A PROPOSAL FOR
A WATER QUALITY MONITORING
STRATEGY FOR MISSOURI

Missouri Department of Natural Resources
Water Pollution Control Program

October 2011

1. Introduction

This document is a description of the present water quality monitoring program and a proposal for a comprehensive statewide water quality monitoring program for Missouri.

2. Objectives

The overall objective of the monitoring program is to provide data sufficient to allow a water quality assessment of all waters of the state.

Specific objectives of the monitoring program are;

2.1 to characterize background or reference water quality conditions
2.2 to better understand daily, flow event and seasonal water quality variations and their underlying processes
2.3 to characterize aquatic biological communities and habitats and to distinguish between:
    2.31 unimpaired biotic communities
    2.32 biotic communities impaired by water chemistry
    2.33 biotic communities impaired due to habitat quality
2.4 to assess time trends in water quality
2.5 to characterize the impact of local and regional point and nonpoint source discharges on water quality
2.6 to provide water quality information to support these management activities:
    2.61 to check for compliance with water quality standards
    2.62 to check for compliance with wastewater permit limits
    2.63 to develop water quality based permit limits and Total Maximum Daily Load studies
    2.64 to develop the state 303(d) list and state 305(b) report
    2.65 to determine the effectiveness of watershed management programs
2.7 to support development of strategies to return impaired waters to compliance with water quality standards**.**

3. Monitoring Design

Three general types of water quality monitoring will be used. These three are fixed stations, intensive surveys and screening level monitoring. A fixed station monitoring program collects a selected group of analytes at predetermined sites on a regular schedule. Fixed station programs typically collect data at given sites for several years. Intensive surveys typically employ several monitoring sites in a small geographic area and sample with greater frequency, often multiple times per day. The duration of most intensive surveys is short, often lasting only one to a few days. These surveys are often repeated multiple times over a one to three year period. Screening level monitoring includes a number of low intensity, short duration monitoring activities. These activities typically provide smaller amounts of data but have the advantage of monitoring more sites for a given amount of monitoring resources expended.

3.1 Fixed Station Network

The fixed station network is designed to locate water chemistry, sediment, fish tissue and biological monitoring sites equitably among the major physiographic and land use divisions in Missouri.
The fixed station network serves to meet monitoring objectives 2.1, 2.2, 2.3, 2.4, 2.61, 2.63, 2.64 and 2.65 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. The current fixed station stream network includes 70 sites monitored between six and 12 times annually by the US Geological Survey for a wide variety of physical, chemical and bacteriological constituents and six of these sites are also sampled at less frequent intervals for a wide variety of pesticides. Most of these streams are fifth order or larger. There are two additional sites on the Missouri River where data sondes are deployed to collect continuous data from spring through autumn. These sites are listed in Appendix C. Cost of monitoring program in FFY 2012 was $ 1,540,190. DNR's share of the total cost was $1,315,190.

The Department of Natural Resources, Environmental Services Program in support of the Water Protection Program under the Wadeable Streams QAPP and the Low Flow Survey QAPP monitors water quality at 57 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. Cost of current monitoring program: approximately $75,000.

The department funds two lake monitoring programs by the University of Missouri, Columbia. The Statewide Lake Assessment Program (SLAP) monitors approximately 40 lakes four times each during the summer of nutrients, chlorophyll, volatile and non-volatile solids and secchi depth. The Lakes of Missouri Volunteer Monitoring Program collects data typically four to six times per year on approximately 30 lakes annually, including multiple sampling sites on larger reservoirs for nutrients, chlorophyll, and secchi depth. Combined cost of these two programs is $200,000.

In coordination with USEPA Region VII, MDNR maintains a fish tissue-monitoring program of approximately 14 fixed sites monitored approximately once every two years for whole fish. These sites include a total of four sites on the Missouri and Mississippi Rivers and 10 sites on larger interior rivers. Missouri DNR current cost to collect these samples is approximately $14,000. Analytical work is done by USEPA Region VII. DNR and the Missouri Department of Conservation currently jointly run a fish tissue-monitoring program of 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. Sites are determined in consultation with regional MDC staff, DNR and the Missouri Department of Health and Senior Services.

The Department of Conservation also runs a Resource Assessment and Monitoring Program (RAM) that monitors approximately 100 stream sites annually. Habitat

assessment and aquatic invertebrate and fish community monitoring are performed on each stream. Each year, 100 samples are divided relatively equally among each of three Ecological Drainage Units. It will take about 8 years to cover the state with this sampling program. Metrics for assessing the biological integrity of fish communities were developed for Ozark and Ozark Border streams in 2008 (Doisey and Rabeni) but was unsuccessful for prairie streams.

