# Lake of the Ozarks
# Watershed Management Plan
**March 2010**

**Focusing on Area:**
**Buck Creek, HUC # 102901090406**
**Lick Branch, HUC # 102901090407**

Photo Courtesy J Rogers

**Written By**
**Lake of the Ozarks Watershed Alliance, Inc.**
**(LOWA)**

**Mission statement for LOWA**

**Citizens will preserve, protect, and improve the Lake of the Ozarks, its Watershed and natural resources, while maintaining our economic, social, and environmental health.**

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Missouri Department of Natural Resources

LOWA our lake - one voice

Missouri River Communities Network

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The authors of this watershed management plan for the Lake of the Ozarks would like to remind the readers that a watershed management plan is a dynamic, living document. As more information becomes available, projects, calculations, and details will be amended appropriately to ensure the maximum success for keeping the Lake of the Ozarks a healthy and vibrant watershed for years to come. Copies of this watershed management plan will be available for public viewing online at www.soslowa.org and will be updated on a regular basis. The master paper copy, maintained and updated, will be kept at the LOWA office and other paper copies will be updated every 4 years. Paper copies will be available for public viewing at the LOWA office (phone 573 434 4400), the AmerenUE Shoreline Management Office (phone 573 289 7116), the Camdenton MDC office (573 346 2210), as well as at each County Court House and at branches of public libraries within the WMP Focus Areas.

MO Stream Team participants monitoring the Little Niangua, one of the many rivers and streams that flow into the Lake of the Ozarks

Following is a list of acronyms used in this plan:

BMP – Best Management Practice
CHL - Chlorophyll
HOA – Home Owners Association
HUC – Hydrologic Unit Code
ISS – Inorganic Suspended Solids
LID – Low Impact Development
LIL – Low Impact Landscape
LMVP – Lakes of Missouri Volunteer Program
LOWA – Lake of the Ozarks Watershed Alliance
LOZ – Lake of the Ozarks
MDNR – Missouri Department of Natural Resources
MPN/100 mL (mpn/100 mL) - most probable number per 100 milliliters
NPDES – National Pollutant Discharge Elimination System
PSA – Public Service Announcement
SMYN – Show-Me Yards and Neighborhoods
STP – Stormwater Treatment Practice
SWCD – Soil and Water Conservation District
SWPPP – Storm Water Pollution Prevention Plan
SWRD – Storm Water Retention Device
TMDL – Total Maximum Daily Load
TN – Total Nitrogen
TP – Total Phosphorus
TSS – Total Suspended Solids
USACE – United States Army Corps of Engineers
WMP – Watershed Management Plan
WMP focus area – Buck Creek and Lick Branch HUC's

Following is a list of pertinent definitions.

BMP - Best Management Practice – any of the structural or non-structural features of a site or a building designed to minimize storm water runoff and other storm water effects, using the hydrology of natural systems, native vegetation, and Low Impact design techniques.

Green pumping company – disposes of the waste material pumped out of a septic tank in a responsible manner.

LOWA LIL's – all the Low Impact measures and BMPs aimed at keeping storm water and other runoff out of the Lake of the Ozarks. LOWA will encourage property owners to use many LOWA LILs through a cost-share incentive program.

Rain Event – any precipitation that results in measurable amounts of runoff on an impervious surface.

Secchi disc – a heavy disc marked in black and white quadrants lowered into the water to measure water clarity.

Strategy – a description of a set of actions and/or BMPs designed to address specific impairments and their sources and targeted at load reductions.

Watershed Yard – Green space, often a residential lawn, designed to minimize storm water runoff and other storm water effects, using the hydrology of natural systems, native vegetation, BMPs, and Low Impact design techniques.

WMP focus area – the area encompassed by Buck Creek HUC #102901090406 and Lick Branch HUC # 102901090407.


Image from:
http://community.thenewstribune.com/files/images/GNPC_Rain_Garden.preview.jpg
A rain garden utilizes deep rooted native plants growing in a depression in the ground to catch the stormwater runoff and allow the water to be drawn up by the plants and/or soak into the ground, replenishing the aquifer.

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Image of volunteers for LOWA's Household Hazardous Waste Reclamation Day in Camden County, October 10, 2009.

## SECTION I. EXECUTIVE SUMMARY

The full watershed for the Lake of the Ozarks (LOZ) extends into Kansas and takes in 8,960,000 acres or 14,000 square miles of land, which is far too large for any one watershed management plan (see figure I-1). Even when one considers simply the 886,900 acre watershed for Lake of the Ozarks from Bagnell Dam to Truman Dam, there are simply too many variables and influences to take into account in one single watershed management plan. Because of the many different influences on LOZ and the sheer size of its watershed, Lake of the Ozarks Watershed Alliance (LOWA) decided to narrow the focus of this watershed management plan (WMP) to some of the most densely populated and fastest growing areas of the lake. The 2 12-digit HUCs (Hydrologic Unit Codes) of focus are the Buck Creek, HUC #102901090406, and the Lick Branch, HUC #102901090407 subwatersheds, and they will be referred to as the WMP focus area (see figure I-2). This part of the LOZ watershed was chosen because this area is home to some of the first shoreline to be developed, and the water quality of this area has been, and has the potential to be, affected by the waste and pollution of dense populations and largely unregulated development. This area can be stressed by under functioning septic tanks, land disturbance sites with unconfined soil along the shoreline, and other nonpoint source pollution storm water issues.

In the spring of 2006, citizens around the Lake of the Ozarks met in a series of meetings held at different locations around the entire lake shoreline to discuss issues concerning LOZ. Survey after survey showed the same results: citizens were concerned about safety and the water quality of the lake. That same spring, Lake of the Ozarks Watershed Alliance was born and quickly adopted the following mission statement: **Citizens will protect, preserve, and improve the Lake of the Ozarks, its watershed and natural resources while maintaining our economic, social, and environmental health.** Since then, stakeholders from all around the Lake have come together to volunteer their time, energy, skills, and ideas to work together to **keep** the Lake of the Ozarks healthy and safe. In fact, safety issues are also health issues, and these were some of the very first issues LOWA tackled. Boats being driven by intoxicated individuals led LOWA to address two problems at once. A Designated Captain Program was established by LOWA to allow the driver of the boat to receive a non-alcoholic beverage at participating bars and restaurants. This successful program was later turned over to another citizen group at LOZ, the Lake Safety Council. In addition, dock slip sizes became an issue as AmerenUE was writing its Shoreline Management Plan (SMP). LOWA provided citizens with a forum in which to express their opinions and this survey of opinions did sway the results of the SMP. Safety issues at the lake also include the water quality of the lake which can affect the health of the public; and the stakeholders of the WMP focus area are dedicated to maintaining and improving the health of the Lake of the Ozarks.

The Buck Creek and Lick Branch subwatersheds of the Lake of the Ozarks larger watershed begin at Bagnell Dam and encompass the first 18 miles of the main channel of the Lake of the Ozarks, as well as its many side coves. These 2 areas also include parts of Osage Beach and Lake Ozark in the eastern part of the watershed focus area, and extend to the municipalities of Laurie and Sunrise Beach to the west. This is a very

densely populated part of the LOZ watershed and includes many marinas, businesses, and condominiums, in addition to single residence homes. Part of this population is hooked to one larger waste water treatment plant in the area, and part is on smaller scaled waste water permitted plants (mostly associated with condominium projects and small subdivisions); however, most of the population is still on private, aging septic tanks around the shoreline in an area largely unsuited to septic tanks. This lack of adequate waste water treatment impacts the Lake of the Ozark and its watershed and is another reason for LOWA to choose this area for the WMP focus, while realizing the issue of septic tanks on the shoreline is not limited to the WMP focus area, but also is a lake-wide issue.

The overall goal of this watershed management plan centers on maintaining and improving the water quality of the Lake of the Ozarks. The Strategies (descriptions of the approaches being taken to address the impairments to the watershed) for the WMP focus area take this general goal and address it with details and specificity appropriate to the needs of the WMP focus area. To begin addressing the needs of the LOZ watershed, LOWA is focusing on, but realizes the issues are not limited to, the Buck Creek HUC #102901090406 and Lick Branch HUC #102901090407 subwatersheds (see figure 3) because this part of the Lake of the Ozarks has some of the highest population, marina, and business densities; and this area is one of the fastest growing parts of LOZ. In addition, future growth at LOZ is projected to occur mostly around and in these two subwatersheds. An unexpected benefit to selecting these two areas for focus is that the nutrient load criteria for lakes and reservoirs are based at the dam end of the water body, which is where the WMP focus area is located. LOWA's Strategy goals for the WMP focus area are to reduce the bacteria load, the nutrient load, and the amount of sediment reaching the lake.

Nutrient criteria have been proposed for the Lake of the Ozarks and the Strategies address nutrients largely through a long-term approach. By reducing nutrient loading small amounts per year over a long period of time, large reductions can be accomplished. For example, if the 2008 phosphorus load of 0.041 milligrams per liter were to be reduced by 2% per year, after 22 years, the phosphorus content would be at the nutrient criterion level for phosphorus proposed for LOZ of 0.026 milligrams per liter. If each suggested Strategy reduces the phosphorus level by a small percentage per year, the effect of all the Strategies taken together could reach a total goal of a 2% per year reduction. Likewise, to reach the nutrient criterion level proposed for nitrogen at the Lake of the Ozarks would take about 18 years to go from the 2008 load of 0.679 milligrams per liter to the criterion level of 0.520 milligrams per liter, with a reduction rate of 1.5% per year from all implemented Strategies together. This percent reduction was simply used as an example of how incremental decreases over time can bring about large changes. This WMP will <u>not</u> be using percent reductions to measure load reductions. Instead, a long term goal of the WMP for the focus area is to reduce the phosphorus and nitrogen levels to the nutrient criteria levels established for the Lake of the Ozarks by implementing a variety of Strategies which, together, will reduce nutrient levels incrementally each year until the nutrient criteria levels are reached. However, LOWA would like to point out that the nutrient criteria levels set for the Lake of the Ozarks at this time are rather controversial.

Since Bagnell Dam is located in the Ozarks ecoregion (an ecoregion is an area of the Earth that has similar climate, soil characteristics, and life), the entire lake is classified based on characteristics of lakes for that ecoregion. Some feel that the nutrient criteria levels for LOZ are set unreasonably low because most of LOZ's watershed is in the Osage Plains ecoregion, whose lakes have much higher nutrient criteria levels. This watershed management plan is designed to be amendable and adaptable as new information arises and new technologies and ideas are developed.

The amount of sediment reaching the lake and the amount of bacteria in the lake will also be addressed by the combined action of several specific Strategies. Unlike the amount of nutrients in the water at present, the amount of sediment and bacteria in the water can be reduced significantly within a relatively shorter period of time compared to that for reducing the amount of nutrients. The amount of E. coli in the lake's water is being studied through a partnership between MO Department of Natural Resources (MDNR), AmerenUE (utility company that owns the land under the Lake of the Ozarks and manages Bagnell Dam and the Lake of the Ozarks as a hydroelectric power generating facility), MO Department of Conservation (MDC), and LOWA. AmerenUE is providing the funding for a 5-year study of E. coli in the coves of LOZ, MDNR has designed the study, analyzes the samples, and reports the results, MDC coordinates the volunteers for sampling, and LOWA trained volunteers collect the water samples and either deliver the samples to an MDNR courier or to the MDNR lab for the analysis. The amount of bacteria is recorded as a measure of the number of bacteria colonies per 100 milliliters of water (most probable number or mpn) and the MDNR standard for E. coli in this study is to have a measurement of less than 126 mpn per 100 mL of water (126 mpn/100 mL). The standard of 126 mpn/100 mL is generally used to refer a geometric mean of at least 5 samples taken regularly spaced out over one month's time and a standard of 235 mpn/100 mL water is used as the allowable limit for swimming for a single, one-time, sample. For this WMP, the determination of exceedances (an "exceedance" is a measurement over the state standard) will be based on the single sample state standard for E. coli of 235 mpn/100 mL water. Since the amount of bacteria also is affected by sources not addressed in this WMP for the focus area (such as wildlife and runoff from undeveloped watershed), a reduction of the number of samples measuring over the single sample standard for E. coli will not be expected to reach zero. The goal for bacteria for this WMP is to reach no more than one sample over standard per year (an exceedance). Several of the Strategies, working in unison, should be able to accomplish this goal.

The amount of sediment reaching the Lake of the Ozarks has not been studied as extensively as the nutrients or bacteria and some of the technical assistance needed for this WMP is to establish some baseline loading data for the amount of sediments entering LOZ during a rain event at various locations and site conditions. Baseline data will need to be gathered in order to evaluate the effectiveness of the specific Best Management Practices (BMPs) implemented to address sediment loading. The goal of this WMP for the focus area is to reduce the total amount of sediments entering LOZ in the WMP focus area by a significant amount over a 4-year period through a combination of Strategies addressing unconfined soil on land disturbance sites and the establishment of watershed yards with LOWA LILs (LILs stands for Low Impact Landscapes and is a set of

watershed friendly runoff management practices, including rain gardens and rain barrels) in the WMP focus area. Controlling the amount of sediment is important to accomplishing all the goals of the watershed management plan because of sediment's connections to the amount of bacteria and nutrients. Decreasing the amount of sediment reaching the waters of LOZ will also help decrease the amount of bacteria and nutrients.

To accomplish these goals of reducing the amount of sediment, bacteria, and nutrients loading to the Lake of the Ozarks, LOWA will need to establish programs reducing the amount of waste water dumped by boats and leaking from inefficient septic tanks, monitoring BMPs at land disturbance sites, establishing green awards and other incentives for businesses to go beyond their legal requirements, and a cost-share incentive program to help citizens create and install rain gardens, rain barrels, and LOWA LIL watershed lawns. In addition, LOWA believes a plan to establish a regionalized waste water management system to protect this lake from nutrient and bacteria loading is imperative in order to ensure the future health of this priceless resource largely because of the projected impact of the baby boomers retiring to the lake which will represent a significant population increase moving full-time into homes with aging, private septic systems, many of which may be inadequate to treat the waste generated.

The Environmental Protection Agency (EPA) has identified nine elements of a watershed management plan that should be addressed in order to ensure a successful watershed management plan. These nine elements are identified in the Table of Contents as Elements A-I. These nine elements have been incorporated into the different sections of this watershed management plan and are identified at the beginning of the Sections in which they are found.

For successful implementation of this watershed management plan, LOWA is looking forward to continuing a strong partnership with AmerenUE, Missouri Department of Natural Resources (MDNR), the United States Environmental Protection Agency (EPA), Missouri State Water Patrol, U. S. Coast Guard, Lake Area Chamber of Commerce, Camdenton Chamber of Commerce, Lake West Chamber of Commerce, Tri-County Lodging Association, Convention and Visitors Bureau, the Camden County Shoreline District Planning and Zoning Commission, Lakes of Missouri Volunteer Program, MO Stream Team, and local area governments and businesses.

Figure I-1 shows the entire watershed for the Lake of the Ozarks, which is part of the Osage River. This watershed stretches well into the neighboring state of Kansas and encompasses a significant portion of SW Missouri, as well. This watershed has Bagnell Dam in the far eastern portion of the area as part of its boundary. Bagnell Dam also forms part of the boundary of the WMP focus area. Figure I-2 shows the 2 subwatersheds that form the WMP focus area.

Photograph showing Bagnell Dam to the left, the protective barrier net diagonal across the picture, and Bagnell Strip in Lake Ozark, MO in the background.

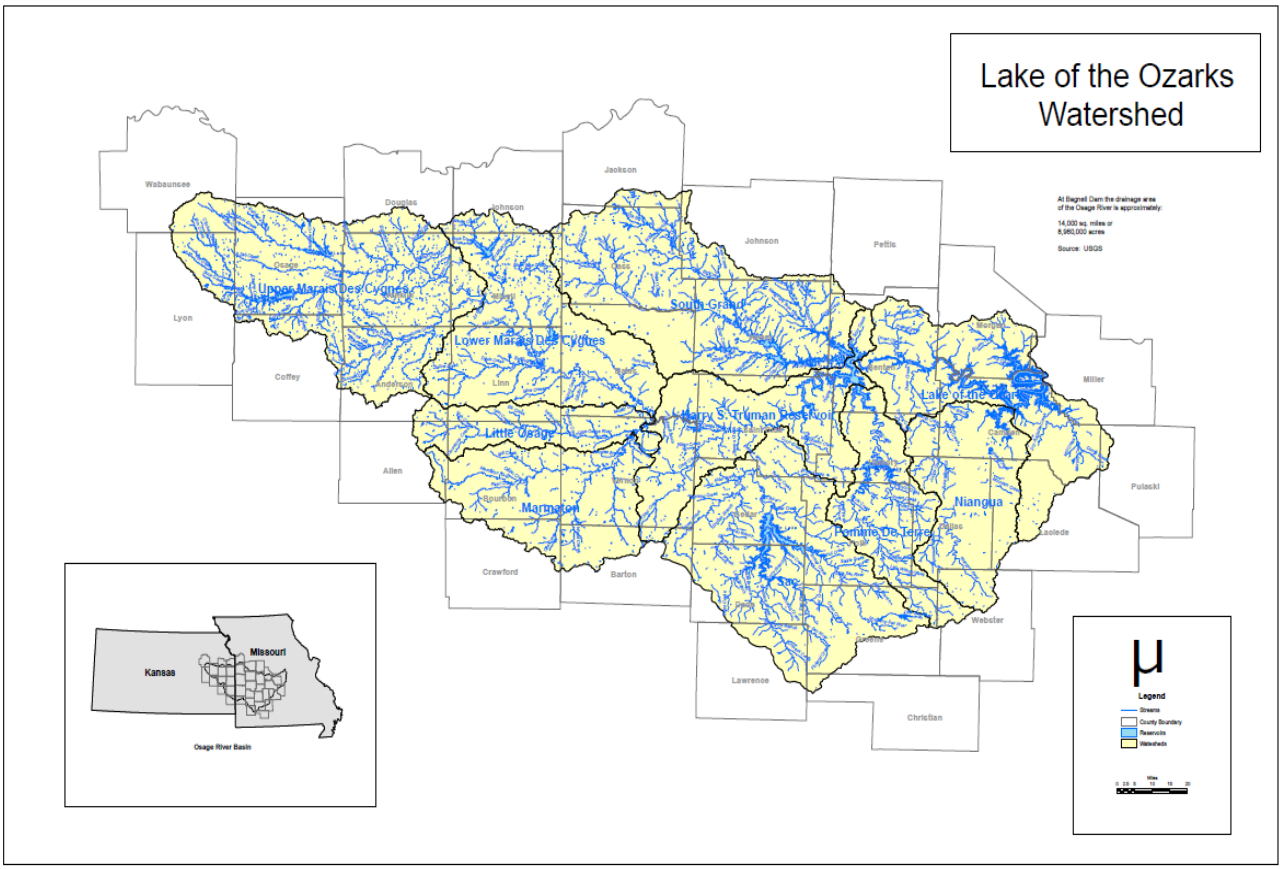



Figure I-1. Lake of the Ozarks and its entire watershed[1].

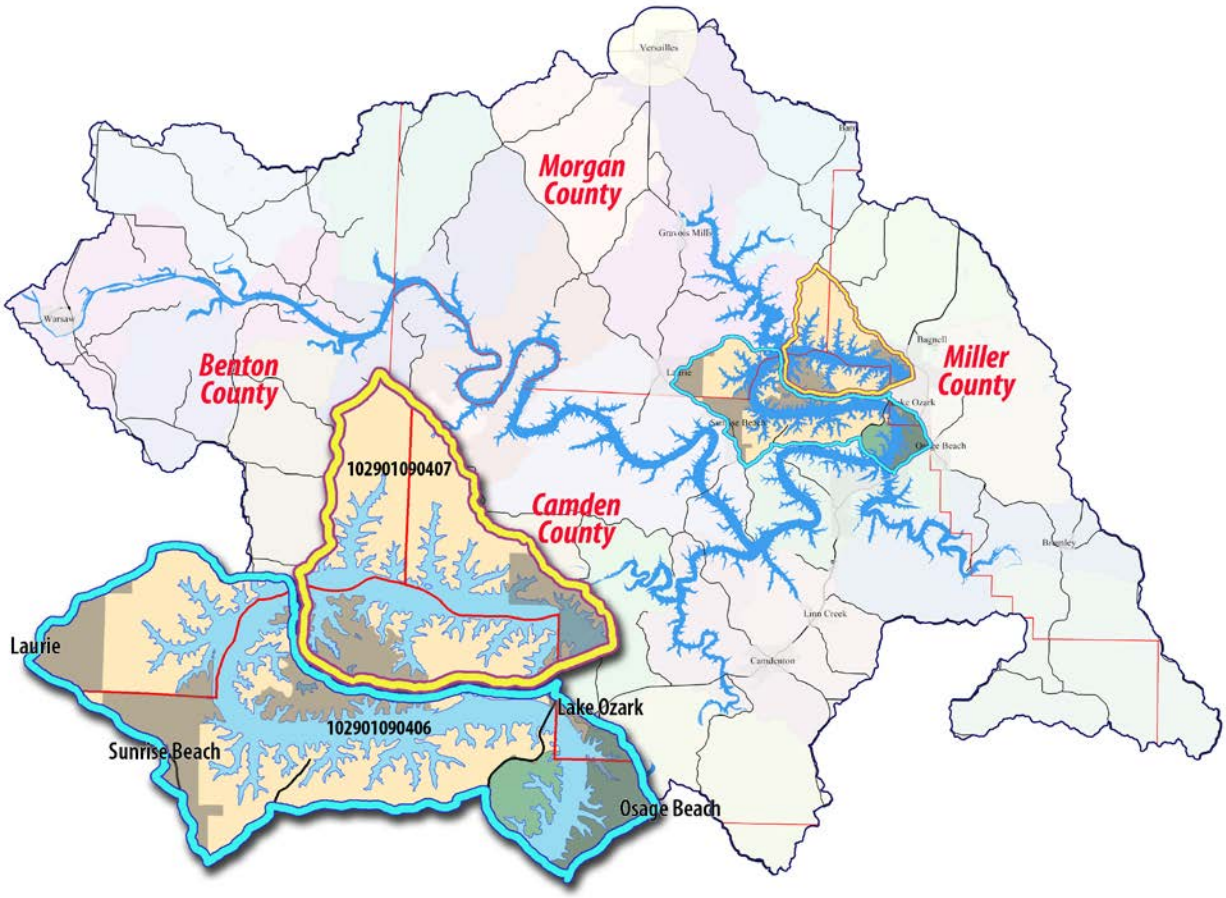



Figure I-2. The two subwatersheds of the WMP focus area, Buck Creek HUC #102901090406 and Lick Branch HUC #102901090407.

## SECTION II. INTRODUCTION

### Subsection II-A. Location

The Lake of the Ozarks is located in south-central Missouri in the Salem Plateau of the Ozarks Highlands, a semi-rural, rapidly urbanizing area in mid Missouri, approximately 45 miles southwest of Jefferson City, Missouri, about 150 miles from Kansas City and about 180 miles from St. Louis. See figure II-A-1. The south eastern half of the lake, itself, is highly developed, while the north western half of the lake is developed only in specific areas. Much of the Lake of the Ozarks is a highly developed and urbanizing reservoir with residential and commercial structures visible around much of the lake. Individual piers and multi-slip docks are common, as evidence of the large population living on the shores of the lake. The land around the lake is an area of steep hills and valleys, springs, streams, and where the land is not developed, woods are the predominant feature. Being an area of karst topography, surface water can often find an easy pathway to the groundwater and thus, groundwater is highly susceptible to pollution from the surface.

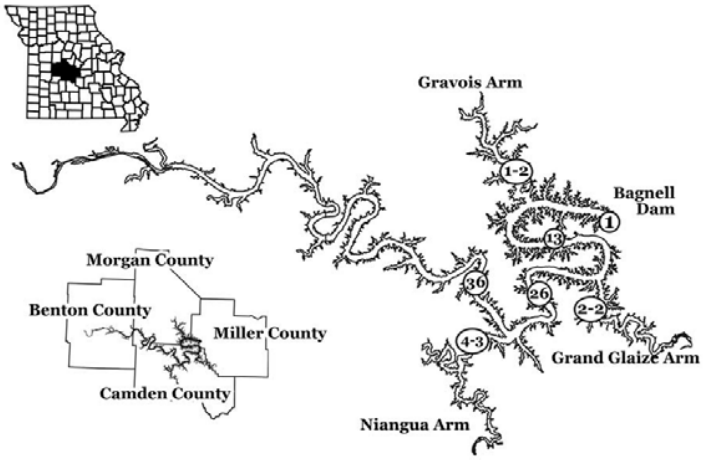



Figure II-A-1. Maps showing location of the Lake of the Ozarks in Missouri, in the 4 counties, and the shape of LOZ with some Lakes of Missouri Volunteer Program (LMVP) sampling sites.[3]

Lake of the Ozarks Watershed Alliance (LOWA), a grass roots organization, was established in 2006 to proactively work at maintaining and improving the water quality of the Lake of the Ozarks (LOZ) and its surrounding watershed, up to Truman Dam in Warsaw, which is located more than 90 river miles to the west of Bagnell Dam. Because even this smaller watershed for the Lake of the Ozarks, from Bagnell Dam to Truman Dam, is so large (886,000 acres), in writing this watershed management plan, LOWA decided to begin addressing the watershed of the Lake of the Ozarks by focusing on two pieces of the dam-to-dam Lake of the Ozarks watershed. These two pieces center around the most densely populated and environmentally affected part of LOZ and are defined by a 12-digit Hydrologic Unit Code naming system used by the US Geological Survey and by Missouri Department of Natural Resources. The two subwatersheds selected for focus

are the Buck Creek HUC #102901090406 and Lick Branch HUC #102901090407 subwatersheds. This area will be referred to as the "WMP focus area". See figure I-2.

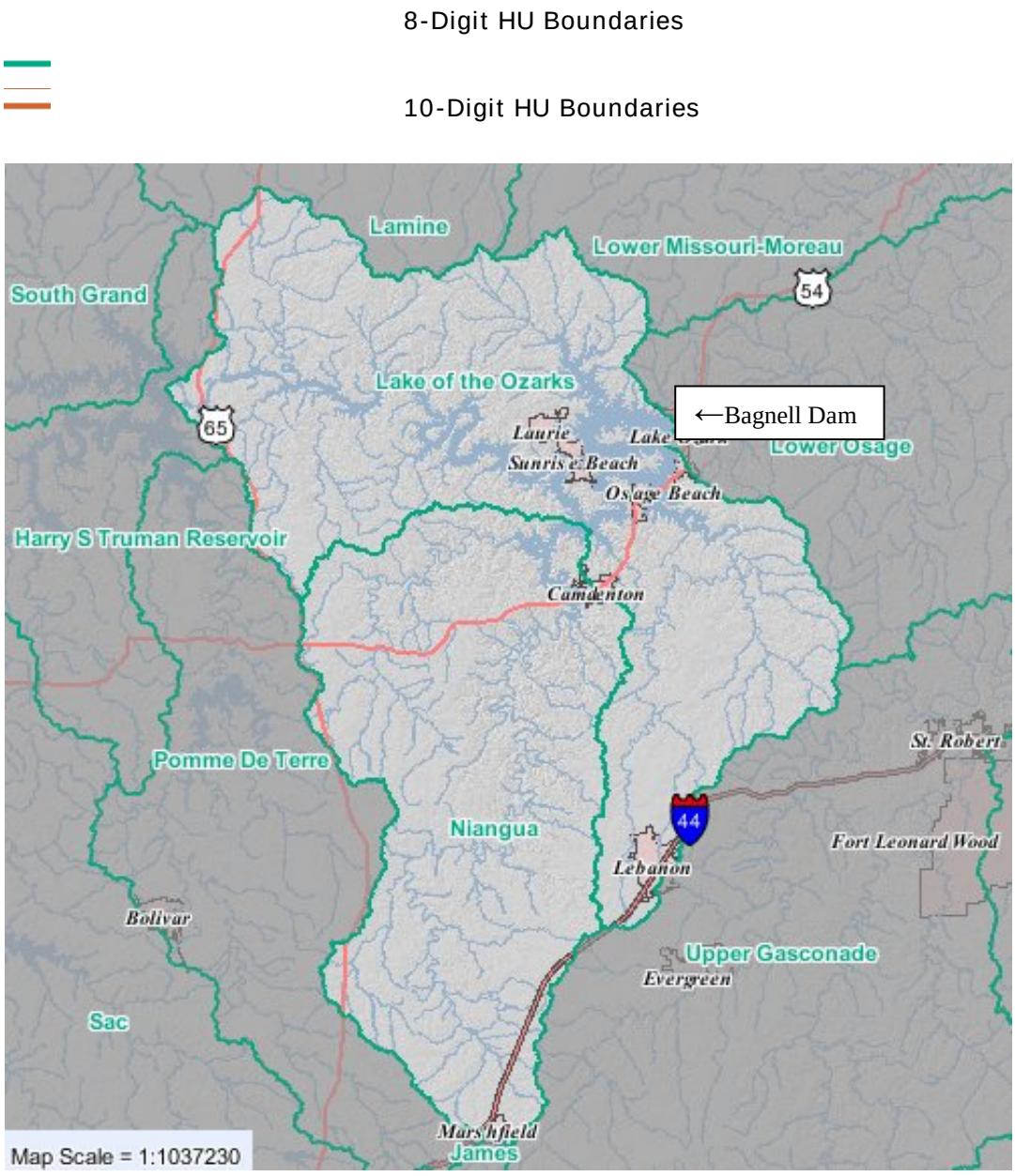



Figure II-A-2. Map of the HUC #10290109 LOZ watershed and the HUC #10290110 Niangua watershed. Image from the CARES map room at: http://ims.missouri.edu/website/watershedTool/profileComb.asp .

The WMP focus area is located on the eastern edge of the Lake of the Ozarks Watershed, defined as HUC # 10290109. Bounded at one end by Bagnell Dam, the WMP focus area extends along the first 18.7 miles of the main channel (Osage Arm) of LOZ and up into the many side coves, but excluding the Gravois Arm at mile marker 6. The WMP focus

area is highly populated with many marinas, restaurants, shops, other businesses, and homes located along the lake's shores and along the many streets and highways near the lake's shores. Urbanization is a large issue for this area as these two subwatersheds are among the areas that have received the most population growth in the last couple of decades, are among the fastest growing areas at the lake today, and are projected to be among the areas most affected by expected future population growth[4] (which in part, LOWA believes, will be fueled by baby boomers becoming full time residents). These two subwatersheds are in the area LOWA believes can be most affected by focused efforts to improve the water quality at the Lake of the Ozarks, thus helping to ensure a healthy and vibrant lake for years to come.

**Subsection II-B. The Plan**

The overall goals for this management plan are to improve and maintain the water quality for the Lake of the Ozarks. In general, the Lake of the Ozarks can suffer from a lack of planning and zoning, unregulated building and development, as well as minimal waste water treatment and aging private septic systems. The accelerated building and construction around the entire lake can and has created soil erosion and water quality issues associated with increased storm water volume and sediments. Improper disposal of domestic sewage, both on water and land, can and has resulted in increased bacterial loads and potential health issues. The quality of many heads of coves could be compromised to the point that they no longer serve as environmental buffers or homes to a diversity of wildlife. Parts of the LOZ watershed, mostly outside the WMP focus area, also suffer from many years of intensive agricultural and logging practices, which could have a detrimental effect upon the overall quality of the Lake and its watershed. Because so little of the WMP focus area is agricultural in land use, but still realizing that agricultural issues from other parts of the watershed do affect the WMP focus area, this watershed management plan will not address the agricultural sources of the watershed impairments.

This watershed management plan is a starting management document that will also be used to facilitate similar goals in the remaining sections of the whole watershed. As other sections of the LOZ watershed are focused upon, additional Strategies to address additional issues may well be added.

Through a 3-pronged approach looking at nutrient levels, sediment levels, and bacteria levels, this plan will put forth a systematic methodology that will, over a 4-year period of time, reduce nutrient, sediment, and bacteria loads, and maintain water quality at LOZ at a level that is environmentally healthy for a reservoir with great fishing as well as whole body contact recreational activities. The WMP focus area was chosen because this area is densely populated, is projected to grow even more in the near future, and because this area is very amenable to this specific set of watershed improvement measures proposed by LOWA. The WMP focus area represents approximately 37,000 acres, of which about 10,500 acres are actual lake water, leaving about 26,500 acres of land. See figures II-B-1, 2, and 3 for individual maps of the Buck Creek and Lick Branch HUCs and of the two subwatersheds together, with some of the major highways marked. An interesting note is

that roads and highways often mark watershed boundaries in this area because the roads often follow ridge tops.

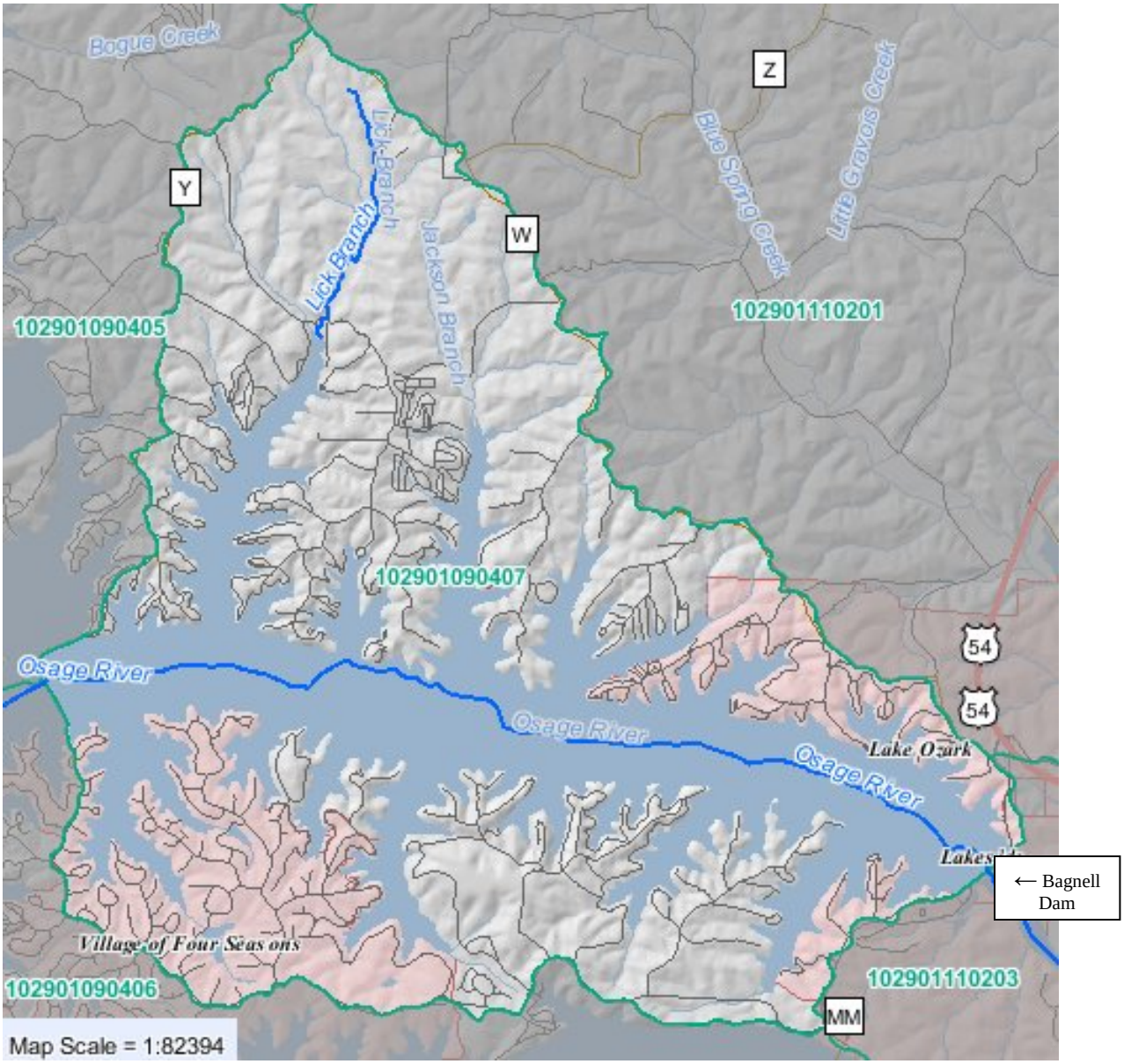



Figure II-B-1. Lick Branch HUC #102901090407. Dark blue lines are streams and pink areas are municipality/urban areas.

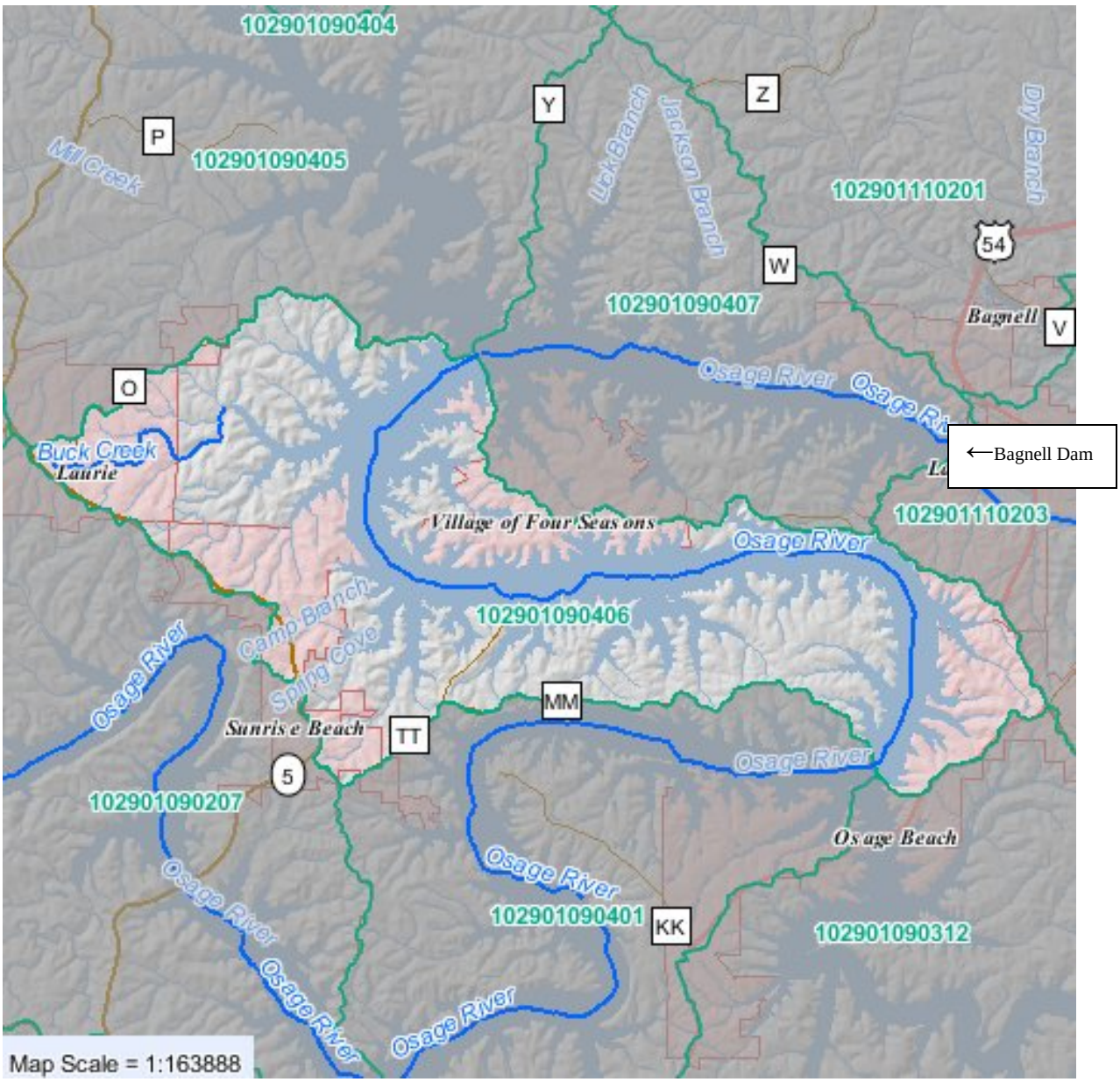



Figure II-B-2. Buck Creek HUC #102901090406. Dark blue lines are streams and pink areas are municipalities/urban areas.

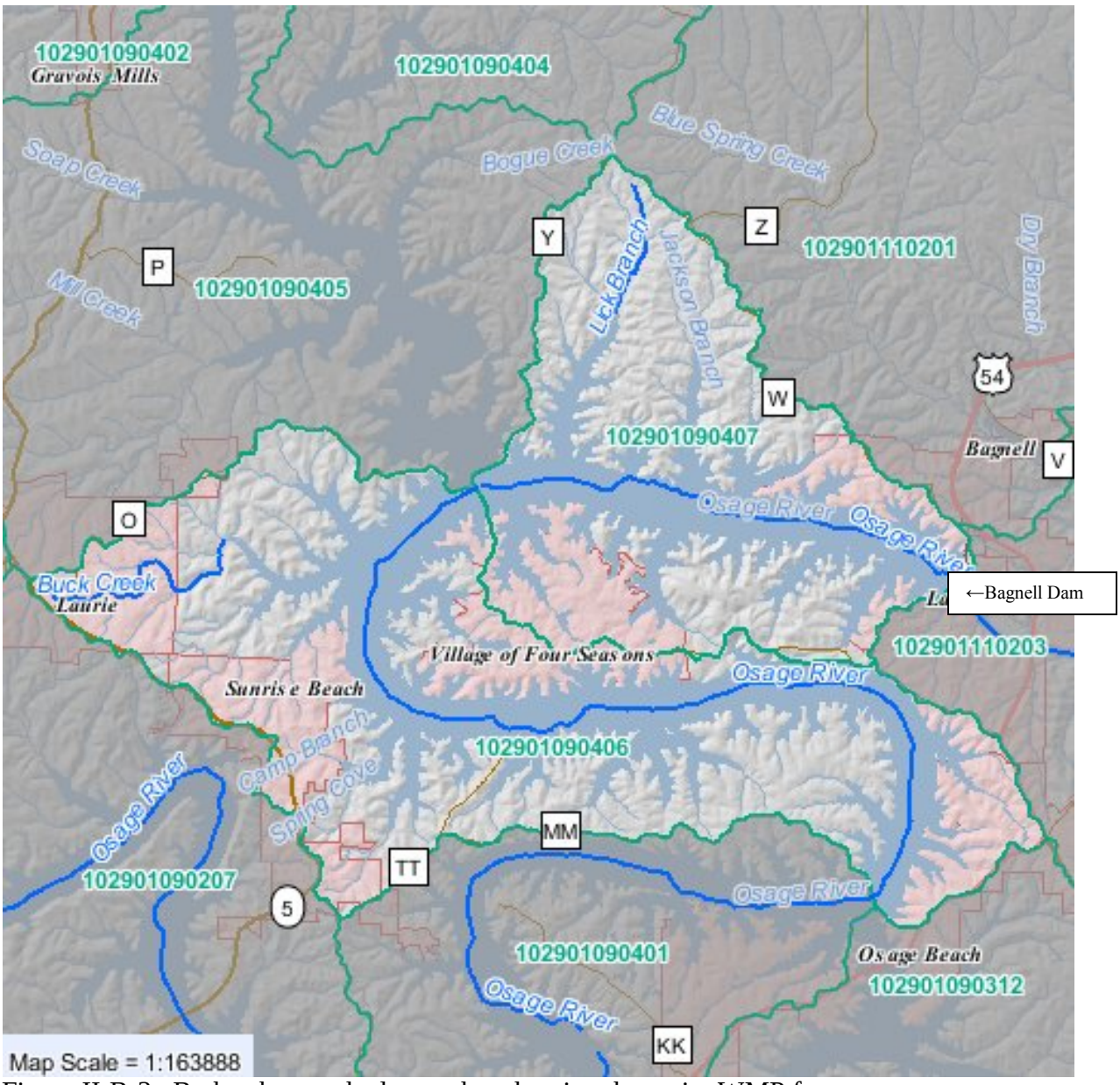



Figure II-B-3. Both subwatersheds together showing the entire WMP focus area, approximately the first 18.7 miles of LOZ, excluding the Gravois Arm. Dark blue lines are streams. The main channel, or Osage Arm, of LOZ is marked as the Osage River.

Map images in figures II-B-1, 2, and 3 from the CARES map room[5].

