

Lake Texoma Watershed, TX

Base Level Engineering (BLE) Results

Contract #HSFE60-15-D-0003

Task Order #70FBR620F00000047

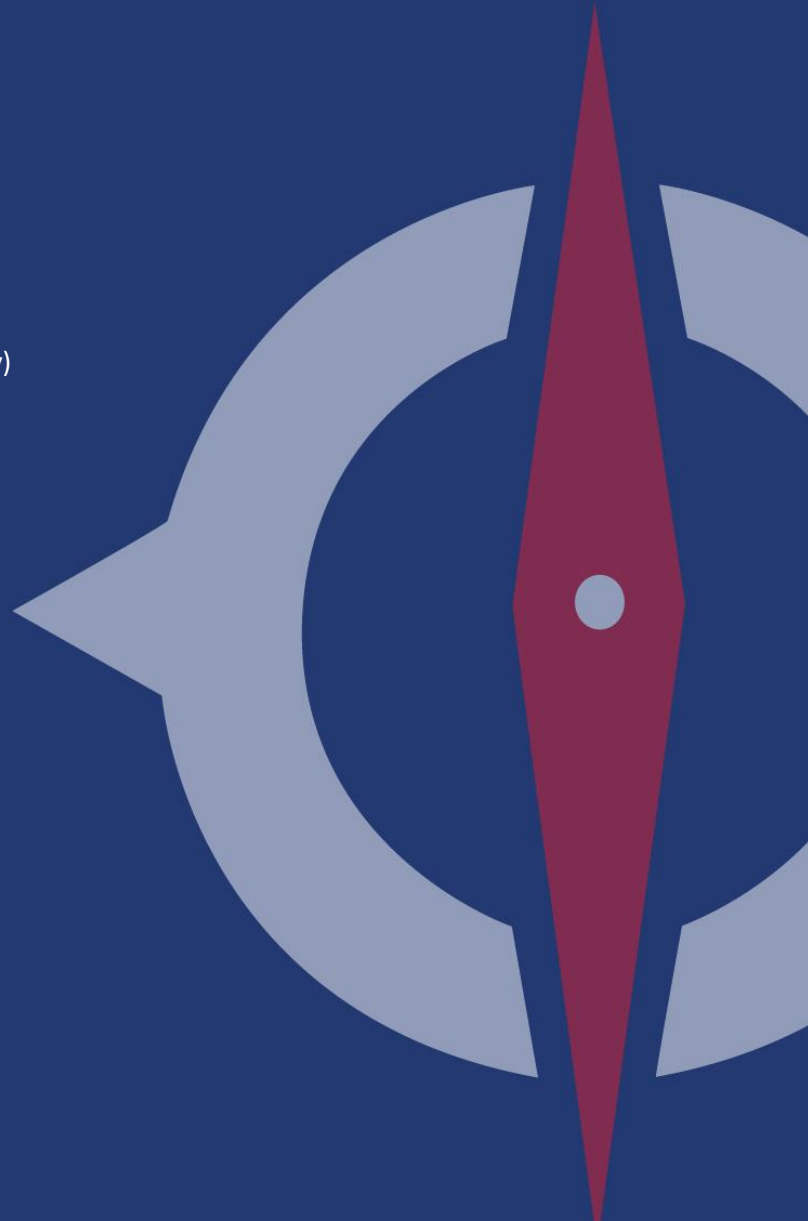
July 2021

Prepared for:

DHS/FEMA (Federal Emergency Management Agency)
Region VI
FRC 800 North Loop 288
Denton, TX 76209-3698

Submitted by:

Compass PTS JV
3101 Wilson Boulevard
Suite 900
Arlington, VA 22201



DOCUMENT HISTORY

DOCUMENT LOCATION

J:/FY2020/20-06-0091S/Hydraulics - Lake Texoma (Marshall County, OK) | BLE (FY20) 06/Hydraulic Data Capture - Hydraulic Data Capture | Lake Texoma (Marshall County, OK) - 01

REVISION HISTORY

Version Number	Version Date	Summary Changes	Team/Author
1	July 2021	Initial Base Level Engineering Draft	Compass PTS JV

APPROVALS

This document requires the approval of the following persons:

Role	Name	Phone Extension	Title (CLIN/RMC)	Review Date	Approved Date
Project Manager	Scott Rushing	(214) 724-5786	Water Resources Team Leader	07/30/2021	07/30/2021

CLIENT DISTRIBUTION

Name	Title/Organization	Location
Diane Howe	FEMA Region VI	Denton, TX
FEMA's MIP	Region VI	See path above



Table of Contents

Executive Summary	i
Base Level Engineering (BLE) Methodology	2
1.1 Topographic Data	4
1.1.1 Evaluation	5
1.2 Hydrology	8
1.2.1 Texas	8
1.2.2 Oklahoma	9
1.2.3 Flood Frequency Analyses	11
1.3 Hydraulics	14
1.4 Quality Control	16
1.5 One-Percent Special Flood Hazard Area Delineation	17
Challenges	17
Results and Recommendations	18
3.1 CNMS Validation of Effective Zone A SFHA	18
3.2 Flood Risk Analysis	23
References	25
Appendix A Summary of Peak Qs	A-1
Appendix B BLE Map	B-1



Executive Summary

FEMA Region VI contracted Compass to complete a Base Level Engineering (BLE) analysis for the HUC-08 watershed Lake Texoma (LTE) on the Texas-Oklahoma Border, to support FEMA's Discovery process and validation of effective Zone A Special Flood Hazard Areas (SFHAs). The BLE process involves using best available data and incorporating automated techniques with traditional model development procedures to produce regulatory-quality flood hazard boundaries for the 1-percent annual chance event as well as estimates of flood hazard boundaries for multiple recurrence intervals.

The source digital terrain data used for surface model development in support of hydrologic and hydraulic analysis as well as mapping activities were leveraged from various local, State, and Federal partners. Details regarding the different datasets used are provided below in Section 1.1.

Flood discharges for this study were calculated the United States Geological Survey (USGS) regression equations. Regression equations were obtained from the USGS Scientific Investigations Report (SIR) 2009-5087, *Regression Equations for Estimation of Annual Peak-Streamflow Frequency for Undeveloped Watersheds in Texas Using an L-moment Based, PRESS-Minimized, Residual-Adjusted Approach* (2009). Also, Regression equations obtained from the USGS Scientific Investigations Report (SIR) 2010-5137, *Methods for Estimating the Magnitude and Frequency of Peak Streamflows for Unregulated Streams in Oklahoma*, were used.

The Hydrologic Engineering Center's River Analysis System (HEC-RAS) program version 4.1.0 was used to compute water surface elevations on a stream by stream basis. All hydraulic models were computed using 1-D steady state analysis.

The stream mile network that was validated for these watersheds was compiled using FEMA's Community Needs Management Strategy (CNMS) inventory. CNMS is an inventory of flood hazard studies and flood hazard mapping needs for areas where a study is needed. This data is helpful for community officials in analyzing and depicting flood hazards to enhance the understanding of flood risks. Communities may use this information to make informed decisions on their planning and flood mitigation efforts. Table ES-1 lists the stream miles associated with this validation analysis.

Table ES-1: Summary of Stream Miles

Source	Red River Stream Miles
CNMS	419.2

The full inventory of Zone A studies in the watershed were classified in CNMS. Total miles validated in CNMS are summarized in Table ES-2 and illustrated in Figure ES-1 below.

Table ES-2: Aggregated Zone A Validation Results

Validation Status	Status Type	Total Miles
Valid	Being Studied	166.0
Unverified	Being Studied	253.2

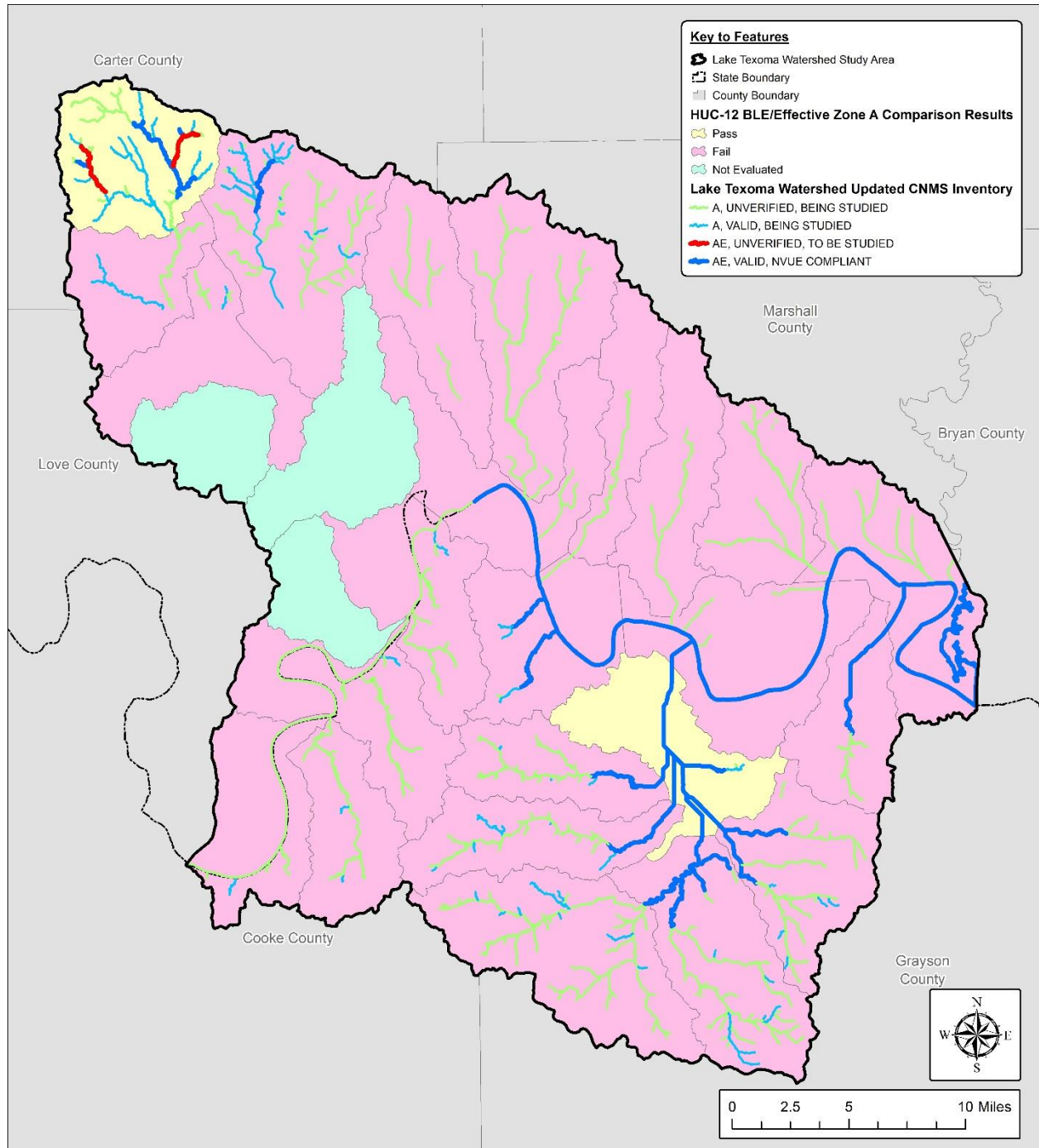


Figure ES-1: Lake Texoma Watershed CNMS Validation Results

An overall risk for each HUC-12 watershed was calculated using the National Flood Risk Percentages Dataset and its proportional area. The weighted risk was multiplied by the percentage of points in the watershed that failed the CNMS comparison to effective to determine the priority score. Figure ES-2 below shows the range of the Lake Texoma Watershed HUC-08 priority scores which can be used to initiate discussions during the Discovery phase.

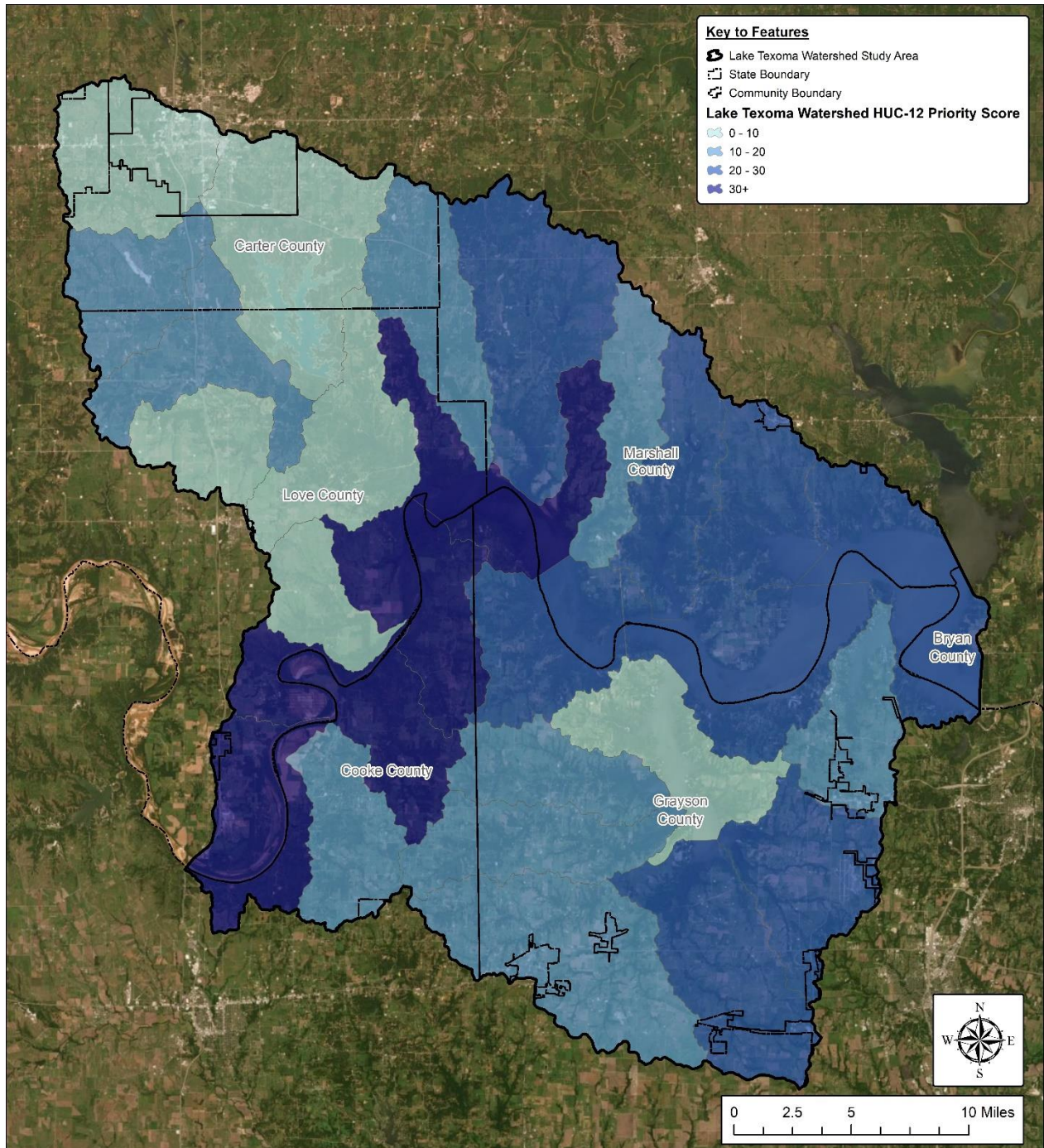


Figure ES-2: Ranking of Lake Texoma Watershed HUC-12



Base Level Engineering (BLE) Methodology

Recent innovations and efficiencies in floodplain mapping have allowed the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) to develop a process called Base Level Engineering (BLE), which can be used to address current program challenges, including the validation of Zone A studies and the availability of flood risk data in the early stages of a Flood Risk Project. The BLE process involves using best available data and incorporating automated techniques with traditional model development procedures to produce regulatory quality flood hazard boundaries for the 1-percent annual chance event as well as estimates of flood hazard boundaries for multiple recurrence intervals. The cost for developing the data and estimates resulting from the BLE process are lower than standard flood production costs. The BLE results may be used for eventual production of regulatory and non-regulatory products.

As described in Title 42 of the Code of Federal Regulations, Chapter III, Section 4101(e), once every five years, FEMA must evaluate whether the information on Flood Insurance Rate Maps (FIRMs) reflects the current risks in flood-prone areas. FEMA makes this determination of flood hazard data validity by examining flood study attributes and change characteristics, as specified in the Validation Checklist of the Coordinated Needs Management Strategy (CNMS) Technical Reference. The CNMS Validation Checklist provides a series of critical and secondary checks to determine the validity of flood hazard areas studied by detailed methods (e.g., Zone AE, AH, or AO). While the critical and secondary elements in CNMS provide a comprehensive method of evaluating the validity of Zone AE studies, a cost-effective approach for evaluating Zone A studies has been lacking.

In addition to the need for Zone A validation guidance, FEMA standards require flood risk data to be provided in the early stages of a Flood Risk Project. FEMA Program Standard SID #29 requires that during Discovery, data must be identified that illustrates potential changes in flood elevation and mapping that may result from the proposed project scope. If available data does not clearly illustrate the likely changes, an analysis is required that estimates the likely changes. This data and any associated analyses should be shared, and results should be discussed with stakeholders.

An important goal of the BLE process is the scalability of the results. Scalability means that the results of a BLE analysis can not only be used for CNMS evaluations of Zone A studies but can also be leveraged throughout the Risk MAP program. The data resulting from a BLE analysis can be updated as needed and used for the eventual production of regulatory and non-regulatory products, outreach and risk communication, and MT-1 processing. Leveraging this data outside the Risk MAP program may also be valuable to external stakeholders.

FEMA Region VI contracted Compass to complete a BLE analysis for the Lake Texoma Watershed on the Texas-Oklahoma Border to support FEMA's Discovery process and validation of effective Zone A Special Flood Hazard Areas (SFHA). The study extents include portions of Carter, Love, Cooke, Grayson, Bryan, and Marshall Counties, and include the following communities: The Cities Ardmore, Healdton, Wilson, Callisburg, Gainesville, Lindsay, Muenster, Valley View, Collinsville, Denison, Knollwood, Sherman, Tom Bean, Whitesboro, and Durant. As well as the towns of Dickson, Gene Autry, Lone Grove, Ratliff City, Springer, Tatums, Oak Ridge, Bells, Dorchester, Gunter, Howe, Pottsboro, Sadler, Southmayd, Tioga, Van Alostne, Whitewright, Achille, Bennington, Bokchito, Caddo, Calera, Colbert, Hendrix, Kemp, Kenefic, Mead, and Silo. The study area consists of 5 HUC-10 basins: Lake Murray Red River, Fobb Bottom Red River, Denison Dam Red River, Horseshoe Bend Red River, Big Mineral Arm Red River. Figure 1 shows the orientation of the Lake Texoma HUC-10 basins with respect to the counties.

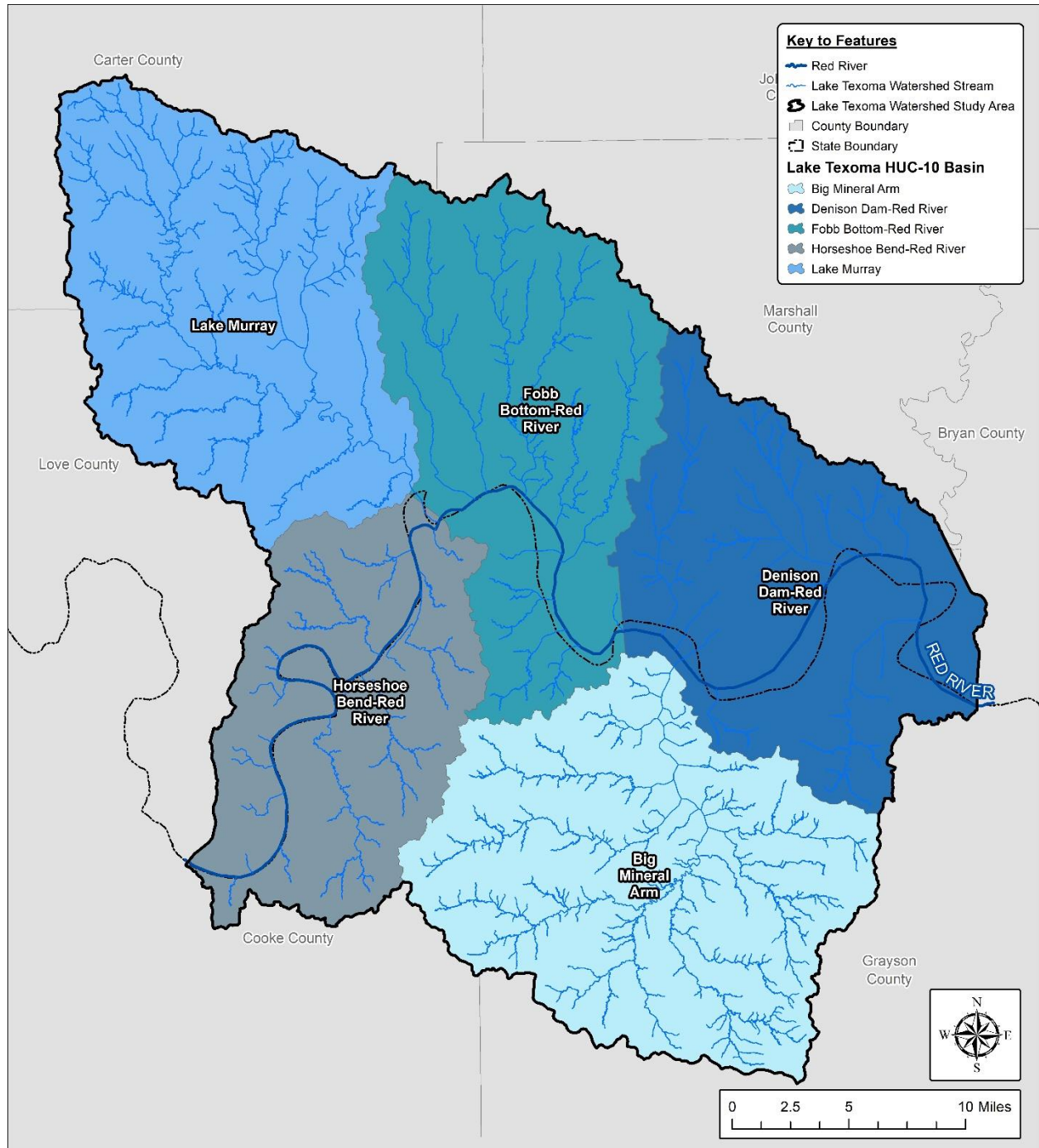


Figure 1: Lake Texoma Watershed HUC-10 Basins

Compass studied approximately 1,106 miles of stream reaches within the Lake Texoma Watershed with a minimum drainage area tolerance of one square mile. The selection and extent of stream reaches studied were based upon the number of stream miles with a minimum drainage area of one square mile and not the number of effective Zone A stream miles. Study reaches were extended above this threshold as appropriate to ensure all effective Zone A flood areas received an updated analysis. Topographic data from multiple sources were used to determine the hydrologic



and hydraulic characteristics of the watershed. The following sections summarize the BLE process and discuss the results along with their recommended use.

