



MISSOURI

DEPARTMENT OF NATURAL RESOURCES

A PROPOSAL FOR A WATER QUALITY MONITORING STRATEGY FOR MISSOURI

Water Pollution Control Program
Federal Fiscal Year
2015-2020

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1.0 Introduction

1.1 The Clean Water Act

The original Federal Pollution Control Act was enacted in 1948 to control water pollution primarily based on state and local efforts. During the 1972 amendments, significant expansion and reorganization of the statute was completed. It was at this time the Federal Pollution Control Act became commonly known as the Clean Water Act (CWA). The CWA establishes the basic structure for regulating discharges of pollutants into waters of the United States and regulating water quality standards for surface waters. The goal of the CWA is “to restore and maintain the chemical, physical, and biological integrity of the Nation’s Waters,” with interim goals that all waters are to be fishable and swimmable where possible. The federal guidelines, objectives, and limits are set under the authority of the U.S. Environmental Protection Agency (EPA), while states, territories, and authorized tribes largely administer and enforce the CWA programs with significant federal financial assistance¹.

The Clean Water Act objectives include:

- Establishing, reviewing, and revising water quality standards (Section 303(c)²);
- Determining water quality standards attainment (Section 305(b)³);
- Identifying impaired waters (Section 303(d)¹);
- Identifying causes and sources of water quality impairments (Section 303(d)¹, 305(b)²);
- Supporting the implementation of water management programs (Section 303¹, 314⁴, 319⁵, 402⁶, etc.); and
- Supporting the evaluation of program effectiveness (Section 303¹, 305², 314³, 319⁴, 402⁵, etc.).

1.2 Section 106 of the Clean Water Act

Since 2006, the EPA and the states have been working together to develop basin wide approaches to water quality management. The EPA is helping foster watershed protection approaches at the state level by looking at states’ water quality problems holistically and targeting the use of limited finances available for effective program management. To assist states, the EPA provides Section 106 grant assistance to:

- Facilitate partnerships with states to collaborate more effectively in water quality priorities;
- Leverage the efficiency of state program implementation;
- Provide resources for enforcement; and,
- Ensure a minimum level of state capacity and commitment to address national water quality goals and objectives.

¹ EPA, The Clean Water Act: Protecting and Restoring our Nation’s Waters: EPA, The Clean Water Act: Protecting and Restoring our Nation’s Waters

² Section 303(d), Impaired Waters List: <http://water.epa.gov/lawsregs/guidance/303.cfm>

³ Section 305(b), Integrated Report: <http://water.epa.gov/lawsregs/guidance/cwa/305b/index.cfm>

⁴ Section 314, Clean Lakes Program: <http://water.epa.gov/type/lakes/clkspgm.cfm>

⁵ Section 319, Nonpoint Source Program: <http://water.epa.gov/polwaste/nps/cwact.cfm>

⁶ Section 402, National Pollutant Discharge Elimination System: <http://water.epa.gov/lawsregs/guidance/wetlands/section402.cfm>

The EPA uses an annual allotment formula⁷ that distributes the Section 106 grant funds among states according to anticipated relative workload and extent of the pollution problems in accordance with 40 CFR 35.162 and 40 CFR 35.160.168. The Section 106 grants are the only source of annual base funding the EPA provides to all 50 states for water quality programs. The grant funds assist states with developing, planning, and administering programs for the prevention, reduction, and elimination of water pollution. As part of the grant requirements, the states annually submit Section 106 grant workplans to the EPA. This provides a mechanism for ensuring that no duplication or redundancy of efforts occur.

Prior to awarding a Section 106 grant to a state, Section 106(e)(1) of the CWA requires the EPA to determine that the state is monitoring the quality of navigable waters, compiling and analyzing data on water quality, and including the data in the state's Section 305(b) Integrated Report. Historically, the EPA has relied on the submission of the 305(b) Integrated Report to determine that states have satisfied the Section 106(e) eligibility requirement for the grant award. However, in March 2000, the U.S. General Accounting Office reported that the EPA and states can not make statistically valid assessment of waters and lack the data to support key management decisions. In an effort to provide guidance to the states, in March 2003, the EPA issued the Elements of State Water Monitoring and Assessment Program guidance to provide a framework for strengthening state monitoring programs by the end of FY2014. The basic framework was developed to be tailored to the specific needs of the states, allowing the states to build upon each state's existing monitoring capabilities. The state's monitoring strategy describes how the monitoring program will serve all water quality management needs and address all waters over time. The monitoring program itself is to be a long-term implementation plan that is comprehensive in scope; identifying technical issues and resource needs that are impediments to an adequate monitoring program.

The EPA, Assessment and Watershed Protection Division, recommends states' monitoring and assessment programs include the following ten elements. Details of each element are described in the "[Elements of a State Monitoring Assessment Program](#)" EPA document number 841-B-03-003), published March 2003⁸.

- Monitoring Program Strategy
- Monitoring Objectives
- Monitoring Design
- Core and Supplemental Water Quality Indicators
- Quality Assurance
- Data Management
- Data Analysis/Assessment
- Reporting
- Programmatic Evaluation
- General Support and Infrastructure Planning

An evaluation of the ten elements serves the water resource management activities as a way to identify needed changes and additions for future monitoring cycles. Annually, the EPA measures the success of a state's Section 106 grant through various performance measures (listed below). These measures are reported by the state to the EPA, and are a way for both the state and the EPA to evaluate the state's monitoring and assessment program to determine how well it serves water quality decision needs for all waters of the state.

⁷ EPA, Water Pollution Control (Section 106) Grants: <http://www2.epa.gov/water-pollution-control-section-106-grants>.

⁸ <http://water.epa.gov/type/watersheds/monitoring/statemonitoring.cfm>

1.3 Section 106 Performance Grant Measures:

- Number of Total Maximum Daily Loads (TMDLs) that are established by states and approved by the EPA.
- Percentage of states within the preceding three-year period that have submitted new or revised water quality criteria acceptable to the EPA that reflect new scientific information from the EPA or other sources not considered in the previous standard.
- Percentage of high priority state National Pollution Discharge Elimination System (NPDES) permits that are issued as scheduled.
- Number of water body segments identified by the state as not attaining standards, where water quality standards are now fully attained.
- Percentage of major NPDES facilities in significant non-compliance at any time during the fiscal year.

2.0 Elements of a Water Monitoring and Assessment Program

2.1 Monitoring Program Strategy

This monitoring strategy describes Missouri's current monitoring program that serves the state's water quality decision needs, and provides an overview of how Missouri plans to address each of the elements in an effort to maintain alignment with CWA goals and objectives.

2.2 Monitoring Objectives

Missouri's objectives reflect the needs of the CWA, the Safe Drinking Water Act, and other water management activities. Water quality monitoring provides the data to characterize waters and identify changes or trends in water quality over time. The collection of monitoring data enables Missouri to identify existing or emerging water quality problems, and determine whether current pollution control measures are effective in complying with the regulations. The CWA requires each state to monitor and assess the health of all waters and report their findings every two years to the EPA. The list of data and findings are discussed in a 305(b) Integrated Report (also known as the 305(b) report or water quality report) and is available from the Missouri Department of Natural Resources website at URL: <http://dnr.mo.gov/env/wpp/waterquality/303d/303d.htm>.

Missouri's overall objective of a monitoring program is to provide sufficient data to allow a water quality assessment of all waters of the state where data is available in both quantity and quality. The specific objectives for Missouri's monitoring program are described in greater detail within the following sections. Also outlined below are the section(s) of the CWA that are associated with each monitoring objective.

Missouri's Water Quality Monitoring Strategy

1.0 Characterize background or reference water quality conditions (Section 305(b))

2.0 Better understand daily flow and seasonal water quality variations, and their underlying processes (Section 305(b))

3.0 Characterize aquatic biological communities and habitats, and to distinguish between:

- 3.2. Unimpaired biotic communities (Section 305(b))
- 3.3. Biotic communities impaired by water chemistry (Section 303(d))
- 3.4. Biotic communities impaired due to habitat quality (Section 303(d))
- 3.5. Assess time trends in water quality (Section 305(b))

4.0 Characterize the impact of local and regional point and nonpoint source discharges on water quality (Section 303(d))

- 4.5. Provide water quality information to support these management activities:
 - 4.5.1. Check for compliance with water quality standards (Section 303)
 - 4.5.2. Check for compliance with wastewater permit limits (Section 402)
 - 4.5.3. Develop water quality based permit limits and TMDL studies (Section 303)
 - 4.5.4. Develop the state 303(d) list and state 305(b) Integrated Report (Section 305(b) integrated reporting)
 - 4.5.5. Determine the effectiveness of watershed management programs (Section 319)

5.0 Support development of strategies to return impaired waters to compliance with water quality standards (Section 303, 314, 319, 402).

2.3 Monitoring Design

Missouri's monitoring design explains how monitoring sites are selected to meet the stated monitoring objectives. To meet decision needs most efficiently, Missouri has integrated several monitoring designs: fixed station, intensive/special, screening-level monitoring, and probability-based design. Appendix A provides an overview of Missouri's existing monitoring program along with identified monitoring gaps.

- Fixed station monitoring program. This program collects a selected group of analytes at predetermined sites on a regular schedule. The fixed station monitoring program typically collects data at given sites for several years. Appendix B provides an overview of the department's fixed station monitoring program. The appendix also includes a list of several cooperative sites (not department sponsored sites) where the data has historically been shared with or used by the department.
- Intensive or special surveys. This type of monitoring typically employs several monitoring sites within a small geographic area at a greater frequency, where samples are collected multiple times per day. The duration of most intensive or special surveys are short, lasting only one to a few days, but are typically repeated multiple times over a one to three year period.
- Screening level monitoring. This monitoring includes a number of low intensity, short duration monitoring activities. These activities typically provide smaller amounts of data but provide the advantage of monitoring higher number of sites at a reduced monitoring expense.
- Probability-based surveys. This program is based upon probabilistic site selection using simple random, stratified, or nested designs. They are designed for making statistically valid inferences about the condition of all the water types within the state over time.

In an effort to maximize efficiency, expand the states resources, and prevent duplication of efforts, Missouri routinely coordinates with other water programs both internally and externally (such as other state agencies or local governments) to share water quality data. Missouri also receives interagency input on monitoring study designs. The agencies most often involved are the U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers, EPA, the Missouri Department of Conservation (MDC), and Missouri Department of Health and Senior Services (MHSS). The department also tracks the monitoring efforts of the National Park Service, the U.S. Forest Service, several of the state's larger cities, the states of Oklahoma, Arkansas, Kansas, Iowa, and Illinois, and graduate level research conducted at the universities within Missouri. The department utilizes a variety of external data as long as the environmental data is collected in accordance with an approved Quality Assurance Program Plan (QAPP) and following EPA or equivalent methods and standard operating procedures (reference 3.2 for Missouri's Quality Assurance Program).

2.4 Fixed Station Network

The objective of this program is to better characterize background or reference water quality conditions, to better understand daily flow and seasonal water quality variations and their underlying processes, to assess time trends and to check for compliance with water quality standards. Missouri's fixed station network is designed to obtain water chemistry, sediment, fish tissue, and biological monitoring sites equitably among the major physiographic and land use divisions.

The fixed station network serves to meet monitoring objectives 1.0, 2.0, 3.0, 4.0, 5.1.1, 5.1.3, 5.1.4, and 5.1.5 noted above. Biological monitoring and long-term fixed station chemical monitoring are considered the most effective ways of documenting the efficacy of nonpoint source control watershed projects. Sites are chosen based on one of the following criteria: 1) site is believed to have water quality representative of many neighboring streams of similar size due to similarity in watershed geology, hydrology and land use, and the absence of any impact from a significant point or discrete nonpoint water pollution source, or 2) site is downstream of a significant point source or discrete nonpoint source area.

The fixed station network monitoring components are described below. The associated estimated cost for each program are calculated as two year averages.

2.4.1 Ambient Stream Network Program

The current fixed station ambient stream network includes approximately 71 sites monitored between four and 12 times annually by the USGS for a wide variety of physical, chemical and bacteriological constituents. Four of these sites are also sampled at less frequent intervals for a wide variety of pesticides. Approximately half the monitoring sites are located on stream segments classified as fifth order streams or larger (categorized as medium or large rivers). Five sites are located on great rivers (stream order 7-8), along with two additional sites on the Missouri River where data sondes are deployed to collect continuous data from spring through autumn. Thirteen sites are classified as small streams (stream order 3-4) and one is classified as very small (stream order 1-2). Five springs are also monitored four to six times per year. The fixed station USGS sites that are supported by the department through

the Water Protection Program (WPP) are listed in Appendix B. MoDNR's share of the total cost is approximately \$1,319,705/year. While approximately \$180,000 is provided annually by USGS through matching funds.

2.4.2 Wadeable Streams

The MoDNR, Environmental Services Program (ESP), in support of the WPP under the Wadeable Streams QAPP, monitors water quality at approximately 58 fixed sites from two to 24 times annually for a shorter list of physical and chemical constituents. Most of these streams are fifth order or smaller (categorized as small to medium rivers). The department supports 2.16 FTE for an estimated cost of \$261,164/year.

2.4.3 Lake Monitoring Program

The MoDNR funds two lake monitoring programs by the University of Missouri-Columbia: Statewide Lake Assessment Project (SLAP) and Lakes of Missouri Volunteer Monitoring Program (LMVP). SLAP monitors approximately 75 lakes four times each during the summer for nutrients, chlorophyll, volatile and non-volatile suspended solids, and secchi depth. The LMVP collects data typically four to six times per year on approximately 66 lakes annually, including multiple sampling sites on larger reservoirs for nutrients, chlorophyll, and secchi depth. The combined cost of these two programs is approximately \$220,000/year.

2.4.4 Fish Tissue Monitoring Program

In coordination with EPA Region 7, MoDNR maintains a fish tissue-monitoring program of approximately 13 fixed (trend) sites monitored approximately once every two years for whole fish used to document contamination levels present in fish in various areas of the state and to determine if differences in tissue levels relate to land use and/or long-term trends. These sites include a total of four sites on the Missouri and Mississippi rivers and nine sites on larger interior rivers. Analytical work was historically completed by EPA Region 7. However, as of August 2013, EPA Region 7 only provides analytical support for mercury. In an effort to track trends across the state, Missouri believes the continuation of a fixed station monitoring network is a monitoring objective that should be maintained. Starting in 2015 the department is providing funding to continue this program at the same historical effort.

In addition, MoDNR and the MDC currently have separate fish fillet monitoring programs. The department's fish fillet program is focused on ensuring there are sufficient data available for the biennial assessment against water quality criteria for the 305(b) Integrated Report and potentially other assessments. The MDC program is focused on providing support to the DHSS for their annual assessment of Missouri fish consumption advisories. Table 1 below provides an overview of each agency's fish tissue monitoring programs.

