FOSS DAM AND RESERVOIR

WASHITA RIVER, OKLAHOMA

WATER CONTROL MANUAL
APPENDIX D
TO
RESERVOIR REGULATION MASTER MANUAL
RED RIVER BASIN

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 looseleaf 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.

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 Reservoir Control Section, Tulsa District Office (918) 581-7668, or the District VHF-FM radio (call signal WUI-3, Hydraulics). If the above office cannot be contacted, assistance can be achieved by contacting, in the order listed, one of the persons shown below. Chapter 7 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 chapter. A separate copy of this chapter has been provided to the project office and must be displayed on the bulletin board at all times.

EMERGENCY PERSONNEL ROSTER
CORPS OF ENGINEERS PERSONNEL

Title and Name	Telephone
Chief, Section 7 Reg Unit, Office Residence	
Project Coordinator, Office Residence	
Backup Coordinator, Office Residence	
Chief, Arkansas River Ctrl Sec, Office Residence	
Chief, Red River Ctrl/Forecast Sec, Office Residence	
Chief, Hydrology-Hydraulics Branch , Residence	
Natural Disaster Specialist Emergency Management Division	

EMERGENCY PERSONNEL ROSTER
(Continued)

BUREAU OF RECLAMATION PERSONNEL

Title and Name	Telephone

EMERGENCY
PERSONNEL ROSTER
(Continued)

BUREAU OF RECLAMATION PERSONNEL

Title and Name	Telephone
Oklahoma-Texas Project Office, OK	
Project Manager [redacted] Residence	
Water Operations Branch Chief [redacted]	
Engineering Technician [redacted] Residence	
Great Plains Region, Billings Office	
Chief, Water Management Branch [redacted] Residence	
Hydraulic Engr., Water Mgmt Branch [redacted] Residence	

FOSS RESERVOIR MASTER CONSERVANCY DISTRICT PERSONNEL

Title and Name	Telephone
Superintendent, Foss Reservoir Office [redacted] Residence	
Dam Tender [redacted]	

SUPPLEMENTAL TELEPHONE LISTING

Title and Name	Telephone
U.S. Geological Survey	(405) 231-4256
Public Affairs Office	(918) 669-7366
Tulsa River Forecast Center	(918) 838-7838
National Weather Service	(800) 522-4739

RAINFALL GAGE REPORTERS

Gage	Reporter
Headrick 3E	
Erick	
Retrop	
Roosevelt	
Sayre	
Sweetwater, TX	
Willow	
Elmer	NWS DARDC
Elk City	
Altus Irrigation Research Station	

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LOCATION:

Foss Dam is located in Custer County, Oklahoma, RM 474.4 on the Washita River about 7 miles north of Foss, Oklahoma.

DRAINAGE AREA:

1,496 square miles
one inch of runoff = 79,787 acre-feet

DAM:

Type: Rolled earth
Length: 18,120 feet
Maximum Height: 134 feet above streambed
Top Width: 30 feet

SPILLWAY:

Type: Uncontrolled circular drop inlet
Crest Elevation: 1668.6 feet NGVD
Diameter: 9 feet 6 inches

IRRIGATION OUTLET WORKS:

Type and size: 5-foot diameter concrete conduit upstream and a freeflow modified 8-foot horseshoe conduit downstream
Control: Two double-gated 2'9"H x 2'9"W with 4-inch bypass
Invert: 1602.0 feet NGVD

LAND ACQUISITION:

	Guide Contour (feet NGVD)	Area (acres)
Fee simple	1654.5	14,040
Easement	1654.5 to 1668.6	1,562

RIVER OUTLET WORKS:

Type and size: 11-foot diameter concrete conduit upstream and a flat-bottom conduit downstream
Control: Two double-gated 6'0"H x 7'6"W gates with 8-inch bypass
Invert: 1597.2 feet NGVD

WATER SUPPLY:

Type and size: 4 upstream concrete-encased 24-inch steel pipes; and downstream modified horseshoe tunnel with one 26-inch steel outlet pipe.
Control: Four 24-inch wedge gate valves
Invert: 1597.2, 1612.0, 1627.0, 1642.0 feet NGVD

LOW FLOW:

8-inch gate valve with 2-inch diameter hole cut in valve

POWER FEATURES:

None

OPERATIONAL
(see Appendix A for "As Authorized" regulation)

Feature	Elevation (feet-NGVD)	Reservoir Area (acres)	Reservoir Capacity Accumulative (acre-feet)	Runoff (inches) (1)	Incremental (acre-feet)	Runoff (inches) (1)	Discharge Capacity (cfs) (8)
Top of dam	1697.0						
Maximum pool	1694.2 (2)	21,980	884,820	11.09	448,290	5.62	7,760 (3)
Spillway crest	1668.6	13,140	436,530	5.47	78,220	0.98	3,990 (5)
Top of flood control pool	1662.2	11,360	358,310	4.49	180,410 (4)	2.26	3,840 (5)
Top of conservation pool	1642.0	6,800	177,900	2.23	165,480 (6)	2.07	3,350 (5)
Top of inactive pool	1597.2 (7)	1,360	12,420	0.16	12,420	0.16	0
Streambed	1563.0	0	0	0	0	0	0
Operational Flood Control Storage to Maximum Storage	1662.2-1694.2	--	526,510 (3)	6.60	--		
Irrigation and Water Supply Storage (4)	1597.2-1642.0	--	165,480	2.07	--		
Sediment Storage (not Distributed)	1563.0-1597.2	--	76,000	--	--		

(1) Contributing drainage area is 1,496 square miles.
(2) Based on 78.9% Probable Maximum Flood.
(3) Total spillway and river outlet works.
(4) Includes 3,500 acre-feet of sediment storage.
(5) River outlet works only.
(6) Jointly used to meet irrigation and municipal requirements.
(7) Invert elevation of river outlet works intake structure.
(8) Total of spillway and outlet combined.

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I - INTRODUCTION

1-01. Authorization. This manual is submitted in accordance with ER 1110-2-240 and ER 1110-2-241 and prepared in accordance with EM 1110-2-3600 and ETL 1110-2-251.

1-02. Purpose and scope. The purpose of this manual is to document the plan of water control; to present detailed information to a higher authority; and to give guidance to personnel who will become concerned with, or responsible for, regulation of the reservoir during the life of the project. This manual also updates the Foss Reservoir Regulation Manual, Appendix D to the Red River Basin Reservoir Regulation Master Manual, and supersedes regulations contained in the Reservoir Regulation Manual for Foss Reservoir dated January 1961.

1-03. Related manuals. This manual is Appendix D to the Red River Basin Water Control Master Manual. Other manuals found in this referenced Master Manual are:

Appendix A - Texoma	(May 1975)
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Part VI - Dierks	(May 1975)
Part VII - Millwood	(Sep 1973)
Appendix F - Arbuckle	(Nov 1966)
Appendix G - Pat Mayse	(Nov 1966)
Appendix H - Hugo	(May 1982)
Appendix J - Lake Kemp	(May 1973)
Appendix K - Mountain Park Dam and Tom Steed Reservoir	(Jan 1976)
Appendix L - Waurika	(Apr 1977)
Appendix M - Sardis Lake	(Jul 1984)
Appendix N - McGee Creek	(Apr 1989)
Appendix DCP-1 - Upper Red River Basin Drought Contingency Plan	(Oct 1989)
Appendix DCP-2 - Lower Red River Basin Drought Contingency Plan	(Pending Approval)

The locations of existing and authorized projects are shown on Plate 1-1.

1-04. Project owner. U.S. Department of Interior, Bureau of Reclamation (Reclamation).

1-05. Operating agency. The Foss Reservoir Master Conservancy District (District) is responsible for operation and maintenance (O&M) of Foss Dam. All operations are supervised by the Bureau of Reclamation from their Oklahoma-Texas Project Office in Oklahoma City, Oklahoma. The Great Plains Regional Office, Billings, Montana, provides oversight for the Project Office. The Regional Office publishes the Standing Operating Procedures (SOP), and revisions must be approved by the regional director. The Regional Office coordinates the Review of Maintenance examinations and

provides technical Operation and Maintenance assistance. The regional director has assigned the Water, Land, and Power Division this supervisory responsibility.

Operation and maintenance of the dam and reservoir are accomplished by District personnel under the direction of the Superintendent. The Superintendent supervises equipment operations at the dam, reservoir data recording and reporting, the reporting of any unusual occurrences, and the performance of routine maintenance work.

The District is responsible for reporting operational information to Reclamation and to the U.S. Army Corps of Engineers (Corps) District office, Tulsa, Oklahoma, in accordance with existing flood control regulations and the Standing Operating Procedures.

1-06. Regulating agencies. The Bureau of Reclamation, Oklahoma-Texas Project Office in Oklahoma City, Oklahoma, is responsible for all regulation of Foss Reservoir other than that which relates to the flood control pool. Normal daily regulation procedures are established by Reclamation and carried out by the District.