## SECTION III. DESCRIPTION OF THE WATERSHEDS

### Subsection III-A. Geology and Soils

The geology of the Lake of the Ozarks watershed is composed of sedimentary rocks, most of which are soluble limestone and dolomite, also known as carbonate rocks. Over many thousands of years, surface and underground waters have burrowed the uplands into a labyrinth of thousands of caves, springs, and sinkholes, a topography known as karst. The carbonate rocks cover a hidden core of older, harder igneous rocks.
In karst areas, ground water is particularly susceptible to contamination from the surface as contaminated surface water, including water in streams, finds unobstructed pathways and conduits down to the aquifers and ground water of the watershed. Although surrounded by many karst features, the WMP focus area, itself, has few karst features. (See figure III-A-1)

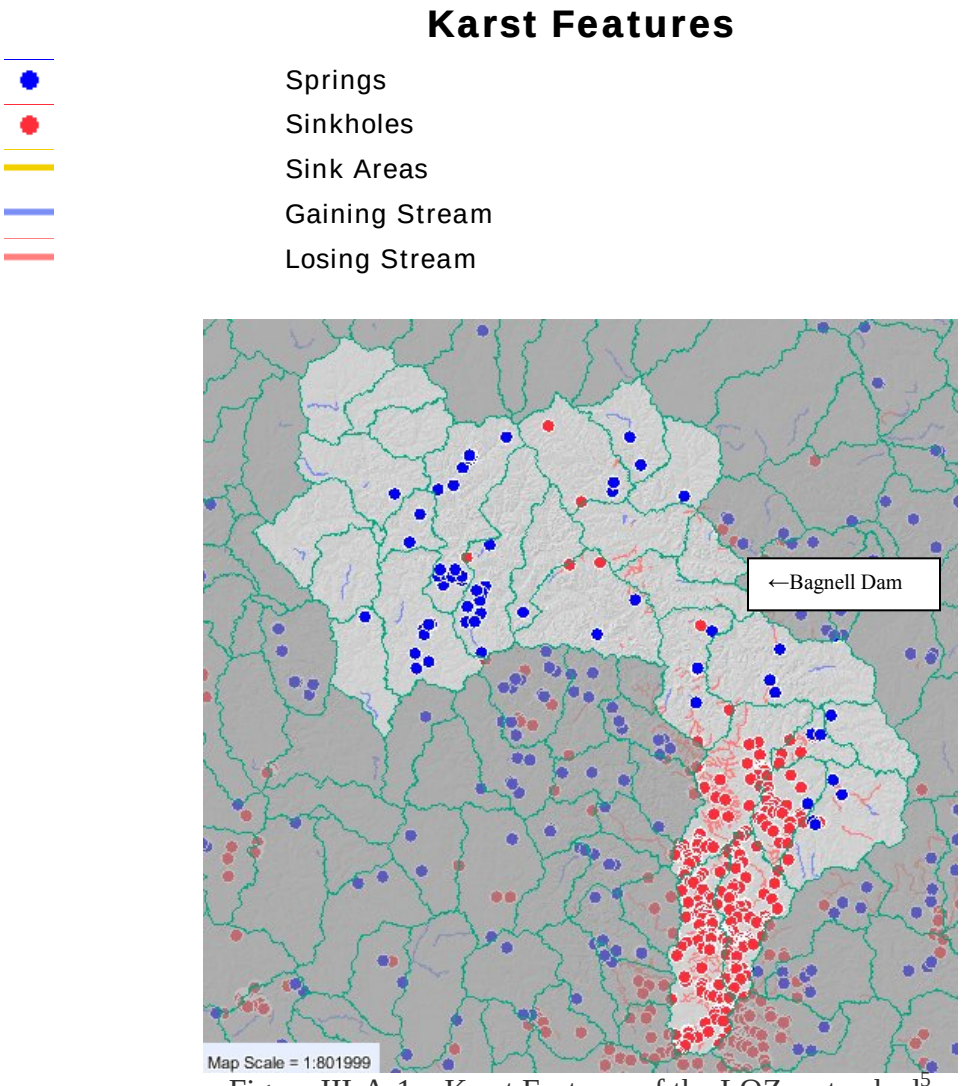



Figure III-A-1 – Karst Features of the LOZ watershed[5]

In Figure III-A-1, Buck Creek shows 1 gaining stream of 1 mile and 7 losing streams of 7.73 miles and Lick Branch shows 1 gaining stream of 1 mile and 3 losing streams of 1.97 miles.

The following sets of maps from the Watershed Tool in the CARES map room[5] characterize the thin soils and terrain of the WMP focus area and its shoreline as being highly erodible with low infiltration rates on steep slopes. The two selected 12-digit HUC's have over 19,000 acres of highly erodible soil and are subject to severe erosion when not protected.[6] (See figure III-A-2.) For more information on soils, soil types, and their properties, please refer to http://www.dnr.mo.gov/env/wpp/nps/index.html .
The first maps show the soils of the WMP focus area.

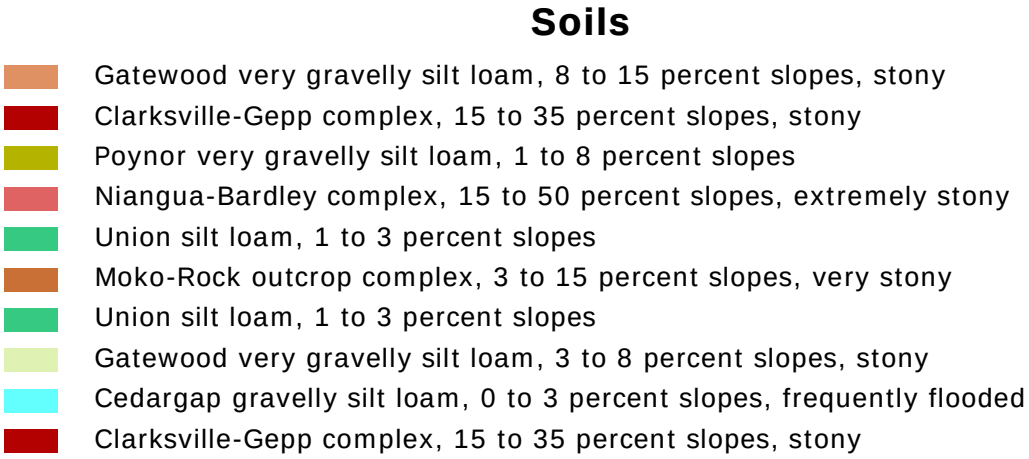
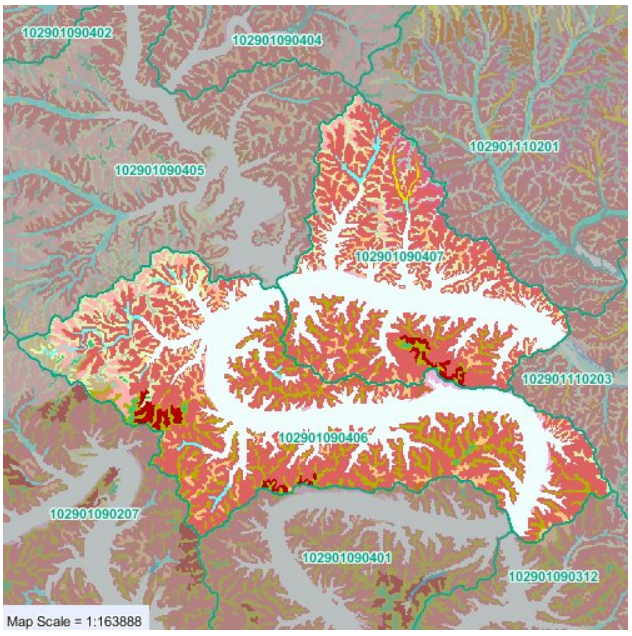



Figure III-A-2. Soil Types for Buck Creek and Lick Branch HUCs, the WMP focus area[5]



### Buck Creek-Lake of the Ozarks (102901090406)

| Map Unit Name (top 5) | Acres | Percent |
|---|---|---|
| Niangua-Bardley complex, 15 to 50 percent slopes, extremely stony | 9,013 | 39.32% |
| Water | 6,730 | 29.36% |
| Poynor very gravelly silt loam, 1 to 8 percent slopes | 2,362 | 10.31% |
| Rueter gravelly silt loam, 3 to 8 percent slopes | 1,158 | 5.05% |
| Bardley-Moko complex, 3 to 15 percent slopes, extremely stony | 1,071 | 4.67% |

### Lick Branch-Lake of the Ozarks (102901090407)

| Map Unit Name (top 5) | Acres | Percent |
|---|---|---|
| Niangua-Bardley complex, 15 to 50 percent slopes, extremely stony | 6,196 | 42.54% |
| Water | 4,267 | 29.30% |
| Rueter gravelly silt loam, 3 to 8 percent slopes | 1,197 | 8.22% |
| Bardley-Moko complex, 3 to 15 percent slopes, extremely stony | 789 | 5.41% |
| Poynor very gravelly silt loam, 1 to 8 percent slopes | 629 | 4.32% |

In addition to the land having many steep slopes, most of the soils in the WMP focus area are also very erodible[5]. See figure III-A-3.

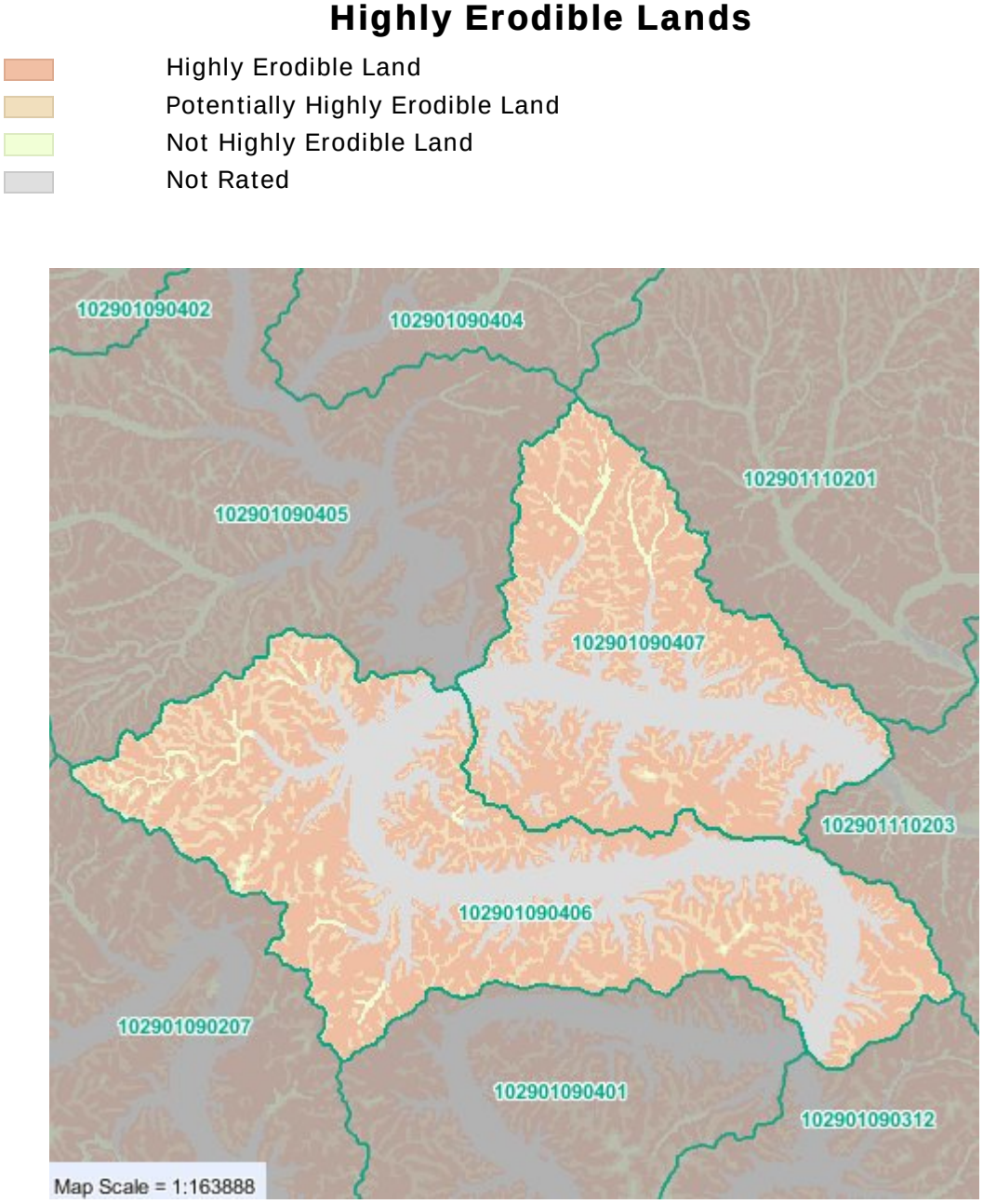



Figure III-A-3. Erodible soils in the WMP focus area of Buck Creek and Lick Branch[5]

### Buck Creek – Lake of the Ozarks (102901090406)

| | Highly Erodible | Potentially Highly Erodible | Not Highly Erodible | Not Rated (Water) |
|---|---|---|---|---|
| Acres | 11,707 | 4,037 | 354 | 6,724 |
| Percent | 51.30% | 17.69% | 1.55% | 29.46% |

### Lick Branch – Lake of the Ozarks (102901090407)

| | Highly Erodible | Potentially Highly Erodible | Not Highly Erodible | Not Rated (Water) |
|---|---|---|---|---|
| Acres | 7,995 | 2,153 | 189 | 4,316 |
| Percent | 54.56% | 14.69% | 1.29% | 29.46% |

### Summary – Buck Creek and Lick Branch together

| | Highly Erodible | Potentially Highly Erodible | Not Highly Erodible | Not Rated (Water) |
|---|---|---|---|---|
| Acres | 0 | 0 | 0 | 37,457 |
| Percent | 52.93% | 16.19% | 1.42% | 29.46% |

Yet another way of looking at soils is by hydrologic soil properties, or how quickly water percolates through the soil. Figure III-A-4 shows most of the soils have slow infiltration rates, some have moderate infiltration rates, and a small amount have very slow infiltration rates.
(The 'not rated' parts are lake.)

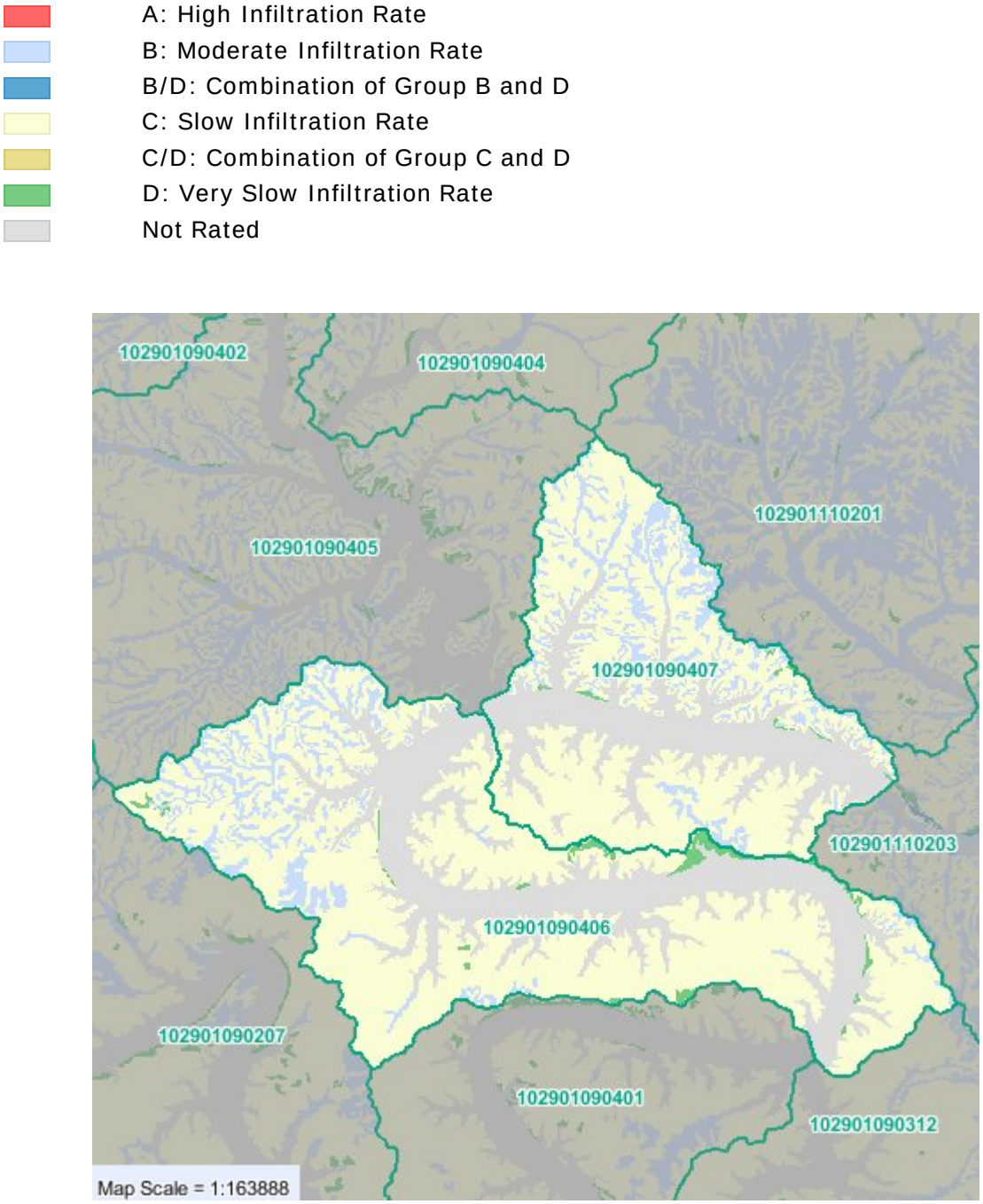



Figure III-A-4. Infiltration Rates for Soils in the WMP focus area

### Buck Creek – Lake of the Ozarks (102901090406)

| Group Type | A | B | B/D | C | C/D | D | Not Rated |
|---|---|---|---|---|---|---|---|
| Acres | 0 | 2,005 | 0 | 13,728 | 0 | 365 | 6,724 |
| Percent | 0.00% | 8.79% | 0.00% | 60.15% | 0.00% | 1.60% | 29.46% |

### Lick Branch – Lake of the Ozarks (102901090407)

| Group Type | A | B | B/D | C | C/D | D | Not Rated |
|---|---|---|---|---|---|---|---|
| Acres | 0 | 2,024 | 0 | 8,243 | 0 | 70 | 4,317 |
| Percent | 0.00% | 13.81% | 0.00% | 56.25% | 0.00% | 0.48% | 29.46% |

## Subsection III-B. Aquatic Resources

### Subsection III-B-1. General

The area covered by the WMP focus area is part of the Salem Plateau groundwater province, otherwise known as the Ozark aquifer. Streams draining from the Salem Plateau generally contain water that is calcium-magnesium-bicarbonate type with low sulfate and chloride levels[7]. Being a karst region, sink holes and losing stream segments of the Ozark aquifer can provide a direct conduit for surface water to enter groundwater. This allows for relatively quick groundwater recharge, but also provides a direct link for surface contamination to enter groundwater. This direct link and relatively quick recharge time are also responsible for great variations in the water quality of springs in the basin. Ground water can play a role in the water quality of the lake as well, but ground water issues will only be addressed for this WMP focus area partially, and then in relation to septic tanks along the shoreline of the WMP focus area. Future plans for other parts of the LOZ watershed may add additional Strategies to address these, as well as other, ground water concerns. Other factors that can influence water quality at the Lake of the Ozarks include reservoir configuration, water retention time, and nutrient inputs.

Bagnell Dam is owned and managed by AmerenUE for hydroelectric generation and minimum flow release requirements. Water levels at the Lake of the Ozarks are lowered in the fall and winter to accommodate runoff and shoreline clean-up activities. During the summer months, water levels are stabilized for recreation. Full pool at the Lake of the Ozarks is 660 feet[8].

AmerenUE published fishery data for Lake of the Ozarks in the *Lake of the Ozarks Historical Fishery Data Summary* released in May 2003. This report describes the fish

community with a particular focus on the status, health, and value of the Lake of the Ozarks' sport fishery. This report identifies habitat, fish stocking trends, species-specific information, management and protection plans, and the effects of project operations on the fishery. Habitat and water quality are listed as some of the most important factors for maintaining a healthy fishery. Consistently high productivity of the fishery is closely tied to the right amount of nutrients, resulting in high primary productivity (plankton) and large populations of gizzard shad, which is the primary food source of sport fish except paddlefish.

The principal sport fishes in most of the Lake of the Ozarks are warm water species including largemouth bass, black and white crappie, bluegill, other sunfishes, walleye, paddlefish, black bass, white and hybrid-striped bass, and blue, flathead, and channel catfish. These species frequent shoreline areas with standing timber, submerged woody debris, aquatic vegetation, or other cover. Spawning of various fish species occurs in the spring and early summer over nests constructed in shallow-water habitats, often in areas sheltered by undercut banks, fallen timber and other overhead cover.

As one of the largest reservoirs in the country, between 700,000 to 1,000,000 fishing trips occur at the Lake of the Ozarks each year, representing 14 percent of the entire fishing effort in the state of Missouri[9]. Primary sport fish in the Lake of the Ozarks include largemouth bass, white crappie, white bass, catfish, paddlefish, and walleye. In recent years, as many as 529 bass fishing tournaments have been held in a year at the Lake of the Ozarks. The 1999 economic value of just the fishery was estimated at $78 million[10], and by 2009, the taxable sales for the Lake of the Ozarks 4 county region was over $1.3 billion[11]. One of the indirect goals of this watershed management plan is to help maintain and improve the sports fishery of LOZ by maintaining and improving the water quality of LOZ.

**Subsection III-B-2. Invasive Exotic Species**

The relatively recent arrival of the zebra mussel (*Dreissena polymorpha*) to the Lake of the Ozarks does have grave implications for the stability of the entire LOZ ecosystem. Zebra mussels are filter feeders and as they proliferate and their large populations filter the food that is at the base of the food chain for LOZ, less food will be available for the species already present at LOZ, including the fish. The potential for very negative consequences to the fishing industry at LOZ are tremendous, based on observations of other lakes invaded by zebra mussels. Zebra mussels also encrust surfaces and clog intake pipes and boat motors resulting in larger maintenance costs for hydroelectric dam operators, such as AmerenUE for Bagnell Dam, and boat owners. Other consequences of the zebra mussel arrival could be many and remain to be seen.[12] Currently, MDNR, MDC, and other agencies are monitoring this issue and this WMP will not address the Zebra Mussel issue at this time.

Two other invasive exotic species, the Chinese mystery snail (*Cipangopaludina chinensis*) and the quagga mussel (*Dreissena bugensis*), though not yet found in the WMP focus area, may have been found upstream from the WMP area in the Niangua

River, upstream from the Niangua arm of the Lake of the Ozarks. The Chinese mystery snail has definitely been identified; however, some controversy exists over the positive identification of the quagga mussel. These species, like the zebra mussel, spread downstream with the current. Spreading with the current can bring the species from an upstream area to a downstream area and the WMP area is downstream of the possible entry points for these two new invasive exotics. See figure III-B2-1.

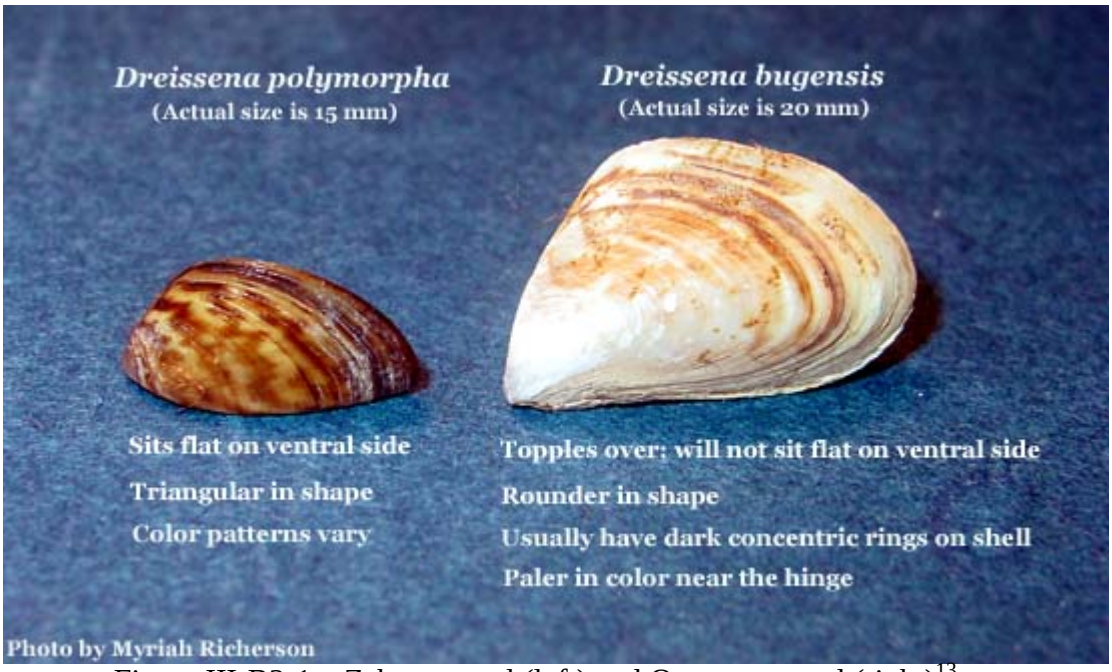



Figure III-B2-1. Zebra mussel (left) and Quagga mussel (right)[13]

The Chinese mystery snail (see figure 11) was first reported to MDC in the summer of 2008. "Chinese mystery snails, a species on Missouri's list of prohibited species, … have the potential to multiply out of control and upset the ecological balance in Missouri waters" said Fisheries Management Biologist Craig Fuller. Since being discovered at a private boat ramp at Mountain Creek Campground, the snails have been found a short distance downstream in the Niangua River, at the Conservation Department's Prosperine Access. Considering how many high flows have occurred on the Niangua River in the past year, Fuller says it seems likely the snails already have spread to other locations as well. [14]

Figure III-B2-2. Chinese mystery snail[14]

**Subsection III-B-3. Source Water Protection Areas**

The WMP focus area encompasses a significant portion of the Osage Beach and Lake Ozark area of LOZ and is a highly commercialized and developed portion of the lake with many marinas, businesses, and condominium developments along its shore, as well as many residential communities and individual residences. Most of the population of the WMP area is concentrated along the shoreline. Much of the land area is considered to be a source water protection area for the drinking water even though all drinking water for this area comes from ground water. And because this is an area of Karst topography, contaminants on the ground's surface and in the surface waters of the watershed can reach the ground water and pollute it. This potential for ground water contamination from the surface is another reason to control nutrients, bacteria, and sediments throughout the watershed. See figure III-B3-1 below.

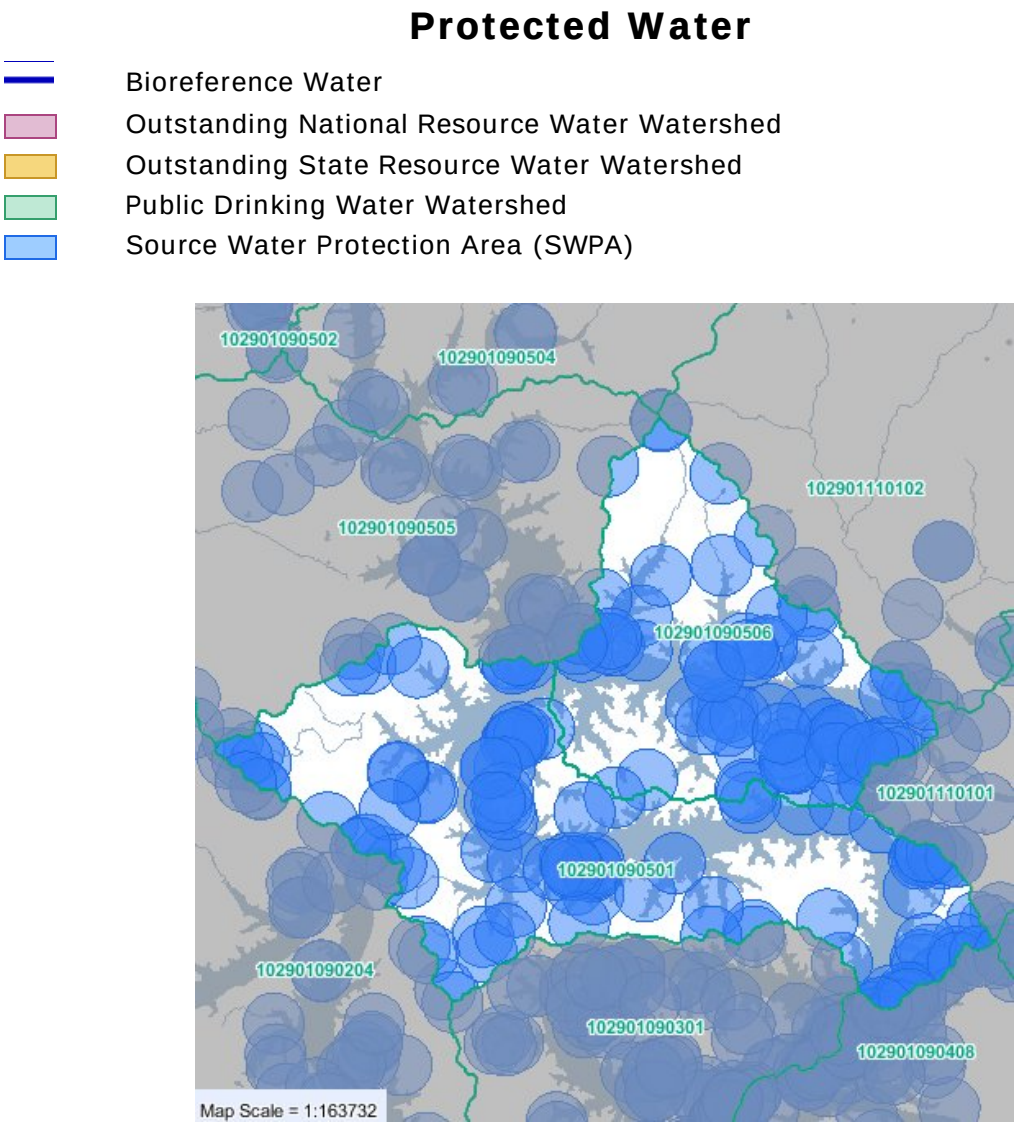



Figure III-B3-1. Source Water Protection Areas in the WMP focus area[5]

## Subsection III-C. Terrestrial Resources

The development that has occurred around and on the shores of LOZ has greatly altered and diminished the native wildlife and vegetation once found there. However, away from LOZ shores and into the watershed, one still finds the following flora and fauna:

### Subsection III-C-1. Potential Natural Vegetation.

Vegetation types are mapped as oak-hickory forest, oak-hickory-pine forest, mosaic of bluestem prairie and oak-hickory forest, and cedar glades. Dry upland sites include post oak-blackjack oak-black hickory with lichen-moss ground cover, and short leaf pine-oak in areas of sandstone bedrock. Climate conditions for vegetation in the WMP focus area are described as mesic, or moderately moist. Mesic slopes sites have white oak-northern red oak-bitternut hickory-flowering dogwood. Riparian sites have river birch-silver maple. Glades have little bluestem-bald grass; eastern red cedar has invaded these prairie sites as a result of fire suppression. Native species of vegetation are the plants of choice for a rain garden because they are adapted to the climate of the area, and thereby hardy, but native plants of the WMP focus area are typically deep rooted, as well[16].

### Subsection III-C-2. Potential Natural Wildlife

Major ungulates are white-tailed deer and cattle. The major predator is the coyote. The mink, otter, beaver, black bear, fox, and bobcat had declined but are recovering. This area supports opossum and some threatened and endangered bats; armadillo recently have begun invading. Bird species total 143, including bald eagle and other raptors, turkey, various owls, wood duck, roadrunner, kingfisher, and various woodpeckers. Great blue heron and other birds associated with aquatic habitats may be found in the project area in addition to various songbirds (many warblers). Habitat diversity (glades, sinkholes, caves, etc.) contributes to a rich herpetofauna, including, but not limited to, many species of snakes, turtles, and salamanders[16].

### Subsection III-C-3. Threatened or Endangered Species

The Department of Conservation is charged with the protection and management of Missouri's fish, forest, and wildlife resources. The Department maintains two references relating to the status of listed plants and animals in Missouri; the *Missouri Species of Conservation Concern Checklist* and the *Wildlife Code of Missouri*. All species in the State of Missouri that are protected are listed in the *Wildlife Code of Missouri* under 3CSR 10-4.111 and are protected by State Endangered Species Law 252.240. Some of the plants and animals in the checklist also appear in the *Wildlife Code of Missouri* and are afforded special legal protection. All federally endangered and threatened plants and animals are protected by the Endangered Species Act of 1973 (ESA) and by Missouri State Endangered Species Law. See Table III-C3-1 for the threatened or endangered species found in the WMP focus area.

**Table III-C3-1**

**THREATENED AND/OR ENDANGERED SPECIES LIST FOR THE WMP FOCUS AREA**

| Common Name | Scientific Name | Federal Status | State Status |
|---|---|---|---|
| Bald Eagle | *Haliaeetus leucocephalus* | | Endangered |
| Gray Bat | *Myotis grisescens* | Endangered | Endangered |
| Indiana Bat | *Myotis sodalis* | Endangered | Endangered |

Habitat loss due to land development could negatively affect the continued existence of the threatened or endangered species still found in the WMP focus area. Maintaining and improving the health of the Lake of the Ozarks and its watershed will only help these species.

**Subsection III-D. Recreation Resources**

AmerenUE catalogued the quantity, location, and ownership of Lake of the Ozarks facilities in its recreation study for the Lake of the Ozarks conducted from May 2001 through June 2002 (AmerenUE 2002*d*). Aspects of recreation resources considered in this inventory include facilities and use, carrying capacity, navigation, and public safety. The overall estimated recreation visits to 12 of the public access areas on the Lake of the Ozarks during the primary recreation season (June through October 2001) were 207,419. Visitors to public access areas participated in a variety of recreational activities, and the most frequent primary activity was motor boating (20.7 percent). The second most popular primary activity was picnicking (16.4 percent). The other activities with 10 percent or more participating, were bank/pier fishing (11.5 percent), sightseeing (10.9 percent), boat fishing (10.8 percent), swimming/sunbathing (10 percent). Private resorts and marinas provide boat rentals, boat launching, and boat housing facilities for a great number of individuals. In 2007, there were approximately 73 marinas in operation on Lake of the Ozarks and 200 total lodging and resort establishments at the Lake of the Ozarks, 63 of which were lakefront. In 2001 and 2002, marinas averaged close to nine boats launched per day on weekends, and lakefront resorts averaged approximately eight boats launched on weekend days[17]. There are more than 25,000 individual private docks on the Lake of the Ozarks, which indicates that private homeowner use of the lake is a large part of the recreation use.[8]

**Subsection III-E. Land Use**

The WMP focus area has undergone major changes in land use within the last 300 years. From the early European settlers' displacement of the Osage tribe of Native Americans to the construction of Bagnell Dam on the Osage River, the entire river basin has experienced dramatic shifts in land use. The creation of the Lake of the Ozarks has been a primary factor for the WMP focus area in changing land use from rural agriculture to an urbanized vacation and recreational development area. The shoreline within the WMP focus area contains many businesses catering to the recreation and tourism trades in

addition to many condominium complexes and single residence homes. The majority of the lands immediately adjacent to the Lake of the Ozarks shoreline are privately owned. Direction over these lands is contained within Chapter 64 of the Missouri Revised Statutes, which provides for the establishment of planning and zoning districts bordering the lake. The County Commission of any county that borders the Lake of the Ozarks can create a planning and zoning district, and some towns have adopted their own planning and zoning (P&Z) regulations. Those towns located along the WMP focus area shoreline that have adopted zoning regulations include Osage Beach, Lake Ozark, Laurie, Sunrise Beach, and village of Four Seasons. Of the 4 counties bordering LOZ, only Camden County has formed a P&Z district with the Camden County Shoreline District Planning and Zoning Commission. That part of the WMP focus area that is in Camden County is also included in the Camden County Shoreline District.

Of the 1,235 miles of shoreline 85.3 miles are state protected areas, 596.75 miles (51.89 percent) are potentially developable and 553.25 miles (48.10 percent) are developed.[8] Using the tables and information of Figure III-E-1, the WMP focus area is about 30% water (lake) and 16% urban, almost half forested, and the rest, about 6%, is grasslands[5]. The urbanized areas along the shoreline are the critical areas of focus for this watershed management plan.

Land use by a shoreline resident around the 8 mile marker.

## Table IIIE-1

### Land Use/Land Cover Key for Fig III-E-1

- Developed, High Intensity
- Developed, Medium Intensity
- Developed, Low Intensity
- Developed, Open Space
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Herbaceous Wetlands
- Open Water

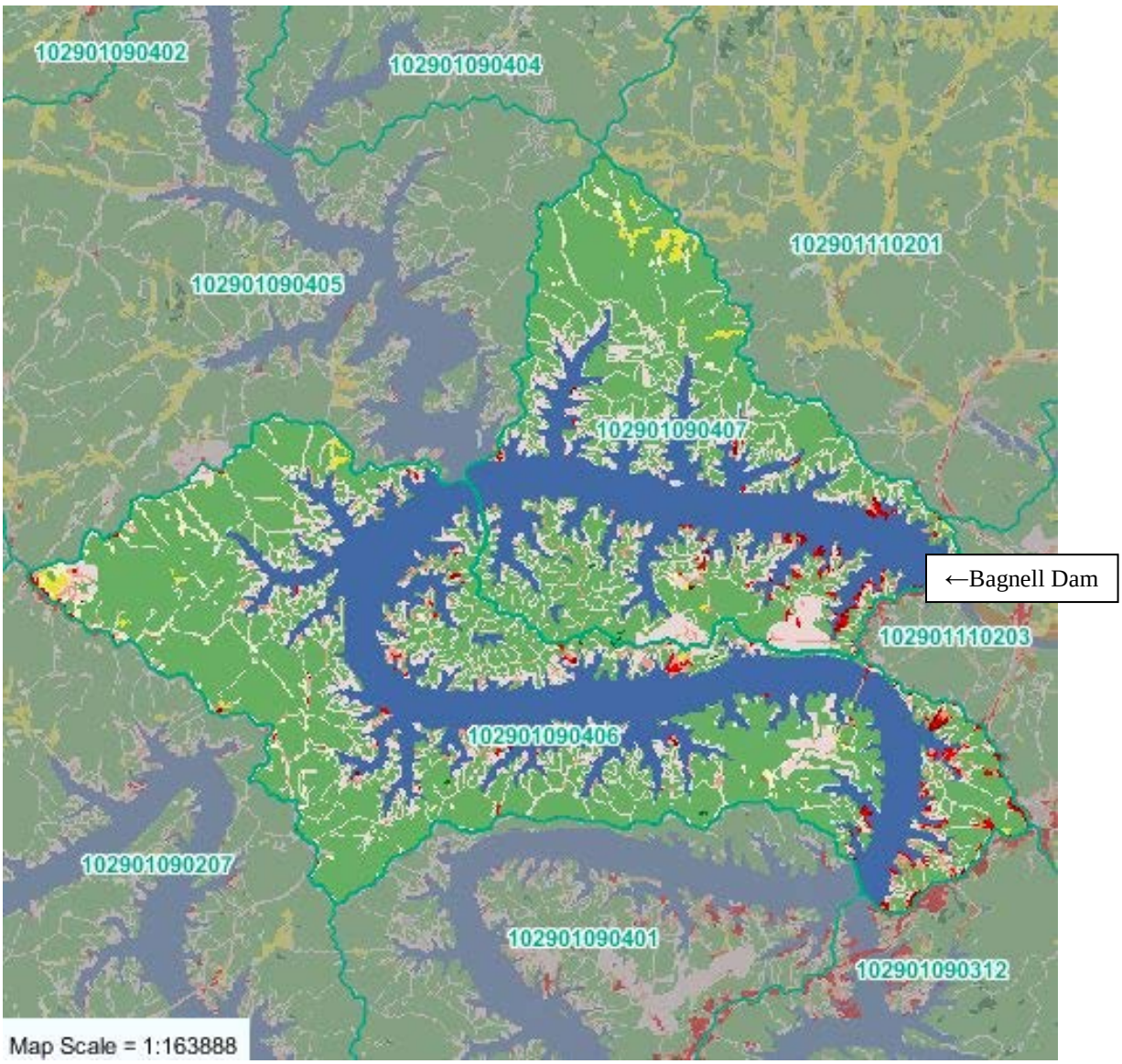
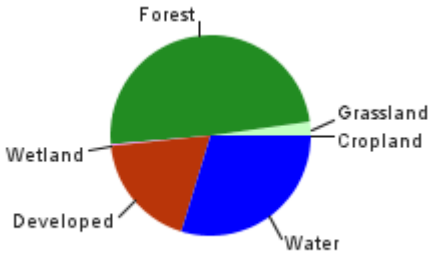



Figure III-E-1. Land Use and Land Cover for the WMP focus area[5]. This map shows the heavily populated and urbanized shoreline of LOZ. See Key in Table IIIE-1.

## Land Use Buck Creek-Lake of the Ozarks (102901090406)

| | Cropland | Grassland | Forest | Wetland | Developed | Water |
|---|---|---|---|---|---|---|
| Acres | 18 | 536 | 11,266 | 88 | 4,237 | 6,773 |
| Percent | 0.08% | 2.34% | 49.16% | 0.38% | 18.49% | 29.55% |

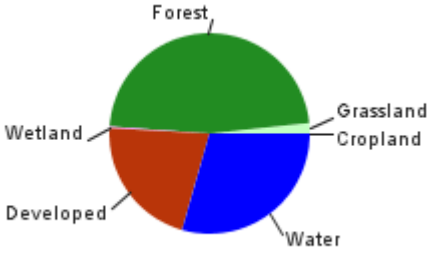



*Source: U.S. Geological Survey National Land Cover Database, 2001.*

*Note: This table shows grouped land cover types. For a detailed listing, click here.*

## Land Use Lick Branch-Lake of the Ozarks (102901090407)

| | Cropland | Grassland | Forest | Wetland | Developed | Water |
|---|---|---|---|---|---|---|
| Acres | 12 | 251 | 6,873 | 49 | 3,118 | 4,265 |
| Percent | 0.08% | 1.72% | 47.18% | 0.34% | 21.40% | 29.28% |

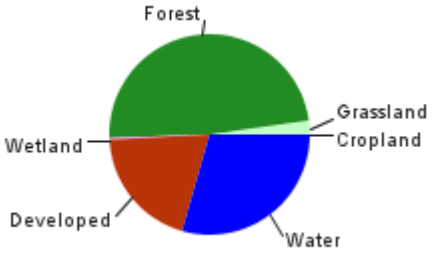



*Source: U.S. Geological Survey National Land Cover Database, 2001.*

*Note: This table shows grouped land cover types. For a detailed listing, click here.*

## Land Use Summary: Buck Creek and Lick Branch together

| | Cropland | Grassland | Forest | Wetland | Developed | Water |
|---|---|---|---|---|---|---|
| Acres | 30 | 787 | 18,139 | 137 | 7,355 | 11,037 |
| Percent | 0.08% | 2.10% | 48.39% | 0.37% | 19.62% | 29.44% |




*Source: U.S. Geological Survey National Land Cover Database, 2001.*

*Note: This table shows grouped land cover types. For a detailed listing, click here.*

**Subsection III-F. Water Resource Concerns**

Most of the shoreline of the WMP focus area is highly developed and supports an active urban community and a large tourism industry. Designated uses for the water of the Lake of the Ozarks include livestock and wildlife watering, protection of warm water aquatic life, human fish consumption, and whole body contact, but in the WMP focus area, livestock watering and other agricultural issues will not be a concern for this watershed management plan at this time. Future watershed managers working from this plan and expanding to other focus areas around the Lake of the Ozarks may wish to consider agricultural issues in their plans. At LOWA's formational meetings and within the WMP focus area, local stakeholders have expressed concern regarding both water quality and water quantity in recent years, especially as impacted by land use. Groundwater, as opposed to surface water, serves as the principle source of drinking water for area residents. While the surface water of the Lake of the Ozarks is primarily used for recreational use, including supporting a large fishing industry, the lake, itself, is also used by AmerenUE for production of hydroelectricity.

