ADEM Surface Water Quality Monitoring Strategy

Introduction

The initial ADEM monitoring strategy, 'ADEM's Strategy for Sampling Environmental Indicators of Surface Water Quality Status' (*ASSESS*), was developed in 1997 and implemented on a five-year, basin rotational cycle. An integral part of *ASSESS* was a thorough review of the Strategy at the end of each monitoring cycle. As part of ADEM's Monitoring Strategy review process, personnel from ADEM's Field Operations Division, Water Division and Office of Education and Outreach met in 2004 to review results from ADEM's first five-year monitoring cycle. The purpose of the meeting was to conduct a comprehensive review of ADEM surface water quality monitoring programs, to include identification of data needs not met by *ASSESS*, and discussion of potential changes to the monitoring design that could address these needs. Based on these identified needs and guidance from the USEPA *Elements of a State Water Monitoring and Assessment Program*, the 2005 Monitoring Strategy was developed.

This Monitoring Strategy is intended to be the first step in an ongoing, iterative planning process. The Strategy sets forth a ten-year plan to address the USEPA monitoring program guidance requirements. Reassessments of initiatives, needs, and resources must be made on a continual basis however. ADEM's Monitoring Strategy is implemented on a five-year, basin monitoring cycle with an in-depth review of the Strategy conducted at the end of each five-year cycle. Annual coordination and planning meetings are conducted internally with monitoring, criteria/standards, permitting, and education/outreach staff involved. Annual status reports are also provided to USEPA Region 4 to document progress towards ADEM's monitoring goals.

Monitoring Program Strategy

The initial 1997 strategy was developed to focus and document the Department's surface water quality monitoring mission. A specific objective of the 1997 strategy

was to implement a coordinated monitoring approach to use available resources as effectively as possible. To this end, the Department developed an adaptive management strategy that included implementation of a Watershed Management Approach, development of tiered and probabilistic monitoring methods, and scheduled internal reviews of ADEM's monitoring programs. The strategy was reviewed in 2004 to ensure that resulting data were meeting program objectives. A revised monitoring strategy was proposed in 2004 to address emerging data needs and potential areas of program improvement identified during the review.

The monitoring strategy developed in 2005 is designed to characterize water quality, to identify impacts from a variety of sources, and to provide a systematic and integrated framework for gathering necessary information to support the decision-making process. The strategy incorporates specific protocols and methodologies to ensure that monitoring activities provide the highest quality information and make the most efficient use of available resources.

The overall strategy incorporates a combination of targeted, probabilistic, and long-term ambient monitoring stations to meet state monitoring goals and objectives. The strategy incorporates most of these stations into a five-year rotating basin monitoring cycle. Ambient monitoring, intensive monitoring, and targeted monitoring conducted on an as-needed basis are also conducted annually as statewide efforts.

In the revised monitoring strategy, core indicators and sampling frequencies were selected to meet data quantity and quality requirements as outlined in Alabama's Listing and Assessment Methodology so that all waterbodies can be categorized in Alabama's Integrated Report, listing/delisting decisions can be made, and sites can be prioritized for §319 funding and BMP implementation.

The goal of the Department is to implement a comprehensive monitoring program that serves all water quality needs and addresses wadeable rivers and streams, nonwadeable rivers and reservoirs, estuaries, coastal areas, wetlands, and groundwater to the extent allowed by available resources. However, Alabama is faced with a tremendous challenge to accurately monitor and report on the condition of over 77,000 miles of perennial and intermittent streams and rivers, 463,587 acres of publicly-

owned lakes and reservoirs, 610 square miles of estuaries, 50 miles of coastal shoreline, 2.3-3.1 million acres of wetlands, as well as groundwater reserves estimated at about 533 trillion gallons.

To this end, ADEM's Monitoring Strategy is designed to meet the data requirements of Alabama's Listing and Assessment Methodology so that all waters can be fully assessed and categorized in Alabama's Integrated Report. It incorporates a watershed-based probabilistic monitoring design and a Human Disturbance Gradient (HDG) to classify each watershed by its potential level of disturbance. By monitoring watersheds in proportion to the number of watersheds in each HDG category, the Monitoring Strategy will provide an estimate of overall water quality throughout the basin group. Additionally, by sampling the entire gradient of watershed conditions within the basin group, the Monitoring Strategy will increase ADEM's monitoring capacity by providing data to develop indicators and criteria appropriate for wadeable rivers and streams, nonwadeable rivers and reservoirs, estuaries, coastal areas, wetlands, and groundwater.

Monitoring Objectives

Consistent with the Clean Water Act and applicable to all waters of the State including wadeable rivers and streams, nonwadeable rivers and reservoirs/lakes, estuaries, coastal waters, wetlands, and groundwater, the overall objectives of the Monitoring Strategy are as follows:

1. Establishing, reviewing, and revising water quality standards.
    a. Provide data that will assist in the implementation of a strategy to maintain and/or improve the status of the State's water resources and their associated use classifications.
    b. Provide data for use in determining what designated uses can be supported or attained and for the establishment of criteria to protect existing designated uses.
2. Determining water quality standards attainment (status and trends).
    a. Document the water quality status of additional waterbodies

within the State's river basins, thereby increasing the cumulative percentage of Alabama waters assessed year to year.

b. Implement a monitoring strategy that can be applied to all river basins and continue on the rotational cycle.

c. Evaluate chemical, physical, and biological conditions of waterbodies within the targeted watershed using environmental indicators identified by the EPA as an appropriate assessment tool.

d. Estimate the status and trends in ecological condition of priority watersheds and historical ambient monitoring stations.

e. Establish a basis of comparison through regular monitoring of least-impacted reference stations within each watershed and ecoregion.

3. Identifying impaired waters.

a. Identify watersheds impaired by point and non-point source pollution on a statewide basis.