1.1 Topographic Data

An inventory of existing topographic data was conducted for the Lake Texoma BLE project footprint. Figure 2 depicts the datasets identified and leveraged across the project area. USGS, TNIRIS, and other State and Federal agencies were queried to build the inventory with the most current and available data sources.

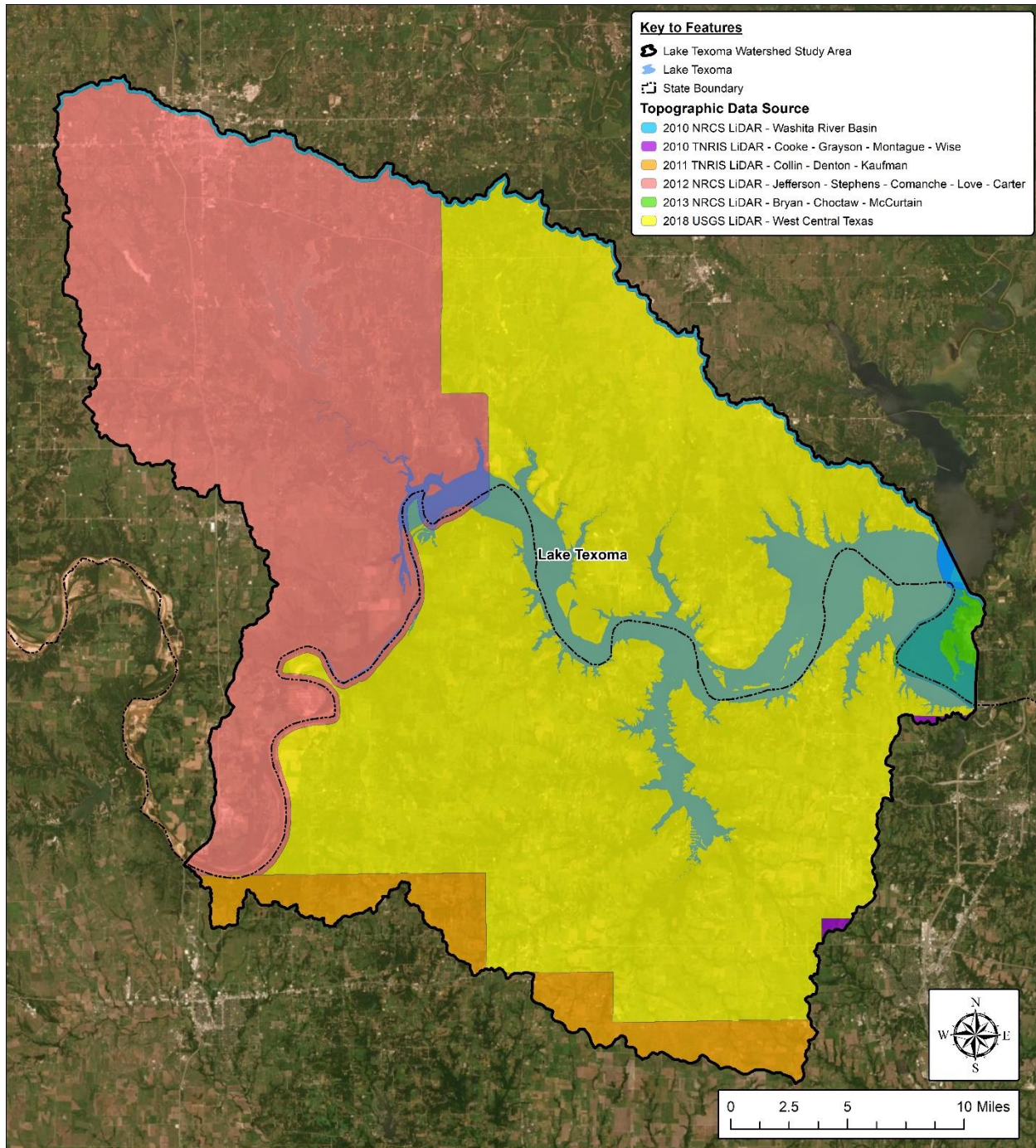


Figure 2: Extent of LiDAR Data for Lake Texoma Watershed

1.1.1 Evaluation

A data coverage assessment was conducted to check for data gaps, extent, accuracy, and completeness. A review of related documentation, reports, indexes, and metadata associated with the leverage datasets ensured each dataset meets FEMA accuracy requirements for topographic data. Decisions to leverage or exclude a dataset (or portion of it), were based generally on the following criteria coupled with engineering judgment:



- Data meet FEMA vertical accuracy standards (Table 1)
- Date of origination
- Data density and coverage

Table 1 depicts the Risk Map SID 43 vertical accuracy requirements based on flood risk and terrain slope within the floodplain being mapped.

Table 1: FEMA Vertical Accuracy Requirements for Leveraged Data

Level of Flood Risk	Typical Slopes	Specification Level	Vertical Accuracy*	LiDAR Nominal Pulse Spacing (NPS)
High (Deciles 1,2,3)	Flattest	Highest	24.5 cm / 36.3 cm	≤ 2 meters
High (Deciles 1,2,3)	Rolling or Hilly	High	49.0 cm / 72.6 cm	≤ 2 meters
High (Deciles 2,3,4,5)	Hilly	Medium	98.0 cm / 145 cm	≤ 3.5 meters
Medium (Deciles 3,4,5,6,7)	Flattest	High	49.0 cm / 72.6 cm	≤ 2 meters
Medium (Deciles 3,4,5,6,7)	Rolling	Medium	98.0 cm / 145 cm	≤ 3.5 meters
Medium (Deciles 3,4,5,6,7)	Hilly	Low	147 cm / 218 cm	≤ 5 meters
Low (Deciles 7,8,9,10)	All	Low	147 cm / 218 cm	≤ 5 meters

*Vertical Accuracy at 95% Confidence Level (FVA or NVA)/(CVA or VVA)

Table 2 depicts the complete list of source elevation data and attributes leveraged for the Lake Texoma Watershed BLE project. All the Terrain datasets used for hydrology, hydraulic analyses, and mapping meet the highest specification level defined in Table 1. Further explanation of the Table 2 datasets can be referenced in section 1.1.1.1.

Table 2: Source Topographic Data Available for the Lake Texoma Watershed

Year	Description	Data Type	RMSE	Source/Owner
2010	2010 NRCS Washita River Basin LiDAR	Airborne LiDAR	9.3 cm	NRCS
2010	2010 TNRIS LiDAR Cooke - Grayson - Montague - Wise	Airborne LiDAR	4.7 cm	TNRIS
2011	2011 TNRIS LiDAR Collin – Denton - Kaufman	Airborne LiDAR	10 - 15 cm	TNRIS
2012	2012 NRCS LiDAR Jefferson - Stephens – Comanche – Love – Carter	Airborne LiDAR	9.3 cm	NRCS
2013	2013 NRCS LiDAR – Bryan – Choctaw - McCurtain	Airborne LiDAR	9.3 cm	NRCS
2018	2018 USGS West Central Texas LiDAR	Airborne LiDAR	< 10 cm	USGS

1.1.1.1 Lake Texoma Watershed Source Terrain Data

The source elevation data for the Lake Texoma Watershed are DEMs derived from the FEMA/USGS and NRCS LiDAR data. Only points classified as “ground” points (i.e., bare earth) were imported from the LiDAR and used for development of the project DEMs.



Bare-earth LiDAR data are typically made by filtering non-ground returns (e.g. buildings, vegetation, etc.) from the raw laser returns. Figure 2 depicts the extent of the data defined in Table 2.

2010 NRCS Washita River Basin LiDAR - The 2010 Washita River Basin LiDAR was collected with a nominal pulse spacing of 1 meter. The data was compiled to meet 18.3 cm vertical accuracy at 95% confidence level (RMSE * 1.96).

2010 TNRIS LiDAR Cooke - Grayson - Montague - Wise - The 2010 TNRIS LiDAR for Cooke, Grayson, Montague, and Wise Counties was collected with a nominal pulse spacing of 1 meter. The data was compiled to meet 9.2 cm vertical accuracy at 95% confidence level (RMSE * 1.96).

2011 TNRIS LiDAR Collin – Denton - Kaufman - The 2011 TNRIS LiDAR for Cooke, Denton, and Kaufman Counties was collected with a nominal pulse spacing of 0.5 meters. The data was compiled to meet a range of 19.6 cm to 29.4 cm vertical accuracy at 95% confidence level (RMSE * 1.96).

2012 NRCS LiDAR Jefferson – Stephens – Comanche – Love – Carter - The 2012 NRCS LiDAR for Jefferson, Stephens, Comanche, Love, and Carter Counties was collected with a nominal pulse spacing of 1 meter. The data was compiled to meet 18.3 cm vertical accuracy at 95% confidence level (RMSE * 1.96).

2013 NRCS LiDAR - Bryan - Choctaw - McCurtain - The 2013 NRCS LiDAR for Bryan, Choctaw, and McCurtain Counties was collected with a nominal pulse spacing of 1 meter. The data was compiled to meet 18.3 cm vertical accuracy at 95% confidence level (RMSE * 1.96).

2018 USGS West Central Texas LiDAR - The 2018 USGS West Central Texas LiDAR was collected with a nominal pulse spacing of 0.71 meters. The data was compiled to meet better than 19.6 cm vertical accuracy at 95% confidence level (RMSE * 1.96).

1.1.1.2 Terrain Data Processing

The LiDAR data were processed in Environmental System Research Institute (ESRI) ArcGIS software to create a composite Digital Elevation Model (DEM) dataset for the project area. The DEM was used to generate hydrologically correct stream centerlines and served as a source for horizontal alignment and vertical elevation during manual revisions.

The Watershed Information System (WISE) Terrain Analyst (WTA) module software platform was utilized to create a Hydrologically correct DEM (HDEM) for the project area. WTA is used to identify natural sinks, peaks, and flat areas in the DEM surface. The WTA module uses several routines that take localized elevations from the source topographic data and apply them to the streams. This ensures that the streams in the watershed are lower in elevation than any overbank sumps and descend in height down to an outfall. The final generated streams file is then “burned” into DEMs to force flow through structures while preventing it from jumping out of the channel banks.

During the hydro enforcement of DEM, elevations of the cells were algorithmically calculated and the best path to route flow was determined without filling sinks in the DEM. Once all calculations were completed, the flow was checked confirming that all drainage flowed downstream correctly and routed to outside of the HUC-08 basin. The outputs from the processing described above, which included composite DEMs and HDEM (10-ft and 50-ft cell-size), were used during the hydrology, hydraulics, and floodplain mapping processes.

In addition to the quantitative assessment of the source digital terrain, a qualitative visual inspection of the composite DEM was performed using a hillshade derived from the 10-foot DEM.



The visual inspection indicated no unusual or non-terrestrial features were observed in the composite DEM, assuring the surface files used for hydrologic, hydraulic analyses, and floodplain mapping activities are sufficient for BLE analysis.

1.2 Hydrology

The Lake Texoma watershed crosses the states of Texas and Oklahoma. Flood discharges for this study were calculated using two different United States Geological Survey (USGS) regression equations.

In both states, the drainage area for each sub-basin was determined based on automated basin delineations performed by WISE based on the 50-foot DEM. Basin break points were set by the user with a sub-basin target of one square mile (outside population centers) in size. This criterion was adjusted for streams with larger drainage areas to avoid excessive and unnecessary discharge breaks. Break points were also set just upstream of stream confluences. Cumulative drainage area was determined based on these automated delineations performed by WISE in combination with a stream connectivity routine that defined the stream reach segments with upstream and downstream neighbors. WISE was also used to calculate the main-channel slope and main-channel length for each basin. The basin shapefile attribution was automated by WISE with drainage area, main-channel slope, and precipitation.

The sub-basin shapefile was attributed with the computed discharges, and those discharges were incorporated into the HEC-RAS models using an automated routine in WISE. Discharges, as well as water surface elevation results, were associated with the hydraulic cross sections prior to generation of floodplain boundaries and grid mapping. Those results are available in GIS format as part of this BLE submittal package.

1.2.1 Texas

For the portion of the Lake Texoma Watershed located in Texas, the regression equations were obtained from the USGS Scientific Investigations Report (SIR) 2009-5087, *Regression Equations for Estimation of Annual Peak-Streamflow Frequency for Undeveloped Watersheds in Texas Using an L-moment Based, PRESS-Minimized, Residual-Adjusted Approach* (2009).

The mean annual precipitation values for both Texas regression equations were determined based on gridded coverage obtained from the PRISM Climate Group and available for download from the following location: <http://prism.oregonstate.edu/normals/>. The annual precipitation values reflect data for the climatological period 1981-2010 as recorded by the Natural Resources Conservation Service (NRCS).

Main-channel slope was calculated in WISE. An automated routine determined the longest flowpath from upstream of a reach to the outlet of the sub-basin of interest. The elevations for those endpoints were based on the 10-foot DEM developed from the LiDAR.

Table 3 presents the published equations used in this study. In these equations, Q_i represents peak streamflow for i -recurrence interval (annual chance exceedance) in cubic feet per second (cfs), P represents mean annual precipitation in inches, S represents dimensionless main-channel slope, Ω represents the OmegaEM parameter, and A represents cumulative drainage area in square miles.



Table 3: Summary of Regression Equations in Texas (SIR 2009-5087)

Recurrence Interval	Equation
Q _{10%}	$P^{1.203} \times S^{0.403} \times 10^{[0.918\Omega + 13.62 - 11.97A^{(-0.0289)}]}$
Q _{4%}	$P^{1.140} \times S^{0.446} \times 10^{[0.945\Omega + 11.79 - 9.819A^{(-0.0374)}]}$
Q _{2%}	$P^{1.105} \times S^{0.476} \times 10^{[0.961\Omega + 11.17 - 8.997A^{(-0.0424)}]}$
Q _{1%}	$P^{1.071} \times S^{0.507} \times 10^{[0.969\Omega + 10.82 - 8.448A^{(-0.0467)}]}$
Q _{0.2%}	$P^{0.988} \times S^{0.569} \times 10^{[0.976\Omega + 10.40 - 7.605A^{(-0.0554)}]}$
Variables: Q _i , peak flow for i recurrence interval annual chance exceedance in cubic feet per second; P, mean annual precipitation, in inches; S, Main-channel slope (dimensionless); Ω, OmegaEM parameter; and A, cumulative drainage area, in square miles.	

Discharges for the 1-percent plus and 1-percent minus annual chance event were calculated as $Q_{1\%+/-} = Q_{1\%} \pm 10^{1.6 \times 0.30}$, where 0.30 is the mean residual standard error for the Q_{1%} equation.

From USGS SIR 2009-5087, the OmegaEM parameter is a generalized terrain and climate index that expresses relative differences in peak-streamflow potential. A shapefile was developed and populated with OmegaEM values based on Figure 2 in SIR 2009-5087. This shapefile was used, along with a python script in ArcCatalog, to determine OmegaEM values on a sub-basin basis. For sub-basins spanning more than one OmegaEM grid, the sub-basin's centroid determined its OmegaEM parameter.

1.2.2 Oklahoma

For the portion of the Lake Texoma Watershed located in Oklahoma, flood discharges for this study were calculated using both USGS regression equations. Regression equations obtained from the USGS Scientific Investigations Report (SIR) 2010-5137, *Methods for Estimating the Magnitude and Frequency of Peak Streamflows for Unregulated Streams in Oklahoma* (2010) contain the most recent regression equations for Oklahoma and were weighted according to area as the basis for regression calculations. Weighted discharges for streams with gages were calculated using the weighting procedure described also in SIR 2010-5137.

Table 4 shows the published equations for unregulated streams. In these equations, Q_i represents peak streamflow for i-recurrence interval (annual chance exceedance) in cubic feet per second (cfs), CONTDA is the cumulative drainage area in square miles, CSL10_85_{fm} represents the main-channel slope measured between two points along the channel, one at 10 percent of the channel length and the other at 85 percent of the channel length, and PRECIP represents mean annual precipitation in inches.

Main-channel slope, in feet per mile, was calculated using the WISE software. An automated routine determined the longest flowpath from upstream of a reach to the outlet of the sub-basin of interest.



The slope was determined by dividing the elevation change by the distance along the longest flowpath between points at 10-percent and 85-percent of the distance from the outlet to the basin divide. The elevations for those endpoints were based on the 10-foot DEM developed from the LiDAR.

Table 4: Summary of Regression Equations in Oklahoma

Recurrence Interval	Region 2 Equation
Q _{10%}	$126 (\text{CSL10_85fm})^{(0.46)} (\text{CONTDA})^{(0.78)}$
Q _{4%}	$174 (\text{CSL10_85fm})^{(0.47)} (\text{CONTDA})^{(0.78)}$
Q _{2%}	$204 (\text{CSL10_85fm})^{(0.50)} (\text{CONTDA})^{(0.79)}$
Q _{1%}	$240 (\text{CSL10_85fm})^{(0.50)} (\text{CONTDA})^{(0.79)}$
Q _{0.2%}	$363 (\text{CSL10_85fm})^{(0.51)} (\text{CONTDA})^{(0.80)}$
¹ Variables: Q _i peak flow for i recurrence interval (a.c.e.), in cubic feet per second; CONTDA, Contributing Drainage Area in square miles; CSL10_85fm, Main-channel 10-85 slope (feet per mile);	

For ungaged streams with flood control structures, equations listed in Table 5 were used. These equations, also from the SIR 2010, require the same parameters CSL10_85fm and PRECIP however they use the “contributing drainage area of the unregulated part of the basin or the drainage area downstream from the floodwater retarding structure”. This parameter is identified as “DAUNREG” in the equations below. This method was only used for those basins where the DAUNREG is at least 14% of the cumulative drainage area and for only those flood control structures identified in the dam inventory file obtained from the Oklahoma Water Resource Board (OWRB).

Table 5: Summary of Regression Equations for Ungaged Streams with Flood Control Structures (SIR 2010-5137)

Recurrence Interval	Equation ¹
F _{10%(r)}	$1.74(\text{DAUNREG})^{0.66}\text{PRECIP}^{1.42}(\text{CSL10_85fm})^{0.21}$
F _{4%(r)}	$4.90(\text{DAUNREG})^{0.66}\text{PRECIP}^{1.24}(\text{CSL10_85fm})^{0.23}$
F _{2%(r)}	$13.18(\text{DAUNREG})^{0.66}\text{PRECIP}^{1.05}(\text{CSL10_85fm})^{0.21}$
F _{1%(r)}	$26.9(\text{DAUNREG})^{0.65}\text{PRECIP}^{0.92}(\text{CSL10_85fm})^{0.21}$
F _{0.2%(r)}	$126(\text{DAUNREG})^{0.64}\text{PRECIP}^{0.64}(\text{CSL10_85fm})^{0.19}$
¹ Variables: F _{x(r)} peak flow adjusted for x recurrence interval (a.c.e.), in cubic feet per second; DAUNREG, Contributing Drainage Area in square miles;	



Recurrence Interval	Equation ¹
	CSL10_85fm, Main-channel slope (feet per mile); PRECIP, Mean Annual Precipitation in inches

Discharges for the 1-percent plus and 1-percent minus a.c.e. were calculated as well. These values were computed as $Q_{1\%+} = Q_{1\%} \times (1.3572)$ and $Q_{1\%-} = Q_{1\%} \times (0.6428)$, where 35.72% (0.3572) is the mean residual standard error of prediction for the $Q_{1\%}$ equation.

1.2.3 Flood Frequency Analyses

A flood frequency analysis was prepared for the Lake Texoma watershed. Gauges within the Pecan Waterhole, Bois D'Arc, and Farmers Mud HUC-8's were also included in the frequency analysis. Peak annual discharge from eleven USGS gages were processed to generate frequency discharges at each gage. Table 4 presents the gages included in the flood frequency analysis including the source of the data, location of the gage, period of record, and stream the gage is located on. Figure 3 shows the locations of USGS gages within Lake Texoma that were utilized in the flood frequency analyses.