Regulation of flood control storage, between elevations 1642.0 and 1662.2 feet National Geodetic Vertical Datum (NGVD), is directed by the Corps in accordance with approved flood control regulations as required by Section 7 of the Flood Control Act of 1944 (58 Stat. 890, 33 USC 709). When the pool is above elevation 1162.2 feet NGVD, Reclamation is responsible for directing storage and release of all waters. Assistance is provided by the Corps in evaluating the real-time situation at the request of, and is used at the discretion of, Reclamation.

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III - HISTORY OF PROJECT

3-01. Authorization. Foss Reservoir was authorized by Public Law 419, 84th Congress, 2nd Session, approved 25 February 1956. The dam was constructed by Reclamation, and the reservoir is operated by that agency except for the flood control storage between elevations 1642.0 and 1662.2 feet NGVD. The flood control regulations are under the direction of the Assistant Secretary of the Army for Civil Works, supervised by the Corps, Tulsa District, and performed for Reclamation by District personnel.

3-02. Planning and design. Foss Reservoir is part of Reclamation's comprehensive plan of improvement for the Washita River Basin. This plan, entitled "Plan of Improvement for Washita River Subbasin, Red River Basin, Oklahoma and Texas", was published in 1953 as House Document No. 219, 83rd Congress, 1st Session. This plan consists of a 7-reservoir system with an aggregate flood control storage of 738,000 acre-feet on the Washita River and its tributaries plus irrigation and water supply works. The reservoirs planned were Foss, Mountain View, and Durwood on the mainstem of the Washita River, Fort Cobb on Cobb (Pond) Creek, Gracemont on Sugar Creek; Chickasha on the Little Washita River, and Purdy on Rush Creek. Foss Reservoir, after sedimentation, provides 24 percent of the total flood control storage for the system.

The plan of improvement studied by Reclamation, as published in House Document 219, with certain exceptions, was authorized by Public Law 419, 84th Congress, 2nd Session, and was signed by the President on 25 February 1956. This law authorized the construction of Fort Cobb Reservoir (completed in November 1959) on Cobb (Pond) Creek and Foss Reservoir (completed in February 1961) on the main stem of the Washita River. The locations of Fort Cobb and Foss Reservoirs are shown on Plate 1-1.

The flood control requirements were studied by the Corps and are contained in a report entitled: "Comprehensive Survey Report for Red River, Louisiana, Arkansas, Oklahoma, and Texas (above Fulton, Arkansas)" dated 15 January 1948. The flood control storage recommended in that report for Foss Reservoir was 177,000 acre-feet and was confirmed by a Tulsa District letter dated 28 June 1951 to the Area Engineer, Bureau of Reclamation, Oklahoma City, Oklahoma. Reclamation allocated 180,500 acre-feet for flood control storage initially, which included 3,500 acre-feet for 73 years of sediment deposition.

The U.S. Department of Agriculture, Soil Conservation Service (SCS), published a review survey report of the Washita River watershed in November 1951. The provisions of this report were enacted into law by Public Law No. 566 (1954) and amended by Public Law 1018 (1956). Under the provisions of these laws, SCS has constructed 1,067 detention structures in the Washita Basin as of April 1991. There are 199 of these structures upstream of Foss Reservoir, and 868 have been completed on the Washita River watershed downstream of the dam.

3-03. Construction. A resume of construction activities is given in Table 3-1.

TABLE 3-1

RESUME OF CONSTRUCTION ACTIVITIES

ACTIVITY	DATE
Construction Began	31 October 1958
Final Storage Began	13 February 1961
Current Conservation Pool Filled	30 May 1977
As-Authorized Conservation Pool Filled	(1)

(1) As-authorized conservation pool level (1652.0 feet NGVD) has not been reached.

3-04. Related projects. Foss Reservoir acts in conjunction with Fort Cobb Reservoir located on Cobb (Pond) Creek, Arbuckle Reservoir located on Rock Creek, and the SCS detention structures to provide partial regulation of Washita River flows.

The SCS has developed a comprehensive plan for the construction of numerous small detention structures in the Washita River Basin and has constructed 199 detention structures upstream of Foss Reservoir. These structures control, to some extent, the runoff from 860 square miles of the 1,496-square-mile drainage area upstream of Foss Dam. These structures fill, on average, once in 5 years to once in 25 years. They have a total of 98,985 acre-feet of storage at the crest of the emergency spillway and a combined surface area of 10,698 acres. (Foss Reservoir has 6,800 acres of surface area at the operational conservation pool elevation of 1642.0 feet NGVD). These detention structures reduce the base inflow into Foss Reservoir and also aid in the control of many minor and intermediate floods in the Washita River Basin. The large combined surface area increases evapotranspiration losses when these structures are near their conservation levels. The actual effect these structures have on the runoff characteristics of the basin cannot be determined with any degree of accuracy, because information concerning the levels of the conservation storage is not available. There are 868 structures in the basin downstream of Foss Dam. They have a storage volume of 465,000 acre-feet at their conservation levels. These structures control to some extent the runoff from 2,150 square miles of the 6,449-square-mile drainage area downstream of Foss Dam.

3-05. Modification to regulation. The regulation of Foss Reservoir has been modified to adjust for the reduction in channel capacity downstream of the project. No significant releases were made into the channel downstream of Foss Reservoir from the time of closure in February 1961 until October 1977 when releases were made to lower the conservation pool because of seepage under the embankment. The channel capacity has been reduced because of encroachment in the channel, existing low-water crossings and general deterioration of the channel downstream of the project. Currently, bankfull flow is 1,000 cfs at the Foss gage and 1,900 cfs at the Clinton gage, however, releases have been limited to 1,000 cfs due to flooding in the reach between the dam and Clinton, Oklahoma.

Foss Reservoir has been operated for a conservation pool of 1642.0 feet NGVD since 1977 because of a seepage problem and a change in the inflow design flood. Because of these changes, the pool has never reached the as-authorized flood control pool level, but releases have been made to maintain the lower conservation pool.

3-06. Principal Regulation Problems. Seepage at the Foss Dam in October 1977 resulted in the reservoir being regulated to a conservation pool of 1642.0 feet NGVD, 10 feet below the as-authorized conservation pool level of 1652.0 feet NGVD. Reclamation has installed a series of relief wells and toe drains to control this seepage.

Revised Probable Maximum Flood (PMF) studies were initiated for Foss Reservoir in 1981. An inflow design flood decision analysis for Foss Reservoir is given in Technical Memorandum FD-2-222-1 dated August 1984. The results of this analysis by Reclamation indicated that the inflow design flood should be equated to the PMF. One of the alternatives considered to reduce the possibility of dam failure from overtopping was to lower the top of conservation pool to elevation 1642.0 feet NGVD. A portion of the conservation storage was allocated for irrigation on the condition that the demand would develop within a given time frame (10 years). This time has elapsed and the irrigation storage amounts to approximately the storage between elevation 1642.0 feet and 1652.0 feet NGVD. The decision was made by Reclamation, with the concurrence of the Corps and the District to reduce the top of conservation pool to elevation 1642.0 feet NGVD.

IV - WATERSHED CHARACTERISTICS

4-01. General characteristics. The Washita River watershed upstream of Foss Reservoir is roughly elliptical in shape, with an average length of 80 miles and an average width of 20 miles. Foss Reservoir has a drainage area of 1,496 square miles. Land elevations vary from about 3000 feet NGVD in the vicinity of Miami, Texas (near the headwaters of the Washita River), to elevation 1562 feet NGVD at the Foss Dam site. Streambed slopes range from 11 feet per mile in the upper 80 miles of its course to about 5 feet per mile near the reservoir. The stream pattern consists of one principal stream with several minor tributaries. A stream profile of the Washita River is shown on Plate 4-1.

4-02. Topography. The Washita River, a tributary of the Red River, is located in southwestern Oklahoma and the eastern portion of the Panhandle of Texas (see Plate 1-1). Within the limits of the Foss Reservoir watershed are parts of three Texas counties and four Oklahoma counties. The headwater areas of the Washita River Basin are in the east portion of the high plains of the Texas Panhandle from where the basin extends southeastward into Oklahoma to Foss Dam. This section is a relatively flat plain interrupted by north-trending bands of hilly terrain with relief rarely exceeding 250 feet. Topography throughout most of the basin is erosional in character, and is principally associated with the entrenchment of the main stream and tributaries in the old plain surface. The terrain is rolling to hilly with mild slopes, a matured stream, and rather sparse vegetative cover, mostly grass. The trend of major drainages is southeast in wide, alluvium-filled valleys. Drainage patterns are dendritic with the Washita River forming the main stem.

4-03. Geology and soils. Foss Dam and Reservoir are located in the Osage Section of the Central Lowlands Physiographic Province. The soils in the basin above Foss Dam consist mostly of the Miles-Vernon soil association group. In the Texas Panhandle there is a small amount of Lithosol soils. The soils of the Miles-Vernon group vary in color from red to reddish brown or grayish brown and range in texture from sand to clay. The Miles soils have fairly deep surface soils, usually rather sandy and mellow. The Vernon soils are thin, red, immature soils and have crumbly clay subsoils. The Lithosol soils are a group of miscellaneous intrazonal and azonal soils varying greatly in character and degree of soil development, nature and depth of soil and soil material, and in external features of relief, stoniness, and drainage. In this area the soils are comparatively light colored.

