Missouri Department of Natural Resources

Total Maximum Daily Load (TMDL)

for

James River,
Webster, Greene, Christian and Stone Counties, Missouri

Completed March 30, 2001
Approved May 7, 2001

Phased Total Maximum Daily Load (TMDL)
For James River
Pollutant: Nutrients and Unknown

January 3, 2002

Name: James River

Location: Webster, Greene, Christian and Stone Counties

Hydrologic Unit Code (HUC): 11010002

Water Body Identification (WBID): 2347, 2362, 2365

Missouri Stream Class: The impaired segments of James River are Class P streams.[1]

Beneficial Uses:
2347 – Irrigation, Livestock and Wildlife Watering, Protection of Warm Water Aquatic Life and Human Health-Fish Consumption, Whole Body Contact Recreation, Boating and Canoeing, Cool Water Fishery.
2362 – Irrigation, Livestock and Wildlife Watering, Protection of Warm Water Aquatic Life and Human Health-Fish Consumption, Whole Body Contact Recreation, Boating and Canoeing, Cool Water Fishery.
2365 – Drinking Water Supply, Livestock and Wildlife Watering, Protection of Warm Water Aquatic Life and Human Health-Fish Consumption, Whole Body Contact Recreation, Boating and Canoeing, Cool Water Fishery.

Size of Impaired Segments:
2347 – 28 miles
2362 – 26 miles
2365 – 4 miles

Location of Impaired Segments:

2347 – From Section 10, T24N, R24W to Section 8, T26N, R22W
(Approximately from Table Rock Lake to the confluence with Finley Creek)
2362 – From Section 8, T26N, R22W to Lake Springfield Dam
(Approximately from Finley Creek to Springfield)
2365 – From Highway 65 to Section 24, T29N, R17W
(Approximately from Springfield to headwaters in Webster County)

Pollutant: Nutrients

[1] Class P streams maintain flow even during drought conditions. See 10 CSR 20-7.031(1)(F)

Pollutant Source: Urban Point and Nonpoint Sources, Agricultural Nonpoint Sources

Permit Numbers:

The Water Quality Standards for the state of Missouri require all permitted point sources in the Table Rock Lake basin with a discharge of greater than or equal to 22,500 gallons/day have a phosphorus limit of 0.5 milligrams per liter (mg/L)[2]. The James River is a tributary to Table Rock Lake. The permits listed below are the facilities that discharge to the impaired segments of the James River and will have a phosphorus limit included in their permit. See Appendix C for facility discharge information and compliance schedule. The point sources that have a discharge of less than 22,500 gallons/day are included in the wasteload allocation, but are being grouped for the purposes of this TMDL.

Permit No. MO-0106151	Fremont Hills WWTF
Permit No. MO-0104027	Sparta WWTF
Permit No. MO-0107182	Galena WWTF
Permit No. MO-0102318	Clever WWTF
Permit No. MO-0028037	Nixa WWTF
Permit No. MO-0094129	English Village MHP
Permit No. MO-0099163	Ozark WWTP
Permit No. MO-0049522	Springfield SW WWTP
Permit No. MO-0040835	Crane WWTP
Permit No. MO-0102679	Rogersville WWTF
Permit No. MO-0022985	Seymour WWTP
Permit No. MO-0093556	MDOC, Ozark Correctional Center
Permit No. MO-0099813	Fordland WWTF

TMDL Priority Ranking: High

1. Background and Water Quality Problems

The James River watershed is located in the Springfield Plateau physiographic region, which is part of the Ozark Plateaus Province in the White River Basin. The area is underlain with Burlington-Keokuk limestone containing many fractures and solution channels. Consequently, the area is dominated by Karst features, which include losing streams, springs, caves and sinkholes. The hydrology involves a high level of interaction between surface water and ground water. Rainfall averages about 43 inches per year. The total area of the James River watershed addressed by this TMDL is 987 square miles.

The James River headwaters begin in the eastern part of Webster County about 30 miles east of Springfield. It flows in a westerly direction for about 40 miles before turning southward to flow into Table Rock Reservoir about 40 miles below the mouth of Wilson's Creek. Below Galena, the river starts to be influenced by the backwaters of Table Rock Lake. Streams in this basin are typical Ozark streams with gravel substrate, clear water and representative Ozark flora and fauna. Stream habitat quality is fair to good throughout most of the basin.[3]

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[2] 10 CSR 20-7.015(3)(G)
[3] Missouri Department of Conservation, James River Watershed Inventory and Assessment, MDC Web Site, http://www.conservation.state.mo.us/fish/watershed/james/contents/170cotxt.htm.

The predominant soil type, the Goss-Wilderness soil association, is part of the Ozark Border soils. Narrow ridgetops and valleys characterize these soils. The Goss-Wilderness soils were formed from cherty limestone or dolomite. They consist of a 5-8 inch surface layer of dark brown cherty silt loam and a subsurface layer from 8 to 60 inches thick of very cherty silt clay loam. Permeability is moderate to slow. Runoff is medium and the available water capacity is low. These soils are used for pastureland, hayland, or woodland, with some areas in cropland.[4] Soil erosion ranges from 18 to 24 tons/acre/year for tilled land, 2.5 to 5 tons/acre/year for permanent pasture and 0.25 to 0.5 tons/acre/year for non-grazed forest. Gully erosion is slight at 0-100 tons/square mile according to a publication produced by University Extension and the Department of Natural Resources. Approximately 1.1 to 2 tons/acre/year of sediments reach impoundments or streams in the area. Of this total 89% is due to sheet and rill erosions, 3% is attributed to streambank erosion, and 7% comes from erosion in urban areas.[5]

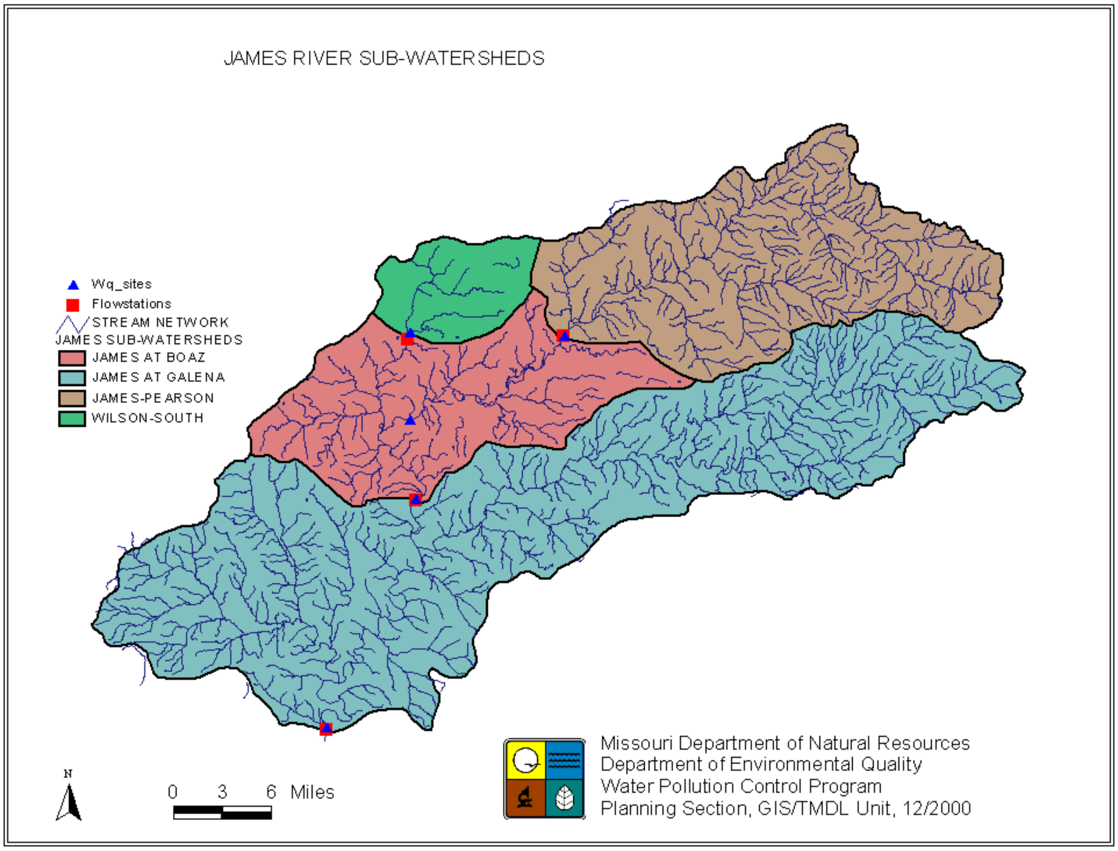
As previously stated, there are three impaired segments in the James River: from the headwaters to Lake Springfield Dam; from Lake Springfield Dam to the confluence with Finley Creek; from Finley Creek to Table Rock Lake. For the purposes of this TMDL, the river was divided into four sub-watersheds (Figure 1). These sub-watersheds were based on the location of gaging and water quality data sites. The three main tributaries to the impaired segments include Pearson Creek, Wilson Creek and Finley Creek. The city of Springfield, located in Greene County, is the largest urban area with a population of approximately 140,500. Due to the explosive increase of tourism in recent years, several smaller communities have also experienced rapid development. These include the communities of Ozark and Nixa located in Christian County.

