

**EUFAULA LAKE
CANADIAN RIVER, OKLAHOMA
WATER CONTROL MANUAL**

**APPENDIX N
TO
WATER CONTROL MASTER MANUAL
ARKANSAS RIVER BASIN**

**PREVIOUS EDITION – JANUARY 1994
REVISED EDITION – MARCH 2014**

**DEPARTMENT OF THE ARMY
TULSA DISTRICT, CORPS OF ENGINEERS
OKLAHOMA**



DEPARTMENT OF THE ARMY
SOUTHWESTERN DIVISION, CORPS OF ENGINEERS
1100 COMMERCE STREET, SUITE 831
DALLAS, TEXAS 75242-1317

CESWD-RBT

MEMORANDUM FOR Commander, Tulsa District, ATTN: CESWT-EC-H

SUBJECT: Eufaula Lake Water Control Manual Approval

1. Reference email CESWT-EC-H, 29 July 2013, Subject as above. Approval reference from Mike Sterling (SWD) email dated 16 September 2013.
2. Review of the subject Eufaula Lake Water Control Manual has been completed. The manual is approved for distribution.

Encl

A handwritten signature in black ink, appearing to read "Ray Russo".

RAY RUSSO, P.E.
Acting Director, Regional Business Directorate

NOTICE TO USERS OF THIS MANUAL

Regulations specify that this Water Control Manual be used in loose-leaf form, and only those sections, or parts thereof, requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that inserts can be made to keep the Manual current. All elevations referred to in this manual, unless noted otherwise, are in feet, NGVD29 (National Geodetic Vertical Datum 1929).

EMERGENCY REGULATION ASSISTANCE PROCEDURES

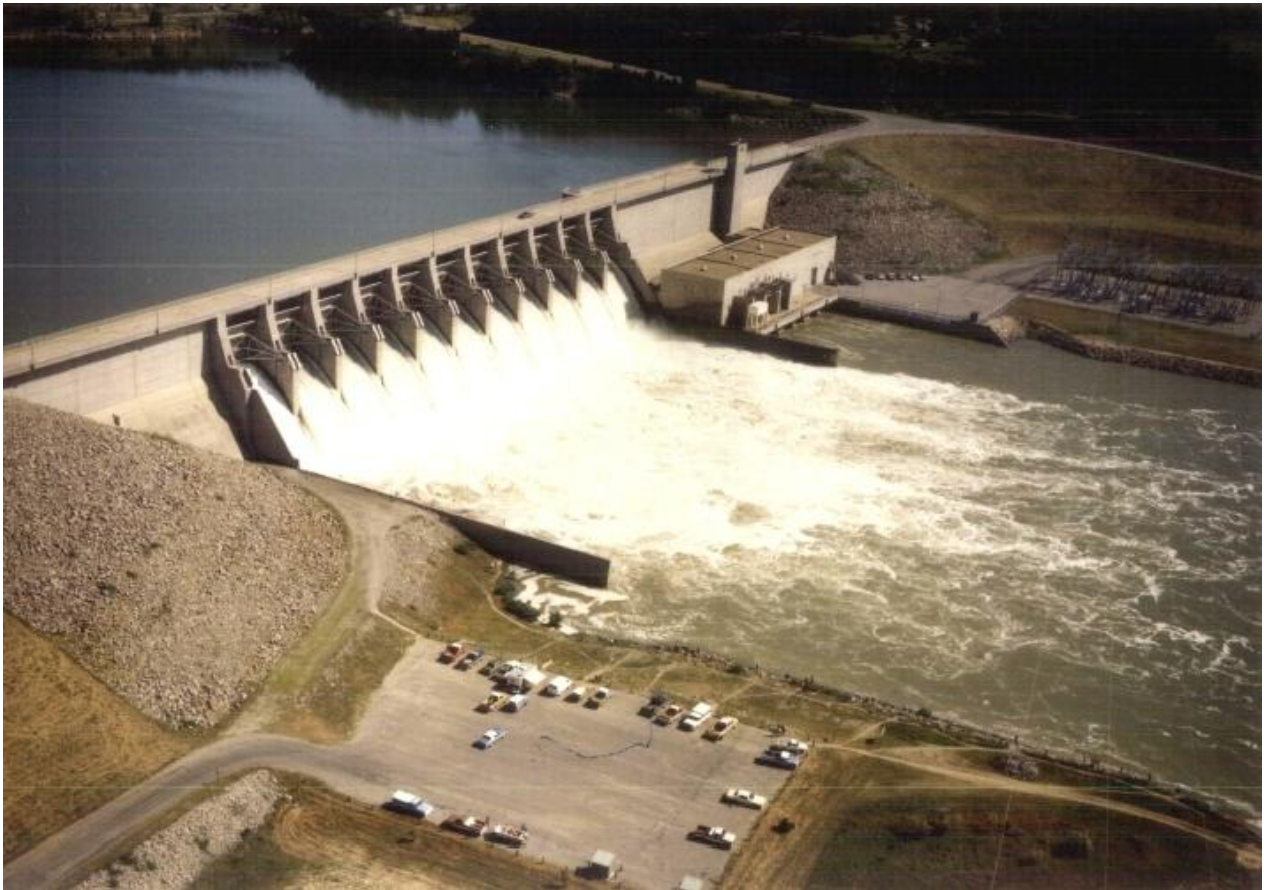
In the event that unusual conditions arise during duty hours and at various hours during weekends and holidays, contact can be made by telephone to the Water Management Section, Tulsa District Office (918) 669-7085. If the above office cannot be contacted, assistance can be achieved by contacting, in the order listed, one of persons shown below. Section VII of this Manual contains detailed instructions for emergency regulations. All project personnel associated with regulation of the project must be thoroughly familiar with the procedure outlined in this section.

EMERGENCY

PERSONNEL

ROSTER

<u>TITLE AND NAME</u>	<u>RESIDENCE TELEPHONE</u>
Coordinator [REDACTED]	(b) (6) [REDACTED] [REDACTED]
Backup Coordinator [REDACTED]	(b) (6) [REDACTED] [REDACTED]
Chief, Water Management Section [REDACTED]	(b) (6) [REDACTED] [REDACTED]
Chief, Hydrology-Hydraulics Branch [REDACTED]	(b) (6) [REDACTED] [REDACTED]



EUFULA DAM AND SPILLWAY

**EUFAULA LAKE, CANADIAN RIVER, OKLAHOMA
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PERTINENT DATA

LOCATION:

Eufaula Dam is located on the Canadian River at RM 27, about 12 miles east of Eufaula, OK.

DRAINAGE AREA:

47,522 square miles above the dam, which includes 9,700 square miles normally considered as non-contributing.
1 Inch of Runoff = 448,267 Acre-feet

DAM:

Type: Concrete gravity and Earth Embankment
Top of Dam Elev. = 612.0 feet, NGVD29
Length: 3,200 feet (including spillway and powerhouse intake)
Max Height: 114 feet above streambed
Top Width of Embankment: 36 feet

SPILLWAY:

Location: Near left abutment
Crest Elevation: 565.0 feet, NGVD29
Overflow Length: 520 feet (gross) & 440 feet (net)
Type: Gate controlled concrete gravity ogee weir
Control: 11 – 32' high x 40' wide tainter gates
Hoists: Individual electric-motored

LAND ACQUISITION:

	Guide Contour	Area (acres)
Fee Simple	597.0 feet	153,291
	600.0 feet plus backwater	29,906

OUTLET WORKS:

Type & Size: One 5'8" x 7'0" rectangular sluice
Location: Near left end of spillway
Control: Hydraulic, vertical-lift double gate
Invert Elevation: 500.0 feet

POWER FEATURES:

Installed Capacity
Current: 90,000 kilowatts (kW)
No. of Units: 3
Penstock Invert Elevation:
506.0 feet, NGVD29

PERTINENT DATA (continued)

	Elevation (feet NGVD29)	Area (acres) ⁽¹⁾	Lake Capacity			Spillway Capacity (c.f.s.) 11 gates	Outlet Works Capacity (c.f.s.) ⁽³⁾
			Accumulative (acre-feet) ⁽¹⁾	Runoff (inches) ⁽²⁾	Incremental (acre-feet) ⁽¹⁾		
Top of dam	612.0	200,150	6,034,620	--	1,323,220	-	
Maximum pool	604.96	166,780	4,711,400	10.51	788,430	474,000	2,490
Top of induced surcharge	600.0	146,240	3,922,970	8.75	423,120	384,000	2,430
Top of flood control pool	597.0	135,050	3,499,850	7.81	1,355,535	329,000	2,400
Top of conservation pool	585.0	94,525	2,144,315	4.78	1,346,325	147,000	2,230
Spillway crest	565.0	42,720	797,990	1.78	--	--	
Top of inactive pool	565.0	42,720	797,990	1.78	--	--	1,940
Flood Control Storage	585.0-597.0	--	1,358,430	3.03	--	--	
Power Storage ⁽⁴⁾	565.0-585.0	--	1,130,874	3.00	--	--	
Invert of lowest intake	500.0	6	12	--	12	--	0
Streambed at dam	498.0						

(1) Based on 2004 bathymetric survey and 2010 LiDAR survey (above top of conservation pool only)

(2) Runoff from normal contributing lower drainage basin area of 8,405 square miles.
One Inch of Runoff = 448,267 acre-feet.

(3) Discharge without spillway operating

(4) Power storage (1,130,874 ac-ft) is conservation pool (1,346,325 ac-ft) minus sediment reserve storage (135,591 ac-ft) and water supply storage (79,860 ac-ft). Storage based on 2034 sediment projection.

EUFAULA LAKE, CANADIAN RIVER, OKLAHOMA
WATER CONTROL MANUAL
APPENDIX N
TO
WATER CONTROL MASTER MANUAL
ARKANSAS RIVER BASIN

I - INTRODUCTION

1-01. Authorization. This manual is submitted in accordance with ER 1110-2-240 and prepared in accordance with EM 1110-2-3600 and ER 1110-2-8156.

1-02. Purpose and Scope. The purpose of this manual is to document the plan of water control; to present detailed information to higher authority; and to give guidance to personnel who will become concerned with, or responsible for, regulation of the lake during the life of the project.

1-03. Related Manuals. This manual is Appendix N to the Arkansas River Basin Water Control Master Manual. Other related manuals important to the regulation of Eufaula Lake are:

- Appendix E - Pensacola (Part I)
Markham Ferry (Lake Hudson)(Part II)
and Fort Gibson (Part III)
- Appendix G - Tenkiller
- Appendix H - Optima, Fort Supply, and Canton
- Appendix L - Oologah
- Appendix P - Lake Thunderbird
- Appendix Q - Lake Meredith
- Appendix S - Navigation System
- Appendix Z - Arcadia

The locations of existing and authorized projects are shown on Plate 1-1. Design memoranda important to the regulation of Eufaula Lake are shown in Table 1-1. Supplementary Pertinent Data are given in Exhibit A of this manual.

1-04. Project Owner. Eufaula Lake is owned by the U.S. Government.

TABLE 1-1
PERTINENT REPORTS AND DESIGN MEMORANDA
FOR EUFAULA DAM AND LAKE

Memorandum No.	Title	Date Submitted
1	Hydrology - Part I	10 Apr 1964
1	Hydrology - Part II	21 Jan 1966
2	General Design	11 Mar 1966
3A	Preliminary Master Plan	17 Jun 66
3B	Master Plan (Revised)	15 Sep 76
4-1	Real Estate - Dam site, Work Area, and Access Roads	9 Sep 66
4-3	Real Estate - Remainder of Lake	21 Jun 74
5	Left Abutment Access Road	15 Mar 66
6	Embankment	7 May 76
7	Outlet Works and Spillway	13 Apr 78
8	Construction Materials (Concrete Aggregates)	6 Apr 66
9	Project Buildings and Overlook	23 Mar 66
23	Reservoir Clearing	18 Jun 82
24	Sedimentation and Degradation Ranges	15 Jul 74
26	Plugging Oil and Gas Wells	25 Feb 80
27	Right Abutment Access Road	17 Jun 80
28	Initial Filling	30 May 84
	Eufaula Lake, Canadian River, Operation and Maintenance Manual, Volume I	Jul 1992
	Eufaula Lake, Canadian River, Operation and Maintenance Manual, Volume II, Flood Emergency Plan	Nov 2011
	Eufaula, Arcadia, Canton, Fort Supply and Optima Lakes, Canadian River Basin, Drought Contingency Plan	Sep 1990

1-05. Operating Agency. The U.S. Army Corps of Engineers, Tulsa District, is the operating agency for Eufaula Lake. The Lake Manager, Eufaula Lake, operating through the Operations Project Manager, Eastern Area, and the Operations Division, Tulsa District, has the responsibility for project operations. The project will be manned 24 hours a day when the lake level is above elevation 595.0 feet, National Geodetic Vertical Datum of 1929 (NGVD29). Below elevation 595.0 feet, the project will be manned for the normal 5-day work week. However, when the project is in a flood control regulation, operation personnel will closely monitor the project and the downstream river reaches. The project is furnished a list of the Water Management Section personnel to contact when necessary. The Lake Manager will furnish the Water Management Section a list of project personnel, giving their office and home telephones and addresses.

1-06. Regulating Agencies. The regulating agency for Eufaula Lake is the Corps of Engineers, with the lake's regulation being the responsibility of the Water Management Section, Hydrology-Hydraulics Branch, Tulsa District. Regulation of Eufaula Lake is coordinated with the Southwestern Power Administration (SWPA), which is the responsible federal agency for marketing hydroelectric power and energy from the project. SWPA schedules hydropower releases from the project on a daily basis in coordination with the Water Management Section.

II - DESCRIPTION OF PROJECT

2-01. Location. Eufaula Dam is located at river mile 27.0 on the Canadian River and is approximately 12 miles east of the town of Eufaula and 31 miles south of Muskogee, Oklahoma. The reservoir is located in Okmulgee, Haskell, McIntosh, and Pittsburg Counties, Oklahoma. The project location and vicinity are shown on Plate 2-1.

2-02. Purpose. Eufaula Lake is a multi-purpose project authorized for flood control, water supply, hydropower, navigation, and sediment control. The project was designed to provide maximum flood protection on the Canadian River and the Arkansas River when operated in conjunction with the Arkansas River Basin System.

2-03. Physical Components.

a. Embankment. The embankment is a rolled, earth filled structure consisting of random fill with an impervious core. The crest of the embankment is at elevation 612.0 feet. The maximum height of the structure is 114 feet. The width of the embankment at crest height is 36 feet including 24 feet of roadway paving and six foot shoulders. A cutoff trench with a bottom width of 49 feet is provided for the full length of the embankment. The upstream slopes of the embankment are protected by dumped riprap on backing material while the downstream slopes are grass covered. A general plan and section of the embankment are shown on Plate 2-2.

b. Spillway. The spillway is a gated, concrete, gravity, ogee weir type structure with a gross length of 520 feet and a net overflow length of 440 feet, with a crest elevation of 565.0 feet. The structure is located near the left abutment. Flows over the spillway are controlled by eleven 40' wide x 32' high tainter gates, which are operated by individual electric powered hoists. The rate of travel for each gate is approximately one foot of arc per minute. An emergency diesel powered generating unit is located at the project to provide electricity in case normal electric service is interrupted. The concrete slab stilling basin has two rows of baffles and a 6-foot high end sill. A general plan and section through the spillway is shown on Plate 2-2.

c. Outlet Works. The outlet works consist of one 5'8" x 7'0" sluice. This sluice passes through the base of the spillway along the centerline of an intermediate pier. The sluice outlet is equipped with a tetrahedral type deflector, and the flow is controlled by a hydraulically operated gate with a similar gate for emergency operation. A section of the spillway and outlet works is shown on Plate 2-2.

d. Water Quality. Water Quality is not an authorized purpose, and there is no water quality storage in Eufaula Lake. However, small temporary releases are occasionally made to alleviate dissolved oxygen deficiency or pollution downstream.

e. Water Supply. The water supply facility consists of a 5'8" x 7'0" rectangular sluice near the left end of the spillway. The invert elevation of the sluice is at elevation 500.0 feet.

f. Sedimentation and Degradation Ranges. Recent advancements in surveying technology have made older hydrologic survey methods obsolete. Range line surveys were used at Eufaula prior to 2004. A total of seventy five (75) sedimentation ranges and seventeen (17) degradation ranges are still in place for the lake area, their ends marked with permanent markers. Range line surveys have been replaced by methods such as SONAR (Sound Navigation And Ranging) and LiDAR (Light Detection and Ranging) from which detailed contours of the lake bed and flood pool can be produced. Sediment surveys are performed periodically by Tulsa District personnel or by contract for the purpose of computing sediment deposition, and for developing new lake area and capacity data. The historical sedimentation and degradation ranges are shown on Plates 2-3 and 2-4, respectively.

g. Hydroelectric Power. Hydroelectric power is generated at the dam and marketed by SWPA. The powerhouse is located between the spillway and the left abutment and contains three 30,000 kilowatt (kW) Francis-type generators. Three 22-foot diameter penstocks with an inlet invert elevation of 506.00 feet provide the water for the turbines. The inlet of the penstocks is controlled by two 20' x 40' vertical lift gates. The power head with full conservation pool is 94 feet and 74 feet when the conservation pool is empty. Historical average annual energy output (1968-2012) is 258,875 megawatt hours (MWh). The minimum energy produced was 43,774 MWh in 1956.

2-04. Related Control Facilities. None.

2-05. Real Estate Acquisition. The fee taking line for Eufaula Lake is a semi-blocked perimeter to elevation 597.0 feet, which is the top of the flood control pool. Flowage easements were acquired in the flat pool area above the fee taking line to elevation 600.0 feet. In the upper reaches, the flowage easement is to elevation 600.0 feet, or the elevation of the envelope curve of backwater effects of the 50-year flood after 50 years of sedimentation, whichever is higher. The envelope curve of backwater effects for the Canadian, North Canadian, and Deep Fork Rivers and for Gaines Creek with initial conditions are shown on Plates 2-5 through 2-8. Plates 2-9 through 2-12 show the backwater effects after 50 years of sedimentation. There are 153,291 acres in fee simple title and 29,906 acres in easement.

2-06. Public Facilities. A public overlook shelter is located on the upstream side of the right abutment. The Corps of Engineers maintains twenty parks, the State of Oklahoma maintains two parks, and the City of Eufaula maintains two parks. The public use areas are shown on Plate 2-13.

III - HISTORY OF PROJECT

3-01. Authorization. Eufaula Lake was authorized for construction by the River and Harbor Act approved 24 Jul 1946 (Public Law 525, 79th Congress, 2nd Session, H.R. 6407) for the purposes of flood control, hydroelectric power, water supply, sediment control, and navigation.

3-02. Planning and Design. The survey report entitled "Arkansas River and Tributaries, Arkansas and Oklahoma", was published in 1947 as House Document No. 758, 79th Congress, 2nd Session. This report included consideration of Eufaula Lake as a unit in the comprehensive development of the Arkansas River Basin for flood control, hydroelectric power, navigation and other uses. The general plan of improvement recommended in the report was approved by the Rivers and Harbors Act of 24 July 1946.

The Definite Project Report was submitted to the Chief of Engineers by letter dated, 29 Sep 1949. Studies conducted for this report resulted in the selection of two plans for detailed study and presentation. These two plans consisted of a two-reservoir plan with dams at the Canadian and Onapa sites, on the Canadian and North Canadian rivers at river miles 48.3 and 9.9, respectively, and a one-reservoir plan with a dam at the Eufaula site on the Canadian River at river mile 27.0. In the two-reservoir plan the Canadian Reservoir would provide for sediment control and generation of hydroelectric power, with flood flows on the Canadian River being diverted into Onapa Reservoir through a spillway located in the divide between the two streams. Onapa Reservoir would provide control of flood flows and sediment control on the North Canadian River and both reservoirs would be developed for recreation and fish and wildlife uses. The one-reservoir plan would provide for sediment control, generation of hydroelectric power, flood control, and other useful purposes, including recreational and fish and wildlife uses. The report recommended that the one-reservoir plan be selected as the Definite Project Plan. In a letter dated 26 Aug 1954, the Office of Chief of Engineers returned the Definite Project Report for retention until such time as planning could be resumed. In Aug 1955 the Tulsa District recommended that supplemental memoranda be submitted in lieu of a revised Definite Project Report. On 5 Oct 1955 the Definite Project Report was approved by the Office, Chief of Engineers and directed that individual design memoranda be prepared for each specific feature of the project. Feature design memoranda have been prepared covering such topics as hydrology, structural features of the project, relocation of roads and utilities, hydroelectric power, and real estate. Section 3133 of WRDA 2007 established the creation of the Lake Eufaula Advisory Committee to provide information and recommendations to the Corps of Engineers regarding the operations of Eufaula Lake for the various project purposes. The draft charter for the advisory committee has been developed and staffed to the Secretary of the Defense for approval.

3-03. Construction. A resume of construction activities for Eufaula Lake is presented in Table 3-1.

TABLE 3-1
RESUME OF CONSTRUCTION ACTIVITIES

Activity	Date
Construction began	1 Feb 1956
Date of diversion	1 Feb 1963
Final storage began	10 Feb 1964
Conservation pool filled	20 Mar 1968

3-04. Related Projects. Eufaula Lake is a component of the multi-purpose Arkansas River Basin flood control and navigation system. Included in this system are completed projects in the Verdigris, Walnut, Canadian, North Canadian, Grand, Caney, Illinois, and Poteau River Basins. Related projects upstream of Eufaula Lake include Arcadia Lake on the Deep Fork River, Canton and Optima Lakes on the North Canadian River, Fort Supply Lake on Wolf Creek, Lake Thunderbird on the Little River, and Lake Meredith on the Canadian River. The Natural Resources Conservation Service (NRCS), in cooperation with local watershed districts, has constructed over 320 flood retarding structures in the Eufaula Lake watershed (see Plate 3-1).

3-05. Modification to Regulations. The regulation of Eufaula Lake has been modified to coincide with the present Arkansas River System Operating Plan as discussed in the Arkansas River Basin Water Control Master Manual.

3-06. Principle Regulation Problems. The principal regulating problem for Eufaula Lake is the change in channel capacity from 100,000 c.f.s. in the 1960's to the current 40,000 c.f.s. This change is due primarily to channel encroachments and changing land use practices. Other regulation problems include flooding of recreation areas when the pool rises above elevation 590.0 feet, severe shoreline erosion caused by wind and wave action, and flooding of the powerhouse when spillway releases are greater than 260,000 c.f.s. Twenty-four hour surveillance of the dam begins at elevation 595.0 feet.

IV - WATERSHED CHARACTERISTICS

4-01. General Characteristics. The Canadian River rises in the Sangre de Cristo Mountains in northeastern New Mexico at an elevation of approximately 8,000 feet, NGVD29, and flows in an easterly direction through the Texas Panhandle and through western Oklahoma until it joins with the Arkansas River (elevation 450 feet, NGVD29), about 450 miles above its mouth, near Webbers Falls, Oklahoma. The slope of the stream is about 43 feet per mile in the extreme headwaters area and varies from nine to five feet per mile in New Mexico and Texas, six feet per mile in western Oklahoma, and about two feet per mile in eastern Oklahoma. The channel is wide and meandering with low banks above Norman, Oklahoma, (river mile 211). Between Norman and the river's mouth, the banks gradually increase in height. Channel capacity at the Texas-Oklahoma state line is approximately 70,000 c.f.s. and at the mouth about 40,000 c.f.s. The river basin is approximately 560 miles long. It is wide in the western portion then narrows in the central portion, and widens again in the eastern portion with an average width of 85 miles. The area of the basin is 47,705 square miles, of which 47,522 square miles are above Eufaula Dam and includes 9,700 square miles normally classified as non-contributing.

A major tributary of the Canadian River is the North Canadian River which enters the main stream at river mile 38.5. The North Canadian River rises in the high Plateau region of northwestern New Mexico, is about 840 miles in length, and roughly parallels the Canadian River. The basin has an area of 17,712 square miles. Smaller tributaries of the Canadian River in eastern Oklahoma are Little River with a drainage area of 973 square miles, and Gaines Creek with 1,163 square miles of drainage area. A major tributary of the North Canadian River is the Deep Fork River which has a drainage area of 2,548 square miles. Stream profiles of the Canadian River, North Canadian River, Deep Fork River and Gaines Creek are shown on Plates 4-1 through 4-4.

4-02. Topography. Most of the western portion of the basin lies in the high plains region. The terrain is level or gently rolling with elevations varying from about 5,000 to 3,000 feet, NGVD29. The soils of this region have a high infiltration rate. The cap rock, which forms the eastern border of the high plains, is a distinct escarpment outlining highly eroded, rough, broken lands. East of the cap rock lies an area of rolling prairies and broken hills, varying in elevation from about 3,000 to 1,000 feet, NGVD29. The soils of this area vary widely in fertility, structure and use. Natural cover consists of short grasses. To the east of the urban areas in and around Oklahoma City, the Canadian River and its principal tributaries flow through heavily wooded plains surrounded by low and gently rolling hills. Cover consists of oak-hickory forests interspersed with short and tall grasslands or small farms. Pine tree forests can be found in the rolling hill areas in the extreme southeast portion of the basin.

4-03. Geology and Soils. The dam site is on the eastern border of the prairie plains subdivision of the Osage plains physiographic division. The rock strata are assigned to the Des Moines series. Bedrock is sedimentary and Pennsylvanian in age, principally

consisting of the Boggy and Savanna formations. Regional dip is westward 40 to 60 feet per mile. The ridge and plain topography is due to unequal resistance to erosion with sandstone capping elongated ridges and shale forming the valleys. Some westward and southwest trending folds and faults related to the Ozark dome uplift also influence the structure of the area. The overlying consists mainly of Pleistocene terraces and Holocene or Recent alluvium. The Pleistocene deposits are mainly gravel, sand and silty clay while an occurrence of volcanic ash is present in the alluvium.

4-04. Sediment. The lake inflow carries a large amount of sediment that comes mostly from the Canadian River. During periods of low flow, the channel meanders over a wide sandy bed between banks that are easily eroded. During periods of high flows, bank caving and erosion occur at many locations. Four bathymetric surveys have been conducted (1964, 1969, 1977, and 2004) since completion of the project. There was also a 2010 LiDAR survey from the bottom of the flood pool to the top of the dam. The amount of storage lost to sediment accumulation below elevation 597 feet since 1964 is 451,038 acre-feet, according to the merged 2004 bathymetric and 2010 LiDAR surveys. It is estimated that the sediment deposition is 7,600 acre-feet annually, with 48 percent being deposited below the top of conservation pool. Based on the merged 2004 bathymetric and 2010 LiDAR surveys, there is 3,499,854 acre-feet of sediment storage remaining. This remaining storage is distributed as follows: 38.73 percent flood pool (1,355,539 acre- feet), 38.47 percent conservation pool (1,346,325 acre-feet), and 22.80 percent inactive pool (797,990 acre-feet).

4-05. Climate. Climatic characteristics of the Canadian River Basin above the dam site are dissimilar. In the western portion of the basin, the winters are often severe, snowfall is relatively heavy, and the summers are usually mild. The central and eastern portions are characterized by moderate winters and long summers with high temperatures. Local thunderstorms with high intensities occur over the basin during the spring, summer and fall months. Wind movements can be of considerable magnitudes in the spring months. There is a comparatively high percentage of sunshine and evaporation across the basin. Climatic characteristics for the basin are shown in the following tabulation.

a. Temperature. (Period of Record is Jan 1930 through Dec 2010)

Mean annual	59.5 degrees F
Maximum in a point near Eufaula Lake Eufaula, OK (14 Jul 2003)	112 degrees F
Minimum in a point near Eufaula Lake Eufaula, OK (10 Jan 1977)	-23 degrees F

b. Rainfall.

Mean Annual (Period of record 1930 – 2010)	37.89 inches
Maximum annual (1973)	66.8 inches
Minimum annual (1978)	16.3 inches
Percent during growing season (Apr through Oct)	62 %

The average monthly and annual rainfall and runoff data are shown in Table 4-1.

c. Snowfall. (Period of record 1930 – 2010)

Maximum Annual (1979)	17.0 inches
Minimum (Several years)	Zero
Annual Snowfall Average	6.7 inches

d. Evaporation. Following the construction of the Eufaula Project, evaporation data was collected from an evaporation pan on site. In 1996, Tulsa District migrated from physical evaporation measurements to using an empirical formula, based on meteorology data collected on site. The formula incorporates electronically collected data for solar radiation, wind speed air temperature and relative humidity. Average monthly pan evaporation figures are shown in Table 4-2, for the period Oct 1979 through Dec 2010.

e. Wind. The prevailing wind is from a southerly direction, with the greatest wind movements occurring in the spring months. Wind velocity data indicate the highest wind speed that can reasonably be expected at the dam site is 60 miles per hour and the highest wind speed for a one-hour duration is 43 miles per hour.

4-06. Storms and Floods. Most major storms in the Eufaula Lake drainage basin have occurred in April through June and September through November. However, major storms can occur at any time. The storms that produce precipitation over the basin are of three general types; (1) thunderstorms, (2) frontal storms, and (3) remnants of hurricanes. The largest storm in the 50 years of record was the 17 Nov – 26 Dec 1992 storm, that produced an average of 10.48 inches of rain. The time of year and antecedent soil moisture condition are also major factors that determine the amount of runoff from a given storm. Major storms in the basin are listed in Table 4-3, located in the Supplemental Tables Section. The top twenty annual peaks for major gage sites are presented in Table 4-4.

TABLE 4-1

AVERAGE MONTHLY AND ANNUAL RAINFALL
AND RUNOFF UPSTREAM OF EUFAULA DAM

Month	Average Rainfall (inches)	Percent of Average Annual Rainfall	Average Runoff ^{(1) (2)}		Percent of Average Annual Runoff
			(acre-feet)	(inches)	
Jan	1.64	4.33	252,200	0.56	5.64
Feb	2.04	5.38	321,180	0.72	7.18
Mar	2.88	7.60	468,920	1.05	10.49
Apr	3.77	9.95	561,900	1.25	12.57
May	5.60	14.78	811,130	1.81	18.15
Jun	4.42	11.67	595,930	1.33	13.33
Jul	2.94	7.76	247,800	0.55	5.54
Aug	2.78	7.34	136,690	0.30	3.06
Sep	4.00	10.55	203,700	0.45	4.56
Oct	3.36	8.87	326,830	0.73	7.31
Nov	2.54	6.70	273,770	0.61	6.12
Dec	1.92	5.07	270,320	0.60	6.05
TOTAL	37.89	100.00	4,470,370	9.96	100.00

(1) Period of Record is Jan 1923 through Dec 2010 (from Annual Report)

(2) Drainage area upstream of Eufaula Dam is 47,522 square miles, of which approximately 37,822 contributes to flow at the dam. Runoff from lower drainage area of 8,405 square miles.

TABLE 4-2
 ESTIMATED MONTHLY EVAPORATION
 EUFAULA LAKE⁽¹⁾
 Oct 1979 – Dec 2010

Month	Evaporation (inches)
Jan	2.44
Feb	2.71
Mar	4.51
Apr	5.86
May	6.47
Jun	7.62
Jul	9.32
Aug	8.57
Sep	6.04
Oct	4.70
Nov	3.50
Dec	2.54
Annual Total	64.28

(1) National Weather Service Class "A" pan until 1996. Empirical estimate of pan evaporation since 1996.

TABLE 4-4

TOP TWENTY ANNUAL PEAK FLOWS AT STREAM GAGES

Deep Fork Near Beggs, OK			North Canadian River Near Wetumka, OK			Canadian River at Calvin, OK		
DATE	FLOW (c.f.s.)	STAGE	DATE	FLOW (c.f.s.)	STAGE	DATE	FLOW (c.f.s.)	STAGE
11 May 1943	66,800	34.55	Oct 1923	N/A	26.90	03 May 1990	146,000	18.97
15 Apr 1945	60,900	34.11	Apr 1927	N/A	26.50	11 May 1950	174,000	17.35
24 Jun 1948	53,400	33.35	15 Apr 1945	66,000	26.40	05 May 1941	150,000	17.00
16 Mar 1990	37,000	31.19	31 Oct 1941	25,000	24.40	29 May 1987	154,000	15.88
13 Jun 1974	31,000	30.69	10 May 1943	28,300	23.72	18 May 1949	146,000	15.55
06 Nov 1974	29,800	30.36	24 Jun 1948	30,000	20.99	10 May 1993	93,400	15.32
14 May 1993	30,700	30.03	27 Apr 1999	24,300	19.40	21 Oct 1983	144,000	15.29
11 Jun 1941	31,000	29.78	14 May 1993	29,000	19.29	24 Jun 1948	149,000	15.20
26 May 1957	30,300	29.75	12 Jun 1941	16,600	19.18	31 May 1937	135,000	15.00
27 Feb 1985	27,700	29.65	29 Jun 2007	23,900	18.45	10 May 1943	130,000	14.80
03 Nov 1941	27,100	28.79	08 May 1995	22,600	18.34	08 Oct 1970	130,000	14.50
24 May 1949	23,200	27.80	10 Apr 2008	23,200	18.20	18 May 1957	134,000	14.10
05 Apr 1988	20,900	27.53	18 May 1949	32,200	17.60	30 Oct 1941	100,000	13.90
12 May 1995	21,800	27.36	05 Aug 1992	16,660	17.22	26 Apr 1999	96,800	13.57
29 Apr 1999	19,600	27.06	11 May 1950	36,000	16.49	17 Mar 1998	95,200	13.45
12 May 1950	20,200	26.85	27 Apr 1998	16,800	16.42	08 May 1995	92,100	13.24
21 Mar 1998	18,900	26.82	30 May 2001	17,300	16.05	21 Aug 1958	104,000	12.70
01 Jul 2007	18,700	26.21	05 May 1990	27,000	15.53	20 May 1982	69,400	12.69
18 May 1947	17,700	25.90	09 Oct 2009	16,300	15.34	20 May 1955	102,000	12.60
20 Oct 1985	15,800	25.50	25 May 1957	39,400	15.00	11 May 1992	62,100	12.59

Flood Stage = 18.0 feet
 Period of Record is
 1 Oct 1938 – Present

Flood Stage = 14.0 feet
 Period of Record is
 1 Oct 1937 – Present

Flood Stage = 17.0 feet
 Period of Record is
 1 Jul 1905 – Present

Note: N/A indicates not available
 Annual Peak Flows are the highest flow during a given water year (1 Oct to 30 Sep of following calendar year) and are based on published data from the USGS website.

4-07. Runoff Characteristics. The watershed of the Canadian River includes two major basins, the Canadian and North Canadian Rivers. The upstream portion of both drainage basins, which lie in the High Plains region of Texas and Oklahoma, rarely produce flood flows which contribute to inflow into Eufaula Lake. In general, stream flows of the Canadian Rivers along their entire lengths are characterized by irregularity, varying from flashy peak flows, which occur in all reaches, to long periods of low flow. Most major floods which occur in Eufaula Lake originate downstream from Bridgeport, Oklahoma. Pertinent data for stream gaging stations used for regulation of Eufaula Lake are given in Table 4-5. Monthly and annual flows past the dam are shown in Table 4-6, located in the Supplemental Tables Section. The inflow volume frequency by months is shown in Table 4-7. The inflow duration curve is shown on Plate 4-5.

4-08. Water Quality. The most recent water quality data available for Eufaula Lake were collected at 17 sampling locations in Eufaula Lake by the Oklahoma Water Resource Board between October 2006 and July 2007 and have been published in the 2011-2012 Oklahoma Lakes Report, Beneficial Use Monitoring Program (BUMP) 2011-2012 Oklahoma Lakes Report, by the Oklahoma Water Resources Board (OWRB). Additional water quality data have been collected at 7 sampling locations by Tulsa District personnel from multiple locations in Eufaula Lake in 2001. Beneficial uses designated within the State of Oklahoma Water Quality Standards (WQS), Title 785:Chapter 45, include Public-Private Water Supply, Fish and Wildlife Propagation (Warm Water Aquatic Community), Agriculture, Recreation (Primary Body Contact Recreation), and Aesthetics. Generally, surface water quality in Eufaula Reservoir is moderately impacted due to elevated nutrient (nitrogen and phosphorus) concentrations within the reservoir.

The OWRB utilizes multiple chemical water quality parameters to assess support of designated beneficial uses identified as non-supporting based upon dissolved oxygen (D.O.) concentrations of less than 2.0 mg/l in greater than 41% to 56% of the water column from the Dam to the uppermost areas of the Deep Fork Arm, North Canadian Arm, Longtown Creek Arm, and South Canadian Arm of the reservoir. Additionally, the aesthetics beneficial use has been identified as non-supporting based upon average true color exceeding a value of 70 units in 63% of samples collected in the Gaines Creek Arm of the reservoir. OWRB and USACE sampling locations within the lake are shown Plate 4-6.

The Tulsa District 2001 water quality survey of Eufaula Reservoir reported significant inflow events early in the sampling period influenced water quality in Eufaula Lake, Oklahoma. Events transported significant quantities of sediment, dissolved and sediment-bound nutrients, and organic material from the watershed into the lake. Storage of runoff water from spring inflow events, and declining inflows through late summer, contributed to a vertical thermal stratification of deeper portions Eufaula Lake from late June through August. Minimum observed dissolved oxygen concentrations in the hypolimnion occurred during this period. Lake-wide mean turbidity of 31.9 NTU represents moderately turbid water, and exceeded the State of Oklahoma lake water quality standard of 25 NTU. During the summer of 2012, and following at least two

years of drought, Lake Eufaula experienced a significant blue-green algae bloom. Drought increases this phenomenon due to the decrease in inflow dilution, and the development of shallower and warmer waters within the lake.

Alkalinity levels in the lake were moderate (mean of 89.1 mg/l) implying most of the lake is reasonably well buffered; an exception may be portions of the Gaines Creek Arm where lowest alkalinities were observed. Levels of pH varied, within regionally normal values, from 6.75 to 9.12. Based on 2001 data, Eufaula Lake waters are classified as moderately hard (lake-wide mean of 120.9 mg/l) and are suitable for a variety of municipal, industrial, and agricultural uses.

Priority pollutant metals observed at concentrations above the analytical detection limits included arsenic, cadmium, chromium, lead, and mercury. A few of the samples contained mercury and lead above the Oklahoma Criterion for Fish Consumption and Water. There were also a few of the samples that had chromium above the Oklahoma Criterion for Public and Private Water Supply. An awareness of the presence of mercury, lead, and other metals is advised. Records of the sampling results from the Oklahoma BUMP can be found at the web address: <http://www.owrb.ok.gov/quality/monitoring/bump.php>. Records of the sampling results from the USACE sampling program are kept at the Tulsa District Office, Planning and Environmental Division, Environmental Analysis and Compliance Branch.

4-09. Channel and Flooding Characteristics. The regulating channel capacity on the Canadian River below Eufaula Dam is 40,000 c.f.s. and is 84,340 c.f.s. at the Whitefield gage. Rating curves for the Purcell and Calvin gages on the Canadian River and the Tecumseh gage on the Little River upstream of Eufaula Lake are presented in Plates 4-7, 4-8, and 4-9, respectively. Rating curves for the Harrah and Wetumka gages on the North Canadian River upstream of Eufaula Lake are presented in Plates 4-10 and 4-11, respectively. The rating curves for the Deep Fork River near the Warwick and Beggs gages are presented in Plates 4-12 and 4-13, respectively. The channel in the Deep Fork River changes routinely, gaining sediment deposits when vegetation is present, and experiencing scouring during high flow events. The rating curves for the Canadian River near Whitefield gage and the Arkansas River at Van Buren gage are presented in Plates 4-14 and 4-15, respectively. Rating curves used by the Arkansas River Control Section are adjusted to changing conditions and are maintained in current status. Crest time of travel from Eufaula Dam to Van Buren, Arkansas is about 24 hours. A simplified diagram showing crest travel time is presented in Plate 4-16. Travel time varies with magnitude of the flood; therefore this diagram should be used as a guide only.

TABLE 4-5

PERTINENT DATA FOR UPSTREAM GAGING STATIONS

STATION	STREAM	MILES ABOVE MOUTH	GAGE ZERO (ft., NGVD29)	FLOOD STAGE (ft.) ⁽¹⁾	DRAINAGE AREA (sq. mi.) ⁽²⁾	MAXIMUM FLOOD OF RECORD		
						DATE	STAGE (ft.)	FLOW (c.f.s.)
Warwick, OK	Deep Fork R	190.9	823.05	14.0	532	21 Oct 1983	22.05	28,700 ⁽⁴⁾
Beggs, OK	Deep Fork R	85.0	632.50	18.0	2,018	11 May 1943	34.55	66,800
Harrah, OK	N Canadian R	230.0	1,055.69	15.0	8,602	9 May 1993	21.90	25,500 ⁽⁵⁾
Wetumka, OK	N Canadian R	84.4	683.28	14.0	9,391	Oct 1923	26.90	N/A
Tecumseh, OK	Little River	77.2	898.52	11.0	456	Jun 1932	25.58	60,000 ^{(3) (4)}

STATION	STREAM	2 nd LARGEST FLOOD OF RECORD			3 rd LARGEST FLOOD OF RECORD			PERIOD OF RECORD
		DATE	STAGE (ft.)	FLOW (c.f.s.)	DATE	STAGE (ft.)	FLOW (c.f.s.)	(FLOW AND / OR STAGE)
Warwick, OK	Deep Fork R	9 Jun 1995	21.28	34,600 ⁽⁵⁾	13 Sep 1989	20.97	20,400 ⁽⁵⁾	Oct 1983 – Present
Beggs, OK	Deep Fork R	15 Apr 1945	34.11	60,900	24 Jun 1948	33.35	53,400	Aug 1938 – Present
Harrah, OK	N Canadian R	29 May 1987	19.60	27,200 ⁽⁵⁾	10 Jun 1995	19.26	17,700 ⁽⁵⁾	Oct 1968 – Present
Wetumka, OK	N Canadian R	Apr 1927	26.50	N/A	15 Apr 1945	26.40	66,000	Oct 1928 – Present
Tecumseh, OK	Little River	18 May 1949	19.68	32,300	20 Oct 1983	19.24	12,700 ⁽⁵⁾	Mar 1944 – Present

TABLE 4-5 (continued)

STATION	STREAM	MILES ABOVE MOUTH	GAGE ZERO (ft.,NGVD29)	FLOOD STAGE (ft.) ⁽¹⁾	DRAINAGE AREA (sq. mi.) ⁽²⁾	MAXIMUM FLOOD OF RECORD		
						DATE	STAGE (ft.)	FLOW (c.f.s.)
Purcell, OK	Canadian R	184.9	1,017.14	8.0	21,138	29 May 1987	14.75	102,000 ⁽⁵⁾
Calvin, OK	Canadian R	94.1	682.72	17.00	23,151	3 May 1990	18.97	146,000 ⁽⁵⁾
Whitefield, OK	Canadian R	18.8	473.16	17.50	37,876	10 May 1943	25.50	281,000
Van Buren, AR	Arkansas R	316.6	372.36	22.00	22,241	12 May 1943	38.00	850,000 ⁽⁵⁾

STATION	STREAM	2 nd LARGEST FLOOD OF RECORD			3 rd LARGEST FLOOD OF RECORD			PERIOD OF RECORD
		DATE	STAGE (ft.)	FLOW (c.f.s.)	DATE	STAGE (ft.)	FLOW (c.f.s.)	(FLOW AND / OR STAGE)
Purcell, OK	Canadian R	19 May 1982	14.50	50,500 ⁽⁵⁾	9 May 1993	14.42	84,100 ⁽⁵⁾	⁽⁶⁾
Calvin, OK	Canadian R	11 May 1950	17.35	174,000	5 May 1941	17.00	150,000	Sep 1904 – Present
Whitefield, OK	Canadian R	3 May 1990	25.32	241,000 ⁽⁵⁾	16 Apr 1945	21.80	255,000	Jul 1938 – Present
Van Buren, AR	Arkansas R	17 Apr 1945	N/A	650,000 ⁽⁵⁾	2 Nov 1941	N/A	485,000 ⁽⁵⁾	Oct 1927 – Present

(1) Regulating Flood Stages

(2) Contributing Drainage Area

(3) Estimated Value

(4) Historic Peak Value

(5) Discharge affected by regulation or diversion

(6) Purcell gage was installed in Sept 1959, and was discontinued in June 1961. It was reestablished in Oct 1979 and was in operation through Sep 1983. It was again reestablished in Oct 1985, and has operated through the present

N/A indicates not available

NOTE: Flow and stage data taken from published information shown on the USGS website.

TABLE 4-7

INFLOW VOLUME FREQUENCY (Jan 1923 - Dec 2010)
 MONTHLY INFLOW VOLUME IN 1,000s of ACRE-FEET

Month	Frequency of Occurrence in Years					
	2	5	10	25	50	100
Jan	116	342	590	977	1,272	1,651
Feb	134	404	758	1,318	1,750	2,330
Mar	314	750	1,104	2,277	1,964	2,337
Apr	381	812	1,214	2,330	2,499	3,243
May	591	1,229	1,765	2,617	3,229	3,963
Jun	399	930	1,395	2,340	2,692	3,342
Jul	117	349	605	996	1,616	2,305
Aug	68	192	324	704	789	1,073
Sep	115	341	541	709	1,040	1,253
Oct	142	439	852	1,830	1,960	2,334
Nov	137	406	769	1,415	1,948	2,332
Dec	129	402	709	1,276	1,734	2,327

4-10. Upstream Structures. Operational structures in the Canadian River basin upstream of Eufaula Dam are: Ute Lake in New Mexico and Lake Meredith in Texas on the Canadian River; in Oklahoma, Lake Thunderbird on the Little River; Fort Supply on Wolf Creek, Optima and Canton Lakes on the North Canadian River; and Arcadia Lake on the Deep Fork River. There are also numerous city lakes and small dams constructed by the Natural Resource Conservation Service throughout the drainage basin.

4-11. Downstream Structures. Structures downstream of Eufaula Lake in the Arkansas River Basin include the following: Robert S. Kerr Lock & Dam No. 15 and W. D. Mayo Lock & Dam No. 14 on the Arkansas River and Wister Lake on the Poteau River.

4-12. Economic Data.

a. Population. The population of the counties and cities traversed by the Canadian River below Eufaula Dam are shown in Table 4-8. Although varying proportions of the counties listed lie within the watershed boundary, the entire population of each county is included.

b. Agriculture. Farming and ranching are the principal occupations within the Canadian River Basin. The major crops grown are wheat, alfalfa, corn, grain sorghum, hay, and pecans. Table 4-9 includes the amount of acres and the annual value of the crops in the floodplain.

c. Industry. Fort Smith, Arkansas is the major metropolitan area downstream of Eufaula Lake. The largest companies in the river system area are located there. The top three industries in Fort Smith are Retail Trade, Health Care and Social Assistance, and Professional, Scientific, & Technical Services. In the surrounding counties the top industries are Retail Trade, Accommodation & Food Services, and Health Care and Social Assistance. Tables 4-10A through 4-10G display the major industries in Fort Smith, Arkansas and McIntosh, Pittsburg, Haskell, Sequoyah, and Le Flore counties in Oklahoma, and Sebastian County, Arkansas along with corresponding data on number of establishments, sales, annual payroll, and employees.

d. Flood Damages. The estimated average annual flood damages prevented by Eufaula Dam on the Canadian River are presented in Table 4-11 while the top five flood events, in terms of flood damages prevented, to pass through Eufaula Dam are presented in Table 4-12. Plates 4-17 and 4-18 show structural loss and area curves for reaches along the Arkansas River from Eufaula Dam downstream to the vicinity of Fort Smith, Arkansas.

TABLE 4-8

POPULATION OF COUNTIES AND CITIES
DOWNSTREAM OF EUFAULA DAM

County	Major Cities	U.S. Census Population			% Change (2000-2010)
		1990	2000	2010	
Oklahoma					
McIntosh		16,779	19,456	19,698	15.95%
	Checotah	3,290	3,481	3,474	5.81%
	Eufaula	2,652	2,639	2,758	-0.49%
Pittsburg		40,581	43,953	45,115	8.31%
	McAlester	16,370	17,783	18,232	8.63%
Haskell		10,940	11,792	12,152	7.79%
	Stigler	2,574	2,731	2,829	6.10%
Sequoyah		33,828	38,972	41,034	15.21%
	Sallisaw	7,122	7,989	8,740	12.17%
	Roland	2,481	2,842	3,258	14.55%
Le Flore		43,270	48,109	49,802	11.18%
	Poteau	7,210	7,939	8,246	10.11%
	Heavener	2,601	3,201	3,228	23.07%
Arkansas					
Sebastian		99,590	115,071	122,274	15.54%
	Ft. Smith	72,798	80,268	84,375	10.26%
1990 Census, 2000 Census, *2007 or 2008 Population Estimates http://factfinder.census.gov/					

TABLE 4-9

ANNUAL VALUE OF CROPS
DOWNSTREAM OF EUFAULA DAM

Canadian River		
Crops	Eufaula Dam to Fort Smith, AR	
	Acres	Value (\$)
Alfalfa	3,190	766,072
Corn	14,400	3,768,551
Grain Sorghum	1,950	398,292
Hay	290	116,883
Improved Pasture	6,430	15,590,664
Nursery	510	925,418
Soybeans	45,780	6,514,773
Spinach	6,700	6,807,200
Sunflower Seeds	830	872,108
Wheat	20,920	2,790,049
Total	101,000	38,550,010
Yield Rates from Oklahoma State University Crop Enterprise Budgets 2009, 2009 Current Normalized Prices, Acres maintained from Jan 1944 WCM		

TABLE 4-10A

2002 ECONOMIC CENSUS FOR
McINTOSH COUNTY, OK

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue (\$1,000's)	Annual Payroll (\$1,000's)	Number of Employees
31-33	Manufacturing*	13	-	2,867	119
42	Wholesale trade	6	2,476	126	10
44-45	Retail trade	90	184,519	13,327	858
51	Information	3	N	D	a
53	Real estate & rental & leasing	13	3,303	707	44
54	Professional, scientific, & technical services	28	9,097	3,175	118
56	Administrative & support & waste management & remediation service	14	4,112	657	46
62	Health care & social assistance	46	31,887	14,221	849
71	Arts, entertainment, & recreation	6	11,410	1,181	127
72	Accommodation & food services	46	13,932	3,303	367

Source: U.S. Bureau of the Census, 2002 Economic Census, * 2006 County Business Patterns

Key to Table:

a = 0 – 19 employees

D = Withheld to avoid disclosing data for individual companies; data are included in higher totals

N = Not available or not comparable

TABLE 4-10B

2002 ECONOMIC CENSUS FOR
PITTSBURG COUNTY, OK

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue (\$1,000's)	Annual Payroll (\$1,000's)	Number of Employees
31-33	Manufacturing	26	196,313	21,021	741
42	Wholesale trade	40	D	D	e
44-45	Retail trade	190	430,020	38,531	2,192
51	Information	19	N	6,731	247
53	Real estate & rental & leasing	35	12,353	2,921	164
54	Professional, scientific, & technical services	73	22,876	7,266	288
56	Administrative & support & waste management & remediation service	36	27,071	10,914	567
61	Educational services	3	D	D	a
62	Health care & social assistance	96	131,116	58,086	2,282
71	Arts, entertainment, & recreation	5	D	D	b
72	Accommodation & food services	83	46,279	12,724	1,308
81	Other services (except public administration)	65	19,087	5,085	305

Source: U.S. Bureau of the Census, 2002 Economic Census

Key to Table:

a = 0 – 19 employees

b = 20 – 99 employees

D = Withheld to avoid disclosing data for individual companies; data are included in higher totals

e = 250 – 499 employees

N = Not available or not comparable

TABLE 4-10C

2002 ECONOMIC CENSUS FOR
HASKELL COUNTY, OK

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue (\$1,000's)	Annual Payroll (\$1,000's)	Number of Employees
31-33	Manufacturing*	4	-	1,092	77
42	Wholesale trade	5	9,437	735	42
44-45	Retail trade	36	86,148	7,288	428
51	Information	2	N	D	b
53	Real estate & rental & leasing	5	D	D	a
54	Professional, scientific, & technical services	21	2,315	698	29
56	Administrative & support & waste management & remediation service	4	D	D	a
61	Educational services	1	D	D	a
62	Health care & social assistance	27	30,067	14,693	941
71	Arts, entertainment, & recreation	4	1,637	529	22
72	Accommodation & food services	15	3,972	975	116
81	Other services (except public administration)	18	6,369	1,911	108

Source: U.S. Bureau of the Census, 2002 Economic Census, * 2006 County Business Patterns

Key to Table:

a = 0 – 19 employees

b = 20 – 99 employees

D = Withheld to avoid disclosing data for individual companies; data are included in higher totals

N = Not available or not comparable

TABLE 4-10D

2002 ECONOMIC CENSUS FOR
SEQUOYAH COUNTY, OK

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue (\$1,000's)	Annual Payroll (\$1,000's)	Number of Employees
31-33	Manufacturing*	22	-	23,797	760
42	Wholesale trade	16	D	D	c
44-45	Retail trade	135	283,706	20,593	1,333
51	Information	6	N	1,212	46
53	Real estate & rental & leasing	22	4,235	899	50
54	Professional, scientific, & technical services	39	10,538	3,906	173
56	Administrative & support & waste management & remediation service	16	6,115	3,298	342
62	Health care & social assistance	72	67,791	30,556	1,947
71	Arts, entertainment, & recreation	10	D	D	e
72	Accommodation & food services	67	26,441	7,037	852
81	Other services (except public administration)	38	8,984	2,217	116

Source: U.S. Bureau of the Census, 2002 Economic Census, * 2006 County Business Patterns

Key to Table:

c = 100 – 249 employees

D = Withheld to avoid disclosing data for individual companies; data are included in higher totals

e = 250 – 499 employees

N = Not available or not comparable

TABLE 4-10E

2002 ECONOMIC CENSUS FOR
LE FLORE COUNTY, OK

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue (\$1,000's)	Annual Payroll (\$1,000's)	Number of Employees
31-33	Manufacturing	27	D	D	f
42	Wholesale trade	24	D	D	c
44-45	Retail trade	164	324,725	28,330	2,063
51	Information	11	N	2,394	82
53	Real estate & rental & leasing	22	8,249	1,078	67
54	Professional, scientific, & technical services	60	D	D	c
56	Administrative & support & waste management & remediation service	28	17,139	8,613	256
61	Educational services	1	D	D	a
62	Health care & social assistance	67	99,732	40,198	1,809
71	Arts, entertainment, & recreation	8	D	D	c
72	Accommodation & food services	50	19,044	5,018	568
81	Other services (except public administration)	50	12,539	2,901	174

Source: U.S. Bureau of the Census, 2002 Economic Census

Key to Table:

a = 0 to 19 employees

c = 100 to 249 employees

D = Withheld to avoid disclosing data for individual companies; data are included in higher totals

f = 500 to 999 employees

N = Not available or not comparable

TABLE 4-10F

2002 ECONOMIC CENSUS FOR
SEBASTIAN COUNTY, AR

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue (\$1,000's)	Annual Payroll (\$1,000's)	Number of Employees
31-33	Manufacturing	217	5,319,542	662,934	22,084
42	Wholesale trade	226	1,382,446	76,767	2,282
44-45	Retail trade	598	1,478,430	137,287	7,529
51	Information	62	N	D	g
53	Real estate & rental & leasing	147	126,345	21,214	829
54	Professional, scientific, & technical services	289	D	D	g
56	Administrative & support & waste management & remediation service	139	135,321	74,562	5,439
61	Educational services	15	D	D	b
62	Health care & social assistance	356	720,073	361,469	10,874
71	Arts, entertainment, & recreation	30	D	D	e
72	Accommodation & food services	241	163,582	45,777	4,702
81	Other services (except public administration)	216	84,102	23,755	1,322

Source: U.S. Bureau of the Census, 2002 Economic Census

Key to Table:

b = 20 to 99 employees

D = Withheld to avoid disclosing data for individual companies; data are included in higher totals

e = 250 to 499 employees

g = 1,000 to 2,499 employees

N = Not available or not comparable

TABLE 4-10G

2002 ECONOMIC CENSUS FOR
FORT SMITH, ARKANSAS

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue (\$1,000's)	Annual Payroll (\$1,000's)	Number of Employees
31-33	Manufacturing	176	4,248,813	548,162	18,527
42	Wholesale trade	197	D	D	g
44-45	Retail trade	538	1,411,467	130,021	7,058
51	Information	55	N	49,460	1,497
53	Real estate & rental & leasing	133	109,093	19,483	750
54	Professional, scientific, & technical services	259	129,709	42,776	1,507
56	Administrative & support & waste management & remediation service	117	129,537	73,297	5,369
61	Educational services	14	D	D	b
62	Health care & social assistance	319	703,605	353,385	10,428
71	Arts, entertainment, & recreation	27	D	D	e
72	Accommodation & food services	215	155,777	43,702	4,445
81	Other services (except public administration)	186	78,948	22,599	1,251

Source: U.S. Bureau of the Census, 2002 Economic Census

Key to Table:

b = 20 to 99 employees

D = Withheld to avoid disclosing data for individual companies; data are included in higher totals

e = 250 to 499 employees

g = 1,000 to 2,499 employees

N = Not available or not comparable

TABLE 4-11

AVERAGE ANNUAL FLOOD DAMAGES PREVENTED

Average Annual Flood Damages Prevented by Eufaula Lake (Eufaula Dam)		
Years in Operation	Cumulative Damages Prevented (2008 \$1,000s)	Average Annual Damages Prevented (2008 \$1,000s)
44	433,327.77	9,848.36

TABLE 4-12

TOP FIVE FLOOD EVENTS
DOWNSTREAM OF EUFAULA DAM

Year	Damages Prevented (\$1,000s)	Damages Prevented (2008 \$1,000s)
2002	33,391.29	42,441.36
2008	22,937.21	22,937.21
1993	21,096.00	33,648.32
1989	17,978.00	32,372.09
2007	17,885.23	18,655.24

V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01. Hydrometeorological Stations.

a. Facilities. The Water Management Section, Hydrology-Hydraulics Branch, Tulsa District; the National Weather Service (NWS); and the U.S. Geological Survey (USGS) cooperate to collect data and maintain a reliable communication network. All pertinent reporting observation stations are shown on Plate 5-1. Pool elevation data are provided by a bubbler gage connected to a digital recorder and wired to a transmitting type data collection platform (DCP). This equipment is located in a gage house on the dam.

All stream gaging stations are automated gages consisting of float wells or bubbler gages connected to digital recorders and DCPs. The Canadian River at Whitefield gage and the Arkansas River at Van Buren, Arkansas gage are key stations for regulation purposes. Important stream gages used to forecast inflows into Eufaula Lake are Purcell and Calvin on the Canadian River; Tecumseh on the Little River; Harrah and Wetumka on the North Canadian River; and Warwick and Beggs on the Deep Fork River. Automated stream gaging stations are equipped with automated rain gages that provide precipitation data transmitted along with stage data. Precipitation and stream gaging stations are shown on Plate 5-1.

b. Reporting. The reporting procedures for precipitation and stream gaging stations are on a cooperative basis with the NWS and the USGS. The reporting of data from pool elevation and stream gaging stations has been automated by using DCPs that record data hourly and transmit the data every hour or when a threshold value is exceeded. The data are transmitted via Geostationary Operational Environmental Satellite (GOES) to a downlink and computer facility owned and operated by the National Oceanic and Atmospheric Administration (NOAA) near Washington, D.C. The data are then transmitted to a domestic satellite (DOMSAT) that passes the data to the Tulsa District's Receive Only Terminal (DROT). The data from the NOAA computer facility may also be transferred via the Internet. When received, the river stage is converted to flow and lake elevation is converted to storage. All the data are then stored in a database on the Tulsa District Water Control Data System (WCDS) for access when needed. DCPs also report rainfall data in the same way. Besides DCP data, observer rainfall data are collected and stored in the computer system for use in forecasting.

Observers telephone the NWS offices in this region and the NWS then encodes the data into a Standard Hydrologic Exchange Format (SHEF). The data are then transferred to the WCDS by electronic data transmission from the Arkansas-Red Basin River Forecast Center. Once the data are received, they are decoded and handled similarly to the DCP data. Informative display of all data is possible by using several versatile computer programs developed for use on the WCDS. Table 5-1, located in the Supplemental Tables Section, contains a list of automated stream gage and rainfall

stations. Detailed instructions on reporting criteria are presented in Exhibit B, Standing Instructions to Lake Manager.

c. Maintenance. Maintenance and repair of stream gages are the responsibility of the administering agency. Both the Corps of Engineers and the USGS have stream-gaging equipment in the Arkansas River Basin. The Hydrology-Hydraulics Branch, Tulsa District, is charged with the responsibility for the equipment placed by the Corps of Engineers.

5-02. Water Quality Stations.

a. Facilities. Water quality stations for the Canadian River Basin are listed in Table 5-2 (A, B, C). Water quality samples are taken at periodic intervals to determine the chemical, biological and sediment quantities contained in the stream and lake waters. This includes nine water quality sampling stations within Eufaula Lake operated by COE. Water quality samples from the lake are taken by COE when resources are allocated for that purpose. The COE requests funding on 10 year intervals. OWRB has a total of seventeen water quality sampling stations within Eufaula Lake. These are part of the BUMP (Beneficial Use Management Program) program that anticipates that sampling will be done every five years. The USGS has a total of ten water quality sampling stations in the upstream reaches of the Canadian River Basin. Several characteristics, dissolved oxygen, specific conductance, and temperature are recorded on a daily basis. For all water quality sampling stations, sampling can be and is done on an 'as needed' basis, when conditions arise that need investigating.

b. Reporting. The reporting procedures for water quality stations are determined by the organization collecting the samples. OWRB water quality sampling results can be found on the web at: <http://www.owrb.ok.gov/studies/reports/reports.php> . USGS water quality sampling results can be found on the web at: <http://waterdata.usgs.gov/ok/nwis/current/?type=quality> . Water quality samples taken by COE personnel will be reported and maintained by the Environmental Analysis Section, Planning Branch, Tulsa District Office. A discussion of water quality problems associated with Lake Eufaula is found in Paragraph 4-08.

c. Maintenance. Maintenance and repair of the water quality stations are the responsibility of the operating agency as shown in Table 5-2 (A, B, and C), located in the Supplemental Tables Section.

5-03. Sediment Stations.

a. Facilities. The gages at Deep Fork River near Beggs, North Canadian River near Wetumka, and Canadian River at Calvin are used for sediment measurement. These stations are operated by the USGS. The Corps of Engineers maintains 75 sediment ranges within the lake and 15 degradation ranges below the lake. These ranges are surveyed periodically for the purpose of computing sediment deposition and

new lake area/capacity data. The sedimentation and degradation ranges are shown on Plates 2-3 and 2-4, respectively.

b. Reporting. Sediment surveys are made infrequently for Eufaula Lake. The last re-surveys were done in 2004 (conservation pool bathymetric survey) and 2010 (flood pool LiDAR survey).

c. Maintenance. Maintenance on the sediment and degradation data is performed by Tulsa District.

5-04. Recording Hydrologic Data. Hydrologic information is recorded as it is received by the Water Management Section as follows:

a. Stages and Discharges. The raw data that the Water Management computer retrieves from the central computer are stored as they are received. These raw data are then sorted by station and stored again. Several computer programs convert the raw data into stage/pool elevation data and the corresponding flow/storage values as determined from rating curves. These processed data are then stored in two databases. To prevent the databases from filling, they are periodically archived on tape for permanent storage. Stream flow measurements made by the USGS are reported to the Hydrology-Hydraulics Section. The measurements are entered into the database for storage.

b. Precipitation. Precipitation data from the DCP stations and the project are combined with NWS observer precipitation data that can then be used by computer programs for plotting distribution, determining basin rainfall, and forecasting runoff (see Section VI).

c. Water Quality Data. Water quality sampling stations upstream and within Eufaula Lake are maintained by USGS, OWRB and COE. Water quality data are recorded and reported as described in paragraph 5-02.b.

5-05. Communication Network. Wire facilities at Eufaula Lake are local and long distance telephone service. Radio communication is by VHF-FM fixed station (call signal WUI-322) capable of reaching local mobile stations, the Tulsa District, and other stations on the local, north, and south loops of the District via repeater relay. Maintenance of the telephone lines is the responsibility of the company leasing the line to the Government. The District radio technician makes quarterly inspections of the project's fixed equipment and makes repairs as conditions warrant. To alert the public of impending gate changes a warning siren which is activated before each tainter gate or sluice gate change is located on the downstream side of the spillway. The siren is operated from the powerhouse control room. A horn which is blown for 5 minutes before power releases are made is located on top of the powerhouse. The horn is activated automatically from the powerhouse control room or remotely from the Eufaula powerhouse when power releases are initiated.

