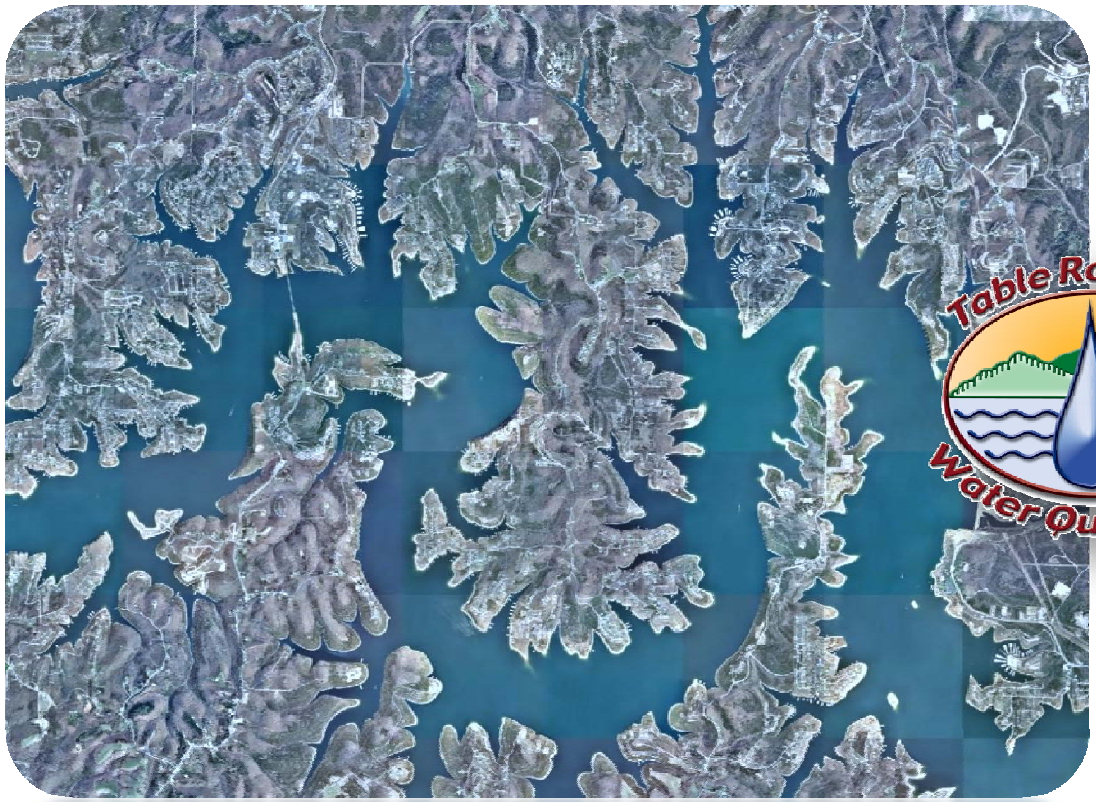
Western Table Rock Lake Watershed Management Plan



Tammy Trantham
Education & Outreach Director

Gopala Borchelt
Executive Director

July 9, 2012

The Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under Section 319 of the Clean Water Act. G10-NPS-06

STATE OF MISSOURI Jeremiah W. (Jay) Nixon, Governor • Sara Parker Pauley, Director
DEPARTMENT OF NATURAL RESOURCES
www.dnr.mo.gov

November 26, 2012

Mr. Richard Meyerkord, President
Table Rock Lake Water Quality, Inc.
P.O. Box 606
Kimberling City, MO 65686

RE: Department of Natural Resources Acceptance with Conditions of the Western Table Rock Lake Watershed Management Plan

Dear Mr. Meyerkord:

The Missouri Department of Natural Resources (Department), Water Protection Program's nonpoint source staff and Watershed Management Plan (WMP) Review Committee have reviewed your WMP for Western Table Rock Lake watersheds (Hydrologic Unit Codes (HUCs) 110100011204, 110100010801, 110100010803, 110100010804, 110100011202, 110100011203, 110100010806, 110100010805, 110100010807, 110100011107, and 110100010808). Staff reviewed the WMP to ensure that all nine critical planning elements required by the Environmental Protection Agency (EPA) were addressed. Elements that were considered during the evaluation process included: land use and sources of impairment, expected load reduction described, proposed management measures, technical and financial assistance, information/education and public participation, implementation schedule and milestones, load reduction evaluation and a monitoring component.

After carefully reviewing the document, it is our opinion that your plan does address, to particular extent, each of the required elements and it meets some of the basic requirements established by EPA. Time constraints associated with the grant did not allow for the final revisions that were needed. Nonetheless, the Department did not want to deny the efforts of the process up to the end of the subgrant. Therefore, we are accepting this plan with conditions, as outlined in this letter. The Department requests that any future revisions of this plan consider the following conditions as recommended by the Department's WMP Review Committee and EPA to address the following concerns:

- Element A1 (Sources of impairment are identified and described): All sources of impairment are not identified and not at a detailed HUC 12 scale. The WMP is missing the Carlisle 2003 reference in the list of reference.
- Element A2 (Specific sources of impairment are geographically identified): In regards to the sources, using ArcGIS to draw a 1,500-foot buffer and outlining city boundaries does not identify the main sources of nutrient impairment. The watersheds' major land uses of agricultural and forest need to be addressed since the significant sources of loading may be coming from agricultural land, forests, road ditches, etc. Some studies show that agriculture

might be a greater contributor to nutrients in these watersheds. Some clustered areas on the shoreline might have failing on-site waste systems. Approximate number and location of failing waste systems seem critical to writing an implementation plan.

- Element A3 (Pollutant loads area attributed to each source of impairment and quantified): A detailed assessment is a necessary component for implementation planning of best management practices (BMPs). Loading from specific critical areas can be roughly estimated as part of an assessment. Currently, due to the lack of water quality standards, adding an explanation from Table Rock Lake Water Quality, Inc. would help explain the reasoning for the current lack of pollutant loads. Load reduction targets needs to be identified for each pollutant source.
- Element B1 (Load reductions achieve environmental goal): Load reductions for some agricultural practices have been estimated by universities or agricultural agencies. Expected load reductions should be explained, reasons for the percentage, and BMP area needed for load reduction goal. Need more specifics about what these percentages mean.
- Element B4 (Data sources and/or modeling processes are accurate and verifiable, assumptions can be reasonably justified); C1 (Specific management measures are identified and rationalized): Providing a bit more information on the future BMPs and focusing on expanding the list beyond rain gardens, information and educational events, and demonstrations. The load reductions will have to be adjusted and calibrated for each type of BMP implemented, e.g., a rain garden vs. a land applied mature to pasture areas. Creating a more defined implementation plan with costs, commitments, schedules, and BMP numbers and size, and locations will create an ease in applying for future funding from various sources and implementation of the BMPs. Management measures are not well researched. Provide more information on areas that the counties, cities, foresters, agricultural producers are willing to implement. These entities' practices may have bigger bang for the buck and leveraging opportunities.
- Element D5 (Economic and environmental benefits are discussed and weighed against implementation costs): More discussion on the economic and environmental benefits vs. implement costs; however, it is understandable that it depends on the partners to do the cost-share.
- Element G (A description of interim, measurable milestones for determining whether nonpoint source management measures or other control action are being implemented): The WMP should focus on all cost-share available, not just Environmental Quality Incentives Program. The schedule, timeline, interim measures, and milestones were not well connected and streamlined into one cohesive table. The plan lacked a comprehensive section describing the relationship between these items. The milestones identified should relate to the entire area of the eleven HUCs in this plan and the BMPs needed to reduce loads to the desired levels.
- Element H3-5 [Interim water quality indicator milestones are clearly identified; Criteria include both quantified measures of implementation progress and pollutant reduction; and qualitative measures of overall program success (including public involvement and buy-in)]: Discuss more on these sub-elements. Data should also include the Arkansas side of the lake.

Your organization is to be commended for taking the initiative to start this challenging project. The development of a WMP using a locally led process demonstrates the importance of citizen involvement as we address the water quality issues of Missouri. The plan should be revisited on a regular basis and revisions made as new information becomes available to keep the plan current. A Department fully-accepted plan puts your organization and other partners in a better position for potential future funding opportunities as you begin or continue to implement the plan. This plan is Department conditionally-accepted and more detail is still needed to achieve full adequacy and effectively compete for 319 Nonpoint Source Grant funds. To ensure that any watershed partners that might use this plan or wish to revise it are aware of the necessary revisions, please insert a copy of this letter at the front of all copies that are distributed.

Thank you for allowing us the opportunity to comment on your WMP. A copy will be forwarded to EPA Region 7. If you have any questions or would like additional information, please do not hesitate to call Valerie Hentges or me at (573) 751-7144, or by mail at Missouri Department of Natural Resources, Water Protection Program, P.O. Box 176, Jefferson City, MO 65102.

Sincerely,

WATER PROTECTION PROGRAM

Greg Anderson
Nonpoint Source Coordinator
Watershed Protection Section

GA:vhd

ACKNOWLEDGEMENTS

Table Rock Lake Water Quality thanks many people for taking the initiative in collaborating with us and providing advice, information and assistance toward completing the Table Rock Lake Watershed Management Plan. By attending stakeholder meetings, providing financial support, advice, data and review/revision support you have helped to create a realistic, community-based plan with activities, policies and timelines to help protect water quality in Table Rock Lake.

To all of our stakeholders; thank you for taking time out of your busy lives to attend our evening meetings and discuss the issues and explore solutions for protecting water quality. Thanks to some stakeholders, our Technical Committee and Advisory Committee, for their experience and advice during plan's revisions. A special thanks to Gary Lomax for volunteering his time to help with the visual survey summary.

TRLWQ also wants to recognize the following organizations that have contributed resources in the form of the time of their valuable members providing advice, expertise and collaboration: U.S. Army Corps of Engineers, Missouri Department of Conservation, Missouri Department of Natural Resources, the Ozarks Water Watch, Lakes of Missouri Volunteers Program, University of Missouri Extension and Roaring River Parks Alliance.

Thank You!

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INTRODUCTION

Table Rock Lake is located in the Ozark region of Southwest Missouri on the White River valley. Its watershed is over 4,000 square miles, encompassing all or parts of 21 counties in Missouri and Arkansas.

The immediate, surrounding watershed of Table Rock Lake, which this Watershed Management Plan focuses on, covers the 244,000 acres of sub-watersheds that drain the various creeks and river-mouths surrounding the lake.

This Watershed Management Plan *(hereafter referred to in this document simply as the "Plan")* further sub-divides the Table Rock Lake watersheds into the Eastern Plan and Western Plan. This is done to allow for a more focused approach to help pinpoint priority areas and water quality issues within the distinct regions of Table Rock Lake Watershed.

Arkansas counties Benton, Boone, and Carroll along with Missouri's Stone and Barry counties make up the Western portion of the Table Rock Lake Watershed. The Eastern portion of the Table Rock Lake Watershed consists of Taney and Stone counties of Missouri and Boone County, AR (Figure 1).

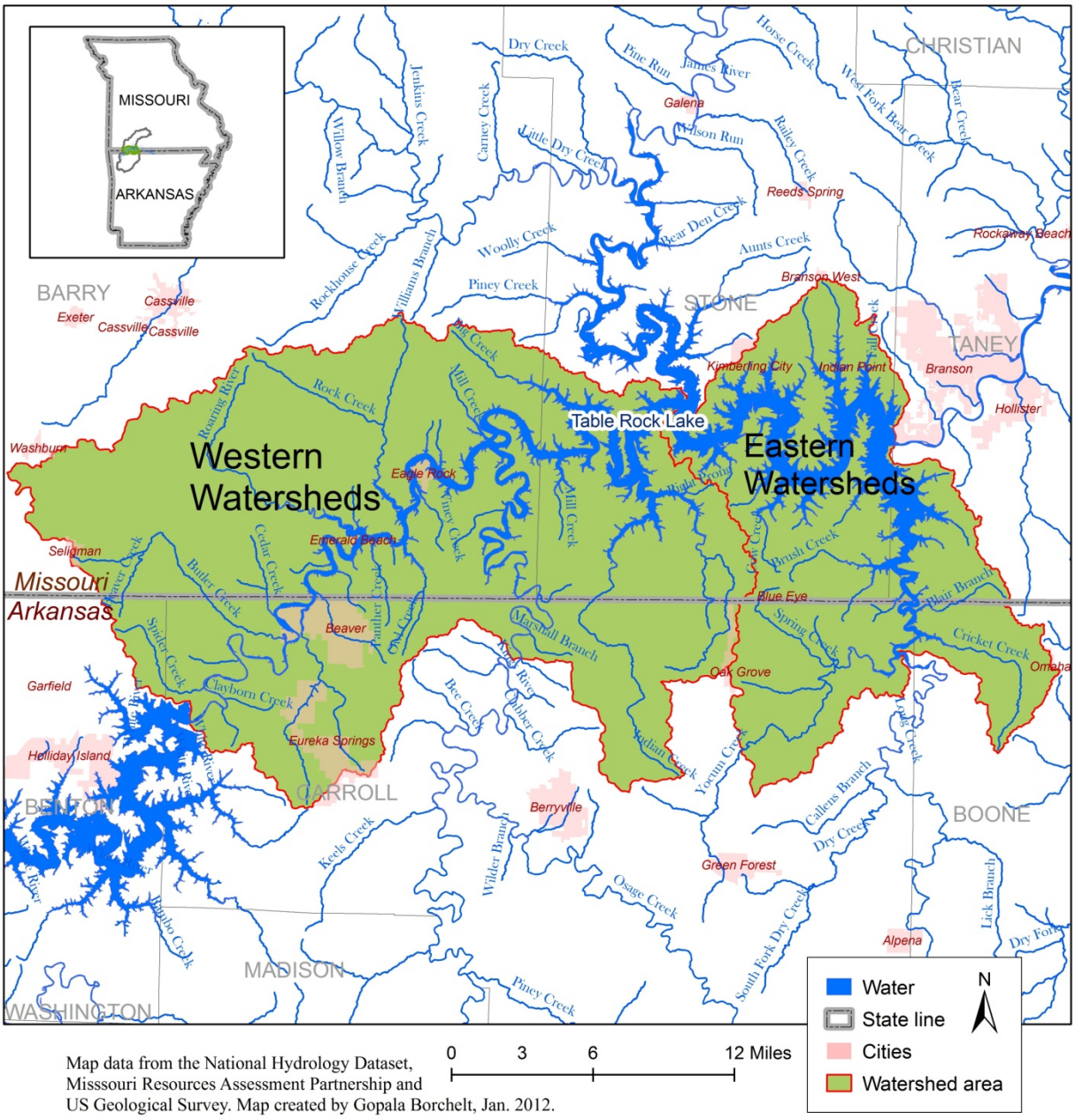


FIGURE 1. TABLE ROCK LAKE WATERSHEDS. SHOWING THE DELINATION BETWEEN THE EASTERN AND WESTERN TABLE ROCK LAKE WATERSHED PROJECTS.

Table Rock Lake Water Quality, Inc. (TRLWQ) is a non-profit organization dedicated to keeping Table Rock Lake clean and healthy. This grass-roots organization had previously organized the development of a watershed management plan for the lower portion of the James River, a tributary to Table Rock Lake. This Table Rock Lake Watershed Management Plan document is also a result of TRLWQ and its partner's collaboration, research and analysis.

Participation by citizen stakeholders from all over the Table Rock Lake watershed is critical to the success of this Plan. There were over 50 stakeholders involved in the planning process for this document including local government officials, business owners, realtors, retirees and homeowners. By acquiring the input of local citizens, the watershed management plan not only acquires the advantage of local buy-in of the Plan's activities, but also allows for inclusion of local community projects and ideas.

The Eastern side of Table Rock Lake tends to have more population and development while the Western portion of the lake is mainly rural and contains a large section of the Mark Twain National Forest. Differences in land use and development between the Eastern and Western sides of the Table Rock Lake watershed meant that the two stakeholder groups developed for these areas would have different ideas on what were the top priorities for protecting water quality in Table Rock Lake. Each stakeholder group has valid arguments and solutions so two plans were written which together form Table Rock Lake Watershed Management Plan.

November 15, 2010 Stakeholder Meeting

PURPOSE OF PLAN

The purpose of the Table Rock Lake Watershed Management Plan is to identify projects and goals to reduce the nutrient pollution that contributes to the lake's impairment. The ultimate goal is to get Table Rock Lake and the arms and branches of the lake back within water quality standards and to remove the lake from the 303(d) list of impaired waters.

This Plan will increase the success of future water quality improvement projects by helping to determine priority areas where water quality protection efforts should be focused. The Plan also fulfills some grant and funding source requirements as well as lists practical projects and education activities that a local population would support. It assists other organizations and municipalities in water quality related efforts by providing insight into the sources of pollution, needed remediation projects and targeted goals for water quality improvement.

This watershed management plan follows the EPA's 9 key elements recommended for development of a watershed management plan. The basic elements are listed as follows:

EPA'S 9 ELEMENTS OF A WMP

1. Identify all of the pollution sources that will need to be controlled to reduce water pollution levels.
2. Estimate your expected pollution reductions once the Plan is completed.
3. Describe the controls and actions within the watershed that are needed in order to achieve the desired water pollution reductions.
4. Estimate of the amounts of technical and financial assistance needed to complete the Plan.
5. Information/education components needed in order to complete the Plan.
6. Include a schedule or timeline for the completion of the Plan.
7. Identify measurable milestones for determining whether the Plan is working (achieving the desired water pollution reductions).
8. Set measurable, appropriate criteria to determine whether water pollution reductions are being achieved over time.
9. Include a monitoring component in the Plan that accurately evaluates the effectiveness of the Plan.

TABLE ROCK LAKE WATERSHED FACTS & DATA

The 244,873 acres of the immediate surrounding Table Rock Lake Watersheds are characteristic of typical Ozarks landscapes. Landscape features such as sinkholes, caves, bedrock fractures and loosing streams are common and allow direct linkages from surface waters into groundwater and drinking water sources. These features, known as karst, are formed over time by the erosion and weathering of limestone and dolomite bedrock as slightly acidic rainwater creates channels, caverns and sinkholes into this material (Borchelt 2007).