Land uses in the watershed include urban development, agricultural use and forest (See Appendix A). The urban area is estimated to be approximately 4% of the total watershed with the Wilson Creek basin being most heavily urbanized. The Springfield area is a shopping, industrial, medical, and educational center for the region. The Springfield area also offers a variety of tourist attractions including the Wilson's Creek Battlefield and the Bass Pro Shop. It is also in close proximity to the popular tourist destination, Branson, Missouri. Tourism has a tremendous impact on the local economy in the James River and Table Rock Lake Basins. The following information was obtained from the Missouri Department of Tourism. Sales on 17 Standard Industrial Codes (lodging, restaurants, etc.) were used to determine business activity to give an average dollar amount regarding what tourism adds to the local economy. According to this measure, tourism contributes the following amounts in each county:

Christian County	$29,939,000	Taney County	$400,910,000 (Branson)
Greene County	$348,649,000	Webster County	$14,051,000
Stone County	$107,318,000		
		Total =	$900,867,000

[4] Soil Survey of Greene and Lawrence Counties, Missouri, USDA Soil Conservation Service, 1982
[5] Missouri Department of Conservation, *James River Watershed Inventory and Assessment*, MDC Web Site, http://www.conservation.state.mo.us/fish/watershed/james/contents/170cotxt.htm

Figure 1. James River Sub-watersheds Used in TMDL Calculation



Approximately 70% of the land in the James River watershed is used for agricultural production. Originally, these prairie areas consisted primarily of big bluestem and other prairie grasses. Today these soils are farmed or used for pasture or hay. Farming operations include beef and dairy cattle, hogs, poultry production, fruit crops, corn, and feed and forage crops. The chief agricultural use, however, involves cattle operations. In 1997, Greene County ranked second in the state for numbers of beef cattle and ninth in dairy cows. A study done by Springfield City Utilities in 1986 indicated elevated levels of total phosphorus in tributaries primarily draining land used for agricultural.[6] Approximately 30% of farmed acres in Greene County participate in a Natural Resource Conservation Service (NRCS) conservation plan. It is assumed this rate of participation by agriculture landowners is fairly consistent throughout the watershed.

The remaining 26% of the land in the watershed is forested. The hardwood forest consists of second growth oaks. The oak/hickory association is common on ridges, uplands, and uphill slopes on drier, more acidic soils. Other areas support stands of eastern red cedar. This species is harvested for use in lining closets and making souvenirs and novelties for the tourist trade.

Surface water problems in the James River watershed have been documented by DNR since 1965. Historically, the major concern was low dissolved oxygen (DO) due to sewage and urban storm water

[6] Watershed Committee of the Ozarks, *Water Resources of Greene County*, 1997

runoff. The City of Springfield's Southwest Wastewater Treatment Plant was built in the 1950s and provided primary treatment of sewage. The U.S. Department of the Interior performed a comprehensive water quality study on the James River in June of 1969.[7] The data indicated elevated levels of nutrients in the James, particularly when values were compared above and below the confluence with Wilson Creek. The Southwest Treatment Plant was upgraded in 1977 and a subsequent study performed by the United States Geological Survey (USGS) in 1982[8] indicated the DO levels in the James River increased significantly. And a study published by USGS in 1987 [9] found DO levels in the James River above the state standard of 5.0 milligrams per liter (mg/L).

A current concern in the basin is the discharge of nutrients, especially phosphorus, from sewage treatment plants. The discharge from the Southwest Treatment Plant in Springfield historically has had a phosphorus load of 3-4 mg/L. According to estimates, this constitutes about 64% of the total phosphorus loading to the James River above Boaz (about 1000 pounds/day). The wastewater discharge also accounts for about 27% of the daily phosphorus loading to Table Rock Lake. [10] Due to accelerated eutrophication of Table Rock Lake, especially in the James River arm, a phosphorus limit was adopted by the Missouri Clean Water Commission of 0.5 mg/L for all point sources that discharge over 22,500 gallons/day to the Table Rock Lake Basin.[11]

Increased algae blooms in the James River have been observed, but have not been documented quantitatively. There is, however, extensive data documenting the decline in clarity and increase of chlorophyll a (an indicator of the amount of algae that is suspended in the water) in Table Rock Lake[12]. The University of Missouri Columbia and the Lakes Volunteer Water Quality Monitoring Program have several years of data collected on Table Rock. This data indicates phosphorus is the limiting nutrient for the increased algal growth in the lake. There is also a growing public perception that the water quality of Table Rock is declining and it could negatively affect the tourism industry, which is the major economic generator for the area. The James River is a major contributor to the nutrient loading in Table Rock Lake. Reducing the load in the James should result in water quality improvements in Table Rock.

The following are historic and current efforts that help address the nutrient impairment of the James River:

- Rule making regarding phosphorus limit of 0.5 mg/L for all wastewater plants in the Table Rock basin with discharges ∃22,500 gallons/day.

- On August 21, 1995, the Springfield City Council approved a Phosphorus Ban Ordinance.[13] This amendment banned household laundry detergents which contain more than 0.5% of phosphorus and dishwashing detergents containing more than 8.7% phosphorus from being sold to the public. The ordinance banned high phosphorus detergents to be used, sold, manufactured, distributed or discharged into the City of Springfield's sewer system. This ordinance limits the amount of phosphorus entering

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[7] Kerr, Robert S., *James River-Wilson Creek Study*, U.S. Dept. of the Interior, Federal Water Pollution Control Administration, June 1969

[8] Berkas, W.R., *Streamflow and Water Quality Conditions, Wilson Creek and James River*, U.S. Geological Survey, 1982

[9] Berkas, W.R., *Traveltime, Reaeration and Water-Quality Characteristics During Low-Flow Conditions in Wilson Creek and the James River Near Springfield, Missouri*, U.S. Geological Survey, Report 87-4074, 1987

[10] Watershed Committee of the Ozarks, *Water Resources of Greene County*, 1997

[11] 10 CSR 20-7.015(3)(G)

[12] Data collected by Jack Jones, University of Missouri

[13] Watershed Committee of the Ozarks, *Water Resources of Greene County*, 1997, page 88.

Springfield treatment plants and subsequently being discharged to receiving streams. The ordinance did not, however, address phosphorus detergents being used by the private sector, such as restaurants and hotel chains.

- The James River Watershed 319 Project is sponsored by the James River Basin Partnership, a not-for-profit 501(c)(3) organization. Other participants and partners involved in this project include the Natural Resources Conservation Service, Missouri Department of Conservation, Soil and Water Conservation Districts, University Outreach Extension, City of Nixa, Gary Ellison Productions, Inc., Missouri Neon, Bass Pro Shops, Missouri Stream Teams and Southwest Missouri Resource Conservation & Development. The five-year, $3,127,316 project proposes to improve and sustain water quality in three subwatersheds of the James River: Lower Finley/Elk Valley, Upper Flat Creek and an Urban Target area directly below Springfield Lake. A variety of best management practices (BMP) are proposed to address not only agricultural pollutants, but urban pollutants as well. Practices include riparian corridor restoration, well and cistern plugging and sinkhole protection. Additionally, septic tank clean-out and rebates on the cost of urban soil testing will apply to the Urban Target area. Agricultural soil testing and effluent testing will apply to the Lower Finley/Elk Valley and Flat Creek areas. Fifteen agricultural operations will receive total nutrient management plans targeting nitrogen and phosphorus management to ensure land application procedures that will be protective of water quality. Educational outreach efforts include the James River Rescue, presentations to civic groups, Clean Water Kids water quality education program, a toll-free water quality information resource line and news releases about the James River Basin Partnership and water quality information for publication in local media. The funding for this project is appropriated and the sub-grant agreement is under development.[14] The project is scheduled to begin in June 2001.

- A proposal for an Agriculture Nonpoint Source (AgNPS) Special Area Land Treatment (SALT) project for the Spring Creek watershed has been submitted. Spring Creek is a tributary of Crane Creek and Crane Creek flows into the James above Galena. Partners in the grant proposal include: Natural Resources Conservation Service; Farm Service Agency; Missouri Departments of Conservation and Natural Resources; Stone and Christian County Soil and Water Districts; University Extension; Stone County Publishing Co., Inc.; Southwest Missouri Resource Conservation & Development; Judy Berkstresser, 141st District State Representative; Reeds Spring High School Stream Team; Hurley High School Science/Biology Program; Farm Credit Services of Western Missouri. The project targets 27,860 acres in the Spring Creek watershed of the James River Basin and the grant provides seven years of funding to complete the project. The cost of this project is $750,000. The money will be used to offer cost share for such practices as sediment and erosion control structures, permanent grass seedings, no-till interseedings and critical area treatment to slow runoff and trap sediment, pesticides and nutrients. Other practices being funded include Intensive Grazing System Management, Riparian Corridor Establishment and Management and fencing and alternative watering systems for livestock to eliminate their unrestricted access to streams. Water quality education activities include dinners, informational meetings, field days, the formation of new Stream Teams at local schools and a one-day Grazing School for landowners. This project has not yet been funded, but it is anticipated the project will be approved in the near future. [15]

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[14] E-mail correspondence, Becky Shannon, 319 Unit Chief, Missouri DNR, 11/13/00.
[15] E-mail correspondence, Becky Shannon, 319 Unit Chief, Missouri DNR, 11/13/00.

Description of the Applicable Water Quality Standards

The impairment of the James River is based on exceedence of the general criteria contained in Missouri's Water Quality Standards. The general criteria state:

- Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses.[16]
- Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses.[17]

The occurrence of excessive benthic algae and green colored water caused by suspended algae constitute a violation of Missouri Water Quality Standards.

Missouri Effluent Regulations at 10 CSR 20-7.015(3)(G) prescribe a specific set of compliance measures as implementation tools put into effect to meet water quality standards for discharges to Table Rock Lake watershed.

Anti-degradation Policy

Missouri's Water Quality Standards include the EPA "three-tiered" approach to anti-degradation, and may be found at 10 CSR 20-7.031(2).

Tier I defines baseline conditions for all waters—it requires that existing beneficial uses are protected. TMDLs would normally be based on this tier, assuring that numeric criteria (such as dissolved oxygen, ammonia) are met to protect uses.

Tier II requires no degradation of high-quality waters, unless limited lowering of quality is shown to be necessary for "economic and social development." A clear implementation policy for this tier has not been developed, although if sufficient data on high-quality waters are available, TMDLs could be based on maintaining existing conditions, rather than the minimal Tier I criteria.

Tier III (the most stringent tier) applies to waters designated in the water quality standards as outstanding state and national resource waters; Tier III requires no degradation under any conditions. Management may require no discharge or prohibition of certain polluting activities. TMDLs would need to assure no measurable increase in pollutant loading.

This TMDL will result in the protection of existing beneficial uses, which conform to Missouri's Tier I anti-degradation policy.

