Kentucky Nutrient Management Strategy

Kentucky Division of Water

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Introduction

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Chapter I

What follows in the first four sections of this strategy is information on already established programs. The compilation of this information outlines established programs and gives a foundation on which to build the nutrient reduction strategy. Chapter II of the document will focus more on the actions that will occur in the development of the Nutrient Reduction Strategy.

1. Sources of Nutrients in Kentucky

There are many sources of nutrients in Kentucky. It is impossible to develop a strategy for reduction of those nutrients without first having an idea of where they might be originating. Nationally, it is estimated that about 10% of nitrogen and 25% of phosphorus originates from point sources (USGS, 1999). The remaining loads come from nonpoint sources that do not require a permit. The high percentage of nonpoint source inputs of nutrients makes managing nutrient levels in streams a challenge since they are unregulated and often hard to measure. Included below is a list of some of the known sources of nutrients in Kentucky.

1.1 Permitted outfalls

The Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500), also known as the Clean Water Act, created the system for permitting wastewater discharges in Section 402 known as the National Pollutant Discharge Elimination System (NPDES). Under NPDES, all facilities which discharge pollutants from a point source into waters of the United States are required to obtain a permit. In Kentucky, those permits are written by the Kentucky Division of Water (KDOW). In 2011, Kentucky had more than four thousand permits, excluding resource extraction and construction general permits, which may discharge nitrogen or phosphorus. More than 96% of these are minor facilities (in the case of domestic wastewater treatment plants these are facilities with a design capacity of less than 1 million gallons per day). There are one hundred thirty-six major dischargers. Of the four thousand permits, fifty-two percent have ammonia limits, with less than 1% having limits or monitoring for nitrite/nitrate or Total Kjeldahl Nitrogen (TKN) and none have limits for Total Nitrogen (TN). About 2% have Total Phosphorus (TP) limits, while 9% have monitoring for TP(ICIS 12/17/13).

1.1.1 Wastewater treatment plants

Wastewater treatment plants (WWTPs) use a combination of physical, chemical and biological processes to remove contaminants from sewage before it is discharged into a

stream. There are differing mechanisms and degrees of treatment based on plant design and capacity. Some plants may only have primary treatment that removes solids through screening and settling. Other plants may have tertiary treatment including biological processes as well as physical removal, chemical treatment or membrane filtration. The level of treatment is critical in larger cities since the mean annual excretion of phosphorus is 1.2 pounds per person (USEPA, 1976).

Smaller package treatment plants can be a large contributor of nutrients in states like Kentucky that are mostly rural and lack sewer infrastructure in these areas. Since many of these small package treatment plants are privately owned, there are often problems with continuity of service and upkeep.

1.1.2 Industrial discharges

The largest industrial discharges of nitrogen occur at power plants and through power generation. Most of this discharge is into the atmosphere through fossil fuel combustion. The atmospheric contribution is covered under the nonpoint source section on atmospheric deposition (Section 1.2.1). There is a wastewater contribution of nutrients at power plants. The EPA proposed effluent guidelines identifies the process of flue gas desulphurization as a contributor of nutrients, particularly nitrogen, to wastewater.

There are no large industrial dischargers of phosphorus in Kentucky.

1.1.3 Municipal Separate Storm Sewer System and sewer overflows

The contribution of nutrient pollution from urban sources is mainly through the human activities that occur in the watershed. These inputs, however, are often greater in urban areas due to higher percentages of impervious surface as compared to rural settings. Urban stormwater is regulated under the Municipal Separate Storm Sewer System (MS4). According to population and density, MS4s are designated as either Phase I or Phase II and are required to be permitted. Smaller urban areas may not reach the thresholds for the MS4 program and are included in the nonpoint source section of this document. In Kentucky, there are 2 Large MS4 communities (Louisville/Jefferson Co and Lexington/Fayette Co), no Medium category, and 103 Phase II communities under 47 permits. Permits are for a 5 year term. Large communities have individual permits, but the Phase II MS4s are covered under a general permit. The general permit was last renewed on March 1, 2010.

Combined sewer systems are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same collection system. Most of the time, these systems transport all of their wastewater to a treatment plant, where it is treated and then discharged to a stream. During periods of heavy rainfall, however, the wastewater volume in a combined sewer system can exceed the capacity of the collection system. For this

reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other water bodies. This overflow from a combined system is called a Combined Sewer Overflow (CSO). Kentucky has 17 areas with combined sewer systems with a total of 297 CSO outfalls. Figure 1.1 shows MS4 and CSO communities in Kentucky.

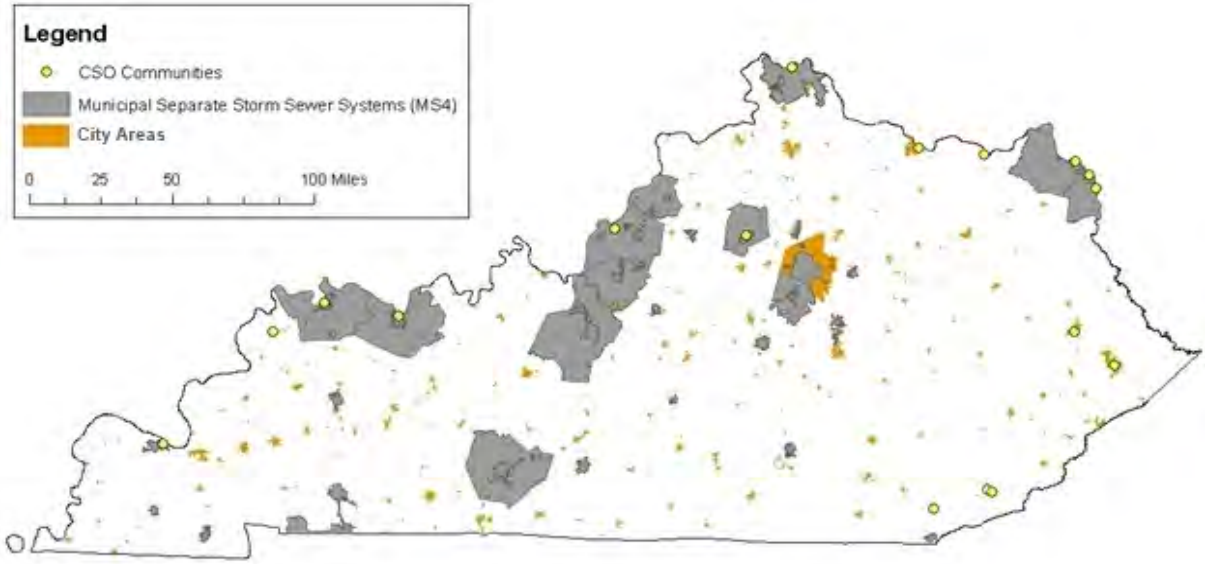

Figure 1.1 Wet weather regulated communities in Kentucky

Sanitary sewer overflows (SSOs) are unintentional overflows from a sewage collection system. These are often associated with rainfall events that overload the system because of stormwater entering through leaking pipes. Other causes of SSOs include blockages, line breaks and power failures. They can occur with any sewer system during wet or dry weather. The EPA estimates 23,000 to 75,000 SSOs occur each year in the United States (EPA, 2000). SSOs may overflow from manholes, down city streets or back up into buildings. The primary pollutants of concern are pathogens, nutrients and total suspended solids.

1.1.4 Construction stormwater

Stormwater runoff from construction activities can have a significant impact on water quality. As stormwater flows over a construction site, it can pick up pollutants like sediment, debris and chemicals and transport these to a nearby storm sewer system or directly to a stream, river or lake. Since many of the soils in Kentucky are naturally high in phosphorus, it is important to control sediment runoff from these sites. Kentucky requires construction

site operators engaged in clearing, grading and excavating activities that disturb one or more acres, including smaller sites in a larger common plan of development, to obtain a permit for their stormwater discharges. The most recent renewal of the general permit, KYR10, became effective August 1, 2009 and requires the operator to develop a Stormwater Pollution Prevention Plan (SWPPP) that describes how the site will be managed. The operator is also responsible for routine inspections and maintenance of all BMPs on the site until the site is stabilized. Operators are not eligible for a general permit if the property contains a stream impaired for sediment with a Total Maximum Daily Load (TMDL), is designated as a Cold Water Aquatic Habitat (CWAH), Exceptional Water, Outstanding National Resource Water (ONRW) or Outstanding State Resource Water (OSRW).

1.1.5 Industrial stormwater

In Kentucky, Industrial Stormwater is permitted through individual permit or under the general permit KYR00. The most recent renewal of the general permit became effective June 1, 2013 and contains a list of considerations for choosing the appropriate control measures and best management practices. The permit requires development of monitoring plans for total suspended solids, oil and grease, pH and flow, as well as a requirement to assess pollutant types and quantity and their potential impact on water quality.

1.2 Nonpoint Source

Nonpoint source (NPS) pollution is pollution that does not come from a point source. It generally results from stormwater runoff, atmospheric deposition, or seepage. Nonpoint sources, including agriculture, atmospheric deposition, habitat alteration and urban runoff, are listed as contributors to impairment in 80% of Kentucky's waters. The top causes of these impairments in Kentucky are from sediment, pathogens and nutrients (KDOW, 2010). In some areas of Kentucky, the limestone geology is naturally high in phosphorus and so any activity causing erosion also increases the amount of phosphorus in the water.

Nationally, it is estimated that about 90% of nitrogen and 75% of phosphorus originates from nonpoint sources (USGS, 1999). Additionally, more than 70% of the nitrogen and phosphorus delivered to the Gulf of Mexico comes from agricultural sources while urban contributes about 10% (See Figure 1.2). Of the remaining portion, atmospheric deposition plays a larger role in the contribution of nitrogen, while natural land is more significant in phosphorus contribution (Alexander et al, 2008).

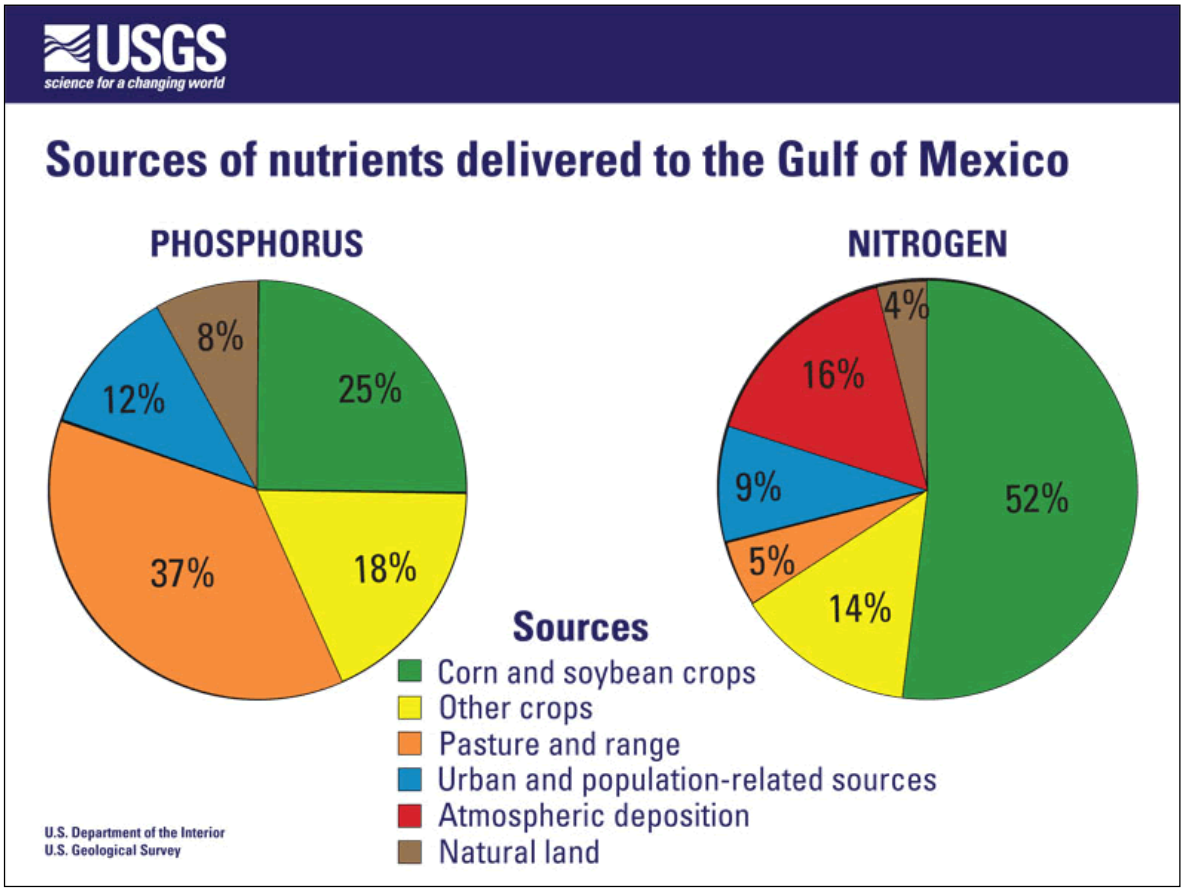

Figure 1.2 Sources of nutrients delivered to the Gulf of Mexico (Alexander et al, 2008)

1.2.1 Atmospheric deposition

The Earth's atmosphere is about 78% nitrogen and contains about three-fourths of the nitrogen available in the environment. Most of this nitrogen is in the form of nitrogen gas, but some compounds of nitrogen and oxygen also are present. Some of these compounds are produced by chemical reactions in the atmosphere, and are released into the atmosphere from the combustion of fossil fuels. Nitrogen compounds in the atmosphere change and eventually leave the atmosphere in the form of nitrate. Nitrate can dissolve in rainwater or snow and then can reach streams or ground water through runoff or seepage. More than 3.2 million tons of nitrogen is deposited in the United States each year from the atmosphere (Figure 1.3). (Mueller and Helsel, 2013)

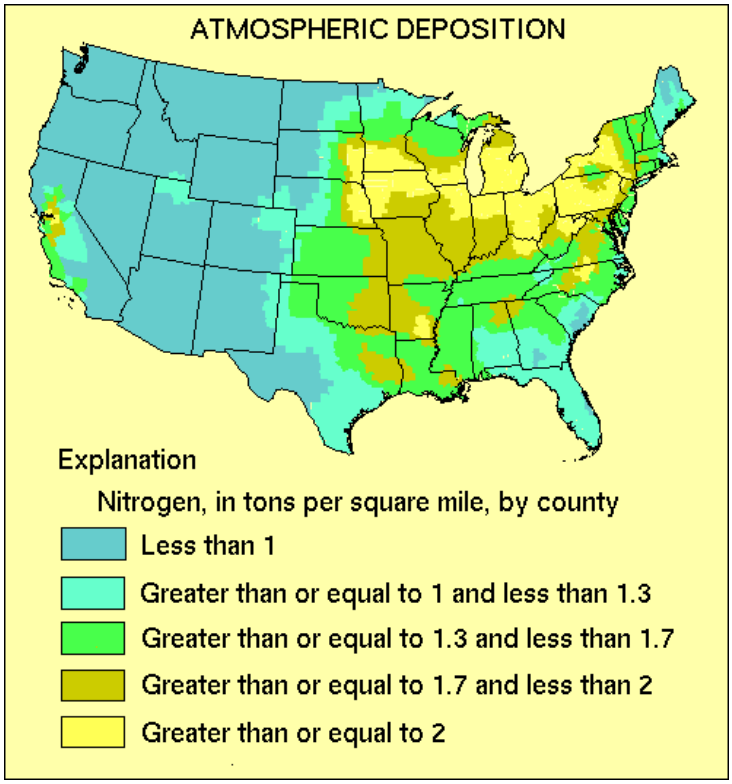

Figure 1.3 Atmospheric deposition in the US. (Mueller and Helsel, 2013)

Much of the information we know about atmospheric deposition of nitrogen comes from the National Atmospheric Deposition Program. This program began in 1977 through the U.S. State Agricultural Experiment Stations and has continued to develop to track amounts, trends and geographic distribution of acids, nutrients and base cations in precipitation. Coal combustion is one source of these nitrogen compounds in the atmosphere. Wet deposition of nitrate ions in Kentucky varies somewhat across the state with areas along the Ohio River receiving higher amounts than those in other areas. Only 22 miles of Kentucky streams were listed in the 2010 Integrated Report as impaired with atmospheric deposition as a source, although more than 58,000 acres of lakes and reservoirs were listed with atmospheric deposition as a source (KDOW, 2010).