Several water quality concerns connected to land use around the Lake of the Ozarks are as follows:

- A major concern of sediment being washed into the lake is linked to the large degree of urbanization and development along the shores of the lake in the WMP area.
- Livestock production occurs on approximately 5% of the land base throughout the LOZ watershed. The WMP area shows an average of about 6% grasslands. Continuous grazing of cattle permits livestock concentration in or near riparian areas, thus potentially placing nutrient and bacterial loading in close proximity to streams. However, this concern is not considered a high priority for the WMP focus area and will not be addressed in the BMPs for this plan at this time.
- Wave action from boat traffic on the lake is also a contributor to soil erosion. The WMP area has a very high density of boat traffic, marinas, and private boat docks, in addition to many properties trying to protect their shorelines with sea walls, which are undercut by wave action which contributes to soil erosion and sediments entering the Lake. Seawalls also serve to amplify the effects of wave action throughout the water basin.
- Bacterial concerns from recreational boaters, on-site sewage systems around the lake's shoreline, and runoff from impervious surfaces, unconfined soil on land disturbance sites, and the compacted lawns of lake residents are a major concern of this WMP focus area. In addition, the older on-site sewage systems found throughout the WMP focus area, especially along the shoreline, are not only among the top concerns to be addressed, but are also concerns where Strategies could take a longer time period to be fully implemented. The WMP focus area includes many high density residential areas that are presently served by individual septic systems. Many of these older systems may be failing or inadequate and need to be updated. In addition, many systems are currently in

second homes that may well become full-time homes for the baby boomers poised to retire at the Lake.

- Nutrient loading from a variety of sources, including but not limited to, soil erosion, wildlife, lawn and garden fertilization, pets, on-site sewage facilities, improper disposal of the waste from a boat's holding tank, livestock production, and golf course maintenance all contribute to the nutrient load for LOZ, and throughout the waters of the WMP focus area. Monitoring data from the Lakes of Missouri Volunteer Program indicate nutrient and chlorophyll concentrations in The Lake of the Ozarks are among the highest 25% of all Missouri lakes[18]. As a side note, LOZ hosts hundreds of fishing tournaments a year and offers anglers great fishing opportunities. The lake needs a certain amount of algae and nutrients to be a productive fishery. However, LOWA wants to be proactive and reduce nutrient levels to a more balanced ratio and avoid the problems of Table Rock Lake in 1999 when the entire lake turned into something resembling pea soup and many millions had to be spent to get that ecosystem back into balance, including adding expensive treatments to take nutrients out of the waste water in the WWTP's (waste water treatment plants) of that watershed. See figure III-F-1.

Figure III-F-1. Table Rock Lake algal bloom, 1999.[19]

Figure III-F-1a. LOWA volunteers for the MDNR LOZ E. coli Cove Study showing their collection awards.


Figure III-F-1b. LOWA award for most successful and largest volunteer water quality monitoring event for MDNR.

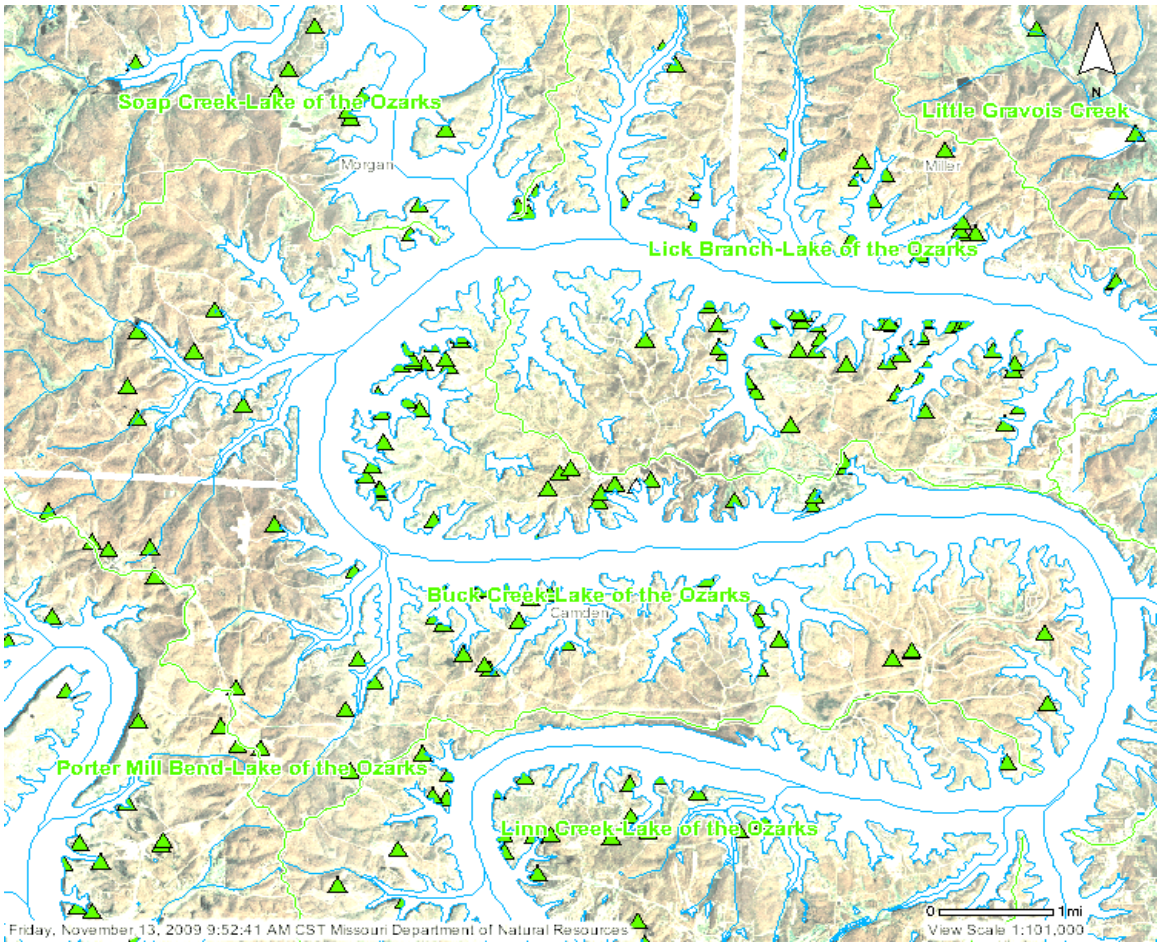



Figure III-F-2. NPDES (National Pollutant Discharge Elimination System) Waste Water Outfalls (permitted wastewater facilities) in the WMP focus area shown as green triangles[20].

**Subsection III-G. Demographics**

The lake area's population has grown steadily from 1990 to 2007[4]. Table IIIG-1 shows population figures for the various counties around LOZ for 1990, 2000, and 2007. Table IIIG-2 shows the % change and average annual growth for the same counties. Figure III-G-1 shows most of the WMP area's population clustered around the lake's shoreline and figure III-G-2 shows the tremendous growth for parts of the WMP area from 1980 to 2000. The tremendous growth and urbanization of the WMP focus area is the main reason for the concerns in the WMP focus area. And now, the baby boomers are poised to retire into their second homes here at the Lake of the Ozarks. These homes typically have aging septic tanks sized for a weekend home that will have to meet the sewage needs of full time residents living a modern lifestyle. Data for Tables IIIG-1 and 2 and Figure III-G-2 come from the Camden County preliminary draft of their Master Plan for the Shoreline District of Camden County and reflect updated US Census information as well as county and state census information. The map in figure III-G-1 is from Census 2000 data and was included to indicate the population density clustering along the lake's shoreline. This map does not reflect the updated information from the state and county and covers a slightly different area and so the population numbers may not add up exactly. Instead, the reader should glean from this information that the WMP focus area has grown and developed rapidly mostly along the shoreline of LOZ, which consists largely of steep slopes and highly erodible soil (see Subsection III-A). The shoreline of the WMP focus area is considered to be the critical area for the watershed management plan.

**Table IIIG-1. Population of 4 counties around LOZ[4]**

| Area | 1990 | 2000 | 2007 |
|---|---|---|---|
| Camden Co. | 27,495 | 37,051 | 40,487 |
| Morgan Co. | 15,574 | 19,309 | 20,820 |
| Miller Co. | 20,700 | 23,564 | 24,898 |
| Benton Co. | 13,859 | 17,180 | 18,470 |

**Table IIIG-2. LOZ area population changes[4]**

| County | 1990-2007 | | 1990-2000 | | 2000-2007 | |
|---|---|---|---|---|---|---|
| | % change | Avg rate | % change | Avg rate | % change | Avg rate |
| Camden | 47.3% | 1.4% | 34.8% | 3.0% | 9.3% | 1.3% |
| Morgan | 33.7% | 1.1% | 24.0% | 2.2% | 7.8% | 1.1% |
| Miller | 20.3% | 0.7% | 13.8% | 1.3% | 5.7% | 0.8% |
| Benton | 33.3% | 1.1% | 24.0% | 2.2% | 7.5% | 1.0% |

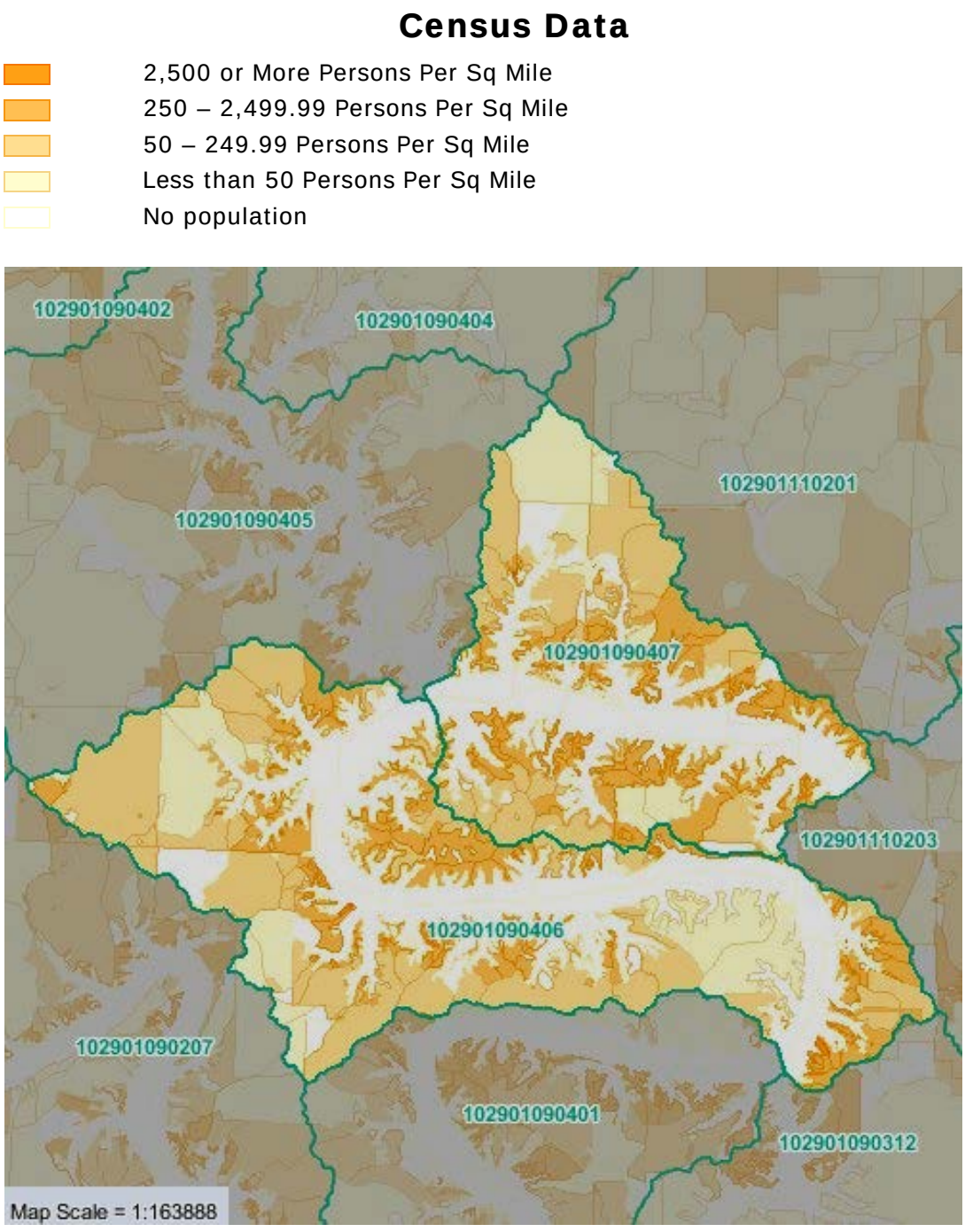



Figure III-G-1. Census data from 2000 for the WMP area[5]. As a side note, Camden County had the lowest census return in the state.

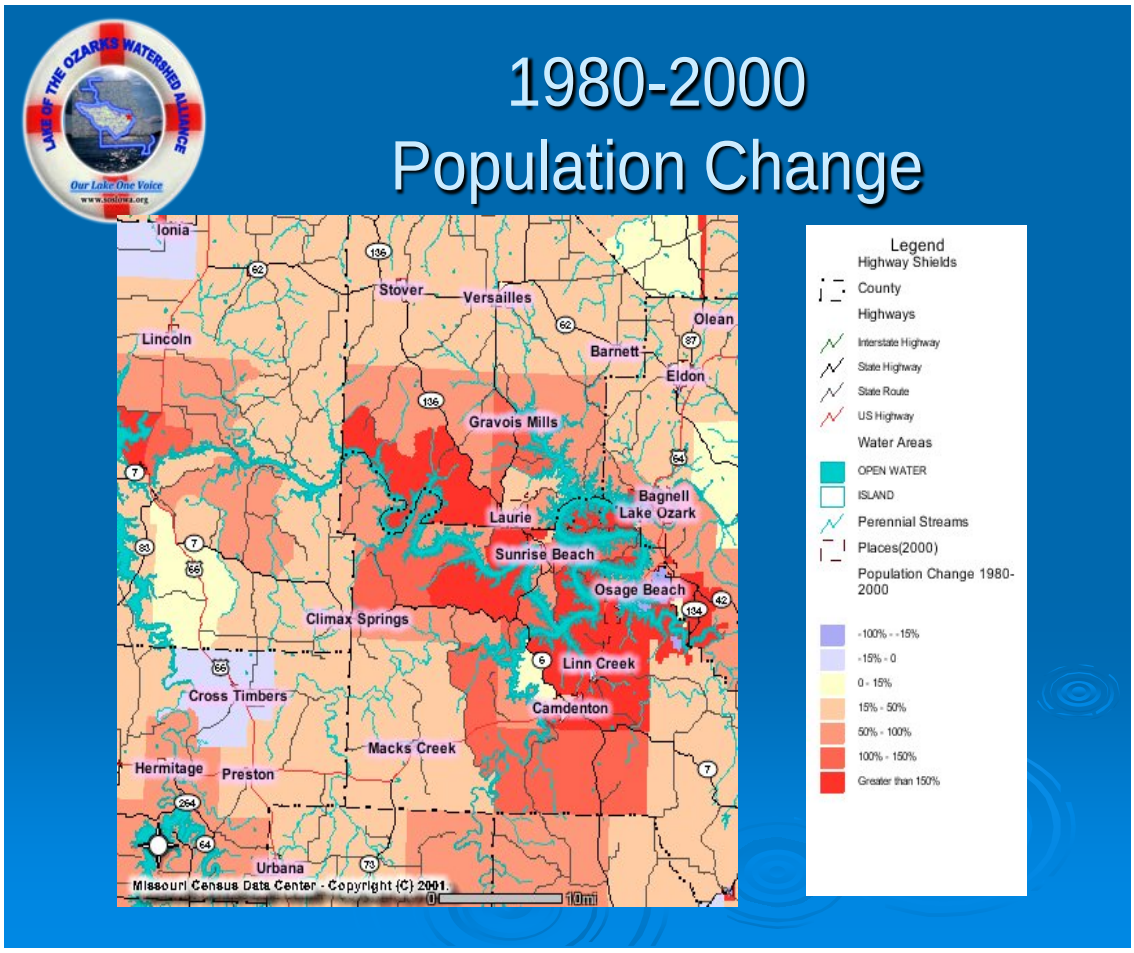



Figure III-G-2. Notice the dark red areas around the shoreline show a population change of greater than 150% from 1980 to 2000 for parts of the WMP focus area[4].

## SECTION IV. WATERSHED STAKEHOLDERS

### Subsection IV-A. Groups and Organizations

All who may have an interest in the Lake of the Ozarks Watershed are encouraged to participate in the management of the watershed by assisting in the maintenance and improvement of the health of the Lake of the Ozarks, as well as by acting upon policies and practices which will ensure the long-term social, economic, and environmental health of the watershed. Partners to the watershed management plan include AmerenUE, MDNR, University of Missouri Extension, Soil and Water Conservation Districts, county and state Health and Senior Services departments, EPA Region 7, MO Water Patrol, the Camden County Shoreline District Planning and Zoning Commission, the area Chambers of Commerce, Tri-County Lodging Association, Visitors and Convention Bureau, the Public Works departments of area municipalities, MDC, MO Stream Team, Lakes of Missouri Volunteer Program, and many, many others.

Potential stakeholders of the WMP area are a diverse group, including, but not limited to, the citizens who live on the lake's shores or in the watershed year round, people who enjoy a second home in the WMP area or vacation time at an area resort, businesses and developers of the area, as well as municipal governments, agencies, and community associations. In short, anyone who lives, works, or who simply enjoys the Lake of the Ozarks is a stakeholder of the WMP area.

Figure 17 – Potential stakeholders of WMP area are many[21]

### Subsection IV-B. Public Input

In forming LOWA, 3 organizational public meetings, each at different locations around the lake, were held during the spring of 2006. Environmental concerns that impair the

lake were identified, discussed and prioritized. The top concerns included: sediment, bacteria, nutrient loading, sewage, and shoreline trash. Since then, LOWA has held many public meetings with opportunities for open discussions of stakeholders' questions, comments, and concerns. LOWA maintains a website at www.soslowa.org where anyone may post comments, volunteer for events and activities, or contact the Executive Board of LOWA. In addition, LOWA has an office in Laurie, MO at PO Box 836, zip code 65079, phone 573 374 1331.

A few entities within the WMP focus area have begun to address some of the nonpoint source pollution issues of concern to the area. The Camden County Shoreline District Planning and Zoning Commission has recently published for public review and comment the preliminary draft of the district's Master Plan[4]. In this plan are many sections devoted to maintaining and improving the watershed of LOZ. For example, the Master Plan's Strategy 3.2.2: Establish a conservation overlay to protect water quality that incorporates low impact development and storm water management measures within 300 feet of the private property line (up to the AmerenUE property line), includes the promotion of many of the watershed-friendly Strategies of this WMP such as installing rain gardens and rain barrels, and limiting the use of fertilizer by encouraging native species. The city of Osage Beach has taken the state minimum storm water requirements and has issued ordinances that go beyond the minimum requirements. For example, a land disturbance of ½ an acre or 2 lots, whichever is smaller, instead of a full one acre of land disturbance is enough in Osage Beach to require a permit and an approved Storm Water Pollution Protection Plan (SWPPP). LOWA has written grants and promoted septic tank pump-out programs to provide the public with education about proper maintenance of septic tanks and why caring for a septic tank is so important to the health of the watershed and the lake. These pump-out programs also offered home owners a discount for the pump-out. In addition, LOWA has also developed a program to discourage boaters from dumping their waste water directly into the lake, which included an educational brochure about pumping out wastes instead of dumping wastes and provided a map showing marinas and campgrounds around the lake that offered pumping stations. All of these past programs and contemporary planning documents and ordinances compliment and work with the Strategies developed in this watershed management plan.

After approval of this WMP, paper copies of the WMP will be kept at several locations around the lake including the LOWA office in Laurie, the AmerenUE office in Lake Ozark, Benton, Camden, Morgan, and Miller county courthouses, and at the branches of the WMP focus area public libraries. An electronic copy of the WMP will be found on the LOWA website at www.soslowa.org. The electronic copy and the LOWA office copy will be kept up to date on all modifications and additions to the WMP. The paper copies found around the lake will be updated every 4 years. These copies are made available to the public for their information and use and comments from the public will be welcome.

## SECTION V. CAUSES AND SOURCES OF IMPAIRMENT
**This section includes the following element of a successful watershed plan:**
**ELEMENT A: IDENTIFICATION OF CAUSES AND SOURCES OF IMPAIRMENT**

### Subsection V-A. Watershed Profile

As discussed in Section III, Description of the Watersheds, the WMP focus area has many steep slopes, highly erodible soils, and soils with a fairly low infiltration rate. During rain events, these factors all contribute to soil erosion and the washing of sediments into the lake. Combined with too much fertilizer use, underperforming waste water treatment systems and treatment plants around the shoreline of the WMP focus area and in its watershed, the causes and sources of impairments to the WMP focus area become apparent. Please see figure V-A-1, a Google map of the shoreline and coves of the WMP focus area, showing a shoreline densely populated with marinas, businesses, residences, and resorts, many of which have golf courses. Notice the concentrations of docks, most of which cover multiple boat slips, along almost the entire shoreline and the golf course areas, denoted by a yellow pushpin icon, as well as the urbanized area of Lake Ozark and Business Hwy 54.

Watershed managers for the Lake of the Ozarks must maintain several uses for the lake and its watershed. Whole body contact with the water must be maintained, as well as managing the ecosystem to maintain a highly productive game fishery. AmerenUE also must answer to the Federal Energy Regulatory Commission because AmerenUE manages LOZ and Bagnell Dam as a hydroelectric generating plant which brings other management considerations to be addressed while keeping the recreational uses for LOZ as other top priorities. In the WMP focus area sediment, nutrients, and bacteria are reaching the lake. The high density of residential lawns, impervious surfaces, unconfined soil on land disturbance sites, and resorts with golf courses are a few of the sources of sediments, excess nutrients, and bacteria entering the lake. In this Section V, the WMP will discuss the causes and sources of sediment loading, nutrient loading, and bacteria loading to the WMP focus area in much greater detail.


Figure V-A-1. Google map of WMP focus area showing the high population density of businesses, marinas, and residences along the shoreline, as well as the concentration of golf courses in that area. Bagnell Dam and some golf course areas are marked by yellow icons. The urban area of Lake Ozarks and Highway 54 are also labeled. The thin white line is the Miller (right) and Camden (left) county border.

**Subsection V-B. 303d Impaired Waters**

Section 303(d) of the federal Clean Water Act requires that each state identify waters that are not meeting water quality standards and for which adequate water pollution controls have not been required. Water quality standards protect such beneficial uses of water, as is the case for LOZ, whole body contact (such as swimming), maintaining fish and other aquatic life, and providing drinking water for people, livestock and wildlife. The 303(d) List helps state and federal agencies keep track of waters that are impaired, but not addressed by normal water pollution control programs.

Currently, The Lake of the Ozarks is on the draft issue of the 2010 303(d) List of Impaired Waters for nutrients. The Niangua Arm is listed for phosphorus and the Osage Arm, i.e., the main channel of LOZ, is listed for nitrogen. The almost 19 miles of the Osage Arm is the WMP focus area and the Niangua Arm is up lake from the WMP focus area, and thus still impacts the down lake area, which includes the WMP focus area.

All 3 of the impairments this watershed management plan has identified for LOZ involve nutrients. One of the impairments identified by this WMP is nutrient loading, and the other 2 are bacteria loading and sediment loading. Bacteria are associated with waste entering the lake and waste material is high in nutrients. Also, a lot of material that is washed into the lake is a source of nutrients, including leaves, trash, plant debris, and sediments. Sediments include soil, clay, silt, organic material, and rocks. Soil has both organic material with phosphorus and nitrogen and inorganic material with phosphorus. One of the goals of this WMP is to reduce the volume of runoff reaching the lake. Reducing the amount of runoff can also reduce the amount of nutrients reaching the lake.

**Subsection V-C. TMDL list and associated pollutants**

Under the federal Clean Water Act, the Total Maximum Daily Load, also known as TMDL, program provides a framework for identifying and cleaning up impaired waters. Section 303(d) requires states to list impaired waters for which the necessary pollution controls have not yet been required and for which a TMDL study has not been written.[12] According to the Consent Decree signed in 2000 by the U.S. Environmental Protection Agency, the American Canoe Association and the Sierra Club, EPA is responsible for ensuring that 30 Missouri TMDLs be completed by the end of the 2009 calendar year. The Missouri Department of Natural Resources is working with EPA to complete these TMDLs through a Memorandum of Understanding. Neither TMDLs for the Lake of the Ozarks, nor for any of the streams or creeks emptying into LOZ had been established by MDNR as of January, 2010.[22] LOWA considers the development of TMDLs within the WMP area of LOZ to be of a high priority because of the high population density within this area and the accompanying water quality issues. Although TMDLs have not been established for LOZ yet, some nutrient criteria specifically for the Lake of the Ozarks have been proposed, but not officially set.

**Subsection V-D. Nutrient Criteria**

The material in this section comes from *The Lakes of Missouri Volunteer Program (LMVP) 2008 Data Report*[18]. The state of Missouri is currently in the process of developing nutrient criteria for reservoirs, which would identify when a reservoir has too much phosphorus, nitrogen or chlorophyll. Some nutrient criteria for the Lake of the Ozarks have been proposed through work by LMVP.

2008 was a particularly wet year for Missouri and the Lake of the Ozarks. The water level in the lake, itself, was rather consistent throughout the 2008 sampling season, varying by less than three feet. However, the water level in the Osage River below Bagnell Dam and Truman Reservoir (above the Lake of the Ozarks on the Osage River) each varied by 20 feet. So while the Lake of the Ozarks level did not rise, flow increased substantially during 2008, particularly during June and July.

The increased flow from Truman Reservoir meant more sediment was scoured from the upper end of Lake of the Ozarks as water was released from Truman dam, and the sediments quickly flushed down-lake. As a result, the nutrient and inorganic suspended solids (ISS) concentrations and Secchi transparency values (Secchi values measure the distance a black and white disc can be seen in the water column - the lower the value, the less clear the water) all tend to rise and fall based more on Truman Lake's water level (and the release of water from Truman Dam in Warsaw) than the level of the Lake of the Ozarks, which remains relatively constant for the benefit of the private docks around the lake's shoreline.

Two of the sites being monitored by LMVP at the Lake of the Ozarks are in the main channel of LOZ at mile markers 3 and 13 (numbered going upstream from Bagnell Dam), and these sites are located in Buck Creek or Lick Branch HUC's. A third site, 1-2, representing the main channel of the Gravois Arm 2 miles from the main lake, is close to the northern boundary of the Buck Creek HUC. (The Gravois Arm flows directly into the Buck Creek HUC.) See figure II-A-1.

In looking at trend data for phosphorus (TP) at LOZ, the current long term average is 0.024 mg/L, slightly lower than the proposed nutrient criterion level of 0.026 mg/L at the dam.

Nutrient criteria levels for nitrogen, chlorophyll, and Secchi depth have also been proposed but long term averages for these parameters were not available. However, if one averages data for these from 2005-2008, one can make a tentative comparison of the averages and the proposed criteria levels.

No EPA standards or Missouri standards for ISS could be found. The ISS measurement reflects the amount of very fine sediment in the water and is often directly related to the amount of bacteria in the water because bacteria is thought to use suspended particles of sediment as a platform on which to reproduce and grow. The 2008 mean value for ISS at site 3 in 2008 was 0.0018 mg/L, at site 13 it was 0.0017 mg/L, and at 1-2 the ISS average was 0.0019 mg/l. Although no standards for ISS were found, this data can be considered

a baseline which can be compared to future ISS measurements in order to assess the effectiveness of certain implemented BMPs, at selected sites.

Table VD-1 summarizes the nutrient criteria being proposed for LOZ and the long term average (including 2009 data) measured at LOZ for that parameter. ISS is also included in the long term averages even though a criterion level for this parameter has not yet been proposed. 2007, 2008, and 2009, it should be noted, were all high flow years.

**Table VD-1. Nutrient Criteria and Long Term Averages[18a] at LOZ**

| Nutrient | Long Term Avg. | Criterion Level | 2008 data at Site 3 |
|---|---|---|---|
| **TP** | **0.026 mg/L** | **0.026 mg/L** | **0.041 mg/L (too high)** |
| **TN** | **.532 mg/L** | **0.520 mg/L** | **0.679 mg/L (too high)** |
| **CHL** | **0.0148 mg/L** | **0.0109 mg/L** | **0.0117 mg/L (too high)** |
| **Secchi** | **65.0 inches** | **39.36 inches** | **49 inches (good)** |
| **ISS** | **0.0011 mg/L** | **n/a** | **0.0011 mg/L** |

**Subsection V-E. Sources of Impairments to the LOZ and WMP watershed**

Water in the Lake of the Ozarks owes part of its nutrient load to the fact that Truman Reservoir, at its dam in Warsaw, empties directly into the headwaters of the Lake of the Ozarks. Both reservoirs are part of the whole watershed of the Lake of the Ozarks but the watersheds draining to each reservoir are quite different. Truman Reservoir is an Army Corps of Engineers lake and does not allow development on its shoreline. The watershed draining to Truman Reservoir is largely agricultural and brings with it an agriculture-based load of nutrients, much higher in phosphorus and nitrogen than the watersheds typical of the Ozarks. The watershed draining to the Lake of the Ozarks (also, technically, a reservoir) is very mixed. Around the WMP focus area, the watershed has very little agriculture and is developed, urbanized, and suburbanized with a shoreline full of development. However, the watersheds draining to the northern part of LOZ have a lot more agriculture influencing the water quality. This watershed management plan, focusing on two developed and more urbanized HUC's, will not address the agricultural aspect of nutrient loads influencing the water quality of LOZ and will reserve the right to add more Strategies in the future and additional watershed management plans that will focus on the impairments influencing other parts of the Lake of the Ozarks and its watershed.

Water quality issues in the WMP focus area center around sediments, nutrients, and bacteria and the main sources of these impairments center on nonpoint source pollution (NPS) stemming from urbanization of the watershed. The WMP focus area is one of the most densely populated and developed parts of the entire LOZ watershed, and the shoreline is the critical area of this WMP. Excess sediments wash into the lake from land disturbance sites with unconfined soil, grassy and wooded residential areas, and the impervious surfaces of surrounding roofs, streets and parking lots. Along with the sediments and other materials come nitrogen, phosphorus, and bacteria.

Nitrogen in the runoff comes from plant debris, as well as untreated (or under treated) wastes, both animal and human. Feces and urine from pets wash off of lawns, parking lots, and streets. Excess nitrogen from human waste can end up in the lake from improperly functioning septic tanks. Another potential source of nitrogen in the Lake of the Ozarks is from recreational boaters who might dump their waste water into the lake instead of taking that waste to be pumped out at an appropriate facility. And another source of nitrogen is from fertilizer washing into the lake water. This fertilizer comes from residential lawns, golf courses, and other green spaces.

The main sources of excess phosphorus in the WMP watershed are runoff from fertilizers and waste water from cleaning. Golf courses, prevalent in the WMP area, use a lot of phosphorus in their fertilizers in the maintenance of their greens. Home owners also apply fertilizer to their lawns and gardens. These fertilizers can run off into the lake when improperly applied. Residences, marinas, restaurants, etc, typically use a lot of phosphorus in their cleaning supplies. This phosphorus often ends up in the lake. Another source of phosphorus to the lake is from human waste and other feces, similar to sources of nitrogen.

Bacteria are always present in the lake, but their numbers can rise to unhealthy levels when feces and sediments are washed into the lake, often during rain events, and when wastewater treatment systems function improperly. The bacteria can come from animal feces in runoff and from overflowing or improperly working wastewater treatment plants and septic tanks. Data from several studies over the last 35 years has shown that the presence of E. coli bacteria increases as development and recreational use increase. Please see Appendix A for a summary of these reports. In an August 1985, MO Geological Survey report evaluating groundwater and surface water contamination potential at LOZ, the authors concluded that the geologic nature of the shoreline around LOZ is such that on-site wastewater systems like septic tanks present problems of inadequate treatment of wastes before entering the lake.[26] Around the same time, a masters thesis entitled Limnological characteristics of the main channel and nearshore areas of Lake of Ozarks, MO by Jeffrey D. Mitzelfelt found a direct relationship between the amount of development and the number of times a cove exceeded the standard for bacteria (in this case, fecal coliform). And, the mean fecal coliform concentration in the most highly developed coves was 50 times the mean concentration of that in the main channel.[27]

In 1992, MDNR produced a report on water quality at LOZ and recommended a thorough water quality study be done to assess the impact of the large increase in development as well as the newly built WWTP in Osage Beach. The report also pointed out a shift in the main source of nutrients with the construction of Truman Dam, away from the Osage River waters to point source discharges, septic tanks, and lawn maintenance in the developed areas[28]. The study in which the DNR report was an Appendix strongly recommended removing the septic tanks from the shoreline of LOZ. This study, from 1996 and commissioned by the Lake Group for Clean Water and Economic Development, stated plainly that unless human waste around the Lake was disposed of in

a competent and professional manner, the chances of the lake staying clean were not good.[28]

Recently, in 2009, O'Hearn, in her masters thesis entitled Nutrients, Chlorophyll, and Bacterial Fecal Indicators in Coves and Open Water Areas of Lake of the Ozarks, MO, and using data collected in 2007, looked at E. coli (EC), fecal coliform (FC), and a type of bacterium only found in people called Bacteroides thetaiotaomicron (BT). This study found that if EC and FC are present, but BT is not, contamination is highly likely to be from non-human sources. But, if BT was present, there was definitely a human source among the sources of bacteria. The study also found that, of all the samples which exceeded standards for EC, only half contained BT. In addition, on average, BT counts increased as FC and EC increased. Because 2007 was a year of high flow and large discharge from Truman, and because high pool levels in LOZ tended to force main channel water to backflow into coves, establishing links between water quality and watershed land uses in various coves was not possible for this study. However, this lack of relationship in this study does not indicate a lack of human influence. O'Hearn cites several previous studies showing that as the amount of urbanization increases, the amount of nutrients increases and that the nutrient increase was attributable to an increase in septic tank waste and an increase in housing density.[29] As an interesting side note with the O'Hearn study, one undeveloped cove about mid-reach in the study area on the Grand Glaize Arm had not only the largest nutrient, chlorophyll, and EC means of any cove in the Grand Glaize Arm's study reach, but also the largest BT frequency. This cove also had a discharge lagoon that treats septic waste from park visitors confirming the human source of this nutrient and bacteria loading.[29]

Based on these studies, LOWA recommends the removal of on-site septic systems along the shoreline where lack of soil and space preclude the effective operation of traditional septic tanks. Furthermore, LOWA agrees with the recommendations of the May 1999 Lake of the Ozarks Water and Wastewater Conceptual Plan prepared for the Lake Group Task Force by HNTB Corporation that stated centralized systems in combination with decentralized systems was probably the most cost-effective water and wastewater approach for LOZ. In addition, the study anticipated that a Lake-wide systematic management approach would be needed to ensure proper operation of the on-site wastewater systems[31]. A copy of each of these studies can be found at www.sosLowa.org.

The WMP focus area has ill-functioning and under-functioning septic tanks along its shore. In addition, many baby boomers are poised to retire to homes at LOZ that were second homes with septic tanks not designed for year-round residence. In addition to wastewater treatment systems, another important source of bacteria is from sediment washed into the lake. Sediment provides the bacteria with better growing conditions so the presence of sediments in the water generally leads to increased amounts of bacteria. Boaters can also add to the amount of bacteria in the water when they dump their waste water directly into the lake instead of pumping that waste out at an appropriate facility. Waste materials also bring nutrients with them, adding to the nutrient load as well.

## SECTION VI. STRATEGIES – THE PLAN

**This section combines the following elements of a successful watershed management plan:**

**ELEMENT C – PROPOSED BMPs FOR LOAD REDUCTION**
**ELEMENT D – TECHNICAL AND FINANCIAL ASSISTANCE NEEDS**
**ELEMENT F – IMPLEMENTATION SCHEDULE**
**ELEMENT G – MEASURABLE MILESTONES**
**ELEMENT I – MONITORING**

In this section, each Strategy will be stated and then described. After the description, the impairments the Strategy is designed to address are stated. Measurable Milestones, items to be monitored, costs associated with that Strategy, and an implementation schedule are also described in this section. An analysis of expected outcomes in terms of ranked effectiveness will be discussed under Section VII, Loads.

As each Strategy is described in this section, specific programs and projects will not be described in enough detail for full implementation. The authors of this WMP will let future grant writers working from this plan customize the projects and programs described in this WMP to fit the needs of their grant parameters. Those future grant writers will provide the details needed for successful implementation of the Strategies in their focus areas. The Strategies described in this section have been designed to broadly fit the needs of the WMP focus area of the Lick Branch and Buck Creek subwatersheds, while still fitting many of the needs of different focus areas for the LOZ watershed. This WMP is a dynamic document meant to be amended and updated as new needs for keeping LOZ vibrant and healthy arise. New Strategies may be written and existing Strategies may be modified so that all the needs of the Lake of the Ozarks larger watershed may be met in the future. The Strategies of this watershed management plan are written with the WMP focus area in mind and with extensions to the entire watershed expected.

Several maps have already been used in this WMP to delineate and describe the LOZ watershed and the WMP focus area. These maps are figures I-1, I-2, II-A-1, II-B-3, and V-A-1. This section will introduce several more maps to be used in conjunction with those listed above. The first two maps in this section are figures VI-1 and VI-2 which feature the 2 subwatersheds of the WMP focus area focused into the lake shore with the main channel and main coves marked in mile markers to 0.1 mile (1/10 mile). Please note, these maps, provided by AmerenUE, are using the other HUC numbering system but the captions provide the MDNR accepted HUC numbers. The shoreline is the critical area for the WMP focus area. See figure VI-4 for a map with the critical area highlighted.

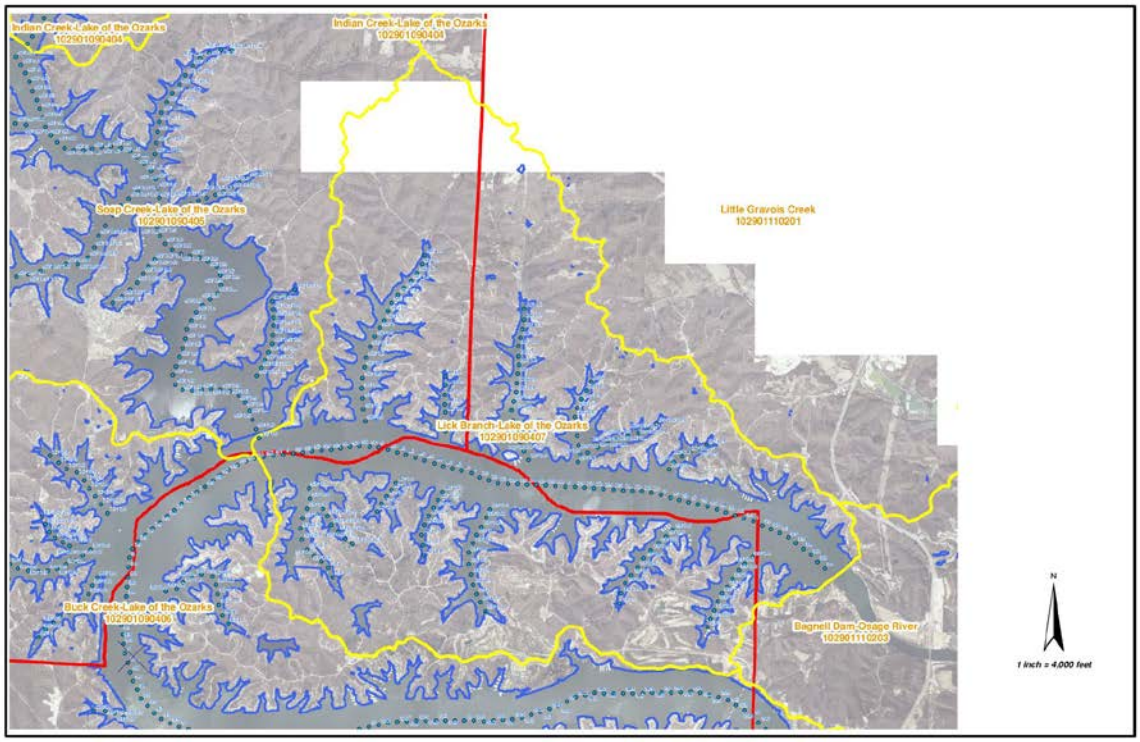



Figure VI-1.The Lick Branch HUC#102901090407 of the WMP focus area. The yellow lines are HUC boundaries and the red lines are county boundaries.

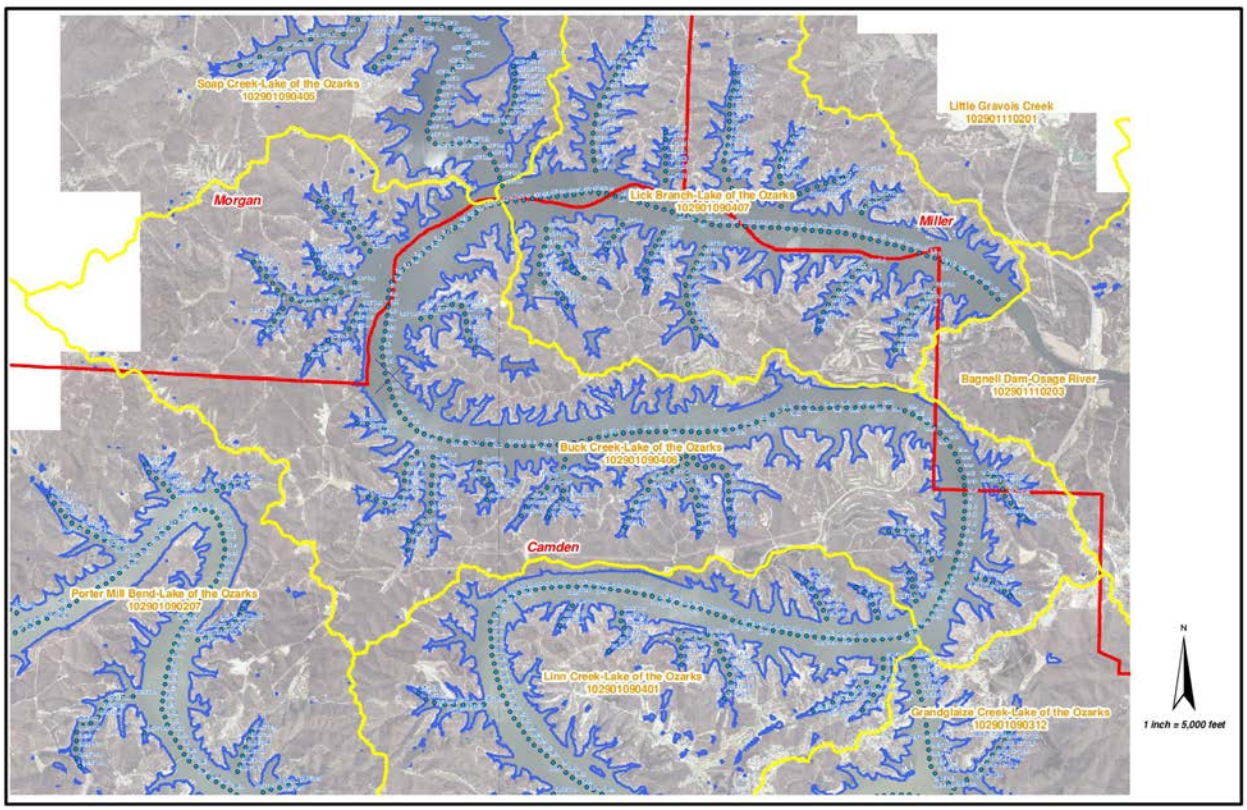



Figure VI-2. The Buck Creek HUC#102901090406 of the WMP focus area. The yellow lines are HUC boundaries and the red lines are county boundaries.