Table 3.12
Overview of Current Monitoring Program and Additional Needs

Medium	Aquatic Resource	Size	MDNR sponsored sites	unsponsored sites, data used	Type of Monitoring	# of New Sites Needed	Freq. of Monitoring (#/yr)	Selection Method	Indicators Needed	Rationale
Water	Great Rivers	Miss. 362 Mo. 490 miles	1 **3**	18 6	Chemical	1 2	4-12, + continuous	J	WC, SC, B, FT, H, Bac-T	
Water	Large Rivers Non-wade		14	2+	Chemical	7	6-12	A	WC, SC, B, FT, H, Bac-T	2.1,2.2,2.4, 2.5,2.6,2.7
	Medium Rivers wadeable		**38**	8+			6-12	P(RAM)	WC, SC, B, FT, H, Bac-T	
	Smaller Class. Streams Int. streams		43	33+	Chemical		2-24	J	WC, SC, B, FT, H	2.5,2.6,2.7
			0	7		+60 screening		P		
	Large Lakes Class L2	13	13		Chemical	0	4-12	A	B, SC, H	2.1,2.2,2.4, 2.5,2.6,2.6 4,2.65,2.7
					Bacteria				FT	
	Medium Lakes Class L1,L3	102	60						B, SC, H FT	
	Small Lakes Class L1,L3	300+	63		Chemical		4	J	FT	2.2,2.4,2.5, 2.6,2.7
					Bacteria					
			100		Clarity		12	A		
	Ground-water	Thousands of wells	0		Chemistry	50	1	TBD	WC, WL	2.1,2.4,2,5, 2.6,2.61, 2.65
			0		Nitrate	50	4			
Water	Wetlands	643,000 acres	0					TBD	WC, SC, B, H	
Fish Tissue	Rivers & Lakes		DNR 12		Chemical (Toxicants)	40	2YR	J		2.1,2.4,2.5, 2.6,2.7
			DNR 5				*	J		
			MDC 30				*	J		
Water	Precipit-ation	NA	2		Chemical		**	**	WC	2.1,2.2,2.4
Water	Full access public beaches	23	23		bacteria	0	Rec. season	A	Bac-T	
Water	Limited access beaches	10 to 15	0		bacteria	10 to 15	Rec. season	A	Bac-T	
Biological	Smaller Streams		55		Aq. Inverts. (DNR)	-30	2	J		2.3
			0			30	2	P		
	Smaller Streams			67	Aq. Inverts & Fish (MDC)	0	5YR	P	Refine fish IBI	2.3

.

Note: Monitoring 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

3.2 Special Studies

Special studies tend to be driven by the need for site specific water quality information. This information is used to assist the water quality management process. Examples of these needs would be to develop water quality based NPDES permit limits, to assist in compliance and enforcement activities or to better understand the water quality of an area so that water quality management activities meet the needs of the waters in question. The goal of this monitoring proposal is to develop a system that anticipates the need for intensive surveys and completes all needed intensive surveys in a timely manner.

Current special studies being conducted by the department include:

- Wasteload Allocation Studies for wastewater treatment facilities that will be used to judge compliance with instream water quality standards and if necessary, be used to develop water quality based permit limits. Approximately ten WLA studies are completed annually.
- Chemical monitoring targeted at coal, industrial, municipal or heavy metal mining sites or 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 studies below hydropower dams. Continuous DO monitors are maintained below the dams 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 invertebrate biomonitoring twice annually at approximately 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.
- Contracted Studies. At any given time, the department typically has 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 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.

3.3 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. The state volunteer water quality monitoring program is also a significant source of screening level information. 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. Three Water Protection Program staff in the Monitoring and Assessment unit devotes a total of 0.25 FTE to rapid stream assessments. This represents an assessment of approximately 100 streams annually below wastewater discharges, mining areas or landfills.

4. Core Indicators

4.1 Details of Proposed Core and Supplemental Indicators

Table 4.1 Details of Proposed Core and Supplemental Indicators

Protection of Aquatic Life Core Indicators	Recreation Core Indicators	Drinking Water Supply Core Indicators	Fish and Shellfish Consumption Core Indicators
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 KJN, NH3N,NO2+NO3N total P Diss. Al,Cd,Cu,Fe,Pb,Zn Sediment Toxicity	Fecal Coliform Total N, total P For lakes only: Secchi depth Chlorophyll VSS NVSS	Diss As,Cd,Cu,Pb,Zn NO2+NO3N Dissolved Solids For lakes only: Chlorophyll VSS NVSS Total N, total P	Pesticides PCBs Hg,Pb Dioxins Dibenzo Furans
Supplemental Indicators	Supplemental Indicators	Supplemental Indicators	Supplemental Indicators
Diss. Co, Ni, Cr, Th Bioassay toxicity Pesticides	Hazardous chemicals	Taste and odor causing substances Diss Fe, Mn	Heavy metals, PAHs

5. Quality Assurance

Missouri DNR has an EPA approved quality assurance program in place. All internal water quality monitoring by the DNR Division of Environmental Quality must be done

under a Quality Assurance Project Plan with the DNR laboratory and approved by the Department QA manager. Environmental monitoring contracted to those outside of the department requires the contractor to develop a Quality Assurance Project Plan that must be reviewed and approved by the department.

6. Data Management

The Water Protection Program began using the Water Quality Assessment (WQA) data management system in September 2010. Using this new system, the Water Protection Program is now downloading data from our main environmental data file to the EPA NDX system on a quarterly basis. The WQA system also allows for automated transfer of our assessment database directly into EPA's ATTAINS 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 associate metadata (name of sampling organization, contact information, analytical methods used, quality assurance rating) can be accessed by the public directly from the DNR website.

DNR currently maintains stewardship of the 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.

7. 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 303d home page on the DNR website. All assessments are now entered into the WQA system. All classified waters appear automatically within WQA as do any unclassified waters which have been previously assessed as "impaired". When any other unclassified water is first assessed as impaired, it is entered into the WQA system.

8. Reporting

8.1 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 USEPA annual by April 1 of odd numbered years. In even numbered years the Water Protection Program 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.

8.2 Other Reports

Other water quality related reports include Total Maximum Daily Load Studies, Water Quality Basin Plans, Water Quality Review Sheets 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 DNR website or are available for public viewing in the department's files.

9. Program Evaluation

As part of the PPA/PPG process, Missouri DNR and USEPA Region VII will review the department's monitoring strategy. This review would include: (1) an update of the current program description biennially, (2) update the GAPs analysis biennially, and (3) identify monitoring strategy GAPs to be addressed in the next PPA/PPG cycle (annually).

10. General Support and Infrastructure Planning

The table below summarizes the estimated funds necessary to implement the expansion of the current monitoring program to address the GAPs.