Table 4: Flood Frequency Analysis Stream Gages

Gage Number	Flooding Source and Location	Published Drainage Area (mi ²)	Period of Record
USGS 07331600	Red Rv at Denison Dam nr Denison, TX	39720	1962-2020
USGS 07335500	Red River at Arthur City, TX	40677	1936-2020
USGS 07336820	Red Rv nr De Kalb, TX	39340	1984-2020
USGS 07351500	Red Rv at Fulton, AR	46444	1950-2020
USGS 08065350	Trinity Rv nr Crockett, TX	13911	1964-2019
USGS 07315700	Mud Creek nr Courtney, OK	574	1967-2020
USGS 07332600	Bois D'Arc Ck nr Randolph, TX	72	1967-1984
USGS 07332620	Bois D'Arc Ck at FM 1396 nr Honey Grove, TX	270	2007-2020
USGS 07332622	Bois D'Arc Ck at FM 409 nr Honey Grove, TX	370	2010-2020
USGS 07336750	Little Pine Ck nr Kanawha, TX	75.4	1969-1980
USGS 07336800	Pecan Bayou nr Clarksville, TX	100	1962-1977

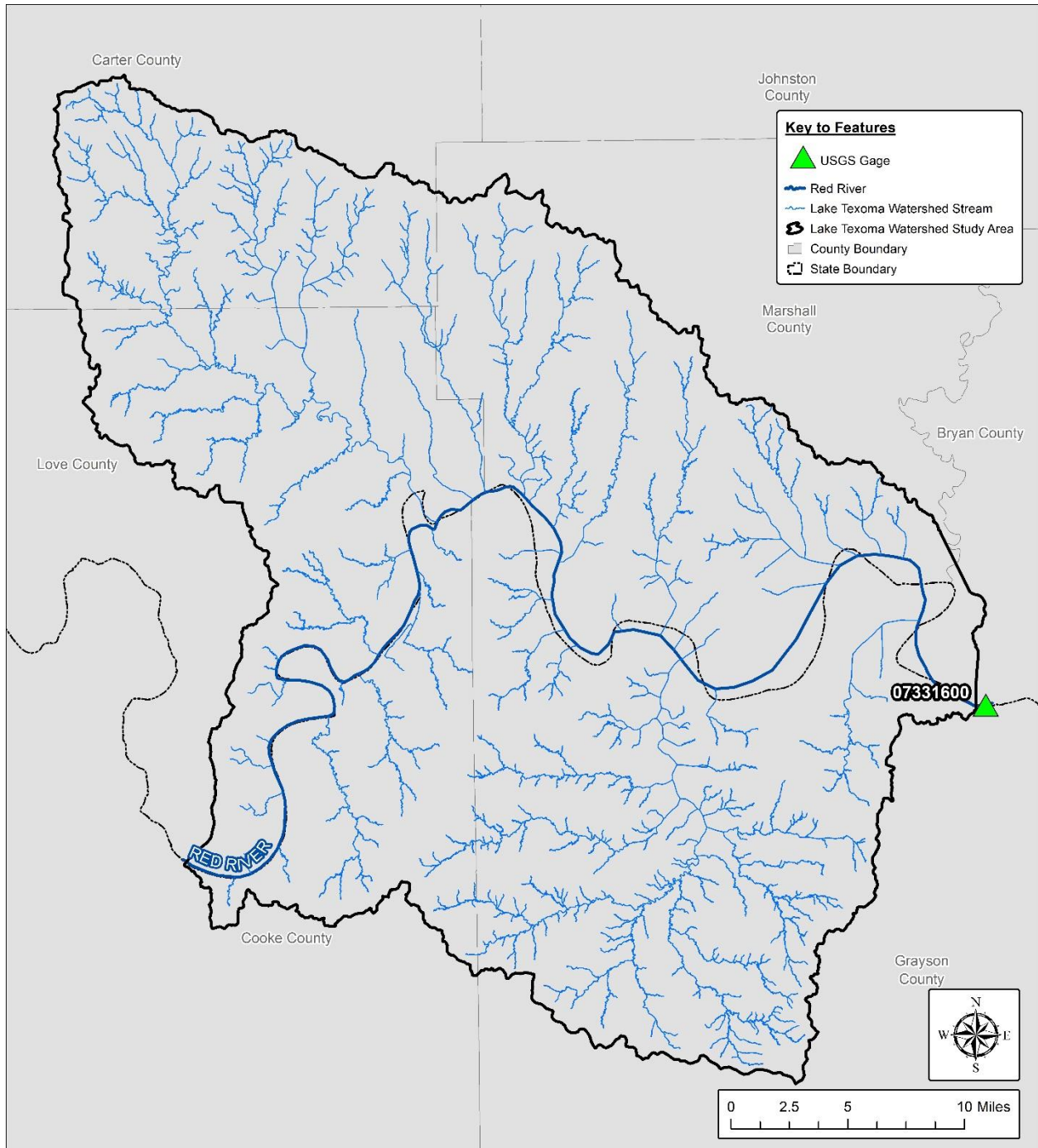


Figure 3: Locations of USGS Gages Utilized in Flood Frequency Analysis

A flood frequency analysis was computed for each USGS gage to determine the peak discharges for the Lake Texoma Watershed using the USGS “Guidelines for Determining Flood Flow Frequency, Bulletin 17B”, revised September 1982. The USACE flood frequency analysis was leveraged along the Red River Main Stem. Flows between the gauges were interpolated based on cumulative drainage areas and no adjustment factor was necessary along the main stem. No adjustment factor was used for the rest of the Lake Texoma HUC-8.

A comparison of 1-percent annual chance event frequency analysis compared to the USACE frequency analysis is shown in Figure 4, below. The 1-percent annual chance event peak streamflow comparisons as calculated with the 2009 regression model and from gage data for Lake Texoma tributaries is shown in Figure 5. The frequency analysis results indicated that no adjustment factors would be required within the Lake Texoma HUC-8.

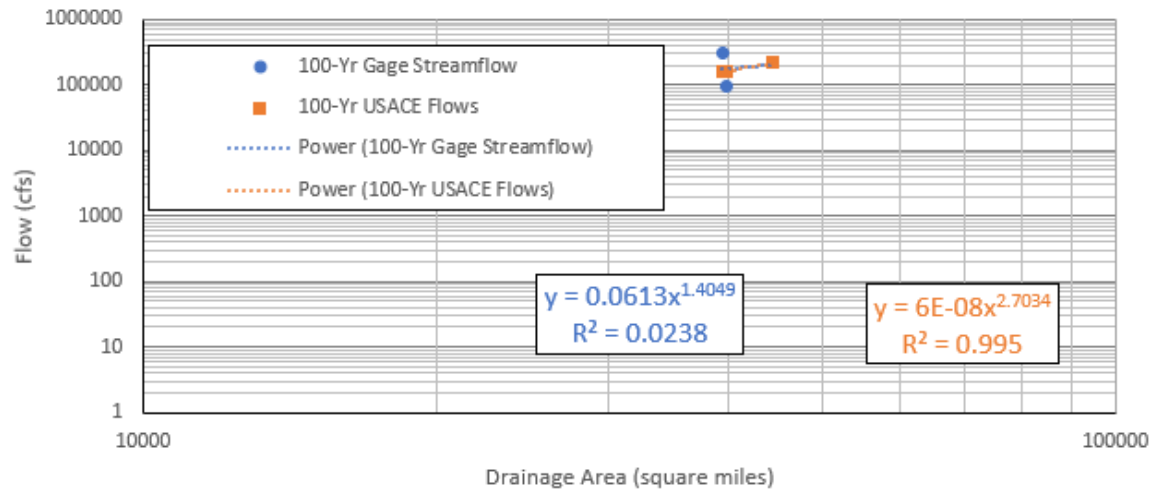


Figure 4: 1-Percent Annual Chance Event Flood Frequency Analysis for Lake Texoma Mainstem

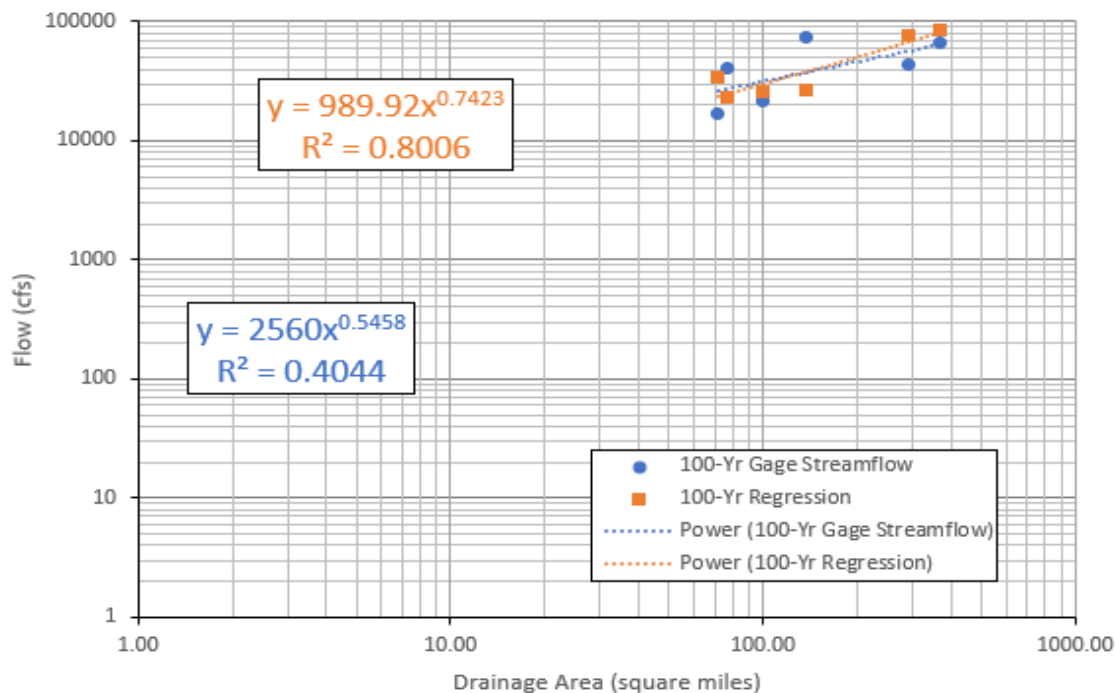


Figure 5: 1-Percent Annual Chance Event Flood Frequency Analysis for Lake Texoma Creek Tributaries



1.3 Hydraulics

The hydraulic approach for this BLE analysis of the Lake Texoma Watershed consisted of using the terrain model described in Section 1.1 in combination with the hydrologic outputs from Section 1.1.1 to establish water surface elevations using 1-D steady state analysis. The Hydrologic Engineering Center's River Analysis System (HEC-RAS) program version 4.1.0 was chosen as the computer model to compute water surface elevations on a stream by stream basis. The WISE software was used to establish model stream orientation, generate initial hydraulic cross-section layout and stationing, assign n-values to cross-sections, and develop all input files for the HEC-RAS program. ESRI's ArcMap program was used to review and refine cross-section layout orientation.

First pass cross-section layout was performed using an automated routine in WISE based on the cumulative drainage area at the cross-section location. A first draft model was created based on this initial cross-section layout, and draft boundaries were developed. At this stage, a second pass inspection for cross-section placement occurred. Significant refinement occurred during this step. To improve the hydraulic models, additional cross-sections were added as needed to better define the BLE floodplain boundary. Cross-sections were extended in locations where overtopping occurred. Orientation of cross-sections was refined to improve on the perpendicular orientation to flow. Additional cross-sections were added at floodplain constrictions and at downstream portions of tributaries to ensure a proper tie-in with receiving streams. Cross-sections were adjusted to remove sections that intersected hydraulic crossings in the floodplain. For some of the largest studied streams, cross-sections were laid out manually to have more reasonable spacing and better capture the constrictions in the floodplain.

Cross-sections were not drawn on top of roadways or railroads but were placed at the upstream and downstream face of major roads and railroads. Ineffective flow stations were placed in the hydraulic models as appropriate to account for flow constrictions and other locations deemed by the engineer to be ineffective at conveying flow downstream.

Cross-sections were drawn on dam tops for significant dams with well-defined spillways to better represent ponded water upstream of the structures. In so doing, it was assumed that most of the flow during a flood event would pass the spillway and that the hydraulic model would reasonably estimate flow across the spillway as represented in the hydraulic cross-section. The elevations used in the modeling were checked against effective Zone A boundaries, and the results were deemed reasonable.

The relationship between cumulative drainage area and assigned channel geometry is shown in Table 5. These default values for dimensions and spacing were subject to change based on engineering judgment.

Table 5: Cross-Section Default Parameters

Drainage area (upper limit) (mi ²)	XS Spacing (ft)	Channel Top Width (ft)		Channel Bottom Width (ft)		Channel Depth (ft)
		Minimum	Maximum	Minimum	Maximum	
1	500	5	12	4	11	0.1
2	500	5	14	4	13	0.1
4	500	9	14	8	13	0.3
6	500	11	16	10	15	0.3

Drainage area (upper limit) (mi ²)	XS Spacing (ft)	Channel Top Width (ft)		Channel Bottom Width (ft)		Channel Depth (ft)
		Minimum	Maximum	Minimum	Maximum	
10	500	12	17	11	16	0.5
20	500	14	22	13	21	0.5
30	500	16	24	15	23	0.5
40	500	17	26	16	25	0.5
50	600	17	27	16	26	0.5
75	600	19	30	18	29	0.5
100	750	19	32	18	31	0.5
200	750	22	36	21	35	0.5
300	1000	23	38	22	37	0.5

In typical BLE projects, Manning's roughness coefficients (n-values) are determined using the 2016 National Land Cover Data (NLCD) dataset in combination with n-values from Chow (1959) and Calenda et al. (2005). The association between the n-values and the NLCD Classification is shown in Table 6. Manning's n-value takeoffs are performed by WISE (default values taken from the "Normal" column). N-values within channel banks are constrained by the automated routine to a range of 0.030 to 0.070. Then, overbank and channel n-values are manually adjusted in certain locations based on engineering judgment.

Table 6: Manning's "n" Roughness Based on 2016 NLCD Classification (Moore, 2011)

NLCD Classification	Minimum	Normal	Maximum	Source
Open Water	0.025	0.03	0.033	Chow 1959
Developed, Open Space	0.01	0.013	0.016	Calenda et al. 2005
Developed, Low Intensity	0.038	0.05	0.063	Calenda et al. 2005
Developed, Medium Intensity	0.056	0.075	0.094	Calenda et al. 2005
Developed, High Intensity	0.075	0.1	0.125	Calenda et al. 2005
Barren Land	0.025	0.03	0.035	Chow 1959
Deciduous Forest	0.1	0.12	0.16	Chow 1959
Evergreen Forest	0.1	0.12	0.16	Chow 1959
Mixed Forest	0.1	0.12	0.16	Chow 1959
Scrub/Shrub	0.035	0.05	0.07	Chow 1959
Grassland/Herbaceous	0.025	0.03	0.035	Chow 1959
Pasture/Hay	0.03	0.04	0.05	Chow 1959
Cultivated Crops	0.025	0.035	0.045	Chow 1959
Woody Wetlands	0.08	0.1	0.12	Chow 1959
Emergent Herbaceous Wetland	0.075	0.1	0.15	Chow 1959



The boundary condition used for most of the study streams was normal depth with a default value of 0.005 ft/ft. For streams with large drainage areas (generally greater than 8 square miles), the normal depth slope was calculated based on the channel inverts of the downstream cross-sections.

In cases where streams tie into a lake, a normal depth slope was calculated based on the channel inverts of the downstream cross-sections (typically between 0.0001 and 0.001 ft/ft). Several HUC-10s within this watershed are located in urban areas with storm drain systems, which are unaccounted for in the BLE models. Simplifications of these systems may considerably affect perceived risk.

1.4 Quality Control

Following the initial BLE analysis in each watershed, the flood hazard area delineations created by the BLE process were reviewed for areas where the results were not ideal.

Quality Control (QC) results indicated that some of the models should be extended to cover the scope of effective flood hazard data. Those streams were extended farther upstream to match the extents of the SFHA data.

Typical manual editing resulting from reasonability checks included adding cross-sections, adjusting orientation of cross-sections, trimming cross-sections and reduction of the default “V” angle of cross-sections. Examples of default “V” angled cross-sections are shown in Figure 6. The majority of the cross sections were adjusted. Other examples of manual editing included the addition of cross-sections at confluence areas (see Figure 7 below), modifications to improve perpendicular orientation at the channel, adjustment of discharge breaks to better represent flow addition points, revisions to dam spillways and dam tops, additional cross-sections bounding major hydraulic structures, and revisions to n-values.

A major component of the QC process was an automated check that identified locations where the 1-percent and 0.2-percent annual chance event profiles were crossed by any other frequency profile. Significant effort was made to reasonably resolve all of these instances. Another automated check identified locations where there was a drawdown of greater than 0.5 foot on the 1-percent and 0.2-percent annual chance event water surface profiles. This check is particularly useful for identifying errors in the model such as a channel that is too wide, a poorly placed cross-section, or a need for additional cross-sections. Again, significant effort was made to reasonably resolve these drawdown situations.

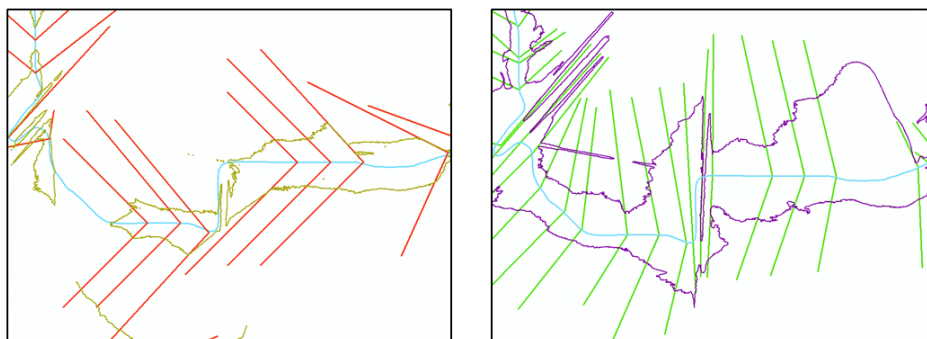


Figure 6: Default “V” angle cross-sections automated by WISE (left). Manually edited cross-sections to more accurately capture terrain (right). Resulting flood boundaries shown in gold (left) or purple (right) for clarity.

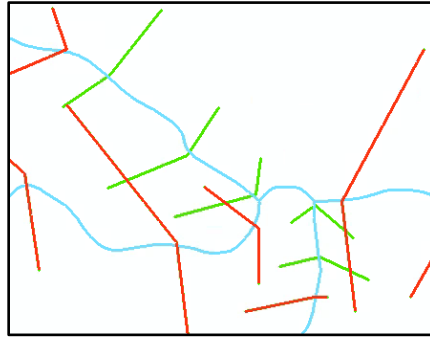


Figure 7: Manually added cross-sections (green) to improve accuracy of tie-ins at confluences.

1.5 One-Percent Special Flood Hazard Area Delineation

The 10-percent, 1-percent and 0.2-percent annual chance event boundaries were mapped using a routine that develops water surface elevation grids based on the 10-foot cell size DEM developed from the LiDAR dataset used for this project (see Section 1.1). This product was converted to a polygon for cleaning. The cleaning routine involved manual inspection of the polygons to identify and remove areas of disconnected flooding. In general, areas with a size of less than 5,000 square feet were removed and all others were investigated to determine whether they should be considered as potentially part of the SFHA. This investigation was aided by the ground DEM and aerial imagery. Manual adjustments to the polygons were made to account for spillways on dams which could not be accurately modeled using HEC-RAS as well as disconnected areas along the flooding source that should reasonably be connected.

Following the removal of disconnected flooding areas and other boundary adjustments, the small islands in the floodplain were filled. Islands with a size between roughly 5,000 and 30,000 square feet were inspected and, in general, islands that were less than 10,000 square feet were filled.

Once the island filling process was complete, the water surface raster mapping routine was run and set to conform to the polygon boundary. This ensures that the water surface raster and the floodplain boundary are consistent with each other. The depth raster product was created at the end of the process by performing a raster subtraction with the water surface elevation raster and the ground DEM.

Challenges

Challenges encountered during BLE analyses vary based on available data on which to run the analysis. The Lake Texoma Watershed presented challenges as summarized in the following paragraphs.

A significant effort was made to improve water surface elevation tie-ins at stream confluences. Cross-sections were manually added on the downstream end of nearly every stream, some of which traverse the receiving stream, so that the water surface elevation of the tributary would be lower than that of the receiving stream.

There are a significant number of small-sized dams on the tributaries throughout the watershed. Discharges calculated with the regression equations do not take into account the impact of these structures apart for ungaged streams with flood control structures, see [Section 1.2.2](#). There may be need for further investigation when upgrading these models for detailed studies.



A significant effort was made to maintain consistent discharges along the Red River mainstem between the Lake Texoma, Farmers Mud, Pecan Waterhole and Bois D'Arc Watershed BLE studies. Revisions were made to the regression equation parameters in this study to ensure consistent discharges between the two BLE studies mentioned.

As part of this study, areas where mapping was significantly different than current effective mapping or required a more detailed analysis were identified and documented. These are part of the GIS deliverables under Areas of Mitigation Interest (AOMI's).

The effective, steady-state HEC-RAS model received from the U.S. Army Corp of Engineers (USACE) on October 2020 was used as a starting point for the Red River mainstem model for this study. The original model can be obtained from USACE.

Revisions to the USACE Red River hydraulic cross sections and HEC-RAS model were required to provide mapping using BLE methodology. Storage areas were removed, cross sections were extended, and ineffective areas were revised due to the higher flows calculated during this study. Bank stations were also adjusted to better represent the main channel. Manning's roughness coefficients (n-values) were updated based on the increased roughness coefficients attributed to high flows in the USACE hydraulic model.

No hydrologic calculations were performed along the mainstem. The USACE frequency analysis was utilized and applied to the hydraulic model. Flows between the gauges were interpolated based on cumulative drainage area.