The two programs have different statistical requirements and threshold criteria, so are operated separately. However, the three agencies (MoDNR, MDC, and DHSS) meet annually to review proposed sampling sites and look for opportunities to create efficiencies in fish collection and data analysis. In combination, these fish tissue-monitoring programs collect fish at about 30-50 sites annually. Samples are typically composites of five or more

fish, and fillets or plugs are analyzed rather than the whole fish. This program does not employ fixed sites. These sites are selected based on each agency’s program focus as mentioned above. MoDNR’s combined cost for supporting both the fixed station (13 trend) sites and status sites (42 sites) is approximately \$94,625/year. This program supports 0.75 FTE.

Table 1. State Agency Objectives for Fish Tissue Monitoring Program in Missouri

Organization	Primary Objective(s)	Site Selection Priorities	Criteria for Assessment	Assessment Deliverable
DHSS	<ul style="list-style-type: none"> To ensure the safe consumption of Missouri fish through development and issuance of fish consumption advisories. 	<ul style="list-style-type: none"> Public or private inquiries. Sites identified by new toxicological information or reassessments (e.g. dioxin, PCB congeners). Expanded analytical needs (e.g. omega-3 fatty acids). 	<ul style="list-style-type: none"> Review available fish contaminant levels relative to DHSS human health consumption criteria (continually updated). 	<ul style="list-style-type: none"> Annual fish consumption advisory posted on web after addition or removal of advisories based on new data.
MDC	<ul style="list-style-type: none"> To provide technical support to DHSS and other relevant agencies for monitoring fish contaminants to assess the safe consumption of sport-caught fish in Missouri. 	<ul style="list-style-type: none"> Long-term monitoring of areas with advisory. Monitor additional water bodies identified by MDC field staff or other mechanism. 	<ul style="list-style-type: none"> MDC does no assessments but provides their data to DHSS for evaluation relative to fish consumption advisories. MDC provides courtesy copy of data to MoDNR which may be used in their assessments. 	<ul style="list-style-type: none"> MDC’s “Summary of Missouri Fishing Regulations” includes a summary page with DHSS’s most recent fish consumption advisory recommendations. Annual MDC Fish Contaminant Report.
MoDNR	<ul style="list-style-type: none"> To ensure that all waters meet the designated use of human health protection from consumption of fish. To detect spatial and temporal changes in fish contaminant concentrations. 	<ul style="list-style-type: none"> Assessment of impairment relative to water quality criteria. TMDL monitoring. Trend analysis at MoDNR’s 13 long-term monitoring sites (Whole fish). 	<ul style="list-style-type: none"> Water quality criteria for fish contaminants as specified in the Listing Methodology Document. 	<ul style="list-style-type: none"> 303(d) impaired waters list. 305(b) integrated water quality report.

Updated September 18, 2015

2.4.5 Sediment Monitoring

The sediment monitoring is completed by MoDNR’s ESP under the WPP Sediment Monitoring QAPP. Monitoring is conducted to determine if stream sediments contain levels of trace substances (e.g. metals) in excess of naturally occurring amounts and if potentially toxic levels of any trace contaminants occur. Approximately 10-12 sites are monitored annually that are representative of regional conditions and/or targeted to areas of concern. The MoDNR supports 0.27 FTE for a cost of approximately \$26,953/year.

2.5 Intensive and Special Studies

The objective of intensive and special studies is to characterize the water quality impacts from a specific pollutant source area. These studies are designed to determine the contaminants of

concern based on previous water quality studies, effluent sampling and/or Missouri State Operating Permit applications. These studies employ multiple sampling stations downstream and upstream (if appropriate). If contaminants of concern have significant seasonal or daily variation, season of the year and time of the day variation must be accounted for in the sampling design.

Intensive and special studies tend to be driven by the need for site specific water quality information to assist the water quality management process. Examples include the development of water quality based NPDES permit limits, to assist in compliance and enforcement activities, or to evaluate water quality of an area to determine effectiveness of land management activities. The estimated cost to support these activities is approximately \$892,832+/year.

Intensive and special studies that may be conducted by the department include:

- Wasteload Allocation Studies (WLA) for wastewater treatment facilities used to judge compliance with instream water quality standards and if necessary, be used to develop water quality-based permit limits. Five to eight WLA studies may be completed annually. The department supports 2.37 FTE at approximately \$250,762/year.
- Chemical monitoring targeted at coal, industrial, municipal or heavy metal mining sites or Concentrated Animal Feeding Operations (CAFOs). The need for this type of monitoring varies greatly from year to year. Typical number of sites monitored would range between 0 and 30. Sampling frequency would depend on intended use of the data.
- Dissolved oxygen (DO) studies below hydropower dams or other areas of concern. Once deployed, continuous DO monitors are maintained for a stipulated period of time.
- Stream morphology studies characterizing the degree of sinuosity and the degree of heterogeneity of channel width and depth.
- Aquatic macroinvertebrate biomonitoring twice annually at approximately 45-50 sites. Sampling sites are divided between targeted sites where there are concerns with either point source discharges, discrete nonpoint source areas such as active or abandoned mining sites or concerns related to watershed-wide nonpoint source problems and reference sites to which targeted sites are compared. The department supports 7.35 FTE at an estimated cost of \$694,070/year.
- Contracted Studies. At any given time, the department may have several contracts for water quality monitoring that are ongoing. The majority of these support Section 319 funded watershed projects to control nonpoint source pollution, but outside contractors have been used to complete Use Attainability Analyses (UAA) of streams, and simple monitoring projects when costs or manpower limitations made them attractive, or when technically demanding work required a contractor with special training, skills or equipment. These costs can vary from year to year. For Section 319 funded monitoring projects, these costs are outlined within the project's subgrant agreement.

2.6 Screening Level Monitoring

Rapid stream assessment protocols that rely on visual evidence and qualitative sampling of aquatic biota are the typical screening level monitoring procedures used by the department. Some additional water chemistry sampling occurs as a result of inspections and complaint investigations. Missouri currently employs two types of screening level monitoring strategies: volunteer water quality and macroinvertebrate monitoring and MoDNR staff conducted low flow surveys.

2.6.1 Volunteer Water Quality Monitoring Program

The Volunteer Water Quality Monitoring (VWQM) Program provides a significant source of screening level information. The department completes a comprehensive review of invertebrate and water chemistry data collected by level 2, 3 and 4 volunteers. Data meeting the following criteria will be screened by MoDNR for the thresholds outlined in Table 2 below and scheduled for more intensive follow-up monitoring.

- Site must be located on streams with designated uses,
- contain at least four years of data,
- have three invertebrate sampling replicates occurring at least twice per year (spring and fall),
- have at least five water chemistry samples (preferably collected quarterly)

Table 2. VWQM Data Screening Thresholds

Parameter	Criteria
Invertebrate Scores	15 or lower
Chloride	≥230 mg/L
Dissolved Oxygen	5.0 mg/L or less
Ammonia	≥1 mg/L
Nitrate as Nitrogen	≥2 mg/L
Phosphate	≥3 mg/L
pH	6.5 or lower
Specific Conductivity	≥1600 uS/cm

As part of the VWQM Program, the department also supports a lake monitoring program to gain an understanding of the trophic status of small lakes (generally <10 acres) currently not monitored as part of the SLAP or LMVP. For both MoDNR sponsored volunteer programs, the department supports 4.15 FTE (2.48 WPS, 1.67 ESP) at an estimated cost of \$313,286/year.

2.6.2 Low Flow Surveys

The purpose of this monitoring is to provide a rapid and inexpensive method of screening large numbers of waters for obvious water quality problems and to determine where more intensive monitoring is needed. This represents an assessment of approximately 80-100 streams annually below wastewater discharges, mining areas, quarries, or landfills. In the last few years the department's ability to conduct screening level monitoring has been greatly reduced by the need to increase the level of intensive surveys. The department supports 1.5 FTE at an estimated cost of \$44,536/year.

2.7 Probability Based Surveys

The MDC Resource Assessment and Monitoring (RAM) Program monitors approximately 70 stream sites annually (categorized as small to large rivers, stream order 2-5). Aquatic macroinvertebrate and fish communities, water quality, and habitat are assessed at each stream site. Originally, Ecological Drainage Units (EDUs) were randomly sampled in a five-year rotation, but in 2010 MDC switched to randomly sampling three ecological subregions in

rotation to allow coverage of the state every five years with two crews instead of three. The Central Plains was sampled in 2010-2011, the Ozarks in 2012-2013, and the Mississippi Alluvial Basin in 2014. The RAM Program will focus on sampling streams for several research projects for the next several years before returning to a random sampling of wadeable streams statewide. This program is a monitoring partnership based upon RAM and various MoDNR monitoring programs that is formalized in a signed Memorandum of Understanding between agencies. The information is used by MDC for trend monitoring in priority watersheds and tracking species ranges. MoDNR uses the data for trend monitoring statewide and 305(b) reporting. MDC may also refer potentially impaired sites to MoDNR for more intensive assessment. Metrics for assessing the biological integrity of fish communities were developed for Ozark and Ozark Border streams in 2008 (Doisy, Rabeni, Combes, and Sarver) but was unsuccessful for Central Plains and Mississippi Alluvial Basin streams. MDC currently supports 2 FTEs, 6 temporary field staff, and 5 temporary lab staff to meet MDC's goals for a combined cost of approximately \$181,000/year.

On a smaller scale and to aid in gathering additional data in priority watersheds, in FY2016 the department initiated a randomized chemical monitoring program in the Sac River Basin. Basin monitoring will involve quarterly collection of surface water samples from approximately ten randomly chosen sites for approximately 2-3 years. The data will be used to gain additional baseline or background information about the watershed. This monitoring utilizes approximately 0.25 FTE, at an estimated cost of \$35,000/year.

2.8 Climate Change Monitoring

In 2015, the department attended the Central Plains Climate Change Wadeable Streams Network workshop. The goal of the workshop was to get as many EPA Region 7 states and tribal bioassessment representatives together as possible to develop a long-term monitoring strategy for wadeable perennial streams in the Central Plains and Ozarks ecoregions. The project's focus will be to determine how climate change will affect aquatic ecosystems and with additional knowledge, how bioassessment programs need to respond. The EPA Region 7 will obtain temperature and level logger sondes that will be loaned to participating states on a long-term basis. States will be responsible for the annual collection of macroinvertebrate and water quality samples, the development of a data logger maintenance and data retrieval program, as well as completing a cross section profile of the stream channel to calculate a flow rating curve.

To date, it is proposed that up to six sites be monitored in public ownership that met the core requirements for reference stream selection. Potential sites may be chosen from Table I of Missouri's Water Quality Standards, or MDC RAM reference sites with at least two of the six sites being targeted to urban areas. Proposed sampling is to start during the spring of 2016. It is estimated that the climate change monitoring will involve approximately 1 FTE, at an estimated cost of \$53,616/year.

3.0 Core Indicators

3.1 Details of Proposed Core and Supplemental Indicators

Table 3 describes MoDNR's core and supplemental indicators utilized by the state for the determination of water quality decision needs. The process includes assessing water quality

standards attainments and designated use support, identifying needed changes to water quality standards, describing causes and sources of impairments, developing water quality-based source controls, and assessing whether physical, chemical and biological integrity are supported. Details of the department’s assessment methods and processes are described in Methodology for the Development of the Section 303(d) List and Missouri Water Quality (305(b)) Integrated Report. Reference the MoDNR website: <http://www.dnr.mo.gov/env/wpp/waterquality/index.html> for additional information.

Table 3. Details of Proposed Core and Supplemental Indicators

	Protection of Aquatic Life	Recreation	Drinking Water Supply	Fish and Shellfish Consumption
Core Indicators	<ul style="list-style-type: none"> • Quantitative Sampling of Aq. Invertebrates • Quantitative Sampling of Fish • Qualitative Sampling of Invertebrates and Fish • Habitat Assessment • Flow • Water Temperature • Dissolved Oxygen • pH • Conductivity • Sulfate • Chloride • TKN, NH³N, NO²+NO³N • Total P • Diss. Al, Cd, Cu, Fe, Pb, Zn 	<ul style="list-style-type: none"> • Fecal Coliform/E. coli • Total N, Total P <p>For lakes only:</p> <ul style="list-style-type: none"> • Secchi depth • Chlorophyll • VSS • NVSS 	<ul style="list-style-type: none"> • Diss. As, Cd, Cu, Pb, Zn • NO²+NO³N • Dissolved Solids <p>For lakes only:</p> <ul style="list-style-type: none"> • Chlorophyll • VSS • NVSS • Total N, Total P 	<ul style="list-style-type: none"> • Pesticides • PCBs • Hg, Pb • Dioxins • Dibenzo Furans
Supplemental Indicators	<ul style="list-style-type: none"> • Diss. Co, Ni, Cr, Th • Bioassay toxicity • Pesticides 	<ul style="list-style-type: none"> • Hazardous chemicals 	<ul style="list-style-type: none"> • Taste and odor causing substances • Diss. Fe, Mn 	<ul style="list-style-type: none"> • Heavy metals, PAHs

3.2 Quality Assurance

MoDNR has an EPA approved quality assurance (QA) management program in place and describes the processes to be followed for all MoDNR environmental monitoring activities. All internal water quality monitoring completed by the department’s Division of Environmental Quality must be done under a QAPP with the MoDNR ESP laboratory and approved by the MoDNR QA manager. Environmental monitoring contracted to those outside of the department requires the contractor to also develop a QAPP that must be reviewed and approved by MoDNR. Data generated in the absence of an MoDNR approved QAPP may be used if the department determines the data is scientifically defensible after making a review of the quality assurance procedures used by the data generator. This review includes 1) names of all persons involved in the monitoring program, their duties and a description of training and work related experience; 2) all written procedures, standard operation procedures, or QAPPs pertaining to the monitoring effort; 3) a description of all the field methods used, brand names and model number of any equipment and description of calibration and maintenance procedures; and 4) a description of laboratory analytical methods.

The following MoDNR, WPP monitoring programs are completed following a peer reviewed QAPP process:

- Wasteload Allocation
- Special Studies
- Low Flow Surveys
- Ambient and Wadeable Streams Network
- Sediment Monitoring
- Fish Tissue Monitoring
- Volunteer Water Quality Monitoring
- Lake Monitoring
- Biological Assessments
- Section 319 nonpoint source project monitoring

3.3 Data Management

In 2010 the department's WPP began using the Water Quality Assessment (WQA) data management system. This system allows the WPP to download data from the main environmental data file to the EPA Water Quality Exchange (WQX) system on a quarterly basis where the data is then uploaded by EPA into STORET. The WQA system also allows for automated transfer of assessment database directly into EPA's ATAINS⁹ database.