5-06. Communication with Project.

a. Water Management Section with Project Office. Instructions for the storage and release of water from the lake will be communicated by the Water Management Section to the responsible project operating personnel for the implementation of the provisions set forth in Section IX of this manual. This communication will normally be made by telephone but could on occasion be made by VHF-FM radio. The reports by the project office, described in paragraph 5-07. and Exhibit B of this manual, will be communicated directly to the Water Management Section. Should communication between the project and Tulsa District be disrupted, the Lake Manager will, on his or her own initiative, direct regulation of the lake according to emergency regulations as required in Section VII and Exhibit B of this manual. A chart, "Organization For Flood Control Regulation" is shown on Plate 5-2.

b. Between Project Office and Others. Communications between project personnel and other Federal, State, and local agencies will be sufficient to facilitate the coordination described in Section IX of this manual.

5-07. Project Reporting Instructions. Hydrologic data items affecting release of water, confirmation of change in releases as instructed, complaints, operating machinery failure, or out-of service times for maintenance shall be reported to the Water Management Section as they occur.

The following data should be included in the daily report to the Water Management Section from all flood control storage projects with hydropower. Data are typically reported by telephone, fax, or email. Data collected will be reviewed and input into the Water Management Section's data base before 10 a.m. and published to the lake data morning report located at http://www.swt-wc.usace.army.mil/old_resv rept.htm by 10 a.m. See Plate 5-3 for lake data reporting details.

a. As of 8 a.m. Each Weekday.

- 1) Pool elevations at 12 noon, 4 p.m., and 12 midnight of the previous day and the current 8 a.m. pool elevation and tailwater elevation (if available).
- 2) The total precipitation amounts for the previous 24-hour period (7 a.m. to 7 a.m. time period).
- 3) The current wind direction and wind speed (Beaufort scale).
- 4) Water supply withdrawal or release for previous day (if available).
- 5) The average power discharge in day second feet (d.s.f.) for the previous 24-hour period (midnight to midnight).

- 6) The net power generation in MWh for the previous 24-hour period (midnight to midnight.)
- 7) The total discharge in d.s.f. for the previous 24-hour period (midnight to midnight).
- 8) The 8 a.m. instantaneous power discharge in c.f.s.
- 9) The 8 a.m. instantaneous total discharge in c.f.s.
- 10) The total hourly discharge in c.f.s. for the previous 24-hour period (midnight to midnight).
- 11) The current gate setting and any gate changes made during the past 24-hour period including the time and pool elevation (and tailwater elevation if necessary) when the change was made.

b. As of 8 a.m. Each Monday.

- 1) The same data from the weekend as required in 5-07.a. above.
- 2) The current pool elevation readings from the pool gage, the recording chart or tape, the shaft encoder or data logger, and the wire weight or staff gage. If wind or weather prevents readings on Monday, then these readings can be taken on the next day that weather permits.

c. Weekends and Holidays.

- 1) Daily reports are not required to be submitted on weekends and holidays except during flood periods.

d. During Flood Periods.

- 1) During flood periods, weekend and holiday reports should include the same data as required in 5-07.a. above as well as the 8 a.m. pool elevation from the pool gage.
- 2) In addition to the data in 5-07.a., 5-07.b., 5-07.c. above, additional reports of lake elevations may be requested by Water Management Section personnel.

5-08. Warnings. It is the responsibility of the powerhouse Superintendent to initiate a warning to the Tulsa District and local law enforcement agencies if emergency situations develop. They have the responsibility to properly recognize emergency situations and to seek assistance from supervisory offices, if time permits. They must be knowledgeable of conditions that constitute an emergency such as a dam failure possibility. The downstream population should be notified as early as possible of a

potential problem. Initial notification by project personnel will include (listed by priority), Chief of Operations, Chief of Operations Technical Support, Chief of Engineering and Construction, Chief of Emergency Management, as set forth in the Operations and Maintenance Manual Volume II, Eufaula Lake, Flood Emergency Plan, dated Nov 2011. The Eufaula Lake project personnel have compiled a list of downstream contacts for use in emergency situations.

5-09. Frequency of Gate Changes. During flood periods, gate changes may be directed by the Water Management Section at any time. The initial transition to flood releases or vice versa may require gate changes every hour. When floodwater has significantly risen into the flood control pool, gate changes can be expected two or more times daily. Only under the most unusual circumstances will changes be ordered more frequently than once every hour.

VI - HYDROLOGIC FORECASTS

6-01. General. Hydrologic forecasts are necessary in predicting stream flow upstream and downstream of Eufaula Lake to determine if and when releases should be made.

a. Role of Corps of Engineers. Hydrologic forecasts are made by the Water Management Section, Tulsa District, for use in the regulation of lakes for flood control and other authorized purposes and for the benefit of Corps of Engineers' construction projects and flood management activities. As distinguished from the NWS, who furnishes weather and flood forecasts to the public, the Tulsa District furnishes information on current and forecasted lake levels and lake releases, along with technical advice. The Water Management Section (lake levels recording), telephone number (918) 669-7521, is listed in the Tulsa telephone directory to provide the public a means of obtaining current lake information such as pool levels and discharges. General news releases are made by the Public Affairs Office which is kept fully informed of the hydrologic situation as appropriate. Further discussion of the role of the Corps of Engineers in hydrologic forecasts is presented in Section V of the Arkansas River Basin Water Control Master Manual.

b. Role of Other Agencies. The NWS, Tulsa, Oklahoma, is the official agency making flood forecast information available to the public. This information is distributed by the NWS Automation of Field Operations and Services (AFOS) network to subscribing government agencies and the various news media. The NWS issues routine scheduled reports containing the following forecasts:

- (1) Weather forecasts (daily, severe weather, and 5-day extended).
- (2) National weather summaries and additional details for the five south-central states (four times daily).
- (3) Quantitative precipitation forecasts (four times daily – one 24-hour and one 48-hour quantitative precipitation forecast and two 6-hour quantitative precipitation forecasts).
- (4) Three-day river stage forecasts (when available).
- (5) Rainfall required to produce bank full stages (weekly).
- (6) Urgent priority messages such as severe weather warnings, watches, forecasts and statements, and instructions from Civil Defense during emergency conditions are transmitted immediately, regardless of scheduled traffic. Unscheduled traffic, including the following, is sent when appropriate.
 - (a) Damage reports.
 - (b) Road information and winter weather conditions.

- (c) River and flood warning bulletins, forecasts, and statements.
- (d) Thirty-day forecast.
- (e) Road information and winter weather conditions.

(7) Percent chance of precipitation (twice daily).

6-02. Flood Conditions Forecasts.

a. Requirements. Flood condition forecasts are necessary whenever substantial rainfall has occurred on the basin upstream of or downstream of Eufaula Dam. Personnel in the Water Management Section have developed a flood-forecasting model for Eufaula Lake. This model was calibrated to historical flood events. Basin subdivisions contained in the forecasting model are presented on Plate 6-1. To use this model the following data are required:

- (1) Rainfall for stations listed in Table 5-1.
- (2) Eufaula Lake pool elevation for time of forecast.
- (3) Flood hydrographs for stream gages listed in Table 5-1.
- (4) Releases from Eufaula Lake, including projected releases, from time of forecast until the end of the forecast period.

b. Methods. Inflow forecasts are made using a slightly modified HEC-1 computer program. Precipitation data are received from the NWS observers, the DCPs by the water control computer, the Oklahoma Mesonet, and also the NWS Stage III digital radar. The average precipitation over the project basin is computed by a computer program called VIEWRAIN. The VIEWRAIN program takes the DCP data and plots isohyetal maps of 24-hour rainfall. The VIEWRAIN program also computes the basin and subbasin average rainfalls for input into the HEC-1 forecasting model. The HEC-1 program uses the hourly DCP rainfalls to distribute the subbasin average rainfalls. Beginning loss rates are chosen based upon historical storm reproductions. Rainfall excess is computed by subtracting the applicable losses from the incremental rainfall amounts. One-hour unit hydrographs are computed using Snyder's coefficients or are entered directly into the data file for each subarea. Flood hydrographs are computed by applying the rainfall excess to the unit hydrographs. Computed flood hydrographs are compared with observed flood hydrographs for gages listed in Table 5-1. Loss rates are adjusted and the HEC-1 model is rerun until the computed and observed hydrographs converge. Calibrated loss rates are applied to un-gaged subareas and flood hydrographs are combined and routed to compute an inflow hydrograph. Using projected releases from Eufaula Lake, the inflow hydrograph is routed through the lake to determine elevations. Flood control releases are projected based upon conditions on the Arkansas River System and following procedures described in section V of the Arkansas River Basin Water Control Master Manual. Unit hydrographs are presented on Plates 6-2 through 6-6. A sample inflow computation is shown on Plate 6-7.

6-03. Conservation Purpose Forecasts.

a. Requirements. Conservation forecasts may be requested by Project personnel to predict pool levels during fish spawning season, special recreation events, and water supply. Forecasts may also be requested for water quality.

b. Methods. Forecasts for conservation purposes during non-flood periods would rely largely on statistical interpretation of historical data. The inflow duration curve, Plate 4-5, and the peak inflow probability curve, Plate 8-5, would be considered with NWS forecasts in making conservation forecasts during non-flood periods.

6-04. Long-Range Forecasts.

a. Requirements. The regulatory decision involved in evacuating stored floodwater, sustaining yield during low flow periods, and maintaining constant or slowly changing pool levels for conservation purposes is dependent on accurate estimates of the water volume that will pass through the lake.

b. Methods. Reliable methods for long range runoff forecasts are not presently available. The NWS publishes an "Average Monthly Weather Outlook" semi-monthly, which may be used as an estimate of the trend of the weather but should not be given too much weight for one forecast, especially for a specific point. The NWS forecasts described in paragraph 6-01.b. are more useful in a shorter range.

6-05. Drought Forecasts. Droughts can be forecast when runoff is dependent upon snowmelt by measuring snow pack in the mountains. However, on projects where runoff is a result of a rainfall event, as in the Tulsa District, no techniques are available at this time to forecast droughts. Future pool drawdowns can be forecast by estimating water supply usage and evaporation rates.

VII - WATER CONTROL PLAN

7-01. General Objectives. The primary objectives of the Eufaula project are flood damage reduction, hydropower production and sediment control for navigation. Eufaula Lake will be operated as a unit in a multiple-purpose system for flood control providing benefits on the Canadian and Arkansas Rivers. Flood releases from Eufaula Lake will be made in accordance with the predicted runoff from the uncontrolled area downstream, the allowable stage for the downstream control points, the predicted volume of inflow into the lake, and the proportion of available storage remaining in the various lakes in the system. All of the flood control storage will be utilized to provide benefits, categorized as method A in paragraph 3-3c(2)(b) of EM 1110-02-3600, 30 Nov 1987.

7-02. Major Constraints. The major constraints on the operation of Eufaula Lake include the channel capacity downstream of the dam and the stage of the Arkansas River at Van Buren, Arkansas. The non-damaging flood release on the Canadian River downstream of the dam is currently estimated to be about 40,000 c.f.s. This release should not be exceeded unless inflow forecasts show that the available flood storage in the lake is inadequate or emergency instructions calling for higher releases are issued. The flood stage at the Van Buren gage is 22 feet. The Van Buren gage is ordinarily the primary control for system flood releases. Releases will be made so that, when combined with discharges from other lakes and intervening area runoff, the target flows at all locations specified by the Arkansas River Basin Water Control Master Manual will not be exceeded. The tainter gates are capable of discharging 329,000 c.f.s. at the top of flood pool, elevation 597.0 feet. The invert of the sluice gate is elevation 500.0 feet, which is the lowest elevation at which water can be released from the dam.

7-03. Overall Plan for Water Control.

a. General. Eufaula Lake is regulated as a unit in a multipurpose system for the benefit of water resources in the Arkansas River Basin. Development of water resources is discussed in the Arkansas River Basin Water Control Master Manual, while the specific purposes of each of the various projects are detailed in the appropriate Appendix.

b. System Regulation. Eufaula Lake will be regulated for control of floods on the Canadian River downstream from the Eufaula Dam and in the total Arkansas River system for control of floods on the Arkansas River to Van Buren, Arkansas. When the floodwaters are being accumulated in the system, each lake shall be regulated to retain equivalent flood control capabilities, as much as possible. Priority for releases, as shown on curve "B" Plate 7-57 of the Arkansas River Basin Water Control Master Manual, will be given to the lake with the least amount of flood storage available, depending on predicted inflows into the lake and conditions downstream. Section 7 of the Arkansas River Basin Water Control Master Manual provides detailed information on the Arkansas River System operation, necessary to determine the allowable flood

releases from Eufaula Lake. In addition, Eufaula Lake will be regulated for navigation and hydropower.

7-04. Standing Instructions to Powerhouse Superintendent. During flood periods, Eufaula Lake will be regulated in accordance with the normal regulations for flood control operation as directed in subparagraph 7-05.a. and Exhibit B of this manual. Instructions for the storage and discharge of flood water are to be issued by the Water Management Section. In the event communication with Tulsa District is disrupted, the lake regulation is the responsibility of the powerhouse Superintendent and is to be regulated in accordance with subparagraph 7-05.b. and Exhibit B of this manual. In addition, the powerhouse Superintendent will immediately make every effort to re-establish communications with Tulsa District. The powerhouse Superintendent will make daily observations of the weather station and pool level data and report those observations as directed in paragraph 5-07.a. through 5-07.d., and also repeated in Exhibit B. Should an emergency situation occur, in which communication is not lost, such as inoperable gates, a drowning accident, excessive trash in gates, a broken buoy line, or power outage, the Water Management Section will be notified immediately.

7-05. Flood Control.

a. Normal Flood Control Regulations. Eufaula Lake will be regulated for optimum flood reductions on the Canadian River from the dam to its confluence with Arkansas River and from that point to Van Buren, Arkansas. The regulations as shown in Table 7-1 will govern releases from Eufaula Lake. During flood control regulation the spillway gates generally are operated in a uniform setting with no more than 1 foot difference in opening between any gates.

b. Emergency Flood Control Regulations. When communication with the Tulsa District is disrupted, the powerhouse Superintendent will, on his or her own initiative, direct regulation of the lake in accordance with the schedule shown in Table 7-2 until communication is restored. In addition, the Lake Manager will make every effort to re-establish communication with Tulsa District. The spillway gates shall be operated at a uniform opening as discussed in paragraph 7-05.a.

c. Constraints. During normal operations releases from Eufaula Lake will not exceed 40,000 c.f.s., and when combined with releases from other reservoirs and intervening area flow will not exceed target flows at various locations specified by the Arkansas River Basin Water Control Master Manual. The releases will be gradually increased from full power discharge (13,100 c.f.s.) to 40,000 c.f.s. by increments of 7,000 c.f.s. or less and then decreased in the same manner. If the 40,000 c.f.s. release must be exceeded, then the stage-damage curves shown on Plates 4-17 and 4-18 should be used as a guide in determining the effects. Floodwater shall be released as soon as possible while the flooding of low-lying farmland kept to a minimum.

TABLE 7-1

NORMAL FLOOD CONTROL REGULATION SCHEDULE
 EUFAULA LAKE
 CANADIAN RIVER, OKLAHOMA

LAKE STAGE	POOL CONDITIONS	REGULATION
585.0 and Below	--	Releases are made through the turbines for hydroelectric power generation or to meet downstream water quality needs as discussed in paragraph 7-07, but will not exceed target discharges downstream of the dam.
585.0 - 597.0 and forecasted not to exceed 597.0	Rising	Releases will not exceed 40,000 c.f.s. or target discharges specified by the Arkansas River Basin Water Control Master Manual, whichever is less.
597.0 - 600.0 or forecasted to exceed 597.0	Rising	Releases will be based on inflow forecasts and made such that the pool elevation will not exceed elevation 600.0 feet, if possible. Plate 7-1, Spillway Gate Regulation Schedule - Inflow Parameter, will be used as a guide for determining releases so that the lake will not rise beyond the induced surcharge limits. If the pool rises to elevation 600.0 feet, releases will be made as near equal to inflow as possible. Releases will be made by operating all the spillway gates at uniform openings.
600.0 or above	Rising	The spillway gates will be opened as necessary to pass inflow or until all gates are fully opened, whichever is less.
597.0 or above attained	Falling	The maximum gate opening shall be held until the pool elevation recedes to elevation 597.0 feet.
597.0 - 585.0	Falling	If the maximum releases rate was smaller than 40,000 c.f.s., releases will not exceed 40,000 c.f.s. or target discharges specified by the Arkansas River Basin Water Control Master Manual, whichever is less. If the maximum rate exceeds 40,000 c.f.s., releases shall be made equal to the previous 6-hour inflow or 40,000 c.f.s., whichever is greater.

TABLE 7-2

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE
 EUFAULA LAKE
 CANADIAN RIVER, OKLAHOMA

LAKE STAGE	POOL CONDITIONS	REGULATION
585.0 and Below	--	Continue releases being made at time of communication failure.
585.0 – 600.0	Rising	Maintain current releases until communication is restored. If, after 12 hours, communication has not been restored, or the pool is above or has risen to elevation 594.0 feet at any time within the 12 hour period, releases shall be made in accordance with Plate 7-1. Releases will be adjusted every two hours in accordance with Plate 7-1. At no time will releases be decreased while the pool is rising.
600.0 or above	Rising	All spillway gates will be raised in 1-foot increments until the pool elevation crests or until all gates are fully opened, whichever occurs first.
597.0 or above attained	Falling	The maximum gate opening shall be held until the pool elevation recedes to elevation 597.0 feet.
597.0 - 585.0	Falling	If the maximum releases rate was smaller than 40,000c.f.s., then that release will be maintained until the pool recedes to elevation 585.0 feet. If the maximum rate exceeds 40,000 c.f.s., releases shall be reduced to the previous 6-hour inflow or 40,000 c.f.s., whichever is greater, until the pool recedes to elevation 585.0 feet. When the pool nears elevation 585.0 feet, releases shall be gradually reduced so that releases are equal to inflow by the time the pool recedes to elevation 585.0 feet.

d. Operational Curves. The Spillway Gate Regulation Schedule - Inflow Parameter is shown on Plate 7-1. The Inflow vs. Rate of Rise Nomograph is shown on plate 7-2. The spillway rating curves for partial and full gate openings (one gate) are shown on Plate 7-3. The sluice rating curves are shown on Plate 7-4. The tailwater rating curve is shown on Plate 7-5. The evaporation curves are shown on Plate 7-6. Elevation versus area and capacity data are compiled in Table 7-3, located in the Supplemental Tables Section, and curves are displayed on Plate 7-7. Rating curves used by the Water Management Section are adjusted for changing conditions and are maintained in current status.

7-06. Recreation. No storage or releases are designated for recreation at Eufaula Lake. Recreation features at the project include camping, picnicking, swimming, boating, hiking, and fishing. Some recreation area access roads close due to flooding beginning at elevation 590.0 feet. At elevation 587.0 feet, some campsites begin to flood. The locations of public use facilities are shown on Plate 2-13 of this manual.

7-07. Water Quality. Eufaula Lake has no storage allocated for water quality. However, small releases may be requested during the summer through the sluice outlet to increase the dissolved oxygen in the stilling basin to prevent fish kills.

7-08. Fish and Wildlife. Fish and wildlife is an authorized project purpose, no specific storage is provided. The project does, however, provide secondary benefits to fish and wildlife. Project personnel monitor water quality in the stilling basin, and a small release is made to relieve fish distress due to low dissolved oxygen levels immediately downstream of the dam. Upon request by Oklahoma Department of Wildlife Conservation, and/or the United States Fish and Wildlife Service (USFWS), deviations for seasonal pools have been approved to enhance habitat and food supply. Also, the USFWS has requested seasonal pool deviations to facilitate releases to protect the habitat of the endangered Interior Least Tern that use downstream islands for nesting purposes. In recent years, the USFWS has not requested the seasonal pool plans which would hold water for extended operation manipulation, but has requested that the normal hydropower generation be timed to keep the birds nesting higher on the islands. They have also have begun to emphasize the development of additional island habitat. At this time, the most promising sites for additional habitat have been identified on the Arkansas River, utilizing material from navigational dredging operations.

7-09. Water Supply.

a. General. Eufaula Lake has a total of 1,343,650 acre-feet of conservation storage which includes 79,860 acre-feet of water supply storage, with a yield of 50.045 million gallons per day (m.g.d.). The Corps of Engineers issues contracts for this storage. The Oklahoma Water Resources Board (OWRB) issues permits, or water rights, to withdraw water from the lake and the Canadian River downstream of the lake. Table 7-4 lists current contracts for storage in Eufaula Lake.

TABLE 7-4
WATER SUPPLY CONTRACTS
EUFAULA LAKE

User Name	Agreement Type	Present Storage AC-FT	Future Storage AC-FT	Total User Storage AC-FT	Yield M.G.D.
Total Water Supply based on 2034 sediment projection		79,860			68.26
Not under agreement		37,614	0	36,764	31.42
City of Checotah	storage	2,276	0	2,276	1.95
City of Eufaula (Eufaula Public Works Authority)	storage	2,295	0	2,295	1.96
Juniper Water Company, Inc	storage	17,168	0	17,168	14.67
Pittsburg County Water Authority	storage	1,211	0	1,211	1.03
Haskell County Water Company	storage	569	0	569	0.49
Haskell County RWD #1	storage	73	0	73	0.06
Porum PWA	storage	751	0	751	0.64
Muskogee County RWD #3	storage	436	0	436	0.37
Pittsburg County RWD #4	storage	73	0	73	0.06
Lakeside Water Company, Inc.	storage	28	0	28	0.02
Haskell County RWD #3	storage	36	0	36	0.03
Krebs Utilities Authority	storage	799	0	799	0.68
RWD, Gas, Sewer & Solid Waste #8	storage	2,143	0	2,143	1.83
Pittsburg Co. PWA	storage	702	0	702	0.60
Longtown RW & S District #1	storage	1,429	0	1,429	1.22
PSO	storage	145	0	145	0.12
McAlester PWA	storage	8,911	0	8,911	7.62
Bristow Point Property Owners Association, Inc	storage	24	0	24	0.02
Warner Utilities Authority	storage	993	0	993	0.85
Haskell County RWD (850 ac-ft pending)	storage	0	850	850	0.73
Twin Rivers Estates, Inc	storage	12	0	12	0.01
Bridgeport Dunes Condominiums Homeowners Assoc. Inc	storage	12	0	12	0.01
Pittsburg Co RWD #14	storage	460	0	460	0.39
Duchess Creek Mobile Home Park	storage	12	0	12	0.01
RWS & SWM Dist. #2, McIntosh County	storage	1,429	0	1,429	1.22
B&B Gas Well Service, LLC	storage	17	0	17	0.01
OTRD - Arrowhead Golf Course	storage	109	0	109	0.09
OTRD - Fountainhead Golf Course	storage	133	0	133	0.11
Total		79,860		79,860	68.26

b. Regulation Procedure for Water Supply. Withdrawals for municipal and industrial water supply are made from user installed and maintained outlet structures. At the present time there are fifteen known municipal/industrial outlet structures, as well as numerous private intakes for personal use of shoreline landowners. Water withdrawal from storage under water supply agreements will be metered and read by the User and reported to the Water Supply Specialist by the 5th day of the month following usage.

c. Accounting Procedure for Water Supply. Accounting procedures for conservation storage in multi-purpose projects have been developed by the Tulsa District and approved by Southwestern Division (SWD) to account for the withdrawal of water from lakes by each water storage user, including hydropower releases. Losses are charged to each user in proportion to the user's average remaining storage. Inflows, after deductions for downstream water rights and vested rights, are credited to the storage account of the user in proportion to the user's contracted storage. When conservation storage falls to 75%, monthly accounting of water supply usage is initiated. Each user will periodically be notified of his remaining water supply storage, and when a user's storage is depleted, no withdrawals from storage will be made for that user. When inflows are sufficient to restore the lake to the conservation pool elevation, all user accounts are made whole (reset to 100%), and water accounting is discontinued. An example of the water storage accounting procedures is shown on Plate 7-8. No accounting is necessary where all conservation storage is contracted for by one user or when the Corps is not the contracting agency.

7-10. Water Rights.

a. General. The OWRB has issued water rights on the Canadian River downstream of Eufaula Lake. These water rights locations and authorized amounts are shown in Table 7-5. The OWRB should be contacted for updated water rights summaries.

b. Regulation Procedure for Water Rights. Releases from inflow to satisfy downstream water rights will be made at the request of the OWRB which will inform the Water Management Section as to the amount and time distribution of the required release. No withdrawal from storage in the lake will be made for downstream water rights unless the water right holder has contracted storage allocated in the lake.

TABLE 7-5

WATER RIGHTS DOWNSTREAM OF EUFAULA DAM

PERMIT #	Entity Name	Qtr	Qtr	Qtr	Sec	TSP	RNG	COUNTY	AcFt /Yr	Purpose	Date Filed	Date Issued
19950035	Lee H Tyler Revocable Trust	NW	SE	NE	02		19E	Muskogee	2280.0	Irrigation	8/10/1995	11/14/1995
20020056	(b) (6)	SW	NE	SE	02	10N	20E	Haskell	2190.0	Irrigation	12/23/2002	3/11/2003
19810106	(b) (6)	SW	NE	SE	02	10N	20E	Haskell	600.0	Irrigation	4/24/1981	7/14/1981
20030011	JRC Ranch LLC	SW	NE	SE	28	10N	20E	Muskogee	2622.0	Irrigation	3/27/2003	7/8/2003
Total Downstream Rights									7,692.0			

7-11. Hydroelectric Power. Eufaula Lake contains 1,346,325 acre-feet of conservation storage between elevations 585.0 feet and 565.0 feet. The conservation pool includes sediment reserve storage of 135,592 ac-ft, water supply storage of 79,860 ac-ft, and the power pool of 1,130,873 ac-ft. The powerhouse contains three 30,000 kW Francis-type generators with a full power discharge of about 13,100 c.f.s. The turbines are used in conjunction with the spillway and outlet works for flood control releases. Flood control releases of 13,100 c.f.s. or less are made through the turbines, if operable. The Water Management Section will notify the Southwestern Power Administration (SWPA) of the daily outflow volume required through turbines for flood releases. The release of water from the power pool (elevation 565.0 feet to 585.0 feet) will be for the production of hydroelectric power and will be determined by SWPA.

7-12. Navigation. Navigation is a project purpose; however, no specific storage for navigation is provided. Flows used for the navigation purpose come from hydropower storages. Eufaula Lake will be regulated for flood control in conjunction with the other reservoirs in the navigation system, to help provide a tapered recession of flows along the Arkansas River navigation channel. The coordinated regulation of the reservoir is discussed in Chapter 7 of the Arkansas River Basin Water Control Master Manual.

7-13. Sedimentation. There are no regulation procedures for sediment; however, Eufaula Lake does provide sediment storage as a project purpose for the benefit of the McClellan-Kerr Arkansas River Navigation System.

7-14 Drought Contingency Plans. A Drought Contingency Plan for projects in the Canadian River basin has been completed, in accordance with ER 1110-2-240 and ER 1110-2-1941. The Plan has been published as Exhibit DCP-4 to the Water Control Master Manual, Arkansas River Basin, and contains coordination and instructions necessary for operations during a drought. Copies of the plan are kept at the Eufaula project office and at the Tulsa District Office.

7-15. Flood Emergency Action Plans. A flood emergency action plan is outlined in the Operation and Maintenance Manual, Volume II, for Eufaula Dam – Eufaula Lake, Canadian River, Texas and Oklahoma, dated Nov 2011. The purpose of the manual is to specify procedures to protect the public from possible property damage or loss of life as a result of uncontrolled releases of water due to failure, or severe damage to the dam appurtenant works.

7-16. Deviation From Normal Flood Control Regulation. Deviation from normal flood control regulation of the lake is occasionally necessary. Prior approval for a deviation is obtained from SWD, except as noted in subparagraph 7-16.a., shown below. Deviation requests fall into the following categories:

a. Emergencies. The water control plan is subject to temporary modification by the Corps if found necessary in time of emergency. Request for and actions on such

modifications may be made by the fastest means of communication available. Also, the powerhouse Superintendent may temporarily deviate from the water control plan in the event an immediate short-term departure is deemed necessary for emergency reasons to avoid serious hazards. The powerhouse Superintendent may deviate from the water control plan whenever necessary to protect the safety of the dam. Such actions shall be immediately reported by the fastest means of communication available. Actions shall be confirmed in writing as soon as possible to the Water Management Section and shall include justification for the action. Continuation of the deviation will require the express approval of SWD. A written confirmation showing the deviation and conditions will be furnished by the Water Management Section to SWD.

b. Unplanned Minor Deviations. There are unplanned instances that create a temporary need for minor deviations from the normal regulations of the reservoir, although they are not considered emergencies. Construction accounts for the major portion of the incidents and include utility stream crossings, bridge work, and major construction contracts. Changes in releases are sometimes necessary for maintenance and inspection. Requests for changes of release rates are generally from a few hours to a few days. Each request is analyzed on its own merits. Consideration is given to upstream watershed conditions, potential flood threat, conditions of the lakes, and possible alternative measures. In the interest of maintaining good public relations, the requests are complied with providing there are no adverse effects on the overall operation of the project (or projects) for the authorized purposes. Approval for these minor deviations will normally be obtained by the Water Management Section from SWD by telephone or email. Normally, SWD is advised by telephone of these minor deviations with written follow-up communication to confirm the deviation.

c. Unplanned Major Deviations There are unplanned instances that create a temporary need for major deviations from the normal regulation plan and may be considered, but are not, emergencies. Flood control releases account for the major portion of these incidents and typical examples include project pre-releases or exceeding downstream channel capacity, incidents that have a short window of opportunity in an effort to minimize damages or optimize benefits. Requests for changes in release rates generally involve time periods ranging from a few hours to a few days. Each request is analyzed on its own merits. In evaluating the proposed deviation, consideration must be given to upstream watershed conditions, potential flood threat, and condition of the lake, and alternative measures that can be taken. Approval for these major deviations normally will be obtained from SWD by telephone or email. Written confirmation explaining the deviation and its cause will be furnished to the Division water control manager.

d. Planned Deviations. Advance approval of the SWD water control manager is required prior to any deviation from the plan of regulation prescribed or approved by the Corps in the interest of flood control, except in emergency conditions provided for in subparagraph 7-16.a. Each condition will be analyzed on its own merits. When conditions appear to warrant a prolonged deviation from the approved plan, the Water Management Section will investigate and evaluate the proposed deviation to insure that

the overall integrity of the plan would not be unduly compromised. Approval of prolonged deviations will not be granted unless such investigation and evaluations have been conducted to the extent deemed necessary by the SWD water control manager.

7-17. Rate of Release Change. The increase and decrease in releases from the lake shall be accomplished in a manner which minimizes damage to the reservoir area and downstream channel as shown in Table 7-6. Every reasonable precaution will be made to minimize erosion, bank sloughing, undercutting, and danger to human and animal life. Situations will arise which will not allow an orderly increases and/or decreases. Examples of these situation are large flood releases, described in paragraph 7-05 and drownings which occur downstream of the dam.

TABLE 7-6
RELEASE RATE CHANGES
INCREASING RELEASES TO CHANNEL CAPACITY ⁽¹⁾

Current Release Range (c.f.s.)	Maximum Increase (c.f.s.)	Minimum Time between Changes (hours) ⁽²⁾
0 – 40,000	6,700	2

DECREASING RELEASES BELOW CHANNEL CAPACITY ⁽¹⁾

Current Release Range (c.f.s)	Maximum Decrease (c.f.s.)	Minimum Time between Changes (hours) ⁽²⁾
40,000 – 0	6,700	2

(1) See Table 7-1 for releases (both rising and falling) that will exceed channel capacity.

(2) A maximum of 3 gate changes per day under normal operating conditions.

VIII - EFFECT OF WATER CONTROL PLAN

8-01. General. The effects of emergency flood control regulations (communication between Tulsa District and the Eufaula Project Office is disrupted) on the spillway design flood and the standard project flood and examples of the normal and emergency regulations of a historical major flood are presented in the following paragraphs. The floods were selected to show the effects of the flood control regulations for Eufaula Lake on a variety of possible flood conditions.

8-02. Flood Control.

a. Spillway Design Flood. The Spillway Design Flood (SDF) was taken from Plate 32 of the Reservoir Regulation Manual for Eufaula Reservoir dated Sep 1962. The total inflow volume was 4,711,400 acre-feet over a 10-day period. The peak inflow was 955,000 c.f.s. The peak outflow and pool elevation on a full pool were 474,000 c.f.s. and 604.96 feet, respectively. The peak outflow and pool elevation on an empty pool were 390,000 c.f.s. and 600.32 feet, respectively. Plate 8-1 shows the operational hydrographs and pool elevations for the SDF.

b. Standard Project Flood. The Standard Project Flood (SPF) was developed in accordance with Civil Works Engineering Bulletin No. 52-8, dated 26 Mar 1952. The SPF was assumed to be one half of the SDF. The total inflow volume was 2,456,000 acre-feet over a 10-day period. The peak inflow was 477,500 c.f.s. The peak outflow and pool elevation on a full pool were 378,000 c.f.s. and 599.90 feet, respectively. The peak outflow and pool elevation on an empty pool were 96,000 c.f.s. and 596.60 feet, respectively. Hydrographs for the SPF routed through Eufaula Lake are shown on Plate 8-2.

c. Flood of Apr - May 1990. The flood of Apr - May 1990 had a total inflow volume of 2,374,000 acre-feet over a 16-day period. The peak inflow was 389,000 c.f.s. The peak outflow and pool elevation with the experienced regulations were 237,000 c.f.s. and 599.77 feet, respectively. The peak outflow and pool elevation on a full pool using emergency regulations would be 228,000 c.f.s. and 599.76 feet respectively. Plate 8-3 contains the operational hydrographs and pool elevations for the actual and emergency regulations.

d. Flood of May – Aug 2007. This flood had a total inflow volume of 4,256,072 acre-feet over an 85 day period (27 May -19 Aug 2007). The peak inflow was 171,465 c.f.s., the peak discharge was 50,703 c.f.s., and the peak pool was 598.10 feet on 17 Jul 2007, using normal regulations. Due to continued intermittent rainfall, the flood pool was finally totally evacuated on 16 Nov 07. Plate 8-4 contains the operational hydrographs and pool elevations for the actual operation and the routing of this flood using the emergency regulations.

8-03. Recreation. Recreation features at the project include camping, picnicking, swimming, boating, hiking, and fishing. Recreational areas begin to flood as the pool rises above elevation 590.0 feet. Recreation activities are also affected when the lake level falls below normal pool due to drought and hydropower releases. Most of the ramps will be unusable if the lake drops below elevation 578.0 feet.

8-04. Water Quality. Eufaula Lake, overall, has good water quality which would not be significantly altered during flood control operations. Small releases have occasionally been made during the summer through the sluice outlet to increase the dissolved oxygen in the stilling basin to prevent fish kills.

8-05. Fish and Wildlife. Periodically, the ODWC requests a manipulation of the Eufaula pool level to enhance fish spawning and waterfowl habitat. The request usually involves limiting the drawdown of the conservation pool during the summer and limiting the rise during fall and spring. To be implemented, the plan requires approval from SWD and should not conflict with flood control operations or the needs of SWPA.

8-06. Water Supply. The quality of water in Eufaula Lake is considered good, requiring only conventional treatment to be suitable for domestic and industrial use. Withdrawals for water supply purposes will have no major effect on the operation of the lake.

8-07. Hydroelectric Power. During normal operations, releases will be made primarily through the turbines to maintain the pool at elevation 585.0 feet. The conservation storage is allocated to hydroelectric power generation (1,210,733 ac-ft), water supply storage (79,860 ac-ft) and sediment reserve storage (135,592 ac-ft). During flood operations, discharges will be made through the turbines as long as possible. At discharges greater than 260,000 c.f.s. the tailwater approaches the powerhouse parking lot at elevation 514.0 feet and sandbagging of the powerhouse entrances may be required.

8-08. Navigation. The coordination of flood releases from Eufaula Lake along with other lakes (discussed in Chapter VII of the Arkansas River Basin Water Control Master Manual) will significantly benefit navigation along the Kerr-McClellan Navigation system by providing a tapered recession of flows along the system. The controlled recession will enable navigation to continue while shoals are removed from the navigation channel. Another benefit from Eufaula Lake is sediment storage that will reduce the incidence of shoaling in the navigation system.

8-09. Frequencies.

a. Peak Inflow Probability. Estimated natural flows taken from "Riverware" run 2010-01 at the dam site for the period Jan 1940 through Dec 2008 were used to compute the maximum annual peak inflow probability. The inflow probability was derived in accordance with Bulletin 17B, "Guidelines for Determining Flood Flow Frequency," dated Jun 2006. The peak inflow probability curve (natural conditions) is shown on Plate 8-5.

b. Pool Elevation Duration and Probability. The pool elevation hydrographs resulting from the Arkansas River system routing of the computed flows at the dam site were used to compute maximum and minimum annual pool elevations which were converted to partial duration series. The computations were made using the general procedures presented in ER 1110-2-1450, dated 10 Oct 1962. The annual series was converted to a partial duration series by Langbein's conversion Table described in "Transactions American Geophysical Union," Volume 30, Dec 1949. Plate 8-6 shows the pool elevation probability curve and Plate 8-7 shows the pool elevation duration curve. Plates 8-8 through 8-14 show pool elevations from simulated and actual operational hydrographs for the period of record Jan 1940 through Dec 2011.

c. Key Control Points. The key control points downstream of Eufaula Lake are the Whitefield gage on the Canadian River and the Van Buren gage on the Arkansas River. The stage-discharge curves for these gages are shown on Plates 4-14 and 4-15, respectively. Channel capacity at the Whitefield gage is 84,340 c.f.s. The regulating stage and discharge are 17.50 feet and 84,340 c.f.s., respectively. The regulating flood stage at the Van Buren gage is 22.0 feet.

8-10. Other Studies. The Arkansas River Basin, Arkansas and Oklahoma, Feasibility Report, dated May 1991 evaluated the need and opportunity to reduce flood damages and develop additional municipal, industrial, and agricultural water supplies within the Arkansas River Basin in Arkansas and Oklahoma. This system operating plan this study recommended, included the 60,000 c.f.s , three day bench at Van Buren during the tapered flood evacuation of the Arkansas River Basin. This final operating plan is contained in the Arkansas River Basin Water Control Master Manual, revised Chapter 7 that was approved Oct 2007. Due to increasing public demand to open new areas of the lake to private limited development, including the use of authorities granted under the Oklahoma Lakes Demonstration Program (Sec. 3134 of WRDA 2007), Tulsa District determined that updates to the project master plan and associated shoreline management plan were needed. The proposed Eufaula Lake Master Plan and the proposed Shoreline Management Plan have been updated and were released in Apr 2013. In association with these proposed updates, the Environmental Impact Statement (EIS) is currently under review and is scheduled for completion in late FY 2013. Once the Lake Eufaula Advisory Committee has been formed, one of its priorities will be to consider the development of a permanent seasonal pool plan.

IX - WATER CONTROL MANAGEMENT

9-01. Responsibilities and Organizations.

a. Corps of Engineers. Eufaula Lake is a Corps of Engineers project, with the Tulsa District prescribing and directing the flood control releases. Operation and Maintenance, as well as regulation of the conservation storage, will be the responsibility of the Corps. Project reporting instructions and an organization chart are presented in Section V, and project regulating instructions are presented in Section VII of this manual.

(1) Responsibilities and Duties During Normal Operations. The Water Management Section, Hydrology-Hydraulics Branch, Tulsa District, is charged with the following responsibilities and duties under general supervision of the Engineering and Construction Division.

- (a) Routine regulation of lakes and distribution of routine data.
- (b) Investigations and refinement of regulation procedures.
 - 1). Analysis of past floods.
 - 2). Reconnaissance to determine channel capacities.
 - 3). Improvement of forecasting techniques.
 - 4). Plan and coordinate the hydrologic reporting network with the NWS and the USGS.
- (c) Train personnel in flood control duties.
 - 1). Make periodic visits to projects by Section personnel to familiarize themselves with regulation facilities, become acquainted with the operating personnel, discuss emergency regulation procedures with operating personnel, and provide the background for improving facilities and methods.
 - 2). Instruct personnel of the Hydrology-Hydraulics Branch in flood control procedures to supplement the Water Management Section during flood emergencies, when necessary.
- (d) Prepare reports on lake regulation.
 - 1). Recurring reports.
 - 2). Water control manuals.

3). Post-flood reports.

(2) Responsibilities and Duties During Flood Emergencies. During flood emergencies, the Water Management Section is responsible for the following:

(a) Evaluation of current hydrologic, hydraulic, and meteorological data.

(b) Performing or obtaining reservoir forecasts.

(c) Presentation of storm and flood analysis to the District Commander and other interested Tulsa District personnel.

(d) When necessary, furnish personnel to help project operating personnel in flood regulations.

(e) Regulation of lakes according to flood control regulation schedules.

(f) Furnish information to higher authority.

1). Provide initial reports to SWD and the Office of the Chief of Engineers by telephone.

2). Provide hydrologic data for situation reports.

(g) Furnish information to the Reservoir Information Control Center (RICC). The duties of the powerhouse Superintendent under flood conditions are set forth in Section VII of this manual. The details of the overall procedures of the Tulsa District under emergency conditions are set forth in Tulsa District Supplement A, Natural Disaster Activities, to ER 500-1-1.

(3) Assignment of Personnel. During non-flood periods, the Water Management Section accomplishes the routine regulation of the lake. However, during flood periods, assistance of other personnel may be required to maintain effective regulation of the lake. Plate 5-2 shows the organization of the Water Management Section during a major flood. The area and size of the flood will determine the number of people engaged in each activity.

(4) Provision for 24-hour Alert. The NWS and project personnel are provided with a list of names, addresses, and telephone numbers of key personnel of the Engineering Division with instructions to provide warning if unusual conditions occur. Responsible personnel will be on duty at the Tulsa District Office 24 hours a day.

whenever basin and/or project conditions warrant and during flood emergencies. Responsible personnel will be on duty at the project office or on call at all times.

(5) Role of Lake Manager. The Lake Manager will regulate the lake during flood periods according to instructions issued by personnel of the Water Management Section. The instructions follow the "Normal Regulations for Flood Control," included in Section VII. If the Lake Manager loses communication with Tulsa District, he/she will immediately attempt to re-establish communication with Tulsa District while following the instructions outlined in the Section "Emergency Regulations for Flood Control" included in Section VII and Exhibit B of this manual. The Lake Manager will make daily observations as directed in paragraph 5-07.

b. Other Federal Agencies. The NWS and the USGS cooperate with the Water Management Section, Hydrology-Hydraulics Branch, Tulsa District, to accumulate rainfall and stream flow data. The Environmental Protection Agency (EPA), together with the State of Oklahoma, establishes the standards for water quality releases. SWPA cooperates with the Corps of Engineers to market hydropower produced by the project.

c. State Agencies. Management of the fish and wildlife resources of the Eufaula Lake project is the responsibility of the Oklahoma Department of Wildlife Conservation (ODWC).

d. Private Organizations. Presently, there are no privately owned flood control protection facilities at Eufaula Lake whose regulation is coordinated with the Corps of Engineers.

9-02. Interagency Coordination. Cooperative arrangements with other Federal agencies, State agencies and local interests are discussed in Section X of the Water Control Master Manual, Arkansas River Basin, Tulsa and Little Rock Districts, date Jul 1980, and in the following subparagraphs.

a. Local Press and Corps Bulletins. The Corps of Engineers, the NWS, and USGS coordinate in forecasting flood stages, stream flow, and pool elevations. The NWS is officially responsible for issuing flood warnings to the public. This information will be supplemented by the Corps of Engineers bulletins from the Public Affairs Office (PAO) on observed conditions and with technical advice to enable local interests, within the limits of their capabilities, to obtain optimal flood protection and to perform rescue and relief functions. The Corps of Engineers further assists in flood control through the office of the Emergency Operations Manager, who furnishes sandbags and other necessary equipment based on equipment on hand and need. To facilitate the distribution of these data, the Reservoir Information Control Center (RICC) is in operation when conditions warrant.

b. National Weather Service. The Tulsa District and the NWS's Arkansas-Red Basin River Forecast Center exchange hydrometeorological data and reports to prevent duplication of effort in obtaining and distributing data. This exchange of data is

discussed in greater detail in Section VI of this manual. The NWS is the responsible agency for issuing public forecasts of stream stages.

c. U.S. Geological Survey. The Corps of Engineers and the USGS cooperate in a program for the construction, maintenance, and operation of stream gaging stations throughout the Tulsa District. During floods, the Corps of Engineers and the USGS coordinate field activities to maximize the number of stream discharge measurements.

d. Power Marketing Agency. The SWPA is responsible for the sale and delivery of all electric power and energy generated at Eufaula Dam to municipalities and rural electric cooperatives. Close coordination is maintained between the Tulsa District and SWPA. The Tulsa District provides SWPA with daily inflow forecasts to Eufaula Lake. SWPA provides the Tulsa District with daily, weekly, and monthly power generation schedules.

e. North American Electric Reliability Corporation (NERC). The NERC's mission is to ensure the reliability of the North American bulk power system. It is the electric reliability organization certified by the Federal Energy Regulatory Commission to establish and enforce reliability standards for the bulk-power system. As part of the bulk-power system, the hydropower projects in SWD are under NERC regulations. To meet requirements for hydropower operations under NERC, the Operating Plan For Southwestern Division (SWD) Corps of Engineers (COE) Hydropower was established by SWD in Sep 2010 (see Exhibit D).

f. Other Federal, State, or Local Agencies. The Tulsa District exchanges information with State government officials, the Oklahoma Department of Transportation, Oklahoma Highway Patrol, and others during flood emergencies. The Tulsa District also coordinates with State agencies concerning fish and wildlife throughout normal operations.

9-03. Interagency Agreements. Exhibit C is a Memorandum of Understanding (MOU) between The US Department of Energy (via SWPA) and the Corps of Engineers detailing hydropower operations at Lake Eufaula, dated 23 Jul 1980.

9-04. Commissions, River Authorities, Compacts, and Committees.

There are no commissions or a river authority on Canadian River. Arkansas River Basin compacts have been established between the states of Arkansas and Oklahoma and Kansas and Oklahoma. The major purposes of these compacts are:

a. To promote interstate comity between Arkansas and Oklahoma and Kansas and Oklahoma.

b. To provide for an equitable apportionment of the waters of the Arkansas River between Arkansas and Oklahoma and Kansas and Oklahoma and to promote the orderly development thereof.

c. To provide an agency for administering the water apportionment agreed to in the compacts.

d. To encourage the maintenance of an active pollution abatement program in each of the three states and to seek the further reduction of both natural and manmade pollution in the waters of the Arkansas River Basin.

9-05. Reports.

a. Daily Reports. In accordance with Tulsa District policy, this report is prepared following procedures outlined by the Water Management Section on a daily basis, except Saturday, Sunday, and holidays, to cover a period of 24-hours. The report provides data for use by personnel, whose work requires knowledge about the regulation of lakes, field investigations, stream gaging, and construction of flood control projects affected by releases from lakes, answering public inquiries, and preparing public releases. The report includes information on pool elevation, flood control storage, releases, inflow and rainfall. The report is completed and dispatched from the Water Management Section, Hydrology-Hydraulics Branch by 10:00 a.m. daily under normal conditions.

b. Monthly Lake Reports. The Water Management Section prepares monthly reports in accordance with EM 1110-2-3600 and ER 1110-2-240. These reports are records for all flood control, navigation, and multiple-purpose storage lakes under supervision of or of direct interest to the Tulsa District. Supplemental information on the regulation of the lakes, such as explanation of deviations from approved schedules, is added as a note on the reports or as an attachment. These tabulations are promptly prepared each month and maintained in such form as to be readily available for transmittal to the Chief of Engineers or others, upon request. The monthly lake reports are also available on the Tulsa District Web Page from 1994 to the present at www.swt-wc.usace.army.mil/EUFCharts.html.

c. Flood Situation Reports. The Water Management Section provides daily information to the Readiness and Security Branch for situation reports during floods in accordance with ER 500-1-1 and OM 500-1-6. The report contains various types of information about the floods. Pertinent data specifically required for lakes are as follows: name of lake, lake stage, predicted maximum stage, rates of inflow and outflow in c.f.s., percent of flood control storage used to date and at predicted maximum stage, and any special information particularly pertinent to the flood situation.

d. Post Flood Reports. This report is prepared according to ER 500-1-1 and OM 500-1-6 when practicable after a flood that has caused major damages. The report describes flood emergency operations by the Corps of Engineers and others. Included in summary form are: available hydrologic information, damage estimates, and other engineering data as are considered essential for flood control and flood plain studies or in the review of possible claims against the United States for damages. The Tulsa District Planning Division personnel, using information compiled and prepared by the

Water Management Section prepare the report. The report should be completed within approximately three months of the time of flooding, including a statement of final damages and associated costs.

e. Annual Reports. The Water Management Section prepares this report. The report contains a summation of the general conditions of the river basins and the individual projects in the Tulsa District for the preceding fiscal year. The report also presents the activities and accomplishments of the Water Management Section for the past year. The report is forwarded to the SWD Water Management Section for inclusion in the SWD's annual report.

f. Summary of Reports. Table 9-1 is a summary of the reports required in the regulation of the lakes in the Tulsa District.

TABLE 9-1
TABULATION OF REPORTS

Name of Report	When Required	Regulation Requiring Reporting
Daily Report	Daily, except Saturday, Sunday, and holidays	Tulsa District Policy
Monthly Lake Report	Monthly	ER 1110-2-3600 EM 1110-2-240
Flood Situation Report	During Floods	OM 500-1-6 ER 500-1-1
Post flood Report	Following a flood causing major damage	OM 500-1-6 ER 500-1-1
Annual Report	Annually	ER 1110-2-1400

**EUFAULA LAKE, CANADIAN RIVER, OKLAHOMA
WATER CONTROL MANUAL
APPENDIX N
TO
WATER CONTROL MASTER MANUAL
ARKANSAS RIVER BASIN
SUPPLEMENTAL TABLES**

TABLE 4-3

MAJOR STORMS
MAY 1960 THROUGH DEC 2010
CANADIAN RIVER BASIN
UPSTREAM OF EUFAULA DAM

Date of storm	Average Basin Rainfall (inches)	Date of storm	Average Basin Rainfall (inches)
17-20 May 1960	4.46	19-21 May 1977	3.84
21-23 Jul 1960	4.00	17-22 Jun 1980	3.01
12-14 Sep 1961	3.50	28-31 Jul 1981	3.84
2-9 Sep 1962	3.27	11-18 Oct 1981	6.56
24-27 Aug 1963	3.16	30-31 Jan 1982	3.18
5-11 May 1964	3.87	12-17 May 1982	4.51
14-30 Aug 1964	5.77	23-28 May 1982	3.48
15-23 Sep 1964	3.15	11-15 May 1983	4.74
14-19 Nov 1964	3.45	17-21 Oct 1983	7.69
17-24 Apr 1966	3.52	15-21 Oct 1984	4.47
19-26 Jul 1966	4.07	13-16 Dec 1984	3.25
9-14 Apr 1967	5.35	21-23 Feb 1985	3.70
2-8 Sep 1967	4.24	5-7 Jun 1985	4.01
6-14 May 1968	4.76	11-15 Oct 1985	3.16
10-15 Aug 1968	3.44	18-20 Oct 1985	3.37
22 May - 5 Jun 1970	3.70	15-17 May 1986	3.75
21-24 Sep 1970	5.19	27 Sep-2 Oct 1986	7.38
5-9 Oct 1970	3.77	13-21 Feb 1989	4.03
20-23 Oct 1972	3.96	13-24 May 1989	3.89
30 May-5 Jun 1973	5.55	1-8 Jun 1989	3.84
22-26 Nov 1973	4.73	1-14 Jul 1989	3.72
6-10 Jun 1974	4.55	10-14 Sep 1989	4.57
17-21 Apr 1976	4.05	17-20 Jan 1990	3.63

TABLE 4-3 (continued)

Date of storm	Average Basin Rainfall (inches)	Date of storm	Average Basin Rainfall (inches)
11-15 Mar 1990	5.63	8-15 Jul 1996	5.92
14-28 Apr 1990	10.25	20 Dec 97 – 17 Jan 98	8.26
2-3 May 1990	5.31	15-20 Mar 1998	3.80
17-22 Sep 1990	6.11	1-6 Oct 1998	5.23
7-10 Nov 1990	3.02	22-27 Apr 1999	5.05
15-26 May 1991	3.36	16-26 Jun 1999	3.43
27 Aug – 8 Sep 1991	4.67	8-15 Sep 1999	3.83
14-19 Sep 1991	3.16	17-29 Jun 2000	5.13
24 Oct – 5 Nov 1991	7.29	21 Oct – 10 Nov 2000	9.06
18-24 Dec 1991	3.69	28 May – 1 Jun 2001	4.13
9 Mar – 3 May 1992	9.71	15-22 Sep 2001	3.41
11-24 May 1992	5.17	10-14 Oct 2001	3.39
1-26 Jun 1992	8.26	19-27 Jun 2004	3.19
31 Jul – 7 Aug 1992	5.08	3-6 Jan 2005	3.19
10-14 Nov 1992	3.47	29 Apr – 11 May 2005	4.80
17 Nov – 26 Dec 1992	10.48	15-17 Oct 2006	3.19
15 Mar – 9 Apr 1993	3.91	7-12 May 2007	3.99
6-20 May 1993	4.50	22 May – 2 Jun 2007	3.24
13-18 Sep 1993	4.83	26 May – 11 Jun 2007	5.22
7-15 Mar 1994	5.86	8-24 Jun 2007	5.90
22 Apr – 5 May 1994	4.30	18-20 Aug 2007	3.22
24 May – 1 Jun 1994	6.56	18-19 Mar 2008	3.01
5-18 Jul 1994	3.67	8-10 Apr 2008	3.83
5-9 Aug 1994	6.48	8-13 Aug 2008	3.29
31 Aug – 7 Sep 1994	6.14	30 Apr – 7 May 2009	3.96
3-6 Nov 1994	3.73	4-10 Oct 2009	4.85
6-9 May 1995	3.70	14-15 Jun 2010	3.48
30 May – 7 Jun 1995	3.01	8-9 Sep 2010	3.62
22-23 Apr 1996	3.34		

TABLE 4-6

EUFAULA DAM SITE
MONTHLY INFLOWS (acre-feet)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1923	86,300	659,500	352,300	330,600	2,146,000	1,825,000	59,200	69,500	569,100	1,797,000	966,400	1,125,000	9,985,900
1924	248,600	269,800	367,300	722,000	535,900	402,300	82,400	70,700	91,600	47,500	46,800	55,200	2,940,100
1925	68,600	18,100	19,500	178,500	304,800	55,500	67,500	170,600	427,700	326,800	241,100	52,500	1,931,200
1926	297,500	94,000	73,900	485,400	346,900	346,400	310,000	82,700	585,700	2,757,000	177,900	543,900	6,101,300
1927	851,000	306,300	625,000	2,391,000	592,300	771,800	486,400	1,396,000	362,900	892,500	236,400	339,100	9,250,700
1928	182,500	111,300	153,600	789,700	827,700	715,200	489,300	323,500	65,000	86,300	199,000	193,000	4,136,100
1929	331,900	112,000	398,900	374,200	1,328,000	847,900	275,600	76,100	168,600	268,300	84,700	225,700	4,491,900
1930	236,800	423,100	22,200	8,000	798,600	303,100	28,800	21,000	4,900	159,500	89,100	460,500	2,555,600
1931	58,000	791,000	369,600	327,200	292,600	152,800	119,700	105,000	23,200	314,900	787,600	379,300	3,720,900
1932	2,197,000	864,400	174,400	136,200	81,400	1,301,000	873,000	149,000	45,300	58,000	28,300	390,900	6,298,900
1933	275,600	72,900	497,100	793,400	1,222,000	126,700	46,600	594,800	933,100	223,000	206,300	24,200	5,015,700
1934	318,500	81,400	284,900	474,600	275,100	98,800	24,700	13,700	600,100	244,800	303,200	107,500	2,827,300
1935	250,400	89,200	918,400	277,300	1,568,000	2,042,000	539,200	90,700	432,400	158,800	316,800	465,100	7,148,300
1936	115,900	71,400	52,400	49,600	160,500	244,800	55,500	45,400	338,100	350,500	47,400	103,700	1,635,200
1937	321,200	140,400	177,700	208,200	171,500	749,900	76,600	65,600	233,600	72,400	149,500	163,500	2,530,100
1938	158,300	2,134,800	507,600	661,000	934,400	663,600	213,000	124,700	118,600	62,300	30,300	14,300	5,622,900
1939	50,500	60,200	40,200	243,100	134,400	180,400	352,800	103,200	9,300	6,600	7,700	7,300	1,195,700
1940	6,700	15,100	9,400	197,000	146,800	116,300	341,300	139,100	189,700	10,000	164,400	201,000	1,536,800
1941	301,500	366,700	92,100	710,800	1,047,000	1,558,000	492,200	267,400	505,200	2,536,000	1,704,000	404,500	9,985,400
1942	142,200	203,500	185,200	2,349,000	851,600	923,700	329,500	249,500	406,000	338,800	506,200	402,800	6,888,000
1943	156,000	83,300	176,700	324,200	2,964,000	350,900	40,400	16,400	25,700	77,600	19,000	41,700	4,275,900
1944	120,200	256,900	514,400	203,100	704,200	444,000	60,100	35,000	63,000	223,300	62,200	145,400	2,831,800
1945	69,100	441,000	2,255,000	2,756,000	614,400	1,692,000	671,200	158,300	398,900	815,900	73,300	51,800	9,996,900
1946	467,100	612,100	343,900	375,700	1,237,000	581,900	276,800	60,700	88,300	252,300	499,500	1,203,000	5,998,300
1947	103,600	50,300	83,200	1,067,000	2,119,000	824,800	216,100	55,100	39,800	33,200	49,000	60,200	4,701,300

T-4-G-1

TABLE 4-6 (continued)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1948	126,200	317,700	694,800	105,000	403,100	1,802,000	908,400	119,300	28,400	14,100	22,000	37,200	4,578,200
1949	94,000	816,100	442,000	226,000	2,288,000	1,486,000	175,100	57,100	122,500	118,000	41,700	76,300	5,942,800
1950	411,600	414,500	87,600	149,600	1,861,000	217,700	1,867,000	780,000	1,189,000	176,600	44,700	37,100	7,236,400
1951	73,600	407,000	354,800	157,400	651,800	962,500	285,300	78,300	97,600	45,000	107,700	37,700	3,258,700
1952	58,800	86,500	365,200	689,100	293,100	143,400	49,100	16,800	9,200	2,400	16,500	18,500	1,748,600
1953	11,200	14,800	380,100	699,000	484,300	18,700	504,400	129,500	84,000	215,900	160,100	122,200	2,824,200
1954	98,000	47,400	38,400	49,800	1,301,000	104,800	9,300	3,500	890	11,700	3,300	26,700	1,694,790
1955	42,200	95,800	258,700	126,300	862,200	208,500	81,000	55,400	111,400	299,700	14,600	11,200	2,167,000
1956	12,200	70,600	15,100	13,500	163,300	98,700	9,300	2,800	160	140	9,700	17,100	412,600
1957	28,900	109,000	194,700	1,775,000	2,875,000	2,504,000	272,400	167,000	416,700	52,500	274,500	118,200	8,787,900
1958	181,100	129,600	631,800	477,300	585,100	771,500	490,300	597,000	169,800	40,900	35,400	29,200	4,139,000
1959	28,500	32,900	303,400	179,000	750,000	279,800	753,900	202,300	389,100	1,665,000	363,000	598,400	5,545,300
1960	568,900	456,100	332,000	337,200	2,020,000	341,400	581,400	222,500	41,800	218,700	94,000	205,000	5,419,000
1961	121,500	135,800	367,600	333,100	527,600	250,700	504,700	107,100	297,700	206,700	460,500	359,500	3,672,500
1962	176,800	131,100	337,200	542,200	115,100	551,500	211,400	94,600	209,500	155,400	151,900	216,300	2,893,000
1963	65,000	39,300	93,100	345,800	149,700	55,600	95,400	47,900	47,800	6,400	3,200	10,200	959,400
1964	8,400	29,400	71,000	211,900	531,900	159,700	17,500	149,900	140,200	3,000	360,500	7,700	1,691,100
1965	110,300	169,300	87,100	259,200	339,300	160,400	58,300	68,400	96,000	55,600	14,000	20,800	1,438,700
1966	16,300	186,400	99,500	472,800	152,900	32,500	74,200	58,900	52,200	10,200	24,400	3,700	1,184,000
1967	1,600	1,900	13,800	661,100	272,500	99,400	34,400	16,000	270,700	186,500	84,400	152,000	1,794,300
1968	417,000	246,900	1,104,800	552,200	1,299,700	540,800	238,700	118,700	83,600	50,700	456,800	502,600	5,612,500
1969	333,200	684,700	637,700	529,800	1,005,800	235,300	53,500	26,800	24,800	498,600	21,500	139,600	4,191,300
1970	120,600	64,800	360,000	768,700	346,900	339,400	33,500	11,100	369,700	1,310,800	167,000	23,500	3,916,000
1971	167,200	172,900	106,400	161,100	227,900	410,500	112,500	75,000	272,300	579,500	116,600	948,200	3,350,100
1972	92,200	94,200	117,200	260,500	218,100	35,600	49,500	17,500	48,400	268,900	882,200	160,700	2,245,000
1973	586,700	366,600	1,700,900	1,669,100	491,100	1,376,000	66,600	47,700	383,400	431,900	1,338,900	397,500	8,856,400
1974	125,100	219,100	436,700	432,700	622,400	1,050,500	21,000	61,800	540,500	364,500	1,391,900	288,300	5,554,500
1975	288,700	1,002,700	1,010,200	662,200	1,045,900	917,800	241,300	171,800	60,600	19,600	135,700	141,200	5,697,700

TABLE 4-6 (continued)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1976	59,400	48,400	322,400	784,400	454,300	155,700	35,500	3,300	17,400	28,100	13,900	57,200	1,980,000
1977	87,300	82,100	548,300	222,200	529,700	116,300	60,700	50,300	108,300	21,200	29,700	2,000	1,858,100
1978	18,200	188,700	398,400	223,400	628,800	447,100	21,200	18,600	1,800	6,200	54,400	20,900	2,027,700
1979	67,100	123,800	326,600	245,400	608,900	1,009,600	260,200	66,000	59,600	26,400	200,700	43,800	3,038,100
1980	44,000	71,400	93,600	147,800	576,200	461,600	19,000	3,300	20,200	8,300	17,300	49,200	1,511,900
1981	17,200	44,300	94,600	62,900	207,800	284,700	88,300	63,800	31,400	915,600	377,300	48,600	2,236,500
1982	308,600	524,200	194,100	59,300	1,895,200	1,367,600	289,400	33,100	27,000	19,000	113,700	302,300	5,133,500
1983	123,600	803,900	311,000	446,700	1,236,500	313,800	68,800	9,400	1,700	844,000	225,300	63,300	4,448,000
1984	92,400	169,800	614,100	439,100	279,500	148,800	31,700	15,200	25,000	445,700	307,600	875,900	3,444,800
1985	818,400	956,200	2,030,500	991,700	801,100	620,000	82,100	65,100	30,700	753,300	660,700	417,500	8,227,300
1986	67,000	207,000	322,900	729,300	1,139,900	517,700	42,400	59,200	189,400	1,499,200	632,400	318,700	5,725,100
1987	62,600	966,200	1,344,600	215,000	929,900	677,000	290,900	110,100	99,400	45,200	286,200	1,375,100	6,402,200
1988	494,100	204,900	1,095,900	1,141,500	125,200	79,700	156,300	31,700	82,700	50,400	136,700	111,500	3,710,600
1989	253,500	775,400	558,300	137,500	599,900	1,362,200	298,200	232,300	668,900	86,700	81,100	49,200	5,103,200
1990	456,800	575,800	2,520,800	2,598,100	2,970,200	222,700	82,500	115,300	305,000	105,500	189,200	214,800	10,356,700
1991	433,390	87,170	191,400	266,280	530,180	534,740	74,380	20,530	263,400	664,360	637,490	1,581,620	5,284,940
1992	364,560	218,980	372,890	561,720	985,880	1,575,870	535,640	862,810	667,520	28,160	1,091,800	1,871,600	9,137,430
1993	645,820	1,167,270	698,780	1,361,160	2,519,400	407,310	92,430	38,880	775,140	100,170	188,430	399,270	8,394,060
1994	126,150	348,690	1,003,440	330,050	719,600	167,210	92,630	63,070	43,640	73,072	956,642	277,750	4,201,944
1995	457,197	110,878	678,357	799,549	1,855,683	1,974,574	178,832	148,564	180,796	151,143	44,232	87,274	6,667,079
1996	148,366	55,082	183,870	671,415	294,018	201,833	415,345	344,038	431,114	137,853	1,217,274	287,409	4,387,617
1997	105,522	839,913	383,014	709,399	484,053	461,461	268,229	141,721	39,571	302,087	117,324	784,712	4,637,006
1998	1,678,388	352,468	1,779,547	522,652	537,727	182,284	36,794	208	99,373	557,711	352,240	410,386	6,509,778
1999	186,251	469,594	879,385	1,493,576	1,162,629	766,821	441,725	6,803	88,405	35,802	25,786	143,110	5,699,887
2000	92,233	183,375	343,959	252,519	760,474	766,970	268,963	12,893	23,405	265,591	736,374	284,434	3,991,190
2001	734,688	1,651,264	465,131	250,516	761,664	599,116	57,323	32,232	173,953	227,507	51,968	428,436	5,433,798
2002	137,506	255,237	578,785	883,748	257,657	347,212	58,017	25,686	14,380	77,357	78,943	207,117	2,921,645
2003	84,388	154,217	348,501	140,134	159,325	151,599	23,108	41,058	115,142	68,133	31,339	28,860	1,345,804