The principal structural element in the region is the Anadarko basin. The axis of this structural low is situated just south and west of the Foss Dam area and trends west-northwest. The Wichita-Amarillo Mountain system, which borders the Anadarko basin on the south, is a structural high consisting of a Precambrian igneous intrusive mass overlain by a thick sequence of early and middle Paleozoic marine sedimentary rocks. These rocks were strongly folded and faulted during the late Paleozoic and are unconformably overlain by marine clastic and chemically precipitated rocks deposited near the close of the Paleozoic Era. These latest sedimentary rocks are flat lying to gently warped. Localized dissolution and subsidence structures, resulting from subsurface dissolution of evaporites, occur in the region.

The bedrock foundation at Foss Dam belongs to the Permian Cloud Chief Formation. This formation is generally impermeable and consists primarily of gypsiferous red silty shale but includes siltstone and sandstone layers and gypsum lentils. Sinkholes and filled chimneys are prominent features of the Cloud Chief Formation in some areas. The Cloud Chief Formation and the underlying Rush Springs Sandstone form much of the reservoir rim, but the floor of the reservoir basin is generally covered by thick alluvial deposits.

TABLE 4-1

AVERAGE MONTHLY AND ANNUAL RAINFALL
AND RUNOFF UPSTREAM OF FOSS DAM

MONTH	AVERAGE RAINFALL[1] (INCHES)	PERCENTAGE OF AVERAGE ANNUAL RAINFALL	AVERAGE RUNOFF[2][3] (ACRE-FEET)	(INCHES)	PERCENT OF AVERAGE ANNUAL RUNOFF
January	0.7	3	1,820	0.02	3
February	1.0	4	2,340	0.03	4
March	1.7	7	3,730	0.05	6
April	2.0	8	9,440	0.11	14
May	4.4	17	16,280	0.21	25
June	3.5	14	12,980	0.16	20
July	2.3	9	4,070	0.05	6
August	2.5	10	3,230	0.04	5
September	2.7	11	2,940	0.04	5
October	2.3	9	4,180	0.05	6
November	1.3	5	2,590	0.03	4
December	0.8	3	1,720	0.02	2
TOTAL	25.2	100	65,320	0.81	100

(1) Period of Record 1930 through 1989.
(2) Drainage Area Above Foss Dam = 1,496 Square Miles.
(3) Period of Record 1926 through 1990.

At Foss Dam the Washita River Valley contains up to 130 feet of Quaternary-age alluvium of clay, silt, sand, and minor gravel. The alluvial deposits within the valley are of generally low permeability. Clean, well-sorted stream, terrace and dune sands and silty sands with significant permeability occur at various places within the valley fill and on the valley slopes.

4-04. Sediment. Reclamation initially allocated 76,000 acre-feet of storage for 73 years of sediment deposition below the maximum flood control pool. However, only 3,500 acre-feet of sediment is expected to be deposited between elevations 1652.0 and 1668.6 feet NGVD. Accumulation of sediment to date in Foss Reservoir has been less than expected due to the numerous SCS small detention structures upstream trapping large amounts of silt.

4-05. Climate. The climate of the region surrounding Foss Reservoir is subhumid, bordering on the semi-arid classification. Rainfall distribution is highly erratic. Drought periods of varying lengths interspersed with short violent storm periods are characteristic, particularly during the growing season. Most storms over the basin are associated with frontal action between cold, dry polar air masses and warm, moist air masses from the Gulf of Mexico. Convective-type thunderstorms also frequently cause intense precipitation over relatively small areas. Climatic characteristics for the basin are given in the following paragraphs.

a. Temperature. The mean annual temperature is approximately 60 degrees Fahrenheit (F), with a January mean of about 37 degrees F and July mean of about 82 degrees F. The average number of days per year on which the temperature is 32 degrees F or below is 114; 90 degrees F or above is 88 days. Maximum recorded temperature in the area was 115 degrees F; minimum recorded temperature was -11 degrees F.

b. Precipitation. The average annual basin precipitation is 24 inches, with a maximum yearly total of 35 inches in 1959 and a minimum yearly total of 14 inches in 1970. Approximately 71% of the total annual rainfall occurs during the growing season (April through September). Average monthly and annual rainfall and runoff data are given in Table 4-1.

c. Snowfall. Mean annual snowfall is approximately 9 inches, 60% of which normally occurs during January and February.

d. Evaporation. The mean annual lake evaporation (considered to be 70% of the recorded pan evaporation) for the region is approximately 64 inches. The estimated monthly pan evaporation at Foss Reservoir is given in Table 4-2.

TABLE 4-2

ESTIMATED MONTHLY PAN EVAPORATION(1)

EVAPORATION MONTH	EVAPORATION (INCHES)	AVERAGE DAILY EVAPORATION (INCHES)	PERIOD OF RECORD (YEARS)
January	2.68	.09	19
February	3.35	.12	20
March	6.12	.20	30
April	8.58	.29	37
May	9.78	.32	35

TABLE 4-2 (continued)

ESTIMATED MONTHLY PAN EVAPORATION[1]

EVAPORATION MONTH	EVAPORATION (INCHES)	AVERAGE DAILY EVAPORATION (INCHES)	PERIOD OF RECORD (YEARS)
June	11.60	.39	38
July	13.25	.43	38
August	12.25	.40	38
September	9.15	.31	34
October	6.84	.22	34
November	4.19	.14	23
December	3.26	.11	18
Annual	91.05	.25	

(1) Weighted Average Using Data from Altus Dam, OK, Ft. Supply Dam, OK, and Foss Dam, OK.

e. Wind. Prevailing winds are southerly to southeasterly except in January and February when northerly winds predominate. The average wind speed is 12 miles per hour in summer and 15 miles per hour in spring.

4-06. Storms and floods. The Washita River and its tributaries upstream of Foss Reservoir are flashy, with substantial proportions of their total flow occurring during short periods of high runoff. During seasonal low-flow periods, zero flow frequently occurs. Rainfall is greatest during spring and early summer; hence about 60% of total annual flow is observed to occur during the months of April, May, and June, while less than 20% occurs during July, August, and September. It is not unusual for several consecutive crests to follow within comparatively short periods due to recurrent heavy rainfall over isolated portions of the basin. Floods of considerable magnitude are occasionally produced by heavy rainfall over a large portion of the basin. Investigations indicate that, on the average, bankfull capacity of the main stream is exceeded 2 to 3 times annually in the vicinity of the Carnegie gage.

Reporting and recording precipitation stations in the Foss watershed are sparse. Storms with an average precipitation of 3 inches or more or storms causing major floods over the Washita River watershed upstream of the Foss Dam are listed in Table 4-3. These averages were computed from published rainfall records from stations in and surrounding the watershed and do not necessarily record the center of intense storms or the basin coverage. Because of this, and since antecedent rainfall, season of the year, and many other factors influence storm runoff, floods have frequently followed periods of relatively small amounts of recorded rainfall. Likewise, greater amounts of recorded rainfall may cause only minor flooding. Major floods at the Cheyenne, Clinton, and Carnegie gages are listed in Table 4-4.

The Washita River Basin is long and narrow. The river flows generally from a northwest to southeast direction which is perpendicular to the axes of the major frontal storms. This basin shape and orientation result in the generation of floods in relatively short reaches of the river. Floods resulting from runoff over the entire watershed are extremely infrequent.

TABLE 4-3

MAJOR STORMS: JANUARY 1923 - DECEMBER 1990
WASHITA RIVER WATERSHED UPSTREAM OF FOSS DAM

DATE OF STORM	AVERAGE RAINFALL (INCHES)	DATE OF STORM	AVERAGE RAINFALL (INCHES)
Jun 7-9, 1923	3.52	Oct 17-19, 1965	3.67
Sep 14-19, 1923	8.55	Aug 25-27, 1969	4.23
Oct 12-16, 1923	3.60	Jul 23-26, 1975	4.04
Sep 25-28, 1926	3.28	May 16-21, 1977	3.94
Oct 1-3, 1926	3.34	Sep 20-21, 1978	3.86
Mar 27-28, 1929	3.26	Jun 8-10, 1979	3.02
Sep 7-9, 1929	4.29	May 15-16, 1980	3.42
Apr 3-4, 1934	3.65	May 16-18, 1982	4.74
May 17-19, 1935	3.77	Oct 17-22, 1983	4.90
Oct 21-23, 1941	3.35	Dec 13-16, 1984	3.23
Oct 14-18, 1942	4.20	Sep 28-Oct 3, 1986	10.75
Oct 5-7, 1946	4.03	Oct 21-23, 1986	4.10
Jul 19-21, 1950	4.49	May 19-28, 1987	8.23
May 16-17, 1951	5.04	Jun 24-28, 1988	3.02
Apr 26-May 2, 1954	2.67	Sep 14-18, 1988	6.42
May 1-4, 1957	3.00	May 11-18, 1989	5.95
Jun 19-21, 1958	3.43	May 31-Jun 7, 1989	8.23
May 26-27, 1959	2.45	Apr 22-27, 1990	5.58
Jun 1-5, 1965	3.08	May 29-30, 1990	2.92
Sep 17-21, 1965	5.58		