Environmental data including water, sediment and tissue chemistry, biological community data for fish and aquatic invertebrates, and toxicity test results are housed in a single web based DB2 data file. This data and associated metadata (name of sampling organization, contact information, analytical methods used, quality assurance rating) can be accessed by the public directly from the MoDNR website.

MoDNR currently maintains stewardship of the National Hydrography Dataset (NHD) database for the state of Missouri, and is actively working to correct errors and assign nationally accepted stream and lake names. All locational data in our environmental data files are linked to the appropriate NHD segment.

3.4 Data Analysis and Assessment

All of the department's data analysis and assessment procedures are given in the most current version of the Section 303(d) Listing Methodology Document. This document is revised for each 303(d) listing cycle through a public participation process and is located on the 303(d) home page on the WPP website¹⁰. All assessments are entered into the WQA system. All waters with designated uses appear automatically within WQA as do any waters without designated uses which have been previously assessed as "impaired." When any other water without designated uses is first assessed as impaired, it is entered into the WQA system at the time of assessment.

⁹ <http://www2.epa.gov/waterdata/assessment-and-total-maximum-daily-load-tracking-and-implementation-system-attains>

¹⁰ <http://dnr.mo.gov/env/wpp/waterquality/303d/303d.htm>

3.5 Reporting

3.5.1 Clean Water Act Reporting

Missouri will continue to provide Section 319 nonpoint source water quality assessments and Section 314 lake water quality assessments as part of its Section 305(b) reporting requirements. Electronic assessment file updates are forwarded to EPA annually by April 1 of odd numbered years. In even numbered years, the WPP submits an integrated report containing the 305(b) report and the most recent proposed 303(d) list as one of the appendices to the report.

3.5.2 Other Reports

Other water quality related reports include TMDL Studies, Water Quality Basin Plans, Water Quality Review Sheets (WQRS) developed in association with calculation of appropriate NPDES permit limits, and miscellaneous data summary reports associated with water quality data review and assessments. These reports are available either on the department’s website or are available for public viewing in the department’s files.

3.6 Program Evaluation

As part of the Performance Partnership Agreement/Performance Partnership Grants (PPA/PPG) process, the department and EPA Region 7 will review Missouri’s monitoring strategy. This review would include: (1) the current program description biennially, (2) the GAP analysis biennially (Appendix A), and (3) identify monitoring strategy gaps to be addressed in the next PPA/PPG cycle (annually). During the annual review, the department will update information as needed.

3.7 General Support and Infrastructure Planning

For convenience, Appendix C provides a summary of the monitoring and estimated funding needs necessary to implement an expansion of the current monitoring program to address identified monitoring gaps. Each monitoring gap is discussed in greater detail in Appendix A and a summary table provided in Appendix C of this document. In addition, each monitoring gap is prioritized according to the criteria described in Table 4 below:

Table 4. Priorities for Water Quality Monitoring

Priority Level 1:	Monitoring required to meet court orders or other legally binding agreements.
Priority Level 2:	Monitoring for time critical department/program information needs. This would include TMDLs, Water Quality Review Sheet (WQRS), enforcement actions, and special investigations related to human health or other environmental emergencies.
Priority Level 3:	Development of aquatic biological criteria for streams and research on the linkage of the health of aquatic biological communities to physical and chemical characteristics of the watershed. Problem identification and compliance monitoring for human health related water quality standards.
Priority Level 4:	Problem identification and compliance monitoring for non-human health

	related water quality standards. Development of chemical and physical water quality standards.
Priority Level 5:	Statewide water quality assessment and reporting requirements (Sec. 305(b) requirement to assess all of the state's waters).
Priority Level 6:	Development of biological criteria for lakes. Assessment of trophic conditions in lakes. Development of water quality criteria for wetlands. Assessment of condition of wetlands.

Appendix A: Gaps Analysis

FIXED STATION NETWORK

GAP 1. Great Rivers (7-8 Stream Order Classification, the Missouri and Mississippi rivers).

GAP 1.1 Water Chemistry Monitoring

Priority Level 4

Estimated Annual Cost: \$250,000+

Background:

Missouri River: The Missouri River has adequate chemical monitoring upstream of Kansas City. The Army Corps of Engineers currently operates eight stations between Yankton, South Dakota and Rulo, Nebraska. The USGS monitors at St. Joseph. Between Kansas City and the mouth there is currently only one monitoring site sponsored by MoDNR, at Hermann, about 60 miles upstream from the St. Louis area. One additional monitoring site is needed on the river immediately downstream of the Kansas City metro area.

Mississippi River: There is currently at least one chemical monitoring site on the Mississippi River between the Des Moines and Ohio rivers. There are currently no fixed station monitoring points on the portion of the Mississippi bordering Missouri downstream of the Ohio River.

In addition, the Upper Mississippi River Basin Association (UMRBA) water quality task force developed a comprehensive Upper Mississippi Clean Water Act Recommended Monitoring Plan.¹¹ This plan recommends a series of both chemical and biological monitoring of the upper Mississippi River. MoDNR will consider recommendations and implement a monitoring plan as resources allow.

2015 Update:

Missouri River: To date, there are ten USGS gage stations along the Missouri River supported by one or more agencies: USGS, U.S. Army Corps of Engineers (USACE), Ameren, or MoDNR. Only a few sites currently collect water chemistry. As of 2009, of the eight data sonde sites previously supported by the USACE, the MoDNR continues to support two on the Missouri at St. Joseph (gage number 06818000) and Hermann (gage number 06934500). These two locations are continuously monitored for dissolved oxygen, temperature, specific conductivity, and pH. The purpose of these sites are to monitor the potential impacts of large municipal wastewater treatment facilities on large river systems. The current annual cost of maintaining two continuous monitoring sites at St. Joseph and Hermann is approximately \$50,000/year.

¹¹ <http://www.umrba.org/wq/cwa-monitoring-plan-2-14.pdf>

Previous sites monitored by MoDNR were at Waverly (gage number 06895500) and Boonville (gage number 06909000) from 2006 to 2009. MoDNR also funded a monthly fixed station monitoring site on the Missouri near Sibley (gage number 06894100) beginning in October 2008. In addition, three sites were monitored monthly on the Missouri River by the USGS and/or private consulting firm (sponsored by the St. Louis Metropolitan Sewer District (MSD)) for a wide variety of analytes in the St. Louis area: near Chesterfield, St. Charles and at Columbia Bottoms. This monitoring program began in 2004 and ended in 2007.

Mississippi River: Up through 2014, the USACE – St. Louis District collected a subset of water quality parameters at the USGS gage located at Cape Girardeau, Missouri (gage number 07020850). As part of the National Water Quality Accounting Stream Network, the USGS is collecting water quality samples at the gage located on the Mississippi River at Thebes, Illinois (gage number 07022000). MoDNR supports a USGS gage station on the Mississippi River below Grafton (gage number 05587455). Water quality parameters collected from this site include nutrients (12/year), total residuals (8/year), major ions (4/year), and trace metals and major ions (4/year). Current annual cost of this gage station is approximately \$26,100/year.

Recommendation:

Missouri River: Since the collection of water quality samples (and measurement of flow) on very large rivers requires specialized equipment, it is recommended that one additional data sonde station be added via an extension of MoDNR's existing joint funding agreement for ambient monitoring with the USGS. Current annual costs to collect continuous sonde data per site is \$25,000/year, while the additional chemical monitoring annual cost is \$25,000/year.

Rationale: The area of Missouri River below Kansas City metro area is not adequately monitored.

Mississippi River: Up to three additional water quality monitoring sites could be added to the ambient network to support coordinated Gulf Hypoxia data collection efforts. The lack of water quality monitoring in the lower portion of the Mississippi River appears to be a monitoring gap noted during various discussions relating to the upper and lower Missouri River meetings. It is recommended that at least one chemical and sonde monitoring site in the segment of the river downstream of the Ohio River will be added. Annual estimated cost: \$25,700/yr/site for chemical monitoring, with an annual estimated cost to collect continuous sonde data at \$25,000/yr/site.

Additional water quality monitoring (chemical and sonde) or funding allocation needed to support a portion of the recommendations is provided in the Upper Mississippi River Clean Water Act Recommended Monitoring Plan¹². Further discussion is needed.

¹² <http://www.umrba.org/wq/cwa-monitoring-plan-2-14.pdf>

GAP 1.2 Biological and Habitat Monitoring

Priority Level 3

Estimated Annual Cost: \$480,000

Background:

There are no biological criteria for the great rivers. One research project completed in 2006 has initiated the attempt to characterize aquatic invertebrate communities of the Missouri River and discussed the possibilities for defining “reference conditions.” More research on fish and invertebrate communities in the great rivers is needed that will lead to the development and refinement of biological criteria.

2013 Update:

The Upper Mississippi River Basin Association (UMRBA) contracted for the production of a guidance document on how to approach development of biological criteria for the upper Mississippi River. This document was recently completed and distributed throughout the five-state area for technical review. The only major shortcoming of the document was that it relied on Regional Environmental Monitoring and Assessment Program (REMAP) data and thus discussed biological criteria only for main channel habitats.

Recommendation:

The department needs to give higher priority to the use of existing monitoring funds for research leading to the development of biocriteria for great rivers. The department also needs to explore the use of the Great Rivers Environmental Monitoring and Assessment Program (EMAP) toward this end. Once such criteria are developed, a regular program of biological monitoring for these rivers would be needed. Approximately ten sites each would be monitored on the Missouri and the Mississippi over a four-year period. Approximately five sites would be monitored annually for fish, invertebrates, and physical habitat characteristics. Some sites or specific habitats would also be monitored for water and sediment chemistry.

Research needs are projected to require ten years at an annual level of funding of \$100,000. Implementation of the monitoring program (5 sites annually) estimated annual costs: \$380,000/year.

Rationale: Physical changes to very large rivers (channelization, extensive streambank levee systems that separate the river from its floodplain) may exert stresses on river biota not measurable by methods other than biological means. Because all streams show changes in several environmental variables in a longitudinal direction, multiple sampling locations are required. For biological monitoring, MoDNR generally uses a spacing of five to ten miles between monitoring points on smaller streams. For very large rivers where the rate of change in environmental variables per mile of stream is less, a site spacing of 25 to 40 miles may be adequate; thus the recommendation of ten sites each on the Missouri and Mississippi Rivers.

GAP 2. Large/Medium Rivers (4-5 Stream Order Classification) - the larger interior rivers of the state, not including the Missouri or the Mississippi Rivers.

GAP 2.1 Water Chemistry Monitoring.

Priority Level 4

Estimated annual cost per site: \$52,400

Background:

Missouri currently has 32 fixed station monitoring sites monitored between 6 and 12 times annually on medium to large rivers (orders 4-5) (excluding the Missouri and Mississippi Rivers). This network covers all but seven of the streams in this size category. The seven streams presently without fixed station monitoring are: Wyaconda River, North Fabius River, Middle Fabius River, Nishnabotna River, Warm Fork of the Spring River, Spring River and Shoal Creek.

2015 Update:

Wyaconda (USGS gage number 05496000), North Fabius (USGS gage number 05497150), Spring River (USGS gage number 07185764) and Shoal Creek (USGS gage number 07187000) were added to our fixed station monitoring contract with USGS in October 2008. Chemical monitoring is conducted six times per year at the current annual cost of \$52,000.

Recommendation:

At minimum, the Warm Fork Spring River and Middle Fabius River should remain relatively high priority for adding to our fixed station network. Only a small portion of the lower Nishnabotna River lies within the state. As long as Iowa continues to monitor both forks of the Nishnabotna in Iowa, a monitoring site in Missouri would be a relatively low priority addition to our fixed station network. These stations should be added to the fixed station network either by amendment of the joint funding agreement with USGS for monitoring of ambient waters or by modification of the existing QAPP for ambient monitoring by the MoDNRESP. Other large/medium stream segments could be monitored on a five-year rotational basis to fill monitoring needs or for watershed characterization. Estimated annual cost: \$26,200/site.

GAP 2.2 Biological and Habitat Monitoring

Priority Level 3

Estimated annual costs: \$100,000/site

Background:

There are no biological criteria for the large rivers (order 5-6). More research on fish and invertebrate communities in the large rivers is needed that will lead to the development and refinement of biological criteria.

Recommendation:

The department needs to give higher priority to the use of existing monitoring funds for research leading to the development of biocriteria for large rivers. Once such criteria are developed, a regular program of biological monitoring for these rivers would be needed. Approximately 38 sites, one on each of the larger rivers would be sampled once every

five years. Thus seven to eight sites would be monitored annually for fish, invertebrates, and physical habitat characteristics. Some sites or specific habitats would also be monitored for water and sediment chemistry. Research needs are projected to require ten years at an annual level of funding of \$100,000/site.

GAP 3. Small (Wadeable) Streams (3-4 Stream Order Classification)

GAP 3.1 Water Chemistry Monitoring

Priority Level 4

Estimated annual cost: \$672,000 (60 sites)

Background:

For every large (non-wadeable) river in the state there are typically 10-20 smaller wadeable stream tributaries that are tributaries to it. Thus, there are an estimated 380 to 760 smaller streams that have been recognized as having multiple beneficial uses. Currently 14 of these streams are monitored 6 to 12 times annually by the USGS, and 52 additional streams are monitored one to 4 times per year by the department's ESP, regional office staff, and Missouri State Parks staff. Thus, the current fixed station network is sampling only about 6-12% of this type of stream.

Small stream fixed station monitoring sites are either targeted sites or sites believed to be representative of regional water quality. Currently all 52 MoDNR sites are considered targeted sites. Over half of these targeted sites measure water quality impacts related to specific point source or discrete nonpoint source areas and the remaining sites are currently being used to determine nutrient levels in streams, and on gathering background data in the watershed.

2015 Update:

The number of small streams in the USGS and MoDNR fixed station network has increased from 46 to 52 now. The reason for the increase in the number of additional fixed station sites is to provide additional monitoring to gain water quality background information in priority watersheds that are targeted for stakeholder involvement, and non point source implementation, and document watershed improvements.

Recommendation:

Based upon the number of wastewater dischargers, large CAFOs and other potentially significant pollutant sources on smaller streams, 30 targeted sites are recommended for measuring water quality impacts from these sources. The remaining 13 sites, and a recommended additional 47 sites, should be used to initiate a probability based monitoring system that can be used to assist in state-wide water quality assessment and Section 305(b) integrated reporting. These 60 sites would represent approximately 8 to 16 percent of all smaller classified streams. These sites would be located based upon a stratified random selection procedure that would guarantee that all major physiographic provinces in the state are represented.

These stations should be added to the fixed station network either by amendment of the joint funding agreement with USGS for monitoring of ambient waters or by modification of the existing QAPP for ambient monitoring by the MoDNR ESP.