TABLE 4-6 (continued)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
2004	126,646	123,969	523,446	406,955	79,142	245,012	192,925	68,728	3,769	226,783	804,379	259,382	3,061,136
2005	941,002	283,561	278,543	202,029	65,456	240,678	73,588	129,989	27,273	42,447	2,975	17,157	2,304,698
2006	41,951	25,190	107,109	112,365	293,776	48,992	14,232	10,513	30,149	16,800	74,500	84,100	859,677
2007	541,843	177,127	116,828	458,585	1,343,216	1,727,331	2,172,825	749,961	308,137	165,027	50,778	282,550	8,094,208
2008	136,564	359,946	1,463,426	1,640,950	648,847	880,872	87,671	298,963	137,159	39,670	57,819	49,588	5,801,475
2009	73,588	153,364	149,556	316,567	1,071,090	212,334	38,877	133,093	228,995	1,294,135	253,590	215,408	4,140,597
2010	386,733	632,836	606,312	343,036	577,595	691,805	528,276	33,620	321,823	10,200	18,500	23,550	4,174,286
MIN	1,600	1,900	9,400	8,000	65,456	18,700	9,300	208	160	140	2,975	2,000	412,600
MAX	2,197,000	2,134,800	2,520,800	2,756,000	2,970,200	2,504,000	2,172,825	1,396,000	1,189,000	2,757,000	1,704,000	1,871,600	10,356,700
MEAN	252,202	321,182	468,921	561,897	811,129	595,932	247,799	136,687	203,698	323,421	271,720	267,516	4,462,104

T-4-6-4

TABLE 5-1

AUTOMATED GAGES ⁽¹⁾

LOCATION:	TYPE	SWT ID	SHEF ID	USGS ⁽²⁾ STATION #	LATITUDE NORTH Deg Min Sec	LONGITUDE WEST Deg Min Sec
Washita River at Alex, OK	PRECIP	ALEX	ALXO2	07328100	34 55 33	97 46 25
Washita River at Anadarko, OK	PRECIP	ANAD	ANDO2	07326500	35 05 03	98 14 35
Arbuckle Lake Dam	PRECIP	ARBU	ARBO2	07330300 ⁽³⁾	34 25 50	97 01 50
Arcadia Lake Dam	PRECIP	ARCA	ACDO2	07242340 ⁽³⁾	35 38 54	97 21 47
Deep Fork River nr Beggs, OK	PRECIP	BEGG	BGSO2	07243500	35 40 26	96 04 06
South Canadian River at Calvin, OK	PRECIP	CALV	CLVO2	07231500	34 58 40	96 14 36
Kiamichi River nr Clayton, OK	PRECIP	CLAY	CLTO2	07335790	34 34 29	95 20 26
North Canadian River nr El Reno, OK	PRECIP	ELRE	ELNO2	07239500	35 33 47	97 57 26
Eufaula Lake Dam	PRECIP	EUFA	EUFO2	07244800 ⁽³⁾	35 18 25	95 21 45
Cimarron River nr Guthrie, OK	PRECIP	GUTH	GTRO2	07160000	35 55 14	97 25 32
Gaines Creek nr Hartshorne, OK	PRECIP	HART	HAHO2	N/A ⁽³⁾	34 49 03	95 28 50
Arkansas River at Haskell, OK	PRECIP	HASK	HSKO2	07165570	35 49 22	95 38 16
Heyburn Lake Dam	PRECIP	HEYB	HEYO2	07165000 ⁽³⁾	35 56 49	96 17 54
Wildhorse Creek nr Hoover, OK	PRECIP	HOOV	HVRO2	07329700	34 32 29	97 14 49
McGee Creek Wildlife Refuge	PRECIP	MCGM	MGWO2	07333900	34 27 30	95 52 00
Arkansas River at Muskogee, OK	PRECIP	MUSK	MKGO2	07194500	35 46 10	95 17 49
South Canadian River Trib at Norman, OK	PRECIP	NOR2	NCTO2	07229053 ⁽³⁾	35 10 02	97 26 53
North Canadian River bl Lake Overholser nr OKC, OK	PRECIP	OKC1	OLBO2	07241000	35 28 43	97 39 47
North Canadian River nr Okemah, OK	PRECIP	OKEM	OEMO2	N/A ⁽³⁾	35 25 46	96 24 28
Washita River nr Pauls Valley, OK	PRECIP	PAUL	PLVO2	07328500	34 45 17	97 15 04
South Canadian River at Purcell, OK	PRECIP	PURC	PRCO2	07229200	35 00 50	97 20 50
Fourche Maline River nr Red Oak, OK	PRECIP	REDO	RDOO2	07247500	34 54 45	95 09 20

T5-1-1

TABLE 5-1 (continued)

LOCATION:	TYPE	SWT ID	SHEF ID	USGS ⁽²⁾ STATION #	LATITUDE NORTH Deg Min Sec	LONGITUDE WEST Deg Min Sec
Cimarron River nr Ripley, OK	PRECIP	RIPL	RIPO2	07161450	35 59 09	96 54 43
Sardis Lake Dam	PRECIP	SARD	CYDO2	07335775	34 37 45	95 21 03
Cottonwood Creek nr Seward, OK	PRECIP	SEWA	SWDO2	07159750	35 48 49	97 28 40
Sans Boise Creek nr Stigler, OK	PRECIP	STIG	SSBO2	N/A ⁽³⁾	35 09 50	95 06 13
Deep Fork River nr Stroud, OK	PRECIP	STRD	SDFO2	N/A ⁽³⁾	34 41 10	96 39 45
Lake Thunderbird Dam	PRECIP	THUN	NRMO2	07229900	35 13 24	97 13 02
Deep Fork River nr Warwick, OK	PRECIP	WARW	WRWO2	07242380	35 40 51	97 00 29
Arkansas River at Webbers Falls L&D	PRECIP	WEBB	WFLO2	07194550 ⁽³⁾	35 33 16	95 10 02
North Canadian River nr Wetumka, OK	PRECIP	WETU	WETO2	07242000	35 15 56	96 12 21
Wewoka Creek nr Wewoka, OK	PRECIP	WEWO	WWCO2	N/A	35 11 42	96 14 53
Canadian River nr Whitefield, OK	PRECIP	WHIT	WHTO2	07245000	35 15 44	95 14 13
2 miles NNE of Ada	MESONET	ADSO2	ADSO2	N/A ⁽⁴⁾	34 47 54	96 40 08
4 miles SE of Bristow	MESONET	BRSO2	BRSO2	N/A ⁽⁴⁾	35 46 49	96 21 14
3 miles NNE of Clayton	MESONET	CASO2	CASO2	N/A ⁽⁴⁾	34 39 23	95 19 33
3 miles NNE of Sparks	MESONET	CHSO2	CHSO2	N/A ⁽⁴⁾	35 39 10	96 48 14
1 mile E of Centrahoma	MESONET	CNSO2	CNSO2	N/A ⁽⁴⁾	34 36 32	96 19 59
6 miles ESE of Oilton	MESONET	DRSO2	DRSO2	N/A ⁽⁴⁾	36 01 52	96 29 50
5 miles WNW of El Reno, OK	MESONET	ERSO2	ERSO2	N/A ⁽⁴⁾	35 32 54	98 02 11
4 miles WNW of Eufaula	MESONET	EUSO2	EUSO2	N/A ⁽⁴⁾	35 18 11	95 39 25
6.3 miles SW of Fittstown	MESONET	FTSO2	FTSO2	N/A ⁽⁴⁾	34 33 07	96 43 04
4 miles WDW of Guthrie, OK	MESONET	GTSO2	GTSO2	N/A ⁽⁴⁾	35 50 56	97 28 47
4.1 miles W of Hectorville	MESONET	HESO2	HESO2	N/A ⁽⁴⁾	35 50 29	96 00 08
3 miles ESE of Holdenville	MESONET	HLSO2	HLSO2	N/A ⁽⁴⁾	35 04 14	96 21 21
4 miles S of McAlester	MESONET	MCSO2	MCSO2	N/A ⁽⁴⁾	34 52 56	95 46 51
2 miles SSW of Minco	MESONET	MOSO2	MOSO2	N/A ⁽⁴⁾	35 16 20	97 57 19

T5-1-2

TABLE 5-1 (continued)

LOCATION:	TYPE	SWT ID	SHEF ID	USGS ⁽²⁾ STATION #	LATITUDE NORTH Deg Min Sec	LONGITUDE WEST Deg Min Sec
2.1 miles NW of Norman	MESONET	NRSO2	NRSO2	N/A ⁽⁴⁾	35 14 09	97 27 53
6.1 miles N of Oklahoma City, OK	MESONET	OCSO2	OCSO2	N/A ⁽⁴⁾	35 33 20	97 30 38
3 miles E of Oklahoma City	MESONET	OESO2	OESO2	N/A ⁽⁴⁾	35 28 20	97 27 50
3 miles SW of Morris	MESONET	OGSO2	OGSO2	N/A ⁽⁴⁾	35 34 55	95 54 53
3 miles E of Okemah	MESONET	OMSO2	OMSO2	N/A ⁽⁴⁾	35 25 54	96 15 45
3.7 miles W of Oklahoma City	MESONET	OYSO2	OYSO2	N/A ⁽⁴⁾	35 28 16	97 34 56
6 miles SSW of Washington	MESONET	PCSO2	PCSO2	N/A ⁽⁴⁾	34 58 56	97 31 15
2 miles NNW of Perkins	MESONET	PRSO2	PRSO2	N/A ⁽⁴⁾	35 59 55	97 02 53
3 miles ESE of Byars	MESONET	SFSO2	SFSO2	N/A ⁽⁴⁾	34 50 58	97 00 11
3 miles NNW of Shawnee	MESONET	SHSO2	SHSO2	N/A ⁽⁴⁾	35 21 53	96 56 53
3 miles NE of Bowlegs	MESONET	SMSO2	SMSO2	N/A ⁽⁴⁾	35 10 17	96 37 52
2 miles ENE of Spencer	MESONET	SNSO2	SNSO2	N/A ⁽⁴⁾	35 32 31	97 20 29
3 miles SE of Stuart	MESONET	SUSO2	SUSO2	N/A ⁽⁴⁾	34 52 35	96 04 11
3 miles WNW of Stigler	MESONET	STSO2	STSO2	N/A ⁽⁴⁾	35 15 54	95 10 52
2.4 miles NE of Vanoss	MESONET	VASO2	VASO2	N/A ⁽⁴⁾	34 47 29	96 50 37
2 miles SW of Wilburton	MESONET	WBSO2	WBSO2	N/A ⁽⁴⁾	34 54 03	95 20 52
Deep Fork River nr Beggs, OK	STREAMGAGE	BEGG	BGSO2	07243500	35 40 26	96 04 06
South Canadian River nr Bridgeport, OK	STREAMGAGE	BRID	BRIO2	07228500	35 32 37	98 19 03
South Canadian River at Calvin, OK	STREAMGAGE	CALV	CLVO2	07231500	34 58 40	96 14 36
North Canadian River nr Harrah, OK	STREAMGAGE	HARR	HRH02	07241550	35 30 01	97 11 37
Gaines Creek nr Hartshorne, OK	STREAMGAGE	HART	HAHO2	N/A ⁽³⁾	34 49 03	95 28 50
South Canadian River Trib at Norman, OK	STREAMGAGE	NOR2	NCTO2	07229053 ⁽³⁾	35 10 02	97 26 53
South Canadian River at Norman, OK	STREAMGAGE	NORM	NRCO2	07229050	35 11 40	97 29 05

TABLE 5-1 (continued)

LOCATION:	TYPE	SWT ID	SHEF ID	USGS ⁽²⁾ STATION #	LATITUDE NORTH Deg Min Sec	LONGITUDE WEST Deg Min Sec
North Canadian River bl Lake Overholser nr OKC, OK	STREAMGAGE	OKC1	OLBO2	07241000	35 28 43	97 39 47
North Canadian River at Brittion Rd at OKC, OK	STREAMGAGE	OKC3	OKBO2	07241520	35 33 56	97 22 01
North Canadian River nr Okemah, OK	STREAMGAGE	OKEM	OEMO2	N/A ⁽³⁾	35 25 46	96 24 28
South Canadian River at Purcell, OK	STREAMGAGE	PURC	PRCO2	07229200	35 00 50	97 20 50
Little River near Sasakwa, OK	STREAMGAGE	SASA	SASO2	07231000	34 57 55	96 30 44
North Canadian River at Shawnee, OK	STREAMGAGE	SHAW	SNCO2	7241800	35 19 59	96 52 09
Deep Fork River nr Stroud, OK	STREAMGAGE	STRD	SDFO2	N/A ⁽³⁾	34 41 10	96 39 45
Little River nr Tecumseh, OK	STREAMGAGE	TECU	TCMO2	07230500	35 10 21	96 55 54
South Canadian River nr Mustang, OK (Tuttle, OK)	STREAMGAGE	TUTL	TUCO2	07228940	35 19 27	97 43 25
Deep Fork River nr Warwick, OK	STREAMGAGE	WARW	WRWO2	07242380	35 40 51	97 00 29
North Canadian River nr Wetumka, OK	STREAMGAGE	WETU	WETO2	07242000	35 15 56	96 12 21
Wewoka Creek nr Wewoka, OK	STREAMGAGE	WEWO	WWCO2	N/A ⁽³⁾	35 11 42	96 14 53
Canadian River nr Whitefiled, OK	STREAMGAGE	WHIT	WHTO2	07245000	35 15 44	95 14 13
Arcadia Lake Dam	POOL	ARCA	ACDO2	07242340 ⁽³⁾	35 38 54	97 21 47
Eufaula Lake Dam	POOL	EUFA	EUFO2	07244800 ⁽³⁾	35 18 25	95 21 45
Lake Thunderbird Dam	POOL	THUN	NRMO2	07229900	35 13 24	97 13 02

- (1) Current data for all gages can be found at <http://www.swt-wc.usace.army.mil>
- (2) Unless otherwise noted, current and historical data can be found at <http://nwis.waterdata.usgs.gov/ok/nwis>
- (3) Gages installed and maintained by Tulsa District Corps of Engineers
- (4) Current and historical data can be found at <http://www.mesonet.org/index.php/weather/local>

**TABLE 5-2 - A
WATER QUALITY STATIONS – COE**

Primary Station Code	Location Description	Type	Operating Agency	Reporting or Non-Reporting	Period of Record	Frequency of Analysis	Latitude (North)	Longitude (West)
1EUFOKS0037	Eufaula Dam Site at Bouy line	Physical/chemical	COE	Non-Reporting	2001 - present	10 years or as needed	35:18:30.0	-95:21:45.0
1EUFOKS0038	Near Longtown NE of Hwy 9	Physical/chemical	COE	Non-Reporting	2001 - present	10 years or as needed	35:15:31.1	-95:30:48.1
1EUFOKS0039	South Canadian Arm W of Hwy 69	Physical/chemical	COE	Non-Reporting	2001 - present	10 years or as needed	35:13:25.5	-95:38:15.2
1EUFOKS0040	Mouth of Gaines Creek Arm at Hwy 9A Bridge	Physical/chemical	COE	Non-Reporting	2001 - present	10 years or as needed	35:13:04.4	-95:35:39.2
1EUFOKS0044	Deep Fork Arm near Gentry Creek Cove	Physical/chemical	COE	Non-Reporting	2001 - present	10 years or as needed	35:29:14.7	-95:40:47.5
1EUFOKS0172	Stilling basin below dam	Physical/chemical	COE	Non-Reporting	2001 - present	10 years or as needed	35:18:23.8	-95:21:27.3
1EUFOKS0173	Crowder Point – Gaines Creek Arm at Blocker Rd Bridge	Physical/chemical	COE	Non-Reporting	1997 - present	10 years or as needed	35:06:20.1	-95:38:34.9
1EUFOKS0174	North Canadian Arm near Fountainhead State Park	Physical/chemical	COE	Non-Reporting	2001 - present	10 years or as needed	35:22:40.9	-95:38:11.3
1EUFOKS0175	At Hwy 69 Bridge	Physical/chemical	COE	Non-Reporting	2001 - present	10 years or as needed	35:19:56.7	-95:35:12.0

TS-2-1

**TABLE 5-2 - B
WATER QUALITY STATIONS - USGS**

Primary Station Code	Location Description	Type	Operating Agency	Reporting / Non-reporting	Period of Record	Frequency of Analysis	Latitude (North)	Longitude (West)
07243500	Deep Fork River near Beggs, OK	Temperature	USGS	Non-Reporting	Not available	Daily	35:40:26	-96:04:06
07241550	N Canadian River, near Harrah, OK	Physical / Chemical	USGS	Reporting	1996 to present	Daily	35:30:01	-97:11:37
07242000	N Canadian River, near Wetumka, OK	Physical/ Chemical	USGS	Non-Reporting	1953-1989	Daily	35:15:56	-96:12:21
07231500	N Canadian River near Calvin, OK	Physical/ Chemical	USGS	Non-Reporting	1965-1982	Daily	34:58:40	-96:14:36
07237500	N Canadian River near Woodward, OK	Physical/ Chemical	USGS	Reporting	1938 - present	Daily	36:26:12	-99:16:41
07239450	N Canadian River near Calument, OK	Physical/ Chemical	USGS	Reporting	1974 - present	Daily	35:37:01	-98:03:54
07239500	N Canadian River near El Reno, OK	Physical/ Chemical	USGS	Reporting	1938 – present	Daily	35:33:47	-97:57:26
07239700	N Canadian River near Yukon, OK	Physical / Chemical	USGS	Reporting	1952 - present	Daily	35:32:22	-97:44:32
07241000	N Canadian River below Lake Overholser	Physical / Chemical	USGS	Non-Reporting	1959 – present	Daily	35:28:43	-97:39:47
07241520	N Canadian River near Britten Rd.	Physical / Chemical	USGS	Reporting	1988-present	Daily	34:33:56	-97:22:01

T5-2-2

**TABLE 5-2 – C
WATER QUALITY STATIONS - OWRB**

Primary Station Code	Location Description	Type	Operating Agency	Reporting / Non-reporting	Period of Record	Frequency of Analysis	Latitude (North)	Longitude (West)
520700010020-01	Eufaula Lake Deep Fork Arm	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.454356	-95.612858
520700010020-02	Eufaula Lake Deep Fork Arm	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.427667	-95.600147
520500010020-03	Eufaula Lake N Canadian Arm	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.382211	-95.629992
5205000100520-04	Eufaula Lake N Canadian Arm	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.300447	-95.553956
220600010020-05	Eufaula Lake	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.284831	-95.514717
220600010020-06	Eufaula Lake	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.307044	-95.437550
220600010020-07	Eufaula Lake	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.306775	-95.362056
220600010060-08	Eufaula Lake Longtown Creek Arm	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.233919	-95.499906
220600010050-09	Eufaula Lake Canadian Arm	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.225264	-95.596286
220600010050-10	Eufaula Lake Canadian Arm	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.20280	-95.697314
220600010050-11	Eufaula Lake Canadian Arm	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.228856	-95.63380
220600050010-12	Eufaula Lake Coal Creek	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.200469	-95.593789
220600050010-13	Eufaula Lake Gaines Creek Arm	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.164397	-95.599461

T5-2-3

**TABLE 5-2 – C (Cont.)
WATER QUALITY STATIONS - OWRB**

Primary Station Code	Location Description	Type	Operating Agency	Reporting / Non-reporting	Period of Record	Frequency of Analysis	Latitude (North)	Longitude (West)
220600050010-14	Eufaula Lake Coal Creek	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.101444	-95.647236
220600050010-15	Eufaula Lake Coal Creek	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.050036	-95.671122
220600050010-16	Eufaula Lake Ash Creek	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	35.019964	-95.602278
220600050010-17	Eufaula Lake Gaines Creek Arm	Physical / Chemical	OWRB	Non-reporting	1994 - present	5 years or as needed	34.974711	-95.630314

**TABLE 7-3
ELEVATION – AREA – CAPACITY DATA
EUFAULA LAKE, OKLAHOMA
2004 CONSERVATION POOL SURVEY & 2010 FLOOD POOL LIDAR SURVEY**

**AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET**

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
495	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001
	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001
496	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002
497	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.003	0.003
	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.004	0.004
498	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.004
	0.004	0.004	0.005	0.005	0.005	0.006	0.006	0.006	0.006	0.007
499	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.005	0.006	0.006
	0.007	0.008	0.008	0.009	0.008	0.010	0.010	0.011	0.011	0.012
500	0.006	0.006	0.007	0.007	0.008	0.008	0.008	0.009	0.009	0.010
	0.012	0.013	0.014	0.014	0.015	0.016	0.017	0.018	0.018	0.019
501	0.010	0.011	0.012	0.012	0.013	0.014	0.015	0.016	0.016	0.017
	0.020	0.021	0.023	0.024	0.025	0.027	0.028	0.029	0.030	0.032

TABLE 7-3-1

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
502	0.018	0.021	0.023	0.026	0.029	0.032	0.034	0.037	0.040	0.042
	0.033	0.036	0.039	0.042	0.045	0.048	0.051	0.054	0.057	0.060
503	0.045	0.049	0.053	0.057	0.061	0.066	0.070	0.074	0.078	0.082
	0.063	0.070	0.076	0.083	0.089	0.096	0.102	0.109	0.115	0.122
504	0.086	0.092	0.092	0.104	0.110	0.116	0.121	0.127	0.133	0.139
	0.128	0.139	0.151	0.162	0.174	0.185	0.196	0.208	0.219	0.231
505	0.145	0.153	0.161	0.169	0.177	0.185	0.192	0.200	0.208	0.216
	0.242	0.260	0.278	0.296	0.314	0.333	0.351	0.369	0.387	0.405
506	0.224	0.234	0.243	0.253	0.262	0.272	0.282	0.291	0.301	0.310
	0.423	0.450	0.477	0.504	0.531	0.559	0.586	0.613	0.640	0.667
507	0.320	0.330	0.341	0.351	0.362	0.372	0.382	0.393	0.403	0.414
	0.694	0.731	0.768	0.805	0.842	0.880	0.917	0.954	0.991	1.028
508	0.424	0.435	0.446	0.456	0.467	0.478	0.489	0.500	0.510	0.521
	1.065	1.113	1.160	1.208	1.256	1.304	1.351	1.399	1.447	1.494

TABLE 7-3-2

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
509	0.532	0.546	0.561	0.575	0.589	0.604	0.618	0.632	0.646	0.661
	1.542	1.602	1.662	1.722	1.782	1.842	1.901	1.961	2.021	2.081
510	0.675	0.693	0.712	0.730	0.749	0.767	0.785	0.804	2.457	0.841
	2.141	2.217	2.293	2.370	2.446	2.522	2.598	2.674	2.751	2.827
511	0.859	0.883	0.907	0.930	0.954	0.978	1.002	1.026	1.049	1.073
	2.903	3.001	3.098	3.196	3.294	3.392	3.489	3.587	3.685	3.782
512	1.097	1.128	1.158	1.189	1.219	1.250	1.280	1.311	1.341	1.372
	3.880	4.004	4.128	4.251	4.375	4.499	4.623	4.747	4.870	4.994
513	1.402	1.440	1.478	1.516	1.554	1.593	1.631	1.669	1.707	1.745
	5.118	5.277	5.437	5.596	5.756	5.915	6.074	6.234	6.393	6.553
514	1.783	1.830	1.876	1.923	1.970	2.017	2.063	2.110	2.157	2.203
	6.712	6.912	7.113	7.313	7.514	7.714	7.914	8.115	8.315	8.516
515	2.250	2.306	2.363	2.419	2.475	2.532	2.588	2.644	2.700	2.757
	8.716	8.968	9.220	16.534	9.725	9.977	10.229	10.481	10.734	10.986

TABLE 7-3-3

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
516	2.813	2.870	2.928	2.985	3.042	3.100	3.157	3.214	3.271	3.329
	11.238	11.549	11.859	12.170	23.977	12.792	13.102	13.413	13.724	14.034
517	3.386	3.431	3.475	3.520	3.565	3.610	3.654	3.699	3.744	3.788
	14.345	14.707	15.069	15.430	15.792	16.154	16.516	16.878	17.239	17.601
518	3.833	3.870	3.907	3.944	3.981	4.018	4.055	4.092	4.129	4.166
	17.963	18.365	18.766	19.168	19.570	19.972	20.373	20.775	21.177	21.578
519	4.203	4.235	4.266	4.298	4.330	4.362	4.393	4.425	4.457	4.488
	21.980	22.417	22.854	23.291	23.728	24.165	24.602	25.039	25.476	25.913
520	4.520	4.543	4.567	4.590	4.614	4.637	4.660	4.684	4.707	4.731
	26.350	26.814	27.278	27.742	28.206	28.670	29.133	29.597	30.061	30.525
521	4.754	4.776	4.797	4.819	4.841	4.863	4.884	4.906	4.928	4.949
	30.989	31.475	31.962	32.448	32.935	33.421	33.907	34.394	34.880	35.367
522	4.971	4.995	5.019	5.043	5.067	5.091	5.115	5.139	5.163	5.187
	35.853	36.362	36.870	37.379	37.888	38.397	38.905	39.414	39.923	40.431

TABLE 7-3-4

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
523	5.211 40.940	5.236 41.474	5.262 42.008	5.287 42.542	5.313 43.076	5.338 43.610	5.363 44.144	5.389 44.678	5.414 45.212	5.440 45.746
524	5.465 46.280	5.493 46.840	5.521 46.840	5.550 47.960	5.578 48.520	5.606 49.081	5.634 49.641	5.662 50.201	5.691 50.761	5.719 51.321
525	5.747 51.881	5.779 52.471	5.811 53.062	5.843 53.652	5.875 54.243	5.908 54.833	5.940 55.423	5.972 56.014	6.004 56.604	6.036 57.195
526	6.068 57.785	6.107 58.411	6.147 59.037	6.186 59.663	6.226 60.289	6.265 60.916	6.304 61.542	6.344 62.168	6.383 62.794	6.423 63.420
527	6.462 64.046	6.503 64.711	6.543 65.376	6.584 66.041	6.624 66.706	6.665 67.371	6.705 68.036	6.746 68.701	6.786 69.366	6.827 70.031
528	6.867 70.696	6.919 71.408	6.970 72.119	7.022 72.831	7.073 73.542	7.125 74.254	7.177 74.965	7.228 75.677	7.280 76.388	7.331 77.100
529	7.383 77.811	7.436 78.576	7.490 79.342	7.543 80.107	7.597 80.872	7.650 81.638	7.703 82.403	7.757 83.168	7.810 83.933	7.864 84.699

TABLE 7-3-5

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
530	7.917 85.464	7.968 86.281	8.018 87.099	8.069 87.916	8.120 88.733	8.171 89.551	8.221 90.368	8.272 91.185	8.323 92.002	8.373 92.820
531	8.424 93.637	8.474 94.504	8.524 95.370	8.574 96.237	8.624 97.104	8.674 97.971	8.723 98.837	8.773 99.704	8.823 100.571	8.873 101.437
532	8.923 102.304	8.972 103.222	9.021 104.139	9.069 105.057	9.118 105.975	9.167 106.893	9.216 107.810	9.265 108.728	9.313 109.646	9.362 110.563
533	9.411 111.481	9.453 112.444	10.293 113.406	9.537 114.369	9.579 115.331	9.621 116.294	9.663 117.256	12.393 118.219	9.747 119.181	9.789 120.144
534	9.831 121.106	9.871 122.109	9.910 123.112	9.950 124.116	9.989 125.119	10.029 126.122	10.068 127.125	10.108 128.128	10.147 129.132	10.187 130.135
535	10.226 131.138	10.270 132.182	10.313 133.225	10.357 134.269	10.401 135.312	10.445 136.356	10.488 137.399	10.532 138.443	10.576 139.486	10.619 140.530
536	10.663 141.573	10.718 142.666	10.772 143.758	10.827 144.851	10.881 145.943	10.936 147.036	10.990 148.128	11.045 149.221	11.099 150.313	11.154 151.406

TABLE 7-3-6

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
537	11.208 152.498	11.272 153.651	11.337 154.803	11.401 155.956	11.465 157.108	11.530 158.261	11.594 159.414	11.658 160.566	11.722 161.719	11.787 162.871
538	11.851 164.024	11.912 165.241	11.973 166.458	12.034 167.675	12.095 168.892	12.156 170.109	12.217 171.325	12.278 172.542	12.339 173.759	12.400 174.976
539	12.461 176.193	12.518 177.467	12.575 178.740	12.631 180.014	12.688 181.288	12.745 182.562	12.802 183.835	12.859 185.109	12.915 186.383	12.972 187.656
540	13.029 188.930	13.096 190.266	13.164 191.602	13.231 192.939	13.298 194.275	13.366 195.611	13.433 196.947	13.500 198.283	13.567 199.620	13.635 200.956
541	13.702 202.292	13.764 203.694	13.825 205.096	13.887 206.498	13.949 207.900	14.011 209.302	14.072 210.703	14.134 212.105	14.196 213.507	14.257 214.909
542	14.319 216.311	14.379 217.773	14.440 219.236	14.500 220.698	14.560 222.161	14.621 223.623	14.681 225.085	14.741 226.548	14.801 228.010	14.862 229.473
543	14.922 230.935	14.992 232.461	15.061 233.986	15.131 235.512	15.200 237.037	15.270 238.563	15.339 240.089	15.409 241.614	15.478 243.140	15.548 244.665

TABLE 7-3-7

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
544	15.617 246.191	15.691 247.790	15.765 249.389	15.840 250.988	15.914 252.587	15.988 254.187	16.062 255.786	16.136 257.385	16.211 258.984	16.285 260.583
545	16.359 262.182	16.425 263.851	16.491 265.520	16.557 267.190	16.623 268.859	16.690 270.528	16.756 272.197	16.822 273.866	16.888 275.536	16.954 277.205
546	17.020 278.874	17.086 280.609	18.406 282.344	17.218 284.079	17.284 285.814	17.350 287.549	17.416 289.283	17.482 291.018	17.548 292.753	17.614 294.488
547	17.680 296.223	17.758 298.030	17.836 299.837	17.914 301.643	17.992 303.450	18.071 305.257	18.149 307.064	18.227 308.871	18.305 310.677	18.383 312.484
548	18.461 314.291	18.539 316.175	18.616 318.059	18.694 319.944	18.771 321.828	18.849 323.712	18.927 325.596	19.004 327.480	19.082 329.365	19.159 331.249
549	19.237 333.133	19.324 335.100	19.412 337.067	19.499 339.034	19.587 341.001	19.674 342.968	19.761 344.934	19.849 346.901	19.936 348.868	20.024 350.835
550	20.111 352.802	20.210 354.861	20.308 356.919	20.407 358.978	20.505 361.037	20.604 363.096	20.703 365.154	20.801 367.213	20.900 369.272	20.998 371.330

TABLE 7-3-8

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
551	21.097 373.389	21.217 375.558	21.338 377.726	21.458 379.895	21.578 382.064	21.699 384.233	21.819 386.401	21.939 388.570	22.059 390.739	22.180 392.907
552	22.300 395.076	22.418 397.366	22.537 399.655	22.655 401.945	22.774 404.234	22.892 406.524	23.010 408.813	23.129 411.103	23.247 413.392	23.366 415.682
553	23.484 417.971	23.613 420.384	23.742 422.797	23.871 425.209	24.000 427.622	24.129 430.035	24.258 432.448	24.387 434.861	24.516 437.273	24.645 439.686
554	24.774 442.099	24.897 444.638	25.021 447.178	25.144 449.717	25.268 452.257	25.391 454.796	25.514 457.335	25.638 459.875	25.761 462.414	25.885 464.954
555	26.008 467.493	26.123 470.153	26.239 472.812	26.354 475.472	26.469 478.131	26.585 480.791	26.700 483.451	26.815 486.110	26.930 488.770	27.046 491.429
556	27.161 494.089	27.269 496.859	27.376 499.630	27.484 502.400	27.591 505.171	27.699 507.941	27.806 510.711	27.914 513.482	28.021 516.252	28.129 519.023
557	28.236 521.793	28.345 524.669	28.454 527.546	28.563 530.422	28.672 533.299	28.781 536.175	28.890 539.051	28.999 541.928	29.108 544.804	29.217 547.681

TABLE 7-3-9

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
558	29.326	29.454	29.583	29.711	29.839	29.968	30.096	30.224	30.352	30.481
	550.557	553.552	556.548	559.543	562.538	565.534	568.529	571.524	574.519	577.515
559	30.609	30.748	30.886	31.025	31.163	31.302	31.440	31.579	31.717	30.748
	580.510	583.639	586.768	589.897	593.026	596.156	599.285	602.414	605.543	608.672
560	31.994	32.178	32.363	32.547	32.731	32.916	33.100	33.284	33.468	33.653
	611.801	615.085	618.370	621.654	624.938	628.223	631.507	634.791	638.075	641.360
561	33.837	34.063	34.288	34.514	34.740	34.966	35.191	35.417	35.643	35.868
	644.644	648.142	651.639	655.137	658.634	662.132	665.630	669.127	672.625	676.122
562	36.094	36.317	36.539	36.762	36.984	37.207	37.430	37.652	37.875	38.097
	679.620	683.340	687.059	690.779	694.498	698.218	701.938	705.657	709.377	713.096
563	38.320	38.551	38.782	39.014	39.245	39.476	39.707	39.938	40.170	40.401
	716.816	720.766	724.716	728.666	732.616	736.566	740.515	744.465	748.415	752.365
564	40.632	40.841	41.049	41.258	41.467	41.676	41.884	42.093	42.302	42.510
	756.315	760.483	760.483	760.483	760.483	760.483	760.483	760.483	760.483	760.483

TABLE 7-3-10

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
565	42.719 797.990	42.940 802.372	43.160 806.754	43.381 811.136	43.601 815.518	43.822 819.900	44.043 824.282	44.263 828.664	44.484 833.046	44.704 837.428
566	44.925 841.810	45.170 846.419	45.415 851.027	45.905 855.636	45.905 860.245	46.150 864.854	46.395 869.462	46.640 874.071	46.885 878.680	67.220 883.288
567	47.375 887.897	47.629 892.763	47.884 897.628	48.138 902.494	48.393 907.359	48.647 912.225	48.901 917.090	49.156 921.956	49.410 926.821	49.665 931.687
568	49.919 936.552	50.169 941.669	50.418 946.787	50.668 951.904	50.918 957.022	51.168 962.139	51.417 967.256	51.667 972.374	51.917 977.491	52.166 982.609
569	52.416 987.726	52.648 993.085	52.879 998.443	53.111 1003.802	53.342 1009.161	53.574 1014.520	53.806 1019.878	54.037 1025.237	54.269 1030.596	54.500 1035.954
570	54.732 1041.313	54.972 1046.905	55.211 1052.497	55.451 1058.090	55.690 1063.682	55.930 1069.274	56.170 1074.866	56.409 1080.458	56.649 1086.051	56.888 1091.643
571	57.128 1097.235	57.362 1103.067	57.597 1108.900	57.831 1114.732	58.066 1120.565	58.300 1126.397	58.534 1132.229	58.769 1138.062	59.003 1143.894	59.238 1149.727

TABLE 7-3-11

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
572	59.472 1155.559	59.696 1161.618	59.921 1167.677	60.145 1173.736	60.369 1179.795	60.594 1185.855	60.818 1191.914	61.042 1197.973	61.266 1204.032	61.491 1210.091
573	61.715 1216.150	61.938 1222.432	62.161 1228.714	62.384 1234.997	62.607 1241.279	62.831 1247.561	63.054 1253.843	63.277 1260.125	63.500 1266.408	63.723 1272.690
574	63.946 1278.972	64.194 1285.488	64.441 1292.004	64.689 1298.520	64.936 1305.036	65.184 1311.552	65.432 1318.068	65.679 1324.584	65.927 1331.100	66.174 1337.616
575	66.422 1344.132	66.690 1350.909	66.958 1357.686	67.227 1364.462	67.495 1371.239	67.763 1378.016	68.031 1384.793	68.299 1391.570	68.568 1398.346	68.836 1405.123
576	69.104 1411.900	69.372 1418.945	69.641 1425.989	69.909 1433.034	70.177 1440.078	70.446 1447.123	70.714 1454.168	70.982 1461.212	71.250 1468.257	71.519 1475.301
577	71.787 1482.346	72.042 1489.650	72.296 1496.955	72.551 1504.259	72.805 1511.564	73.060 1518.868	73.315 1526.172	73.569 1533.477	73.824 1540.781	74.078 1548.086
578	74.333 1555.390	74.593 1562.950	74.853 1570.511	75.114 1578.071	75.374 1585.631	75.634 1593.192	75.894 1600.752	76.154 1608.312	76.415 1615.872	76.675 1623.433

TABLE 7-3-12

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
579	76.935 1630.993	77.230 1638.835	77.524 1646.677	77.819 1654.518	78.114 1662.360	78.409 1670.202	78.703 1678.044	78.998 1685.886	79.293 1693.727	79.587 1701.569
580	79.882 1709.411	80.164 1717.542	80.446 1725.672	80.727 1733.803	81.009 1741.933	81.291 1750.064	81.573 1758.194	81.855 1766.325	82.136 1774.455	82.418 1782.586
581	82.700 1790.716	82.976 1799.123	83.252 1807.530	83.528 1815.938	83.804 1824.345	84.080 1832.752	84.356 1841.159	84.632 1849.566	84.908 1857.974	85.184 1866.381
582	85.460 1874.788	85.755 1883.481	86.051 1892.173	86.346 1900.866	86.641 1909.559	86.937 1918.252	87.232 1926.944	87.527 1935.637	87.822 1944.330	88.118 1953.022
583	88.413 1961.715	88.701 1970.703	88.989 1979.690	89.277 1988.678	89.565 1997.665	89.854 2006.653	90.142 2015.640	90.430 2024.628	90.718 2033.615	91.006 2042.603
584	91.294 2051.590	91.617 2060.863	91.940 2070.135	92.264 2079.408	92.587 2088.680	92.910 2097.953	93.233 2107.225	93.556 2116.498	93.880 2125.770	94.203 2135.043
585	94.526 2144.315	94.632 2153.479	94.738 2162.643	94.844 2171.807	94.950 2180.971	95.057 2190.135	95.163 2199.299	95.269 2208.463	95.375 2217.627	95.481 2226.791

TABLE 7-3-13

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
586	95.587 2235.955	95.810 2245.654	96.033 2255.353	96.257 2265.052	96.480 2274.751	96.703 2284.451	96.926 2294.150	97.149 2303.849	97.373 2313.548	97.596 2323.247
587	97.819 2332.946	98.154 2342.995	98.489 2353.043	98.824 2363.092	99.159 2373.140	99.494 2383.189	99.829 2393.238	100.164 2403.286	100.499 2413.335	100.834 2423.383
588	101.169 2433.432	101.467 2443.736	101.764 2454.040	102.062 2464.344	102.359 2474.648	102.657 2484.953	102.954 2495.257	103.252 2505.561	103.549 2515.865	103.847 2526.169
589	104.144 2536.473	104.526 2547.081	104.909 2557.689	105.291 2568.297	105.674 2578.905	106.056 2589.514	106.438 2600.122	106.821 2610.730	107.203 2621.338	107.586 2631.946
590	107.968 2642.554	108.411 2653.651	108.854 2664.748	109.297 2675.845	109.740 2686.942	110.183 2698.039	110.626 2709.136	111.069 2720.233	111.512 2731.330	111.955 2742.427
591	112.398 2753.524	112.760 2764.982	113.122 2776.440	113.484 2787.898	113.846 2799.356	114.208 2810.814	114.569 2822.271	114.931 2833.729	115.293 2845.187	115.655 2856.645
592	116.017 2868.103	116.396 2880.042	116.775 2891.981	117.154 2903.920	117.533 2915.859	117.912 2927.798	118.290 2939.736	118.669 2951.675	119.048 2963.614	119.427 2975.553

TABLE 7-3-14

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
593	119.806 2987.492	120.155 2999.744	120.503 3011.996	120.852 3024.249	121.200 3036.501	121.549 3048.753	121.898 3061.005	122.246 3073.257	122.595 3085.510	122.943 3097.762
594	123.292 3110.014	123.647 3122.512	124.002 3135.010	124.357 3147.508	124.712 3160.006	125.068 3172.504	125.423 3185.002	125.778 3197.500	126.133 3209.998	126.488 3222.496
595	126.843 3234.994	127.263 3248.066	127.682 3261.137	128.102 3274.209	128.521 3287.281	128.941 3300.353	129.360 3313.424	129.780 3326.496	130.199 3339.568	130.619 3352.639
596	131.038 3365.711	131.440 3379.125	131.841 3392.540	132.243 3405.954	132.644 3419.368	133.046 3432.783	133.448 3446.197	133.849 3459.611	134.251 3473.025	134.652 3486.440
597	135.054 3499.854	135.383 3513.586	135.713 3527.318	136.042 3541.050	136.372 3554.782	136.701 3568.515	137.030 3582.247	137.360 3595.979	137.689 3609.711	138.019 3623.443
598	138.348 3637.175	138.687 3651.241	139.026 3665.307	139.366 3679.373	139.705 3693.439	140.044 3707.505	140.383 3721.570	140.722 3735.636	141.062 3749.702	141.401 3763.768
599	141.740 3777.834	142.190 3792.347	142.641 3806.861	143.091 3821.374	143.541 3835.888	143.992 3850.401	144.442 3864.914	144.892 3879.428	145.342 3893.941	145.793 3908.455

TABLE 7-3-15

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
600	146.243 3922.968	146.666 3938.209	147.088 3953.449	147.511 3968.690	147.933 3983.930	148.356 3999.171	148.779 4014.412	149.201 4029.652	149.624 4044.893	150.046 4060.133
601	150.469 4075.374	150.862 4090.833	151.255 4106.293	151.648 4121.752	152.041 4137.212	152.434 4152.671	152.826 4168.130	150.862 4090.833	150.862 4090.833	150.862 4090.833
602	154.398 4229.968	154.768 4245.677	155.138 4261.387	155.509 4277.096	155.879 4292.806	156.249 4308.515	156.619 4324.224	156.989 4339.934	157.360 4355.643	157.730 4371.353
603	158.100 4387.062	158.505 4403.119	158.909 4419.176	159.314 4435.232	159.718 4451.289	160.123 4467.346	160.527 4483.403	160.932 4499.460	161.336 4515.516	161.741 4531.573
604	162.145 4547.630	162.628 4564.689	163.110 4581.748	163.593 4598.807	164.075 4615.866	164.558 4632.926	165.040 4649.985	165.523 4667.044	166.005 4684.103	166.488 4701.162
605	166.970 4718.221	167.382 4735.329	167.795 4752.437	168.207 4769.544	168.619 4786.652	169.032 4803.760	169.444 4820.868	169.856 4837.976	170.268 4855.083	170.681 4872.191
606	171.093 4889.299	171.482 4906.742	171.870 4924.185	172.259 4941.628	172.647 4959.071	173.036 4976.514	173.425 4993.957	173.813 5011.400	174.202 5028.843	174.590 5046.286

TABLE 7-3-16

TABLE 7-3 (continued)
ELEVATION-AREA-CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
607	174.979 5063.729	175.447 5082.460	175.915 5101.191	176.384 5119.921	176.852 5138.652	177.320 5157.383	177.788 5176.114	178.256 5194.845	178.725 5213.575	179.193 5232.306
608	179.661 5251.037	180.158 5269.375	180.655 5287.713	181.152 5306.050	181.649 5324.388	182.147 5342.726	182.644 5361.064	183.141 5379.402	183.638 5397.739	184.135 5416.077
609	184.632 5434.415	185.101 5453.368	185.569 5472.321	186.038 5491.274	186.507 5510.227	186.976 5529.180	187.444 5548.133	187.913 5567.086	188.382 5586.039	188.850 5604.992
610	189.319 5623.945	189.903 5644.747	190.486 5665.549	191.070 5686.352	191.653 5707.154	192.237 5727.956	192.820 5748.758	193.404 5769.560	193.987 5790.363	194.571 5811.165
611	195.154 5831.967	195.654 5852.232	196.153 5872.498	196.653 5892.763	197.152 5913.029	197.652 5933.294	198.152 5953.559	198.651 5973.825	199.151 5994.090	199.650 6014.356
612	200.150 6034.621									

TABLE 7-3-17

EXHIBIT A
SUPPLEMENTARY PERTINENT DATA
EUFAULA LAKE

EXHIBIT A
SUPPLEMENTARY PERTINENT DATA
EUFAULA LAKE

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EXHIBIT A
SUPPLEMENTARY PERTINENT DATA
EUFAULA LAKE

1 - GENERAL INFORMATION

Other names for project	None
Location	Canadian River Basin, Canadian River, at river mile 27.0, approximately 12 miles east of Eufaula, Oklahoma
Type of project	Dam and Lake
Objectives of regulation	Multipurpose – Flood control, hydropower, water supply, regulating flows of Canadian River, navigation, recreation, and fish and wildlife
Project owner	US Government
Operating agency	US Army Corps of Engineers. The normal working hours of operation for weekdays are 7:00 a.m. to 4:30 p.m. Working hours for weekends, holidays and nights vary. Working hours under flood emergency conditions are 24 hours
Regulating agency	US Army Corps of Engineers.
Code of Federal Regulations, Title 33 (applies to Section 7 Projects)	Does not apply
Federal power distributing and marketing	Southwestern Power Administration (SWPA)
Other inter-agency agreement	Memorandum of Understanding (MOU) between the Corps of Engineers and SWPA, dated 23 Jul 1980

1 - GENERAL INFORMATION (continued)

Water rights	Water rights have been granted in the North Canadian River Between Eufaula Dam and the confluence with the Arkansas River in the amount of 8,452 ac-ft per year. Releases may be required from Eufaula Lake to meet some of these water rights. (See Table A-1 below)
Water supply	Total available storage for water supply is 79,860 (See Table A-2 below)
Project cost through FY 2009	\$143,393,492.36
Closure date	Lake -- Feb 1964 Power Unit #1 – Jul 1964 Power Unit #2 – Sep 1964 Power Unit #3 – Aug 1964
Special project features	None
Other	None

TABLE A-1

WATER RIGHTS DOWNSTREAM OF EUFAULA DAM

PERMIT #	Entity Name	Qtr	Qtr	Qtr	Sec	TSP	RNG	COUNTY	AcFt /Yr	Purpose	Date Filed	Date Issued
19950035	Lee H Tyler Revocable Trust	NW	SE	NE	02		19E	Muskogee	2280.0	Irrigation	8/10/1995	11/14/1995
20020056	(b) (6)	SW	NE	SE	02	10N	20E	Haskell	2190.0	Irrigation	12/23/2002	3/11/2003
19810106	(b) (6)	SW	NE	SE	02	10N	20E	Haskell	600.0	Irrigation	4/24/1981	7/14/1981
20030011	JRC Ranch LLC	SW	NE	SE	28	10N	20E	Muskogee	2622.0	Irrigation	3/27/2003	7/8/2003
Total Downstream Rights									7,692.0			

TABLE A-2

WATER SUPPLY AGREEMENTS

User Name	Agreement Type	Present Storage AC-FT	Future Storage AC-FT	Total User Storage AC-FT	Yield M.G.D.
Total Water Supply based on 2034 sediment projection		79,860			68.26
Not under agreement		37,614	0	36,764	31.42
City of Checotah	storage	2,276	0	2,276	1.95
City of Eufaula (Eufaula Public Works Authority)	storage	2,295	0	2,295	1.96
Juniper Water Company, Inc	storage	17,168	0	17,168	14.67
Pittsburg County Water Authority	storage	1,211	0	1,211	1.03
Haskell County Water Company	storage	569	0	569	0.49
Haskell County RWD #1	storage	73	0	73	0.06
Porum PWA	storage	751	0	751	0.64
Muskogee County RWD #3	storage	436	0	436	0.37
Pittsburg County RWD #4	storage	73	0	73	0.06
Lakeside Water Company, Inc.	storage	28	0	28	0.02
Haskell County RWD #3	storage	36	0	36	0.03
Krebs Utilities Authority	storage	799	0	799	0.68
RWD, Gas, Sewer & Solid Waste #8	storage	2,143	0	2,143	1.83
Pittsburg Co. PWA	storage	702	0	702	0.60
Longtown RW & S District #1	storage	1,429	0	1,429	1.22
PSO	storage	145	0	145	0.12
McAlester PWA	storage	8,911	0	8,911	7.62
Bristow Point Property Owners Association, Inc	storage	24	0	24	0.02
Warner Utilities Authority	storage	993	0	993	0.85
Haskell County RWD (850 ac-ft pending)	storage	0	850	850	0.73
Twin Rivers Estates, Inc	storage	12	0	12	0.01
Bridgeport Dunes Condominiums Homeowners Assoc. Inc	storage	12	0	12	0.01
Pittsburg Co RWD #14	storage	460	0	460	0.39
Duchess Creek Mobile Home Park	storage	12	0	12	0.01
RWS & SWM Dist. #2, McIntosh County	storage	1,429	0	1,429	1.22
B&B Gas Well Service, LLC	storage	17	0	17	0.01
OTRD - Arrowhead Golf Course	storage	109	0	109	0.09
OTRD - Fountainhead Golf Course	storage	133	0	133	0.11
Total		79,860		79,860	68.26

2 - LAKE INFORMATION ELEVATIONS, AREAS AND STORAGES

Feature	Elevation (feet, NGVD29)	Lake area (acres)	Storage	
			Accumulative (Acre-feet) ⁽¹⁾	Runoff Inches ⁽²⁾
Top of dam	612.0	200,150	6,034,620	--
Maximum pool	604.96	166,780	4,711,400	10.51
Top of surcharge	600.0	146,240	3,922,970	8.75
Top of flood control pool	597.0	135,050	3,499,850	7.81
Top of power pool (3)	585.0	94,525	2,144,315	4.78
Spillway crest	565.0	42,720	797,990	1.78
Top of inactive pool	565.0 ⁽³⁾	42,720	797,990	1.78
Flood control storage	585.0 – 597.0	--	1,358,430	3.03
Power storage	565.0 – 585.0 ⁽⁴⁾	--	1,130,874	3.00
24 hour surveillance begins	595.0			
Streambed at dam	498.0	0	0	

(1) Storage yield of approximately 50.045 m.g.d. for water supply

(2) From 8,405 square miles of lower contributing drainage area. Total drainage area is 47,522 square miles

(3) Provides for sediment storage and minimum head for hydropower generation

(4) Power storage (1,130,874 ac-ft) is conservation pool (1,346,325 ac-ft) minus sediment reserve storage (135,591 ac-ft) and water supply storage (79,860 ac-ft). Storage based on 2034 sediment projection.

NOTE: Area and Storage based on 2000 Conservation re-survey and 2010 Lidar Survey

2 - LAKE INFORMATION ELEVATIONS, AREAS AND STORAGES (continued)

Real estate taking for land fee title	The fee taking line is a semi-blocked perimeter to elevation 597.0 feet NGVD29, which is the top of the flood control pool, containing 153,291 acres
Real estate taking for Easement	Flowage easements were acquired in the flat pool area above the fee taking line to elevation 600.0 feet, NGVD. In the upper reaches the flowage easement is to elevation 600.0 feet, NGVD, or the elevation of the envelope curve of backwater effects of the 50-year flood after 50 years of sedimentation, whichever is higher. Total easement acreage is 29,906 acres
Range of clearing	The upper limit of clearing is elevation 597.0 feet. There is no lower limit of clearing other than the streambed
Channel capacity downstream of dam	Non-damaging channel capacity immediately downstream of Eufaula Dam is estimated to be 40,000 c.f.s. This flow rate can be discharged when the lake is at elevation 574.0 and above
Reservoir length at top of conservation pool	28.6 miles
Reservoir length at top of flood control pool	35.5 miles
Shoreline length at top of power pool	600 miles
Safety aspects, possibly requiring warning	At elevation 587.0 feet some campgrounds begin to flood. Several roads are closed beginning at elevation 590.0 Downstream of the dam, a warning siren will sound before power releases are changed
Emergency drawdown	The minimum time required to empty from the top of power pool (elevation 585.0) to top of inactive pool (elevation 565.0) with a maximum release of 40,000 c.f.s. is about 21 days

3 – HYDROLOGY

Drainage area 47,522 square miles
Lower drainage area 8,405 square miles

Spillway Design Flood

Maximum water surface elev. 604.96 feet, NGVD29
Peak inflow (into full pool) 955,000 c.f.s.
Total storm runoff 10.51 inches
Volume (into full pool) 4,711,400 acre-feet
Maximum outflow 474,000 c.f.s.
Duration of flood 10 days
Seasonal distinction All Seasons

Standard Project Flood

Maximum water surface elev. 599.90 feet, NGVD29
Peak inflow (into full pool) 477,500 c.f.s.
Total storm runoff 5.48 inches
Volume (into full pool) 2,456,000 acre-feet
Maximum outflow 378,000 c.f.s.
Duration of flood 10 days
Seasonal distinction All seasons

Climate Moderate

One inch of runoff 448,267 acre-feet

Storm types Primarily Thunderstorms

Flood seasons Mar through Jun, and Sep through Nov, although records show floods can occur at any time during the year

Low flow season Dec – Feb and in Aug, but low flow can occur during any time of the year

Minimum daily inflow and date of occurrence 0 c.f.s. on several occasions (1923-2010)

Minimum monthly inflow and date 140 c.f.s. in October 1956 (1923-2010)

Minimum annual inflow and year 412,600 acre-feet in 1956
Period of record 1923-2010

3 - HYDROLOGY (continued)

Average annual inflow	4,462,104 acre-feet. Period of record 1923-2010
Maximum annual inflow and year	10,356,700 acre-feet in 1990 Period of record 1923-2010
Maximum monthly inflow and date	2,970,200 acre-feet in May 1990 Period of record 1923-2010
Maximum daily inflow and date	311,100 c.f.s. on 03 May 1990
Maximum instantaneous inflow and date	389,000 c.f.s. on 03 May 1990
Maximum flood volume and date	2,616,000 acre-feet for 09-30 May 1943
Name and location of key stream flow stations upstream of Eufaula Dam	Canadian River at Purcell Canadian River at Calvin Little River near Tecumseh N. Canadian River below Lake Overholser, near Oklahoma City N. Canadian River at Oklahoma City (Britton Rd) N. Canadian River at Harrah N. Canadian River at Wetumka Deep Fork River at Warwick Dry Creek near Kendrick Deep Fork River near Beggs Canadian River near Whitefield
Type of hydro-meteorological data recorded at dam site	Precipitation (recording and non-recording) Pool elevation (recording and staff) Tailwater elevation (recording and staff) Wind at 8 a.m. Temperature (maximum and minimum)
Number of precipitation stations used in hydrologic forecasting inflow	34 recording and 30 Mesonet gages, plus 21 stream gages and 3 pool gages
Number of snow courses	None
Number of sediment ranges	75
Number of degradation ranges	17

4 - EMBANKMENT

Location	Canadian River at stream mile 27.0
Purpose	Flood control, hydropower, water supply, recreation, regulating flows of Canadian River, navigation, and fish and wildlife
Type	Non-overflow embankment
Type of fill	Concrete gravity and rolled earth fill embankment
Slope protection	Riprap on upstream face; grassed on downstream face
Height	114 feet above streambed
Length	3,200 feet (including spillway and powerhouse)
Top elevation	612.0 feet, NGVD29
Design flood	Spillway Design flood developed in original project design
Freeboard	7 feet above design flood peak
Used for roadway	Yes. State Highway 71 crosses the embankment and spillway with a 24-foot wide asphalt roadway
Elevation of stream bed	Approximately 498.0 feet, NGVD29

5 - SPILLWAY

Location	Across the original river channel near left abutment
Type	Gated concrete, gravity, ogee weir
Crest elevation	565.0 feet, NGVD29
Net overflow length	440 feet
Number and size of gates	Eleven (11) - 40' wide x 32' high
Type of gates	Tainter
Top of gate elevation	597.0 feet NGVD29, in closed position
Induced surcharge	3 feet
Design head	30 feet
Maximum discharge capacity	474,000 c.f.s. at 604.96 feet NGVD29
Bridge deck elevation	612.0 feet, NGVD29
Type of energy dissipater	Stilling basin
Time required to open and close all gates	Gates raise or lower separately or together at a rate of 1.0 foot per minute
Type of emergency closure	Bulkheads are provided for tainter gates, sluice gate, and penstocks
Spillway activation	The tainter gates, except for periodic maintenance, are activated only during flood conditions. During normal conditions, discharges are released through the sluice gate or the powerhouse

6 - OUTLET FACILITIES

a - FLOOD CONTROL SLUICE

Location	The base of the spillway along the centerline of an intermediate pier
Purpose	Low flow and flood control releases
Number and size of gates	1 rectangular, 5'8" wide x 7'0" high
Type of service gates	Hydraulically operated, vertical-lift, double gated
Entrance invert elevation	500.0, feet NGVD29
Exit invert elevation	500.0, feet NGVD29
Discharge at pertinent elevations*	Spillway crest – 1,940 c.f.s. (elev. 565.0 feet) Top of power pool – 2,230 c.f.s. (elev. 585.0 feet) Top of flood control pool – 2,400 c.f.s.(elev. 597.0 feet) Top of maximum pool – 2,490 c.f.s. (elev. 604.96 feet)
Minimum pool elevation when inoperative	500.0 feet, NGVD29
Type of emergency closure	Bulkhead lowered by a hoist into frames provided at the sluice entrances
Type energy dissipater	Tetrahedral deflector

* Discharges are without spillway operating

7 - HYDROELECTRIC POWER FACILITIES

Location	Between spillway and left abutment
Type	Storage
Installed capacity	90,000 kilowatts (kW)
Number, capacity, type	Three 30,000 kW Francis-type units
Power online date	Power Unit #1 – Jul 1964 Power Unit #2 – Sep 1964 Power Unit #3 – Aug 1964
Number and size of penstocks	Three 22-foot diameter
Turbine discharge	
Design head	4,420 c.f.s. for one unit
Top of Conservation Pool	13,100 c.f.s. with all three units
Design head (net head)	96 feet
Max net head for power	125.0 feet
Average net head	
Conservation pool full	94.0 feet
Conservation pool empty	74.0 feet
Minimum flow required for continuous power	1,716 c.f.s.
Draw down	20.0 feet
Minimum net head	70.0 feet
Critical drawdown	1955 to 1957
Dependable capacity	77,000kW
Average annual energy	260,300,000 kWh
Primary	93,400,000 kWh
Secondary	166,900,000 kWh
Specific hydroelectric power storage	1,343,650 acre-feet (includes 56,000 acre- feet for water supply)
Critical tailwater elevation	512.0 feet, NGVD29

8 - CONTROL POINTS/RIVER REACHES

a. Whitefield Gage (Canadian River)

Location	At river mile 18.8 on Canadian River, 0.8 miles north of Whitefield, Oklahoma, 8.2 miles downstream of Eufaula Dam, State Highway 2 bridge
Purpose	Measure discharge and serve as control point for flood releases from Eufaula Lake
Channel description	The channel is well defined and fairly straight in the vicinity of the gage, the flood plain is broad with trees, cultivated crops and some rural development
Drainage area	47,576 square miles of which 47,522 are above Eufaula Dam, and 9,700 square miles are non-contributing
Uncontrolled drainage area	54 square miles
Target flow rate	40,000 c.f.s.
NWS flood stage	17.5 feet, 84,340 c.f.s. (current rating curve)
Corps regulating stage	17.5 feet, 84,340 c.f.s. (current rating curve)
Time of water travel Eufaula Dam to gage	2 hours
Description of equipment	Water-stage recorder
Zero of gage	Elevation 473.16 feet
Maximum stage of record	25.5 feet, 10 May 1943
Maximum flow of record	281,000 c.f.s., 10 May 1943
Channel usage	Water supply, fishing and fish spawning

8 - CONTROL POINTS/RIVER REACHES (continued)

b. Van Buren Gage (Arkansas River)

Location	Near left bank of upstream side of U.S. Highway 64 bridge at Van Buren, AR, at navigation mile 300.4 on the Arkansas River
Purpose	Provide stage and precipitation data and serve as a control point for flood releases from Eufaula Lake and other upstream reservoirs
Channel description	The channel is well defined and straight downstream of the gage. The left bank is high, and the right bank is a combined levee and floodwall that protects properties on the right overbank
Drainage area	150,483 square miles, of which 22,241 square miles is probably non-contributing
Uncontrolled drainage area	5,574 square miles
NWS flood stage	22.0 feet, 125,000 c.f.s. (current rating curve)
Corps regulating stage	22.0 feet, 150,000 c.f.s. (current rating curve)
Time of water travel Eufaula Dam to gage	24 hours
Description of equipment	Water-stage recorder with telemeter
Zero of gage	380.24 ft, NVGD29
Maximum stage of record	38.00 feet, 12 May 1943
Maximum flow of record	850,000 c.f.s., 12 May 1943
Channel usage	Navigation, water supply, fishing and fish spawning

EXHIBIT B
STANDING INSTRUCTIONS TO LAKE MANAGER
EUFAULA LAKE

EXHIBIT B
 STANDING INSTRUCTIONS TO LAKE MANAGER
 EUFAULA LAKE

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EXHIBIT B
STANDING INSTRUCTIONS TO LAKE MANAGER
EUFAULA LAKE

I - GENERAL

1. Operation. The lake will be regulated in accordance with the normal regulations for flood control as directed in Section VII of this Manual or Paragraph II-1.a. of this Exhibit. Instructions for the storage and discharge of floodwater will be issued by the Water Management Section. In the event communications with the Tulsa District are disrupted, the lake will be regulated in accordance with the schedule of emergency regulations for flood control (see Section VII of this Manual or paragraph II-1.b. of this Exhibit). In addition, the Powerhouse Superintendent will immediately make every effort to re-establish communications with the Tulsa District.

2. Project Reporting Instructions. Hydrologic data items affecting release of water, confirmation of change in releases as instructed, complaints, operating machinery failure, or out-of service times for maintenance shall be reported to the Water Management Section as they occur.

The following data should be included in the daily report to the Water Management Section (Hydrology-Hydraulics Branch, Tulsa District) from all flood control storage projects with hydropower. Data is typically reported by telephone, fax, or email. Data collected will be reviewed and input into the Water Management Section's data base before 10 a.m. and published to the lake data morning report located at http://www.swt-wc.usace.army.mil/old_resv rept.htm by 10 a.m. See Plate 5-3 for lake data reporting details.

a. As of 8 a.m. Each Weekday.

- 1) Pool elevations at 12 noon, 4 p.m., and 12 midnight of the previous day and the current 8 a.m. pool elevation and tailwater elevation (if available).
- 2) The total precipitation amounts for the previous 24-hour period (7 a.m. to 7 a.m. time period).
- 3) The current wind direction and wind speed (Beaufort scale).
- 4) Water supply withdrawal or release for previous day (if available).
- 5) The average power discharge in day second feet (d.s.f.) for the previous 24-hour period (midnight to midnight).