4-07. Runoff characteristics. Many of the western and central rivers and streams of Oklahoma are dry, or nearly dry, most of the year. They are subject to sudden rises and severe flash floods of short duration as a result of thunderstorm activity. It is not unusual for several consecutive crests to follow within comparatively short periods due to recurrent heavy rainfall. Floods of considerable magnitude are occasionally produced by a general heavy rain. The alluvial soil in the Foss watershed is sandy and porous, and as a result, high peak flows generated on the tributaries are rapidly reduced and even considerable flood volume can be lost in the sandy soil. As the Washita River upstream of Foss Reservoir is situated in a plains area, there is no dependable spring or summer stream flow resulting from snow melt. Pertinent data for stream gaging stations used for regulation of Foss Reservoir are given in Table 4-5. The estimated monthly and yearly runoff at the Foss site from January 1926 through March 1956 was taken from the Bureau's "Definite Plan Report, Vol. 11 Foss Division" dated January 1958. In March 1956, the U.S. Geological Survey (USGS) established a gage on the Washita River at river mile 473.5, 0.9 mile downstream of Foss Dam, and the runoff from this gage was used from April 1956 through 22 April 1957, when the gage was washed out. It was reestablished in February 1958 and discontinued in December 1958. Runoff for the period May 1957 through January 1958, while the Foss gage was inoperative, was obtained by drainage area ratio. The intervening runoff between the Cheyenne gage on Sandstone Creek, the Cheyenne gage on the Washita River, the Arapaho gage on Barnitz Creek and the Clinton gage was determined by subtracting the runoff at the upstream gages from the runoff at the Clinton gage. The amount of runoff which occurred at Foss Dam from this intervening area was computed by direct drainage area ratio and this runoff was added to the runoff which occurred

drainage area ratio and this runoff was added to the runoff which occurred upstream of the Cheyenne gage to obtain the total estimated runoff at the Foss Dam. The flows from 1961 through December 1990 are taken from the actual records at Foss Dam. The estimated monthly and yearly runoff at the Foss Dam are given in Table 4-6 located on pages T4-1 and T4-2. The inflow volume frequency by months is given in Table 4-7. The inflow duration curve is shown on Plate 4-2.

4-08. Water quality. Foss Reservoir water quality can be considered good and satisfactory for municipal supplies and downstream releases. It is a semi-turbid reservoir, with the northwest end remaining fairly turbid and the downstream half being fairly clear. Water quality remains fairly constant throughout the reservoir because of mixing due to wind and wave action. Weak, intermittent thermal stratification does occur, however, which may lead to water quality deterioration near the bottom of the lake for short periods during mid to late summer; the surface water usually remains in good condition. The reservoir does contain a high level of hardness. Water treatment for municipal use is presently being accomplished at the demineralization plant located immediately downstream of the dam.

4-09. Channel and floodway characteristics. In the Foss area of the basin, the flat alluvial valleys of the Washita and its tributaries are sharply delineated by steeply sloping land which rises to an elevation about 200 feet above the flood plain. The flood plain of the Washita River upstream of Foss Reservoir averages about 3,000 feet in width. The flood plains of the tributaries below Foss Dam are rather narrow (1/2 mile or less) while those of the main stem, between Foss Dam and Anadarko, are relatively wide (up to 2 miles). The alluvial soil is sandy and porous. As a result, high peak flows generated on the tributaries are rapidly reduced and considerable flood volume is lost in the sandy soil. The river channel downstream from the dam is sediment choked but well-defined. Human access is difficult, except at county road crossings, because of the dense growth of streamside cottonwood and willow vegetation along most of the river between the dam and Clinton, Oklahoma.

Most of the lands adjacent to the river are in private ownership. The river channel between Foss Dam and Clinton is crossed by 10 bridges which are well above the channel and appear capable of passing flows of approximately 2,000 cfs. Eight bridges are steel (with wood deck) and two are concrete highway bridges. Three low-water crossings consisting of ramps with box culverts or corrugated-metal pipe are known to exist within the 10-mile reach between the dam and Clinton, Oklahoma. These structures are in various stages of disrepair and were built by landowners adjacent to the river for intermittent access to farmlands. These crossings do not appear to be constructed to carry river base flow. Because of this, periodic washouts of the crossings occur. It is doubtful that any of the crossings were constructed to withstand flows in excess of 300 cfs without damage.

The estimated channel capacity of the Washita River downstream of Foss Dam near Clinton, Oklahoma, is 1,900 cfs. The channel capacity of the Washita River near Carnegie, Oklahoma, is 6,000 cfs. Discharge rating curves for the Cheyenne, Clinton, Carnegie, and Anadarko gages are shown on Plates 4-3 through 4-6, and are valid for approximations only. Current operational channel capacity downstream of Foss Dam can be found in Chapter 7. Discharge rating curves used by the Reservoir Control Section are adjusted for changing conditions and are maintained in current status insofar as possible. Crest travel times for the Washita River basin are shown on Plate 4-7. This is a simplified diagram and should be used as a guide only, as the crest travel time depends on the magnitude of the flood and the antecedent flows.

TABLE 4-4

FLOODS FOR PERIOD OF DISCHARGE RECORD
(*Indicates Stage Value Modified to Reflect Current Gage Datum)

CHEYENNE Datum 1900.98 Ft. NGVD Flood Stage 13.5 Feet			CLINTON Datum 1467.60 Ft. NGVD Flood Stage 18 Feet			CARNEGIE Datum 1244.23 Ft. NGVD Flood Stage 23 Feet		
Date	Stage	Peak CFS	Date	Stage	Peak CFS	Date	Stage	Peak CFS
04-03-34	21.90*[1]	52000[2]	04-05-34	33.90[1]	110000[2]	05-23-38	24.84*	7080
05-18-38	15.20*	14600	06-05-36	28.50	26900	05-05-41	26.21*	9030
05-23-41	18.50*	40000	05-30-37	20.50	3650	05-23-41	25.64*	8330
06-09-41	15.00*	13400	05-19-38	24.90	13000	06-06-41	25.99*	9050
10-23-41	15.11*	14000	04-11-40	25.50	15000	06-07-41	25.99*	9050
08-15-45	13.99*	9900	05-04-41	21.84	9320	06-13-41	26.27*	8320
07-01-46	14.16*	8900	05-21-41	22.36	11000	10-23-41	26.86*	10300
10-06-46	13.80*	7100	05-22-41	19.56	5750	10-27-41	25.68*	8700
08-15-48	14.20*	8900	05-25-41	21.24	8000	04-26-42	24.42*	7080
03-06-49	14.80*	8900	06-10-41	22.86	12500	04-29-42	25.23*	8080
06-04-49	15.60*	11900	06-18-41	19.93	6050	05-18-43	23.93*	5770
05-18-50	13.71*	6500	10-24-41	21.62	8840	05-28-43	24.12*	6690
07-05-50	14.10*	8450	10-25-41	22.13	10100	04-11-44	24.54*	6670
05-18-51	14.16*	5040	04-27-42	21.34	8200	06-14-44	27.74*	14000
06-07-51	14.29*	4700	06-13-44	18.18	4930	04-13-45	24.01*	6670
04-29-54	20.24*	69800	04-10-45	22.19	10400	04-16-45	26.00*	9810
10-11-60	13.45*	7310	04-08-47	21.70	9060	05-14-47	26.49*	9200
05-16-77	14.34	4660	05-12-47	21.24	8110	05-17-47	27.20*	10600
05-31-77	13.49	3260	05-16-47	19.32	5930	05-18-49	31.21*	50000
			11-01-48	21.41	8110	06-04-49	27.31*	14900
			05-21-49	18.34	5300	07-21-50	23.45*	5590
			07-21-50	18.36	5060	08-03-50	24.89*	6870
			05-16-51	31.09	66800	05-18-51	30.50*	40900
			05-20-51	18.48	5230	07-19-53	25.29*	8550
			05-01-54	23.99	13100	05-27-54	24.28*	6720
			05-24-54	21.29	5960	10-05-56	29.04*	23900
			06-08-55	20.93	6270	04-24-57	26.41*	12600
			10-04-55	23.21	7550	05-03-57	26.40*	11600
			04-20-57	19.88	4440	06-04-57	23.70*	6200
			04-23-57	20.63	4900	05-29-59	25.64*	9300
			05-12-57	18.49	3700	07-29-59	26.00*	10700
			05-30-57	19.84	4380	10-05-60	26.25*	11000
			06-20-58	20.68	4100	09-13-61	23.83*	5740
			05-05-59	18.92	3810	11-04-61	23.35*	5730
			05-26-59	27.84	22200	11-11-62	24.52*	6300
			07-27-59	19.21	4500	11-07-64	23.10*	5500
			10-02-59	21.61	6140	09-22-65	28.47*	17400
			09-17-62	24.30	7760	10-19-65	25.88*	10100
			06-22-65	18.03	3450	05-06-69	25.18*	8260
			03-31-73	18.47	2490	04-01-73	24.52*	5240
			08-27-74	18.21	2630	08-27-74	25.11*	6110
			06-11-75	19.58	2580	07-27-75	26.34*	5340
			05-21-77	20.33	2980	05-22-77	27.77*	9800
			05-27-82	24.42	5890	05-28-77	26.92*	6860
			10-03-86	25.93	10600	05-29-78	25.98*	5900
			05-27-87	23.34	4670	06-10-79	23.90*	4200
			09-19-88	21.98	3390	05-17-80	26.40*	6060
			06-04-89	20.20	2440	05-21-80	26.19*	5820
			06-08-89	23.59	5040	05-31-80	26.61*	6310
						05-21-82	27.45*	11300
						10-19-85	23.19	4840
						09-30-86	28.61[1]	11100[2]
						10-05-86	29.57[1]	25200[2]
						10-23-86	27.51	10100
						11-06-86	22.94	4840
						05-28-87	29.23	22000
						03-04-88	25.33	9960
						06-14-89	27.51	10100