1.2.2 Urban non-MS4, including lawn maintenance and golf courses

Developed land such as cities, neighborhoods and commercial areas create nonpoint source pollution in many of Kentucky's streams. Of the stream miles assessed for the 2010 Integrated Report for Kentucky, "Urban Runoff" or "Municipal" are the suspected sources of impairment for 2,059 stream miles while "Residential Related" is the source of impairment for 1,398 stream miles (KDOW, 2010). Not all of the urban areas contributing to the impairment of these streams meet the requirements to be considered a MS4 area. Events contributing NPS in developed areas include increased runoff from impervious surfaces,

nutrients and pesticides from lawn applications and bacteria from pets and onsite wastewater systems.

Lawn maintenance and greens maintenance of golf courses may also contribute nonpoint source nutrient pollution. Kentucky has more than 300 public or private golf courses, with most clustered near urban areas. Kentucky State Parks has 19 courses, making up the Kentucky State Park Golf Trail. Addition of fertilizers and pesticides to greens may result in runoff to streams similar to the runoff from subdivisions where lawn treatments are applied. Many of the golf courses are near urban areas, but may be outside MS4 boundaries.

1.2.3 Onsite wastewater

According to the 1990 US Census, 40% of the homes in Kentucky relied upon onsite sewage systems to treat wastewater. An additional 57,000 thousand homes did not have adequate plumbing, with many homes relying on straight pipes. Inadequate wastewater treatment is especially problematic in Eastern Kentucky where the steep terrain and poor soil cover makes it difficult to install onsite systems. Additionally, homes in the karst regions of the state may have hidden system failures since the sewage flows into the karst system instead of presenting as a surface failure. Figure 1.4 illustrates the extent of areas in the state with known public water distribution lines, contrasted with the portion of the state that also has public sewer service. This figure does not account for the additional populated areas of the Commonwealth served by well or other water supply sources. It can be assumed that areas of Kentucky with public water service and without public sewer service are utilizing some form of onsite wastewater treatment or straight pipe. The cost to repair failing septic systems can often be significant. Typical systems cost between $3000 and $7000, but actual installation cost may vary depending on site conditions (NSFC, 1995).

In Kentucky, KRS 211.350 requires that any home constructed or installed after July 15, 1998 demonstrate installation of an onsite system if not hooked to a sewer system, prior to electrical service connection. This has helped to reduce the number of new homes with no onsite treatment. The Kentucky Department of Public Health has oversight on the installation and inspection of onsite systems to insure proper design standards for meeting local conditions.

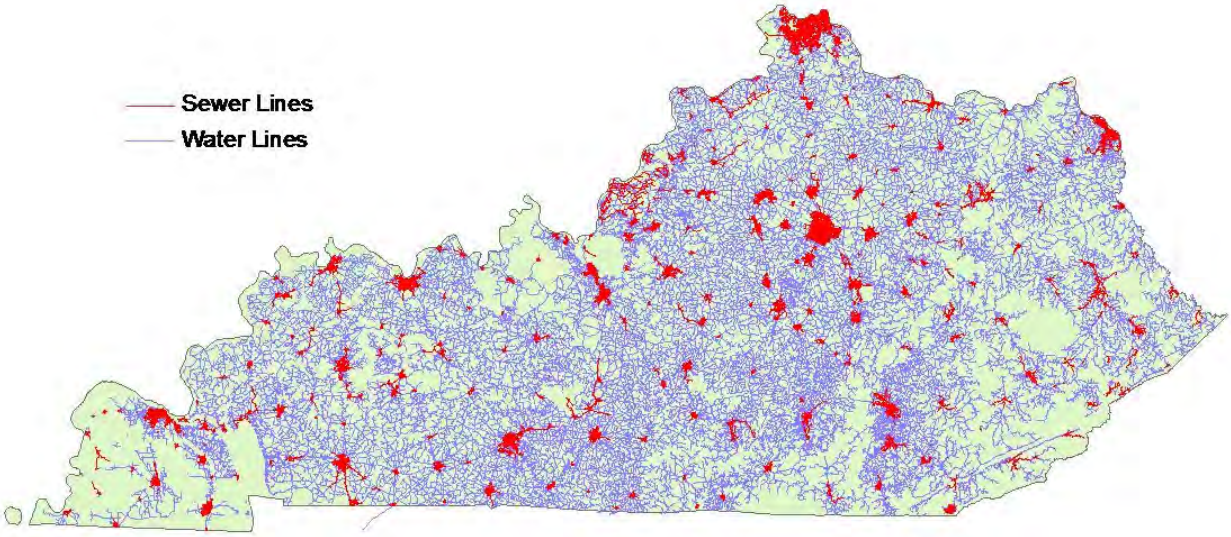

Figure 1.4 Sewer and water infrastructure in Kentucky.

Nutrient contribution is not only through failing systems; even properly operated systems can release more than ten pounds of nitrogen per person per year. This is because conventional systems are only 28% effective in removing TN and 57% effective in removing TP. Other types of treatment, like sand filters and water separation are more effective at removing TN with efficiencies of between 55 and 83%, but are more expensive to install and may not be suited for local conditions (USEPA, 1993).

1.2.4 Agriculture

Kentucky has approximately 85,700 farms, with the average farm size of 163 acres (USDA, 2011). Farms across Kentucky vary in crop or livestock, from row crops in the Jackson Purchase portion of the state to horses in the Bluegrass. Agriculture is a very important industry in Kentucky accounting for nearly five billion dollars in farm cash receipts in 2011 and more than ten percent of Kentucky jobs. Although perhaps best known for horses, Kentucky's top commodity by dollar value is poultry (Table 1.1) (KACTFFA, 2013). Nutrient management is very valuable to the farmer. Nutrients can be very expensive to manage and to purchase for field applications. That is why nutrient management is important for water quality as well as the profitability of farming.

Table 1.1Top Kentucky Commodities by Dollar Value (2011)

Poultry	$ 952,882,000
Horses	$ 800,000,000
Corn	$ 786,292,000
Cattle & Calves	$ 629,000,000
Soybeans	$ 601,212,000
Tobacco	$ 325,236,000
Dairy Products	$ 232,200,000
Wheat	$ 199,216,000
Hay	$ 135,694,000
Hogs	$ 118,977,000

The General Assembly passed the Kentucky Agriculture Water Quality Act (AWQA) in 1994. The goal of the act is to protect surface and groundwater resources from pollution as a result of agriculture and silviculture (forestry) activities. The AWQA mandates that landowners with ten or more acres in agricultural or silvicultural production must develop a water quality plan based upon guidance from the Kentucky Agriculture Water Quality Plan. It is the sole responsibility of each landowner to develop, implement and revise when needed, a water quality plan for their individual operations. Each plan should contain best management practices (BMPs) that provide methods for the landowner to address nonpoint source pollution. For example, a landowner may choose to fence cattle, like those pictured in Figure 1.5, out of the stream. In 2013, the BMP for Nutrient Management (Livestock BMP #11) was updated to reflect changes in the NRCS Practice Code 590. Agricultural Water Quality Plans can be developed online at www.bae.uky.edu/awqpt/.

Figure 1.5 Cows in a Kentucky creek.

2. Stakeholders

Every person in the Commonwealth of Kentucky is a stakeholder in this nutrient management strategy. In order for nutrient loadings to be effectively reduced, no one sector can bear the entire responsibility. There are a variety of ways that individuals can

stay informed with the process of nutrient reduction in the state. For example, listed below are some of these ways that are supported by the local universities.

Kentucky Center of Excellence for Watershed Management

The Kentucky Center of Excellence for Watershed Management (KCEWM) at the Kentucky Resource Research Institute was designated on March 22, 2011. The Centers of Excellence in Watershed Management of Region 4 EPA began in 2007 to provide the expertise of colleges and universities to develop viable solutions to watershed problems. The KCEWM was the seventh in the Region at time of designation, although there are currently ten. The KCEWM works to support development and implementation of watershed –based plans and provide expertise to stakeholder organizations or local governments.

Land Grant Universities

The Morrill Act of 1862 and 1890 allowed for creation of land grant universities through the sale of federally held land to endow the colleges. The mission of these institutions is to focus on the teaching of practical agriculture, science, military science and engineering. The Commonwealth has two land grant universities, the University of Kentucky and Kentucky State University. Both universities continue to do formal and non-formal education about agriculture and other nutrient related topics to engage and educate stakeholders across the state.

- **University of Kentucky (UK) College of Agriculture** - www2.ca.uky.edu

  The UK College of Agriculture is engaged in research and extension activities related to agricultural water quality, and has partnered with the Kentucky Division of Water on various projects to implement best management practices and encourage landowner adoption of Kentucky Agriculture Water Quality Act plans.

- **Kentucky State University (KSU)**- www.kysu.edu/landGrant

  Kentucky State University is a public, comprehensive 1890 land-grant institution. The Land Grant Program (LGP) at KSU works to uphold the mission through its commitment to research, service, and teaching in the food and agricultural sciences. The KSU LGP works to resolve agricultural, educational, economic and social problems of the people of the Commonwealth of Kentucky, especially limited resource persons and families. Its three distinct areas are the Community Research Service (CRS), the Cooperative Extension Program (CEP), and Aquaculture Research Center (ARC).

3. Methods of Addressing Nutrients

3.1 Effluent requirements

Reporting of effluent quality and quantity through imposition of discharge limits or monitoring and reporting requirements can be effective ways of knowing the input of nutrients from a discharger, however, these only affect point sources. Not all watersheds have point source dischargers, so this tool is not effective in reducing nutrients in all watersheds. In Kentucky, some dischargers to nutrient impaired waters are required to meet technology based Total Phosphorus limits of 1.0 mg/l as a monthly average and 2.0 mg/l as a daily maximum. The limit would likely be lower for discharges to a receiving stream with an approved nutrient TMDL.

In the Municipal Separate Storm Sewer (MS4) program, Phase I communities have monitoring strategies that vary with community. These communities report on their monitoring findings in their annual report, but do not have effluent limits.

3.2 Planning

There are a variety of ways that planning can be used to help address nutrient issues. The review of the following planning documents provides KDOW an opportunity to encourage the addition of mechanisms or practices that would reduce the level of nutrients. The Continuing Planning Process (CPP) is a federal regulatory requirement authorized under Clean Water Act Section 303e, which requires each state to develop a water quality planning process for safeguarding the state's waters from water pollution. In addition to the portion of the document related to effluent limits and permit issuance, TMDL development and area wide planning may also help in the reduction in nutrients statewide. The Triennial review, as a portion of the CPP process, also provides the KDOW an opportunity every three years to update water quality standards.

3.2.1 Facility plans

Facility plans regulations are outlined in 401 KAR 5:006. A regional facility plan is required if a new wastewater treatment plant is proposed, an existing treatment plant is to be expanded by more than 30% of its average daily design capacity, or the population served is increased by more than 30%. Prior to preparing a facility plan municipalities are required to meet with the KDOW to discuss the water quality problems in their planning area and their current and future wastewater infrastructure needs. These introductory meetings allow KDOW to communicate to municipalities their current and future needs for nutrient reduction.

3.2.2 Total Maximum Daily Loads

Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that are too polluted to meet the water quality standards. The law requires that the state then develop a Total Maximum Daily Load (TMDL) for these waters. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. A TMDL can be thought of as a watershed diet; the watershed's intake of a pollutant must be reduced by a certain percentage in order for the watershed to be healthy once again. By calculating current and allowable levels of nutrients, TMDL documents provide a framework for placing additional limits on NPDES-permitted sources of nutrients and for guiding nonpoint source reduction goals. In order to develop a TMDL for pollutants with narrative standards, such as nutrients, KDOW must identify the specific level of the pollutant that will result in the narrative standards being met. This process involves a waterbody-specific analysis of the pollutant in question and how it is contributing to the failure to meet the narrative standards. An example of the process of defining a target for a nutrient TMDL can be found here: water.ky.gov/watershed/Documents/FloydsFork/Targets%20Description_102111.pdf.

3.2.3 Watershed based plans

A watershed approach is a flexible framework for managing water resource quality and quantity within specified drainage areas or watersheds. This approach engages diverse individuals and groups and emphasizes the use of management practices supported by science and technology. The watershed approach to planning uses a series of cooperative, iterative steps to characterize existing conditions, identify and prioritize problems, define objectives, develop protection or remediation strategies, and implement and adopt selected actions as necessary. The outcomes of this process are documented in a watershed based plan. A watershed plan is a strategy that provides assessment and management information for a geographically-defined watershed, including the analyses, actions, participants, and resources for developing and implementing the plan. The EPA developed A Handbook for Developing Watershed Plans to Restore and Protect Our Waters in 2008 to help provide guidance for groups working on watershed plans. EPA has also come out with a simplified version of the original Handbook titled A Quick Guide to Developing Watershed Plans to Restore and Protect Our Waters in 2013.

The Watershed Planning Guidebook for Kentucky Communities was created to provide additional information and specifics to people working on developing plans in Kentucky. It helps Kentuckians work together to improve and protect the waterways they appreciate and use. The Guidebook provides a step-by-step process that Kentucky communities may use to create an effective watershed plan.

3.3 Funding

Funding is often the limiting factor to adoption of new practices. There is funding currently available to address many sources of nutrients. The information contained below is not an exhaustive list, but mentions some of the resources that can be used to manage nutrients in Kentucky. There are a variety of federally administered programs as well as private nonprofit groups and foundations that may have funding available for projects. The sources listed below are administered by agencies within state government.

The Kentucky Clean Water State Revolving Funds (CWSRF) are available for planning, design and construction of wastewater treatment plants and sewer line extensions, which may remove failing septic systems or treatment plants, or upgrade current plants to install higher levels of treatment. Funds are also available for stormwater projects and nonpoint source projects in the state. SRF is a 20-year loan program administered through an interagency agreement with the KDOW and Kentucky Infrastructure Authority. The CWSRF ranking criteria was revised in 2014 to support Kentucky nutrient reduction strategy. In SFY-2014 wastewater treatment plant projects that propose the installation of nutrient controls because they discharge to nutrient impaired waters receive an additional 30 points; the extra points will propel these types of projects to the top of the CWSRF project priority list.

The Kentucky Soil Erosion and Water Quality Cost Share Program and Kentucky Soil Stewardship Program were created to help farmers protect soil and water resources and to implement their Agriculture Water Quality plans. The 1994 Kentucky General Assembly established this financial and technical assistance program. Kentucky Revised Statute 146.115 establishes that funds are administered by local conservation districts and the Kentucky Soil and Water Conservation Commission with priority given to animal waste-related problems, agricultural district participants and to producers who have their Agriculture Water Quality plans on file with their local conservation districts. Funding comes from the Kentucky General Assembly through direct appropriations to the program from the Tobacco Settlement Funds and from funds provided by the Kentucky Department of Agriculture.

The Kentucky County Agricultural Investment Program (CAIP) is administered by the Kentucky Governor's Office of Agricultural Policy. It provides funding up to $5000 for projects such as development of alternative water sources or animal waste handling. Additionally, participants are required to attend at least one educational event within six months of funding.

The Kentucky Nonpoint Source (NPS) Pollution Control Program is authorized under §319 of the Clean Water Act (CWA) amendments of 1987. The amendments deal with a wide variety of pollutants that enter the water by sources other than a point source discharge. Kentucky NPS Program provides grants to implement the Kentucky Nonpoint Source Management Plan. These grants provide 60% federal funding to entities developing watershed based

plans or implementing the BMPs of an existing plan. The grant recipient is responsible for providing the remaining 40% of project cost through in-kind match or additional non-federal funds.

3.4 Agriculture Water Quality Act

In 1994, the General Assembly passed the Kentucky Agriculture Water Quality Act (KRS 224.71-100 through 224.71-145). This law guides the state's agriculture/silviculture industry in its continuing efforts to address environmental issues associated with its activities. The Act established a 15-member Agriculture Water Quality Authority representing the state's agriculture and environmental community. The Authority was appointed by the Governor and charged with development and support of a statewide agricultural water quality plan. The Authority instituted a committee process through which agriculture and silviculture producers, educators, and technical and regulatory advisors, from across the state, have developed the Kentucky Agricultural Water Quality Plan.

The plan is an effort to produce a practical, flexible, coordinated natural resources management system that protects the waters of the Commonwealth and complies with applicable government rules and regulations. It is based on pollution prevention through the use of Best Management Practices (BMPs). A brochure titled Understanding the AWQA is also available to help producers understand the requirements of the Act. Additionally, The University of Kentucky has developed a web-based tool to help producers develop their plan online. The Kentucky Agriculture Water Quality Act Planning Tool provides step by step instructions on how to develop an Agriculture Water Quality Plan.

3.5 Education

Education is one of the most important BMPs that can be done in any area. Without understanding the problem, few people are willing to become part of the solution. In Kentucky, the Kentucky Environmental Education Council (KEEC) completes a survey of the general population every 5 years to determine levels of currently environmental knowledge. In 1999, 2004 and 2009, water pollution was listed as the leading environmental problem in Kentucky. There are also large disparities in the knowledge of how power is generated in Kentucky (less than half identified coal-fired power plants) and more than half of the respondents believe factory waste is the source of water pollution (KEEC, 2009). Nutrient reduction education will be available for the public as well as for technical staff who interact with the public like Conservation office staff and Technical Service Providers.

