HYDROLOGY

Precipitation

The Big Piney Watershed is situated in one of the wetter parts of Missouri which receives from 32 inches of precipitation in the Northwest to 48 inches in the Southeast portion of the state (Figure Hy01)(MDNR 1986). Analysis of precipitation data based on Easterling et al. (1995) indicates that the Big Piney Watershed receives an average of approximately 41.5 inches of precipitation annually. Analysis of individual annual precipitation amounts for the period 1923 to 1994 indicates a trend toward increased annual precipitation amounts within the watershed (Figure Hy02a). Mean monthly precipitation data for the period indicates that the combined months of April, May, and June receive the most precipitation at 13.39 inches. The combined months of December, January, and February receive the least amount of precipitation at 7.32 inches. May receives the highest mean precipitation amount at 4.91 inches, while January receives the lowest at 2.18 inches (Figure Hy02b).

United States Geological Survey Gaging Stations

The USGS has, as of 2002, two active surface discharge gage stations within the Big Piney Watershed (Table Hy01 and Figure Hy01) (USGS 2002a and USGS 2003). Station 06930000 (Big Piney River Near Big Piney, Mo.) is located on the Big Piney River 14.8 miles upstream from Spring Creek and 3.0 miles east of Big Piney, Missouri (USGS 2000a). The datum of the gage is 800.99 ft above mean sea level (msl). Station 06930000 has been recording daily discharge data periodically since October 1921. Station 06930060 (Big Piney Below Ft. Leonard Wood, Mo.) is located on the Big Piney River at the Highway J/FLW East Gate Road crossing approximately 2.8 miles upstream from Spring Creek. Station 06930060 has been recording daily discharge data since December 1999.

In addition to the previously mentioned active stations, historical daily discharge and/or peak flow records exist for 3 additional surface discharge stations within the watershed with various records available from 1950 to 1997 (Table Hy01).

Daily Mean Discharge Statistics

While discharge data exists for 5 sites within the Big Piney Watershed, Station 06930000 (Big Piney River Near Big Piney, Mo.) provides the most long-term comprehensive dataset available. At this site, discharge data was collected continuously from 1921 to 1982, 1988 to 1996, and 1999 to present. Although some limitations are presented by gaps in this dataset as well as the fact that it is not a record of discharge for the entire watershed, it has been used for analysis because of its extensiveness relative to the remaining stations.

The annual mean discharge of the Big Piney River near Big Piney, Missouri is 542 cubic feet per second (cfs) (USGS 2003a). The highest daily mean discharge at this station is 22,900 cfs which occurred on September 26, 1993. The lowest daily mean discharge is 60cfs which occurred on September 7, 2001. Table Hy02 lists annual, highest daily, and lowest daily mean discharges as well as the median daily discharge for four analyzed stations. The gap in data between and 1981

and 1989 makes it difficult to accurately determine a single trend in annual mean daily discharge for Big Piney River near Big Piney. For the period of 1923-1981, a trend of decreasing annual mean discharge is indicated; while discharge for the period 1989-1994 shows an increasing trend (Figure Hy03). Annual precipitation trends for these periods appear reflective of these discharge trends even if somewhat more moderate; however, the precipitation for the entire period of 1923-1994 shows increasing precipitation amounts. This would seem to indicate that the missing discharge data perhaps hides an increasing trend in discharge for the entire period. Analysis of all available discharge data for the Big Piney River near Big Piney reveals that daily mean discharge has been lowest during the months of August, September, and October and highest during March, April, and May (Figure Hy03). The same relative differences are exhibited by daily median discharge as well (Figure Hy03).

As alluded to previously, the drainage area contributing runoff to Station 06930000 is only 74% of the entire Big Piney Watershed. The runoff from the largest 5th order subwatershed in the watershed is excluded from the drainage area of this station. Currently, no daily stream discharge data is available for the Big Piney River downstream of Spring Creek.