- 6) The net power generation in megawatt hours (MWh) for the previous 24-hour period (midnight to midnight.)
- 7) The total discharge in d.s.f. for the previous 24-hour period (midnight to midnight).
- 8) The 8 a.m. instantaneous power discharge in c.f.s.
- 9) The 8 a.m. instantaneous total discharge in c.f.s.
- 10) The total hourly discharge in c.f.s. for the previous 24-hour period (midnight to midnight).
- 11) The current gate setting and any gate changes made during the past 24-hour period including the time and pool elevation (and tailwater elevation if necessary) when the change was made.

b. As of 8 a.m. Each Monday.

- 1) The same data from the weekend as required in I - 2.a. above.
- 2) The current pool elevation readings from the pool gage, the recording chart or tape, the shaft encoder or data logger, and the wire weight or staff gage. If wind or weather prevents readings on Monday, then these readings can be taken on the next day that weather permits.

c. Weekends and Holidays.

- 1) Daily reports are not required to be submitted on weekends and holidays except during flood periods.

d. During Flood Periods.

- 1) During flood periods, weekend and holiday reports should include the same data as required in I - 2.a. above as well as the 8 a.m. pool elevation from the pool gage.
- 2) In addition to the data in I - 2.a., I - 2.b., and I - 2.c. above, additional reports of lake elevations may be requested by Water Management Section personnel.

3. Reporting Unusual Events. Events or conditions not normally encountered in the routine operation of the dam and lake which might endanger the dam or necessitate temporary or permanent revision of the operating procedures such as settlement, movement, or cracking of the earth embankment or abutments; unusual change in seepage rates, or development of new seepage areas; mechanical malfunction or failure; structural settlement, movement, cracking, or vibration; landslides, rockslides, or

indications of an impending movement; or an occurrence indicating any degree of jeopardy to the safety of the dam, or to the safety of the public shall be reported promptly to the Water Management Section, Hydrology-Hydraulics Branch.

4. Warnings. It is the responsibility of the Powerhouse Superintendent and project personnel authorized to make gate changes to maintain a list in current status of residents and/or property which might be endangered or inconvenienced by large and/or prolonged releases. If damaging releases are expected to occur, notification will be made by telephone, or oral warning by Corps employees. Notification will be made in accordance with the Tulsa District supplements to ER 500-1-1. This would include media such as radio, television, telephone, citizens band radio, use of law enforcement and civil defense agencies and their communication system, National Guard and reserve units, supplemented by oral warning by Corps employees. Studies have been made to determine the possible downstream flood conditions that could exist in the event of a maximum spillway release or failure of the dam at maximum pool. Approximate water surface profiles and flooded area maps giving the results of these studies are kept in the Eufaula Lake Operation and Maintenance Manual, Volume II, Flood Emergency Plan. In every case, when a gate change is made a horn is blown to give warning to people immediately downstream of Eufaula Dam.

5. Frequency of Gate Changes. During flood periods, gate changes may be directed by the Water Management Section at any time. When the floodwaters have significantly risen into the flood control pool, gate changes can be expected two or three times daily. When the pool level is at or above the top of the flood control pool, gate changes may occur every hour. Only under the most unusual circumstances will changes be ordered more frequently than once every hour. Frequency of gate changes during low flow operation will generally be less than once a day.

II - REGULATION PROCEDURES

1. Regulating River Stages and Discharges. The regulation schedules provide that the channel capacity of 40,000 c.f.s is not to be exceeded insofar as practicable. Floodwaters will be released as rapidly as practicable with consideration given to minimizing flooding of low-water crossing and low-lying farmland. Factors considered in the determination of releases are: maximum inflow into the reservoir during a rise, general climatic conditions, season of the year with respect to the probability of floods, status of crops in low-lying farmlands, and maximum non-damaging stages or discharges.

- a. Normal flood control regulations. Under normal procedures, instruction for storage and release of water for conservation and flood control will be issued by the District Office Water Management Section (in accordance with Table B-1). Implementation of the instructions is to be confirmed back to the Water Management Section as soon as the required action is completed. Instructions originating from any other source should not be processed. Eufaula Lake will be regulated for optimal flood reductions on the Canadian River from the dam downstream to the Arkansas River, and on the Arkansas River downstream to Van Buren, Arkansas.
- b. Emergency flood control regulations. Should communication with Tulsa District be disrupted, the Powerhouse Superintendent will, on his or her own initiative, direct regulation of the lake in accordance with the rules of regulation shown in Table B-2 until communication is restored. In addition, the Powerhouse Superintendent will immediately make every effort to reestablish communication with Tulsa District. The spillway gates will be operated at a uniform opening.

2. During Emergency Events. The Powerhouse Superintendent may temporarily deviate from the current release rates in the event an immediate short-term departure is deemed necessary for emergency reasons to protect the safety of dam, or to avoid serious hazards to life. Such actions shall be immediately reported by the fastest means of communication available. Actions shall be confirmed in writing the same day to the Water Management Section and shall include justification for the action. Continuation of the deviation will require the express approval of the Water Management Section and Southwestern Division (SWD).

TABLE B -1

NORMAL FLOOD CONTROL REGULATION SCHEDULE
 EUFAULA LAKE
 CANADIAN RIVER, OKLAHOMA

LAKE STAGE	POOL CONDITIONS	REGULATION
585.0 & Below	--	Releases are made through the turbines for hydroelectric power generation or to meet downstream water quality needs as discussed in paragraph 7-07, but will not exceed target discharges downstream of the dam.
585.0 – 597.0 & forecasted not to exceed 597.0	Rising	Releases will not exceed 40,000 c.f.s. or target discharges specified by the Arkansas River Basin Water Control Master Manual, whichever is less.
597.0 to 600.0 or forecasted to exceed 597.0	Rising	Releases will be based on inflow forecasts and made such that the pool elevation will not exceed elevation 600.0 feet, if possible. Plate 7-1, Spillway Gate Regulation Schedule, Inflow Parameter, will be used as a guide for determining releases so that the lake will not rise beyond the induced surcharge limits. If the pool rises to elevation 600.0, releases will be made as near equal to inflow as possible. Releases will be made by operating all the spillway gates at uniform openings.
600.0 or above	Rising	The spillway gates will be opened as necessary to pass inflow or until all gates are fully opened, whichever is less.
597.0 or above attained	Falling	The maximum gate opening shall be held until the pool elevation recedes to elevation 597.0 feet.
597.0 to 585.0	Falling	If the maximum releases rate was smaller than 40,000 c.f.s. releases will not exceed 40,000 c.f.s. or target discharges specified by the Arkansas River Basin Water Control Master Manual, whichever is less. If the maximum rate exceeds 40,000 c.f.s. releases shall be made equal to the previous 6-hour inflow or 40,000 c.f.s., whichever is greater.

TABLE B – 2

EMERGENCY FLOOD CONTROL
 REGULATION SCHEDULE FOR EUFAULA LAKE
 CANADIAN RIVER, OKLAHOMA

LAKE STAGE	POOL CONDITIONS	REGULATION
585.0 & Below	--	Continue releases being made at time of communication failure.
585.0 – 600.0	Rising	Maintain current releases until communication is restored. If, after 12 hours, communication has not been restored, or the pool is above or has risen to elevation 594.0 feet at any time within the 12 hour period, releases shall be made in accordance with Plate 7-1. Releases will be adjusted every two hours in accordance with Plate 7-1. At no time will releases be decreased while the pool is rising.
600.0 or above	Rising	All spillway gates will be raised in 1-foot increments until the pool elevation crests or until all gates are fully opened, whichever occurs first.
597.0 or above attained	Falling	The maximum gate opening shall be held until the pool elevation recedes to elevation 597.0 feet.
597.0 to 585.0	Falling	If the maximum releases rate was smaller than 40,000 c.f.s., then that release will be maintained until the pool recedes to elevation 585.0 feet. If the maximum rate exceeds 40,000 c.f.s., releases shall be reduced to the previous 6-hour inflow or 40,000 c.f.s., whichever is greater, until the pool recedes to elevation 585.0 feet. When the pool nears elevation 585.0 feet, releases shall be gradually reduced so that releases are equal to inflow by the time the pool recedes to elevation 585.0 feet.

EXHIBIT C

MEMORANDUM OF UNDERSTANDING

COPY 3

This MEMORANDUM OF UNDERSTANDING is entered into by and between the United States Department of Energy, Southwestern Power Administration (hereinafter called "the Administrator"), and the United States Department of the Army, Corps of Engineers (hereinafter called "the Corps"),

WITNESSETH:

WHEREAS certain statutes provide that various projects constructed in the States of Arkansas, Missouri, Oklahoma, Kansas, Texas, and Louisiana, by the Department of the Army shall be operated and maintained under the direction and supervision of the Corps of Engineers and

WHEREAS the projects set forth in Exhibit A of this memorandum ("Projects") have been or are being constructed and, as shown on Exhibit A, the Division Engineer of either the Missouri River, Lower Mississippi Valley, or Southwestern Division (hereinafter called "the Division Engineer"), is responsible for the operation and maintenance of said Projects; and

WHEREAS the Division Engineer, Southwestern Division, has been delegated authority by the Director of Civil Works to negotiate and sign this memorandum as the representative of the Corps of Engineers; and

WHEREAS the Administrator recognizes the Corps' responsibility to operate the projects to serve all authorized functions including power; and

WHEREAS the Administrator is authorized by Section 5 of PL 534, 78th Congress dated December 22, 1944, to dispose of the electric energy generated from said Projects, surplus to the energy required for their operation and maintenance and to recover the cost of producing and transmitting this energy, including the amortization of capital investment allocated to power over a reasonable period of years; and

WHEREAS the Corps recognizes the Administrator's responsibility for marketing and transmission of the power generated at the projects; and

WHEREAS the Administrator coordinates and schedules the hydroelectric generation at the Projects that constitute the Southwestern Federal Power System; and

WHEREAS the Corps and the Administrator desire to meet the above recited obligations and desire that certain procedures be implemented to maintain an effective working relationship between the staff elements of the Corps and of the Administrator.

NOW, THEREFORE, the parties hereto mutually agree as follows:

1. Term of Memorandum. This memorandum shall be effective commencing on the date of execution and shall remain in effect until terminated upon 90 days prior written notice by either party.

2. Availability of Hydroelectric Generation.

(a) The Division Engineer, during the term of this memorandum, shall make available to the Administrator all of the hydroelectric generation available at the Projects listed in Exhibit A (attached hereto and hereby made a part of this memorandum), in excess of the amounts reserved for use by the projects in accordance with schedules provided by the Administrator and mutually agreed upon by the Administrator and the Division Engineer. The parties hereto agreed to supersede said Exhibit A with a new Exhibit A whenever it becomes necessary to do so as a result of any changes occurring with respect to an existing Project or Projects, or the addition of a new project or projects.

(b) Subject to temporary interruption or reduction in the availability of hydroelectric generation which, in the opinion of the Division Engineer, is necessary for the purpose of maintenance, replacement, installation of equipment, or investigation and inspection, and subject to emergencies, or other extraordinary conditions, the Corps shall operate the Projects so as to schedule and to make available hydroelectric generation as requested by the Administrator, provided that, in the opinion of the Division Engineer, compliance with such request in the operation of the Projects:

(1) Would not require the safe limits of the generating, transforming and switching facilities, and appurtenant equipment of said Projects to be exceeded, or otherwise cause damage to the same;

(2) Would not conflict with the statutory requirements for the operation of said Projects with regard to authorized purposes such as flood control, navigation, irrigation, water supply, and recreation, etc;

(3) Would avoid, insofar as practicable, harmful effects on the environment, including established fish and wildlife resources and recreation;

(4) Would not infringe upon the vested property rights of third parties;

(5) Would not be inconsiderate of the effect on any major downstream construction or maintenance activities being undertaken by public or private entities.

(c) The use by the Corps of hydroelectric generation and the outages contemplated by subsection (b) of this section, shall be scheduled in advance, so far as is practicable, to the end that there will be a minimum

of interference with the availability of hydroelectric generation to the Administrator in accordance with subsection (a) of this section.

3. Emergency. It is recognized that the Administrator has obligations to its customers, the Southwest Power Pool, and the regional power industry to maintain its reliability and prevent power failures and brownouts. In the event that conditions arise which require power and energy in excess of the amount which the Division Engineer and Administrator have mutually agreed to be available from hydro sources, and in excess of that normally available from thermal sources, the Administrator will act to acquire needed power and energy from other sources. If this is not sufficient, the Administrator, after advising the Division Engineer, may declare a power emergency. The Division Engineer's concurrent declaration of operating limits will be based on relaxation of the five limitations contained in the preceding subsection 2(b) to the maximum extent that the emergency justifies and considering any unusual situations that may exist at that time.

4. Detailed Operating Arrangements. The Division Engineer, responsible for particular projects as shown on Exhibit A, and the Administrator will establish mutually satisfactory detailed operating arrangements to be followed in the coordination of their respective responsibilities. Such detailed operating arrangements will be prepared as needed to insure effective coordination between operations for power generation, other authorized project purposes, and protection of the environment. Such detailed operating arrangements when approved by the appropriate Division Engineer and Administrator, will be attached to this Memorandum of Understanding under Exhibit B (attached hereto and hereby made a part of this memorandum) and shall be subject to amendment with the prior written approval of the appropriate Division Engineer and Administrator.

5. License for Lines and Facilities. During the term of this Memorandum the Division Engineer will permit use by the Administrator of land under jurisdiction of the Corps in connection with the operation of the Projects necessary for the location of electric power transmission lines, control and communications lines and cables, substations, switching stations, radio stations, and appurtenances constructed or found necessary by the Administrator for construction in connection with the marketing of electric power and energy produced at said Projects. Before commencement of any construction on lands under the jurisdiction of the Corps, the Administrator will submit to the Division Engineer copies of his layout, plans, and designs, and construction activities will not be started until the Division Engineer has furnished a permit or letter to the Administrator approving the construction and the location thereof. The Administrator will provide any environmental impact statement required for proposed construction.

6. Cooperation. The Division Engineer and the Administrator will make available to each other all the information necessary for the Administrator and the Division Engineer to meet their responsibilities

pursuant to law. The timely interchange of certain data and information will be necessary to insure efficient operation for all purposes. Accordingly, such interchange will be made promptly as pertinent data and information become available. Any equipment shall be installed in such a way that there will be no adverse effect on the existing equipment of the other party. The specific information interchanged between the Administrator and the Division Engineer shall include, but not be limited to, the following:

(a) The Division Engineer will furnish data on power resources available at the Projects and data which have a bearing on loading of the plants and limitations of operation.

(b) The Administrator will furnish data on estimated Federal system load requirements, and other pertinent information as are needed to permit the Division Engineer to carry out his responsibilities for multiple-purpose operation at the Projects.

(c) The Division Engineer and the Administrator will discuss plans for adding or changing power projects, transmission facilities, and control and communication facilities in the preliminary planning phases to ensure effective coordination.

(d) The Division Engineer will furnish the Administrator with Reservoir Regulation Manuals for information and comment prior to final approval.

(e) The Administrator will furnish the Division Engineer power sales contracts for information. In addition, those contracts providing for the sale of power generation from Projects not integrated with the SWPA System, will be furnished to the Division Engineer for comment prior to final approval.

(f) The Division Engineer will furnish the Administrator summarized financial statements and operating reports with respect to construction and operation of the Projects. The financial statements will include costs as incurred under the Corps' GAO approved accounting system. The Administrator will furnish the Division Engineer like statements and reports with respect to the marketing of and accounting for revenues from power and energy made available to it from the Projects. Such statements and reports for each Project will be furnished promptly after the close of each governmental fiscal year following commencement of generation and for such other periods during each year and in such form as may be mutually agreed upon from time to time.

IN WITNESS WHEREOF, the parties hereto have executed this Memorandum
as of 23 July 1980.

UNITED STATES OF AMERICA

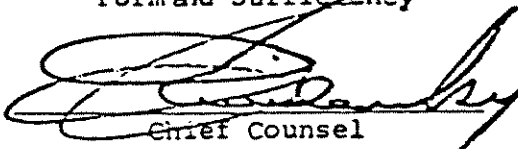
Department of Energy



By

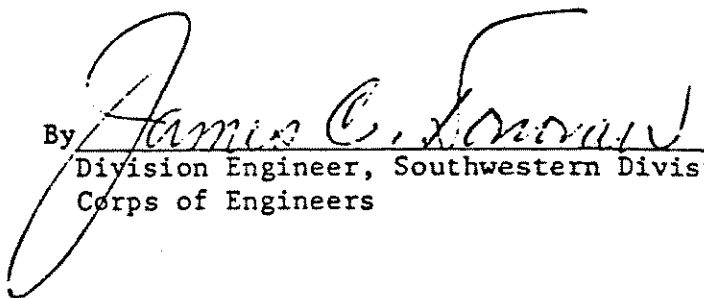
Administrator
Southwestern Power Administration

Approved as to Legal
Form and Sufficiency



Chief Counsel
Southwestern Power Administration

Department of the Army



By

Division Engineer, Southwestern Division
Corps of Engineers

Projects of the Corps

(Completed and Under Construction)

Projects for which the Division Engineer, Southwestern Division is responsible:

Beaver Lake	Keystone Lake
Broken Bow Lake	Norfolk Lake
Bull Shoals Lake	Ozark Lake
Dardanelle	Sam Rayburn Dam and Reservoir
Denison Dam-- Lake Texoma	Table Rock Lake
Eufaula Lake	Tenkiller Ferry Lake
Ft. Gibson Lake	Webbers Falls Lake
Greers Ferry Lake	Whitney Lake
Robert S. Kerr Lake	<i>Robert S. Kerr Lake</i>

Projects for which the Division Engineer, Missouri River Division is responsible:

Stockton Lake
Harry S. Truman Dam and Reservoir

Projects for which the Division Engineer, Lower Mississippi Valley Division is responsible:

Clarence Cannon Dam and Reservoir
Blakely Mountain Dam - Lake Ouachita
DeGray Lake
Narrows Dam - Lake Greason

EXHIBIT A



**DEPARTMENT OF THE ARMY
SOUTHWESTERN DIVISION, CORPS OF ENGINEERS**

1114 COMMERCE STREET
DALLAS, TEXAS 75242-0216

October 30, 1986

REPLY TO
ATTENTION OF:

Water Management Branch
Engineering Division

SWPA OFFICIAL COPY

From/Date:	SD 11/03/86	
Assigned to:	CODE	DATE
No Action Req.:	INITIAL	DATE
Copies to:		
SURNAME	DATE	Route Code
W	11/5	100
STG	11/6	101
J.P.	11-7	300
W. H. H.	11/13	330

Mr. Ronald H. Wilkerson
Administrator
Southwestern Power Administration
Post Office Box 1619
Tulsa, Oklahoma 74101

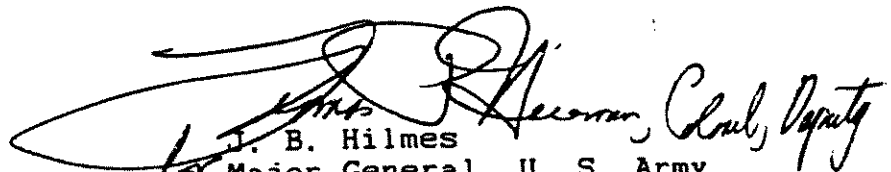
Dear Mr. Wilkerson:

In your letter transmitted to me on 23 October 1986, you referred to the meeting between our staffs of 22 October 1986. As expressed by my staff in that meeting, there is a safety hazard created downstream during rapid hydropower generation changes and the safety of the people in the downstream areas must be considered during start up of the hydropower units. Therefore, Table 5, title "Response time to change in generation" defining these limitations cannot be deferred as requested by your staff.

I do understand that there is a meeting next week among you, your customer, and the Little Rock District to discuss these issues as they pertain to Bull Shoals and Table Rock projects. However, I must reemphasize from a safety standpoint that those criteria and responsibilities contained in the Draft Operating Arrangement are considered SWD operating policies and will be used until these differences are resolved.

I have included a copy of the Draft Operating Arrangement dated 20 October 1986 for your reference. I am also looking forward to the formal signing of this document in the near future.

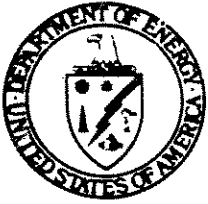
Sincerely,


J. B. Hilmes
Major General, U. S. Army
Division Engineer

Enclosure

Copies Furnished:

Commander, Little Rock District
Commander, Tulsa District
Commander, Fort Worth District



Department of Energy
Southwestern Power Administration
Post Office Box 1619
Tulsa, Oklahoma 74101

OCT 23 1986

Major General Jerome B. Hilmes
Division Engineer
Southwestern Division
U.S. Army Corps of Engineers
1114 Commerce Street
Dallas, TX 75242-0216

Dear General Hilmes:

In accordance with the meeting between our staffs in Dallas yesterday, it was recommended you and I delay signing the Operating Arrangement on Monday, October 27, 1986, as previously scheduled. A customer has expressed concerns about some operational criteria that appear to be in conflict with provisions in his power sales contract. Southwestern Power Administration, Little Rock District Corps of Engineers, and this particular customer have previously scheduled a meeting next week in Arkansas where this issue among others will be discussed and hopefully resolved. If we are successful, I would anticipate signing the Operational Arrangement in the near future. I will contact you to arrange a convenient time for that signing.

Sincerely,

A handwritten signature in cursive script that reads "Ronald H. Wilkerson".

Ronald H. Wilkerson
Administrator

20 OCT 86

DRAFT

EXHIBIT "B" OF

CONTRACT NO. DE-GMIS-80 SW 00058

OPERATING ARRANGEMENT

BETWEEN THE SOUTHWESTERN DIVISION

OF THE CORPS OF ENGINEERS AND THE

SOUTHWESTERN POWER ADMINISTRATION

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OPERATING ARRANGEMENT
(Reservoir Regulation and Power Scheduling)

1. Authority. This Arrangement states the principles and procedures relating to reservoir regulation and power scheduling of Corps of Engineers Hydroelectric Projects within the Southwestern Division (SWD) and the Southwestern Power Administration (SWPA). This Arrangement was developed in compliance with Paragraph 4 of the Memorandum of Understanding (MOU) dated 23 July 1980 and the authority therein.
2. Revision or Termination. This Operating Arrangement shall be effective commencing on the date of execution and shall remain in effect until terminated upon 90 days prior written notice by either party. It is provided further, that this Operating Arrangement may be amended with the mutual written consent of both parties.
3. Obligations. SWD and SWPA agree on the following obligations:
 - a. Obligations of SWPA:
 - (1) The marketing and transmission of surplus (in excess of project requirements) power.
 - (2) The preparation of monthly estimates of generation requirements for each SWD project.
 - (3) The scheduling of power plants to meet system requirements.
 - (4) To contract for the sale of power generated at SWD projects.
 - b. Obligations of SWD:
 - (1) The regulation of SWD projects for authorized purposes and in accordance with Presidential directives.
 - (2) The daily operation and maintenance of electric generation and switchyard facilities at each SWD power plant.
 - (3) The planning of hourly, daily and monthly regulations of SWD projects.
 - (4) The preservation of project integrity.
 - c. SWD and SWPA agree to consult on load and resource requirements.
 - d. SWD and SWPA agree to undertake improvements in their respective computer facilities.

4. Procedures.

a. Power Allocations and Monthly Meetings.

(1) A monthly hydropower meeting will be held by SWPA on or before the last Thursday of each month to develop a 30-day operational plan, including allocations for the next month, and to review current operations, planned outages, transmission limitations, reservoir conditions (current and projected), and other items of mutual concern. The meeting may be conducted by telephone conference, providing each party approves.

(2) SWD will furnish SWPA recommended monthly available energy along with maximum and minimum energy quantities for their projects for the following month. Recommended monthly hydropower energies will consider the individual project rule curve, system guide curve, projected reservoir condition, and other beneficial reservoir uses. This information will be provided formally within four (4) working days prior to the monthly hydropower meeting.

(3) SWPA will furnish SWD its anticipated energy needs for the following month from SWD projects. Monthly hydropower needs will consider load requirements, the condition of the interconnected reservoir system, system guide curve, projected reservoir conditions, available capacity, inflow trends and the ability to obtain energy at a reasonable cost from other sources. This data will be available for two (2) days before the monthly hydropower meeting.

(4) Prior to each month's operations, an agreement between SWPA and SWD as to the proposed generation (hydropower allocation) to be accomplished at each SWD project will be obtained. A written confirmation of that agreement will be provided to SWD by SWPA. In the event that an agreement cannot be obtained at the monthly meeting, negotiations between the Administrator and Division Commander will commence.

b. Operation.

(1) General.

(a) SWPA will schedule the monthly hydropower production in accordance with the monthly agreement. However, in the event of special conditions or unforeseen events, SWPA may schedule hydropower production differently than specified in the monthly agreement, provided that these changes are arranged with the responsible SWD District Office prior to scheduling.

(b) Operation of SWD projects for hydropower operations within approved regulations will be handled between SWPA and the appropriate SWD District Office. Only in cases of disagreement concerning operations, will SWD become involved in the day-to-day operations described herein.

(c) Energy generation will commence or be adjusted when the dispatcher makes a request to the power plant operator. The power plant operator will verify that the request is within the limits agreed to between the two agencies and that it does not violate any special instructions issued by the District office. If these conditions are satisfied, the operator will commence generation to the requested limits as rapidly as conditions and equipment will permit. If the request exceeds the limits or violates the conditions previously established, the power plant operator will advise the dispatcher as to what generation is available from the power plant. It is the intent that, to the extent possible, dispatchers and power plant operators relay all problems to the respective control offices.

(d) Daily (prior to 10.00 a.m.), SWD District Offices will provide SWPA a 4-day forecast of inflow, pool elevations and any limiting constraints for each project.

(2) Flood Control Operations.

(a) During flood control operations, SWD District Office will furnish to SWPA a weekly statement of flood control objectives for the next seven days relative to individual pool regulations and planned release volumes. The release schedule will be furnished by phone until adequate computer interconnections are available.

(b) SWPA will plan its weekly generation schedule compatible with stated flood control release schedules for the week.

(c) SWD District Offices will make a daily declaration to SWPA of energy available or required releases. The minimum hydropower releases are listed in Table 1. Only under flood conditions as defined in paragraph 4(b)(4)(e) herein may generation be limited to less than shown in Table 1.

(d) SWD District Offices will provide SWPA, when possible, 48-hour notice of a change in operation that will affect power production.

(e) SWPA will reschedule generation between projects and/or obtain non-hydropower to meet its needs as expeditiously as possible to effect any reductions in project releases required by SWD District Offices for flood control needs.

(3) Conservation Operation.

(a) Each day prior to 3.30 p.m., SWPA will furnish the SWD District Offices updated hourly generation schedules for each project for the remainder of the current day and for the following day. Weekend and holiday generation schedules will be furnished by 3.30 p.m., on the last working day prior to the weekend or holiday and will also include the schedule for the next working day.

(b) SWPA will be responsible for daily hydropower operations to meet the needs of their customers and downstream release requirements shown in Table 2. Table 3 shows desirable downstream release requirements to be accomplished providing hydrologic conditions are favorable. Favorable hydrologic conditions are included in Table 3.

(c) SWPA will furnish SWD a weekly statement of their generation plans and objectives relative to pool manipulations, balancing operations, thermal purchases and other details which will provide an understanding of scheduling and generation patterns and the effects to be expected at each project. The weekly statement will be provided, if possible, by 2:00 p.m., on the preceding Friday and will include an estimate of daily release volumes from each project. This will be by telephone until such time as adequate computer interconnections are available.

(d) Release schedules by SWPA and the districts will consider project and system guide curves, pool zone criteria, drawdown limits, current and projected pool conditions, downstream needs, and the needs of other authorized uses of the project.

(e) Table 4 shows maximum drawdown rates within the conservation pool for applicable Corps projects.

(4) Special Operations.

(a) General. Normally, special operations will be coordinated by SWD Districts and documented in the minutes of the monthly hydropower meeting. Those special operations which have significant impacts on SWPA will be coordinated by SWD. If an emergency does not exist, SWD will consult with SWPA on alternatives and the impacts of these alternatives on the economics and reliability of the federal hydropower system. SWD will notify SWPA of the special operating limits which are necessary for the operation of its projects. Notification will be provided as soon as each special operating limit is determined. Written or teletype confirmation of each special operation limit will be transmitted by SWD to SWPA. Such notifications and confirmations will include the nature of the limit, the firmness of the limit, its probable duration, and the reason for the limit.

(b) Short Term Power Emergency. It is recognized that certain situations which adversely affect system reliability may occur. Such circumstances demand a rapid response to prevent deterioration of the system reliability. The necessary response may involve a deviation from previously agreed to schedules. These situations (short term emergencies) typically involve overloaded facilities and/or low voltage and may arise slowly, as when due to high power demands, or suddenly, as when due to the loss of a line, station, or generator on the SWPA or a neighboring system. When possible, the response deemed necessary by the SWPA dispatcher will be coordinated prior to scheduling with the appropriate SWD District Office.

When the required response time does not permit prior coordination the power plant operator will follow the direction of the SWPA dispatcher within limits specified in Table 5 and the safe operating limits of the generating, transforming and switching equipment, and the necessary coordination will begin as soon as practical. Table 5 lists the minimum time required for each project to respond to a generation change under normal and emergency conditions.

(c) Declared Power Emergency. It is recognized that SWPA has obligations to its customers, the Southwest Power Pool, and the regional power industry to maintain its reliability and prevent power failures and brownouts. In the event that conditions arise which require power and energy in excess of the amount which the Division Commander and Administrator have mutually agreed to be available from hydro sources, and in excess of that normally available from thermal sources, the Administrator will act to acquire needed power and energy from other sources. If this is not sufficient, the Administrator, after advising the Division Commander, may declare a power emergency. The Division Commander's concurrent declaration of operating limits will be based on relaxation of the five limitations listed in this paragraph to the maximum extent that the emergency justifies and considering any unusual situations that may exist at that time.

- (i) Would not require the safe limits of the generating, transforming and switching facilities, and appurtenant equipment of said projects to be exceeded or otherwise cause damage to the same.
- (ii) Would not conflict with the statutory requirements for the operation of said projects with regard to authorized purposes such as flood control, navigation, irrigation, water supply, and recreation, etc,
- (iii) Would avoid, insofar as practicable, harmful effects on the environment, including established fish and wildlife resources and recreation.
- (iv) Would not infringe upon the vested property rights of third parties.
- (v) Would not be inconsiderate of the effect on any major downstream construction or maintenance activities by public or private entities.

(d) Short Term Emergency. Short term emergencies requiring a reduction in releases such as for drowning, imminent loss of life or property, emergency maintenance or to preserve the

integrity of the project may be coordinated directly between SWD powerhouse personnel and SWPA dispatcher. Information documenting the emergency and the actions taken shall be forwarded to SWPA at the earliest possible time.

(e) Flood Constraints. SWPA recognizes that the SWD has the responsibility to minimize flooding to the extent possible by the regulation of Federal projects. Hydropower generation will be constrained to the extent possible during flood periods to prevent reservoir releases from adding to downstream flood damages. Normally, the constraints on power generation at SWD projects during flood periods will not be less than the minimum hydropower releases as shown on Table 1. However, conditions may occur where it is desirable for reservoir releases to be reduced below the Table 1 values to prevent or reduce downstream flooding. In this event, the SWD district office will notify SWPA of the restriction and its estimated duration. SWPA, if possible, will take action to reschedule generation such that the restriction can be accomplished. If this proposed restriction of power generation results in a determination by SWPA that a significant economic loss to the Federal Government or to SWPA customers would result, SWPA shall report that impact to the SWD district. Upon receipt of the SWPA finding of significant economic impact, the district shall increase the permissible release to the Table 1 value or request SWD to formally establish the constraint with documentation to SWPA describing the need, duration, and impacts of the constraint. If under such constraints as established by SWD, SWPA determines there is not enough power and energy available to maintain electric service to consumers in the marketing area, the Division Commander, based on the information provided by the respective SWD district offices and SWPA, will declare sufficient energy available by project to meet minimum needs.

(5) Individual Project Regulation and System Hydropower Operation. To enhance the working relationship between SWD and SWPA and to form a basis for general concurrence on how the individual projects and the power system will be operated, the following will be undertaken:

(a) SWD will provide Water Control Manuals to SWPA for information and comment before final adoption. Table 6 is a list of applicable projects.

(b) SWD will provide operating guide curves and pool zone criteria for each of the SWD hydroelectric projects within the SWPA marketing area. Subsequent changes of and addition to operating guide curves will be transmitted by letter from the Division Commander to SWPA. The SWPA will comment by letter.

(c) The parties will undertake cooperative effort to establish a system guide curve that will reflect SWPA and SWD needs, including defining the periods that supplemental power may be purchased to offset the power demands.

(d) SWD will provide any update of plant efficiency curves (included in this agreement by reference) for maximizing power performance at individual projects as shown in Table 7.

(e) The Administrator will furnish SWD power sales contract for information. In addition, those contracts providing for the sale of power generation from Projects listed by name in the contracts will be furnished to the Division Commander for comment prior to final approval.

(6) Generation Scheduling. Request for actual generation at a power plant will be given to the power plant operator by the SWPA dispatcher or dispatcher designated in writing by SWPA. To the maximum extent possible, these directions will conform with the generation guidelines agreed to by the appropriate representatives of SWPA and the SWD.

(7) Generating Equipment Maintenance Schedule. The planned outage schedule will be prepared by the SWD in January each year and will be furnished to SWPA by February 1. The SWD will make every effort to avoid scheduling outages during power system peak load periods (Jun 15 - Sep 15 and Dec 15 - Mar 15). SWPA requests for schedule changes shall be submitted to SWD in writing within 30 days after receipt of the schedule. SWD will accommodate the requests to the maximum extent practicable within available resources, including manpower resources. SWPA requests for rescheduling during the course of the year due to unanticipated load requirements or water conditions, shall be transmitted to the SWD by letter. SWD will furnish a timely response. Changes to the schedule initiated by SWD during the course of the year will be coordinated with SWPA. A revised schedule will be prepared and distributed if any significant changes are made during the year. The SWD will give SWPA as much advance notice as possible in the event of unplanned or forced outages.

(8) Switching Activities. All switching at SWD power plants which may affect the high-voltage transmission system or the availability of a unit will be coordinated with each party. Detailed procedures governing clearance and hold orders will be developed and included as a part of the Arrangement.

c. Reporting. The following summary of reporting requirements is not intended to include all aspects of data and information exchange needed between the SWPA and SWD elements.

(1) Daily observed hydrologic data, forecasts, flood control release requirements and schedules will be supplied by telephone between SWPA and SWD District Offices. Summary confirmations will be supplied on the computer data file program to the extent possible.

(2) Weekly plans and schedules will be exchanged by SWPA and SWD District Offices by telephone until adequate computer interconnections are available. At that time, these will be furnished through the interconnected facilities.

(3) Notifications of constraints, emergencies or revisions will be furnished by telephone with computer data file confirmation. All elements will be included in the notification for coordinated approvals and actions. Follow-up teletypes or letters may be required for official documentation.

(4) Special needs or operations will be furnished by telephone with follow-up teletype or letter between SWPA and SWD with copies to appropriate SWD District Office. When possible these may be covered in monthly hydropower meetings and documented in the meeting minutes without additional correspondence.

(5) Monthly hydropower meeting minutes (including pre-meeting summaries, agenda, needs, recommendations and follow-up allocations) will be furnished by teletype or letter to all elements.

(6) Record of actual hydropower generated during the previous month will be provided for each project by SWPA by mail until adequate computer connections are available.

(7) Records of hourly generation and water releases for each power plant will be furnished to SWPA.

TABLE 1
 MINIMUM HYDROPOWER RELEASES
 DURING FLOOD CONDITIONS

<u>Reservoir</u>	<u>Allowable Daily Release</u>	
	<u>Volume (DSF)</u>	<u>Energy (MWH) (1)</u>
Beaver	950	332
Broken Bow	850	290
Bull Shoals	3,750	1,352
Denison	2,300	429
Eufaula	2,150	358
Fort Gibson	1,800	197
Greers Ferry	1,200	404
Keystone	1,500	216
Norfork	1,300	410
Sam Rayburn	1,150	161
Table Rock	2,550	943
Tenkiller Ferry	600	160
Whitney	500	86

(1) Energy values represent the energy produced by the daily release volume when pool elevation is at top of power pool.

TABLE 2
WATER RELEASE REQUIREMENTS
FOR INTSTREAM FLOW NEEDS

Project	Period of Time in Effect	Forecast Air Temperature (Degrees Fahrenheit)							
		90 or Below		91 - 95		96 - 104		105 and above	
		Generation (MWH)	Discharge (DSF)	Generation (MWH)	Discharge (DSF)	Generation (MWH)	Discharge (DSF)	Generation (MWH)	Discha. (DSF)
Beaver 1/	May 1 - Oct 15	29	85	43	125	56	165	68	200
Table Rock	May 1 - Dec 1	34	100	48	140	60	175	68	200
Bull Shoals	May 1 - Oct 15	80	250	120	375	160	500	240	750
Norfolk	May 1 - Oct 15	40	145	60	218	80	290	100	360
Greers Ferry 2/	May 1 - Oct 15	35	115	45	150	54	175	69	225
Keystone	Jan - Dec	Minimum release is 140 MWH, 1,000 DSF three times/week. Example: Monday, Wednesday, and Friday; Tuesday, Thursday, and Saturday.							
Broken Bow	Jan - Dec	Maintain 100 CFS from re-regulation structure, require minimum of 250 MWH, 750 DSF twice a week (separate by 3 days).							

1/ If feasible, minimum one hour morning and afternoon.

2/ Increase required release by 50 percent on one day of a 3-day period.

TABLE 3

DESIRABLE
WATER RELEASE REQUIREMENTS
FOR INSTREAM FLOW NEEDS

PROJECT	PERIOD OF TIME IN EFFECT	WATER RELEASE REQUIREMENTS	FAVORABLE HYDROLOGIC CONDITIONS
Dardanelle	Jan - Dec	Maximum 50-hour down time (minimum generation is 1,750 MWH 1/ per week, or inflow, whichever is less). Use at least 25 percent weekly total on Monday and Friday when minimum weekly generation scheduled.	Not restricted.
Denison	Jan - Dec	Generate at least one hour with one unit every fourth day, or as needed to replenish oxygen content of water in the tailrace and stilling basin.	Above elevation 612.0
Eufaula	Jan - Dec	Generate at least one hour with one unit every fourth day, or as needed to replenish oxygen content of water in the tailrace and stilling basin.	Not restricted.
Tenkiller Ferry	Oct 16 - May 31 Jun 1 - Oct 15	One Hour 10 MW Morning and Afternoon. One Hour 10 MW Morning and Afternoon.	Not restricted.
Bull Shoals	May 1 - Oct 15	The minimum combined operation at Bull Shoals and Norfork shall not be less than a 3-day summation of 6,000 DSF (approximately 2,000 MWH). This applies for all air temperature conditions at or above 85 .	Above elevation 649.0
Norfork	May 1 - Oct 12	Same as above.	Above elevation 545.0

1/ Minimum generation is based on 3,000 DSF.

TABLE 4

MAXIMUM DRAWDOWN
RATES IN CONSERVATION POOL

<u>Project</u>	Maximum Drawdown Per Week (ft)	Maximum Drawdown In Any Consecutive 4-Week Period (ft)
Beaver	2.0	6.0
Norfolk	1.5	5.0
Greers Ferry	1.0	4.0
Table Rock	1.5	4.5
Bull Shoals	1.5	4.5
Keystone	1.0	3.0
Tenkiller Ferry	1.5	4.5
Eufaula	1.0	3.0
Denison	1.0	3.0
Broken Bow	2.0	6.0
Sam Rayburn	1.0	2.0
Whitney	1.0	3.0

TABLE 5
RESPONSE TIME TO CHANGE IN GENERATION

<u>PROJECT</u>	<u>TIME</u>	
	<u>NORMAL</u>	<u>EMERGENCY</u>
<u>FORT WORTH DISTRICT</u>		
Sam Rayburn	20 Minutes	5 Minutes
Whitney	20 Minutes	5 Minutes
<u>LITTLE ROCK DISTRICT</u>		
Beaver	10 Minutes	5 Minutes
Bull Shoals	10 Minutes <u>1/</u>	5 Minutes
Table Rock	10 Minutes <u>2/</u>	5 Minutes
Norfolk	10 Minutes	5 Minutes
Greers Ferry	10 Minutes	5 Minutes
Dardanelle	10 Minutes	5 Minutes
Ozark	10 Minutes	5 Minutes
<u>TULSA DISTRICT</u>		
Broken Bow	20 Minutes	5 Minutes
Denison	20 Minutes	5 Minutes
Eufaula	20 Minutes	5 Minutes
Fort Gibson	20 Minutes	5 Minutes
Keystone	20 Minutes	5 Minutes
Robert S. Kerr	20 Minutes <u>3/</u>	5 Minutes
Tenkiller Ferry	20 Minutes	5 Minutes
Webbers Falls	20 Minutes	5 Minutes

Notes:

General. Indicated Emergency Start Up and Loading times assume the powerplant control room operator is starting and loading only the local units. If the operator is starting and loading remote units, response times could be as much as twice as long for starting and loading the local units. Exact Emergency Start Up and Loading times for remote plants will depend greatly upon how many units, both local and remote, the control room operator is attempting to start and load.

1/ During normal operations, the initial start up and final shutdown should not exceed 100 megawatts per hour. Additional changes should not exceed 100 megawatts per 30 minutes.

2/ During normal operations, the initial start up and final shutdown should not exceed 115 megawatts per hour.

3/ First two units may start simultaneously. A lag of 1/2 hour between third and fourth units or a lag of one hour if third and fourth are started simultaneously.

TABLE 6
WATER CONTROL MANUALS

<u>TITLE</u>	<u>DATE</u>
Lake Regulation Manual, Broken Bow Lake	Oct 1973
Water Control Manual, Lake Texoma	May 1975
Reservoir Regulation Manual for Eufaula Reservoir	Sep 1962
Reservoir Regulation Manual for Pensacola, Markham Ferry and Fort Gibson Reservoirs	Sep 1964
Reservoir Regulation Manual for Keystone Reservoir	Nov 1963
Reservoir Regulation Manual, Robert S. Kerr Lock and Dam and Reservoir	Apr 1971
Lake Regulation Manual, Tenkiller Ferry Lake	Jul 1976
Reservoir Regulation Manual, Webbers Falls Lock and Dam	May 1972
Sam Rayburn	Jan 1982
Whitney	Apr 1975
Reservoir Regulation Manual for Greers Ferry Reservoir	Mar 1963 Revised Nov 1966
Reservoir Regulation Manual for Beaver, Table Rock, Bull Shoals and Norfork Reservoirs	Mar 1963 Revised Oct 1966
Regulation Manual for Ozark Lake and Pool No. 13	Oct 1974
Regulation Manual for Pool No. 9 and Lake Dardanelle	Feb 1976
Master Water Control Manual, Arkansas River	Jul 1980

TABLE 7

PROJECTS WITH PLANT EFFICIENCY CURVES

Beaver

Broken Bow

Bull Shoals (1)

Dardanelle

Denison

Eufaula

Fort Gibson

Greers Ferry

Keystone

Norfolk (1)

Ozark

Sam Rayburn

Table Rock

Tenkiller Ferry (1)

Webbers Falls

Whitney

(1) Curves developed before units were rewound

IN WITNESS WHEREOF, the parties have executed this Memorandum as of _____, 1986.

UNITED STATES OF AMERICA
Department of Energy

By _____
Administrator
Southwestern Power Administration

Approved as to Legal
Form and Sufficiency

Chief Counsel
Southwestern Power Administration

UNITED STATES OF AMERICA
Department of the Army

By _____
Division Commander
Southwestern Division
Corps of Engineers

Approved as to Legal
Form and Sufficiency

Division Counsel
Southwestern Division
Corps of Engineers

EXHIBIT D

**OPERATING PLAN FOR SOUTHWESTERN DIVISION (SWD)
CORPS OF ENGINEERS (COE) HYDROPOWER**

OPERATING PLAN

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OPERATING PLAN

(Reservoir Regulation and Power Scheduling)

1. Purpose To outline processes and procedures for coordination of operations, maintenance, regulation of our power plant generation equipment and schedules. The goal is to operate projects within the authorized purposes. This document does not supersede any information or requirements, contained in water control manuals (see Table 6 for list of manuals and latest revisions), or other legal determinations. Also this document does not supersede or replace the 1986 Operating Arrangement between the Corps of Engineers (COE) and Southwestern Power Administration (SWPA).

2. Activities. SWD and SWPA activities include:

2.1 Activities of SWD:

2.1.1 The regulation of SWD District projects in accordance with authorized purposes and in accordance with approved water control plans and approved deviations.

2.1.2 The daily operation and maintenance of electric generation equipment and project facilities, including scheduling of outages at each SWD power plant.

2.1.3 The determination of hourly, daily and monthly water release requirements at SWD projects.

2.1.4 The preservation of project integrity.

2.2 Activities of SWPA:

2.2.1 The marketing and transmission of surplus (in excess of project requirements) power.

2.2.2 The preparation of monthly estimates of generation requirements for each SWD project.

2.2.3 The hourly, daily and monthly scheduling of power plants to meet system requirements.

2.2.4 To contract for the sale of power and energy generated at SWD projects.

2.3 SWD and SWPA will consult on load and resource requirements.

3. Procedures.

3.1 Power Allocations and Monthly Meetings.

3.1.1 A monthly hydropower meeting will be held by SWPA each month to develop a 30-day operational plan, including allocations for the next month, and to review current operations, planned outages, transmission limitations, reservoir conditions (current and projected), and other items of mutual concern. The meeting may be conducted by telephone conference or in person.

3.1.2 SWD may furnish SWPA recommended monthly available energy along with maximum and minimum energy quantities for their projects for the following month. Development of recommended monthly hydropower energies will consider the individual project rule curve, projected reservoir condition, water quality, endangered species, fish and wildlife and any authorized reservoir uses. This information will be provided formally via email prior to the monthly hydropower meeting.

3.1.3 SWPA will furnish SWD its anticipated energy needs for the following month from SWD projects. These monthly hydropower needs will consider SWPA system guide curve, load requirements, the condition of the interconnected reservoir system, projected reservoir conditions, available capacity, inflow trends and the ability to obtain energy from other sources. This information will be available to each SWD district via email prior to the monthly hydropower meeting.

3.1.4 During the monthly operational meeting, both SWPA and each SWD District will agree on the proposed generation (hydropower allocation) at each SWD project. The agreed upon releases will be documented in the final monthly operations meeting minutes prepared by SWPA which will be transmitted via email.

3.2 Operation.

3.2.1 General.

3.2.1.1 SWPA will schedule the monthly hydropower production in accordance with the monthly agreement. However, in event of special conditions or unforeseen events, SWPA may schedule hydropower production differently than specified in monthly agreement, provided that these changes are arranged with the responsible SWD District Office prior to scheduling.

3.2.1.2 Operation of SWD projects for hydropower operations within approved regulations will be handled between SWPA and the appropriate SWD District Office. Occasionally SWD will become involved in regional and special day-to-day operations described herein.

3.2.1.3 Power plant system controller shall begin or adjust generation in accordance with SWPA schedule as requested. The power plant system controller will verify that the request is within the limits agreed to between the two agencies and that it does not violate any special instructions issued by the District Office. If these conditions are satisfied, the controller will commence generation to the requested limits in a manner consistent with the system needs (normally across the hour in a ten-minute period). If the request exceeds the limits or violates the conditions previously established, the power plant system controller will advise the dispatcher as to what generation is available from the power plant.

3.2.1.4 Daily, SWD District Offices will make available to SWPA 4-day forecast of inflow, pool elevations and any limiting constraints for each project.

3.2.1.5 If it is determined that a turbine is operating in a rough zone, either the load will be changed or the unit will be shutdown to prevent damage to equipment. Power Plant System controller will contact the SWPA Dispatcher to facilitate the reliability of the bulk power system.

3.2.1.6 Notification of all scheduled and unscheduled outages shall be made using the attached unit un-availability for (Form 2) or revision thereto. The report shall be used to notify SWPA, internal Corps Offices and SWD. Notifications will be given when unit is removed and returned to service.

3.2.2 Flood Risk Management Operations.

3.2.2.1 During flood risk management operations, SWD H&H District Offices will furnish to SWPA a statement of flood control objectives for the next four days relative to individual pool regulations and planned release volumes. The release schedule will be furnished via email.

3.2.2.2 SWPA will plan its generation schedule consistent with flood releases.

3.2.2.3 SWD District Offices will coordinate daily if necessary with SWPA and provide required releases. The firm power hydropower releases are listed in Table 1. Generation may be limited to less than that shown in Table 1 for conditions described in para 3.2.4.5

3.2.2.4 SWPA will reschedule generation between projects and/or obtain other resources to meet its needs to effect any changes in project releases required by SWD District Offices for flood risk management needs to the extent possible. In the event SWPA is unable to reschedule generation or obtain sufficient resources to meet its needs,

SWPA may declare a power emergency in accordance with Section 3.2.4.3 Declared Power Emergency.

3.2.3 Conservation Operation.

3.2.3.1 Each day prior to 3:30 p.m., SWPA will furnish the SWD District Offices updated hourly generation schedules for each project for the remainder of the current day and for the following day. Weekend and holiday generation schedules will be furnished by 3:30 p.m., on the last working day prior to the weekend or holiday and will also include the schedule for the next working day.

3.2.3.2 SWPA will be responsible for daily hydropower operations to meet needs of their customers and downstream release requirements shown in Table 2. Table 3 shows desirable downstream release requirements to be accomplished providing hydrologic conditions are favorable. Favorable hydrologic conditions are included in Table 3.

3.2.3.3 SWPA will furnish SWD a weekly statement of their generation plans and objectives relative to pool manipulations. The weekly statement will be provided, if possible by 2:00 p.m., on the preceding Friday and will include an estimate of daily release volumes from each project.

3.2.3.4 Release schedules by SWPA and the Districts will consider project and system curves, pool zone criteria, drawdown limits, current and projected pool conditions, downstream needs, and the needs of other authorized uses of the project.

3.2.3.5 Table 4 shows maximum drawdown rates within the conservation pool for applicable Corps projects.

3.2.4 Special Operations

3.2.4.1 General. Normally, special operations will be coordinated by SWD Districts and SWPA. These operations will be documented in the minutes of the monthly hydropower meeting. If these special operations arise after the scheduled monthly meeting the SWD District will email the completed special operations form (Form 1) to SWPA. SWD Districts will coordinate with SWD those special operations which have significant impacts on SWPA. SWD Districts will notify SWPA of the special operating limits which are necessary for the operation of its projects. SWPA will be notified of planned special operations by email using the special operations form. SWD Districts will notify SWPA as soon as each special operating schedule is determined.

3.2.4.2 Short Term Power Emergency. It is recognized that certain situations which adversely affect system reliability may occur. Such circumstances demand a rapid response to prevent deterioration of the system reliability. The necessary response may involve a

modification from previously agreed to schedules. These situations (short term emergencies) typically involve overloaded facilities and/or low voltage and may arise slowly, as when due to high power demands, or suddenly, as when due to the loss of a line, station, or generator on the SWPA or a neighboring system. When possible, the response deemed necessary by the SWPA will be coordinated prior to scheduling with the appropriate SWD District Office. When the required response does not permit prior coordination, the power plant system controller will follow the direction of the SWPA dispatcher within limits specified in Table 5 and the safe operating limits of the generating, transforming and switching equipment, and the necessary coordination will begin as soon as practical. Table 5 lists the minimum time required for project to respond to a generation change under normal and emergency conditions.

3.2.4.3 Declared Power Emergency. It is recognized that SWPA has an obligation to its customers, the Southwest Power Pool (SPP), and various regulatory bodies to adhere to mandatory reliability standards and requirements in an effort to minimize power system disturbances. In the event of a declared power emergency, the power plant system controller can make limited excursions beyond normal operation limits provided that equipment rating is not exceeded. For all operations, either normal or emergency, the power plant system controller shall operate his equipment in accordance with the listed criteria below.

- (a) Would not require the safe limits of the generating, transforming and switching facilities, and appurtenant equipment of said projects to be exceeded or otherwise cause damage to the same.
- (b) Would not conflict with the statutory requirements for the operation of said projects with regard to authorized purposes.
- (c) Would avoid, insofar as practicable, harmful effects on the environment, including established fish and wildlife resources and recreation.
- (d) Would not infringe upon the vested property rights of third parties.
- (e) Would not be inconsiderate of the effect on any major downstream construction or maintenance activities by public or private entities.

3.2.4.4 Short Term Emergency. Short term emergencies requiring a reduction in releases such as for drowning, imminent loss of life, emergency maintenance or to preserve the integrity of the project may be coordinated directly between SWD powerhouse personnel and SWPA

dispatcher. Information documenting the emergency and the actions taken shall be forwarded by the power plant system controller to SWPA, and District H&H staff at the earliest possible time. Depending on circumstances, initial notification by power plant system controller may be by telephone and then followed up with an email.

3.2.4.5 Flood Constraints. SWD has the responsibility to minimize flooding to the extent possible by the regulation of Federal projects. Hydropower generation may be constrained during flood periods to prevent reservoir releases from adding to downstream damages. For any changes to scheduled generation, the District H&H staff will notify SWPA and power plant system controller. The actual request for generation load change will be confirmed and initiated by the SWPA dispatcher to the power plant system controller.

3.2.5 Generation Scheduling. Request for actual generation at a power plant will be given to the power plant system controller by the SWPA dispatcher or dispatcher designated in writing by SWPA. To the maximum extent possible, these requests will conform to the weekly schedules.

3.2.6 Generating Equipment Maintenance Schedule. The planned routine outage schedule will be prepared by SWD Districts and will be furnished to SWPA by February 1. The Planned routine outages should avoid the agreed to seasonal power peak load periods when practical. Changes to the scheduled outages should be provided to SWPA prior to the monthly scheduled operational meeting or as soon as practical. SWPA requests for rescheduling during the course of the year due to unanticipated load requirements or water conditions shall be transmitted to SWD Districts via email. Changes to the schedule initiated by a District during the course of the year will be coordinated with SWPA.

3.2.7 Unplanned Outages. The Districts will notify SWPA as soon as possible in the event of forced outages.

3.2.8 Switching Activities. Switching operations which affect the high-voltage transmission system or the availability of a unit will be coordinated with SWPA.

TABLE 1
FIRM POWER RELEASES

<u>RESERVOIR</u>	<u>ALLOWABLE VOLUME (DSF)</u>	<u>DAILY RELEASE ENERGY (MWH) (1)</u>
BEAVER	950	332
BROKEN BOW	850	290
BULL SHOALS	3,750	1,352
DENISON	2,300	429
EUFAULA	2,150	358
FORT GIBSON	1,800	197
GREERS FERRY	1,200	404
KEYSTONE	1,500	216
NORFORK	1,300	410
SAM RAYBURN	1,150	161
TABLE ROCK	2,550	943
TENKILLER FERRY	600	160
WHITNEY	500	86

(1) Energy values represent the energy produced by the daily release volume when pool elevation is at top of the power pool.

TABLE 2
WATER RELEASE REQUIREMENTS
FOR INSTREAM FLOW NEEDS

Project	Period of Time in Effect	Forecast Air Temperature (Degrees Fahrenheit)							
		90 or Below		91 - 95		96 - 104		105 & Above	
		Generation (MWH)	Discharge (DSF)	Generation (MWH)	Discharge (DSF)	Generation (MWH)	Discharge (DSF)	Generation (MWH)	Discharge (DSF)
Beaver 1/	May 1 - Oct 15	29	85	43	125	56	165	68	200
Table Rock	May 1 - Dec 1	34	100	48	140	60	175	68	200
Bull Shoals	May 1 - Oct 15	80	250	120	375	160	500	240	750
Norfolk	May 1 - Oct 15	40	145	60	218	80	290	100	360
Greers Ferry 2/	May 1 - Oct 15	35	115	45	150	54	175	69	225
Broken Bow	Jan - Dec	Maintain 100 CFS from re-regulation structure.							

1/ If feasible, minimum one hour morning and afternoon.

2/ Increase required release by 50 percent on one day of a 3-day period.

TABLE 3

DESIRABLE
WATER RELEASE REQUIREMENTS
FOR INSTREAM FLOW NEEDS

<u>Project</u>	<u>Period of Time in Effect</u>	<u>Water Release Requirements</u>	<u>Favorable Hydrologic Conditions</u>
Dardanelle	Jan - Dec	Maximum 50-hour down time (minimum generation is 1,750 MWH 1/ per week, or inflow, whichever is less). Use at least 25 percent weekly total on Monday and Friday when minimum weekly generation scheduled.	Not Restricted.
Denison	Jan - Dec	Generate at least one hour with one unit every fourth day, or as needed to replenish oxygen content of water in the tailrace and stilling basin.	Above elevation 612.0
Eufaula	Jan - Dec	Generate at least one hour with one unit every fourth day, or as needed to replenish oxygen content of water in the tailrace and stilling basin.	Not Restricted.
Bull Shoals	May 1 - Oct 15	The minimum combined operation at Bull Shoals and Norfolk shall not be less than a 3-day summation of 6,000 DSF (approximately 2,000 MWH). This applies for all air temperature conditions at or above 85.	Above elevation 649.0
Norfolk	May 1 - Oct 12	Same as above.	Above elevation 545.0

1/ Minimum generation is based on 3,000 DSF.

TABLE 4
MAXIMUM DRAWDOWN
RATES IN CONSERVATION POOL

<u>PROJECT</u>	MAXIMUM DRAWDOWN PER WEEK (FT)	MAXIMUM DRAWDOWN IN ANY CONSECUTIVE 4-WEEK PERIOD (FT)
BEAVER	2.0	6.0
NORFORK	1.5	5.0
GREERS FERRY	1.0	4.0
TABLE ROCK	1.5	4.5
BULL SHOALS	1.5	4.5
KEYSTONE	1.0	3.0
TENKILLER FERRY	1.5	4.5
EUFAULA	1.0	3.0
DENISON	1.0	3.0
BROKEN BOW	2.0	6.0
SAM RAYBURN	1.0	2.0
WHITNEY	1.0	3.0

TABLE 5

RESPONSE TIME TO CHANGES IN GENERATION

<u>PROJECT</u>	<u>TIME</u>	
	<u>NORMAL</u>	<u>EMERGENCY</u>
<u>FORT WORTH DISTRICT</u>		
SAM RAYBURN	10 minutes	5 minutes
WHITNEY	10 minutes	5 minutes
<u>LITTLE ROCK DISTRICT</u>		
BEAVER	10 minutes	5 minutes
BULL SHOALS	10 minutes <u>1/</u>	5 minutes
TABLE ROCK	10 minutes <u>2/</u>	5 minutes
NORFORK	10 minutes	5 minutes
GREERS FERRY	10 minutes	5 minutes
DARDANELLE	10 minutes	5 minutes
OZARK	10 minutes	5 minutes
<u>TULSA DISTRICT</u>		
BROKEN BOW	10 minutes	5 minutes
DENISON	10 minutes	5 minutes
EUFAULA	10 minutes	5 minutes
FORT GIBSON	10 minutes	5 minutes
KEYSTONE	10 minutes	5 minutes
ROBERT S. KERR	10 minutes <u>3/</u>	5 minutes
TENKILLER FERRY	10 minutes	5 minutes
WEBBERS FALLS	10 minutes	5 minutes

Notes:

General. Indicated Emergency Start Up and Loading times assume the power plant control room operator is starting and loading only the local units. If the operator is starting and loading remote units, response times could be as much as twice as long for starting and loading the local units. Exact Emergency Start Up and Loading times for remote plants will depend greatly upon how many units, both local and remote, the control room operator is attempting to start and load.

1/ During normal operations, the initial start up and final shutdown should not exceed 100 megawatts per hour. Additional changes should not exceed 100 megawatts per 30 minutes.

2/ During normal operations, the initial start up and final shutdown should not exceed 115 megawatts per hour.

3/ First two units may start simultaneously. A lag of ½ hour between third and fourth units or a lag of one hour if third and fourth are started simultaneously.

TABLE 6

WATER CONTROL MANUALS

<u>TITLE</u>	<u>DATE</u>
Lake Regulation Manual, Broken Bow Lake	Feb 2000
Lake Texoma Water Control Manual,	Apr 1993
Reservoir Regulation Manual for Eufaula Reservoir	Jan 1994
Reservoir Regulation Manual for Pensacola, Markham Ferry and Fort Gibson Reservoirs	Nov 1992
Reservoir Regulation Manual for Keystone Reservoir	Jan 1990
Reservoir Regulation Manual, Robert S. Kerr Lock And Dam Reservoir	Dec 1998
Lake Regulation Manual, Tenkiller Ferry Lake	Mar 1977
Reservoir Regulation Manual, Webbers Falls Lock And Dam	Dec 1997
Sam Rayburn Reservoir Water Control Manual	Jan 1982
Whitney Lake Water Control Manual	Apr 1975
Dam B Reservoir (R.D. Willis)	Mar 1956
Reservoir Regulation Manual for Greers Ferry Reservoir	Mar 1963
	Revised Nov 1966
Reservoir Regulation Manual for Beaver Lake	Oct 1998
Reservoir Regulation Manual for Table Rock, Bull Shoals, and Norfolk Reservoirs	Mar 1963
	Revised Oct 1966
Regulation Manual for Ozark L&D and Pool No. 13	Oct 1974
Regulation Manual for Lake Dardanelle and Pool No. 9	Feb 1976
Arkansas River Master Water Control Manual	Oct 1980
	Revised Oct 2007, (- Chapter 7)

FORM 1

**Special Hydropower Operations Request
Southwestern Power Administration**

Project: Date prepared:

Submitter

Name/District:

Phone: Cell

Email:

Purpose:

Units affected/Proposed
Operation:

From: hours

Month:

Day:

To: hours

Month:

Day:

On-site contact

Person(s):

Agency/Organization:

Phone Number:

Cell Phone Number:

Comments:

Emailed to:

FORM 2

**CORPS OF ENGINEERS (TULSA)
UNIT UNAVAILABILITY REPORT**

STATION:

UNITS

TYPE OF OUTAGE:

GDFO: Generator Delayed Forced Outage. GFO: Generator Forced Outage. GSO: Generator Scheduled Outage.
NGDF: Non-Generator Delayed Forced Outage. NGFO: Non-Generator Forced Outage NGSO: Non-Generator Scheduled Outage

RELAYS OPERATED:

BREAKERS TRIPPED:

ESTIMATED TIME TO RETURN TO SERVICE: HRS.