Item	Prior-ity	Administrative	Equipment	DNR Personnel	Contractual	**Total**
Large Streams –Chemistry	4	3,000			247,000*	250,000
Large Streams - Biological	4	4,000			376,000	380,000
Small Streams-Chemistry	4	12,000	60,000	600,000		672,000
Fish Community Monitoring-Data Interp.	3	1,000*			35,000**	36,000
Improving Volunteer Mon. Data collection/submission	4			2,000		2,000
Expansion of Low Flow Survey Program	2	1,600	20,000	108,400**		130,000
Census of Lakes and their Bacterial Mon. Pgrms.	3	600		5.400		6,000
Biological Monitoring of Lakes-Criteria development	6	1,000*			79,000*	80,000
Lake Biomonitoring Pgrm.	6	5,000		45,000		50,000
Expansion of Volunteer Mon. Program on Lakes	6	5,000	5,000	40,000		50,000
Wetlands Inventory	6	1,000*			49,000*	50,000
Wetlands Monitoring Pgrm	6	5,000	15,000	80,000		100,000
Expansion of PDWP Chem. Analysis of Groundwater, Data Mngt by WPCB	3		2,000	23,000		25,000
Develop UAA and WQRS QAPPs and monitoring needs document	2	completed 2007		0		0
WQ Monitoring for UAA or WQRS Purposes	2					

Total for Priorities 2 & 3		4,200	22,000	145,800	35,000	221,000
Total for Priority 4		19,000	60,000	602,000	623,000	1,354,000
Total for Priority 6		17,000	20,000	165,000	128,000	330,000
Grand Total		40,200	102,000	912,800	786,000	1,905,000

* see Gap Analysis, Gap 1.
** see Gap Analysis, Gap 3.

Appendix A: Gaps Analysis

FIXED STATION NETWORK

GAP 1. Great Rivers (The Missouri and Mississippi Rivers).

GAP 1.1 Water Chemistry Monitoring. 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 MDNR, at Hermann, about 60 miles upstream from the St. Louis area. One additional monitoring site is needed on the river, immediately downstream of the KC metro area. 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. The addition of one site in this segment of the river is recommended.

2011 Update: The Corps of Engineers has withdrawn funding for the eight data sonde sites they funded previously. Missouri DNR has switched our two data sonde sites on the Missouri (previously at Waverly and Boonville) to St. Joseph and Herrmann. Missouri DNR also funded a monthly fixed station monitoring site on the Missouri near Sibley beginning in October 2008. In addition, three sites were monitored monthly on the Missouri by the USGS (sponsored by 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.

Recommendation: 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 Missouri DNR's existing joint funding agreement for ambient monitoring with the US Geological Survey. Estimated annual cost: $25,000. Rationale: the area of Missouri R. below Kansas City metro area is not adequately monitored. Priority Level 4.

GAP 1.2 Biological and Habitat Monitoring. 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.

2011 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. The only major shortcoming of the document was that it relied on 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 EMAP program 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 is 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: $80,000. 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 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, DNR 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. Priority Level 3.

GAP 2. Large Rivers (the larger interior rivers of the state, not including the Missouri or the Mississippi rivers).

GAP 2.1 Water Chemistry Monitoring. Missouri currently has 32 fixed station monitoring sites monitored between 6 and 12 times annually on large rivers (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.

2011 Update: Wyaconda, North Fabius, Spring River and Shoal Creek were added to our fixed station monitoring contract with USGS in October, 2008.

Recommendation: Warm Fork Spring River, 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 Quality Assurance Project Plan for ambient monitoring by the DNR Environmental Services Program. Estimated annual cost per site: $26,000. Priority Level 4.

GAP 2.2 Biological and Habitat Monitoring. There are no biological criteria for the large rivers. 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. Estimated annual costs: $100,000. Priority Level 3.

GAP 3. Small (Wadeable) Streams

GAP 3.1 Water Chemistry Monitoring. For every large (non-wadeable) river in the state there are typically 10-20 smaller wadeable classified streams tributary to it. Thus there are an estimated 380 to 760 smaller streams that have been recognized as having multiple beneficial uses. Currently 12 of these streams are monitored 6 to 12 times annually by the USGS, and 34 additional streams are monitored quarterly by the DNR Environmental Services Program. 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 46 sites are considered targeted sites. About one-third of these targeted sites measure water quality impacts related to specific point source or discrete nonpoint source areas and the remaining two-thirds are sites are currently being used to determine nutrient levels in reference (high quality) streams.

2011 Update: The number of small streams in the USGS and DNR fixed station network has decreased from 46 a few years ago to 43 now. The reason for the reduction is the increase in frequency of fixed station monitoring on Black Creek and North Fork Spring River which the department has identified as two watersheds where we want to develop a long term monitoring program to assess the effectiveness of nonpoint source watershed projects.

Recommendation: Based upon the number of wastewater discharges, 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) 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 Quality Assurance Project Plan for ambient monitoring by the DNR Environmental Services Program. The department should look at our present use of Section 319 funds (up to 20% can be used for water quality monitoring) and also look at the present Special Area Land Treatment (SALT) program administered by the department Soil and Water Program. Watersheds that receive multiple SALT grants would seem to be good candidates to have some of those funds dedicated to a fixed station water quality monitoring site within the watershed. Estimated annual cost: $672,000. Priority Level 4.

GAP 3.2 Biological Monitoring

The Department of Natural Resources, Environmental Services Program currently monitors aquatic invertebrates at 55 sites twice annually, collecting physical habitat data and some water chemistry at these sites. The current program is composed mainly of targeted sites supporting the department's TMDL program. The Department of Conservation currently collects fish and aquatic invertebrates at approximately 100 sites annually. This sampling also includes collection of physical habitat data. All sampling in a given year occurs within three of the 16 Ecological Drainage Units (EDUs) in the state and the entire state is therefore sampled in about five years. Together, these two

programs represent adequate fixed station biological monitoring coverage for wadeable streams.

