution controls; and,
6) secure and administer available federal funds and encourage local efforts in watershed management.

DSW is responsible for producing and updating the Ohio Nonpoint Source Assessment which identifies waters that are impaired and/or impacted by nonpoint sources. By including impacted waters, the list of waters becomes more inclusive than that identified by the Ohio Water Resource Inventory or the 303(d) list.

Unified Watershed Assessments

To further efforts to protect and restore water resources, the U.S. EPA Administrator and the Secretary of Agriculture, in consultation with several other agencies developed the Clean Water Action Plan (CWAP). The CWAP was completed in February, 1998 to promote a collaborative effort on the part of

federal, state, tribal, and local governments, the public and private sectors to restore and sustain the health of the nations water resources. A key component of the CWAP is the creation of Unified Watershed Assessments (UWA) by each state. The UWA compiles existing assessment efforts on the condition of water resources for the purpose of developing common priorities for watershed restoration and protection. The UWA emphasizes broad consultation with environmental and natural resource agencies and others in the development of the UWA and incorporates both "clean water and natural resource goals".

Watershed Categories Defined for Unified Watershed Assessments

Category 1)	**Watersheds in Need of Restoration** (watersheds not meeting, or facing imminent threat of not meeting, clean water or other natural resource goals)
Category 2)	**Watersheds Meeting Goals, including those Needing Action to Sustain Water Quality** (watersheds meeting clean water and other natural resource goals but in need of prevention measures to sustain water quality)
Category 3)	**Watersheds with Pristine/Sensitive Aquatic System Conditions on lands Administered by Federal, State or Tribal Governments** (watersheds with pristine/sensitive aquatic system conditions but require protection measures, and are on federal, state, or tribal lands)
Category 4)	**Watersheds where more information is needed to assess conditions**

Table 2. Criteria for categorizing watersheds identified by the Unified Watershed Assessment process.

Unified Watershed Assessments should complete two basic tasks: 1) place all watersheds in the State in one of four categories (Table 2); and, 2) define watershed restoration priorities and develop watershed restoration action strategies. The development of the Ohio UWA was guided by the Ohio Natural Resources Coordinating Committee (ONRCC). The ONRCC is comprised of representatives from federal, State and regional agencies including the U.S. Forest Service, Geological Survey, National Park Service, Natural Resources Conservation Service, U.S. Department of the Interior, Office of Surface Mining, the Ohio Departments of Natural Resources, Agriculture, and Health, the Ohio Environmental Protection Agency, and the Ohio River Valley Water Sanitation Commission. Through a

series of meetings held from July through September 1998, the ONRCC suggested criteria for categorization and prioritization of watersheds for the UWA. Additional input and comment on the UWA was sought from the State Technical Committee of the NRCS.

The criteria used to determine which category a watershed is placed are: 1) the percentage of assessed river and stream miles within a watershed; and, 2) the percentage of assessed miles that are threatened, partially attaining, or not attaining the designated aquatic life use. As such the UWA process relies heavily on the Ohio EPA waterbody system used to compile the 305(b) report, which is an outcome of the Five-Year Basin Approach. Designated uses are assigned in the Ohio Water Quality Standards. These uses include aquatic life, public water supply, agricultural water supply, industrial water supply and recreation. Rivers, streams and lakes are periodically assessed as to whether they are supporting these beneficial uses. In reporting on attainment of water quality standards, Ohio EPA emphasizes aquatic life use attainment because: 1) aquatic life criteria frequently result in the most stringent requirements compared to those for the other use categories, (*i.e.*, protecting for aquatic life uses should assure the protection of other uses); 2) aquatic life uses apply to virtually every Ohio waterbody and the diverse criteria (conventional substances, nutrients, toxics, habitat, physical, and biological factors) apply to all water resource management issues; 3) aquatic life uses and the accompanying chemical, physical and biological criteria provide a comprehensive and accurate ecosystem perspective toward water resource management; and 4) the existence of an extensive and comprehensive database of aquatic life, physical habitat, water chemistry, sediment, and effluent data, most of which is readily accessible via electronic databases. In addition to assessing use attainment, this array of data is used to ascribe causes and sources of impairment of surface waters.

Assessed waters are categorized as either fully attaining, fully attaining but threatened, partially attaining, or not attaining the aquatic life use. The fully attaining, but threatened category means that the assessed waters are meeting all chemical and biological standards but that changes in land uses and/or water uses threaten to degrade the quality of the resource. The specific percentages for each category are listed below.

Category 1: Watersheds in Need of Restoration
Watersheds where 20 percent or more of the river and stream miles have been assessed, and where 10 percent or more of assessed waters are not attaining, threatened, or partially attaining the aquatic life use designations.

Category 2: Watersheds Meeting Goals, including those Needing Action to Sustain Water Quality
Watersheds where 20 percent or more of the river and stream miles have been assessed, and where less than 10 percent of assessed waters are not attaining, threatened, or partially attaining the aquatic life use designations.

Category 3: Watersheds with pristine/sensitive aquatic system conditions on <u>federal, state, or tribal lands</u>
Watersheds where 20 percent or more of the river and stream miles have been assessed and where less than 10 percent of assessed waters are not attaining, threatened, or partially attaining the aquatic life use designations *(No category three watersheds have been identified for Ohio.)*

Category 4: Watersheds where more information is needed to assess conditions
Watersheds where less than 20 percent of the rivers and streams have been assessed.

Two key objectives of the UWA are to: 1) integrate human health, water quality, and natural resource goals into the restoration prioritization process; and, 2) identify watersheds where common priorities and opportunities exist for actions by federal, State and local governments, as well as local stakeholders. Human health, water quality, and natural resource goals are incorporated into the watershed prioritization process through measures of the extent and severity of impairment to aquatic life, fish consumption, and recreational uses in the watershed; identification of watersheds where elevated levels of nitrates or pesticides have been detected at public water supply surface intakes, identification of the predominant sources of impairment in the watershed; and measures of physical and habitat features of watershed that can facilitate recovery of aquatic life.

Source Water Protection Program

The Source Water Assessment and Protection program (SWAP) is a recent and innovative effort to protect Ohio's streams, rivers, lakes, reservoirs, and ground waters that are used as public water supplies from future contamination. The SWAP program will identify drinking water protection areas and provide information about how to reduce the potential for contaminating waters within those areas. The goal of the program is to ensure the long-term availability of an abundant supply of safe drinking water for the citizens of Ohio.

As required under the 1996 Amendments to the Safe Drinking Water Act, the proposed SWAP program will address all legally designated public water supply systems. These are facilities that provide drinking water to the public, whether from an underground well or spring, or, from a surface water such as a stream, lake, reservoir, or river. The program does not address individual residential wells or cisterns. In Ohio, there are approximately 6,100 public water systems. More than 5,800 of these utilize ground water. While only 317 systems use surface water, a number of them -- such as those in Cincinnati, Columbus, Cleveland, and Toledo -- serve large populations. The Safe Drinking Water Act Amendments of 1996 require source water assessments for *all* public water systems in the United States. U.S. EPA expects all States to complete assessments for all public water systems by the year 2004.

Under the SWAP program, assessments of source water areas will be conducted for both ground and surface sources of drinking water. Information gathered through these assessments will then be used to direct protection and remediation activities as needed. Essentially, the program will consist of four steps:

1) Delineation of the protection area;

2) Inventory of the facilities and land uses within the protection area that could contaminate the drinking water;

3) Susceptibility analysis which determines the *likelihood* that the source water could become contaminated; and

4) Implementation of protection activities to avoid contamination of the

surface water body or aquifer, or to reduce the levels of existing contaminants.

The first three steps of this process involve identifying and assessing the SWAP area of a public water system's drinking water supply. Ohio EPA proposes to conduct an additional step, called a "resource characterization", which involves collecting the regional and site-specific hydrogeologic information that is necessary to: a) adequately delineate SWAP areas for ground water systems; b) determine the susceptibility of an aquifer or watershed; and, c) identify areas of an aquifer or watershed that require special attention. Numerous parameters, including aquifer porosity, hydraulic conductivity, ground water levels, pumping rates, and well depths, will be entered into a database that will be used by staff who are completing other portions of the assessment. Ground water pollution potential maps (DRASTIC maps) and aquifer maps created by the Ohio Department of Natural resources will also be used . For ground water systems, resource characterization will be the first step in the assessment process, because the information is critical for delineating the SWAP areas. For surface water systems, the SWAP area will be delineated first, then a resource characterization will be completed for the SWAP area.

The process for delineating the boundaries of the source water protection areas will differ for ground and surface waters. For ground waters, the delineation will be based on a five-year capture zone -- the SWAP area will be the area from which ground water flows into a well within five years. Once the outer border of the SWAP area is delineated, a smaller area within that area -- the inner management zone -- will also be delineated, based on the one-year capture zone. Capture zones can be calculated from various equations and ground water flow models.

The delineation of surface water areas will be based on a combination of existing watershed boundaries, including USGS hydrologic unit maps, and some modifications to them. Several smaller areas within the SWAP area -- the emergency management zone and the corridor management zone -- will be delineated and targeted for specific inventory and protection activities. A resource characterization then will be conducted to gain an understanding of the physical, biological, chemical, and hydrological characteristics of the SWAP watershed. Factors such as the potential for surface runoff and the ease of transport of surface

runoff to the source water in the SWAP watershed will be used in conducting the resource characterization. Biological and chemical water quality data will not only reveal source waters that are already contaminated, but will provide direction for conducting future monitoring and selection of appropriate protection activities.

Maps of each stream, river, lake, reservoir, or aquifer supplying the drinking water--and its surrounding protection area -- will be created by Ohio EPA. The Agency may seek help in completing these assessments from other agencies, subcontractors, or a combination of the two.

Once a public water system SWAP area is identified, the next step is to inventory and locate on a map any known potential sources of pollution within that area that might cause drinking water contamination. Ohio EPA will provide a map of the SWAP area to the public water supplier showing the boundaries of the SWAP Area and special management areas within the SWAP, the location of the public water wells or intake, and the locations of any potentially significant contaminant sources that already are entered in Ohio EPA’s databases. Ohio EPA also will provide forms and checklists to assist public water suppliers in inventorying the potential contaminant sources in their SWAP areas. The inventory information can be obtained by a variety of methods, including visual surveys, mailed surveys, phone surveys, and site visits. Also, sites located on Ohio EPA’s initial maps need to be verified. Since local residents are more familiar with their environs, Ohio EPA will ask local water suppliers, citizens, government officials and employees, and those who are concerned with their drinking water quality to work together to verify locations and complete the inventory. Direct technical assistance will be provided by Ohio EPA and/or its contractors, as needed.

Because the SWAP areas for surface water systems may be thousands of square miles, local inventory efforts will be expected primarily in the designated management areas, and any sub-watersheds that are subsequently designated. However, the initial maps provided by Ohio EPA will include the locations of known potentially significant contaminant sources throughout the entire SWAP area.

Ohio EPA will then determine the *likelihood* that the drinking water in each source water protection area could become contaminated—a process called “susceptibility

analysis." Once the assessment is completed, it will be written up in a report that will include: 1) a description of the hydrogeologic setting; 2) identification of potentially significant contaminant sources; 3) an assessment of existing aquifer or water resource quality; and, 4) suggested protective actions. These reports will be made available to the public in various formats, including the Ohio EPA web page. Public water systems will also be required to share with their consumers at least a summary of the information on their own Source Water Protection areas.

The fourth step is perhaps the most important part of the SWAP program, where preventive steps will be taken to protect source waters. Information contained in the final SWAP report will provide local water supply operators and other stakeholders with suggested protection activities. This report will be sent directly to public water suppliers and will be made available in various formats through Ohio EPA's Web page, through copies sent to local libraries, and upon request.

Protective actions can be voluntary or mandated by a local authority, such as the municipality, township, county, water-and-sewer district, etc. Ohio EPA anticipates that protective actions in many SWAP areas will consist primarily of education and the encouragement of voluntary Best Management Practices. This is especially true for the state's 4,000 or so noncommunity systems, which have little or no authority over activities occurring beyond the supplier's own property lines. However, some communities may decide to pass ordinances or zoning that enables the local officials to protect and/or clean up areas. In some cases, preventive measures may consist of the municipality buying up undeveloped land around a stream or well field so that it can control the kinds of activities that take place there. In other cases, prevention will depend on better enforcement of state and local environmental regulations at facilities subject to such regulations. The kinds of preventive measures that may be taken, and the degree to which they are needed, will depend largely on the number and types of contaminant sources in the source water protection area and susceptibility analysis. In any case, preventive measures are expected to be initiated and led *by the affected community*, with technical assistance from Ohio EPA. While some protective measures may be easily implemented, it may take many years to establish effective pollution prevention programs.