GAP 3.2 Biological Monitoring

Priority Level: 3

Estimated cost for contractor: \$40,000

Background:

The MoDNR ESP currently monitors aquatic macroinvertebrates at 55 sites twice annually, collecting physical habitat data and some water chemistry at these sites. The current biological monitoring program is composed mainly of targeted sites supporting the MoDNR TMDL program. As stated previously, the MDC currently collects fish and aquatic invertebrates at approximately 70 sites annually. This sampling also includes collection of physical habitat data. Sites are randomly chosen within three ecological subregions, and sampling occurs for two years each in the Central Plains and Ozarks, and one year in the Mississippi Alluvial Basin. The entire state is, therefore, sampled in about five years. Together, these two programs represent adequate fixed station biological monitoring coverage for Wadeable streams for both agencies.

2015 Update:

As a result of experienced invertebrate biologist staff changes between 2009 and 2015, the MoDNR aquatic invertebrate monitoring program has decreased from 55 sites to the present 45-50 sites. The MDC RAM program still monitors between 60-70 sites annually for aquatic macroinvertebrate (using MoDNR protocols) and fish communities.

Biocriteria have been established by MoDNR for aquatic invertebrate communities in Prairie, Ozark Border and Ozark Plateau streams. MoDNR, in conjunction with the University of Missouri (Doisy, Rabeni, Combes, and Sarver 2008), have developed biocriteria for fish communities in Ozark Border and Ozark Plateau streams. Both fish and invertebrate community data are now being used by MoDNR to assess streams for the integrated report. Since the MDC RAM sites are selected randomly, that data will allow MoDNR to include some probabilistic assessment in the 2016 305(b) Integrated Report.

In 2015, the MoDNR WPP proposed changes to its Water Quality Standards, applying designated uses to all streams indicated as blue lines on USGS 1:100,000 topo maps. As a result, this increased the number of small classified streams in the state by a factor of six to eight. The biological monitoring efforts may need to shift monitoring needs to obtain aquatic life use classification information on these small, headwater streams (≥ 3 order). See GAP 4.2 for additional information.

In 2013, the MoDNR entered into a cooperative agreement with the University of Missouri-Columbia to (1) identify candidate reference stream reaches of Wadeable streams in Missouri using existing landscape-level data; (2) develop a quantitative, scientifically-defensible method to determine candidate reference site conditions in Missouri Wadeable streams for each of the Missouri Resources Assessment Partnership stream size classification; and (3) validate reference site methodology and selection using on-site physical habitat and biological sampling. This work is expected to be completed in June 2016. Cost to complete the scope of work: \$273,000.

Recommendation:

MoDNR should work with an appropriate contractor to attempt to develop biocriteria for fish communities in Central Plains and Mississippi Alluvial Basin streams when sufficient fish community data has been collected through the RAM program. Estimated annual cost: \$40,000.

GAP 4. Intermittent (unclassified) Streams (≥ 3 Stream Order Classification)

GAP 4.1 Screening Level Stream Surveys of Unclassified Streams (Random, Non-targeted Sites)
Priority Level 4

Estimated Annual Cost: \$140,000

Background:

Prior to 2014, there was an estimated 84,000 miles of undesignated use streams in Missouri apportioned among an estimated 20,000 to 30,000 individual streams. These waters are covered by the narrative criteria within the state Water Quality Standards and are required to be free from aesthetic problems related to odor, color, objectionable bottom deposits or floating materials. These streams must also be free from conditions harmful to aquatic life.

The department currently conducts screening level surveys on undesignated use streams below wastewater discharges or other potential pollutant sources, but does not routinely survey other undesignated use streams. A relatively small number of sites (approximately 50) are monitored frequently enough by state trained volunteers using a protocol similar to the one used by department staff.

2015 Update:

In 2014, the WPP proposed changes to the state's Water Quality Standards that would bring in all streams indicated as blue lines on USGS 1:100,000 topo maps. Following the rulemaking, an additional 91,290 miles of stream and 2,361 lake features received designated use protection for aquatic habitat and recreation. Total "fishable/swimmable" protection in Missouri now stands at approximately 115,772 miles of stream and 3,081 lake features. Therefore, this increased the number of small classified streams in the state and the need to focus monitoring efforts in these areas.

Since 2009, the Missouri VWQM Program shifted emphasis to increase retention of previously trained volunteers and increasing the number of those that passed minimum quality assurance tests, by providing additional training sessions for previously trained volunteers and to require re-certification of acceptable quality assurance every three years.

Recommendation One:

The VWQM program should continue to encourage or mentor more of its trained volunteers to submit data regularly. Annual estimated cost: \$2,000.

Recommendation Two:

Expand the screening level stream survey program within the MoDNR to include regional office staff, and other water program staff to conduct screening level stream

surveys. This expansion would require the addition of one-half FTE. Estimated annual cost: \$130,000.

Training and transportation, plus any costs associated with hiring additional personnel are estimated at \$9,000. This would result in an additional 300 non-targeted screening level stream surveys annually.

GAP 4.2. Biological Monitoring of Candidate Reference Streams

Background:

As discussed in GAP 3.2, the MoDNR increased its classified stream network to include all streams indicated as blue lines on USGS 1:100,000 topo maps. Local and instream habitat is a key indicator of aquatic system health, however, very little biological data have been collected from these small, newly classified, headwater streams. To be consistent with EPA use designations, these small headwater streams have been assigned the use designation of fishable and swimmable. Because alterations of physical habitat assessment in streams can be used to define designated uses for these waters, stream sampling programs frequently collect dozens of physical habitat metrics at each stream site, and many may be redundant or unrelated to aquatic system health. Due to the volume of information collected, it can be overwhelming to manage. Therefore, efforts often attempt to develop a hybrid approach that combines multiple habitat metrics into one index score.

A critical first step in evaluating a habitat index is to determine the range of habitat conditions in the area of interest (in this case, Missouri) to fully evaluate which habitat metrics are associated with highly degraded versus highly pristine sites. Therefore, there is a need to identify candidate reference reaches that can be used as a benchmark of high quality stream habitat in Missouri. The overall goal of this study is to develop quantitative and scientifically-defensible criteria for identifying candidate reference reaches. Physical habitat data collected from candidate reference reaches during this phase of the project will be used in the next phase to develop a physical habitat index for Missouri wadeable streams.

Update 2015:

In 2013, the MoDNR entered into a cooperative agreement with the University of Missouri–Columbia, and MDC for the Development of Reference Reaches for Missouri Streams. The project scope of service and objectives are provided below:

1. Identify candidate reference stream reaches of wadeable streams in Missouri using existing landscape-level data.
2. Develop a quantitative, scientifically-defensible method to determine candidate reference site conditions in Missouri wadeable streams for each Missouri Resources Assessment Partnership (MoRAP) stream size classification.
3. Validate reference site methodology and selection using on-site physical habitat and biological sampling.

The project is following a systematic process to determine candidate reference reaches for Missouri streams. At the end of this three-year study, the University of Missouri-

Columbia will be able to frame and describe a scientifically based, validated method to identify candidate reference reaches for headwater, creek, and small river streams classes in Missouri with high water quality and biotic integrity. The study will provide a candidate reference stream list and a framework to continue to refine the list and the metrics as additional sampling is added, particularly in areas with limited available data, or in areas that are unique to the state (e.g., bootheel) - a critical step for development of a useful, statewide physical habitat index for Missouri streams. The project has completed two of the three-year project. Total project funding: \$272,925.

Before biocriteria can be established, additional monitoring will be necessary. Statewide monitoring of headwater streams is estimated at \$50,000/site.

GAP 4.3 Use Attainability Analyses for Recreational Use

Priority Level: 2

Estimated Annual Cost: \$15,000 -\$18,000+ /per 5-mile survey

Background: As discussed in GAP 4.1, approximately 91,290 miles of stream and 2,361 lake features received designated use protection for aquatic habitat and recreation. To ensure that these waters are appropriately classified for recreational use, a UAA may be necessary. Between 2007 and 2008, the department completed recreational UAA on approximately 135 water bodies using contractual services. At that time, the cost of a recreational UAA was approximately \$15,000 to \$18,000 per five-mile survey.

Recommendation:

With the number of newly classified stream miles, it would be unrealistic to complete a UAA for each 5-mile stream segment. In the interim, the department should consider completing recreational UAA on priority waters or water bodies where a determination is warranted in making a regulatory/water quality decision. Similar to completing low flow screening surveys, training and transportation, plus any costs associated with hiring additional personnel is estimated at \$9,000. It is estimated that 1.0 FTE could complete approximately 150 recreational UAA surveys annually.

GAP 5. Reservoirs

GAP 5.1 Large Multi-Purpose Reservoirs

Priority Level (see below)

Estimated Annual Cost: \$81,000+

GAP 5.1.1 Bacterial Monitoring at Public Use Areas

Priority Level 3

Annual Estimated Cost: \$6,000

Background:

There are 14 large multi-purpose reservoirs in Missouri. Thirteen are operated by the USACE and one, Lake of the Ozarks, by Ameren Missouri. Many public access swimming areas are not regularly monitored for bacteria.

Update 2015:

Each year during the recreational season, the Missouri State Parks conducts weekly bacterial monitoring at seven lakes for a total of ten designated state park beaches. This information is posted to the department's beach status website <http://dnr.mo.gov/asp/beaches/>. The USACE generally collects bacteriological data prior to the three major holidays (e.g. Memorial Day, 4th of July, and Labor Day). Swimming beach lake closures would then be posted on that USACE lake webpage.

Recommendation:

The department needs to make a census of these public swimming areas and investigate what organizations are conducting bacterial sampling at these sites, what testing methods are being used, and at what frequency. Following this census, the department needs to make a recommendation for any additional bacterial sampling needs and how to meet them. Estimated cost for census \$6,000.

GAP 5.1.2 Biological Monitoring

Priority Level 6

Estimated Annual Cost: \$130,000

Background:

There are currently no biocriteria available to assess the biological health of reservoirs. Research is needed to develop such criteria.

Recommendation:

The department should fund research leading to the development of biological criteria for reservoirs and lakes. Once biocriteria are in place, reservoir-monitoring programs should be amended to include biomonitoring. Estimated costs for research is \$80,000. Estimated cost of biomonitoring of lakes is estimated at \$50,000/site/year.

GAP 5.2 Smaller Reservoirs and Lakes

Priority Level (see below)

Estimated Annual Cost: \$61,000+

GAP 5.2.1 Water Clarity

Priority Level 6

Annual Estimated Cost: \$55,000

Background:

As discussed earlier, with the 1:100,000 stream network expansion, there are approximately 3,081 classified lakes within Missouri (previously 449). Approximately ten of these are natural lakes occurring in the floodplains of the great rivers and the others are reservoirs. Approximately 70 of these are currently monitored at least four times during the summer. This monitoring is for nutrients, suspended solids, chlorophyll and water clarity. The remaining reservoirs are not regularly monitored as part of a statewide monitoring effort. It is estimated that

1,019 smaller reservoirs/lakes (less than 10 acres) are classified within Missouri's Water Quality Standards. Little is known about human recreational uses or bacterial monitoring programs on most of these smaller lakes.

2015 Update:

In 2009, the WPP began a volunteer secchi monitoring program for small lakes not currently monitored by other programs. As of 2015, of the 60 lakes adopted, 21 volunteers are still actively collecting information once every three weeks during the recreational season for Secchi disk, air temperature and water temperature. The information collected will be used to gain the general trophic status of these small lakes/reservoirs. See Appendix B for list of lakes actively monitored under this program. The annual estimated cost for this program is: \$5,000/yr.

Recommendation:

Continue to support the SLAP and the LMVP as well as the small lake volunteer Secchi monitoring program. The small lake Secchi monitoring program can be used as screening level monitoring for when and where to expand the SLAP or the LMVP. An expansion of 12 lakes to either one of these programs is estimated at \$50,000/year.

GAP 5.2.2. Census of Bacterial Monitoring at Public Use Areas

Priority Level 3

Estimated annual cost: \$6,000

Background:

Similar situation as discussed in GAP 5.1.1.

Recommendation:

The department also needs to make a census of public swimming areas on these smaller reservoirs and investigate what organizations are conducting bacteriological sampling, what testing methods are used and at what frequency. Following this census, the department needs to make a recommendation for any additional bacterial sampling needs and how to meet them. Estimated cost for census of beaches and current bacterial monitoring: \$6,000.

GAP 6. Wetlands

Priority Level: 6

Estimated Annual Cost: \$150,000

Background:

Since 1988, MoDNR's Water Resources Center has been collaborating with EPA Region 7 on wetland research and protection projects. In recent years, the EPA has been approaching states on the need for more focus and better use of resources to enhance wetland protection and restoration efforts.

The state will work with EPA Region 7, Office of Research and Development (ORD) and the EPA National Wetlands Monitoring Workgroup and other Region 7 states via the

Regional Wetlands Monitoring Workgroup to develop a statewide wetland protection plan and an implementation strategy for protection of public and private wetlands. The protection plan will include goals and a methodology to document net losses or gains in wetlands within the state. The plan will include: (1) a wetlands inventory (by type of wetland); (2) a monitoring and assessment program; (3) information on actual and potential mitigation sites; (4) establishment of wetland restoration and protection partnerships; and (5) outreach and education.

Milestones for the wetland program will include: (1) a wetlands inventory by type of wetland; (2) establishment of a wetlands technical advisory committee to help determine appropriate monitoring and assessment protocols; (3) a pilot project for wetlands monitoring to assess baseline biological and chemical conditions; (4) a wetlands biological indicator development project; (5) a project to develop a set of rapid assessment methods for determining wetland conditions; and (6) a reference site development program.

When completed, the above activities will allow the following actions to take place: (1) an improvement in reporting the status of wetlands in the state 305(b) report; (2) listing of specific wetlands within state Water Quality Standards; (3) development of chemical and or biological criteria for wetlands and inclusion of these within the state Water Quality Standards; and (4) judging the success of state wetland mitigation efforts.

2015 Update:

MoDNR's Water Resources Center received federal cost share to facilitate a wetland program plan. Through a collaborated process involving state, federal and private entities, a Missouri Wetland Program Plan was developed for 2013- 2018. This document outlines current and future wetland goals, actions, and activities. This document can be viewed and downloaded from EPA's website:

http://water.epa.gov/type/wetlands/upload/Missouri_Wetland_Program_Plan_Final_-_updates_9-17-2014.pdf

In October 2013, the MoDNR was awarded an EPA Section 104(b) Wetland Program Development grant. The goal of the WPP wetland grant is to establish a set of reference wetlands in Missouri, with the potential emphasis on riparian wetlands in floodplains of the Missouri and Mississippi river tributaries. These reference wetlands may be used as a foundation upon which to base wetland water quality standards and establish an Index of Biotic Integrity for Missouri Wetlands.