Flow Duration

Flow duration curves are useful for determining the variability or flashiness of stream flow as well as how the discharge of a stream is sustained over time. These factors are determined by many variables including climate, watershed land cover/land use, soil type, and topography. A daily flow duration curve has been plotted for Station 06930000 (Big Piney River near Big Piney) (Figure Hy04) using data from whole calendar years only for the period of record 1922-1994. Analysis of this data results in a flow duration curve which is similar to those exhibited by other Ozark streams. The slope above the 10 percentile range, within the higher discharge range, is relatively steep indicating that flood type discharges are infrequent or not sustained for long periods of time. In the 10 to 90 percentile range, the slope is moderate indicating well sustained stream discharges over extended periods of time. This is at least partially attributable to the storage and transport capacity of the karst topography within the watershed and surrounding area.

10:90 Ratio

The 10:90 ratio is used as an indicator of discharge variability. It is the ratio of the discharge which is equaled or exceeded 90% of the time. It is useful for determining summer carrying capacity in streams as well as for interbasin comparisons. The lower the 10:90 ratio, the lower the variability of flow. The 10:90 ratio for the Big Piney near Big Piney is 8.3 (Skelton 1976). This is a low value relative to 10:90 values of drainages of similar size in areas outside the Ozark region of the state (Skelton 1976). This value is similar to 10:90 values from surrounding watersheds with the exception of the remainder of the Upper Gasconade which exhibits 10:90 ratios over twice that of the Big Piney (Table Hy03). The relatively low 10:90 ratios of the Big Piney and surrounding watersheds are due in large part to the water storage and release characteristics of the karst geology, a feature shared by many Ozark watersheds. It is important to note, however, that many streams within the Ozarks (many of which do not have discharge records) are "losing" in nature and thus will

typically exhibit higher 10:90 ratios. An example of this is the Eleven Point River near Thomasville (Station 07070500) which has a drainage area similar in size to that of the Jacks Fork at Eminence, but which has a high concentration of losing streams and a 10:90 ratio of 22.9 as compared to 6.9 for the Jacks Fork.

Instantaneous Discharge

On the Big Piney River, the highest instantaneous peak flow of 43,400 cfs was recorded in 2002 below FLW. The record instantaneous low flow at this site was 103 cfs in 2001. Table Hy02 lists the highest and lowest instantaneous discharge rates that have occurred at selected stations within the Big Piney Watershed.

7-day Q2, Q10, Q20 Low Flow and Slope Index

Q2, Q10, and Q20 seven day low flows refer to the lowest 7 day discharges that have a recurrence interval, on average, of 2, 10, and 20 years respectively. Some of the issues which low flow statistics help answer include the relative permanency of a stream and thus the streams ability to support aquatic life, the influence of groundwater in a particular watershed, as well as issues related to effluent discharge. The Big Piney station near Big Piney has seven day Q2, Q10, and Q20 low flow values of approximately 115, 82, and 75 cfs, respectively (Skelton 1976 and MDNR 1997). Table Hy04 lists low flow values for additional sites within the Big Piney Watershed. When analyzed relative to drainage area, these values are many times higher than those of north and west Missouri prairie streams and relatively similar to other Ozark streams which, as a basic rule, tend to have the highest sustained low flows in Missouri (Skelton 1976). The slope index (SI, ratio of the seven day Q2 to Q20) is 1.5 for the Big Piney River at Big Piney for discharge data between 1922 and 1972. This is a low slope index, an indication of low variability in annual low flows. Slope index values for additional gage stations are given in Table Hy04.

Flood Frequency

Magnitudes and frequencies of flooding for the Big Piney near Big Piney range from 12,600 cfs with a frequency of 2 years to 52,800 cfs for a 100 year frequency (Alexander and Wilson 1995). Table Hy05 lists additional flood frequency estimates.

Table Hy01. USGS continuous surface discharge gage stations within the Big Piney River Watershed (USGS 2003a and 2003b). Active stations (as of 2004) are in bold. Period of record for peak flow measurements is given in parenthesis.

Station #	Station Name	Drainage Area (mi ²)	Period of Record
06928700	Beeler Branch Near Cabool Mo.	7.78	1967-1976 (1967-1979)
06929000	Coyle Branch At Houston, Mo.	1.10	(1950-1979)
06929315	Paddy Cr. Ab. Slabtown Spring, Mo.	34.2	1993-1997 (1993-1997)
06930000	Big Piney River Near Big Piney, Mo.	560.00	1921-Present (1922-Present)
06930060	Big Piney Below Ft. Leonard Wood, Mo.	593.00	1999-Present (2001-Present)

Table Hy02. Discharge statistics for selected United States Geological Survey Discharge Gage Stations within the Big Piney Watershed (USGS 1998b, 2003a, and 2003c).