4. Identifying causes and sources of water quality impairments.

a. Identify existing point and non-point sources of pollution within each river basin.

5. Implementing water management programs.

a. Implement a more efficient strategy to use and direct the water quality monitoring resources available to the ADEM by using a coordinated approach.

b. Prioritize watersheds in greatest need of management and identify major sources of pollution within these watersheds.

6. Evaluating program effectiveness.

a. Provide data for trend analyses, development of nutrient criteria and monitoring of compliance with standards.

b. Compile and analyze data in accordance with Alabama's assessment methodology. Results are compared to information from previous assessments to determine if permits are within

appropriate limits, if TMDL changes have been effective, if non-point source control practices have resulted in improvements, etc.

Monitoring Design

Alabama's 2005 Water Quality Monitoring Strategy documented ADEM's data needs and developed methods to meet these data needs. The Strategy also implemented the Rivers and Streams Monitoring Program (RSMP) and the Rivers and Reservoirs Monitoring Program (RRMP) to coordinate monitoring efforts and ensure consistency within wadeable and nonwadeable waterbodies. Together, these programs can be used to more effectively:

1. determine attainment of existing water quality standards;
2. develop and adopt new, or revise existing, water quality standards;
3. develop TMDLs for impaired waterbodies;
4. monitor trends in water quality after the implementation of TMDLs and Watershed Management Plans;
5. categorize waters of the State for integrated reporting purposes (i.e., Category 1-5); and,
6. develop tiered aquatic life uses and biological condition gradients

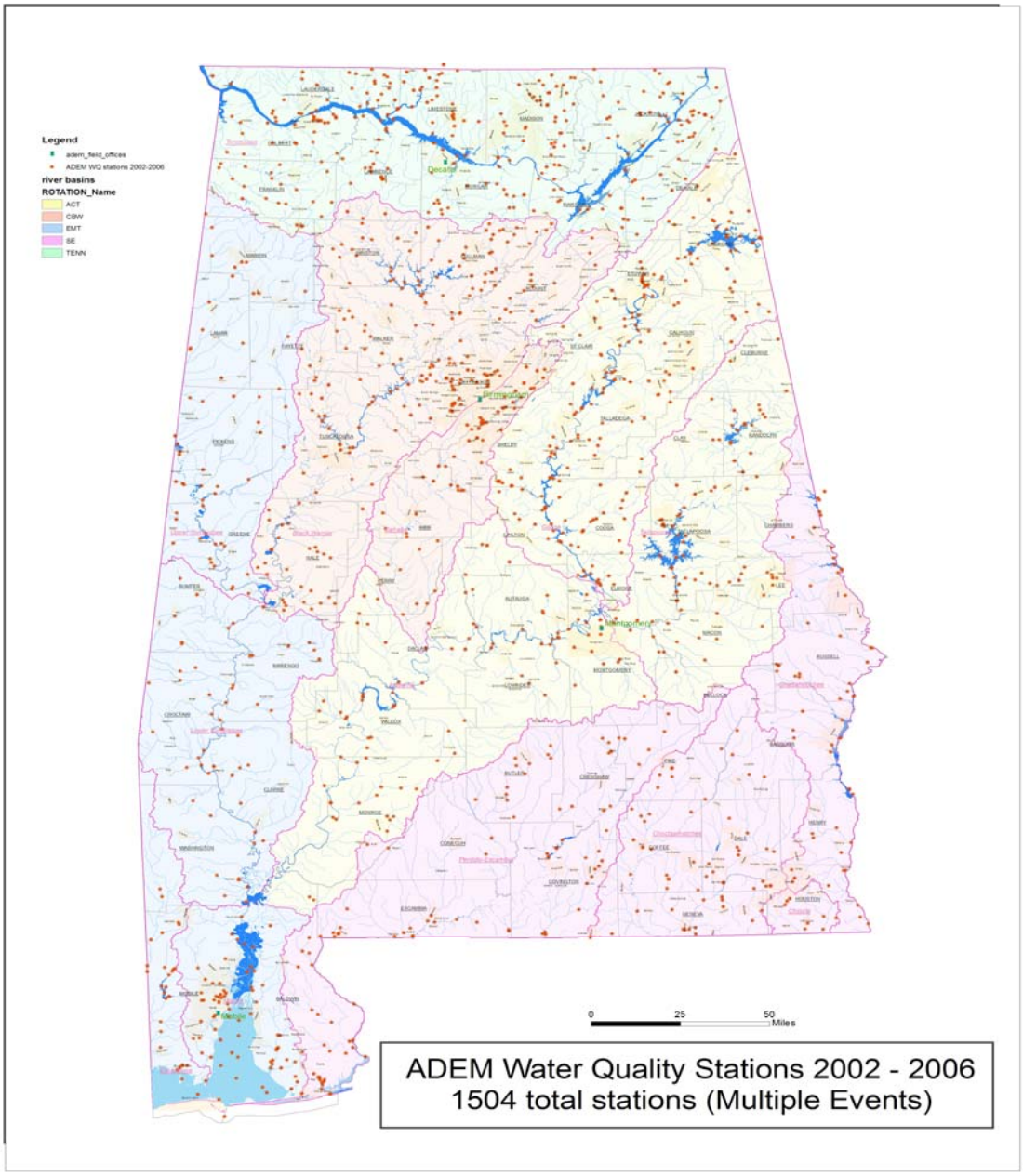
Coordination within the RSMP includes the assessments of wadeable waters, to include ecoregional reference reaches, ambient trend monitoring stations, nonpoint source assessment stations, 303(d) monitoring stations, and special studies. Coordination within the RRMP includes assessments of nonwadeable waters for the same purposes. For coastal waters, coordination of monitoring activities and consistency in sampling techniques was enhanced by an expanded network of long-term stations for ambient trend monitoring and more intensive management of monitoring activities for the various coastal programs.