Recommendation:

Conduct long-term chemical monitoring of the wetlands identified through the Section 104(b) Wetland Program Development grant (approx. 21) and the department's Water Resources Center (approx. 6) for the development of wetland water quality standards. Costs: Wetlands Inventory: \$50,000. Wetlands Monitoring Program annual costs: \$100,000

GAP 7. Groundwater

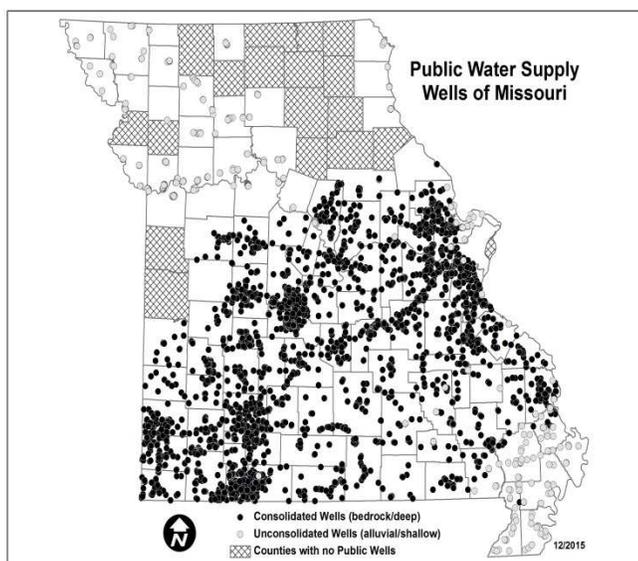
Priority Level: 5

Estimated Annual Cost: \$25,000+

Background:

Many areas of the state use groundwater as a public drinking water supply source. The Safe Drinking Water Act (SDWA) requires annual monitoring for nitrate and monitoring every three years for fifteen inorganic chemicals (Sb, Asbestos, As, Ba, Be, Cd, Cr, Cu, CN, F, Pb, Hg, NO₂, Se and TI), 53 organic chemicals including several pesticides, PCBs, PAHs, phthalates and volatile hydrocarbons, and radionuclides (alpha and beta particles, Ra 226 and 228 and Uranium).

There are three potential concerns with the SDWA monitoring program serving as a statewide groundwater monitoring program. One, is the list of analytes sufficient? Two, is the frequency of sampling sufficient? Three, is the spatial distribution of wells sampled adequate to characterize the spatial variation in groundwater quality?



The list of analytes does not address aesthetic issues such as levels of manganese, iron and total dissolved solids. Since overpumping of aquifers and saltwater intrusion is an issue in certain areas of the state, total dissolved solids is an important analyte. It is unknown if the current frequency of analysis is adequate to accurately characterize water quality in the various aquifers. The distribution of public drinking water wells is shown in the figure to the left. This map indicates that in the portion of the state north of the

Missouri River most public drinking water wells are shallow. These wells draw water only from alluvial or shallow unconsolidated aquifers. In northeastern Missouri many areas do not have public drinking water wells. Thus additional wells may be needed for sampling in northern Missouri.

Recommendation:

Dissolved iron, dissolved manganese, total dissolved solids, sulfates and chloride should be added to the list of analytes monitored. The adequacy of the frequency of monitoring should be addressed by an analysis of water chemistry data at selected wells in different areas of the state. This analysis should determine if sample sizes are adequate to characterize water quality with respect to drinking water standards with a high degree of statistical confidence. Additional wells into the deep aquifer should be added to the groundwater monitoring network at several locations in northern Missouri and at least two wells in shallow potentially potable aquifers should be added in Schuyler and

Monroe counties in northeastern Missouri. Cost: \$25,000-\$30,000 annually and possibly some one-time costs associated with drilling new wells.

GAP 8. Precipitation

Priority Level: 2

Estimated Annual Cost: \$16,000/site

Background:

Currently there are two National Atmospheric Deposition Program (NADP) monitoring sites that analyze precipitation for a wide variety of chemicals in Missouri. One site is near the southeastern corner of Missouri, in Mingo National Wildlife Refuge (NWR), and the other is in the center of the state, near Ashland. These two sites measure a wide variety of physical and chemical attributes of water on a frequent basis but it is currently unknown if these two sites provide precipitation data that is representative in all parts of the state. There are many sites, well spaced statewide, that measure amount of precipitation but not precipitation chemistry.

Watershed models require information on precipitation quality and quantity. The department needs to ascertain whether or not the present network of precipitation monitoring is adequate for water quality modeling.

2011 Update:

In 2010, the WPP took over full funding of the Mingo NADP precipitation site that includes measurement of wet deposition of mercury, and also provided the funding to begin similar monitoring at the Baskett Wildlife Research and Education Center near Ashland. The funding for these two sites will continue until 2016.

Recommendation:

The department should review all the water quality models now in use by the agency or its contractors or models that may be used in the next several years. The precipitation data needs of these models and the overall importance of precipitation data to the accuracy of the model need to be evaluated (sensitivity analysis). Based on this evaluation, the department should make recommendations concerning the need for additional precipitation monitoring sites. A cost is estimated at \$16,000/site/yr.

SPECIAL STUDIES

GAP 9. Wasteload Allocation Studies and other Intensive Studies

Priority Level 2,3

Estimated Annual Cost: (see Gap 3.1)

Background:

The current program is adequate for assessing chemical impacts of localized nonpoint source areas such as active and abandoned mining sites, closed landfills and other areas where drainage from disposed materials may affect water quality. The current program is not adequate to provide the data necessary to meet the needs of the WQRS process for reissuance of wastewater discharge permits nor is it adequate to assess the success of the implementation plans based on TMDL studies, particularly phased TMDLs. The present

special studies program is not adequate for statewide monitoring for more extensive nonpoint sources such as row crop agriculture or pastures, development/revision of water quality standards, UAA, or determination of stream classification. The current biomonitoring programs of the MoDNR and the MDC RAM program would meet this need, pending completion of contractual studies discussed in Gap 3.2.

2011 Update:

The department contracted for approximately 150 recreational UAA in 2007 at a cost of approximately \$586,000. The department still needs to determine any additional WQRS or UAA needs. Biocriteria for aquatic macroinvertebrates exists for all Wadeable streams in the state except in the Mississippi Embayment, and for fish for Ozark Border and Ozark Plateau streams. This allows use of biological surveys to assess the impacts of point sources and localized and extensive nonpoint sources. The majority of this data is generated by MDC and having random site selection, cannot be directed at specific streams.

Recommendation One:

The department needs to formalize its plan for obtaining the data necessary to meet the requirements of the WQRS process, for UAAs and for studies to determine stream classification. The plan should describe in detail what kind and amount of data would be required and how much of these data needs are to be met by monitoring done by the department. A QAPP for each of these types of studies should be developed and used to conduct these studies. Estimated cost: \$10,000. Priority Level 2.

Recommendation Two:

All other special study needs should be addressed through the existing annual monitoring needs identification process.

GAP 10. Targeted Screening Level Stream Surveys

Priority Level: 5

Estimated Annual Cost: \$62,000

Background:

In the last few years the department's ability to conduct screening level monitoring has been greatly reduced by the need to increase our intensive surveys. The WPP staff in the Monitoring and Assessment Unit devote a total of 0.15 FTE to targeted screening level stream assessments. This represents assessment of approximately 100 streams annually below wastewater discharges, mining areas or landfills. Approximately 1,000 permits to discharge wastewater are re-issued annually by the department. It is estimated that the WQRS process for 70% of these would benefit from a screening survey of the receiving stream prior to re-issuance of the permit.

Recommendation:

The targeted screening survey program should be increased so that it has the capacity to conduct an additional 600 stream surveys annually, and be used to support the WQRS process (one FTE). The goal of this portion of our monitoring program is to provide relatively current screening level information on all point and discrete nonpoint source

sites where this type of monitoring is appropriate. The objective is to monitor the receiving waters of each of these point source facilities or sites at least once every five years, preferably within 18 months of permit reissuance. Approximately one FTE would be required. Estimated cost: \$12,000 for training and transportation, \$50,000 personnel costs. Priority Level 2. Note: the department may wish to consider using this monitoring program to assist in the development of UAAs.

DATA MANAGEMENT

GAP 11. Entering Data into a national database

Priority Level: 5

Estimated Annual Cost: Undetermined cost. Updates are on-going and as needed

Background:

The department needs to identify and implement a system of loading data generated by the department into a national database. In addition, data generated by outside organizations under contract to the department must have a system for entry into this national database. The department also needs to fund information technology services from Office of Administration (OA) staff to assist in updating the program's Assessment Data Base (ADB) to make it compatible to the national EPA ADB.

2011 Update:

The WPP began using its new data management system (WQA) in September 2010. This system includes the functionality to load data directly from our main environmental data file to the EPA WQX system. Downloads are now being made quarterly. The WQA system also allows for automatic download of our assessment data directly to the EPA ATTAINS database. The first download occurred in the spring of 2012.

Recommendation:

MoDNR will continue to communicate with EPA to review, and improve as needed, the functionality of the download processes of data to the WQX and ATTAINS national databases.

DATA ANALYSIS AND ASSESSMENT

GAP 12. Consolidated Assessment and Listing Methodology

Priority Level: 5

Estimated Annual Cost: Undetermined cost. Updates are on-going and as needed

Background:

The current EPA Consolidated Assessment and Listing Methodology (CALM) Guidance five category system results in a de facto requirement that the same (relatively high) level of data assurance be used for the 305(b) report as for the 303(d) list. Missouri has traditionally used a wide range of data for making statewide assessments in the 305(b) reporting, including a lot of data that does not meet the minimum data quality standards for 303(d) listing. Our present inability to use this kind of data will result in fewer waters being assessed and an underestimate of impaired waters.

Recommendation:

EPA should review its guidance requiring a consolidated listing and decide if the benefits of a consolidated listing outweigh the restrictions it imposes on the completeness and accuracy of the 305(b) report.

REPORTING

GAP 13. Integrated Reporting

Priority Level:

Estimated Annual Cost: Undetermined cost. Updates are on-going and as needed

Background:

Missouri presently uses 10 CSR 20-7.031 Table H waters as the reporting units in our water quality assessment file used to generate impaired waters for section 305(b) and 303(d) purposes. This is inconsistent with the EPA guidance requesting all states use the NHD list of water body segments as the reporting units. Since it is a national system, use of NHD segments by all states would improve the consistency of 305(b) reports.

2011 Update:

MoDNR can now use the WQA system to assess both classified and unclassified waters. All water bodies within the WQA system have a unique water body identification number and each water body is linked to its corresponding NHD reach address of the reach code.

Recommendation:

MoDNR will continue to make updates to WQA as needed in an effort to keep the database up-to-date to meet current standards and reporting needs.

Appendix B: Fixed Station Chemical Monitoring Sites

USGS Ambient Stream Network

HUC 8	Station Number	Station Name	Frequency (per/yr)	Stream size	Stream Order	Monitoring Type	Gaged (Y=yes)
07110001	05495000	Fox River at Wayland	6	Medium	4-5	CL	Y
11010003	05496000	Wyaconda River above Canton	6	Small	3-4	CL	Y
11010003	05497150	North Fabius River near Ewing	6	Small	3-4	CL	Y
07110003	05500000	South Fabius River near Taylor	12	Medium	4-5	CL	Y
07110008	05503100	Black Creek below Shelbyville, MO	5	Medium	4-5	CM	Y
07110008	05514500	Cuivre River near Troy	6	Medium	4-5	CL	Y
07110009	05587455	Mississippi River below Grafton	12	Great	7-8	CL	Y
10240010	06817700	Nodaway River near Graham	6	Large	5-6	CL	Y
10240011	06818000	Missouri River at St. Joseph	12	Great	7-8	CL	Y
10240012	06821190	Platte River at Sharps Station	6	Large	5-6	CL	Y
10300101	06894100	Missouri River at Sibley	12	Great	7-8	CL	
10280101	06896187	Middle Fork Grand River near Grant City	6	Small	3-4	CL	
10280102	06898100	Thompson River at Mt. Moriah	6	Medium	4-5	CL	
10280102	06898800	Weldon River at Princeton	6	Medium	4-5	CL	
10280102	06899580	No Creek near Dunlap	12	Small	3-4	CL	
10280103	06899950	Medicine Creek near Harris	12	Small	3-4	CL	
10280103	06900100	Little Medicine Creek near Harris	12	Small	3-4	CL	
10280103	06900900	Locust Creek near Unionville	12	Small	3-4	CL	
10280103	06902000	Grand River near Sumner	12	Large	5-6	CL	Y
10280202	06905500	Chariton River near Prairie Hill	6	Large	5-6	CL	Y
10280202	06905725	Mussel Fork near Mystic	12	Small	3-4	CL	
10280203	06906300	East Fork Little Chariton River near Huntsville	6	Medium	4-5	CL	
10300103	06907300	Lamine River near Pilot Grove	9	Medium	4-5	CL	
10290104	06917630	East Drywood Creek at Prairie State Park	6	Very Small	1-2	CM	Y
10290105	06918070	Osage River above Schell City	6	Large	5-6	CL	Y
10290106	06918600	Little Sac River near Walnut Grove	12	Medium	4-5	CL	
10290107	06921070	Pomme de Terre River near Polk	9	Medium	4-5	CL	Y
10290108	06921590	South Grand River at Archie	6	Small	3-4	CL	Y
10290110	06923700	Niangua River at Bennett Spring	6	Medium	4-5	CL	Y
10290111	06926510	Osage River below St. Thomas	6	Large	5-6	CL	Y
10290203	06927850	Osage Fork Gasconade River near Lebanon	6	Medium	4-5	CL	
10290201	06928440	Roubidoux Spring at Waynesville	6	Medium	4-5	CL	
10290202	06930450	Big Piney River at Devils Elbow	9	Medium	4-5	CL	
10290203	06930800	Gasconade River above Jerome	12	Large	5-6	CL	Y
01740102	07014000	Huzzah Creek near Steelville	6	Medium	4-5	CL	
07140102	07014200	Courtois Creek at Berryman	6	Medium	4-5	CL	
07140102	07014500	Meramec River near Sullivan	12	Large	5-6	CL	Y
07140103	07016400	Bourbeuse River above Union	9	Medium	4-5	CL	Y
07140104	07018100	Big River near Richwoods	9	Medium	4-5	CL	Y
07140102	07019280	Meramec River at Paulina Hills	12	Large	5-6	CL	
07140105	07020550	South Fork Saline Creek near Perryville	6	Small	3-4	CL	Y
07140107	07021020	Castor River at Greenbriar	6	Medium	4-5	CL	Y
08020202	07036100	St. Francis River near Saco	9	Medium	4-5	CL	Y
08020202	07037300	Big Creek at Sam A. Baker State Park	6	Medium	4-5	CL	Y
08020201	07042450	St. John's Ditch at Henderson Mound	9	Medium	4-5	CL	
08020204	07046250	Little River Ditches near Rives	12	Large	5-6	CL	
11010001	07050150	Roaring River Spring at Cassville	6	Medium	4-5	CL	
11010002	07052152	Wilson Creek near Brookline	12	Small	3-4	CL	
11010002	07052250	James River near Boaz	6	Medium	4-5	CL	
11010002	07052345	Finley Creek below Riverdale	12	Medium	4-5	CL	
11010002	07052500	James River at Galena	12	Medium	4-5	CL	Y
11010002	07052820	Flat Creek below Jenkins	12	Medium	4-5	CL	
11010003	07053700	Lake Taneycomo at Branson	6	Large	5-6	CL	
11010003	07053900	Swan Creek near Swan	6	Small	3-4	CL	
11010006	07057500	North Fork River near Tecumseh	6	Large	5-6	CL	Y
11010006	07057750	Bryant Creek below Evans	6	Medium	4-5	CL	
11010007	07061600	Black River below Annapolis	6	Medium	4-5	CL	
11010008	07066110	Jacks Fork above Two River	12	Medium	4-5	CL	
11010008	07067500	Big Spring near Van Buren	4	Medium	4-5	CL	Y
11010008	07068000	Current River at Doniphan	12	Large	5-6	CL	Y
11010008	07068510	Little Black River below Fairdealing	6	Medium	4-5	CL	Y
11010011	07071000	Greer Spring at Greer	4	Medium	4-5	CL	Y