The weathered rock in the Ozarks region forms residual soils containing resistant cherts and clay. Erosion of the residual soil accounts for the tumbled gravels found in streambeds of the watershed. Slopes can be 5 to 90 degrees and tend to be steeper in areas close to creeks or water bodies. Soils on the broad ridge tops or in the river valleys are relatively deep with thin silt-loams over clayey residuum on limestone, shale and sandstone bedrock. Soils on slopes are thin and poor, supporting mainly smaller oaks, smoke-bush and cedar (Borchelt 2007). With karst terrain and thin soils, the TRL area is considered vulnerable to water pollution of not only surface waters, but also ground water and drinking water aquifers.

POPULATION GROWTH

The 2010 U.S. Census data shows that population in the Table Rock Lake (TRL) Watershed area is growing. Focusing on the three main counties in the TRL watershed (Taney, Barry, & Stone), the population has increased by 17 percent since the year 2000. In Arkansas, a 34 percent increase in population during this time period was also largely concentrated on counties included in or around the TRL watershed. Table 1 show that TRL area county populations increased by almost 29 percent over all.

TABLE 1. TABLE SHOWS THE GROWTH IN POPULATION FROM 2000 TO 2010. THE LARGE GROWTH IN POPULATION WILL PUT A NEW STRAIN ON THE AREAS NATURAL RESOURCES. U.S. CENSUS 2000 & 2010 DATA.

County	2000 Population	2010 Population	% Change
Taney County, MO	39,703	51,675	30.2
Barry County, MO	34,010	35,597	4.7
Stone County, MO	28,658	32,202	12.4
Benton County, AR	153,406	221,339	44.2
Boone County, AR	33,948	36,903	8.7
Carroll County, AR	25,357	27,446	8.2
Total Watershed Population	315,082	405,162	
Watershed Population % Change		28.6	
Missouri Counties % Change		16.7	
Arkansas Counties % Change		28.6	

Census data maps are available in Appendix I.

The Table Rock Lake area with its spring-fed streams, lakes hills and bluffs, as well as premier fishing and an abundance of recreational activities have made the area a very popular vacation and retirement destination. As the baby boomer generation continues to reach retirement age and move near Ozark area lakes, there is the possibility the TRL area could see an even larger population growth over the next 10 years.

LAND USE & DEVELOPMENT

The land use around TRL has historically been forest and agriculture consisting of small family farms in the lowlands and cleared plateau areas with hardwood forests and glades on the slopes of hills. Farmers raise cattle, hogs, and poultry and grow fruit and vegetables.

Many areas that were historically fields or glade environments have been developed into residential neighborhoods, commercial districts and resorts and condos to accommodate an expanding population. Development of the TRL area within the last decade has seen some of the highest rates in the country with urban areas increasing by over 600 percent since 1991 (see Table 2). While open areas including glades and fields decline, forest areas have increased slightly within the watershed. This may be due to some decline in cattle farming and maintenance of pasture open spaces, as well as forest encroachment into formerly open space and glades within the national park lands.

Another land use change which has occurred in the last five to ten years, particularly in the western portion of the TRL watershed, is the large increase in numbers of confined animal feeding operations (CAFOs) the majority of which are contract poultry production farms.

Based on 2005 land use analysis done by the University of Missouri through the Missouri Resources Assessment Partnership, much of the land around Table Rock Lake is forested (62 percent). For both the Eastern and Western portions of Table Rock Lake watershed, forested regions dominate the land use. Over 11 percent of the Western portion of the watershed is open field which is expected due to the larger amount of agricultural activity in these areas. The Eastern Table Rock Lake watershed has a larger portion of urban and residential development with approximately 6 percent of the land use developed (Table 2). This urban land use tends to be concentrated around the shoreline of the lake where the most desirable real estate is to be found (Figures 2 & 3).

TABLE 2. LAND USE DATA FROM THE TABLE ROCK LAKE WATERSHED SHOWS THE CHANGE IN LAND USE FROM 1991 TO 2005. **DATA FROM THE MISSOURI RESOURCES ASSESSMENT PARTNERSHIP, 2004.**

	1991 Data			2005 Data		
Portion of Lake	**Land Use**	**Acres**	**Percentage of Total Land Use**	**Land Use**	**Acres**	**Percentage of Total Land Use**
Table Rock Lake	Urban	1,084	0.44%	Urban	6,876	2.81%
	Quarry-bare	2,841	1.16%	Quarry-bare	4,013	1.64%
	Fields	72,289	29.56%	Fields	45,217	18.47%
	Forest	135,749	55.50%	Forest	152,823	62.41%
	Water	32,618	13.34%	Water	35,943	14.68%
	Total	244,582	100.00%	Total	244,873	100.00%
Eastern TRL	Urban	886	1.24%	Urban	4,317	6.03%
	Quarry-bare	723	1.01%	Quarry-bare	1,960	2.74%
	Fields	19,176	26.84%	Fields	8,435	11.78%
	Forest	32,784	45.88%	Forest	37,697	52.66%
	Water	17,882	25.03%	Water	19,177	26.79%
	Total	71,449	100.00%	Total	71,586	100.00%
Western TRL	Urban	198	0.11%	Urban	2,559	1.48%
	Quarry-bare	2,118	1.22%	Quarry-bare	2,054	1.19%
	Fields	53,114	30.68%	Fields	36,782	21.23%
	Forest	102,966	59.47%	Forest	115,120	66.44%
	Water	14,737	8.51%	Water	16,766	9.68%
	Total	173,133	100.00%	Total	173,281	100.00%

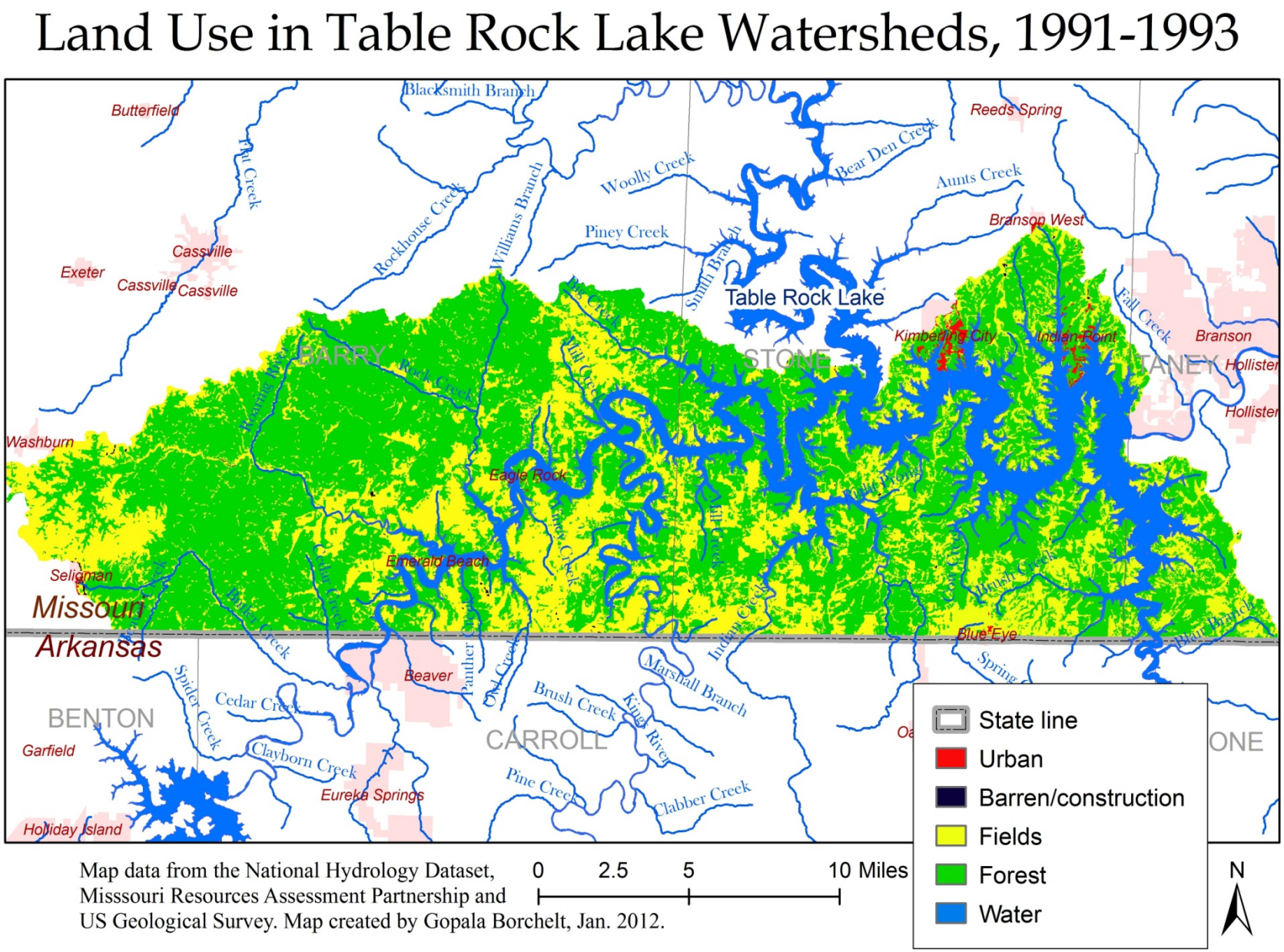


FIGURE 2. LAND USE MAP OF WHOLE TABLE ROCK LAKE WATERSHEDS (EASTERN & WESTERN) FROM 1991-1993.

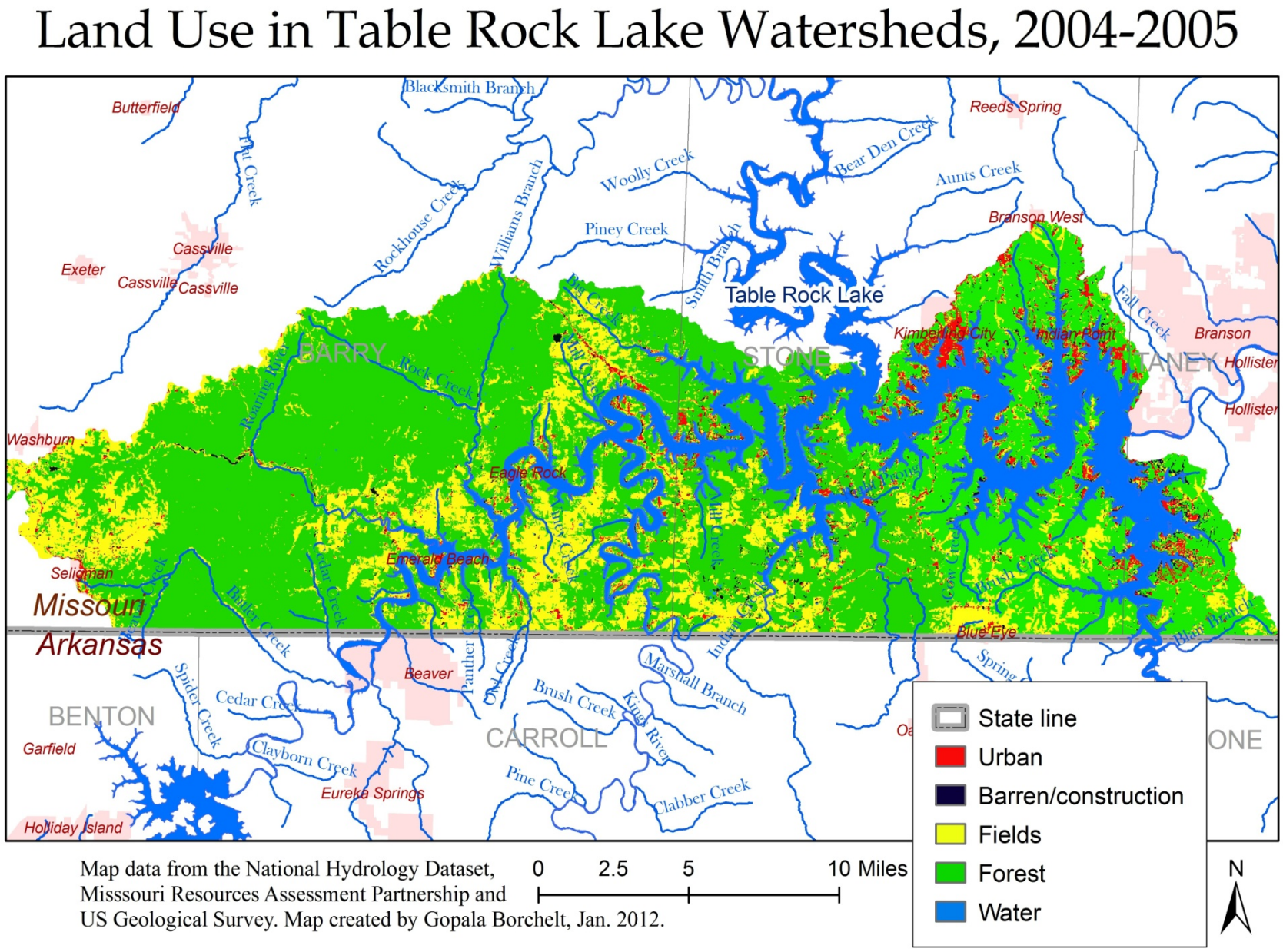


FIGURE 3. LAND USE MAP FOR ENTIRE TABLE ROCK LAKE WATERSHED FROM 2004-2005.

Table Rock Lake has been listed by the Environmental Protection Agency (the 303(d) List) as impaired due to excessive nutrient concentrations, particularly nitrogen and phosphorus, since 2002. According to the 2010 303(d) List of impaired waters, TRL is still listed for excessive nutrients particularly in the James River, Kings River and Long Creek arms of the lake. The Upper portion of the White River, main-stem of the lake, is also listed as impaired for excessive chlorophyll (algae cells) and nitrogen although currently there is no nutrient standard or criteria established for Missouri lakes. These listings are therefore based upon narrative criteria which includes visual evidence and long-term sample results.

Excessive nutrient loading causes over-growth of algae known as eutrophication in the lakes and streams. In a study by Jones et. al. 2008, a compilation of research showed that total phosphorus (TP) increases with more total nitrogen (TN) input into the aquatic ecosystem in Missouri reservoirs. Increased nutrient and algae concentration can lead to water quality problems when these algae choke out the indigenous aquatic species and reduce water clarity and recreational uses. Decaying algae decreases dissolved oxygen in the water and may cause streams to become unable to support fish and other aquatic life (Borchelt 2007).

Water clarity, measured using a Secchi disk, is often used to gauge the health of an aquatic ecosystem. Missouri reservoirs, especially in the Ozarks show that algal biomass is well correlated ($r^2 = 0.7$) with Secchi transparency (Tony Thorpe, Lakes of Missouri Volunteer Program, personal communication).

An important note is that Table Rock Lake is a large reservoir and warrants special consideration to focus on each distinct portion of the lake. In the study by Jones et. al. 2008, it was shown that Table Rock Lake was an oligotrophic (low nutrients and algae growth) lake based on the samples taken near Table Rock Dam, while various arms or branches of the lake such as the James River mouth or Long Creek area, where it receives water from these tributaries, shows tendencies toward being more eutrophic (high nutrients and algae growth). Jones et. al. 2008 stated that nutrient concentrations in the arms of Table Rock Lake need to be considered differently than water at the Table Rock Dam.

Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant that a body of water can absorb and still meet (not violate) water quality standards (Mo DNR Fact Sheet “What are TMDLs?”). The TMDL is written for waters that are in violation of the current water quality standards, of which Table Rock Lake is in violation. A TMDL report for TRL watershed is planned for but has not yet been completed by the Missouri Department of Natural Resources (As of December 2010, http://www.dnr.mo.gov/env/wpp/tmdl/ info/7313-table-rock-lk-info.pdf).

Water quality standards listed for Table Rock Lake, pending EPA approval, are not to exceed 0.009 mg/L TP, 0.253 mg/L TN, and 0.0026 mg/L CHL. There are currently some areas in the Table Rock Lake watershed that exceed these water quality standards in their average/mean nutrient and chlorophyll levels. However, it would be unwise to treat the whole lake to one water quality standard since the nutrient loading varies from one region or arm of the lake to another.

The Lakes of Missouri Volunteer Program (LMVP) provides water quality data that shows the differences in nutrient concentrations from their many sample sites in Table Rock Lake. Figure 4 identifies the sample sites on Table Rock Lake and listed on Tables 3 and 4.

The major tributaries of Table Rock Lake have played a large role in nutrient input to the lake through varying types of anthropological impacts including urban development, residential development and agricultural development. For example the Kings River site #7 has higher TP levels than the James River site #4.5. Kings River arm has more agricultural impacts than the James River which has also been regulated for TP from the City of Springfield municipal waste discharge since 2001 (Figure 5).