In addition to the Water Quality Monitoring Strategy, a Surface Water Quality Monitoring Plan (SWQMP) was also developed for the first time in 2005 that will integrate activities associated with all surface water monitoring programs each year. A Departmental Water Quality Monitoring Coordinator was appointed in 2005 to improve communication within the ADEM and other agencies, and to ensure consistency in monitoring activities. A primary contact was established for the

Central and Branch Field Offices to assist with coordination and communication.

Coordination and communication among staff members involved in monitoring and assessment activities is highly valued and considered integral to the design of a successful monitoring program. These activities involve ADEM staff from the Field Operations Division, Water Division, and Office of Education and Outreach. There is extensive interchange and support among the staff of these groups. In general, however, Field Operations staff is responsible for water quality monitoring data collection, analysis, interpretation, and reporting, with Water Division staff responsible for data assessment (use support/listing), criteria, and standards. Staff from the Office of Education and Outreach function as Section 319 NPS program administrators and provide guidance for nonpoint source basin water quality assessments and nonpoint source intensive surveys that determine best management practice effects. Technical discussions and meetings among these staff members involving all aspects of monitoring programs are conducted on an as-needed basis. Annual coordination meetings are also conducted to facilitate coordination and communication. Following the initial, comprehensive review conducted in 2004, regular evaluation and review of monitoring programs by these staff members will be conducted at the end of each five-year basin rotation.

ADEM Water Quality Monitoring Locations, 2002-2006.



ADEM WATER QUALITY MONITORING PROGRAMS

Coastal Monitoring Programs

(Insert Link for Coastal Monitoring)

Rivers and Reservoirs Monitoring Program (RRMP)

Background

The Rivers and Reservoirs Monitoring Program assesses the water quality and trophic status of nonwadeable rivers and publicly-owned lakes/reservoirs in the State, with monitoring in the Tennessee River system conducted through a collaborative monitoring effort between ADEM and the Tennessee Valley Authority (TVA). ADEM has defined publicly-owned lakes/reservoirs as those that are of a multiple-use nature, publicly-accessible, and exhibit physical/chemical characteristics typical of impounded waters. Lakes designated strictly for water supply, privately owned lakes, or lakes managed by the Alabama Department of Conservation and Natural Resources (ADCNR) strictly for fish production are not included in this definition. Currently, forty lakes/reservoirs meet this definition of being publicly-owned. Initiated in 1990 as the Reservoir Water Quality Monitoring Program, the program was given the name Rivers and Reservoirs Monitoring Program (RRMP) in 2004 with the addition of free-flowing river reaches.

Objectives

Objectives of the program are to:

a) develop and maintain a water quality database for all rivers and publicly-accessible lakes in the state sufficient to conduct comprehensive assessments of water quality, categorize waters for the Integrated Assessment Report, develop criteria, and determine criteria compliance;

b) establish trends in river and lake trophic status that are only established through long-term, consistent monitoring efforts; and,

c) conduct biennial assessments of water quality for all publicly-accessible lakes as required by Section 314 of the Clean Water Act.

Water quality monitoring of mainstem reservoir locations in the Tennessee River system is conducted by the TVA through its Reservoir Vital Signs Monitoring Program (RVSP). The objectives of the program are to provide basic information in the "health" or integrity of the aquatic ecosystem in each TVA reservoir and to provide screening-level information for describing how well each reservoir meets the "fishable/swimmable" goal of the Clean Water Act. Sampling activities involve examination of appropriate physical, chemical, and biological indicators in the forebay, mid-, and upper-regions of each reservoir. The TVA program provides results of monitoring to ADEM through program reports and data exchanges.

Over the last several years, collaborative efforts between the staff of the ADEM and TVA programs led to the incorporation of consistent monitoring techniques and the monitoring of reservoir tributary embayments by ADEM which are not routinely monitored in the TVA program.

Design

Lakes monitored for the program range in size from 350 to 45,200 acres. Smaller lakes have a minimum of one station, typically in the dam forebay. In larger reservoirs, additional stations are added in the mid-reservoir and upper reservoir (transition area) as needed. Tributary embayment stations are established in larger embayments and/or those with larger inflows, with selection of embayments distributed throughout the range of human disturbance. River stations are located along the length of the flowing reach to the extent that resources allow, with stations partitioned according to tributaries and point/nonpoint sources.

At each station, collection of water samples and *in situ* measurements (depth, temperature, dissolved oxygen, pH, and conductivity) are conducted at the thalweg. Water samples are collected as a photic zone composite. *In situ* measurements are conducted at one-meter intervals. Beyond thirty meters in depth, measurements are made

at five-meter intervals to the bottom if there is little observed change in measurements. Chlorophyll *a* concentrations are used to calculate Carlson's Trophic State Index for determinations of oligotrophic, mesotrophic, eutrophic, and hypereutrophic conditions.

Monitoring of rivers and lakes occurs at three levels of effort under the RRMP:

1) Intensive monitoring of river, main-stem reservoir, and tributary embayment stations is conducted monthly April-October on a five-year rotating basin schedule to provide a comprehensive determination of water quality throughout the algal growing season and provide data that can be used to develop nutrient criteria and total maximum daily loads;

2) Compliance monitoring of reservoirs with established nutrient criteria is conducted monthly April-October at least once every three years; and,

3) Critical period monitoring of rivers and mainstem reservoir stations is conducted at least once every two years in August to maintain a water quality database of this critical water quality period that extends from 1985 to the present, and to satisfy Section 314 requirements of biennial assessment of lake water quality.