HUC 8	Station Number	Station Name	Frequency (per/yr)	Stream size	Stream Order	Monitoring Type	Gaged (Y=yes)
11010011	07071500	Eleven Point River near Bardley	6	Medium	4-5	CL	Y
11070207	07185764	Spring River above Carthage	12	Medium	4-5	CL	Y
11070207	07186480	Center Creek near Smithfield	9	Medium	4-5	CL	Y
11070207	07186600	Turkey Creek near Joplin	9	Small	3-4	CL	Y
11070207	07187000	Shoal Creek above Joplin	12	Medium	4-5	CL	Y
11070208	07189000	Elk River near Tiff City	12	Large	5-6	CL	
11070208	07189100	Buffalo Creek at Tiff City	12	Medium	4-5	CL	Y
10240011	06818000	Missouri River at St. Joseph	Continuous WQ monitor, Oct 2014, Apr-Sep 2015				Y
10300200	06934500	Missouri River at Hermann	Continuous WQ monitor, Oct 2014, Apr-Sep 2015				Y

Fixed Station Chemical Monitoring Sites: WPP Sites (MRBI Priorities, USGS Sites Partically Supported by SWCP 2010-2016)

HUC 8	Station Number	Station Name	Frequency (per/yr)	Stream size	Stream Order	Monitoring Type
10280103	6899900	Medicine Creek near Lucerne	12	Medium	4-5	CM
10280103	6900050	Medicine Creek near Laredo	12	Medium	4-5	CM
10280103	6900640	Muddy Creek near Chula	12	Medium	4-5	CM
10280103	6901250	Little East Fork Locust Creek near Browning	12	Medium	4-5	CM
10280103	6901500	Locust Creek near Linneus	12	Medium	4-5	CM
10280103	6902995	Hickory Branch near Mendon	12	Small	3-4	CM

Pre-existing gage stations at Medicine Creek near Laredo and Locust Creek near Linneus are funded by MDNR-Water Resources.

Fixed Station Chemical Monitoring Sites: Missouri State Parks Sites

HUC 8	Number of Sites	Station Name	Frequency (per/yr)	Stream size	Stream Order	Monitoring Type
10290109	1	Coakley Hollow - Lake of the Ozarks State Park	3	Very Small	1-2	CM
07110008	1	Sugar Creek - Cuivre River State Park	3	Very Small	1-2	CM
10290104	1	East Drywood - Creek Prairie State Park	3	Small	3-4	CM
11010001	1	Ketchum Hollow - Roaring River State Park	3	Very Small	1-2	CM
07140101	1	Pickle Creek - Hawn State Park	3	Very Small	1-2	CL

Fixed Station Chemical Monitoring Sites: WPP Sites (Targeted Trend Monitoring)

HUC 8	Number of Sites	Station Name	Frequency (per/yr)	Stream size	Stream Order	Monitoring Type
10290104	2	2 nd Nicholson Creek	6	Small	3-4	CS
10290104	1	Drywood Creek	6	Small	3-4	CS
10290108	1	Tributary to Big Otter Creek below AML	2	Small	3-4	CS
10290108	2	Big Otter Creek	2	Small	3-4	CS
10290108	2	East Fk. Tebo Creek	2	Small	3-4	CS
10290108	1	Middle Fk. Tebo Creek	2	Small	3-4	CS
10290108	1	West Fk. Tebo Creek	2	Small	3-4	CS
10280203	3	Sugar Creek	2	Small	3-4	CS
10280203	2	Tributary to Sugar Creek (From Huntsville Gob Reclamation Area)	2	Small	3-4	CS
10280203	1	Tributary to Sugar Creek (Calfee Slope trib)	2	Small	3-4	CS
10300102	5	Cedar Creek @ AML Area	2	Small	3-4	CS
10300102	1	Renfro Creek (Tributary to Cedar Creek)	2	Small	3-4	CS
10300102	1	Manacle Creek	2	Small	3-4	CS
10300101	2	Mill Creek	4	Small	3-4	CS
07140102	1	L. Courtois Creek	2	Small	3-4	CS
08020202	6	Goose Creek (2), Saline Creek, Toller Branch, Artesian Mine Flow, Trib from Old Smelter	2	Small	3-4	CL
11070207	1	Jacobs Br.	3	Small	3-4	CL
11070207	1	Beef Br.	3	Small	3-4	CL
11070207	1	Joplin Cr.	3	Small	3-4	CL
11070207	1	Lone Elm Cr.	3	Small	3-4	CL
11070207	2	Turkey Cr.	3	Small	3-4	CL
11070207	1	Leadville Hollow	3	Small	3-4	CL
11070207	1	Mineral Br.	3	Small	3-4	CL
11070207	1	Oronogo Br.	3	Small	3-4	CL
11070207	2	Center Cr.	3	Small	3-4	CL
10280203	1	Sinking Creek	3	Small	3-4	CL
11070207	2	Blackberry Creek	2	Small	3-4	CL
10280103	1	Locust Cr	1	Small	3-4	CL

HUC 8	Number of Sites	Station Name	Frequency (per/yr)	Stream size	Stream Order	Monitoring Type
07110005	1	Black Creek	5 (Rec Season)	Small	3-4	CM
07110008	1	N. Fk. Cuivre River	5 (Rec Season)	Small	3-4	CM
11070207	3	N. Fk. Spring River	24	Small	3-4	CM
11070207	1	Oposum Creek (NWQI)	24	Small	3-4	CM

Long-term Station Chemical Monitoring Sites: WPP Sites (TMDL/WQS Priorities)

HUC 8	Number of Sites	Station Name	Frequency (per/yr)	Stream size	Stream Order	Monitoring Type
08020204	1	Castor River	4	Medium	4-5	CM
08020204	1	Ditch #1	4	Small	3-4	CM
08020204	3	Main Ditch	4	Small	3-4	CM
08020204	1	Lateral #2 Main Ditch	4	Small	3-4	CM
08020201	1	North Cut Ditch	4	Small	3-4	CM
08020204	1	Ash Slough Ditch	4	Small	3-4	CM
08020201	1	Tenmile Pond	4	Medium	4-5	CM
08020201	1	Fish Lake Ditch	4	Small	3-4	CM
08020204	1	Ditch #43	4	Small	3-4	CM
08020204	1	Ditch #290	4	Small	3-4	CM
08020204	1	Ditch #258	4	Small	3-4	CM
08020203	1	Ditch #1	4	Small	3-4	CM
08020203	1	Mingo Ditch	4	Medium	4-5	CM
08020204	1	Unnamed Ditch	4	Medium	4-5	CM
08020204	1	Bell Fountain Ditch	4	Medium	4-5	CM
11070207	3	Shoal Creek	14	Small	3-4	CS
11070207	3	Pogue Creek	14	Small	3-4	CS
11070207	2	Joyce Creek	14	Small	3-4	CS

Long-term Station Chemical Monitoring Sites: WPP Sites (OMW: Randomized Monitoring)

HUC 8	Number of Sites	Station Name	Frequency (per/yr)	Stream size	Stream Order	Monitoring Type
10290106	1	Stinking Creek	4	Small	3-4	CM
10290106	2	Horse Creek	4	Medium	4-5	CM
10290106	1	Bear Creek	4	Small	3-4	CM
10290106	1	Maze Creek	4	Small	3-4	CM
10290106	1	Sac River	4	Small	3-4	CM
10290106	1	Little Sac River	4	Medium	4-5	CM
10290106	1	Sinking Creek	4	Small	3-4	CM
10290106	1	North Dry Sac River	4	Small	3-4	CM
10290106	1	Cedar Creek	4	Small	3-4	CS

Fix Station Biological Monitoring Sites: Fish Tissue

HUC 8	Number of Sites	Station Name	Frequency	Stream size	Stream Order	Monitoring Type
11070207	1	Center Creek near Smithfield	biennially	Medium	4-5	CL
11010008	1	Current River at Deer Leap Access	biennially	Medium	4-5	CL
10290203	1	Gasconade River at Jerome	biennially	Medium	4-5	CL
10280103	1	Grand River near Brunswick	biennially	Medium	4-5	CL
11010002	1	James River near Boaz	biennially	Medium	4-5	CL
08020204	1	Little River Ditches at Hornersville	biennially	Medium	4-5	CL
07140102	1	Meramec River at Eureka	biennially	Medium	4-5	CL
07110006	1	Middle Fork Salt River at Paris	biennially	Medium	4-5	CL
10290111	1	Osage River near St. Thomas	biennially	Medium	4-5	CL
08010100	1	Mississippi River at Caruthersville	biennially	Great	7-8	CL
07110004	1	Mississippi River at Hannibal	biennially	Great	7-8	CL
10240011	1	Missouri River at Kansas City	biennially	Great	7-8	CL
10240011	1	Missouri River at St. Joseph	biennially	Great	7-8	CL

Fix Station Biological Monitoring Sites: Supported in combination with MoDNR and MDC (wadeable reference sites)

Reference Table 1 of 10 CSR 20-7 (page 128) URL: <http://s1.sos.mo.gov/cmsimages/adrules/csr/current/10csr/10c20-7a.pdf>

Long-Term Lake Monitoring Sites (SLAP Program)

Primary Lakes: to be monitored each summer between May through August

MU#	County	Lake	Frequency	Monitoring Type
133	Adair	Forest	4	CS
89	Benton	Truman	4	CS
117	Callaway	Little Dixie	4	CS
118	Cass	Rain Tree	4	CS
70	Cass	North	4	CS
93	Cedar	Stockton	4	CS
182	Clark	Fox Valley	4	CS
72	Clay	Smithville	4	CS
74	Clay	Watkins Mill	4	CS
80	Daviess	Viking	4	CS
96	Greene	Fellows	4	CS
95	Greene	McDaniel	4	CS
185	Harrison	Harrison Co.	4	CS
92	Hickory	Pomme de Terre	4	CS
186	Iron	Bismark	4	CS
39	Iron	Council Bluff	4	CS
183	Johnson	Hazel Hill	4	CS
114	Knox	Henry Sever	4	CS
121	Lafayette	Higginsville	4	CS
57	Lewis	Deer Ridge	4	CS
5	Lincoln	Lincoln	4	CS
87	Linn	Brookfield	4	CS
48	Macon	Long Branch	4	CS
149	Miller	Lake Ozarks	4	CS
184	Moniteau	Manito	4	CS
180	Nodaway	Bilby Ranch	4	CS
181	Nodaway	Mozingo	4	CS
179	Nodaway	Nodaway Co.	4	CS
110	Phelps	Little Prarie	4	CS
3	Pike	Bowling Green #1	4	CS
145	Ralls	Mark Twain	4	CS
36	Reynolds	Clearwater	4	CS
7	St. Charles	Kraut Run	4	CS
91	St. Clair	Atkinson	4	CS
18	St. Francois	Capri	4	CS
112	St. Francois	Shayne	4	CS
150	Saline	Blind Pony	4	CS
115	Shelby	Hunnell	4	CS
98	Stone	Table Rock	4	CS
30	Wayne	Wapapello	4	CS

Secondary Lake List – To be monitored until four summers of data has been collected (SLAP Program)

MU#	County	Lake	Frequency	Monitoring Type
79	Caldwell	Breckinridge	4	CS
248	Cooper	Prairie Home #2	4	CS
228	Daviess	Jamesport Comm.	4	CS
213	DeKalb	Cameron #3	4	CS
229	Gentry	King City (east)	4	CS
230	Gentry	King City (west)	4	CS
143	Harrison	Old Bethany	4	CS
173	Holt	Big Lake	4	CS
166	Jackson	Cat Claw	4	CS
170	Jackson	Coot	4	CS
167	Jackson	Cottontail	4	CS
169	Jackson	Gopher	4	CS
165	Jackson	Jackrabbit	4	CS
168	Jackson	Nell	4	CS
222	Lewis	Ewing	4	CS
239	Lewis	New LaBelle	4	CS

MU#	County	Lake	Frequency	Monitoring Type
218	Linn	Bucklin	4	CS
233	Linn	Linneus	4	CS
242	Livingston	Pike	4	CS
231	Macon	LaPlata	4	CS
188	Mississippi	Big Oak	4	CS
256	Montgomery	Wellsville	4	CS
172	Platte	Bean Lake	4	CS
253	Platte	Tobacco Hill	4	CS
238	Ralls	Monroe Rte J	4	CS
226	Randolph	Higbee City	4	CS
152	St. Francois	Lafayette	4	CS
141	Scotland	Show Me	4	CS
127	Shelby	Clarence East	4	CS
128	Shelby	Clarence West	4	CS
123	Shelby	Shelbyville	4	CS
142	Sullivan	Milan (new)	4	CS
237	Sullivan	Milan North	4	CS
251	Sullivan	Sears Comm.	4	CS

MoDNR Sechhi Disk Lake Monitoring Program (active monitoring sites as of 11-2015)

