

GEOLOGY



A.

A.1. PHYSIOGRAPHIC REGION

The Meramec River basin is one of the most rugged regions of the Midwest. Most of the Meramec River basin lies within the Salem Plateau subdivision of the Ozark Plateau. The lower Meramec River lies within the Central Lowland Region.

Topography varies from wide ridges and gentle slopes to narrow ridges, steep slopes and bluffs. Gently rolling topography is found in the north and west portions. Steeply rolling topography is found in the south-central portions (USDA 1966). Land elevations range from 400 feet to 1,400 feet. Major features of the geology are Mississippian, Precambrian igneous, Ordovician Cincinnati and Champlian series, and Canadian series rock formations (Missouri Department of Natural Resources or MDNR 1986). Major rock types are dolomite, limestone, chert, and sandstone. Karst features such as caves, sinkholes, and underground streams are locally prominent in the Salem Plateau (MDNR 1986).

A unique feature of the karst Ozark Uplands is the presence of many springs. The Dry Fork watershed in Dent and Phelps counties is thought to contribute to Meramec Spring (Vineyard & Feder 1982; see subsection, D.2.1., Figure 13). The Dry Fork disappears or loses to reappear many miles north near the Meramec River (Pflieger 1971).

A.2. GEOLOGY

The Meramec River basin possesses a range of surface rocks varying in age from the Pennsylvanian to the Precambrian period (MDNR 1984, 1995a). The majority of the surface rock types are the Ordovician Age rock of the Gasconade and Roubidoux formations, which is underlain chiefly by limestone, dolomite to cherty dolomite with minor sandstone. To a lesser extent, the lower portions of the basin near the Mississippi River have rock of the Mississippian Age, which is a mix of St. Louis Limestone, Salem Formation, Keukok Limestone, and Burlington Limestone (MDNR 1979, 1995a). Between Gray Summit and Valley Park, the river winds through the geologically older Ordovician Age rock laid from oldest to youngest by St. Peter Sandstone, Joachim Dolomite, and Plattin Formation (limestone, shale, and chert). In the Huzzah-Courtois Creek watershed, the Cambrian rocks are overlain from oldest to youngest by the Davis (shale, dolomite, and conglomerate) Formation, Derby-Doerun Dolomite, and Potosi Dolomite at the surface (MDNR 1979, 1995a). The Potosi Dolomite is found primarily along the bottomlands of the upper and middle Meramec River, Huzzah and Courtois creeks. A fault dissects the Huzzah Creek watershed dividing the older Potosi Dolomite and the younger Gasconade and Roubidoux formations.

A.2.1. Losing Streams

Permeable geologic material of the Meramec River region allows streams to lose water to bedrock aquifers. Thirty percent or more of the stream flow must be lost to bedrock within two miles flow distance downstream of an existing discharge to be considered a losing stream (MDNR Clean Water Commission Water Quality Standards, 10 CSR 20-7.01, 1994). Most losing streams within the Meramec

River basin are found in Crawford, Phelps, Reynolds, and Dent counties, totaling 160.4 miles of streams for the listed counties (MDNR Division of Geology and Land Survey 1992). Knowledge of losing streams is useful for fish kill and pollution investigations. For example, a losing stream section of the Dry Fork had a break in an ammonia pipeline that killed cave crayfish in Maramec Spring. A list of the known losing streams is available from the Department of Natural Resources Division of Geology and Land Survey and the Water Pollution Control Program.

A.3. SOIL

The Natural Resources Conservation Service "NRCS" (formerly known as Soil Conservation Service "SCS") Soil Survey characterizes the Meramec River basin in an aggregate of soils known as the Deep Loess Hills area (Figure 2) within the northern most river portions (Jefferson and St. Louis counties), shifting to the Ozark Border and the Ozark Plateau to the southwestern extent (MDNR 1986). The Meramec River Watershed Regions and Generalized Soil Associations map (Figure 2) is based on 1991 Missouri digital soil survey data (NRCS). Associations have changed from the original SCS 1979 generalized soil references, illustrating improved information. The physiographic regions, however, have not changed and show the relative position of each region. Local variations in climate and parent material, landforms, and vegetation produce a variety of separate soil types. Based on the 1979 SCS Generalized Soils, within all major land resource areas, the Hartville-Ashton-Cedargap-Nolin Association parallels the Meramec River channel.

A.3.1. Soil Types

Within the Deep Loess Hills area, the Menfro-Winfield Association (Table 1) comprises part of the Meramec River basin (Allgood and Persinger, SCS 1979). Menfro is a deep, well-drained soil with slopes of 2 to 20%. Menfro formed in loess (wind-deposited silt, commonly accompanied by some clay and fine sand) ridge tops and side slopes. On the surface lies silt loam underlain by moderately permeable, silty clay loam subsoil. While formed, however, in the same loess ridge tops and side slopes and having the same surface and subsurface soil as Menfro, Winfield is moderately well drained with slopes of 2 to 20%.

The Ozark Border is a transitional area between the Deep Loess Hills area and the Ozark Plateau. Ridge tops have a thin mantle of loess caps and soils formed in fragipans (Allgood & Persinger 1979). Fragipans are loamy, brittle subsurface horizons, low in porosity and content of organic matter and low or moderate in clay. It appears cemented and restricts roots. Soil associations are similar to the Ozark Plateau with the exclusion of the Union and the Gasconade. The deep, cherty clayey soil is high in iron that oxidizes on exposure, giving a red color to the soils. Within the Ozark Border, two soil associations predominate: the Union-Goss-Gasconade-Peridge Association and the Hobson-Clarksville-Gasconade Association (Table 1).

Forests, scattered glades, and prairie areas are found in the Ozark Plateau. Soil types in this area are variable, generally having infertile, stony clay soils in some areas and fertile, loess-capped soils in others (MDNR 1986). Stony, cherty soils characterize much of the Ozark Plateau. Weathering of limestones, an important soil forming rock, leaves little behind except chert; as a result, soil formation is slow (Pflieger 1971). Within the Ozark Plateau four associations predominate: the Lebanon-Hobson-Clarksville Association, Hobson-Coulstone-Clarkville Association, the Captina-Clarksville-Doniphan Association, and the Hartville-Ashton-Cedargap-Nolin Association (Allgood & Persinger 1979). Possessing unique features, Lebanon is a moderately well-drained soil, holding a limited effective root zone due to the

presence of a fragipan. The Clarksville, which is largely devoted to the production of trees (USDA 1966), is excessively drained and formed in cherty dolomite and limestone residuum. On the surface is a very cherty silt loam underlain by very cherty, silty clay loam (Allgood & Persinger 1979).

A.3.2. Erosion Potential

Sheet, rill, and gully erosion are the three types of upland erosion that affect the streams in the Meramec River basin (Anderson 1980). Soil scientists define rill erosion as an incision created in the land greater than 12 inches in depth. These incisions occur mostly on recently tilled soils. Sheet erosion is soil removal by raindrop splash and overland flow that does not create channels greater than 12 inches in depth. In the Meramec River basin, sheet and rill erosion contribute 24-30 tons/acre from tilled land, 5-9 tons/acre from permanent pasture, and 0.25-0.5 tons/acre from non-grazed forest land to soil losses. In a 1978 Soil Conservation Service (SCS) Erosion Inventory Report for all upland types in the Meramec River basin combined, sheet erosion soil losses were 3.5 tons/acre/year (Anderson 1980). Also, sediment yield by stream basins was 0.9 tons/acre/year. The sediment sources are 80% sheet and rill erosion, 7% gully erosion, 3% stream bank, and 3% urban (Anderson 1980).

In comparison to other basins in this survey, the Meramec River basin was lower in actual sediment, mainly because the basin has comparatively less upper watershed development. Best Management Practices advocated by the SCS (called the Natural Resources Conservation Service, starting in 1995) are used by some landowners to reduce the impact of these forms of sedimentation (Anderson 1980). The 1979 SCS Missouri Water Quality Management Plan designated practices for erosion reduction and sediment control. Within the Meramec River basin resource area as defined by Soil Conservation Service, practices most needed were grade stabilization structures, contour farming, crop residue use, and conservation cropping systems. The watershed approach to improving streams was advocated at least as early as the 1940s. As Bill T. Crawford (1944) in *The Meramec - St. Louis Playground* writes, "to save the soil is to save the stream and this can be accomplished by cultivating only the gentle slopes, terracing, contour farming, strip cropping, substituting forage crops for row crops, reforestation, and preventing wood fires and overgrazing."