For public water systems with large SWAP areas that cross many jurisdictions and

have multiple concerns, a concerted planning effort among stakeholders may be the most effective approach to implementing protection activities. Ohio EPA will provide assistance to these efforts via the Wellhead Protection Program for ground water systems and the Watershed Action Planning Approach for surface water systems.

2.8 Hazardous Waste Sites

The Agency has a goal of cleaning up 400 sites by the year 2000 which DERR will help to achieve through a variety of mechanisms. We will significantly decrease the areas of contamination in Ohio by making available more efficient and flexible ways for interested parties to accomplish site cleanup. We plan to offer flexibility in cleanup by making available a variety of types and combinations of cleanup options from voluntary action, emergency response, time critical and non-time critical removal actions to fully detailed remedial cleanup actions so that the most efficient environmentally protective option can be quickly and easily performed. This strategy includes combining our efforts with other divisions' efforts to effectively use the geographic initiative and multi-media approach to achieve site cleanup. Current sites undergoing cleanup will be factored into this philosophy and will also benefit from a more enhanced and integrated cleanup program. Cleanup mechanisms and resources will be geared toward reducing the greatest environmental threats first.

Voluntary Action Program

The DERR Voluntary Action Program (VAP) will provide the opportunity for areas to be cleaned up and redeveloped (brownfields initiatives) with minimal agency oversight. We intend to incorporate brownfields types of assessments in our preliminary assessment/site investigation grant with U.S. EPA. During 1996, the VAP will complete the second set of rules which deal with investigation and performance standards for cleanup. A subsequent major strategy will consist of conducting outreach activities to encourage maximum participation in the program by volunteers, professionals, and laboratories. Additionally, the Division will refine coordination issues between Central Office and the District Offices to ensure smooth implementation of the program and achieve proper balance with our enforcement program to move toward the Agency's goal of cleaning up 400 sites by the year 2000. The VAP will work with other state agencies to develop and implement financial tools and incentives as well as look for creative ways to make

the cleanup and redevelopment of "brownfields" sites an economic preference to development in "greenfields." Over the next few years, we will need to monitor and evaluate the effectiveness of the program to identify areas that require rule/legislative modifications or written guidance.

Monitoring and assessment activities conducted in connection with VAP sites must be overseen by a certified professional (CP). Cps must follow Ohio EPA and U.S. EPA methods and QA/QC procedures. Ohio EPA certifies CPs for such work including a bioassessment/biocriteria certification process.

Remedial Response Program

The Remedial Response Program has the cleanup goal of 400 sites by the year 2000. The Division is continuing to make improvements in the technical areas of the cleanup program to streamline and accelerate site remediation efforts. As an example, one area the Division will concentrate on is streamlining the risk assessment phase by providing guidance, training, and standardized risk assessment procedures and generic standards.

DSW provides direct technical expertise in the area of surface water assessments associated with remedial investigations and risk assessments. These resources are located in EAU and are allies with the tools and methods used in the Five-Year Basin Approach. In addition, this provides the opportunity to explore new assessment tools in conjunction with the site-specific assessments.

Emergency Response and Special Investigations

Emergency Response is a well established program that consistently provides 24-hour, 365 days/year statewide coverage for responding to accidental or unauthorized releases. Emergency Response maintains the computerized Release Reporting System which is the principal database for documenting spills. The Special Investigations Program conducts criminal investigative work. Again, monitoring and assessment information is essential within these programs.

2.9 **Comparative Risk**

Comparative risk is a planning process that endeavors to analyze and assess the risks from environmental issues and ultimately rank the issues on the basis of the risks they pose. Comparative risk is based on the premise that there are limited

resources to deal with all of the environmental problems we face; therefore, we need to focus those resources in a manner that will result in the greatest overall reduction of risk. The risks must be identified using science and public values, not one or the other, and the process of comparative risk is set up to do this. Without comparative risk or some similar tool to bring available information into the environmental management arena, we may continue to respond to the environmental crisis of the day--syringes washed up on the shore, newly discovered hazardous waste sites, or the reporting of a new toxic hazard.

The Ohio Comparative Risk Project is a citizen-based environmental planning project that evaluates environmental problems in Ohio based on scientific evidence and public values. The information is being used to develop an environmental priority list and strategies for policy makers and citizens to use in reducing risks. Phase 1 of the Project involved gathering scientific and public data about environmental issues in Ohio. Quantitative scientific data were obtained from environmental professionals and published reports about environmental conditions in the state. Data about the public's environmental concerns and priorities were obtained from a number of outreach activities involving more than 20,000 Ohio citizens. Phase 1 resulted in the Ohio State of the Environment Report, a 508-page document published in December 1995. A 35-page companion report, Facts and Figures About Ohio's Environment, is also available. Ohio's results can be compared to other states via the State Environmental Goals and Indicators Project (SEGIP; Berquist et al. 1998). Phase 1 also resulted in a ranking of 45 potential threats to Ohioans' health, environment and quality of life.

2.10 **Lake Erie Programs**

Lake Erie programs consist of Ohio EPA involvement in activities related to the Lakewide Management Plan, Remedial Action Plans for the four areas of concern, and the activities of the Lake Erie Office. Monitoring and assessment activities conducted by Ohio EPA have historically been very limited in scope and this is reflected in the lack of definitive assessment information in the Ohio Water Resource Inventory (305[b] report). However, DSW has become involved in several initiatives which should address these deficiencies in the next 5-10 years.

RAP Program

There are four Remedial Action Plans (RAPs) in Ohio: Ashtabula River (USEPA),

Black River, Cuyahoga River, and Maumee River. Ohio EPA is responsible for ensuring RAPs are implemented in Ohio. These areas are the State's most polluted and environmentally impacted rivers which empty into Lake Erie. Ohio's Remedial Action Plan Program (GLIN) addresses the restoration of beneficial uses (GLIN) in Ohio's four Lake Erie Areas of Concern (AOC) (GLIN). As requested in the Great Lakes Water Quality Agreement, (IJC) the RAPs take an ecosystem approach and incorporate active public involvement.

Year after year, the same locations were identified as the most contaminated areas around the Great Lakes. The adoption and implementation of environmental laws and regulations significantly reduced the discharge of pollutants, but these areas continued to experience severe environmental degradation. In 1985, the Water Quality Board of the International Joint Commission (IJC) recommended the development of comprehensive remedial action plans (RAPs) to concentrate on the cleanup and restoration of these areas. New, creative, innovative, collaborative and wide-reaching approaches would be needed to achieve this goal. The eight Great Lakes states and Ontario agreed to the challenge and Ohio EPA took the lead for the program in Ohio.

Neither the State nor Federal Governments had sufficient resources, the historical knowledge, or even the authorities to restore all the impairments identified. Ohio EPA invited the local communities to become active participants in the decision making involved with the RAPs. Initial public meetings on the RAP process and the outstanding environmental problems in each AOC were held in 1987. At those meetings, the local communities showed a great interest in taking a strong role in restoring their rivers.

Local committees have been created in each of the areas to coordinate them development and implementation of the RAP. Ohio EPA works with these committees as an equal partner in the RAP process. The local committees have been built with the intention of obtaining representation from all of the local agencies, organizations, and unaffiliated citizens with an interest or a stake in river remediation.

Each of Ohio's RAPs has been organized somewhat differently, depending on the unique characteristics of each AOC. These characteristics include: environmental

problems in the AOC, sources and causes of the problems, available resources - both technical and financial, political climate, public interest, and the volunteer base.

The ecosystem approach and the public involvement requirements of the RAP process have allowed us to be as flexible and innovative as we need to be to restore all beneficial uses to each AOC. With funding from U.S. EPA and the State, Ohio EPA has been able to support a full-time coordinator for each RAP. However, much cross-program technical assistance has been provided by staff from several divisions and districts. This agency-wide cooperation has been invaluable to the RAP program.

Lakewide Management Plan (LaMP)

LaMP stands for Lakewide Management Plan. A LaMP is a comprehensive management plan to restore and protect the waters in each of the Great Lakes. Using LaMPs as a tool to restore water quality is highlighted in the Great Lakes Water Quality Agreement(GLWQA). LaMPs are currently underway for Lakes Ontario, Erie, Michigan and Superior.

The goal of the Lake Erie Lakewide Management Plan is to preserve, restore and protect the beneficial uses of Lake Erie. The development of the Lake Erie LaMP can best be thought of as a problem solving process. The first step is to identify impairments and then the causes and sources. Finally, the desired state for the lake needs to be articulated. A vision of the desired state of Lake Erie allows progress in resolving water quality problems to be evaluated and to identify when the objectives for a clean and healthy lake have been reached. The completion of these steps will set the stage for action.

Three Lake Erie LaMP technical subcommittees are working on each of the aspects mentioned above. The Beneficial Use Impairment Assessment Subcommittee is identifying current water quality problems. The Sources and Loadings Subcommittee is identifying the key chemical sources of identified water quality problems. The Ecosystem Objectives Subcommittee is developing objectives that define the collective desired state for Lake Erie and reflect sound science and public values. When the work of these three subcommittees is complete, the core elements needed to begin the action planning process will be in place. It is

recognized that all Lake Erie water quality issues are not captured within the 14 beneficial use impairments identified by the Great Lakes Water Quality Agreement. Similarly, all impairments are not caused by chemical contaminants. These issues will be addressed as the LaMP development process continues.

U.S. EPA Region 5 and Environment Canada have been serving as the federal co-leads for this initial effort. In the United States, the State of Ohio has served as the lead State, with participation from Michigan, Pennsylvania, and New York. In Canada, other participating agencies have been the Department of Fisheries and Oceans, Agriculture Canada, the Ontario Ministry of Natural Resources, the Ontario Ministry of Agriculture, Food, and Rural Affairs, and the Ontario Ministry of Environment and Energy.

Beneficial Use Impairments

This principal purpose of the Beneficial Use Impairment Assessment or BUIA is to determine the overall health and well-being of the lake. The Great Lakes Water Quality Agreement lists 14 beneficial use impairments against which the health of the Great Lakes are to be measured. These impairments and associated criteria are:

- **Restrictions on fish and wildlife consumption**: When contaminant levels in fish or wildlife populations exceed current standards, objectives or guidelines, or public health advisories are in effect for human consumption of fish and wildlife.

- **Tainting of fish and wildlife flavor**: When ambient water quality standards, objectives, or guidelines for the anthropogenic substance(s) known to cause tainting are being exceeded or survey results have identified tainting of fish and wildlife flavor.

- **Degraded fish and wildlife populations**: When fish or wildlife management programs have identified degraded fish or wildlife populations. In addition, this use will be considered impaired when relevant, field-validated, fish and wildlife bioassays with appropriate quality assurance/quality controls confirm significant toxicity from water column or sediment contaminants.

- **Fish tumors or other deformities**: When the incidence rates of fish tumors or other deformities exceed rates at unimpacted control sites or when survey data confirm the presence of neoplastic or preneoplastic liver tumors in bullheads or suckers.

- **Bird or animal deformities or reproductive problems**: When wildlife survey data confirm the presence of deformities (e.g. cross-bill syndrome) or other reproductive problems (*e.g.*, egg-shell thinning) in sentinel wildlife species.

- **Degradation of benthos**: When the benthic macroinvertebrate community structure significantly diverges from unimpacted control sites of comparable physical and chemical characteristics. In addition, this use will be considered impaired when toxicity (as defined by relevant, field-validated bioassays with appropriate quality assurance/quality controls) of sediment associated contaminants at a site is significantly higher than controls.

- **Restrictions on dredging activities**: When contaminants in sediments exceed standards, criteria, or guidelines such that there are restrictions on dredging or disposal activities.

- **Eutrophication or undesirable algae**: When there are persistent water quality problems (*e.g.*, dissolved oxygen depletion of bottom waters, nuisance algal blooms or accumulation, decreased water clarity, etc.) attributed to cultural eutrophication.

