GEOLOGY/GEOMORPHOLOGY

Physiographic Region

The Big Piney Watershed lies within the Salem Plateau Subdivision of the Ozark Plateau Physiographic Region. The Salem Plateau Subdivision is a highly dissected plateau with upland elevations ranging from 1000 to 1400 feet above mean sea level (msl) and local relief (local relief refers to the difference in elevation between two nearby points such as a valley and an adjoining ridge top) ranging from 100 - 200 feet in the uplands to 200 - 500 feet elsewhere (MDNR 1986). Elevations within the watershed range from a maximum of approximately 1,663 feet above msl in the uplands to approximately 688 feet above msl in the lower portions of the watershed. Local relief data obtained from the Missouri Department of Conservation (MDC) Fisheries Research Fish Collection Database (1998a) indicates a minimum local relief of 56 feet and a maximum of 394 for MDC fish collection sites within the watershed.

Soils

The Big Piney Watershed occurs within the Ozarks Soil Region. Allgood and Persinger (1979) describe the Ozark Soils Region as

> "cherty limestone ridges that break sharply to steep side slopes of narrow valleys. Loess occurs in a thin mantle or is absent. Soils formed in the residuum from cherty limestone or dolomite range from deep to shallow and contain a high percentage of chert in most places. Some of the soils formed in a thin mantle of loess are on the ridges and have fragipans, which restrict root penetration. Soil mostly formed under forest vegetation with native, mid-tall and tall grasses common in open or glade area."

The following is a list of Ozark soil associations found in the Big Piney Watershed based on analysis of STATSGO soils database for Missouri (USDA-NRCS 1994):

Arkana-Moko-Gassville
Clarksville-Goss-Doniphan
Gepp-Doniphan-Agnos
Huntington-Nolin-Peridge
Lebanon-Yelton-Viburnum
Nixa-Coulstone-Clarksville
Viraton-Clarksville-Lebanon
Viraton-Scholten-Tonti

Geology and Karst

Ordovician dolomites and sandstone dolomites dominate the geology of the watershed, while small isolated remnants of Mississippian Limestone and Pennsylvanian Limestone occur in the upper portion of the watershed (Figure Ge01). Dolomites of the Jefferson City-Cotter Formation occur in the headwaters of the watershed and is absent in the Northeast portion of the watershed.

As streams become larger and move out of the headwaters, the Jefferson City-Cotter Dolomite is replaced by the dolomites and sandstones of the Roubidoux Formation. Streams in the lower elevations of the watershed as well as the valleys of much of the Big Piney River and Spring Creek incise Gasconade dolomite, a formation which is associated with most of the large springs in the Ozarks.

As is the case in most watersheds of the Ozarks, the geology of the Big Piney Watershed (primarily consisting of soluble rock formations of dolomites and sandstone dolomites), in combination with an average annual precipitation of over 42 inches, has created a karst landscape within the watershed. This karst landscape is characterized, in part, by a close relationship between the surface water and groundwater systems. Within karst landscapes, points or areas of surface water/ground water interaction include losing streams, sinkholes, and springs.

Losing streams are one manner in which surface water is transported or "lost" to the groundwater system. Within the Big Piney Watershed, 51 miles of streams have been designated as "losing" in the Rules of Department of Natural Resources Division 20-Clean Water Commission Chapter 7-Water Quality (Table Ge01 and Figure Ge02) (MDNR 2000b). This is estimated at 1 mile of losing stream to 14.8 square miles of watershed area (1:14.8). While slightly higher, this concentration of losing streams is relatively similar to that which has been documented within the remainder of its parent watershed, the Gasconade, which has a ratio of 1 mile of losing streams to 16.0 square miles of watershed area. In comparison, the neighboring North Fork and Current River Watersheds have losing stream/area ratios of 1:7.7 and 1:12.5 respectively. The longest losing segment within the Big Piney Watershed occurs in a 17 mile portion of Spring Creek. Within MDNR 2000b, a losing stream is defined as "A stream which distributes 30% or more of its flow during low flow conditions through natural processes, such as through permeable geologic materials into a bedrock aquifer within two (2) miles flow distance downstream of an existing or proposed discharge". Due to the specific nature of this definition, many streams within the watershed, which possibly lose large amounts of flow to the groundwater system, may have yet to be surveyed or classified as being "losing" in the broader sense of the word. Further study may be needed in order to develop a comprehensive understanding of the role of losing streams within the watershed.

In addition to losing streams, sinkholes provide another point of surface to groundwater interaction. The MDNR has identified 153 sinkholes or probable sinkholes within the Big Piiney Watershed (Figure Ge02)(MDNR 2002). Additional detailed mapping of sinkholes (not included in this report) as well as other geologic features was completed on FLWMR and the surrounding area as part of an extensive geologic mapping project funded by FLWMR and conducted in 1994-1995 by the USGS in support of geohydrologic and water quality studies conducted there (Harrison et al. 1996).

Springs are the naturally occurring outlets of groundwater systems. Spring flow accounts, to a large extent, for the higher sustained flows of many Ozark streams, including the Big Piney, relative to streams in other regions of Missouri. Within the Big Piney Watershed there are 67 known springs (1 spring /11.3 square miles of watershed area) (Vineyard and Feder 1974 and MDNR 2000a) (Figure Ge01). Vineyard and Feder (1974) lists discharges for 17 springs within

the watershed (Table Ge02). Ten of these springs have discharges exceeding 1 cubic foot per second (cfs). The largest spring within the watershed is Stone Mill Spring which has an average flow of approximately 29 cfs. Figure Lu02 shows recharge areas for 8 springs within the watershed and two springs which occur outside the watershed but whose recharge areas occur partially within the watershed.

Stream Order, Mileage and Permanency

Stream order is "a hierarchy in which stream segments are arranged" (Judson et al. 1987). The process of stream ordering is accomplished by examining maps and assigning orders to stream segments based on other streams which flow into them. Using the Strahler/Horton method of stream ordering, when two stream segments of the same order join, the new segment they create is the next highest order. For instance, a first order stream would be a stream in which no other streams intersect it. A second order stream is created by the joining of two first order streams. A third order stream is created by the joining of two second order streams and so on. If the main channel of a stream happens to be a lower order than that of the intersecting stream, the main channel assumes the higher order. If the main channel is a higher order stream than the intersecting stream, it maintains the higher order (Figure Ge03).