[16] 10 CSR 20-7.031(3)(A)
[17] 10 CSR 20-7.031(3)(C)

2. Calculation of Load Capacity

A. Determination of TMDL Target

The goal of this TMDL is to reduce the frequency of benthic algal blooms in excess of 100 mg/m^2 Chl_a through in-stream nutrient limits on total phosphorus and total nitrogen. Reduction of benthic algae will be the end point used to determine the success of the TMDL implementation plan. Algal biomass increases with additions of usable forms of phosphorus until nitrogen begins to limit the system also (transitional zone). As phosphorus levels continue to rise, nitrogen eventually becomes the limiting nutrient (Leibig's Law of the Minimum). Table 1 summarizes published Nitrogen:Phosphorus ratios for limiting algal response.

Table 1. Published Nitrogen Limiting Thresholds (N:P)

Information Source	N Limiting Threshold	Transition	P Limiting Threshold
Schanz and Juon (1983)	<10:1	10:1 – 20:1	>20:1
Petersen et al (1993)			>20:1
Stockner and Shortreed (1978)			>20:1
Pringle (1987)			>20:1
Grimm and Fisher (1986)	<10:1		
Dodds et al (1998)	<12.6:1		
Borchardt (1996)			>17:1
Lohman (1988) Saline Creek (Miller Co)	<12:1		

For the periods specified, total nitrogen (TN)[18] concentration values were divided by total phosphorus (TP) concentration values to arrive at a mean TN:TP ratio for the sites shown in Figure 1. Studentized range tests, tests to determine the normality of the distribution, revealed nutrient ratios (w/s=5.9, n=553, α=0.05) and total nitrogen (w/s=6.4, n=553, α=0.05) were lognormally distributed.[19] Increased phosphorus inputs since the late 1970s have produced a nitrogen limited situation in many areas of the James River Basin (Table 2). A phosphorus limit near 0.070 mg/L would allow control of algal growth by creating a phosphorus limited situation.

[18] TN = NH3-N + NO2 &NO3-N + Org. N
[19] U.S. Environmental Protection Agency, *Practical Methods for Data Analysis*, EPA/600/R096/084, January 1998

Figure. 2. Map of James River Basin showing relative locations of water quality monitoring sites.

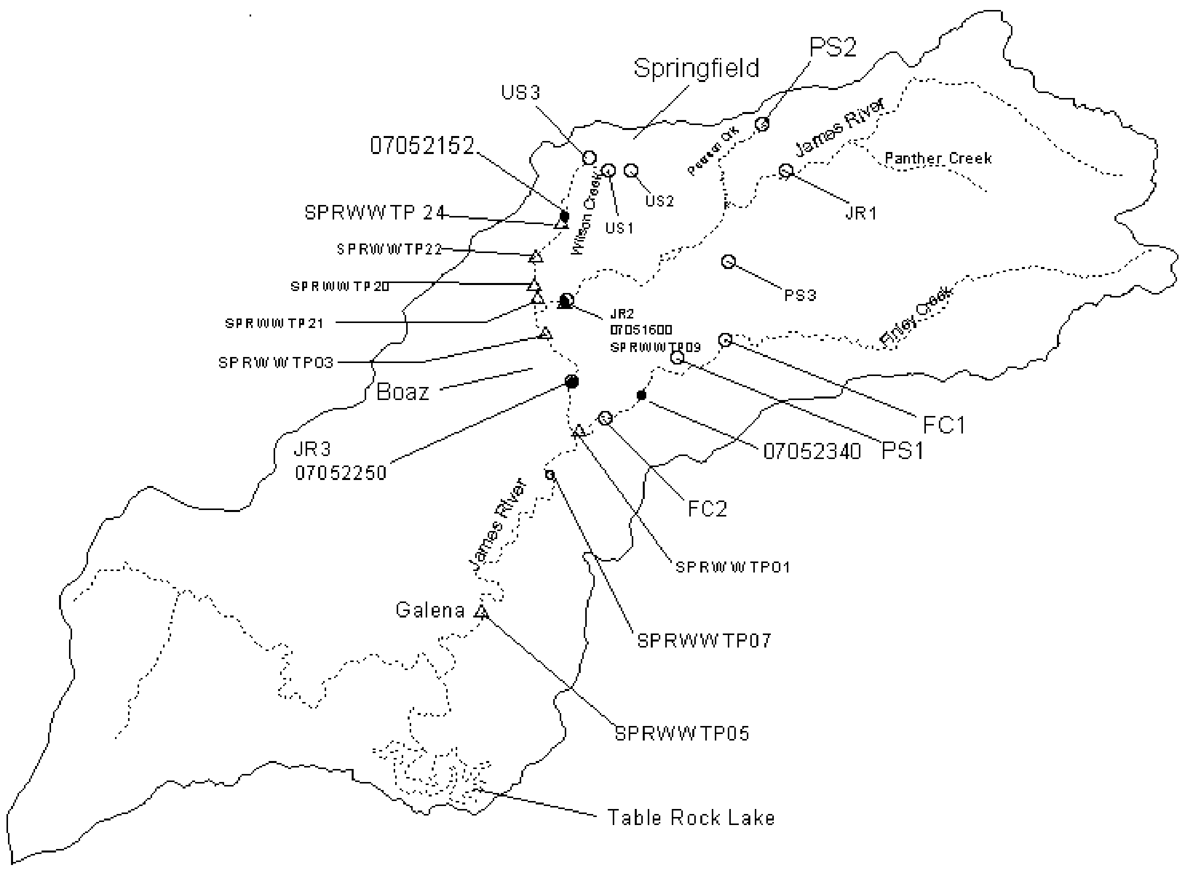


Table 2. Nutrient Limitation Determination for Sites on James River above Galena.

Station ID	Period of Record	Sample Number	TN:TP (Geomean)	Standard Error (log 10 units)	Limiting Nutrient	TP (ug/L) Geomean to achieve 20:1
JR1	1978-1979	27	32.2	0.61	P	N/A
JR2	1978-1979	27	34.1	0.57	P	N/A
JR3	1978-1979	27	31.9	0.44	P	N/A
FC1	1978-1979	27	43.6	0.54	P	N/A
FC2	1978-1979	27	19.8	0.45	P	N/A
US1	1978-1979	33	67	0.73	P	N/A
US2	1978-1979	20	80.5	0.66	P	N/A
US3	1978-1979	20	70.5	0.41	P	N/A
PS1	1978-1979	32	48	0.39	P	N/A
PS2	1978-1979	20	83.3	0.42	P	N/A
PS3	1978-1979	19	60.4	0.4	P	N/A

07052340	1973-1975	24	34.4	0.51	P	N/A
07051600	1967-1977	97	37.2	0.40	P	N/A
07052152	1993-1999	34	3.6	0.14	N	528.0
07052250	1992-1999	39	7.4	0.21	N	165.6
SPRWWTP01	1997-1999	5	4.9	0.16	N	71.4
SPRWWTP03	1992-1999	12	7.8	0.42	N	233.5
SPRWWTP05	1993-1999	10	6.6	0.33	N	126.7
SPRWWTP07	1993-1999	7	5.5	0.22	N	145.2
SPRWWTP09	1993-1999	5	8.6	0.45	N	123.8
SPRWWTP20	1993-1999	8	4.5	0.23	N	322.3
SPRWWTP21	1993-1999	12	3.8	0.20	N	286.5
SPRWWTP22	1993-1999	7	3.6	0.16	N	294
SPRWWTP24	1993-1999	14	3.7	0.17	N	500.2
07052152	1997-1999	16	3.5	0.19	N	384.0
07052250	1997-1999	16	6.9	0.24	N	153.4

Algal and Nutrient Benchmarks

Several studies in past decades have focused on nuisance algal growth, associated nutrient relations, and trophic state. Periphyton chlorophyll$_a$ (Chl$_a$) is the measurement of the amount of photosynthesis occurring in the water. It is used to determine the amount of suspended algae present in a waterbody. A value of 150 milligrams per square meter (mg/m^2) Chl$_a$ is generally agreed upon as a nuisance algal level. Nutrient concentrations that lead to specific algal biomass values, however, are often obscured by interactions from light, disturbance, and grazing (Cattaneo, 1987). See Table 3 for information obtained from literature search.

Table 3. Potential Algal and Nutrient Limits as Suggested by Literature Review.

Variable	Units	Value	Risk/Justification	Source
Mean Benthic Chl$_a$	mg/m^2	>70	Eutrophication	EPA 2000
Sestonic Chl$_a$	µg/L	>30	Eutrophication	EPA 2000
Total Nitrogen	µg/L	>1500	Eutrophication	EPA 2000
Total Phosphorus	µg/L	>75	Eutrophication	EPA 2000
Benthic Chl$_a$	mg/m^2	100-150	Nuisance Growth	EPA 2000
Benthic Chl$_a$	mg/m^2	>50	Decreased Recreational Uses	Nordin (1985)
Benthic Chl$_a$	mg/m^2	>100	Reduced Invertebrate Diversity	Nordin (1985)
Benthic Chl$_a$	mg/m^2	>75	Increased Biomass Recovery following disturbance	Lohman (1992)
PO_4-P	µg/L	0.3-0.6	Saturated Growth Rate of Benthic Diatoms	Bothwell (1988)
PO_4-P	µg/L	20-50	Maximum Benthic Algal Biomass	Borchardt (1996)
Total Phosphorus	µg/L	38-90	Max. Periphytic biomass between 100-200 mg/m^2	Dodds et al (1997)
Total Phosphorus	µg/L	20-39	Prevent Mean Periphytic Biomass of 100 mg/m^2 in Clark Fork River, MT	EPA 2000

Nutrient and Algal Relationships

Based on literature values presented in Table 3, benthic chlorophyll$_a$ measurements collected by Smart [20] were grouped into the impairment classes shown in Table 4. This data indicates that excessive algal biomass occurs at TP values above 106 micrograms per liter (µg/L). A linear predictive relationship between benthic chlorophyll$_a$ and nutrient concentration is not, however, clear or precise based on his 1978-79 data.

Table 4. Periphytic Biomass and Nutrient Relationships Based on Algal Impairment in the James River Basin.