**Strategy 1 – Education Outreach and Information:**

**Strategy 1A – Work with city and county to educate public**
**Strategy 1B – Work with the media to educate public**
**Strategy 1C – Work with schools to educate public**

This set of Strategies all relate to educational programs about care of the watershed for the public and will all share the following Impairments and Expected Outcomes:

All 3 of the Education Outreach and Information (shortened to Education) Strategies are concerned with different aspects of helping not only the public, but people in businesses, government, and organizations as well, become aware of the many reasons taking care of the watershed is important in their lives, the many ways their behaviors affect the watershed, and the many actions all stakeholders can take to help the watershed. Education is vital for the success of the remaining Strategies and is interwoven throughout each Strategy. When change in the quality of the watershed involves changing the behaviors of people, the people involved have to not only understand the reasons for the need to change, they must also want to change. Without the educational aspect of knowing what changes are needed and why those changes are needed, people will not have enough reason to change their behaviors in ways that will benefit the watershed. And, when the change also involves costs or inconvenience, then education and understanding become even more important. This education Strategy is difficult to assign a load reduction number to because education does not stand alone. How much of the success of a program is because of the educational aspects surrounding that program? That, too, is difficult to measure.
Strategy 1, the Education Strategy, impacts all of the impairments for the WMP focus area. This Strategy calls for articles, workshops, meetings, etc. on such a large variety of subjects, all aspects of care for the environment and explanations of the impairments will be covered from many perspectives in order to meet the needs of all of the WMP focus area stakeholders.

**Impairment** – nutrient loading, sediment loading, and bacteria loading

Image showing soil erosion along a stream bank.

**EDUCATION OUTREACH AND INFORMATION STRATEGY 1A: Work with city and county officials to implement education programs concerning care of the watershed for citizens.**
**EDUCATION OUTREACH AND INFORMATION STRATEGY 1B: Work with the media to implement educational programs concerning care of the watershed for all stakeholders.**

The first two education Strategies work together yet work at different levels to bring a series of informational meetings, presentations, workshops, articles, interviews, and other programs to the public. Care of the watershed is a very large topic with many aspects, dimensions, and levels of understanding. The stakeholders of the WMP focus area are a diverse group and need many different venues for education in order for the information about care of the watershed to reach everyone. Working in conjunction with city and county officials is important because the programs and projects described in this WMP need to compliment and support the programs and projects that may already be in place or that may be part of a city or county Master Plan. For example, Camden County has recently released a draft copy of their Lake District Master Plan which recommends rain gardens to property owners. This watershed management plan can enhance those efforts and build upon them for the joint success of everyone. Having a positive and supportive working relationship with the various forms of media is important also. Use of media to advertise and promote watershed events is very necessary and when a supportive relationship is in place, articles, interviews, and programs about the many aspects of care for the watershed will also be promoted by the various media outlets. Meetings are necessary to plan events and coordinate efforts and presentations can be given to the many and varied clubs and organizations throughout the WMP focus area. Without programs and events to build understanding and awareness, the successful implementation of the other Strategies would be much more difficult.

**Measurable Milestones** –

- Meetings with city and county officials – 4 per year for first 4 years
- Soil Erosion Workshops – 2 per year for first 4 years; 2 per year for remaining 20 years
- Meetings with citizens – 4 per year for first 4 years; 2 per year for next 20 years
- Articles in newspapers – 10 per year for first 4 years; 5 per year for next 20 years
- Articles on radio – 10 per year for first 4 years; 5 per year for next 20 years
- Articles in area publications not a newspaper – 1 per year per publication for each of 24 years
- Interviews on radio – 4 per year for first 4 years; 1 per year for last 20 years
- Presentations at clubs and civic organizations – 10 per year for first 4 years; 4 per year for next 20 years
- Programs on local area cable TV highlighting the watershed yards, rain barrels, and rain gardens throughout the WMP area – 1 per year
- Public Service Announcements (PSA's) for WMP area watershed events such as LOWA public meetings, workshops, and programs – 1 per event per year for each of 24 years

**Monitoring –**

- Number of meetings/presentations and number of attendees
- Number of articles and circulation of newspaper/radio
- Number of interviews and circulation of radio
- Number of cable TV programs and circulation of the program(s)
- Number of PSA's and number of people each PSA reaches

**Cost –**

- Meetings/presentations – average $300 for room and refreshments with 20 meetings per year = $6000
- times the first 4 years = $24,000 for first 4 years. For next 20 years = 8 meetings per year X 20 years = 160 meetings X $300 per meeting = $48,000 for next 20 years. Total = $72,000 for 24 years.
- Articles and Interviews – Will share cost of office staffers with skills to write and publish articles, develop and make presentations, and other tasks associated with the educational BMPs. Will need 2 FTE (Full-time employee) staffers per year for the first 4 years and 1 FTE staffer per year for next 20 years. Cost of 2 staffers at $30,000 per year = $60,000 per year times 4 years = $240,000. One staffer per year for the next 20 years = $600,000.

Image showing wild water fowl and development at the Lake of the Ozarks.

**EDUCATION OUTREACH AND INFORMATION STRATEGY 1C: Work with schools to implement educational programs concerning care of the watershed.**

This Strategy specifically targets school aged young people, PreK–12, whether in a public, parochial, private, or home-school setting. In class, interactive, hands on/minds on presentations, fully aligned to the Show-Me Standards and all other current curricular frameworks for Missouri, will compliment outside educational opportunities and other in class presentations will stand alone, but all will have as a revolving theme, care of the watershed. LOWA will utilize staffers, volunteers, teachers, and various agency personnel to develop and present a variety of programs for a variety of student audiences.
The Clean Water Celebration is timed to coincide with Earth Day in April and this program targets the middle school student at the 5th grade level. This water festival will bring the students out of the classroom and down to live water, either a local stream or the shore of the Lake of the Ozarks. At the water's edge, students will perform some MO Stream Team water quality tests including air and water temperature, pH, turbidity, conductivity, hardness, dissolved oxygen, and phosphates while rotating though various stations. Other stations will include posters and discussions of clean water issues and care of the watershed as students interact with adult volunteers, as well as personnel from MO Stream Team, MDNR, and MDC. T-shirts of the event will be given to all participants. Before students go to the river, teachers will have the option of having a guest speaker present a lively program about care of the watershed and clean water issues to the students in the classroom. If possible, transportation costs for the students to get to and from the stream or lake will be offered to the school districts so that more students may participate.
At the high school level is another field trip with classroom presentation option. This clean water event is open to high school science classes, grades 9-12, but targeted to Environmental Science, Conservation Biology, and similar life science courses at grades 10-12. These students will also travel to a nearby stream or the lake's shore and conduct water quality assessments. In addition to the chemical tests listed for the middle school students, high school students will also test for nitrates and perform a visual evaluation of their area, similar to MO Stream Team's Visual Survey but customized to fit their location. Rotating stations and discussions of care of the watershed and clean water issues at the high school level will also be a part of the high school clean water program. T-shirts will be given to all participants. An in-class presentation before the field trip about care of the watershed and clean water issues is an option for teachers. And, if possible, transportation costs for the students to get to and from the stream or lake will be offered to the school districts so that more students may participate.
Another possible field trip for students is to the Osage Beach Regional Wastewater Treatment Plant. This facility is located on the outskirts of Osage Beach and services part of the WMP focus area. Subject to the schedules of the plant operators, an informative 45-minute tour of the WWTP can be conducted, with time for questions at the end. An in-class presentation on wastewater treatment is available to teachers upon request. Help with costs for transportation could be available.
Other in-class presentations on watershed issues and topics may also be conducted at the request of teachers

**Measurable Milestones –**

1. Clean Water Celebration – A water festival for all 5th graders in the WMP area focusing on care of the watershed. Water quality monitoring and educational displays and presentations will be conducted the shore of the Lake of the Ozarks or a stream within the WMP area. LOWA will work with area teachers to arrange for students to spend a morning or an afternoon by the water performing water quality measurements like pH, temperature, and dissolved oxygen as well as enjoying discussions and displays about the link between a healthy watershed and a healthy lake or stream.
2. Earth Day is Every Day – Water Quality Monitoring field trip for high school science classes at the shore of the Lake of the Ozarks or a stream within the WMP area. High school science students, grades 9 – 12, will use MO Stream Team equipment and protocols to conduct a water quality monitoring event along the shore of LOZ or a stream while learning about the link between a healthy watershed and a healthy lake or stream. LOWA will work with area teachers to arrange for students to spend a morning or an afternoon by the water performing water quality measurements like pH, temperature, and dissolved oxygen as well as enjoying critical thinking discussions about local water quality issues.
3. Waste Water Treatment Plant (WWTP) field trip for high school science classes at the WWTP in Lake Ozark, MO. Students will spend a memorable morning or afternoon seeing first hand what goes into treating wastewater. LOWA will work with area teachers and WWTP personnel to arrange schedules and transportation.
4. In-class presentations on care of the watershed. LOWA will also present customized talks on more specific watershed issues to classes at the request of area teachers.

**Monitoring** –

- Number of classrooms
- Number of students
- Number of teachers
- Number of public school districts
- Number of non-public schools
- Number of home-schoolers/home-schooling groups
- Number of events and what kind

**Cost** – note: transportation costs are included to encourage more schools to participate

1. 20 buses @ $100 = $2000. Each bus holds students for 10 stations @ $50 X 20 buses = $10,000. Subtotal = $12,000.

2. 20 buses @ $100 = $2,000. Each bus holds students for 6 stations@ $50 X 20 buses = $6,000. Subtotal = $8,000.

3. 20 buses @ 100 = $2,000. Subtotal = $2,000.

4. Presentations: materials and supplies = $600. Mileage for 300 miles @ $0.38 = $120. Share office staffers with other Education BMPs. Subtotal = $720

Total for C: $12,000 + $8,000 + $2,000 + $720 = $22,720 per year and $90,880 for 4 years

**Technical Assistance** – for information and materials for all 3 Education Strategies:

- AmerenUE
- MDNR
- U MO Extension
- EPA
- NRCS
- Center for Watershed Protection
- Show-Me Yards and Neighborhoods
- County and Municipality Agencies

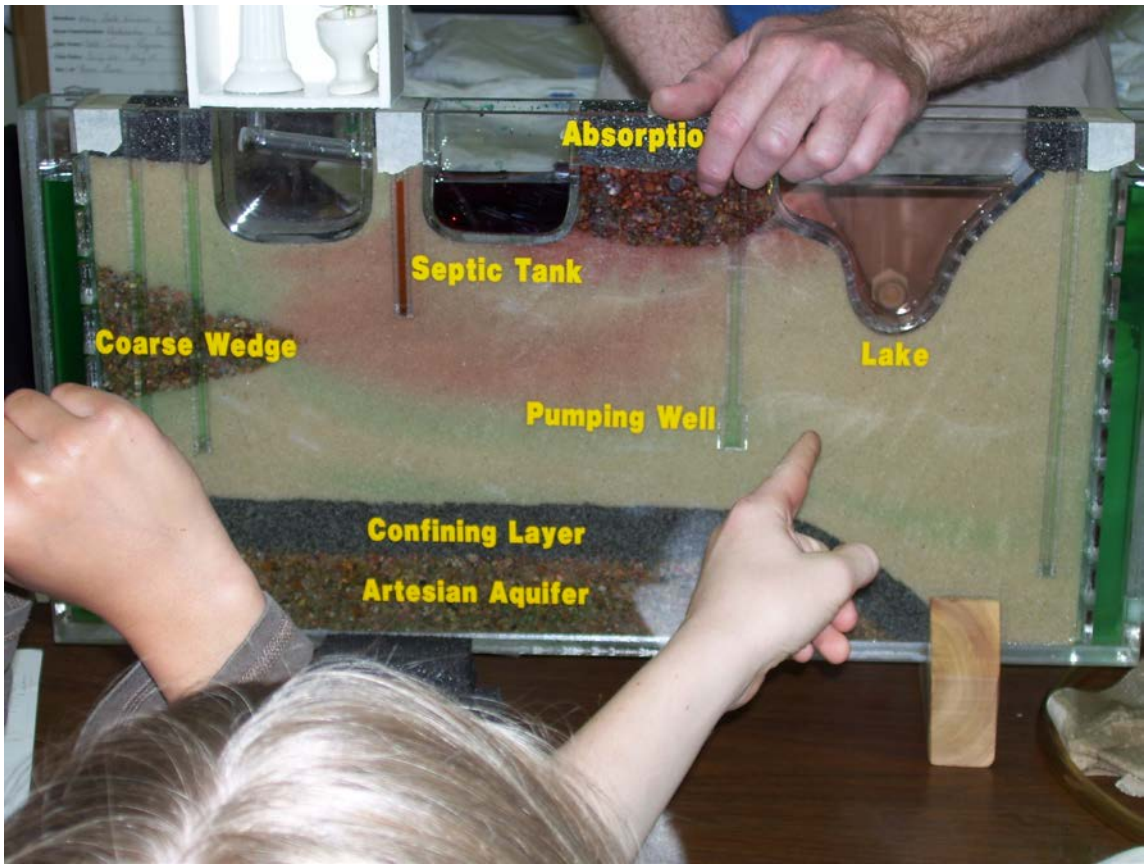
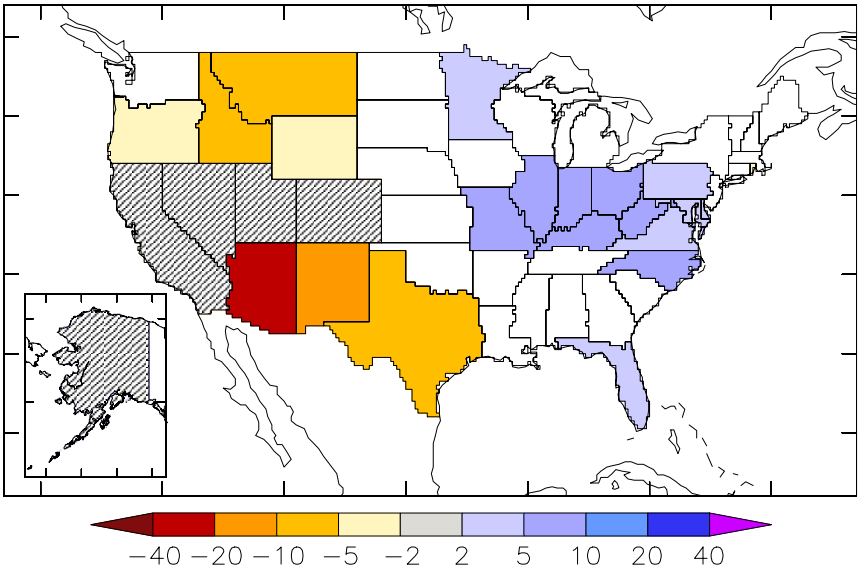



Figure VI-2a. Groundwater model at LOWA's Clean Water Celebration with middle school students at a lake area school.

A point of interest:
For Strategies related to stream flow, projections for Missouri under global climate change are for an increase in average annual runoff[33]. See figure VI-3 below.

**Model-Projected Changes in Annual Runoff, 2041-2060**

Percentage change relative to 1900-1970 baseline. Any color indicates that >66% of models agree on sign of change; diagonal hatching indicates >90% agreement.




(After Milly, P.C.D., K.A. Dunne, A.V. Vecchia, Global pattern of trends in streamflow and water availability in a changing climate, *Nature*, **438**, 347-350, 2005.)

Figure VI-3. Modeled changes in Annual Runoff[33]. Missouri shows an expected increase in the amount of runoff with more than 66% of models agreeing on that change amount.

**STRATEGY 2 – Runoff**

**STRATEGY 2A – Cost-share incentive program for developers**
**STRATEGY 2B – Cost-share incentive program for home-owners**
**STRATEGY 2C – Porous pavement**
**STRATEGY 2D – Trained Volunteer Evaluators (TVEs)**

This group of Strategies will all reduce impairments by reducing runoff volume and will all share the following Impairments.

**Impairments** – nutrient loading, sediment loading, and bacteria loading

**Figure VI-3a. Sediment plume from runoff meeting clear water.**

**STRATEGY 2A. Cost-share for development:**

Strategy 2A offers an incentive cost-share program for developers who go beyond the state and local minimum requirements for storm water treatments. LOWA will model their program after the *Brush Creek Mid-Shed Project Low Impact Development Evaluation System for Cost-Share Program;* Platte Land Trust; July, 2005[34] (see Appendix B, customizing the components of the program to fit the WMP focus area needs. In this Strategy, developers may apply to LOWA to be reimbursed for part of the costs of installing and maintaining "green" storm water retention devices and other storm water treatments. Some of the SWTs (storm water treatments) may be permanent and some may only be in place during construction. If a developer has installed a SWT device not on LOWA's list of SWTs approved for reimbursement, the developer may apply to LOWA to add that device to the list. Each SWT will have a point value attached based on the effectiveness of the SWT. Sites of land disturbance will be evaluated by trained LOWA volunteers (TVEs) for the installation and maintenance of the SWTs, and a total point value will be assigned to each site. Based on the total number of points a site is awarded, the reimbursement percentage will vary. The more points a site is awarded, the higher the percentage for reimbursement will be, with a cap for total possible reimbursement (cap will be established based on reimbursement funds available). Giving higher point totals more reimbursement should be an incentive for developers to install many SWTs and maintain the SWTs after a rain event. If builders can get part of their costs back for installing and maintaining highly effective SWTs and for designing and installing permanent SWTs that will keep working long after the construction is completed, those builders will have an incentive to go beyond the minimum treatment requirements. Going beyond minimum requirements should result in an even larger load reduction in sediments (and thereby in nutrients and bacteria loading as well) than had only the minimum requirements been met.

Strategy 2A is designed to reduce the volume of runoff reaching the Lake of the Ozarks, thus reducing the sediment load reaching the lake. The critical area for Strategy 2A is considered to be the group of land disturbance sites along the shoreline of LOZ in the WMP focus area because construction has occurred there and will continue to occur. Please see figures VI-1, 2, and 4.

Water Quality Monitoring with Earth Science students below Bagnell Dam.

Water Quality Monitoring with Stream Team on the Little Niangua.

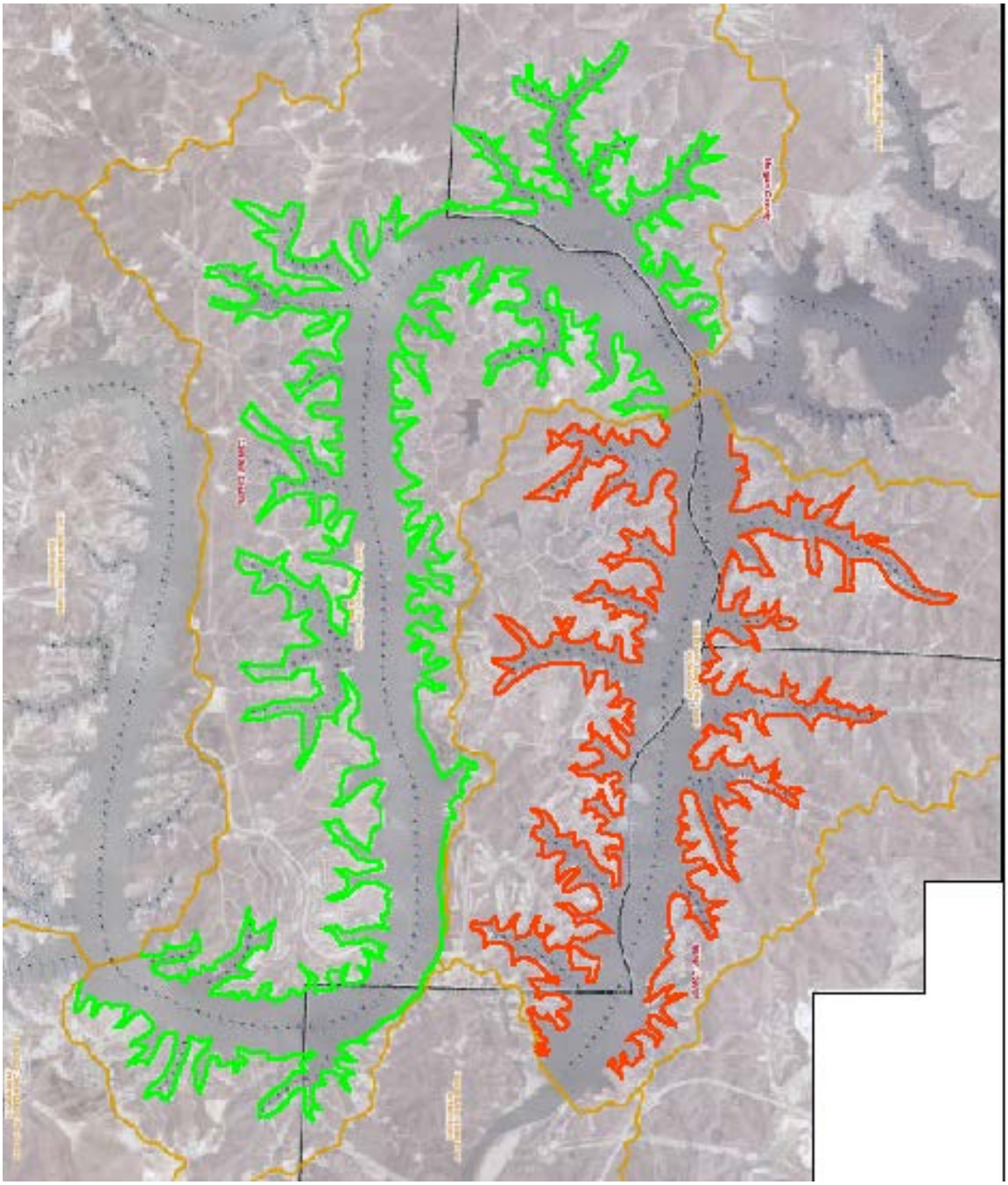


**Figure VI-4. This is a vertical image of LOZ showing the critical area for the WMP focus area being the shoreline of the lake. The Lick Branch critical area is outlined in red and the Buck Creek critical area is outlined in green. The black line is the county line and the tan line is HUC boundaries. Bagnell Dam is at the beginning of the red section in the lower right.**

**Measurable Milestones** –

1. Amount of impervious surfaces relative to conventional development
2. Amount of land disturbance on construction sites
3. Amount of erosion and sediment transport during and immediately after construction
4. Reduction in velocity of runoff
5. Reduction in runoff volume
6. Type of storm water collection system
7. Development of a Natural Resources Protection Plan
8. Buffering of streams, wetlands, forests, lake and other sensitive features
9. Conservation of trees and other vegetation

**Monitoring** –

1. % decrease in street, sidewalk, and driveway impervious surfaces
2. Relative levels of cutting and filling. % of site graded, cut, and/or filled.
3. Relative to use and effectiveness of sediment and erosion controls. Measure amount of soil loss before and after construction.
4. Reduction (by %) in runoff rate compared to immediately prior pre-development land use conditions for the 10-year design storm using locally approved storm water runoff models (Ex: TR-55)
5. Volume of runoff (by %) compared to immediately prior pre-development land use conditions for the 10-year design storm using locally approved storm water runoff models (Ex: TR-55)
6. Evaluate and score general design parameters of storm water collection, detention and treatment systems that go beyond required NPDES requirements such as vegetated open channels, creation of wetlands with vegetated filters, infiltration devices, and storm water recycling measures (such as ponds, rain barrels, and rain gardens)
7. Degree of planning and long-term protection such as conducting a natural resources assessment, linking natural areas into a continuous open space system, permanency of protection of natural areas/open space by such methods as easements and restrictive covenants
8. Extent and type of buffer used at site, width and design of buffer, planted with native vegetation or not, and management plan in place
9. Prior to development, an analysis will be made on % cover and types of vegetation to compare to same analysis made after development. Measure % loss.
10. Develop 2 presentations per year to explain and promote the cost-share program within the building community.
11. Additional water quality monitoring around shoreline.

**Cost** – Cost will depend on the type of and number of sites qualifying, what their BMPs are, and the degree to which the sites' costs will be shared. Following is an example scenario of possible costs for the reimbursement part of this Strategy. Using a model

Table of % Cost Share Eligibility (Table VI-1) and an example possible scenario, example costs for this Strategy can be calculated.

**Table VI-1**

| **%Cost Share Eligibility** | | | | | |
|---|---|---|---|---|---|
| **Evaluation Score** | **Eligible % Cost-Share** | **Maximum Cost-Share Funding** | | | |
| | | **Sites ≤1 acre** | **Sites >1 to ≤5 acres** | **Sites >5 to ≤20 acres** | **Sites >20 acres** |
| Platinum (14-18) | 75% | Up to $2000 | Up to $5000 | Up to $20,000 | Up to $50,000 |
| Gold (9-13) | 60% | Up to $1500 | Up to $3500 | Up to $12,500 | Up to $35,000 |
| Silver (5-8) | 50% | Up to $1000 | Up to $2000 | Up to $7,500 | Up to $20,000 |
| Bronze (1-4) | 25% | Up to $500 | Up to $1000 | Up to $5000 | Up to $10,000 |

Using Table VI-1, cost for an example scenario can be calculated as follows:
20 condominium projects of 1-5 acres
5 Platinum @ $5000 = $25,000
10 Gold @ $3500 = 35,000
5 Silver @ $2000 = 10,000
5 Bronze @ $1000 = 5,000
Subtotal for condos = $75,000

Add one Subdivision project of > 20 acres:
Gold @ $35,000
Added to the condos = Total = $110,000 in cost-share paybacks for one year.
Cost for 4 years = $440,000

Cost of developing and presenting 2 workshops per year @ $300 per workshop = $600/yr. Cost for 4 years = $2400

**Implementation Schedule**
LOWA will organize and implement the cost-share program
LOWA and trained volunteers will monitor and evaluate projects in the cost-share program.
LOWA will develop and present the workshops
Workshops will be presented in early spring and late summer
Projects will be evaluated as they are submitted by LOWA.

**Technical Assistance** – for help in evaluating effectiveness of BMP designs, Strategies, and for measuring volume and velocity of runoff from sites.

AmerenUE
EPA
Camden County Shoreline District Planning and Zoning
NRCS
SWCD
U of MO Extension
MDNR
Municipal and County Agencies
Schultz and Summers Engineering
MEC Water Resources – Geosyntec
Scott's Concrete
Rice Concrete

Technical assistance will be needed to conduct baseline load studies and enough subsequent follow up load studies to adequately evaluate the effectiveness of the BMPs in this Strategy. The entity conducting load studies for this Strategy can be the same entity conducting load studies for the other Strategies as well. An entity(s) to conduct load studies for this watershed management plan is discussed in Section VIII Technical and Financial Assistance Cost Summation.

**Figure VI-4a. Development along the shoreline of LOZ.**

**STRATEGY 2B – Cost-share for home owners:**
Develop a cost-share incentive program to encourage citizens to create watershed yards.[35] This program will incorporate aspects of Show-Me Yards and Neighborhoods (SMYN) Yard Certification Checklist[33] (see Appendix C) and the *Brush Creek Mid-Shed Project Low Impact Development Evaluation System for Cost-Share Program*[34], customizing the components of the program to fit the WMP focus area needs. In this cost-share program, property owners are encouraged to develop a watershed "yard" and points/inches totaling to a goal of 36 inches; and, since 36 inches equals a yard, 36 inches is the target goal for lawns and residential green spaces. LOWA will develop a list of LOWA LILs (Low Impact Landscape designs for reducing sediment, nutrient, and bacteria loads going to the lake) with point values attached for evaluating residential areas applying to the LOWA LILs cost-share incentive program. Trained LOWA volunteers will evaluate the property and assign points for the various SWTs (and BMPs) in place. If a home-owner has installed a device not on LOWA's approved list, the home-owner can apply to have that SWT added to the LOWA LIL list. Strategy 2B is designed to reduce the volume of runoff through the use of SWTs like rain gardens and rain barrels. Since this program is for adding to already established residences, the SWTs in the LOWA LILs program should be permanent. Property owners will be evaluated on the type of SWT, the installation of the SWT, and on how well the SWT is maintained after a rain event. A cap on total reimbursement possible will be calculated based on amount of reimbursement funds available.

Strategy 2B is designed to reduce the volume of runoff reaching the Lake of the Ozarks by encouraging property owners to install and maintain BMPs and SWTs on their property through a cost-share program. The critical area for Strategy 2B is the shoreline of LOZ in the WMP focus area. See figure VI-4. Because residences, including homes and condominiums, and businesses are so close together along the shoreline, one cannot easily differentiate between the areas, and the entire shoreline is considered to be the critical area for this Strategy.

**Measurable Milestones**

- Provide 4 presentations per year to explain the program and the concept of a watershed yard and to encourage participation
- Provide 2 workshops per year on installing rain barrels
- Provide 2 workshops per year on designing and installing rain gardens
- Provide 2 workshops per year on designing a watershed yard
- Provide 2 workshops per year on planting and maintaining a rain garden
- Promote rain barrels with an art contest – one contest per year
- Provide cost-share money back to eligible participants
- Develop and promote one model watershed yard per year open for visitation and reference

**Monitoring**

- Number of presentations and attendees
- Number of rain barrel workshops and attendees
- Number of rain barrel kits sold

- Number of rain barrels installed
- Number of complete rain barrels sold
- Number of designing and installing rain garden workshops and attendees
- Number of planting and maintaining rain garden workshops and attendees
- Number of participants in rain barrel art contest
- Number of businesses participating in rain barrel art contest
- Number of participants in the cost-sharing program
- Number of model watershed yards established
- Amount of money awarded in cost-sharing program
- Number of water quality samples tested from along the shoreline

**Costs**

Depending on the home owners' score on the checklist, they may be eligible to have part of their costs returned to them by the following guide: 30-36 points earns 75% back; 24-29 points earns 50% back, 18-23 points earns 25% back, and 12-17 points earns 10% back. The points are out of 36 possible.

Costs for this Strategy 2B will be calculated from the following assumptions:

1) average cost of a presentation or workshop is $300,

2) average cost of putting in a rain garden is $800 ($550 for materials and excavating, $100 for rain barrel, and $150 for other expenses),

3) and average cost for establishing a model watershed yard is $3000 (at least 2 rain garden sites, 2 rain barrels and other modifications)

- 12 presentations or workshops per year @ $300 = $3600/year
- Signage for model watershed yards, rain gardens, and other promotions of watershed yards = $5000/yr
- With a cost-share goal of 50 participants per year, calculating % based on $2000 average expenses, and an example scenario as follows:

    10 @ 75% = 10 x $1500 = $15,000
    15 @ 50% = 15 x $1000 = $15,000
    15 @ 25% = 15 x $500 = $ 7,500
    10 at 10% = 10 x $200 = $ 2,000
    This gives a total of $39,500/yr

$3600 for presentations/yr + $39,500 for cost-shares/yr + $5000/yr for signage = $48,100/yr.

For 4 years = $192,400

**Implementation Schedule**

LOWA will develop presentations and present workshops

LOWA will run the art contest for rain barrels

Each year for 4 years:

January – Prepare presentation; schedule times and locations

February – contact plant nurseries

March – first program presentation

April – first rain garden design and install workshop; begin cost-share evaluations; first rain barrel workshop; second program presentation; begin development of watershed yard

May – begin art contest

June – third program presentation
July – run the art contest
August – second rain garden design and install workshop; first rain garden plant and maintain workshop; fourth program presentation; art contest winner; model watershed yard completed and open for visitation
September – second plant and maintain workshop
November – summarize year's accomplishments

**Technical Assistance** – for help in evaluating effectiveness of designs and Strategies and for measuring volume and velocity of runoff from sites.
AmerenUE
EPA
Camden County Shoreline District Planning and Zoning
NRCS
SWCD
U of MO Extension
MDNR
Municipal and County Agencies
Schultz and Summers Engineering
Springfield's Show-Me Yards and Neighborhoods Program
Missouri Clean Water AmeriCorps Program
MO Stream Teams
Grow Native
MEC Water Resources – Geosyntec
MDC
Rice Concrete, Inc.
Scott's Concrete

Technical assistance will be needed to conduct baseline load studies and enough subsequent follow up load studies, as well as BMP studies, to adequately evaluate the effectiveness of this Strategy. The entity conducting load studies for this Strategy can be the same entity conducting load studies for the other Strategies as well. An entity(s) to conduct load studies for this watershed management plan is discussed in Section VIII Technical and Financial Assistance Cost Summation.

**STRATEGY 2C – Pervious pavement (defined as any surfacing material that allows precipitation to permeate through the surface and infiltrate the ground). Also known as porous pavement.**

Develop a program to encourage the use of pervious pavement in all new construction projects, as well as paving projects, involving locations such as sidewalks, driveways, parking lots, playgrounds, on land already developed, and other appropriate surfaces.

Pervious pavement is a relatively new technique for covering surfaces that allows for precipitation to infiltrate into the ground, instead of running off, so that recharge areas can function to replenish aquifers in a fashion more attuned to the natural hydrology of the land. As land is covered with impervious surfaces, the total volume of runoff increases dramatically and therefore, the sediment, nutrient, and bacteria loads to the lake increase proportionally. The use of pervious pavement can reduce the volume of runoff, thus reducing the loads reaching the lake. Several types of pervious pavement exist, including grid-type or line-type designs where only part of the surface has pavement and the rest of the surface is ground, and a porous cement, or other substance, that is solid and looks impervious but allows rain to trickle through, helping to recharge the aquifer. Any material that provides a covering for the land surface while still allowing for precipitation to infiltrate and recharge the aquifer can be considered pervious pavement.

Strategy 2C is designed to reduce the volume of runoff reaching the Lake of the Ozarks by allowing more precipitation to infiltrate and percolate through the surface and recharge the aquifer. The critical area for Strategy 2C is the shoreline of LOZ in the WMP focus area. See figure VI-4.

**Measurable Milestones**

- Provide 2 informational workshops per year for builders, developers, paving and cement companies, or other construction industry businesses, as well as individuals, explaining what pervious pavement is and why it is important for the health of the watershed
- Provide 2 workshops per year where pervious pavement will be installed and techniques discussed
- Develop educational materials for workshop attendees and other interested parties

**Monitoring**

- Number of square feet of pervious pavement installed in WMP area
- Number of workshops and attendees
- Number of different educational materials developed
- Number of water quality tests along the shoreline.

**Cost**

4 workshops @ $300 = $1200/yr

One test pour per year to be a part of the workshops. LOWA has agreements with local businesses to host these workshops/test pours and to do at least one test pour per year at an inkind cost of $10,000 per year.

Total = $11,200 per year.

$44,800 for 4 years.

**Implementation Schedule**
LOWA will develop schedules and work with a construction company like Scott's Concrete and Rice Concrete to develop presentations and workshops
Each year:
Mid-February: Informational workshop
Mid-April: Technical workshop
Mid-July: Informational workshop
Mid-September: Technical workshop

**Technical Assistance** – for help in evaluating effectiveness of designs and Strategies; for measuring volume and velocity of runoff from sites.
NRCS
SWCD
U of MO Extension
MDNR
Municipal and County Agencies
Dr. John T. Kevern, Ph.D., LEEP AP
Schultz and Summers Engineering
Scott's Concrete, Sunrise Beach, MO (local company already working with pervious concrete) to provide Technical Workshops
Rice Concrete
Other companies to provide Technical workshops on other pervious pavement techniques

Technical assistance will be needed to conduct baseline load studies and enough subsequent follow up load studies to adequately evaluate the effectiveness of this Strategy. The entity conducting load studies for this Strategy can be the same entity conducting load studies for the other Strategies as well. An entity(s) to conduct load studies for this watershed management plan is discussed in Section VIII Technical and Financial Assistance Cost Summation


Flood gates wide open at Bagnell Dam, Spring 2008.

**STRATEGY 2D – Trained Volunteer Evaluators (TVEs)**

Develop a program to monitor land disturbance sites for adherence to the permitted, and required, Storm Water Pollution Protection Plan (SWPPP) and to monitor participants in the cost share incentive programs of Strategies 2A and 2B. This will include:
1) Initial evaluation to ensure appropriate storm water treatments (SWTs, which also include BMPs) are in place in accordance with MO State and EPA Region 7 requirements for storm water protection;
2) Additional evaluation of SWTs after each rain event for each site; and
3) Provide advice to individuals for land disturbance sites too small to require a permit or a SWPPP.

This Strategy will involve training a group of people (trained volunteer evaluators, or TVEs) to evaluate adherence to a SWPPP, evaluate the implementation of the SWTs, and evaluate the maintenance of the SWTs after a rain event. Camden County Shoreline District Planning and Zoning Commission employs one individual for this task and has offered to train the LOWA volunteers for the TVE Program. A trained evaluator will visit construction sites where permit applications have been approved. This individual will evaluate the construction site for adherence to the approved SWPPP and whether the SWTs have been installed appropriately. A TVE will also visit the site after a rain event to ensure that the SWTs are still functioning as designed since many SWTs need maintenance after a rain event in order to function effectively after the next rain event. These TVEs will also be available to individuals whose land disturbance site is too small to require a permit or a SWPPP and who want to minimize soil erosion and runoff on their sites.

The TVE will also evaluate the site for the cost-share incentive program (see Strategy 2A – Cost-share for Developers), during each visit. Construction sites are eligible for a cost-share program if some of the SWTs they have in place go beyond the state or local minimum requirements for storm water protection. These sites may receive a percentage of their costs for those eligible SWTs paid back to them. This program, explained in Strategy 2A, provides an incentive for developers to be more effective in reducing the volume of storm water runoff reaching the lake. Runoff from construction sites can carry sediments, bacteria, and nutrients. So, as the volume of runoff is reduced, the sediment, nutrient, and bacteria loading are also reduced. TVEs may also evaluate residential sites where land disturbance is too small to require a permit but the land owner wants to participate in the cost-share incentive program for property owners described in Strategy 2B – Cost-share for home owners.

This Strategy 2D – Evaluating Adherence to SWPPP – is an important because this Strategy 2D sets up a trained group of evaluators to ensure minimum requirements are being met on land disturbance sites and to ensure that maintenance is performed as needed on SWTs. Additionally, this Strategy 2D sets up a mechanism of trained volunteer evaluators by which the cost-share incentive programs established in other Strategies can also be implemented. This Strategy 2D is designed to be able to be run completely independently of other Strategies or in conjunction with other Strategies.

Referring to figure VI-4, the critical area for Strategy 2D is the shorelines of the main channel of LOZ, as well as the coves, from Bagnell Dam to the end of the WMP focus area at about mile marker 18.7. This is an urbanized area of high population density.

**Measurable Milestones**

- Develop a program to certify volunteers as trained evaluators
- Obtain copies of approved land disturbance applications with SWPPP from permitting agency
- A trained volunteer evaluator will visit each land disturbance site before land disturbance begins and after each rain event
- A trained volunteer evaluator will complete an Adherence to SWPPP form (developed by LOWA) with evaluations of SWT effectiveness during each evaluation visit. The Adherence to SWPPP form will also have entry sections to include data necessary for cost-share applications.
- Load studies will be conducted to determine volume of runoff and loading parameters before land disturbance and during land disturbance for additional evaluation of effectiveness of BMPs and Strategies.

**Monitoring**

- Number of people trained as evaluators
- Number of construction sites visited
- Number of SWTs evaluated
- Number of cost-share evaluations completed
- Number of visits where site was not in compliance with its own SWPPP plan
- Number of SWTs not adequately maintained after a rain event
- Number of load studies conducted
- Number of gallons of runoff prevented from reaching the lake because of evaluation visits and subsequent report
- Pounds of sediment prevented from reaching the lake because of evaluation visits and subsequent report
- Pounds of TP and TN prevented from reaching the lake because of evaluation visits and subsequent report

**Cost**

The trained evaluators will be volunteers. LOWA will arrange for the training from an inkind source. Technical assistance is needed to perform load studies for land disturbance sites. This cost can be included in the overall cost for technical assistance to perform both the baseline load studies and the subsequent BMP and load studies needed to evaluate the effectiveness of the Strategies in general, though not to evaluate the adherence to SWPPP for this Strategy.

A cost for an administrative assistant to coordinate TVEs and the site visits is incurred by this Strategy, but this cost can be absorbed by the cost of a staffer or Project Manager to administer other Strategies as well. Please see Section VIII Technical and Financial Assistance Cost Summation.

**Implementation Schedule**

- LOWA will organize and implement the training program for TVEs.
- LOWA will obtain copies of approved land disturbance permit applications.
- LOWA will organize schedules of site visits for trained volunteers.
- LOWA will develop an Adherence to SWPPP form for use on site to conduct evaluations of adherence and for use in evaluating applications in the cost-share incentive programs

**Technical Assistance** – for help in evaluating effectiveness of implemented BMPs, potential effectiveness of BMP design, and Strategies; and for measuring volume and velocity of runoff from sites.

NRCS
SWCD
U of MO Extension
MDNR
Schultz and Summers Engineering
Camden Co. Shoreline District Planning and Zoning Commission

Technical assistance will be needed to conduct baseline load studies and enough subsequent follow up load studies and BMP studies to adequately evaluate the effectiveness of this Strategy. The entity conducting load studies for this BMP can be the same entity conducting load studies for the other Strategies as well. An entity(s) to conduct load studies for this watershed management plan is discussed in Section VIII Technical and Financial Assistance Cost Summation.

Volunteering for water quality. The Secchi disc measurement.

**STRATEGY 3 – Seawall/Riprap**
Develop an awareness program for lake shore residents encouraging the use of riprap instead of seawalls to stabilize the lake shoreline, reduce shoreline erosion, and improve fish habitat.

As discussed in Subsection III-A, the WMP focus area has very steep slopes and highly erodible soils. The shoreline around the lake is subject to a lot of erosion as natural, wind-formed waves and man-made waves from boats break against the bare shore. In order to stabilize the shoreline, many property owners turn to building seawalls which, in the long term, are ineffective, and in the short term, amplify the destructive effect of wave action. In addition, seawalls destroy part of the fish habitat, the fish nursery area, including spawning areas and shelter for the newly hatched fish. AmerenUE will not even approve the construction of a seawall if the amount of vertical erosion at the shore is less than 3 feet.

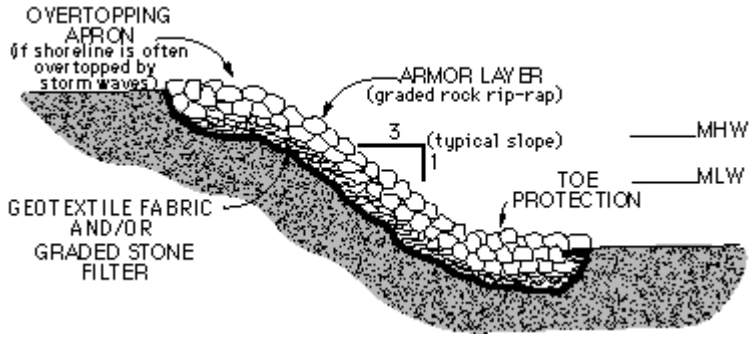



Figure VI-5. Proper rip-rap placement (MHW=mean high water, MLW=mean low water).

Placement of large rock, usually referred to as rip-rap, is the preferred and most common form of shoreline stabilization for the Lake of the Ozarks because riprap reduces the amount of soil erosion and is more effective at stabilizing the shoreline (see figure VI-5). When a seawall is installed, a fair amount of digging is involved, which loosens soil and subjects the soil to water erosion. When riprap is installed, minimal digging is involved, and the cobble-sized rock is simply placed on top of the shaped soil/lake bed surface. Technical methods are available to determine rock size, placement geometry, and elevations to ensure the best protection. Whereas seawalls destroy fish habitat, riprap provides fish habitat. The cobble-sized rocks give fish a stratum upon which to lay their eggs and the spaces between the rocks provide places for young fish to hide. In addition, waves hitting against a seawall will, over several years, undercut the seawall, causing further soil erosion, allowing sediments to wash into the lake. The solution for an undercut seawall is to bring in some riprap.
While the seawall is in place, waves hitting against the seawall bounce off the seawall with a ricocheting effect, traveling back into the basin from which the wave originated. Many times, these waves bounce back across the basin only to hit another seawall and echo off again. Some days, especially in the popular parts of the lake, like the WMP focus area, the lake can get rather rough and waves can become dangerous for smaller boats. Notice in figure VI-5, the riprap is placed to extend beyond the bottom of the

slope and out onto the lake bottom, as well as up onto the top of the rise at the shoreline for a couple of feet. Whereas seawalls bounce waves back, riprap breaks up the wave action and dampens the energy of the wave so there is no bounce back.
Thus, the use of riprap for shoreline stabilization at LOZ is much preferred and recommended over seawalls because riprap reduces the amount of soil erosion, which reduces the sediment load to the lake. As part of its Shoreline Management Plan, AmerenUE already has an extensive program helping property owners to install riprap instead of seawalls and to repair undercut seawalls with riprap. LOWA will augment this program with a vigorous education, information, and outreach program utilizing a variety of media and a variety of venues to reach a variety of audiences.