Maximum orders for streams within the Big Piney Watershed have been obtained from a 1:24,000 scale Geographic Information System (GIS) hydrography coverage. There are 91 third order and larger streams within the watershed (Table Ge03 and Figures Ge04 and Ge05). These streams account for a total of approximately 602 stream miles or 30% of the total stream miles within the watershed. Of the 91 third order and larger streams within the watershed, 70 are third order (287.3 miles), 14 are fourth order (111.4 miles), and 6 are fifth order (92.6 miles). The Big Piney River is is 110.5 miles long and becomes sixth order at the confluence of West Piney Creek.

Permanent stream mileage data based on the 1:24,000 National Hydrography Dataset (NHD) for the Watershed indicates that approximately 322 stream miles (16%) within the watershed have permanent water. This equals approximately 1 mile of permanent stream for every 2.3 square miles of drainage area. The Big Piney River has permanent water for approximately 107 of its 111 mile length according to NHD data. Table Ge03 lists permanent stream mileage for the remaining third order and larger streams in the watershed.

It is important to note that permanent stream mileage data within the 1:24,000 NHD is based on USGS Digital Line Graph hydrography data which, in turn is based upon USGS 1:24,000 scale topographic maps (USGS 1998e, USGS 1999b, MoRAP 2002). The USGS assigns a stream permanent status based on that stream having flow twelve months out of the year during normal precipitation (Weirich 1993, Blanc etal. 1999). This method may not take into account periods of drought or the possible 'losing' nature of a stream.

Drainage Area

Total drainage area of the Big Piney Watershed is 755 square miles (482,956 acres). There are 5 major subwatersheds (based on 5th order streams) within the watershed. These include the

subwatersheds of Spring Creek, West Piney Creek, Arthur Creek, Big Paddy Creek, and Bald Ridge Creek (Figure Ge06). The largest of these is the Spring Creek Subwatershed with a drainage area of 109 square miles (69,448 acres). In order to facilitate analysis of watershed characteristics the watershed was divided based on eleven digit hydrologic units. This resulted in 4 units. The largest of these units is the Middle Big Piney Unit which drains approximately 254 square miles (162,815 acres).

Stream Channel Gradient

Channel gradient was determined for all fifth order and larger streams within the watershed using data derived from 1:24,000 scale hydrography and hypsography coverages for the Big Piney Watershed (Figures Ge07-12). Average gradients for fifth order and larger streams within the watershed range from 7.3 feet per mile to 38.9 feet per mile. The Big Piney River has an average gradient of 7.3 feet/mile. This is similar to the gradient of the Jacks Fork River which is 7.1 feet per mile.

Table get01. Big Piney Watershed stream reaches designated as losing in Table J Rules of Department of Natural Resources Division 20-Clean Water Commission Chapter 7-Water Qualaity. Code of Regulations (MDNR 2000b).

Stream Name	Counties	Miles	From	To
Bradford Br.	Phelps	2.0	se se se 05 34n 09w	se nw ne 06 34n 09w
Unnamed Trib.	Pulaski	2.0	se sw sw 23 35n 11w	ne se ne 25 35n 11w
Dry Br.	Pulaski	4.0	se 11 35n 11w	c 25 36n 11w
Trib. to Big Piney R.	Pulaski	2.0	nw ne nw 34 35n 11w	nw nw sw 36 35n 11w
Round Pound Hollow	Pulaski	3.0	sw sw ne 33 36n 11w	se se nw 25 36n 11w
Brushy Cr.	Texas	2.5	sw nw sw 07 32n 08w	sw nw se 10 32n 09w
Spring Cr.	Texas	2.0	ne ne nw 32 33n 08w	nw sw se 36 33n 09w
Spring Cr.	Texas, Phelps	17.0	ne ne se 01 32n 09w	se nw se 36 35n 10w
Kelly Hollow	Texas	3.0	nw sw se 32 31n 08w	se sw nw 25 31n 09w
L. Paddy Cr.	Texas	1.5	nw ne nw 03 32n 11w	nw se se 35 33n 11w
B. Paddy Cr.	Texas	3.0	sw nw sw 24 32n 11w	ne ne ne 18 32n 10w
Bald Ridge Cr.	Texas, Pulaski	5.5	sw se nw 22 33n 11w	nw sw ne 36 34n 11w
Mooney Br.	Texas	2.0	ne ne ne 19 33n 09w	ne sw nw 12 33n 10w
Trib. to Piney Cr.	Texas	1.5	se se sw 04 29n 10w	ne ne ne 03 29n 10w
Watershed Total		***51.0***		

Table get02. Location and discharge (cubic feet per second) of selected springs in the Big Piney Watershed (Vineyard and Feder 1974).

Name	County	UGSG 7.5' Quad. Name	Discharge (CFS)
Boiling Spring	Texas	Prescott	13.40*
Cox Spring	Phelps	Flat	0.01*
Coyle Spring	Texas	Houston	0.60
Hales Cem. Spring	Pulaski	Devils Elbow	0.01
Hazelton Spring	Texas	Slabtown Spring	6.28*
Mathis Spring	Phelps	Flat	0.02*
Miller Spring	Pulaski	Big Piney	18.90*
Ousley Spring	Pulaski	Devils Elbow	0.75*
Pillman Spring #1	Phelps	Devils Elbow	8.61*
Prewett Spring	Pulaski	Slabtown Spring	17.45*
Pruett Spring	Phelps	Flat	0.15
Relfe (Coppedge) Spring	Phelps	Flat	19.40*
Roaring Spring	Texas	Slabtown Spring	1.31*
Shanghai Spring	Pulaski	Devils Elbow	18.00*
Slabtown Spring	Texas	Slabtown Spring	14.00*
Stone Mill Spring	Pulaski	Big Piney	29.00*
Unnamed	Phelps	Devils Elbow	<0.01

*Average of multiple measurements.

Table get03. Third order and larger streams of the Big Piney Watershed.
Note: Unnamed Streams are designated with the prefix 'BPW' (Big Piney Watershed) followed by a number assigned according to the streams location in the watershed hierarchy relative to other third order and larger unnamed streams.

Stream Name	Order	USGS 7.5' Quad at Mouth	Receiving Stream-Order	Permanent Miles*	Total Miles*
Anderson Creek	3	Beulah	Big Piney R.-6	0.0	2.8
Arthur Creek	5	Prescott	Big Piney R.-6	10.5	13.3
BPW001	3	Elbow	Big Piney R.-6	0.0	3.8
BPW002	3	Big Piney	Spring Cr.-5	0.0	2.4
BPW003	3	Flat	Elm Cr.-3	0.0	2.3
BPW004	3	Flat	Sherrill Cr.-4	0.0	2.7
BPW005	3	Beulah	Sherrill Cr.-4	1.5	2.9
BPW006	3	Maples	Sherrill Cr.-4	0.0	1.1
BPW007	3	Maples	Sherrill Cr.-4	0.0	3.0
BPW008	3	Flat	Spring Cr.-4	0.0	3.5
BPW009	3	Beulah	Spring Cr.-4	0.0	11.2
BPW010	3	Devils Elbow	Big Piney R.-6	0.0	3.0
BPW011	3	Big Piney	Big Piney R.-6	0.0	7.0

Table 3 continued

Stream Name	Order	USGS 7.5' Quad at Mouth	Receiving Stream-Order	Permanent Miles*	Total Miles*
BPW012	3	Big Piney	Watts Hol.-4	0.0	2.0
BPW013	3	Slabtown Spring	Long Hol.-4	0.0	1.5
BPW014	3	Slabtown Spring	Big Piney R.-6	0.3	2.4
BPW015	3	Slabtown Spring	Big Piney R.-6	0.0	4.1
BPW016	3	Slabtown Spring	L. Paddy Cr.-4	0.0	2.1
BPW017	3	Slabtown Spring	L. Paddy Cr.-4	0.0	2.1
BPW018	3	Success	Big Paddy Cr.-4	0.0	2.0
BPW019	3	Success	Steam Mill Hol.-4	1.1	3.4
BPW020	3	Prescott	Mullin Br.-3	0.0	2.3
BPW021	3	Success	Burton Br.-4	0.0	3.5
BPW022	3	Bucyrus	West Piney Cr.-5	3.2	5.5
BPW023	4	Huggins	West Piney Cr.-5	0.0	4.0
BPW024	3	Huggins	BPW023-4	0.0	3.2
BPW025	3	Huggins	West Piney Cr.-4	1.5	4.8
BPW026	3	Houston	Indian Cr.-3	0.4	2.3
BPW027	3	Cabool NE	Big Piney R.-5	1.7	3.2
BPW028	3	Elk Creek	Elk Cr.-4	0.0	4.2
BPW029	3	Elk Creek	Elk Cr.-4	2.1	3.5
BPW030	3	Elk Creek	Elk Cr.-3	0.0	2.8
BPW031	3	Cabool NE	Big Piney R.-5	0.0	1.8
BPW032	3	Cabool SE	Potter Cr.-4	0.0	3.1
BPW033	3	Cabool SE	Potter Cr.-3	0.0	2.1
BPW034	3	Cabool SE	Big Piney R.-4	0.0	3.9
Bald Ridge Creek	5	Big Piney	Big Piney R.-6	5.8	11.5
Bear Creek	3	Cabool NE	Big Piney R.-5	1.3	4.2
Beeler Branch	3	Cabool NE	Big Piney R.-4	3.1	5.0
Bender Creek	4	Prescott	Arthur Cr.-5	3.3	10.4
Berry Branch	5	Cabool NE	Big Piney R.-5	2.4	4.4
Big Paddy Creek	5	Slabtown Spring	Big Piney R.-6	11.0	11.1
Big Piney River	6	Dixon	Gasconade R.	107.4	110.5
Boone Creek	3	Prescott	Big Piney R.-6	6.6	11.2
Bradford Branch	3	Flat	Spring Cr.-5	0.0	3.4
Bridges Hollow	3	Prescott	Steam Mill Hol.-4	0.0	3.1
Brushy Hollow	3	Success	Big Paddy Cr.-4	0.0	3.4
Burton Branch	4	Prescott	Big Piney R.-6	5.0	7.8
Cap Hollow	3	Big Piney	Crossing Hol.-4	0.0	2.5
Chambers Hollow	3	Flat	Spring Cr.-5	0.0	2.9
Cole Hole Hollow	3	Licking	Bender Cr.-4	0.0	2.8
Crossing Hollow	4	Big Piney	Big Piney R.-6	0.7	6.9
Devils Hollow	3	Houston	Arthur Cr.-3	0.0	3.9
Dog Creek	3	Elk Creek	Hog Creek-4	0.0	3.4
Dry Creek	4	Devils Elbow	Big Piney R.-6	4.5	6.6

Table 3 continued

Stream Name	Order	USGS 7.5' Quad at Mouth	Receiving Stream-Order	Permanent Miles*	Total Miles*
Elk Creek	4	Cabool NE	Big Piney R.-5	5.8	8.2
Elm Creek	3	Flat	Bradford Br.-3	0.0	3.2
Emery Hollow	3	Bucyrus	Big Piney R.-6	0.0	5.7
Falls Hollow	3	Big Piney	L.Bald Ridge Cr.-4	2.0	3.3
Flat Rock Hollow	3	Houston	Arthur Cr.-4	1.8	3.6
Hamilton Creek	3	Bucyrus	West Piney Cr.-5	8.6	12.8
Hog Creek	4	Bucyrus	Big Piney R.-5	8.1	10.9
Hooker Hollow	3	Devils Elbow	Big Piney R.-6	0.0	3.6
Hungry Hollow	3	Bucyrus	West Piney Cr.-5	0.0	3.1
Indian Creek	3	Houston	Big Piney R.-5	6.4	8.2
Jacktar Hollow	3	Prescott	Big Piney R.-6	1.4	1.4
Kelly Hollow	3	Raymondville	Flat Rock Hol.-3	0.0	4.2
Lawrence Hollow	3	Flat	Spring Cr.-5	0.0	2.6
Little Bald Ridge Cr.	4	Big Piney	Bald Ridge Cr.-5	3.2	4.9
Little Hog Creek	3	Elk Creek	Hog Cr.-4	1.8	3.6
Little Paddy Creek	4	Slabtown Spring	Big Paddy Cr.-5	4.2	6.9
Long Hollow	4	Slabtown Spring	Bald Ridge Cr.	0.0	4.6
McCourtney Hollow	3	Big Piney	Big Piney R.-6	0.0	8.0
Mooney Branch	3	Slabtown Spring	Big Piney R.-6	0.0	9.8
Mullin Branch	3	Prescott	Arthur Cr.-5	2.2	4.6
Opossum Creek	3	Bucyrus	West Piney Cr.-5	4.0	6.3
Potter Creek	4	Cabool NE	Big Piney R.-5	7.6	8.7
Rocky Branch (1)	3	Slabtown Spring	Big Piney R.-6	2.1	4.5
Round Pond Hollow	3	Devils Elbow	Dry Cr.-4	0.0	2.2
Sherrill Creek	4	Flat	Spring Cr.-5	8.7	13.7
Slabtown Branch	3	Slabtown Spring	Big Piney R.-6	0.0	6.6
Smoky Hollow	3	Devils Elbow	Big Piney R.-6	0.0	5.2
Spring Creek	5	Devils Elbow	Big Piney R.-6	19.3	32.3
Spurlock Hollow	3	Bucyrus	West Piney Cr.-5	2.2	4.8
Steam Mill Hollow	4	Prescott	Big Piney R.-6	6.6	9.4
Teasley Hollow	3	Big Piney	Spring Cr.-5	0.0	5.2
Watts Hollow	4	Big Piney	Big Piney R.-6	0.0	8.4
West Piney Creek	5	Bucyrus	Big Piney R.-6	17.4	20.0
Wolf Hollow	3	Slabtown Spring	Big Piney R.-6	0.4	6.1
Brushy Creek	3	Houston	Big Piney R.-6	6.6	8.8
Rocky Branch (2)	3	Bucyrus	Big Piney R.-5	0.0	2.6

*****Determined from Analysis of 1:24,000 scale GIS hydrography coverage

Abbreviations: Br.-Branch, Cr.-Creek, Hol.-Hollow, R.-River

Figure Ge01.

Big Piney Watershed

Geology and Springs

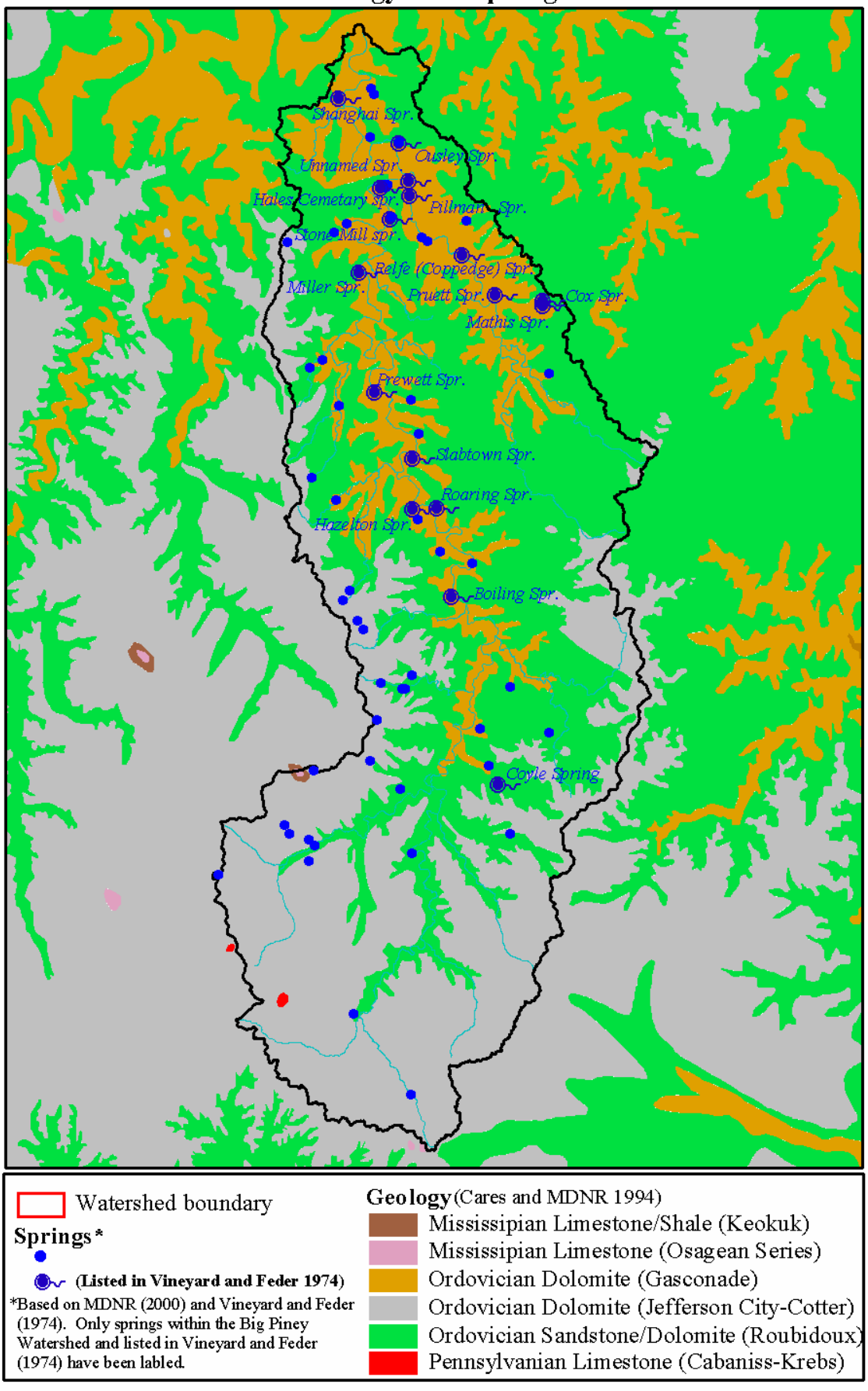
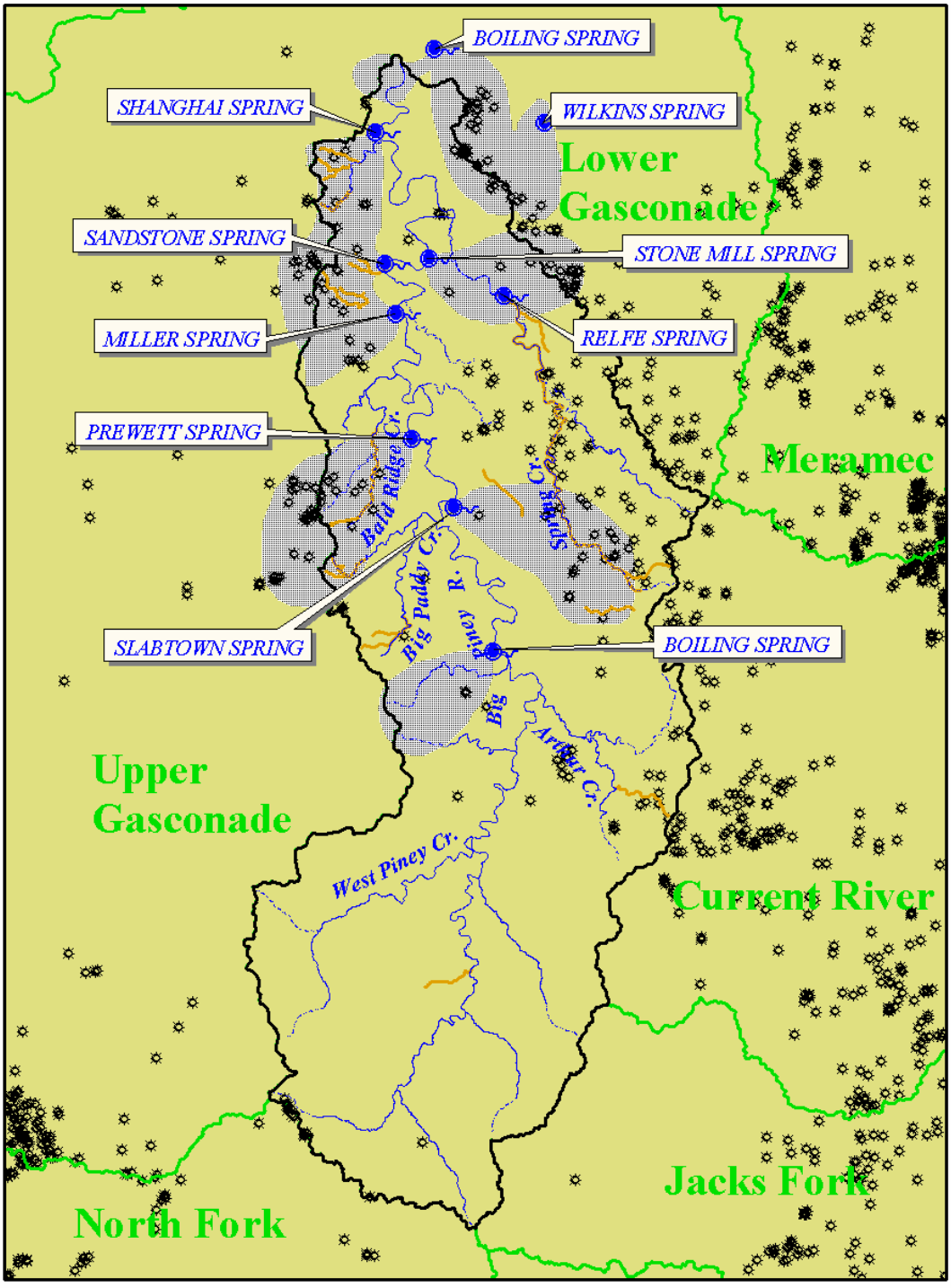


Figure Ge02.

Big Piney Watershed

Karst Features



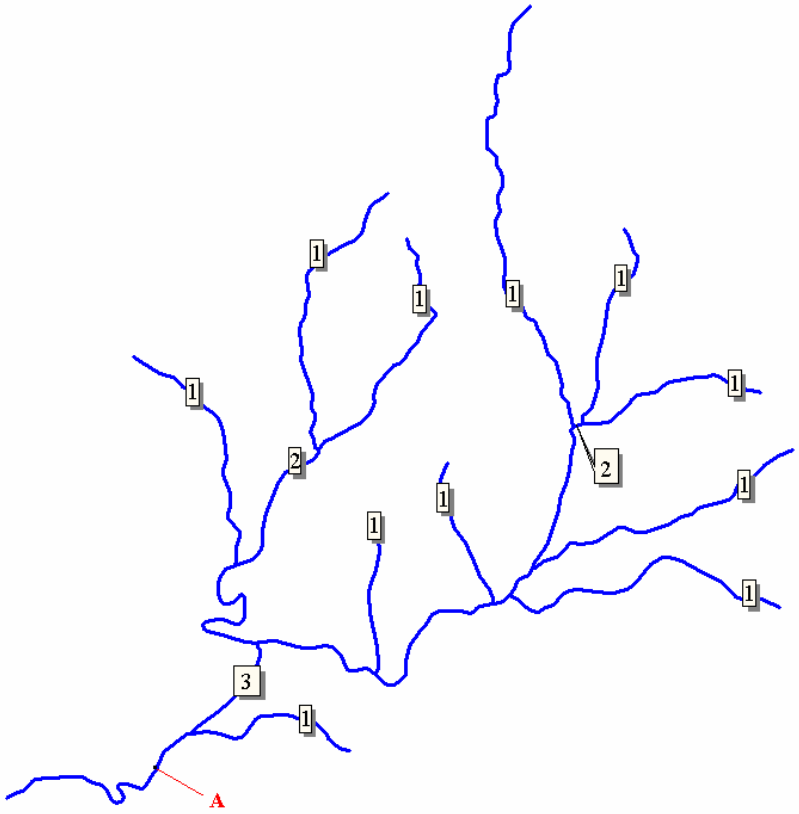
Legend

- Watershed boundary
- Neighboring Watershed boundary
- Spring Recharge Area*
- Known/Probable Sinkhole (MDNR 2002)
- Losing Stream

*Adapted from Mugel and Imes (2003)

N

Figure Ge03. Example of Stream Order



The stream order at point "A" is 3.

Figure Ge04.

Lower Big Piney Streams
(Third Order and Larger)

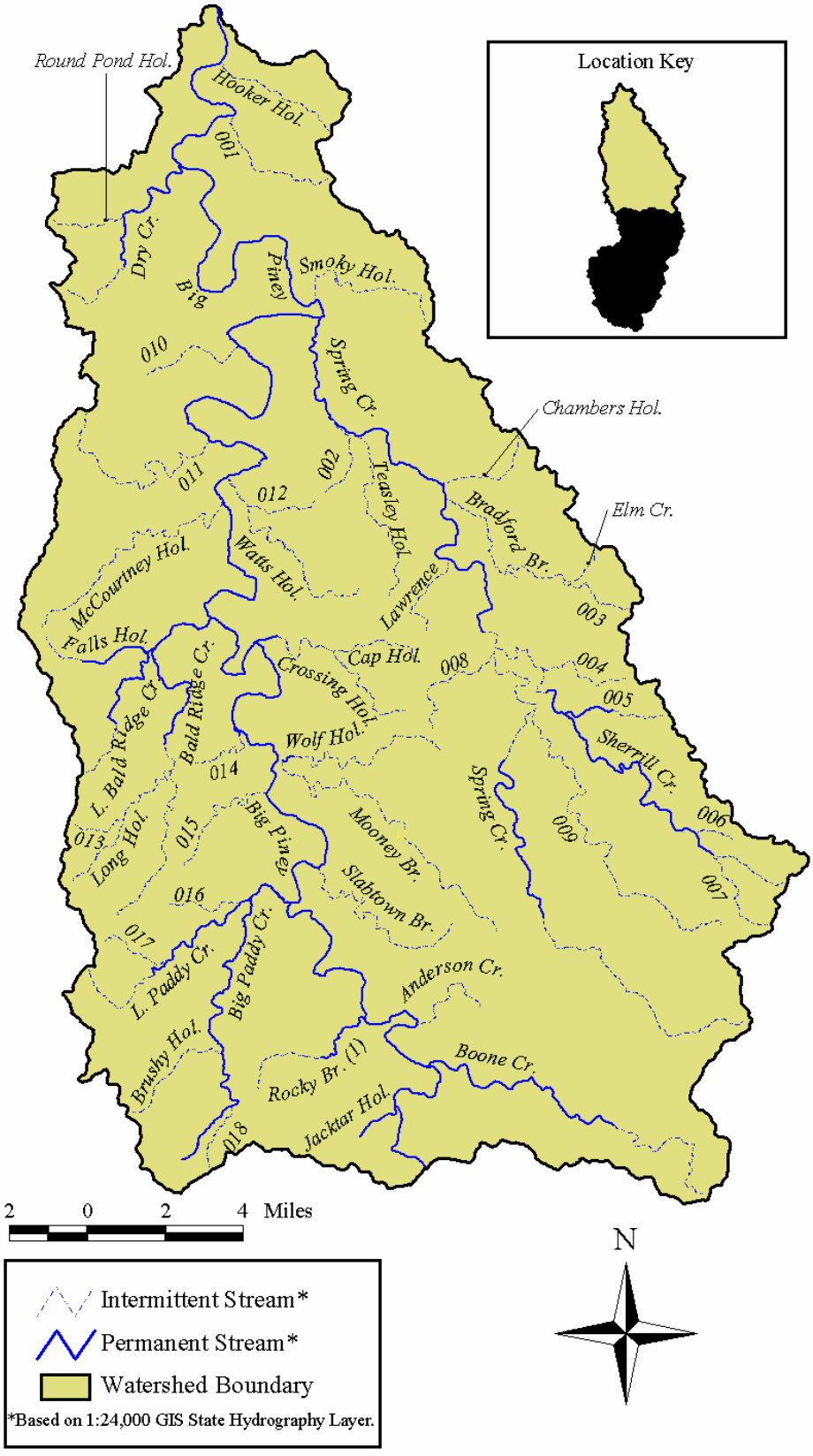


Figure Ge05.

Upper Big Piney Streams
(Third Order and Larger)

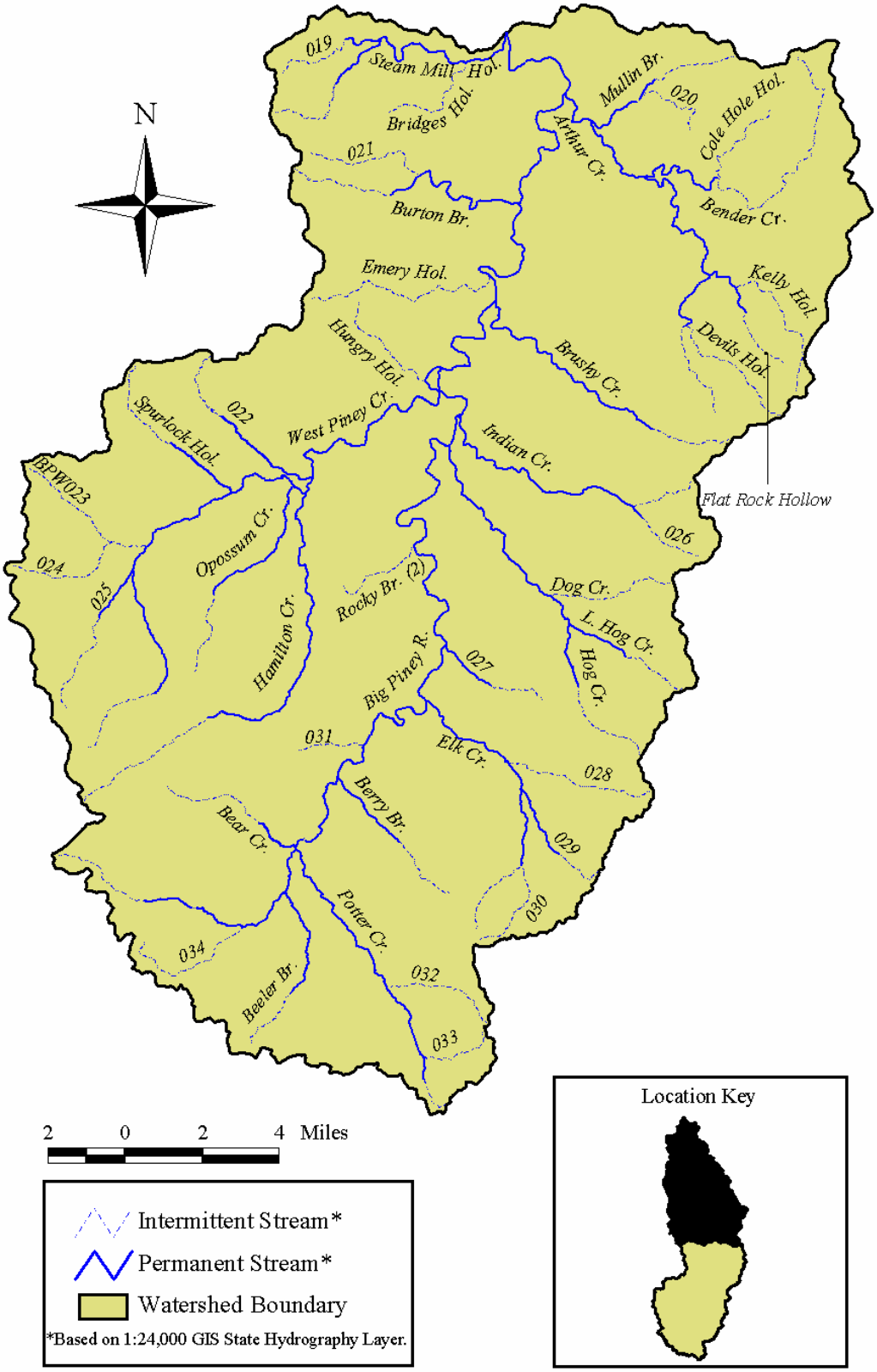


Figure Ge06.

Big Piney Watershed

Hydrologic Units & Subwatersheds

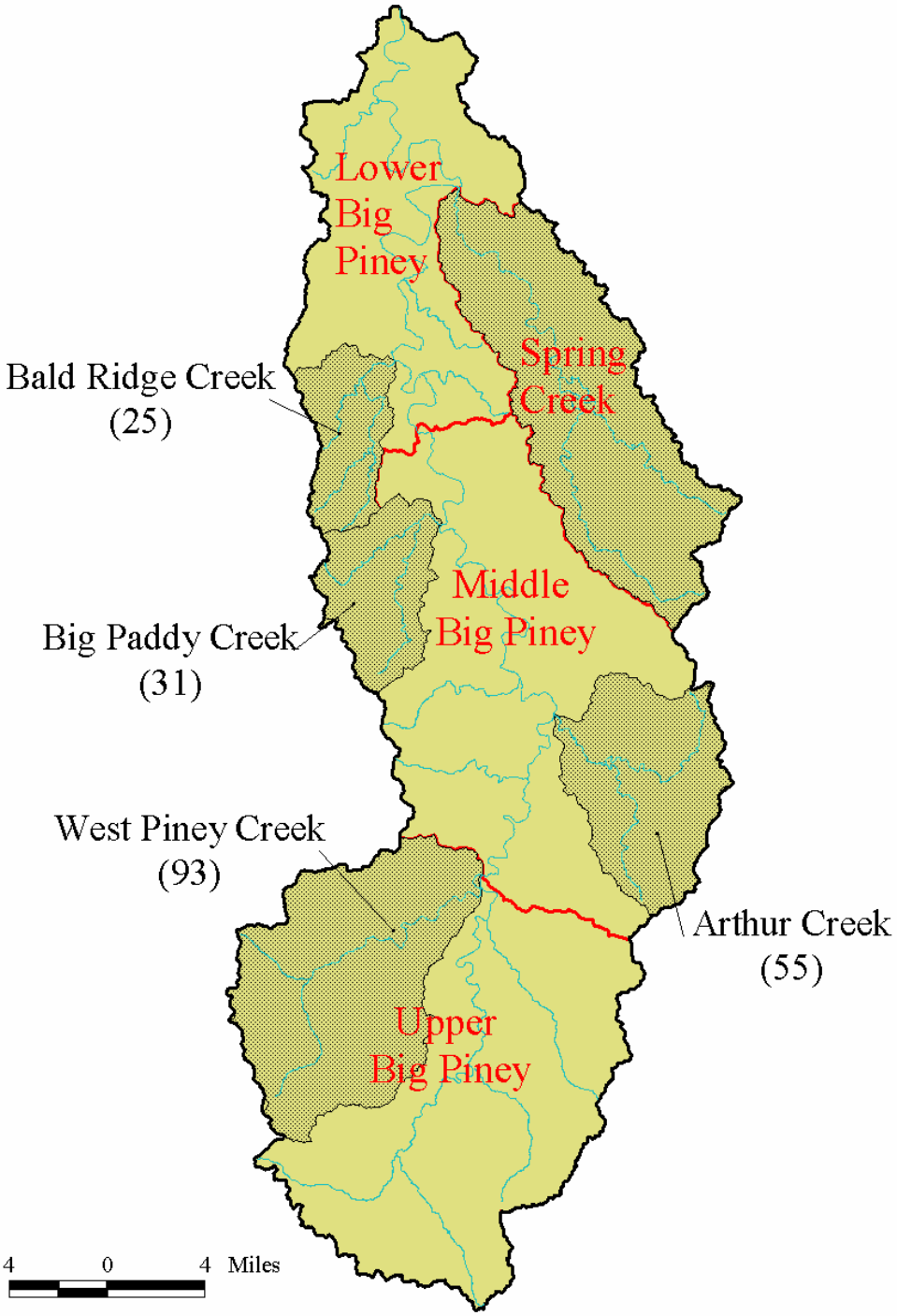


Figure Ge07.

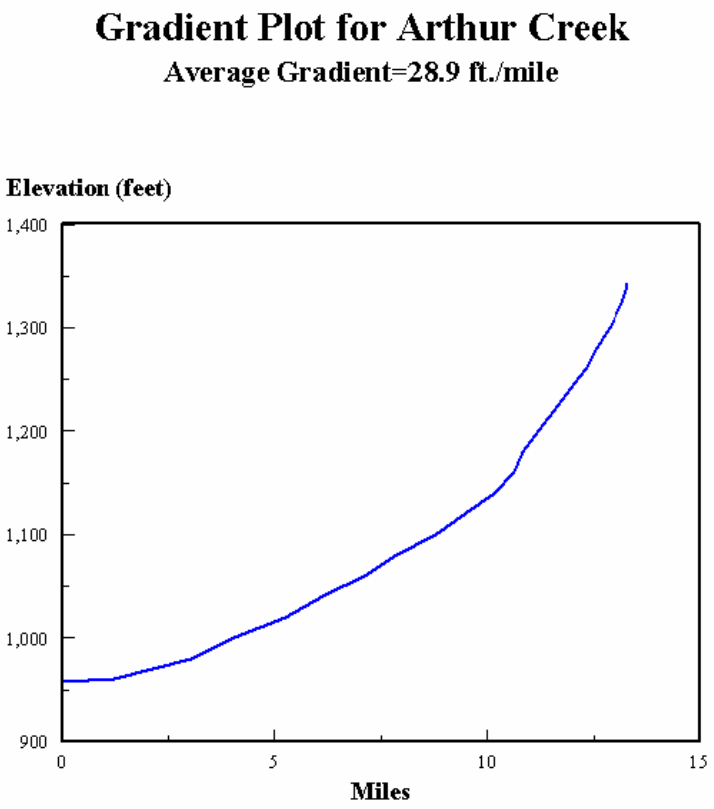


Figure Ge08.

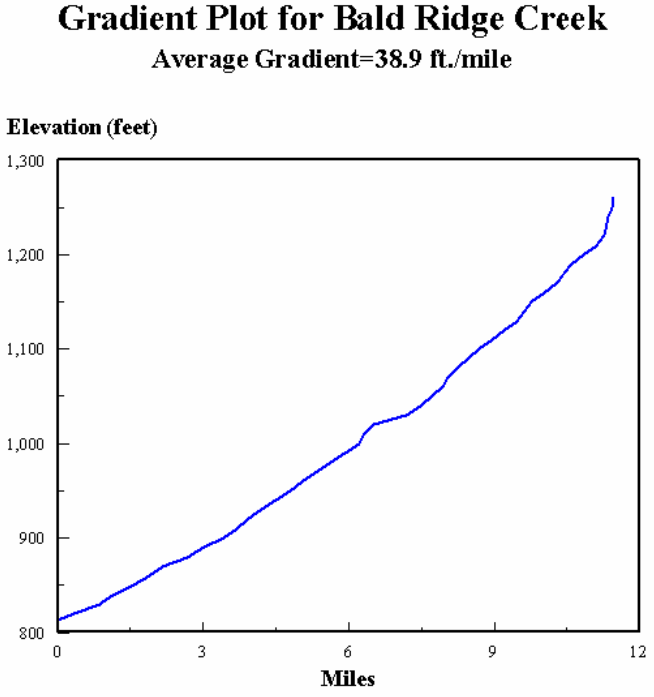


Figure Ge09.