Project WET

In 2012, the Kentucky Division of Water became the official Host Institution of Project WET in the Commonwealth. Since 1984, Project WET, an award-winning 501(c)(3) nonprofit organization, has dedicated itself to the mission of reaching children, parents, teachers and

community members of the world with water education. KDOW offers trainings throughout the year to equip formal and non-formal teachers with the tools available through Project WET and allow that water education to be spread through to many individuals in the state through the training of these educators. Interested individuals may visit water.ky.gov/ProjectWET for more information on the program in Kentucky and to find out about upcoming workshops.

Watershed Watch

The Watershed Watch in Kentucky program was established as a way to encourage the public to monitor the water quality in their local streams. It was established as a nonprofit organization in 1997. The Division of Water provides administrative and technical assistance for the volunteer monitoring organization. Watershed Watch has provided a starting point for numerous local watershed groups that are now working to develop and implement nine-key element watershed plans.

3.6 Policy

While structural BMPs may result in immediate reduction of nutrients at a specific location, policy changes may take longer to affect water quality, but result in larger impacts statewide. Policy changes may take place through formal changes in regulations, such as the recent revision to the definition of eutrophication in 401 KAR 10:031. This change clarified the expectations for surface waters with respect to protecting against the adverse effects of excess nutrients, allowing for more uniform interpretation of the narrative criteria.

KDOW continues to pursue data collection and analyses focused on the question of how to further define expectations for nutrients in Kentucky's surface waters. Given the wide variety of waterbodies in the state and the many ways in which nutrients can affect them, this question is complex and will require groundwork set in place, in part, by the actions described in this plan.

Kentucky has recently updated the Kentucky Nonpoint Source Management Plan (NPSMP) to meet new federal CWA Section 319 guidance. The recent version includes tracking of many nutrient reduction milestones and continued coordination of NPS program goals with Nutrient Reduction Strategy goals.

3.7 Partnerships

The Kentucky Division of Water has many relationships with organizations that share a similar mission. These organizations are our partners in addressing nutrient reductions. A distinction is made where some organizations share an interest in or have a role in nutrient reduction, but where their primary mission is not funding or implementing protection of natural resources or data collection. For the sake of this document, the organizations whose missions don't include funding, implementation or data collection are called stakeholders.

Through the implementation of the strategy, organizations that were once considered stakeholders may become partners. This list will continue to grow and develop as the plan evolves over time. It should not be considered exhaustive.

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force

The Mississippi River/Gulf of Mexico Watershed Nutrient Task Force was established in 1997 to help understand the causes and effects of eutrophication in the Gulf of Mexico and reduce the size and severity of the Hypoxic Zone. The group developed their first Action Plan in 2001 to coordinate actions across the basin. An updated Action Plan was developed in 2008 and is still being implemented today. To read the 2008 Action Plan, visit water.epa.gov/type/watersheds/named/msbasin/actionplan.cfm. The task force consists of five federal agencies, 12 state agencies (including Kentucky) and the tribes within the Mississippi/Atchafalaya River Basin.

Lower Mississippi Basin River Conservation Committee

The Lower Mississippi Basin River Conservation Committee (LMRCC) is a group of 12 state natural resource conservation and environmental quality agencies from the six states in the lower Mississippi River Basin. It provides a regional forum for the conservation of natural resources of the Mississippi River floodplain and focuses on habitat restoration, long –term conservation planning and nature-based economic development. Participating states include Arkansas, Kentucky, Louisiana, Mississippi, Missouri and Tennessee.

The group is currently working on the Lower Mississippi River Resource Assessment; a study of the information needed for river-related management, the needs of natural habitats and species, and the need for more river-related recreation and public access. The draft of this document is expected to be completed late 2013.

Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) is a partner in nutrient reduction both generally, in terms of mission overlap, as well as specifically through NRCS initiatives. The Kentucky Division of Water attends all meetings of the State Technical Committee and works with NRCS to prioritize areas for nutrient management and water quality best management practice implementation.

The Mississippi River Basin Healthy Watersheds Initiative (MRBI) is a partnership of NRCS, producers and landowners to implement voluntary conservation practices that improve water quality, restore wetlands, enhance wildlife habitat and sustain agricultural profitability in the Mississippi River Basin. Watersheds selected for this program in Kentucky include the Lower Green, Licking, Red and Bayou De Chien-Mayfield. MRBI uses key conservation practices such as nutrient management, conservation crop rotation, cover

crops and residue and tillage management to address concerns in the region. Technical and financial assistance are provided through Cooperative Conservation Partnership Initiative (CCPI) and Wetlands Reserve Enhancement Program (WREP).

The National Water Quality Initiative (NWQI) began in 2012. It is an NRCS initiative that provides a percentage of the Environmental Quality Incentives Program (EQIP) funding to 165 small watersheds throughout the nation where nitrogen, phosphorous, sediment and pathogens are a critical concern. NRCS identified priority watersheds through the help of local partnerships and state water quality agencies. Kentucky basins selected for NWQI are Bennettstown-Little River, Headwaters Hinkston Creek and Clarks Run. Under this program, producers receive assistance for installing conservation systems including nutrient management, cover crops, conservation cropping, filter strips, terraces, and in some cases, edge-of-field water quality monitoring.

NRCS also works to certify Technical Service Providers (TSP) to assist landowners in developing conservation plans and design and installation of conservation practices. A list of available TSPs can be found at www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/technical/tsp/.

A complete list of NRCS programs can be found at www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/farmbill/?&cid=nrcs143_008208.

United States Geological Survey

The United States Geological Survey (USGS) is a science organization providing information on ecosystems and the environment. They are charged nationally with managing water, biological, energy and mineral resources. Kentucky is fortunate to have a local Water Science Office. Much of the baseline information for nutrient impacts in the state came from the use of USGS gauging stations. Additionally, the early nutrient information for loading estimates came from the USGS SPARROW model.

Kentucky Division of Water also participates in the Kentucky Agriculture and Science Monitoring Committee (KASMC) that was founded by USGS in 2009. Members represent a wide range of state, federal and local agencies as well as academic institutions and the agricultural industry. KASMC works collectively to coordinate resources and expertise in order to address the agricultural science and monitoring needs of the citizens of Kentucky. KASMC also serves as a subcommittee under Kentucky's Agriculture Water Quality Authority and provides information to help resource managers.

Ohio River Valley Water Sanitation Commission

The Ohio River Valley Water Sanitation Commission (ORSANCO) was authorized in 1936 through Public Resolution 104 of the 74th Congress of the United States to improve water quality in the Ohio River. Membership in ORSANCO includes 8 member states and the federal government. Participation was codified by Kentucky Revised Statutes 224.18-760 in 1942. Final establishment of the Commission occurred in 1948.

ORSANCO operates programs to improve water quality in the Ohio River and its tributaries, including: setting wastewater discharge standards; performing biological assessments; monitoring for the chemical and physical properties of the waterways; and conducting special surveys and studies. ORSANCO also coordinates emergency response activities for spills or accidental discharges to the river, and promotes public participation in programs.

Agriculture Water Quality Authority

The Kentucky Agriculture Water Quality Authority is a multidiscipline peer group of 10 state or federal agencies and organizations and 3 at-large members that work together to evaluate, develop, and improve best-management practices in conservation plans, compliance plans, and forest stewardship management plans; establish statewide and regional agriculture water quality plans; and otherwise promote soil and water conservation activities that protect waters of the Commonwealth from the adverse impacts of agriculture operations. The Authority was established in 1994 through Kentucky Revised Statute 224.71-110.

Kentucky Division of Conservation

The Kentucky Division of Conservation (KDOC) provides assistance to the 121 conservation districts for development, administration and implementation of sound conservation programs. The conservation districts assist landowners and land users in solving soil and water resource problems.

Since 1994, the KDOC has worked to provide financial and technical assistance to producers for planning and installation of best management practices. Producers must have an Agriculture Water Quality plan on file with their local conservation district to be eligible for this state cost share funding. The funding comes from the Kentucky General Assembly through direct appropriations to the program from the Tobacco Settlement Funds and from funds provided by the Kentucky Department of Agriculture.

Practices eligible for cost share are agriculture and animal waste control facilities; streambank stabilization; animal waste utilization; vegetative filter strips; integrated crop management; pesticide containment; sinkhole protection; pasture and hay land forage quality; heavy use area protection; rotational grazing system establishment; water well

protection; forest land and cropland erosion control systems; closure of agriculture waste impoundment; on-farm fallen animal composting; soil health management; precision nutrient management; strip intercropping system; livestock stream crossing and riparian area protection. For more information about the State Cost Share program, visit conservation.ky.gov/Pages/StateCostShare.aspx.

Kentucky Governor's Office of Agriculture Policy

The Kentucky Governor's Office of Agricultural Policy is a link between the Governor and agriculture industry. The office provides staff to the Kentucky Agricultural Development Board, the Kentucky Agricultural Finance Corporation and the Kentucky Agricultural Resource Development Authority. The office also represents Kentucky interests in state and national agricultural policy.

Chapter II

Chapter II begins the portion of the document where the Division outlines goals for the future. The sections of this portion conclude with tactics and actions that will help outline the path of KDOW in reducing nutrients in Kentucky and to the Gulf of Mexico. As the Nutrient Reduction Strategy continues, the tactics and actions of the strategy may evolve to meet new requirements as new information is gained. This strategy should be considered iterative and actions are based on current knowledge of concerns. These Tactics and related Actions will guide the implementation and progress reporting for the Nutrient Reduction Strategy. See Appendix A for a list of all tactics and actions for the Nutrient Reduction Strategy and the anticipated schedule of implementation.

4. Assess and Prioritize Watersheds

Implementing and tracking nutrient reduction activities, as well as monitoring success of these activities will be accomplished at two basic scales of watershed size. Larger river basins are useful for identifying major areas that deliver excess nutrients to larger waterbodies downstream, such as the Ohio River and the Mississippi River, and for implementing and tracking activities that are state- or basin-wide in nature. Most activities are implemented on smaller watershed scales, however, and are more focused on water quality in the local area and more immediate downstream waters. Prioritizing and targeting smaller watersheds for specific activities allows for more effective implementation and easier tracking of small scale changes.

Information on nutrient loads from HUC6 and HUC8 watersheds will be compiled in order to identify general areas with greater contribution to the excess nutrients in downstream

waters. HUC6 levels in Kentucky include entire river basins while HUC8 level watersheds contain portions of river basins. Several sources of information are available for prioritization, including computer models and monitoring data from state, regional, and federal monitoring programs. The USGS SPARROW model report in 2002 shows Kentucky with net incremental loads of 303,697 kg/year of TN and 9,266 kg/year of TP. See Figures 4.1 and 4.2 for distributions of incremental yields of TN and TP for the Mississippi/Atchafalaya River Basin. The SPARROW report also allows us to look at the proportion of the nutrient flux comparing each contributing state. Since the Mississippi River covers 41% of the land area and includes drainage from all or part of 31 states, the ability to compare input is very important (Committee on the Mississippi River and the Clean Water Act, National Research Council, 2008). According to the USGS SPARROW report of 2002, Kentucky is responsible for 6.1% of the TN flux and 9.0% of the TP flux, ranking 6th for TN and 5th for TP of the contribution from those 31 states.

The USGS SPARROW model for the Mississippi River Basin (Alexander et al 2002) estimated the N and P yield (load per area) that is ultimately delivered to the Gulf of Mexico from drainages in the basin. The model, and the associated SPARROW Decision Support System, will be used to examine these delivered yield estimates, as well as estimates of incremental yields, or the yields originating in each basin. Whereas the delivered yields are helpful in identifying watersheds most responsible for Kentucky's share of nutrient inputs to the Gulf, the incremental yields represent the likelihood of high nutrient inputs within the basin which affect more immediate downstream waters. Both the delivered yield and incremental yield are important factors that will be considered in prioritization. It is important to remember that this information is modeled and not actual measured data at all of these locations.

Monitoring data are available for HUC6 and some HUC8 level watersheds from several monitoring programs. These data will be used to estimate current nutrient loads, and where possible, identify recent trends. KDOW maintains an Ambient Water Quality Monitoring Network with 73 primary monitoring stations statewide, and 105 stations sampling on a rotating basin schedule (Figure 4.3). Many of the stations in this network correspond to USGS gages, which has made possible an analysis of trends by USGS using the data from this network for the period of 1979-2004 (http://pubs.usgs.gov/sir/2009/5027/). Additional data are available from ORSANCO, which maintains monitoring stations along the Ohio River and its major tributaries (http://www.orsanco.org/bimonthly-water-quality-sampling). A small number of stations in USGS's National Stream Quality Accounting Network (NASQA) and National Water Quality Assessment Program (NAWQA) also will provide data for estimating loads.

All of this information will be used to prioritize areas for implementation and additional study. These tools help KDOW target limited resources for greater investment of time to improve water quality in key areas.

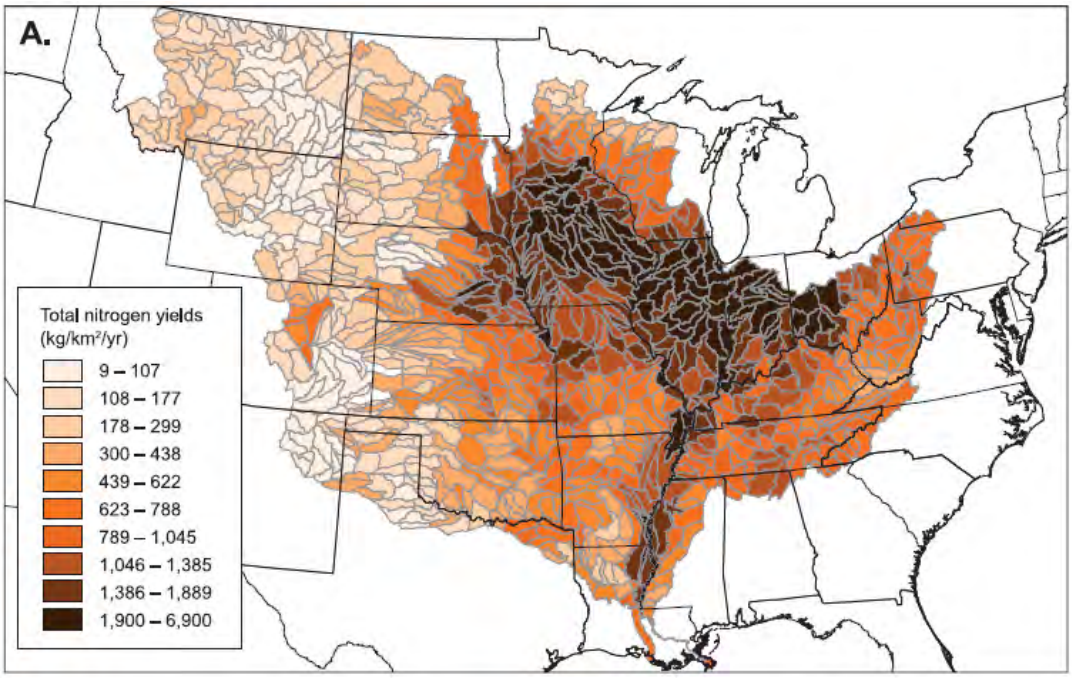

Figure 4.1 Distributions of incremental yields of total nitrogen for HUC8 watersheds in the Mississippi/Atchafalaya River Basin for conditions similar to 2002 (Robertson et al 2009)

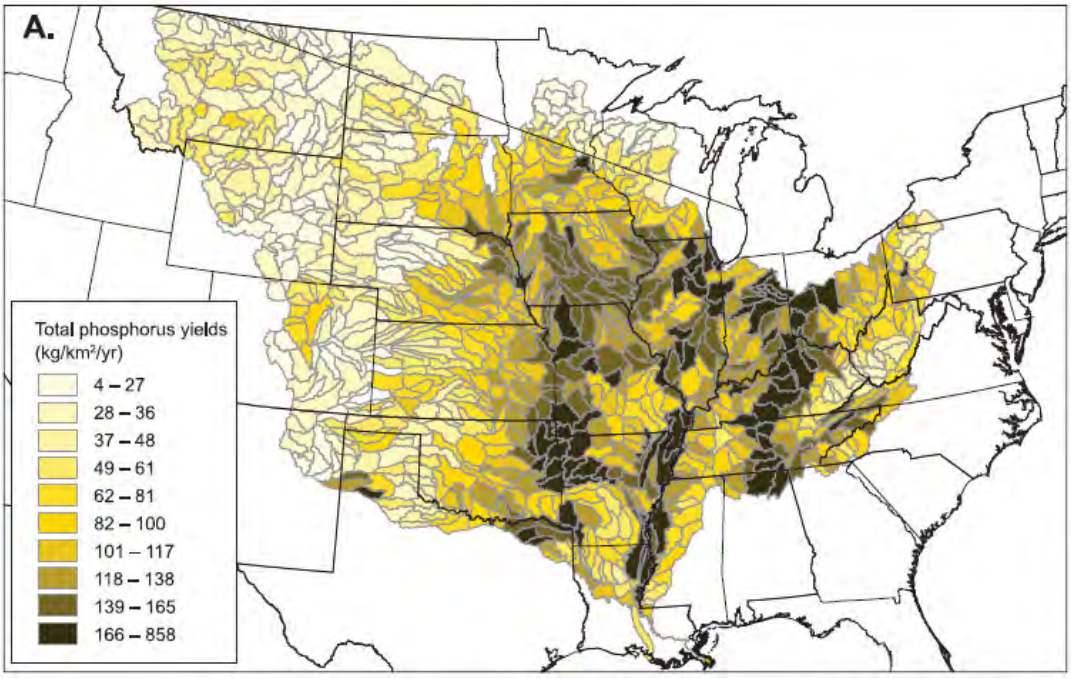

Figure 4.2 Distributions of incremental yields of total phosphorus for HUC8 watersheds in the Mississippi/Atchafalaya River Basin for conditions similar to 2002 (Robertson et al 2009)

Figure 4.3 KDOW sampling ambient sampling locations

4.1Monitoring

Kentucky Division of Water's ambient and probabilistic monitoring of water quality provides valuable information for the development of the Integrated Report to Congress every two years. While the information collected through normal monitoring is valuable, in order to prioritize watersheds, Kentucky has been working to fill data gaps to complement the regularly collected data. The first study to fill a known gap was conducted in 2007 and 2008 in the Crawford-Mammoth Cave Upland ecoregion. This publication is available at pubs.usgs.gov/sir/2010/5164/. Additional studies were funded with USGS in 2013 and 2014 to complete studies in the Inner and Outer Bluegrass. In addition to nutrient levels, Kentucky will also be tracking Harmful Algal Blooms (HABs) to help determine the impacts nutrients are having in streams and reservoirs.