2011 Update: DNR lost its most experienced invertebrate biologist in 2009. Since then our aquatic invertebrate monitoring program has decreased from 55 sites to the present 50 sites. The MDC RAM program still monitors between 80 and 100 sites annually for aquatic invertebate (using DNR protocols) and fish communities. Biocriteria have established by DNR for aquatic invertebrate communities in prairie, Ozark border and Ozark Plateau streams. MDC in conjunction with the University of Missouri (Doisy and Rabeni) have developed biocriteria for fish communities in Ozark Border and Ozark Plateau streams. Both fish and invertebrate community data are now being used by DNR to assess streams for our integrated report. Since the MDC RAM sites are selected randomly, that data will allow DNR to include some probabilistic assessment in the 2012 report.

Recommendation: MDC should focus additional attention on increasing fish community data for prairie streams and then work with an appropriate contractor to attempt to develop an IBI for fish communities in prairie streams. Estimated cost for contractor: $40,000.

GAP 4. Intermittent (unclassified) Streams

GAP 4.1 Screening Level Stream Surveys of Unclassified Streams (Non-targeted Sites)

There are an estimated 84,000 miles of unclassified 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 unclassified streams below wastewater discharges or other potential pollutant sources, but does not survey other unclassified 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.

2011 Update: In 2009 the Missouri Volunteer Monitoring 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.
The Water Protection Program is currently proposing changes to its water quality standards that would bring all streams indicated as blue lines on USGS 1:100,000 topo maps. This would increase the number of small classified streams in the state by a factor of six to eight.

Recommendation One: The volunteer monitoring program should continue to encourage more of its trained volunteers to submit data regularly. Priority Level 4.

Recommendation Two: Expand the screening level stream survey program within DNR. This expansion would require the addition of one-half FTE.

Estimated annual costs: $9,000 for training and transportation, plus any costs associated with hiring additional personnel. This would result in an additional 300 non-targeted screening level stream surveys annually. Priority Level 4.

GAP 5. Reservoirs

GAP 5.1 Large Multi-Purpose Reservoirs.

GAP 5.1.1 Bacterial Monitoring at Public Use Areas. There are 14 large multi-purpose reservoirs in Missouri. Thirteen are operated by the US Army Corps of Engineers and one, Lake of the Ozarks, by AmerenUE. Many public access swimming areas are not regularly monitored for bacteria.

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 $1000. Priority Level 3. (Possible PPA/PPG item)

GAP 5.1.2 Biological Monitoring. 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 of research $80,000. Estimated cost of biomonitoring of lakes: unknown. Priority Level 6.

GAP 5.2 Smaller Reservoirs and Lakes

GAP 5.2.1 Water Clarity and Bacterial Monitoring at Public Use Areas. There are 442 smaller reservoirs and lakes that are classified within Missouri's water quality standards. 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. Little is known about human recreational uses or bacterial monitoring programs on most of these smaller lakes.

2011 Update: In 2009, the Water Protection Program began a volunteer secchi monitoring program for small lakes not currently monitored by other programs. To date, 40 volunteers have submitted data on 45 lakes.

Recommendation: Continue to support the Statewide Lake Assessment Program and the Lakes of Missouri Volunteer Monitoring Program as well as the small lake secchi program. Priority Level 6.

The department also needs to make a census of public swimming areas on these smaller reservoirs and investigate what organizations are conducting bacterial 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: $5,000. Priority Level 3.

GAP 6. Wetlands

The state will work with EPA Region VII, ORD and the EPA National Wetlands Monitoring Work Group and other Region VII states via the Regional Wetlands Monitoring Workgroup to develop a state-wide 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, (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, (6) a reference site development program.

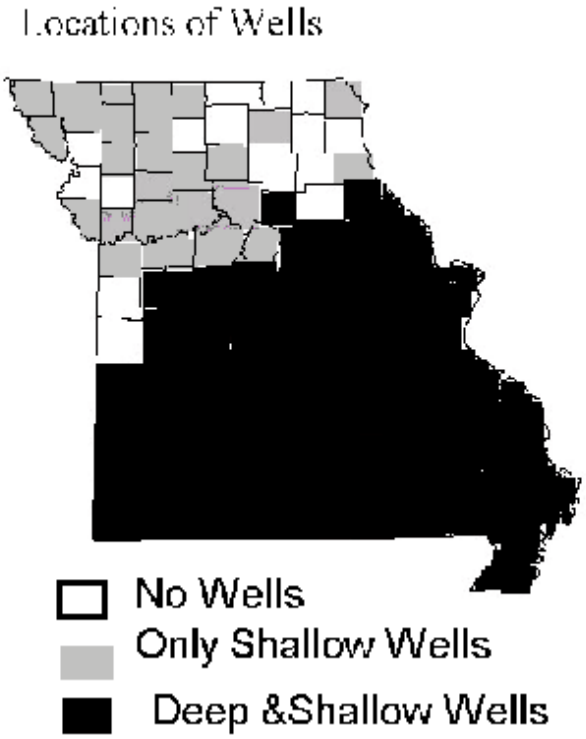
When completed the above activities will allow the following actions to take place: (1) an improvement in reporting the status of wetlands in the state 305(b) report, (2) listing of specific wetlands within state water quality standards, (3) development of chemical and or biological criteria for wetlands and inclusion of these within the state water quality standards, and (4) judging the success of state wetland mitigation efforts.
Costs: Wetlands Inventory: $50,000. Wetlands Monitoring Program annual costs: $100,000.

GAP 7. Groundwater

Many areas of the state use groundwater as a public drinking water supply source. The Safe Drinking Water Act 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 Tl) , 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 in at several locations in northern Missouri and at least two wells into shallow potentially potable aquifers should be added in Schuyler and Monroe counties in northeastern Missouri.

