LAKE TEXOMA (DENISON DAM)
RED RIVER, OKLAHOMA AND TEXAS
WATER CONTROL MANUAL

APPENDIX A
TO
MASTER WATER CONTROL MANUAL
RED RIVER BASIN

PREVIOUS EDITION – APRIL 1993
REVISED EDITION – OCTOBER 2011

DEPARTMENT OF THE ARMY
TULSA DISTRICT, CORPS OF ENGINEERS
OKLAHOMA

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 at (918) 669-7023. If the above office cannot be contacted, assistance can be achieved by contacting, in the order listed, one of the 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

TITLE AND NAME	RESIDENCE TELEPHONE
Coordinator (b) (6)	(b) (6)
Backup Coordinator (b) (6)	
Chief, Water Management Section (b) (6)	
Chief, Hydrology-Hydraulics Branch (b) (6)	

POWERHOUSE, OUTLET WORKS, AND DAM AT LAKE TEXOMA (DENISON DAM)

LAKE TEXOMA (DENISON DAM)
RED RIVER, OKLAHOMA AND TEXAS

APPENDIX A
TO
MASTER WATER CONTROL MANUAL
RED RIVER BASIN

TABLE OF CONTENTS

Section Title **Page**

TABLES

TABLES (continued)

EXHIBITS

PLATES

PLATES (continued)

PLATES (continued)

PERTINENT DATA

LOCATION:
Denison Dam is located in Bryan County, OK and Grayson County, Texas at RM 725.9 on the Red River, about 5 miles northwest of Denison, TX.

DRAINAGE AREA:
39,719 square miles above the dam, of which 33,783 square miles are contributing.
1 Inch of Runoff = 1,801,760 Acre-feet

DAM:
Type: Rolled Earth fill Embankment
Top of Dam Elev. = 670.0 feet, NGVD29
Length: 17,200 feet (including spillway)
Max Height: 165 feet above streambed
Top Width of Embankment: 40 feet

SPILLWAY:
Crest Elevation: 640.0 feet, NGVD
Length: 2,000 feet
Type: Uncontrolled concrete chute

LAND ACQUISITION:

	Guide Contour	Area (acres)
Fee Simple	640.0 feet on OK side 650.0 feet on TX side and in upper reaches	195,481

OUTLET WORKS:
Type & Size: Three 20' diameter conduits
Location: Near right end of embankment (on left side of the river channel)
Control: Six 9'x 19' vertical lift gates and two 9'x 19' emergency gates
Invert Elevation: 523.0 feet

POWER FEATURES:
Installed Capacity
Current: 70,000 kilowatts
Potential: 199,000 kilowatts
No. of Units: 2
Penstock Invert Elevation:
523.0 feet, NGVD29
Additional penstocks
(for future units): 3

PERTINENT DATA (continued)

Feature	Elevation (feet NGVD29)	Area (acres) [1]	Lake Capacity			Spillway Capacity (c.f.s.)	Outlet Works Capacity (c.f.s.)
			Accumulative Capacity (acre-feet) [1]	Accumulative Runoff (inches) [2]	Incremental Capacity (acre-feet) [1]		
Top of dam	670.0	--	--	--	--	-	
Maximum pool	666.4	--	--	--	--	1,048,400	75,000
Top of induced surcharge	643.0	148,849	5,487,354	3.05	435,980	35,650	68,400
Top of flood control pool and spillway crest	640.0	141,418	5,051,374	2.81	2,534,949	0	67,500
Top of conservation pool	617.0	74,686	2,516,425	1.40	1,467,403	-	60,300
Top of inactive pool	590.0	40,434	1,049,022	0.58	1,049,015	-	50,400
Invert of lowest intake	523.0	12	7	-	7		0
Streambed	505.0						

(1) Based on 2002 survey

(2) Runoff from normal contributing drainage basin area of 33,783 square miles.
One Inch of Runoff = 1,801,760 acre-feet.

B

LAKE TEXOMA (DENISON DAM)
RED RIVER, OKLAHOMA AND TEXAS
APPENDIX A
TO
MASTER WATER CONTROL MANUAL
RED 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 A to the Red River Basin Reservoir Regulation Master Manual. Other related manuals important to the regulation of Lake Texoma are:

Appendix B - Altus
Appendix C - Fort Cobb
Appendix D - Foss
Appendix E - Little River System
Part I - Pine Creek
Part III - Broken Bow
Part IV - DeQueen
Part V - Gillham
Part VI - Dierks
Part VII - Millwood
Appendix F - Arbuckle
Appendix G - Pat Mayse
Appendix H - Hugo
Appendix J - Lake Kemp
Appendix K - Mountain Park Dam and Tom Steed Reservoir
Appendix L - Waurika
Appendix M - Sardis
Appendix N - McGee Creek

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

1-04. Project Owner. Lake Texoma (Denison Dam) is owned by the U.S. Government.

1-05. Operating Agency. The U.S. Army Corps of Engineers is the operating agency for Lake Texoma. The Lake Manager, Lake Texoma, through the Operations Project Manager, Red River Area, and the Operations Division, Tulsa District, has the responsibility for project operations. The project is placed under 24-hour surveillance when the lake level is above elevation 632.0 feet, National Geodetic Vertical Datum 1929 (NGVD29). When the project is in flood control operations, project personnel will closely monitor the project and the downstream river reaches. The project office has been furnished a list of the Water Management personnel to contact when necessary.

TABLE 1-1

PERTINENT REPORTS AND DESIGN MEMORANDA
FOR LAKE TEXOMA (DENISON DAM)

Memorandum No.	Title	Date Submitted
DM-5	Denison Dam (Lake Texoma) Red River, Texas & Oklahoma, Repair of Embankment Protection Stone, Cumberland Levee	Apr 1961
	Red River Water Control Master Manual	Nov 1962
DM-3	Denison Dam and Lake Texoma, Red River, Texas and Oklahoma Master Plan	(Updated) Jun 1978
	Denison Dam – Lake Texoma, Red River, Oklahoma and Texas, Operations and Maintenance Manual – Volume I, Dam and Structures	Nov 1983
	Denison Dam – Lake Texoma, Red River, Oklahoma and Texas, Operations and Maintenance Manual – Volume II, Flood Emergency Plan	Aug 1997
	Upper Red River, Oklahoma and Texas, Red River Basin, Waurika Lake and Lake Texoma, Drought Contingency Plan	(Updated) Feb 2006

The Lake Manager will furnish the Water Management Section a list of project personnel, giving their office and home telephone numbers and addresses.

1-06. Regulating Agencies. The regulating agency for Lake Texoma 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 the 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.

1.07. Lake Texoma Advisory Committee. In an effort to gain a greater degree of public participation in the management of Lake Texoma, and in accordance with PL 100-71 (see Exhibit B), the Lake Texoma Advisory Committee was established in Jan 1988. The committee consists of a Chairperson, Vice-Chairperson and Secretary. The committee membership consists of persons representing the following areas of interest,

but is not limited to: lake associations, water supply, hydropower, marina operations, state park departments, state and federal wildlife departments, navigation, real estate associations, county governments, environmental groups, private boat docks, flood control and other interest areas as appropriate. Currently, the LTAC meets twice a year, once in the spring and once in the fall. The purpose of the LTAC is to advise and make recommendations concerning issues relevant to the operation and management of Lake Texoma/Denison Dam, to the Tulsa District Engineer. Issues that may be considered by the LTAC include, but are not limited to: lake levels, lake shore management, water quality, wildlife and fisheries management, recreation, law enforcement, cultural resources protection, water safety, erosion control, land management and other such subjects that affect the overall lake area. The LTAC will not consider or discuss subjects contrary to public law or currently in litigation. LTAC had a large part in the establishment of the current Seasonal Pool Plan at Lake Texoma.

II - DESCRIPTION OF PROJECT

2-01. Location. Denison Dam is located at river mile 725.9 on the Red River and is about 5 miles northwest of the town of Denison, Texas, on U.S. Highway 75A. The project location and general vicinity is shown on Plate 2-1.

2-02. Purpose. Lake Texoma is a multi-purpose project for flood control, regulation of flows on the Red River, water supply, hydropower, recreation, navigation, and other beneficial uses including fish & wildlife. The project was designed to provide maximum flood protection on the Red River when operated in conjunction with the other flood control projects in the Red River Basin.

2-03. Physical Components.

a. Embankment. The embankment is a rolled earth fill structure with the crest of the embankment at elevation 670.0 feet. It has a maximum height of 165 feet above the streambed. The width of the embankment at crest height is 40 feet, including 24 feet of roadway paving. The upstream slopes of the embankment are protected by riprap while the downstream slopes are grass covered. A general plan and a section of the main embankment are shown on Plate 2-2.

b. Spillway. The spillway is an uncontrolled concrete gravity chute-type structure, with a crest length of 2,000 feet. It is located in a saddle near the right abutment. The location and a section of the spillway are shown on Plate 2-2.

c. Outlet Works. The outlet works consist of three 20-foot-diameter concrete conduits located near the right abutment. These conduits extend from the intake structure, through the embankment, to a stilling basin on the downstream side of the embankment. Flow through the conduits is controlled by six 9-foot by 19-foot vertical lift gates and two emergency gates located in the intake structure. The concrete slab stilling basin consists of four rows of baffles and an end sill. The location and sections through the conduits and outlet works are shown on Plate 2-2.

d. Sediment and Degradation Ranges. The U.S. Geological Survey (USGS) performs sediment and water quality sampling by request for special projects. At the present, chloride control studies are funding the sampling of Denison Dam tailwater, at the Gainesville, Texas, gage and Dickson, Oklahoma, gage sites. The measurement of sediment deposited in the lake is accomplished by taking sonic soundings along established sediment ranges and/or by georeferenced bathymetry surveys. The cross sections of these ranges were determined in Aug 1939 and the end of each range is marked by permanent monuments with known vertical and horizontal positions. Sediment resurveys were made in Sep 1948, Jun 1954, Mar 1962, 1969, 1985, and 2002. The 88 sedimentation ranges are shown on Plate 2-3. In order to provide information on the stream channel downstream from the dam, 39 degradation ranges across the flood plain have been established extending to near the Fulton, Arkansas,

gage. The 39 degradation ranges downstream of Denison Dam are shown on Plates 2-4 and 2-5.

e. Hydroelectric Power Facilities. The powerhouse contains two 35,000 kilowatt (kW) generators, with provisions for three additional 43,000 kW units. One 20-foot diameter steel-lined conduit provides water for each power unit penstock. Each of the five power conduits is equipped with two 9-foot x 19-foot vertical lift gates located in the intake structure. Unit 1 had a “rewind” completed in Nov 2005, and Unit 2 had a “rewind” completed in May 2006. The maximum turbine discharge is now 13,600 c.f.s. (with two units on overload at 88 megawatts (mW) at elevation 617.0 feet. The powerhouse and power conduits are located adjacent to the outlet works near the right abutment. The location of the powerhouse is shown on Plate 2-2.

f. Water Supply Facilities. A list of current water supply users with approved contracts is shown in Table 7-4. No water supply intake structures were designed or built with the original Denison Dam project. The structures that currently exist were built by the water supply users when needed. Currently, there are four intake structures in the lake because the Texas Power and Light withdraws water from the Red River approximately 19 river miles downstream of Denison Dam. The City of Denison withdraws water through two vertical turbine pumps in wet wells located about one-half mile west of the dam on the south side of the lake; the invert elevations of the two intakes are 588.8 feet and 600.0 feet. The Red River Authority of Texas has an intake structure with an invert elevation of 601.0 feet on the south side of the lake, about 5 to 6 miles west of the dam near the Preston Shores development. The North Texas Municipal Water District withdraws water through five pumps located on the south side of the lake about 3 to 4 miles west of the dam on the southeast side of Grandpappy Point; these pumps can withdraw water from elevations considerably below elevation 600.0 feet.

2-04. Related Control Facilities. In the vicinity of Platter, Oklahoma, a rolled earth fill dike having a total length of 5,870 feet and a maximum height of 15 feet was built to protect the town from flooding. A system of levees collectively called the Cumberland Levee was built to protect the Cumberland Oil Field. The Cumberland Oil Field was discovered while the Lake Texoma project was under construction; the field consists of 139 oil wells in an area extending from river mile 16.0 to mile 20.0 on the west bank of the Washita River (Plate 2-6). The total length of the levees is about 23,480 feet and the maximum height is approximately 90 feet above the riverbed. The original crest elevation of the levees was 646.0 feet, but was raised 1 foot during the 1957 flood to elevation 647.0 feet. The levees were raised again in May 1990 in response to high flood waters. The levees were designed so that the crest could be raised 6 feet, with a crown width of 20 feet with side slopes not exceeding 1V on 2H. Plate 2-6 shows a 1990 top of levee profile superimposed on the bottom profile and flow lines developed in the early 1970's. No new information on the flow lines, bottom profile, or cross sections is currently available. The twenty-four hour flood surveillance at the Cumberland Levee begins at elevation 632.0 feet, which is the same as for Lake Texoma.

2-05. Real Estate Acquisition. The fee taking line for the land surface rights to the Lake Texoma area is a semi blocked perimeter to elevation 640.0 feet, except in the upper reaches of the lake and on the Texas side, where land was purchased to elevation 650.0 feet. The purchase of land to elevation 650.0 started in Sec. 28, R2E, T8S, on the Red River and Sections 12 and 13, R5E, T4S, on the Washita River. The purchase of land to elevation 650.0 feet was due to the backwater effects as determined by the envelope curve of the 50-year frequency flood routed on a full pool. The Texas side of the lake was purchased to elevation 650.0 feet because of rugged terrain. Mineral rights were not acquired with the lake area surface lands. When the discovery of oil in the Cumberland Field occurred in 1940, it proved more advantageous to build dikes and cut a bypass channel around this valuable resource than to buy up the mineral rights in the area that would otherwise be submerged. Claims totaling about $6,000,000 for denying the exercise of mineral rights in the other lands now covered by Lake Texoma were later filed against the Government. Those claims not invalidated by the statute of limitations were settled for about $2,000,000 by the Department of Justice on the basis of the present plan of regulation for Lake Texoma.

2-06. Public Facilities. Recreation facilities developed by the Government include these basic facilities: roads, parking areas, trails, boat ramps, picnic areas, water and sanitary facilities, primitive campgrounds, and electrical outlets at campgrounds. The Corps of Engineers collects camping fees and recreation user fees as a source of revenue for maintaining and upgrading these facilities. Concession facilities operated by private interests supply food and refreshments, bait, fishing and hunting supplies, marinas, dock space, and other miscellaneous items for public convenience. Public use areas are shown on Plate 2-7.

III - HISTORY OF PROJECT

3-01. Authorization. Construction of the Lake Texoma (Denison Dam) project was approved by Congress under the Flood Control Act approved 28 Jun 1938 (Public Law 761, 75th Congress).

3-02. Planning and Design. A report, "Control of Floods in the Alluvial Valley of the Lower Mississippi River," was published in 1931 as House Document 798, 71st Congress, 3rd Session. This report reviewed projects included in the Flood Control Act approved by Congress on 15 May 1928 for flood control and navigation on the Mississippi River and its alluvial valley. Studies were made for a system of reservoirs located on tributaries of the Mississippi River. One of these sites was the Lake Texoma site, but the construction of a reservoir was not economically justified at that time. The comprehensive report on the Red River, published in 1936 as House Document 378, 72nd Congress, 2nd Session, considered the possibilities of navigation on the Red River and combined flood control and navigation projects. This report stated that the construction of Denison Dam appeared warranted if local interests were in a position to cooperate in the cost of the project. A report on the survey of the Denison Reservoir (Lake Texoma) and the Red River in Louisiana, Arkansas, Oklahoma, and Texas was transmitted to Congress on 12 Mar 1938. This report was published as House Document 541, 75th Congress, 3rd Session, and led to the authorization for the construction of Denison Dam for flood control and hydroelectric power in the Flood Control Act of 28 Jun 1938.

Following authorization of Lake Texoma by the Flood Control Act of Jun 28th 1938, a definite project report for the project, dated Apr 1939, was submitted to the Chief of Engineers by the U.S. Engineer Office, Denison, Texas. This report was approved as a basis of design by the Chief of Engineers. Public Law 868, 76th Congress, 3rd Session, approved 17 Oct 1940, authorized Denison Reservoir to improve navigation, regulate flow of the Red River, control floods, and provide other beneficial uses. An Act of Congress, approved 22 Dec 1944 and Public Law 85-500, approved 3 Jul 1958, known as the "Water Supply Act of 1958," authorized the Secretary of the Army to contract for water supply storage to State and local interests. Public Law 454, 78th Congress, 2nd Session, approved 30 Sep 1944, authorized the impoundment to be designated as Lake Texoma. Public Law 273, 83rd Congress, 1st Session, approved 14 Aug 1953, authorized water supply storage of 21,300 acre-feet for Denison, Texas. Public Law 164, 84th Congress, 1st Session, approved 15 Jul 1955, authorized the construction of Willis Bridge. Public Law 85-146, 85th Congress, approved 14 Aug 1957, authorized water supply storage of 41,000 acre-feet for Sherman, Texas. Public Law 99-662, 99th Congress, approved 17 Nov 1986, authorized the use of Lake Texoma for recreation. Public Law 100-71 created the Lake Texoma Advisory Committee and called for the development of a lake management plan.

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

TABLE 3-1

RESUME OF CONSTRUCTION ACTIVITIES

Activity	Date
Construction began	Aug 1939
Date of diversion	Jul 1942
Final storage began	Jan 1944
Power pool filled and Power Generation Started	Mar 1945

3-04. Related Projects. Lake Texoma is an integral part of a multi-purpose plan for flood control, generation of hydroelectric power, navigation, and other beneficial water uses on the Red River and its tributaries. Lake Texoma is aided in providing flood protection to the Red and Atchafalaya River valleys by McGee Creek, Pat Mayse, Sardis (formerly Clayton), Hugo, Pine Creek, Broken Bow, DeQueen, Gillham, Dierks, Millwood, Cooper, Wright Patman, Lake 'O Pines, Caddo, Bodcau, and Wallace Lakes, all of which are in operation; Boswell and Lukfata Lakes were de-authorized on 16 Apr 2002 and Tuskahoma Lake was de-authorized on 19 Jul 1992.

3-05. Modifications to Regulations. The regulation of Lake Texoma has been modified to coincide with the present Red River System Operating Plan as discussed in the Red River Water Control Master Manual, dated Nov 1962. The flood control and conservation regulations for Lake Texoma supersede those included in the "Report on Review of Reservoir Regulations for Flood Control on Lower Red River," submitted Feb 1959 and revised Sep 1960, and the previous Reservoir Regulation Manuals dated May 1975 and Apr 1993.

3-06. Principal Regulation Problems. There have been no significant structural problems at the Texoma project related to the regulation of Lake Texoma. However, there are some problems associated with the lake elevation, downstream flows, and the dissolved oxygen levels in downstream flows:

a. Lake Elevation. In the past there have been some questions among users and landowners on the lake as well as downstream landowners along the Red River as to

what should be the normally regulated lake level throughout the year. High and low pool elevations have caused serious problems to many lake activities in the past. The lake has normally been regulated to the top of conservation pool elevation of 617.0 feet. Most of the boat dock and marina operators prefer the lake level to be maintained between elevations 615.0 feet and 617.0 feet. When the lake level drops below elevation 612.0 feet, most of the boat docks and marinas have to shut down. Major problems with most all lake activities occur when the lake level drops below 610.0 feet. Conversely, when the lake level rises to an elevation above 621.0 feet, walkways and roadways at some marinas and parks begin to flood. Major problems for most lake activities occur when the pool rises above elevation 625.0 feet. At elevation 630.0 feet, most boat docks and marinas are closed due to flooding. In Jul 1987, the Lake Texoma Advisory Committee was formed in accordance with PL 100-71 (Exhibit B) to allow lake users, lake concessionaires, other state and federal agencies, and people with downstream agricultural and navigation interests to make recommendations to the Corps concerning the regulation and management of Lake Texoma.

b. Seasonal Pool. In Oct 1991, the Lake Texoma Advisory Committee voted to recommend a specific seasonal pool plan for Lake Texoma. The idea of a new lake level management plan was first recommended by the Committee in 1989. The various interest groups represented by the Committee each developed seasonal pool plans that would meet their individual needs. These individual plans were incorporated into a consensus plan that the Committee voted to accept as a recommended plan to manage the lake level throughout the year. The recommended plan was studied and analyzed by the Tulsa District to determine if it would have any effects on flood control regulation. The plan was found to provide some minor benefits to downstream flood control and a minor reduction in the frequency of high and low pools in the lake. Two public meetings were held in Jan 1992 to present the plan to the public and to allow the public to voice any support or opposition to the proposal. Original documentation on the public meetings conducted is filed in the Hydrology-Hydraulics Branch, Tulsa District. No opposition to the plan was voiced at the public meetings and no written opposition was received during the comment period. The seasonal pool plan was implemented in Apr 1992 as an approved deviation to the normal regulation of Lake Texoma until approval of the revised Water Control Manual. In 1997, the Seasonal Pool Plan was revised. This current Seasonal Pool Plan is shown on Plate 7-1. The seasonal and transitional pool guidelines dictates a drawdown of the lake level to elevation 615.0 feet in the late winter and early spring, a rise to elevation 619.0 feet during May and through the summer, a drawdown to elevation 616.5 feet in the late summer and early fall, and a rise to elevation 618.5 feet in the late fall and early winter. Results of the seasonal pool study are presented in paragraph 8-10.

c. Downstream Flows. It is difficult to maintain accurate rating curves on the Red River downstream of Denison Dam due to the shifting channel banks of the Red River and because of the continuous cycle of sediment deposits and channel scour. The USGS is responsible for keeping the rating curves updated by making periodic flow measurements. When the downstream area experiences flooding, most of the damage is to agricultural areas. Downstream of Lake Texoma, there are problems with bank

caving during high flows and flow recession in the reach of the Red River stretching from Denison Dam to Index, Arkansas. Efforts to minimize bank caving by regulating procedures are discussed in paragraph 7-13.

d. Dissolved Oxygen. There have been problems with low dissolved oxygen concentrations in water released through the hydropower turbines primarily during the months of Aug through Oct. Upon request from the Texas Department of Parks and Wildlife, and /or the Oklahoma Department of Wildlife Conservation, small discharges have been made through the flood conduit to provide aeration. Different options have been studied to improve dissolved oxygen in the stilling basin. No alternatives have been implemented, as it has been found that the low flow releases are supersaturated with oxygen, and are sufficient to keep fish distress to a minimum.

e. Endangered Species. Tulsa District issued an Endangered Species Biological Assessment in 2003. U.S. Fish and Wildlife Service in turn issued an Endangered Species Biological Opinion in 2005. These both addressed the interior least terns. The Interior Least Terns nest on sandy open areas around the lakes and on islands in the rivers. Separately, Tulsa District developed the Management Guidelines and Strategies for Interior Least Terns in 2003, addressing operating procedures at numerous lakes in Tulsa District, including Lake Texoma. Over the years, it has been found that releases from Lake Texoma only have impact on the interior least tern nesting up to the confluence of the Blue River with the Red River. From that point on, the uncontrolled tributaries to the Red River have the major impact on nesting sites. While this is recognized at this time, Lake Texoma releases are evaluated each year for any anticipated impacts on the interior least terns and their nesting habitat.

IV - WATERSHED CHARACTERISTICS

4-01. General Characteristics. The Red River rises in the Staked Plains near the eastern edge of New Mexico, flows generally eastward about 800 miles across the Texas Panhandle and between the states of Oklahoma and Texas, to Fulton in southwestern Arkansas, then flows south and southeast 463 miles until it enters the Atchafalaya River near the Mississippi River at Red River Landing (Mississippi River mile 302). The total length of the Red River is approximately 1,222 miles. The fall of the river varies from about 23 feet per mile near the source to about 1.5 feet per mile at Denison Dam (river mile 725.9). At Alexandria, Louisiana, the slope of the river is about 0.5 feet per mile. From about river mile 1,200 to the headwaters of Lake Texoma, the channel is wide and sandy with a poorly defined, shifting, low-water channel. From Denison Dam to Fulton, Arkansas, the river flows between high banks about 1,000 feet apart. The low-water channel is poorly defined and is subject to continual shifting with fluctuations in stream flow. The banks rise 15 to 25 feet above the low-water flow line. From Fulton, Arkansas, to Alexandria, Louisiana, the high banks are about 1,000 to 1,200 feet apart and rise 20 to 35 feet above the low-water flow line. Controlling channel capacities for the Red River vary from 45,000 c.f.s. at Denison Dam to 128,000 c.f.s. at Fulton, Arkansas. The Washita River is the largest tributary entering the Red River upstream of the dam. The Washita River has an approximate length of 626 miles and a drainage area of about 7,950 square miles. Between Denison Dam and the Fulton, Arkansas, stream gage the most important tributaries enter the Red River from the north. These tributaries include: Boggy Creek which enters the Red River at mile 664.0; Kiamichi River which enters the Red River at mile 607.0; and Little River which enters the Red River at mile 465.0. Stream profiles of the Red River and larger tributaries upstream of Fulton, Arkansas, are shown on Plates 4-1 and 4-2.

4-02. Topography. The Red River flows through three physiographic provinces: the Great Plains province, the Osage Plains section of the Central Lowland province, and the West Gulf Coastal Plain. The terrain of the Red River drainage basin includes virtually flat areas in New Mexico's Staked Plains, rolling hills in Texas and Oklahoma, and areas of low topographic relief in the Gulf Coastal Plain. Throughout New Mexico, Texas, and Oklahoma, the river channel is shallow, meandering, and subject to frequent changes. The Red River drainage system has been partially controlled to alleviate flooding in its drainage area. Land use in the drainage basin consists of crop production, ranching, and oil and gas production.

4-03. Geology and Soils. Lake Texoma is located in the Osage Plains section of the Central Lowland physiographic province. The bedrock strata are sedimentary rocks, mostly limestones and sandstones of upper Paleozoic age. The tertiary alluvial deposits include dune sand and loess.

4-04. Sediment. The lake inflow carries a large amount of sediment which comes mostly from the Red River. During periods of low flow, the channel is a wide, sandy waste with a poorly defined, shifting, low water channel. During periods of high flow, bank caving

and erosion occur at many locations. Several sediment re-surveys have been completed since the original survey in 1939, with the most recent being completed in 2002. Based on the changes between the 1939 and 2002 surveys, approximately 8.75 percent of the flood control storage, 22.25 percent of the conservation storage, and 15.74 percent of the inactive storage has been lost to sediment deposition since storage began in 1944. This is an annual rate of 14,833 acre-feet of sedimentation per year.

4-05. Climate. The climate in the Red River basin above Fulton, Arkansas, is generally mild with long summers and high temperatures. Winters are short and moderate except in the western portion of the basin where winters are more severe. The western third of the basin is located in a semiarid region where wind movements are generally excessive and the evaporation is high. In the central and eastern portion of the watershed, precipitation is usually adequate for agricultural purposes, and wind movements and evaporation are moderate. Climatic characteristics for that portion of the basin upstream of Lake Texoma are shown in the following tabulation.

a. Temperature. Denison Dam Period of Record (1940 – 2009)

Mean annual	62.4 degrees F
Maximum in basin upstream of Lake Texoma	
Altus, OK (19 Jul 1943)	120 degrees F
Tishomingo, OK (26 Jul 1943)	120 degrees F
Minimum in basin upstream of Lake Texoma	
Tulia, TX (12 Feb 1899)	-23 degrees F

b. Precipitation. (Average in basin upstream of Lake Texoma)

Mean Annual (Period of record 1930 – 2009)	26.76 inches
Maximum annual (1941)	45.13 inches
Minimum annual (1956)	17.95 inches
Percent during growing season (Apr through Oct)	75 %
Average Annual Snowfall	3 to 13 inches

Runoff from snowfall is not excessive and has not been a factor of importance in contributing to floods. The average monthly and annual rainfall and runoff data are shown in Table 4-1. The locations of precipitation and stream gaging stations are shown on Plate 5-1.

TABLE 4-1

AVERAGE MONTHLY AND ANNUAL RAINFALL
AND RUNOFF UPSTREAM OF DENISON DAM

Month	Average Rainfall (inches)	Percent of Average Annual Rainfall	Average Runoff (acre-feet)	Runoff [1][2] (inches)	Percent of Average Annual Runoff
Jan	1.10	4.11	175,370	0.10	4.31
Feb	1.29	4.82	216,410	0.12	5.17
Mar	1.73	6.46	316,700	0.18	7.76
Apr	2.40	8.97	456,670	0.25	10.78
May	4.34	16.22	818,340	0.45	19.40
Jun	3.48	13.00	733,820	0.41	17.67
Jul	2.14	8.00	259,890	0.14	6.03
Aug	2.27	8.48	174,170	0.10	4.31
Sep	2.92	10.91	240,260	0.13	5.60
Oct	2.57	9.60	359,880	0.20	8.62
Nov	1.37	5.12	223,820	0.12	5.17
Dec	1.15	4.30	216,000	0.12	5.17
TOTAL	26.76	100.00	4,191,330	2.32	100.00

(1) Period of record - Jan 1906 through Dec 2009.
(2) Drainage area upstream of Denison Dam is 39,719 square miles, of which approximately 33,783 contribute to flow at the dam.

c. Evaporation. Following the construction of the Denison 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 Jan 1941 through Dec 2009. Plate 4-3 shows curves based on the 2002 sediment survey data for lake evaporation.

TABLE 4-2

ESTIMATED MONTHLY
EVAPORATION (Lake Texoma)
Jan 1941 – Dec 2009

Month	Evaporation (inches) [1]	
	Normal	Drought Periods [2]
Jan	2.54	3.25
Feb	3.34	4.22
Mar	5.52	6.70
Apr	6.91	7.84
May	7.65	9.12
Jun	9.31	12.39
Jul	10.63	13.09
Aug	9.87	12.81
Sep	7.11	9.31
Oct	5.47	6.34
Nov	3.72	4.11
Dec	2.70	3.02
Annual Total	**74.77**	**92.20**

(1) National Weather Service Class "A" pan until 1996. Empirical estimate of pan evaporation since 1996.
(2) Using 1952 through 1956 as an example drought period.

d. Wind. The prevailing winds are from the south and southeast during the summer and from the northwest in the winter. A study of available wind velocity data indicates that the highest wind velocity that can reasonably be expected for a duration of one hour or more is 42 miles per hour.

4-06. Storms and Floods. Flood-producing storms in the semiarid and sub humid regions upstream of Lake Texoma are rare. Economic losses from floods upstream of Denison Dam are small except along the long, narrow watershed of the Washita River. Floods along the Washita River are developed by intense rains covering a small portion of the watershed. These intense rains produce floods of high peaks and relatively small volumes in short reaches of the river. Major flood-producing storms in the Lake Texoma Basin are listed in Table 4-3. These averages were computed from available rainfall station data in the vicinity which do not always record the actual center of intense storms. Due to this fact and because antecedent rainfall, season of the year, and various other factors influence storm runoff in the basin, floods have frequently followed storm periods with relatively small amounts of recorded rainfall. Storms with large amounts of recorded rainfall have not always caused major floods and in some

TABLE 4-3

MAJOR STORMS
JAN 1906 THROUGH DEC 2009
RED RIVER BASIN
UPSTREAM OF DENISON DAM

Storm Dates	Average Basin Rainfall (inches)	Storm Dates	Average Basin Rainfall (inches)
03-11 Aug 1906	4.11	05-16 Jun 1941	3.61
22-24 May 1908	5.09	28 Sep - 09 Oct 1941	4.74
01-06 Dec 1913	3.09	29-31 Oct 1941	1.61
17-26 Apr 1915	4.00	06-09 Apr 1942	3.03
02-08 Jun 1915	3.99	11-19 Mar 1945	2.18
12-18 Oct 1915	4.06	10-17 Apr 1945	2.51
21-27 Oct 1918	4.60	18-25 Apr 1945	3.39
04-11 Oct 1919	4.86	08-18 Jun 1945	3.02
09-16 May 1920	4.00	24-30 Sep 1945	5.13
07-11 May 1922	2.55	09-12 Dec 1946	2.35
11-16 Oct 1923	5.41	06-24 May 1947	7.47
22-27 Apr 1925	2.86	04-15 May 1950	3.32
10-25 Sep 1925	4.55	15-20 May 1951	4.62
14-19 Aug 1926	2.93	09-12 May 1954	3.60
25 Sep - 04 Oct 1926	6.40	16-20 May 1955	4.16
10-19 May 1928	3.57	02-05 Oct 1955	2.73
08-13 May 1929	3.51	19 Apr - 04 May 1957	9.30
21-26 May 1933	2.16	22-26 May 1957	2.10
12-19 May 1935	4.71	29 May - 05 Jun 1957	3.80
12-19 Jun 1935	2.08	21-22 Sep 1957	2.60
14-18 Feb 1938	3.42	29 Sep - 04 Oct 1959	4.21
01-07 May 1941	3.01	11-19 Oct 1960	3.71
18-24 May 1941	3.47	05-13 Jun 1962	3.69

TABLE 4-3 (continued)

Storm Dates	Average Basin Rainfall (inches)	Storm Dates	Average Basin Rainfall (inches)
22-26 Jul 1962	2.10	23-27 Jul 1975	2.52
04-09 Sep 1962	2.00	12-19 Apr 1976	2.42
26-31 May 1964	2.22	19-27 May 1977	2.71
14-17 Sep 1964	2.00	25-28 May 1978	2.22
14-29 Nov 1964	2.40	15-16 May 1980	2.65
20-26 Jun 1965	1.98	23-30 Sep 1980	3.12
16-22 Sep 1965	2.76	23-31 May 1981	2.55
21-26 Apr 1966	2.42	02-07 Jun 1981	2.55
21-25 Aug 1966	2.92	11-17 Oct 1981	5.60
09-13 Apr 1967	3.12	12-14 May 1982	2.52
17-23 Jan 1968	2.38	16-28 May 1982	5.60
05-17 May 1968	3.50	18-28 Jun 1982	3.54
02-08 May 1969	3.55	17-21 Oct 1983	5.73
21-29 Aug 1969	2.90	03-07 Jun 1985	4.23
20-24 Sep 1969	2.35	18-19 Oct 1985	2.24
26-31 May 1971	2.33	31 Aug - 05 Sep 1986	3.40
05-18 Aug 1971	3.52	20-29 May 1987	4.90
21-26 Sep 1971	3.20	14-24 Sep 1988	5.38
18-23 Oct 1972	2.65	12-18 May 1989	3.58
29 Oct - 01 Nov 1972	2.90	31 May - 05 Jun 1989	2.88
01-03 Jun 1973	2.50	07-14 Jun 1989	4.27
27-31 Jul 1973	2.18	08-14 Sep 1989	4.08
03-08 Sep 1973	3.65	10-15 Mar 1990	3.03
27 Apr - 01 May 1974	3.19	23 Mar - 01 Apr 1990	2.12
21-31 Aug 1974	2.55	13-28 Apr 1990	6.30
15-20 Sep 1974	3.30	02-03 May 1990	2.80
22-25 Sep 1974	2.30	25 May - 03 Jun 1990	2.90

TABLE 4-3 (continued)

Storm Dates	Average Basin Rainfall (inches)	Storm Dates	Average Basin Rainfall (inches)
18 Jul -05 Aug 1990	4.02	19-22 Feb 1997	2.29
17-22 Sep 1990	2.25	21-28 Apr 1997	3.02
20-25 May 1991	2.28	6-23 Aug 1997	2.93
29 May – 25 Jun 1991	6.76	19-29 Dec 1997	2.36
22-29 Jul 1991	2.15	15-20 Feb 1998	2.23
27 Aug – 8 Sep 1991	3.76	15-19 Mar 1998	2.69
13-25 Sep 1991	3.48	28 Oct – 3 Nov 1998	2.29
22 Oct – 5 Nov 1991	3.30	23 May – 1 Jun 1999	2.46
16-24 Dec 1991	3.15	26 Jun – 4 Jul 2000	2.26
17-26 May 1992	2.10	21-30 Oct 2000	4.34
28 May – 14 Jun 1992	5.38	1-8 Jul 2002	2.01
19 Jun – 24 Jul 1992	6.03	3-6 Mar 2004	2.06
19-26 Nov 1992	3.40	17-23 Jun 2004	2.18
1-24 Jan 1993	2.22	25 Jun – 3 Jul 2004	2.02
10-21 Feb 1993	2.13	13-18 Nov 2004	2.10
6-12 May 1993	2.60	17-24 Mar 2006	2.17
7-17 Mar 1994	2.14	11-24 Aug 2006	2.73
19 Apr – 16 May 1994	4.73	15-17 Oct 2006	2.96
20-30 May 1994	2.42	26-31 Mar 2007	2.72
5-18 Jul 1994	4.15	6-12 May 2007	2.89
2 Nov – 12 Dec 1994	4.43	24 May – 4 Jun 2007	3.03
21 May – 6 Jun 1995	6.77	10 Jun – 7 Jul 2007	7.25
31 Jul – 5 Aug 1995	4.18	18-21 Aug 2007	2.30
15-22 Sep 1995	4.03	15-21 Aug 2008	3.46
20-25 Apr 1996	2.32	9-14 Sep 2008	2.07
8-15 Jul 1996	2.75	25 Apr – 3 May 2009	3.74
23 Jul – 5 Aug 1996	2.37	27 Jul – 3 Aug 2009	2.00
21 Aug - 1 Sep 1996	3.30	4-15 Sep 2009	2.59

instances have resulted in only minor flooding. Storms in the Red River basin upstream of Fulton, Arkansas, which produce major floods on the main stem are usually of large areal extent and cause flooding on several tributaries. Storms rarely result in simultaneous flooding of all tributaries due to the large areal extent of the basin. The variable distribution, sequence, and intensities of precipitation for each storm result in widely varied flood conditions. Smaller high intensity storms frequently cause maximum or near maximum floods on the tributaries without resulting in overflows on the main stem. Floods for the period of record at pertinent stations are shown in Tables 4-4a and 4-4b, located in the Supplemental Tables Section.

4-07. Runoff Characteristics. Runoff throughout the Red River basin upstream of Fulton, Arkansas, is irregular. While the surface and river slopes of the western portion of the basin are conducive to high runoff, this part of the basin has the least rainfall, and the infiltration rate is very high. Certain areas in the high plains, particularly in the Prairie Dog Town Fork and North Fork basins, are considered to be non-contributing to runoff in the stream. In the eastern portion of the basin, the river slope varies from 3.0 feet to 1.0 foot per mile. Because of topographic characteristics and soil types, this part of the basin is more conducive to higher rates of runoff than the western portion. Pertinent data for stream gaging stations in the Red River basin are shown in Tables 4-5a through 4-5c. The estimated monthly and annual inflows at Denison Dam for the period of Jan 1906 through Dec 2009 are shown in Table 4-6, located in the Supplemental Tables Section. The inflow volume frequency (volume by months) is shown in Table 4-7. This inflow has been modified to reflect conditions with the existing upstream flood control projects. Flow duration curves (inflow and outflow) using flows modified by existing flood control projects are shown on Plate 4-4.

Peak inflows taken from monthly inflow computation records at the dam site for the period 1940 through 2007 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 Sep 1981. The peak inflow probability curve is shown on Plate 4-5.

4-08. Water Quality. Lake Texoma develops stratification during the late summer and early fall. Due to this stratification, the dissolved oxygen (DO) levels in the turbine discharge and in the water immediately downstream of the dam drop to levels that may be dangerous for some types of fish. Upon request from the Texas Department of Parks and Wildlife and/or the Oklahoma Department of Wildlife Conservation, a small release through the flood control conduits may be made during low flow periods to relieve fish distress due to low dissolved oxygen levels immediately downstream of the dam. Aspirating aeration systems and ways of injecting air into the generating turbine discharge have been studied, but not found to be cost effective when compared to the super saturation that occurs when low flow releases (50 c.f.s.) are made through the conduit gates. The USGS maintains a water quality sampling station just downstream of Denison Dam. Water temperature, specific conductance and chemical analyses are collected by request for special studies. Zebra mussel biological material was detected in Lake Texoma in 2008, with the first adult Zebra mussel being reported in 2009.

TABLE 4-5a

PERTINENT DATA FOR UPSTREAM GAGING STATIONS

STATION	STREAM	MILES ABOVE MOUTH	GAGE ZERO (ft.,NGVD)	FLOOD STAGE (ft.) (1)	DRAINAGE AREA (sq. mi.) (2)	MAXIMUM FLOOD OF RECORD		
						DATE	STAGE (ft.)	FLOW (c.f.s.)
Mangum, OK	Salt Fk. Red R	35.5	1490.00	9.0	1,357	16 Jun 1938	14.70	60,000
Headrick, OK	No Fk. Red R	33.0	1294.83	12.0	3,845	18 May 1935 (3)	19.80	60,000
Burkburnett, TX	Red River	933.0	952.57	9.0	14,634	21 Oct 1983	16.90	166,000
Terral, TX	Red River	872.0	770.31	22.0	22,787	22 Oct 1983	33.60	210,000
Gainesville, TX	Red River	791.5	700.00	25.0	24,846	31 May 1987	40.08	265,000

STATION	STREAM	2nd LARGEST FLOOD OF RECORD			3rd 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)
Mangum, OK	Salt Fk Red R	3 Oct 1986	14.66	21,400	16 May 1957	14.55	72,000	Oct 1937 – Present
Headrick, OK	No Fk Red R	4 Oct 1986	19.07	59,000	10 May 1993	18.83	56,100	Oct 1937 – Present
Burkburnett, TX	Red River	6 Jun 1995	16.61	174,000	4 Jun 1991	13.78	103,000	Dec 1959 – Present
Terral, TX	Red River	30 May 1987	32.65	225,000	7 Jun 1995	30.56	236,000	Apr 1938 – Present
Gainesville, TX	Red River	24 Oct 1983	37.14	151,000	13 Jun 1995	36.63	169,000	May 1936 – Present

(1) Regulating Flood Stages
(2) Contributing Drainage Area
(3) Historic Peak Discharge

4-9

TABLE 4-5b
PERTINENT DATA FOR ADDITIONAL UPSTREAM GAGING STATIONS

STATION	STREAM	MILES ABOVE MOUTH	GAGE ZERO (ft.,NGVD)	FLOOD STAGE (ft.) (1)	DRAINAGE AREA (sq. mi.) (2)	MAXIMUM FLOOD OF RECORD		
						DATE	STAGE (ft.)	FLOW (c.f.s.)
Cheyenne, OK	Washita River	543.9	1900.98	13.5	794	29 Apr 1954	15.24	69,800
Carnegie, OK	Washita River	353.9	1244.23	18.0	3,129	5 Jun 1995	31.50	40,200
Clinton, OK	Washita River	447.4	1467.44	18.0	1,977	3 Apr 1934 (3)	33.90	90,000
Pauls Valley, OK	Washita River	146.5	854.61	24.0	5,330	10 Jun 1941	30.60	22,000
Dickson, OK	Washita River	63.4	650.57	27.0	7,202	30 May 1987	45.24	105,000

STATION	STREAM	2nd LARGEST FLOOD OF RECORD			3rd 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)
Cheyenne, OK	Washita River	3 Apr 1934 (4)	16.90	52,000	23 May 1941	13.5	40,000	Oct 1937 – Present
Carnegie, OK	Washita River	19 Aug 2007	30.81	23,100	10 May 1993	30.68	25,500	Oct 1937 – Present
Clinton, OK	Washita River	16 May 1951	31.09	66,800	5 Jun 1936	28.50	26,900	Oct 1935 – Present
Pauls Valley, OK	Washita River	11 May 1950	29.88	30,000	1 Oct 1945	29.70	18,600	Oct 1937 – Present
Dickson, OK	Washita River	31 Oct 1941	44.37	85,000	11 May 1943	44.35	91,300	Aug 1928 – Present

(1) Regulating Flood Stages
(2) Contributing Drainage Area
(3) Discharge is an Estimate
(4) Historic Peak Discharge

4-10

TABLE 4-5c
PERTINENT DATA FOR DOWNSTREAM GAGING STATIONS

STATION	STREAM	MILES ABOVE MOUTH	GAGE ZERO (ft.,NGVD)	FLOOD STAGE (ft.) (1)	DRAINAGE AREA (sq. mi.) (2)	MAXIMUM FLOOD OF RECORD		
						DATE	STAGE (ft.)	FLOW (c.f.s.)
Arthur City, TX	Red River	633.1	375.07	27.0	38,595	28 May 2008	43.20	400,000
De Kalb, TX	Red River	556.9	302.92	23.7	41,412	6 May 1990	34.62	279,000
Index, AR	Red River	485.3	246.87	19.8	42,100	23 Feb 1938	34.25	297,000
Fulton, AR	Red River	463.0	224.94	25.0	46,444	2 Apr 1945	37.40	276,000

STATION	STREAM	2nd LARGEST FLOOD OF RECORD			3rd 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)
Arthur City, TX	Red River	19 May1892	34.80 (3)	(4)	19 Feb 1938	34.30	222,000	Jul 1936 – Present
De Kalb, TX	Red River	Jun 1957	32.20	205,000	11 Dec 1971	31.55	189,000	Oct 1968 – Present
Index, AR	Red River	10 May 1990	32.30	270,000	25 May 1925	31.10	(3)	Jul 1936 – Present
Fulton, AR	Red River	24 Feb 1938	36.5	338,000	24 Apr 1927	35.0	(3)	Oct 1927 – Sep 1981

(1) Regulating Flood Stages
(2) Contributing Drainage Area
(3) Gage Height Records Collected at Same Site Since 1891
(4) Not Determined or Available

4-11

TABLE 4-7

INFLOW VOLUME FREQUENCY
(1926-2009)

Frequency Of Occurrence (years)	Monthly Inflow in Thousands of Acre-Feet											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2	110	132	162	282	526	465	112	99	151	168	118	114
5	247	317	446	634	1,200	1,050	275	204	382	528	310	304
10	386	577	702	996	1,840	1,620	475	312	590	915	537	509
25	765	956	1,529	2,149	3,151	3,141	821	748	961	2,000	894	868
50	878	1,300	1,590	2,340	3,960	3,590	1,110	814	1,370	2,220	1,280	1,270
100	1,190	2,900	2,960	3,220	5,210	4,790	1,380	1,010	2,950	2,970	1,900	1,760

4-12

4-09. Channel and Flooding Characteristics. The regulating channel capacity on the Red River just downstream of Denison Dam is estimated to be 45,000 c.f.s. Downstream of Denison Dam at Fulton, Arkansas, the regulating channel capacity is estimated to be 128,000 c.f.s. Discharge rating curves for gages on the Red River at Arthur City and De Kalb, Texas, and Index and Fulton, Arkansas, are shown on Plates 4-6 through 4-9. The channel between Denison Dam and Fulton, Arkansas, is about 1,000 feet wide, and the banks are 15 to 25 feet high. From Fulton, Arkansas, to Alexandria, Louisiana, the channel is about 1,000 to 1,200 feet wide, and the banks are 20 to 35 feet high. The banks downstream of Denison Dam become unstable and prone to sloughing and erosion when the water level is high or as the water level recedes after periods of high water. Crest time of travel from Denison Dam to Fulton, Arkansas, is about 92-136 hours. A simplified diagram showing crest travel time is shown on Plate 4-10. Since crest travel times vary with the magnitude of a flood, this diagram should be used only as a guide.

4-10. Upstream Structures. Operational structures upstream of Lake Texoma in the Red River basin include Altus, Fort Cobb, Foss and Tom Steed Reservoirs, Lake Kemp, and Waurika, Truscott, and Arbuckle Lakes.

4-11. Downstream Structures. Operational structures downstream of Lake Texoma in the Red River basin include the following: McGee Creek Reservoir, Pat Mayse and Sardis (formerly Clayton) Lakes, Hugo, Pine Creek, Broken Bow, DeQueen, Gillham, Dierks, and Millwood Lakes, Cooper, Wright Patman, Lake O' Pines, Caddo, Bodcau, and Wallace Lakes and the Red River Locks and Dams 1 through 5. The US Army Corps of Engineers is responsible for regulating the flood waters of all of the above mentioned projects.

4-12. Economic Data.

a. Population. The population of counties and major cities in the Red River Basin below Denison Dam are shown in Table 4-8.

b. Industry. The top industries of the area other than agriculture include Retail Trade, Health Care & Social Assistance, and Accommodation & Food Services. Tables 4-8A through 4-8O provide the major industries along with corresponding data on number of establishments, sales, annual payroll, and employees downstream of Lake Texoma.

c. Agriculture. Agriculture and livestock raising are the principal industries in the Red River Basin, which is predominantly rural in character. The principal crops grown in the basin from Denison Dam to Fulton, Arkansas, are wheat, oats, grain sorghum, broomcorn, cotton, corn, pecans, and alfalfa. Large quantities of dairy and beef cattle, along with hogs, sheep, goats, and poultry are marketed from the area. Table 4-9 shows the annual acreage and value of crops in the floodplain downstream of Denison Dam. Table 4-10 and 4-11 show farm land-use and farming facts for the counties downstream of Denison Dam.

d. Flood Damages. Flooding of minor to moderate magnitude occurred along the Red River basin between Denison Dam and Fulton, Arkansas, in the spring of 1957. Flood damages were minor in the reach from Denison Dam to Arthur City, Texas, and moderate downstream of Arthur City. Crop damages to grains, alfalfa, and corn ranged from moderate to severe depending on the growth cycle of the individual crops. Structural losses varied from minor to moderate, with agricultural properties suffering heavy damages and lesser losses sustained by highways and secondary roads, railroads, public utilities, and business properties. Loss of land due to bank caving was also reported in a number of localities. There were no levee failures, but substantial costs were incurred in the Index, Arkansas, area for flood fighting necessary to maintain local levees. In the area along the Red River from Denison Dam to Fulton, Arkansas, an estimated 154,000 acres were inundated.

Major flooding occurred along the Red River Basin upstream and downstream of Denison Dam in late Apr and early May in 1990. Twenty counties in Oklahoma and ten counties in Texas were declared disaster areas due to the flooding. There were 65 residential units damaged or destroyed in Oklahoma and Texas and almost $10 million in damages to public property in the basin upstream and downstream of Denison Dam. The agricultural damage included loss of crops and livestock, damage to structures and machinery, and loss or damage of land. Levee flood damage control efforts included constructing a ring levee around a weak section of the Bowie County Levee along the Red River in northeastern Texas to cut-off boil areas, and raising the Cumberland Levee on the Washita arm of Lake Texoma to prevent overtopping. The estimated average annual flood damages prevented by Denison Dam are presented in Table 4-12. Table 4-13 lists the top five flood events to occur, in terms of flood damages prevented, below Denison Dam. Plates 4-11 through 4-13 show the Structural Loss and Area curves for the areas of Denison Dam to the mouth Boggy Creek, for the mouth of Boggy Creek to the mouth of the Kiamichi River, and for the mouth of the Kiamichi River to Fulton, Arkansas, respectively.

TABLE 4-8

POPULATION OF COUNTIES AND CITIES
DOWNSTREAM OF DENISON DAM

County	Major Cities	U.S. Census Population			% Change (2000-2010)
		1990	2000	2010	
Oklahoma					
Bryan		32,089	36,534	42,416	16.10
	Durant	12,823	13,549	15,856	17.03
Johnston		10,032	10,513	10,597	0.80
	Tishomingo	3,116	3,162	3,034	-4.05
Love		8,157	8,831	9,423	6.70
	Marietta	2,306	2,445	2,626	7.40
Marshall		10,829	13,184	15,840	20.15
	Madill	3,069	3,410	3,770	10.56
Choctaw		15,302	15,342	15,205	-0.89
	Hugo	5,978	5,536	5,310	-4.08
McCurtain		33,433	34,402	33,151	-3.64
	Idabel	6,957	6,952	7,010	0.83
	Broken Bow	3,961	4,230	4,120	-2.60
Texas					
Cooke		30,777	36,363	38,437	5.70
	Gainesville	14,256	15,538	16,002	2.99
Grayson		95,021	110,959	120,877	8.94
	Denison	21,505	22,773	22,682	-0.40
	Sherman	31,601	35,082	38,521	9.80
Fannin		24,804	31,242	33,915	8.56
Lamar		43,949	48,499	49,793	2.67
Bowie		81,665	89,306	92,565	3.65

TABLE 4-8 (continued)

County	Major Cities	U.S. Census Population			% Change (2000-2010)
		1990	2000	2010	
Texas, cont'd					
	Texarkana	31,656	34,782	36,411	4.68
Red River		14,317	14,314	12,860	-10.16
Arkansas					
Little River		13,966	13,628	13,171	-3.35
Hempstead		21,621	23,587	22,609	-4.15
Miller		38,467	40,443	43,462	7.46
1990 Census, 2000 Census, 2010 Census http://www.factfinder.census.gov and http://factfinder2.census.gov/faces/nav/jsf/pages/index.html					

TABLE 4-8A

2002 ECONOMIC CENSUS FOR BRYAN 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	38	228,100	37,000	1,404
42	Wholesale trade	30	457,400	16,300	531
44-45	Retail trade	118	282,400	24,200	1,533
51	Information	12	N	4,400	138
53	Real estate & rental & leasing	23	6,100	1,200	82
54	Professional, scientific, & technical services	43	41,200	16,300	370
56	Administrative & support & waste management & remediation service	17	D	D	h
61	Educational services	2	D	D	a
62	Health care & social assistance	72	105,900	37,400	1,664
71	Arts, entertainment, & recreation	9	D	D	e
72	Accommodation & food services	50	27,400	7,500	773

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
e = 250 – 499 employees
h = 2,500 to 4,999 employees
N = Not available or not comparable

TABLE 4-8B

2002 ECONOMIC CENSUS FOR JOHNSTON 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	14	92,000	17,800	631
42	Wholesale trade	10	45,800	2,400	71
44-45	Retail trade	38	33,200	2,800	199
51	Information	2	N	D	a
53	Real estate & rental & leasing	3	500	100	9
54	Professional, scientific, & technical services	7	1,400	500	20
56	Administrative & support & waste management & remediation service	5	700	300	12
62	Health care & social assistance	23	19,600	9,600	556
71	Arts, entertainment, & recreation	2	D	D	a
72	Accommodation & food services	11	2,900	800	118
81	Other services (except public administration)	8	1,300	200	20

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 4-8C

2002 ECONOMIC CENSUS FOR LOVE 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	9	D	D	f
42	Wholesale trade	6	D	D	b
44-45	Retail trade	31	30,400	2,900	216
51	Information	3	N	401	21
53	Real estate & rental & leasing	1	D	D	a
54	Professional, scientific, & technical services	11	D	D	b
62	Health care & social assistance	8	5,700	2,500	144
71	Arts, entertainment, & recreation	4	D	D	b
72	Accommodation & food services	14	5,200	1,600	135
81	Other services (except public administration)	5	D	D	b
31-33	Manufacturing	9	D	D	f

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
f = 500 to 999 employees
D = Withheld to avoid disclosing data for individual companies; data are included in higher totals

TABLE 4-8D

2002 ECONOMIC CENSUS FOR MARSHALL 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	19	113,800	30,100	909
42	Wholesale trade	8	26,500	2,900	60
44-45	Retail trade	56	84,300	8,200	525
51	Information	4	N	D	a
53	Real estate & rental & leasing	12	2,100	700	62
54	Professional, scientific, & technical services	19	3,500	1,200	60
56	Administrative & support & waste management & remediation service	3	D	D	a
62	Health care & social assistance	19	24,000	8,500	356
71	Arts, entertainment, & recreation	6	5,900	1,000	77
72	Accommodation & food services	29	10,400	2,700	261
81	Other services (except public administration)	11	3,300	700	47

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 4-8E

2002 ECONOMIC CENSUS FOR CHOCTAW 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*	12	-	13,000	319
42	Wholesale trade	11	29,800	1,500	42
44-45	Retail trade	59	104,300	8,900	609
51	Information	7	N	1,400	60
53	Real estate & rental & leasing	6	1,800	200	32
54	Professional, scientific, & technical services	21	D	D	b
56	Administrative & support & waste management & remediation service	5	1,200	500	94
62	Health care & social assistance	31	26,400	12,200	803
71	Arts, entertainment, & recreation	7	D	D	c
72	Accommodation & food services	23	8,700	2,300	278
81	Other services (except public administration)	17	2,900	600	64

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

b = 20 – 99 employees
c = 100 to 249 employees
D = Withheld to avoid disclosing data for individual companies; data are included in higher totals
N = Not available or not comparable

TABLE 4-8F

2002 ECONOMIC CENSUS FOR McCURTAIN 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	24	992,400	92,100	2,861
42	Wholesale trade	34	57,500	5,500	225
44-45	Retail trade	127	187,000	17,800	1,114
51	Information	11	N	4,200	110
53	Real estate & rental & leasing	14	4,400	600	56
54	Professional, scientific, & technical services	31	16,200	7,000	403
56	Administrative & support & waste management & remediation service	12	6,400	4,100	458
62	Health care & social assistance	59	45,100	20,400	1,107
71	Arts, entertainment, & recreation	10	15,700	1,000	80
72	Accommodation & food services	47	17,500	4,400	554
81	Other services (except public administration)	31	6,800	1,600	124

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

Key to table:

N = Not available or not comparable

TABLE 4-8G

2002 ECONOMIC CENSUS FOR COOKE COUNTY, TX

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	67	501,000	134,500	4,399
42	Wholesale trade	54	101,500	11,600	525
44-45	Retail trade	203	415,900	36,700	2,025
51	Information	13	N	5,100	146
53	Real estate & rental & leasing	25	13,700	1,900	104
54	Professional, scientific, & technical services	43	11,900	4,500	155
56	Administrative & support & waste management & remediation service	21	4,400	1,600	114
61	Educational services	2	D	D	a
62	Health care & social assistance	72	D	D	f
71	Arts, entertainment, & recreation	14	D	D	b
72	Accommodation & food services	70	35,300	10,100	1,098
81	Other services (except public administration)	56	18,200	5,500	294

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
f = 500 to 999 employees
D = Withheld to avoid disclosing data for individual companies; data are included in higher totals
N = Not available or not comparable

TABLE 4-8H

2002 ECONOMIC CENSUS FOR GRAYSON COUNTY, TX

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	132	2,678,500	329,100	7,807
42	Wholesale trade	121	390,000	34,058100	1,066
44-45	Retail trade	468	1,368,800	120,600	5,889
51	Information	36	N	17,500	538
53	Real estate & rental & leasing	117	55,400	9,200	472
54	Professional, scientific, & technical services	208	D	D	g
56	Administrative & support & waste management & remediation service	104	76,900	33,400	1,950
61	Educational services	11	1,700	500	48
62	Health care & social assistance	343	582,200	222,700	7,385
71	Arts, entertainment, & recreation	49	22,700	5,000	361
72	Accommodation & food services	190	116,100	32,800	2,941
81	Other services (except public administration)	166	46,300	12,300	782

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

Key to table:

D = Withheld to avoid disclosing data for individual companies; data are included in higher totals
g = 1,000 to 2,499 employees
N = Not available or not comparable

TABLE 4-8I

2002 ECONOMIC CENSUS FOR FANNIN COUNTY, TX

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	35	256,100	30,600	996
42	Wholesale trade	19	113,600	3,500	129
44-45	Retail trade	90	270,000	24,200	974
51	Information	13	N	1,700	64
53	Real estate & rental & leasing	17	4,100	700	49
54	Professional, scientific, & technical services	34	6,600	1,800	124
56	Administrative & support & waste management & remediation service	17	4,700	1,800	88
61	Educational services	1	D	D	a
62	Health care & social assistance	44	90,200	38,700	1,305
71	Arts, entertainment, & recreation	4	400	200	9
72	Accommodation & food services	39	13,800	4,200	497
81	Other services (except public administration)	32	9,700	2,300	110

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
g = 1,000 to 2,499 employees
N = Not available or not comparable

TABLE 4-8J

2002 ECONOMIC CENSUS FOR LAMAR COUNTY, TX

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	54	2,236,300	162,300	4,472
42	Wholesale trade	59	152,100	14,200	471
44-45	Retail trade	249	536,000	51,000	2,684
51	Information	20	N	6,300	225
53	Real estate & rental & leasing	39	16,900	2,700	128
54	Professional, scientific, & technical services	63	20,000	6,600	273
56	Administrative & support & waste management & remediation service	39	31,800	15,500	1,215
61	Educational services	2	D	D	b
62	Health care & social assistance	147	D	D	h
71	Arts, entertainment, & recreation	13	3,700	1,100	90
72	Accommodation & food services	87	52,000	15,100	1,449
81	Other services (except public administration)	93	24,500	6,700	518

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

Key to table:

b = 20 – 99 employees
D = Withheld to avoid disclosing data for individual companies; data are included in higher totals
h = 2,500 to 4,999 employees
N = Not available or not comparable

TABLE 4-8K

2002 ECONOMIC CENSUS FOR BOWIE COUNTY, TX

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	70	978,500	132,300	3,264
42	Wholesale trade	127	D	D	g
44-45	Retail trade	442	1,151,900	105,300	5,679
51	Information	27	N	11,000	460
53	Real estate & rental & leasing	111	67,800	1,200	961
54	Professional, scientific, & technical services	146	78,200	22,400	753
56	Administrative & support & waste management & remediation service	77	50,000	21,000	1,151
61	Educational services	10	D	D	b
62	Health care & social assistance	263	588,600	235,800	6,931
71	Arts, entertainment, & recreation	17	6,700	1,800	180
72	Accommodation & food services	129	94,000	26,000	2,651
81	Other services (except public administration)	171	90,100	33,000	1,239

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

b = 20 – 99 employees
D = Withheld to avoid disclosing data for individual companies; data are included in higher totals
g = 1,000 to 2,499 employees
N = Not available or not comparable

TABLE 4-8L

2002 ECONOMIC CENSUS FOR RED RIVER COUNTY, TX

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	16	79,600	14,800	655
42	Wholesale trade	3	D	D	a
44-45	Retail trade	52	53,100	4,900	367
51	Information	3	N	300	16
53	Real estate & rental & leasing	6	D	D	a
54	Professional, scientific, & technical services	6	1,600	600	17
56	Administrative & support & waste management & remediation service	5	2,000	400	22
61	Educational services	1	D	D	a
62	Health care & social assistance	16	22,200	8,800	372
71	Arts, entertainment, & recreation	3	300	60	7
72	Accommodation & food services	12	D	D	b
81	Other services (except public administration)	20	3,900	1,100	60

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 4-8M

2002 ECONOMIC CENSUS FOR LITTLE RIVER 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	11	D	D	g
42	Wholesale trade	12	21,300	1,200	51
44-45	Retail trade	50	81,200	5,700	390
51	Information	3	N	400	13
53	Real estate & rental & leasing	8	1,300	200	20
54	Professional, scientific, & technical services	12	8,500	1,300	53
56	Administrative & support & waste management & remediation service	4	D	D	b
62	Health care & social assistance	12	D	D	e
71	Arts, entertainment, & recreation	3	600	200	21
72	Accommodation & food services	12	4,700	1,300	158
81	Other services (except public administration)	13	D	D	b

Source: U.S. Bureau of the Census, 2002 Economic Census, *2006 County Business Patterns
Key to table:
b = 20 – 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 4-8N

2002 ECONOMIC CENSUS FOR MILLER 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	25	602,100	123,600	2,638
42	Wholesale trade	47	D	D	f
44-45	Retail trade	144	310,000	28,400	1,696
51	Information	11	N	4,400	108
53	Real estate & rental & leasing	16	8,800	1,500	52
54	Professional, scientific, & technical services	42	15,100	4,600	191
56	Administrative & support & waste management & remediation service	21	9,500	5,300	329
61	Educational services	5	D	D	a
62	Health care & social assistance	65	47,000	16,700	983
71	Arts, entertainment, & recreation	8	6,700	2,100	129
72	Accommodation & food services	78	95,800	16,100	1,452
81	Other services (except public administration)	50	15,400	5,000	281

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
f = 500 to 999 employees
N = Not available or not comparable

TABLE 4-8O

2002 ECONOMIC CENSUS FOR HEMPSTEAD 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	32	D	D	h
42	Wholesale trade	17	35,000	3,600	169
44-45	Retail trade	97	153,900	14,700	942
51	Information	8	N	D	b
53	Real estate & rental & leasing	16	D	D	b
54	Professional, scientific, & technical services	26	D	D	c
56	Administrative & support & waste management & remediation service	12	D	D	c
61	Educational services	1	D	D	a
62	Health care & social assistance	55	51,200	21,500	947
71	Arts, entertainment, & recreation	8	2,200	500	31
72	Accommodation & food services	30	17,000	4,600	549
81	Other services (except public administration)	41	12,500	3,300	172

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
c = 100 to 249 employees
D = Withheld to avoid disclosing data for individual companies; data are included in higher totals
h = 2,500 to 4,999 employees
N = Not available or not comparable

TABLE 4-9

ANNUAL VALUE OF CROPS
BELOW DENISON DAM

Crops	Denison Dam to Boggy Creek		Boggy Creek to Kiamichi River		Kiamichi River to Fulton, AR		Total	
	Acres	Value ($)	Acres	Value ($)	Acres	Value ($)	Acres	Value ($)
Cotton	7,190	1,706,800	2,050	486,600	30,480	7,235,300	39,720	9,428,700
Corn	1,920	442,800	340	78,400	4,850	1,118,600	7,110	1,639,900
Wheat	1,080	135,900	-	-	-	-	1,080	135,900
Alfalfa	7,790	1,451,300	2,730	508,600	12,820	2,388,400	23,340	4,348,300
Hay Costal Bermuda	18,940	7,633,700	-	-	1,210	487,700	20,150	8,121,400
Improved Pasture	-	-	9,560	1,983,200	14,890	3,088,900	24,450	5,072,200
Unimproved Pasture	15,710	3,259,000	24,920	5,169,700	187,220	38,838,800	227,850	47,267,500
Woods	13,190	53,600	10,760	38,100	82,090	286,100	106,040	377,800
Idle	1,080	2,600	340	900	2,940	7,500	4,360	11,100
Total	66,900	14,685,800	50,700	8,265,500	336,500	53,451,400	454,100	76,402,700

Yield Rates from Oklahoma State University Crop Enterprise Budgets 2009 Current Normalized Prices, Acres maintained from WCA

TABLE 4-10

COUNTY ACRES IN FARM LAND

County	Land in Farms 2002 (Acres)	Land in Farms 2007 (Acres)	Total County (Acres)	2002 % Farm Land	2007 % Farm Land
Oklahoma					
Marshall	164,275	157,754	237,440	69.19	66.44
Bryan	458,275	490,688	581,760	78.77	84.35
Choctaw	337,443	326,300	495,360	68.12	65.87
McCurtain	357,991	339,615	1,185,280	30.20	28.65
Texas					
Cooke	458,775	455,393	559,360	82.02	81.41
Grayson	441,246	400,414	597,760	73.82	66.99
Fannin	483,446	473,853	570,880	84.68	83.00
Lamar	470,216	521,001	586,880	80.12	88.77
Bowie	307,531	291,674	568,320	54.11	51.32
Red River	422,645	449,525	672,000	62.89	66.89
Arkansas					
Little River	147,173	139,291	340,480	43.23	40.91
Miller	158,208	174,931	399,360	39.62	43.80
Hempstead	203,678	210,571	466,560	43.66	45.13

Source: 2007 Agriculture Census http://www.agcensus.usda.gov
National Association of Counties http://www.naco.org

TABLE 4-11

FARMING FACTS DOWNSTREAM OF DENISON DAM

County	Number of Farms in 2002	Number of Farms in 2007	Average Size of Farms in 2002 (Acres)	Average Size of Farms in 2007 (Acres)	Average Market Value of Production per farm in 2007 ($)
Oklahoma					
Marshall	477	545	344	289	30,240
Bryan	1,673	1,701	274	288	37,766
Choctaw	545	1,134	308	288	33,414
McCurtain	1,855	1,796	193	189	103,678
Texas					
Cooke	1,765	1,956	260	233	29,802
Grayson	2,597	2,723	170	147	19,405
Fannin	1,976	2,110	245	225	23,090
Lamar	1,725	1,817	273	287	33,234
Bowie	1,337	1,610	230	181	30,062
Red River	1,217	1,206	347	373	29,743
Arkansas					
Little River	424	482	347	289	137,996
Miller	516	601	307	291	81,094
Hempstead	783	894	260	236	186,933
Source: 2007 Agriculture Census http://www.agcensus.usda.gov					

TABLE 4-12

AVERAGE ANNUAL FLOOD DAMAGES PREVENTED

Average Annual Flood Damages Prevented by Lake Texoma (Denison Dam)		
Years in Operation	**Cumulative Damages Prevented (2008 $1,000's)**	**Average Annual Damages Prevented (2008 $1,000's)**
65	878,700	13,500

TABLE 4-13

TOP FIVE FLOOD EVENTS
DOWNSTREAM OF DENISON DAM

Top Five Floods of Record		
Year	**Damages ($1,000s)**	**Damages (2008 $1,000's)**
1957	10,050	116,970
2007	111,160	115,950
1945	3,010	81,290
1995	50,120	76,120
1990	33,290	58,470

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 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 key stream gages used in forecasting inflows into Lake Texoma include Gainesville, Terral, and Burkburnett on the Red River, and Dickson, Pauls Valley and Alex on the Washita River. The key gages for downstream regulation include Arthur City, De Kalb, Index, and Fulton. 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 high data rate DCPs which record and transmit the data hourly or when a threshold value is exceeded. The data is 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 is then transmitted to a domestic satellite (DOMSAT) which in turn 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 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.

