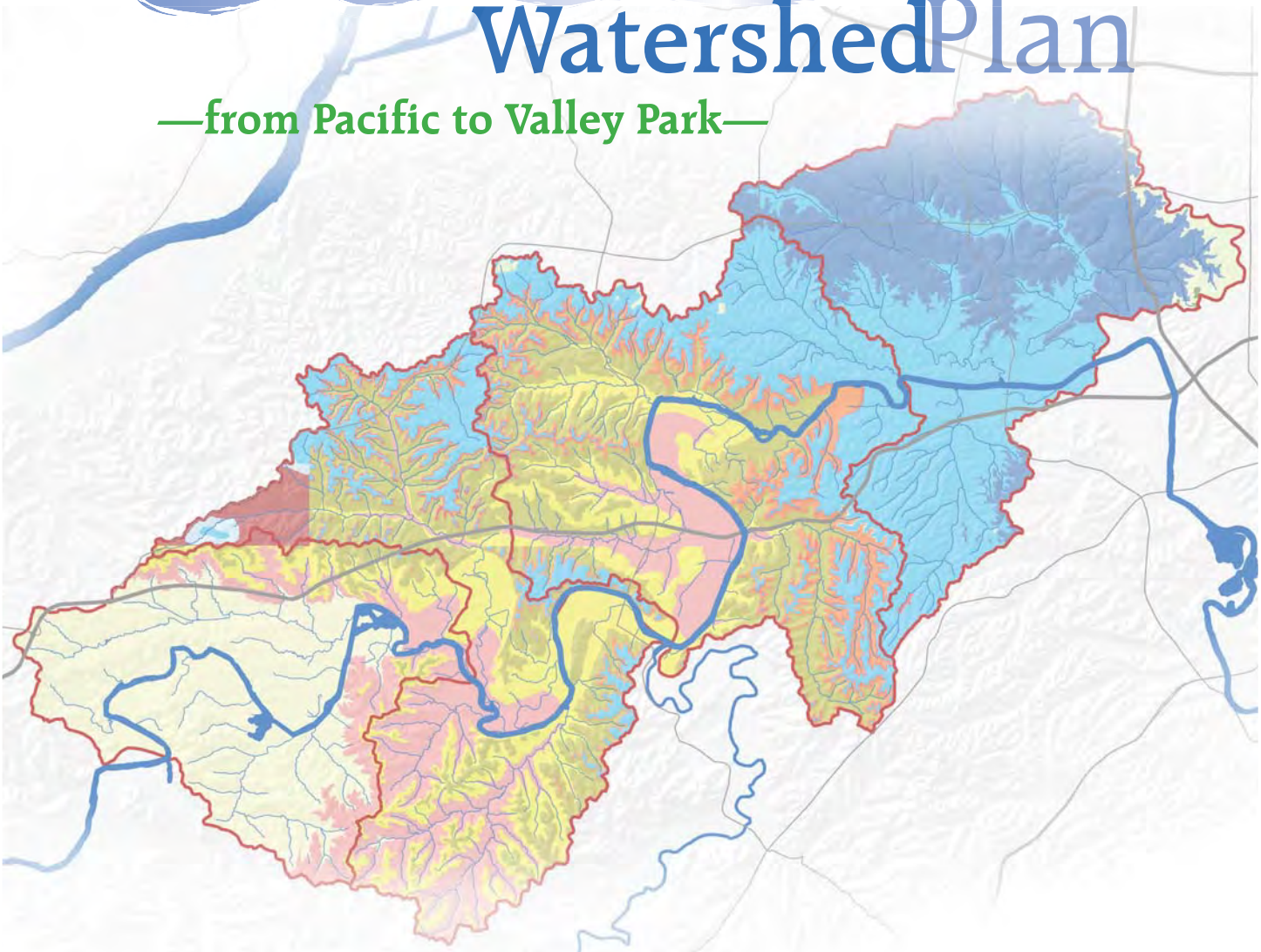
Water Quality, Green Infrastructure and Watershed Management for the Lower Meramec Watershed

FINAL

January 2012

Lower Meramec Watershed Plan

—from Pacific to Valley Park—



This project and report was supported by a grant from the United States Environmental Protection Agency, Region 7

EAST-WEST GATEWAY
Council of Governments

Creating Solutions Across Jurisdictional Boundaries

Lower Meramec Watershed Plan

Water Quality, Green Infrastructure and Watershed Management for the Lower Meramec Watershed

East-West Gateway Council of Governments

January 2012

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009 and Section 604(b) of the Clean Water Act

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Documents available in pdf format at the Lower Meramec Watershed Plan web page:
http://www.ewgateway.org/environment/waterresources/Watersheds/LowerMeramec/lowermeramec.htm

LaBarque Creek Watershed Conservation Plan, 2009
Prepared by Missouri Department of Conservation for Friends of LaBarque Creek

Fishpot Creek Watershed: A Demonstration of Geomorphic-Based Stream Channel Management Method, 2003
Prepared by Intuition & Logic for the St. Louis County Soil and Water Conservation District

Lower Meramec River Source Water Protection Strategy Exchange Report, 2009
Prepared by the Meramec River Tributary Alliance

St. Louis County Meramec River Greenway Concept Plan, 2003
Prepared by St. Louis County Department of Parks and Recreation and St. Louis County Department of Planning

PowerPoint - Green Infrastructure, Nonpoint Education for Municipal Officials (NEMO), Lower Meramec Tributary Watershed Planning

PowerPoint - Rain Gardens, Nonpoint Education for Municipal Officials (NEMO), Lower Meramec Tributary Watershed Planning

Documents available in pdf format at the Lower Meramec Watershed Plan web page:
http://www.ewgateway.org/environment/waterresources/Watersheds/LowerMeramec/lowermeramec.htm

PowerPoint - Native Plants, Nonpoint Education for Municipal Officials (NEMO), Lower Meramec Tributary Watershed Planning

PowerPoint - Natural Resource Based Planning, Nonpoint Education for Municipal Officials NEMO), Lower Meramec Tributary Watershed Planning

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Lower Meramec Watershed Plan

Executive Summary

Water Quality, Green Infrastructure and Watershed Management
For the Lower Meramec Watershed

Scope of Plan and Background

The Lower Meramec River watershed extends 109 miles from Meramec State Park at Sullivan to the confluence with the Mississippi River, and it lies wholly within the East-West Gateway region and the three counties of Franklin, Jefferson, and St. Louis.

The plan area includes the 12 digit watersheds of (1) Brush Creek; (2) Fox and LaBarque Creeks; (3) Hamilton, Carr, Flat, Forby and Kiefer Creeks; and (4) Grand Glaize, Williams and Fishpot Creeks. These tributaries enter the Meramec between Pacific and Valley Park. Three of these streams – Kiefer, Fishpot and Grand Glaize, are listed for pollutant loads that exceed standards. Based on the assessment and recommendations of previous planning efforts[1], East-West Gateway Council of Governments (EWG) entered into an agreement with the Missouri Department of Natural Resources (MoDNR) to develop a nine-element watershed plan. The overall objective of this plan is to provide a framework for managing and improving water quality in the Lower Meramec River Basin. The recognized need to focus on the Meramec River Basin and the Lower Meramec Watershed dates back to the original *208 Water Quality Management Plan* (208 Plan), completed in 1978 by EWG for the St. Louis region.[2]

Background

The 208 Plan, in 1979, recommended a long-term focus on watershed planning for both sewage facility construction and stormwater management. The 208 Plan also identified the Meramec River as the region's number one priority river and watershed area, deserving protection both as a drinking water source and because it is biologically diverse and contains important habitat. The 208 Plan demonstrated through computer modeling that in-stream water quality could not be met with point source controls alone. The 208 Plan still provides a legal framework for planning and managing sewage and water quality in the region. This current nine-element watershed plan builds upon the *208 Plan*.

In a report East-West Gateway made to MoDNR pursuant to updating the *208 Plan* in March 2010, watershed planning was emphasized as a way to address pollution in specific water bodies. And in 2009, the U.S. Forest Service provided a grant to the St. Louis Regional Open Space Council and a coalition or more than thirty agencies and organizations to develop the *Lower Meramec Source Water Protection Strategy Exchange*. The *Exchange* was completed in July 2009 and concluded that:

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[1] *"Water Quality Futures: Watershed Planning for the Lower Meramec River"* (July 2005); Links are at http://www.ewgateway.org/environment/waterresources/WRCProducts/wrcproducts.htm

[2] *"St. Louis, Missouri, Water Quality Management Plan"* (1978), completed to meet requirements of section 208 in the Federal Clean Water Act.

> The primary problem to be addressed by any actions taken with respect to the Lower Meramec River Tributary (LMRT) Watersheds is the same problem that all watersheds face – the natural functions and benefits of a watershed become significantly degraded when combined with human influence and development, unless proactive efforts are made to protect the watershed's functions and benefits. While the LMRT watersheds are generally considered to be in good condition, especially considering the proximity to a large urban area, evidence of degradation, in the form of increased erosion, decreased biodiversity, changing flow dynamics, and other effects has already been clearly documented.[3]

That report recommends public education programs for municipal officials as well as local citizens to promote best practices and interest in watershed planning. That report also identifies septic tank failure and storm water runoff as major contributing factors to poor water quality. The goals outlined by that broad coalition include the following:

1. Develop strategies to protect a vitally important source of drinking water for 200,000 St. Louis county residents.
2. Improve and protect habitat and recreational areas in streams and restore degraded tributaries.
3. Develop strategies to protect healthy, sensitive streams that are at risk of being degraded by human actions.
4. Develop long range plans for public education.
5. Achieve and maintain compliance with water quality standards.

Addressing Problems

This watershed plan continues and builds on the goals above. Throughout this planning process a coalition of state, local, federal and community representatives have met regularly to address critical problems in the Lower Meramec planning area. EWG employed a series of workshops, conferences, meetings and field trips to discuss planning goals and implementation policies with citizens, municipal officials and park managers.

This new watershed plan creates a long-term framework for restoring the three sub-watersheds that are designated as degraded streams and protecting the healthy streams. The plan identifies stormwater runoff as an area-wide source of pollution and recommends a long-term strategic approach to building awareness and support to improve stormwater management practices in local government and the private sector. In the short term, between now and 2016, the plan recommends actions by local government and public agencies that can be quickly implemented to address water quality problems and serve as demonstration and education projects. The plan also identifies the need to reduce or eliminate failing septic systems in key areas, and begins an educational program in the short term, followed by more stringent local government regulation in the mid term to reduce septic system failures. Mid term – five to ten year efforts – also include more detailed modeling and more strategic project implementation in sub-watersheds that will involve citizens working on their own private property.

[3] "*Lower Meramec River Source Water Protection Strategy Exchange Report*" (July, 2009)

During the first five years, this plan should provide an important framework for a variety of partners to continue working together to educate local government leaders and citizens about watersheds, watershed planning and strategies to reduce pollution. In the first two years of the plan, an accompanying watershed brochure and a septic system management brochure, along with informational maps will help to educate government officials, developers and citizens on problems and solutions, recommend best management practices, provide an implementation schedule, milestones and a means for evaluating progress.

Meramec River at Route 66 State Park

Models, Monitoring & Load Reductions

In the current phase of the plan, EWG used a Simple Model but quickly discovered that the study area was too large to accommodate a detailed load analysis, and that models available provide general detail as to volumes that can be achieved by short-term projects. Current models and current loadings provide a baseline for plans going forward. EWG used such models to develop a table to demonstrate how water quality goals can be achieved for the three degraded streams by the year 2031.

During the planning process, EWG conducted a thorough review of some twenty-six (26) watershed models to identify a more complex model that will function in an urban and suburban setting as needed. Near the end of this planning process, EWG was able to purchase the WMS watershed model with separate funds. This WMS model will enable EWG to conduct analysis of pollutants and carry out more detailed strategies for load reduction in the sub-watersheds over the next five years. By 2016, the modeling, combined with continued monitoring of pollutants will provide a more complete framework for measuring achievements by 2020.

City, County & State Owned Public Lands,

A key recommendation of this watershed plan is to focus on public lands within the four 12-digit watersheds. The area under study has many state and local parks and conservation areas that were established to protect biological resources, and to provide public access to the river. Communities and agencies can *quickly* move to implement best management practices in parks and other public lands, including city municipal buildings and maintenance facilities, to improve water quality, reduce costs for storm water management, improve flood control, and demonstrate a variety of practices to the general public. Such projects can be administered and evaluated by public agencies and watershed partners, and because public parks have many users, the projects will have potential for a broad impact. The target for this plan is implementation of the

recommended actions in public lands between now and 2016. Over these five years, an aggressive focus on demonstration projects on public lands has a high degree of probable success and will serve to build awareness and support among local elected leaders and create a strong impetus for second stage projects, which can target private lands on a voluntary basis. In addition, this targeted focus will support initiatives of the Meramec Greenway, a grand scale vision to protect the Meramec River corridor, while providing increased public access to the river. While funding is uncertain, EWG will assist local agencies to find funds to carry out projects and provide advice on strategies.

Sub-Watershed Planning

The plan also prioritizes additional planning in sub-watersheds with the greatest need- The plan calls for sub-watershed plans for Kiefer Creek, Fishpot Creek and Grand Glaize Creek to be completed in the short-term, and for plans for at least eight other sub-watersheds to be complete by 2020. With initial planning efforts now already beginning in Kiefer Creek, this plan has already been successful in accomplishing one goal – to identify the highest priority sub-watersheds (based on both level of interest and level of pollution) and build support for more detailed analysis. This planning process has served as a catalyst to encourage such planning, helped to identify where the priorities should be, and provide base level information.

Public Awareness & Education

This plan has successfully engaged local government staff in discussion of issues, concerns, problems and solutions. The public meetings over the last eighteen months have begun to develop support for future efforts to improve water quality and reduce high volume events. Awareness of water quality problems is limited, and water quality has been an afterthought in many communities. Therefore this plan has attempted to establish a realistic timeframe for education of public officials by involving them in demonstration projects in the short-term, from which other goals, such as improved stormwater ordinances and development criteria may develop in the mid-term.

As a part of the plan, EWG developed one brochure on the Meramec River tributaries, to inform the public about the resources we enjoy, and another brochure to inform owners of individual treatment systems (septic systems) about potential for failure, and strategies for successful operation. The brochures will be disseminated over the next year, to assist local governments in outreach and education, to support more comprehensive management efforts and to promote septic system regulation that will be enacted by 2016.

The Plan will provide the Meramec River Tributary Alliance (MRTA), and each of the partners within it, a framework for common action, and provide a basis for future activities. The on going meetings of MRTA, plus the Water Resource Council at EWG together will serve as places where partners can track progress in meeting goals in the plan. In addition, this plan may aid separate efforts by MSD in the eastern portion of the study area, and American Water Company throughout the Meramec Basin, to prioritize and implement management practices.

II. Characterize the Watershed

A. Study Area Overview and Description (Element A)

The Lower Meramec study area is composed of four watersheds draining approximately 116,000 acres (182 square miles) of Franklin, Jefferson and St. Louis counties. (See Map 1) The watersheds in this study are:

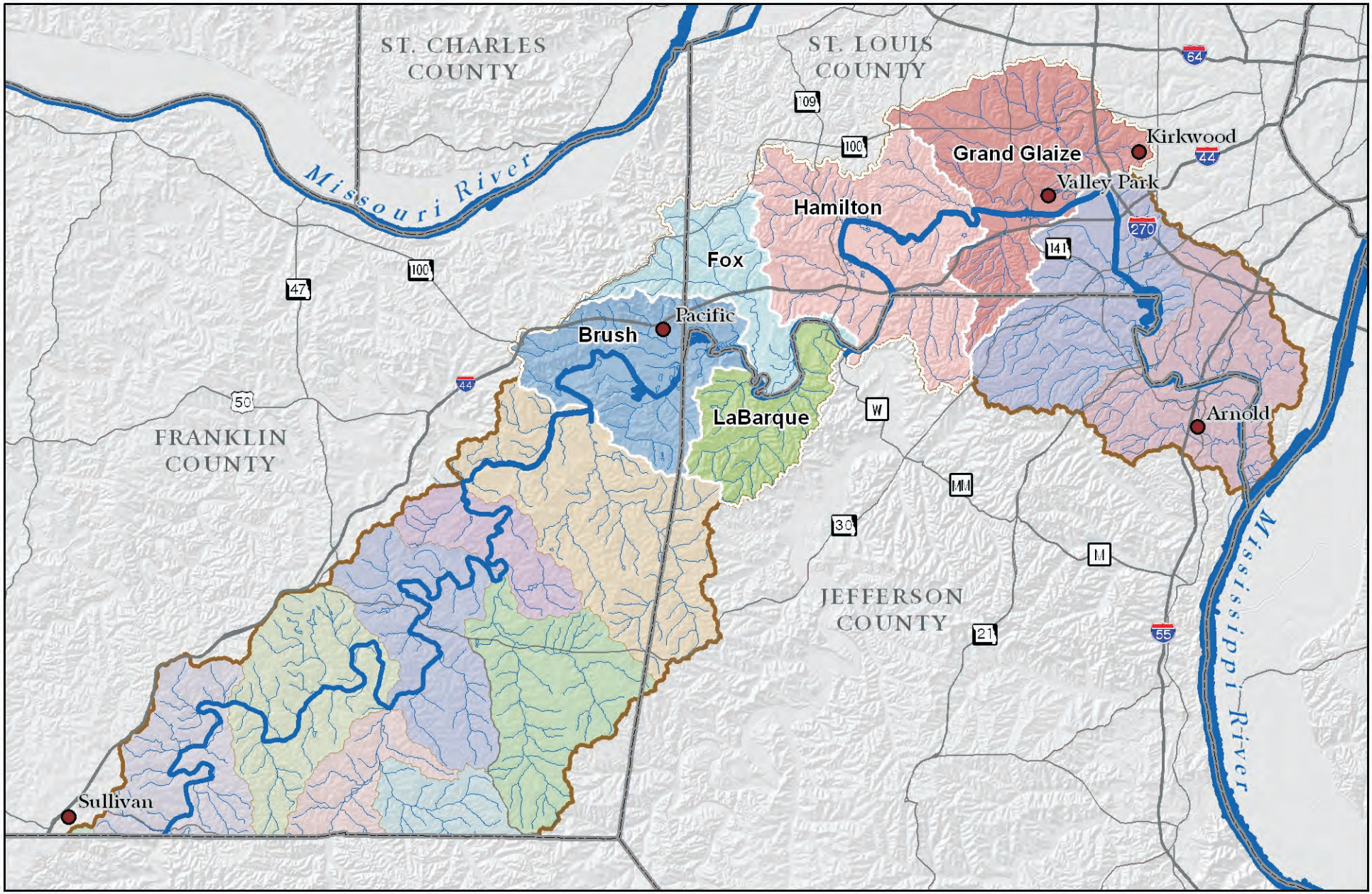
Brush Creek (HUC 071401020902)
Fox Creek (HUC 071401020903)
Hamilton Creek (HUC 071401021001)
Grand Glaize Creek (HUC 071401021002)

For purposes of this study, the Fox Creek watershed has been separated into the Fox Creek (north of the Meramec River) and LaBarque Creek (south) watersheds. Information about each watershed (incorporated units, creeks, size) is presented in Table 1. Nineteen incorporated municipalities are located all or partially in the study area. (See Table 2) The majority of the municipalities are in St. Louis County. Pacific is in Franklin County and Parkdale, Peaceful Village and Byrnes Mill are in Jefferson County. (See Map 2)

Meramec River Orientation, June 2010

Lower Meramec River Watershed

Map 1



Watersheds (12 Digit HUC)

- Selected Watersheds
- Other Watersheds

- Meramec River Watershed (8 digit HUC)
- River or Stream
- Major Road
- County Boundary

N

0 1 2 4 Miles

Sources: USDA/NRCS via MSDIS, East-West Gateway Council of Governments

August 2011

East-West Gateway Council of Governments

Creating Solutions Across Jurisdictional Boundaries

Table 1
Lower Meramec River Watersheds

12-Digit Hydrologic Unit	County	Acres	Square Miles	Creeks	Municipalities
Brush Creek 071401020902	Franklin St. Louis Jefferson	23,584	36.9	Brush, Winch Brush, Segment draining to Meramec* Segment draining to Meramec	Pacific Pacific
Fox Creek 071401020903		28,201	44.1		
Fox Creek sub-watershed	Franklin St. Louis	14,691	23.0	Little Fox Little Fox, Fox, Segment draining to Meramec	Pacific Wildwood, Eureka
LaBarque Creek sub-watershed	Jefferson	13,510	21.1	McFall, LaBarque, Segment draining to Meramec	Lake Tekakwitha
Hamilton Creek 071402021001	St. Louis Jefferson	34,956	54.6	Hamilton, Carr, Forby, Flat, Kiefer, Segment draining to Meramec Antire, Little Antire	Wildwood, Eureka, Ellisville, Ballwin Byrnes Mill, Peaceful Village
Grand Glaize Creek 0714010021002	St. Louis Jefferson	29,895	46.7	Fishpot, Grand Glaize, Segment draining to Meramec Williams, Segment draining to Meramec	Ellisville, Ballwin, Chesterfield, Town & Country, Twin Oaks, Winchester, Manchester, Country Life Acres, Des Peres, Kirkwood, Fenton, Valley Park Parkdale
Total		116,636	182.2		

* Segment is a section of land, which drains directly to the Meramec River

Source – Center for Applied Research and Environmental Systems (CARES), University of Missouri-Columbia
East-West Gateway Council of Governments

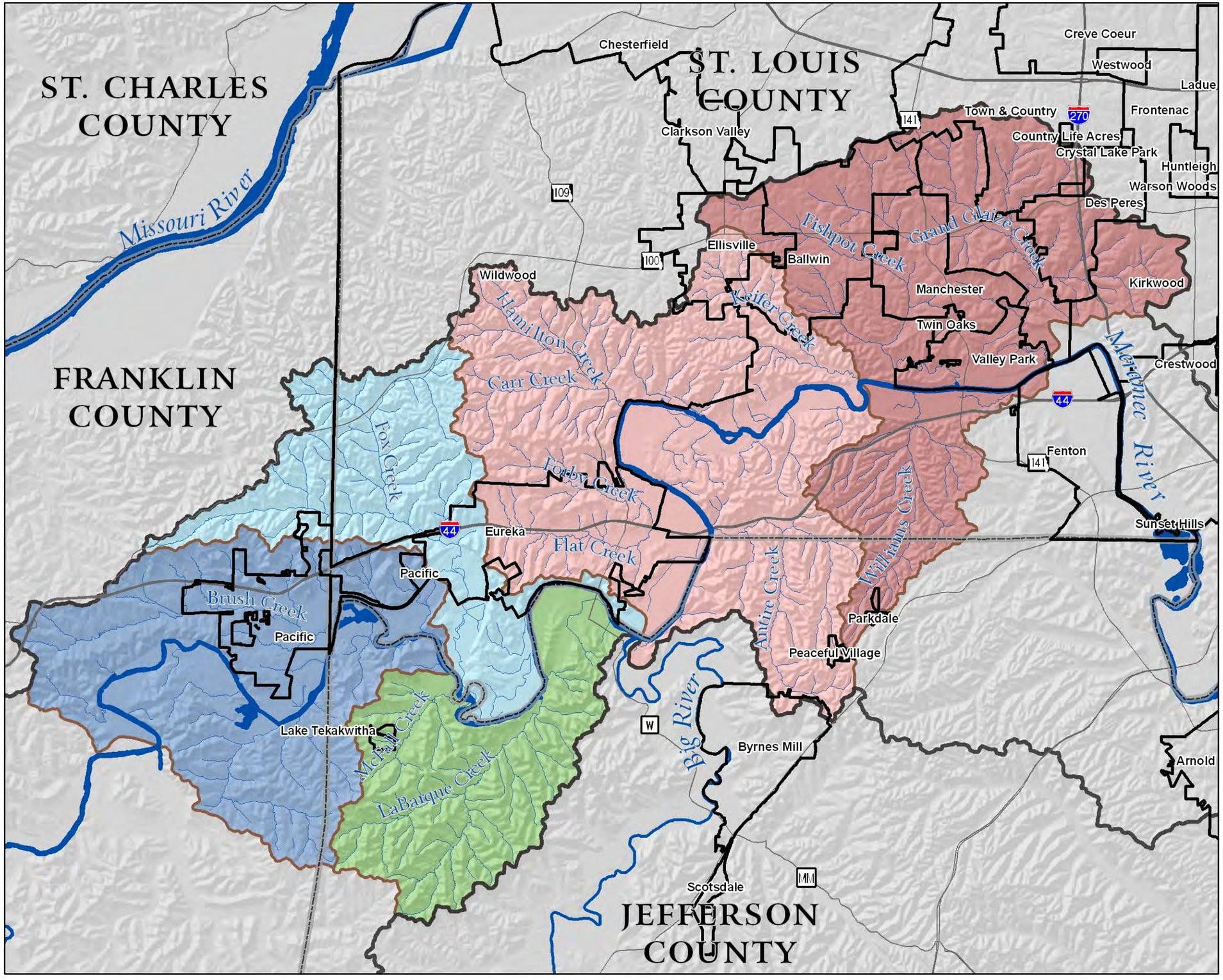
Table 2
Incorporated Land in Lower Meramec River Study Area

Municipality	Total Municipal Acres	Percent of Municipality in Meramec Watershed
Franklin County		
Pacific	3,732.4	100
Jefferson County		
Byrnes Mill	170.7	5.1
Lake Tekakwitha	137.9	100
Parkdale	57.6	71.8
Peaceful Village	105.8	100
St. Louis County		
Ballwin	5,100.6	89.1
Chesterfield	51.8	0.2
Country Life Acres	12.0	15.4
Des Peres	1,818.6	65.6
Ellisville	1,912.4	68.3
Eureka	6,777.7	100
Fenton	140.0	3.4
Kirkwood	2,190.1	37.3
Manchester	3,235.2	100
Town & Country	2,513.7	34
Twin Oaks	169.7	100
Valley Park	2,012.8	99.3
Wildwood	17,829.6	41.4
Winchester	1546.9	100

East-West Gateway Council of Governments

Map 2

Lower Meramec River Watersheds



Legend

Basemap Elements

- Meramec River Watershed
- County Boundary
- Municipal Boundary
- River or Stream
- Interstate Highway
- Major Road

Watersheds

- Brush Creek Watershed
- Fox Creek Watershed
- Grand Glaize Creek Watershed
- Hamilton Creek Watershed
- LaBarque Creek Watershed

0 1 2 4 Miles

Sources: USDA-NRCS via MSDIS,
East-West Gateway Council of Governments
October 2010

The Open Space Council for the St. Louis Region

East-West Gateway Council of Governments

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

B. Socio-Economic

Using 2010 Census information, the population in the study area was estimated to be 168,352. Approximately 68 percent of the study area population resides in the St. Louis County portion of the Grand Glaize Creek watershed. (Table 3) The Fox Creek and LaBarque Creek watersheds each contain two percent of the total population.

Since 1990, population in the study area has increased 34 percent. (Table 4) Population in the Fox Creek watershed increased 168 percent over this 20-year period while increase in the Grand Glaize watershed was 18 percent. The generalized distribution of population in the study area from 1990 to 2010 is presented in a series of maps. (See Maps 3, 4 and 5) In 1990 the majority of the population was in that portion of the Grand Glaize Creek watershed north of the Meramec River. There were population concentrations in the freestanding communities of Eureka and Pacific and along I-44 in Franklin County. Over the last two decades population has moved west beyond Kiefer Creek and into Wildwood.

The median household income by watershed ranges from $53,000 in the Brush Creek watershed to $88,295 in the Hamilton Creek watershed. The median for the entire study area is $77,402. (See Table 5)

Table 3
2010 Population by Watershed

Watershed	2010 Population	Percent Share
Brush Creek	13,568	8.1
Fox Creek	4,493	2.7
LaBarque Creek	3,217	1.9
Hamilton Creek	31,901	18.9
Grand Glaize Creek	115,173	68.4
Total	168,352	100

U.S. Bureau of the Census
East-West Gateway Council of Governments

Table 4
1990-2010 Population by Watershed

Watershed	1990 Population	2000 Population	2010 Population	Percent Change 1990-2010
Brush Creek	9,756	10,816	13,568	39.1
Fox Creek	1,676	3,229	4,493	168.1
LaBarque Creek	2,033	2,549	3,217	58.2
Hamilton Creek	14,852	25,238	31,901	114.8
Grand Glaize Creek	97,324	104,226	115,173	18.3
Total	125,641	146,058	168,352	34.0

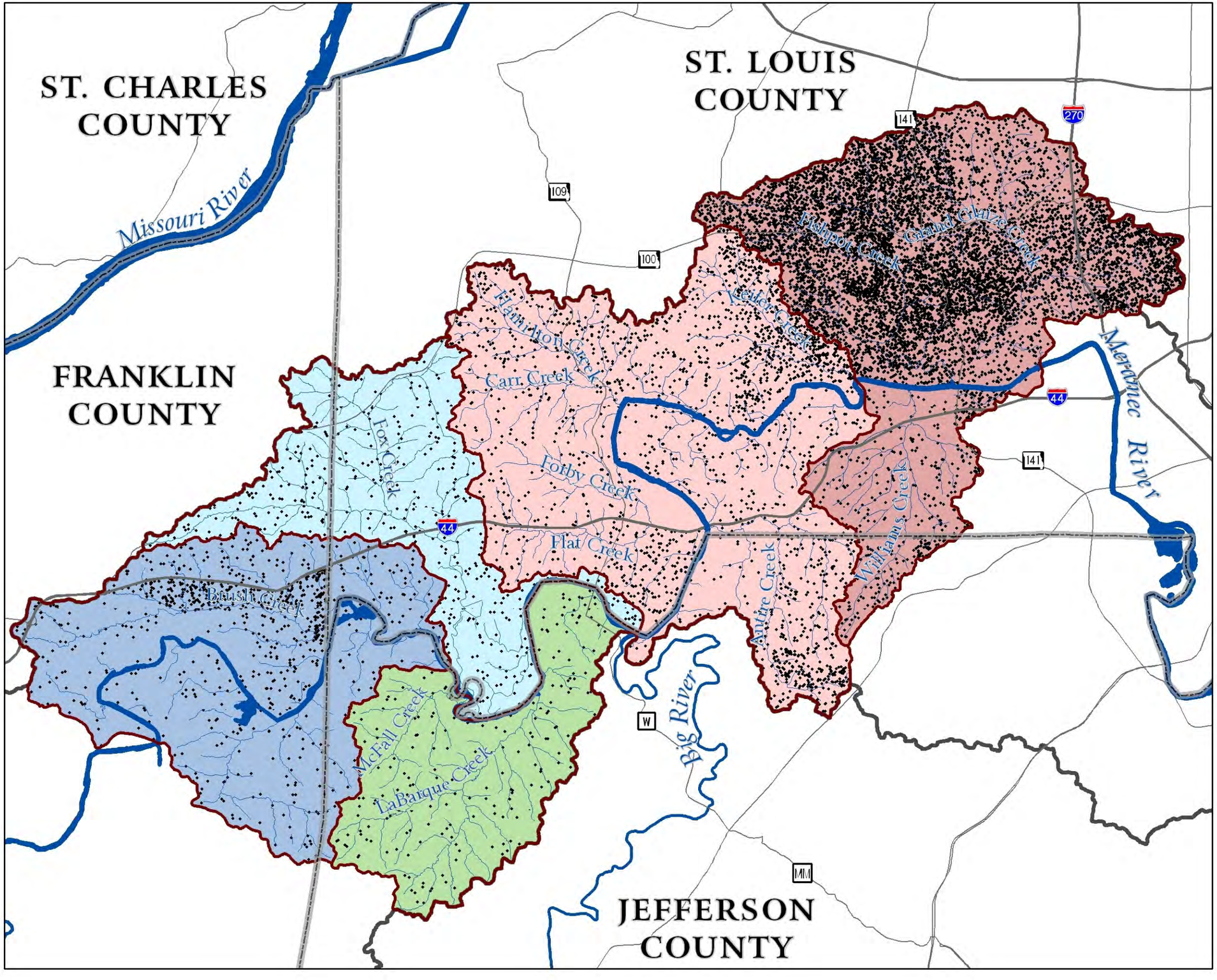
U.S. Bureau of the Census
East-West Gateway Council of Governments

Table 5
Median Household Income by Watershed

Watershed	Median Household Income
Brush Creek	$53,731
Fox Creek	$72,813
LaBarque Creek	$75,258
Hamilton Creek	$88,295
Grand Glaize Creek	$76,259
Lower Meramec Study Area	$77,402

Source – 2005-2009 5 Year American Community Survey, US. Bureau of the Census
East-West Gateway Council of Governments
Calculated median household income from Table B19001, based on block groups with centroids within watershed areas.

Map 3



Lower Meramec Watershed

Population Density 1990

Legend

Basemap Elements

- Meramec River Watershed
- County Boundary
- River or Stream
- Interstate Highway
- Major Road

Watersheds

- Brush Creek Watershed
- Fox Creek Watershed
- Grand Glaize Creek Watershed
- Hamilton Creek Watershed
- LaBarque Creek Watershed

- One Dot = 10 Persons

0 1 2 4 Miles

Sources: US Census Bureau,
East-West Gateway Council of Governments
March 2011

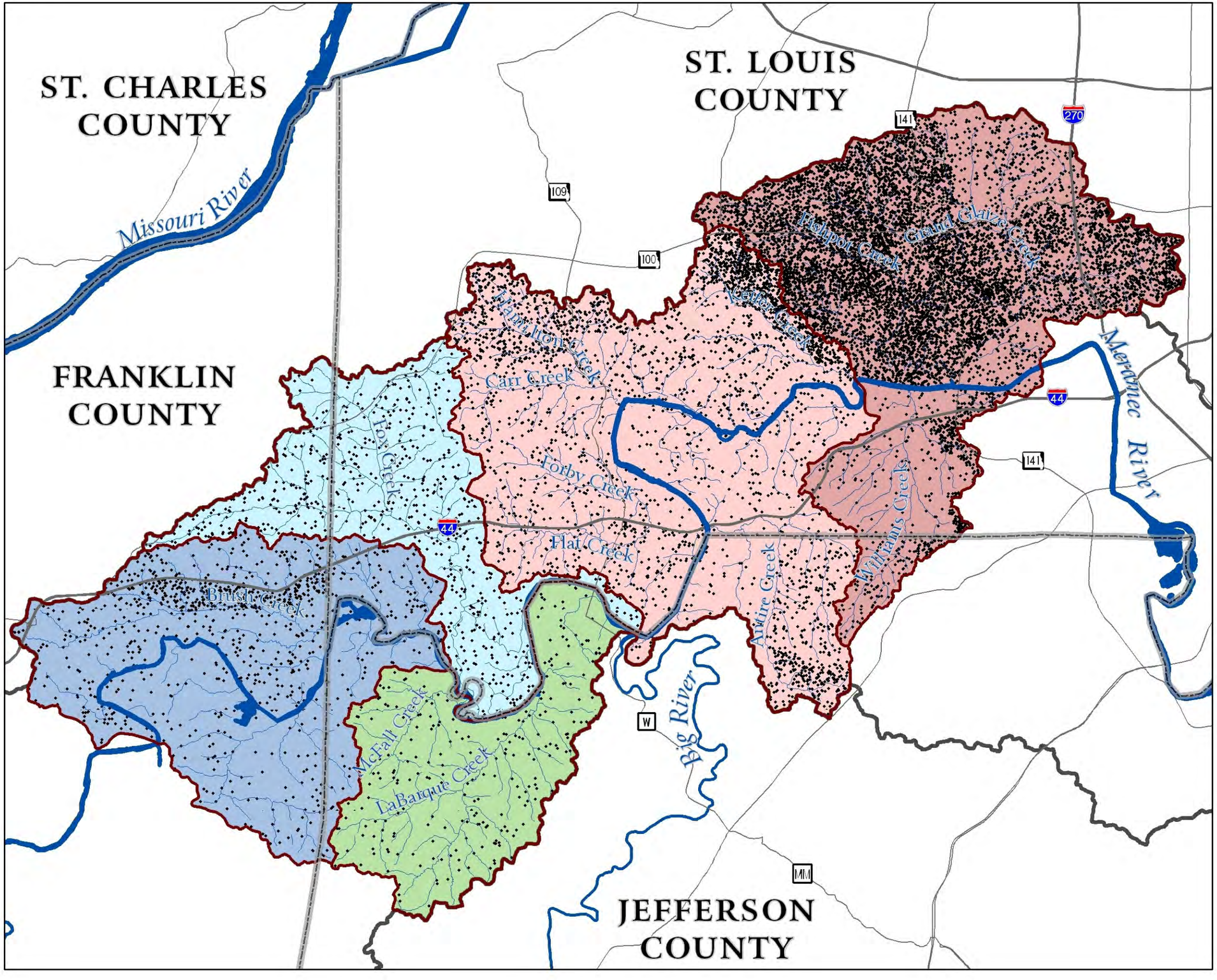
The Open Space Council for the St. Louis Region

East-West Gateway Council of Governments

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 4



Lower Meramec Watershed

Population Density 2000

Legend

Basemap Elements

- Meramec River Watershed
- County Boundary
- River or Stream
- Interstate Highway
- Major Road

Watersheds

- Brush Creek Watershed
- Fox Creek Watershed
- Grand Glaize Creek Watershed
- Hamilton Creek Watershed
- LaBarque Creek Watershed

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Sources: US Census Bureau,
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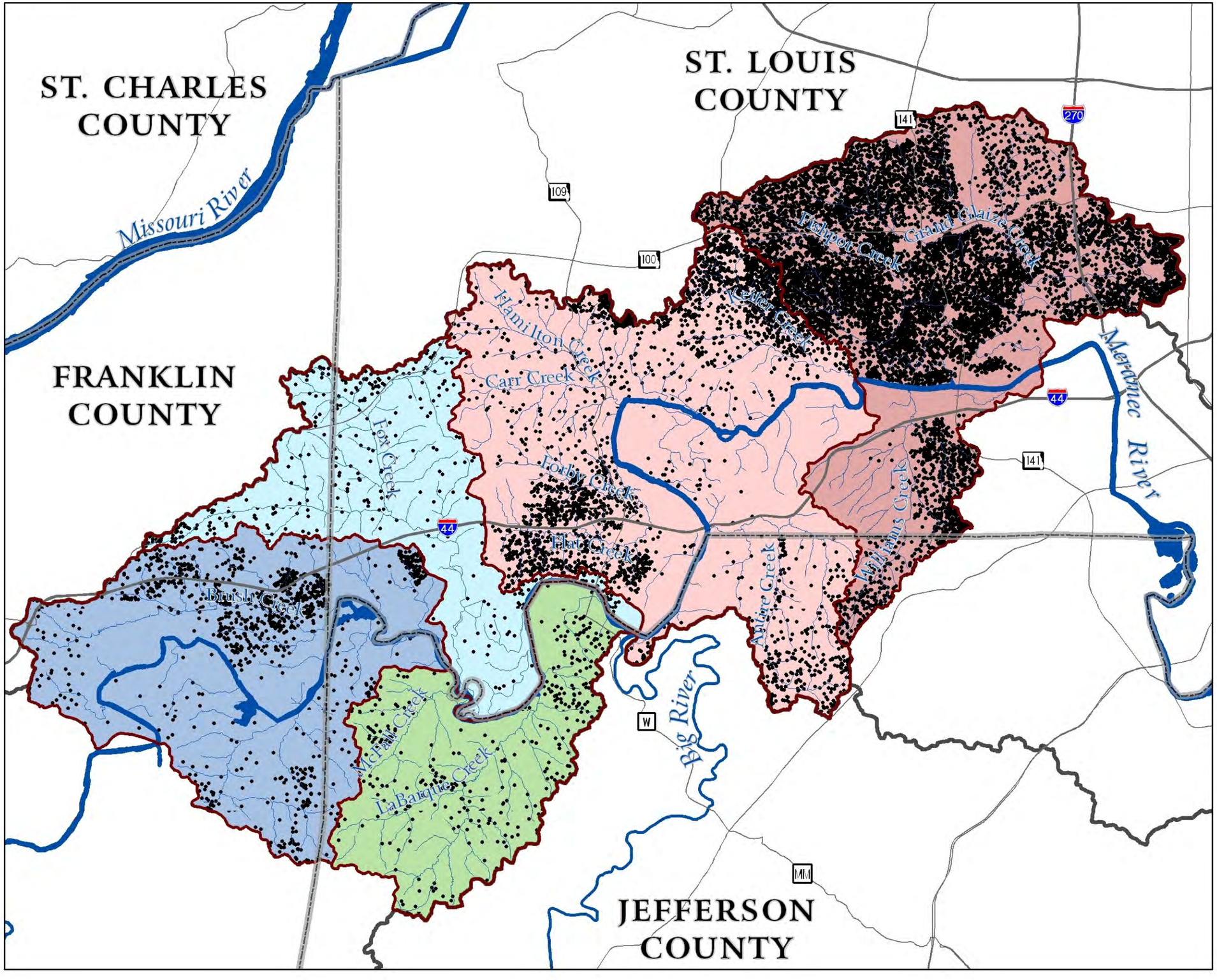
Map 5



Lower Meramec Watershed

Population Density 2010

Legend

Basemap Elements

- Meramec River Watershed
- County Boundary
- River or Stream
- Interstate Highway
- Major Road

Watersheds

- Brush Creek Watershed
- Fox Creek Watershed
- Grand Glaize Creek Watershed
- Hamilton Creek Watershed
- LaBarque Creek Watershed

- One Dot = 10 Persons

0 1 2 4 Miles

Sources: US Census Bureau,
East-West Gateway Council of Governments
March 2011

The Open Space Council for the St. Louis Region

East-West Gateway Council of Governments

Missouri Department of Natural Resources

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C. Land Use

Approximately 33 percent of the land in the Lower Meramec study area can be considered developed or built up. This includes residential, commercial, industrial and institutional properties. (See Table 6) The majority of the developed land is in the St. Louis county portion of the study area from Ellisville to Kirkwood. Developed land can also be found along I-44 and in the freestanding municipalities of Eureka and Pacific. Publicly owned recreation land occupies 20 percent of the study area. This category includes municipal, county and state parks as well as conservation areas. The largest tracts of recreation land are in the Hamilton Creek and LaBarque Creek watersheds. Land in the vacant/undeveloped category makes up 29 percent of the study area. No structures are found on these lands. These could be forested areas, grass or pasture or land being prepared for development. The largest tracts of vacant/undeveloped land are found in the western part of the study area in the Brush Creek, Fox Creek and LaBarque Creek watersheds. The agricultural category includes cropland, orchards, nurseries, livestock structures and permanent pastures. Institutional uses incorporate all activities serving large segments of the population, whether provided by public or private interests. It includes governmental office and service structures, cemeteries, museums, libraries, schools, colleges, prisons, hospitals, religious facilities and nursing homes.

Table 6
Land Use Lower Meramec River Study Area

Categories	Acres	Percent Share
Multi-Family Residential	1,357.4	1.2
Single-Family Residential	24,449.4	21.0
Commercial	2,101.7	1.8
Industrial	3,341.4	2.9
Institutional	3,295.9	2.8
Common Ground	3,581	3.1
Right of Way	72.2	0.1
Subtotal – Developed	38,199.2	32.7
Recreational	23,899.3	20.5
Agricultural	11,980.0	10.3
Vacant/Undeveloped*	33,884.5	29.1
Unassigned*	8,673.0	7.4
Total	116,636.0	100

Assessor's Office in Franklin, Jefferson and St. Louis counties and County GIS Departments
East-West Gateway Council of Governments

*The acreage for each land use category was based on how each county assessor assigned property to a specific use category for assessment purposes. Vacant/undeveloped land did not have any structures on it. These could be forested areas, grass or pasture or land being prepared for development. If the assessor could not identify a specific use for a property, it was placed in the unassigned category

D. Wastewater Treatment

In the five watershed study area, the State of Missouri has issued 60 National Pollutant Discharge Elimination System (NPDES) permits for point source wastewater discharges into creeks and the Meramec River. (See Map 6). Additional NPDES permits have been issued for land disturbance and stormwater management but have not been inventories for purposes of this study. The majority of these wastewater permits have been issued for domestic wastewater treatment performed by nine sewer districts, Pacific, Eureka, subdivisions, apartment units and mobile home parks. The MSD covers St. Louis County east of State Highway 109 (Grand Glaize and east half of Hamilton Watershed). Some residences in this area are not served by MSD. The Franklin County Public Water and Sewer District #3 operates the wastewater treatment facilities at five subdivisions in Franklin County. The Northeast Public Sewer District runs four wastewater treatment facilities in Jefferson County. The Brush Creek Sewer District and the City of Pacific have an agreement so Pacific can accept the wastewater of Brush Creek for treatment. The study area lies outside of the MSD combined sewer overflow (CSO) service area. Therefore, local CSO issues have not been identified. The Brush Creek Sewer District has completed an infiltration/inflow study and is implementing corrective actions. There are nine industrial use permits in the study area; two for landfill operations, and one for mineral extraction. A permit has been issued for a groundwater remediation action in St. Louis County. Another permit is for an automobile manufacturing facility that is now closed. The remaining permits have been issued for commercial-institutional uses which range from golf courses to convenience stores to a church. Information on domestic, industrial and commercial-institutional permits can be found in Appendix A.