Cost: $25,000 annually and possibly some one time costs associated with drilling new wells.

GAP 8. Precipitation

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 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 state-wide, 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 Water Protection Program 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 CA near Ashland. The funding for these two sites will continue until June 30, 2013.

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.

SPECIAL STUDIES

GAP 9. Wasteload Allocation Studies and other Intensive Studies

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 Water Quality Review Sheet (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. Nor is the present special studies program adequate for statewide monitoring for more extensive nonpoint sources such as row crop agriculture or pastures, for development/revision of water quality standards, use attainability analyses or determination of stream classification. The current biomonitoring programs of the Department of Natural Resources and the Department of Conservation RAM program would meet this need, pending completion of contractual studies discussed in Gap 3.2.
Estimate cost: see Gap 3.2. Priority Level 3.

2011 Update: The department contracted for approximately 150 Whole Body Contact Use Attainability Analyses in 2007 at a cost of approximately $586,000. The department still needs to determine any additional WQRS or UAA needs. Biocriteria for aquatic invertebrates 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, 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 Use Attainability Analyses 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 Quality Assurance Project Plan (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

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. Water Protection Program 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 Water Quality Review Sheet 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. 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 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 Water Protection Program 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 should occur in the spring of 2012.

Recommendation: DNR 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. The current EPA 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. 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 National Hydrography Dataset (NHD) list of waterbody 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: DNR can now use the WQA system to assess both classified and unclassified waters. All waterbodies within the WQA system have a unique waterbody identification number and each waterbody is linked to its corresponding NHD reach address of the reach code.

Recommendation:

Appendix B.
Priorities for Water Quality Monitoring

- **Priority Level One**: Monitoring required to meet court orders or other legally binding agreements.
- **Priority Level Two**: Monitoring for time critical department/program information needs. This would include TMDLs, WQRS, enforcement actions, special investigations related to human health or other environmental emergencies.
- **Priority Level Three**: 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 Four**: Problem identification and compliance monitoring for non-human health related water quality standards. Development of chemical and physical water quality standards.
- **Priority Level Five**: Statewide water quality assessment and reporting requirements (Sec. 305b requirement to assess all of the state's waters).
- **Priority Level Six**: 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 C
Fixed Station Chemical Monitoring Sites

Fixed Station Monitoring Sites in Missouri

Sites Supported Partially or Wholly by Mo. DNR

Site Name	Size	Type	Org	Freq	HUC 8
Fox R. at Wayland	M	CL	GS	6	7110001
S. Fabius R. nr Taylor	M	CL	GS	12	7110003
Cuivre R. nr Troy	M	CL	GS	6	7110008
Mississippi R. nr. Grafton, Ill.	G	CL	GS	12	7110009
Nodaway R. nr Graham	L	CL	GS	6	10240010
Missouri R. nr. St. Joseph	G	CL	GS	12	10240011
Platte R. at Sharps Station	L	CL	GS	6	10240012
Middle Fork Grand R. nr Grant City	S	CL	GS	6	10280101
Thompson R. nr Mt. Moriah	M	CL	GS	6	10280102
Weldon R. at Princeton	M	CL	GS	6	10280102
No Creek near Dunlop	S	CL	GS	12	10280102
Medicine Cr. nr Harris	S	CL	GS	12	10280103
L. Medicine Cr. nr Harris	S	CL	GS	12	10280103
Locust Creek nr Unionville	S	CL	GS	12	10280103
Grand R. nr. Sumner	L	CL	GS	12	10280103
Chariton R. nr. Prairie Hill	L	CL	GS	6	10280202
Mussel Fork nr Mystic	S	CL	GS	12	10280202
E. Fk. Chariton R. nr Huntsville	M	CL	GS	6	10280203
Lamine R. nr Pilot Grove	M	CL	GS	9	10300103
Osage R. nr Schell City	L	CL	GS	6	10290105
L. Sac R. nr Walnut Grove	M	CL	GS	12	10290106
Pomme de Terre R. nr Polk	M	CL	GS	9	10290107
S. Grand R. at Archie	S	CL	GS	6	10290108
Niangua R. bl. Bennett Spring	M	CL	GS	6	10290110
Osage R. bl. St. Thomas	L	CL	GS	6	10290111
Roubidoux Spring bl. Waynesville	M	CL	GS	6	10290201
Big Piney R. at Devil's Elbow	M	CL	GS	9	10290202
Gasconade R. at Jerome	L	CL	GS	12	10290203
Huzzah Cr. nr. Steelville	M	CL	GS	6	7140102
Courtois Creek nr. Berryman	M	CL	GS	6	7140102
Meramec R. nr. Sullivan	L	CL	GS	12	7140102
Bourbeuse R. nr. Union	M	CL	GS	9	7140103
Big R. nr Richwoods	M	CL	GS	9	7140104
Meramec R. at Paulina Hills	L	CL	GS	12	7140102
Castor R. at Zalma	M	CL	GS	6	7140107
St. Francis R. nr Saco	M	CL	GS	9	8020202
Big Creek at Sam Baker State Park	M	CL	GS	6	8020202
St. John's Ditch at Henderson Mound	M	CL	GS	9	8020201
Little River ditches nr Rives	L	CL	GS	12	8020204
Roaring River nr Cassville	M	CL	GS	6	11010001
Wilson's Cr. nr Brookline	S	CL	GS	12	11010002
James R. at Boaz	M	CL	GS	6	11010002
James R. at Galena	M	CL	GS	12	11010002

