Peak Streamflow on Selected Streams in Arkansas, December 2015

By Brian K. Breaker

Heavy rainfall during December 2015 resulted in flooding across parts of Arkansas; rainfall amounts were as high as 12 inches over a period from December 27, 2015, to December 29, 2015 (fig. 1). Although precipitation accumulations were highest in northwestern Arkansas, significant flooding occurred in other parts of the State. Flood damage occurred in several counties as water levels rose in streams, and disaster declarations were declared in 32 of the 75 counties in Arkansas.

Given the severity of the December 2015 flooding, the U.S. Geological Survey (USGS), in cooperation with the Federal Emergency Management Agency (FEMA), conducted a study to document the meteorological and hydrological conditions prior to and during the flood; compiled flood-peak gage heights, streamflows, and flood probabilities at USGS streamflow-gaging stations; and estimated streamflows and flood probabilities at selected ungaged locations.

This report provides hydrologic information pertaining to the severity of floods that occurred in Arkansas in 2015 and recalculated flood-frequency statistics for 33 USGS streamflow-gaging stations in Arkansas that incorporate peaks from the December 2015 flood (table 1). In addition to streams with streamflow-gaging stations, nine ungaged locations in northwestern Arkansas were selected for indirect discharge measurement computations in order to calculate the peak flow and to estimate the annual exceedance probability (or recurrence interval) of the peak flow (table 1). For comparison, flood-frequency statistics were calculated for a previous event that occurred at streamflow-gaging station Red River at Index, Ark. (07337000). Methods used to obtain peak flows are briefly discussed. All data to support this study can be obtained from the USGS National Water Information System (U.S. Geological Survey, 2016). Flood probability statistics and associated inundation areas and peak water-surface elevations are used for infrastructure design, community planning, and for the protection of life and property.

Estimating Peak Streamflows

Peak streamflow was calculated for 33 USGS streamflow-gaging stations using the discharge-rating curve method (Rantz and others, 1982). Discharge-rating curves represent the graphical relation between measured streamflow and gage height. Streamflow can be calculated by the use of extrapolation between direct measurements, often beyond the highest streamflow measurement, when it cannot be measured at a site; however, excessive extrapolation—greater than two times the highest measured streamflow—can result in large errors in the estimation of peaks (Rantz and other, 1982).

Field measurements of peak gage heights and streamflow at the selected stations during the December 2015 flood were used to verify the accuracy of recorded water-surface elevations and to supplement the high-flow data used to create discharge-rating curves for each site. Independent verifications of peak gage heights were obtained with auxiliary devices such as crest-stage gages and by identifying and surveying high-water marks. At locations where USGS streamflow-gaging stations did not exist, peak streamflows were determined by a variety of indirect methods including the USGS Slope Area Computation (SAC) program (Fulford, 1994; Bradley, 2012) and width contractions (Matthai, 1967).

Probabilities of Peak Streamflows

The probability that a peak streamflow (annual exceedance probability) will occur at a given location in a given year is determined from annual peak streamflow data. The USGS streamflow-gaging stations with the longest period of streamflow record are considered the most reliable for estimating annual exceedance probabilities (AEP). An AEP of 0.02 means that there is a 2-percent chance that a specific peak streamflow may occur at a given location in a given year. Recurrence intervals are determined from the AEP for a given location by dividing one by the AEP; therefore, an AEP of 0.02 is equivalent to a 50-year flood.

The AEPs corresponding to peak streamflows during the December 2015 flood event that occurred in Arkansas for 33 USGS streamflow-gaging stations and 9 ungaged locations were estimated to determine the relative recurrence intervals for the peak streamflows. Streamflows associated with selected AEPs (0.10, 0.04, and 0.01) were estimated using the expected moments algorithm (Cohn and others, 1997; Cohn and others, 2001) in the USGS PeakFQ program (Veilleux and others, 2014). The AEP estimated from the peak streamflow record for a given USGS streamflow-gaging station and the AEP estimated from regional regression equations developed using peak streamflow records from USGS streamflow-gaging stations are used to create weighted estimates of AEPs. Where weighted estimates of AEPs can be made from multiple computations of AEPs, uncertainty of the AEP estimate is reduced. At locations where no USGS streamflow-gaging station was present, AEPs were estimated using regional regression equations. The AEP estimates at 22 USGS streamflow-gaging stations were obtained by weighting at-site AEP estimates with regional regression equations from Wagner and others (2016). The AEP estimates for eight USGS streamflow-gaging stations affected by regulation, diversion, or urbanization included in this report were not