In addition to the DCP data, observer rainfall data is collected and stored in the computer system for use in forecasting. Observers telephone the NWS offices in their region and the NWS then encodes the data into a Standard Hydrologic Exchange Format (SHEF). This data is then transferred to the WCDS by electronic data transmission from the Arkansas-Red Basin River Forecast Center. Once the data is received, it is 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 for data collected by project personnel are presented in paragraph 2. of Exhibit C, 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 Red River Basin. The Water Management Section, 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. Pertinent reporting water quality stations with published data downstream of Lake Texoma are shown in Table 5-2. Other water quality sampling activities are conducted in the Lake Texoma area by the Oklahoma University Biological Station.

b. Reporting. The reporting procedures for water quality stations are made in cooperation with the USGS. Water quality samples are taken by the USGS at periodic intervals to determine the chemical and biological quality of the stream water. Copies of the annually published data entitled "Water Resources Data for Oklahoma" are sent to the Corps of Engineers. A discussion of water quality problems downstream of Lake Texoma 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.

5-03. Sediment Stations.

a. Facilities. The eighty-eight (88) sedimentation ranges upstream of Denison Dam and the thirty-nine (39) degradation ranges downstream of Denison Dam are used for sedimentation and degradation measurements (subparagraph 2-03.d.). These ranges are surveyed periodically for the purpose of computing sediment deposition and new lake area/capacity data. The sedimentation ranges were established in Aug 1939 and both ends of each range are identified with permanent markers of known vertical and horizontal positions. Sedimentation in Lake Texoma is discussed in paragraph 4-04.

b. Reporting. As necessary. The last sediment survey was completed in 2002.

c. Maintenance. Maintenance on the sediment and degradation ranges is the responsibility of the Tulsa District.

TABLE 5-2

PERTINENT REPORTING WATER QUALITY STATIONS

Name & Location	Station	Type	Recording or non-recording	Period of record	Frequency of sample analysis	Operating agency
Red River at Denison Dam	07331600	Chemical Analysis	Non-recording	1944-present	Semi-monthly	USGS
		Water Temperature	Non-recording	1945-present	Daily	USGS
		Specific Conductance	Non-recording	1944-present	Daily	USGS
Red River near De Kalb, Texas	07336820	Chemical Analysis	Non-recording	1992-2008	Semi-monthly	USGS
		Water Temperature	Non-recording	1992-2008	Daily	USGS
		Specific Conductance	Non-recording	1992-2008	Daily	USGS
Red River near Foreman, Arkansas	07336860	Chemical Analysis	Non-recording	1974-present	Monthly	Ark. Dept. of Pollution Control and Ecology
Red River at Index, Arkansas	07337000	Chemical Analysis	Non-recording	1980-present	Semi-monthly	USGS

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 it is 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 Water Management 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. No regular water quality sampling stations are maintained in Lake Texoma by the Corps of Engineers or USGS. Water quality data at other locations are recorded by the USGS and reported as described in paragraph 5-02.b.

5-05. Communication Network. Wire facilities at the Lake Texoma Office consist of local and long-distance telephone service. Radio Communication is by a VHF-FM fixed station (call signal WUI-330) capable of reaching local mobile stations, the Tulsa District, stations on the local loop of the Tulsa District and other stations on the north and south loop of the Tulsa District via repeater relay. Maintenance of the telephone lines is the responsibility of the company leasing the lines to the Government. The Tulsa 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 and hydropower generation releases, warning horns are located on the conduit gate tower, on the downstream end of the conduit, and on the spillway. Control buttons for these devices are found on the gate control panels.

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 or e-mail, but could be made by VHF-FM radio. The reports by the project office, described in paragraph 5-07. and Exhibit C of this manual, will be communicated directly to the Water Management Section. Should communication between the project and the Tulsa District be disrupted, the Lake Manager will, on his/her own initiative, direct regulation of the lake according to emergency regulations as required in Section VII and Exhibit C 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_resvrept.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 day second feet (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 Lake Manager to initiate a warning to the local threatened area emergency representatives if emergency situations develop. He/she has the responsibility to properly recognize emergency situations and to seek assistance from supervisory offices, if time permits. He/she 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. Minimum notification procedures are as follows: A “General Alert” should be issued by the Lake Manager to the Civil Defense when life-threatening high releases from a dam failure or flooding are predicted to reach the downstream population at risk within 6 hours; An “Evacuation Warning” should be issued by the Lake Manager when analysis of the threatening event and lake response indicate that life-threatening floodwaters will reach the downstream population in 4 hours or less. The Lake Texoma 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 Lake Texoma 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 No. 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 Reservoir Regulation Master Manual for the Red River Basin.

b. Role of Other Agencies. The NWS, Oklahoma City, 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 any time:

(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 above or below Denison Dam. Personnel in the Water Management Section have developed a flood-forecasting model for Lake Texoma. This model was calibrated to historical flood events. Basin subdivisions contained in the forecasting model are presented in Plate 6-1. To use this model the following data is required:

(1) Rainfall for stations listed in Table 5-1.

(2) Lake Texoma pool elevation for time of forecast.

(3) Flood hydrographs for stream gages listed in Table 5-1.

(4) Releases from Lake Texoma, 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 is received from the NWS observers, the DCP 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 ungaged subareas and flood hydrographs are combined and routed to compute an inflow hydrograph. Using projected releases from all upstream lakes, the inflow hydrograph is routed through the lake to determine elevations. Flood control releases are projected based upon conditions on the Red River System and following procedures described in section V of the Red River Basin Water Control Master Manual. Unit hydrographs are presented on Plates 6-2 through 6-11. A sample inflow computation is shown on Plate 6-12.

6-03. Conservation Purpose Forecasts.

a. Requirements. Conservation forecasts may be requested by Project personnel to predict pool levels during fish spawning season, and special recreation events. 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 flow duration curve (Plate 4-4) and the peak inflow probability curve (Plate 4-5) 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 6-01b are more useful in a shorter range.

6-05. Drought Forecasts. Droughts can be forecasted 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 forecasted by estimating water supply usage and evaporation rates.

VII - WATER CONTROL PLAN

7-01. General Objectives. The primary objectives of the Lake Texoma project are flood control, hydropower production, provision of water supply for state and local interests, recreation, regulation of flows on the Red River, improvement of navigation, and other beneficial uses, such as fish and wildlife. Flood control and hydropower production were the two original uses authorized by the Flood Control Act approved 28 Jun 1938; other uses were added through the passage of subsequent public laws (see paragraph 3-02). Under normal operating procedures, Lake Texoma will be operated as a unit in a multiple purpose system to provide optimal flood control benefits in the Red River basin. The emergency procedures assume no communication with the Tulsa District, the other lakes of the system, or with the precipitation and gaging stations. Flood releases from Lake Texoma will be made in accordance with the predicted runoff from the uncontrolled area downstream, the allowable stages 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 optimal benefits, categorized as method A in paragraph 3-3c(2)(b) of EM 1110-02-3600, 30 Nov 1987.

7-02. Major Constraints. The channel capacity downstream of Denison Dam is currently in the range of 45,000 to 50,000 c.f.s. The outlet works are capable of discharging 67,500 c.f.s. at the top of the flood control pool (elevation 640.0 feet). The invert of the outlet works, the lowest elevation from which water can be released from the dam, is at elevation 523.0 feet. The recession of floodwaters on the Red River downstream of Denison Dam is to be monitored so releases from the dam, when combined with releases from other flood control lakes and the runoff from the uncontrolled drainage area, will not exceed bank full. The regulating stage and corresponding discharge for each regulating station are shown in Table 7-1.

7-03. Overall Plan for Water Control.

a. General. Lake Texoma is regulated as a unit in a multiple purpose system for the benefit of water resources in the Red River basin.

b. System Regulation. Lake Texoma, in conjunction with McGee Creek Reservoir and Pat Mayse, Hugo, and Millwood Lakes, is regulated to optimize flood control and other water resources benefits on the Red River from Lake Texoma to the river mouth. These projects share the channel capacity of the Red River during flood conditions. During floods, the channel capacity of the Red River at the various control points may restrict releases from these projects. Pending development of the system regulation plan, the channel capacity at the control points will be shared proportionally among the upstream projects contributing to flow at that point based on achieving and maintaining a balance of the percentage of flood control storage utilized. If a project is unable to use its portion of the channel capacity because of other constraints, the unused portion

TABLE 7-1

REGULATING STAGES AND DISCHARGES

Station	Affected Lakes	Regulating Stage (feet)	Regulating Discharge [1] (c.f.s.)
Denison, Texas (nr)	Texoma --		45,000
Arthur City, Texas	Texoma, McGee Creek, and Pat Mayse	27.0	84,600
De Kalb, Texas	Texoma, McGee Creek Hugo, and Pat Mayse	23.7	51,100
Index, Arkansas	Texoma, McGee Creek Hugo, and Pat Mayse	19.8	95,000
Fulton, Arkansas	Texoma, McGee Creek, Hugo, Millwood, and Pat Mayse	25.0	128,000

[1] Present estimated regulating discharges subject to change due to changing channel conditions.

will be redistributed among the remaining projects. System flood control operation shall allow Lake Texoma to release the minimum flow of approximately 2,300 c.f.s. that is required to generate the firm energy (429 mWh/day) of the Texoma project in accordance with the power system demands. However, when conditions warrant, releases at Lake Texoma may be reduced below the daily average for firm power, or shut off completely. Because Millwood and Hugo Lakes have a more immediate effect on the lower portion of the Red River, they are operated to fine tune the regulated flows in the lower reaches.

7-04. Standing Instructions to Lake Manager. During flood periods, the lake will be regulated in accordance with the normal regulations for flood control operation as directed in subparagraph 7-05.a. and Exhibit C of this manual. Instructions for the storage and discharge of floodwater will be issued by the Water Management Section of the Tulsa District. If communication with the Tulsa District is disrupted, the lake regulation will become the responsibility of the Lake Manager and will be in accordance with subparagraph 7-05.b. and Exhibit C of this manual. In addition, the Lake Manager will immediately make every effort to reestablish communication with the Tulsa District. The Lake Manager will make daily observations of the weather station and pool level data and report those observations as directed by the Water Management Section. Should an emergency situation occur in which communication is not lost, such as inoperable gates, drowning accident, excessive trash in gates, broken buoy line, or power outage, the Water Management Section will be notified immediately.

7-05. Flood Control.

a. Normal Flood Control Regulations. Lake Texoma will be regulated in conjunction with existing lakes and reservoirs on the Red River and tributaries for the control of floods on the Red River from Denison Dam to Fulton, Arkansas. Stream gages on the Red River at Arthur City and De Kalb, Texas, and Index and Fulton, Arkansas, will be used as control points for the regulation of flood flows. Stream gages at Blue, Oklahoma, on the Blue River; Caney, Oklahoma, on Clear Boggy Creek; and Farris and Unger, Oklahoma, on Muddy Boggy Creek will serve as indices of runoff from uncontrolled areas downstream of Denison Dam. The following regulations will govern releases from Lake Texoma as long as communications are not disrupted between the project and the Tulsa District.

(1) When the lake level is between the bottom of the conservation pool (elevation 590.0 feet) and the top of the transitional pool (as shown on Plate 7-1) releases will normally be made through the hydropower units and will be governed by the power generation requirements explained in paragraph 7-11 and shown on Plate 7-1. When flood estimates indicate that the lake level will exceed the top of the seasonal pool and elevation 617.0 feet, regulated releases may be made such that the combined flow from Lake Texoma releases, releases from downstream lakes, and other downstream flows will not cause either of the following: a) stages above bank full for the Red River between Denison and Fulton, or b) stages at the Fulton gage above 25 feet or the stage corresponding to 100,000 c.f.s. (whichever is smaller) if there is flooding or a prediction of flooding on the Red River downstream of Fulton. If there is no flooding and no predicted flooding on the Red River downstream of Fulton, the flows at the Fulton gage should be regulated to a maximum stage of 25 feet, regardless of discharge. In any event, the Lake Texoma releases must not exceed the channel capacity downstream of the dam (currently in the range of 45,000 to 50,000 c.f.s.).

(2) When the lake level rises above the top of the transition pool as shown on Plate 7-1, regulated releases may be made at the maximum rate permissible, as stated in subparagraph (1), but limited such that the combined flow from Lake Texoma releases, releases from downstream lakes, and other downstream flows will not cause either of the following: a) stages above bank full for the Red River between Denison and Fulton, or b) stages at the Fulton gage above 25 feet or the stage corresponding to 100,000 c.f.s. (whichever is smaller) if there is flooding or a prediction of flooding on the Red River downstream of Fulton. If there is no flooding and no predicted flooding on the Red River downstream of Fulton, the flows at the Fulton gage will be regulated to a maximum stage of 25 feet, regardless of discharge. In any event, the Lake Texoma releases must not exceed the channel capacity downstream of the dam (currently 45,000 to 50,000 c.f.s.). Releases may be made at less than the maximum rate permissible if it is considered more beneficial. Factors that will be considered in the determination

of releases are the following: maximum inflow into the lake during the rise, general climatic conditions, season of the year with respect to probability of floods and status of crops on low-lying farmland, and, when the flood control pool is full, the likelihood of overtopping the Cumberland levees. Releases will be gradually increased or decreased in accordance with paragraph 7-05.c. in order to minimize bank caving in the reaches downstream from the project.

(3) When the predicted inflow is such that an eventual discharge from the dam in excess of that permitted under subparagraph (2) is clearly evident and the pool level is approaching the spillway crest, elevation 640.0 feet, regulated releases in excess of those provided for in subparagraph (2) (but not to exceed 60,000 c.f.s.) may be made if the resulting overall benefits appear to justify such action. When the lake level is approaching or predicted to exceed the top of the surcharge pool, elevation 643.0 feet, total outflow may exceed 60,000 c.f.s., but in no event shall the total outflow cause the flows downstream from the dam to exceed the maximum flows that would have occurred without the Denison project. **NOTE**: The conduit outlet and stilling basin must be visually monitored very closely during all high releases and during high tailwater events. If unusual conditions occur (such as riprap displacement, surging, submerged outlet, or the hydraulic jump moving out of the stilling basin), close all conduit gates immediately and continue efforts to re-establish communications with Tulsa District..

(4) When flows from areas downstream of Denison will produce near bank full or above bank full stages on the Red River between Denison and Fulton, releases from Lake Texoma may be reduced below the daily average flow of 2,300 c.f.s. for firm energy (429 mWh/day) or shut off completely if it would aid in reducing peak stages or the duration of above bank full stages. During periods when flood control releases are being made from lakes in the Red River System, and the river is not forecasted to exceed the regulating stages in Table 7-1, the maximum restriction the Corps would place on releases from Lake Texoma would be to limit releases to the flow which is required to generate the firm energy of the project unless emergency conditions required otherwise. This energy may be produced in accordance with the system demands and the capacity of the plant.

(5) All regulations will be coordinated with the Lower Mississippi Valley Division through the Southwestern Division (SWD) to care for unusual conditions in the Red River below Fulton.

b. Emergency Flood Control Regulations. Should communication with the Tulsa District be disrupted, the Lake Manager will, on his/her own initiative, direct operation of the lake in accordance with Table 7-2 until communications are restored. In addition, the Lake Manager will immediately make every effort possible to re-establish communications with the Tulsa District and, if necessary, send information to the Tulsa District by any means. No change in regulation will be made for a period of 24 hours

following disruption of communication unless the pool is above or expected to crest above elevation 640.0 feet, then see Table 7-2 for instructions. In making the transition from the regulation in force at the time of the communication failure to emergency regulation, no change in releases exceeding 15,000 c.f.s. per 6-hour period shall be made.

c. Constraints. The releases from Denison project should not be allowed to exceed the downstream channel capacity, currently in the range of 40,000 to 50,000 c.f.s, insofar as practicable. The increase and decrease in releases from the lake shall be accomplished in a manner which minimizes damage to the lake area and the downstream channel. Below elevation 640.0, changes in release are limited to 7,500 c.f.s. per gate change, with a minimum of four hours between gate changes and a maximum of three gate changes per day. This limits the maximum change in flow rate to 22,500 c.f.s. per day when the pool is below elevation 640.0. When the pool is above elevation 640.0, changes in release are limited to 10,000 c.f.s. per gate change every two hours, with no limit on the number of gate changes per day. Every reasonable precaution will be made to eliminate bank sloughing, undercutting, excessive erosion, and danger to human and animal lives, if possible. Situations will arise which will not allow an orderly increase and/or decrease in releases. Examples of these situations are large flood releases and drownings which occur downstream of the dam.

d. Operational Curves. The elevation-area and elevation-capacity curves are shown on Plate 7-2, and the data for those curves are listed in 7-3, located in the Supplemental Tables Section. Both the elevation-area and elevation-capacity data were calculated from the 2002 survey with the area and capacity of the Cumberland Pool included only for elevations above 619.0 feet. The discharge rating curves for the uncontrolled spillway and the conduits in the outlet works are shown on Plates 7-3 and 7-4, respectively. The tailwater rating curve is shown on Plate 7-5.

7-06. Recreation. Although recreation is an authorized project purpose, no storage is provided specifically for that purpose and no special regulations are made for recreational activities. The seasonal pool plan recommended by the Lake Texoma Advisory Committee does enhance recreation interests in the lake by raising the normal pool elevation during the months of Jun, Jul, and Aug which should benefit most recreational activities.

7-07. Water Quality. Although water quality is not an authorized project purpose, low flow regulation is authorized. Power releases are usually adequate to meet downstream water rights, which incidentally, helps to maintain water quality. Normally, low flow releases in addition to power generation requirements are made through the turbines. While low flow regulation is an authorized project purpose, the specific demand for this purpose has been negligible and no storage has been provided for it. In addition to power releases, a release of 50 c.f.s. through the flood control conduits may be requested during the summer when necessary to increase dissolved oxygen levels immediately downstream of the dam, based on monitoring by the Texas Department of Parks and Wildlife and/or the Oklahoma Department of Wildlife Conservation.

TABLE 7-2

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE
LAKE TEXOMA, RED RIVER, OKLAHOMA

A. Rising Pool

When communications are disrupted, the following emergency regulations will remain in effect until:
(a) Communications are restored, or
(b) The pool begins falling.

NOTE: No change in regulation will be made for a period of 24 hours following disruption of communication unless the pool is above or expected to crest above elevation 640.0 In making the transition from the regulation in force at the time of communication loss to emergency regulation, the maximum change in release rate shall be 15,000 c.f.s. per 6-hour period. At no time shall a reduction in discharges be made while the pool is rising.

Lake Stage	Pool Conditions	Regulation
Below 619.0	Rising	Continue the release being made at the time communication was disrupted.
619.0 - 625.0	Rising	Release a total of 15,000 c.f.s.
625.0 - 635.0	Rising	Release a total of 30,000 c.f.s.
635.0 - 637.5	Rising	Release a total of 45,000 c.f.s.
637.5 - 640.0	Rising	Release a total of 60,000 c.f.s.
640.0 - 643.0	Rising	Adjust flood conduit gates to maintain a total release of 60,000 c.f.s.
Above 643.0	Rising	Increase releases by 10,000 c.f.s. every two hours until flood conduit gates are fully open or pool begins to fall.

NOTE: The conduit outlet and stilling basin must be visually monitored very closely during all high releases and during high tailwater events. If unusual conditions occur (such as riprap displacement, surging, submerged outlet, or the hydraulic jump moving out of the stilling basin), close all conduit gates immediately and continue efforts to re-establish communications with Tulsa District..

TABLE 7-2 (continued)

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE
LAKE TEXOMA, RED RIVER, OKLAHOMA

B. Falling Pool

When communications are disrupted, the following emergency regulations will remain in effect until:

(a) Communications are restored,
(b) The pool begins rising again, or
(c) The pool reaches elevation 619.0 feet, at which time releases will be made in accordance with paragraph 7-11. and Plate 7-1.

NOTE: No change in regulation will be made for a period of 24 hours following disruption of communication unless the pool is above or expected to crest above elevation 640.0 feet. Should the pool begin rising, the regulations outlined above for rising pool conditions will be followed. In making the transition from the regulation in force at the time of communication loss to emergency regulation, the maximum change in release rate shall be 15,000 c.f.s. per 6-hour period.

Lake Stage	Pool Conditions	Regulation
Above 643.0	Falling	Maintain the maximum gate setting attained during rising pool conditions.
640.0 - 643.0	Falling	Adjust flood conduit gates to maintain a total release of 60,000 c.f.s.
637.5 - 640.0	Falling	Release a total of 60,000 c.f.s.
630.0 - 637.5	Falling	Release a total of 45,000 c.f.s.
625.0 - 630.0	Falling	Release a total of 35,000 c.f.s.
620.0 - 625.0	Falling	Release a total of 25,000 c.f.s.
619.0 - 620.0	Falling	Release a total of 15,000 c.f.s.
Below 619.0	Falling	Releases will be made in accordance with paragraph 7-11 and Plate 7-1.

NOTE: The conduit outlet and stilling basin must be visually monitored very closely during all high releases and during high tailwater events. If unusual conditions occur (such as riprap displacement, surging, submerged outlet, or the hydraulic jump moving out of the stilling basin close all conduit gates immediately and continue efforts to re-establish communications with the Tulsa District.

7-08. Fish and Wildlife. Although fish & wildlife is an authorized project purpose, no specific storage is provided. The project does, however, provide secondary benefits to fish and wildlife. Releases from Lake Texoma cannot be regulated to achieve any particular water temperature in the river downstream of the dam because the dam is not equipped with multiple level intakes. Upon request from the Texas Department of Parks and Wildlife and/or the Oklahoma Department of Wildlife Conservation, a small release through the flood control conduits may be made during low flow periods to relieve fish distress due to low dissolved oxygen levels immediately downstream of the dam. The seasonal pool plan proposed by the Lake Texoma Advisory Committee in coordination with the Oklahoma Department of Wildlife Conservation, the Texas Department of Parks and Wildlife, and other interested agencies is designed to enhance the fish and wildlife management in the lake by having a seasonally fluctuating lake level which should improve habitat and food supply.

7-09. Water Supply.

a. General. Lake Texoma currently has a total water supply storage of 300,000 acre-feet with a total dependable yield of 294.73 million gallons per day (m.g.d.). The dependable yield was determined as the 100% dependable yield for the critical drought during the period of record (1938-2000). The Water Resources Development Act of 1986 (WRDA) authorized 300,000 acre-feet of storage to be reallocated from hydropower to water supply upon completion of a reallocation study. The reallocation study was completed in 2010. This reallocation was split between Texas and Oklahoma water users, with 150,000 acre-feet available to each. Texas entities have entered into water storage agreements with the Tulsa District for their entire 150,000 acre-feet which is reflected in the current 300,000 acre-feet of total water supply storage in Lake Texoma. Currently there is still 150,000 acre-feet of the 686,730 acre-feet of hydropower storage available for reallocation and water storage agreements for Oklahoma users. Table 7-4 lists the current water supply agreements.

b. Regulation Procedure for Water Supply. Lake Texoma is not regulated for water supply because the withdrawal points for all but one of the current water supply contracts are within the lake and have invert elevations at least 16 feet below the top of the conservation pool (elevation 617.0 feet). The only current water supply user that does not withdraw water directly from the lake is the Texas Power and Light facility at Savoy, Texas, which withdraws water from the Red River approximately 19 river miles downstream of Denison Dam. Texas Power and Light has not requested the Corps to alter the releases at Lake Texoma because the Savoy facility has a large storage pond to supply sufficient water during periods of low flow on the Red River.

TABLE 7-4
WATER SUPPLY AGREEMENTS -- LAKE TEXOMA

Revised 7 Jul 2011

USER NAME	APPROVAL DATE	AGREEMENT TYPE	PRESENT STORAGE (AC-FT) [1]	FUTURE STORAGE (AC-FT)	TOTAL USER STORAGE (AC-FT)	YIELD (M.G.D.)
GTUA F/Pottsboro (Pending) [2]		Storage	1,514.70	0	1,514.70	1.488
GTUA F/Sherman, TX [3]	9/23/2005	Storage	11,600	0	11,600	11.396
Pointe Vista	9/23/2005	Storage	275	0	275	0.270
City of Denison	9/21/1953	Storage	21,300	0	21,300	20.926
Texas Power & Light Co.	8/8/1961	Storage	16,400	0	16,400	16.112
Red River Authority of Texas	11/18/1969	Storage	450	0	450	0.442
Red River Authority of Texas	8/2/1983	Storage	2,054	0	2,054	2.018
North TX Municipal Water District	12/17/1985	Storage	85,406	0	85,406	83.906
Buncombe Creek View Addition	4/9/1992	Storage	0.3	0	0.3	0.000
GTUA F/Sherman, TX [3]	9/24/1992	Storage	5,500	0	5,500	5.403
GTUA F/Sherman, TX [3]	10/29/1997	Storage	5,500	0	5,500	5.403
North TX Municipal Water District [4]	9/27/2010	Reallocation	100,000	0	100,000	98.244
GTUA F/Sherman, TX [4]	9/27/2010	Reallocation	50,000	0	50,000	49.122
Identified as available for reallocation for State of Oklahoma [5]				150,000		
Hydropower [5]		Storage			686,730	674.67
TOTAL			300,000	150,000	986,730	969.40

Yield for total conservation pool storage of 986,730 ac-ft = 969.4 m.g.d.
Yield for current water supply agreements of 300,000 ac-ft = 294.73 mgd

7-9

(1) Storage remaining after 100 years sedimentation from the date the project became operational based on the 2002 sediment survey.

(2) GTUA has requested the remaining 1,515 acre-feet of storage identified for reallocation from the 1985 reallocation; storage will be used for water supply for the town of Pottsboro.

(3) Public Law 85-146 states the rights to storage for Sherman, Texas. Actual law states 41,000 acre-feet, but withdrawal is limited. Amount shown reflects the conservation storage required for the withdrawal limitation during critical hydrologic period.

(4) Section 838 of Public Law 99-662 authorizes the Secretary of the Army to reallocate up to 150,000 acre-feet of storage from hydropower purposes to water supply purposes for entities in the State of Texas.

(5) Includes 150,000 acre-feet identified in Section 838 PL 99-662 as available for reallocation from hydropower purposes to water supply purposes for entities in the State of Oklahoma.

7-10

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 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 7-6. 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. Water rights on the Red River downstream of Lake Texoma are regulated by the Oklahoma Water Resources Board (OWRB) and the Texas Water Commission (TWC). Table 7-5 (located in the Supplemental Tables Section) lists water rights at the lake and water rights downstream to the Arkansas state line, respectively.

b. Regulation Procedure for Water Rights. Normally, the power generation releases from Lake Texoma and inflows from tributaries provide enough water to satisfy downstream water rights. However, if necessary, releases from Lake Texoma will be increased to satisfy downstream water rights at the request of the OWRB or the TWC. The OWRB or TWC will inform the Tulsa District Water Management Section of the amount and time 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 available in the lake.

7-11. Hydroelectric Power.

a. Storage. The storage in Lake Texoma between elevations 590.0 feet and 617.0 feet (less 300,000 acre-feet for water supply) has been allocated for hydropower generation. When the top of the seasonal pool is above elevation 617.0 feet, the storage between elevation 617.0 feet and the top of the seasonal pool is also available for hydropower. Hydropower generation is conducted in collaboration with SWPA. A portion of the flood control storage above the top of the seasonal pool is designated as a transitional pool. The storage in the transitional pool is divided into two zones of release rates which are used to increase the power generation and minimize downstream bank caving by tapering the flood control releases. As shown on Plate 7-1, when the transitional pool is above elevation 617.0 feet, releases through the flood control conduits may be necessary in addition to hydropower releases so that a falling pool can be maintained when possible and the transitional pool emptied within a

reasonable period of time. Releases from the transitional pool or the conservation pool may be constrained, if necessary, to minimize downstream flooding. During flood regulation, power releases normally would not be reduced to less than the average daily release of approximately 2,300 c.f.s. for firm energy (429 mWh/day). Curves relating discharge and power generation are shown on Plates 7-7 and 7-8. See Exhibit B, Public Law 100-71, for additional requirements for management of storage within the power (conservation) pool.

b. Hydropower Drawdown Constraints. In accordance with the Operating Plan for Southwestern Division (SWD) Corps of Engineers (COE) Hydropower (Exhibit E) required by North American Electric Reliability Corporation (NERC), the following are hydropower constraints at Lake Texoma. Per the Operating Plan, allowable firm power release is 2,300 c.f.s., or 429 mWh per day. The minimum downstream water quality requirement is generation for 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, as long as pool elevation remains above 612.0 feet. The maximum hydropower drawdown rate in the conservation pool is limited to 1.0 feet per week and 3.0 feet in any consecutive 4-week period. Response time to changes in hydropower generation is limited to 10 minutes under normal operating conditions, and to 5 minutes under emergency operating conditions.

7-12. Navigation. Although improvement of navigation is one of the designated purposes of Lake Texoma and Denison Dam, there is no storage provided nor is there currently any significant commercial navigation along the Red River upstream of Fulton, Arkansas. Consequently, there are no regulating procedures for Lake Texoma that are solely for the purpose of benefiting navigation.

7-13. Regulation to Minimize Bank Erosion. There is a highly erodible lens (or layer) of soil, a few feet in thickness, located at about 2/3 to 3/4 of the bank full stage. This lens of erodible soil is prevalent in the upper reach of the Red River (downstream of Denison Dam) represented by the Arthur City gage. Experience has shown that if the water surface is held in this range for long periods of time, undercutting and bank caving will result. Efforts should be made to avoid holding water levels in this range for long periods of time. Water levels above 3/4 bank full or below 2/3 bank full have been shown to minimize this erosion problem. Bank caving is a problem that has occurred along the Red River for many years due to the characteristics of the river. In an effort to minimize these problems, when the pool is below elevation 640.0 feet, flood releases shall be gradually increased to the needed level at a rate of no more than 7,500 c.f.s. at one time and no more than 22,500 c.f.s. in one day, when possible. During shutdown, releases shall be gradually decreased in the same manner to prevent sudden change in the river level. When practicable, releases should be decreased gradually enough to avoid more than about a one foot drop each 24 hours at the De Kalb and Index gages. This regulation permits saturated banks to drain out gradually and minimizes stream bank caving. When possible, the last portion of flood control storage at Hugo Lake on the Kiamichi River will be held and released in time to offset the cuts from Lake Texoma and allow the level of the Red River below the confluence of the Kiamichi River to drop

at a slower rate. Bank erosion on the Red River also causes the problem of large amounts of sediment to be deposited in the river channel during a flood recession. The sediment deposits significantly reduce the channel capacity in some locations.

7-14 Drought Contingency Plans. The Upper Red River, Oklahoma and Texas, Red River Basin, Waurika Lake and Lake Texoma, Drought Contingency Plan was prepared in Feb 1993 and updated in Feb 2006.

7-15. Flood Emergency Action Plans. A flood emergency action plan is outlined in the Operation and Maintenance Manual, Volume II, for Denison Dam – Lake Texoma, Red River, Texas and Oklahoma, dated Aug 1997. 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 Lake Manager 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 Lake Manager 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 lake, although they are not considered emergencies. Construction accounts for the major portion of these incidents and includes 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. The Corps of Engineers SWD is normally advised by telephone of these minor deviations with written follow-up 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, 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 lake area and the downstream channel. Below elevation 640.0 feet, changes in release are limited to 7,500 c.f.s. per gate change, with a minimum of four hours between gate changes and a maximum of three gate changes per day. This limits the maximum change in flow rate to 22,500 c.f.s. per day when the pool is below elevation 640.0 feet. When the pool is above elevation 640.0 feet, changes in release are limited to 10,000 c.f.s. per gate change every two hours, with no limit on the number of gate changes per day. Every reasonable precaution will be made to eliminate bank sloughing, undercutting, excessive erosion, and danger to human and animal lives, if possible. Situations will arise which will not allow an orderly increase and/or decrease in releases. Examples of these situations are large flood releases and drownings that occur downstream of the dam.

VIII - EFFECT OF WATER CONTROL PLAN

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

8-02. Flood Control.

a. Spillway Design Flood. The Spillway Design Flood is the flood that would result from the storm of May 1943 (SW2-20) transposed to a critical position over the Red River basin and increased by 34%. The development and routing of this flood is described in the report "Revised Spillway Design Flood, Denison Dam (Lake Texoma)," prepared by the Tulsa District using current criteria in Oct 1968 (see subparagraph 8-02.b. for the original Spillway Design Flood). The volume of runoff entering Lake Texoma from this flood would be 11,985,000 acre-feet with a peak inflow of 1,830,000 c.f.s. and a maximum outflow of 1,130,000 c.f.s. The maximum pool elevation from this flood would be 666.4 feet. Plate 8-1 shows the operational hydrograph of the Spillway Design Flood routed through Lake Texoma with a beginning pool elevation of 640.0 feet (top of flood control pool).

b. Standard Project Flood. The Standard Project Flood is the flood that would result from a design storm furnished by the NWS and based on the Lower Mississippi Valley Division's 2-26 storm that occurred during Jul 1933 in Louisiana. The Standard Project Flood is the original Spillway Design Flood for which the project was initially designed; the current Spillway Design Flood described in subparagraph 8-02.a. is a larger flood with 30% more runoff volume and a 36% higher peak inflow than the original Spillway Design Flood. The volume of runoff entering Lake Texoma from the Standard Project Flood would be 9,190,000 acre-feet with a peak inflow of 1,350,000 c.f.s. and a maximum outflow of 828,000 c.f.s. The maximum pool elevation would be 661.4 feet. Plate 8-2 shows the operational hydrograph of the Standard Project Flood routed through Lake Texoma with a beginning pool elevation of 640.0 feet (top of flood control pool).

c. Flood of Apr – Jun 1957. The flood of Apr - Jun 1957 caused the maximum pool elevation of record at that time, 643.15 feet on 5 Jun 1957, following a record low of 599.98 feet established on 1 Mar 1957. During the period between 19 Apr and 4 May, there was an average of 9.6 inches of rainfall over the Red River basin upstream of Fulton, Arkansas, with 9.3 inches occurring upstream of Denison Dam and 10.3 inches occurring downstream of Denison Dam. The runoff during this period raised the pool elevation to 634.5 feet on 22 May, with a peak inflow of 190,000 c.f.s. on 20 May. A second period of heavy rainfall occurred between 22 May and 26 May, producing an average of 2.8 inches over the basin above Fulton, with 2.1 inches upstream of Denison

Dam and 5.2 inches downstream of Denison Dam. On 28 May, the pool rose to elevation 640.0 feet (top of flood control pool and spillway crest). Rainfall which occurred over the Red River basin upstream of Denison Dam from 29 May to 5 Jun averaged 3.8 inches and created another period of high inflow which reached a peak of 130,000 c.f.s. on 1 Jun 1957. This flood was the subject of the document "Report on Review of Reservoir Regulations for Flood Control on Lower Red River," dated 1959 and revised Sep 1960, in which the regulations described in Section VII of this manual were developed. Plate 8-3 shows the operational hydrographs for the lake and Plates 8-4 and 8-5 show the discharge hydrographs at Arthur City, Texas, and Fulton, Arkansas, derived in that report.

d. Flood of Apr - May 1990. The flood of Apr-May 1990 resulted from an average rainfall of 9.15 inches over the Red River basin upstream of Denison Dam between 13 Apr and 4 May. The inflow to Lake Texoma peaked on 5 May at approximately 300,000 c.f.s. (instantaneous inflow) and the pool elevation peaked on 6 May at 644.76 feet, which was the highest elevation ever recorded. The pool elevation stayed above 630.0 feet through 7 Jun and it stayed above 620.0 feet through 27 Jun. Flooding along the Red River and tributaries was much worse between Lake Texoma and Fulton, Arkansas, than it was upstream of Lake Texoma; the average rainfall over the Red River basin between Denison Dam and Fulton during the period 13 Apr to 4 May was 13.32 inches. Plate 8-6 shows the operational hydrographs for the 1990 flood at Lake Texoma; Plate 8-7 shows the observed and routed hydrographs at Arthur City and De Kalb, Texas; and Plate 8-8 shows the observed and routed hydrographs at Index and Fulton, Arkansas.

e. Flood of Jun - Jul 2007. The Jun - Jul 2007 flood was chosen as an example to route through the lake and to make releases downstream. This flood was the result of a Red River basin rainfall of 7.25 inches above Denison Dam. The flood had a peak inflow into Lake Texoma of 191,900 c.f.s and a volume of 2,966,900 acre-feet. The maximum pool elevation was 640.73 and the peak outflow was 41,700 c.f.s. The pool elevation stayed above 630.0 feet through 11 Aug and it stayed above 620.0 feet through 5 Sep. Plate 8-9 shows the operational hydrographs for this flood at Lake Texoma; Plate 8-10 shows the observed and routed hydrographs at Arthur City and De Kalb, Texas; and Plate 8-11 shows the observed and routed hydrographs at Index and Fulton, Arkansas.

8-03. Recreation. As discussed in subparagraph 3-06.a., problems due to high water levels are first noticeable when the pool elevation rises to about 621.0 or 622.0 feet; serious problems occur whenever the pool elevation exceeds 630.0 feet. Problems due to low water levels occur whenever the pool elevation drops below about 610.0 to 612.0 feet.

8-04. Water Quality. The releases discussed in paragraph 7-07. will provide some flow in the river below the dam thus reducing periods of no flow and stagnation.

8-05. Fish and Wildlife. Lake Texoma provides an improved fishery over the natural river, allowing some species of sport fish to flourish in contrast to previous natural river conditions. Some wildlife habitat was inundated due to impoundment; however, wildlife management of the lake's perimeter lands strives to replace these losses. It should be noted that the Interior Least Tern is known to nest in the Red River from Denison Dam downstream to Index, Arkansas.

8-06. Water Supply. As shown in Table 7-4, there are currently 14 water supply users with approved contracts. These contracts are for municipal and industrial use of water from Lake Texoma.

8-07. Hydroelectric Power. A Memorandum of Understanding (MOU) between The US Department of Energy (via SWPA) and the Corps of Engineers detailing hydropower operations at Lake Texoma was signed on 23 Jul 1980 (see Exhibit D). During normal operations, releases will be made primarily through the hydropower turbines to maintain the pool elevation at or below the top of the seasonal pool. The conservation storage from elevation 617.0 to 590.0 feet, less water supply storage, is allocated to hydropower generation. (Currently water supply storage is 300,000 acre-feet, with an additional 150,000 acre-feet available for reallocation from to water supply from hydropower generation for Oklahoma entities). Seasonal storage of water above elevation 617.0 feet is also allocated to hydropower during the times of the year when the seasonal pool is above elevation 617.0 feet. The generation of power along with other conservation uses during hot and dry periods will draw the pool below the top of the seasonal pool.

8-08. Navigation. Although improvement of navigation is one of its designated purposes, the project is not currently regulated for navigation.

8-09. Frequencies.

a. Peak Inflow Probability. Lake Texoma daily inflows with upstream lakes in operation were taken from Riverware computer run "REDCOE 602 Base Model ManualData.mdl" for the period Jan 1938 through Dec 2007 and were used to compute the maximum annual peak daily inflow probability. The inflow probability was derived in accordance with Bulletin 17B, Guidelines for Determining Flood Flow Frequency, Sep 1981, with SWD requirements as stated in the Corps of Engineers Disposition Form (DF) dated 22 Aug 1979. The peak daily inflow probability curve is shown on Plate 4-5.

b. Pool Elevation Duration and Probability. The pool elevation hydrographs resulting from the Red 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, 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 8-12 shows the pool elevation probability curve and Plate 8-13 shows the pool elevation duration curve.

Plates 8-14 through 8-19 show pool elevations for simulated and actual operational hydrographs for the period of record Jun 1944 through Dec 2010.

c. Key Control Points. Discharge rating curves used in the regulation of Lake Texoma are shown on Plates 4-6 through 4-9.

8-10. Other Studies. Other recent and current studies sponsored by Tulsa District on the Red River include (1) a bank stabilization study (from Denison Dam to Index, Arkansas), the Denison Dam - Lake Texoma Restudy, (2) the Red River Basin Comprehensive Study, (3) the development of storage-discharge relationships for the Denison forecast model, (4) Washita River storage-discharge curves for the Denison forecast model, (5) the implementation of a proposed seasonal pool plan, (6) Storage Reallocation Report, Lake Texoma, Oklahoma and Texas, Dated Apr 2009, (7) Shoreline Management Plan, Lake Texoma, Oklahoma and Texas, latest revision 1996, and (8) Lake Texoma Regional Sewer System Study, Planning Assistance to States Program, Dated 2001. The bank stabilization study evaluated different methods of protecting the channel banks as well as the possible use of levees to protect some areas from flooding. The Denison Dam-Lake Texoma Restudy was completed and published in a final document in Sep 1990. The Red River Basin Comprehensive Study was completed in Mar 1989 and was published in a six volume report. The development of the storage-discharge curves for the Red River above Lake Texoma and for the Washita River have been completed, and both are being used in the forecast model for Lake Texoma. The seasonal pool plan proposal by the Lake Texoma Advisory Committee was studied and compared to the existing pool level plan using the "SUPER" model to simulate the flows for the period 1938 to 1990. Results of the seasonal pool study were that the proposed seasonal pool (as shown in Plate 7-1) compared to the existing plan had (1) little to no effect on high flows in the Red River below the dam; (2) a higher percentage of total outflow through the hydropower units; (3) less frequent and lower duration low pool levels; and (4) little to no effect on the frequency and duration of high pool levels.

IX - WATER CONTROL MANAGEMENT

9-01. Responsibilities and Organizations.

a. Corps of Engineers. Lake Texoma (Denison Dam) 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 Water Management 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 lake 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 or email.

2). Provide hydrologic data for situation reports.

(g) Furnish information to the Reservoir Information Control Center (RICC). The duties of the Lake Manager 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 24 hours a day whenever basin and/or project conditions warrant and during flood emergencies. Responsible personnel will be on duty at the project 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 the Tulsa District, he/she will immediately attempt to reestablish communication with the Tulsa District while following the instructions outlined in the Section "Emergency Regulations for Flood Control" included in Section VII and Exhibit C 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, together with the State of Oklahoma, establishes the standards for water quality releases. The SWPA coordinates with the Water Management Section for hydropower releases (see section 9-02.d.).

c. State Agencies. Since Lake Texoma is located in both Oklahoma and Texas, the management of the fish and wildlife resources fall under the purview of the Texas Parks and Wildlife Department (Texas portion of the lake) and the Oklahoma Department of Wildlife Conservation (Oklahoma portion of the lake).

d. Private Organizations. Presently, there are no privately owned flood control protection facilities at Lake Texoma 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 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 RICC is in operation when conditions warrant.

b. National Weather Service. The Tulsa District, the Arkansas-Red Basin River Forecast Center of the NWS and the Lower Mississippi River Forecast Center of the NWS 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 Denison 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 Denison Dam. 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 E).

f. Other Federal, State, or Local Agencies. The Tulsa District exchanges information with state and local government officials, the State Highway Department, the Oklahoma Highway Patrol and the Texas Highway Patrol, and others during flood emergencies. The Tulsa District also coordinates with federal and state (Oklahoma and Texas) fish and wildlife agencies throughout normal operation.

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

9-04. Commissions, River Authorities, Compacts, and Committees. The Red River Authority of Texas and the Red River Interstate Compact Commission are both entities involved with developing, protecting, and distributing water resources within the Red River basin. The Red River Authority of Texas (520 Hamilton Building, Wichita Falls, Texas, 76301) was created by the Texas Legislature in 1959 as a conservation and reclamation district encompassing all or part of 43 counties in Texas. The authority provides administrative, technical, and financial assistance to entities in Texas for the purpose of planning, conservation, reclamation, water development, pollution control,

and regional sponsorship of local water and wastewater projects. The Red River Interstate Compact Commission is composed of two commissioners from each state (Oklahoma, Texas, Arkansas, and Louisiana) plus one federal representative. Together, the nine members negotiate agreements between the states for matters involving waters of the Red River.

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/DENIcharts.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

LAKE TEXOMA (DENISON DAM), RED RIVER
OKLAHOMA AND TEXAS

APPENDIX A
TO
MASTER WATER CONTROL MANUAL
RED RIVER BASIN

SUPPLEMENTAL TABLES

TABLE 4-4a

TOP TWENTY ANNUAL PEAK STAGES
AND CORRESPONDING DISCHARGES
FOR STATIONS UPSTREAM OF DENISON DAM

MANGUM [1] FLOODSTAGE 9.0 FT			HEADRICK [2] FLOODSTAGE 12.0 FT [3]			BURKBURNETT [4] FLOODSTAGE 9.0 FT			TERRAL [5] FLOODSTAGE 22.0 FT		
DATE	STG FT.	FLOW C.F.S.	DATE	STG FT.	FLOW C.F.S.	DATE	STG FT.	FLOW C.F.S.	DATE	STG FT.	FLOW C.F.S.
16 Jun 1938	14.70	60,000	18 May 1935	19.80	60,000	21 Oct 1983	16.90	166,000	22 Oct 1983	33.60	210,000
3 Oct 1986	14.66	21,400	4 Oct 1986	19.07	59,000	6 Jun 1995	16.61	174,000	30 May 1987	32.65	225,000
16 May 1957	14.55	72,000	10 May 1993	18.83	56,100	4 Jun 1991	13.78	103,000	7 Jun 1995	30.56	236,000
4 Apr 1997	14.29	26,100	5 Jun 1995	17.49	52,700	29 May 1987	13.78	98,700	8 Jun 1941	28.12	197,000
19 Jul 1953	13.75	44,800	21 Oct 1983	17.27	30,200	27 Jul 1975	12.64	61,400	19 May 1935	27.20	(6)
7 Jul 1993	13.53	17,300	28 May 1977	17.26	35,000	21 Sep 1965	12.15	58,000	19 May 1951	26.68	164,000
27 May 1977	13.50	36,800	15 Jun 2007	16.87	13,600	1 Jun 1980	12.11	42,200	1 Jul 1907	24.00	102,000
28 May 1978	13.45	36,000	5 Oct 1955	16.50	30,700	27 Apr 1997	12.10	72,100	4 May 1990	23.78	115,000
10 Jun 1954	13.30	38,100	27 Apr 1997	15.88	25,400	19 Oct 1960	11.88	53,500	7 Oct 1955	23.30	111,000
24 Apr 1973	13.17	30,700	10 Jun 1941	15.85	27,400	12 May 1993	11.57	55,000	4 Jun 1957	22.72	110,000
24 Jun 1975	13.10	29,900	30 May 1978	15.70	26,400	19 Oct 1965	11.46	62,800	21 Dec 1991	22.48	107,000
4 Jun 1995	12.88	14,200	8 Oct 2004	15.64	9,740	31 May 1977	11.26	37,700	21 May 1955	22.44	109,000
29 May 1980	12.82	30,000	5 Mar 2004	15.56	10,700	31 May 1978	11.10	44,700	18 Mar 1998	22.32	99,400
4 Jun 1965	12.38	27,500	19 Oct 1965	15.43	20,600	19 Oct 1985	10.95	34,600	5 Jun 1991	21.79	89,500
27 May 1956	12.20	35,900	20 Sep 1965	15.38	20,600	20 Dec 1991	10.88	31,300	31 Oct 1941	21.45	91,000
8 Jun 1941	12.20	32,500	19 May 1951	14.96	24,900	17 Mar 1998	10.80	59,800	14 May 1954	21.42	85,800
13 May 1958	12.18	32,500	19 Oct 1960	14.90	23,500	16 Jun 1989	10.73	38,400	14 Oct 1981	21.31	58,000
13 Sep 1976	12.09	17,400	13 May 1947	14.85	21,780	10 Jun 1960	10.52	38,600	2 Nov 1972	21.24	48,400
21 Jun 1948	11.77	21,500	5 May 1969	14.85	17,900	7 Jun 1985	10.50	42,000	10 May 1993	21.14	84,100
20 Sep 1974	11.75	14,200	30 Sep 1986	14.56	12,300	2 Jun 1968	10.50	33,000	8 Jun 1985	20.94	62,600

NOTES:

(1) Mangum Gage Period of Record –11 Apr 1905 through 30 Jun 1906 and 1 Oct 1937 through 30 Sep 2009
(2) Headrick Gage Period of Record – 1 Oc t 1937 through 30 Jun 2009
(3) Prior to 29 Jan 1969, flood stage at Headrick was 7.0 ft.
(4) Burkburnett Gage Period of Record –11 Jul 1924 through 24 Aug 1925 and 1 Dec 1959 through 30 Sep 2009
(5) Terral Gage Period of Record –1 Apr 1938 through 30 Sep 2009
(6) Data is Unavailable

TABLE 4-4a (continued)

GAINESVILLE [1] FLOOD STAGE 25.0 FT			CHEYENNE [2] FLOOD STAGE 13.5 FT [5]			CARNEGIE [3] FLOOD STAGE 18.0 FT			CLINTON [4] FLOOD STAGE 18.0 FT		
DATE	STG FT.	FLOW C.F.S.	DATE	STG FT.	FLOW C.F.S.	DATE	STG FT.	FLOW C.F.S.	DATE	STG FT.	FLOW C.F.S.
31 May 1987	40.08	265,000	29 Apr 1954	15.24	69,800	5 Jun 1995	31.50	40,200	3 Apr 1934	33.90	90,000
24 Oct 1983	37.14	151,000	3 Apr 1934	16.90	52,000	19 Aug 2007	30.81	23,100	16 May 1951	31.09	66,800
13 Jun 1995	36.63	169,000	23 May 1941	13.50	40,000	10 May 1993	30.68	25,500	5 Jun 1936	28.50	26,900
5 May 1990	33.13	134,000	4 Jun 1949	10.60	11,900	5 Oct 1986	29.57*	25,200	5/??/1935	28.00	25,000
11 May 1993	30.99	117,000	22 Apr 1990	16.60	7,250	30 Sep 1986	28.61	11,100	26 May 1959	27.84	22,200
3 Jul 2007	30.58	95,900	16 May 1977	14.34	4,660	14 Jun 1989	27.51	10,100	15 Sep 1996	26.24	10,800
19 Mar 1998	29.62	102,000	30 Aug 2003	14.04	1,590	20 Oct 1983	26.70	40,600	3 Oct 1986	25.93	10,600
14 Oct 1981	29.45	103,000	9 Jun 1996	12.92	1,430	4 Mar 1988	25.88	9,960	11 Apr 1940	25.50	15,000
23 Dec 1991	28.69	94,100	8 Sep 2007	14.15	1,420	12 Mar 1990	25.61	8,580	3 Aug 1995	25.43	9,100
2 May 2009	26.55	65,300	15/19/1982	12.50	1,420	18 May 1951	25.50	40,900	19 May 1938	24.90	13,000
21 May 1951	26.53	146,000	9 Jun 2008	13.93	1,300	5 Oct 1955	24.04	23,900	27 May 1982	24.42	5,890
5 Jun 1957	25.14	102,000	22 Sep 1997	12.63	1,240	9 Jan 1900	23.47	17,400	9 Jan 1900	24.30	7,760
7 Jun 1985	24.56	77,400	5 Jun 1995	10.90	585	22 May 1977	22.70	9,800	1 May 1954	23.99	13,100
9 Jun 1941	24.15	168,000	12 Jun 2005	12.08	561	14 Jun 1944	22.74	14,000	11 Jun 1983	13.95	6,070
10 Jun 1989	23.88	76,100	24 Apr 1999	11.26	547	28 Apr 1997	22.49	8,240	8 Jun 1989	23.58	5,020
29 Apr 1997	23.79	60,100	16/0/2001	11.64	504	21 May 1982	22.45	11,300	4 Oct 1955	23.21	7,550
28 Oct 2000	23.74	56,300	17 Mar 1998	10.76	422	17 May 1947	22.20	10,600	10 Jun 1941	22.86	12,500
6 Jun 1991	23.35	64,500	15 Aug 2004	11.51	412	3 Jun 1991	21.73	5,290	11 Apr 1997	22.57	3,400
4 Oct 1941	22.32	156,000	16/091979	10.77	400	31 May 1980	21.61	6,310	10 Apr 1945	22.19	10,400
8 Oct 1955	21.70	106,000	23 Mar 2000	10.96	392	24 Apr 1957	21.41	12,600	25 Oct 1941	22.13	10,100

NOTES:

(1) Gainesville Gage Period of Record –27 May1936 through 27 Jun 1937 and 15 Nov 1937 through 30 Sep 2009
(2) Cheyenne Gage Period of Record – 1 Oct 1937 through 30 Sep 2009
(3) Carnegie Gage Period of Record – 1 Oct 1937 through 30 Sep 2009
(4) Clinton Gage Period of Record – 18 Oct 1935 through 30 Sep 2009
(5) Prior to 1 Jan 1977, flood stage at Cheyenne was 8.0 ft.

29.57* Mean gage height of measurement #157, crest unknown

TABLE 4-4a (continued)

PAULS VALLEY [1] FLOOD STAGE 24.0 FT			DICKSON [2] [3] FLOOD STAGE 27.0 FT		
DATE	STAGE FT.	FLOW C.F.S.	DATE	STAGE FT.	FLOW C.F.S.
10 Jun 1941	30.60	22,000	30 May 1987	45.24	105,000
11 May 1950	29.88	30,000	31 Oct 1941	44.37	85,000
1 Oct 1945	29.70	18,600	11 May 1943	44.35	91,300
31 Oct 1941	29.15	16,200	3 May 1990	44.26	118,000
29 May 1987	28.72	43,600	12 May 1950	42.57	80,100
22 May 1949	28.42	21,700	19 May 1957	42.30	98,000
19 May 1947	28.04	15,200	1 May 1908	42.00	71,000
11 May 1943	27.75	14,000	1 Oct 1945	41.54	64,800
18 May 1957	27.34	35,800	17 Feb 1938	41.20	68,000
15 Jun 1945	26.23	9,770	16 Mar 1945	38.51	50,500
22 Oct 1983	25.82	28,400	1 Apr 1927	38.00	43,500
25 Jun 1948	24.00	12,100	19 May 1935	37.22	36,400
23 May 1951	23.00	20,100	25 May 1947	35.22	35,800
10 May 1993	21.49	31,200	25 May 1933	33.92	27,600
9 Jun 1944	21.18	8,010	9 Oct 1970	33.14	43,600
23 Aug 2007	20.53	27,300	9 May 1936	31.97	24,500
3 May 1990	20.35	28,000	26 Nov 1973	31.85	42,300
9 Jun 1995	19.68	29,100	10 May 1993	31.64	56,500
3 Oct 1959	19.53	18000	13 Jun 1941	31.56	21,000
9 Jun 1979	19.50	12200	29 May 1982	31.53	41,800

NOTES:

(1) Pauls Valley Gage Period of Record –5/20/1899 through 12/31/1899 and 10/1/1937 through4/30/2009
(2) Dickson Gage Period of Record –8/4/1928 through9/30/1989
(3) Formerly Known as Durwood Gage

TABLE 4-4b

TOP TWENTY ANNUAL PEAK STAGES
AND CORRESPONDING DISCHARGES
FOR STATIONS DOWNSTREAM OF DENISON DAM

ARTHUR CITY, TX FLOOD STAGE 27.0 FT			DE KALB, TX [2] FLOOD STAGE 24.0 FT			INDEX, AR FLOOD STAGE 25.0 FT			FULTON, AR FLOOD STAGE 27.0 FT		
DATE	STG FT.	FLOW C.F.S.	DATE	STG FT.	FLOW C.F.S.	DATE	STG FT.	FLOW C.F.S.	DATE	STG FT.	FLOW C.F.S.
28 May 2008	43.20	400,000	6 May 1990	34.62	279,100	23 Feb 1938	34.25	297,000	2 Apr 1945	37.4	276,000
19 May 1892	34.80	(1)	Jun 1957	32.20	205,000	10 May 1990	32.30	270,000	24 Feb 1938	36.5	338,000
19 Feb 1938	34.30	222,000	11 Dec 1971	31.55	189,000	25 May 1925	31.10	(1)	24 Apr 1927	35.0	(1)
4 May 1990	34.21	275,000	12 May 2009	28.84	103,000	23 Apr 1927	30.80	(1)	24 Jun 1935	34.8	(1)
10 Jun 1915	33.70	(1)	14 Jul 2007	28.64	78,400	1 May 1942	29.85	178,000	24 May 1892	34.8	(1)
17 Jun 1935	31.70	(1)	21 Mar 2008	28.58	82,300	8 Jun 1957	28.56	154,000	12 May 1990	34.35	(1)
26 Apr 1942	31.55	199,000	26 Apr 1973	28.54	131,000	1 Apr 1945	28.05	152,000	26 May 1935	34.1	(1)
12 Jun 1941	31.27	183,000	9 May 1969	27.38	112,200	16 Jun 1941	27.83	145,000	2 Jun 1908	34.1	(1)
6 10 1891	30.00	(1)	29 Mar 1977	27.14	110,000	21 May 1920	27.60	(1)	2 May 1915	34.1	(1)
5 Jul 2003	28.80	(1)	22 Mar 1968	26.77	(1)	21 Feb 1932	27.40	(1)	3 May 1890	34.0	(1)
6 Jun 1957	28.35	136,000	22 Mar 2002	26.57	96,600	21 May 1929	27.20	(1)	19 May 1920	33.6	(1)
27 Jul 1959	28.35	34,700	18 Feb 2001	26.51	96,100	21 May 1930	27.20	(1)	2 May 1942	33.2	208,000
18 Oct 1923	28.20	(1)	26 Nov 1996	26.51	93,900	18 Dec 1923	27.00	(1)	12 Dec 1913	33.2	(1)
1 Jun 2002	27.30	(1)	23 Feb 1969	26.23	(1)	15 May 1922	26.30	(1)	28 Jan 1938	32.9	(1)
16 Apr 1927	27.00	(1)	7 Jun 1973	25.95	(1)	14 Dec 1971	25.62	142,000	24 Mar 1894	32.9	(1)
3 Dec 1913	26.70	(1)	10 May 1995	25.79	84,400	6 May 1958	25.32	145,000	15 Apr 1942	32.7	(1)
15 May 1929	26.70	(1)	18 May 1989	25.65	78,100	23 May 1928	25.00	(1)	22 May 1930	32.5	(1)
14 May 1982	26.65	142,000	5 Jan 2005	25.54	92,500	29 May 1933	24.70	(1)	4 Feb 1916	32.2	(1)
3 May 1958	26.35	120,000	11 Nov 1974	25.07	(1)	29 Jan 1949	24.56	112,000	1 Dec 1902	32.2	(1)
11 Dec 1971	26.35	121,000	19 May 1968	25.00	108,000	25 Apr 1952	24.50	112,000	30 Jan 1949	32.0	(1)

(1) Data Unavailable

(2) Broken Period of Record

TABLE 4-6

LAKE TEXOMA MONTHLY INFLOWS (Acre-Feet)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1906	178,900	122,700	192,500	591,500	1,594,000	969,300	518,300	1,725,000	825,300	341,900	114,200	247,200	7,420,800
1907	299,400	132,200	317,900	101,800	818,400	1,354,000	747,100	306,800	133,300	624,700	261,200	211,500	5,308,300
1908	169,700	94,300	149,400	1,225,000	4,114,000	4,403,000	969,100	147,000	111,300	644,400	140,400	472,800	12,640,400
1909	81,200	62,800	73,200	64,900	71,300	442,100	93,500	66,400	34,200	25,000	114,000	393,000	1,521,600
1910	101,300	63,300	49,500	166,500	152,800	144,300	240,300	91,400	40,600	20,700	16,800	17,600	1,105,100
1911	20,500	113,900	74,000	74,700	92,500	141,600	332,700	261,000	352,600	51,800	28,000	359,000	1,902,300
1912	151,900	131,100	538,000	600,400	503,600	563,500	254,600	453,200	249,900	194,300	176,700	92,200	3,909,400
1913	131,600	91,600	106,400	119,000	448,900	120,300	345,000	89,800	237,400	406,400	430,800	1,708,000	4,235,200
1914	213,400	122,200	199,800	533,800	1,407,000	630,200	206,000	739,700	572,400	187,500	138,600	124,200	5,074,800
1915	184,500	135,000	341,900	1,799,000	1,957,000	3,549,000	915,600	529,400	398,100	1,336,000	227,900	127,300	11,500,700
1916	797,500	275,000	131,600	1,264,000	440,300	559,300	175,200	69,500	151,100	195,500	89,300	51,500	4,199,800
1917	39,500	29,400	35,700	111,900	124,200	360,600	164,800	164,200	122,000	38,100	22,000	41,200	1,253,600
1918	48,000	35,500	32,000	727,700	216,400	618,900	89,200	31,400	230,900	912,500	502,200	452,600	3,897,300
1919	309,900	206,600	116,800	656,300	1,261,000	514,900	405,800	118,700	131,500	1,313,000	649,800	190,000	5,874,300
1920	329,000	173,100	104,500	290,400	1,329,000	378,500	195,500	614,900	924,700	739,700	599,200	219,500	5,898,000
1921	186,300	289,400	346,200	624,200	140,900	1,294,000	282,800	79,900	59,500	56,000	48,800	33,800	3,441,800
1922	30,700	28,100	96,500	884,800	1,335,000	354,100	148,200	41,200	28,000	30,100	92,200	51,800	3,120,700
1923	37,500	217,200	86,300	251,300	924,800	1,316,000	105,800	41,800	482,000	2,144,000	879,000	607,000	7,092,700
1924	174,000	98,900	305,000	571,000	383,000	159,000	103,000	82,500	66,100	67,500	43,900	41,900	2,095,800
1925	45,600	41,400	35,700	303,000	472,000	72,900	35,300	245,000	1,000,000	379,000	169,000	46,700	2,845,600
1926	97,200	566,000	119,000	357,000	363,000	202,000	453,000	555,000	299,000	1,640,000	151,000	314,000	5,116,200
1927	276,000	263,000	282,000	1,566,000	250,000	344,000	527,000	264,000	106,000	381,000	77,400	171,000	4,507,400
1928	135,000	163,000	105,000	375,000	1,019,000	1,170,000	498,000	186,000	53,000	28,100	127,000	88,500	3,947,600
1929	101,000	70,000	206,000	278,000	1,087,000	584,000	217,000	51,500	569,000	141,000	149,000	105,000	3,558,500
1930	103,000	287,000	132,000	82,700	1,350,000	515,000	81,800	35,700	55,900	602,000	104,000	498,000	3,847,100
1931	89,800	312,000	271,000	224,000	285,000	91,600	205,000	52,300	20,800	296,000	298,000	290,000	2,435,500
1932	836,000	679,000	183,000	183,000	358,000	918,000	779,000	159,000	212,000	84,200	38,000	323,000	4,752,200
1933	176,000	66,100	344,000	194,000	1,322,000	172,000	102,000	309,000	327,000	105,600	62,600	73,000	3,253,300
1934	113,300	100,400	308,100	179,200	230,500	133,100	27,900	12,900	318,600	82,800	192,200	71,000	1,770,000
1935	51,100	36,000	382,800	185,900	2,690,000	1,333,000	369,200	148,300	341,700	98,000	98,400	310,900	6,045,300
1936	71,900	51,700	64,800	39,200	549,000	408,700	75,600	25,700	985,500	451,800	71,600	87,000	2,882,500