- **Restrictions on drinking water consumption or taste and odor problems**: When treated drinking water supplies are impacted to the extent that: 1) densities of disease- causing organisms or concentrations of hazardous or toxic chemicals or radioactive substances exceed human health standards, objectives or guidelines; 2) taste and odor problems are present; or 3) treatment needed to make raw water suitable for drinking is beyond the standard treatment used in comparable portions of the Great Lakes which are not degraded (*i.e.*, settling, coagulation, disinfection).

- **Beach closings**: When waters, which are commonly used for total-body contact or partial-body contact recreation, exceed standards, objectives, or

guidelines for such use.

- **Degradation of aesthetics**: When any substance in water produces a persistent objectionable deposit, unnatural color or turbidity, or unnatural odor (*e.g.*, oil slick, surface scum).

- **Added costs to agriculture and industry**: When there are additional costs required to treat the water prior to use for agricultural purposes (i.e. including, but not limited to, livestock watering, irrigation and crop-spraying) or industrial purposes (i.e. intended for commercial or industrial applications and non-contact food processing).

- **Degradation of phytoplankton and zooplankton**: When phytoplankton or zooplankton community structure significantly diverges from unimpacted control sites of comparable physical and chemical characteristics. In addition, this use will be considered impaired when relevant, field-validated, phytoplankton or zooplankton bioassays (*e.g.*, *Ceriodaphnia;* algal fractionation bioassays) with appropriate quality assurance/quality controls confirm toxicity in ambient waters.

- **Loss of fish and wildlife habitat**: When fish or wildlife management goals have not been met as a result of loss of fish or wildlife habitat due to a perturbation in the physical, chemical or biological integrity of the Boundary Waters, including wetlands.

For each beneficial use impairment assessment that has been completed to date, a technical report is available (LaMP 1997a,b,c,d; 1998a,b).

Ohio EPA Biological Assessment and Biocriteria Development

In 1993, Ohio EPA initiated the development of biological assessment methods and biological criteria development for the Lake Erie nearshore and the inundated mouths of rivers and harbors (*i.e.*, lacustuaries). The field work for this effort was largely completed in 1997. Working versions of an Index of Biotic Integrity (IBI) for the fish community and the Invertebrate Community Index (ICI) were developed as a result. These new tools and database will be used to produce a comprehensive assessment of the status of the Lake Erie shoreline and lacustuary

areas, which has been essentially lacking in the past. This should result in a significant upgrade to the Lake Erie portion of the Ohio Water Resource Inventory. This will also be of value to the LaMP beneficial use impairment assessment and the RAP process.

Lake Erie Quality Index

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

The *Quality Index* did not address what needs to be done to achieve the established environmental, recreational, and economic goals it identified. The Lake Erie Commission initiated a follow-up effort called the *Lake Erie Protection and Restoration Plan*, that is to map out a long-term strategy for achieving the goals presented in the *Quality Index* and ensure future improvements to Lake Erie. The Plan will focus on the various metrics established in the *Quality Index,* catalogue all current efforts underway, and identify the additional initiatives and resources necessary to achieve the *Quality Index* goals and objectives. This plan will be completed in the year 2000.

2.11 **Ohio River Valley Sanitation Commission**

The Ohio River Valley Water Sanitation Commission (ORSANCO), established by compact in 1948 to control and abate pollution in the Ohio River Valley, is an interstate commission representing eight states and the federal government. Member states are: Illinois, Indiana,Kentucky, New York, Ohio, Pennsylvania, Virginia and West Virginia. The Commission operates programs to improve water quality in the Ohio River and its tributaries, including setting wastewater discharge standards, performing biological assessments, monitoring for chemical and physical properties of the waterways, and conducting special surveys

and studies. ORSANCO also coordinates emergency response activities for spills or accidental discharges to the river, and promotes public participation in programs, such as the Ohio River Sweep and River Watchers volunteer monitoring program.

ORSANCO essentially conducts all monitoring and assessment activities in the Ohio River mainstem on the behalf of the States. This includes data management, interpretation, and assessment including the 305(b) report. ORSANCO operates a network of fixed stations which are sampled monthly for chemical/physical parameters and a selection of continuous four parameter monitors. Recently, more emphasis has been placed on intensive and investigative surveys which generally use navigational dam pools as study units. ORSANCO also initiated an extensive bioassessment and biological criteria development program in 1992 including fish and macroinvertebrate community assessments. To date, a working index for the fish community has been developed and termed the Ohio River Fish Index (ORFIn). This work is expected to continue and will likely lead to an improved 305(b) report and possibly refined designated aquatic life uses.

Chapter 3: Ohio EPA Surface Water Monitoring Programs

3.1 Introduction

Monitoring and assessment information, when based on a sufficiently comprehensive and rigorous system of environmental indicators, is integral to protecting human health, preserving and restoring ecosystem integrity, and sustaining a viable economy (ITFM 1992). Such a strategy is intended to achieve a better return on public and private investments in environmental protection and natural resources management. In short, more and better monitoring and assessment information is needed to answer the fundamental questions that have been repeatedly asked about the condition of our water resources and to shape the strategies needed to deal with both existing and emerging problems within the context of watershed-based management. These principles have guided the development of surface water monitoring and assessment at Ohio EPA for the past 21 years and will continue to do so in the future.

A Long Term Vision for Monitoring and Assessment

The long-term vision espoused by the ITFM (1995) and which is reflected in the U.S. EPA 106/604b guidance is to develop a process for the comprehensive assessment of the waters of each State. This is to be accomplished by implementing a multi-year monitoring and assessment framework at all relevant geographic scales to support all water quality management objectives (including risk-based decision making). Some of the key elements of this approach are:

- development and implementation of a statewide monitoring strategy.
- publishing monitoring and assessment results from relevant sources (*e.g.,* Watershed-specific reports, State 305[b] reports).
- maintaining data storage, retrieval, and management.
- taking appropriate regulatory and management actions based on those results.

These efforts would fall short if a linkage between program management and monitoring and assessment were not made an integral part of the overall water quality management process (Figure 12). This, too, is part of the long range vision for revitalizing the role of water quality monitoring nationwide (ITFM 1995). The Ohio EPA process of using monitoring and assessment information reflects these

attributes.

3.2 **Key Principles of the Adequate State Watershed Monitoring Approach**
In 1997, ASIWPCA and U.S. EPA, in concert with a cooperative agreement with Ohio EPA, collaborated in an effort to better define the important concepts, principles, and elements needed for State watershed monitoring and assessment programs. The resulting document entitled *Important Concepts and Elements of an Adequate State Watershed Monitoring and Assessment Program* (Yoder 1997) is summarized here as an outline of the approach taken by Ohio EPA to surface water monitoring and assessment.

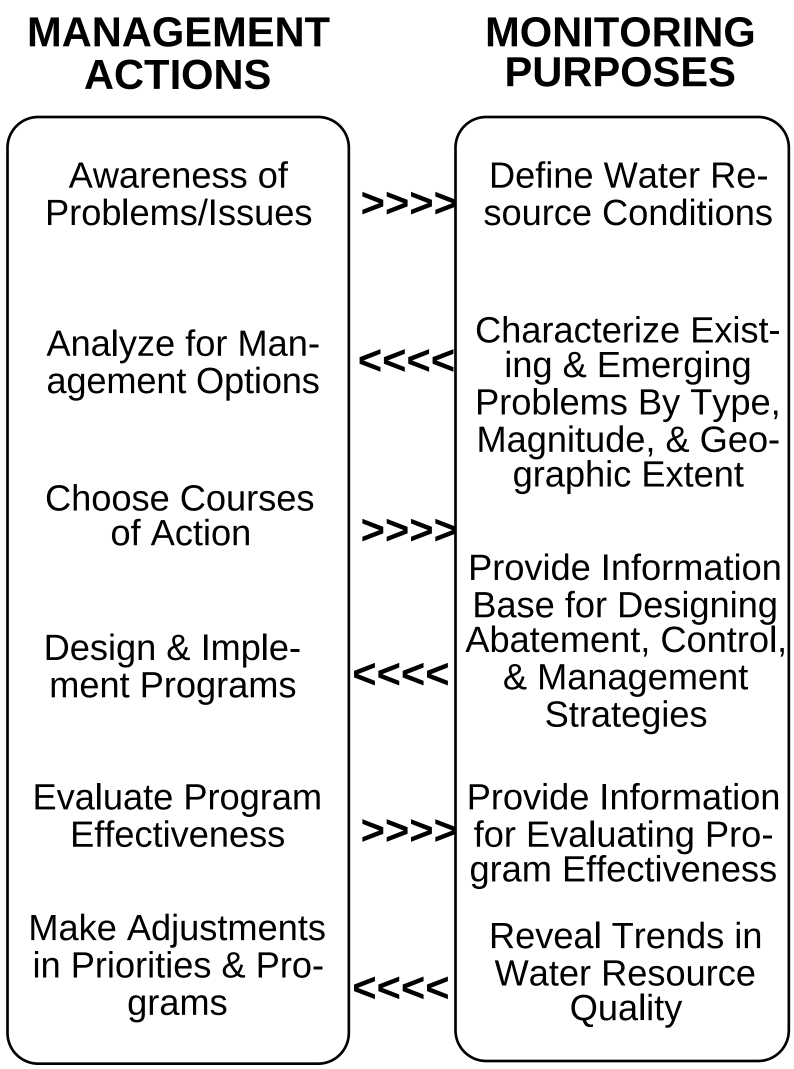

Figure 12. The relationship between management actions and the purposes of monitoring and assessment (after ITFM 1995).

Program Goals for States
The following is a compilation of the major program goals that should shape the design of an adequate State monitoring and assessment program and thus become the identifiable characteristics (Yoder 1997). While this is patterned after the major monitoring compendia and program guidance that has recently been developed (ITFM 1995; U.S. EPA 1994 [106/604b guidance]), the specifics of implementation lie within the

custodial responsibilities of State water programs.

1) The 18 national water indicators and the goals each measures (U.S. EPA 1995a) serve as core indicators with other goals and indicators as needed to fulfill the following purposes:

- Conserve and enhance public health.
- Conserve and enhance ecosystems.
- Support uses designated by States/Tribes in Water Quality Standards (WQS).
- Conserve and improve ambient conditions.
- Reduce or prevent loadings and other stressors (*e.g.*, habitat degradation).

2) Assess all water resource types within an organized temporal framework (*e.g.*, rotating basin approach) by employing the following approaches:

- Achieve virtually 100% coverage through a mix of different spatial schemes, *i.e.*, targeted sites, rotating basin cycles, and/or probabalistic design.
- Utilize appropriate and robust techniques for extrapolation and stratification of monitoring and assessment results (*i.e.*, every mile of every stream need not be monitored to achieve the 100% coverage goal).
- Maximize interagency and inter-organizational cooperation and collaboration.
- When appropriate, make use of volunteer organization results.

3) Produce a "better" 305b report:

- National statistics are currently biased by wide differences between State approaches to monitoring & assessment including indicators usage and calibration - one result is widely divergent State estimates of impaired waters (generally overly optimistic estimates of the full attainment of aquatic life uses).
- Assignment of impairment (or lack thereof) to associated causes and sources also reveals the inconsistent usage of indicators and indicator frameworks - *e.g.*, habitat has been under-reported by most States (almost one-half of States reported zero impaired miles for rivers and streams in 1992).

4) Support the emerging watershed approaches:

- Reductions in State monitoring and assessment programs jeopardize the science basis for successfully implementing watershed-based approaches which are ostensibly based (in part) on addressing previously overlooked or under-emphasized problems.
- Management applications most commonly take place at the watershed level thus monitoring and assessment must be relevant to this management scale and be capable of detecting impairments and characterizing aquatic resources at this scale.

5) Satisfy basic questions that are frequently encountered and/or asked by water quality program managers:

- What is the condition of surface, ground, estuarine, and coastal waters?
- How and why are conditions changing over time?
- What are the associated causes and sources of impairment?
- Are water quality management programs producing the desired results?
- Are State and national water quality goals being attained?