Baseline conditions for nutrient concentrations for Kentucky will be determined using Division of Water ambient site data (Figure 4.3) along with the information from the USGS NAWQA and NASQAN sites (Figure 4.4) and data collected along the Ohio River and its major tributaries by ORSANCO (Figure 4.5). Kentucky has many years of data available publicly through the Water Quality Portal, which includes information from many agencies including USGS and KDOW. USGS information can be found on their nutrient info page or at ORSANCO on their bimonthly sample page. The National Water Quality Monitoring Council also has a Water Quality Portal with data from USGS, EPA and the National Water Quality Monitoring Council available for download.

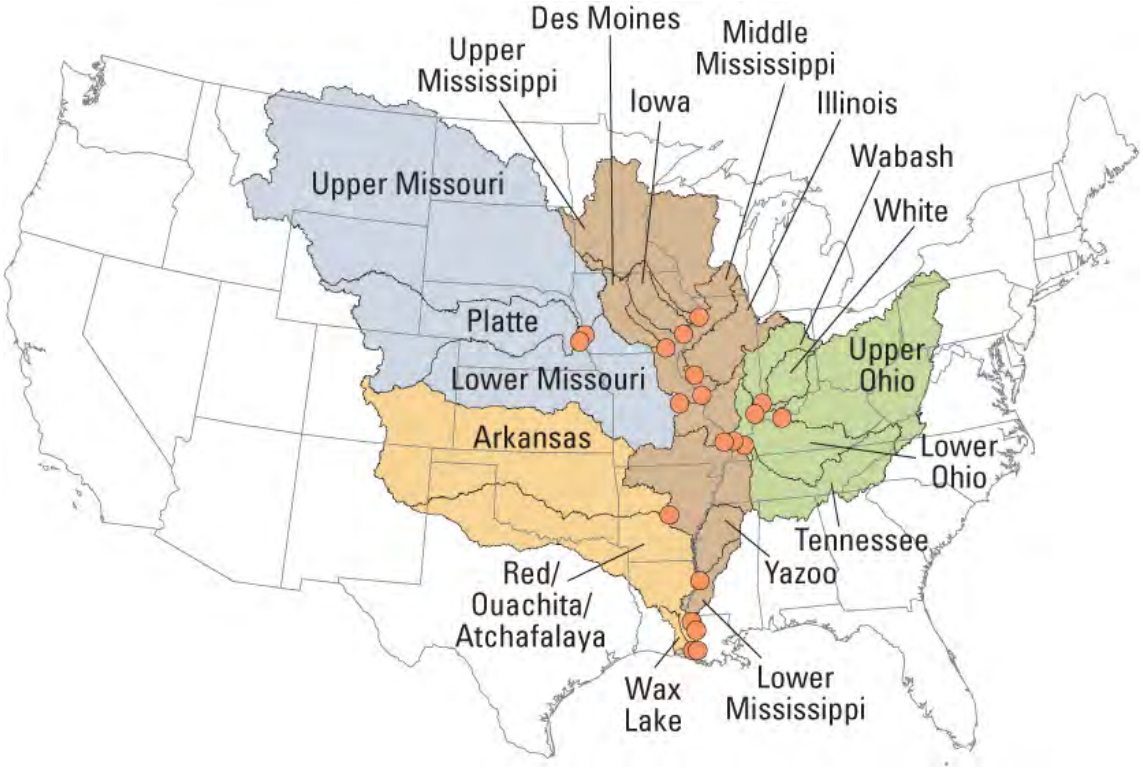

Figure 4.4 NASQAN sampling locations

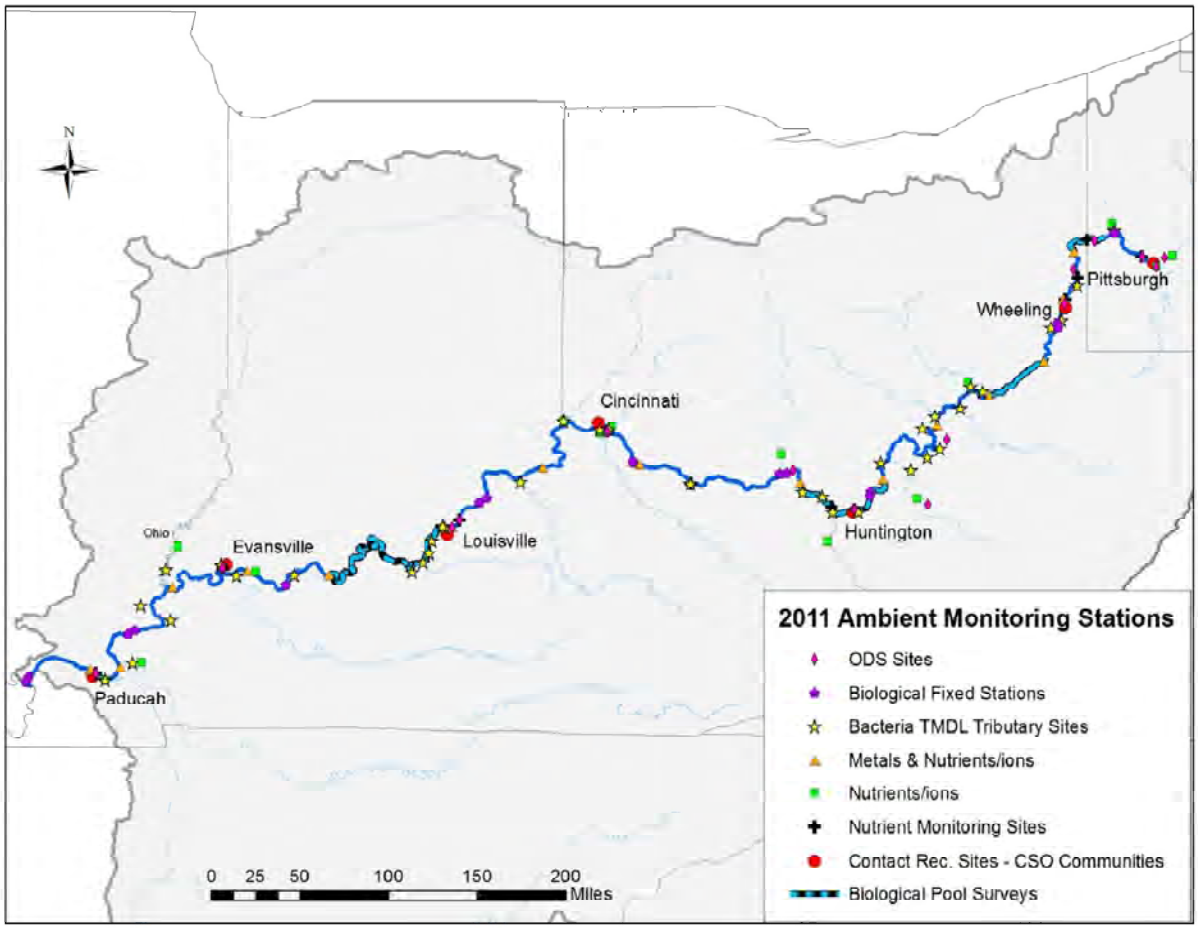

Figure 4.5 ORSANCO ambient monitoring stations

To achieve the goal of **Assess and Prioritize Watersheds**, KDOW has developed specific tactics and actions. See Appendix A for a list of all tactics and actions for the Nutrient Reduction Strategy and the anticipated schedule of implementation.

Tactic

Establish baseline loading data for Kentucky

Specific Actions

Perform data analysis of existing data from USGS, ORSANCO, KDOW and KWRRI

Assemble a data review team of partner agencies

Compile weather/rainfall data for large river systems

Determine loading estimates for each major river basin (HUC6 or HUC8 scale)

Establish trend analysis for concentrations for each major river basin

Identify data gaps

4.2 Prioritization

Watersheds for targeting specific nutrient reduction activities will be chosen at the HUC12 level, focusing on the HUC6 or HUC8 watersheds identified in section 4 as being the areas with the greatest concern for either local or downstream nutrient loadings. HUC12 watersheds will be prioritized using information from monitoring data and past assessments, information on nutrient impacts and problems, and the results of predictive tools designed to identify places where activities are likely to be successful.

KDOW monitors water quality in small and large waterbodies throughout the state through its statewide monitoring programs, including the Ambient Water Quality Network described in section 4.1. The data from these programs are used primarily to identify the extent to which waterbodies are meeting water quality standards. Monitoring data also are contributed from other entities, such as Kentucky Department of Fish and Wildlife Resources, Kentucky State Nature Preserves Commission, US Forest Service, and US Army Corps of Engineers. KDOW's monitoring programs and water quality assessments are described in the Integrated Water Quality Report sent to EPA every two years (http://water.ky.gov/waterquality/pages/integratedreport.aspx). Past and ongoing assessments will provide information of known areas where nutrient impacts are occurring.

One area of emerging concern regarding the impact of nutrients on waterbodies is the potential for harmful algal blooms (HABs) in Kentucky's lakes. Limited data are available regarding the extent and severity of HABs in Kentucky. KDOW initiated a multi-agency HAB Advisory Task Force in 2013 with a goal of better understanding the severity of HABs in Kentucky, creating channels of communication for the sharing of HAB-related information, developing resources for public education on HABs, and establishing common methods and triggers for advising the public of risks associated with HABs.

An important consideration in prioritizing HUC12 watersheds will be the likelihood that nutrient reduction activities will be successful in reversing nutrient-related problems. EPA's Recovery Potential Tool uses traits related to the ecological and social setting of watershed, combined with information on pollutants, to develop a ranking for the potential for recovery. This tool provides a rapid and flexible means to make complex comparisons of using a large set of indicators.

To achieve the goal of **Assess and Prioritize Watersheds**, KDOW has developed specific tactics and actions. See Appendix A for a list of all tactics and actions for the Nutrient Reduction Strategy and the anticipated schedule of implementation.

Tactic

Identify Priority watersheds (HUC12 scale)

Specific Actions

Establish a Nutrient Management Steering Committee

Use Recovery Potential Screening Tool to determine watershed recovery rankings

Determine Nutrient Priority Watersheds

Tactic

Compile Priority watershed information

Specific Actions

Determine baseline load for Nutrient Priority Watersheds

Determine data gaps

Analyze land use in Nutrient Priority Watersheds

Establish load reduction goals for Nutrient Priority Watersheds

Compile source-specific BMP list to Nutrient Priority Watersheds

Tactic

Harmful Algal Blooms (HABs)

Specific Actions

Develop procedures for tracking occurrences of HABs

Participate in HAB workgroup

Develop Frequently Asked Questions document for HABs

Develop fact sheet for water treatment plants about HABs

5. Source Specific Strategies for Nutrient Management

Some tools and approaches are statewide and others are specific to targeted watersheds or watersheds with nutrient impaired reaches. Once designated, Nutrient Priority Watersheds will have plans developed that include a list of appropriate BMPs, educational tools and specific load reduction goals. These plans will not contain specific BMPs required for implementation, but a list of tools that are appropriate for that watershed in reducing nutrient levels.

5.1 Point Sources

Point sources include a wide variety of permitted discharges. This includes wastewater treatment plants, industrial discharges as well as entire cities permitted through the MS4 program. The Division of Water inspects more than 20% of the total number of permitted wastewater facilities throughout the Commonwealth each year, as dictated by Kentucky's Clean Water Act Section 106 grant commitments. In addition to routine inspections, the Division conducts Compliance Sampling Inspections (CSI) in order to provide comparative analysis for Discharge Monitoring Report (DMR) data received from self-monitoring facilities. Inspectors routinely offer technical assistance to wastewater treatment operators in order to return the facility to compliance through education and outreach regarding proper operation and maintenance of systems. Inspectors also work with systems to reduce infiltration of storm water and groundwater that influence the design capacity of the plant. KDOW inspectors also regularly respond to citizen complaints regarding sewage discharges and, through enforcement procedures, improve compliance of failing systems or unpermitted discharges.

In 2014, the Division formed a Wastewater Advisory Council to obtain stakeholder input and advice on technical, regulatory and policy issues relating to wastewater. As with other environmental sectors, wastewater is becoming more complex especially with the challenge of operating, maintaining and regionalizing wastewater infrastructure. The Council will provide helpful insight and opportunity to effectively collaborate among the agencies challenged with managing wastewater.

To achieve the goal of developing **Source Specific Strategies for Nutrient Management**, KDOW has developed specific tactics and actions. See Appendix A for a list of all tactics and actions for the Nutrient Reduction Strategy and the anticipated schedule of implementation.

Tactic

Track decreasing nutrient inputs through permitting actions

Specific Actions

Conduct analysis of DMR data

Track number of permits with TP limits

Track number of permits with TN limits

Track number of permits with monitoring requirements

Track number of general construction permits issued

Track number of package plants removed from service

Track number of CSO overflows

Track compliance and the need for technical assistance at wastewater treatment facilities

Conduct meetings of the Wastewater Advisory Council

Tactic

Municipal Separate Storm Sewer System (MS4) Program

Specific Action

Track number of people attending urban training events offered by MS4 communities

Tactic

Reduce nutrient inputs to streams through SRF funding

Specific Actions

Number of funded projects with enhanced removal

Number of CSOs/SSOs removed with funds

Tactic

Update Kentucky Nutrient Criteria Development Plan

Action

Benchmark surrounding state numeric and narrative nutrient standards

Investigate technology and associated cost for enhanced nutrient removal

Participate in EPA Region 4 Regional Technical Advisory Group on nutrients

5.2 Agriculture

The challenge of nutrient management on agricultural lands comes in balancing crop requirements with application rates. Some addition of nutrients is often necessary for optimum crop yield; however, incorrect timing or placement can result in loss of nutrients, resulting in increased nutrient concentrations in streams. Nutrients are a valuable asset to agriculture and their loss to streams is a loss of income. Since the individual farmer can choose which BMPs to install to prevent nutrients from reaching the stream, education will also be a valuable approach to reducing nutrient pollution in Kentucky. KDOW routinely inspects agricultural facilities and requires the completion of an Agriculture Water Quality Plan that includes BMP plans that reduce the volume of nutrients reaching surface water. KDOW has communication protocols that coordinate state and federal agencies to ensure support for stakeholders that need assistance in nutrient reduction.

To achieve the goal of developing **Source Specific Strategies for Nutrient Management**, KDOW has developed specific tactics and actions. See Appendix A for a list of all tactics and actions for the Nutrient Reduction Strategy and the anticipated schedule of implementation.