Results and Recommendations

The BLE results for this study produced a SFHA that compares reasonably well with the effective SFHA. These boundaries provide an additional estimated SFHA in areas that do not currently have an SFHA mapped. These results provide context for flood risk communication as part of the Discovery process and should be verified through community work map meetings before being applied to a regulatory product.

A map showing the BLE results is included as Appendix B.

3.1 CNMS Validation of Effective Zone A SFHA

The following summarizes the results of the CNMS validation assessments for the effective Zone A studies in the Lake Texoma Watershed.

3.1.1.1 Initial Assessment A1 – Significant Topography Update Check

The significant topography update check determines whether a topographic data source is available that is significantly better than what was used for the effective Zone A modeling and mapping. For most of the study area the effective Zone A topographic data source is unknown, but most likely would have leveraged contours from USGS 24K map products. This caused all but one reach to FAIL this element because the elevation data leveraged in the BLE study represents a significant improvement from the USGS 24K map products. The exception to this is a portion of Hickory Creek Tributary A in Carter County, OK, which utilized LiDAR in 2014.



3.1.1.2 Initial Assessment A2 – Check for Significant Hydrology Changes

The significant hydrology changes check determines whether new regression equations have become available from the USGS since the date of the effective Zone A study. If newer regression equations exist for the area of interest, then an engineer must determine whether these regression equations would significantly affect the 1-percent annual chance flow. A majority of the reaches being assessed did not use regression methods or the hydrologic methods are unknown/undocumented. Reaches in Cooke County, TX have several streams that used regression methods after 2003 and new regression methods have since been published. However, the regression equation comparison analysis did not show a significant change in discharges. These streams also PASS this check.

3.1.1.3 Initial Assessment A3 – Check for Significant Development

The significant development check, using the National Urban Change Indicator (NUCI) dataset, assesses increased urbanization in the watershed of the BLE. If the percentage of urban area within the HUC-12 watershed containing the effective Zone A study is 15 percent or more and has increased by 50 percent or more since the effective analysis, the study would fail this check. Although the NUCI data provide year-to-year changes in urbanization, the NLCD also is needed to establish a baseline of urban land cover for this analysis. The check for significant development in the Lake Texoma study area was completed by evaluating percentage of urban change at the HUC-12 level. All of the watershed is classified as rural and, therefore, all reaches PASS this assessment.

Table 7 presents the summarized results of checks A1 through A3.

Table 7: A1-A3 Validation Results

Assessment Checks	Pass / Fail	Notes
A1 - Topography	Fail/Pass	Available LiDAR sources in areas of effective studies that did not utilize LiDAR/Studies within Leon County utilized LiDAR for effective study
A2 - Hydrology	Pass	Regression was not used for effective studies or the most current regression equations were used; Regression was used for effective studies and new equations now exist but no significant changes in discharges are shown.
A3 - Development	Pass	Watershed is classified as Non-Urban

3.1.1.4 Validation Check A4 – Check of Studies Backed by Technical Data

Zone A studies that pass all initial assessment checks described above may be categorized as “Valid” in the CNMS Inventory only if the effective Zone A study is supported by modeling or sound engineering judgment and all regulatory products are in agreement. If the effective Zone A study passes all initial assessment checks, but is not supported by modeling, or if the original engineering method used is unsupported or undocumented, a comparison of the BLE results and effective Zone A’s is performed. Due to lack of documentation of the original engineering methods in the majority of reaches, check A4 has been marked as FAIL for these reaches. Reaches in Cooke County, TX have documentation of engineering methods, and therefore, PASS this check.



3.1.1.5 Validation Check A5 – Comparison of BLE and Effective Zone A

The BLE/effective Zone A comparison method leverages the existing Floodplain Boundary Standard (FBS) certification procedures described in FEMA SID 113, but with a slight modification. This modified FBS comparison approach uses the 1-percent plus and 1-percent minus flood profiles and horizontal and vertical tolerances described in FEMA's Automated Engineering guidance document dated May 2016. For the comparison of BLE and effective Zone A in the Texas/Oklahoma study area, the following vertical and horizontal tolerances were used to conduct the modified FBS procedure. One point was placed every 200 feet along the floodplain boundaries for comparison.

Vertical Tolerance: +/- 10 feet (one-half contour interval of assumed effective topographic source).

Horizontal Tolerance: +/- 75 feet (standard horizontal tolerance for BLE comparison testing).

Of the 385 modeled BLE streams in the study area, 275 were found to correspond (within the tolerance limits) with effective Zone A flood zones. Comparison results for these streams were grouped at the HUC-12 level and are summarized in Table 8 to better understand the general health of the HUC-12 watershed, but the validation check was performed at the stream level. Streams where the percentage of passing FBS sample points is greater than or equal to 85% are marked as "Pass", otherwise marked as "Fail".

Table 8: HUC-12 Zone A Validation Results

HUC-12 Watershed		Total FBS points	Fail	Pass	%Pass	BLE Comparison Pass? (>85%)	Priority Score
Watershed Name	Watershed Number						
Lake Texoma	All Streams	34,388	17,362	17,026	49.5%	Fail	
Headwaters Hickory Creek	111302100101	1,730	215	1,515	87.6%	Pass	7.60
Upper Hickory Creek	111302100102	831	163	668	80.4%	Fail	14.78
Lake Murray	111302100104	3,024	580	2,444	80.8%	Fail	9.49
Middle Hickory Creek	111302100105	182	48	134	73.6%	Fail	16.61
Hickory Creek	111302100201	1,204	390	814	67.6%	Fail	16.20
Leeper Lake-Red River	111302100202	1,152	1,015	137	11.9%	Fail	44.05
Horseshoe Bend-Red River	111302100204	1,662	1,032	630	37.9%	Fail	31.05
Thomas Creek-Red River	111302100205	1,851	1,414	437	23.6%	Fail	38.20
Wilson Creek	111302100301	933	355	578	62.0%	Fail	17.29
Little Hauani Creek	111302100302	2,455	1,510	945	38.5%	Fail	23.30
Brier Creek	111302100303	907	696	211	23.3%	Fail	19.18
Delaware Bend-Red River	111302100304	923	837	86	9.3%	Fail	38.61
Fobb Bottom-Red River	111302100305	663	501	162	24.4%	Fail	27.99
Upper Big Mineral Creek	111302100401	3,470	910	2,560	73.8%	Fail	17.53
Harris Creek	111302100402	2,254	906	1,348	59.8%	Fail	27.09
Lower Big Mineral Creek	111302100403	2,668	770	1,898	71.1%	Fail	20.95
Sandy Creek	111302100404	1,278	420	858	67.1%	Fail	16.43
North Branch Brushy Creek	111302100405	784	258	526	67.1%	Fail	16.45
Walnut Creek-Big Mineral Arm	111302100406	71	9	62	87.3%	Pass	3.17
Buncombe Creek	111302100501	1,037	878	159	15.3%	Fail	21.17

HUC-12 Watershed		Total FBS points	Fail	Pass	%Pass	BLE Comparison Pass? (>85%)	Priority Score
Watershed Name	Watershed Number						
Rock Creek	111302100502	2,474	2,024	450	18.2%	Fail	25.66
Treasure Island-Red River	111302100503	1,197	1,130	67	5.6%	Fail	23.60
Little Mineral Arm	111302100504	284	64	220	77.5%	Fail	11.27
Denison Dam-Red River	111302100505	1,354	1,237	117	8.6%	Fail	22.84

VALIDATION RESULTS

Based on the validation assessments and BLE comparison results described above, the CNMS inventory of Zone A studies in the Lake Texoma Watershed has been updated as summarized in Table 9 and illustrated in Figure 8 below. The priority scores are illustrated in Figure 9.

Table 9: Aggregated Zone A Validation Results

Validation Status	Status Type	Total Miles
Valid	Being Studied	166.0
Unverified	Being Studied	253.2

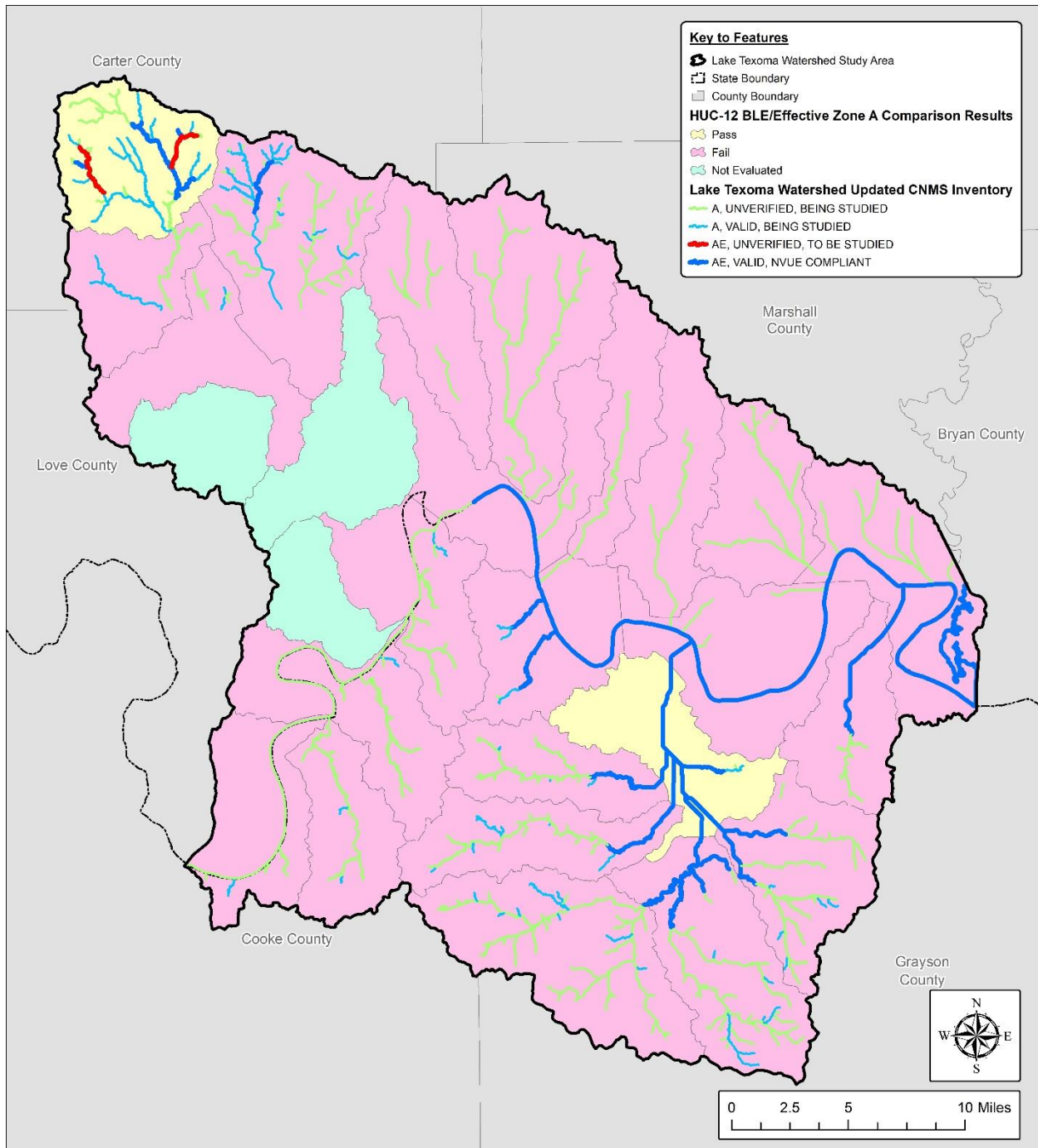


Figure 8: Lake Texoma Watershed CNMS Validation Results

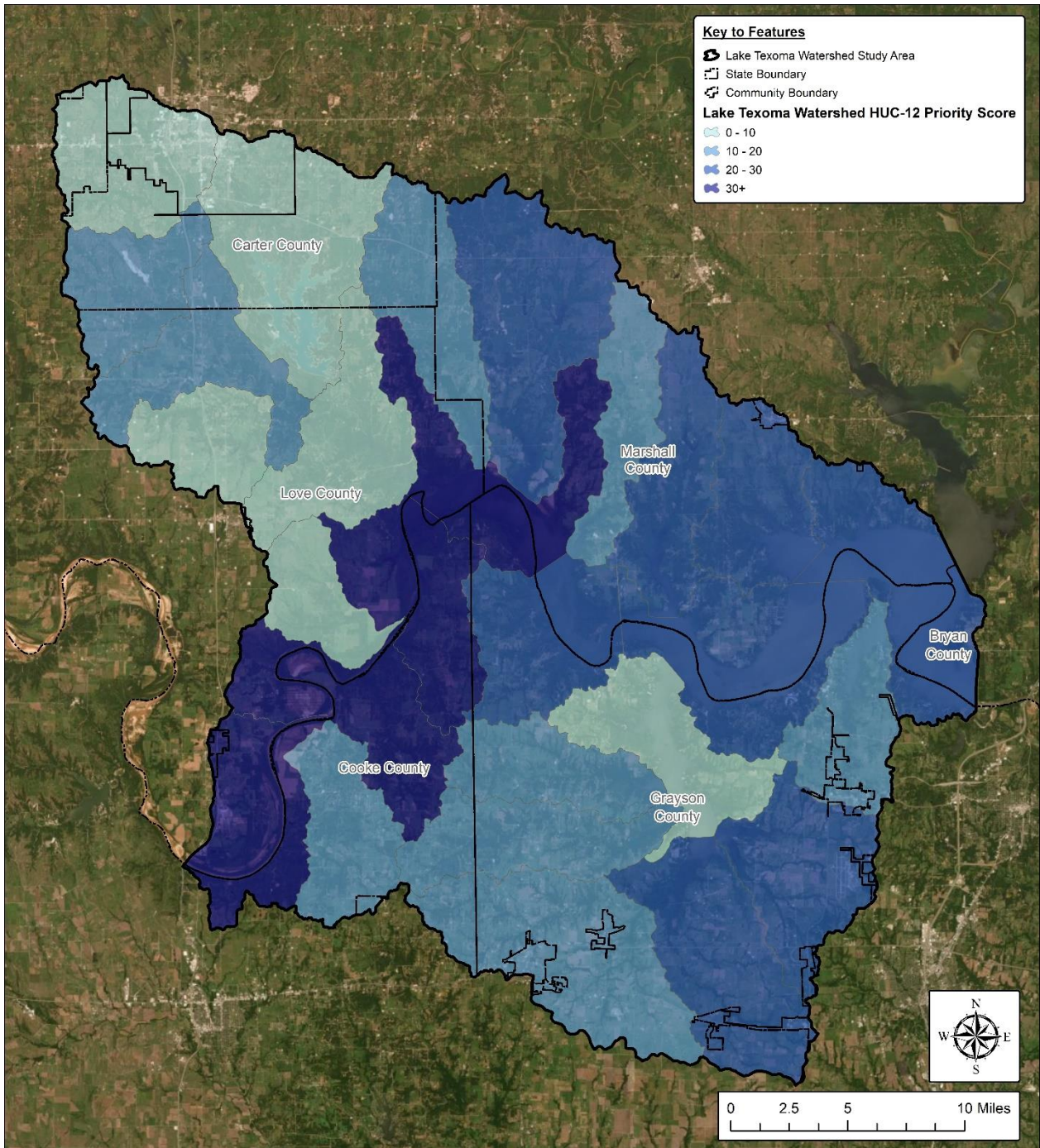


Figure 9: Ranking of Lake Texoma Watershed HUC-12s

3.2 Flood Risk Analysis

A flood risk analysis was performed for this project. The updated 1-percent annual chance grid (known as the 'refined' grid) was used to perform the flood risk analysis to produce the flood losses. The refined grid loss results are stored in the S_FRAC_Ar feature class.

Hazus version 5.0 was used for the basic and refined loss analysis.



The losses are reported via census blocks. It is important to note that Hazus version 5.0 uses dasymetric census blocks. Dasymetric mapping removes undeveloped areas (such as areas covered by other bodies of water, wetlands, or forests) from the Census blocks, changing their shape and reducing their size in these areas. For more information on dasymetric data visit FEMA's [Media Library](#) for the [Hazus-MH Data Inventories: Dasymetric vs. Homogenous](#), or [Hazus 3.0 Dasymetric Data Overview](#).

Hazus analysis was performed on a watershed level for the study area extents to ensure proper model processing. A summary of results per county for the 1-percent annual chance event scenarios are shown in Table 10.

Table 10: Hazus 5.0 Results for 1-Percent Annual Chance Scenario for Lake Texoma

County	Full Replacement - Total Loss	Dollar Exposure (Replacement Value) - Buildings	Dollar Exposure (Replacement Value) - Contents
Bryan	\$8,766,000	\$601,926,000	\$323,040,000
Carter	\$232,434,000	\$16,903,452,000	\$11,718,624,000
Cooke	\$58,842,000	\$996,936,000	\$717,858,000
Grayson	\$318,774,000	\$13,220,436,000	\$8,056,956,000
Love	\$1,124,568,000	\$2,038,950,000	\$2,038,950,000
Marshall	\$81,780,000	\$5,792,538,000	\$3,411,942,000
Total	\$1,825,164,000	\$39,554,238,000	\$26,267,370,000



References

- Asquith, W. and Roussel, M. (2009). *Regression Equations for Estimation of Annual Peak-Streamflow Frequency for Undeveloped Watersheds in Texas Using an L-moment-Based, PRESS Minimized, Residual-Adjusted Approach SIR 2009-5087*, United States Geological Survey.
- Chow, Ven T. (1959). "Development of Uniform Flow and Its Formulas." *Open Channel Hydraulics*, Blackburn, Caldwell, NJ, 109-113.
- Federal Emergency Management Agency (FEMA) (2016). "Guidance for Flood Risk Analysis and Mapping – Automated Engineering." <https://www.fema.gov/media-library-data/1469144112748-f3c4ecd90cb927cd200b6a3e9da80d8a/Automated_Engineering_Guidance_May_2016.pdf> (Feb. 1, 2018).
- National Resources Conservation Service (NRCS). "Texas Precipitation – Average monthly and annual precipitation for the climatological period 1981-2010." <<http://www.twdb.texas.gov/mapping/gisdata.asp>> (Oct. 2015).
- USGS, "Methods for Estimating Flood Magnitude and Frequency of Peak Streamflows for Unregulated Streams in Oklahoma", Scientific Investigations Report 2010-5137, (2010)
- U. S. Army Corps of Engineers, Hydrologic Engineering Center. (2010). *HEC-RAS River Analysis System*, Version 4.1.0. Davis, California.
- 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." < <https://dx.doi.org/10.3133/fs20133108>> (Feb. 1, 2018).
- Xian, G., Homer, C., Dewitz, J., Fry, J., Hossain, N., and Wickham, J. (2011). *The change of impervious surface area between 2001 and 2006 in the conterminous United States*. Photogrammetric Engineering and Remote Sensing, 77(8), 758-762.
- U. S. Geological Survey, Interagency Advisory Committee on Water Data (1982). *Guidelines for determining Flood Flow Frequency*, Bulletin #17B of the Hydrology Subcommittee, Revised September 1981, Editorial Corrections March 1982. Reston, VA.
- Watershed Concepts, a Division of Hayes, Seay, Mattern & Mattern (2008). *Watershed Information System (WISE)*, Version 4.1.0.