[1] High Water Mark
[2] Estimated Flow

TABLE 4-5

PERTINENT DATA FOR STREAM GAGING STATIONS

Station	Stream	Miles Above Mouth	Drainage Area (Sq Mi)	Elevation of Zero of Gage (Ft NGVD)	Flood Stage (Ft)	Maximum of Record			Minimum of Record			Period of Record
						Stage (Ft)	Discharge (CFS)	Date	Stage (Ft)	Discharge (CFS)	Date	
Cheyenne, Oklahoma	Washita River	543.9	794	1,900.98	13.5	15.24	69,800	4-29-54	(1)	0	(2)	Oct 1937-Date
Foss, Oklahoma	Washita River	473.5	1,551	1,560.00	18.0	20.40	14,000	4-9-57	(1)	0	1956 (2)	Mar 1956-Apr 1957 Feb 1958-Dec 1958 Jul 1961-Date
Clinton, Oklahoma	Washita River	447.4	1,997	1,467.60	18.0	31.09	66,800	5-16-51	(1)	0	(2)	Oct 1935-Date
Carnegie, Oklahoma	Washita River	353.9	3,129	1,244.23	23.0	31.21	50,000	5-18-49	(1)	0	1956,64 (2)	Nov 1937-Date
Anadarko, Oklahoma	Washita River	305.0	3,656	1,150.00	19.0	26.80	29,000	5-25-03	(1)	0	8-1-64	Oct 1902-Sep 1908 Jun 1924-Jun 1925 Oct 1935-Feb 1938 Oct 1963-Date

(1) Pool at Gage or Streambed Dry; Stage not Significant
(2) At Times

TABLE 4-6

ESTIMATED MONTHLY AND ANNUAL FLOWS IN ACRE-FEET
WASHITA RIVER AT FOSS DAM

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1926	2130	1710	6150	19180	14520	6160	4330	13480	17530	18600	4700	3580	112100
1927	2940	1640	2140	13480	0	26460	9790	11620	5070	30	150	1620	74940
1928	1140	1570	2290	6760	34060	19640	9900	3000	1340	13880	9880	3260	106720
1929	2090	2240	9010	0	17340	28500	2440	3400	15500	4790	2660	540	88510
1930	280	1120	300	10980	16540	16030	2930	1050	3400	9750	1820	1270	65470
1931	1030	1360	4830	6650	5090	13580	3760	2370	2640	2590	2310	1380	47590
1932	1690	1100	730	8690	0	17320	120	3080	1570	1200	150	3510	39160
1933	1770	880	1220	3090	650	7680	1230	3500	720	1610	0	2420	24770
1934	1440	1910	3380	180000	36530	22440	320	4710	2690	0	490	1910	255800
1935	650	1320	2000	0	20780	18170	1240	1910	530	1530	800	710	49640
1936	790	900	600	9390	43200	48660	1880	580	14220	2510	1220	1230	125200
1937	1250	1200	1150	1130	12890	10980	2540	5330	6760	1210	600	780	45820
1938	780	870	1310	11500	42090	13200	4600	850	610	210	1590	360	77970
1939	3590	620	2400	5510	12880	17430	5000	3630	150	150	210	200	51770
1940	160	350	190	16440	4750	1440	8810	3290	1320	140	2390	350	39630
1941	260	360	480	14910	79130	50340	9780	10230	3890	38430	7820	5520	221200
1942	4070	3700	4890	33430	8330	37930	7670	7560	9560	26650	6430	6380	156600
1943	6270	4590	4540	8010	17100	9030	3050	640	680	3160	600	2270	59940
1944	2720	2430	3930	5470	6830	11070	6850	2220	3300	1700	1610	3460	51590
1945	2280	2130	3960	14150	1980	7070	2490	4370	5810	1010	330	620	46200
1946	1290	1470	1410	950	8060	7050	6940	1870	530	12780	2980	1500	46830
1947	1580	1190	2000	26500	45580	16790	3320	580	150	190	220	510	98610
1948	410	3300	7200	1000	1840	5730	2050	10240	350	330	9610	720	42780
1949	1070	13860	7590	5960	60400	40610	5050	990	2800	1210	1070	1730	142300
1950	1790	1970	1690	1340	7210	1720	23870	12760	7170	2020	1550	1880	64970
1951	2240	2680	2700	2170	69380	35890	3830	390	5320	790	1600	1550	128500
1952	2160	1870	2460	4480	3130	800	10	0	0	0	10	50	14970
1953	80	70	320	370	1200	5030	3950	530	0	3760	710	130	16150
1954	120	130	160	10300	46870	11230	660	300	30	10	50	90	69950
1955	120	100	50	160	8400	15290	3690	2760	430	10710	330	240	42280
1956	310	600	200	25	5060	1160	2200	49	1	4980	150	47	14780
1957	79	78	363	32590	49840	12537	1850	380	547	1410	516	511	100700
1958	597	372	607	1300	774	9420	8310	4430	314	87	161	140	26510
1959	340	500	490	1990	53480	10520	15260	5000	7460	19230	22500	11670	148400
1960	7660	14840	11790	6960	7470	10210	10180	3120	1430	18680	4730	4800	101900
1961	3830	5800	3230	3550	3180	9470	1480	0	290	300	1780	1230	34140
1962	1440	1290	890	3600	2750	12010	3810	6170	7830	3130	2410	2560	47890
1963	1690	3660	3800	2460	3970	3880	1600	320	1560	0	60	20	23020
1964	190	1880	930	2840	3880	2250	0	900	670	540	8760	1070	23910
1965	1270	1130	2170	3600	1680	13850	2470	540	8830	7100	1890	2300	46830
1966	2870	2650	4430	2250	2550	1080	1280	1560	360	0	70	0	20100
1967	360	120	1090	2560	1020	5090	1930	600	1870	180	150	210	15180

TABLE 4-6 CONCLUDED

ESTIMATED MONTHLY AND ANNUAL FLOWS IN ACRE-FEET
WASHITA RIVER AT FOSS DAM

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1968	930	1010	4960	3530	4740	4880	1380	8470	1970	3400	2200	1090	38560
1969	1250	3280	9880	5520	7720	2310	200	5050	2260	160	20	300	37950
1970	150	1090	2230	9690	4470	1440	890	3980	680	140	110	120	24990
1971	130	710	1410	4860	3910	9880	1100	2070	1330	2370	180	600	28550
1972	230	890	1790	790	3500	1490	1840	840	1110	290	830	630	14230
1973	1990	1110	5540	6990	9860	4420	1350	1250	3670	2970	120	970	40240
1974	1650	1320	6410	6580	7430	1220	320	3730	2980	1250	6700	1710	41300
1975	2920	3400	6990	5320	11240	9280	15350	3480	1350	340	3250	810	63730
1976	430	2320	2420	6630	7940	4400	930	1830	650	200	240	280	28270
1977	500	2130	1450	2960	41450	19010	5220	5010	1330	760	1750	1970	83540
1978	1000	320	4180	5870	14200	4660	220	1540	3940	310	780	140	37160
1979	1680	1490	7020	3620	6720	11300	6710	1730	150	460	770	160	41810
1980	2010	2320	4120	4250	20240	11290	740	310	70	61	273	243	45930
1981	474	500	2360	1700	1250	1760	5270	1560	287	4420	59	0	19640
1982	479	1790	3390	1780	57590	20520	7870	2450	483	714	1360	2580	101000
1983	3220	4000	7220	5810	6990	24470	1720	2100	122	3220	1500	452	60820
1984	2500	3860	4620	5680	3450	5930	664	503	531	1160	779	2170	31850
1985	1800	2760	5750	4420	3690	4270	73	2910	53	1140	1160	555	28580
1986	2270	1800	1080	3180	4120	8300	5020	2950	6010	26040	25780	4320	93870
1987	6410	12500	22100	9340	30980	16580	6240	330	5640	2200	2130	8820	123270
1988	5590	1500	10970	11830	7140	5440	2820	410	5070	230	4660	500	56210
1989	6050	3210	9230	4370	20580	43450	3360	9640	2180	1800	1950	5480	111300
1990	5750	6670	6330	13230	16480	12930	2940	7440	3770	1150	4310	3690	84690
Mean	1820	2340	3730	9440	16280	12980	4070	3230	2940	4180	2590	1720	65320
Max	7660	14840	22100	180000	79130	50340	23870	13480	17530	38430	25780	11670	255800
Min	79	70	50	0	0	800	0	0	0	0	0	0	14230

TABLE 4-7

INFLOW VOLUME FREQUENCY
(January 1926 - December 1990)

MONTH	MONTHLY INFLOW VOLUME IN ACRE-FEET FREQUENCY OF OCCURRENCE IN YEARS				
	2	5	10	25	50
January	1,300	2,800	4,100	5,700	7,000
February	1,550	3,100	4,900	8,500	12,800
March	2,800	6,400	8,600	11,000	13,000
April	5,000	10,800	16,000	31,000	55,000
May	7,800	31,000	48,000	63,000	78,000
June	10,000	19,000	31,000	45,000	53,000
July	2,800	6,500	9,500	15,000	21,000
August	2,200	5,500	8,800	12,300	14,500
September	1,500	5,000	7,700	12,500	18,500
October	1,200	4,700	14,500	25,000	37,000
November	1,100	5,400	6,500	13,500	20,500
December	950	2,800	4,600	7,500	10,200

Upstream structures. There are no major control structures upstream of Foss Reservoir within the Washita River Basin. There are, however, small detention structures upstream of Foss Reservoir which were constructed by the SCS. These small structures have acted to trap a large amount of the sediment in the runoff, therefore reducing the amount of sediment reaching Foss Reservoir.