REPAIRS OR CORRECTIONS MADE

RESTORED

DATE

TIME:

TOTAL UNAVAILABLE TIME: HOURS MINUTES

POWER PLANT:

Name

Signature **Date**

Title

PLATES AND DRAWINGS

EUFAULA LAKE



US ARMY CORPS OF ENGINEERS
TULSA DISTRICT

U.S. Representative

U.S. Senator

KANSAS

- 1 Jerry Moran (R)
- 2 Lynn Jenkins (R)
- 4 Todd Tiahirt (R)

- Sam Brownback (R)
- Pat Roberts (R)

OKLAHOMA

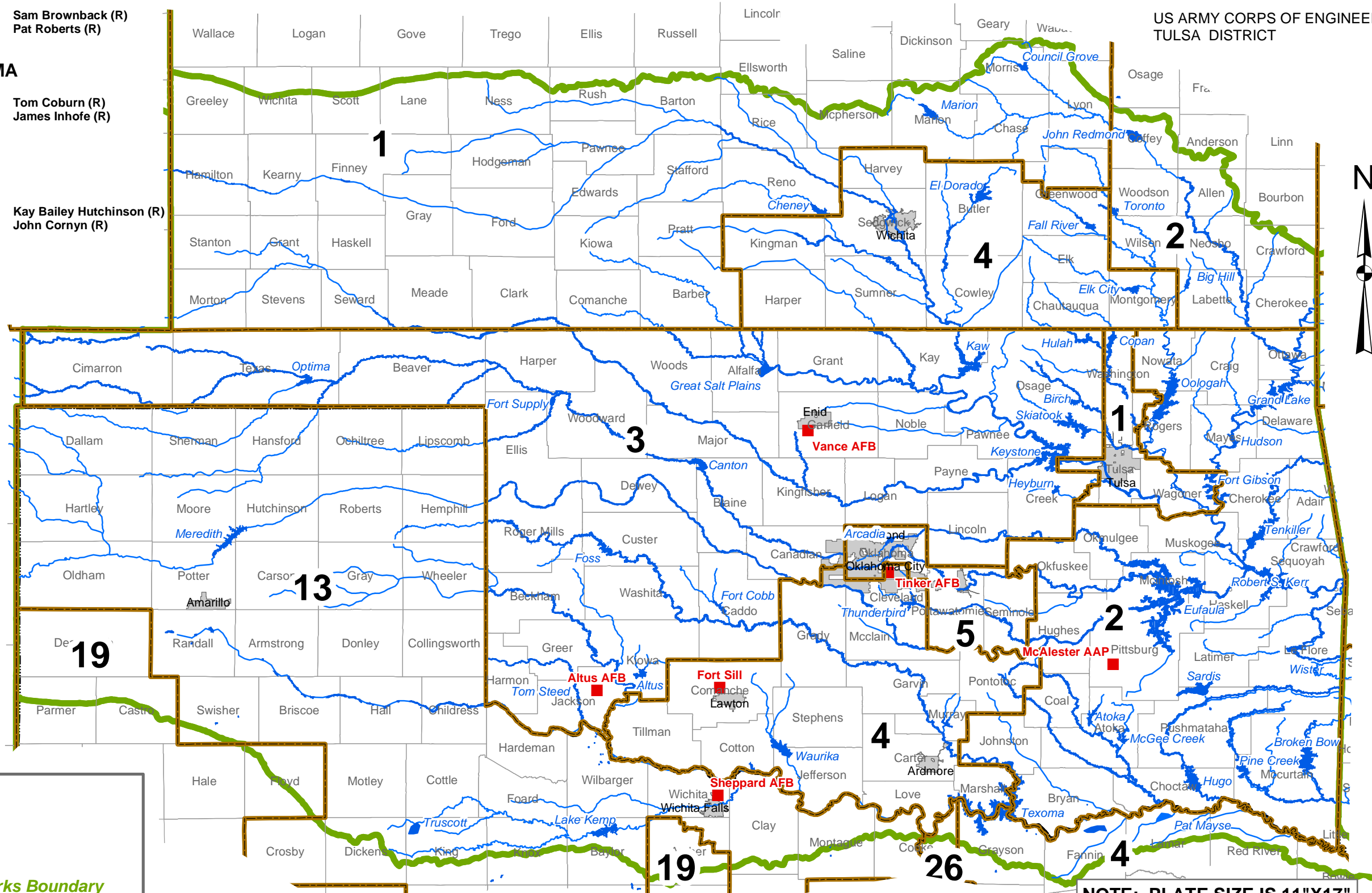
- 1 John Sullivan (R)
- 2 Dan Boren (D)
- 3 Frank Lucas (R)
- 4 Tom Cole (R)
- 5 James Lankford (R)

- Tom Coburn (R)
- James Inhofe (R)

TEXAS

- 4 Ralph M. Hall (R)
- 13 Mac Thornberry (R)
- 19 Randy Neugebauer (R)
- 26 Michael C. Burgess (R)

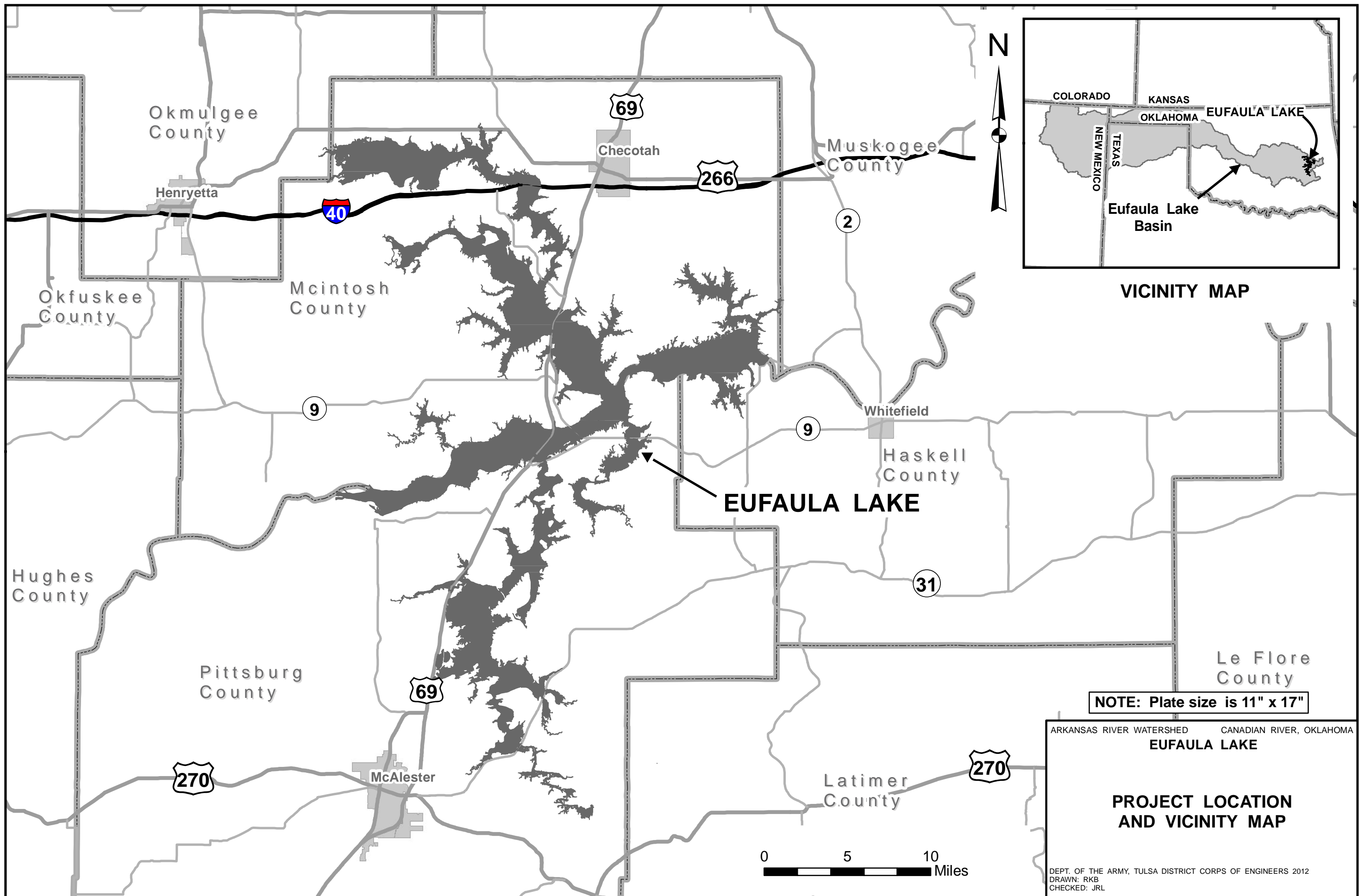
- Kay Bailey Hutchinson (R)
- John Cornyn (R)



- Lakes
- Military Installations
- Tulsa District Civil Works Boundary
- 111th Congressional Boundaries

NOTE: PLATE SIZE IS 11"X17"

**EUFAULA LAKE
TULSA DISTRICT PROJECTS**



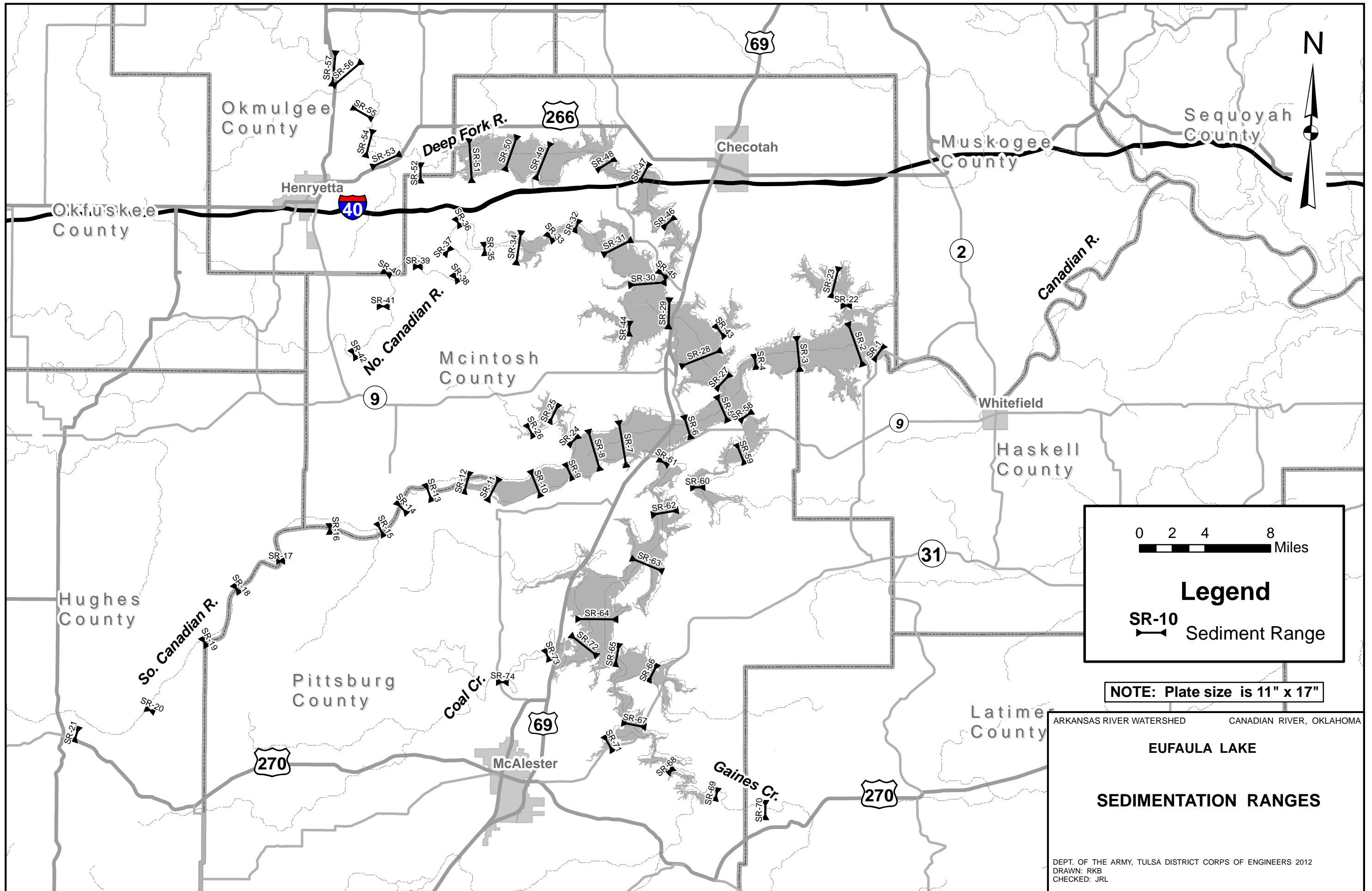
NOTE: Plate size is 11" x 17"

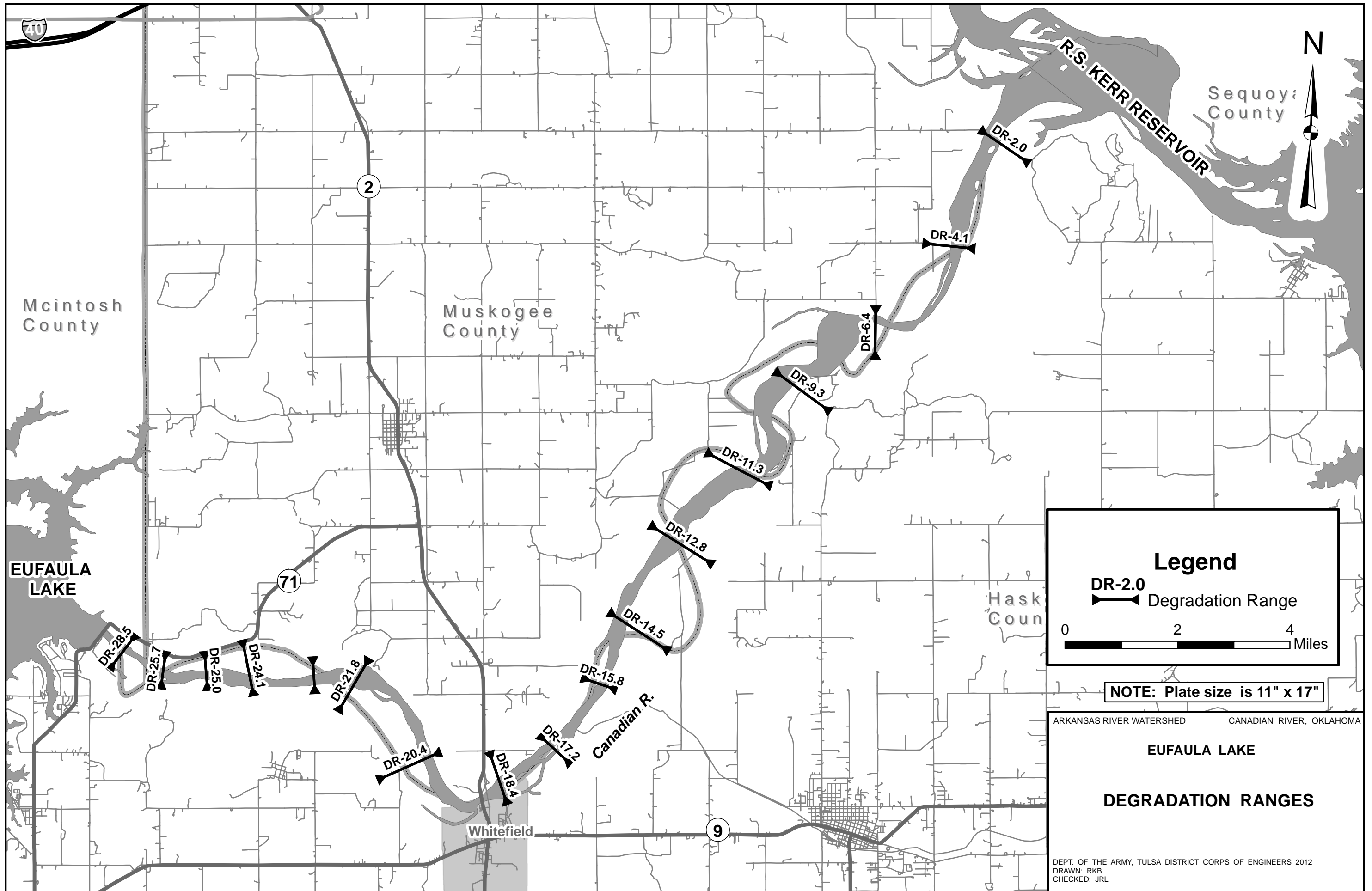
ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

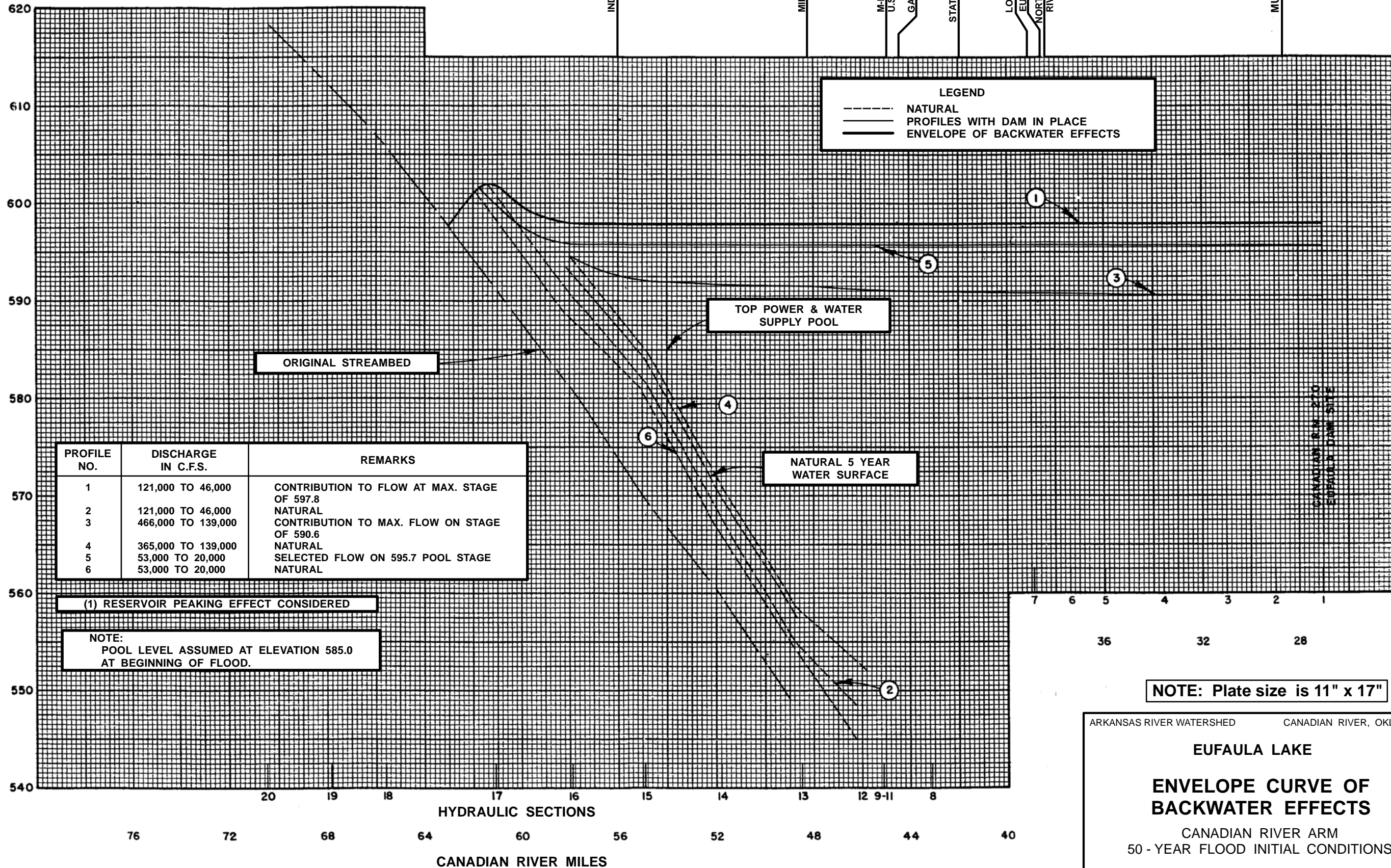
GENERAL PLANS AND SECTIONS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL





ELEVATION IN FEET (NGVD29)



PROFILE NO.	DISCHARGE IN C.F.S.	REMARKS
1	121,000 TO 46,000	CONTRIBUTION TO FLOW AT MAX. STAGE OF 597.8
2	121,000 TO 46,000	NATURAL
3	466,000 TO 139,000	CONTRIBUTION TO MAX. FLOW ON STAGE OF 590.6
4	365,000 TO 139,000	NATURAL
5	53,000 TO 20,000	SELECTED FLOW ON 595.7 POOL STAGE
6	53,000 TO 20,000	NATURAL

(1) RESERVOIR PEAKING EFFECT CONSIDERED

NOTE:
POOL LEVEL ASSUMED AT ELEVATION 585.0 AT BEGINNING OF FLOOD.

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

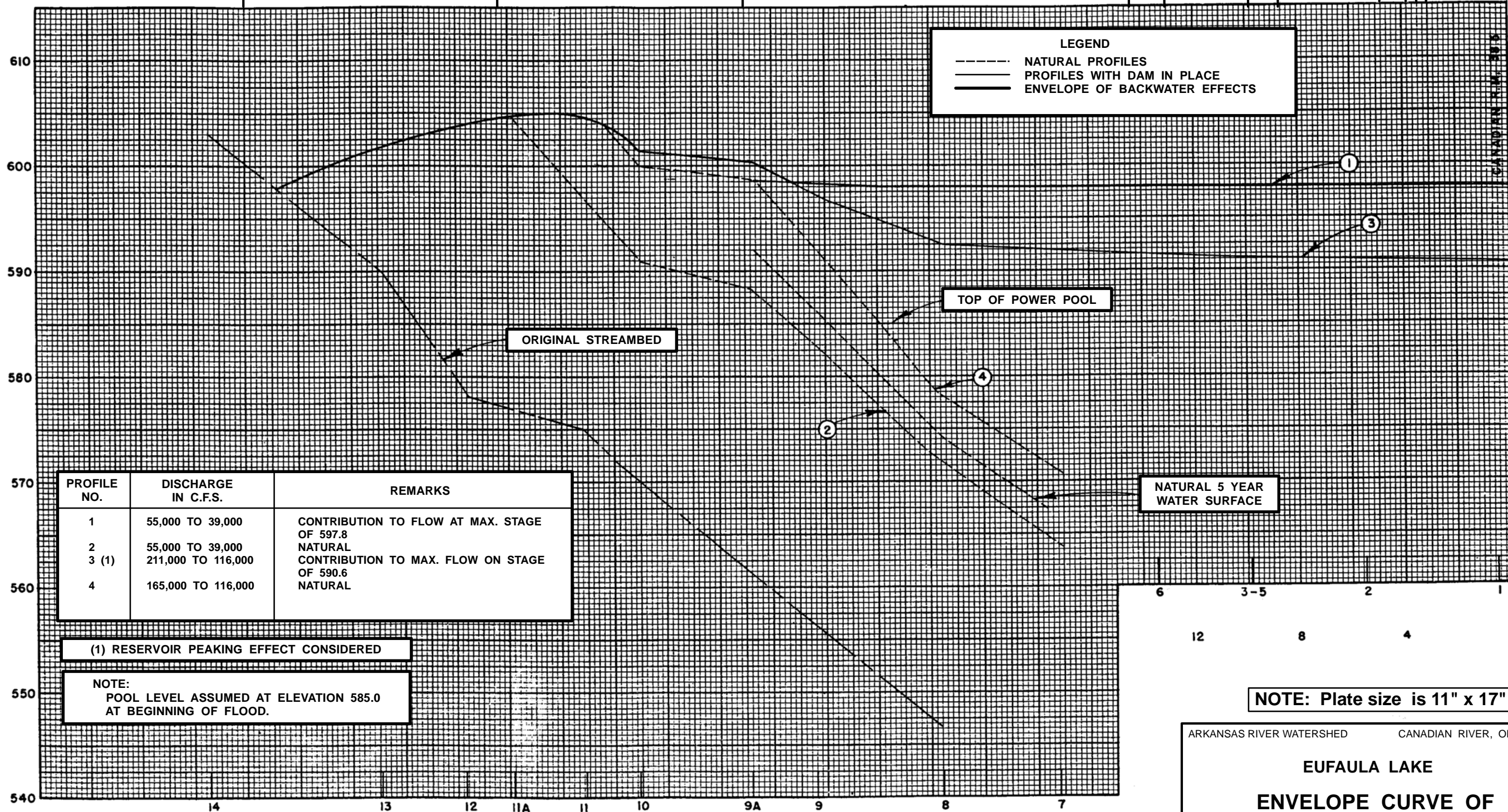
ENVELOPE CURVE OF BACKWATER EFFECTS

CANADIAN RIVER ARM
50 - YEAR FLOOD INITIAL CONDITIONS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL

NOTE: Plate size is 11" x 17"

ELEVATION IN FEET (NGVD29)



PROFILE NO.	DISCHARGE IN C.F.S.	REMARKS
1	55,000 TO 39,000	CONTRIBUTION TO FLOW AT MAX. STAGE OF 597.8
2	55,000 TO 39,000	NATURAL CONTRIBUTION TO MAX. FLOW ON STAGE OF 590.6
3 (1)	211,000 TO 116,000	
4	165,000 TO 116,000	NATURAL

(1) RESERVOIR PEAKING EFFECT CONSIDERED

NOTE:
POOL LEVEL ASSUMED AT ELEVATION 585.0 AT BEGINNING OF FLOOD.

LEGEND
 - - - - - NATURAL PROFILES
 ———— PROFILES WITH DAM IN PLACE
 ———— ENVELOPE OF BACKWATER EFFECTS

6 3-5 2 1
12 8 4

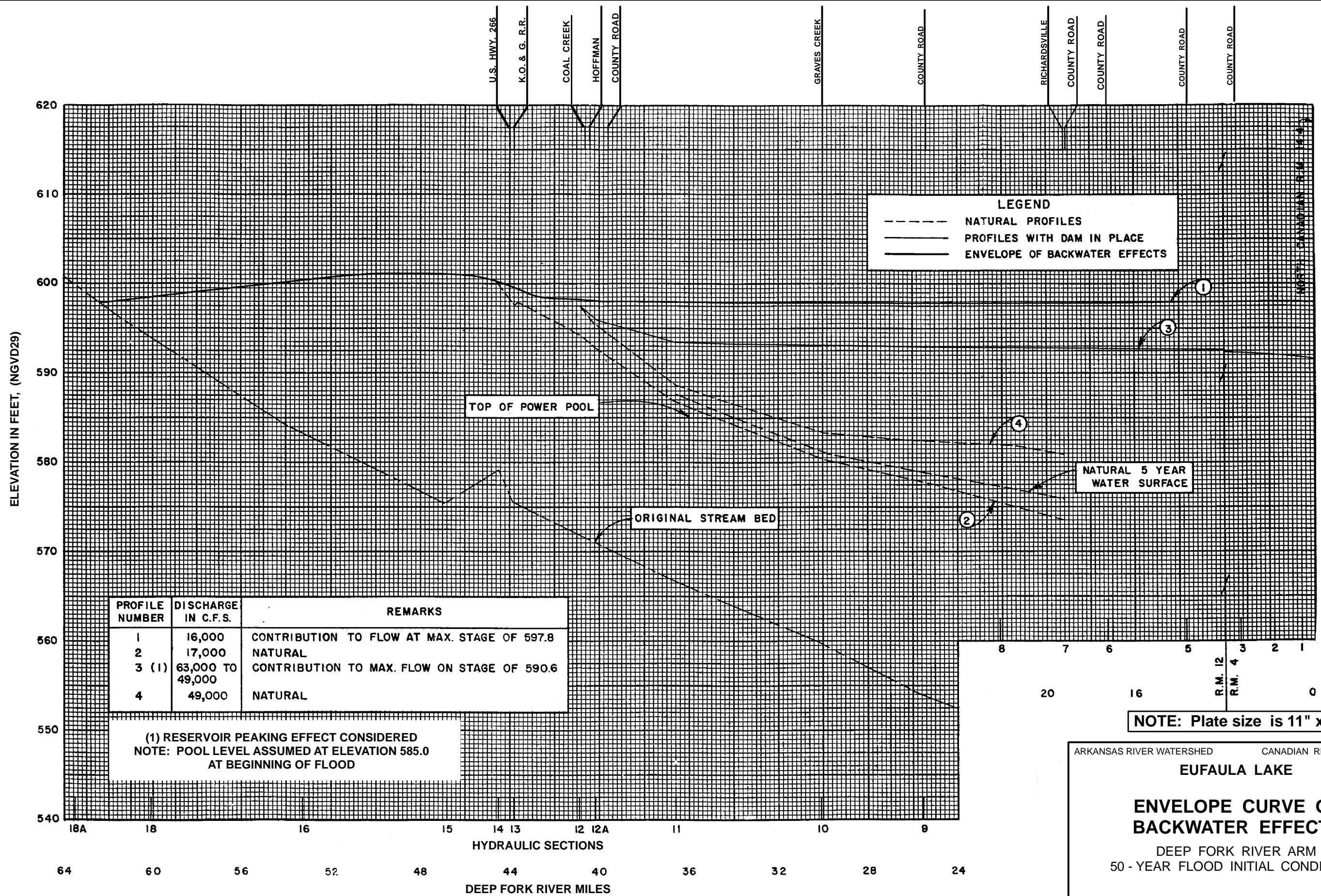
NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE
ENVELOPE CURVE OF
BACKWATER EFFECTS

NORTH CANADIAN RIVER ARM
 50 - YEAR FLOOD INITIAL CONDITIONS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL



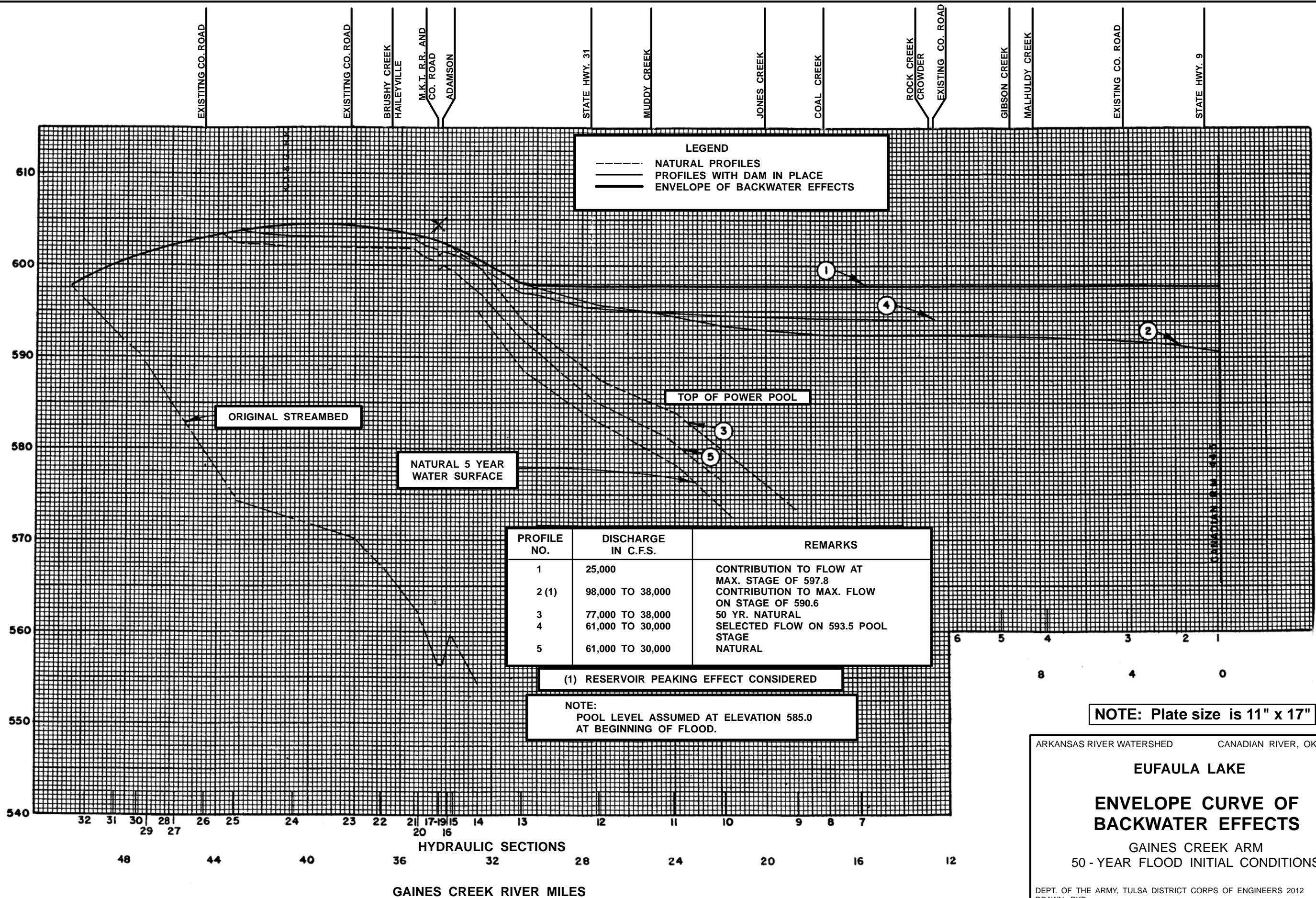
PROFILE NUMBER	DISCHARGE IN C.F.S.	REMARKS
1	16,000	CONTRIBUTION TO FLOW AT MAX. STAGE OF 597.8
2	17,000	NATURAL
3 (1)	63,000 TO 49,000	CONTRIBUTION TO MAX. FLOW ON STAGE OF 590.6
4	49,000	NATURAL

(1) RESERVOIR PEAKING EFFECT CONSIDERED
 NOTE: POOL LEVEL ASSUMED AT ELEVATION 585.0
 AT BEGINNING OF FLOOD

NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA
EUFAULA LAKE
ENVELOPE CURVE OF BACKWATER EFFECTS
 DEEP FORK RIVER ARM
 50 - YEAR FLOOD INITIAL CONDITIONS
 DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL

ELEVATION IN FEET (NGVD29)



LEGEND
 - - - - - NATURAL PROFILES
 _____ PROFILES WITH DAM IN PLACE
 _____ ENVELOPE OF BACKWATER EFFECTS

PROFILE NO.	DISCHARGE IN C.F.S.	REMARKS
1	25,000	CONTRIBUTION TO FLOW AT MAX. STAGE OF 597.8
2 (1)	98,000 TO 38,000	CONTRIBUTION TO MAX. FLOW ON STAGE OF 590.6
3	77,000 TO 38,000	50 YR. NATURAL
4	61,000 TO 30,000	SELECTED FLOW ON 593.5 POOL STAGE
5	61,000 TO 30,000	NATURAL

(1) RESERVOIR PEAKING EFFECT CONSIDERED

NOTE:
 POOL LEVEL ASSUMED AT ELEVATION 585.0 AT BEGINNING OF FLOOD.

NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

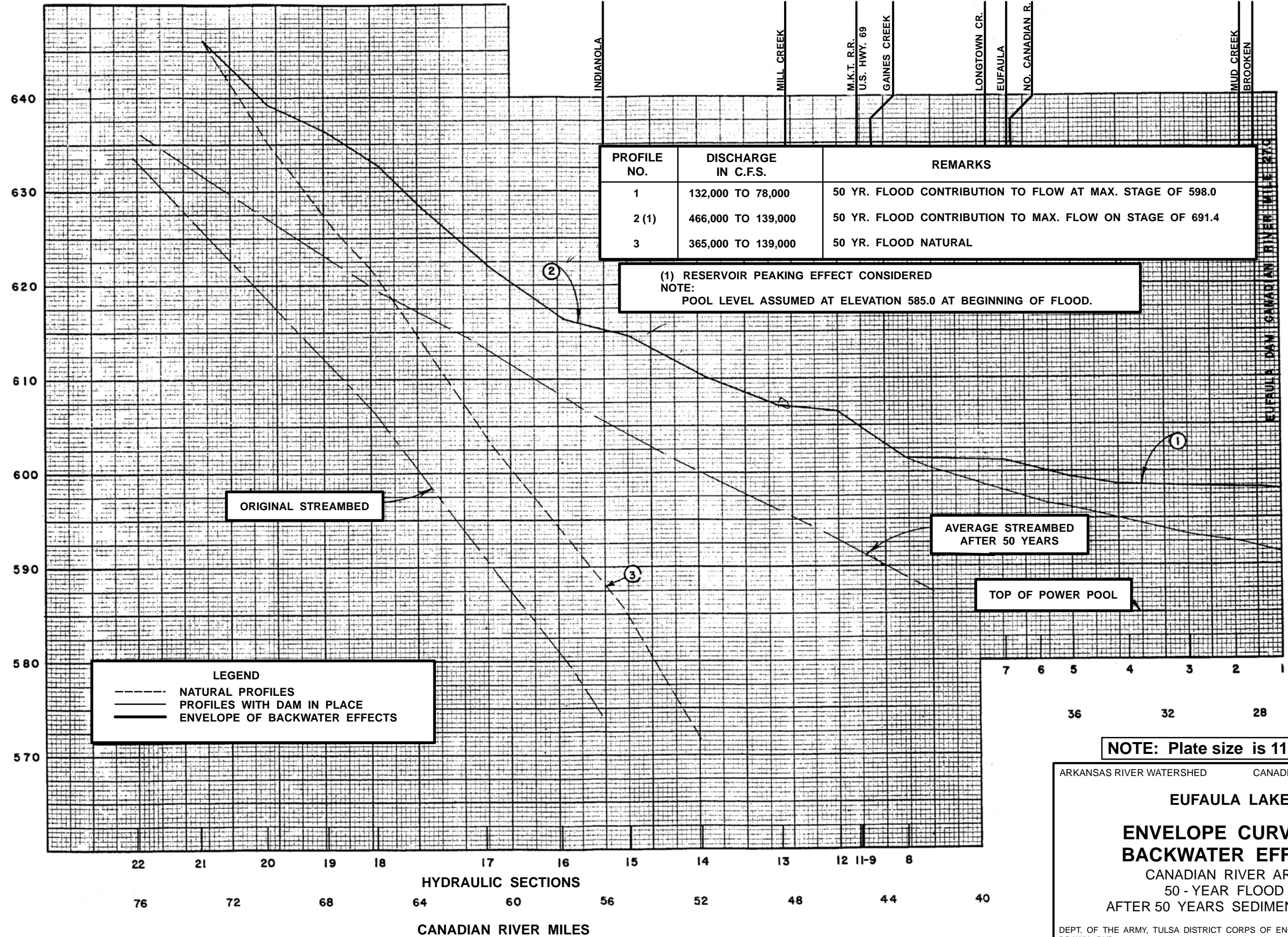
EUFULA LAKE

ENVELOPE CURVE OF BACKWATER EFFECTS

GAINES CREEK ARM
 50 - YEAR FLOOD INITIAL CONDITIONS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL

ELEVATION IN FEET (NGVD29)



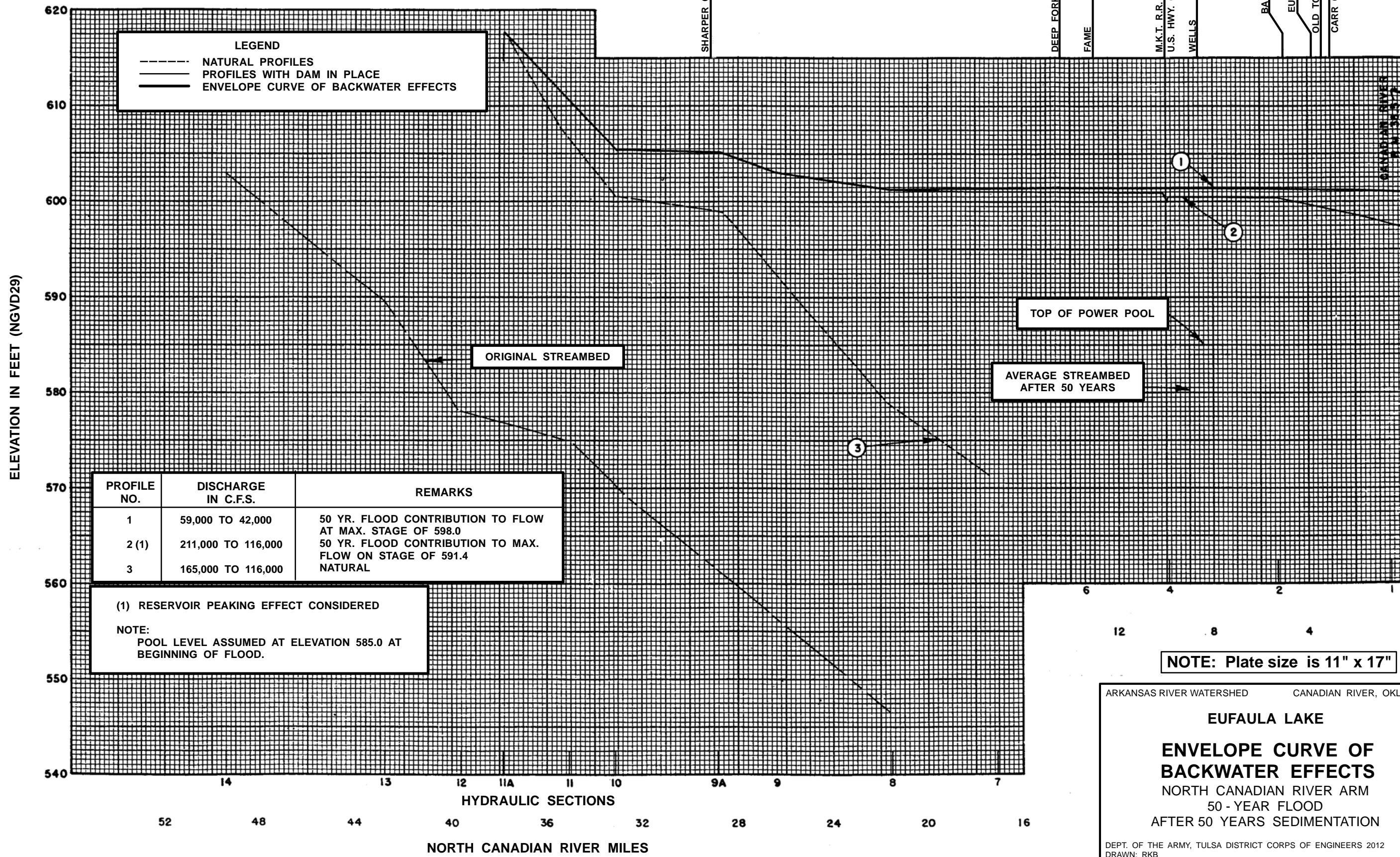
ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

ENVELOPE CURVE OF BACKWATER EFFECTS

CANADIAN RIVER ARM
50 - YEAR FLOOD
AFTER 50 YEARS SEDIMENTATION

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL



LEGEND
 - - - - - NATURAL PROFILES
 _____ PROFILES WITH DAM IN PLACE
 _____ ENVELOPE CURVE OF BACKWATER EFFECTS

PROFILE NO.	DISCHARGE IN C.F.S.	REMARKS
1	59,000 TO 42,000	50 YR. FLOOD CONTRIBUTION TO FLOW AT MAX. STAGE OF 598.0
2 (1)	211,000 TO 116,000	50 YR. FLOOD CONTRIBUTION TO MAX. FLOW ON STAGE OF 591.4
3	165,000 TO 116,000	NATURAL

(1) RESERVOIR PEAKING EFFECT CONSIDERED
 NOTE:
 POOL LEVEL ASSUMED AT ELEVATION 585.0 AT BEGINNING OF FLOOD.

NOTE: Plate size is 11" x 17"

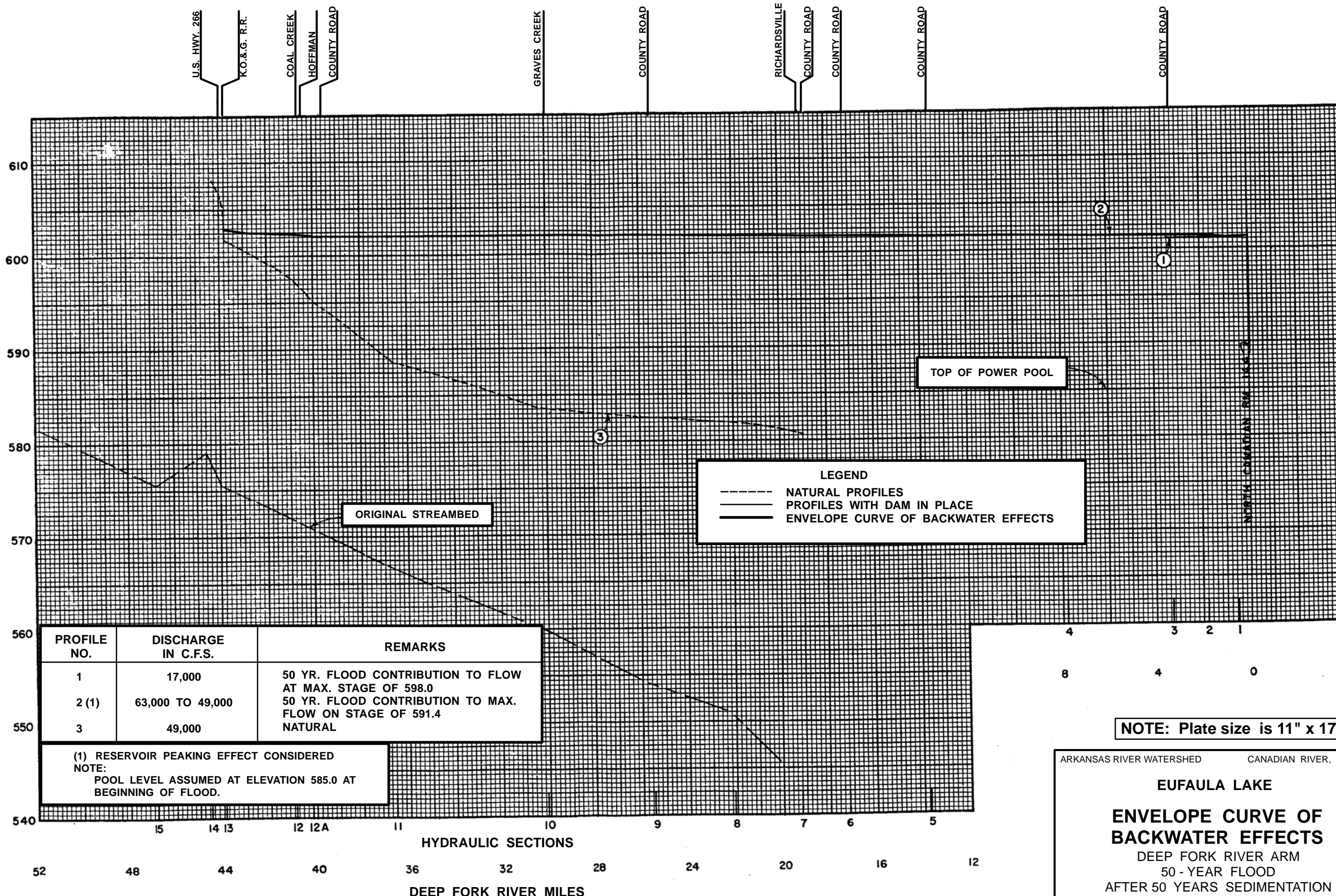
ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

ENVELOPE CURVE OF BACKWATER EFFECTS
 NORTH CANADIAN RIVER ARM
 50 - YEAR FLOOD
 AFTER 50 YEARS SEDIMENTATION

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL

ELEVATION IN FEET (NGVD29)



PROFILE NO.	DISCHARGE IN C.F.S.	REMARKS
1	17,000	50 YR. FLOOD CONTRIBUTION TO FLOW AT MAX. STAGE OF 598.0
2 (1)	63,000 TO 49,000	50 YR. FLOOD CONTRIBUTION TO MAX. FLOW ON STAGE OF 591.4
3	49,000	NATURAL

(1) RESERVOIR PEAKING EFFECT CONSIDERED
 NOTE:
 POOL LEVEL ASSUMED AT ELEVATION 585.0 AT BEGINNING OF FLOOD.

LEGEND
 - - - - - NATURAL PROFILES
 _____ PROFILES WITH DAM IN PLACE
 _____ ENVELOPE CURVE OF BACKWATER EFFECTS

NOTE: Plate size is 11" x 17"

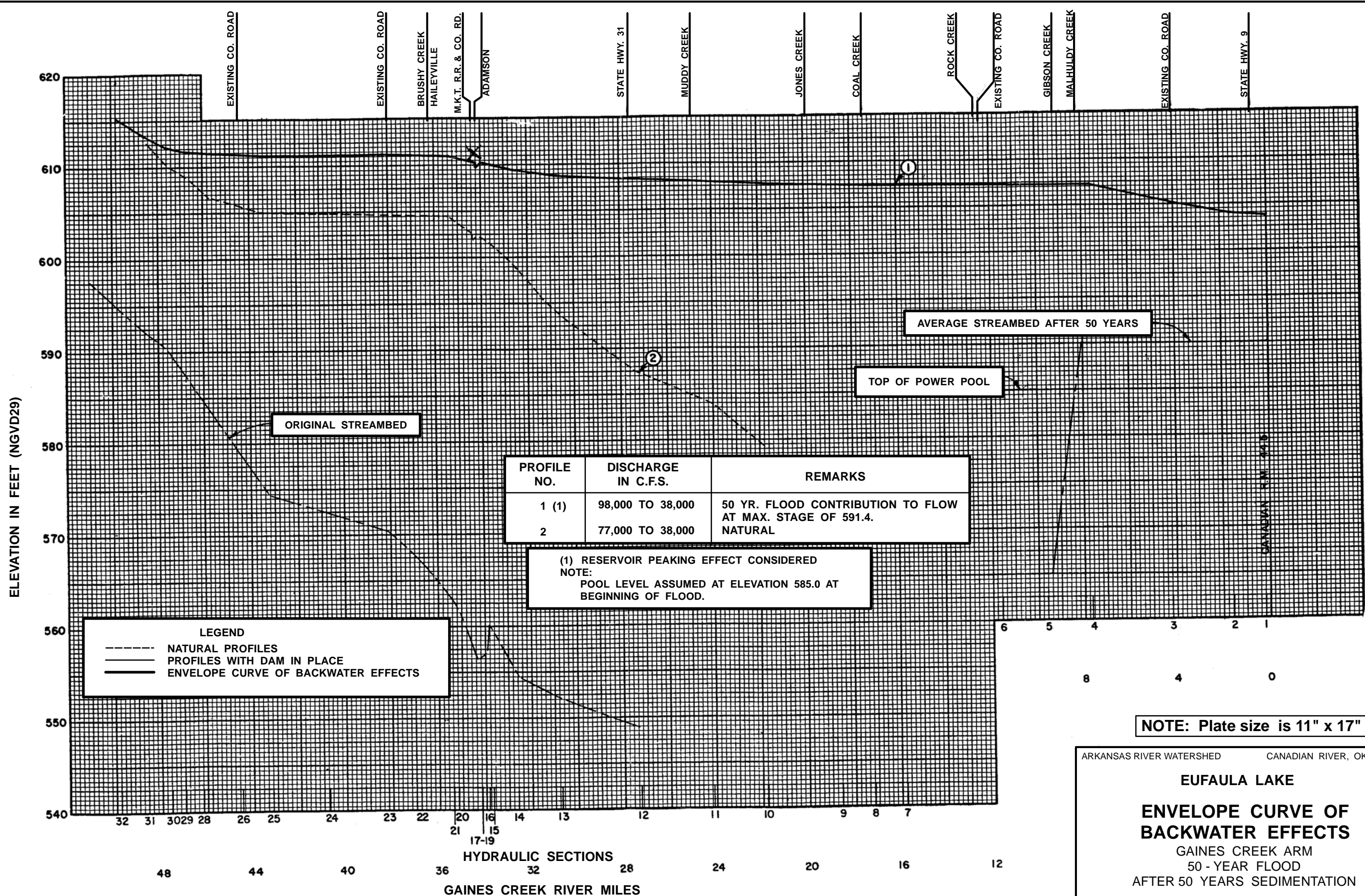
ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

ENVELOPE CURVE OF BACKWATER EFFECTS

DEEP FORK RIVER ARM
 50 - YEAR FLOOD
 AFTER 50 YEARS SEDIMENTATION

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL



NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

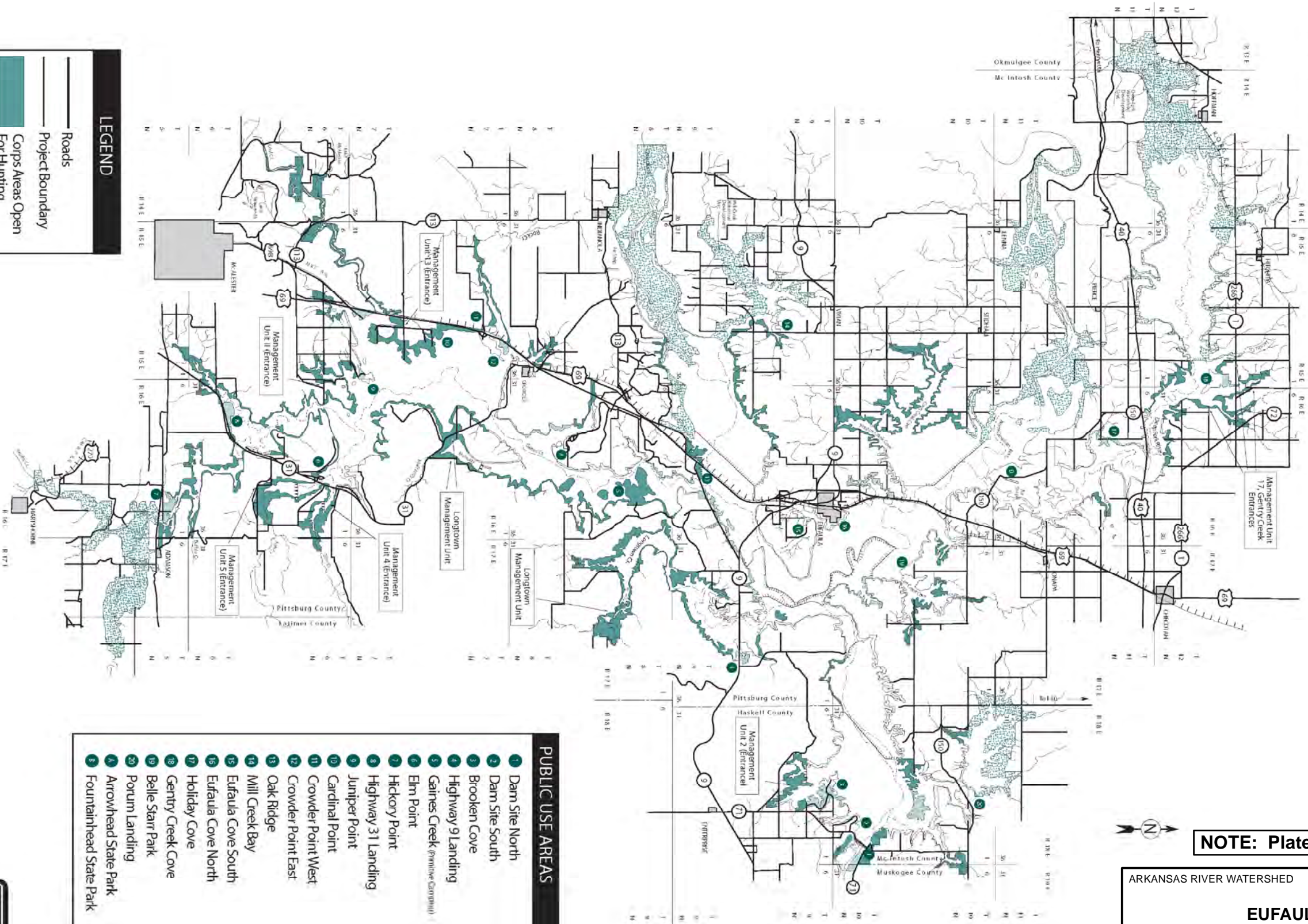
ENVELOPE CURVE OF BACKWATER EFFECTS

GAINES CREEK ARM
50 - YEAR FLOOD
AFTER 50 YEARS SEDIMENTATION

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL

EUFaula LAKE

PUBLIC HUNTING AREA



LEGEND

- Roads
- Project Boundary
- Corps Areas Open For Hunting
- State Areas Open For Hunting
- See Restrictions

- PUBLIC USE AREAS**
- 1 Dam Site North
 - 2 Dam Site South
 - 3 Brooken Cove
 - 4 Highway 9 Landing
 - 5 Gaines Creek (Primitive Campsite)
 - 6 Elm Point
 - 7 Hickory Point
 - 8 Highway 31 Landing
 - 9 Juniper Point
 - 10 Cardinal Point
 - 11 Crowder Point West
 - 12 Crowder Point East
 - 13 Oak Ridge
 - 14 Mill Creek Bay
 - 15 Eufula Cove South
 - 16 Eufula Cove North
 - 17 Holiday Cove
 - 18 Gentry Creek Cove
 - 19 Belle Starr Park
 - 20 Porum Landing
 - A Arrowhead State Park
 - B Fountainhead State Park

NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

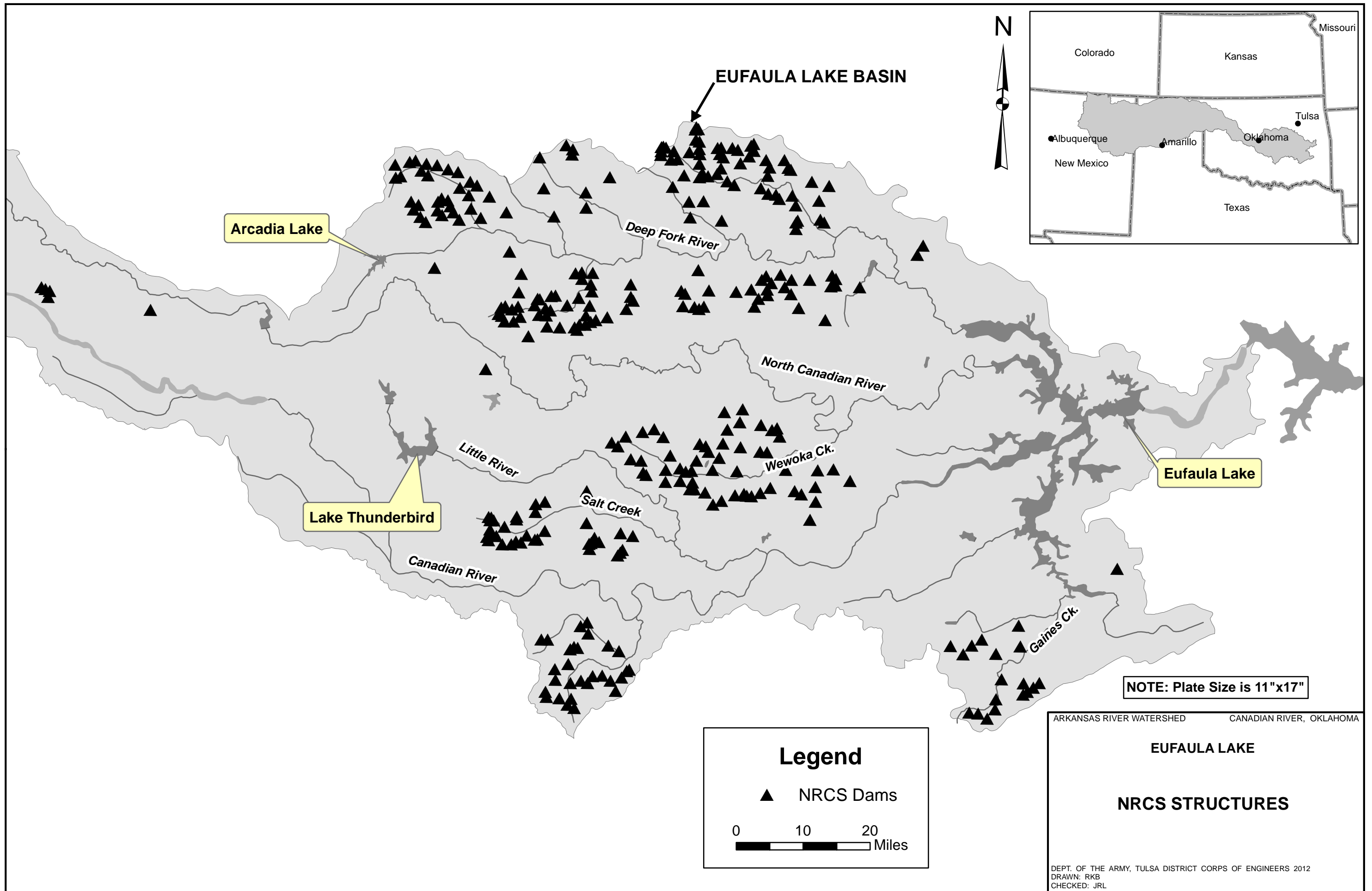
EUFaula LAKE PUBLIC USE AREAS

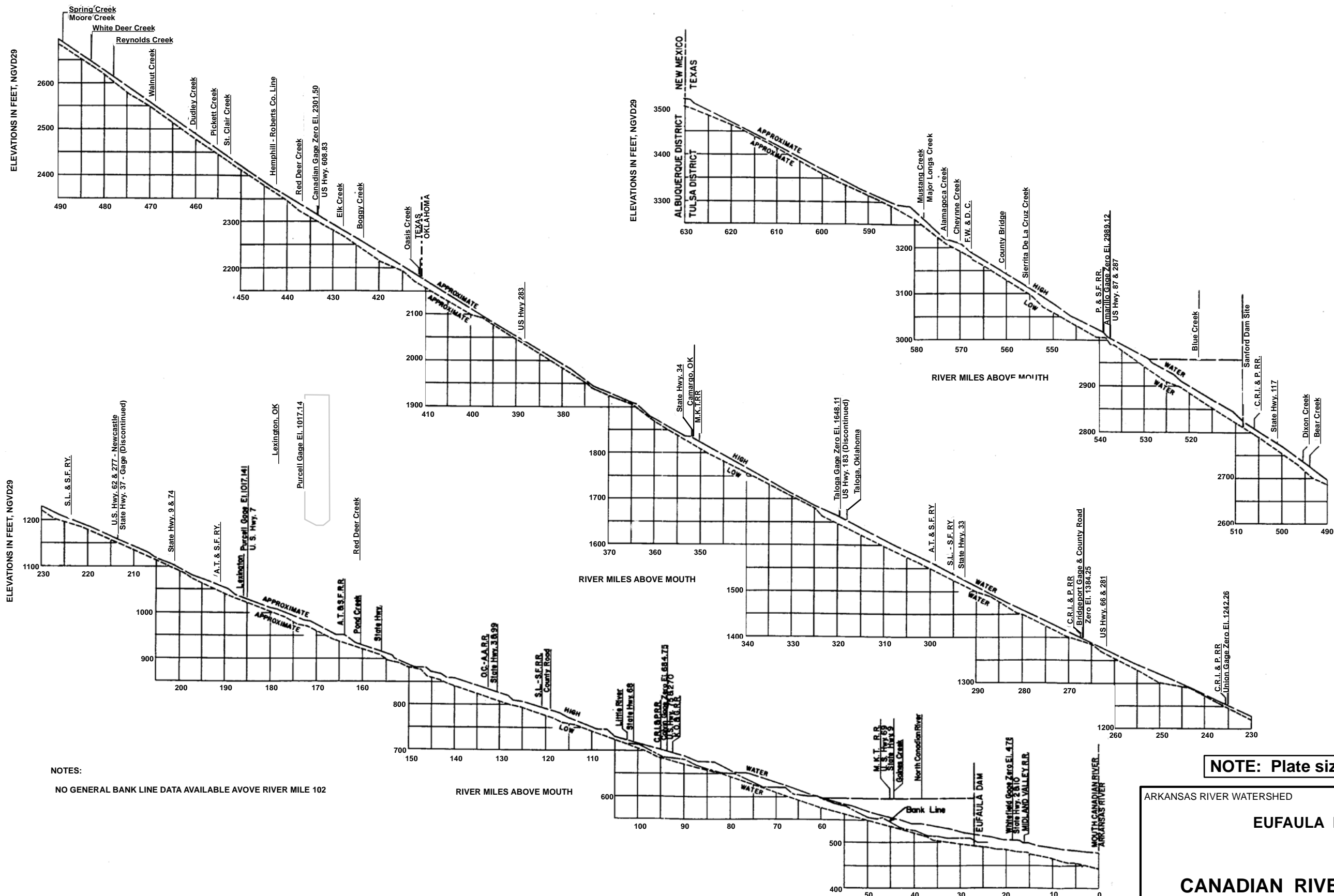
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL

2011

RESERVOIR DATA
Top of conservation pool El. 585
600 Shoreline miles at El. 585
Total project land & water acreage 164868