Appendix A Summary of Peak Qs

Table A-1: Summary of Hydrology

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
Big Mineral Arm				
BEAVER CREEK	0.82	1671	1236	2260
BEAVER CREEK	1.49	2664	1970	3603
BEAVER CREEK	3.05	4598	3400	6218
BEAVER CREEK	4.03	5888	4354	7963
BEAVER CREEK	4.22	5833	4313	7888
BEAVER CREEK	4.36	5905	4366	7986
BEAVER CREEK	4.59	6229	4606	8424
BEAVER CREEK	4.68	6275	4640	8486
BEAVER CREEK	5.49	6465	4780	8743
BEAVER CREEK	12.73	12375	9151	16736
BEAVER CREEK	15.21	13725	10149	18561
BEAVER CREEK	16.06	13874	10259	18763
BEAVER CREEK	17.58	14240	10530	19258
BEAVER CREEK	19.09	14799	10943	20014
BEAVER CREEK	20.07	15254	11279	20629
BEAVER CREEK	20.52	15048	11127	20351
BEAVER CREEK	31.27	20240	14966	27372
BEAVER CREEK	31.93	20158	14906	27261
BEAVER CREEK	33.68	20065	14837	27136
COPPER CREEK	0.83	1449	1071	1960
COPPER CREEK	1.69	2483	1836	3358
COPPER CREEK	1.85	2586	1912	3497
COPPER CREEK	2.33	3040	2248	4111
COPPER CREEK	3.55	4408	3259	5961
DRY BRANCH	0.99	1708	1263	2310
DRY BRANCH	1.64	2341	1731	3166
DRY BRANCH	2.40	3166	2341	4282
ELBA CREEK	0.43	1003	742	1356
ELBA CREEK	1.92	3077	2275	4161
ELBA CREEK	2.48	3605	2666	4875
ELBA CREEK	4.10	5266	3894	7122
ELBA CREEK	4.25	5364	3966	7254
ELBA CREEK	4.87	5928	4383	8017
ELBA CREEK	5.43	6404	4735	8661

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
ELBA CREEK	6.34	6934	5127	9377
ELBA CREEK	6.50	7063	5223	9552
ELBA CREEK	7.89	7905	5845	10691
ELBA CREEK	8.44	8368	6188	11317
ELBA CREEK	8.89	8430	6233	11401
ELBA CREEK	9.80	9018	6668	12196
HARRIS CREEK	0.88	1834	1356	2480
HARRIS CREEK	1.71	3254	2406	4401
HARRIS CREEK	2.57	4441	3284	6006
HARRIS CREEK	2.89	4564	3375	6172
HARRIS CREEK	3.04	4619	3415	6247
HARRIS CREEK	3.78	5476	4049	7406
HARRIS CREEK	5.68	6982	5163	9442
HARRIS CREEK	6.03	7318	5411	9897
HARRIS CREEK	12.19	12763	9437	17260
HARRIS CREEK	12.67	13350	9871	18054
HARRIS CREEK	14.12	13628	10077	18430
HARRIS CREEK	14.51	13269	9812	17945
HARRIS CREEK	19.04	16169	11956	21867
HARRIS CREEK	19.95	16194	11974	21901
HARRIS CREEK	20.52	16105	11909	21780
HARRIS CREEK	36.45	24425	18061	33032
LAKE TEXOMA	141.36	47720	35286	64536
LAKE TEXOMA	145.54	48438	35817	65507
LAKE TEXOMA	146.77	48616	35948	65747
LAKE TEXOMA	149.18	48252	35679	65255
LAKE TEXOMA	181.84	54241	40108	73355
LAKE TEXOMA	209.02	58837	43506	79570
LAKE TEXOMA	213.41	58911	43561	79670
LAKE TEXOMA	214.27	58641	43361	79305
LAKE TEXOMA	215.10	58263	43082	78794
LAKE TEXOMA	216.54	57990	42880	78425
LAKE TEXOMA	217.35	57726	42685	78068
LAKE TEXOMA	226.60	58860	43523	79601
LAKE TEXOMA	227.67	58559	43301	79194
LAKE TEXOMA	230.94	58364	43156	78931
LAKE TEXOMA	231.41	58094	42957	78565
LAKE TEXOMA	232.93	57576	42574	77865



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
MARTIN CREEK	1.01	1763	1304	2384
MARTIN CREEK	2.01	2678	1980	3622
MARTIN CREEK	2.99	3449	2550	4664
MARTIN CREEK	3.14	3496	2585	4728
MINERAL CREEK	15.69	12110	8955	16377
MINERAL CREEK	17.17	13073	9667	17680
MINERAL CREEK	18.55	13578	10040	18363
MINERAL CREEK	19.21	13767	10180	18618
MINERAL CREEK	19.38	13730	10152	18568
MINERAL CREEK	23.24	15002	11093	20288
MINERAL CREEK	23.44	15699	11608	21231
MINERAL CREEK	24.08	15944	11790	21562
MINERAL CREEK	24.56	15437	11415	20877
MINERAL CREEK	25.62	15794	11679	21360
MINERAL CREEK	27.28	15990	11824	21625
MINERAL CREEK	56.90	28326	20945	38308
MINERAL CREEK	58.60	27372	20240	37017
MINERAL CREEK	60.83	27979	20689	37838
MINERAL CREEK	94.55	38259	28290	51741
MINERAL CREEK	98.09	38187	28237	51643
MINERAL CREEK	99.17	38379	28379	51903
MINERAL CREEK	102.97	38761	28661	52420
MINERAL CREEK	104.68	38624	28560	52234
MUSTANG CREEK	1.05	1642	1214	2221
MUSTANG CREEK	1.62	2122	1569	2870
MUSTANG CREEK	3.12	3544	2621	4793
MUSTANG CREEK	5.69	5682	4201	7684
MUSTANG CREEK	6.24	5882	4349	7955
MUSTANG CREEK	8.72	7473	5526	10106
MUSTANG CREEK	9.02	7342	5429	9929
MUSTANG CREEK	10.30	7767	5743	10504
MUSTANG CREEK	23.32	15056	11133	20361
MUSTANG CREEK	23.55	14823	10961	20046
MUSTANG CREEK	26.12	15765	11657	21320
MUSTANG CREEK	27.33	15301	11314	20693
MUSTANG CREEK	28.52	16250	12016	21976
MUSTANG CREEK	29.55	15603	11537	21101
MYER BRANCH	1.27	1888	1396	2553

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
MYER BRANCH	2.27	2829	2092	3826
MYER BRANCH	3.13	3497	2586	4729
MYER BRANCH	4.25	4239	3134	5733
MYER BRANCH	4.43	4327	3200	5852
NORTH BRANCH	1.56	2193	1622	2966
NORTH BRANCH	3.29	4079	3016	5516
NORTH BRANCH	4.40	4731	3498	6398
NORTH BRANCH	4.81	5022	3713	6792
NORTH BRANCH	5.65	5460	4037	7384
NORTH BRANCH	6.43	6320	4673	8547
NORTH BRANCH	6.69	6465	4780	8743
NORTH BRANCH	7.04	6369	4709	8613
NORTH BRANCH	8.07	7362	5444	9956
NORTH BRANCH	8.25	7431	5495	10050
NORTH BRANCH	8.82	7817	5780	10572
NORTH BRANCH	9.33	8031	5938	10861
NORTH BRANCH BRUSHY CREEK	1.06	2414	1785	3265
NORTH BRANCH BRUSHY CREEK	1.78	3198	2365	4325
NORTH BRANCH BRUSHY CREEK	3.01	4952	3662	6697
NORTH BRANCH BRUSHY CREEK	3.19	4778	3533	6462
NORTH BRANCH BRUSHY CREEK	7.48	8420	6226	11387
NORTH BRANCH BRUSHY CREEK	7.92	8320	6152	11252
NORTH BRANCH BRUSHY CREEK	9.57	9175	6784	12408
NORTH BRANCH BRUSHY CREEK	10.88	9896	7317	13383
NORTH BRANCH BRUSHY CREEK	11.32	10104	7471	13664
NORTH BRANCH BRUSHY CREEK	11.73	9840	7276	13307
NORTH BRANCH BRUSHY CREEK	11.91	10092	7462	13648
NORTH BRANCH BRUSHY CREEK	12.32	9993	7389	13514
NORTH BRANCH BRUSHY CREEK	16.97	12874	9519	17411
NORTH BRANCH BRUSHY CREEK	17.55	13198	9759	17849
NORTH BRANCH BRUSHY CREEK	19.41	13890	10271	18785
NORTH BRANCH BRUSHY CREEK	20.14	13932	10302	18841
NORTH BRANCH BRUSHY CREEK	20.32	14329	10595	19378
NORTH BRANCH BRUSHY CREEK	22.07	14380	10633	19447
NORTH BRANCH BRUSHY CREEK	24.49	15267	11289	20647
NORTH BRANCH BRUSHY CREEK	26.24	15908	11763	21514
NORTH BRANCH BRUSHY CREEK	26.92	15826	11702	21403
RED BRANCH	0.88	1503	1111	2033

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
RED BRANCH	2.83	3801	2811	5140
RED BRANCH	3.21	4076	3014	5512
RED BRANCH	4.48	5208	3851	7043
SANDY CREEK	1.12	2195	1623	2968
SANDY CREEK	1.68	2702	1998	3654
SANDY CREEK	2.90	4358	3222	5894
SANDY CREEK	4.10	5324	3937	7200
SANDY CREEK	4.76	5734	4240	7755
SANDY CREEK	6.87	7817	5780	10572
SANDY CREEK	7.55	8150	6026	11022
SANDY CREEK	7.98	8483	6273	11472
SANDY CREEK	8.19	8564	6333	11582
SANDY CREEK	8.40	8647	6394	11694
SANDY CREEK	8.59	8600	6359	11631
SANDY CREEK	9.41	9157	6771	12384
SANDY CREEK	13.53	11336	8382	15331
SANDY CREEK	14.39	12219	9035	16525
SANDY CREEK	16.45	13386	9898	18103
SANDY CREEK	18.16	14070	10404	19028
SANDY CREEK	18.90	13867	10254	18754
SANDY CREEK	19.84	14241	10530	19259
SANDY CREEK	22.72	15223	11256	20587
SANDY CREEK	23.61	15929	11778	21542
SANDY CREEK	24.67	16222	11995	21938
SANDY CREEK	24.87	16297	12051	22040
SANDY CREEK	25.00	16450	12164	22247
SANDY CREEK	25.66	16607	12280	22459
SANDY CREEK	27.74	17205	12722	23268
SANDY CREEK	28.82	17340	12822	23450
SANDY CREEK	29.35	17536	12967	23715
SANDY CREEK	30.78	17969	13287	24301
SANDY CREEK	31.94	17937	13263	24258
SANDY CREEK 1	1.05	1931	1428	2611
SANDY CREEK 1	1.45	2418	1788	3270
SANDY CREEK TRIBUTARY 2	1.09	2106	1557	2848
SANDY CREEK TRIBUTARY 2	1.87	2900	2144	3922
SANDY CREEK TRIBUTARY 3	0.90	1679	1242	2271
SANDY CREEK TRIBUTARY 3	1.19	2048	1514	2770



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
SCOTT BRANCH	1.02	1926	1424	2605
SCOTT BRANCH	1.42	2416	1786	3267
SCOTT BRANCH	1.62	2670	1974	3611
SCOTT BRANCH	2.64	3790	2802	5126
SCOTT BRANCH	3.79	4784	3537	6470
SOUTH BRANCH	0.99	1848	1366	2499
SOUTH BRANCH	2.11	3369	2491	4556
SOUTH BRANCH	3.35	4819	3563	6517
SOUTH BRANCH	3.82	5349	3955	7234
SOUTH BRANCH	4.71	6015	4448	8135
SOUTH BRANCH	6.36	7369	5449	9966
UNT001 IN BMAR	0.77	1223	904	1654
UNT001 IN BMAR	1.86	2388	1766	3229
UNT001 IN BMAR	3.78	4186	3095	5661
UNT001 IN BMAR	4.64	4940	3653	6681
UNT001 IN BMAR	6.68	6610	4888	8939
UNT001 IN BMAR	12.39	10250	7579	13862
UNT002 IN BMAR	1.06	1619	1197	2190
UNT002 IN BMAR	1.55	2170	1605	2935
UNT003 IN BMAR	1.17	2016	1491	2726
UNT003 IN BMAR	1.85	2811	2079	3802
UNT004 IN BMAR	1.00	1777	1314	2403
UNT004 IN BMAR	1.96	2726	2016	3687
UNT004 IN BMAR	2.42	2917	2157	3945
UNT004 IN BMAR	2.70	3316	2452	4485
UNT004 IN BMAR	4.47	4879	3608	6598
UNT005 IN BMAR	1.05	1578	1167	2134
UNT007 IN BMAR	0.91	1566	1158	2118
UNT008 IN BMAR	1.04	1768	1307	2391
UNT008 IN BMAR	1.46	2116	1565	2862
UNT009 IN BMAR	0.95	1517	1122	2052
UNT009 IN BMAR	1.48	2115	1564	2860
UNT010 IN BMAR	1.55	2280	1686	3083
UNT010 IN BMAR	2.26	2927	2164	3958
UNT010 IN BMAR	2.40	3198	2365	4325
UNT011 IN BMAR	0.65	1038	768	1404
UNT011 IN BMAR	0.95	1472	1088	1991
UNT012 IN BMAR	0.53	1008	745	1363



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT012 IN BMAR	1.15	1948	1440	2634
UNT013 IN BMAR	0.46	889	657	1202
UNT015 IN BMAR	0.49	927	685	1254
UNT016 IN BMAR	0.90	1807	1336	2444
UNT017 IN BMAR	0.65	1561	1154	2111
UNT018 IN BMAR	0.74	1601	1184	2165
UNT019 IN BMAR	0.55	1180	873	1596
UNT021 IN BMAR	0.98	2050	1516	2772
UNT022 IN BMAR	0.58	1189	879	1608
UNT022 IN BMAR	1.06	1856	1372	2510
UNT023 IN BMAR	0.29	654	484	884
UNT024 IN BMAR	0.91	1646	1217	2226
UNT024 IN BMAR	1.25	2300	1701	3110
UNT025 IN BMAR	0.47	1024	757	1385
UNT026 IN BMAR	0.51	1173	867	1586
UNT029 IN BMAR	0.14	397	294	537
UNT030 IN BMAR	0.75	1437	1063	1943
UNT030 IN BMAR	0.98	1802	1332	2437
UNT030 IN BMAR	1.19	2098	1551	2837
UNT031 IN BMAR	0.20	492	364	665
UNT032 IN BMAR	0.18	464	343	628
UNT033 IN BMAR	0.20	587	434	794
UNT034 IN BMAR	0.52	1087	804	1470
UNT035 IN BMAR	0.29	635	470	859
UNT036 IN BMAR	1.01	1550	1146	2096
UNT036 IN BMAR	1.19	1861	1376	2517
UNT037 IN BMAR	1.04	1725	1276	2333
UNT037 IN BMAR	1.82	2663	1969	3601
UNT037 IN BMAR	2.17	3213	2376	4345
UNT038 IN BMAR	0.63	1093	808	1478
UNT039 IN BMAR	1.00	2034	1504	2751
UNT039 IN BMAR	1.43	2594	1918	3508
UNT039 IN BMAR	1.47	2625	1941	3550
UNT039 IN BMAR	2.38	3755	2777	5078
UNT039 IN BMAR	3.16	4721	3491	6385
UNT039 IN BMAR	3.90	5502	4068	7441
UNT039 IN BMAR	5.42	6994	5172	9459
UNT039 IN BMAR	6.85	8292	6131	11214



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT040 IN BMAR	0.97	1733	1281	2344
UNT040 IN BMAR	1.29	2186	1616	2956
UNT041 IN BMAR	1.05	1805	1335	2441
UNT041 IN BMAR	1.19	1881	1391	2544
UNT041 IN BMAR	1.37	2154	1593	2913
UNT043 IN BMAR	0.37	1107	819	1497
UNT044 IN BMAR	0.99	1893	1400	2560
UNT044 IN BMAR	1.30	2322	1717	3140
UNT045 IN BMAR	0.33	708	524	957
UNT045 IN BMAR	0.56	1057	782	1429
UNT045 IN BMAR	0.98	2119	1567	2866
UNT046 IN BMAR	0.13	329	243	445
UNT047 IN BMAR	0.25	692	512	936
UNT048 IN BMAR	0.19	437	323	591
UNT049 IN BMAR	0.11	296	219	400
UNT050 IN BMAR	1.00	1513	1119	2046
UNT050 IN BMAR	1.50	2114	1563	2859
UNT051 IN BMAR	0.91	2263	1673	3060
UNT053 IN BMAR	0.38	893	660	1208
UNT054 IN BMAR	0.17	467	345	632
UNT055 IN BMAR	0.35	634	469	857
UNT056 IN BMAR	0.83	1421	1051	1922
UNT056 IN BMAR	1.13	1819	1345	2460
UNT057 IN BMAR	0.26	476	352	644
UNT058 IN BMAR	0.43	763	564	1032
UNT059 IN BMAR	0.38	728	538	985
UNT060 IN BMAR	0.78	1376	1017	1861
UNT061 IN BMAR	0.51	1086	803	1469
UNT062 IN BMAR	0.40	878	649	1187
UNT063 IN BMAR	1.04	1898	1403	2567
UNT063 IN BMAR	1.30	2214	1637	2994
UNT064 IN BMAR	1.02	1921	1420	2598
UNT064 IN BMAR	1.58	2529	1870	3420
UNT064 IN BMAR	3.00	4176	3088	5648
UNT065 IN BMAR	1.07	1994	1474	2697
UNT066 IN BMAR	0.34	645	477	872
UNT067 IN BMAR	0.65	1204	890	1628
UNT067 IN BMAR	1.07	1626	1202	2199



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT068 IN BMAR	0.24	521	385	705
UNT071 IN BMAR	0.78	1895	1401	2563
UNT072 IN BMAR	0.21	442	327	598
UNT073 IN BMAR	0.34	785	580	1062
UNT074 IN BMAR	0.28	844	624	1141
UNT074 IN BMAR	1.18	2512	1857	3397
UNT074 IN BMAR	1.46	2978	2202	4027
UNT075 IN BMAR	1.03	2141	1583	2895
UNT075 IN BMAR	2.44	4328	3200	5853
UNT075 IN BMAR	3.17	5048	3733	6827
UNT075 IN BMAR	4.13	5972	4416	8076
UNT075 IN BMAR	4.79	6480	4792	8763
UNT075 IN BMAR	6.03	7568	5596	10235
UNT076 IN BMAR	0.96	2012	1488	2721
UNT080 IN BMAR	0.62	1115	824	1508
UNT081 IN BMAR	0.68	1614	1193	2183
UNT081 IN BMAR	1.78	3077	2275	4161
UNT081 IN BMAR	4.13	6882	5089	9307
UNT081 IN BMAR	5.20	8098	5988	10952
UNT081 IN BMAR	5.85	8482	6272	11471
UNT081 IN BMAR	7.32	9744	7205	13178
UNT081 IN BMAR	8.45	10696	7909	14465
UNT081 IN BMAR	8.88	10689	7904	14456
UNT081 IN BMAR	11.24	12705	9395	17182
UNT081 IN BMAR	13.67	14107	10431	19078
UNT081 IN BMAR	13.91	14045	10385	18994
UNT081 IN BMAR	14.55	13800	10204	18663
UNT081 IN BMAR	15.38	13828	10225	18701
UNT083 IN BMAR	1.27	2864	2118	3873
UNT083 IN BMAR	1.44	2929	2166	3961
UNT085 IN BMAR	0.25	639	472	864
UNT085 IN BMAR	0.63	1346	995	1820
UNT086 IN BMAR	0.15	414	306	560
UNT087 IN BMAR	0.56	1206	892	1631
UNT087 IN BMAR	0.99	1969	1456	2663
UNT087 IN BMAR	1.64	3084	2280	4171
UNT087 IN BMAR	1.96	3399	2513	4597
UNT088 IN BMAR	0.62	1374	1016	1858



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT090 IN BMAR	1.02	1845	1364	2495
UNT090 IN BMAR	1.89	2985	2207	4037
UNT091 IN BMAR	0.21	488	361	660
UNT092 IN BMAR	0.22	502	371	679
UNT093 IN BMAR	1.04	1980	1464	2678
UNT093 IN BMAR	2.04	3198	2365	4325
UNT093 IN BMAR	2.22	3424	2532	4631
UNT093 IN BMAR	3.52	4992	3691	6751
UNT093 IN BMAR	4.00	5131	3794	6939
UNT094 IN BMAR	0.88	1581	1169	2138
UNT094 IN BMAR	1.25	2052	1517	2775
UNT095 IN BMAR	0.26	644	476	871
UNT096 IN BMAR	0.51	1120	828	1515
UNT096 IN BMAR	1.22	2102	1554	2843
UNT097 IN BMAR	0.40	844	624	1141
UNT098 IN BMAR	1.03	1490	1102	2015
UNT098 IN BMAR	1.41	1766	1306	2388
UNT102 IN BMAR	0.52	1126	833	1523
UNT103 IN BMAR	0.42	914	676	1236
UNT104 IN BMAR	0.20	628	464	849
UNT105 IN BMAR	0.14	463	342	626
UNT106 IN BMAR	0.72	1444	1068	1953
UNT107 IN BMAR	0.90	1718	1270	2323
UNT107 IN BMAR	1.20	2113	1562	2858
UNT107 IN BMAR	2.29	3582	2649	4844
UNT107 IN BMAR	2.77	3928	2905	5312
UNT107 IN BMAR	3.42	4781	3535	6466
UNT108 IN BMAR	1.02	1883	1392	2547
UNT109 IN BMAR	0.18	459	339	621
UNT110 IN BMAR	0.60	1065	787	1440
UNT111 IN BMAR	0.83	1602	1185	2167
UNT112 IN BMAR	1.00	1822	1347	2464
UNT112 IN BMAR	1.87	2798	2069	3784
UNT114 IN BMAR	0.55	1052	778	1423
UNT115 IN BMAR	0.81	1529	1131	2068
UNT116 IN BMAR	1.15	2005	1483	2712
UNT116 IN BMAR	2.06	2808	2076	3797
UNT118 IN BMAR	0.70	1247	922	1686



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT119 IN BMAR	1.07	1932	1429	2613
UNT120 IN BMAR	0.17	487	360	659
UNT121 IN BMAR	0.13	373	276	504
UNT122 IN BMAR	0.15	418	309	565
UNT127 IN BMAR	0.57	1338	989	1809
UNT128 IN BMAR	0.23	685	507	926
UNT138 IN BMAR	0.20	492	364	665
UNT139 IN BMAR	0.88	1872	1384	2532
UNT141 IN BMAR	0.73	1428	1056	1931
UNT143 IN BMAR	0.31	733	542	991
UNT144 IN BMAR	0.14	425	314	575
UNT145 IN BMAR	0.31	780	577	1055
UNT150 IN BMAR	0.31	613	453	829
UNT153 IN BMAR	0.45	1128	834	1525
UNT154 IN BMAR	0.85	1567	1159	2119
UNT155 IN BMAR	1.05	1882	1392	2545
UNT156 IN BMAR	1.17	1970	1457	2664
UNT156 IN BMAR	1.39	2290	1693	3097
UNT157 IN BMAR	0.22	600	444	811
UNT158 IN BMAR	0.96	1653	1222	2235
UNT160 IN BMAR	0.14	426	315	576
UNT161 IN BMAR	0.14	422	312	571
UNT162 IN BMAR	0.24	641	474	867
UNT163 IN BMAR	1.12	1903	1407	2574
UNT164 IN BMAR	0.29	723	535	978
UNT164 IN BMAR	0.71	1238	915	1674
UNT165 IN BMAR	0.15	445	329	602
UNT168 IN BMAR	0.82	1545	1142	2089
UNT168 IN BMAR	2.14	3264	2414	4414
UNT168 IN BMAR	2.38	3276	2422	4430
UNT169 IN BMAR	0.75	1584	1171	2142
UNT170 IN BMAR	0.73	1534	1134	2075
UNT171 IN BMAR	0.46	1104	816	1493
UNT171 IN BMAR	0.69	1451	1073	1962
UNT175 IN BMAR	0.35	870	643	1177
UNT176 IN BMAR	0.58	1560	1154	2110
UNT181 IN BMAR	0.50	775	573	1048
UNT182 IN BMAR	0.38	929	687	1256