Lake Name	Lake Location	City
Beaver Lake	Mark Twain Forest	Poplar Bluff
Chesterfield Commons Lake	Chesterfield Mall area	Chesterfield
Coves North Lake	KC Green Hills Rd and Barry Rd	Kansas City
Fellows Lake	Springfield	Ozark
Iron Mountain Lake	Iron Mountain	Bismark
Lac Shayne	Terre du Lac	St. Louis
Lake Perry	Perryville	Saint Mary
Lake Winnebago	Kansas City	Lake Winnebago
Palmer Lake	Palmer	Palmer
Peculiar Lake	Peculiar	Peculiar
Pinewoods Lake	near Elsinore	Poplar Bluff
Potosi Lake	Potosi	Potosi
Prarie Lee Lake	Subdivision	Lee's Summit
Raintree Lake	Subdivision	Lee's Summit
Rivers Edge Lake	Chesterfield Outlet mall	Chesterfield
Smithville Lake	near KC	Edgerton
Spanish Lake/Sunfish Lake	Spanish Lake	Bridgeton
Valley Water Mill	Springfield	Springfield
Winegar Lake	Scrivener State Wildlife area	Russellville
Woodridge Lake	Subdivision	Warrenton
Zajic Lake	Englewood Park	Kansas City

State Park Bacteriological Monitoring (Annually between May and Sept)

HUC 8	Number of Sites	State Park Lake	Frequency	Monitoring Type
07110008	2	Cuivre River State Park Lake	weekly	CS
08020202	2	Lake Wappapello	weekly	CS
07140104	2	St. Joe - Monsanto	weekly	CS
07140104	2	St. Joe - Pim	weekly	CS
07140105	2	Trail of Tears	weekly	CS
07110005	2	Mark Twain Lake	weekly	CS
10290106	2	Stockton Lake	weekly	CS
10290107	2	Pomme de Terre Lake	weekly	CS
10290107	2	Pomme de Terre Lake - Hermitage	weekly	CS
10300102	2	Finger Lakes	weekly	CS
10290109	2	Lake Ozarks - PB1	weekly	CS
10290109	2	Lake Ozarks - GGB	weekly	CS
10280203	2	Long Branch	weekly	CS
10290108	2	Truman Lake - Campground	weekly	CS
10290108	2	Truman Lake - Public Beach	weekly	CS
07110001	2	Wakonda Lake	weekly	CS
10300101	2	Watkins Mill	weekly	CS
10280202	2	Thousand Hills Lake	weekly	CS

Type: CL=chemical monitoring, more than 20 analytes,CM=chemical 10-19 analytes, CS= chemical <10 analytes

USGS Gaged Stations: showing a combination of MoDNR sponsored, co-sponsored, and unsponsored sites

Station Number	Name	Cooperator
MISSISSIPPI RIVER MAIN STEM		
05587450	Mississippi River at Grafton, IL	Corp of Engineers – St. Louis (COE/STL) (also WPP MDNR Ambient Network)
05587498	Mississippi River Pool Lock and Dam 26 at Alton, IL	COE/STL
07010000	Mississippi River at St. Louis, MO	COE/STL
07020500	Mississippi River at Chester, IL	COE/STL
07020850	Mississippi River at Cape Girardeau, MO	COE/STL
07022000	Mississippi River at Thebes, IL	COE/STL
Mississippi River Basin-Des Moines River		
05490600	Des Moines River at St. Francisville, MO	NSIP (National Monitoring Site supported by USGS)
Mississippi River Basin-Fox-Wyaconda		
05495000	Fox River at Wayland, MO	NSIP (also WPP MDNR Ambient Network)
05496000	Wyaconda River above Canton, MO	COE/RI (Rock Island) (also WPP MDNR Ambient Network)
Mississippi River Basin-Fabius River		
05497150	North Fabius River near Ewing, MO	COE/RI (also WPP MDNR Ambient Network)
05498150	Middle Fabius River near Ewing, MO	COE/RI
05498700	South Fabius River above Newark, MO	Water Resource Center (WRC) MDNR
05500000	South Fabius River near Taylor, MO	COE/RI (also WPP MDNR Ambient Network)
Mississippi River Basin-North-Bear		
05501000	North River at Palmyra, MO	COE/RI
05502000	Bear Creek at Hannibal, MO	COE/RI
Mississippi River Basin-Salt River		
05502300	North Fork Salt River at Hagers Grove, MO	COE/STL
05502500	North Fork Salt River near Shelbina, MO	COE/STL
05503100	Black Creek below Shelbyville, MO	Water Protection Program (WPP) MDNR (MDNR staff collecting WQ samples)
05503800	Crooked Creek near Paris, MO	COE/STL
05504800	South Fork Salt River above Santa Fe, MO	COE/STL
05506100	Long Branch near Santa Fe, MO	COE/STL
05506350	Middle Fork Salt River near Holliday, MO	COE/STL
05506800	Elk Fork Salt River near Madison, MO	COE/STL
05507600	Lick Creek at Perry, MO	COE/STL
05507800	Salt River near Center, MO	COE/STL
05508000	Salt River near New London, MO	COE/STL
05508805	Spencer Creek below Plum Creek near Frankford, MO	COE/STL
Mississippi River Basin-Cuivre-Dardenne		
05514500	Cuivre River near Troy, MO	COE/STL, NSIP
05514840	Dardenne Creek at O'Fallon, MO	City of St. Peters, MoDNR, St. Charles County Soil and Water Conservation District, City of O'Fallon
05514860	Dardenne Creek at Old Town St. Peters, MO	City of St. Peters, MoDNR, St. Charles County Soil and Water Conservation District, city of O'Fallon
MISSOURI RIVER MAIN STEM		
06818000	Missouri River at St. Joseph, MO	COE/KC (Kansas City), NSIP
06893000	Missouri River at Kansas City, MO	COE/KC, NSIP, MoDNR-WRC (temp monitoring)
06894650	Missouri River at Napoleon, MO	MoDNR, NSIP
06895500	Missouri River at Waverly, MO	COE/KC, MoDNR WRC, NSIP
06906500	Missouri River at Glasgow, MO	COE/KC, MoDNR, NSIP (WRC - temp monitoring)
06909000	Missouri River at Boonville, MO	COE/KC, NSIP
06910450	Missouri River at Jefferson City, MO	Ameren/MoDNR, NSIP (WRC - temp monitoring)
06934500	Missouri River at Hermann, MO	COE/KC, NSIP
06935450	Missouri River at Washington, MO	NSIP
06935550	Missouri River near Labadie, MO	Ameren
06935965	Missouri River at St. Charles, MO	COE/STL, MoDNR, NSIP (WRC - temp monitoring)
Missouri River Basin-Tarkio-Nodaway		
06813000	Tarkio River at Fairfax, MO	MoDNR, NSIP
06817700	Nodaway River near Graham, MO	COE/KC (also WPP MoDNR Ambient Network)
Missouri River Basin-Platte River		
06819500	One Hundred and Two River at Maryville, MO	MoDNR, NSIP
06820410	One Hundred Two River near Bolckow, MO	MoDNR, NSIP
06820500	Platte River near Agency, MO	COE/KC
06821080	Little Platte River near Plattsburg, MO	COE/KC
06821150	Little Platte River at Smithville, MO	COE/KC
06821190	Platte River at Sharps Station, MO	COE/KC (also WPP MoDNR Ambient Network)

Station Number	Name	Cooperator
Kansas River Main Stem		
Missouri River Basin-Blue River		
06893150	Blue River at Blue Ridge Blvd Ext in KC, MO	City of KC, MO Water Services Department
06893195	Blue River at Red Bridge Road, Kansas City, Mo	City of KC, MO Water Services Department
06893400	Indian Creek at 103rd St in Kansas City, MO	City of KC, MO Water Services Department
06893500	Blue River at Kansas City, MO	COE/KC
06893510	Blue River at Highway 71, Kansas City, Mo	City of KC, MO Water Services Department
06893530	Blue River at 63rd Street, Kansas City, Mo	City of KC, MO Water Services Department
06893553	Blue River at Colorado Avenue, Kansas City, Mo	City of KC, MO Water Services Department
06893557	Brush Creek at Ward Parkway in Kansas City, MO	NSIP
06893562	Brush Creek at Rockhill Road in Kansas City, MO	City of KC, MO Water Services Department
06893578	Blue River at Stadium Drive in Kansas City, MO	COE/KC
06893588	Blue River at 17th Street, Kansas City, Mo	City of KC, MO Water Services Department
06893590	Blue River at 12th Street in Kansas City, MO	COE/KC
06893620	Rock Creek at Kentucky Road in Independence, MO	City of Independence
06893820	Little Blue R. at Lees Summit Rd in Independence	City of Independence
06893830	Adair Creek at Independence, MO	City of Independence
06893890	East Fork Little Blue River near Blue Springs, MO	City of Independence
06893970	Spring Branch Ck at Holke Rd in Independence, MO	City of Independence
06894000	Little Blue River near Lake City, MO	COE/KC, City of Independence
06894200	Fishing River above Mosby, MO	WRC MoDNR
Missouri River Basin-Crooked and Wakenda River		
06895000	Crooked River near Richmond, MO	WRC MoDNR
06896000	Wakenda Creek at Carrollton, MO	WRC MoDNR
Missouri River Basin-Grand River		
06896400	East Fork Grand River at Albany, MO	WRC MoDNR
06896900	Grand River near Pattonsburg, MO	NSIP
06897000	East Fork Big Creek near Bethany, MO	WRC MoDNR
06897500	Grand River near Gallatin, MO	Dept. of Transportation (DOT)
06899500	Thompson River at Trenton, MO	NSIP
06899680	Grand River at Chillicothe, MO	COE/KC
06899700	Shoal Creek near Braymer, MO	WRC MoDNR
06899900	Medicine Creek at Lucerne, MO	Soil and Water Program (S&W) MoDNR
06900050	Medicine Creek near Laredo, MO	S&W, WRC MoDNR
06900640	Muddy Creek near Chula, MO	S&W, WRC MoDNR
06901205	East Locust Creek near Boynton, MO	WRC MoDNR, MDC
06901250	Little East Locust Creek near Browning, MO	S&W MoDNR
06901500	Locust Creek near Linneus, MO	S&W MoDNR
06902000	Grand River near Sumner, MO	COE/KC (also WPP MoDNR Ambient Network)
06902100	Grand River below Sumner, MO (auxiliary gage)	COE/KC
06902995	Hickory Branch near Mendon, MO	S&W MoDNR
Missouri River Basin-Chariton River		
06904050	Chariton River at Livonia, MO	MDC
06904500	Chariton River at Novinger, MO	NSIP
06905500	Chariton River near Prairie Hill, MO	COE/KC (also WPP MoDNR Ambient Network)
06906000	Mussel Fork near Musselfork, MO	NSIP
06906150	Long Branch Creek near Atlanta, MO	MDC
06906200	East Fork Little Chariton River near Macon, MO	COE/KC
Missouri River Basin-Blackwater-Moniteau-Moreau		
06906800	Lamine River near Otterville, MO	MDC
06907700	Blackwater River at Valley City, MO	WRC MoDNR
06908000	Blackwater River at Blue Lick, MO	COE/KC
06909500	Moniteau Creek near Fayette, MO	WRC MoDNR
06909950	Petite Saline Creek at Hwy U nr Boonville, MO	WRC MoDNR, NSIP
06910230	Hinkson Creek at Columbia, MO	WRC MoDNR
06910750	Moreau River near Jefferson City, MO	WRC MoDNR, NSIP
Missouri River Basin-Osage River		
06917060	Little Osage River at Horton, MO	NSIP
06917560	Marmaton River near Richards, MO	WRC MoDNR
06917630	East Drywood Creek at Prairie State Park	WRC MoDNR (also WPP MoDNR Ambient Network)
06918060	Marmaton River near Nevada, MO	COE/KC, NSIP
06918070	Osage River above Schell City, MO	COE/KC (also WPP MoDNR Ambient Network)
06918250	Osage River at Taberville, MO	COE/KC
06918440	Sac River near Dadeville, MO	WRC MoDNR
06918460	Turnback Creek above Greenfield, MO	COE/KC
06918493	South Fork Dry Sac River near Springfield, MO	Watershed Committee of the Ozarks
06918740	Little Sac River near Morrisville, MO	COE/KC
06919000	Sac River near Stockton, MO	COE/KC

Station Number	NAME	COOPERATOR
06919020	Sac River at Hwy J below Stockton, MO	COE/KC
06919500	Cedar Creek near Pleasant View, MO	COE/KC
06919900	Sac River near Caplinger Mills, MO	COE/KC
06920520	Weaubleau Creek near Weaubleau, MO	WRC MoDNR
06921070	Pomme de Terre River near Polk, MO	COE/KC (also WPP MoDNR Ambient Network)
06921200	Lindley Creek near Polk, MO	COE/KC
06921350	Pomme de Terre River near Hermitage, MO	COE/KC
06921590	South Grand River at Archie, MO	WRC MoDNR (also WPP MoDNR Ambient Network)
06921600	South Grand River at Urich, MO	NSIP
06921720	Big Creek near Blairstown, MO	WRC MoDNR/NSIP
06921760	South Grand River near Clinton, MO	MDC
06922500	Osage River at Warsaw, MO	COE/KC
06923250	Niangua River at Windyville, MO	WRC MoDNR
06923500	Bennett Spring at Bennett Springs, MO	MoDNR (also WPP MoDNR Ambient Network)
06923940	Niangua River ab Lake Niangua nr Macks Creek, MO	MDC
06923950	Niangua River at Tunnel Dam near Macks Creek, MO	Sho-Me Power
06925250	Little Niangua River near Macks Creek, MO	WRC MoDNR
06926000	Osage River near Bagnell, MO	Ameren
06926080	Osage River near Tuscombua, MO	
06926290	Tavern Creek below St. Elizabeth, MO	WRC MoDNR
06926510	Osage River below St. Thomas, MO	Ameren (also WPP MoDNR Ambient Network)
06927000	Maries River at Westphalia, MO	NSIP
Missouri River Basin-Auxvasse Creek		
06927240	Auxvasse Creek near Reform, MO	WRC MoDNR
Missouri River Basin-Gasconade River		
06928000	Gasconade River near Hazelgreen, MO	NSIP
06928300	Roubidoux Creek above Fort Leonard Wood, MO	U.S. Army Garrison, FLW
06928420	Roubidoux Creek at Polla Rd bl Ft. Leonard Wood	U.S. Army Garrison, FLW
06930000	Big Piney River near Big Piney, MO	U.S. Army Garrison, FLW
06930060	Big Piney below Fort Leonard Wood, MO	U.S. Army Garrison, FLW
06932000	Little Piney Creek at Newburg, MO	No cooperator
06933500	Gasconade River at Jerome, MO	NSIP (also WPP MoDNR Ambient Network)
06934000	Gasconade River near Rich Fountain, MO	WRC MDC, MoDNR, NSIP
Missouri River Basin-St. Louis County		
06935755	Bonhomme Creek near Ellisville, MO	MSD – St. Louis Metropolitan Sewer District
06935770	Bonhomme Creek near Clarkson Valley, MO	MSD
06935830	Caulks Creek at Chesterfield, MO	MSD
06935850	Creve Coeur Creek at Chesterfield, MO	MSD
06935890	Creve Coeur Creek near Creve Coeur, MO	MSD
06935955	Fee Fee Creek near Bridgeton, MO	MSD
06935980	Cowmire Creek at Bridgeton, MO	MSD
06935997	Mill Creek near Florissant, MO	MSD
06936475	Coldwater Creek near Black Jack, MO	MSD
06936530	Spanish Lake Trib. nr Black Jack, MO	MSD
Mississippi River Basin-St. Louis County		
07001910	Watkins Creek near Bellefontaine Neighbors, MO	MSD
07001985	Watkins Creek at Bellefontaine Neighbors, MO	MSD
07005000	Maline Creek at Bellefontaine Neighbors, MO	MSD
07010022	River Des Peres near University City, MO	MSD
07010030	River Des Peres Tributary at Pagedale, MO	MSD
07010035	Engelholm Creek near Wellston, MO	MSD
07010040	Denny Creek at Ladue, MO	MSD
07010055	Deer Creek at Litzinger Road at Ladue, MO	MSD
07010061	Two Mile Creek at Ladue, MO	MSD
07010070	Sebago Creek near Rock Hill, MO	MSD
07010075	Deer Creek at Ladue, MO	MSD
07010082	Black Creek near Brentwood, MO	MSD
07010086	Deer Creek at Maplewood, MO	MSD
07010088	River Des Peres at Shrewsbury, MO	MSD
07010090	MacKenzie Creek near Shrewsbury, MO	MSD
07010094	Grammond Creek near Wilbur Park, MO	MSD
07010097	River Des Peres at St. Louis, MO	MSD
07010180	Gravois Creek near Mehlville, MO	MSD
07010208	Martigney Creek near Arnold, MO	MSD
07019072	Kiefer Creek near Ballwin, MO	MSD
07019090	Williams Creek near Peerless Park, MO	MSD
07019120	Fishpot Creek at Valley Park, MO	MSD
07019150	Grand Glaize Creek near Manchester, MO	MSD