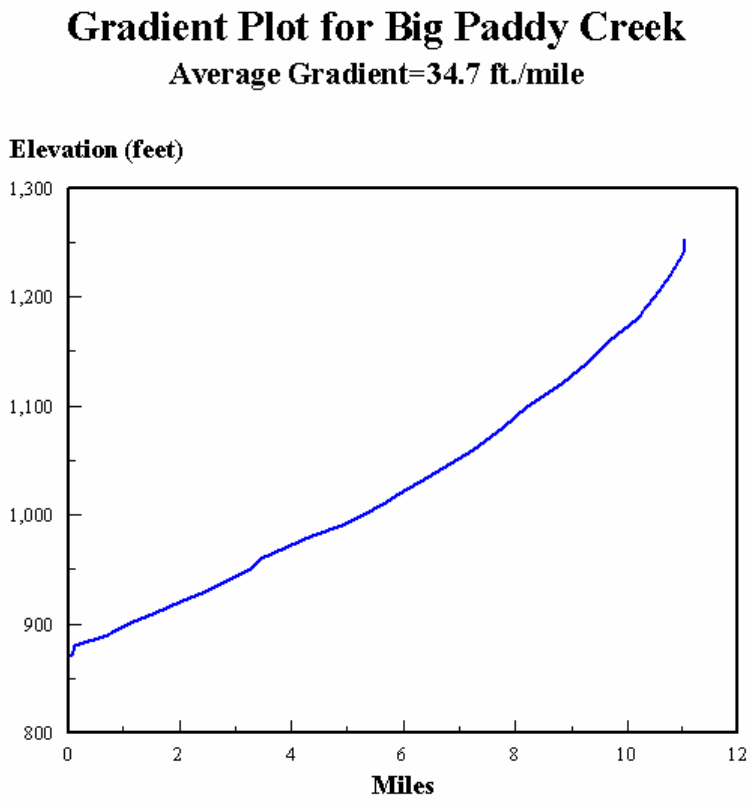


Figure Ge10

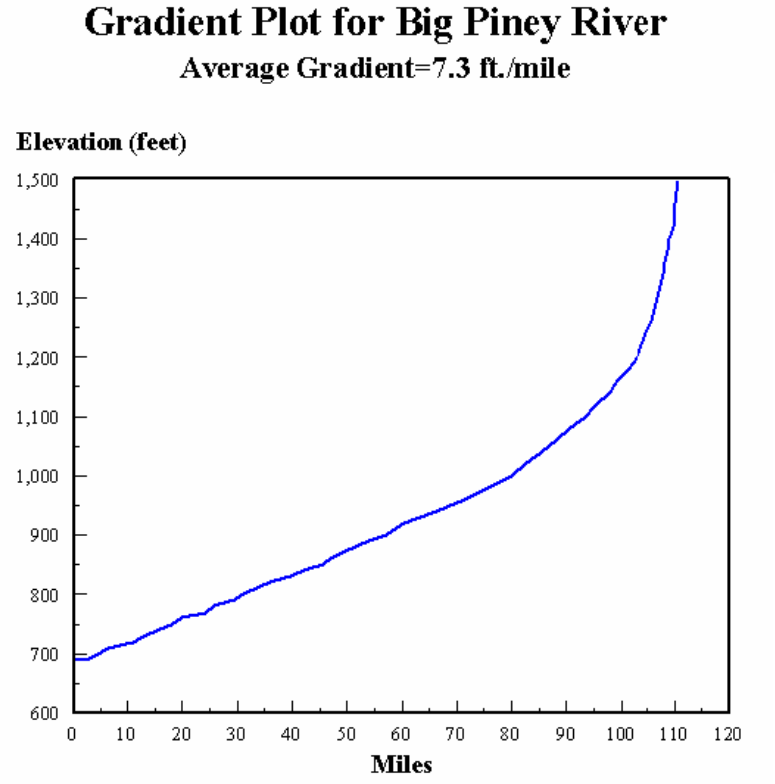


Figure Ge11

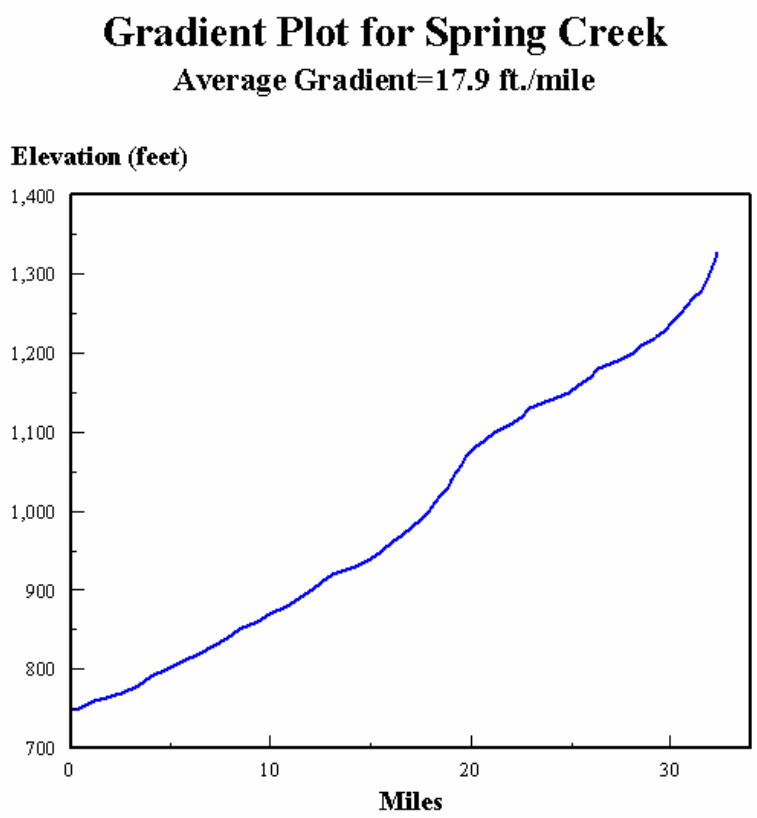


Figure Ge12.