Downstream structures. Two major structures are downstream of Foss Reservoir in the Washita River Basin: Fort Cobb Reservoir on Cobb (Pond) Creek, a northern tributary of the Washita River, with a drainage area of 314 square miles; and Arbuckle Reservoir on Rock Creek, also a northern tributary of the Washita River, with a drainage area of 126 square miles. Both of these projects are operated and regulated by Reclamation, except for flood control regulation which is the responsibility of the Corps. A large number of small SCS detention structures are located in the Washita River watershed downstream of Foss Reservoir.

4-12. Economics.

Population. The upper Washita River, downstream of Foss Reservoir, traverses counties in the southwest portion of the State of Oklahoma. The population of the counties and larger communities within the basin are listed in Table 4-8. The largest population centers are located in the northern and central portions of the basin, including the communities of Clinton, Anadarko, and Chickasha.

TABLE 4-8

POPULATION OF COUNTIES AND CITIES IN THE UPPER WASHITA RIVER

COUNTY City	YEAR 1970	 1980	 1990	PERCENT CHANGE 1980 - 1990
CADDO	28,931	30,905	29,550	-4.38%
Anadarko	6,682	6,378	6,586	3.26%
CUSTER	22,665	25,995	26,897	3.47%
Clinton	8,513	8,796	9,298	5.71%
GRADY	29,354	39,490	41,747	5.72%
Chickasha	14,194	15,828	14,988	-5.31%
KIOWA	12,532	12,711	11,347	-10.73%
Hobart	4,638	4,735	4,306	-9.06%
WASHITA	12,141	13,798	11,441	-17.08%
Cordell	3,261	3,301	3,400	3.00%
TOTAL	105,623	122,899	120,982	-1.56%

Source: U.S. Bureau of Census Decennial Census of Population and Housing.

b. Agriculture. Sorghum, wheat, and cotton are the principal crops grown in the upper Washita River Basin. Wheat pasture is utilized as an important source of winter feed for livestock. In the drainage basin downstream of Foss Reservoir, about 60% of the area is cultivated farm land, and 40% is pasture and range land. The acres planted and the annual value of crops produced in the upper Washita River downstream of Foss Reservoir are shown in Table 4-9.

TABLE 4-9

ANNUAL VALUE OF CROPS
(1990 Normalized Prices)

CROPS	WASHITA RIVER FOSS DAM TO GARVIN-GRADY COUNTY LINE, OKLAHOMA ACRES	VALUE $
Sorghum	8,490	554,000
Wheat	12,000	457,000
Cotton	4,830	1,243,500
Alfalfa	420	54,500
Pecans	250	25,900
Peanuts	550	76,000
Pasture & Woods	14,260	8,600
Idle	3,820	-----
TOTAL	44,620	$2,419,500

c. Industry. Agriculture, with crop and cattle production, is the major industry in the upper Washita River Basin. Other industries relating to agricultural activities include cotton gins and compresses, grain elevators, and flour mills. Mineral resources consist of oil, gas, helium, and gypsum. Oil and gas fields underlie a portion of the watershed, and related industries consist of refineries, carbon black plants, and oil and gas pumping plants.

d. Flood damages. The estimated average annual damages, damages prevented, and residual damages along the Washita River from Foss Dam to the Garvin-Grady county line, are presented in Table 4-10. The estimated values are based on January 1990 prices for structures, and 1990 adjusted normalized crop prices. Structural loss and area curves are shown on Plates 4-8 through 4-10.

TABLE 4-10

AVERAGE ANNUAL DAMAGES
(January 1990 Structure and 1990 Normalized Crop Prices)

WASHITA RIVER
FOSS DAM TO GARVIN-GRADY COUNTY LINE

REACH AND ITEM	ESTIMATED AVERAGE ANNUAL DAMAGES $	DAMAGES PREVENTED $	RESIDUAL DAMAGES $
Foss Dam to Garvin-Grady County Line			
Crops	619,500	63,500	556,000
Structures	2,499,400	401,200	2,098,200
TOTAL	3,118,900	464,700	2,654,200

V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01. Hydrometeorological stations.

a. General. The water control data system must meet the specific needs of the water control manager. The data system must include facilities to perform the following functions:

(1) Observe and store data at field stations.
(2) Transmit data from field stations.
(3) Decode and validate transmitted data.
(4) Store and retrieve data from database.
(5) Provide graphical and tabular data displays.
(6) Exchange data with other users.

A majority of the data input into the water control data collection system are time-variable data. They represent observations of the water regulation at various projects, water levels in the river basins, and hydrometeorological elements that affect these river basins. Although non-variable data are used in the data processing (such as reservoir capacities, outflow capabilities, etc.), the principal requirement is to gather, process and transmit time-variable data.

Hydrometeorological elements collected are:

(1) Water levels in rivers, lakes, and reservoirs.
(2) Precipitation measured at ground stations or estimated by radar or other sensors.
(3) Air temperature.
(4) Pan evaporation.
(5) Humidity.
(6) Wind speed and direction.

b. Facilities. The Corps, National Weather Service (NWS), USGS, Reclamation and the District share in the cost and maintenance of the data collection and communication network required to regulate Foss Reservoir. Pertinent reporting stations are shown on Plate 5-1. The key stream gages for regulation of Foss Reservoir are: Cheyenne-upstream, Clinton-downstream, Carnegie-downstream, and Anadarko-downstream.

c. Reporting. The reporting procedure for precipitation and stream gaging is on a cooperative basis with the NWS. The reporting criteria for the pertinent precipitation and stream gaging stations are shown in Table 5-1. Hydrometeorological data collected by project personnel at Foss Dam are transmitted to the Reservoir Control Section, Hydrology-Hydraulics Branch, Tulsa District Office, by telephone (see Emergency Personnel Roster, page ii). Detailed instructions on reporting criteria are presented in Exhibit E, Standing Instructions to Damtender.

d. Maintenance. Maintenance and repair of the weather stations instrumentation are responsibilities of the NWS. Maintenance, repair and historical recording of stream gages are responsibilities of the USGS. The Hydraulic Engineering Section, Hydrology-Hydraulics Branch, Tulsa District, is charged with the responsibility for the equipment owned by the Corps.

e. Automation. Presently, only a few stream gages in the Tulsa District are manually called by telephone. The remainder are dual reporting data collection platforms (DCPs) which record data hourly and transmit the data every four hours as well as random transmissions when threshold values are exceeded. The data is transmitted via satellite to a downlink and computer facility owned and operated by the National Oceanic and Atmospheric Administration (NOAA) in Washington, D.C. The data is transferred to the Tulsa District water control computer using telephone modems. When received, the river stage is converted to flow, and lake elevation is converted to storage. All the data is then stored

TABLE 5-1

REPORTING CRITERIA FOR PERTINENT STATIONS

STATION	REPORT TO	TIMES OF REPORT
RAINFALL STATIONS		
Airport Stations	National Weather Service	6-Hour Rainfall as of 6 a.m., 12 Noon, 6 p.m., and 12 Midnight.
Foss Dam	Corps of Engineers	Reporting Criteria Identical to that Listed in Subparagraph 5-07d.
All Other Stations	National Weather Service	24-Hour Rainfall as of 7 a.m., 1 p.m., 7 pm., whenever 0.50 or more of Rainfall has Accumulated in the Rainfall Gage.
STREAM GAGE STATION		
Washita River		
Upstream of Foss		
Cheyenne	Corps of Engineers	Every 4 Hours and on Set Demand Requirement
Downstream of Foss		
Clinton	Corps of Engineers	Every 4 Hours and on Set Demand Requirement
Carnegie	Corps of Engineers	Every 4 Hours and on Set Demand Requirement
Anadarko	Corps of Engineers	Every 4 Hours and on Set Demand Requirement
RADAR STATIONS	National Weather Service	Hourly

in a data base in the Corps' Water Control Data System (WCDS) for access when needed. DCPs also report rain data in the same way.

In addition to DCP data, observer rainfall data is collected and stored in the data base for use in forecasting. Observers phone the NWS offices in this region, and the NWS then encodes that data into a Standard Hydrologic Exchange Format (SHEF). This data is then transferred to the WCDS computer using telephone modems and a dedicated phone line to the Tulsa River Forecast Center (RFC). Once the data is received, it is decoded and handled in a manner similar to the DCP data. Informative display of all this data is possible through the use of several computer programs.

5-02. Water quality stations. There are no water quality stations in the lake. Water quality of the stream is monitored by the Oklahoma Water Resources Board.

5-03. Sedimentation stations.

a. Facilities. There are no sediment stations on the Washita River near Foss Reservoir. There are, however, 46 sedimentation ranges upstream of Foss Dam and 15 degradation ranges downstream of the dam. These ranges are surveyed periodically by Reclamation personnel for the purpose of computing sediment deposition and new lake area and capacity data. The sedimentation and degradation ranges are shown on Plates 2-6 and 2-7.

b. Maintenance. Maintenance on the sediment ranges is performed by Reclamation.

5-04. Recording hydrologic data. Hydrologic information is recorded as it is received by the Reservoir Control Section as follows:

a. Stages and discharges. The stages received from stream gaging stations and the corresponding discharges are maintained in the WDCS data base.

b. Precipitation. The precipitation data received from the NWS and DCPs are maintained in the WCDS data base.

c. Water quality data. Studies by Oklahoma State University (OSU) during 1974 through 1976 indicated that total dissolved solids ranged from a low of 1,656 to 2,018 milligrams per liter (mg/l). Dissolved solids include calcium sulfate, sodium sulfate, sodium chloride and magnesium sulfate. A water treatment plant immediately downstream of the dam provides good municipal and industrial water to users in Clinton, Cordell, Hobart, and Bessie, Oklahoma.

d. Radar and satellite reports. Current computer-enhanced satellite images, weather charts, and national radar summaries are automatically received into the WCDS computer from a private vendor. Also, a computer-enhanced image of the real-time radar scope image depicting cloud coverage and relative intensity is available from the NWS and is routinely received from Oklahoma City. NWS locations in and near the Tulsa District with this capability, in addition to Oklahoma City, are Kansas City and Monett, Missouri; Garden City and Wichita, Kansas; Amarillo, Texas; and others. Hard copies of any of this data are available by use of several plotters located in the Reservoir Control Section.

The current radar system provides information about the areal distribution of precipitation. The NEXRAD (NEXt Generation RADar) system of data collection, which is being developed by the NWS in cooperation with other agencies, uses sophisticated reflectivity and Doppler radar

technology. NEXRAD will provide useful quantitative precipitation data with high areal resolution. The radars are connected to computers which process the information into visual and digital output. Access to the NEXRAD system is expected to be available to the Corps in the testing phase in the near future.

5-05. Communication network. Wire facilities at Foss Reservoir are local and long distance telephone service. Maintenance of the telephone lines is the responsibility of the company leasing the line to the U.S. Government.

5-06. Communication with project.

a. Regulating office with project office. Instructions for the storage and release of water from the flood control pool at Foss Reservoir will be communicated by the Reservoir Control Section to the damtender for the implementation of the provisions set forth in Chapter 9 of this manual. This communication will normally be made by long distance telephone. The reports by the project office, described in paragraph 5-07 and Exhibit C of this manual, will be communicated directly to the Reservoir Control Section. Should communication between the project and the Reservoir Control Section be disrupted, the damtender at the project will, on his own initiative, direct regulation of the lake in accordance with the Loss of Communication regulations as required in Chapter 7 and Exhibit C of this manual. A chart, "Organization for Flood Control Regulation, Foss Reservoir," is shown on Plate 5-2.

b. Between project office and others. Communication between project personnel and other Federal, State and local agencies will be sufficient to effect the coordination described in Chapter 9 of this manual.

5-07. Project reporting instructions. Daily lake data from Foss Reservoir (see Plate 5-3) will be submitted to the Reservoir Control Section during normal working hours. The Reservoir Control Section is normally manned from 7:45 a.m. to 4:30 p.m. daily and various hours during flood control operations and weekends and holidays. Data for nonworking days shall be read from the recorder chart and submitted the following workday. Should unusual conditions arise during nonworking hours, one of the persons listed in the Emergency Personnel Roster on page *ii* should be contacted. Reports should be transmitted by 9:00 a.m. via telephone. The following data should be included in the daily report.

a. As of 8:00 a.m. Pool elevations at 8:00 a.m. and for the previous day at 12 noon, 4:00 p.m., and 12 midnight (all values should be read from the recorder chart); number of river outlet gates open, with the height of the openings; municipal and industrial release volumes for the preceding 24 hours ending at midnight; precipitation and evaporation in inches for the preceding 24 hours (7:00 a.m. to 7:00 a.m.); wind velocity and direction (at 8:00 a.m.).

b. Each gate operation. Date and time of gate operation, number and height of gates open before and after gate operation, and lake elevation. Confirmation of gate changes shall be made immediately after completion of the change. Complaints about pool elevations or releases, operating machinery failure and out-of-service times for maintenance shall be reported to the Reservoir Control Section as they occur.

c. During flood periods. In addition to subparagraphs a and b above, reports should also be made at 1:00 p.m. and 7:00 p.m. or as instructed by Reservoir Control Section.

d. Rainfall reports. Rainfall reports shall be made as follows:

(1) At 8:00 a.m. all precipitation that has occurred during the preceding 24 hours, 7:00 a.m. to 7:00 a.m. as shown on Plate 5-3 (covered by routine report on working days).

(2) At 1:00 p.m. when 0.50 inch or more of precipitation has occurred since 7:00 a.m. or if it has continued to rain since reporting at 8:00 a.m.

(3) At 7:00 p.m. when 0.50 inch or more of precipitation has occurred since the 8:00 a.m. report and no 1:00 p.m. report was made, or if it has continued to rain since reporting at 1:00 p.m.

(4) Report at once the occurrence of 2.00 inches or more of precipitation that occurs during a period of 6 hours or less.

(5) During non-normal working hours, the report should be made to one of the persons listed on the Emergency Personnel Roster on page *ii*; however, if no contact can be made, rainfall reports should be made to the NWS (see Supplemental Telephone Listing, page iv).

5-08. Early Warning System. An Early Warning System (EWS) was chosen by the Bureau of Reclamation (Reclamation) as the preferred corrective action for alleviating a hydrologic deficiency that was identified through Reclamation's Safety of Dams Program. The hydrologic deficiency is that Foss Dam will safely pass 86 percent of the Probable Maximum Flood (PFM). Agencies with responsibilities in the EWS include Reclamation, the Foss Reservoir Master Conservancy District (District), local disaster and emergency services agencies downstream from Foss Dam, the State of Oklahoma Disaster and Emergency Services Agency, the Corps of Engineers (Corps), and the National Weather Service.

The concept of how this EWS will function has been established and a discussion follows. However, as of the date of this document, work remains to be accomplished in regards to coordinating between the various agencies involved with the system. When coordination between the various agencies has been completed, Reclamation will develop a Memorandum of Understanding (MOU) that will list the responsibilities of all the aforementioned agencies.

The EWS will consist of four components - detection, decisionmaking/notification, warning, and evacuation. The following is a brief explanation of each component as they pertain to Foss Dam.

a. Detection. This component is used to detect hydrologic events which may require high releases from the dam or may endanger the safety of the structure.

The primary means of detection for the Foss Dam EWS will be existing Data Collection Platforms (DCP) at Foss Dam and in the drainage area above Foss Dam. These DCPs which transmit data via satellite, provide real-time monitoring and transmission of rainfall, streamflow, and reservoir elevation data. A composite data base of the real-time information collected by the DCP's is used as input to the Corps' rainfall-runoff computer model. Results obtained from the Corps' modeling program will be used to provide forecasting information to dam operations personnel. Dam operations personnel will utilize forecasting information from the Corps in deciding when to provide alerts and warnings to the downstream officials. The main goal of this ESW is to provide a minimum of 4 hours lead time for evacuation of downstream areas.

The secondary, or backup, means of detection is the fact that the damtender for Foss Dam lives near the dam and would be aware of any large storms in the area or rising reservoir levels. The reservoir will be monitored on a 24-hour-a-day basis by dam operating personnel (District

and/or Reclamation) once the elevation of the reservoir exceeds 1642.0 feet (top of conservation pool).

b. Decisionmaking/Notification. This component is used by operating personnel to decide when and how alerts and warnings will be provided to the local officials responsible for evacuation of the flood plain.

Decision Criteria, listed in Table 5-2, provide guidance for operations personnel in deciding when to provide alerts and warnings to downstream officials responsible for warning and evacuating the downstream populations. Reclamation is investigating the possibility of developing a new format, entitled Emergency Classification Levels, that would replace the decision criteria and would include actions to be taken by all parties involved in EWS.

Dam operations personnel will rely on forecasting from the Corps in deciding when to provide alerts and warnings to the downstream officials. This will necessitate the Corps provide forecasting both above and below the flood pool, which will be included in the Foss Dam EWS MOU. When communication is lost with the Corps, operations will be in accordance with the Foss Reservoir Water Control Manual, which includes a section on operations when communication is lost.