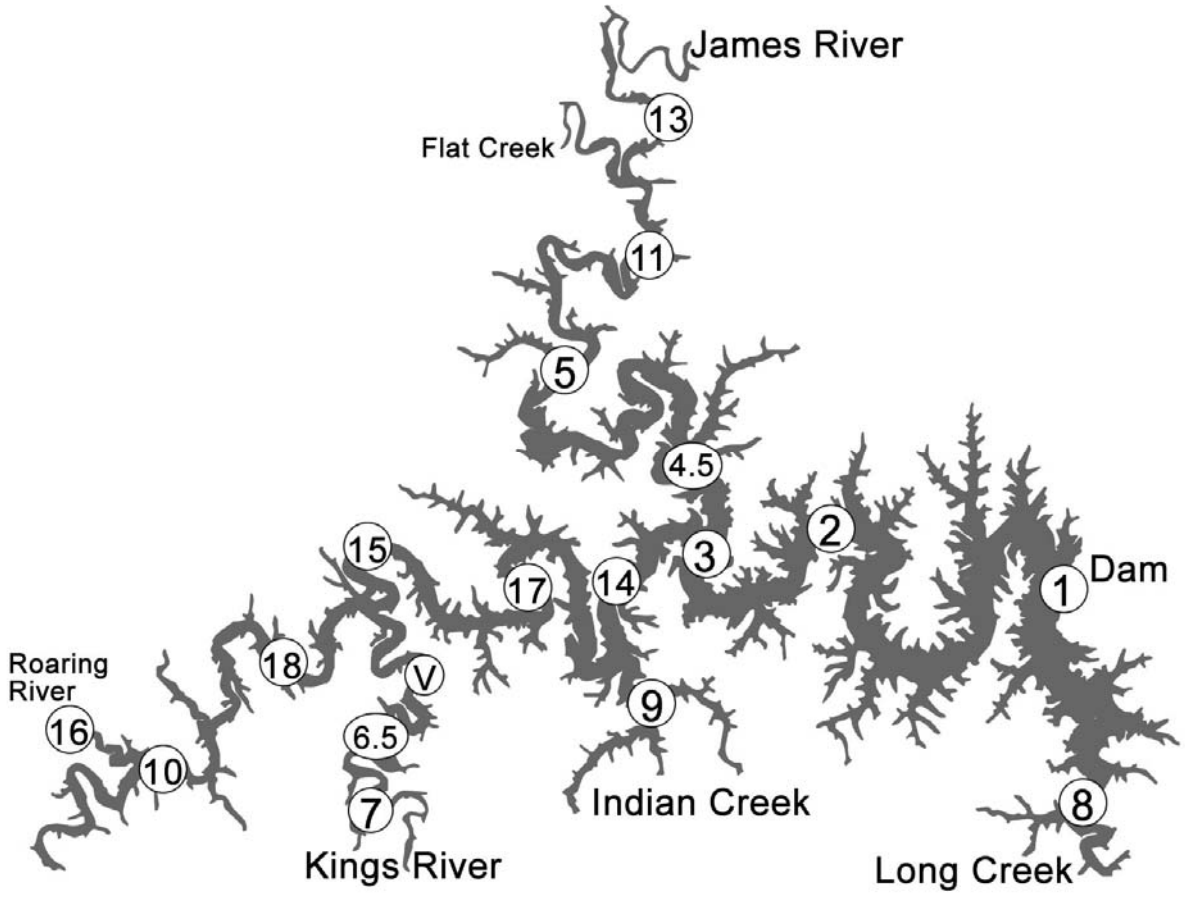


FIGURE 4. MAP OF SAMPLE SITES FROM THE LAKES OF MISSOURI VOLUNTEER PROGRAM ON TABLE ROCK LAKE. NUMBERS CORRESPOND TO SAMPLES IN TABLES 5 & 6. SITE DATA FOR 5, 11 & 13 ARE NOT SHOWN. (SOURCE: LMVP 2010 DATA REPORT)

TABLE 2. DATA FROM THE LAKES OF MISSOURI VOLUNTEER PROGRAM (LMVP) IS SHOWN FOR CLARITY (SECCHI), TOTAL PHOSPHORUS (TP), TOTAL NITROGEN (TN) AND CHLOROPHYLL (CHL) OR ALGAE. THE AVERAGES OVER THE ENTIRE SAMPLING SEASON ARE SHOWN. SITE NUMBERS CORRESPOND WITH FIGURE 7. HIGHLIGHTED MEASURES EXCEED THE NUTRIENT CRITERIA.

Main Lake Sites

	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Site #	**18**	**18**	**17**	**17**	**3**	**3**	**2**	**2**	**1**	**1**
Secchi (inches)	118		118		120		115		113	
TP (mg/L)	0.009	0.009	0.009	0.009	0.011	0.011	0.007	0.007	0.005	0.005
TN (mg/L)	0.309	0.338	0.419	0.441	0.567	0.573	0.542	0.593	0.446	0.514
CHL (mg/L)	0.004	0.004	0.005	0.005	0.007	0.008	0.005	0.005	0.004	0.005

TABLE 3. DATA FROM THE LAKES OF MISSOURI VOLUNTEER PROGRAM (LMVP) IS SHOWN FOR CLARITY (SECCHI), TOTAL PHOSPHORUS (TP), TOTAL NITROGEN (TN) AND CHLOROPHYLL (CHL) OR ALGAE. THE AVERAGES OVER THE ENTIRE SAMPLING SEASON ARE SHOWN. TRIBUTARY SITE NUMBERS CORRESPOND AS FOLLOWS: #7 IS KINGS RIVER, #16 IS ROARING RIVER, #4.5 IS JAMES RIVER, AND #8 IS LONG CREEK. HIGHLIGHTED MEASURES EXCEED THE NUTRIENT CRITERIA.

Tributary Sites

	2009	2010	2009	2010	2009	2010	2009	2010
Site #	**7**	**7**	**16**	**16**	**4.5**	**4.5**	**8**	**8**
Secchi (inches)	34	36	40	41	121	123	86	92
TP (mg/L)	0.042	0.042	0.029	0.029	0.011	0.012	0.014	0.015
TN (mg/L)	0.505	0.542	0.812	0.906	0.523	0.629	0.592	0.654
CHL (mg/L)	0.017	0.025	0.008	0.012	0.006	0.006	0.009	0.011

Cumulative nutrient loading in streams results from point sources and nonpoint sources (NPS) of pollution that occur in association with development, both urban and agricultural. Point sources of pollution including municipal and community wastewater treatment plants producing more than 3,000 gallons per day are currently regulated to maintain a National Pollution Discharge Elimination Systems (NPDES) permit. This permit is used to monitor pollution levels in their discharge and regulate the nutrient loading that is allowed in the discharge. Figure 5 shows the decrease in phosphorus outputs that the City of Springfield Southwest Wastewater Treatment Plant was able to achieve as a result of additional phosphorus removal facilities installed at the plant in 2001.

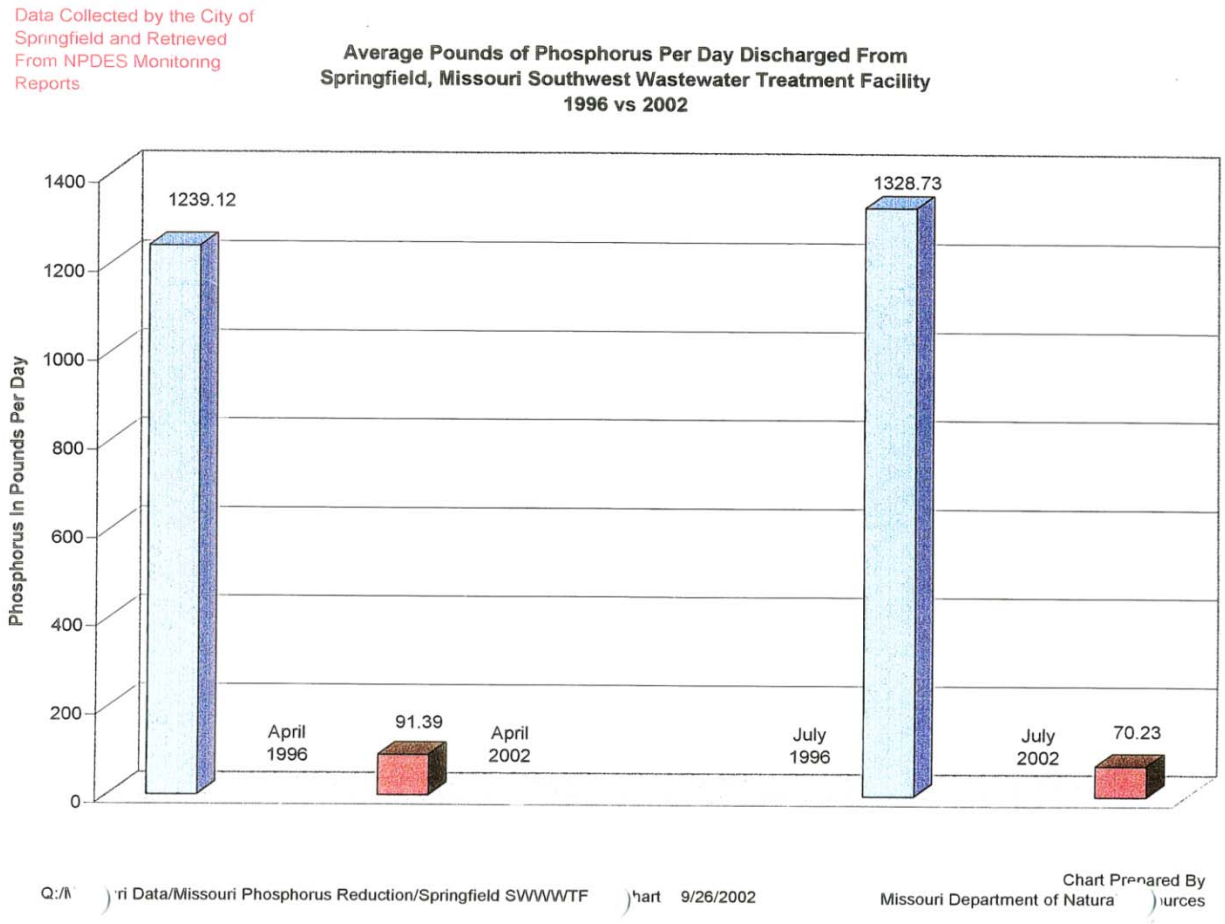


FIGURE 5. CITY OF SPRINGFIELD SOUTHWEST WASTEWATER TREATMENT PLANT PHOSPHORUS DECREASES FROM 1996 TO 2002. (SOURCE: CITY OF SPRINGFIELD, MO)

Nonpoint source pollution is much more difficult to regulate or reduce than point source pollution since it is an amalgam of widespread micro-sources caused by certain land development and land use practices. This Plan focuses on reducing nonpoint source pollution in the TRL watershed.

While acknowledging all types of point and nonpoint source water pollution, this Plan focuses on the major nonpoint, nutrient pollution sources that have been identified in the Table Rock Lake watershed.

The major nonpoint nutrient pollution sources have been identified as:

- Failing and inadequate onsite wastewater treatment systems (septic tanks)
- Stormwater runoff from commercial and residential development
- Stormwater runoff from some agricultural management practices, specifically excessive or poorly timed poultry litter, manure and fertilizer applications

FAILING ONSITE WASTEWATER TREATMENT SYSTEMS

The karst geology (rocky, shallow soils) of the Table Rock Lake watershed is not conducive to use conventional onsite wastewater treatment systems, septic systems, for household wastewater treatment. As our population retires or moves into many older lake homes, often the aging septic tank is no longer adequate to treat their wastewater. The old metal, rusted 500 gallon tank is a common issue for failed septic systems, which are often costly to replace.

Nationally, more than half the existing onsite treatment systems are over 30 years old, and surveys indicate at least 10 percent of these systems back up on the ground's surface or into the home each year (U.S. EPA March 2003). More research has shown that 20 percent of systems are malfunctioning to some degree (U.S. EPA March 2003).

The Table Rock Lake area, with its rocky, shallow soils may have an even greater failure rate of onsite septic systems that can impact water quality in the lake. A study commissioned by TRLWQ in 2001 found that optical brighteners were detectable in some of the developed coves of Table Rock Lake (TRLWQ 2001). This study states that septic effluent plumes were indicated by increased fluorescence caused by optical brighteners used in household detergents. Plumes were observed in developed, protected coves, with larger more defined plumes found immediately after the July 4th weekend (indicating greater lake use and septic system discharges).

Failing onsite systems not only cause problems for surface waters, i.e. lakes and streams, but also groundwater and wells can be at risk of contamination. Stone County, MO Health Department reports approximately 24 well samples tested positive for E. coli in their water systems for 2010.

Table 1 shows the populations of Stone and Barry Counties are 32,202 and 35,597 respectively. Out of these numbers, approximately 3,819 people in Stone and 14,155 in Barry are on public sewer and water service (MO Public Utility Alliance, 2010). This leaves 28,383 in Stone County and 21,442 in Barry County using onsite wastewater systems.

Approximately half of Stone County, MO and one third of Barry County, MO are included in the immediate surrounding Table Rock Lake watershed. By dividing the Stone County population that is using onsite systems by 1/2 and the Barry County population by 1/3, an approximation can be made that indicates 14,192 Stone County residents and 7,140 Barry County residents are on private onsite wastewater systems in the TRL watershed. Given that the U.S. Census estimates the average household is approximately 2.5 persons, we therefore calculate there are 5,677 households in Stone County and 2,856 households in Barry County that use onsite wastewater systems (Table 4).

Using these figures and the expectation that 20 percent of onsite systems are malfunctioning, our estimate for the total number of failing septic systems in the immediate surrounding Table Rock Lake Watershed is 1,707.

TABLE 4. SUMMARY OF FAILING SEPTIC SYSTEMS ESTIMATES AROUND TABLE ROCK LAKE

	Stone County	Barry County
Estimated # of households in TRL watershed	5,677	2,856
Estimated number of failing septic systems (households * 20%)	1,135	571

Table 4 shows the estimated number of failing septic tanks in the immediate surrounding watershed of Table Rock Lake. However, this number may be a very conservative estimate and the actual number of malfunctioning systems may be much higher since soils in the Table Rock area are not conducive to properly treating wastewater using conventional onsite systems. In addition, many aging housing developments that were built with septic systems may face a slow failure in their wastewater treatment systems.

Some communities that have already experienced this and have installed smaller cluster treatment facilities to service their subdivisions. The challenge of these facilities is that they require ongoing professional maintenance which the subdivisions usually pass on to the homeowners through monthly sewer fees. As costs of maintenance and increased regulations on effluent treatment rise, smaller subdivisions face higher sewer rates to maintain these facilities.

POLLUTED STORMWATER RUNOFF FROM URBAN DEVELOPMENT

With the increasing number of homes and commercial developments being built along the lake the potential for stormwater runoff issues is becoming a huge concern. The growth in urban land use over the years reflects more development in the watershed, particularly in the areas adjacent to the lake. As land becomes developed, the increased impervious surfaces contribute more polluted stormwater runoff. During rainfall events in the Table Rock lake watershed, some coves and distinct areas of the lake become visibly cloudy as a result of sediment washing into the lake from adjacent development.

Above: Images of Table Rock lakeside areas that have been cleared of vegetation for community access (left) and for resort/condo development (right).

Below: Images of sediment washing into Table Rock Lake, during a normal rainfall event (left) and extreme sediment transport during the June 2008 flooding period (right).

Evidence has shown that when a watershed becomes more than 10% impervious, water quality within that watershed becomes prone to degradation, loss of species and loss of beneficial uses (Morse 2003). This is due to the nonpoint source pollution including oil, gas, sediments, soils, pet waste, lawn fertilizers, metals and herbicides and pesticides that is contained in typical urban stormwater. Urbanized land areas in the Eastern portion of the TRL watershed grew from just over 1 percent of the watershed in 1991 to 6 percent in

2004 (Table 2). However, the immediate shoreline of Table Rock Lake experienced the most development with over 10 percent of the first 1500 ft. of shoreline becoming developed as of the 2004 land use analyses estimates.

TRLWQ conducted a visual assessment of the condition and types of the development in communities around Table Rock Lake to gain a better understanding of the possible stormwater and wastewater impacts this development may be causing. Communities around the lake include residential housing, commercial development for resorts and condos, land clearing for expected subdivisions on the lakefront, paved surfaces and new construction.

A recurring theme, as expected, is that areas closer to Table Rock Lake and with access to then by road and proximity to towns are more heavily developed than areas farther from the lake and farther from towns and villages.

In heavily developed or dense residential areas, less open space is available for stormwater to slow down and soak in. Also, less area is available for adequate treatment of onsite wastewater, as lot sizes are reduced to the minimum size. The majority of the 19 locations included in the visual assessment on the lake were over 90% developed (90% of lots had homes or buildings on them).

One of the more prominent issues with lake front communities that were found in the visual assessment was the fact that property owners mow or remove vegetation up to the water line. The U.S. Army Corps of Engineers actually prohibits removal of vegetation within their take line with limited allowances given to holders of a Corps-issued vegetative permit. However, enforcement and follow-up of the proper use of vegetative permits is often not feasible and cannot be adequately enforced due to limited Corps resources. TRLWQ and stakeholders agree that there is need to encourage homeowners to leave a buffer area of un-managed vegetation between their mowed portion of the lawn and the water line to help decrease stormwater runoff pollution entering the lake.

Kings River survey point showing the mowed lawn to the water's edge.

The most noticeable erosion problems were gravel roadways leading up to boat launches and docks. Most of these embankments are steep and allow stormwater to pick up speed as it heads towards the lake. As gravel washes into Table Rock Lake it also carries smaller sediments and soils. Sediment is large contributor to nutrient input into any water body. Projects need to be implemented to aid boat dock owners to improve the roadways to their docks and launch ramps to allow the capture of gravels and sediments.

Ten of the nineteen sites observed appeared to have central wastewater treatment facilities at least for some properties. Some areas were a mix with a resort having central treatment but local homeowners using individual onsite wastewater treatment systems. Central treatment systems require ongoing professional maintenance to maintain adequate nutrient reductions. With the large number of individual homes found during this survey, it is important to consider how many homes are on individual septic systems. If the homes are more than 15 years old it is quite common for homes to have old metal septic tanks. These metal tanks do not last long and are no longer permitted to be installed. Many homeowners, especially those in retirement and on fixed incomes, need financial assistance to replace failing or outdated septic systems.

Finally, some communities differed greatly from each other by the fact that some were dominated by multi-million dollar homes and others had mainly lower-income trailer homes. Again, there are many people in this area that want to upgrade their septic tanks and protect their health and the health of Table Rock Lake. However, replacing their system with an adequate onsite wastewater system that could cost up to $20,000.00 is just not financially feasible for some people. Funding sources in the form of loans or grants are needed to help these areas improve their wastewater treatment facilities.

Additional information and pictures taken as part of TRLWQ's visual assessment of development around Table Rock Lake can be found in Appendix I.

NUTRIENT-RICH STORMWATER RUNOFF FROM POULTRY LITTER APPLICATIONS

One of the largest growing sectors in agriculture in Southwest Missouri and Northwest Arkansas is poultry production farms. Waste management is one of the top concerns with the growth of this industry since tons of poultry waste, called litter, is often spread on pasture and crop land to add nutrients to the soil and dispose of the waste. About 100-120 tons of litter is produced annually by 100,000 chickens (Carlisle, 2003 in Nutrient Mgmt book).

It is difficult to estimate the number of poultry farms in the Table Rock Lake watershed since much of the available statistics are by county only and are often out dated. The Nutrient Management Guide by Greene, Davis, and Medley was written in 2003. The STEPL model used by the DNR which has 2007 data lists far fewer poultry animals than the 2003 study.