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT182 IN BMAR	0.67	1525	1128	2062
UNT184 IN BMAR	0.22	582	430	787
UNT185 IN BMAR	0.09	272	201	368
UNT186 IN BMAR	0.30	774	572	1047
UNT187 IN BMAR	0.16	434	321	587
UNT188 IN BMAR	0.47	944	698	1277
UNT189 IN BMAR	0.59	1273	941	1722
UNT189 IN BMAR	1.07	1960	1449	2651
UNT191 IN BMAR	0.30	762	563	1031
UNT192 IN BMAR	0.45	922	682	1247
UNT193 IN BMAR	0.45	1086	803	1469
UNT194 IN BMAR	0.22	493	365	667
UNT195 IN BMAR	0.25	694	513	939
UNT196 IN BMAR	0.96	2232	1650	3019
UNT197 IN BMAR	0.24	557	412	753
UNT197 IN BMAR	0.36	790	584	1068
UNT198 IN BMAR	0.60	1488	1100	2012
UNT199 IN BMAR	0.16	360	266	487
UNT202 IN BMAR	0.37	805	595	1089
UNT203 IN BMAR	0.11	256	189	346
UNT205 IN BMAR	0.67	1347	996	1822
UNT206 IN BMAR	0.74	1215	898	1643
UNT207 IN BMAR	0.54	1063	786	1438
UNT208 IN BMAR	0.17	393	291	531
UNT209 IN BMAR	0.13	369	273	499
UNT210 IN BMAR	0.12	382	282	517
UNT211 IN BMAR	0.88	1762	1303	2383
UNT213 IN BMAR	0.20	547	404	740
UNT221 IN BMAR	0.21	534	395	722
UNT222 IN BMAR	0.26	584	432	790
UNT223 IN BMAR	0.20	502	371	679
UNT229 IN BMAR	0.48	1107	819	1497
UNT231 IN BMAR	0.58	1164	861	1574
UNT232 IN BMAR	0.38	993	734	1343
UNT235 IN BMAR	0.17	538	398	728
UNT237 IN BMAR	0.78	1589	1175	2149
UNT239 IN BMAR	0.08	227	168	307
UNT241 IN BMAR	0.10	284	210	384



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT245 IN BMAR	0.10	248	183	335
UNT248 IN BMAR	0.10	310	229	419
UNT249 IN BMAR	0.10	294	217	398
UNT250 IN BMAR	0.12	355	262	480
UNT251 IN BMAR	0.98	1676	1239	2267
UNT252 IN BMAR	1.00	2054	1519	2778
UNT252 IN BMAR	1.68	2570	1900	3476
UNT252 IN BMAR	2.35	3427	2534	4635
UNT252 IN BMAR	3.49	4643	3433	6279
UNT252 IN BMAR	3.92	4967	3673	6717
UNT300 IN BMAR	0.59	1445	1068	1954
UNT301 IN BMAR	0.02	61	45	82
UNT302 IN BMAR	0.27	607	449	821
UNT303 IN BMAR	0.46	1110	821	1501
UNT304 IN BMAR	0.13	494	365	668
UNT305 IN BMAR	0.32	816	603	1104
UNT307 IN BMAR	0.29	779	576	1054
UNT308 IN BMAR	0.68	1468	1085	1985
UNT308 IN BMAR	1.11	2171	1605	2936
UNT309 IN BMAR	0.28	748	553	1012
UNT310 IN BMAR	0.22	599	443	810
UNT312 IN BMAR	0.08	207	153	280
UNT313 IN BMAR	0.11	312	231	422
UNT314 IN BMAR	0.20	477	353	645
UNT315 IN BMAR	0.18	415	307	561
UNT316 IN BMAR	0.10	261	193	353
UNT317 IN BMAR	0.76	1513	1119	2046
UNT318 IN BMAR	0.39	785	580	1062
UNT319 IN BMAR	0.62	1254	927	1696
UNT320 IN BMAR	0.19	559	413	756
UNT321 IN BMAR	0.63	960	710	1298
WALNUT CREEK	1.15	1721	1273	2327
WALNUT CREEK	1.68	2560	1893	3462
WALNUT CREEK	2.29	3034	2243	4103
WALNUT CREEK	2.75	3795	2806	5132
WALNUT CREEK	3.43	4439	3282	6003
WALNUT CREEK	4.30	5098	3770	6894
WALNUT CREEK	4.62	5273	3899	7131

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
WALNUT CREEK	7.63	7610	5627	10292
WALNUT CREEK	8.45	7761	5739	10496
WALNUT CREEK	9.12	8163	6036	11040
Denison Dam				
BUNCOMBE CREEK	1.17546	1736	1116	2356
BUNCOMBE CREEK	7.9754	6049	3888	8210
BUNCOMBE CREEK	9.56534	6889	4428	9350
BUNCOMBE CREEK	11.43558	8712	5600	11824
BUNCOMBE CREEK	17.73663	11029	7089	14969
BUNCOMBE CREEK	19.01567	11128	7153	15103
BUNCOMBE CREEK	25.14855	13229	8504	17954
BUNCOMBE CREEK	28.16269	14050	9031	19069
BUNCOMBE CREEK	29.64899	14132	9084	19180
BUNCOMBE CREEK	32.22369	14670	9430	19910
BUNCOMBE CREEK	14.11456	10012	6436	13588
BUNCOMBE CREEK	34.15517	14236	9151	19321
BUNCOMBE CREEK	7.20733	6180	3973	8387
BUNCOMBE CREEK	2.05913	2423	1558	3288
BUNCOMBE CREEK	15.31872	10546	6779	14313
BUNCOMBE CREEK	16.30954	10381	6673	14089
BUNCOMBE CREEK	4.53891	4187	2691	5683
BUNCOMBE CREEK	5.81531	5230	3362	7098
BUNCOMBE CREEK	27.50592	13790	8864	18716
BUNCOMBE CREEK	19.86633	11436	7351	15521
BUNCOMBE CREEK	28.68775	13769	8851	18687
CANEY CREEK	0.7278	1186	762	1610
CANEY CREEK	1.41095	1927	1239	2615
CANEY CREEK	3.68924	4046	2601	5491
CANEY CREEK	3.86886	4181	2688	5674
CANEY CREEK	6.85719	6085	3911	8259
CANEY CREEK	32.07385	14844	9542	20146
CANEY CREEK	7.58526	6386	4105	8667
CANEY CREEK	5.00529	4940	3175	6705
CANEY CREEK	10.3304	7838	5038	10638
CANEY CREEK	10.77913	7840	5040	10640
CANEY CREEK	11.60549	7765	4991	10539
CANEY CREEK	12.3645	7710	4956	10464
LIMESTONE CREEK	0.95513	2077	1335	2819

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
LIMESTONE CREEK	1.28585	2576	1656	3496
LIMESTONE CREEK	4.87914	5074	3262	6886
LIMESTONE CREEK	2.28923	3832	2463	5201
LIMESTONE CREEK	2.68452	3916	2517	5315
LIMESTONE CREEK	2.95238	4093	2631	5555
LIMESTONE CREEK	4.28002	5095	3275	6915
LITTLE MINERAL CREEK	0.75793	1481	1095	2003
LITTLE MINERAL CREEK	1.48179	2445	1808	3307
LITTLE MINERAL CREEK	4.44834	5823	4306	7875
LITTLE MINERAL CREEK	10.15096	10622	7854	14365
LITTLE MINERAL CREEK	13.53315	13286	9824	17968
LITTLE MINERAL CREEK	17.62171	14721	10885	19908
LITTLE MINERAL CREEK	18.79376	15126	11185	20456
LITTLE MINERAL CREEK	23.06679	16835	12448	22767
LITTLE MINERAL CREEK	25.95394	16942	12528	22912
LITTLE MINERAL CREEK	5.91139	7086	5240	9583
LITTLE MINERAL CREEK	6.58018	7603	5622	10282
LITTLE MINERAL CREEK	28.10088	16989	12562	22976
LITTLE MINERAL CREEK	14.54988	13766	10179	18617
LITTLE MINERAL CREEK	15.24083	13960	10323	18879
LITTLE MINERAL CREEK	24.83714	16797	12420	22716
MCLAUGHLIN CREEK	0.95334	1661	1068	2254
MCLAUGHLIN CREEK	1.88228	2747	1766	3728
MCLAUGHLIN CREEK	2.87481	3060	1967	4153
MCLAUGHLIN CREEK	7.00408	4571	2938	6204
MCLAUGHLIN CREEK	4.01422	3964	2548	5380
MCLAUGHLIN CREEK	5.67231	4252	2733	5771
MILL CREEK	1.34091	3035	2244	4104
MILL CREEK	3.52074	5878	4346	7949
MILL CREEK	6.39895	7968	5892	10776
MILL CREEK	8.18609	9038	6683	12223
MILL CREEK	4.77395	6791	5022	9184
OIL BRANCH	1.00086	2213	1423	3003
OIL BRANCH	1.21958	2292	1473	3111
ROCK CREEK	1.26146	1879	1208	2550
ROCK CREEK	1.98666	2721	1749	3693
ROCK CREEK	3.82016	4535	2915	6155
ROCK CREEK	4.03978	4834	3107	6561

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
ROCK CREEK	7.22432	6670	4287	9053
ROCK CREEK	15.0144	11343	7291	15395
ROCK CREEK	18.06165	12278	7892	16664
SANDY CREEK	0.5732	1535	987	2083
SANDY CREEK	1.30477	2272	1460	3084
SANDY CREEK	3.04259	3873	2490	5256
SANDY CREEK	3.96987	4041	2598	5484
SANDY CREEK	5.38096	4738	3046	6430
SANDY CREEK	7.31462	5235	3365	7105
SOLDIER CREEK	0.971	1721	1106	2336
SOLDIER CREEK	1.62805	2408	1548	3268
SOLDIER CREEK	4.00974	3960	2545	5375
SOLDIER CREEK	4.67001	4133	2657	5609
SOLDIER CREEK	5.34491	4199	2699	5699
UNT04 IN DDRR	0.91244	1398	899	1897
UNT04 IN DDRR	1.8483	2105	1353	2857
UNT05 IN DDRR	0.91146	1505	967	2043
UNT05 IN DDRR	1.53766	2136	1373	2899
UNT06 IN DDRR	0.90796	1486	955	2017
UNT06 IN DDRR	1.47964	2303	1480	3126
UNT07 IN DDRR	0.91352	1560	1003	2117
UNT07 IN DDRR	1.7286	2807	1804	3810
UNT08 IN DDRR	0.9319	2116	1360	2872
UNT08 IN DDRR	1.34549	2473	1590	3356
UNT09 IN DDRR	3.61149	4150	2668	5632
UNT09 IN DDRR	4.66123	4422	2842	6002
UNT09 IN DDRR	0.9276	2019	1298	2740
UNT09 IN DDRR	1.79554	2779	1786	3772
UNT09 IN DDRR	2.39702	3105	1996	4214
UNT10 IN DDRR	1.01557	1618	1040	2196
UNT11 IN DDRR	1.25958	2646	1701	3591
UNT11 IN DDRR	2.34527	3843	2470	5216
UNT12 IN DDRR	1.00185	2224	1430	3018
UNT12 IN DDRR	2.09024	3647	2344	4950
UNT13 IN DDRR	0.98974	1930	1241	2619
UNT16 IN DDRR	1.01952	1897	1219	2575
UNT16 IN DDRR	1.83027	3030	1948	4112
UNT16 IN DDRR	2.43477	3294	2117	4471



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT18 IN DRRR	1.00167	2340	1730	3165
UNT18 IN DRRR	1.23877	2581	1908	3491
UNT20 IN DRRR	0.16213	609	391	827
UNT20 IN DRRR	1.01631	2594	1667	3521
UNT20 IN DRRR	2.63827	2928	1882	3974
UNT20 IN DRRR	1.71868	3314	2130	4498
UNT24 IN DRRR	0.96517	1751	1126	2376
UNT25 IN DRRR	2.02361	3192	2052	4332
UNT25 IN DRRR	0.93486	1542	991	2093
UNT26 IN DRRR	0.60127	1505	967	2043
UNT26 IN DRRR	1.10865	2243	1442	3044
UNT26 IN DRRR	2.13068	2493	1603	3383
UNT28 IN DRRR	0.62046	1051	676	1426
UNT28 IN DRRR	1.65729	2203	1416	2990
UNT29 IN DRRR	1.06802	1647	1059	2235
UNT29 IN DRRR	0.29189	785	505	1065
UNT30 IN DRRR	1.13825	1776	1142	2410
UNT30 IN DRRR	1.85861	2459	1581	3337
UNT32 IN DRRR	1.0075	1854	1192	2516
UNT32 IN DRRR	1.21931	2006	1289	2723
UNT36 IN DRRR	1.95242	2870	2122	3881
UNT36 IN DRRR	2.94117	4118	3045	5569
UNT36 IN DRRR	0.90061	1634	1208	2210
UNT36 IN DRRR	1.27177	2035	1505	2752
UNT37 IN DRRR	0.52164	1242	918	1680
UNT37 IN DRRR	0.95374	2111	1561	2855
UNT39 IN DRRR	1.07592	2125	1571	2874
UNT40 IN DRRR	1.18515	2187	1617	2958
UNT40 IN DRRR	1.66141	2759	2040	3731
UNT40 IN DRRR	2.8853	3881	2870	5249
UNT40 IN DRRR	3.34327	4416	3265	5972
UNT41 IN DRRR	3.25826	4901	3624	6628
UNT41 IN DRRR	0.98804	1797	1329	2430
UNT41 IN DRRR	1.41382	2384	1763	3224
UNT42 IN DRRR	1.17986	2130	1575	2881
UNT43 IN DRRR	1.00714	2018	1492	2729
UNT43 IN DRRR	1.29025	2530	1871	3422
UNT44 IN DRRR	1.13376	2468	1825	3338

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT44 IN DDDR	1.92398	4207	3111	5689
UNT44 IN DDDR	2.45441	4510	3335	6099
UNT48 IN DDDR	0.80071	2108	1559	2851
UNT48 IN DDDR	1.33251	2434	1800	3292
UNT50 IN DDDR	0.93953	1526	981	2071
UNT50 IN DDDR	2.32824	2702	1737	3667
UNT50 IN DDDR	2.77858	2640	1697	3583
UNT51 IN DDDR	0.37726	857	551	1163
UNT52 IN DDDR	0.21657	676	435	917
UNT52 IN DDDR	0.46748	1101	708	1494
UNT53 IN DDDR	0.85236	1567	1007	2127
UNT54 IN DDDR	0.66853	1373	883	1863
UNT56 IN DDDR	0.35798	1045	672	1418
UNT56 IN DDDR	0.46499	1284	825	1743
UNT57 IN DDDR	0.15343	492	364	665
UNT57 IN DDDR	0.70323	1545	1142	2089
UNT58 IN DDDR	0.67965	1350	868	1832
UNT59 IN DDDR	0.15182	543	349	737
UNT60 in DDDR	0.44694	1062	683	1441
UNT60 IN DDDR	1.13744	1825	1173	2477
UNT61 IN DDDR	0.59369	1759	1131	2387
UNT61 IN DDDR	0.72453	1604	1031	2177
UNT63 IN DDDR	0.78717	1456	936	1976
UNT64 IN DDDR	0.36288	436	280	592
UNT65 IN DDDR	0.1767	256	165	347
UNT66 IN DDDR	0.84317	942	606	1278
Fobb Bottom				
BOGGY CREEK	1.157168	1942	1248	2636
BOGGY CREEK	2.150769	2618	1683	3553
BOGGY CREEK	3.098725	3349	2153	4545
BOGGY CREEK	3.727527	3588	2306	4870
BOGGY CREEK	4.681223	4297	2762	5832
BOGGY CREEK	5.630524	4462	2868	6056
BOGGY CREEK	7.386991	4682	3010	6354
BOGGY CREEK	8.288047	4892	3145	6639
BOGGY CREEK	9.383071	5503	3537	7469
BOGGY CREEK	10.37712	6143	3949	8337
BOGGY CREEK	11.250018	6277	4035	8519

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
BOGGY CREEK	12.072237	6636	4266	9006
BOGGY CREEK	6.612108	4636	2980	6292
BRIAR CREEK	1.07933	2518	1862	3405
BRIAR CREEK	2.098847	4256	3147	5756
BRIAR CREEK	3.944003	6889	5094	9317
BRIAR CREEK	4.790716	7065	5224	9555
BRIAR CREEK	10.095196	12278	9079	16605
BRIAR CREEK	4.658751	7134	5275	9648
BRIER CREEK	1.29464	2227	1432	3022
BRIER CREEK	2.076966	2851	1833	3869
BRIER CREEK	3.432048	3800	2443	5157
BRIER CREEK	4.337588	4310	2770	5850
BRIER CREEK	6.883914	5906	3796	8016
BRIER CREEK	7.421696	5943	3820	8066
BRIER CREEK	9.898882	7133	4585	9681
BRIER CREEK	12.010912	8441	5426	11456
BRIER CREEK	13.003526	8813	5665	11961
BRIER CREEK	13.55718	9015	5795	12235
BRIER CREEK	15.386554	9852	6333	13371
BRIER CREEK	16.060283	9509	6112	12906
BRIER CREEK	17.243099	9993	6424	13562
BRIER CREEK	18.190875	10046	6458	13634
BRIER CREEK	18.921638	10083	6481	13685
BRIER CREEK	19.999444	10434	6707	14161
BRIER CREEK	21.111057	10750	6910	14590
BRIER CREEK	22.165817	10714	6887	14541
BRIER CREEK	24.04747	10910	7013	14807
BRIER CREEK	24.458452	10953	7041	14865
CATLIN CREEK	1.044626	2456	1816	3321
CATLIN CREEK	1.311858	2581	1908	3491
CATLIN CREEK	4.773678	6185	4573	8364
HAUANI CREEK	1.138695	2304	1481	3127
HAUANI CREEK	2.138215	3255	2092	4418
HAUANI CREEK	2.903502	3595	2311	4879
HAUANI CREEK	9.278868	7925	5094	10756
HAUANI CREEK	10.262963	8508	5469	11547
HAUANI CREEK	11.606656	9032	5806	12258
HAUANI CREEK	12.122019	9261	5953	12569

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
HAUANI CREEK	16.323838	11477	7377	15577
HAUANI CREEK	18.216253	11272	7246	15298
HAUANI CREEK	19.10897	11551	7425	15677
HAUANI CREEK	20.106606	11557	7429	15685
HAUANI CREEK	20.835216	11232	7220	15244
HAUANI CREEK	10.39402	8428	5418	11438
HAUANI CREEK	17.216286	11423	7343	15503
HOUSE CREEK	0.899267	1599	1028	2170
HOUSE CREEK	2.417463	3109	1998	4220
HOUSE CREEK	3.304799	3720	2391	5049
HOUSE CREEK	6.347387	5727	3681	7773
HOUSE CREEK	7.339912	5896	3790	8002
HOUSE CREEK	8.189046	5593	3595	7591
HOUSE CREEK	11.485057	7057	4536	9578
HOUSE CREEK	12.112065	7140	4590	9690
HOUSE CREEK	1.446281	2420	1556	3284
LITTLE HAUANI CREEK	1.028933	2018	1297	2739
LITTLE HAUANI CREEK	1.666523	2619	1683	3555
LITTLE HAUANI CREEK	2.648466	3737	2402	5072
LITTLE HAUANI CREEK	2.915878	3809	2448	5170
LITTLE HAUANI CREEK	4.97742	5868	3772	7964
LITTLE HAUANI CREEK	5.857223	6300	4050	8550
LITTLE HAUANI CREEK	6.809125	6649	4274	9024
LITTLE HAUANI CREEK	8.00844	7365	4734	9996
LITTLE HAUANI CREEK	13.805222	10573	6796	14350
LITTLE HAUANI CREEK	14.674124	10295	6618	13972
LITTLE HAUANI CREEK	17.211443	11072	7117	15027
LITTLE HAUANI CREEK	17.7755	10949	7038	14860
LITTLE HAUANI CREEK	22.329319	12604	8102	17106
LITTLE HAUANI CREEK	24.988611	12313	7915	16711
LITTLE HAUANI CREEK	25.922937	12641	8126	17156
LITTLE HAUANI CREEK	26.76947	11800	7585	16015
LITTLE HAUANI CREEK	51.785432	18411	11835	24987
LITTLE HAUANI CREEK	54.990781	18736	12044	25428
LITTLE HAUANI CREEK	50.162283	19261	12381	26141
LITTLE HAUANI CREEK	15.925656	11101	7136	15066
LITTLE HAUANI CREEK	23.241829	12795	8225	17365
LITTLE HAUANI CREEK	24.085224	12347	7937	16757