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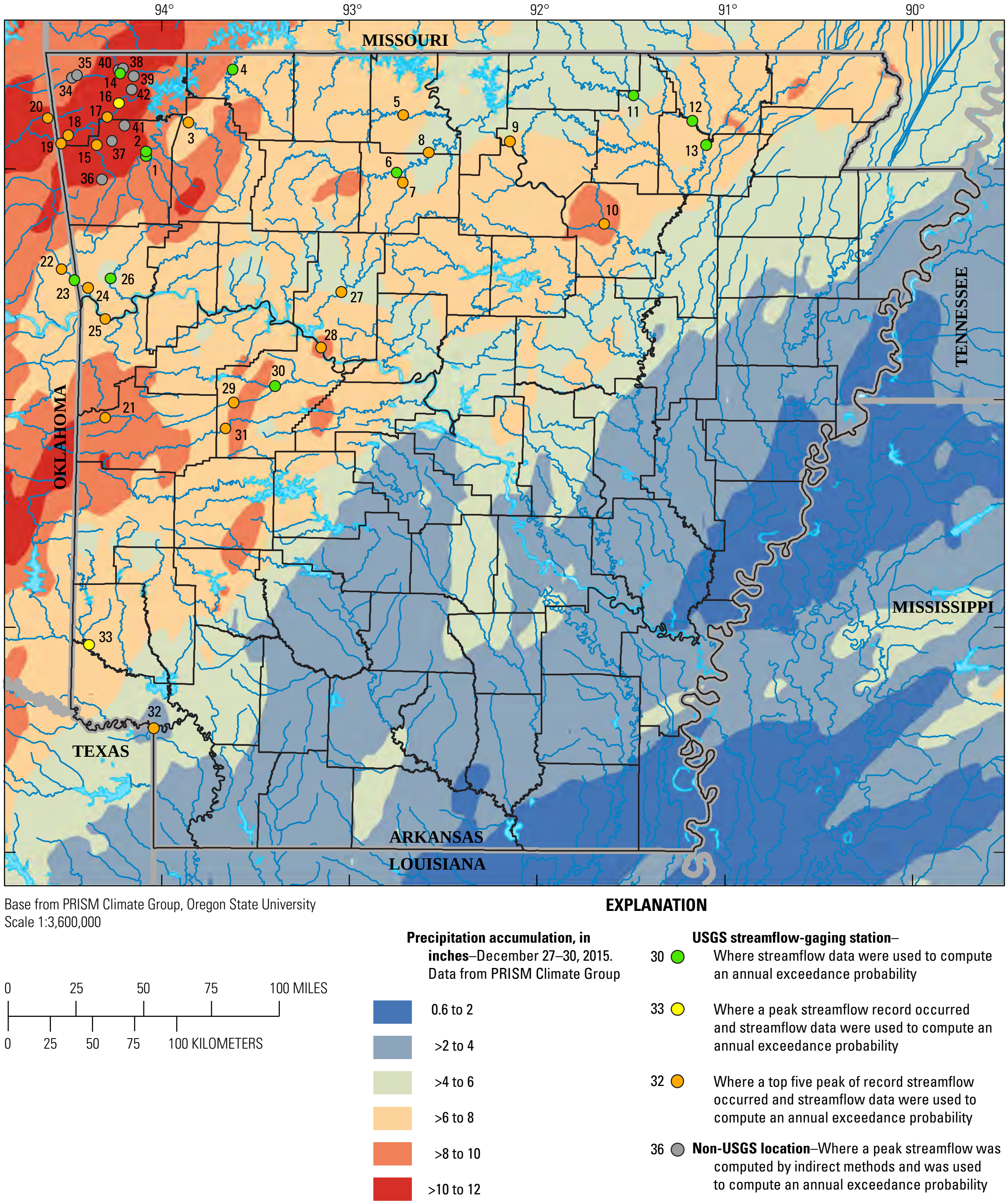

Figure 1. Location of U.S. Geological Survey streamflow-gaging stations and the total precipitation accumulation that occurred over the duration of the December 2015 flood event.

Table 1. Site information for U.S. Geological Survey streamflow-gaging stations measured during the December 2015 flood event.