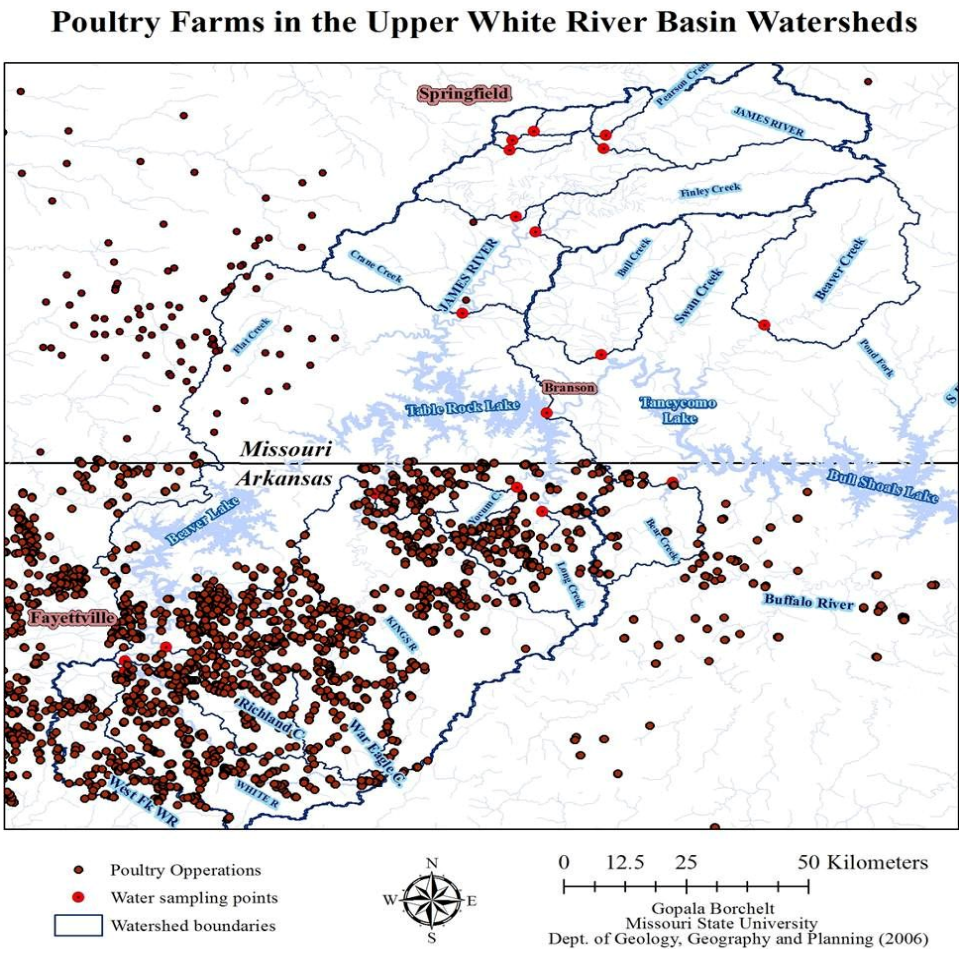
As of 2004, there were an estimated 525,493 birds (chickens and turkeys) within the immediate Table Rock Lake watershed (Nutrient Management in SW Mo). The James River Watershed, which is a major tributary of Table Rock Lake, produces 40,303,952 birds and 48,092 tons of manure annually. While it also appears that there are many poultry farms surrounding the immediate Table Rock Lake watershed, there are not as many of these farms within the project Plan area (Figure 6).

However, according to the USDA National Agriculture Statistics Service, the total number of poultry animals produced and sold from farms in the four main counties surrounding Table Rock Lake (Benton, Carroll, Stone, Barry) in 2007 was nearly 287 million animals. This number of poultry animals may produce upwards of 287,000 tons of litter. This litter is spread on pastures, many of which are adjacent to streams and tributaries that drain into Table Rock Lake. Pasture and farm land, which is more abundant in the western portion of the Table Rock Lake watershed, becomes more of the water quality concern that the actual locations of poultry production facilities especially if the litter is spread in excessive amounts or adjacent to streams.

According to Greene, Davis, & Medley this litter does not have a balanced nutrient ratio of nitrogen to phosphorus optimal for plant uptake and growth. Poultry litter, on average, has a N:P ratio of 2.2:1 (Evers, 2002). Plants reach their maximum uptake of nitrogen while much of the phosphorus is left behind. The phosphorus can then either be adsorbed by soil particles or dissolved in rainwater. This dissolved or particulate phosphorus is then washed into adjacent streams during rainfall events and potentially leads to reduced water quality (Evers, 2002).

FIGURE 6. POULTRY FARMS, ALL SIZES, IN THE UPPER WHITE RIVER BASIN AND SURROUNDING WATERSHEDS.

DATA FROM THE UNIVERSITY OF ARKANSAS'S CENTER FOR ADVANCED SPATIAL TECHNOLOGIES HTTP://WWW.CAST.UARK.EDU



To recap, the cumulative nutrient loading to tributaries and to Table Rock Lake include point sources such as NPDES permitted wastewater treatment plants and also smaller waste discharges, nonpoint sources such as polluted stormwater runoff from urban and agricultural development and onsite wastewater treatment systems.

This Watershed Management Plan focuses on addressing nonpoint sources of nutrient pollution through voluntary activities, incentives and education. This Plan will promote local, community-driven efforts to reduce nonpoint source nutrient pollution to the Table Rock Lake watershed.

BEST MANAGEMENT PRACTICES

Some tried and true projects and activities for nonpoint source pollution reduction are known as best management practices (BMPs) for watershed protection. In order to preserve the water quality of the Table Rock Lake, BMPs need to become general knowledge and applied through education, voluntary adoption and backed up by policy and regulatory enforcement. Some BMPs to reduce nutrient pollution from NPS pollution include:

1. *Provide education on low-impact development (LID) techniques*
2. *Encourage voluntary participation in LID techniques for homeowners and business owners.*
3. *Promote the use of riparian corridors and buffers between water sources and anthropological developments and agricultural developments.*
4. *Prevent the deposition of livestock manure in nearby water bodies by filtering with vegetation, fencing livestock out of streams and construction of alternative watering ponds or troughs.*
5. *Better estimations of timing and rate of fertilizer applications to agricultural fields and lawns using soil tests and estimation of vegetative needs.*
6. *Reduction of nutrient runoff from residential areas through education, constructed rain gardens, promotion of vegetative buffers and ongoing maintenance of LID practices*
7. *Work with city and county regulatory agencies to change ordinances and enforce BMPs for development.*
8. *Gradual remediation of failing residential onsite wastewater treatment systems through both education/incentives and regulation such as point-of-sale inspections as utilized in Stone County, Missouri.*
9. *Promotion and construction of clustered community wastewater treatment facilities for the many small communities that currently contain numerous older and often failing onsite wastewater systems.*

BMPS FOR AGRICULTURAL RUNOFF

The agricultural community needs to become aware of the benefit of nutrient management plans for their farms. By following these well-planned goals, fields will benefit from the correct amount of fertilization and environmental risk will be low. Poultry litter is a very beneficial fertilizer to pastures and croplands when applied correctly.

Poultry litter is an excellent source of plant nutrients and organic matter. Because nutrients in litter are different than that of certain plant nutrient requirements, careful consideration must be taken when land applying to avoid over-application of certain nutrients, primarily phosphorus (Payne, E-1027). This over-application of nutrients can lead to eutrophication of local waterways. Not only does this affect the recreational value of the water but also possibly drinking water sources are affected.

Nutrient management plans are designed to aid landowners in applying the correct amount of natural fertilizer, poultry litter, to their crop lands. The major components of a nutrient management plan are to identify what type of crop the litter will be applied to, necessity of a soil testing on the desired field of application, and litter testing for the amount nutrients available (Payne, E-1027). With these three components identified then the desired amount nutrients can be applied to the field.

As always, best management practices help prevent any excess runoff into local water resources too. It is always recommended to implement these practices in addition to a nutrient management plan implementation. Riparian buffer strips are one of the most common methods. A riparian buffer strip is a linear band of permanent vegetation adjacent to an aquatic ecosystem intended to maintain or improve water quality by trapping and removing various nonpoint source pollutants from both overland and shallow subsurface flow (Fischer 2000). Not only do riparian buffer strips help prevent water pollution they also provide a rich habitat to the flora and fauna. Riparian buffers in headwater streams (i.e., those adjacent to first-, second-, and third-order systems) have much greater influences on overall water quality within a watershed than those buffers occurring in downstream reaches (Fischer 2000). In other words, buffer strips need to be implemented on the upper reaches of Table Rock Lake to help prevent the pollution from getting into the lake. Even the best buffer strips along larger rivers and streams cannot significantly improve water that has been degraded by improper buffer practices higher in the watershed (Fischer 2000).

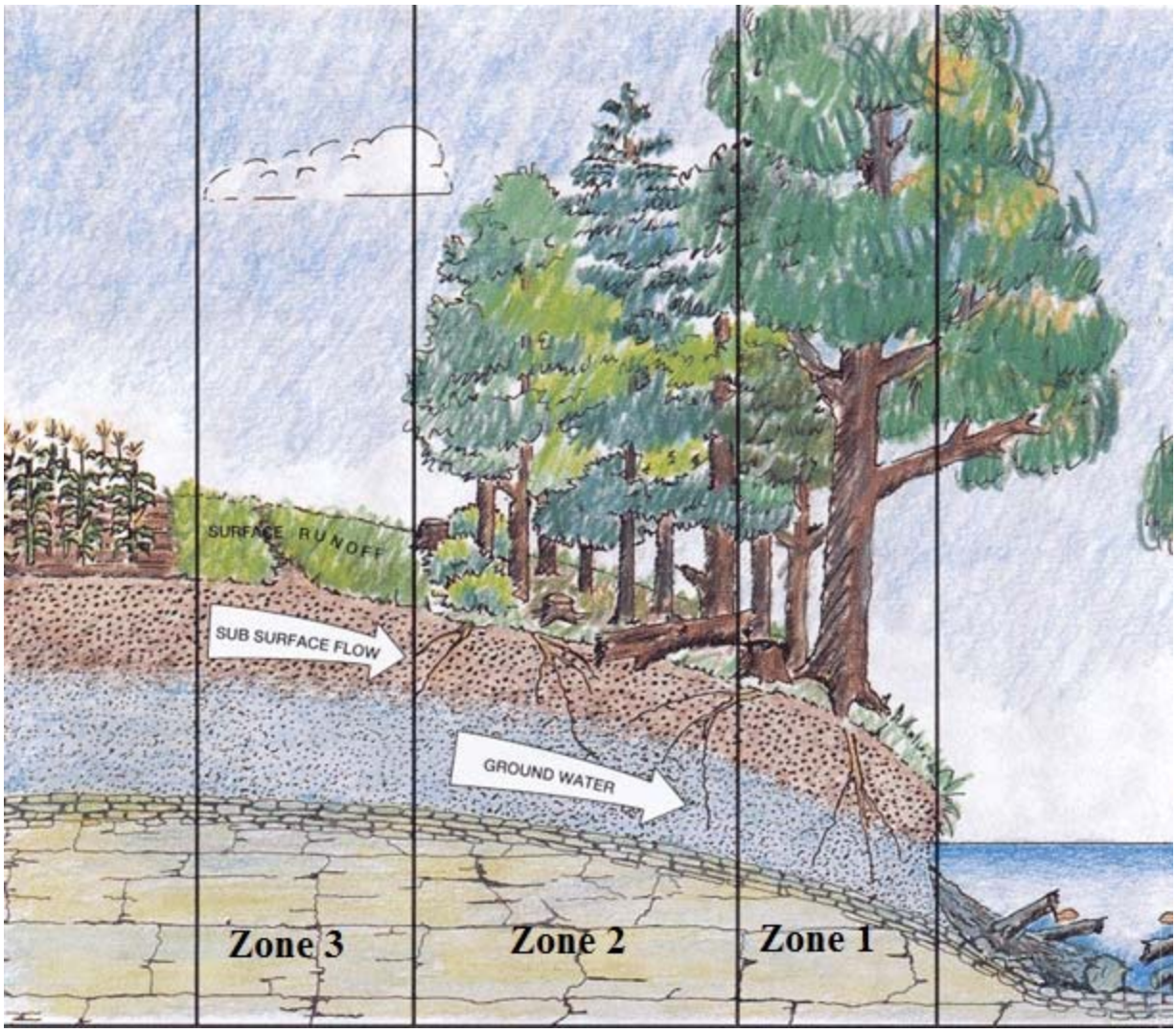


FIGURE7. EXAMPLE DIAGRAM OF RIPARIAN BUFFER ZONE. PICTURE TAKEN FROM FISCHER, 2000.

To show how riparian buffer zones work refer to Figure 7with the following descriptions (Fischer 2000).

> Zone 1. This zone begins at the stream edge and is the area that provides streambank stabilization and habitat for both aquatic and terrestrial organisms. Primary functions of this zone include provision of shade, and input to the stream or river of detritus and large woody debris from mature forest vegetation. Vegetation in this zone also helps reduce flood effects, stabilize streambanks, and remove some sediment and nutrients. Vegetation should be composed of native, non-invasive trees and shrubs of density that permits understory growth; it should also tolerate frequent inundations.
>
> Zone 2. The objective in this zone is to provide a managed riparian forest with a vegetation composition and character similar to natural riparian

forest in the region. Species of vegetation used in this zone should be reasonably flood- and drought-tolerant. The primary function of Zone 2 is to remove sediments, nutrients and other pollutants from surface and groundwater. This zone in combination with Zone 1, also provides most of the enhanced habitat benefits, and allows for recreation and aesthetic benefits.

Zone 3. This zone typically contains grass or herbaceous filter strips and provides the greatest water quality benefits by slowing runoff, infiltrating water, and filtering sediment and its associated chemicals. The primary concern in this zone is the initial protection of the stream from overland flow of non-point source pollution such as herbicides and pesticides applied to lawns, agricultural fields, and timber stands. Properly designed grassy and herbaceous buffer strips may provide quality habitat to several upland wildlife species.

Riparian buffer zones would be a great method for reducing the amount of runoff from agricultural areas. These methods have been used for years by the Natural Resource Conservation Service and Missouri Department of Conservation. Implementing more of these practices in the Western Table Rock Lake watershed is a wise decision.

One of Missouri neighboring states, Oklahoma, already has some poultry litter regulations in place due to the high amounts of nutrients in their water ecosystems as well. Their program has been successful for over 5 years. Josh Payne of the Oklahoma State University Extension has worked with a state-wide poultry litter market and also helps with continuing education opportunities for poultry growers. In Oklahoma, all poultry farmers have to complete an educational component (http://poultrywaste.okstate.edu/oklahoma_regulations.asp) and a nutrient management plan for their land is mandatory. If a farmer does not have the land for the amount litter produced, they can advertise it on Oklahoma Litter Market (http://www.ok-littermarket.org/). This method helps poultry farmers find other nutrient deficient lands to apply their poultry litter to prevent over application on their lands.

BMPS FOR STORMWATER RUNOFF

When talking about the management of stormwater it has been shown that the most cost effective way to deal with a drop of water is at the point at which it touches the earth. As we develop the land and change the land use in a watershed, the natural hydrology and stormwater drainage patterns change as well. The ability of water to soak into the ground is also hindered greatly by most types of development including buildings, parking lots and roads which causes more stormwater runoff. Stormwater is therefore traditionally dealt with by routing it quickly away from developed areas into downstream where its volume becomes even more difficult to control. Stormwater runoff carries with it water pollutants

such and pet and animal wastes, soil erosion, oil and grease and other pollutants from the developed landscape directly into our waterways.

Goals of the BMPs dealing with stormwater management are to help water spread out near its source, soak it into the ground and filter through soils and vegetation to remove pollutants before it reaches streams, rivers and lakes.

Projects recommended in this Plan include the creation of rain gardens and bioretention basins. Rain gardens are non-engineered depressions in the low-lying areas of lawns and other landscape areas that are filled with intermittent water-tolerant plants (usually native) that soak up rain water run-off from yards, roof-tops and driveways. Bioretention basins are larger, semi-engineered and engineered detention basins filled with plants and shrubs that also help soak in and filter stormwater run-off from commercial and community developments. These low impact development (LID) techniques can not only reduce stormwater runoff but also enhance a landscape with more diverse plant and shrub species providing habitat for insects and birds.

In addressing onsite wastewater treatment system issues, TRLWQ has executed a successful program in the past with the cooperation of the Missouri DNR to help homeowners through cost-share to remediate their failing septic systems. Along with this, the "Pump-Out" program, educated homeowners about the importance of maintenance and getting their septic systems pumped out as well as provided a $50 rebate incentive. Upon the completion of this program, 27 onsite wastewater systems were replaced and 110 pump outs were completed. The homeowner education component was one of the most important steps in this process.

Another successful accomplishment that TRLWQ has been part of was the promotion and passing of the Stone County Point of Sale Ordinance for wastewater treatment systems. This requires an inspection of the septic system and completed property transfer certificate to make sure the system is functioning properly as it changes ownership. Stone County is now one of the few counties in the state of Missouri that requires an onsite septic tank inspection at the time of sale of the property. This new ordinance has been well-received in the public's eye and many community members are in favor of continuing it. Along with this, the Stone County Health Department now has a database that is documenting the location and types of septic systems on properties.