The critical area for this Strategy will be the shoreline of the lake, including the side coves, in the WMP focus area. Please see figure VI-4. The impairment is sediment loading, keeping in mind that with sediment loading automatically comes nutrient loading and bacteria loading. Also, when the sediment load is reduced, the nutrient and bacteria loads are also reduced.

**Impairments** – sediment loading

**Measurable Milestones**

- Develop one program per year to educate the public about sea walls, wave action, and the preferred use of riprap for shoreline stabilization
- Installing riprap instead of a sea wall in new construction
- Replacing or covering over an old sea wall with riprap
- Develop a fact sheet on the issue of riprap v sea walls

**Monitoring**

- Number of programs presented and attendees – program may be presented at meetings with other presentations
- Number of sea walls replaced or covered with riprap
- Number of riprap stabilization berms installed instead of a sea wall
- Number of fact sheets developed
- Number of fact sheets distributed

**Cost**

Printing of fact sheet - $300/yr. = $1200 over 4 years
Negligible costs for presentations since they will be with other presentations or at the invitation of other groups.
Individuals will cover their own costs for shoreline stabilization.

**Implementation Schedule**

LOWA will develop materials and presentation and make presentations
February – presentation at first LOWA meeting of the year
Throughout the year – present to local groups on invitation

**Technical Assistance**
AmerenUE
Riprap installers

Technical assistance will be needed to conduct baseline load studies and enough subsequent follow up load studies to adequately evaluate the effectiveness of this Strategy. The entity conducting load studies for this Strategy can be the same entity conducting load studies for the other Strategies as well. An entity(s) to conduct load studies for this watershed management plan is discussed in Section VIII Technical and Financial Assistance Cost Summation.

Figure VI-5a. Older seawall reinforced by riprap. Photo courtesy of Horseshoe Bend Dock and RipRap Company.

**STRATEGY 4 – Expand water quality monitoring**

Expand water quality monitoring in the WMP area to include more sites, more frequent sampling, and more parameters being tested.

One of the first programs LOWA became involved in was a monitoring program MDNR was setting up with AmerenUE to test the Lake of the Ozarks for the presence of E. coli bacteria. Scientists with MDNR designed the study and originally planned on about 20 sites per month, alternating with 20 other sites on alternate months. LOWA offered a cadre of volunteers willing to be trained to collect the samples and tripled the number of sites sampled each month. The 2007 season began a 5-year study and the sampling sites have shifted each year in order to reach almost all of LOZ by the end of the 5-year period.

In the early days of LOWA, surveying the public as to what their concerns about the Lake of the Ozarks were, repeatedly concerns about bacteria in the water and water quality in general were among the top priorities for the participants. In addition, at LOWA's public meetings, no matter at which location around the lake, great interest in and concerns about water quality and bacteria arise. In the summer of 2009, when results from the season's first round of E. coli sampling showing many exceedances were held up and not released to the public promptly, stakeholders around the Lake were angry. People want to know what is in the lake.

At present, there are a few groups that monitor in the Lake of the Ozarks and surrounding watershed. Missouri Stream Team trains volunteers to monitor the creeks and rivers of the watershed. The Stream Team program tests many different aspects of the stream, from the macroinvertebrates living in the stream to the amount of water flowing past, and the testing includes some chemical parameters. Two of the parameters are phosphate and nitrate, nutrients of interest for this watershed management plan. Streams flow into the Lake of the Ozarks and their waters influence the water quality of LOZ. Another monitoring group is Lakes of Missouri Volunteers Program which has had a monitoring program at LOZ for many years. LMVP samples are taken in the middle of the main channel and main arm channels for temperature, Secchi depth (clarity of the water), chlorophyll, phosphorus, nitrogen, and ISS. Data from this program is published annually as well as displayed on the LMVP website at www.lmvp.org . In 2008, LOZ had sites monitored. LMVP has also worked closely with EPA Region 7 and MDNR to establish nutrient criteria for LOZ. A third monitoring program at LOZ is the E. coli monitoring in the coves at LOZ, which was described above, and which will end in 2011. A map of the sampling sites with results can be found on the LOWA website at www.sosLowa.org. Of the two monitoring programs sampling in the lake, one monitors in the main channel for nutrient information but not bacteria, and the other monitors in the coves for bacteria, but not nutrients. In addition, these programs only sample seasonally, from April or May to September or October.

The purpose of Strategy 4 is to expand the amount of monitoring currently being conducted at the Lake of the Ozarks. More sites need to be tested for all the parameters of concern, including TP, TN, ISS, CHL, TSS, Secchi depth, and E. coli bacteria; and bacteria levels in the coves need to be tested more frequently.

Another goal of Strategy 4 is to provide WMP focus area residents with a discounted drinking water test kit. In 2008, LOWA arranged with an area lab to provide a drinking

water sampling kit complete with instructions, a sampling bottle, a mailing box, address, and postage at a discounted rate. This program was very successful, and LOWA distributed all 250 kits to eager homeowners. LOWA has kept a program of providing a discounted drinking water test kit to the stakeholders of the WMP focus area going with help from the Dept. of Health and Senior Services and has plans to have the drinking water tested by an independent local water quality lab.
The critical areas for Strategy 4 (please see figure VI-4) are the channels of LOZ and its arms and coves in the WMP focus area, as well as the dock areas all along the convoluted shoreline.

**Impairments** – none. This is testing for analyzing effectiveness of Strategies on impairments of nutrient, bacteria, and sediment loading.

**Measurable Milestones**

- Expand water quality testing to more cove sites and more main channel sites
- Expand E. coli sampling frequency to once per month at each site for March through October
- Test for E. coli each time
- Test for TP, TN, ISS, and TSS in March, June, and October
- Provide materials and discount for citizens to get their own water tested

**Monitoring**

- Number of sites tested in coves
- Number of sites tested in main channel
- Frequency of testing
- Number of citizens getting their own water tested
- Number of discounts for citizens own provided

**Cost**

Assume 300 sites monitored by a non-volunteer entity
E. coli, TP, TN, ISS, and TSS – 3 times per year at $200/site = $180,000 per year
E. coli only – 5 times per year - $100/site = $150,000 per year
Total = $230,000 per year; and
$920,000 for 4 years.
Citizen water testing $5 discount with 250 participants per year = $1250/yr
Citizen water testing with $5 discount for 4 years = $5000.

**Implementation Schedule**

LOWA and trained volunteers will collect the water samples
An independent lab contracting with LOWA will do the testing
LOWA will report results
March through October – sample and test for E. coli once a month
March, June, and October – sample and test for TP, TN, ISS, and TSS once a month in each of those months.

**Technical Assistance**
MDNR
LMVP
Independent lab for testing and citizen water testing

Technical assistance will be needed to conduct baseline load studies and enough subsequent follow up load studies. The entity conducting load studies for any of the Strategies can be the same entity conducting load studies for the other Strategies as well. An entity(s) to conduct load studies for this watershed management plan is discussed in Section VIII Technical and Financial Assistance Cost Summation.

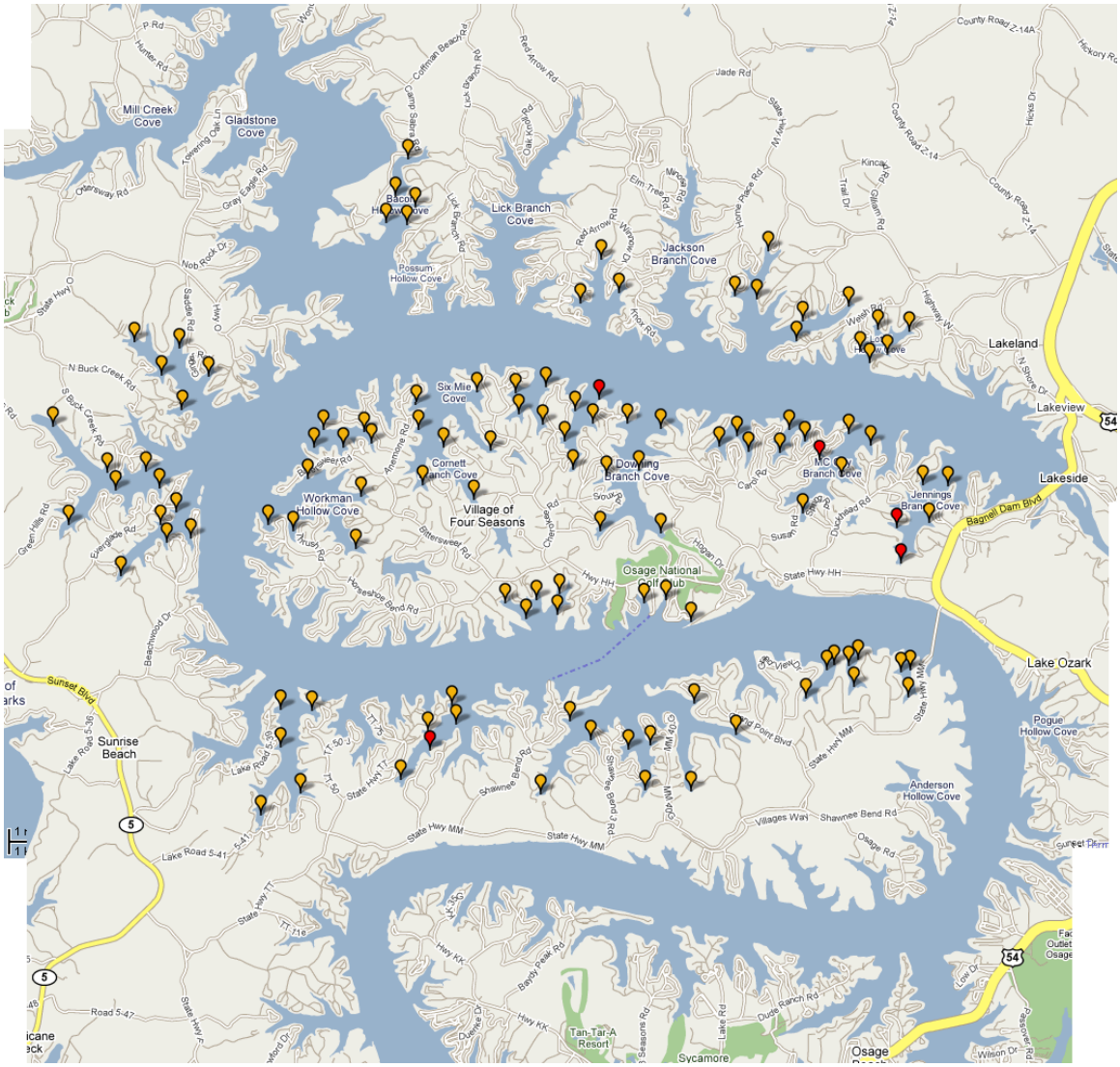



**Figure VI-5b. 2007 LOZ Cove Study testing sites for E. coli bacteria. Online results can be found at www.sosLowa.org; click on 'water quality'.**

**STRATEGY 5 – Ordinances**

**Work with city and county officials to enact watershed ordinances:**

- **A. use of low phosphorus and phosphorus free fertilizers for the WMP area**
- **B. Sunset Law for all on-site sewage systems, septic tanks, and private water wells that do not meet state standards and end the grandfathered systems presently in existence under SB 446.**
- **C. Establish resolutions supporting the formation of a regional council to coordinate and integrate wastewater collection and treatment systems, including on-site systems; and to assume ownership of the 400+ permitted systems in the Lake of the Ozarks watershed on a voluntary basis.**

One may feel that the passage of clean water legislation and protection regulations would mean that watershed management should be a matter of enforcement, but the minimum requirements won't always take care of the complete scope of water protection. And, because every area has its own unique combination of physical, social, and governmental characteristics, sometimes the passage of ordinances to address specific problems is necessary.

**Ordinance A:** Fertilizers. Fertilizers typically contain a blend of phosphorus, potassium, and nitrogen (PKN). These elements are plant nutrients and when lake water receives too many plant nutrients under certain conditions, algal blooms can result. In 1999, Table Rock Lake in southwestern Missouri reached its tripping point for too many nutrients and the lake water turned into something resembling pea soup (see figure III-F-1). At the Lake of the Ozarks, the nutrient that would cause those tripping points to be reached is phosphorus. Currently, in the WMP focus area, the main source of phosphorus, above its background load from agricultural areas beyond Truman Dam and from undeveloped parts of the watershed, is from fertilizer runoff. Residential lawns often have compacted soils from construction, the soils in the WMP focus area have low infiltration rates, and the slopes in the WMP focus area are generally steep. Fertilizer applied to these areas often does not have an opportunity to completely soak into the ground before a rain event and so a portion of the fertilizer often runs off the ground. In addition, the WMP focus area also has many golf courses that use fertilizer on a regular basis to maintain the golf greens. Soil tests to determine the proper amount of fertilizer to apply are seldom performed and the soils in the WMP focus area usually have plenty of phosphorus, especially for native plants, including grasses. Some common problems with fertilizer are not always applying fertilizer in the right amount or at the right time, and golf courses contribute a significant amount to the TP load of their area. Ordinance A wants area merchants to offer low and no phosphorus fertilizers to consumers in the WMP area.

In 1999, because the citizens and stakeholders of the Table Rock Lake watershed, who had been warned about nutrient problems, were not able to proactively control the input of nutrients to their lake, the WWTPs were required to install expensive equipment that would remove nutrients from the wastewater. Sewer bills for the entire area rose in order to pay for the nutrient-removing equipment.

Ordinance A, which would reduce the amount of phosphorus in fertilizers sold around the Lake of the Ozarks and specifically in the WMP focus area, is a necessary piece of the whole picture in reducing the phosphorus load at LOZ. LOWA will work with city and county officials to achieve a low or no phosphorus ordinance.

The critical area for Ordinance A is the shoreline of the WMP focus area (please see figure VI-4). This part of the LOZ shoreline is densely populated with many shoreline residences and golf courses in close proximity to the lake. Please see figure VI-6, a Google Earth map showing a concentration of golf courses around mile markers 12.5 to 18.5 in the WMP focus area, making that a critical area as well.

Ordinance A addresses phosphorus loading, which is part of nutrient loading. By providing lake area residents and businesses the opportunity to purchase low or no phosphorus fertilizer and by providing the educational programs to build an understanding of why low or no phosphorus fertilizer is necessary. Ordinance A will include all 4 counties of LOZ and should help to reduce the phosphorus load at LOZ. Since the Niangua Arm of LOZ is up-lake from the WMP focus area, businesses and residents of the Niangua Arm will be targeted for education, outreach and information, as well as those in the WMP focus area. Golf courses, a large source of phosphorus in the runoff, in both areas will also be targeted for the education, outreach and information campaign.

Figure VI-6. WMP focus area, near Bagnell Dam, showing golf course areas marked with yellow push pin icons. Bagnell Dam, to the right, is also marked by a push pin icon.

Ordinance B will propose a Sunset Law that would require all on-site sewage systems, septic tanks, and private wells that do not currently meet state minimum requirements and

standards to do what is necessary in order to comply with all regulations. In addition, systems in the WMP focus area under a grandfather clause for SB 446 will lose their grandfathered status and will also have to comply with current state standards. This ordinance is necessary because the WMP focus area currently has many shoreline residences with older septic tanks. The WMP focus area, being the part of LOZ closest to Bagnell Dam, was among the first part of LOZ to be developed, and many of those homes have older wastewater systems. The Village of 4 Seasons along HH has many small, inadequate systems specifically grandfathered in under SB 446.

Underfunctioning wastewater systems have the potential to undermine the Strategies of this watershed management plan which target the nutrient and bacteria loading in the WMP focus area. Without addressing one of the large sources of nutrient and bacteria loading in the WMP focus area, i.e., the plethora of poorly functioning septic tanks lining the Lake of the Ozarks, the rest of the Strategies designed to reduce the nutrient and bacteria loads at LOZ will only be able to do part of the job. Ordinance B will try to establish the ground work whereby the problem of leaky septic tanks in the WMP focus area can begin to be addressed. In the future, perhaps other BMPs can be written to help fund the upgrading of septic systems and/or connection to a WWTP for the property owners of the WMP focus area. In the meantime, LOWA is researching alternative methods of managing wastewater when a WWTP is not available. One method, called a Submerged-Flow Wetland is being pioneered by Dr. Dennis Sievers and others in the Biological Department at the U of Columbia, MO, and shows great potential as a relatively inexpensive ($2000 - $3000 per residence as opposed to $20,000 - $30,000 for the cost of connecting to a WWTP) method to manage wastewater at the Lake of the Ozarks.[45] Ordinance B will work in conjunction with Ordinance C such that any system not covered by Ordinance C shall be subject to ordinance B.

The critical area for Ordinance B is the shoreline of the WMP focus area. Please see figure VI-4. The area of the Village of 4 Seasons, where underfunctioning wastewater systems have been grandfathered, is the shore of LOZ between mile markers 10 to 16, and that is a more specific locale for the critical area of Ordinance B. Ordinance B is designed to reduce nutrient and bacteria loading at LOZ as the many underfunctioning septic systems around the lake are brought up to a more effective operating level.

Ordinance C establishes the legal foundation for a regional wastewater treatment coordinating council that would provide the management to ensure the performance of all wastewater systems, community, municipal, as well as individual on-site systems, at the Lake of the Ozarks. This council would also initiate an engineering study, referred to as the Phase II Study, to determine the most effective system of WWTPs (to be referred to as ‘hubs’ for this discussion), cluster systems, and other on-site systems to service the wastewater treatment needs of the lake district region. In addition, the council would advise and assist communities in financing and building the various systems. Details of system placement and operations would be worked out during the Phase II Study. This regional advisory and coordinating council is needed because at present, permitted facilities, large and small, are being constructed throughout the Lake District without any plan or coordination. Many facilities built by engineering firms for home owner associations (HOAs) get turned over to the HOAs with little training or notification and

the HOA is often ignorant about maintaining the facility. Many lake homes around the shoreline with septic tanks are in soils unsuited to septic tanks and need an alternative.

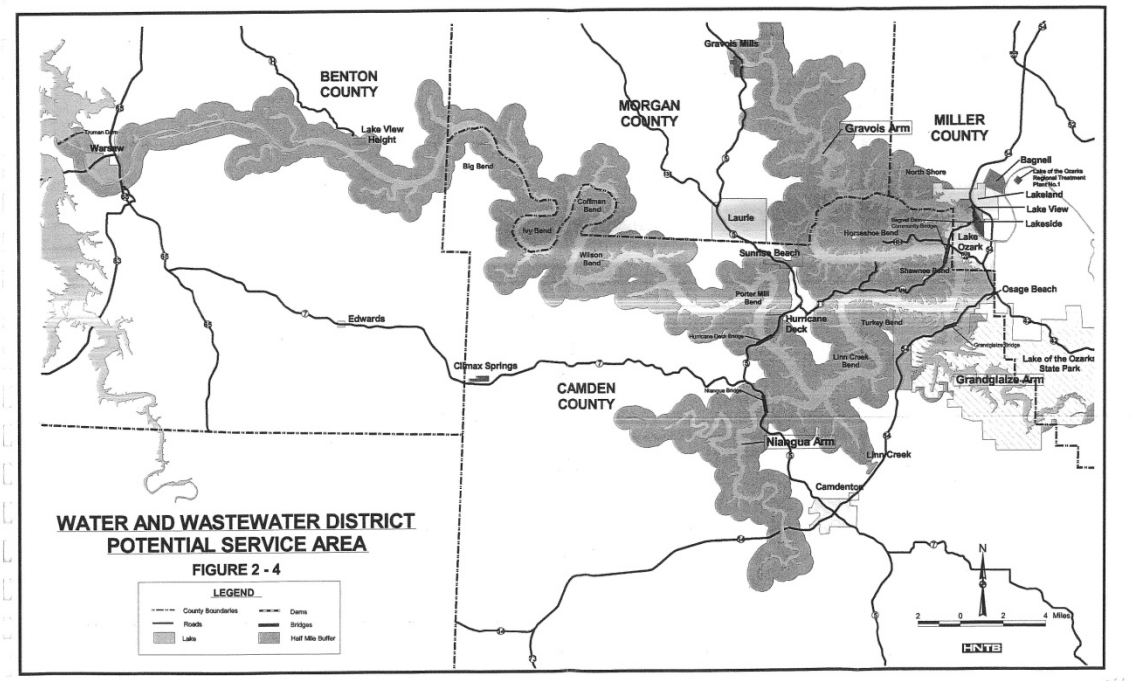



Figure VI-6a. Map from Lake of the Ozarks Water and Wastewater Conceptual Plan for the Lake Group Task Force identifying the Lake Area Wastewater District.[31]

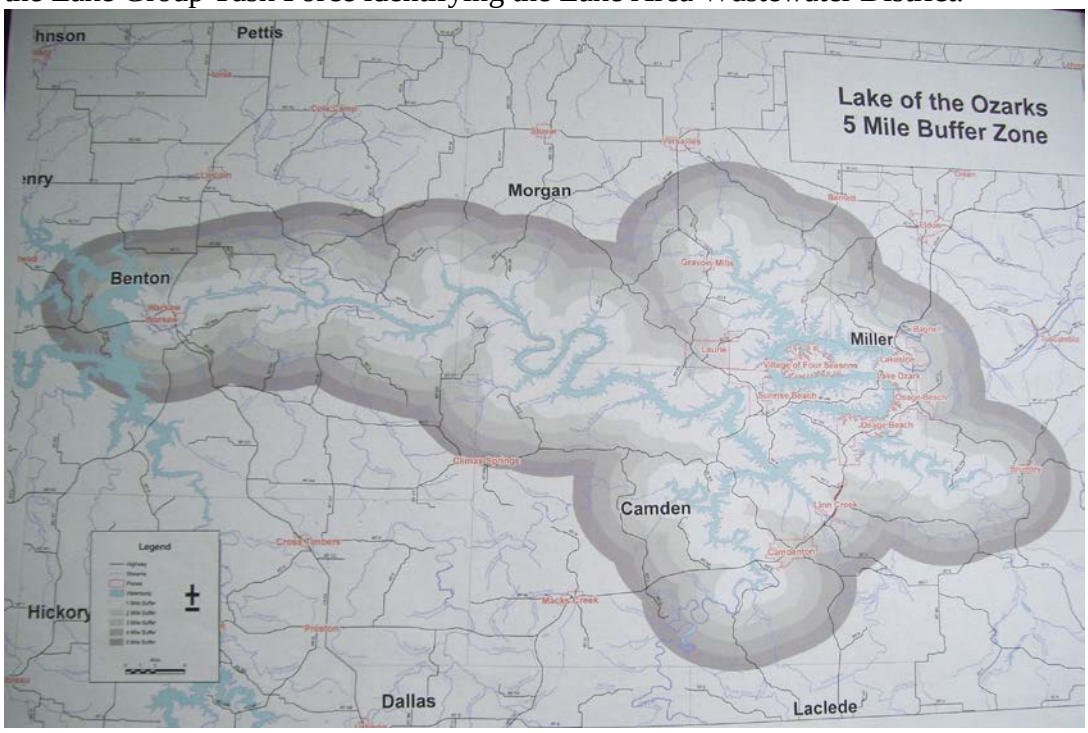



Figure VI-6b. Map showing a 5 mile buffer zone around LOZ. Zones are in 1-mile increments. A similar and larger version of this map can be found on the last page of this watershed management plan.

**Table VI-2. Key to Figure VI-7 Marina and Condominium Location**

| | | | |
|---|---|---|---|
| **A1** | **Bohemian Townhouses** | **Q2** | **Southwood Shores Condos** |
| **B1** | **Granada Condominiums** | **R2** | **Charleston Condominiums** |
| **C1** | **Newport Condominiums** | **S2** | **Estates at Palisades Highlands** |
| **D1** | **Glencove Yacht Club** | **T2** | **Treetop Village** |
| **E1** | **Berger's Marina** | **U2** | **Water's Edge Condos** |
| **F1** | **Bud's Yacht Haven Marina** | **V2** | **Lodge of Four Seasons** |
| **G1** | **Willows on the Lake** | **W2** | **Highland Shores Condos** |
| **H1** | **The Bears Condominium** | **X2** | **Emerald Bay Amenities** |
| **I1** | **Big Bear Resort** | **Y2** | **Palisades Condominiums** |
| **J1** | **Koala Bear Condominiums** | **Z2** | **Cedar Crest Development** |
| **K1** | **Duckhead Townhomes** | **A3** | **Porto Cima Resort** |
| **L1** | **Greenleaf Condominiums** | **B3** | **Harbor at Port Royale** |
| **M1** | **Monarch Cove Condo** | **C3** | **Sunrise Bay Condos** |
| **N1** | **Maywood Estates** | **D3** | **Majestic Point Condos** |
| **O1** | **The Falls Condominiums** | **E3** | **Eleven West Condominiums** |
| **P1** | **Hawk Harbor Estates** | **F3** | **Westside Bay Condominiums** |
| **Q1** | **Grandview Condominiums** | **G3** | **Nantucket Bay Development** |
| **R1** | **Copper Ridge Condos** | **H3** | **Lone Oak Point Condos** |
| **S1** | **Glencove Partnership** | **I3** | **DVP Enterprises** |
| **T1** | **Bentwood Condominiums** | **J3** | **Sunrise Ridge Condos** |
| **U1** | **The Breakers Condos** | **K3** | **Summer Point** |
| **V1** | **Wood Crest Condominiums** | **L3** | **Lake Shores Marina** |
| **W1** | **Tara Condominiums** | **M3** | **Big Thunder Property** |
| **X1** | **Jonathan's Landing** | **N3** | **Millstone Marina** |
| **Y1** | **Four Seasons Racquet & Country Club** | **O3** | **Millstone Development** |
| **Z1** | **SSH Country Club Cove** | **X3** | **North Shore Condominiums** |
| **A2** | **Eagle Point** | **Y3** | **Timberlake Condominiums** |
| **B2** | **Steeple Ridge Condos** | **Z3** | **Forest Pointe** |
| **C2** | **Windjammer Condos** | **A4** | **Adventure Boat Rentals** |
| **D2** | **Wheelhouse Marina** | **B4** | **Atlantis Island Condos** |
| **E2** | **Cactus Point Club** | **C4** | **Village Marina** |
| **F2** | **Shady Gators** | **D4** | **Aqua Moon Marina** |
| **G2** | **Camden on the Lake** | **E4** | **Summerhaven Condos** |
| **H2** | **Aqua Fin** | **1** | **MarineMax of MO, Inc** |
| **I2** | **Ro-Anda Resort** | **2** | **Indian Pointe Condo OA** |
| **J2** | **Alhonna Resort** | **3** | **Summer Ridge CO, Inc** |
| **K2** | **Sunset Cove Development** | **4** | **Cape Royale at Ski Harbor** |
| **L2** | **The Palms Development** | **5** | **Sunset Beach Resort** |
| **M2** | **Wren Rob Amenities** | **115** | **Harbour Bay Condo POA** |
| **N2** | **Bay Point Condominiums** | **116** | **The Evergreens on the Lake CO** |
| **O2** | **Regatta Bay Condominiums** | **119** | **The Getaway** |
| **P2** | **Bristol Bay Condominiums** | | |

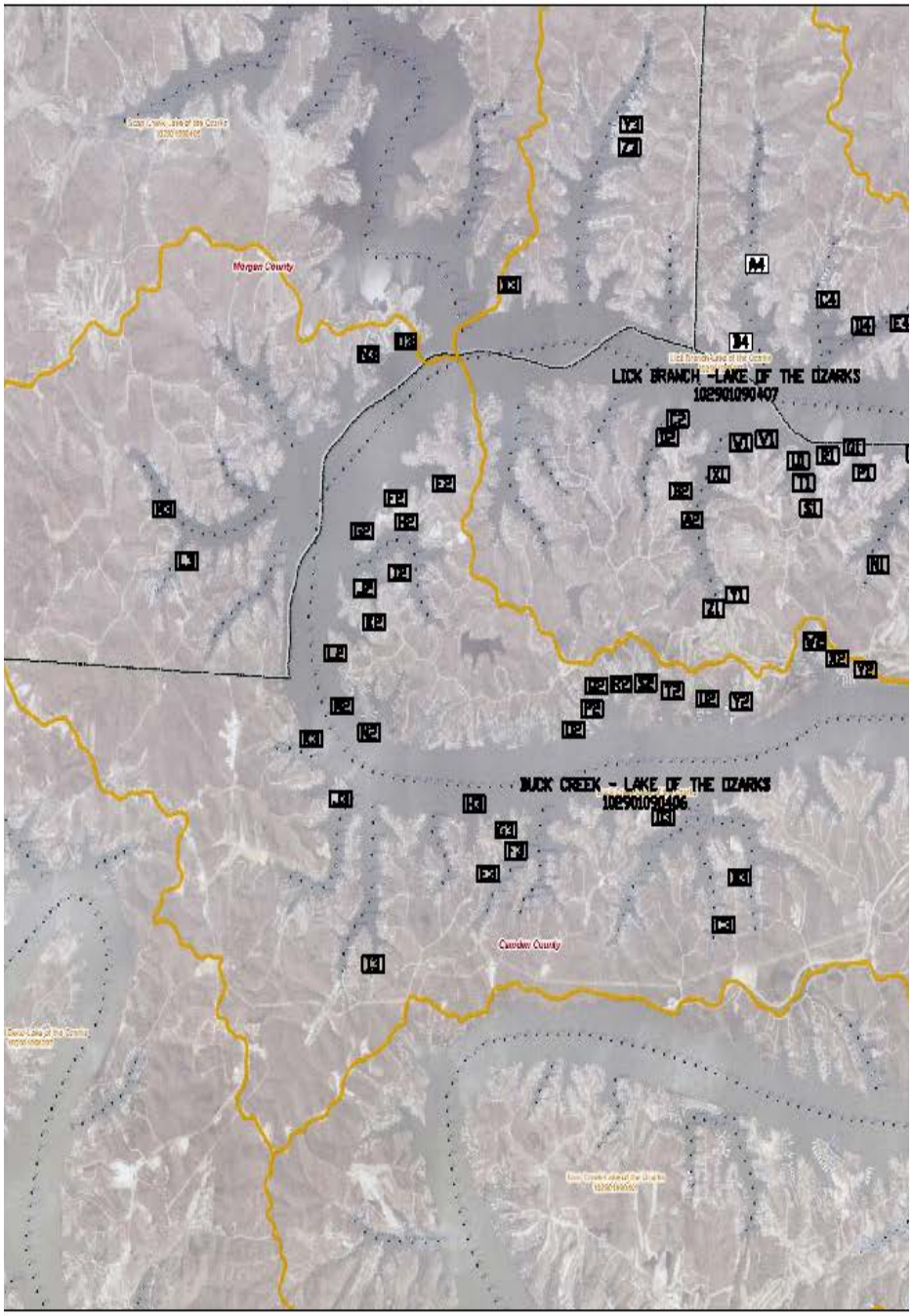



Figure VI-7. Marina and Condominium Locations. See Key in Table VI-2. The yellow line shows HUC boundaries and the dark blu

Condominiums along the shores of the WMP focus area

The wastewater problem at LOZ is complex and the Lake District is very large. A regional approach to wastewater management at the Lake of the Ozarks and Ordinance C would establish the regional advisory and coordinating council for the management of wastewater at LOZ. Both the Action Plan for the Management of Wastewater at the Lake of the Ozarks, November, 2009, written by Lake of the Ozarks Watershed Alliance (please see Appendix D) and the Lake of the Ozarks Water and Wastewater Conceptual Plan (Phase I Study), written for the Lake Group Task Force by HNTB, May, 1999 (available online at www.soslowa.org) discuss in detail the need for a regional wastewater management coordinating council that will help address the issue of human waste reaching the Lake of the Ozarks.. This Strategy 5 on Ordinances is targeted at reducing the nutrient load by focusing on low or no phosphorus fertilizers, maintenance of septic tanks around the lake's shore, and management of wastewater at LOZ on a regional basis. Ordinances B and C also target bacteria loading by focusing on management of wastewater.

**Impairments** – nutrient loading and bacteria loading

**Measurable Milestones** – for all ordinances

- Write ordinances in partnership with city and county officials
- Submit ordinances
- Get ordinances passed
- Present workshops and meetings for citizens, businesses, marinas, landscapers, golf courses, and other groups to explain the ordinance and why it is needed
- Use radio, newspapers, and TV to explain the ordinance and why it is needed

**Monitoring**

- Number of ordinances written, submitted, and passed
- Extent of WMP area covered by ordinances
- Number of articles and interviews in media

**Cost**

One LOWA staffer @ $30,000/year for 2 years = $60,000

**Implementation Schedule**

Year One – Hire staffer – LOWA
Make legislative contacts – Staffer
Write ordinances in partnership with city and county officials – Staffer
Year Two – Submit ordinances to appropriate committee – Staffer
Track ordinances and take steps necessary to ensure passage – Staffer
Final report to LOWA – Staffer

**Technical Assistance**

Advice and counseling on legislative process and on existing ordinances and other pertinent legislation

Technical assistance will be needed to conduct baseline load studies and enough subsequent follow up load studies to adequately evaluate the effectiveness of this Strategy. The entity conducting load studies for this Strategy can be the same entity conducting load studies for the other Strategies as well. An entity(s) to conduct load studies for this watershed management plan is discussed in Section VIII Technical and Financial Assistance Cost Summation.

**Figure VI-8. Lake of the Ozarks – The Crown Jewel of Missouri.**

## STRATEGY 6 – Waste in the Lake

Strategy 6 is called Waste in the Lake because each of the Strategies in this section addresses different sources of how human waste reaches the Lake of the Ozarks. Strategy 6 addresses the heart of LOZ stakeholders' concerns for safety and water quality. All stakeholders need to feel confident that there is no leakage, overflow, or negligent discharge of human sewage into the lake. To that end, Strategy 6A addresses proper maintenance of septic tanks for the many residences along the shoreline of the WMP focus area. Strategy 6B partners with the MO Water Patrol and AmerenUE to provide for a program to encourage boaters to dispose of their wastewater responsibly through a Pump Don't Dump campaign of education and awareness. And, Strategy 6C works with a long-term perspective for the management of wastewater at LOZ by providing for the establishment of a regional wastewater advisory and coordinating council to integrate the treatment of wastewater around the lake and throughout the WMP focus area. In 2007, a 4-year study of E. coli bacteria in the coves of the Lake of the Ozarks began. In every year of the program so far, testing has identified at least one malfunctioning permitted facility that could then be fixed, so there is historical evidence of permitted facilities leaking human waste into the lake. Human waste in the WMP focus area is a problem for several reasons. One reason, as mentioned above and discussed under Strategy 5, Ordinances, is the many, small, poorly managed permitted wastewater facilities around the shoreline of the WMP focus area (see figure III-F-2). Another reason human waste in the lake is a problem in the WMP focus area is the plethora of septic tanks in drastically varying degrees of efficiency. With steep slopes, slow infiltration of precipitation, and erodable soils, much of the WMP focus area has conditions not suitable for septic tanks. A significant number of septic tanks along the shoreline are older and underfunctioning at present and when retirees come to live full time at the lake in what was once a second home, often the septic system is inadequate for the new demands.

Critical areas for the 3 Strategies under Strategy 6 will be identified under each separate Strategy 6 discussion. Strategy 6, being concerned with the treatment, or lack of treatment, of wastewater, does not significantly reduce the amount of sediment win the water and so sediment loading is not one of the impairments that Strategy 6 will address. Strategy 6 does address both nutrient and bacteria loading. Strategy 6 addresses nutrient loading because human waste and wastewater from human sources, whether from a septic tank or WWTP, does contain both nitrogen and phosphorus. Even though the solid part of human waste isn't reaching the lake from a properly functioning system, the liquid effluent is a source for TP and TN, which is nutrient loading. Bacteria loading becomes an issue when untreated or partially treated human waste reaches the lake from improperly working waste treatment systems. Many small permitted waste treatment systems are scattered throughout the watershed of the WMP focus area (see figure III-F-2) and a significant portion of these are poorly managed and malfunction from time to time, sending raw or partially treated waste into the lake, raising the E. coli levels. One reason frequent testing for E. coli throughout the WMP focus area is needed is to monitor for the occasional malfunctioning permitted system so that the problem can be alleviated

as soon as possible. Bacteria can also reach the lake from poorly functioning septic tanks.

Some residences in the WMP focus area have systems not up to state standards that are grandfathered. And, some full-time residences have poorly maintained and underfunctioning septic tanks, both sources of bacteria to the lake. Part of the projection of future growth for the WMP focus area is the baby boomer generation poised to retire to their vacation homes that have septic tanks which are not only too small for full time year round use, but are also aging. These residences represent sporadic bacterial contamination to the lake at present and are a concern for significant bacterial contamination to LOZ for the future unless addressed now. For these reasons, the Strategies under Strategy 6 are targeting nutrient and bacteria loading.

**Impairments** – nutrient and bacteria loading


Figure VI-9. Pump Out Program workshop about septic tank maintenance.

**STRATEGY 6A – Pump-Out Program – Encourage proper maintenance of septic tanks through educational workshops and pump-out discounts.**

Strategy 6A establishes a program to educate home owners about the need for proper maintenance on a septic tank. Strategy 6A also provides the home owner with an opportunity to sign up to get their septic tank pumped by a "green" pumping company, i.e., one that disposes of the pumped material in a responsible manner, and Strategy 6A provides for a discount on the pumping bill. In 2008, LOWA received 2 mini-grants under the 319 grant system administered by MDNR to provide a presentation about ground water, pollution, and how to maintain a septic tank, along with a free meal. A meal was provided to increase attendance and allow working citizens more opportunities to attend. Providing a meal more than doubled attendance compared to workshops without a meal provided. Then, participants were able to sign up to have their septic tanks pumped at a discounted rate. Participants had to attend the presentation to receive the discount. The pump-out program was highly successful and LOWA successfully implemented both grants. Strategy 6A is designed to reduce nutrient and bacteria loading by helping residents properly maintain their septic tanks. The critical area for this Strategy is the shoreline of the WMP focus area. Please see figure VI-4.

**Measurable Milestones**

- Provide 7 workshops per year at several locations throughout WMP area. Workshops will explain how septic tanks work, why they need to be properly maintained, when to get a septic tank pumped out, and how to get a discount to have a tank pumped out. In addition, each workshop will offer participants a free meal.
- Contract with a reputable (one that disposes of the pumped out waste in a responsible manner) septic pump-out company

**Monitoring**

- Number of workshops and attendees
- Number of tanks signed up to be pumped
- Number of tanks pumped out
- Gallons of waste pumped out
- Number of discounts provided

**Cost**

7 workshops/yr with 50 attendees/workshop = 350 attendees/yr
Meal @ $10.00 x 350 = $3500/yr
Discount $35 x 350 = $12,250
Subtotal = $15,750/yr
For 4 years = $63,000

**Implementation Schedule** - LOWA responsible

January – Schedule all workshops with a time and a location. Contract with a pump-out company(s). Develop flyers and public service announcements.
February – Interviews on radio and article in paper to promote the program

March – First workshop
April – Second workshop
May – Third workshop
June – Fourth workshop
July – Fifth workshop
August – Sixth workshop
September – Seventh workshop
October – Work with pump-out company(s)
November – Complete all paper work
December – Final annual report
Repeat each year for 4 years

**Technical Assistance**

At this time, no technical assistance is anticipated. LOWA has already developed this program with assistance from Bob Broz, U of MO Extension.
LOWA will make available septic tank inspections from licensed inspectors for concerned citizens that wish to know the health of their septic tank.

Technical assistance will be needed to conduct baseline load studies and enough subsequent follow up load studies to adequately evaluate the effectiveness of this Strategy. The entity conducting load studies for this Strategy can be the same entity conducting load studies for the other Strategies as well. An entity(s) to conduct load studies for this watershed management plan is discussed in Section VIII Technical and Financial Assistance Cost Summation.

Figure VI-10. EPA Sr. Environmental Engineer, Office of Wastewater Management, Joyce Hudson, LOWA Executive Director, Donna Swall, and Alex Owutaka, EPA Env. Eng. Wastewater Infrastructure Management Branch (WIMB), at MO Smallflows Organization (MSO) Conference, January 2010.

**STRATEGY 6B –** Work with US Coast Guard and the MO Water Patrol to develop a Pump Don't Dump program to encourage boaters to pump out their waste water holding tank instead of emptying the contents of the holding tank directly into the lake.
Strategy 6B is the Pump Don't Dump program. How many boaters simply release the contents of their wastewater holding tank directly into the lake instead of taking their boat to a pumping station? In 2007, LOWA developed a brochure (see Appendix G) with a map of the Lake of the Ozarks that showed the location of all the marinas and camp grounds with pumping stations willing to take boats. This brochure also listed the names, phone numbers, and addresses of the businesses with the pumping stations and had some information tidbits about why wastes should not be dumped directly into the lake. Hundreds of brochures were distributed throughout the Lake District and the public welcomed the information provided by LOWA. Strategy 6B would expand this program, update the brochure, and provide educational seminars and articles to educate boaters about responsible boating.
This Strategy 6B is designed to reduce nutrient and bacteria loading by greatly reducing the number of boaters who dump the contents of their wastewater holding tanks directly into the lake. The critical area is the lake in the WMP focus area, but the whole lake will benefit.

**Measurable Milestones**

- Present 4 seminars per year at different locations around the WMP area to boat owners
- Work with area marinas, campgrounds, and other facilities to provide pumping stations for boats
- Develop a brochure with map and list of participating facilities explaining the importance of the program to help protect the water quality at LOZ

**Monitoring**

- Number of seminars and attendees
- Number of marinas and other facilities providing pumping stations for boats
- Number of brochures produced
- Number of different materials for seminars produced

**Cost**

4 seminars @ $300/seminar = $1200/yr
Seminars for 4 years = $4800
10,000 brochures printed @ $3000
Materials for seminars/yr = $200
For 4 years = $800
Total = $8600 for 4 years

**Implementation Schedule** – LOWA responsible
January – February: Develop seminar presentation and materials. Develop brochure and print.
March: First seminar and distribute brochure around lake
May: Second seminar

June: Third seminar
July: Fourth seminar

**Technical Assistance**
US Coast Guard and MO Water Patrol for information about regulations concerning discharging untreated wastes into the water and to be guest speakers at the seminars

Technical assistance will be needed to conduct baseline load studies and enough subsequent follow up load studies. The entity conducting load studies for any of the Strategies can be the same entity conducting load studies for the other Strategies as well. An entity(s) to conduct load studies for this watershed management plan is discussed in Section VIII Technical and Financial Assistance Cost Summation**.**

Figure VI-11. Boat's holding tank being pumped out at a marina's pump station.

**STRATEGY 6C –** Develop a two-pronged management plan for properly treating and disposing of domestic wastewater around the Lake of the Ozark's shores. The management plan will encourage citizens to create neighborhood management of their wastewater and develop a cost-share program based on the Brush Creek Mid-Shed Evaluation System[34]. This plan will incorporate aspects of on-site management and operation, centralized management of decentralized systems, and regionalization when practical.

**Measurable Milestones**

- Provide 4 presentations per year to explain the program and the concept of a watershed approach to domestic wastewater management
- Provide 2 workshops per year on installing on site systems that are normally acceptable in the soils commonly found at the Lake
- Provide 2 workshops per year on designing and installing small cluster systems
- Provide 1 workshops per year on designing and maintaining 'alternative' on site systems in areas where traditional systems are unacceptable
- Promote the importance of proper on-site treatments one time per year to area high school junior level biology classes
- Coordinate with local supply houses to only stock 'approved' tanks, pipes, and appurtenances
- Promote the importance of proper on-site treatment one time per year at a local civic organization
- Provide cost-share money back to eligible participants for proper design of individual systems
- LOWA will initiate an education campaign supporting the NPDES permit requirements for proper operation and maintenance of discharging wastewater treatment facilities.
- LOWA will 'bridge the gap' in communication between the Department of Health, which regulates on-site septic systems, and the Department of Natural Resources, which regulates discharging wastewater treatment facilities.
- LOWA will conduct coordination meetings two times per year with representatives from each county's health department. The purpose of the meetings will be to educate and inform new and existing employees of the importance of proper permitting, inspection, and complaint resolution.
- LOWA will make septic tank inspections by licensed inspectors available to concerned citizens.

**Monitoring**

- Number of presentations and attendees
- Number of permitted installers attending workshops
- Number of permits issued for on-site systems by 'trained –vs- untrained' personnel
- Number of participants in school presentations
- Number of businesses participating in civic meetings
- Number of participants in the cost-sharing program

- Amount of money awarded in cost-sharing program

**Costs**

Costs will be calculated from the following assumptions: average cost of a presentation or workshop is $300.