[ft³/s, cubic feet per second; AR, Arkansas; >, greater than; <, less than; Hwy, highway; OK, Oklahoma; L&D, Lock and Dam; misc, miscellaneous is the ungaged location used in the study]

Site identification number	Station number	Station or stream name and location	Latitude, in decimal degrees	Longitude, in decimal degrees	Peak streamflow, in ft³/s	Recurrence interval, in years
1	07048550	West Fork White River east of Fayetteville, AR	36.053889	-94.083056	33,100	>10
2	07048600	White River near Fayetteville, AR	36.073056	-94.081111	54,000	10
3	07049000	War Eagle Creek near Hindsville, AR	36.200000	-93.855000	43,100	>25
4	07050500	Kings River near Berryville, AR	36.427222	-93.620833	47,600	20
5	07055607	Crooked Creek at Kelly Crossing at Yellville, AR	36.230278	-92.709444	34,000	20
6	07056000	Buffalo River near St. Joe, AR	35.983056	-92.747222	109,000	20
7	07056515	Bear Creek near Silver Hill, AR	35.940000	-92.713333	20,600	>10
8	07056700	Buffalo River near Harriet, AR	36.067778	-92.577500	130,000	20
9	07060500*	White River at Calico Rock, AR	36.116667	-92.143056	165,000	>25
10	07061000*	White River at Batesville, AR	35.760278	-91.641111	168,000	>10
11	07069305**	Spring River at Town Branch Bridge at Hardy, AR	36.313611	-91.482778	39,900	<10
12	07069500	Spring River at Imboden, AR	36.205556	-91.171667	55,700	<10
13	07072500	Black River at Black Rock, AR	36.102500	-91.097778	91,500	10
14	07188804***	McKisic Creek tributary at Hwy 71B at Bentonville, AR	36.413222	-94.219556	1,780	10
15	07194800	Illinois River at Savoy, AR	36.103056	-94.344444	30,200	10
16	07194880	Osage Creek near Cave Springs, AR	36.281466	-94.227984	5,850	10
17	07195000**	Osage Creek near Elm Springs, AR	36.221944	-94.288333	23,900	25
18	07195400**	Illinois River at Hwy 16 near Siloam Springs AR	36.144722	-94.494722	74,900	25
19	07195430**	Illinois River south of Siloam Springs, AR	36.108611	-94.533333	94,400	50
20	07195855**	Flint Creek near West Siloam Springs, OK	36.216111	-94.605278	7,020	10
21	07247000**	Poteau River at Cauthron, AR	34.918889	-94.299444	26,100	25
22	07249800	Lee Creek at Short, OK	35.565833	-94.531944	37,600	<10
23	07249985	Lee Creek near Short, OK	35.517222	-94.464167	64,300	>10
24	07250085*	Lee Creek at Lee Creek Reservoir near Van Buren, AR	35.484444	-94.392778	72,400	<25
25	07250550*	AR River at James W. Trimble L&D near Van Buren, AR	35.348889	-94.298333	369,000	<100
26	07251500*	Frog Bayou at Rudy, AR	35.525833	-94.271389	31,100	<25
27	07257500	Illinois Bayou near Scottsville, AR	35.466389	-93.041111	64,300	>25
28	07258000*	Arkansas River at Dardanelle, AR	35.226111	-93.149444	421,000	<100
29	07260000	Dutch Creek at Waltreak, AR	34.986944	-93.613056	21,200	50
30	07260500**	Petit Jean River at Danville, AR	35.058611	-93.395556	21,400	10
31	07261500**	Fourche LaFave River near Gravelly, AR	34.872500	-93.657222	148,000	>100
32	07337000*	Red River at Index, AR	33.551944	-94.041111	256,000	>100
32	07337000*	Red River at Index, AR	33.551944	-94.041111	128,000	10
33	07340000**	Little River near Horatio, AR	33.919444	-94.386667	68,600	>100
34	misc1***	Railroad Hollow Creek south of Gravette, AR	36.392206	-94.475949	500	<10
35	misc2***	Walnut Creek south of Gravette, AR	36.401821	-94.449604	1,200	25
36	misc3***	Muddy Fork south of Prairie Grove, AR	35.953373	-94.318459	700	10
37	misc4***	Clear Creek at Wheeler, AR	36.120098	-94.262847	9,700	>25
38	misc5***	Spanker Creek near Bella Vista, AR	36.430413	-94.206729	2,400	<25
39	misc6***	Brush Creek near Bentonville, AR	36.398099	-94.147009	1,800	>10
40	misc7***	Little Sugar Creek at Bella Vista, AR	36.425131	-94.215902	13,000	>100
41	misc8***	Brush Creek at Springdale, AR	36.186155	-94.197540	1,300	<10
42	misc9***	Turtle Creek at Rogers, AR	36.340292	-94.157765	600	<10

*Known to be affected by regulation and not weighted with regional regression equations.