T4-6-1

TABLE 4-6 (continued)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1937	155,800	79,700	184,500	242,600	105,500	656,500	85,900	261,900	180,800	232,100	57,600	95,200	2,338,100
1938	161,400	1,100,000	637,600	465,000	1,147,000	686,400	158,500	92,800	57,700	32,700	40,800	23,800	4,603,700
1939	102,900	45,300	61,400	144,900	90,300	241,800	143,500	116,500	23,900	25,400	23,900	14,800	1,034,600
1940	11,200	28,400	15,300	209,800	458,000	422,400	445,200	227,400	82,100	23,900	257,600	205,600	2,386,900
1941	140,500	400,700	145,000	563,100	1,975,000	3,093,000	475,800	219,900	308,000	2,523,000	1,515,000	322,700	11,681,700
1942	178,100	160,100	196,100	2,586,000	896,000	651,000	176,800	167,300	365,300	476,000	488,900	179,200	6,520,800
1943	180,400	102,500	157,000	573,300	1,675,000	701,300	131,800	42,300	40,700	45,600	28,700	27,500	3,706,100
1944	72,200	236,000	277,400	192,200	333,400	403,900	98,600	73,900	37,700	230,300	117,000	145,600	2,218,200
1945	116,600	434,100	1,924,000	1,352,000	379,800	1,053,000	777,700	286,600	447,100	1,226,000	99,000	62,900	8,158,800
1946	485,600	539,200	294,200	222,300	376,600	512,300	263,900	137,800	177,900	151,300	336,900	786,400	4,284,400
1947	102,400	54,300	99,900	867,900	2,182,000	785,800	165,400	64,900	23,100	61,200	65,500	295,200	4,767,600
1948	65,700	276,700	389,700	100,200	482,000	480,500	509,900	71,100	26,700	1,400	1,100	12,500	2,417,500
1949	88,500	416,200	232,200	140,200	1,064,000	856,500	113,200	49,600	243,800	214,300	42,700	68,400	3,529,600
1950	187,700	253,400	55,800	106,000	1,428,000	408,700	958,400	1,089,000	855,000	227,400	38,400	50,600	5,658,400
1951	75,100	142,600	154,300	81,800	1,610,000	1,792,000	413,300	68,400	68,400	74,500	72,700	19,000	4,572,100
1952	37,000	49,300	105,500	324,500	566,300	186,000	50,400	2,000	2,000	1,900	10,000	23,900	1,358,800
1953	18,700	19,000	143,000	230,400	174,800	101,100	274,000	128,600	38,200	627,000	270,000	121,700	2,146,500
1954	63,600	16,800	23,200	133,200	1,680,000	414,200	8,100	6,100	6,800	75,500	6,300	51,700	2,485,500
1955	48,900	66,100	112,800	102,000	1,187,000	732,000	179,200	99,700	326,400	1,045,000	82,800	46,100	4,028,000
1956	37,300	88,500	51,100	45,700	264,300	181,400	73,000	27,600	4,300	68,500	64,300	68,700	974,700
1957	29,900	73,300	138,200	1,732,000	4,705,000	1,936,000	224,200	96,200	383,000	146,000	598,700	112,800	10,175,300
1958	285,700	125,200	257,700	336,900	814,300	269,600	228,600	112,600	35,100	15,400	23,600	22,700	2,527,400
1959	32,400	32,200	66,300	166,600	460,900	495,500	380,900	146,600	180,200	1,047,000	155,700	449,900	3,614,200
1960	407,600	412,700	279,300	183,200	408,400	387,400	280,300	95,100	83,500	779,400	141,800	321,700	3,780,400
1961	135,200	164,900	351,300	328,000	251,000	477,000	267,000	90,000	259,200	196,600	333,200	197,800	3,051,200
1962	76,000	97,800	111,800	193,200	182,400	1,495,000	221,900	135,800	404,300	178,300	328,600	272,700	3,697,800
1963	64,300	87,400	146,000	244,400	140,600	245,400	79,400	10,800	27,000	9,700	15,200	20,400	1,090,600
1964	25,100	74,700	85,500	120,700	206,800	192,500	29,200	90,000	264,400	67,300	585,000	95,900	1,837,100
1965	88,900	135,600	64,600	131,000	357,000	338,400	98,100	42,400	333,300	422,300	97,600	62,500	2,171,700
1966	68,600	218,200	111,600	518,800	285,400	71,800	28,700	192,300	350,800	119,700	12,800	15,400	1,994,100
1967	30,200	27,800	42,800	705,200	265,900	302,900	183,400	48,200	140,200	52,200	35,100	44,600	1,878,500
1968	273,200	110,200	530,300	289,000	972,500	807,400	264,000	56,800	180,400	119,000	179,700	187,400	3,969,900
1969	131,700	347,400	467,300	357,800	1,307,000	308,200	45,000	44,600	260,900	107,300	47,100	103,100	3,527,400

T4-6-2

TABLE 4-6 (continued)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1970	67,100	167,900	309,300	329,100	271,200	162,800	14,900	2,800	315,100	455,800	49,600	28,900	2,174,500
1971	46,500	46,400	48,000	57,000	80,300	162,100	50,200	243,900	238,800	290,200	83,900	522,300	1,869,600
1972	49,900	35,200	43,800	99,900	370,800	88,000	53,400	16,500	51,000	141,800	694,800	73,500	1,718,600
1973	351,800	265,800	769,600	1,404,900	202,500	948,700	141,900	172,700	578,100	572,400	701,500	273,300	6,383,200
1974	82,900	136,200	221,000	174,600	688,100	290,000	30,400	129,900	665,300	536,100	829,900	133,100	3,917,500
1975	226,200	508,300	620,400	409,500	1,161,200	1,142,100	601,100	454,400	155,600	63,100	92,700	84,800	5,519,400
1976	85,000	63,000	147,700	435,400	348,500	276,000	97,900	21,900	218,400	66,100	81,200	44,700	1,885,800
1977	70,700	159,200	476,300	265,900	1,118,100	468,800	95,600	156,700	125,500	2,000	36,500	20,000	2,995,300
1978	20,800	96,000	167,300	150,900	359,400	1,084,700	79,700	46,700	39,400	17,800	52,000	23,800	2,138,500
1979	57,100	91,400	434,800	248,200	488,100	788,200	163,600	139,500	73,200	27,400	57,800	44,200	2,613,500
1980	61,700	67,400	44,800	60,300	523,200	637,000	57,900	5,700	143,300	127,200	26,900	114,600	1,870,000
1981	29,400	59,900	328,800	140,500	408,500	719,500	58,900	41,700	45,900	2,246,700	241,000	67,500	4,388,300
1982	133,800	281,600	197,800	105,500	2,542,000	1,732,000	502,500	146,200	48,800	30,400	86,600	110,600	5,917,800
1983	89,500	193,200	212,000	223,100	680,300	398,100	149,500	44,100	11,500	1,415,300	477,000	104,900	3,998,500
1984	126,000	130,500	244,100	201,300	135,700	167,800	32,000	31,800	13,900	261,100	181,100	493,500	2,018,800
1985	712,200	631,100	1,492,200	963,400	594,100	1,467,400	148,400	58,300	39,200	793,200	214,600	136,300	7,250,400
1986	85,700	163,800	149,600	358,400	520,900	670,000	94,200	24,900	661,500	1,958,500	1,035,000	510,400	6,232,900
1987	579,200	924,100	1,507,200	326,100	1,064,300	2,926,200	700,200	144,000	220,400	140,000	198,700	858,800	9,589,200
1988	504,100	221,300	813,300	680,700	176,700	145,200	104,900	26,200	315,200	109,800	69,100	82,200	3,248,700
1989	141,900	348,500	323,500	154,400	736,600	2,380,600	344,500	116,900	607,000	111,900	97,000	46,300	5,409,100
1990	281,600	221,600	1,985,100	3,101,800	3,094,000	546,300	152,800	149,500	194,300	86,800	175,500	94,700	10,084,000
1991	272,600	123,000	223,300	249,700	547,800	1,494,700	273,100	164,000	819,400	470,400	478,200	1,993,600	7,109,800
1992	764,600	598,700	663,900	436,800	525,900	1,792,300	647,400	162,600	287,400	56,800	570,800	999,100	7,506,300
1993	450,600	1,009,000	1,045,500	1,008,200	3,135,900	652,200	249,700	108,900	273,700	203,500	104,100	330,500	8,571,800
1994	100,000	275,500	546,600	270,000	935,200	333,700	457,900	58,600	136,900	238,400	744,800	317,000	4,414,600
1995	176,300	112,300	521,200	669,000	1,671,300	3,129,800	382,000	1,163,300	540,100	305,400	143,600	146,600	8,960,900
1996	161,100	98,800	166,800	270,400	90,200	239,800	180,300	313,200	895,800	333,000	753,300	332,200	3,834,900
1997	164,600	948,700	487,300	1,364,100	1,161,300	804,900	223,700	230,300	222,500	234,300	138,800	435,200	6,415,700
1998	977,500	583,300	2,027,100	597,400	350,300	184,900	24,600	11,700	16,000	61,900	137,900	115,600	5,088,200
1999	92,200	174,200	357,800	324,200	544,200	517,700	176,100	24,800	82,300	23,200	25,300	113,300	2,455,300
2000	50,300	54,400	268,900	252,400	262,000	275,200	186,400	4,000	0	610,000	920,700	344,500	3,228,800
2001	447,900	1,352,000	560,700	297,400	627,700	354,400	29,400	26,900	340,400	209,900	60,800	208,200	4,515,700
2002	80,700	98,900	330,600	962,000	194,200	285,800	129,800	138,900	55,600	131,700	178,200	229,000	2,815,400

T4-6-3

TABLE 4-6 (continued)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
2003	122,600	108,500	157,500	94,800	283,300	386,200	93,000	4,100	117,200	9,400	23,500	18,000	1,418,100
2004	40,900	68,000	328,600	195,900	125,400	295,600	355,300	98,200	29,600	150,900	835,300	256,500	2,780,200
2005	522,000	271,700	147,000	92,600	97,900	154,600	86,000	319,500	140,400	88,100	18,600	12,900	1,951,300
2006	44,900	38,100	150,400	203,300	243,400	42,100	5,800	10,800	65,400	273,500	123,000	10,200	1,210,900
2007	266,600	102,300	169,300	705,800	1,106,700	2,217,400	2,182,700	663,400	317,100	163,600	93,000	134,900	8,122,800
2008	94,600	128,800	537,400	686,400	319,100	247,900	80,700	253,300	100,200	81,400	57,400	34,300	2,621,500
2009	46,100	74,100	67,300	307,600	1,599,100	203,100	93,600	89,500	127,900	472,400	203,100	114,700	3,398,500
AVG	175,400	216,400	316,700	456,700	818,300	733,800	259,900	174,200	240,300	363,600	224,800	215,000	4,195,100
MIN	11,200	16,800	15,300	39,200	71,300	42,100	5,800	2,000	0	1,400	1,100	10,200	974,700
MAX	977,500	1,352,000	2,027,100	3,101,800	4,705,000	4,403,000	2,182,700	1,725,000	1,000,000	2,523,000	1,515,000	1,993,600	12,640,400

T4-6-4

TABLE 5-1

LAKE TEXOMA (DENISON DAM) AUTOMATED GAGES

Station	Operating Agency	Alternate ID	USGS ID	SHEF ID	LAT (north) Deg Min Sec	LONG (west) Deg Min Sec
Automated Stream Gages						
Cow Creek nr Addington, OK	USGS	ADDI	07313585	ADDO2	34 14 42	97 58 27
Washita River nr Alex, OK	USGS	ALEX	07328100	ALXO2	34 55 33	97 46 25
Washita River at Anadarko, OK	USGS	ANAD	07326500	ANDO2	35 05 03	98 14 35
Red River near Arthur City, TX	USGS	ARTH	07335500	ARCT2	33 52 30	95 30 06
Prairie Dog Town Fk Red R. nr Brice, TX	USGS	BRIC	07298500	BICT2	34 37 40	100 56 25
Red River near Burkburnett, TX	USGS	BURK	07308500	BKBT2	34 06 36	98 31 53
Elm Fk of N Fk Red River nr Carl, OK	USGS	CARL	07303400	CRLO2	35 00 42	99 54 12
Washita River at Carnegie, OK	USGS	CARN	07325500	CAGO2	35 07 02	98 33 49
Little Washita River nr Cement, OK	USGS	CEME	07327447	CMTO2	34 50 16	98 07 27
Wichita River nr Charlie, TX	USGS	CHAR	07312700	CIET2	34 03 11	98 17 47
Washita River near Cheyenne, OK	USGS	CHEY	07316500	CHYO2	35 37 35	99 40 05
Pease River nr Childress, TX	USGS	CHIL	07307800	CDPT2	34 13 39	100 04 24
Prairie Dog Town Fk Red R. nr Childress, TX	USGS	CHIP	07299540	CHLT2	34 34 09	100 11 37
Washita River near Clinton, OK	USGS	CLIN	07325000	CLIO2	35 31 51	98 58 00
Cobb Creek near Ft. Cobb, OK	USGS	COBB	07326000	FCCO2	35 08 37	98 26 33
Washita River near Cordell, OK	OWRB	CORD	07325150	CCWO2	35 17 30	98 50 11
Mud Creek nr Courtney, OK	USGS	COUR	07315700	CORO2	34 00 15	97 34 00
Red River nr Courtney, OK	USGS	COUT	07315650	COUO2	33 55 03	97 30 30
North Criner Creek nr Criner, OK	USGS	CRIN	07328180	CRNO2	34 58 17	97 35 04
Little Washita River nr Cyril, OK	USGS	CYRI	07327442	CYLO2	34 53 33	98 13 58
Red River nr Davidson, OK	USGS	DAVD	07308240	DVDO2	34 12 42	99 04 54

T5-1-1

TABLE 5-1 (continued)

Station	Operating Agency	Alternate ID	USGS ID	SHEF ID	LAT (north) Deg Min Sec	LONG (west) Deg Min Sec
Automated Stream Gages (con't)						
Honey Creek bl Turner Falls nr Davis, OK	USGS	DAVI	07329780	DVSO2	34 25 54	97 08 49
Red River near De Kalb, TX	USGS	DEKA	07336820	DEKT2	33 41 02	94 41 39
Red River at Denison Dam nr Denison, TX	USGS	DEN2	07331600	DSTT2	33 49 08	96 33 47
Washita River near Dickson, OK	USGS	DICK	07331000	DURO2	34 14 00	96 58 32
Beaver Creek nr Electra, TX	USGS	ELEC	07312200	ELTT2	33 54 21	98 54 17
Salt Fork Red River nr Elmer, OK	USGS	ELME	07301110	ESFO2	34 28 44	99 22 55
Washita River nr Foss, OK	USGS	FOSB	07324400	FBFO2	35 32 20	99 10 10
Red River at Fulton, AR	USGS	FULT	07341500	FLTA4	33 36 26	93 48 49
Red River near Gainesville, TX	USGS	GAIN	07316000	GSVT2	33 43 40	97 09 35
Elm Fk of North Fk Red Riv nr Granite, OK	USGS	GRAN	07337500	GNTO2	34 53 20	99 22 41
NF Red River near Headrick, OK	USGS	HEAD	07305000	HEAO2	34 38 17	99 06 12
Lelia Lake Ck bl Bell Ck nr Hedley, TX	USGS	HEDL	07299890	HLCT2	34 56 08	100 41 46
Little Wichita River above Henrietta, TX	USGS	HENR	07314900	HTAT2	33 49 36	98 14 23
East Fk Little Wichita R. nr Henrietta, TX	USGS	HNRI	07315200	HTWT2	33 48 46	98 05 05
Wildhorse Creek nr Hoover ,OK	USGS	HOOV	07329700	HVRO2	34 32 29	97 14 49
Red River at Index, AR	USGS	INDX	07337000	INGA4	33 33 07	94 02 28
N. Fk Red River bl Altus Dam nr Lugert, OK	USGS	LUGE	07303000	LGTO2	34 53 22	99 18 24
Wichita River nr Mabelle, TX	USGS	MABE	07312100	MBLT2	33 45 36	99 08 33
MacKenzie Res nr Silverton , TX	USGS	MAKZ	07298100	MKZT2	34 32 43	101 26 16
SF Red River at Mangum, OK	USGS	MANG	07300500	MGMO2	34 51 30	99 30 30
Mill Creek nr Mill Creek, OK	USGS	MILC	07331200	MCKO2	34 24 18	96 51 47
Pennington Creek nr Mill Creek , OK	USGS	MLCP	07331294	MCPO2	34 26 29	96 47 37
Little Washita River East of Ninnekah, OK	USGS	NINN	07327550	NKHO2	34 57 48	97 53 57

T5-1-2

TABLE 5-1 (continued)

Station	Operating Agency	Alternate ID	USGS ID	SHEF ID	LAT (north) Deg Min Sec	LONG (west) Deg Min Sec
Automated Stream Gages (con't)						
Washita River near Pauls Valley, OK	USGS	PAUL	07328500	PLVO2	34 45 17	97 15 04
Groesbeck Creek at SH 6 nr Quanah, TX	USGS	QUNH	07299670	QGCT2	34 21 16	99 44 24
Deep Red Creek nr Randlett, OK	USGS	RAND	07311500	RNDO2	34 13 15	98 27 10
Pennington Creek nr Reagan , OK	USGS	REAG	07331300	RPCO2	34 20 51	96 42 28
Elm Creek nr Roosevelt, OK	OWRB	RSVT	N.A.	RVTO2	34 49 53	99 07 27
Otter Creek nr Snyder, OK	USGS	SNYD	07307010	SYDO2	34 38 16	98 59 54
Rock Creek at Sulphur, OK	USGS	SULP	07329852	SRCO2	34 29 43	96 59 18
Red River near Terral, OK	USGS	TERR	07315500	TRLO2	33 52 43	97 56 03
North Fk Red River nr Tipton, OK	USGS	TIPT	07307028	TIPO2	34 30 25	99 12 28
Tierra Blanca Ck abv Buffalo Lk nr Umbarger , TX	USGS	UMBA	07295500	UMBT2	34 50 55	102 10 32
Pease River nr Vernon, TX	USGS	VERN	07308200	VERT2	34 10 46	99 19 24
East Cache Creek nr Walters, OK	USGS	WALT	07311000	WLTO2	34 21 44	98 16 56
Beaver Creek at Waurika, OK	COE	WAUB	07313650	WAKO2	34 09 31	98 00 26
Prairie Dog Town Fk Red R. nr Wayside, TX	USGS	WAYS	07297910	WAYT2	34 50 15	101 24 49
Salt Fork Red River nr Wellington, TX	USGS	WELL	07300000	WLGT2	34 57 27	100 13 14
Wichita River at Wichita Falls, TX	USGS	WFAL	07312500	WICT2	33 54 34	98 32 00
Automated Pool Gages						
Lake Altus at Lugert, OK	USGS	ALTU	07302500	ALTO2	34 53 08	99 17 43
Arbuckle Lake on Rock Creek, OK	COE	ARBU	07330300	ARBO2	34 26 00	97 01 46
Lake Texoma nr Denison, TX	COE	DENI	07331500	DSNT2	33 49 05	96 34 20

T5-1-3

TABLE 5-1 (continued)

Station	Operating Agency	Alternate ID	USGS ID	SHEF ID	LAT (north) Deg Min Sec	LONG (west) Deg Min Sec
Automated Pool Gages (con't)						
Fort Cobb Res nr Fort Cobb, OK	COE	FCOB	07325900	FTCO2	35 09 28	98 27 23
Foss Reservoir nr Foss, OK	USGS	FOSS	07324300	FOSO2	35 32 20	99 11 09
Lake Kemp nr Mabelle, TX	USGS	KEMP	07312000	SYOT2	33 45 30	99 09 03
Tom Steed Lake nr Mountain Park, OK	COE	TOMS	07305400	MTNO2	34 44 19	98 59 14
Waurika Lake nr Waurika, OK	COE	WAUR	07313400	WRLO2	34 13 57	98 02 51
Automated Rainfall Gages						
Cow Creek nr Addington, OK	USGS	ADDI	07313585	ADDO2	34 14 42	97 58 27
Willow Creek nr Albert, OK	USGS	ALBT	07325860	AWCO2	35 14 00	98 27 57
Washita River nr Alex, OK	USGS	ALEX	07328100	ALXO2	34 55 33	97 46 25
Lake Altus at Lugert, OK	USGS	ALTU	07302500	ALTO2	34 53 08	99 17 43
Canadian River nr Amarillo, TX	USGS	AMAR	07227500	AMAT2	35 28 13	101 52 45
Washita River at Anadarko, OK	USGS	ANAD	07326500	ANDO2	35 05 03	98 14 35
Arcuckle Lake on Rock Creek, OK	COE	ARBU	07330300	ARBO2	34 26 00	97 01 48
Little Wichita River nr Archer City, TX	USGS	ARCH	07314500	ALWT2	33 39 45	98 36 46
Muddy Boggy Creek at Atoka, OK	USGS	ATMB	07332950	ATMO2	34 23 23	96 07 12
S Wichita Rv bl Low Flow Dam nr Guthrie, TX	USGS	BATE	07311783	BPST2	33 37 19	100 12 31
S Wichita River nr Benjamin, TX	USGS	BENJ	07311800	BENT2	33 38 39	99 48 02
Blue River nr Blue, OK	USGS	BLUE	07332500	BLUO2	33 59 49	96 14 27
Lake Amon G Carter nr Bowie, TX	USGS	BOWI	08043700	BCAT2	33 28 27	97 51 46

T5-1-4

TABLE 5-1 (continued)

Station	Operating Agency	Alternate ID	USGS ID	SHEF ID	LAT (north) Deg Min Sec	LONG (west) Deg Min Sec
Automated Rainfall Gages (con't)						
Prairie Dog Town Fk Red R. nr Brice, TX	USGS	BRIC	07298500	BICT2	34 37 40	100 56 25
Red River near Burkburnett, TX	USGS	BURK	07308500	BKBT2	34 06 36	98 31 53
Canton Lake nr Canton, OK	COE	CANT	07238500	CNLO2	36 04 54	98 36 07
N Fork Red River nr Carter, OK	USGS	CARE	07301500	CARO2	35 10 05	99 30 25
Elm Fk of N Fk Red River nr Carl, OK	USGS	CARL	07303400	CRLO2	35 00 42	99 54 12
Washita River at Carnegie, OK	USGS	CARN	07325500	CAGO2	35 07 02	98 33 49
E Fk Cheyenne Crk Trib nr Channing, TX	USGS	CHAN	07227460	CHYT2	35 40 30	102 16 50
Wichita River nr Charlie, TX	USGS	CHAR	07312700	CIET2	34 03 11	98 17 47
Washita River near Cheyenne, OK	USGS	CHEY	07316500	CHYO2	35 37 35	99 40 05
Pease River nr Childress, TX	USGS	CHIL	07307800	CDPT2	34 13 39	100 04 24
Prairie Dog Town Fk Red R. nr Childress, TX	USGS	CHIP	07299540	CHLT2	34 34 09	100 11 37
Washita River near Clinton, OK	USGS	CLIN	07325000	CLIO2	35 31 51	98 58 00
Washita River near Cordell, OK	OWRB	CORD	07325150	CCWO2	35 17 30	98 50 11
Red River nr Courtney, OK	USGS	COUT	07315650	COUO2	33 55 03	97 30 30
Red River nr Davidson, OK	USGS	DAVD	07308240	DVDO2	34 12 42	99 04 54
Honey Creek bl Turner Falls nr Davis, OK	USGS	DAVI	07329780	DVSO2	34 25 54	97 08 49
Red River at Denison Dam nr Denison, TX	USGS	DEN2	07331600	DSTT2	33 49 08	96 33 47
Lake Texoma nr Denison, TX	COE	DENI	07331500	DSNT2	33 49 05	96 34 20
Washita River near Dickson, OK	USGS	DICK	07331000	DURO2	34 14 00	96 58 32
Little Beaver Ck nr Duncan, OK	USGS	DUNC	07313000	DLBO2	34 29 35	98 06 50
Cobb Creek nr Eakly, OK	USGS	EAKL	07325800	EAKO2	35 17 26	98 35 38
Lake Creek nr Eakly, OK	USGS	EKLY	07325850	EKCO2	35 17 27	98 31 44
Beaver Creek nr Electra, TX	USGS	ELEC	07312200	ELTT2	33 54 21	98 54 17

T5-1-5

TABLE 5-1 (continued)

Station	Operating Agency	Alternate ID	USGS ID	SHEF ID	LAT (north) Deg Min Sec	LONG (west) Deg Min Sec
Automated Rainfall Gages (con't)						
Elk City, OK Municipal Airport		ELKA	N.A.	ELCO2	35 25 37	99 23 43
North Canadian River nr El Reno, OK	USGS	ELRE	07239500	ELNO2	35 33 47	97 57 26
Erick, OK		ERIC	N.A.	ERCO2	35 12 20	99 51 32
Fort Cobb Reservoir nr Fort Cobb, OK	COE	FCOB	07325900	FTCO2	35 09 28	98 27 23
Muddy Boggy Creek nr Farris, OK	USGS	FMUD	07334000	FRSO2	34 16 17	95 54 43
Forrestburg, TX	COE	FORR	N.A.	FBTT2	33 27 50	97 34 20
Washita River nr Foss, OK	USGS	FOSB	07324400	FBFO2	35 32 20	99 10 10
Foss Reservoir nr Foss, OK	USGS	FOSS	07324300	FOSO2	35 32 20	99 11 09
Lake Frederick nr Frederick, OK	USGS	FRDR	07311415	FDLO2	34 30 43	98 53 11
Red River near Gainesville, TX	USGS	GAIN	07316000	GSVT2	33 43 40	97 09 35
Elm FK of N Fk Red River nr Granite, OK	USGS	GRAN	07302000	GNTO2	34 53 20	99 22 41
Gunter, TX	COE	GUNT	N.A.	GUNT2	33 22 32	96 45 44
Washita River nr Hammon, OK	USGS	HAMM	07324200	HMMO2	35 39 23	99 18 21
NF Red River near Headrick, OK	USGS	HEAD	07305000	HEAO2	34 38 17	99 06 12
Little Wichita River above Henrietta, TX	USGS	HENR	07314900	HTAT2	33 49 36	98 14 23
Wildhorse Creek nr Hoover ,OK	USGS	HOOV	07329700	HVRO2	34 32 29	97 14 49
Beaver Creek nr Hulen, OK	COE	HULE	07312920	HUBO2	34 28 41	98 10 39
Sweetwater Creek nr Kelton, TX	USGS	KELT	07301410	KTNT2	35 28 23	100 07 14
Lake Kemp nr Mabelle, TX	USGS	KEMP	07312000	SYOT2	33 45 30	99 09 03
Canadian River Nr Konowa, OK	OWRB	KONO	N.A.	KCRO2	34 56 00	96 40 59
Lefors, TX		LEFO	N.A.	LEFT2	35 26 30	100 48 41
Middle Wichita R. nr Guthrie, TX	USGS	LOWR	07311630	TLPT2	33 47 45	100 04 29

T5-1-6

TABLE 5-1 (continued)

Station	Operating Agency	Alternate ID	USGS ID	SHEF ID	LAT (north) Deg Min Sec	LONG (west) Deg Min Sec
Automated Rainfall Gages (con't)						
Wichita River nr Mabelle, TX	USGS	MABE	07312100	MBLT2	33 45 36	99 08 33
MacKenzie Reservoir nr Silverton , TX	USGS	MAKZ	07298100	MKZT2	34 32 43	101 26 16
SF Red River at Mangum, OK	USGS	MANG	07300500	MGMO2	34 51 30	99 30 30
Elm Fk Trinity Rv nr Muenster, TX	USGS	MUEN	08050300	MNTT2	33 36 36	97 22 57
Lake Meredith nr Sanford, TX	USGS	MERE	07227900	MRIT2	35 42 38	101 33 03
Mill Creek nr Mill Creek, OK	USGS	MILC	07331200	MCKO2	34 24 17	96 51 48
Pennington Creek nr Mill Creek , OK	USGS	MLCP	07331294	MCPO2	34 26 29	96 47 37
Montague, TX	COE	MOTG	N.A.	MGUT2	33 39 01	97 45 30
Canadian River Tributary at Norman, OK	USGS	NOR2	07229053	NCTO2	35 10 02	97 26 53
N Canadian Rv blw Lk Overholser nr Oklahoma City, OK	USGS	OKC1	07241000	OLBO2	35 28 43	97 39 47
North Wichita Rv nr Paducah, TX	USGS	PADU	07311600	PWRT2	33 57 02	100 03 52
Washita River near Pauls Valley, OK	USGS	PAUL	07328500	PLVO2	34 45 17	97 15 04
Running Water Draw at Plainview, TX	USGS	PLAI	08080700	PNVT2	34 10 44	101 42 08
Canadian River at Purcell, OK	USGS	PURC	07229200	PRCO2	35 00 50	97 20 50
Groesbeck Creek at SH 6 nr Quanah, TX	USGS	QUNH	07299670	QGCT2	34 21 16	99 44 24
Pennington Creek nr Reagan , OK	USGS	REAG	07331300	RPCO2	34 20 51	96 42 28
North Fk Red River nr Sayre, OK	USGS	SAYR	07301481	SAYO2	35 17 05	99 37 18
North Canadian River nr Seiling, OK	USGS	SEIL	07238000	SEIO2	36 11 00	98 55 15
Wichita River nr Seymour, TX	USGS	SEYM	07311900	SEYT2	33 42 01	99 23 18
N Fork Red River nr Shamrock, TX	USGS	SHAM	07301300	SHAT2	35 15 51	100 14 29
Desert Water Coop #2 at Hwy 160 nr Sherman, TX	COE	SHER	N.A.	DWHT2	33 25 39	96 24 06

T5-1-7

TABLE 5-1 (continued)

Station	Operating Agency	Alternate ID	USGS ID	SHEF ID	LAT (north) Deg Min Sec	LONG (west) Deg Min Sec
Automated Rainfall Gages (con't)						
Otter Creek nr Snyder, OK	USGS	SNYD	07307010	SYDO2	34 38 16	98 59 54
Sweetwater Creek nr Sweetwater , OK	USGS	SWEE	07301420	SWTO2	35 25 20	99 58 08
Red River near Terral, OK	USGS	TERR	07315500	TRLO2	33 52 43	97 56 03
Tom Steed Reservoir on Otter Creek	COE	TOMS	07305400	MTNO2	34 44 19	98 59 14
North Fk Wichita River nr Truscott, TX	USGS	TRUN	07311700	TRST2	33 49 14	99 47 10
Truscott Brine Lk nr Truscott, TX	COE	TRUS	07311669	TBPT2	33 47 52	99 50 11
Tierra Blanca Ck abv Buffalo Lk nr Umbarger , TX	USGS	UMBA	07295500	UMBT2	34 50 55	102 10 32
Valley View, TX	COE	VALV	N.A.	VVWT2	33 26 16	97 10 06
Pease River nr Vernon, TX	USGS	VERN	07308200	VERT2	34 10 46	99 19 24
East Cache Creek nr Walters, OK	USGS	WALT	07311000	WLTO2	34 21 44	98 16 56
North Canadian River blw Weavers Crk nr nr Watonga, OK	USGS	WATO	07239300	WATO2	35 48 43	98 25 14
Beaver Creek nr Waurika, OK	COE	WAUB	07313650	WAKO2	34 09 31	98 00 26
Waurika Lake nr Waurika, OK	COE	WAUR	07313400	WRLO2	34 13 57	98 02 51
Prairie Dog Town Fk Red R. nr Wayside,TX	USGS	WAYS	07297910	WAYT2	34 50 15	101 24 49
Salt Fork Red River nr Wellington,TX	USGS	WELL	07300000	WLGT2	34 57 27	100 13 14
Wichita River at Wichita Falls, TX	USGS	WFAL	07312500	WICT2	33 54 34	98 32 00
Wheeler, TX		WHEE	N.A.	WLRT2	35 26 00	100 16 00
Wichita Mtn Wildlife Refuge nr Indiahoma, OK	U.S. Forest Service	WMTN	N.A.	WMRO2	34 46 28	98 44 45

T5-1-8

TABLE 5-1 (continued)

Station	Operating Agency	Alternate ID	USGS ID	SHEF ID	LAT (north) Deg Min Sec	LONG (west) Deg Min Sec
OK Mesonet Rainfall Gages						
Acme	OK	ACSO2	N.A.	ACSO2	34 48 29	98 01 23
Ada	OK	ADSO2	N.A.	ADSO2	34 47 54	96 40 08
Altus	OK	ALSO2	N.A.	ALSO2	34 35 13	99 20 17
Apache	OK	APSO2	N.A.	APSO2	34 54 51	98 17 31
Ardmore	OK	ARSO2	N.A.	ARSO2	34 11 33	97 05 08
Burneyville	OK	BNSO2	N.A.	BNSO2	33 53 37	97 16 09
Bessie	OK	BSSO2	N.A.	BSSO2	35 24 06	99 03 30
Butler	OK	BTSO2	N.A.	BTSO2	35 35 29	99 16 14
Chickasha	OK	CCSO2	N.A.	CCSO2	35 01 56	97 54 52
Camargo	OK	CMSO2	N.A.	CMSO2	36 01 43	99 20 47
Centrahoma	OK	CNSO2	N.A.	CNSO2	34 36 32	96 19 59
Cheyenne	OK	CYSO2	N.A.	CYSO2	35 32 46	99 43 40
Ketchum Ranch	OK	DNSO2	N.A.	DNSO2	34 31 43	97 45 53
Durant	OK	DTSO2	N.A.	DRTSO2	33 55 14	96 19 12
Erick	OK	EKSO2	N.A.	EKSO2	35 12 17	99 48 12
El Reno	OK	ERSO2	N.A.	ERSO2	35 32 54	98 02 11
Fort Cobb	OK	FCSO2	N.A.	FCSO2	35 08 55	98 27 57
Fittstown	OK	FTSO2	N.A.	FTSO2	34 33 07	96 43 04
Grandfield	OK	GRSO2	N.A.	GRSO2	34 14 21	98 44 39
Hobart	OK	HBSO2	N.A.	HBSO2	34 59 22	99 03 10
Hollis	OK	HISO2	N.A.	HISO2	34 41 07	99 49 59
Hinton	OK	HTSO2	N.A.	HTSO2	35 29 03	98 28 53
Lane	OK	LNSO2	N.A.	LNSO2	34 18 31	95 59 49

T5-1-9

TABLE 5-1(continued)

Station	Operating Agency	Alternate ID	USGS ID	SHEF ID	LAT (north) Deg Min Sec	LONG (west) Deg Min Sec
OK Mesonet Rainfall Gages (con't)						
Medicine Park	OK	LWSO2	N.A.	LWSO2	34 43 45	98 34 09
Madill	OK	MDSO2	N.A.	MDSO2	34 02 08	96 56 38
Mangum	OK	MNSO2	N.A.	MNSO2	34 50 09	99 25 26
Minco	OK	MOSO2	N.A.	MOSO2	35 16 20	97 57 19
Newport	OK	NESO2	N.A.	NESO2	34 13 41	97 12 05
Ninnekah	OK	NISO2	N.A.	NISO2	34 58 03	97 57 07
Norman	OK	NRSO2	N.A.	NRSO2	35 14 09	97 27 53
Washington	OK	PCSO2	N.A.	PCSO2	34 58 56	97 31 15
Putnam	OK	PMSO2	N.A.	PMSO2	35 53 56	98 57 37
Pauls Valley	OK	PVSO2	N.A.	PVSO2	34 42 55	97 13 45
Ringling	OK	RNSO2	N.A.	RNSO2	34 11 37	97 35 17
Retrop	OK	RTSO2	N.A.	RTSO2	35 07 21	99 21 36
Seiling	OK	SESO2	N.A.	SESO2	36 11 25	99 02 25
Byars	OK	SFSO2	N.A.	SFSO2	34 50 58	97 00 11
Sulphur	OK	SLSO2	N.A.	SLSO2	34 33 57	96 57 01
Tipton	OK	TPSO2	N.A.	TPSO2	34 26 22	99 08 15
Tishomingo	OK	TSSO2	N.A.	TSSO2	34 19 57	96 40 44
Vanoss	OK	VASO2	N.A.	VASO2	34 47 29	96 50 37
Watonga	OK	WNSO2	N.A.	WNSO2	35 50 30	98 31 34
Waurika	OK	WRSO2	N.A.	WRSO2	34 10 03	97 59 17
Walters	OK	WTSO2	N.A.	WTSO2	34 21 52	98 19 12
Weatherford	OK	WXSO2	N.A.	WXSO2	35 30 29	98 46 30

T5-1-10

TABLE 7-3
ELEVATION-AREA-CAPACITY
LAKE TEXOMA
BASED ON 2002 RESURVEY

AREA IN 1000'S OF AC

ELEV (ft, NGVD29)	0	1	2	3	4	5	6	7	8	9
520	.000	.000	.002	.012	.036	.057	.081	.152	.231	.299
530	.400	.503	.650	1.003	1.391	1.679	1.921	2.153	2.402	2.693
540	3.033	3.388	3.824	4.327	4.746	5.273	5.871	6.609	7.363	8.131
550	8.900	9.908	11.048	11.997	12.854	13.636	14.341	15.052	15.710	16.337
560	16.926	17.525	18.136	18.822	19.446	20.020	20.719	21.368	21.996	22.744
570	23.517	24.254	25.071	25.955	26.804	27.698	28.604	29.448	30.294	31.071
580	31.896	32.748	33.671	34.791	35.765	36.727	37.627	38.377	39.049	39.723
590	40.434	41.157	41.968	42.847	43.797	44.702	45.588	46.520	47.492	48.398
600	49.380	50.463	51.572	52.695	53.835	54.986	56.151	57.386	58.583	59.779
610	61.022	62.321	63.809	65.498	67.524	69.854	72.516	74.686	76.197	81.965
620	84.911	88.077	91.242	94.408	97.574	100.740	103.905	107.071	110.237	113.402
630	116.568	118.757	121.195	124.124	126.538	128.692	131.477	134.220	136.716	138.881
640	141.418	144.198	146.649	148.849	150.867	152.979	154.793	157.193	159.302	160.984
650	162.478	165.260	168.040	170.810	173.580	176.350	179.120	181.890	184.660	187.430
660	190.200	.000	.000	.000	.000	.000	.000	.000	.000	.000

TABLE 7-3 (continued)
Elevation-Area-Capacity

CAPACITY IN 1000'S OF ACRE-FEET

ELEV (ft, NGVD29)	0	1	2	3	4	5	6	7	8	9
520	.000	.000	.001	.008	.032	.079	.148	.264	.456	.721
530	1.070	1.522	2.098	2.925	4.122	5.657	7.457	9.494	11.771	14.319
540	17.182	20.392	23.998	28.074	32.610	37.620	43.192	49.432	56.418	64.165
550	72.680	82.084	92.562	104.085	116.510	129.755	143.744	158.440	173.821	189.845
560	206.476	223.702	241.532	260.011	279.145	298.878	319.248	340.291	361.973	384.343
570	407.474	431.359	456.022	481.535	507.914	535.165	563.316	592.342	622.213	652.896
580	684.379	716.701	749.911	784.142	819.420	855.666	892.843	930.845	969.558	1008.944
590	1049.022	1089.818	1131.380	1173.788	1217.110	1261.359	1306.504	1352.558	1399.564	1447.509
600	1496.398	1546.320	1597.337	1649.471	1702.736	1757.146	1812.715	1869.483	1927.468	1986.649
610	2047.049	2108.721	2171.786	2236.439	2302.950	2371.639	2442.824	2516.425	2591.867	2670.948
620	2754.385	2840.880	2930.539	3023.364	3119.355	3218.512	3320.835	3426.323	3534.977	3646.796
630	3761.781	3879.444	3999.420	4122.079	4247.410	4375.025	4505.109	4637.958	4773.426	4911.225
640	5051.374	5194.182	5339.605	5487.354	5637.212	5789.136	5943.021	6099.015	6257.262	6417.405
650	6579.136	6743.005	6909.655	7079.080	7251.275	7426.240	7603.975	7784.480	7967.755	8153.800
660	8342.615	.000	.000	.000	.000	.000	.000	.000	.000	.000

TABLE 7-3 (continued)
Elevation-Area-Capacity

POOL ELEV [FT. NGVD2)	CAPACITY [1000'S OF ACRE-FEET]									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
520.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
521.0	.000	.000	.000	.000	.000	.000	.000	.001	.001	.001
522.0	.001	.001	.002	.002	.003	.003	.004	.005	.006	.007
523.0	.008	.009	.011	.013	.015	.017	.020	.022	.025	.029
524.0	.032	.036	.040	.044	.048	.053	.057	.062	.068	.073
525.0	.079	.084	.090	.097	.103	.110	.117	.124	.132	.140
526.0	.148	.156	.165	.175	.186	.197	.209	.222	.235	.249
527.0	.264	.280	.296	.313	.331	.350	.370	.390	.411	.433
528.0	.456	.479	.503	.528	.553	.580	.606	.634	.662	.691
529.0	.721	.751	.782	.815	.848	.883	.918	.955	.992	1.031
530.0	1.070	1.111	1.152	1.195	1.238	1.283	1.329	1.375	1.423	1.472
531.0	1.522	1.573	1.625	1.679	1.735	1.791	1.850	1.910	1.971	2.034
532.0	2.098	2.165	2.235	2.309	2.386	2.467	2.552	2.640	2.731	2.826
533.0	2.925	3.027	3.133	3.243	3.357	3.475	3.596	3.722	3.851	3.984
534.0	4.122	4.262	4.406	4.552	4.701	4.853	5.008	5.166	5.327	5.490
535.0	5.657	5.826	5.997	6.171	6.348	6.526	6.708	6.891	7.077	7.266
536.0	7.457	7.650	7.845	8.043	8.244	8.446	8.651	8.858	9.068	9.279
537.0	9.494	9.710	9.929	10.151	10.375	10.601	10.830	11.062	11.296	11.532
538.0	11.771	12.013	12.257	12.505	12.755	13.008	13.265	13.524	13.786	14.051
539.0	14.319	14.590	14.864	15.142	15.423	15.708	15.996	16.287	16.582	16.880
540.0	17.182	17.487	17.795	18.107	18.423	18.742	19.065	19.392	19.722	20.055
541.0	20.392	20.733	21.078	21.428	21.782	22.141	22.503	22.871	23.242	23.618
542.0	23.998	24.383	24.773	25.168	25.568	25.973	26.383	26.798	27.218	27.643
543.0	28.074	28.508	28.947	29.391	29.838	30.289	30.745	31.205	31.669	32.138
544.0	32.610	33.087	33.570	34.058	34.551	35.049	35.553	36.061	36.576	37.095
545.0	37.620	38.150	38.686	39.228	39.777	40.331	40.891	41.457	42.029	42.607
546.0	43.192	43.782	44.381	44.986	45.599	46.219	46.847	47.482	48.125	48.774
547.0	49.432	50.096	50.768	51.448	52.136	52.830	53.533	54.243	54.960	55.685
548.0	56.418	57.158	57.906	58.661	59.424	60.195	60.974	61.760	62.554	63.355
549.0	64.165	64.982	65.806	66.639	67.479	68.326	69.182	70.045	70.915	71.794

TABLE 7-3 (continued)
Elevation-Area-Capacity

POOL ELEV [FT. NGVD29]	CAPACITY [1000'S OF ACRE-FEET]									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
550.0	72.680	73.575	74.480	75.395	76.321	77.256	78.202	79.157	80.123	81.098
551.0	82.084	83.081	84.089	85.108	86.138	87.181	88.234	89.299	90.375	91.463
552.0	92.562	93.672	94.791	95.919	97.057	98.205	99.362	100.528	101.704	102.890
553.0	104.085	105.289	106.501	107.722	108.952	110.190	111.437	112.692	113.956	115.229
554.0	116.510	117.799	119.097	120.401	121.714	123.035	124.363	125.699	127.044	128.395
555.0	129.755	131.122	132.496	133.878	135.266	136.661	138.064	139.473	140.890	142.313
556.0	143.744	145.181	146.626	148.078	149.537	151.003	152.476	153.956	155.444	156.938
557.0	158.440	159.949	161.464	162.985	164.514	166.048	167.590	169.138	170.692	172.253
558.0	173.821	175.395	176.976	178.562	180.155	181.754	183.360	184.972	186.590	188.214
559.0	189.845	191.481	193.124	194.772	196.427	198.087	199.753	201.425	203.103	204.786
560.0	206.476	208.172	209.873	211.581	213.294	215.014	216.740	218.471	220.209	221.952
561.0	223.702	225.457	227.219	228.987	230.760	232.540	234.327	236.119	237.917	239.722
562.0	241.532	243.349	245.173	247.004	248.841	250.686	252.537	254.395	256.260	258.132
563.0	260.011	261.896	263.788	265.686	267.590	269.500	271.417	273.339	275.268	277.204
564.0	279.145	281.093	283.046	285.005	286.969	288.940	290.916	292.898	294.886	296.879
565.0	298.878	300.884	302.896	304.916	306.942	308.975	311.016	313.063	315.118	317.179
566.0	319.248	321.323	323.404	325.492	327.587	329.688	331.796	333.910	336.030	338.158
567.0	340.291	342.431	344.577	346.730	348.889	351.054	353.225	355.403	357.586	359.777
568.0	361.973	364.176	366.387	368.606	370.831	373.065	375.305	377.554	379.809	382.072
569.0	384.343	386.621	388.907	391.201	393.503	395.812	398.129	400.453	402.786	405.126
570.0	407.474	409.829	412.192	414.562	416.939	419.324	421.716	424.116	426.523	428.937
571.0	431.359	433.789	436.226	438.672	441.126	443.588	446.059	448.537	451.024	453.519
572.0	456.022	458.533	461.053	463.583	466.121	468.668	471.223	473.788	476.361	478.944
573.0	481.535	484.134	486.743	489.359	491.984	494.618	497.260	499.911	502.570	505.238
574.0	507.914	510.599	513.293	515.996	518.707	521.428	524.157	526.896	529.643	532.400
575.0	535.165	537.939	540.723	543.515	546.317	549.127	551.947	554.776	557.613	560.460
576.0	563.316	566.181	569.054	571.935	574.825	577.724	580.630	583.546	586.469	589.402
577.0	592.342	595.291	598.249	601.215	604.189	607.172	610.163	613.163	616.171	619.188
578.0	622.213	625.246	628.287	631.336	634.393	637.457	640.529	643.609	646.697	649.792
579.0	652.896	656.007	659.126	662.254	665.390	668.534	671.687	674.847	678.016	681.194

TABLE 7-3 (continued)
Elevation-Area-Capacity

POOL ELEV [FT. NGVD29]	CAPACITY [1000'S OF ACRE-FEET]									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
580.0	684.379	687.573	690.775	693.986	697.206	700.434	703.670	706.915	710.169	713.431
581.0	716.701	719.981	723.269	726.567	729.874	733.190	736.516	739.851	743.195	746.548
582.0	749.911	753.283	756.667	760.062	763.469	766.886	770.315	773.755	777.206	780.668
583.0	784.142	787.626	791.119	794.623	798.136	801.659	805.192	808.734	812.286	815.848
584.0	819.420	823.001	826.592	830.192	833.803	837.422	841.052	844.691	848.339	851.998
585.0	855.666	859.343	863.029	866.724	870.428	874.142	877.864	881.595	885.335	889.084
586.0	892.843	896.609	900.383	904.164	907.953	911.750	915.554	919.365	923.184	927.011
587.0	930.845	934.686	938.533	942.388	946.249	950.117	953.992	957.873	961.761	965.656
588.0	969.558	973.466	977.381	981.303	985.231	989.166	993.108	997.057	1001.012	1004.975
589.0	1008.944	1012.919	1016.902	1020.892	1024.890	1028.894	1032.905	1036.924	1040.950	1044.982
590.0	1049.022	1053.069	1057.123	1061.185	1065.254	1069.329	1073.413	1077.503	1081.601	1085.705
591.0	1089.818	1093.937	1098.065	1102.201	1106.345	1110.497	1114.658	1118.826	1123.003	1127.187
592.0	1131.380	1135.581	1139.791	1144.010	1148.238	1152.474	1156.719	1160.973	1165.236	1169.507
593.0	1173.788	1178.077	1182.376	1186.684	1191.002	1195.330	1199.667	1204.013	1208.369	1212.735
594.0	1217.110	1221.494	1225.887	1230.289	1234.701	1239.121	1243.551	1247.989	1252.437	1256.893
595.0	1261.359	1265.834	1270.317	1274.810	1279.311	1283.821	1288.340	1292.868	1297.404	1301.950
596.0	1306.504	1311.068	1315.640	1320.223	1324.814	1329.415	1334.025	1338.644	1343.273	1347.911
597.0	1352.558	1357.215	1361.882	1366.558	1371.244	1375.940	1380.645	1385.360	1390.085	1394.820
598.0	1399.564	1404.318	1409.081	1413.852	1418.633	1423.423	1428.222	1433.031	1437.848	1442.674
599.0	1447.509	1452.354	1457.208	1462.073	1466.947	1471.831	1476.725	1481.628	1486.542	1491.465
600.0	1496.398	1501.341	1506.296	1511.261	1516.237	1521.224	1526.221	1531.229	1536.249	1541.279
601.0	1546.320	1551.371	1556.434	1561.508	1566.594	1571.690	1576.797	1581.915	1587.045	1592.185
602.0	1597.337	1602.500	1607.674	1612.859	1618.056	1623.263	1628.482	1633.713	1638.954	1644.207
603.0	1649.471	1654.746	1660.032	1665.330	1670.640	1675.961	1681.293	1686.636	1691.991	1697.358
604.0	1702.736	1708.125	1713.526	1718.938	1724.362	1729.797	1735.244	1740.702	1746.172	1751.653
605.0	1757.146	1762.651	1768.167	1773.694	1779.234	1784.785	1790.347	1795.922	1801.508	1807.105
606.0	1812.715	1818.336	1823.969	1829.615	1835.274	1840.944	1846.627	1852.323	1858.031	1863.751
607.0	1869.483	1875.228	1880.984	1886.753	1892.533	1898.326	1904.130	1909.947	1915.775	1921.615
608.0	1927.468	1933.332	1939.208	1945.096	1950.996	1956.909	1962.833	1968.769	1974.717	1980.677
609.0	1986.649	1992.633	1998.629	2004.638	2010.660	2016.693	2022.740	2028.798	2034.870	2040.953

TABLE 7-3 (continued)
Elevation-Area-Capacity

POOL ELEV [FT. NGVD29]	CAPACITY [1000'S OF ACRE-FEET]									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
610.0	2047.049	2053.158	2059.280	2065.414	2071.562	2077.722	2083.896	2090.083	2096.282	2102.495
611.0	2108.721	2114.960	2121.215	2127.484	2133.768	2140.067	2146.381	2152.710	2159.054	2165.412
612.0	2171.786	2178.175	2184.581	2191.004	2197.444	2203.901	2210.375	2216.865	2223.373	2229.898
613.0	2236.439	2242.999	2249.579	2256.180	2262.800	2269.441	2276.103	2282.784	2289.486	2296.208
614.0	2302.950	2309.714	2316.502	2323.312	2330.146	2337.003	2343.884	2350.788	2357.715	2364.665
615.0	2371.639	2378.638	2385.663	2392.715	2399.794	2406.899	2414.031	2421.189	2428.374	2435.586
616.0	2442.824	2450.087	2457.371	2464.677	2472.004	2479.353	2486.724	2494.117	2501.531	2508.967
617.0	2516.425	2523.901	2531.393	2538.899	2546.420	2553.957	2561.509	2569.076	2576.657	2584.254
618.0	2591.867	2599.515	2607.221	2614.985	2622.807	2630.686	2638.623	2646.618	2654.670	2662.780
619.0	2670.948	2679.159	2687.400	2695.670	2703.969	2712.298	2720.657	2729.045	2737.462	2745.909
620.0	2754.385	2762.893	2771.431	2780.001	2788.603	2797.237	2805.902	2814.599	2823.328	2832.088
621.0	2840.880	2849.703	2858.558	2867.445	2876.364	2885.314	2894.296	2903.309	2912.354	2921.431
622.0	2930.539	2939.679	2948.851	2958.054	2967.289	2976.556	2985.854	2995.184	3004.546	3013.939
623.0	3023.364	3032.821	3042.309	3051.829	3061.381	3070.964	3080.579	3090.225	3099.904	3109.614
624.0	3119.355	3129.128	3138.933	3148.770	3158.638	3168.538	3178.469	3188.433	3198.427	3208.454
625.0	3218.512	3228.602	3238.723	3248.877	3259.061	3269.278	3279.526	3289.806	3300.117	3310.460
626.0	3320.835	3331.241	3341.679	3352.149	3362.650	3373.183	3383.748	3394.344	3404.972	3415.631
627.0	3426.323	3437.046	3447.800	3458.586	3469.404	3480.254	3491.135	3502.048	3512.993	3523.969
628.0	3534.977	3546.016	3557.087	3568.190	3579.325	3590.490	3601.689	3612.918	3624.179	3635.472
629.0	3646.796	3658.152	3669.540	3680.959	3692.410	3703.893	3715.407	3726.953	3738.531	3750.140
630.0	3761.781	3773.449	3785.139	3796.850	3808.583	3820.339	3832.116	3843.915	3855.736	3867.579
631.0	3879.444	3891.332	3903.244	3915.180	3927.141	3939.127	3951.137	3963.171	3975.229	3987.312
632.0	3999.420	4011.554	4023.717	4035.910	4048.132	4060.383	4072.664	4084.974	4097.313	4109.681
633.0	4122.079	4134.503	4146.952	4159.425	4171.922	4184.443	4196.988	4209.557	4222.150	4234.769
634.0	4247.410	4260.075	4272.761	4285.469	4298.198	4310.948	4323.721	4336.515	4349.330	4362.167
635.0	4375.025	4387.908	4400.819	4413.758	4426.725	4439.719	4452.742	4465.792	4478.870	4491.976
636.0	4505.109	4518.271	4531.460	4544.676	4557.919	4571.191	4584.490	4597.815	4611.169	4624.550
637.0	4637.958	4651.393	4664.852	4678.336	4691.846	4705.380	4718.939	4732.523	4746.133	4759.767
638.0	4773.426	4787.108	4800.813	4814.538	4828.286	4842.055	4855.846	4869.658	4883.492	4897.347
639.0	4911.225	4925.125	4939.052	4953.003	4966.980	4980.982	4995.010	5009.063	5023.141	5037.245

TABLE 7-3 (continued)
Elevation-Area-Capacity

POOL ELEV [FT. NGVD29]	CAPACITY [1000'S OF ACRE-FEET]									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
640.0	5051.374	5065.530	5079.713	5093.925	5108.164	5122.431	5136.725	5151.047	5165.398	5179.776
641.0	5194.182	5208.614	5223.071	5237.552	5252.058	5266.587	5281.142	5295.721	5310.325	5324.953
642.0	5339.605	5354.282	5368.979	5383.699	5398.441	5413.205	5427.991	5442.799	5457.628	5472.480
643.0	5487.354	5502.250	5517.165	5532.100	5547.056	5562.031	5577.027	5592.043	5607.080	5622.136
644.0	5637.212	5652.310	5667.428	5682.567	5697.729	5712.910	5728.113	5743.337	5758.582	5773.848
645.0	5789.136	5804.442	5819.768	5835.111	5850.472	5865.852	5881.250	5896.665	5912.099	5927.552
646.0	5943.021	5958.513	5974.028	5989.567	6005.130	6020.718	6036.330	6051.965	6067.624	6083.307
647.0	6099.015	6114.745	6130.496	6146.268	6162.061	6177.875	6193.710	6209.566	6225.444	6241.343
648.0	6257.262	6273.201	6289.156	6305.128	6321.118	6337.123	6353.146	6369.186	6385.242	6401.315
649.0	6417.405	6433.511	6449.632	6465.768	6481.918	6498.084	6514.265	6530.460	6546.670	6562.896
650.0	6579.136	6595.397	6611.687	6628.004	6644.350	6660.723	6677.124	6693.552	6710.009	6726.493
651.0	6743.005	6759.545	6776.113	6792.708	6809.332	6825.982	6842.662	6859.368	6876.103	6892.865
652.0	6909.655	6926.473	6943.318	6960.191	6977.093	6994.021	7010.978	7027.961	7044.974	7062.013
653.0	7079.080	7096.175	7113.297	7130.448	7147.625	7164.831	7182.064	7199.326	7216.615	7233.931
654.0	7251.275	7268.647	7286.046	7303.474	7320.929	7338.411	7355.921	7373.459	7391.025	7408.619
655.0	7426.240	7443.889	7461.565	7479.270	7497.001	7514.761	7532.549	7550.364	7568.207	7586.077
656.0	7603.975	7621.901	7639.854	7657.835	7675.845	7693.881	7711.946	7730.038	7748.158	7766.305
657.0	7784.480	7802.683	7820.914	7839.171	7857.458	7875.771	7894.113	7912.481	7930.878	7949.303
658.0	7967.755	7986.235	8004.743	8023.278	8041.841	8060.431	8079.050	8097.696	8116.370	8135.071
659.0	8153.800	8172.557	8191.342	8210.153	8228.993	8247.861	8266.757	8285.680	8304.631	8323.609

TABLE 7-3 (continued)
Elevation-Area-Capacity

POOL ELEV [FT. NGVD29]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES] .0	.1	.2	.3	.4	.5	.6	.7	.8	.9
520.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
521.0	.000	.000	.000	.000	.000	.000	.000	.001	.001	.001
	.000	.000	.001	.001	.001	.001	.001	.002	.002	.002
522.0	.001	.001	.002	.002	.003	.003	.004	.005	.006	.007
	.002	.003	.004	.005	.006	.007	.008	.009	.010	.011
523.0	.008	.009	.011	.013	.015	.017	.020	.022	.025	.029
	.012	.014	.017	.019	.022	.024	.026	.029	.031	.034
524.0	.032	.036	.040	.044	.048	.053	.057	.062	.068	.073
	.036	.038	.040	.042	.045	.047	.049	.051	.053	.055
525.0	.079	.084	.090	.097	.103	.110	.117	.124	.132	.140
	.057	.060	.062	.064	.067	.069	.072	.074	.076	.079
526.0	.148	.156	.165	.175	.186	.197	.209	.222	.235	.249
	.081	.088	.095	.102	.109	.117	.124	.131	.138	.145
527.0	.264	.280	.296	.313	.331	.350	.370	.390	.411	.433
	.152	.160	.168	.176	.184	.192	.199	.207	.215	.223
528.0	.456	.479	.503	.528	.553	.580	.606	.634	.662	.691
	.231	.238	.245	.252	.258	.265	.272	.279	.285	.292
529.0	.721	.751	.782	.815	.848	.883	.918	.955	.992	1.031
	.299	.309	.319	.329	.340	.350	.360	.370	.380	.390
530.0	1.070	1.111	1.152	1.195	1.238	1.283	1.329	1.375	1.423	1.472
	.400	.410	.421	.431	.441	.452	.462	.472	.483	.493
531.0	1.522	1.573	1.625	1.679	1.735	1.791	1.850	1.910	1.971	2.034
	.503	.518	.533	.547	.562	.577	.591	.606	.621	.635
532.0	2.098	2.165	2.235	2.309	2.386	2.467	2.552	2.640	2.731	2.826
	.650	.685	.721	.756	.791	.827	.862	.897	.933	.968
533.0	2.925	3.027	3.133	3.243	3.357	3.475	3.596	3.722	3.851	3.984
	1.003	1.042	1.081	1.120	1.158	1.197	1.236	1.275	1.314	1.352
534.0	4.122	4.262	4.406	4.552	4.701	4.853	5.008	5.166	5.327	5.490
	1.391	1.420	1.449	1.477	1.506	1.535	1.564	1.593	1.622	1.650
535.0	5.657	5.826	5.997	6.171	6.348	6.526	6.708	6.891	7.077	7.266
	1.679	1.703	1.727	1.752	1.776	1.800	1.824	1.849	1.873	1.897

TABLE 7-3 (continued)
Elevation-Area-Capacity

POOL ELEV [FT. NGVD29]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES] .0	.1	.2	.3	.4	.5	.6	.7	.8	.9
536.0	7.457	7.650	7.845	8.043	8.244	8.446	8.651	8.858	9.068	9.279
	1.921	1.944	1.967	1.991	2.014	2.037	2.060	2.083	2.107	2.130
537.0	9.494	9.710	9.929	10.151	10.375	10.601	10.830	11.062	11.296	11.532
	2.153	2.178	2.203	2.228	2.253	2.278	2.303	2.327	2.352	2.377
538.0	11.771	12.013	12.257	12.505	12.755	13.008	13.265	13.524	13.786	14.051
	2.402	2.431	2.460	2.489	2.519	2.548	2.577	2.606	2.635	2.664
539.0	14.319	14.590	14.864	15.142	15.423	15.708	15.996	16.287	16.582	16.880
	2.693	2.727	2.761	2.795	2.829	2.863	2.897	2.931	2.965	2.999
540.0	17.182	17.487	17.795	18.107	18.423	18.742	19.065	19.392	19.722	20.055
	3.033	3.069	3.104	3.140	3.175	3.211	3.246	3.282	3.317	3.353
541.0	20.392	20.733	21.078	21.428	21.782	22.141	22.503	22.871	23.242	23.618
	3.388	3.432	3.475	3.519	3.563	3.606	3.650	3.693	3.737	3.780
542.0	23.998	24.383	24.773	25.168	25.568	25.973	26.383	26.798	27.218	27.643
	3.824	3.874	3.925	3.975	4.025	4.076	4.126	4.176	4.227	4.277
543.0	28.074	28.508	28.947	29.391	29.838	30.289	30.745	31.205	31.669	32.138
	4.327	4.369	4.411	4.453	4.495	4.537	4.578	4.620	4.662	4.704
544.0	32.610	33.087	33.570	34.058	34.551	35.049	35.553	36.061	36.576	37.095
	4.746	4.799	4.852	4.904	4.957	5.010	5.062	5.115	5.168	5.220
545.0	37.620	38.150	38.686	39.228	39.777	40.331	40.891	41.457	42.029	42.607
	5.273	5.333	5.393	5.452	5.512	5.572	5.632	5.692	5.752	5.811
546.0	43.192	43.782	44.381	44.986	45.599	46.219	46.847	47.482	48.125	48.774
	5.871	5.945	6.019	6.093	6.166	6.240	6.314	6.388	6.462	6.535
547.0	49.432	50.096	50.768	51.448	52.136	52.830	53.533	54.243	54.960	55.685
	6.609	6.685	6.760	6.835	6.911	6.986	7.062	7.137	7.212	7.288
548.0	56.418	57.158	57.906	58.661	59.424	60.195	60.974	61.760	62.554	63.355
	7.363	7.440	7.517	7.594	7.670	7.747	7.824	7.901	7.977	8.054
549.0	64.165	64.982	65.806	66.639	67.479	68.326	69.182	70.045	70.915	71.794
	8.131	8.208	8.285	8.362	8.439	8.516	8.592	8.669	8.746	8.823
550.0	72.680	73.575	74.480	75.395	76.321	77.256	78.202	79.157	80.123	81.098
	8.900	9.001	9.102	9.203	9.303	9.404	9.505	9.606	9.707	9.807
551.0	82.084	83.081	84.089	85.108	86.138	87.181	88.234	89.299	90.375	91.463
	9.908	10.022	10.136	10.250	10.364	10.478	10.592	10.706	10.820	10.934
552.0	92.562	93.672	94.791	95.919	97.057	98.205	99.362	100.528	101.704	102.890
	11.048	11.143	11.238	11.333	11.428	11.523	11.618	11.712	11.807	11.902

TABLE 7-3 (continued)
Elevation-Area-Capacity

POOL ELEV [FT. NGVD29]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES] .0	.1	.2	.3	.4	.5	.6	.7	.8	.9
553.0	104.085	105.289	106.501	107.722	108.952	110.190	111.437	112.692	113.956	115.229
	11.997	12.083	12.168	12.254	12.340	12.426	12.511	12.597	12.683	12.768
554.0	116.510	117.799	119.097	120.401	121.714	123.035	124.363	125.699	127.044	128.395
	12.854	12.932	13.010	13.089	13.167	13.245	13.323	13.401	13.480	13.558
555.0	129.755	131.122	132.496	133.878	135.266	136.661	138.064	139.473	140.890	142.313
	13.636	13.707	13.777	13.848	13.918	13.989	14.059	14.130	14.200	14.271
556.0	143.744	145.181	146.626	148.078	149.537	151.003	152.476	153.956	155.444	156.938
	14.341	14.412	14.483	14.554	14.625	14.697	14.768	14.839	14.910	14.981
557.0	158.440	159.949	161.464	162.985	164.514	166.048	167.590	169.138	170.692	172.253
	15.052	15.118	15.184	15.250	15.315	15.381	15.447	15.513	15.578	15.644
558.0	173.821	175.395	176.976	178.562	180.155	181.754	183.360	184.972	186.590	188.214
	15.710	15.773	15.835	15.898	15.961	16.024	16.086	16.149	16.212	16.274
559.0	189.845	191.481	193.124	194.772	196.427	198.087	199.753	201.425	203.103	204.786
	16.337	16.396	16.455	16.514	16.573	16.632	16.691	16.749	16.808	16.867
560.0	206.476	208.172	209.873	211.581	213.294	215.014	216.740	218.471	220.209	221.952
	16.926	16.986	17.046	17.106	17.166	17.226	17.285	17.345	17.405	17.465
561.0	223.702	225.457	227.219	228.987	230.760	232.540	234.327	236.119	237.917	239.722
	17.525	17.586	17.647	17.708	17.770	17.831	17.892	17.953	18.014	18.075
562.0	241.532	243.349	245.173	247.004	248.841	250.686	252.537	254.395	256.260	258.132
	18.136	18.205	18.273	18.342	18.410	18.479	18.548	18.616	18.685	18.753
563.0	260.011	261.896	263.788	265.686	267.590	269.500	271.417	273.339	275.268	277.204
	18.822	18.885	18.947	19.009	19.072	19.134	19.197	19.259	19.321	19.384
564.0	279.145	281.093	283.046	285.005	286.969	288.940	290.916	292.898	294.886	296.879
	19.446	19.503	19.561	19.618	19.676	19.733	19.791	19.848	19.905	19.963
565.0	298.878	300.884	302.896	304.916	306.942	308.975	311.016	313.063	315.118	317.179
	20.020	20.090	20.160	20.230	20.300	20.370	20.440	20.509	20.579	20.649
566.0	319.248	321.323	323.404	325.492	327.587	329.688	331.796	333.910	336.030	338.158
	20.719	20.784	20.849	20.914	20.979	21.044	21.108	21.173	21.238	21.303
567.0	340.291	342.431	344.577	346.730	348.889	351.054	353.225	355.403	357.586	359.777
	21.368	21.431	21.494	21.556	21.619	21.682	21.745	21.808	21.871	21.933
568.0	361.973	364.176	366.387	368.606	370.831	373.065	375.305	377.554	379.809	382.072
	21.996	22.071	22.146	22.221	22.295	22.370	22.445	22.520	22.594	22.669
569.0	384.343	386.621	388.907	391.201	393.503	395.812	398.129	400.453	402.786	405.126
	22.744	22.821	22.899	22.976	23.053	23.131	23.208	23.285	23.362	23.440

