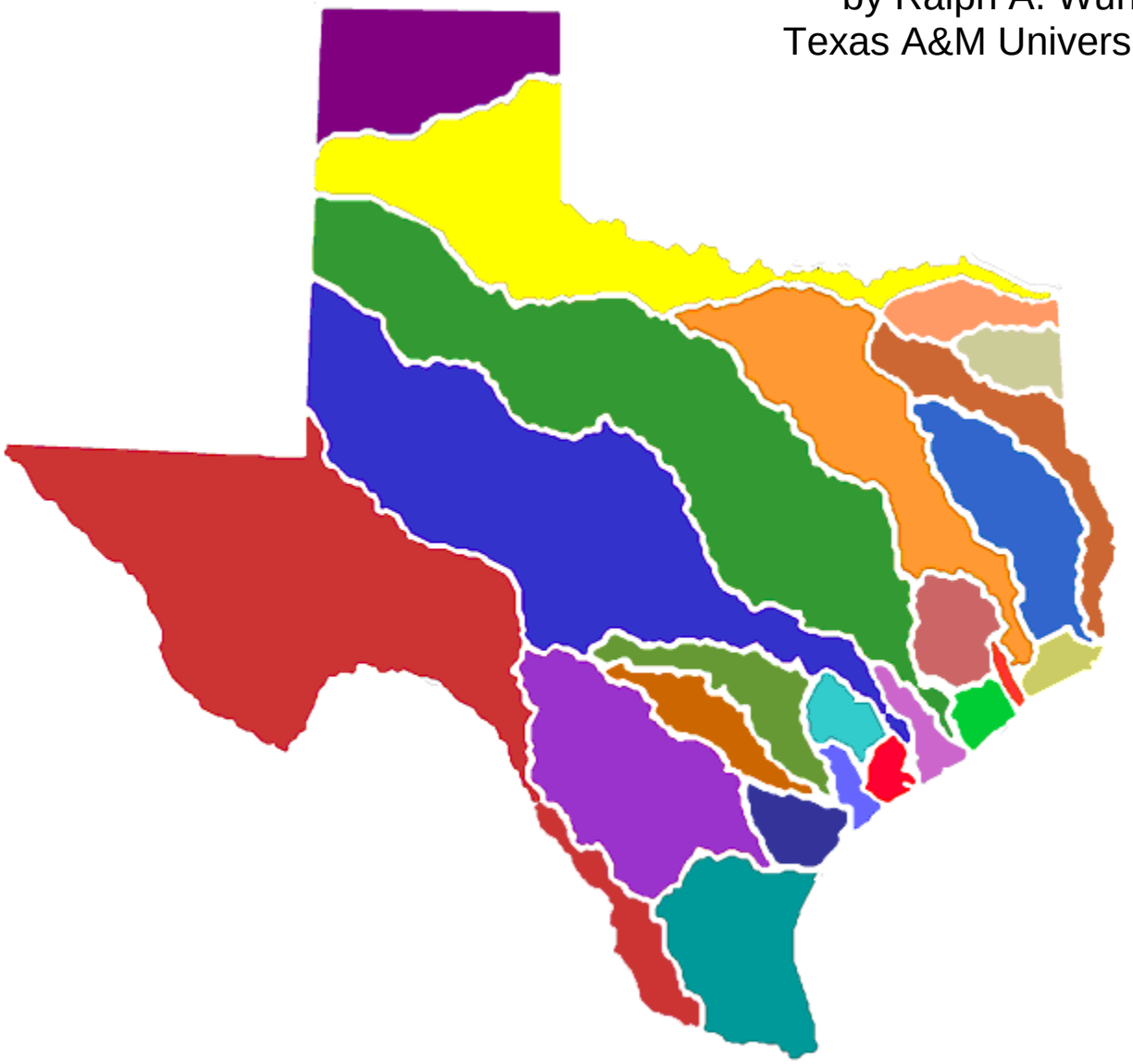
Incorporation of Environmental Flow Standards and Other Water Management Complexities in Water Availability Modeling

by Ralph A. Wurbs
Texas A&M University



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Texas Water Resources Institute
make every drop count

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by

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for the

Texas Commission on Environmental Quality
Austin, Texas 78711-3087

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ABSTRACT

The Water Rights Analysis Package (WRAP) modeling system and WRAP simulation input datasets called Water Availability Models (WAMs) are employed by the water management community of Texas to assess surface water availability throughout the state. The 15 major river basins and eight coastal basins of Texas are modeled with 20 WAMs. The WAM datasets and an array of information are accessible at a water availability modeling website maintained by the Texas Commission on Environmental Quality (TCEQ). WRAP software, manuals, online training courses, and publications are available at a WRAP website maintained at Texas A&M University (TAMU). The generalized WRAP modeling system is explained in detail by reference, users, fundamentals, hydrology, daily, and salinity manuals published as Texas Water Resources Institute (TWRI) technical reports. WRAP and the WAMs have been routinely applied in preparing and evaluating water use permit applications; statewide, regional, and operational planning; and other water management endeavors throughout Texas since 2000. The WRAP/WAM modeling system has also been continually improved and expanded over the past 25 years. This "synthesis report" covers recent research and development yet to be fully implemented along with an experience base accumulated over the past more than two decades.

Water availability modeling is essential for effective water resources planning, development, allocation, and management. Complexities and issues in assessing water availability in river and reservoir systems are explored in this report along with synthesizing assessment capabilities. Incorporation of environmental flow standards (EFS) established pursuant to the 2007 Senate Bill 3 (SB3) is a major focus. Routine applications of WRAP and the WAMs are based on a monthly computational time step. The SB3 EFS process motivated development of auxiliary WRAP modeling capabilities employing a daily computational time step. Modeling reservoir flood control operations has also been added to the daily version of the simulation model. Hydrologic variability and stationarity are governing concerns in water management. Updating WAM hydrologic periods-of-analysis with lengthening records of observed stream flow, precipitation, and reservoir evaporation data is another key aspect of water availability modeling.

Daily and modified monthly versions of WAMs for the Brazos, Trinity, Neches, Colorado, Lavaca, and Nueces River Basins developed in TCEQ-sponsored research at TAMU provide case studies for this report. These studies focus on expanding capabilities for incorporating SB3 EFS in water availability modeling but also address other complexities of water management and associated computer modeling. An overview of water availability throughout Texas as well as in the case study river basins is presented.

This synthesis report supplements the WRAP manuals, WAM reports, and other publications with additional practical information and guidance for addressing complexities of river system hydrology, water management, and associated water availability assessments. The report explores statewide water management and water availability as well as computer modeling thereof. The intended audience ranges from engineers and scientists with extensive WRAP and WAM modeling experience to water managers and stakeholders interested in a general overview of surface water availability in Texas and practices and capabilities for performing assessments of surface water availability.

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Subchapter G Brazos River Basin and Its Associated Bay and Estuary System, March 2014.
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APPENDIX A
PLOTS OF OBSERVED RESERVOIR STORAGE
DISCUSSED IN CHAPTERS 3 AND 4

List of Figures in Appendix A

Introduction to Appendix A

The daily reservoir storage volumes plotted in the figures of Appendix A are from the online database of water conditions data maintained by TWDB and accessible through the following TWDB website (https://www.twdb.texas.gov/surfacewater/conditions/index.asp) . The database is described at the TWDB website and discussed in Chapters 3 and 4 of this report. The database includes historical daily storage contents for 122 large water supply reservoirs from initial impoundment to the present as well as an array of other related information.

The reservoir storage datasets were downloaded by the author as Microsoft Excel CSV (comma-separated values) files. *HEC-DSSVue* was employed to read the downloaded Excel CSV files, store the data in a DSS file, and prepare the plots.

Historical daily reservoir storage time series are discussed in Chapters 3 and 4. Figures 3.3 and 4.13 on pages 73 and 110 and the figures in Appendix A are in the same format with the same legend. Figures 3.3 and 4.13 are plots of the summation of daily storage volumes for 122 reservoirs through July 1, 2025. The daily volumes plotted in Figures A1 through A20 cover the period from initial impoundment of each individual reservoir through February 5, 2024. Figures A21 through A35 time series extend from January 1, 1994 through May 21, 2024. Construction was complete and water was being impounded in most major reservoirs in Texas by 1994.

Reservoir storage is a meaningful metric of water availability that reflects both hydrologic conditions and water resources development and management. The 35 figures in Appendix A provide a graphical articulation of past surface water availability. Figures A1 through A20 illustrate the history of river/reservoir system development throughout the state. Figures A21 through A35 focus on the most recent thirty years comprising the period during which most major reservoirs were in full operation. Figures A1 through A6, A17, A19, and A21 through A35 are comprised of summations of storage quantities for all reservoirs located in each of the 15 major river basins that are included in the TWDB database. The reservoirs included in the TWDB database are listed by river basin at the TWDB website cited above. The Lavaca and San Antonio River Basin each include only one reservoir in the TWDB database. The Canadian, Nueces, and Guadalupe River Basins each have two reservoirs in the database. The ten other major river basins have three or more reservoirs in the database. The Brazos and Trinity River Basins with 28 and 24 reservoirs in the database are the basins with the largest number of major reservoirs included.

The legend below is applicable to all figures in Appendix A as well as the summations of all 122 reservoirs in the TWDB database plotted in Figures 3.3 and 4.13 of Chapters 3 and 4.

blue solid line	Total daily storage contents (acre-feet)
red dashed line	Active daily conservation storage contents allocated for use by water users in Texas (acre-feet)
black dotted line	Active conservation storage capacity used to store water for use by water users in Texas (acre-feet)

The difference between total storage and active conservation storage includes: (1) flood control and surcharge storage, (2) active conservation storage used by water users in Mexico and neighboring states, and (3) inactive storage that may be used hydropower head or recreation but does not supply diversions or releases of water from the reservoir.

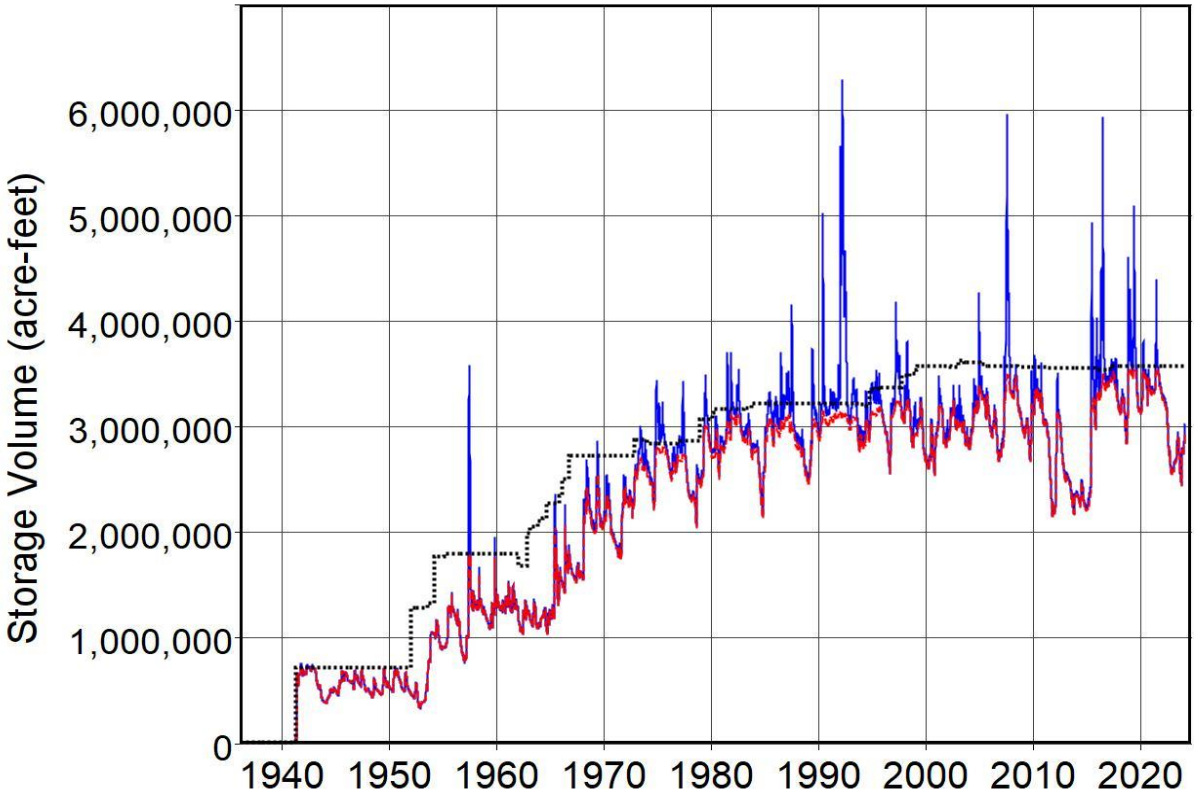

Figure A1 Storage Summations for 28 Reservoirs in the Brazos River Basin

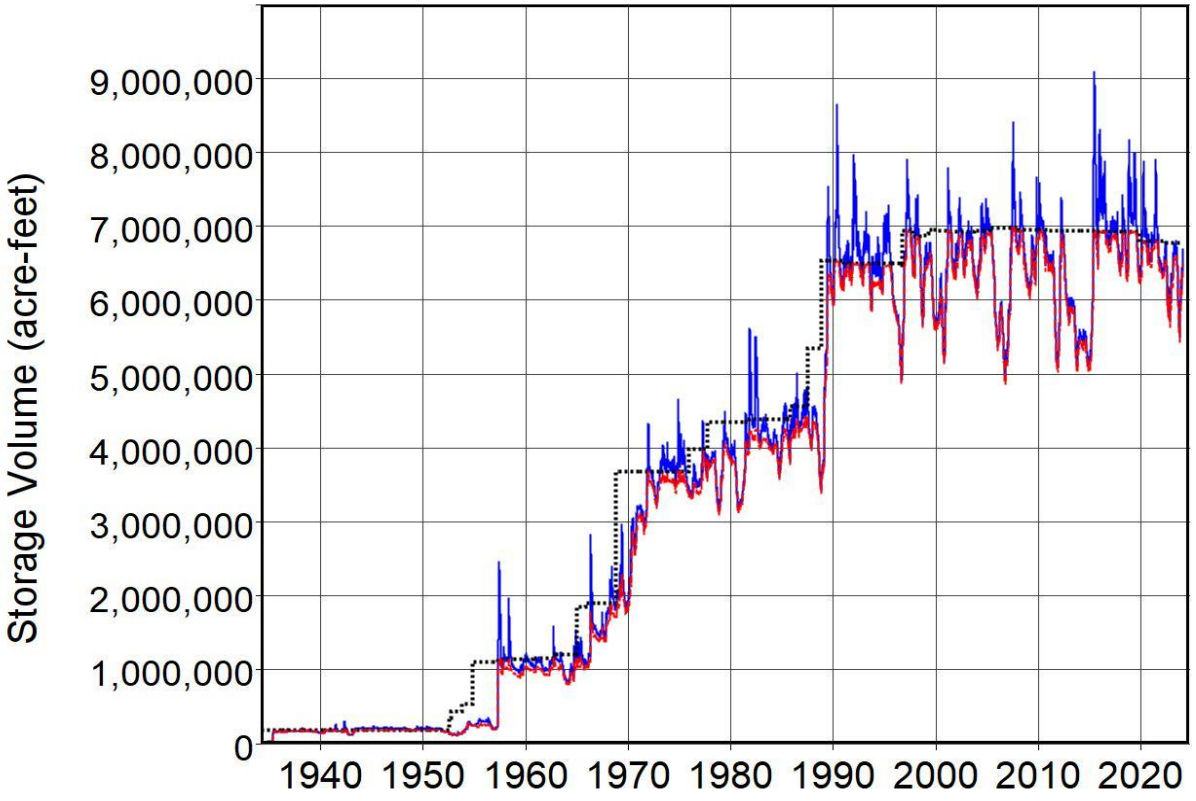

Figure A2 Storage Summations for 24 Reservoirs in the Trinity River Basin

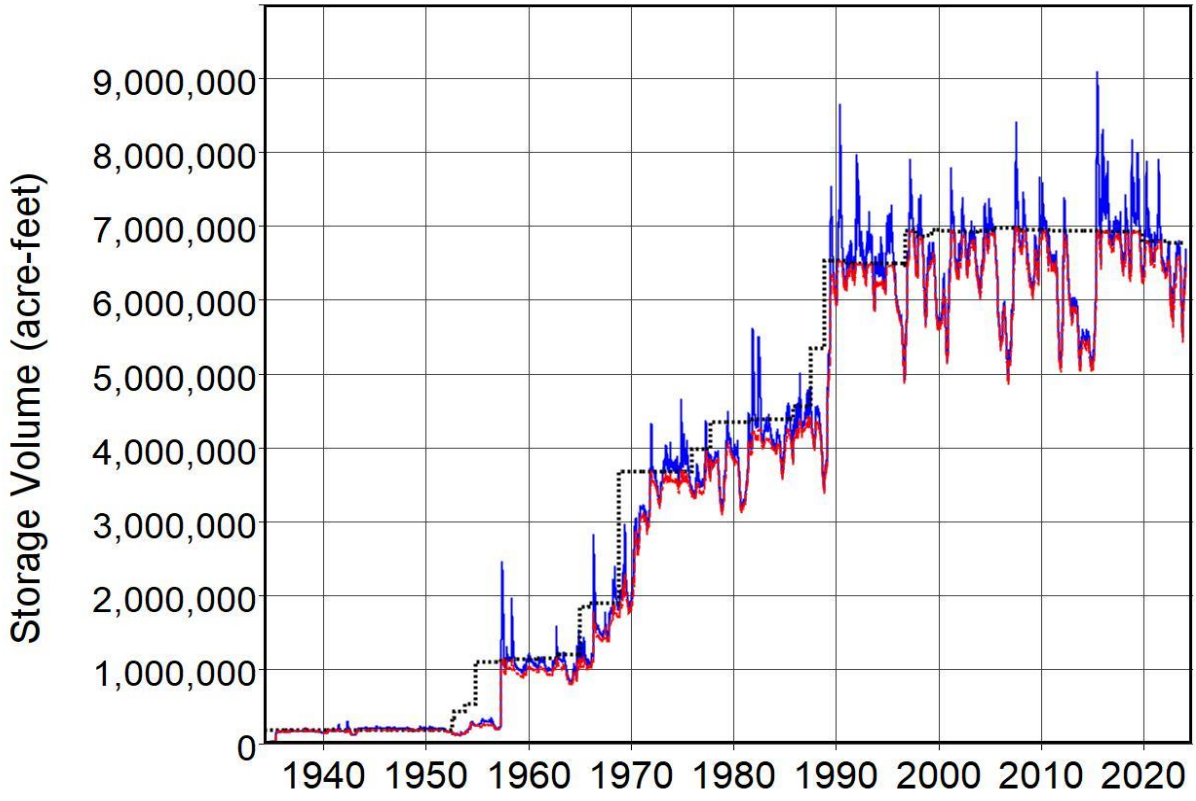

Figure A3 Storage Summations for 8 Reservoirs in the Neches River Basin

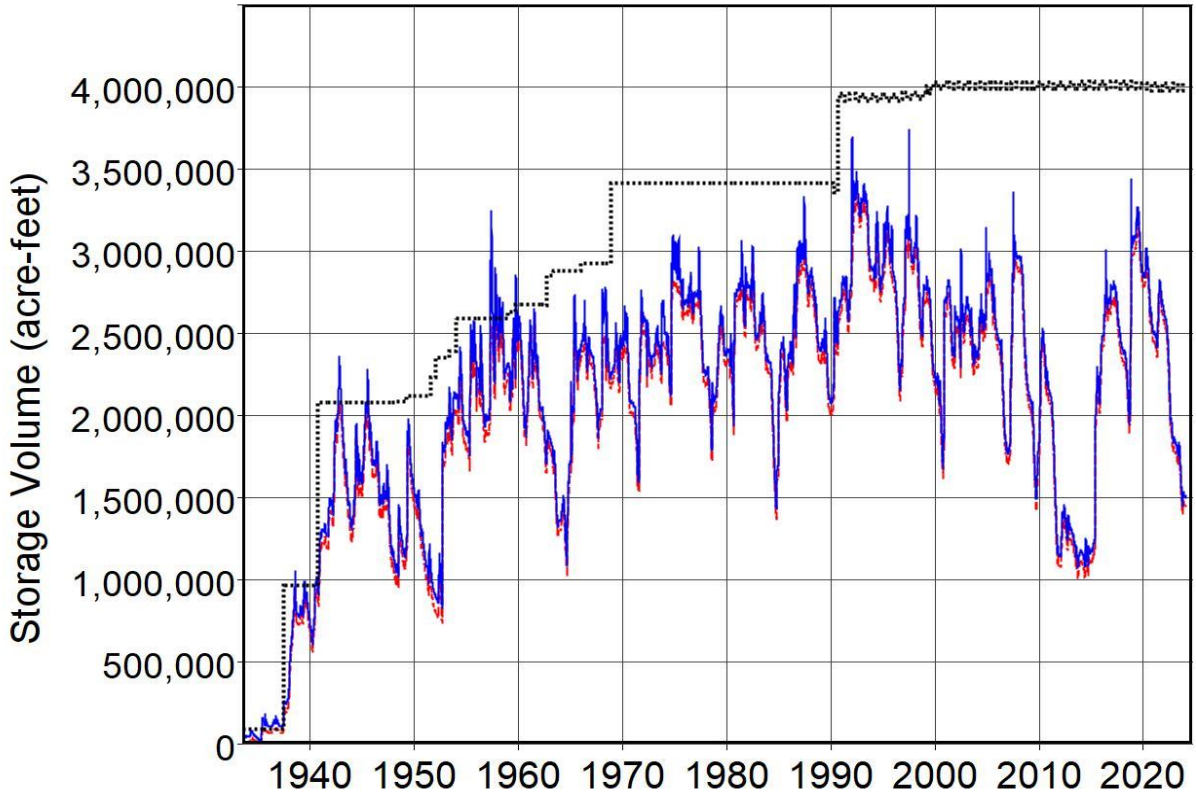

Figure A4 Storage Summations for 19 reservoirs in the Colorado River Basin

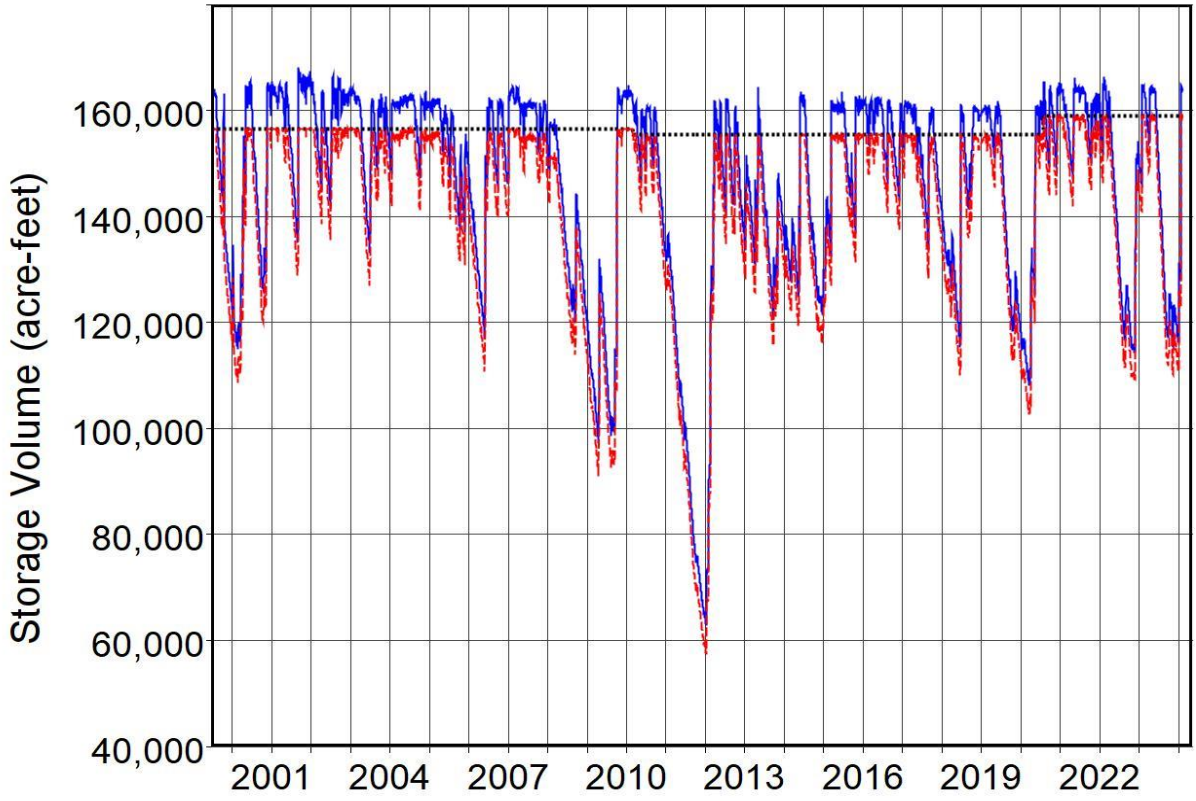

Figure A5 Storage in Lake Texana on the Navidad River in the Lavaca River Basin

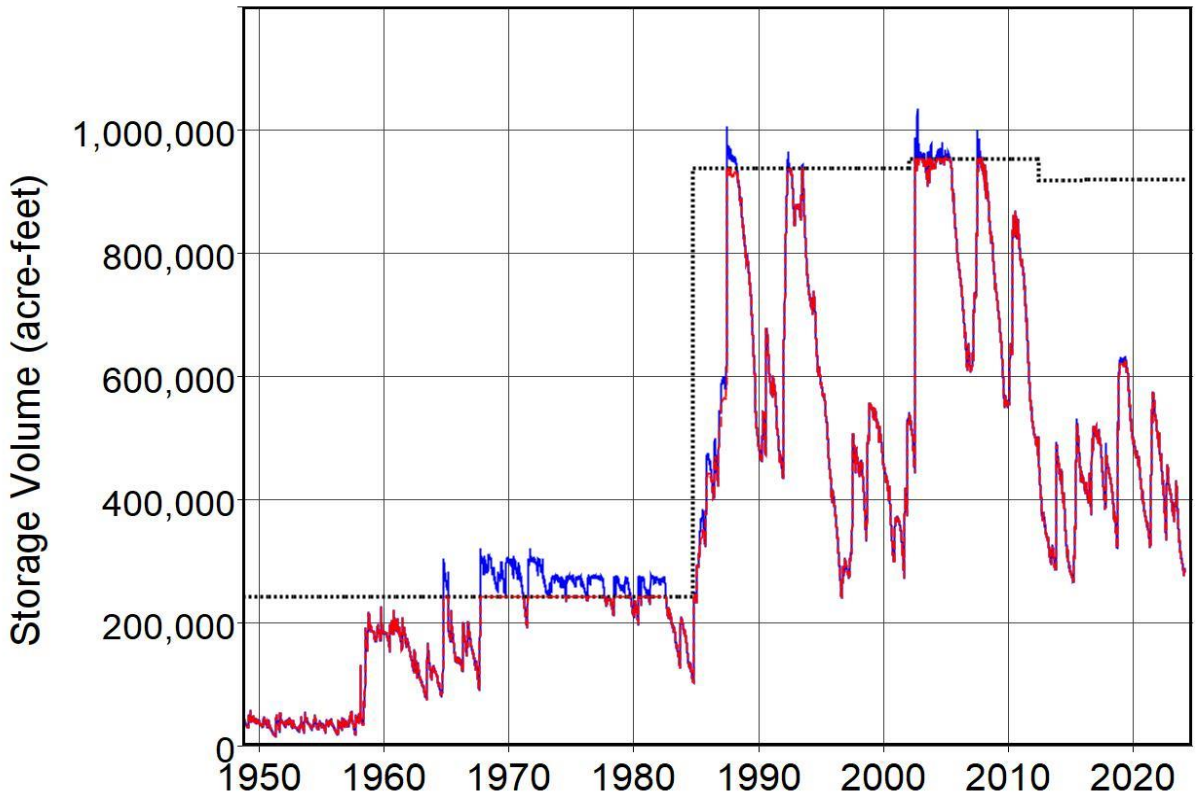

Figure A6 Storage in Lakes Corpus Christi and Choke Canyon in Nueces River Basin

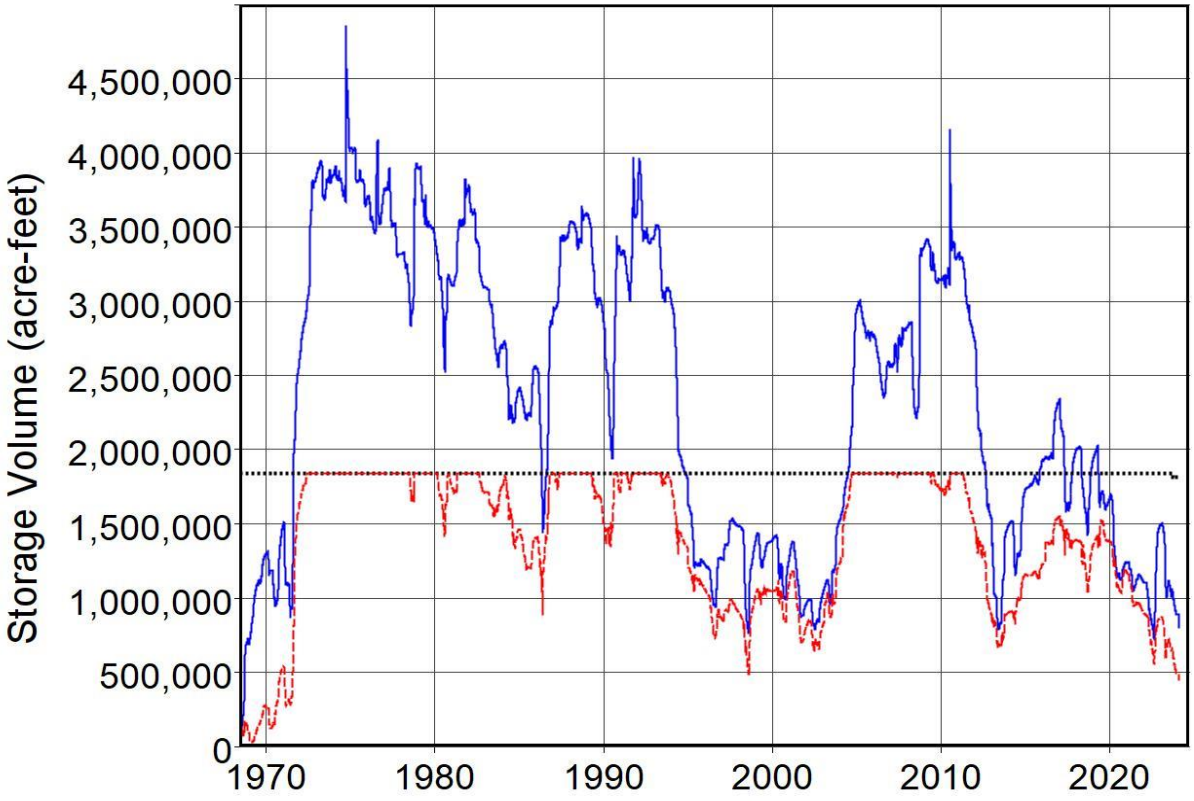

Figure A7 Storage in International Amistad Reservoir on the Rio Grande

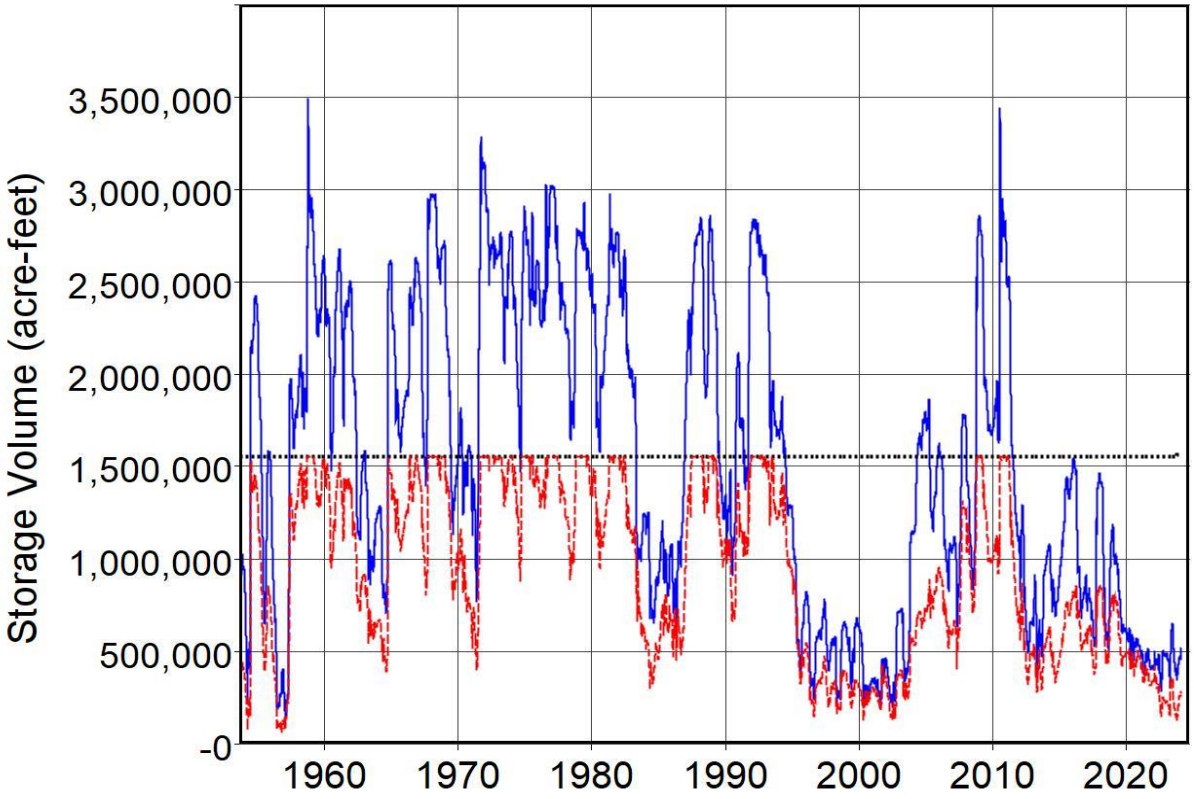

Figure A8 Storage in International Falcon Reservoir on the Rio Grande

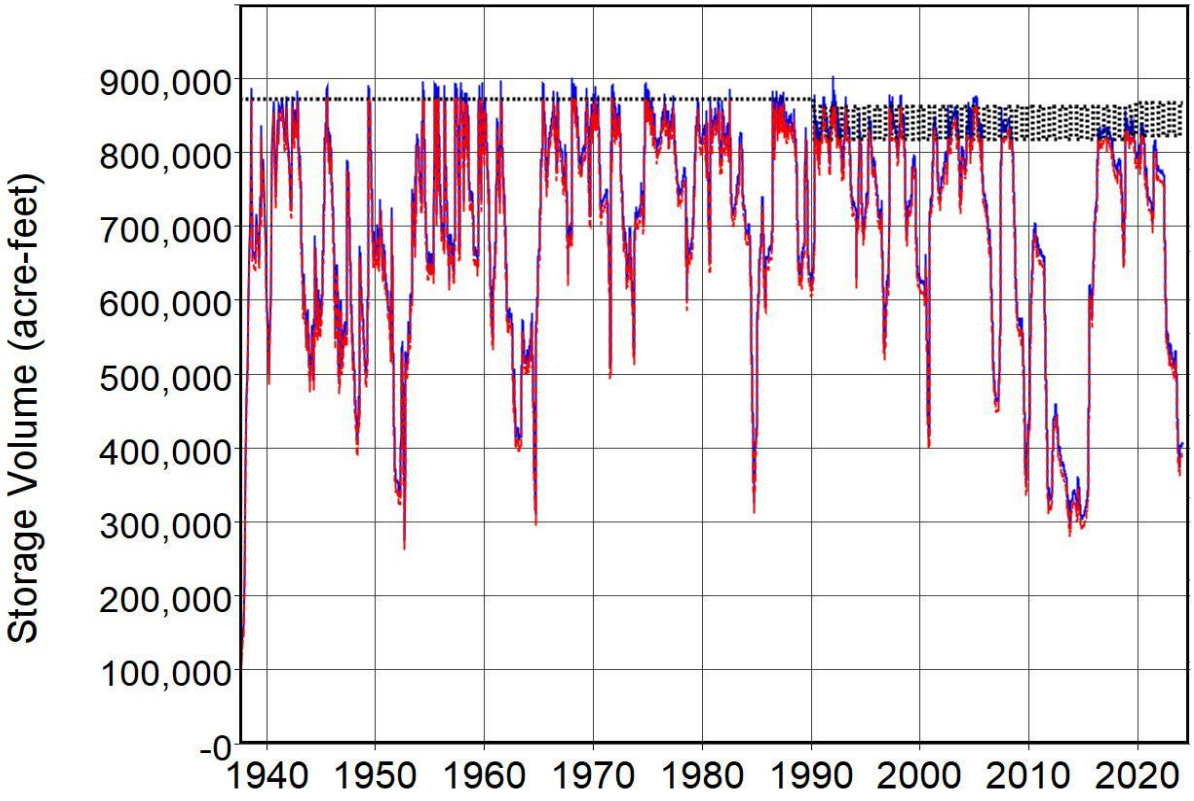

Figure A9 Storage in Lake Buchanan on the Colorado River

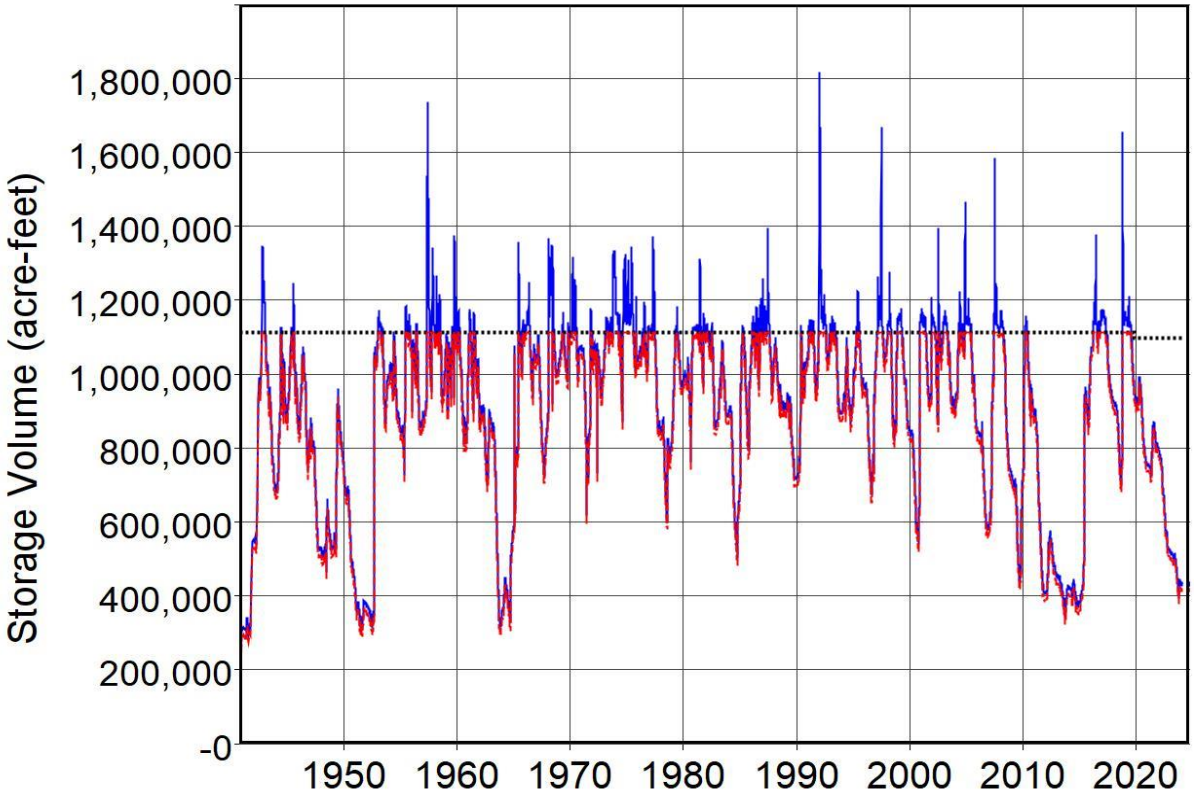

Figure A10 Storage in Lake Travis on the Colorado River

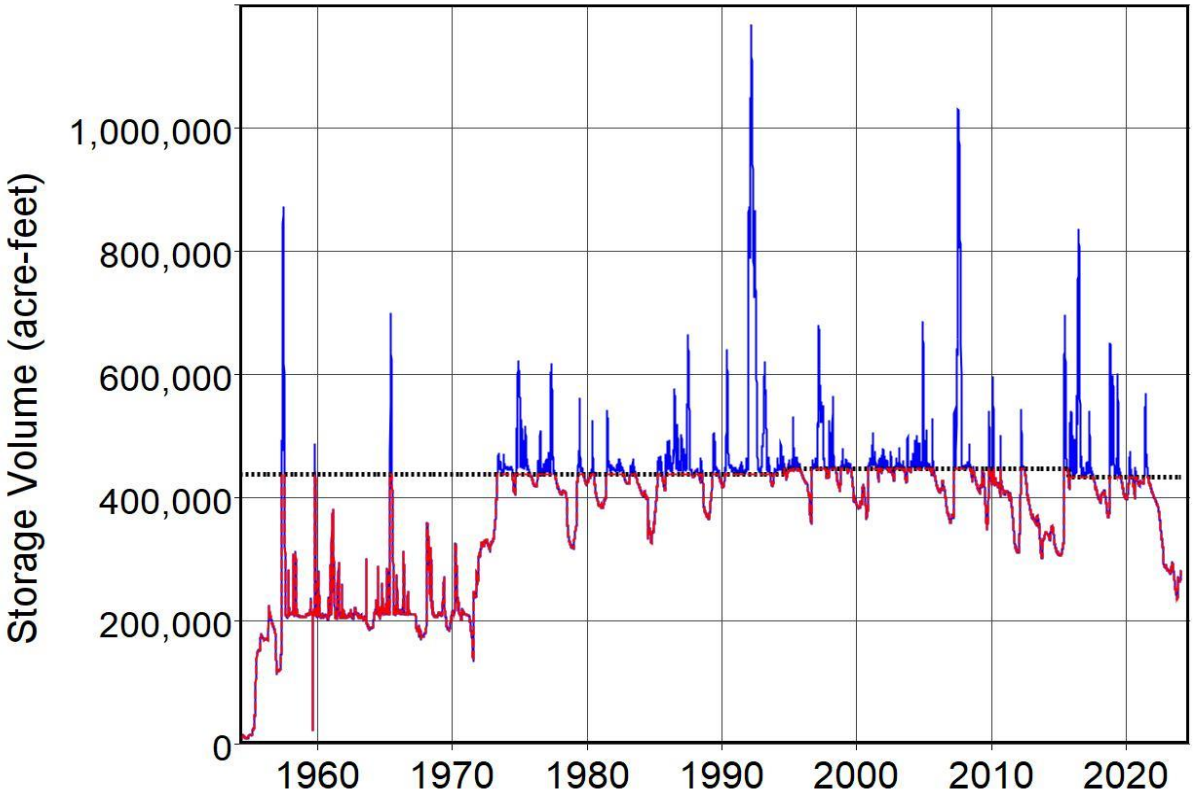

Figure A11 Storage in Belton Reservoir on the Leon River in the Brazos River Basin