Tactic

Reduce nutrient pollution through BMP installations on farms

Specific Actions

Compile information on BMP effectiveness and costs

Track number of CNMPs developed annually with NRCS funds

Track number of BMPs installed in Nutrient Priority Watersheds

Track number of BMPs installed in NWQI watersheds

Track number of BMPs installed in MRBI watersheds

Track trend in State Cost Share dollars

Track trend in NRCS cost share dollars

Track load reductions from installation of BMPs with Clean Water Act Section 319(h) funds

Tactic

Increase the number of farmers with updated and implemented AWQP

Specific Actions

Conduct Kentucky Nutrient Management Plan training

Track number of people trained annually at Kentucky Nutrient Management training events

Conduct AWQP training events

Track number of AWQPs completed or updated annually

Conduct open forums in Nutrient Priority Watersheds

Develop updated AWQP workbooks for farmers completing paper plans

5.3 Other nonpoint source pollution

As shown in Figure 1.2, pollution comes from many sources. Most of the sources have been addressed above; however, urban lands in non-MS4 areas and rural lands (non-agricultural)also contribute to nonpoint source pollution. In these areas, onsite wastewater disposal is often the largest concern; however, stormwater management can also result in lower nutrient levels even in mostly rural watersheds. While legacy channel sediment and natural lands also contribute to overall nutrient concentrations, no specific actions to reduce that these effects are included at this time.

To achieve the goal of developing **Source Specific Strategies for Nutrient Management**, KDOW has developed specific tactics and actions. See Appendix A for a list of all tactics and actions for the Nutrient Reduction Strategy and the anticipated schedule of implementation.

Tactic

Reduce nutrient pollution from non-agriculture nonpoint sources

Specific Actions

Compile information on BMP effectiveness and costs

Conduct training events on reducing nonpoint source nutrient pollution

Track number of people trained at onsite-septic education events

Track number of people attending Low Impact Development training events

Track load reductions from BMPs installed on non-agricultural lands with Clean Water Act Section 319(h) funds

5.4 Trading

The Kentucky Department for Environmental Protection is participating in the Ohio River Basin Pilot Water Quality Trading Program. The purpose of the pilot is to evaluate the feasibility of intrastate and interstate water quality trading, to refine the credit generation and transaction process prior to a future regulatory compliance scenario, and develop and test a tracking registry for the pilot that includes documentation of the practices and verification of their installation. The pilot involves conservation and water quality agencies in Indiana, Kentucky and Ohio. The project provides funding to agricultural producers to implement additional conservation practices that reduce nutrient loads. The load reductions from these projects are modeled to generate available credits. Credits would be available for purchase to retire as stewardship credits during the pilot project. Water quality trading could provide additional methods of funding nutrient load reductions for producers and provides additional methods to meet future permit requirements. A trading registry also provides an opportunity to offset the cost of control equipment for permittees that generate load reductions greater than those needed by the regulated permittee.

5.5 Education

The knowledge gaps identified in surveys like those completed by KEEC (2009) demonstrate the need for education of the general public about their impact on water resources. In order for there to be a change in behavior, there must be more education of the public and a better understanding of community leaders about the impacts to water quality from these sources of nutrients. Many educational resources have been developed on the topic of nutrients and are available for free. Below is a list of some of the sites with a variety of age appropriate resources for training both in the classroom and for the general public.

Sources for Educational Materials

- Community Outreach Toolkit: The toolkit is designed to assist watershed groups, NGOs, states, and federal partners with messaging and outreach to the media about nutrient pollution through newspapers, magazines, radio stations, television stations and websites.
- EPA's Nutrient Pollution Outreach and Education Materials: The site includes a wealth of information on EPA actions to reduce nutrient pollution, state efforts to develop numeric nutrient criteria, and EPA tools, data, research, and reports. There is also information for homeowners, students, and educators, including basic information about the sources of nutrient pollution; how it affects the environment, economy, and public health; and what people can do to reduce the problem.
- EPA's What You Can Do: In Your Classroom: Online educational resources from EPA and other federal agencies. Teachers and students can work to reduce and prevent nutrient pollution in their communities through these resources for use in the classroom.
- Future Farmers of America Curriculum – EPA worked with several federal agencies on lesson plans for young farmers about source water protection and management practices that can help control runoff to protect surface and groundwater.
- KYTC MS4 toolkit: Kentucky's Transportation Cabinet compiled this list of resources for MS4 communities to help them have tools to utilize in Stormwater education.
- NRCS:
    - Backyard Conservation: Tips for conservation practices that help conserve and improve natural resources around your home.
    - Science and Technology Training Library: This portal serves as a launching point for current and archived forestry, conservation, bioenergy and natural resource webinars.

To achieve the goal of **Education**, KDOW has developed specific tactics and actions. See Appendix A for a list of all tactics and actions for the Nutrient Reduction Strategy and the anticipated schedule of implementation.

Tactic

Conduct training for audiences in Nutrient Priority Watersheds and professional audiences about nutrients

Specific Actions

Track number of nutrient specific presentations

Track number of educators trained in Project WET in Nutrient Priority Watersheds

6. Document and Verify Progress

Progress of the Nutrient Reduction Strategy will initially be tracked through completion of actions and tasks associated with implementing or strengthening nutrient reduction activities. These goals can be measured and reported on over relatively short timeframes. Changes in nutrient loads, concentrations, and impacts that result from these activities require longer timeframes to measure. Goals for these measures are expected to take varying amounts of time to meet, depending on the size of the watershed and the specific reduction activities being implemented. Once priority watersheds are selected and specific nutrient reduction activities identified, KDOW will outline specific measures and goals for those activities.

6.1 Success Monitoring

The outcome of efforts to reduce nutrients will be measured by monitoring changes in nutrient loads, concentrations, and impacts. Once load estimates and concentrations for HUC6 or HUC8 watersheds are determined (see section 4) these will serve as a baseline for measuring nutrient reduction trends over time. A monitoring strategy will be established to ensure that comparable nutrient data will be collected at necessary intervals on a long term basis.

Monitoring changes in HUC12 watersheds will focus on trends in nutrient concentrations and impacts. Most measures and goals for monitoring changes in HUC12 watersheds will be specific to the watershed in question.

Monitoring for success will be done through targeted efforts in nutrient priority watersheds as well as through trend analysis of the Kentucky ambient monitoring network. Ambient sampling is done through the Water Quality Branch and with the support of the Compliance and Technical Assistance Branch's ten (10) regional offices.

To achieve the goal of **Document and Verify Progress**, KDOW has developed specific tactics and actions. See Appendix A for a list of all tactics and actions for the Nutrient Reduction Strategy and the anticipated schedule of implementation.

Tactic

Monitor water quality for changes in nutrient levels

Specific Actions

Establish monitoring locations for trend

Analyze data from baseline sources

Track baseline location data to determine changes over strategy timeframe

6.2 Reporting

As part of regular grant commitments, KDOW is responsible for reporting program success through a variety of EPA strategic reporting measures. Some of these measures have requirements that could include reporting of nutrient reduction successes. Measures specific to the watershed program and nonpoint source program (SP-10, 11 and 12 and WQ-10) require watershed scale improvements in water quality. Measures of other programs, including permitting and inspection activity, may also help in tracking a reporting of the Kentucky Nutrient Reduction Strategy. Information on specific EPA reporting measures can be found at water.epa.gov/resource_performance/planning/FY-2013-NWPG-Measure-Definitions-Water-Quality.cfm. The EPA accepted success stories for the states are on the EPA NPS Success Story webpage. Additionally, KDOW will be compiling annual reports of progress on achieving tactics and actions as encouraged in the Stoner Memo. These reports will be issued on a calendar year schedule.

To achieve the goal of **Document and Verify Progress**, KDOW has developed specific tactics and actions. See Appendix A for a list of all tactics and actions for the Nutrient Reduction Strategy and the anticipated schedule of implementation.

Tactic

Report annually on progress towards accomplishing milestones

Specific Actions

Complete report annually

Compile and report load reductions every even-numbered year

Tactic

Report Success Stories

Specific Actions

Track SP-10, 11 or 12 or WQ-10 success stories that are submitted for nutrient impaired watersheds

Provide stories for publication in Land, Air and Water of individuals or entities that do something they didn't have to that reduces nutrients

7. Public Outreach and Stakeholder Involvement

Education will occur to specific audiences in targeted areas. However, since much of nutrient pollution occurs without traveling through a pipe, the education will need to be broad based and reach all the citizens of the state.

To achieve the goal of **Public Outreach and Stakeholder Involvement**, KDOW has developed specific tactics and actions. See Appendix A for a list of all tactics and actions for the Nutrient Reduction Strategy and the anticipated schedule of implementation.

Tactic

Encourage public input into the nutrient reduction strategy

Specific Actions

Number of Nutrient Management Steering Committee meetings

Press releases or Blog posts about nutrient management

Maintain and update the Nutrient Reduction Strategy webpage

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Appendix A

Schedule of Implementation

Objective 1 Assess and Prioritize Watersheds

Tactic 1.1 Establish baseline loading data for Kentucky

- Action: Perform data analysis of existing data from USGS, ORSANCO, KDOW and KWRRI
- Action: Assemble a data review team of partner agencies
- Action: Compile weather/rainfall data for large river systems
- Action: Determine loading estimates for each major river basin (HUC6 or HUC8 scale)
- Action: Establish trend analysis for concentrations for each major river basin
- Action: Identify data gaps

Tactic 1.2 Identify Priority watersheds (HUC12 scale)

- Action: Establish a Nutrient Management Steering Committee
- Action: Use Recovery Potential Screening Tool to determine watershed recovery rankings
- Action: Determine Nutrient Priority Watersheds

Tactic 1.3 Compile Priority watershed information

- Action: Determine baseline load for Nutrient Priority Watersheds
- Action: Determine data gaps
- Action: Analyze land use in Nutrient Priority Watersheds
- Action: Establish load reduction goals for Nutrient Priority Watersheds
- Action: Compile source-specific BMP list to Nutrient Priority Watersheds

Tactic 1.4 Harmful Algal Blooms

- Action: Develop procedures for tracking occurrences of Harmful Algal Blooms (HAB)
- Action: Participate in HAB workgroup
- Action: Develop Frequently Asked Questions document for HABs
- Action: Develop Fact Sheet for water treatment plants about HABs

Objective 2 Source Specific Strategies for Nutrient Management

Tactic 2.1 Track decreasing nutrient inputs through permitting actions

- Action: Conduct analysis of DMR data
- Action: Track number of permits with TP limits

	Action	Track number of permits with TN limits
	Action	Track number of permits with monitoring requirements
	Action	Track number of general construction permits issued
	Action	Track number of package plants removed from service
	Action	Track number of CSO overflows
	Action	Track compliance and the need for technical assistance at wastewater treatment facilities
	Action	Conduct meetings of the Wastewater Advisory Council
Tactic 2.2	Municipal Separate Storm Sewer System (MS4) Program	
	Action	Track number of people attending urban training events offered by MS4 communities
Tactic 2.3	Reduce nutrient inputs to streams through SRF funding	
	Action	Number of funded projects with enhanced removal
	Action	Number of CSOs/SSOs removed with funds
Tactic 2.4	Update the Kentucky Nutrient Criteria Development Plan	
	Action	Benchmark surrounding state numeric and narrative nutrient standards
	Action	Investigate technology and associated cost for enhanced nutrient removal
	Action	Participate in EPA Region 4 Regional Technical Advisory Group on nutrients
Tactic 2.5	Reduce nutrient pollution through BMP installations on farms	
	Action	Compile information on BMP effectiveness and costs
	Action	Track number of CNMPs developed annually with NRCS funds
	Action	Track number of BMPs installed in Nutrient Priority Watersheds
	Action	Track number of BMPs installed in NWQI watersheds
	Action	Track number of BMPs installed in MRBI watersheds
	Action	Track trend in State Cost Share dollars
	Action	Track trend in NRCS cost share dollars
	Action	Track load reductions from installation of BMPs with Clean Water Act Section 319(h) funds
Tactic 2.6	Increase the number of farmers with updated and implemented Agriculture Water Quality Plans	
	Action	Conduct Kentucky Nutrient Management Plan Training

	Action	Conduct AWQP training
	Action	Conduct open forums in Nutrient Priority Watersheds to answer questions
	Action	Develop updated AWQP workbooks for farmers completing paper plans
Tactic 2.7	Reduce nutrient pollution from non-agriculture nonpoint sources	
	Action	Compile information on BMP effectiveness and costs
	Action	Conduct training events on reducing nonpoint source nutrient pollution
	Action	Track load reductions from BMPs installed on non-agricultural lands with Clean Water Act Section 319(h) funds
	Action	Track number of people trained at onsite-septic education events
	Action	Track number of people attending Low Impact Development training events

Objective 3 Education

Tactic 3.1	Conduct training for audiences in Nutrient Priority Watersheds and professional audiences about nutrients	
	Action	Track number of nutrient specific presentations to stakeholders
	Action	Track number of educators trained in Project WET in Nutrient Priority Watersheds

Objective 4 Document and Verify Progress

Tactic 4.1	Monitor water quality for changes in nutrient levels	
	Action	Establish monitoring locations for trend
	Action	Analyze data from baseline sources
	Action	Track baseline location data to determine changes over strategy timeframe
Tactic 4.2	Report annually on progress towards accomplishing milestones	
	Action	Complete report annually
	Action	Compile and report load reductions every even-numbered year
Tactic 4.3	Report Success Stories	

Action	Track SP-10, 11 or 12 or WQ-10 success stories that are submitted for nutrient impaired watersheds
Action	Provide stories for publication in Land, Air and Water of individuals or entities that do something they didn't have to that reduces nutrients

Objective 5 Public Outreach and Stakeholder Involvement

Tactic 5.1 Encourage public input into the nutrient management process

Action	Number of Nutrient Management Steering Committee meetings
Action	Press releases or Blog posts about nutrient management
Action	Maintain and update the Nutrient Reduction Strategy webpage

Appendix B

Nutrient Criteria Development Plan for the Commonwealth of Kentucky

Kentucky Department For Environmental Protection

Division of Water

Water Quality Branch

September 2012

This amended report has been approved for release:

_____

Sandy Gruzesky, Director
Kentucky Division of Water

_____

Date

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I. Introduction

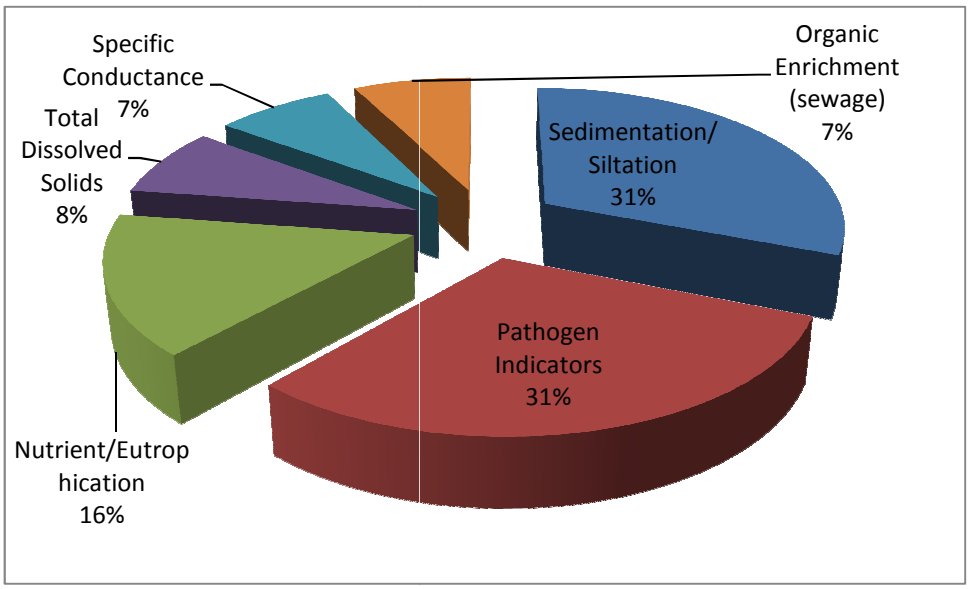
This plan supersedes the previous (October 2008) document entitled *Nutrient Criteria Development Pan For the Commonwealth of Kentucky, as Revised* (2008), submitted to EPA (United States Environmental Protection Agency) in January 2009. Explained within this document the Kentucky Division of Water (DOW) establishes its intent to develop state-specific nutrient criteria rather than adopt the EPA published section 304(a) nutrient criteria. The current plan for DOW brings together the tenets of that document, but expands on the complexity of this subject, both from the technical and administrative challenges this process entails. This plan outlines the nutrient field studies the commonwealth has undertaken during approximately the last 10 years, the environmental relationships considered in developing numeric nutrient criteria that are protective of the aquatic resources, but also reasonable in consideration of the implementation and assessment procedures and processes such a complex regulation demands.