TABLE 7-3 (continued)
Elevation-Area-Capacity

POOL ELEV [FT. NGVD29]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES] .0	.1	.2	.3	.4	.5	.6	.7	.8	.9
570.0	407.474	409.829	412.192	414.562	416.939	419.324	421.716	424.116	426.523	428.937
	23.517	23.591	23.664	23.738	23.812	23.886	23.959	24.033	24.107	24.180
571.0	431.359	433.789	436.226	438.672	441.126	443.588	446.059	448.537	451.024	453.519
	24.254	24.336	24.417	24.499	24.581	24.663	24.744	24.826	24.908	24.989
572.0	456.022	458.533	461.053	463.583	466.121	468.668	471.223	473.788	476.361	478.944
	25.071	25.160	25.248	25.336	25.425	25.513	25.601	25.690	25.778	25.867
573.0	481.535	484.134	486.743	489.359	491.984	494.618	497.260	499.911	502.570	505.238
	25.955	26.040	26.125	26.210	26.295	26.380	26.465	26.549	26.634	26.719
574.0	507.914	510.599	513.293	515.996	518.707	521.428	524.157	526.896	529.643	532.400
	26.804	26.893	26.983	27.072	27.162	27.251	27.340	27.430	27.519	27.609
575.0	535.165	537.939	540.723	543.515	546.317	549.127	551.947	554.776	557.613	560.460
	27.698	27.789	27.879	27.970	28.060	28.151	28.242	28.332	28.423	28.514
576.0	563.316	566.181	569.054	571.935	574.825	577.724	580.630	583.546	586.469	589.402
	28.604	28.688	28.773	28.857	28.942	29.026	29.111	29.195	29.279	29.364
577.0	592.342	595.291	598.249	601.215	604.189	607.172	610.163	613.163	616.171	619.188
	29.448	29.533	29.617	29.702	29.787	29.871	29.956	30.040	30.125	30.209
578.0	622.213	625.246	628.287	631.336	634.393	637.457	640.529	643.609	646.697	649.792
	30.294	30.372	30.449	30.527	30.605	30.683	30.760	30.838	30.916	30.993
579.0	652.896	656.007	659.126	662.254	665.390	668.534	671.687	674.847	678.016	681.194
	31.071	31.154	31.236	31.319	31.401	31.484	31.566	31.649	31.731	31.814
580.0	684.379	687.573	690.775	693.986	697.206	700.434	703.670	706.915	710.169	713.431
	31.896	31.981	32.067	32.152	32.237	32.322	32.407	32.493	32.578	32.663
581.0	716.701	719.981	723.269	726.567	729.874	733.190	736.516	739.851	743.195	746.548
	32.748	32.840	32.933	33.025	33.117	33.210	33.302	33.394	33.486	33.579
582.0	749.911	753.283	756.667	760.062	763.469	766.886	770.315	773.755	777.206	780.668
	33.671	33.783	33.895	34.007	34.119	34.231	34.343	34.455	34.567	34.679
583.0	784.142	787.626	791.119	794.623	798.136	801.659	805.192	808.734	812.286	815.848
	34.791	34.889	34.986	35.083	35.181	35.278	35.375	35.473	35.570	35.668
584.0	819.420	823.001	826.592	830.192	833.803	837.422	841.052	844.691	848.339	851.998
	35.765	35.861	35.958	36.054	36.150	36.246	36.342	36.438	36.535	36.631
585.0	855.666	859.343	863.029	866.724	870.428	874.142	877.864	881.595	885.335	889.084
	36.727	36.817	36.907	36.997	37.087	37.177	37.267	37.357	37.447	37.537

TABLE 7-3 (continued)
Elevation-Area-Capacity

POOL ELEV [FT. NGVD29]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES] .0	.1	.2	.3	.4	.5	.6	.7	.8	.9
586.0	892.843	896.609	900.383	904.164	907.953	911.750	915.554	919.365	923.184	927.011
	37.627	37.702	37.777	37.852	37.927	38.002	38.077	38.152	38.227	38.302
587.0	930.845	934.686	938.533	942.388	946.249	950.117	953.992	957.873	961.761	965.656
	38.377	38.444	38.512	38.579	38.646	38.713	38.780	38.847	38.915	38.982
588.0	969.558	973.466	977.381	981.303	985.231	989.166	993.108	997.057	1001.012	1004.975
	39.049	39.117	39.184	39.251	39.319	39.386	39.453	39.521	39.588	39.656
589.0	1008.944	1012.919	1016.902	1020.892	1024.890	1028.894	1032.905	1036.924	1040.950	1044.982
	39.723	39.794	39.865	39.936	40.007	40.079	40.150	40.221	40.292	40.363
590.0	1049.022	1053.069	1057.123	1061.185	1065.254	1069.329	1073.413	1077.503	1081.601	1085.705
	40.434	40.506	40.579	40.651	40.723	40.796	40.868	40.940	41.013	41.085
591.0	1089.818	1093.937	1098.065	1102.201	1106.345	1110.497	1114.658	1118.826	1123.003	1127.187
	41.157	41.238	41.319	41.400	41.481	41.563	41.644	41.725	41.806	41.887
592.0	1131.380	1135.581	1139.791	1144.010	1148.238	1152.474	1156.719	1160.973	1165.236	1169.507
	41.968	42.056	42.144	42.232	42.320	42.408	42.495	42.583	42.671	42.759
593.0	1173.788	1178.077	1182.376	1186.684	1191.002	1195.330	1199.667	1204.013	1208.369	1212.735
	42.847	42.942	43.037	43.132	43.227	43.322	43.417	43.512	43.607	43.702
594.0	1217.110	1221.494	1225.887	1230.289	1234.701	1239.121	1243.551	1247.989	1252.437	1256.893
	43.797	43.888	43.978	44.069	44.159	44.250	44.340	44.431	44.521	44.612
595.0	1261.359	1265.834	1270.317	1274.810	1279.311	1283.821	1288.340	1292.868	1297.404	1301.950
	44.702	44.791	44.879	44.968	45.056	45.145	45.234	45.322	45.411	45.500
596.0	1306.504	1311.068	1315.640	1320.223	1324.814	1329.415	1334.025	1338.644	1343.273	1347.911
	45.588	45.681	45.775	45.868	45.961	46.054	46.147	46.241	46.334	46.427
597.0	1352.558	1357.215	1361.882	1366.558	1371.244	1375.940	1380.645	1385.360	1390.085	1394.820
	46.520	46.617	46.715	46.812	46.909	47.006	47.103	47.201	47.298	47.395
598.0	1399.564	1404.318	1409.081	1413.852	1418.633	1423.423	1428.222	1433.031	1437.848	1442.674
	47.492	47.583	47.673	47.764	47.854	47.945	48.036	48.126	48.217	48.307
599.0	1447.509	1452.354	1457.208	1462.073	1466.947	1471.831	1476.725	1481.628	1486.542	1491.465
	48.398	48.496	48.595	48.693	48.791	48.889	48.987	49.085	49.184	49.282
600.0	1496.398	1501.341	1506.296	1511.261	1516.237	1521.224	1526.221	1531.229	1536.249	1541.279
	49.380	49.488	49.597	49.705	49.813	49.922	50.030	50.138	50.247	50.355
601.0	1546.320	1551.371	1556.434	1561.508	1566.594	1571.690	1576.797	1581.915	1587.045	1592.185
	50.463	50.574	50.685	50.796	50.907	51.018	51.129	51.239	51.350	51.461

TABLE 7-3 (continued)
Elevation-Area-Capacity

POOL ELEV [FT. NGVD29]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES] .0	.1	.2	.3	.4	.5	.6	.7	.8	.9
602.0	1597.337	1602.500	1607.674	1612.859	1618.056	1623.263	1628.482	1633.713	1638.954	1644.207
	51.572	51.684	51.797	51.909	52.021	52.134	52.246	52.358	52.471	52.583
603.0	1649.471	1654.746	1660.032	1665.330	1670.640	1675.961	1681.293	1686.636	1691.991	1697.358
	52.695	52.809	52.923	53.037	53.151	53.265	53.379	53.493	53.607	53.721
604.0	1702.736	1708.125	1713.526	1718.938	1724.362	1729.797	1735.244	1740.702	1746.172	1751.653
	53.835	53.950	54.065	54.180	54.296	54.411	54.526	54.641	54.756	54.871
605.0	1757.146	1762.651	1768.167	1773.694	1779.234	1784.785	1790.347	1795.922	1801.508	1807.105
	54.986	55.103	55.219	55.336	55.452	55.569	55.685	55.802	55.918	56.035
606.0	1812.715	1818.336	1823.969	1829.615	1835.274	1840.944	1846.627	1852.323	1858.031	1863.751
	56.151	56.275	56.398	56.522	56.645	56.769	56.892	57.016	57.139	57.263
607.0	1869.483	1875.228	1880.984	1886.753	1892.533	1898.326	1904.130	1909.947	1915.775	1921.615
	57.386	57.506	57.625	57.745	57.865	57.985	58.104	58.224	58.344	58.463
608.0	1927.468	1933.332	1939.208	1945.096	1950.996	1956.909	1962.833	1968.769	1974.717	1980.677
	58.583	58.703	58.822	58.942	59.062	59.181	59.301	59.420	59.540	59.660
609.0	1986.649	1992.633	1998.629	2004.638	2010.660	2016.693	2022.740	2028.798	2034.870	2040.953
	59.779	59.903	60.028	60.152	60.276	60.401	60.525	60.649	60.773	60.898
610.0	2047.049	2053.158	2059.280	2065.414	2071.562	2077.722	2083.896	2090.083	2096.282	2102.495
	61.022	61.152	61.282	61.412	61.542	61.672	61.801	61.931	62.061	62.191
611.0	2108.721	2114.960	2121.215	2127.484	2133.768	2140.067	2146.381	2152.710	2159.054	2165.412
	62.321	62.470	62.619	62.768	62.916	63.065	63.214	63.363	63.512	63.660
612.0	2171.786	2178.175	2184.581	2191.004	2197.444	2203.901	2210.375	2216.865	2223.373	2229.898
	63.809	63.978	64.147	64.316	64.485	64.654	64.823	64.991	65.160	65.329
613.0	2236.439	2242.999	2249.579	2256.180	2262.800	2269.441	2276.103	2282.784	2289.486	2296.208
	65.498	65.701	65.903	66.106	66.309	66.511	66.714	66.916	67.119	67.322
614.0	2302.950	2309.714	2316.502	2323.312	2330.146	2337.003	2343.884	2350.788	2357.715	2364.665
	67.524	67.757	67.990	68.223	68.456	68.689	68.922	69.155	69.388	69.621
615.0	2371.639	2378.638	2385.663	2392.715	2399.794	2406.899	2414.031	2421.189	2428.374	2435.586
	69.854	70.120	70.386	70.653	70.919	71.185	71.451	71.717	71.984	72.250
616.0	2442.824	2450.087	2457.371	2464.677	2472.004	2479.353	2486.724	2494.117	2501.531	2508.967
	72.516	72.733	72.950	73.167	73.384	73.601	73.818	74.035	74.252	74.469
617.0	2516.425	2523.901	2531.393	2538.899	2546.420	2553.957	2561.509	2569.076	2576.657	2584.254
	74.686	74.837	74.988	75.139	75.290	75.442	75.593	75.744	75.895	76.046
618.0	2591.867	2599.515	2607.221	2614.985	2622.807	2630.686	2638.623	2646.618	2654.670	2662.780
	76.197	76.774	77.351	77.927	78.504	79.081	79.658	80.235	80.812	81.388

TABLE 7-3 (continued)
Elevation-Area-Capacity

POOL ELEV [FT. NGVD29]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES] .0	.1	.2	.3	.4	.5	.6	.7	.8	.9
619.0	2670.948	2679.159	2687.400	2695.670	2703.969	2712.298	2720.657	2729.045	2737.462	2745.909
	81.965	82.260	82.554	82.849	83.144	83.438	83.733	84.027	84.322	84.617
620.0	2754.385	2762.893	2771.431	2780.001	2788.603	2797.237	2805.902	2814.599	2823.328	2832.088
	84.911	85.228	85.544	85.861	86.177	86.494	86.811	87.127	87.444	87.760
621.0	2840.880	2849.703	2858.558	2867.445	2876.364	2885.314	2894.296	2903.309	2912.354	2921.431
	88.077	88.394	88.710	89.027	89.343	89.660	89.976	90.293	90.609	90.926
622.0	2930.539	2939.679	2948.851	2958.054	2967.289	2976.556	2985.854	2995.184	3004.546	3013.939
	91.242	91.559	91.875	92.192	92.508	92.825	93.142	93.458	93.775	94.091
623.0	3023.364	3032.821	3042.309	3051.829	3061.381	3070.964	3080.579	3090.225	3099.904	3109.614
	94.408	94.725	95.041	95.358	95.674	95.991	96.308	96.624	96.941	97.257
624.0	3119.355	3129.128	3138.933	3148.770	3158.638	3168.538	3178.469	3188.433	3198.427	3208.454
	97.574	97.891	98.207	98.524	98.840	99.157	99.474	99.790	100.107	100.424
625.0	3218.512	3228.602	3238.723	3248.877	3259.061	3269.278	3279.526	3289.806	3300.117	3310.460
	100.740	101.057	101.373	101.690	102.006	102.323	102.639	102.956	103.272	103.589
626.0	3320.835	3331.241	3341.679	3352.149	3362.650	3373.183	3383.748	3394.344	3404.972	3415.631
	103.905	104.222	104.538	104.855	105.172	105.488	105.805	106.121	106.438	106.755
627.0	3426.323	3437.046	3447.800	3458.586	3469.404	3480.254	3491.135	3502.048	3512.993	3523.969
	107.071	107.388	107.704	108.021	108.338	108.654	108.971	109.287	109.604	109.921
628.0	3534.977	3546.016	3557.087	3568.190	3579.325	3590.490	3601.689	3612.918	3624.179	3635.472
	110.237	110.554	110.870	111.187	111.503	111.820	112.136	112.453	112.769	113.086
629.0	3646.796	3658.152	3669.540	3680.959	3692.410	3703.893	3715.407	3726.953	3738.531	3750.140
	113.402	113.719	114.035	114.352	114.669	114.985	115.302	115.618	115.935	116.252
630.0	3761.781	3773.449	3785.139	3796.850	3808.583	3820.339	3832.116	3843.915	3855.736	3867.579
	116.568	116.787	117.006	117.225	117.444	117.663	117.882	118.100	118.319	118.538
631.0	3879.444	3891.332	3903.244	3915.180	3927.141	3939.127	3951.137	3963.171	3975.229	3987.312
	118.757	119.001	119.245	119.489	119.732	119.976	120.220	120.464	120.707	120.951
632.0	3999.420	4011.554	4023.717	4035.910	4048.132	4060.383	4072.664	4084.974	4097.313	4109.681
	121.195	121.488	121.781	122.074	122.367	122.660	122.952	123.245	123.538	123.831
633.0	4122.079	4134.503	4146.952	4159.425	4171.922	4184.443	4196.988	4209.557	4222.150	4234.769
	124.124	124.366	124.607	124.848	125.090	125.331	125.573	125.814	126.055	126.297
634.0	4247.410	4260.075	4272.761	4285.469	4298.198	4310.948	4323.721	4336.515	4349.330	4362.167
	126.538	126.754	126.969	127.184	127.400	127.615	127.830	128.046	128.261	128.477
635.0	4375.025	4387.908	4400.819	4413.758	4426.725	4439.719	4452.742	4465.792	4478.870	4491.976
	128.692	128.971	129.249	129.528	129.806	130.085	130.363	130.642	130.920	131.199

TABLE 7-3 (continued)
Elevation-Area-Capacity

POOL ELEV [FT. NGVD29]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES] .0	.1	.2	.3	.4	.5	.6	.7	.8	.9
636.0	4505.109	4518.271	4531.460	4544.676	4557.919	4571.191	4584.490	4597.815	4611.169	4624.550
	131.477	131.751	132.026	132.300	132.574	132.849	133.123	133.397	133.671	133.946
637.0	4637.958	4651.393	4664.852	4678.336	4691.846	4705.380	4718.939	4732.523	4746.133	4759.767
	134.220	134.470	134.719	134.969	135.219	135.468	135.718	135.967	136.217	136.467
638.0	4773.426	4787.108	4800.813	4814.538	4828.286	4842.055	4855.846	4869.658	4883.492	4897.347
	136.716	136.933	137.149	137.366	137.582	137.799	138.015	138.232	138.448	138.665
639.0	4911.225	4925.125	4939.052	4953.003	4966.980	4980.982	4995.010	5009.063	5023.141	5037.245
	138.881	139.135	139.389	139.642	139.896	140.150	140.403	140.657	140.911	141.164
640.0	5051.374	5065.530	5079.713	5093.925	5108.164	5122.431	5136.725	5151.047	5165.398	5179.776
	141.418	141.696	141.974	142.252	142.530	142.808	143.086	143.364	143.642	143.920
641.0	5194.182	5208.614	5223.071	5237.552	5252.058	5266.587	5281.142	5295.721	5310.325	5324.953
	144.198	144.443	144.688	144.933	145.178	145.424	145.669	145.914	146.159	146.404
642.0	5339.605	5354.282	5368.979	5383.699	5398.441	5413.205	5427.991	5442.799	5457.628	5472.480
	146.649	146.869	147.089	147.309	147.529	147.749	147.969	148.189	148.409	148.629
643.0	5487.354	5502.250	5517.165	5532.100	5547.056	5562.031	5577.027	5592.043	5607.080	5622.136
	148.849	149.051	149.253	149.454	149.656	149.858	150.060	150.262	150.464	150.665
644.0	5637.212	5652.310	5667.428	5682.567	5697.729	5712.910	5728.113	5743.337	5758.582	5773.848
	150.867	151.078	151.290	151.501	151.712	151.923	152.134	152.346	152.557	152.768
645.0	5789.136	5804.442	5819.768	5835.111	5850.472	5865.852	5881.250	5896.665	5912.099	5927.552
	152.979	153.161	153.342	153.523	153.705	153.886	154.068	154.249	154.430	154.612
646.0	5943.021	5958.513	5974.028	5989.567	6005.130	6020.718	6036.330	6051.965	6067.624	6083.307
	154.793	155.033	155.273	155.513	155.753	155.993	156.233	156.473	156.713	156.953
647.0	6099.015	6114.745	6130.496	6146.268	6162.061	6177.875	6193.710	6209.566	6225.444	6241.343
	157.193	157.404	157.615	157.826	158.037	158.248	158.458	158.669	158.880	159.091
648.0	6257.262	6273.201	6289.156	6305.128	6321.118	6337.123	6353.146	6369.186	6385.242	6401.315
	159.302	159.470	159.639	159.807	159.975	160.143	160.311	160.480	160.648	160.816
649.0	6417.405	6433.511	6449.632	6465.768	6481.918	6498.084	6514.265	6530.460	6546.670	6562.896
	160.984	161.133	161.283	161.432	161.582	161.731	161.880	162.030	162.179	162.329
650.0	6579.136	6595.397	6611.687	6628.004	6644.350	6660.723	6677.124	6693.552	6710.009	6726.493
	162.478	162.756	163.035	163.313	163.591	163.869	164.147	164.426	164.704	164.982
651.0	6743.005	6759.545	6776.113	6792.708	6809.332	6825.982	6842.662	6859.368	6876.103	6892.865
	165.260	165.538	165.816	166.094	166.372	166.650	166.928	167.206	167.484	167.762
652.0	6909.655	6926.473	6943.318	6960.191	6977.093	6994.021	7010.978	7027.961	7044.974	7062.013
	168.040	168.317	168.594	168.871	169.148	169.425	169.702	169.979	170.256	170.533

TABLE 7-3 (continued)
Elevation-Area-Capacity

POOL ELEV [FT. NGVD29]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES] .0	.1	.2	.3	.4	.5	.6	.7	.8	.9
653.0	7079.080	7096.175	7113.297	7130.448	7147.625	7164.831	7182.064	7199.326	7216.615	7233.931
	170.810	171.087	171.364	171.641	171.918	172.195	172.472	172.749	173.026	173.303
654.0	7251.275	7268.647	7286.046	7303.474	7320.929	7338.411	7355.921	7373.459	7391.025	7408.619
	173.580	173.857	174.134	174.411	174.688	174.965	175.242	175.519	175.796	176.073
655.0	7426.240	7443.889	7461.565	7479.270	7497.001	7514.761	7532.549	7550.364	7568.207	7586.077
	176.350	176.627	176.904	177.181	177.458	177.735	178.012	178.289	178.566	178.843
656.0	7603.975	7621.901	7639.854	7657.835	7675.845	7693.881	7711.946	7730.038	7748.158	7766.305
	179.120	179.397	179.674	179.951	180.228	180.505	180.782	181.059	181.336	181.613
657.0	7784.480	7802.683	7820.914	7839.171	7857.458	7875.771	7894.113	7912.481	7930.878	7949.303
	181.890	182.167	182.444	182.721	182.998	183.275	183.552	183.829	184.106	184.383
658.0	7967.755	7986.235	8004.743	8023.278	8041.841	8060.431	8079.050	8097.696	8116.370	8135.071
	184.660	184.937	185.214	185.491	185.768	186.045	186.322	186.599	186.876	187.153
659.0	8153.800	8172.557	8191.342	8210.153	8228.993	8247.861	8266.757	8285.680	8304.631	8323.609
	187.430	187.707	187.984	188.261	188.538	188.815	189.092	189.369	189.646	189.923

TABLE 7-5A

SURFACE WATER RIGHTS IN LAKE TEXOMA
RED RIVER, OKLAHOMA AND TEXAS

PERMIT #	ENTITY or NAME	1/4	1/4	1/4	Sec	Twnshp	Rng	COUNTY	Amt (af/yr)	PURPOSE	DATE FILED	DATE ISSUED
(b) (6)		SE	SE	NW	34	07S	07E	Bryan, OK	226.5	Irrigation	28 Jun 2006	10 Oct 2006
20000007	Kleen Oilfield Service Co	NE	NW	NE	09	07S	03E	Love, OK	2.0	Mining	14 Mar 2000	1 Aug 2000
(b) (6)		SE	SW	SE	13	08S	05E	Marshall, TX	558.0	Irrigation	28 Nov 2001	14 May 2002
		SE	NE	SW	09	07S	04E	Marshall, TX	324.0	Irrigation	29 Jul 1974	8 Oct 1974
20010002	Buncombe Creek Enterpr Inc	SW	SW	NW	32	07S	05E	Marshall, TX	287.0	Irrigation	11 Jan 2001	8 May 2001
19970008	Pointe Vista Development LLC	SW	NE	SE	26	06S	06E	Marshall, TX	275.0	Irrigation	1 Apr 1997	8 Jul 1997
19820062	Pointe Vista Development LLC	SW	SE	SW	25	06S	06E	Marshall, TX	220.0	Irrigation	13 Apr 1982	10 Aug 1982
(b) (6)		NE	NW	SE	34	07S	04E	Marshall, TX	200.0	Irrigation	13 Jun 1974	10 Sep 1974
19990025	Lollis Farms	NW	NE	NW	03	08S	04E	Marshall, TX	200.0	Irrigation	4 Aug 1999	13 Jun 2000
19560078B	Pointe Vista Development LLC		SE	SW	25	06S	06E	Marshall, TX	155.0	Irrigation	31 Jan 1956	12 Aug 1969
20010035A	TEEKS1, LLC	SE	SW	SE	13	08S	05E	Marshall, TX	92.5	Irrigation	28 Nov 2001	14 May 2002
(b) (6)		SW	SW	NW	32	07S	05E	Marshall, TX	80.0	Irrigation	4 Jun 1974	13 Aug 1974
19560078A	Tourism & Recreation, Dept of		NE	SW	36	06S	06E	Marshall, TX	78.0	Public Supply	31 Jan 1956	12 Aug 1969
(b) (6)		NE	SE	NW	25	07S	05E	Marshall, TX	70.0	Irrigation	13 Jul 2006	13 Nov 2006
19860010	University of Oklahoma	NE	NE	NE	08	08S	05E	Marshall, TX	7.0	Public Supply	5 Feb 1986	13 May 1986
19570284	Bridgeview Camp A Corp		SE	SW	13	06S	06E	Marshall, TX	3.0	Public Supply	28 Mar 1957	12 Aug 1969
19810164	Buncombe Creek View	SW	SE	NE	05	08S	05E	Marshall, TX	1.0	Public Supply	21 Aug 1981	10 Nov 1981
		TOTAL							**2,779.0**			

T7-5-1

TABLE 7-5B

STREAM WATER RIGHTS ON RED RIVER
DOWNSTREAM OF DENISION DAM TO ARKANSAS BORDER

PERMIT #	ENTITY or NAME	1/4	1/4	1/4	Sec	Twnshp	Rng	COUNTY	TOTAL PERMIT (ac-ft/yr)	PURPOSE	DATE FILED	DATE ISSUED
20080012	Ritchey, Inc, Alan	NE	SE	SE	05	09S	11E	Bryan, OK	3,950.0	Irrigation	11 Apr 2008	12 Aug 2008
20030026	TXI Operations LP	NW	SE	SE	11	10S	09E	Bryan, OK	600.0	Mining	29 Jul 2003	9 Dec 2003
	(b) (6)	SE	SW	SW	12	09S	08E	Bryan, OK	488.0	Irrigation	9 Jan 1981	14 Apr 1981
		NE	NE	SE	17	09S	10E	Bryan, OK	438.0	Irrigation	14 Apr 1999	16 Nov 1999
		NE	SW	SE	23	09S	10E	Bryan, OK	400.0	Irrigation	25 Jun 1991	16 Oct 1991
20050023	Two Rivers Organic Ranch LP	NW	NE	NW	14	08S	12E	Bryan, OK	375.0	Irrigation	20 Oct 2005	14 Mar 2006
	(b) (6)	NE	NE	SE	36	09S	09E	Bryan, OK	370.0	Irrigation	9 Dec 2005	19 Apr 2006
		NE	NE	SW	19	09S	10E	Bryan, OK	358.0	Irrigation	9 Jun 1983	13 Sep 1983
19840067B	S & C Holdings LLC,	NW	NE	SW	06	09S	08E	Bryan, OK	326.0	Irrigation	31 Oct 1984	14 May 1985
	(b) (6)	NE	SE	SE	10	09S	08E	Bryan, OK	320.0	Irrigation	8 Sep 1998	9 Mar 1999
		SE	SW	NE	15	08S	12E	Bryan, OK	265.0	Irrigation	4 Apr 1979	12 Jun 1979
		SE	SE	SW	29	09S	09E	Bryan, OK	260.0	Irrigation	5 Sep 1980	13 Jan 1981
				NW	16	09S	08E	Bryan, OK	160.0	Irrigation	21 Jul 1975	14 Oct 1975
		NE	NE	SE	30	09S	09E	Bryan, OK	160.0	Irrigation	10 Apr 1986	9 Sep 1986
			SE	SW	29	09S	09E	Bryan, OK	132.0	Irrigation	20 Sep 1957	13 Apr 1965
		NE	NW	SW	06	09S	08E	Bryan, OK	120.0	Irrigation	16 Apr 1984	10 Jul 1984
19960031	Hocking Farms, Smith Lee &	SE	SW	NE	15	08S	12E	Bryan, OK	119.0	Irrigation	13 May 1996	10 Sep 1996
	(b) (6)		E2	E2	19	09S	10E	Bryan, OK	117.0	Irrigation	19 Apr 1950	13 Apr 1965
			NW	SW	31	08S	08E	Bryan, OK	100.0	Irrigation	18 Feb 1965	13 Apr 1965
				SW	33	09S	09E	Bryan, OK	99.0	Irrigation	21 Nov 1956	13 Apr 1965
				SW	33	09S	09E	Bryan, OK	94.0	Irrigation	17 Feb 1955	13 Apr 1965
		NW	SE	SW	33	09S	09E	Bryan, OK	92.0	Irrigation	22 Feb 1955	13 Apr 1965

T7-5-2

TABLE 7-5B (continued)

PERMIT #	ENTITY or NAME	1/4	1/4	1/4	Sec	Twnshp	Rng	COUNTY	TOTAL PERMIT (ac-ft/yr)	PURPOSE	DATE FILED	DATE ISSUED
19710256B	S & C Holdings LLC.		NW	NW	06	09S	08E	Bryan, OK	54.0	Irrigation	10 May 1971	14 Sep 1971
[redacted]	(b) (6)		NW	NE	04	10S	09E	Bryan, OK	48.0	Irrigation	15 Mar 1957	13 Apr 1965
[redacted]	(b) (6)		E2	NW	07	09S	08E	Bryan, OK	47.0	Irrigation	22 Jul 1957	13 Apr 1965
20070022	Southern Materials Inc	SW	SW	NW	33	09S	09E	Bryan, OK	41.1	Mining	20 Mar 2007	10 Jul 2007
[redacted]	(b) (6)	SE	NW	NW	06	09S	08E	Bryan, OK	38.0	Irrigation	21 Aug 1998	12 Jan 1999
[redacted]	[redacted]	SW	SE	SW	22	07S	16E	Choctaw, OK	1,012.0	Irrigation	22 Apr 2002	12 Nov 2002
20080020	OKFA LLC	NW	SE	NW	25	09S	24E	McCurtain, OK	300.0	Irrigation	18 Jul 2008	12 Nov 2008
		TOTAL							**10,883.1**			

T7-5-3

EXHIBIT A

SUPPLEMENTARY PERTINENT DATA

LAKE TEXOMA

EXHIBIT A

SUPPLEMENTARY PERTINENT DATA

LAKE TEXOMA

TABLE OF CONTENTS

EXHIBIT A
SUPPLEMENTARY PERTINENT DATA
LAKE TEXOMA

1 - GENERAL INFORMATION

Other names for project	Formerly Denison Reservoir
Location	Red River Basin, Red River, at river mile 725.9, State of Oklahoma and Texas
Type of project	Dam and Lake
Objectives of regulation	Multipurpose – Flood control, hydropower, water supply, regulating flows of Red River, improving 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
Water rights	13,662 acre-feet per year
Project cost through FY 2009	$85,119,763

Closure date	Lake -- Jan 1944 Power Unit #1 – Mar 1945 Power Unit #2 – Sep 1949
Special project features	None
Other	None

TABLE A-1
WATER SUPPLY AGREEMENTS

User Name	Present Storage, ac-ft [1]	Future Storage (ac-ft)	Total User Storage (ac-ft)	Yield, m.g.d.	Approval Date
GTUA F/Pottsboro (Pending) [2]	1,514.70	0	1,514.70	1.488	
GTUA F/Sherman, TX [3]	11,600	0	11,600	11.396	23 Sep 2005
Pointe Vista	275	0	275	0.270	23 Sep 2005
City of Denison	21,300	0	21,300	20.926	21 Sep 1953
Texas Power & Light Co.	16,400	0	16,400	16.112	8 Aug 1961
Red River Authority of Texas	450	0	450	0.442	18 Nov 1969
Red River Authority of Texas	2,054	0	2,054	2.018	2 Aug 1983
North TX Municipal Water District	85,406	0	85,406	83.906	17 Dec 1985
Buncombe Creek View Addition	0.3	0	0.3	0.000	9 Apr 1992
GTUA F/Sherman, TX [3]	5,500	0	5,500	5.403	24 Sep 1992
GTUA F/Sherman, TX [3]	5,500	0	5,500	5.403	29 Oct 1997
North TX Municipal Water District [4]	100,000	0	100,000	98.244	27 Sep 2010
GTUA F/Sherman, TX [4]	50,000	0	50,000	49.122	27 Sep 2010
Identified as available for reallocation for State of Oklahoma [5]		150,000			
Hydropower [5]			686,730	674.67	
TOTAL	**300,000**	**150,000**	**986,730**	**969.40**	

Yield for total conservation pool storage of 986,730 ac-ft = 969.4 m.g.d.
Yield for current water supply agreements (not including hydropower) of 300,000 ac-ft = 294.73 mgd

(1) Storage remaining after 100 years sedimentation from the date the project became operational based on the 2002 sediment survey.

(2) GTUA has requested the remaining 1,515 acre-feet of storage identified for reallocation from the 1985 reallocation; storage will be used for water supply for the town of Pottsboro.

(3) Public Law 85-146 states the rights to storage for Sherman, Texas. Actual law states 41,000 acre-feet, but withdrawal is limited. Amount shown reflects the conservation storage required for the withdrawal limitation during critical hydrologic period.

(4) Section 838 of Public Law 99-662 authorizes the Secretary of the Army to reallocate up to 150,000 acre-feet of storage from hydropower purposes to water supply purposes for entities in the State of Texas.

(5) Includes 150,000 acre-feet identified in Section 838 PL 99-662 as available for reallocation from hydropower purposes to water supply purposes for entities in the State of Oklahoma.

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	670.0			
Maximum pool	666.4			
Top of surcharge	643.0	148,849	5,487,354	3.05
Top of flood control pool and spillway crest	640.0	141,418	5,051,374	2.81
Top of conservation pool (3)	617.0	74,686	2,516,425	1.40
Top of inactive pool	590.0	40,434	1,049,022 (4)	0.58
Flood control storage	617.0 - 640.0	-	2,534,949	1.41
Conservation storage	590.0 - 617.0	-	1,467,403 (5)	0.81
24 hour surveillance begins	632.0			
Streambed at upstream toe of dam	505.0	0	0	

(1) Storage yield of approximately 294.73 m.g.d. for water supply
(2) From 33,783 square miles of contributing drainage area
(3) Top of Conservation Pool varies by season. See Plate 7-1 for seasonal elevations.
(4) Provides for sediment storage and minimum head for hydropower generation
(5) Includes 300,000 acre-feet for water supply

NOTE: Area and Storage based on 2002 re-survey

Real estate taking for land fee title	The fee taking line is a semi-blocked perimeter to elevation 640.0 feet, except in the upper reaches where land was purchased to elevation 650.0 feet.
Real estate taking for Easement	(Not available)
Range of clearing	The upper limit of clearing is elevation 620.0 feet. There is no lower limit of clearing other than the streambed.
Channel capacity downstream of dam	Non-damaging channel capacity immediately downstream of Denison Dam is estimated at 45,000 c.f.s. This varies to about 124,500 c.f.s at the Fulton, AR gage.
Reservoir length at top of conservation pool	57 miles east to west
Shoreline length at top of conservation pool	580 miles
Safety aspects, possibly requiring warning	At elevation 621.0 feet to 622.0 feet, the walkways of some marinas become submerged. At elevation 625.0 feet to 626.0 feet, serious problems occur for many marinas and other structures near the lake. Downstream of the dam, a warning siren will sound before power releases are changed.
Emergency drawdown	Above elevation 640.0 feet, the lake is drawn down through the emergency spillway and through the outlet works and hydropower units. Below elevation 640.0 feet, the lake can be drawn down through the outlet works and hydropower units. At the maximum flow through the outlet works and hydropower units, the time required to draw the water level down to elevation 523.0 feet would be 21 days from the top of conservation pool or 39 days from the top of flood pool (assuming no inflow into the lake).

3 – HYDROLOGY

Drainage area	39,719 square miles, of which 33,783 contribute to runoff

Spillway Design Flood

Maximum water surface elev.	666.4 feet, NGVD29
Peak inflow (into full pool)	1,830,000 c.f.s.
Total storm runoff	6.65 inches
Volume (into full pool)	11,985,000 acre-feet
Maximum outflow	1,130,000 c.f.s.
Duration of flood	12 days
Seasonal distinction	All Seasons

Standard Project Flood

Maximum water surface elev.	661.4 feet, NGVD29
Peak inflow (into full pool)	1,350,000 c.f.s.
Total storm runoff	5.10 inches
Volume (into full pool)	9,190,000 acre-feet
Maximum outflow	828,000 c.f.s.
Duration of flood	10 days
Seasonal distinction	All seasons

Climate	Moderate
One inch of runoff	1,801,760 acre-feet
Storm types	Primarily Thunderstorms
Flood seasons	Mar through Jun, and Sep through Oct, although records show floods can occur at any time during the year.
Low flow season	Nov – Feb and Jul - 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
Minimum monthly inflow and date	0 c.f.s. on several occasions
Minimum annual inflow and year	814,295 acre-feet in 2006 Period of record 1906-2009

Average annual inflow	4,191,247 acre-feet Period of record 1906-2009
Maximum annual inflow and year	12,640,400 acre-feet in 1908 Period of record 1906-2009
Maximum monthly inflow and date	4,705,000 acre-feet in May 1957
Maximum daily inflow and date	304,000 c.f.s. on 01 Jun 1987
Maximum instantaneous inflow and date	350,000 c.f.s. on 13 Oct 1981
Maximum flood volume and date	8,517,000 acre-feet for May – Jun 1908
Name and location of key stream flow stations upstream of Denison Dam	Washita River: Dickson, OK (river mile 63.4) Pauls Valley, OK (river mile 146.5) Red River: Gainesville, TX (river mile 791.5) Terral, TX (river mile 872.0)
Type of hydrometeorological 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	97 recording and 45 Mesonet gages, plus 58 stream gages and 8 pool gages.
Number of snow courses	None
Number of sediment ranges	88
Number of degradation ranges	39

4 – EMBANKMENT

Location	Red River at stream mile 725.9
Purpose	Flood control, hydropower, water supply, recreation, regulating flows of Red River, improving navigation, and fish and wildlife.
Type	Non-overflow embankment
Type of fill	Rolled earth fill with impervious core
Slope protection	Riprap on upstream face; grassed on downstream face.
Height	165 feet above streambed
Length	17,200 feet (including spillway)
Top elevation	670.0 feet, NGVD29
Design flood	Spillway Design flood
Freeboard	3.6 feet above maximum pool
Used for roadway	Yes. Highway 75A crosses the embankment and spillway with a 24-foot wide asphalt roadway
Elevation of stream bed	Approximately 505.0 feet, NGVD29 (at center of dam)

5 – SPILLWAY

Location	Near right abutment
Type	Uncontrolled chute with weir entrance
Crest elevation	640.0 feet, NGVD29
Net overflow length	2000 feet
Maximum discharge capacity	1,050,000 c.f.s.
Type of energy dissipater	Apron and plunge pool
Frequency of pool attaining crest elevation	Approximately 23 years

6 – CUMBERLAND LEVEE

Location	West side of Washita River arm (river miles 16-20)
Purpose	Protection of Cumberland Oil Field.
Type	Non-overflow, rolled earth levee.
Type of fill	Impervious (river side) and random.
Slope protection	Riprap on river side and grass on oil field side.
Height (maximum)	90 feet
Length	23,480 feet
Top elevation	Approximately 648.0-649.0 (after being raised 1-2 feet during May 1990 flood)

Design flood	Reasonably expectant flood 100,000 c.f.s. (peak) 518,000 acre-feet (Volume) Probable maximum flood 174,000 c.f.s. (peak) 901,300 acre-feet (volume)
Freeboard	4.5 feet (upper end) 2.1 feet (lower end)
Flood closure structure	None
Drainage structure	Five submersible pumps with combined capacity of approximately 40,000 gallons per minute (g.p.m.). Located at south end of Cumberland Oil Field in pre-project river channel. Each pump discharges into a 20-inch diameter pipe; these five pipes are joined into one 60-inch diameter pipe that goes over the levee.

7 – PLATTER DIKE

Location	Near Platter, Oklahoma, about 5 to 6 miles north of Denison Dam on the east side of the Washita River channel
Purpose	Protection of the town of Platter.
Type	Rolled earth fill.
Height (maximum)	15 feet
Length	5,870 feet

8 – OUTLET FACILITIES

Location	Near right abutment
Purpose	Low flow and flood control releases
Type of outlet	Three 20’ diameter conduits
Number and size of gates	Six 9’ x 19’ service and two 9’ x 19’ emergency gates
Entrance invert elevation	523.0, feet NGVD29
Discharge at pertinent elevations	Bottom of conservation pool – 50,400 c.f.s. (elev. 590.0 feet) Top of conservation pool – 60,120 c.f.s. (elev. 617.0 feet) Top of flood control pool – 67,500 c.f.s. (elev. 640.0 feet) Top of maximum pool – 75,000 c.f.s. (elev. 666.4 feet)
Minimum pool elevation when inoperative	523.0 feet, NGVD29
Minimum time required to open or close service gates	Average time is 10 minutes from completely closed to completely opened positions
Type energy dissipater	Concrete stilling basin with four rows of baffles and an end sill

9 – HYDROELECTRIC POWER FACILITIES

Location	Adjacent to outlet works near right abutment
Type	Storage
Installed capacity	Current: 70,000 kilowatts Potential: 199,000 kilowatts
Number, type, capacity	Current: Two 35,000 kilowatt units Potential: Two 35,000 kilowatt units Three 43,000 kilowatt units
Power online date	Mar 1945 (first unit) Sep 1949 (second unit) Unit 1 rewind complete Nov 2005 Unit 2 rewind complete May 2006
Number and size of penstocks	Two 20-foot diameter (currently being used) Five 20-foot diameter (total available)
Maximum turbine discharge	13,600 c.f.s.(with two units on overload at 88 mW) (at elevation 617.0 feet)
Average net head	Power pool full 103.2 feet Power pool empty 75.0 feet Critical hydro-period 92.2 feet

Firm Energy	429 MWh/day (2,300 c.f.s.)
Drawdown during critical drought	27 feet
Critical drought periods	1955 - 1957 and 1963 - 1964
Minimum peaking capability	55,600 kilowatts at bottom of conservation pool
Dependable capacity	54,000 kilowatts
Usable conservation storage (estimated for year 2044)	986,730 acre-feet at top of power pool (includes 300,000 acre-feet for water supply), remaining amount for hydroelectric power
Critical tailwater elevation	527.0 (power plant becomes submerged)
Constraints	Downstream channel capacity is 45,000 c.f.s.; maximum rate of pool drawdown is 1 foot per week or 3 feet per 4-week period.

10 - CONTROL POINTS/RIVER REACHES

a. Arthur City Gage (Red River)

Location	At river mile 633.1 on Red River, U.S. Highway 271 bridge
Purpose	Measure discharge and serve as control point for flood releases from Lake Texoma
Channel description	Meandering over wide sandy bed
Drainage area	44,531 square miles of which 38,595 square miles is contributing
Uncontrolled drainage area	4,466 square miles
NWS flood stage	27.0 feet, 84,600 c.f.s. (current rating curve)
Corps regulating stage	27.0 feet, 84,600 c.f.s. (current rating curve)
Time of water travel Denison Dam to gage	36-48 hours
Description of equipment	Water-stage recorder
Zero of gage	Elevation 375.07 feet
Maximum stage of record	43.2 feet, 28 May 1908
Maximum flow of record	400,000 c.f.s., 28 May 1908

b. Dekalb Gage (Red River)

Location	At river mile 556.9 on Red River, U.S. Highway 259 bridge
Purpose	Measure discharge and serve as control point for flood releases from Lake Texoma

10 - CONTROL POINTS/RIVER REACHES (continued)

Channel description	Meandering over wide sandy bed
Drainage area	47,348 square miles of which 5,936 square miles is probably non-contributing
Uncontrolled drainage area	5,574 square miles
NWS flood stage	24.0 feet, 54,800 c.f.s. (current rating curve)
Corps regulating stage	23.7 feet, 51,200 c.f.s. (current rating curve)
Time of water travel Denison Dam to gage	66-90 hours
Description of equipment	Water-stage recorder with telemeter
Zero of gage	Elevation 302.92
Maximum stage of record	34.2 feet, 6 May 1990
Maximum flow of record	279,000 c.f.s., 6 May 1990

c. Index Gage (Red River)

Location	At river mile 485.3 on Red River, U.S. Highway 71 bridge
Purpose	Measure discharge and serve as control point for flood releases from Lake Texoma
Channel description	Sandy bed inside levees
Drainage area	48,036 square miles of which 5,936 square miles is probably non-contributing
Uncontrolled drainage area	6,255 square miles
NWS flood stage	25.0 feet,141,000 c.f.s. (current rating curve)

10 - CONTROL POINTS/RIVER REACHES (continued)

Corps regulating stage	19.8 feet, 95,100 c.f.s. (current rating curve)
Time of water travel Denison Dam to gage	84-120 hours
Zero of gage	Elevation 246.87 feet
Maximum stage of record	34.25 feet, 23 Feb 1938
Maximum flow of record	297,000 c.f.s., 23 Feb 1938

d. Fulton Gage (Red River)

Location	At river mile 463.0 on Red River, U.S. Highway 67 bridge
Purpose	Measure discharge and serve as control point for flood releases from Lake Texoma
Channel description	Sandy bed inside levees
Drainage area	52,336 square miles of which 5,892 square miles is probably non-contributing
Uncontrolled drainage area	6,255 square miles
NWS flood stage	27.0 feet,146,000 c.f.s. (current rating curve)
Corps regulating stage	25.0 feet, 128,000 c.f.s. (current rating curve)
Time of water travel Denison Dam to gage	92-136 hours
Zero of gage	Elevation 224.94
Maximum stage of record	37.4 feet, 2 Apr 1945
Maximum flow of record	338,000 c.f.s., 24 Feb 1938

EXHIBIT B

PUBLIC LAW 100-71

LAKE TEXOMA

Public Information.
Oklahoma.
Arkansas.
Louisiana.
Texas.
88 Stat. 39.

PUBLIC LAW **100-71**
JULY 11, 1987

Pursuant to the Federal Advisory Committee Act (Public Law 92-463), the Secretary of the Army is directed to establish an advisory committee for the Denison Dam (Lake Texoma), Red River Texas and Oklahoma project authorized by the Flood Control Act approved June 28, 1938 (52 Stat. 1219). The purpose of the Committee shall be advisory only and it shall provide information and recommendations to the Corps of Engineers regarding the operations of Lake Texoma for its Congressionally authorized purposes. The Committee shall be composed of representatives equally divided among the project purposes and between the States of Texas and Oklahoma.

The Corps of Engineers, taking into consideration recommendations of the Southwestern Power Administration and the Lake Texoma Advisory Committee, shall, to the extent feasible, develop a management plan for the conservation pool in Lake Texoma that:

(1) attempts to maintain a water surface elevation between 617 and 612 msl: ***Provided however,*** That hydroelectric power will be generated to help satisfy electric loads when the water surface elevation is between 617 and 612 msl;

(2) when the water surface elevation drops to 612 msl or lower, implements a public information program;

(3) when the water surface elevation is between 612 and 607 msl, provides for the Corps to notify the SWPA that hydro-electric power generation should only be made when it is needed for rapid response, short term peaking purposes as determined by the power scheduling entity;

(4) when the water surface elevation is between 607 and 590 msl-

(a) provides for the Corps to notify the SWPA that hydro-electric power generation should only be made to satisfy critical power needs on the power scheduling entity's electrical system as determined by the power scheduling entity; and

(b) provides for the Corps of Engineers to notify municipal and industrial water users that they should implement water conservation measures

designed to lessen the impact of municipal and industrial water withdrawals.

Any amendments to the current water control plan specified above shall not supersede or adversely affect any existing permit, lease license contract, public law or flood control operation relating to Denison Dam (Lake Texoma). The management plan shall have no impact upon the provisions of section 838 of the Water Resources Development Act of 1986. The management plan shall be re-evaluated on or after September 30, 1989 by the Corps of Engineers, taking into consideration the recommendations of the Southwestern Power Administration and the Lake Texoma Advisory Committee.

The United States Army Corps of Engineers, Tulsa District, shall issue a final report on the Oklahoma portion of the comprehensive study of the Red River Basin, Oklahoma, Arkansas, Louisiana and Texas, no later than September 30, 1988.

The management plan specified above should be formally processed to the Committees on Environment and Public Works and Public Works and Transportation in the Senate and House of Representatives, respectively, if appropriate, for authorization as required prior to any amendments to the current operating plan that could impact health and safety, authorized purposes, or expose the Federal Government to liability. None of the funds in this Act or any other Act relating to water resource development may be used to construct or enter into an agreement to construct additional hydroelectric power generation units at Denison Dam (Lake Texoma) until September 30, 1989.

Section 91 of the Water Resources Development Act of 1974 is amended by striking out "$28,725,000" in the last sentence and inserting in lieu thereof "$30,500,000".

EXHIBIT C

STANDING INSTRUCTIONS TO LAKE MANAGER

LAKE TEXOMA

EXHIBIT C

STANDING INSTRUCTIONS TO LAKE MANAGER

LAKE TEXOMA

TABLE OF CONTENTS

TABLE INDEX

EXHIBIT C
STANDING INSTRUCTIONS TO LAKE MANAGER
LAKE TEXOMA

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-2.a. through II-2.e. 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 Office 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 Lake Manager will immediately make every effort to re-establish communications with the Tulsa District Office.

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 from all flood control storage projects with hydropower. Data are typically reported by telephone, fax, email, or posted to the Water Managements Section server mailbox: swt-wc@usace.army.mil. 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" by 10 a.m.

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., and 5-07.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 Lake Manager 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 Lake Texoma Operation and Maintenance Manual, Volume II, Contingency Plan for Emergencies. In every case, when a gate change is made a horn is blown to give warning to people immediately downstream of Denison 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 immediately downstream of Denison Dam of 45,000 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 crossings 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, and status of crops in low-lying farmlands.

2. Normal Flood Control Regulations. Lake Texoma will be regulated in conjunction with existing lakes and reservoirs on the Red River and tributaries for the control of floods on the Red River from Denison Dam to Fulton, Arkansas. Stream gages on the Red River at Arthur City and De Kalb, Texas, and Index and Fulton, Arkansas, will be used as control points for the regulation of flood flows. Stream gages at Blue, Oklahoma, on the Blue River; Caney, Oklahoma, on Clear Boggy Creek; and Farris and Unger, Oklahoma, on Muddy Boggy Creek will serve as indices of runoff from uncontrolled areas downstream of Denison Dam. The following regulations will govern releases from Lake Texoma as long as communications are not disrupted between the project and the Tulsa District.

(1) When the lake level is between the bottom of the conservation pool (elevation 590.0 feet) and the top of the transitional pool (as shown on Plate 7-1) releases will normally be made through the hydropower units and will be governed by the power generation requirements explained in paragraph 7-11. of the manual and shown on Plate 7-1. When flood estimates indicate that the lake level will exceed the top of the seasonal pool and elevation 617.0 feet, regulated releases may be made such that the combined flow from Lake Texoma releases, releases from downstream lakes, and other downstream flows will not cause either of the following: a) stages above bank full for the Red River between Denison and Fulton, or b) stages at the Fulton gage above 25 feet or the stage corresponding to 128,000 c.f.s. (whichever is smaller) if there is flooding or a prediction of flooding on the Red River downstream of Fulton. If there is no flooding and no predicted flooding on the Red River downstream of Fulton, the flows at the Fulton gage should be regulated to a maximum stage of 25 feet, regardless of discharge. In any event, the Lake Texoma releases must not exceed the channel capacity downstream of the dam (currently in the range of 45,000 to 50,000 c.f.s.).

(2) When the lake level rises above the top of the transition pool as shown on Plate 7-1, regulated releases may be made at the maximum rate permissible, as stated in subparagraph (1), but limited such that the combined flow from Lake Texoma releases, releases from downstream lakes, and other downstream flows will not cause either of the following: a) stages above bank full for the Red River between Denison and Fulton, or b) stages at the Fulton gage above 25 feet or the stage corresponding to 100,000 c.f.s. (whichever is smaller) if there is flooding or a prediction of flooding on the Red River

downstream of Fulton. If there is no flooding and no predicted flooding on the Red River downstream of Fulton, the flows at the Fulton gage will be regulated to a maximum stage of 25 feet, regardless of discharge. In any event, the Lake Texoma releases must not exceed the channel capacity downstream of the dam (currently 45,000 to 50,000 c.f.s.). Releases may be made at less than the maximum rate permissible if it is considered more beneficial. Factors that will be considered in the determination of releases are the following: maximum inflow into the lake during the rise, general climatic conditions, season of the year with respect to probability of floods and status of crops on low-lying farmland, and, when the flood control pool is full, the likelihood of overtopping the Cumberland levees. Releases will be gradually increased or decreased in accordance with paragraph 7-05.c. of the manual so as to minimize bank caving in the reaches downstream from the project.

(3) When the predicted inflow is such that an eventual discharge from the dam in excess of that permitted under subparagraph (b.) is clearly evident and the pool level is approaching the spillway crest, elevation 640.0 feet, regulated releases in excess of those provided for in subparagraph (2) (but not to exceed 60,000 c.f.s.) may be made if the resulting overall benefits appear to justify such action. When the lake level is approaching or predicted to exceed the top of the surcharge pool, elevation 643.0 feet, total outflow may exceed 60,000 c.f.s., but in no event shall the total outflow cause the flows downstream from the dam to exceed the maximum flows that would have occurred without the Denison project. **NOTE**: The conduit outlet and stilling basin must be visually monitored very closely during all high releases and during high tailwater events. If unusual conditions occur (such as riprap displacement, surging, submerged outlet, or the hydraulic jump moving out of the stilling basin), close all conduit gates immediately and continue efforts to establish communications with Tulsa District.

(4) When flows from areas downstream of Denison will produce near bank full or above bank full stages on the Red River between Denison and Fulton, releases from Lake Texoma may be reduced below the daily average flow of 2,300 c.f.s. for firm energy (429 MWh/day) or shut off completely if it would aid in reducing peak stages or the duration of above bank full stages. During periods when flood control releases are being made from lakes in the Red River System, and the river is not forecasted to exceed the regulating stages in Table 7-1, the maximum restriction the Corps would place on releases from Lake Texoma would be to limit releases to the flow which is required to generate the firm energy of the project unless emergency conditions required otherwise. This energy may be produced in accordance with the system demands and the capacity of the plant.

(5) All regulations will be coordinated with the Lower Mississippi Valley Division through Southwestern Division (SWD) to care for unusual conditions in the Red River below Fulton.

5. During Emergency Events. The Lake Manager 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 SWD.

TABLE C-1

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE
LAKE TEXOMA, RED RIVER, OKLAHOMA

A. Rising Pool

When communications are disrupted, the following emergency regulations will remain in effect until:

(a) Communications are restored, or
(b) The pool begins falling.

NOTE: No change in regulation will be made for a period of 24 hours following disruption of communication unless the pool is above or expected to crest above elevation 640.0 In making the transition from the regulation in force at the time of communication loss to emergency regulation, the maximum change in release rate shall be 15,000 c.f.s per 6-hour period. At no time shall a reduction in discharges be made while the pool is rising.

Lake Stage	Pool Conditions	Regulation
Below 619.0	Rising	Continue the release being made at the time communication was disrupted.
619.0 - 625.0	Rising	Release a total of 15,000 c.f.s.
625.0 - 635.0	Rising	Release a total of 30,000 c.f.s.
635.0 - 637.5	Rising	Release a total of 45,000 c.f.s.
637.5 - 640.0	Rising	Release a total of 60,000 c.f.s.
640.0 - 643.0	Rising	Adjust flood conduit gates to maintain a total release of 60,000 c.f.s.
Above 643.0	Rising	Increase releases by 10,000 c.f.s. every two hours until flood conduit gates are fully open or pool begins to fall.

NOTE: The conduit outlet and stilling basin must be visually monitored very closely during all high releases and during high tailwater events. If unusual conditions occur (such as riprap displacement, surging, submerged outlet, or the hydraulic jump moving out of the stilling basin), close all conduit gates immediately and continue efforts to re-establish communications with Tulsa District.

TABLE C-1 (continued)

B. Falling Pool

When communications are disrupted, the following emergency regulations will remain in effect until:

(a) Communications are restored,
(b) The pool begins rising again, or
(c) The pool reaches elevation 619.0 feet, at which time releases will be made in accordance with paragraph 7-11. of the manual and Plate 7-1.

NOTE: No change in regulation will be made for a period of 24 hours following disruption of communication unless the pool is above or expected to crest above elevation 640.0 feet. Should the pool begin rising, the regulations outlined above for rising pool conditions will be followed. In making the transition from the regulation in force at the time of communication loss to emergency regulation, the maximum change in release rate shall be 15,000 c.f.s. per 6-hour period.

Lake Stage	Pool Conditions	Regulation
Above 643.0	Falling	Maintain the maximum gate setting attained during rising pool conditions.
640.0 - 643.0	Falling	Adjust flood conduit gates to maintain a total release of 60,000 c.f.s..
637.5 - 640.0	Falling	Release a total of 60,000 c.f.s.
630.0 - 637.5	Falling	Release a total of 45,000 c.f.s.
625.0 - 630.0	Falling	Release a total of 35,000 c.f.s.
620.0 - 625.0	Falling	Release a total of 25,000 c.f.s.
619.0 - 620.0	Falling	Release a total of 15,000 c.f.s.
Below 619.0	Falling	Releases will be made in accordance with paragraph 7-11. of the manual and Plate 7-1.

NOTE: The conduit outlet and stilling basin must be visually monitored very closely during all high releases and during high tailwater events. If unusual conditions occur (such as riprap displacement, surging, submerged outlet, or the hydraulic jump moving out of the stilling basin close all conduit gates immediately and continue efforts to re-establish communications with Tulsa District.

EXHIBIT D

MEMORANDUM OF UNDERSTANDING

CONTRACT NUMBER
DE-(AM)75-80SW00058

COPY

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

Robert D. Smith

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 Greeson

EXHIBIT A

DEPARTMENT OF THE ARMY
SOUTHWESTERN DIVISION, CORPS OF ENGINEERS
1114 COMMERCE STREET
DALLAS, TEXAS 75242-0216

REPLY TO ATTENTION OF

October 30, 1986

SWPA OFFICIAL COPY

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

Water Management Branch
Engineering Division

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,

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

EXHIBIT "B"

OPERATING ARRANGEMENT

TABLE OF CONTENTS

TABLES

Exhibit "B"

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 documentated 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 pre-pared 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

Reservoir	Allowable Daily Release Volume (DSF)	Energy (MWH) (1)
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
Norfork	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

Project	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 CHANGE IN GENERATION

PROJECT	TIME	
	NORMAL	EMERGENCY
FORT WORTH DISTRICT		
Sam Rayburn	20 Minutes	5 Minutes
Whitney	20 Minutes	5 Minutes
LITTLE ROCK DISTRICT		
Beaver	10 Minutes	5 Minutes
Bull Shoals	10 Minutes 1/	5 Minutes
Table Rock	10 Minutes 2/	5 Minutes
Norfork	10 Minutes	5 Minutes
Greers Ferry	10 Minutes	5 Minutes
Dardanelle	10 Minutes	5 Minutes
Ozark	10 Minutes	5 Minutes
TULSA DISTRICT		
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 3/	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

TITLE	DATE
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

Norfork (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 E

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

OPERATING PLAN

TABLE OF CONTENTS

ENCLOSURES

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) typica1ly 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

RESERVOIR	ALLOWABLE VOLUME (DSF)	DAILY RELEASE ENERGY (MWH) (1)
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
Norfork	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

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.
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

PROJECT	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

PROJECT	TIME	
	NORMAL	EMERGENCY
FORT WORTH DISTRICT		
SAM RAYBURN	10 minutes	5 minutes
WHITNEY	10 minutes	5 minutes
LITTLE ROCK DISTRICT		
BEAVER	10 minutes	5 minutes
BULL SHOALS	10 minutes 1/	5 minutes
TABLE ROCK	10 minutes 2/	5 minutes
NORFORK	10 minutes	5 minutes
GREERS FERRY	10 minutes	5 minutes
DARDANELLE	10 minutes	5 minutes
OZARK	10 minutes	5 minutes
TULSA DISTRICT		
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 3/	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

TITLE	DATE
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,	Mar 1963
Bull Shoals, and Norfork Reservoirs	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 UNAVAILIBILITY 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**

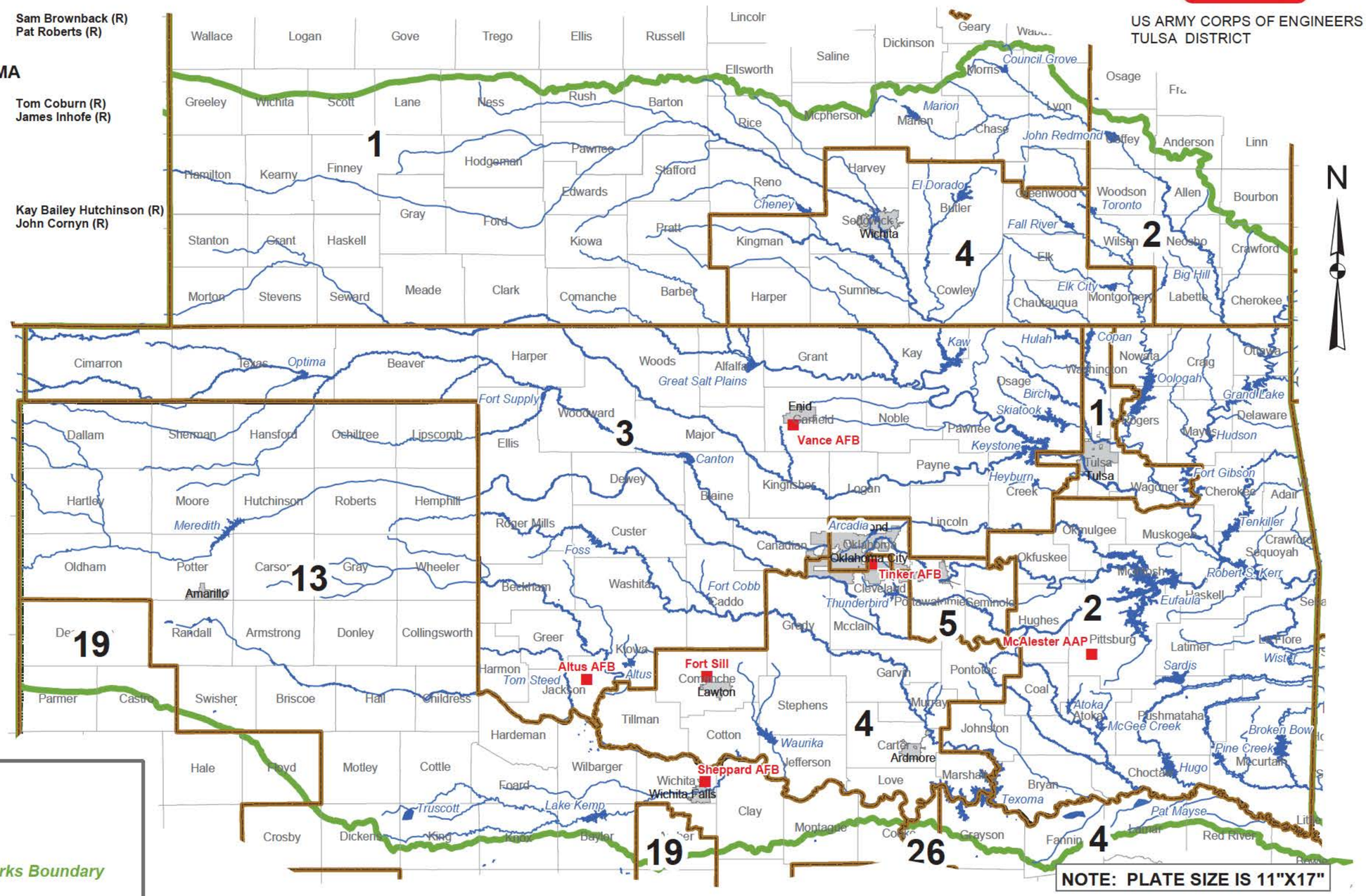
Title

PLATES AND DRAWINGS

LAKE TEXOMA (DENISON DAM)

US ARMY CORPS OF ENGINEERS
TULSA DISTRICT

U.S. Representative	U.S. Senator
KANSAS	
1 Jerry Moran (R)	Sam Brownback (R)
2 Lynn Jenkins (R)	Pat Roberts (R)
4 Todd Tiahirt (R)	
OKLAHOMA	
1 John Sullivan (R)	Tom Coburn (R)
2 Dan Boren (D)	James Inhofe (R)
3 Frank Lucas (R)	
4 Tom Cole (R)	
5 James Lankford (R)	
TEXAS	
4 Ralph M. Hall (R)	Kay Bailey Hutchinson (R)
13 Mac Thornberry (R)	John Cornyn (R)
19 Randy Neugebauer (R)	
26 Michael C. Burgess (R)	



NOTE: PLATE SIZE IS 11"X17"

PLATE 1 - 1

Murray County

Johnston County

377

35

Carter County

Ardmore

Washita River

69

N

Marshall County

Bryan County

Durant

70

Choctaw County

Love County

OKLAHOMA

LAKE TEXOMA

TEXAS

Red River

Denison

377

35

82

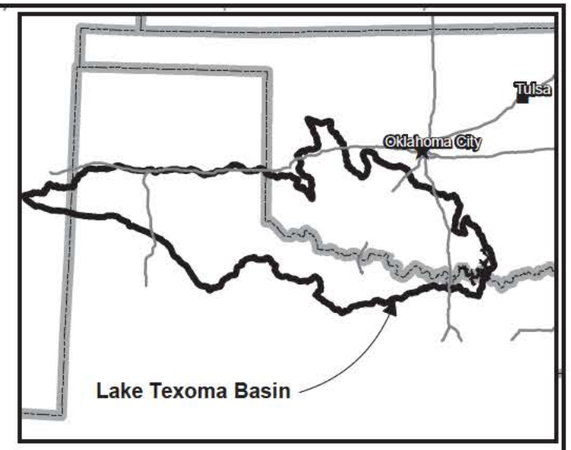
Grayson County

Gainesville

Sherman

Cooke County

0 4 8 16 24 Miles



NOTE: Plate is 11" x 17"

RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

PROJECT LOCATION AND VICINITY MAP

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

PLATE 2 - 1

(b) (7)(F)

LAKE TEXOMA (DENISON DAM)