Water quality assessments of these nonwadeable waterbodies serve as a complement to the assessment of wadeable rivers and streams. Determinations of water quality in tributary embayments allow for more definitive determinations of water quality because these embayments function as the settling basin for nutrients and sediment originating upstream in the flowing portion of the tributary. With decreased shading and increased retention time, full expression of the biological impacts of excessive nutrients is often observed in the embayment. Therefore, in addition to determining the water quality of these portions of the rivers and reservoirs, determining the water quality of tributary embayments also serves as an excellent indicator of the water quality of upstream tributaries.

Core and Supplemental Water Quality Indicators

Core Indicators: Secchi transparency, light transmittance, temperature, turbidity, total dissolved solids, total suspended solids, specific conductance, hardness, alkalinity, dissolved oxygen, pH, ammonia, nitrate + nitrite, total Kjeldahl nitrogen, dissolved reactive phosphorus, total phosphorus, chlorophyll *a*, field observations (recent/current

weather, air temperature, flow conditions, obvious point/nonpoint sources, presence of filamentous algae and macrophytes).

Supplemental Indicators: Fecal coliform, chloride, ultimate carbonaceous biochemical oxygen demand, 5-day carbonaceous biochemical oxygen demand, total/dissolved metals, algal growth potential tests.

Rivers and Streams Monitoring Program (RSMP)

Background

ASSESS outlined seven programs established to meet ADEM's monitoring objectives in wadeable rivers and streams. A coordinated monitoring approach was employed to use available resources as effectively as possible. To this end, the Department developed an adaptive monitoring strategy for wadeable rivers and streams that included implementation of a Watershed Management Approach, an Ecoregional Reference Reach Program, and development of tiered and probabilistic monitoring methods.

ASSESS implemented an adaptive management strategy to evolve as the needs of the Department change or better information or sampling techniques become available. An important component of this strategy was a thorough review of ADEM's monitoring programs to address program weaknesses and changing data needs. As part of this effort, ADEM's wadeable streams monitoring programs were reviewed in 2004. The findings of this review are summarized in the following paragraphs.

Review of the first five year monitoring cycle have shown that ADEM's tiered monitoring approach effectively met the needs of both the Office of Education and Outreach (OEO), responsible for administering ADEM's §319 program, and ADEM's Water Quality Branch (WQB), responsible for developing the State's §303(d) list. During the first tier or phase of monitoring, basin-wide screening assessments were conducted at stream reaches where landuse estimates and nonpoint source information from the local Soil and Water Conservation Districts indicated a moderate or high potential for impairment from nonpoint sources in non-urban areas. At that time, the §319 program only needed a method to prioritize waterbodies for funding, thereby concentrating implementation of best management practices in areas with high risk land use practices, but also providing enough flexibility to administer funds in areas where there was also stakeholder interest.

The basin-wide screening assessments also served as the first phase of ADEM's §303(d)/TMDL process. The list of potentially-impaired sub-watersheds generated during the basin-wide screening assessments was prioritized for further monitoring to more accurately assess the extent and cause of impairment.

Recent changes to EPA and ADEM monitoring requirements impacted the effectiveness of ADEM's tiered monitoring approach as a management tool for ADEM's §303(d) and §319 Programs however. First, the EPA required that §319 funds only be used on waterbodies with approved TMDLs. Then in 2004, the EPA released the Integrated Water Quality Monitoring and Assessment Report Guidance which requires that all waters in the state be placed into one of five categories that indicates whether or not a waterbody is meeting all of its use classifications. In 2005, the ADEM Water Quality Assessment and Listing Methodology established minimum data quantity and quality requirements necessary to categorize all waterbodies. With these requirements, the basin-wide screening assessment results were of limited value to both programs because they did not meet the minimum data requirements to categorize any water as impaired and place it on the §303(d) list.

Review of the Alabama Monitoring and Assessment Program (ALAMAP), ADEM's probabilistic monitoring program, indicated that revisions were required to meet the primary objective of providing an accurate estimate of overall water quality in wadeable rivers and streams. Additionally, the ALAMAP data were too limited to be useful or applicable to ADEM's other monitoring programs.

Development and evaluation of nutrient and sediment TMDLs throughout the state require the development of accurate and reliable indicators that can detect both impairment from these sources and any changes in water quality due to decreases in nutrient and sediment loads. In addition, the EPA has required that all states have nutrient criteria for wadeable rivers and streams developed or in development by 2008. In the first five-year basin cycle, emphasis was placed on collection of baseline water quality data and screening of water quality conditions in potentially impaired waters and waters with no recent assessment data. To meet the challenges and requirements described above during the next five-year basin cycle, wadeable rivers and streams monitoring activities were coordinated into the RSMP to allow greater emphasis on intensive-level monitoring.

Objectives

The objectives of ADEM's Rivers and Streams Program are to provide data to:

- estimate overall water quality;
- categorize waters in Alabama's Integrated Assessment Report; and,
- develop nutrient criteria, sediment criteria, biological condition gradients, and assessment criteria that can be used to assess wadeable rivers and streams statewide.

Design

All monitoring activities conducted on wadeable rivers and streams are coordinated under ADEM's Rivers and Streams Monitoring Program (RSMP) to ensure consistency among samples and the most efficient use of available resources. Four types of wadeable, flowing sites are monitored as part of the RSMP:

1) Probabilistic sites
2) Ecoregional reference sites
3) Targeted and intensive survey sites
4) Ambient trend sites

- **Probabilistic sites** are sites in randomly-selected watersheds that reflect both overall water quality conditions within a basin group, as well as the complete gradient of potential human disturbances. They are sampled in accordance with ADEM's five year rotating basin cycle.
- **Targeted sites** are selected by ADEM's Water Quality Branch, Office of Education and Outreach, or one of the Clean Water Partnerships of Alabama to provide data for listing/delisting decisions, TMDL development, Use Attainability Analyses, and education and outreach. Where possible, targeted sampling is conducted in accordance with ADEM's five year rotating basin cycle.
- Long term **ecoregional reference reaches,** established to reflect the best available conditions present within a specific ecoregion, are sampled to evaluate assessment results. Reaches to be sampled each year are selected to compliment the Level IV Ecoregions within any given basin group.
- **Ambient trend sites** are sampled to identify long-term trends in water quality statewide and to provide data for the development of TMDLs and water quality criteria. Sampling frequency and parameters collected at these sites vary from other station types. They are sampled statewide every year.