NOTES:
NO GENERAL BANK LINE DATA AVAILABLE ABOVE RIVER MILE 102

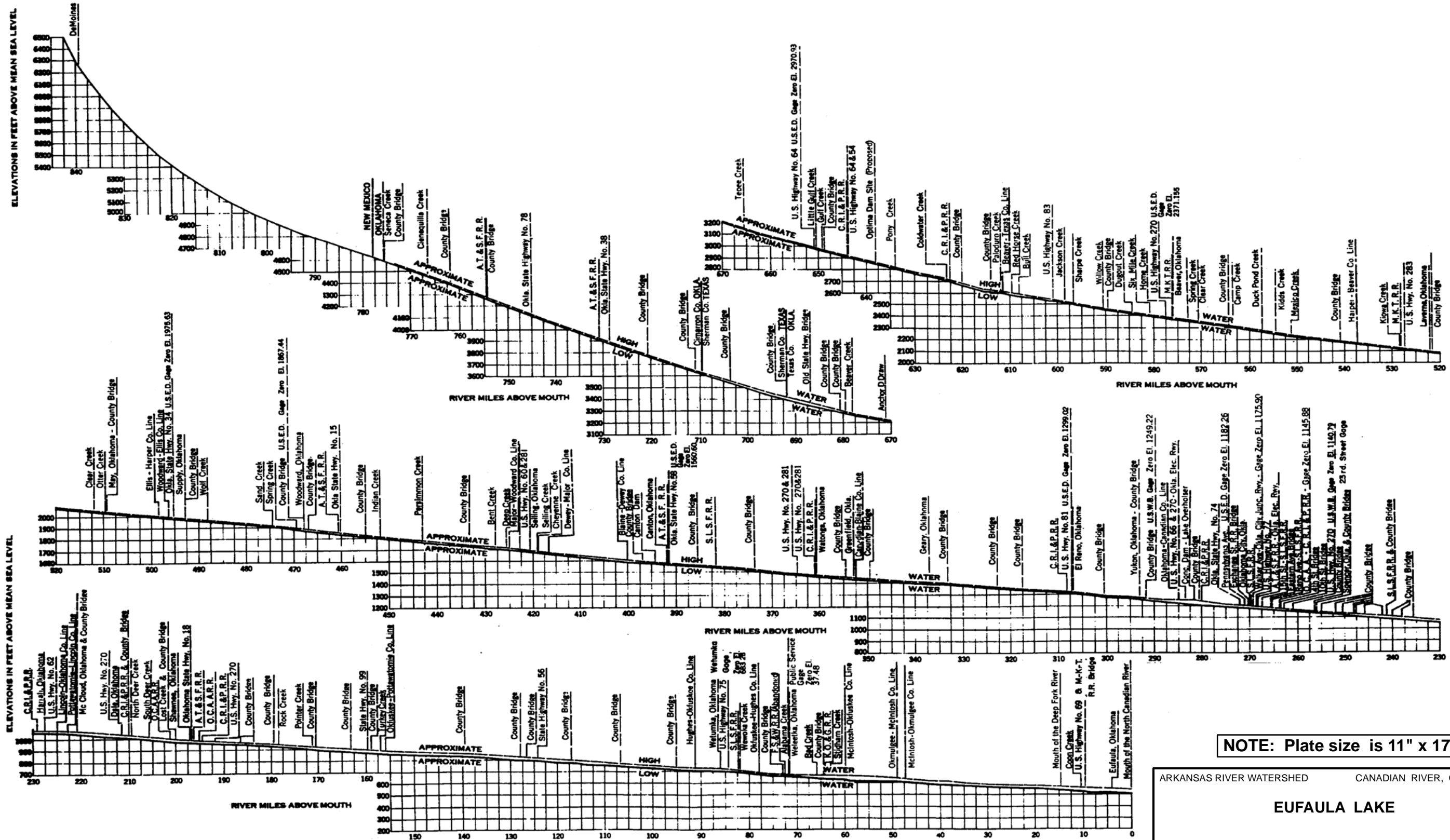
NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

CANADIAN RIVER PROFILES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL



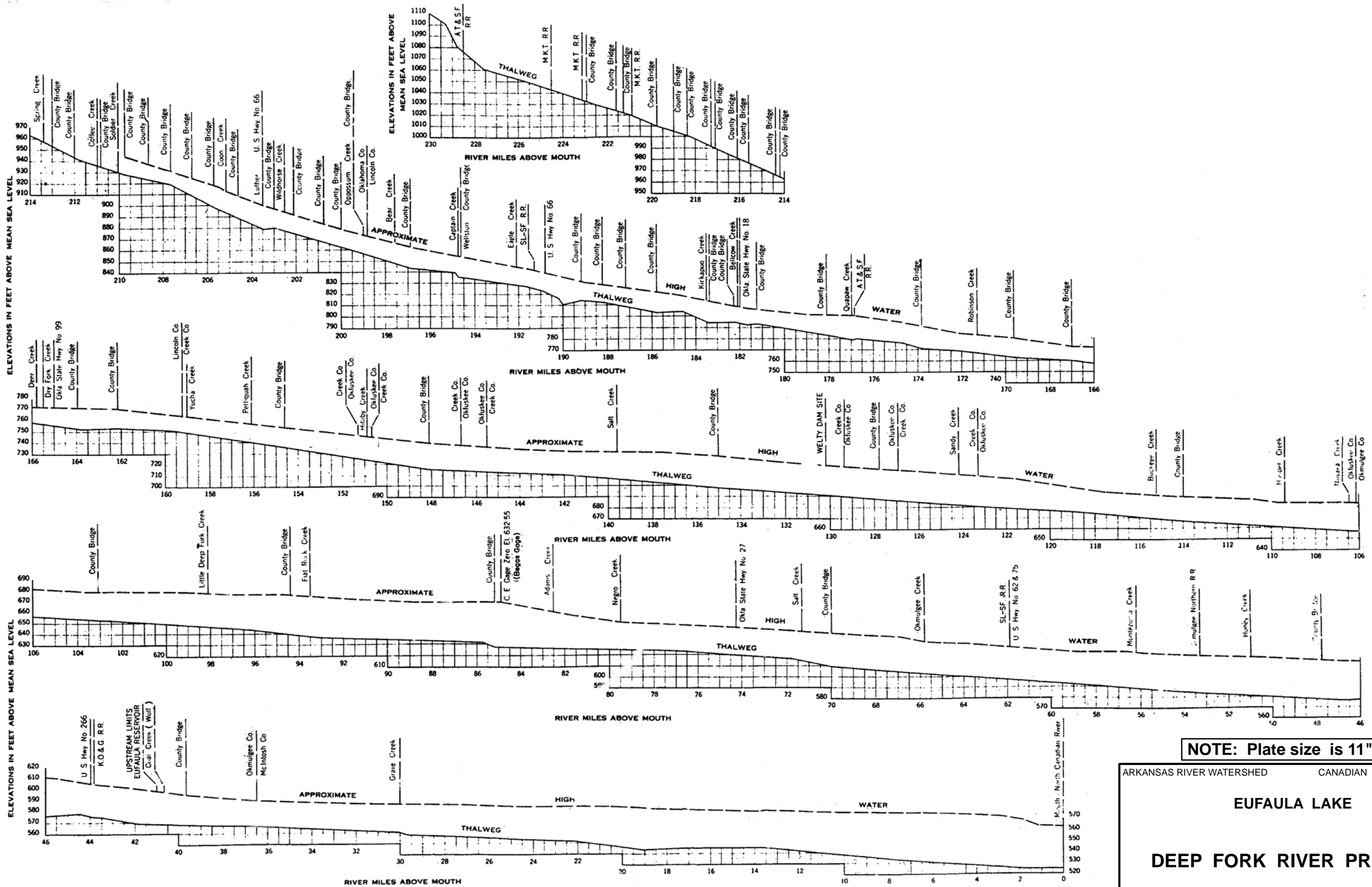
NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFALA LAKE

NORTH CANADIAN RIVER PROFILES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL



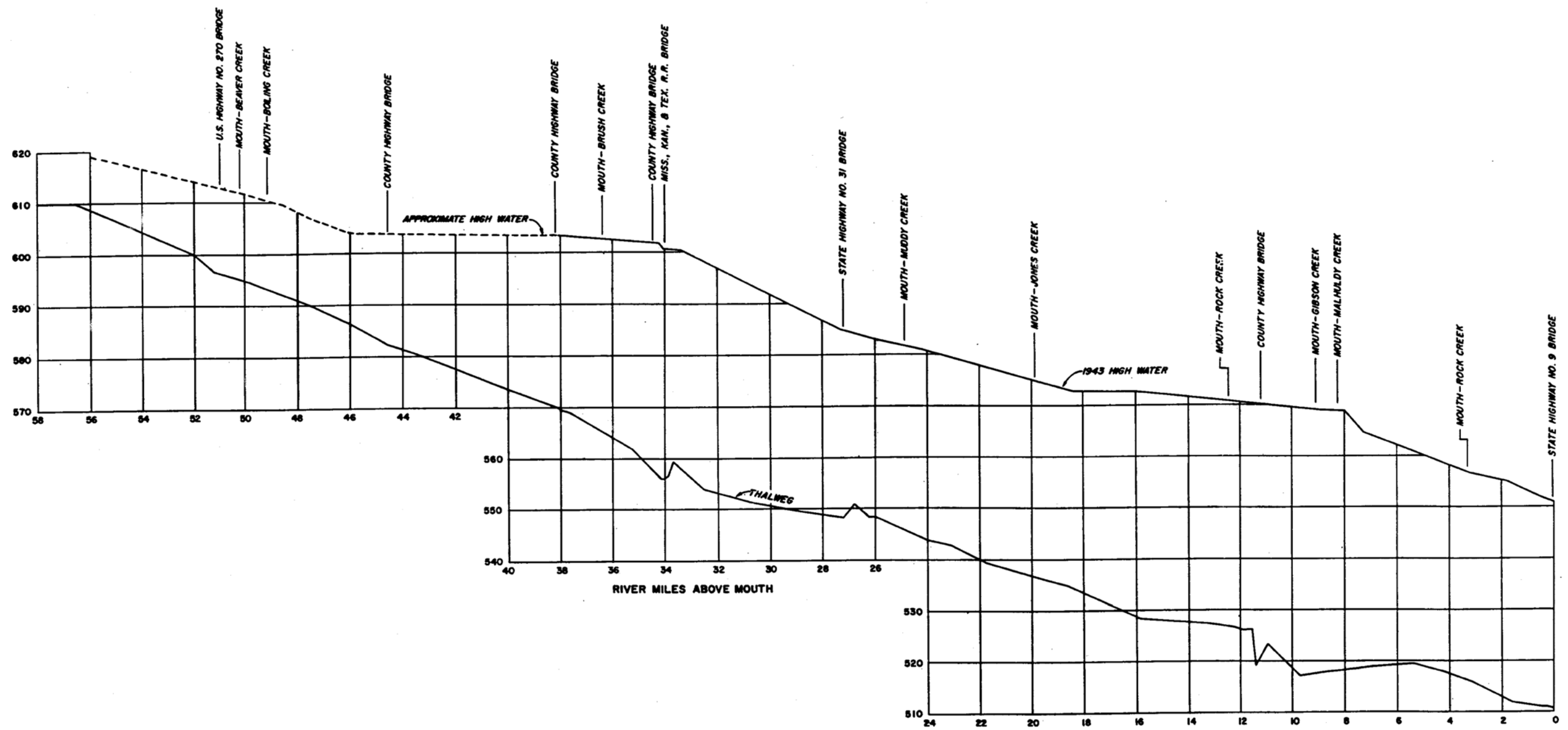
NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

DEEP FORK RIVER PROFILES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL



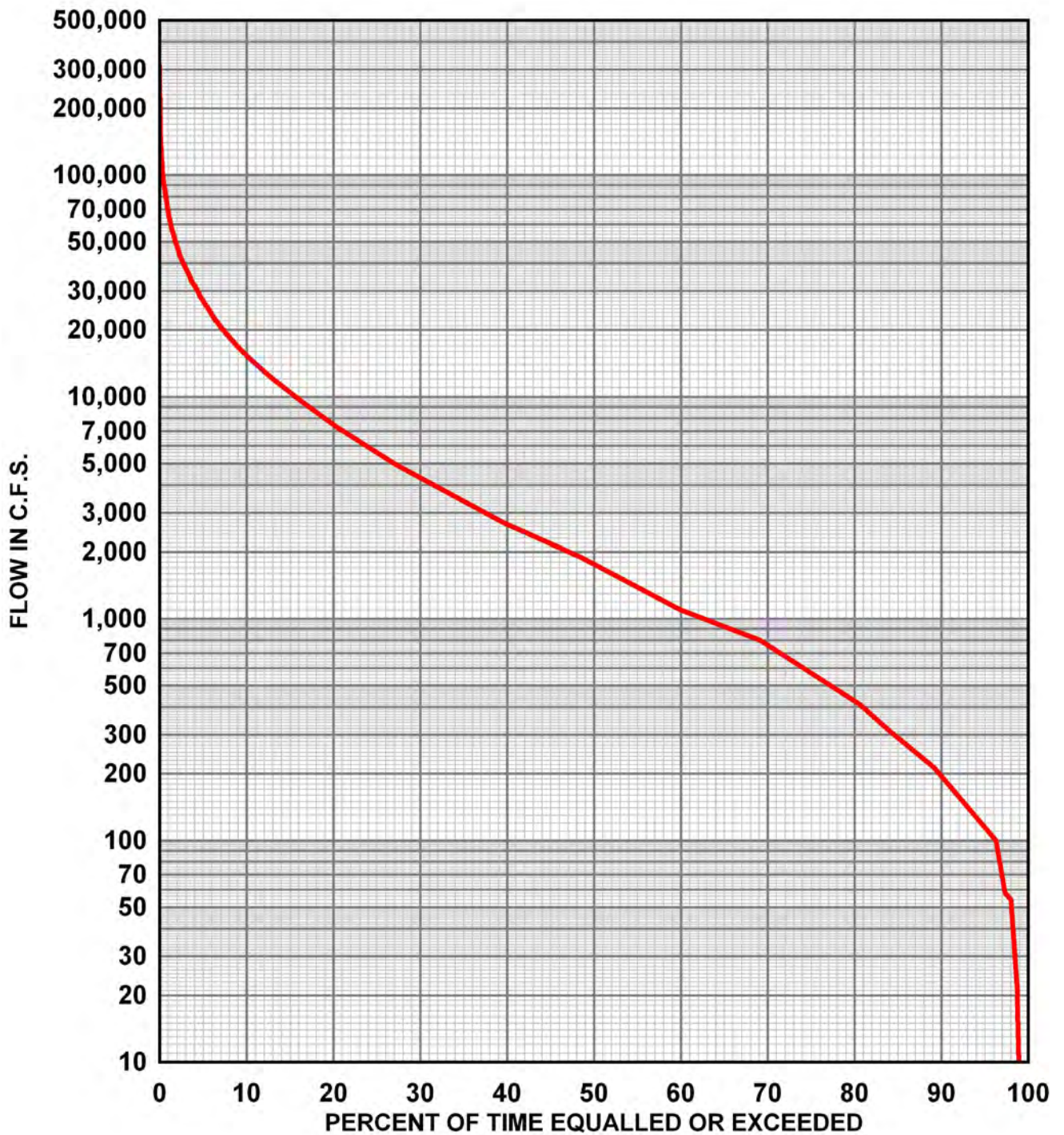
NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

GAINES CREEK PROFILE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL



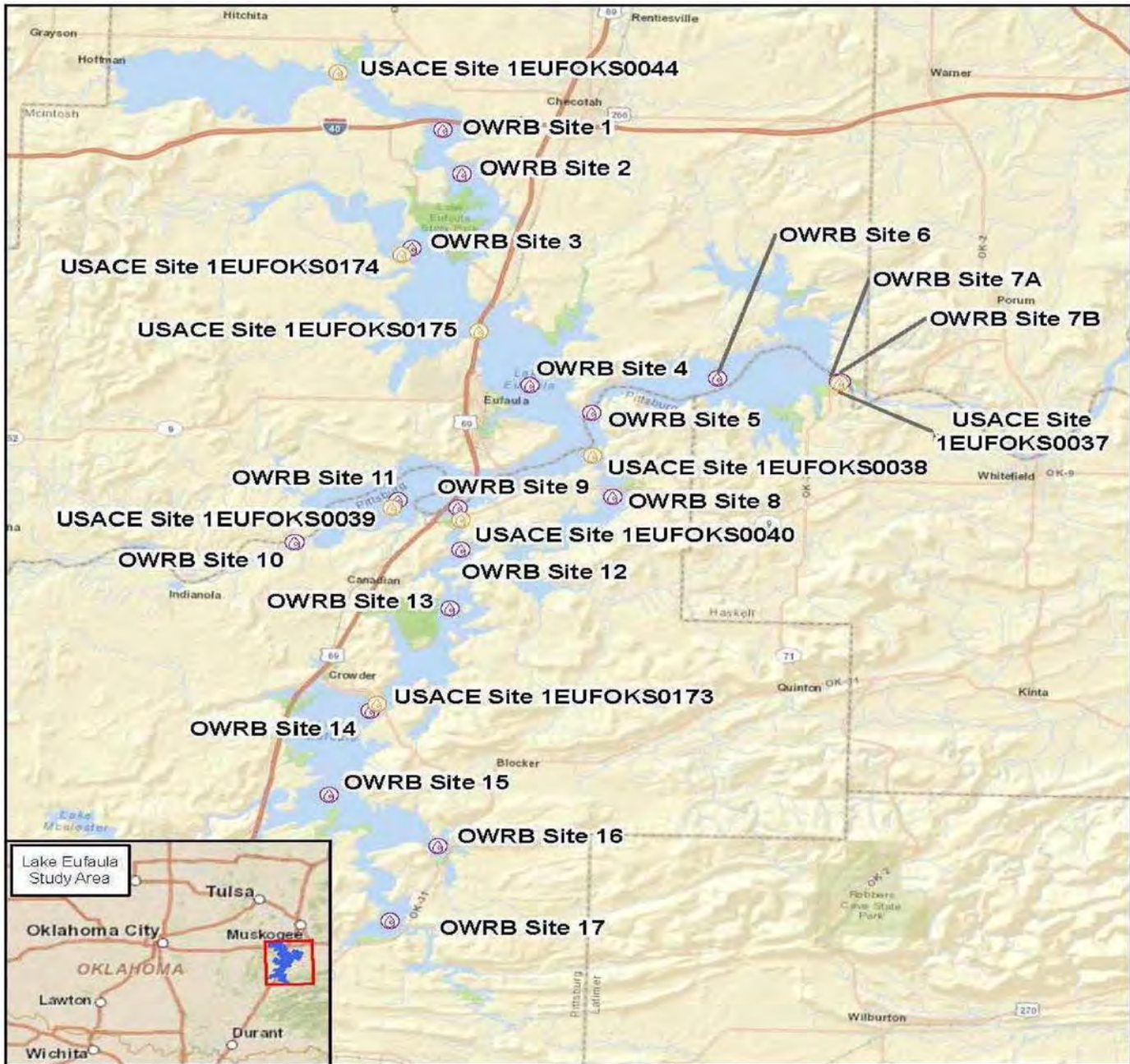
NOTE:
 CURVE IS BASED ON PERIOD
 OF RECORD JAN 1940 THRU
 JAN 2009 AND FROM RIVERWARE
 COMPUTER RUN

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA



EUFAULA LAKE

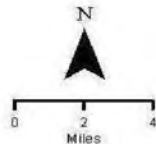
INFLOW DURATION CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL



Legend

-  USACE Water Quality Sites
-  OWRB Water Quality Sites



U.S. Army Corps of Engineers
 Tulsa District
 Lake Eufaula SMP & EIS
 Water Quality Sites
Updated: October 18, 2012

Basemap Source: ESRI World Street Map

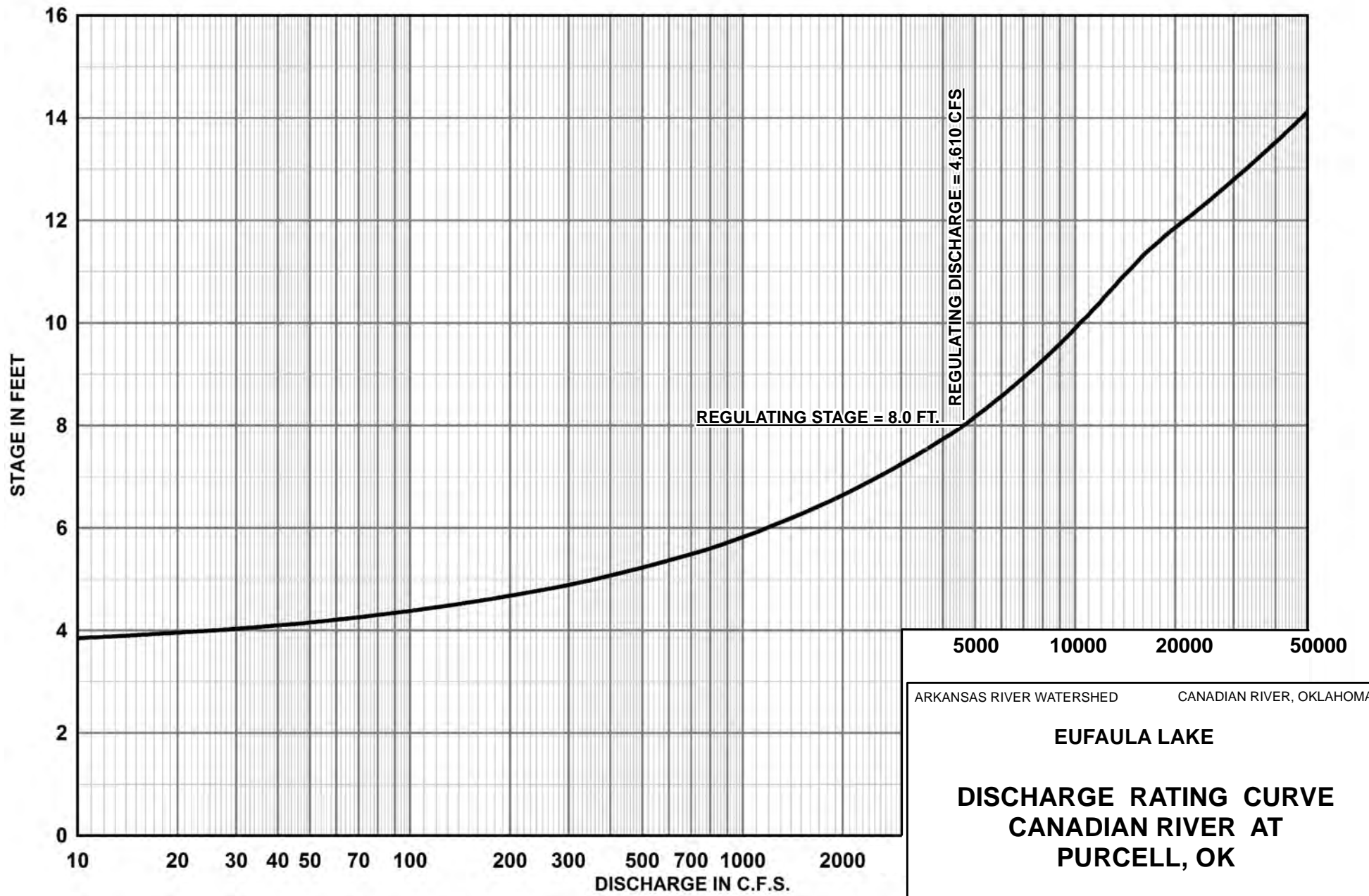
ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFULA LAKE

OWRB & USACE

SAMPLING LOCATIONS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL

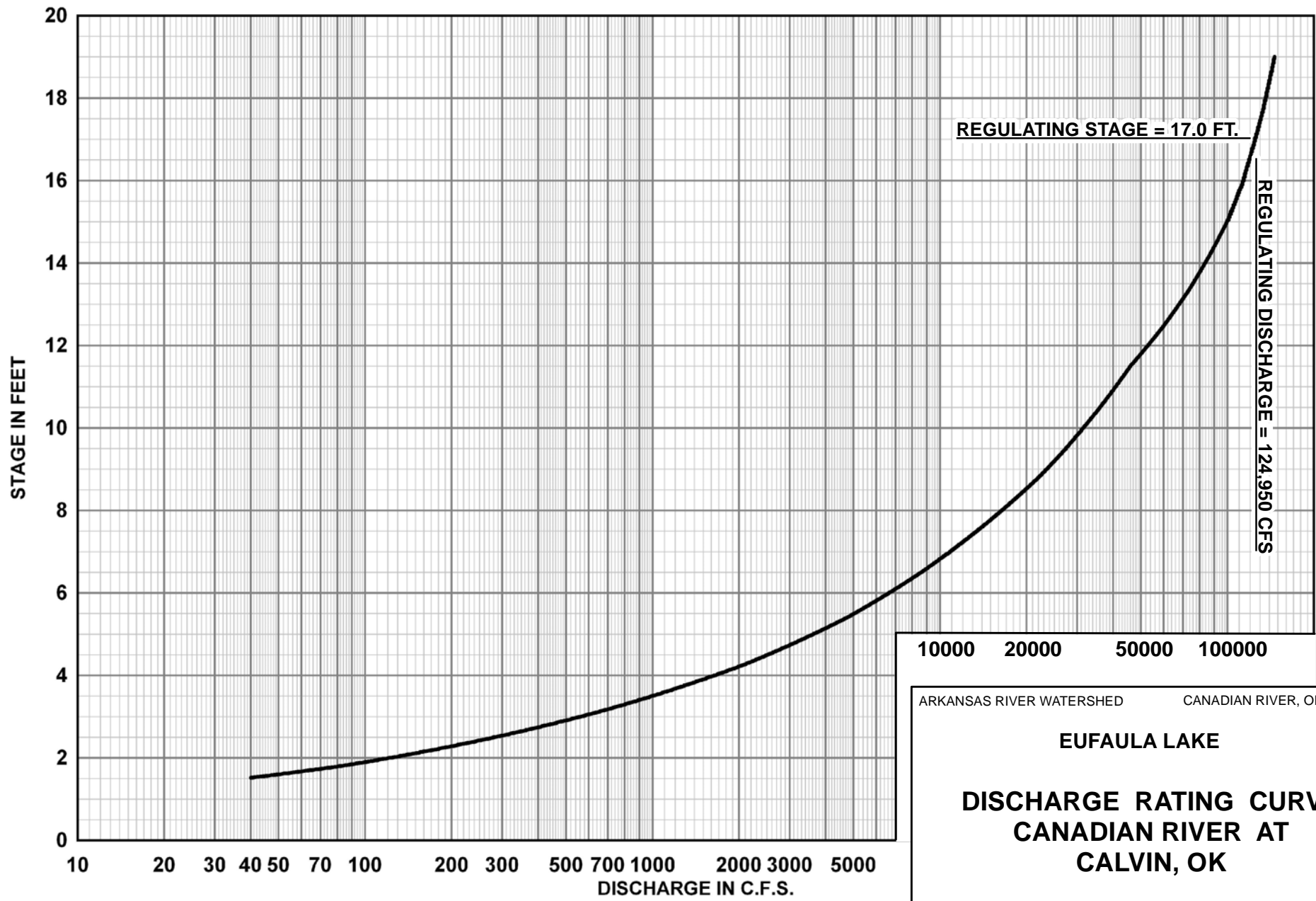


ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**DISCHARGE RATING CURVE
CANADIAN RIVER AT
PURCELL, OK**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL



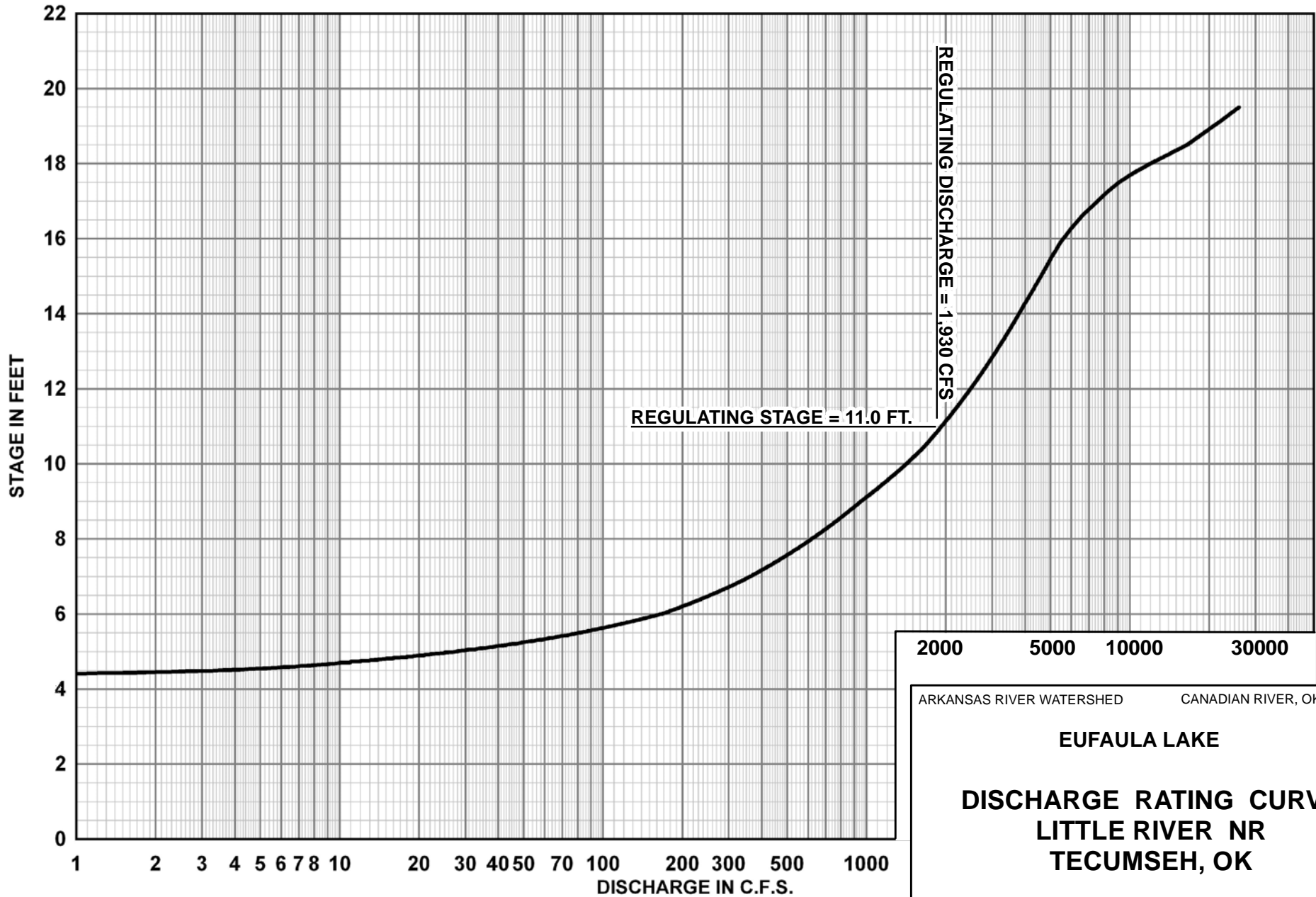
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ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**DISCHARGE RATING CURVE
CANADIAN RIVER AT
CALVIN, OK**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL



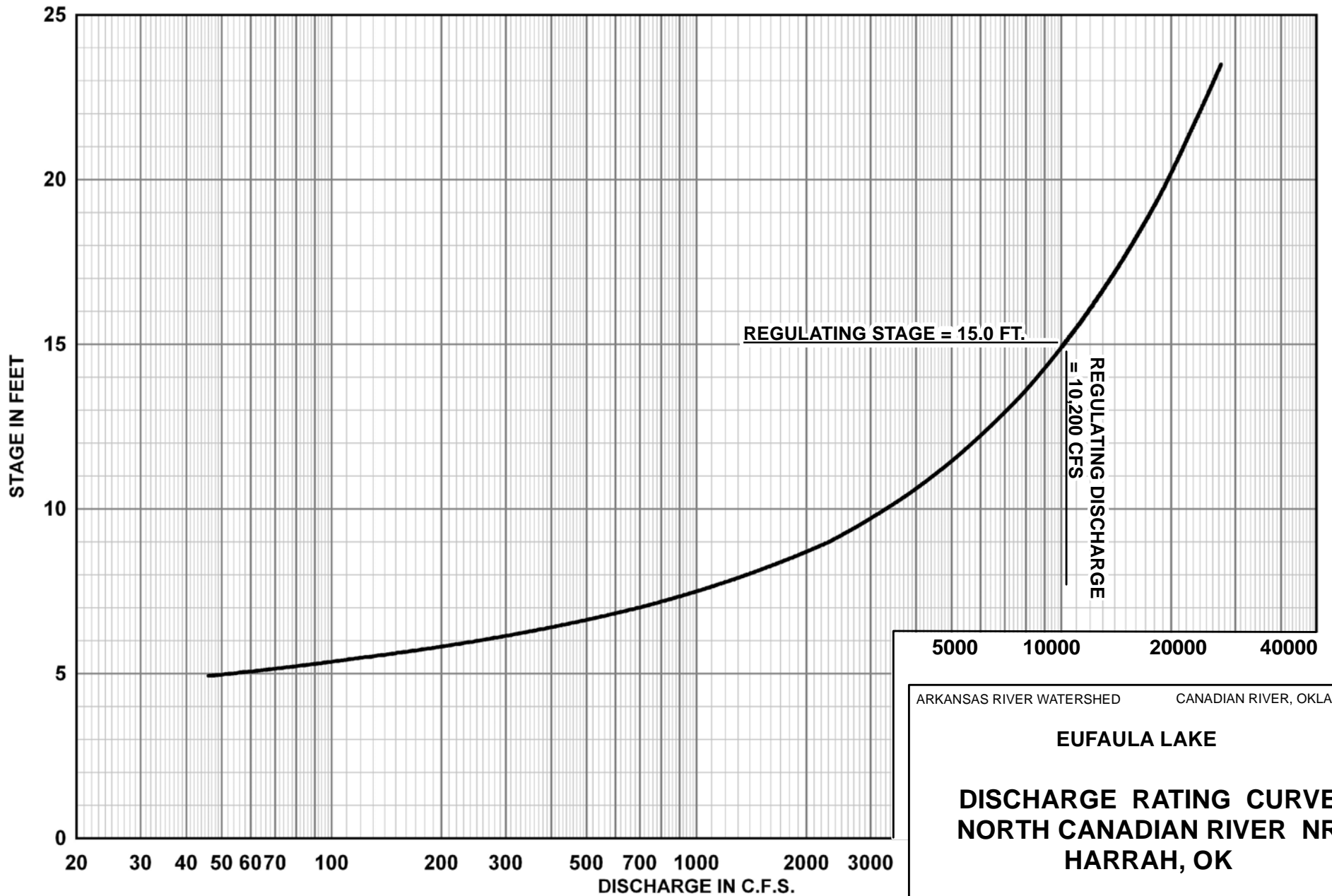
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ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFULA LAKE

**DISCHARGE RATING CURVE
LITTLE RIVER NR
TECUMSEH, OK**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL

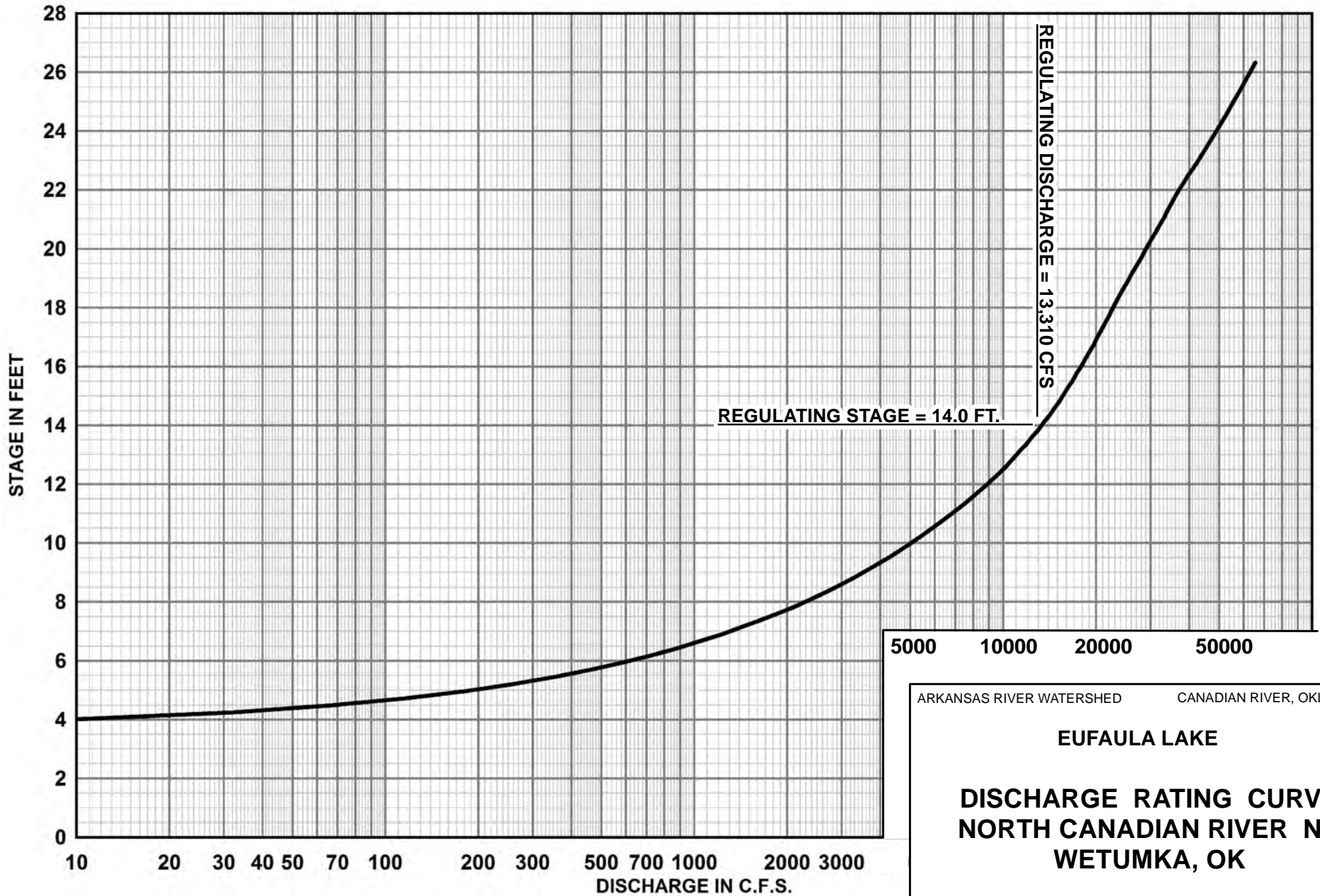


ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**DISCHARGE RATING CURVE
NORTH CANADIAN RIVER NR
HARRAH, OK**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL

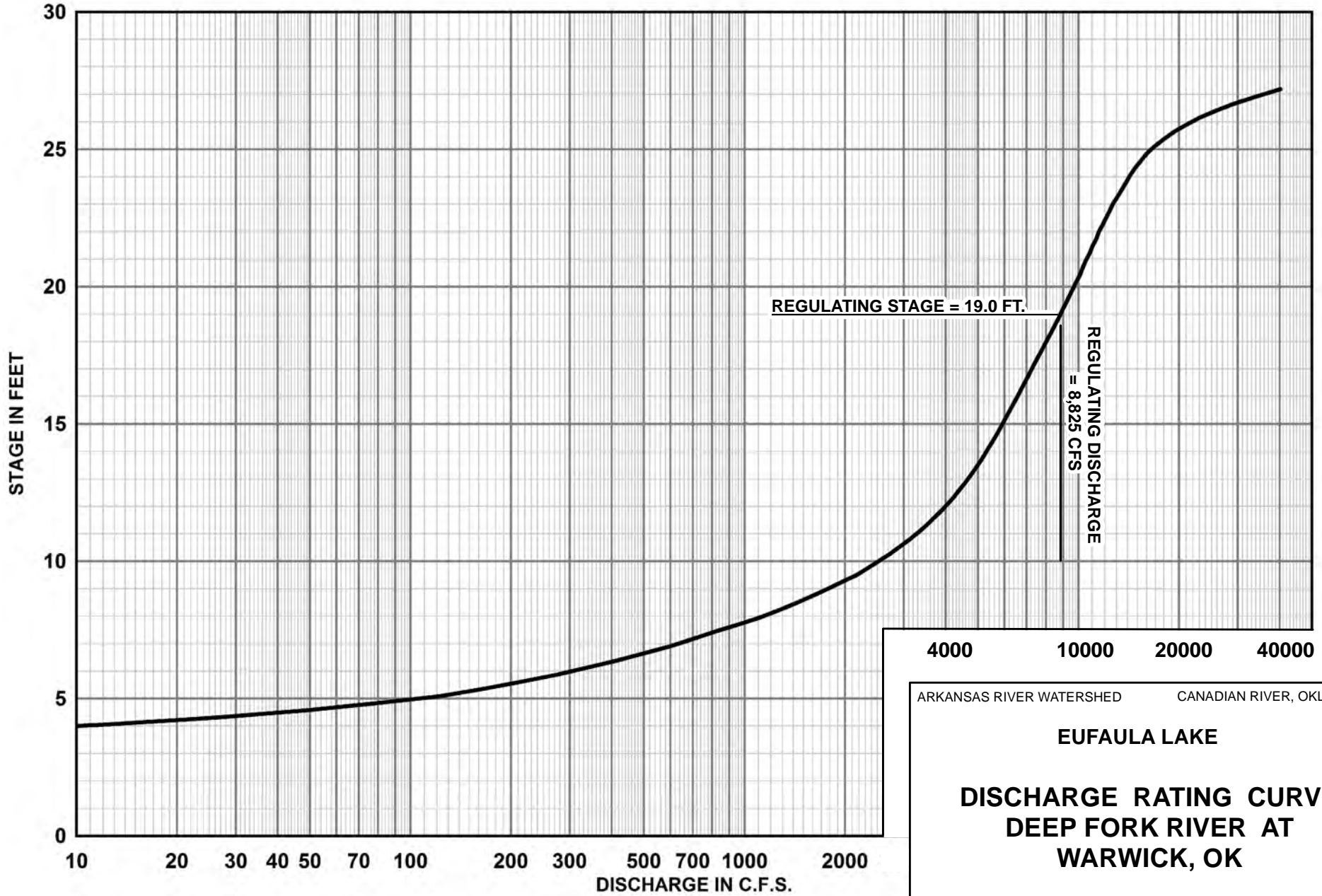


ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**DISCHARGE RATING CURVE
NORTH CANADIAN RIVER NR
WETUMKA, OK**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL



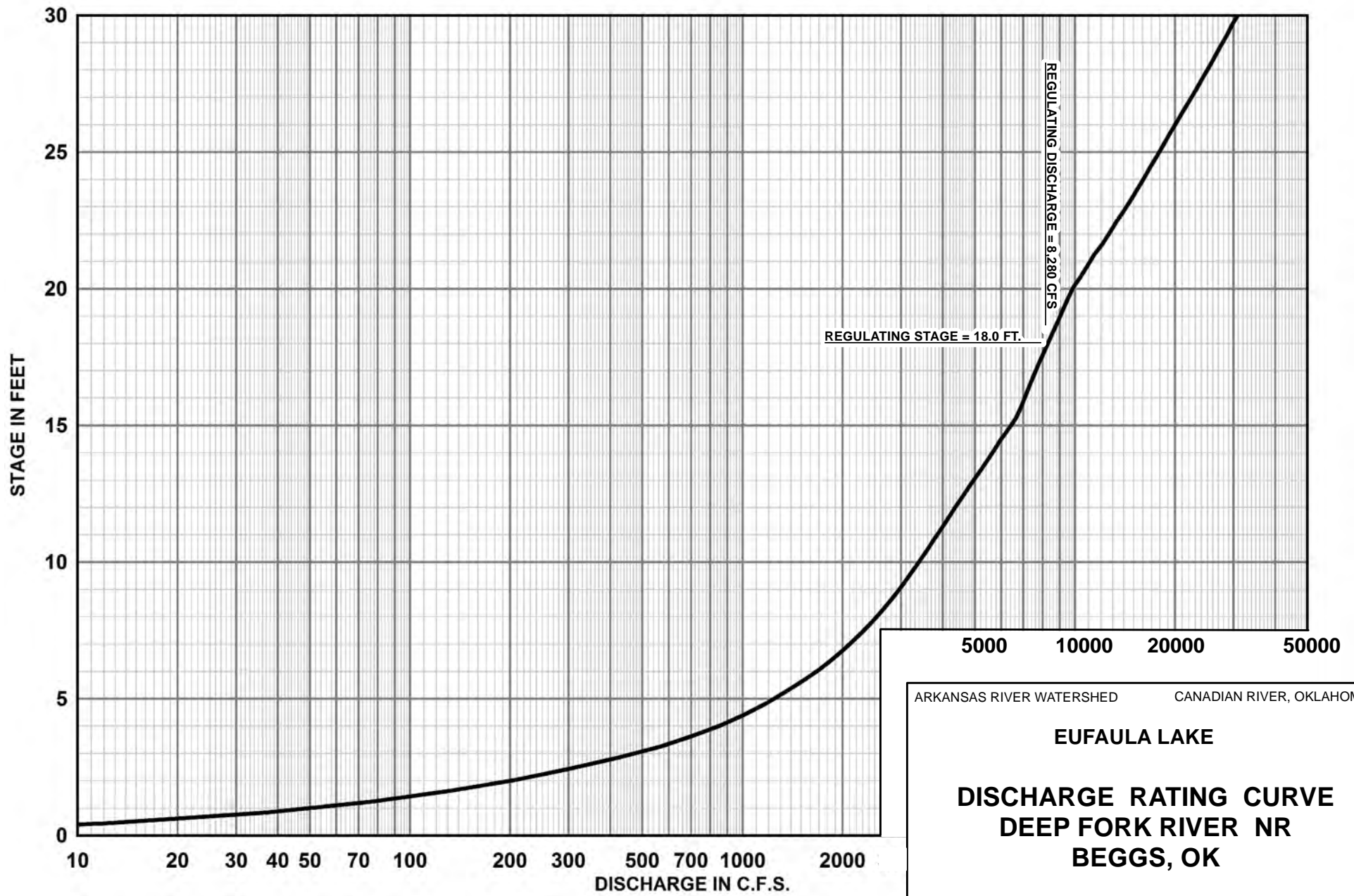
4000 10000 20000 40000

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**DISCHARGE RATING CURVE
DEEP FORK RIVER AT
WARWICK, OK**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL

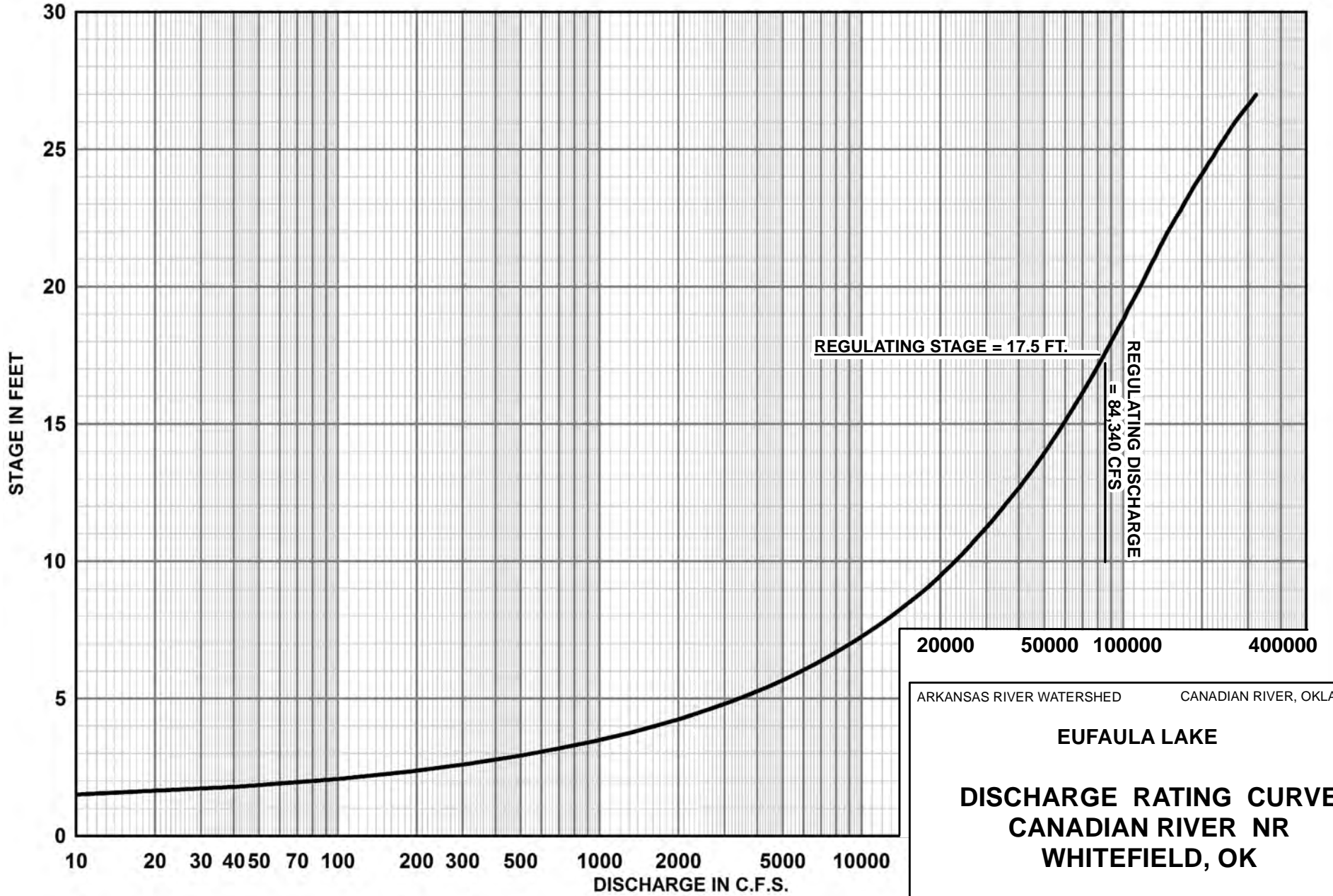


ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**DISCHARGE RATING CURVE
DEEP FORK RIVER NR
BEGGS, OK**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL

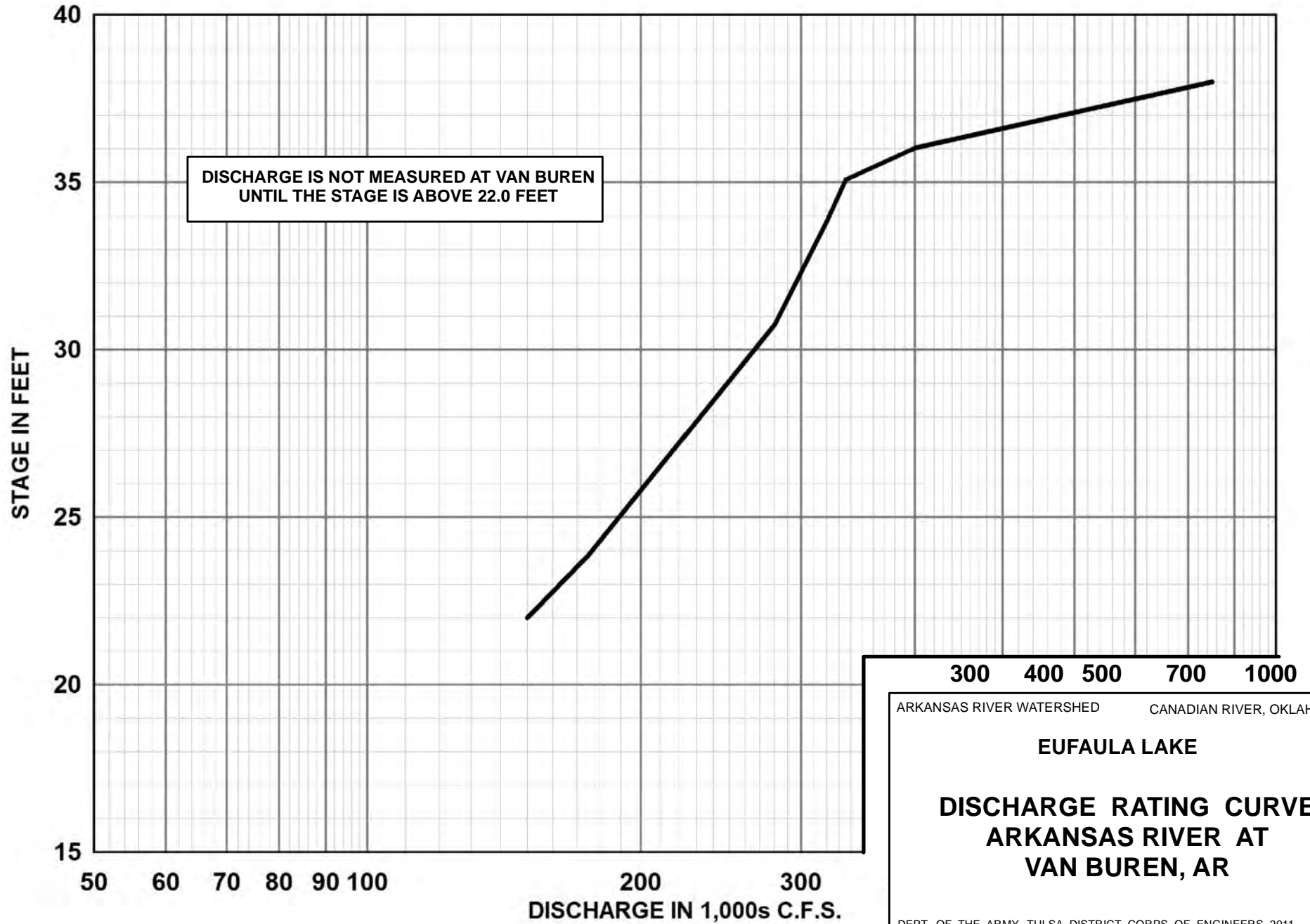


ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFULA LAKE

**DISCHARGE RATING CURVE
CANADIAN RIVER NR
WHITEFIELD, OK**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL

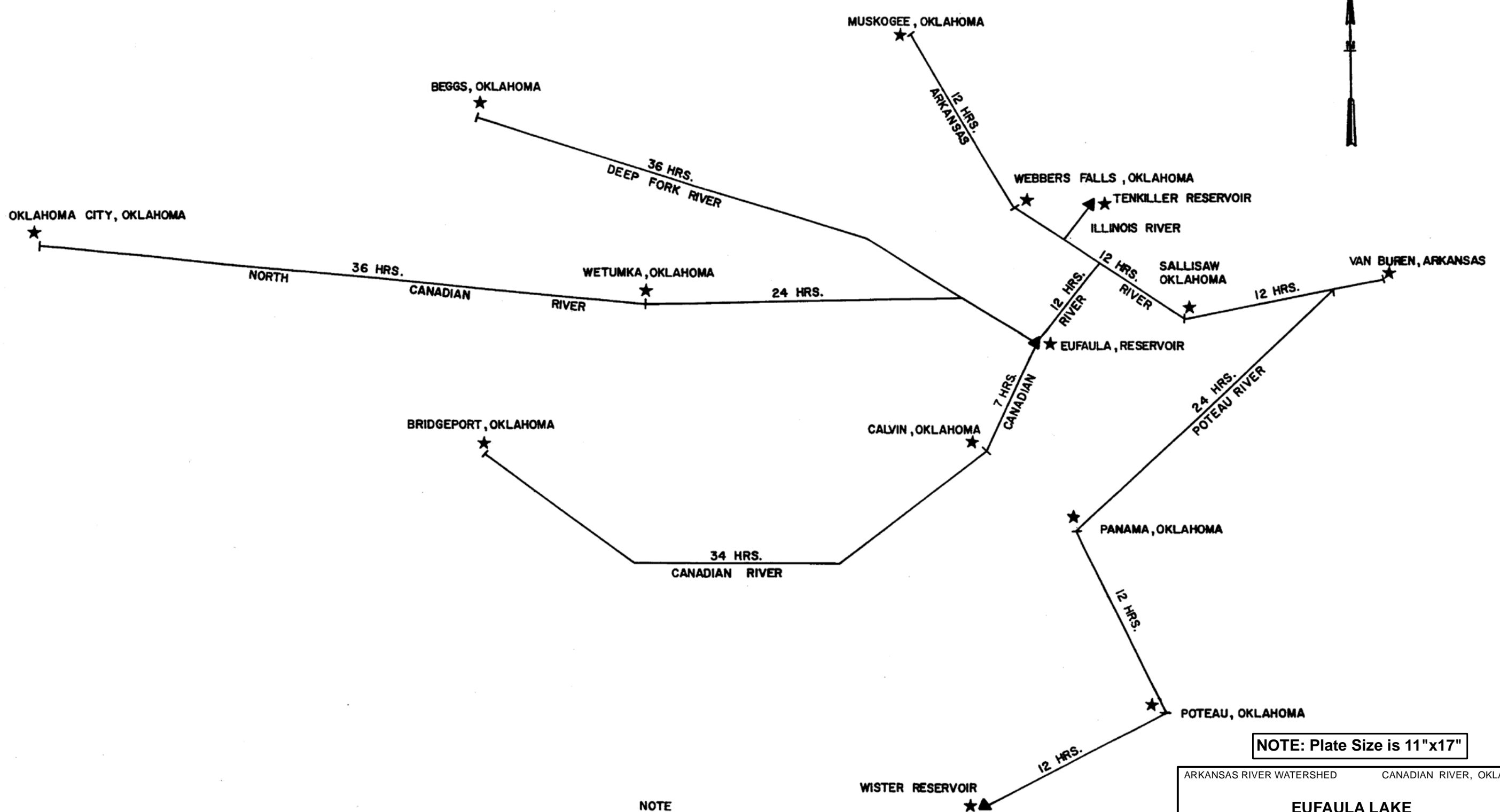


ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**DISCHARGE RATING CURVE
ARKANSAS RIVER AT
VAN BUREN, AR**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL



NOTE
 I. TIME OF TRAVEL IN HOURS FOR
 LARGE RISES IS SHOWN:
 ★ — 24 — ★

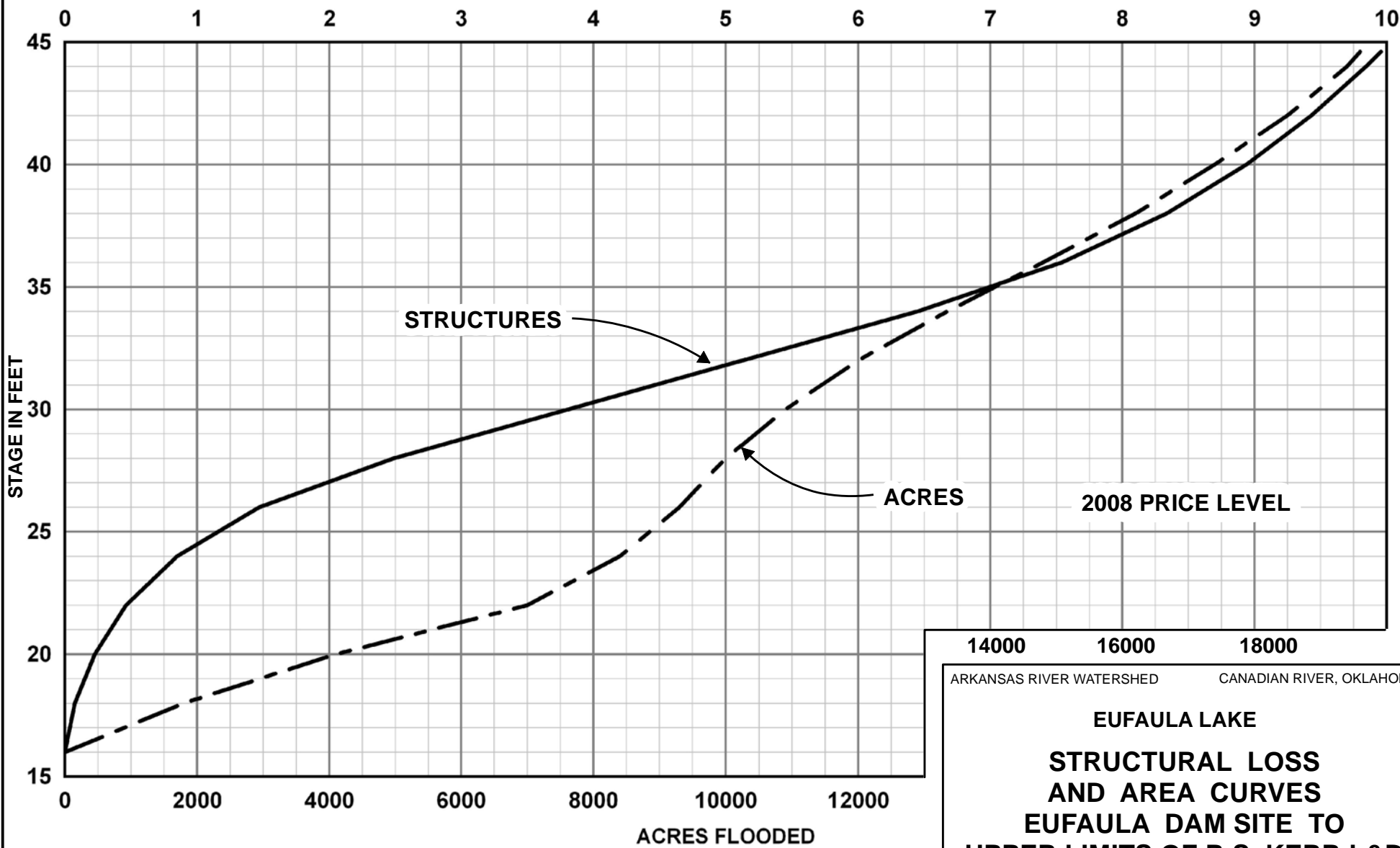
NOTE: Plate Size is 11"x17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE
 CREST TRAVEL TIME

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL

STRUCTURAL LOSSES IN MILLIONS \$



14000 16000 18000

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

STRUCTURAL LOSS

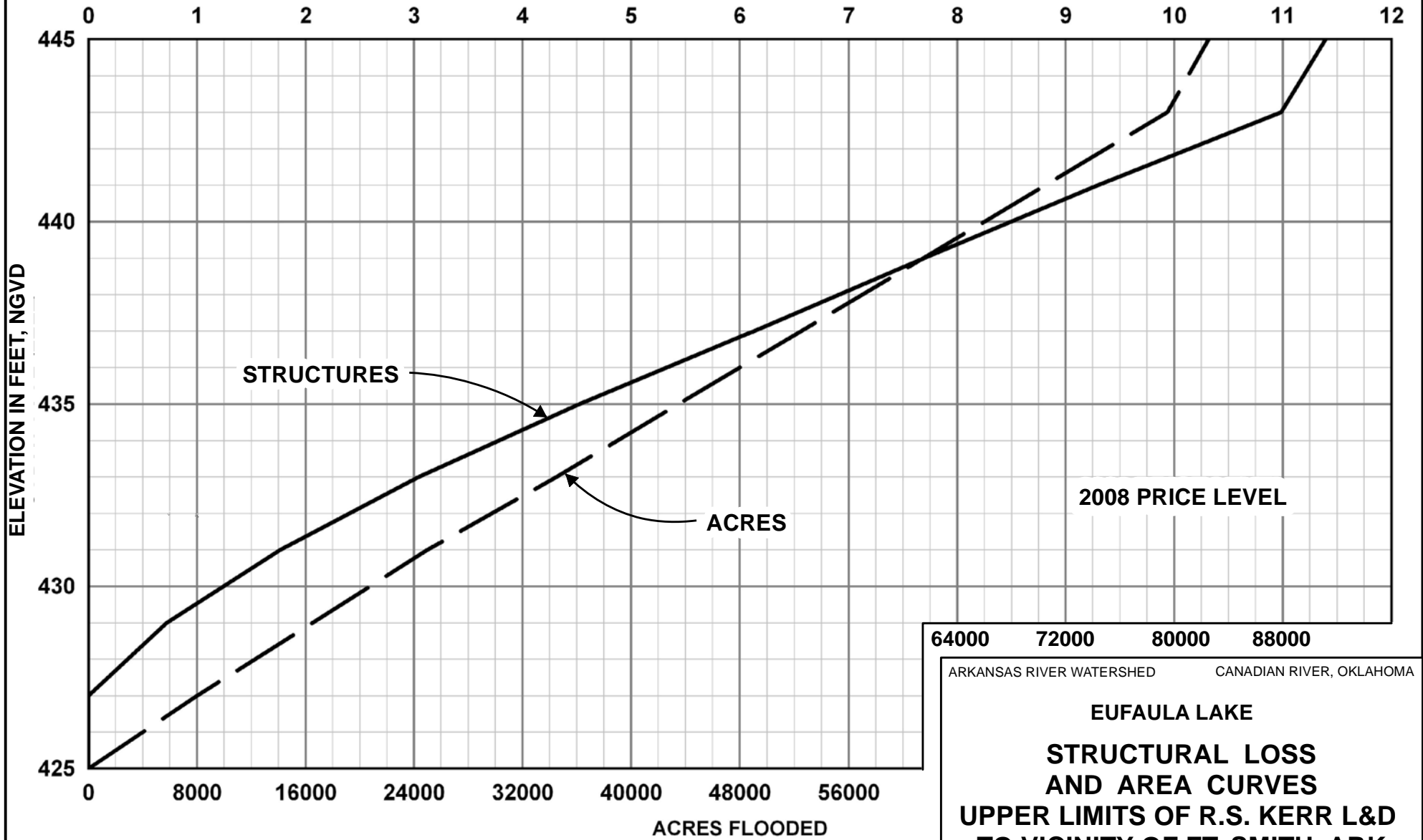
AND AREA CURVES

EUFAULA DAM SITE TO

UPPER LIMITS OF R.S. KERR L&D

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL

STRUCTURAL LOSSES IN MILLIONS \$



64000 72000 80000 88000

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

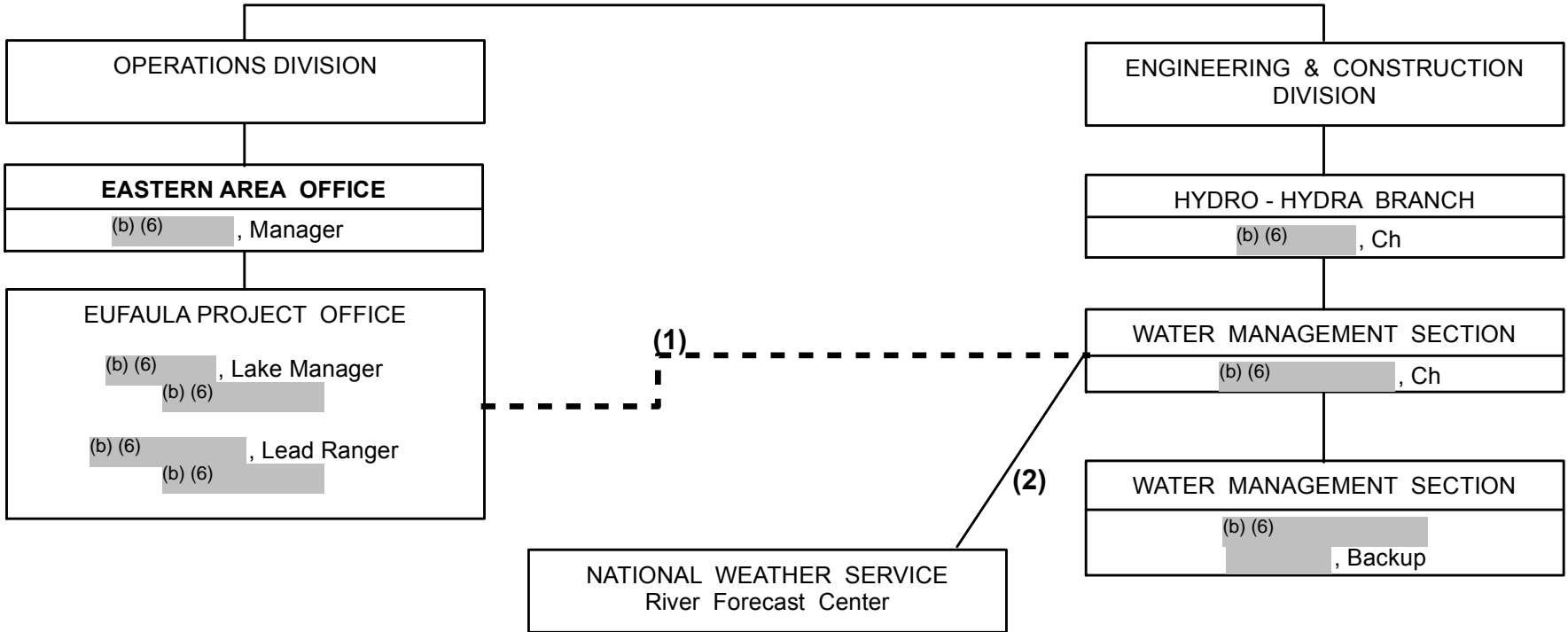
STRUCTURAL LOSS AND AREA CURVES

UPPER LIMITS OF R.S. KERR L&D TO VICINITY OF FT. SMITH, ARK

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL

**U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT**

DISTRICT ENGINEER



1. DIRECT COMMUNICATIONS ARE MAINTAINED BETWEEN EUFAULA PROJECT OFFICE AND THE WATER MANAGEMENT SECTION FOR TRANSMISSION OF RESERVOIR DATA, REGULATIONS AND INSTRUCTIONS.
2. PRECIPITATION AND STREAM GAGE DATA ARE SHARED BY THE NATIONAL WEATHER SERVICE, RIVER FORECAST CENTER.