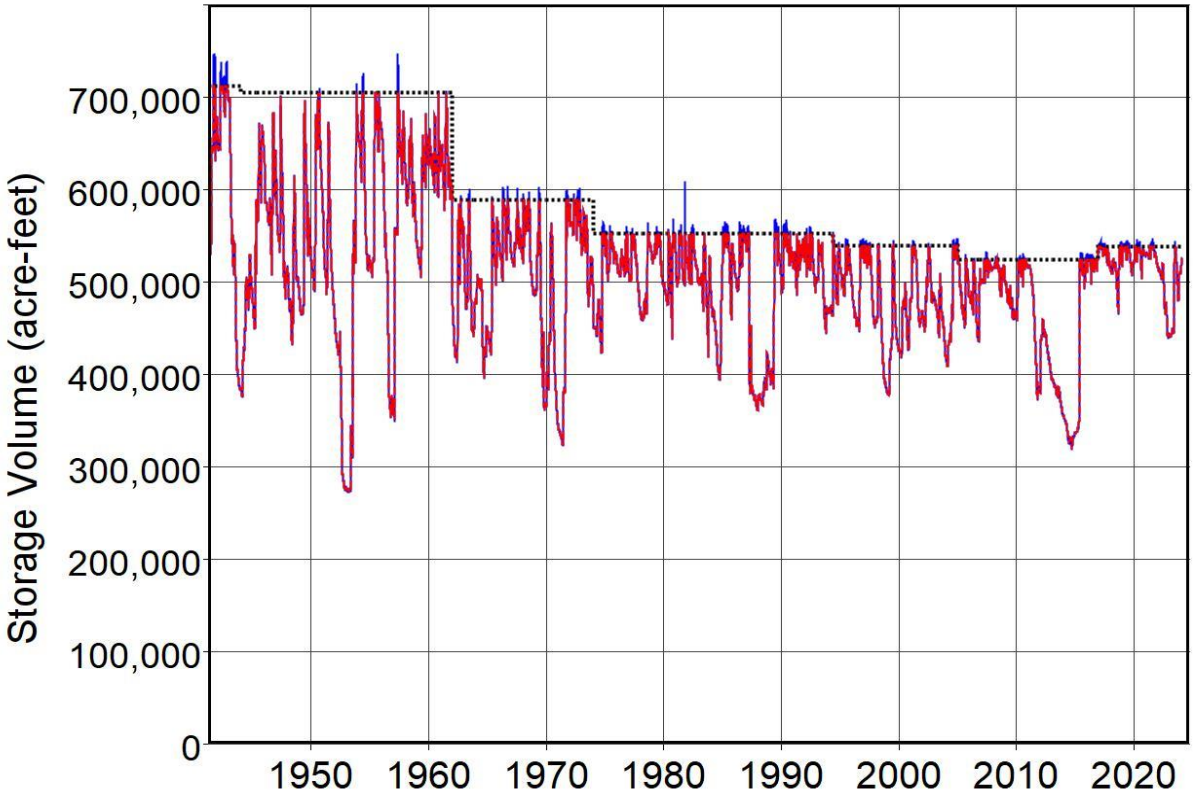

Figure A12 Storage in Possum Kingdom Reservoir on the Brazos River

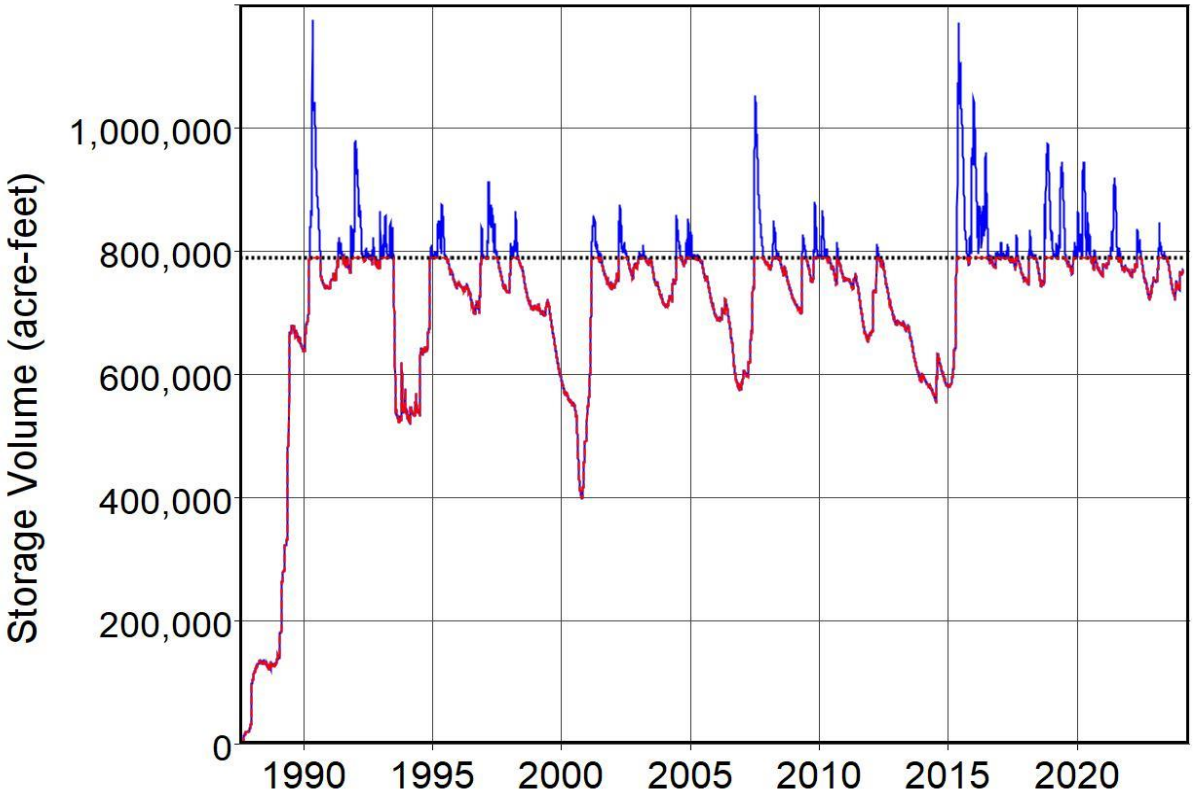

Figure A13 Storage in Ray Roberts Reservoir on the Elm Fork of the Trinity River

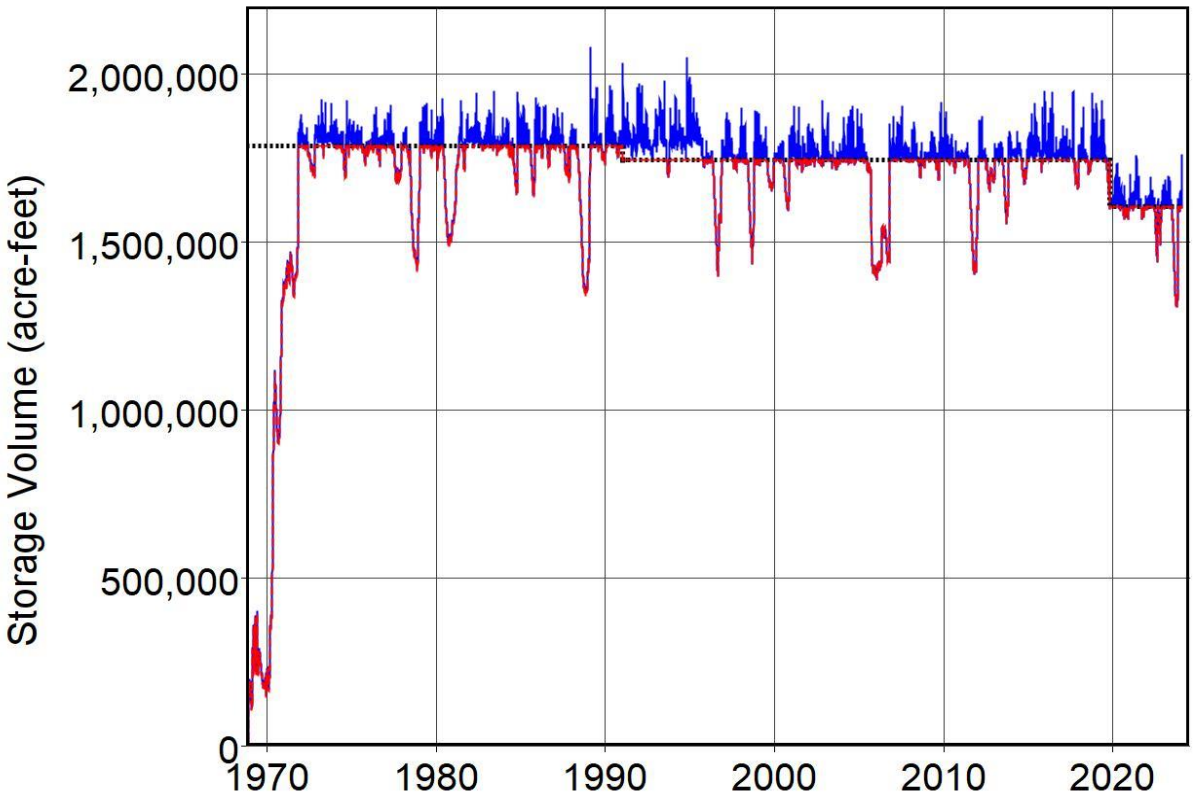

Figure A14 Storage in Lake Livingston on the Trinity River

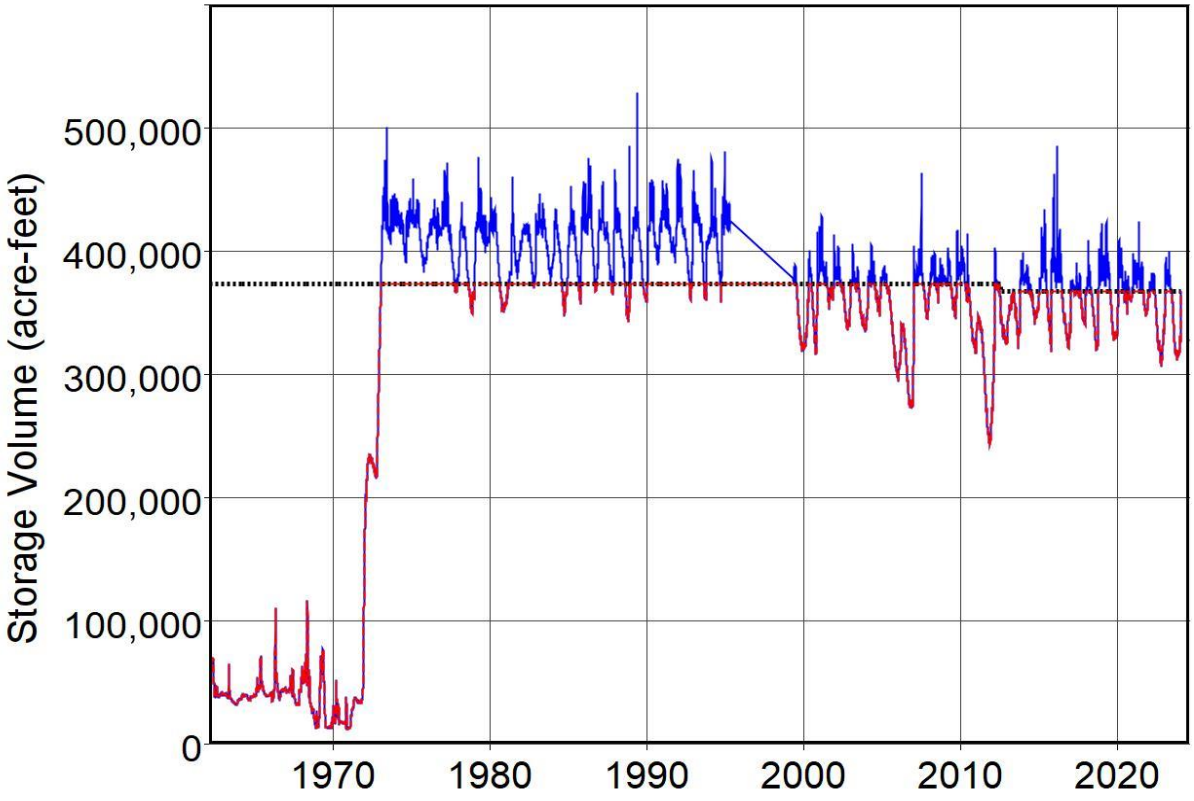

Figure A15 Storage in Lake Palestine on the Neches River

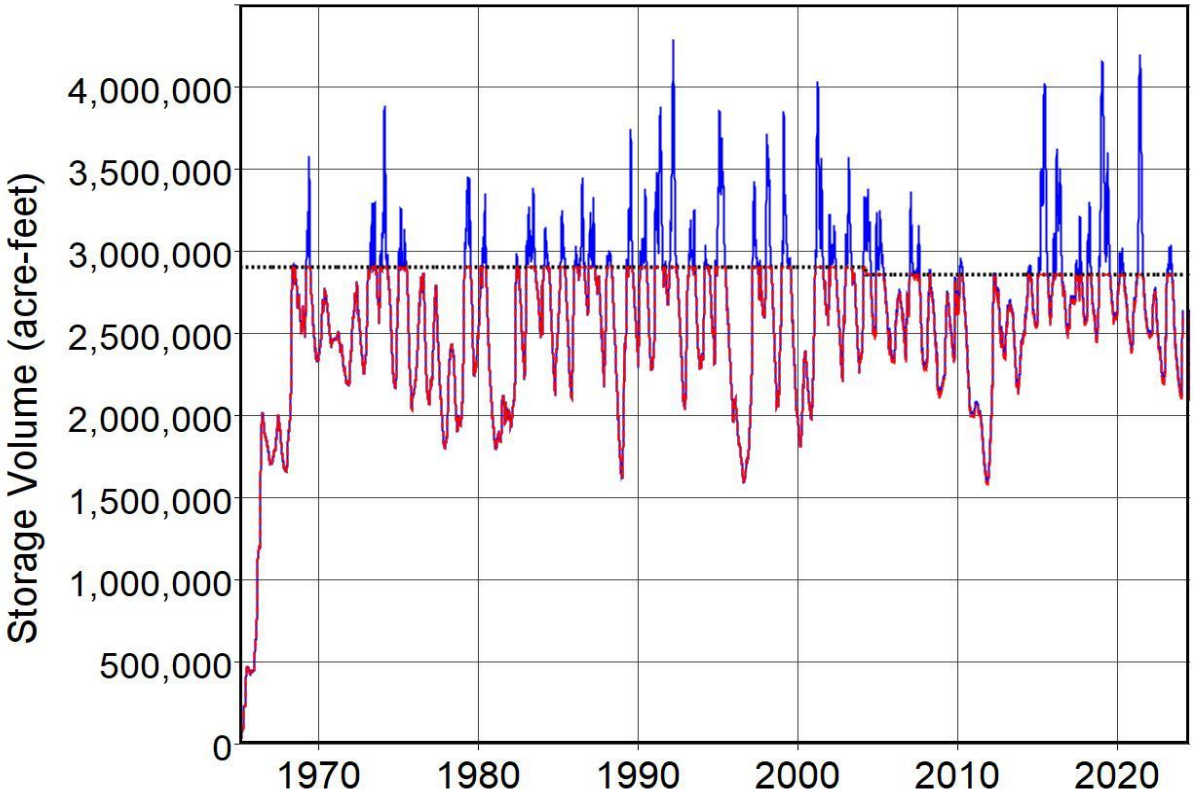

Figure A16 Storage in Sam Rayburn Reservoir on the Angelina River in the Neches Basin

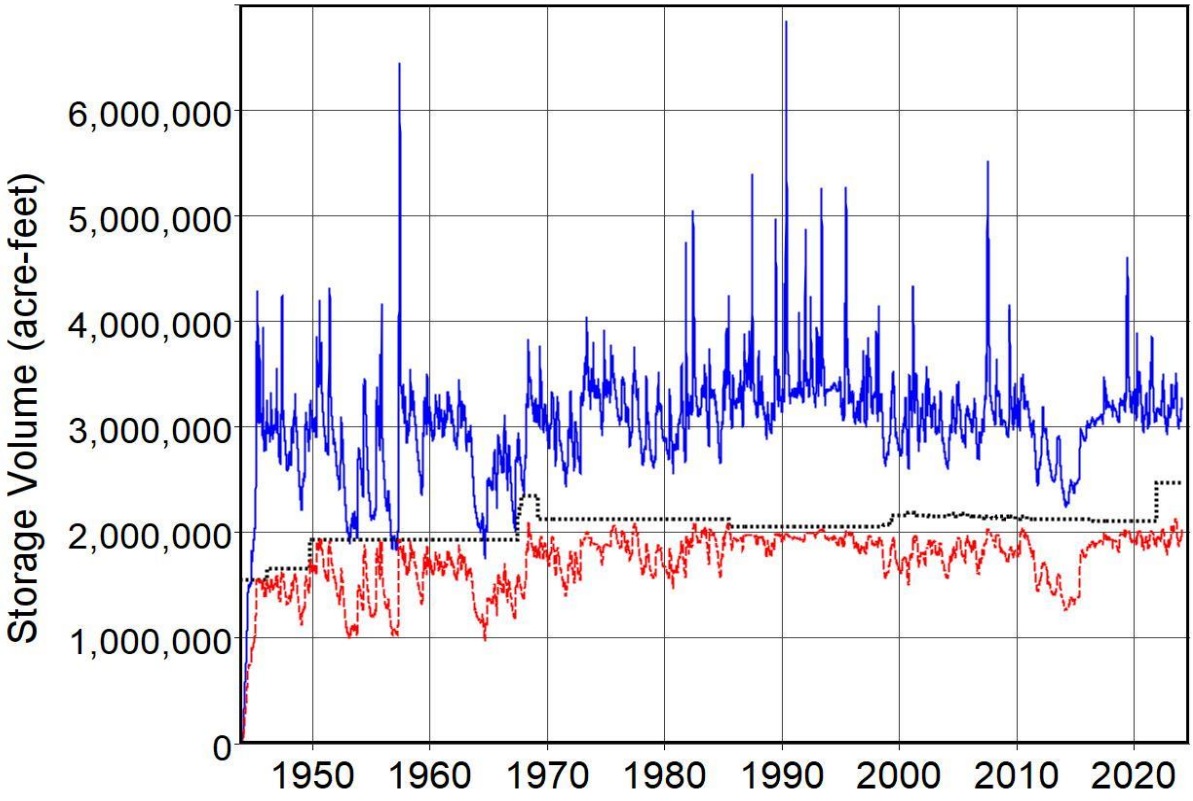

Figure A17 Storage Summations for 13 Reservoirs in the Red River Basin

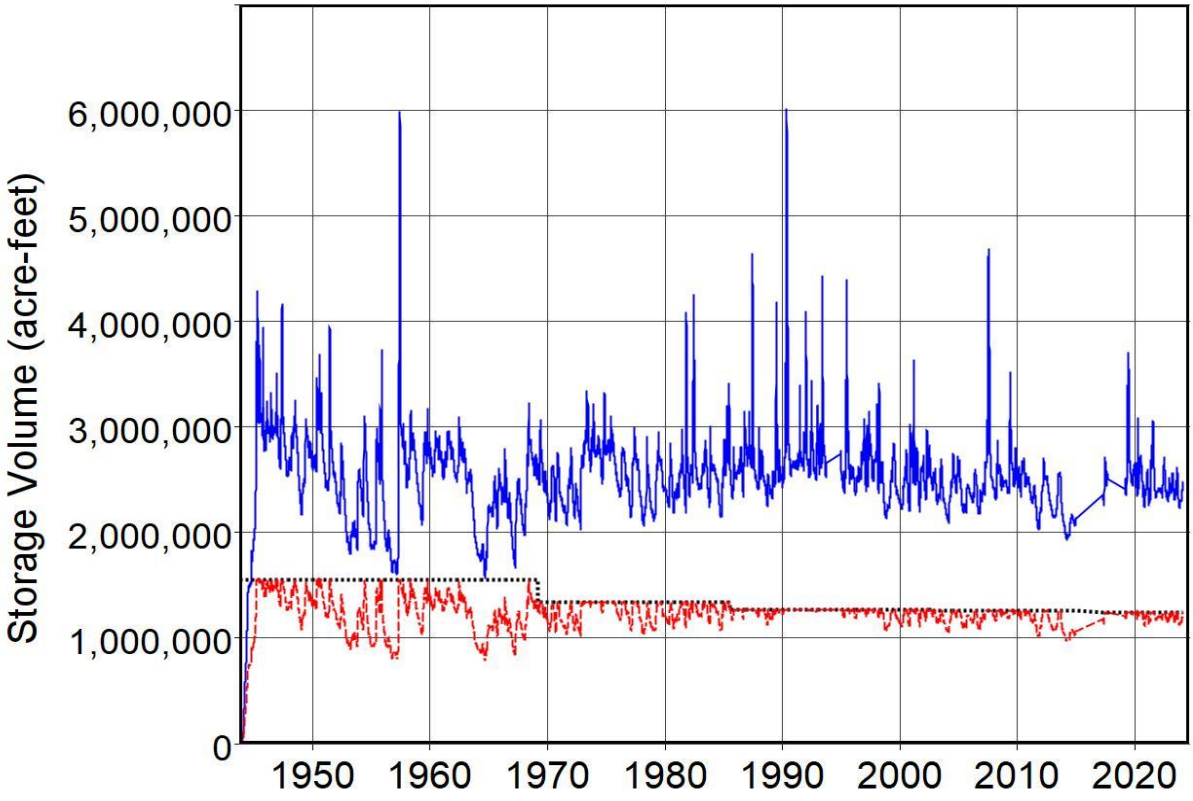

Figure A18 Storage in Lake Texoma on the Red River

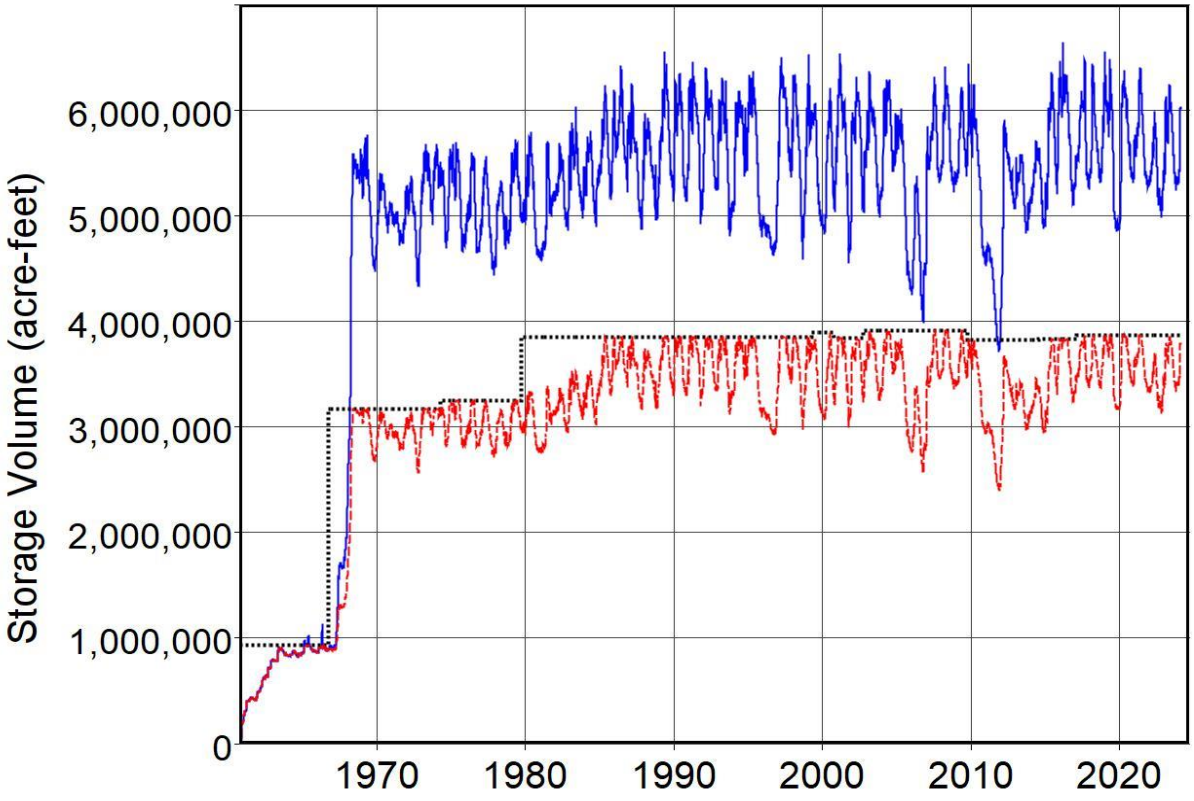

Figure A19 Storage Summations for Six Reservoirs in the Sabine River Basin

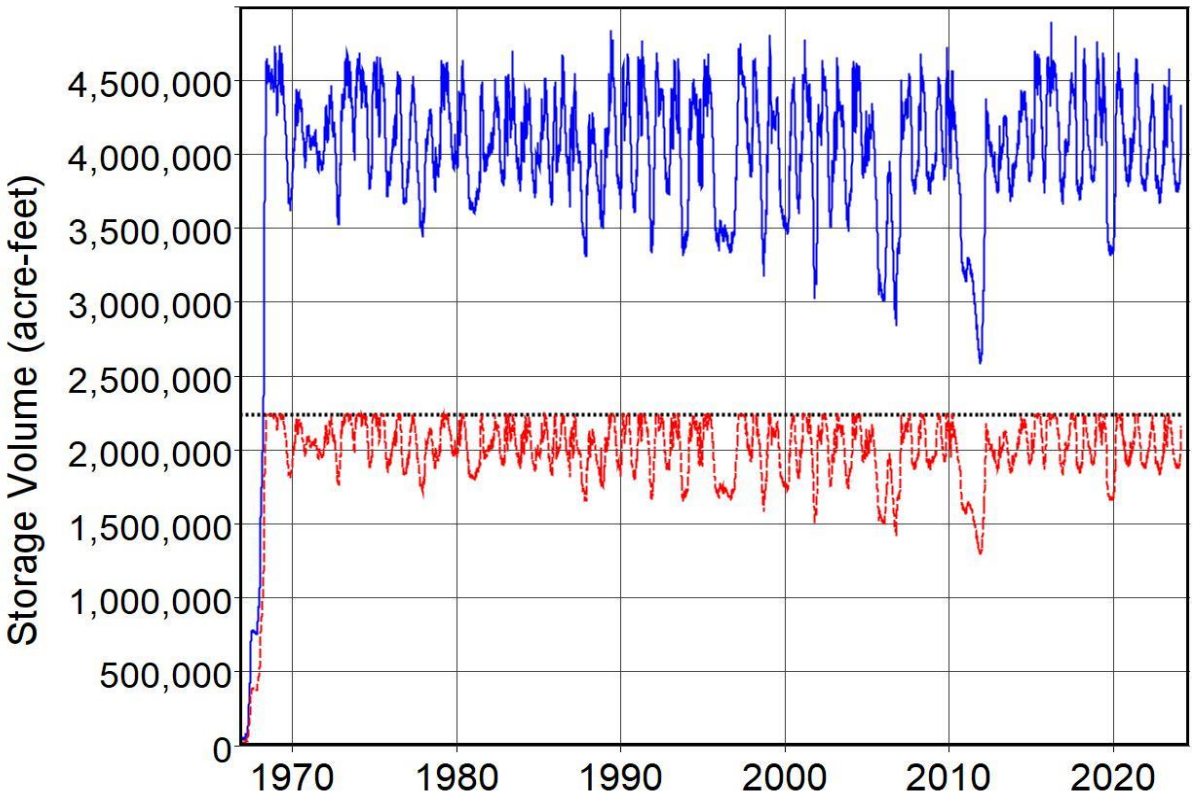

Figure A20 Storage in Toledo Bend Reservoir on the Sabine River

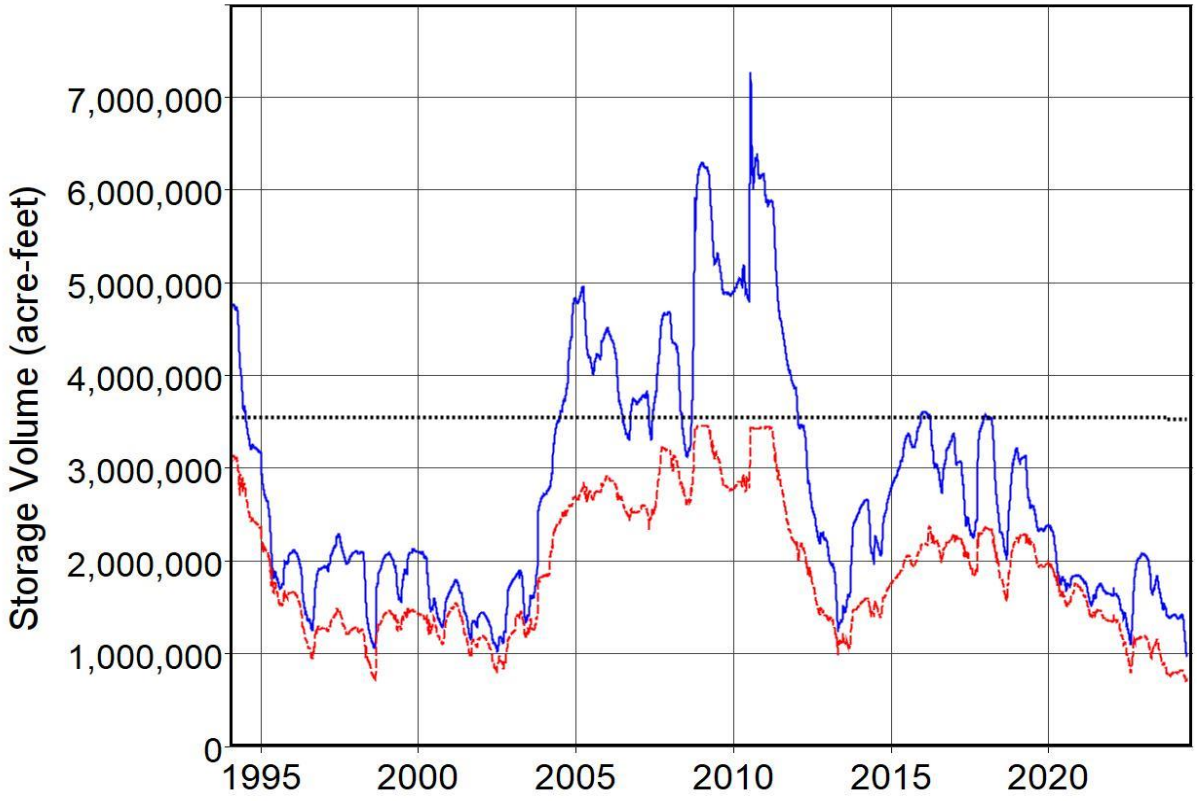

Figure A21 Storage in Amistad, Falcon, and Red Bluff Reservoirs in the Rio Grande Basin

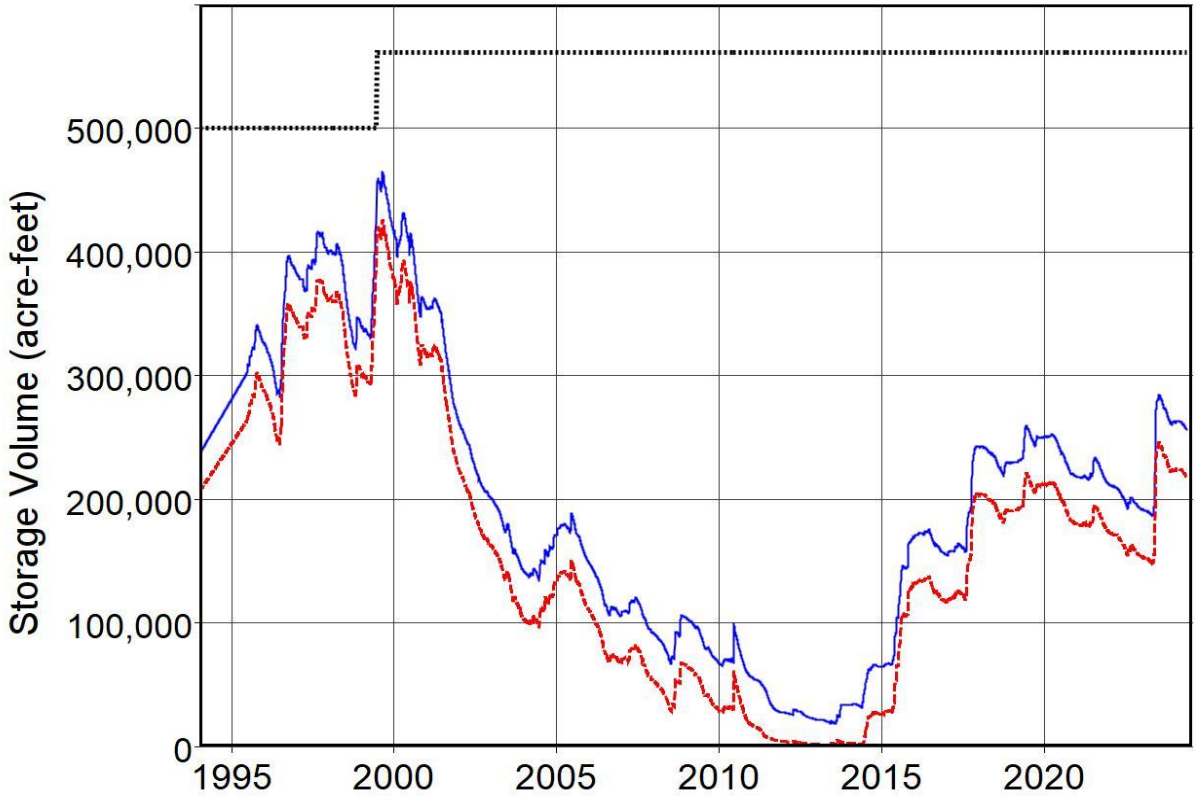

Figure A22 Storage in Meredith and Palo Duro Reservoirs in the Canadian River Basin

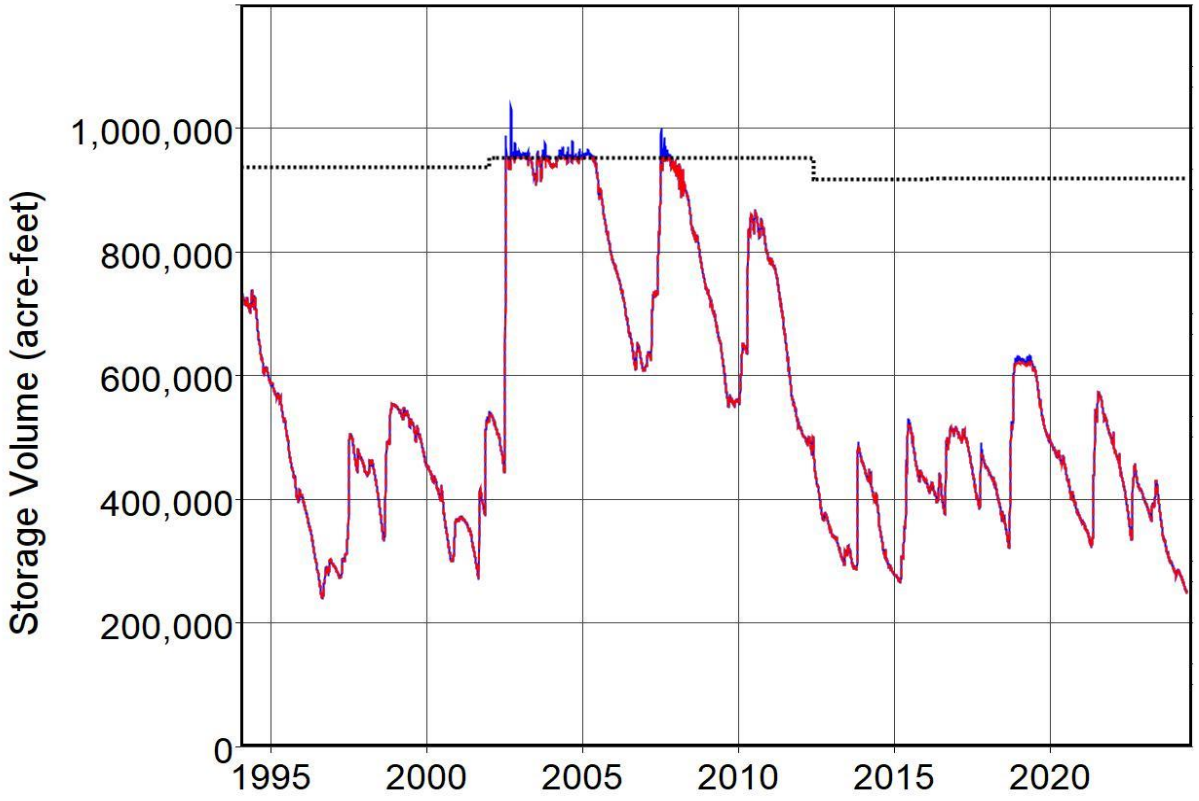

Figure A23 Storage in Corpus Christi and Choke Canyon Reservoirs in the Nueces River Basin

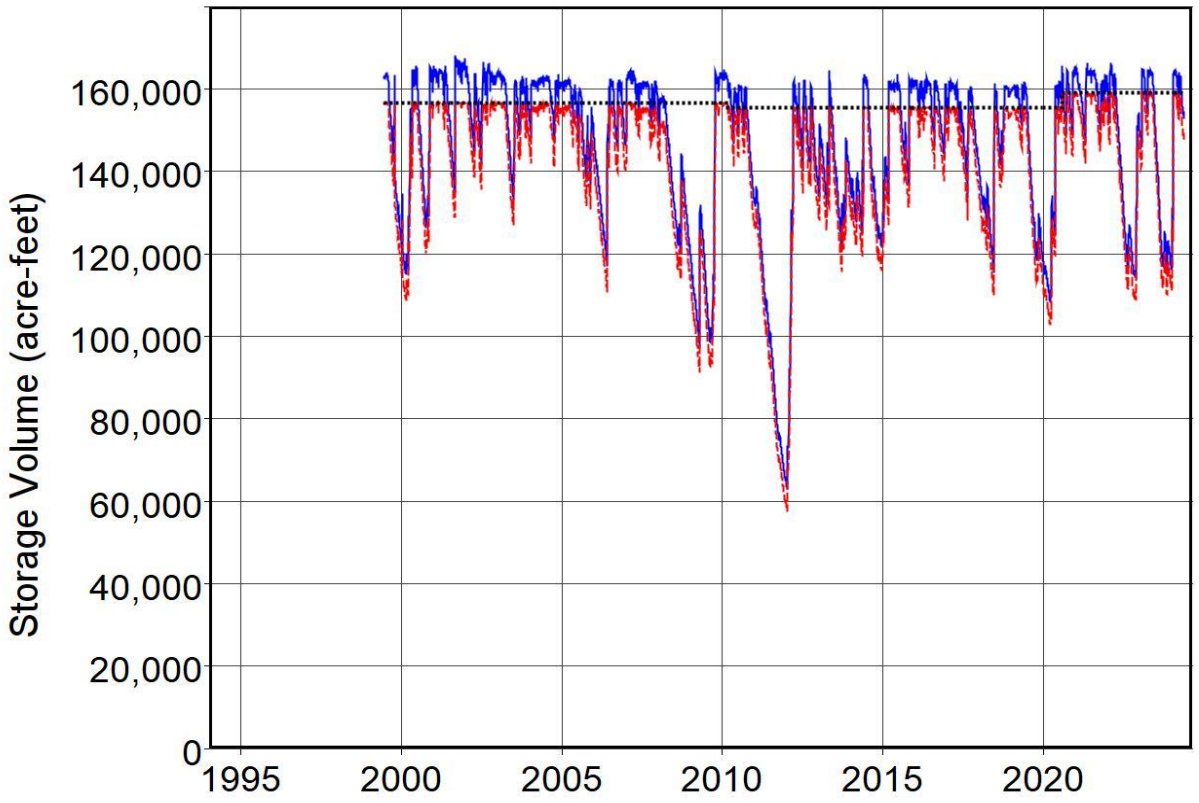

Figure A24 Storage in Lake Texana in the Lavaca River Basin

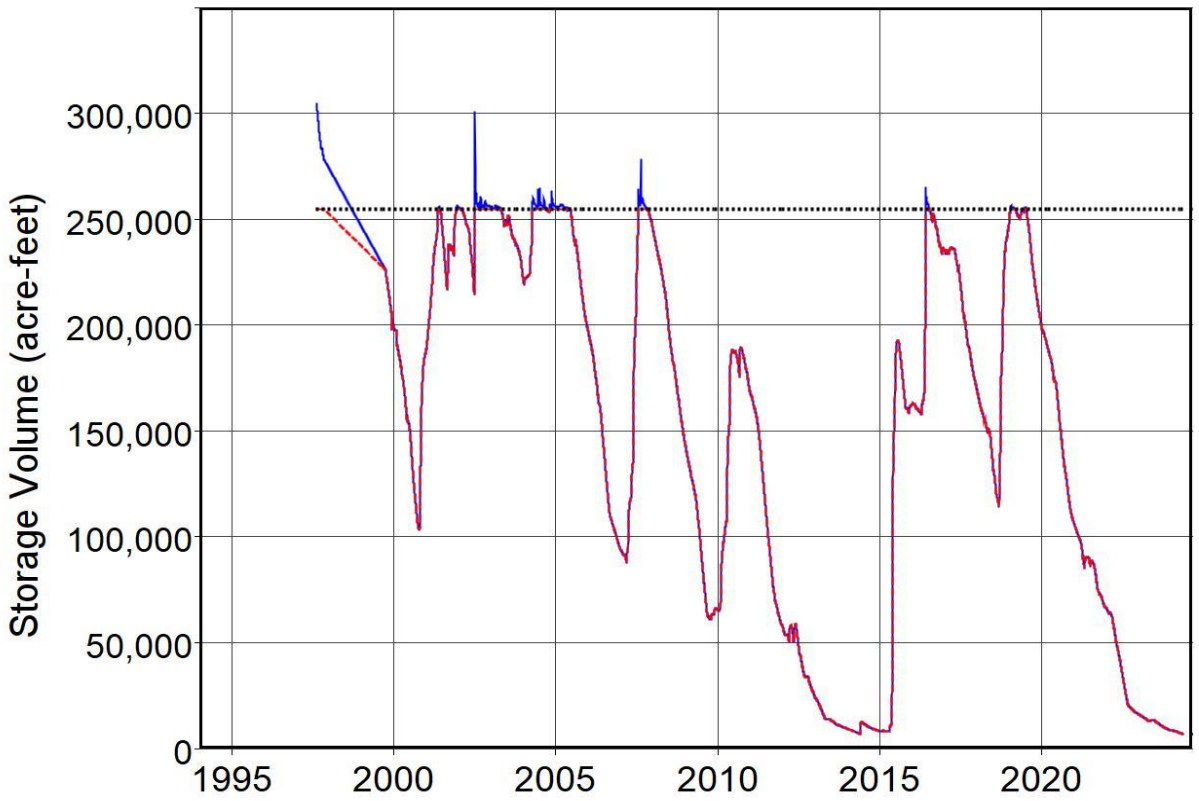

Figure A25 Storage in Lake Medina in the San Antonio River Basin

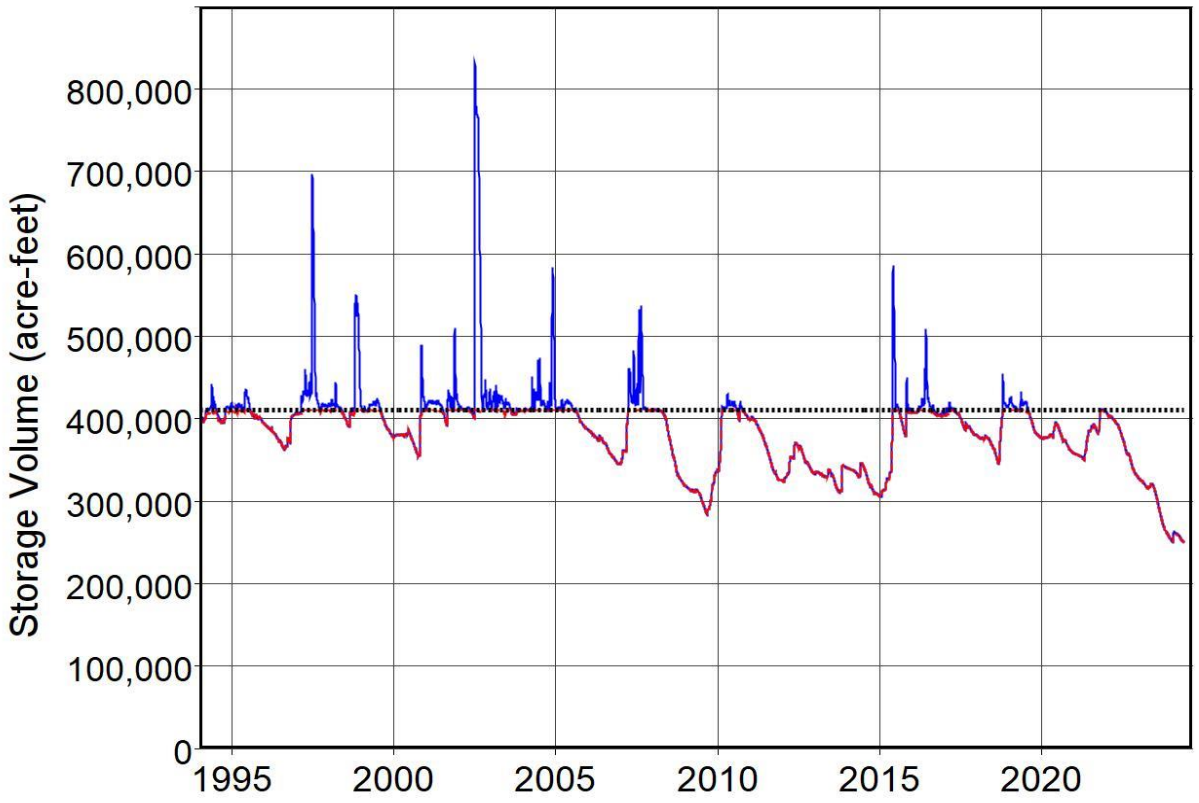

Figure A26 Storage in Canyon and Coleto Creek Reservoirs in the Guadalupe River Basin

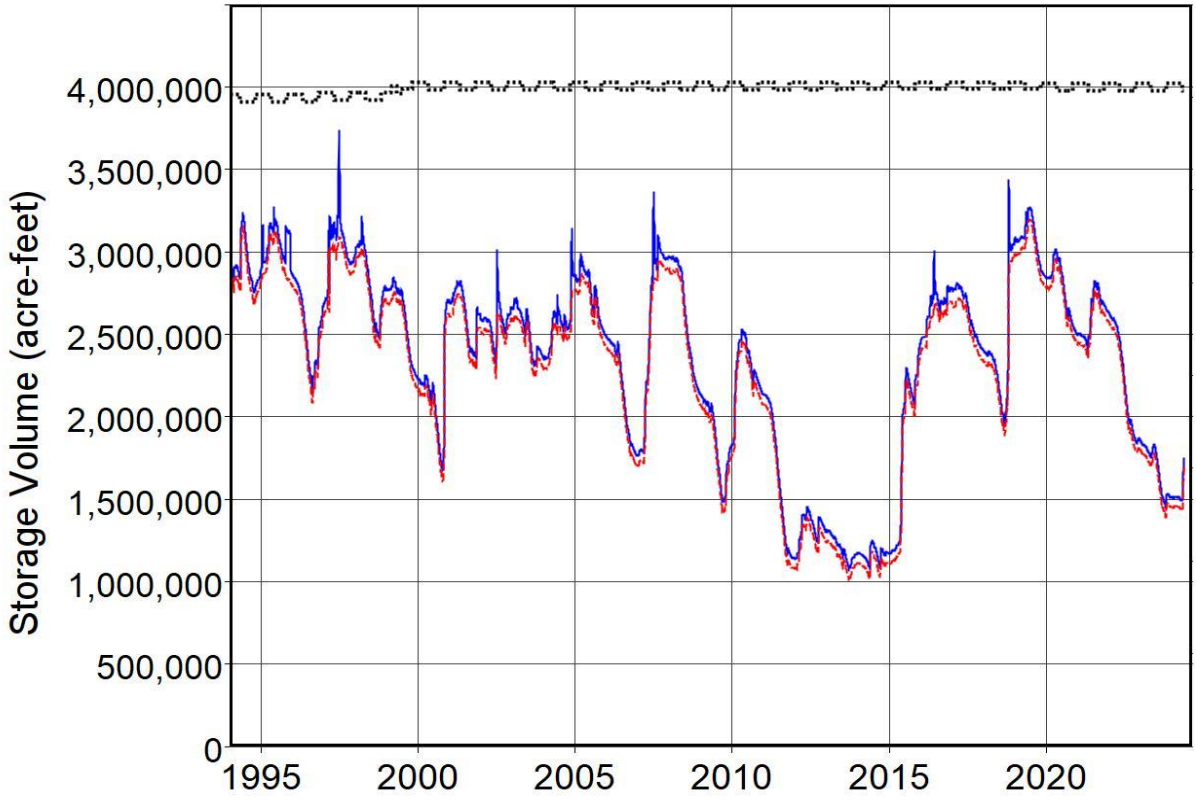

Figure A27 Storage Summations for 19 Reservoirs in the Colorado River Basin

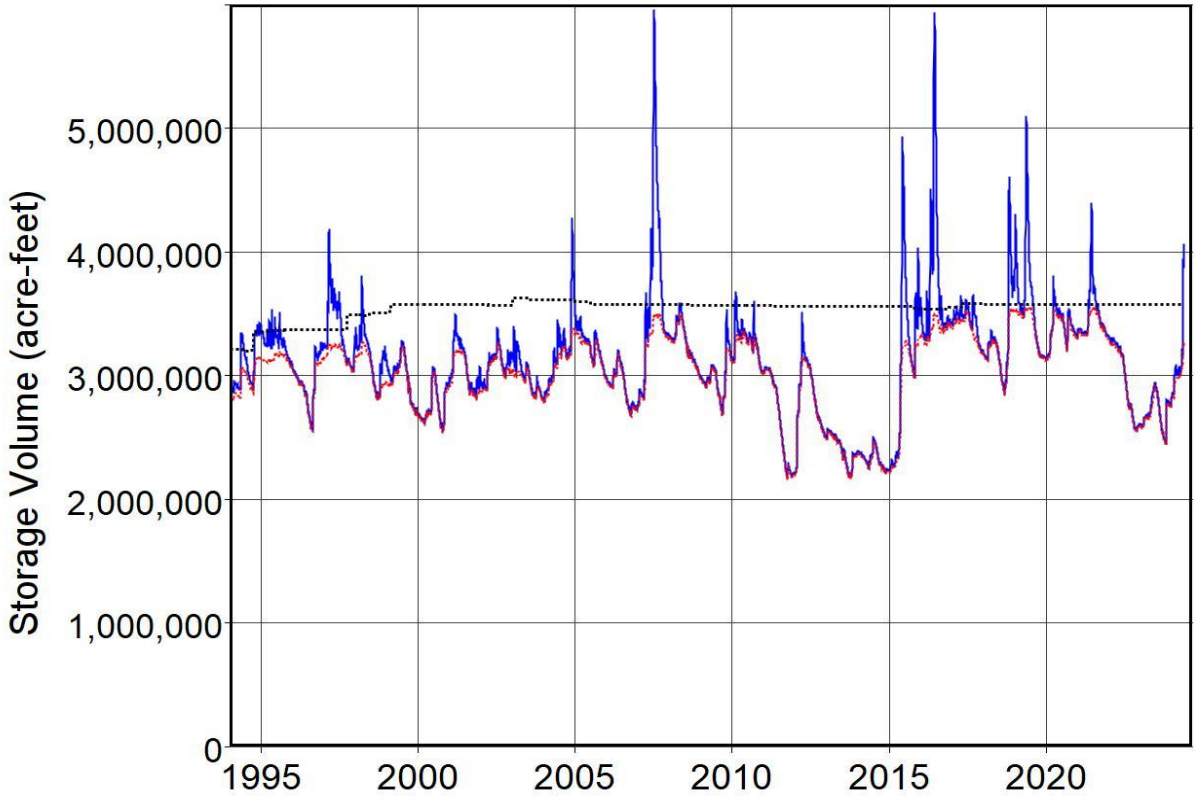

Figure A28 Storage Summations for 28 Reservoirs in the Brazos River Basin

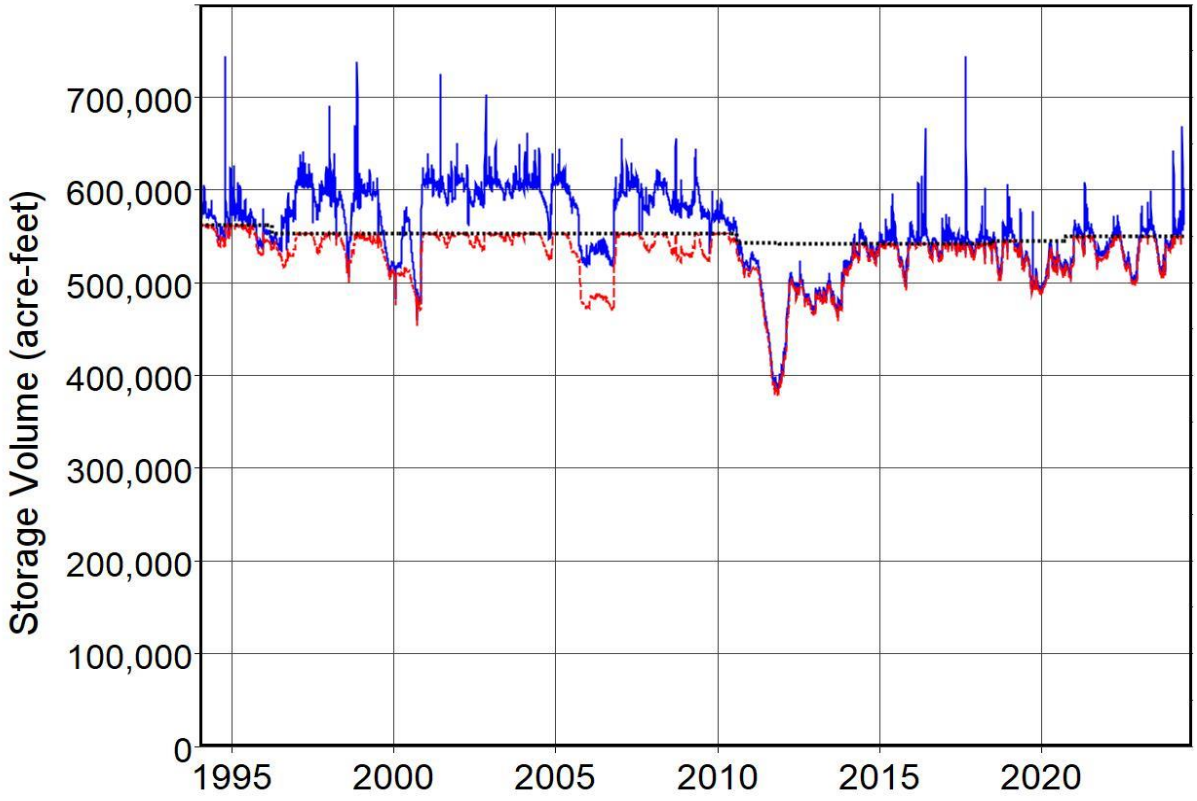

Figure A29 Storage Summations for 4 Reservoirs in the San Jacinto River Basin

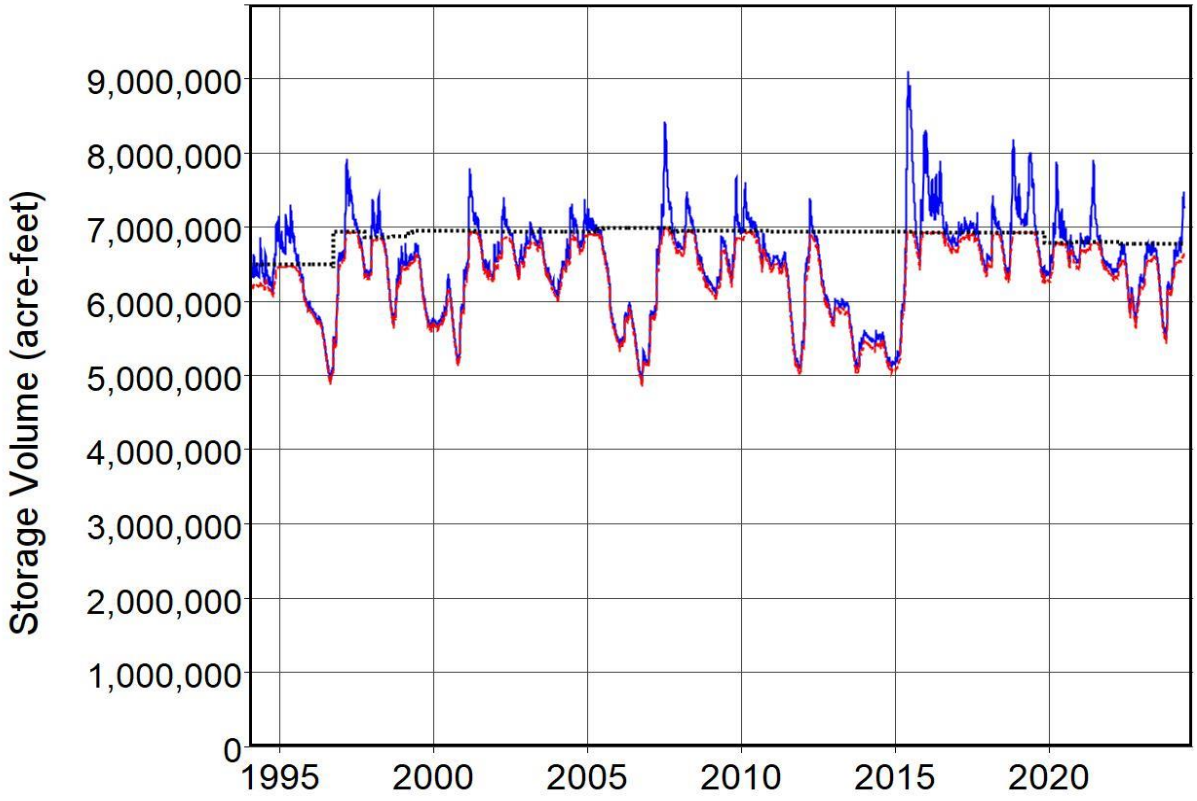

Figure A30 Storage Summations for 24 Reservoirs in the Trinity River Basin

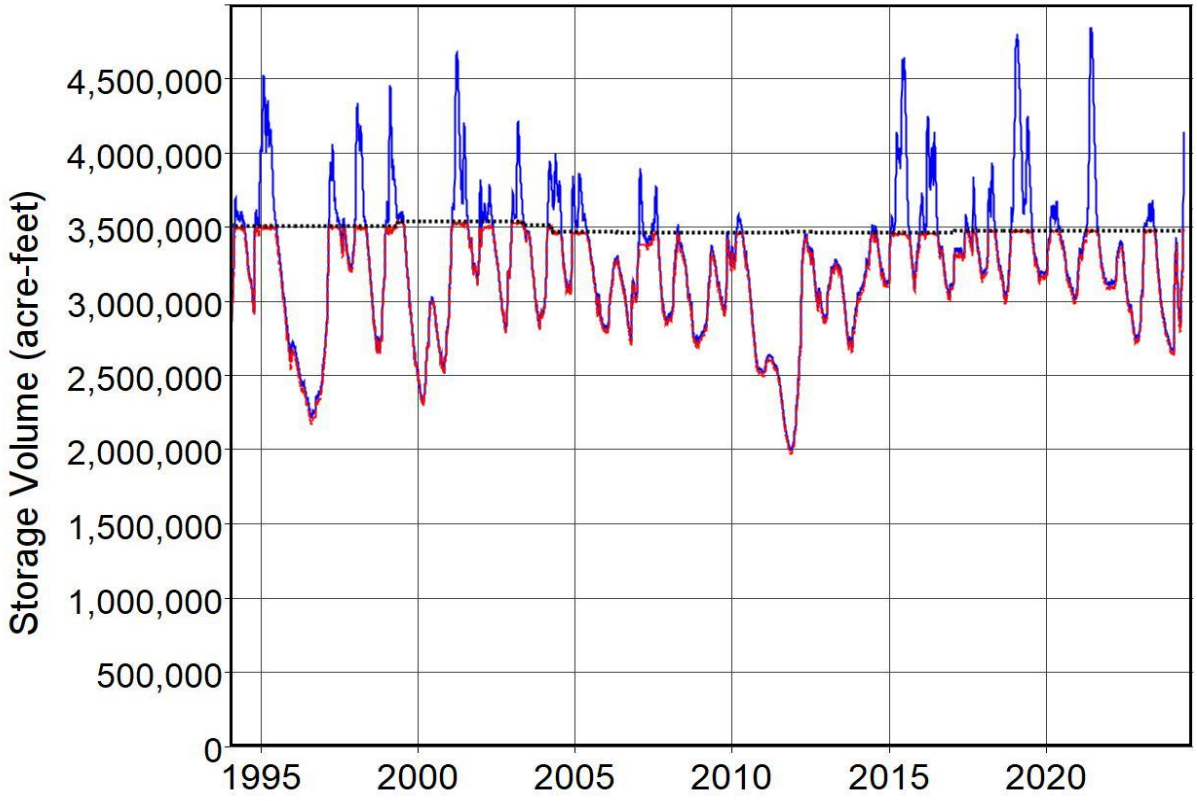

Figure A31 Storage Summations for 7 Reservoirs in the Neches River Basin

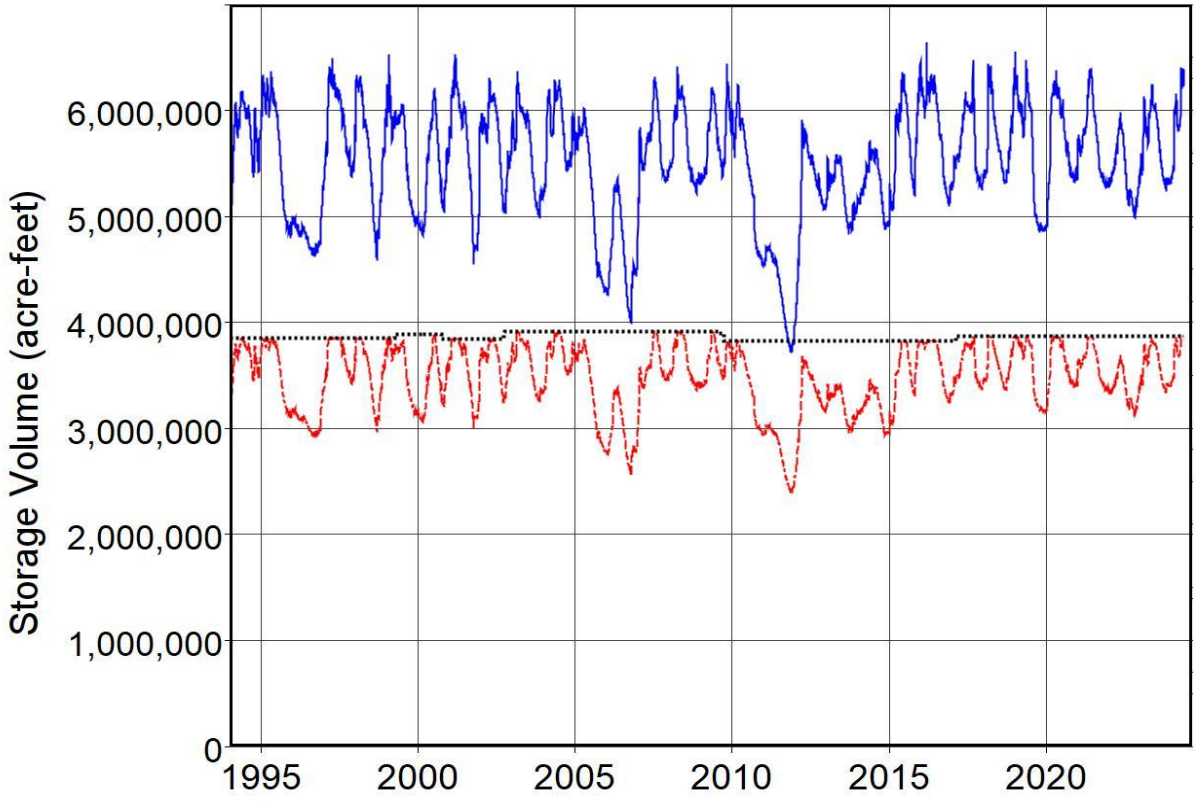

Figure A32 Storage Summations for 6 Reservoirs in the Sabine River Basin

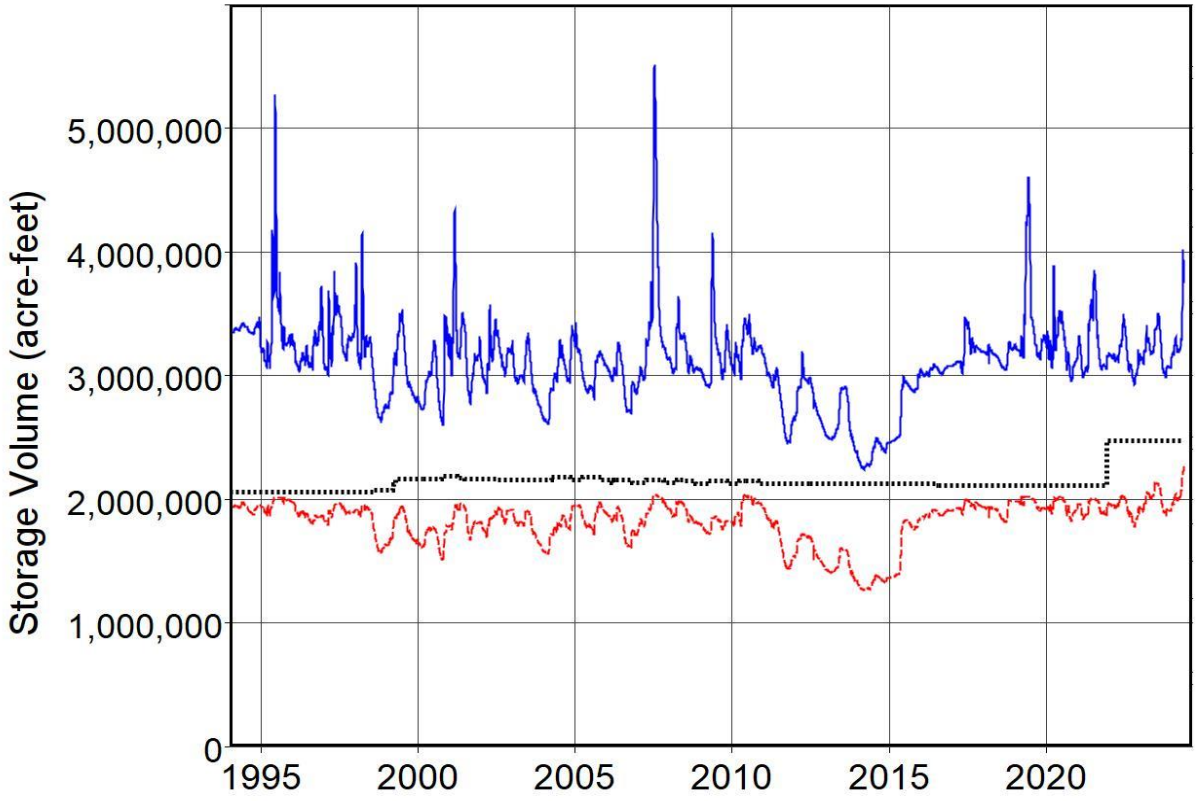

Figure A33 Storage Summations for 13 Reservoirs in the Red River Basin

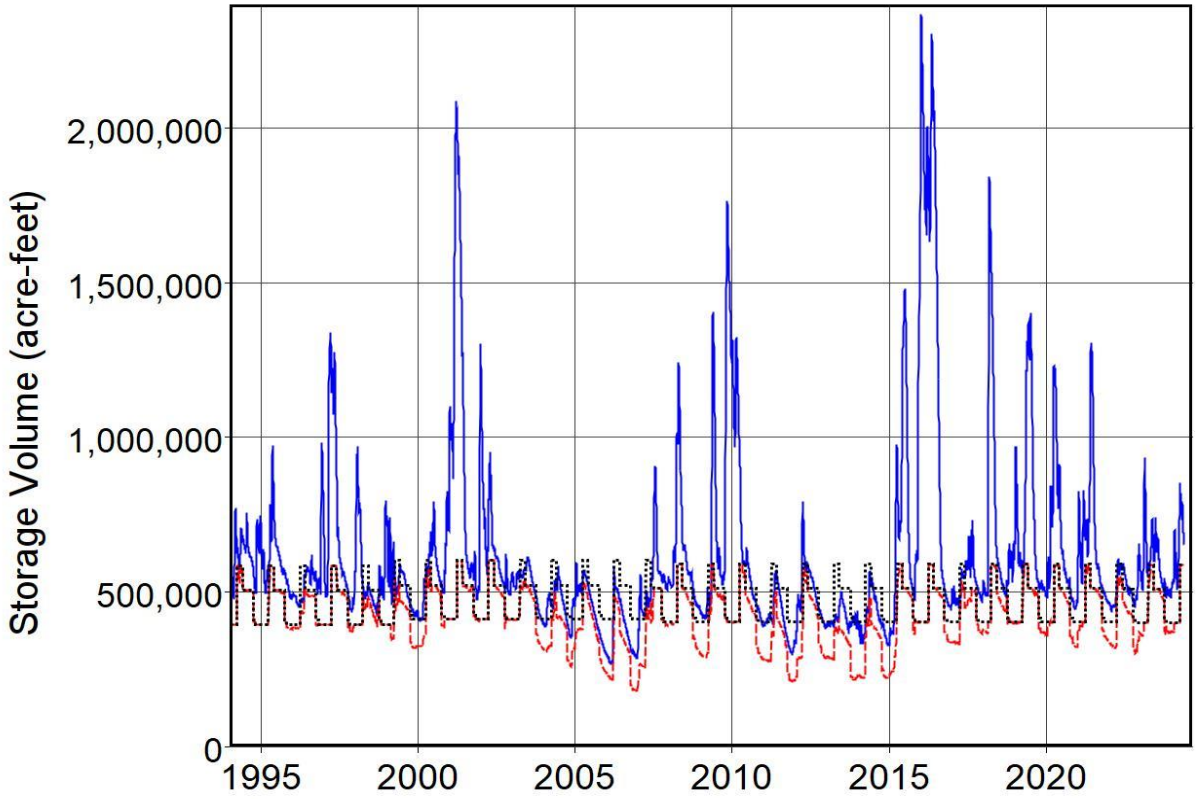

Figure A34 Storage Summations for 3 Reservoirs in the Sulphur River Basin

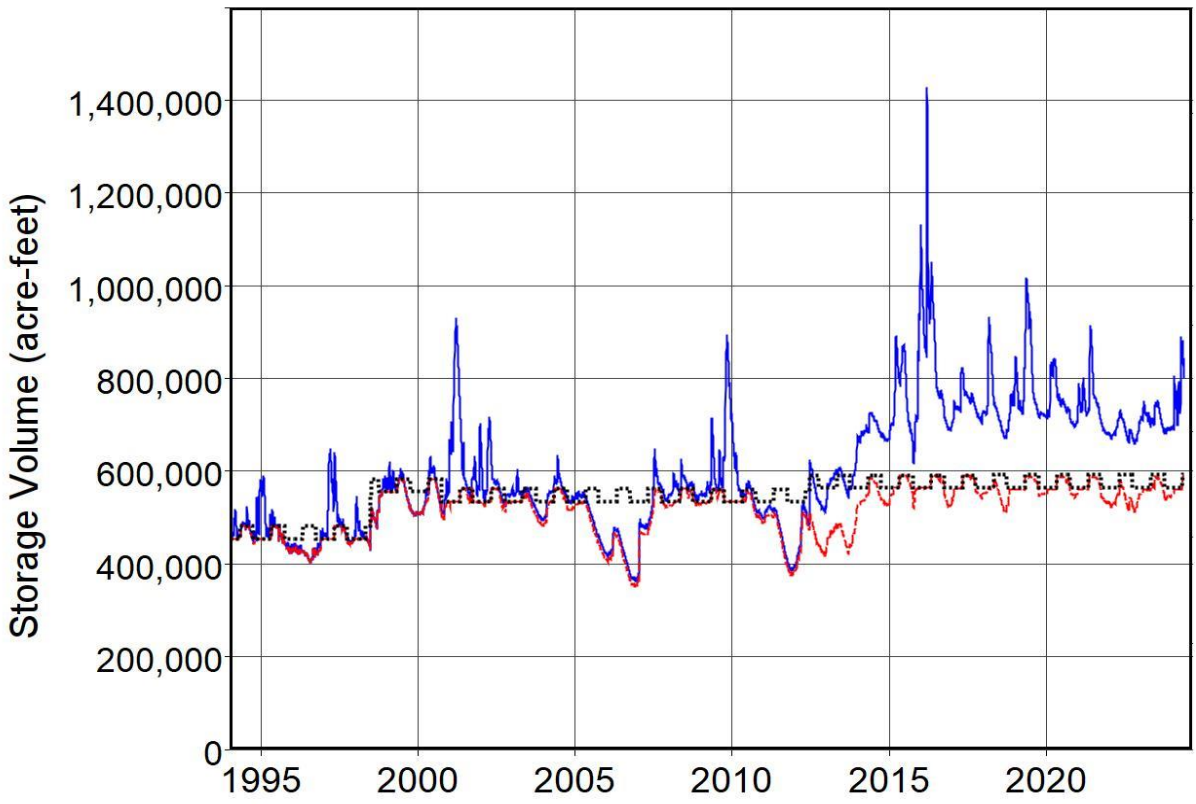

Figure A35 Storage Summations for 5 Reservoirs in the Cypress Creek Basin

APPENDIX B
PLOTS OF OBSERVED STREAM FLOWS DISCUSSED IN CHAPTER 4

The plots of daily, monthly, and annual means of stream flows observed at U.S. Geological Survey (USGS) gage sites presented in this appendix are discussed in Chapter 4. The daily flows were downloaded from the National Water Information System (NWIS) website maintained by the USGS (https://waterdata.usgs.gov/nwis) into a DSS file using *HEC-DSSVue*. The daily mean flows in cubic feet per second (cfs) were aggregated to monthly and annual means in cfs and plotted within *HEC-DSSVue*. One cfs is equivalent to 1.9835 acre-feet/day.

The sixteen gage sites with flow plots included in Appendix B are listed below. The beginning of the period-of-record for each gage is shown in the sixth column. The flows in the figures extend through February 8, 2024. Eleven gages have complete records with no gaps. Five gages have gaps with missing daily observed data. Daily flows of the Brazos River at Richmond have a gap of missing data extending from July 1906 through September 1922. The Colorado River at San Saba gage has three gaps of missing data between October 1919 and October 1923 totaling 513 days. The Lavaca River at Hallettsville has no data for October 1992 through September 2015. The Frio River at Derby has no data during October 1987 through September 1989. The gage on the Nueces River at Mathis has 52 days of missing data during May and June 1966.

Figure Label	Gage Location Stream and Nearest City	USGS Gage ID	Drainage Area ($mile^2$)	Mean Flow (cfs)	Record Begins	Days Missing	Page
B1	Brazos River at Waco	08096500	19,993	2,356	1/1900	0	450
B2	Brazos River at Richmond	08114000	35,541	7,535	10/1922	5,936	451
B3	Navasota River at Easterly	08110500	968	428	3/1924	0	452
B4	Trinity River at Dallas	08057000	6,106	1,833	10/1903	0	453
B5	Trinity River near Oakwood	08065000	12,833	5,461	10/1923	0	454
B6	Trinity River at Romayor	08066500	17,186	8,076	5/1924	4	455
B7	Neches River near Rockland	08033500	3,636	2,398	7/1904	0	456
B8	Neches River near Evadale	08041000	7,951	6,266	4/1921	0	457
B9	Colorado River nr San Saba	08147000	19,819	939	11/1915	513	458
B10	Colorado River at Austin	08158000	27,606	2,038	3/1898	0	459
B11	Colorado River at Columbus	08161000	30,237	2,922	5/1916	0	460
B12	Lavaca River at Hallettsville	08163500	108	49.2	8/1939	8,400	461
B13	Lavaca River near Edna	08164000	817	362	8/1939	0	462
B14	Frio River, Derby	08205500	1,462	134	8/1915	1,462	463
B15	Nueces River, Three Rivers	08210000	15,427	708	7/1915	0	464
B16	Nueces River, Mathis	08212000	16,600	634	8/1939	52	465

The upper graph in each figure is a plot of daily flows. The lower graph in each figure contains plots of monthly flows (**blue solid line**) and annual flows (**red dotted line**).

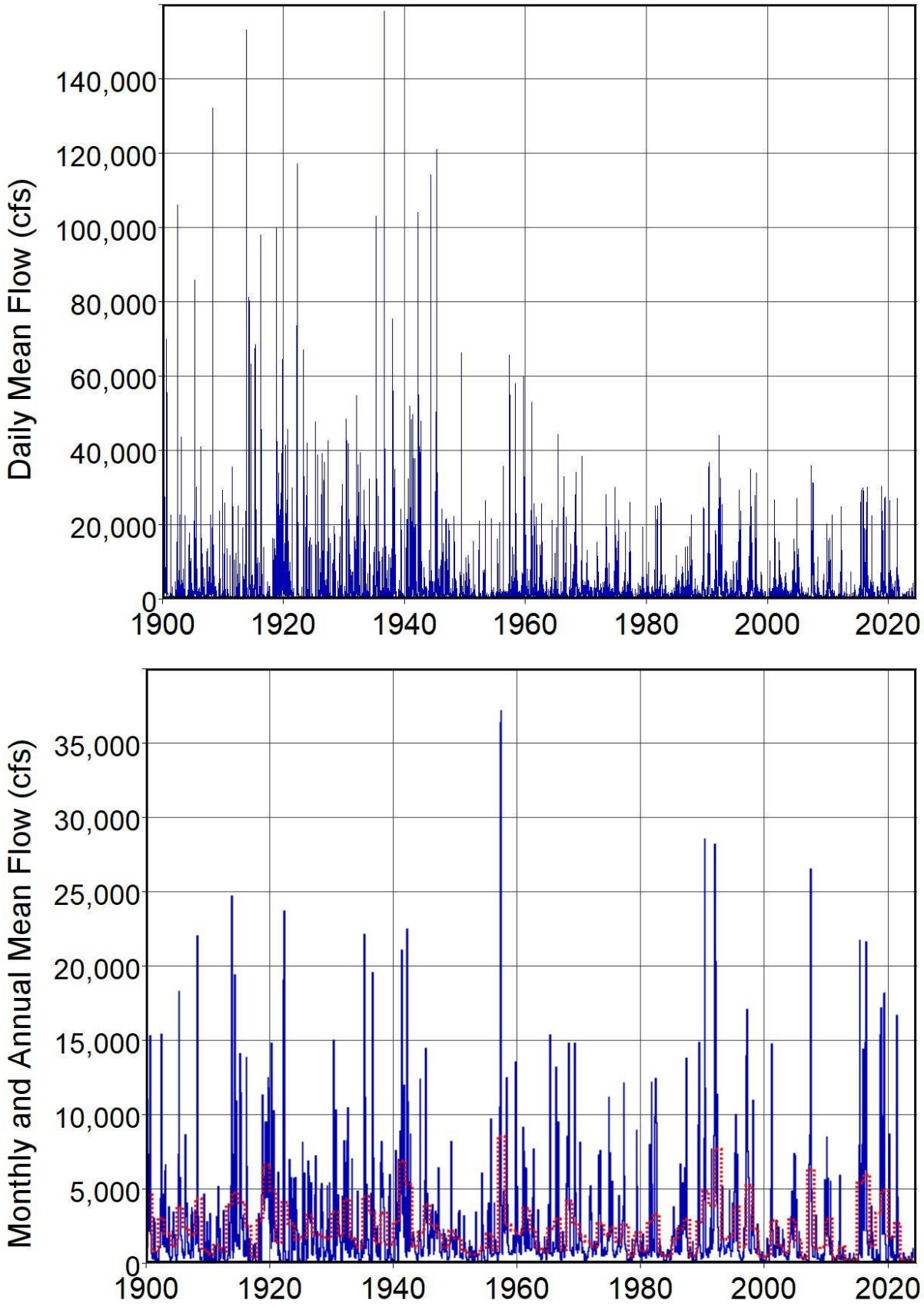

Figure B1 Observed Flows of Brazos River at Waco Gage

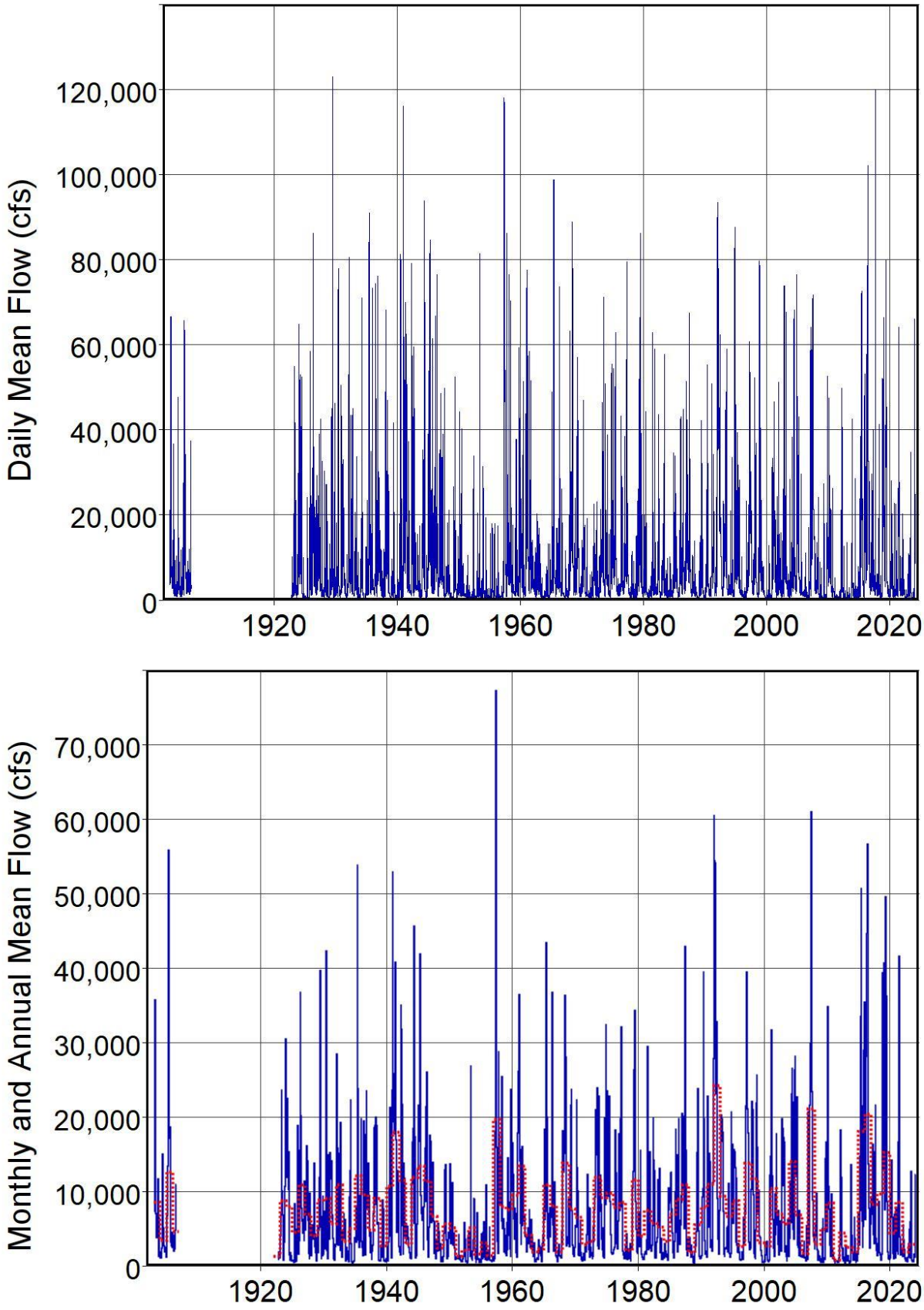

Figure B1 Observed Flows of Brazos River at Richmond Gage

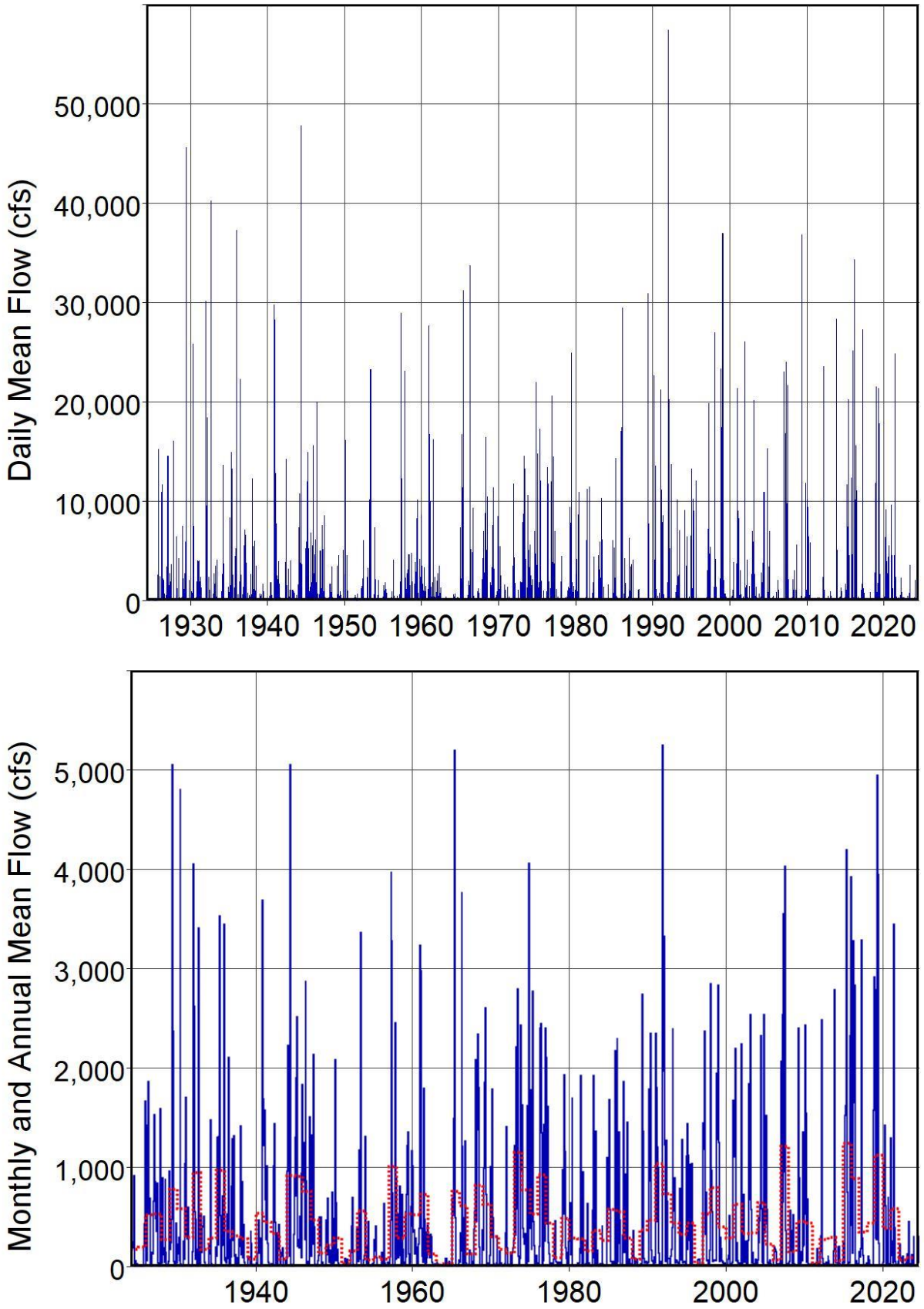

Figure B3 Observed Flows of Navasota River at Easterly Gage

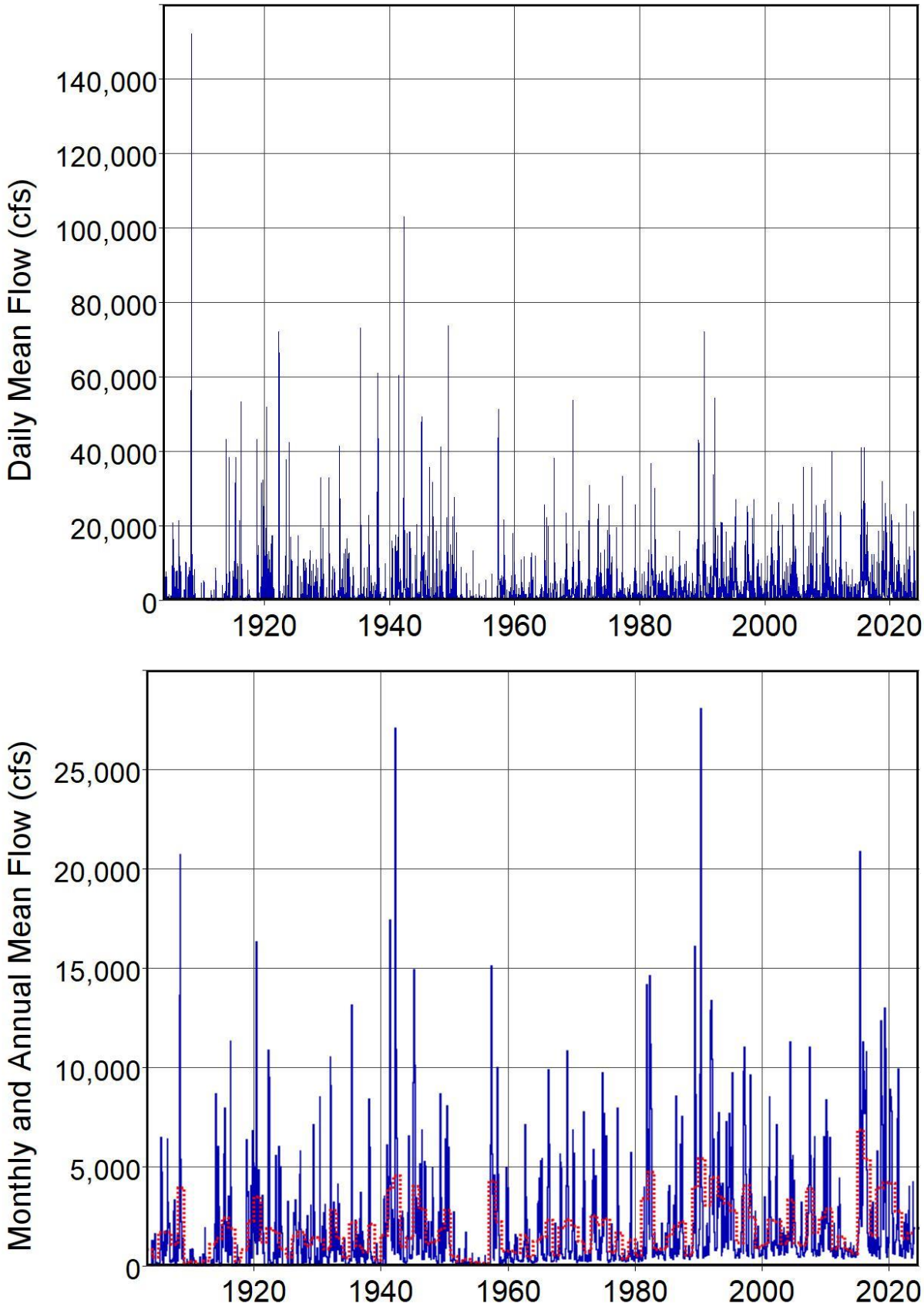

Figure B4 Observed Flows of Trinity River at Dallas Gage

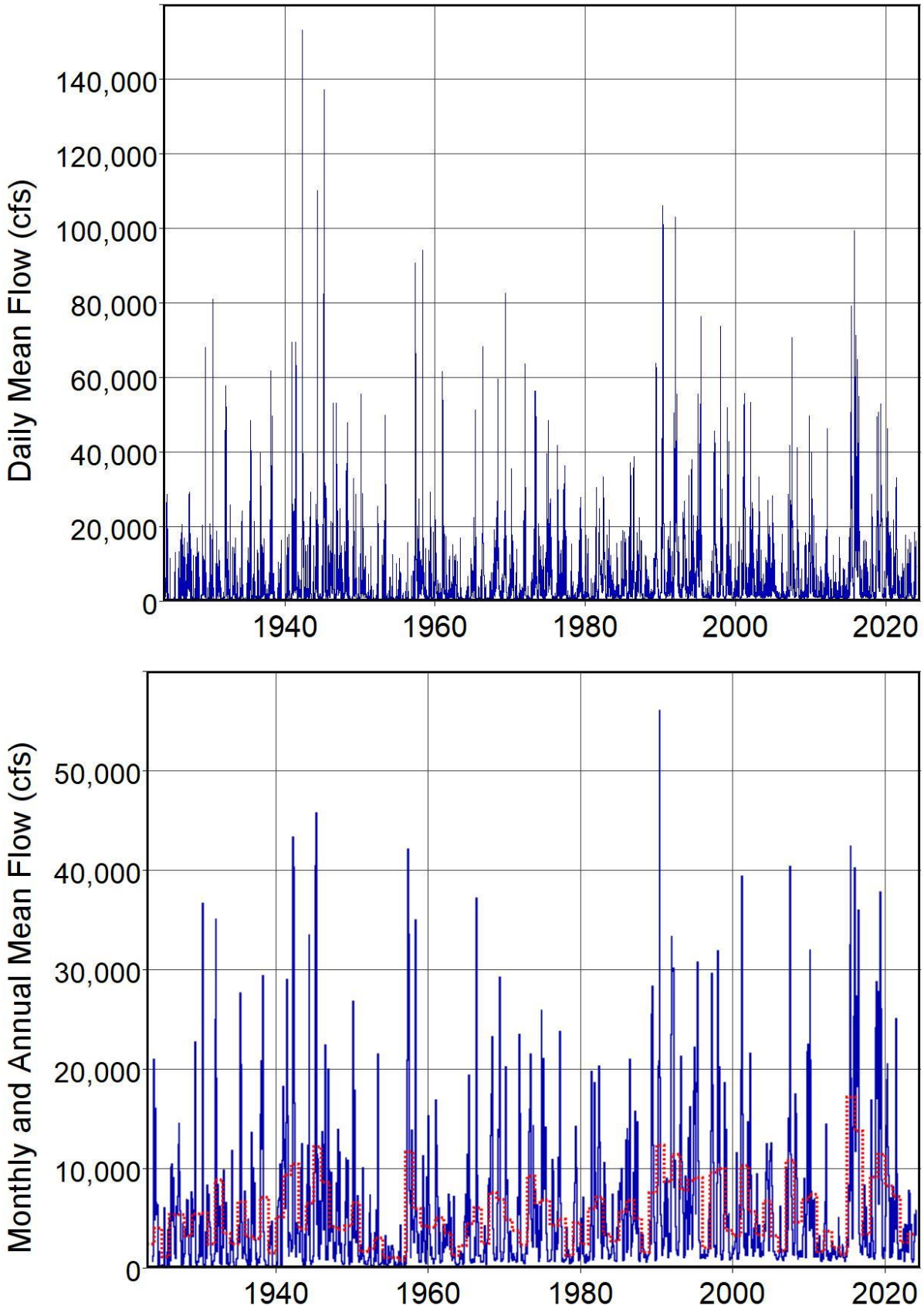

Figure B5 Observed Flows of Trinity River at Oakwood Gage

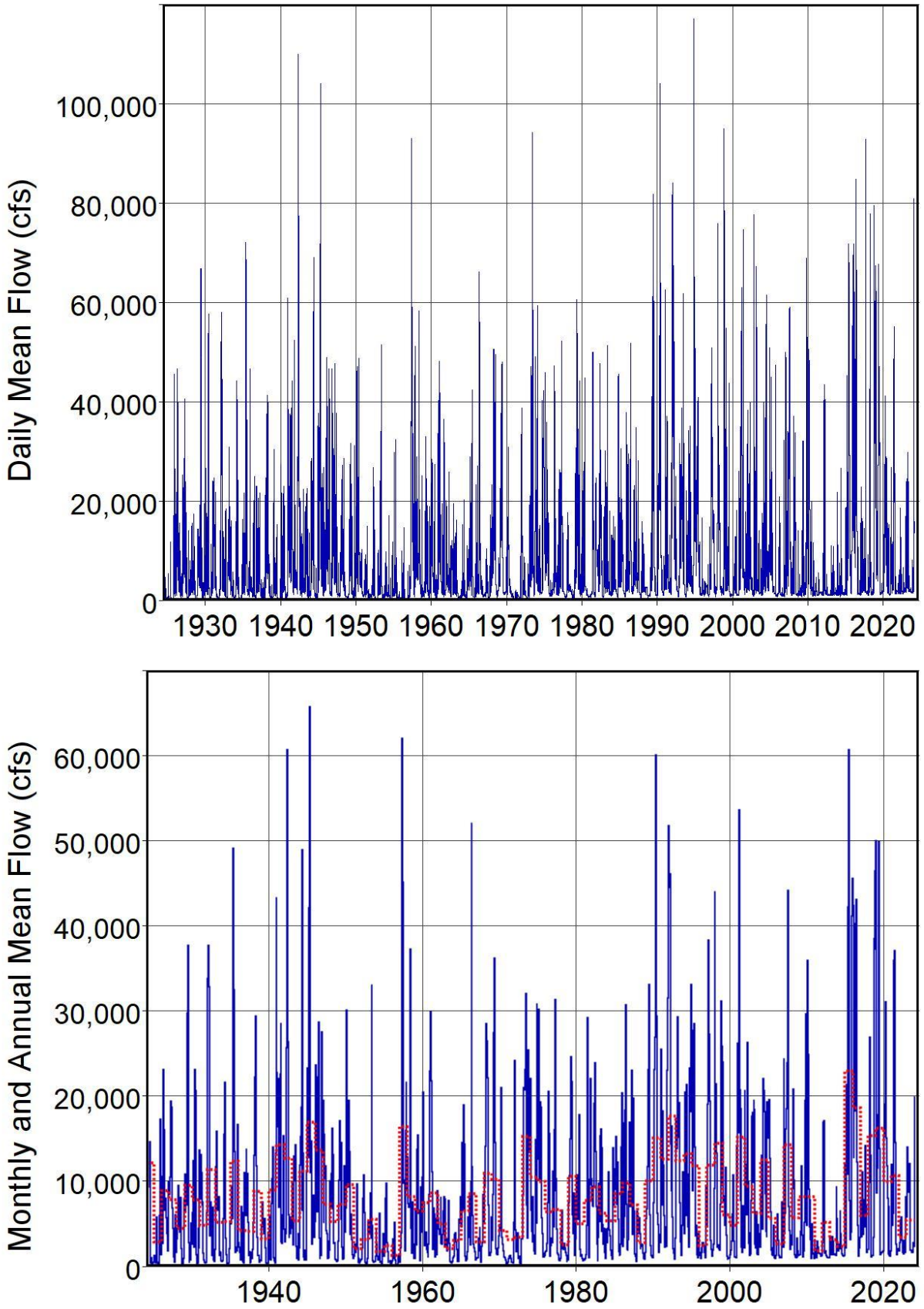

Figure B6 Observed Flows of Trinity River at Romayor Gage

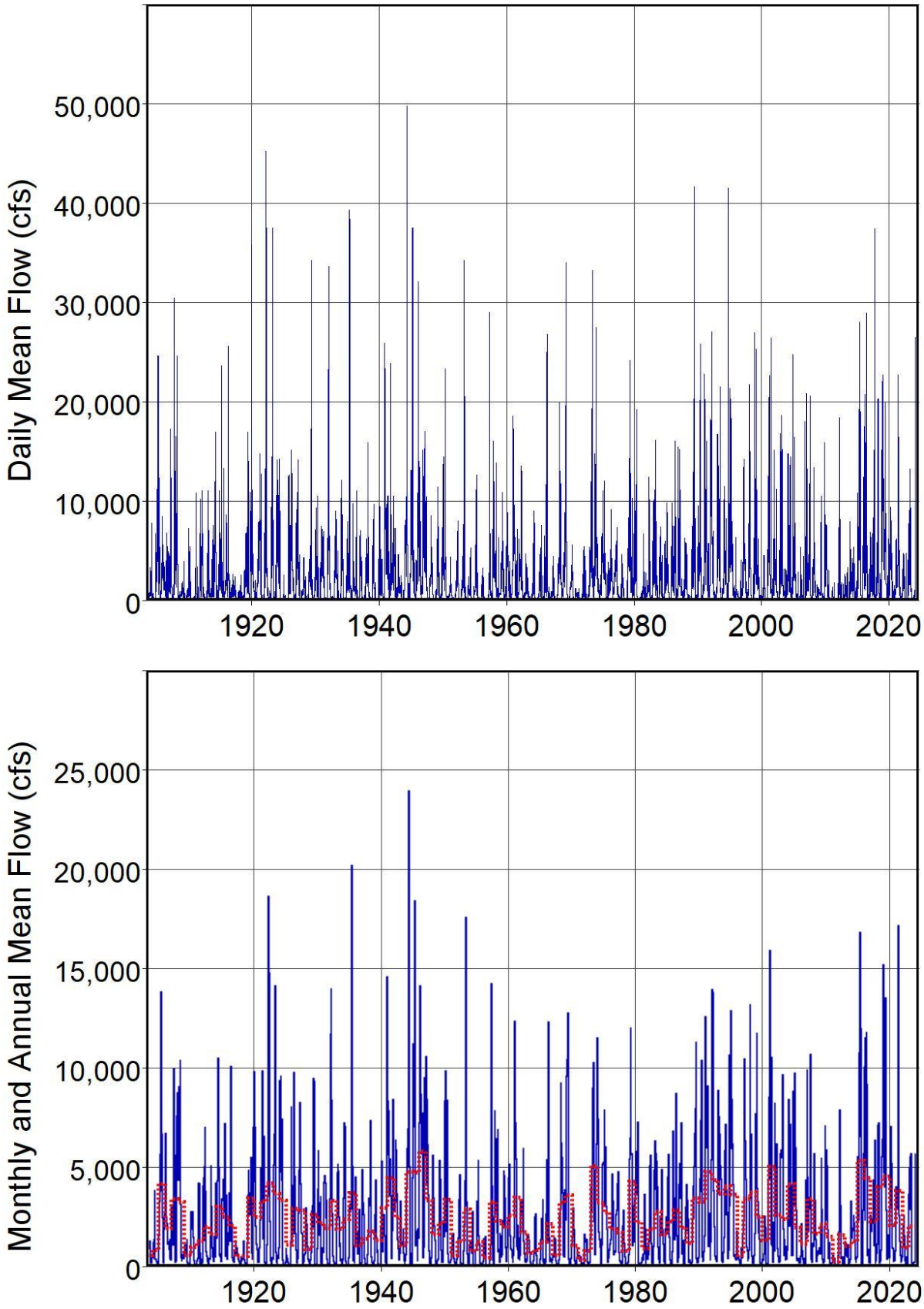

Figure B7 Observed Flows of Neches River at Rockland Gage

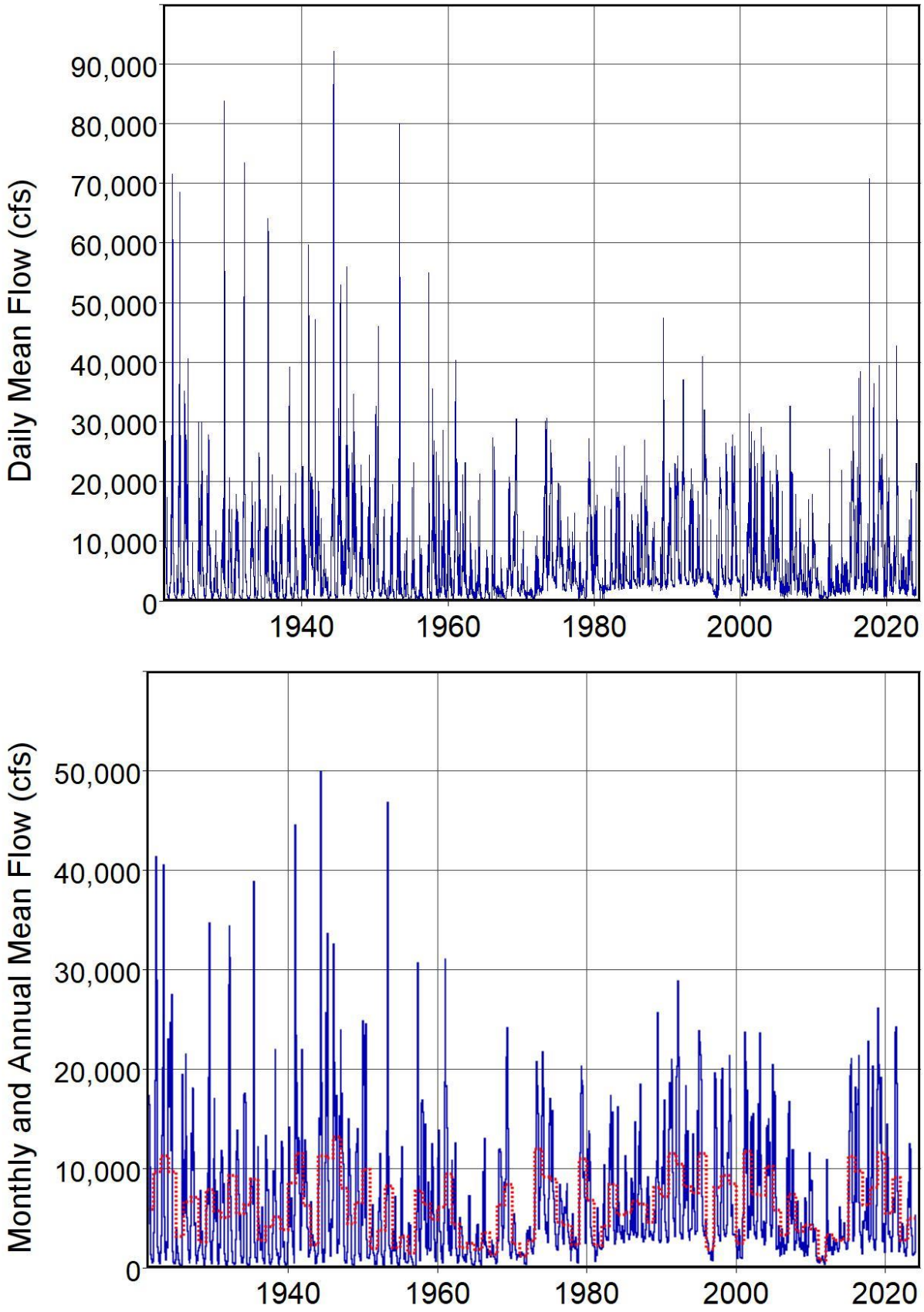

Figure B8 Observed Flows of Neches River at Evadale Gage

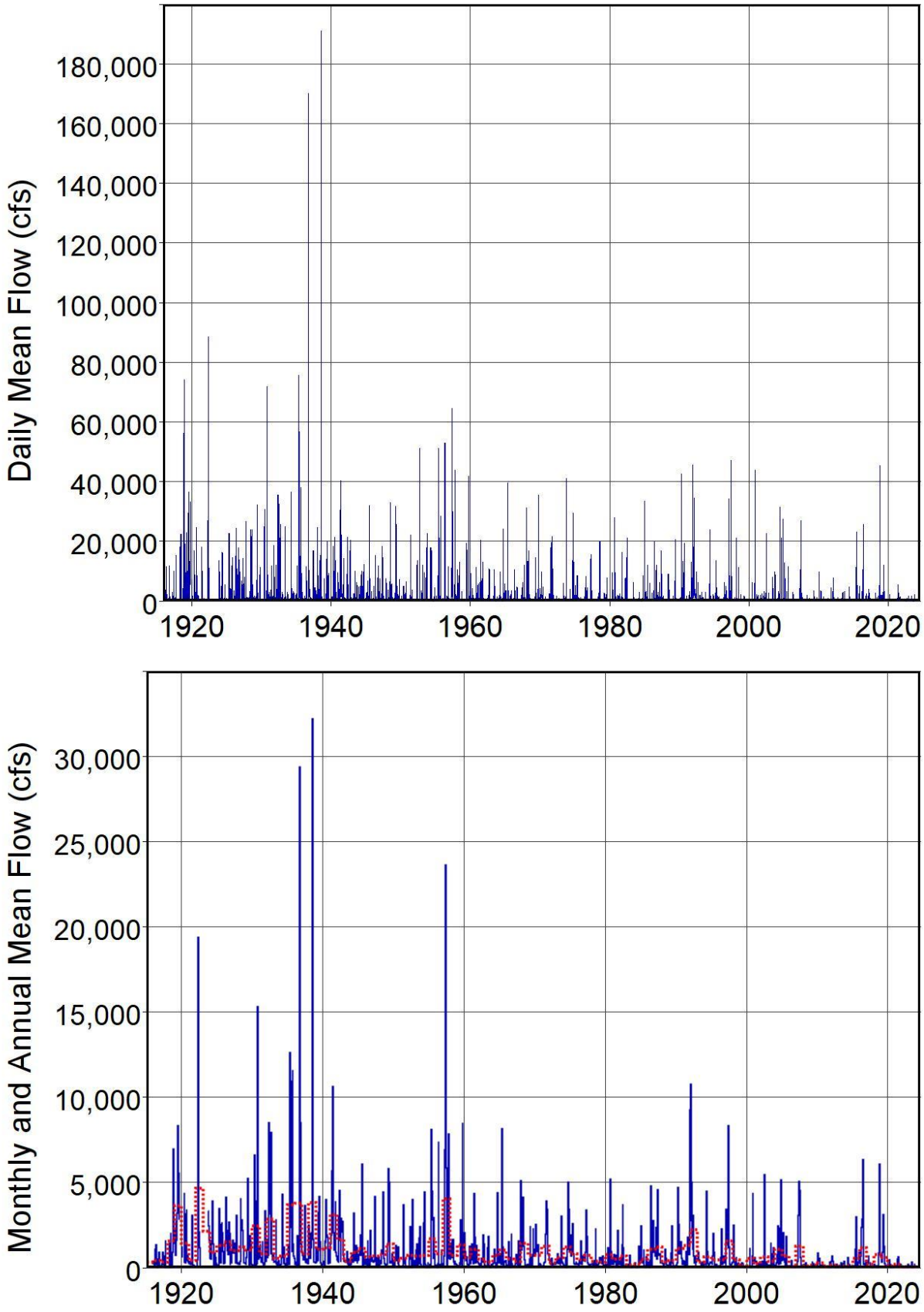

Figure B9 Observed Flows of Colorado River at San Saba Gage

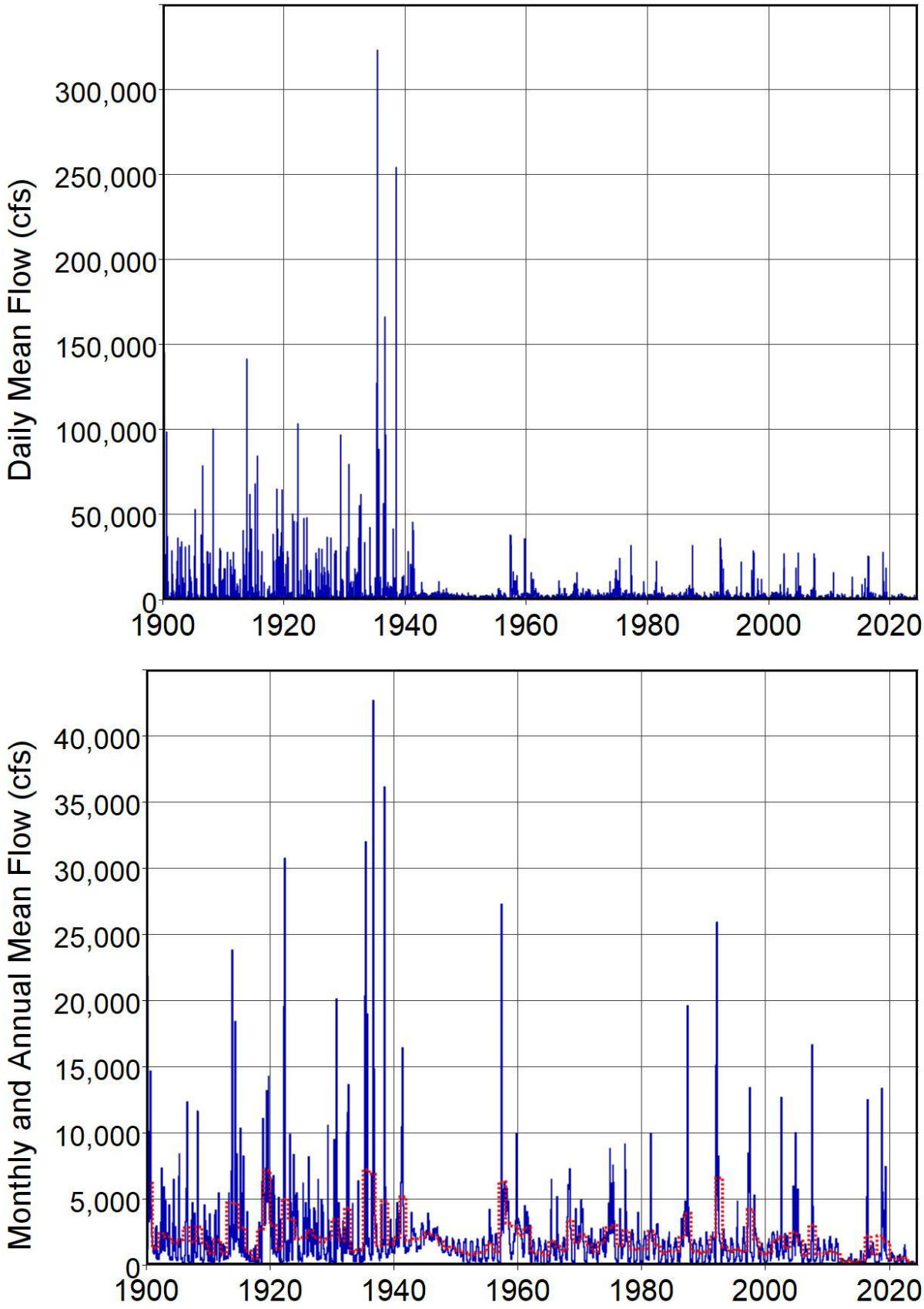

Figure B10 Observed Flows of Colorado River at Austin Gage

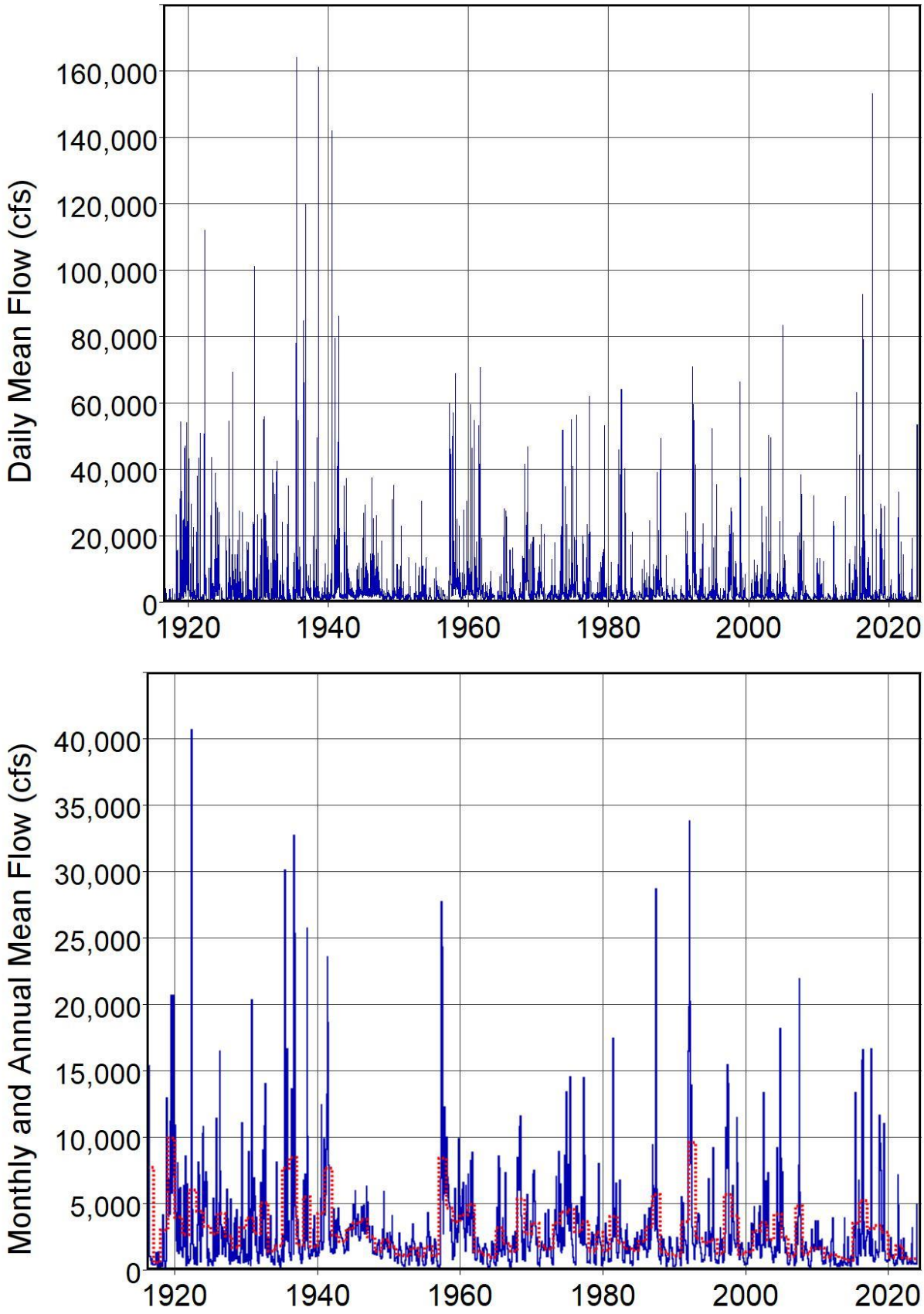

Figure B11 Observed Flows of Colorado River at Columbus Gage

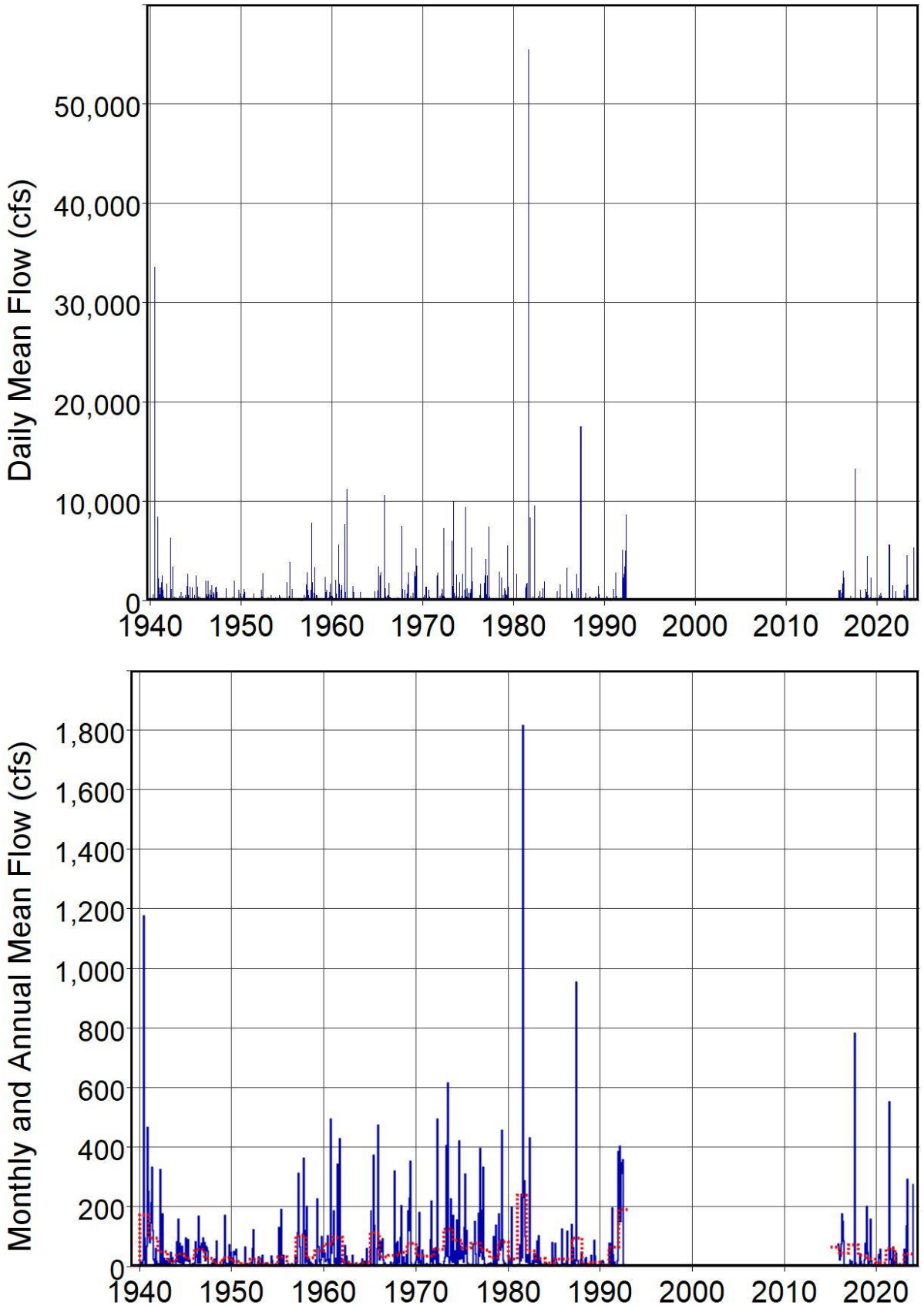

Figure B12 Observed Flows of Lavaca River at Hallettsville Gage

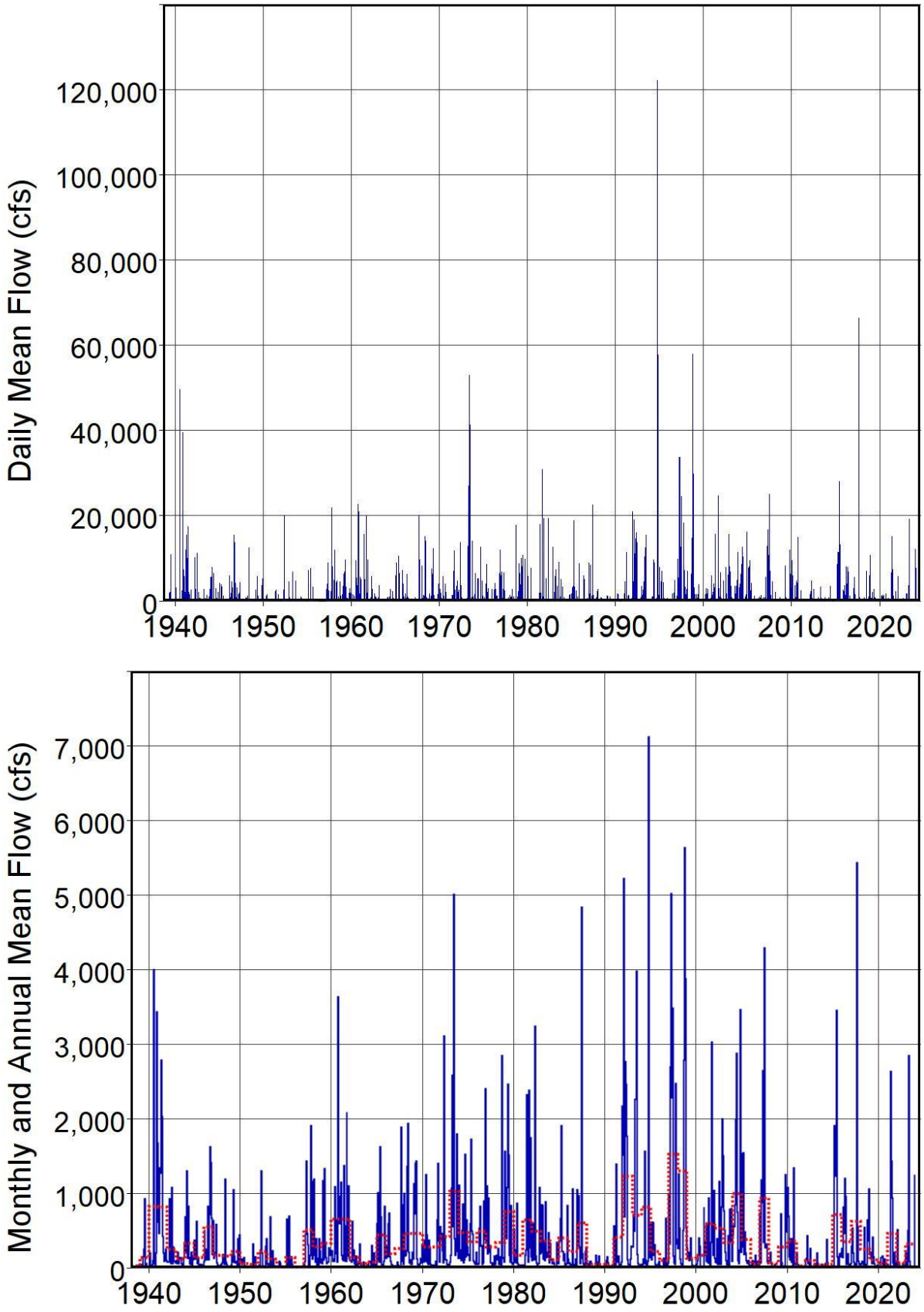

Figure B13 Observed Flows of Lavaca River at Edna Gage

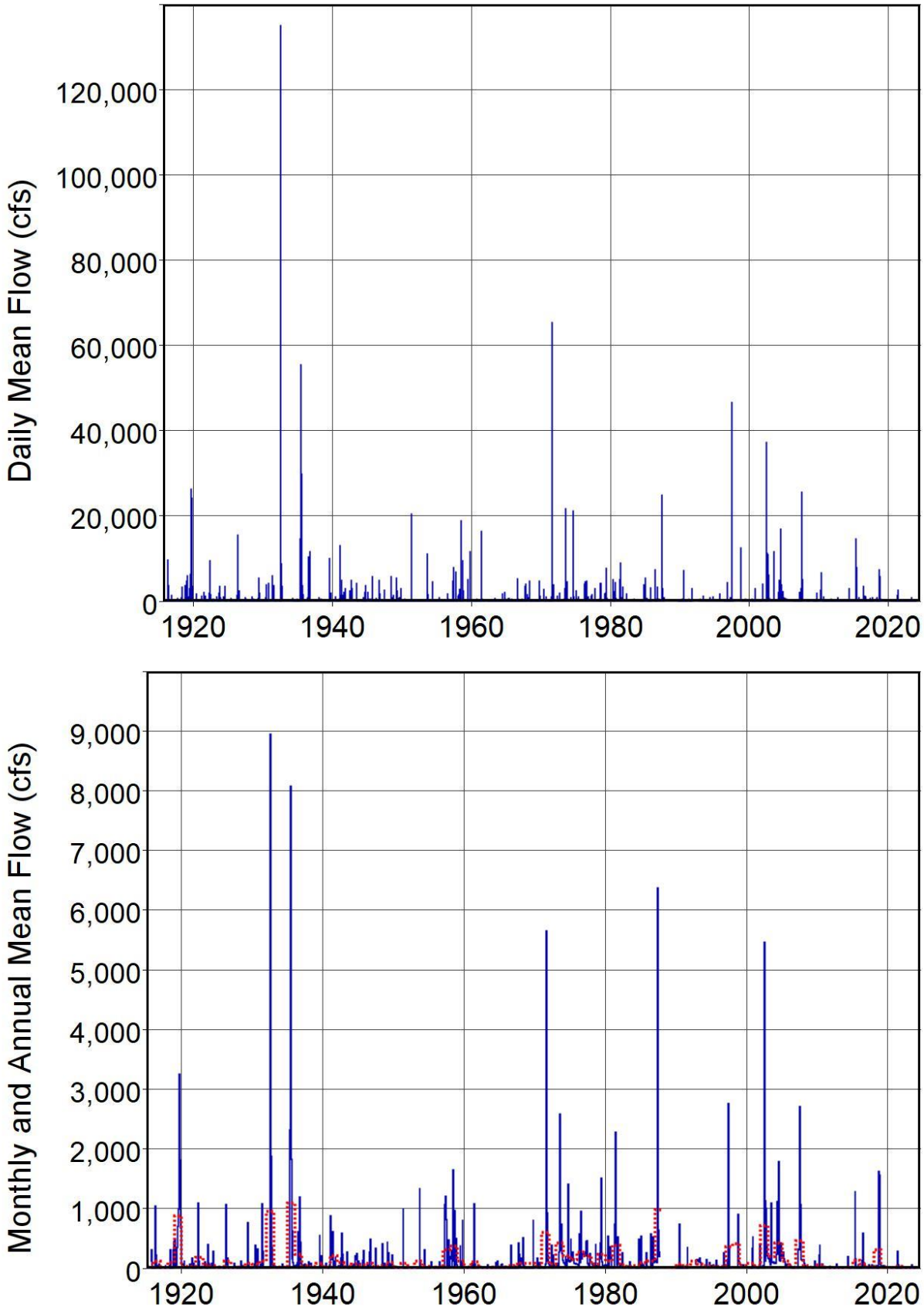

Figure B14 Observed Flows of Frio River at Derby Gage

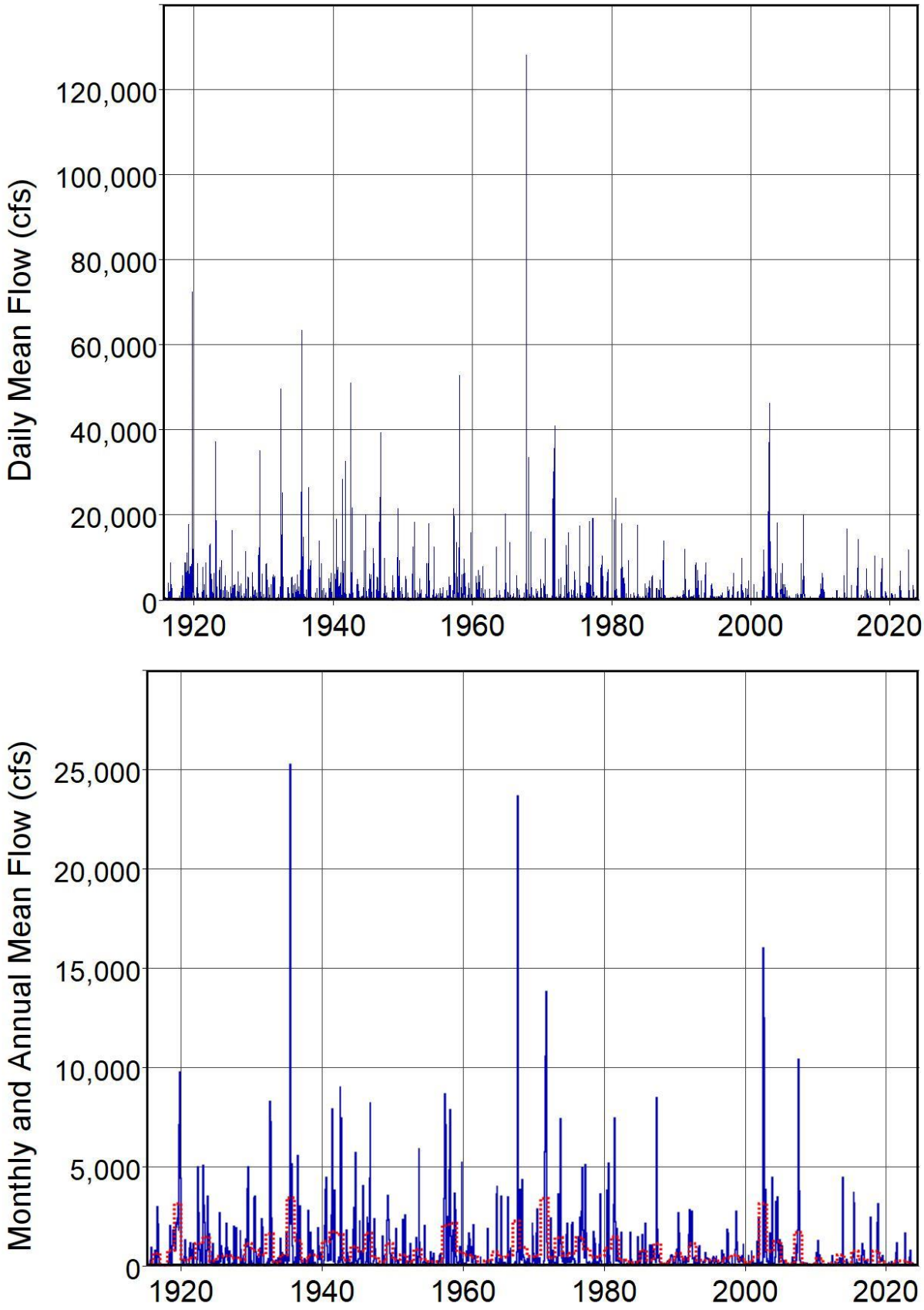

Figure B15 Observed Flows of Nueces River at Three Rivers Gage

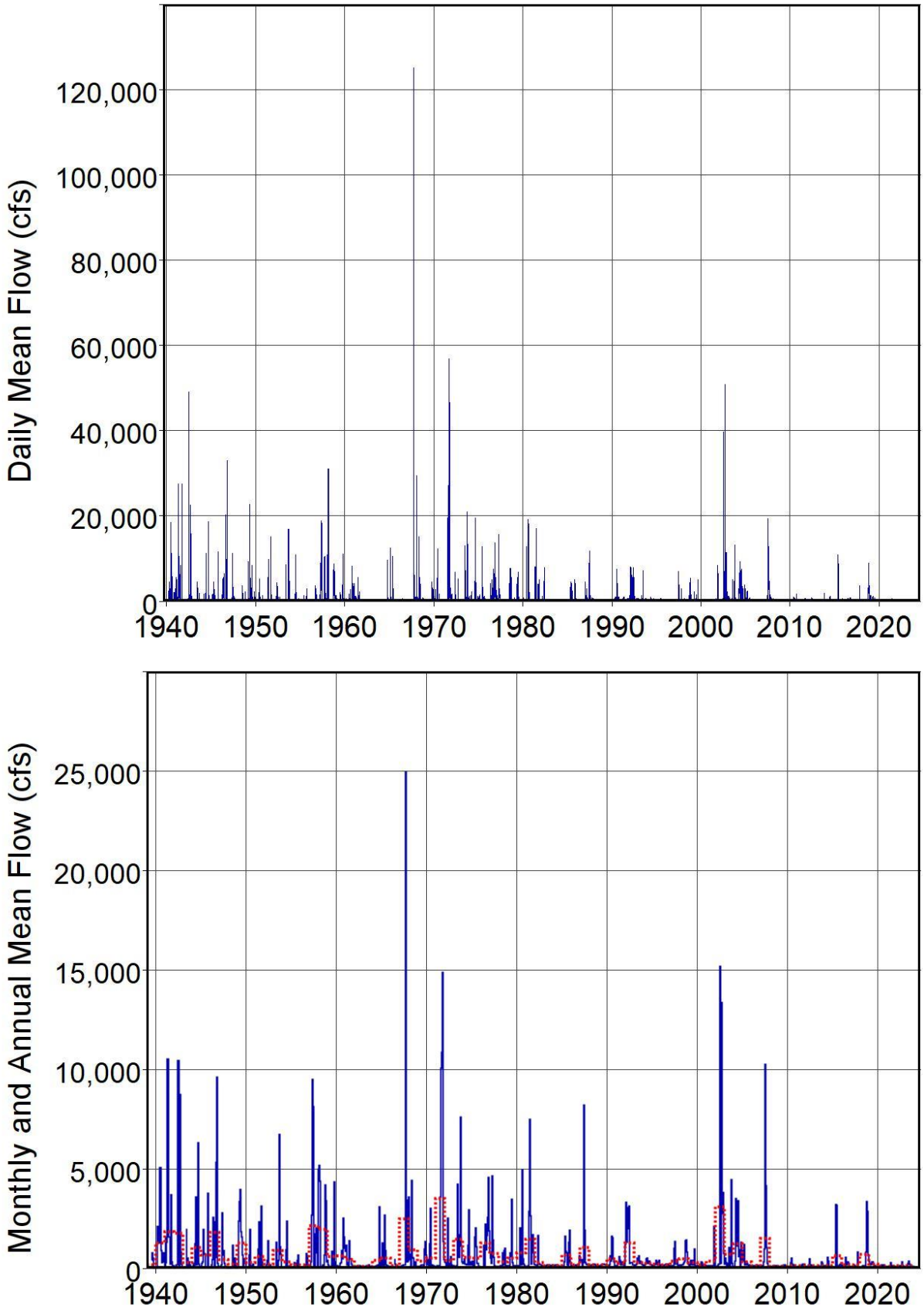

Figure B16 Observed Flows of Nueces River at Mathis Gage

APPENDIX C
PLOTS OF SIMD MONTHLY SB3 EFS TARGETS AND SHORTAGES DISCUSSED IN CHAPTERS 7 THROUGH 12

Appendix C is comprised of plots of 1940-2023 monthly instream flow targets for Senate Bill 3 (SB3) environmental flow standards (EFS) and shortages in meeting the targets. These quantities were computed in daily *SIMD* simulations with each of the six case studies. The USGS gage sites represented by WAM control points for each of the plots are listed in Table C1. The legend for the plots in Appendix C is as follows.

blue solid line - monthly SB3 EFS instream flow targets in acre-feet
red dotted line - monthly shortages in acre-feet in meeting the targets

Daily SB3 EFS instream flow targets computed in a daily *SIMD* simulation are summed to monthly quantities by *SIMD*. The monthly summations of daily targets are transferred to a DSS input file read by *SIM*. Therefore, the monthly instream flow targets plotted in Appendix C represent monthly targets for both daily *SIMD* and monthly *SIM* simulations. The monthly instream flow shortages in Appendix C are likewise *SIMD* summations of daily shortages. However, the *SIMD* simulated shortages are not converted to *SIM* input. Shortages computed in *SIM* simulations typically vary from those plotted in Appendix C even though the monthly targets are the same in both *SIM* and *SIMD* simulations.

Table C1
Locations of SB3 EFS Targets and Shortages

WAM CP ID	Stream	Nearest City	USGS Gage No.	Watershed Area (square miles)	Figure Label	Page Number
		Brazos River Basin (Chapter 7)				
SFAS06	Salt Fork Brazos River	Aspermont	08082000	2,504	C1	470
DMAS09	Double Mountain Fork	Aspermont	08080500	1,891	C2	470
BRSE11	Brazos River	Seymour	08082500	5,996	C3	471
CFNU16	Clear Fork Brazos	Nugent	08084000	2,236	C4	471
CON026	Clear Fork Brazos	Lueders	08084200	2,542	C5	472
BRSB23	Brazos River	South Bend	08088000	13,171	C6	472
BRPP27	Brazos River	Palo Pinto	08089000	14,309	C7	473
BRGR30	Brazos River	Glen Rose	08091000	16,320	C8	473
NBCL36	North Bosque River	Clifton	08095000	977	C9	474
BRWA41	Brazos River	Waco	08096500	20,065	C10	474
LEGT47	Leon River	Gatesville	08100500	2,379	C11	475
LAKE50	Lampasas River	Kempner	08103800	817	C12	475
LRLR53	Little River	Little River	08104500	5,266	C13	476
LRCA58	Little River	Cameron	08106500	7,100	C14	476
BRBR59	Brazos River	Bryan	08109000	30,016	C15	477
NAEA66	Navasota River	Easterly	08110500	936	C16	477
BRHE68	Brazos River	Hempstead	08111500	34,374	C17	478
BRRI70	Brazos River	Richmond	08114000	35,454	C18	478
BRRO72	Brazos River	Rosharon	08116650	35,775	C19	479

Table C1 (Continued)
Locations of SB3 EFS Targets and Shortages

WAM CP ID	Stream	Nearest City	USGS Gage No.	Watershed Area (square miles)	Figure Label	Page Number
		Trinity River Basin (Chapter 8)				
8WTGP	West Fork of Trinity River	Grand Prairie	08049500	3,065	C20	480
8TRDA	Trinity River	Dallas	08057000	6,106	C21	480
8TROA	Trinity River	Oakwood	08065000	12,833	C22	481
8TRRO	Trinity River	Romayor	08066500	17,186	C23	481
		Neches River Basin (Chapter 9)				
NENE	Neches River	Neches	08032000	1,145	C24	482
NERO	Neches River	Rockland	08033500	3,631	C25	482
ANAL	Angelina River	Alto	08036500	1,273	C26	483
NEEV	Neches River	Evadale	08041000	7,885	C27	483
VIKO	Village Creek	Kountze	08041500	861	C28	484
		Colorado River Basin (Chapter 10)				
B20000	Colorado River	Silver	08123850	4,560	C29	485
C30000	South Concho River	Christoval	08128000	258	C30	485
C10000	Concho River	Paint Rock	08136500	5,185	C31	486
D40000	Colorado River	Ballinger	08126380	6,090	C32	486
D30000	Elm Creek	Ballinger	08127000	464	C33	487
E10000	San Saba River	San Saba	08146000	3,048	C34	487
F20000	Pecan Bayou	Mullin	08143600	2,074	C35	488
F10000	Colorado River	San Saba	08147000	19,830	C36	488
G10000	Llano River	Llano	08151500	4,201	C37	489
H10000	Pedernales River	Johnson City	08153500	901	C38	489
J50000	Onion Creek	Driftwood	08158700	124	C39	490
J30000	Colorado River	Bastrop	08159200	28,580	C40	490
J10000	Colorado River	Columbus	08161000	30,244	C41	491
K20000	Colorado River	Wharton	08162000	30,601	C42	491
		Lavaca River Basin (Chapter 11)				
GS300	Lavaca River	Edna	08164000	817	C43	492
DV501	Navidad River	Edna	08164390	579	C44	492
GS1000	Sandy Creek	Ganado	08164450	289	C45	493
WGS800	West Mustang Creek	Ganado	08164503	178	C46	493
ECB720	East Mustang Creek	Louise	08164504	53.9	C47	494
		Nueces River Basin (Chapter 12)				
CP01	Nueces River	Laguna	08190000	737	C48	495
CP02	West Nueces River	Bracketville	08190500	694	C49	495
CP03	Nueces River	Uvalde	08192000	1,861	C50	496
CP05	Nueces River	Cotulla	08194000	5,171	C51	496
CP06	Nueces River	Tilden	08194500	8,093	C52	497

CP07	Frio River	Concan	08195000	389	C53	497
CP08	Dry Frio River	Reagan Wells	08196000	126	C54	498
CP12	Sabinal River	Sabinal	08198000	206	C55	498
CP13	Sabinal River	Sabinal	08198500	241	C56	499
CP16	Seco Creek	Utopia	08201500	45.0	C57	499
CP18	Hondo Creek	Tarpley	08200000	95.6	C58	500
CP25	Frio River	Derby	08205500	3,429	C59	500
320603	Frio River	Tilden	08206600	4,493	C60	501
CP26	San Miguel Creek	Tilden	08206700	783	C61	501
CP28	Atascosa River	Whitsett	08208000	1,171	C62	502
CP29	Nueces River	Three Rivers	08210000	15,427	C63	502
CP30	Nueces River	Mathis	08211000	16,660	C64	503

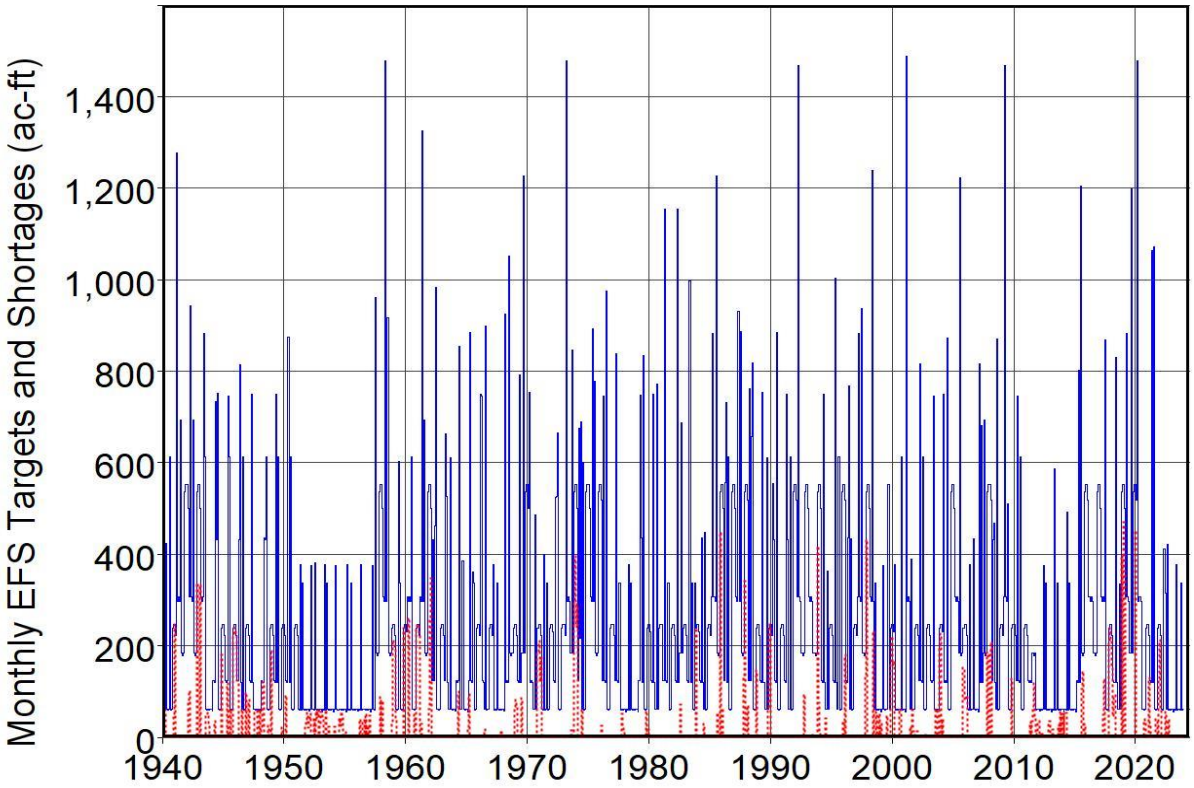

Figure C1 SB3 EFS Targets and Shortages for Salt Fork of Brazos River at Aspermont

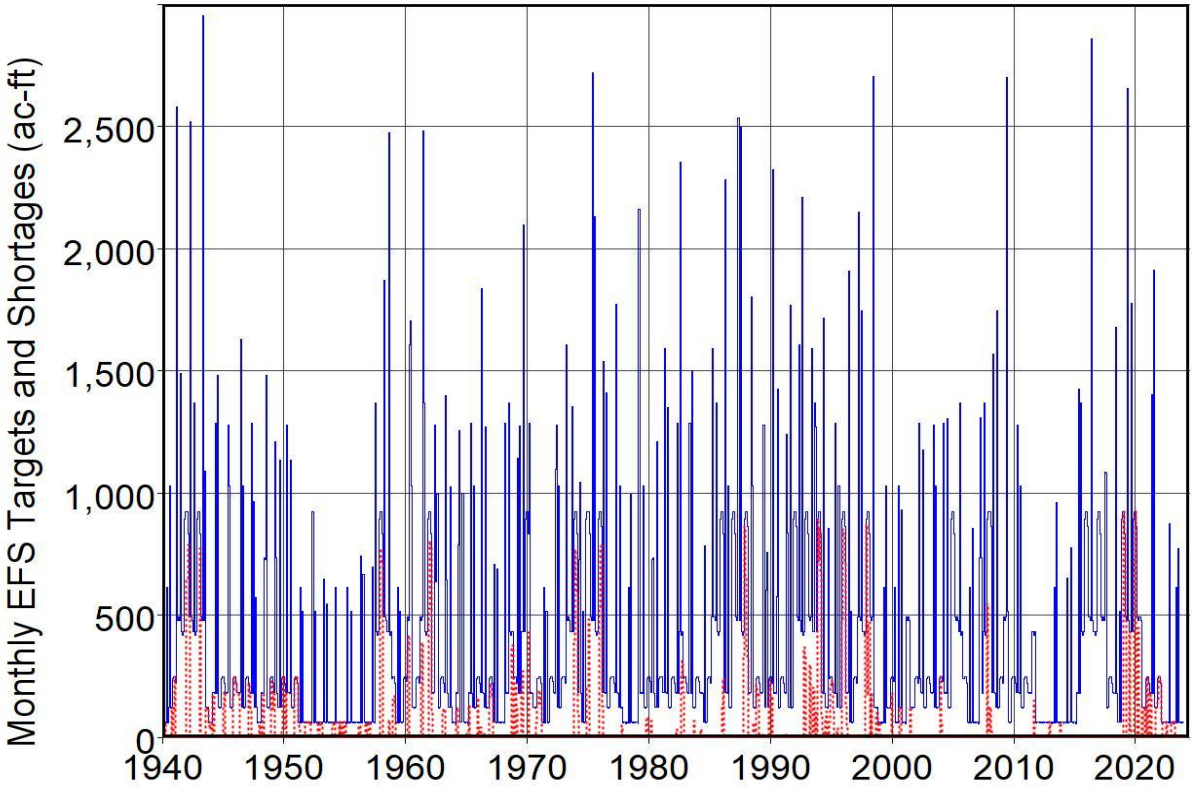

Figure C2 SB3 EFS Targets and Shortages for Double Mountain Fork at Aspermont

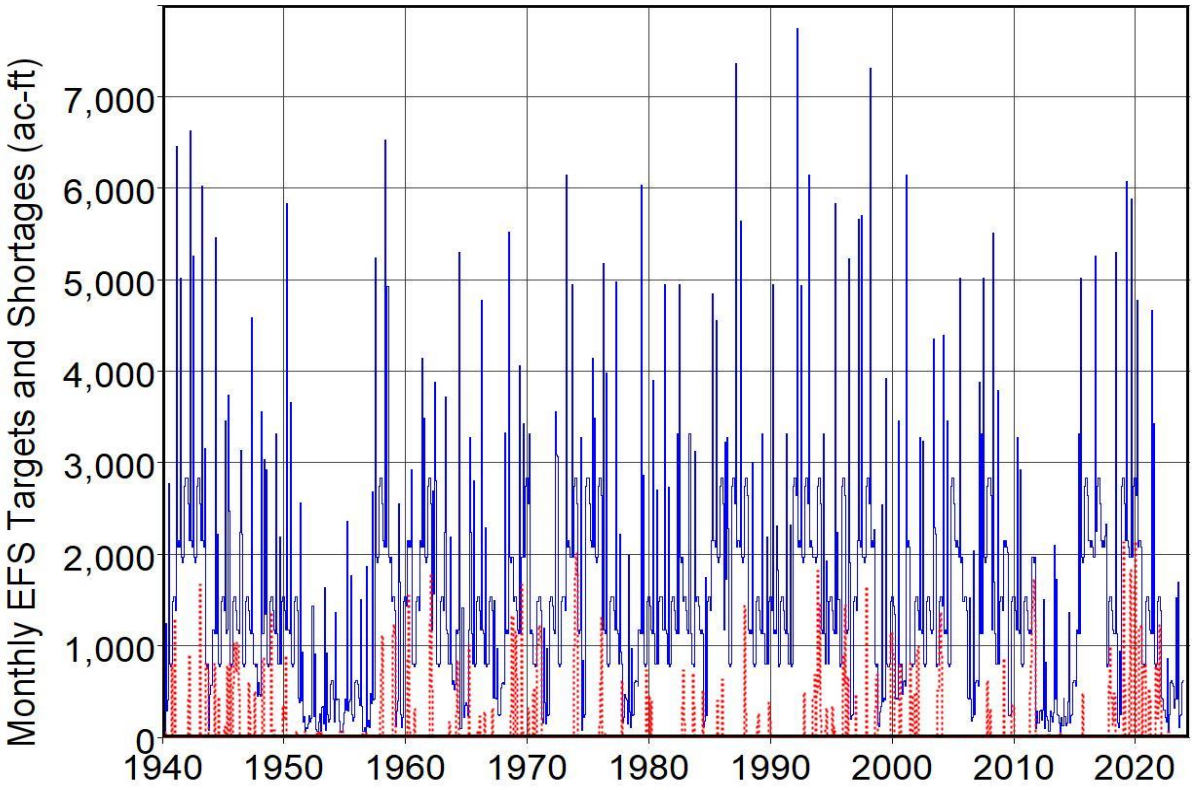

Figure C3 SB3 EFS Targets and Shortages for Brazos River at Seymour

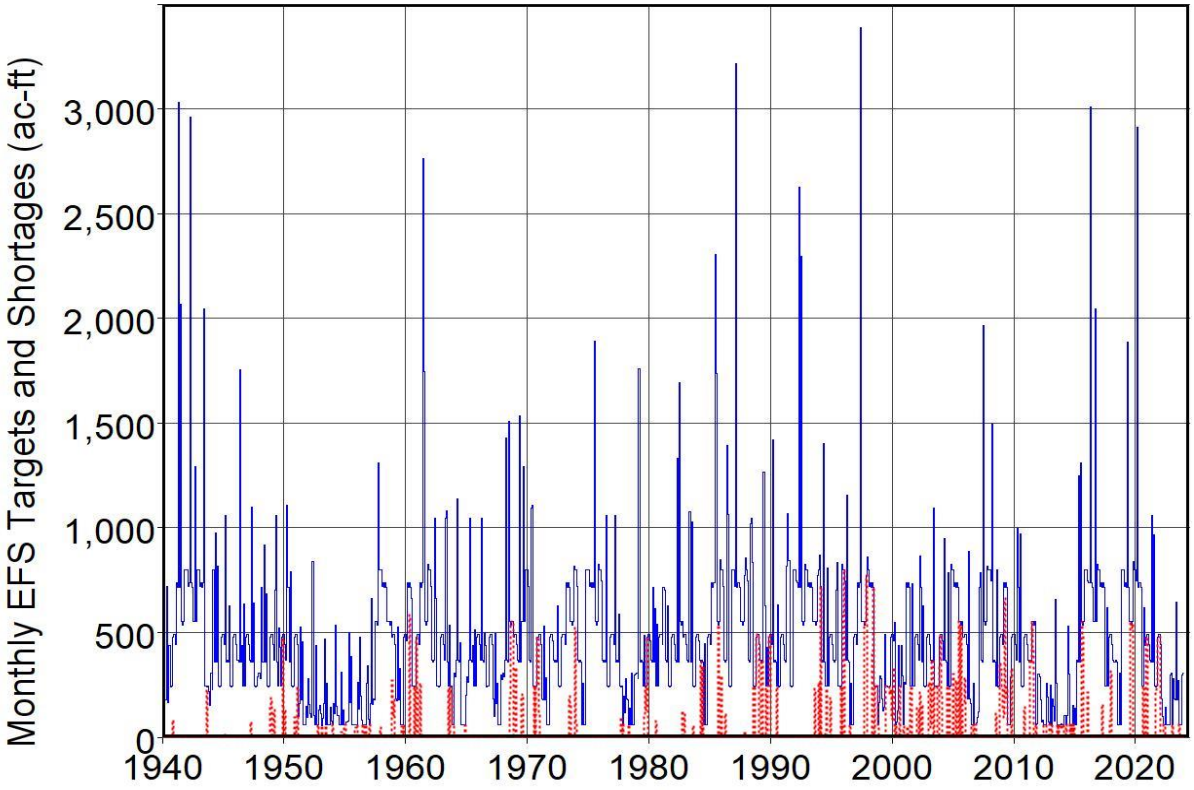

Figure C4 SB3 EFS Targets and Shortages for Clear Fork of Brazos River at Nugent

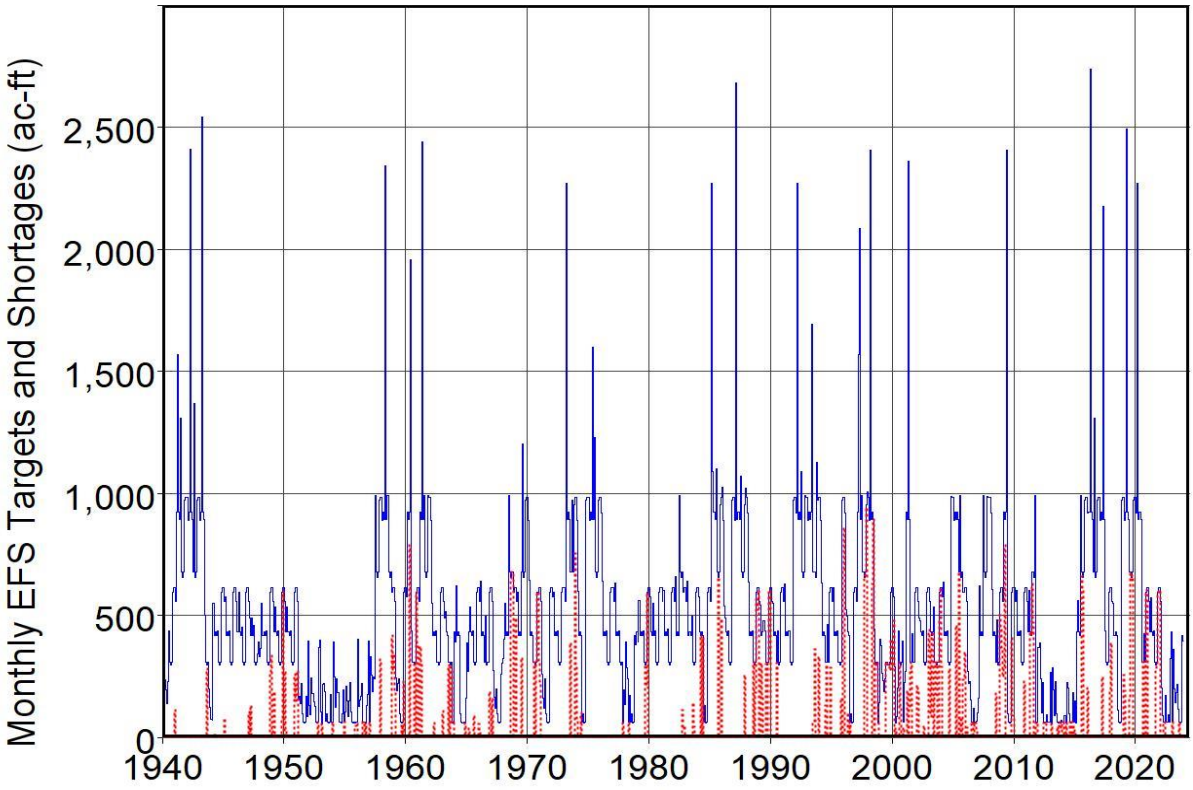

Figure C5 SB3 EFS Targets and Shortages for Clear Fork of Brazos River at Lueders

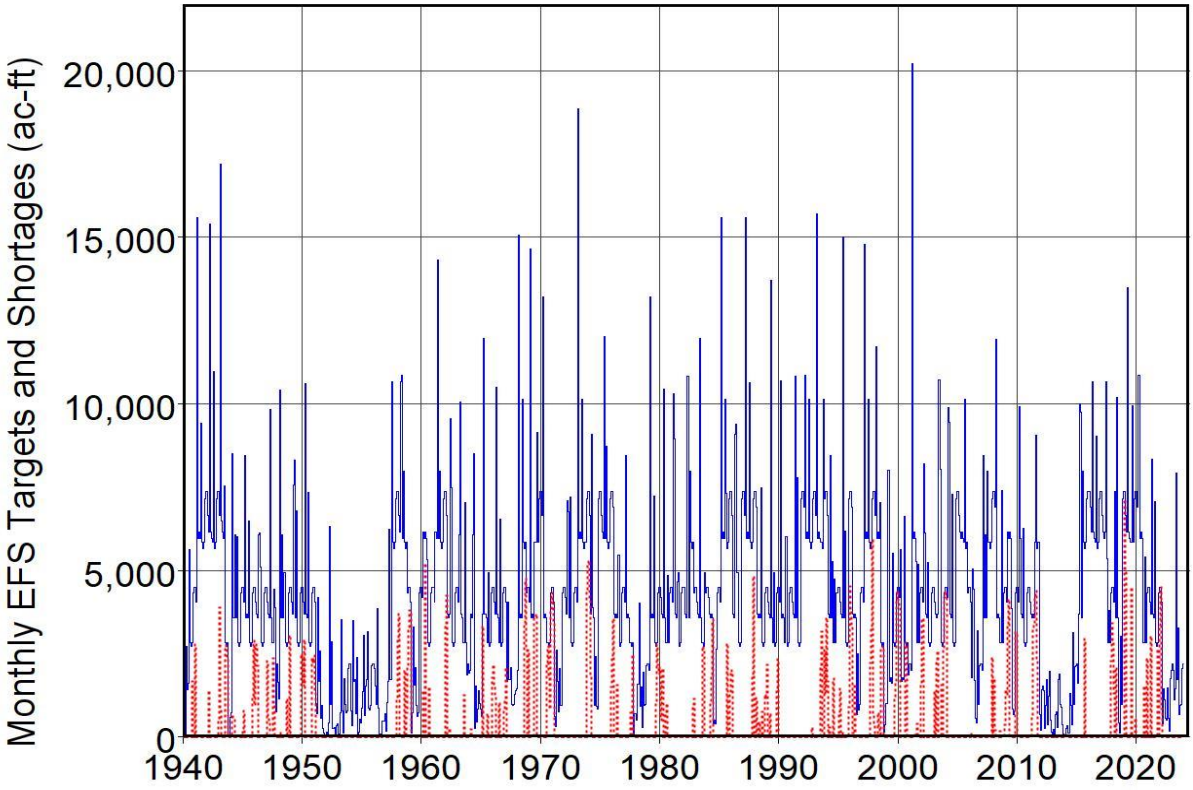

Figure C6 SB3 EFS Targets and Shortages for Brazos River at South Bend

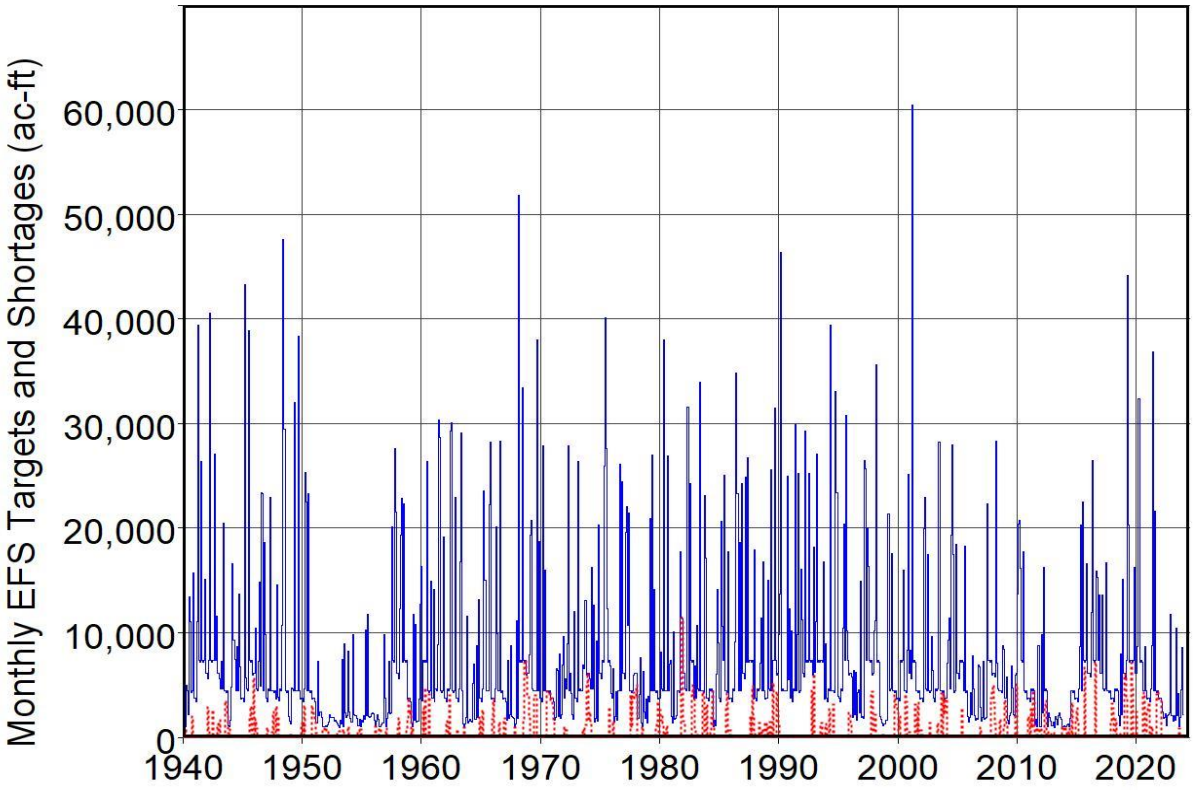

Figure C7 SB3 EFS Targets and Shortages for Brazos River at Palo Pinto

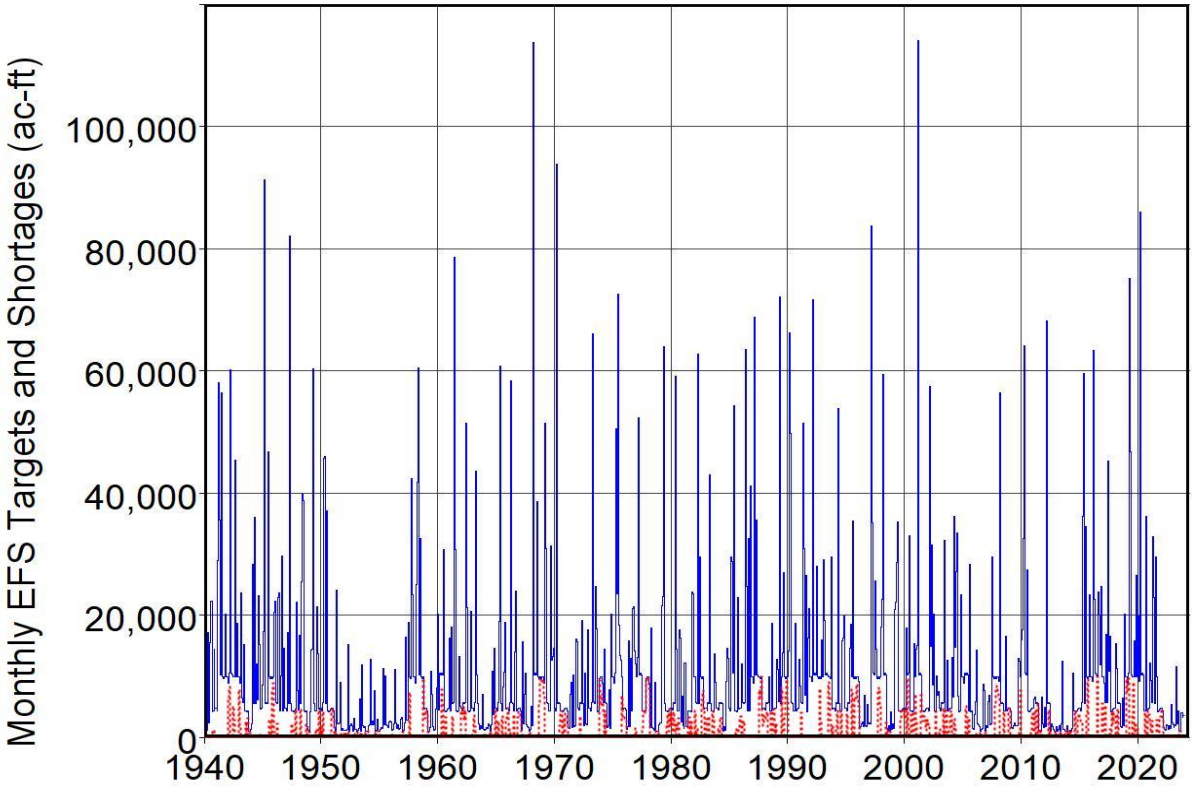

Figure C8 SB3 EFS Targets and Shortages for Brazos River at Glen Rose

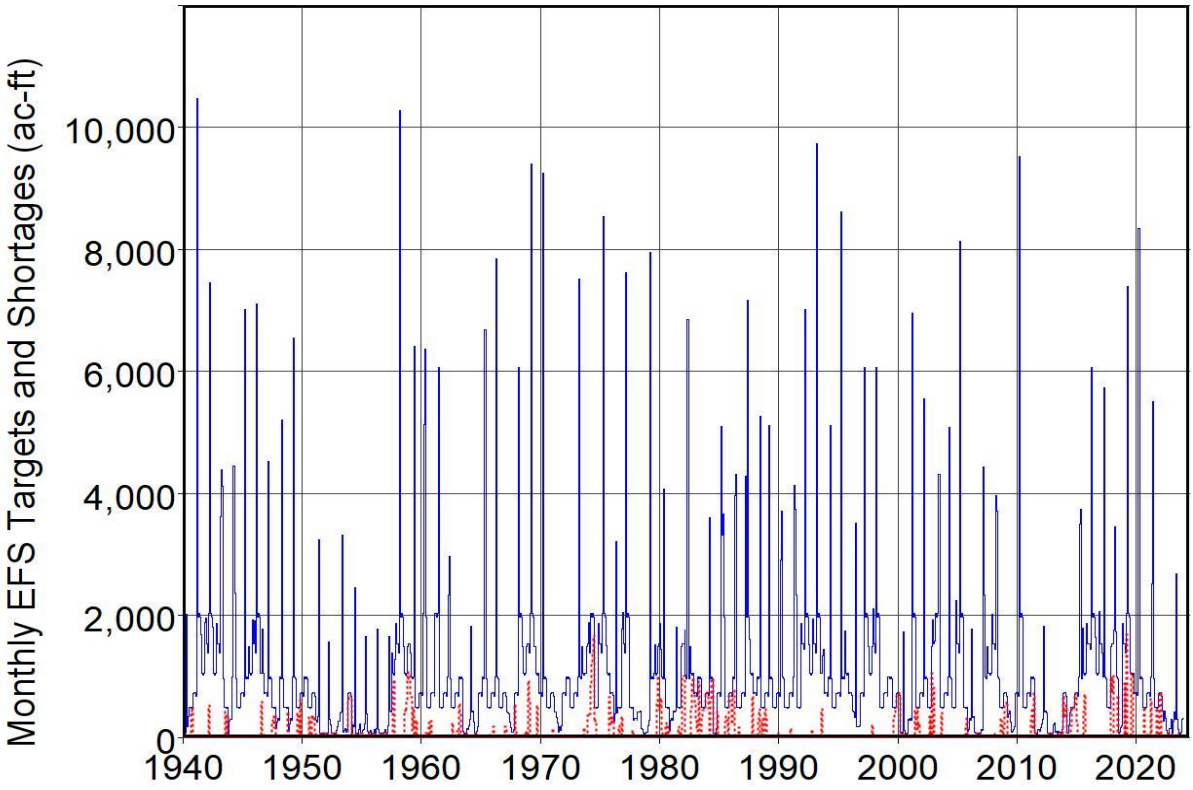

Figure C9 SB3 EFS Targets and Shortages for North Bosque River at Clifton

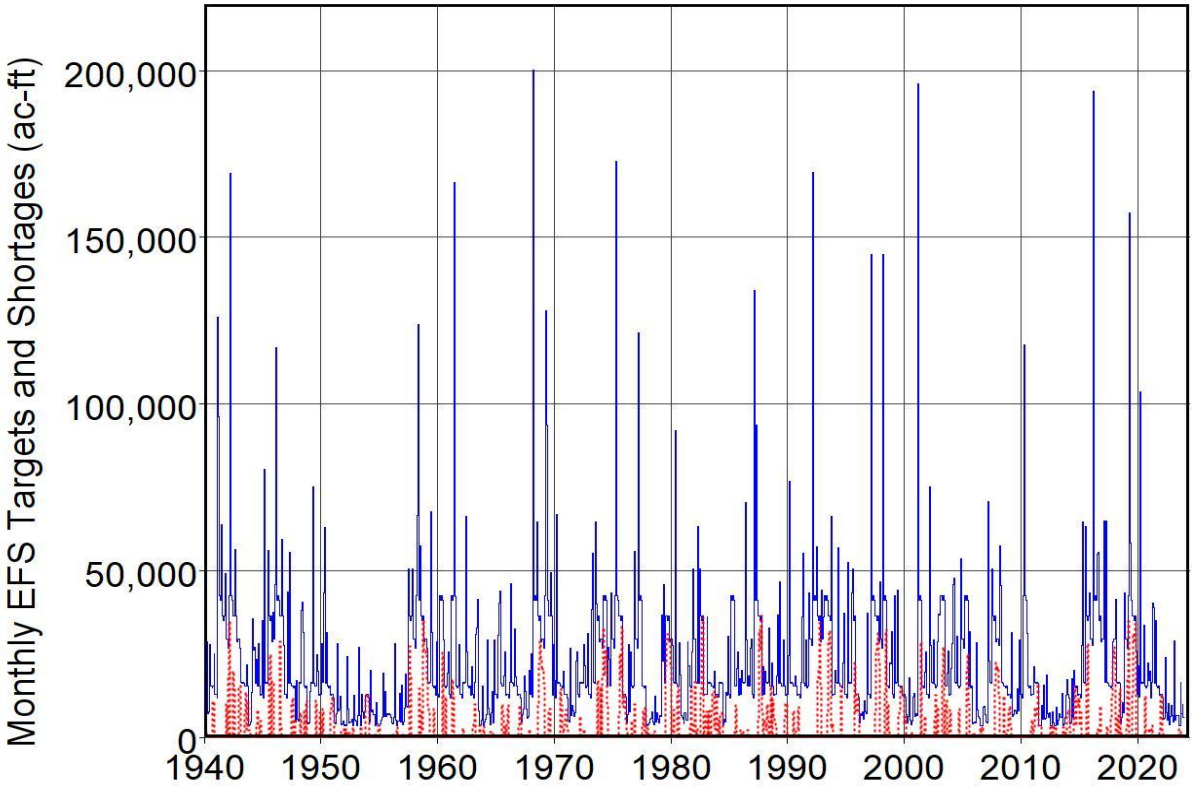

Figure C10 SB3 EFS Targets and Shortages for Brazos River at Waco

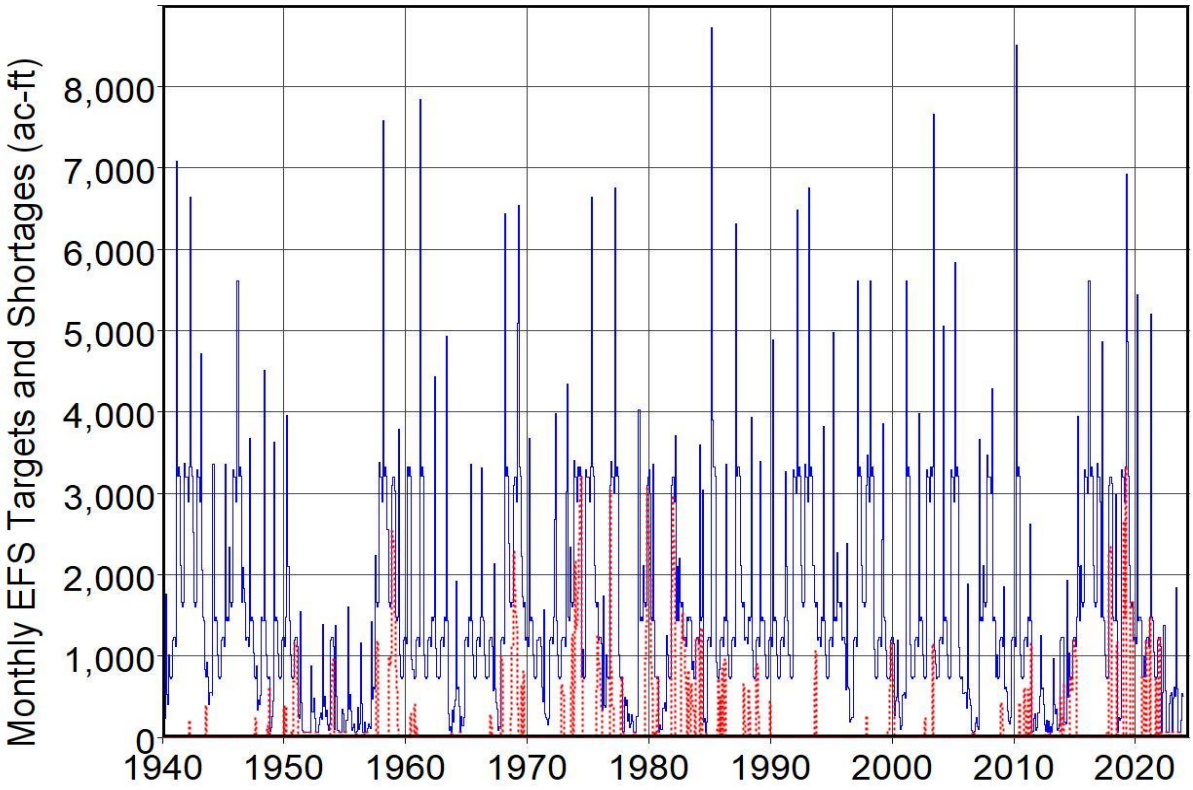

Figure C11 SB3 EFS Targets and Shortages for Leon River at Gatesville

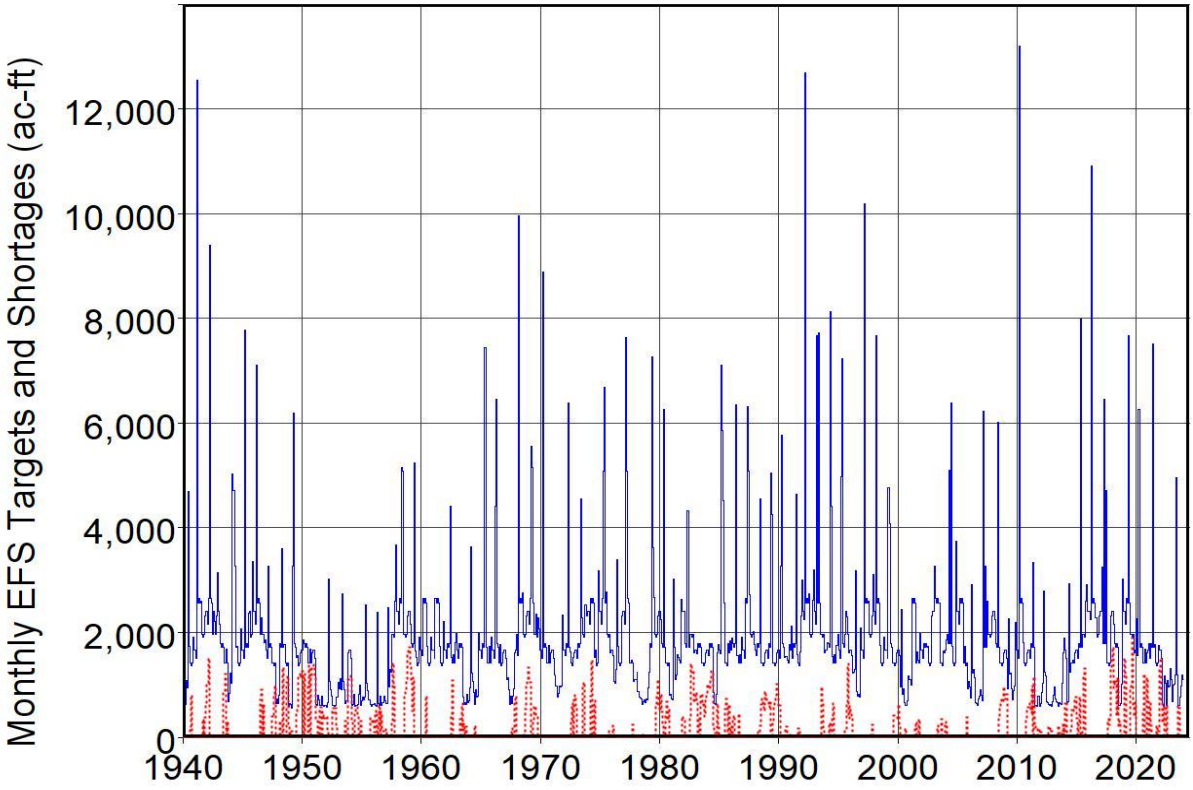

Figure C12 SB3 EFS Targets and Shortages for Lampasas River at Kepner

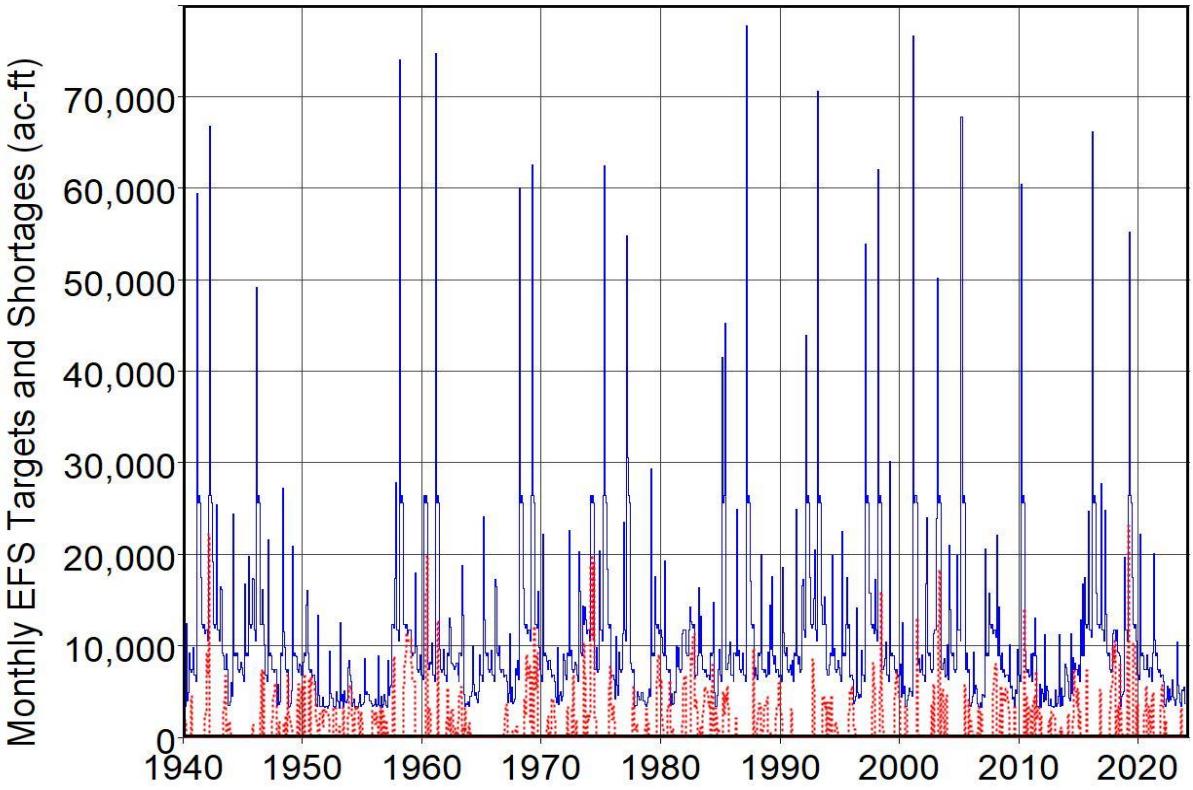

Figure C13 SB3 EFS Targets and Shortages for Little River at Little River

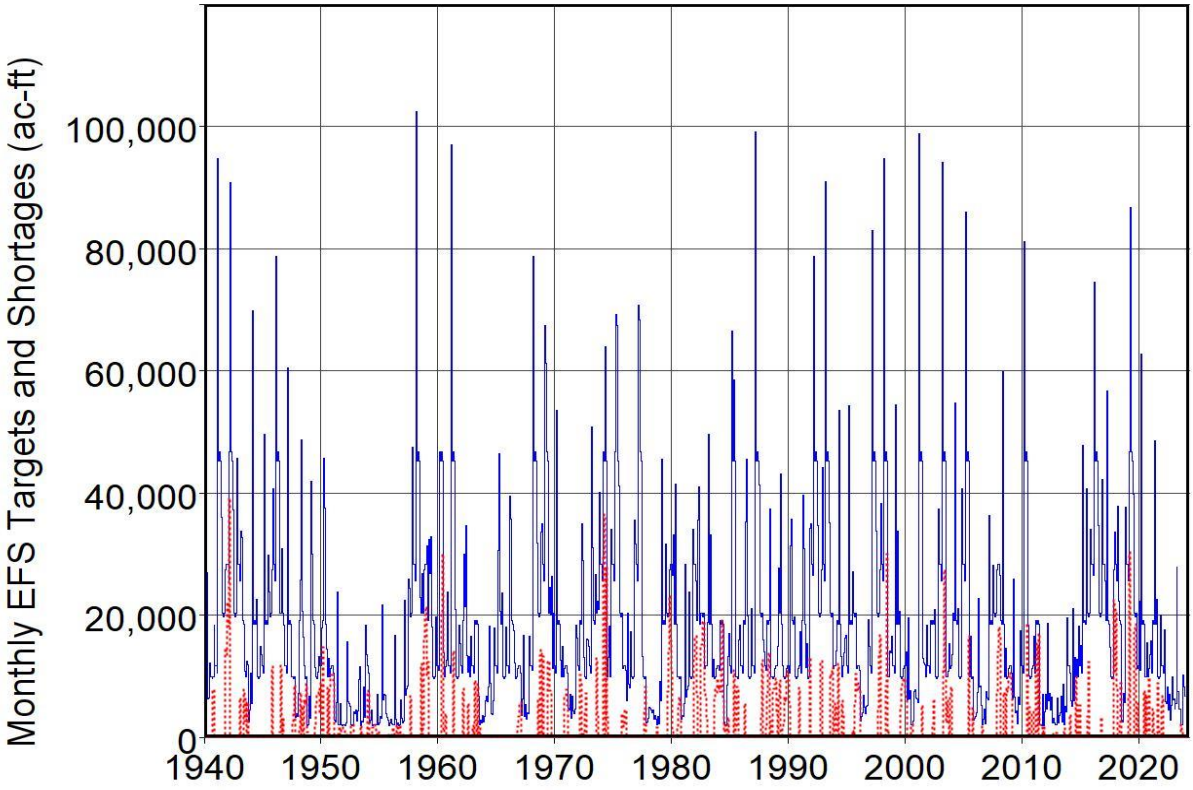

Figure C14 SB3 EFS Targets and Shortages for Little River at Cameron

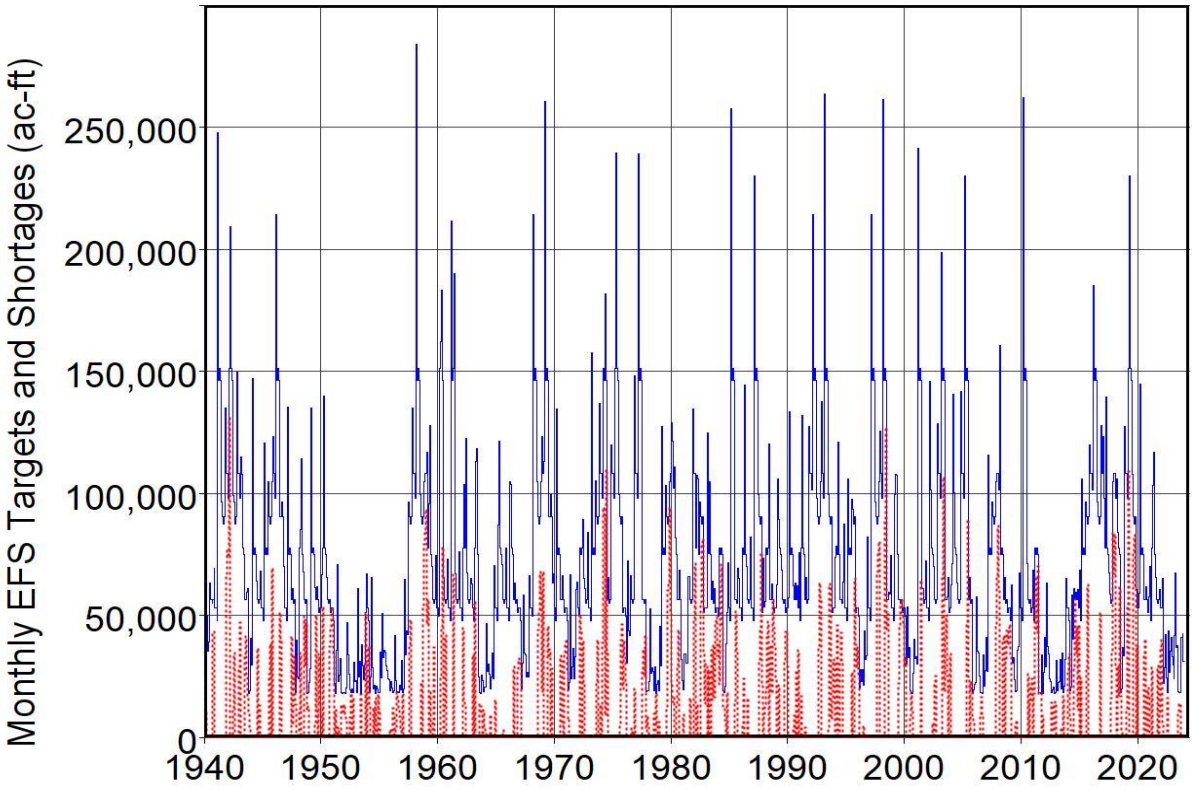

Figure C15 SB3 EFS Targets and Shortages for Brazos River at Bryan

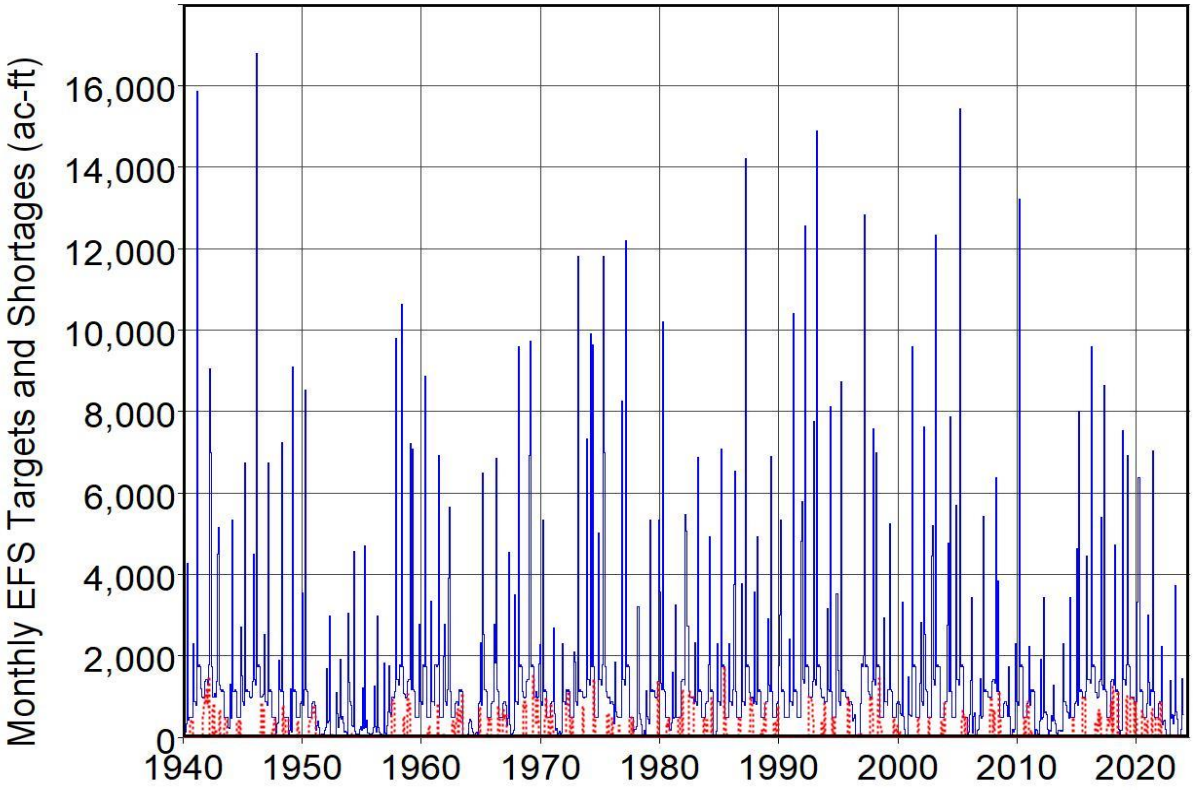

Figure C16 SB3 EFS Targets and Shortages for Navasota River at Easterly

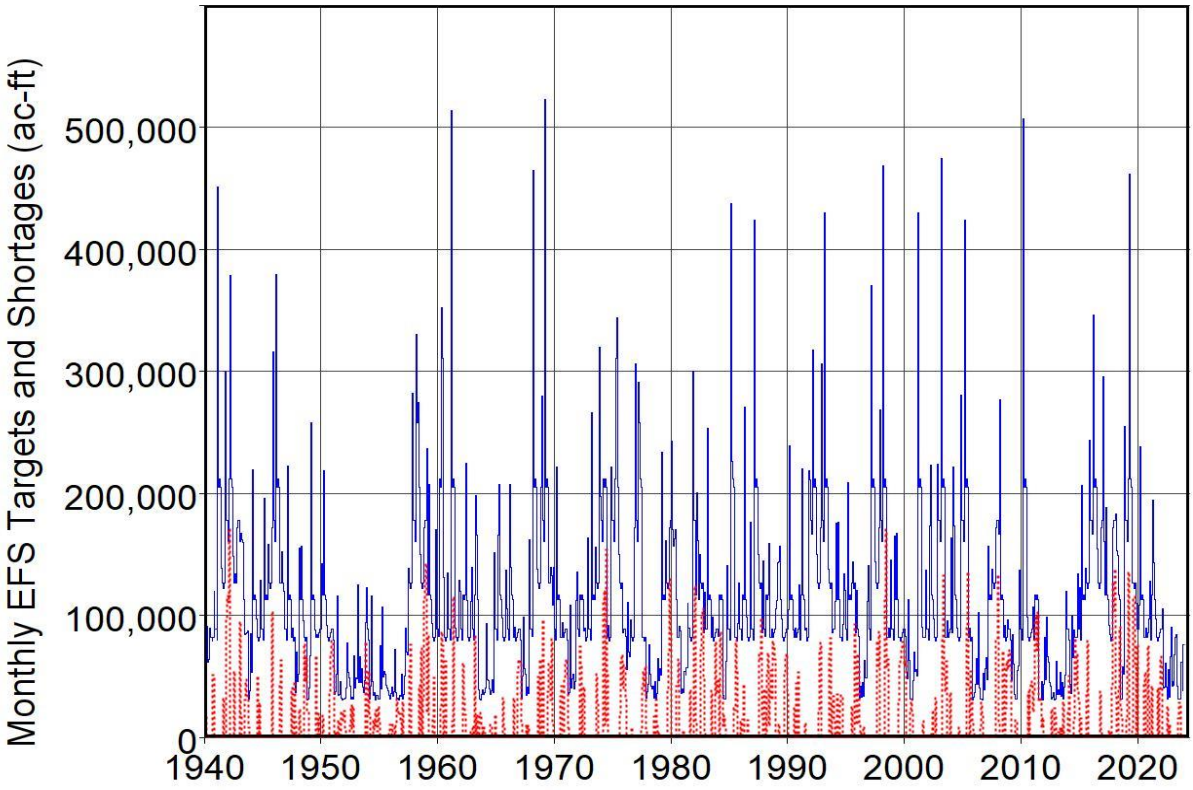

Figure C17 SB3 EFS Targets and Shortages for Brazos River at Hempstead

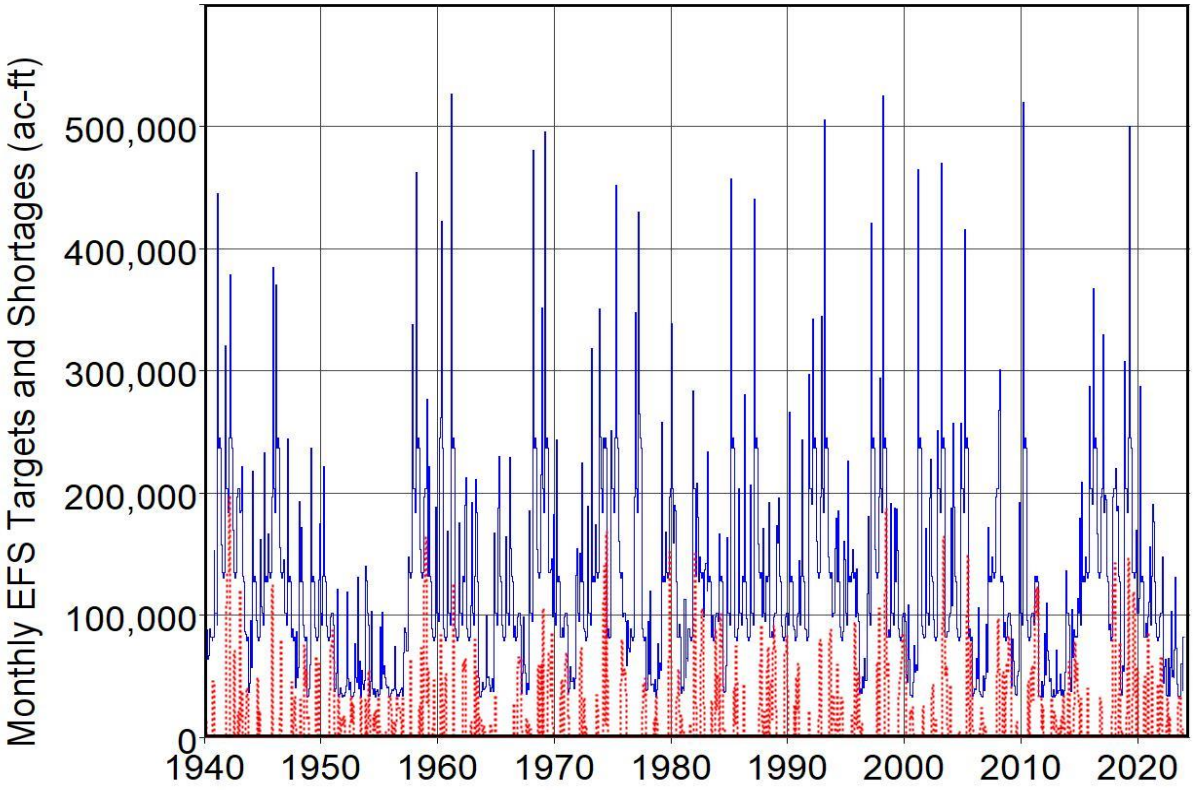

Figure C18 SB3 EFS Targets and Shortages for Brazos River at Richmond

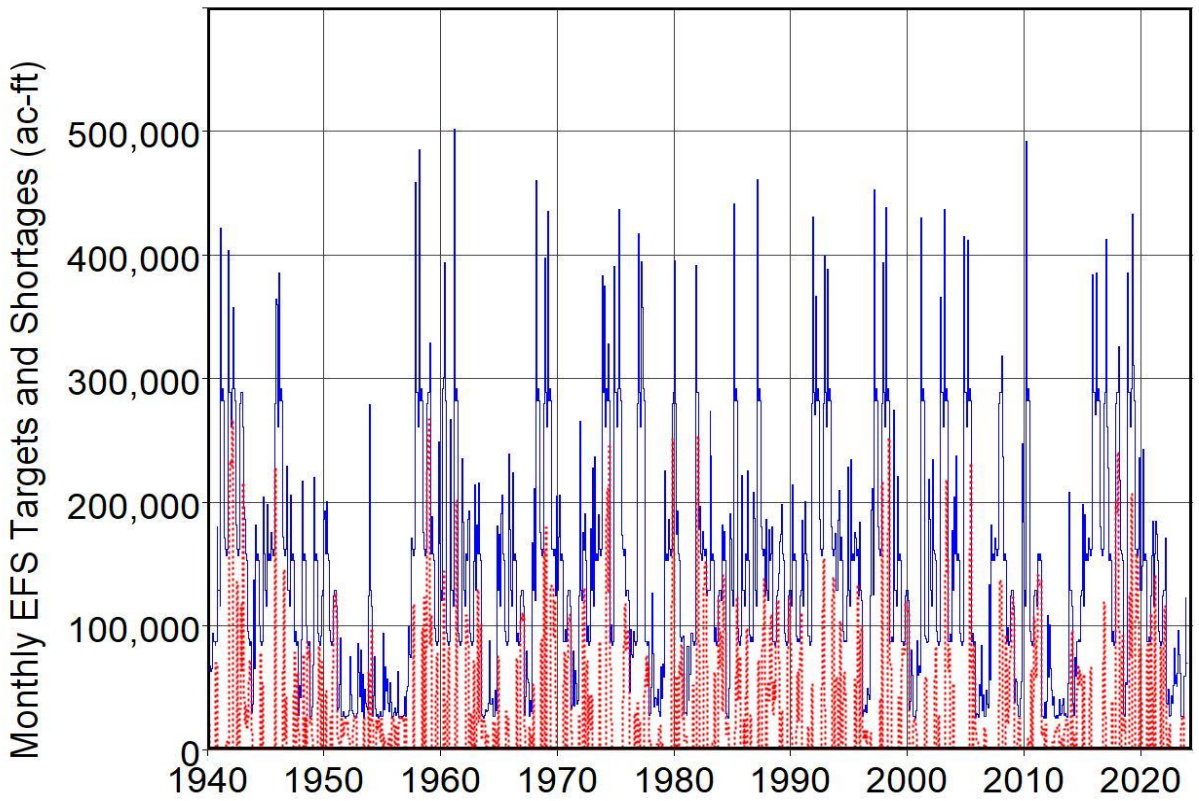

Figure C19 SB3 EFS Targets and Shortages for Brazos River at Rosharon

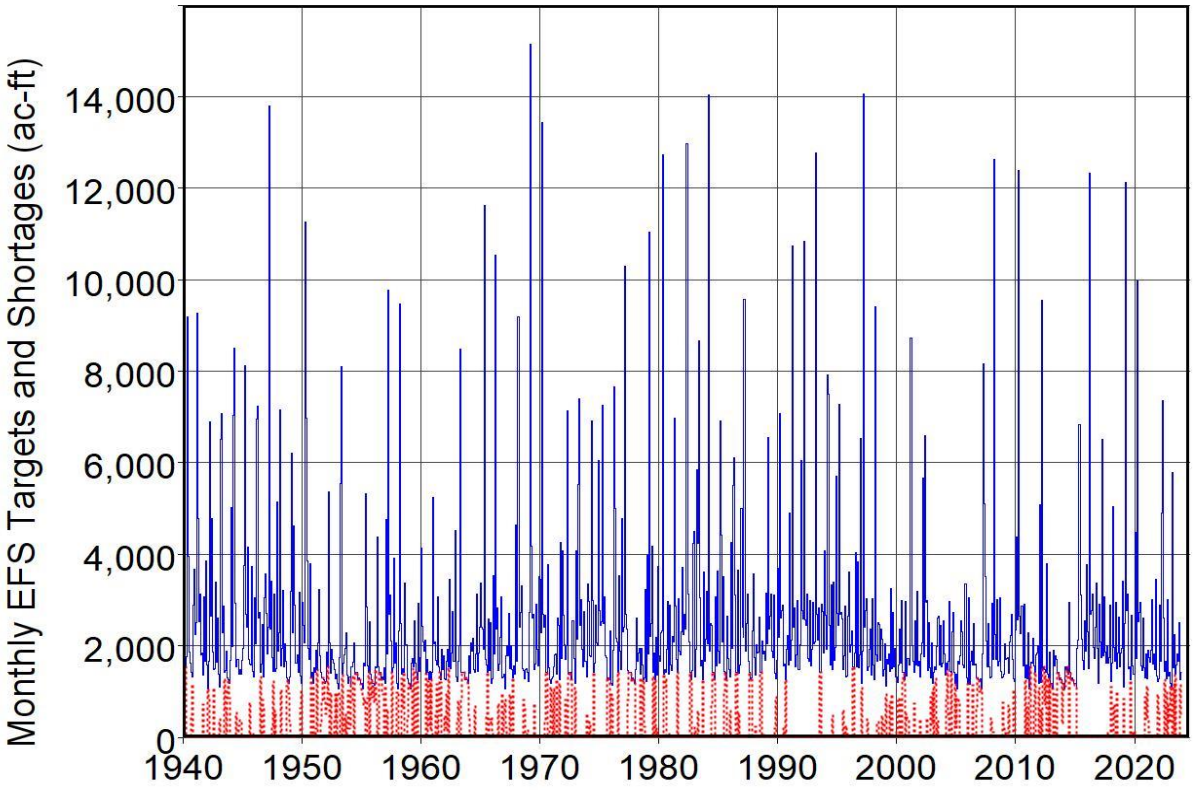

Figure C20 SB3 EFS Targets and Shortages for West Fork the Trinity River at Grand Prairie

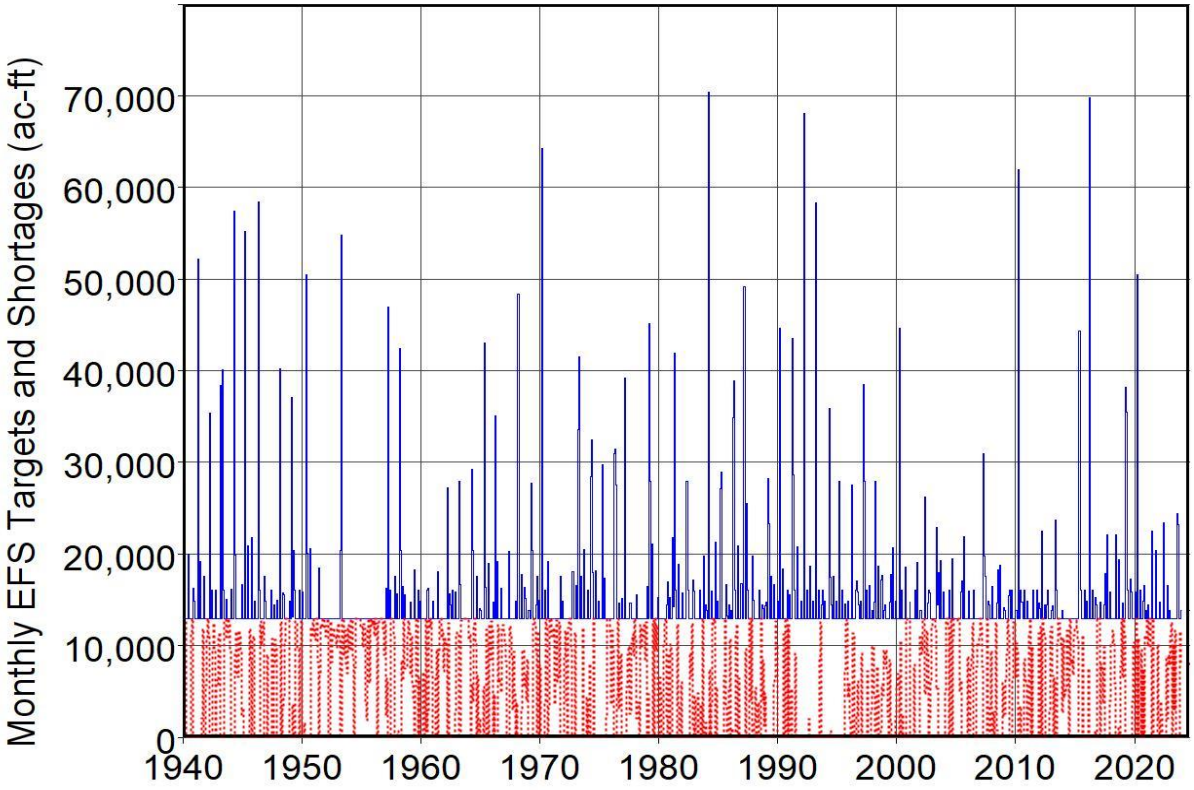

Figure C21 SB3 EFS Targets and Shortages for the Trinity River at Dallas

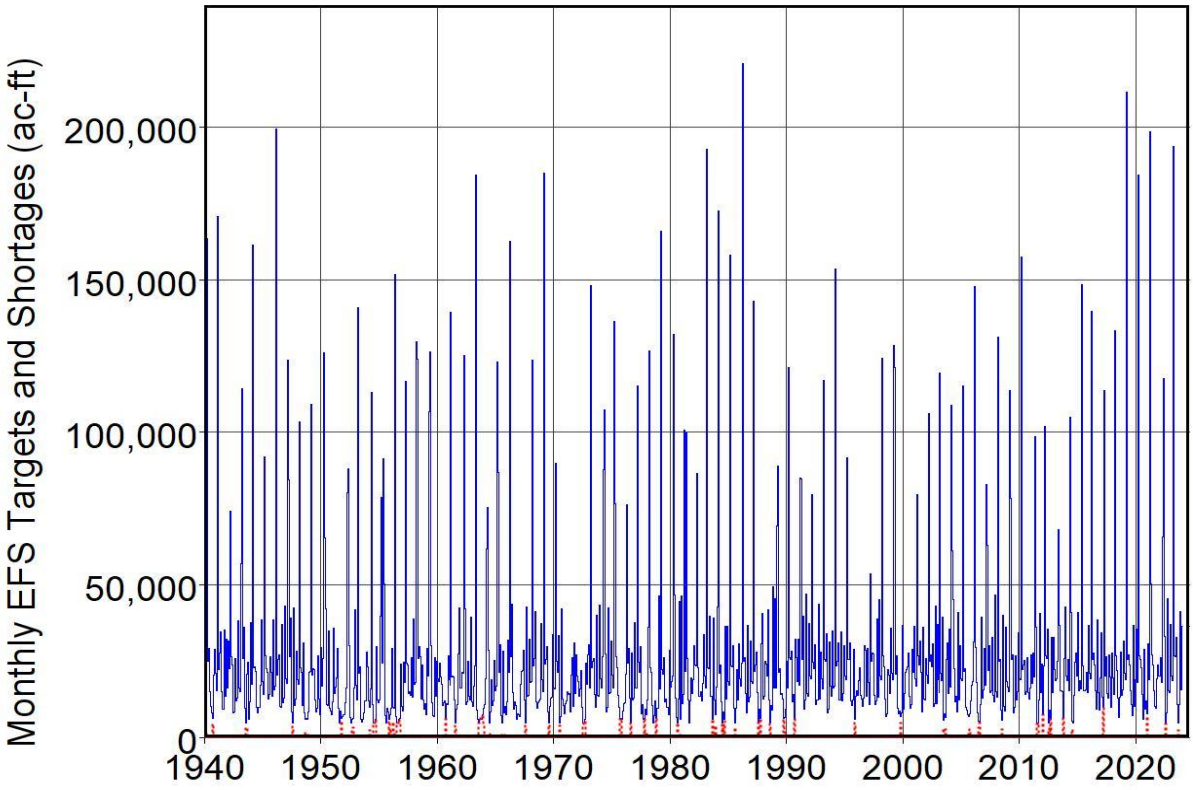

Figure C22 SB3 EFS Targets and Shortages for the Trinity River at Oakwood

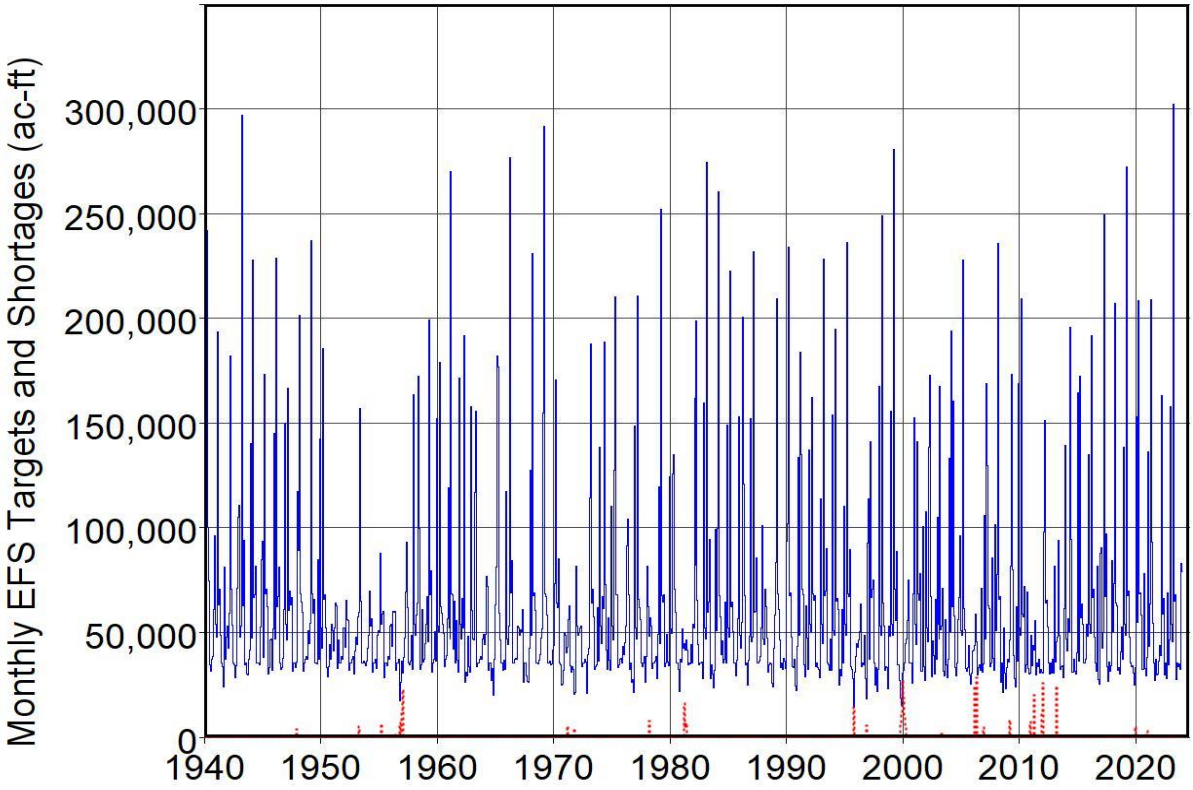

Figure C23 SB3 EFS Targets and Shortages for the Trinity River at Romayor

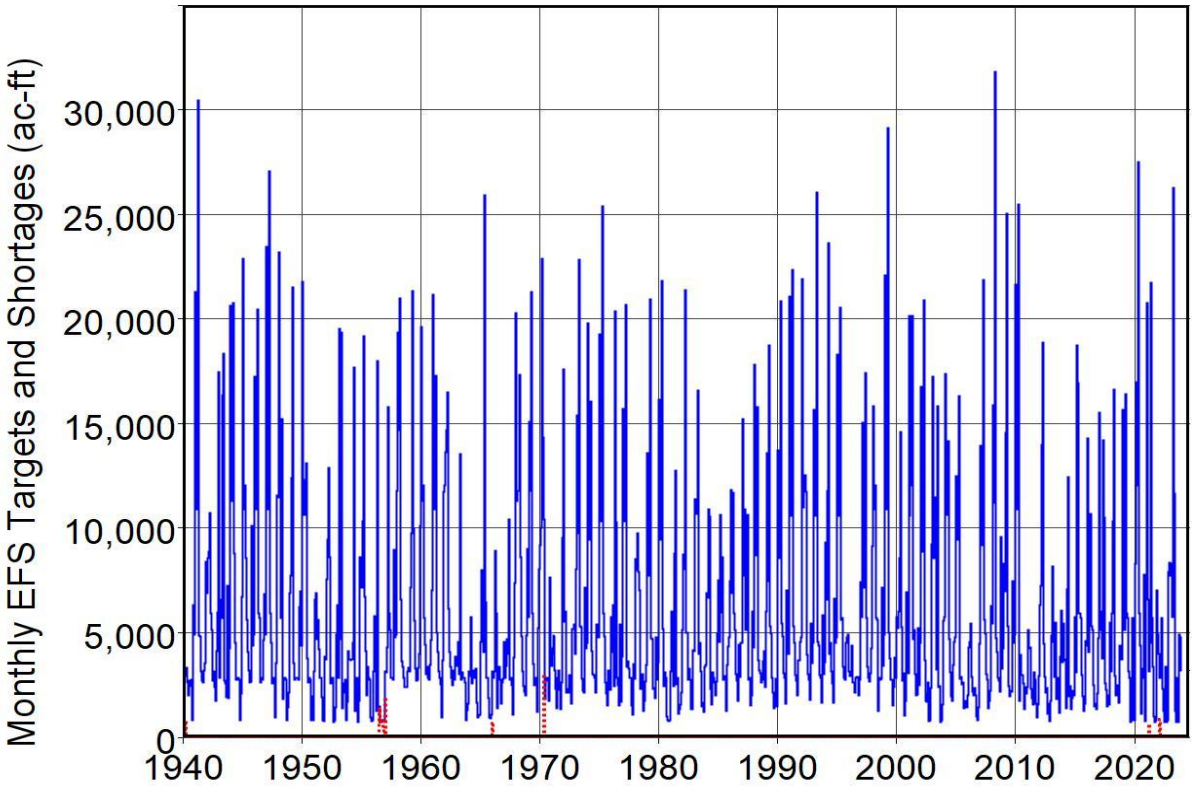

Figure C24 SB3 EFS Targets and Shortages for the Neches River at Neches

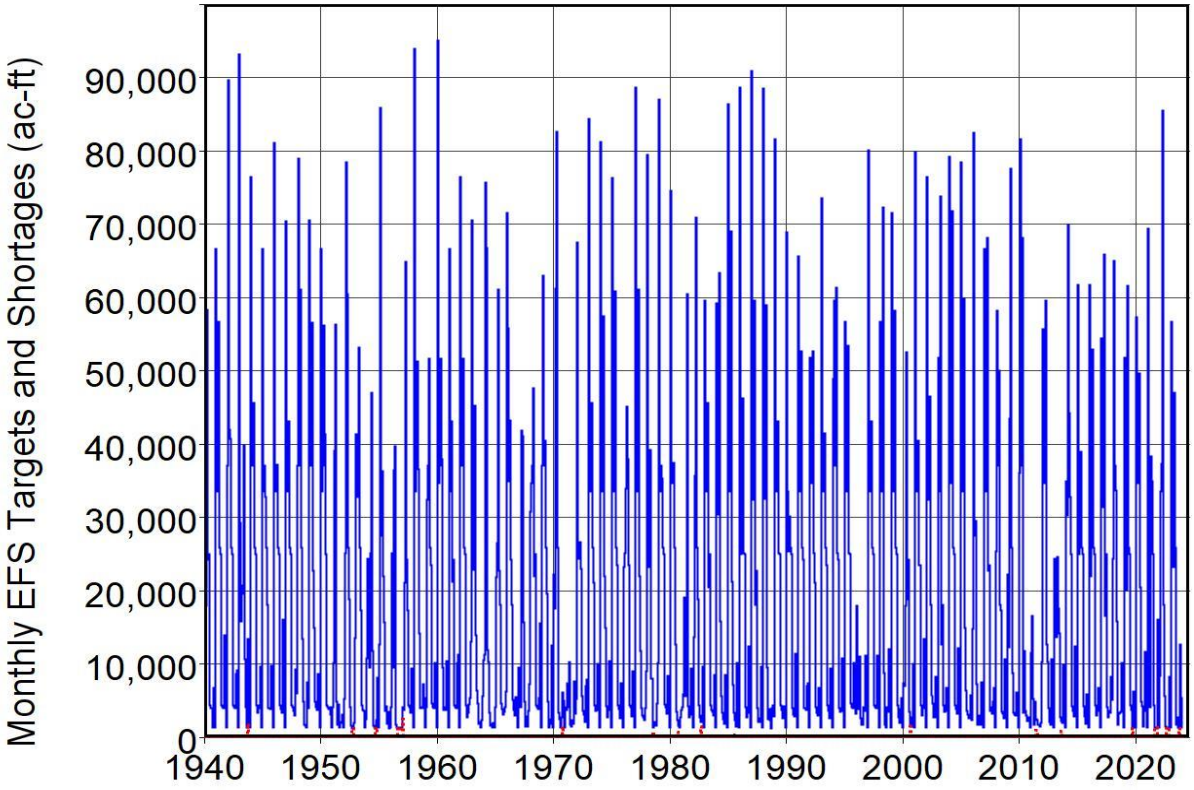

Figure C25 SB3 EFS Targets and Shortages for the Neches River near Rockland

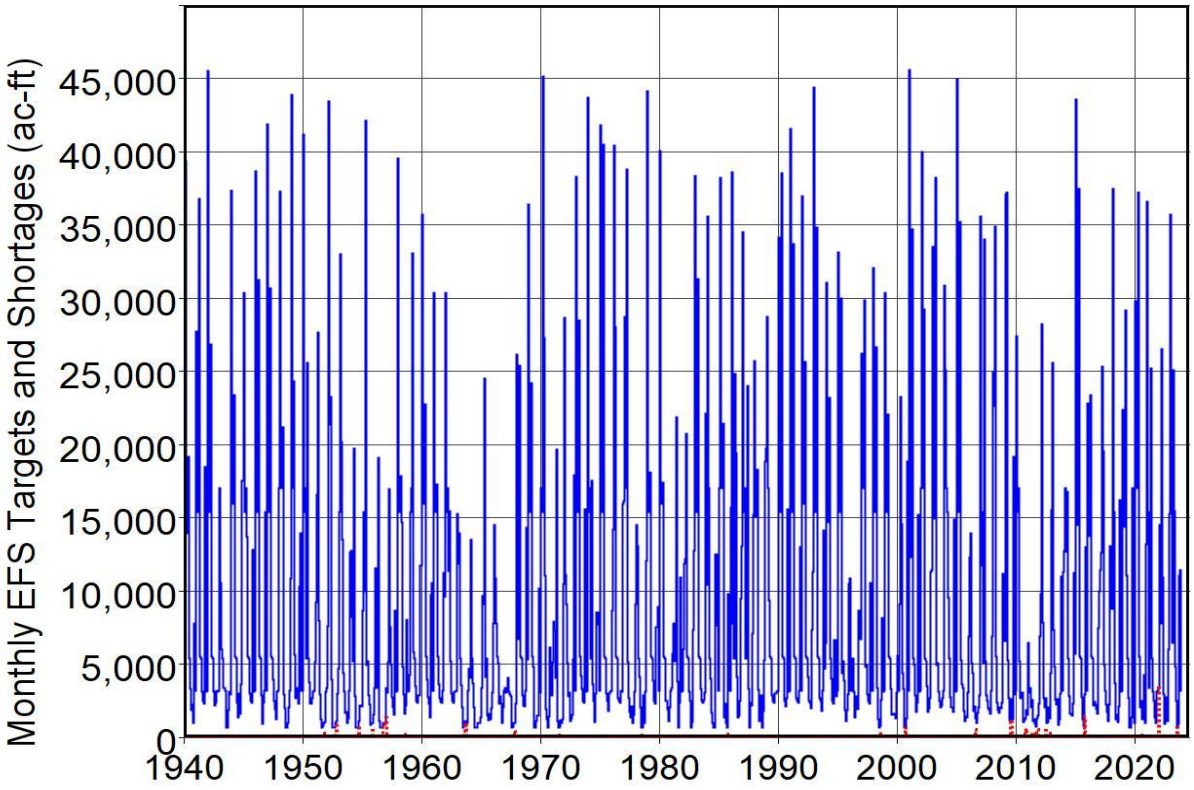

Figure C26 SB3 EFS Targets and Shortages for the Angelina River near Alto

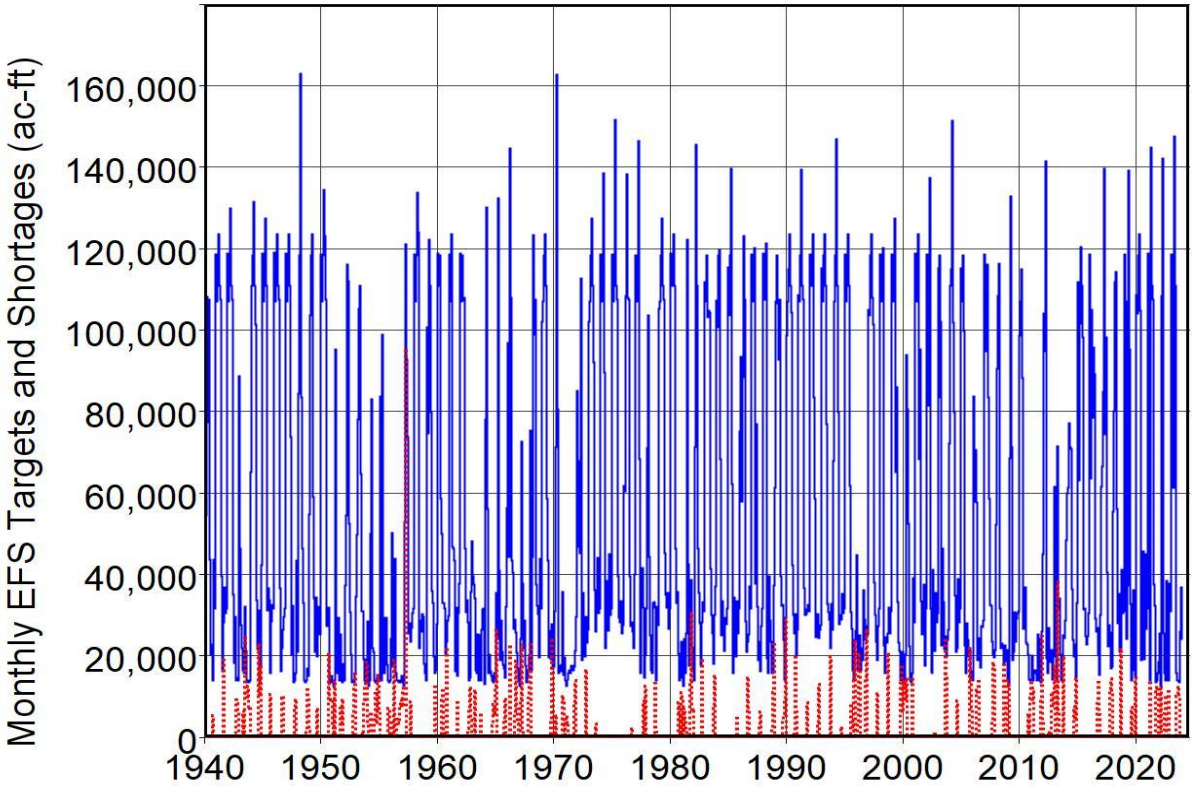

Figure C27 SB3 EFS Targets and Shortages for the Neches River at Evadale

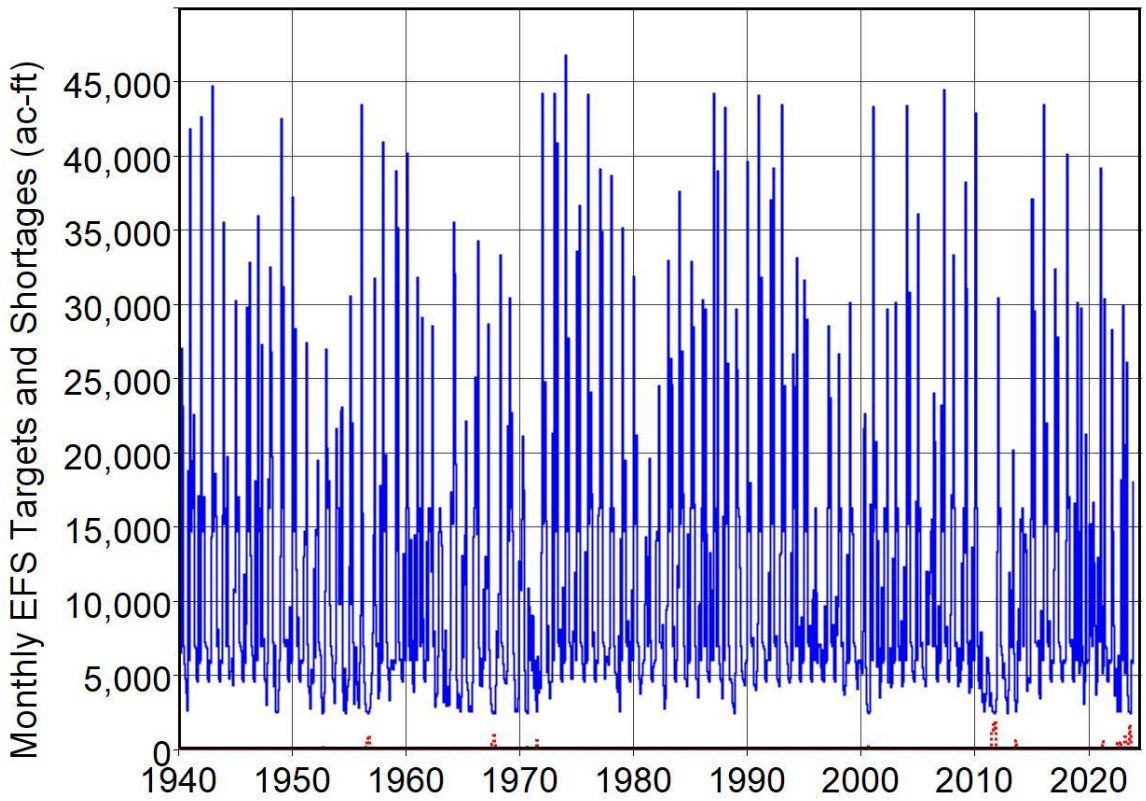

Figure C28 SB3 EFS Targets and Shortages for Village Creek near Kountze

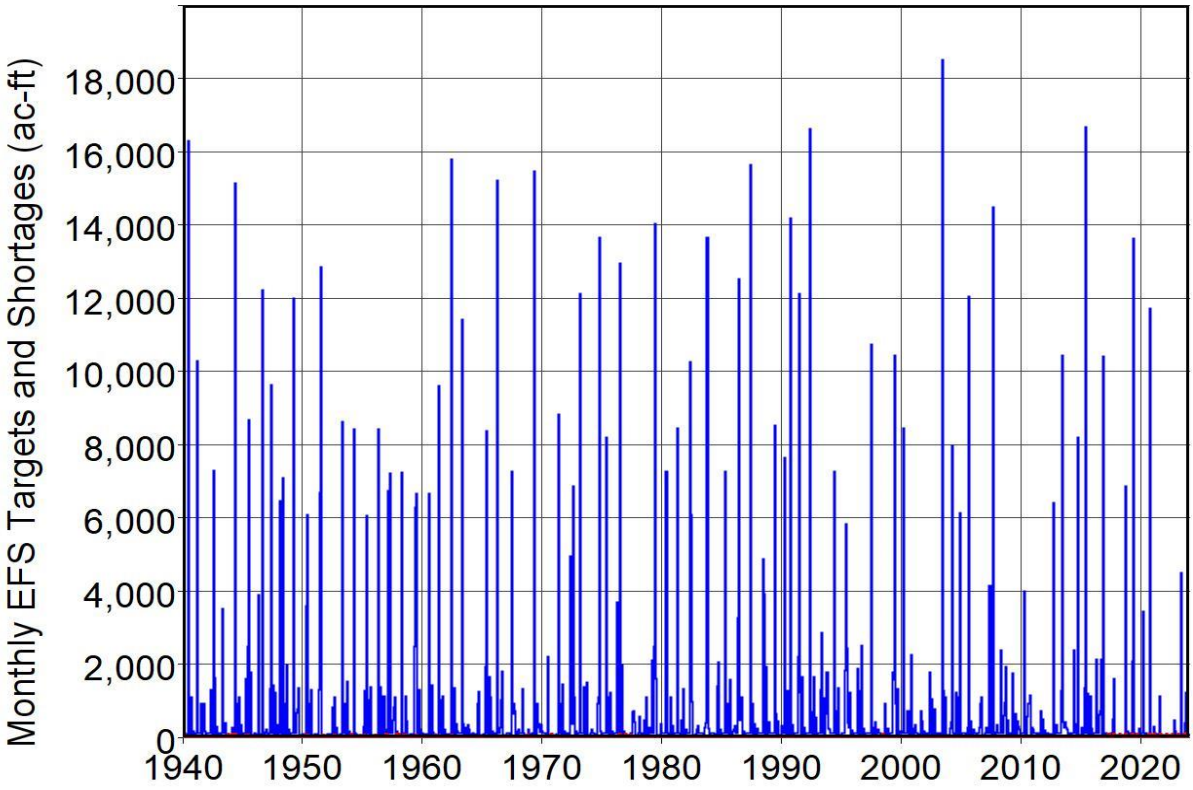

Figure C29 SB3 EFS Targets and Shortages for Colorado River above Silver

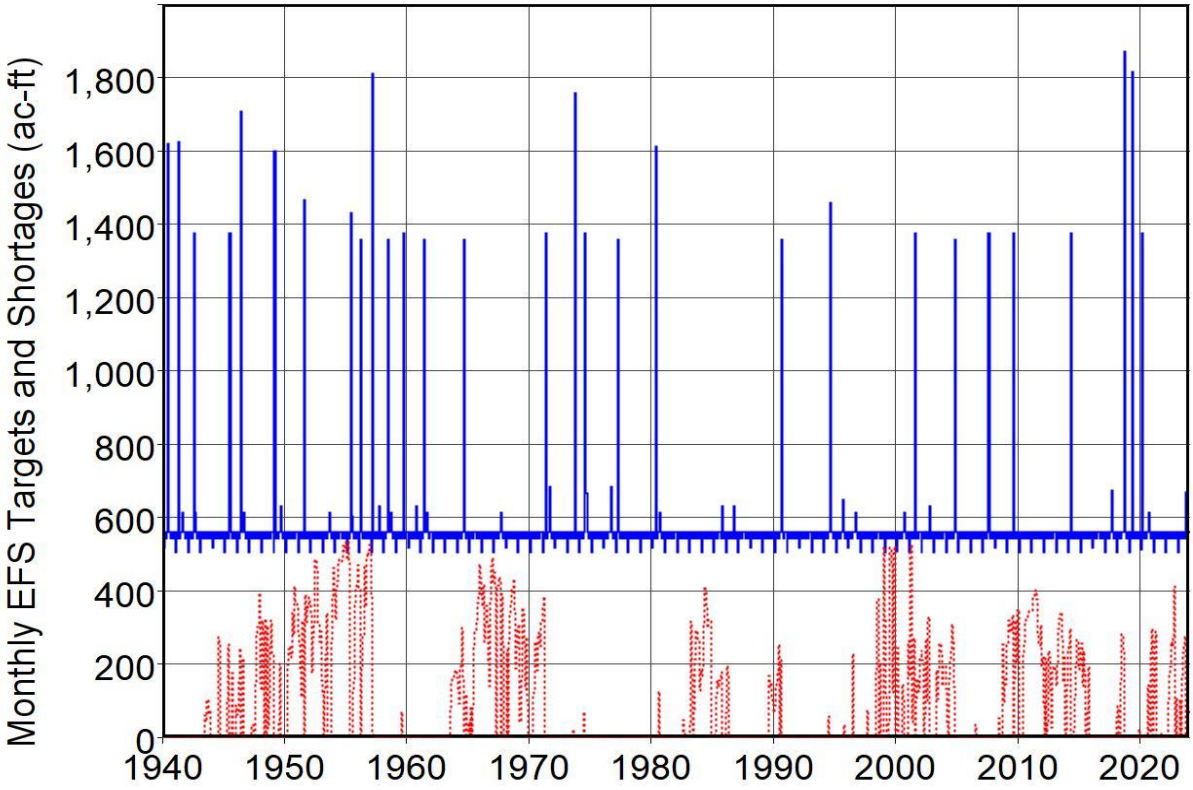

Figure C30 SB3 EFS Targets and Shortages for South Concho River at Christoval

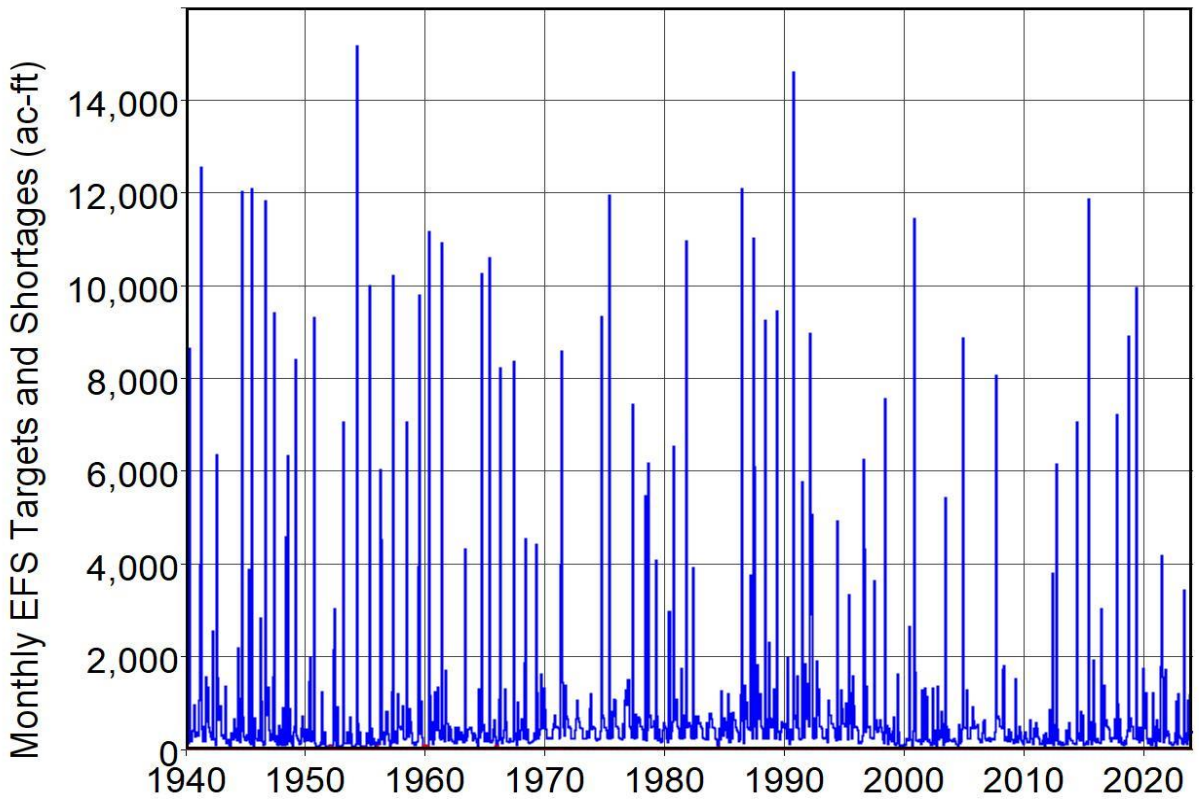

Figure C31 SB3 EFS Targets and Shortages for Concho River at Paint Rock

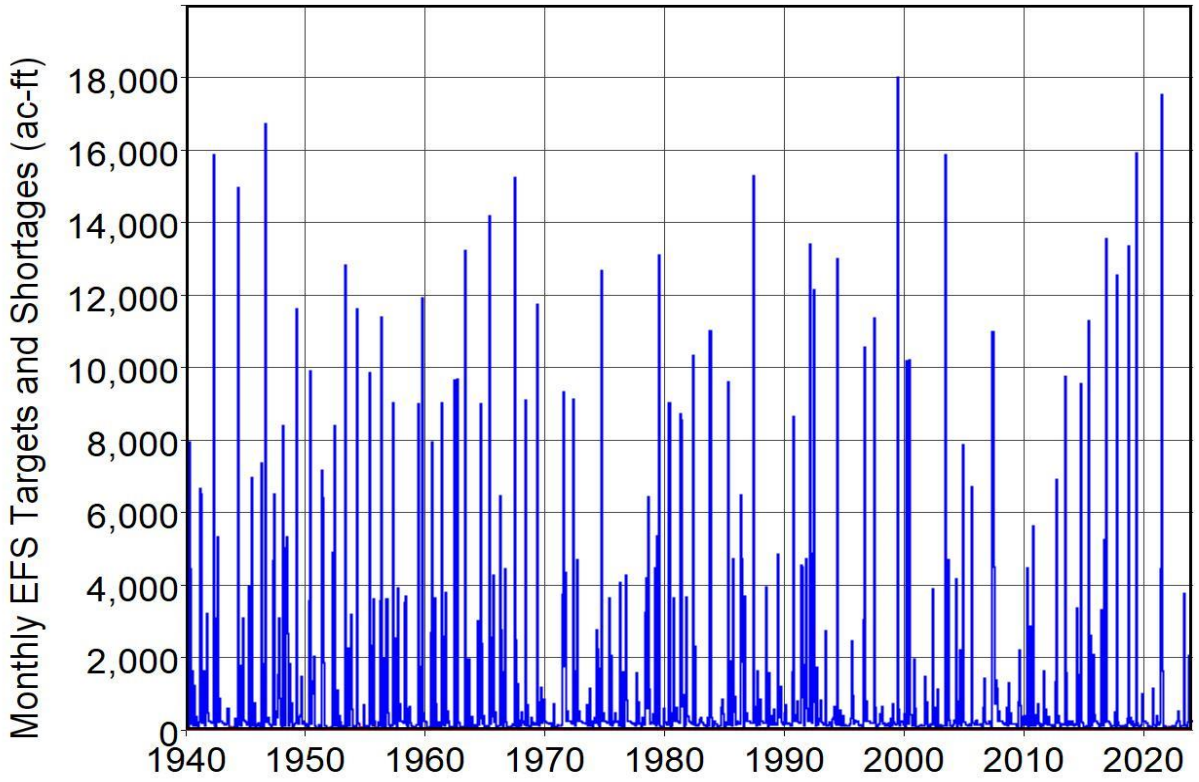

Figure C32 SB3 EFS Targets and Shortages for Colorado River near Ballinger

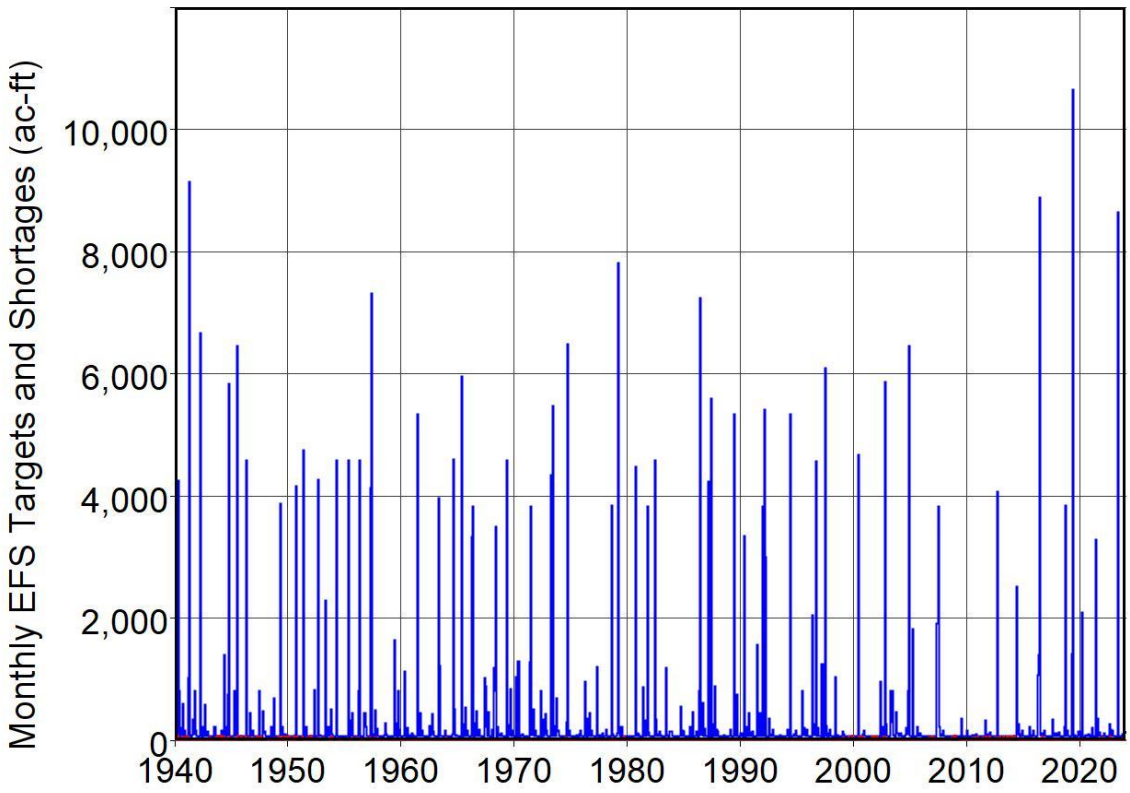

Figure C33 SB3 EFS Targets and Shortages for Elm Creek at Ballinger

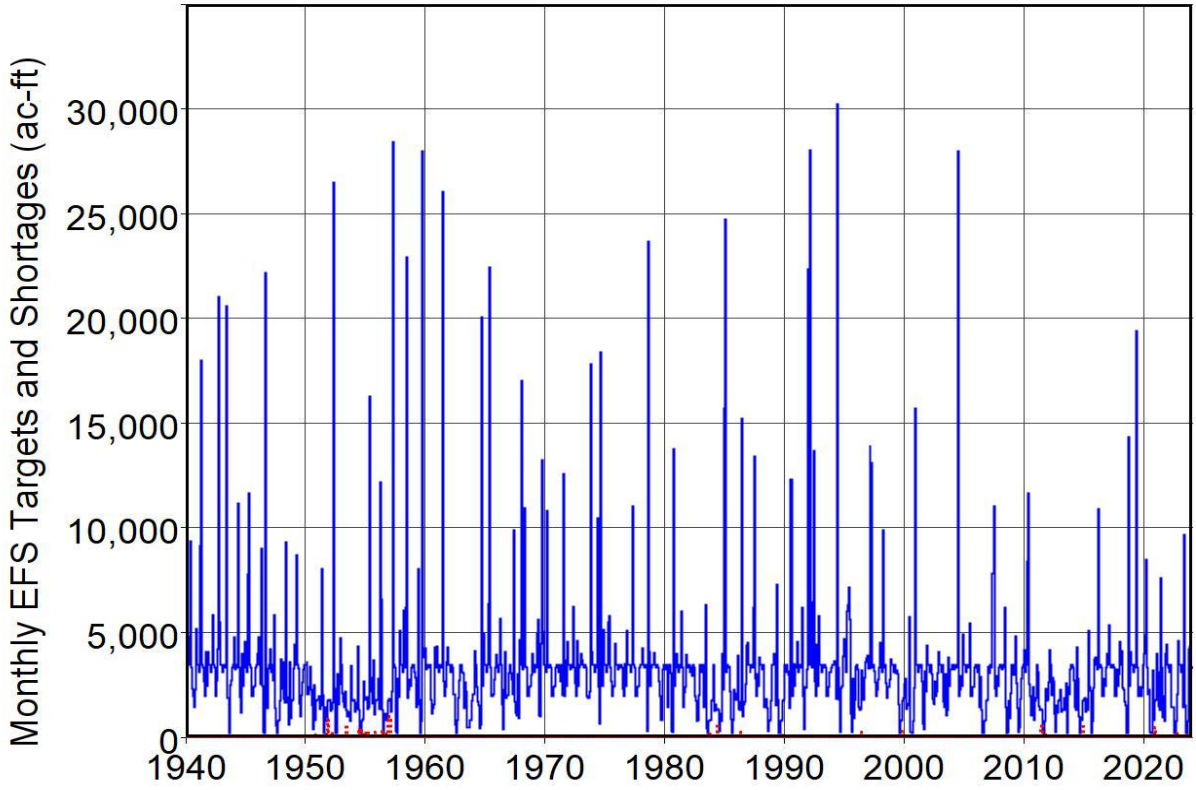

Figure C34 SB3 EFS Targets and Shortages for San Saba River at San Saba

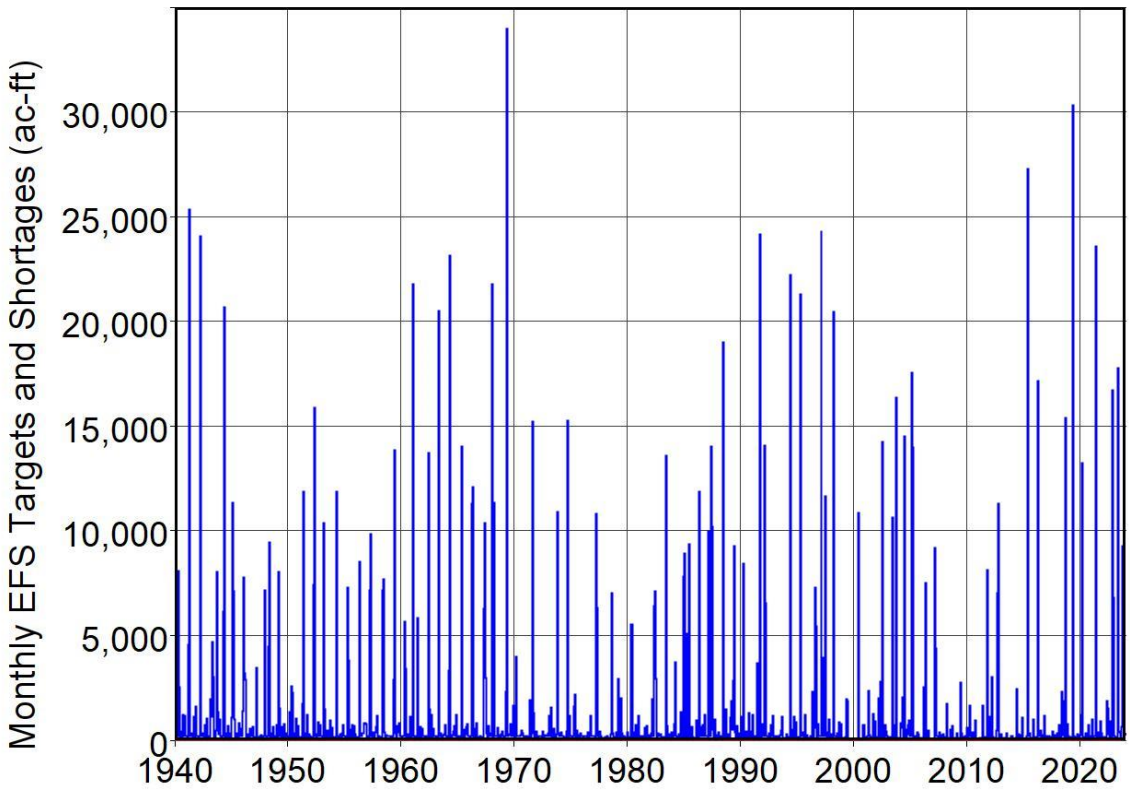

Figure C35 SB3 EFS Targets and Shortages for Pecan Bayou near Mullin

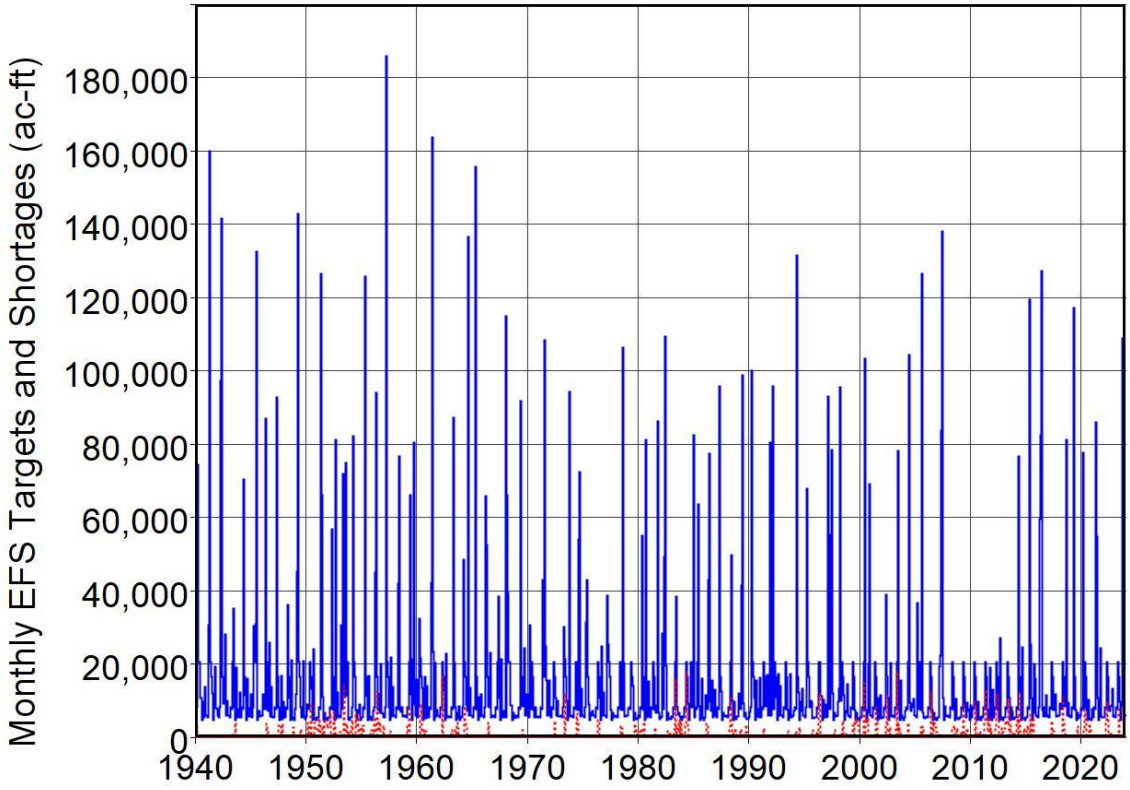

Figure C36 SB3 EFS Targets and Shortages for Colorado River near San Saba

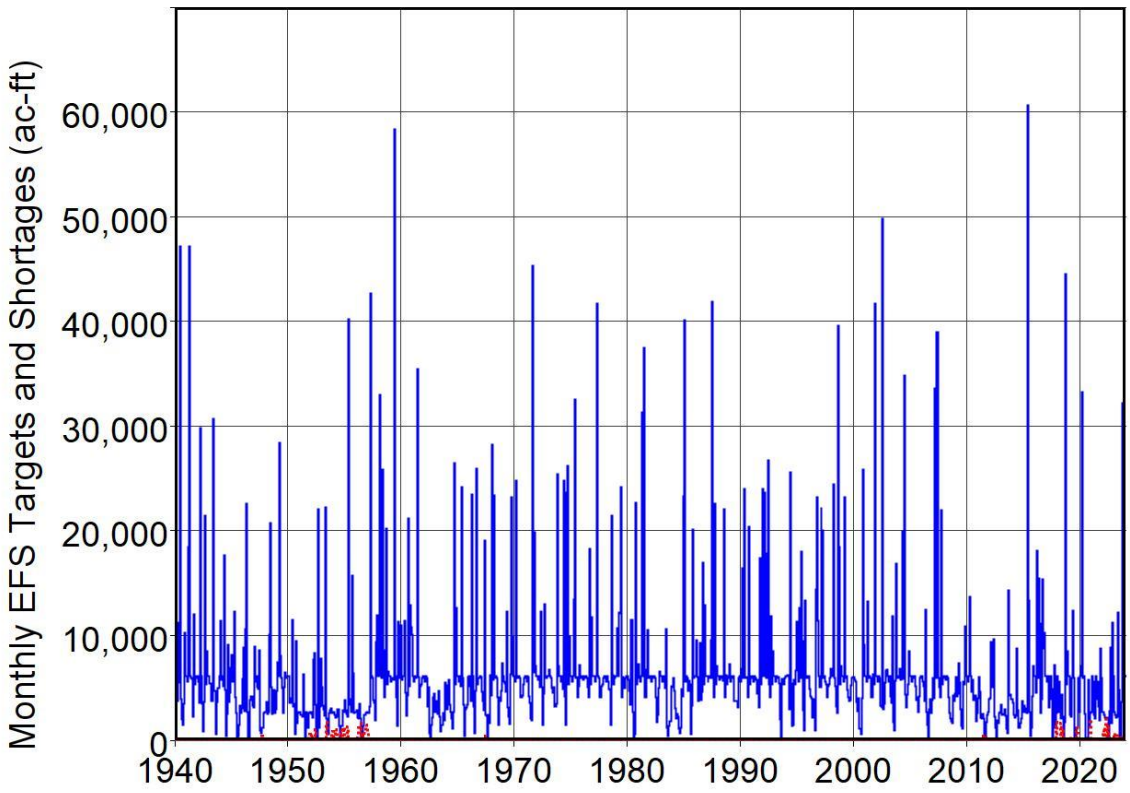

Figure C37 SB3 EFS Targets and Shortages for Llano River at Llano

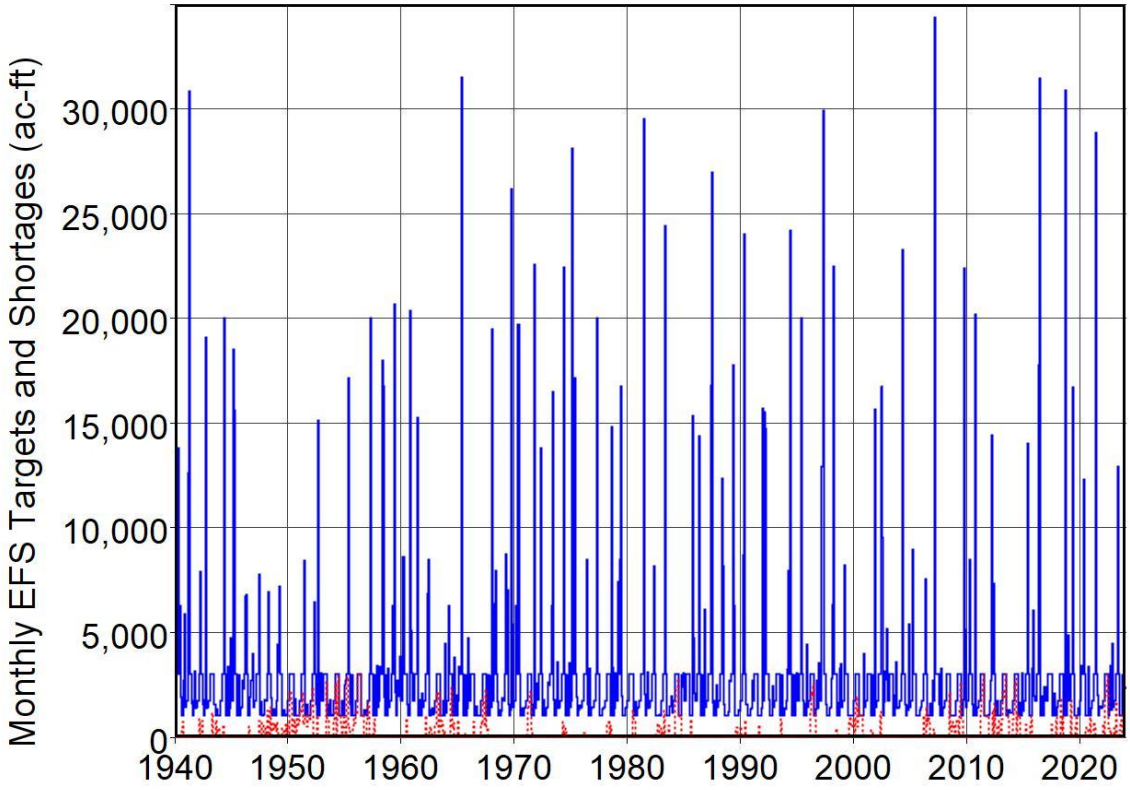

Figure C38 SB3 EFS Targets and Shortages for Pedernales River near Johnson City

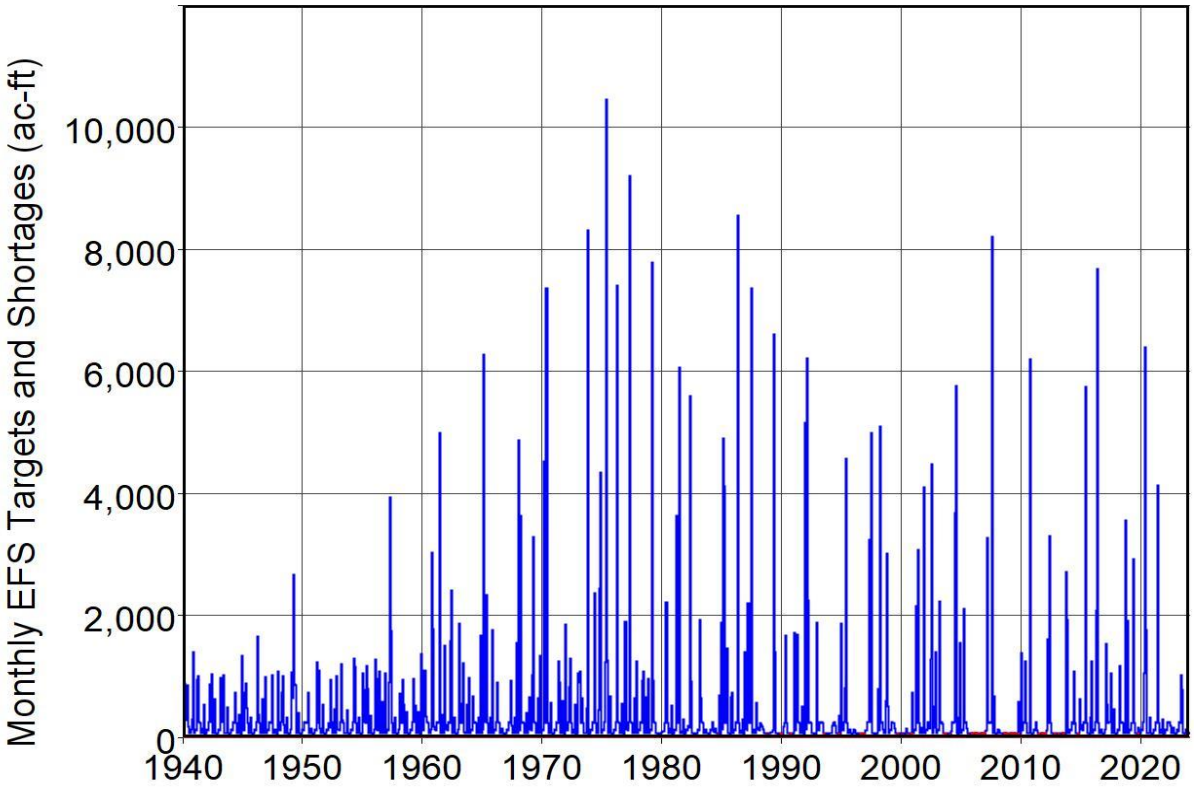

Figure C39 SB3 EFS Targets and Shortages for Onion Creek near Driftwood

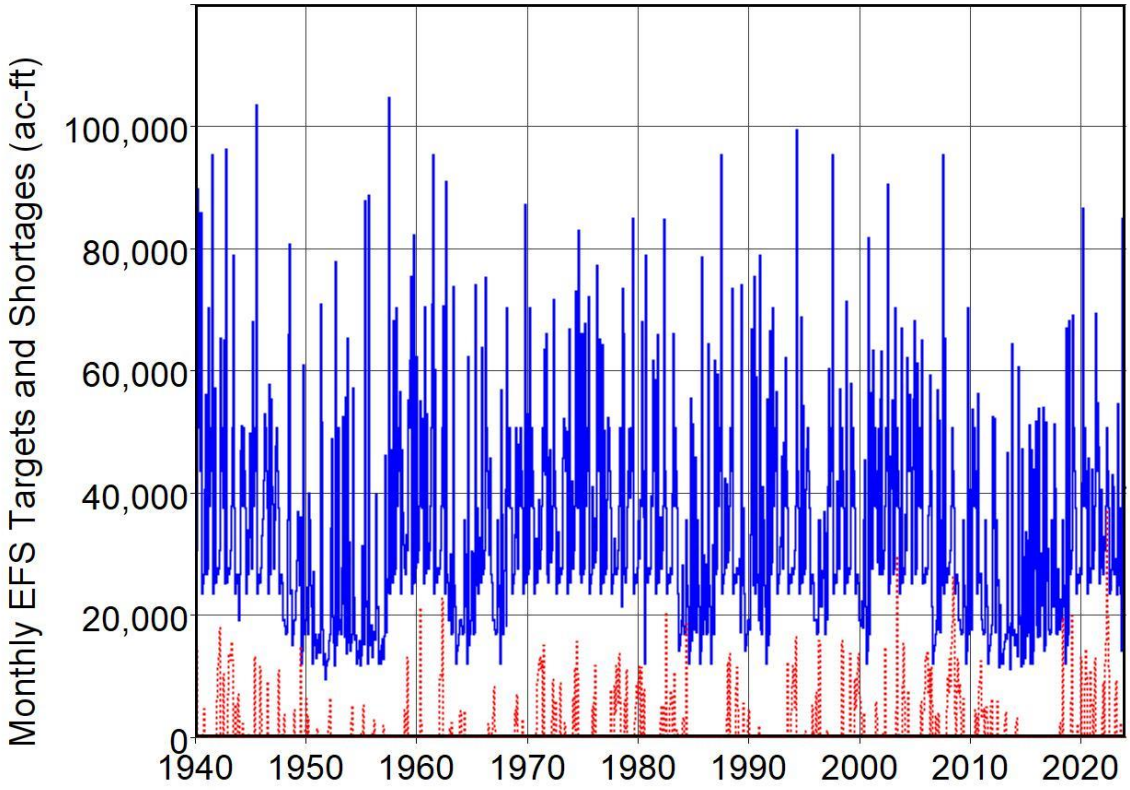

Figure C40 SB3 EFS Targets and Shortages for Colorado River at Bastrop

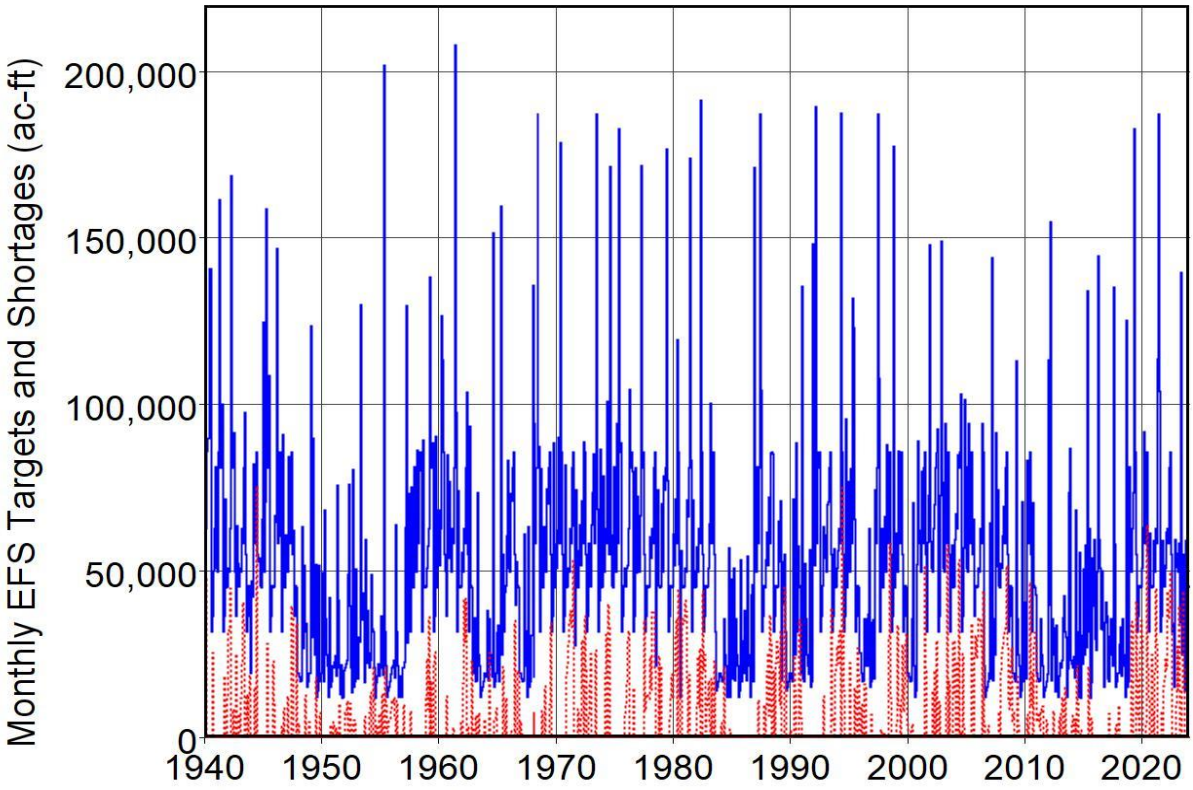

Figure C41 SB3 EFS Targets and Shortages for Colorado River at Columbus

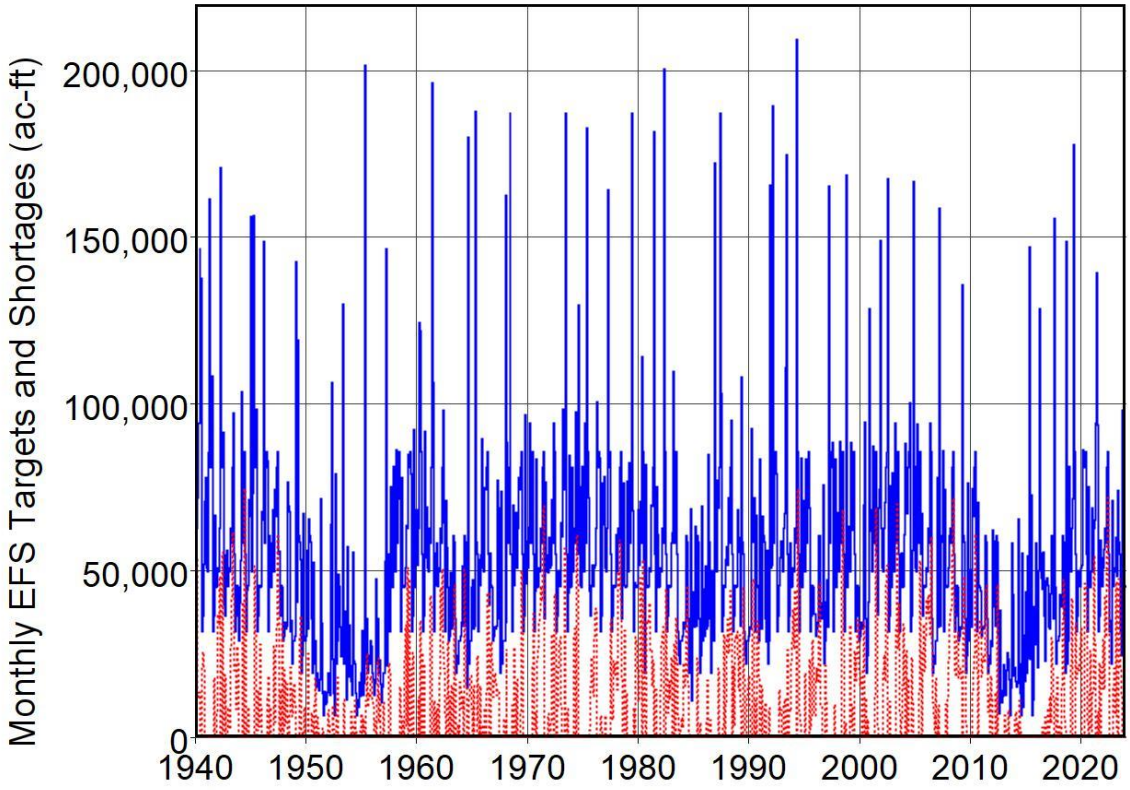

Figure C42 SB3 EFS Targets and Shortages for Colorado River at Wharton

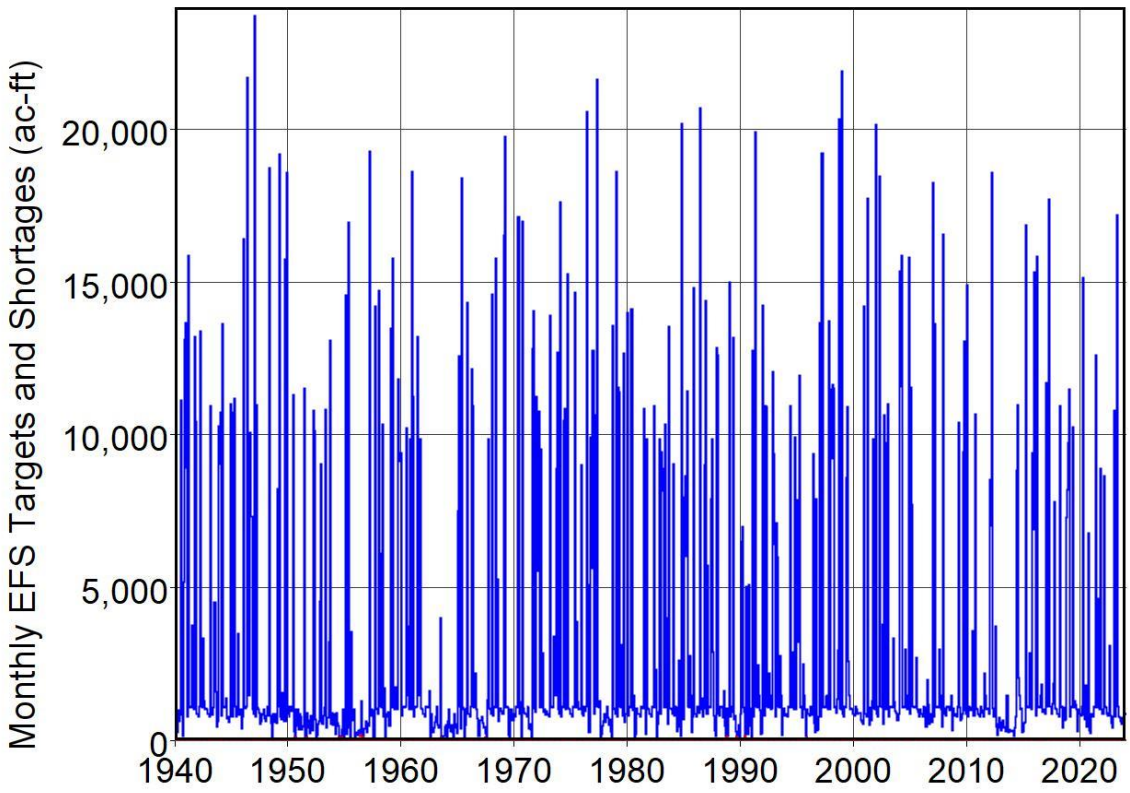

Figure C43 SB3 EFS Targets and Shortages for Lavaca River near Edna

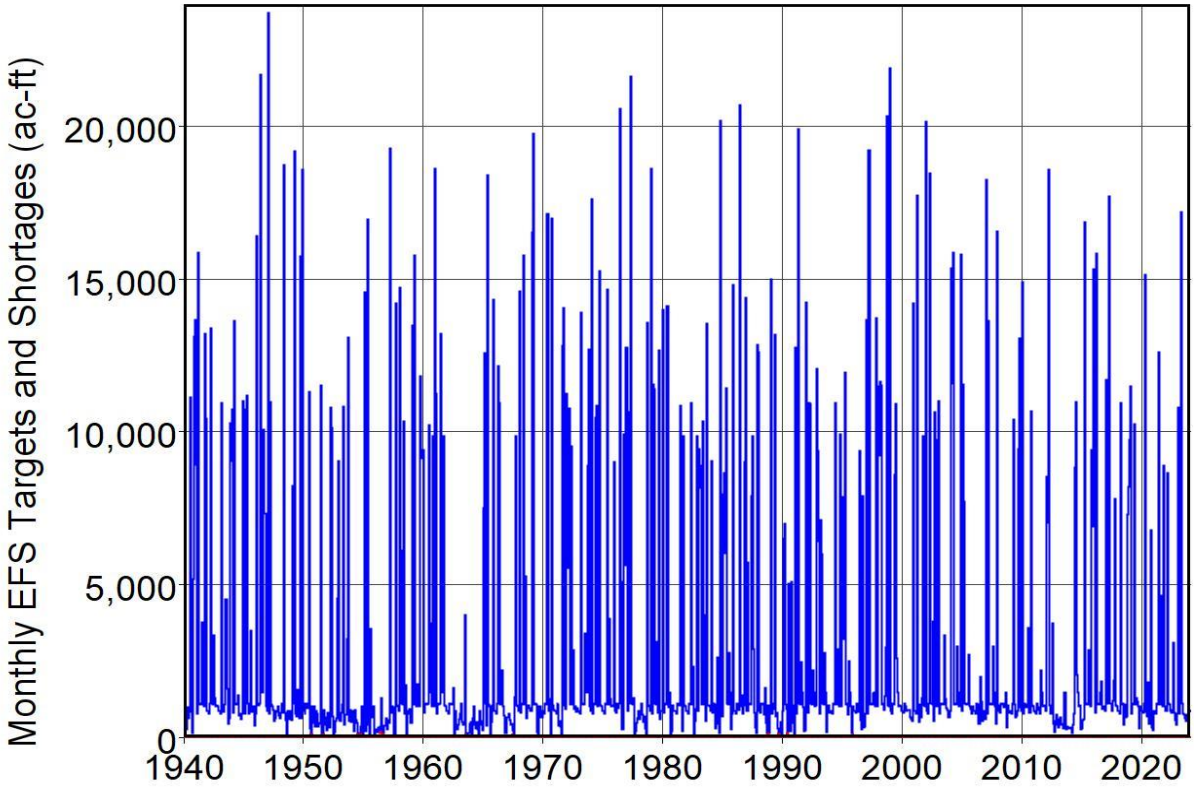

Figure C44 SB3 EFS Targets and Shortages for Navidad River at Strane Park near Edna

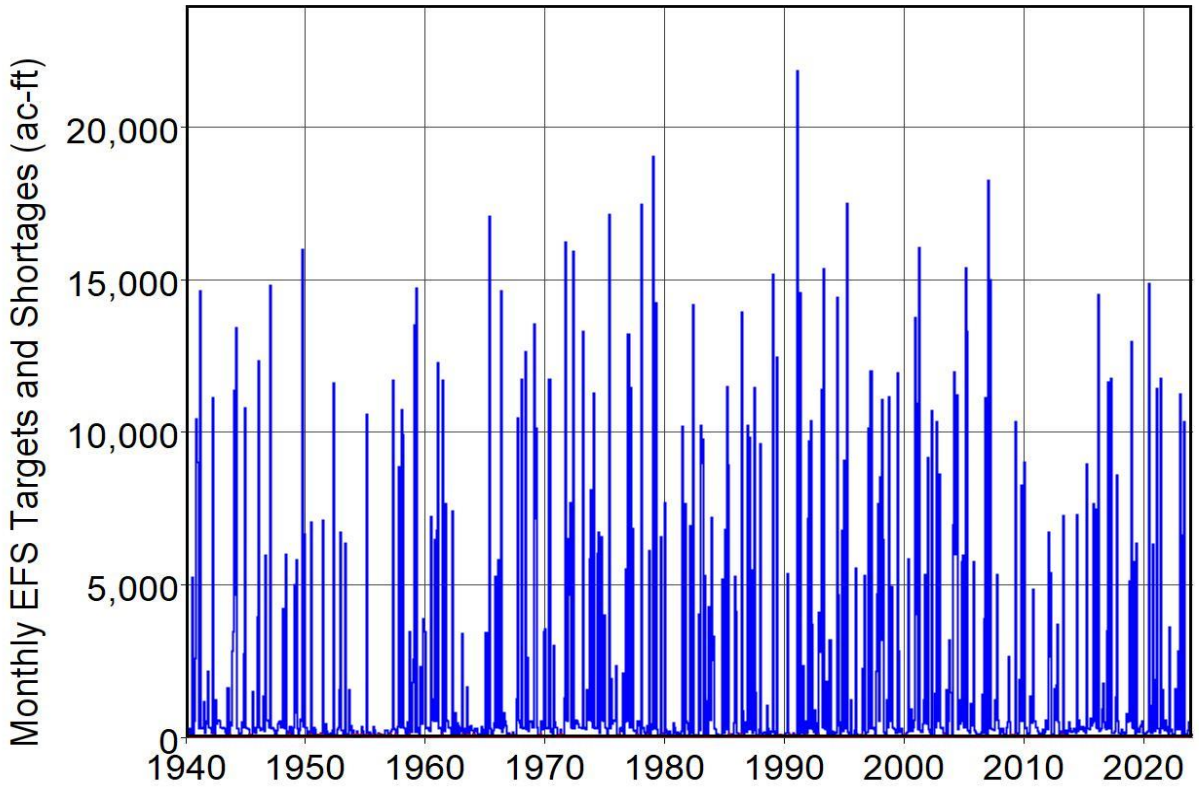

Figure C45 SB3 EFS Targets and Shortages for Sandy Creek near Ganada

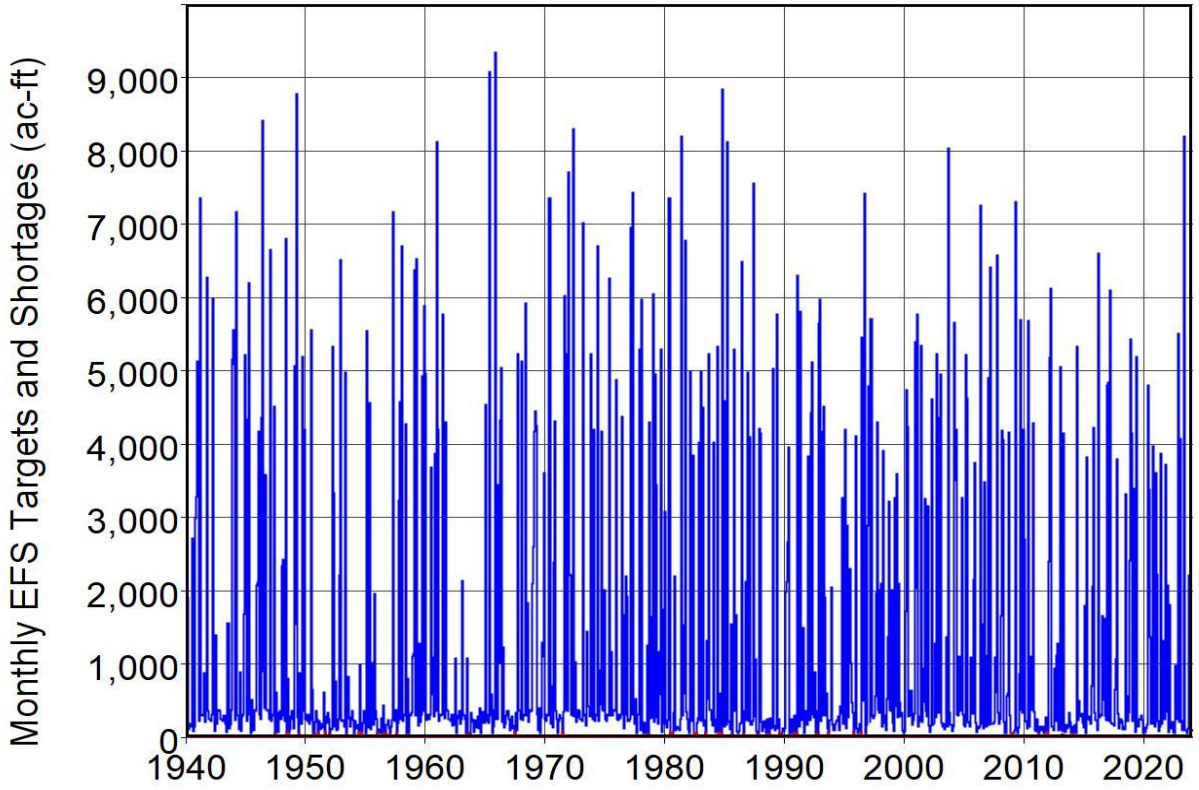

Figure C46 SB3 EFS Targets and Shortages for West Mustang Creek near Ganada

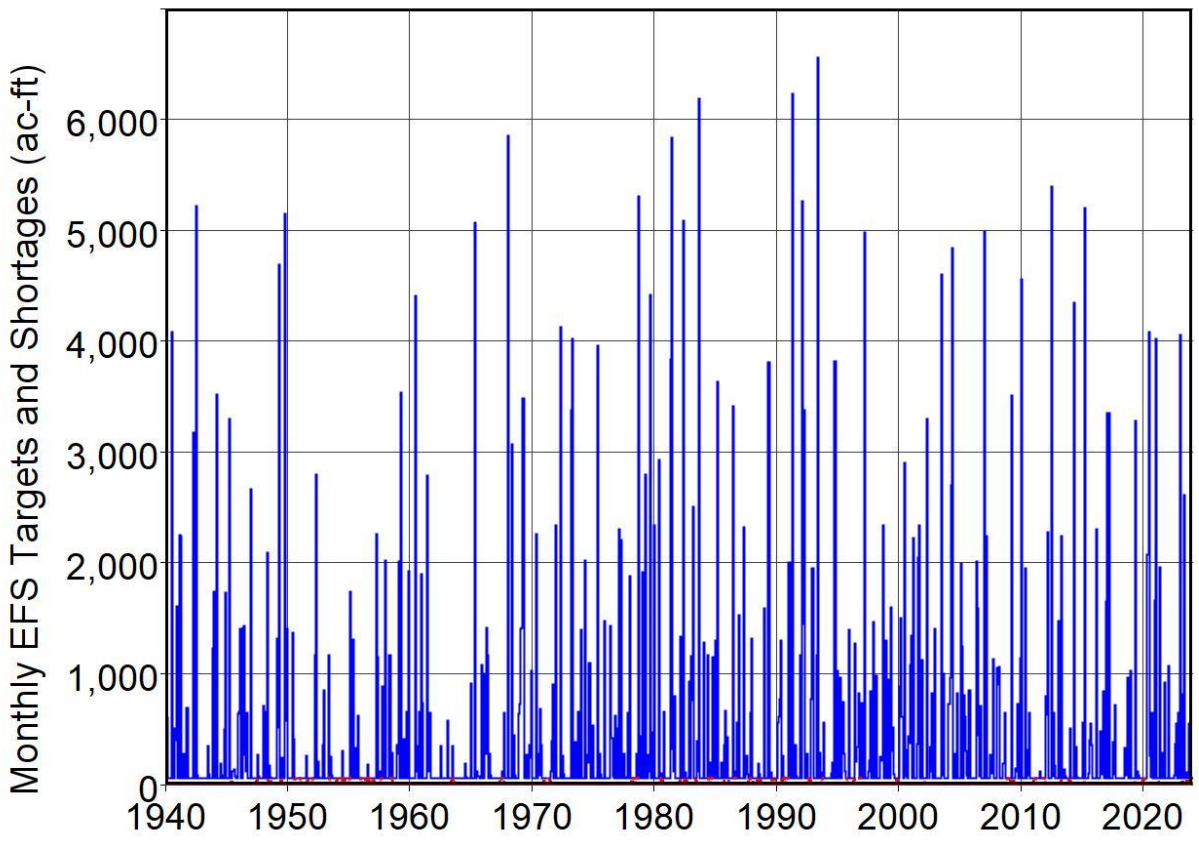

Figure C47 SB3 EFS Targets and Shortages for East Mustang Creek near Louise

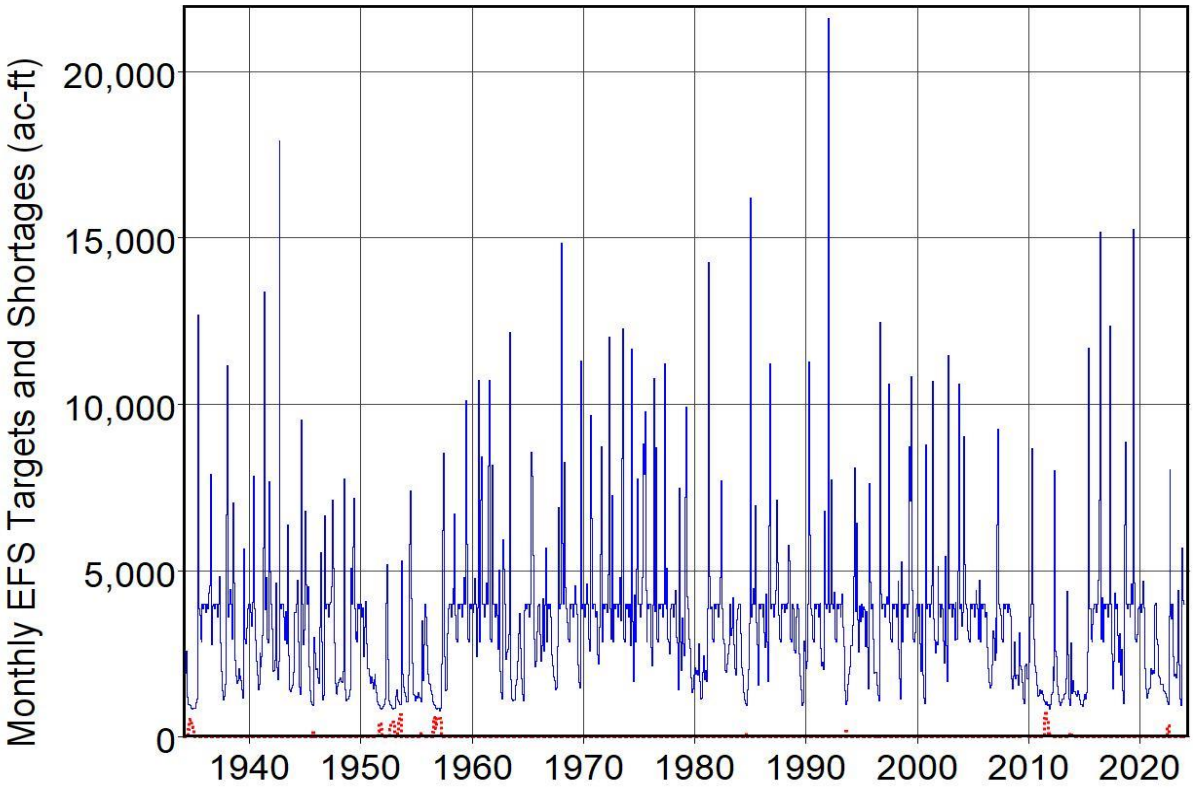

Figure C48 SB3 EFS Targets and Shortages for Nueces River at Laguna

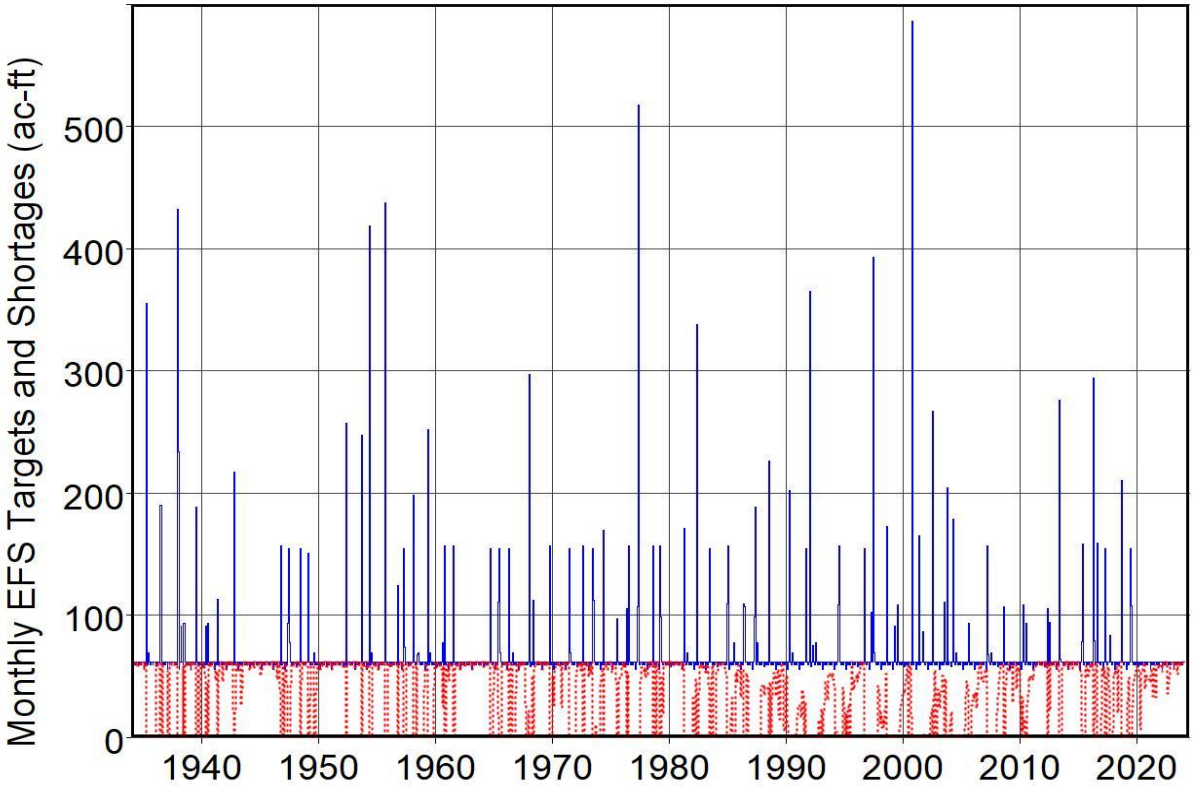

Figure C49 SB3 EFS Targets and Shortages for West Nueces River near Brackettville