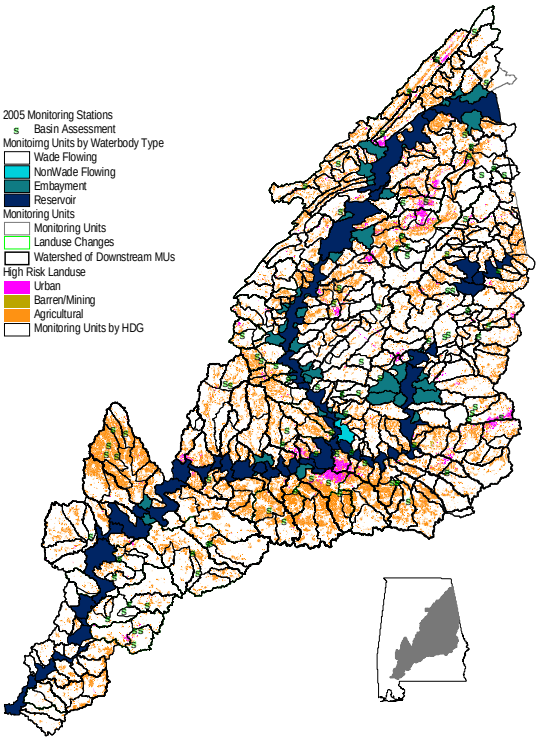
Tiered monitoring efforts are no longer used to screen potentially impaired sites. A set of core indicators are collected at all stations to meet the new data requirements for

Alabama's Integrated Assessment Report and Listing and Assessment Methodology. Because these programs meet Alabama's new data requirements, the collected data can be used in listing/delisting decisions and categorizing waters in the Integrated Report.

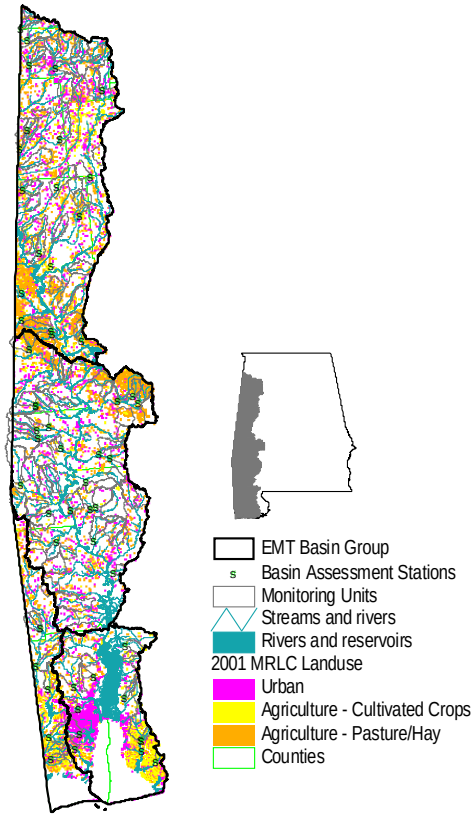
ADEM's reach-based probabilistic monitoring design was modified to a watershed-based probabilistic monitoring program. A Human Disturbance Gradient (HDG) was developed to classify each watershed by its potential level of disturbance. By monitoring the watersheds in proportion to the number of watersheds in each HDG category, the monitoring strategy will provide an estimate of overall water quality throughout the basin. Additionally, by sampling the entire gradient of watershed conditions within the basin group, the monitoring strategy will increase ADEM's monitoring capacity by providing data to develop indicators and criteria appropriate for wadeable rivers and streams statewide. Because the HDG provides disturbance and landuse information for all stations assessed within the basin group, it will enable ADEM to document the "least-impaired" landuse characteristics to set criteria for reference reach status in each Ecoregion or Bioregion. It will also assist ADEM in stressor identification for §303(d) listing and TMDL development.

Core and Supplemental Water Quality Indicators

Temperature, turbidity, stream flow, total dissolved solids, total suspended solids, specific conductance, hardness, alkalinity, dissolved oxygen, pH, ammonia, nitrate + nitrite, total Kjeldahl nitrogen, dissolved reactive phosphorus, total phosphorus, total/dissolved metals, pesticides, chloride, ultimate carbonaceous biochemical oxygen demand, 5-day carbonaceous biochemical oxygen demand, chlorophyll *a*, fecal coliform, aquatic macroinvertebrate assessments, fish IBI assessments, periphyton assessments, habitat assessments.



91 sites in 68 randomly-selected monitoring units (MUs) in the Alabama-Coosa-Tallapoosa Basin

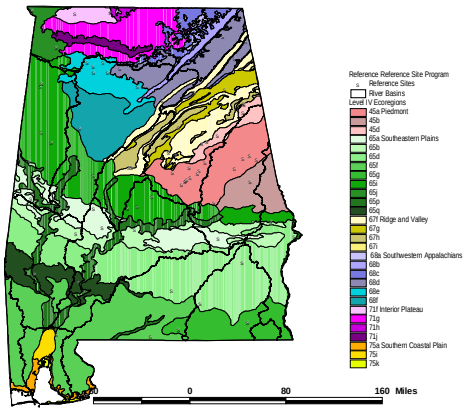


60 sites in 60 randomly-selected monitoring units (MUs) in the Escatawpa-Tombigbee-Mobile Basin.