ACTIVITIES AND PROJECTS SPECIFIC TO THE WESTERN TABLE ROCK LAKE WATERSHED

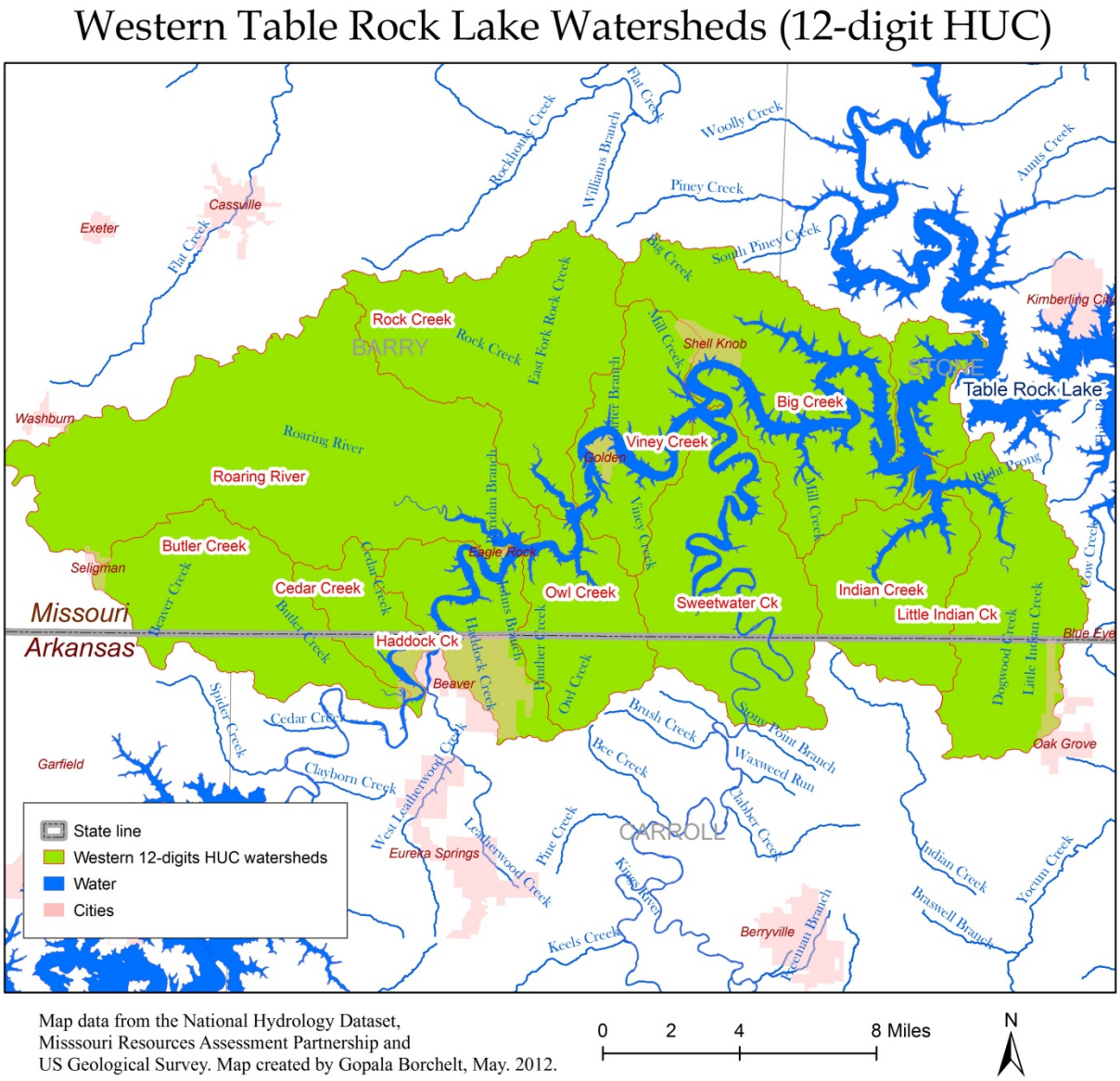


FIGURE8. WESTERN TABLE ROCK LAKE WATERSHED AREA. THE HYDROLOGIC UNIT CODES (HUC) 12 SUB WATERSHED AND NAMES ARE SHOWN. THERE ARE 11 HUC 12 SUBWATERSHEDS MAKING UP THE WESTERN PORITON OF TABLE ROCK LAKE: BIG CREEK - TABLE ROCK LAKE (110100011204), BUTLER CREEK (110100010801), CEDAR CREEK - TABLE ROCK LAKE (110100010803), HADDOCK CREEK - TABLE ROCK LAKE (110100010804), INDIAN CREEK (110100011202), LITTLE INDIAN CREEK (110100011203), OWL CREEK - TABLE ROCK LAKE (110100010806), ROARING RIVER - TABLE ROCK LAKE (110100010805), ROCK CREEK - TABLE ROCK LAKE (110100010807), SWEETWATER CREEK - KINGS RIVER (110100011107), AND VINEY CREEK - TABLE ROCK LAKE (110100010808).

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In a series of four stakeholder meetings, water quality problems and possible BMPs and solutions were discussed. Goals for the Plan were arranged into both short term and long term goals for watershed protection activities. Ultimately these goals were divided up into goals reasonable for the next 5 years and then goals for the next 10 to 15 years.

In order to plan activities and projects, priority areas within the Table Rock Lake watershed needed to be identified. This was done using several factors.

Factors used in determining the priority areas to focus projects and remediation efforts:

1. Proximity to Table Rock Lake and its tributaries. Agriculture dominates the Western Table Rock Lake Watershed and with this poultry production operations. Top concerns include the spreading of poultry litter close to water resources without adequate buffers to filter the nutrients.

2. Water quality monitoring data. Some of the larger tributaries to Table Rock Lake have shown a higher nutrient loading than that of the main channel of the lake. Although this higher loading is shown to partially originate upstream of the immediate watershed area that this Plan addresses, the lakeshore development in the large tributaries including Kings River is also a factor in the loading.

3. Land use factors such as impervious surfaces and densely populated, aging subdivisions. An assessment of 19 subdivision sites throughout Table Rock Lake watershed has shown that there are many aging subdivisions and several cleared and underdeveloped subdivisions that are potentially affecting water quality in their locations on the lake. Underdeveloped areas are often cleared of vegetation and left to erode soil into the lake. Some of the older subdivisions have older onsite wastewater treatment tanks that are often rusted, metal tanks or have failing drain fields.

Figure 9 illustrates the priority areas near Table Rock Lake based upon pastureland and open space which shows the land use types and percentages that are quantified within this 1,500 foot buffer. Within 1,500 feet of the lake, pasture/field areas make up 18% of the land use while the whole Western TRL watershed is approximately 21% (Table 2). So the shoreline area contains a large percentage of the total fields and pasture land surfaces in the Western portion of the Table Rock Lake watershed.

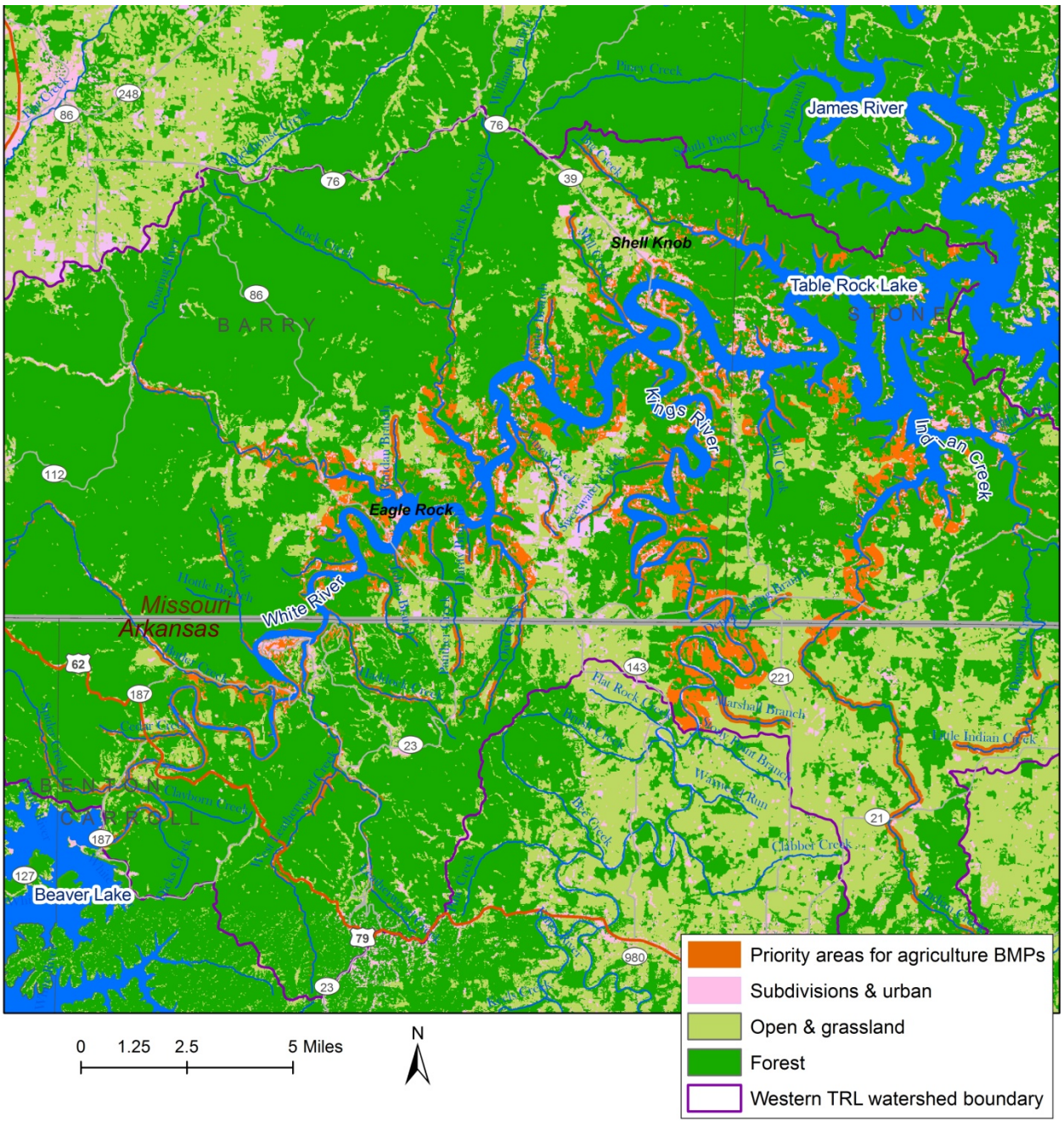


FIGURE 9. PRIORITY AREAS FOR AGRICULTURAL BMPS IN THE WESTERN TABLE ROCK LAKE WATERSHED.

Priority areas for onsite wastewater treatment systems remediation projects and education programs include the areas where older homes and subdivisions are prevalent around the lake. Some of these subdivisions are highlighted in the map in Figure 11. Subdivisions included are mainly those that have been established for more than 20 years, when septic systems were not as well regulated or not as much was known about proper installation and maintenance.

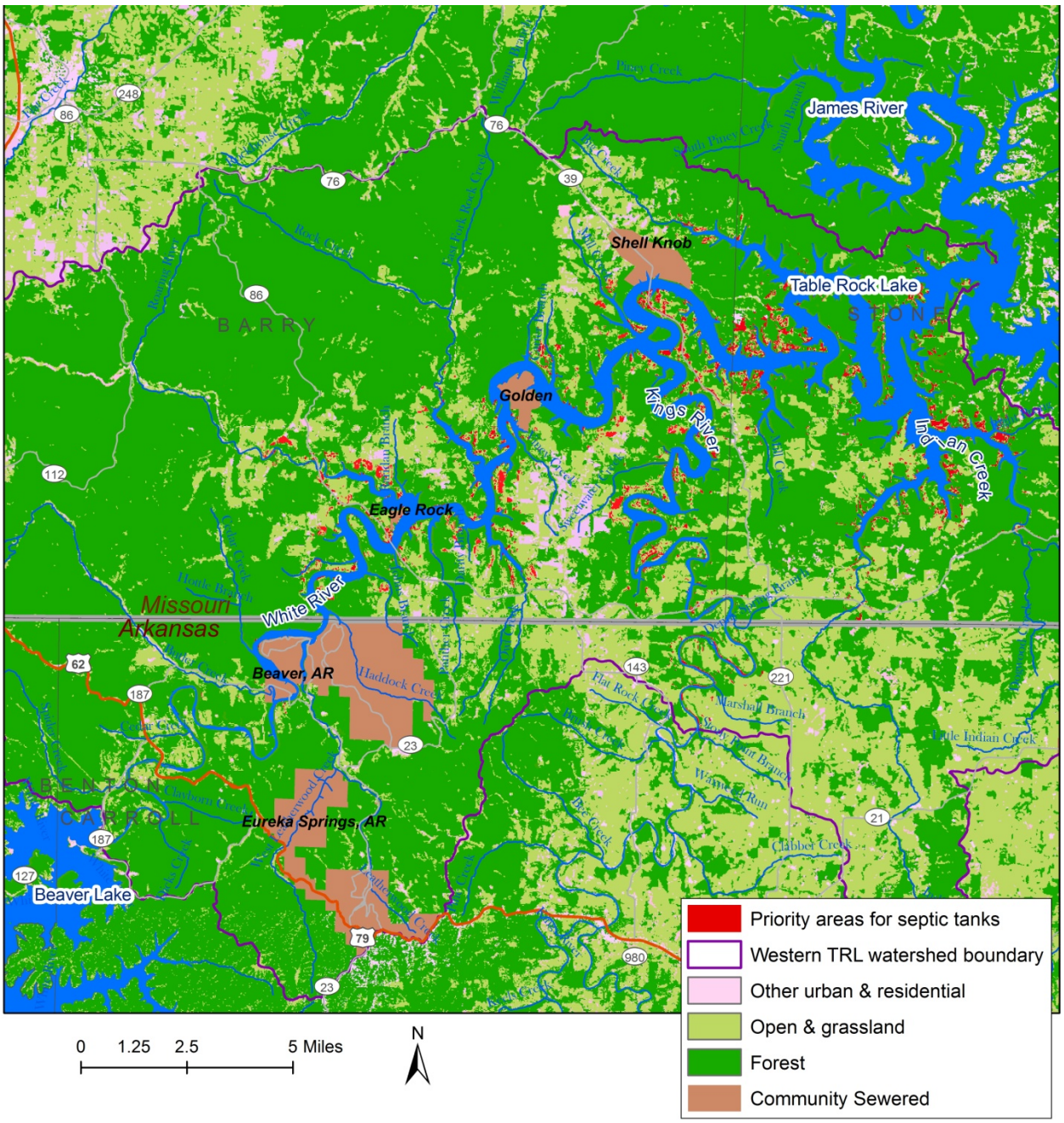


FIGURE 11. PRIORITY AREAS FOR SEPTIC TANK REMEDIATION IN THE WESTERN TABLE ROCK LAKE WATERSHED.

EDUCATION PROJECTS

Education of the local population and community leaders is critical to the success of all of the projects outlined in this Watershed Management Plan. Residents, visitors and businesses need to be aware of their impact on the watershed and also become aware of what they can do to prevent pollution and degradation of water quality. A top project for the Western Table Rock Lake Watershed was to organize a committee of stakeholders to facilitate discussions between local citizens, leaders of the agricultural community, and local watershed groups. Due to the lack of attendance from any of the agricultural community members to the stakeholder meetings, it was expressed that a group needed to be put together to start discussions. Agriculture is a huge economic factor in the Western TRL Watershed and this is recognized by all parties. By starting a committee to help bring in guest speakers about certain topics (i.e. poultry litter applications, riparian buffer strips, funding opportunities, etc) locals will gain a better understanding of resources they can use to help protect water quality.

Economic growth in the Table Rock Watersheds is driven by tourism and recreation which is an estimated 3 billion –dollar industry in Stone and Taney Counties (U.S. Army Corps of Engineer's Jim Sandberg). Table Rock Lake has an estimated 5 million visitors annually, supports over 100 resorts, 22 dock builders and 325 fishing tournaments per year. The health of Table Rock Lake is therefore the livelihood of many residents in the watershed.

Table Rock Lake watershed contains a large number of seasonal homeowners or vacation homeowners. Involvement of this section of the population in water quality activities and education presents additional challenges. A possible way to reach these part-time residents is by to hosting watershed education seminars at local marinas during peak tourist seasons. Seasonal homeowners are also very interested in protecting water quality and must not be overlooked in the public education and water quality protection projects.

Many residents and part-time residents, especially those closer to the shoreline, fish, swim and enjoy the water on a regular basis. They therefore have a personal interest in protecting the water quality of the lake as it is tied to their personal lifestyles, property values and economic wellbeing. Local stakeholders in the TRL Plan recognized the need for education on what activities local residents can do to protect water quality in conjunction with a mentorship program to help residents establish their own rain gardens, nutrient management programs and septic system maintenance schedules including other BMPs.

The Rain Gardens for Water Quality program will be done in conjunction with the LakeSmart Homeowner Certification program and Water Quality workshops programs shown in the Education Projects section and Table 5. This program will be aimed at promoting residents of the watershed to become involved in water quality protection through work on their own properties and homes. This allows for public education, participation and ownership of these best management practices (BMPs).

In addition to building rain gardens and controlling stormwater runoff, many homeowners in the Table Rock Lake area would benefit and help protect the lake by following a nutrient management plan. Lake area homeowners, as with many residential areas, enjoy beautiful, well-maintained lawns and gardens. Often there is a tendency to over apply fertilizers or apply the same treatment of fertilizers year after year to the lawn while this may not be needed. Residential neighborhoods also differ significantly from one another in their establishment of fertilized and manicured lawns. These are more often associated with more affluent neighborhoods and have a pattern of being located closer to the shoreline of the lake. The Nutrient Management Plans for Yards program would target areas that have more densely populated subdivisions with a large number of fertilized yards. This program's approach will follow the outline of the current City of Springfield's *Show Me Yards* program and the James River Basin Partnership's *Get Tested* soil test program. Each of these programs provides the homeowner with a detailed, multi-year plan for adequate nutrient application tailored to their own properties.

TRLWQ has performed a Septic Tank Pumpout program in the past which proved to be very beneficial in promoting septic maintenance education in the Table Rock Lake area. Surveys of the participants in this program showed an increase in public awareness of the negative impacts that failing septic systems can have on water quality. They also showed an increase in awareness of the need for proper and regular septic system maintenance. The number one motivator for individuals to participate in this educational program, however, continues to be the $50 rebate incentive for having their septic tank pumped out (usually covers 1/3 of the cost). TRLWQ receives regular calls inquiring if the program is still in effect. Instead of an individual home visit by water quality program staff, the project shown in Table 8 would require attendance by the homeowner in a short septic maintenance seminar or workshop in order to receive their certificate for a pump out rebate.

The TRL Watershed Management Plan's Stakeholder committee recognized the importance of team work and partnerships in tackling the multiple tasks of water quality protection. The use of local talent, college and university programs for students and currently completed and relevant educational curriculum were all highlighted as potential resources for this Plan. The Capacity building: Student Internships program (Table 5) will provide opportunities for local college and university students to gain knowledge and experience in many aspects of watershed protection. When a student participates in the program, they will not only gain experience in working with the public in activities and events coordination, but will also be able to do science-based work such as water quality data analysis and research. In addition to the experience gained by students, local watershed protection organizations will gain always much-needed assistance with projects and events.

There is a wealth of information and education curriculum available for water quality protection programs available from organizations such as the Missouri Department of Conservation, MO Department of Natural Resources, University of Missouri Extension, University of Arkansas, Beaver Water District, James River Basin Partnership, EPA, USDA,

NRCS and other agencies and organizations. The Watershed-Based Education Curriculum program will pull together the information pertinent to the Table Rock Lake watershed and provide a comprehensive water quality curriculum for teachers, educators and the community. This curriculum will be useable to reach grade level science requirements for teachers and educators.

Without accurate and long-term data the water quality improvements in Table Rock Lake will not be accurately measured or monitored. This Plan therefore lists the establishment of a voluntary water quality monitoring network throughout the watershed as one of its projects. This network will have a coordinating position sponsored by a local water quality organization to help direct and drive to volunteer network and ensure long-term monitoring in achieved. The program will link the established Missouri Stream Team program and the Lakes of Missouri Volunteer Program's established water quality analysis facilities to produce useable and scientifically proven water quality monitoring data.

TABLE 5. EDUCATION PROJECTS FOR THE WESTERN TABLE ROCK LAKE WATERSHED.

Project	Description	Funding Sources	Responsible Party, Partnerships-needed	Number of events and/or projects	Monitoring for success/expected reduction in nutrient loading
Committee to hold workshops and discussions between watershed groups & agricultural groups.	This committee would facilitate discussions between the local citizens and leaders of the local agricultural community. Topics would include how to implement best management practices to protect water quality while minimizing costs to the farmer.	This would be a volunteer committee.	TRLWQ, Roaring River Parks Alliance, local city councils, local Farm Bureau representatives, local citizens	Quarterly meetings with introduction of guest speakers for public to encourage new knowledge on issues	Tracking attendance for meetings, online surveys after meetings to aid feedback on progress and suggestions for improvement
Capacity building and student internship opportunities	Provide positions for students to build experience and assist in watershed protection projects. Community service opportunities for students are plentiful in the watershed protection efforts of organizations such as TRLWQ, which often have limited staffing abilities.	TRLWQ and other local watershed organizations will offer internships through some of their existing projects and grant-funded work.	TRLWQ, OWW and other local watershed groups will work with local university and college programs offer projects for students to build experience and enhance hands-on education.	The yearly goal is to offer 2 internship positions working in water quality protection activities.	Internship participation and effective project completion will be measures of the success. Additional measures will be the number of hours spent by interns on watershed protection activities.
Create unified, watershed-based water quality education curriculum.	Create/combine presentations and/or tutorials of the many available water quality/quantity conservation techniques and resources available. Tailor these subjects to the needs and interests of all different types of local audiences; homeowners, business owners, real-estate, government, municipality etc.	TRLWQ will seek assistance through local universities, education grants, corporate sponsorships and partnerships with other local and regional watershed groups.	Local watershed groups, Missouri Department of Conservation, Missouri DNR, etc.	Education and curriculum materials will be shared and incorporated into other projects including the water quality workshops.	Ongoing presentation will be evaluated by follow-up surveys for student, presentation attendees and online surveys
Water Quality Workshops within the local TRL Watershed	Training for local residents on Low-impact Development (LID) techniques for homes businesses. This will also involve local service providers related to LID including landscapers, excavators, wastewater pumpers.	319 program-LakeSmart Grant (TRLWQ); ongoing years through TRLWQ and community partners	TRLWQ, Collaboration with the City of Springfield's, MO Show-Me Yards Lawn Care Professionals Certification Program.	First WQ Fair by summer 2014; workshops at 2 per year; ongoing to continue education	Evaluation completed through surveys of participants in the training and workshops. These evaluations will be used to enhance the effectiveness of the workshops as a public education tool.
LakeSmart certification program	Develop "LakeSmart" kits for homeowners that includes rain garden plans, proper yard maintenance , septic maintenance and eco-friendly products that they can readily incorporate into their own homes to help them become eco-friendly homes.	Initial 3 years will be funded through 319 (to TRLWQ), community funds, volunteers in fields of landscape design, gardening, and wastewater and stormwater systems.	TRLWQ will seek partnerships with local landscape and home improvement entities to provide the components of the LakeSmart kits.	Ongoing Yearly goal of this project will be to get 20 participants in the LakeSmart certification program.	This project will be considered a success based upon homeowner participation and eventually project self-promotion by neighbors and participants. Success is measured through participant feedback and requests for evaluation of their work on the LakeSmart kit activities.

NUTRIENT REDUCTION PROJECTS

Nutrient reduction projects included in this Plan for the Western portion of the Table Rock Lake watershed are focused on reduction of agricultural runoff and wastewater facilities pollution. Two of the projects in the Plan, which are outlined in Table 6, are centered on agricultural runoff. These are the completion of nutrient management plans for property owners and participation in EQIP to implement BMPs to prevent agricultural runoff.

Putting these two projects together would benefit the agricultural producers the most. By completing a nutrient management plan first, with the aid of the Natural Resource Conservation Service (NRCS) or the local Soil and Water Conservation Districts (SWCD), an accurate plan for each property owner can be put together on the amount of fertilizer/manure that can be applied to their land.

This Plan's goal for the nutrient management plans is to complete 5 per year starting in 2013. The stakeholder committee, mentioned in the Education Projects section above can is a great tool to introduce the nutrient management plans to local landowners and provide the knowledge and education on the topic at public meetings.

Once a nutrient management plan is completed then the landowner may qualify for certain incentives to implement BMPs. The Environmental Quality Incentives Program (EQIP) is a voluntary program that promotes certain conservation practices for up to 10 years on any piece of property. Many of these projects for this program are used to protect local waterways. EQIP is sponsored by NRCS.

Local SWCD also provide programs that landowners can use to protect their land value and water quality. Some of their available programs include permanent vegetative cover management, planned grazing systems, and resource protection through livestock exclusion. Participation in these programs can help prevent farmland erosion and nutrient runoff. This will help protect the water quality downstream.

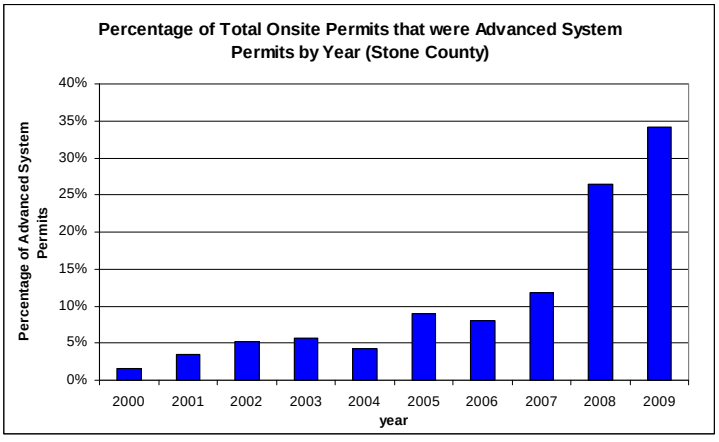
The nutrient reduction short-term goals for nutrient management plans and vegetative buffer restoration are a 15% reduction in nutrient loading from areas where more than one BMP is implemented. By using GIS modeling of site locations and information provided by the participants on the dimensions and size of their BMP area, an estimation of the amount of nutrient removal from the Table Rock Lake system can be calculated. The STEPL model estimates that manure-applied cropland may have runoff nutrient concentrations of 12 to 18 mg/L of TN and 3 to 4 mg/L of TP (manure is not specified and cattle, hogs of poultry). The model does not, however, have the option for estimation of the nutrient input from land-applied manure to pasture areas, a common practice in the Western TRL watershed. With 18% of the area in close proximity to Table Rock Lake being open pasture, land applications of poultry litter to these areas many heavily impact the water quality.

The key to maintaining proper wastewater treatment and protecting water quality is to provide adequate maintenance of the wastewater treatment system. Whether it is an onsite wastewater systems or decentralized community wastewater treatment plant, a common problem in regard to water quality contamination for both surface and ground water is the lack of ongoing and adequate maintenance of the system by the user or owner. This plan therefore will promote the adoption by medium to large community wastewater treatment plants to join with the non-profit cooperative, Ozarks Clean Water Company, for ongoing maintenance. Establishment of an RME (Responsible Management Entity) for this ongoing maintenance and often DNR reporting requirements will ensure that this critical task is properly continued and the treatment system is kept in compliance with changes in regulations.

Passage of a point-of-sale ordinance for septic systems in Barry County will ensure that long-time failing and outdated septic tanks eventually are addressed and fixed as they change ownership. This type of ordinance has been passed and well received in Stone County and has helped the county provide better water quality protection, home buyer and seller assistance and public health protection. Stone County Health Department reports approximately 24 well samples tested positive for E. coli in their water systems for 2010. These numbers were only those where the property owner elected to take a water sample for analysis and most of these could be attributed to failing septic systems.

As new technologies are being accepted and proven for wastewater treatment, new and replacement septic systems in Stone County are seeing a shift from the conventional, gravity-fed tank and drain field to more advanced treatment systems. The advanced treatment systems contain, in addition to a septic tank, a pretreatment chamber with aeration to promote digestion of wastewater by bacteria. Pretreated wastewater is then pumped into dispersal lines or drip irrigation lines which spread it out in the soil for final treatment. Whether an advanced treatment or a conventional septic system is installed on a particular property depends upon the soils at that site. Since southern Stone County near Table Rock Lake often has very thin and rocky soils, many new advanced treatment systems are being installed in the southern portion of the county. These systems are required depending on soil analysis and provide much better wastewater treatment than the conventional septic system. The downside to advanced treatment systems, besides additional maintenance requirements, is costs, which is usually double or triple the cost of conventional systems.

CHART SHOWS INCREASE IN THE PERCENTAGE OF STONE COUNTY SEPTIC PERMITS THAT HAD ADVANCED TREATMENT FROM 2000 TO 2009.



In order to assist homeowners with cost to remediate their failing septic system in the Table Rock Lake watershed, the Plan calls for a revolving fund to be available to area homeowners. This program will provide assistance based upon financial need and will be a combination of grant and loan depending on income and ability to repay. Ozarks Water Watch in partnership with TRLWQ is currently administering a loan and grant program funded through the MoDNR's State Revolving Fund program to provide cost-share to residents of the Upper White River Basin. This project will remediate at least 100 inadequate and failing septic systems by the end of 2013. Estimated nutrient reduction from the replacement of 100 failing septic systems can be calculated based upon typical nutrient concentrations in household wastewater, average family water usage. This number has been estimated from pervious projects as approximately 9.4 lbs/yr of TN and 2 lbs/yr of TP (Onsite System Identification and Remediation Project, G08-NPS-13).

Upon completion of the cost-share program and remediation of 100 septic systems, expected nutrient load reductions are 940 lbs/yr of TN and 200 lbs/yr of TP.

Other nutrient reduction projects included in this Plan for the Western portion of the Table Rock Lake watershed are focused on reduction of stormwater runoff pollution and wastewater facilities pollution. Two of the projects in the Plan, which are outlined in Table 6, are centered on stormwater runoff. These are the Rain Gardens for Water Quality program and the LID Landscaping Demonstration project.

The Rain Gardens for Water Quality program, in conjunction with the *LakeSmart* Homeowner Certification program and Water Quality workshops (a program of the current Table Rock Lake Community Stormwater Demonstration Project), will promote individual adoption of stormwater reduction measures. This program will help reduce stormwater runoff from residential areas primarily and will focus on areas that have more densely populated subdivisions such as those shown in Figure 11. Features of this nutrient reduction project will include information, resources and plans for homeowners and business owners for implementing rain gardens, rain barrels, detention basins and nutrient management plans. An incentive for follow-through and follow-up by participants in the project will include a certificate and recognition as a *LakeSmart* business or *LakeSmart* home. This program will eventually be incorporated into the local community or city planning department as an ongoing policy.

The nutrient reduction goal for the Rain Gardens for Water Quality program is 15% reduction in the nutrient loading from areas where multiple rain gardens have been established. This goal will be monitored using GIS and modeling of the site locations and information provided by the participants on the dimensions and size of their rain garden. The size, shape, location and components of these voluntarily implemented BMPs are highly variable and therefore expected nutrient reductions from this project are not accurately predictable until after they have been completed.

LID (low impact development) Landscaping Demonstration Project will work with local resorts, marinas, parks and cities to install 26 demonstration sites near Table Rock Lake. These sites will capture stormwater runoff from development and filter it through vegetation and soil to remove pollutants and sediments such and nutrients, oils and grease, fertilizers, pesticides and herbicides. Lab and field experiments conducted by the University of Maryland in conjunction with Prince George's County Dept. of Environmental Resources found that properly designed and constructed bioretention cells are able to achieve excellent removal of heavy metals: typical copper (Cu), zinc (Zn), and lead (Pb) reductions of greater than 90%. A mulch layer (highly organic-more acidic) is credited with most of this uptake. Phosphorus removal appears to increase with depth of the soil in the retention basin and reach a maximum of approximately 80% removal by about 2 to 3 feet in soil depth. This is due to phosphorus being bound to clay minerals in the soil. Nitrogen removal also appears to depend on depth but showed an average removal around 60%.

The Table Rock Lake Community Stormwater Demonstration Project (aka the *Table Rock LakeSmart Project*) is currently ongoing and has installed a demonstration site in Kimberling City at the Port of Kimberling Resort. This site drains approximately 7 acres of highly impervious/urban, sloped land. Using the dimensions and establishment of this first site, the Plan estimates that the remaining 25 sites planned for the project will capture an estimated additional 175 acres of this developed area for a total of 182 acres of urban land use treated with stormwater bioretention features. With up to 60% nitrogen and 80% phosphorus being captured in studies of bioretention basins, the Table Rock LakeSmart Project can be estimated to reduce nutrient pollution by at least 50% per acre, leaving room for error or slight imperfections in installation or maintenance since these will not be completed in a study environment.

Expected nutrient loading from 182 acres of urban land use in the Table Rock Lake watershed according to the STEPL model is approximately 1,683 lbs/yr for total nitrogen (TN) and 234 lbs/yr for total phosphorus (TP) with moderate soil infiltration conditions and slope. The Table Rock LakeSmart Project is therefore expected to reduce yearly nutrient loading to Table Rock Lake by at least 842 lbs for TN and 117 lbs for TP once all 26 sites (182 acres) are completed.

TN loading from 182 urban acres	TP loading from 182 urban acres	Reduction in TN	Reduction in TP
1683 lbs/yr	234 lbs/yr	842 lbs/yr	117 lbs/yr

TABLE6. NUTRIENT REDUCTION PROJECTS FOR WESTERN TABLE ROCK LAKE WATERSHED.

Project	Description	Funding Sources	Responsible Party, Partnerships-needed	Number of events and/or projects	Monitoring for success/expected reduction in nutrient loading
Completion of nutrient management plans for local farmers and landowners	Assistance would be provided by TRLWQ and the Natural Resource Conservation Service (NRCS) to help agricultural producers complete a nutrient management plan.	To aid TRLWQ in writing plans: 319 funding would be applied for; with a completed nutrient management plan, agricultural producers would be eligible for EQIP funding (from NRCS)	TRLWQ, NRCS, possibly Missouri Department of Conservation, local agricultural producers	Complete 3 nutrient management plans per year starting in 2014; project completion 2020.	Pre- and post-surveys for agricultural producers on nutrient management plan components; follow-up to check if nutrient management plan guidelines are being followed.
Encourage participation in EQIP programs for Animal Feeding/Waste Operations Applications.	Program encourages BMPs such as maintaining nutrient management plans, implementation of buffers, proper disposal of waste, etc.	NRCS, possible 319 funds through MDNR through project with TRLWQ	Agricultural producers, NRCS, TRLWQ, MDNR	Implement 3 BMPs for specific nutrient management plans per year starting 2015. With 3 nutrient plans per year & 3 BMPs per plan = 9 BMPs per year starting in 2015.	Tracking the number of BMPs installed and mapping their locations; long-term monitoring of waterways may be used to see actual nutrient reduction. Goal for nutrient reduction is at least 15% reduction in nutrient loading in areas that have multiple BMPs installed.
Upper White River Septic Remediation Program	Financial assistance to homeowners with failing septic systems through grants and no-interest loans	State Revolving Funds, in partnership with TRLWQ and Ozarks Water Watch	Missouri DNR, Ozarks Water Watch, Missouri Department of Conservation, and TRLWQ Completion by 2016	Complete 100 septic system remediations in 5 yrs	Number of systems successfully replaced, repayment of loans to continue the program, estimation of the amount of phosphorus removed from potentially impacting the watershed
Septic Tank Pump-Out Program with Homeowner Education	This program would offer educational sessions and the possibility of a $50 rebate incentive to any homeowner who has their septic tank pumped out. The homeowner would be required to attend a half-day workshop on onsite system types and maintenance required.	TRLWQ and the State of Missouri Department of Health and Senior Services, through Missouri Department of Conservation, and DNR project funding	TRLWQ, Missouri DNR, Missouri Department of Conservation, County Health Department, Homeowners Associations, community governments, local pumper and wastewater industry professionals	500 participants in 5 years (100 per year)	Track the number of pump-outs and completed surveys from the half-day workshops to observe what the homeowners had learned. A follow-up survey and pump-out rebate request form will determine how many homeowners follow-up with the pump-out program. Modeling and typical nutrient concentrations in wastewater will be used to determine the expected nutrient load reduction to the watershed.

Project	Description	Funding Sources	Responsible Party, Partnerships-needed	Number of events and/or projects	Monitoring for success/expected reduction in nutrient loading
Establish an RME (Responsible Management Entity) for community wastewater plants	Promotion of medium to large cluster treatment plant operations and new treatment plant constructions that are currently managed by developers or HOAs to join with Ozarks Clean Water Company for ongoing maintenance.	Contracts would be worked out between the individual homeowner's associations (HOAs) and OCWC	Local homeowner's associations, OCWC, and TRLWQ. Initially, outside funding may be needed in order to bring a failing plant up to adequate treatment standards.	This project will be ongoing. Since turning over management of cluster treatment plants is voluntary, the goal is low—1 plant per year.	An increase in the number of plants managed by OCWC to ensure that wastewater is being properly treated. Nutrient loading reduction will depend on the severity of failure and subsequent remediation of the treatment plants.
Pass a point-of-sale ordinance for septic systems in Barry County.	Pass a Point-of-Sale Septic Tank Ordinance similar to the one in Stone County. This would require cooperation amongst all parties involved in regulation of onsite systems in the county. Build an onsite wastewater database for Taney County	Either 319 funds, State Revolving Funds, or local community funding (or a combination) are needed for this project	Barry County Health Department, Barry County Planning Commission, Barry County Commission, TRLWQ and Stone County	Process to begin discussion and cooperation within 5 years. Complete in 5 to 10 years. This type of change may take many years to implement.	Passage and implementation of a point-of-sale ord. for tracking proper maintenance of septic systems. Successful setup and training of staff on use of database for TC Health Department, being able to track the status and number of onsite systems in the county.
Rain Gardens for water quality program (Homeowners)	Provide resources and instructions for homeowners to install their own rain gardens on their properties as part of an overall stormwater prevention campaign which includes the homeowner certification program.	319 Grant with DNR & TRLWQ for promotional components, in cooperation with local area residents for installations	TRLWQ, homeowners, partnerships with the local county, cities, Homeowner associations and chambers of commerce	Goal: 15 per year, for 3 years and ongoing after that (total of 75 rain gardens in 5 yrs)	TRLWQ will pursue opportunities to focus multiple rain gardens on priority areas identified in the Plan. Goal: 15% reduction in nutrient runoff from project areas where multiple plantings have occurred; Visual inspection, modeling will be used to measure achievement of goals.
LID landscaping demonstration sites (Table Rock LakeSmart Project)	Install stormwater bioretention and vegetative buffer facilities in areas with highly impervious surfaces. These locations will be in areas down-slope from parking lots, drainage areas, developed residential or commercial land, and public recreation areas.	319 Grant with DNR & TRLWQ in cooperation with local community businesses and government	TRLWQ, U.S. Army Corps of Engineers, resort owners, businesses, homeowners associations and local municipalities	Goal: 26 demonstration sites by 2015. Estimated 7 acres of runoff captured per site (182 acres addressed in this BMP project)*	Goal: 50% reduction in the nutrient runoff from project areas where demonstration sites have been installed. Nutrient reduction will be estimated through modeling using expected nutrient retention data, BMP site dimensions and drainage area characteristics.

MONITORING FOR WATER QUALITY IMPROVEMENTS AND FUTURE WATERSHED PLANNING

Establishment of water quality standards (WQS) is essential for successful monitoring and evaluation of water quality improvements in a watershed. Once established, numeric WQS assist States in producing Total Maximum Daily Loads (TMDLs) for watershed and also produce permits to control nutrient levels. Water Quality Standards for Table Rock Lake are 0.009 mg/L TP, 0.253 mg/L TN, and 0.0026 mg/L CHL. There are currently some areas in the Table Rock Lake watershed that exceed these water quality standards in their average/mean nutrient and chlorophyll levels. As shown in the Water Quality Conditions section above and in Table 7, nutrient concentrations vary greatly from one area of the lake to another across the large watershed of Table Rock Lake. So nutrient reduction activities will need to be directed by adequate and accurate, long-term water quality monitoring to identify the locations in the lake that have higher nutrients and chlorophyll.

TABLE 7. WATER QUALITY STANDARDS LISTED FOR TABLE ROCK LAKE, PENDING EPA APPROVAL, COMPARED TO AVERAGE WATER QUALITY IN SECTIONS OF THE EASTERN PORTION OF TABLE ROCK LAKE. HIGHLIGHTED ARE ABOVE WQS.

Average concentrations for 2009 and 2010	Table Rock Lake numeric WQS	Concentrations at main channel of Eastern TRL	Concentrations at the mouth of James River	Concentrations at Long Creek arm
Total Nitrogen (mg/L)	0.253	~0.524	.0567 - 0.573	0.592 - 0.694
Total Phosphorus (mg/L)	0.009	0.005 - 0.007	0.011	0.014 - 0.015
Chlorophyll (mg/L)	0.0026	0.004 - 0.005	0.007 – 0.008	0.009 - 0.011

Element b of the EPA's 9 key elements to a watershed management plan (pg 4 above) calls for an estimate of the nutrient load reductions from the projects in this Plan. This requires allocation of the nutrient contributions from the various sources that results in the total nutrient load in the watershed. Since Table Rock Lake is positioned in the middle of the Upper White River Basin watershed, the contributions of watersheds upstream of Table Rock Lake must also be considered in the total loading. Also since Table Rock Lake receives water and nutrient loading from multiple large tributaries whose watersheds lie outside of the immediate surrounding TRL watershed addressed in this Plan, the loading contributions from these tributaries must be considered.

So the total nutrient loading in Table Rock Lake is not all accounted for by the land area within the Eastern and Western portions of the immediate watershed that is addressed in

this Plan. This Watershed Management Plan therefore focuses on reducing nutrient loading coming from the localized watershed surrounding the lake and measures success of projects based upon the total nutrient reduction accomplished by the projects and BMPs implemented. This approach is also accompanied by long-term and more widespread monitoring of the water quality in Table Rock Lake and its tributaries in order to monitor the contributions of nutrients coming from the tributary watersheds and those from the localized Table Rock Lake Watersheds.

Currently there are several organizations that are gathering water quality data in the region including the Lakes of Missouri Volunteer Program which collects water quality data from lakes throughout Missouri during the spring and summer months. The LMVP has been collecting data on Table Rock Lake for about 20 years. These data have enabled stakeholders to show the changes to the water quality in the lake. This Watershed Management Plan will expand the data collection to the tributaries by linking the established Missouri Stream Team program and the Lakes of Missouri Volunteer Program's established water quality analysis to produce useable, long-term water quality data.

Through several of the implementation projects in this Plan, TRLWQ will build a model to determine the estimated nutrient load reductions caused by the BMPs such as bioretention basins, rain gardens and vegetative buffer areas. In addition, the septic remediation projects will estimate the potential nutrient loading reductions based upon the amount of wastewater being properly treated rather than failing to a nearby stream or to groundwater.

Increases in public awareness of water quality issues and changes in behavior to protect water quality are components that are difficult to monitor, but very important to acknowledge. TRLWQ and other watershed groups have been successful in promoting public awareness of water quality issues and the need to work together to solve the issues. Many citizens feel their voices and activities are not heard, so watershed groups can help represent communities and citizens that want to make a difference and change water quality for the better. Monitoring through surveys at various events, online communication and second-hand watershed information requests from entities such as County Health Departments, City Councils, County Commissions and chambers of commerce are all indicators of successful public information and education.

As water quality monitoring is increased and projects and education activities are implemented, the Table Rock Lake Watershed Management Plan is designed to be updated to reflect progress and reset priorities and goals. Parties responsible for changes and updates to the WMP include all stakeholders in the Table Rock Lake Watershed. Specifically responsible are watershed conservation groups such as the Table Rock Lake Water Quality Inc., regulatory agencies such as county health departments, county planning and zoning committees and groups directly dependent upon the water quality for their livelihood such as resorts and outdoor recreation outfitters.

Table Rock Lake Water Quality, Inc. and other stakeholders are eager to take immediate responsibility for implementing and updating this WMP. TRLWQ proposes to update this document by 2014. This will allow for the completion of the many short-term projects listed in the Plan and a reassessment of progress and direction for long-term watershed protection activities.

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APPENDIX I

TABLE 8. STAKEHOLDER COMMITTEE MEMBERS:

Name	Affiliation	Name	Affiliation
Rita Hlansey	Garden Club	Nita Fredsbo	Garden Club
Loren Patterson	Lake View Acres	Bob Rickey	Roaring River Parks Alliance
Barbara Harmony	Leatherwood Creek	Rick Balsley	Trace Hollow Resort
Connie Balsley	Trace Hollow Resort	Pat Costner	Leatherwood Creek
Dave Steinman	St. John's – Cassville	Chris Fischer	Leatherwood Creek-AR Forestry Commission
Rodney Raley*	USACE	Donna Mulkey*	
Jim Sandberg*	USACE	Tracie Snodgrass*	
Mike Snodgrass*		Jim Riedel*	Roaring River Parks Alliance
Sharon Riedel*	Roaring River Parks Alliance	Melissa Bettes*	JRBP

*** = Members added after first meeting**

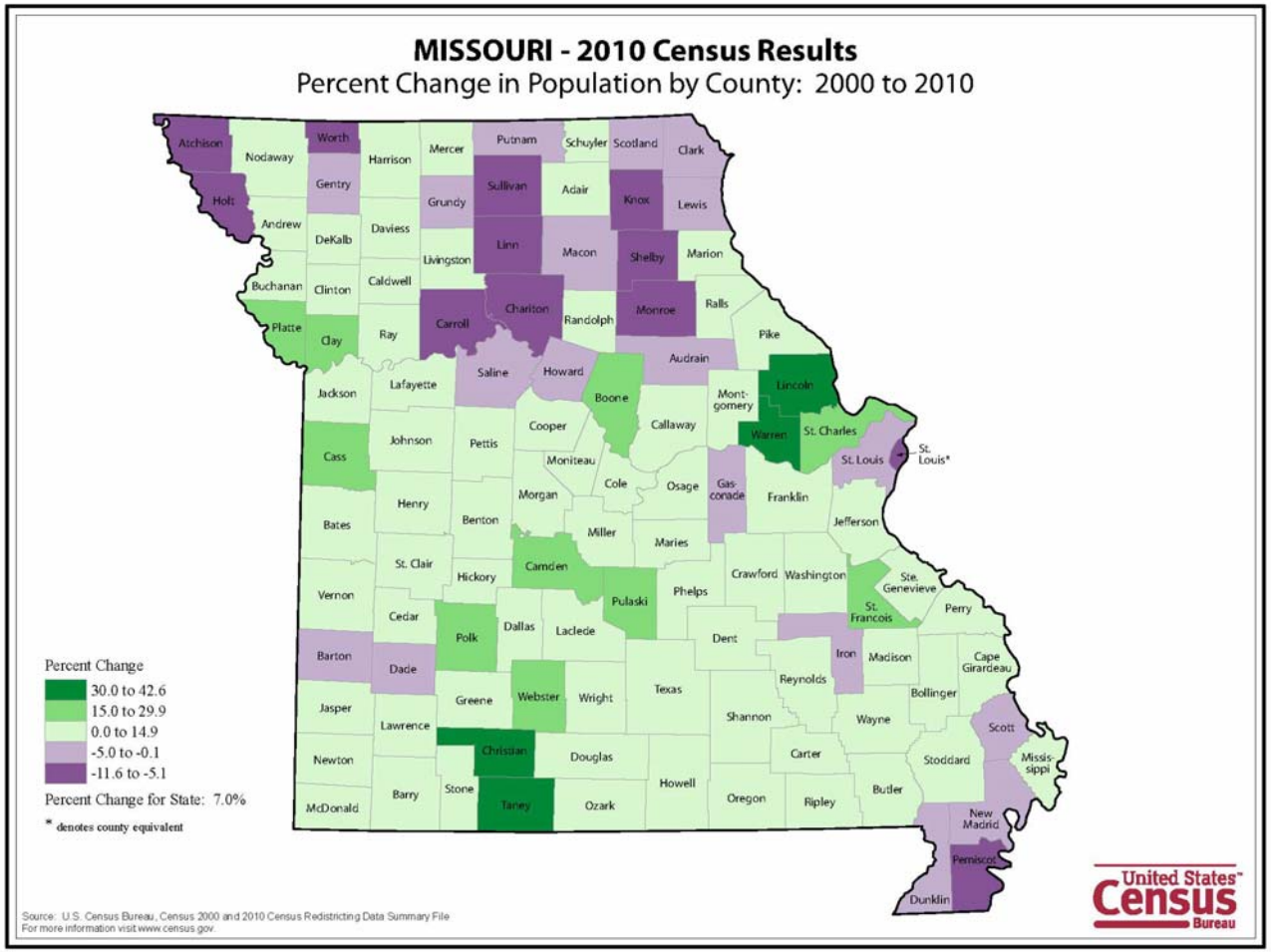

FIGURE 12. U.S. CENSUS DATA FOR MISSOURI SHOWS THAT THE COUNTIES CLOSE TO THE LAKE EXPERIENCED A SLIGHT TO LARGE INCREASE IN POPULATION, I.E. CHRISTIAN AND TANEY COUNTIES.

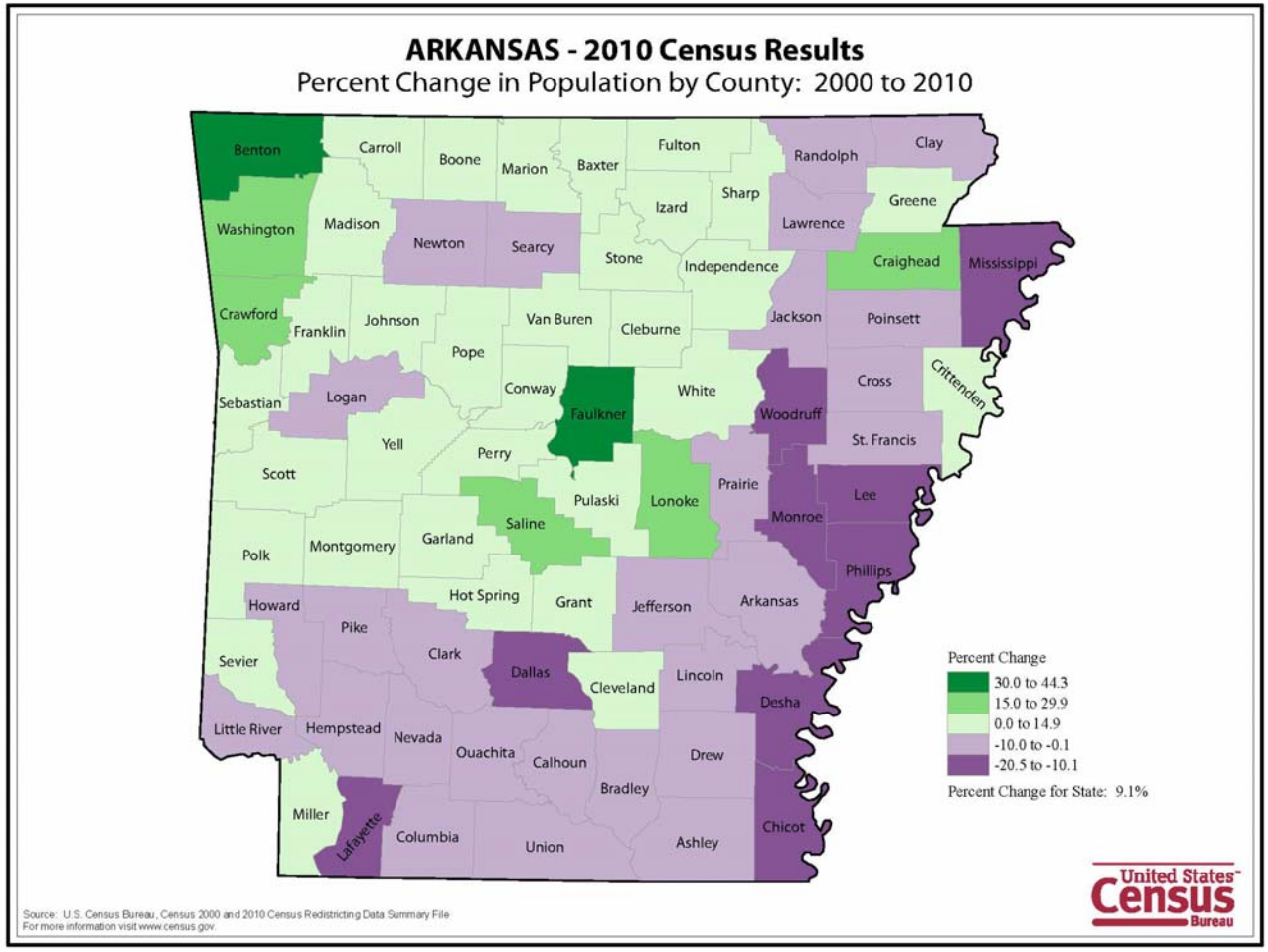

FIGURE 13. U.S. CENSUS DATA FOR ARKANSAS SHOW THAT COUNTIES SURROUNDING BEAVER LAKE EXPERIENCED A LARGE POPULATION GROWTH WHICH ULTIMATELY WILL AFFECT DOWNSTREAM WATER RESOURCES INCLUDING TRL.

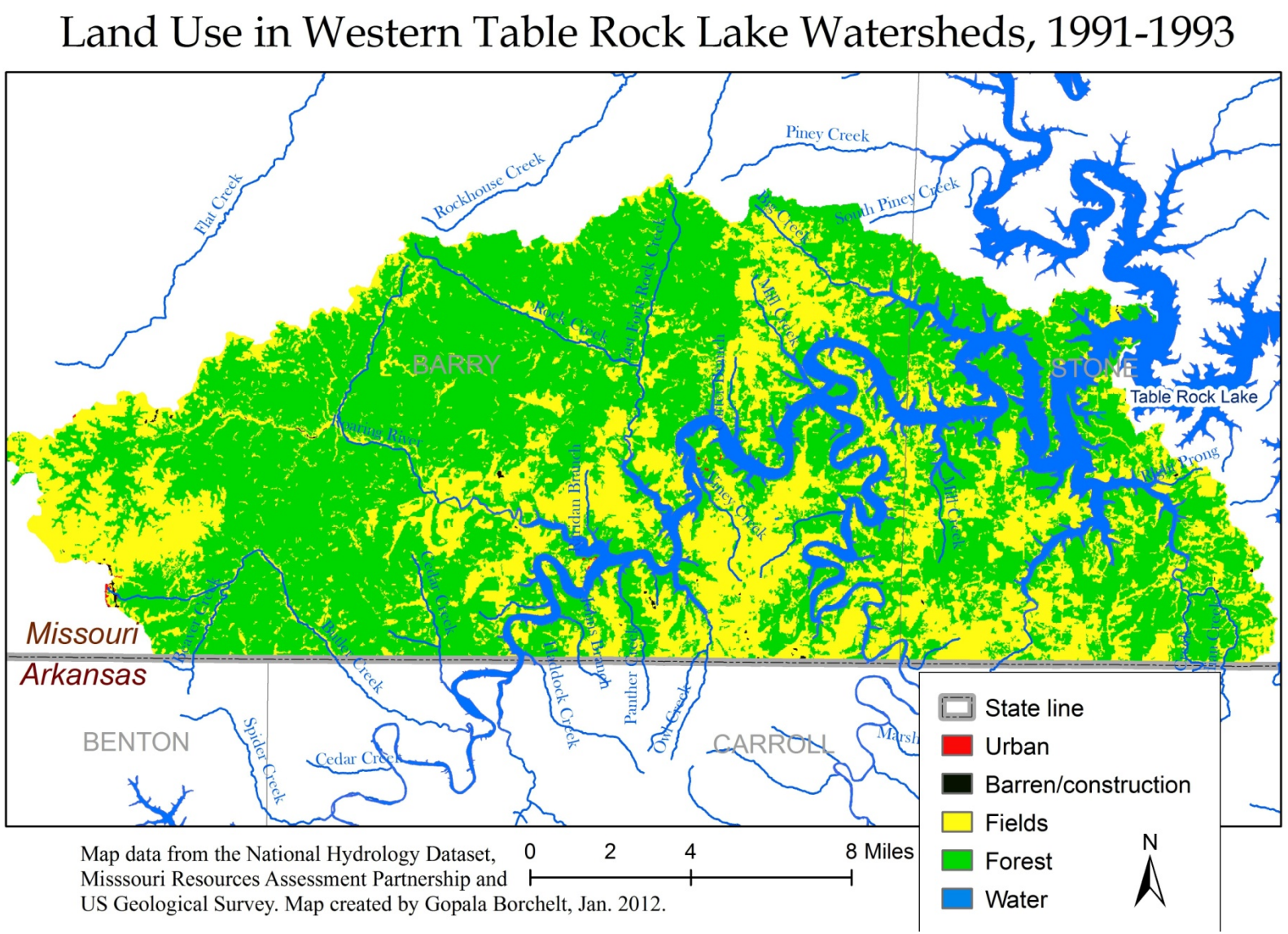

FIGURE 14. LAND USE IN THE WESTERN TABLE ROCK LAKE WATERSHED FROM 1991-1993.