Station #	Station Name	Median	Mean	Instant Peak Flow	Max	Instant Low Flow	Min
06928700	Beeler Branch Near Cabool Mo.	1.7	7.1	4,700 10/26/70 4/15/72	545 1/29/69	N/A	0.0 (m)
06929315	Paddy Cr. Above Slabtown Spring, Mo.	4.6	24.3	8,610 11/14/93	2,320 11/14/93	0.22 9/19/93	0.41 8/17/96
06930000	Big Piney River Near Big Piney, Mo.	257	542	38,300 5/9/02	22,900 9/26/93	58 9/7,8/01	60 9/7/01
06930060	Big Piney River Below Ft. Leonard Wood, Mo.	221	543	43,400 5/9/02	32,300 5/9/02	103 9/6/01	103 9/6/01

⁽m)=Multiple measurements at this value.

Table Hy03. Comparison of 10:90 ratios from the Big Piney (in bold) and surrounding watersheds (Skelton 1976).

Station #	Name	Watershed	Drainage Area	10:90
07066000	Jacks Fork at Eminence	Jacks Fork	398	6.8
07057500	North Fork River near Tecumseh	North Fork	561	4.6
07058000	Bryant Creek near Tecumseh	North Fork	570	6.9
07066500	Current River near Eminence	Current	1,272	5.5
07067000	Current River at Van Buren	Current	1,667	5.0
07068000	Current River at Doniphan	Current	2,038	4.1
06928000	Gasconade River at Hazelgreen	Gascoande	1,250	25.0
06928500	Gasconade River near Waynesville	Gasconade	1,680	20.7
06930000	Big Piney River near Big Piney	Big Piney	560	8.3
06932000	Little Piney Creek at Newburg	Gasconade	200	6.1
07013000	Meramec River near Steelville	Meramec	781	8

Table Hy04. Low flow calculations for selected USGS stations within the Big Piney Watershed (Skelton 1976 and MDNR 1997).

Station #	Station Name	Drainage Area (mi ²)	Q2	Q10	Q20	Slope Index
06928700	Beeler Branch near Cabool	7.78	0.2	ı	-	NC
06928900	Big Piney River near Houston	N/A	24.0	17.0	15.0	1.6
06929310	Hazleton Spring at Hazleton	N/A	5.0	3.9	1	NC
06929320	Slabtown Spring near Licking	N/A	11.0	9.5	-	NC
06930000	Big Piney near Big Piney	560	115.0	82.0	75.0	1.5
06930030	Stone Mill Spring near Spring Creek	N/A	20.0	16.0	-	NC
06930100	Spring Creek at Spring Creek	N/A	21.0	15.0	9.5	2.2
06930400	Shanghai Spring near Waynesville	N/A	9.4	7.2	-	NC

NC=Not Calculable

Table Hy05. Two to 100 year flood discharges (cubic feet per second) for selected USGS Gage Stations within the Big Piney Watershed (Alexander and Wilson 1995).

Station		Recurrence Interval (years) (Discharge in cubic feet per second)						
		5	10	25	50	100		
06929000 (Coyle Branch at Houston, Mo.)	216	424	601	869	1,100	1,360		
06930000 (Big Piney near Big Piney, Mo)	12,600	21,800	28,700	38,000	45,300	52,800		

Figure Hy01. Big Piney Watershed Hydrologic Stations

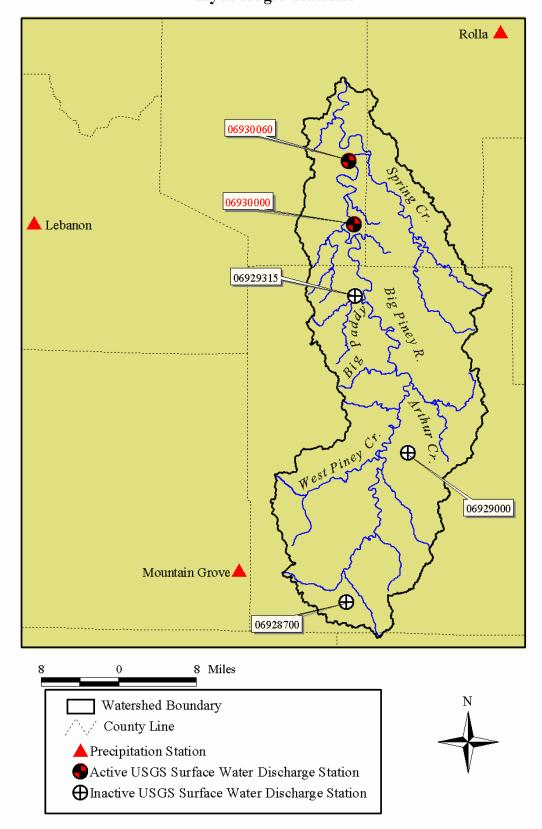


Figure Hy02. (a) Estimated mean annual precipitation amounts and (b) mean monthly precipitation amounts in the Big Piney Basin for years 1923-1994 based on analysis of Easterling et al. (1995).

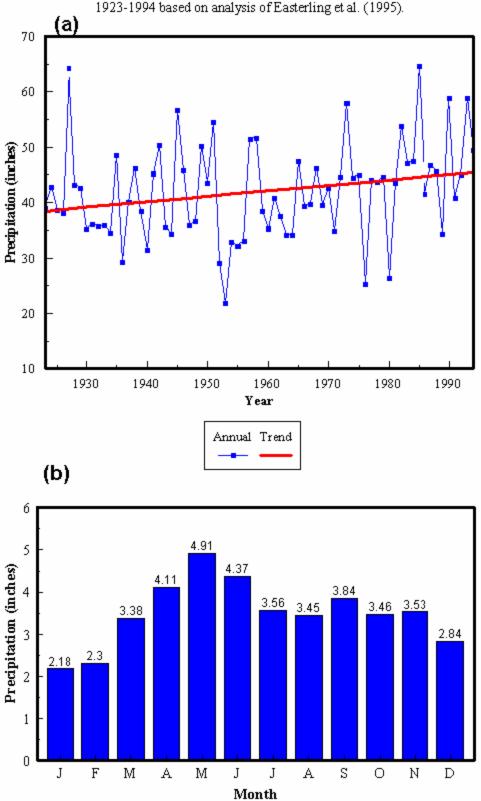


Figure Hy03.

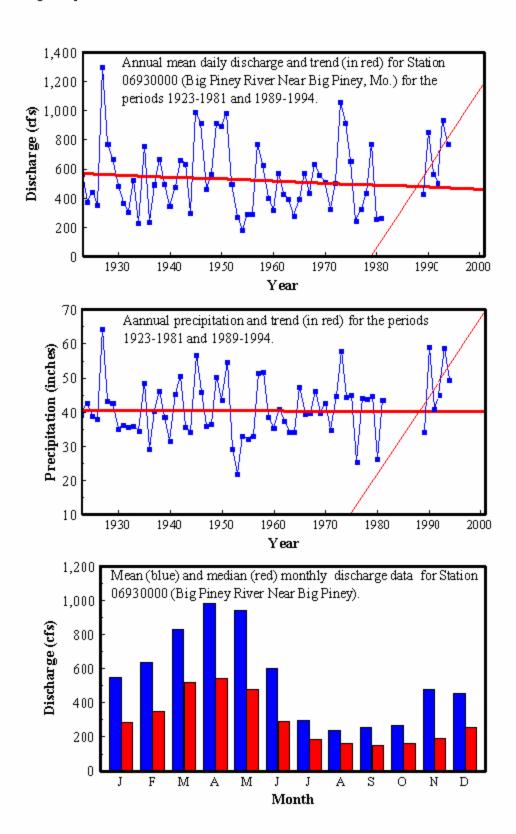


Figure Hy04. Flow duration curve for Station 06930000 (Big Piney River Near Big Piney, Mo.)

Discharge (cub ic feet per second)