6) Integrate the water resource integrity concepts that have been developed during the past 10-15 years into monitoring and assessment approaches, environmental indicators, and watershed-based programs:

- The five factors that determine the integrity of water resources (see Figure 2) should be used to guide the development of environmental indicators - indicators which represent or extend to each major factor and which reflect the integrity of the water resource as a whole (*e.g.,* composite measures, indices) are needed.
- Follow the stressor, exposure, response paradigm for determining the most appropriate roles for specific indicators - avoid the inappropriate substitution of stressor and exposure indicators for response indicators.
- Utilize appropriate regionalization schemes (*e.g.,* ecoregions, subregions) to stratify and partition natural variability for ambient indicators.
- Incorporate tiered and refined use designations in the State WQS as appropriate.
- Use the water indicators hierarchy (see Figure 1) as an operational framework for State water quality management programs - make linkages

between administrative activities and indicators of stress, exposure, and response.

The Ohio EPA program meets the majority of these goals, particularly in the infrastructure of monitoring and assessment tools and resources, environmental indicators use and development, WQS, and integration with water quality management. An area for improvement is in meeting the goal of assessing 100% of the State's waters and consistently assessing all resource types. This will be addressed in chapter 5 (monitoring needs assessment).

State Monitoring and Assessment Program Objectives

The following are some of the principal objectives that State monitoring and assessment programs should have as priorities. Fully meeting some of these objectives requires time to acquire and develop the necessary database, indicators, and staff expertise. However, this is dependent on the status of existing and past State monitoring and assessment efforts -- for Ohio, there exists a 20+ year database. Using the following objectives provides a basis for determining the adequacy of a given State program. A well rounded approach to indicators and monitoring design utilizing a core set of chemical, physical, and biological indicators should provide the information needed to simultaneously meet these objectives without the need to redesign the approach for each different objective.

1) Baseline characterizations of surface water resources:

- Status and trends information.
- Aquatic resource characterization.

2) Identification and characterization of existing and emerging problems:

- Selection of indicators and the overall indicator framework will strongly influence the adequacy of problem identification and characterization (we cannot address problems that we do not know about or adequately understand).
- The indicator framework and monitoring design must be prepared to provide information and insights to problems that may not yet be understood or even recognized.

- There will be a need to go beyond point source paradigms.
- Make better linkages between designated uses and indicators.

3) Guide and evaluate the water quality management and regulatory process:

- Monitoring and assessment information should drive the regulatory and management processes from problem identification through to assessing the effectiveness of these efforts.
- The 305[b] process (*i.e.,* Water Body System) should be the central reporting mechanism for State programs - this will further benefit the compendia and assessments compiled by EPA, other federal agencies, and private organizations.
- Support the development and refinement of aquatic life and other designated uses in State WQS.
- Examples of other regulatory and management programs that can be influenced and include 303[d] listing, TMDLs, water quality-based permitting, compliance and enforcement, prioritizing grants and other financial assistance, the State nonpoint source assessment (319 program), etc.
- Monitoring and assessment information should provide the impetus for improved regulatory or program management directions (*e.g.,* initiatives to restore and protect riparian habitat, nutrient criteria, sediment criteria, antidegradation, etc.) and enhance existing efforts (CSOs, stormwater, 404/401 program, chemical criteria validation, biological criteria, etc.).

4) Evaluation of overall water quality management program effectiveness:

- Demonstrate the effectiveness of 25+ years of CWA program implementation.
- Establish linkages between administrative activities (*i.e.,* “bean counts”) and environmental results (*i.e.,* ambient chemical, physical, and biological indicators).
- Which actions worked and which ones did not? Provide insights on why and suggest what specific program and/or resource adjustments might be needed.

5) Responding to emergencies, complaint investigations:

- Quantify environmental damages on a spatial and/or temporal basis.
- Characterize resources at risk.
- Define the magnitude of apparent problems.

6) Identify and characterize reference conditions:

   - Baseline for development of indicator benchmarks for evaluating designated use attainment/non-attainment (*e.g.*, biological criteria) and other management objectives.
   - This functions as a long term data source for characterizing ambient biological, chemical, and physical conditions through time.

The Ohio EPA program meets all of these objectives by having the tools and resources in terms of criteria, program structure, and design, the Five-Year Basin Approach being the fundamental framework of the latter.

Monitoring Design Approaches

A key issue facing the States is the selection of an appropriate monitoring design. It has been recognized for some time that the traditional fixed station design (*e.g.*, NAWQMN, NASQAN) common to many historical State monitoring networks is simply insufficient to meet the previously stated objectives. However, State monitoring and assessment resources continue to be limited and therefore must be prioritized. Selecting information-effective spatial designs is a critical step in the process. Two approaches, a synoptic, targeted design commonly referred to as a rotating basin approach and the probabalistic design developed by the U.S. EPA EMAP program are summarized here. The strengths and weaknesses of each are indicated with respect to the multiple issues that State monitoring and assessment programs must address.

Rotating Basin Approach

1) Strengths:
   - Organized, systematic approach based on accumulating assessment information at a local scale over a fixed period of time, usually 5 or 10 years.
   - Coincides with various management programs which are supported by the monitoring and assessment information (*i.e.*, NPDES permit reissuance,

basin-wide water quality planning, proposed 5-year 305b reporting cycle).
- Provides monitoring and assessment information at a local or reach specific scale so that the many issues which occur at this level can be addressed while providing the opportunity to aggregate upwards to a watershed, regional, statewide, or national scale once sufficient data exists.
- There is more opportunity to define gradients of specific human disturbances with assessment information (*e.g.,* Karr's human activity "dose" - ecological response curve).
- Develop and maintain tabs on reference condition in a predictable and standardized time frame.

2) Weaknesses:
   - Visiting a basin/segment/watershed once every 5 or 10 years may not be sufficient to satisfy all information needs.
   - Larger scale assessment information (*i.e.,* in support of a statewide assessment) is generally only available after 10 years of effort.

The entirety of Ohio EPA's Five-Year Basin Approach sampling utilizes this design.

Probabalistic Design

1) Strengths:
   - statistically robust design.
   - "faster" route to a statewide assessment - aggregate to national scale.
   - transcends State boundary limitations - can facilitate collaborative monitoring between States.

2) Weaknesses:
   - lacks site-specific/issue-specific resolution.
   - logistics are potentially more difficult (i.e., more difficult access to remote monitoring sites).
   - reference condition may be more difficult to define on probability basis alone.
   - local scale issues may be overlooked.

A case example from the Ohio portion of the E. Corn Belt Plains ecoregion Regional EMAP project is summarized in Yoder (1997). In this example the

results of the 1994 probabalistic sampling was compared to four years of rotating basin monitoring in the same region.

Other Designs
The current Ohio EPA approach emphasizes a rotating basin approach and this represents a 20+ year database commitment. We have recently implemented a third design which is termed the Geometric Site Selection process and this is used as part of the five-year basin assessments. Sites within a watershed area are selected based on a geometric progression of drainage area starting with the largest area of the watershed and working down to the 2-5 square mile range. This approach is not entirely random, but it allows for appropriate stratification according to available stream sizes (based on drainage area). Some of the principal benefits of this design are the ability to economize sampling resources on a watershed scale, development of a stratified database, and the enhanced ability to capture previously unassessed streams. This approach has been particularly useful for watersheds that are targeted for TMDL development in that unassessed waters and outdated assessments can be resolved just prior to TMDL development. Gaps which occur along the larger mainstem rivers and streams are filled with the synoptic, targeted approach to assure that historical continuity is retained for both basin-specific and statewide assessments.

Coverage of All Aquatic Resource Types
Defining the different aquatic resource types that a State program needs to address is another critical step in the process. This includes the major aquatic ecosystem types such as flowing waters (*i.e.*, rivers and streams), lakes and reservoirs, coastal waters, great lakes, estuaries, or wetlands. Further stratification within each should take place (*e.g.*, headwater streams, wadable streams, large rivers, depressional wetlands, riparian wetlands, etc.) and may be accounted for *a priori* or as part of the indicator development and calibration process. Other stratification elements, which include watershed driving factors (*e.g.*, ecoregions) and other physical vectors, are incorporated as well. Designated aquatic life uses provide an additional layer of stratification. Taken together all of these processes should result in more finely tuned and accurate indicator expectations or benchmarks against which management program success will ultimately be judged.

Ohio EPA has emphasized flowing waters (rivers and streams) since the majority of

water quality management issues occur in these water body types. This includes larger streams and rivers that are generally regarded as being non-wadeable. The experience gained in performing assessments here has led to the development of techniques in other water body types including the Lake Erie nearshore (coastal waters) and river mouth and harbor areas (estuaries), the Ohio River mainstem in cooperation with ORSANCO (great river), and wetlands. We expect that these developmental efforts will be developed into routine components of the overall monitoring and assessment process and include the integration of information with the development and refinement of WQS and designated uses. The specifics are included in the needs assessment in Chapter 5. The inland lake and reservoir program is limited, by comparison, to assessments of trophic state and on a schedule which was recently modified to coincide with the Five-Year Basin Approach.

Monitoring and Assessment Components

State monitoring and assessment programs need to include the appropriate ambient measurements in order to adequately meet the previously stated goals and objectives. The Intergovernmental Task Force on Monitoring Water Quality (ITFM 1992, 1993) recommended the minimum elements of an adequate monitoring and assessment program that will support meeting the previously stated goals and objectives. These also represents the elements essential to implementing the hierarchy of water indicators framework which is needed not only to demonstrate program effectiveness, but provide opportunities for feedback resulting in future program improvements. Table 3 lists indicators by categories by categories of management objective and these are further stratified by general uses and the indicator level specified by the indicators hierarchy (see Figure 3). More specifically, a set of core and supplemental indicators and parameters was recommended for surface water monitoring (Figure 13). The core parameters consisting of two biological organism groups, habitat parameters, and basic field water quality parameters are measured everywhere. Supplemental parameters and indicators are selected in accordance with applicable designated uses and these largely include the suite of chemical water quality, bacterial, and tissue contaminant indicators and parameters. Ohio EPA follows this approach in the five-year basin process and all other extensions in an effort to meet the aforementioned goals and objectives. Utilization of this approach allows for the implementation of comprehensive, but cost-effective monitoring and assessment.

The ITFM (1995) concluded that the implementation of the national recommendations and strategy would result in an adequate information base to achieve the environmental protection and natural resource management goals and objectives established for the nation's aquatic resources. Some of the steps towards a more comprehensive and effective approach to ambient monitoring include the following which also summarizes the major points of this document:

1) Develop a goal oriented approach to monitoring, assessment, and indicators development where indicators are sufficiently specific so as to explicitly measure the identified national goals and those relevant to State WQS.

2) Evaluate information priorities and identify existing information gaps.

3) Develop a comprehensive and flexible approach that addresses all relevant scales and aquatic resource types.

4) Take advantage of inter-organizational collaboration whenever appropriate.

5) Link traditional compliance monitoring with watershed-based ambient monitoring.

6) Deal effectively with methods comparability to maximize the flexibility in monitoring and assessment approaches while producing data and information of known quality and power of assessment.

7) Automate and streamline data and information management including data entry, storage, and retrieval.

8) Develop better assessment and reporting at all relevant scales; publish results on a regular basis.

9) Promote the development of incentives and the elimination of disincentives to the development of better State ambient monitoring programs and indicators.