Class	Benthic Chla Range (mg/m^2)	Nutrient	Sample #	Geometric Mean	95% C.I.
Non-Impairing	0-75.9	TP (µg/L)	111	69.6	58 – 84
		TN (µg/L)	111	3240.6	2628 – 3995
Partially Impairing	76-99.9	TP (µg/L)	35	46	33 – 64
		TN (µg/L)	35	2818.4	1864 – 4260
Impaired	100-149.9	TP (µg/L)	31	47.7	35 – 65
		TN (µg/L)	31	4190.5	2887 – 6082
Excessive	150-500	TP (µg/L)	102	105.5	80 – 139
		TN (µg/L)	102	2403.1	1921 – 3005

Determination of Target Load

Algal levels judged to be excessive impair the James River and are caused by nutrient enrichment. Other factors contribute to the accrual and loss of algal biomass. These include light, temperature, hydrologic disturbance and invertebrate grazing. Managing nutrient levels, however, is considered the most feasible option for reducing the standing crop of benthic algae.

Based on the information cited, the recommended in-stream total phosphorus level should not exceed 0.075 mg/L and the in-stream total nitrogen level should not exceed 1.5 mg/L (mesotrophic/eutrophic boundary). These levels of nutrient loading will keep the benthic algal biomass between 100-200 mg/m^2 in the James River. Saturation growth rates of benthic algae can occur at levels less than 0.075mg/L (or 75 µg/L) TP. But considering the absence of a precise predictive relationship, the justification of a more stringent limit would be difficult.

Nutrient Target Recommendations

In-stream total phosphorus is not to exceed 0.075 mg/L and total nitrogen is not to exceed 1.5 mg/L for any twenty-four hour period throughout a calendar year. Limits apply to all classified streams and rivers that feed into impaired segments of the James River. Catastrophic events (such as floods, tornadoes, etc.) result in situations that exceed feasible management and the nutrient load recommendations do not apply under those circumstances.

[20] Smart, Miles M., 1980, Stream Watershed Relationships in the Missouri Ozark Plateau Province, PhD Dissertation, University of Missouri-Columbia.

B. TMDL Calculation

Model Objective

A spreadsheet model was developed for this TMDL to estimate current TP and TN loads and to develop Load Duration Curves based on the target concentration. The area of interest is the James River watershed, upstream of Galena. The total area, covering 987 square miles (mi^2) was divided into four sub-watersheds. These are Upper James-Pearson (246 mi^2), Wilson-South Creek (58.3 mi^2), James upstream of Boaz (462 mi^2), and James upstream of Galena (987 mi^2). See Figure 1 for map depicting sub-watersheds. James-Pearson and Wilson-South Creek sub-watersheds are independent and they both discharge into, and are part of, the James upstream of Boaz sub-watershed. In turn, James upstream of Boaz is part of the James upstream of Galena sub-watershed. For the purpose of this TMDL, only James River upstream of Galena watershed is considered and therefore, nutrient loading is evaluated a Galena.

Methodology

Daily flow data from USGS gauging stations on James River at Boaz (07052250, 1972-80), on James River near Springfield (07050700, 1988-98), on Wilson Creek below Springfield (07052150, 1967-72), and on James River at Galena (USGS 07052500, 1992-1998) were utilized to develop four separate flow duration curves. Although longer term records are available for some of these stations, selections of time periods are more representative of current land use conditions in the watershed. From each curve, flow ranges in cubic feet per second (cfs) and the average number of days per year in each range were derived. From the water quality data, the average concentration (mg/L) of TP and TN for each flow range was determined.

A table was created containing the flow ranges and the average pollutant concentrations within each range. The average pollutant concentrations were multiplied by the mid-point of each flow range. The result was then multiplied by the conversion constant (5.39) to calculate the daily loading in pounds per day (lb/day). This daily load was then multiplied by the number of days per year in each flow range to estimate the load of each pollutant in every flow range during that period. The sum of these loads is the annual load estimate. See Table 5 for the phosphorus calculation table and Table 6 for the nitrogen calculation table for James River at Galena. This site encompasses the entire watershed being addressed in this TMDL.
Steps used to calculate annual load estimate expressed as formulas:

(mid-point of flow range) * (average pollutant concentration) * 5.39 = daily load in lb/day

(daily load) * (# of days/year in flow range) = load per period for flow range

sum of loads per period for all flow ranges = annual load estimate

Table 5. Annual Load Estimate Table for Phosphorus at Galena, MO

Station name : James River At Galena, MO
Station number: 07052500 (Flow)
Water Quality Data from SPRWWTP05

Flow Range (cfs)	Number of days/year in range	Mid-point Flow (cfs)	TP Concent. mg/l	TP lb./day	TP lb./period	TP Target Load (lb./period)
0 to 50	3.18	25	1.25	168	536	32
51 to 75	6.39	63	0.88	296	1,893	161
76 to 117	24.57	96	0.73	377	9,266	952
118 to 188	52.56	152	1.21	992	52,131	3,231
189 to 310	57.52	249	0.75	1000	57,507	5,784
311 to 525	59.28	418	0.65	1467	86,979	10,005
526 to 907	58.01	716	0.40	1544	89,559	16,792
908 to 1594	47.39	1,250	0.27	1797	85,178	23,956
1595 to 2839	31.49	2,216	0.42	4977	156,745	28,214
2840 to 5115	15.34	3,977	0.31	6538	100,311	24,667
5116 to 9305	5.82	7,210	0.40	15674	91,148	16,949
9306 to 17063	2.40	13,184	0.26	18357	44,082	12,798
17064 to 31504	0.84	24,283	0.53	69370	58,530	8,283
31505 to 58511	0.21	45,007	0.35	84906	17,634	3,779
				Load/year	**851,498**	**155,603**

lb./day : pounds per day.
TP : Total Phosphorus.
cfs: cubic feet per second.
Target load is based on a TP concentration of 0.075 mg/l.

Table 6. Annual Load Estimate Table for Nitrogen at Galena, MO

Station name : James River At Galena, MO
Station number: 07052500 (Flow)
Water Quality Data from SPRWWTP05

Flow range @ Galena	Mid pt flow (cfs)	Number of days/year in range	TN mg/l	TN lb./day	TN Load lb/period	TN Target Load (lb/period)
0 to 50	25	3.2	**12.48**	1,682	5,350	643
51 to 75	63	6.4	**11.93**	4,018	25,661	3,227
76 to 117	96	24.6	11.43	5,904	145,074	19,039
118 to 188	152	52.6	10.59	8,683	456,363	64,625
189 to 310	249	57.5	3.89	5,216	300,008	115,675
311 to 525	418	59.3	2.15	4,827	286,155	200,106
526 to 907	716	58.0	2.67	10,297	597,330	335,846
908 to 1594	1,250	47.4	4.39	29,617	1,403,608	479,126
1595 to 2839	2,216	31.5	1.89	22,530	709,488	564,282
2840 to 5115	3,977	15.3	1.85	39,656	608,442	493,333
5116 to 9305	7,210	5.8	**1.78**	69,323	403,133	338,979
9306 to 17063	13,184	2.4	**1.66**	118,083	283,565	255,962
17064 to 31504	24,283	0.8	**1.43**	187,795	158,449	165,650
31505 to 58511	45,007	0.2	**1.01**	245,268	50,939	75,575
TN = Total Nitrogen				**Load/year**	**5,433,565**	**3,112,067**

TN = KJN + NH3-N
Target Load is based on TN concentration of 1.5 mg/l.

Charts 1 and 2 compile the present, target and point source annual loads for each of the sub-basins. Chart 1 shows the loads of total phosphorus and chart 2 shows the loads of total nitrogen.