Flat Cr. at Flat Creek	M	CL	GS	12	11010002
Lake Taneycomo at Branson	L	CL	GS	6	11010003
Swan Creek nr Swan	S	CL	GS	6	11010003
North Fork R. nr Tecumseh	L	CL	GS	6	11010006
Bryant Cr. bl. Evans	M	CL	GS	6	11010006
Black R. bl. Annapolis	M	CL	GS	6	11010007
Jacks Fk. above Two Rivers	M	CL	GS	12	11010008
Big Spring at Van Buren	M	CL	GS	4	11010008
Current R. at Doniphan	L	CL	GS	12	11010008
L. Black R. below Fairdealing	M	CL	GS	6	11010008
Eleven Point R. nr. Bardley	M	CL	GS	6	11010011
Center Creek nr Smithfield	M	CL	GS	9	11070207
Turkey Creek nr Joplin	S	CL	GS	9	11070207
Elk River at Tiff City	L	CL	GS	12	11070208
Buffalo Creek at Tiff City	M	CL	GS	12	11070208
Wyaconda R. above Canton	S	CL	GS	6	11010003
Black Cr. @ CR 478	S	CM	DNR	24	7110008
N. Fk. Spring R. at Redbud Rd.	M	CM	DNR	24	11070207
N. Fabius R. nr. Ewing	S	CL	GS	6	11010003
N. Fk. Spring R. at SW 60th Rd.	S	CM	DNR	24	11070207
N. Fk. Spring R. at Hwy 160	S	CM	DNR	24	10280201
Old Channel Little River @Hwy D, Lilbourn	S	CM	DNR	4	08020204
Maple Slough at SE Sec.34, 26N,15E, Miss. Co.	S	CM	DNR	4	08020201
Long Branch at Hwy VV, Nodaway Co.	S	CM	DNR	4	10240010
Plattin Cr. At Hwy T, Jefferson Co.	S	CM	DNR	4	7140101
Saline Cr. At Hwy Z, Ste. Genevieve Co.	S	CM	DNR	4	07140105
Cypress Ditch Lateral nr Dudley, Stoddard Co.	S	CM	DNR	4	10290106
Little River Ditch at SR 114, Stoddard Co. 2,25,12	S	CM	DNR	4	08020204
Sugar Cr. And Tribs nr Huntsville (5 sites)	S	CS	DNR	2	10290203
Cedar Cr and Tribs nr Stephens (8 sites).	S	CS	DNR	2	10300102
Big Otter Cr. And Tribs, St. Clair Co. (3 sites)	S	CS	DNR	2	10290105
Tebo Creek tribs (4 sites)	S	CS	DNR	2	10290108
Mill Cr. , Jackson Co. (2 sites)	S	CS	DNR	2	10300103
L. Courtois, Marys Cr. Nr Pea Ridge Mine (3 sites)	S	CS	DNR	2	7110102
Tristate Mining area tribs (10 sites)	S	CS	DNR	3	11070207
Sugar Cr. in Cuivre River State Park	S	CM	DNR	3	7110008
E. Drywood Cr. in Prairie State Park	IB	CM	DNR	3	10290104
Sugar Cr. At Hwy 146, Harrison Co.	S	CM	DNR	4	10280102
Grindstone Cr. nr. Santa Rosa	S	CM	DNR	4	10280103
W. Fk. Yellow Creek in Linn Co.	S	CM	DNR	4	10280103
E. Fk. Yellow Cr. in Linn Co.	S	CM	DNR	4	10280103
Shoal Cr. @Hwy A, Caldwell Co.	S	CM	DNR	4	10280103
Charette Cr. @Hwy 47, Warren Co.	S	CM	DNR	4	10300200
Pickle Cr. in Hawn State Park	S	CM	DNR	3	7140105
Ketchum Hollow in Roaring River State Park	IB	CM	DNR	3	11010001
Coakley Hollow in Lake Ozark State Park	IB	CM	DNR	3	10290109
Finley Creek at Riverdale	M	CL	GS	12	11010002
Missouri R. at Sibley	G	CL	GS	12	10300101
Cedar Cr. Nr. Pleasant View	S	CL	GS	12	10290106
Big Cr. Nr. Blairstown	S	CL	GS	12	10290108
Osage Fork Gasconade R. nr. Lebanon	M	CL	GS	6	10290203
Greer Spring at Greer	M	CL	GS	4	11010011
Spring R. ab. Carthage	M	CL	GS	12	11070207
Shoal Cr. Ab. Joplin	M	CL	GS	12	11070207

S. Fk. Saline Cr. Nr. Perryville	S	CL	GS	6	07140105

Site Name	Size	Type	Org	Freq	HUC 8
Missouri R. at Waverly	G	CS	GS	cont.	10300101
Missouri R. at Boonville	G	CS	GS	cont.	10300101

Comment

size: G=great river(7-8 order), L=large interior river(5-6 order), M=medium sized river (order 4-5)
S=small river or creek (0rder 3-4), IB= itty bitty creek (order 1-2)

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

Type: Cont. =

Org= sampling organization: GS=USGS, .
DNR=Missouri DNR
Freq.= #/year or Cont=continous (data sonde)