Simply upgrading the monitoring program to include more and better measurements and the better conversion of data to information, while important,

*Table 3. Summary matrix of recommended environmental indicators for meeting management objectives for status and trends of surface waters (a bold **X is** recommended as a primary indicator after ITFM 1993; other recommended indicators are designated by √). The corresponding EPA indicator hierarchy level (see Figure 3) is also listed for each suite of indicator groups.*

	Categories of Management Objectives					
	Human Health		**Ecological Health**		**Economic Concerns**	
INDICATOR GROUP	Consump- of Fish/ Shellfish	Public Water Supply	Recreation (swimming, fishing, boating)	Aquatic/ Semi- aquatic Life	Industry/ Energy/ Transpor- tation	Agriculture/ Foresrty/ Mining
Biological Response Indicators (Level 6)						
Macroinvertebrates		X	**X**	**X**		X
Fish	**X**	X	**X**	**X**		X
Semiaquatic animals	X		**X**	**X**	X	
Pathogens	**X**	X	**X**		**X**	
Phytoplankton	**X**	**X**	X	**X**	**X**	
Periphyton				**X**		
Aquatic Plants		X	**X**	X	XX	
Zooplankton		X	X	X	X	
Chemical Exposure Indicators (Levels 4&5)						
Water chemistry	X	**X**	**X**	**X**	X	**X**
Odor/Taste	**X**	**X**	**X**			X
Sediment Chemistry	**X**	**X**	**X**	**X**	**X**	**X**
Tissue Chemistry	**X**	X		X	X	
Biochemical Markers	√	√	√	√		√
Physical Habitat/Hydrological Indicators (Levels 3&4)						
Hydrological Measures	X	**X**	X	**X**	**X**	**X**
Temperature	X	X	**X**	**X**	**X**	√
Geomorphology	X	X	**X**	**X**	**X**	**X**
Riparian/Shoreline	X	**X**	√	**X**	X	**X**
Habitat Quality	√	√	√	√	√	√

Table 3. Continued

	Categories of Management Objectives					
	Human Health		**Ecological Health**		**Economic Concerns**	
INDICATOR GROUP	Consump- of Fish/ Shellfish	Public Water Supply	Recreation (swimming, fishing, boating)	Aquatic/ Semi-aquatic Life	Industry/ Energy/ Transpor-tation	Agriculture/ Foresrty/ Mining
Watershed Scale Stressor Indicators (Levels 3,4,&5)						
Land Use Patterns	X	**X**	**X**	**X**	X	**X**
Human Alterations	X	**X**	**X**	**X**	X	√
Watershed Imperm.	√	√	√	√	√	√
Pollutant Loadings Indicators (Level 3)						
Point Source Loads	√	√	√	√	√	√
Nonpoint Loadings	√	√	√	√	√	√
Spills/Other Releases	√	√	√	√	√	√

is alone insufficient. To achieve the overall goal of improving the use of monitoring and assessment information in the watershed approach, water quality management must mature to focus primarily on the condition of the environment as the overall measure of program success (Figure 14). Whereas the performance of the program was once a principal measure of effectiveness, the program is now an important tool to be used alongside monitoring and assessment and environmental indicators to improve the quality of the environment.

CORE INDICATORS/PARAMETERS

- **Fish Assemblage** • **Macroinvertebrates** • **Periphyton**

(Use Community Level Data From At Least Two)

Physical Habitat Indicators
- Channel morphology • Flow
- Substrate Quality • Riparian

Chemical Quality Indicators
- pH • Temperature
- Conductivity • Dissolved O_2

For Specific Designated Uses Add the Following:

AQUATIC LIFE
Base List:
- Ionic strength
- Nutrients, sediment

Supplemental List:
- Metals (water/sediment)
- Organics (water/sediment)

RECREATIONAL
Base List:
- Fecal bacteria
- Ionic strength

Supplemental List:
- Other pathogens
- Organics (water/sediment)

WATER SUPPLY
Base List:
- Fecal bacteria
- Ionic strength
- Nutrients, sediment

Supplemental List:
- Metals (water/sediment)
- Organics (water/sediment)
- Other pathogens

HUMAN/WILDLIFE CONSUMPTION
Base List:
- Metals (in tissues)
- Organics (in tissues)

Figure 13. Core indicators and parameters for an adequate State watershed monitoring and assessment program with supplemental chemical parameters according to the applicable designated use(s). Parameters are added based on site and watershed-specific needs and overall water quality management objectives (after ITFM 1993).

3.2 Ohio EPA Surface Water Monitoring Program Implementation

Planning for environmental data collection activities within the Division of Surface Water generally follows a Data Quality Objectives (DQO) approach to the design, sampling, and assessment of monitoring results in support of the overall surface water quality management goals and objectives. This involves strategic planning for the purpose of ensuring that data collection operations are performed in a cost-effective manner. This is accomplished by assuring that only appropriate and useful data will be collected while maintaining the ability to adequately assess the surface waters of the state. DSW has approximately 30 years of comprehensive experience in operating statewide and regional ambient surface water monitoring networks and in the use and development of cost-effective, but sufficiently robust

chemical, physical, and biological measures and indicators. Incorporated into this process has been the consideration of the need for sufficiently rigorous decision criteria and thresholds including the appropriate resolution and sensitivity of the data and indicators. This has allowed DSW to focus on problems in relation to their known and probable impact on the environment. At the same time, a reliance on a key set of core indicators (Table 3; Figure 13) has allowed DSW to discover and better understand previously unknown or poorly understood problems and phenomena.

Two Approaches to Watershed-Based Water Quality Management

	PROGRAM FOCUSED APPROACH	RESOURCE FOCUSED APPROACH
Goal:	Program Performance	Environmental Performance
Measures:	Administrative Actions	Indicator End-points
Results:	Improve Programs	Programs are Tools to Improve the Environment

Figure 14. The goals, measures, and results of program based and resource based approaches to water quality management. State programs will evolve towards a resource based approach by developing and using a sufficiently comprehensive and rigorous system of environmental indicators.

Resources Devoted to Monitoring and Assessment

Resources devoted to monitoring and assessment activities include the Monitoring and Assessment Section (Ecological Assessment and Water Quality Modeling Units) and the five District Water Quality Units. In SFY 1999, monitoring and assessment resources in terms of full time positions comprised approximately 53 FTEs (full time equivalents) or 16% of all resources devoted to water quality management (includes surface water component of the State Revolving Loan Fund program and the Division of Environmental Services laboratory support: Table 4). Funding amounts are detailed in Table 5 and this comprised approximately 21% of the water quality management budget. In terms of adequacy, these resources come close to some "rules of thumb" for determining monitoring and assessment support, but fall short of others. For example, the 16% figure is well within the 15-20% that has been advanced as meeting adequate State monitoring and assessment needs as a proportion of the water quality management program. However, the 18 FTEs devoted to Ecological Assessment falls short of the 29 FTEs needed to meet

the goal of 1 FTE for every 1000 miles of perennial and designated stream and river mile (Yoder and Rankin 1995). More information on resource needs is detailed in Chapter 5.

Monitoring Networks and Design

DSW uses a tiered approach to the selection and use of a variety of chemical, physical, and biological indicators and measures. These decisions are based on the type of aquatic resource being assessed (*i.e.*, small stream, large river, lake, wetland), the environmental complexity of the setting (includes consideration of potential stressors), and the water quality management objectives and purposes at issue. For example, in a small stream setting with only one or two potential stressors, one biological organisms group might be assessed using a qualitative bioassessment, a habitat assessment, and a chemical water quality assessment analyzing for field, demand, and nutrient series. A handful of sampling sites would suffice and the field sampling would be completed in a matter of days. In a more complex watershed setting with multiple stressors and the potential for unknown and undocumented sources, the sampling requirements are much more rigorous and would include quantitative bioassessment of two organism groups, a habitat assessment, more intensive chemical water quality sampling with metals, other selected toxics, and organic scans of both the water column and bottom sediments. The sampling site density would be in proportion to the location and entry of potential stressors into the aquatic system. The entire sampling effort would span the summer-fall index period and require many days to complete.

To further illustrate the DQO process used to scale environmental monitoring of surface waters, two examples are offered. The different types of indicators and parameters that comprise the DSW watershed monitoring and assessment

Table 4. Full-time equivalent (FTE) resources in the Division of Surface Water by major program area for State Fiscal Year 1999. Surface water related FTEs for the State Revolving Loan Fund (SRF) and Division of Environmental Services (DES) Based on the DSW table of organization.

I. **Program Administration**: 15 FTE (5% of WQ Mgmt.)
- Administration/Management - 10
- Fiscal - 5

II. **Permitting/Compliance Assistance**: 148 FTE (45% of WQ Mgmt.)
- Administration/Management - 2
- Permit Issuance/PTI/Antideg. - 98
- Permit Processing/Reporting - 15
- Stormwater - 8
- Agricultural/Sludge - 7
- Compliance/Tech. Asst. - 8
- 401 Certification - 10

III. **Watersheds/NPS/WQS**: 35 FTE (11% of WQ Mgmt.)
- Administration/Management - 3
- Water Quality Standards - 5
- Nonpoint Source - 10
- Lake Erie/RAPs - 9
- GIS/Support - 4
- Watersheds/UWA - 2

IV. **Monitoring & Assessment**: 53 FTE (16% of WQ Mgmt.)
- Administration/Management - 2
- Water Quality Modeling/TMDLs - 15 (4.5% of WQ Mgmt.)
- Ecological Assessment - 18 (5.5% of WQ Mgmt.)
  - *Biological surveys - [10]*
  - *Data Support/Biocriteria - [3]*
  - *Wetland Indicators - [2]*
  - *Lake Erie - [1]*
  - *Remedial Response - [2]*
- Ambient WQ/Compliance/Complaint - 18 (5.5% of WQ Mgmt.)

DSW Totals:	251 FTE
SRF Total:	38 FTE
Lab. Services:	40 FTE
TOTAL WQ Management:	**329** FTE

Table 5. Funding breakdowns for chemical water quality, biological/habitat, and water quality modelling/TMDL monitoring in SFY 1999.

I. Chemical Water Quality:	
• Sample collection/data analysis	$1.06 million
• Laboratory Analysis (water/sediment; 5450 samples)	$1.93 million
• Fish tissue contaminants (555 samples)	$0.29 million
Subtotal	$3.28 million
II. Biological/Habitat:	
• Fish/Macroinvertebrates	$1.14 million
• Biocriteria Development & Maintenance	$0.20 million
• Equipment/Supplies	$0.10 million
Subtotal	$1.44 million
III. WQ Modeling/TMDLs:	
• WLA/TMDL	$0.90 million
• Equipment/Supplies	$0.15 million
Subtotal	$1.05 million
TOTAL	$5.77 million (21% of WQ Mgmt. Budget)

approach is consistent with the recommendations of the Intergovernmental Task Force on Monitoring Water Quality (ITFM 1992) for core and supplemental indicators for use in State programs (Figure 13). The core parameters form the basis of all monitoring and assessment as these are collected in nearly all situations. These comprise the baseline of the assessment process used by DSW and are directly linked to the data and information needs for fundamental assessment questions such as use attainment status, water quality standards compliance, use attainability, delineating associated causes/sources of threat or impairment, and basic reporting (*e.g.*, 305b report) and listing requirements (*e.g.*, 303d listings). The supplemental parameters are added, as in the preceding example, as the complexity

and assessment needs (or questions) increase in diversity, quantity, and complexity. Table 3 showed a larger suite of indicator categories that are related to classes of possible management objectives. These may be addressed as part of the field sampling or accessed later in the analysis and reporting phases of the assessment process.

These approaches economize sampling resources by scaling the intensity and complexity of the monitoring and assessment effort ion accordance with the questions to be resolved. This type of approach also allows for more flexible management responses that are attenuated by the information revealed about the environmental complexity of the setting, the quality of the aquatic resource, and the potential pollution problems encountered. Effective implementation of this process is had only through the experience and knowledge gained by conducting monitoring and assessment for many years and over a wide geographical area.

A second example of the DQO process is with the selection of the appropriate biological assessment method and protocol for a given situation. Table 6 defines a hierarchy of bioassessment methods from very simple, comparatively low resolution protocols to the more rigorous and reliable techniques practicable for' State bioassessment program. The level of the bioassessment is comparably defined by the skill or expertise level required by the operator, the standard methodology associated with each (appropriate QA/QC procedures included), the relative accuracy of the method in terms of making the "correct" assessment, the discriminatory power (i.e., the ability to detect actual changes in condition), and how this should influence policy decisions made with that method. This type of matrix should allow program managers to evaluate the need for comparative rigor in environmental decision making with level of effort required for a given bioassessment technique. This is both a programmatic and individual study decision in that the monitoring and assessment program needs to have the appropriate suite of tiered methods (calibrated and verified) available before deciding which ones to apply to a given assessment question. Table 7 illustrates these same concepts in a different manner by showing the relative capabilities of different levels of bioassessment currently available to DSW to fulfill and/or satisfy various needs within the major surface water program areas at Ohio EPA. Designations of excellent, good, fair, and poor indicate the relative capability and power of the bioassessment method to provide an adequate, cost-effective, and

Table 6. Hierarchy of ambient bioassessment approaches defined by Yoder (1995) that use information about indigenous aquatic biological communities (NOTE: this applies to aquatic life use attainment only - it does not apply to bioaccumulation concerns, wildlife uses, human health, or recreation uses).