Ecoregional Reference Sites

Innate regional differences exist in climate, landform, soil, natural vegetation, and hydrology. These factors, in turn, affect nutrient regime, substrate characteristics, and the composition of biological communities within aquatic ecosystems. By defining relatively homogeneous ecological areas, ecoregions provide a geographic framework for more efficient management of aquatic ecosystems and their components. The USEPA has recommended the development of ecoregional reference conditions as a scientifically defensible method of defining expected habitat, biotic, and chemical conditions within streams, rivers, reservoirs, and wetlands. Level IV ecoregions have been developed or are under development in 37 states nationwide. Griffith et al. (2001) delineated six Level III ecoregions in Alabama: Piedmont, Southeastern Plains, Ridge and Valley,

Southwestern Appalachians, Interior Plateau, and the Southern Coastal Plain. Within these, they delineated 27 Level IV ecoregions.



ADEM has maintained a network of least-impaired wadeable, flowing reference sites since 1991. Intensive monitoring assessments, including chemical, physical, habitat, and biological data, are conducted to develop baseline reference conditions for each of Alabama's 29 Level IV subecoregions.

Specific selection criteria were used to ensure that reference reaches were typical of the subecoregion and relatively unimpaired. Watersheds containing the highest percentage of natural vegetation were first located using topographic maps and land use information compiled by USEPA and local Soil and Water Conservation Districts. Departmental databases were used to ensure that potential reference watersheds do not contain any point source discharges, mining, or urban runoff, and minimal agricultural sources. Improved GIS capabilities have enhanced ADEM's ability to more accurately quantify land use within each of the reference reach watersheds. Intensive water quality, habitat and biological assessments were then conducted to verify that the reaches were in good condition.

Through this process, a total of 594 locations have been investigated as potential reference reaches statewide. Information from these site visits identified 53 ecoregional

reference reaches across the state. An additional 13 candidate reaches are currently being monitored to validate their selection.

In the future, ADEM will use its HDG categories and intensive water quality data, habitat assessment information, and biological assessment data to verify and document the "least-impaired" status of ecoregional reference sites. Additionally, because ADEM's Basin Assessment Program provides landuse information for all stations assessed within the basin group, it will enable ADEM to set criteria for reference reach status in each Ecoregion or Bioregion.

Intensive Surveys

Background

In *ASSESS*, intensive survey methods were described for both ADEM's point and nonpoint source assessment programs. Nonpoint source intensive watershed assessments were conducted before and after implementation of Best Management Practices (BMPs) to monitor trends in water quality and physical habitat and to evaluate the effectiveness of the BMPs. Point source assessments, such as Water Quality Demonstration (WQD) studies were conducted on selected streams receiving treated wastewater from municipal wastewater treatment facilities that have been newly constructed or have been renovated using partial funds through the Alabama Revolving Loan Program. Intensive Waste Load Allocation (WLA) Surveys were conducted to obtain information to develop water quality models used in determining the allowable wasteload (permit limits) for each point source.

Objectives

Once a waterbody is assessed as impaired, an intensive survey is conducted to identify the causative agent and its source, to quantify the level and extent of the impairment, and to assess the effectiveness of pollution abatement actions. In waterbodies where nutrient and sediment TMDLs are required, intensive surveys are conducted to develop indicators of nutrient and sediment impairments, to establish least-impaired conditions, and to set criteria protective of aquatic life and habitat quality.

Intensive Surveys currently conducted by the Department are requested by ADEM's Water Quality Branch or Office of Education and Outreach and fall under seven general types of investigations:

1. 72-hour Diurnal Dissolved Oxygen Studies
2. Intensive Fecal Coliform and Enterococci Studies
3. TMDL Development
4. Criteria Development
5. Use Attainability Assessments
6. NPS Intensive Investigations
7. Water Quality Demonstration Studies

Design

These objectives require assessment data that can detect subtle differences in chemical, physical, and biological conditions within a stream. Assessments are based on comparison with an upstream control, study-specific reference reaches, or paired watersheds (least-impaired or similarly impaired). The number of study and reference stations may also be increased to determine the extent or source of the impairment.

72-hour Diurnal Dissolved Oxygen Studies: ADEM is investigating diurnal DO patterns as an indicator of nutrient enrichment. Dissolved oxygen concentrations show daily variations, with peaks in late afternoon and minimums at dawn. These peaks are due to the production of oxygen by algae during daylight hours and consumption of dissolved oxygen at night by algae and other organisms in the water and bottom sediments. These daily swings increase when nutrient pollution triggers algal blooms. Diurnal dissolved oxygen, temperature, pH, and conductivity are measured continually for a minimum of 72-hours using datasondes deployed at each station.

Intensive Fecal Coliform and Enterococci Studies: Fecal coliform and Enterococci samples are collected to ensure that the full-body contact recreation use is being attained. Intensive studies are requested at stations where grab samples indicate impairment. Once a waterbody is known to be impaired for pathogens, intensive fecal coliform studies are conducted along with monthly collection of grab samples to determine which of ADEM's pathogen criteria will become the "driver" of TMDL development. During each intensive fecal coliform study, at least five fecal coliform bacteria samples are collected at each station within a 30-day period and at least 24 hours apart. Stream flows and field parameter measurements are taken during each site visit.

Total Maximum Daily Load (TMDL) and Criteria Development Investigations: TMDL investigations are required for waters known to be impaired. Listed waters occur statewide, with some major basins having many more listings than others. Water quality monitoring needs for TMDL development are communicated from ADEM's Water Quality Branch to ADEM Field Operations on an annual basis. Water quality monitoring data is typically collected within a 2-year period prior to TMDL development to ensure that timely and accurate data is being used to develop the TMDL. In some instances,

longer-term data and information are needed to address uncertainties, fill data gaps, or to better calibrate a particular water quality model. The complexities of the issues involved with TMDL development usually determine the nature and extent of the data and information needed.