**Known to be affected by regulation or urbanization and weighted with regional regression equations.

***Annual exceedance probability estimates computed from regional regression equations from Southard (2010).

weighted with regional regression equations. The AEP estimates for nine ungaged, urbanized locations, which have greater than a 1-percent impervious surface in their respective watersheds, were obtained using regional regression equations from Southard (2010).

Two USGS streamflow-gaging stations experienced record peak streamflows and 23 stations experienced top five peak streamflows (table 2) during the December 2015 flood event in Arkansas. Ranks for peak streamflows are based on water year, defined as October 1 of the previous year through September 30 of a given year. The AEPs ranged from less than 1 to 30 percent for peak streamflows analyzed in this study. The Red River at Index, Ark. (07337000), experienced a peak streamflow of 256,000 cubic feet per second (ft^3/s) in June 2015 and a peak streamflow of 128,000 ft^3/s in December 2015, corresponding to AEPs of 3 and 9 percent, respectively.

Table 2. Station number and information related to calculation of annual exceedance probability for the December 2015 flood event.

[AEP, annual exceedance probability; ft³/s, cubic feet per second; NA, not applicable; misc, miscellaneous is the ungaged location used in the study]

Station number	Flood data					AEP for observed 2015 flood		
							66.7 percent confidence interval	
	Rank	Number of annual peaks in analysis	Date of peak streamflow	Peak stage, in feet	Peak streamflow, in ft³/s	Estimate, in percent	Lower, in percent	Upper, in percent
07048550	5	24	12/28/2015	24.61	33,100	9	9	29
07048600	6	53	12/28/2015	30.39	54,000	11	6	15
07049000	3	58	12/28/2015	26.73	43,100	4	2	8
07050500	8	79	12/28/2015	33.18	47,600	8	6	13
07055607	4	32	12/28/2015	25.85	34,000	8	6	18
07056000	6	78	12/28/2015	45.58	109,000	6	4	11
07056515	3	17	12/28/2015	13.74	20,600	10	8	26
07056700	4	60	12/28/2015	48.49	130,000	5	3	10
07060500*	3	65	12/29/2015	34.20	165,000	3	2	7
07061000*	3	45	12/29/2015	24.13	168,000	8	3	10
07069305	6	15	12/28/2015	15.60	39,900	30	25	52
07069500	16	81	12/28/2015	24.84	55,700	20	15	24
07072500	11	112	12/29/2015	27.15	91,500	10	7	12
07188804***	NA	NA	12/28/2015	NA	1,780	NA	NA	NA
07194800	5	24	12/27/2015	19.65	30,200	11	11	29
07194880	1	17	12/27/2015	12.55	5,850	10	1	11
07195000**	2	51	12/28/2015	16.84	23,900	5	1	6
07195400**	2	17	12/28/2015	25.00	74,900	4	4	19
07195430**	2	21	12/28/2015	26.95	94,400	3	3	15
07195855*	3	30	12/28/2015	14.07	7,020	10	4	15
07247000**	2	49	12/28/2015	22.83	26,100	4	1	7
07249800	5	17	12/28/2015	22.36	37,600	20	17	40
07249985	8	75	12/28/2015	24.79	64,300	7	7	14
07250085*	3	24	12/28/2015	26.99	72,400	8	5	19
07250550*	3	53	12/30/2015	400.23	369,000	3	2	9
07251500*	6	68	12/28/2015	17.43	31,100	7	5	12
07257500	5	70	12/28/2015	23.20	64,300	4	4	10
07258000*	2	53	12/30/2015	40.83	421,000	3	1	6
07260000	4	71	12/28/2015	20.21	21,200	3	3	8
07260500*	7	69	12/28/2015	29.15	21,400	10	6	14
072615000	3	78	12/28/2015	31.64	148,000	1	1	6
07337000*	2	73	6/4/2015	34.41	256,000	1	1	4
07337000*	7	73	12/31/2015	23.50	128,000	9	6	13
07340000*	1	48	12/30/2015	34.21	68,600	1	0	4
misc1***	NA	NA	12/27–12/28/2015	NA	500	NA	NA	NA
misc2***	NA	NA	12/27–12/28/2015	NA	1,200	NA	NA	NA
misc3***	NA	NA	12/27–12/28/2015	NA	700	NA	NA	NA
misc4***	NA	NA	12/27–12/28/2015	NA	9,700	NA	NA	NA
misc5***	NA	NA	12/27–12/28/2015	NA	2,400	NA	NA	NA
misc6***	NA	NA	12/27–12/28/2015	NA	1,800	NA	NA	NA
misc7***	NA	NA	12/27–12/28/2015	NA	13,000	NA	NA	NA
misc8***	NA	NA	12/27–12/28/2015	NA	1,300	NA	NA	NA
misc9***	NA	NA	12/27–12/28/2015	NA	600	NA	NA	NA