This plan revision is in response to policy issued by EPA in 2001 that encourages states to provide a narrative framework in order to show progress toward criteria development. In 2000 and 2001, EPA published recommended nutrient criteria for lakes and reservoirs and rivers and streams based on national nutrient ecoregion data. The EPA expects states to develop a plan for adopting nutrient criteria into their water quality standards with an approach, including a strategy, milestones and schedule that are mutually agreed upon by states and EPA. States can use the criteria published by EPA or develop their own criteria by a scientifically defensible methodology. If states do not demonstrate substantial progress in adopting criteria according to the plan or have not developed a plan by the end of 2004, EPA has proposed to promulgate their ecoregional criteria. Under the Act (Clean Water Act) Section 303(c)(4)(B) the EPA administrator may exercise authority granted him under the Act and promulgate revised or new water quality criteria for a state where necessary to meet requirements under the Act. Therefore, it is imperative the commonwealth continue to show progress in developing numeric nutrient criteria through annual updates to this mutually agreed upon plan between the DEP - (Kentucky Department For Environmental Protection) DOW and EPA.

Development of numeric nutrient criteria became a consequential topic that rose to the forefront of water quality criteria development needs when it became widely recognized that two prominent coastal resources were in ongoing decline due in large part by nutrient related impairments to designated uses. Meanwhile, as states and tribes report the condition of water quality each biennium as required under the Act the pollutant "nutrients" has become the third leading cause for impairment to the nation's waterbodies (National Assessment, accessed May 13, 2011). Kentucky's 2010 Integrated Report listed "nutrient/eutrophication biological indicators" as the third leading cause of impairment. This pollutant was behind "sedimentation/siltation and fecal coliform + *E. coli* (pathogen indicators)," first and second ranking pollutants, respectively (Figure 1). Given transport mechanism for nutrients is strongly linked to sediment runoff, and bacteria are closely linked as well, it is not surprising the reported order of these pollutants in assessed waterbodies. At time of writing (July 2011), Kentucky is not to the point it can set numeric nutrient criteria, but considerable progress has been made

toward accomplishing that end primarily for wadeable streams. Development of nutrient criteria for reservoirs is slightly behind wadeable streams, while boatable (large) rivers are in the early stages of specific field studies to address the relationship of nutrients and response indicators. Wetlands are the last waterbody type to be considered for nutrient criteria development. The reason for this is quite simply less is known or understood about the nutrient-related dynamics of these waterbodies and indicator response levels.

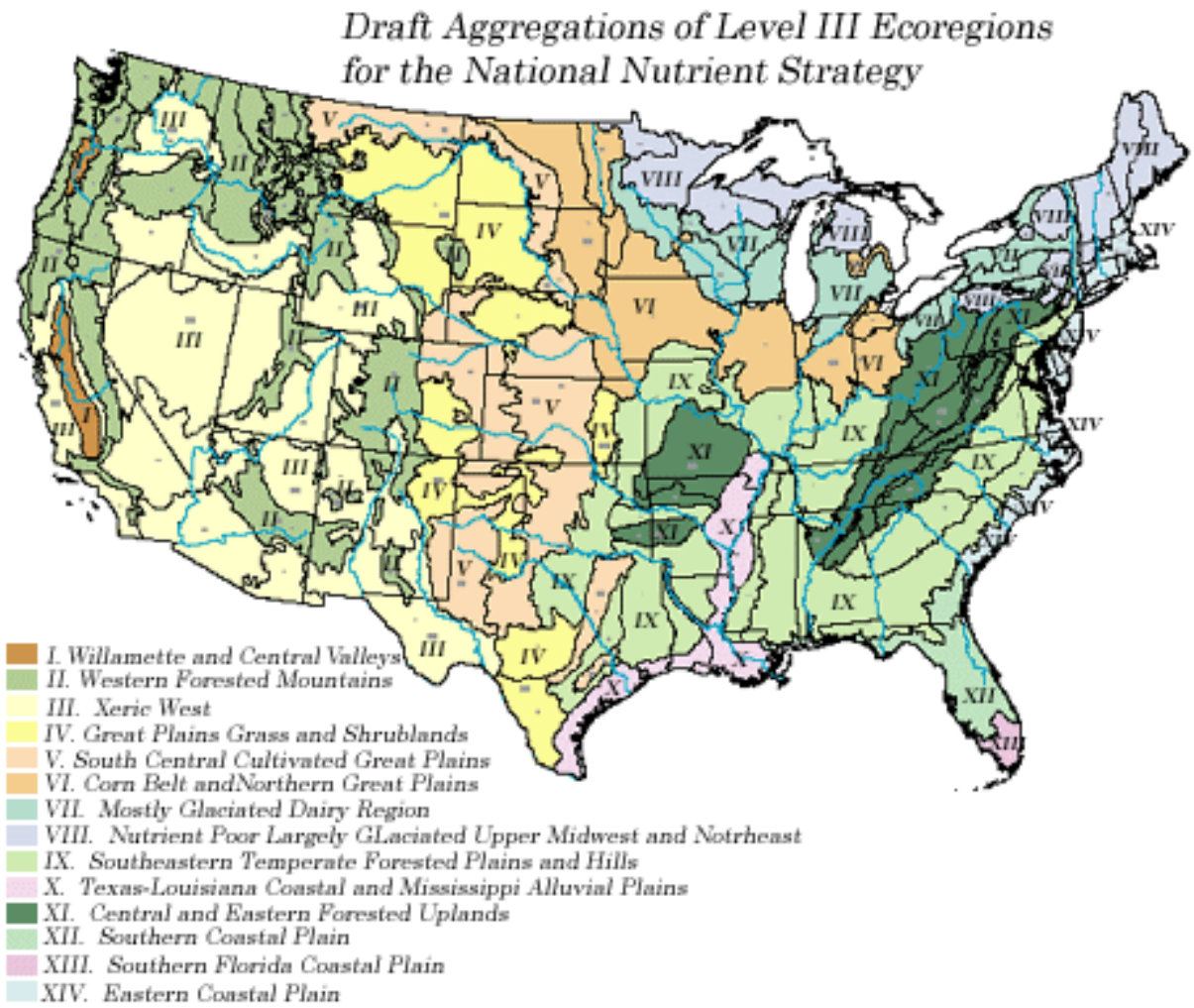
Figure 1. Relative proportion (rounded to nearest integer) of pollutants contributing to impairment in Kentucky streams (2010 Integrated Report).



II. Overview of USEPA's Nutrient Criteria Technical Guidance for Rivers and Streams

In July 2000 EPA published *Nutrient Criteria Technical Guidance Manual For Rivers and Streams* (Guidance), offering states and tribes guidance on how they might consider nutrient criteria development. In that manual there are various approaches that can be taken to develop numeric nutrient criteria. Kentucky boundaries encompass three EPA Nutrient Ecoregions for rivers and streams (Figure 2). Nutrient Ecoregion IX (Southeastern Temperate Forested Plains and Hills) (EPA, 2000) is geographically the largest nutrient region, comprising approximately the western two-thirds of the state. Approximately the eastern one-third of the state is in Nutrient Ecoregion XI (Central and Eastern Forested Uplands) (EPA, 2000). A small portion of the state immediately along the Mississippi River is in Nutrient Ecoregion X (Texas-Louisiana Coastal and Mississippi Alluvial Plains) (EPA, 2001). This region stretches from the Texas Gulf Coast up to the mouth of the Ohio River. Lakes and reservoirs are also distributed within the same three EPA Nutrient Ecoregions; however, the only lakes that occur in Nutrient Ecoregion X are oxbows.

Figure 2. Aggregate Level III Ecoregions Developed for Nutrient Ecoregions by U.S. Environmental Protection Agency. (Source: USEPA Office of Water, Nutrient Ecoregions.)



III. Kentucky's Current Nutrient Criteria and Approach to Numeric Criteria Development.

Kentucky has narrative criteria in its water quality standards to protect waters from unwanted effects of eutrophication. The regulation states, *In lakes and reservoirs and their tributaries, and other surface waters where eutriphication problems may exist, nitrogen, phosphorous, carbon and contributing trace element discharges shall be limited in accordance with:*

1) *the scope of the problem;*
2) *the geography of the affected area; and*
3) *relative contributions from existing and proposed sources.*

The DOW uses this narrative to apply phosphorus controls on point source dischargers to reduce cultural eutrophication in receiving waters on a case-by-case basis.

Rather than using default national Section 304(a) criteria developed by EPA for specific broad nutrient regions for streams, rviers and lakes (reservoirs), Kentucky prefers to develop criteria that reflect localized conditions wherever possible to protect certain designated uses. The DOW will utilize processes outlined in the technical guidance manuals to produce scientifically defensable criteria. The DOW and other Region IV states have found the 304(a) nutrient criteria suggested by EPA to be on a scale too large to reflect local conditions that vary by states within the broad nutrient regions that were identified in Ecoregion Level III due to heterogeniety of these diverse regions. In waterbodies that are shared with bordering states (Tennessee, Virginia and West Virginia), consideration will be given to consistency with those neighboring states.

For criteria on all classes of waterbodies, the DOW prefers an effects-based approach offered in the Guidance that reflect localized condtions to protect specific designated uses. Other approaches will be considered should analysis for the preferred approach not provide a clear path to establish nutrient criteria. One alternate approach is distribution analysis that use reference stream condition for each established class of stream and bioregion. Kentucky may choose a different percentile than those suggested in the 304(a) criteria documents and technical guidance. A combination of both effects-based and distributional analysis may be used yielding a weight-of-evidence for nutrient criteria developement; published effects based values may be utilized where warranted. Waterbody criteria development will follow the appropriate EPA technical guidance manuals (USEPA 2000 - 2001). The DOW will prioritize its efforts on protection of the aquatic life use.

Water Class	Use	Parameters
Wadeable Streams	Aquatic Life	TN, TP
Boatable Waters	Aquatic Life	TN, TP, Chlorophyll *a*
Lakes and reservoirs	Aquatic Life	TN, TP, Chlorophyll *a*, Secchi depth
Wetlands (Swamps)	Aquatic Life	TN, TP, Chlorophyll *a,* aquatic macrophytes, unknown

Wadeable Streams

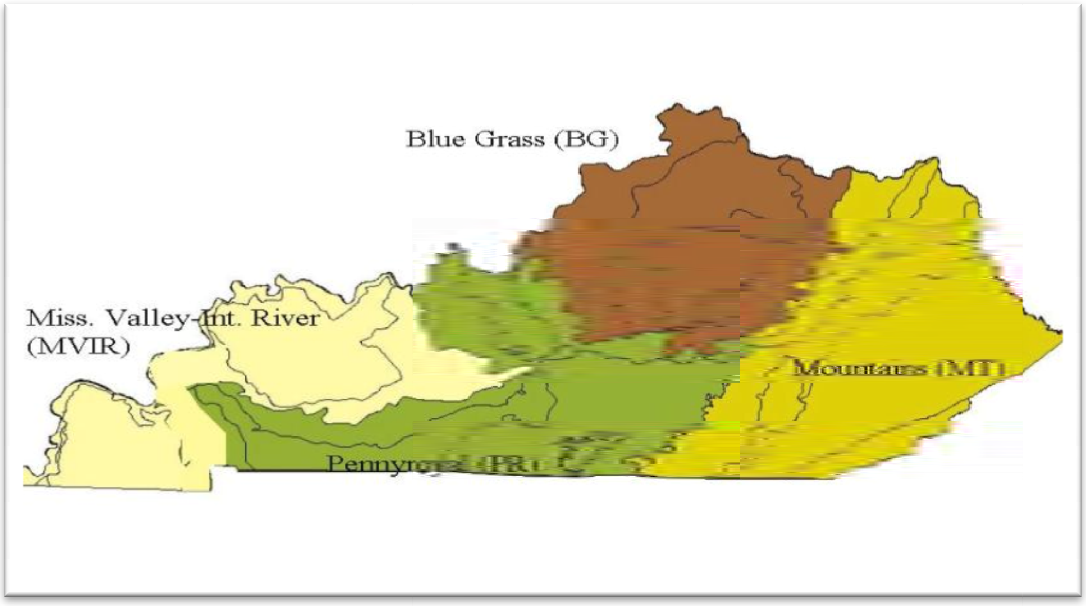
Given the DOW's longstanding wadeable stream biological monitoring programs that go back to the early 1980s the choice was made to begin numeric nutrient criteria development on this class of waterbody. Once criteria are developed and implemented, the majority of waterbody resources in the commonwealth will have numeric nutrient criteria. Response variables under consideration are macroinvertebrates, periphyton (diatoms and other attached algae) and fishes; the causal variables total nitrogen (TN) and total phosphorus (TP). Following is a review of data collection and analysis projects that are ongoing or have occurred to date.

Summary of Projects

The DOW's existing fish, macroinvertebrate and diatom community data obtained from biosurveys sampled from 1999-2007 were analyzed to identify possible thresholds in TN and TP above which there were clear changes in biological integrity or community attributes. Kentucky bioregions (Figure 3) were used as the regional classification, and relationships were examined using non-parametric change-point analysis and visual inspection of scatterplots with LOWESS smoothing functions. Results were used to identify regions with good or poor relationships, highlight potential confounding factors, and prioritize further data collection activities. A DOW report is in preparation summarizing this analysis and other biology-related studies (see below); the expected completion date is end-of-year 2011.

Multiple sources of nutrient data from DOW bioassessment programs were examined to characterize ambient nutrient conditions in wadeable streams across Kentucky's ecoregions and bioregions. Data from Kentucky's Reference Reach network were used as estimates of least impacted conditions regionally. Data from the probabilistic bioassessment program were used to describe the typical range and distribution of nutrient concentrations across ecoregions and bioregions. Finally, nutrient data associated with all samples resulting in "Good" or "Excellent" scores on Kentucky's Macroinvertebrate Bioassessment Index were summarized to estimate nutrient concentration ranges in streams that fully support aquatic life use. Nutrient data for these summaries were primarily collected from one-time grab sample events during normal flow (non-runoff or base flow) conditions during the spring and summer seasons (excludes high flow and conditions below base flow) and were coincident with biological sampling. The analysis is undergoing update with recently collected data. A DOW report is in preparation and expected for completion end-of-year 2011.

Figure 3. Bioregions identified for Kentucky wadeable streams through development of multimetric indices for fishes, macroinvertebrates and periphyton (diatoms).



Additionally, a set of 30 sites was selected from Kentucky's Reference Reach network to represent a full range of ecoregions and stream sizes. Nutrients were sampled twice during high flow or runoff conditions (spring 2006 and spring 2008) and twice during periods of low flow (summer 2006 and late spring 2007) to characterize nutrient conditions under those flow regimes. This study was funded in part through a 104(b)(3) grant from EPA. A final report was submitted in 2008.

In 2007 DOW participated in a study conducted by EPA Region IV. The DOW sampled benthic algae in 10 streams using the Region IV methodology and submitted those samples along with nutrient data to the Region IV project coordinator. The goal of the study was to examine response of algal communities to nutrients in the Southeastern U.S. and to promote collaboration on regional studies. EPA's report on this study is in preparation with no expected completion date available.

Fish, macroinvertebrates, and diatoms were sampled in spring and summer 2008 at 22 streams selected to represent a gradient of expected nutrient inputs; however, all streams required in-stream habitat conditions that scored good to fair. Nutrients were sampled monthly in order to capture short and longer-term antecedent nutrient conditions potentially impacting biological

responses. From this study, a USGS (U.S. Geological Survey) report on analysis of nutrient breakpoints in macroinvertebrate community attributes was published:

> Crain, A.S. and Caskey, B.J., 2010. Breakpoint analysis and relations of nutrient and turbidity stressor variables to macroinvertebrate integrity in streams in the Crawford-Mammoth Cave Uplands Ecoregion, Kentucky, for the development of nutrient criteria: U.S. Geological Survey Scientific Investigations Report 2010—5164, 29 p (http://pubs.usgs.gov/sir/2010/5164/).

In addition to the above report, a DOW report is in preparation describing results from analysis of nutrient and habitat relationships compared with macroinvertebrate, fish and diatom community attributes. It is anticipated the report will be completed by the end-of-year 2011.

A study in the Mountains Bioregion was undertaken by DOW in spring and summer 2008 to collect macroinvertebrate and diatom samples at 14 stream locations selected to represent seven comparable pairs; each stream had a collection site upstream and one downstream of a nutrient source, typically a WWTP (Wastewater Treatment Plant) outfall. Sites were chosen to minimize non-nutrient stressors such as elevated conductivity and degraded habitat. Nutrients were sampled seasonally to characterize year-round conditions. A DOW report is in preparation describing analysis of nutrient relationships with macroinvertebrate and diatom community attributes and is expected to be completed end-of-year 2011.

A random survey design was used to select 25 sites from each of two ecoregions, the Western Pennyroyal Karst Plain and Eastern Highland Rim. Sites were sampled for nutrients and other water quality variables in the fall (2009), spring (2010) and twice in summer (2010). Macroinvertebrates and diatoms were sampled in summer 2010. Results will be used to characterize typical nutrient concentrations in streams in these ecoregions, as well as to examine relationships with the biological community. Data preparation is underway and an analysis report is expected to be completed end-of-year 2011.