BIOASSESSMENT TYPE/LEVEL	SKILL REQUIRED[1]	ORGANISM GROUPS[2]	TECHNICAL COMPONENTS[3]	ECOLOGICAL COMPLEXITY[4]	ENVIRONMENTAL ACCURACY[5]	DISCRIMINATORY POWER[6]	POLICY RESTRICTIONS[7]
1. Stream Walk (Visual Observations)	Non-biologist	None	Handbook[8]	Simple	Low	Low	Many
2. Volunteer Monitoring	Non-biologist to Technician	Invertebrates	Handbook[9], Simple equipment	Low	Low to Moderate	Low	Many
3. Professional Opinion (*e.g.,* RBP Protocol V)	Biologist w/ experience	None or Fish/Inverts.	Historical records	Low to Moderate	Low to Moderate	Low	Many
4. RBP Protocol I&II	Biologist w/ training	Invertebrates	Tech. Manual,[10] Simple equip.	Low to Moderate	Low to Moderate	Low to Moderate	Many
5. Narrative Evaluations	Aquatic Biologist w/training & experience	Fish &/or Inverts.	Std. Methods, Detailed taxonomy Specialized equip.	Moderate	Moderate	Moderate	Moderate
6. Single Dimension Indices	(same)	(same)	(same)	Moderate	Moderate	Moderate	Moderate
7. Biotic Indices (HBI, BCI, etc.)	(same)	Invertebrates	(same)	Moderate to High	Moderate to High	Moderate	Moderate to Few
8. RBP Protocols III&V	(same)	Fish & Inverts.	Tech. Manual,[10] Detailed taxonomy, Specialized equip., dual organism groups	High	Moderate to High	Moderate to High	Few
9. Regional Reference Site Approach	(same)	Fish & Inverts.	Same plus baseline calibration of multimetric indices & dual organism groups	High	High	High	Few
10. Comprehensive Bioassessment	(same)	All Organism Groups	Same except all organism groups are sampled	Highest	High	High	Few

[1] Level of training and experience needed to accurately implement and use the bioassessment type.
[2] Organism groups that are directly used and/or sampled; fish and macroinvertebrates are most commonly employed in the midwest states.
[3] Handbooks, technical manuals, taxonomic keys, and data requirements for each bioassessment type.
[4] Refers to ecological dimensions inherent in the basic data that is routinely generated by the bioassessment type.
[5] Refers to the ability of the ecological end-points or indicators to differentiate conditions along a gradient of environmental conditions.
[6] The relative power of the data and information derived to discriminate between different and increasingly subtle impacts.
[7] Refers to the relationship of biosurveys to chemical-specific, toxicological (i.e. bioassays), physical, and other assessments and criteria that serve as surrogate indicators of aquatic life use attainment/non-attainment.
[8] Water Quality Indicators Guide: Surface Waters (Terrell and Perfetti 1989)
[9] Ohio Scenic River Stream Quality Monitoring (Kopec and Lewis 1983).
[10] U.S. EPA Rapid Bioassessment Protocol (Plafkin et al. 1989).

Table 7. The relative capabilities of different levels of bioassessment to fulfill and/or satisfy various needs within of major surface water program areas at Ohio EPA. Designations of EXCELLENT, GOOD, FAIR, POOR, etc. indicate the relative capability and power of the bioassessment method to provide an adequate, cost-effective, and sufficiently comprehensive assessment for each program need.

MAJOR PROGRAM AREAS

	Basic --Reporting--		WQS -Program-		----Watersheds/Nonpoint Sources----					------NPDES Permitting------				
Level of Bioassessment	5 Yr. Basin Surveys	305b Report	Use Desig.	Chem. Criteria	General Screen	Education Involvement	NPS Assess.	Habitat	Problem Discovery	Permit Terms	Priority Setting	CSOs Storm.	Toxic Impact	Mixing Zones
A- Full Scale: (Fish, Macroinvertebrates based on mulimetric indices)	EXCELL.	EXCELL.	EXC.	EXC.	EXCELL.	FAIR[1]	EXC.	EXC.	EXCELL.	EXC.	EXC.	EXC.	EXC.	EXC.
B- Partial Bioassess ments (Fish **o**r Macroinvertebrates)	GOOD	GOOD	GOOD[2]	FAIR	GOOD[2]	FAIR[1]	GOOD[2]	GOOD[2]	GOOD[2]	GOOD	GOOD	GOOD	GOOD	GOOD
C- Qualitative Bioassment (Macroinvertebrates based on narrative criteria)	FAIR[3]	GOOD	POOR[4]	POOR[4]	GOOD	FAIR[1]	FAIR[4]	POOR[4]	GOOD[2]	FAIR	POOR[4]	GOOD[2]	FAIR	GOOD
D- EPA Rapid Bioassessment Protocol II (Macroinvertebrates, family level of taxonomy)	FAIR[3]	FAIR[5]	POOR[4]	POOR[4]	GOOD	GOOD[1]	FAIR[4]	FAIR[4]	GOOD	FAIR	POOR[4]	FAIR[5]	FAIR[5]	FAIR[5]
E- "Volunteer" Methods (Macroinvertebrates based on SQM procedure)	POOR[6]	FAIR[7]	POOR[6]	POOR[6]	FAIR[7]	EXCELL.[8]	FAIR[7]	POOR[6]	FAIR[7]	POOR[6]	POOR[6]	FAIR[7]	POOR[6]	POOR

Table 7. (continued)

FOOTNOTES:

1 - Fair because complexity of data makes interpretation by untrained persons difficult; good because lower level of taxonomy is easier to attain.

2 - Good only if macrohabitat is not a major limiting factor or if the Exceptional Warmwater Habitat or Modified Warmwater Habitat use designations are not an issue.

3 - Fair if this is the only level included; level is strengthened if “A” level of assessment is available.

4 - Poor because quantitative indices are lacking; can be strengthened with addition of Qualitative Habitat Evaluation Index results (not normally part of this level).

5 - Fair because family level of taxonomy limits interpretation power and utility of the resulting assessment.

6 - Poor because the inherent methodology lacks sufficient resolution or reproducibility even with fine tuning and training.

7 - Fair only if the assessment parameters have been sufficiently calibrated against the A-D levels of bioassessment; otherwise the rating is poor.

8 - Excellent rating because the method can be used and understood by unskilled volunteers.

sufficiently comprehensive assessment for each program need. When the baseline requirements of the Ohio WQS (*e.g.,* the biological criteria) and the inherent decision error risks and tendencies implied by these two tables are considered, the appropriate level of assessment and data collection that is needed to support a given situation should be obvious.

Monitoring and Assessment Coordination

The coordination of ambient monitoring within DSW is the principal responsibility of the Monitoring and Assessment Section which consists of two units, Water Quality Modeling (WQM) and Ecological Assessment (EAU). WQM is responsible for all aspects of monitoring relevant to wasteload allocations and TMDLs including the selection of parameters, methods use and development, sampling design, and QA/QC. The supervisor of WQM has the primary responsibility for overseeing completion of these tasks. EAU is responsible for other aspects of ambient monitoring including the Five-Year Basin Approach, special investigations, and maintenance of the regional reference site network. This includes the selection and development of environmental indicators, parameters, indices, statistical analysis, methods implementation and development, and QA/QC. The manager of EAU is responsible for overseeing the completion of these tasks. The District Surface Water Quality groups are responsible within this process for all chemical/physical sampling including methods usage, sample custody, and field QA/QC. The Districts are also responsible for carrying out duties related to the fixed station network. Laboratory analysis is performed by the Division of Environmental Services (DES) and they are responsible for all methods and QA/QC aspects of that work. The Quality Assurance Officer within DES is responsible for the maintenance and coordination of the Quality Assurance Program Plan (QAPP) and the manual of field and laboratory methods.

Essential Technical Elements of the Five-Year Basin Approach

DSW's approach to surface water monitoring and management via the Five-Year Basin Approach essentially serves as an environmental feedback process taking the observations made in levels 4, 5, and 6 as evidence of program effectiveness or as environmental "cues" to effect needed changes or adjustments within levels 1, 2 and 3 (see Figure 3). This hierarchy is essentially in place within the assessment process and represents, from a technical assessment and indicators framework standpoint, a true watershed approach. The environmental indicators used in this process are categorized as stressor, exposure, and response indicators. Stressor indicators generally include activities that impact, but which may or may not degrade the environment. This includes point and nonpoint source

loadings, land use changes, and other broad-scale influences that generally result from anthropogenic activities. Exposure indicators include chemical-specific, whole effluent toxicity, tissue residues, and biomarkers, each of which suggest or provide evidence of biological exposure to stressor agents. Response indicators include the direct measures of the status of use designations. For aquatic life uses the community and population response parameters that are represented by the biological indices that comprise Ohio EPA's biological criteria are the principal response indicators. For human body contact uses (*e.g.*, Primary Contact Recreation) fecal bacteria (*e.g., E. coli,* fecal coliforms) are the principal response indicators. The key to having a successful watershed approach is in using the different types of indicators within the roles that are the most appropriate for each. The inappropriate use of stressor and exposure indicators as substitutes for response indicators is at the root of the national problem of widely divergent 305(b) statistics reported between the States. This issue was extensively discussed in the 1996 Ohio Water Resource Inventory (Ohio EPA 1997) and Yoder and Rankin (1998).

Monitoring for Status and Trends

An assessment of the impact of multiple sources on the receiving waters of a study area (*i.e.*, watershed) includes an evaluation of the available chemical/ physical (water column, effluents, sediment, flows), biological (fish and macroinvertebrate assemblages), and habitat data which have been collected by DSW pursuant to the Five-Year Basin Approach. Other data may be used provided it was collected in accordance with DSW methods and protocols as specified by the Ohio Water Quality Standards (WQS) and DSW guidance documents. Other information which is evaluated includes, but is not limited to, NPDES permittee self-monitoring data and effluent and mixing zone bioassays conducted by DSW, the permittee, or U.S. EPA. The integration of this information for each study area is accomplished via the assessment process. Besides evaluating status and trends for the applicable designated uses, the assessment also identifies and describes causal associations of use impairments by delineating the predominant causes and sources of impairment. The completion of this process enables the structured use of the output from the assessment (i.e., the assessment of water bodies) to support virtually any Ohio EPA program where surface water quality is a concern.

The Five-Year Basin Approach Planning Process

The sequence of events within the Five-Year Basin Approach for a given basin year from the initial screening of issues through the production of a final assessment are described in Table 8. This includes the major milestones and activities needed to select watershed areas

Table 8. Sequence of steps and milestones in the Five-Year Basin Approach conducted annually by Ohio EPA, Division of Surface Water.

December - February: (Months 1 3)	Initial screening of the major hydrologic areas takes place by soliciting input from the various program offices.
February - March: (Months 3 thru 4)	Final prioritization of issues and definition of study areas. Resource allocation takes place and study team assignments are made.
March - May: (Months 4 thru 5)	Study planning takes place and consists of detailed map reconnaissance, review of historical monitoring efforts, and initial sampling site selection by the study team. Final study plans are reviewed and approved.
May - June: (Months 5 thru 6)	Final study plans are used to develop logistics for each field crew. Preparations are made for full-scale field sampling.
June - October: (Months 6 thru 10)	Field sampling takes place with field crews operating somewhat independently on a day-to-day basis, but coordinated by the study plan and team leader. Study team communication takes place as necessary, especially to resolve unexpected situations.
October - February: (Months 10 thru 14)	Laboratory sample analysis takes place for chemical and biological parameters. Raw data is entered into Ohio EPA databases for reduction and analysis. The study team meets to review the information base generated by the field sampling and to coordinate the data analysis and reporting effort.
November - May: (Months 11 thru 17)	Information about indicator levels 3-6 is retrieved, compiled, and used to produce analyses which will support the evaluation of status and trends and causal associations within the study area. Integration of the information (*i.e.*, assessment) is initiated.
May - December: (Months 17 thru 24)	The assessment process is completed by first producing working copies of the assessment for review by the study team and a final edit for an internal peer review. This may be in the form of a formal report or a folder of analytical summaries, tables, and figures. The final assessment is approved by senior management for use and distribution both within and outside of Ohio EPA. The assessment is used to support a number of DSW program obligations and includes the Ohio Water Resource Inventory (305b report), TMDLs/303[d] listing, Water Quality Permit Support Documents (PSDs) in support of NPDES permit reissuance, water quality standards (*e.g.*, use designation revisions), the Ohio Nonpoint Source Assessment, remedial investigations of hazardous waste sites, Natural Resource Damage Assessments, and other programs where surface water quality is of concern.

for monitoring, planning the monitoring activities, conducting the monitoring, data custody and analysis, data management and QA/QC, transformation of data into information, assessment and interpretation of the results, and the making of conclusions and recommendations.