Fixed Station Chemical Monitoring Sites Not Sponsored by DNR

Site Name	Size	Type	Org	Freq	HUC 8	Comment
Missouri R. at Hermann	G	CL	GS	12	10300200	
Missouri R. at Kansas City	G	CM	KCMO	50+	10240011	City of KC
Missouri R. nr. St. Charles	G	CM	MAWC	50+	10300200	Mo. American Water Co.
Mississippi R. nr Thebes, Ill.	G	CL	GS	12	7140101	
Des Moines R. at St. Francisville,Mo.	L	CL	IDNR	12	7100009	Iowa DNR
Mississippi R. nr. Quincy, Ill	G	CL	IEPA	4	7110004	Illinois EPA
Mississippi R. at Keokuk, Ia.	G	CL	IEPA	6		Illinois EPA
Mississippi R. at L&D 21	G	CL	IEPA	4	7110004	Illinois EPA
Mississippi R. at Clarksville, Mo.	G	CL	IEPA	4	7110004	Illinois EPA
Mississippi R. just ab. Cuivre R.	G	CM	LTRMP	12	7110004	USGS Long Term Resource Mon. Prgm.
Dardenne Cr. at Hwy B	S	CM	LTRMP	12	7110009	USGS Long Term Resource Mon. Prgm.
Mississippi R. at Hartford, Ill	G	CM	LTRMP	12	7110009	USGS Long Term Resource Mon. Prgm.
Peruque Cr. nr mouth	S	CM	LTRMP	12	7110009	USGS Long Term Resource Mon. Prgm.
Mississippi R. just ab. Meramec R.	G	CL	IEPA	4	7140101	Illinois EPA
Mississippi R. ab. St. Louis	L	CL	GS	9	07140101	for MSD
Maline Cr. nr mouth	S	CL	GS	4	7140101	USGS for StL MSD
Mississippi R. at St. Louis (Eads Bridge, RDB)	L	CL	GS	9	07140101	for MSD
River des Peres at St. Louis	S	CL	GS	4	7140101	USGS for StL MSD
River des Peres nr. University City	S	CL	GS	4	7140101	USGS for StL MSD
Mississippi R. at Oakville	L	CL	GS	9	7140101	USGS for StL MSD
Meramec R. ab. Cook Station	S	CM	GS	2	7140102	NAWQA
Grand Glaize Cr. at Valley Park	S	CL	GS	4	7140101	USGS for StL MSD
Mississippi R. at Kimmswick	L	CL	GS	9	7140101	USGS for StL MSD
St. Francis R. nr. Fisk	L	CS	GS	9	08020203	sediment study
St. Francis R. nr. Glennonville	L	CS	GS	9	08020203	sediment study
Wilhelmina Cutoff nr Campbell	S	CS	GS	9	08020203	sediment study
Williams Cr. nr Peerless Park	S	CL	GS	4	7140101	USGS for StL MSD
Fenton Cr. at Hwy 141	S	CL	GS	4	7140101	USGS for StL MSD
Matesse Cr. at Ringer Road	S	CL	GS	4	7140101	USGS for StL MSD
Mississippi R. at Chester, Ill.	G	CM	IEPA	4	7140105	Illinois EPA
Mississippi R. 3 mi.abl. Cape Girardeau	G	CM	LTRMP	12	7140105	USGS Long Term Resource Mon. Prgm.
Mississsissippi R. 6 mi.ab. Cape Girardeau	G	CM	LTRMP	12	7140105	USGS Long Term Resource Mon. Prgm.

Mississippi R. nr. Trail of Tears State Park	G	CM	LTRMP	12	7140105	USGS Long Term Resource Mon. Prgm.
Mississippi R. nr. Neely's Landing	G	CM	LTRMP	12	7140105	USGS Long Term Resource Mon. Prgm.
Mississippi R. nr. Whittenburg	G	CM	LTRMP	12	7140105	USGS Long Term Resource Mon. Prgm.
9 sites in Fellows,McDaniel,Stockon Res.+tribs		CM	CU	50	10290106	City Utilities of Springfield
2 sites on Osage R. below Bagnell Dam	L	CS	UE	50+	10290111	AmerenUE
Indian Cr. at State Line Bridge	S	CL	KDHE	6	10300101	Kansas Dept. of Health & Environ.
Blue River nr Stanley	S	CL	KDHE	6	10300101	USGS
Brush Cr. at Rockhill Rd.-KC	IB	CS	GS	100+	10300101	USGS
Brush Cr. at Wornell Rd.-KC	S	CL	GS	6	10300101	USGS
Brush Cr. nr state line	IB	CL	GS	6	10300101	USGS
Marais des Cygnes R. at Hwy 69	S	CL	KDHE	6	10290102	Kansas Dept. of Health & Environ.
L. Osage R. nr Fulton, KS	S	CL	KDHE	6	10290103	Kansas Dept. of Health & Environ.
Marmaton R. nr. Ft. Scott, KS	S	CL	KDHE	6	10290104	Kansas Dept. of Health & Environ.
Missouri R. at Chesterfield	L	CL	GS	9	10300200	for MSD
Missouri R. at St. Charles	L	CL	GS	9	10300200	for MSD
Creve Coeur Cr. at Hwy 340	IB	CL	GS	5	10300200	USGS for StL MSD
Missouri R. at Columbia Bottoms	L	CL	GS	9	10300200	for MSD
Coldwater Cr. nr. Jamestown	S	CL	GS	7	10300200	USGS for StL MSD
Kings R. n. of Berryville,Ark.	M	CL	ADEQ	12	11010001	Arkansas DEQ
Long Cr. nr. Denver, Ark.	S	CL	ADEQ	12	11010001	Arkansas DEQ
James R. at Hootentown Access	M	CM	SPW	6	11010002	Springfield Dept. of Public Works
James R. at Nelson Mill Bridge	M	CM	SPW	6	11010002	Springfield Dept. of Public Works
James R. at Galena	M	CM	SPW	6	11010002	Springfield Dept. of Public Works
James R. at Delaware Access	M	CM	SPW	6	11010002	Springfield Dept. of Public Works
Finley Creek nr. Mouth	S	CM	SPW	6	11010002	Springfield Dept. of Public Works
5 locations on Wilson's Cr.	S	CM	SPW	6	11010002	Springfield Dept. of Public Works
Terrell Cr. nr. Mouth	S	CM	SPW	6	11010002	Springfield Dept. of Public Works
Schuler Cr. nr. Mouth	S	CM	SPW	6	11010002	Springfield Dept. of Public Works
Table Rock Lake at McCords Bend		CM	SPW	6	11010002	Springfield Dept. of Public Works
31 sites on Current,Jacks Fk and tribs	S-L	CS	NPS	6	11010008	National Park Service
9 sites on Current R.	M-L	CM	GS	2	11010008	USGS for Nat. Park Service
Warm Fork nr. Thayer, Mo.	M	CM	ADEQ	12	11010010	Arkansas DEQ
Cave Spring Br. At state line	IB	CM	OKDEQ	12	11070206	Oklahoma DEQ
2 sites on Cave Spg.Br. Just over state line	S	CM	OKDEQ	12	11070206	Oklahoma DEQ
Center Cr. nr. Smithfield,Mo.	M	CL	KDHE	6	11070207	Kansas Dept. of Health & Environ.
Turkey Cr. at Hwy P	S	CL	KDHE	6	11070207	Kansas Dept. of Health & Environ.
Lake Taneycomo- 2 sites	L	CS	GS	cont.	11010003	for COE
N. Fk. White R. nr. Cabool	S	CM	GS	1	11010006	NAWQA
E. Fk. Black R.	S	CS	GS	cont.	11010007	for Ameren
Black R. nr. Annapolis	M	CS	GS	cont.	11010007	for AMeren
Barren Fork nr. Timber	S	CM	GS	2	11010008	NAWQA
Big Creek nr Mauser Mill	S	CM	GS	2	11010008	NAWQA
North Prong Jacks Fork bl. Arroll	S	CM	GS	2	11010008	NAWQA
Mahan’s Cr. ab. Eminence	IB	CM	GS	2	11010008	NAWQA
Greer Spring	S	CL	GS	4	11010011	
North Indian Cr. nr. Wanda	S	CM	GS	2	11070208	NAWQA