- 11 presentations or workshops per year @ $300 = $3300/year. For 4 years = $13,200
- With a cost-share goal of 20 participants per year, calculating % based on $800 average expenses, and an example scenario as follows:

  10 @ 50% = 10 x $400 = $4000
  10 @ 25% = 10 x $200 = $2000
  This gives a total of $6000/yr. For 4 years = $24,000

$3000 for presentations/yr + $6000 for cost-shares/yr = $9000/yr.
For 4 years = $37,200

**Implementation Schedule**

LOWA will develop presentations and present workshops
LOWA will present to the schools and civic groups
Each year for 4 years:
January – Prepare presentation; schedule times and locations
February – contact schools
March – first program presentation
April – first on-site design approved; begin cost-share evaluations; first installer workshop; second program presentation
May – begin civic group education program
August – second on-site design and install
September – second round of school presentations
November – summarize year's accomplishments

**Technical Assistance**

Missouri Department of Health
Missouri Department of Natural Resources
Missouri Clean Water AmeriCorps Program
Sanitarians from local Health Departments
Schultz and Summers Engineering
MEC/Geosyntec
U of MO Extension Services

Technical assistance will be needed to conduct baseline load studies and enough subsequent follow up load studies. The entity conducting load studies for any of the Strategies can be the same entity conducting load studies for the other Strategies as well. An entity(s) to conduct load studies for this watershed management plan is discussed in Section VIII Technical and Financial Assistance Cost Summation**.**

## SECTION VII. LOADS

**This section combines both of the following elements of a successful watershed management plan:**

**ELEMENT B – CALCULATING LOAD REDUCTION AND TOTAL LOAD**

**ELEMENT H – CRITERIA FOR DETERMINING LOAD REDUCTION**

### Subsection VII-A. Sediments

The amount of sediment entering the whole Lake of the Ozarks watershed varies considerably throughout the year and the same can certainly be said for the WMP focus area. One group of contributors to sediment entering the Lake of the Ozarks is land disturbance sites with unconfined soil. As was stated in Subsection III-A, the WMP focus area (with about 30% of its area being lake) has land surface with about 46% steep or very steep hillsides and is only 1.4% not highly erodible soils. That combination of attributes brings a high propensity for soil erosion and for sediments to enter the lake. Projects with land disturbance sites can begin most seasons of the year but seldom in the winter. Unconfined sediment from land disturbance during construction can wash into LOZ from any of those sites during a rain (or thaw) event. Spring and fall typically have large rain events conducive to sediment running off land disturbance sites with improperly functioning storm water retention devices (SWRD's). Another set of locations for sediment entering LOZ during rain events is from residential areas. The typical lawn is not conducive to retaining storm water because the ground is typically compacted from construction, which means it has reduced infiltration. Soils in the WMP focus area typically have low infiltration rates anyway (see Subsection III-A), so residential areas typically have increased runoff, carrying loose sediment and other material with the storm water.

Sediments entering the lake are a concern for 2 main reasons. One reason is that sediments carry with them nutrients such as phosphorus and nitrogen and so sediments in the water also add to nutrient loading. The second reason sediments in the lake are a concern is that not only does sediment actually carry bacteria into the water, but the sediment particles seem to act as a platform on which the bacteria can grow and multiply. So even though bacteria by itself will multiply in the water, when sediment is also in the water, bacteria will multiply even more. Sediment, therefore, also increases the bacteria load in the water. Another reason, not necessarily related to this WMP, that sediment in the water is disadvantageous is that the sediment reduces the quality of fish habitat as it covers over fish eggs and fills in the spaces between rocks needed for cover and food sources. Protection of warm water aquatic life is one of the beneficial uses listed for LOZ, so reducing the amount of sediment entering the lake also protects warm water aquatic life.

Very little data concerning sediment loads at the Lake of the Ozarks or in the WMP focus area, either from past studies or from recent monitoring, could be found by the authors of this watershed management plan. However, ISS (Inorganic Suspended Solids) and TSS (Total Suspended Solids) data for LOZ is available. Both ISS and TSS measure how many very small particles are suspended – not sinking – in the water. One source of suspended solids is sediments entering the lake water. One part of the sediments is the very small silt and clay particles of dirt. So, one part of the ISS and TSS measurements

would be the suspended particles of clay and silt. **Therefore, one can expect that if the amount of sediment is reduced, ISS and TSS levels should also reduce correspondingly.** The Lakes of Missouri Volunteer Program does measure these parameters and in 2008, the seasonal geometric mean for ISS at site 3 was 1.8 mg/L and the seasonal geometric mean for TSS (not published) was 4.1 mg/L. In looking at data from 2005-2008, a 4-year average of the seasonal geometric means for ISS is 1.15 mg/L. The value for ISS at Site 3 correlates strongly with the amount of flow from Truman Reservoir. Both 2007 and 2008 were high flow years, while 2005 was a moderate flow year and 2006 was a low flow year.[18]

One area of technical assistance needed for the successful implementation of this WMP is in establishing a baseline sediment load under different conditions for the WMP focus area, keeping in mind future implementation plans for other areas within the LOZ watershed may also need to get technical assistance for baseline sediment load studies in those areas. With baseline data, one can quantitatively evaluate the effectiveness of implemented Strategies and BMPs. Because no sediment load data was available for the Lake of the Ozarks or the WMP focus area, this watershed management plan will evaluate the effectiveness of the Strategies by using research studies and by examining the nature of the Strategy. The following is a chart of each Strategy, stating whether it addresses a load reduction in sediments, and, if so, how (Table VIIA-1).

**Table VIIA-1. Strategies and Sediment Loads**

| STRATEGY | Y/N | HOW STRATEGY AFFECTS SEDIMENT LOADING |
|---|---|---|
| **1A, 1B** | **Y** | **This Education Strategy will teach all the different stakeholders about soil erosion and ways to reduce the amount of sediments entering the lake through a combination of meetings, presentations, articles in various media, and by workshops on rain barrels, rain gardens, and other LOWA LIL's (Low Impact Landscapes)** |
| **1C** | **Y** | **In class interactive presentations on care of the watershed that relate to soil erosion and sediment loading.** |
| **2A** | **Y** | **Reduce the amount of sediment by encouraging developers to go beyond the state minimum in terms of storm water retention through a cost-share incentive program** |
| **2B** | **Y** | **Development of a cost-share incentive program for property owners to install watershed friendly green spaces and LOWA LIL's on their property** |
| **2C** | **Y** | **Pervious pavement is a watershed friendly surface that not only covers surfaces to prevent soil erosion, but also allows for more aquifer recharge to happen during a rain event than would have happened had the surface been covered with an impervious substance. More recharge to the aquifer means less volume and velocity of runoff, both of which lead to less soil erosion.** |

| | | |
|---|---|---|
| **2D** | **Y** | **This Strategy trains TVEs (Trained Volunteer Evaluators) to monitor land disturbance sites for adherence to their SWPPP (Stormwater Pollution Prevention Plan) both initially and after rain events. This monitoring system may well prevent and/or catch practices that would have allowed sediments to reach the lake.** |
| **3** | **Y** | **Riprap is commonly used to prevent soil erosion in a variety of settings. This Strategy encourages the use of riprap instead of seawalls for shoreline stabilization at the Lake of the Ozarks. The choice of which shoreline stabilization device to install does make a difference in the amount of soil erosion at the shoreline. Soil erosion occurs at the site as the land surface for the sea wall is being prepared. Once the sea wall is in place, over time, wave action undercuts the sea wall causing more erosion and the solution to undercutting is usually to bring in riprap. The use of riprap, initially, instead of a sea wall, reduces considerably the amount of erosion during installation of the shoreline stabilization device, as well as the soil erosion through wave action at the sea wall. In addition, seawalls amplify the effect of wave action within the lake or cove basin which increases soil erosion along unprotected parts of the shoreline. Riprap breaks up the wave, reducing the effects of wave action, thus reducing soil erosion within the basin also.** |
| **4** | **N** | **This Strategy expands monitoring which, though necessary, will not affect the amount of sediments entering the lake.** |
| **5** | **N** | **The ordinances are not related to sediment loading.** |
| **6** | **N** | **Waste in the lake does not significantly affect sediment loading** |

Since not much is known at present about the size of the sediment load to the Lake of the Ozarks at the WMP focus area, this watershed management plan has tried to address the known sources of the sediment loading impairment. The goal of the collected Strategies is to reduce the total sediment load by a significant and measurable amount over a 4-year period by implementing a variety of Strategies to address the known sources of sediment to the lake within the WMP focus area. The reduction will be measured in comparison to the baseline sediment load to be established at the onset of the implementation of the WMP. In Table VII-2, the Strategies have been prioritized by effectiveness in reducing the amount of sediment entering the Lake of the Ozarks in the WMP focus area. The total effect for all Strategies combined should be very significant and measurable. LOWA believes the goal of a significant and measurable reduction in the amount of sediment reaching the lake is possible if land disturbance sites can be monitored by a team of trained volunteers, if builders go beyond the required minimums, and if residents take advantage of a cost-share program to install LOWA LILs and watershed friendly yards to work with stormwater runoff. According to Caraco in "Evaluating the Impact of Watershed Treatment"[32], when behaviors need to be changed, educating the public and increasing awareness of issues become very important. For this reason, the Education Strategies are given a significant impact towards the successful implementation of all the

Strategies. See Table VIIA-2 for a ranking of the effect on sediment loading from each Strategy.

**Table VIIA-2. Ranked Effectiveness of Strategies on Sediment Load Reduction**

| Strategy | Rank | Effect of Strategy on Sediment Load Reduction |
|---|---|---|
| **2D** | **1** | **Monitor construction sites for adherence to SWPPP and maintenance of BMPs and other SWTs because failure to maintain BMPs is fairly common on land disturbance sites.[37] Also, sediment plumes at land disturbance sites after a heavy rain were seen by many citizens at LOZ during the boom construction times of 2005-2007.** |
| **1** | **2** | **Educate the public.[32] LOWA plans extensive information outreach programs through a variety of media and venues to reach the diversity of stakeholders at LOZ.** |
| **2B** | **3** | **Cost share incentive program for property owners ranked fairly high because LOWA believes many lake shore property owners and businesses will be influenced by the information outreach programs of LOWA and will want to install LOWA LILs on their properties and take advantage of the cost share incentive program.** |
| **3** | **4** | **Riprap instead of seawalls is ranked higher than the cost share for developers program because riprap is known to work and LOWA's information and outreach campaign will augment AmerenUE's already running extensive program encouraging the use of riprap for shoreline stabilization.** |
| **2A** | **5** | **Cost share incentive program for developers is ranked fairly low because in order to qualify for this cost share incentive program, builders will have to go beyond the minimum requirements and minimum requirements are getting more stringent with time. For example, one of the new guidelines is to require a SWPPP in situations where it was simply recommended before.** |
| **2C** | **6** | **Pervious pavement is ranked low because LOWA believes this Strategy will be more prevalent in new construction as opposed to post-construction and that there will be fewer new construction sites than already established sites. Also, this technology will take time to catch on partly because of its expense.** |

**Subsection VII-B. Nutrients**

Total phosphorus (TP) and total nitrogen (TN) are the nutrients being targeted by this WMP. In the draft issue of the 2010 List of Impaired Waters, the Niangua Arm of LOZ is listed for phosphorus and the Osage Arm (i.e., the main channel of LOZ) is listed for

nitrogen. The first 18.7 miles of the Osage Arm is the WMP focus area and the Niangua Arm meets the Osage Arm near mile marker 31, up-lake of the WMP focus area. Since the current in the Osage Arm flows from Truman Dam to Bagnell Dam, waters entering the Osage Arm from the Niangua Arm are still a concern to the WMP focus area.

As a result of implementing the Strategies of this watershed management plan, a significant amount of nitrogen will be reduced from the nitrogen load of the WMP focus area. Baseline load studies need to be performed. Then, in conjunction with the load studies of selected BMPs in targeted coves compared to reference coves in the WMP focus area, well-founded load reduction calculation can be performed. Until those load studies can be performed, some estimates based on watershed models can be calculated. See Appendix E for the calculation details. Using the Simple Method to Calculate Urban Loads from the Stormwater Manager's Resource Center[39], Table VIIB-1 shows some calculated loads for the WMP focus area.

**Table VIIB-1. WMP Focus Area Calculated Loads**

| Load Item | Annual Load |
|---|---|
| **TP** | **16,632 pounds/year** |
| **TN** | **275,440 pounds/year** |
| **ISS** | **730,180 pounds/year** |
| **TSS** | **1,668,188 pounds/year** |

Part of the background nutrient load at the Lake of the Ozarks comes from Truman Reservoir, an Army Corps of Engineers lake also on the Osage River, which begins at Warsaw, over 95 miles up lake from Bagnell Dam, and drains a large agriculturally based watershed. Truman Dam releases that water into the top of the Lake of the Ozarks, around mile marker 96. This watershed management plan will not be addressing that source of nutrients in the WMP focus area and will expect a future WMP for a different focus area to address that source. In this WMP focus area, as in any watershed, there will be certain background levels of nutrient load below which even the most effective BMP implementation will not be able to reach. Technical assistance will be needed to determine background levels of nutrient loads, as well as baseline nutrient loads for the WMP focus area before implementation of Strategies. Nutrient loads at the 2 year mark, and again at the 4 year mark, will also be determined with technical assistance. BMPs may be added, modified, or eliminated as data is gathered and conditions and needs change. At the 4 year mark, a vigorous review will determine the schedule for future load studies.

Through an active and extensive educational outreach program and the use of LOWA LILs, such as watershed lawns, rain gardens and rain barrels, infiltration devices, and other storm water treatments, and by implementing pump-out programs, pump don't dump programs, by assisting in programs that better care for human waste water around the lake, by implementing a program to work with golf courses and their fertilization programs, ordinances addressing fertilizers and waste water, and monitoring adherence to storm water regulations, LOWA expects a significant reduction in nutrient loading in the

coves of the WMP focus area over the 4 year period with reductions increasing as more parts of the Strategies are implemented.

A reduction in the phosphorus load will, LOWA believes, be more difficult to achieve than a reduction in the nitrogen loads. Much of the phosphorus load seems to be from the watershed of the Osage River, itself. This is a watershed that stretches into the plains of Kansas and encompasses a very different ecoregion from the one in which Bagnell Dam is located. Streams and rivers from the Osage Plains region are subject to a lot more agricultural influences bringing in more nutrients from their watersheds than are the streams and rivers of the Ozark Highland region, where Bagnell Dam and much of LOZ are located. In addition, some controversy exists over what constitutes a desirable phosphorus limit that balances all of the listed beneficial uses for LOZ. Lake of the Ozarks is famous for its fishing and hosts more fishing tournaments than any other lake in Missouri. Studies have shown that as levels of phosphorus in a body of water are reduced, the stocks of fish are likewise reduced in numbers.[40] Where the balance between a healthy fishery and an algal bloom is, no one yet knows. LOWA believes that the Strategies of this watershed management plan do not endanger the great fishing found at LOZ. According to the 2008 LMVP Data Report for LOZ, the long term average for TP of 0.024 mg/L included the 2 high flow/high TP years of 2007 and 2008. The criterion level for TP has been set at 0.026 mg/L for LOZ. The Strategies for phosphorus in the WMP are meant to be proactive for the WMP focus area even though they are being reactive to the levels of phosphorus in the Niangua Arm.

Different Strategies will affect the levels of nitrogen and phosphorus differently. The following chart (Table VIIB-2) lists the Strategies, states whether a Strategy will affect TP, TN, or both (nutrient loading), and describes briefly how that effect will be accomplished.

**Table VIIB-2. Strategy Effects on Nutrient Loading**

| STRATEGY | Y/N | HOW STRATEGY AFFECTS NUTRIENT LOADING |
|---|---|---|
| **1A, 1B** | **Y** | **Teaching the public how to care for the watershed will include ways to reduce their effect on nutrient loadings, personal and combined.** |
| **1C** | **Y** | **In class interactive presentations about care of the watershed will include sources of nutrients and ways individuals can reduce the amount of phosphorus and nitrogen entering the lake at the WMP focus area.** |
| **2A** | **Y** | **Reducing runoff will reduce the amount of nutrients being washed from land disturbance sites into the lake.** |
| **2B** | **Y** | **Installing BMPs and establishing LOWA LILs will reduce the amount of runoff, thus reducing the amount of nutrients being washed off of lawns and other green spaces along the LOZ shoreline.** |
| **2C** | **Y** | **Installing pervious pavement instead of impervious pavement** |

| | | |
|---|---|---|
| | | **and replacing impervious pavement with pervious pavement will reduce the amount of runoff, thereby reducing the amount of nutrients being washed into the lake.** |
| **2D** | **Y** | **Using the TVE program should reduce the amount of runoff from land disturbance sites, thus reducing the amount of nutrients being washed into the lake.** |
| **3** | **y** | **Encouraging the use of riprap instead of seawalls for shoreline stabilization will have a small effect on nutrient loading because sediments do carry some nutrients.** |
| **4** | **N** | **This Strategy expands monitoring which, while important, will not affect nutrient loading.** |
| **5** | **Y** | **Ordinance A addresses the amount of phosphorus in fertilizers and should reduce phosphorus loading.**<br>**Ordinances B and C both address poorly functioning septic tanks and should reduce both nitrogen and phosphorus loading as the volume of under treated wastewater entering the lake is reduced.** |
| **6A** | **Y** | **This Strategy addresses waste in the lake with a septic tank pump out program and should reduce nutrient levels in the lake by helping citizens properly maintain their on-site septic systems.** |
| **6B** | **Y** | **Development of a Pump Don't Dump program to encourage boaters to pump out their waste water holding tank at a pumping station instead of emptying the contents into the lake should reduce nutrient levels in the lake.** |
| **6C** | **Y** | **Establishment of a lake-wide sewer coordinating council should reduce the amount of nutrients going into the lake by reducing the number of underperforming septic tanks now in operation around the lake's shores.** |

One source of nutrients entering the Lake of the Ozarks includes the many poorly functioning on-site septic systems along the shoreline of LOZ. Another source of nutrients in LOZ is the runoff from shoreline establishments, including green spaces around businesses, residences, and other properties, as well as from golf courses, resorts, and other tourist destinations. See figure VII-B-1 for a Google Earth image of part of the WMP focus area showing the densely populated and developed shoreline of LOZ near Bagnell Dam.


**Figure VII-B-1. Close-up of WMP focus area at Bagnell Dam (upper right) showing areas of dense population nestled within areas of woods and other vegetation. Image from Google Earth. The white line is a county boundary line.**

Because no nutrient load studies have been performed for the WMP focus area, establishing a total load amount and thereby a load reduction for each BMP is exceedingly difficult, at present. In fact, in accessing the NPDES Urban Performance Tool[41], little information is found that directly pertains to the Midwest. However, this tool did list performances for different BMP types from other areas. In terms of reducing the amount of stormwater runoff (which would reduce all 3 loads, bacteria, nutrient, and

sediment, for LOZ) the Urban BMP Tool found vegetated buffer strips, detention basins, and infiltration basins to be most effective. Many BMP studies are for land disturbance sites as opposed to being post-construction retrofits, but parallels can be drawn. Vegetated buffer strips, for example, are similar to riparian buffer zones, part of the LOWA LILs. And, rain gardens can be considered to be a type of infiltration basin. In terms of projecting which BMPs are most effective at removal, other BMP studies are available.

The Center for Watershed Protection has produced many studies evaluating storm water treatments and BMPs. For example, "Evaluating the Impact of Watershed Treatment" by Caraco[32] analyzes the effectiveness of different treatments in reducing phosphorus loads, both during new development and after development. This study finds that infiltration practices, including bioretention areas (rain gardens) and pond systems, were most effective at removing phosphorus while also reducing the volume of runoff. Pervious pavement was also found to be an effective stormwater retrofit. In general, reducing the amount of impervious cover through Better Site Design was found to reduce the phosphorus load while also reducing the volume of storm water runoff. Regardless of type of BMP or location, all studies found that as impervious cover increases, the volume of runoff increases, and the nutrient loading also increases. Impervious cover is found to be an across the board effect. Many of the post development practices work because they reduce phosphorus loadings at their source and thus, generally require changes in individual behaviors that generate phosphorus loadings. Changes in individual behaviors require intensive outreach and/or enforcement programs on the part of a municipality or lake association to be effective.

Strategies for preventing the nutrient, nitrogen, from entering the Lake are somewhat different from those for phosphorus. Riparian covers, so effective at reducing the volume of storm water runoff are, when designed properly, also effective in removing nitrogen. An EPA report entitled "Riparian Buffer Width, Vegetative Cover, and Nitrogen Removal Effectiveness[43] discusses how to design buffers to work most effectively. In a report analyzing BMPs affecting the Chesapeake Bay[44], bioretention areas were not listed under the Urban BMPs. However, a similar category, Urban Infiltration Practices with Sand and Vegetative Buffers, had a 85% reduction efficiency for both TN and TP (with a 95% reduction in sediments) and Urban Infiltration Practices without Sand and Vegetative Buffers was listed at 80% removal efficiencies for TN and 85% for TP (also with 95% sediment removal). Septic pumping and septic denitrification were both listed at 50% efficiency for TN (n/a for TP) and both Structural and Non-Structural Shoreline Erosion Control was listed at 75% reduction efficiencies for TN, TP, and sediments. Septic connections were rated at 55% for TN and Urban Forest Buffer was rated at 25% for TN, 50% for TP, and 50% for sediments.

In ranking the effectiveness of the various Strategies for the Lake of the Ozarks WMP, the cited reports and studies were taken into account, as well as the culture and location of the WMP focus area. Two sets of rankings were projected for nutrient loading because some of the proposed Strategies will have effects seen in a relatively short period of time (like reducing the amount of sediment entering the lake from land disturbance sites with

unconfined soil), while the effects of other Strategies will take a number of years to be fully realized (like establishing effective wastewater treatment around the entire lake). This ranking is summarized in Table VIIB-3, Ranked Effectiveness of Strategies on Nutrient Loading. Under the 4-year ranking, those Strategies working with property owners to reduce the amount of runoff entering the lake, along with the Education Strategies, were deemed to be more effective than the Strategies aimed at keeping the nutrients from wastewater out of the lake because the issue of regionalizing wastewater treatment at LOZ and getting the septic tanks off of the shoreline will take more time than more immediate remedies like establishing LOWA LILs and monitoring the storm water treatment practices of land disturbance sites. In addition, several reports described high effectiveness for infiltration devices and vegetated buffer zones in keeping nutrients from entering a body of water. In the long-term perspective, though, ordinances to work with the wastewater issues around the lake and educating the public will be key to establishing a lake-wide coordinating council for the management of wastewater around the lake so that the poorly functioning septic tanks around the shoreline of LOZ can finally be removed. The rest of the Strategies for working with property owners and developers will still be important pieces of the long term strategy while the Pump Out program and the Riprap program will become relatively less effective in the 24-year picture.

Taking all of these studies into account, the Strategies for this watershed management plan were ranked by effectiveness of reducing the nutrient load. This ranking is summarized in Table VIIB-3 Ranked Effectiveness of Strategies. In ranking the Strategies, post development was given a higher ranking than new development because the number of residences already established far exceeds the construction sites of new development, so the impact area is much larger. For the purpose of this table, some of the Strategies were combined. In addition, Table VIIB-3 also differentiates between long term effectiveness (24 years) and short term (4-year) effectiveness because some Strategies (like establishing a regional wastewater district) will take longer than others to fully implement. Even though one Strategy may not seem to have a lot of effect on reducing nutrient loading, each Strategy is important as a piece of the whole; all the Strategies work together to reduce nutrient loading at LOZ.

**Table VIIB-3. Ranked Effectiveness of Strategies on Nutrient Loading**

| 4 year ranking from most effective to least effective | STRATEGY | | 24 year ranking from most to least effective | STRATEGY |
|---|---|---|---|---|
| 1 | 2B – LOWA LILs | | 1 | 5 – ordinances |
| 2 | 2D – TVEs on land disturbance sites | | 2 | 1 – all education |
| 3 | 1 – all the education BMPs | | 3 | 6C – Regional wastewater district |
| 4 | 6A – pump-out septic tanks | | 4 | 2B – LOWA LILs |

| | | | | |
|---|---|---|---|---|
| **5** | **2A – cost share for developers** | | **5** | **2D – TVEs on land disturbance sites** |
| **6** | **2C – porous pavement** | | **6** | **2A – cost share for developers** |
| **7** | **3 – shoreline stabilization** | | **7** | **3 – shoreline stabilization** |
| **8** | **6B – Pump Don't Dump** | | **8** | **6A – pump-out septic tanks** |
| **9** | **6C – Regional wastewater district** | | **9** | **6B – Pump Don't Dump** |
| **10** | **5 - Ordinances** | | **10** | **3 – shoreline stabilization** |

With no baseline data, using load reduction numbers is not feasible at this time. Technical assistance will be needed to establish a baseline for nutrient loading throughout the WMP focus area, as well as to establish the effectiveness of the various BMPs and Strategies. Obtaining load reduction data on installed BMPs in conjunction with baseline load data will allow load reductions to be calculated. However, the Storm Water Manager's Resource Center does provide a Simple Method to Calculate Urban Loads[29].

Calculating an annual load for phosphorus gives 16,632 pounds/year = Annual load of Phosphorus.
Calculating an annual load for nitrogen gives 275,440 pounds/year = Annual load of Nitrogen.

The parameters, ISS and TSS, are not really nutrients and are more related to the total sediment load. Sediments do carry nutrients and so calculating ISS and TSS loads is helpful in determining current loads and future load reductions for sediments. As sediment loads and ISS and TSS values decrease, one would expect a corresponding reduction in nutrient loads.

Calculating an annual load for ISS gives 730,180 pounds/year = Annual load of ISS.
Calculating an annual load for TSS gives 1,663,188 pounds/year = Annual load of TSS.

In looking at wastewater, and using a calculation method used by engineering firms in their design calculations for WWTPs, (please see Appendix E for details and reference), one gets an annual loading of 1,662,210,000 gallons or about 1.66 billion gallons of waste water. If one knew the phosphorus and nitrogen loads coming into the lake with the effluent from the WWTPs, then one could add the wastewater load for a pollutant with the urban storm water calculated loads to get a closer indication of the total nutrient and pollutant loads going into the WMP focus area.

As a side note, the Osage Beach Regional Wastewater Treatment Plant does not empty any effluent into the Lake of the Ozarks. All of its effluent goes into the Osage River below Bagnell Dam. That being said, Plant Manager Gary Hutchison stated that his plant removes 99+ % of the substances found in the influent. They test for ammonia nitrogen

on a weekly basis and that comes out at less than 0.05 mg/L regularly. Phosphorus was tested for on 9/29/2009 and the TP value was 0.092 mg/L (compared to the LOZ standard of 0.026 mg/L for LOZ).

Please see Appendix E for details on all calculations.

**Subsection VII-C. Bacteria**

The number of times bacteria, specifically E. coli, is above the standard (an exceedance) in the Lake of the Ozarks at any site or time period within the WMP focus area, is proposed to be reduced to one per year by the end of a 4 year period. The level of exceedances is not expected to reach zero because some E. coli in LOZ is from wild fowl swimming in LOZ and some is from runoff in undeveloped areas of the LOZ watershed and this watershed management plan will not address those sources.

The International BMP Database published a report in 2008 compiling the results of analyzing the effectiveness of various BMPs on the reduction of bacteria loads[45]. This study found that, when comparing inflow to outflow, bioretention areas (rain gardens) were quite effective in reducing E. coli. Ponds and sand filters were also cited as effective. Bioswales were not found to be very effective with bacteria loads. This watershed management plan proposes to reduce bacteria in the lake by implementing programs that eliminate bacteria-laden human waste from reaching the lake. Two perspectives are taken for bacteria load reductions in this watershed management plan. In the short, 4 year term, programs such as encouraging proper maintenance of septic tanks and discouraging the dumping of waste water from onboard boats directly into the lake instead of utilizing one of the many pumping stations found around the lake, as well as abundant opportunities for public education and outreach about reducing one's own contribution to the bacteria loading at the lake should show a significant impact relatively quickly and the impact should build as participation in the various programs builds.

For the full impact of this watershed management plan to be felt, however, one must take a long-term perspective. The many septic tanks around the shoreline, a significant number of which are either presently inadequate or are poised to become inadequate as retirees move in full time to what was once a second home, and any malfunctioning or underfunctioning permitted treatment systems will have to be addressed. A regional coordinating council is needed to integrate the present array of various systems, ensure designs are adequate to meet needs efficiently, and help communities obtain funding. The WMP focus area would benefit tremendously from such a regional integrated approach because a significant portion of this area is presently on septic tanks in soils and population densities unsuited for septic tanks and lateral lines. It will take time to build the mosaic of waste water treatment plants, cluster plans, and effective on-site plans; but in the mean time, the short term steps can be taken as a necessary part of the whole and the first steps of the long term plan can begin.

**E. coli Testing – The MDNR Cove Study for LOZ**

In the spring of 2007, LOWA teamed up with MDNR to help with a study of E. coli concentrations in the coves at the Lake of the Ozarks. This was designed to be a 5-year study, sampling a different part of LOZ each year. The study was funded by AmerenUE. MDNR designed the study, analyzed the samples, and reported the results. LOWA offered volunteers to collect the samples and either courier the samples to the MDNR lab for analysis or turn the samples over to an MDNR courier. With the addition of LOWA volunteers, over 3 times as many samples were able to be collected and analyzed compared to the original design with just MDNR personnel collecting the samples as well as running the analyses. This study is one of the bases of data from which LOWA has worked in order to design BMPs to address E. coli contamination from human sources.

E. coli is short for the scientific name for a whole group of bacteria, *Escherichia coli*, a few of which, but certainly not all, can make people very ill and even cause death. There are many other microscopic pathogens that can be found in lake water and when E. coli readings are high, there is a high probability that other disease-causing microbes will be present as well, so the concentration of E. coli is used as an indication of the presence of pathogenic (disease-causing) organisms. When a sample of water is collected for analysis, the water is incubated under specific conditions and then the number of bacteria colonies that have grown is determined in a measurement called Most Probable Number per 100 milliliters of water, or MPN/100 mL (also seen as mpn/100 mL). Standards for how many bacteria colonies can be present for different water uses have been determined by the EPA. The single sample standard for whole body contact, which is one of the uses for which the Lake of the Ozarks has been designated, is 235 MPN/100 mL. Any sample testing at 235 MPN/100 mL or more is considered to be above the standard. Another standard for E. coli exists for a geometric mean of at least 5 samples spread over one month, and that number is 126 MPN/100 mL, and that is the MPN that MNDR chose to be the standard for the LOZ Cove Study for E. coli, even though generally only one sample every other month is taken for a total of 3 samples per monitoring season. In the MDNR study, sites testing at above the 126 MPN/100 mL standard were examined to determine a possible source of the high readings and the site was retested until the sample tested less than standard. In the 3 years that the study has been running, several instances of underperforming wastewater treatment systems have been detected and corrected.

The part of the Lake of the Ozarks sampled in 2007 was from Bagnell Dam to around mile marker 16 at the Community Toll Bridge. This area coincides very closely with the WMP focus area, which goes from Bagnell Dam to almost the 19 mile marker, but the WMP focus area does not include the Gravois Arm of LOZ. The 2008 sampling sites ran from the Community Toll Bridge to about the 29 mile marker and include the Grand Glaize arm. Except for miles 16-19, the 2008 sampling area is not in the WMP focus area, nor is the 2009 sampling area which went from the 29 mile marker to the 53 mile marker and includes the Niangua Arm of the Lake of the Ozarks. However, the Niangua Arm has been listed on the 303(d) List of Impaired Waters for phosphorus and, being up-lake from the WMP focus area, is still an area of concern for this WMP. A couple of coves in the 2007 sampling sites have been retested in 2008 and 2009 and have continued

to be problematic in terms of testing over the 126 MPN/100 mL standard for E. coli contamination[47] with the sources of contamination having been malfunctioning wastewater treatment systems.

A summary of the Cove Study results follows:
2007 – of 357 collections, 8 showed bacteria above standard – 2.2%
2008 – of 321 collections, 9 showed bacteria above standard – 2.8%
2009* – of 321 collections, 46* showed bacteria above standard – 14.3% [46] *
* The May sampling for 2009 was right after a heavy (>2 inches) rain which had washed a lot of material into the lake. This sampling date accounted for 44 of the 46 high E. coli readings for the entire season
Average 333 samples per year
A geometric mean of 14.9 samples above standard per year and an arithmetic mean of 21 samples above standard per year are both skewed high because of the very high number for the 2009 season. If the 2009 data is not used, the average number of exceedances per year is 8-9.

If number of samples above standard is reduced by an average of 4 samples per year, about 4 years will be needed to reduce the number of samples testing above standard due to human causes essentially to zero. Because wildfowl are a part of the LOZ ecosystem and because E. coli is not tested to determine whether it was human or animal, LOWA does not have zero readings over 126 MPN/100mL as the end goal for E. coli contamination. LOWA does, however, have an end goal of zero readings over 126 MPN/100mL due to human causes.

Bacteria – Public beach closings – There are no public beaches within the WMP focus area, but there are public beaches in watersheds flowing into LOZ upstream (up lake) close to the WMP focus area so contamination could conceivably flow into the WMP focus area. MDNR tests the public beaches (PB) in the Lake of the Ozarks State Park and uses a combination of single sample results and geometric means for 30 day periods to determine when to close a public beach. The EPA single sample standard for public beaches is < 235 MPN/100 mL and the geometric mean is compared to the whole body contact standard of < 126 MPN/100 mL. Dates of when single sample results were over standard for 2009 at PB#1 and PB#2 are listed in Table VIIC-1.[48]

**Table VIIC-1. Public Beach E. coli tests 2009**

| PB # 1 date | MPN/100 mL | | PB #2 | MPN/100 mL date |
|---|---|---|---|---|
| 5/18 | >1000 | | 6/8 | ~500 |
| 6/1 | >600 | | 6/11 | >500 |
| 6/15 | ~2000 | | 6/15 | ~2000 |
| 6/17 | >2400 | | 6/24 | ~500 |

This watershed management plan will not be implementing Strategies to address E. coli contamination at the LOZ state beaches, but will be keeping track of the testing at the beaches for possible influences to the WMP focus area.

Table VIIC-2 will list the Strategies for the WMP focus area and describe how each will or will not address bacteria loading. Table VIIC-3 will then, after a discussion of BMP studies addressing bacteria, rank the Strategies by effectiveness.

**Table VIIC-2. BMPs and Bacteria Loads**

| STRATEGY | Y/N | HOW STRATEGY AFFECTS BACTERIA LOADING |
|---|---|---|
| **1** | **Y** | **Education to all citizens about how their behaviors affect bacteria loading in the watershed and what they can do to help** |
| **2A** | **Y** | **Bacteria increases as sediment load increases so encouraging developers to go beyond state and local requirements for storm water protection will help to reduce the bacteria loads at LOZ** |
| **2B** | **Y** | **Encouraging property owners around LOZ to install LOWA LILs will help reduce the volume of runoff from their land, thus reducing the amount of pet waste, sediment, and other bacteria-containing materials from washing into LOZ.** |
| **2C** | **Y** | **Pervious pavement reduces runoff by increasing infiltration. Reducing runoff volume also reduces the amount of material washed into the lake, including the amount of bacteria.** |
| **2D** | **Y** | **Ensuring adherence to SWPPPs by developers will decrease the amount of runoff, thus decreasing the amount of bacteria entering the water.** |
| **3** | **y** | **Reducing the amount of soil erosion at the shoreline will reduce the amount of sediment in the water, thus reducing the bacteria load.** |
| **4** | **N** | **This Strategy increases the amount of testing and monitoring at LOZ which is very important, but, monitoring in and of itself, does not reduce loads.** |
| **5** | **Y** | **Ordinances B and C relate to reducing the amount of human sewage reaching the lake and will thus reduce bacteria loading.** |
| **6A** | **Y** | **Encouraging the proper maintenance of septic tanks around the lake will reduce the amount of bacteria reaching the lake.** |
| **6B** | **Y** | **A Pump Don't Dump program to encourage boaters to pump out their waste water at a pumping station will help to reduce bacteria loading at LOZ.** |

| | | |
|---|---|---|
| **6C** | **Y** | **Developing a management plan for properly treating and disposing of domestic wastewater around the lake's shores will help to reduce the amount of bacteria entering the water.** |

When discussing bacteria and E. Coli at the Lake of the Ozarks, one is inevitably drawn to the issue of tens of thousands of septic tanks lining the shores of LOZ in areas unsuited to traditional septic tank wastewater treatment because of thin soils, karst topography, and small lot sizes. The LOZ watershed management plan has several Strategies designed to address wastewater entering LOZ in the WMP focus area. One is a multilevel Education Strategy working with all parts of the stakeholders' communities from property owners to tourists and from businesses to municipal and civic agencies and organizations. Caraco[32] discusses the crucial role education plays when trying to get people to change behaviors and habits; and, the rest of the Strategies' effectiveness hinges on this vital role. Working with education and information outreach to implement behavior changes and working to help citizens with the expenses involved with change is the essence of the Runoff Strategies and the Waste in the Lake Strategies. LOWA believes the Waste in the Lake Strategy 6A, developing a program to educate people about why properly maintaining their septic tanks is so important and to provide a discounted pump out for their septic tank, will be very effective at reducing the bacteria loads entering the Lake in the WMP focus area in the short term perspective because, based on the bacterial hotspots found in the LOZ Cove Study for E. coli, the septic tanks along the shores of the WMP area seem to be a large source of bacteria in LOZ. Strategy 6C, which establishes a regional approach to wastewater treatment at LOZ will be the most effective of the Strategies in the long run and, many years will be needed to engineer, finance, and build all the different types of wastewater treatment systems in the appropriate areas to most efficiently treat the wastewater around the entire Lake of the Ozarks not only now, but also for future decades.

Also in the short term is the Pump Don't Dump program where boaters are encouraged to use one of the many pumping stations available to them when emptying the contents of their boats' holding tanks, instead of simply dumping that waste directly into the Lake. Only anecdotal data exists on how prevalent the dumping without pumping practice is, but Strategy 6B will incorporate pre- and post-implementation surveys as part of the implementation procedure for this program. In a newspaper article from June 2007 in the *Lake Sun Leader*, Kevin Hess from MDNR speculates about a couple of possible sources for the 3 isolated hotspots in the first sampling for the MDNR LOZ Cove Testing Project as being either runoff from wastewater systems or large boats dumping waste.[49] The Pump don't Dump program will also be both a short term and a long term approach because new visitors to LOZ will continue to need the information and outreach of Pump Don't Dump. The Runoff Strategies, which includes the LOWA LILs, will address bacteria loading not only by reducing the amount of storm water runoff, but also by implementing specific types of BMPs.

In *Storm water*; May 2008, Clary, et al analyzed the data in the International Storm water BMP Database for bacteria studies and found 600 pairs of influent v effluent data pairs

for a variety of BMP types.[45] This study found overall that no single BMP type consistently reduced bacteria in surface effluent to levels below in-stream primary contact standards and that watershed managers should not assume that structural BMPs can meet numeric effluent limits for bacteria for all water bodies and under all conditions. However, BMP categories with potential include retention ponds and media filters with bioretention cells where filtration is a key unit in the process. Wetlands, pervious pavement, and manufactured devices had too few data pairs for analysis; however pervious pavement with sand layers above the subsurface underdrains should perform similarly to media filters. This study concludes that it is important to also consider whether the BMP reduces the volume and velocity of storm water runoff and the frequency of discharges. Such BMPs as bioretention, vegetated biofilters and sometimes dry, extended detention basins have shown the ability to reduce runoff volume via infiltration and/or evapotranspiration losses and these factors should also be considered in BMP selection. The Storm Water Center fact sheet on bioretention areas[42] states that, while highly effective at nutrient removal, rain gardens are not at all effective for removal of bacteria (-58% removal efficiency, which means that more came out in the effluent than came in with the influent). In a different study, Phillips, et al, in looking at the cost and effectiveness of storm water treatments[50] gave a rating of 4 out of 5 in bacteria removal efficiencies for filter systems, for filter and bioretention systems, and for pervious pavement. Infiltration basins received a rating of 3 out of 5 while vegetated swales and media filters received a rating of 2 out of 5, again confirming that different results from different studies show no one kind of BMP will always be effective against bacteria loading and site characteristics must be considered in BMP selection.

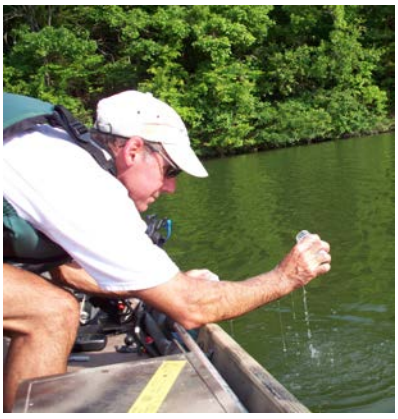
With these factors in mind, Table VIIC-3 ranks the Strategies by effectiveness of reducing bacteria loading at LOZ both from a 4-year short term perspective and from a 24-year long term perspective. Education outreach and information is rated number one in effectiveness for the short term perspective because this Strategy will be essential for successful implementation of the WMP Strategies because increasing awareness of issues is needed to change long held attitudes and beliefs. Over the long-term, however, regionalization into one well-managed wastewater district for all 4 counties bordering LOZ will have to happen for wastewater entering the lake to end. So the long-term perspective will build on the short term successes and Strategy 6C, developing a regional wastewater district for LOZ, is ranked most effective in the long term. Looking at the short term, the Pump Out Program of Strategy 6A is ranked second most effective because it addresses the issue of proper septic tank maintenance around the shores of the densely developed WMP focus area, which is one of the main sources of waste in the lake. The Pump Don't Dump program is ranked third in short term effectiveness because that is a direct source of waste in the lake that could well be more prevalent than is reported. Strategy 2B, the LOWA LILs, and ranked 4$^{th}$ in the short term because these retrofit BMPs are so variable in their effectiveness for removing bacteria. The Ordinances Strategy comes in 5$^{th}$ in the short term because ordinances will take some time to get passed and then time for their implementation to take effect. Because of that time factor and their overall importance to the success of several Strategies, Strategy 5, Ordinances, is ranked 2$^{nd}$ in the long term effectiveness. Pervious pavement, Strategy 2C, will also take time for its effectiveness to be felt so it is ranked 6$^{th}$ in the short term

and 4th in the long term. Education outreach and information is ranked 3rd for the long term. Much of its effect is needed right away, but the Education Strategy will also be needed in perpetuity as new issues, new information, and new stakeholders arise. Shoreline stabilization with riprap, Strategy 3, and Strategies 2A and 2D are ranked fairly low because shoreline erosion and land disturbance sites are not major sources of bacteria entering the lake. Please refer to Table VIIC-3 for a summary of the ranked effectiveness for reducing bacteria loading both from a 4-year perspective and a 24-year perspective.

**Table VIIC-3. Strategies Ranked by Effectiveness in Reducing Bacteria Loading**

| 4 year ranking from most to least effective | Strategy | | 24 year ranking from most to least effective | Strategy |
|---|---|---|---|---|
| 1 | 1 – the education Strategies | | 1 | 6C – regional wastewater district |
| 2 | 6A – pump-out septic tanks | | 2 | 5 – ordinances |
| 3 | 6B – Pump Don't Dump | | 3 | 1 – the education BMPs |
| 4 | 2B – LOWA LILs | | 4 | 2C – porous pavement |
| 5 | 5 – ordinances | | 5 | 2B – LOWA LILs |
| 6 | 2C – porous pavement | | 6 | 6B – Pump Don't Dump |
| 7 | 2A + 2D – construction sites | | 7 | 6A – pump-out septic tanks |
| 8 | 3 – shoreline stabilization | | 8 | 2A + 2D – construction sites |
| 9 | 6C – regional wastewater district | | 9 | 3 – shoreline stabilization |

Mark Templeton, Director, Missouri DNR



Greg Stoner, MDC Fisheries Biologist and LOWA Water Quality Chair

Fig. VII-C-1. Water Quality Monitoring for bacteria in the LOZ MDNR E. coli Cove Study for the Lake of the Ozarks.

**Subsection VII-D. Summary of Loading Effectiveness**

Table VIID-1 shows the ranked effectiveness for reducing a load of each Strategy for each of the loading impairments. If the rankings for each Strategy are then averaged arithmetically, one can obtain a ranking of the Strategies for overall effectiveness in addressing all 3 of the impairments for the WMP focus area. The overall ranking of the Strategies, in order, can be found in Table VIID-2 .

**Table VIID-1. Ranked Effectiveness of Strategy for Impairments**

| STRATEGY | RANKING FOR EACH IMPAIRMENT (NR means Not Ranked for that impairment) | | | | | AVERAGE RANKING |
|---|---|---|---|---|---|---|
| | Sediment | Nut -4 yr | Nut–24 yr | Bac -4 yr | Bac-24 yr | |
| 1-all | 2 | 3 | 2 | 1 | 3 | 2.2 |
| 2A | 5 | 5 | 6 | 7 | 8 | 6.2 |
| 2B | 3 | 1 | 4 | 4 | 5 | 3.4 |
| 2C | 6 | 6 | 7 | 6 | 4 | 5.8 |
| 2D | 1 | 2 | 5 | 7 | 8 | 4.6 |
| 3 | 4 | 7 | 10 | 8 | 9 | 7.6 |
| 4 | NR | NR | NR | NR | NR | NR |
| 5 | NR | 10 | 1 | 5 | 2 | 4.5 |
| 6A | NR | 4 | 8 | 2 | 7 | 5.25 |
| 6B | NR | 8 | 9 | 3 | 6 | 6.5 |
| 6C | NR | 9 | 3 | 9 | 1 | 5.4 |

**Table VIID-2. Overall Ranked Effectiveness for Strategies**

| Overall Effectiveness Ranking | Strategy |
|---|---|
| 1 | 1 – Education |
| 2 | 2B – LOWA LILs |
| 3 | 5 – Ordinances |
| 4 | 2D – Trained Volunteer Evaluators (TVEs) |
| 5 | 6A – Pump-out Septic Tanks |
| 6 | 6C – Regional Wastewater District |
| 7 | 2C – Porous Pavement |
| 8 | 2A – Cost-share for Developers |
| 9 | 6B – Pump Don't Dump |
| 10 | 3 – Seawall/Riprap |
| NR | 4 – Extra Monitoring – Not Ranked |

Thus, according to the methodology outlined at the beginning of Subsection VII-D, Summary of Loading Effectiveness, the Education Outreach and Information Strategy 1 is ranked the most effective of all the Strategies when looking at all three loading impairments together and both the long and short term perspectives. For the rest of the Strategies to succeed, raising awareness of watershed issues and providing solutions for all stakeholders is necessary. Table VIID-2 lists LOWA LILs, the property owners' cost share incentive program, as ranking 2nd overall most effective, Ordinances are 3rd and the TVE program is 4th. Pumping out septic tanks and establishing a regional wastewater district for LOZ are 5th and 6th, respectively; and then, pervious pavement, incentives for developers, Pump Don't Dump, and encouraging the use of riprap as a shoreline stabilization treatment round out the overall effectiveness ranking. Tables VIID-1 and VIID-2 rank overall effectiveness with both a 4-year and a 24-year perspective taken into account. However, many watershed grants are mainly concerned with, and calculate load reduction estimates for a short term perspective. Tables VIID-3 and VIID-4 will rank Strategy effectiveness for the 4-year perspective by itself.

**TABLE VIID-3. FOUR YEAR RANKED EFFECTIVENESS**

| STRATEGY | RANKING FOR EACH IMPAIRMENT (NR means Not Ranked for that Impairment) | | | AVERAGE RANKING |
|---|---|---|---|---|
| | **Sediment** | **Nutrient** | **Bacteria** | |
| **1 – ALL** | **2** | **3** | **1** | **2.0** |
| **2A** | **5** | **5** | **7** | **5.7** |
| **2B** | **3** | **1** | **4** | **2.7** |
| **2C** | **6** | **6** | **6** | **6.0** |
| **2D** | **1** | **2** | **7** | **3.3** |
| **3** | **4** | **7** | **8** | **6.3** |
| **4** | **NR** | **NR** | **NR** | **NR** |
| **5** | **NR** | **10** | **5** | **7.5** |
| **6A** | **NR** | **4** | **2** | **3.0** |
| **6B** | **NR** | **8** | **3** | **5.5** |
| **6C** | **NR** | **9** | **9** | **9** |

**TABLE VIID-4. 4-YEAR OVERALL RANKED EFFECTIVENESS**

| OVERALL EFFECTIVENESS RANKING | STRATEGY |
|---|---|
| 1 | 1 – EDUCATION |
| 2 | 2B – LOWA LILs |
| 3 | 6A – PUMP OUT PROGRAM |
| 4 | 2D – TVEs |
| 5 | 6B – PUMP DON'T DUMP |
| 6 | 2a – DEVELOPER'S INCENTIVE |
| 7 | 2C – PERVIOUS PAVEMENT |
| 8 | 3 – RIPRAP |
| 9 | 5 – ORDINANCES |
| 10 | 6C – REGIONALIZED WASTEWATER DISTRICT |
| NR | 4 – MORE MONITORING |

When examining ranked effectiveness for a 4-year project as in Table VIID-4, the Education Outreach and Information Strategy again ranks most effective and is followed by the LOWA LILs program. Over the short term perspective, maintenance of septic tanks should show significant effect as should the Trained Volunteer Evaluator program. The Pump Don't Dump Strategy, the developer's incentive program, the Strategy for pervious pavement and the Riprap Strategy are all fairly closely ranked; and then Ordinances and regionalizing the lake district into one coordinated, efficient, wastewater management system come in last for the short term, even though they both ranked very high and very important for long term success at LOZ in reducing loads.

In an article entitled, "Selecting Storm water BMPs", by Jay Landers, and in coordination with the International BMP database[51], the point is made that there are many contradictions in the data on effectiveness of various BMPs which makes choosing the most effective BMP difficult. Many variables must be taken into account and appropriate BMPs need to be tailored to the area of concern. "Everyone wants a single number to say, 'Device X gets Y amount of control of a certain pollutant' … however, storm water treatment involves too many variables to be condensed that simply". A judgment must be made when there is a range of pollution control that can be accomplished or achieved. Indeed, the same can be said for BMPs that address water quality issues other than storm water control. BMPs, by their very nature, are customized for their area and can only be evaluated by considering a range of pollution control, rather than a specific number.

In this WMP, since LOWA does not have a lot of load data to work with, and since technical assistance will be needed to determine baseline load conditions, estimates for load reductions with the various Strategies are just that – estimates – and are given with a large margin of estimation.

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Even though the effect of some of the Strategies may seem small and relatively insignificant, no one Strategy can address all the impairments fully. All Strategies are needed to be working together so that the full effect of this watershed management plan can be realized.

## SECTION VIII. Financial and Technical Assistance Cost Summation

### Subsection VIII-A. Technical Assistance Costs:

Baseline Load Study – Will need to hire an entity to run the study = $75,000
2 year Load Study = $75,000
4 year Load Study = $75,000
Extra Monitoring – Will need a trained lab and field assistant = $30,000 per year
Lab and Field Assistant for 4 years = $120,000

### Subsection VIII-B. General Costs Summary

**Other expenses that will apply to all the Strategies are:**

Administrative Staffers to develop presentations, programs, workshops, and articles = $30,000 per year. Will need 2 positions = $60,000/year
2 positions for 4 years = $240,000

Attendance, mileage, etc. for training workshops and conferences:
$5000 per year
for 4 years = $20,000

Annual salary for WMP Project Director
$60,000 per year
for 4 years = $240,000

Contractual CPA 10 visits/yr @ $500/visit = $5,000/yr
for 4 years = $20,000

Office @ $1200 per month x 12 months = $14,400
for 4 years = $57,600

Supplies $5,000 per year
for 4 years = $20,000

**Summary of costs taken from Section VI:**

| BMP | per year | per 4 years |
|---|---|---|
| 1A/1B | $ 6,000 | $ 24,000 |
| 1C | 22,720 | 90,880 |
| | | |
| 2A | $110,000 | $440,000 |
| | | 2,400 |
| 2B | 48,100 | 192,400 |
| 2C | 600 | 2,400 |

| | | |
|---|---|---|
| 3 | 300 | 1,500 |
| 4 | 230,000 | 920,000 |
| | 1,250 | 5,000 |
| 5 | 30,000 | 60,000 |
| 6A | 15,750 | 63,000 |
| 6B | 1,200 | 4,800 |
| | 3,000 | 3,000 |
| | 200 | 800 |
| 6C | 3,300 | 13,200 |
| | 6,000 | 24,000 |
| **Plus Technical Assistance And other expenses:** | | |
| Training, etc. | 5,000 | 20,000 |
| WMP Project Director | 60,000 | 240,000 |
| 2 Administrative Asst | 60,000 | 240,000 |
| CPA | 5,000 | 20,000 |
| Office | 14,400 | 57,600 |
| Supplies | 5,000 | 20,000 |
| Load Studies | 45,000 | 180,000 |
| **Totals** | **$672,820** | **$2,624,980** |

## C. WMP Funding Opportunities
## Part 1: Grants
## Part 2: Fundraisers
## Part 3: Businesses & Organizations

## Part 1: Corporate and Foundation Grants:

3M Community Giving
Alcoa Foundation
Anderson-Rogers Foundation
Andrew W. Mellon Foundation

Bridgestone Firestone Trust Fund
Conservation Technology Support Program, The
Cottonwood Foundation
Environmental Support Center
Lawrence Foundation
Lumpkin Foundation
Patagonia Environmental Grant
Rockefeller Family Fund
Rohm & Haas Foundation
Rudolf Steiner Foundation
Shell Oil Company Foundation
Surdna Foundation
Swanson Family Foundation
The Turner Foundation
Tides Foundation
UPS Foundation
WalMart Foundation
Wells Fargo
Weyerhaeuser Family
William and Flora Hewlett Foundation

## Government Grants

Also see http://www.educationmoney.com/envrn_qulty.html

10.760 Water and Waste Disposal Systems for Rural Communities DEPARTMENT OF AGRICULTURE

10.761 Technical Assistance and Training Grants, RURAL UTILITIES SERVICE, DEPARTMENT OF AGRICULTURE

10.904 Watershed Protection and Flood Prevention, NATURAL RESOURCES CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE

10.906 Watershed Surveys and Planning, NATURAL RESOURCES CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE

66.418 Construction Grants for Wastewater Treatment Works, OFFICE OF WATER, ENVIRONMENTAL PROTECTION AGENCY

66.951 Environmental Education Grants, OFFICE OF ENVIRONMENTAL EDUCATION, ENVIRONMENTAL PROTECTION AGENCY

•Community Action for a Renewed Environment (CARE):
For details on list below, see: http://cfpub.epa.gov/fedfund/

Bring Back the Natives Grant Program
Clean Water State Revolving Fund
Community Development Block Grants/Entitlement Grants
Community-based Habitat Restoration Partnership Grants
Environmental Quality Incentives Program
Five-Star Restoration Program
National Fish and Wildlife Foundation Keystone Initiatives
Native Plant Conservation Initiative
Nature of Learning Grants Program
Nonpoint Source Implementation Grants (319 Program)
Partners for Fish and Wildlife Program
Public Works and Development Facilities Program
Pulling Together Initiative
Science to Achieve Results
Source Reduction Assistance Grant Program
State Wildlife Grant Program (Non-Tribal)
Targeted Watershed Grants Program
Water and Waste Disposal Systems for Rural Communities
Wetlands Reserve Program

## Part 2: Fund Raisers

### Actual:

Marathon Canoe/Kayak Paddle Race called "Two Dam Days Paddle Race" running the entire length of the Osage Arm of the Lake of the Ozarks. See Appendix H for more information.
The new LOWA Paddlers Club will support LOWA through memberships and various family oriented events.

### Possible:

Benefit Golf Outing
Restaurant Discount Contributions
Garage Sales
Silent Auctions
Contribution jars in stores
Sale of lake preservation specialty items
Cake sale
Sale of discount cards
Organization credit card issuance
See's Candy Fund Raiser

## Part 3: Local Businesses and Organizations:

All of the lake area businesses and commercial establishments have a vested interest in a healthy and vibrant Lake of the Ozarks. The following businesses have expressed a commitment to helping LOWA with workshops:
Scott's Concrete and Rice Concrete, Inc. have both expressed a desire to host a series of workshops and the accompanying test pour for pervious pavement.
Ozark Riprap expressed a desire to host one installation riprap shoreline protection workshop per year for 4 years.
Tan-Tar-A Resort has offered meeting space for LOWA's many educational outreach and information presentations and many other area resorts, such as Lodge of Four Seasons, Porto Cima, and Old Kinderhook, have donated meeting space to LOWA in the past.

LOWA is confident that as funding is established and the Strategies are implemented, many of the area businesses and citizens will step forward and offer their skills and services as inkind donations.


Figure VIII-1. LOWA Paddlers enjoying the Lake of the Ozarks.

## SECTION IX. EDUCATION OUTREACH AND INFORMATION.

**This section includes the following element of a successful watershed plan:**

**ELEMENT E – INFORMATION AND EDUCATION**

Community involvement is critical to successful watershed planning and implementation of protection strategies. Input from, information dissemination to, and education of citizens, community leaders, local government staff, and other stakeholders is a key component of the successful implementation of this watershed management plan. In Ranked Effectiveness, the Education Strategy was ranked most effective overall in reducing the nutrient, bacteria, and sediment loads to the Lake of the Ozarks at the WMP focus area.

### Subsection IX-A. Lake District Plan Committee

A committee of interested stakeholders formed shortly after the formation of LOWA with the focus of developing a watershed management plan for the Lake of the Ozarks. Because the LOZ watershed encompasses a large area over 4 counties, the committee chose the name Lake District Plan (LDP) Committee. The committee met on a weekly and semi-monthly basis for 18 months to gather data and plan the report. These meetings had the regular support of the Camden County Planning and Zoning Commission, MDNR, AmerenUE, Miller Co SWD (Soil and Water District), Morgan County, various area Chambers, and volunteers from LOWA. Updates of progress on the watershed management plan (LDP) were and still are given at each LOWA public meeting.

### Subsection IX-B. Stream Team

One way the public can get involved with LOWA's watershed management plan is to participate in a Stream Team Water Quality Monitoring (WQM) Event hosted by LOWA. Utilizing LOWA and Stream Team trained volunteers, the public is invited to come to a stream site and learn about watershed and stream health while obtaining hands-on experiences in water quality assessment. Stream Teams under LOWA can also encourage public participation through litter clean-ups and storm drain stenciling. LOWA is Stream Team # 3215 and will be monitoring specific streams within the WMP area for several reasons, including baseline measurements, monitoring the effectiveness of certain BMPs, as well as general monitoring for the benefit of public interest and awareness. The public will be encouraged to participate in all of these events.

### Subsection IX-C. Public meetings

LOWA holds public meetings at sites around the Lake at least four times a year. The meeting sites rotate around the Lake of the Ozarks in order to attract people from all different areas of the LOZ watershed. Many meetings are held at banks or resorts within the WMP focus area because that is an area of large population density and has many of the Lake's stakeholders. Each public meeting has a time for each person present to introduce himself, as well as a public forum time for comments, questions, and concerns. The meetings also feature guest speakers presenting on many and varied watershed topics

of interest to LOZ stakeholders. A few examples of topics in the recent past are a talk on E. coli and other infectious water borne diseases, zebra mussels and other invasive exotic species at the Lake of the Ozarks, results from the E. coli cove study, and what a watershed management plan will mean for the Lake of the Ozarks and its watershed. Detailed notes are taken at these meetings and the notes are published on LOWA's website at www.sosLowa.org. Local newspaper and radio stations attend the LOWA public meetings and report news and information from the meeting to their readers. The *Kansas City Star, St. Louis Post Dispatch*, and the *Chicago Tribune* have also found occasion to report on news from LOWA and the LOZ watershed. In addition, TV stations from St. Louis, Kansas City, Columbia, Jefferson City, and Springfield, as well as radio stations from these markets, have also reported on news from LOWA and the LOZ watershed.

**Subsection IX-D. Workshops**

Another way the stakeholders are informed is through a partnership with AmerenUE to present Low Impact Development (Soil Erosion) workshops to area builders, developers, architects, landscapers, students, interested citizens, and others in the building trade. These workshops present the latest in land disturbance and storm water regulations and a discussion of effective BMPs for the area. Two workshops per year are presented, one in the spring and one in the fall, to an audience of about 30 participants. In partnership with AmerenUE, LOWA plans to keep these workshops going on the same schedule for at least the next several years.

Interactive workshops to educate the public about the need for regular maintenance of septic tanks have also been developed. These workshops not only educate home owners about how their septic tanks work, but also provide discounts with a reputable septic pump out company. Eight of these workshops have been conducted, six in conjunction with grants from MDNR. The grants provided money for a meal for participants (presented at meal times to give working people a better chance to participate) as well as a discount to have a septic tank pumped out. Providing a meal also increased attendance by more than double compared to workshops without a meal provided. LOWA hopes to host more pump-out workshops similar to these in the WMP focus area in the future.

Also coming up, LOWA plans to host workshops for putting rain barrels together from parts, rain barrel installation and rain garden design and creation. Some of the workshops will be held inside, like putting a rain barrel together or designing a rain garden. However, some workshops will be held on location, at sites where rain barrels will be installed and/or rain gardens will be dug and planted, and these workshops on site will be "working" workshops where neighborhood volunteers will actually put the rain garden(s) or rain barrel(s) in place with help and guidance from LOWA volunteers.

**Subsection IX-E. Schools**

LOWA has presented Earth Day Clean Water Celebrations for to the 5$^{th}$ graders of the School of the Osage for the past 3 years to a total of about 160 students each year. In

addition, last year, LOWA organized a water quality monitoring event on the Osage River just below Bagnell Dam for the 170 high school Environmental Science students, also from School of the Osage. Clean Water events and presentations for school children about watershed health and water quality issues are very important to LOWA. Educational events for school children will continue and be expanded in the 2009-2010 school year and keep expanding for years to come to eventually include students from all the school districts within the dam-to-dam LOZ watershed.

**Subsection IX-F. Media Coverage**

Announcements of upcoming events and meetings are made by the area's local newspapers and radio stations. The Executive Director of LOWA holds interviews with the local radio stations, participates in call-in talk shows, and presents PSAs for the local cable TV on all kinds of watershed issues of public concern, like the E. coli testing program conducted by MDNR every year in the coves of the Lake of the Ozarks. Future use of media coverage will include regular articles and input on watershed related issues in the community. LOWA plans to continue fostering good relationships with all media, not only with regard to this Watershed Management Plan, but for all future outreach and educational events.

**Subsection IX-G. Website**

LOWA maintains a website at www.soslowa.org to help communicate effectively with the public on upcoming events and issues and has recently begun a Facebook site. The LOWA website provides archives of notes from all public meetings, descriptions of the working committees of LOWA, links to sites about other area watershed issues (like the quarry blasting near a lake area's wastewater treatment plant issue), and links to other agencies and watershed groups that also provide watershed information. The LOWA website also provides citizens with opportunities to be placed on LOWA's master email list to receive LOWA meeting announcements, minutes, and notice of other events, comment on LOWA projects and events, as well as to contact LOWA officers.

**Subsection IX-H. Festivals and Events**

LOWA also provides education outreach and information to LOZ stakeholders through participation in Lake Area festivals and events. Displays and booths highlighting watershed issues, as well as LOWA programs and projects, are presented by LOWA volunteers at events such as the Fall Festival in Osage Beach and the Shoot-Out at Captain Ron's in Sunrise Beach. And, LOWA will be hosting the annual Two Dam Days Paddle Race and will have clean water festival events at the beginning, middle, and at the end of race locations. The race itself will be a major public outreach event that will hopefully become a well-known national event. The first Two Dam Days Paddle Race will be held September 25 and 26, 2010.

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Figure X-1. LOWA volunteers at a MO Stream Team water quality monitoring event on the Little Niangua, a tributary of the Lake of the Ozarks.

Figure X-2. Paddlers on the lake.

**XI. Appendices**

## Appendix A. Summaries of Historical Studies on the Lake of the Ozarks

### August 1985
### An Engineering Geologic Approach to Evaluating Groundwater and Surface-water Contamination Potential at Lake of Ozarks, Missouri

By: James E. Vandike, John W. Whitfield, Donald H. Meir, and Cynthia Endicott
This is a Missouri DNR report which discusses the geology of the Lake of the Ozarks region and the fact that its' nature is such that on-site waste water systems present probems of inadequacy.

### May 1996
### A Report of the Technical, Political, and Regulatory Issues Regarding Wastewater Disposal at Lake of the Ozarks

By Thomas M. Utterback and Edward Edgerley
Report to the Lake Group for Clean Water and Economic Development
This report was a review of the existing water quality studies, the Missouri regulatory scheme, technological literature and specifications, limited inspection of on-site treatment facilities at the Lake, and of discussions with various officials and resource people, and members of the Lake Group. The report presented recommendations and also provided extensive attachments including:

**The 1992 Department of Natural Resources Report on Water Quality at the Lake** and
**The DOH Survey on Well Water Quality**

### November 1996
### Joint Resolution of Camden, Miller, Morgan, and Benton Counties

This resolution appointed a task force to study and recommend a procedural and substantive process to result in the franchising of one or more regulated utilities for the provision of clean drinking water, wastewater collection and treatment; and authorizing the task force to negotiate and draft interim regulations with all appropriate state agencies.

### May 1999
### Lake of the Ozarks Water and Wastewater Conceptual Plan Prepared for the Lake Group Task Force by HNTB Corporation

This exhaustive engineering report includes recommendations, the most significant of which stated:

"8. To best serve the diverse population of the area it is likely that the most cost effective water and wastewater approach will be to use centralized systems in combination with decentralized systems. In addition, it is anticipated that a systematic management approach will be needed to ensure proper operation of the on-site wastewater systems."

## 2000
## Management Plan for Lake of the Ozarks Camden, Morgan, Miller, and Benton Counties
## By Greg Stoner, Fisheries Management Biologist

The purpose of this plan is to provide direction, continuity of effort, and a comprehensive source of past and present management efforts and observations to future managers of Lake of the Ozarks. The time period covered by this plan will be approximately 10 years. The goal is to manage Lake of the Ozarks in a manner which will maximize public use, enjoyment, and awareness, while at the same time ensuring long-term quality of the resource for future generations. This report focuses on managing the fishery of LOZ.

## Jan 2002
## Historical Water Quality Study – Osage Project
## Prepared for: AmerenUE by:
## Duke Engineering & Services, Inc. .-- Portland , Maine

Duke Engineering & Services, Inc. (DE&S) was contracted by AmerenUE to conduct a study on historical water quality and this report documents the results of that study. This report consists of six major sections addressing issues of concern or requests for information. (total length of the report is 151 pages)

## MAY 1985
## Limnological Characteristics of the Main Channel and Nearshore Areas of Lake of the Ozarks , Missouri
## By Jeffrey D. Mitzelfeld

This research by Mitzelfeld in the early '80s clearly showed that on-site wastewater treatment posed a health-hazard to recreational users at the Lake of the Ozarks . His recommendation at that time was that wastewater be treated in a centralized plant and that effluent from said plant be discharged below the dam. Whether because of his recommendation or not, the cities of Lake Ozark and Osage Beach have followed those recommendations and a great deal of the urban load on the Lake of the Ozarks was thus removed. The city of Camdenton followed suit with a centralized plant and the cities of Laurie and Gravois Mills are not far behind. Much progress has been made since this study of about 25 years ago.

Notes of Special Interest:
During the course of this study which ranged 1981-1982, the mean fecal coliform concentration in the most highly developed coves was 50 times the mean concentration of that in the main channel.

The highly developed coves exceeded the state standard for recreational waters two-thirds of the sampling times. The number of times a cove exceeded the standard was in proportion to the degree of cove development.

Reference as far back as 1972 is provided showing that elevated fecal coliform concentrations result due to storm events.

During this study, large increases were noted in fecal coliform concentrations in developed coves following each of fhe season's three main holidays.

Fecal coliform concentrations were also higher immediately after the weekend.

There were occasions when, in undeveloped coves, anchored house-boats near the sampling station resulted in fecal coliform concentrations as high as 364 ml/200 ml whereas sampling stations at other locations in the cove showed no such increase.

To protect the health of the public, the author recommended that wastewater be treated in a central wastewater treatment plant and discharged below the lake. The author further states that for those areas in which discharge beyond the lake's whatershed is not possible, then the discharge should be to the middle of the main channel.

A copy of the abstract as presented in the thesis follows:

**Abstract:**

*"Lake of the Ozarks is a large main stream reservoir located in the Ozark Plateau of west central Missouri . The reservoir attracts an extensive tourist population and, thus, a great deal of recreational development surrounds the lake. The main purpose of this study was to determine if this development affects the water quality of the nearshore waters as measured by trophic status and fecal coliform concentrations. Twenty-nine coves representing a range of development from no development to intensive development and located in the Grandglaize-Turkey Bend region of the lake were selected for study.*

*The results of the study revealed that nearshore waters had more eutrophic characteristics as development of the adjacent watershed increased. Although differences in trophic status were small, they were consistent. Similar comparisions of fecal coliform data showed large increases in concentrations (up to 50 times) with increases in development. Fecal coliform concentrations were also fuund to be related to population of the lake area as measured indirectly by road use data. Fecal coliform concentrations were observed to increase dramatically during weekends and holidays when the tourist population was also higher.*

*This study has shown that current sewage treatment methods are not totally effective in the removal of nutrients and pathogenic organisms. If current trends in increased development continue, alternative methods of sewage treatment must be implemented if further degradation of the nearshore waters is to be avoided. Additionally, collection of*

*fecal coliform samples for purposes of water quality monitoring may need to be scheduled during weekends or holidays in order to protect the large number of people using the lake area during these periods."*

## MAY 2009 – O'Hearn Thesis

**NUTRIENTS, CHLOROPHYLL AND BACTERIAL FECAL INDICATORS IN COVES AND OPEN WATER AREAS OF LAKE OF THE OZARKS, MISSOURI by REBECCA O'HEARN**
**A Thesis presented to the Faculty of the Graduate School at the University of Missouri-Columbia In Partial Fulfillment of the Requirements for the Degree Master of Science, May 2009**
Request has been made to the university for permission to provide a link to this thesis. Only the notes below are available at this time:
O'Hearn Thesis—notes by a layman
In these notes, abbriviaions are used thourghout as follow:
TP - total phosphorus
TN – total nitrogen
Chl – chlorophyll concentration
FC- Fetal coliform concentration
EC- E-coli concentration
BT- Bacteroides thetaiotaomicron, an organism found only in the human gut
Note: the test used here for BT was DNA based and showed only presence or absence
Notes from the thesis:
Human Activities Effect:
Relationships between anthropogenic (human influences) metrics ( measurable elements) and water quality variables (TP, TN, Chl, FC and EC) were not apparent.
Proximity to Dam a Factor:
Values of all constituents tested decreased as proximity to the dam increased.
Factors Affecting Values—Rain and wind speed::
Other factors being equal, wind speed (and its accompanying wave action) had the greatest influence on ec and fc whereas rain events significantly increased these values.
Human Activities Did Affect BT Occurrence:
BT, an organism specific to the human gut, did not respond as the above, but…"…BT was positively related to a surrogate for anthropogenic activity among daily means."
BT Could Be Marker for Human Waste Contamination Whereas EC or FC Cannot:
"These results indicate 1) conventional fecal indicators (FC and EC) often represent bacteria from soil erosion and sediment resuspension. Factors controlling these processes often dilute or obscure anthropogenic influences, and 2) relationships between BT and anthropogenic factors are not obscured by hydrologic and climatic processes, which allows detection of anthropogenic influences during circumstances when conventional fecal indicators (FC and EC) fail to detect them."
Prior Researcher Found Development Areas Higher in FC than non-developed:
Mitxelfelt in 1981 to 1984 study found that coves had greater fecal coliform than main channel and that the fecal coliform in the coves increased as a function of the degree of cove development.

BT an exclusive human gut resident:
New research has documented Bacteroides thetaiotaomicron is largely an exclusive human gut resident and does not replicate in external environments.
RESULTS:
TP varied (over a 28 year period) in direct proportion to dam discharge.
As in prior studies, TP and TN decrease (even in the coves) as Dam proximity increases.
Nutrients nor Chl correlated with anthropogenic activity.
Heavy rain increases FC and EC (Aug 20 of 07 collection after 2.9 inches rain greatly increased the FC and EC). But BT was un-affected.
FC and EC in the Osage Arm were, on average, 4 times higher in the coves than in the main channel.
FC and EC were both higher in main channel coves than in the Grand Glaize coves but no difference was seen in BT counts.
FC and EC, like the nutrients, decreased with proximity to the Dam, but this relationship was not seen for BT
BT was increased as "metrics" decreased (metrics include "land area", "water area", and cove perimeter.
FC and EC correlated with one another (avg of 2 to 3 FC per EC) and inversely with Secchi depth.
If FC and EC are present, but BT is not, contamination is from non-human source (or source is not of recent origin); of the samples which exceeded stream effluent standards for EC, only one third contained BT. But on average, the BT counts increased as the FC and EC increased.
What was most compelling was the positive relationship between BT and traffic volume despite record discharge rates, high inflow, possible dilution from increased pool level, and wind speed. (traffic volume was measurement of vehicles on Hwy 54 at a specified point on a Friday prior to holiday weekend vs that on a normal week-day)
More than 3/4ths of samples showing FC/EC did not show BT:
. In 2007, FC (262 detections) and BT (46 detections) were detected concurrently in 36 of 311 samples (12%). E. coli (291 detections) and BT were detected concurrently in 41 samples (13%). Therefore, 226 FC positive samples (73%) and 250 EC positive samples (80%) may have represented non-human sources of bacterial contamination or naturalized FC and EC bacteria of anthropogenic origin.
State Park cove showed contamination:
"…While anthropogenic influence was not apparent in individual coves because main channel hydrology dominated cove characteristics, Cove 33 mid-reach in the Grand Glaize Arm study area was the exception. Cove 33 was undeveloped and located in a state park. This watershed, however, contains a discharge lagoon that treats septic waste from park visitors (Figure 3, Appendix 5). In 2007, this cove had the largest nutrient, Chl, and EC means of any cove on the Grand Glaize Arm study reach. The largest BT frequency also occurred in Cove 33, which confirmed there was anthropogenic loading of nutrients and EC."

**APPENDIX B.** ***Brush Creek Mid-Shed Project Low Impact Development Evaluation System for Cost-Share Program;*** **Platte Land Trust; July, 2005.**

# Brush Creek Mid-Shed Project

# Low Impact Development Evaluation System

# For Cost-Share Program

July 2005

Platte Land Trust
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## *Project Information*

The Platte Land Trust, a local organization working to preserve key natural areas, has been awarded a grant from the Missouri Department of Natural Resources' Section 319 Clean Water Act funding to study conditions along Brush Creek and develop stream protection strategies. The primary objective of the Brush Creek Mid-Shed project (Project) is to minimize the impacts to Brush Creek from the rapid land development within the area. The project does not have the authority or desire to impede development, but rather to assist landowners, developers, and local government with new technologies that can help minimize the damage to the stream's natural resources.

The Project also includes a cost-share incentive program that encourages best management practices (BMPs). Through this aspect of the project, a Low Impact development (LID) concept will be used to reduce pollution and improve conventional development practices. Additionally, using stormwater management technologies that are 'Low Impact' will aid in the prevention of area flooding, damage to infrastructure due to erosion, and loss of the stream's natural riparian corridor.

## *Cost Share Program Eligibility*

The Low Impact Development Evaluation System is a tool the Project will use to determine which developments in the area demonstrate adequate stream protection strategies and provide minimal environmental impacts to Brush Creek. To be eligible for cost-share funds, developments must be located within the Mid-Shed project area of the Brush Creek Watershed (HUC 10240011). The Mid-Shed project area encompasses approximately 2400 acres. The project area begins just north of the intersection of Highway 152 and Interstate 435, continuing south along I-435 to just south of its intersection with Highway 45. Developers, builders, home and/or property owners, and local governments that demonstrate low impact BMPs for protection of Brush Creek are all eligible to submit a development project for evaluation.

Development projects will be reviewed and evaluated on a first come, first served basis. Cost share will be awarded to those that rank within the Platinum, Gold, Silver, and Bronze scoring ranges, as indicated on the '% Cost Share Eligibility' Table at the end of the scoring criteria and calculation sheet. Total funding availability will be determined annually, and subject to availability of Project funds. Interested parties should contact the Project Coordinator before completing the evaluation criteria to determine funding availability.

## *Cost Share Program Process*

The Brush Creek Mid-Shed Project Cost Share Program will generally follow the below steps
:

| Process Step | | Applicant | PLT/Project |
|---|---|---|---|
| *1* | Indicate interest | X | X |
| *2* | Examine LID BMPs and site design options | X | X |
| *3* | Develop site design | X | |
| *4* | Evaluate design using LIDES | X | |
| *5* | Verification of preliminary LIDES score | | X |
| *6* | Develop site, implement LID BMPs | X | |
| *7* | Field verification* of LID BMPs | | X |
| *8* | Determine final LIDES score and % cost-share eligibility | | X |
| *9* | Provide documentation for eligible expenses | X | |
| *10* | Reimbursement at % cost share eligibility | | X |

*The Project may conduct site visits before, during, and post-construction to verify LID Evaluation System criteria requirements as necessary.

## *Cost Share Eligible Expenses*

Eligible cost-share expenses include the costs associated for the installation, supplies, and/or design of LID BMPs (structural or non-structural), subject to approval by the Platte Land Trust and the Missouri Department of Natural Resources, according to Section 319 funding requirements. Section 319 cost-share funding may not be used for drainage, dredging, or flood control projects; large equipment purchases; NPDES required practices; permit fees of any type; and land acquisition.

Structural BMP (see Terms and Definitions) eligible expenses include supplies and/or installation costs. For example, both the purchase of permeable pavement and installation costs are eligible for cost share. Documentation accepted for cost share reimbursements include receipts for supplies and invoices for installation cost.

Due to the nature of non-structural BMPs (see Terms and Definitions), which have no physical construction costs; the Project will share costs for site design. The project recognizes that more planning and design is necessary to implement these types of BMPs, such as less onsite grading, leaving existing vegetation, reducing street widths, etc. Documentation accepted for cost share reimbursement for this type of BMP includes invoices for site design services such as consulting fees, design charrettes, engineering design fees, etc.

The applicant is responsible for obtaining pre-approval for any costs that would be part of a cost-share reimbursement request. The Platte Land Trust reserves the right to deny reimbursement requests for cost-share that have not been pre-approved and do not provide adequate documentation. The Platte Land Trust will be responsible for ensuring

all reimbursement requests are compliant with Section 319 guidelines and reporting responsibilities.

## *Low Impact Development*

Low Impact Development is an ecological friendly approach to site development and storm water management that aims to mitigate developmental impacts to land, water, and air. The approach emphasizes the integration of site design and planning techniques that conserve the natural systems and hydrologic functions of a site. The overall goal is to mimic a site's pre-development hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to its source.

Although the term 'low impact development' can be loosely defined, the appropriate definition of LID is distinct and should not be confused with other stormwater management and development strategies. The key distinction of LID from these other strategies is that it is an ecosystem based approach. LID seeks to design the built environment to remain a functioning part of an ecosystem rather than exist apart from it. LID is not a land use control strategy and relies more heavily on smarter and advanced technologies than it does on conservation and growth management. The LID approach includes five basic tools:

1) encourage conservation measures
2) promote impact minimization techniques such as impervious surface reduction
3) provide for strategic runoff timing by slowing flow using the landscape
4) use an array of integrated Best Management Practices (BMPs) to reduce and filter runoff
5) advocate pollution prevention measures to reduce the introduction of pollutants to the environment

***LID Benefits***

In addition to the practice just making good sense, LID techniques can offer many benefits to a variety of stakeholders. A few of the benefits for the environment, municipalities, and developers are listed below.

- <u>Developers</u>
  - Reduce land clearing and grading costs
  - Reduce storm water management costs
  - Potentially reduce infrastructure costs (streets, curbs, gutters, sidewalks)
  - Potentially increase lot yields
- <u>Municipalities</u>
  - Reduce municipal infrastructure and utility maintenance costs (streets, curbs, gutters, sidewalks, storm sewers)
  - Increase collaborative public/private partnerships
  - Balance growth needs with environmental protection
  - Protect regional flora and fauna
- <u>Environment</u>
  - Reduce impacts to local terrestrial and aquatic plants and animals
  - Protect water quality by reducing sediment, nutrient, and toxic loads
  - Preserve integrity of ecological and biological systems
  - Preserve trees and natural vegetation

- Increase lot and community marketability

Overview of the Evaluation System

The Brush Creek Mid-Shed Project would like to acknowledge that these evaluation criteria have been based in part upon The Conservation Fund's Conservation Development Evaluations
System (CeDES) and the Saginaw Bay Watershed Initiative Network's (SBWIN) Conservation Development Recognition Program (References A and B).

The evaluation criteria are designed for rating new residential or commercial Low Impact and/or conservation developments. The system recognizes that each development has site-specific limitations that are taken into consideration during the planning and design phase. Furthermore, each criterion to be evaluated may not apply to every development. The criteria are feature-oriented; points are awarded or deducted for satisfying a specified criterion. Ideally, each criterion will be related to an accepted industry standard. The scoring system is based on the premise that developments should meet certain protective measures. Positive points will be awarded to developments that employ practices that go beyond basic measures to minimize impacts on water quality and natural resources. Negative points will be assessed for aspects of developments that do not meet basic protection measures. Examples of negative practices include encroachments into wetlands or 100-year floodplains with fill or structures. A total of 18 points are available under the Evaluation Criteria, with four categories of recognition.

Platinum LID Development – 14-18 Points
Gold LID Development – 9-13 Points
Silver LID Development – 5 – 8 Points
Bronze LID Development – 1 - 4 Points

The Project has identified three critical areas that need to be considered in a development that protects the environment and enhances the overall quality of life. Project members will rate each development based on its ability to achieve LID principles. The areas to be evaluated are as follows:

- Site Design/Innovation and Construction
- Storm Water Management
- Protection of Natural Resources

The evaluation criteria are intended to provide a tool that the project and its stakeholders can use in determining the extent that a development protects and enhances the Brush Creek watershed and its habitat. It shall be maintained and updated by the project Steering Committee.

The criteria do not address all of the issues that are important to achieving sustainable development. Although the Project supports infill development and the redevelopment of brownfield sites, these criteria have not been designed to achieve these broader goals.

Terms and Definitions

**Best Management Practices (BMPs):** ***stormwater management and conservation practices that have been demonstrated to effectively control movement of pollutants, prevent degradation of soil and water resources, and that are compatible with the land use. BMPs can be divided into two categories: structural and non-structural.***

- **Structural BMPs** ***can be thought of as engineering solutions to stormwater management (Ex. stormwater ponds and open channels).***
- **Non-structural BMPs** ***have no physical structures, but are designed to limit the amount of pollutants available in the environment that would potentially end up in stormwater runoff. Non-structural BMPs can be achieved through such things as education, management, and development practices. Some examples include ordinances and practices associated with land use and comprehensive site planning.***

*Conventional Development*: the term used to describe typical development practices in the community. Conventional land development typically involves removing vegetation, compacting the soil, and putting in large areas of impervious surfaces. Further, conventional practice collects and conveys stormwater runoff through storm drains and pipes to a centralized, manmade stormwater facility to manage stormwater flow and remove pollutants.

*Impervious Surface*: a surface which does not easily allow the infiltration or penetration of water. During rainstorm events, a large percentage of water will runoff. Examples include roof tops, paved walks, roadways, driveways, sidewalks, etc.

*Low Impact Development (LID)*: an ecological friendly approach to site development and storm water management that aims to mitigate developmental impacts to land, water, and air. The approach emphasizes the integration of site design and planning techniques that conserve the natural systems and hydrologic functions of a site.

*Natural Resource Assessment*: an evaluation of onsite and area natural resource assets and ecological features. Assessments may involve both the compilation of existing information and the acquisition of new information.

*Natural Resource Protection Plan:* a defined long-term strategy for protecting onsite natural assets and ecological features.

*Pervious Surface:* a surface which allows infiltration or penetration of water. During rainstorm events a percentage of water will infiltrate into the surface with the remaining storm water running off. The percentage runoff is dependent on the type, slope, percent saturation, etc. of the surface. Examples include lawns, farm fields, parks, wooded areas, golf courses, etc.

Evaluation Criteria

The applicant's development will be rated according to its degree of compliance (on a percentage basis) with the scoring system listed below. Each development will be judged on the following core criteria.

Please circle the appropriate response. Use the comment section after each criterion to elaborate on your response. If a criterion does not apply, explain why.

## 1. Site Design/Innovation and Construction Practices

### 1A: Amount of Impervious Surfaces Relative to Conventional Development

Rationale: The greater the area of impervious surface, the greater the volume and level of contamination of water runoff and the lower the infiltration for natural replenishment of groundwater. The criterion is also an indicator for the decrease in nutrient loadings, which have been proven to correlate well with percent impervious surfaces.

Measurement: The percent decrease in street, sidewalk, and driveway surfaces compared to local conventional designed developments. The conventional design impervious rating for residential and commercial developments within the Project area is 30% and 50%, respectively.

(Note: Heavy turf grass areas like ball fields and golf courses are virtually impervious in most parts of the region. Because of our heavy clay soils, the combination of the compaction from the grading and the shallow roots of the grass mean that very little water actually soaks into the ground in these areas)

Scoring:

| Points | Determination |
|---|---|
| -2 | No decrease |
| -1 | 5% decrease |
| 0 | 10% decrease |
| +1 | 15% decrease |
| +2 | 25% decrease |
| X | Does not apply |

Comments: _____

Calculation: Total acres deemed impervious/ Total acreage of site

**1B: Preservation of Natural Features/Land Form Change**

Rationale: Generally, the less disturbance there is, the lower the impact of the development on water quality and natural resources. This criterion is intended to measure the disturbance of the land during construction.

Measurement: Relative levels of cutting and filling.

Scoring:

| Points | Determination |
|---|---|
| -2 | Mass disturbance/grading, more than 80% of site |
| -1 | Significant/large contiguous areas of grading, 50%-80% of site |
| 0 | Minimum cut and fill, grading areas between 30%-50% of site |
| +1 | Grading <30% of site, cut and fill depth and area minimized |
| +2 | No cut and fill, grading only of foundations and streets |
| X | Does not apply |

Comments: _____

**1C: Sediment and Erosion Control**

Rationale: Minimizing erosion and other sediment transport during and immediately after construction minimizes a major source of damage to water quality, watersheds and ecological health.

Measurement: Relative to use of sediment and erosion controls. The local soil erosion enforcement agency will be consulted by the Project to evaluate this criterion.

Scoring:

| Points | Determination |
|---|---|
| -2 | Ineffective application of soil erosion control measures |
| -1 | Required construction erosion controls in place, but failing |
| 0 | Required construction controls in compliance and monitored |
| +1 | Required construction erosion controls exceeded |
| +2 | No visible soil loss observed |
| X | Does not apply |

Comments: _____

_____

_____

_____

## 2. Storm Water Management

### 2A: Runoff Rate

Rationale: Reducing the velocity of runoff from a development site by retaining more on-site and allowing it to infiltrate naturally, allows more runoff to infiltrate, and reduces erosion and downstream pollution.

Measurement: Rate of runoff as compared to immediately prior pre-development land use conditions for the 10-year design storm using locally approved stormwater runoff models (Ex. TR-55). *Please provide support for your response.*

Scoring:

| Points | Determination |
|---|---|
| -2 | >15% increase in runoff rate |
| -1 | 0%-15% increase in runoff rate |
| 0 | No increase in rate of runoff |
| +1 | 0%-5% decrease in runoff rate |
| +2 | >5% decrease in runoff rate |
| X | Does not apply |

Comments: _____

_____

_____

_____

## 2B: Runoff Volume

Rationale: Reducing the total volume of runoff from a development site, by retaining more on-site and allowing it to infiltrate, reduces erosion, sedimentation, and other impacts on surrounding bodies of water. Reduction in runoff volume may be attained by many methods including grass swales, buffers, reduction of impervious surfaces, on-site detention, infiltration basins, etc.

Measurement: Volume of runoff as compared to immediately prior pre-development land-use conditions for the 10 year design storm using locally approved stormwater runoff models (Ex. TR-55). *Please provide support for your response*.

Scoring:

| Points | Determination |
|---|---|
| -2 | >15% increase in runoff volume |
| -1 | 0%-15% increase in runoff volume |
| 0 | No increase in runoff volume |
| +1 | 0%-5% decrease in runoff volume |
| +2 | >5% decrease in runoff volume |
| X | Does not apply |

Comments: _____

_____

_____

## 2C: Storm Water Collection System

Rationale: How storm water is captured, conveyed, stored and treated before it is released affects water quality and infiltration.