A.3.3. Riparian-Wetland Types

In wetland classification systems (several systems exist), water regime, soil characteristics, vegetation, and possible landscape positions are used to categorize natural Missouri wetlands into eight generalized types: swamp, shrub swamp, forested wetland, marsh, wet meadow, fens and seeps, pond and lake borders, and stream beds (Epperson 1992). For instance, fen wetlands have saturated soils from alkaline groundwater, while seep wetlands have a primary source of saturated soils from neutral, acidic, or saline groundwater. A cross-reference comparison among the generalized Missouri wetland types, the US Fish and Wildlife Services Cowardin System, the SCS Food Security Act System, and the Missouri Natural Terrestrial Communities System is presented in *Missouri Wetlands: A Vanishing Resource* by Epperson, 1992.

Riparian-wetland types are land adjacent to streams and are. The Missouri Department of Conservation's Natural Heritage Database contains an inventory of Missouri Natural Terrestrial Communities that are on publicly- and privately-owned land. This database also lists those rare and endangered species that are within different wetlands types or streams. The following are Missouri Natural Terrestrial Communities found within the Meramec River basin as listed in the Heritage Database: deep muck fen, fen, mesic bottomland forest, gravel wash, and wet-mesic bottomland forest (Table 2).

A.4. WATERSHED AREA

We estimated the basin's surface area from the MDC Fisheries Research GIS database (Table 3). The Meramec River basin drains a total of 2,149 square miles and 1,375,493 acres of land. The upper watersheds, the Dry Fork, the Upper Meramec River, the Huzzah Creek, and Courtois Creek, respectively, comprise 383, 345, 266, 220 square miles or 17.9, 16.1, 12.4, and 10.2% of the total basin area. The U.S. Geological Survey divides the Meramec River into the 11-digit (see Table 3 for clarification) Upper Meramec River watershed from river mile 166-218, the Upper Middle Meramec River watershed from river mile 110-166, Lower Middle Meramec River watershed from river mile 42-110, and the Lower Meramec River watershed from river mile 0-42 (see Figure 1 or Appendix A for clarification). The lower watersheds, the Lower Meramec River, the Lower Middle Meramec River, Indian Creek, and Upper Middle Meramec River, respectively, drain 234, 250, 158, and 293 square miles or 10.9, 11.6, 7.4, and 13.6% of the total watershed area.

A.5. STREAM ORDER AND MILEAGE

Stream order was determined using a system of classification that was first defined by Horton (1945) and later modified by A.N. Strahler (1952). Strahler called all unbranched tributaries first-order streams; two first-order streams join to make a second-order stream, and so on downstream to the stream mouth.

East Central Region Fisheries personnel determined stream mileage using a pair of locking dividers and U.S. Geological Survey topographic maps (Table 1-A, Appendix A) and tabulated stream mileages by name, watershed position, and mile marker confluence (Table 2-A to 9-A, Appendix A). The Meramec River has a total of 218 linear stream miles and 201 miles of permanent stream flow.

A.6. GRADIENT PLOT

Missouri Department of Conservation biologists in the East Central and St. Louis regions collected elevation and distance data from USGS 7.5 minute topographic maps (usually 20-foot contours). They tabulated gradient by stream order and watershed, measuring the vertical drop over a given distance for the number of streams that were third-order or greater (Table 2-A to 9-A, Appendix-A). Average gradient for the Upper Meramec River watershed is 34.7 feet/mile, and the average gradient for the Lower Meramec River watershed is 1.0 feet/mile.

Within a watershed, we created gradient plots for all fourth-order or greater streams, and for third-order streams that were at least 4.25 miles long (Appendix A, Figure 1-A thru 8-A). Also, a composite map of the Meramec River and tributaries was plotted (Appendix A, Figure A). In comparison, Courtois Creek is higher in elevation than Huzzah Creek, resulting in a much higher gradient (48.4 feet/mile versus 9.1 feet/mile). The Dry Fork, a losing stream, has a relatively mild stream gradient in most areas (15.3 feet/mile). The remaining tributaries, the Upper Meramec River (73.0 feet/mile) and Indian Creek (155.0 feet/mile), represent systems with the highest gradients.