GENERAL PLAN AND SECTIONS

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

PLATE 2 - 2

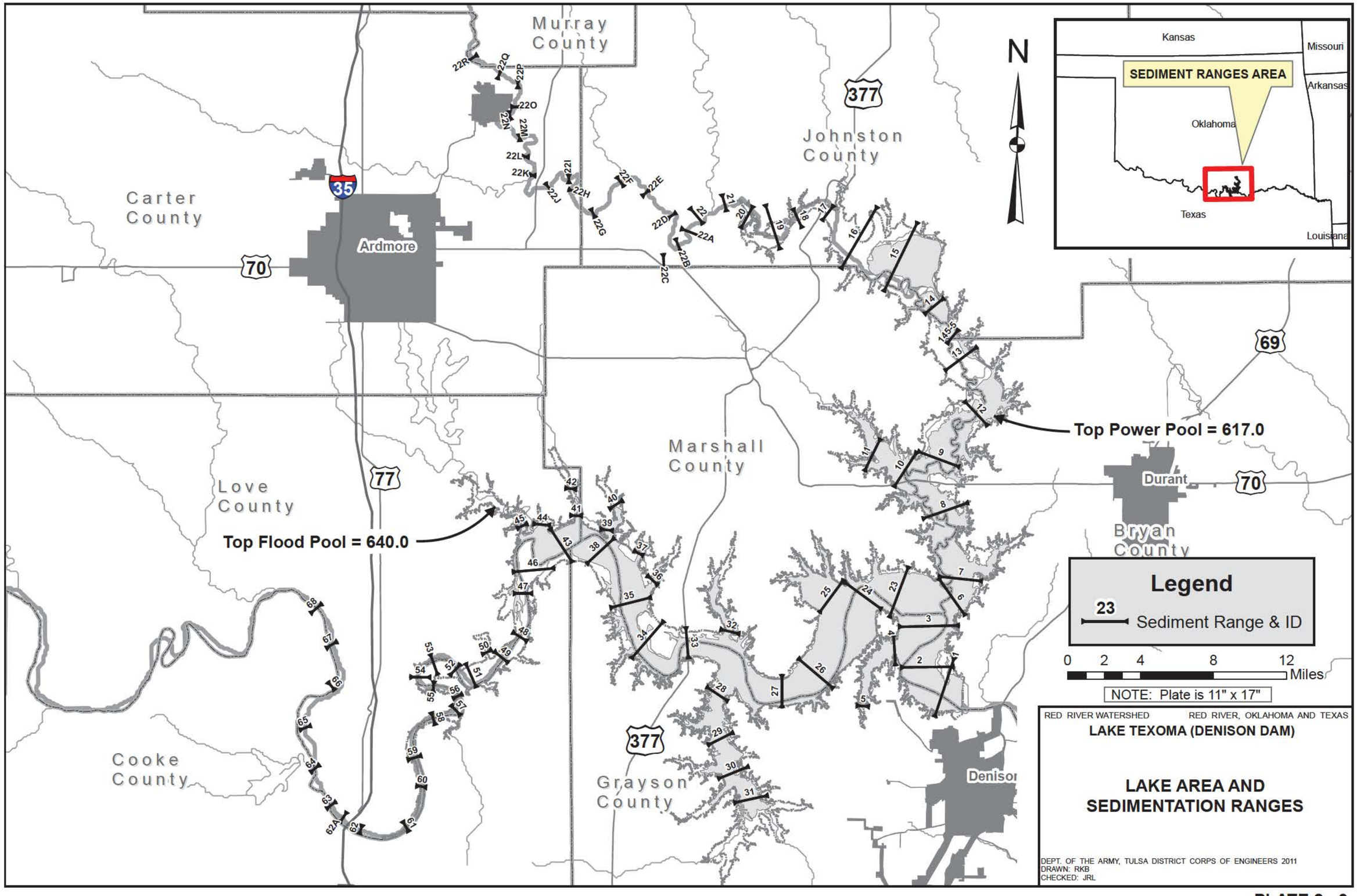

Murray County
Carter County
Ardmore
Johnston County
Marshall County
Love County
Cooke County
Grayson County
Durant
Bryan County
Denison
35
70
77
377
69
N
Kansas
Missouri
Arkansas
Oklahoma
Texas
Louisiana
SEDIMENT RANGES AREA
Top Power Pool = 617.0
Top Flood Pool = 640.0
Legend
23 Sediment Range & ID
0 2 4 8 12 Miles
NOTE: Plate is 11" x 17"
RED RIVER WATERSHED
RED RIVER, OKLAHOMA AND TEXAS
LAKE TEXOMA (DENISON DAM)
LAKE AREA AND SEDIMENTATION RANGES
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 2 - 3

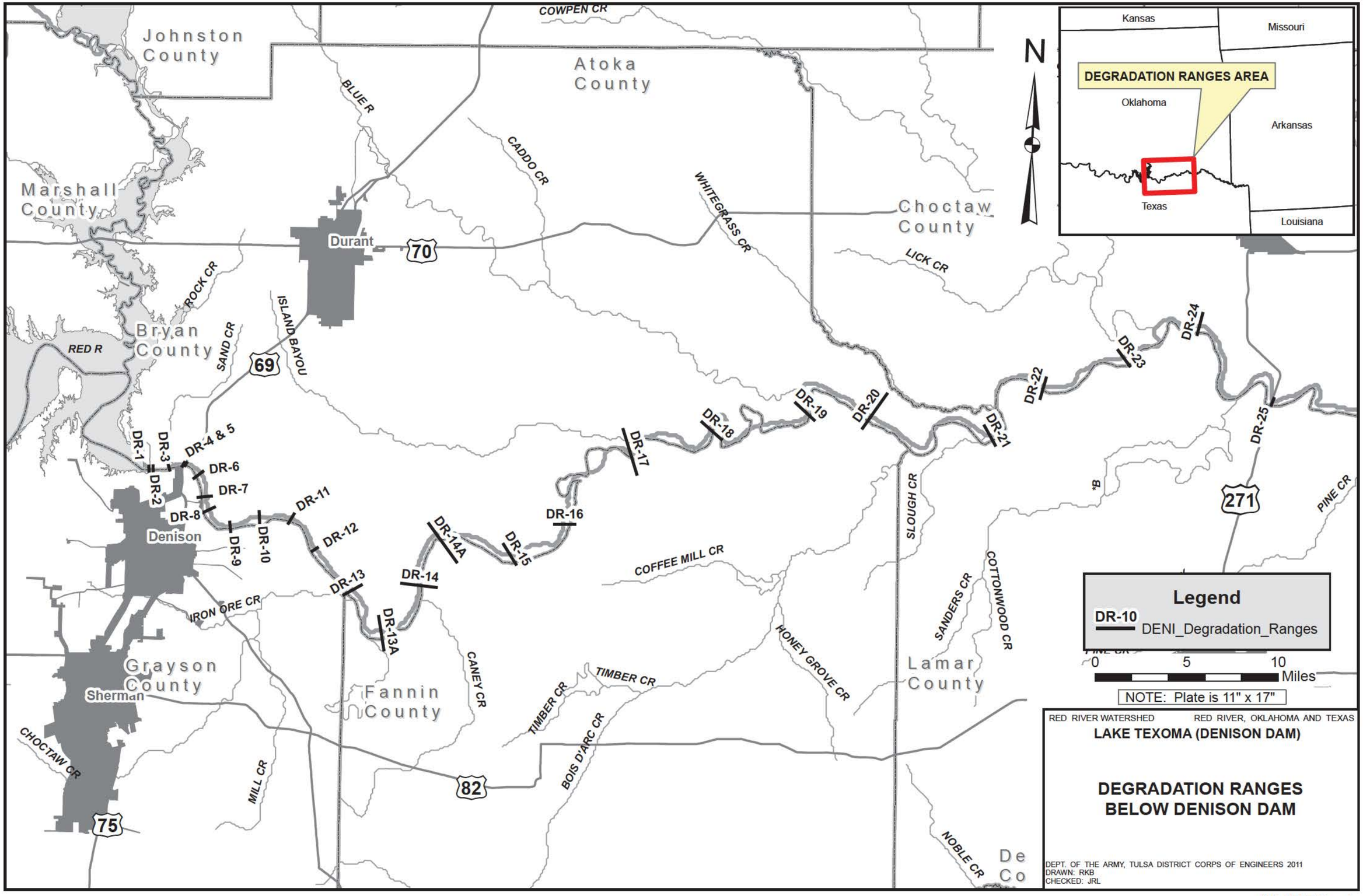

Johnston County
Marshall County
Bryan County
Atoka County
Choctaw County
Grayson County
Fannin County
Lamar County
Durant
Denison
Sherman
COWPEN CR
BLUE R
CADDO CR
WHITEGRASS CR
LICK CR
ROCK CR
RED R
SAND CR
ISLAND BAYOU
IRON ORE CR
COFFEE MILL CR
CANEY CR
TIMBER CR
TIMBER CR
BOIS D'ARC CR
HONEY GROVE CR
SLOUGH CR
SANDERS CR
COTTONWOOD CR
PINE CR
CHOCTAW CR
MILL CR
NOBLE CR
70
69
82
75
271
DR-1
DR-2
DR-3
DR-4 & 5
DR-6
DR-7
DR-8
DR-9
DR-10
DR-11
DR-12
DR-13
DR-13A
DR-14
DR-14A
DR-15
DR-16
DR-17
DR-18
DR-19
DR-20
DR-21
DR-22
DR-23
DR-24
DR-25
N
Kansas
Missouri
DEGRADATION RANGES AREA
Oklahoma
Arkansas
Texas
Louisiana
Legend
DR-10
DENI_Degradation_Ranges
0
5
10
Miles
NOTE: Plate is 11" x 17"
RED RIVER WATERSHED
RED RIVER, OKLAHOMA AND TEXAS
LAKE TEXOMA (DENISON DAM)
DEGRADATION RANGES
BELOW DENISON DAM
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 2 - 4

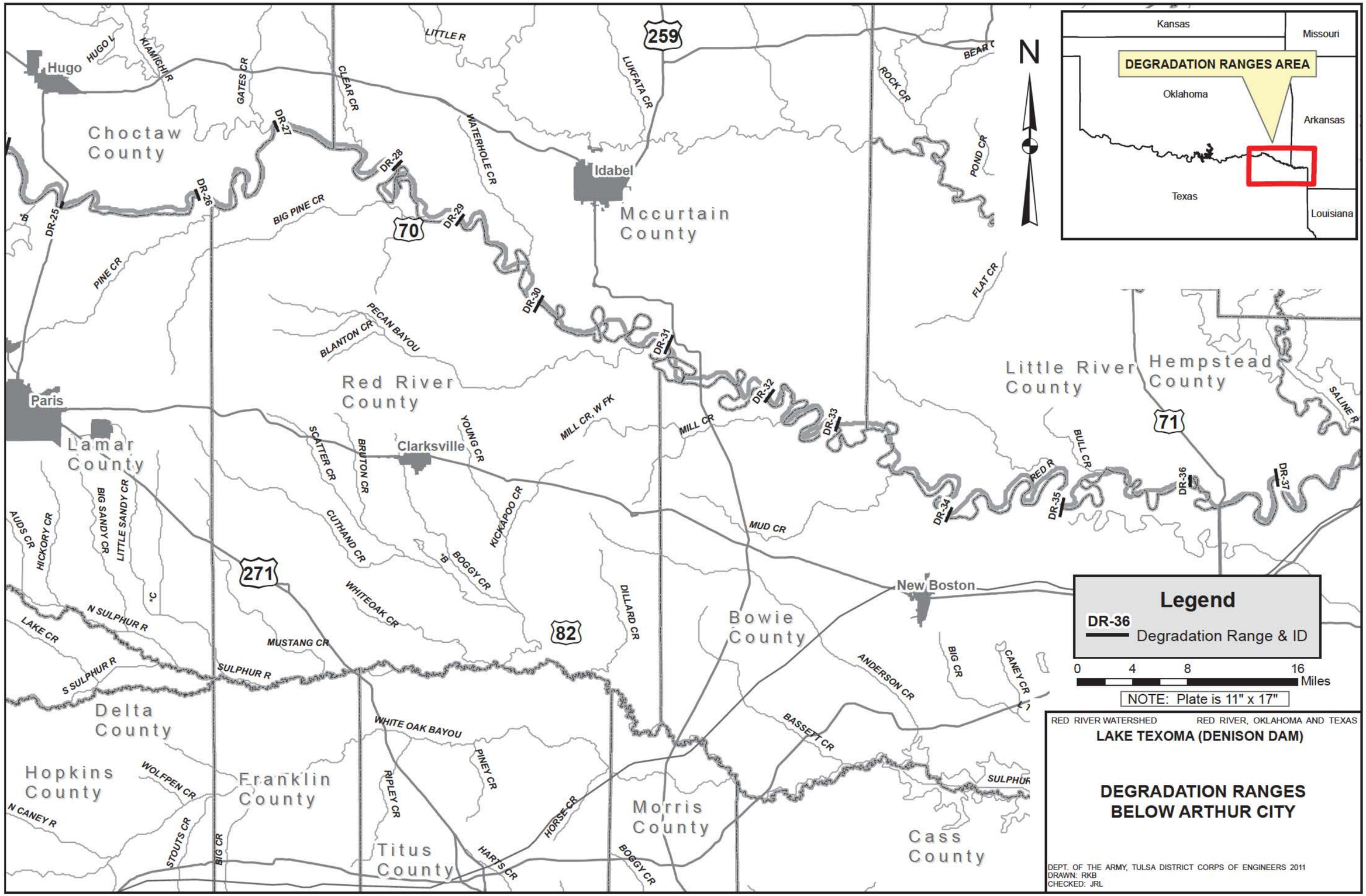
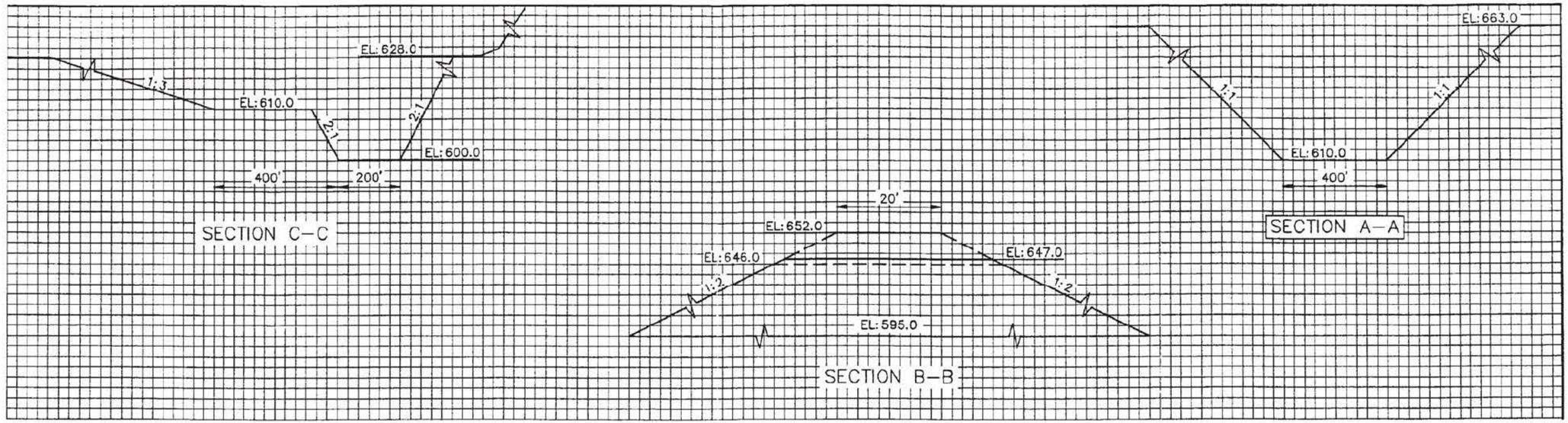
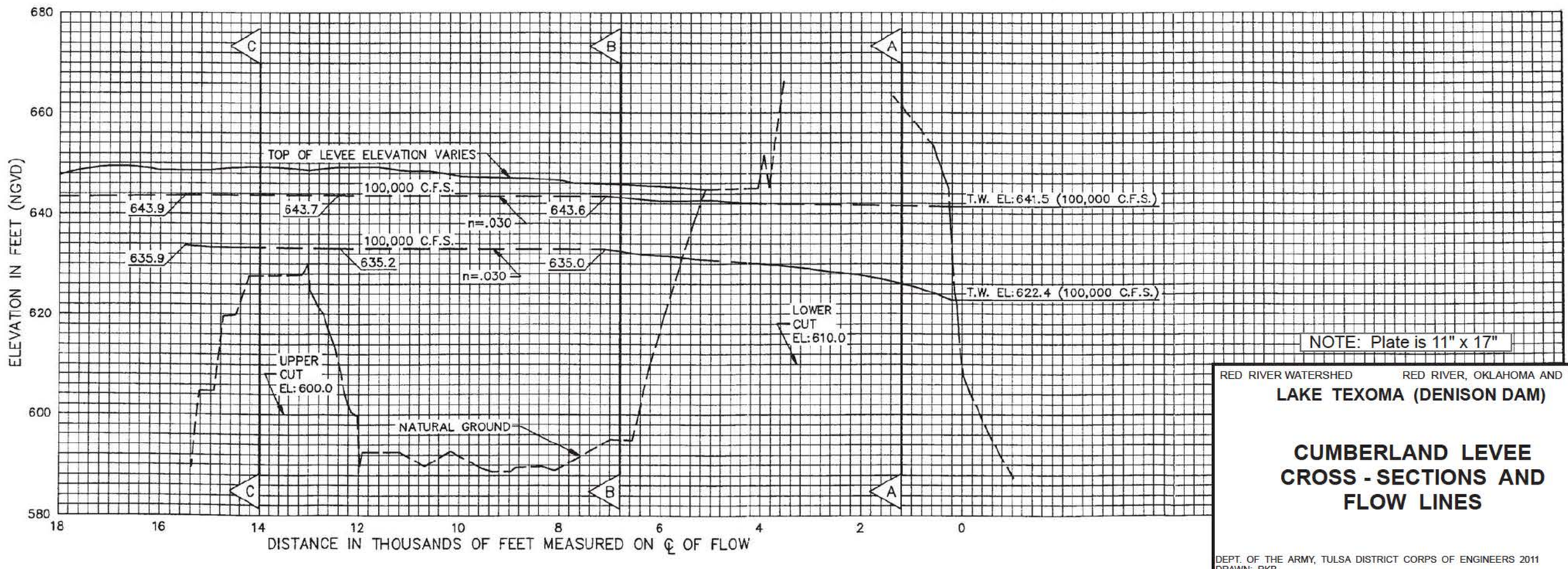

Hugo
Choctaw County
Idabel
Mccurtain County
Paris
Lamar County
Red River County
Clarksville
Little River County
Hempstead County
New Boston
Bowie County
Delta County
Hopkins County
Franklin County
Titus County
Morris County
Cass County
259
70
271
82
71
DR-25
DR-26
DR-27
DR-28
DR-29
DR-30
DR-31
DR-32
DR-33
DR-34
DR-35
DR-36
DR-37
HUGO L
KIAMICHI R
GATES CR
CLEAR CR
LITTLE R
WATERHOLE CR
LUKFATA CR
ROCK CR
POND CR
FLAT CR
BIG PINE CR
PINE CR
PECAN BAYOU
BLANTON CR
MILL CR, W FK
MILL CR
RED R
SALINE R
BULL CR
SCATTER CR
BRUTON CR
YOUNG CR
KICKAPOO CR
CUTHAND CR
BOGGY CR
MUD CR
AUDS CR
HICKORY CR
BIG SANDY CR
LITTLE SANDY CR
WHITEOAK CR
DILLARD CR
N SULPHUR R
LAKE CR
MUSTANG CR
S SULPHUR R
SULPHUR R
ANDERSON CR
BIG CR
CANEY CR
BASSETT CR
WHITE OAK BAYOU
PINEY CR
RIPLEY CR
HORSE CR
HARTS CR
WOLFPEN CR
STOUTS CR
N CANEY R
BIG CR
BOGGY CR
SULPHUR
N
Kansas
Missouri
DEGRADATION RANGES AREA
Oklahoma
Arkansas
Texas
Louisiana
Legend
DR-36
Degradation Range & ID
0 4 8 16 Miles
NOTE: Plate is 11" x 17"
RED RIVER WATERSHED
RED RIVER, OKLAHOMA AND TEXAS
LAKE TEXOMA (DENISON DAM)
DEGRADATION RANGES BELOW ARTHUR CITY
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 2 - 5





NOTE: Plate is 11" x 17"

RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

CUMBERLAND LEVEE CROSS - SECTIONS AND FLOW LINES

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

PLATE 2 - 6

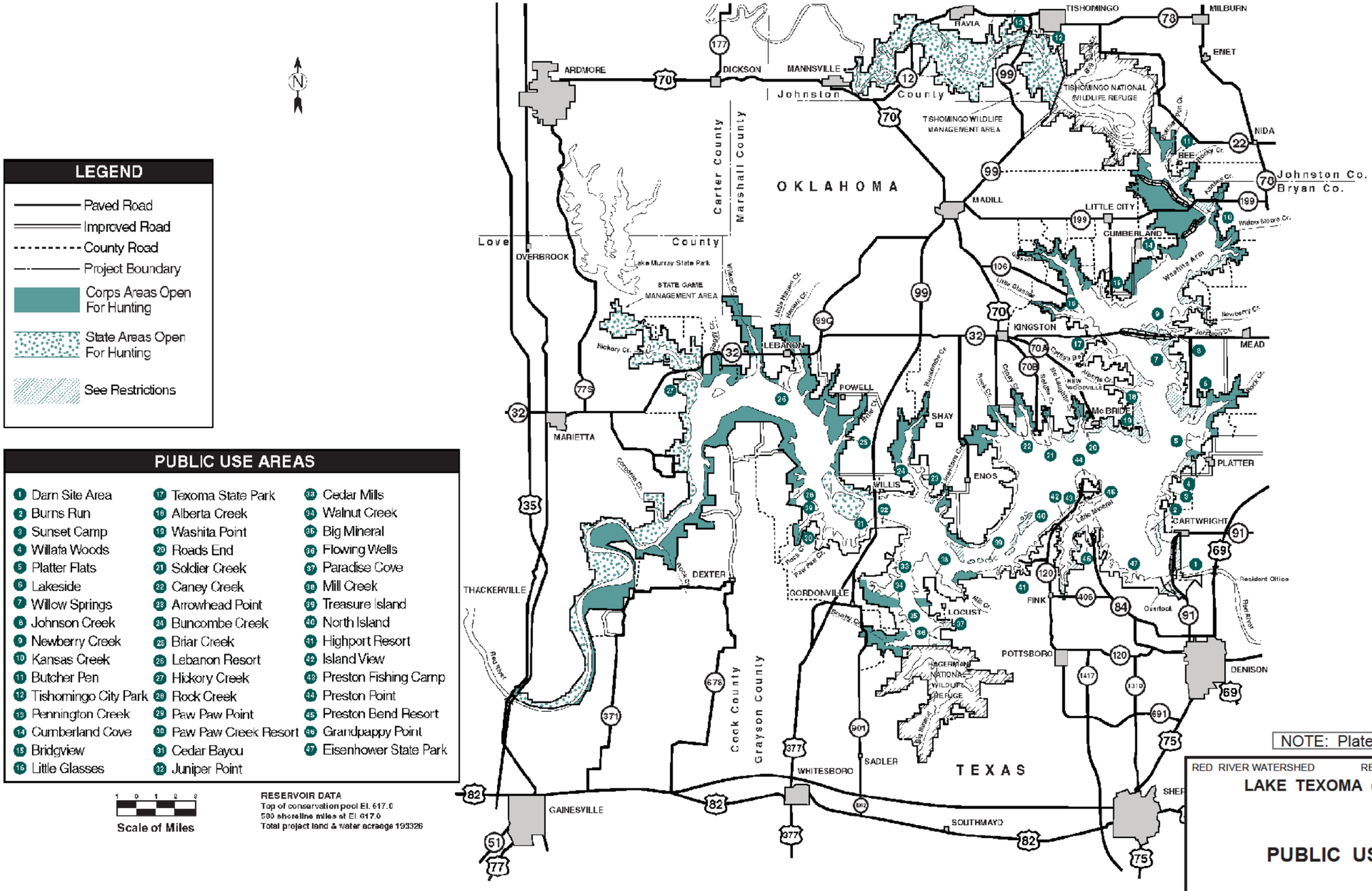
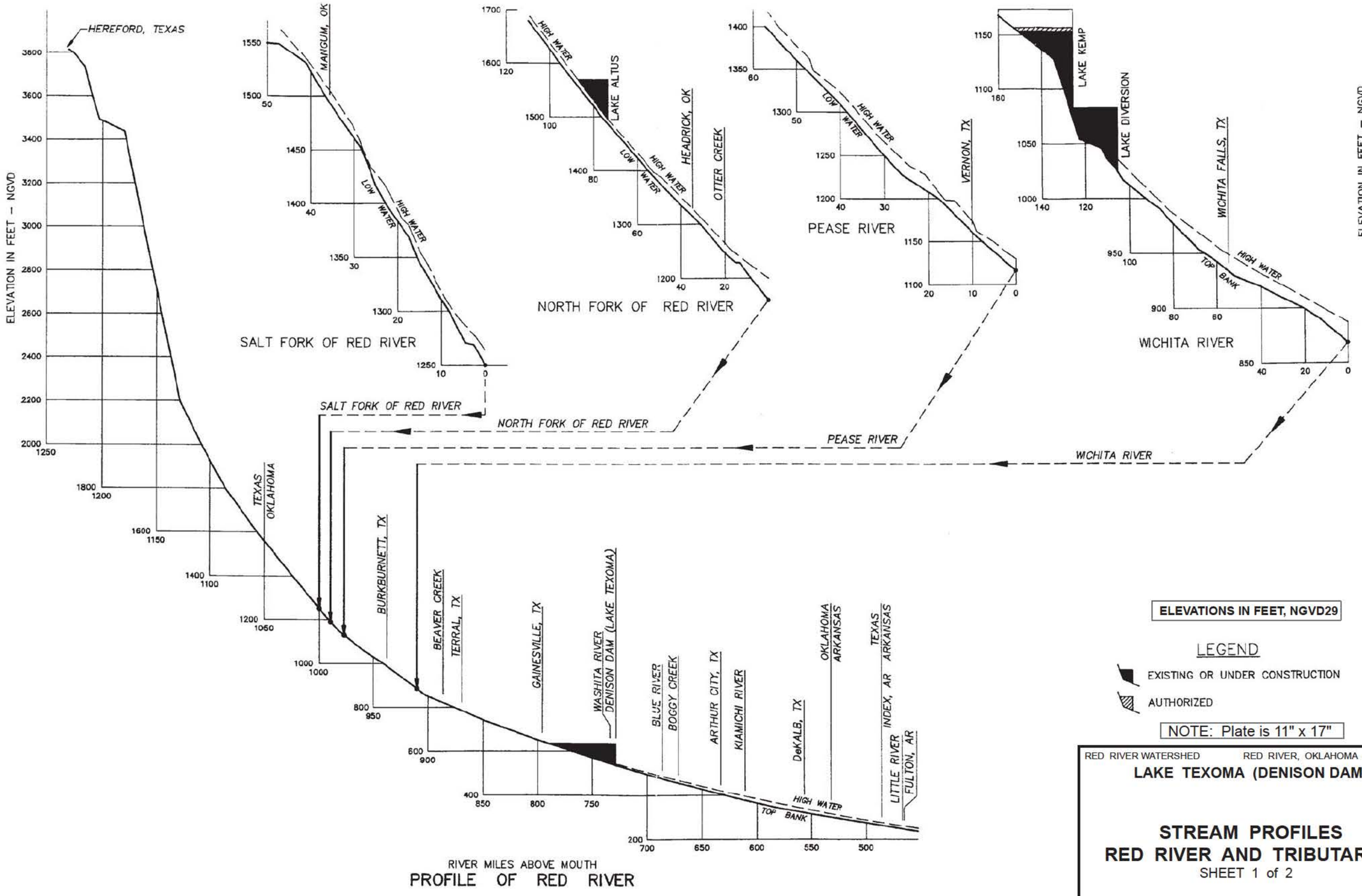

N
LEGEND
Paved Road
Improved Road
County Road
Project Boundary
Corps Areas Open For Hunting
State Areas Open For Hunting
See Restrictions
PUBLIC USE AREAS
1 Dam Site Area
2 Burns Run
3 Sunset Camp
4 Willafa Woods
5 Platter Flats
6 Lakeside
7 Willow Springs
8 Johnson Creek
9 Newberry Creek
10 Kansas Creek
11 Butcher Pen
12 Tishomingo City Park
13 Pennington Creek
14 Cumberland Cove
15 Bridgview
16 Little Glasses
17 Texoma State Park
18 Alberta Creek
19 Washita Point
20 Roads End
21 Soldier Creek
22 Caney Creek
23 Arrowhead Point
24 Buncombe Creek
25 Briar Creek
26 Lebanon Resort
27 Hickory Creek
28 Rock Creek
29 Paw Paw Point
30 Paw Paw Creek Resort
31 Cedar Bayou
32 Juniper Point
33 Cedar Mills
34 Walnut Creek
35 Big Mineral
36 Flowing Wells
37 Paradise Cove
38 Mill Creek
39 Treasure Island
40 North Island
41 Highport Resort
42 Island View
43 Preston Fishing Camp
44 Preston Point
45 Preston Bend Resort
46 Grandpappy Point
47 Eisenhower State Park
1 0 1 2 3
Scale of Miles
RESERVOIR DATA
Top of conservation pool El. 617.0
580 shoreline miles at El. 617.0
Total project land & water acreage 193326
ARDMORE
DICKSON
MANNSVILLE
Johnston County
TISHOMINGO
RAVIA
MILBURN
ENET
TISHOMINGO NATIONAL WILDLIFE REFUGE
TISHOMINGO WILDLIFE MANAGEMENT AREA
NIDA
BEE
Johnston Co.
Bryan Co.
Carter County
Marshall County
OKLAHOMA
MADILL
LITTLE CITY
CUMBERLAND
Love County
OVERBROOK
Lake Murray State Park
STATE GAME MANAGEMENT AREA
KINGSTON
MEAD
LEBANON
POWELL
SHAY
NEW WOODVILLE
McBRIDE
MARIETTA
PLATTER
WILLIS
ENOS
CARTWRIGHT
DEXTER
THACKERVILLE
GORDONVILLE
LOCUST
FINK
Resident Office
Overlook
POTTSBORO
DENISON
Cook County
Grayson County
GERMAN NATIONAL WILDLIFE REFUGE
WHITESBORO
SADLER
TEXAS
GAINESVILLE
SOUTHMAYD
NOTE: Plate is 11" x 17"
RED RIVER WATERSHED
RED RIVER, OKLAHOMA AND TEXAS
LAKE TEXOMA (DENISON DAM)
PUBLIC USE AREAS
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 2 - 7



ELEVATIONS IN FEET, NGVD29

LEGEND

EXISTING OR UNDER CONSTRUCTION

AUTHORIZED

NOTE: Plate is 11" x 17"

RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

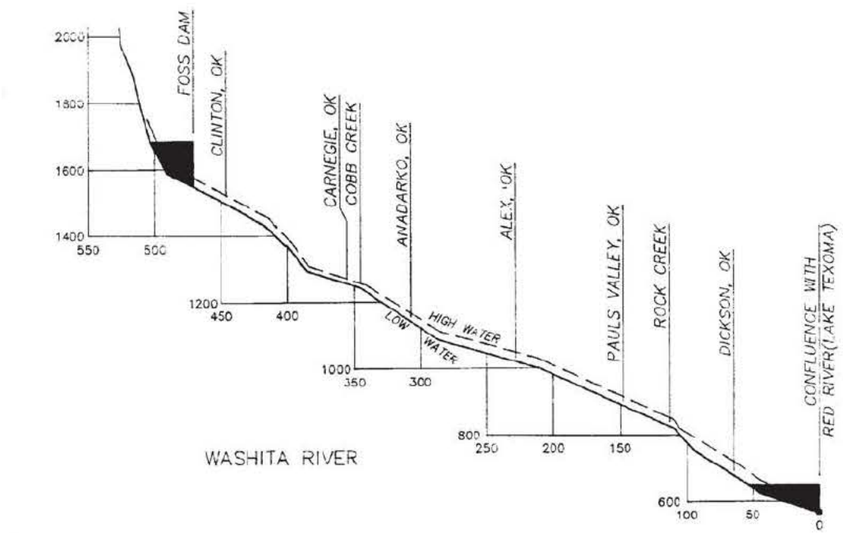
LAKE TEXOMA (DENISON DAM)

STREAM PROFILES
RED RIVER AND TRIBUTARIES

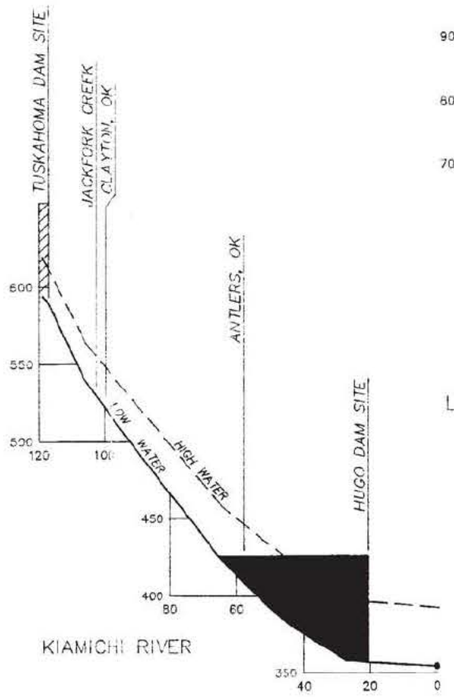
SHEET 1 of 2

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

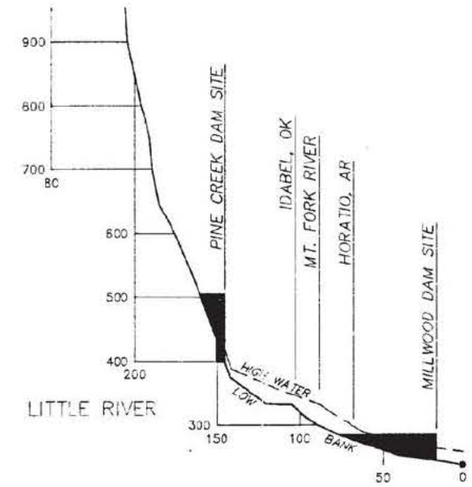
PLATE 4 - 1



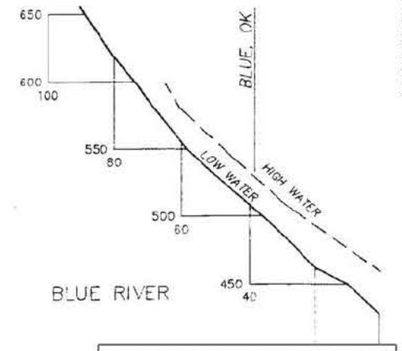
WASHITA RIVER



KIAMICHI RIVER



LITTLE RIVER



BLUE RIVER

ELEVATION IN FEET – NGVD

ELEVATION IN FEET – NGVD

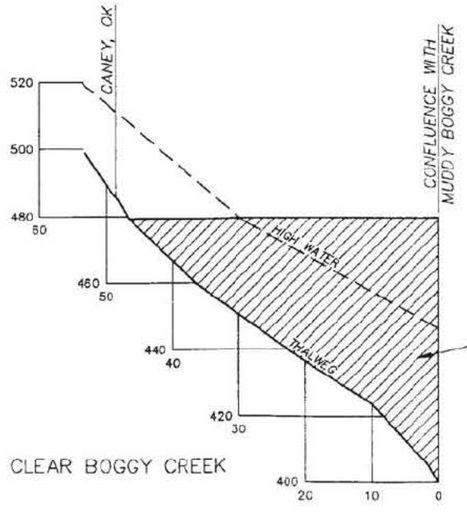
ELEVATIONS IN FEET, NGVD29

LEGEND

EXISTING OR UNDER CONSTRUCTION

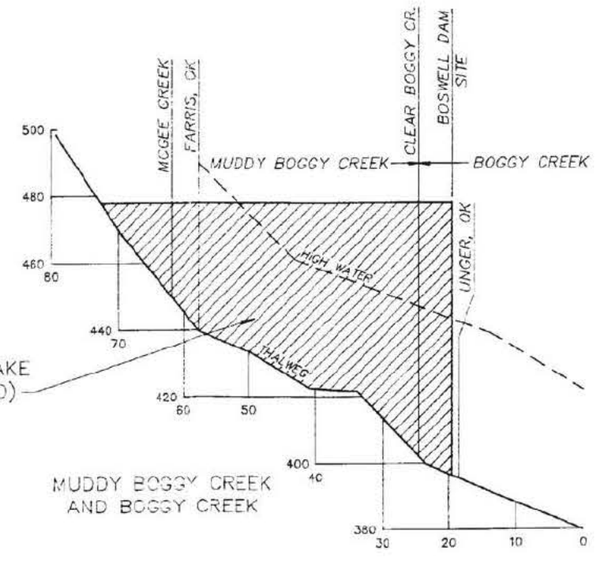
AUTHORIZED

NOTE: Plate is 11" x 17"



CLEAR BOGGY CREEK

BOSWELL LAKE (PROPOSED)



MUDDY BOGGY CREEK AND BOGGY CREEK

RIVER MILES ABOVE MOUTH

RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

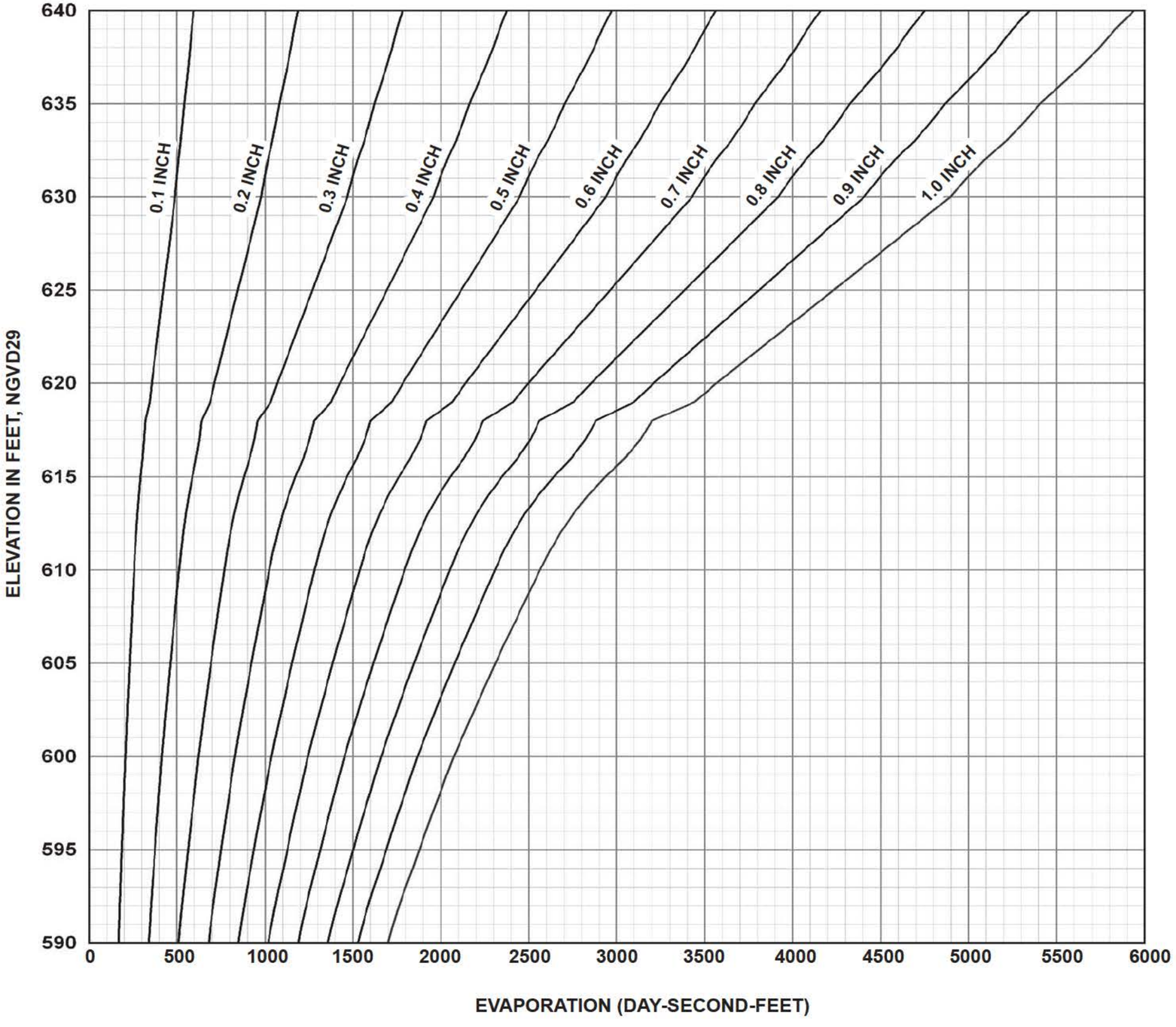
LAKE TEXOMA (DENISON DAM)

STREAM PROFILES
RED RIVER AND TRIBUTARIES

SHEET 2 of 2

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

PLATE 4 - 2



NOTES:

NOTATION AT LEFT OF EACH CURVE DENOTES CALCULATED LAKE EVAPORATION.

CUMBERLAND POOL INCLUDED ONLY FOR ELEVATIONS ABOVE 619.0 FEET, NGVD29

NOTE: Plate is 11" x 17"

RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

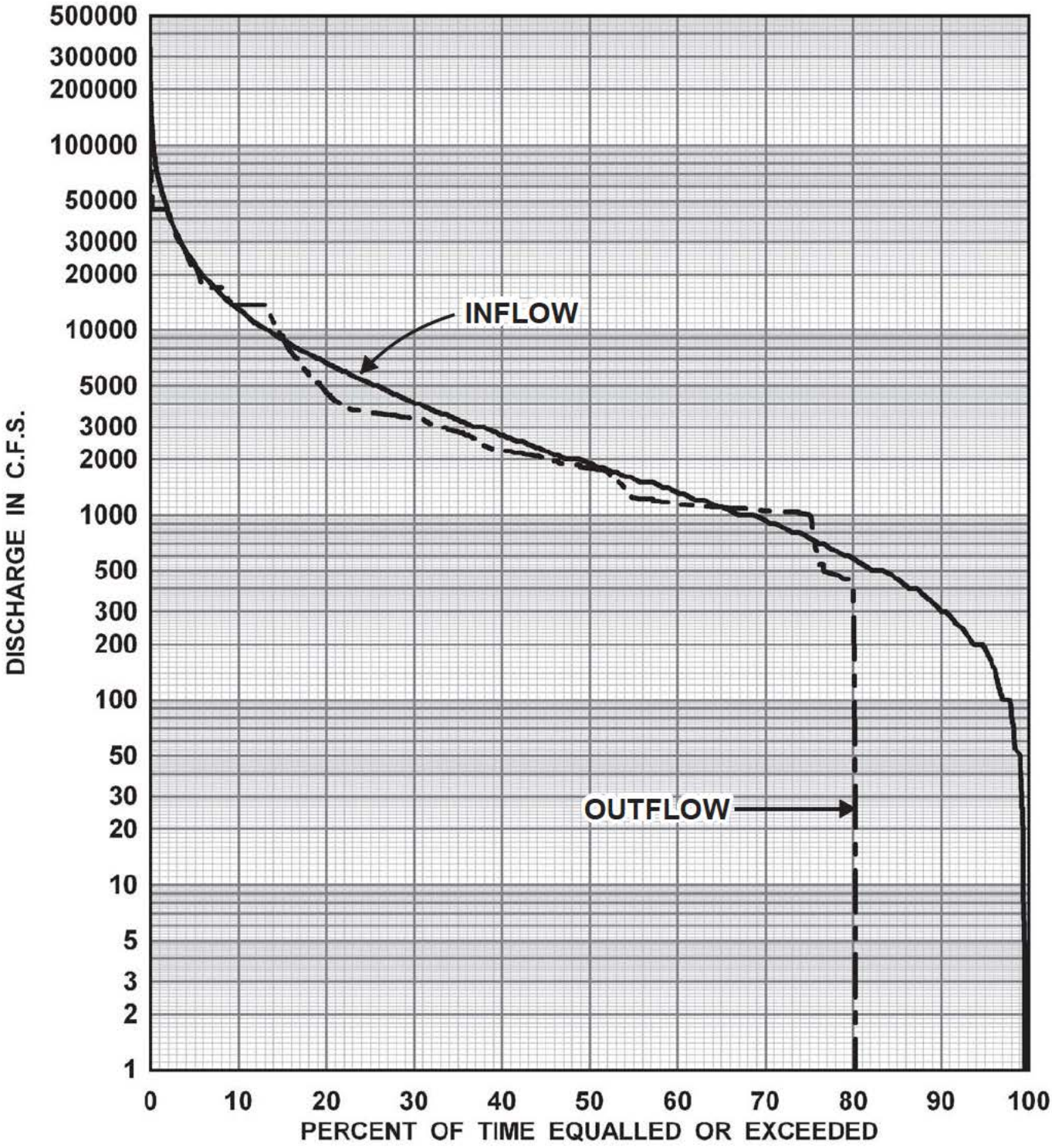
LAKE TEXOMA (DENISON DAM)

LAKE EVAPORATION CURVES

BASED ON 2002 SURVEY

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

PLATE 4 - 3



NOTE:

BASED ON PERIOD OF RECORD
JAN 1938 THRU DEC 2007 AND
FROM RIVERWARE RUN REDCOE_602 BaseModel ManualData.mdl

ESTIMATED YIELD OF 250 M.G.D.
USED IN MODEL RUN

RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

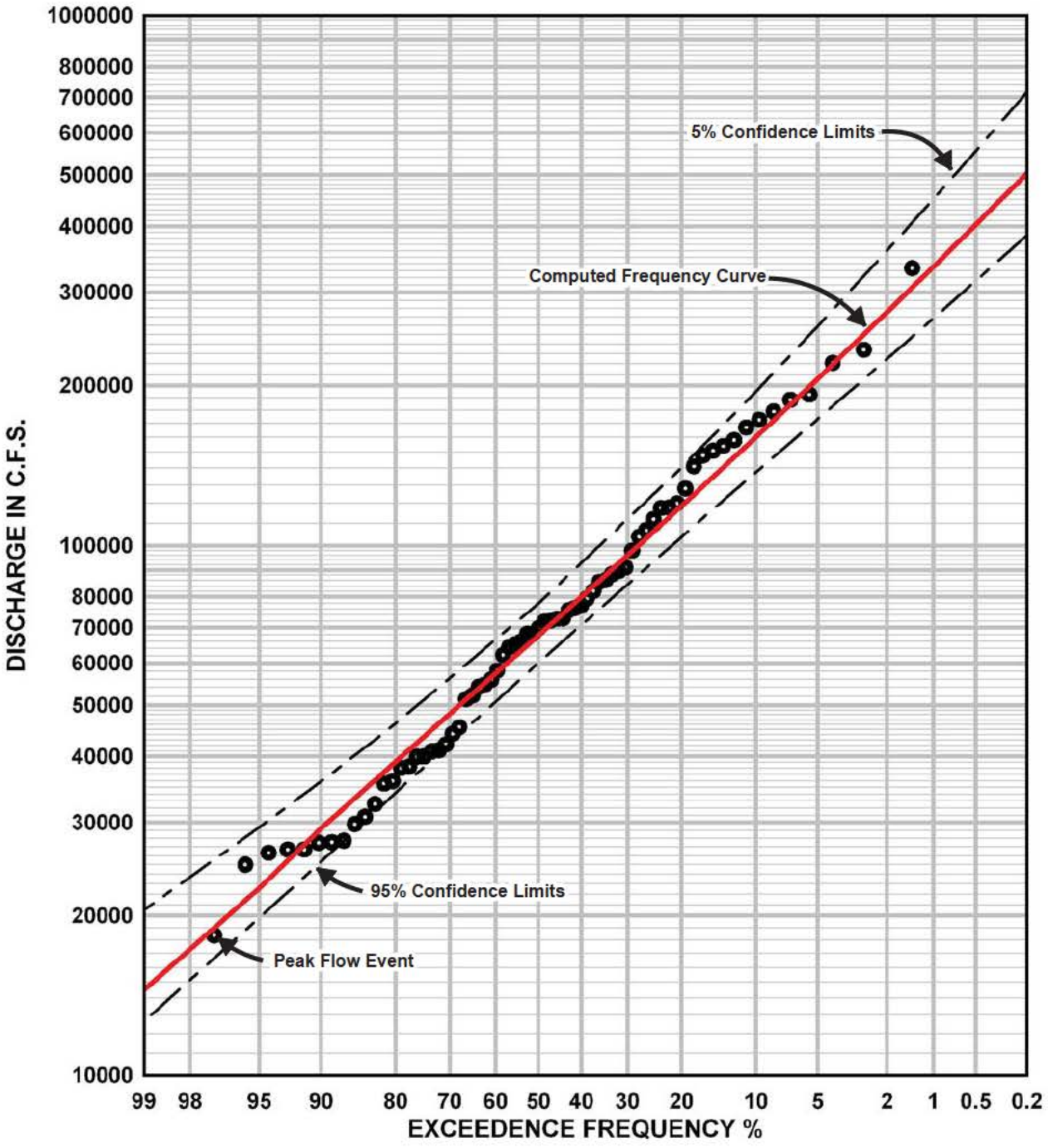
LAKE TEXOMA (DENISON DAM)

FLOW DURATION CURVES

INFLOW AND OUTFLOW

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

PLATE 4 - 4



CUMULATIVE FREQUENCY CURVE OF ANNUAL PEAK INFLOWS

NOTE:

1. **BASED ON PERIOD OF RECORD JAN. 1938 THRU DEC. 2007**
2. **HEC Statistical Software Package (HEC-SSP) was used**
3. **A GENERALIZED SKEW OF 0.0 AND A MEAN SQUARE ERROR OF 0.325 WAS USED**

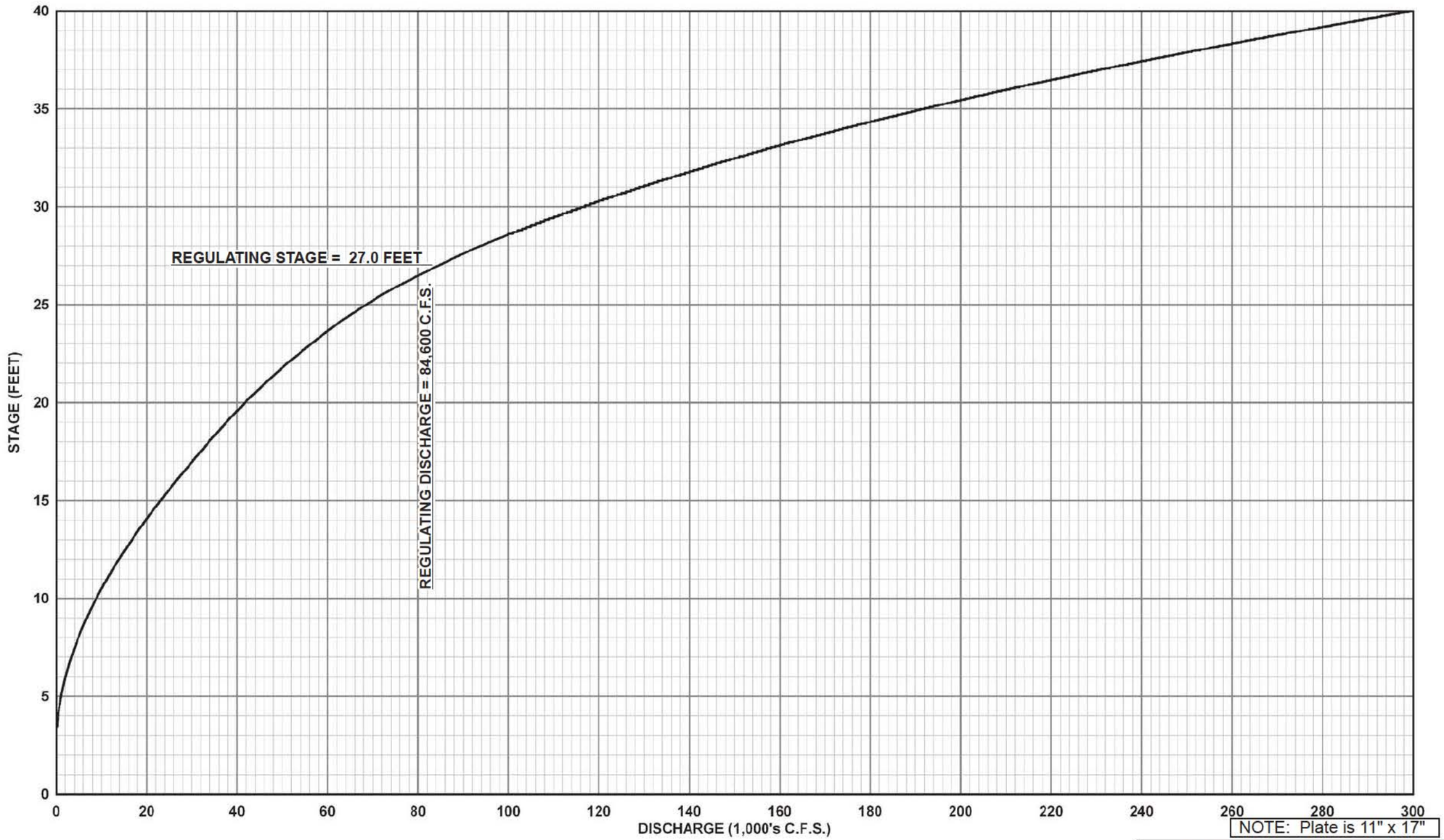
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

PEAK INFLOW PROBABLITY CURVE

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

PLATE 4 - 5



NOTE: Plate is 11" x 17"

NOTE:

THE CORP PERIODICALLY APPLIES SHIFTS TO RATING CURVES TO MORE CLOSELY MATCH MEASURED VALUES.

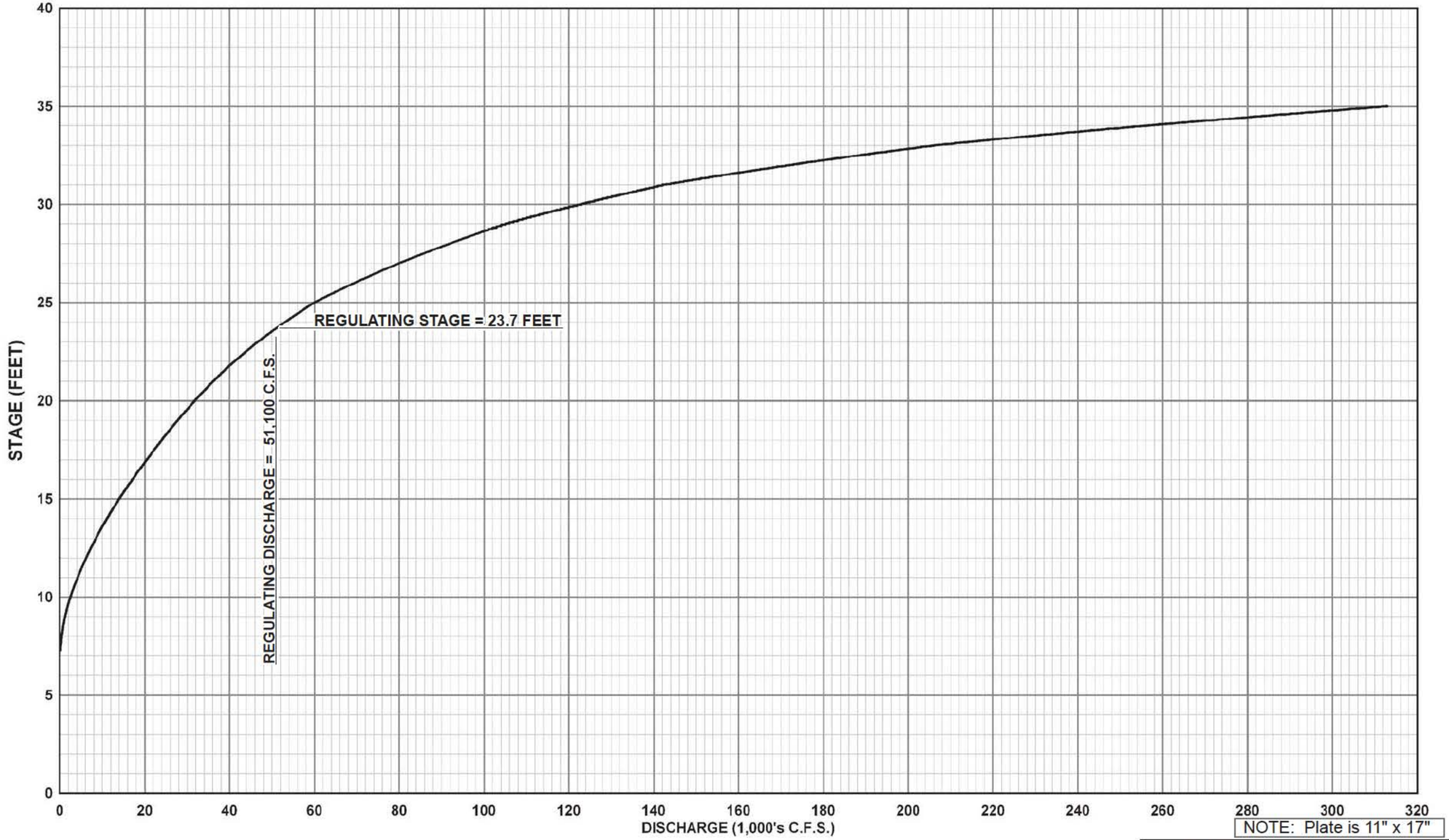
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

DISCHARGE RATING CURVE ARTHUR CITY, TEXAS

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

PLATE 4 - 6



NOTE: Plate is 11" x 17"

NOTE:

THE CORP PERIODICALLY APPLIES SHIFTS TO RATING CURVES TO MORE CLOSELY MATCH MEASURED VALUES.

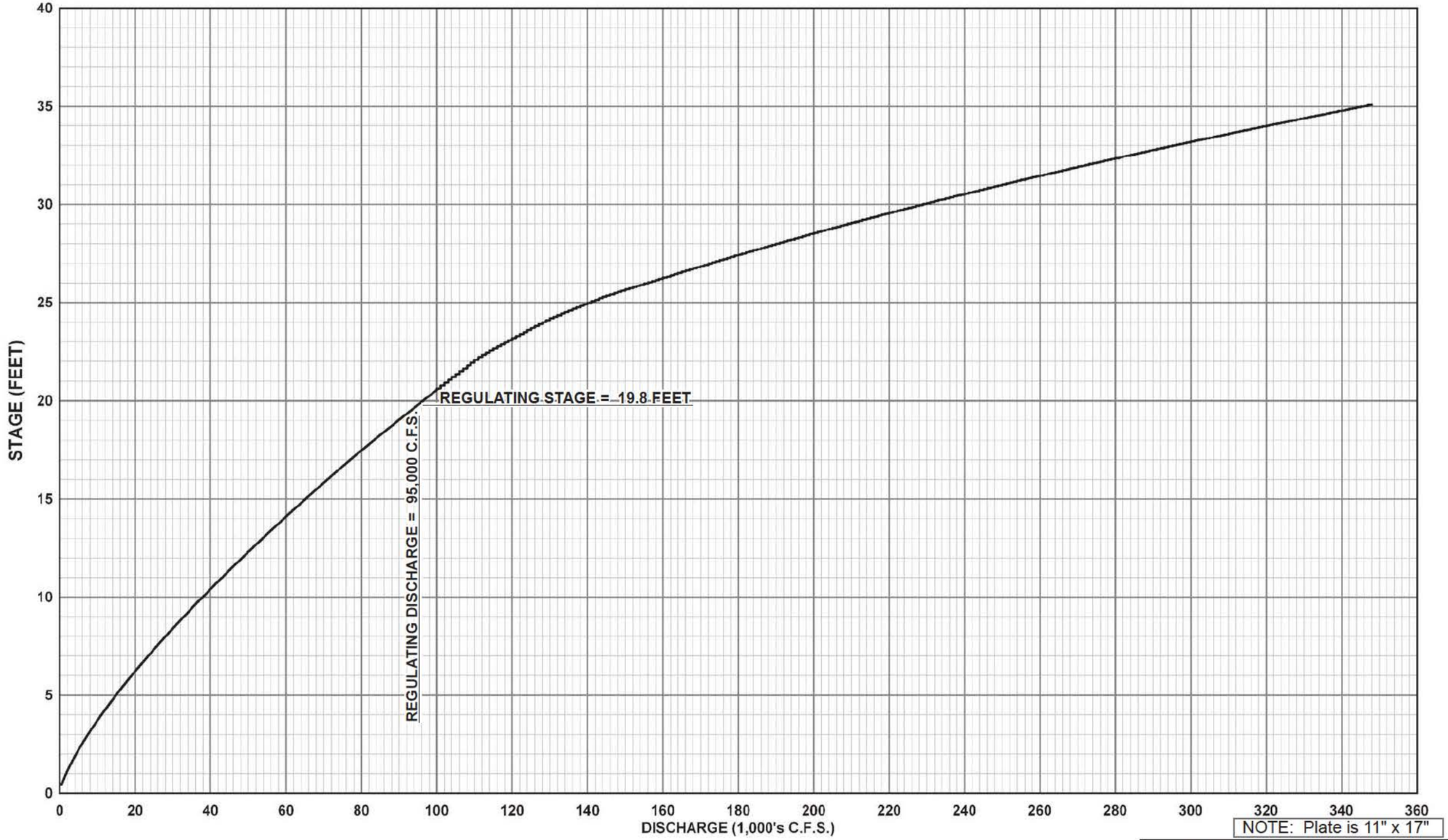
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

DISCHARGE RATING CURVE
De KALB, TEXAS

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

PLATE 4 - 7



NOTE: Plate is 11" x 17"

NOTE:

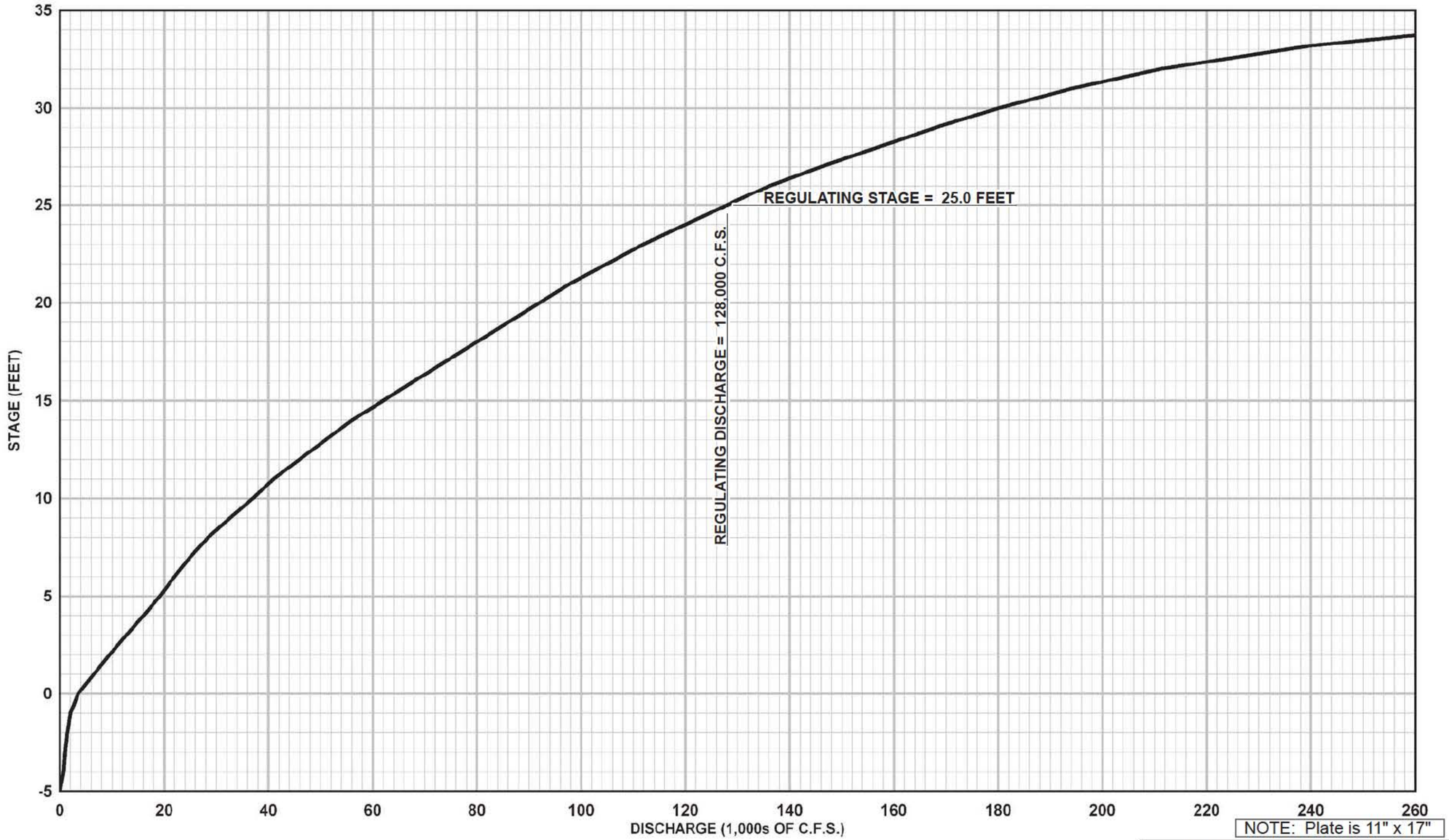
THE CORP PERIODICALLY APPLIES SHIFTS TO RATING CURVES TO MORE CLOSELY MATCH MEASURED VALUES.

RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

DISCHARGE RATING CURVE INDEX, ARKANSAS

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



NOTE: Plate is 11" x 17"

RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

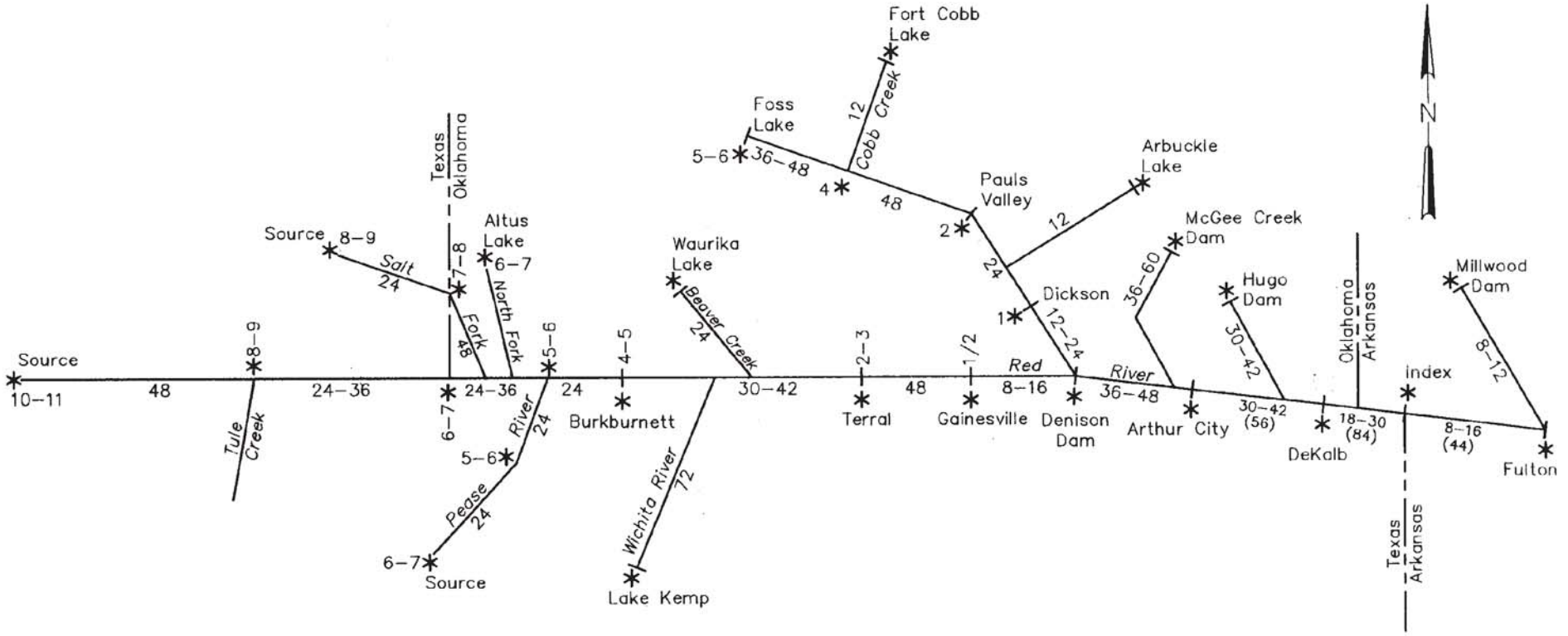
DISCHARGE RATING CURVE
FULTON, ARKANSAS

NOTE:

THE CORP PERIODICALLY APPLIES SHIFTS TO RATING CURVES TO MORE CLOSELY MATCH MEASURED VALUES.

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

PLATE 4 - 9



NOTES:
TIME OF TRAVEL IN HOURS FOR LARGE RISES IS SHOWN BETWEEN ASTERISKS, i.e. *24*

APPROXIMATE TIME IN DAYS FOR RUNOFF TO REACH LAKE TEXOMA IS SHOWN ADJACENT TO ASTERISKS *5 - *6

TIME OF CREST TRAVEL DURING OUT OF BANKS FLOW EXPERIENCED IN 1990 FROM ARTHUR CITY TO FULTON IS SHOWN IN PARENTHESES BELOW THE EXPECTED TIMES.

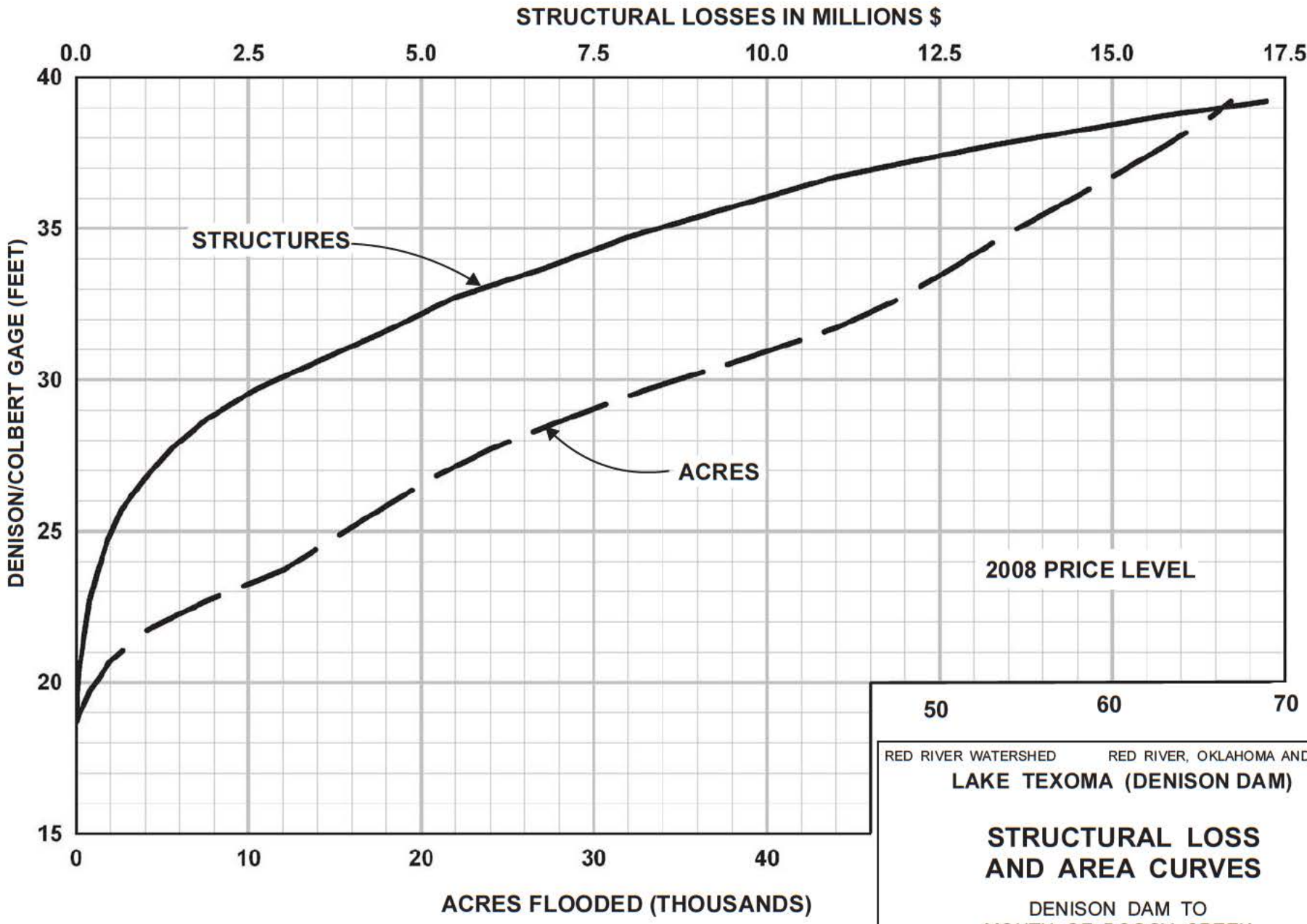
RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

TIME OF CREST TRAVEL

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

PLATE 4 - 10



RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

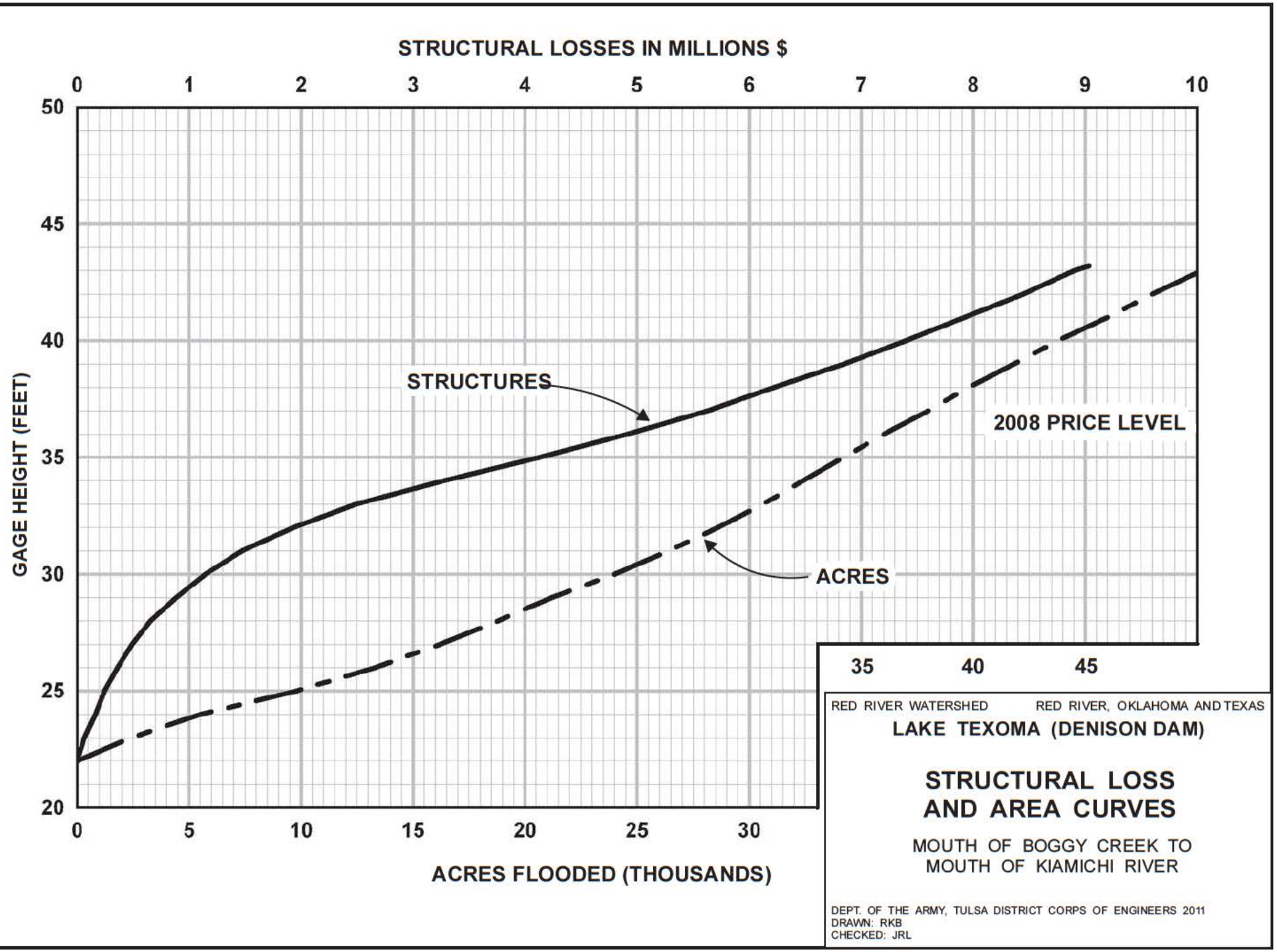
LAKE TEXOMA (DENISON DAM)

STRUCTURAL LOSS AND AREA CURVES

DENISON DAM TO
MOUTH OF BOGGY CREEK

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

PLATE 4 - 11



RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

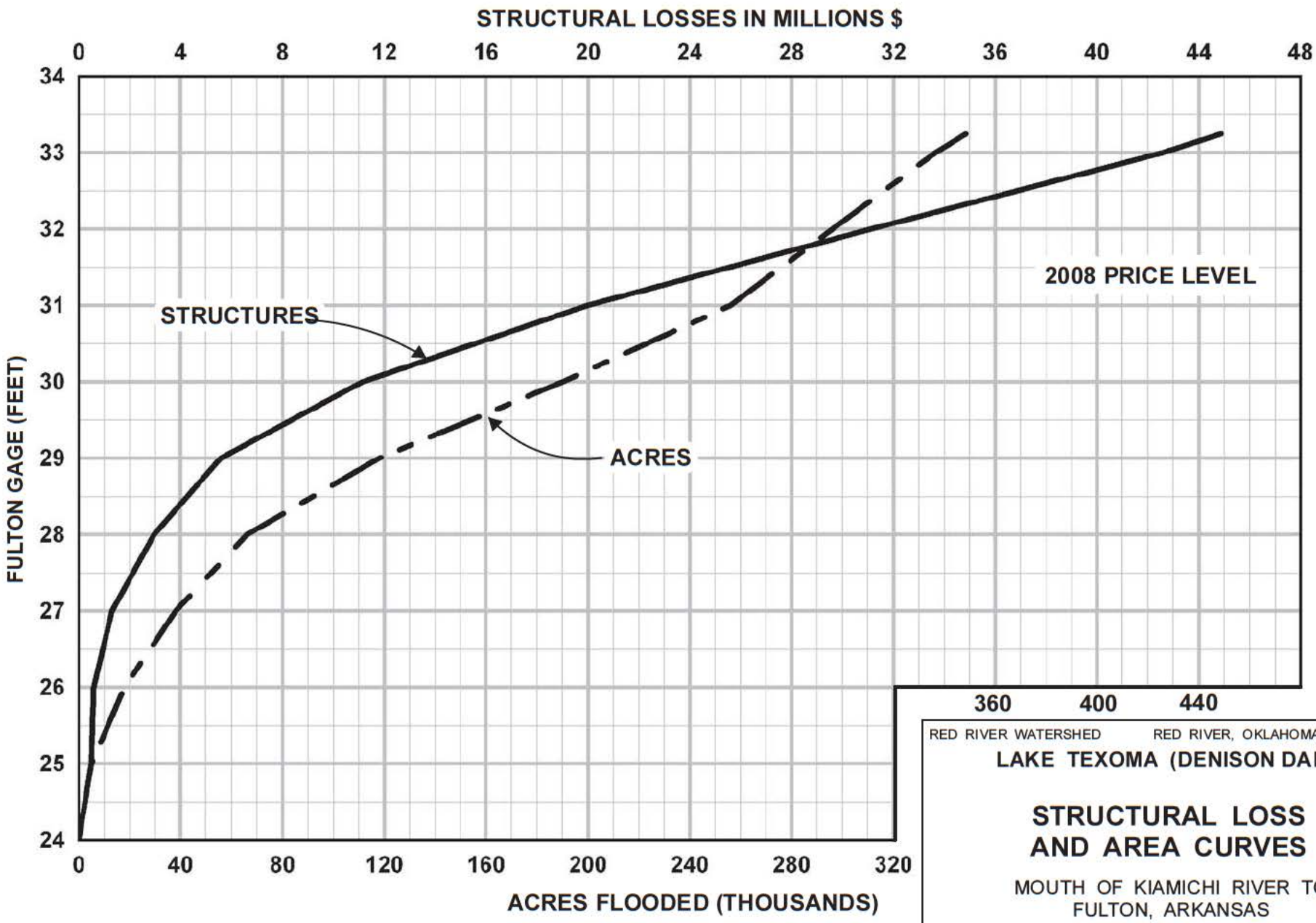
LAKE TEXOMA (DENISON DAM)

STRUCTURAL LOSS AND AREA CURVES

MOUTH OF BOGGY CREEK TO MOUTH OF KIAMICHI RIVER

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

PLATE 4 - 12



RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

STRUCTURAL LOSS AND AREA CURVES

MOUTH OF KIAMICHI RIVER TO FULTON, ARKANSAS

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

PLATE 4 - 13

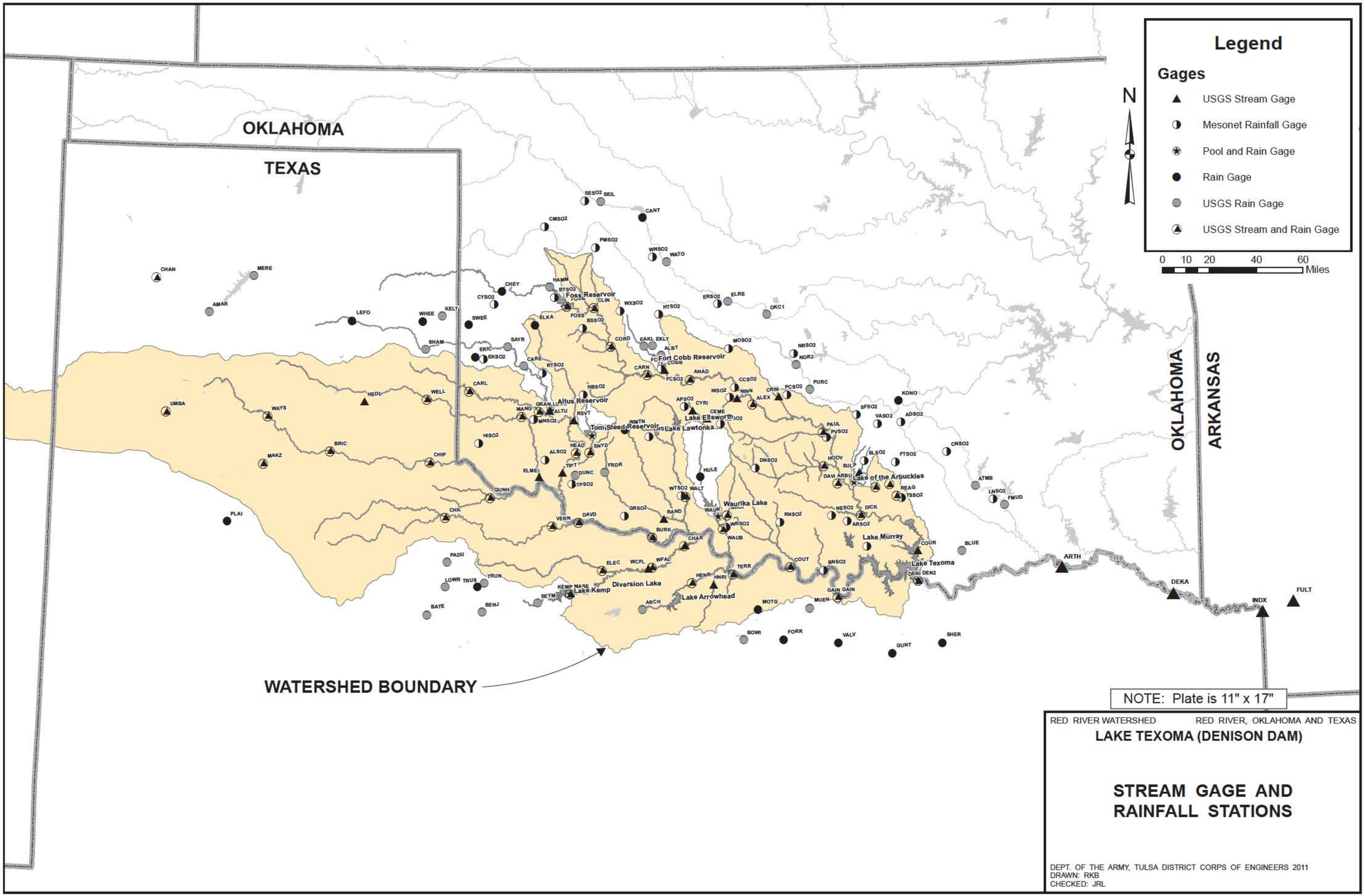
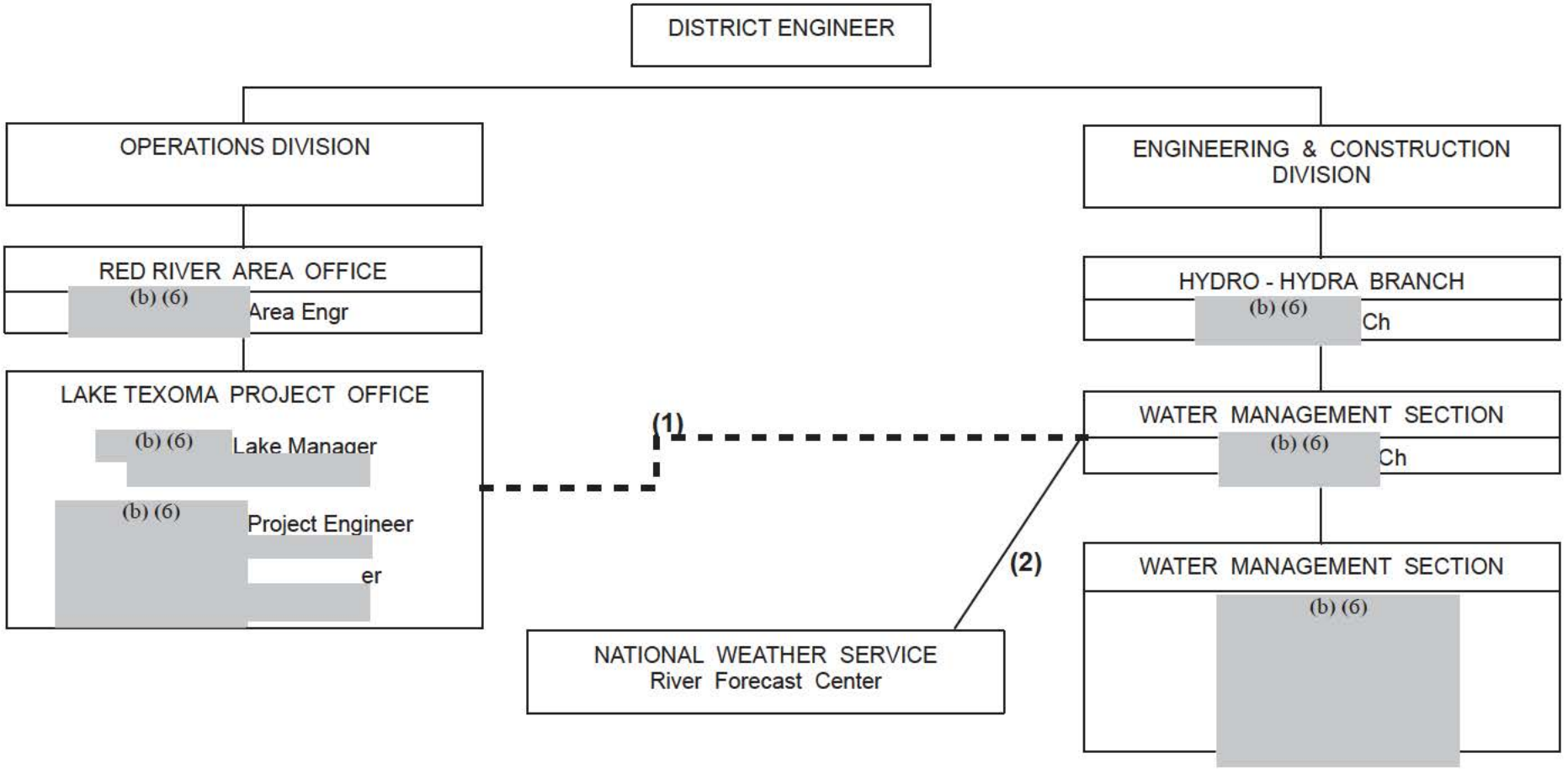

Legend
Gages
USGS Stream Gage
Mesonet Rainfall Gage
Pool and Rain Gage
Rain Gage
USGS Rain Gage
USGS Stream and Rain Gage
N
0 10 20 40 60
Miles
OKLAHOMA
TEXAS
OKLAHOMA
ARKANSAS
Foss Reservoir
Fort Cobb Reservoir
Altus Reservoir
Tom Steed Reservoir
Lake Ellsworth
Lake Lawtonka
Lake of the Arbuckles
Waurika Lake
Lake Murray
Lake Texoma
Diversion Lake
Lake Kemp
Lake Arrowhead
WATERSHED BOUNDARY
NOTE: Plate is 11" x 17"
RED RIVER WATERSHED
RED RIVER, OKLAHOMA AND TEXAS
LAKE TEXOMA (DENISON DAM)
STREAM GAGE AND
RAINFALL STATIONS
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 5 - 1

U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT



1. DIRECT COMMUNICATIONS ARE MAINTAINED BETWEEN LAKE TEXOMA 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.

RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

ORGANIZATION FOR FLOOD CONTROL REGULATION

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

PLATE 5 - 2

LAKE DATA

_____ 19___

LINE NUMBER	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 AVE POWER DISCHARGE	12M									
7	24 HR AVE 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	LAKE CONDITIONS	8AM									
13	WEATHER COND.	8AM									
14	TOTAL PRECEDING 6 HOUR PRECIPITATION ENDING AT	1PM 7PM 1AM 7AM									
15	TOTAL 24 HOUR PRECIPITATION	7AM									
16	COMMENTS ON PRECIP. DIST.										
17	EVAPORATION 24 HOURS	8AM									
18	WIND DIRECTION	8AM									
19	WIND VELOCITY	8AM									
20	WATER SUPPLY										
21	GATE SETTINGS NO, TYPE, 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	RIVER STAGE- LOW FLOW WEIR										

SWT FORM 813
REVISED JAN 1985

REPLACES EDITION
OF APR 1983

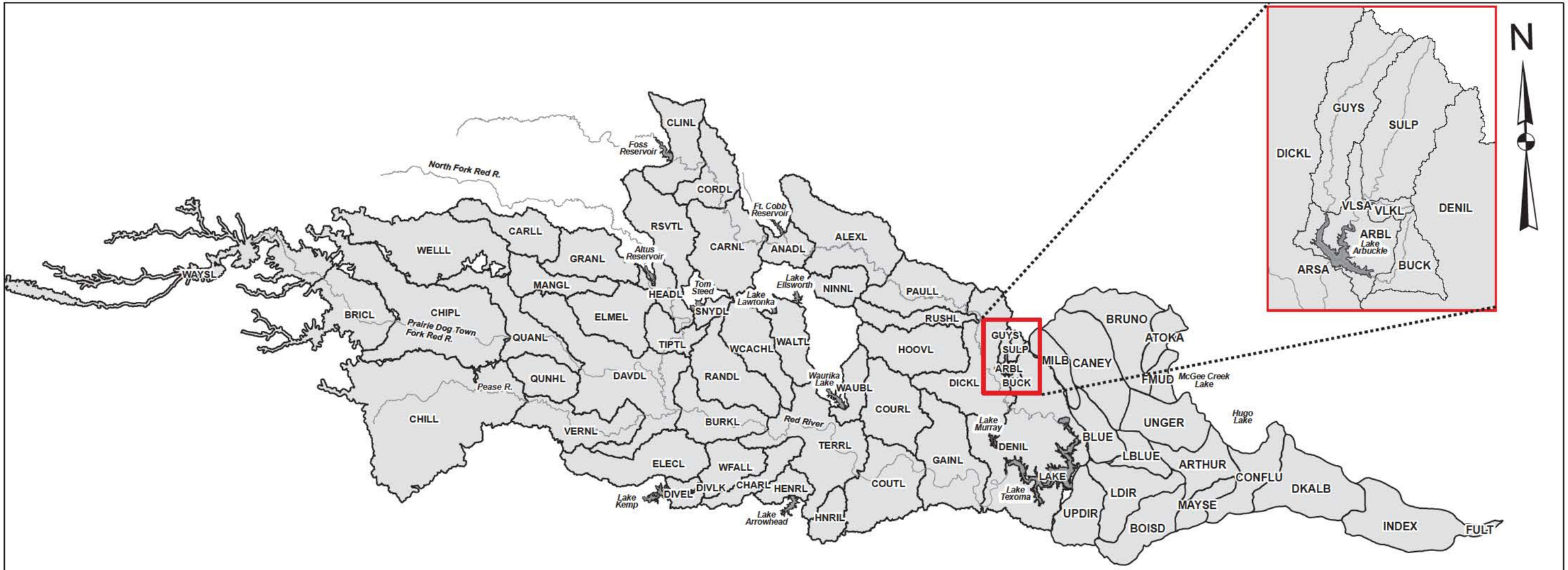
PROPONENT SWTED-HR

RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

LAKE DATA

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



Subbasins Upstream of Denison Dam

TIPTL	RUSHL	COURL
ANADL	ELMEL	TERRL
CARNL	PAULL	CHILL
MANGL	DICKL	CHIPL
ALEXL	QUANL	WELLL
WALTL	HOOVL	ELECL
CARLL	DAVDL	COUTL
CLINL	HNRIL	CHARL
CORDL	WFALL	GAINL
GRANL	WAYSL	DIVEL
RSVTL	BRICL	SULP
HEADL	BURKL	BUCK
LAKE	WCACHL	ARBL
DENIL	NINNL	GUYS
SNYDL	RANDL	VLKL
VERNL	WAUBL	VLSA
HENRL	QUNHL	ARSA
DIVLK		

Subbasins Downstream of Denison Dam

FULT
LBLUE
BOISD
MAYSE
FMUD
CONFLU
DKALB
INDEX
ATOKA
ARTHUR
UNGER
CANEY
BRUNO
BLUE
MILB
LDIR
UPDIR

0 25 50 100 Miles

NOTE: Plate is 11" x 17"

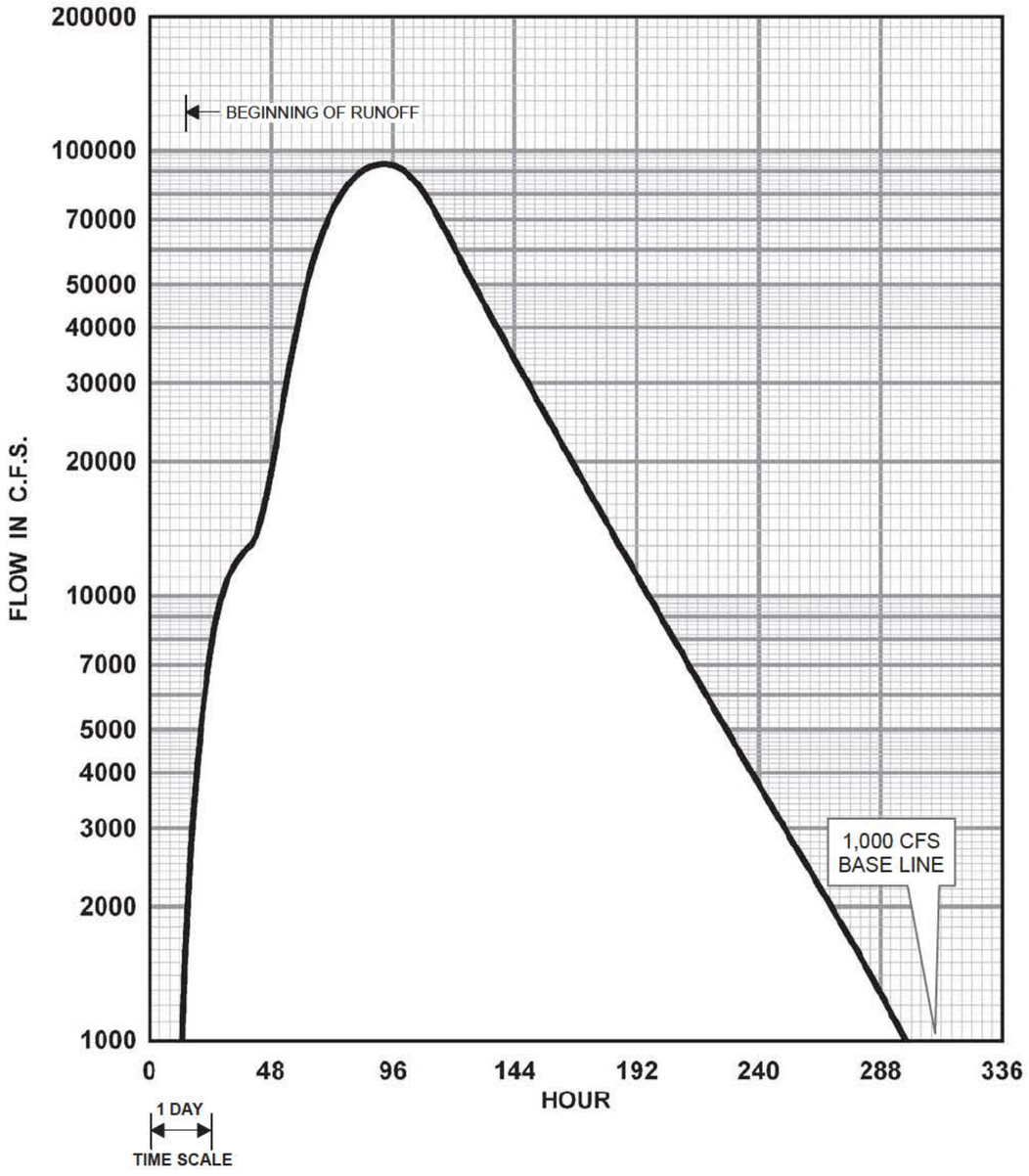
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

FORECAST REACHES

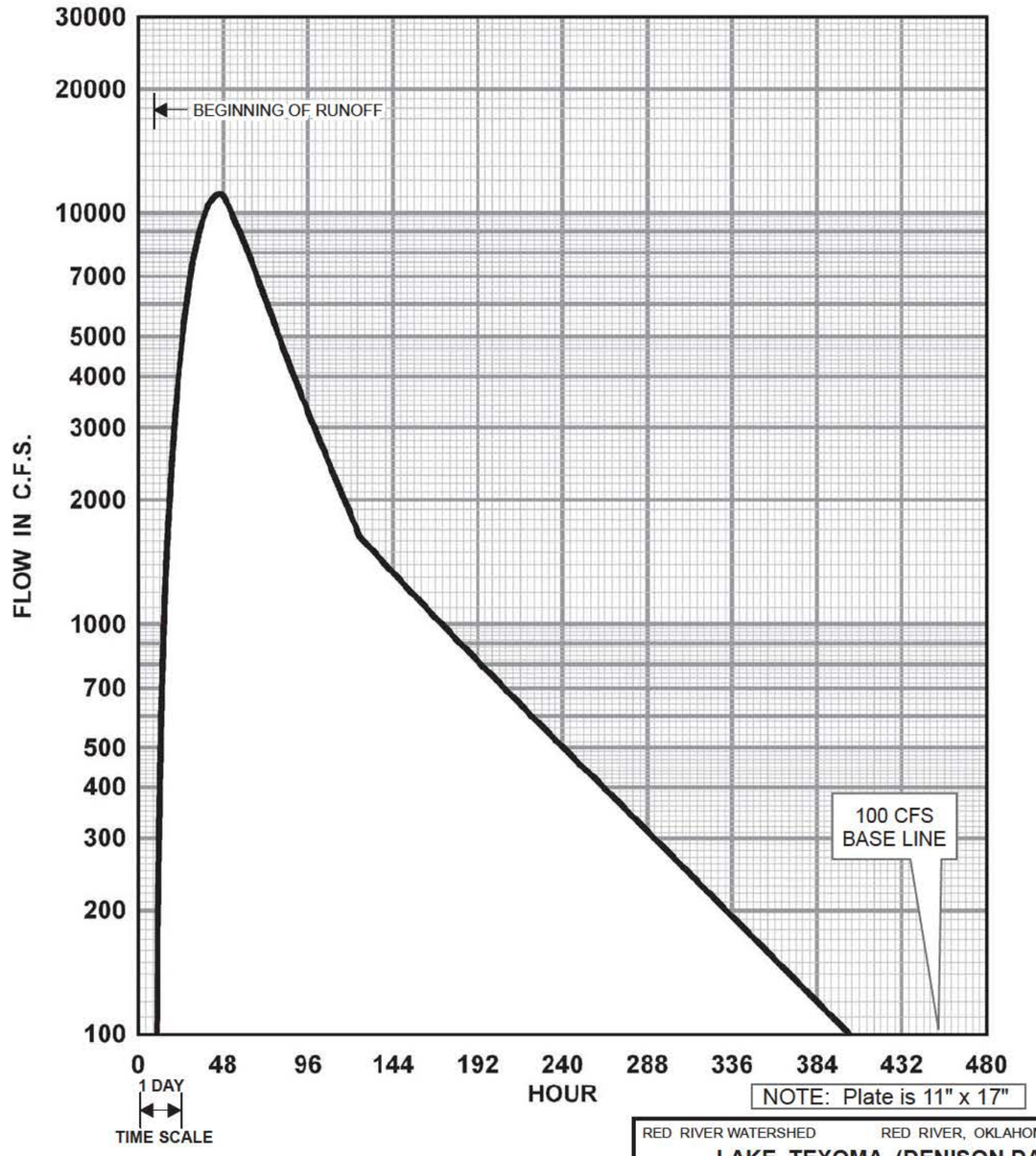
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 6 - 1



Burkburnett Gage
on Red River -

Drainage Area = 14,634 Sq. Mi.
1" Runoff = 780,480 Ac-Ft
Peak Flow = 93,300 c.f.s.



Wichita Falls Gage
on Wichita River -

Drainage Area = 1,054 Sq. Mi.
1" Runoff = 56,213 Ac-Ft
Peak Flow = 11,150 c.f.s.

NOTE: Plate is 11" x 17"

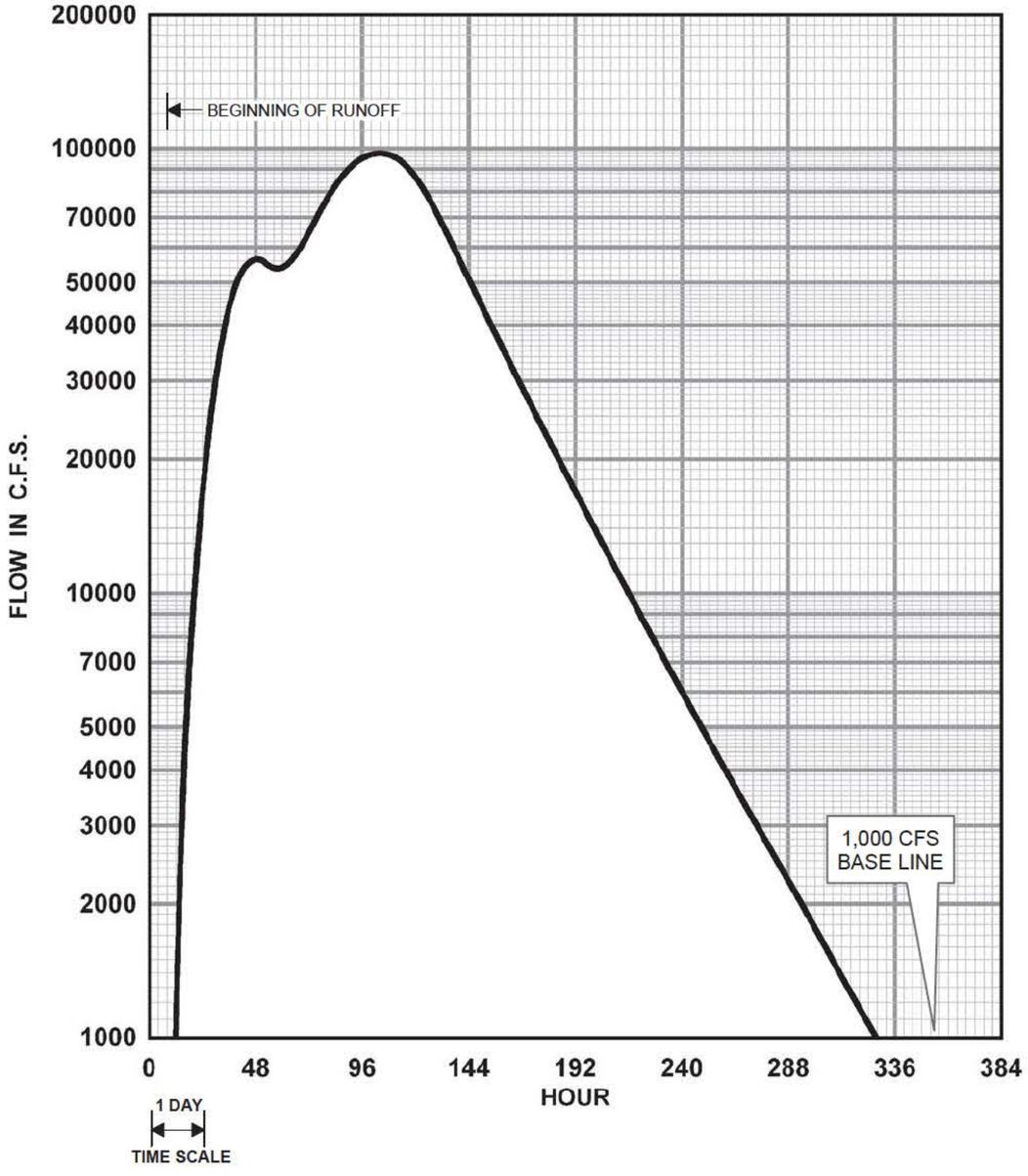
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

UNIT HYDROGRAPHS FOR TOTAL AREAS ABOVE

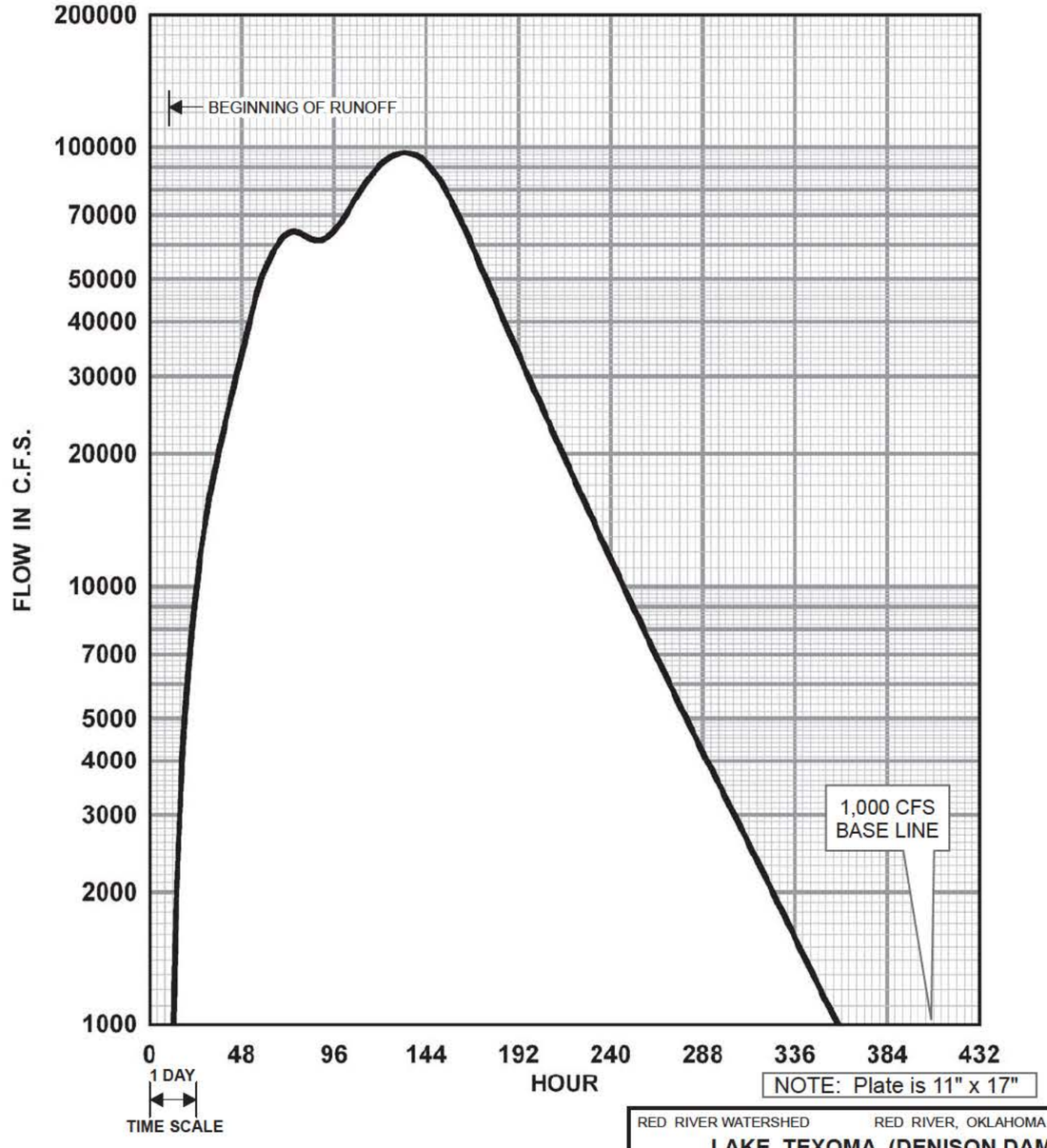
BURKBURNETT AND WICHITA FALLS, TX

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



Terral Gage -

Drainage Area = 22,787Sq. Mi.
1" Runoff = 1,215,307 Ac-Ft
Peak Flow = 97,630c.f.s.



Gainesville Gage -

Drainage Area = 24,846 Sq. Mi.
1" Runoff = 1,325,120 Ac-Ft
Peak Flow = 97,140 c.f.s.

NOTE: Plate is 11" x 17"

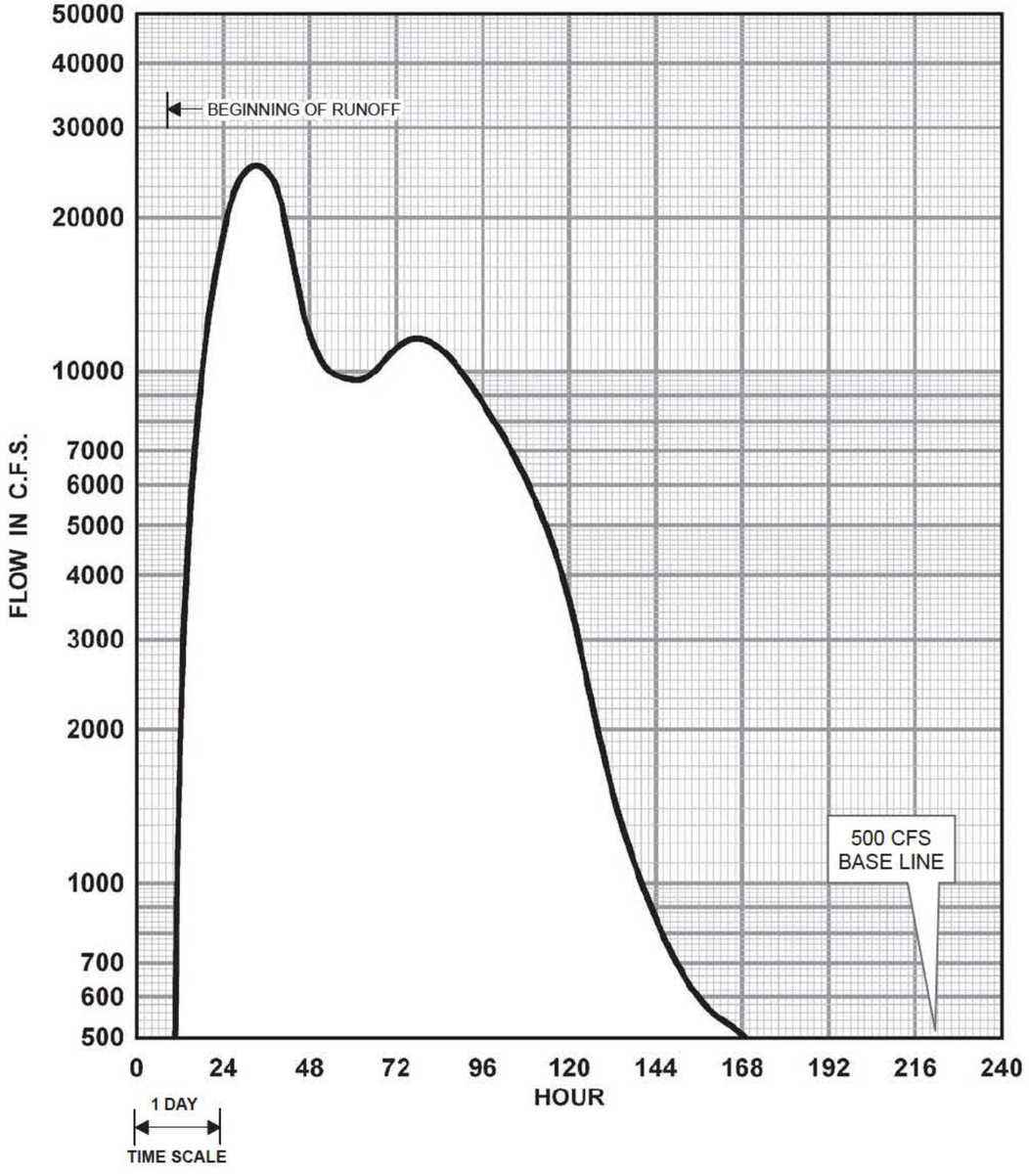
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

UNIT HYDROGRAPHS FOR TOTAL AREAS ABOVE

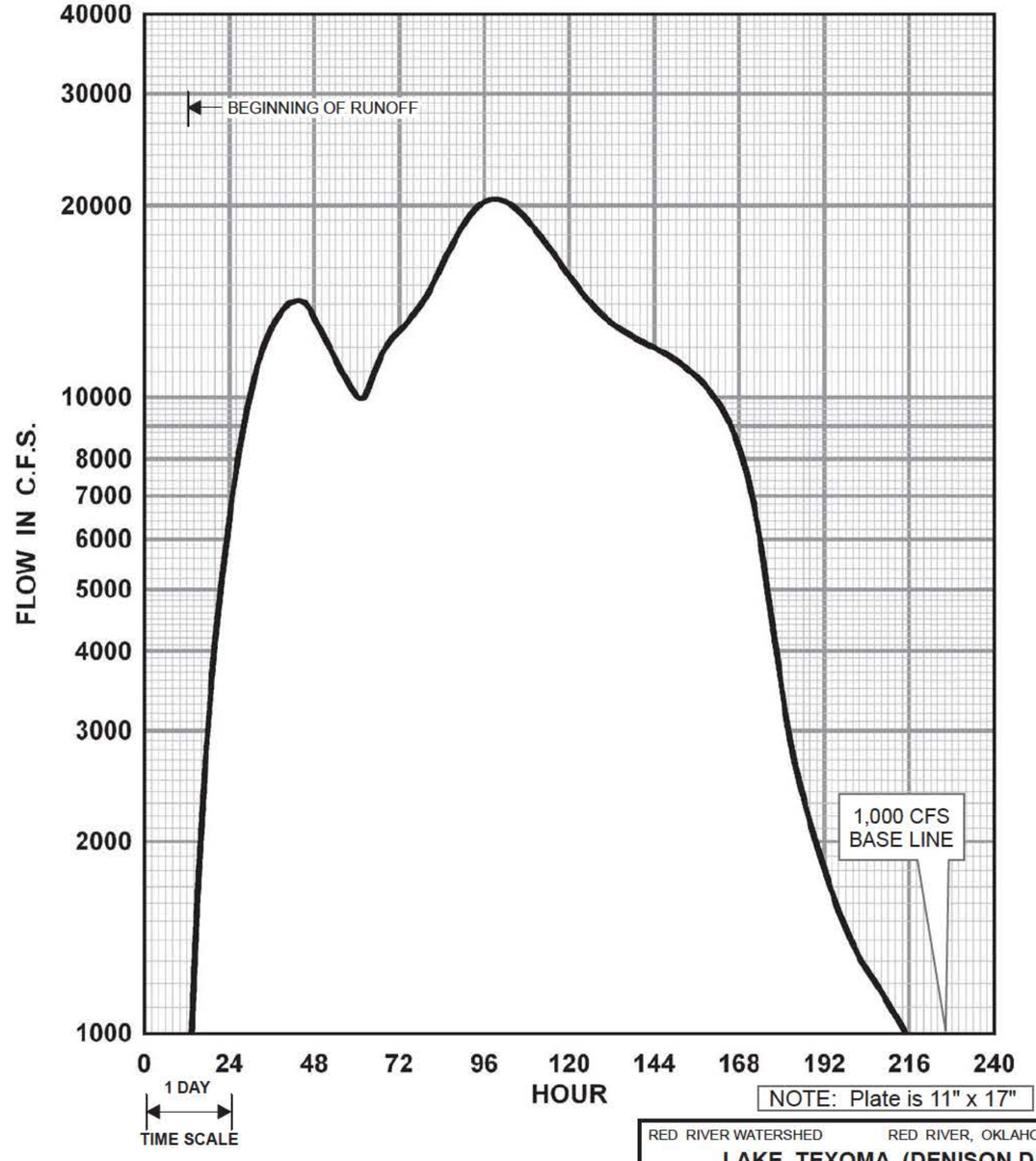
TERRAL AND GAINESVILLE GAGES ON RED RIVER

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



Carnegie Gage -

Drainage Area = 1,633 Sq. Mi.
1" Runoff = 87,100 Ac-Ft
Peak Flow = 25,300 c.f.s.



Alex Gage -

Drainage Area = 2,987 Sq. Mi.
1" Runoff = 159,307 Ac-Ft
Peak Flow = 20,490 c.f.s.

NOTE: Plate is 11" x 17"

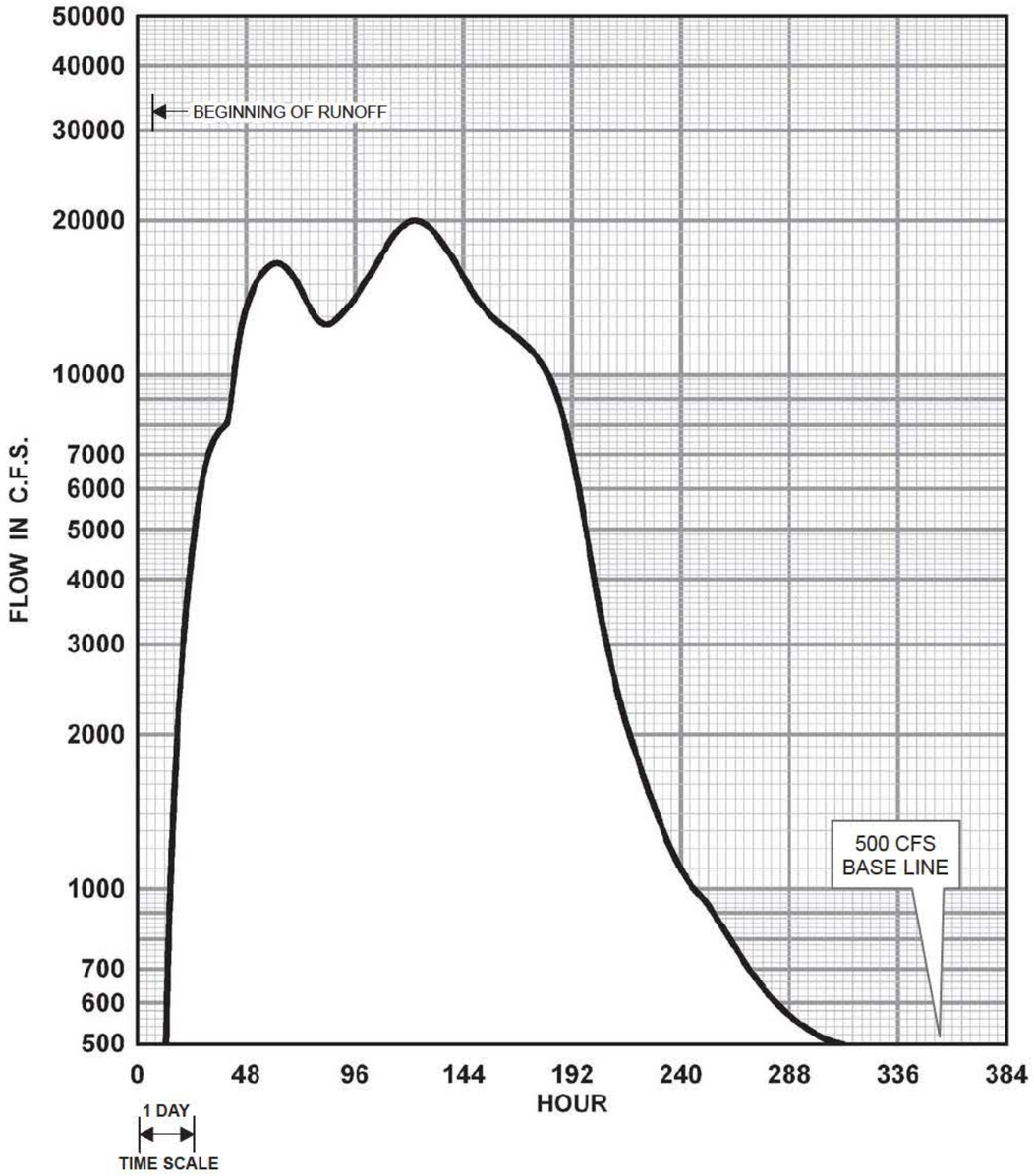
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

UNIT HYDROGRAPHS FOR TOTAL AREAS ABOVE

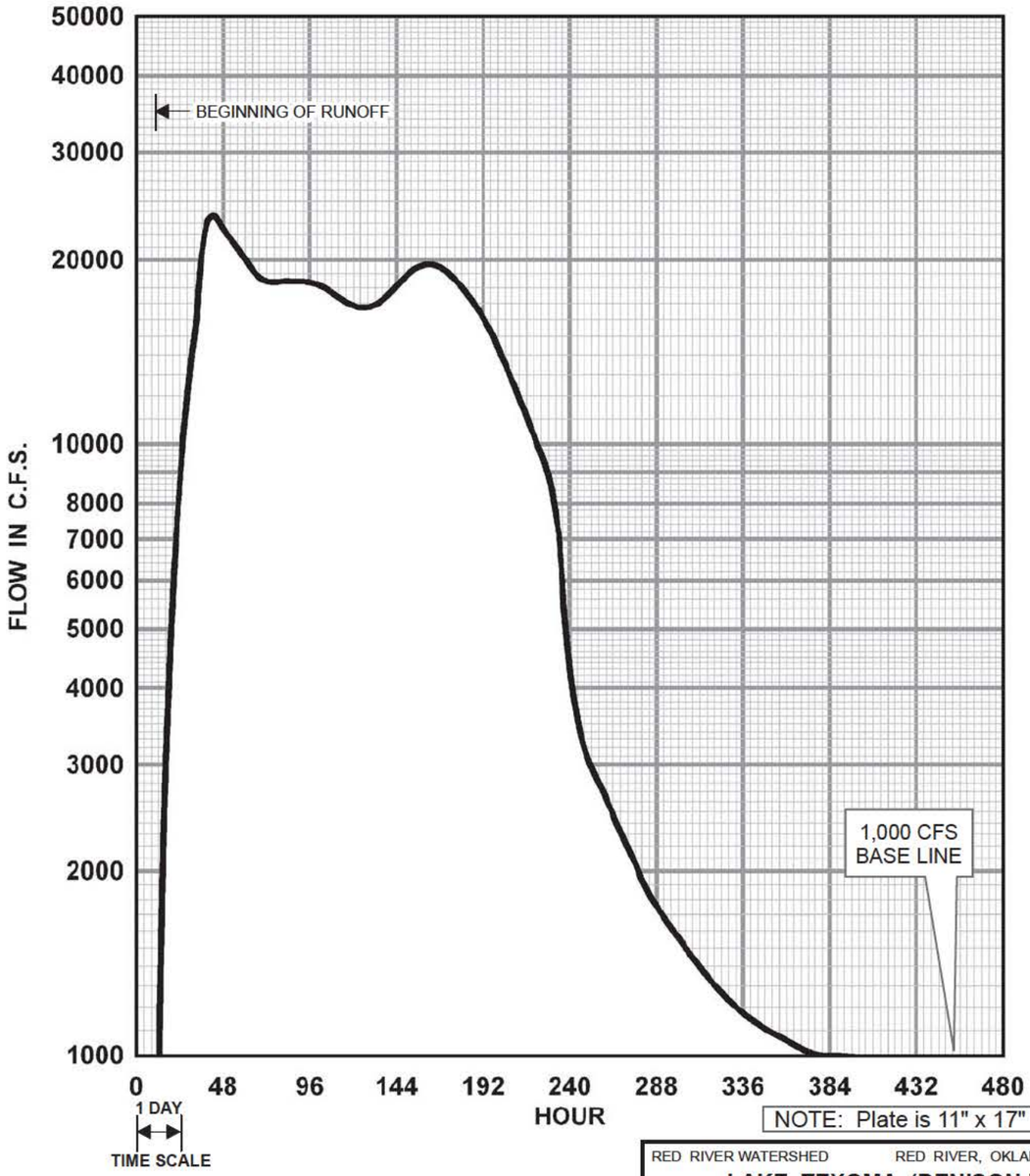
CARNEGIE AND ALEX GAGES ON WASHITA RIVER

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



Pauls Valley Gage -

Drainage Area = 3,530 Sq. Mi.
1" Runoff = 188,533 Ac-Ft
Peak Flow = 19,990 c.f.s.



NOTE: Plate is 11" x 17"

Dickson Gage -

Drainage Area = 5,276 Sq. Mi.
1" Runoff = 281,387 Ac-Ft
Peak Flow = 23,630 c.f.s.

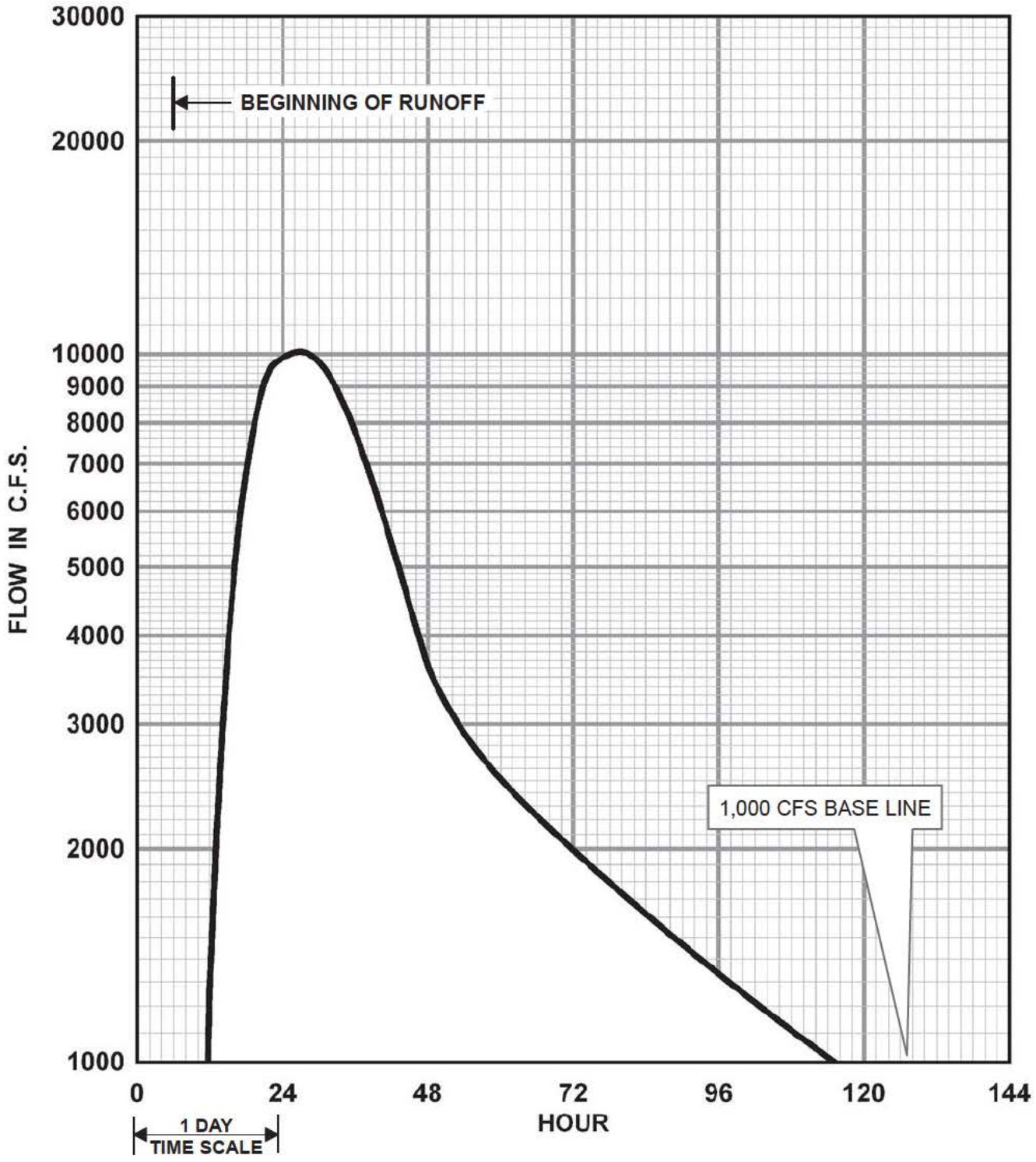
RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

UNIT HYDROGRAPHS FOR TOTAL AREAS ABOVE

PAULS VALLEY AND DICKSON GAGES ON WASHITA RIVER

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



DRAINAGE AREA = 476 SQ. MI.
1" RUNOFF = 25,387 AC.FT.
PEAK FLOW = 10,090 C.F.S.

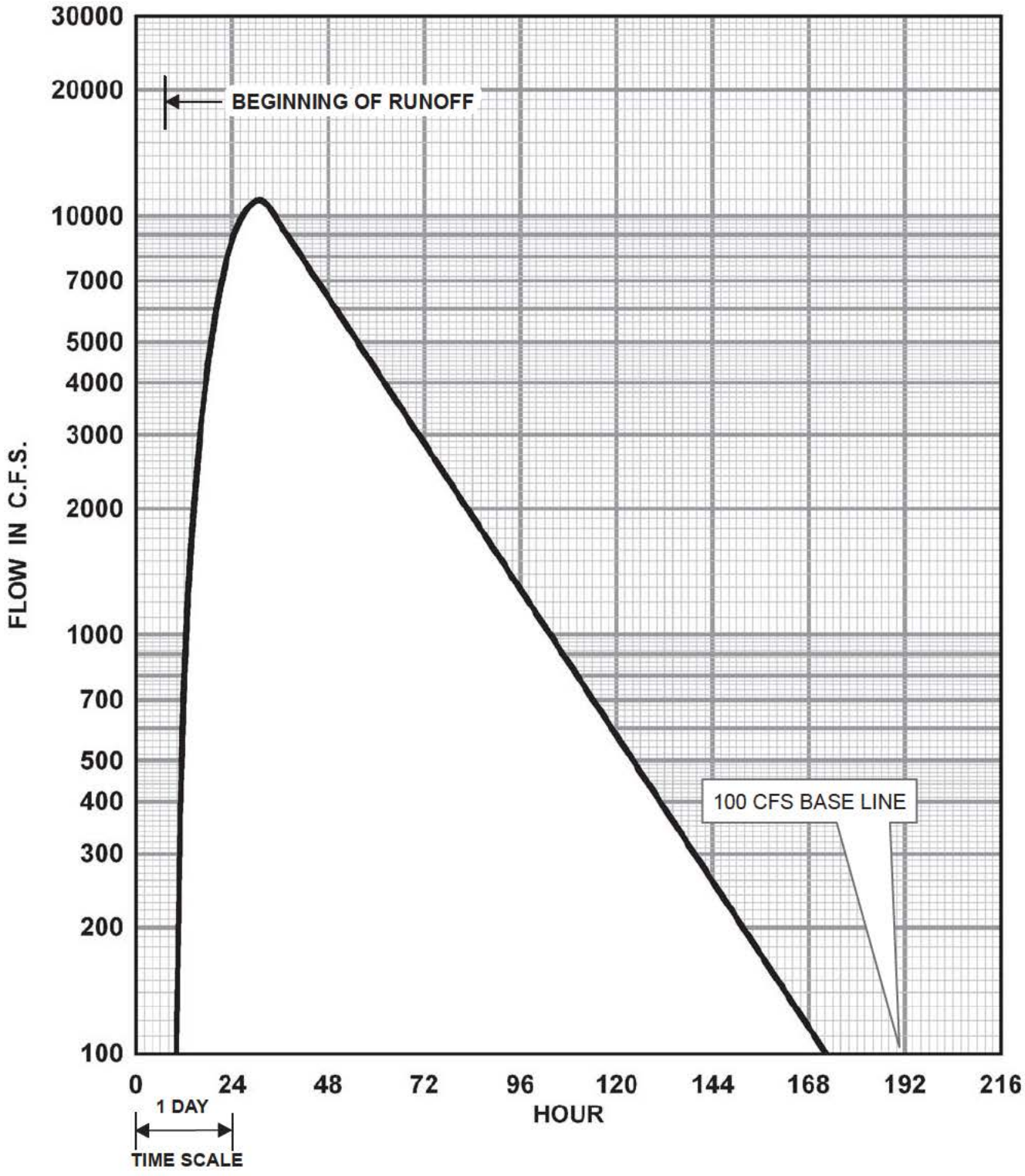
RED RIVER WATERSHED — RED RIVER, OKLAHOMA & TEXAS

LAKE TEXOMA (DENISON DAM)

UNIT HYDROGRAPH FOR AREA ABOVE BLUE GAGE ON BLUE RIVER

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

PLATE 6 - 6



DRAINAGE AREA = 720 SQ. MI.
1" RUNOFF = 38,400 AC.FT.
PEAK FLOW = 10,940 C.F.S.

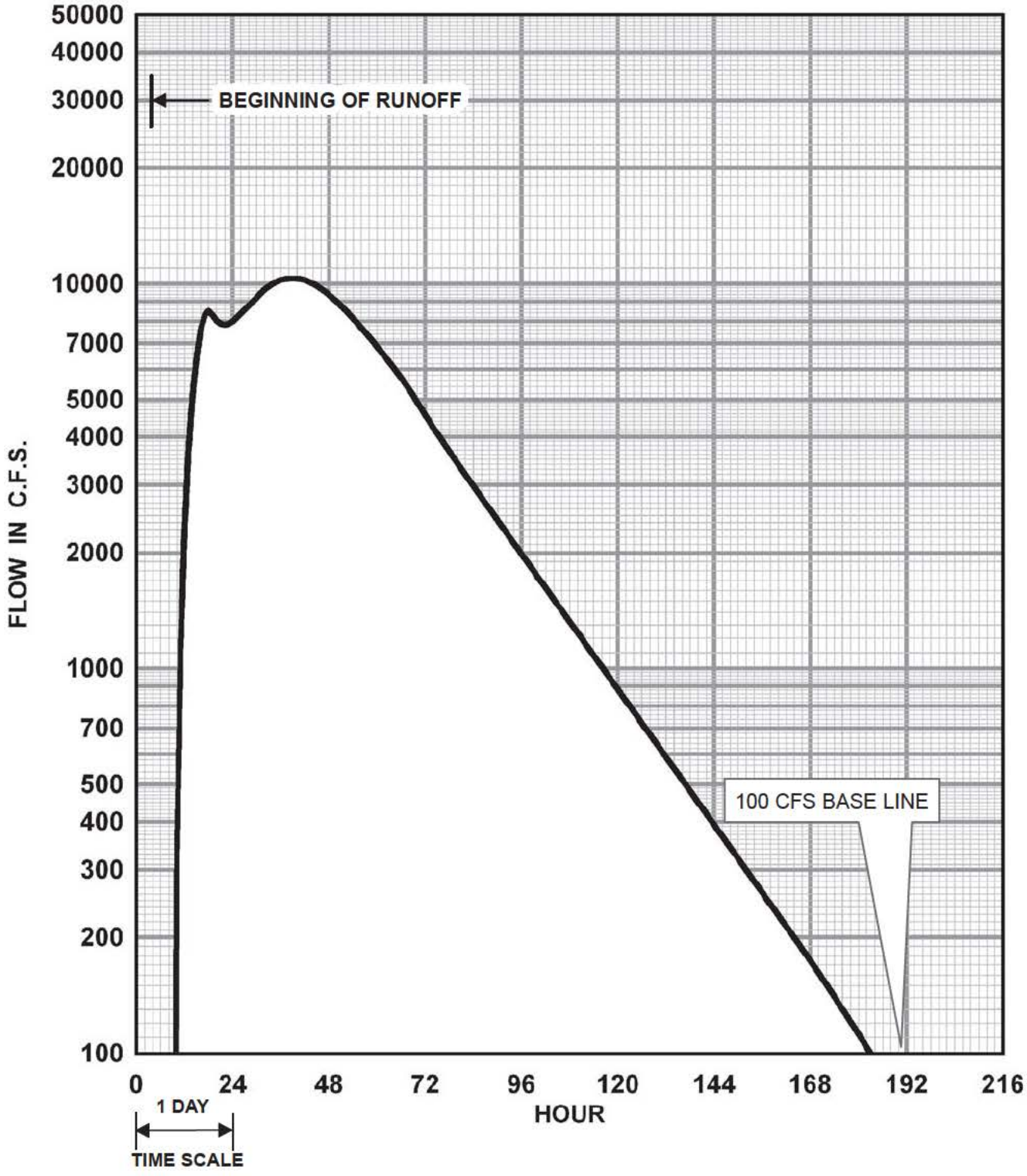
RED RIVER WATERSHED — RED RIVER, OKLAHOMA & TEXAS

LAKE TEXOMA (DENISON DAM)

UNIT HYDROGRAPH FOR AREA ABOVE CANEY GAGE ON CLEAR BOGGY CREEK

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

PLATE 6 - 7



DRAINAGE AREA = 911 SQ. MI.
1" RUNOFF = 48,587 AC.FT.
PEAK FLOW = 10,320 C.F.S.

RED RIVER WATERSHED — RED RIVER, OKLAHOMA & TEXAS

LAKE TEXOMA (DENISON DAM)

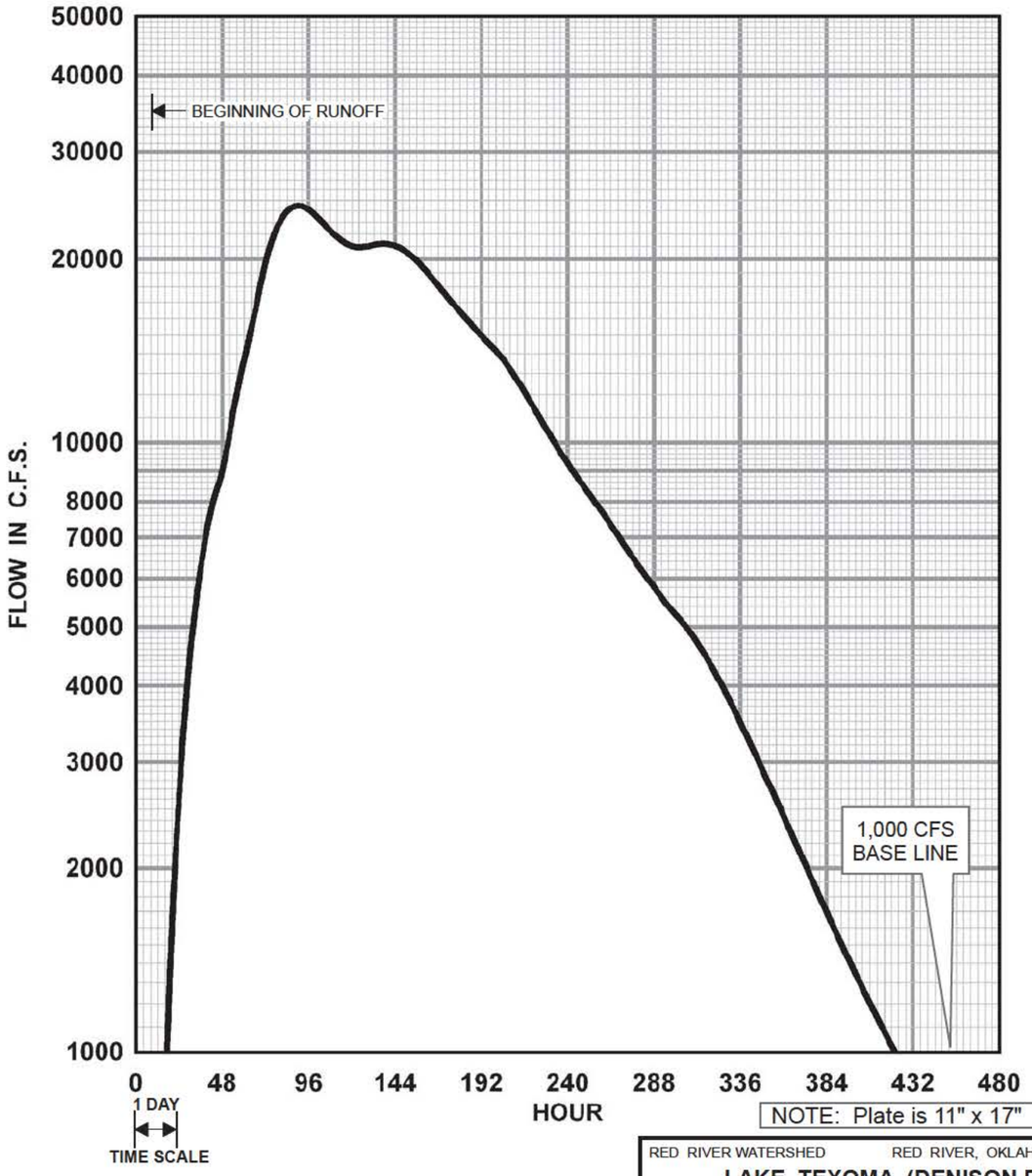
UNIT HYDROGRAPH FOR AREA ABOVE FARRIS GAGE ON MUDDY BOGGY CREEK

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

PLATE 6 - 8

Arthur City Gage -

Drainage Area = 4,636 Sq. Mi.
1" Runoff = 247,253 Ac-Ft
Peak Flow = 22,780 c.f.s.



DeKalb Gage -

Drainage Area = 5,744 Sq. Mi.
1" Runoff = 306,347 Ac-Ft
Peak Flow = 24,480 c.f.s.

NOTE: Plate is 11" x 17"

RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

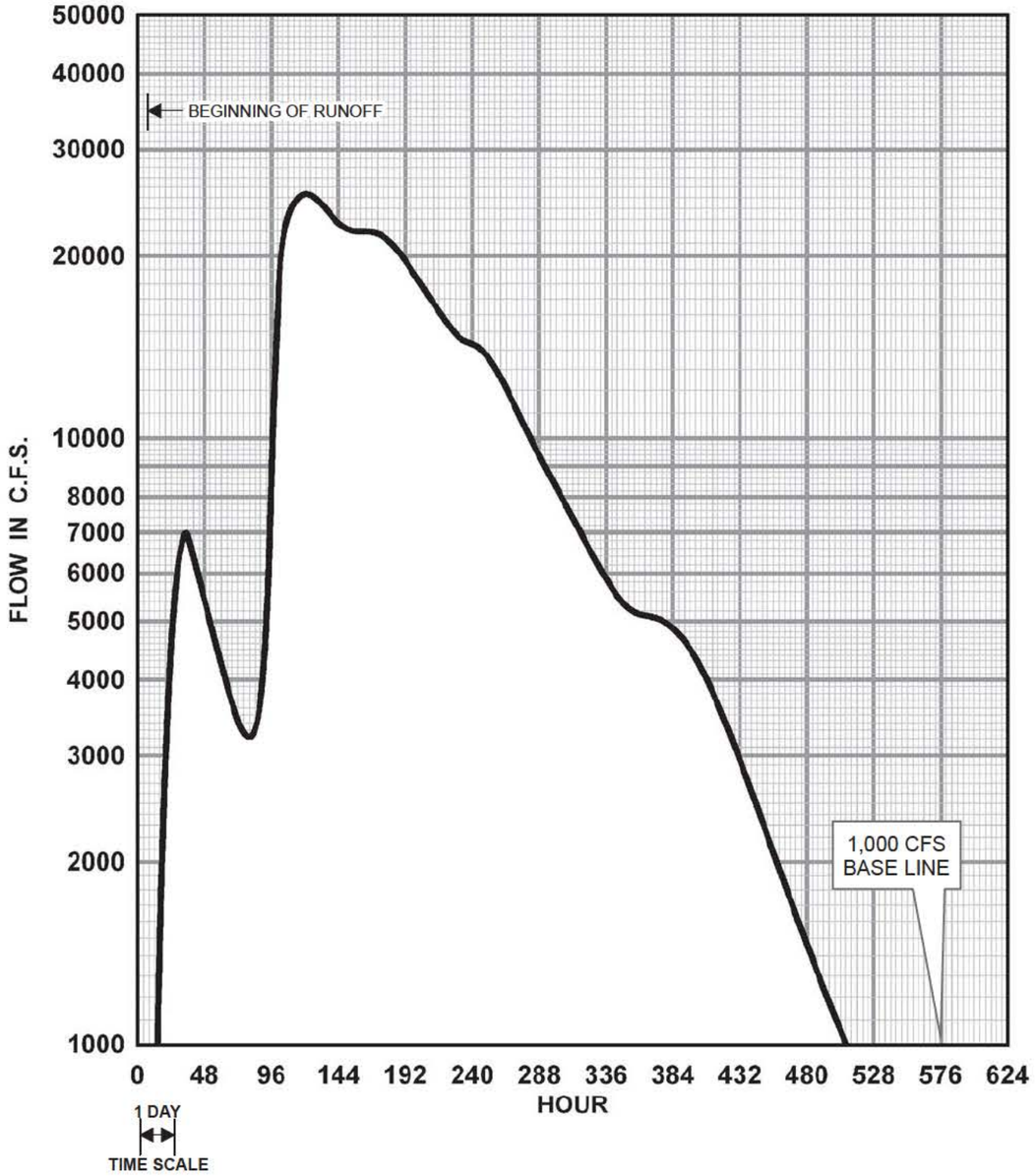
LAKE TEXOMA (DENISON DAM)

UNIT HYDROGRAPHS FOR TOTAL AREAS ABOVE

ARTHUR CITY AND DeKALB GAGES ON RED RIVER

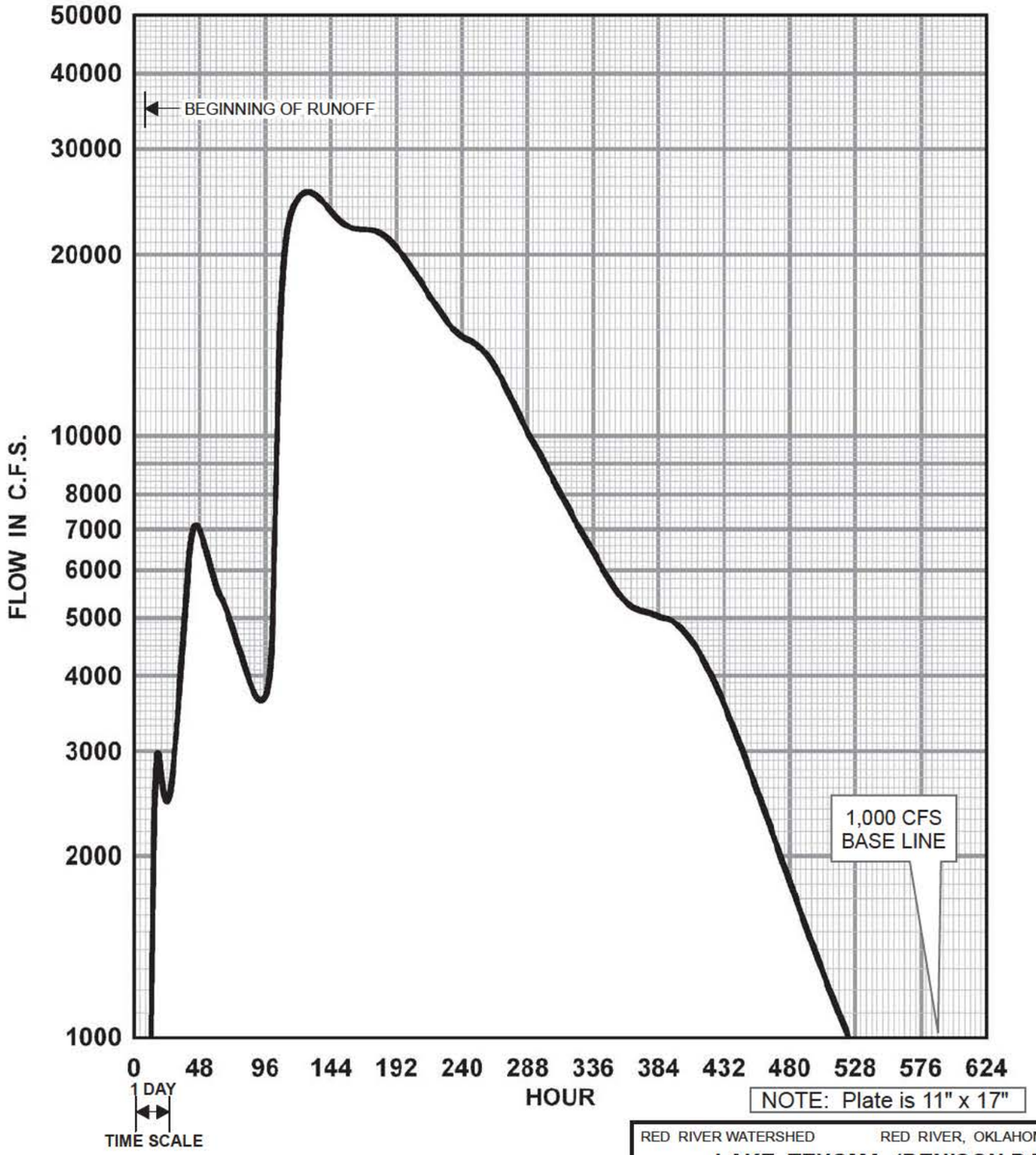
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 6 - 9



Index Gage -

Drainage Area = 6,396 Sq. Mi.
1" Runoff = 341,120 Ac-Ft
Peak Flow = 25,340 c.f.s.



Fulton Gage -

Drainage Area = 6,486 Sq. Mi.
1" Runoff = 345,920 Ac-Ft
Peak Flow = 25,440 c.f.s.

NOTE: Plate is 11" x 17"

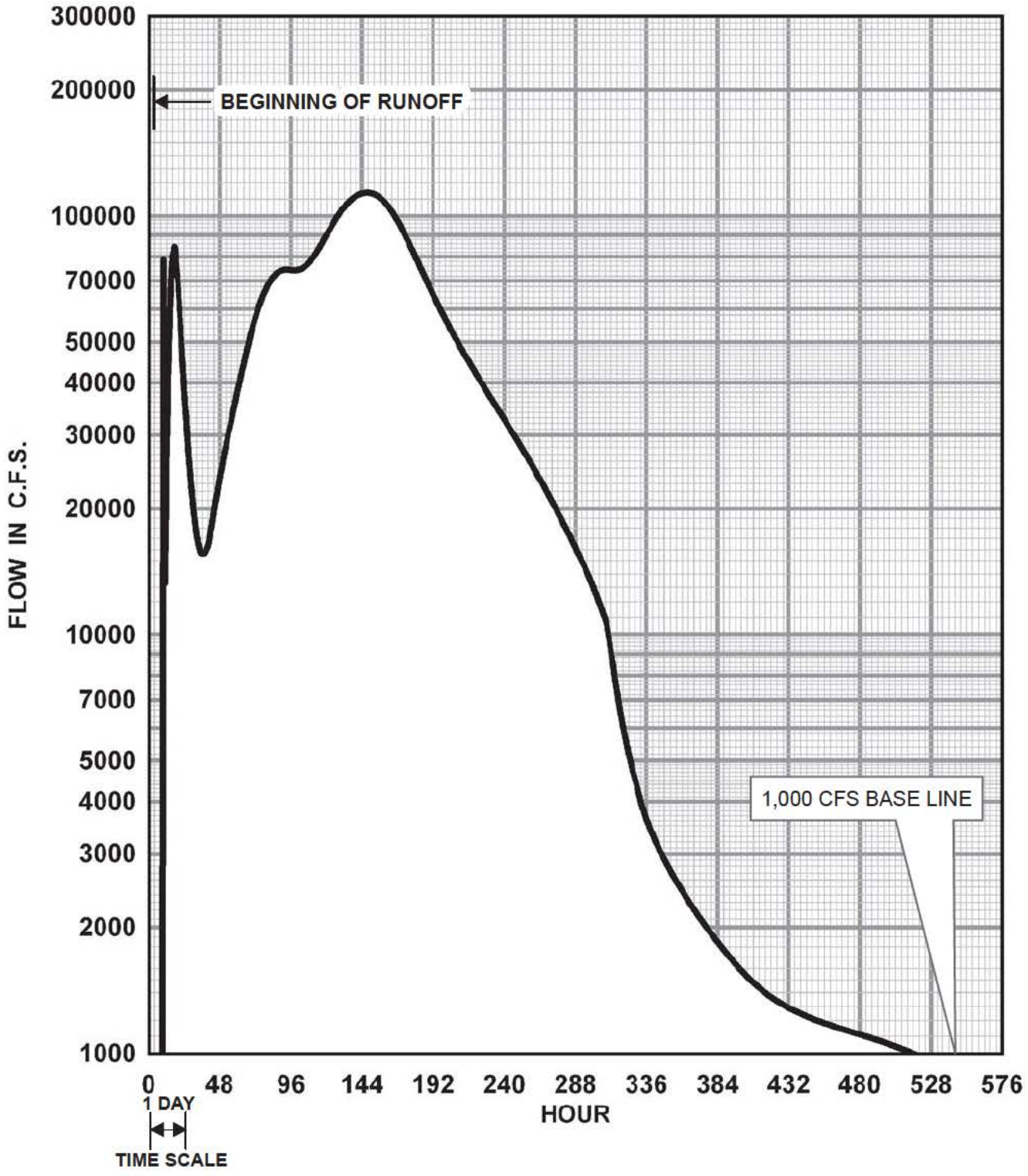
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

UNIT HYDROGRAPHS FOR TOTAL AREAS ABOVE

INDEX AND FULTON GAGES ON RED RIVER

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



DRAINAGE AREA = 33,783 SQ. MI.
1" RUNOFF = 1,801,760 AC.FT.
PEAK FLOW = 113,870 C.F.S.

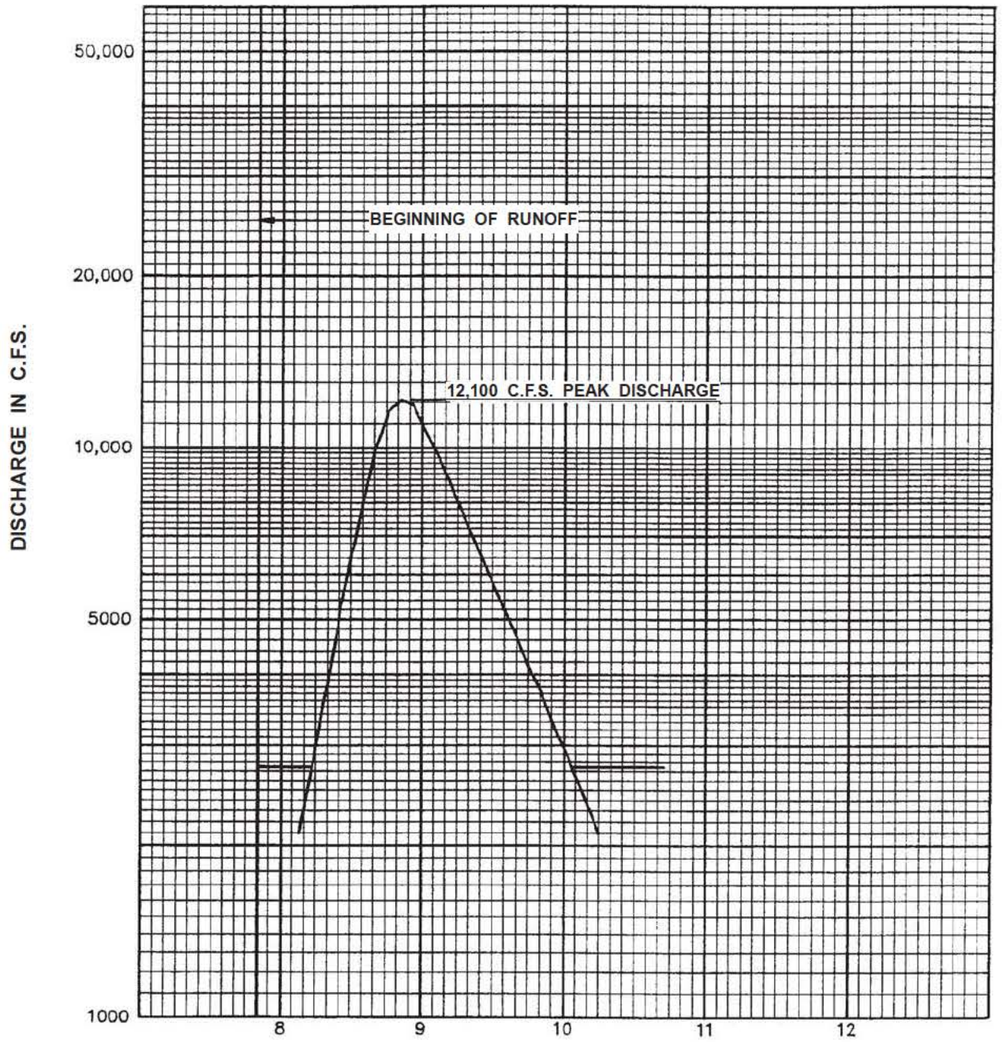
RED RIVER WATERSHED — RED RIVER, OKLAHOMA & TEXAS

LAKE TEXOMA (DENISON DAM)

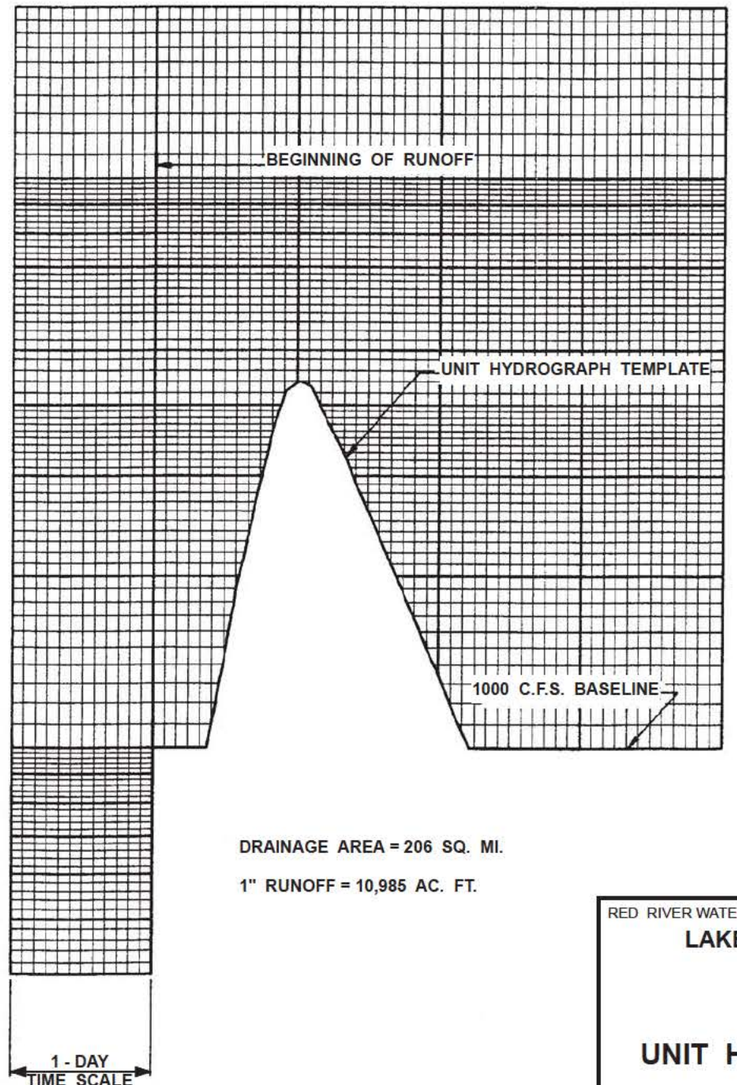
UNIT HYDROGRAPH FOR DENISON DAM INFLOW

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

PLATE 6 - 11



NOTE:
SAMPLE INFLOW HYDROGRAPH
2.75 IN. OF RUNOFF APPLIED
TO UNIT HYDROGRAPH
VOLUME = 30,209 AC. FT.
PEAK = 12,100 C.F.S.



DRAINAGE AREA = 206 SQ. MI.

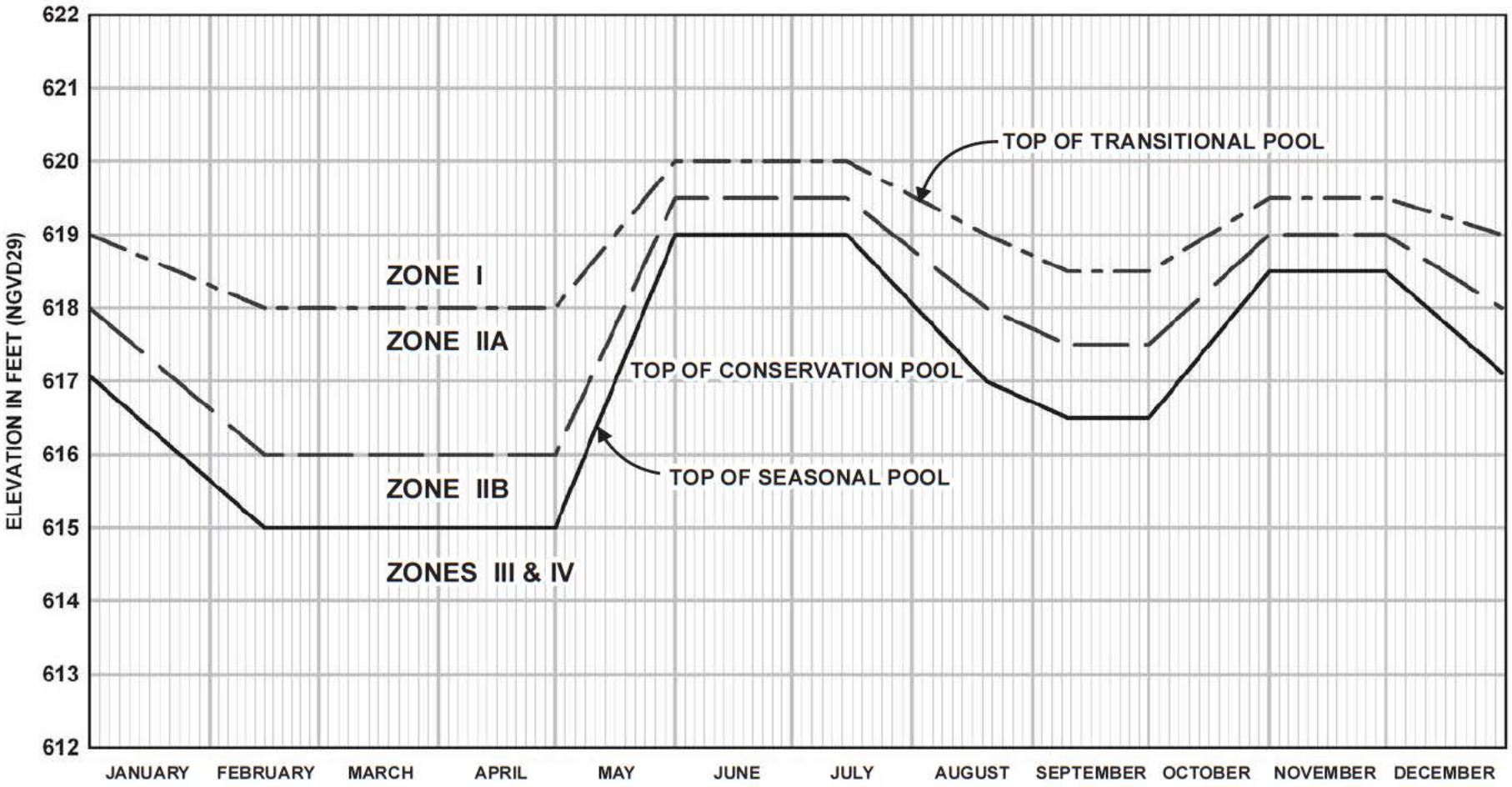
1" RUNOFF = 10,985 AC. FT.

RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

UNIT HYDROGRAPH EXAMPLE

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



ZONE I	RELEASES WILL BE MADE IN ACCORDANCE WITH FLOOD CONTROL REQUIREMENTS FOR THE RED RIVER BELOW DENISON DAM
ZONE IIA	REQUIRED RELEASE RATE WILL BE 6,500 C.F.S. PLUS THE 3 - DAY AVERAGE FORECASTED NET INFLOW
ZONE IIB	REQUIRED RELEASE RATE WILL BE 3,200 C.F.S. PLUS THE 3 - DAY AVERAGE FORECASTED NET INFLOW
ZONES III & IV	RELEASE RATE WILL BE BASED ON POWER DEMAND
NOTE:	RELEASES EXCEEDING FULL TURBINE CAPACITY (13,600 C.F.S.) WILL NOT NORMALLY BE MADE BELOW ELEV. 617.0

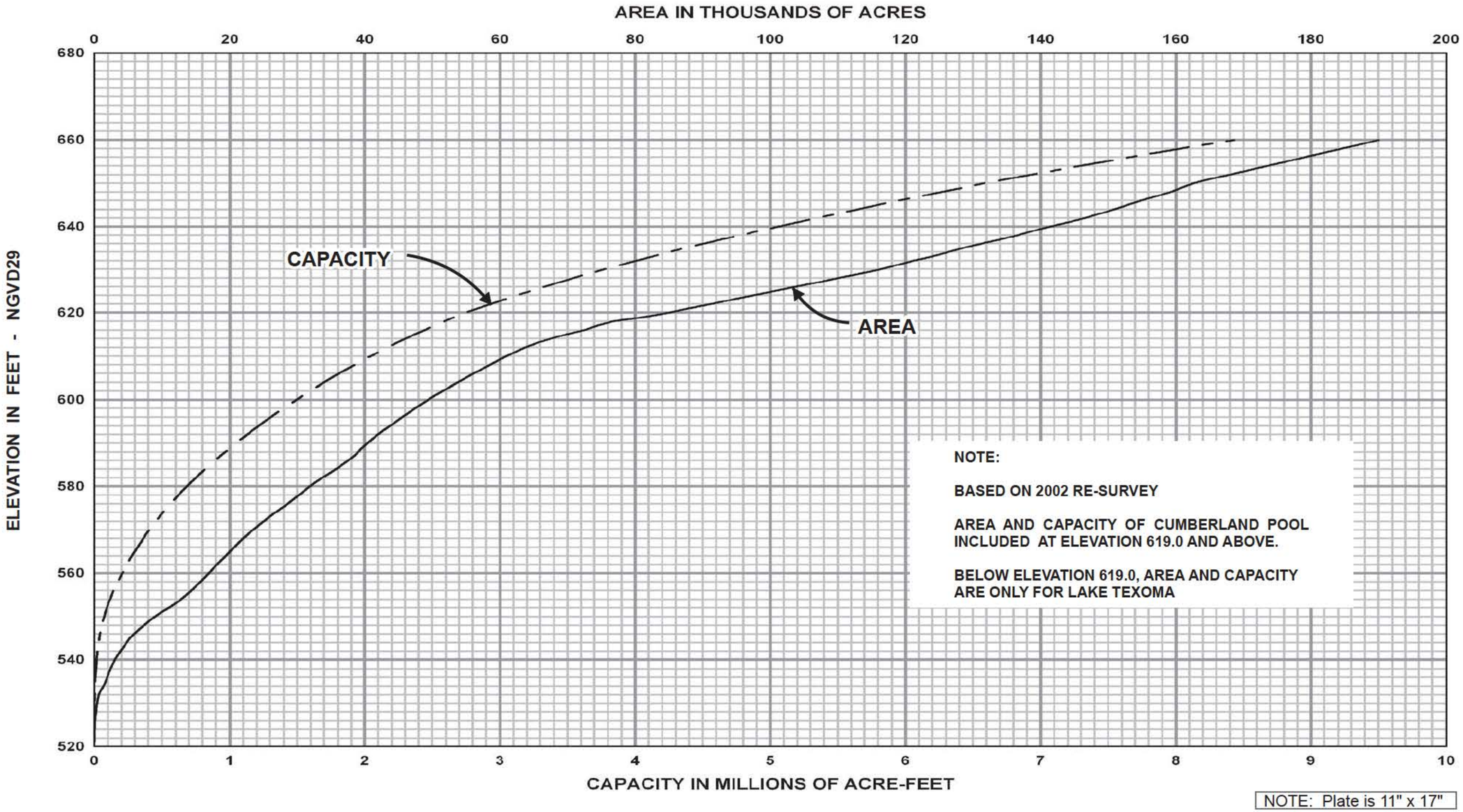
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

SEASONAL AND TRANSITIONAL POOL GUIDELINES

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

PLATE 7 - 1



NOTE:

BASED ON 2002 RE-SURVEY

AREA AND CAPACITY OF CUMBERLAND POOL INCLUDED AT ELEVATION 619.0 AND ABOVE.

BELOW ELEVATION 619.0, AREA AND CAPACITY ARE ONLY FOR LAKE TEXOMA

NOTE: Plate is 11" x 17"

RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

ELEVATION - AREA AND ELEVATION - CAPACITY CURVES

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

PLATE 7 - 2

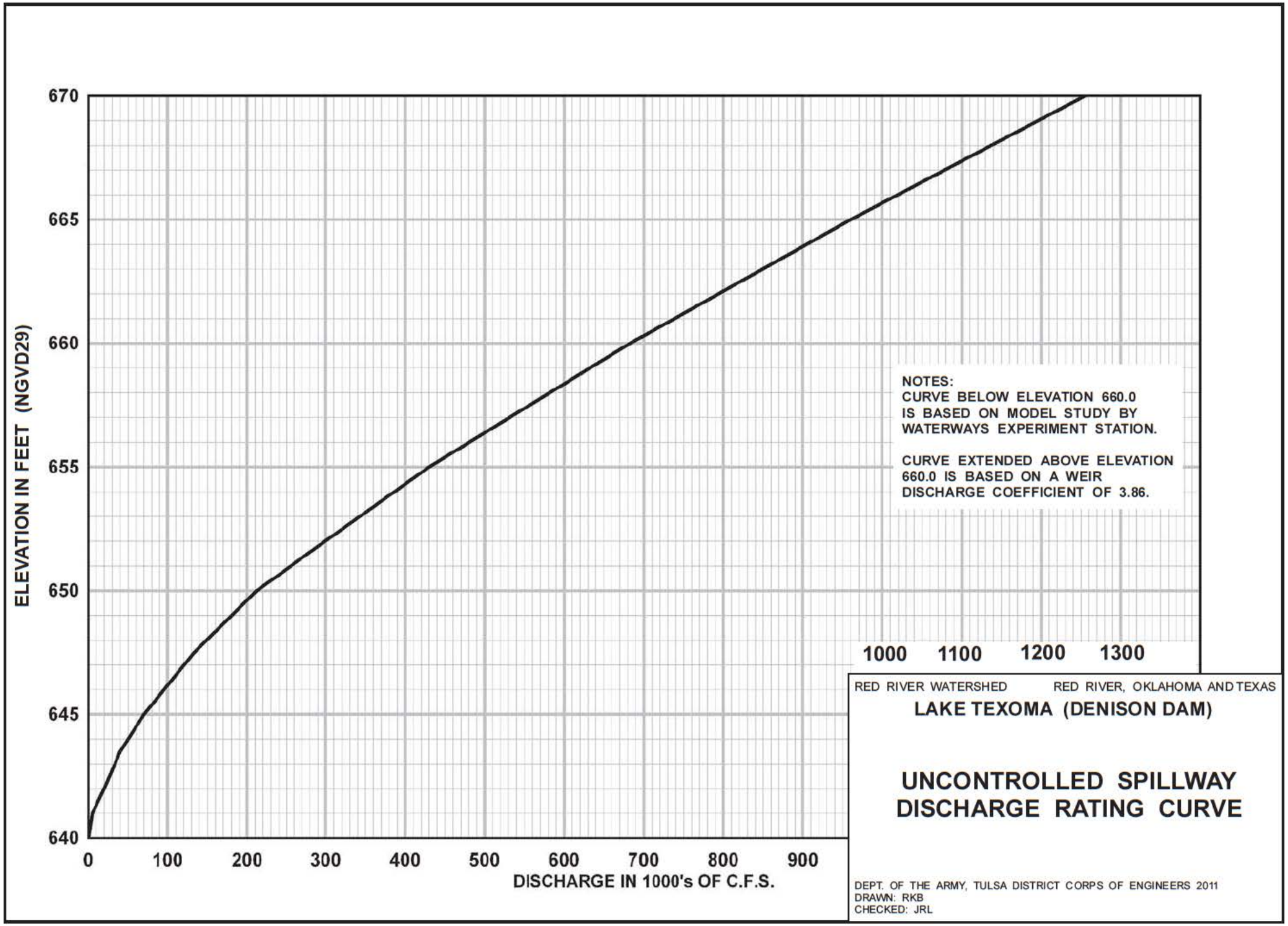
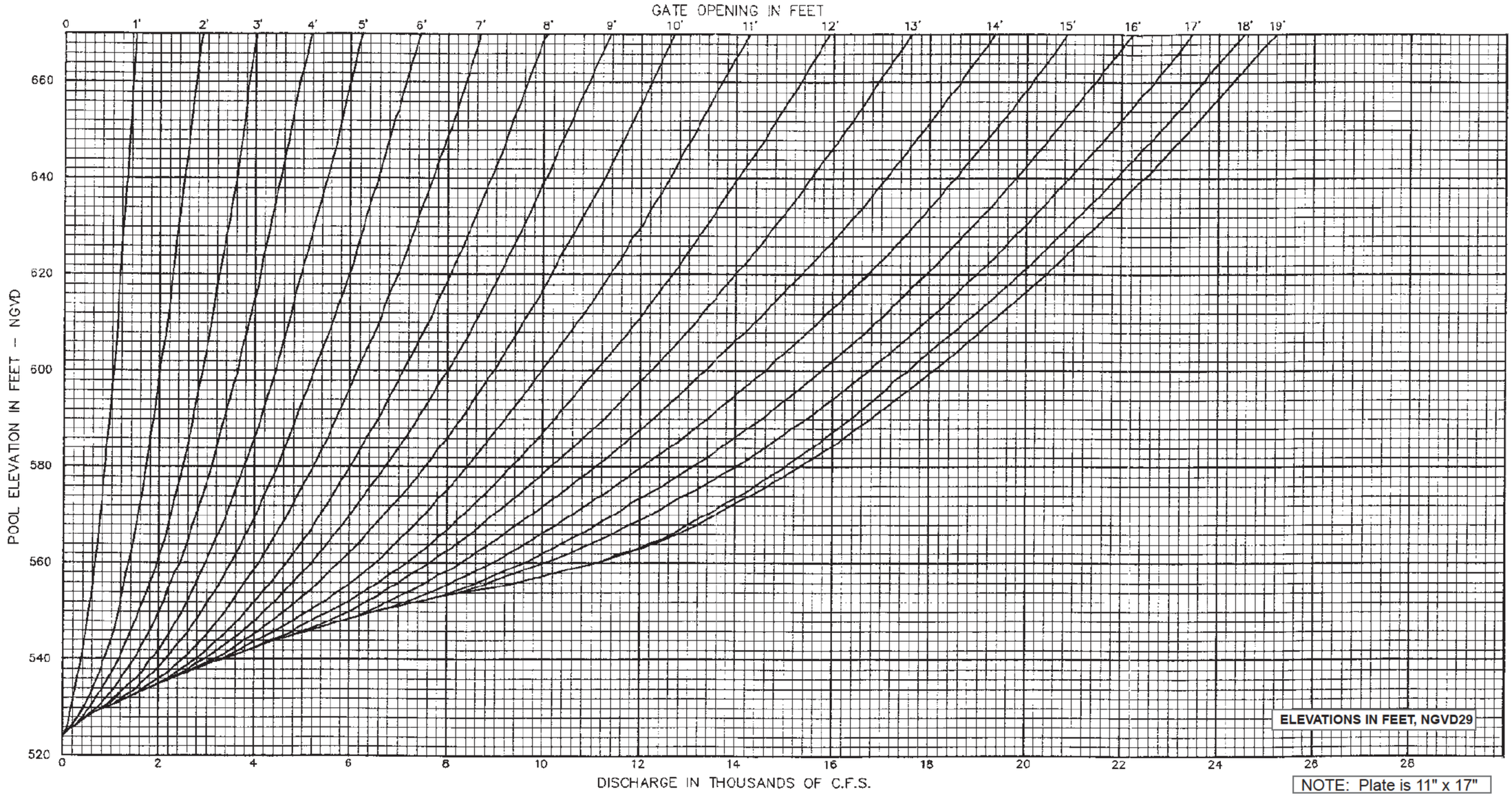

670
665
660
655
650
645
640
ELEVATION IN FEET (NGVD29)
0
100
200
300
400
500
600
700
800
900
DISCHARGE IN 1000's OF C.F.S.
1000
1100
1200
1300
NOTES:
CURVE BELOW ELEVATION 660.0 IS BASED ON MODEL STUDY BY WATERWAYS EXPERIMENT STATION.
CURVE EXTENDED ABOVE ELEVATION 660.0 IS BASED ON A WEIR DISCHARGE COEFFICIENT OF 3.86.
RED RIVER WATERSHED
RED RIVER, OKLAHOMA AND TEXAS
LAKE TEXOMA (DENISON DAM)
UNCONTROLLED SPILLWAY
DISCHARGE RATING CURVE
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 7 - 3



NOTE: Plate is 11" x 17"

NOTE:
DISCHARGE IS FOR 1–20' DIAMETER
CONDUIT CONTAINING 2–9'x19' GATES
THREE CONDUITS ARE AVAILABLE

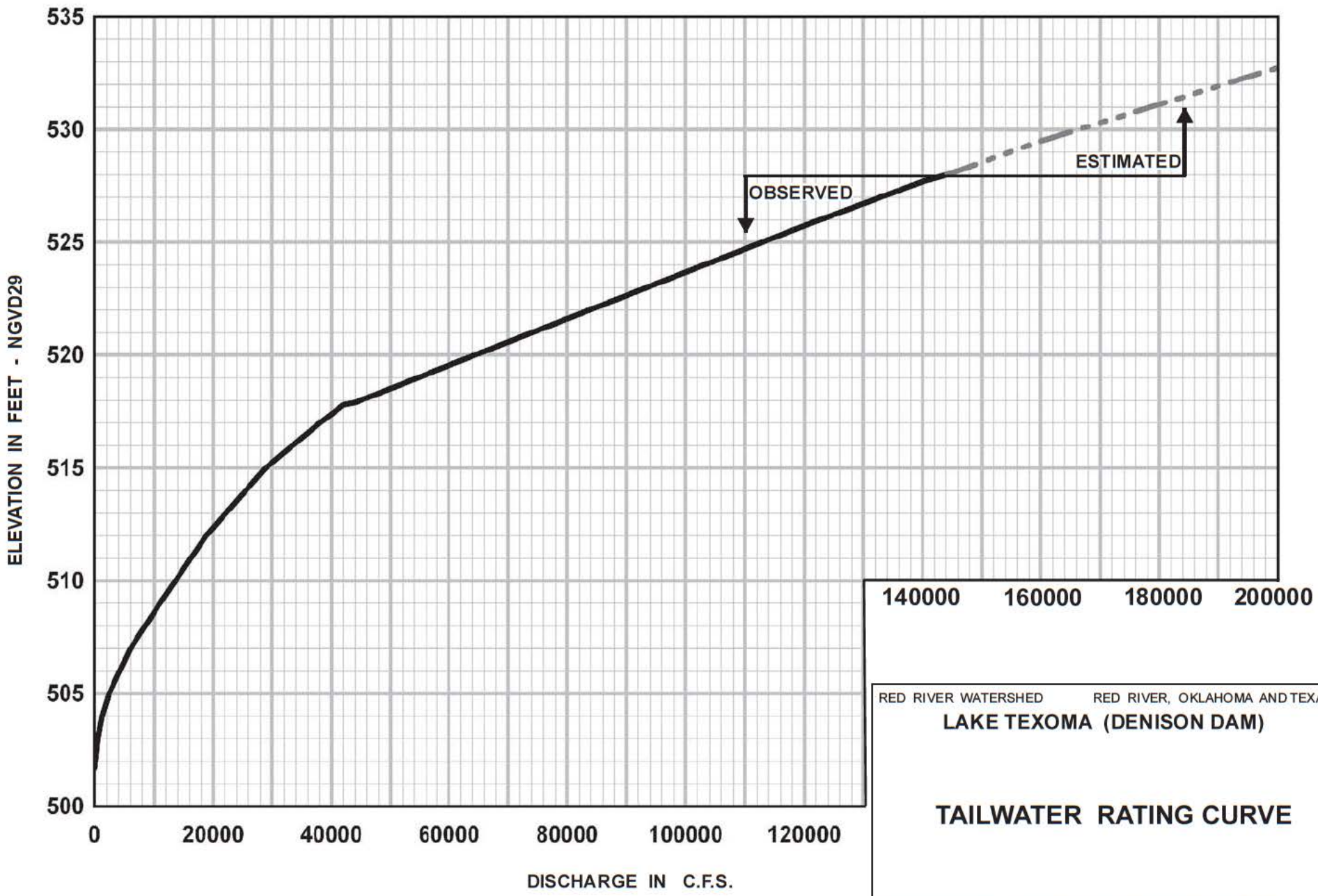
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

OUTLET WORKS CONDUIT DISCHARGE RATING CURVE

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

PLATE 7 - 4



RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

TAILWATER RATING CURVE

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

PLATE 7 - 5

MONTH	USER	BEGINNING STORAGE A.F.	INFLOW SHARE A.F.	TOTAL LOSSES A.F.	WITH-DRAWN A.F.	ENDING STORAGE A.F.
JAN	LAKE	986730	7,800	93,100	115,800	785,630
	1	21300	106	1,219	3,000	17,187
	2	16400	81	933	2,500	13,048
	3	85406	14	159	300	84,961
	4	100000	472	5,542	10,000	84,930
	5	50000	112	1,391	0	48,721
	6	26894	0	0	0	26,894
	7	686730	7,015	83,856	100,000	509,889
FEB	LAKE	785,630	4,500	87,050	129,200	573,880
	1	17,187	61	1,080	2,000	14,168
	2	13,048	47	804	2,000	10,291
	3	84,961	8	146	200	84,623
	4	84,930	272	5,169	5,000	75,033
	5	48,721	65	1,422	0	47,364
	6	26,894	0	0	0	26,894
	7	509,889	4,047	78,429	120,000	315,507
MAR	LAKE	573,880	3,700	64,570	141,100	371,910
	1	14,168	50	783	2,000	11,435
	2	10,291	39	552	2,000	7,778
	3	84,623	6	113	100	84,416
	4	75,033	224	3,954	7,000	64,303
	5	47,364	53	1,186	0	46,231
	6	26,894	0	0	0	26,894
	7	315,507	3,328	57,982	130,000	130,853
APR	LAKE	371,910	475,000	44,040	113,350	689,520
	1	11,435	6,474	520	2,500	14,889
	2	7,778	4,985	363	1,800	10,600
	3	84,416	832	83	50	85,115
	4	64,303	28,883	2,782	4,000	86,404
	5	46,231	4,588	819	0	50,000
	6	26,894	0	0	0	26,894
	7	130,853	429,238	39,473	105,000	415,618
MAY	LAKE	689,520	416,520	32,040	87,270	986,730
	1	14,889	8,318	408	1,500	21,299
	2	10,600	7,804	304	1,700	16,400
	3	85,115	420	58	69	85,408
	4	86,404	19,582	1,988	3,998	100,000
	5	50,000	4,588	819	0	53,769
	6	26,894	0	0	0	26,894
	7	415,618	379,887	28,773	80,002	686,730

*** WATER SUPPLY STORAGE ACCOUNTING**
LAKE TEXOMA

****CONSERVATION STORAGE**	**986,730 A.F.**
CONTRACTED STORAGE USER #1	**21,300 A.F.**
CONTRACTED STORAGE USER #2	**16,400 A.F.**
CONTRACTED STORAGE USER #3	**85,406 A.F.**
CONTRACTED STORAGE USER #4	**100,000 A.F.**
CONTRACTED STORAGE USER #5	**50,000 A.F.**
CONTRACTED STORAGE USER #6	**26,894 A.F.**
CONTRACTED STORAGE USER #7	**686,730 A.F.**

***Conservation storage taken from reallocation finalized in 2010**
****Storage remaining after 100 years sedimentation from the date the project became operational based on the 2002 sediment survey.**

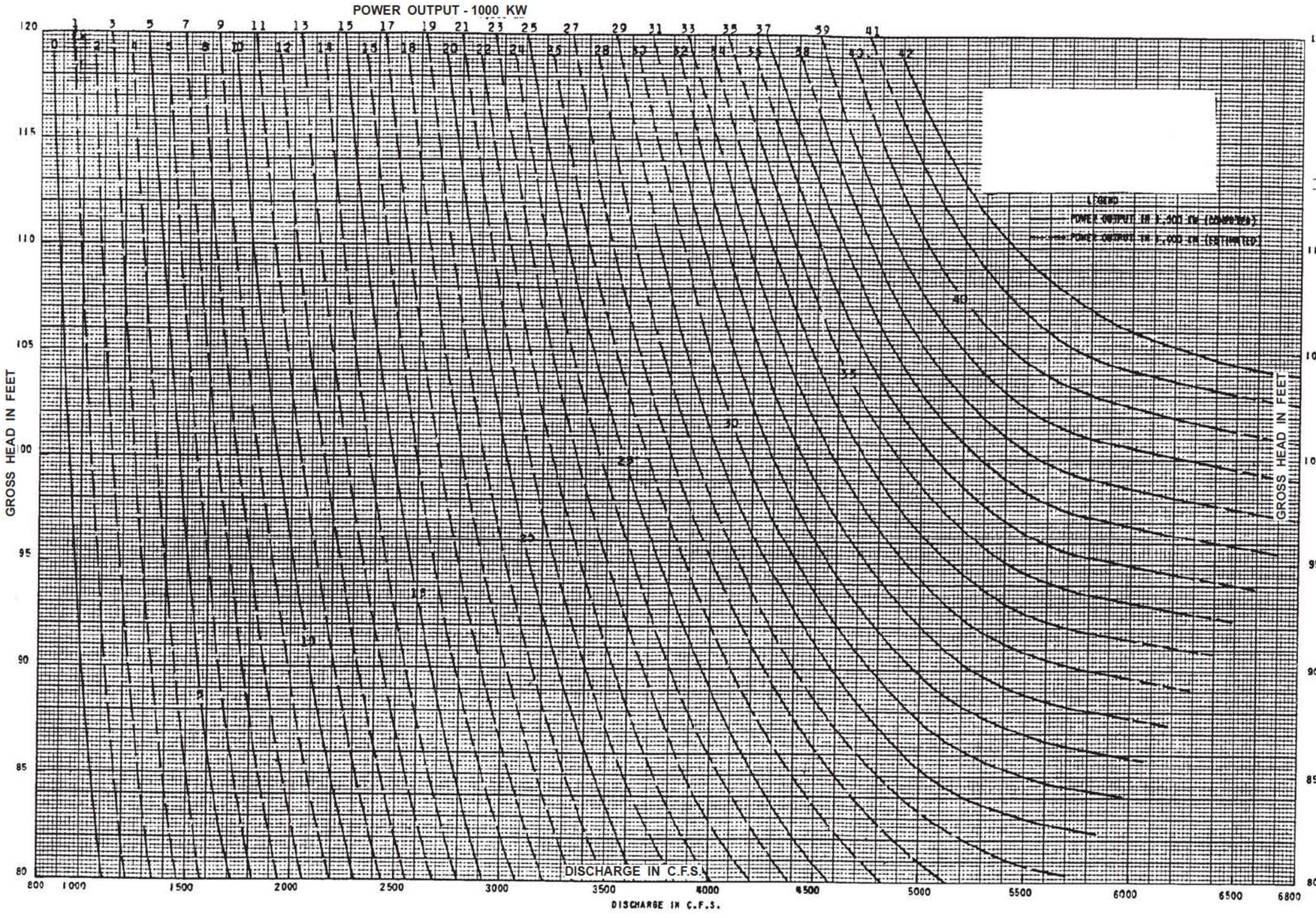
RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

WATER SUPPLY STORAGE ACCOUNTING EXAMPLE

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

PLATE 7 - 6



NOTE: Plate is 11" x 17"

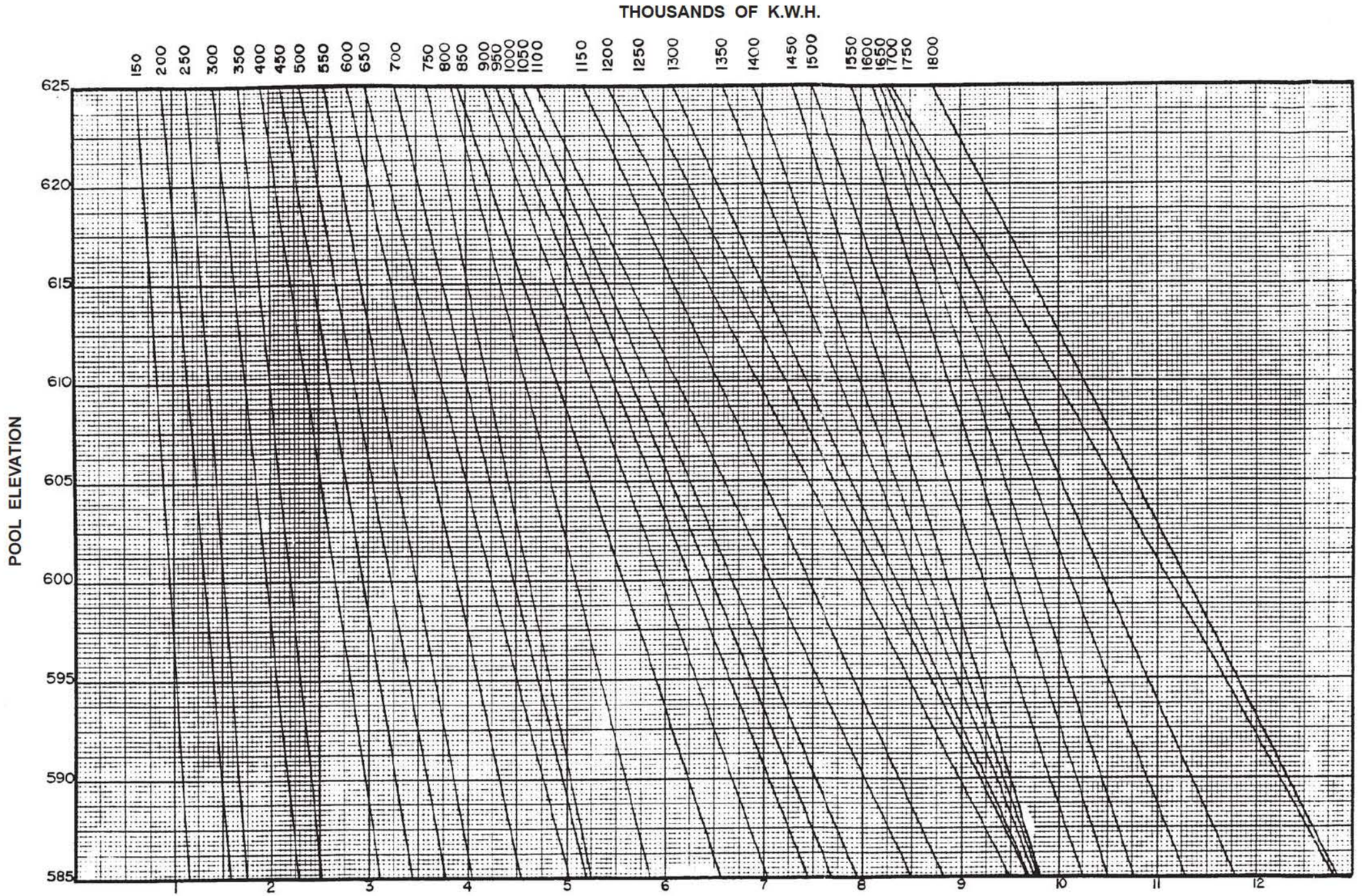
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

POWER DISCHARGE CURVES MAIN GENERATOR NO. 1

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

PLATE 7 - 7



NOTE:
THIS CURVE IS BASED ON THE TURBINES MAXIMUM EFFICIENCY CURVE. THEREFORE, ACTUAL DISCHARGE WILL BE SLIGHTLY HIGHER.

NOTE: Plate is 11" x 17"

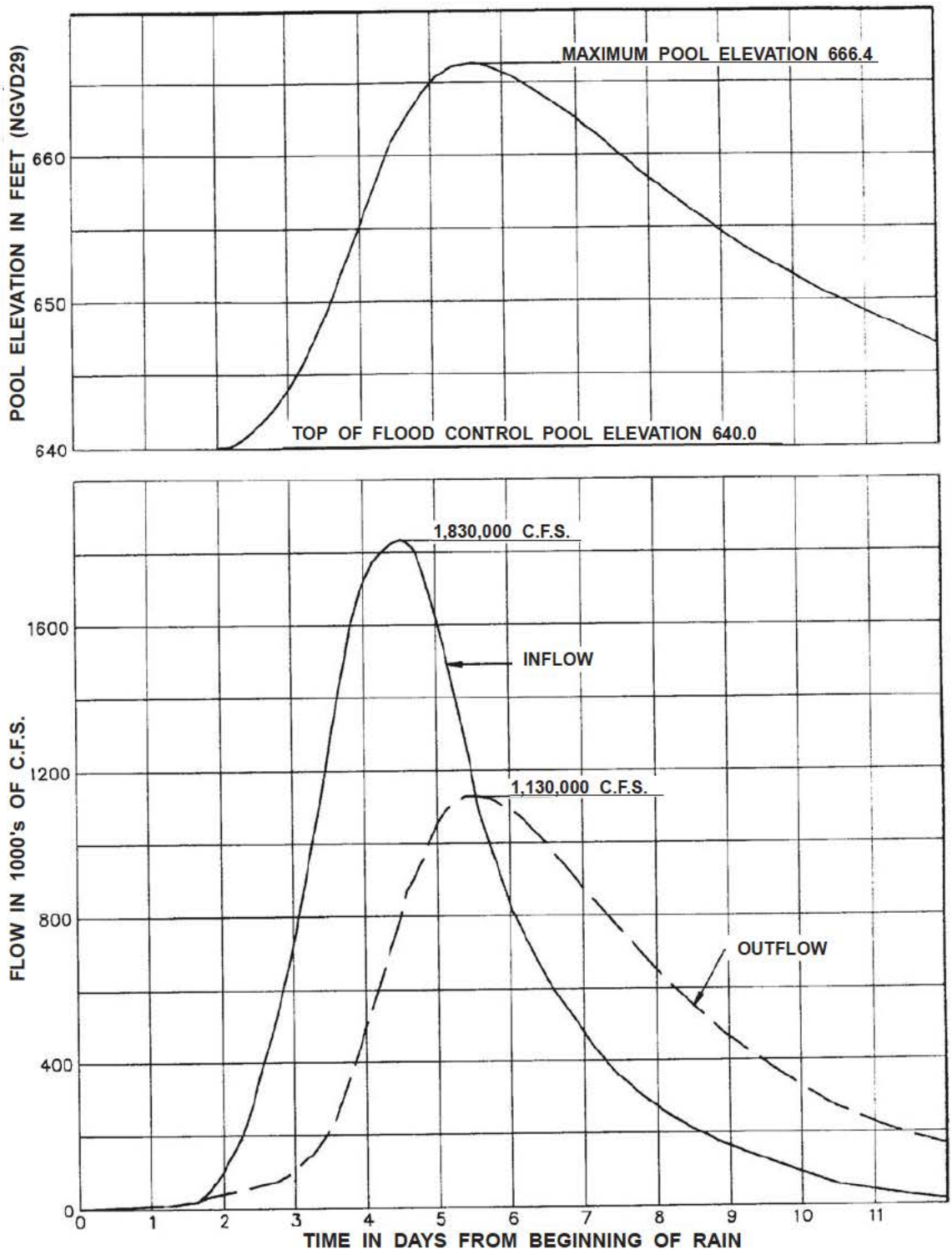
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

KILOWATT HOUR DISCHARGE CURVES

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

PLATE 7 - 8



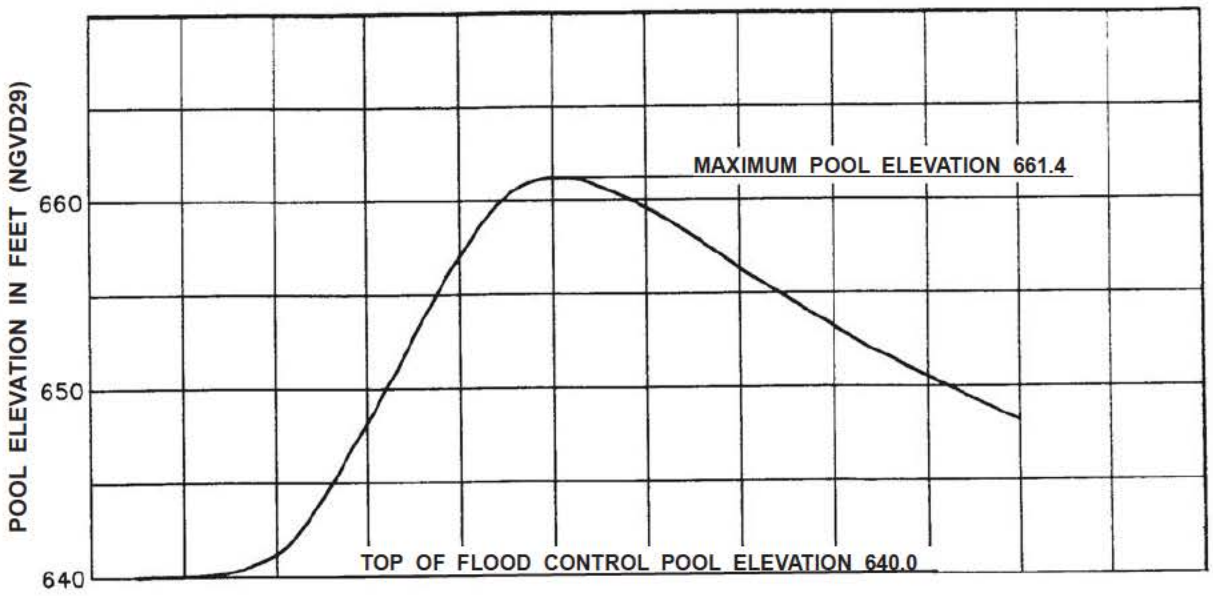
RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

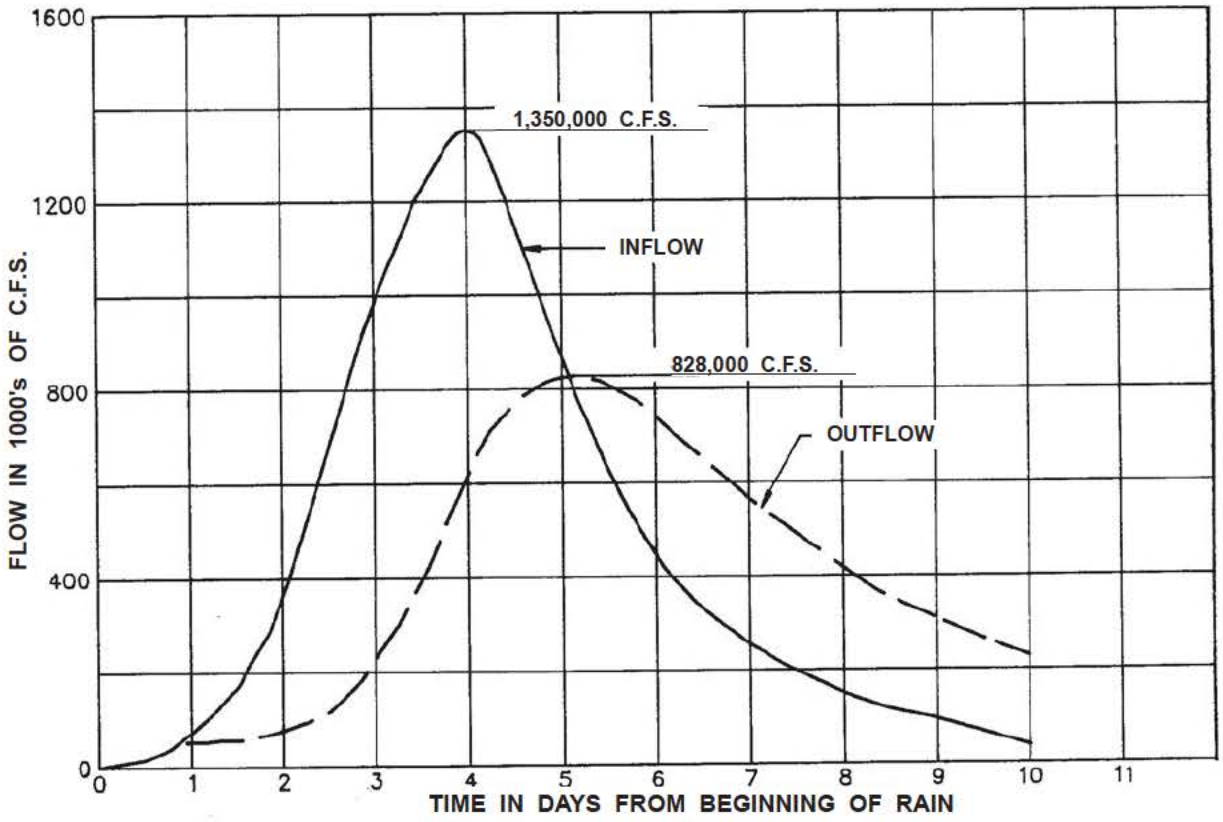
LAKE TEXOMA (DENISON DAM)

OPERATIONAL HYDROGRAPH SPILLWAY DESIGN FLOOD

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

PLATE 8 - 1





RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

OPERATIONAL HYDROGRAPH STANDARD PROJECT FLOOD

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

PLATE 8 - 2

AVERAGE BASIN RAINFALL IN INCHES

POOL ELEVATION IN FEET – NGVD

FLOW IN THOUSANDS OF C.F.S.