Station Number	Name	Cooperator
07019175	Sugar Creek at Kirkwood, MO	MSD
07019185	Grand Glaize Creek near Valley Park, MO	MSD
07019195	Yarnell Creek at Fenton, MO	MSD
07019220	Fenton Creek near Fenton, MO	MSD
07019317	Mattese Creek near Mattese, MO	MSD
Mississippi River Basin-Meramec River		
07010350	Meramec River at Cook Station, MO	WRC MoDNR
07013000	Meramec River near Steelville, MO	COE/STL, NSIP
07014000	Huzzah Creek near Steelville, MO	WRC MoDNR
07014500	Meramec River near Sullivan, MO	COE/STL , NSIP (also WPP MoDNR Ambient Network)
07015720	Bourbeuse River near High Gate, MO	COE/STL
07016500	Bourbeuse River at Union, MO	COE/STL (also WPP MoDNR Ambient Network)
07017020	Meramec River at Pacific, MO	COE/STL, NSIP
07017200	Big River at Irondale, MO	COE/STL
07017260	Big River below Desloge, MO	COE/STL
07017610	Big River below Bonne Terre, MO	EPA
07018100	Big River near Richwoods, MO	COE/STL (also WPP MoDNR Ambient Network)
07018500	Big River at Byrnesville, MO	COE/STL, NSIP
07019000	Meramec River near Eureka, MO	COE/STL
07019130	Meramec River at Valley Park, MO	COE/STL
Mississippi River Basin-Saline Creek		
07020550	South Fork Saline Creek near Perryville, MO	WRC MoDNR (also WPP MoDNR Ambient Network)
Mississippi River Basin-Castor River		
07021000	Castor River at Zalma, MO	WRC MoDNR
07021020	Castor River at Greenbriar, MO	WRC MoDNR(also WPP MoDNR Ambient Network)
Mississippi River Basin-St. Francis River		
07034000	St. Francis River near Roselle, MO	COE/STL
07035000	Little St. Francis River at Fredericktown, MO	COE/STL
07035800	St. Francis River near Mill Creek, MO	COE/STL
07036100	St. Francis River near Saco, MO	COE/STL (also WPP MoDNR Ambient Network)
07037300	Big Creek at Sam A Baker State Park, MO	COE/STL (also WPP MoDNR Ambient Network)
07037500	St. Francis River near Patterson, MO	COE/STL
07039500	St. Francis River at Wappapello, MO	COE/STL
07043500	Little River Ditch No. 1 near Morehouse, MO	WRC MoDNR
Mississippi River Basin-White River		
07050152	Roaring River at Roaring River State Park	WRC MoDNR
07050690	Pearson Creek near Springfield, MO	DOT, City of Springfield
07050700	James River near Springfield, MO	City of Springfield - Utilities
07052000	Wilson Creek at Springfield, MO	City of Springfield-Public Works
07052100	Wilson Creek near Springfield, MO	City of Springfield-Public Works
07052120	South Creek near Springfield, MO	City of Springfield-Public Works
07052152	Wilson Creek near Brookline, MO	WRC MoDNR
07052250	James River near Boaz, MO	WRC MoDNR
07052345	Finley Creek below Riverdale, MO	WRC MoDNR
07052500	James River at Galena, MO	COE/LR, WPP MoDNR (Ambient Network)
07052820	Flat Creek below Jenkins, MO	WRC MoDNR
07053810	Bull Creek near Walnut Shade, MO	COE/LR (Little Rock), DOT
07054080	Beaver Creek at Bradleyville, MO	COE/LR, DOT
07057500	North Fork River near Tecumseh, MO	COE/LR, MDC (also WPP MoDNR Ambient Network)
07058000	Bryant Creek near Tecumseh, MO	COE/LR, DOT
07061270	East Fork Black River near Lesterville, MO	COE/LR, Ameren
07061290	E. Fk. Black R. bl Lower Taum Sauk Reservoir from index velocity	Ameren
07061500	Black River near Annapolis, MO	COE/LR
07061600	Black River below Annapolis, MO	COE/LR (also WPP MoDNR Ambient Network)
07061900	Logan Creek at Ellington, MO	COE/LR, DOT
07062050	Clearwater Tailwater near Piedmont, MO	COE/LR
07062500	Black River at Leeper, MO	COE/LR
07062575	Black River above Williamsville, MO	COE/LR
07063000	Black River at Poplar Bluff, MO	COE/LR
07064440	Current River at Montauk State Park, MO	WRC MoDNR
07064533	Current River above Akers, MO	WRC MoDNR (also WPP MoDNR Ambient Network)
07065200	Jacks Fork near Mountain View, MO	WRC MoDNR/NPS (also WPP MoDNR Ambient Network)
07065495	Jacks Fork at Alley Spring, MO	NSIP
07066000	Jacks Fork at Eminence, MO	NSIP
07066510	Current River above Powder Mill, MO	NPS
07067000	Current River at Van Buren, MO	COE/LR, NSIP (also WPP MoDNR Ambient Network)
07067500	Big Spring near Van Buren, MO	WRC MoDNR (also WPP MoDNR Ambient Network)

Station Number	NAME	COOPERATOR
07068000	Current River at Doniphan, MO	COE/LR, NSIP (also WPP MoDNR Ambient Network)
07068510	Little Black River below Fairdealing, MO	WRC MoDNR (also WPP MoDNR Ambient Network)
07071000	Greer Spring at Greer, MO	WRC MoDNR (also WPP MoDNR Ambient Network)
07071500	Eleven Point River near Bardley, MO	COE/LR, NSIP (also WPP MoDNR Ambient Network)
Mississippi River Basin-Arkansas River		
07185700	Spring River at La Russell, MO	WRC MoDNR
07185765	Spring River at Carthage, MO	NSIP (also WPP MoDNR Ambient Network)
07185910	North Fork Spring River near Purcell, MO	WRC MoDNR
07186000	Spring River near Waco, MO	COE/Tulsa, DOT
07186480	Center Creek near Smithfield, MO	EPA (also WPP MoDNR Ambient Network)
07186900	Hickory Creek at Neosho, MO	URS
07187000	Shoal Creek above Joplin, MO	COE/Tulsa, MDC (also WPP MoDNR Ambient Network)
07188653	Big Sugar Creek near Powell, MO	WRC MoDNR (WRC-chemical monitoring)
07188838	Little Sugar Creek near Pineville, MO	WRC MoDNR (WRC-chemical monitoring)
07188885	Indian Creek near Lanagan, MO	WRC MoDNR (WRC-chemical monitoring)
07189100	Buffalo Creek at Tiff City, MO	WRC MoDNR (also WPP MoDNR Ambient Network)

Appendix C: Overview of Current Monitoring Program and Summary of Gap Needs

Medium	Aquatic Resource	Size/#.	MDNR sponsored sites	un-sponsored sites, data used	Type of Monitoring	# of New Sites Needed	Freq. of Monitoring	Selection Method	Indicators Needed	Monitoring Objective	Priority Level	Annual Estimated Cost (\$)	GAP #	
							(#/yr)							
Water: <i>Ambient Network</i> <i>Wadeable Streams</i> <i>Intensive/Special Studies</i> <i>Probability Based</i> <i>Screening</i> <i>Targeted Monitoring</i>	Great Rivers	Miss. 362 miles	1	5	Chemical	1	4-12, +Continuous	J	WC, SC, Bac-T	1.0, 2.0, 4.0, 5.0, 6.0	4	\$250,00	1.1	
		Mo. 490 miles	3	10		2								
	Large Rivers (non-wadeable)		13	2+	Chemical	7	4-12	A	WC, SC, Bac-T	1.0, 2.0, 4.0, 5.0, 6.0	4	\$26,200 per site	2.1	
	Medium Rivers (Wadeable)		58	75-100 (RAM)		10+	1	A, P (RAM)	WC, SC, Bac-T					
	Small Stream (wadeable)		52		Chemical	60+	4-12	p	WC, SC, Bac-T	1.0, 2.0, 4.0, 5.0, 6.0	2,3,4	\$672,000	3.1, 9	
	<i>Smaller Class Streams (Int. Streams)</i>		75 targeted screening	43	33+	Chemical	50+	4-24	J,P	WC, SC	4.0, 5.0, 6.0	4,5	\$734,000	3, 4, 9, 10
						visual screening	600+ non-targeted screening	1						
					100+	Bacteria		4	A	Bac-T				
	<i>Large Lakes (Class L2)</i>	21		13		Chemical	0	4-6	A	WC	1.0, 2.0, 4.0, 5.0, 5.1.0, 5.1.4, 6.0,	3,6	\$81,000+	5.1
						Bacteria		4		Bac-T			\$6,000 for census	
	<i>Medium Lakes Class L1,L3</i>	102	60			Chemical	12	4-6	J	WC	2.0, 4.0, 5.0, 5.1, 6.0	6	\$50,000	5.2
						Bacteria		4	A	Bac-T				
						Clarity		4-6	A	Secchi Disk				
	<i>Small Lakes Class L1,L3</i>	300+	63	0		Chemical	50	4-6	J	FT	1.0, 4.0, 5.0, 5.1.1, 5.1.5, 6.0	5	\$5,000	7
Bacteria						4		A	Bac-T					
Clarity						12		A	Secchi Disk					
Ground-water	Thousands of wells	0		Chemistry	50	1	TBD	WC, WL	1.0, 4.0, 5.0, 5.1.1, 5.1.5, 6.0	5	25,000+			
		0		Nitrate	50	4								
Wetlands	643,000 acres	0		Chemical	21	2	J	WC, SC	1	6	\$150,000	6		
Full access public beaches	23	18	(COE)	bacteria	0	Rec. season	A	Bac-T		3	\$6,000 (Census)	5.1, 5.2		
Limited access beaches	10 to 15	0			10 to 15									
Atmospheric <i>Targeted Monitoring</i>	Precipitation	NA	2		Chemical		**	**	WC	1.0, 2.0, 4.0	2	\$22,400 per site	8	

Medium	Aquatic Resource	Size/#.	MDNR sponsored sites	unsponsored sites, data used	Type of Monitoring	# of New Sites Needed	Freq. of Monitoring	Selection Method	Indicators Needed	Monitoring Objective	Priority Level	Annual Estimated Cost (\$)	GAP #	
Fish Tissue: <i>Targeted Monitoring</i>	Rivers & Lakes		13 (Fixed Station)		Chemical (Toxicants)	40	2YR	J	FT	1.0, 4.0, 5.0, 5.1, 6.0	4	\$5,000 per site for metals/organic constituents	1, 2, 3, 4, 5	
			12				*							
				MDC 30			*							
Biological: <i>Targeted Monitoring</i> <i>Probability Based</i>	Great Rivers	Miss. 362 miles Mo. 490	0		Aq. Inverts. (MDNR) Fish (MDC)	10	1	J/P	B, H		3	\$380,000 per 5 sites	1.2	
	Large Rivers (non-wadeable)		14	2+	Aq. Inverts, Fish, and Habitat	38	7-8	J	B,H	1.0, 2.0, 4.0, 5.0, 5.1, 6.0	3	\$100,000 per site	2.2	
	Medium Rivers (Wadeable)		38	75-100 (RAM)		1	P (RAM)							
	Smaller Streams (wadeable)			Inverts 45		Aq. Inverts. (MDNR) Fish (MDC)	30	2	J	B, H	3	3	\$50,000 per site	3.2
				Fish 70			30	2	P				B, H	
	Smaller Streams (headwater)					biological	TBD	2	J	B,H	1.0,3.0	4	\$273,000 (Candidate Ref.); \$55,000 per site	4.2
	Lakes					biological		2		B, H		6	\$130,000	5.1
	Wetlands					biological	21	2	J	B, H		6	\$150,000	
Sediment: <i>Targeted Monitoring</i>	Small to Medium Rivers		10-12		Chemical	60+	3	J	SC	4.0, 5.0	4	\$2,400 per site	1.1, 2.1	
UAA: <i>Special Studies</i>	Small/Headwater streams 1:100,000 NHD	91,000+ miles	0		Recreational Use		1/five mile segment during rec. season	A			2	\$15,000-\$18,000 per mile survey	4.3	

- Frequency: # = # of times per year, YR = monitored once per year, 2 YR = monitored every 2nd year, 3YR = monitored every third year, etc.
- Selection Method: A= All waters in this group are monitored J=judgmental, P=stratified random selection
- Note: A negative number in the Needed Number of Sites column indicates that in the future the current number of sites can be reduced by this number due to increases in other types of monitoring.
- No fixed schedule, ** Follows National Atmospheric Deposition Program guidelines.
- MDNR sponsored stream sites includes 58 monitored by USGS and 37 by MDNR (95 total)
- Great rivers = 7 - 8 order; large rivers = 5 - 6 order; medium rivers = 4 - 5 order; small = ≤3rd order
- Indicators: WC = water chemistry; B = biology; FT = fish tissue; SC = sediment chemistry; H = habitat; Bacteria = Bac-T; WL = water level