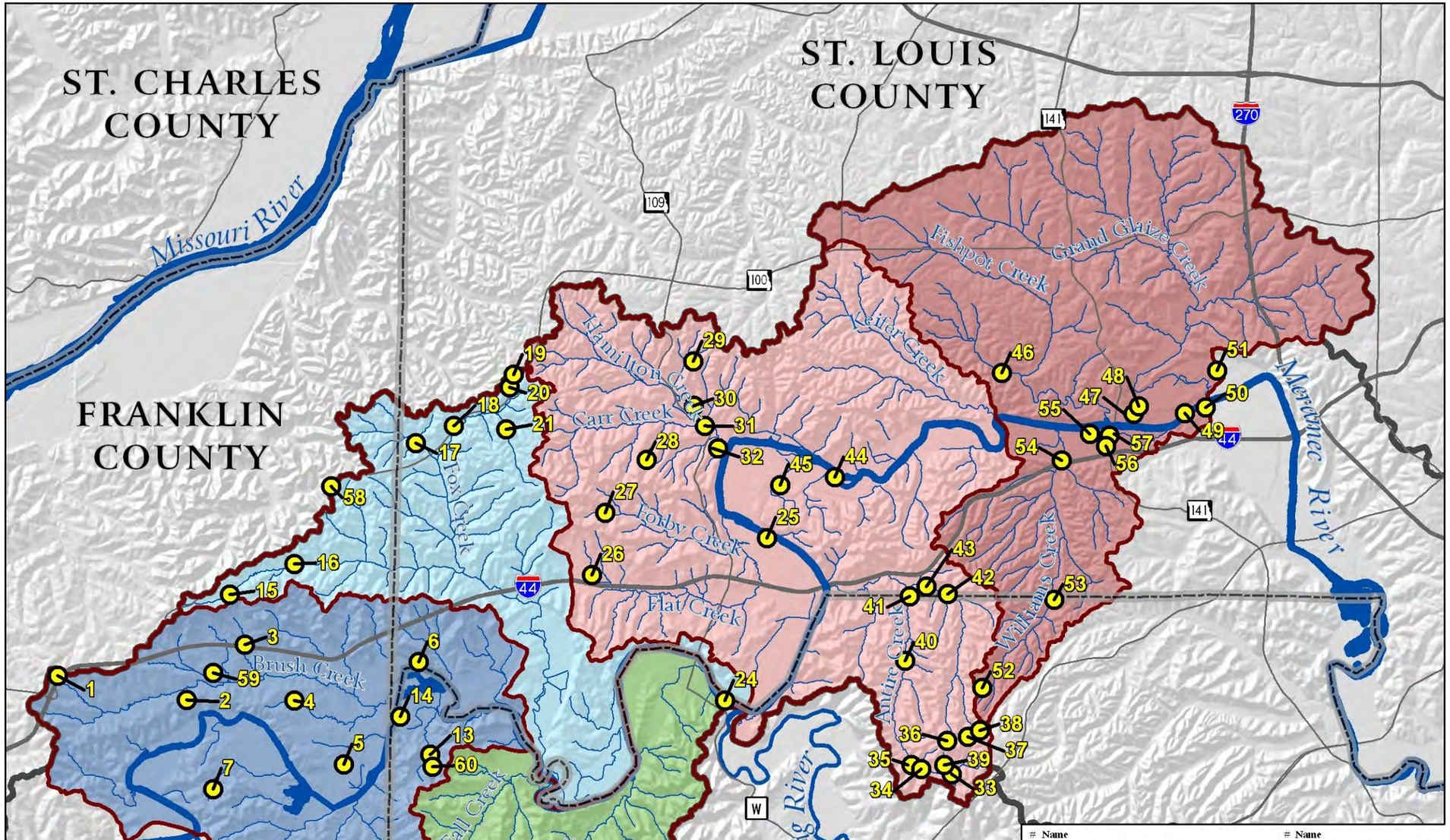
E. Individual Sewage Disposal Systems

The 1990 Census has the most recent information on the types of wastewater treatment available in the study area by housing units. Overall 12 percent of the housing units in the study area had individual sewage disposal treatment (such as a septic tank). (See Table 7) However, there was a wide range of septic tank usage between the watersheds. In the LaBarque Creek watershed in 1990, 96 percent of the housing units had septic tanks while only 3.4 percent of the housing units in the Grand Glaize Creek watershed were on septic. Nevertheless, it is Grand Glaize that is impaired by bacteria. Brush Creek on the other hand, has seen a major reduction in number of septic systems in use, because of the completion of the Brush Creek Sewer District.

Table 7
1990 Sewer Service in Lower Meramec River Study Area

Watershed	Housing Units Connected to						Total	
	Public Sewer		Septic Tank		Uses Other Means			
	Total	%	Total	%	Total	%	Total	%
Brush Creek	1,934	58.1	1,314	39.4	82	2.5	3,330	100
Fox Creek	732	51.2	658	45.9	41	2.9	1,431	100
LaBarque Creek	18	2.4	713	96.1	11	1.5	742	100
Hamilton Creek	5,192	70.9	2,024	27.6	110	1.5	7,326	100
Grand Glaize Creek	25,531	96.5	1,241	3.4	34	0.1	36,806	100
Study Area	43,407	87.5	5,950	11.9	278	0.6	49,635	100

Map 6



Lower Meramec Watershed

National Pollutant Discharge Elimination System Sites

Legend

Basemap Elements

- Meramec Watershed
- County Boundary
- River or Stream
- Interstate Highway
- Major Road
- NPDES Outfall Locations

Watersheds

- Brush Creek
- Fox Creek
- Grand Glaize Creek
- Hamilton Creek
- LaBarque Creek

0 1 2 4 Miles

Sources: Missouri Department of Natural Resources, East-West Gateway Council of Governments

May 2011

The Open Space Council for the St. Louis Region

East-West Gateway Council of Governments

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

#	Name
1	FCPSWD#3 Twin View WWTF
2	Shaw Nature Reserve
3	FCPWSD#3 Ad Deum Subdivision
4	Summit Hills Farm Subdivision
5	Pacific WWTF
6	US Silica, Pacific Plant
7	Kober's MHP
8	Calvey Creek SD - Catawissa Lagoon
9	Windfall Estates MHP
10	Meramec Valley R-3 Nike Elementary School
11	Crestview Acres (MHP) SD
12	Sylvan Manor - Sunset Acres SD
13	Lake Cattails Subdivision (aka Fairways Subdivsion)
14	Palisades Village Subdivision
15	FCPWSD#3 Little Fox Creek
16	FCPWSD#3 Horseshoe Valley WWTF
17	Estates at Autumn Farms
18	Rockwood Harvest Assembly of God
19	Estates at August Tavern Creek
20	Metro West FPD Station #5
21	Hencken Valley Estates WWTF
22	St. Joseph's Hill Infirmary
23	Winterwood Subdivision
24	Jefferson County SD Mirasol WWTF
25	Eureka WWTF
26	Six Flags St. Louis
27	Kiwanis Camp Wyman
28	Hidden Valley Golf Course
29	Bartizan Point Estates
30	LaSalle Springs Middle School
31	Radcliffe Place Subdivision
32	Marianst Retreat Center
33	Engineered Coil, dba Marlo Coil
34	H.R. Electronics warehouse in use
35	NPSD Walnut Ridge WWTF
36	NPSD Pere Cliff MHP
37	Sunny Acres II LLC
38	Villas of Williams Creek MHP (formerly Rosecliff MHP)
39	Pembroke Park Apts
40	Laurel Acres MHP
41	NPSD Antire Springs Plant
42	BSA Beaumont Scout Reservation
43	BSA Beaumont Scout Reservation
44	Pevely Farm (Subdivision) Interim WWTF
45	Players Club of St. Louis
46	Onyx Oak Ridge Landfill
47	Reichhold Inc
48	Valley Park TCE Site Wainwright Operable Unit (Wainright Industries)
49	MSD Grand Glaize WWTF
50	Daimler Chrysler St. Louis
51	Bohn & Dawson, Inc
52	Woodridge Apts
53	NPSD - Paradise Valley
54	Peerless Park I-44 Center
55	Peerless Demolition Landfill
56	Fred Weber Inc Waste Transfer
57	Motomart
58	FCPWSD#3 - Victoria Gardens
59	Circle C MHP
60	Lakewood Care Center

F. Hydrologic Soil Group Classification

Specific soil characteristics affect the rate of infiltration of water into the soil, and conversely, the volume and velocity of stormwater runoff. Soils are classified by the Natural Resource Conservation Service (NRCS) into four hydrologic soil groups (A, B, C, D) based on the physical drainage properties of each soil series, including texture and permeability, as well as certain physiographic properties, such as depth to bedrock and water table. Soils are categorized in terms of their runoff potential, with the best soils being well drained (Group A) and the worst (Group D) being poorly drained. The poorly drained soils are typically composed of clay soils which presents, locally, in areas of thin soils over sandstone. These poorly drained soils should be avoided for placement of septic tank drainfields. Also, these soils, in combination with suburban development, will intensify runoff volumes and velocities which will increase streambank erosion and flash flooding.

Group A soils have low runoff potential and high infiltration rates even when thoroughly saturated. They consist primarily of deep sand, loamy sand or sandy loam type soils and have a high rate of water transmission. Typically, these soils are located near streams and in floodplains.

Group B soils have a moderate infiltration rate when thoroughly saturated and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils include silt loams or loams.

Group C are sandy clay loam soils. These soils have low infiltration rates when thoroughly saturated. They consist chiefly of soils with a layer near the surface that impedes downward movement of water or soils with moderately fine to fine texture.

Group D soils in this group have the highest runoff potential. They have very low infiltration rates when thoroughly saturated. This group contains clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious materials.

A Hydrological Soil Group map was prepared for the study area and for each watershed in the study area (See Map 7). Information about the soils groups in the study area can be found in Table 8.

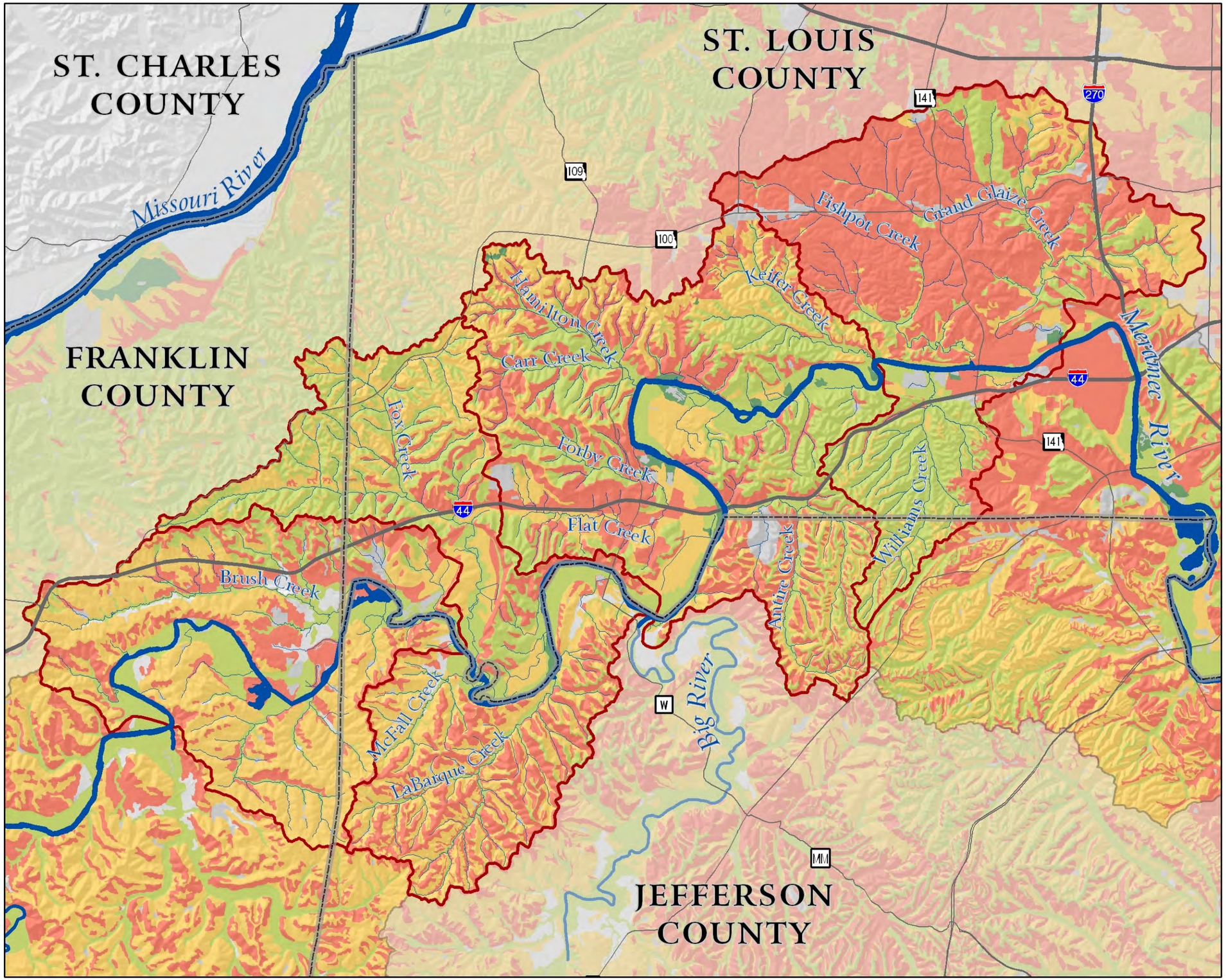
Table 8
Hydrologic Soil Groups by Watershed (Acres)
Lower Meramec River Study Area

Hydrologic Soil Group	Brush Creek	Fox Creek	LaBarque Creek	Hamilton Creek	Grand Glaize Creek	Total	Percent Share
A	2.8	68	7.1	385.8	61.4	525.1	0.5
B	4,977.8	7,030.4	2,081.4	12,730.2	8,209.2	35,029.0	30.0
B/D	0.5	0	87.3	18.4	0	106.2	0.1
C	11,136.3	5,290.5	6,003.2	9,702.6	3,550.4	35,683.0	30.6
C/D	696.4	0	130.4	41.8	0	868.6	0.7
D	5,776.7	2,144.9	4,995.6	10,802.2	16,902.1	40,621.5	34.8
No Data	993.5	157.2	205.0	1,275.0	1,171.9	3,802.6	3.3
Total	23,584.0	14,691.0	13,510.0	34,956.0	29,895.0	116,636.0	100

Source – USDA, Natural Resource Conservation Service

Hydrologic Soil Group
A – Low runoff potential, well drained
B – Moderately low runoff potential
C – Moderately high runoff potential
D – High runoff potential, poorly drained
No Data – Hydrologic characteristics of soil could not be determined

Map 7



Lower Meramec Watershed

Soil Hydrologic Group & Runoff Potential

Legend

- Sub-Watersheds
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Hydrologic Group - Runoff Potential

- A - Low
- B - Moderately Low
- C - Moderately High
- D - High
- No Data

N

0 1 2 4 Miles

Sources: USDA-NRCS,
East-West Gateway Council of Governments
October 2010

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G. Geology

Beginning with the Hamilton Creek sub-watershed and the Antire Creek sub-watershed, the western part of the study area contains dolomite, limestone and shale from the Ordovician series. (See Map 8). In these layered sedimentary beds, springs and caves can be found and sinkholes can develop. The eastern part of the study area contains limestone and chert from the Mississippian series (the youngest geologic series). In these layered sedimentary beds, springs and caves can be found and sinkholes can develop. As a result of uplift and erosion, rolling hills, plateaus and deep creek valleys are evident. The creek valleys have cut through the rock layers and exposed them in cliffs, particularly in LaBarque Creek watershed and along the Meramec River. In hilly areas, erosion has removed soluble rocks, leaving only a thin soil. The creek valleys and the Meramec River valley contain silt, sand and gravel—materials that have been carried by flowing water and deposited in these valleys

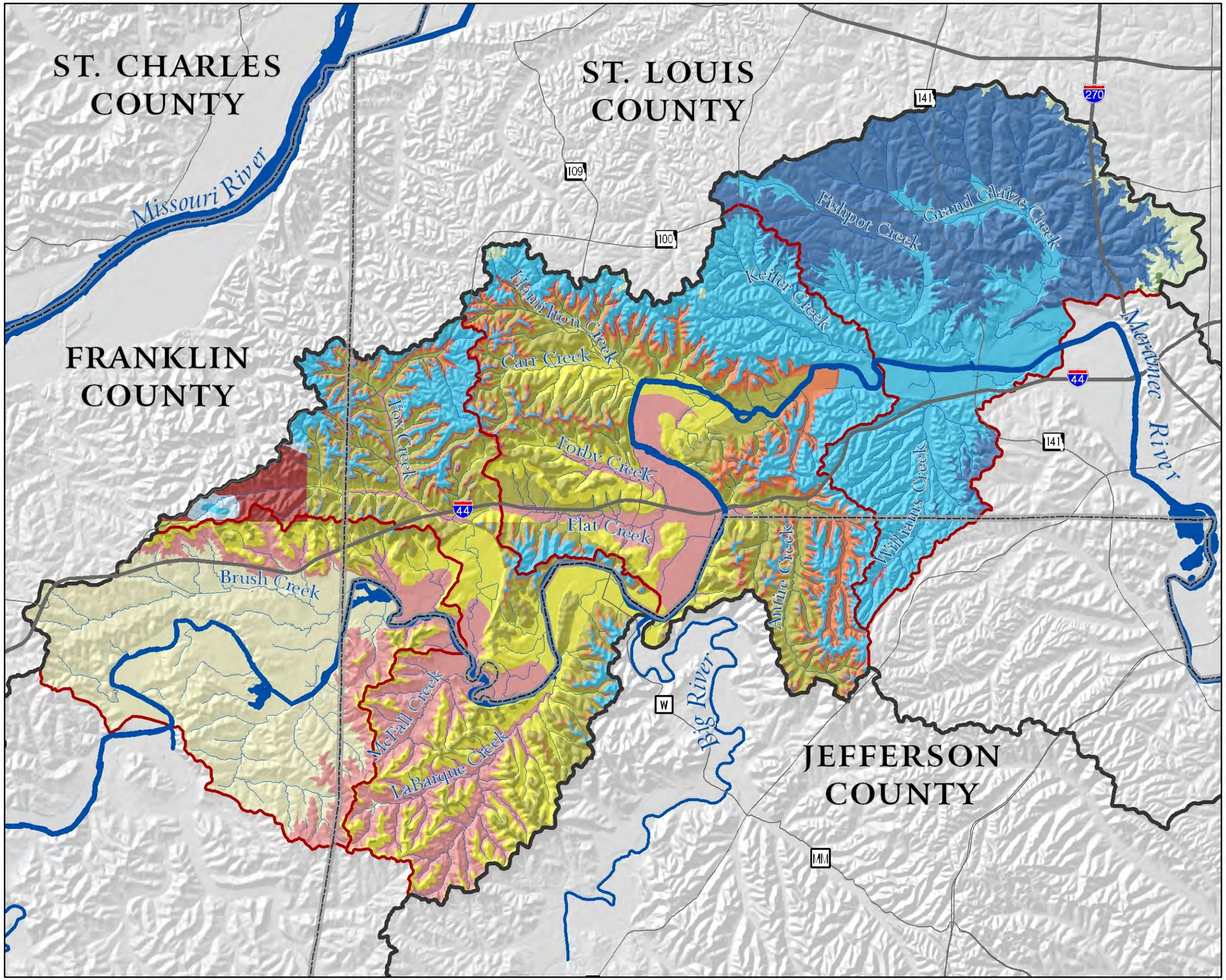
A band of St. Peter sandstone (friable quartz sand) is present in the north and eastern portion of the Brush Creek watershed as well as in the LaBarque and McFall Creek sub-watersheds. This feature is one of the few places in Missouri where limestone overlaying sandstone bedrock can be found. Pure sand beaches can be found in the lower reaches of these creeks.

The dolomite, sandstone and chert layers found in the western portion of the study area have very stony soil cover over bedrock. There are localized areas on uplands and on gentle slopes which have thicker cover. Septic tank drainfields can be located here but require extensive site investigation.

Much of the eastern portion of the study area consists of limestone with thin-bedded flaggy dolomite. This limestone has solution openings along joints and bedding planes. Scattered sinkholes and small caves also characterize the area. Portions of the limestone near streams and creeks are covered by thick loess. Areas having thick soil cover are better suited for septic systems and lagoons; locations with thin soils are to be avoided.

Buder Bluffs

Map 8



Lower Meramec Watershed

Bedrock Geology

Legend

Basemap Elements

- Meramec Watershed
- Sub-Watersheds
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Geologic Series

- Devonian System
- Mississippian, Kinderhookian Series
- Mississippian, Meramecian Series
- Mississippian, Osagean Series
- Ordovician, Decorah & Plattin formations
- Ordovician, Jefferson City & Cottor formations
- Ordovician, Joachim & Dutchtown formations
- Ordovician, Maquoketa & Kimmswick formations
- Ordovician, St. Peter and Everton formations
- Ordovician System, undifferentiated
- Pennsylvanian, Cabaniss Subgroup
- Pennsylvanian, Marmaton Group
- Pennsylvanian, undifferentiated
- Silurian System

0 1 2 4 Miles

Sources: Missouri Departmenf of Natural Resources, East-West Gateway Council of Governments

October 2010

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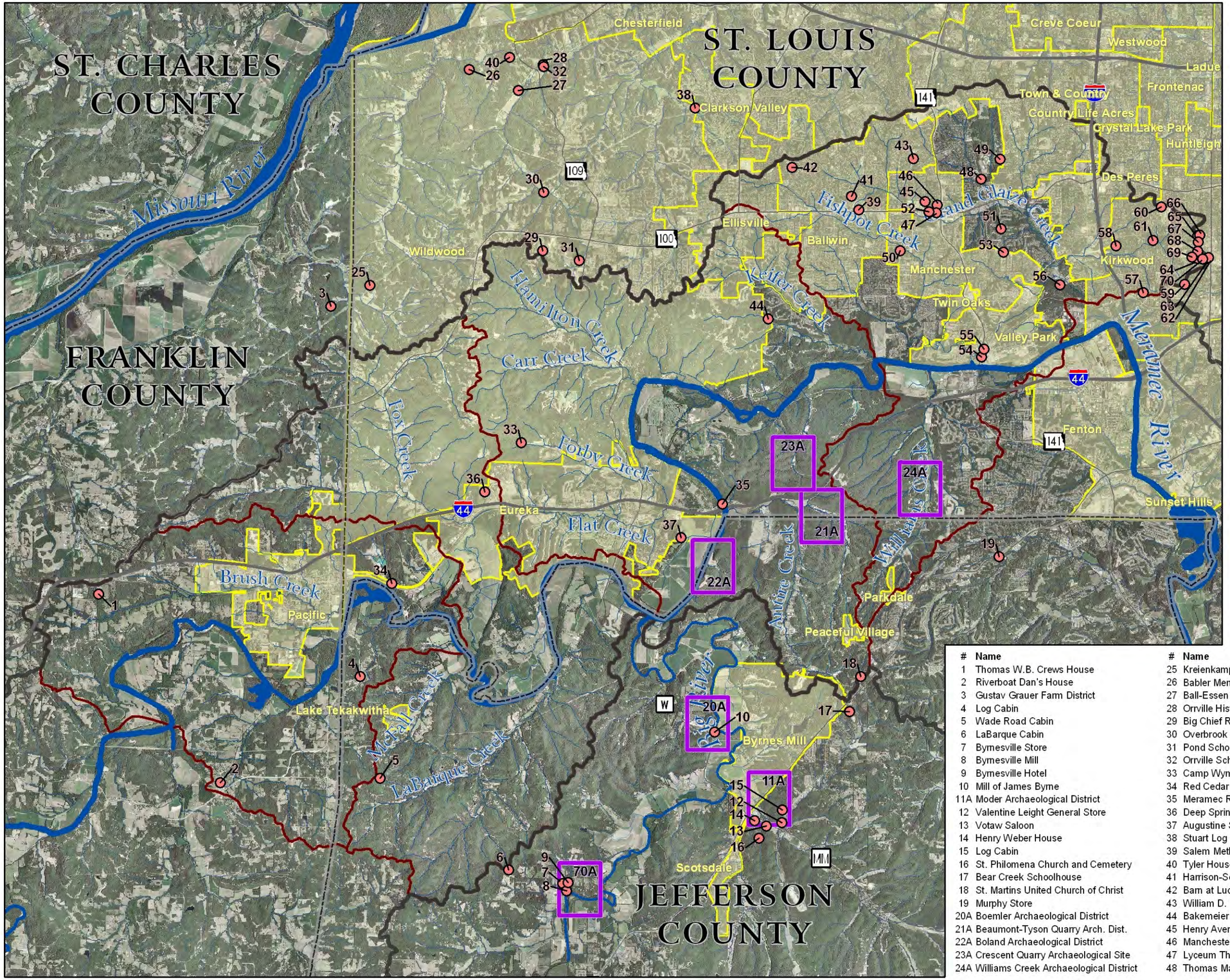
H. Cultural Resources

Cultural resources refer to sites, districts and buildings of historical, cultural and architectural interest. They are an inventory of potential information about specific developments and activities in the recent and prehistoric past. In addition, archeological districts were identified on an area-wide basis. These areas consist of the physical remains of human activity, usually Native American settlements with associated hunting and gathering activities, which took place in the past. Archeological sites can be found on the bottomlands associated with the Meramec River and its tributaries. Information about cultural resources in the Lower Meramec River watershed was gathered and presented in map form. (See Map 9) The cultural resources identified here are significant at the national, state or local level. Appendix B contains information on the cultural resources within the study area.

Jensen's Point – Pacific MO

Map 9



Lower Meramec Watershed

Cultural Resources

Legend

Basemap Elements

- Meramec Watershed
- Sub-Watersheds
- Incorporated Area
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Cultural Resources

- Landmarks
- Archaeological Sites (generalized)

0 1 2 4 Miles

Sources: Missouri Departmenf of Natural Resources, East-West Gateway Council of Governments

November 2010

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East-West Gateway Council of Governments

Missouri Department of Natural Resources

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#	Name
1	Thomas W.B. Crews House
2	Riverboat Dan's House
3	Gustav Grauer Farm District
4	Log Cabin
5	Wade Road Cabin
6	LaBarque Cabin
7	Byrnesville Store
8	Byrnesville Mill
9	Byrnesville Hotel
10	Mill of James Byrne
11A	Moder Archaeological District
12	Valentine Leight General Store
13	Votaw Saloon
14	Henry Weber House
15	Log Cabin
16	St. Philomena Church and Cemetery
17	Bear Creek Schoolhouse
18	St. Martins United Church of Christ
19	Murphy Store
20A	Boemler Archaeological District
21A	Beaumont-Tyson Quarry Arch. Dist.
22A	Boland Archaeological District
23A	Crescent Quarry Archaeological Site
24A	Williams Creek Archaeological District

#	Name
25	Kreienkamp Store
26	Babler Memorial St. Pk. Hist. Dist.
27	Ball-Essen Farmstead Historic District
28	Orrville Hist. Dist. Hoppenberg-Fick Store
29	Big Chief Restaurant (Pond)
30	Overbrook (Pond)
31	Pond School (Pond)
32	Orrville School
33	Camp Wyman
34	Red Cedar Inn
35	Meramec River US Rte 66 Bridge- J421
36	Deep Springs Farm Buildings
37	Augustine School and Farm
38	Stuart Log Cabin
39	Salem Methodist Church
40	Tyler House
41	Harrison-Schmidt-Dahlke Log House
42	Barn at Lucerne
43	William D. Bacon Log House
44	Bakemeier Farm
45	Henry Avenue Historic District
46	Manchester Methodist Espicopal Church
47	Lyceum Theatre
48	Thomas Mason House

#	Name
49	Jarville
50	Hugh Tumilty Farmhouse
51	John Dietrich House
52	Wagonmaker's House Local Hist. Dist.
53	Woerner Cabin
54	Valley Park Grain Elevator
55	Sacred Heart Church
56	Barretts Railroad Tunnels
57	William Bopp House
58	Kraus & Goetz House
59	Mary Schaffer House
60	DePombiray-Moore-Locket-Ruhl House
61	Hoch Farm Barn
62	Bopp House
63	Hoffman-Ward House
64	Olive Chapel AME Church
65	Professor Frances Nipher House
66	Robertson-Kraft House
67	James W. & Mary Way House
68	Mudd's Grove
69	Theodore & Lena Richter House
70	Patrick & Moire McMullen House
70A	Bonnacker Mill site

I. Conservation Opportunity Areas

In the Lower Meramec study area, Missouri Department of Conservation (MDC) and partner agencies have identified five Conservation Opportunity Areas as priority places for protecting quality terrestrial and aquatic resources. The Conservation Opportunity framework identifies the best places where MDC and their partners can combine technology, expertise and resources to protect areas of outstanding conservation resources that are threatened with potentially damaging development. (See Map 10 and Table 9) Each Conservation Opportunity Area is to have a stakeholder team to develop a specific profile for it and determine goals and conservation actions. A profile has been developed for the LaBarque Creek Conservation Opportunity Area and is available on the Department of Conservation web site (www.mdc.mo.gov/landwater-care/priority-focus-areas/conservation-opportunity-areas/resource/labarque-creek-watershed).

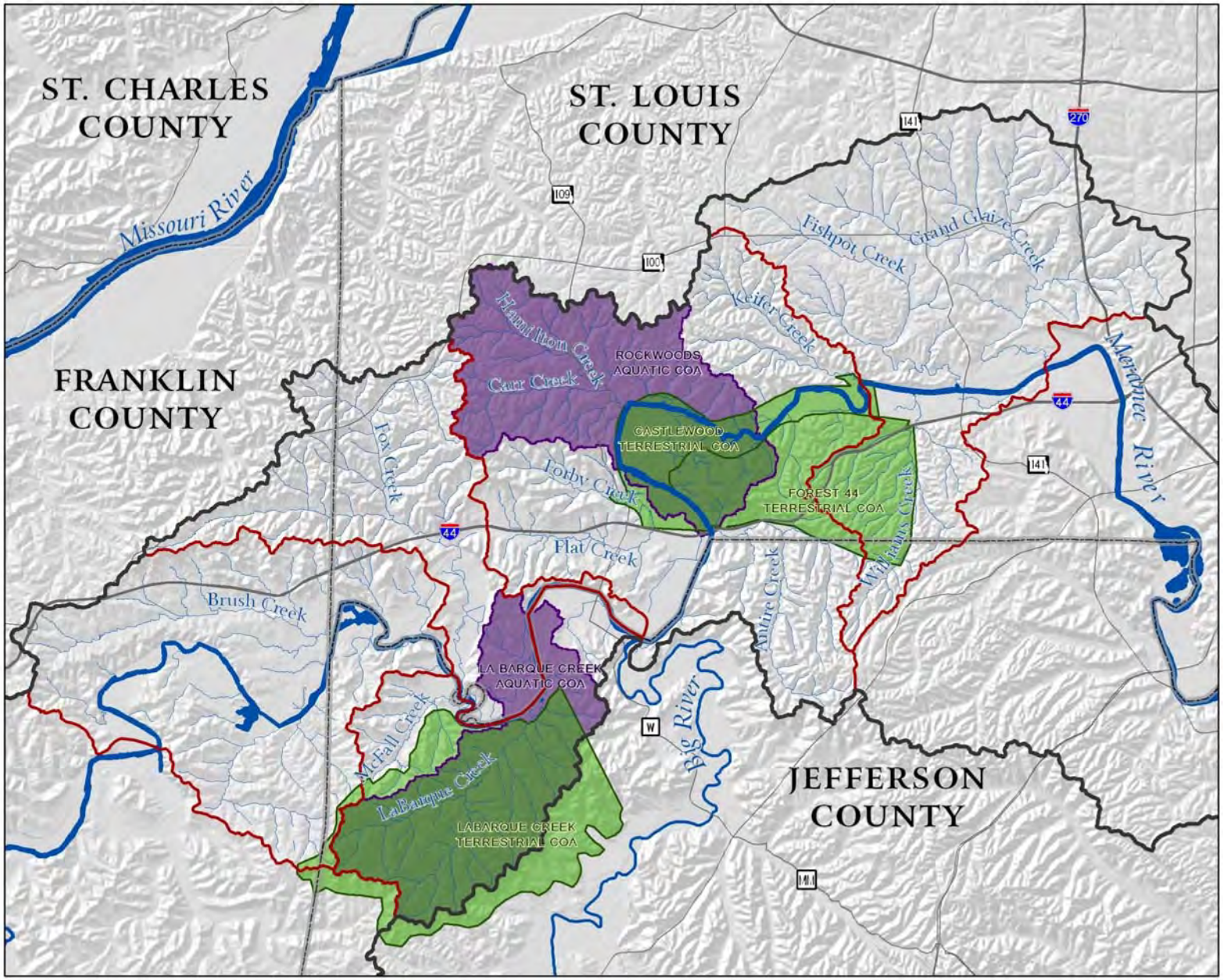
Table 9
Conservation Opportunity Areas

Name	Watershed
LaBarque Creek Terrestrial	LaBarque Creek
LaBarque Creek Aquatic	LaBarque Creek/Fox Creek
Rockwoods Aquatic	Hamilton Creek
Castlewood Terrestrial	Hamilton Creek
Forest 44 Terrestrial	Hamilton Creek/Grand Glaize Creek

Source – Missouri Department of Conservation

LaBarque Creek

Map 10



Lower Meramec Watershed

Conservation Opportunity Areas

Legend

Basemap Elements

- Meramec Watershed
- Sub-Watersheds
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

- Terrestrial Conservation Opportunity Area
- Aquatic Conservation Opportunity Area

0 1 2 4 Miles

Sources: Missouri Department of Conservation, East-West Gateway Council of Governments
October 2010

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J. Water Quality Sampling and Biological Assessment

1. Water Quality Sampling

a. Volunteer Monitoring Efforts

There is much public interest in the creeks and the Lower Meramec River study area. Trained volunteers participating in the Missouri Stream Team program have adopted sites on the Meramec River and the major creeks for water quality sampling and other activities. In the study area there are 72 teams which are currently active or have been in the past. A Stream Team can work with more than one stream. Over time a site can be adopted by one or more Stream Team. Table 10 presents Stream Teams and sites by watershed. In addition to water quality monitoring, Stream Teams can also perform: visual survey of site; litter pick-up; adopt an access project; plant trees; improve habitat; prepare inventory guide; or work on a greenway project. Map 11 and Table 11 contain information on Meramec River Stream Team water quality monitoring sites along the main stem of the lower Meramec River. Monitoring results can be found in Appendix C. Due to the periodic nature of Stream Team sampling of the five sub-watersheds within the study area, no attempt was made to map the monitoring locations and list their associated sampling results. More detailed information on these Stream Team monitoring efforts can be found at the Missouri Stream Team website at www.mostreamteam.org/interactivemap.

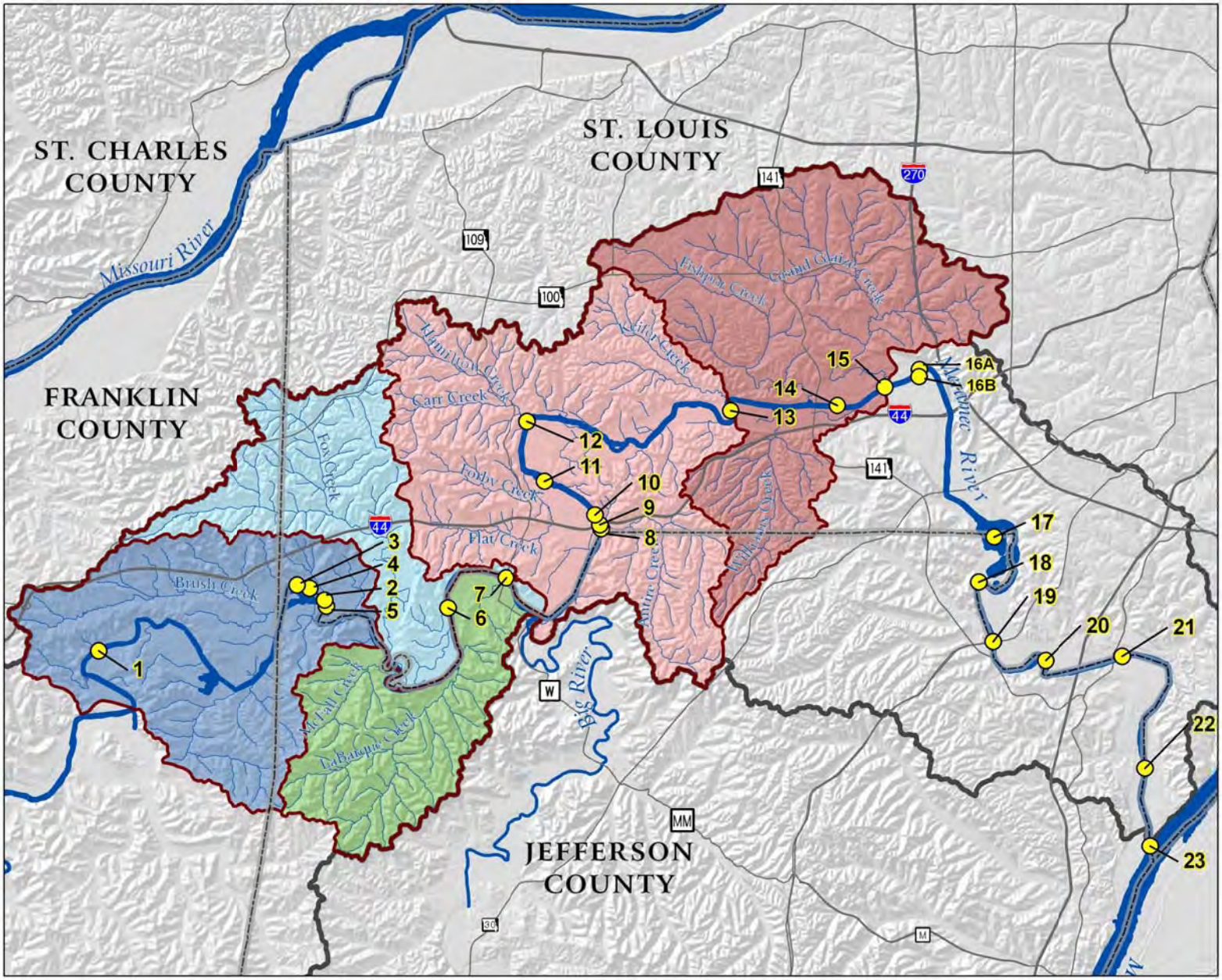
Table 10
Stream Teams in Lower Meramec River Study Area

Watershed	Teams*	Water Quality Monitoring Sites	Non Monitoring Sites
Brush Creek	12	16	1
Fox Creek	11	8	0
LaBarque Creek	18	18	1
Hamilton Creek	27	14	7
Grand Glaize Creek	28	30	15
Total	72	86	24

*A Stream Team can be active in more than one watershed.
Source – Missouri Stream Team interactive map, www.mostreamteam.org

The kayakswarm is an unofficial group of local kayakers composed of both recreational as well as more advanced boaters. In 2008, the kayakswarm partnered with the Missouri Stream Team program to gather water quality data and photographs of every river mile of the Meramec River. Appendix C contains the 2008 water chemistry data collected at the GPS measured mile points in the Lower Meramec study area. More information about kayakswarm activities since 2008 can be found at their website, www.lmvp.org/kayakswarm.

Map 11



Lower Meramec Watershed

Stream Team Water Quality Monitoring Sites

Legend

Basemap Elements

- Meramec River Watershed
- County Boundary
- River or Stream
- Interstate Highway
- Major Road

Watersheds

- Brush Creek Watershed
- Fox Creek Watershed
- Grand Glaize Creek Watershed
- Hamilton Creek Watershed
- LaBarque Creek Watershed
- Water Quality Monitoring Site

0 1 2 4 Miles

Sources: Missouri Stream Team, East-West Gateway Council of Governments
April 2011

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Table 11
Stream Team Meramec River Sample Sites

Map #	Sample Site	County
1	Shaw Nature Reserve	Franklin
2	Pacific Palisades CA	St. Louis
3	Pacific Palisades CA 0.8 mi ups boat ramp	St. Louis
4	Pacific Palisades CA 0.5 mi ups boat ramp	St. Louis
5	Pacific Palisades CA 300 yds ds boat ramp	St. Louis
6	Alllenton access	St. Louis
7	Highway W Bridge	St. Louis
8	500 ft ups of I-44 Bridge	St. Louis
9	Under I-44 Bridge	St. Louis
10	300 yds ds Old Route 66 Bridge	St. Louis
11	600 ft ds from 2nd railroad bridge near Route 66 State Park	St. Louis
12	Glencoe access	St. Louis
13	Castlewood State Park Access	St. Louis
14	Valley Park boat ramp	St. Louis
15	At confluence Grand Glaize Creek	St. Louis
16A	Greentree Park access (Team 5976)	St. Louis
16B	Greentree Park access (Team 407)	St. Louis
Following sites outside the study area		
17	George Winter Park	Jefferson
18	South of George Winter Park at Corisande Hill Road	Jefferson
19	Highway 21 Bridge	Jefferson
20	Lower Meramec Park off Meramec Bottoms Road	St. Louis
21	400 yds ds Highway 61-67 Bridge	St. Louis
22	Telegraph Road Bridge	St. Louis
23	Floodplain Meramec and Mississippi Rivers	St. Louis

Source – Missouri Stream Team interactive map, www.mostreamteam.org

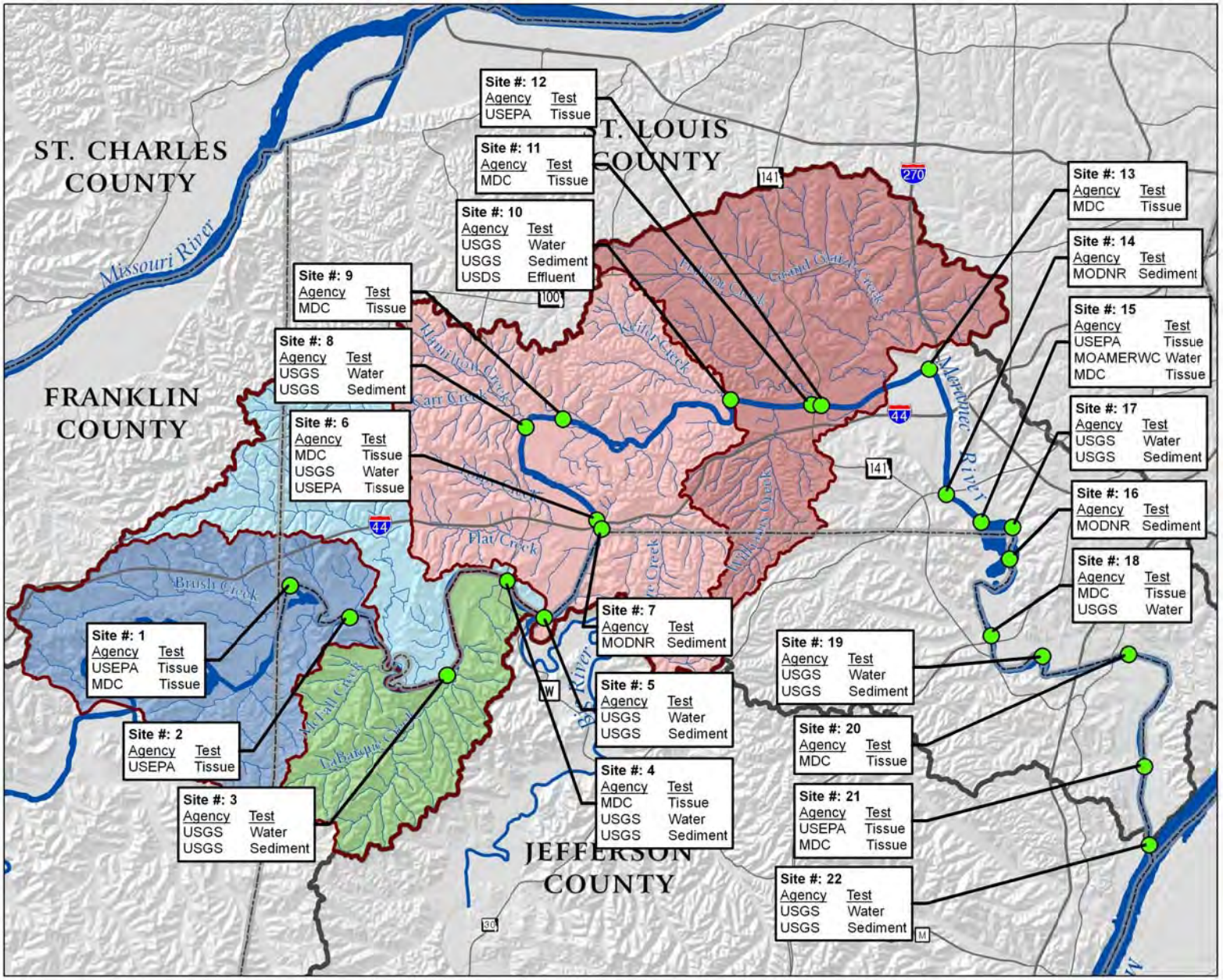
mi – Miles
ups – Upstream
ds – Downstream
yds – Yards
ft – Feet

b. Government/Sewer District Water Quality Monitoring

Within the study area, The U.S. Geological Survey (USGS) has conducted raw water grab samples at five sites along the Meramec River. (See Map 12) At three sites single samples were taken on the same day in 2009. Over 300 samples were gathered at a site near Eureka between 1979 and 1994. From August 2009 through January 2010, 20 samples were gathered from a site near where Kiefer Creek enters the Meramec River. Information was gathered on: water temperature; flow; chloride; dissolved oxygen; nitrogen; phosphate; and dissolved solids. Water quality sampling results can be found in Appendix C. Additional information is available from the Missouri Water Quality Assessment System. Fish tissue and sediment samples have also been collected by USGS, U.S. Environmental Protection Agency, MoDNR and MDC. Sampling by site and media are presented in Table 12.