Measurement: General design parameters of storm water collection, detention, and treatment systems.

Scoring:

| Points | Determination |
|---|---|
| -2 | Curb and gutter, conventional dry detention pond |
| -1 | Curb and gutter and wet detention pond |
| 0 | Vegetated open channels (grass swales, ditches),created wetland |
| +1 | Vegetated open channels, created wetland with vegetated filters |
| +2 | Vegetated open channels, infiltration devices, wetland treatment, or Stormwater Recycling (ponds, rain barrels, rain gardens, etc) |
| X | Does not apply |

Comments: _____

_____

## 3. Protection of Natural Resources

### 3A: Development of Natural Resources Protection Plan

Rationale: A site's entire set of resources needs to be considered holistically and protected in an integrated manner.

Measurement: Degree of natural resource-based site planning and long term protection.

Scoring:

| Points | Determination |
|---|---|
| -1 | No natural resource (NR) protection plan or assessment |
| 0 | NR assessment conducted, but no significant linkage to site design |
| +1 | NR assessment conducted, natural areas linked into continuous open space system |
| +2 | NR assessment conducted, natural areas linked, permanent protection of natural areas/open space (Ex. easements, restrictive covenants) |
| X | Does not apply |

Comments: _____

_____

**3B: Buffering of Streams, Wetlands, Streambeds, Mature Forests and Other Sensitive Features**

Rationale: Generally, buffering surface waters and other sensitive features on a site minimizes the environmental impact of a development on those features.

Measurement: Extent and type of buffer used at site.

Scoring:

| Points | Determination |
|---|---|
| -2 | Permanent building on stream banks, lake shores, or filled wetlands. |
| -1 | Significant disturbance during construction without restrictions. |
| 0 | Buffer meets local minimum standards. |
| +1 | Minimum 75 foot buffer designed to maximize protection (Ex. Planted with appropriate native vegetation) |
| +2 | Minimum 75 foot buffer, with buffer maintenance and ecological management plan in place. |
| X | Does not apply |

Comments: _____

_____

_____

**3C: Tree and Vegetation Conservation**

Rationale: Generally, if mature trees and/or other vegetation exist on the site, preserving them lowers the impact of the project on local ecosystems.

Measurement: Loss of mature trees or other vegetated cover.

*Note*: Prior to development, an analysis will need to be undertaken to determine the percentage of the site that is covered by existing foliage. After the infrastructure has been installed and buildings are in place, another analysis will need to be made to ascertain how much of the existing foliage remains.

Loss of foliage means loss of mature tree cover or prairie, not low quality brush.

Scoring:

| | **Existing Tree/Vegetated Cover on Site** | | | |
|---|---|---|---|---|
| Points | **10-35%** | **35-50%** | **50-75%** | **75-100%** |
| -2 | loss > 10% | loss>30% | loss>50% | loss>70% |
| -1 | loss 0-10% | loss 20-30% | loss 30-50% | loss 60-70% |
| 0 | no net loss | loss 0-20% | loss 10-30% | loss 50-60% |
| +1 | no absolute loss | no net loss | loss 0-10% | loss 40-50% |
| +2 | no absolute loss, with add'l planting | no absolute loss | no net loss | loss <40% |
| X | Does not apply | | | |

Comments: _____

_____

_____

References


A. Conservation Development Evaluation System. Version 12.17.99. The Conservation Fund, Great Lakes Office.

B. Conservation Development Recognition Program. Saginaw Bay Watershed Initiative Network. January 11, 2000.

Calculation Sheet

**1. Site Design and Construction Practices**

**1A.** _____
**1B.** _____
**1C.** _____

**Total Points:** _____

**2. Storm Water Management**

**2A.** _____
**2B.** _____
**2C.** _____

**Total Points:** _____

**3. Protection of Natural Resources**

**3A.** _____
**3B.** _____
**3C.** _____

**Total Points:** _____

**Grand Total Points:** _____

Total points available = 18

Platinum LID Development – 14-18 Points
Gold LID Development – 9-13 Points
Silver LID Development – 5 – 8 Points
Bronze LID Development – 1 - 4 Points

| **%Cost Share Eligibility** | | | | | |
|---|---|---|---|---|---|
| **Evaluation Score** | **Eligible % Cost-Share** | **Maximum Cost-Share Funding** | | | |
| | | **Sites ≤1 acre** | **Sites >1 to ≤5 acres** | **Sites >5 to ≤20 acres** | **Sites >20 acres** |
| Platinum (14-18) | 75% | Up to $2000 | Up to $5000 | Up to $20,000 | Up to $50,000 |
| Gold (9-13) | 60% | Up to $1500 | Up to $3500 | Up to $12,500 | Up to $35,000 |
| Silver (5-8) | 50% | Up to $1000 | Up to $2000 | Up to $7,500 | Up to $20,000 |
| Bronze (1-4) | 25% | Up to $500 | Up to $1000 | Up to $5000 | Up to $10,000 |

**APPENDIX C – SMYN YARD CERTIFICATION CHECKLIST**

# Show-Me Yards & Neighborhoods (SMYN)

## Show-Me Yards & Neighborhoods – Yard Certification Checklist

Does your yard measure up?

**Show-Me Yards & Neighborhoods (SMY&N) honors model landscapes as certified Show-Me Friendly Yards and provides a Show-Me Yard sign to those homeowners.**

To be certified as a Show-Me Yard, your landscape must:
Collect at least 36 inches on this Yardstick Checklist
Receive full points for practices marked with 2 asterisks**
Receive partial credit for practices marked with 1 asterisk*
Comply with all existing codes and laws

### Mowing for a Healthier Environment

Mow lawns high to encourage a deeper, more drought and pest tolerant root system.** 2”
Sharpen mower blades monthly so grass blades heal and recover. 1”
Lawn mower engine serviced twice annually to reduce emissions contributing to air pollution.* 2”
Use an electric lawn mower instead of one powered by gasoline. 4”

### Water Efficiently

Irrigate lawn and landscape only when they wilt. Apply < ¾ inches of water per application. 3”
*For a yard that uses an irrigation system (in-ground or hose-end sprinklers):*
Calibrate irrigation/sprinkler system to apply < 3/4 inches of water.** 3”
Put a rain gauge in your yard to track irrigation amounts.** 2”
Install a rain shut-off device for in-ground irrigation systems.** 2”
Make sure irrigation system waters lawn areas separately from plant beds. 2”
Use drip or micro-irrigation in plant and flower beds. 2”
*For a yard that does not use an irrigation system:*
Design and maintain a landscape that exists predominantly on rainfall once plants are established. 6”

### Mulch

Maintain a 2 – 3” layer of organic mulch over tree roots, shrubs and plant beds, leaving a 2-inch space between the plant base and the mulch.* 2”
Create self-mulching areas under trees where leaves can remain as they fall. 1”
Use by-product mulches or recycled mulches. 1”
Replenish mulch once or twice a year to maintain 2-3” depth. 1”

### Recycle

Whenever possible, recycle grass clippings by allowing them to remain on the lawn. 2”
Use leaves and pine needles found in your yard as mulch. 2”
Create and maintain a compost pile with yard clippings, leaves, kitchen scraps, etc. 3”

## Wildlife

Plant vines, shrubs, and trees that provide cover, nesting areas or food sources for birds, butterflies and other wildlife. 3”
Provide a water source, such as a bird bath or a small pond for wildlife. 1”
Provide wildlife shelters such as a bat house, bird house, brush pile, etc. 1”
Identify five kinds of wildlife (insects, reptile, birds, etc.) that live in your yard. 2”

## Yard Pests

Treat only affected plants or lawn areas with pesticide applications. Avoid indiscriminate spraying.** 3”
Check your landscape every 1 – 2 weeks for signs of problems. 2”
Learn to identify 5 beneficial insects that provide natural control of harmful pests. 2”
Use environmentally friendly pesticides such as horticultural oils and insecticidal soaps. 2”
Use non-chemical approaches to pest controls, such as pruning off affected areas, hand removing insects, etc., whenever possible. 3”

## Right Plant – Right Place

Ensure that your landscape does not contain plants identified by legal code as invasive exotics such as kudzu, privet, and wintercreeper.**
Replace problem-prone plants with low maintenance native or non-native species. 2”
Group plants according to their water and maintenance needs. 2”
Determine how much grass you need for children, pets, and recreation. Replace the rest with low maintenance ground covers, shrubs, mulch, or other porous surfaces. 3”
Use trees and shrubs to shade southern and western walls of home and air conditioner compressor. 1”
Use deciduous trees on southern exposures to allow the sun to passively heat your home in winter. 1”
Reduce yard waste by choosing plants that will not require frequent pruning at maturity. 1”
Preserve native plants when building on a new site. Maintain a protective “do not disturb” barrier under the dripline of trees. 3”

## Fertilizing

Fertilize as needed to maintain quality of lawns and landscape plants.* 2”
Use natural organic or other slow release fertilizers.* 2”
Use iron instead of nitrogen to make your lawn green during the summer. 1”

## Stormwater Runoff

Direct downspouts and gutters to drain onto the lawn, plant beds, or containment areas.* 1”
Plant groundcovers or use mulch on thinly vegetated areas to decrease erosion.* 2”
Use mulch, bricks, flagstones, gravel, or other porous surfaces on walkways, patios or drives. 1”
Collect and use rainwater to irrigate plants. 2”
Create swales or terracing to catch and filter stormwater. 3”
Pick up after pets to reduce bacterial and nutrient pollution in stormdrain systems. 2”
Clean up oil spills and leaks using cat litter on driveways. 2”
Sweep grass clippings, fertilizer, and soil from driveway onto lawn. Remove trash from street gutters. 2”

## On the Waterfront

Remove invasive exotic aquatic plants by cutting, pulling or raking. Remove dead plant material from water after using herbicides to reduce pollution. 2”
Establish a border of low maintenance plants between your lawn and the waterline to absorb nutrients and to provide wildlife habitat.** 2”
Establish a 10 – 30 foot “no fertilizer” zone along the waterline.* 2”
Where feasible, plant native vegetation in the zone along the waterfront. 4”

TOTAL INCHES _____

**Please return to:**

Choose Environmental Excellence
c/o Barbara Lucks
840 Boonville Avenue
Springfield, MO 65802

Name _____

Address _____

_____

Phone Number _____

# APPENDIX D. ACTION PLAN FOR THE MANAGEMENT OF WASTEWATER AT THE LAKE OF THE OZARKS

## LAKE OF THE OZARKS
### The Pollution Problem

Combinations of problems combine to impede area-wide application of modern sewage treatment technology. The crisis is not occasioned by local recklessness or abject ignorance. There are efforts everywhere. The pace and magnitude of development, limited options, and past concentration on local solutions have allowed the problem to overtake customary solutions. ***With approximately 30,000 on-site septic systems along the 1,150-mile shoreline, as baby boomers take up full-time residency in these homes, the water quality could be seriously at risk***. The purpose here is to present a suggestion worthy of support by all.

Leaders - local, county, state and national, have not yet marshaled their talents and resources in a cooperative effort for a comprehensive solution. Leaders have not yet joined to present a solution truly ideal and acceptable to all.

Local, municipal, or district plants provide solutions in limited areas, but comprehensive local public sewage treatment is stymied by the combination of costs.

Areas that can afford collection cannot afford a treatment plant. A recent example is Rocky Mount, a community that tried to use excess capacity of a neighboring community plant, but such use was denied.

Areas that provide treatment cannot allow use of excess capacity by neighbors. Lake Ozark/Osage Beach is an example. Peak demands during the lake "season" discourage providing excess capacity use to neighbors. Much of the lake area is relegated to methods of treatment, e.g. septic tanks and lateral fields, which become ineffective and unreliable over time and demand endless policing.

Shoreline and near shoreline septic tanks and fields stretch along 1,150 miles – a distance longer than the shore line of California. For years, responsible engineering studies have cautioned that the local geology - weathered carbonate bedrock - and the lake slopes limit on-site waste disposal and result in migration from septic tanks and fields to degrade **both** ground water tapped incessantly for individual shallow wells **and** the lake.

Understanding the problem, the task is to propose an effective solution that should be acceptable and embraced by all, including MDNR – one that enables local entities with their own choices of organizations and professionals to attend to their own problem. Endless regulations, threatened enforcement, and attention to local solutions only, for 70 years, have not kept up with the task.

It may be true here, as Winston Churchill once reportedly joked, "Americans always do precisely the right thing - **after -** they have tried absolutely everything else."

It is suggested that there is a good mutually acceptable solution but that it will not be embraced by all and cannot be achieved until local, county, state and national officials **and** local leaders marshal the support, talent and ability of all - to frame and apply an area-wide solution.

## IS THERE A PROMISING SOLUTION?

**The solution must be one that supplements and enables local entities and developers to provide local solutions, and is worthy of enthusiastic support from the governor and the missouri dnr.**

**Can sewage be delivered to the spokes of a "spokes-hub" system for treatment at reasonable cost, to lessen the burden on all local entities and permit reliable termination of pollution of the environment?**

**It appears that the answer is YES, *if* all cooperate and come together to make it occur.**

1. **EPA FUNDING OF HUB TREATMENT PLANTS "HUBS" AND COLLECTION "SPOKES".** Because of the threat to the environment, drinking water and lake water quality, as well as public health, a comprehensive area-wide system of centralized treatment plants (hubs) and limited collection mains (spokes) should be constructed, through EPA funding. Local, county, state, and national leaders must join to encourage EPA participation. EPA provided the initial funding for the Lake Ozark and Osage Beach plant and systems. An area-wide solution is an even more effective approach.

2. **TO ENABLE LOCAL ENTITIES TO BUILD COLLECTION FACILITIES, THE ENTIRE COST OF TREATMENT CANNOT BE CHARGED BACK TO THE LOCALITY**. For the concept to work, much of the cost of the hub-spoke systems could be paid by the fairest financing tax of all - a sales tax in the lake region to be used solely for this purpose. Any solution must encourage rather than burden local governments. It must ease the burden on local entities. It must enable local entities to pursue their projects with their own professionals, rather than burden or usurp their efforts with additional endless regulations, planning, supervision and interference. **The concept demands legislation to permit a local referendum for such a sales tax.** Passage of such an issue will not occur unless leaders at all levels join forces to explain and encourage the solution.

3. **OPERATION OF HUB/SPOKE SYSTEMS. A 2007 improvement in the law authorizes organization of an area common service district whose function can be to operate such hubs and spokes to provide wastewater treatment to all local municipalities, districts, developments, etc. who need to be relieved of the economic burden of**

**providing for both collection and treatment.** Such an entity would simply reduce the burdens on local entities and not interfere in the planning, engineering and financing of local entities. Existing plants may well minimize construction of rare excess capacity capital improvements by accessing the spokes for disposition of peak demands.

## IMPLEMENTATION

Coordination with EPA, the legislature, the Governor, DNR, and local officials and professionals must be undertaken to further develop the concept, the service entity, proposed financing methodology, and to provide recommendations and proposed legislation promptly. If the concept is a good one, it should be worthy of true support at both local and the highest levels, and local leaders should not be bashful about requesting that all join hands.

# APPENDIX E. DETAILED LOAD CALCULATIONS

**Subsection VII-A:**
The average of seasonal geometric means for ISS at Site 3 over a 4-year period. (These figures have a significant correlation with the amount of discharge from Truman Reservoir.

Table App E-1:

| YEAR | SEASONAL GEOMETRIC MEAN |
|---|---|
| 2005 | 1.0 mg/L |
| 2006 | 0.4 mg/L |
| 2007 | 1.4 mg/L |
| 2008 | 1.8 mg/L |
| AVG | Arithmetic average = 1.15 mg/L |

**Subsection VII-B:**
Nutrient load calculation details using the Storm Water Manager's Resource Center's Simple Method to Calculate Urban Loads[29].

**Calculating Loads for Nutrients**

An estimated pollutant load for chemical constituents is a product of annual runoff volume I and pollutant concentrations, where the annual load (L) is equal to the product of a coefficient (in this case, 0.226), the annual runoff I, the pollutant concentration I, and the area of the land involved (A).

$L = 0.226 \times R \times C \times A$

R = annual runoff
C = pollutant concentration (mg/L)
A = area (38,500 acres for the WMP focus area)

At this point, R, annual runoff, is an unknown, but can be calculated:

Annual runoff is calculated as the product of runoff volume and a coefficient where

$R = P \times Pj \times Rv$

P = annual rainfall (41 inches/year for the WMP focus area)
Pj = fraction of annual events that produce runoff (usually 0.9)
Rv = runoff coefficient

The runoff coefficient, Rv, is an unknown but can be calculated using a measure called impervious fraction, Ia, based on the amount of impervious cover.

$Rv = 0.05 + 0.9(Ia)$

Ia = impervious fraction

Impervious fraction is based on the amount of impervious cover in the area being studied. Impervious fraction is calculated by multiplying the percent of impervious cover of different land uses by the percent of total watershed each land use takes up. Table AppE-2 shows the type of land use and the % of impervious cover for that land use. Table AppE-3 shows the type of land use and the % of the watershed that land use takes up. And, figure VII-B-1 is a map showing a close-up of different land uses in the WMP focus area. This map in figure VII-B-1 shows the densely packed residences, resorts and marinas nestled within wooded and vegetated areas, helping to explain the relatively low percentage given in the CARES map labeled figure II-E-1and its accompanying legend. This shows a break down of different land uses for the WMP focus area. This map and chart called the residential areas "urban" and showed about 16.5% of the total 37,475 acres to be labeled as urban. The author of this load calculation will take this estimate of 16.5% urban and call that to be about 1/10 actual city type/commercial and urban environment and the remaining 9/10 of the 16.5% to be densely packed residential areas of about 1/3 acre lots on average. Other land use percentages were based on figure II-E-1 and percentages were adjusted to reflect percent of land acres without the lake acres. Table AppE-2 was developed from a chart from the U. of Delaware, Water Resources Agency in their *Guide to Natural Resources Planning*[52] and a similar chart developed by Cloud for her masters thesis and published by the U. of Delaware, Water Resources Agency[53].

**Table AppE-2. Type of land use and % impervious cover**

| Land Use | % Impervious Cover |
|---|---|
| **Commercial and business district** | **85** |
| **Industrial** | **72** |
| **Residential – 1/8 acre or less lot size** | **65** |
| **Residential – 1/4 acre** | **38** |
| **Residential – 1/3 acre** | **30** |
| **Residential – 1/2 acre** | **25** |
| **Residential – 1 acre** | **20** |
| **Residential – 2 acres** | **12** |
| **Mobile Home Parks** | **50** |
| **Transportation – roads, streets, etc.** | **75** |
| **Agricultural** | **3** |
| **Undeveloped** | **0** |
| **Forest** | **0** |
| **Water** | **100** |
| **Barren – rock outcrops, beaches, etc** | **10** |
| **Mixed Urban/Built up** | **80** |
| **Marinas/docks** | **90** |

**Table AppE-3. % Area for each Land Use**

| Land Use | % Area |
|---|---|
| **Commercial/Business** | **2.3** |
| **1/3 acre lot** | **21.0** |
| **Agriculture/grasslands** | **8.5** |
| **Undeveloped/Forest** | **68.2** |

Table AppE-3 uses the land use charts for the WMP focus area that accompany figure II-E-1 to estimate the percent area for the major land uses in the WMP focus area.

Using data from Tables AppE-2 and 3, the impervious fraction, Ia, can be calculated. Table AppE-4 shows the calculation of % Land Area for that land use times % Impervious Cover for that land use. When those calculations are added, one gets the Impervious Fraction for the entire area of concern, i.e., the WMP focus area.

**Table AppE-4 – Impervious Fraction Calculation**

| Land Use | % Land Area | % Imp Cover | Impervious Fraction |
|---|---|---|---|
| **Commercial/Business** | **2.3** | **85** | **1.955** |
| **1/3 acre Residential** | **21.0** | **30** | **0.063** |
| **Agriculture/Grasslands** | **8.5** | **3** | **0.00255** |
| **Undeveloped/Forest** | **68.2** | **0** | **0.000** |
| **Total** | **100** | | **1.99** |

Table AppE-4 shows that, taking into account the different land uses and how much of the land area each use takes up, the Ia, or Impervious Fraction, for the WMP focus area is 1.99.

When the calculated figure for Ia is then inserted into the equation for Rv, or the runoff coefficient, we get

$Rv = 0.05 + 0.9(Ia)$
$Rv = 0.05 + 0.9(1.99)$
$Rv = 1.84$

The Runoff Coefficient, Rv, is then inserted into the equation for Annual Runoff or

$R = P \times Pj \times Rv$
$R = (41 \text{ inches/year}) (0.9) (1.84)$
$R = 67.9 \text{ inches/year}$

Now that R is known, the estimated load for different nutrients and pollutants can be calculated. This set of calculations will use the 2008 TP, TN, ISS, and TSS values for LOZ at site 3.

Calculating an annual load for phosphorus, using the Simple Method to Calculate Urban Loads, as discussed above, where L = annual phosphorus load,

$L_{phos}$ = 0.226 x R x C x A
$L_{phos}$ = (0.226) (67.9 inches/year) (0.041 mg/L) (26,435 acres)
$L_{phos}$ = 16,632 pounds/year = Annual load of Phosphorus

Calculating an annual load for nitrogen, using the Simple Method to Calculate Urban Loads, as discussed above, where L = annual nitrogen load,

$L_{nit}$ = 0.226 x R x C x A
$L_{nit}$ = (0.226) (67.9 inches/year) (0.679 mg/L) (26,435 acres)
$L_{nit}$ = 275,440 pounds/year = Annual load of Nitrogen

The parameters, ISS and TSS, are not really nutrients and are more related to the total sediment load. Sediments do carry nutrients and so calculating ISS and TSS loads is helpful in determining current loads and future load reductions for sediments. As sediment loads and ISS and TSS values decrease, one would expect a corresponding reduction in nutrient loads.

Calculating an annual load for ISS, using the Simple Method to Calculate Urban Loads, as discussed above, where L = annual pollutant load,

$L_{ISS}$ = 0.226 x R x C x A
$L_{ISS}$ = (0.226) (67.9 inches/year) (1.8 mg/L) (26,435 acres)
$L_{ISS}$ = 730,180 pounds/year = Annual load of ISS

Calculating an annual load for TSS, using the Simple Method to Calculate Urban Loads, as discussed above, where L = annual pollutant load,

$L_{TSS}$ = 0.226 x R x C x A
$L_{TSS}$ = (0.226) (67.9 inches/year) (4.1 mg/L) (26,435 acres)
$L_{TSS}$ = 1,663,188 pounds/year = Annual load of TSS.

**Calculating Loads of Wastewater Effluent**

Loads for waste water are calculated below using a method from Schultz and Summers Engineering[54] to determine loading on the lake from a waste water perspective:

Assume that a) the two HUC's represent about 30% of the lake's developed shoreline; b) the average lakeshore property is 100 feet; and c) the lake has 1,150 miles of shoreline.

30% of 1,150 miles is 345 miles of shoreline in the WMP area
345 miles times 5,280 feet/mile times 1 home/100 feet gives about 18, 216 homes.

If each home generates 250 gallons of waste water per day, the calculation comes out to 4,554,000 gallons per day for a total load per day. Take that times 365 days per year and one gets an annual loading of 1,662,210,000 gallons or about 1.66 billion gallons of waste water.

This loading calculation does take into account resorts as well as full time residents and part time residents and this same calculation is used by engineering firms in their design calculations for WWTPs.

If one gallon of water weighs 8.35 lbs, then 1.66 billion gallons of water weighs almost 14 billion lbs. ($1.66 \times 10^9$ gallons/year x 8.35 lbs/gallon = $13.86 \times 10^9$ lbs/year) If one knew the phosphorus and nitrogen loads coming into the lake with the effluent from the WWTPs, then one could add the wastewater load for a pollutant with the urban storm water calculated loads to get a closer indication of the total nutrient and pollutant loads going into the WMP focus area.

As a side note, the Osage Beach Regional Wastewater Treatment Plant does not empty any effluent into the Lake of the Ozarks. All of its effluent goes into the Osage River below Bagnell Dam. That being said, Plant Manager Gary Hutchison stated that his plant removes 99+ % of the substances found in the influent. They test for ammonia nitrogen on a weekly basis and that comes out at less than 0.05 mg/L regularly. Phosphorus was tested for on 9/29/2009 and the TP value was 0.092 mg/L (compared to the LOZ standard of 0.026 mg/L for LOZ).

**APPENDIX F. LOWA MAIN BROCHURE, VERSION 2.0**
**( page 1 of 2 )**

## Elements of LOWA

### LAKE DISTRICT PLAN (LDP)/LID

LOWA will be working with various city/ county planning officials, governmental agencies and other organizations in the 4 County Lake District to address water quality, growth and development issues in order to maintain our beautiful landscape and quality of life. LOWA will be partnering with Ameren UE to co-host a series of workshops for local architects, builders, and landscapers focusing on how to meet the demands of growth while protecting our water quality.

### OUTREACH/EDUCATION

Environmental Education is our priority. We plan to coordinate fun community events, as well as events held in cooperation with the school districts in our four county area. Our goal is for all of our citizens to learn about the Lake of the Ozarks watershed and what we can do to protect it.

### RECYCLING

LOWA is assisting in the establishment of a lake wide collection and recycling program. The fully implemented program would involve collection points available to all lake area residents as well as tourists and second home owners. The full program would entail collection, removal, sorting and packaging for resale to manufacturing companies. Recycling benefits everyone from the original user to the recycling company and the down line remanufacturer as well as savings in utility bills for everyone.
To find the latest information on recycling at the Lake or a drop off location near you, visit: www.soslowa.org, click on elements of LOWA, then recycling.

*For more information, Please visit*
**www.soslowa.org and click on the individual elements and programs of LOWA**

## Elements of LOWA

### WATER QUALITY

Activities of the Water Quality Committee are aimed at assisting the Department of Natural Resources in the development of a long-term water sampling program at the Lake. Samples will be collected from 100+ sites annually from a variety of locations throughout the reservoir. This testing will be conducted to monitor trends in E-Coli levels.

### WASTE WATER

The Wastewater Committee is dedicated to working with the community, the Missouri Department of Natural Resources (DNR), the Environmental Protection Agency (EPA), as well as local agencies in all four counties. The object is to address wastewater management and to help protect human health and the environment.


### LAKE SAFETY

Lake Safety will team with the Water Safety Council and other organizations promoting programs to make Lake of the Ozarks a Safer Boating Lake. Some examples are to promote the importance of wearing life jackets, launch a Designated Captain on Board Program, provide safety tips and simple "Rules of the Water" education for safer navigation, ensuring a great experience for all.

### STREAM TEAM

Missouri Stream team is a volunteer citizens organization that monitors the health of the state's rivers and creeks. Stream Teams test the biological diversity and the water quality of the creeks and streams. They also help the Missouri Department of Natural Resources (DNR) maintain a data base of the health of our state's waters.

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LOWA is pla
gallons of eff
Sign up today
a discount. Ju
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Lake Area

Adventure
Blue Moon M
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# LOWA MAIN BROCHURE ( page 2 of 2 )

## LOWA MEMBERSHIP

*It's easy to join LOWA Online at soslowa.org ~ You can use paypal*

- ❑ Water Quality
- ❑ Lake District Plan (LDP/LID)
- ❑ Waste Water
- ❑ Recycling
- ❑ Lake Safety
- ❑ Education/Outreach
- ❑ Stream Team
- ❑ Membership

Name _____

Address _____

City, State, Zip _____

Phone _____

E-Mail _____

❑ Resident Home Owner ❑ 2nd Home Owner

*Your tax deductible donation will help ensure clean water for you, your children, your grand-children for generations to come.*

*You Can Help, Join LOWA TODAY!*

- ❑ $1000 - Lake
- ❑ $500 - Main Channel
- ❑ $250 - Arm
- ❑ $10 - Bucket (Kids)
- ❑ $100 - Branch
- ❑ $50 - Cove
- ❑ $25 - Spring
- ❑ Extra Donation $_____

With membership, you will receive a membership card, membership decal, discounts from local merchants and services, plus a forum for your voice to be heard.

❑ Inform me via email of upcoming events.

Contact Us: LOWA
P.O. Box 836
Sunrise Beach, MO 65079-0836
Phone: (573) 374-8360
www.soslowa.org

## Our Lake, One Voice!

### Mission Statement

***Citizens will preserve, protect and improve the Lake of the Ozarks, its watershed and natural resources while maintaining our economic, social and environmental health.***

### Are You Interested In?

Sharing Watershed Education?

Waste Water Program?

Lake Safety?

Improving Water Quality?

Promoting Low Impact Development?

Joining a Stream Team?

Recycling?

Lake District Planning?

*If so, then join LOWA today!*

Register on the web or use the Membership form in this brochure. If any questions, please contact us.

www.soslowa.org

LOWA
P.O. Box 836
Sunrise Beach, Missouri 65079-0836

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# APPENDIX G. LOWA PUMP OUT BROCHURE, 2007 (page 1 of 2)

## LOWA MEMBERSHIP

*It's easy to join LOWA Online at soslowa.org ~ You can use paypal*

- ❑ Water Quality
- ❑ Lake District Plan (LDP/LID)
- ❑ Waste Water
- ❑ Recycling
- ❑ Lake Safety
- ❑ Education/Outreach
- ❑ Stream Team
- ❑ Membership

Name _____

Address _____

City, State, Zip _____

Phone _____

E-Mail _____

❑ Resident Home Owner ❑ 2nd Home Owner

*Your tax deductible donation will help ensure clean water for you, your children, your grand-children for generations to come.*

*You Can Help, Join LOWA TODAY!*

- ❑ $1000 - Lake
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❑ Inform me via email of upcoming events.

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Phone: (573) 374-8360
www.soslowa.org

## NEW BOATER EDUCATION LAW

All persons born after January 1, 1984, who operate any vessel on the lake in the State of Missouri must have on board, their boating safety identification card issued by the Missouri State Water Patrol (MSWP) along with a photo I.D. The card is obtained by successfully completing a boating safety course approved by the MSWP. The boating safety identification card requirement also applies to nonresidents. Nonresidents may obtain a 30-day non-renewable temporary permit.


## LIFE JACKETS (PFD)

All vessels 16 feet in length or longer must carry one wearable U.S. Coast Guard-approved PFD (life jacket) for each person on board or being towed. Vessels less than 16 feet in length must carry one wearable or one throwable Type IV USCG approved PFD for each person on board the boat or being towed.

Under Missouri State Law, children under 7 years of age must wear a USCG -approved PFD at all times while on board any vessel.

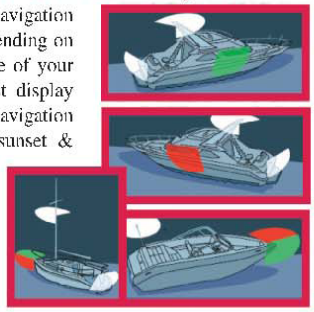
One USCG-approved Type IV personal flotation device must be on board vessels 16 feet or longer and readily accessible, in addition to the above requirement.

Each person riding on a Personal Water Craft (PWC) must wear a USCG-approved type I, II. III, V PFD with impact rating.

## NAVIGATION LIGHTS

*For boats 40' or less under power*

The required navigation lights differ depending on the type and size of your vessel. You must display the required navigation lights between sunset & sunrise and during time of restricted visibility.



## SOUND-PRODUCING D

*Lake of the Ozarks is a federally c*

- Vessels less than 65.6 feet (20 mete includes PWC's, are required to carry or horn or some other means to mak signal that are audible for at least one-
- Vessels that are 65.6 feet (20 meter are required to carry on board a whist that are audible for at least one mile.

## SOUND SIGNALS

Changing Direction:

- One short blast tells other boaters " on my port (left) side."
- Two short blasts tell other boaters " on my starboard (right) side."
- Three short blasts tell other boaters

Restricted Visibility:

- One prolonged blast at intervals of minutes is the signal used by power underway.
- One prolonged blast plus two shor of not more than two minutes is the si vessels.

## DIVER DOWN FLA

The law requires divers and snorkel flag. Must be 12" x 16" in size and mu radius of flag. No boats within 50 yar down flag requires all boats in the v speed within 50 yards of the boat. Fla 360 degrees.


## CARBON MONOXIDE POI

*what you can't s*

The U.S. Coast Guard wants you to k

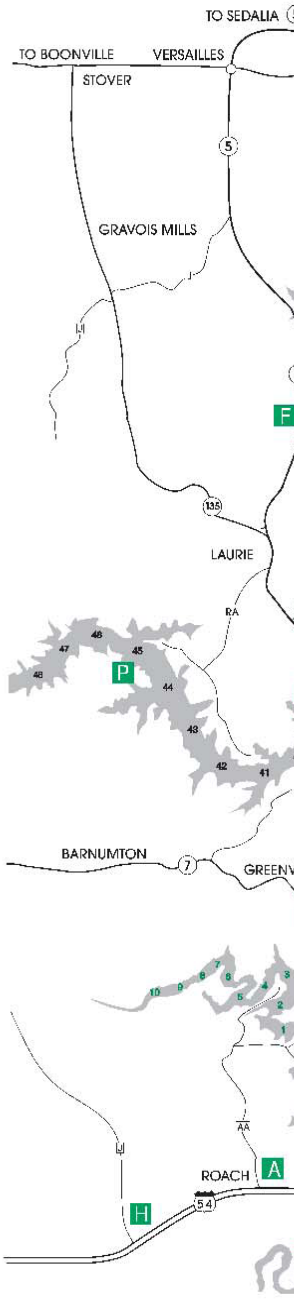
- CO can harm and even kill you, ins boat.
- CO symptoms are similar to seasick intoxication.
- CO symptoms can affect you wheth underway, moored, or anchored.
- You cannot see, smell or taste CO, exhaust fumes, CO is present.
- CO can make you sick in seconds. concentrations, even a few breaths ca

*...CO poisonings are preventabl*

**LOWA PUMP OUT BROCHURE (page 2 of 2)**

# BOAT WASTE WATER PUMP OUT STATIONS
# LAKE OF THE OZARKS

| Map Location | Marina Name | Land Location | Phone Number | Water Location |
|---|---|---|---|---|
| A | Adventure Marina | Rocky Mount | 573-964-1999 | mm05 |
| B | Aqua Moon Marina and Boat Works | Eldon | 573-365-0781 | mm03 |
| C | Blue Moon Marina | Osage Beach | 573-348-3178 | mm20 |
| D | Dave Hungenast Motorsports Marina | Osage Beach | 573-348-2321 | mm01 |
| E | Glencove Yacht Club | Lake Ozark | 573-365-3355 | mm01 |
| F | Glencove Marina | Lake Ozark | 573-365-4001 | mm03 |
| G | Glencove Yacht Club Marina | Osage Beach | 573-348-2296 | mm21 |
| H | Harbour Marina | Gravois Mills | 573-372-6200 | mm5.5 |
| I | Kelly's Port Marina | Osage Beach | 573-348-4700 | mm19.5 |
| J | Lighthouse Marina | Sunrise Beach | 573-374-5256 | mm39 |
| K | Lodge of Four Seasons Marina | Lake Ozark | 573-365-3000 | mm13 |
| L | Marina & Resort at Toad Cove | Lake Ozark | 573-365-5500 | mm07 |
| M | MarineMax at Lake of the Ozarks | Lake Ozark | 573-365-5382 | mm17 |
| N | Mariners Pier 31 Marina and Restaurant | Camdenton | 573-873-5283 | mm31 |
| O | Millstone Marina | Laurie | 573-372-6272 | mm07 |
| P | The Moorings Yacht Club | Osage Beach | 573-216-3140 | mm02 |
| Q | Porto Cima | Lake Ozark | 573-365-8531 | mm16 |
| R | Silver Sands Resort | Sunrise Beach | 573-374-6820 | mm38.5 |
| S | Tan-Tar-A Marina | Osage Beach | 573-348-3131 | mm26.5 |
| T | Village Marina | Lake Ozark | 573-365-1800 | mm03 |
| U | Westport Yacht Club | Gravois Mills | 573-372-6112 | mm05 |
| V | Wheel House Marina | Lake Ozark | 573-365-6077 | mm04 |
| W | Yacht Haven Marina | Lake Ozark | 573-365-5333 | mm01 |



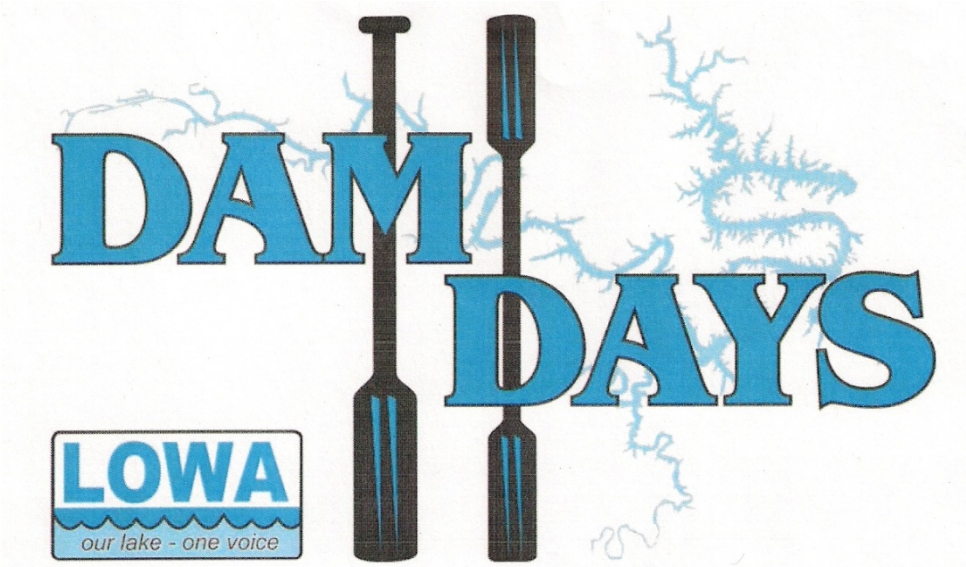

This brochure layout and information a courtesy of LOWA, printed in cooperation with Ameren UE

MISSION STATEMENT
Citizens will preserve, protect and improve the Lake of the Ozarks, its Watershed, and natural resources while maintaining our economic, social and environmental health.

Website: www.soslowa.org
P.O. Box 836
Sunrise Beach, Missouri 65079

Ameren UE

## APPENDIX H. TWO DAM DAYS MARATHON PADDLE RACE FLYER




September, 25th and 26th, 2010
Lake of the Ozarks
www.soslowa.org

### A two day paddle race on the entire Osage Arm of Lake of the Ozarks.

Saturday, September 25th, racers will start at Drake Harbor in wonderful Warsaw, MO, and grind it out for more than 60 miles to the Stage One finish line at Captain Ron's near the 34 mm of the Osage Arm.. After a good night of rest, Stage Two will be a 34 mile shootout from Captain Ron's to Iguana Watersports near Bagnell Dam.

- Racers will compete for thousands in Prize Money with more sponsors coming aboard daily!
- Proceeds benefit LOWA, an investment in a healthy Lake of the Ozarks. The Lake of the Ozarks Watershed Alliance is a 501(c)(3) Non-Profit Organization.

### Recreational Division

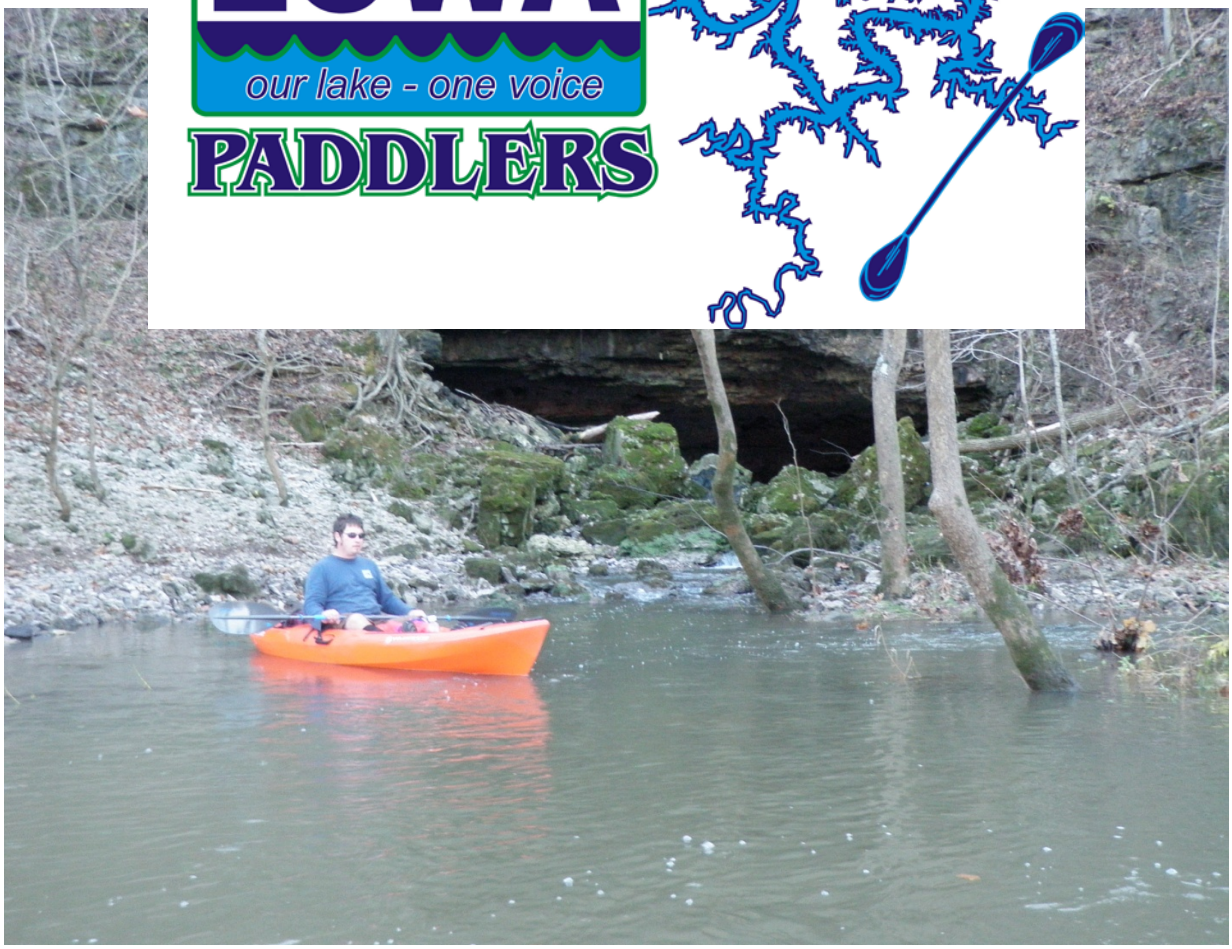
The notion of paddling 100 miles in two days sounds a bit extreme to most people. We will have a recreational division for the weekend warrior, with a shorter course starting at a yet to be determined location. Paddlers in this division will make it to Captain Ron's in plenty of time to get the Clean Water party started. Enjoy awesome food from the Captain's kitchen as well as great drinks and live entertainment. Great prizes from local business partners will be awarded to the winners of this division during the festivities. Registration, as well as rules and other information for both divisions will open soon at www.soslowa.org .

Exhibition space for the event is being made available, on a first come first served basis, for businesses and organizations that would like to showcase their products and services to a responsible, outdoor oriented, paddling community. For more info call Donna at (573) 434-4400, or Kevin at (573) 280-7446.

LOWA

our lake - one voice

PADDLERS



## Join the LOWA Paddlers Club!

LOWA invites you to be a part of the fun side of watershed management. LOWA Paddlers, a great way to be a part of a healthy Lake of the Ozarks. LOWA Paddlers seek to enhance everyone's enjoyment of our great lake and it's tributaries by working with state agencies and private landowners to improve access and water quality issues. As a Paddle America Club of the American Canoe Association, http://www.americancanoe.org, we draw upon the strength and knowledge of the nation's oldest and most respected paddling organization. Benefits include members only access to special paddling events, discounts on ACA membership, as well as a 10% club discount at Oz Cycles and Kayaks, http://www.oz-cycles.com, the Lake Area's only quality bike and boat shop. Don't own a canoe or kayak? Ozark Expedition Outfitters, http://www.oe-outfitters.com/ has plenty of sturdy rental boats available to our members at discount rates. Join us in making the Lake of the Ozarks region a paddler's paradise. Sign up at www.sosLOWA.org.