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**ORGANIZATION FOR
FLOOD CONTROL REGULATION**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL

PROJECT **EUFAULA**

LAKE DATA

DATE :

LINE #	ITEM	TIME												
1	POOL ELEVATION	12N												
2	POOL ELEVATION	4PM												
3	POOL ELEVATION	12M												
4	POOL ELEVATION	8AM												
5	TAILWATER ELEVATION	8AM												
6	24 HR AVG POWER DISCHARGE	12M												
7	24 HR AVG TOTAL DISCHARGE	12M												
8	NET POWER GENERATION	12M												
9	GEN#1 HRS OF USE	12M												
	GEN#2 HRS OF USE	12M												
	GEN#3 HRS OF USE	12M												
	GEN#4 HRS OF USE	12M												
10	INSTANTANEOUS POWER DISCHARGE	8AM												
11	INSTANTANEOUS TOTAL DISCHARGE	8AM												
12/13	LAKE WEATHER	8AM												
14	TOTAL PRECEDING 6 HR PRECIPITATION ENDING AT	1PM												
		7PM												
		1AM												
		7AM												
15	TOTAL 24 HOUR PRECIPITATION	7AM												
16	COMMENTS ON PRECIP. DIST.													
17	EVAPORATION 24 HOURS	8AM												
18/19	WIND DIRECTION AND VELOCITY	8AM		B-		B-		B-		B-		B-		B-
20	WATER SUPPLY													
21	GATE SETTINGS NO. TYPE AND OPENING	8AM												
22	GATE CHANGES	DATE TIME												
23	POOL ELEVATION													
24	FROM	GATE SETTING												
25	TO	GATE SETTING												
26	GATE CHANGES	DATE TIME												
27	POOL ELEVATION													
28	FROM	GATE SETTING												
29	TO	GATE SETTING												
30	GATE CHANGES	DATE TIME												
31	POOL ELEVATION													
32	FROM	GATE SETTING												
	TO	GATE SETTING												
33	TO	GATE SETTING												



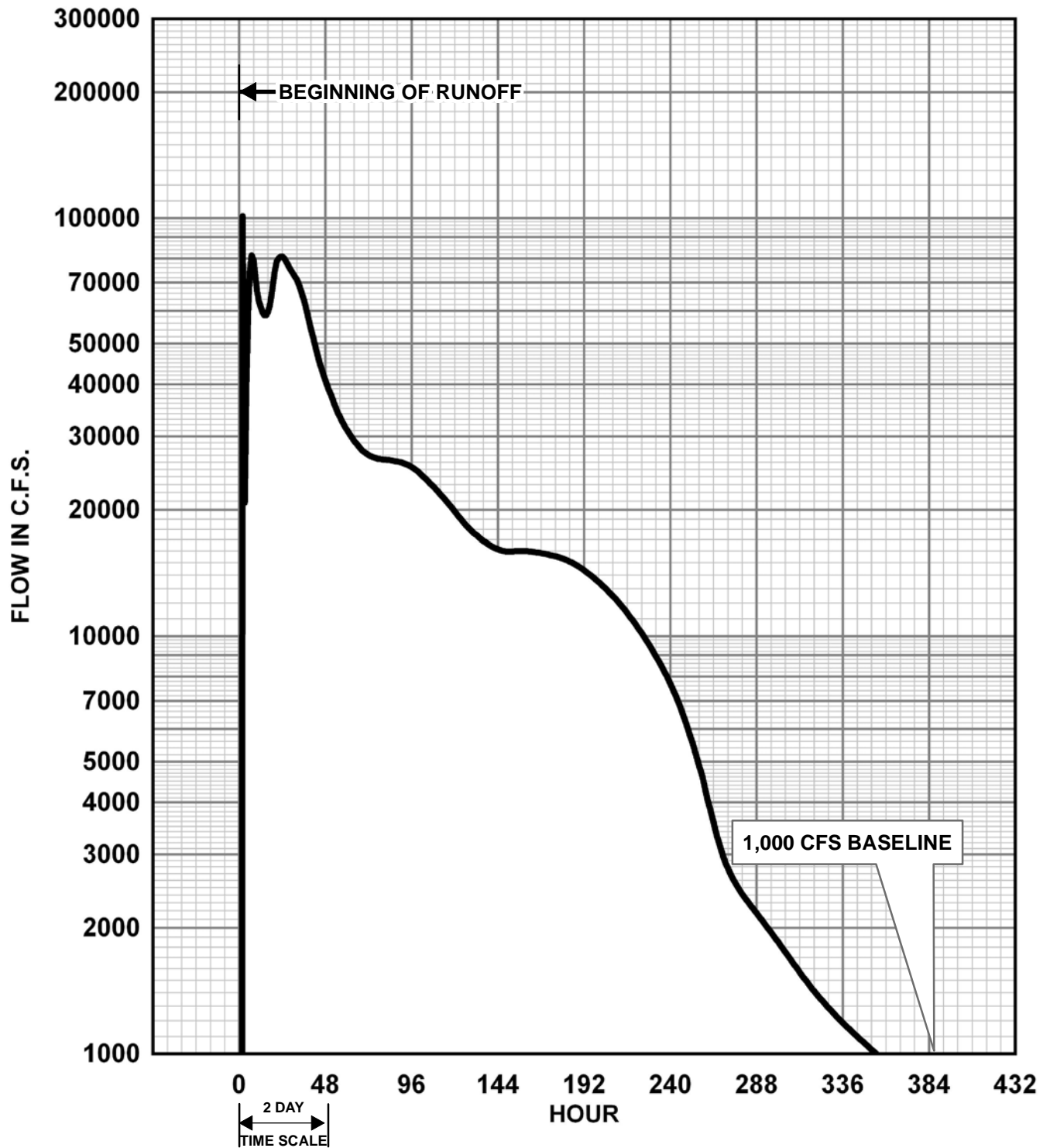
NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

FORECAST REACHES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL

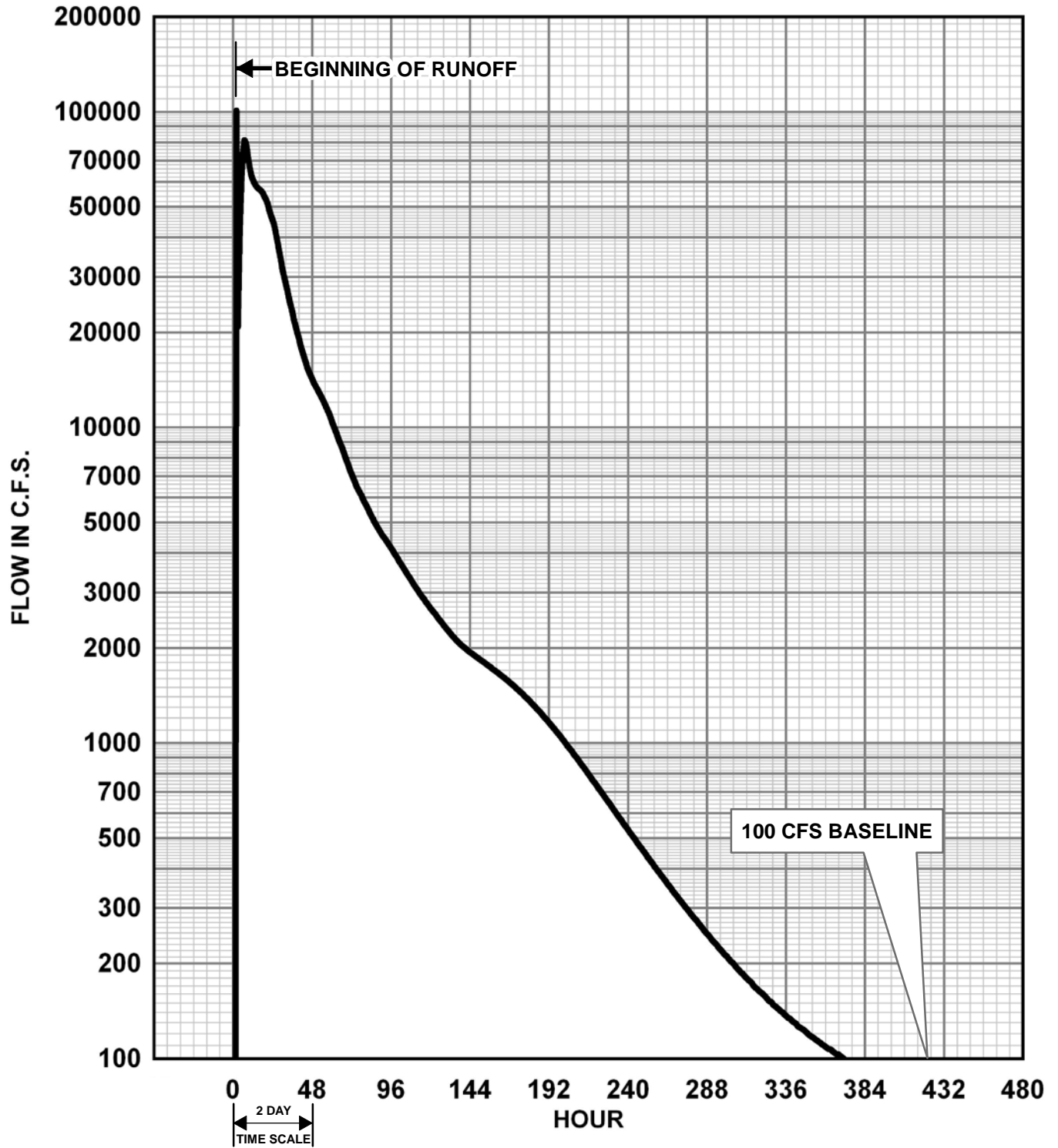


**DRAINAGE AREA = 8,445 SQ. MI.
 1" RUNOFF = 450,120 AC. FT.
 PEAK FLOW = 101,040 C.F.S.**

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

**EUFAULA LAKE
 UNIT HYDROGRAPH FOR
 AREA ABOVE EUFAULA DAM
 AND BELOW ARCADIA LAKE,
 LAKE OVERHOLSER, LAKE THUNDERBIRD,
 AND MINCO, OK**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL



**DRAINAGE AREA = 3,370 SQ. MI.
 1" RUNOFF = 179,620 AC. FT.
 PEAK FLOW = 101,040 C.F.S.**

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

**EUFAULA LAKE
 UNIT HYDROGRAPH FOR
 LOCAL AREA ABOVE EUFAULA DAM
 AND BELOW BEGGS, WETUMKA,
 AND CALVIN GAGES**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL



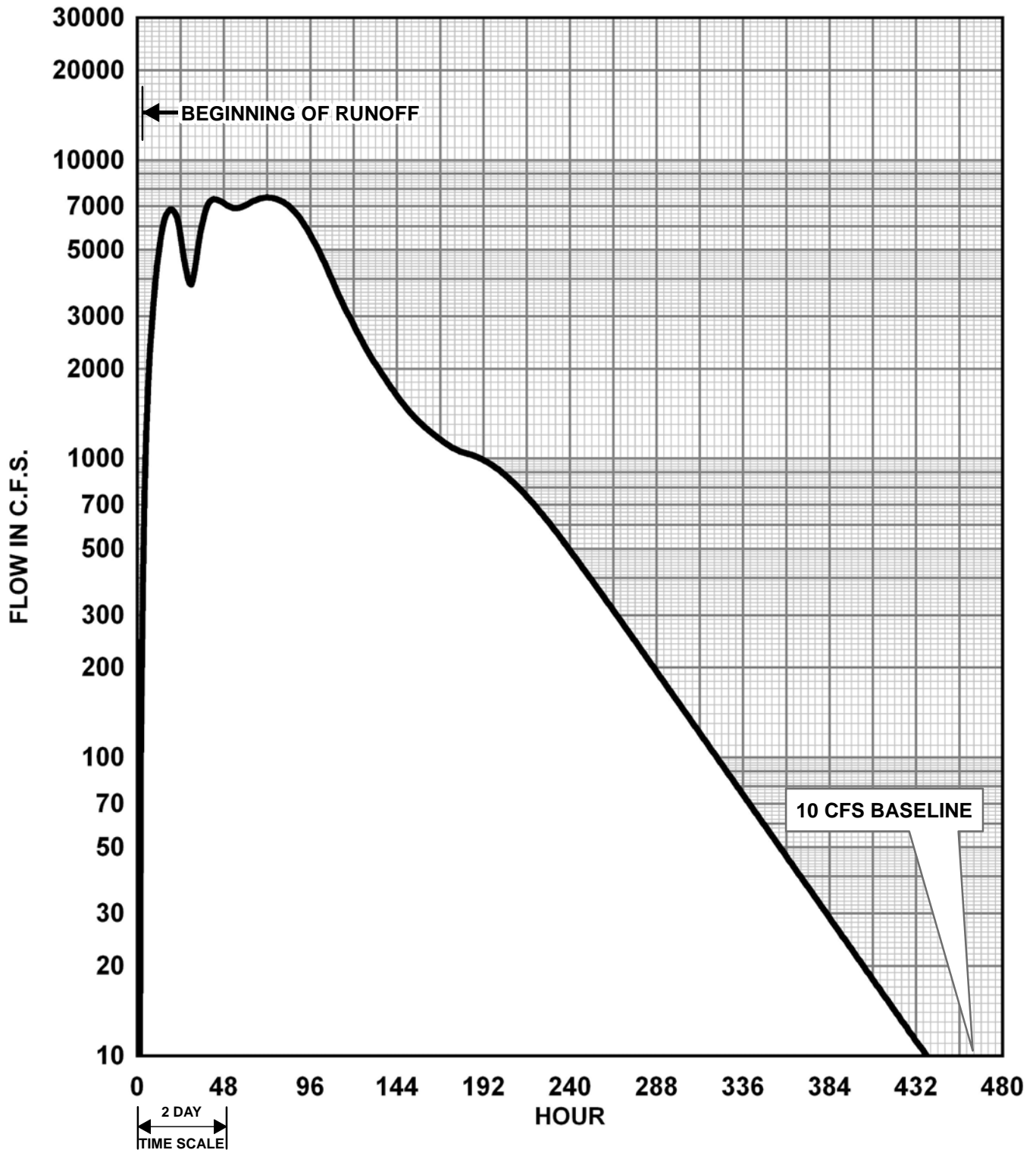
**DRAINAGE AREA = 1,910 SQ. MI.
1" RUNOFF = 101,803 AC. FT.
PEAK FLOW = 13,590 C.F.S.**

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**UNIT HYDROGRAPH FOR
AREA ABOVE BEGGS GAGE
AND BELOW ARCADIA DAM
ON DEEP FORK RIVER**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL



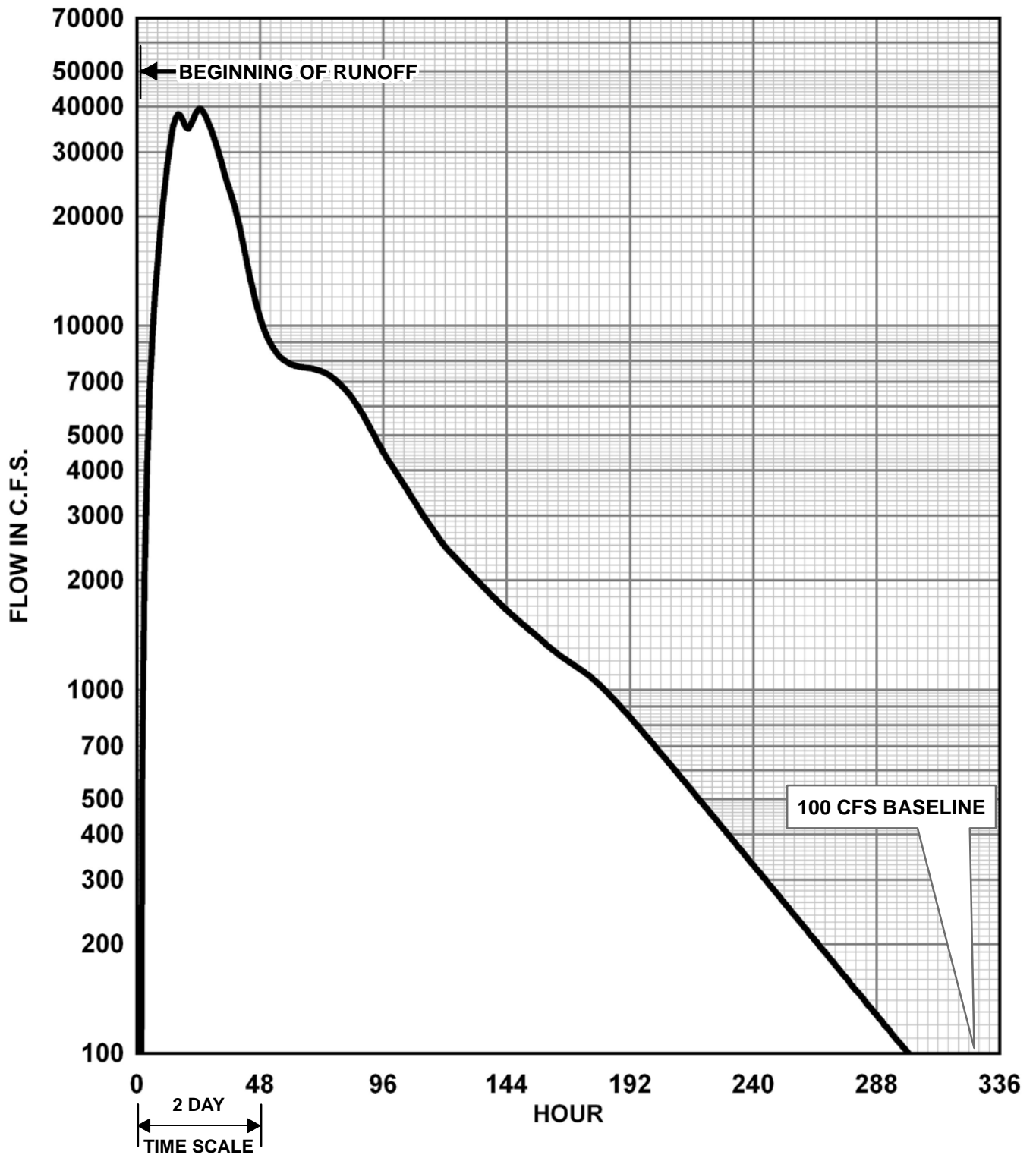
**DRAINAGE AREA = 1,070 SQ. MI.
 1" RUNOFF = 57,030 AC. FT.
 PEAK FLOW = 7,480 C.F.S.**

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**UNIT HYDROGRAPH FOR
 AREA ABOVE WETUMKA GAGE
 AND BELOW LAKE OVERHOLSER
 ON NORTH CANADIAN RIVER**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL



**DRAINAGE AREA = 2,100 SQ. MI.
 1" RUNOFF = 111,930 AC. FT.
 PEAK FLOW = 39,190 C.F.S.**

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**UNIT HYDROGRAPH FOR
 AREA ABOVE CALVIN GAGE
 AND BELOW LAKE THUNDERBIRD
 AND MINCO, OK**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL

LAKE EUFAULA
DISCHARGE AND INFLOW COMPUTATION

Date: _____

Date & Time	Pool Elevation NGVD	Storage ac-ft	Δ storage per 6-hr interval		Gate Opening		Discharge in CFS							INFLOW		
			ac-ft / hr	cfs	NO. & Type	Opening	Instantaneous			Average						
							Fld Cont	Pwer	Total	Fld Cont	Pwer	Evap	Total			
25-Mar 0800	588.24	2458162			11 TG	2.5	26092	12500	38592							
			32951	66463	"	"										
1400	590.12	2655870			"	"	27126	12500	39626							
			25824	52087	"	"										
2000	591.5	2810814			"	"	27885	12500	40385							
			24472	49360	"	"										
3/26 0200	592.75	2957645			"	"	28573	12500	41073							
			-1592	-3211	"	"										
0800	592.67	2948094			"	"	28528	12500	41028							
			-13332	-26890	"	"										
1400	592	2868103			"	"	28160	12500	40660							
			-10885	-21955	"	"										
20000	591.43	2802793			"	"	27246	12500	39746							
			-10431	-21039	"	"										
3/27 0800	590.88	2740208			"	"	27544	12500	40044							
			-9433	-19025	"	"										
1400	590.37	2683613			"	"	27263	12500	39763							
			-16567	-33416	"	"										
20000	589.45	2584209			11 TG	2.75	29422	12500	41922							
			-12249	-24707	"	"										
	588.75	2510713			"	"	28999	12500	41499							
			-18072	-36451	"	"										
	587.69	2402281			"	"	28340	12500	40840							

- (1) Area/Capacity Table
- (2) Subtract storage at beginning of period from storage at end of period. If pool is risin, change in storage is positive (+), If pool is falling, change is negative (-).
- (3) $\frac{\text{Change in storage (ac-ft)} \times 12}{\text{No. of hours in period}} = \text{change in storage in cfs}$
- (4) From discharge rating curves.
- (5) Average discharge during period.
- (6) From evaporation curves
- (7) Inflow + change in storage (cfs) + average discharge + evaporation

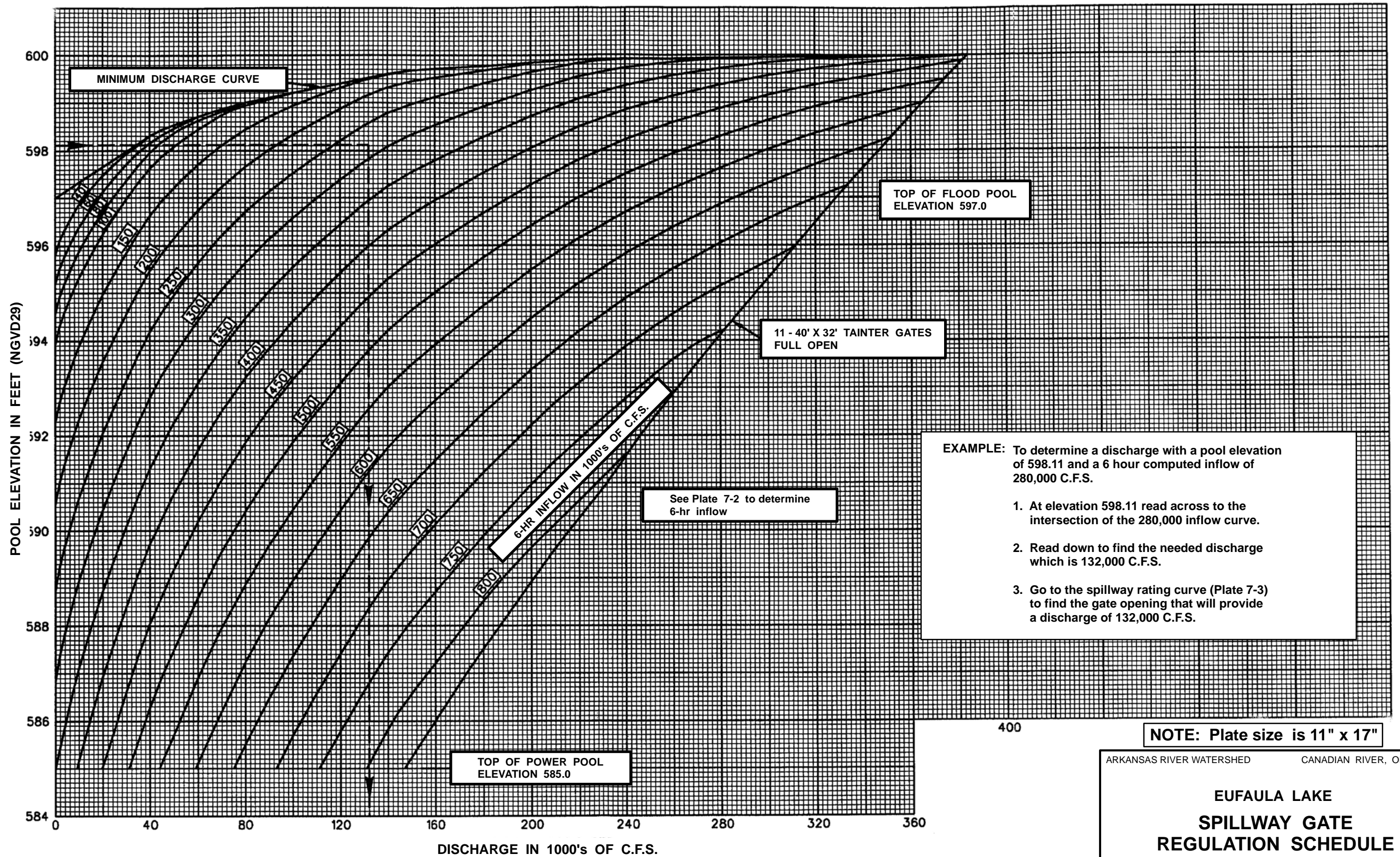
NOTE: During flood periods, evaporation is usually neglected in preliminary inflow calculations.

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**SAMPLE INFLOW
COMPUTATION**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL



EXAMPLE: To determine a discharge with a pool elevation of 598.11 and a 6 hour computed inflow of 280,000 C.F.S.

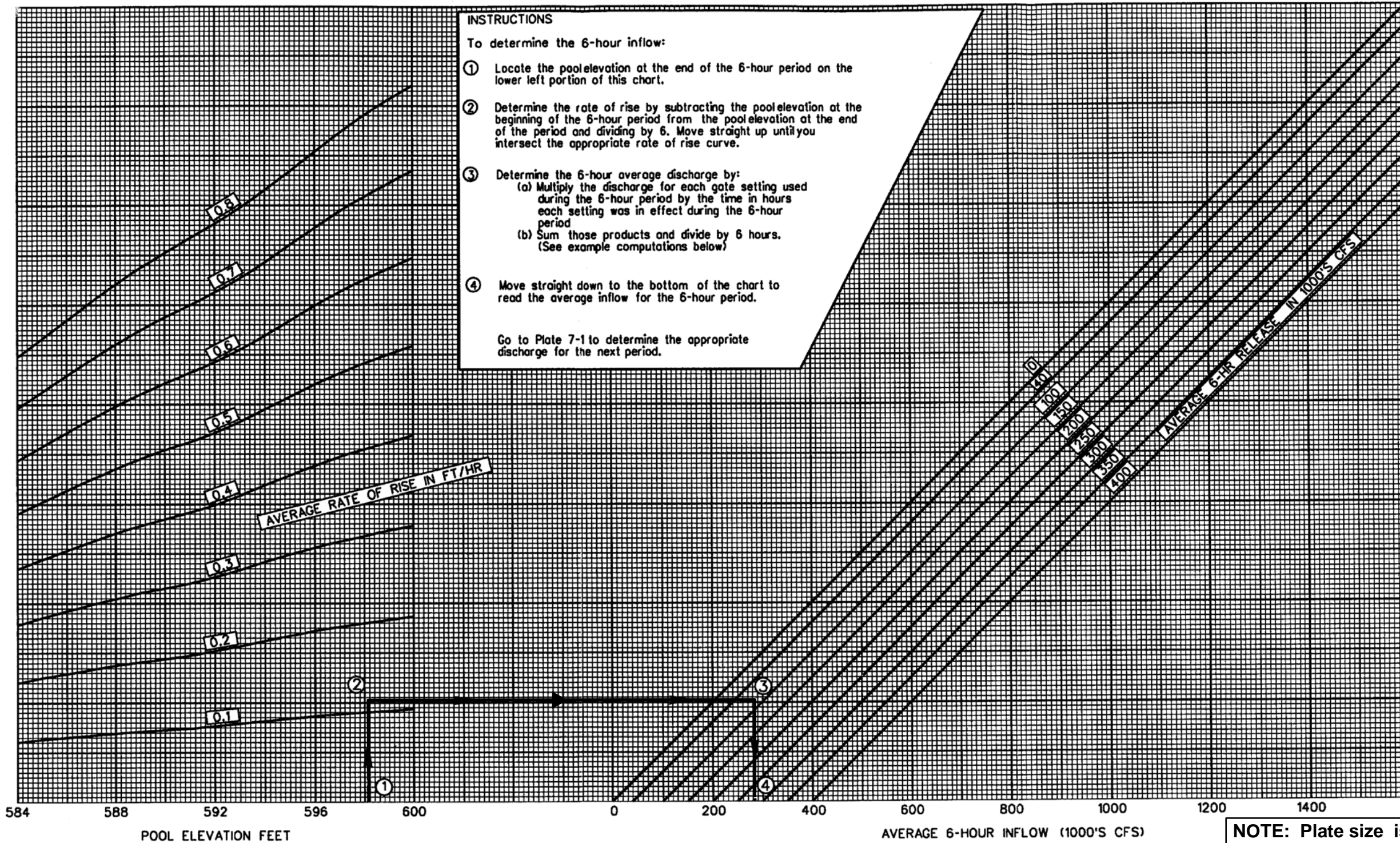
1. At elevation 598.11 read across to the intersection of the 280,000 inflow curve.
2. Read down to find the needed discharge which is 132,000 C.F.S.
3. Go to the spillway rating curve (Plate 7-3) to find the gate opening that will provide a discharge of 132,000 C.F.S.

NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

**EUFAULA LAKE
SPILLWAY GATE
REGULATION SCHEDULE
INFLOW PARAMETER**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL



INSTRUCTIONS

To determine the 6-hour inflow:

- ① Locate the pool elevation at the end of the 6-hour period on the lower left portion of this chart.
- ② Determine the rate of rise by subtracting the pool elevation at the beginning of the 6-hour period from the pool elevation at the end of the period and dividing by 6. Move straight up until you intersect the appropriate rate of rise curve.
- ③ Determine the 6-hour average discharge by:
 - (a) Multiply the discharge for each gate setting used during the 6-hour period by the time in hours each setting was in effect during the 6-hour period
 - (b) Sum those products and divide by 6 hours. (See example computations below)
- ④ Move straight down to the bottom of the chart to read the average inflow for the 6-hour period.

Go to Plate 7-1 to determine the appropriate discharge for the next period.

EXAMPLE COMPUTATIONS:

- ① Begin with a lake elevation of 598.11 feet. Six hours ago the elevation was 597.43 feet.
- ② Rate of rise = $(598.11 - 597.43) / 6 \text{ hrs} = 0.68 \text{ feet} / 6 \text{ hrs} = 0.11 \text{ ft/hr}$
- ③ Releases for last six hours were:

2.0 hrs at 60,600 cfs	=	2.0 x 60,600	=	121,200 cfs
2.0 hrs at 79,200 cfs	=	2.0 x 79,200	=	158,400 cfs
2.0 hrs at 104,000 cfs	=	2.0 x 104,000	=	208,000 cfs
Average release = 487,600 cfs / 6 hrs		Total 6 hrs		487,600 cfs
				= 81,267 cfs
- ④ The resulting 6-hour inflow is 280,000 cfs.

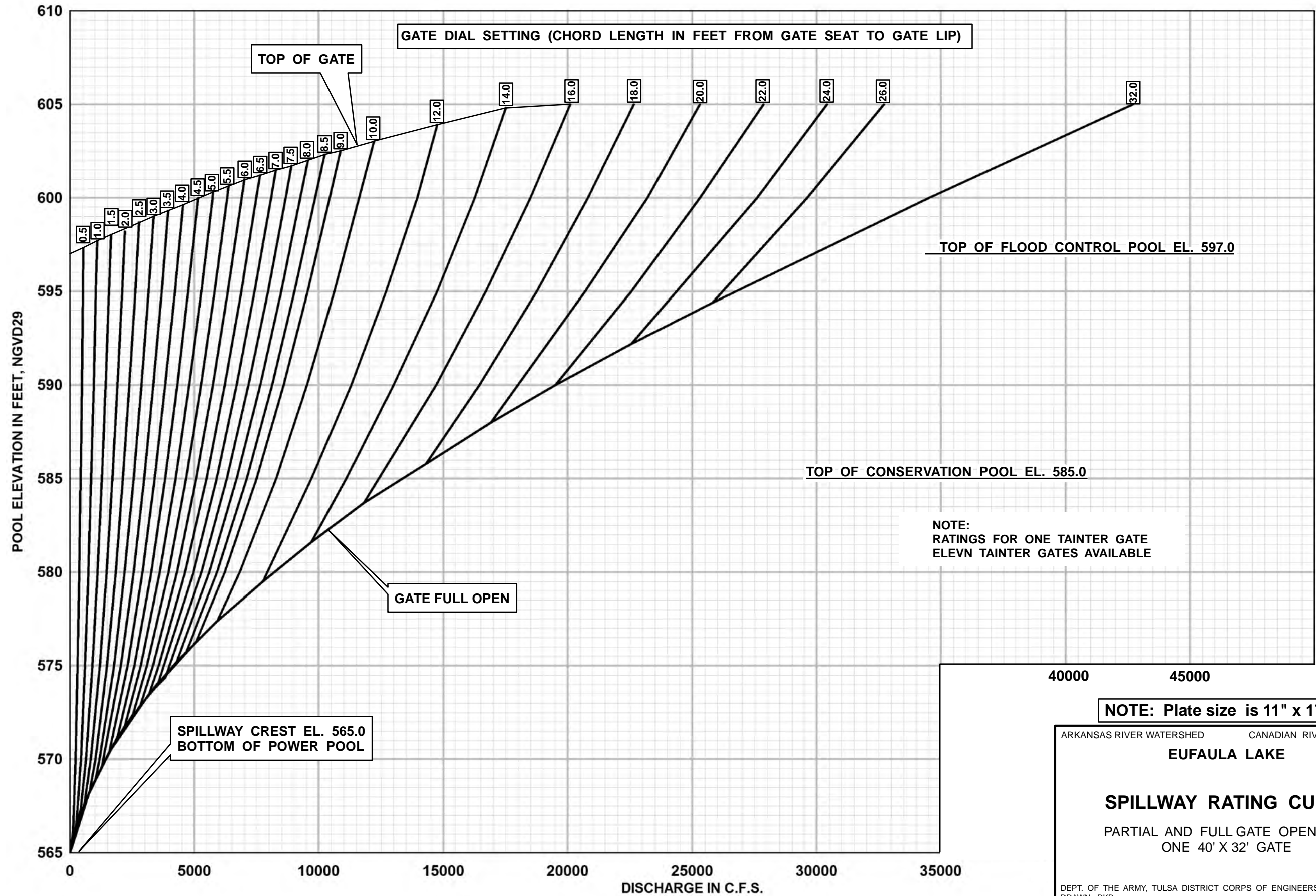
NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFULA LAKE

**INFLOW VS. RATE OF RISE
NOMOGRAPH**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL



NOTE: Plate size is 11" x 17"

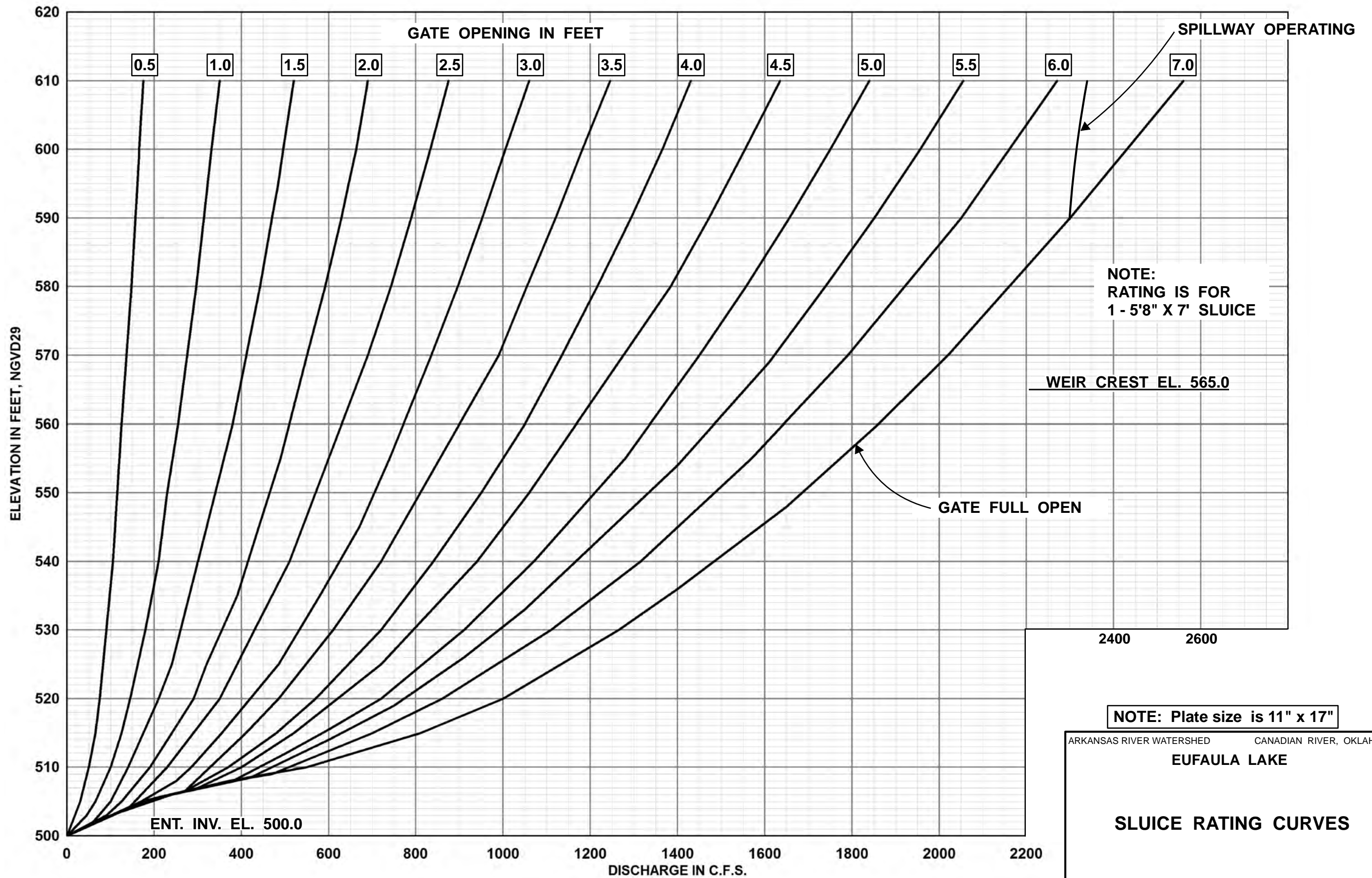
ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

SPILLWAY RATING CURVE

PARTIAL AND FULL GATE OPENINGS
ONE 40' X 32' GATE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL



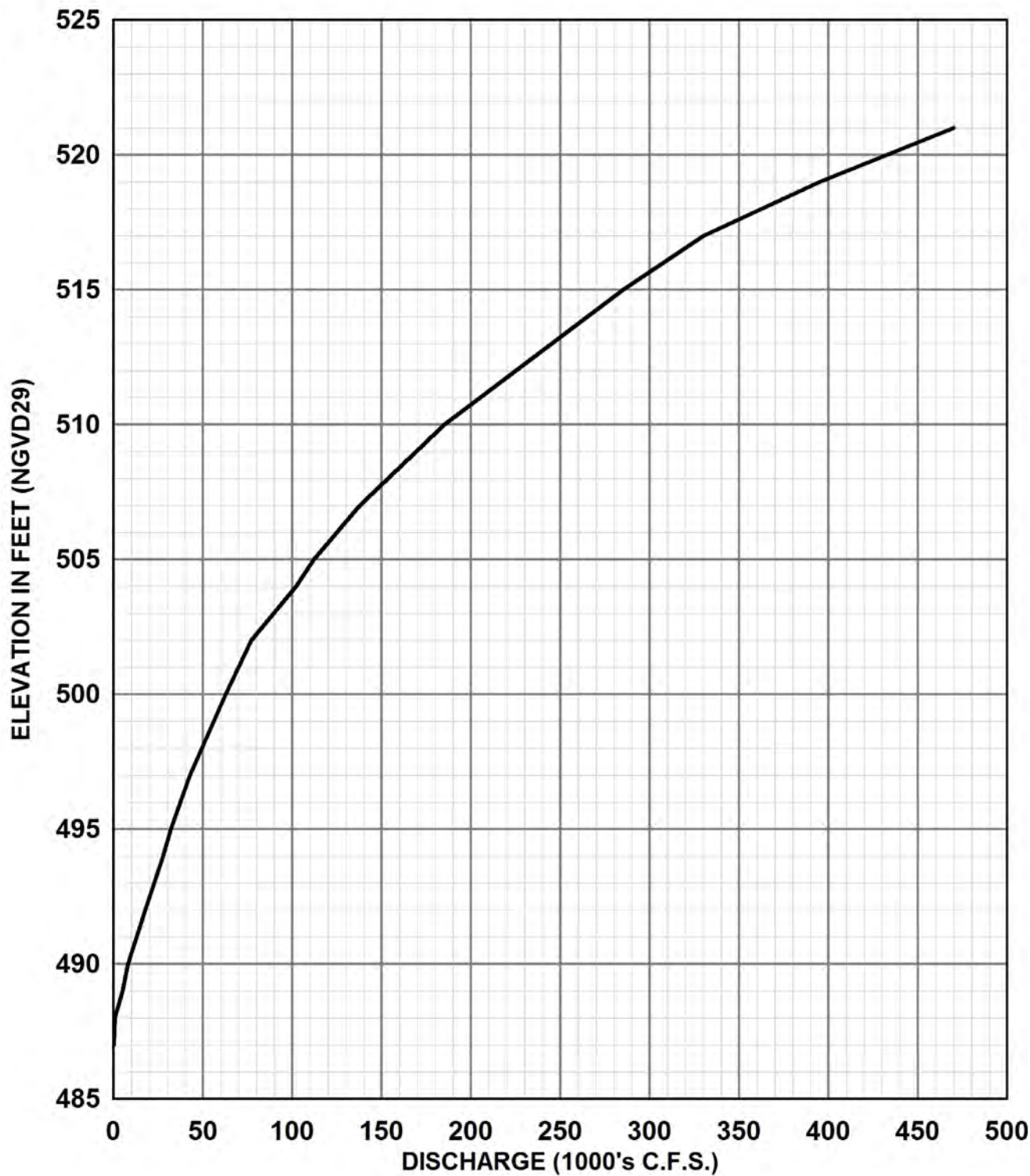
NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

SLUICE RATING CURVES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL



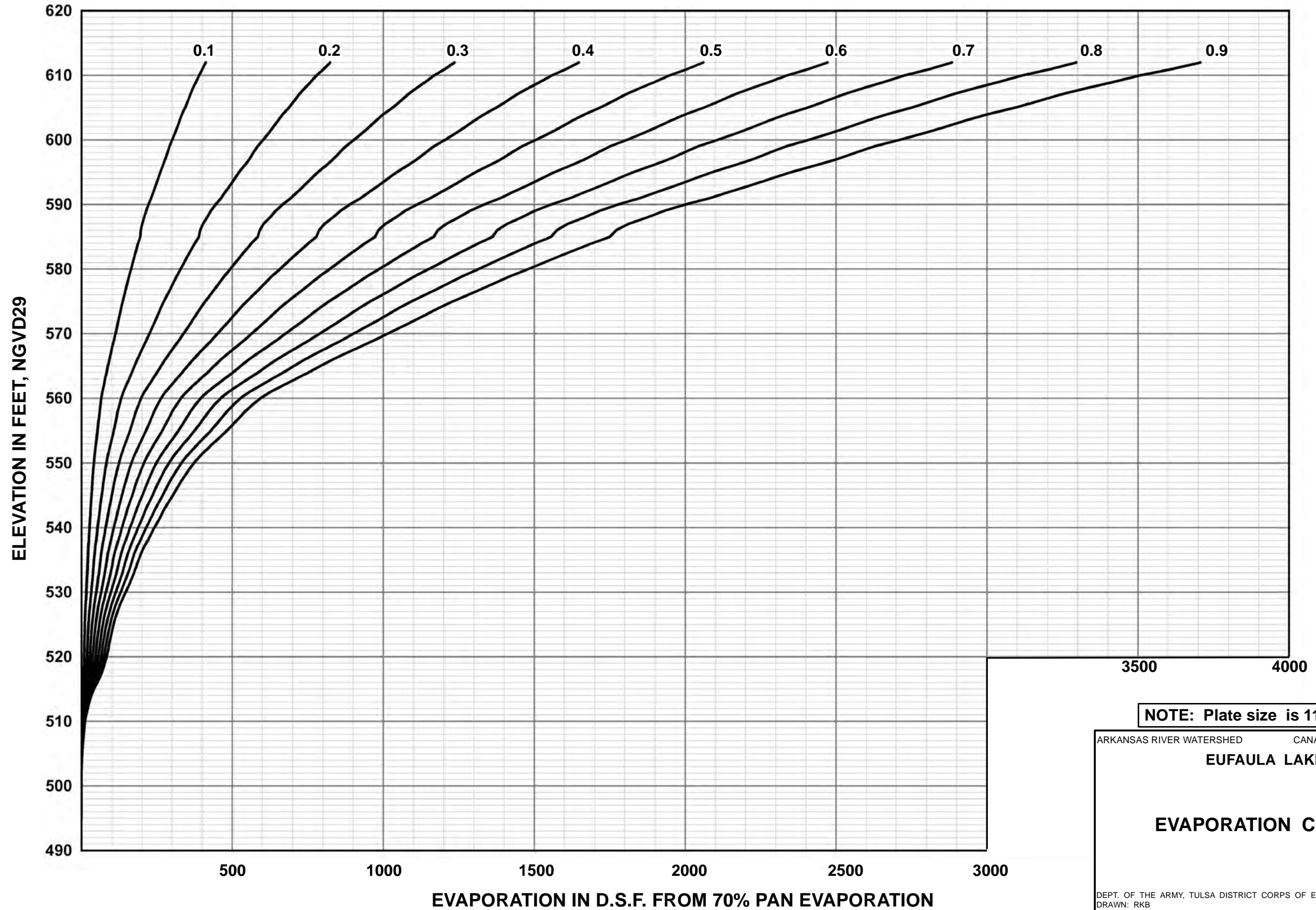
ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

TAILWATER RATING CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL

INCHES PAN EVAPORATION PER DAY



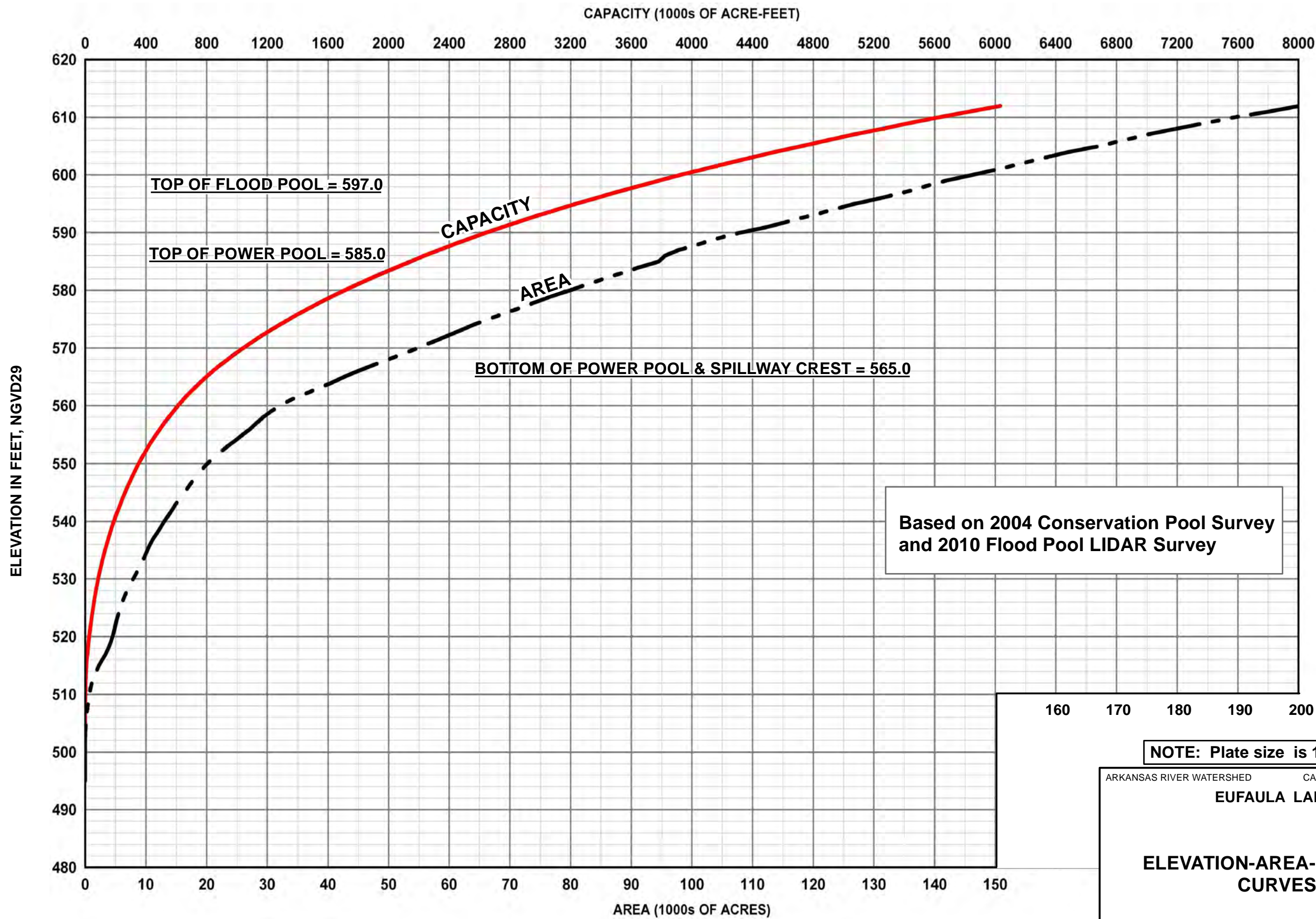
NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

EVAPORATION CURVES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL



Based on 2004 Conservation Pool Survey and 2010 Flood Pool LIDAR Survey

NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

ELEVATION-AREA-CAPACITY CURVES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL

**WATER SUPPLY STORAGE ACCOUNTING
EUFAULA LAKE**

PERIOD MO.YR	USER	USABLE BEGINNING STORAGE	INFLOW SHARE	TOTAL LOSSES	WITH- DRAWN	USABLE ENDING STORAGE		AC-FT
							USABLE CONSERVATION POOL STORAGE (1) (2)	1,210,734
							STORAGE NOT UNDER AGREEMENT (N-A)	37,614
Jul-91	LAKE	1,210,734	74380	17329	145141	1,122,644	AGREEMENT STORAGE USER # 1	17,168
	N-A	37,614	2311	538	0	37,614	AGREEMENT STORAGE USER # 2	8,911
	1	17,168	1055	246	73	17,168	AGREEMENT STORAGE USER # 3	2,143
	2	8,911	547	128	35	8,911	OTHER USERS	14,024
	3	2,143	132	31	76	2,143	USERS # 4 (3)	
	4	14,024	862	201	1	14,024	HYDROPOWER	1,130,874
	5	1,130,874	69474	16186	144956	1,042,784	USER # 5	
Aug-91	LAKE	1,122,644	20528	78923	93488	970,761		
	N-A	37,614	638	2452	0	35,800		
	1	17,168	291	1119	72	16,268		
	2	8,911	151	581	28	8,453		
	3	2,143	36	140	75	1,965		
	4	14,024	238	914	127	13,221		
	5	1,042,784	19174	73717	93186	895,055		
Sep-91	LAKE	970,761	263404	-40152	63583	1,210,734		
	N-A	35,800	8183	-1247	0	37,614		
	1	16,268	3735	-569	67	17,168		
	2	8,453	1939	-296	26	8,911		
	3	1,965	466	-71	64	2,143		
	4	13,221	3051	-465	6	14,024		
	5	895,055	246030	-37504	63420	1,130,874		

- NOTES: 1. USEABLE CONSERVATION POOL STORAGE IS EQUAL TO THE TOTAL CONSERVATION POOL STORAGE (1,346,325 AC-FT) MINUS THE SEDIMENT RESERVE STORAGE (135,592 AC- FT).
2. STORAGE AMOUNTS ARE BASED ON THE 2004 CONSERVATION POOL BATHYMETRIC SURVEY AND THE 2010 FLOOD POOL LIDAR SURVEY WITH A 2034 SEDIMENT PROJECTION.
3. FOR ACTUAL WATER ACCOUNTING, EACH USER WOULD BE LISTED SEPARATELY WITH INFLOW/LOSSES/STORAGE BEING CALCULATED FOR EACH.