Chart 1. Present, Target, & Point Source Total P Loads in Sub-watersheds

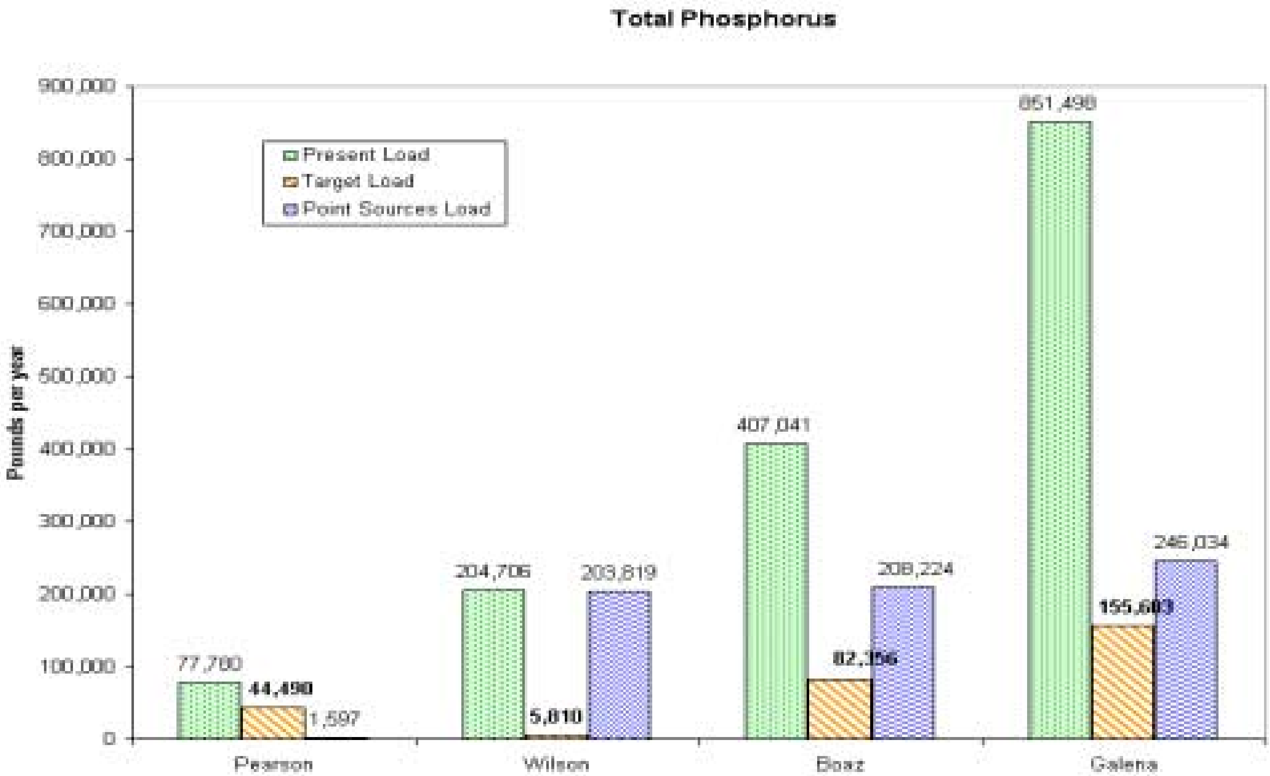
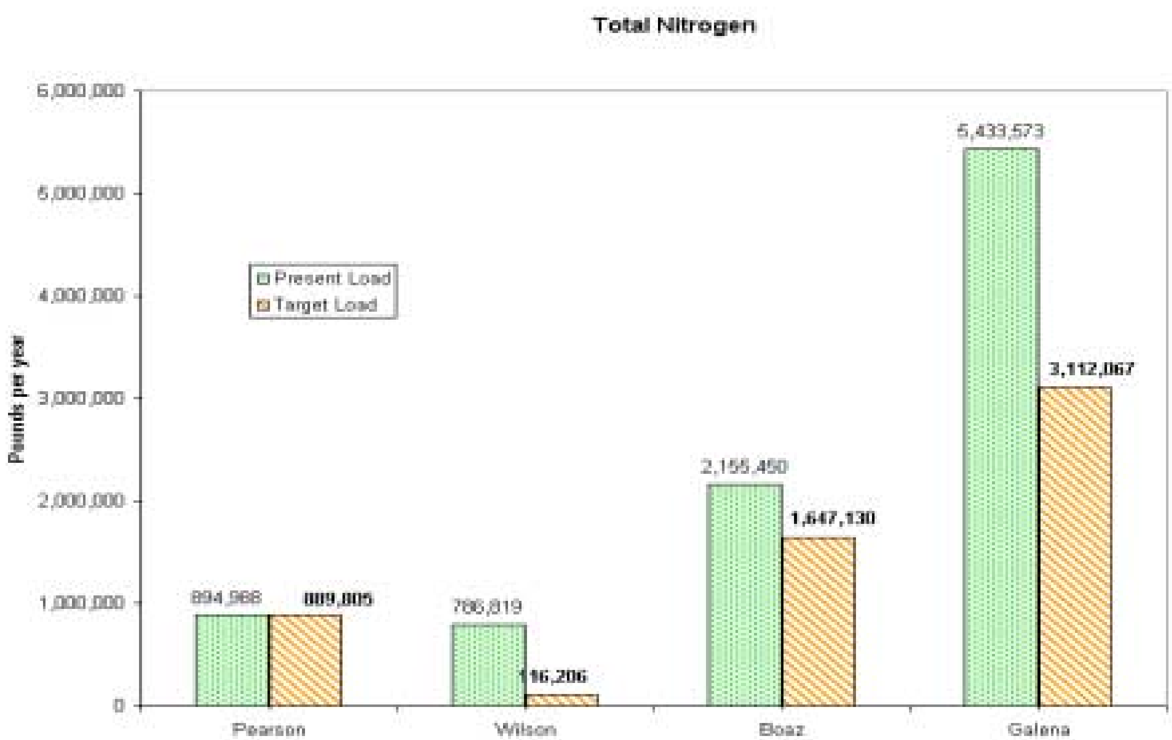


Chart 2: Present and Target Source Total N Loads in Sub-watersheds



Flow duration curves were developed for TP and TN. The discharge of each flow duration curve was multiplied by the **target** concentration of the pollutant and a conversion factor of 5.395 to obtain a pollutant load duration curve expressed in pounds per day (lb./day) for every percent exceedence.

The Waste Load Allocation (WLA) for total phosphorus was based on the design flow for existing permitted facilities. Facilities with a design flow of less than 22,500 gallons/day were assigned an average concentration of 5.0 mg/L. Facilities with higher flow were assigned the 0.5 mg/L concentration that is required for permits under the Effluent Regulations. Any new facility applying for a discharge permit will be restricted to the 0.5 mg/L limit, regardless of design flow. Because the point source contribution to TP is evaluated at the bottom of each sub-watershed, attenuation of the load due to pollutant decay and/or storage does occur. Due to lack of data to estimate the attenuation factor, a conservative approach was taken and no attenuation of the load was assumed.

Allocation of Pollution Reduction Responsibility

In figures 3 and 4, the X-axis represents the probability of time loads are exceeded; the Y-axis represents the associated pounds per day of total nitrogen (TN) and total phosphorus (TP) such that the TMDLs represent a continuum of desired loads over all flow conditions, rather than fixed at a single value. The area is segregated into allocated areas assigned to point sources (WLA) and non-point sources (LA) and is represented graphically by the integrated area under each load duration curve established by this TMDL.

In-stream water quality samples will be analyzed for TP and TN concentrations. This concentration will be converted to a load (lb./day) value and plotted on the load duration curve. If the values fall above the TMDL load duration curve, the target load has not been achieved and the source of the problem can be ascertained to be point or non-point source based on the flow. If the value is on or below the curve, then the target load has been achieved and implementation has been effective. Although achievement of 0.075 mg/L TP and 1.5 mg/L TN in-stream at Galena is the ultimate target load, the 0.075 mg/L TP target will need to be achieved throughout the watershed. Wilson Creek may never achieve this goal due to the magnitude of the loading in a small watershed. This does not, however, preclude achievement of the 0.075 mg/L level in the mainstem of the James River.

Point Sources: There are 23 wastewater facilities releasing effluent into the watershed. The Waste Load Allocation (WLA) for both total phosphorus and total nitrogen is based on the design flows of these wastewater facilities and the desired condition for existing or impending total phosphorus permit limits of 0.5 mg/L for those facilities with design flows greater than or equal to 22,500 G/day, and 5 mg/L for those facilities with smaller design flows which are exempt from the MO Effluent Regulations. The total phosphorus load expected to be discharged by all of these facilities by 2007 is 197 pounds/day, corresponding to a probability flow value of 488 cfs, and the probability that loads will be exceeded 56% of the time. Therefore, the waste load allocation for point sources is demarcated by the area under each respective TMDL load duration curve bounded from 56% to 100%. To meet the target TN load at Galena, the same probability WLA demarcation value (56%) on the TN TMDL load duration curve shows a WLA for TN of 3,949 pounds per day.

The WLAs represents the load in the river which the point sources contribute. In most cases, this is a function of permit limits; in the case of total nitrogen, there is some assimilation and degradation of

the constituent while flowing downstream; biological processes transform available nitrogen into nitrate and ammonia forms in a dynamic fashion, therefore, both species should be considered in total when assessing potential reduction in nitrogen loading to the stream. Further refinement of this allocation may come with information gained through the monitoring conducted through Phase 1 of this TMDL on the non-point source contributions to the nutrient impairment.

Non-point Sources: Given the runoff characteristics of the watershed, overland runoff can easily carry sediment, phosphorus, and nitrogen from the watershed into the stream reaches. The composition of the watershed indicates a mixture of rural and urban non-point sources which may contribute to the downstream impairment. These sources tend to become dominant under higher flow conditions. Therefore, the area under the load duration curves bounded from 0 - 56% constitutes the load allocation for this TMDL.

Figure 3. Total Nitrogen TMDL Load Duration Curve

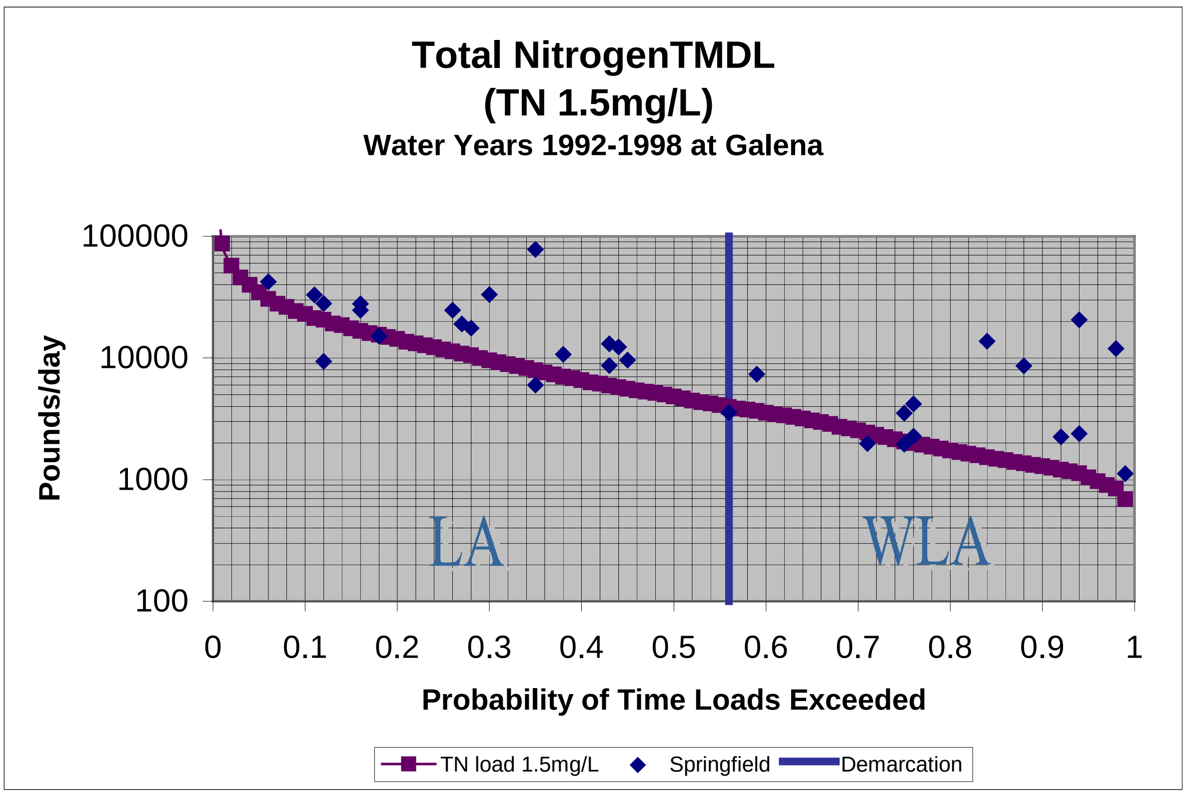
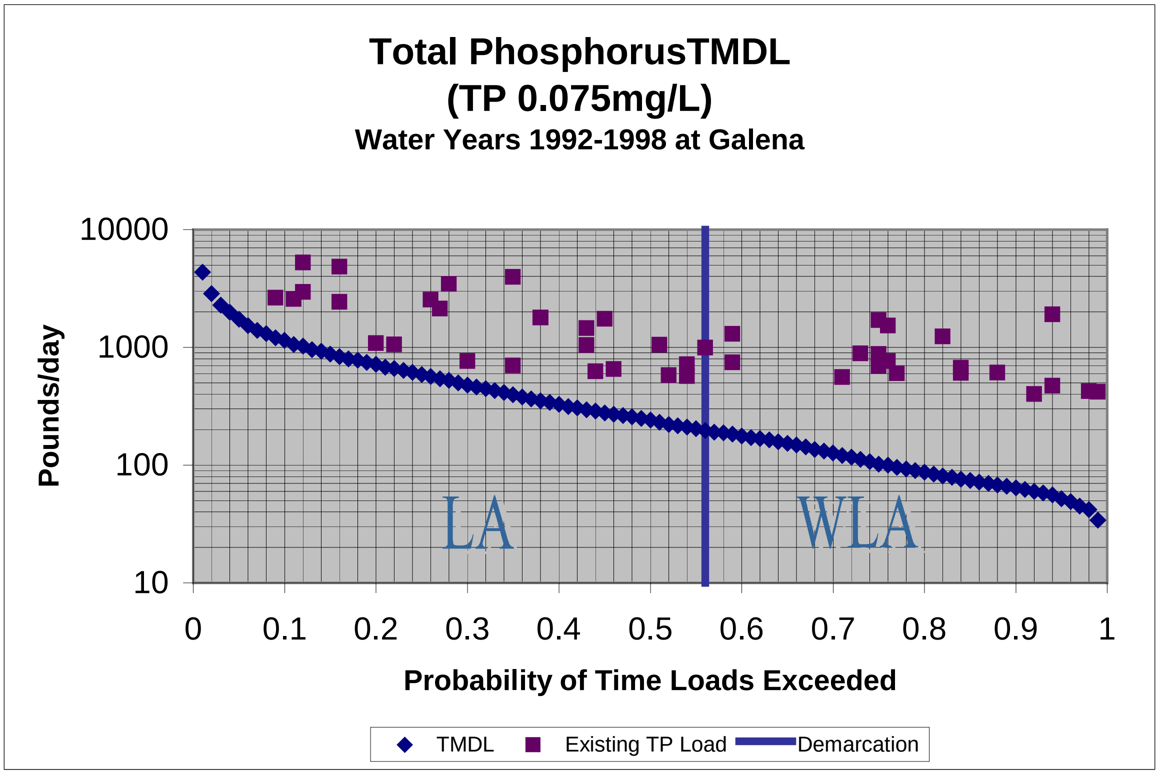


Figure 4. Total Phosphorus TMDL Load Duration Curve



3. Margin of Safety

The margin of safety on the James River will be an implicit margin, not a numeric reduction in load capacity. This implied margin of safety is based on the documentation that the effectiveness of phosphorus removal at wastewater treatment facilities results in a lower phosphorus load at the end of pipe than the stated permit limit of 0.5 mg/L total phosphorus. See Table 7 for information regarding phosphorus removal from treatment facilities located in the Ozarks that have phosphorus removal capabilities in place.

Table 7. Data on Phosphorus Removal from WWTPs in the Ozarks

Facility Name	Average Daily Mean for Phosphorus mg/L.	Average Daily Maximum Mean for Phosphorus mg/L.
Branson WWTP	0.240	0.515
Hollister WWTF	0.325	0.432
Simmons Foods, Inc.	0.279	0.402

The point source permit limits for TP will remain at 0.5 mg/L and the wasteload allocation will not be altered based on this additional phosphorus removal. The load reductions will remain intact to serve as the margin of safety. Also, the wasteload calculation is based on the design flows for the plants, not their actual discharge levels. Most discharges are significantly lower than the design flows. These two factors result in a wasteload calculation that exceeds the actual loading to the system. The margin between the actual load and the calculated load represents the implied margin of safety.

4. Seasonal Variation

Aesthetic impacts (due to algal growth) affecting warm water fisheries and canoeing uses are experienced in late spring, summer, and early fall. Adverse biological effects such as low dissolved oxygen and high algal biomass within streams are observed most frequently in this same time period. Diatom blooms, however, have been known to occur in late fall. If a phosphorus limit were instituted for the growing season only, it would ignore the effects of nutrient re-suspension in the water column from sediment to both the James River and Table Rock Lake. For this reason it is recommend that the 0.075 mg/L TP and 1.5 mg/L TN criterion be in effect year around.

5. Continuous Monitoring Plan for the Phased James River TMDL

The goal of this TMDL is to reduce the frequency of benthic algal blooms in excess of 100 mg/m^2 Chl_a through in-stream nutrient limits of 0.075 mg/L total phosphorus and 1.5 mg/L total nitrogen. Measurement of factors responsible for the accrual and loss of algae need to be collected. The following monitoring schedule has been developed to determine the effectiveness of the TMDL efforts.

Sampling Period

Monitoring efforts will begin June 2001 and continue until phase II efforts begin in 2004. Once initiated, contract personnel will sample 12 sites between 10:00 am – 4:00 p.m. from June 1- September 30 each year. Variables will be measured weekly at each site, with the exception of macroinvertebrates, which will be measured monthly. Table 8 lists the parameters to be monitored and the frequency. Refer to Figure 5 for a map of the proposed monitoring sites.

Table 8. Variables to be Measured in James River TMDL Continuous Monitoring Plan

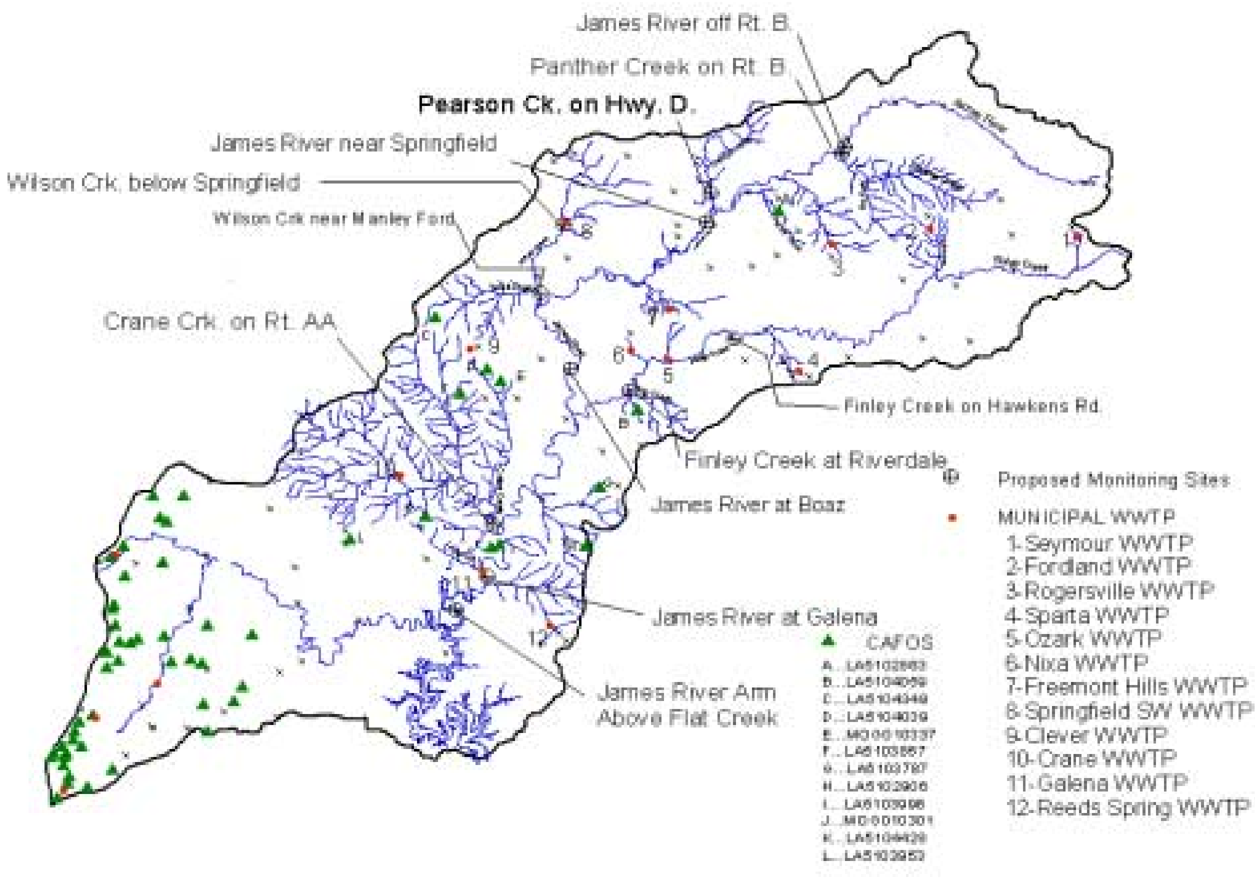
Variable	Frequency	Replicate Samples	Comments
Total Nitrogen	1/week	N/A	
Total Phosphorus	1/week	N/A	
Total Suspended Solids	1/week	N/A	
BOD_5	1/week	N/A	
Conductivity	1/week	N/A	
PH	1/week	N/A	
Dissolved Oxygen	1/week	N/A	
Temperature	1/week	N/A	
Suspended Chl_a	1/week	3	
Benthic Chl_a	1/week	3	Where depth allows
Macroinvertebrates	1/month	3	Where depth allows
Canopy Cover	1/week	N/A	Densiometer
Waterbody Depth	1/week	N/A	
Stream Velocity	1/week	N/A	Where applicable
Stream Flow	1/week	N/A	Where applicable

Methodology Notes:

- Benthic algae will be collected using artificial substrates (bricks) to better allow for trend detection and will be anchored one month prior to sampling.

- A Quality Assurance Project Plan (QAPP) will be in place prior to the initiation of monitoring activities.
- Two automated D.O./temperature data loggers will be used to investigate low flow D.O. and temperature regimes. Initial placement will be in Wilson and Pearson Creeks in an attempt to identify the sources of impairments. These data loggers will be rotated every two weeks so that D.O. and temperature profiles for each site are collected every year.
- Standard operating procedures for collection of these variables will be in accordance with advice from Central Plains Center for Bioassessment (CPCB)-Kansas Biological Survey.

Figure 7. Map of Monitoring Sites for Continuous Monitoring Plan



6. Implementation Plans for the Phased James River TMDL

As indicated in the title of this document, the James River TMDL will be completed in phases. Phase I will include re-issuance of the permits through the established permit process for those facilities that are required to have phosphorus limits. The compliance schedule is established in the Water Quality

Standards[21] (see Compliance Schedule, Appendix C). As Wilson Creek has been shown to be a major contributor of nutrient loading to the James River, reducing the load from this watershed will be a major focus of Phase I. The two most significant sources of nutrient loading in the Wilson Creek watershed are the Springfield Southwest Wastewater Treatment Plant and urban runoff from the City of Springfield. The Southwest Plant has developed plans for the implementation of phosphorus removal. Trial runs of the treatment system have demonstrated the plant may achieve treatment levels well below the 0.5 mg/L phosphorus limit that will be in the NPDES permit. The phosphorus removal at the Southwest Plant was implemented in March 2001. In-stream monitoring will also be added to each permit with phosphorus limits. The permittee will be required to monitor immediately upstream and approximately 50 yards downstream of the outfall.

The Springfield Stormwater Permit will be finalized in the near future. Monitoring to be completed by the City of Springfield covers several parameters including:

- Total Dissolved Solids
- Total Suspended Solids
- Total Kjeldahl Nitrogen
- Nitrate + Nitrite
- Dissolved Phosphorus as P
- Total Phosphorus as P
- Estimates of Stream Flow

Grab samples will be collected from six identified locations that will provide information on the effectiveness of the stormwater management program being implemented by the city. These locations are near city limits and evaluate the cumulative effects of stormwater runoff from sub-watersheds. Ambient sampling will include sample collection at all locations during the second week of March, the second week of May and the second week of November each year. A fourth sample will be collected between March 1 and May 31 and will be a wet weather sample. It will be collected not later than 48 hours after a storm event of at least 0.2 inch and less than 3.0 inches during a 24-hour period. A second part of the monitoring program will involve field screening for illicit discharges. Additionally, each year 25 random points will be selected for monitoring to evaluate industrial discharges to the stormwater system during wet weather periods. Best management practices to be implemented by the city will be identified during the permit process. The city is being encouraged to use the recommended practices for urban stormwater management that are identified in Missouri's approved Nonpoint Source Management Plan[22]. Best management practices may be changed if data shows a specific management practice is not effective in reducing the loading of the pollutants of concern. See the Recommendations section below for information regarding additional plans for addressing urban runoff of pollutants to the James River.

- The issue of increased amounts of nutrient enriched sludge due to phosphorus removal at treatment plants will be addressed in permit issuance. The concern regarding nutrients entering the James River due to inappropriate handling of sludge needs to be addressed. If land application is the chosen method of disposal, treatment plants must obtain a land application permit. Application rates for the sludge are

[21] 10 CSR 20-7.015(3)(G)

[22] Available from the Missouri Department of Natural Resources or on the department web site: http://www.dnr.state.mo.us/deq/wpcp/wpcnpsmp.htm

specified in the permit and are based on agronomic application rates. Other options for sludge management include landfilling or incinerating the sludge. The City of Nixa currently composts its sludge and it gets reused in the community as a fertilizer. Although no option for disposal is full proof in preventing the nutrient load from re-entering the James River, if managed appropriately, innovative sludge management approaches should minimize the problem.
Phase II of the James River TMDL will be partially based on the data collected under the continuous monitoring plan. The Phase I modeling activities for the James focused on the use of mass balance spreadsheets to calculate a flow duration curve. Increases in data quantity and data appropriate for modeling purposes will make possible the use of a more detailed model, such as Hydrologic Simulation Program Fortran (HSPF) or Water Quality Analysis Simulation Program (WASP). Review of the data may also provide information on the effectiveness of Phase I. If indicated, additional modeling will be done to increase the precision and accuracy of the calculated load capacity and allocations. As point sources are being addressed during Phase I, nonpoint sources will be the focus of Phase II. Any additional reductions in nutrient loading needed to get the James River to meet Water Quality Standards will have to be achieved through the management of runoff from nonpoint sources. Phase II will specify implementation plans and possible sources of funding assistance for achieving the needed nonpoint load reductions. This does not exclude the possibility of locally led initiatives being funded to minimize nonpoint source contributions prior to the start of Phase II.

Attenuation of the pollutant load was discussed briefly in the TMDL Calculation section. Attenuation addresses issues such as the natural decay of a pollutant and the natural storage capacity of pollutant within the waterbody. Phosphorus in particular can be stored in large quantities within the system as it often binds with bottom sediments. High flow events flush sediment out of the river into Table Rock Lake. Due to this presently unknown storage factor, it is difficult to estimate when the James River will attain water quality standards. Even when pollutant inputs are greatly reduced, the amount of nutrients stored in the system could continue to cause algal blooms for a period of time. The tentative date for achievement of Water Quality Standards is 2007. This is the date when all the point sources required to implement phosphorus removal must be in compliance. It is also anticipated that by 2007, many Phase II nonpoint source management plans will be in place and contributing to the reduction of nutrients in the river.

Recommendations for further action in Phase I:

- A watershed partnership, working in conjunction with city and county governments, will be encouraged to apply for grant monies to fund a stormwater education position. There are similar positions funded in other areas of the state that could be used as a model. Potential activities include:
  -Presentations on stormwater issues at public meetings, neighborhood association gatherings, civic organizations, etc.
  -Development and inclusion of informational flyers regarding stormwater management in public utility bills
  -Provision of displays containing stormwater runoff information at various community functions
  -Promotion of storm drain stenciling programs
  -Provide informational workshops on erosion control methods for developers
  -Work with local government entities to find funding and methods for implementing land disturbance permit programs

-Provide informational workshops on septic tank installation and maintenance
-Work with local government entities to find funding and methods of implementing septic tank programs

- Public meetings will be scheduled for stakeholders in the watershed. This will provide an opportunity for further problem identification, information gathering for a wider array of possible solutions and gaining the commitment of stakeholders to the TMDL implementation plan.

- The stormwater permit for the City of Springfield and the James River TMDL will be public noticed at approximately the same time. It is anticipated public meetings or availability sessions held on TMDL issues will also include a stormwater permit component when appropriate. When the Phase II Stormwater Permit program goes into effect, Galena Township and Greene and Christian counties will be required to develop stormwater management plans for their more densely populated areas. TMDL and stormwater permitting staff will work jointly on nutrient issues that can be addressed through the stormwater permitting process.

- Explore possibilities for voluntary watershed projects with existing organizations that have a working relationship with the agriculture community. Groups will be encouraged to apply for 319 grants and other sources of funding to facilitate the implementation of nutrient BMPs. Examples of organizations to be approached include the Natural Resource Conservation Service, University Extension, Soil & Water Districts, not-for-profit watershed associations and producer organizations.

7. Reasonable Assurances

The Department of Natural Resources has the authority to write and enforce NPDES permits. This will provide reasonable assurance of compliance from point sources. Reasonable assurance for nonpoint sources will be addressed in Phase II. Options include grants to appropriate parties that include specific milestones to be met and signed agreements with landowners in a watershed stating their concurrence with a specific watershed management plan. A goal of the implementation plan is for agricultural nonpoint sources to meet the Natural Resource Conservation Service's nutrient management standards during Phase II of the TMDL.

8. Public Participation

The water quality limited segments identified in this TMDL are included on the approved 1998 303(d) list for Missouri. Six public meetings to allow input from the public on impaired waters were held between August 18 and September 22, 1998. There were no comments of note regarding the listing of the James River.

TMDLs developed by Missouri are sent to EPA for examination and then the edited drafts are placed on public notice. Following a 30-day public notice, the TMDLs is adjusted in response to comments received, when appropriate.

Public meetings will be held prior to Phase II to provide a venue for participation from affected stakeholders. Additionally, participants on Missouri's TMDL Policy Advisory Committee include representatives from the James River basin. This provides another venue for public participation, as

input by committee members is encouraged. It also provides a venue for information exchange regarding the TMDL process.

9. Appendices

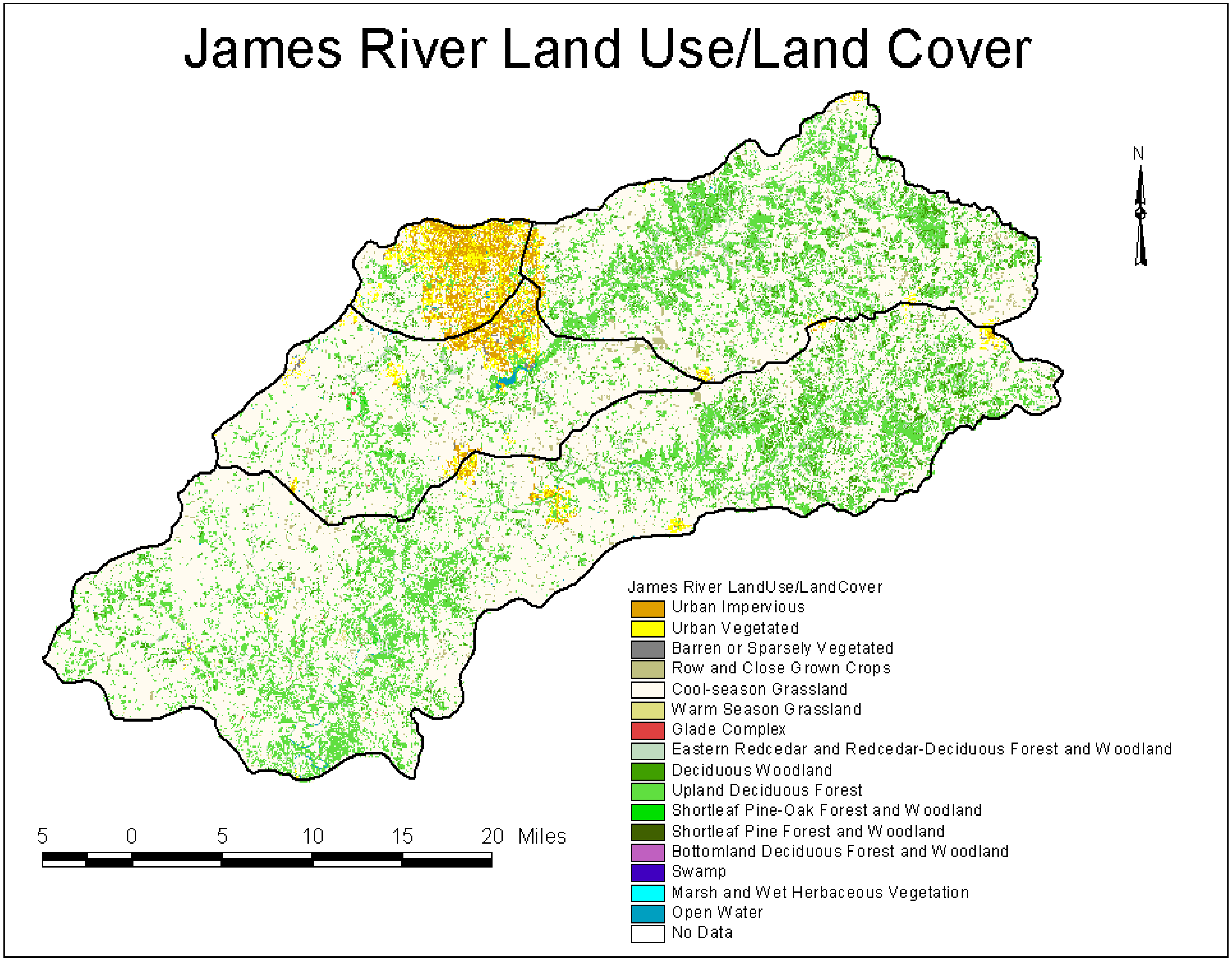
Appendix A – Land use map for the James River watershed
Appendix B – List of Point Sources in Watershed
Appendix C – Compliance Schedule for Facilities Required to Implement Phosphorus Removal
Appendix D - Bibliography

10. Administrative Record and Supporting Documentation

An administrative record on the James River TMDL has been assembled and is being kept on file with the Missouri Department of Natural Resources. It includes the following:

- Copies of the NPDES permits that are required to have phosphorus limits
- Data used for calculating current loading of nutrients
- Data used in the production of load duration curves
- Copies of studies done to support the information provided in this document or the location of supporting information
- All public comment letters received and responses to the public comments

Appendix A
James River Land Use



James River Land Use Type
Area in Acres

Land Use/Land Cover Class	Area (acres)
Urban Impervious	13128.84
Urban Vegetated	11975.54
Barren or Sparsely Vegetated	689.18
Row and Close Grown Crops	9486.36
Cool-season Grassland	425112.23
Warm Season Grassland	798.37
Glade Complex	122.31
Eastern Redcedar and Redcedar-Deciduous Forest and Woodland	19983.69
Deciduous Woodland	25473.09
Upland Deciduous Forest	115917.42
Shortleaf Pine-Oak Forest and Woodland	525.72
Shortleaf Pine Forest and Woodland	0.00
Bottomland Deciduous Forest and Woodland	1.33
Swamp	0.00
Marsh and Wet Herbaceous Vegetation	0.00
Open Water	1013.19
Total	**624227.28**

Appendix B

Point sources in each sub-watershed						
	Galena-Excluding point sources upstream of Boaz					
FACID	**FACNAME**	**CITY**	**D_FLW (GD)**	**D_FLW (CFS)**	**COUNTY**	**REC. STREAM**
MO0115525	WINDRIDGE SUBD	OZARK	11,000	0.017	CHRISTIA	TRIB ELK VALLEY BR
MO0106470	SOUTH OAKS MHP	NIXA	13,000	0.02	CHRISTIA	TRIB FINLEY CR
MO0119008	WOODRIDGE SOUTH SUBD WWTF	SPRINGFIELD	14,000	0.022	CHRISTIA	ELK VALLEY
MO0107182	GALENA WWTP	GALENA	60,000	0.093	STONE	PINE RUN
MO0102318	CLEVER WWTF	CLEVER	70,000	0.109	CHRISTIA	TRIB TO SPRING CR.
MO0093556	MDOC,OZARK CORRECTNL CNTR	FORDLAND	92,000	0.143	WEBSTER	DAVIS CR
MO0104027	SPARTA WWTF	SPARTA	94,000	0.146	CHRISTIA	CARTER HOLLOW
MO0022985	SEYMOUR WWTP	SEYMOUR	252,000	0.391	WEBSTER	TRIB TO FINLEY CR.
MO0040835	CRANE WWTP	CRANE	300,000	0.465	STONE	CRANE CR.
MO0099163	OZARK WWTP	OZARK	750,000	1.163	CHRISTIA	FINLEY CR
MO0028037	NIXA WWTF	NIXA	1,846,000	2.861	CHRISTIA	FINLEY CREEK
MO0099813	FORDLAND WWTF	FORDLAND	100,000	0.155	WEBSTER	TERRELL CREEK
Point sources in Boaz subwatershed exluding Wilson and Pearson						
FACID	**FACNAME**	**CITY**	**D_FLW (GD)**	**D_FLW (CFS)**	**COUNTY**	**REC. STREAM**
MO0119687	MERCHANTS FIELD WWTF	NIXA	1,000	0.002	CHRISTIA	TRIB JAMES R
MO0099325	HIDDEN VALLEY ESTATES	CLEVER	8,000	0.012	STONE	JAMES R.
MO0116980	JAMES RIVER ASSEMBLY OF G	SPRINGFIELD	8,000	0.012	GREENE	TRIB. TO LAKE SPR
MO0085171	TIMBERCREST MHP	SPRINGFIELD	19,000	0.029	GREENE	THOMPSON BR
MO0114464	RIVER DOWNS WEST SUBD	NIXA	19,000	0.029	CHRISTIA	TRIB JAMES RIVER
MO0094129	ENGLISH VILLAGE MHP	NIXA	80,000	0.124	CHRISTIA	TRIB TO JAMES R.
MO0106151	FREMONT HILLS WWTF	NIXA	90,000	0.14	CHRISTIA	TRIB JAMES R.
MO0001961	SPRINGFIELD JR POWER PLANT	SPRINGFIELD	334.100		GREENE	LAKE SPRINGFIELD/JR
Wilson-South Creek sub-watershed						
FACID	**FACNAME**	**CITY**	**D_FLW (GD)**	**D_FLW (CFS)**	**COUNTY**	**REC. STREAM**
MO0121762	COLONIAL MOTOR LODGE	SPRINGFIELD	5,000	**0.008**	GREENE	TRIB WILSON CR
MO0049522	SPRINGFIELD SW WWTP	SPRINGFIELD	42,500,000	**65.875**	GREENE	WILSON CREEK
MO0089940	SPRINGFIELD SW POWER PLANT	SPRINGFIELD	46.000		GREENE	WILSON CREEK
Pearson-James sub-watershed						
FACID	**FACNAME**	**CITY**	**D_FLW (GD)**	**D_FLW (CFS)**	**COUNTY**	**REC. STREAM**
MO0100315	JAMES VALLEY FARM SUBD	SPRINGFIELD	9,000	**0.014**	GREENE	JAMES RIVER
MO0102679	ROGERSVILLE WWTF	SPRINGFIELD	112,000	**0.174**	WEBSTER	SAWYER CREEK

Appendix C

Compliance Schedule

For Facilities Required to Implement Phosphorus Removal
To a Monthly Average of 0.5 mg/L

The rule regarding the removal of phosphorus from discharges to Table Rock Lake can be found in the Missouri Water Quality Standards at 10 CSR 20.7.015(3)(G). The compliance schedule contained in this rule is as follows:

- Facilities with a design flow of 1,000,000 gallons/day or greater must comply with the rule no later than four years from the date of the rule making (November 1999).
- Facilities with a design flow of 100,000 – 999,999 gallons/day must meet an interim phosphorus limit of 1.0 mg/L no later than four years from the effective date of the rule and must attain full compliance with the 0.5 mg/L requirement no later than eight years from the date of the rule.
- Facilities with a discharge of 22,500 – 99,999 gallons/day have no interim limits and must attain full compliance with the 0.5 mg/L monthly average for phosphorus no later than eight years after the date of the rule making.

FACILITY NAME	DESIGN FLOW GALLONS/DAY	COMPLIANCE DATE
Springfield Southwest Wastewater Treatment Plant	42,500,000	November 2003
Nixa Wastewater Treatment Facility	1,846,500	November 2003
Ozark Wastewater Treatment Plant	750,000*	November 2007
Crane Municipal Wastewater Treatment Plant	300,000*	November 2007
Seymour Municipal Wastewater Treatment Plant	252,000*	November 2007
Rogersville Wastewater Treatment Plant	112, 000*	November 2007
Fordland Municipal Wastewater Treatment Facility	100,000*	November 2007
Sparta Wastewater Treatment Facility	94,500	November 2007
MDOC, Ozark Correctional Facility	92,000	November 2007
Fremont Hills Wastewater Treatment Facility	90,000	November 2007
English Village Mobile Home Park	80,250	November 2007
Clever Municipal Wastewater Treatment Facility	70,000	November 2007
Galena Wastewater Treatment Plant	60,000	November 2007

* Plants that must meet an interim limit of 1.0 mg/L by November 2003.

Appendix D

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