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
LITTLE HAUANI CREEK	50.709061	18901	12150	25652
LITTLE HAUANI CREEK	48.054793	18781	12072	25490
LITTLE HAUANI CREEK	48.499181	18940	12175	25705
LITTLE HAUANI CREEK	49.979644	19037	12237	25837
LITTLE HAUANI CREEK	54.443297	19045	12242	25848
LITTLE HAUANI CREEK	23.705345	12869	8272	17466
LITTLE HAUANI CREEK	16.386252	11354	7298	15410
PAWPAW CREEK	1.294192	2509	1855	3393
PAWPAW CREEK	1.950076	3302	2442	4466
PAWPAW CREEK	2.652591	4082	3018	5520
PAWPAW CREEK	3.577591	4372	3233	5913
PAWPAW CREEK	0.681518	1316	973	1780
PAWPAW CREEK	0.890474	1711	1265	2314
ROCK CREEK	0.75085	1625	1202	2198
ROCK CREEK	2.238505	3925	2902	5308
ROCK CREEK	2.411903	4021	2973	5438
ROCK CREEK	4.983338	6924	5120	9364
ROCK CREEK	8.300423	9254	6843	12515
ROCK CREEK	9.01742	9290	6869	12564
ROCK CREEK	7.525967	8700	6433	11766
ROCK CREEK	5.662744	7172	5303	9699
SLICKUM SLOUGH	1.025435	2740	2026	3706
SLICKUM SLOUGH	2.138753	4540	3357	6140
SLICKUM SLOUGH	3.221132	6278	4642	8490
SLICKUM SLOUGH	4.391124	7123	5267	9633
SLICKUM SLOUGH	4.999262	6551	4844	8859
UNT 007 IN FBRR	0.917511	1462	940	1984
UNT 009 IN FBRR	0.872181	1536	987	2085
UNT 010 IN FBRR	1.395615	2557	1644	3470
UNT 010 IN FBRR	1.922546	2864	1841	3887
UNT 010 IN FBRR	2.993267	3426	2202	4650
UNT 010 IN FBRR	3.747346	4226	2716	5736
UNT 010 IN FBRR	5.185646	4920	3163	6677
UNT 010 IN FBRR	7.166211	5564	3577	7551
UNT 010 IN FBRR	7.408916	5755	3699	7811
UNT 010 IN FBRR	8.606966	6469	4158	8780
UNT 010 IN FBRR	6.172969	5557	3572	7542
UNT 011 IN FBRR	1.194563	2238	1439	3037



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT 012 IN FBRR	1.195973	1803	1159	2447
UNT 013 IN FBRR	1.32773	1928	1239	2617
UNT 013 IN FBRR	2.507856	2684	1725	3643
UNT 014 IN FBRR	1.03252	1597	1027	2167
UNT 014 IN FBRR	1.807253	2293	1474	3112
UNT 017 IN FBRR	1.201557	2623	1686	3560
UNT 017 IN FBRR	1.975633	3310	2128	4492
UNT 018 IN FBRR	1.020683	2808	1805	3811
UNT 018 IN FBRR	1.842107	3130	2012	4248
UNT 018 IN FBRR	3.964539	4687	3013	6361
UNT 018 IN FBRR	4.910432	5302	3408	7196
UNT 019 IN FBRR	1.173669	2236	1437	3035
UNT 020 IN FBRR	1.005528	1704	1095	2313
UNT 020 IN FBRR	1.937252	2752	1769	3735
UNT 020 IN FBRR	2.739217	3203	2059	4347
UNT 020 IN FBRR	3.739095	4077	2621	5533
UNT 020 IN FBRR	4.349604	4243	2727	5759
UNT 022 IN FBRR	1.175552	2182	1403	2961
UNT 022 IN FBRR	1.422517	2560	1646	3474
UNT 023 IN FBRR	1.097086	2302	1480	3124
UNT 023 IN FBRR	1.628683	2710	1742	3678
UNT 024 IN FBRR	1.036824	2021	1299	2743
UNT 024 IN FBRR	4.390313	4996	3211	6781
UNT 024 IN FBRR	6.262644	6061	3896	8226
UNT 024 IN FBRR	2.032039	3200	2057	4343
UNT 027 IN FBRR	1.141744	2114	1359	2869
UNT 027 IN FBRR	2.01787	2934	1886	3982
UNT 027 IN FBRR	3.456439	4464	2869	6059
UNT 030 IN FBRR	1.003555	1855	1192	2518
UNT 030 IN FBRR	1.320079	1967	1264	2670
UNT 031 IN FBRR	1.111972	1080	694	1466
UNT 031 IN FBRR	2.116244	2067	1329	2805
UNT 031 IN FBRR	2.638333	2480	1594	3366
UNT 032 IN FBRR	1.021131	1621	1042	2200
UNT 032 IN FBRR	1.970253	2121	1363	2879
UNT 032 IN FBRR	2.907896	2741	1762	3720
UNT 034 IN FBRR	1.178242	2081	1338	2824
UNT 034 IN FBRR	2.17247	2744	1764	3724

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT 034 IN FBRR	2.478442	2966	1907	4025
UNT 035 IN FBRR	1.025346	1767	1136	2398
UNT 035 IN FBRR	1.414626	1996	1283	2709
UNT 035 IN FBRR	2.532516	2859	1838	3880
UNT 035 IN FBRR	3.191808	3257	2094	4420
UNT 036 IN FBRR	0.957013	1565	1006	2124
UNT 039 IN FBRR	1.149098	2079	1336	2822
UNT 040 IN FBRR	1.128921	1888	1214	2562
UNT 040 IN FBRR	1.585277	2392	1538	3246
UNT 041 IN FBRR	1.097534	1762	1133	2391
UNT 041 IN FBRR	2.007737	2583	1660	3506
UNT 041 IN FBRR	2.333617	2765	1777	3753
UNT 044 IN FBRR	1.251238	2031	1306	2756
UNT 046 IN FBRR	1.035748	2024	1497	2737
UNT 046 IN FBRR	1.364228	2670	1974	3611
UNT 048 IN FBRR	1.168378	2328	1721	3148
UNT 048 IN FBRR	2.031591	3435	2540	4645
UNT 048 IN FBRR	2.670526	4008	2964	5420
UNT 050 IN FBRR	0.818106	1643	1215	2222
UNT 051 IN FBRR	1.076819	2148	1588	2905
UNT 051 IN FBRR	1.531831	2597	1920	3512
UNT 052 IN FBRR	1.233392	2449	1811	3312
UNT 052 IN FBRR	1.714478	3143	2324	4251
UNT 054 IN FBRR	0.302833	780	577	1055
UNT 055 IN FBRR	0.228886	564	417	763
UNT 055 IN FBRR	0.366233	945	699	1278
UNT 056 IN FBRR	0.567016	1528	1130	2066
UNT 056 IN FBRR	0.221066	635	470	859
UNT 057 IN FBRR	1.002568	2202	1415	2989
UNT 057 IN FBRR	4.092595	6080	3908	8252
UNT 057 IN FBRR	4.253652	5634	3622	7646
UNT 058 IN FBRR	0.466314	1062	683	1441
UNT 059 IN FBRR	0.360494	907	583	1231
UNT 059 IN FBRR	0.460034	302	194	410
UNT 060 IN FBRR	0.950826	2186	1405	2967
UNT 061 IN FBRR	0.283329	891	573	1209
UNT 063 IN FBRR	0.413313	970	624	1316
UNT 064 IN FBRR	1.005914	1638	1053	2223

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT 065 IN FBRR	0.14635	598	384	812
UNT 065 IN FBRR	0.308128	846	544	1148
UNT 066 IN FBRR	0.360225	974	626	1322
UNT 067 IN FBRR	0.210557	522	336	708
UNT 068 IN FBRR	0.434566	833	535	1131
UNT 069 IN FBRR	0.308752	522	336	708
UNT 070 IN FBRR	0.104292	437	281	593
UNT 071 IN FBRR	0.411519	1276	820	1732
UNT 072 IN FBRR	0.351168	957	615	1299
UNT 073 IN FBRR	0.310993	884	568	1200
UNT 074 IN FBRR	0.344891	1054	779	1425
UNT 076 IN FBRR	0.685141	1898	1220	2576
UNT 076 IN FBRR	0.910472	2336	1502	3170
UNT 077 IN FBRR	0.911592	1982	1274	2690
UNT 077 IN FBRR	1.377321	2491	1601	3381
WILSON CREEK	1.486499	2597	1669	3525
WILSON CREEK	4.649388	5062	3254	6870
WILSON CREEK	1.022835	2321	1492	3150
WILSON CREEK	5.803328	4985	3204	6766
WILSON CREEK	9.813422	7488	4813	10163
WILSON CREEK	12.136547	7884	5068	10700
WILSON CREEK	13.004602	7931	5098	10764
WILSON CREEK	13.484402	7834	5036	10632
WILSON CREEK	22.202763	11834	7607	16061
WILSON CREEK	25.740352	12291	7901	16681
WILSON CREEK	26.707947	12285	7897	16673
WILSON CREEK	28.750992	12854	8263	17445
WILSON CREEK	30.411089	12994	8353	17635
WILSON CREEK	31.475174	13432	8634	18230
WILSON CREEK	34.352312	13239	8510	17968
WILSON CREEK	35.033664	12704	8166	17242
WILSON CREEK	35.538356	12711	8171	17251
WILSON CREEK	5.223911	4886	3141	6631
WILSON CREEK	2.069356	3179	2043	4315
WILSON CREEK	29.568142	13332	8570	18094
WILSON CREEK	27.721594	12891	8286	17496
WILSON CREEK	3.460564	3842	2470	5214
WILSON CREEK	11.321848	7568	4865	10271

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
WILSON CREEK	10.687844	7896	5076	10716
WILSON CREEK TRIBUTARY 1	1.107937	2011	1293	2729
WILSON CREEK TRIBUTARY 1	1.879143	2581	1659	3503
WILSON CREEK TRIBUTARY 1	2.84055	3310	2128	4492
WILSON CREEK TRIBUTARY 1	3.752188	4005	2574	5436
WILSON CREEK TRIBUTARY 3	0.340766	934	600	1268
WILSON CREEK TRIBUTARY 4	0.935124	1613	1037	2189
Horseshoe Bend				
CORCORAN CREEK	1.00364	1986	1277	2695
CORCORAN CREEK	2.00227	2696	1733	3659
CORCORAN CREEK	2.56785	2746	1765	3727
CORCORAN CREEK	7.43264	6382	4102	8662
CORCORAN CREEK	7.74793	6422	4128	8716
CORCORAN CREEK	8.72817	6620	4255	8985
CORCORAN CREEK	9.20937	6545	4207	8883
CORCORAN CREEK	16.76334	8715	5602	11828
CORCORAN CREEK	17.03209	8880	5708	12052
CORCORAN CREEK	18.5033	9144	5878	12410
HICKORY CREEK	1.12063	1178	871	1593
HICKORY CREEK	1.48619	1433	1060	1938
HICKORY CREEK	2.8062	2590	1915	3503
HICKORY CREEK	3.51616	2949	2181	3988
HICKORY CREEK	3.88464	3275	2422	4429
HICKORY CREEK	11.02179	7904	5844	10689
HICKORY CREEK	12.94004	9000	6655	12171
HICKORY CREEK	16.80243	13059	9656	17661
HICKORY CREEK	19.21165	13127	9707	17753
HICKORY CREEK	20.64304	13921	10294	18827
HICKORY CREEK	21.52446	13864	10252	18749
HICKORY CREEK	22.66073	13135	9712	17764
HICKORY CREEK	25.02098	14056	10393	19009
HICKORY CREEK	28.54396	14992	11086	20275
HICKORY CREEK	29.5954	13764	10178	18614
HICKORY CREEK TRIBUTARY 13	1.00073	1871	1383	2530
HICKORY CREEK TRIBUTARY 13	1.80059	2645	1956	3577
HICKORY CREEK TRIBUTARY 18	1.52961	1989	1471	2690
HICKORY CREEK TRIBUTARY 18	1.85009	2132	1576	2883
HICKORY CREEK TRIBUTARY 18	2.94251	2946	2178	3984

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
HICKORY CREEK TRIBUTARY 18	5.64855	4664	3449	6308
HICKORY CREEK TRIBUTARY 18	6.26363	5003	3699	6766
HICKORY CREEK TRIBUTARY 3	1.21537	1740	1287	2353
HICKORY CREEK TRIBUTARY 3	1.64841	2189	1619	2960
JENNY CREEK	1.48036	2944	2177	3981
JENNY CREEK	2.2017	3602	2663	4871
JENNY CREEK	2.58247	4108	3038	5556
JENNY CREEK	3.32462	4676	3458	6324
MASS CREEK	1.03218	1976	1461	2672
MASS CREEK	1.96613	3119	2306	4218
MASS CREEK	3.14428	4272	3159	5777
RED RIVER TRIBUTARY 29	1.24066	1724	1275	2332
RED RIVER TRIBUTARY 29	2.54579	3022	2235	4087
RED RIVER TRIBUTARY 39	0.92706	1810	1338	2448
RED RIVER TRIBUTARY 39	2.13552	3630	2684	4909
RED RIVER TRIBUTARY 39	3.47133	4911	3631	6642
ROCK CREEK NORTH	1.16623	1795	1327	2428
ROCK CREEK NORTH	2.19014	2455	1815	3320
ROCK CREEK NORTH	5.02853	5187	3835	7015
ROCK CREEK NORTH	5.31953	5193	3840	7023
ROCK CREEK NORTH	7.30969	6335	4684	8567
ROCK CREEK NORTH	13.94619	10845	8019	14667
ROCK CREEK NORTH	15.5929	11447	8464	15481
ROCK CREEK NORTH	17.24068	11605	8581	15694
ROCK CREEK NORTH	18.00103	11546	8538	15615
ROCK CREEK NORTH	18.90864	11838	8753	16010
ROCK CREEK NORTH TRIB 3	1.01512	1905	1409	2576
ROCK CREEK NORTH TRIB 3	2.25829	3581	2648	4843
ROCK CREEK NORTH TRIB 3	3.49684	4917	3636	6650
ROCK CREEK NORTH TRIB 3	5.63546	6752	4993	9131
SYCAMORE CREEK	1.03234	2080	1538	2813
SYCAMORE CREEK	1.98819	3470	2566	4693
SYCAMORE CREEK	2.50893	3937	2911	5324
SYCAMORE CREEK	3.21172	5002	3699	6765
SYCAMORE CREEK	3.83756	5798	4287	7841
SYCAMORE CREEK	5.98331	7879	5826	10655
SYCAMORE CREEK	11.49205	12120	8962	16391
SYCAMORE CREEK	11.63271	12102	8949	16367

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
SYCAMORE CREEK	11.84111	11983	8861	16206
SYCAMORE CREEK	15.77556	13745	10164	18589
SYCAMORE CREEK TRIBUTARY 4	1.00275	1926	1424	2605
SYCAMORE CREEK TRIBUTARY 4	1.98409	3299	2439	4462
SYCAMORE CREEK TRIBUTARY 4	2.95811	4432	3277	5994
SYCAMORE CREEK TRIBUTARY 4	3.95521	5419	4007	7329
SYCAMORE CREEK TRIBUTARY 4	4.41659	5904	4366	7984
SYCAMORE CREEK TRIBUTARY 8	1.00535	2327	1721	3147
SYCAMORE CREEK TRIBUTARY 8	1.18308	2571	1901	3477
THOMAS CREEK	0.93244	1547	994	2100
THOMAS CREEK	1.92802	2606	1675	3537
THOMAS CREEK	2.9982	3636	2337	4935
THOMAS CREEK	4.00972	4357	2801	5913
THOMAS CREEK	8.19222	7380	4744	10016
THOMAS CREEK	12.2863	9874	6347	13401
TRIB 1 OF HICKORY CREEK TRIB 18	1.04097	1325	980	1792
TRIB 1 OF HICKORY CREEK TRIB 18	1.71289	1912	1414	2586
TUTTLE BRANCH	1.31598	2586	1912	3497
UNT01 IN HBRR	1.10444	2738	1760	3716
UNT01 IN HBRR	2.21578	3588	2306	4870
UNT05 IN HBRR	3.65337	2982	1917	4047
UNT08 IN HBRR	1.02732	1705	1096	2314
UNT08 IN HBRR	2.78056	3542	2277	4807
UNT08 IN HBRR	4.09215	4660	2995	6325
UNT09 IN HBRR	0.96768	1898	1220	2576
UNT10 IN HBRR	1.44377	2165	1392	2938
UNT10 IN HBRR	3.13567	4436	2851	6021
UNT10 IN HBRR	4.52079	6133	3942	8324
UNT10 IN HBRR	5.20824	6860	4410	9310
UNT11 IN HBRR	1.21797	1923	1236	2610
UNT12 IN HBRR	1.51928	2658	1709	3607
UNT12 IN HBRR	1.95904	4028	2589	5467
UNT16 IN HBRR	1.30137	1591	1176	2152
UNT17 IN HBRR	1.00266	1326	980	1793
UNT17 IN HBRR	1.66455	2041	1509	2760
UNT18 IN HBRR	1.17717	1611	1191	2179
UNT18 IN HBRR	1.65818	2123	1570	2871
UNT18 IN HBRR	2.65797	3146	2326	4255



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT18 IN HBRR	3.12599	3516	2600	4755
UNT22 IN HBRR	1.11798	1839	1182	2496
UNT22 IN HBRR	2.15355	3792	2437	5147
UNT22 IN HBRR	6.07271	8363	5376	11350
UNT23 IN HBRR	1.06382	2322	1493	3151
UNT24 IN HBRR	1.10587	2562	1647	3477
UNT25 IN HBRR	1.72114	1997	1477	2701
UNT25 IN HBRR	2.22188	2292	1695	3100
UNT27 IN HBRR	1.07036	2102	1554	2843
UNT27 IN HBRR	1.837	2830	2093	3827
UNT28 IN HBRR	1.00042	1487	1100	2011
UNT28 IN HBRR	1.31876	1809	1338	2446
UNT31 IN HBRR	1.00167	1968	1455	2661
UNT31 IN HBRR	1.36064	2449	1811	3312
UNT33 IN HBRR	1.6606	2209	1420	2998
UNT33 IN HBRR	2.43988	2813	1808	3818
UNT33 IN HBRR	4.13914	4178	2686	5670
UNT34 IN HBRR	1.00122	1693	1088	2298
UNT34 IN HBRR	1.41561	1927	1239	2615
UNT36 IN HBRR	1.22111	2254	1449	3059
UNT36 IN HBRR	1.75369	2412	1550	3274
UNT36 IN HBRR	4.33032	4096	2633	5559
UNT36 IN HBRR	5.23631	4055	2607	5503
UNT37 IN HBRR	1.00024	1718	1104	2332
UNT37 IN HBRR	1.57586	2091	1344	2838
UNT38 IN HBRR	1.42243	2745	2030	3712
UNT38 IN HBRR	2.42159	3197	2364	4324
UNT38 IN HBRR	2.77531	3205	2370	4334
UNT44 IN HBRR	1.38011	2262	1454	3070
UNT45 IN HBRR	1.05315	973	625	1321
UNT45 IN HBRR	2.07428	1644	1057	2231
UNT45 IN HBRR	2.57951	1623	1043	2203
UNT45 IN HBRR	4.17448	2469	1587	3351
UNT48 IN HBRR	0.61679	1365	1009	1846
UNT51 IN HBRR	1.03351	511	328	694
UNT55 IN HBRR	0.36453	603	446	815
UNT56 IN HBRR	0.43305	1004	742	1358
Lake Murray				

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
ANADARCHE CREEK	54.54285	13205	8488	17922
ANADARCHE CREEK	55.25505	12005	7717	16293
ANADARCHE CREEK	56.06635	20197	12983	27411
EAST ANADARCHE CREEK	1.18703	1913	1230	2596
EAST ANADARCHE CREEK	3.31968	3885	2497	5273
EAST ANADARCHE CREEK	5.74029	5648	3631	7665
EAST ANADARCHE CREEK	6.36165	5638	3624	7652
EAST ANADARCHE CREEK	6.81489	5660	3638	7682
EAST ANADARCHE CREEK	6.99995	5596	3597	7595
EAST ANADARCHE CREEK	7.77762	5794	3724	7864
EAST ANADARCHE CREEK	9.08365	6109	3927	8291
EAST ANADARCHE CREEK	9.93018	5813	3737	7889
EAST ANADARCHE CREEK	20.50118	8932	5741	12123
EAST ANADARCHE CREEK	21.57961	8683	5581	11785
EAST ANADARCHE CREEK	23.57246	8884	5711	12057
EAST ANADARCHE CREEK	24.5857	9393	6038	12748
EAST ANADARCHE CREEK TRIB 1	0.41179	985	633	1337
EAST ANADARCHE CREEK TRIB 2	0.51841	1103	709	1497
EAST ANADARCHE CREEK TRIB 3	0.47115	953	613	1293
EAST ANADARCHE CREEK TRIB 4	0.19083	687	442	932
EAST ANADARCHE CREEK TRIB 4	0.36219	957	615	1299
EAST ANADARCHE CREEK TRIB 5	0.96831	1742	1120	2364
EAST ANADARCHE CREEK TRIB 5	1.68293	2193	1410	2976
FOURCHE MALINE CREEK	0.92957	1564	1005	2123
FOURCHE MALINE CREEK	1.42628	2016	1296	2736
FOURCHE MALINE CREEK	2.0645	2618	1683	3553
FOURCHE MALINE CREEK	3.67729	3730	2398	5062
FOURCHE MALINE CREEK	5.28662	4518	2904	6132
FOURCHE MALINE CREEK	5.77867	4821	3099	6543
FOURCHE MALINE CREEK	6.39761	5081	3266	6896
FOURCHE MALINE CREEK	7.14666	5526	3552	7500
FOURCHE MALINE CREEK	7.48043	5450	3503	7397
FOURCHE MALINE CREEK	7.93491	5331	3427	7235
FOURCHE MALINE CREEK	8.93308	5342	3434	7250
FOURCHE MALINE CREEK	9.38415	5413	3479	7347
FOURCHE MALINE CREEK TRIB 1	0.34462	769	494	1044
FOURCHE MALINE CREEK TRIB 2	0.59024	1368	879	1857
FOURCHE MALINE CREEK TRIB 3	0.49133	1035	665	1405