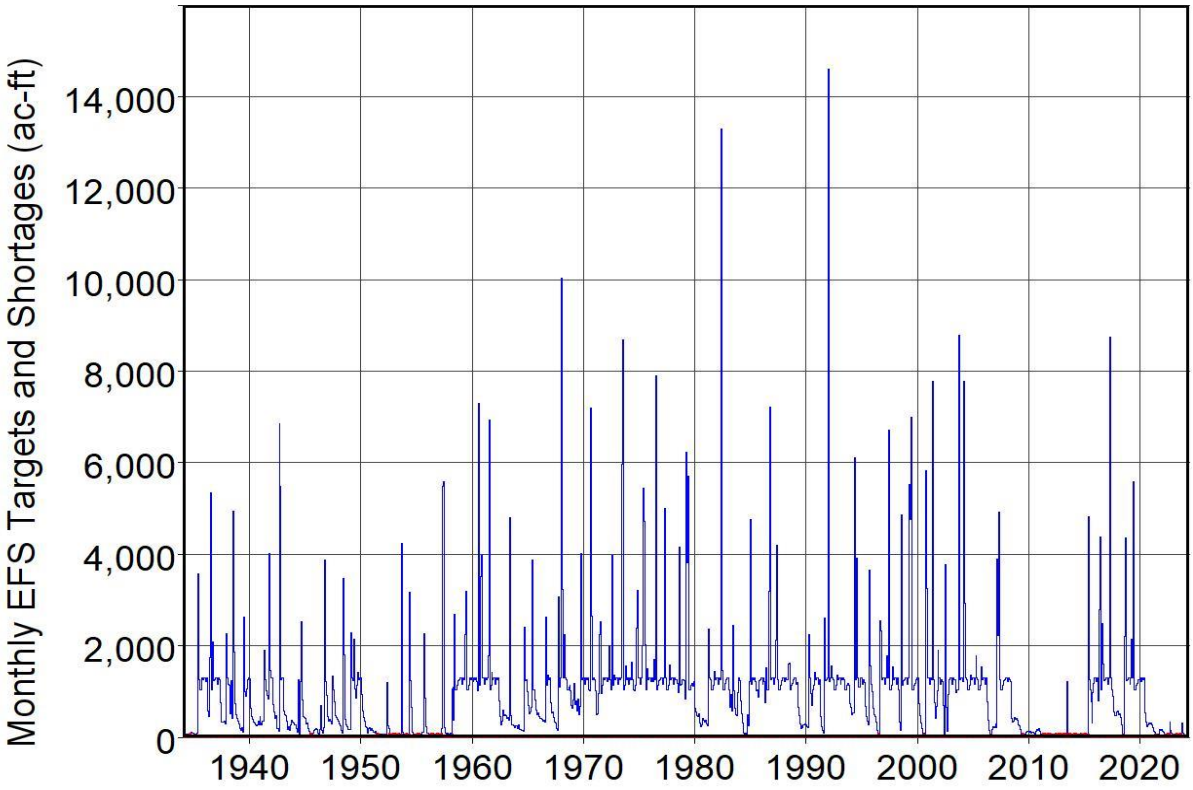

Figure C50 SB3 EFS Targets and Shortages for Nueces River below Uvalde

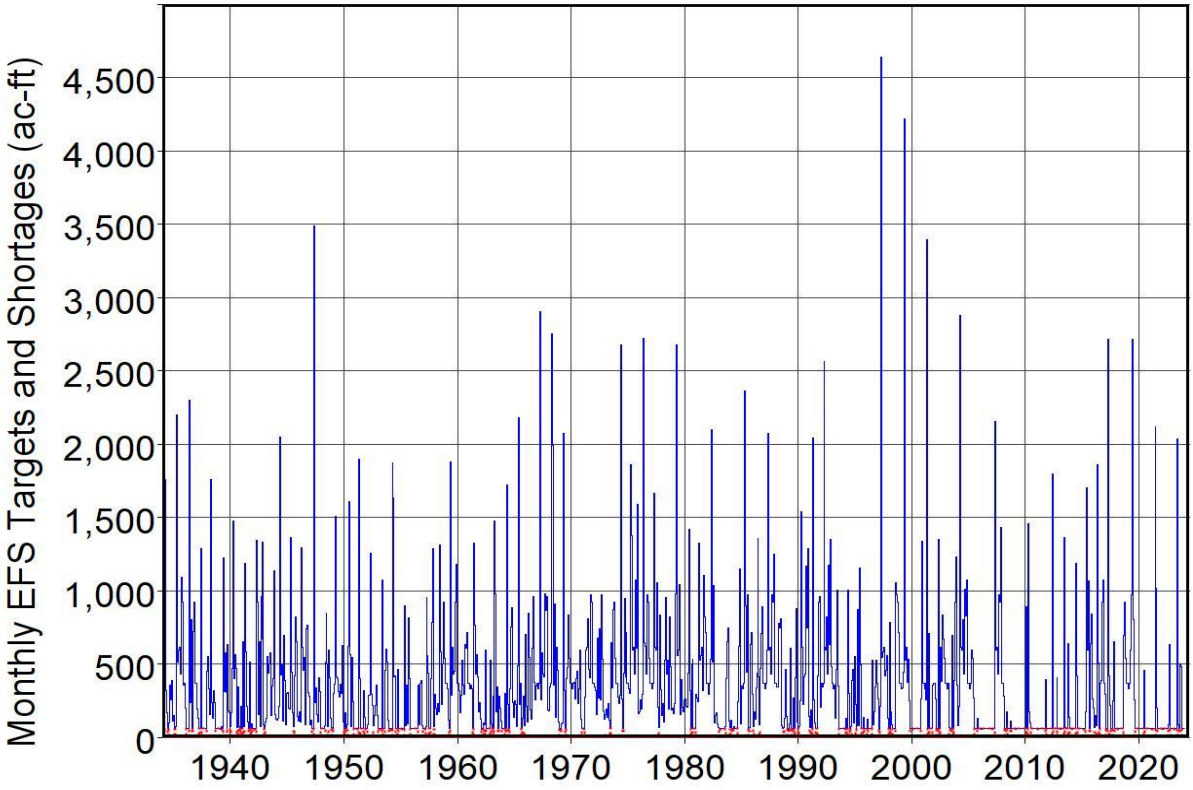

Figure C51 SB3 EFS Targets and Shortages for Nueces River at Cotulla

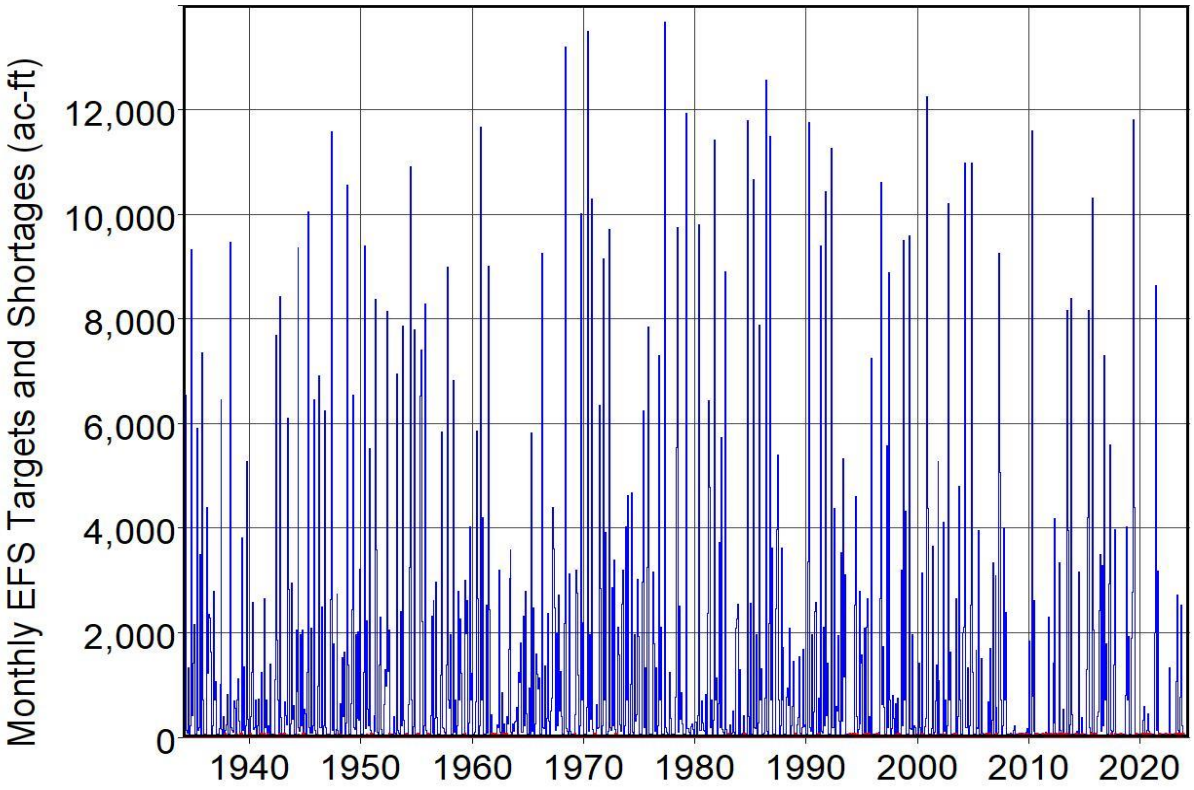

Figure C52 SB3 EFS Targets and Shortages for Nueces River near Tilden

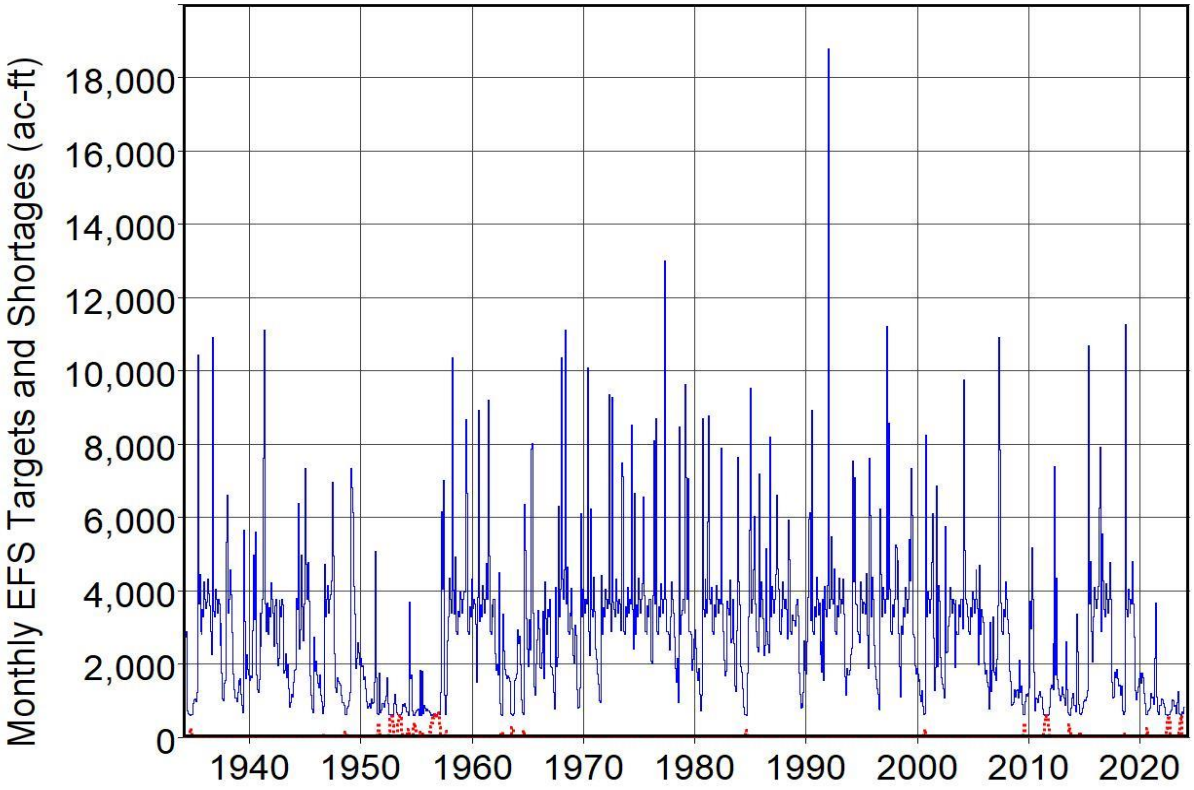

Figure C53 SB3 EFS Targets and Shortages for Frio River at Concan

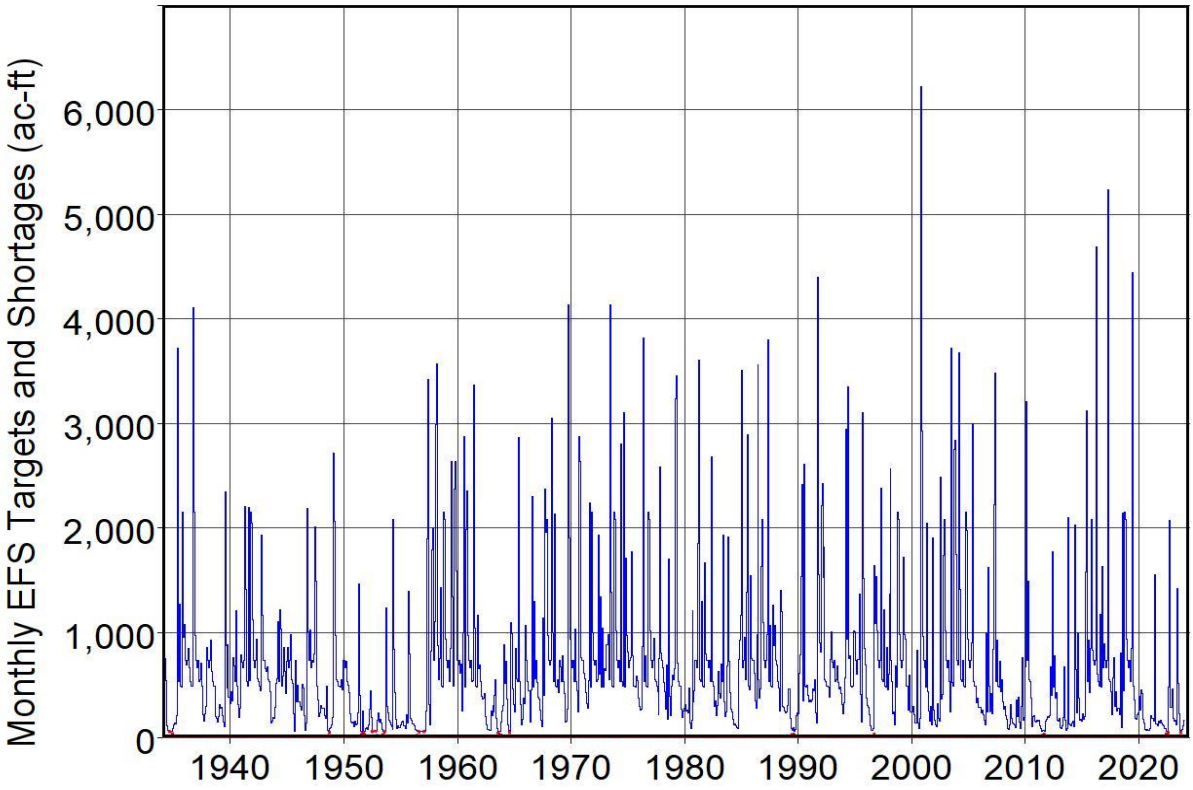

Figure C54 SB3 EFS Targets and Shortages for Dry Frio River near Reagan Wells

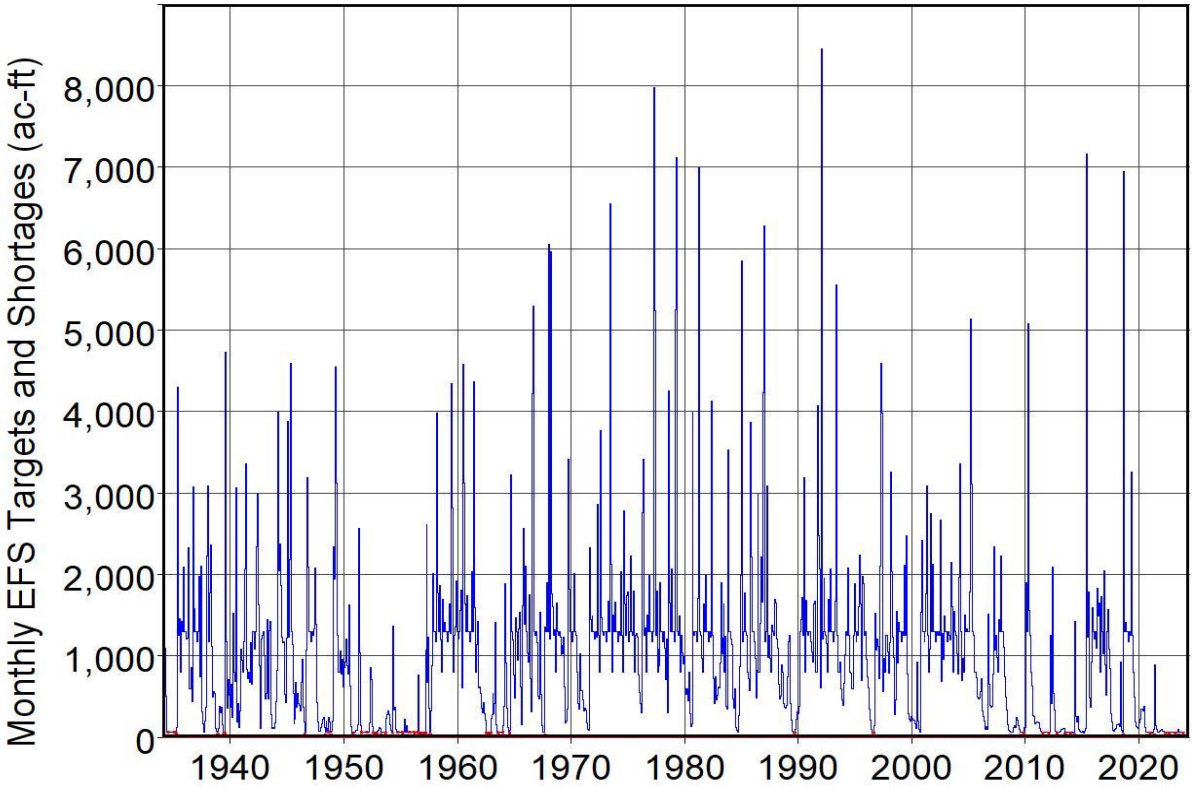

Figure C55 SB3 EFS Targets and Shortages for Sabinal River near Sabinal

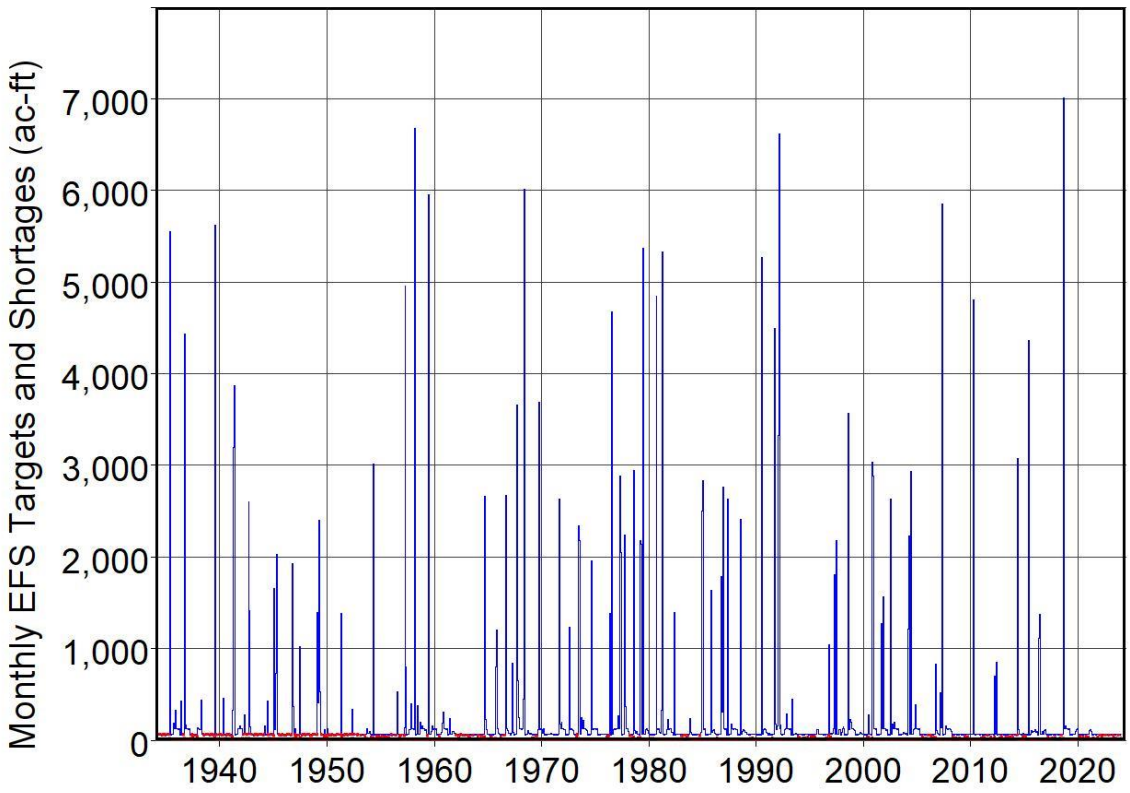

Figure C56 SB3 EFS Targets and Shortages for Sabinal River at Sabinal

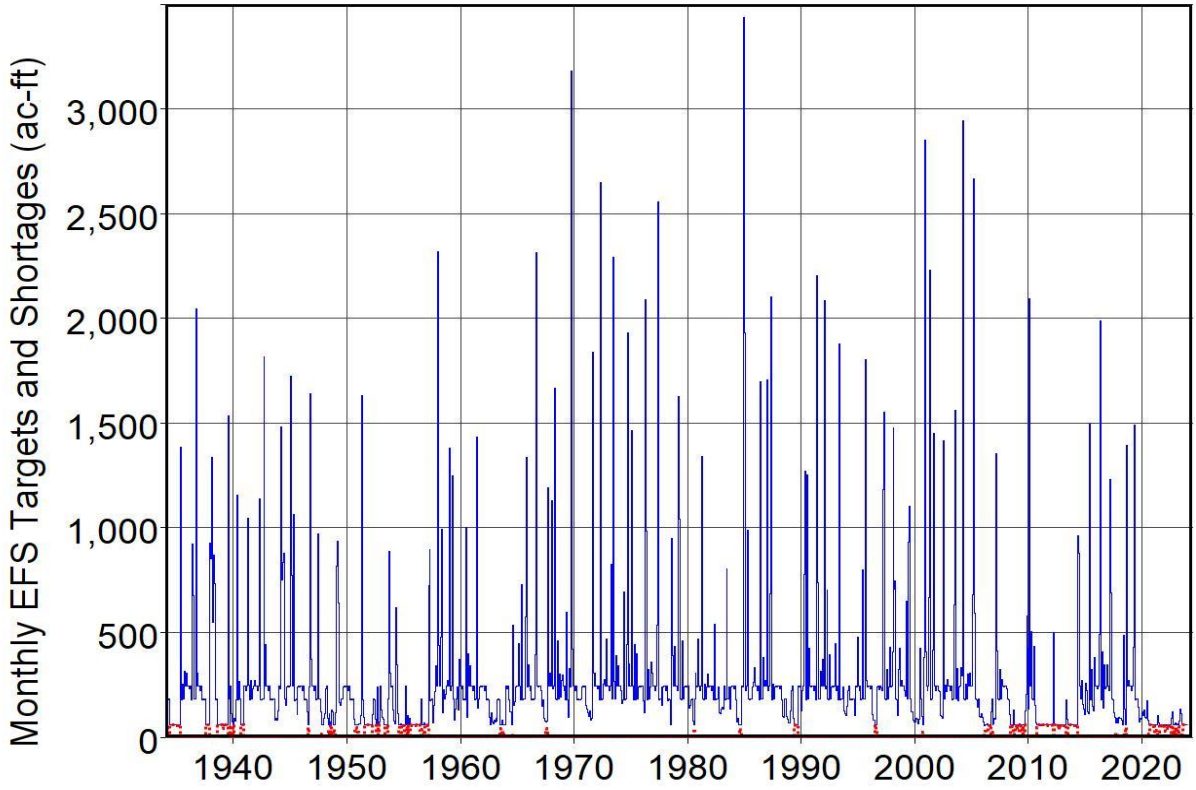

Figure C57 SB3 EFS Targets and Shortages for Seco Creek at Miller Ranch near Utopia

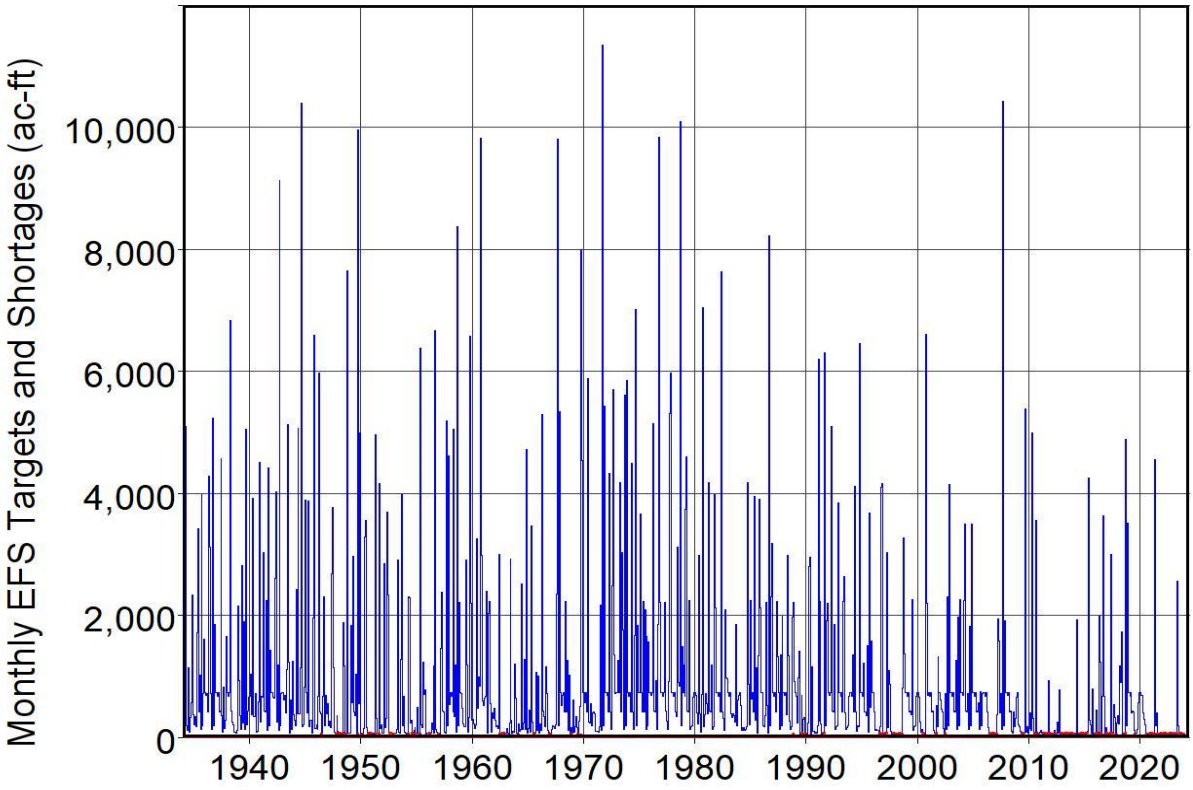

Figure C58 SB3 EFS Targets and Shortages for Hondo Creek near Tarpley

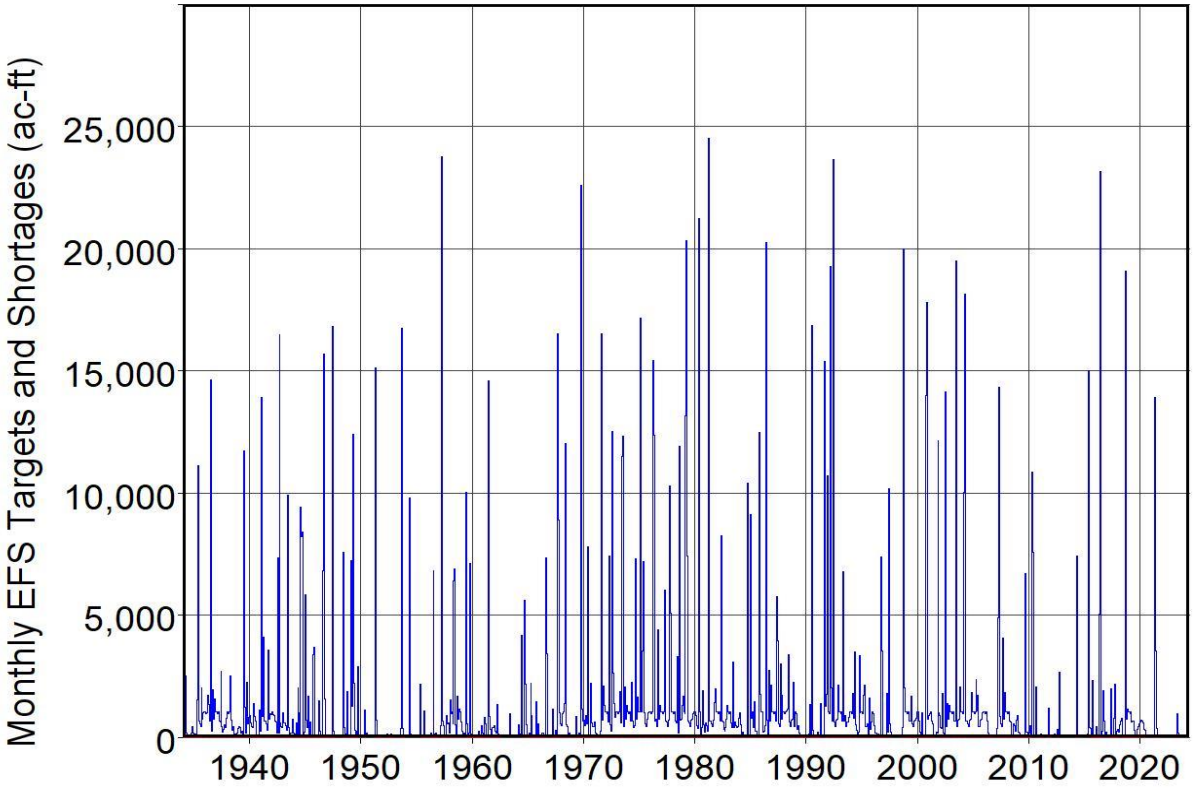

Figure C59 SB3 EFS Targets and Shortages for Frio River near Derby

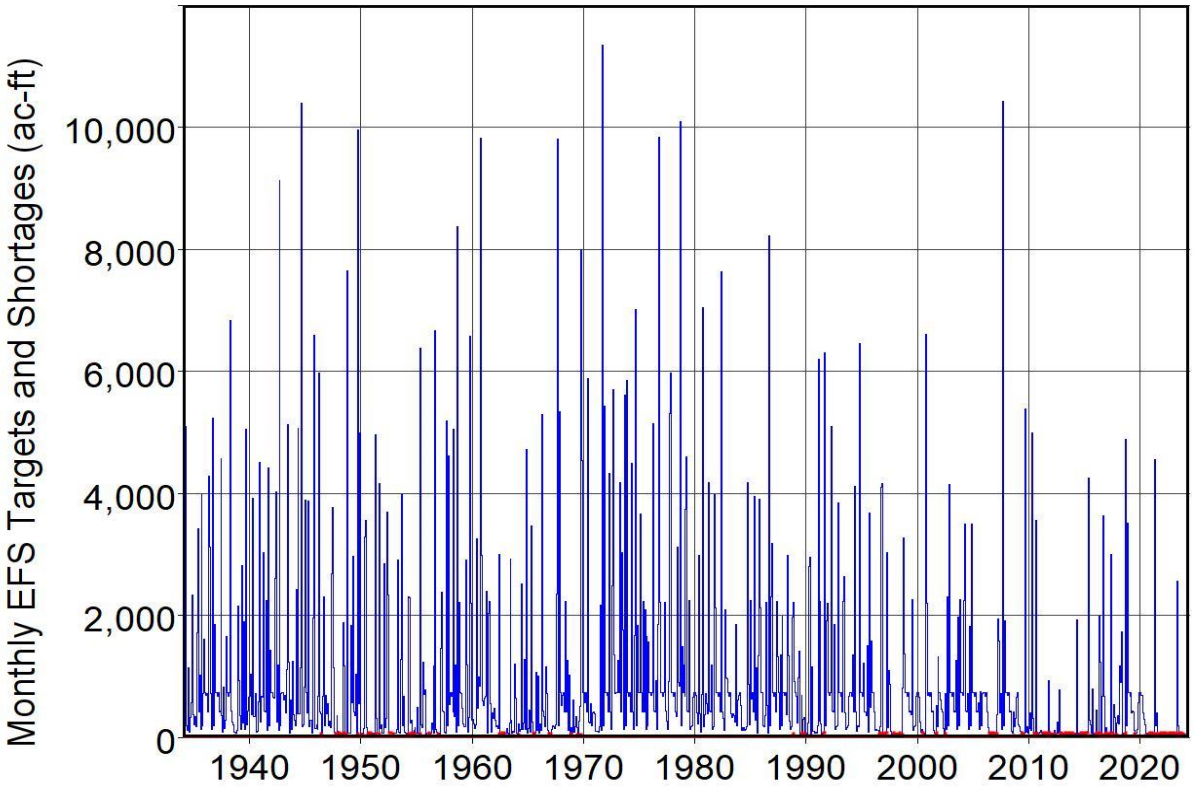

Figure C60 SB3 EFS Targets and Shortages for Frio River at Tilden

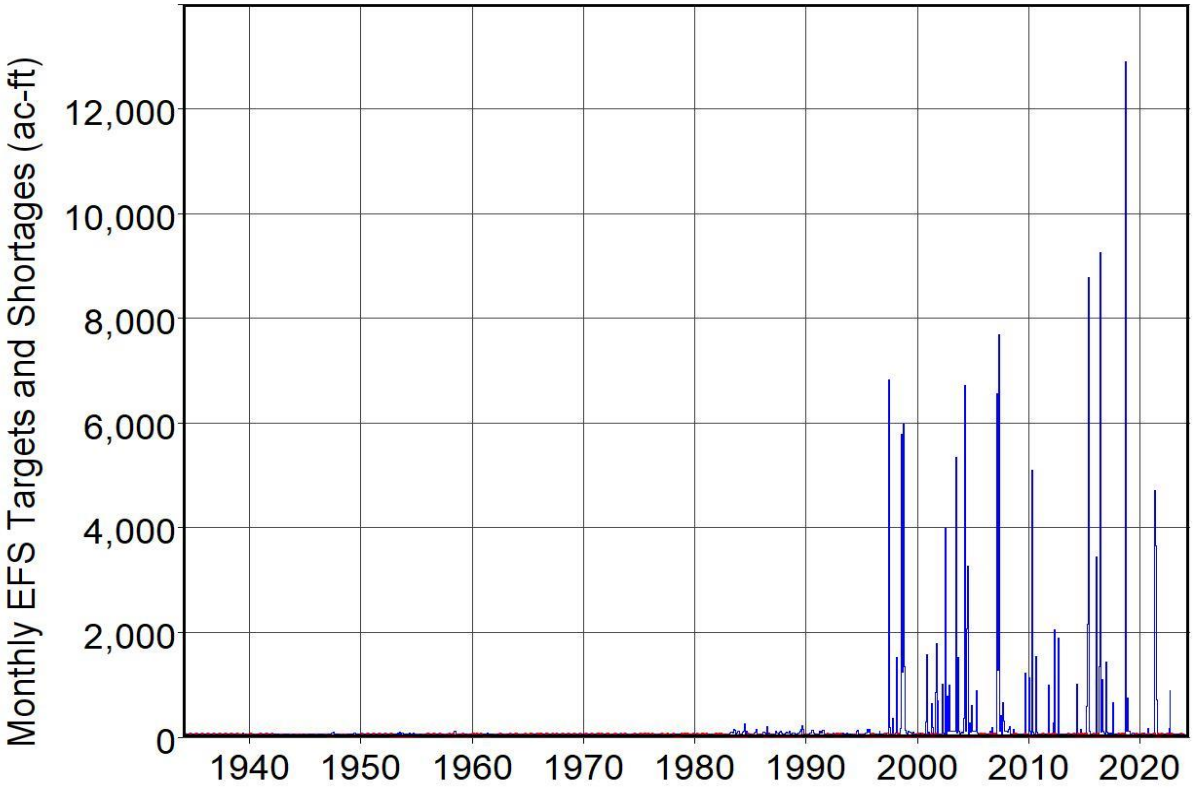

Figure C61 SB3 EFS Targets and Shortages for San Miguel Creek near Tilden

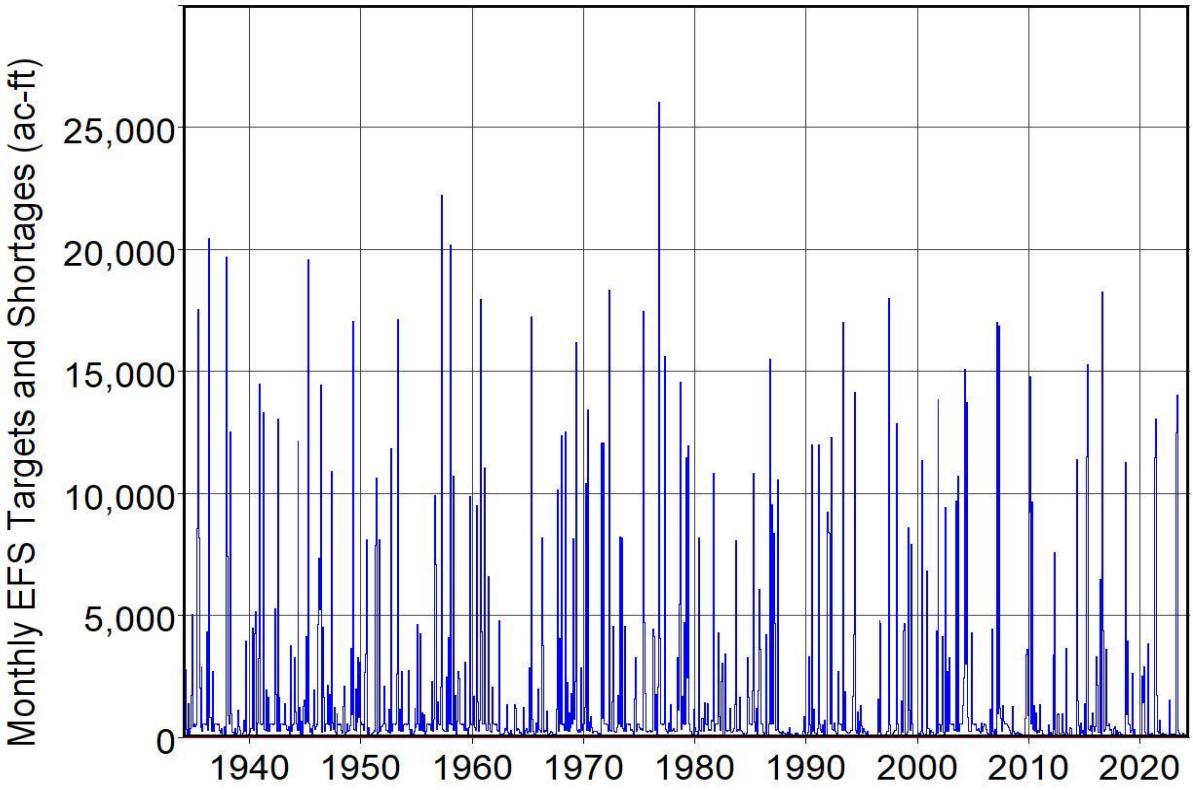

Figure C62 SB3 EFS Targets and Shortages for Atascosa River at Whitsett

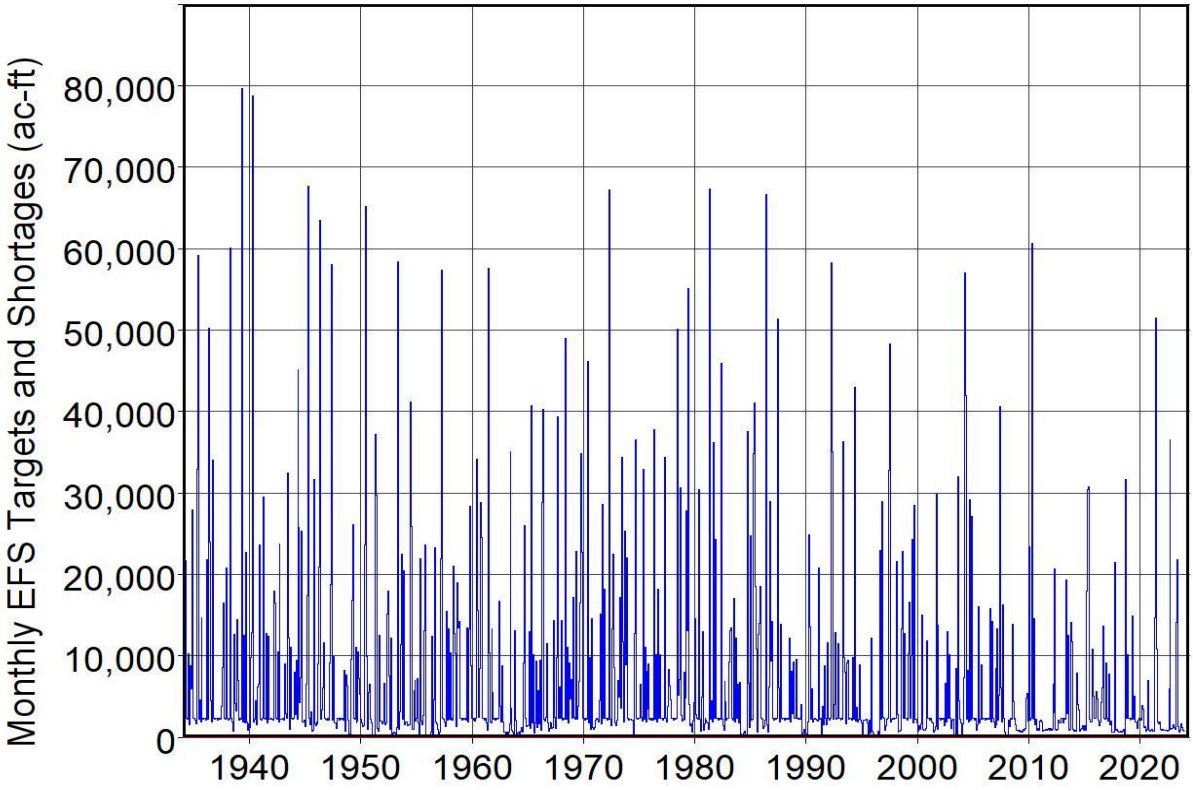

Figure C63 SB3 EFS Targets and Shortages for Nueces River at Three Rivers

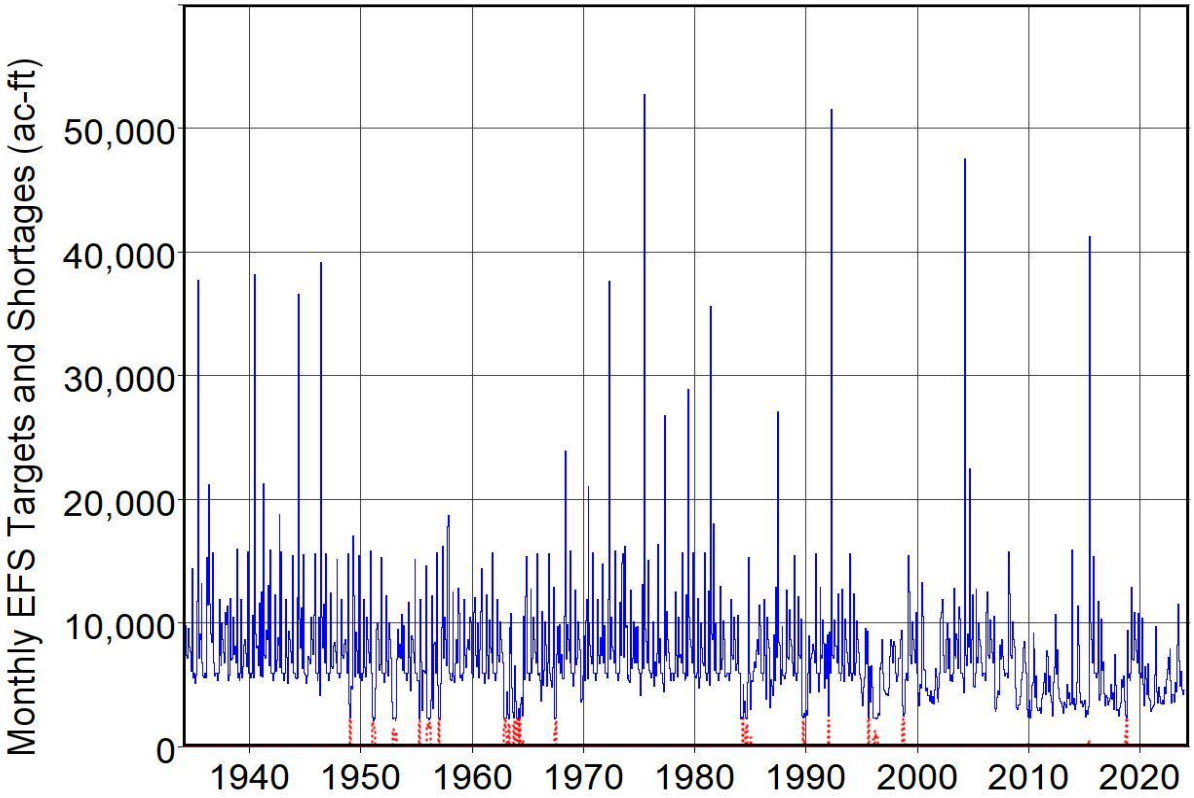

Figure C64 SB3 EFS Targets and Shortages for Nueces River near Mathis