TMDL studies can be conducted to develop water quality models used in determining the allowable maximum daily load for point sources. To assess point source impacts, TMDL studies typically involve time-of-travel studies, flow determination, and intensive sampling of the waterbody and point sources for various water quality parameters over a three or four day period.

Use Attainability Analysis (UAA): UAAs are another type of intensive investigation requested by ADEM's Water Quality Branch on a year-to-year basis. In accordance with the Federal Water Quality Standards Regulation (40 CFR 131.3), UAAs are structured, scientific assessments of the physical, chemical, biological, and economic factors preventing a waterbody from meeting the "fishable/swimmable" goal as defined in Section 101(a)(2) of the Clean Water Act. Consistent with the CWA, the Department routinely conducts UAAs for waterbodies currently classified as "Limited Warmwater Fishery" or "Agricultural and Industrial Water Supply", which do not meet the "fishable/swimmable" goal of the CWA.

NPS Intensive Investigations: Nonpoint source intensive investigations are conducted to determine the effectiveness of best management practices (BMPs) and watershed management plans. These studies are generally constrained to three- to five-years in length due to grant commitments and limitations. However, recent studies suggest that recovery of stream and river systems after BMP implementation can take ten to twenty years. Another difficulty with NPS investigations is a general lack of location data associated with BMPs. Stations are therefore located to assess an entire watershed, rather than the area that would be most affected by the BMP. Because NPS BMP implementation is voluntary, it can also be difficult to get a majority of landowners within a watershed to implement and maintain the necessary BMPs. Additionally, CWA §319 funding must now be used on waterbodies with EPA approved TMDLS.

Water Quality Demonstration Studies: A Water Quality Demonstration Study (WQDS)

typically includes upstream and downstream monitoring during a period before construction or renovation of a wastewater treatment plant has begun, and during a period after construction or renovation is complete. The data is typically collected during the low-flow period of the year, thereby documenting the greatest potential adverse impact attributable to discharge activity. The data collected serve to document improvement of stream water quality resulting from the implementation of improved wastewater treatment.

Core and Supplemental Water Quality Indicators

Core Indicators: Flow (where appropriate), Total stream depth, Sampling depth, Water temperature, Dissolved oxygen, pH, Specific conductance, Turbidity, Total suspended solids, Total dissolved solids, Hardness, Alkalinity, Ammonia-nitrogen, Nitrate+nitrite-nitrogen, Total Kjeldahl nitrogen, Total phosphorus, Dissolved reactive phosphorus, Chlorophyll *a*, Total organic carbon, Five-day carbonaceous biochemical oxygen demand, Chlorides

Supplemental Indicators: Supplemental indicators are determined by the data needs at each targeted site and may include: Total and dissolved Aluminum, Total and dissolved Iron, Total and dissolved Manganese, Dissolved Antimony, Dissolved Arsenic^{+3}, Dissolved Cadmium, Dissolved Chromium^{+3}, Dissolved Copper, Dissolved Lead, Dissolved Mercury, Dissolved Nickel, Dissolved Selenium, Dissolved Silver, Dissolved Thallium, Dissolved Zinc, Habitat assessment/physical characterization, Macroinvertebrate Assessment, Periphyton Bioassessment, Fish IBI Assessment, Diurnal dissolved oxygen surveys, Intensive bacteriological studies, Pesticides, Herbicides, Atrazine

Fish Tissue Monitoring Program (FTMP)

Background

The Alabama Department of Environmental Management (ADEM) and its predecessor, the Alabama Water Improvement Commission (AWIC), have collected fish for analysis of contaminant levels since 1970. For the 20 years that followed, fish collections focused on areas of known or suspected contamination. In 1991, the ADEM expanded its Fish Tissue Monitoring Program (FTMP) to provide statewide screening of bioaccumulative contaminants in fish tissue, and to provide the Alabama Department of Public Health (ADPH) with data needed for determination of potential risk to those who consume fish from Alabama waters. The expanded program historically exists as a cooperative effort between the ADEM, the Alabama Department of Public Health (ADPH), the Alabama Department of Conservation and Natural Resources (ADCNR), and the Tennessee Valley Authority (TVA).

Following expansion of the program to statewide screening, fish from all of Alabama's major reservoirs, rivers, streams, and state-managed public fishing lakes have been collected. Data from these locations are provided to the ADPH for issuance, modification, or removal of fish consumption advisories to the public. To date, samples comprised of several thousand fish have been collected from more than 300 sites for the FTMP.

Objectives

Because of the variability in contaminant concentrations observed in fish collected from locations over several years, and the need for additional monitoring at a number of locations, the approach to annual monitoring was refined in 2002. Annual fish tissue monitoring by ADEM became multi-faceted and directed toward accomplishing four objectives:

a) sampling locations throughout the focus basin (Tier I basin screening);
b) repetitive sampling of sites where the ADPH has determined that FDA limits have been exceeded (Tier II known impact);
c) sampling of sites in south Alabama that have not been sampled in several

years (Tier I screening); and,

d) sampling remaining areas in south Alabama where fish have not been collected for the FTMP (Tier I screening).

Repetitive sampling of sites where FDA action levels have been exceeded proceed as follows:

a) Sites that exceeded FDA limits for the first time the previous year will be sampled for a minimum of two concurrent years to provide verification of contaminant concentrations as requested by the ADPH;
b) Sites where ADPH consumption advisories currently exist will be sampled at a minimum of every three years to provide data for analysis of trends in contaminant concentrations.