Routine monitoring programs for wadeable streams are being reviewed for possible enhancement to better meet the needs of nutrient criteria development and other data needs. The Reference Reach program has added bimonthly water sampling to a subset of Reference Reach segments in order to characterize seasonal variation of nutrient concentrations in reference/least impacted streams. Measurement of flow at these stations is under consideration but is not being implemented at this time. A “rapid periphyton survey” or similar semi-quantitative assessment of algal quantity and condition is under consideration as an addition to routine bioassessment sampling visits.

Boatable (Non-wadeable) Streams

Attachment 1 is a draft implementation plan for the Ohio River developed by the Ohio River Valley Water Sanitation Commission (ORSANCO). We will use elements of this plan

framework to assist in development of nutrient criteria for this class of waterbody; however, since the DOW's plan was originally submitted and subsequent iterations, ORSANCO's development of nutrient criteria has slowed due to various reasons. The DOW will continue to work with ORSANCO on this effort. Our boatable waters biotic database and relationships to designated use impairment are not currently well developed. The DOW is working with ORSANCO to refine biological collection methods, including a new indicator group, macroinvertebrates. Development of this new community index will initially focus on detection of designated use attainment status, but may provide utility in detection of nutrient gradients associated with use support condition. In 2008 DOW participated in EPA's boatable probabilistic study at sites located on the Mississippi River. This was an effort to develop bioassessment methodology. The DOW biological monitoring program will conduct field work to compare, refine and adjust methods to fit local or regional conditions. Once an index is developed it may respond to nutrient gradients for the determination of designated use attainment. Given there are no boatable streams in Kentucky that can serve as a reference condition, least impacted segments of this waterbody class will be included in studies, along with those that may represent a gradient of nutrient conditions throughout the state.

There are limited data collections from selected ambient large river sites. Further collections will depend on available resources and monitoring priorities. Data are needed for several sites in 11 river basins on a monthly or bimonthly basis during the growing season for at least five years to establish background conditions and relationships to aquatic life use.

Current Study

A study specific to boatable waters monitoring for numeric nutrient criteria development was initiated in 2009; field work began in spring 2010. Given the physical characteristics and ecological dynamics of this habitat, response variables will be similar to those applied to reservoirs and lakes. Of the potential nutrient response indicators for this class of waterbodies chlorophyll *a* was selected. The phytoplankton community was considered as a candidate response variable, but not pursued at this time. After investigation into the attributes of including phytoplankton it was determined chlorophyll *a* will likely be the stronger of those two response variables in this class of waterbody. Turbidity measure is not considered a good candidate for a response variable due to the dominant role of suspended inorganic material compared to algal components. Biological community indicators were not considered given the lack of developed collection protocols, seasonal considerations and the time it would take to then develop community indices, as previously noted. A final selection of 33 ambient stations was made from areas across the commonwealth (Table 1). These stations are large watersheds representing either hydrologic or mid-hydrologic (eight digit HUC) stations. However, three of these stations are watershed sites because of specific characteristics desired in the study (primarily boatable or needed for spatial coverage).

Large, boat-only rivers must be put on hold for draft numeric nutrient criteria development; the timeframe is not currently known, but is sure to come after wadeable streams and reservoir criteria are developed. The national probabilistic study findings may be of importance in this effort.

Lakes and Reservoirs

An effects-based approach will be the focus of nutrient criteria development. Candidate response variables will be considered as referenced in the EPA technical guidance for lakes and reservoirs (EPA, 2000). The DOW will initially consider such response variables as chlorophyll *a*, water clarity (Secchi depth), dissolved oxygen and pH. Causal variables will include total phosphorus and total nitrogen. The DOW does not believe EPA's recommended nutrient criteria are applicable to Kentucky reservoirs (EPA, 2000). Preliminary comparisons of data from examples of reservoirs that meet aquatic life designated use show the EPA suggested ecoregional criteria often exceeded, and these exceeded criteria vary by parameter over time (Tables 2 and 3). The values in Tables 2 and 3 represent growing season whole-lake averages from three samples taken form May through October; the normal sampling period to assess designated use support. It is noted some reservoirs (primarily smaller ones constructed and managed by Kentucky Department of Fish and Wildlife [KDFW]) contain some phosphorus enrichment from management for production of game fish; this is a significant element of the public's use of many of these small, local reservoirs. The goal for reservoir nutrient criteria may be related to the historic trophic state condition of those reservoirs that support their designated uses. The historic trophic state condition of reservoirs generally reflect the geology of the region, with most reservoirs either of oligotrophic or mesotrophic nutrient states. Table 4 contains information on the current (as of 2008) trophic state and support level for aquatic life in Kentucky Reservoirs greater than or equal to 1000 surface acres. Figure 4 provides reference for the Level 4 Ecoregions of Kentucky.

In the initial stages consideration will be given to subdivide reservoirs into size classes and ecoregions; however, it is not believed that the ecoregional concept will ultimately apply to manmade reservoirs and those several natural lakes where programmatic monitored data exist. Given the lack of a significant number of natural lakes in Kentucky (and those few are located in West Kentucky), plus the fact the lakes monitoring program has been weighted toward monitoring publically owned and accessible waters, the criteria will apply to manmade lakes (reservoirs). Another issue that may preclude an ecoregional approach in natural lakes is due to significant alteration of water flow in the western portion of the state. This has occurred by the

development of levees, stream diversions, draining of wetlands and channelization for agriculture and land development.

The approach Kentucky has taken for nutrient criteria development requires the use of state-specific waterbody data rather than the use of the EPA national nutrient database. Completed in 2004, the DOW created an Access 2000 database management warehouse through a 104(b)3 EPA grant to migrate reservoir data from three USACE districts to a common database. This database holds 10 years of USACE growing season data from 18 reservoirs (nearly 5000 observations). These data have gone through screening procedures for QA/QC reasons.

Table 1. Statewide chlorophyll *a* stations.

River Basin & Stream	Station	HUC	Mile-point	Location	Latitude (dd)	Longitude (dd)	Collection Frequency[a]	Station Type - Secchi (Y/N)
Big Sandy								
Tug Fork	PRI002	05070201	35.1	at Kermit, WV	37.8379	-82.40970	Dependant on water-year	hydrologic unit index site – N (unlikely to be practicable with bridge sampling & current)
Levisa Fork	PRI064	05070203	29.6	nr Louisa	38.1160	-82.6002	“ “	hydrologic unit index site - Y
Johns Creek	PRI096	05070203	26.6	at McCombs	37.6553	-82.5870	“ “	inflow to Dewey Res. Major tributary - Y
Little Sandy								
Little Sandy River	PRI049	05090104	13.2	at Argillite	38.49053	-82.83404	“ “	hydrologic unit index site - Y
Tygarts Creek							“ “	
Tygarts Creek	PRI048	05090103	23.5	nr Lynn	38.5997	-82.9528	“ “	hydrologic unit index site - N
							“ “	
Cumberland River								
Cumberland River	PRI009	05130101	563.0	at Cumberland Falls	36.83558	-84.34015	“ “	hydrologic unit index site – N (see Tug Fk comment)
Rockcastle River	PRI010	05130102	24.7	at Billows	37.17137	-84.29673	“ “	hydrologic unit index site - N
Cumberland River	PRI007	05130103	423.0	nr Burkesville	36.68879	-85.56670	“ “	hydrologic unit index site - Y
S. Fk. Cumberland R.	PRI008	05130104	44.8	at Blue Heron	36.6703	-84.5492	“ “	hydrologic unit index site - N
Red River	PRI069	05130205	49	nr Keysburg	36.64063	-86.97961	“ “	hydrologic unit index site - N
							“ “	
Kentuck River							“ “	
Kentucky River	PRI114	05100205	56.5	at Frankfort	38.2901	-84.879	“ “	hydrologic unit index site - Y
Kentucky River	PRI066	05100205	30.5	nr Lockport	38.4450	-84.9569	“ “	hydrologic unit index site - Y
Dix River	PRI045	05100205	34.7	nr Danville	37.64176	-84.66113	“ “	hydrologic unit index site - N
Middle Fork Kentucky River	PRI032	05100202	8.4	nr Tallega	37.55505	-83.59373	“ “	hydrologic unit index site - Y
So. Fork Kentucky R.	PRI033	05100203	12.1	at Booneville	37.47513	-83.67082	“ “	hydrologic unit index site

Licking River								
Licking River	PRI111	05100101	35.5	at Butler	38.7898	-84.3674	“ “	hydrologic unit index site - Y

Table 1 (cont.). Statewide chlorophyll *a* stations.

River Basin & Stream	Station	HUC	Mile-point	Location	Latitude (dd)	Longitude (dd)	Collection Frequency[a]	Station Type
Licking River								
Licking River	SRW001	05100101	2.2	At Newport	39.0631	-84.4954	Water year dependant	Watershed - Y
Salt River								
Salt River	PRI029	05140102	22.9	at Shepherdsville	37.98524	-85.71720	“ “	hydrologic unit index site - Y
Salt River	PRI052	05140102	82.5	at Glensboro	38.00231	-85.06028	“ “	major reservoir inflow - N
Brashears Creek	PRI105	05140102	1.2	at Taylorsville	38.03040	-85.35154	“ “	major tributary - N
Floyds Fork	PRI100	05140102	7.4	nr Shepherdsville	38.03447	-85.65936	“ “	major tributary - N
Rolling Fork	PRI057	05140103	12.3	nr Lebanon Jct.	37.82267	-85.74787	“ “	hydrologic unit index site - Y
Chaplin River	SRW002	05140103	17.1	nr Chaplin	37.8912	-85.1993	“ “	Watershed - Y
Green River								
Green River	PRI018	05110001	226.0	at Munfordville	37.2687	-85.8853	“ “	hydrologic unit index site - Y
Nolin River	PRI021	05110001	80.9	at White Mills	37.55536	-86.03182	“ “	major reservoir inflow-tributary - N
Barren River	PRI072	05110002	1.0	nr Woodbury	37.17069	-86.62052	“ “	hydrologic unit index site - Y
Green River	PRI055	05110003	72.0	at Livermore	37.47832	-87.12694	“ “	hydrologic unit index site - Y
Green River	PRI103	05110003	150.0	nr Woodbury	37.18242	-86.61034	“ “	hydrologic unit index site - Y
Rough River	PRI054	05110004	1.0	nr Livermore	37.49934	-87.06574	“ “	hydrologic unit index site - Y
Gasper River	GRN020	05110002	12.1	Hadley	37.0217	-86.6067	“ “	Watershed - N
Tradewater River								
Tradewater River	PRI112	05140205	25.0	nr Piney	37.39896	-87.90456	“ “	hydrologic unit index site - N
Tennessee River								
Clarks River	PRI106	06040006	17.6	nr Sharpe	36.96130	-88.49322	“ “	hydrologic unit index site - Y

Mississippi River								
Bayou de Chien	PRI109	08010201	13.6	nr Cayce	36.61543	-89.03025	Water year dependant	major tributary - N
Mayfield Creek	PRI042	08010201	13.7	nr Magee Springs	36.92989	-88.94297		major tributary - N

Table 2. Comparison of Reservoir (Lake) Data to EPA Nutrient Ecoregion XI Criteria.

Lake	Chlorophyll *a* (µg/L)	TP (µg/L)	TN (mg/L)	Secchi Depth (meters)	Year
Yatesville	5.0	8.2	0.319	2.2	2002
Paintsville	3.8	6.2	0.286	3.9	2002
Grayson	5.4	10.3	0.368	2.2	2002
Martins Fork	3.7	18.0	0.543	1.7	2005
Laurel	2.8	19.8	0.783	2.8	2005
EPA Criteria	2.80	8.0	0.460	2.9	

Table 3. Comparison of Reservoir (Lake) Data to EPA Nutrient Ecoregion IX Criteria.

Lake	Chlorophyll *a* (µg/L)	TP (µg/L)	TN (mg/L)	Secchi Depth (meters)	Year
Cumberland*	2.5	10	0.612	4.7	2005
Barkley	14.8	99	1.736	1.3	2005
Williamstown	17.3	36	0.645	1.1	2009
Marion Co. Sportsmans Lake	13.4	19	0.595	2.8	2009
Sympson Lake	22.7	30	1.190	1.4	2009
EPA Criteria	4.93	20	0.36	1.53	

*While this reservoir is within EPA Nutrient Region IX nearly all of the watershed draining into the reservoir is in EPA Nutrient Region XI.

Seasonal data from approximately 105 publicly owned lakes (primarily smaller reservoirs managed by KDFWR) are in STORET and DOW databases. There are approximately four years

of seasonal data collected for each lake that began in 1982. These data form the remainder of water quality information used in analysis. If more data are required, additional resources will have to be found.

Lacking personnel and resources to begin data analyses, Kentucky was awarded a grant by EPA for a third party (Tetra Tech) to provide analysis and draft benchmarks in 2006. The funds from EPA were not let to Tetra Tech until August 2008. At that time DOW was contacted by Tetra Tech. A brief discussion on the general process of the analysis took place and DOW was presented an "Analytical Plan" while analysis had to go forward since time of the grant was expiring in approximately one month. The draft criteria will need more analysis as they may not be protective of current trophic state conditions, for example, allowing oligotrophic reservoirs to move to mesotrophic state. The small sample size in some regions and lack of reference lakes makes it problematic to incorporate frequency distribution and stressor-response endpoints. We will need to look at this situation in more detail to try and work toward an approach that may work. The EPA agreed to follow up with another grant to Tetra Tech. In 2009 a second iteration of analysis was undertaken through an EPA grant awarded to Tetra Tech. This grant award occurred in 2009 to address some questions in derived benchmark concentrations and refine benchmark recommendations provided in the 2008 analysis. Specifically, benchmarks were generated with the protection of historic trophic states of reservoirs supporting their designated uses. It should be noted EPA did not allow dialogue between DOW and Tetra Tech during the analysis; this potentially resulted in a less robust analysis of the data and consideration of other data-related factors. At this time (2011) the statewide data analysis report completed by Tetra Tech will be of primary consideration in the process of setting numeric reservoir criteria.

Wetlands (Swamps)

Historically, over 1.5 million acres of wetlands occurred in Kentucky; it is currently estimated about 324,000 acres are extant, with the Green River basin containing the largest proportion of remaining wetland acres. The majority of natural wetlands are bottomland hardwood forests located in West Kentucky that are inundated during a portion of the year, typically spring and winter; these are characterized by cherrybark oak, pin oak, overcup oak, sweet gum and green ash. Those wetlands that are continuously flooded are characterized by bald cypress and water tupelo. With EPA's November 2008 release of "Nutrient Criteria Technical Guidance Manual: Wetlands (EPA-822-B-08-001)" the commonwealth will review this document in preparation for addressing numeric nutrient criteria for wetlands. Given the ecological complexity and variability of wetland environments tested monitoring methods for assessment need developed and adopted. Once best available conditions are recognized and wetlands grouped as appropriate, then frequency distribution variables or stressor – response endpoints will be explored by data analysis. The DOW is actively working with the national effort spearheaded by EPA to develop ecological indicators to assist with the classification of different wetland types and ascertain the functional integrity of those waterbodies.