The process is coordinated by the Ecological Assessment Unit (EAU) and includes direct participation from all DSW sections, and indirect participation by several other Ohio EPA divisions and a selection of other State and federal agencies. A study team is assigned to each watershed area and includes a study team coordinator, all members of the sampling team from EAU, the District Water Quality Unit, the Water Quality Modeling Unit, Permits Unit, Enforcement Unit, Nonpoint Source Unit, Watersheds Unit, and, whenever applicable, the Agricultural Permitting Unit and 401 Unit. A written study plan which delineates the study area boundaries, the scope and objectives, specific sampling locations, indicators, parameters, frequencies, and index sampling periods is prepared for each study area. Following management review and approval, this then serves as the blueprint for the data collection phase. Individual program units involved in the sampling are each responsible for assuring data quality, integrity, and adherence to chain-of-custody procedures. Chemical laboratory services are provided by DES except where special needs can only be filled by a contract laboratory. The annual sampling plan and individual plans of study are submitted to Region V in fulfillment of coordination requirements and obligations.

Data collected via this process is validated in different ways, but in accordance with approved QA/QC procedures. Biological data is collected, stored, and analyzed in accordance with the biological criteria users manuals (Ohio EPA 1987 (Vol. II), 1989a (Vol. III). Habitat information is collected, stored, and analyzed in accordance with Ohio EPA (1989a) and Rankin (1989). Data is validated by individual crew leaders and verified by lead workers and supervisors. Data entry is to an in-house system (Ohio ECOS) and is proofed by the data entry analyst and by the crew leader. Fish tissue data is collected via standardized procedures (Ohio EPA 1994b) and entered into an in-house system (Ohio ECOS). All chemical/physical data is collected, stored, and analyzed in accordance with Ohio EPA (1989b). Laboratory results are validated by DES prior to use by the Districts and Water Quality Modelling. Data entry is initially to an in-house database (STORDES), proofread for accuracy, and batch uploaded to STORET at a later date.

Besides Ohio EPA, users of this data are numerous and include regulated entities, academic institutions, federal and stat agencies, private organizations, and the general public. Most

Ohio EPA data is transmitted to these users by direct request, particularly for the biological and habitat data which is not yet accessible via the Internet. Chemical/physical data uploaded to STORET is more broadly accessible through that system. All data must pass QA/QC requirements prior to being released both within and outside of the agency.

Major programs supported by the Five-Year Basin Approach include reporting (305b, 303d, etc.), permitting (Permit Support Documents), planning, nonpoint source assessment and management, water quality standards, and other areas (*i.e.,* unregulated hazardous waste site assessment). The data quality objectives for each program tend to be similar or the same across Ohio EPA programs, thus the potential for decision errors is somewhat the same. Because Ohio EPA consistently uses a multiple indicators approach to monitoring and assessment, the implications of decision errors to the resulting integrated assessment is lessened than if individual indicators were being relied on alone.

Fixed Station Networks

There are two monitoring networks maintained by DSW which qualify as fixed station; the National Ambient Water Quality Monitoring Network (NAWQMN) and the Regional Reference Sites network. The NAWQMN network represents the traditional fixed station design which dates to the 1950s. The network now consists of approximately 40 sites which are sampled monthly for field, demand, nutrient, and selected heavy metals chemical parameters. Macroinvertebrate sampling also takes place at these sites, but at a reduced frequency of approximately once every three years. The Districts are responsible for the chemical/physical sampling and EAU is responsible for the macroinvertebrate sampling. The primary purpose of this network is to provide a long-term database for assessing changes through time. The analysis of trends takes place primarily when such sites are part of a five-year basin survey and the results are interpreted in that context. A portion of the NAWQMN network also overlaps with the International Joint Commission (IJC) on the great lakes, addressing the data needs for assessing water quality conditions in Lake Erie and the major tributaries. The NAWOMN network also overlaps with the U.S. Geological Survey National Stream Quality Accounting Network (NASQAN) which is also comprised of a network of gauging stations and a limited number of four parameter continuous monitors.

The Regional Reference Sites network consists of biological (fish and macroinvertebrates), habitat, chemical/physical water quality, and sediment chemical sampling. There are approximately 450 sites located throughout the state with respect to ecoregion and stream size. The purpose of this network is to define reference condition for biological, chemical,

and physical parameters and indicators. This in turn is used in the development of the biological criteria, refined chemical assessment thresholds, and other assessment indicators and thresholds. EAU is primarily responsible for the design and implementation of this network.

Coordination With Non-Ohio EPA Organizations
Ohio EPA makes an attempt to coordinate monitoring and assessment activities with other organizations on a watershed-specific basis whenever possible. The most logical point of coordination is at the survey area selection and study planning steps. As these surveys logically overlap with watershed activities, stakeholders are invited to participate in the planning and, if appropriate, the sampling activities. The most success in supplementing data collection activities thus far has been with the Ohio DNR, Division of Wildlife in adding fish sampling information. Cooperators must meet the minimum data quality objectives employed routinely by Ohio EPA.

Volunteer organizations are viewed as having the potential to contribute to the basin assessments, but thus far this has been minimal to non-existent. Ohio EPA, in cooperation with Ohio DNR, Division of Soil and Water Conservation, has developed a data entry process for volunteers collecting and submitting macroinvertebrate data based on the Stream Quality Monitoring protocol developed by the Scenic Rivers program. The Stream Quality Database (SQUAD) is available for use and it is expected to capture more of this type of data in the future. We also expect that this activity will increase as the watershed management process becomes better organized. Data quality objectives for this type of bioassessment was previously addressed in a special study by Ohio EPA (1996a).

Chapter 4: **Other Monitoring Networks and Activities in Ohio**

In addition to some of the activities by non-Ohio EPA organizations described in Chapter 2, there are other organized monitoring and assessment efforts with which Ohio EPA has cooperated. While we are not attempting here to exhaustively capture all non-Ohio EPA activities, the major programs are briefly highlighted.

4.1 **U.S. Geological Survey**
!!NAWQA Program Placeholder for final version!!

4.2 Heidelberg Water Quality Laboratory

!!Placeholder for final version!!

4.3 Northeast Ohio Regional Sewer District (NEORSD)

!!Placeholder for final version!!

4.4 Scioto River Cooperative Network

!!Placeholder for final version!!

4.5 County Soil and Water Conservation Districts

!!Placeholder for final version!!

4.6 Watershed Stakeholder Groups

!!Placeholder for final version!!

4.7 Volunteer Monitoring Organizations

!!Placeholder for final version!!

Chapter 5: **Monitoring Needs Assessment**

Since the late 1980s, various needs assessments have been conducted for the Ohio EPA monitoring and assessment program. With the initiation of the Five-Year Basin Approach in 1990, an ongoing assessment of met and unmet needs has been undertaken and tracked. The definition of an unmet need is one which is identified in the annual Five-Year Basin Approach needs assessment, but which is not included in the final list of watershed surveys. Since 1990 this has approximated 40-50% each year (Figure 15). A basic assumption used in determining unmet needs is the goal of meeting 100% of identified assessment needs within the five-year basin planning cycle. DSW established a goal of meeting 80% of the identified annual needs in 1993 as part of the commitment made to the Ohio Legislature as part of the Surface Water Protection Fund legislation, which enabled water programs to be partially funded by NPDES permit fees. Table 9 outlines the annual commitments, goals, and shortfalls in terms of sites sampled and miles of rivers and streams assessed which are the output indicators used to report on DSW performance in this area.

While there is a shortfall in relation to assessing 100% of needs within a five-year cycle, DSW has increased monitoring and assessment output significantly since the inception of the Five-Year Basin Approach in 1990 (Table 10). While some of the increases are due to the

Table 9. Summary of sites sampled and miles of rivers and streams assessed each year during 1992-1997 as reported to the Ohio Legislature. The shortfall is based on the effort needed to meet 80% of the monitoring and assessment needs identified each year in the Five-Year Basin Approach needs assessment.

Category/Year	Annual Need[a]	Assessed	Shortfall[b]
Sites Sampled			
1992	526	280	141
1993	541	250	183
1994	449	291	68
1995	662	305	225
1996	661	325	337
1997	794	369	425
1998	672	402	207
Miles Assessed			
1992	1700	905	455
1993	1680	780	564
1994	1400	905	215
1995	2400	1100	820
1996	3000	1190	1210
1997[c]	2400	1190	730
1998[c]	2400	1190	730

[a] Based on 80% of annual need.
[b] Shortfall is annual need less assessed sites/miles.
[c] Estimates - actual data not yet available.

Table 10. Changes in Division of Surface Water monitoring and assessment performance in the Five-Year Basin Approach among selected sampling output categories between 1990 and 1992, and 1992 and 1998.

Monitoring & Assessment Category	1990	1992	1998	%Increase (+/-) 1990/1992
Fish Assemblage Sites	244	381	617[a]	+153/62%
Macroinvertebrate Sites	185	207	464	+151/124%
Water Chemistry Sites	171	251	342	+100/36%
Sediment Chemistry Sites	59	101	181	+207/79%
Fish Tissue Sites	102	124[b]	190	+86/53%
Streams/Rivers Sampled	86	107	195	+127/82%
305b Miles Assessed - Total Miles[c]	971	1712	3023	+211/77%
305b Miles Assessed - New Miles[c]	355	515	615	+73/19%

[a] 1997 results used - reduced WYE effort in 1998 (475 sites in 1998; +95%/25%).
[b] Year 1993 sites used - first year of new statewide program.
[c] Total miles assessed in biennial 305b reporting period (even years).

addition of new staff with the passage of the permit fees in 1993 and 1994, the majority of the increases in output are due to efficiencies introduced into the sampling and data collection process. This has occurred by better utilizing sampling approaches which are scaled to the complexity of the setting and assessment questions at hand. The majority of the increases in output (Table 10) are largely due to changes made in sample collection procedures which allowed more sites to be assessed with the same resources. For example, water chemistry output was improved by more appropriately scaling sampling frequencies to the assessment questions at hand and increase in the number of sampling sites assessed through time. In the biological sampling output categories, more frequent use of qualitative macroinvertebrate methods over the artificial substrates (3:1 relationship) and one pass fish sampling over 2-3 passes/site has been made (Figure 17), without great cost to the integrity of the assessment. In other areas such as fish tissue, staff reassignments and adding this to the duties of fish crew leaders has allowed the sample collection to keep pace with previous levels. These latter changes were in response to FTE reductions made in fish and macroinvertebrate staffing in 1998 and the loss of the full time fish tissue staff in 1997.

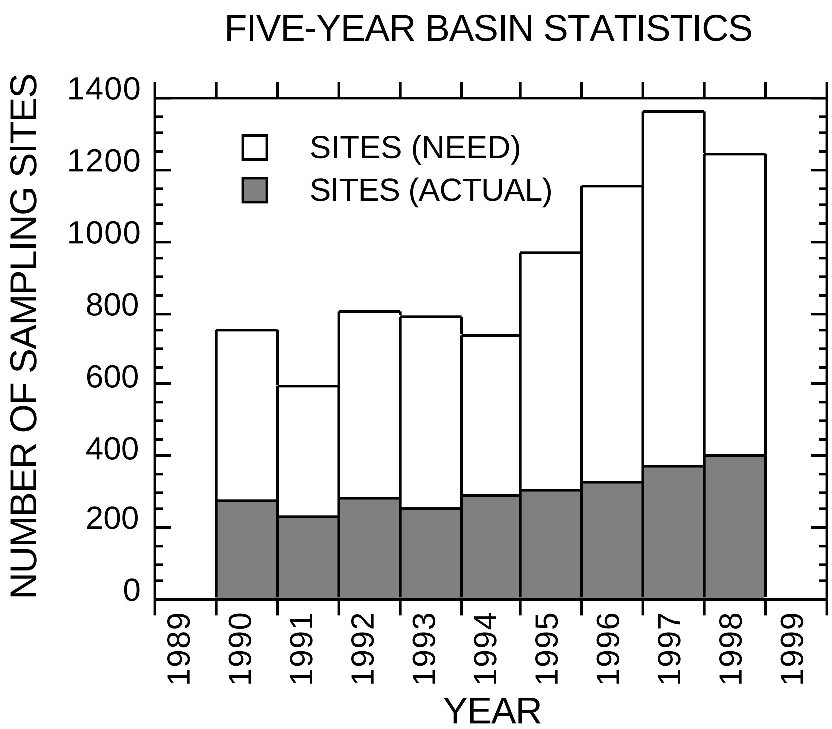

Figure 15. Assessment of sites required to fulfill all assessment needs identified by the planning process for each basin year 1990-1998 compared to sites actually sampled.