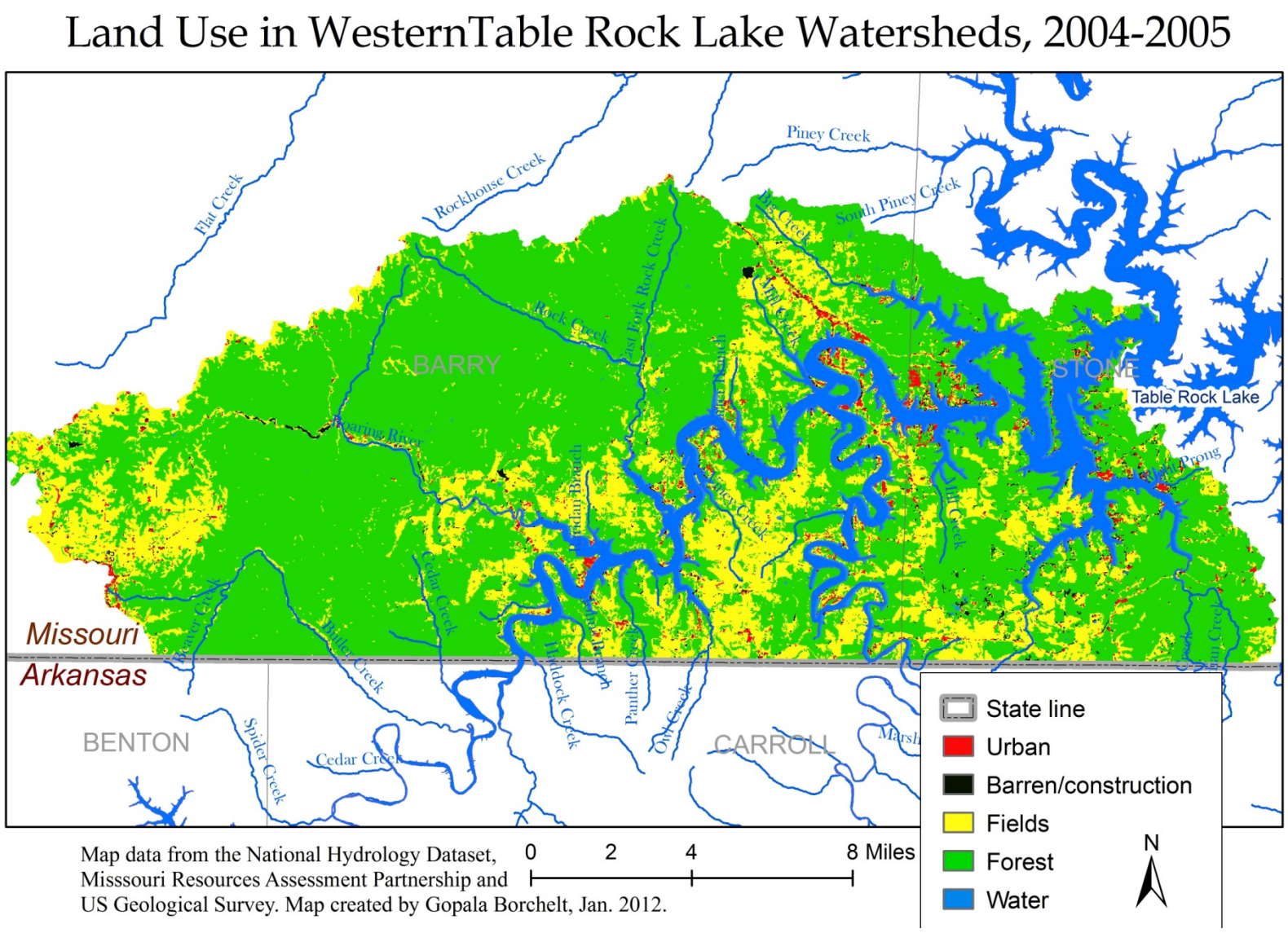

FIGURE 15. LAND USE IN THE WESTERN TABLE ROCK LAKE WATERSHED FROM 2004-2005.

TABLE 9. SUMMARY OF VISUAL SURVEY (PAGES 46-48).

Date of Observation	Location Name	Type & Condition of Housing Structures	Main Road Surfaces	Any new construction or cleared, undeveloped sites	Estimate Percent lots built-out	Central WWT or septic systems	Noticeable run-off problems, erosion controls	Condition of vegetation buffer	Other comments
5/21/2012	Kings River West	Single family; large, medium & small; new and old; well maintained. Hickory Hollow Resort and Kings River Golf Course 18 hole	paved roads	cleared sites, some new construction	lake front 90%+; non-lake front 20%	no central WWT system observed	dock parking lot	significant amount of mowed grass to lake's edge	golf course covers entire pennisula
5/21/2012	Hwy 39/Viola	single family- mix of old an new - mix of small, medium and large; a few mobiles and several cabins. Small number in disrepair (unkept)	main roads paved (50%); balance gravel. Many of the lanes are gravel	some new construction on lake front lots. Some lots are cleared - most are not	lake front 90%+; non-lake front 10%	septic systems per resident	erosion noted on gravel roads	some lots mowed to lake's edge	very wide variety of homes; most expensive on lake front lots
5/21/2012	Shell Knob	single family housing; small to medium size houses; mostly older houses; some cabins; several mobile. A few in disrepair	most roads are paved; gravel roads to docks and lake access	1 new cabin being built; over 75% of land undeveloped. Several cleared lots; most near lake shore	lake front, second tier 90%+; non-lake front 10%	no central WWT system observed	some erosion on gravel roads, lake, and dock access	several instances of mowed grass to lake's edge	medium to gradual slope to lake
5/18/2012	Bread Tray Mtn	mostly older small houses & cabins; some in disrepair; several mobile homes in disrepair	feeder road paved; side roads gravel 50%	no new construction; some cleared lots - also some undeveloped; Fairwood Acres Subdivision	75% of lots built-out	no central WWT system observed	some erosion on gravel roads and boat dock parking area	some mowed areas at lake edge near docks	since this is a very old and somewhat rundown development; the septic systems, if they exist, are suspect
5/16/2012	Cape Fair West	older; smaller homes; single family; hay fields surrounding development	paved roads	no new construction or undeveloped sites; there are cleared lots (areas)	lake front 90%+; non-lake front 20%	no central WWT system observed	no runoff problems observed	90%+ mowed to lake's edge	name of area = Melton's pennisula
5/16/2012	Virgin Bluff	single family; mix of old and new; large and small (some cabins); old, non operational resort (Branson Bluff Resort) - run down	most roads paved; some gravel lanes (10%); dock access roads and parking lots not paved	no new construction; many cleared (mowed) lots; some undeveloped areas	lake front: 90%+; non-lake front: 25%	no central WWT system observed	no run-off problems observed; minor erosion near docks, roads, and parking	large % of lake front homes mow to water's edge; overall a large part of develped land is grass	Table Rock Estates, Hunt Club Circle; abandoned/unkept golf course - part of Branson Bluff Resort
5/5/2012	DD Hwy: Hidden Shores	single family newer subdivision	paved roads; boat dock road and parking lot paved	1 new house in last stages of construction	~90%	WWT system	no run-off problems noted	some mowed to COE line; mowed at three docks; otherwise good buffer on COE land	lots of lawns; possible over fertilizing; nutrients to lake?
5/2/2012	UU/Long Creek	Pasture - cattle; new develpments - high end homes; older/established subdivision; single family houses	gravel; tar/gravel	new homes being built;	Serenity Cove Estates - 90%; others 0-5%	one WWT system; others unknown	none	some lake front homes have mowed grass to lake shore; others good buffers	Serenity Cove Estates; very new future club house pools, docks, no trespassing - could not drive into development

Date of Observation	Location Name	Type & Condition of Housing Structures	Main Road Surfaces	Any new construction or cleared, undeveloped sites	Estimate Percent lots built-out	Central WWT or septic systems	Noticeable run-off problems, erosion controls	Condition of vegetation buffer	Other comments
5/2/2012	JJ Hwy/Twin Island Estates	single family; mix of new and old. Well maintained - yard and house; surburban - like found in many cities	paved roads including dock access	no undevloped sites; a few new house under construction on lake front lots	90%+	WWT System - aerated	No run off issues observed, lots of grass (fertilizer?)	~50% mowed lawns near lake's edge	lots of mowed lawns; club house w/pool; flat terrain on most of subdivision; hill on North end
5/1/2012	Big Cedar Hollow	Big Cedar Lodge Resort (cabin, lodges, and timeshares); subdivision on Lemonwood: single family - mix old to new/medium to high value	paved w/curbs on most of Big Cedar Lodge	no	80% not including Big Cedar	?	No run-off problem visible	good buffer except near Big Cedar docks andmain registration bldg	great landscaping
4/30/2012	Indian Point	Resort cabins; single family housing new and old(established) ; condos;	main roads paved; some interior gravel roads; dock access road gravel; gravel parking at boat docks	no sites being developed; some new home construction	lake front: 90%+; non-lake front: ~50%	septic systems	erosion on dock access roads	50% mowed grass	lake front lots built out. Lots (lakeview/others) are currently being built, larger newer homes are lakeview
5/1/2012	Emerald Point	single family houses; villas (2 & 4 plex); condos. High end housing and condos. Most new	paved with concrete curbing - all roads	new construction - homes; most home sites developed	<10%	WWT System	no runoff problems or erosion noted	good vegetation buffer except by condors on water's edge	excellent development; great landscape; gated. Club house w/ pool and tennis court. Dry dock. Paved dock road and dock parking
4/30/2012	Compton Ridge; Red Cedar Point	mixed: new, mobile, older, single family. Moderate value of newer homes	paved roads; gravel road to docks (medium erosion due to grade); gravel dock parking	cleared home sites - no new construction; several rebuilds	50% for newer development; 80% for older area	WWT System	No erosion problems visible	20% mowed. Lake front homes clear to lake	Extreme mix of housing disrepaired mobile homes and houses to new well kept large single family homes
4/30/2012	Lampe/Cow Creek: Pinnacle Shores	new housing. Single family. Club house w/ pool	entry road paved, balance of roads gravel	new constrution on several home sites; lots cleared except for large trees. Large lots	less than 10%	WWT System	no visible erosion control on some cleared lots. Erosion from gravel roads into steep rev.; erosion fence visible at WWT System site	good vegetation butter (COE Property)	erosion control features observed: silt dams, silt fence, concrete road gutters on steep hills - not all. Burlap like matting on hillside to reduce erosion
4/28/2012	talking rocks	RV Park - paved road; WWT facility (odor); small houses - manufactured; mobile home area - run down. A few mobile homes	paved, some side roads gravel	no	90%+	WWT System - RV park; septic systems for home?	gravel boat parking lot	good veg. buffer	abandoned recreation park; looks like ithas not operated for a long time

Date of Observation	Location Name	Type & Condition of Housing Structures	Main Road Surfaces	Any new construction or cleared, undeveloped sites	Estimate Percent lots built-out	Central WWT or septic systems	Noticeable run-off problems, erosion controls	Condition of vegetation buffer	Other comments
4/26/2012	DD HWY: Show-Me Baseball Camp, Show-Me Shores; Twin Oaks Resort; Shores of TRL Resort; Valley View Resort	Resorts (older, cabins); mobile homes (Show-Me Shores); Ball Fields (Camp); A few single family homes	Paved - 90%; Gravel - 10%; most roads to dock are gravel, many roads with resorts are gravel	no	90%	Show-Me Shores: WWT System; others?	minor; erosion from boat dock roads	50 % mowed grass	most have gentle grade to lake; high end home up on the hill; some resorts have small swimming pools
4/25/2012	Kimberling City; Kimbling Hills	single family; older with a mix of new	paved. Exception-gravel near docks	all sites developed. No new constrution	90%	Central WWT System - Kimberling City operated	minor erosion near dock access areas	vegetation buffer consists of mowed grass on majority of shoreline	most of shoreline is gentle slope to lake; subdivision is on hillside as well as near lakeshore
4/24/2012	Joe Bald Mtn: Overlook Subdivision	single family, condo, townhomes. Upscale	developed, paved. Undeveloped - dirt	new development. New construction. Undeveloped sites	30%	WWT System	erosion control measures in place	most homes have vegetation buffer	club house and pool; grade to lake varies from moderate to steep (cliff on Summer road)
4/20/2012	Aunts Creek - Silver LakeLan and Goldwater Lane; adjacent to Aunts Creek Public Use Area	mostly manufactured homes. Some new and some very old	broken asphalt and gravel (<10%)	none	90%+	none	septic? Most likely	no	large vegetation buffer

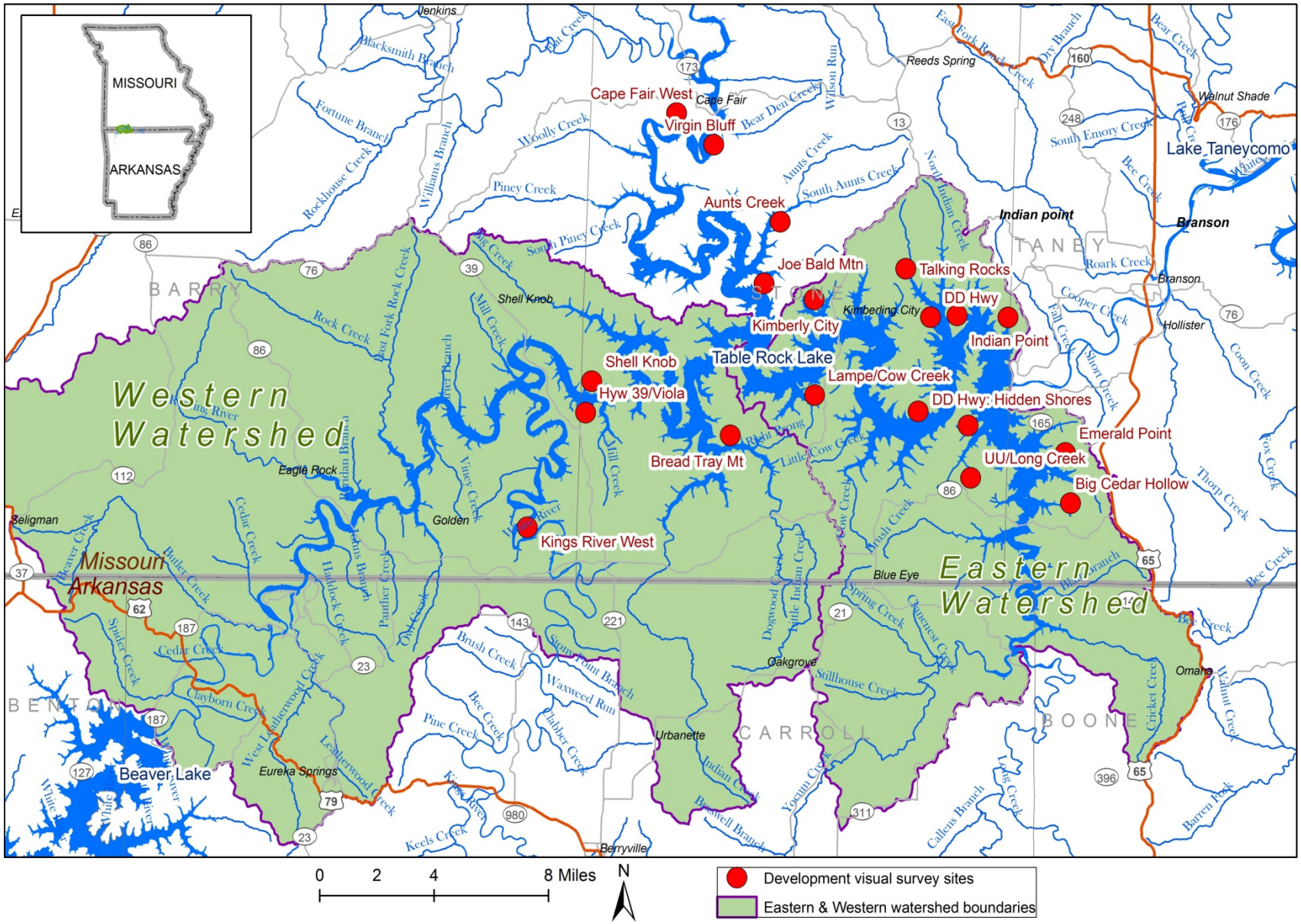

FIGURE16. SURVEY SITES FOR VISUAL SURVEY IN TABLE ROCK LAKE WATERSHEDS.

Compton Ridge near Red Cedar Point

(4 pictures)

DD Hwy near Hidden Shores

(4 pictures)

Joe Bald Mountain (4 pictures)

Bread Tray Mountain

(4 pictures)

Indian Point

(4 pictures)

Talking Rocks

(4 picutures)

Kings River

(4 pictures)

Shell Knob

(4 pictures)

Big Cedar Hollow

(4 pictures)

Cape Fair Site

(4 pictures)

Emerald Point

(4 pictures)

Highway 39 and Viola

(4 pictures)

Highway UU and Long Creek

(4 pictures)

Virgin Bluff

(4 pictures)