Appendix D
Schedule and Budget for Fees Expansion

Gap	Years after Fees Expansion Becomes Effective				
	One	Two	Three	Four	More
1.1 Establish Fixed Station Chemical Mon. Sites on Mo. R. bl. KC.	26,000	27,000	28,100	29,200	yes, annual cost
1.1 Maintain 2 fixed station WQ sondes on Missouri R.: Waverly and Boonville	30,000	31,000	32,000	33,000	yes, annual cost
1.2 Development of Biocriteria for Great Rivers (Mo/Miss) [1]			50,000	50,000	50,000/yr for next 4 yrs
1.2 Biomonitoring of Missouri and Mississippi Rivers.					80,000/yr not beginning before year 8
2.1 Establish fixed station monitoring sites on Wyaconda, N. Fabius, M. Fabius, Warm Fk. Spring, and Nishnabotna rives 6/yr. and Spring River and Shoal Cr. 12/yr.	116,000	120,000	124,000	128,000	yes, annual cost
2.2 Development of Biocriteria for Large Rivers [1]					**50,000[2]/yr** for 6yrs
3.1 Add 44 Fixed Station Mon. Sites on Smaller Streams: field (DNR or contractor), lab (DNR)		ramp up (50%) 345,000	ramp up (50%) 355,000	730,000	yes annual cost
3.2 Biomonitoring of Small Streams: Develop Fish Community Biocriteria (contract)					**35,000** Probably not before year six
4.1 Increase amount of useable volunteer data by 50% (increased communication w/volunteers either via phone, letter, email or newsletters).	1,000	1,000			
4.1 Add 200 screen level surveys of untargeted unclassified waters. (0.5 FTE DNR or contractor)			36,000	37,000	yes, annual cost
5. Census of Lake Monitoring programs and organizations (DNR or contractor)	**6,000**				
5.1 Development of Biological Criteria for Lakes.					**60,000** Probably not before year six
5.1 Expansion of Volunteer Monitoring Program for Lakes (clarity, bacteria) Either DNR (0.2 FTE or UMC) plus travel and equipment.			20,000	20,000	yes, annual cost
6. Conduct Wetlands Inventory (contract)		$50,000			
6. Development of Chemical and Biological Criteria for Wetlands (contract)			**30,000**	**30,000**	**$250,000** over several years
6. Wetlands Monitoring Program					$100,000/yr after criteria are developed
7. Groundwater Monitoring-Initial Study of current monitoring and recommendations for additional analytes, well locations, depths, etc. (DGLS)	**5,000**				

[1] To be done in conjunction with several other organizations. Costs will be spread over many years.
[2] Bold print indicates one-time cost, or cost only for a stipulated time period.

7. Installation of monitoring wells			**25,000-50,000**		
7. Groundwater fixed station monitoring program				50,000	yes, annual cost
8. Precipitation: DNR evaluation of precip. data needs for modeling	**0**				
8. Installation and operation of additional precipitation monitoring sites if needed.					
Gap	Years after Fees Expansion Becomes Effective				
	One	Two	Three	Four	More
9. Special Studies: Use Attainability Analysis studies (contractor)					
9. Expand current Wasteload Allocation Study capacity by four studies annually (DNR or contractor)		ramp up 50% 30,000	61,000	62,000	yes, annual cost
10. Expand Targeted Screening Level Survey program by 500 per year (DNR 1.0 FTE)			62,000	63,000	yes, annual cost
11. Data Management: Develop system for loading DNR data in EPA national database (ITSD)			**10,000**		
11. Transmit DNR data to EPA national database.					yes, annual cost
11. Update state Assessment Database (ADB) system (ITSD and state contractor)					yes, annual cost
Total Annual Estimated Cost	184,000	604,000	846,100	1,232,200	

Note: the expansion of the biological portion of the monitoring program probably does not begin until six to ten years after the initiation of this expansion. The annual costs for full implementation of this biological monitoring program will be very high. The department may want to consider the possibility of reducing the scope of the chemical monitoring program, so that focuses on time trends and beneficial uses other than aquatic life protection (primarily drinking water supply, fish consumption and whole body contact recreation).