Design

In 1997, the FTMP was incorporated into the ADEM Watershed Management Approach. Pursuant to this approach, water quality of each major drainage basin in the state is assessed by ADEM on a five-year rotating basis. In addition to the basin locations sampled each year, the ADEM continues to sample areas of concern outside the focus basin as needed and/or requested by cooperating agencies and as resources allow. The ADEM also continues to monitor dioxin concentrations below paper mills.

The number of sampling locations each year typically varies from forty to fifty stations, consisting of a mix of Tier I stations (screening, basin and south Alabama) and Tier II stations (FDA limit exceedance sites). The number of fish collected each year typically ranges from 480-500. Stations sampled and numbers of fish collected vary according to the size of the basin, number of Tier II sites, and resources available in a given year.

Sampling is typically conducted in the fall of the year, generally October-December for the FTMP. These months are preferred in fish tissue monitoring programs because:

a) Organic pollutants, primarily stored in fatty (lipid) tissue, would be at the greatest concentration as fat content of fish is highest at this time of year;
b) Target species are more easily collected while water levels are low and as water temperatures cool;

c) Fall collections do not interfere with spawning seasons of target species.

Collection methods may include electrofishing and/or gillnets as needed. At each location, six individuals of the same species are collected from each of two primary feeding groups, predators and bottom-feeders. Where mercury contamination is the primary concern, only predator species may be collected if resources are limited. Collected fish are within a size range identified in the SOP, with the additional requirement that catfish weigh a minimum of one pound as requested by the ADPH.

Collected fish at each location may be analyzed as species-specific composite samples (Tier I screening), or as individuals (Tier II known impact) when more definitive contaminant concentration data in fish is needed from an impacted site. Following completion of analyses, all data are compiled and distributed to cooperating agencies and a press release issued to provide analytical results to the public.

Core and Supplemental Water Quality Indicators

Core Indicators: Arsenic, cadmium, lead, mercury, selenium, chlordane, chlorpyrifos, 4,4-DDD, 4,4-DDE, 4,4-DDT, 2,4-DDD, 2,4-DDE, 2,4-DDT, dieldrin, endosulfan I, endosulfan II, endrin, heptachlor, heptachlor epoxide, hexachlorobenzene, lindane, mirex, toxaphene, PCBs, dioxin, relative weight.

Supplemental Indicators: As needed on a Tier II basis.

NPDES Compliance Monitoring Program

Background

Congress passed the Federal Water Pollution Control Act (1965) requiring state development of water quality standards for all interstate waters. Thereafter, the law was amended to include revisions outlined in the Clean Water Act (1972) which further delineated water quality standards on an intrastate level and to require discharging facilities to comply with set-forth permits in order to achieve these water quality standards. The Act was further amended by the Water Quality Act of 1987 which, in part, brought about the regulation of industrial and municipal stormwater.

ADEM has developed a comprehensive monitoring strategy that includes, as a component, the compliance monitoring of NPDES permits issued by the Department.

Objectives

Determination of a facility's compliance with the Departmental issued National Pollutant Discharge Elimination System (NPDES) and/or State Indirect Discharge (SID) permit(s).

Design

Alabama implements various compliance sampling techniques to assure the implementation of state and federal laws and the protection of overall environmental quality. The compliance monitoring programs conducted by ADEM consist of compliance sampling inspections (CSI) of permitted facilities. During the CSI, representative samples required for monitoring parameters listed in the facilities' permit are obtained.

The EPA has issued policies recommending annual inspections of all permitted entities. Generally, a priority list is developed at the beginning of each inspection year based upon those facilities with the longest period between inspections, citizen complaints, federal request and proximity of locations.

A compliance sampling inspection may include (but is not limited to) collection of

samples by grab or composite (flow or timed) of influent, in-process, effluent or receiving waterbody from "end of pipe", in-process locations, or overland flow. Samples of the receiving waterbody may be collected from both upstream and downstream of the outfall/discharge point. Samples may be collected for field measurements, chemical laboratory analysis, microbiological analysis, or bioassay. The sample results can then be used to interpret the degree of potential impact to the receiving water and assess permit compliance.

For those facilities that have intermittent discharges, samples are only collected if a discharge is present during the time of the facility visit. For some types of facilities, only a subset of the permitted discharges may be monitored during any one facility visit. Chemical and bacteriological analyses are performed, as applicable, and the results are reviewed by the appropriate regulatory entity, where they are used to verify the accuracy of the permittee's self-monitoring program and reports, determine compliance with discharge limitations, generally determine the quantity and quality of effluents, develop permits, and provide evidence for enforcement proceedings where appropriate. Field Operations Division staff also conduct CSIs for internal program use (i.e., mining, coalbed methane operations, construction stormwater, Animal Feeding Operations/Concentrated Animal Feeding Operations, and the regulatory aspects of the Nonpoint Source Management Program).

A core set of environmental indicator parameters is also analyzed from effluent samples collected during some CSIs. These data are forwarded to the Water Division for use in TMDL development and other water quality assessments. Each indicator parameter is evaluated on a systematic basis to determine its usefulness for assessing NPDES and SID compliance status.

Core and Supplemental Water Quality Indicators

As applicable on a programmatic basis:

Core Indicators: Total alkalinity, aluminum, antimony, arsenic, atrazine, alachlor, metolachor, aldicarb, cadmium, total organic carbon, chemical oxygen demand, chlorine, chlorophyll *a*, chromium, copper, cyanide, dissolved oxygen, fecal coliform bacteria, carbonaceous biochemical oxygen demand, hardness, iron, lead, manganese, mercury, nickel, ammonia, nitrate + Nitrite, total Kjeldahl nitrogen, organo-chlorine pesticides, organo-phosphorus pesticides, pH, zinc, selenium, semi-volatiles, silver, total dissolved

solids, total suspended solids, specific conductance, temperature, thallium, total phosphorus, dissolved reactive phosphorus, toxicity, turbidity.

Supplemental Indicators: As required by permit.