Raw water grab samples have also been taken on the tributaries to the Meramec River. USGS, MoDNR and the MSD conducted these sampling efforts. Information was gathered on the following: water temperature; flow; chloride; dissolved oxygen; nitrogen; phosphate; metals; and suspended solids. Water quality sampling results and information assembled by MoDNR and their assessments can be found in the Appendix I. Information on sampling in the tributaries of the Meramec River is presented in Table 13.

Map 12



Lower Meramec Watershed

Meramec River Sampling Sites

Legend

Basemap Elements

- Meramec River Watershed
- County Boundary
- River or Stream
- Interstate Highway
- Major Road

Watersheds

- Brush Creek Watershed
- Fox Creek Watershed
- Grand Glaize Creek Watershed
- Hamilton Creek Watershed
- LaBarque Creek Watershed
- Sampling Sites

0 1 2 4 Miles

Sources: Missouri Department of Conservation, East-West Gateway Council of Governments
April 2011

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Table 12
Meramec River Sample Sites

Map #	Sample Site	County	Collector	Media	Occurrence
1	At Pacific	St. Louis	USEPA (1) & MDC (4)	Tissue	5 times in 1985
2	At Allenton	St. Louis	USEPA	Tissue	1 time in 2002
3	0.5 mi ds LaBarque Creek	St. Louis	USGS	Water	1 time in 2009
3	0.5 mi ds LaBarque Creek	St. Louis	USGS	Sediment	1 time in 2009
4	0.5 mi ds Highway 109	St. Louis	MDC	Tissue	5 times in 1985 1 time in 1986 1 time in 2001
4	0.5 mi ds Highway 109	St. Louis	USGS	Water	1 time in 2009
4	0.5 mi ds Highway 109	St. Louis	USGS	Sediment	1 time in 2009
5	0.4 mi ds confluence with Big River	St. Louis	USGS	Water	1 time in 2009
5	0.4 mi ds confluence with Big River	St. Louis	USGS	Sediment	1 time in 2009
6	Near Eureka at I-44	St. Louis	MDC (7) & USEPA (18)	Tissue	25 times from 1982-1988 1 time year in 1990, 1992, 1994, 1996 and 1998
6	Near Eureka at I-44	St. Louis	USGS	Water	328 times from 1982-1994
7	0.5 mi above Rte 66 State	Jefferson	MoDNR	Sediment	1 time in 1998 1 time in 2007
8	0.3 mi ds confluence with Hamilton Creek	St. Louis	USGS	Water	1 time in 2009
8	0.3 mi ds confluence with Hamilton Creek	St. Louis	USGS	Sediment	2 times in 2009
9	At Yeatman	St. Louis	MDC	Tissue	9 times in 1985, 1989, 1995 and 2001
10	Near confluence with Kiefer Creek	St. Louis	USGS	Water	20 times from 2009-2010
10	Near confluence with Kiefer Creek	St. Louis	USGS	Sediment	2 times in 2009
10	Near confluence with Kiefer Creek	St. Louis	USGS	Effluent	3 times in 2009
11	Above Highway 141	St. Louis	MDC	Tissue	6 times in 1984, 1985 and 1991
12	At Valley Park Access	St. Louis	USEPA	Tissue	6 times from 2007-2009

Source - MoDNR Water Quality Assessment System

mi – miles
ds – down stream
MDC – Missouri Department of Conservation
USGS – U.S. Geological Survey
USEPA – U.S. Environmental Protection Agency
Sites 13 – 22 outside of the study area

Table 13
Tributary Streams Raw Water Grab Sample Sites

Sample Site	Collector	Occurrence
Fishpot Creek at Hanna Rd Bridge – Valley Park	USGS	71 samples from 1995-2004
Fishpot Creek at Vance Rd - Valley Park	MSD	54 samples from 2005-2010
Flat Creek at City Park – Eureka	MoDNR	2 samples in 2007
Flat Creek at Augustine Rd Eureka	MoDNR	2 samples in 2007
Brush Creek near St. Louis County Line	MoDNR	16 samples in 2005-2007 analysis for E Coli
Kiefer Creek at Kiefer Creek Rd	MoDNR	4 samples in 2009 analysis for E Coli
Kiefer Creek at Kiefer Creek Rd	MSD	29 samples from 2001-2008
Kiefer Creek near Ballwin	USGS	71 samples from 1996-2004
Williams Creek near Peerless Park	USGS	64 samples from 1997-2004 1 sample in 2010
Williams Creek at I-44 N. Outer Rd	MSD	54 samples in 2005-2010
Antire Creek near Bussen Quarry	MSD	50 samples in 2005-2010
Little Antire Creek at Antire Creek Rd	MSD	56 samples in 2005-2010
Grand Glaize Creek at Quinette Rd – Valley Park	USGS	91 samples from 1997-2007
Grand Glaize Creek near mouth	MSD	94 samples from 2000-2010
Sugar Creek tributary of Grand Glaize Creek	MSD	54 samples from 2005-2010
Grand Glaize Creek at Big Bend	MSD	6 times from 2002-2004
Grand Glaize Creek Various sites	MoDNR & WU	25 times in 2008 (WU) 39 times in 2009 (MoDNR) analysis for E Coli
Simpson Lake –Grand Glaize Creek	UM	7 times from 2004-2008 analysis for Chlorophyll
Brush Creek at Highway F	MoDNR	2 samples in 2008
Brush Creek at Highway N	MoDNR	8 samples from 2005-2008
N. Fork Brush Creek	MoDNR	1 sample in 2005
Brush Creek at Robertsville Rd	MoDNR	1 sample in 2005
Brush Creek various sites	MoDNR	93 samples from2005-2007 analysis for E Coli

Source - MoDNR Water Quality Assessment System

USGS – U.S. Geological Survey
USEPA – U.S. Environmental Protection Agency
MoDNR – Missouri Department of Natural Resources
MSD – Metropolitan St. Louis Sewer District
WU – Washington University
MU – University of Missouri-Columbia

2. Impaired Streams

Grand Glaize Creek (four miles from mouth), Fishpot Creek (3.5 miles from mouth), and Kiefer Creek (1.2 miles) are on the Missouri 2010 303(d) Impaired Waters (Stream) list. (See Map 13) This watershed plan is the first stage in a series of steps to restoring these impaired waters.

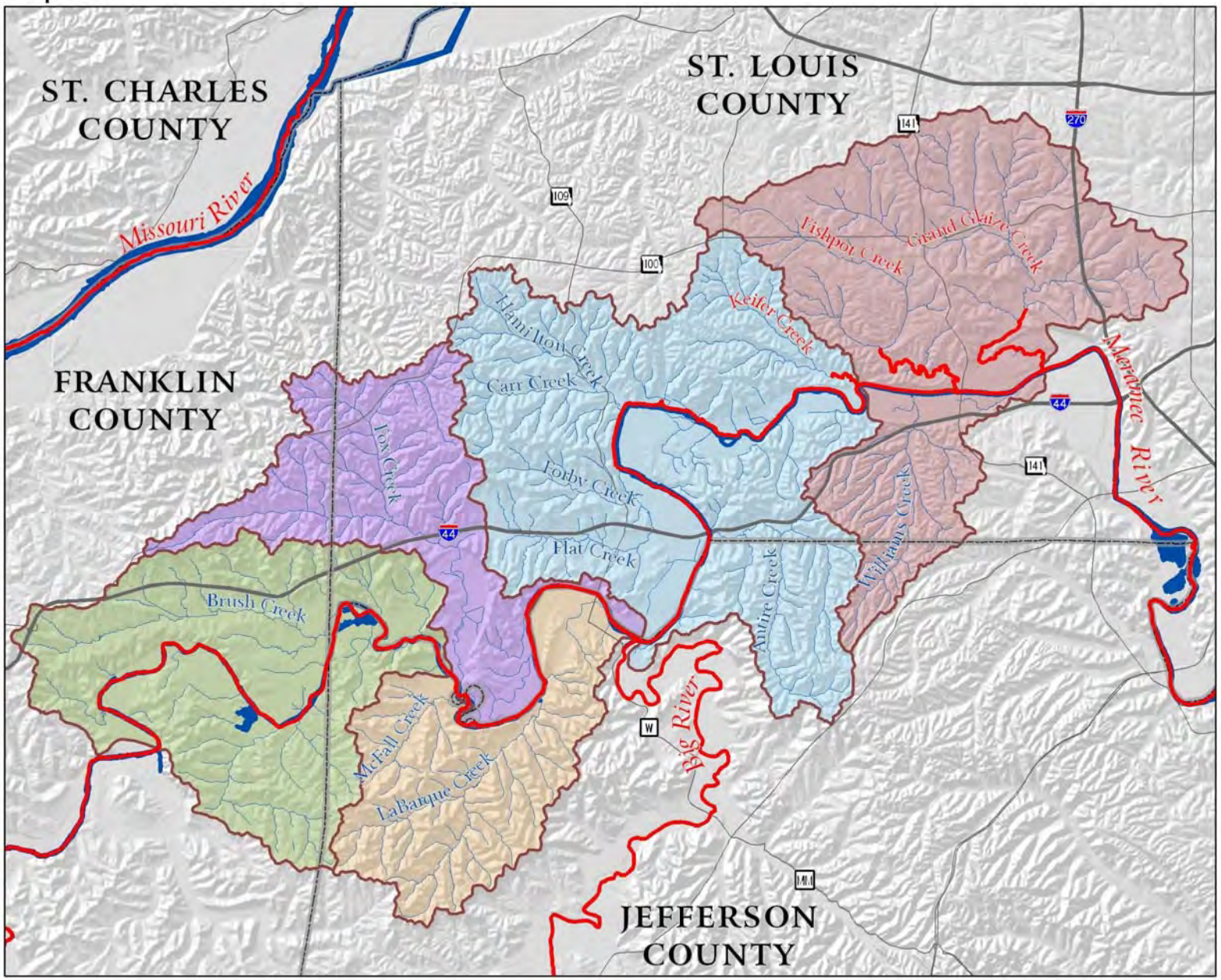
Fishpot Creek is identified as impaired due to bacteria and low dissolved oxygen resulting from urban nonpoint pollution sources and other unknown sources including loss of streamside vegetation. Served by centralized sewers, this watershed is more likely to be impacted by surface runoff, which must be addressed through non-point source runoff controls (i.e., animal waste control, Low Impact Development (LID) practices, etc.) Low dissolved oxygen, if not attributable to a wastewater treatment plant, is the result of algae growth, resulting from nutrient runoff (septic tanks and lawn fertilizers), and loss of wooded vegetation, which leads to warming of the stream. Algae growth and subsequent decomposition reduces oxygen and is harmful to fish and aquatic life. MoDNR will be preparing a bacteria Total Maximum Daily Load (TMDL) and the low dissolved oxygen TMDL study is to be completed in 2016 (See Table 14).

Grand Glaize Creek also has been identified as impaired due to bacteria and chloride. MoDNR is to scheduled a bacteria TMDL study by 2012 and the chloride TMDL study is to be completed in 2014. Grand Glaize Creek is included in a list of Missouri waterways impaired by mercury deposition in fish tissue. This same four-mile section of Grand Glaize Creek has been added to the Missouri 2010 303(d) Impaired Waters list, based on low dissolved oxygen resulting from urban nonpoint pollution sources. The schedule for development of the TMDL plan has not been finalized. As a result of impairment from bacteria from urban nonpoint source pollution, a 1.2-mile section of Kiefer Creek is included in the Missouri 2010 303(d) Impaired Waters list. The schedule for development of the TMDL plan for Kiefer Creek has not been finalized.

Two segments of the Meramec River, from the mouth of the Big River east to Arnold, have been identified as impaired and were placed on the Missouri 2006 303(d) Impaired Waters list due to lead in sediment. Stream sediment has become contaminated as a result of erosion of lead mining tailing piles in St. Francois County, and contamination of stream sediment has led to the contamination of fish and other aquatic life. MoDNR is to prepare a bacteria Total Maximum Daily Load (TMDL) study by 2012. Because the lead source is from outside of the study area, this problem is not addressed in the current plan

As a result of impairment from bacteria from point source and urban/rural nonpoint source pollution, a 22.8-mile section of the Meramec River has been added to the Missouri 2010 303(d) Impaired Waters list. The schedule for development of the TMDL plan has not been finalized. In addition, approximately 22 miles of the Meramec River flowing through the Brush Creek watershed and adjacent to the Fox Creek and LaBarque Creek watershed has been classified as impaired due to mercury. Mercury arrives in the water bodies through atmospheric deposition; therefore efforts to control runoff may have a positive effect on reducing this pollutant as well.

Map 13



Lower Meramec Watershed

Impaired Streams

Missouri 303(d) List, 2010

Legend

Basemap Elements

- Meramec Watershed
- Sub-Watersheds
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

- Impaired River or Stream
- Brush Creek Watershed
- Fox Creek Watershed
- Grand Glaize Creek Watershed
- Hamilton Creek Watershed
- LaBarque Creek Watershed

0 1 2 4 Miles

Sources: MoDNR via MSDIS, East-West Gateway Council of Governments
October 2011

The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Table 14
Missouri Department of Natural Resources
Total Maximum Daily Load (TMDL) Development Schedule

2008 303(d) List of Impaired Waters		
TMDL Scheduled For	Waterbody	Pollutant
2011	Fishpot Creek	Bacteria
2011	Grand Glaize Creek	Bacteria
2012	Meramec River	Lead (sediment)
2014	Grand Glaize Creek	Chloride
2015	Grand Glaize Creek	Mercury (atmospheric deposition)
2015	Meramec River	Mercury (atmospheric deposition)
2016	Fishpot Creek	Low Dissolved Oxygen
2010 303(d) List of Impaired Waters		
TMDL Scheduled For	Waterbody	Pollutant
Not Finalized	Kiefer Creek	Bacteria
Not Finalized	Grand Glaize Creek	Low Dissolved Oxygen
Not Finalized	Meramec River	Bacteria

3. Biological Assessments

The purpose of a biologic assessment is to determine if the aquatic life protection designation use for a particular stream is supported. As part of this assessment, a macroinvertebrate assessment is performed, habitat is characterized and water quality is characterized. At this time, the MoDNR has not conducted a Biological Assessment Report in the Lower Meramec River study area, but macroinvertebrate assessments are currently conduced by MoDNR on wadeable streams.

In 2006 and 2007 macroinvertebrate samples were collected from a riffle/pool site on a Fox Creek. This is the only creek in the study area for which macroinvertebrate sampling has been conducted by MoDNR. The following metrics were calculated: Taxa Richness Index; Ephemeroptera/Plecoptera/Trichoptera Taxa Index; Biotic Index; and Shannon Diversity Index. Results from these indices were then translated into a multi-metric score indicating the ability of a stream to support the aquatic life protection designation. The Fox Creek macroinvertebrate stream condition index scores are presented in Table 15.

Taxa Richness reflects the health of the macroinvertebrate community through a measurement of the number of taxa present in a sample. A taxon (group of one or more organisms) is defined as the lowest identifiable level in the Linnaean taxonomic classification system. The Ephemeroptera/Plecoptera/Trichoptera Taxa Index is the total number of distinct taxa within these insect orders Ephemeroptera; Plecoptera; and Trichoptera. They are considered to be pollution sensitive. The Biotic Index quantifies the invertebrate community as to its overall tolerance to organic pollution by summing tolerances of individual taxon. The Shannon Diversity Index is a measure of the macroinvertebrate community composition which takes into account both richness and evenness.

Sampling LaBarque Creek

Table 15
Fox Creek Macroinvertebrate Stream Condition Index Score

Metric Type	**Metric Value**	**Score: 5**	**Score: 3**	**Final**
Sample – October 12, 2006 Sample Collector – SCI Engineering, Inc.				
Total Taxa Richness	42	79	39	3
Ephemeropta, Plecoptera, Trichoptera Taxa	2	21	11	1
Biotic Index	8.2	5.8	7.9	1
Shannon Diversity Index	3.11	3.09	1.55	5
Macroinvertebrate Stream Condition Index Score				**10**
Number of reference samples used in the criteria calculation				7
Sample – April 17, 2007 Sample Collector – SCI Engineering, Inc.				
Total Taxa Richness	62	92	46	3
Ephemeropta, Plecoptera, Trichoptera Taxa	11	29	15	1
Biotic Index	5.7	5.8	7.9	5
Shannon Diversity Index	2.55	3.3	1.67	3
Macroinvertebrate Stream Condition Index Score				**12**
Number of reference samples used in the criteria calculation				6

Source – Missouri Department of Natural Resources

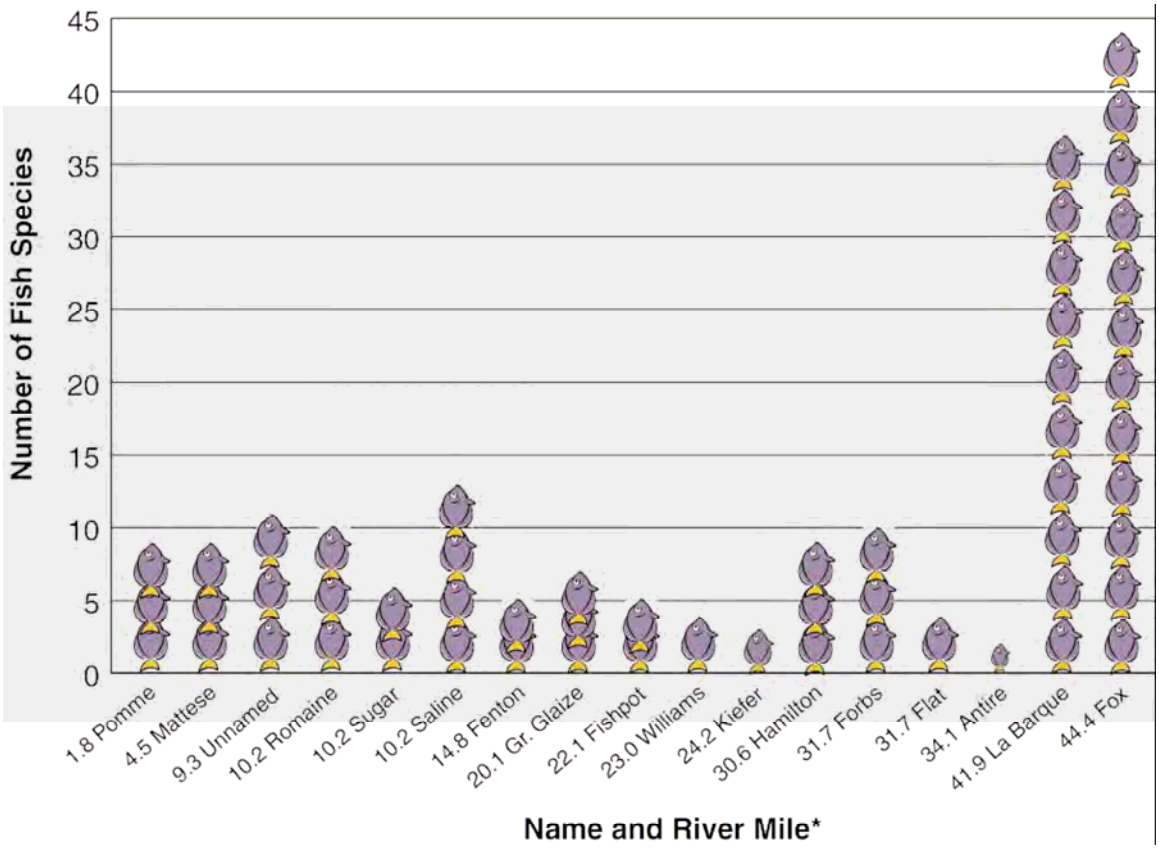
Total Score 16 to 20 – Stream is fully supporting of the aquatic life beneficial use.
Total Score 10 to 14 – Stream is partially supporting of the aquatic life beneficial use.
Total Score 4 to 8 – Stream is not supporting of the aquatic life beneficial use.
Total Score less than 0 – the Index Score information was unavailable at this time.
Due to the scoring procedure, scores with odd integers or integers <4 are not possible.

a. Aquatic Biodiversity

The Meramec River is an outstanding example of the unique aquatic biodiversity emblematic of certain river systems in the interior highlands of the Ozark Mountains. The Meramec River's rich mussel and crayfish fauna includes several species not found in any other watershed on earth, and equals or exceeds that of any other Ozark river. Indeed, the Meramec River's mussel fauna is one of the most diverse and unique in North America. The river supports one of the highest levels of biodiversity of any river in the United States, being home to more than 125 species of fish, 45 species of mussels, and 32 species of crayfish. The pink mucket mussel (*Lampsilis abrupta*), which is on the federal endangered species list, is found in the area. Population monitoring indicates that reproduction in some mussel species is not occurring to maintain that diversity over time.

Fish population studies conducted on the Lower Meramec River (109 miles from Sullivan to mouth) by the MDC have revealed an unexpected finding. While the Meramec River itself has recovered in the last thirty years and currently supports 125 species of fish, its tributaries are in decline. None of the smaller tributaries between the mouth at the Mississippi River and Mile 41.9 near Eureka supports a broad diversity of fish species. LaBarque Creek in Jefferson County with 42 fish species[5] and Fox Creek in St. Louis County with 44 fish species, at Miles 41.9 and 44.4 respectively, are considered healthy streams, while none of fifteen comparably sized tributaries to their east has more that thirteen species and most have fewer than ten (See Figure 1). While more research is needed to understand changing habitat and population declines, it appears likely that the declining fish species is a direct result of the suburban development patterns in the lower Meramec River watershed.

Figure 1
Fish Diversity in Meramec River Tributary Streams



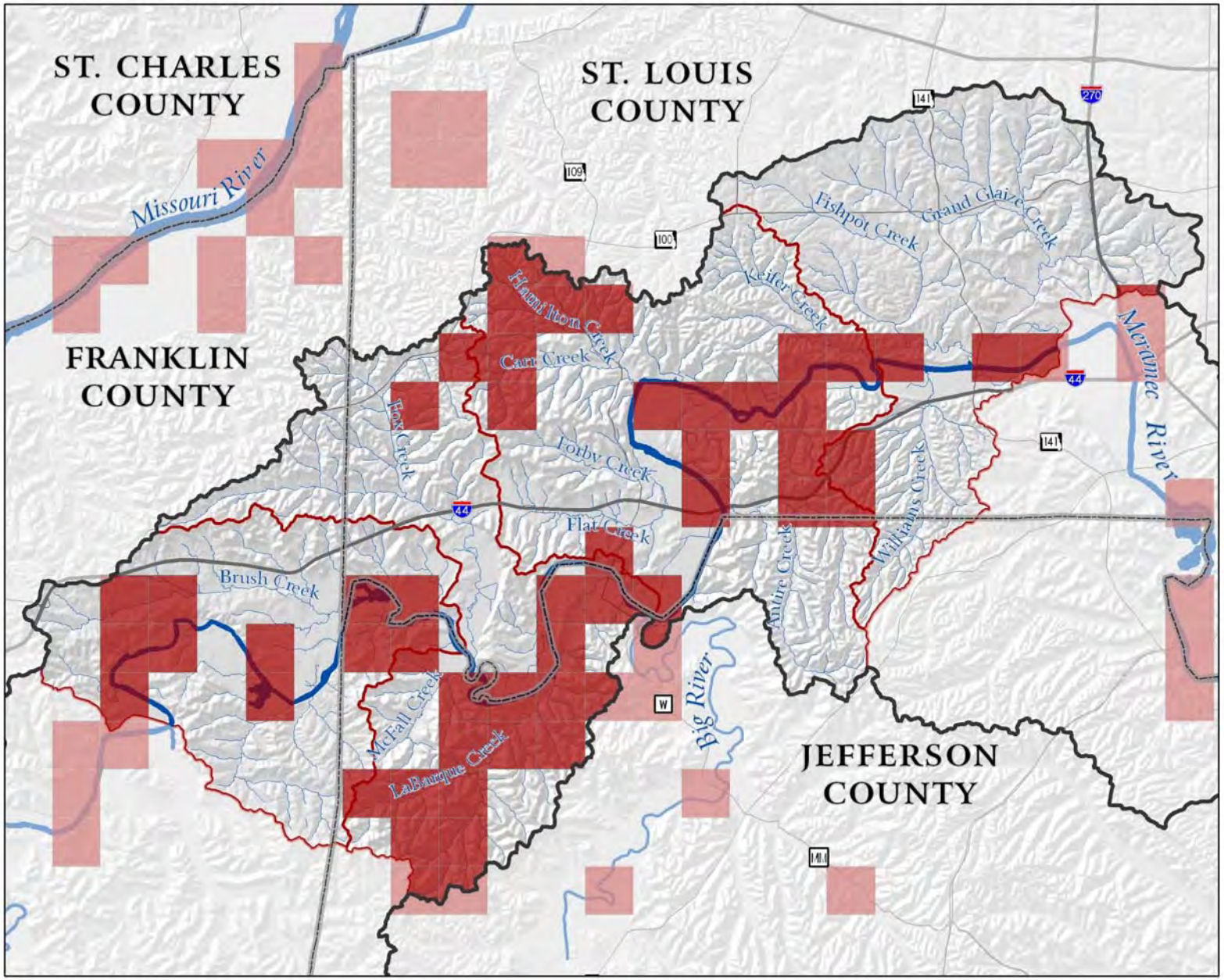
Tributary name and distance (in miles) upstream from Meramec River/Mississippi River confluence

Source: Missouri Department of Conservation (1999)

b. Threatened or Endangered Species

Information on threatened or endangered flora and/or fauna species within the Lower Meramec River study area was assembled and a map was prepared. (See Map 14) Shaded squares represent the one square mile sections within the Public Land Survey System (Township and Range), which have at least one known location of a species listed as threatened or endangered at the State or Federal level. These sections are along the Meramec River and the headwater areas of Hamilton and Carr Creeks (See Tables 16, 17 and 18).

Map 14



Lower Meramec Watershed

Threatened or Endangered Species Locations

Legend

Basemap Elements

- Meramec Watershed
- Sub-Watersheds
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Threatened or Endangered Species*

*Note: Shaded squares represent the sections within the Public Land Survey System (Township and Range) that have at least one known location of a species that is listed as threatened or endangered at the State or Federal level.

0 1 2 4 Miles

Sources: Missouri Department of Conservation, East-West Gateway Council of Governments October 2010

The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Table 16
Federally Identified Threatened, Endangered, Proposed and Candidate Species
Franklin County, Missouri

Species	**Status**	**Habitat**
Mammals		
Gray Bat (*Myotis grisescens*)	Endangered	Caves
Indiana Bat (*Myotis sodalis*)	Endangered	Hibernacula = caves and mines; Maternity and foraging habitat = small stream corridors with well developed riparian woods; upland forests
Indiana Bat (*Myotis sodalis*)	Critical Habitat	Caves 009 and 017
Clams (Freshwater Mussels)		
Pink Mucket (*Lampsilis abrupta*)	Endangered	Rivers
Snuffbox (*Epioblasma triquetra*)	Proposed as Endangered	Small to medium-sized creeks with a swift current
Spectaclecase (*Cumberlandia monodonta*)	Proposed as Endangered	Bourbeuse and Meramec Rivers
Winged Mapleleaf (*Quadrula fragosa*)	Endangered	Medium to large rivers in mud, sand or gravel
Plants		
Decurrent False Aster (*Boltonia decurrens*)	Threatened	Disturbed alluvial soils

Source – U.S. Fish and Wildlife Service

Endangered species is in danger of extinction throughout the area in which it is usually found.
Threatened species is one that could become endangered in the near future.

Table 17
Federally Identified Threatened, Endangered, Proposed and Candidate Species
Jefferson County, Missouri

Species	**Status**	**Habitat**
Mammals		
Gray Bat (*Myotis grisescens*)	Endangered	Caves
Indiana Bat (*Myotis sodalis*)	Endangered	Hibernacula = caves and mines; Maternity and foraging habitat = small stream corridors with well developed riparian woods; upland forests
Clams (Freshwater Mussels)		
Pink Mucket (*Lampsilis abrupta*)	Endangered	Rivers
Scaleshell (*Leptodea leptodon*)	Endangered	Meramec, Big and Bourbeuse Rivers
Sheepnose (*Plethobasus cyphyus*)	Proposed as Endangered	Meramec River
Snuffbox (*Epioblasma triquetra*)	Proposed as Endangered	Small to medium-sized creeks with a swift current
Spectaclecase (*Cumberlandia monodonta)*	Proposed as Endangered	Big and Meramec Rivers

Source – U.S. Fish and Wildlife Service

Endangered species is in danger of extinction throughout the area in which it is usually found.
Threatened species is one that could become endangered in the near future.

Table 18
Federally Identified Threatened, Endangered, Proposed and Candidate Species
St. Louis County, Missouri

Species	**Status**	**Habitat**
Mammals		
Gray Bat (*Myotis grisescens*)	Endangered	Caves
Indiana Bat (*Myotis sodalis*)	Endangered	Hibernacula = caves and mines; Maternity and foraging habitat = small stream corridors with well developed riparian woods; upland forests
Clams (Freshwater Mussels)		
Pink Mucket (*Lampsilis abrupta*)	Endangered	Rivers
Scaleshell (*Leptodea leptodon*)	Endangered	Bourbeuse and Meramec Rivers
Sheepnose (*Plethobasus cyphyus*)	Proposed as Endangered	Shallow areas in larger rivers and streams
Snuffbox (*Epioblasma triquetra*)	Proposed as Endangered	Small to medium-sized creeks with a swift current
Spectaclecase (*Cumberlandia monodonta*)	Proposed as Endangered	Meramec River
Plants		
Decurrent False Aster (*Boltonia decurrens*)	Threatened	Disturbed alluvial soils
Mead's milkweed (*Asclepias meadii*)	Threatened	Virgin prairies
Running buffalo clover (*Trifolium stolonifereum*)	Endangered	Disturbed bottomland meadows

Source – U.S. Fish and Wildlife Service

Endangered species is in danger of extinction throughout the area in which it is usually found.
Threatened species is one that could become endangered in the near future.

K. Pollutant Loadings

The Simple Method to Calculate Urban Stormwater Loads was used to estimate stormwater pollutant loadings for various land uses within a given watershed. The calculation requires basic information characterizing a watershed, including the watershed drainage area and impervious cover by land use type, stormwater runoff pollutant concentrations and annual precipitation. With the Simple Method, the various pollutant loads, i.e., total nitrogen (N), total phosphorus (P); Total Suspended Solids (TSS); and Biological Oxygen Demand (BOD), are calculated by land use type and then totaled. The stormwater pollutant concentrations can be estimated from local or regional data or from national data sources. For the purposes of this analysis, default concentration factors from both the Simple Method and the Spreadsheet Tool for Estimating Pollutant Load (STEPL) were utilized. A description of the Simple Method technique can be found in Appendix D. Table 19 presents the estimates developed for these pollutants: Total nitrogen (N); Total phosphorus (P); Total Suspended Solids (TSS); and Biological Oxygen Demand (BOD).

The estimates calculated using the Simple Method can be used as a starting point for making decisions on management strategies until additional funds become available to conduct more sophisticated watershed modeling or coupled with additional water quality monitoring efforts.

After using the Simple Model presented here, EWG began a review of other watershed models. Following this review, EWG staff selected a watershed modeling platform that will provide a higher potential for success in future watershed scenario planning. The Department of Defense and the U.S. Army Corps of Engineers designed a program called Watershed Modeling Systems (WMS), which is sold commercially by AQUAVEO. This model combines the features of several independent models into one, and provides a simple user interface to load data using GIS. The amount of time spent creating the proper input files for most models can become extensive and costly. WMS has the ability to reduce drastically the amount of time required to run a watershed simulation and reduce the margin for user error. (See Appendix E for spreadsheet of models reviewed.) Key water quality parameters examined include: dissolved oxygen; biochemical oxygen demand; fecal coliform; organic nitrogen; organic phosphorus; and ammonia.

East-West Gateway has purchased this model and has begun an implementation process to determine its effectiveness with modeling runs on a sub-watershed basis. EWG should complete more detailed model runs on the sub-watersheds in the next two to five years.

Lower Meramec Outdoor Classroom
The Open Space Council for the
Greater St. Louis Region

Table 19
Annual Pollutant Loads (Pounds per Year)
Lower Meramec River Study Area

Watershed	Phosphorus	Nitrogen	Total Suspended Solids	Biological Oxygen Demand
Brush Creek	3,308.8	21,806.9	1,024,648.8	68,375.1
Fox Creek	1,666.4	10,047.1	486,228.0	30,593.4
LaBarque Creek	1,133.7	6,807.2	329,830.4	19,225.2
Hamilton Creek	5,065.3	32,144.9	1,513,303.7	97,183.5
Grand Glaize Creek	11,112.7	71,741.1	3,333,022.4	224,654.0
Total	22,286.9	142,547.2	6,687,013.3	439,931.2

Castlewood Overlook – Great Rivers Greenway

Meramec Bend at Castlewood State Park

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III. Meramec Tributary Watersheds: Goals and Solutions (Element B,C,D,F,G,H,I)

A. Goals and Management Objectives of the Watershed Plan:

1. To protect and improve the water quality in tributary streams of the Meramec River so that all designated uses are fully supported in the tributaries and the Meramec main stem.
2. To improve water quality in small tributaries especially by managing stormwater runoff in order to reduce extreme fluctuations in stream flow following storm events and to limit the amount of pollutants being carried by stormwater into the stream.
3. To reduce the flooding and erosion problems during high flow, and increase the volume of water during low flow, in order to maintain a better water quality, support an improved and stabilized stream channel, reduce property loss to residents and reduce costs of road, bridge and infrastructure maintenance to local governments.
4. To demonstrate or recommend effective strategies for water quality protection and improvement and utilize stormwater best management practices on public land.
5. To educate citizens about non-point source pollution and strategies to reduce runoff, and to inspire individual action to provide solutions on privately owned land both to protect healthy streams and improve degraded streams.
6. To provide a framework for planning so that local government officials, along with state and federal agencies and non-governmental organizations can work together to solve non-point source problems in the lower Meramec River watershed.

B. Critical Land Areas for Project Implementation:

The water quality challenges in the target watersheds are dispersed, and any actions to reduce runoff will have potential benefit. Therefore, in order to facilitate immediate actions, the priority geographic targets for implementation in this plan are the public lands, where projects can be implemented in the short term. The plan recommends a focus first in constructing demonstration projects in state, county and city parks and other public spaces, on school property, along public roads and adjacent to bridges and in other lands with high numbers of visitors. A number of projects have been proposed by St. Louis County Parks, by MoDNR State Parks, and by MDC. City officials expressed interest and EWG expects several cities to sponsor their own projects in the short term, however, cities were not able to provide specific examples in time for the completion of this plan. Additional reasons to focus first in these critical areas include the following:

1. A review of the region included in the four water 12-digit watersheds indicates a significant amount of publicly owned land. Much of the public land is along the Meramec River where public use is high and benefits to water quality will also be high.
2. Public awareness of LID strategies is low, and even many city officials are not aware of the potential for stormwater control measures to improve water quality, so incentives for local governments to take the lead in the implementation of Best Management Practices (BMPs) will provide important demonstration and education value and reduce resistance among citizens who are less informed.
3. Parks and public land and certain private land held by non-profit organizations in the watersheds have significant numbers of visitors, who will be educated by seeing successful projects and who will directly benefit from such water quality improvements.

4. Governmental entities should be able to demonstrate that the BMPS, which are recommended for homeowners and often required for new development, are utilized in government owned and managed sites.
5. There should be fewer hurdles to over come if projects are first undertaken in public lands where value of the project can be demonstrated and evaluated over time.
6. Selected privately owned land that can provide strategic protection of water quality has been identified as high priority for public acquisition and easements. Such land is also a target for stormwater control measures.
7. Stream Team monitoring in the public lands will help with evaluation.

C. Management Measures to Achieve Goals—Planning and Education:
Water quality ranked at the top of citizen concern in the survey conducted by EWG (see Appendix G)**.** Even among people who are relatively knowledgeable about environmental issues, however, many people do not understand what a watershed is and have very little idea of the human impacts on water quality through non-point source runoff**.** Public education and involvement will be the most critical factor in addressing non-point source pollution in the long-term. The *first step* is to significantly increase public understanding and awareness of the problems associated with non-point source pollution, of the many sources of pollution in stormwater, and of the best management practices that can be implemented to reduce runoff and reduce pollutant load in runoff. This public education is particularly important in a state like Missouri, where the public values private property rights, and where landowners take pride in caring for their land, but where there is also a general hostility to government regulation.

With a better-educated public, regulatory agencies and watershed partners can encourage voluntary individual action to reduce runoff and control non-point source pollution as a *second step in the process***.** There is evidence of this in the local ownership of the LaBarque Creek watershed plan, where residents are involved in actions and in on-going self-education about ways to protect their watershed and stream**.** With public awareness and approval, the goals of non-point source reduction can be achieved. Without public understanding and awareness, goals of non-point source pollution reduction will not be understood and regulatory efforts will meet with resistance**.** The public who understand the issues will also understand the importance of watershed planning.

Because of public concern about all of the lower Meramec, EWG addressed this plan to cover four 12-digit watersheds in the lower Meramec Basin**.** Over the short term, the plan recommends specific actions to address water quality in the most impaired streams, and also calls for demonstration projects in all of the watersheds in order to facilitate public awareness and education. The plan calls for important educational activities and a five-year framework for developing more detailed sub-watershed plans for three priority streams, Fishpot Creek, Grand Glaize Creek (both in the Grand Glaize Watershed) and Kiefer Creek (in the Hamilton Creek Watershed). While the three listed streams should have top priority for action, all of the streams in the study area need attention now and in the long term**.** In the three priority sub-watersheds the goal is to improve water quality to bring the stream back into compliance with clean water laws governing designated uses**.** In other sub-watersheds, the goal is protection of existing water quality, to prevent further degradation.

Over the mid-term (from now to 2020), this plan calls for development of plans in all of the significant sub-watersheds – at least (12) twelve separate streams in this study area. A cooperative approach among MoDNR, EWG, other governmental agencies and non-profit organizations can support completion of the sub-watershed plans for each of the tributary streams. At a sub-watershed scale, each plan will be unique and involve residents (especially those people whose property includes streams and corridors), along with local government officials and non-profit agency stakeholders, in the site specific plans to achieve the above-defined goals.

The broad goals, which are common to all of the watersheds, along with management strategies for the region as a whole are listed below. The particular priority for each of the watersheds will depend on current situation, funds available and public interest.

1. **Non-point pollution:** In the target planning area (see Appendix I) includes:
    a. Bacteria from septic systems and from surface runoff that carries pet waste directly to streams is the focus of this study. Sewage treatment facilities and other point sources must be addressed separately.
    b. Chloride, the primary source of which is road salt applied in the winter months is a problem in areas even where streams are not degraded.
    c. Sediment, which carries other pollutants (including mercury and lead) and also destroys habitat is a problem throughout the study area. Note that most sources of lead in the Meramec River come from the Big River watershed, which is not included in this study, so this plan does not directly address lead pollution. Note also that although mercury is a problem, and MoDNR is developing strategies to address it, it is only addressed as a component of sediment in this plan.
2. **Stormwater control**: In the initial years of the plan, demonstration projects that address identified pollutants and serve to educate the general public should be placed in highly visible areas will have the greatest impact on public awareness and should inspire individual initiative. BMPS to address non-point source runoff can serve to improve water quality by capturing surface bacteria, and by reducing volume and thereby reducing erosion and sedimentation. Such projects include:
    a. Rain gardens, pervious pavement, bio-swales and other best practices installed in state, county and city parks and other public lands, including city hall, city maintenance facilities and roadway corridors.
    b. Educational interpretation of demonstration projects to help the public learn about water quality problems and solutions and inspire individual initiative to improve water quality.
3. **Septic Tank Management**: To address bacteria levels in the streams, EWG developed a brochure on management of individual sewage disposal systems to be distributed by local governments. Local government regulation can assist in requiring homeowner action, but it is ultimately up to the individual homeowner to maintain their systems, and a strong educational program in the short term should also provide public support for more government action.

4. **Land Protection**: Prioritizing key parcels of land for protection and developing the funding sources necessary to protect the land through outright purchase, conservation easements and private agreements is an important step. Since most land will remain privately owned, it is critical that private landowners be educated to the benefits of protection of stream corridors, and other critical lands. Acquisition of key lands, or protection of large tracts through conservation easements is part of the strategy recommended by the Exchange process sponsored by the US Forest Service in 2009. There are several local non-profit organizations that are working on these issues. The Open Space Council has identified 133 properties including 4000 acres, with an assessed valuation of $5.5 million, along 30.5 miles of the Meramec, (from Robertsville State Park, just outside the study area on the west, to Valley Park on the east), that are in the greenway or which could provided added riparian corridor projection. These parcels are priority areas for conservation easements or public acquisition from willing sellers, but they are not described in detail in this plan.

Exploring the Meramec to Understand the Issues

D. Discussion of Stormwater Management Proposed Projects St. Louis County Department of Parks

St. Louis County Department of Parks provided the following information about project work in County Parks, and also included project work by watershed that is listed above.
These are Best Management Practices that could be implemented in almost every park to reduce stormwater runoff and erosion:

- Remove honeysuckle and replace with native vegetation
- Remove turf grasses and replace with native tree and or prairie plantings
- Remove curbs and allow water to sheet off impervious surfaces
- Provide retention/wetland basins for bldg and parking lot runoff
- Provide native vegetated buffers along all creekways
- Re-vegetate all creek banks and bank cuts to stabilize
- Pervious parking lots
- Rain barrels to collect runoff of buildings
- Develop trails and roadways that do not add to surface runoff and or erosion

- Create swales and detention basins to intercept runoff before it enters waterways
- For construction projects ensure BMP are implemented to reduce runoff and erosion; for example silt fencing to collect sediments from the construction site
- Re-vegetate sites immediately after construction is completed

Implementation of Best Management Practices to reduce Runoff and Erosion

Remove Honeysuckle:

Dense stands of honeysuckle lead to sediment being carried into the ponds, creeks and waterways. Nothing is able to grow underneath the honeysuckle thus; bare ground has the potential for erosion with each precipitous events. Honeysuckle could be removed from all 4 parks along Grand Glaize Creek (Queeny, Love, Museum of Transportation (MOT), and Simpson) and the smaller tributaries. At Queeny Park a plan to begin to eliminate honeysuckle within 100 feet of all creeks and ponds and re-vegetate areas with native plants will reduce sediments from entering the creeks and ponds.

Remove Turf Grasses:

All of the four parks within the Grand Glaize watershed do have areas where the manicured lawn could be replaced with native plantings. Native plantings, whether trees or native grasses have a greater ability to hold the soil in-place and reduce runoff than traditional lawn grasses.

Remove Curbs:

Curbs concentrate runoff and direct the flow into the nearby creeks and drainages. With each new parking lot or roadway and in some cases old parking lots and roadways the curbs could be removed and the runoff allowed to sheet across the ground increasing the amount of water that is being absorbed by the ground reducing runoff. Depending on the slope and volume of stormwater, it may be necessary to combine this activity with bioswales or vegetative berms to prevent rill erosion.

Retention and Wetland Basins:

Parking lots at all parks are a major source of stormwater runoff. In many cases there is room to construct retention/wetland basins to collect the runoff and allow the water to slowly recharge into the ground and evaporate. This would greatly reduce the amount of runoff generated from parking lots entering the creeks and drainages.

Native Buffers along Creeks:

As mentioned above all exotic vegetation should be eliminated along the creeks and drainages. It should be a goal to create a buffer of 100 feet of native vegetation along the drainages. This would serve not only as a filter strip but create a buffer to protect the resource.

Re-Vegetate & Stabilize Creek Banks:

Many of the creeks within the parks meander creating the cutting and filling of the banks. This can lead to an unstable bank susceptible to sloughing off exposing bare ground. These sites should be identified and green practices applied to maintain and repair the bank. For example willow stakes could be driven into the exposed bank for stabilization. If the bank is beyond willow stake control rock revetments can be used for stabilization.

Pervious Parking Lots:

Pervious parking lots should be considered with any new planned parking area. There is not much that can be done with existing parking lots but this should be considered with new and or the replacement of existing parking lots.

Rain Barrels:
Rain barrels could be added to collect runoff from some of the buildings as it flows down the gutters and downspouts. The runoff would be captured in a barrel before it has a chance to flow into the creeks and drainages. The water would be slowly released from the barrel to drainage or allowed to slowly seep back into the ground.

Create Swales and Detention Basins:
Swales and small detention basins could be constructed to intercept runoff and collect and slow the water. This measure could be applied to some of the old fields at Queeny. The water would be held and allowed to be released slowly, or allowed to evaporate or seep into the ground.

Construction BMP's:
With every construction project BMP's need to be a part of the project to make sure that increases in runoff and erosion do not occur.

Waste Treatment:
In some of the more rural parks the Parks Department maintains outhouses. These facilities could be removed and replaced with vaulted structures. This would improve water quality of the neighboring creeks and drainages.

Water Resources Advisory Committee Meeting

E. Discussion of Recommendations from Division of State Parks, Missouri Department of Natural Resources

Missouri State Parks recommended actions for Castlewood State Park and Rte. 66 State Park located in the study area target watersheds which are described in Section IV. Division of State Parks also included recommendations for two other parks in the lower Meramec Watershed that are outside of this study area. For information on the actions proposed at Meramec State Park and Robertsville State Park, (see Appendix L).

F. Metrics: Indicators of Success/ Strategies for Measuring Success:
When project partners apply for funding (from the 319 program or other sources) to implement projects, the following key measures can be used to measure success. It is not necessary that

each project track all of these items, but that appropriate measurements are made for appropriate projects.

1. **Water Quality**
    a. **Biological Health**: The ultimate measure of success will be thriving and diverse biological communities in the tributaries and main stem of the Meramec. *Track macro-invertebrates and fish populations*
    b. **Pollutant Load**: A second measure of success in achieving water quality is the absence of pollutants observed through monitoring and testing of the water of tributary streams. *Track in stream pollutants*
2. **Planning Framework** *Track number of additional plans completed*
    a. **Sub-Watershed Plans**: Success in planning will be measured by the number of individual stream based watershed plans that have been developed and implemented. Success is measured by achieving milestones and various measured indicators of improvement of water quality and that are 'owned' by the residents of the particular watershed. As the public becomes better informed and educated, the public will be able to organize at the level of individual tributary and sub-tributary streams to address non-point source run-off.
    b. **Public Involvement**: Individuals own most of the land in any given watershed and therefore it is public awareness, understanding and action that ultimately can make a difference in water quality practices. *Track the number of people involved*
        1) Number attending planning meetings,
        2) Number participating in volunteer projects
        3) *Number providing leadership to watershed planning efforts*
3. **Management of Stormwater**
    a. **Volume**: Stream flow is a critical factor in stream health. Track fluctuation in stream flow to observe the moderation of high and low flow in tributary streams is a measure of long-term success. This measure must be correlated with rainfall and will probably require long-term measurement of 10-20 years to observe significant results. *Track Stream flow*
    b. **Projects Implemented**: Best Practices to manage stormwater runoff are required in some instances, and can be encouraged but voluntary in other situations. Both are relevant to improving stream health and ideally both required and voluntary projects can be monitored and evaluated. *Track number of measures implemented*
        1) Number of residential rain gardens
        2) Number of other Low Impact Development (LID) practices
        3) *Number of permitted structures and kinds of structures permitted*
    c. **Ordinances**: *Track implementation of city/county ordinances that support, encourage or require best practices*
4. **Reduce Flooding and Erosion Problems. Local government actions can reduce risk and protect stream corridors.** Floods negatively impact water quality; erosion causes excess sediment on streambeds and reduces stream clarity.
    a. **Stream Buffers**: Stream Buffers to protect the channel and provide area for streams to move naturally; buffers support habitat, reduce erosion, offer recreational space and protect water quality**.** *Track width of stream buffers and allow creeks room to move naturally*

b. **Flood Zone protected**: Flood plains are subject to flooding, and the best hazard mitigation strategy is to remove buildings from flood prone areas**.** *Track FEMA buy-outs and other measures to remove property from flood prone areas*
c. **Construction in Floodplain**: Local governments can protect water quality and control flood plain development by enacting ordinances to restrict construction in stream buffer areas**.** *Track number of local governments with stream buffer ordinances and number of actions to restrict construction in floodplain*
d. **Stream stabilization**: Where erosion has occurred, stream banks can be stabilized to reduce further erosion and loss of property. *Track number of stream bank stabilization projects*
e. **Stormwater Controls to protect water quality and reduce flooding**: *Track metrics listed in #3 above for management of stormwater runoff*

5. **Improving Waste Systems (on- site sewage disposal system improvement).** On-site sewage disposal treatment systems need constant attention to function properly. State Government could enact legislation to require a uniform standard for operation and maintenance of such systems**.** Education combined with local government regulations can provide incentives for public to maintain function of individual treatment systems.
    a. **Education of residents** is the key element in fostering responsible management of such systems**.** EWG has produced a brochure for owners of individual treatment systems**.** The brochure explains best practices for safe and effective operation**.** *Track number of people reached; number of brochures distributed*
    b. **Local government can enact ordinances** that require inspection and regular maintenance of on-site treatment systems**.** *Track number of local ordinances passed to require maintenance.*
        1) Develop programs for local governments to educate property owners. *Track number of local governments that educate landowners on best management of their on-site systems*
        2) Work with local government to improve monitoring and management requirements**.** *Track number of local governments that establish regular monitoring system for individual waste systems*
    c. The program can **provide encouragement to individuals and agencies** to experiment with new technologies to handle waste**.** *Track number of demonstration systems installed to manage human waste, including*
        1) Number of composting toilets, or
        2) Number of small scale treatment facilities, to replace on-site treatment (septic tank) systems
    d. **Work with sewer districts** to connect properties that can easily be connected to public sewers**.** *Track numbers of on-site treatment facilities that are removed from the watershed*
6. **Demonstration Projects Serve to Address Specific Problems and to Educate the Public.** Projects on public land will be accessible to a large portion of the public and serve as important tools for education.
    a. **Identify Projects** implemented in Public Lands:
        1) *Track the number of LID measures placed in publicly owned lands (including parks, schools, and other state, city or county owned land,*

where demonstration practices will be evident and accessible to the public)

2) *Track number of composting toilets that replace septic systems or lagoons on public lands*

b. **Evaluation Data**: *Track number of demonstration test sites and results of monitoring to evaluate micro scale effectiveness of Best Management Practices*:

1) Keep evaluation costs low in relationship to implementation costs
2) Work with partners to determine most effective evaluation strategies

7. Education: Since individual initiative is critical to addressing water quality problems at the source, a comprehensive citizen engagement process is the most important activity for the next ten years, and should remain a high and on-going priority for the next twenty years or more.

a. **Citizens Educated**: *Track number of visitors to demonstration sites*
b. **Educational Materials**: *Track number of brochures, presentations, and other public education activities*
c. **Citizens involved in Watershed Planning**: As public awareness increases, more citizens will become involved in the planning process and still more will become involved in actions to improve stream quality *Track numbers involved in planning*
d. **Citizen Projects on Private Land**: *Where possible, track number of people who implement best practices on private land as the result of education/demonstration program experiences*

Example of Low Impact Development Site Design
Kirkwood MO

Meramec River Tributary Alliance Meeting, September 2011

G. Best Management Practices, Timing and Monitoring Recommendations

Implementing the plan is based on the installation of demonstration projects on public parks and/or public institutional structures (i.e. administration buildings, city hall, etc.). Five BMP's have been selected for demonstration purposes. They are:

1. Bioretention
2. Swales
3. Rain Gardens
4. Constructed Wetlands
5. Pervious Pavements

Table 20 presents the removal efficiencies for each of these selected BMPs. Table 21 contains information on the installation cost experience from various regions throughout the country. The pollution problems by watershed and recommended actions over time are delineated in Table 41 in Section IV. A bioretention facility consists of a shallow, landscaped depression, which allows for temporary holding and infiltration of stormwater runoff. It can be sited in parking lots, residential yards and areas, which would be conventionally landscaped. Swales are shallow, grass or vegetated-covered channels designed to convey and slow down stormwater runoff and

facilitate infiltration. A rain garden is a small depression planted with native vegetation. It is designed to temporarily hold and soak in runoff from impervious surfaces (roads, roofs, parking lots) and yards. A rain garden can be installed for an individual residence or government or commercial structures. A constructed wetland is a man-made shallow pool with wetland plants. It is designed to attenuate peak stormwater flow and remove pollutants through filtration. Pervious pavement is designed to allow water to drain through the surface and into the underlying soil or a stone reservoir. Pervious pavement includes porous asphalt and porous concrete as well as materials with void spaces for drainage such as porous pavers or interlocking grid materials.

Also, presented in this section is a proposed in-stream water quality monitoring system. (See Map 15) Ideally, these monitors will be installed prior to the implementation of the BMPs. The monitoring system should provide baseline data and further tracking data to better assess the effectiveness of BMP implementation within a selected sub-watershed. Please note that the proposed monitoring system builds upon existing monitoring network within the five sub-watersheds.

The design goals for the selected BMP demonstration projects are as follows:

1. Implement the five identified BMPs in various locations throughout the study area, as indicated above. Preferably, the BMPs will be installed on public lands to maximize speed of installation, the educational and public outreach opportunities.
2. The performance goal of the various BMP installations will be capturing and treating stormwater runoff from 90 percent of the recorded daily rainfall events, which is based on a rainfall amount of 1.14 inches of rain.
3. Monitor the reduction in peak flow rates in relation to rainfall event, overall volume reduction due to plant uptake and infiltration. Also, document the effectiveness of filtering at least one organic pollutant.
4. Use the BMP demonstration results to build public official awareness of the cost-effectives of bio-retentive BMPs and their applicability to local building and sanitation codes.

Table 20
Best Management Practices – Pollutant Removal Efficiencies – General Overview

Bioretention

Reference Source*	% Total Phosphorus	% Total Nitrogen	% Total Suspended Solids
National Pollutant Removal Performance Database (General)	5	46	59 median
Thinking Outside the Pipe (1)	43	21.3	2.4
Deer Creek Watershed Plan	65	50	75
New Hampshire (General)	65	65	99
Iowa (Swale)	71-90	43	86
Georgia	50	60	80
Stormwater Management Center	29	49	81

* See key at end of table

Swale

Reference Source*	% Total Phosphorus	% Total Nitrogen	% Total Suspended Solids
National Pollutant Removal Performance Database (3 types – primarily dry swales)	24	56	81 median
New Hampshire (Flow through)	TBD	TBD	TBD
New Hampshire (Vegetated swale)	25	20	65
Thinking Outside the Pipe – (Vegetated swale [4])	69.1	32.6	3.7
North & South Rivers (MA) Watershed Association	30	30	49
Iowa (Grass)	29	NA	68
Iowa (Dry)	83	92	93
Iowa (Wet)	28	40	74
Georgia (Dry)	50	50	80
Georgia (Wet)	40	25	80
Stormwater Management Center	34 $\pm$ 33 $\pm$ 1 standard deviation	NA	81 $\pm$ $\pm$ 1 standard deviation limited # studies

Table 20 – Continued
Best Management Practices – Pollutant Removal Efficiencies – General Overview

Rain Garden

Reference Source*	% Total Phosphorus	% Total Nitrogen	% Total Suspended Solids
North & South Rivers (MA) Watershed Association	65	58	90
Thinking Outside the Pipe (3)	26.7	35	66.7
Seattle Study	73	Not included	74
Iowa (Infiltration)	65-85	50	80
Deer Creek Watershed Plan (Series of rain gardens)	65	60	75

Constructed Wetland

Reference Source*	% Total Phosphorus	% Total Nitrogen	% Total Suspended Solids
National Pollutant Removal Performance Database (4 types)	48	24	72 median
New Hampshire	45	55	80
Thinking Outside the Pipe (5)	26.4	12.4	48.2
Chesapeake Bay	50	30	80
North & South Rivers (MA) Watershed Association	55	30	80
Iowa (USEPA 1993)	15 – 45	< 30	50 - 80
Georgia	30	40	80
Stormwater Management Center (Extended detention wetland)	39	56	69

Pervious Pavement

Reference Source*	% Total Phosphorus	% Total Nitrogen	% Total Suspended Solids
New Hampshire (Permeable pavement)	64	60	90
New Hampshire (Permeable Pavement with underdrain)	45	10	90
Thinking Outside the Pipe	13.2	18.8	17.7
Iowa (USEPA 1993)	30 – 65	65 – 100	65 – 100
Georgia (Pervious concrete)	65	50	NA
Stormwater Management Center (Porous pavement)	65	82	95

Table 20 – Continued
Best Management Practices – Pollutant Removal Efficiencies – General Overview

Sources for the Table - Key

National Pollutant Removal Performance Database, Version 3, 2007 prepared by the Center for Watershed Protection
Thinking Outside the Pipe, Southwestern Illinois Resource Conservation & Development, 2009
Deer Creek (MO) Watershed Plan, 2010
New Hampshire Stormwater Manual, 2008
Iowa Stormwater Management Manual, Iowa State University, 2009
Georgia Stormwater Manual, 2001 (Cited in Iowa Manual)
Stormwater Management Center factsheets
North & South Rivers (MA) Watershed Association, BMP tutorial developed by Comprehensive Environmental, Inc.
Seattle WA Summary of Biofilter Effectiveness from Local and National Data Sets, 2006
Chesapeake Bay Storm Water Best Management Practices Categories and Pollutant Removal Efficiencies, Urban Storm Water Work Group
(1) - Number of facilities reduction efficiency associated with
USEPA 1993 - Iowa Manual adapted 1993 USEPA table
Median – National Database had 25-percentile efficiency, 75-percentile efficiency and median efficiency. Median was used.
NA – Not available
TBD – To be determined

Table 21
Best Management Practices – Installation Cost Estimates

Bioretention

Source	Cost
Stormwater Management Center (2000)	$6.80 per cu ft of water storage Construction, Design and Permitting Cost = Volume of Water treated (cu ft)$^{0.99}$
Anne Arundel County MD County Park and Ride Bioretention (2010)	$9.10 sq ft
California Stormwater BMP Handbook (2003)	Commercial, industrial and institutional sites – $10 - $40 sq ft
Warwick Township PA Municipal Campus Expansion (2007)	75' by 50' by 12' basin (3,750 sq ft) - $17,000 $4.63 sq ft
USEPA Stormwater Technology Fact Sheet – Bioretention (1999)	400 sq ft basin - $500 - $1.25 sq ft
LID Stormwater Center (2002)	Commercial, industrial and institutional sites – $10 - $40 sq ft Commercial new - $10,357 Commercial retrofit - $12,355

Swale

Source	Cost
Grassed Swale	
Lake Superior Waters (2002)	$0.50 sq ft; $5.50 cu ft of storage provided (2000)
Stormwater Center (2000)	$0.50 sq ft; $5.50 cu ft of storage
Fairfax County VA LID BMP Fact Sheet (2005)	$6,000 for swale with 900 sq ft surface area $6.66 sq ft
Vegetated Swale	
Tredyffrin Township PA (2006)	$4.50 - $8.50 per linear ft when vegetated from seed $15 - $20 per linear ft when vegetated from sod
Charles River Watershed Association (2008)	$10 per linear foot
California Stormwater BMP Handbook (2003)	$0.50 per sq ft

Table 21 - Continued
Best Management Practices – Installation Cost Estimates

Rain Garden

Source	Cost
Applied Ecological Services Rain Garden Design and Installation	Native Prairie 5 acre site - $5,975 Designed and installed rain garden - $12 - $25 sq ft 200 sq ft rain garden - $9.30 sq ft
The Groundwater Foundation (2009)	Self installed - $3 - $5 sq ft Landscaper - $10 - $15 sq ft
Draft PA Stormwater Management Manual (2005)	$5 - $7 per cu ft of storage provided
Wisconsin DNR and University of Wisconsin Extension (2003)	Self installed - $3 - $5 sq ft Landscaper - $10 - $12 sq ft
Edgewood College WI (2003)	$11 - $13 sq ft
LID Stormwater Center (2002)	Residential lot - $1,075 Average cost per facility installed in 100 lot subdivision - $3,790 Residential single lot - $7,775
University of Rhode Island Cooperative Extension (2006)	Demonstration 160 sq ft rain garden At North Kingston RI Town Hall $1,075 or $6.72 sq ft Landscaper installation - $2,400 or $15 sq ft
10,000 Rain Gardens Kansas City (2011)	Self installed - $10 - $12 sq ft

Constructed Wetland

Source	Cost
Charles River Watershed Association (2008)	$39,000 - $82,000 for a one acre wetland
California Stormwater Management BMP Handbook (2003)	Assumed 25% more expensive than stormwater ponds of an equivalent volume Construction, Design and Permitting Cost = $30.6^{\text{Wetland Volume needed to control the 10-year storm (ft3)}}$ 1 acre foot facility - $57,100
2004 Connecticut Stormwater Quality Manual	Construction, Design and Permitting Cost = $0.6V^{0.705}$ (wetland volume need to control the 10-year storm [ft3])
Stormwater Center (2000)	Construction, Design and Permitting Cost = $0.6V^{0.705}$ (wetland volume need to control the 10-year storm [ft3]) 1 acre foot facility - $57,100

Table 21 – Continued
Best Management Practices – Installation Cost Estimates

Porous/Pervious Pavement (Installation cost estimates by square foot, unless otherwise noted)

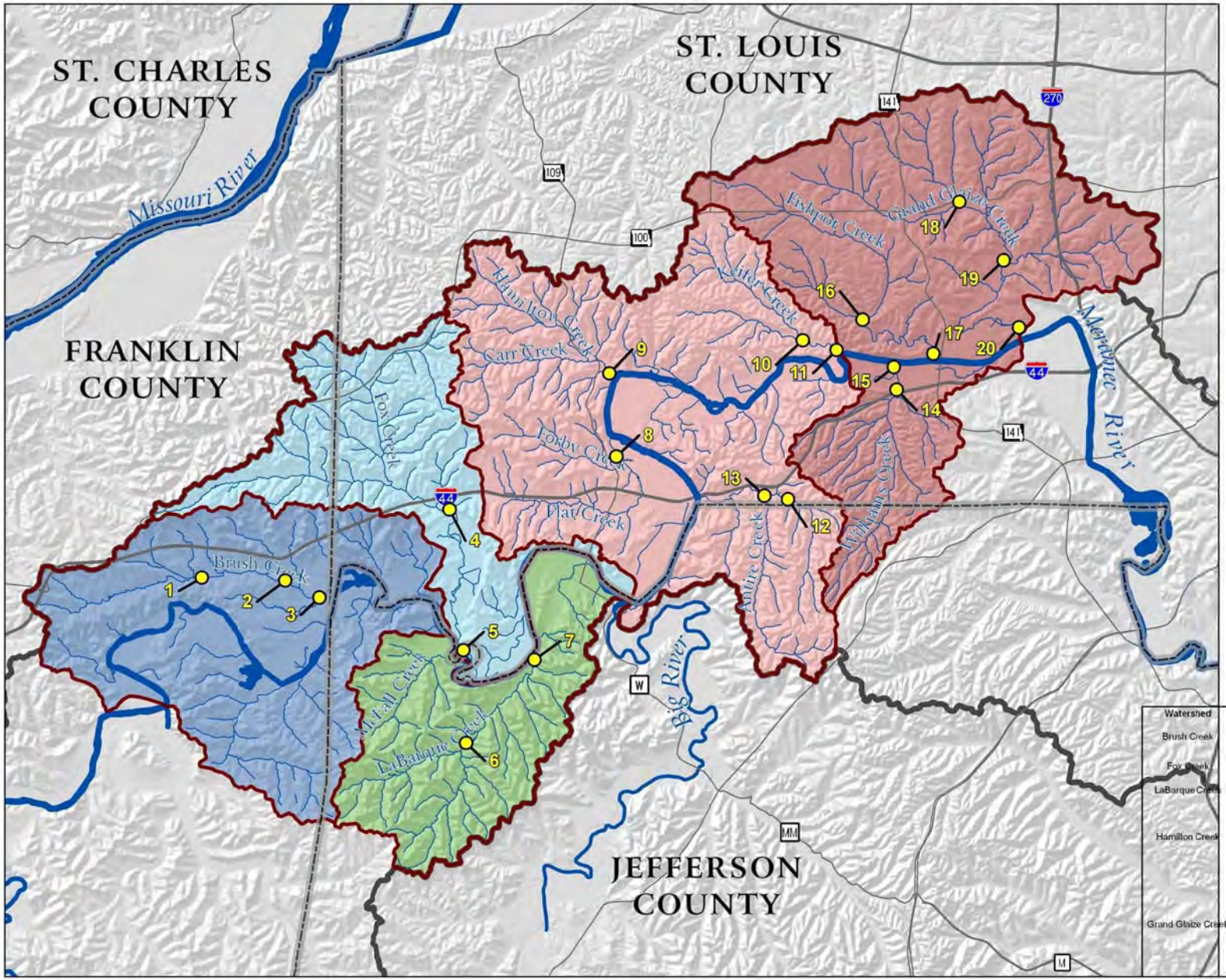
	Information Sources					
Material	**Low Impact Development Center 2000 - 2002**	**Ramsey-Washington Metro District (MN) Demo Project 2006**	**Paver Search 2011**	**National Association of Home Builders Research Center 2001 from Center for Watershed Protection**	**University of Rhode Island Cooperative Extension 2005**	**Charles River Watershed Association 2008**
Porous Pavement Generally	$2 - $3 $45,000 to $100,000 per impervious acre treated					$7 - $15
Porous Asphalt	$0.50 - $1	~ $9.50 for 7,000 sq ft parking lot	$0.50 - $1	$0.50-$1	$0.50 - $1 around $2,000 - $2,500 per parking space	
Porous Concrete	$2 - $6.50		$2.00 - $6.50 of installed pavement		$2 -$4 4 times greater than porous asphalt	
Concrete Lattice Pavers				Turfstone $2 - $3 Checkerblock $3 - $4	Turfstone $2.25 - $2.70 Checkerblock price determined by retailer	

Table 21 – Continued
Best Management Practices – Installation Cost Estimates

Porous/Pervious Pavement (Installation cost estimates by square foot, unless otherwise noted)

	Information Sources					
Material	**Low Impact Development Center**	**Ramsey-Washington Metro District (MN) Demo Project 2006**	**Paver Search**	**National Association of Home Builders Research Center 2001 from Center for Watershed Protection**	**University of Rhode Island Cooperative Extension 2005**	**Charles River Watershed Association**
Interlocking Concrete Pavers	$5 - $10		$5 - $10	Uni-Eco-stone $2- 3	Aquaterra ~ $2.98 Uni-Ecostone starts at $3.07 SF-RIMA $3.10 - $3.20	
Grass/Gravel Plastic Grid Pavers	$1.50 - $5.75		$1.50 - $5.75	Geoweb, Grasspave, Gravelpave, & Grassy Pavers $1 - $2 Geoblock $2 - $3	Grasspave ~ $2.50 Gravelpave $2.25 Geoblock $2.75 (5.5 sq ft) Grass Road Paver Plus $43 (8 sq ft) Turf Track $20 (4 sq ft) Net Paver 50 $2 - $3 (2.7 sq ft)	

Map 15



Lower Meramec Watershed

Proposed In-Stream Water Quality Monitoring Sites

Legend

Basemap Elements

- Meramec Watershed
- County Boundary
- River or Stream
- Interstate Highway
- Major Road
- Propose In-Stream Water Quality Monitoring Sites

Watersheds

- Brush Creek
- Fox Creek
- Grand Glaize Creek
- Hamilton Creek
- LaBarque Creek

0 1 2 4 Miles

Sources: Missouri Department of Natural Resources, East-West Gateway Council of Governments

November 2011

The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Watershed	Number	Creek	Location
Brush Creek	1	Brush	150 ft upstream Ingram Factory line
	2	Brush	At Highway N, 2 miles from mouth
	3	Brush	At Highway F bridge, 1 mile from mouth
Fox Creek	4	Fox	At US Business I-44, downstream railroad
	5	Fox	At mouth of Fox Creek
LaBarque Creek	6	LaBarque	At Rte FF Bridge
	7	LaBarque	At Highway F bridge near mouth
Hamilton Creek	8	Flat/Forby	0.5 Up from Mouth
	9	Hamilton	At Foster Trail Head, Grand Ave & 3rd St Glencoe
	10	Kiefer	At Sontag Rd & Kiefer Creed Rd
	11	Kiefer	At Kiefer Creek Rd, 0.5 mile from mouth
	12	Little Antire	Near where enters Antire Creek, 0.1 mile
	13	Antire	Near Bussen Quarry, 0.9 mile from mouth
	14	Williams	At I-44 North Outer Rd, 0.6 mile from mouth
	15	Williams	Near Peerless Park
	16	Fishpot	At Sulphur Spring Rd
	17	Fishpot	At Vance Rd, 0.6 mile from mouth
Grand Glaize Creek	18	Grand Glaize	Downstream Dietrich Rd Bridge, 4 miles from mouth and 2.8 miles upstream from Spring Creek
	19	Grand Glaize	At Dougherty Ferry Rd, downstream from Sugar Creek
	20	Grand Glaize	0.1 mile from mouth

H. Long-Term (20-year) BMP Implementation Strategy

There are three impaired streams within the study area's five watersheds. Kiefer Creek in the eastern part of the Hamilton Creek watershed has been classified as impaired. In the Grand Glaize Creek watershed, Fishpot Creek and Grand Glaize Creek in St. Louis County have been designated as impaired. (See Map 13) The plan of action over the next 20 years, is to implement a package of BMPs by land use category (Table 22) for these watersheds where the impaired creeks are located.

Depending on the type land use, these BMPs would be implemented by individual homeowners, homeowner associations, private businesses, local governments or school districts. BMP selection will require an analysis and evaluation of cost, funding sources, operation and management requirements, environmental evaluation and BMP siting and construction requirements. The full extent of BMP implementation will be dependent upon the success of the demonstration BMP projects planned for public lands.

It is assumed that the BMP package would be implemented on 60 percent of the existing and planned commercial, industrial, institutional, multi-family residential and single-family residential impervious acreage in the Hamilton Creek and Grand Glaize Creek watersheds. For roads, the assumption would be 20 percent of the impervious surface acreage. Such an aggressive implementation percentage will be dependent upon significant "buy-in" by local governments and developers.

Table 22
BMP Package

Land Use	**BMP**
Commercial	Bioretention (for 90 percent of impervious acreage) Pervious Pavement (for 10 percent of impervious acreage)
Industrial	Bioretention
Institutional	Bioretention
Multi-Family Residential	Vegetated Swales
Single-Family Residential	Rain Gardens
Roads	Vegetated Swales

Based on the calculated load reductions by land use impacting the three impaired streams (Table 23), the assumption is that at the end of the 20-year period the BMP packages will correct the water quality violations of Kiefer Creek, Fishpot Creek and Grand Glaize Creek. Table 24 shows the estimated load reduction associated with this set of BMPs for the Hamilton Creek watershed and the Grand Glaize watershed. These load reductions will have a significant and positive effect on the in-stream water quality of the three impaired streams of Hamilton and Grand Glaize watersheds. At year 10 it is anticipated that the BMP package would be implemented on 25 percent of the existing and planned impervious acreage in these two watersheds.

Finally it is assumed that the riparian corridor along these impaired streams would be protected. Riparian corridor protection would act as a passive bio-filter for remaining urban runoff that would flow overland into the three impaired streams.

Table 23
BMP Package Pollutant Removal Efficiencies

BMP	Percent Total Phosphorus	Percent Total Nitrogen	Percent Total Suspended Solids
Bioretention	50	60	80
Pervious Pavement	45	10	90
Vegetated Swale	25	20	65
Rain Garden	65	60	75

Bioretention – Georgia Stormwater Manual, 2001
Pervious Pavement – New Hampshire Stormwater Manual (permeable pavement with underdrain), 2008
Vegetated Swale – New Hampshire Stormwater Manual, 2008
Rain Garden – Deer Creek (MO) Watershed Plan, 2010

Table 24
Watershed Estimated BMP Load Reduction
Hamilton Creek Watershed
Kiefer Creek - Impaired

Hamilton Creek Watershed Land Use	**Load Reduction Estimate (pounds/year)**		
	Total Phosphorus	**Total Nitrogen**	**Total Suspended Solids**
Commercial	95.1	1056.4	58,340.3
Industrial	100.3	1,002.8	64,180.0
Institutional	37.4	403.2	20,010.0
Multi-Family Residential	19.5	85.9	12,684.2
Single-Family Residential	480.3	2,438.3	138,539.8
Roads	54.2	238.3	35,196.9
Total	786.8	5,224.9	328,951.2

Simple Method to Calculate Urban Stormwater Loads was used

Hamilton Creek Watershed	**Baseline Load (pounds/year) (Table 19)**	**Load Reduction With BMPs (pounds/year)**
Total Phosphorus	5,065.3	786.8
Total Nitrogen	32,144.9	5,224.9
Total Suspended Solids	1,513,303.7	328,951.2

Table 24 - Continued
Watershed Estimated BMP Load Reduction
Grand Glaize Creed Watershed
Fishpot Creek and Grand Glaize Creek - Impaired

Grand Glaize Creek Watershed Land Use	Load Reduction Estimate (pounds/year)		
	Total Phosphorus	**Total Nitrogen**	**Total Suspended Solids**
Commercial	3,897.5	3,664.3	202,366.6
Industrial	153.0	1,529.6	97,898.9
Institutional	66.2	715.1	35,492.7
Multi-Family Residential	78.8	346.8	51,236.6
Single-Family Residential	908.8	4,613.8	262,145.0
Roads	118.8	522.7	77,223.8
Total	5,223.1	11,392.3	726,363.6

Simple Method to Calculate Urban Stormwater Loads was used

Grand Glaize Creek Watershed	Baseline Load (pounds/year) (Table 19)	Load Reduction With BMPs (pounds/year)
Total Phosphorus	11,861.7	5,223.1
Total Nitrogen	71,541.1	11,392.3
Total Suspended Solids	3,333,002.4	726,363.6

I. Technical and Financial Assistance for the Lower Meramec Watershed Plan

Sources of Technical Assistance

Focus St. Louis
The Environmental Sustainability and Stewardship Task Force of Focus St. Louis can assist local governments in the St. Louis region to increase their level of environmental sustainability and stewardship. The Task Force has developed a Sustainability Roadmap tool for local governments.

Great Rivers Greenway District
The Great Rivers Greenway District has carried out many projects in St. Louis County, St. Charles County and the City of St. Louis. These projects have involved partnerships with governments, public agencies and private and non-profit organizations. The District is working for a clean, green, connected St. Louis region. They are working to develop an interconnected system of greenways, parks and trails encircling the St. Louis region. These projects should also encourage economic development.

Metropolitan St. Louis Sewer District
MSD could be a source of technical and financial assistance in that portion of the study area (St. Louis County) which is within their service area boundary. MSD performs water quality monitoring and could offer planning leadership and engineering expertise regarding stormwater best management practices.

Missouri Botanical Garden
As part of the Missouri Botanical Garden, the Litzsinger Road Ecology Center in St. Louis County is an outdoor laboratory for ecological education, research and restoration of local ecosystems. They offer teaching training at the Center and follow-ups at the Center and the particular school and support on-site native planting projects. The Shaw Nature Reserve in Franklin County offers rain garden workshops and brochures and has on-line information as well. The Shaw Nature Reserve (SNR) website contains a list of native plants recommended for use in bioretention systems. The Horticulture Division answer service can respond to questions from the general public about rain gardens.

Missouri Department of Conservation
The Missouri Stream Team Program coordinates volunteer stream team efforts in the region. The goals of the Stream Team Program are education, stewardship and advocacy. Stream Team activities can range from litter pick-up to in-stream water quality data collection. There are many locations along the creeks in the Lower Meramec study area which have been adopted by Stream Teams. The Missouri Stream Team Program is a partnership of the MoDNR, the Conservation Federation of Missouri and the MoDNR. MoDNR maintains online resources concerning native plants as relates to rain garden (Grow Native). MoDNR is a technical resource and could provide financial assistance information.

Missouri Department of Natural Resources and U.S. Environmental Protection Agency Region 7
Under Section 319 of the Clean Water Act, funds are available for watershed planning and implementation from the U.S. Environmental Protection Agency through the MoDNR. The MoDNR staff can provide technical assistance for watershed planning activities and implementation, and information on State Revolving Loan Fund (SRF) and other types of financial assistance available.

Brush Creek Sewer District
The Brush Creek Sewer District in Franklin County has provided mitigation funding for the Shaw Nature Reserve to construct wetlands in order to mitigate damage done in eastern sections of Brush Creek. The Brush Creek Sewer District has replaced a significant number of septic systems with centralized sewage collection and treatment.

Municipalities
The City of Wildwood has taken action to address water quality in much of the Hamilton Creek watershed. Wildwood is an example of how local government leadership can promote actions to address non-point source pollution.

Missouri Coalition for the Environment
The Missouri Coalition for the Environment has been leading walks along the lower reaches of Kiefer Creek, talking with residents, collecting and assembling information in order to lay the groundwork for the development of a Kiefer Creek watershed plan. This plan would address the specific water quality problems in this sub-watershed of the Hamilton Creek watershed.

Friends of LaBarque Creek
The Friends of LaBarque Creek is a non-profit organization made up of primarily residents of the LaBarque Creek watershed. The Friends are working to implement the education and action strategies to protect stream quality which were delineated in the 2009 LaBarque Creek Watershed Plan to protect a healthy stream in northwest Jefferson County.

St. Louis County Soil and Water Conservation District
The St. Louis County Soil and Water Conservation District operates the "ShowMeRainGardens " initiative. Purpose of "ShowMeRainGardens" is to promote rain gardens, to advance low-impact alternative storm water treatment practices, to reduce stormwater-related flooding and erosion and to improve water quality. Partners in this initiative include: MSD; local governments, conservation agencies; private citizens; and the private sector. "ShowMeRainGardens" maintains a website containing information on design and installation of rain gardens, a plant list and plant retailers and also tracks rain gardens in the St. Louis area. The St. Louis County Soil and Water Conservation District funded a major steam geomorphic analysis of management strategies for Fishpot Creek and its tributaries (part of the Grand Glaize Creek watershed). The study was conducted by Intuition and Logic, Inc. The Plan included recommendations for stream channel improvements to stabilize stream banks and improve water quality.

U.S. Army Corps of Engineers
Planning assistance from the Corps of Engineers is available to states on a 50 percent federal -50 percent non-federal cost share basis. The program can cover many types of studies dealing with water resources issues.

Federal Funding Opportunities

The EPA.gov website is a source of information on potential funding:
www.epa.gov/igd/grants/funding_opportunities.htm
www.epa.gov/water/funding.html
http://cfpub.epa.gov/fedfund
http://water.epa.gove/aboutow/owow/funding.cfm

The U.S. Department of Agriculture maintains a web page of funding opportunities for various projects affecting water. www.nal.usda.gov/wqic/funding.shtml . The National Resource Conservation Service (NRCS) also has a number of financial assistance programs. More information can be found at
www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial

Table 25at the end of this section contains a listing of potential grant and funding opportunities. Additional information can be found in Appendix J.

Nine universities in the U.S. have been designated as Environmental Finance Centers (EFC) by the U.S. Environmental Protection Agency. The EFCs are to help states and regulated entities manage the environmental mandates required by federal law. Information on the EFC network can be found at www.epa.gov/efinpage/ . This web site is updated monthly to provide the latest environmental finance information and tools to practitioners out in the field. Boise State University operates the Region 10 EFC and the Region 7 Satellite Office. The Satellite Office provides many of the services, tools and technical assistance to communities in the Midwest.

The Satellite Office maintains an on-line searchable database of potential financial resources for projects. The following list reflects information in this database.

EFC's Directory of Watershed Resources - Missouri Sources – 44 Programs found

Alternative Loan Program
Grow Native! Program
Missouri Sustainable Agriculture Demonstration Award Program
Missouri Wildlife Habitat Incentives Program (WHIP)
Missouri's Aquaculture Program
North Central Region (NCR) – SARE Farmer Rancher Grant Program
North Central Region (NCR) – SARE Professional Development Program Grant
North Central Region (NCR) – SARE Research and Education Grant Program
Conservation Contractor Training
Master Wildlifer Program
Missouri Agroforestry Program

Outdoor Classroom Grant, Missouri
United Sportsmen's League Wildlife Conservation Grant, Missouri
Community Development Block Grant (CDBG) Downtown Revitalization, Missouri
Community Development Block Grant (CDBG) Other Public Needs, Missouri
Community Development Block Grant (CDBG) Water and Wastewater, Missouri
Delta Regional Authority
Industrial Infrastructure Grant
Conservation Field Trip Grant, Missouri
Energy Revolving Fund
Land and Water Conservation Fund (LWCF) – Missouri
Living Lands and Waters – Educational Workshops
Missouri Bootheel Partners Program
Missouri Brownfields Revolving Loan Fund
Missouri Energy Efficiency and Renewable Energy Set-Aside Program
Missouri Rural Water Association (MRWA)
Recreational Trails Program (RTP) – Missouri
Section 319 Nonpoint Source (NPS) Minigrant Program
Section 319 Nonpoint Source Implementation Grant Program – Missouri
Watershed Management Development Grant
Adopt-a-Highway Program, Missouri
Request An Expert Program
Scenic Byways Program
Transportation Enhancement Program, Missouri
Tools for Floodplain Management
Abandoned Well Plugging Program
Boone County Soil and Water Conservation District – Missouri
Plant Diagnostic Clinic
University of Missouri Center for Agoforestry
Missouri Alternatives Center
Region 7 Pollution Prevention Regional Information Center

Table 25
Grants and Funding Opportunities

Grant Program Sponsoring Agency	**General Information**	**Eligibility**	**Level of Assistance**	**Website**
North American Wetland Conservation Act – U.S. Small Grants Program U.S. Fish and Wildlife Service	Program that supports public-private partnerships carrying out projects in U.S. Projects are small scale and must involve long-term protection, restoration and/or enhancements of wetlands and associated uplands habitats.		50 % matching funds required. Maximum grant awards of $75,000.	www.fws.gov/birdhabitat/grants
North American Wetland Conservation Act – U.S. Standard Grants Program U.S. Fish and Wildlife Service	Program that supports public-private partnerships carrying out projects in U.S. Projects must Involve long-term protection, Restoration and/or enhancements of Wetlands and associated uplands Habitats.		50% matching funds required. Maximum grant awards between $75,000 – $1,000,000	www.fws.gov/birdhabitat/grants
Planning Assistance to States U.S. Army Corps of Engineers	Provides assistance with the development of comprehensive plans for the development and conservation of land and water resources. Cover planning level of detail.	States, local governments and other non-federal entities. Non-profits are not eligible but could partner with state or local governments.	Limit for each state is $500,000 Annually. Cost Share is 50-50. Generally studies range from $25,000-$75,000.	www.mvs.usace.army.mil/pm/pmmain.htm
Environmental Education Grants U.S. Environmental Protection Agency	U.S.EPA's Office of Environmental Education, Office of External Affairs and Environmental Education supports environmental education projects that enhance the public's awareness, knowledge and skills to help people make informed decisions that affect environmental quality. Grants are Awarded based on funding appropriated by Congress.	Applicant must represent one of the following types of organization to be Eligible: local education agency; state education or environmental agency; college or university; non-profit organization 501(c) (3), noncommercial educational broadcasting entity; or tribal education agency	Annual funding for this program ranges between $2 and $3 million. Most grants will be in the $15,000 to $25,000 range. Non-federal matching funds of at least 25% are required.	www.epa.gov/enviroed/grants.html

Table 25 - Continued
Grants and Funding Opportunities

Grant Program Sponsoring Agency	**General Information**	**Eligibility**	**Level of Assistance**	**Website**
Watershed Management Plan Development Grant U.S. Environmental Protection Agency administered through Missouri Department of Natural Resources	Provides funding for development of watershed-based management plans to restore watersheds impaired by non-point source pollution Applications due Feb, June and Sept	Eligible organizations include state and local agencies, educational institutions and non-profits organizations with demonstrated 501 (c) (3) status. .	Grant limit is $30,000 Project limit is 3 years	www.dnr.mo.gov/env/wpp/nps
Section 319 Nonpoint Source Minigrant Program U.S. Environmental Protection Agency administered through Missouri Department of Natural Resources	The Minigrant Program provides financial assistance for building watershed protection capacity in watersheds Targeted by Missouri's Nonpoint Source Mgt Plan and other water Quality initiatives. They are a type of Sub-grant. Projects that build Capacity through organizing, planning And/or education will receive priority consideration during review. Applications due in April and Oct	Eligible organizations include state and local agencies, educational institutions and non-profits organizations with demonstrated 501 (c) (3) status.	Grant limit $10,000 Project limit is 24 Months. Matching support: 60% federal and 40% non-federal (cash or eligible in-kind contribution)	www.dnr.mo.gov/env/wpp/nps
Section 319 Nonpoint Source Major Subgrants Program U.S. Environmental Protection Agency administered through Missouri Department of Natural Resources	NPS source grant funds are provided From U.S.EPA through Section 319(h) of Clean Water Act. Funds can be used to implementing best Management practices and associated Activities as detailed in their watershed management plan. Annual announcement on availability of funds. Amount of funding is dependent Upon number of applications received.	Funds are available to public institutions of higher education, units of government and non-profit organizations with demonstrated 501 (c) (3) status. Partnerships with local soil and water conservation districts, university extension, NRCS, local or state governments are encouraged.	Federal dollar allowance is up to $300,000. Duration of project Up to 2 years. Matching support: 60% federal and 40% non-federal (cash or eligible in-kind contribution)	www.dnr.mo.gov/env/wpp/nps

Table 25 - Continued
Grants and Funding Opportunities

Grant Program Sponsoring Agency	**General Information**	**Eligibility**	**Level of Assistance**	**Website**
Targeted Watershed Grants Program U.S. Environmental Protection Agency	Program is designed to encourage successful community-based approaches and management techniques to protect and restore the nation's waterways. It is a competitive program. Program focuses on multi-faceted plans for protecting and restoring water resources that are developed using partnership efforts of diverse stakeholders. Implementation grants support on-the-ground watershed projects and Capacity Building grants are awarded to leading organizations with a national or regional focus that are able to provide training, technical assistance and education to local watershed groups. Check with U.S.EPA for next proposal cycle.	Eligible organizations include State and local governments, public and private non-profit Institutions/organizations, federally recognized Indian tribal governments, U.S. territories or possessions and interstate agencies. For profit commercial entities and all federal agencies are ineligible.	Applicants are required to demonstrate a minimum non-federal match of at least 25% of total project cost. Funding could range from $400,000 to $900.000.	Programs that support public-private Http://water.epa.gov/grants_funding/twg

IV. Watersheds and Sub-watersheds Problems & Solutions (Element A,C,F,G,H)

This section discusses each of the 12 –digit watersheds with special reference to selected sub-watersheds, especially those recognized as impaired. Beginning with the Brush Creek Watershed which drains into the Meramec at City of Pacific, Missouri, these descriptions move east and downstream on the Meramec River.

A. Brush Creek Watershed

HUC - 0714001020902

Brush Creek Watershed
23,606 acres 36.8 square miles
Brush Creek - 8.89 miles Winch Creek - 5.24 miles Meramec River - 14.3 miles

The Brush Creek watershed, 23,606 acres or 36.8 square miles, is located in the western part of the study area. The majority of the watershed is in east central Franklin County with the remainder in southwest St. Louis County and northwest Jefferson County. (See Map 16 at the end of section) Brush Creek, north of the Meramec River, and Winch Creek to the south are the major streams in this Watershed There also are tributaries to these creeks and smaller streams and land areas which drain directly to the Meramec River.

Brush Creek enters the Meramec River at Pacific, 51 miles upstream of the confluence with the Mississippi River. Winch Creek enters the Meramec River at the Catawissa Conservation Area.

Physical Characteristics

That portion of the Brush Creek watershed north of I-44 and east of Pacific contains dissected hills and bluff lands. The area consists of rolling narrow ridge tops and hilly to steep ridge slopes and valley sides. The small streams have narrow valleys and limestone bedrock exposures are common. (See Map 8)

Along the northern drainage divide, the watershed is underlain by limestone and thin bedded flaggy dolomite. Limestone has solution openings along joints and bedding planes. Portions of these areas are covered by thick loess.

There is sandstone-dolomite in the north and east sections of the watershed. The bluffs east of Pacific contain the St. Peter sandstone formation (sandstone). Soils can be very sandy and very permeable. Historically, silica sand has been mined here.

Most of the bedrock in the watershed consists of dolomite with thin soil cover over bedrock. The watershed is generally characterized by dissected plains and rolling hills.

Alluvium or alluvial soils are in the Meramec River valley and the major creeks. These soils have low run-off potential due to their moderate infiltration rates. These soils primarily consist of moderately deep and moderately well to well drained soils with moderately fine to moderately coarse textures. The gentlest slopes are found in the valleys of the Meramec River and creeks and the built up area of Pacific.

Approximately 75 percent of the soils in this watershed have moderate to high potential for runoff to occur due to slow infiltration rates. Some soils have layers near the surface which limit the downward movement of water or are clayey or are thin soils over bedrock. (See Map 17 and Table 26)

Table 26
Brush Creek Watershed
Hydrologic Soil Groups

Hydrologic Soil Group	Acres	Percent Share
A	2.8	0
B	4,977.8	21.1
B/D	0.5	0
C	11,136.3	47.2
C/D	696.4	3.0
D	5,776.7	24.5
No Data	993.5	4.2
Total	23,583.0	100

Source – USDA, Natural Resource Conservation Service

Hydrologic Soil Groups
A – Low runoff potential, well drained
B – Moderately low runoff potential
C – Moderately high runoff potential
D – High runoff potential, poorly drained
No Data – Hydrologic characteristics of soil could not be determined

Approximately one-third of the land area in this watershed has slopes of 10 percent or greater. The steepest slopes, 40 percent or greater, are found in the bluff areas adjacent to the Meramec River in the Shaw Nature Reserve and east of Pacific along Old Route 66. Steep slopes are also found in the north and east along the drainage divide ridge lines. (See Map 18)

Population and Land Use
All of the city of Pacific is within the Brush Creek watershed. A small portion of Wildwood is in the northeast section of the watershed along I-44. North and west of Pacific is unincorporated Gray Summit. Unincorporated Catawissa is in the southern part of the watershed. In 2010, 13,568 people lived in the Brush Creek watershed. (See Map 5)

Approximately 20 percent of the land area in this watershed can be considered developed or built up. (See Map 19) Concentrated residential areas can be found in Pacific, Gray Summit and Catawissa. There are freestanding subdivisions adjacent to Highway F in Jefferson County and Highways O, NN and AP in Franklin County. Individual residences are dispersed throughout the watershed. Commercial uses primarily can be found along Interstate 44, Old Route 66 and in Pacific. Industrial activity (manufacturing and extraction) makes up four percent of the land

area. (See Table 27) The Missouri Eastern Correction Center is located on Old Route 66 in the eastern part of the watershed. Recreation areas open to the public include the Shaw Nature Reserve, 216 acre Catawissa Conservation Area and the 732 acre Pacific Palisades Conservation Area. The conservation areas have access to the Meramec River. (See Map 20) The majority of the land in the watershed is in crop, grass/pasture and forested land. Much of the agricultural land is in the Meramec River valley and the side valleys of the major streams.

Table 27
Brush Creek Watershed Land Use

Land Use	Acres	Percent Share
Multi-Family Residential	84.3	0.4
Single-Family Residential	2,370.6	10.1
Commercial	357.8	1.5
Industrial	939.0	4.0
Institutional	435.2	1.8
Recreation	3,883.8	16.5
Common Ground	280.3	1.2
Right of Way	8.4	0
Agriculture	5,755.6	24.4
Vacant/Undeveloped	7,835.5	33.2
Unassigned	1,633.3	6.9
Total	23,584.0	100

Source – County GIS Departments

Note - Vacant/undeveloped land did not have any structures on it. These could be forested areas, grass or pasture or land being prepared for development. If the assessor could not identify a specific use for a property, it was placed in the unassigned category.

Stream Classification
Brush Creek Watershed is not part of any terrestrial or aquatic Conservation Opportunity Areas of the MDC.

Extending 2.5 miles upstream from the mouth of Brush Creek, the MoDNR has classified it as a class C stream. A class C stream may cease to flow in dry periods but maintains permanent pools which support aquatic life. Designated uses for this creek are: livestock and wildlife watering; protection of warm water aquatic life (general warm-water fishery) and human-health fish consumption; and Category B whole body contact recreation (no public access swimming areas).

Excluding the Meramec River, no creek in this watershed is on the Missouri 2010 303(d) Impaired Waters list developed by MoDNR. In turn, no TMDL has been prepared or is scheduled to be prepared for any creek in this watershed. Likewise, none of the creeks in this

watershed have been identified by MoDNR as an Outstanding National Resource Waters or Outstanding State Resource Waters.

Key Issues and Recommended Actions

While not listed as impaired for sediment, Brush Creek carries a significant sediment load, and there is concern about being able to maintain a healthy stream as population pressures increase. Bacteria counts have improved since the construction of the Brush Creek Sewer District. The Brush Creek Sewer District has removed a significant number of septic systems from service, replacing them with centralized sewage treatment. The Brush Creek District has been managed by Franklin County, but Franklin County is transferring the district to the City of Pacific. The City of Pacific manages the sewage treatment facility that services the sewer district. Brush Creek Sewer District has provided mitigation funding to SNR to construct wetlands in order to mitigate damage done through sewer construction in eastern sections of the stream. This approach of mitigating within the same watershed is an excellent example of how to use wetlands mitigation to have direct positive impact on streams that have been negatively impacted by construction practices. Another mitigation project is being planned for the SNR in the northeastern part of the property, and SNR has also identified a third section of property in the northeast that needs stormwater control to reduce significant erosion into Brush Creek. The City of Pacific has been identifying other specific sites for remediation work, to control overland flow, flooding and sedimentation, especially in selected subdivisions, but those sites were not fully defined at the time this plan was prepared. It is expected that the city will be ready to sponsor a project by 2013. The city has also purchased a number of properties as part of a flood buyout program, and since these properties are close to or on the Meramec and tributaries, these locations are an excellent target for reforestation, and green buffer development to slow runoff and provide shade and reduce erosion to the streams.

<u>Recommended Projects:</u>

Shaw Nature Reserve – Erosion Control, runoff reduction

Along Gray Summit Road, north side, SNR owns property that drains to a tributary to Brush Creek. This 70-80 acre tract of land has experienced erosion into the stream. A planned project is to address erosion with a set of control measures to reduce overland flow, re-grade selected areas to reduce expansion of gullies and stabilize sediment runoff. The Missouri Botanical Garden (parent organization of SNR) is ready to sponsor, and will need assistance of outside funding, possibly 319 funds.

Wastewater Treatment and Drinking Water

In the Brush Creek watershed, the State of Missouri has issued 16 National Pollutant Discharge Elimination System (NPDES) permits for the discharge of treated wastewater to creeks and the Meramec River. (See Map 6 and tables in Appendix A) Wastewater treatment facilities for the City of Pacific, Calvey Creek Sewer District, Crestview Acres Sewer District and Sylvan Manor-Sunset Acres Sewer District have discharge permits. The Brush Creek Sewer District has an agreement with the City of Pacific to treat their wastewater There are also 26 stormwater permits in the watershed. One permit addresses stormwater at an industrial facility near Pacific, another is for an elementary school in the southeast portion of the watershed and there is a permit for a

small residential care facility. The remainder of the permits have been issued for freestanding residential package treatment plants (subdivisions or mobile home parks) throughout the watershed. It is estimated that 2,105 housing units in this watershed utilize individual sewage disposal systems (septic tanks). Additional NPDES permits have been issued for land disturbance and stormwater management in this watershed but have not been inventoried for purposes of this study.

There are 448 private wells in this watershed. The number of public groundwater supply systems total 17. The majority are community water systems serving the same people year round. (See Table 28) The two largest are operated by the City of Pacific and the Missouri Department of Corrections. The other systems are associated with freestanding subdivisions and mobile home parks. The remaining water systems serve an elementary school, a convenience store and the SNR.

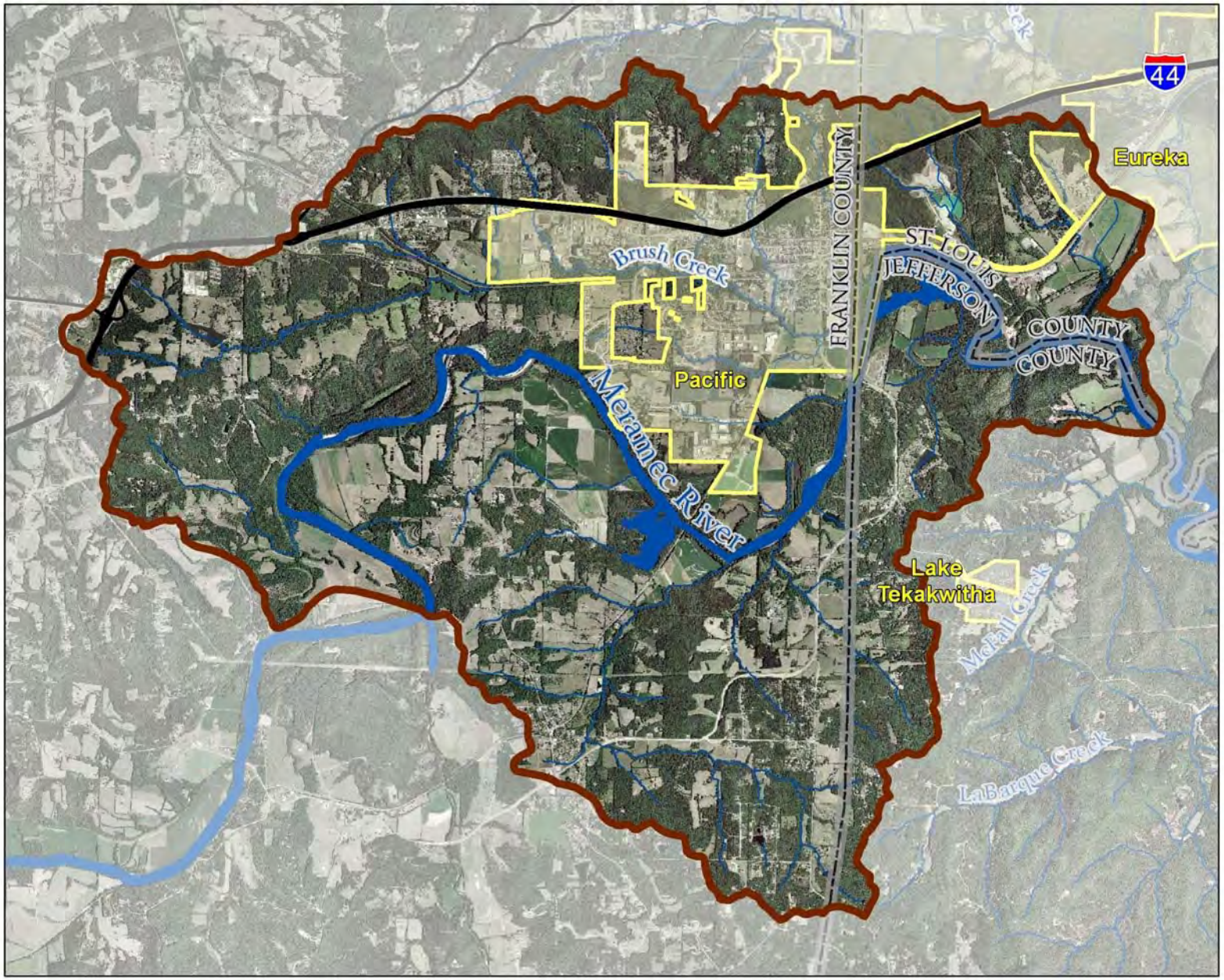
Meramec River at Pacific Palisades

Table 28
Brush Creek Watershed Public Drinking Water Systems

Drinking Water System	Population Served	Number Of Wells	County
Avery Mobile Home Park	110	1	Franklin
Circle C Mobile Home Park	90	1	Franklin
Crestview Acres Subdivision	150	1	Franklin
Evergreen Lakes Subdivision	85	1	Franklin
Franklin County Public Water & Sewer District #3 (FCPWSD#3) 1 site	NA	1	Franklin
Greenwood Valley Subdivision	60	1	Franklin
Hillside Acres Subdivision	80	1	Franklin
Kingsway Mobile Home Park	90	1	Franklin
Kobers Mobile Home Park	NA	1	Franklin
Lake Cattails Subdivision	150	1	Jefferson
Meramec Valley R-3 Nike Elementary School	300	1	Franklin
Missouri Eastern Correction Center	1,000	2	St. Louis
City of Pacific	6,000	3	Franklin
Pacific Heights Subdivision	NA	1	Jefferson
Shaw Nature Reserve	NA	2	Franklin
Sylvan Manor Subdivision	240	1	Franklin
The Market (Convenience Store)	NA	1	Jefferson

NA – Not Available
Population Served - U.S. Environmental Protection Agency, Safe Drinking Water Information System, 2011
Number of Wells - Center for Applied Research and Environmental Systems (CARES) University of Missouri-Columbia, Watershed Evaluation and Comparison Tools based on 2004 source water protection area information from the Missouri Department of Natural Resources
One source water protection area was assumed to represent one well

Map 16



Brush Creek Watershed

Aerial Photograph (2007)

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream
- Incorporated Area, 2009

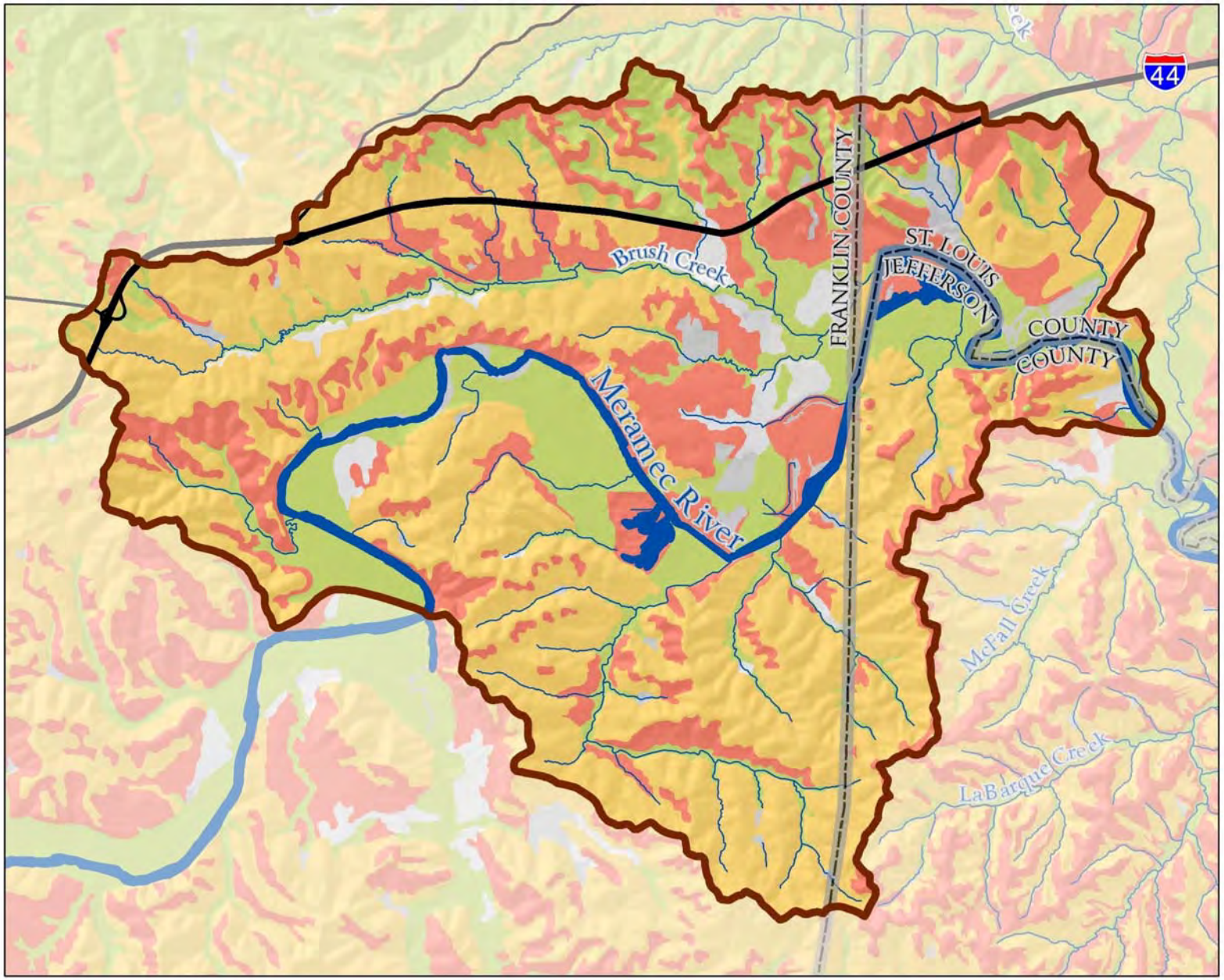
0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments October 2010

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 17



Brush Creek Watershed

Soil Hydrologic Group & Runoff Potential

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Hydrologic Group - Runoff Potential

- A - Low
- B - Moderately Low
- C - Moderately High
- D - High
- No Data

0 0.5 1 2 Miles

Sources: USDA-NRCS,
East-West Gateway Council of Governments
October 2010

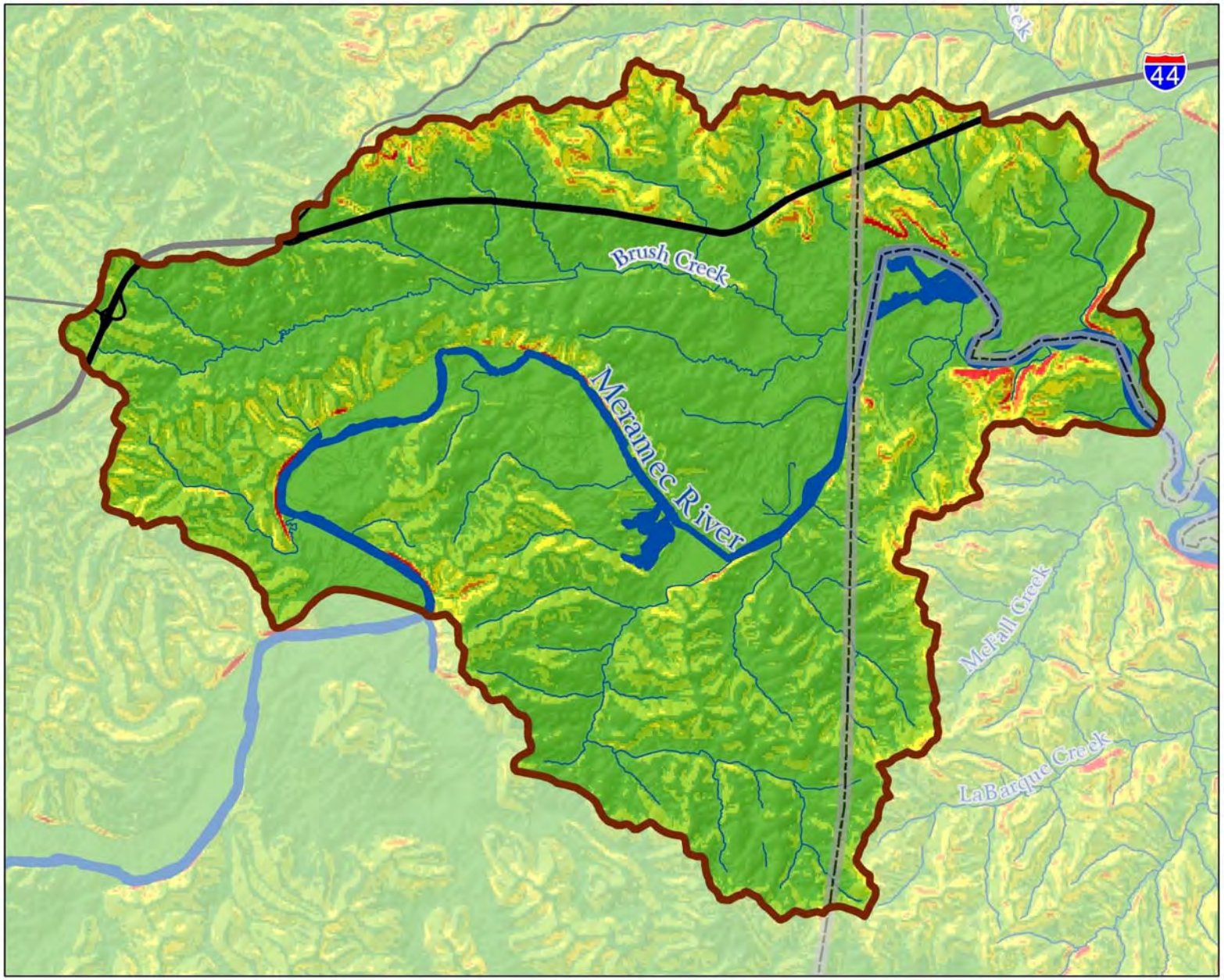
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 18



Brush Creek Watershed

Steep Slopes

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Slope Values

- 0 - 10%
- 11 - 20%
- 21 - 30%
- 31- 40%
- Above 40%

0 0.5 1 2 Miles

Sources: US Geological Survey, East-West Gateway Council of Governments October 2010

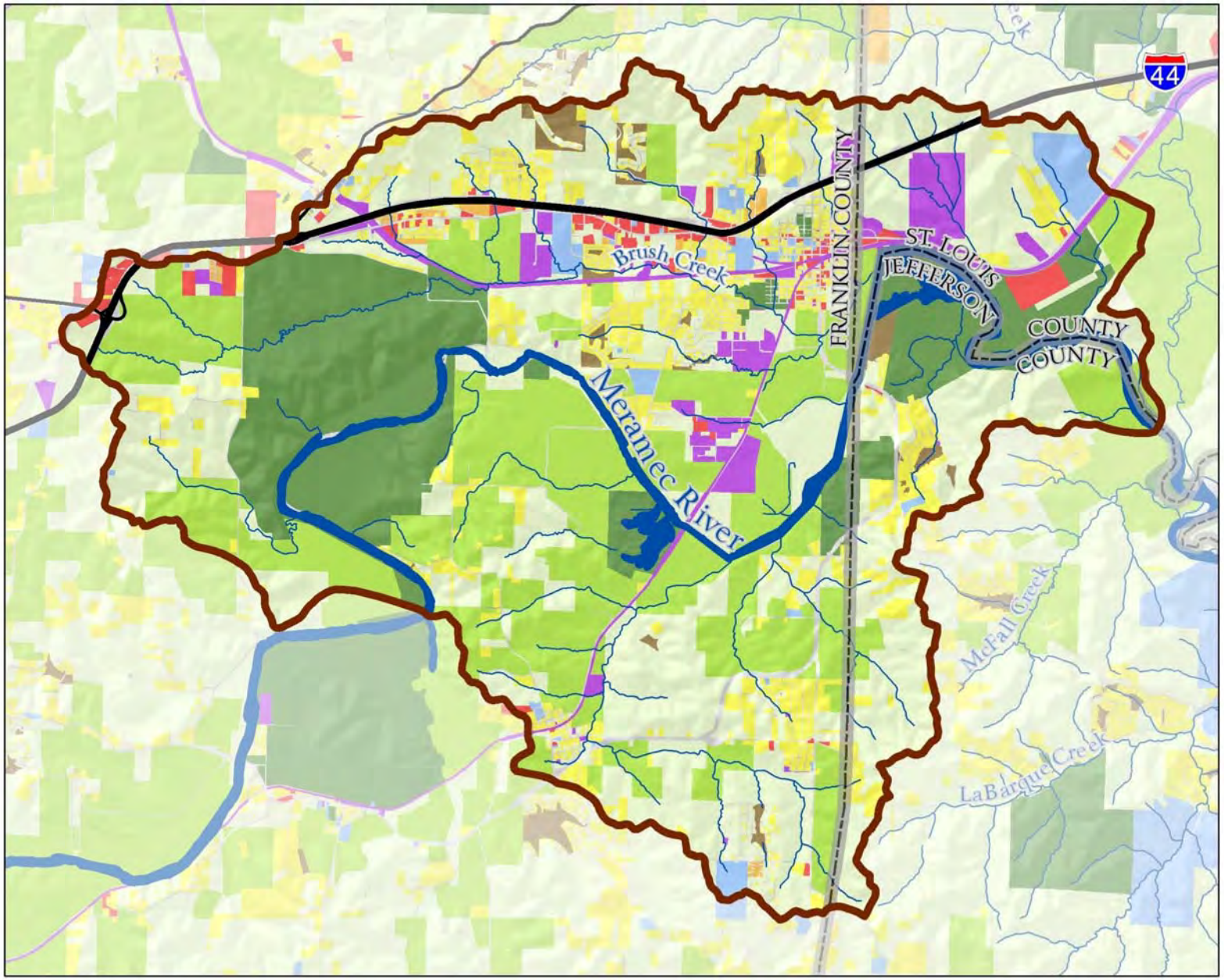
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 19



Brush Creek Watershed

Land Use (2008 parcels)

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Land Use*

- Agricultural
- Recreational
- Commercial
- Industrial
- Institutional
- Single-Family Residential
- Multi-Family Residential
- Common Ground
- Right of Way
- Vacant/Undeveloped

*Note: Land use category colors for areas outside of watershed are faded.

0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments October 2010

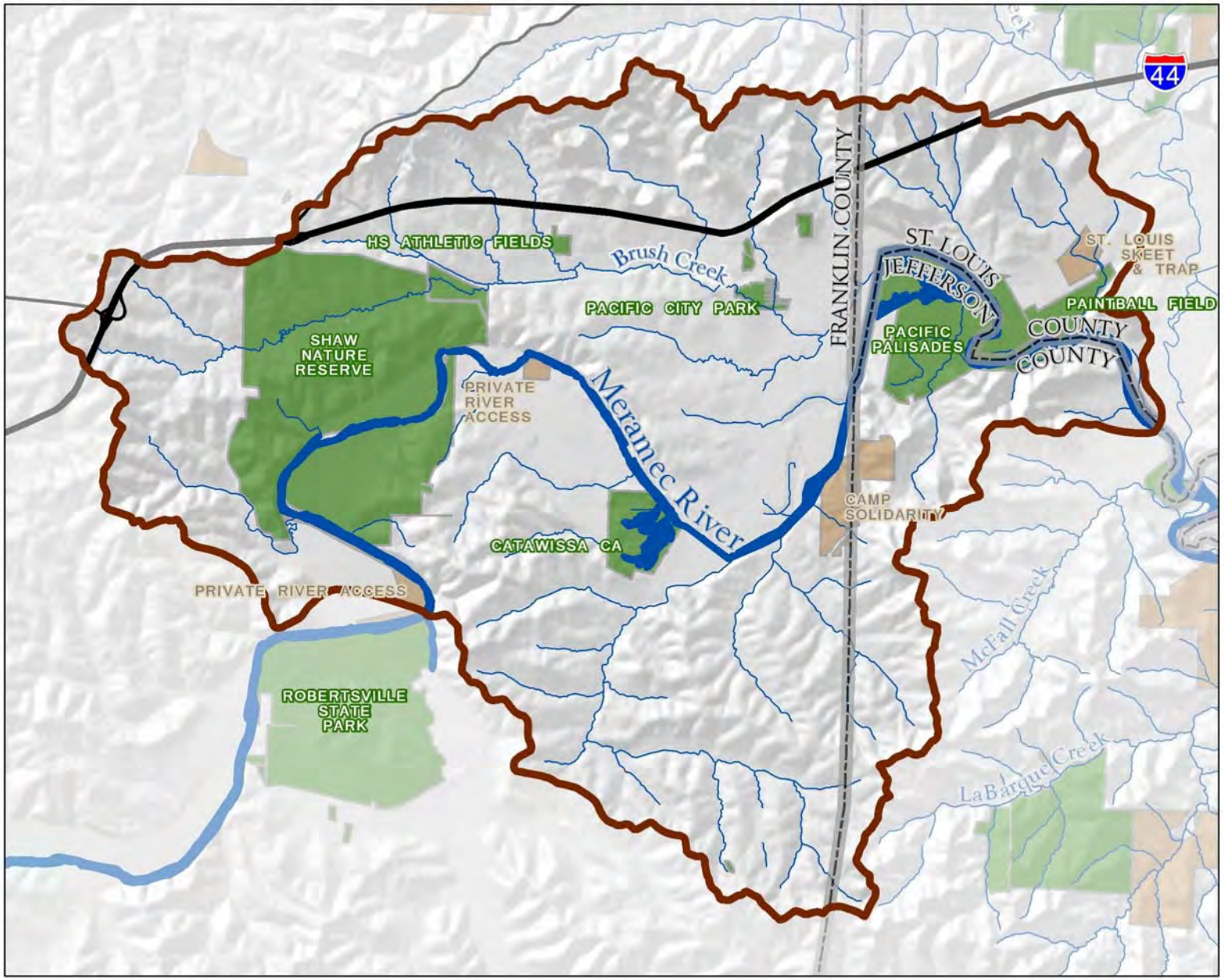
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 20



Brush Creek Watershed

Recreation & Open Space

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream
- Recreational Areas (open to the public)
- Recreational Areas (private)

0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments October 2010

The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

B. Fox Creek Sub-watershed
Fox Creek Watershed
HUC - 071401020903

Fox Creek Watershed

14,691 acres
22.9 square miles

Fox Creek - 9.77 miles
Little Fox Creek - 5.82 miles
Meramec River - 8 miles

Fox and LaBarque Creek Watersheds are a part of the same 12-digit watershed. But for the purposes of this study, EWG separated the two, because they enter the Meramec from opposite sides of the stream, sit in different counties, and have different characteristics. The Fox Creek sub-watershed, 14,691 acres or 23 square miles, is located in the western part of the study area. The majority of the watershed is in southwest St. Louis County with the remainder, adjacent to Little Fox Creek, in east central Franklin County. (See Map 21 at the end of this section) Fox Creek and Little Fox Creek are the major streams in this watershed. There also are tributaries to these creeks and land area in Eureka, which drains directly to the Meramec River.

Fox Creek enters the Meramec River 44.4 miles upstream of the confluence with the Mississippi River.

Physical Characteristics
The majority of the Fox Creek sub-watershed is made up of dissected hills and bluff lands. There are narrow ridge tops and hilly to steep slopes and valley sides. Limestone bedrock exposures are common. In the northeast portion of this sub-watershed there is limestone and chert. South of Old Route 66 there is dolomite with interbedded limestone and shale. (See Map 8) Sandstone-dolomite bedrock is in the southern portion of the watershed in area where Fox Creek enters the Meramec River. Soils can be very sandy and very permeable. Alluvium or alluvial soils are in the Meramec River valley and Fox Creek. These soils primarily consist of moderately deep, moderately well drained soils which have moderately fine to moderately coarse textures.

Approximately 48 percent of the soils have a moderately low potential for runoff to occur. The soils in this group are up to moderately deep and well drained. They have fine to coarse textures such as shallow loess or sandy loam. Approximately 36 percent of the soils in this watershed have moderate to high potential for runoff due to slow infiltration rates. Some soils are clayey or are thin. These soils are found in bluffs in the middle and southern part of the watershed. (See Map 22 and Table 29)

Approximately two-third of the land area in this sub-watershed has slopes of 10 percent or greater. The steepest slopes, 40 percent or greater, are found in the bluff areas adjacent to the Meramec River in Eureka and adjacent to the lower Fox Creek valley. Steep slopes are also found in the north and west along the drainage divide ridge lines. The gentlest slopes are along the Meramec River and the lower Fox Creek valley. (See Map 23)

Table 29
Fox Creek Watershed
Hydrologic Soil Groups

Hydrologic Soil Group	Acres	Percent Share
A	68.0	0.5
B	7,030.4	47.9
B/D	0	0
C	5,290.5	36.0
C/D	0	0
D	2,144.9	14.6
No Data	157.2	1.1
Total	14,691.0	100

Source – USDA, Natural Resource Conservation Service

Hydrologic Soil Groups
A – Low runoff potential, well drained
B – Moderately low runoff potential
C – Moderately high runoff potential
D – High runoff potential, poorly drained
No Data – Hydrologic characteristics of soil could not be determined

Population and Land Use

In Franklin County, a portion of the city of Pacific as well as unincorporated Gray Summit are in the Fox Creek sub-watershed. The majority of the sub-watershed lies within the cities of Wildwood and Eureka in St. Louis County. In 2010, it was estimated that 4,493 people lived in the Fox Creek watershed with the majority residing in Wildwood. (See Map 5)

Approximately 15 percent of the land area in this watershed can be considered developed or built up. (See Map 24) Residential development is found along the creek valleys and the northern drainage divide. There are freestanding subdivisions adjacent to State Highway 100 in Franklin and St. Louis Counties and Fox Creek Road, Model Realty Road and Hencken Road. Commercial uses primarily can be found along Interstate 44 and Old Route 66. Recreation areas make up 12 percent of the land area. (See Table 30) Public recreation areas include the 1,377acre Rockwoods Range Conservation Area, owed and operated by the MDC, and a portion of the St. Louis County Greensfelder Park. (See Map 25) The majority of the land in the watershed is in crop, grass/pasture and forested land. Much of the agricultural land is in the Meramec River valley, that portion of the Fox Creek valley south of Old Route 66 and adjacent to Little Fox Creek.

Table 30
Fox Creek Watershed Land Use

Land Use	Acres	Percent Share
Multi-Family Residential	116.1	0.8
Single-Family Residential	1,901.6	12.9
Commercial	33.7	0.2
Industrial	80.3	0.5
Institutional	35.4	0.2
Recreation	1,719.5	11.7
Common Ground	80.3	0.5
Right of Way	6.7	0
Agriculture	2,694.0	18.3
Vacant/Undeveloped	7,369.3	50.2
Unassigned	654.2	4.5
Total	14,691.0	100

Source – County GIS Departments

Note - Vacant/undeveloped land did not have any structures on it. These could be forested areas, grass or pasture or land being prepared for development. If the assessor could not identify a specific use for a property, it was placed in the unassigned category.

Stream Classification

A segment in the southeast portion of the Fox Creek sub-watershed is part of the LaBarque Creek Aquatic Conservation Opportunity Area as determined by the MDC. Conservation Opportunity Areas are priority places for protecting quality terrestrial and aquatic resources. The Conservation Opportunity framework identifies the best places where the MDC and their partners can combine technology, expertise and resources to protect areas of outstanding conservation resources that are threatened with potentially damaging development. Each Conservation Opportunity Area is to have a stakeholder team to develop a specific profile for it and determine goals and conservation actions. (See Map 10)

Starting at the mouth and extending 7.2 miles upstream, the MoDNR has classified Fox Creek as a class P stream. A class P stream maintains permanent flow in drought periods. Designated uses for this creek are: livestock and wildlife watering; protection of warm water aquatic life (general warm-water fishery) and human-health fish consumption; and Category B whole body contact recreation (no public access swimming areas). In the northeast portion of the watershed, MoDNR has classified 2 miles of a tributary of Fox Creek as a losing stream. A losing stream distributes 30 percent or more of its flow through permeable geologic materials into the bedrock aquifer below. Losing streams are associated with areas of Karst topography.

Excluding the Meramec River, no creek in this sub-watershed is on the Missouri 2010 303(d) Impaired Waters list developed by MoDNR. In turn, no TMDL has been prepared or is scheduled to be prepared for any creek in this watershed. No creeks in this watershed have been

identified by MoDNR as Outstanding National Resource Waters or Outstanding State Resource Waters.

Key Issues and Recommended Actions
Fox Creek is the site of a stream bank mitigation project, which was one of the first of its kind. Currently, changes in that project have created significant barriers to fish passage in the lower creek and should be monitored. If functioning to deny fish passage, these structures should be removed and alternative strategies for controlling erosion should be established.

Significant development is expected in the watershed especially on Historic Highway 66 and along Interstate 44. No special project sites were identified at this time, but monitoring, especially by stream teams, should continue to track any reduction in water quality. Development needs to be accompanied by aggressive control of stormwater runoff, in order to protect this relatively healthy stream. Local government ordinances can contribute to effective development.

Wastewater Treatment and Drinking Water
In the Fox Creek sub-watershed, the State of Missouri has issued eight NPDES permits for the discharge of treated wastewater to creeks and the Meramec River. (See Map 6 and tables in Appendix A) One permit is for a church and another for a fire station. The remainder of the permits have been issued for freestanding residential areas. It is estimated that 757 housing units in this watershed utilize individual sewage disposal systems (septic tanks). Additional NPDES permits have been issued for land disturbance and stormwater management in this watershed but have not been inventoried for purposes of this study.

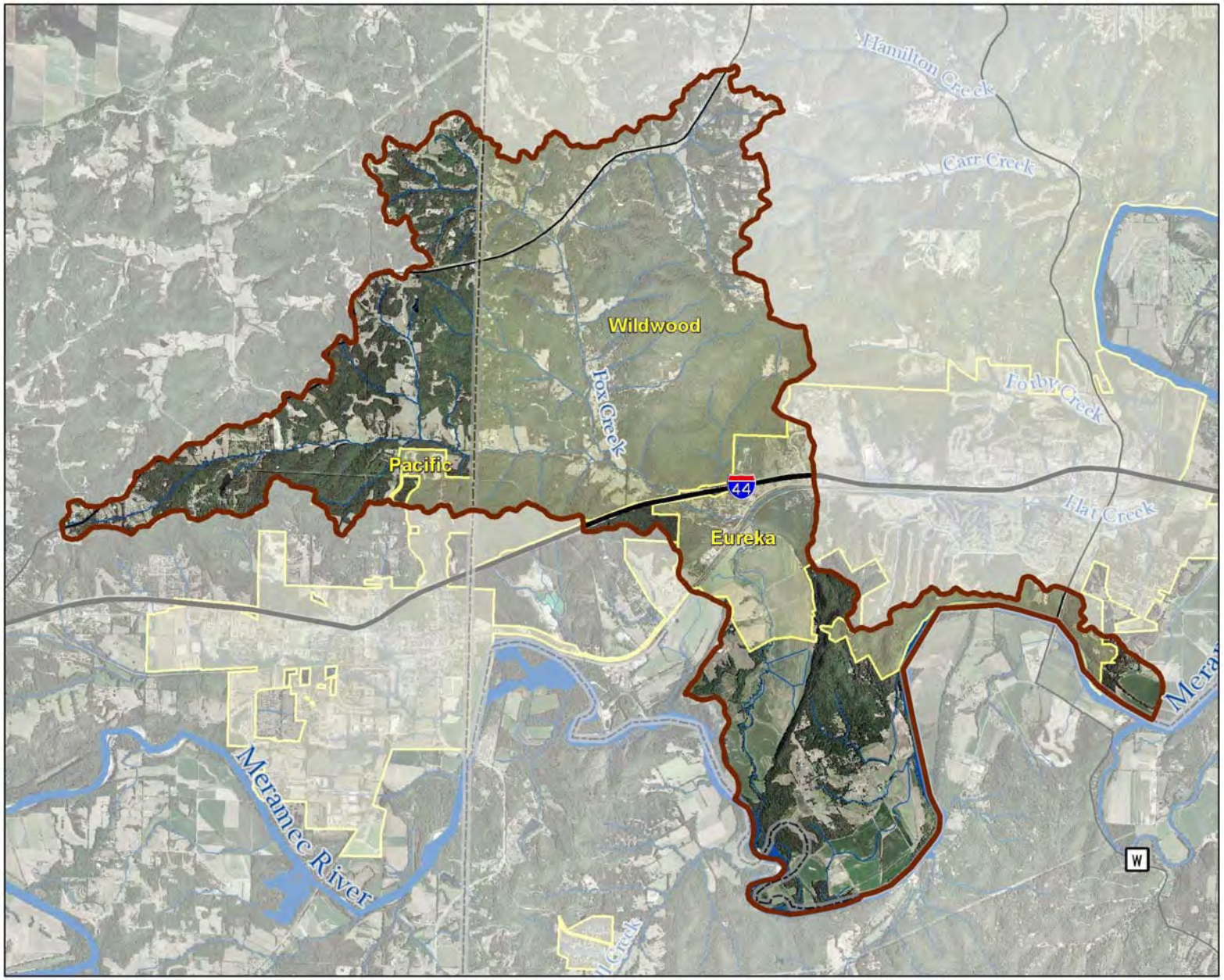
In the entire Fox Creek watershed (Fox Creek and LaBarque Creek sub-watersheds) there are 687 private wells. There are five public groundwater supply systems in the Fox Creek sub-watershed. (See Table 31) Two are community water systems serving the same people year round associated with freestanding residential areas. The remaining water systems serve a non-profit organization, a commercial campground and a motel.

Table 31
Fox Creek Watershed Public Drinking Water Systems

Drinking Water System	Population Served	Number Of Wells	County
AL-PAC Homeless Shelter	NA	1	St. Louis
Holiday Inn at Six Flags	65	1	St. Louis
Jellystone Park Campground	25	1	St. Louis
Franklin County Public Water & Sewer District #3 (FCPWSD#3) 1 site	NA	2	Franklin
Franklin County Public Water & Sewer District #3 (FCPWSD#3) 1 site	NA	1	Franklin

NA – Not Available
Population Served - U.S. Environmental Protection Agency, Safe Drinking Water Information System, 2011
Number of Wells - Center for Applied Research and Environmental Systems (CARES) University of Missouri-Columbia, Watershed Evaluation and Comparison Tools based on 2004 source water protection area information from the Missouri Department of Natural Resources
One source water protection area was assumed to represent one well

Map 21



Fox Creek Watershed

Aerial Photograph (2007)

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Incorporated Area, 2009

N 0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments October 2010

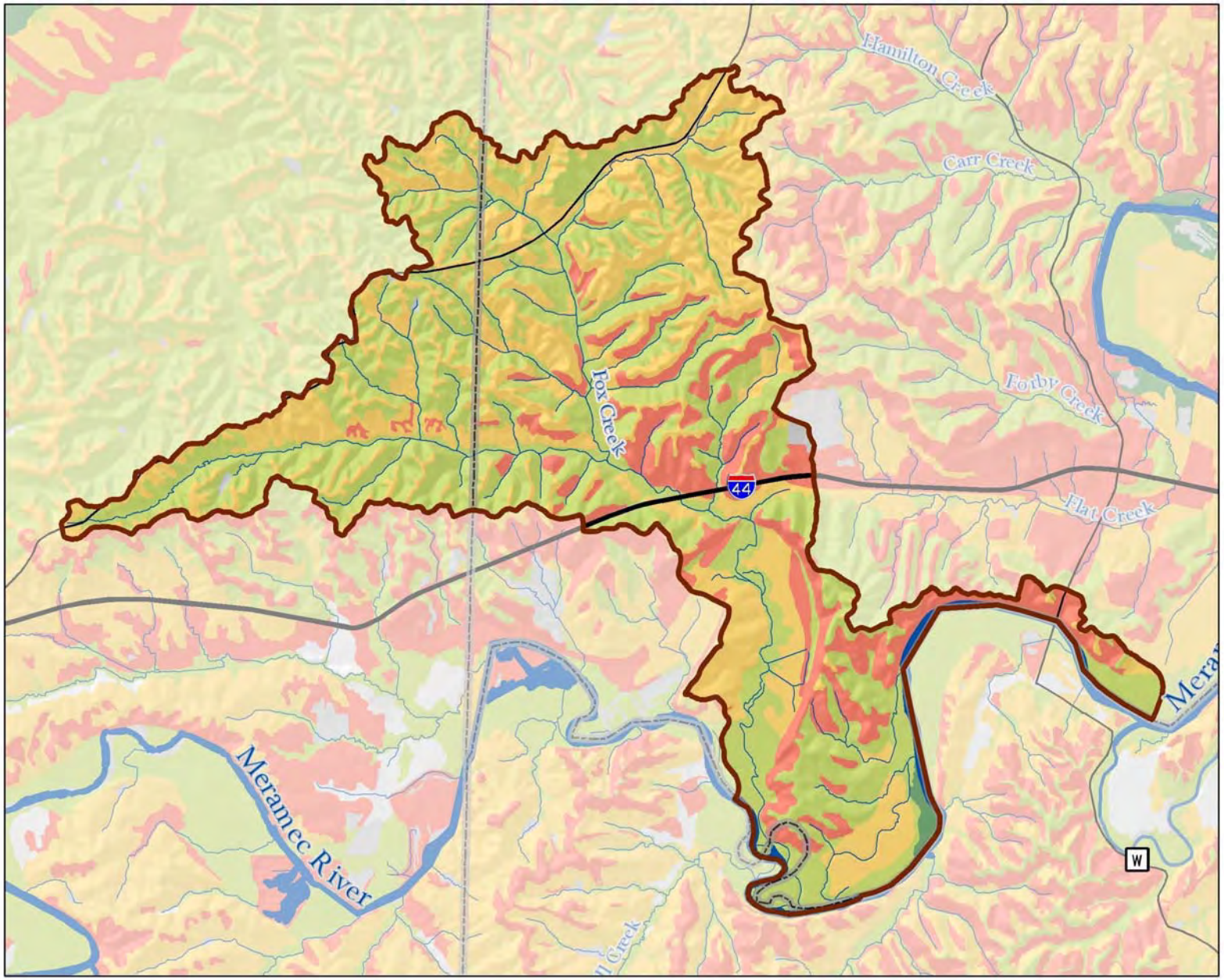
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 22



Fox Creek Watershed

Soil Hydrologic Group & Runoff Potential

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Hydrologic Group - Runoff Potential

- A - Low
- B - Moderately Low
- C - Moderately High
- D - High
- No Data

0 0.5 1 2 Miles

Sources: USDA-NRCS,
East-West Gateway Council of Governments
October 2010

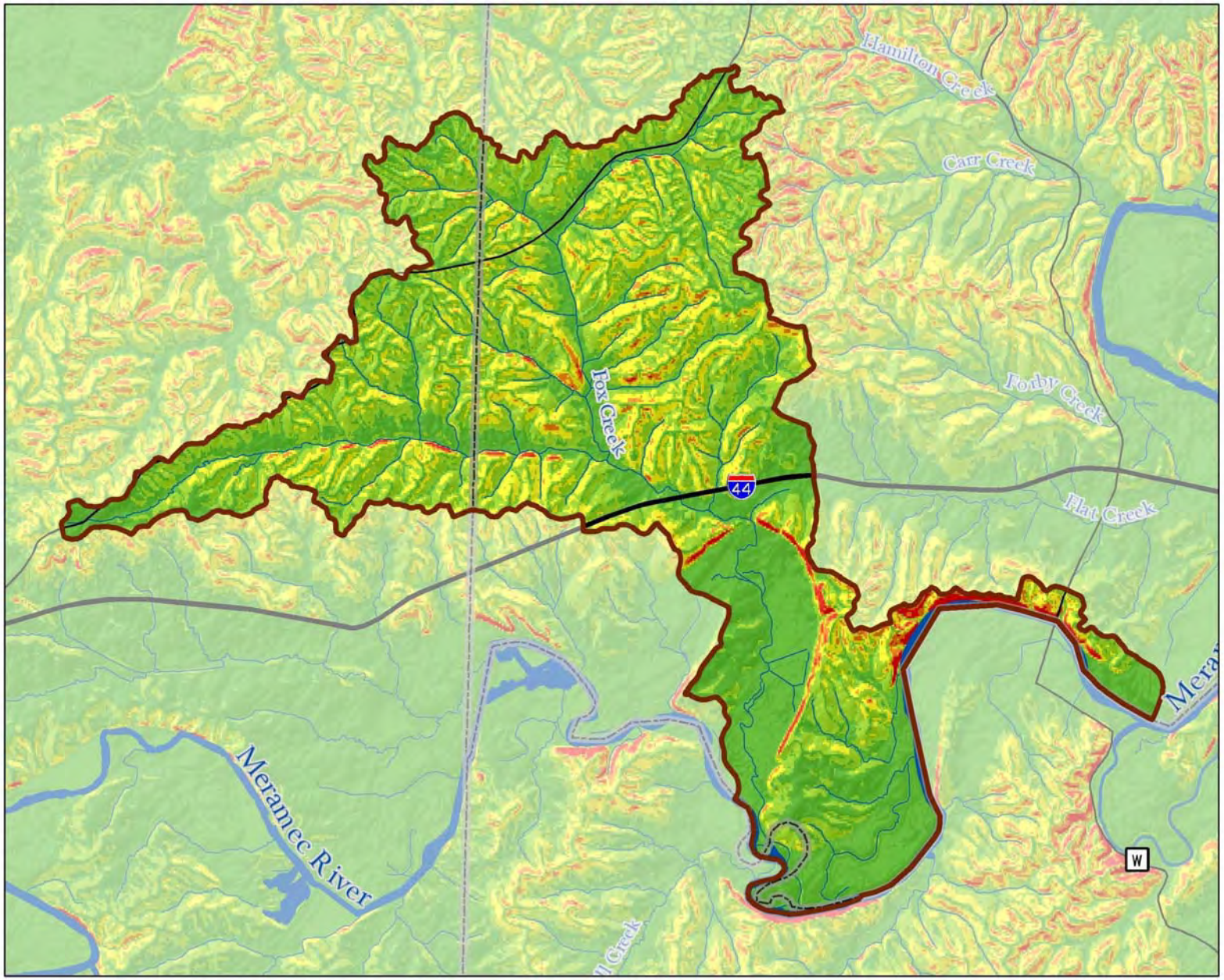
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 23



Fox Creek Watershed

Steep Slopes

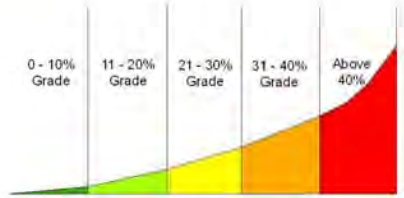
Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Slope Values

- 0 - 10%
- 11 - 20%
- 21 - 30%
- 31- 40%
- Above 40%



0 0.5 1 2 Miles

Sources: US Geological Survey, East-West Gateway Council of Governments October 2010

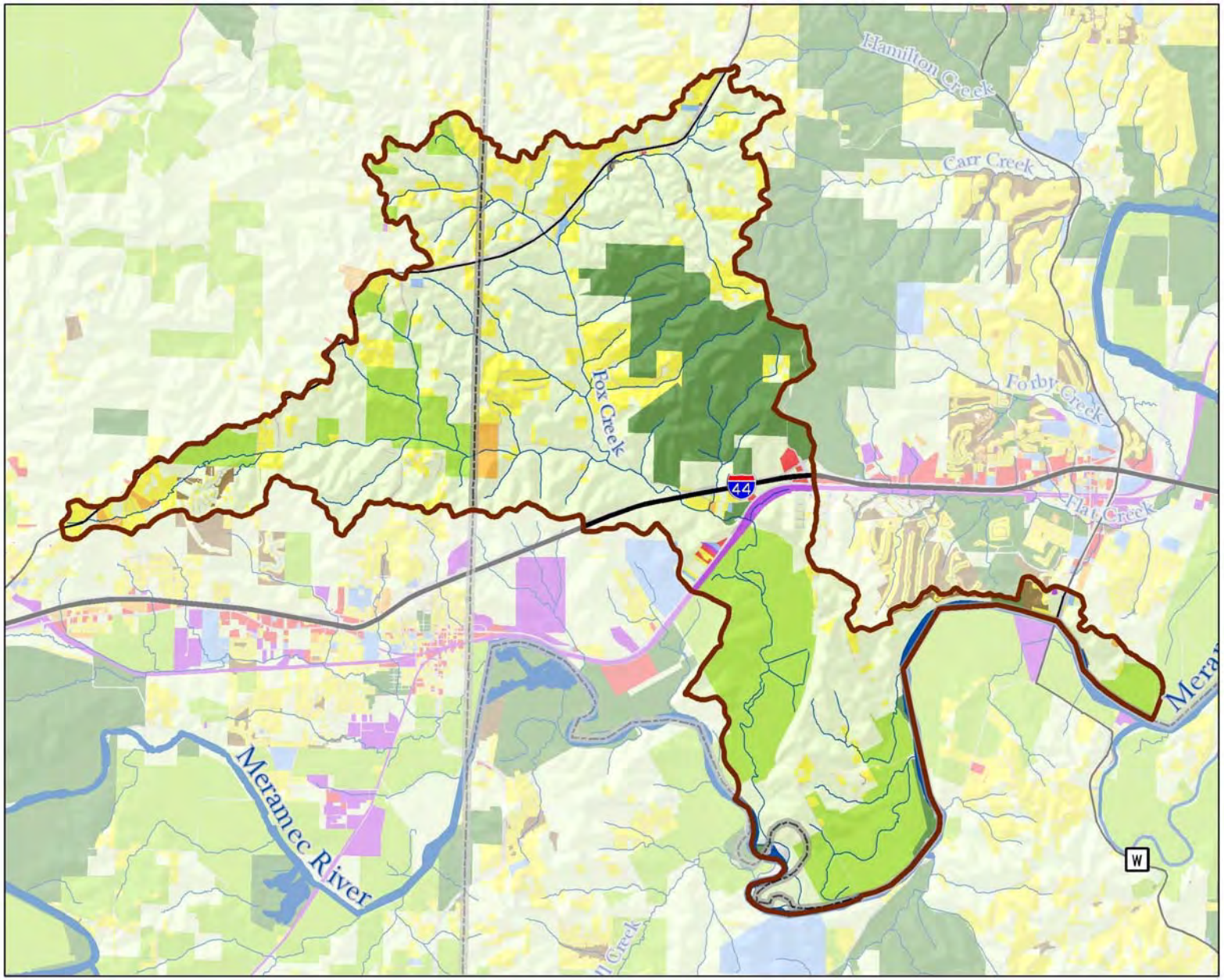
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 24



Fox Creek Watershed

Land Use (2008 parcels)

Legend

Basemap Elements
- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Land Use*
- Agricultural
- Recreational
- Commercial
- Industrial
- Institutional
- Single-Family Residential
- Multi-Family Residential
- Common Ground
- Right of Way
- Vacant/Undeveloped

*Note: Land use category colors for areas outside of watershed are faded.

0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments
October 2010

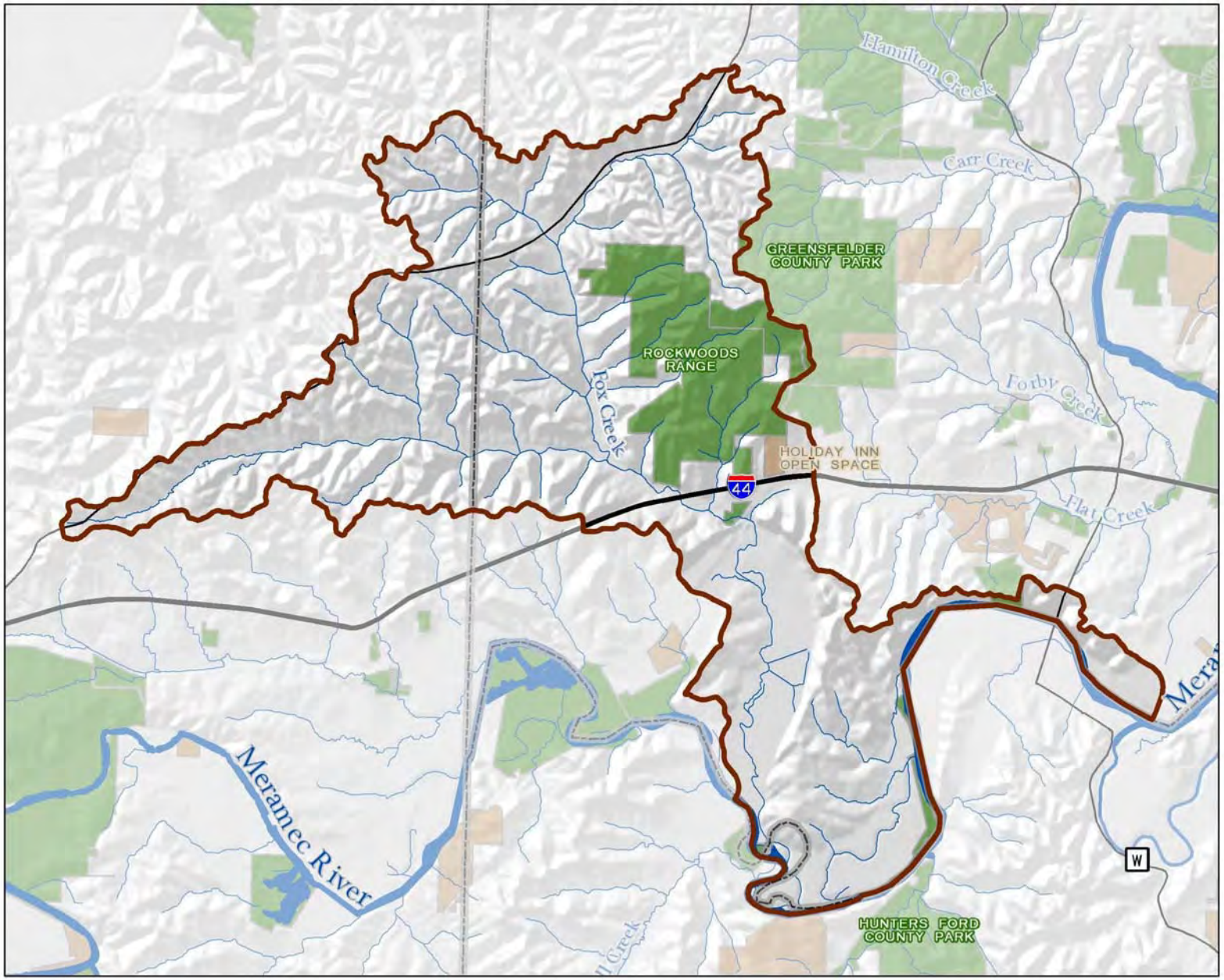
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 25



Fox Creek Watershed

Recreation & Open Space

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

- Recreational Areas (open to the public)
- Recreational Areas (private)

N

0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments
October 2010

The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

On the Al Foster Memorial Trail (Great Rivers Greenway)

Bicyclist on the Al Foster Memorial Trail (Great Rivers Greenway)

C. LaBarque Creek Sub-watershed
Fox Creek Watershed
HUC - 071401020903

LaBarque Creek Watershed

13,510 acres
21.1 square miles

LaBarque Creek - 6.22 miles
McFall Creek - 3.54 miles
Meramec River - 8 miles

Part of the Fox/LaBarque Watershed, the LaBarque Creek Sub-watershed, 13,510 acres or 21.1 square miles, is located in the southwest part of the study area. This entire watershed is located in northwest Jefferson County. LaBarque Creek and McFall Creek are the major streams in this watershed. There also are tributaries to these creeks and smaller streams and land areas which drain directly to the Meramec River. (See Map 26 at the end of this section)

LaBarque Creek enters the Meramec River 41.9 miles upstream of the confluence with the Mississippi River. The LaBarque Creek sub-watershed has been the focus of a major watershed planning effort that involves the residents and local government along with agencies in developing strategies to protect this healthy stream. McFall Creek enters the Meramec near the Swiftwater Bend Access Point (approximately 45 miles from the mouth of the Meramec River).

Physical Characteristics

The LaBarque Creek sub-watershed consists of dissected hills and blufflands. There are narrow ridgetops and hilly to steep slopes and valley sides. Limestone bedrock exposures are common. (See Map 8) Sandstone-dolomite bedrock is prevalent in the McFall Creek sub-sub-watershed and the LaBarque Creek valley. It is found in approximately 40 percent of the watershed. Soils can be very sandy and very permeable. The steeper slopes are underlain by limestone and dolomite with inter-bedded shale. Alluvium or alluvial soils are in the Meramec River valley and the major creeks. These soils have low potential for runoff due to their moderate infiltration rates. The gentlest slopes are adjacent to Meramec River and creek valleys.

Approximately 83 percent of the soils in this watershed have moderate to high potential for runoff due to slow infiltration rates. Some soils have layers near the surface which limit the downward movement of water or are clayey or are thin soils over bedrock. (See Map 27 and Table 32)

The steepest slopes, 40 percent or greater, are found in the bluff area on the south side of the Meramec River between where McFall Creek and LaBarque Creek enter the Meramec River. This area is also known as the Buder Bluffs. A majority of the land in this watershed has slopes of 10 percent or greater. (See Map 28)

Table 32
LaBarque Creek Watershed
Hydrologic Soil Groups

Hydrologic Soil Group	Acres	Percent Share
A	7.1	0.1
B	2,081.4	15.4
B/D	87.3	0.6
C	6,003.2	44.4
C/D	130.4	1.0
D	4,995.6	37.0
No Data	205.0	1.5
Total	13,510.0	100

Source – USDA, Natural Resource Conservation Service

Hydrologic Soil Groups
A – Low runoff potential, well drained
B – Moderately low runoff potential
C – Moderately high runoff potential
D – High runoff potential, poorly drained
No Data – Hydrologic characteristics of soil could not be determined

Population and Land Use

In the northwest portion of this sub-watershed is the recently incorporated village of Lake Tekakwitha, population 254. In 2010, it was estimated that 3,217 people resided in the LaBarque Creek sub-watershed. (See Map 5)

Approximately 22 percent of the land area in this sub-watershed can be considered developed or built up. (See Map 29 and Table 33) Individual residences are dispersed throughout the watershed, especially along or adjacent to State Highway FF and State Highway F. Publicly owned recreation land makes up 12 percent of the watershed. These areas include the 810 acres LaBarque Creek Conservation Area in the upper portion of the watershed and the 1145 acre Young Conservation Area near the mouth of LaBarque Creek. (See Map 30) Institutional land in this sub-watershed is primarily forested/open space. An additional 750 acres has been pledged to the MoDNR for a future State Park. And as this report is being developed the MDC is working to acquire several hundred additional acres. Over 75 percent of the watershed is in crop, grass/pasture and forested land. Much of the agricultural land can be found in the Meramec River valley and McFall Creek.

Table 33
LaBarque Creek Watershed Land Use

Land Use	Acres	Percent Share
Multi-Family Residential	0	0
Single-Family Residential	1,752.8	13.0
Commercial	6.6	0
Industrial	87.2	0.6
Institutional	1,136.7	8.4
Recreation	1,569.4	11.6
Common Ground	66.4	0.5
Right of Way	0	0
Agriculture	1,979.9	14.7
Vacant/Undeveloped	6,553.7	48.5
Unassigned	357.3	2.6
Total	13,510.0	100

Source - County GIS Departments
Note - Vacant/undeveloped land did not have any structures on it. These could be forested areas, grass or pasture or land being prepared for development. If the assessor could not identify a specific use for a property, it was placed in the unassigned category.

Stream Classification
The MDC has identified the 13 square mile LaBarque Creek sub-watershed as both an Aquatic and a Terrestrial Conservation Opportunity Area (COA). The Terrestrial COA also extends into the McFall Creek watershed and the watershed of the Big River. The Aquatic COA crosses the Meramec River and includes a portion of the Fox Creek watershed. The LaBarque Creek watershed demonstrates a healthy and functioning landscape near a highly urbanized region. This permanently flowing stream supports 42 species of fish. Conservation Opportunity Areas are priority places for protecting quality terrestrial and aquatic resources. The Conservation Opportunity framework identifies the best places where the Missouri Department of Conservation and their partners can combine technology, expertise and resources to protect areas of outstanding conservation resources that are threatened with potentially damaging development. Each Conservation Opportunity Area has a stakeholder team to develop a specific profile for it and determine goals and conservation actions. (See Map 10)

Extending 4.5 miles upstream from the mouth of LaBarque Creek, the Missouri Department of Natural Resources (MoDNR) has classified it as a class P stream. A class P stream maintains permanent flow during dry periods. Designated uses for this creek are: livestock and wildlife watering; protection of warm water aquatic life (general warm-water fishery) and human-health fish consumption; and Category B whole body contact recreation (no public access swimming areas).

Excluding the Meramec River, no creek in this sub-watershed is on the Missouri 2010 303(d) Impaired Waters list developed by MoDNR. In turn, no Total Maximum Daily Load (TMDL) has been prepared or is scheduled to be prepared for any creek in this watershed.

In November 2010 the LaBarque Creek sub-watershed was nominated by the LaBarque Creek Stream Team for classification as Outstanding State Resource Water by the Missouri Clean Water Commission. An Outstanding State Resource Water has a high level of aesthetic or scientific value, has an undeveloped watershed and is located or passes through lands which are state or federally owned or which are leased or held in perpetual conservation easement. This request and associated data is under review by MoDNR. Members of the Friends of LaBarque Creek, who manage the watershed plan are divided on the value or such a designation and have requested that the proposal be set-aside for the time being.

Issues to Address

In the LaBarque Creek watershed, a 9-year planning effort concluded in 2009 with a watershed plan to protect a healthy stream and defined the following Vision and Goals:

> The LaBarque Creek Vision Statement: (developed by watershed residents)
> *In 2025, healthy forests and glades blanket the hillsides, diverse native plants and wildlife thrive, clear streams spill over rock formations and flow through valleys, and countless bright stars touch the horizon at night over homes nestled in the natural contours of the watershed.*
>
> **Goals of the LaBarque Creek Watershed Plan:**
> I. Conserve the unique natural resources of the watershed by maintaining aquatic and terrestrial health and diversity, water quality and quantity, and habitat connectivity.
> II. Where development occurs, promote design that conserves watershed natural resources, community character, and a sense of place.
> III. Preserve a high level of quality public and semi-public infrastructure and services.
> IV. Foster a partnership among citizens, local governments, state government, non-governmental organizations, regional initiatives, and agencies.

The LaBarque Creek Watershed plan was signed by a number of partnering organizations in 2009, and today the Friends of LaBarque Creek, a non-profit organization made up primarily of residents of the watershed, are working to implement education and action strategies to protect stream quality. The LaBarque Plan is "owned" by the residents of the watershed and they continue with self education and education of neighbors. And the residents have begun to take action to address non-point source run off on private property. The local governments, especially Jefferson County should continue education and outreach to the residents and support further efforts to mobilize private actions on behalf of maintaining water quality. Sediment is identified as a major concern in the watershed, and there is significant risk of septic system contamination since over 90 percent of residences have individual sewage disposal systems.

Recommended Projects:

1. **The College School –Composting toilet**
   The College School (TCS) has acquired property in the LaBarque Creek watershed at the confluence of Sand Creek and LaBarque Creek. The school has an interest in developing the site with maximum protection of water quality and using the site for educational purposes. The TCS faculty have recommended using composting toilets instead of an in ground septic system in order to accommodate large numbers of students on an occasional basis. Such a system could provide demonstration of effective alternative to a septic system or lagoon treatment, and also reduce risk of pollution from bacteria. This proposed approach is especially useful for a site where no one will be present much of the time, and when students are present they will be in large numbers (20-30), which could risk over-taxing a typical treatment system.
2. **Future DNR State Park**
   MoDNR should work closely with area residents in planning the new state park. Specific actions are needed in the future park site to eliminate ATV traffic that is causing significant erosion, to restore eroded trails and protect sensitive areas. A plan should be developed before any actions are taken to change the makeup of the plant communities in the future park, and that the plan include extensive use of permeable pavement and micro detention to minimize runoff as the park site is developed. It is expected that this plan will be completed in the short term and could begin implementation in mid term.

Wastewater Treatment and Drinking Water

In the LaBarque Creek sub-watershed, the State of Missouri has issued three NPDES permits for the discharge of treated wastewater to creeks and the Meramec River**.** (See Map 6 and tables in Appendix A) The Mirasol Wastewater Treatment Facility, Jefferson County Sewer District, has a permit to discharge to the Meramec River. The other two permits have been issued for a freestanding subdivision and a nursing home operated by the Franciscan Missionary Brothers. It is estimated that 1,203 housing units in this watershed utilize individual sewage disposal systems (septic tanks). Additional NPDES permits have been issued for land disturbance and stormwater management in this watershed but have not been inventoried for purposes of this study.

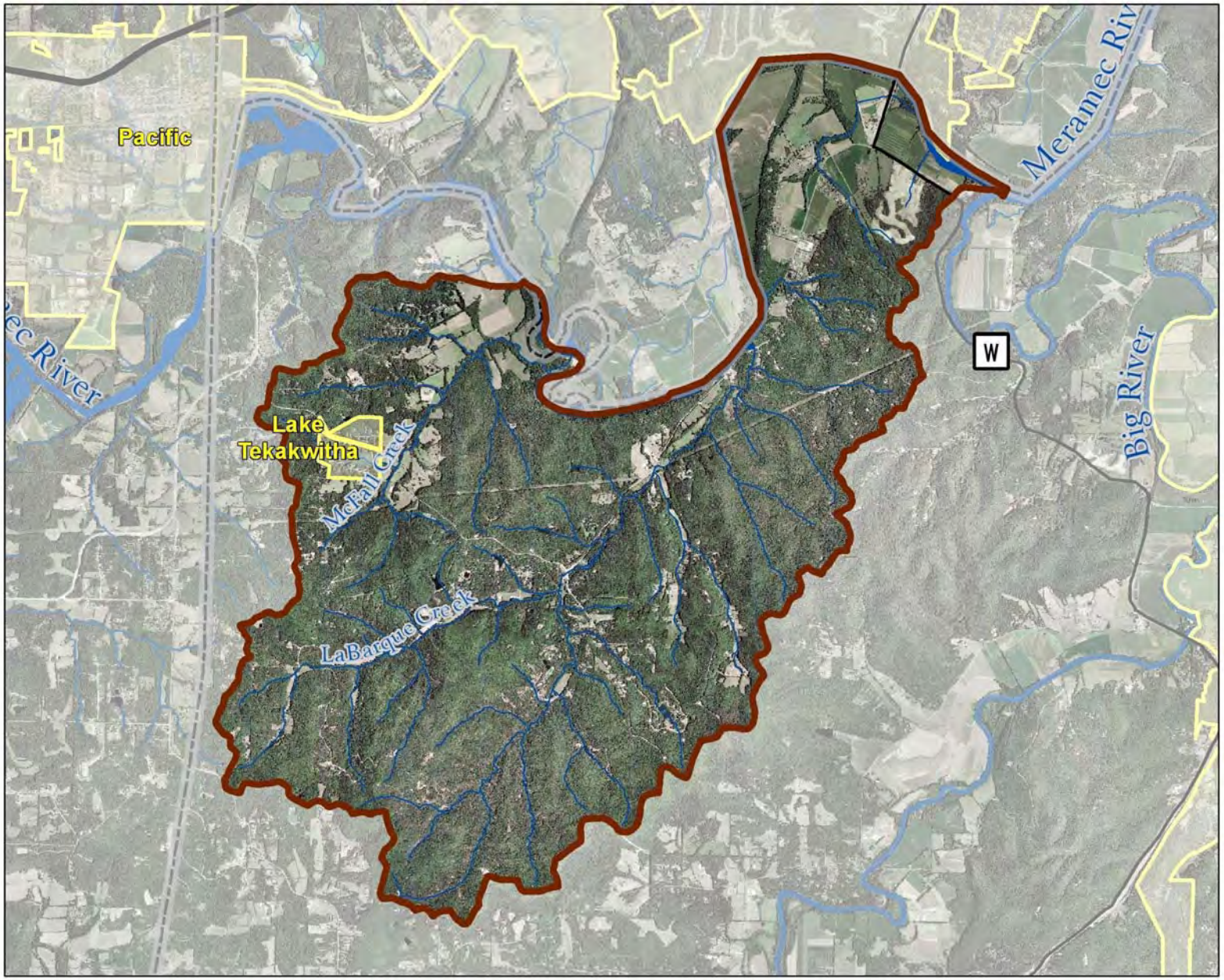
There are 687 private wells in the entire Fox Creek watershed (Fox and LaBarque Creek sub-watersheds). In the LaBarque Creek sub-watershed there are four public groundwater supply systems. (See Table 34) The three community water systems serving the same people year round and are associated with freestanding residential areas. The other water system is for a nursing home operated by the Franciscan Missionary Brothers.

Table 34
LaBarque Creek Watershed Public Drinking Water Systems

Drinking Water System	Population Served	Number Of Wells	County
Block Six Water Association (Subdivision)	50	1	Jefferson
Lakewood Hills Subdivision	400	2	Jefferson
St. Joseph's Hill Infirmary	NA	1	Jefferson
South Shore Water Association (Subdivision)	75	1	Jefferson

NA – Not Available
Population Served - U.S. Environmental Protection Agency, Safe Drinking Water Information System, 2011
Number of Wells - Center for Applied Research and Environmental Systems (CARES) University of Missouri-Columbia, Watershed Evaluation and Comparison Tools based on 2004 source water protection area information from the Missouri Department of Natural Resources.
One source water protection area was assumed to represent one well

Map 26



LaBarque Creek Watershed

Aerial Photograph (2007)

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream
- Incorporated Area, 2009

0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments October 2010

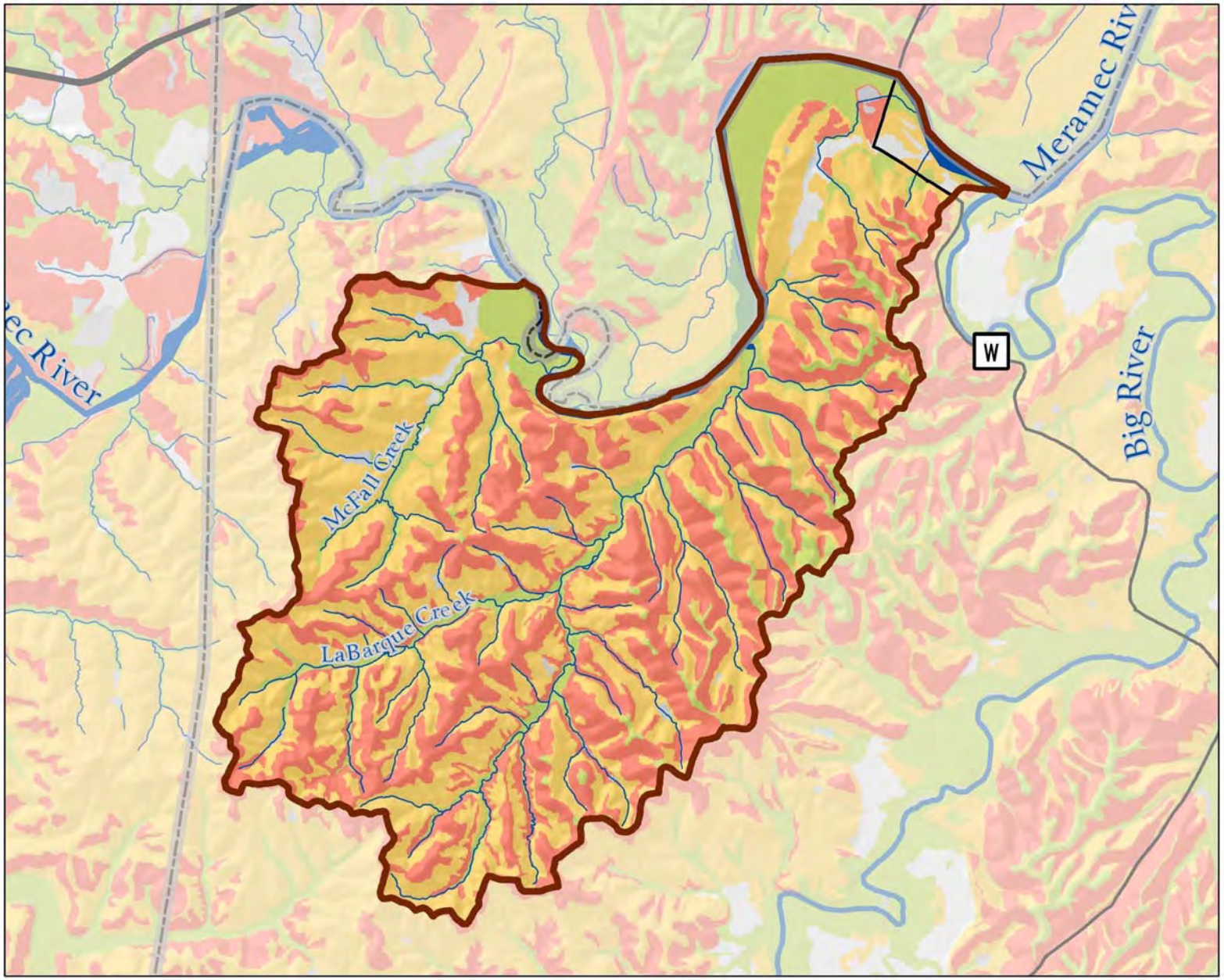
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 27



LaBarque Creek Watershed

Soil Hydrologic Group & Runoff Potential

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Hydrologic Group - Runoff Potential

- A - Low
- B - Moderately Low
- C - Moderately High
- D - High
- No Data

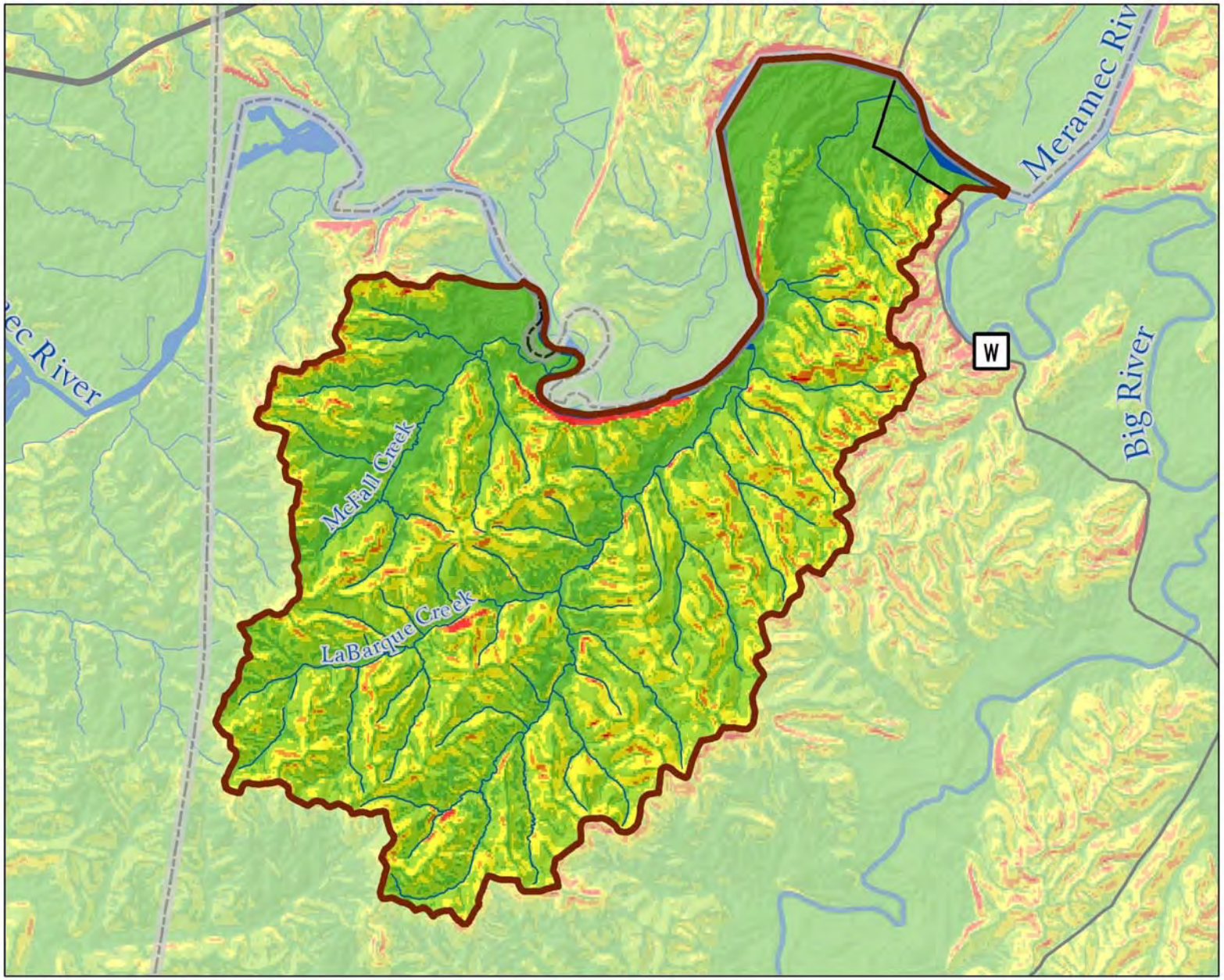
0 0.5 1 2 Miles

Sources: USDA-NRCS,
East-West Gateway Council of Governments
October 2010

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 28



LaBarque Creek Watershed

Steep Slopes

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Slope Values

- 0 - 10%
- 11 - 20%
- 21 - 30%
- 31- 40%
- Above 40%

0 0.5 1 2 Miles

Sources: US Geological Survey,
East-West Gateway Council of Governments
October 2010

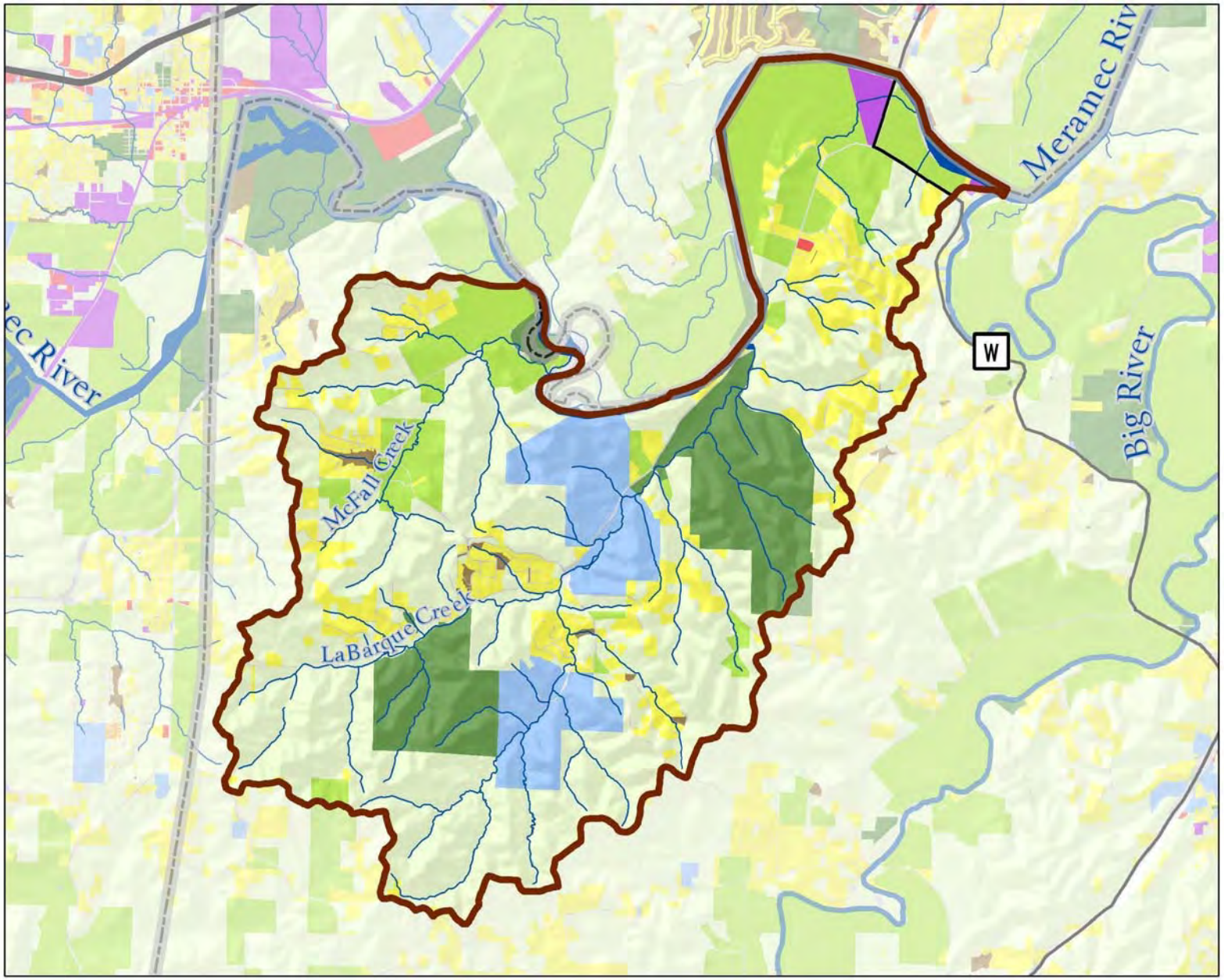
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 29



LaBarque Creek Watershed

Land Use (2008 parcels)

Legend

Basemap Elements
- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Land Use*
- Agricultural
- Recreational
- Commercial
- Industrial
- Institutional
- Single-Family Residential
- Multi-Family Residential
- Common Ground
- Right of Way
- Vacant/Undeveloped

*Note: Land use category colors for areas outside of watershed are faded.

0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments
October 2010

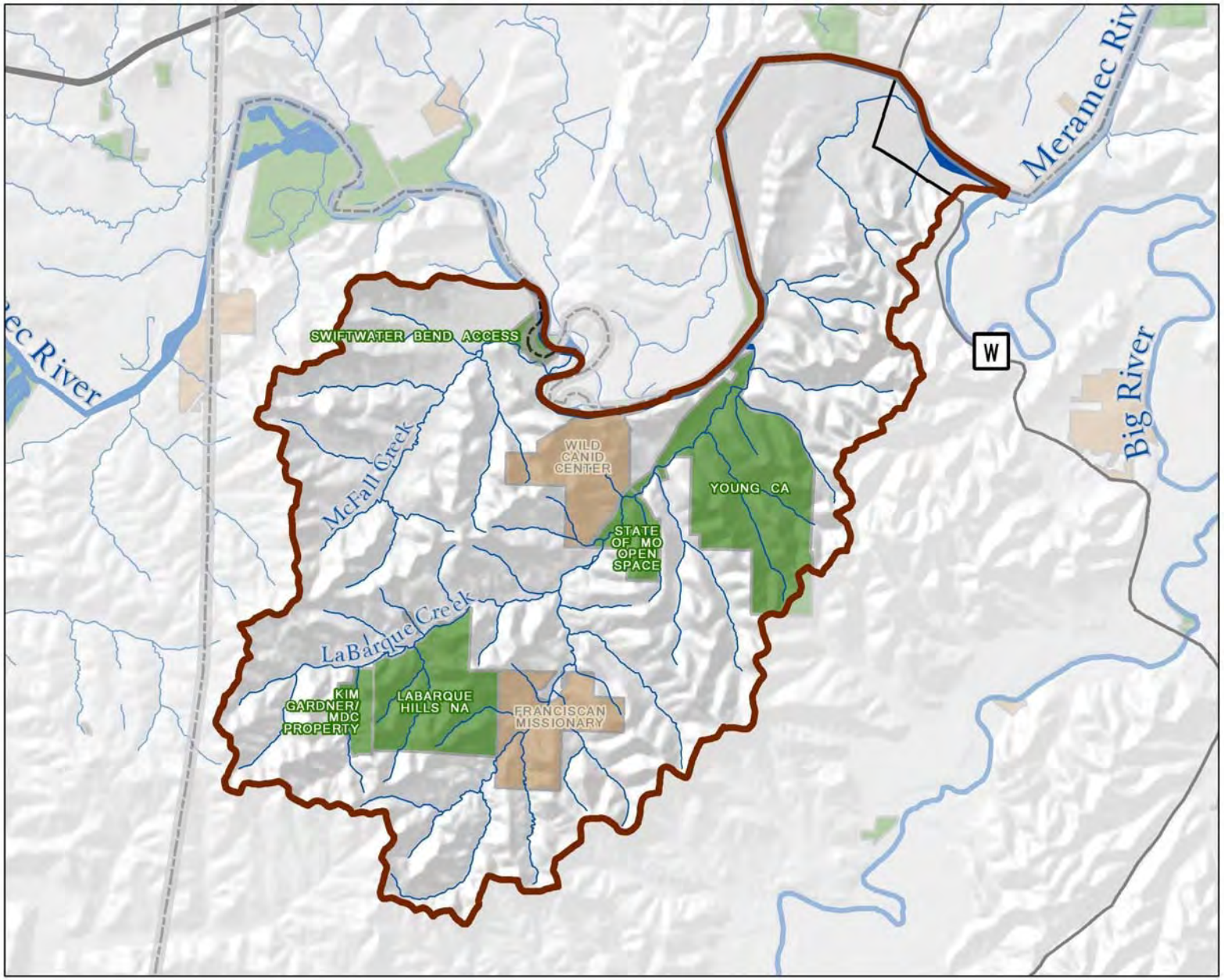
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 30



LaBarque Creek Watershed

Recreation & Open Space

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream
- Recreational Areas (open to the public)
- Recreational Areas (private)

0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments
October 2010

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Rock Hollow Trailhead (Great Rivers Greenway)

Rock Hollow Trail (Great Rivers Greenway)

D. Hamilton Creek Watershed
HUC - 0714001021001

The Hamilton Creek watershed, 34,956 acres or 54.62 square miles, is located in the western part of the study area. It is the largest watershed in this study area. The majority of the watershed is in southern St. Louis County and the remainder is in north central Jefferson County. (See Map 31 at the end of this section) Hamilton, Carr, Flat, Forby and Kiefer Creeks are north of the Meramec River. Carr Creek is a tributary of Hamilton Creek. Antire Creek is on the southern side of the Meramec River. There also are tributaries to these creeks and smaller streams and land areas which drain directly to the Meramec River.

Hamilton Creek Watershed

34,956 acres
54.62 square miles

Hamilton Creek - 4.77 miles
Carr Creek - 4.0 miles
Flat Creek - 4.0 miles
Forby Creek - 3.0 miles
Kiefer Creek - 4.63 miles
Spring Branch Kiefer Creek - 3.13 miles
Antire Creek - 7.35 miles
Little Antire Creek - 3.98 miles
Meramec River - 13.56 miles

Kiefer Creek enters the Meramec River in Castlewood State Park, 24 miles upstream of the confluence with the Mississippi River. Hamilton Creek enters the Meramec near the Glencoe area of Wildwood, 30 miles upstream. Flat Creek enters the Meramec in Eureka approximately 31 miles upstream. Antire Creek enters the Meramec River near Route 66 State Park.

Physical Characteristics

The majority of the Hamilton Creek sub-watershed is made up of dissected hills and blufflands. There are narrow ridgetops and hilly to steep slopes and valley sides. Limestone bedrock exposures are common (See Map 8). Sandstone-dolomite is in the valley of the Meramec River and Flat and Forby Creeks. Soils can be very sandy and permeable. Alluvium or alluvial soils are in the valleys of the Meramec River and creeks within the watershed. These soils primarily consist of moderately deep, moderately well drained soils which have moderately fine to moderately coarse textures. These soils have low run-off potential due to their moderate infiltration rates.

Approximately 59 percent of the soils in this watershed have moderate to high potential for runoff to occur due to slow infiltration rates. Some soils have layers near the surface which limit the downward movement of water or are clayey or are thin soils over bedrock. (See Map 32 and Table 35)

Approximately 64 percent of the land area in this watershed has slopes of 10 percent or greater The steepest slopes, 40 percent or greater, are found along the drainage divides of the major creeks and their tributaries. Gentle slopes are present in the Meramec River Valley and valleys of the major creeks. (See Map 33)

Table 35
Hamilton Creek Watershed
Hydrologic Soil Groups

Hydrologic Soil Group	Acres	Percent Share
A	385.8	1.1
B	12,730.2	36.4
B/D	18.4	0.1
C	9,702.6	27.8
C/D	41.8	0.1
D	10,802.2	30.9
No Data	1,275.0	3.6
Total	34,956.0	100

Source – USDA, Natural Resource Conservation Service

Hydrologic Soil Groups
A – Low runoff potential, well drained
B – Moderately low runoff potential
C – Moderately high runoff potential
D – High runoff potential, poorly drained
No Data – Hydrologic characteristics of soil could not be determined

Population and Land Use

Portions of Eureka, Wildwood, Ellisville, Ballwin and Brynes Mill are in the Hamilton Creek watershed. The village of Peaceful Village in Jefferson County is completely within this watershed. Unincorporated High Ridge is in the southern part of the watershed. In 2010, it is estimated that 31,901 people lived in the Hamilton Creek watershed with the majority residing in incorporated areas. (See Map 5)

Approximately 28 percent of the land area in this watershed can be considered developed or built up. Concentrated residential areas can be found in Eureka, Wildwood, Ellisville and Ballwin. (See Map 34 and Table 36) There are freestanding subdivisions adjacent to Highway 109, Old State Road and Kiefer Creek Road in St. Louis County and Antire Road and Beaumont Scout Road in Jefferson County. Individual residences are located throughout the watershed primarily along the major ridgelines. Commercial uses are concentrated along Interstate 44 in Eureka and Manchester Road in Ellisville. Lands in recreation use make up 12,439 acres (or 36 percent) of the total acreage in the Hamilton Creek watershed. There are a number of municipal and St. Louis County and Jefferson County parks in this watershed as well as Castlewood State Park and Route 66 State Park. (See Map 35) Also in the Hamilton Creek watershed are the Rockwoods Reservation (1,900 acres) and the Klamberg Woods Conservation Area north of the Meramec River, managed by MDC. A portion of the Forest 44 Conservation Area, south of the Meramec River, is also in this watershed. The recreation lands are found in the western and eastern portions of the watershed. Agricultural land can be found in the Meramec River valley and the

side valleys of the major streams. The remainder of the land in the watershed is in grass/pasture or forested land.

Table 36
Hamilton Creek Watershed Land Use

Land Use	Acres	Percent Share
Multi-Family Residential	229.7	0.7
Single-Family Residential	6,370.5	18.2
Commercial	381.2	1.1
Industrial	928.9	2.7
Institutional	608.9	1.7
Recreation	12,438.6	35.6
Common Ground	1,306.5	3.7
Right of Way	35.8	0.1
Agriculture	1,502.6	4.3
Vacant/Undeveloped	9,133.3	26.1
Unassigned	2,019.9	5.8
Total	34,956.0	100

Source - County GIS Departments

Note - Vacant/undeveloped land did not have any structures on it. These could be forested areas, grass or pasture or land being prepared for development. If the assessor could not identify a specific use for a property, it was placed in the unassigned category.

Stream Classification

The Hamilton/Carr Creek sub-watershed and the Crescent segment (south side of the Meramec River), both of which drain directly to the Meramec River make up the Rockwoods Aquatic Conservation Opportunity Area of the MDC. The Crescent area is also part of the Castlewood Terrestrial Conservation Opportunity Area. The Castlewood Area is on both sides of the Meramec River east into Castlewood State Park. A portion of the Forest 44 Conservation Opportunity Area is also within the Hamilton Creek watershed. Conservation Opportunity Areas are priority places for protecting quality terrestrial and aquatic resources. The Conservation Opportunity framework identifies the best places where the MDC and their partners can combine technology, expertise and resources to protect areas of outstanding conservation resources that are threatened with potentially damaging development. Each Conservation Opportunity Area is to have a stakeholder team to develop a specific profile for it and determine goals and conservation actions. (See Map 10)

MoDNR has classified Hamilton, Flat, Kiefer and Antire Creeks as class P streams. A class P stream maintains permanent flow during drought periods. Designated uses for these creeks are: livestock and wildlife watering; protection of warm water aquatic life (general warm-water fishery) and human-health fish consumption; and Category B whole body contact recreation (not public access swimming areas).

Sections of seven streams in this watershed have been identified as a losing stream. A losing stream distributes 30 percent or more of its flow through permeable geologic materials into the bedrock aquifer below. Losing streams are associated with areas of Karst topography.

The Meramec River and a section of Kiefer Creek are on the Missouri 2010 303(d) Impaired Waters list. (See Map 13) The section of Kiefer Creek extends 1.2 mile upstream from the mouth and was identified as impaired due to bacteria from urban nonpoint pollution. The schedule for developing the TMDL plan has not been finalized. No creeks in the area have been identified by MoDNR as Outstanding National Resource Waters or Outstanding State Resource Waters.

Key Issues and Recommended Actions

The City of Wildwood has taken action to address water quality in much of the Hamilton Creek Watershed. Wildwood provides an example of how local government leadership can promote actions on behalf of individual land-owners to address non-point source problems. Sedimentation and erosion are significant problems in the watershed, and strategies to control stormwater runoff will address these issues in the short term on public lands, and long term on private lands.

Recommended actions from Missouri State Parks - Route 66 State Park

- Install pervious paving at visitor center, day use and boat launch parking areas
- Design and construct bank stabilization structures (vegetation/hard) for boat launch and day use areas
- Establish native grasses, trees and shrubs throughout the park as appropriate
- Replace vault toilets with composting toilets
- Install rain barrels at visitor center and shelters
- Research and develop education programs linked to stormwater project work

Recommended actions from St. Louis County Parks - Greensfelder Park

- Eliminate outhouses and replace with compost restrooms or some other more green facility, which will improve water quality**.**

Recommended actions from St. Louis County Department of Parks– Lone Elk Park

- Eliminate honeysuckle and replace with native grasses, trees and or shrubs.
- Reduce turf grasses and replace with native plantings.
- Improve the herbaceous growth in the woodlands reducing runoff.
- Eliminate outhouses and replace with compost restrooms or some other more green facility, which will improve water quality.
- Plant lake banks and coves with native vegetation.
- Remove curbs along roadways.

Kiefer Creek sub-watershed

Kiefer Creek is impaired by bacteria and chloride. The Missouri Coalition for the Environment has begun holding creek walks, talking with residents, conducting background research and laying the groundwork for a Kiefer Creek Watershed Plan that will address the specific problems in the watershed, including high levels of bacteria in the segments of stream running through Castlewood State Park. Because the creek runs through a park, it makes sense to address all non-point source solutions that can be addressed within the park as a short-term priority, in order to demonstrate the commitment from MoDNR to solving the problem and to educate the public through the demonstration projects. In addition, there is opportunity for wetlands restoration that can improve water quality as the creek enters the park. Also in the short term, EWG will provide septic system management brochure for distribution to the few households on individual sewage disposal systems (septic tanks). EWG and partners will also promote education about strategies for elimination of pet waste from streams.

Recommended actions from Missouri State Parks – Castlewood State Park

- Connect all facilities to sewer district
- Replace vault toilet with composting toilet
- Design and construct additional parking in day use/launch area utilizing pervious paving; installation of drainage structures and catch basins
- Replace turf grass and establish native grasses, trees and shrubs throughout the park as appropriate
- Design and construct new boat launch using BMPs
- Install cistern to collect rain water at park service area
- Install rain barrels at residence and shelter
- Research and develop education programs linked to project work

Wastewater Treatment and Drinking Water

In the Hamilton Creek watershed, the State of Missouri has issued 21 NPDES permits for the discharge of treated wastewater to creeks and the Meramec River. (See Map 6 and tables in Appendix A) Wastewater treatment facilities for the City of Eureka and the Northeast Public Sewer District (three sites) have discharge permits. There are two permits in Jefferson County for an industrial facility and a warehouse. One permit is for a school in Wildwood and two permits are for the Beaumont Scout Reservation in Jefferson County. Seven permits have been issued for freestanding residential areas (subdivisions or mobile home parks) throughout the watershed. It is estimated that 3,313 housing units in this watershed utilize individual sewage disposal systems (septic tanks). Additional NPDES permits have been issued for land disturbance and stormwater management in this watershed but have not been inventoried for purposes of this study.

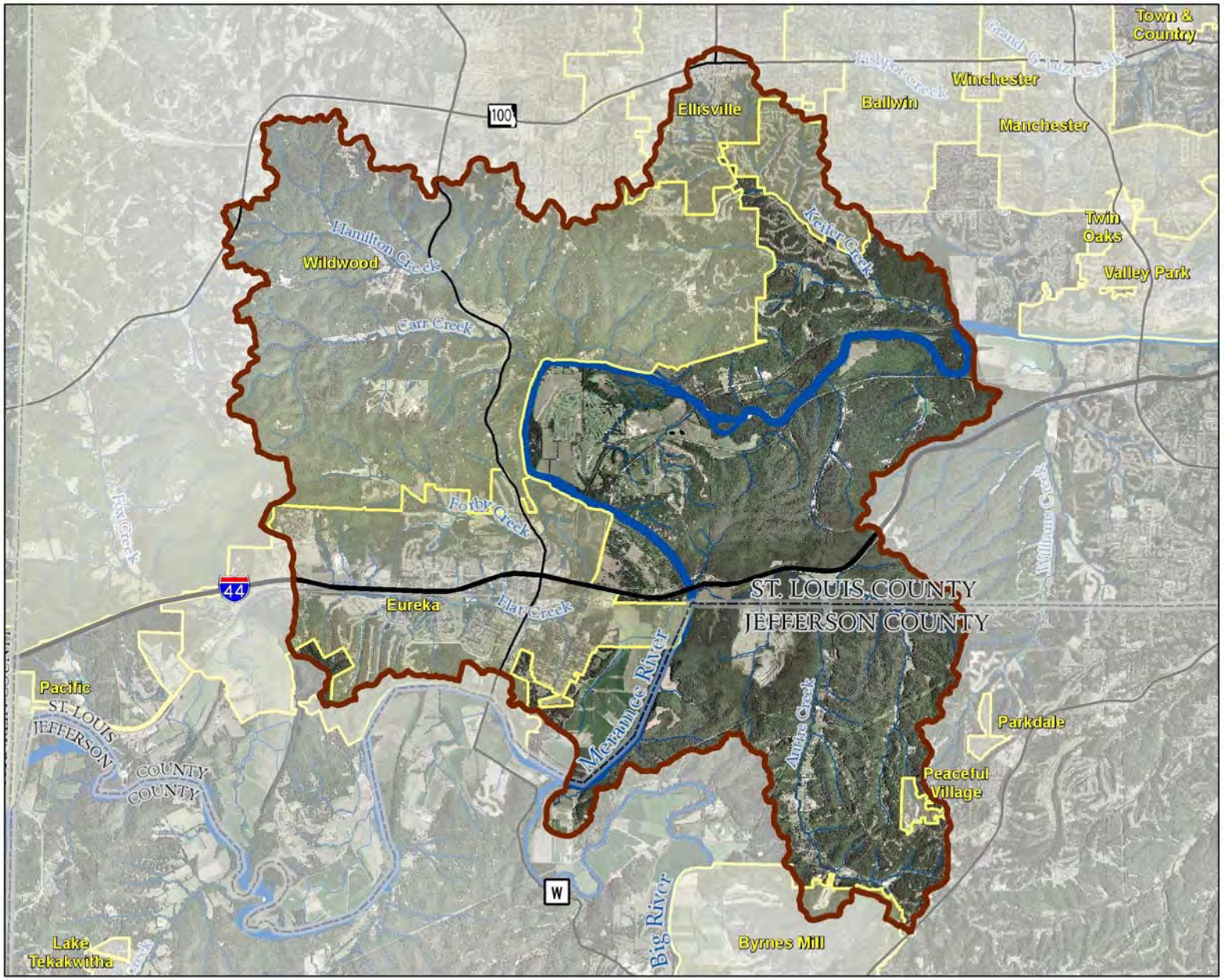
There are 539 private wells in the Hamilton Creek watershed. Of the 14 public groundwater supply systems four are classified as community water systems serving the same people year round. (See Table 37) One is operated by the City of Eureka and the other systems are associated with freestanding residential areas. The remaining water systems serve golf courses, an amusement park and county parks.

Table 37
Hamilton Creek Watershed Public Drinking Water Systems

Drinking Water System	Population Served	Number Of Wells	County
Aberdeen Golf Club	25	NA	St. Louis
Antire Springs Subdivision	260	1	Jefferson
Antire Valley Estates Mobile Home Park	NA	1	Jefferson
Camp Wyman	160	1	St. Louis
City of Eureka	7,800	5	St. Louis
Greensfelder County Park	100	1	St. Louis
Hidden Valley Golf Course	100	1	St. Louis
Laurel Acres Mobile Home Park	126	1	Jefferson
Marianist Retreat Center	25	1	St. Louis
Pevely Farm Golf Club	30	1	St. Louis
Pevely Farm Inc. (Subdivision)	200	2	St. Louis
Players Club Course at Crescent Farms Golf Club	100	1	St. Louis
Quarry Hill Golf Practice Center	NA	1	St. Louis
Rockwoods Reservation	550	2	St. Louis
Six Flags over Mid America	3,200	2	St. Louis
Tyson Research Center	26	2	St. Louis
World Bird Sanctuary at Tyson Research Center	25	NA	St. Louis
West Tyson County Park	30	1	St. Louis

NA – Not Available
Population Served - U.S. Environmental Protection Agency, Safe Drinking Water Information System, 2011
Number of Wells - Center for Applied Research and Environmental Systems (CARES) University of Missouri-Columbia, Watershed Evaluation and Comparison Tools based on 2004 source water protection area information from the Missouri Department of Natural Resources
One source water protection area was assumed to represent one well

Map 31



Hamilton Creek Watershed

Aerial Photograph (2007)

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream
- Incorporated Area, 2009

0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments
October 2010

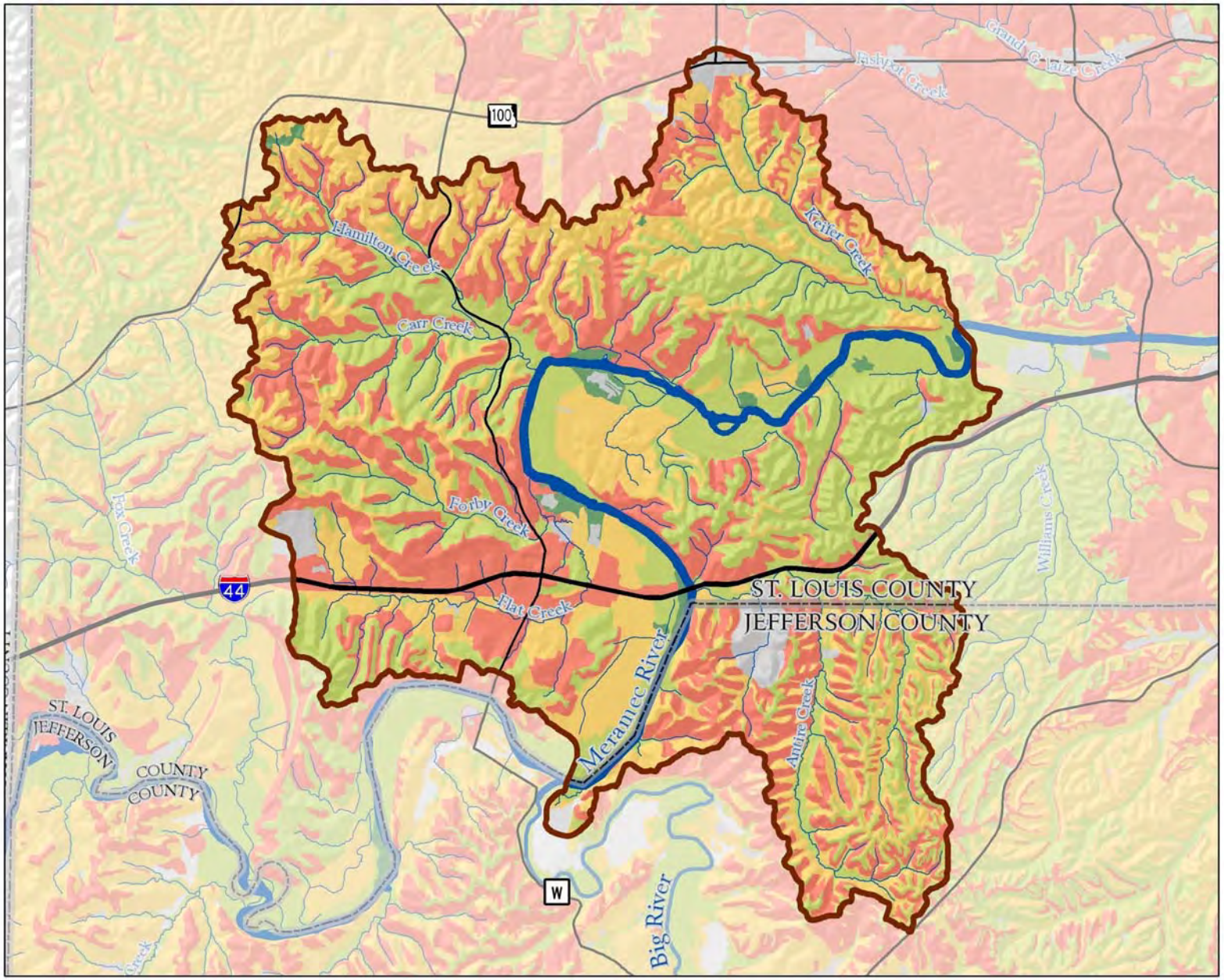
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 32



Hamilton Creek Watershed

Soil Hydrologic Group & Runoff Potential

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Hydrologic Group - Runoff Potential

- A - Low
- B - Moderately Low
- C - Moderately High
- D - High
- No Data

0 0.5 1 2 Miles

Sources: USDA-NRCS,
East-West Gateway Council of Governments

October 2010

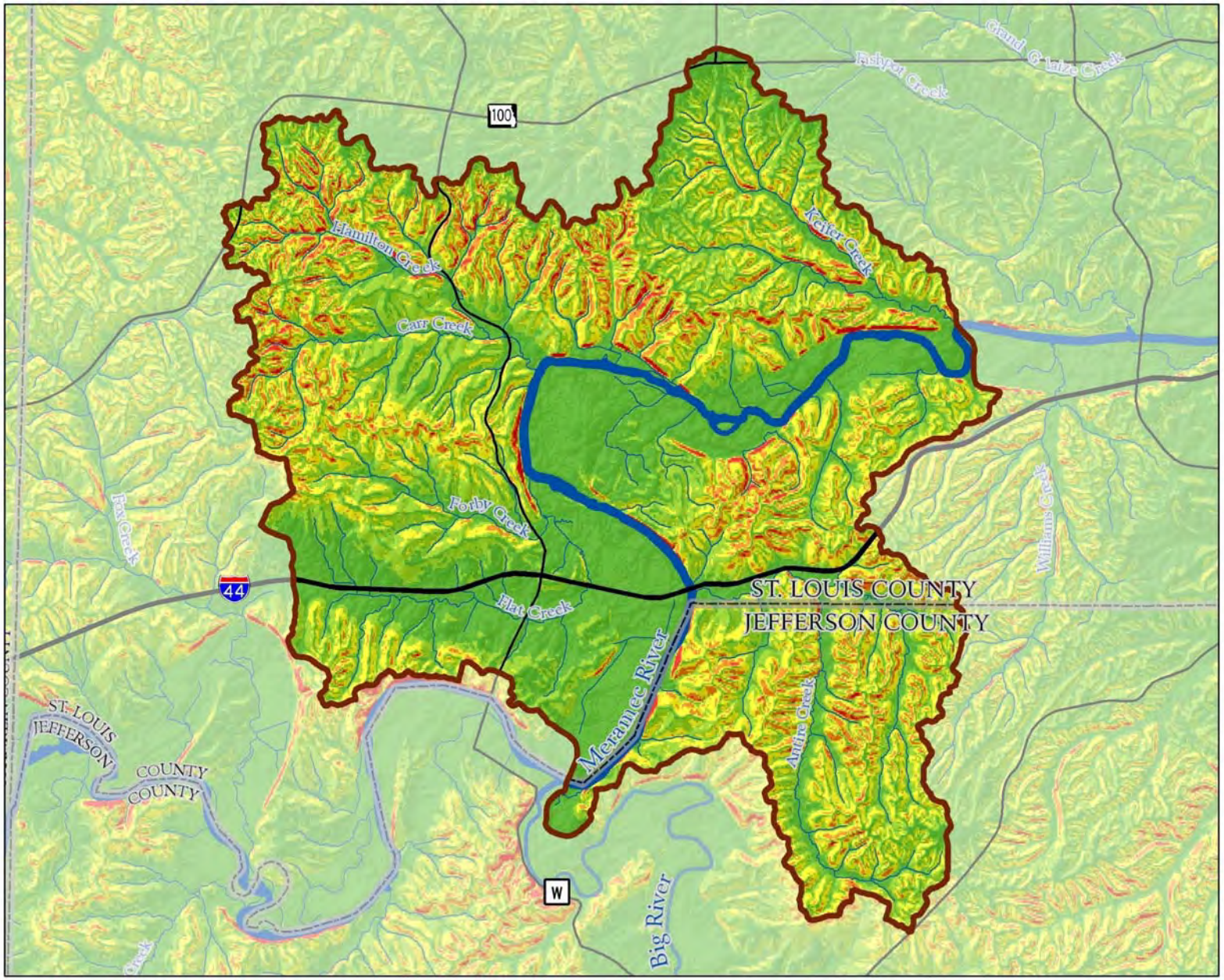
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 33



Hamilton Creek Watershed

Steep Slopes

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Slope Values

- 0 - 10%
- 11 - 20%
- 21 - 30%
- 31- 40%
- Above 40%

0 0.5 1 2 Miles

Sources: US Geological Survey, East-West Gateway Council of Governments October 2010

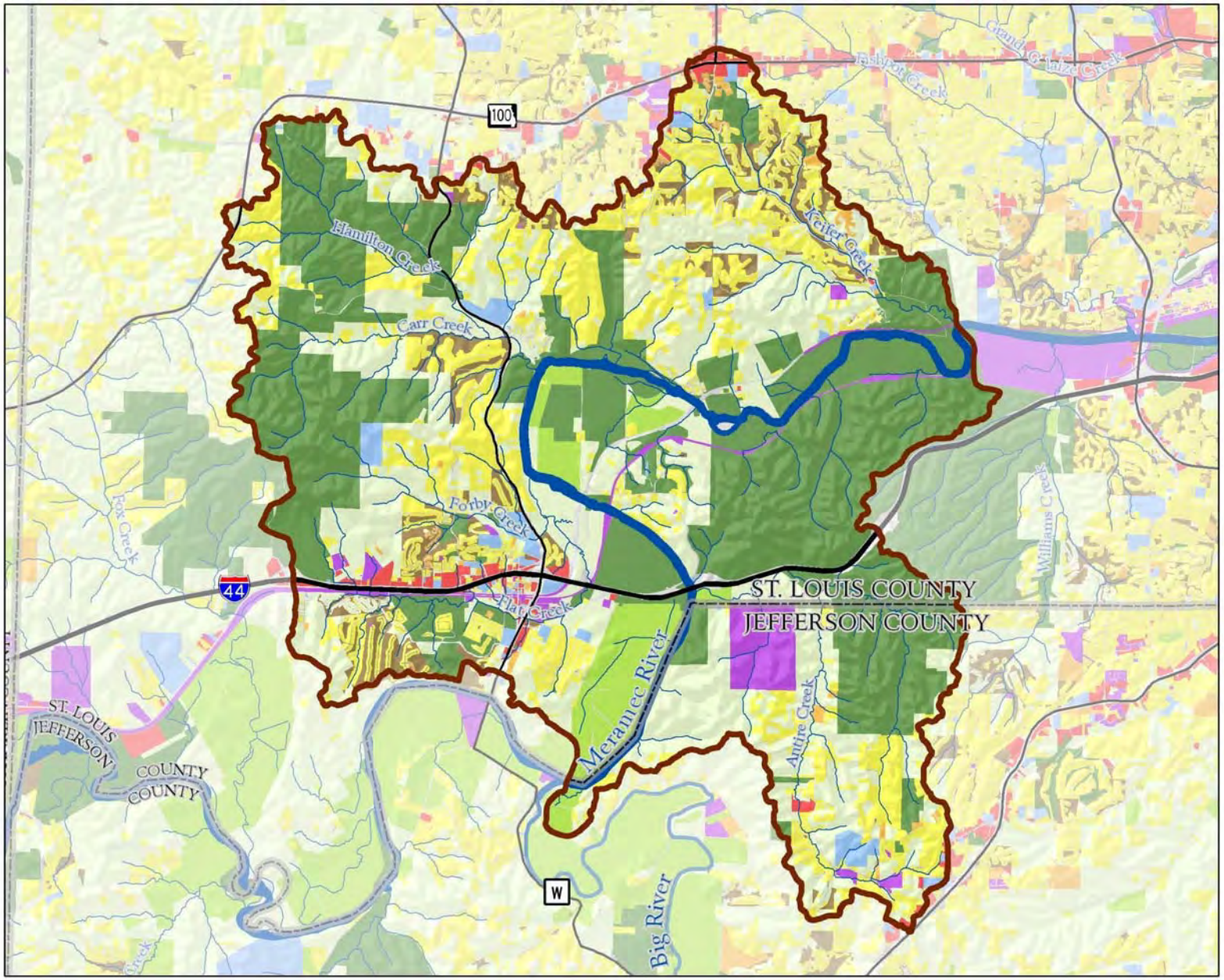
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 34



Hamilton Creek Watershed

Land Use (2008 parcels)

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Land Use*

- Agricultural
- Recreational
- Commercial
- Industrial
- Institutional
- Single-Family Residential
- Multi-Family Residential
- Common Ground
- Right of Way
- Vacant/Undeveloped

*Note: Land use category colors for areas outside of watershed are faded.

0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments
October 2010

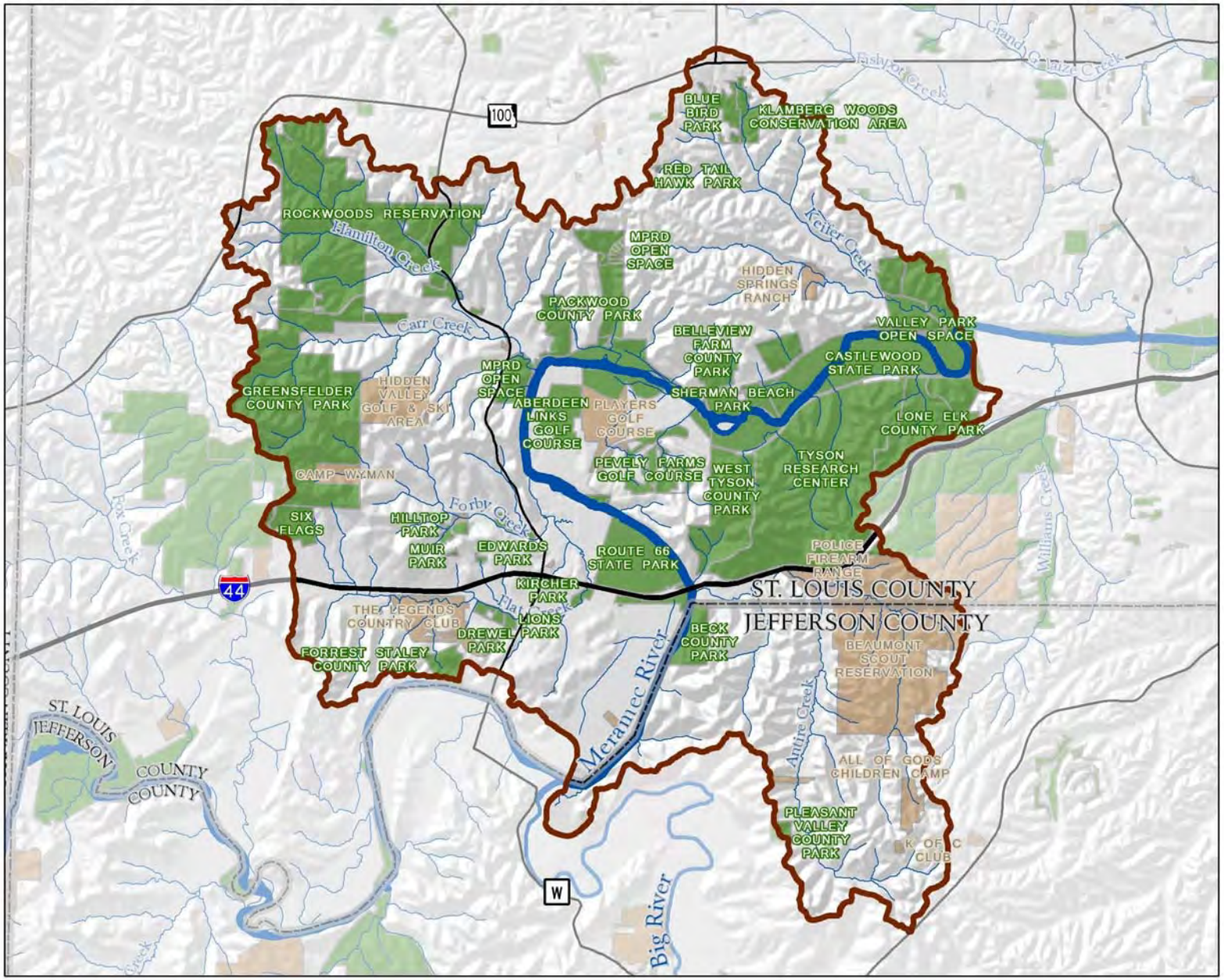
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 35



Hamilton Creek Watershed

Recreation & Open Space

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream
- Recreational Areas (open to the public)
- Recreational Areas (private)

0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments
October 2010

The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

E. Grand Glaize Creek Watershed
HUC - 071401021002

The Grand Glaize Creek watershed, 29,895 acres or 46.71 square miles, is located in the eastern part of the study area. The majority of the watershed is in south central St. Louis County with a small portion in northern Jefferson County. (See Map 36 at the end of this section) Grand Glaize Creek and Fishpot Creek, north of the Meramec River, and Williams Creek to the south are the major streams in this watershed. There also are tributaries to these creeks and smaller streams and land areas which drain directly to the Meramec River.

Grand Glaize Creek Watershed

29,895 acres
46.71 square miles

Grand Glaize Creek - 10.8 miles
Glaize Creek - 2.96 miles
Sugar Creek - 3.56 miles
Fishpot Creek- 9.55 miles
Williams Creek - 6.27 miles
Meramec River - 4.03 miles

Grand Glaize Creek and Fishpot Creek enter the Meramec River at Valley Park, 20.1 and 22.1 miles, respectively, upstream of the confluence with the Mississippi River. Williams Creek flows into the Meramec upstream of the Highway 141 bridge.

Physical Characteristics

The majority of the Grand Glaize Creek watershed is made up of dissected hills and blufflands. There are narrow ridgetops and hilly to steep slopes and valley sides. Limestone bedrock exposures are common. (See Map 8) Alluvium or alluvial soils are in the Meramec River valley and the major Creeks. These soils primarily consist of moderately deep, moderately well drained soils which have moderately fine to moderately coarse textures.

Approximately 69 percent of the soils in this watershed have moderate to high potential for runoff to occur due to slow infiltration rates. Some soils have layers near the surface which limit the downward movement of water or are clayey or are thin soils over bedrock. The location of these soils corresponds to the built /developed areas in the Grand Glaize Creek watershed. (See Map 37 and Table 38)

Slopes in the majority of the watershed are less than 10 percent. Approximately one-third of the land area in this watershed has slopes of 10 percent or greater. The steepest slopes, 40 percent or greater, are found in the bluff areas adjacent to the Meramec River valley in the western part of the watershed. Steep slopes are also found along the drainage divide ridgelines. (See Map 38)

Population and Land Use

All or parts of 12 incorporated units in St. Louis County are located in the Grand Glaize Creek watershed. The village of Parkdale is located in the Jefferson County portion of the watershed. In 2010, it is estimated that 115,173 people lived in this watershed. (See Map 5)

Table 38
Grand Glaize Creek Watershed
Hydrologic Soil Groups

Hydrologic Soil Group	Acres	Percent Share
A	61.4	0.2
B	8,209.2	27.5
B/D	0	0
C	3,550.4	11.9
C/D	0	0
D	16,902.1	56.5
No Data	1,171.9	3.9
Total	29,895.0	100

Source – USDA, Natural Resource Conservation Service

Hydrologic Soil Groups
A – Low runoff potential, well drained
B – Moderately low runoff potential
C – Moderately high runoff potential
D – High runoff potential, poorly drained
No Data – Hydrologic characteristics of soil could not be determined

Over 62 percent of the land area in this watershed can be considered developed or built. (See Map 39 and Table 39) Single family and multi-family residential uses occupy over 12,000 acres and are concentrated in the municipalities. Freestanding subdivisions are adjacent to Highway 141 in St. Louis County south of I-44. Commercial uses primarily can be found along Interstate 44, Highway 141 and Manchester Road. Industrial activity, including sanitary and construction and demolition landfills, makes up five percent of the land area. Approximately 14 percent of the land area is in use for recreation. This includes municipal and county parks and the Forest 44 Conservation area. (See Map 40)

Stream Classification
The Forest 44 Conservation Area has been identified as a terrestrial Conservation Area. Conservation Opportunity Areas are priority places for protecting quality terrestrial and aquatic resources. The Conservation Opportunity framework identifies the best places where the MDC and partners agencies can combine technology, expertise and resources to protect areas of outstanding conservation resources that area threatened with potentially damaging development. Each Conservation Opportunity Area has a stakeholder team to develop a specific profile for it and determine goals and conservation actions. (See Map 10)

Table 39
Grand Glaize Creek Watershed Land Use

Land Use	Acres	Percent Share
Multi-Family Residential	927.3	3.1
Single-Family Residential	12,053.8	40.3
Commercial	1,322.4	4.4
Industrial	1,443.9	4.8
Institutional	1,079.7	3.6
Recreation	4,288.0	14.3
Common Ground	1,847.6	6.2
Right of Way	21.4	0.1
Agriculture	47.9	0.2
Vacant/Undeveloped	2,854.7	9.5
Unassigned	4,008.4	13.4
Total	29,895.0	100

Source - County GIS Departments

Note - Vacant/undeveloped land did not have any structures on it. These could be forested areas, grass or pasture or land being prepared for development. If the assessor could not identify a specific use for a property, it was placed in the unassigned category.

Grand Glaize Creek, extending four miles upstream from the mouth, has been classified by the MoDNR as a class C stream. A class C stream may cease to flow in dry periods but maintains permanent pools which support aquatic life. MoDNR has classified 3.5 miles of Fishpot Creek and 1 mile of Williams Creek as class P streams. A class P stream maintains permanent flow even in drought periods. Designated uses for these creek are: livestock and wildlife watering; protection of warm water aquatic life (general warm-water fishery) and human-health fish consumption; and Category B whole body contact recreation (no public access swimming areas). Two sections of Fishpot Creek have been identified as losing streams. A losing stream distributes 30 percent or more of its flow through permeable geologic materials into the bedrock aquifer below. Losing streams are associated with areas of Karst topography.

Both Grand Glaize Creek and Fishpot Creek have been classified by MoDNR as Metropolitan No Discharge Streams in which no water contaminant except uncontaminated cooling water, permitted stormwater discharges in compliance with permit conditions and excess wet-weather bypass discharges not interfering with beneficial uses, shall be discharged.

The Meramec River, Grand Glaize Creek (four miles from mouth) and Fishpot Creek (3.5 miles from mouth) are on the Missouri 2010 Missouri 303(d) Impaired Waters list. (See Map 13) Fishpot Creek is identified as impaired due to bacteria and low dissolved oxygen resulting from urban nonpoint pollution sources and other unknown sources including loss of streamside vegetation. MoDNR is scheduled to prepare a bacteria Total Maximum Daily Load (TMDL) study by 2011 and the low dissolved oxygen TMDL study is to be completed in 2016. Grand

Glaize Creek has been identified as impaired due to bacteria and chloride. MoDNR is to prepare a bacteria TMDL study by 2011 and the chloride TMDL study is to be completed in 2014. The state is to develop plans delineating how these waterways will be restored to their designated use. This four mile section of Grand Glaize Creek has been included on the Missouri 2010 303(d) Impaired Waters list based on low dissolved oxygen resulting from urban nonpoint pollution sources. The schedule for developing a TMDL plan has not been finalized. Grand Glaize Creek is included in a list of Missouri waterways impaired by mercury deposition in fish tissue.

No creeks have been identified by MoDNR as Outstanding National Resource Waters or Outstanding State Resource Waters.

Key Issues and Recommended Actions

Grand Glaize/Fishpot Creek:

Fishpot Creek and Grand Glaize Creek are both impaired by bacteria, low dissolved oxygen and chloride. Correcting bacteria levels will require reducing general sediment flow, by reducing volume of runoff. In the next five years, focus is on extensive education of property owners to reduce overland flow of pet waste from large and small animals. Homeowner education will begin in 2012. In addition, MSD is beginning an extensive effort to identify and correct the few failing septic systems, and the EWG septic system brochure will be distributed in the short term.

The recommended projects in the parks will be installed in the short term, by 2016, and will educate the public about what individuals can do in their own properties to reduce flow and manage pet waste. Chloride impairment will require major work with local governments to find alternatives to road salt, and to identify exact locations to construct catch basins to slow and remove road salts. MSD is already working with the local governments to build awareness of the chloride problem and is encouraging communities to do a better job of limiting the amounts of road salt applied. More comprehensive strategies include planning catch basins along roadways, which is focused to begin in earnest on the mid term, from 2016-2020. Low dissolved oxygen has numerous sources, including fertilizers, organic waste, pet waste and the reduced tree canopy along the stream channel, which causing a warming of the waters. Restoring the riparian corridor is an important action to improve dissolved oxygen, and it serves to improve habitat as well as improve the general quality of the property. Strategies to reduce runoff have a direct impact on all of these criteria pollutants. The plan calls for implementing strategies in public lands in the short term, and then using the educational benefits of such demonstration projects to encourage voluntary landowner action in mid to long term.

Fishpot Creek was the focus of a major study conducted by Intuition and Logic, Inc., on behalf of the St. Louis County Soil and Water District. That plan includes recommendations for stream channel improvements to stabilize banks, and improve water quality by reducing sedimentation (this study is at http://www.ewgateway.org/lowermeramec/FishpotRpt.pdf) Since that time, MSD has installed stream bank stabilization measures in the lower Fishpot Creek to halt significant erosion of residential yards. The projects listed in the Fishpot study remain a priority, but they are expensive to undertake and will likely not be enough to restore stream health and solve the pollution problems in the stream. Actions of individual landowners

will be needed to address stormwater runoff through out the watershed, to reduce flow volumes following a rain event, and to restore base flow to the system. In the short term, installation of projects at County parks can provide an immediate benefit and help to educate the public.

Recommended projects from St. Louis County Department of Parks – Queeny Park

- Remove curb along the entrance roadway to the complex.
- Concentrate on honeysuckle removal along the drainages above any ponds and along creek ways.
- Replant with native grasses or trees in areas where honeysuckle has been removed.
- Create a detention basin in the area between the Sunken Parking lot and the entrance road.
- Stabilize creek banks with rock and native plantings.
- Reduce turf areas and replace with native plantings.
- Construct detention/wetland basin to collect runoff that falls on or near the Recreation Complex building.
- Increase the width of the creek corridors by planting native grasses and trees.
- Use “rain barrels” to collect building runoff that can be used for watering plants at the complex or the water will be allowed to infiltrate into the ground.

Love Park

- Increase the width of the creek corridor by planting trees and shrubs.
- Remove honeysuckle and replant with native trees and shrubs if necessary.
- Remove all curbs along the roadways.
- Reduce turf grasses.
- Stabilize creek banks.
- Construct detention/wetland basins to collect runoff from parking lots**.**

Museum of Transportation

- Increase the width of the creek corridor running through a portion of the park near the park entrance by planting native trees and shrubs**.**
- Reduce turf grasses.
- Construct detention/wetland basins to collect runoff from the buildings and display areas.
- Eliminate honeysuckle to improve stream bank health.
- Use “rain barrels” to collect building runoff that can be used for watering plants or the water will be allowed to infiltrate into the ground.
- Stabilize creek banks.

Simpson Park

- Remove honeysuckle and replace with native grasses, trees and shrubs.
- Reduce turf grass and replace with native plantings.
- Construct detention/wetland basins to collect water from parking areas.
- Connect to sewer system to remove restroom septic system.

Wastewater Treatment and Drinking Water

In the Grand Glaize Creek watershed, the State of Missouri has issued 12 NPDES permits for the discharge of treated wastewater to creeks and the Meramec River. (See Map 6 and tables in Appendix A) The Grand Glaize wastewater treatment facility of the MSD and the Northeast Public Sewer District Paradise Valley facility have discharge permits. The MSD facility is designed to treat for a population equivalent of 210,000. The majority of the permits have been issued for industrial related activities. One permit is for an inactive industrial facility. One permit has been issued for a freestanding residential area in Jefferson County. It is estimated that 1,623 housing units in this watershed utilize individual sewage disposal systems (septic tanks). Additional NPDES permits have been issued for land disturbance and stormwater management in this watershed but have not been inventoried for purposes of this study.

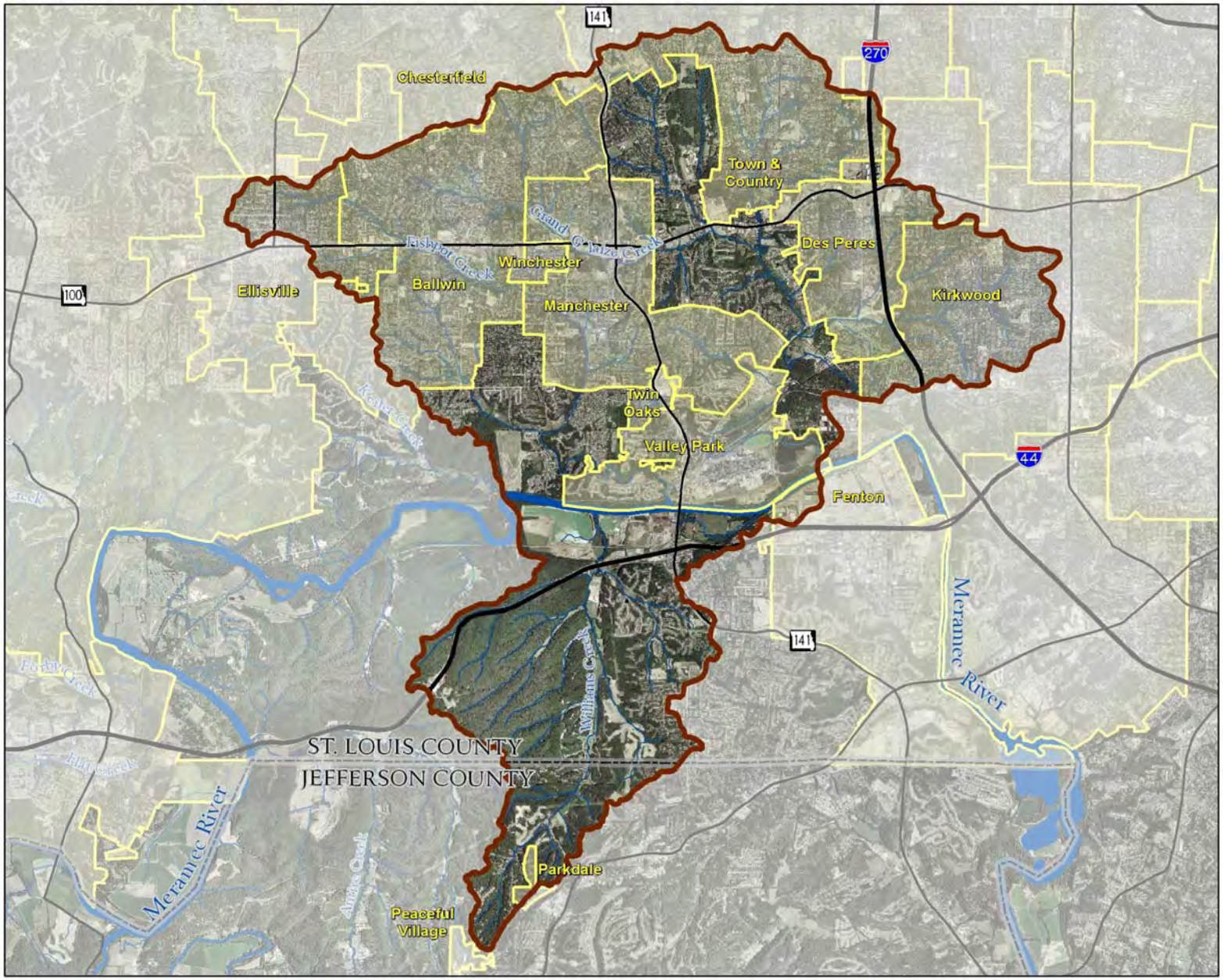
There are 196 private wells in the Grand Glaize Creek watershed. The number of public groundwater supply systems totals five. (See Table 40) The City of Kirkwood operates and maintains a water distribution system for its residents. Starting in 2007, Kirkwood purchases treated water from the Missouri American Water Company. The source of this water is the Missouri River. Two systems are associated with freestanding residential areas. The remaining water systems serve a recreational area and a golf course.

Table 40
Grand Glaize Creek Watershed Public Drinking Water Systems

Drinking Water System	Population Served	Number Of Wells	County
Jay Henges Shooting Range, part of Forest 44 Conservation Area	50	1	St. Louis
City of Kirkwood*	28,000	NA	St. Louis
Paradise Valley Golf and Country Club	50	NA	St. Louis
Paradise Valley Subdivision	NA	2	St. Louis
Woodridge Apartments	70	2	Jefferson

NA – Not Available
*The City of Kirkwood purchases 100 percent of its water from the Missouri American Water Company
Population Served - U.S. Environmental Protection Agency, Safe Drinking Water Information System, 2011
Number of Wells - Center for Applied Research and Environmental Systems (CARES) University of Missouri-Columbia, Watershed Evaluation and Comparison Tools based on 2004 source water protection area information from the Missouri Department of Natural Resources
One source water protection area was assumed to represent one well

Map 36



Grand Glaize Creek Watershed

Aerial Photograph (2007)

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream
- Incorporated Area, 2009

N

0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments
October 2010

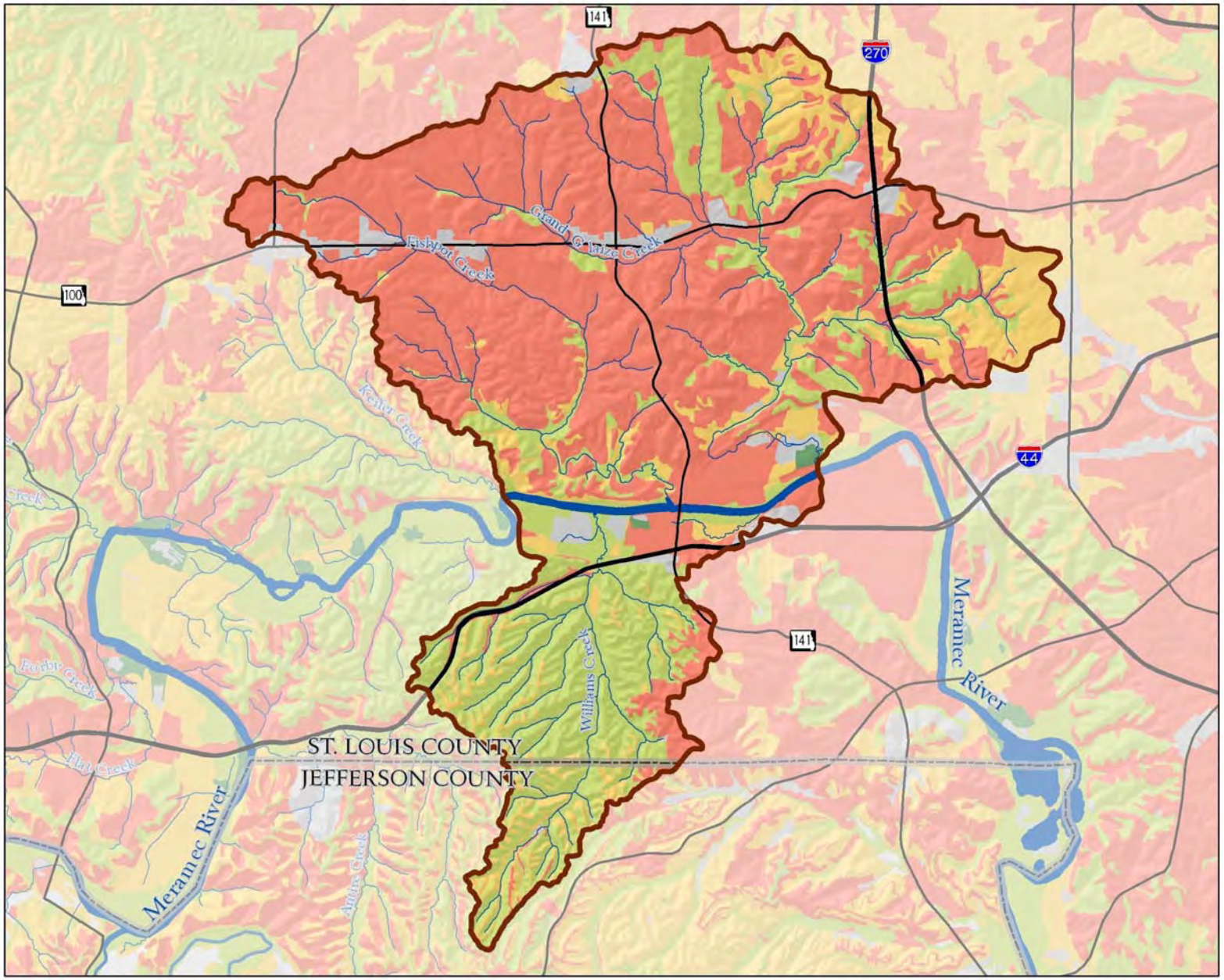
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 37



Grand Glaize Creek Watershed

Soil Hydrologic Group & Runoff Potential

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Hydrologic Group - Runoff Potential

- A - Low
- B - Moderately Low
- C - Moderately High
- D - High
- No Data

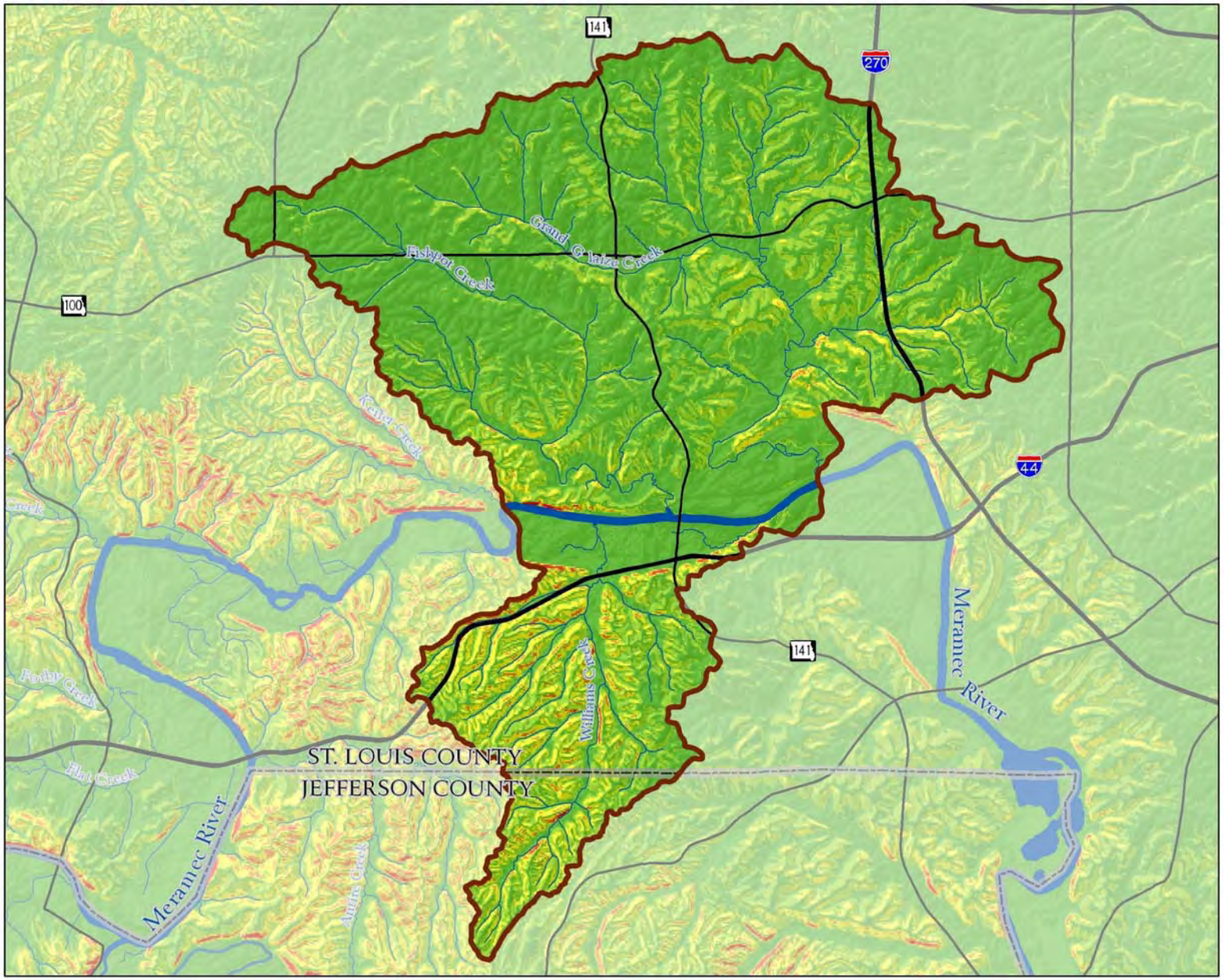
0 0.5 1 2 Miles

Sources: USDA-NRCS, East-West Gateway Council of Governments October 2010

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 38



Grand Glaize Creek Watershed

Steep Slopes

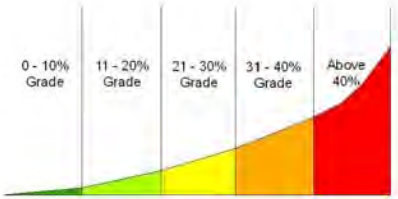
Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Slope Values

- 0 - 10%
- 11 - 20%
- 21 - 30%
- 31- 40%
- Above 40%



N

0 0.5 1 2 Miles

Sources: US Geological Survey, East-West Gateway Council of Governments October 2010

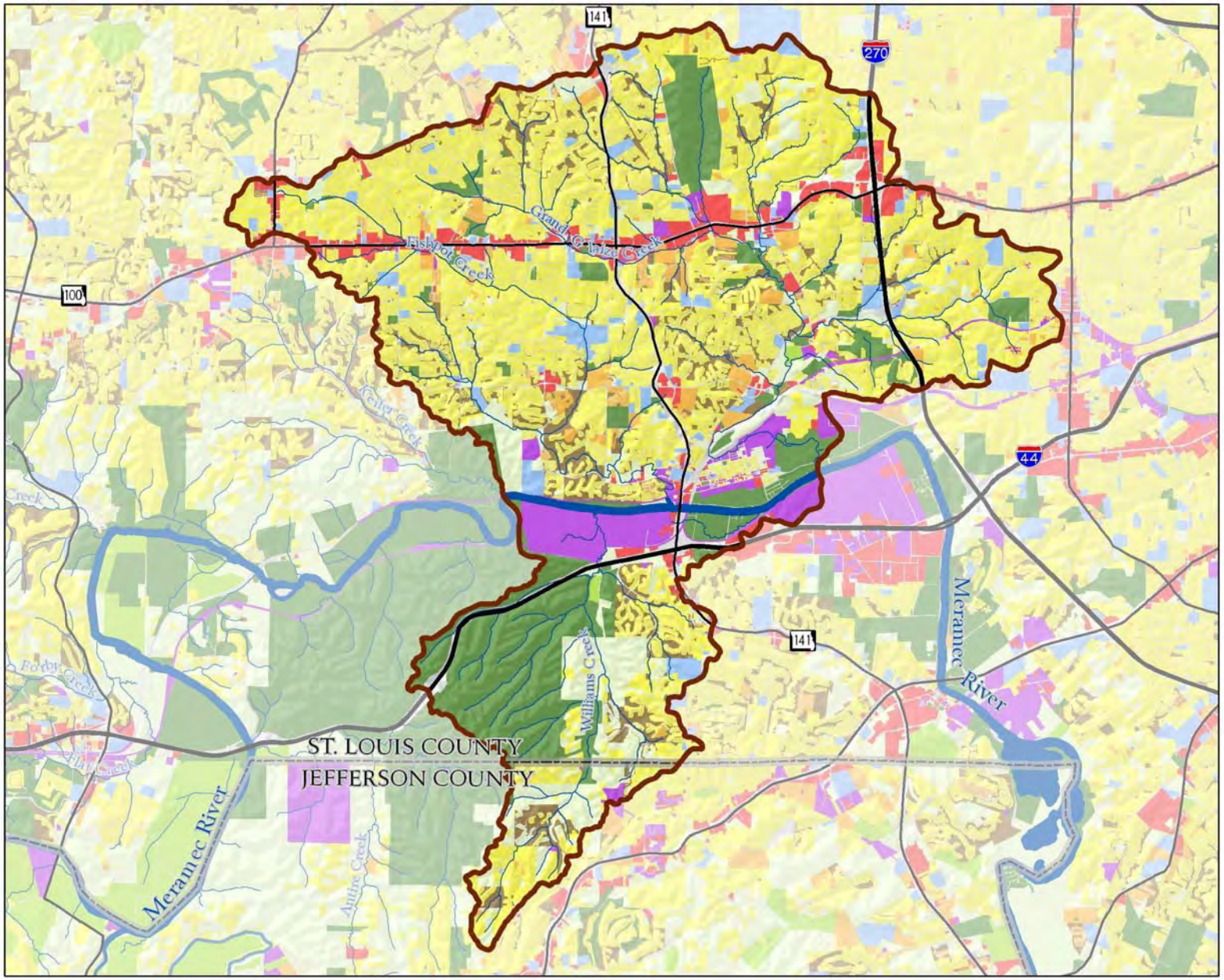
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 39



Grand Glaize Creek Watershed

Land Use (2008 parcels)

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

Land Use*

- Agricultural
- Recreational
- Commercial
- Industrial
- Institutional
- Single-Family Residential
- Multi-Family Residential
- Common Ground
- Right of Way
- Vacant/Undeveloped

*Note: Land use category colors for areas outside of watershed are faded.

0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments
October 2010

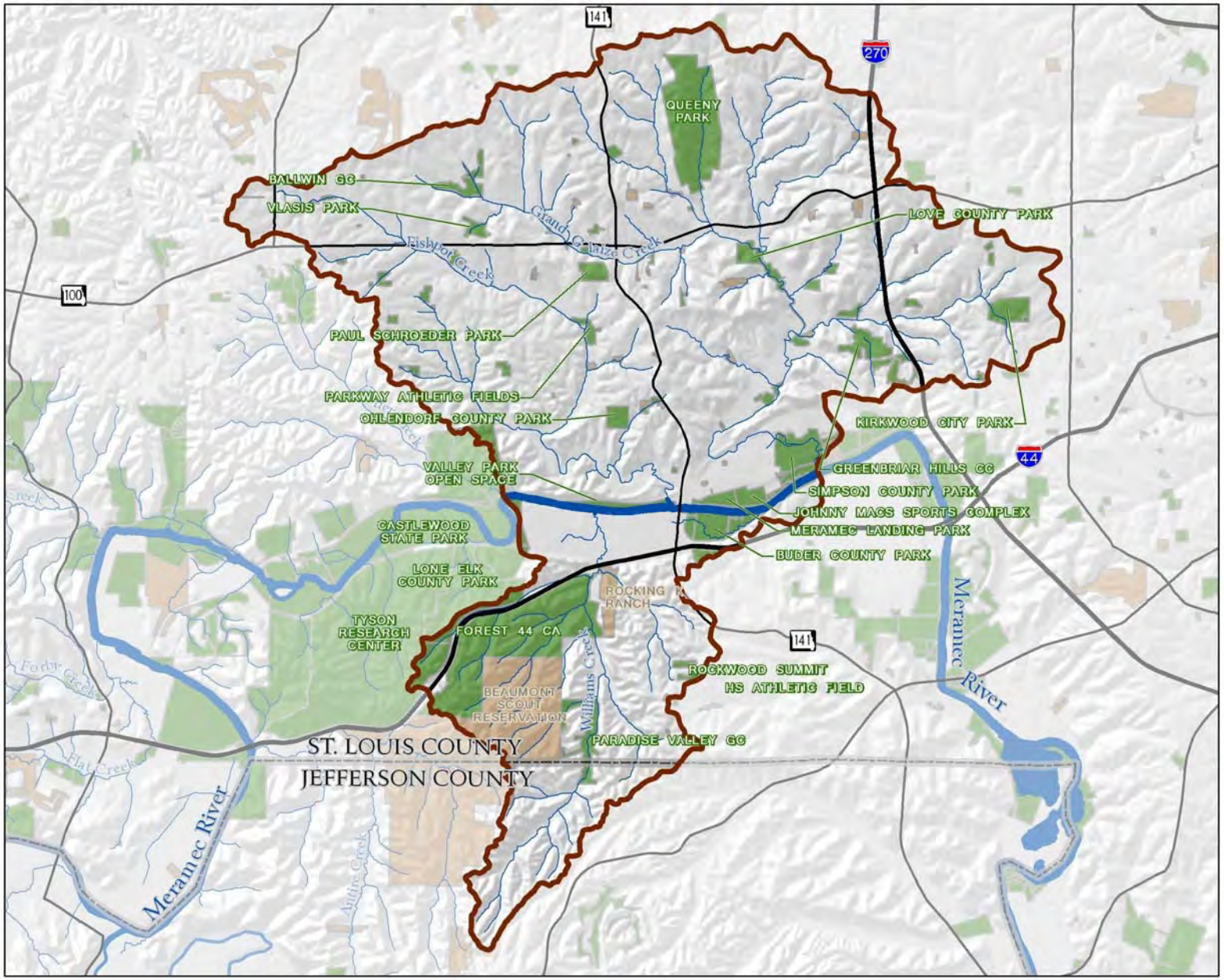
The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

Map 40



Grand Glaize Creek Watershed

Recreation & Open Space

Legend

Basemap Elements

- Watershed Boundary
- County Boundary
- Interstate Highway
- Major Road
- River or Stream

- Recreational Areas (open to the public)
- Recreational Areas (private)

0 0.5 1 2 Miles

Sources: County GIS Departments, East-West Gateway Council of Governments October 2010

The Open Space Council

East-West Gateway

Missouri Department of Natural Resources

U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009, Section 604(b) of the Clean Water Act.

F. Recommended Actions by Watershed

Based on the discussions of key issues and recommended actions, Table 41 summarizes the recommended actions for each watershed and their associated timeline. Information on the pollutant removal efficiencies and general cost estimates of various BMPs are presented in Table 20 and Table 21,of Section III. Also in Section III, Section H contains a discussion of the proposed long term (20-year) BMP strategy and estimated pollutant load reductions for those watersheds with impaired streams.

Open House, Pacific Missouri – November 29, 2011

Table 41
Pollution Problems and Recommended Actions by Watershed

Creek Watershed	Problem	Action	Time in Years
Brush	Sediment	Wetland Construction – Shaw NR (SNR)	1 – 5
	Excess Runoff	Sediment Control SNR	1 – 5
	Low Dissolved Oxygen	Plant trees on FEMA buyout property	1 – 5
		Other projects to be identified	1 – 5
	General	River Walk, park, greenway, rain gardens, wetlands & education	1 – 5
		Sub-watershed plans	5 - 10
LaBarque	Sediment	Control erosion, bio-swales	1 – 5
		Restrict ATVs in new state park	1 – 5
	Bacteria	Demonstration composting toilet – TCS	1 – 5
		Education on septic systems	
		Land protection: Acquisition, Easement	1 – 20
		McFall Creek sub-watershed plan	5 - 10
Fox	Sediment	Control erosion, limit down-cutting without limiting fish passage	1 – 5
		Bio-retention	5 – 10
		Development ordinances (Pacific)	5 – 10
		Sub-watershed plan	5 – 10
		Land protection: Acquisition, Easement	1 - 20
Hamilton	Sediment & miscellaneous pollutants	Pervious Pavement – Rte 66 Park (66)	1 – 10
		Bank stabilization, native plantings	1 – 5
		Remove curbs at Lone Elk Park	1 – 5
		Replace turf with native	1 – 10
	Bacteria	Rain barrels – Greensfelder Park (G)	1 – 5
		Replace vault toilets w/ composting (G)	1 – 5
		Education on septic system care	1 – 5
	Low Dissolved Oxygen	Replace outhouse w/ composting (G)	1 – 10
		Replace honeysuckle w/ trees & natives improve shade (66, Lone Elk & G)	1 – 5
	General	Individual sub-watershed plans for Hamilton, Carr, Flat, Forby Creeks	5 - 10

Table 41 - Continued
Pollution Problems and Recommended Actions by Watershed

Creek Watershed	Problem	Action	Time in Years
Kiefer Sub-watershed	Bacteria*	Connect Castlewood Park facilities to sewers	1 - 10 5 - 10
		Install wetlands in Castlewood Park	5 -10
	Chloride*	Pervious pavement on boat launch and road access – Castlewood	1 - 10
	Sediment	Vegetated Swales along roads	
	General	Reduce runoff with rain barrels, replace turf grass with native in Co Parks	1 - 5
		Develop detailed sub-watershed plan	1 – 5
		Public education on pet waste & septic systems	1 – 5
		BMPs throughout watershed	5 - 20
Fishpot/Grand Glaize	Bacteria*	Reduce sediment, reduce flow volume with BMPs (beginning in public lands) & Education	1 -5
		Education to control pet waste runoff	1 - 5
		BMPS in key private lands	5 - 20
	Low Dissolved Oxygen	Riparian corridor restoration; remove honeysuckle, plant natives & trees	1 -10 1 - 5
		Expand stream buffer in Co. parks	1 -10
	Chloride*	Add pervious pavement in parking lots	1 - 5
		Reduce use of road salt	1 - 5
		Build vegetated swales for road runoff	5 - 10
		Bio-retention to catch parking lot runoff	5 -10
	General	Sub-watershed plan for Fishpot	1 - 5
		Sub-watershed plan for Grand Glaize	1 - 5
		Sub-watershed plan for Williams	5 - 10
Entire Study Area	Misc. pollution, trash	*Operation Clean Stream* – Annual clean up event; public awareness, education	1 - 20
		Meramec Tributary Alliance Quarterly meetings	1 - 20
		Meramec Expedition, Education for Public Officials, yearly event	1 - 20
		Key Land Acquisition & Easements	5 – 20
		Implement Phase II stormwater plans, w/ MSD, Eureka, other partners	1 –20

Stream designated as impaired by this pollutant.

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V. Lower Meramec Watershed Public Involvement Plan and Timeline (Element E)

Robust and meaningful public engagement and feedback has been a cornerstone of the process for developing the Lower Meramec Watershed Plan. The key to developing an effective Lower Meramec Watershed management plan is reaching out to our residents, communities, and local and county governments, and motivating them to act. It is also important to understand our Lower Meramec Watershed audience, create a message that resonates with them, find appropriate ways to communicate our message, and prompt changes in behavior to reduce water pollution in the Lower Meramec Watershed.

On June 15, 2010, the watershed plan kicked off with the Orientation to the Meramec River Tributaries briefing held at Route 66 State Park (see itinerary, Map 41 - Meramec River Orientation). The briefing allowed East-West Gateway staff to work with local government leaders and the public to identify issues and concerns designed to bring healthier streams and stable stream banks to the region.

The orientation emphasized five main goals of the watershed plan.

1. Develop strategies to protect a vitally important source of drinking water for 200,000 St. Louis county residents.

2. Improve and protect habitat and recreational areas in streams and restore degraded tributaries.

3. Develop strategies to protect healthy, sensitive streams that are at risk of being degraded by human actions.

4. Develop long range plans for public education.

5. Achieve and maintain compliance with water quality standards.

The MRTA is a valuable partner and provides a broad coalition for collaboration, helping East-West Gateway to involve and educate the public on watershed planning. The listing of the regional watershed partners is:

American Rivers
Audubon Society
Ducks Unlimited
Ecoworks Unlimited
Franklin County Public Works
Friends of LaBarque Creek
Great Rivers Greenway
Hellmuth & Bicknese Architects
Jefferson County Government
Meramec River Greenway
Meramec River Recreation Association
Ozark Outdoors Riverfront Resort
Ozark Regional Land Trust
Pacific Ring Initiative
R. Barr Consulting
St. Louis County Municipal League
St. Louis County Parks and Recreation Department
St. Louis Earth Day
The Trust for Public Land
U.S. Fish and Wildlife Service
U.S. Forest Service
City of Ballwin

Missouri Stream Team	Missouri Botanical Garden – Shaw Nature Reserve
Missouri Coalition for the Environment	City of Eureka
Missouri Department of Health	City of Des Peres
Missouri Smallmouth Alliance	City of Kirkwood
Missouri Department of Conservation	City of Manchester
Museum of Transportation	City of Pacific
The Nature Conservancy of Missouri	City of Valley Park
Northern Ozark Rivers Partnership	City of Wildwood
City of Ellisville	The Open Space Council for the St. Louis Region
Missouri American Water	East-West Gateway Council of Government
Metropolitan Sewer District	Missouri Department of Natural Resources

The MRTA was briefed at its meetings throughout the 18 months of the project.

EWG coordinated a municipal officials meeting and workshop on Water Quality, Green Infrastructure and Watershed Management in the Lower Meramec River. The meeting was held on April 26, 2011 at the City of Valley Park City Hall. Twenty-six participants representing the various partners and communities were in attendance.

Staff met with the city officials (City Administrators, Directors of Public Works, City Engineers, Directors of Planning, Directors of Parks and Recreation, Building Commissioners, and staff from these various departments) representing the communities that are most affected by the Lower Meramec Watershed from March 2011 – May 2011. Some of the discussions centered on how the communities deal with these issues and their plans for future activities to address the problems identified. The listing below summarizes the meetings for each of the local communities:

CITY OF EUREKA
Meeting date: March 10, 2011
City staff involved: Craig Sabo, Administrator, John Boggs, Building Commissioner

The City of Eureka has been designated as a Municipal Separate Storm Sewer System (MS-4) community, having crossed the 10,000-population threshold as determined by the 2010 census. Thus, the city will be subject to new storm water regulations. Staff will have 2 years to implement the new regulations. We sent the city all of the pertinent watershed maps in our Lower Meramec Watershed file as they requested.

CITY OF PACIFIC
Meeting date: March 10, 2011
City staff involved: Harold Selby, City Administrator, Daniel Rahn, City Engineer

The City of Pacific is discussing storm water improvement and considering a tax to accomplish these improvements. They have bought out 20 homes due to flooding and have an additional 6 or 7 pending. They asked if we could assist with clean up along Brush Creek.

CITY OF VALLEY PARK
Meeting date: March 21, 2011
City staff involved: Marguerite Wilburn, City Clerk, Gerald Martin, Public Works Director

The City of Valley Park is considering a bond issue for storm water projects, especially for their downtown area. They are pleased with the construction of the levee in 2008, which has successfully protected the city. They are planning improvements to Hanna Road to make the area more pedestrian friendly.

CITY OF MANCHESTER
Meeting date: March 22, 2011
City staff involved: Ed Blattner, City Administrator, Bob Ruck, Director of Public Works

The City of Manchester is having an issue with the new flood maps they are receiving from the federal government, where they are using the old hydrology and applying it to various communities. The result is that residents are finding they now live in a flood plain where previously they were not. They are also concerned with channel erosion in their city and also construction in those channel areas.

CITY OF WILDWOOD
Meeting date: March 29, 2011
City staff involved: Joe Vujnich, Director of Planning and Parks, Ryan Thomas, Director of Public Works

The City of Wildwood has between 4,000 and 4,500 septic tanks and many of them have not been maintained properly for a number of years and are now problems for the city. The city also has significant storm water problems mostly west of Route 109. The city has aggressively planned and managed construction to control erosion and protect hillsides and streams.

CITY OF BALLWIN
Meeting date: March 29, 2011
City staff involved: Robert Kuntz, City Administrator, Gary Kramer, Director of Public Works

Staff indicated that their Municipal Board is very pro-environment. They support pervious pavement, rain gardens, etc. There is however concern about the amount of maintenance with regard to establishing pervious pavement sidewalks and parking areas.

CITY OF KIRKWOOD
Meeting date: May 25, 2011
City staff involved: Todd Rehg, Director of Public Works, Chris Pflasterer, Assistant, Public Works

The City of Kirkwood
We discussed the considerable number of "infill" homes being built in Kirkwood, including construction of living facilities at the rear of the property. This is creating changes to runoff patterns. Storm water creates issues in all communities. Kirkwood is considering additional rain gardens, rain barrels dry wells, bioswales, pervious pavement, and other methods to deal with the excess runoff.

CITY OF ELLISVILLE
Meeting date: May 25, 2011
City staff involved: Bill Schwer, City Engineer and Director of Public Works, John Calvert, Assistant Director of Public Works, John Collins, Assistant City Engineer

The City of Ellisville has several activities to control storm water. These include: vortexes, downstream defenders, Bio-retention projects, rain gardens, etc.
They have had stream bank erosion in a few areas and are attempting to correct this problem.

CITY OF DES PERES
Meeting date: May 26, 2011
City staff involved: Doug Harmes, City Administrator, Dennis Knock, Director of Public Works and City Engineer

The City of Des Peres is also experiencing a number of "infill" houses being constructed—20 to 30 per year. These often cause additional run-off, usually because of the larger roofs. The city does require rain gardens or other methods to handle the additional rainwater.

The **Lower Meramec Watershed Survey** was developed by the East-West Gateway Council of Governments staff. The survey was administered online through the East-West Gateway website and in person, in paper form. Additionally, local watershed partners (organizations, local governments) were asked to post the link to the survey on their respective websites for residents to complete. The survey was made available to the public from February 24 to October 31, 2011 and was accessible online at http://www.ewgateway.org/lowermeramec/lowermeramec.htm.

The purpose of the survey was to understand the issues of greatest concern in the Lower Meramec watershed and associated tributaries. The survey was provided to community leaders and the public via watershed meetings, the East-West Gateway website, and partner organizations.

The individuals who responded to this survey were self-selected. Thus, respondents to this survey do not constitute a random sample designed to be representative of the region's population. Rather, this survey elicited attitudes and issues of concern to citizens informed and motivated enough to choose to participate. The value of a survey like this is to alert planners and policy makers to potential areas of concern that may warrant additional study. As with focus groups, open-ended surveys such as this allow unfiltered information to emerge, unconstricted by predefined responses.

A report was prepared containing a summary, analysis and conclusion that highlight the survey's major findings. A summary of the responses to the survey is provided for each question and is presented in the order in which they appear in the survey. To preserve the sentiment of respondents, responses to open-ended questions are recorded in the participants' own words, with no edits made by the authors of the report. Where possible the leading themes that emerge from the responses are summarized. Copies of the survey and the entire report can be found in Appendix G.

The most notable finding was that, when given the opportunity to rank ten issues of greatest concern in the Meramec's watersheds, respondents identified water quality as the most important issue. This sentiment was also reflected in many of the subsequent open-ended survey responses that asked participants to comment on the subject.

The results reflect a wide range of opinions from 130 St. Louis area residents, with 93 percent (121 individuals) having used at least one recreational facility in the area and 87 percent (113 individuals) having used more than one facility.

When presented with a list on common areas of concern for watersheds, on average, all items were ranked as important to very important. On average, respondents identified water quality as the most important among all concerns. Hiking/Biking along the Meramec River were the most frequently participated in recreational activities. Recreational facility use varies from 5.4 percent (Forrest Staley State Park) to 68.5 percent (Lone Elk Park). Additionally, all recreational facilities were used at least occasionally and the majority were used monthly or more than monthly.

Due to the constraints of time and the resources needed to conduct the survey, the number of participants was limited to those who willingly filled out the questionnaire online and at public meetings. Nevertheless, the survey results provide timely and valued information regarding the concerns of citizens and stakeholders and issues surrounding the Meramec River and its tributaries.

The **Lower Meramec Watershed Brochure** was developed for dissemination throughout the region using the Lower Meramec focus as a model. The brochure explains and illustrates what the Lower Meramec Watershed is, the diversity of the fish population in the Meramec River Tributary streams and threats and challenges to the watersheds. Priority local government actions, such as watershed management, LID strategies that protect the watershed are, also, described.

A **Homeowner's Guide to Septic System Maintenance** brochure was also developed for dissemination to homeowners who have septic tanks and other types of individual sewage disposal systems. The brochure describes the elements of a septic system, how it operates, maintenance responsibilities of the homeowner and signs of a malfunctioning septic system.

The draft plan was presented in public open houses at Eureka City Hall on October 27, at Valley Park City Hall on November 2, and at the Tri County Senior Center in Pacific on November 29. EWG staff accompanied by representatives from Metropolitan St. Louis Sewer District were present to inform, educate and answer questions posed by residents living in and affected by the watershed. The plan was also presented in draft form to the Water Resource Council and the Meramec Tributary Alliance. In addition the plan was sent to key stakeholders for comment.

Workshop for Municipal Officials and Interested Stakeholders
April 26, 2011 Valley Park MO

Lower Meramec Watershed Planning Timeline: Project planning Accomplishments

- January 7, 2010 - EWG receives *Clean Water Act Section* 604(b) Water Quality Management Planning Assistance Grant Sub-Award - American Recovery and Reinvestment Act (ARRA) FY 2009 EPA /MoDNR letter agreement.
- Contract period is January 1, 2010 through November 30, 2011 for tasks specified in the Scope of Services and Schedule of Milestones.
- May 21, 2010 – Lower Meramec Watershed planning and requirements presented at Water Resources Committee (Water Resources Advisory Committee (WRC))
- June 15, 2010 - Lower Meramec Watershed Orientation Kickoff
- November 4, 2010 – Lower Meramec Watershed status presented to Water Resources Advisory Committee (WRC)
- February 4, 2011 - Lower Meramec Watershed Survey released
- February 24, 2011 – Meremac River Tributary Alliance meeting at Route 66 State Park
- March 4, 2011 – Lower Meramec Watershed Plan update presented to Water Resources Advisory Committee (WRC)
- March 10 – May 26, 2011 – Staff Assistance Visit East-West Gateway and Lower Meramec Watershed communities
- April 26, 2011 – Lower Meramec Watershed Meeting, Valley Park, MO
- July 23, 2011 - 15th Annual Meramec Watershed Celebration, Meramec State Park
- August 5, 2011 – Lower Meramec Watershed Plan update presented at Water Resources Advisory Committee (WRC)
- August 27 & 28th, 2011 – 44th Annual Operation Clean Stream, Meramec and its Tributaries
- September 1, 2011 – MSD St. Louis County Phase II Stormwater Management Plan, Lower Meramec Watershed Plan presentation
- September 1, 2011 - Lower Meramec Watershed Brochure released
- September 1, 2011 – Lower Meramec Watershed Draft Plan submitted to MoDNR
- September 16, 2011 – Meramec River Tributary Alliance Meeting, Babler State Park
- Late October – November, 2011 – Lower Meramec Watershed Public Open House Meetings
- Late October – November, 2011 – Lower Meramec Watershed Coffee House Conversations
- October 1, 2011 - Operation Wild Lands at Rock Hollow Trail in Wildwood, MO
- October 15, 2011 – Operation Wild Lands at Queeny Park in Ballwin, MO
- October 31, 2011 - Lower Meramec Watershed Survey ends
- October 27, 2011 - Open House, City of Eureka, City Hall, Review of Draft Plan
- November 2, 2011 – Open House City of Valley Park, City Hall, Review of Draft Plan
- November 5, 2011 – Operation Wild Lands at Roger Klamberg Woods Conservation Area in Ellisville, MO
- November 29, 2011 – Open House, Tri County Senior Center, Pacific, Review of Draft Plan

- November 30, 2011 – Lower Meramec Watershed Plan completed and sent to MO DNR
- December 30, 2011 – Revised plan sent to MoDNR

Timeline 2011-2031

- 2011- 2016:
    - Complete sub-watershed plans for Kiefer, Fishpot and Grand Glaize
    - Implement first stage demonstration BMPs in public lands
    - Conduct annual Meramec River *Operation Clean Stream*
    - Hold Meramec Tributary Alliance meetings at least twice per year
    - Hold Water Resource Council meetings quarterly
    - Disseminate brochures on lower Meramec Watershed and Septic system maintenance
    - Conduct presentations to local governments and homeowners associations

- 2016-2021:
    - Complete demonstration projects listed for public lands and educational material to interpret and explain the projects
    - Complete sub-watershed plans for other 6-8 sub-watersheds
    - Work with cities to enact ordinances, develop plans for water quality improvements in sub-watersheds
    - Work with partners on land acquisition, easements and protection of greenway
    - Continue MRTA and Water Resource Council meetings
    - Begin outreach to homeowners to best practices on private property
    - Continue Operation Clean Stream
    - Conduct monitoring of sites in the watersheds to assess impact of demonstration projects

- 2021-2030:
    - Work with cities to implement sub-watershed plans
    - Carry out homeowner program to install rain gardens, bio-swales, etc., on private lands to achieve water quality goals for three key tributaries
    - Adjust plans to reach goals
    - Continue MRTA and Water Resource Council meetings, and Operation Clean Stream

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U.S. Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under the American Recovery and Reinvestment Act of 2009. Section 604(b) of the Clean Water Act.

Missouri Department of Natural Resources

Lower Meramec Watershed Partners supporting development of this project:

Missouri Department of Natural Resources

MISSOURI AMERICAN WATER

The Open Space Council for the St. Louis Region

Special thanks to other participating organizations and communities:

American Rivers
Audubon Society
Ducks Unlimited
Ecoworks Unlimited
Franklin County Public Works
Friends of LaBarque Creek
Great Rivers Greenway
Hellmuth & Bicknese Architects
Jefferson County Government
Meramec River Greenway
Meramec River Recreation Association
Missouri Botanical Garden – Shaw Nature Reserve
Missouri Coalition for the Environment
Missouri Department of Health
Missouri Smallmouth Alliance
Missouri Stream Team
Museum of Transportation
The Nature Conservancy of Missouri
Northern Ozark Rivers Partnership
Ozark Outdoors Riverfront Resort
Ozark Regional Land Trust
Pacific Ring Initiative
R. Barr Consulting
St. Louis County Municipal League
St. Louis County Parks and Recreation Department
St. Louis Earth Day
The Trust for Public Land
U.S. Fish and Wildlife Service
U.S. Forest Service
City of Ballwin
City of Ellisville
City of Eureka
City of Des Peres
City of Kirkwood
City of Manchester
City of Pacific
City of Valley Park
City of Wildwood

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