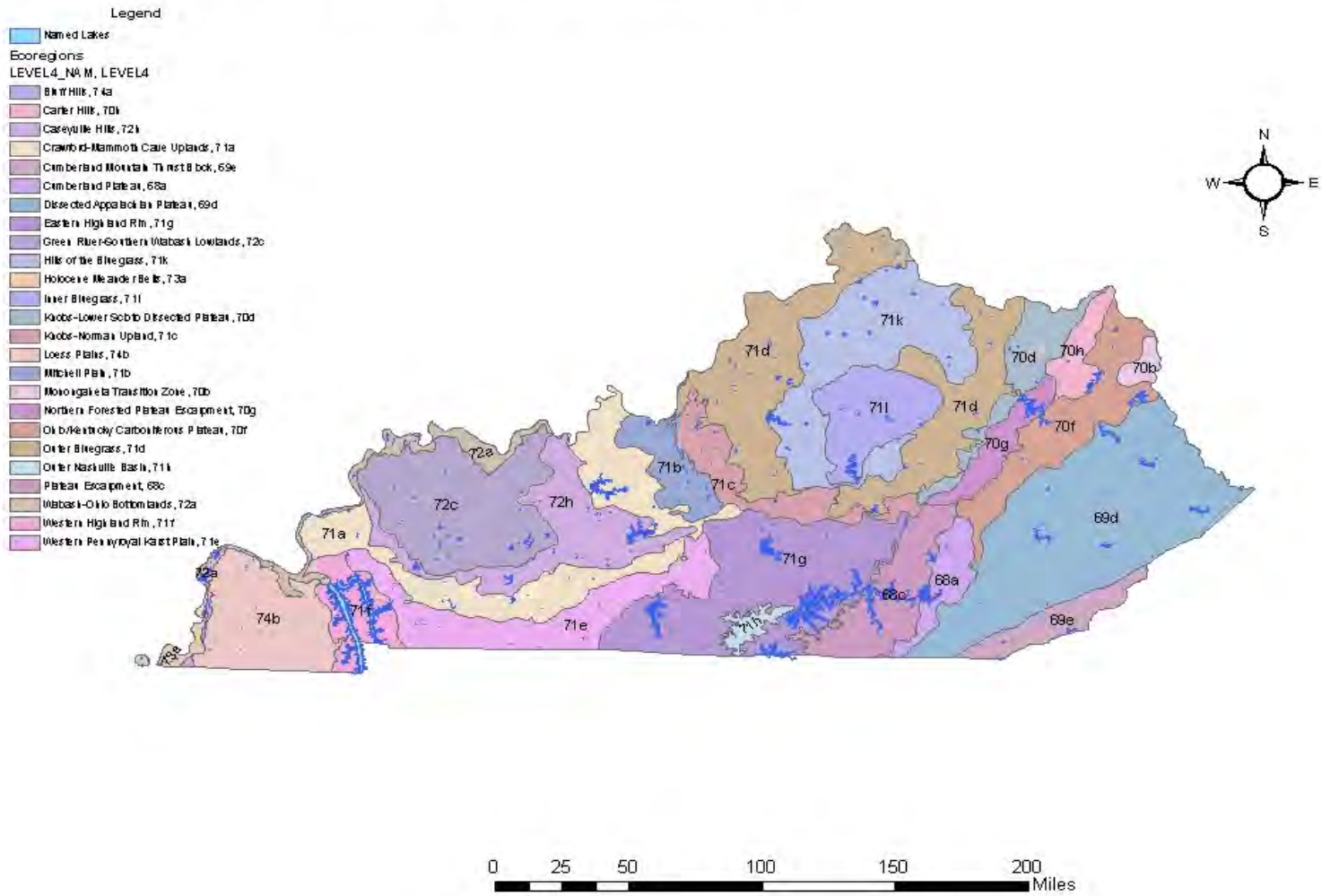
Table 4. Kentucky reservoirs of 1000 surface acres or more, the trophic state and level of aquatic life use support.

Reservoir	Acres	Ecoregion	Trophic State	Aquatic Life Use Support Level
Kentucky	57,093 (within Kentucky)	Western Highland Rim (71f)	Eutrophic—increasing trend	Full Support
Barkley	41,801 (within Kentucky)	Western Highland Rim (71f)	Eutrophic—increasing trend	Full Support
Rough River	4696	Crawford-Mammoth Cave Uplands (71a)	Eutrophic—decreasing trend	Full Support
Nolin River	5596	Outer Nashville Basin (71h)	Eutrophic—increasing	Full Support
Green River	8474	Eastern Highland Rim (71g)	Eutrophic—decreasing	Full Support
Barren River	9924	Eastern Highland Rim (71g)	Eutrophic—decreasing	Full Support
Taylorsville	2936	Hills of the Bluegrass (71k)	Hypereutrophic—increasing	Partial Support
Herrington	2670	Inner Bluegrass	Eutrophic--increasing	Nonsupport
Cumberland	47,674	Eastern Highland Rim (71g)	Oligotrophic—increasing	Full Support
Dale Hollow	6746	Eastern Highland Rim (71g)	Oligotrophic—increasing	Full Support
Laurel River	5830	Cumberland Plateau (68a)	Oligotrophic—increasing	Full Support
Buckhorn	1160	Central Appalachians (68d)	Mesotrophic—trend unknown	Full Support
Fishtrap	1071	Central Appalachians (68d)	Mesotrophic—steady	Full Support
Dewey	1017	Central Appalachians (68d)	Oligotrophic—decreasing	Full Support

Table 4 (cont.). Kentucky reservoirs of 1000 surface acres or more, the trophic state and level of aquatic life use support.

Reservoir	Acres	Ecoregion	Trophic State	Aquatic Life Use Support Level
Paintsville	1000	Central Appalachians (68d)	Oligotrophic—decreasing	Full Support
Grayson	1428	OH/KY Carboniferous Plateau (70f)	Mesotrophic—steady	Full Support
Yatesville	2237	OH/KY Carboniferous Plateau (70f)	Mesotrophic--decreasing	Full Support
Cave Run	7982	Escarpment/OH/KY Carboniferous Forest & Northern Forester Plateau (70f/g)	Mesotrophic—increasing	Full Support

Figure 4. Level 4 Ecoregions of Kentucky, with major reservoirs shown.



IV. Process

State Staffing and Resource Needs

The time, expertise and employees needed to develop water quality criteria and setting site-based (state or regional) water quality standards is great; however, nutrient criteria pose additional layers on the required resources to accomplish ultimate rulemaking and submission of criteria. There is currently less than one FTE (full time equivalent) DOW technical staff resource specifically dedicated to water quality standards. This is less than ideal to concurrently undertake rulemakings for triennial reviews (managing criteria adoption processes, staying informed on national and state issues and proceedings in a timely manner, participation on regional and national workgroups, maintaining data necessary for administration of water quality standards related to special waters [ONRW, OSRW and exceptional waters]), coordinate, manage and administer Section 305(b) requirements, as well as ancillary duties that arise. Given the budget related shortfalls and the overall economic conditions, state funding for additional employees to assist in these areas does not currently exist. The DOW has reassigned approximately one FTE technical staff for data management and analysis for wadeable streams regional benchmark and numeric criteria development. These staffing considerations, and the requisite need for focused studies to gather critical in-stream data throughout the commonwealth, have required the DOW to take a multi-phased reactive approach. As iterative data analysis identify lack of cause - response signals in certain bioregions, special studies were designed (please refer to Section III, Wadeable Streams), resources were scoped and identified for each project often leading to procuring grant funds to implement a given study. This process typically requires at least two years, including field data collection, biological community data processing and identification, before statistical analysis may be undertaken.

Administrative Procedures Necessary for Plan Implementation and Conclusion

Upon completion of the technical development phase of setting numeric nutrient criteria, implementation procedures must be identified. This will be a critical document for permit writers and the permitted community. Given the economic and technical considerations that must be accommodated and addressed in this document, this task will require the attention of staff from water quality standards, assessment and permit writers.

All amendments made to Kentucky's water quality standards regulation must go through the state's administrative process. Included in this process is an economic analysis on how the new regulations would affect the regulated community and agency. A hypothetical outline of the rulemaking process is provided in Table 5 and generally takes up to two years.

Involvement of Critical Decision Makers

Consultation and request for feedback with the DEP leadership continues, and has increased over the course of the last eight years since the initial nutrient development plan was under agreement with EPA Region IV. During the last triennial review (2007) leadership was presented with an update on the DOW's progress and concerns regarding development and proposed submission of numeric nutrient criteria for rulemaking. Given the DOW had data gaps in the Appalachian and Pennyroyal regions and lacked clear endpoint resolution of cause-effect relationships for several areas, particularly the Inner Bluegrass Region (71l), leadership decided not to move forward with less than a statewide set of criteria regulations. Upon that decision the DOW - Water Quality Branch began developing a series of studies to address those data gaps (please refer to Section III). While undertaking numeric nutrient criteria in the 2011-12 triennial review was planned it became apparent the number of field studies necessary to close data gaps, laboratory processing and analytical analysis required this effort be delayed. Once promulgated nutrient criteria will affect nearly every permit decision including, municipalities, the farming community, resource extraction operations and industrial dischargers. Because of the extent of such criteria considerable planning and documentation must be included, primarily centering on implementation procedures and the required regulatory (economic) impact analysis. Complete and accurate presentation of the supporting documents for the criteria as they pertain to waterbody type is essential for building consensus support in the regulated community and state government. Again, the impact of adoption of numeric nutrient criteria into water quality standards will require a considerable amount of outreach and education from thin ranks of staff that will be involved with this effort.

Progress Evaluation

The following is a schedule of activities and milestones describing the procedures that are anticipated to reach the establishment of nutrient criteria (Table 6). While every effort will be made by DOW staffs to reach each milestone as outlined unanticipated events and requirements could alter the accomplishment of milestones. Should conditions require a deviation in the timeline DOW and EPA staffs will work together to document the reason(s) for a shift in the timeline and re-establish a revised mutually agreed upon schedule.

Table 5. Administrative Procedures for Regulation Development and Adoption (Hypothetical Start Data – Wadeable Streams and Reservoirs).

Deadline/Target Date	Requirement	Conditions
April 13, 2012 (must be submitted by 15th of a month)	File with Regulations Compiler.	Attach regulatory impact analysis, tiering statement, federal mandate comparison, fiscal note, and summaries of material incorporated by reference and adopted without change.
May 1, 2012	The regulations are published in the *Kentucky Administrative Register.*	30-day public comment period begins.
May 21 – 31, 2012	Public hearing must be scheduled between these dates.	Written and oral comments are received.
May 31, 2012	Public comment period ends.	
June 15, 2012	File Statement of Consideration regarding comments received from the public and any amended regulations with the Regulations Compiler.	Can file for an extension of an additional 30 days to prepare Statement of Consideration.
July 1, 2012	Any amended regulation is published in the *Kentucky Administrative Register.*	
July 10, 2012 (2nd Tuesday of a month). This step may move to August 14, 2012 should a 30 day extension be requested for Statement of Consideration.	Administrative Regulations Review Subcommittee (ARRS) considers regulation.	
August 1 or September 5, 2012 (1st Wednesday of a month)	Regulations referred to 2nd committee (Interim Joint Committee on Natural Resources and the Environment).	
August 2 or September 6, 2012 (1st Thursday of a month)	2nd committee considers regulations. Regulations become effective upon adjournment or 30 days after referral if the 2nd committee does not meet.	

Schedule and Milestones for

Nutrient Criteria Development[1]

(Past, Current and Future)

Year	Activities
2003	1. Continue wadeable streams nutrient and biological sampling. 2 Continue boatable waters methods development (summer activity). 3. Continue large and small reservoir sampling (May – October). 4. Continue work on nutrient grant to migrate multi-agency reservoir data into a common database; resolve QA/QC issues and identify data gaps. 5. Initiate contacts with state agencies, USACE and TVA regarding interstate and border waters criteria development (winter activity). 6. Participate in ORSANCO nutrient workgroup for Ohio River criteria.
2004	1. Continue wadeable streams nutrient and biological sampling and analysis. 2. Continue boatable waters methods development and expand chlorophyll *a* sampling (summer activity). 3. Continue large and small reservoir sampling and add sampling to fill identified data gaps. 4. Continue work on nutrient grant to add new data and begin analysis for reservoir criteria development. 5. Form workgroups with state agencies, USACE and TVA regarding interstate and border waters criteria development. a. Determine criteria approach in shared waters b. Determine schedule of nutrient development for shared waters 6. Continue to participate in ORSANCO Nutrient Workgroup activities.
2005	1. Continue wadeable streams nutrient and biological sampling and analysis with criteria finalization goal for 2006 triennial review of water quality standards. 2. Finalize boatable waters methods and begin biotic index development for association with nutrient impairments. a. Continue expanded chlorophyllorophyll *a* sampling b. Evaluate relationships between chlorophyllorophyll *a,* nutrients and taste and odor complaints from domestic water suppliers. 3. Continue large and small reservoir sampling (expanded sampling if required to fill data gaps). 4. Continue work on nutrient grant in support of reservoir criteria development. 5. Continue interstate and border waters interagency workgroup meetings. Plan for: a. Nutrient criteria for interstate reservoirs to be established in 2006. b. Continue work on resolving border waters approach for reservoirs and rivers/streams. 6. Continue to participate in ORSANCO Nutrient Workgroup activities with goal of establishing criteria for Ohio River in 2006.

2006

1. Adopt criteria for wadeable streams in each bioregion.
2. Adopt criteria for intrastate reservoirs.
3. Continue boatable water criteria development with effect-based approach.
    a. Test ORSANCO criteria approach to other boatable waters with goal of establishing criteria in 2009 (next triennial review period).
4. Continue workgroup activities on interstate and border waters with goal of adopting criteria in 2009 (next Kentucky triennial review period).
5. Complete all elements of nutrient development grant.
6. Adopt nutrient criteria for the Ohio River into ORSANCO standards.

2007

1. Continue analysis of wadeable streams biological and nutrient data with goal of proposing and adopting criteria for wadeable streams in each bioregion. Analysis will include Loess curve, changepoint, and nutrient interface models. Determine need to collect more data in pennyroyal, inner bluegrass, and mountains bioregions to better establish biological effects across range of nutrient concentrations. Obtained an EPA grant to assist in this effort, with USGS collecting nutrient data in pennyroyal bioregion to compliment biological data collection by KDOW.
2. Continue analysis of data and methods for proposing and adopting criteria for intrastate reservoirs. Obtained EPA grant for contractor to assist in this effort.
3. Postponed efforts to promulgate nutrient criteria in this triennial review because of lack of data to propose criteria in all bioregions of commonwealth.

2008

1. Continue nutrient and biological data collection in several bioregions:
    a. Mountains bioregion;
    b. Pennyroyal bioregion; and
    c. Bluegrass bioregion.
2. Analyze data to establish nutrient levels resulting in significant biological effects.
3. Sufficient data exists for the Mississippi River – Interior Rivers bioregion.
    a. Data analysis continues for this bioregion.
4. Began incorporating target nutrient criteria into NPDES permit renewals for POTWs discharging to nutrient-impaired 303(d) listed water bodies and segments in the bluegrass and pennyroyal bioregions.
    a. These target numbers are derived from ongoing data analysis for the bluegrass and pennyroyal bioregions

2009

1. Continue data analysis of wadeable streams, particular effort given to the three bioregions where data were collected in 2007-8.
2. Anticipate completion of data collection for wadeable streams.
3. Initiate and form contacts with state agencies, USACE and TVA regarding interstate waters criteria development.
    a. Determine criteria approach in shared waters.
    b. Determine schedule of nutrient development for shared waters.
        i. Dependant on staff availability.
4. Continue boatable water methods and criteria development with regard to effect-based (cause and response) approach.

a. This is dependent on finalized methods and response metrics that will come from the EPA studies with DOW cooperating
c. As an alternative may need to look at frequency analysis.

5. Work on further data analysis for reservoirs nutrient criteria development.
   a. This is dependent on EPA awarding another grant to Tetra Tech for further data analysis.

2010
1. Complete data analysis for wadeable streams numeric criteria.
2. Complete data analysis for reservoirs numeric criteria.
3. Meet with stakeholders presenting proposed criteria.
4. Continue work with EPA and other parties on boatable methods and data collection.
5. Continue work with EPA and other parties on wetlands methods and data collection.

2011
1. Complete laboratory analysis of macroinvertebrate and diatom data collected during the 2009-2010 Western Pennyroyal Karst Plain and Eastern Highland Rim ecoregions study.
2. Complete data analysis reports.
3. Continue to explore data analysis in bioregions and ecoregions where effects based relationships may be weak.
4. Continue collecting nutrient and chlorophyll data from boatable waters.
5. Begin formulating a statewide nutrient reduction strategy plan.
6. Procure a contractor to produce the nutrient reduction strategy plan under the framework developed by the DOW.
7. Meet with stakeholders to inform and create partnerships so implementation of the nutrient reduction strategy plan objectives can move forward once finalized.
8. Data collection for wetlands incorporating test protocol for these waters.

2012-13
1. Finalize the statewide nutrient reduction strategy plan.
2. Begin implementation of the nutrient reduction strategy plan based on the appropriate HUC scale.
3. Continue boatable waters nutrient study data collection.
4. Work on development of intrastate reservoir nutrient criteria.
5. Continue wadeable streams criteria refinement.
6. Assess the progress of wetlands monitoring methods and the potential for development of relational cause – response variables for nutrient criteria development.

2014-17
1. Begin informative discourse and partnership-building for wadeable stream and reservoir nutrient criteria adoption with stakeholders.
2. Formulate wadeable stream and reservoir implementation procedures.
3. Continue boatable waters nutrient study data collection.
4. Begin preliminary analysis on boatable water study data.
5. Wetlands monitoring continues with monitoring methods testing.

2018

1. Enter the triennial review with wadeable stream and intrastate reservoir nutrient criteria adoption planned, but contingent on technical variables as well as direction from leadership.
2. Continue toward development of boatable water and interstate reservoir nutrient criteria development.
3. Wetlands remain under consideration and progress is contingent on methodology development as described in this plan.

[1]Adjustments to this schedule will be determined on an annual basis (December of each year) as progress or delays are encountered. EPA Region IV will be provided with an annual progress report by the end of January.

V. References

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