POOL ELEVATION

POOL ELEVATION

INFLOW

DENISON DAM RELEASES

DENISON DAM RELEASES

APRIL

MAY

JUNE

1957

LEGEND

INFLOW

① DENISON DAM OPERATED FOR MAXIMUM DOWNSTREAM BENEFITS.

② DENISON DAM OPERATED IN ACCORDANCE WITH APPROVED REGULATIONS.

③ DENISON DAM OPERATED TO LIMIT POOL ELEVATION TO 640.0 INSOFAR AS POSSIBLE.

NOTE: Plate is 11" x 17"

RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

FLOOD OF APR - JUN 1957
OPERATIONAL HYDROGRAPHS
LAKE TEXOMA

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

PLATE 8 - 3

RAINFALL IN INCHES

1

2

HYETOGRAPH REPRESENTS AVERAGE RAINFALL OVER INTERVENING AREA DENISON – ARTHUR CITY

FLOW IN THOUSANDS OF C.F.S.

250

200

150

100

50

0

UNREGULATED FLOW

REGULATED FLOW ①

DENISON RELEASES AT ARTHUR CITY ①

REGULATED FLOW ③ ② ①

DENISON RELEASES AT ARTHUR CITY ③ ② ①

19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

APRIL MAY JUNE

1957

NOTE: Plate is 11" x 17"

LEGEND

UNREGULATED FLOW

①— DENISON DAM OPERATED FOR MAXIMUM DOWNSTREAM BENEFITS.

②— DENISON DAM OPERATED IN ACCORDANCE WITH APPROVED REGULATIONS.

③— DENISON DAM OPERATED TO LIMIT POOL ELEVATION TO 640.0 INSOFAR AS POSSIBLE.

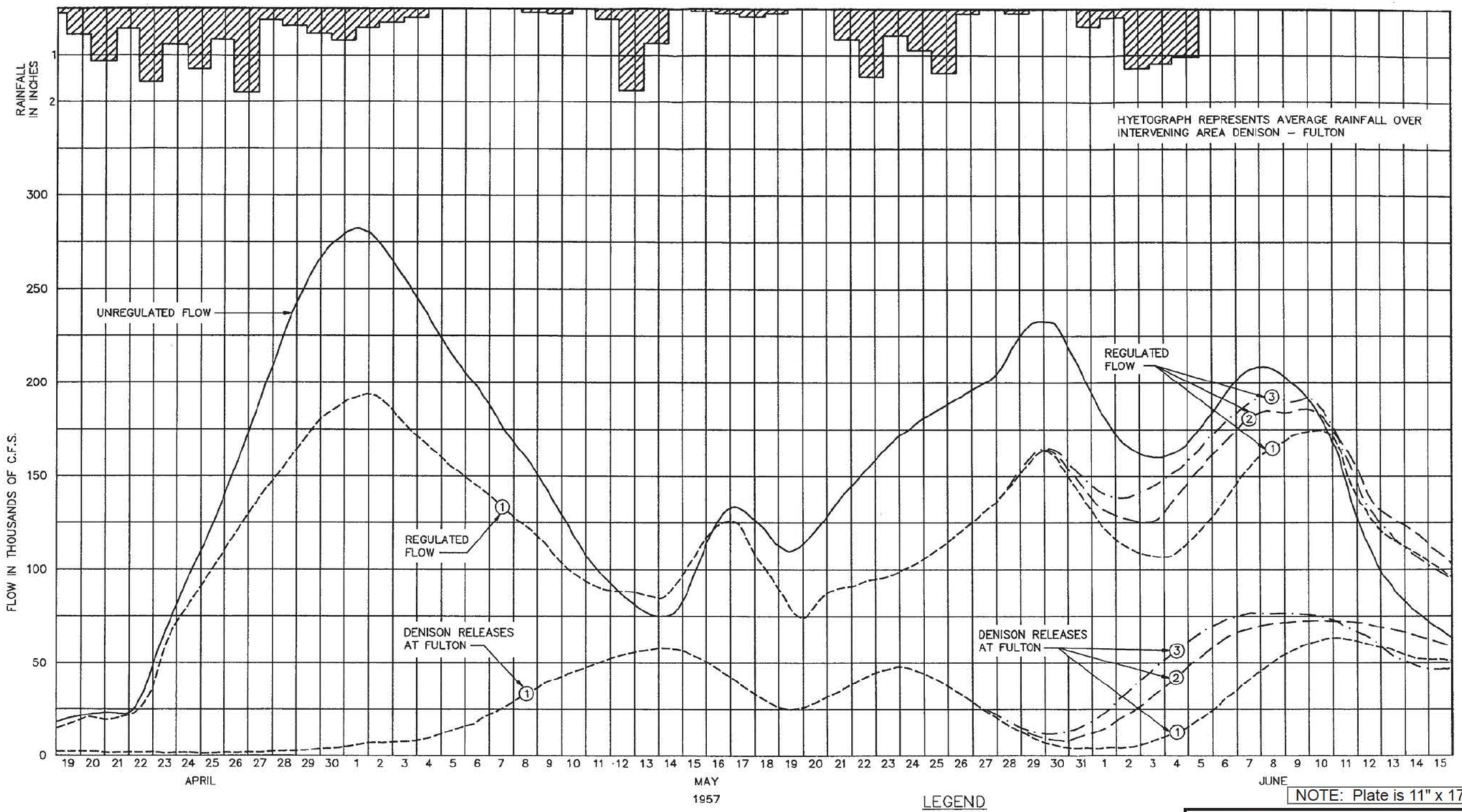
RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

FLOOD OF APR - JUN 1957 OPERATIONAL HYDROGRAPHS AT ARTHUR CITY, TX

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

PLATE 8 - 4



NOTE: Plate is 11" x 17"

LEGEND

- UNREGULATED FLOW
- ①– – – DENISON DAM OPERATED FOR MAXIMUM DOWNSTREAM BENEFITS.
- – –②– – DENISON DAM OPERATED IN ACCORDANCE WITH APPROVED REGULATIONS.
- – ·–③– · – DENISON DAM OPERATED TO LIMIT POOL ELEVATION TO 640.0 INSOFAR AS POSSIBLE.

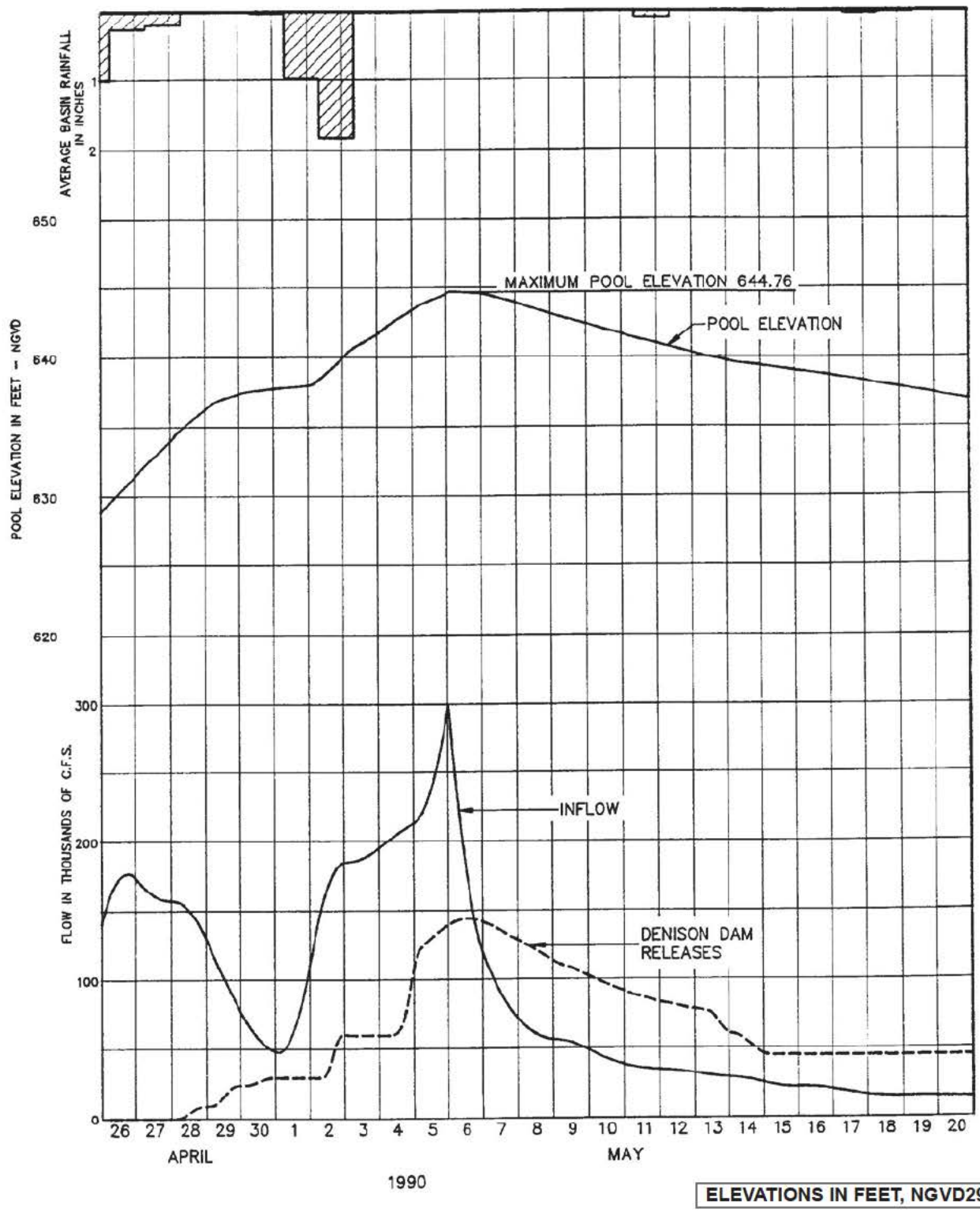
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

FLOOD OF APR - JUN 1957 OPERATIONAL HYDROGRAPHS AT FULTON, AR

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

PLATE 8 - 5



ELEVATIONS IN FEET, NGVD29

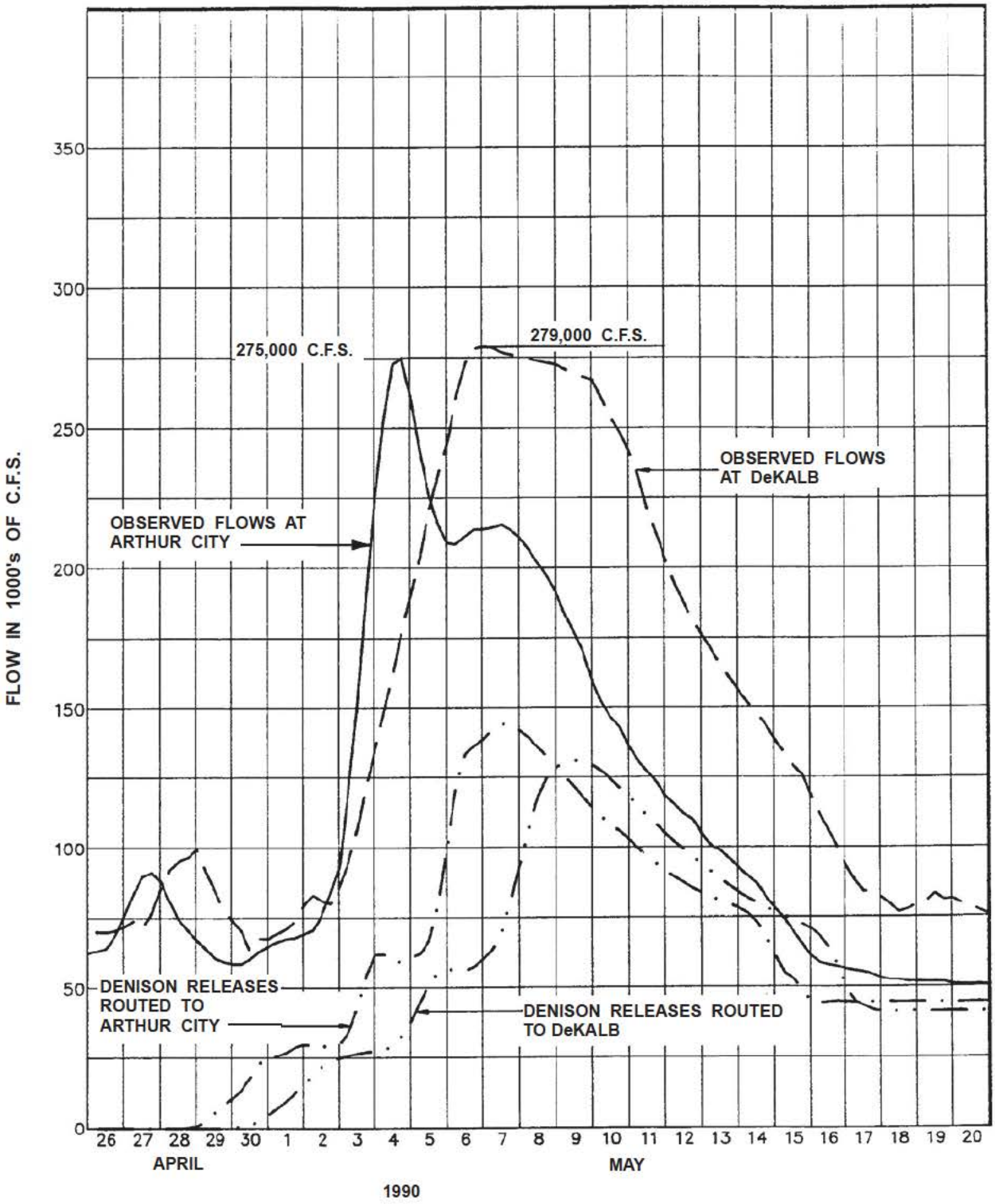
RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

FLOOD OF APRIL - MAY 1990
LAKE TEXOMA
OPERATIONAL HYDROGRAPHS

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

PLATE 8 - 6



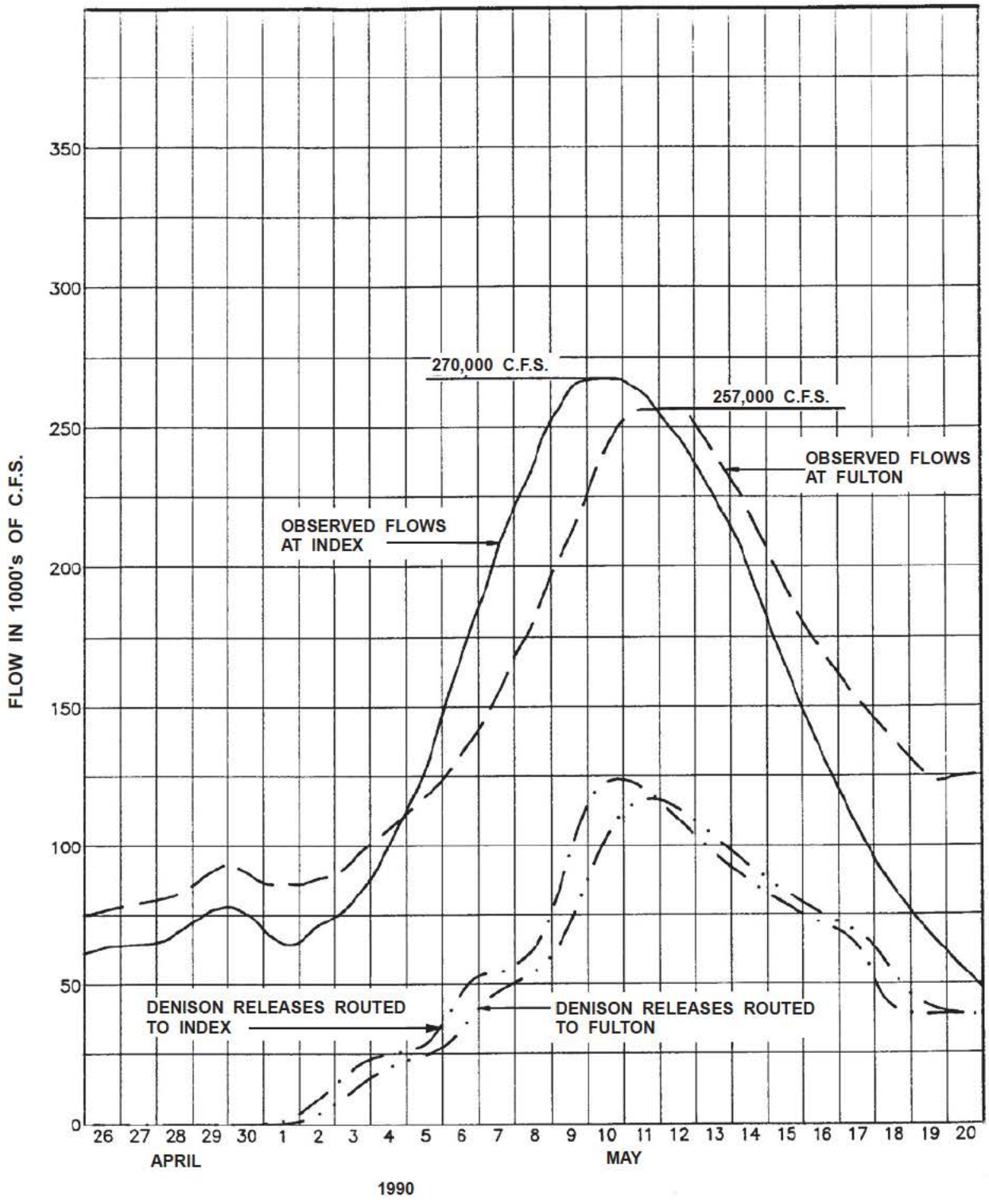
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

FLOOD OF APRIL - MAY 1990 OBSERVED AND ROUTED HYDROGRAPHS AT ARTHUR CITY and DeKALB, TX

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

PLATE 8 - 7



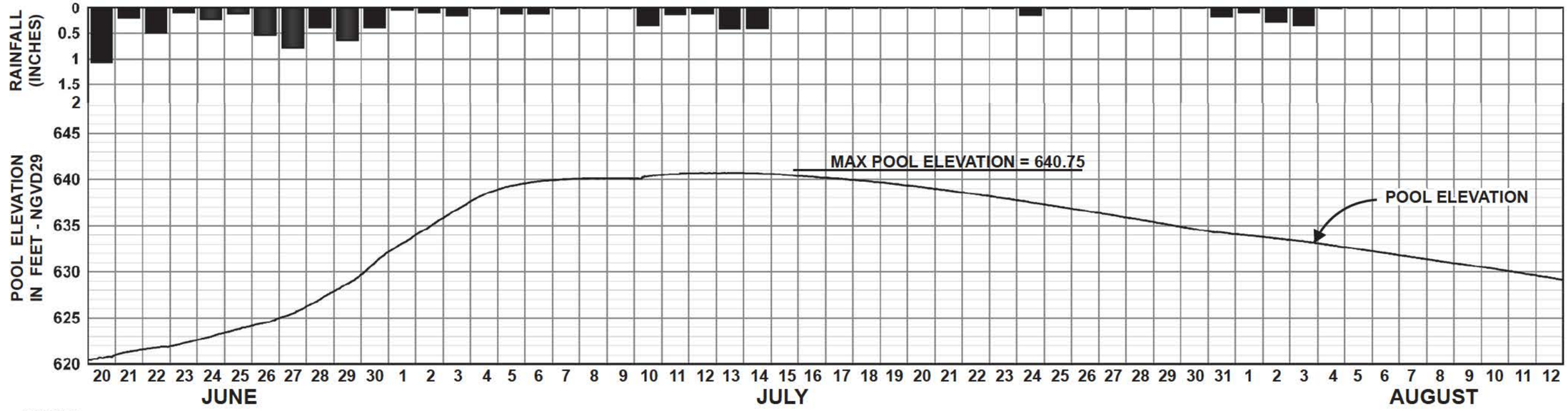
RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

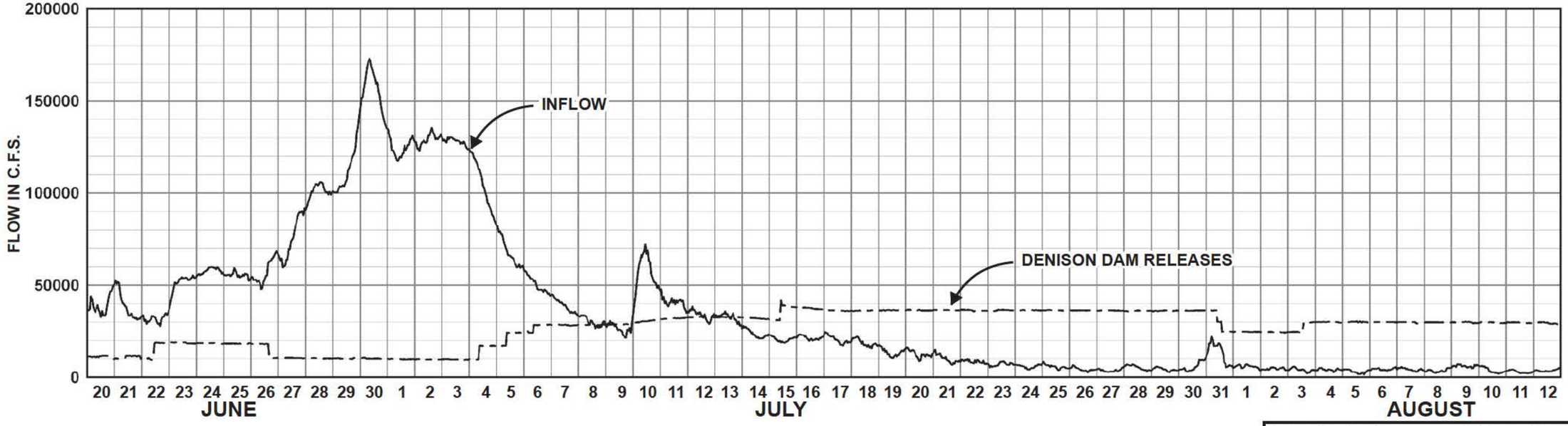
LAKE TEXOMA (DENISON DAM)

FLOOD OF APRIL - MAY 1990 OBSERVED AND ROUTED HYDROGRAPHS AT INDEX and FULTON, AR

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

PLATE 8 - 8





NOTE: Plate is 11" x 17"

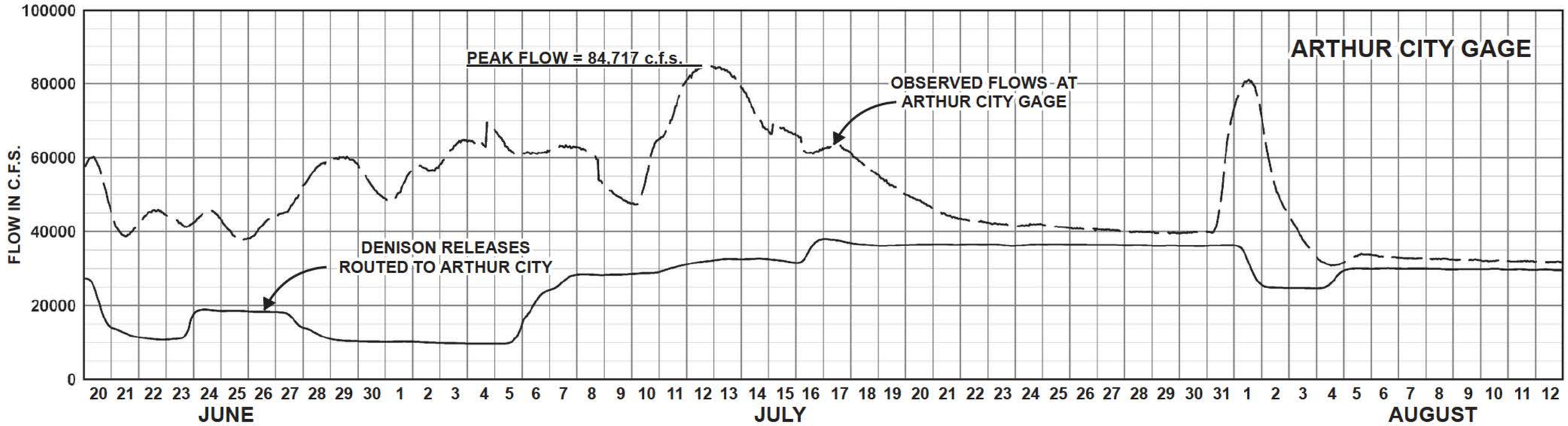
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

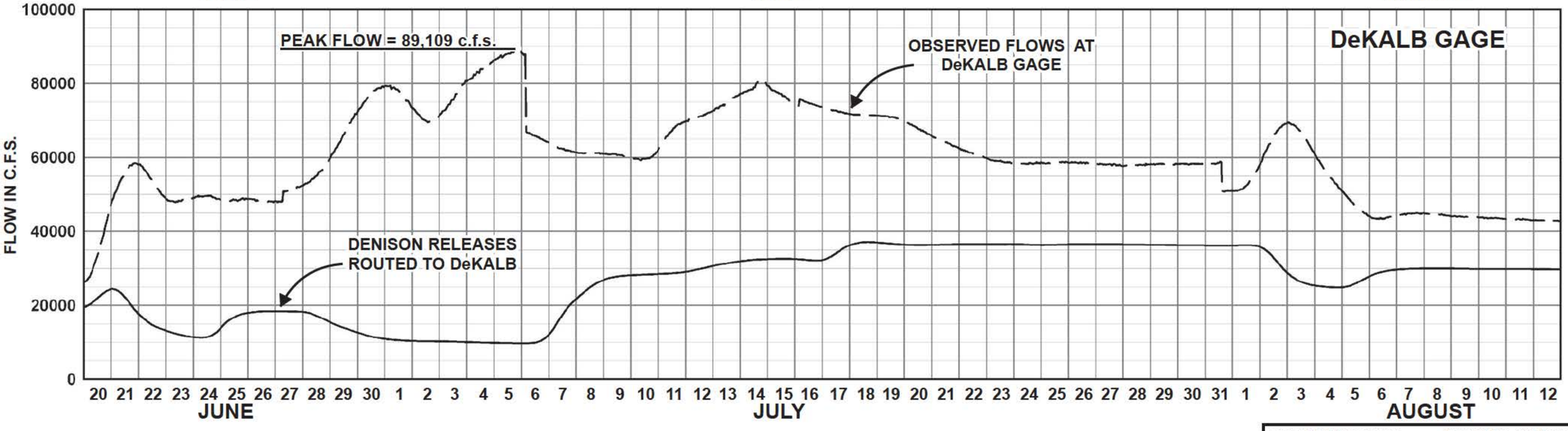
LAKE TEXOMA (DENISON DAM)

FLOOD OF JUNE - AUG 2007
LAKE TEXOMA
OPERATIONAL HYDROGRAPHS

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

PLATE 8 - 9





NOTE: Plate is 11" x 17"

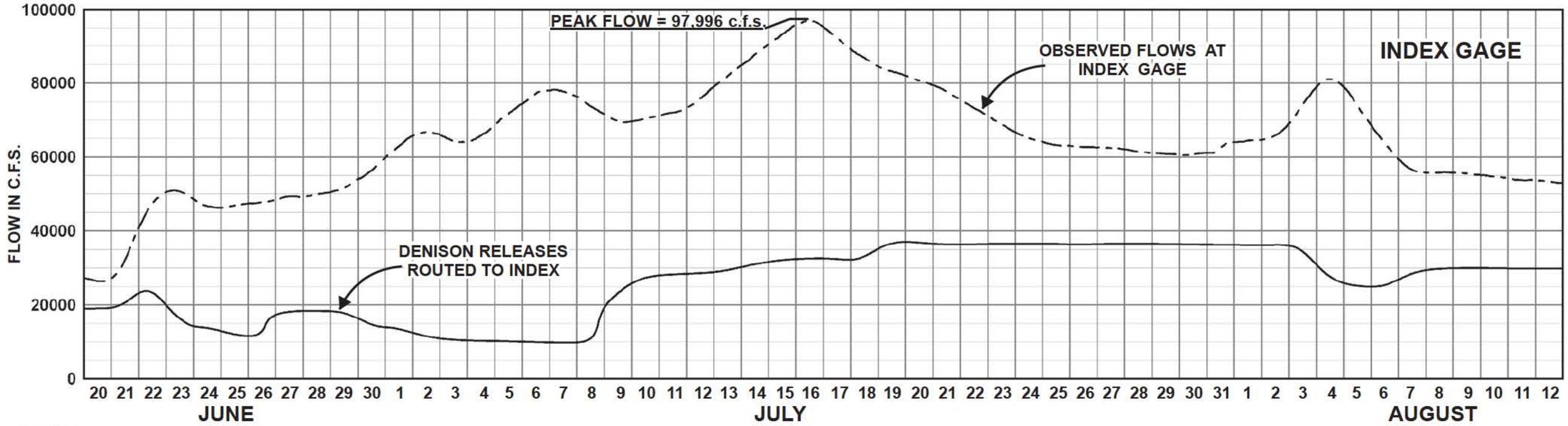
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

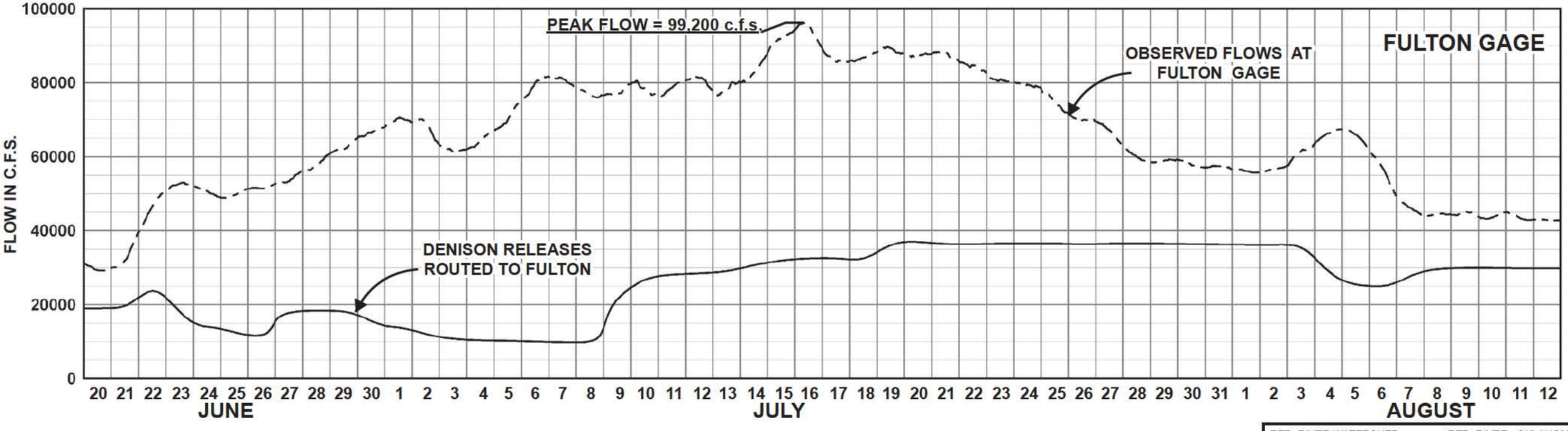
LAKE TEXOMA (DENISON DAM)

FLOOD OF JUNE - AUG 2007 OBSERVED AND ROUTED HYDROGRAPHS AT ARTHUR CITY and DeKALB, TX

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

PLATE 8 - 10





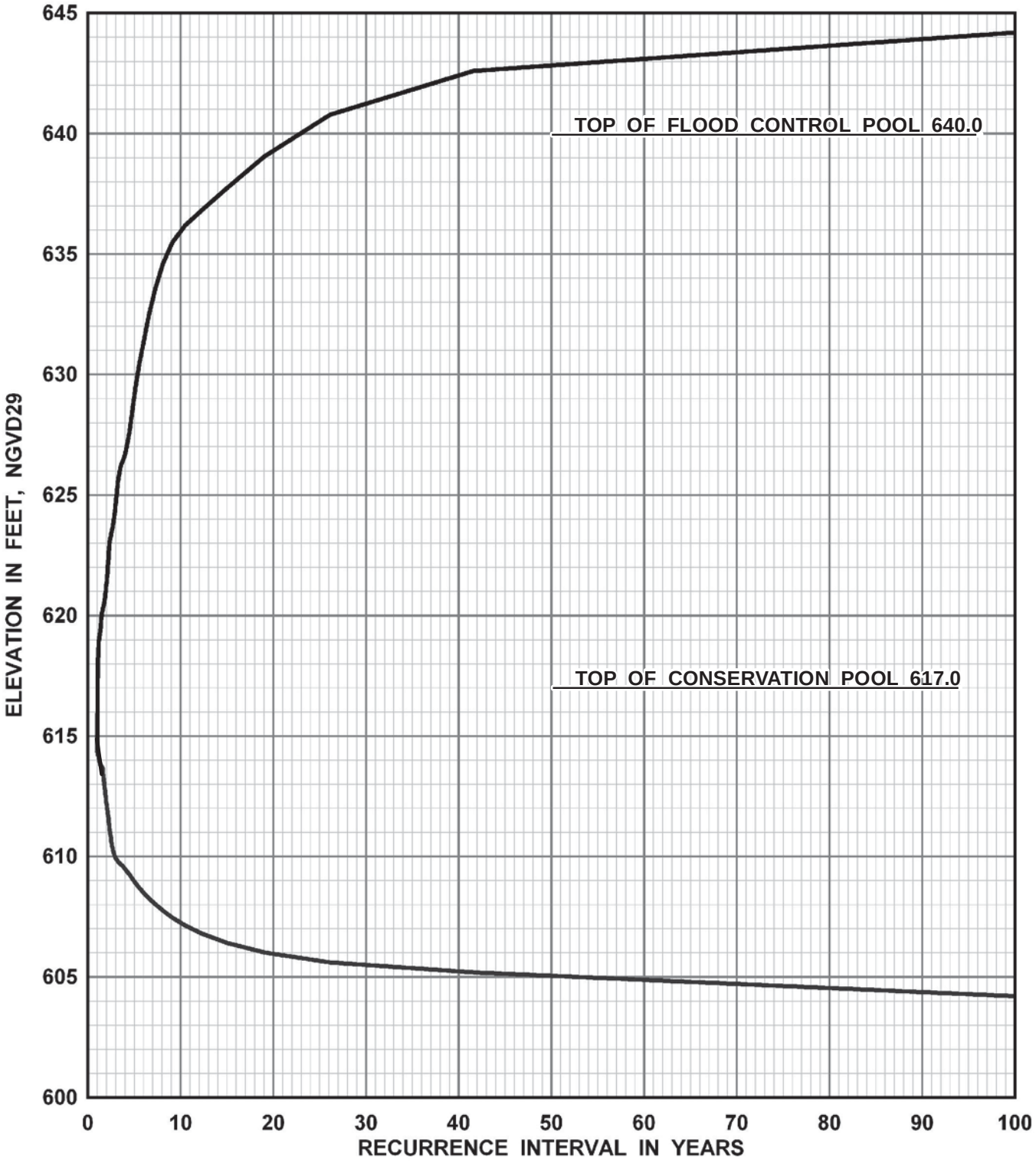
NOTE: Plate is 11" x 17"

RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

FLOOD OF JUNE - AUG 2007 OBSERVED AND ROUTED HYDROGRAPHS AT INDEX and FULTON, ARK

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



NOTE:

BASED ON PERIOD OF RECORD
JAN 1938 THRU DEC 2007 AND
FROM RIVERWARE RUN REDCOE_602 BaseModel
ManualData.mdl

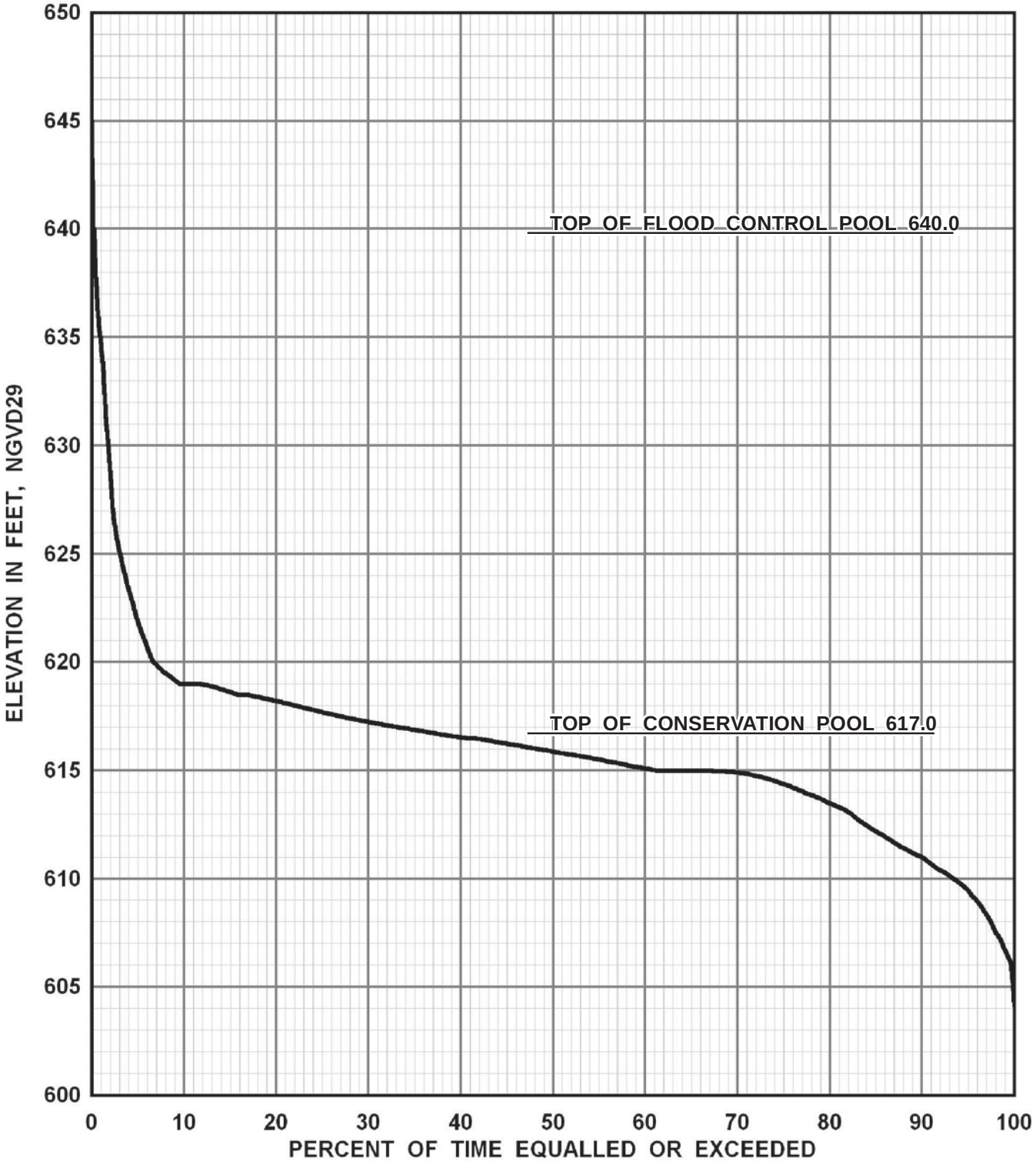
ESTIMATED YIELD OF 250 M.G.D.
USED IN MODEL RUN

RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

POOL ELEVATION PROBABLITY CURVE

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



NOTE:

BASED ON PERIOD OF RECORD
JAN 1938 THRU DEC 2007 AND
FROM RIVERWARE RUN REDCOE_602 BaseModel ManualData.mdl

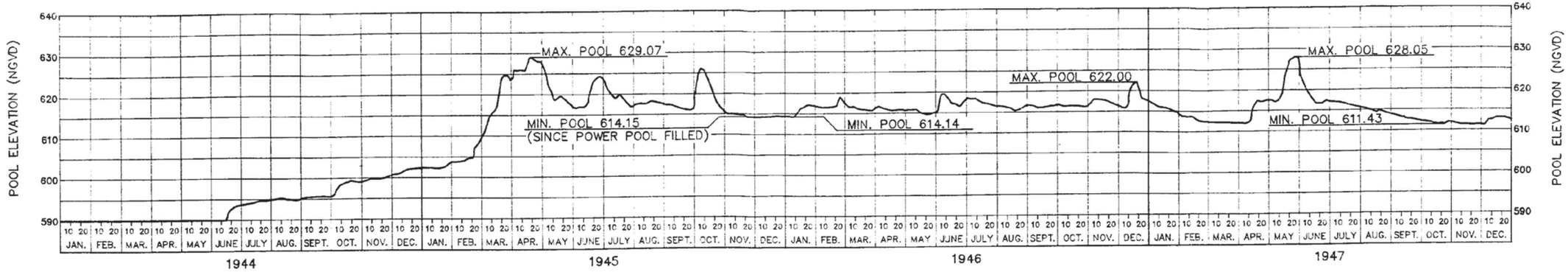
ESTIMATED YIELD OF 250 M.G.D.
USED IN MODEL RUN

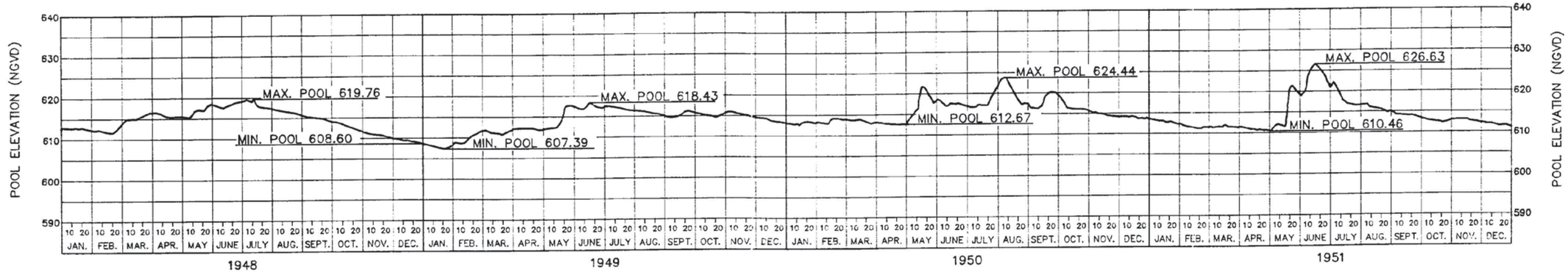
RED RIVER WATERSHED RED RIVER, OKLAHOMA AND TEXAS

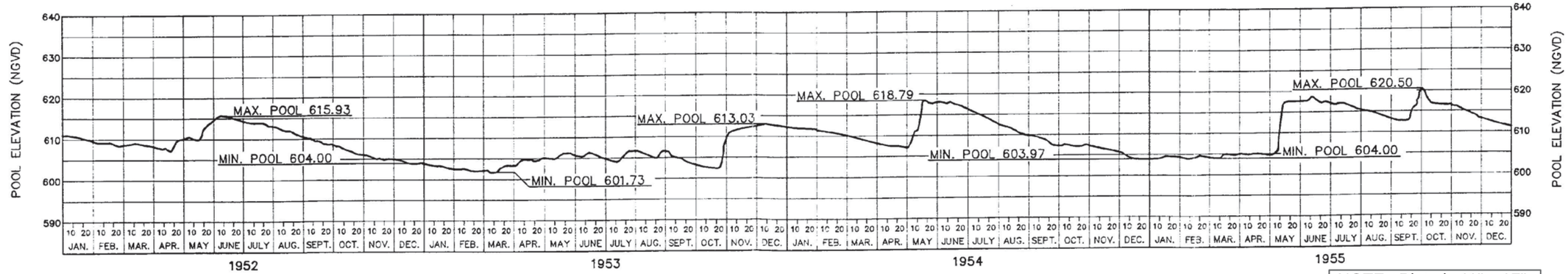
LAKE TEXOMA (DENISON DAM)

POOL ELEVATION DURATION CURVE

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







NOTE: Plate is 11" x 17"

ELEVATIONS IN FEET, NGVD29

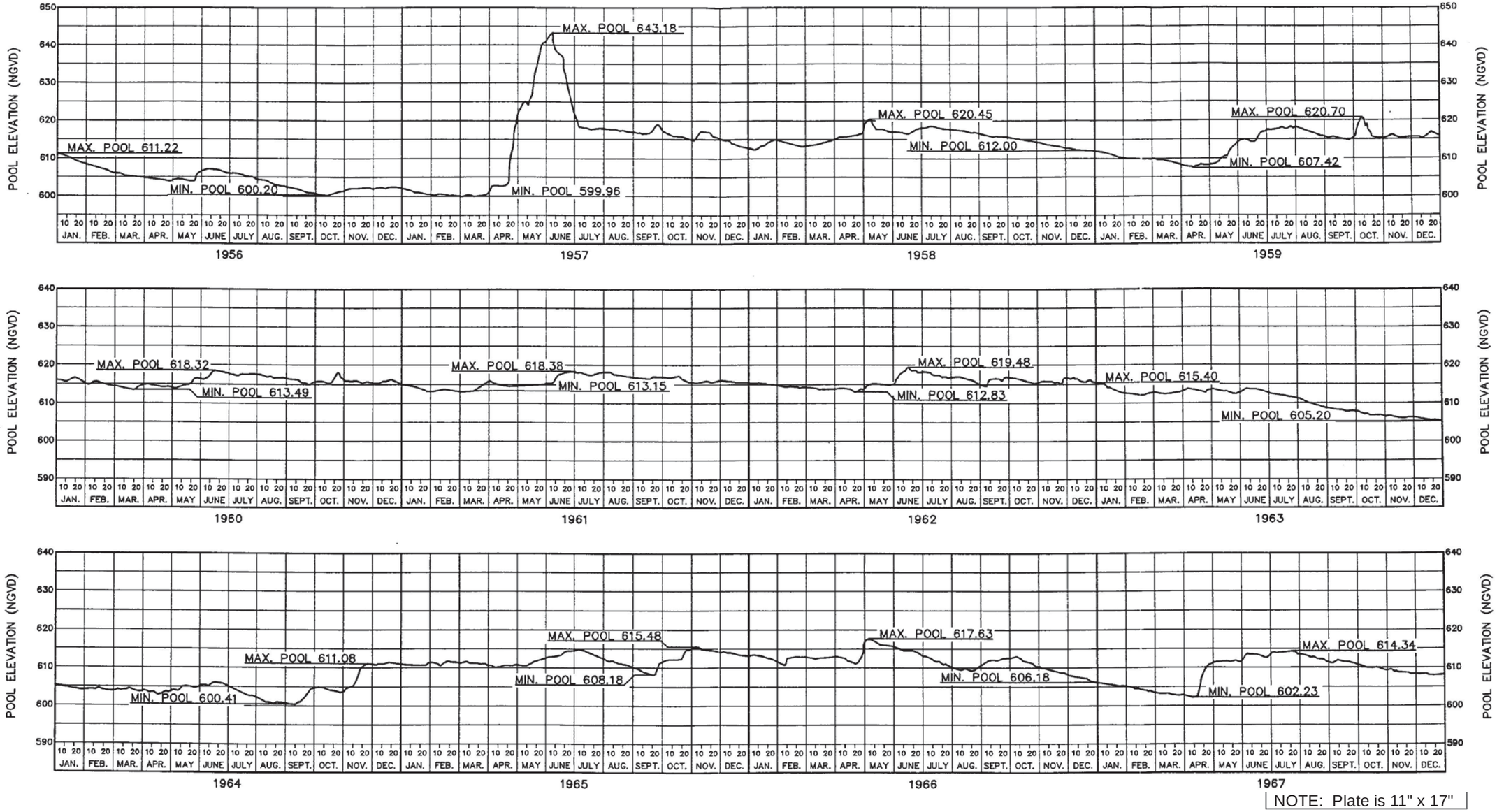
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

POOL ELEVATION HYDROGRAPHS 1944 - 1955

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

PLATE 8 - 14



NOTE: Plate is 11" x 17"

ELEVATIONS IN FEET, NGVD29

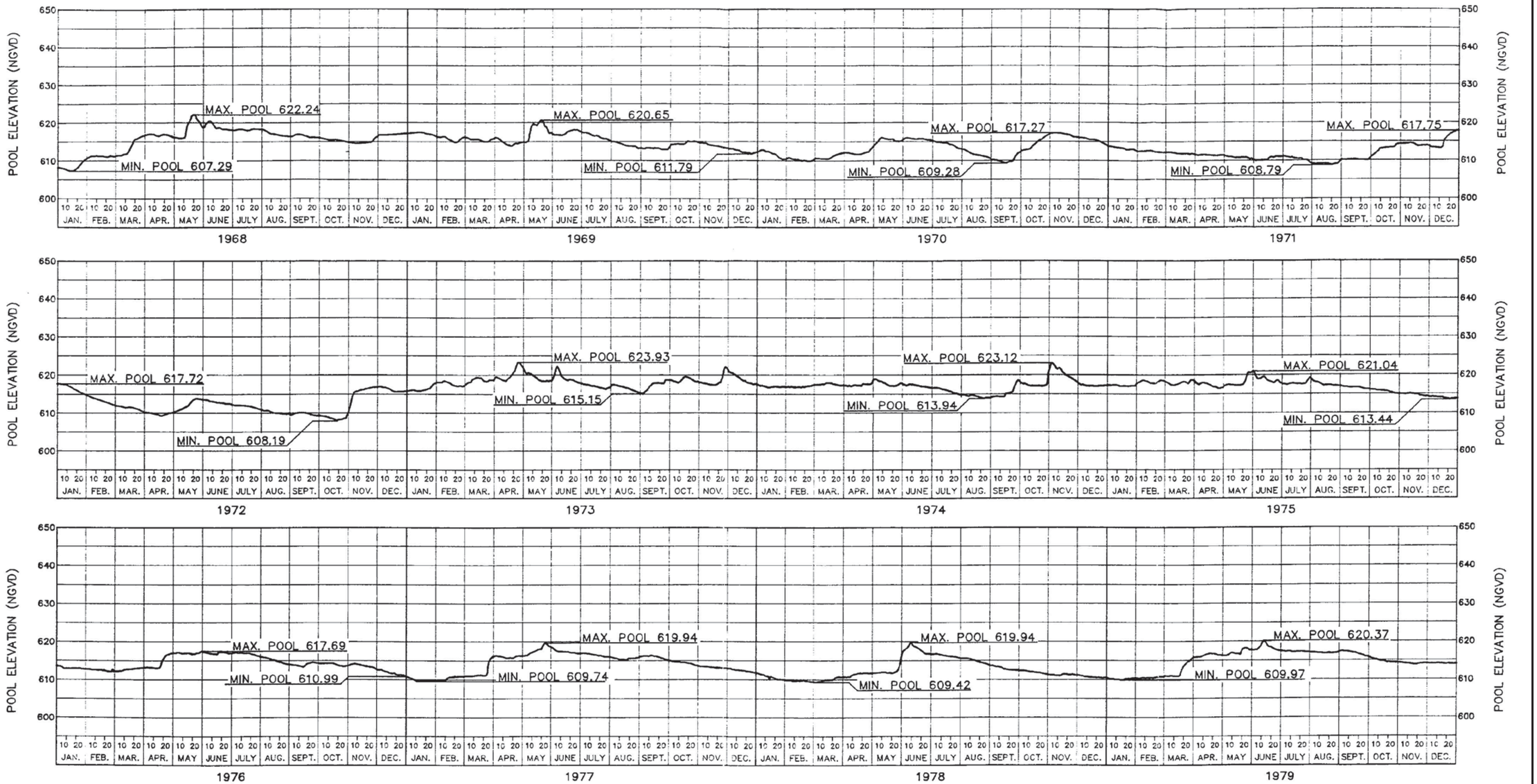
RED RIVER WATERSHED
ARKANSAS RIVER WATERSHED

RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

POOL ELEVATION HYDROGRAPHS 1956 - 1967

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



NOTE: Plate is 11" x 17"

ELEVATIONS IN FEET, NGVD29

RED RIVER WATERSHED

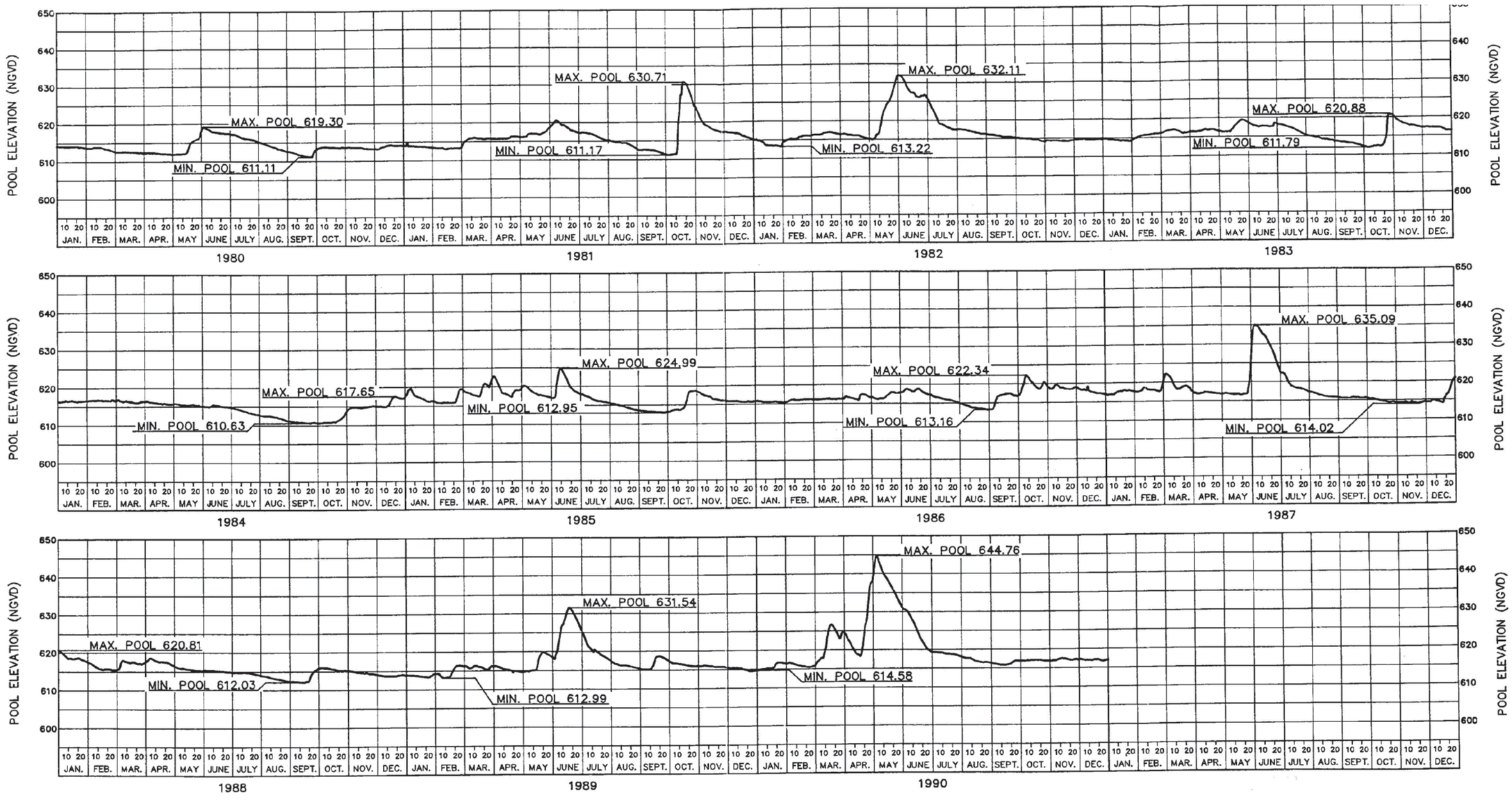
RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

POOL ELEVATION HYDROGRAPHS 1968 - 1979

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

PLATE 8 - 16



NOTE: Plate is 11" x 17"

ELEVATIONS IN FEET, NGVD29

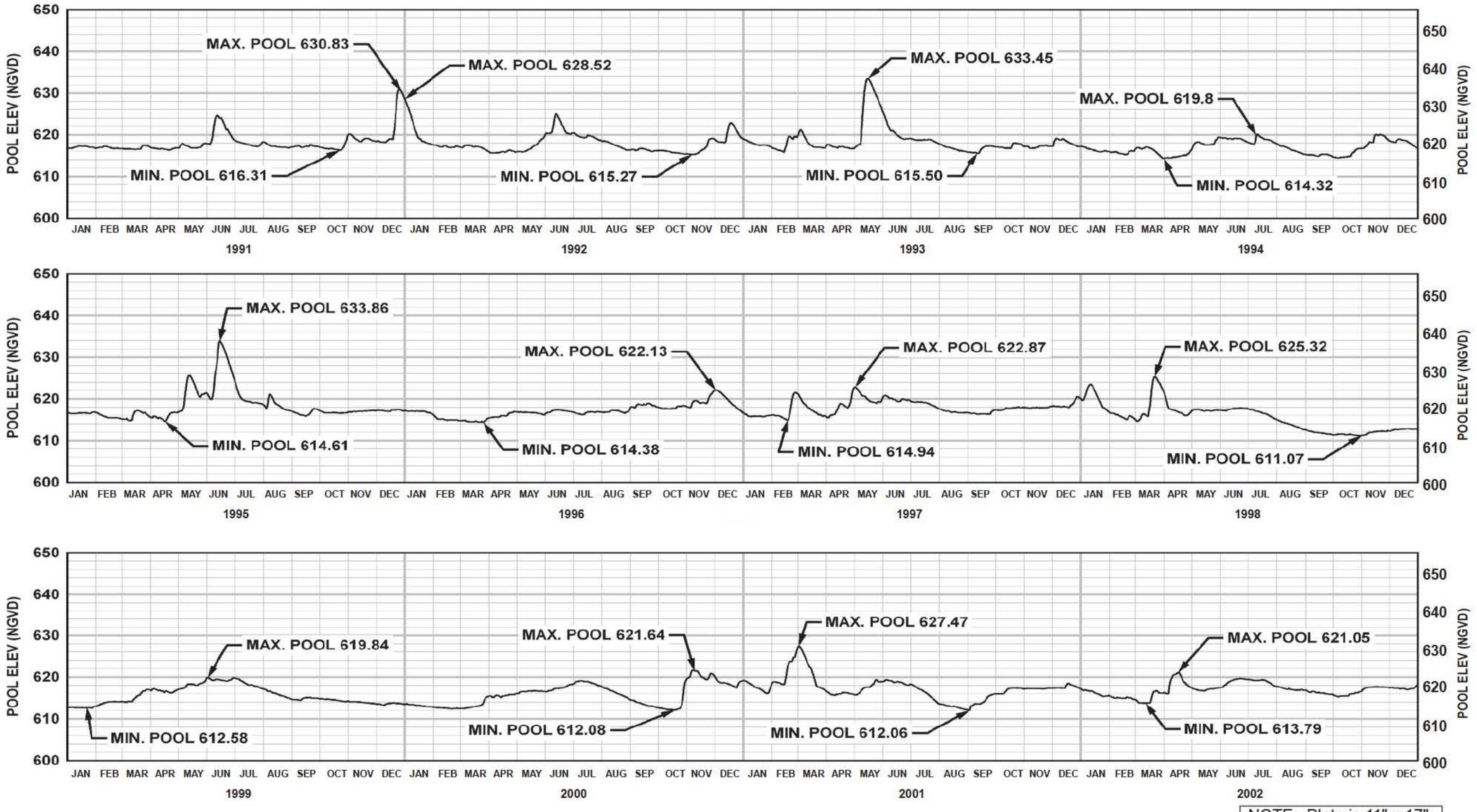
RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

POOL ELEVATION HYDROGRAPHS 1980 - 1990

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

PLATE 8 - 17



NOTE: Plate is 11" x 17"

ELEVATIONS IN FEET, NGVD29

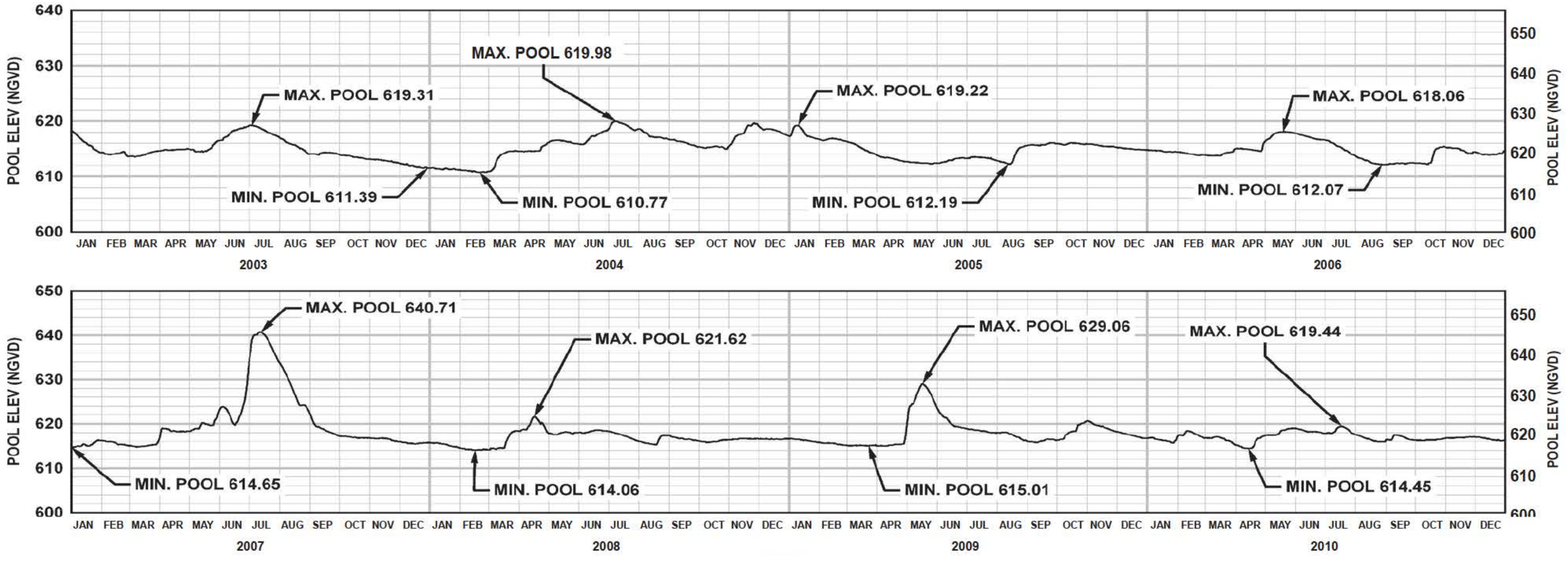
RED RIVER WATERSHED

RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

POOL ELEVATION HYDROGRAPHS 1991 - 2002

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



ELEVATIONS IN FEET, NGVD29

NOTE: Plate is 11" x 17"

RED RIVER WATERSHED — RED RIVER, OKLAHOMA AND TEXAS

LAKE TEXOMA (DENISON DAM)

POOL ELEVATION HYDROGRAPHS 2003 - 2010

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