Table 2. Station number and information related to calculation of annual exceedance probability for the December 2015 flood event.—Continued

[AEP, annual exceedance probability; ft^3/s, cubic feet per second; NA, not applicable; misc, miscellaneous is the ungaged location used in the study]

Station number	Expected peak streamflows for selected AEP with 95 percent confidence intervals, in ft^3/s								
	10 percent AEP, 10-year recurrence			4 percent AEP, 25-year recurrence			1 percent AEP, 100-year recurrence		
		95 percent confidence interval			95 percent confidence interval			95 percent confidence interval	
	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper
07048550	30,540	19,130	51,940	43,700	26,000	83,100	64,400	35,600	14,400
07048600	58,600	44,800	82,300	81,700	59,300	128,000	124,000	81,700	229,000
07049000	30,800	24,600	40,800	41,100	31,600	59,500	58,700	41,500	98,200
07050500	41,800	33,700	53,800	57,600	44,600	80,500	85,600	60,600	139,000
07055607	28,900	18,800	50,800	43,200	26,600	85,900	72,100	40,600	166,000
07056000	92,000	74,100	119,000	124,000	96,300	173,000	178,000	126,000	283,000
07056515	20,200	14,300	34,700	25,900	17,300	51,600	35,300	21,600	85,700
07056700	105,000	82,500	135,000	144,000	110,000	199,000	210,000	148,000	331,000
07060500*	113,000	95,000	148,000	152,000	122,000	229,000	221,000	165,000	441,000
07061000*	156,000	124,000	223,000	208,000	159,000	364,000	301,000	212,000	769,000
07069305	61,000	35,100	128,000	86,300	47,200	208,000	130,000	64,800	372,000
07069500	72,000	56,400	97,000	103,000	78,100	152,000	157,000	106,000	276,000
07072500	95,000	81,100	115,000	131,000	108,000	171,000	203,000	154,000	302,000
07188804***	2,350	1,630	3,380	3,000	2,110	4,280	4,320	2,860	6,500
07194800	32,200	20,300	58,200	46,800	28,400	93,900	72,500	40,700	170,000
07194880	5,880	4,100	9,690	8,090	5,440	14,900	12,000	7,540	25,900
07195000**	17,900	13,000	26,300	26,300	18,200	42,400	41,300	26,200	77,300
07195400**	48,200	31,500	78,700	72,000	45,800	134,000	115,000	67,800	259,000
07195430**	59,400	40,000	102,000	83,500	53,700	159,000	126,000	75,000	235,000
07195855*	7,700	4,870	15,100	12,100	7,350	30,600	20,100	9,910	72,300
07247000**	20,100	16,400	26,400	26,100	20,500	38,200	36,300	26,100	63,200
07249800	45,700	28,700	84,500	63,300	38,600	129,000	92,900	52,700	220,000
07249985	54,500	40,000	75,900	77,300	60,700	105,000	110,000	79,600	168,000
07250085*	65,440	48,000	105,300	86,500	48,000	170,000	119,000	75,600	303,000
07250550*	275,000	239,000	335,000	336,000	285,000	448,000	428,000	344,000	448,000
07251500*	27,800	23,700	33,300	34,550	29,240	44,290	43,460	34,730	63,600
07257500	44,900	35,500	60,000	61,400	46,300	89,600	93,000	67,100	155,000
07258000*	333,000	297,000	389,000	389,000	341,000	485,000	468,000	397,000	686,000
07260000	14,700	12,300	18,000	19,200	15,600	25,100	25,900	19,000	38,600
07260500*	22,800	19,000	29,300	30,700	24,700	43,800	43,700	32,600	74,800
072615000	66,300	52,700	87,500	90,400	68,900	130,000	137,000	96,200	226,000
07337000*	138,000	120,000	165,000	172,000	146,000	221,000	224,000	178,000	322,000
07337000*	138,000	120,000	381,000	172,000	146,000	221,000	224,000	178,000	322,000
07340000*	44,400	38,300	55,430	54,600	45,800	76,900	62,500	51,200	98,500
misc1***	890	620	1,290	1,190	830	1,700	1,730	1,140	2,620
misc2***	960	660	1,380	1,300	910	1,860	1,920	1,270	2,910
misc3***	710	490	1,020	980	680	1,400	1,450	960	2,200
misc4***	6,750	4,660	9,780	8,950	6,260	12,800	13,300	8,770	20,000
misc5***	1,990	1,380	2,890	2,770	1,940	3,970	4,170	2,760	6,300
misc6***	1,630	1,130	2,360	2,240	1,570	3,210	3,340	2,210	5,050
misc7***	5,350	3,700	7,760	7,480	5,230	10,700	11,400	7,530	17,200
misc8***	2,320	1,600	3,360	2,780	1,950	3,980	3,860	2,550	5,840
misc9***	1,610	1,110	2,330	1,950	1,370	2,790	2,720	1,800	4,110