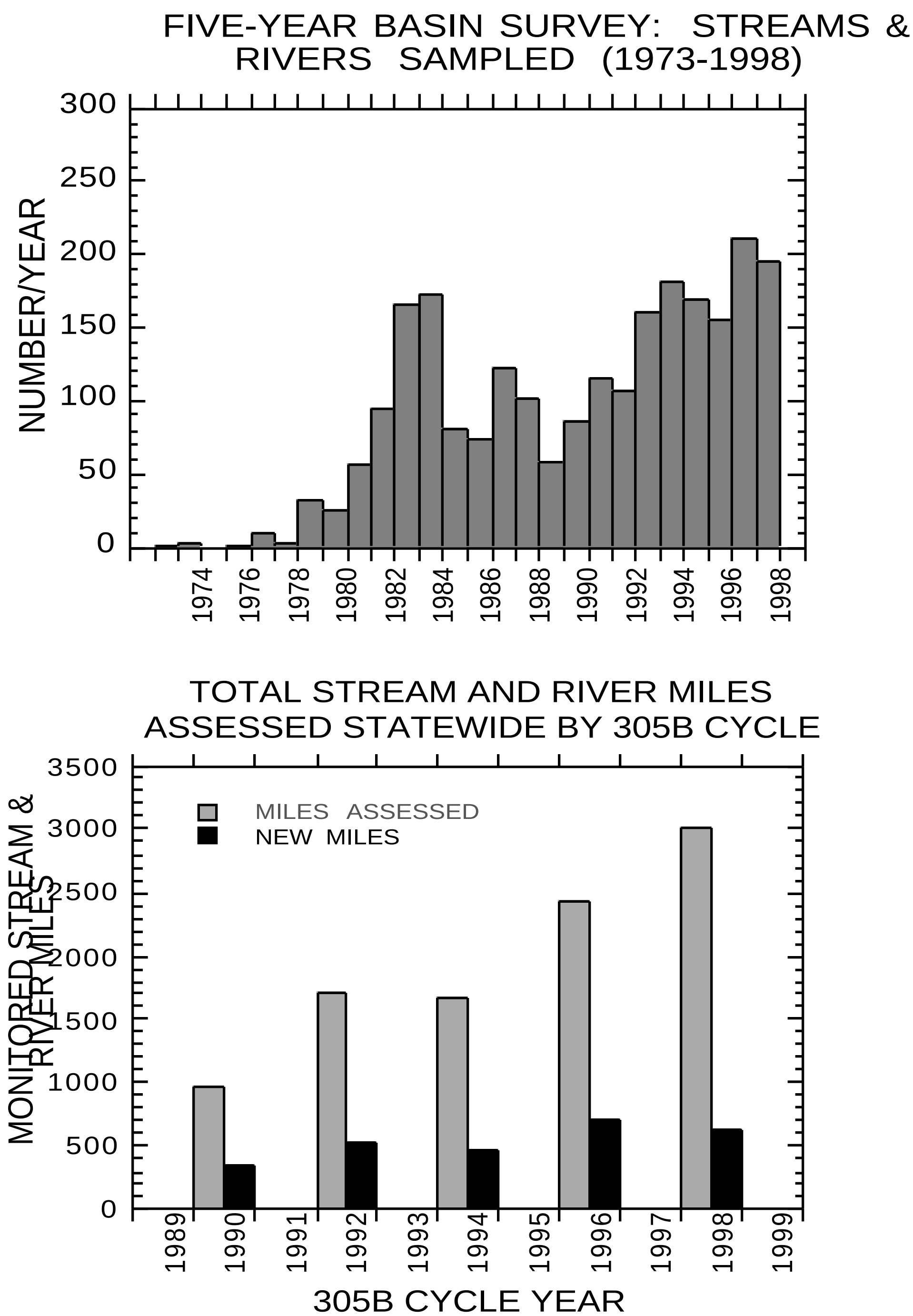

Figure 16. Number of rivers and streams assessed by Ohio EPA between 1973 and 1998 (upper) and monitored level assessments of stream and river miles reported in the Ohio Water Resource Inventory (305[b] report) between 1990 and 1998.

The net result has been an increase in the miles of rivers and streams assessed in the 305(b) report (Table 10; Figure 16). Other developments that are currently underway to improve monitoring and assessment output include the Headwater Habitat assessment methodology, the Nonpoint Source Stream Reach screening tool, and the Geometric Site Selection process which was described in Chapter 3. Each of these should continue to improve the efficiency and cost-effectiveness of the Five-Year Basin Approach and continue progress towards the 80% assessment goal.

Impact of the 15 Year TMDL Development Schedule

As the Five-Year Basin Approach expands to include support of the TMDL development process, the competition for monitoring and assessment resources has increased between programs. This is one of the principal reasons that the proportion of unmet needs has remained the same or increased since the mid-1990s, despite the significant increase in monitoring output. With the shift in priorities in the Five-Year Basin Approach to the 15 year TMDL development schedule (see Chapter 2), the increased output has in effect been "spoken for". Routine program support for NPDES permit reissuance will be affected whenever there is a lack of overlap with the TMDL development watersheds. An additional biological field crew and replacement of vacancies in the District Water Quality Units is needed to keep Permit Support Document production at past levels (Figure 18). In addition, the integrity of the 305(b) database is at stake since this is dependent on revisiting the major assessment and reassessment areas of the 1980s and 1990s. Any diversion from the sequence of this core data and information base may bring an unintended bias to the 305(b) statistics and the integrity of the forecast analysis and ranking of causes and sources.

There will also be benefits to the shift in the basin approach in support of TMDLs. The issue of small, unassessed and, in some cases undesignated streams, will greatly benefit from this approach. This is an obvious prerequisite for TMDL development at the scale water quality management for these issues is and will be taking place. The TMDL design has altered the watershed assessment approach from a mainstem/major tributary approach where major issues and selected streams were assessed to a stratified approach where *all* streams are assessed and watershed level tendencies in quality can be better ascertained. This latter issue is critical in better understanding and ranking associated causes and sources of impairment.

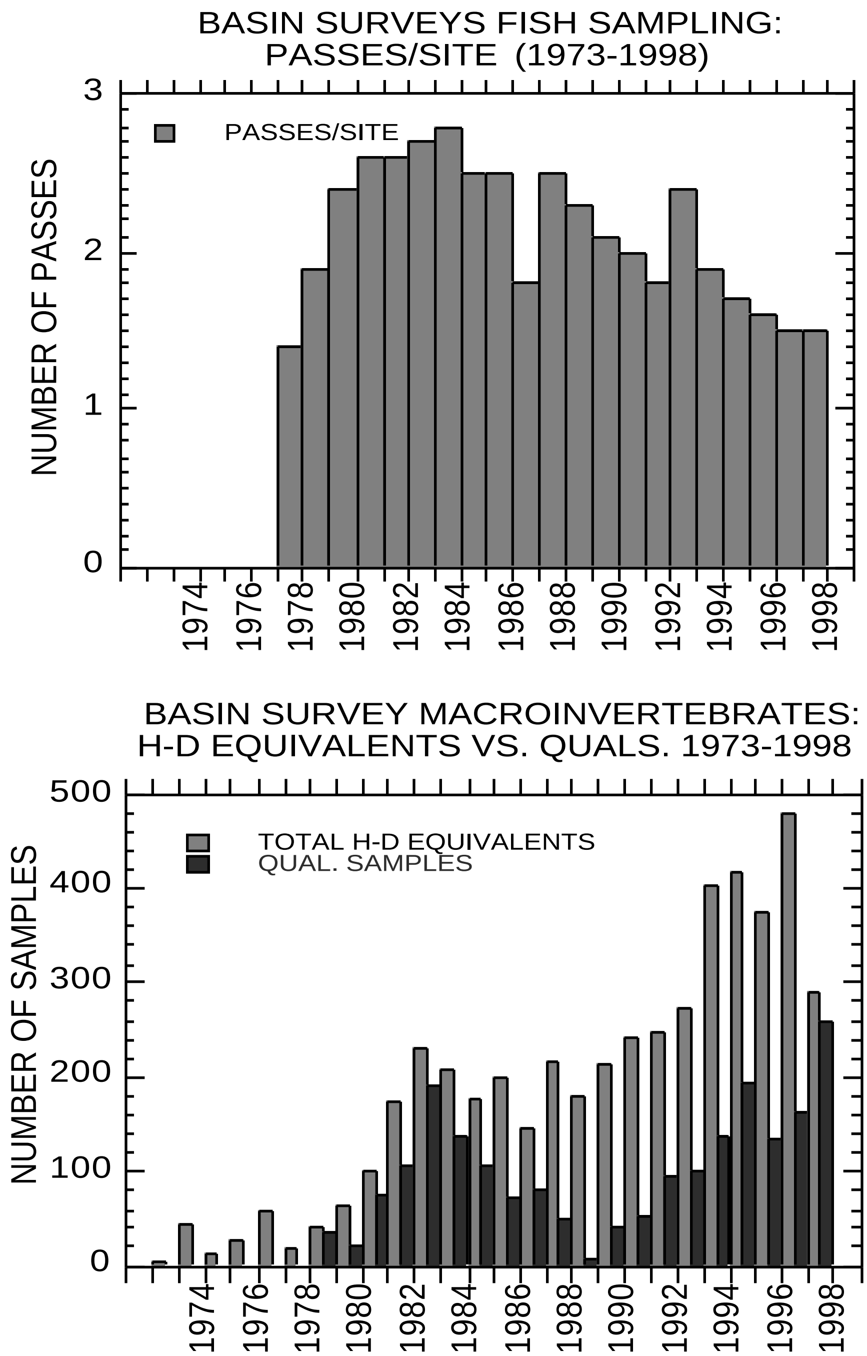

Figure 17. Number of fish sampling passes/site and relationship of qualitative macroinvertebrate samples to artificial substrates (H-Ds) between 1973 and 1998.

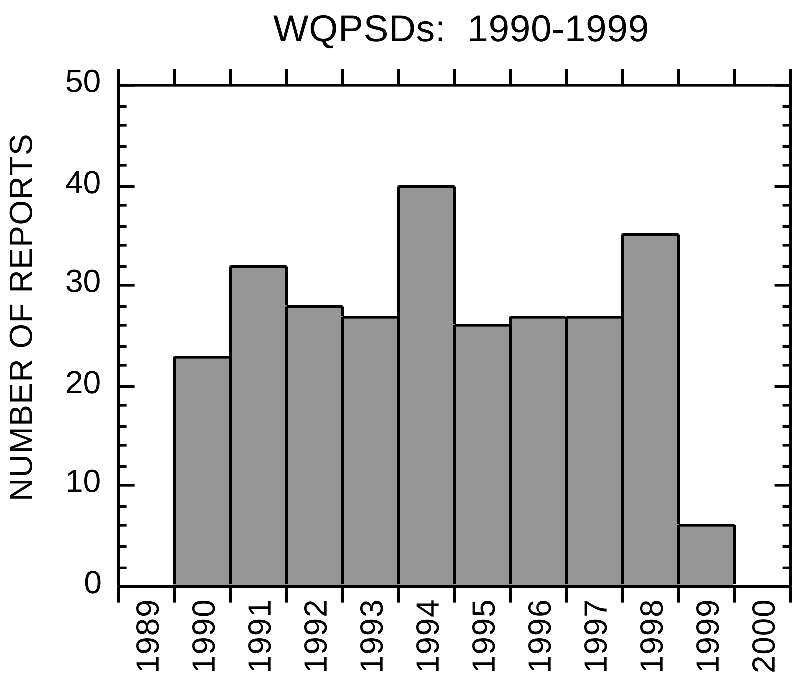

Figure 18. Production of Section 1 of Water Quality Permit Support Documents between 1990 and 1999 (last year is estimated based on basin survey coverage).

!!More detail and analysis to be added in final version!!

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