Gradient plots are useful for understanding channel steepness in relation to geology. The relief of the land influences drainage, runoff, and other factors such as erosion. The average gradient of the river decreases downstream, so the long profile is a hyperbolic curve that decreases in gradient downstream (Appendix A, Figure A). For example, because the Meramec River basin did not undergo glaciation in the last glacial age, the present gradient is the result of erosional processes, structural dissection, and repeated uplift. The Salem Plateau is a very extensive landform covering most of the basin. Many

streams and hollows in the Salem Plateau tilt toward north and east. The lower basin has Deep Loess Hill soil types and elevated older rocks. Also, lower basin streams cut through the Ozark uplift (dolomite and sandstone bedrock), explaining the lower stream gradient. In the upper basin, a fault crosses the path of the Huzzah-Courtois Creek watershed, thrusting up older rocks so that most of the surface rock is Potosi Dolomite in the upper Huzzah-Courtois Creek watershed, changing abruptly to Gasconade and Roubidoux Dolomite. At this point near river mile 3.0, gradient in Shoal Creek decreases abruptly.

A.6.1. Gradient Related to Distribution of Fish

Gradient data was linked with the fish community data via the stream name, river mile, and order. Searches on a species of interest and its occurrence can tell us something about that species' distribution in relation to gradient. As expected, greater numbers of occurrences of catostomids were found at the lower gradients and lesser occurrences at higher gradient. Two other catostomids, the black redhorse and the northern hog sucker, had a greater distribution across stream gradient (Missouri Department of Conservation Fisheries Research Section 1995). The black redhorse was found in gradients ranging from 1 to 22 feet/mile, and the hog sucker gradients ranging from 2 to 33 feet/mile. Among the centrarchids, the species with the widest distribution was the longear sunfish, found in gradients ranging from 2 to 67 feet/mile. The rock bass was not quite so well distributed, occupying gradients ranging from 1 to 37 feet/mile. Benthic species, such as the northern orangethroat darter, the central stoneroller, and the Ozark sculpin, occupy a large number and wide range of gradients. These three species were collected at gradients ranging from 1 to 87 feet/mile. Cyprinids (minnows and shiners), such as the striped shiner, have a wide distribution and are found in relatively unstable, high gradient areas as well as stable, low gradient areas.

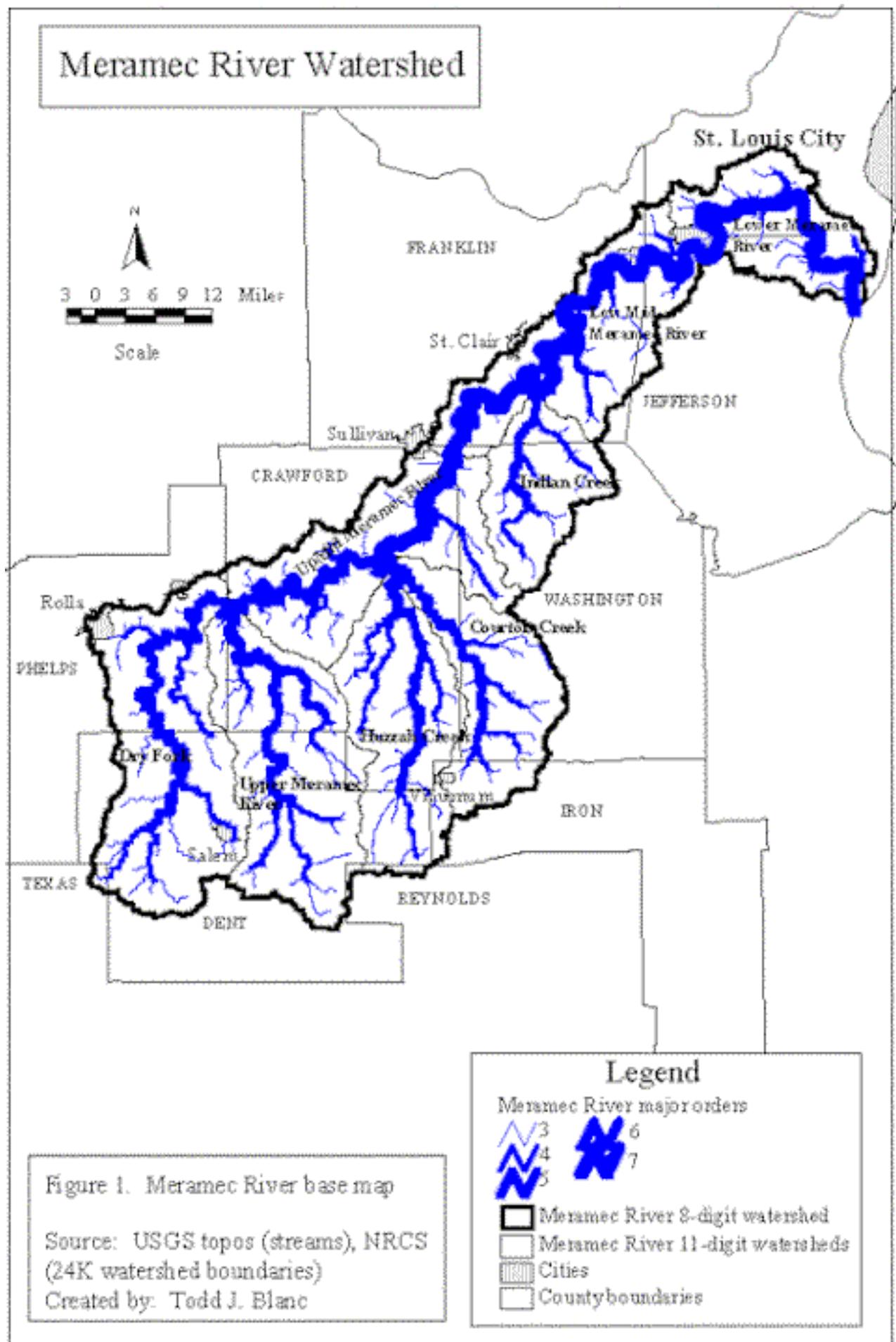


Figure 1. Meramec River base map

Source: USGS topos (streams), NRCS (24K watershed boundaries)
 Created by: Todd J. Blanc

Meramec River Watershed Generalized Soil Associations

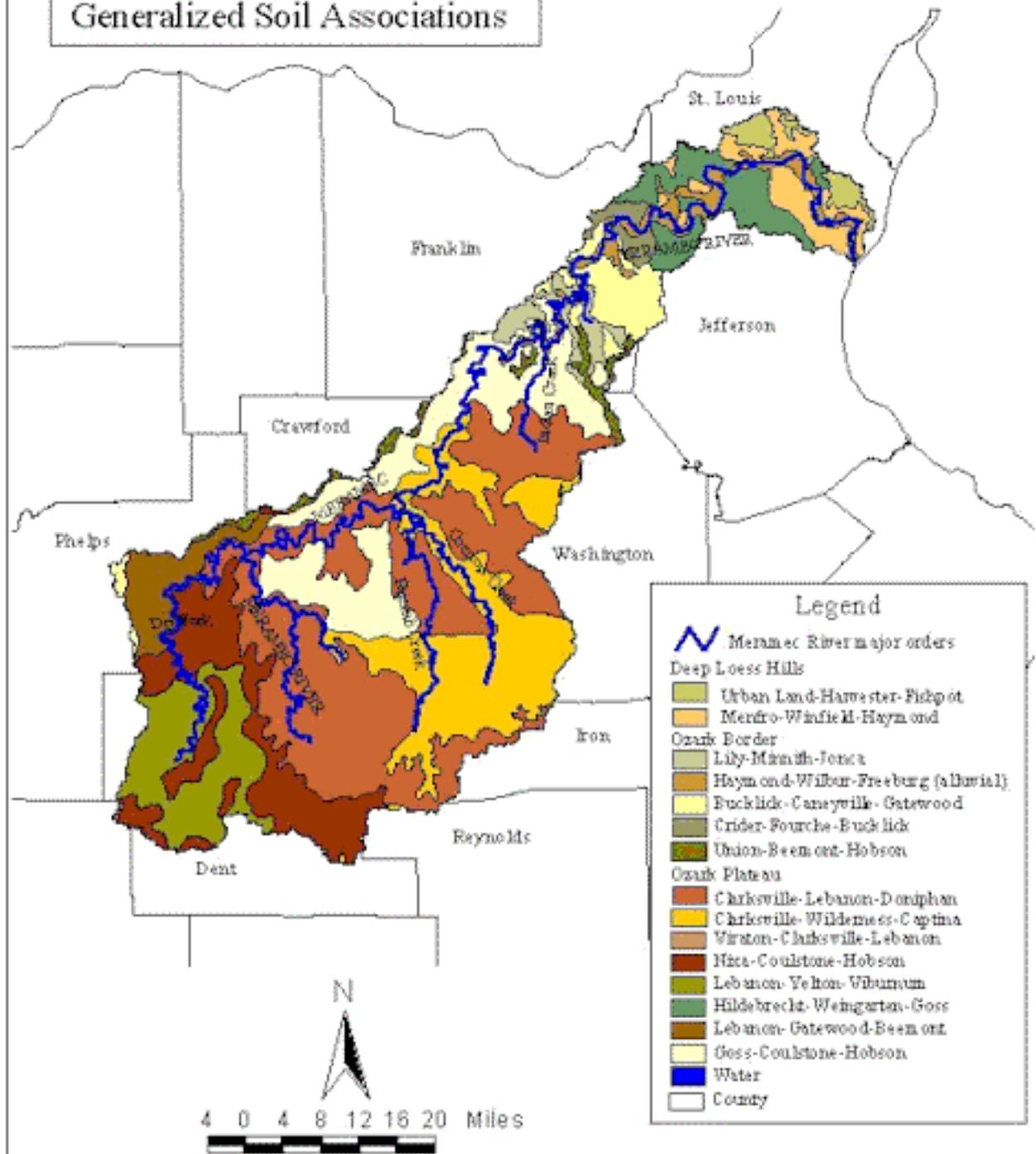


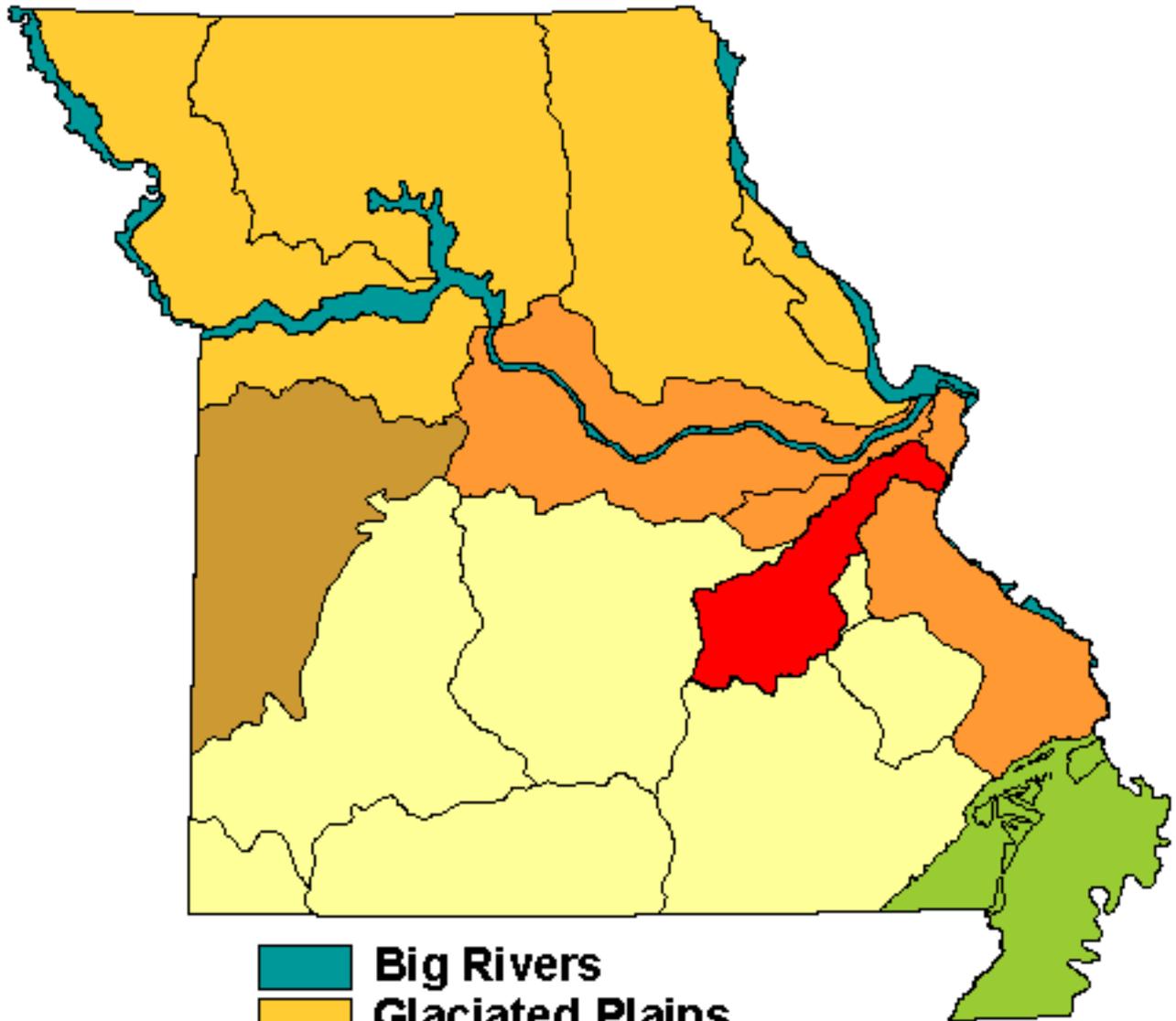
Figure 2. Generalized soils associations map for the Meramec River watershed.

Data source: STATSGO, 1997 & MDC Fisheries Research -- Hydrography.

Created by: Todd Blanc, 1997

Location of the Meramec River Watershed in relation to Missouri's Natural Divisions.

 **Meramec River Watershed**



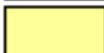
-  **Big Rivers**
-  **Glaciated Plains**
-  **Mississippi Lowlands**
-  **Osage Plains**
-  **Ozark**
-  **Ozark Border**

Table 1. Soil characteristics of the generalized soil associations (SCS 1979) related to hydrology, water management, erosion and runoff within the Meramec River basin (SCS Franklin Co. Soil Survey 1989, Dent Co. Soil Survey 1971, Iron Co. Soil Survey 1991, St. Louis Co. Soil Survey 1982)

Soil Name	<u>Feature Affects</u>		<u>Water Erosion Factors²</u>		<u>Water Features</u>	
	Grassed Waterway ¹	Drainage	K	T	Hydro-Soil Group ³	Water Capacity ⁴
Menfro	Erodes easily	Deep to water	0.37	5	B	0.20-0.24
Winfield	Erodes easily	Frost action(freezing and thawing of soil moisture), slope	0.37	5	B	0.20-0.24
Hartville	Erodes easily, percs slowly	Percs slowly, frost action	0.28-0.43	4	C	0.1-0.24
Union	Erodes easily, shallow root zone	Percs slowly, slope	0.43-0.43	4	C	0.11-0.21
Goss	Large stones, slope, droughty	Deep to water	0.1-0.24	2	B	0.04-0.17

Peridge	Erodes easily	Deep to water	0.37-0.32	5	B	0.16-0.20
Ashton	Erodes easily	Deep to water	0.43-0.28	4	B^a	NA
Cedargap	Large stones	Deep to water	0.1-.024	5	B^b	0.04-0.18
Nolin	Erodes easily	Deep to water	0.43-0.43	5	B^c	0.18-0.23
Hobson	Erodes easily, droughty	Percs slowly, slope	0.37-0.37	3	C	0.01-0.24
Clarksville	Large stones, slope, droughty	Deep to water	0.28-0.28	2	B	0.05-0.12
Gasconade	Large stones, slope, droughty	Deep to water	0.2-0.2	2	D	0.05-0.12
Lebanon	Wetness, erodes easily	Percs slowly, slope	0.32-0.43	4	C	0.02-0.22
Captina	Erodes easily, shallow root zone	Percs slowly, slope	0.43-0.32	3	C	0.14-0.16

Doniphan	Droughty, slope	Deep to water	0.28-0.28	4	B	0.08-0.10
Coulstone	Droughty, slope	Deep to water	0.24-0.24	3	B	0.06-0.09

¹ A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

² Soil erodibility factor (K) reflects the susceptibility of a soil to erode under the action of raindrop impact and water flowing over the surface (sheet and rill erosion). (T) is rating from 1 (most erodible) -10 (least erodible) on erodibility.

³ Refers to the soil behavior according to water infiltration, transmission, and runoff producing characteristics. The slope and the plant cover are not considered but are separate factors in predicting runoff. Group "A" has a high infiltration rate and low runoff potential. The other extreme is group "D" which has a low infiltration rate and a high runoff potential.

⁴ Presented is a range in inches from surface to bottom soil layer.

The amount of water that would be maintained in soil after natural drainage in response to gravity alone. Varies with soil texture, structure, rock fragment content and other soil properties.

The available water capacity in a 60-inch profile or to a limiting layer is:

0-6 inches: Very low, 3-6 inches: Low, 6-9 inches: Moderate, 9-12 inches: High

^a JAN-APR ^b NOV-MAY ^c FEB-MAY

Table 2. Wetland types identified by the Missouri Department of Conservation's Natural Features Inventory (MDC, 1995 printout of the Natural Heritage Database) within the Meramec River basinches

Missouri Natural Terrestrial Community	State Status	Site Name	Township Range Section	Managed Area or Private Owner
Deep Muck Fen	E¹	Cox Wet Meadow	T34N-R6W-S12	Private owner - 1979 Plat map
Deep Muck Fen	E	Spring Creek Wet Meadow	T34N-R6W-S02	Private owner - 1979 Plat map
Fen	R²	Bangert Seep Fens	T35N-R5W-S08	Private owner - 1979 Plat map
Fen	R	Bates Hollow Seep Fens	T34N-R3W-S03	Mark Twain NF
Mesic Bottomland Forest	-	Scott's Ford Access	T38N-R6W-S36	Scotts Ford Access
Mesic Bottomland Forest	-	Springs End Forest NA	T38N-R6W-S36	MDC
Mesic Bottomland Forest	-	Woods (Woodson K.) Memorial CA.	T37N-R5W-S07	MDC
Gravel Wash	-	Indian Trail CA-Fishwater Creek	T35N-R4W-S33/03	MDC
Wet-Mesic Bottomland Forest	R	Teszars Woods NA	T42N-R6E-S04	MDC/Private owner

State Status ¹ Endangered ² Rare

Table 3. Drainage area of major watersheds, Meramec River basin, Missouri (MDC Fisheries Research 1996). The hydrologic unit code - 07140102 - is the prefix to the watershed (USDA) code.

USDA Code	Watershed	Maximum Order	Area (acres)	Area (sq.mi)	% of Basin
010	Dry Fork	5¹	245,478	383.00	17.90
020	Upper Meramec River	5²	220,875	345.00	16.10
030	Huzzah Creek	6³	170,302	266.00	12.40
040	Courtois Creek	5⁴	140,801	220.00	10.20
050	Lower Middle Meramec RM 166-110	5⁵	159,792	250.00	11.60
060	Indian Creek	5⁶	101,046	158.00	7.40
070	Upper Middle Meramec RM 110-42	7⁷	187,513	293.00	13.60
080	Lower Meramec River	7⁷	<u>149,686</u>	<u>250.00</u>	<u>10.90</u>
	Total Meramec River basin		1,375,493	2,149.00	100.00
<p>¹Dry Fork ²Crooked Creek ³Huzzah Creek ⁴Courtois Creek ⁵Brazil Creek ⁶Indian Creek ⁷Meramec River</p>					