*Known to be affected by regulation and not weighted with regional regression equations.

**Known to be affected by regulation or urbanization and weighted with regional regression equations.

***Annual exceedance probability estimates computed from regional regression equations from Southard (2010).

Selected References

Bradley, D.N., 2012, Slope-area computation program graphical user interface 1.0—A preprocessing and postprocessing tool for estimating peak flood discharge using the slope-area method: U.S. Geological Survey Fact Sheet 2012–3112, 4 p.

Benson, M.A., and Dalrymple, Tate, 1967, General field and office procedures for indirect measurements: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. Al, 30 p. [Also available at http://pubs.er.usgs.gov/publication/twri03A1.]

Cohn, T.A., Lane, W.L., and Baier, W.G., 1997, An algorithm for computing moments-based flood quantile estimates when historical flood information is available: Water Resources Research, v. 33, no. 9, p. 2089–2096.

Cohn, T.A., Lane, W.L., and Stedinger, J.R., 2001, Confidence intervals for expected moments algorithm flood quantile estimates: Water Resources Research, v. 37, no. 6, p. 1695–1706.

Fulford, J.M., 1994, User's guide to SAC, a computer program for computing discharge by the slope-area method: U.S. Geological Survey Open-File Report 94–360, 31 p.

Matthai, H.F., 1967, Measurement of peak discharge at width contractions by indirect methods: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A4, 44 p. [Also available at http://pubs.usgs.gov/twri/twri3-a4/.]

PRISM Climate Group, 2016, PRISM climate data: Northwest Alliance for Computational Science and Engineering, accessed June 20, 2016, at http://prism.oregonstate.edu/.

Rantz, S.E., and others, 1982, Measurement and computation of streamflow—Volume 2. Computation of discharge: U.S. Geological Survey Water-Supply Paper 2175, v. 2, 631 p. [Also available at http://pubs.usgs.gov/wsp/wsp2175/html/wsp2175_vol2_pdf.html.]

Southard, R.E., 2010, Estimating the magnitude and frequency of floods in urban basins in Missouri: U.S. Geological Survey Scientific Investigations Report 2010–5073, 27 p.

U.S. Geological Survey, 2016, National Water Information System—Web interface, accessed September 28, 2016, at http://dx.doi.org/10.5066/F7P55KJN.

Veilleux, A.G., Cohn, T.A., Flynn, K.M., Mason, R.R., Jr., and Hummel, P.R., 2014, Estimating magnitude and frequency of floods using the PeakFQ 7.0 program: U.S. Geological Survey Fact Sheet 2013–3108, 2 p. [Also available at http://pubs.usgs.gov/fs/2013/3108/.]

Wagner, D.M., Krieger, J.D., and Veilleux, A.G., 2016, Methods for estimating annual exceedance probability discharges for streams in Arkansas, based on data through water year 2013: U.S. Geological Survey Scientific Investigations Report 2016–5081, 136 p.[Also available at http://dx.doi.org/10.3133/sir20165081.]

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