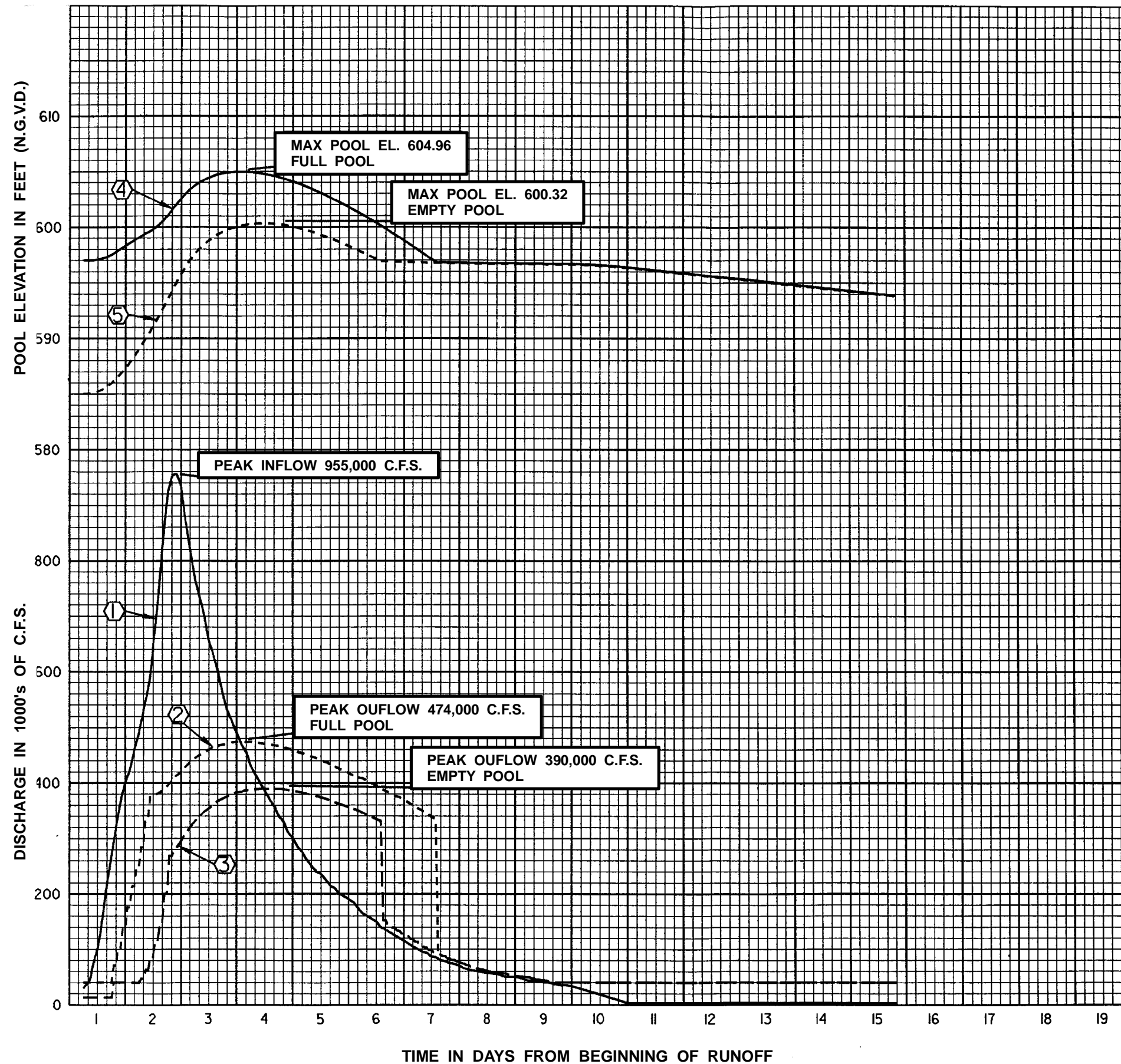
NOTE: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**EXAMPLE CALCULATIONS OF
WATER SUPPLY ACCOUNTING**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL



NOTES: EMERGENCY OPERATIONS

- 1. INFLOW HYDROGRAPH
- 2. OUTFLOW - FULL POOL
- 3. OUTFLOW - EMPTY POOL
- 4. ELEVATION - FULL POOL
- 5. ELEVATION - EMPTY POOL

NOTE: Plate size is 11" x 17"

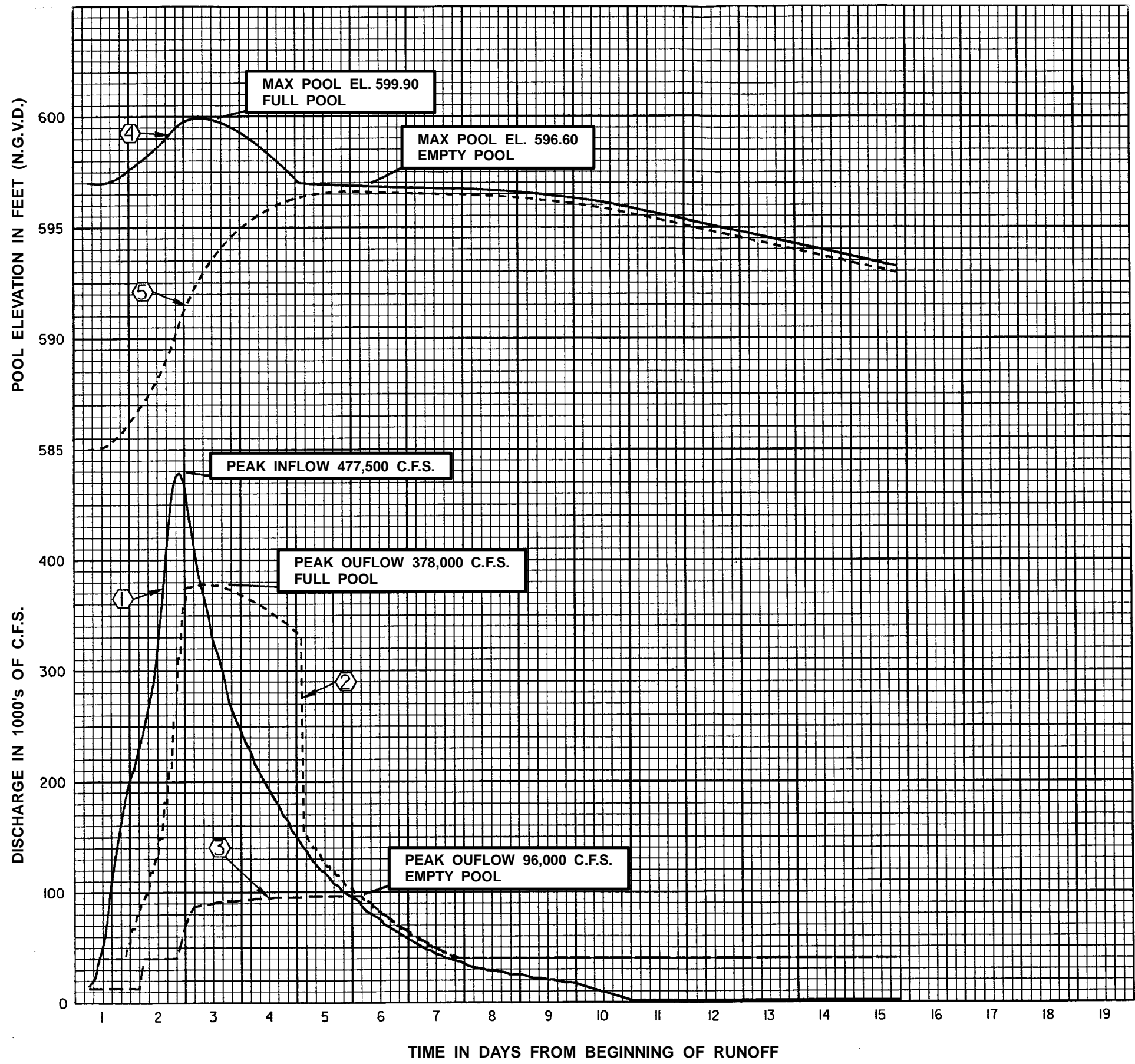
ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

OPERATIONAL HYDROGRAPHS

SPILLWAY DESIGN FLOOD

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL



NOTES: EMERGENCY OPERATIONS

1. INFLOW HYDROGRAPH
2. OUTFLOW - FLOOD ON FULL POOL
3. OUTFLOW - FLOOD ON EMPTY POOL
4. ELEVATION - FLOOD ON FULL POOL
5. ELEVATION - FLOOD ON EMPTY POOL

NOTE: Plate size is 11" x 17"

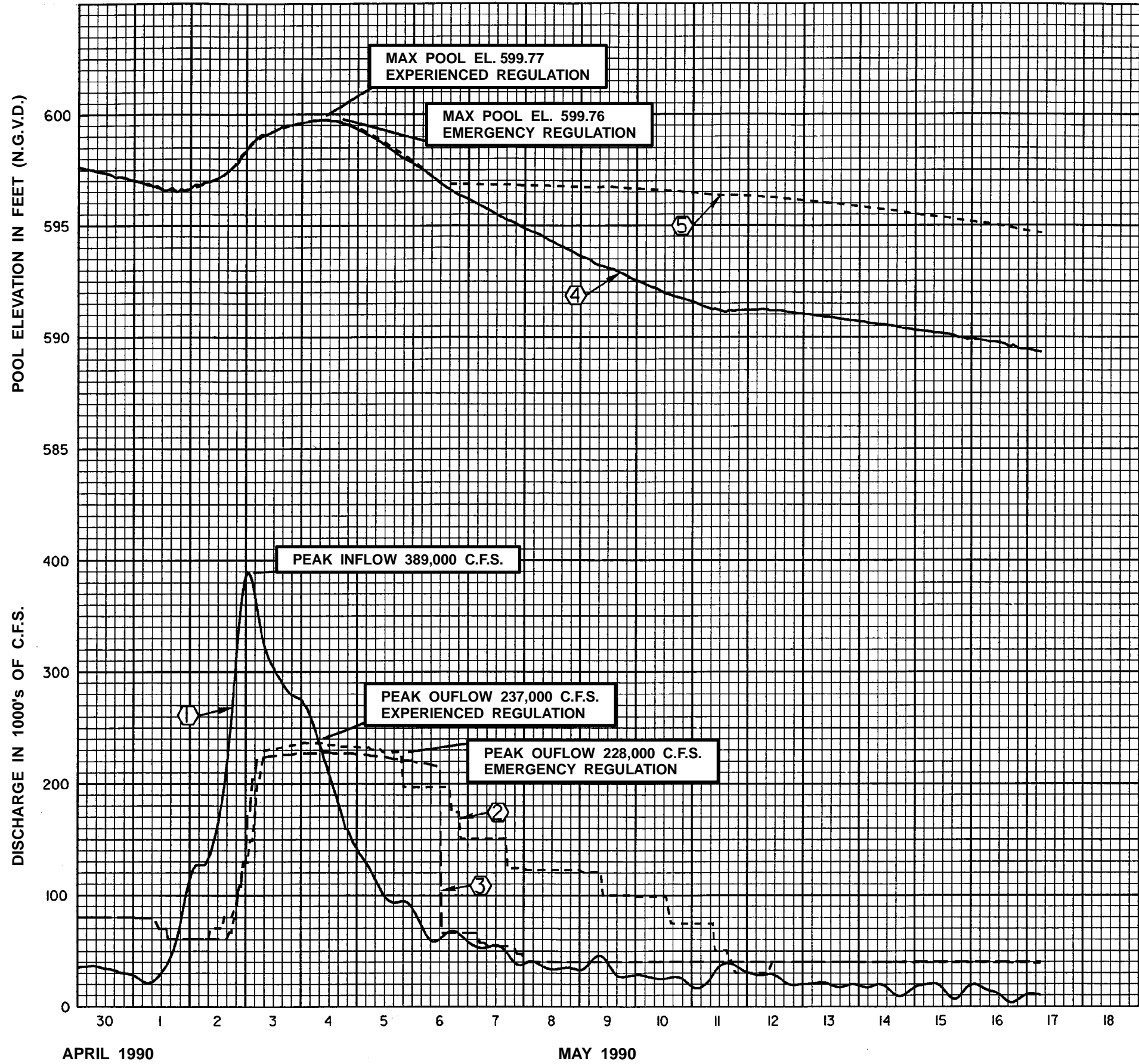
ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

OPERATIONAL HYDROGRAPHS

STANDARD PROJECT FLOOD

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL



NOTES: EMERGENCY OPERATIONS

1. INFLOW HYDROGRAPH
2. OUTFLOW - EXPERIENCED REGULATION
3. OUTFLOW - EMERGENCY REGULATION
4. ELEVATION - EXPERIENCED REGULATION
5. ELEVATION - EMERGENCY REGULATION

NOTE: Plate size is 11" x 17"

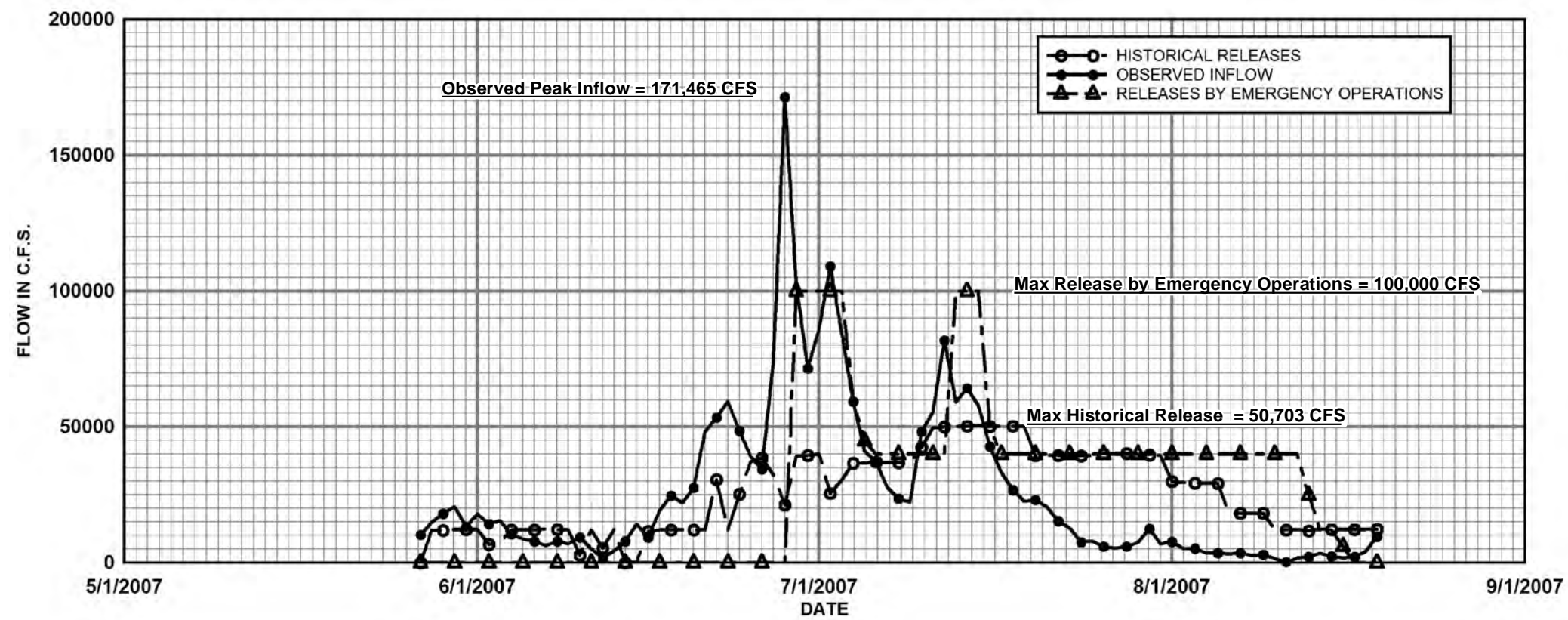
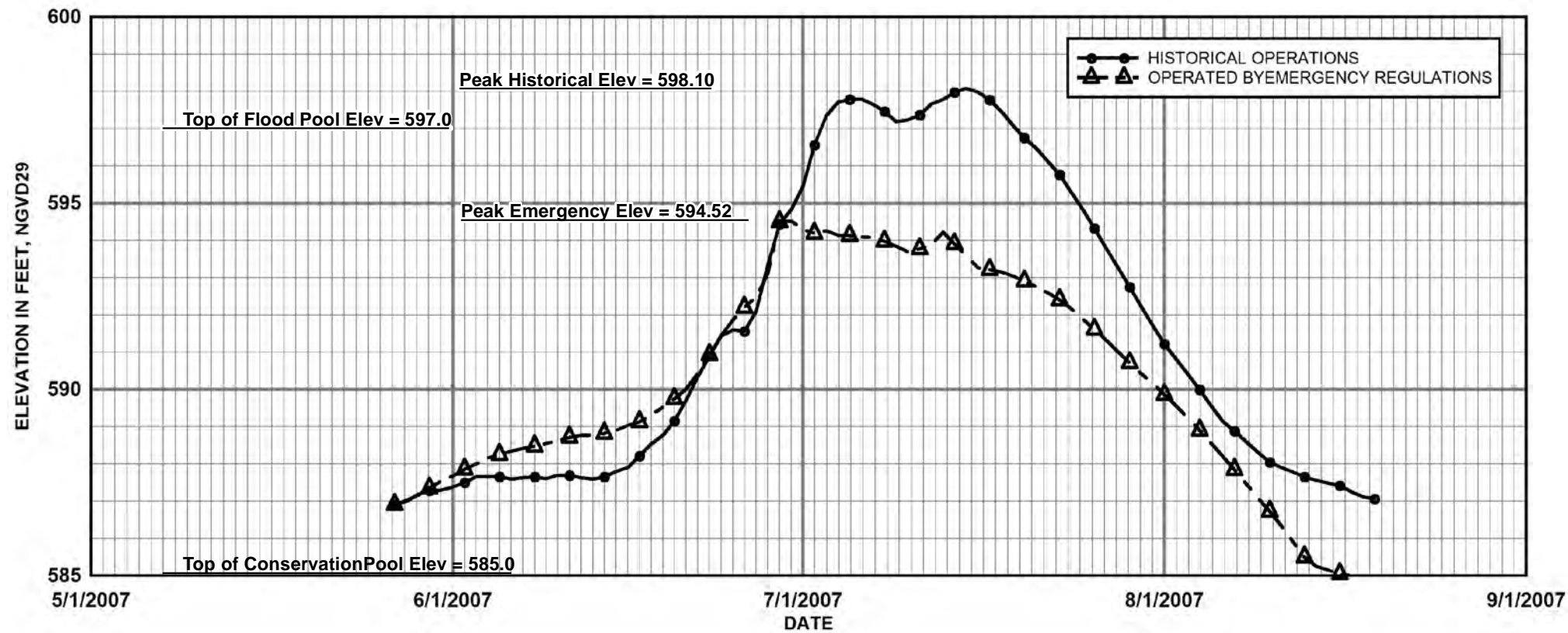
ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

OPERATIONAL HYDROGRAPHS

FLOOD OF APRIL - MAY 1990

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL



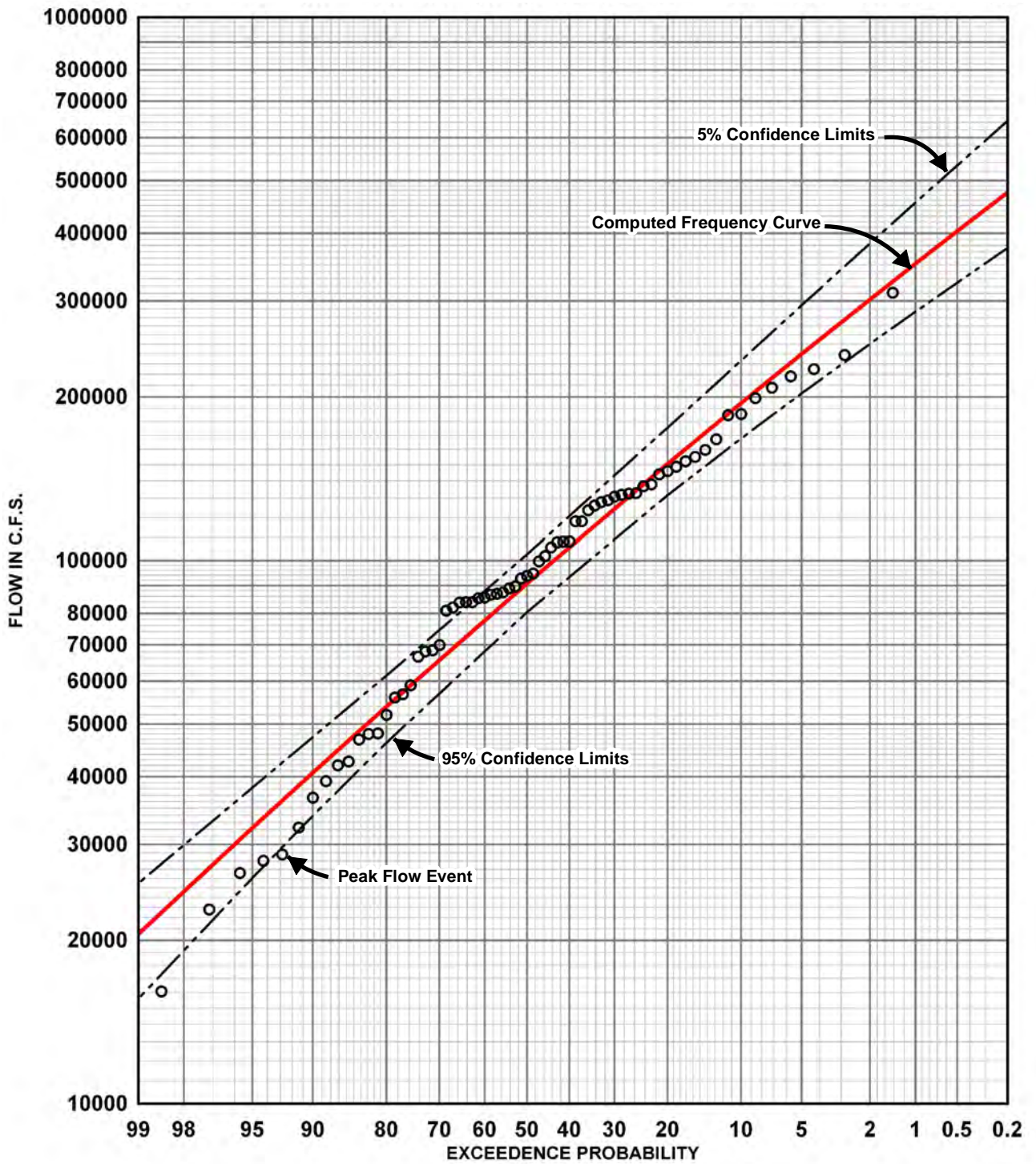
ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

OPERATIONAL HYDROGRAPHS

FLOOD OF MAY - AUG 2007
AT EUFAULA DAM SITE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL



NOTE:

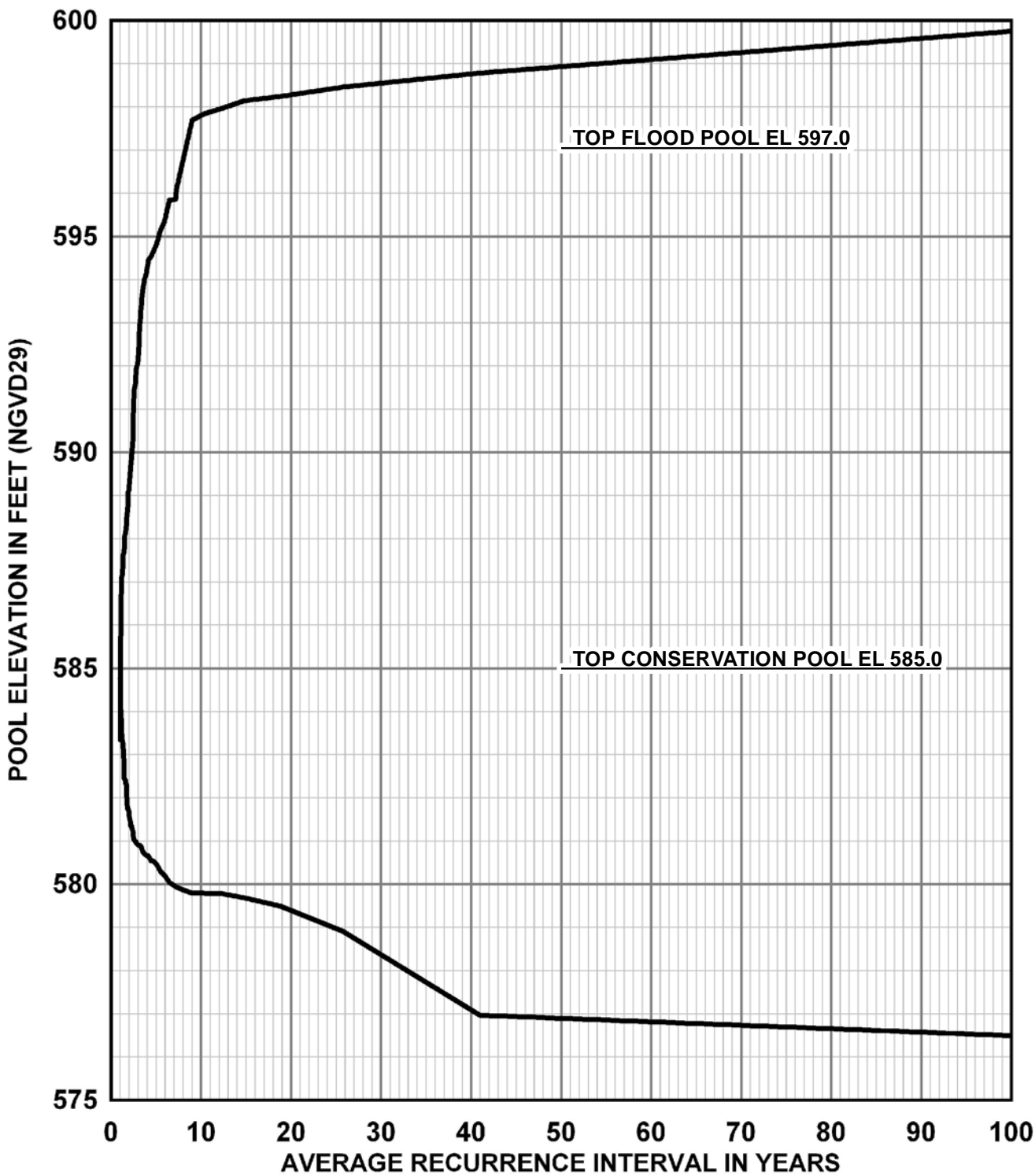
1. BASED ON PERIOD OF RECORD
JAN 1940 TO DEC 2008
2. BASED ON RIVERWARE 6.0.8
MODEL: ARK_Base_29Oct2011,
Meeting Bulletin 17 Guidelines.

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**PEAK INFLOW
PROBABILITY**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL



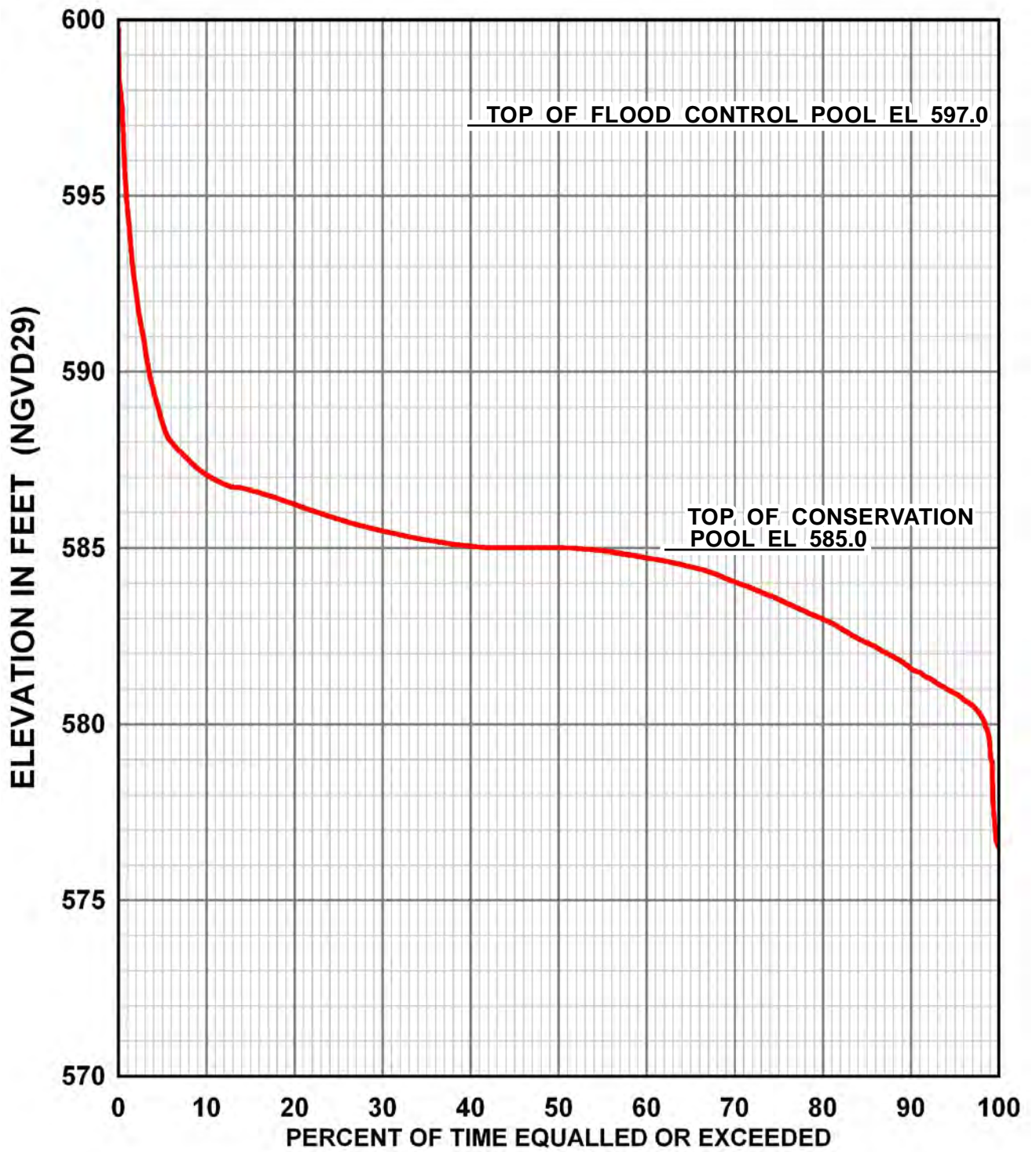
NOTE:

CURVE IS BASED UPON PERIOD
 OF RECORD JAN 1940 THROUGH
 JAN 2009 FROM RIVERWARE
 COMPUTER RUN

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA
EUFAULA LAKE

**POOL ELEVATION
 PROBABILITY CURVE**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
 DRAWN: RKB
 CHECKED: JRL



NOTE:

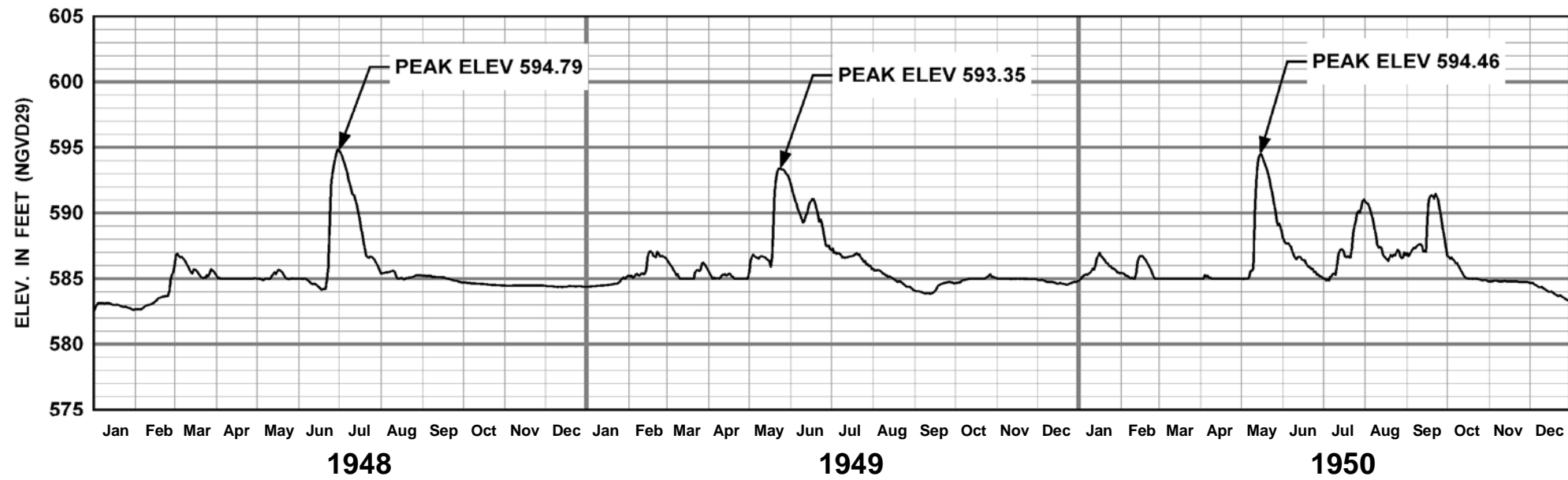
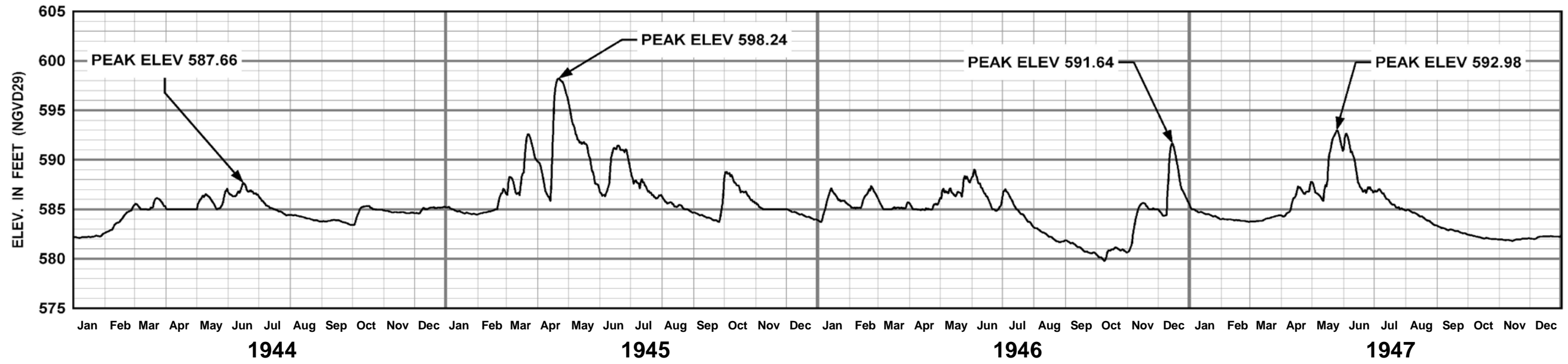
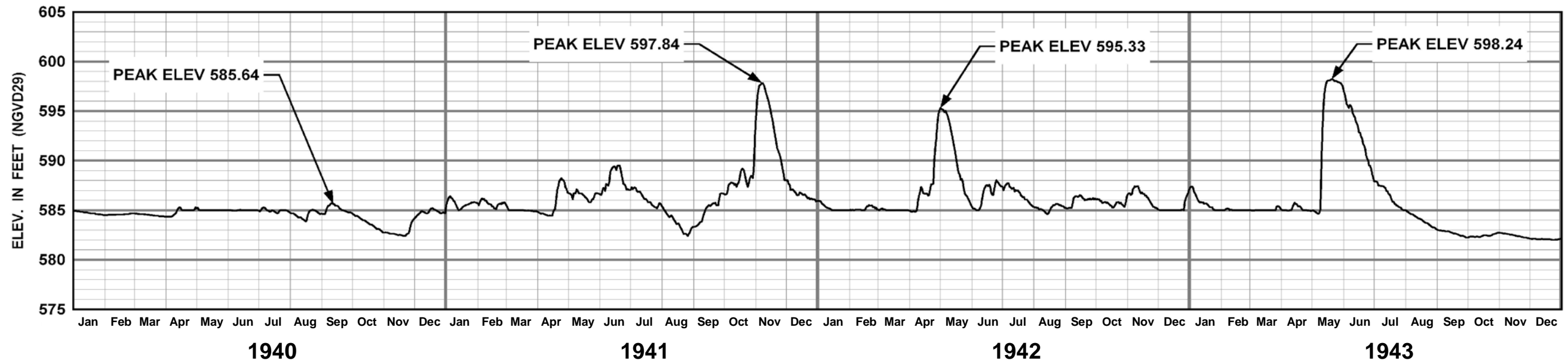
CURVE IS BASED UPON PERIOD OF RECORD JAN 1940 THROUGH JAN 2009 FROM RIVERWARE COMPUTER MODEL

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

POOL ELEVATION DURATION CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
 DRAWN: RKB
 CHECKED: JRL



NOTE: Pool elevations for Jan 1940 through Feb 1964 are based on a simulation using the RiverWare computer program. Elevations for Mar 1, 1964 through Dec 2011 are actual historical values.

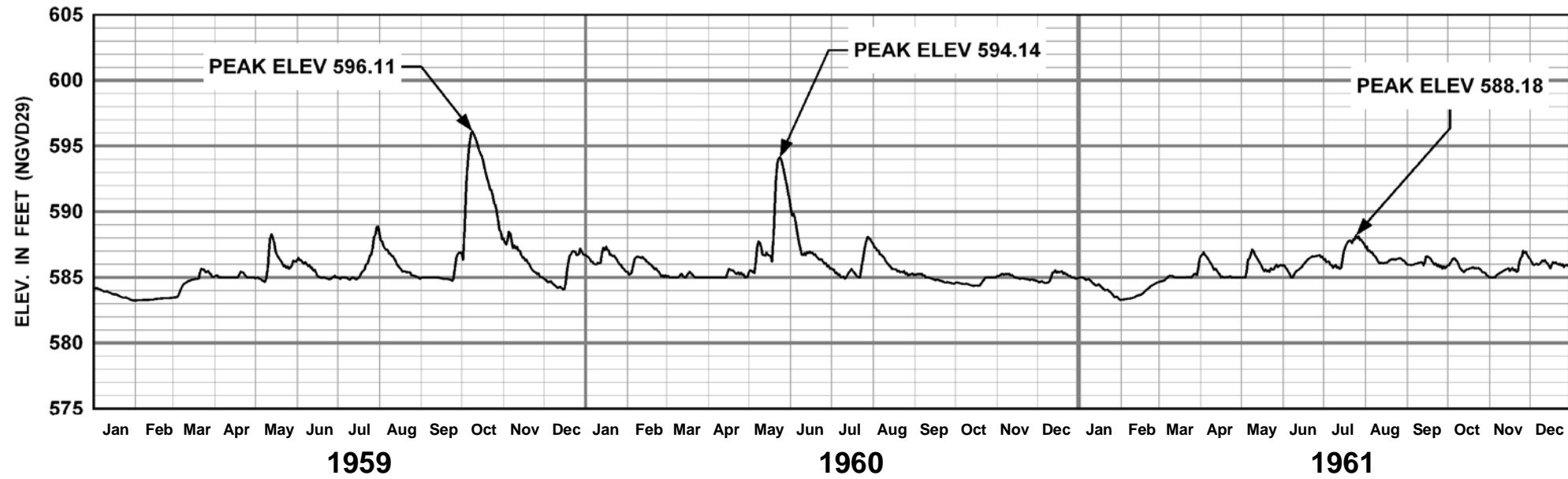
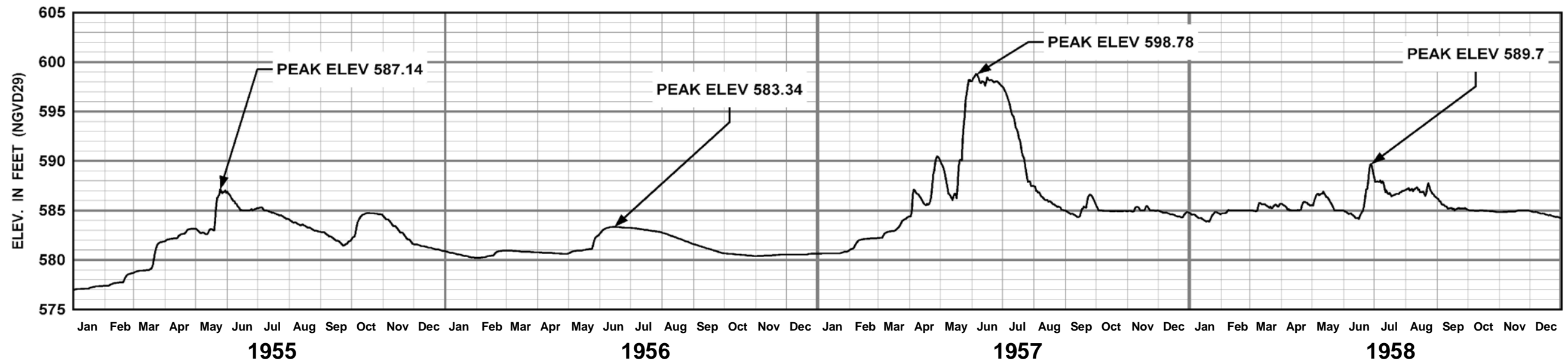
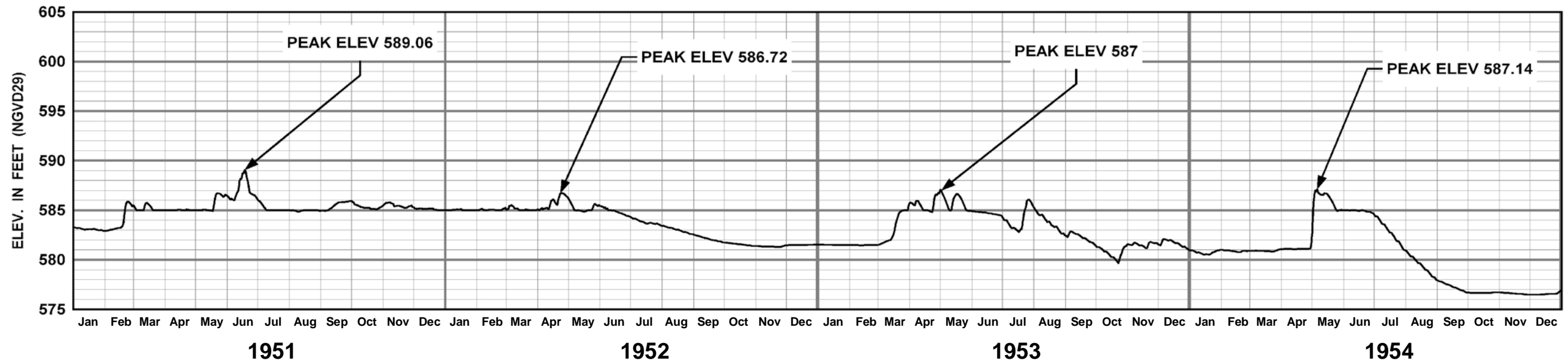
Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFULA LAKE

**POOL ELEVATION
HYDROGRAPHS
1940 - 1950**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL



NOTE: Pool elevations for Jan 1940 through Feb 1964 are based on a simulation using the RiverWare computer program. Elevations for Mar 1, 1964 through Dec 2011 are actual historical values.

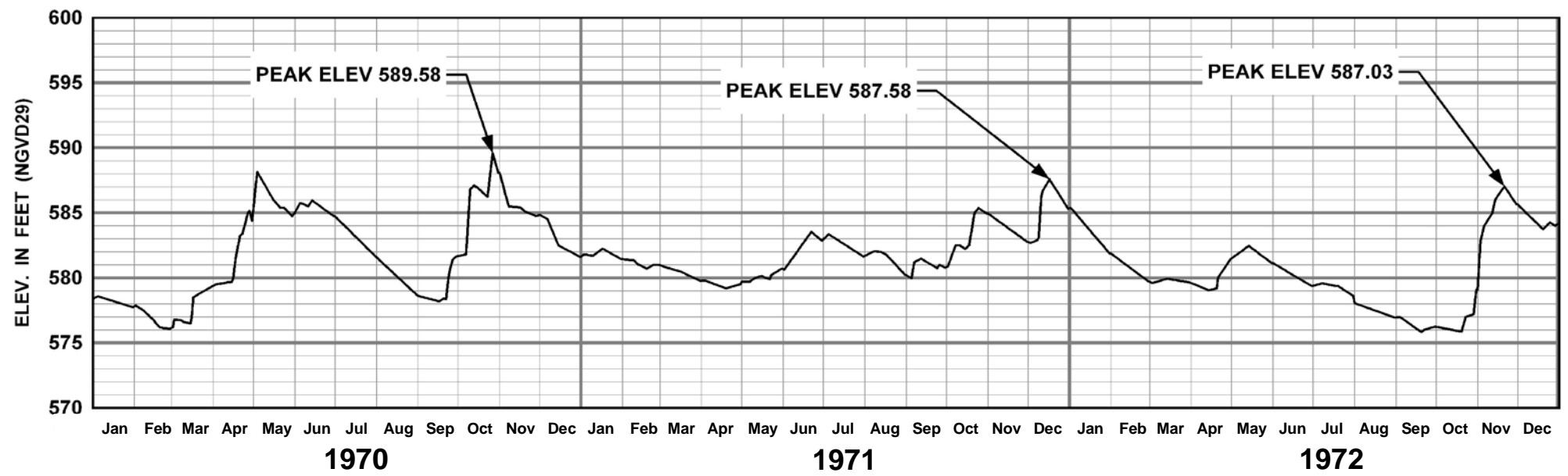
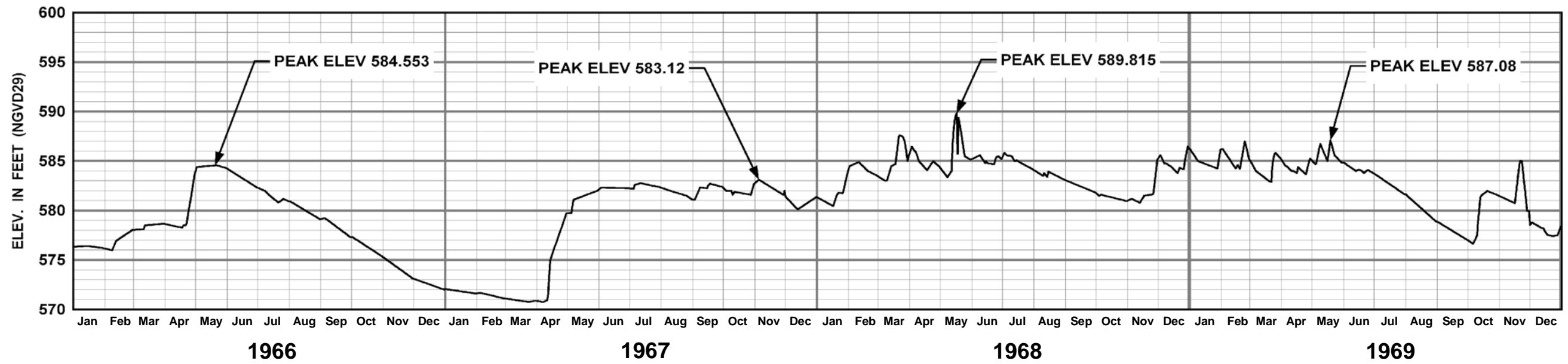
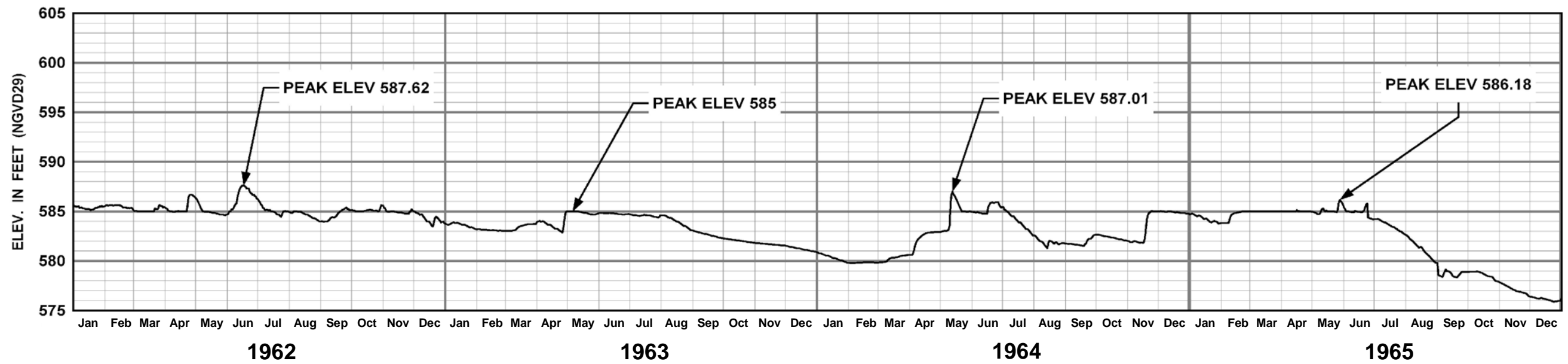
Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFULA LAKE

**POOL ELEVATION
HYDROGRAPHS
1951 - 1961**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL



NOTE: Pool elevations for Jan 1940 through Feb 1964 are based on a simulation using the RiverWare computer program. Elevations for Mar 1, 1964 through Dec 2011 are actual historical values.

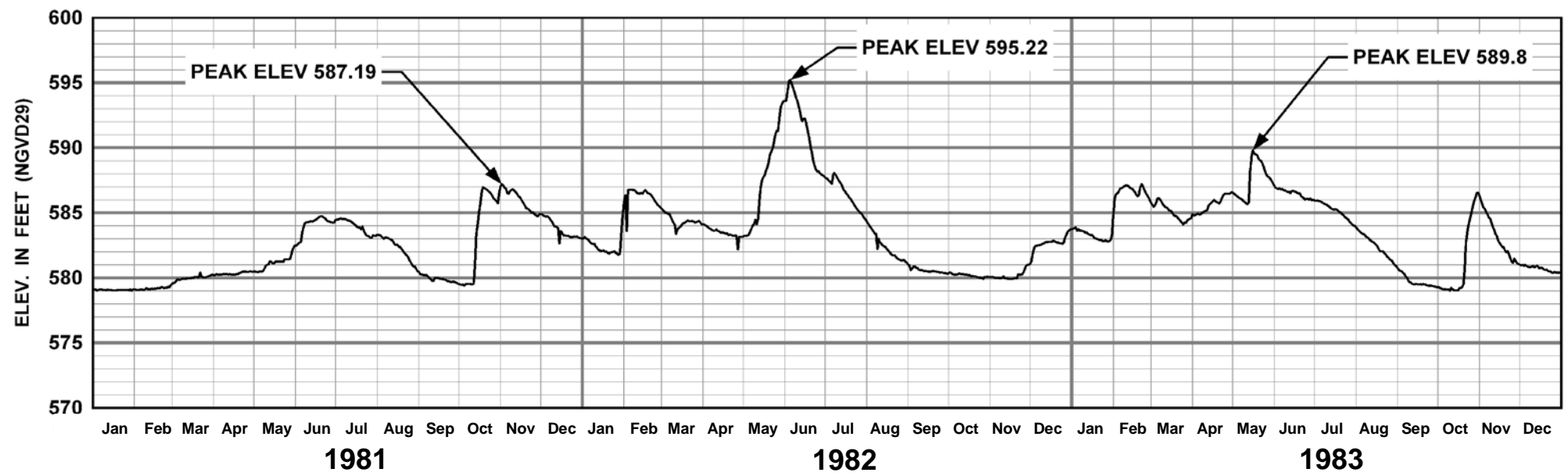
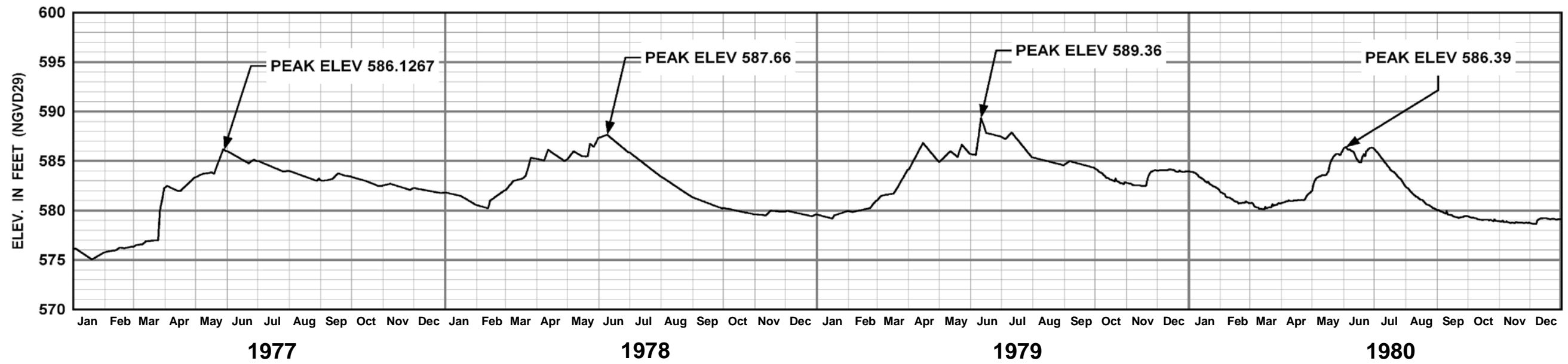
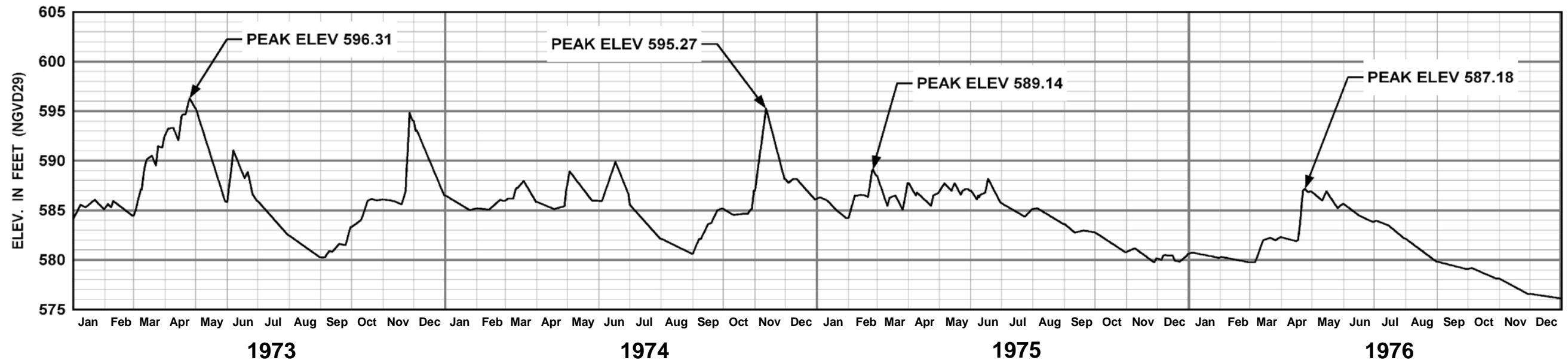
Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFULA LAKE

POOL ELEVATION HYDROGRAPHS
1962 - 1972

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
 DRAWN: RKB
 CHECKED: JRL



NOTE: Pool elevations for Jan 1940 through Feb 1964 are based on a simulation using the RiverWare computer program. Elevations for Mar 1, 1964 through Dec 2011 are actual historical values.

Note: Plate size is 11" x 17"

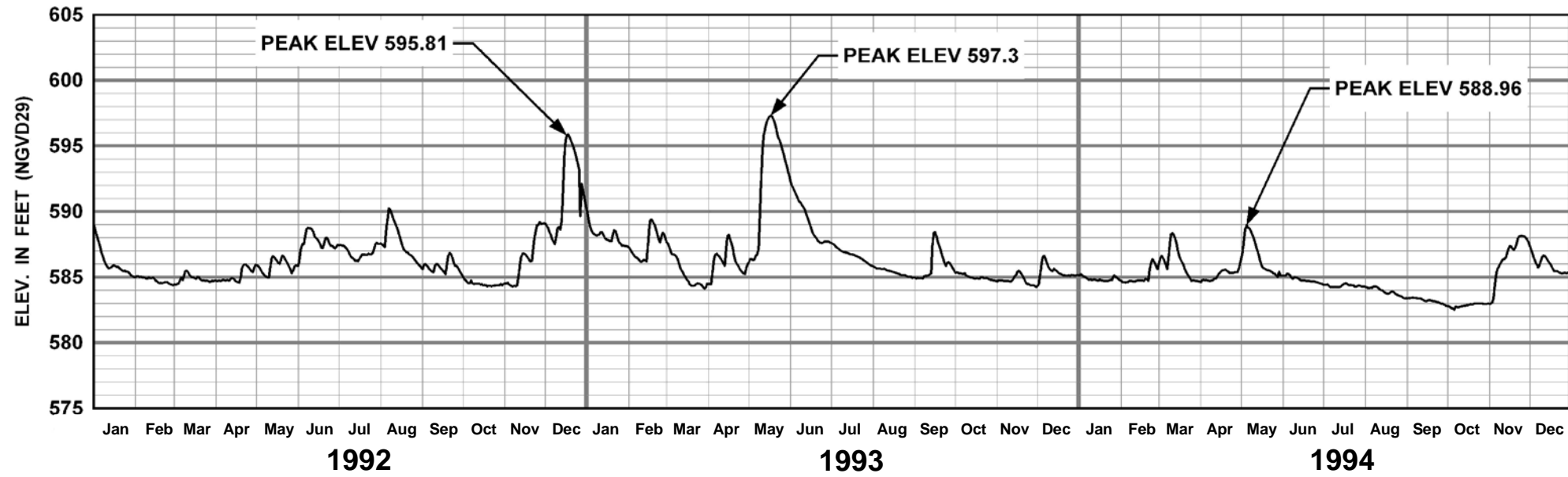
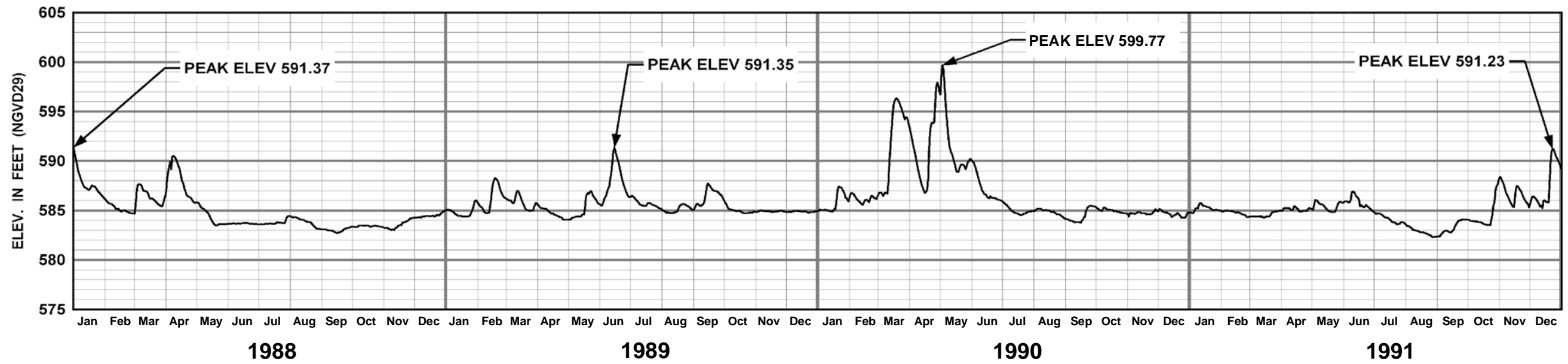
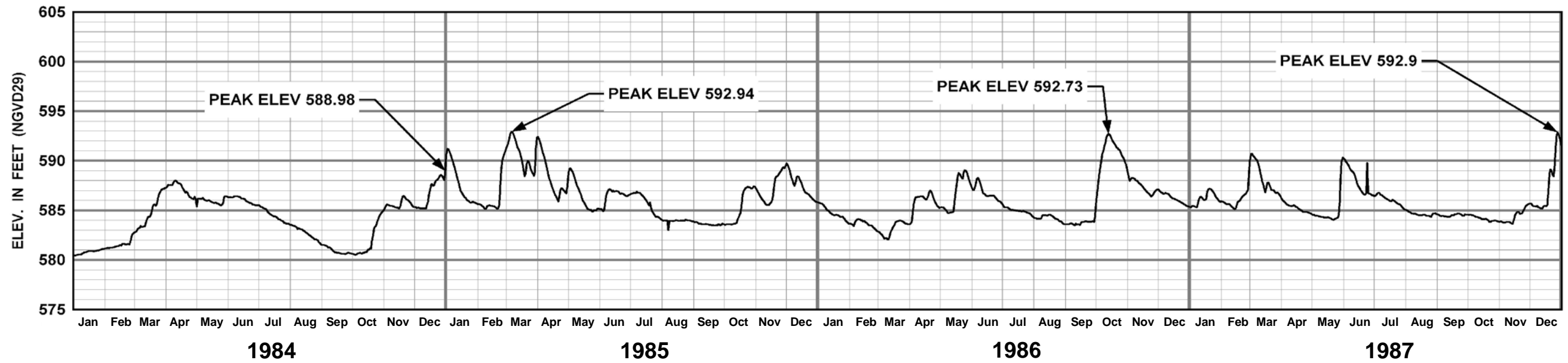
ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

POOL ELEVATION HYDROGRAPHS

1973 - 1983

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
 DRAWN: RKB
 CHECKED: JRL



NOTE: Pool elevations for Jan 1940 through Feb 1964 are based on a simulation using the RiverWare computer program. Elevations for Mar 1, 1964 through Dec 2011 are actual historical values.

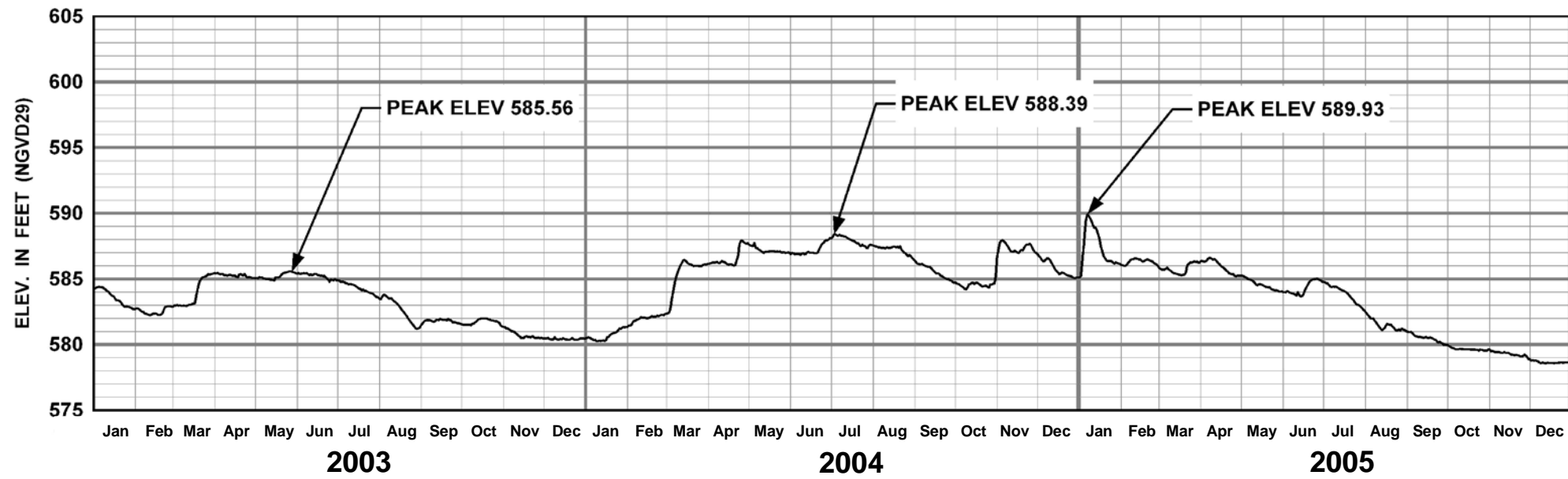
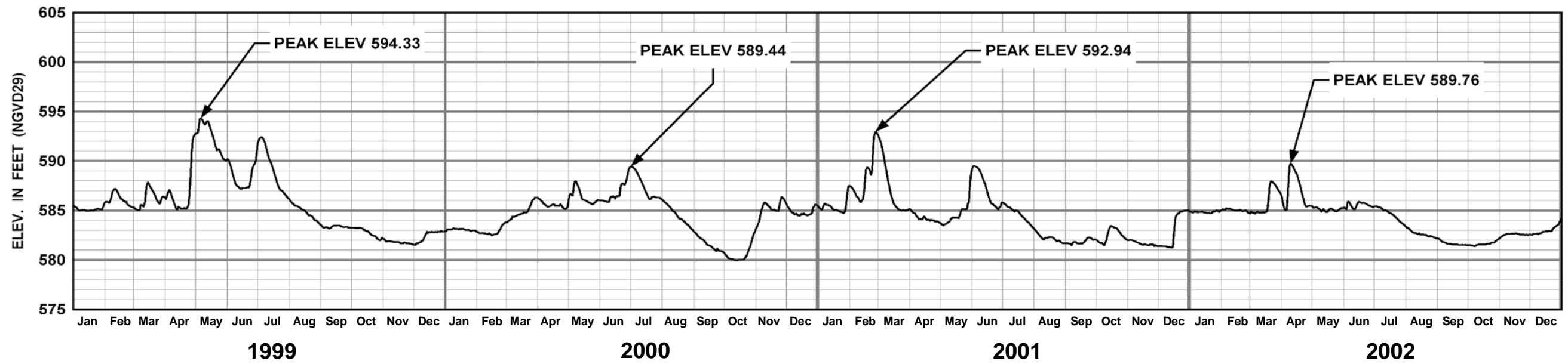
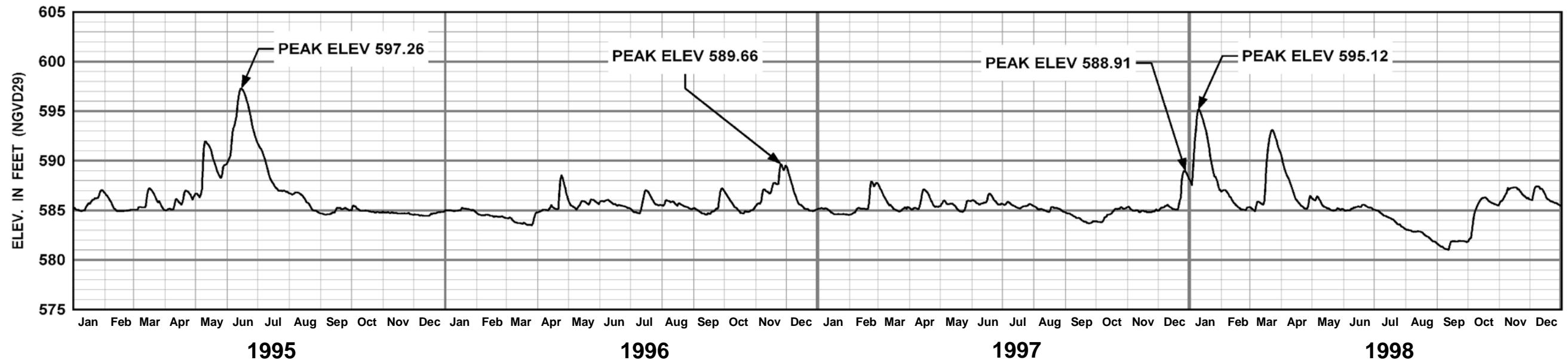
Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**POOL ELEVATION
HYDROGRAPHS
1984 - 1994**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL



NOTE: Pool elevations for Jan 1940 through Feb 1964 are based on a simulation using the RiverWare computer program. Elevations for Mar 1, 1964 through Dec 2011 are actual historical values.

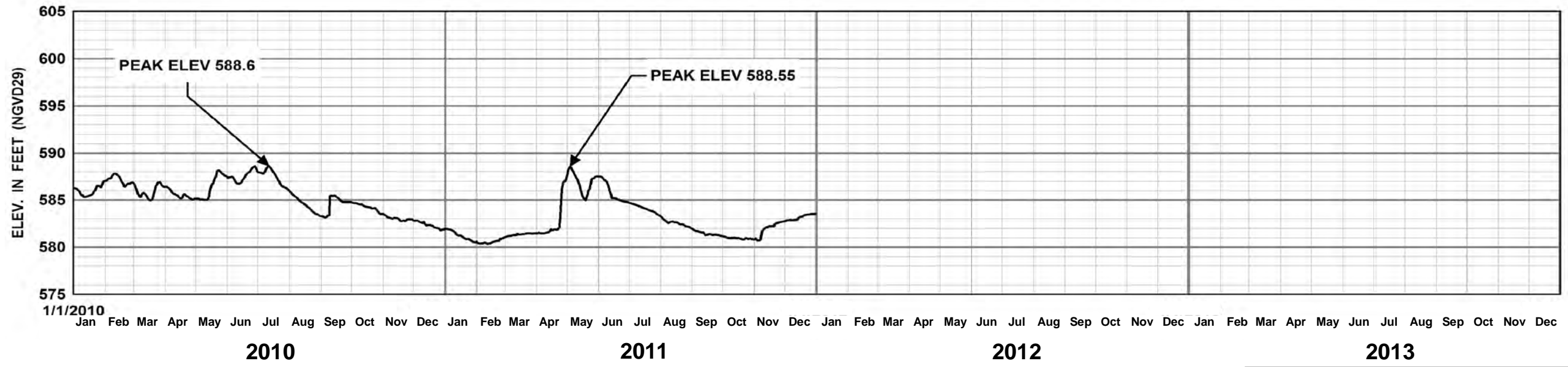
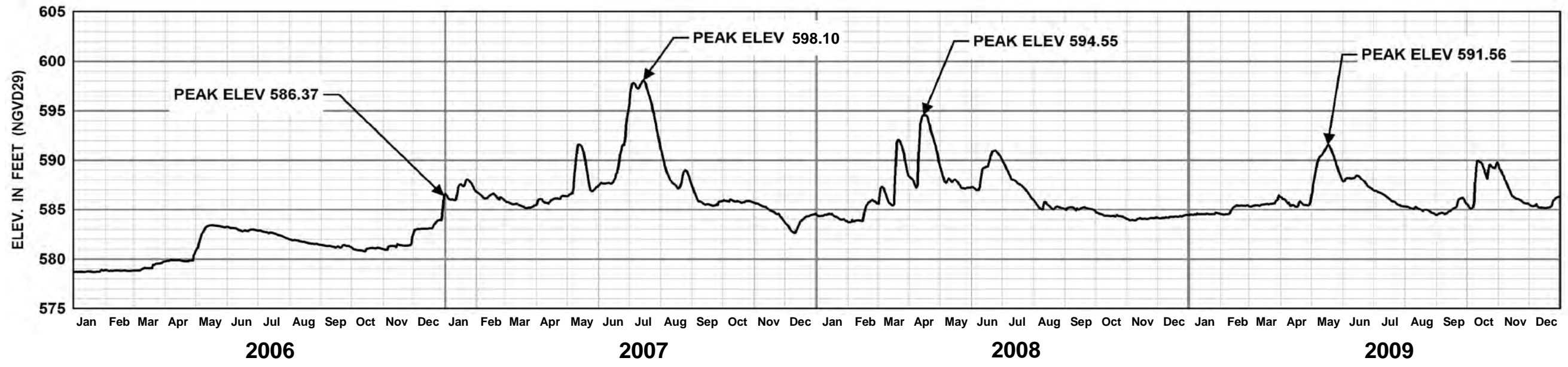
Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**POOL ELEVATION
HYDROGRAPHS
1995 - 2005**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL



NOTE: Pool elevations for Jan 1940 through Feb 1964 are based on a simulation using the RiverWare computer program. Elevations for Mar 1, 1964 through Dec 2011 are actual historical values.

Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED CANADIAN RIVER, OKLAHOMA

EUFAULA LAKE

**POOL ELEVATION
HYDROGRAPHS
2006 - 2011**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL