NEWSLETTER OF THE LAKES OF MISSOURI VOLUNTEER PROGRAM

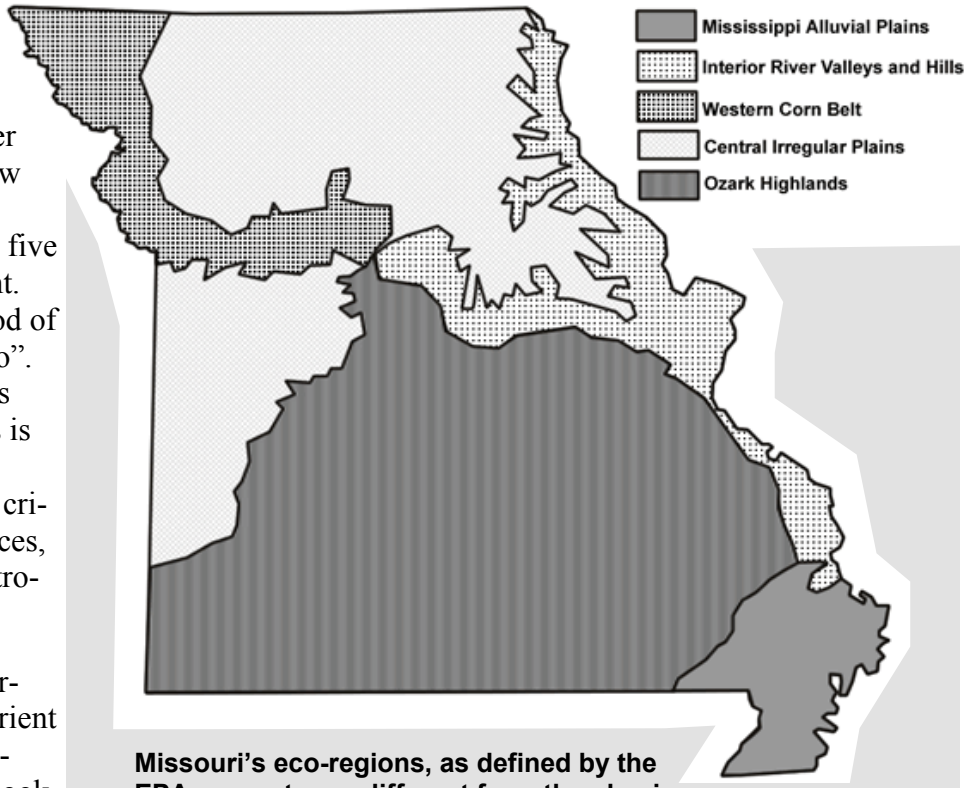
The Water Line

Volume 9 **Number 1** **Winter 2005**

The Criteria for Developing

NUTRIENT CRITERIA

According to the US EPA, the most common pollutants that affect lake and reservoir water quality are nutrients, yet a quick review of Missouri's list of impaired waters (a.k.a. the 303(d) list) shows that only five lakes are listed for nutrient impairment. Are Missouri's lakes really in that good of condition? The answer is probably "no". The reason more lakes are not listed as being impaired by high nutrient levels is that Missouri, along with most other states, lacks nutrient criteria (There is criteria for nitrate in drinking water sources, but nothing for phosphorus or total nitrogen).



Missouri's eco-regions, as defined by the EPA, are not very different from the physiographic regions used by the LMVP. However, the nutrient concentrations in lakes can vary considerably within each region.

The good news is that state agency personnel are working on developing nutrient criteria, though this may be more challenging than it initially sounds. Let's look at some of the issues that need to be taken into consideration during this process.

A Question of Approach

EPA (who is mandating the criteria as part of the Clean Water Act) suggested that states look at lake water quality according to ecoregion (a division of land area based on soils, topography, etc.—see map). The approach would involve gathering available data from each ecoregion, and listing the lakes according to nutrient levels. Criteria could then be set, based on these data, by selecting a statistically descriptive value (such as the median, lower 25%, or upper 25%). This approach would take the overall condition of the lakes within a region into consideration and create one set of criteria.

Continued on page 2

LAKES OF MISSOURI VOLUNTEER PROGRAM

302 A.B. Natural Resources Building
University of Missouri
Columbia, MO 65211

Phone: 573-882-5430
800-895-2260
Fax: 573-884-5070

WWW.LMVP.ORG

Coordinators
Tony Thorpe TONY@LMVP.ORG
Dan Obrecht DAN@LMVP.ORG

Nutrient Criteria—Continued from page 1

The problem with this approach is just that, it would create only one set of criteria for each region! The one-size-fits-all approach could set limits too high to protect lakes that are currently in good shape, or set limits low enough that some lakes could not possibly be able to meet the criteria. Just because two lakes are located in the same region doesn't mean that their water quality will be (or should be) the same.

To add to the confusion, EPA wants states to consider "downstream effects" when developing nutrient criteria. The gist of this is that not only should the lake's water quality be taken into consideration, but also the quality of water going over the spillway or out of the drawdown pipe.

At a 2003 water quality conference in Chicago, states overwhelmingly reported that they would not follow this approach, but would instead look at developing criteria on a lake by lake basis. This would allow for a lake's physical characteristics and watershed features to play a role in determining criteria. But it would also create a lot of work as each lake would have to go through the criteria development process. Another downfall of this approach is that there could be a fair amount of legal action taken as criteria for individual lakes were compared to each other.

In the end, the best approach may be to group lakes together based on use, size and watershed land cover, with different criteria for each lake-group. The criteria should protect those lakes that are currently unimpaired as well as identify those lakes that are impaired.

Factors to Consider

The first factor to consider when setting nutrient criteria for a lake is use. The Missouri DNR lists 12 designated and beneficial uses of stream and lake water. These include protection of aquatic life, irrigation, livestock and wildlife watering, body contact recreation, and drinking water source. Most people would agree that a lake used for irrigation does not need to be held to the same standard as a lake used for swimming or as a drinking water source.

Another issue that needs to be taken into consideration is the physical characteristics of the lake. Comparing a 15 acre lake to a 50,000 acre lake is definitely an apples-oranges approach. Among the physical aspects that need to be considered are lake depth, lake volume, watershed area, and flushing rate. Lake depth is important because shallow lakes have a tendency to mix throughout the year. Sediment and nutrients from a shallow lake's bottom are constantly being mixed into its surface waters, thus leading to a higher level of nutrients than expected based on inputs from the watershed. Volume needs to be considered because a lake with a large volume can dilute inputs more than a lake with a small volume. Watershed area is important because larger watersheds have more potential nonpoint source inputs than smaller watersheds. And finally, flushing rate (which is a product of the lake's volume and its watershed size) determines how fast water moves through the lake. The longer water stays in the lake, the more time nutrients have to settle to the lake bottom.

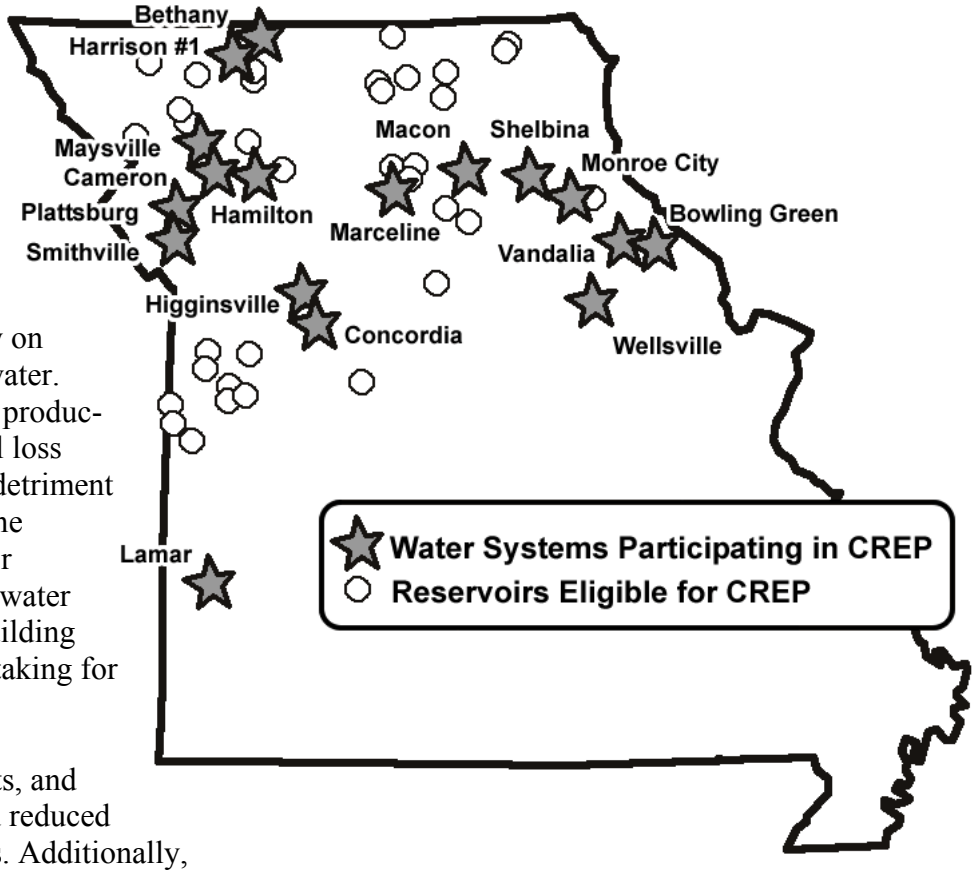
It has been said that a lake is a reflection of its watershed, and this is very true for Missouri's reservoirs. Thin nutrient-poor soils in the Ozarks are quite different than deep, nutrient-rich soils of northern and western Missouri. Along with regional differences in soil type come regional differences in land-use. In Missouri, in-lake nutrient concentrations show a strong relation to both agricultural land use as well as urban land cover. These land uses are major sources for the nonpoint pollution that impacts our lakes.

What is the Goal?

At its simplest, nutrient criteria would tell us which lakes are so impaired by nutrients that the beneficial uses are endangered. With all of these factors to take into consideration it is easy to see how coming up with nutrient criteria is not going to be an easy task. The time line for the Missouri DNR includes lake criteria by early 2006, and stream criteria by 2008. LMVP data will be used in the development of the criteria, and will be important in identifying lakes that are impaired once nutrient criteria are in place. Interested citizens will also be able to attend stakeholder meetings during the development process to voice concerns and ask questions.

Dan Obrecht

Missouri's Conservation Reserve Enhancement Program



The goal of the Conservation Reserve Enhancement Program (CREP) is to reduce the amount of pesticides, sediment, and excess nutrients that enter drinking water reservoirs. Many communities in northern and western Missouri rely on small lakes to supply their drinking water. These reservoirs also happen to be in productive agricultural areas. Excessive soil loss from tilled cropland has long been a detriment to drinking water reservoirs. When the sediment washes into a drinking water lake, the reservoir's capacity to store water diminishes over time. Dredging or building new reservoirs is an expensive undertaking for small communities.

Suspended sediments, excess nutrients, and pesticides result in increased cost and reduced effectiveness of the treatment process. Additionally, the last decade has seen a dramatic increase in drinking water regulations, making it ever more challenging for small communities to meet current standards. In 1994, ten Missouri water systems exceeded the newly established maximum contaminant level for Atrazine. Atrazine is a common pesticide that also washes off from cropland. All ten water systems quickly came into compliance by adjusting their treatment techniques. Treatment techniques, alone, are not a practical way to solve every problem that flows into a drinking water lake. Those systems, as well as all the other systems relying on surface water have had to become more aware of what is happening in their watersheds. A few municipal water systems began paying incentives to farmers to not use Atrazine in the watersheds of their drinking water lakes.

By 2001, the Conservation Reserve Enhancement Program had become available to reduce all forms of pesticides, sediment, and excess nutrients threatening these lakes. CREP is a cooperative effort between the U. S. Department of Agriculture (USDA) and the State of Missouri. The program is similar to the traditional Conservation Reserve Program (CRP) that reimburses farmers in the form of annual rental payments to retire cropland from production. One difference is that CREP provides higher incentives and has fewer restrictions on farms that want to participate. Another difference is that CREP only targets cropland in watersheds of small drinking water reservoirs. The contracts typically last 15 years. While the cropland is out of production, it provides valuable wildlife habitat. Partners such as Quails Unlimited and the Missouri Department of Conservation have offered additional incentives for land owners interested in making their land especially enticing to wildlife by planting native grasses or even trees.

Continued on page 4

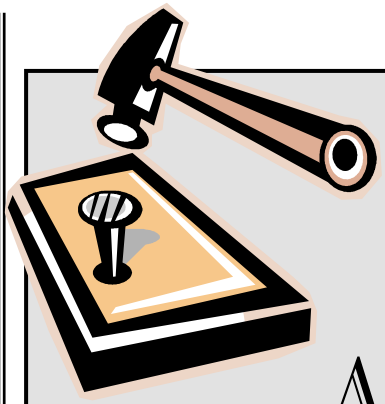
Missouri CREP—continued from page 3

Many state agencies and organizations play a role in CREP. At the Missouri Department of Natural Resources, both the Soil and Water Conservation Program and the Public Drinking Water Branch have a hand in the funding of CREP. The Soil and Water Conservation Program provides a program to help farmers with a portion of the cost of planting their fields into grass. The Public Drinking Water Branch has made grant funds available to public water systems that wish to participate in CREP. These funds are used to pay incentives to the farmers enrolling in the program. These two forms of state funding serve as essential state match money, which is required for receiving the federal funding from USDA. In total, USDA pays for 80 percent of the program.

In addition to providing match for the federal funds, Missouri also committed to measure and report on water quality improvements related to CREP. The Missouri Department of Natural Resources is cooperating with the U. S. Geological Survey (USGS) to map the bathymetric contours to record the current amount of sedimentation in each lake. LMVP data will likely also be used in conjunction with other available data to measure the long-term effects of CREP.

The Public Drinking Water Branch has awarded rural water grants to 17 communities that are participating in CREP. These grants total approximately $1.6 million. Over 15,000 acres have been enrolled in CREP. The USDA approved Missouri's CREP for a total of 50,000 acres and recently extended the enrollment deadline to September 2007. Missouri has an opportunity to further improve the quality of drinking water if more participants can be enticed to enroll in CREP.

Don Scott
Environmental Engineer
Missouri Department of Natural Resources
Public Drinking Water Program
573-526-5448
don.scott@dnr.mo.gov



LIEBIG'S LAW

An important concept to understand when dealing with plants (like algae) is Liebig's Law or the *Law of the Minimum*. This concept was formulated by German chemist Justus von Liebig, often called the "father of the fertilizer industry".

Imagine your are building a dog house using nails and boards. As long as you have both, you can continue building. When you run out of nails, you have to stop building. Nails (or rather lack of nails) are "limiting" your building process. So you buy a 5 pound box of nails and return to work. Inevitably, you will run out of boards next. Even though you still have plenty of nails, you need more boards to continue building. Now boards are "limiting". You could call the home store and have an entire semi truckload of nails brought to your house, but it won't help the doghouse get built, because you need boards.

This is an example of Liebig's Law of the Minimum, which states that plant growth will continue as long as all required factors are present (e.g. light, water, nitrogen, phosphorus, potassium etc.). When one of those factors is depleted, growth stops. Increasing the amount of the "limiting" component will allow growth to continue until that component (or another) is depleted.

The nutrient most typically "limiting" algae growth in lakes is phosphorus. If phosphorus concentrations can be controlled, then algae can be controlled…usually. Sometimes, other nutrients or conditions can limit algae. In Mark Twain Lake, for example, light is the factor that most often limits algae.

Tony Thorpe

Spotlight on MARK TWAIN LAKE

With a surface area of 18,600 acres and a maximum depth of 85 feet, Mark Twain Lake is the largest reservoir in northern Missouri (Figure 1). The dam was initially proposed as a way to relieve flooding problems on the Salt River. The U.S. Army Corps of Engineers completed construction in 1983, and now the lake provides drinking water, flood control, electricity and recreation opportunities for Missourians.

Mark Twain Lake's watershed covers 2300 square miles, with just over half of that covered by row crop agriculture. Grassland and prairie cover a quarter of the land in the watershed. These land uses are typical of northern Missouri, where the soils are deep and fertile.

The lake has water quality similar to the other lakes in the region. Chlorophyll, phosphorus and nitrogen concentrations are in the eutrophic range at the 3 sites monitored for the LMVP by the Mark Twain Lake Sailing Association.

Suspended sediment is a dominant aspect of Mark Twain Lake's water quality. Inputs of sediment, according to a 1986 study, equal 3 pounds per year for each square foot of lake area. A study in 1988 estimated that 4 1/2 pounds of sediments per year for each square foot washed into the lake.

A scientific paper published in 1995 showed that in 79% of the observations made over a 29 month period, light was the factor limiting algae growth. With so much sediment in the water, algae (which are plants) can't get enough sunlight to continue growing. It's similar to putting your African Violet in a closet. No matter how much fertilizer it has, it simply can't grow in the dark. When there is enough light for algae to grow well, growth will continue until the point where phosphorus is limiting, the 1995 study showed. (If you want to know what I mean when I say "limiting" please read Liebig's Law on page 4.)

Continued on page 6

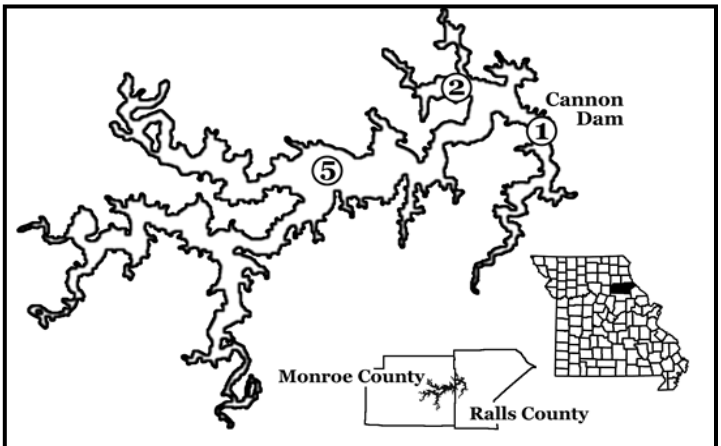


Figure 1. The location of Mark Twain Lake and the LMVP sample sites

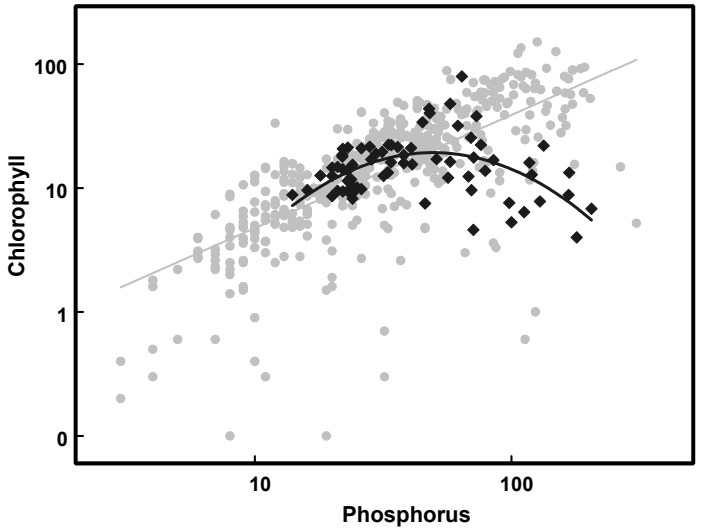


Figure 2. This graph shows Chlorophyll vs. Phosphorus in Missouri lakes. The light grey dots represent the 2004 LMVP data for all lakes. The dark diamonds represent LMVP data for Mark Twain Lake (2002-2004). Note how chlorophyll increases as phosphorus increases with all LMVP data (grey dots). In Mark Twain Lake, there is a mound shaped relationship. Increasing phosphorus means more sediment, which eventually shades out algae.

***Mark Twain Lake**, continued from page 5*

Phosphorus concentrations in Mark Twain Lake are tightly correlated with the concentrations of sediment in the water. This means that the more sediment you have in the lake, the more phosphorus you have. This can be a problem for the algae, which are typically limited by phosphorus in lakes. Algae need phosphorus to grow, but the algae in Mark Twain Lake only get their phosphorus in conjunction with sediments. These are the same sediments that block out the sunlight and ultimately limit the growth of algae! So what you get is a situation (Figure 2) where you get more algae growth as phosphorus increases…to a point. Eventually there is plenty of phosphorus, but not enough light for algae to grow. On Mark Twain Lake, light and nutrients are inversely proportionate (Figure 3), so that as you get more of one, you have less of the other.

The sediments that are suspended in Mark Twain lake are often very small. They can be so small, in fact, that they often pass right through the filters used by the LMVP to measure sediments. Therefore, we are likely underestimating the concentrations of sediments in the lake.

Interestingly, the 1995 study found that the amount of tiny clay particles in the Mark Twain Lake can actually *decrease* during an algae bloom. As algae grow, their cells tend to release organic compounds into the water. These compounds attach to the tiny clay particles and make them heavier. Eventually, the clay particles become so heavy they settle out. This is similar to the flocculation methods used in water treatment plants. Mark Twain Lake algae have the ability to make the water a little more clear so they can get more sunlight.

The 1995 study also showed that the impact of sediment inflows on Mark Twain Lake water quality is different in summer than in winter. In the winter the water column is mixed (not stratified) so inflowing sediments affect the entire water body. In the summer the lake is stratified and inflowing sediments tend to sink below the surface layer. So the surface layer is less affected by sediments in the summer than in the winter (Figure 4). It should be noted, though, that excess sediments still negatively affect Mark Twain Lake whenever they occur, they will simply have varying degrees of impact on the surface layer depending upon the time of year.

All reservoirs will eventually fill in with sediments if they aren't dredged out. The rate at which this occurs is dramatically increased when land in the watershed is disturbed by development and certain agricultural practices. Fortunately there are several efforts to reduce the amount of sediments flowing into Mark Twain Lake due to land disturbances. For more information about these efforts, visit the newsletter online at http://www.lmvp.org/waterline/winter2005.

Tony Thorpe

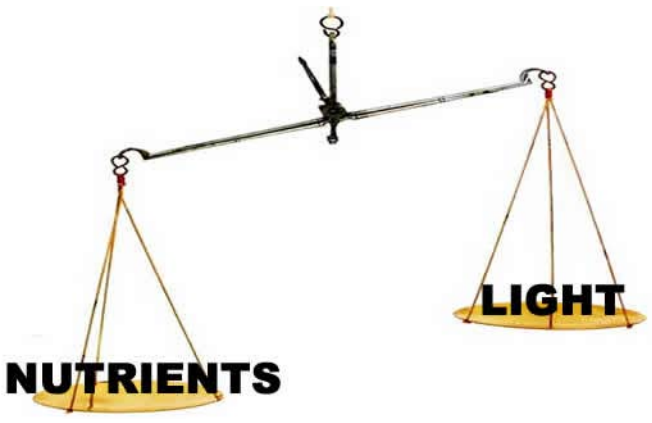


Figure 3. The more nutrients you have in Mark Twain Lake, the less light you have (and vice versa).

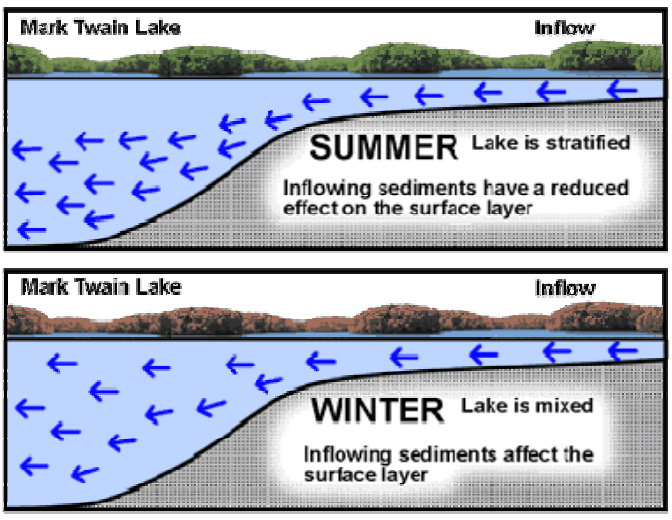
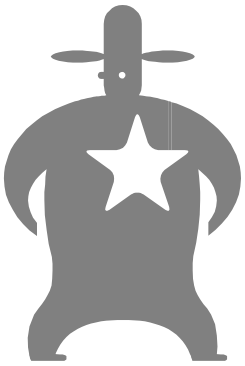


Figure 4. Due to the plunging of inflowing water in Mark Twain, sediments don't effect the surface layer as much in the summer as in the winter. However, the lake bottom will fill in regardless of the season.

Fishable and Swimmable ....it's the LAW



Missouri has until March 1, 2006 to submit a proposal that outlines which streams can't be made safe for swimming, according to a settlement reached between the EPA and the Missouri Coalition for the Environment. The Clean Water Act of 1972 states that ALL waters should be safe for swimming, or there needs to be an explanation of why the water can't be safe for swimming. Missouri was to have provided the exemptions to the EPA by 1983. To be safe for swimming, a water body must have bacteria limits on effluent entering that water body. As I understand it, saying "there is too much pollution from the sewage treatment plant upstream" is not reason enough to exempt water bodies from being classified as "swimmable".

The settlement, reached on December 17, 2004, states that Missouri will have submitted a plan for dealing with the exemptions to the "fishable/swimmable" mandate by March 1 of 2006 or the EPA will step in and issue its own plan. The EPA's plan would probably have more restrictions on effluent than any plan worked out by the DNR and Missouri stakeholders. This should provide some incentive for polluters to work out a deal with the state in a hurry.

One of the stakeholder groups involved in the development of a proposal is the sewer districts. To date, many of these districts haven't been required to disinfect their effluent to remove pathogenic bacteria. According to the St. Louis Post Dispatch, the Urban Areas Coalition (a group of Missouri members of the "Association of Metropolitan Sewerage Agencies") felt that a 2000 DNR regulatory impact report was not acceptable.

The problem the sewerage folks have is with the cost. It will be expensive to install equipment and buy supplies to disinfect the water dumped into Missouri's streams. These costs will certainly be passed on to the taxpayer or consumer. Environmentalists might have problems with the methods used to disinfect the wastewater. Chlorine has long been the disinfectant of choice for sewage outflow. Just as chlorine deters the growth of aquatic life in swimming pools, it will also have negative effects on the aquatic life of receiving streams. Additionally, some byproducts of chlorine disinfection are carcinogenic.

Whatever happens, Missouri must deal with the problem or face the Feds. Ultimately, it probably means cleaner streams and lakes - at great expense. But we've been living on borrowed time since 1983, so I suppose it's time to pay the piper.

For more information, including minutes to the meetings of the Water Quality Coordinating Committee and a copy of the settlement, see the online version of the Water Line at http://www.lmvp.org/Waterline/winter2005/

Tony Thorpe

Some of the other issues addressed in the lawsuit include:

1. **The method used to measure the presence of pathogens must be adjusted**
2. **Mines and sewage plants aren't allowed to discharge into "Outstanding National Resource Waters"**
3. **An "anti-degradation policy" that protects waters that are already cleaner than state standards must be applied**
4. **Standards for certain heavy metals, chemicals, and pollutants must be adjusted**
5. **Several water bodies will regain their status as "cold water fishery"**
6. **Pathogenic bacteria concentrations limits are no longer allowed to exceed allowable levels following rain events**