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
FOURCHE MALINE CREEK TRIB 4	1.07498	1258	809	1707
FOURCHE MALINE CREEK TRIB 5	0.78582	1381	888	1874
HICKORY CREEK	1.08901	1465	942	1988
HICKORY CREEK	1.44422	1795	1154	2436
HICKORY CREEK	1.62617	1977	1271	2683
HICKORY CREEK	4.162	3419	2198	4640
HICKORY CREEK	6.22561	4481	2880	6082
HICKORY CREEK	7.99068	5171	3324	7018
HICKORY CREEK	9.14669	5466	3514	7418
HICKORY CREEK	10.03196	5846	3758	7934
HICKORY CREEK	14.61606	7238	4653	9823
HICKORY CREEK	17.7885	8305	5338	11272
HICKORY CREEK	19.39728	8888	5713	12063
HICKORY CREEK	19.60631	8936	5744	12128
HICKORY CREEK	37.02293	14872	9560	20184
HICKORY CREEK	39.07864	15552	9997	21107
HICKORY CREEK	40.0153	15155	9742	20568
HICKORY CREEK	40.30961	15592	10023	21161
HICKORY CREEK	42.08357	15500	9963	21037
HICKORY CREEK	44.53251	15369	9879	20859
HICKORY CREEK	46.04739	16030	10304	21756
HICKORY CREEK	56.98462	18738	12045	25431
HICKORY CREEK	64.90715	21306	13695	28917
HICKORY CREEK	65.85277	20948	13465	28431
HICKORY CREEK	66.0645	21594	13881	29307
HICKORY CREEK	66.94134	21278	13677	28879
HICKORY CREEK	66.98385	21239	13652	28826
HICKORY CREEK	78.50585	24107	15496	32718
HICKORY CREEK	86.839	24812	15949	33675
HICKORY CREEK	89.07129	25261	16238	34284
HICKORY CREEK	89.88644	25181	16186	34176
HICKORY CREEK	112.74499	29815	19165	40465
HICKORY CREEK	113.68909	30031	19304	40758
HICKORY CREEK	114.67453	29820	19168	40472
HICKORY CREEK	115.36091	30721	19747	41695
HICKORY CREEK	119.03266	29894	19216	40572
HICKORY CREEK	176.00676	40449	26001	54897
HICKORY CREEK	176.81754	39860	25622	54098

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
HICKORY CREEK	177.75061	40904	26293	55515
HICKORY CREEK	178.73171	40981	26343	55619
HICKORY CREEK	179.4269	40020	25725	54315
HICKORY CREEK	179.82551	39991	25706	54276
HICKORY CREEK	192.72391	40846	26256	55436
HICKORY CREEK	203.04304	42315	27200	57430
HICKORY CREEK	204.07735	42498	27318	57678
HICKORY CREEK	204.51276	41177	26469	55885
HICKORY CREEK	207.0433	41084	26409	55759
HICKORY CREEK	214.04654	41508	26681	56335
HICKORY CREEK TRIBUTARY 1	1.097	1485	955	2015
HICKORY CREEK TRIBUTARY 2	1.06687	1786	1148	2424
HICKORY CREEK TRIBUTARY 2	1.67818	2362	1518	3206
HICKORY CREEK TRIBUTARY 2	1.94532	2535	1629	3441
HICKORY CREEK TRIBUTARY 3	0.33709	724	465	983
HICKORY CREEK TRIBUTARY 4	0.90419	1452	933	1971
HICKORY CREEK TRIBUTARY 5	0.63741	1272	818	1726
HICKORY CREEK TRIBUTARY 5	1.4383	2065	1327	2803
HICKORY CREEK TRIBUTARY 6	0.839	1201	772	1630
HICKORY CREEK TRIBUTARY 6	1.3836	1717	1104	2330
HICKORY CREEK TRIBUTARY 6	1.99769	2083	1339	2827
HICKORY CREEK TRIBUTARY 6	2.0089	2154	1385	2923
HICKORY CREEK TRIBUTARY A	0.65606	1116	717	1515
HICKORY CREEK TRIBUTARY A	1.22182	1793	1153	2433
HICKORY CREEK TRIBUTARY A	2.38339	2697	1734	3660
HICKORY CREEK TRIBUTARY A	2.65205	2579	1658	3500
HICKORY CREEK TRIBUTARY A_1	0.39107	792	509	1075
HICKORY CREEK TRIBUTARY A_1	0.7596	1271	817	1725
HICKORY CREEK TRIBUTARY A_1	0.93235	1379	886	1872
HICKORY CREEK TRIBUTARY B	0.4899	1104	710	1498
HICKORY CREEK TRIBUTARY B	1.38064	2429	1561	3297
HICKORY CREEK TRIBUTARY B	2.02567	3110	1999	4221
HICKORY CREEK TRIBUTARY B	3.44541	4163	2676	5650
HICKORY CREEK TRIBUTARY B	4.03709	3964	2548	5380
HICKORY CREEK TRIBUTARY C	1.06839	1514	973	2055
JERRY BRANCH	1.00607	1879	1208	2550
JERRY BRANCH	1.79019	2693	1731	3655
JERRY BRANCH	2.62596	3626	2331	4921

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
JERRY BRANCH	3.7009	4435	2851	6019
JERRY BRANCH	10.64256	7742	4977	10507
JERRY BRANCH	11.39789	7693	4945	10441
LITTLE HICKORY CREEK	1.05431	1952	1255	2649
LITTLE HICKORY CREEK	1.55568	2404	1545	3263
LITTLE HICKORY CREEK	5.08566	5391	3465	7317
LITTLE HICKORY CREEK	5.77732	5397	3469	7325
LITTLE HICKORY CREEK	6.4689	5790	3722	7858
LITTLE HICKORY CREEK	7.10782	5965	3834	8096
LITTLE HICKORY CREEK	7.90845	6239	4010	8468
LITTLE HICKORY CREEK	8.23568	6534	4200	8868
LITTLE HICKORY CREEK	9.33913	6937	4459	9415
LITTLE HICKORY CREEK	10.55019	7050	4532	9568
LITTLE HICKORY CREEK	22.28123	13232	8506	17958
OIL CREEK	1.02185	1440	926	1954
OIL CREEK	1.81583	2161	1389	2933
OIL CREEK	2.47279	2792	1795	3789
OIL CREEK	4.88541	4693	3017	6369
OIL CREEK	5.51108	5206	3346	7066
OIL CREEK	8.11919	6794	4367	9221
OIL CREEK	9.24147	7549	4852	10246
OIL CREEK	9.75495	7766	4992	10540
OIL CREEK	11.02511	8467	5443	11491
OIL CREEK	11.6245	8385	5390	11380
PUMPKIN CREEK	1.01085	1735	1115	2355
PUMPKIN CREEK	1.79404	2100	1350	2850
PUMPKIN CREEK	2.7232	2938	1889	3987
PUMPKIN CREEK	3.59606	3804	2445	5163
PUMPKIN CREEK	4.13169	3915	2517	5313
PUMPKIN CREEK	4.95168	4354	2799	5909
PUMPKIN CREEK	5.94986	5004	3217	6791
PUMPKIN CREEK	6.69964	5244	3371	7117
PUMPKIN CREEK	7.53989	5504	3538	7470
PUMPKIN CREEK	8.49789	5918	3804	8032
PUMPKIN CREEK	8.9571	6188	3978	8398
SALT CREEK	0.92816	1438	924	1952
SALT CREEK	1.51524	2183	1403	2963
SALT CREEK	2.25416	2939	1889	3989

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
SALT CREEK	3.24436	3548	2281	4815
SALT CREEK	4.18247	4050	2603	5497
SALT CREEK	4.99295	4455	2864	6046
SHIGGIN CREEK	1.00006	1794	1153	2435
SHIGGIN CREEK	2.27831	3112	2000	4224
SHIGGIN CREEK	2.5501	3289	2114	4464
SHIGGIN CREEK	3.35755	4043	2599	5487
SHIGGIN CREEK	3.41368	4083	2625	5541
SHIGGIN CREEK	4.87886	5319	3419	7219
SHIGGIN CREEK	5.39602	5078	3264	6892
SHIGGIN CREEK	5.95057	5606	3604	7608
SOUTH BRANCH HICKORY CREEK	0.93406	1851	1190	2512
SOUTH BRANCH HICKORY CREEK	2.3294	3366	2164	4568
SOUTH BRANCH HICKORY CREEK	5.09866	5477	3521	7433
SOUTH BRANCH HICKORY CREEK	5.85355	6086	3912	8260
SOUTH BRANCH HICKORY CREEK	6.64125	6466	4156	8776
SOUTH BRANCH HICKORY CREEK	7.45828	6572	4224	8920
SOUTH BRANCH HICKORY CREEK	8.0149	6610	4249	8971
SOUTH BRANCH HICKORY CREEK	10.61431	8277	5320	11234
SOUTH BRANCH HICKORY CREEK	11.09587	8227	5288	11166
SOUTH BRANCH HICKORY CREEK	11.35718	8221	5284	11158
SPRING BRANCH	1.4722	2299	1478	3120
SPRING BRANCH	2.23883	3026	1945	4107
SPRING BRANCH	3.32713	4114	2644	5584
SPRING BRANCH	6.61821	6263	4026	8500
SPRING BRANCH	7.36242	6730	4326	9134
SPRING BRANCH	7.86801	7061	4539	9583
SPRING BRANCH	8.65285	7346	4722	9970
SPRING BRANCH	8.92967	7378	4743	10013
SPRING BRANCH	9.56834	7532	4842	10222
SPRING BRANCH	10.80442	7387	4748	10026
SPRING BRANCH TRIBUTARY 1	1.22792	2124	1365	2883
SPRING BRANCH TRIBUTARY 1	2.54139	3476	2234	4718
SPRING BRANCH TRIBUTARY 1	2.88055	3655	2349	4961
TALIAFERRO CREEK	0.70727	1203	773	1633
TALIAFERRO CREEK	0.98418	1482	953	2011
TALIAFERRO CREEK	1.17214	1663	1069	2257
TALIAFERRO CREEK	1.36997	1922	1235	2609

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
TALIAFERRO CREEK	1.90327	2178	1400	2956
TALIAFERRO CREEK	3.19961	2913	1872	3954
TALIAFERRO CREEK	4.22253	3747	2409	5085
TALIAFERRO CREEK	5.50363	4089	2628	5550
TALIAFERRO CREEK	6.66618	4551	2925	6177
TALIAFERRO CREEK	9.11539	6060	3895	8225
TALIAFERRO CREEK	10.1002	6512	4186	8838
TALIAFERRO CREEK	11.64262	6990	4493	9487
TALIAFERRO CREEK	15.942	8752	5626	11878
TALIAFERRO CREEK	17.06707	9264	5955	12573
TALIAFERRO CREEK	17.25189	9166	5892	12440
TALIAFERRO CREEK TRIBUTARY 1	0.43331	724	465	983
TALIAFERRO CREEK TRIBUTARY 1	0.6262	902	580	1224
TALIAFERRO CREEK TRIBUTARY 1	1.7883	2346	1508	3184
TALIAFERRO CREEK TRIBUTARY 1	3.48218	3857	2479	5235
TALIAFERRO CREEK TRIBUTARY 1	4.11519	3823	2457	5189
TALIAFERRO CREEK TRIBUTARY 1_1	0.40443	582	374	790
TALIAFERRO CREEK TRIBUTARY 1_1	0.87101	1110	714	1506
TALIAFERRO CREEK TRIBUTARY 1_2	0.14321	437	281	593
TALIAFERRO CREEK TRIBUTARY 1_2	0.57903	1151	740	1562
TALIAFERRO CREEK TRIBUTARY 2	1.01405	1909	1227	2591
TALIAFERRO CREEK TRIBUTARY 2	1.71306	2448	1574	3322
TALIAFERRO CREEK TRIBUTARY 3	1.00777	1792	1152	2432
TALIAFERRO CREEK TRIBUTARY A	1.11134	1874	1205	2543
UNT 004 IN LAMU	0.29109	645	415	875
UNT 007 IN LAMU	0.42658	929	597	1261
UNT 010 IN LAMU	0.69965	1090	701	1479
UNT 012 IN LAMU	0.30274	797	512	1082
UNT 017 IN LAMU	0.15092	542	348	736
UNT 020 IN LAMU	0.24992	672	432	912
UNT 021 IN LAMU	0.19648	528	339	717
UNT 022 IN LAMU	0.25522	716	460	972
UNT 025 IN LAMU	0.54693	1113	715	1511
UNT 026 IN LAMU	1.14434	1802	1158	2446
UNT 028 IN LAMU	0.31593	873	561	1185
UNT 033 IN LAMU	0.36005	1010	649	1371
UNT 034 IN LAMU	0.16751	515	331	699
UNT 036 IN LAMU	0.33574	861	553	1169



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT 037 IN LAMU	0.39078	1042	670	1414
UNT 037 IN LAMU	0.69722	1580	1016	2144
UNT 038 IN LAMU	0.25137	652	419	885
UNT 039 IN LAMU	0.28884	1026	660	1392
UNT 041 IN LAMU	1.004	1935	1244	2626
UNT 041 IN LAMU	1.52385	2577	1656	3498
UNT 042 IN LAMU	0.46479	1164	748	1580
UNT 044 IN LAMU	1.05144	1568	1008	2128
UNT 046 IN LAMU	1.17968	1997	1284	2710
UNT 047 IN LAMU	0.19782	633	407	859
UNT 048 IN LAMU	0.73865	1371	881	1861
UNT 049 IN LAMU	0.32839	916	589	1243
UNT 050 IN LAMU	0.70126	1601	1029	2173
UNT 051 IN LAMU	0.21459	662	426	898
UNT 052 IN LAMU	0.40874	1140	733	1547
UNT 054 IN LAMU	0.35135	1222	786	1658
UNT 055 IN LAMU	1.06148	2059	1324	2794
UNT 055 IN LAMU	1.85484	2637	1695	3579
UNT 055 IN LAMU	2.97614	3827	2460	5194
UNT 055 IN LAMU	5.94134	6171	3967	8375
UNT 055 IN LAMU	6.98229	6623	4257	8989
UNT 056 IN LAMU	1.22227	2592	1666	3518
UNT 056 IN LAMU	2.42491	3339	2146	4532
UNT 057 IN LAMU	1.14999	1860	1196	2524
UNT 059 IN LAMU	1.05853	1869	1201	2537
UNT 059 IN LAMU	1.59191	2411	1550	3272
UNT 061 IN LAMU	1.23653	1802	1158	2446
UNT 061 IN LAMU	1.93689	2178	1400	2956
UNT 062 IN LAMU	1.39508	1775	1141	2409
UNT 062 IN LAMU	2.36307	2599	1671	3527
UNT 062 IN LAMU	2.55422	2603	1673	3533
UNT 062 IN LAMU	2.79114	2745	1764	3726
UNT 062 IN LAMU	3.7043	3328	2139	4517
UNT 062 IN LAMU	7.14101	5261	3382	7140
UNT 062 IN LAMU	7.67628	5570	3580	7560
UNT 065 IN LAMU	0.19047	555	357	753
UNT 065 IN LAMU	0.21944	611	393	829
UNT 066 IN LAMU	0.83066	1181	759	1603



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT 066 IN LAMU	1.04992	1477	949	2005
UNT 066 IN LAMU	1.80579	2125	1366	2884
UNT 066 IN LAMU	2.52606	2564	1648	3480
UNT 067 IN LAMU	0.21701	672	432	912
UNT 068 IN LAMU	0.44057	967	622	1312
UNT 069 IN LAMU	1.02696	1914	1230	2598
UNT 069 IN LAMU	1.27115	2075	1334	2816
UNT 071 IN LAMU	0.96984	1931	1241	2621
UNT 071 IN LAMU	1.11753	1982	1274	2690
UNT 073 IN LAMU	1.01405	1720	1106	2334
UNT 073 IN LAMU	2.01473	2791	1794	3788
UNT 073 IN LAMU	2.39191	3116	2003	4229
UNT 077 IN LAMU	1.00338	2091	1344	2838
UNT 077 IN LAMU	1.24227	2337	1502	3172
UNT 077 IN LAMU	2.46079	3943	2535	5351
UNT 077 IN LAMU	2.73052	3816	2453	5179
UNT 080 IN LAMU	0.3387	850	546	1154
UNT 081 IN LAMU	0.43914	904	581	1227
UNT 083 IN LAMU	0.28373	781	502	1060
UNT 084 IN LAMU	0.31252	720	463	977
UNT 085 IN LAMU	0.37888	851	547	1155
UNT 087 IN LAMU	0.20329	436	280	592
UNT 087 IN LAMU	0.66727	1286	827	1745
UNT 088 IN LAMU	0.20087	515	331	699
UNT 089 IN LAMU	0.08465	415	267	563
UNT 094 IN LAMU	0.10605	333	214	452
UNT 095 IN LAMU	0.13673	444	285	603
UNT 096 IN LAMU	0.31682	765	492	1038
UNT 099 IN LAMU	0.26113	882	567	1197
UNT 100 IN LAMU	0.32552	818	526	1110
UNT 102 IN LAMU	0.21522	715	460	970
UNT 103 IN LAMU	0.12259	420	270	570
UNT 104 IN LAMU	0.09317	330	212	448
UNT 109 IN LAMU	0.15535	495	318	672
UNT 113 IN LAMU	1.20514	1735	1115	2355
UNT 117 IN LAMU	0.29198	876	563	1189
UNT 119 IN LAMU	0.15056	587	377	797
UNT 124 IN LAMU	0.32462	855	550	1160

Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
UNT 126 IN LAMU	0.5984	1209	777	1641
UNT 132 IN LAMU	0.40901	963	619	1307
UNT 133 IN LAMU	0.63454	1203	773	1633
UNT 134 IN LAMU	0.2041	579	372	786
UNT 135 IN LAMU	0.29413	775	498	1052
UNT 141 IN LAMU	1.15143	1960	1260	2660
UNT 142 IN LAMU	1.6841	3219	2069	4369
UNT 146 IN LAMU	1.00221	1884	1211	2557
UNT 146 IN LAMU	2.10405	2670	1716	3624
UNT 149 IN LAMU	0.91738	1503	966	2040
UNT 150 IN LAMU	0.13505	384	247	521
UNT 151 IN LAMU	0.16886	478	307	649
UNT 152 IN LAMU	0.28275	686	441	931
UNT 153 IN LAMU	0.91998	1373	883	1863
UNT 153 IN LAMU	2.11768	2181	1402	2960
WEST ANADARCHE CREEK	0.33503	880	566	1194
WEST ANADARCHE CREEK	0.8121	1363	876	1850
WEST ANADARCHE CREEK	1.76777	2596	1669	3523
WEST ANADARCHE CREEK	2.07069	2755	1771	3739
WEST ANADARCHE CREEK	2.49851	3015	1938	4092
WEST ANADARCHE CREEK	3.52432	3662	2354	4970
WEST ANADARCHE CREEK	6.30264	5179	3329	7029
WEST ANADARCHE CREEK	6.49481	4967	3193	6741
WEST ANADARCHE CREEK	9.67891	6273	4032	8514
WEST ANADARCHE CREEK	9.84884	6084	3911	8257
WEST ANADARCHE CREEK	13.03052	7303	4694	9912
WEST ANADARCHE CREEK	16.41029	8286	5326	11246
WEST ANADARCHE CREEK	16.7949	8079	5193	10965
WEST ANADARCHE CREEK	19.83068	8773	5639	11907
WEST ANADARCHE CREEK	21.50733	8513	5472	11554
WEST ANADARCHE CREEK	23.34612	8275	5319	11231
WEST ANADARCHE CREEK	24.28852	8532	5484	11580
WEST ANADARCHE CREEK	25.03345	8091	5201	10981
WEST ANADARCHE CREEK	27.6985	8210	5277	11143
WEST ANADARCHE CREEK TRIB 1	1.02149	1595	1025	2165
WEST ANADARCHE CREEK TRIB 2	0.36842	1047	673	1421
WEST ANADARCHE CREEK TRIB 2	1.03745	1676	1077	2275
WEST ANADARCHE CREEK TRIB 3	0.6575	1092	702	1482



Stream Name	Drainage Area (sq. mi.)	1% Peak Discharge	1%- Peak Discharge	1%+ Peak Discharge
		(cfs)	(cfs)	(cfs)
WEST ANADARCHE CREEK TRIB 3	2.48633	2858	1837	3879
WEST ANADARCHE CREEK TRIB 3_1	1.05906	2139	1375	2903
WEST ANADARCHE CREEK TRIB 3_1	1.7701	2391	1537	3245
WEST ANADARCHE CREEK TRIB 4	0.16993	453	291	615
WEST ANADARCHE CREEK TRIB 5	0.76744	1494	960	2028
WEST ANADARCHE CREEK TRIB 5	1.06471	1875	1205	2545
WEST ANADARCHE CREEK TRIB 5	1.27455	2067	1329	2805
WEST ANADARCHE CREEK TRIB 5	1.4001	2246	1444	3048
WEST ANADARCHE CREEK TRIB 5	2.58668	2865	1842	3888
WEST ANADARCHE CREEK TRIB 5	3.05631	2868	1844	3892
WEST ANADARCHE CREEK TRIB 6	1.21591	2004	1288	2720
WEST ANADARCHE CREEK TRIB 6	1.98173	2688	1728	3648
WEST ANADARCHE CREEK TRIB 6	2.79984	3014	1937	4091
WEST ANADARCHE CREEK TRIB 6	3.16392	3100	1993	4207
WEST ANADARCHE CREEK TRIB 7	0.24401	546	351	741
WEST ANADARCHE CREEK TRIB 7	0.41185	902	580	1224
WEST ANADARCHE CREEK TRIB 7	0.87337	1343	863	1823
WEST ANADARCHE CREEK TRIB 7	1.91448	2511	1614	3408
WEST ANADARCHE CREEK TRIB 7	2.2426	2758	1773	3743
WEST ANADARCHE CREEK TRIB 7_1	0.99093	1529	983	2075
WEST ANADARCHE CREEK TRIB 8	0.38237	908	584	1232
WEST ANADARCHE CREEK TRIB 8	0.93845	1621	1042	2200
WEST ANADARCHE CREEK TRIB B	0.1946	575	370	780
WEST ANADARCHE CREEK TRIB B	0.32364	798	513	1083
WEST ANADARCHE CREEK TRIB B	1.95438	2483	1596	3370



Appendix B BLE Map