The 24-hour warning point for notifying local officials will be in Clinton, Oklahoma. The primary means of communicating between dam operations personnel and the local officials will be telephone. The secondary, or backup, means of communication will be radio.

c. Warning and Evacuation. These components involve warning and evacuation of the downstream population at risk, and are the responsibility of downstream officials. Specific plans for warning and evacuating the populations below Foss Dam are currently in place. Reclamation is presently reviewing those plans and will provide suggestions for improving the plans to the locals, if needed.

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

TABLE 5-2

FOSS DAM EARLY WARNING SYSTEM DECISION CRITERIA

Event	Action
1. It is forecast that Foss Reservoir will exceed elevation 1642.0 (bottom of proposed flood control pool), and conditions are expected that could produce property damage or be life threatening.	1. The Foss Reservoir Master Conservancy District (District) will contact Reclamation, or vice-versa. Also, dam operating personnel will conduct the 24 hour warning point and will offer the following message: "This is (name and title) at Foss Dam conducting a communications test. No action is required at this time. You will be provided with updates if conditions develop or intensify. End of message. Do you have any questions?"
2a. Forecasts indicate that controlled releases will need to be made from Foss Reservoir, which when combined with downstream inflows, will bring the river to flood stage. Channel capacity is approximately 1,000 cfs below the dam and 1,900 cfs at Clinton.	2a. Dam operating personnel will contact the 24-hour warning point to inform them that the river downstream from Foss Dam is expected to reach flood stage.
2b. It is forecast that Foss Reservoir will reach elevation 1662.2, top of the exclusive flood control pool.	2b. Dam operating personnel will contact the 24-hour warning point and advise them to prepare for possible evacuation of the downstream low-lying areas. Dam operating personnel will remain in close contact with the 24-hour warning point.

See Note 1.

TABLE 5-2 (continued)

FOSS DAM EARLY WARNING SYSTEM DECISION CRITERIA

Event	Action
3. Forecasts indicate that it will be necessary to make controlled or uncontrolled releases that will exceed channel capacity below the dam (approximately 1,000 cfs) or forecasts indicate that it will be necessary to make controlled or uncontrolled releases, which when combined with downstream inflows, will exceed channel capacity further downstream (channel capacity is approximately 1,900 cfs at Clinton). Uncontrolled releases begin at reservoir elevation 1668.6 (crest elevation of uncontrolled spillway).	3. Dam operating personnel will conduct the 24-hour warning point and advise them to evacuate low-lying areas adjacent to the Washita River downstream from Foss Dam. Dam operating personnel will remain in close contact with the 24-hour warning point to provide updated release information for their use in determining additional areas that will require evacuation as releases increase.
4. It is forecast that Foss Reservoir will reach elevation 1697.0 (dam crest elevation) within four hours. Discharge from the reservoir will be about 8,150 cfs at reservoir elevation 1697.0 during a PMF event. Once water begins flowing over the dam, discharge from the reservoir may increase dramatically and rapidly.	4. Dam operating personnel will contact the 24-hour warning point and advise them to evacuate the entire dam failure inundation area along the Washita River below Foss Dam.

Note: Dam operating personnel will obtain concurrence from Reclamation's Project Manager in Oklahoma City before issuing evacuation notices, if practicable.

\1 It is possible that event 2b could occur before event 2a.

VI - HYDROLOGIC FORECASTS

6-01. General. Hydrologic forecasts are necessary in predicting streamflow upstream and downstream of Foss Reservoir to determine if and when releases should be made.

a. Role of Corps of Engineers. Hydrologic forecasts are made by the Reservoir Hydrology Sub-Section for the Reservoir Control Section, Tulsa District, for use in the regulation of lakes for flood control and other authorized purposes and for the benefit of the Corps' construction projects and flood-fighting activities. The NWS furnishes weather and flood forecasts to the public. The District furnishes current information on lake levels, weather, streamflow, or any other available information on observed conditions, along with technical advice and general news releases, all made through the Public Affairs Office (see Supplemental Telephone Listing, page iv).

b. Role of other agencies. The NWS, River Forecast Center in Tulsa, Oklahoma, is the official agency making river flood forecasts. The forecasts are sent to the Reservoir Control Section and other NWS offices via the NWS Automation of Field and Operation Services (AFOS) system. This information is disseminated by Oklahoma Weather Wire circuit (by commercial vendors) to subscribing Government agencies and various news media. The NWS issues routine scheduled reports containing the following forecasts:

(1) Weather forecasts (daily 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 required.

(5) Rainfall required to produce bankfull 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 the circuit is idle.

(a) Damage reports.

(b) Road information and winter weather conditions.

(c) River and flood warning bulletins, forecasts and statements.

(d) Thirty-day forecast.

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

6-02. Flood condition forecasts.

a. Requirements. Flood condition forecasts are necessary whenever substantial rainfall has occurred on the basin upstream or downstream of Foss Reservoir. The Reservoir Hydrology Sub-Section makes forecasts for inflow into Foss Reservoir for the area shown on Plate 6-1. The time required to make forecasts will vary from 2 to 6 hours depending on the timely reception of rainfall reports and the amount of basin area covered by the storm.

b. Methods. The Reservoir Hydrology Sub-Section makes individual lake inflow forecasts and forecasts of flow for the uncontrolled areas downstream of the dams. These forecasts are made using the Corps' Hydrologic Engineering Center (HEC) computer program 723-X6-L2010, HEC-1.

(1) Forecasting River Stages. The official forecasts of the NWS are utilized in predicting river stages. Forecasts are also made by the Reservoir Hydrology Sub-Section by applying the peak flows determined by the forecasting procedures described below to stage discharge curves. Forecasts for the stream gages listed in Table 5-1 are pertinent to the regulation of Foss Reservoir.

(2) Forecasting Flows. An HEC-1 computer forecast model of the drainage area upstream of Foss Reservoir is used to forecast inflows. The area downstream of the dam is modeled in the Lake Texoma Forecast Model. These models are used separately to predict inflow to Foss Reservoir and flows at downstream control points.

(a) Runoff Estimate. Precipitation data is received from the NWS and the data collection platforms by the Water Control Data System (WCDS) computer. The average precipitation over the project basin is computed by a computer program called RAIN. The RAIN program plots isohyetal maps of 24-hour rainfall from the DCP data. It then computes the basin average total rainfall using a variation of the NWS alternate method of rainfall calculation which uses a grid system. The program is able to break the rainfall down into sub-basin totals for input into HEC-1F forecasting models from which reservoir inflow volume estimates are made and pool elevations and time of peak are predicted.

(b) Computer Model. The HEC-1 inflow model for Foss Reservoir consists of three subareas as shown on Plate 6-1. One is for the lake surface at the top of the conservation pool, and the others are for the remaining drainage areas for the Washita River watershed above Cheyenne and the Sandstone Creek Basin. Snyder's coefficients are used to describe the hydrologic characteristics of each subarea. Hydrograph routing is accomplished using the modified puls method which requires input of the storage-discharge relationship within each routing reach. Channel losses are also considered significant for the Washita River and are included in the forecast model. A sample of the input is shown on Plate 6-2.

(c) Inflow Computations. Computation of the forecasted inflow and pool elevation is accomplished by the HEC-1 computer model. Input requirements are runoff (or rainfall and loss rates), initial base flow, if any, starting pool elevation, and controlled releases. The model is run interactively on the WCDS computer located in the Hydrology-Hydraulics Branch of the Tulsa District office. The model can be run on the WCDS computer at the Southwestern Division (SWD) office in Dallas, and can also be loaded on other computers which are used as backups if the primary computer in Tulsa is down. HEC Data Storage System (DSS) files are periodically backed up on magnetic disk and tape. A sample of the summary output is shown on Plates 6-3 and 6-4.

Stream gage stage data is received from the DCPs by the WCDS computer which aids in verifying the predicted hydrographs. The predicted inflow hydrograph is verified and adjusted as necessary by comparing it to the actual developing hydrograph. The developing inflow and lake stage hydrograph is computed from known pool elevations and releases. A sample inflow computation is shown on Plate 6-5.

(d) Flood Control Releases. Estimated hydrographs at control points downstream from the dam are made by procedures described in paragraph 6-02 of this manual. These hydrographs are adjusted to conform with the latest hydrologic information available. Trial releases

within the limitations of Foss Reservoir flood control storage and outlet works are routed and combined with the adjusted hydrographs for determination of hydrographs at the downstream control points. The resulting hydrographs
are examined for concurrence with flow limits at downstream control points and adjusted accordingly.

6-03. Conservation purpose forecasts.

a. Requirements. Conservation forecasts may be requested by Reclamation and/or the District to predict pool levels during fish spawning season, special recreation events, water supply and irrigation supply. Forecasts may also be requested for water quality.

b. Methods. Forecasts for conservation purposes during the non-flood periods would rely largely on statistical interpretation of historical data. Estimated flows at the dam site, see Table 4-6 (pages T4-1 and T4-2), may be used for conservation forecasts. The peak inflow probability curve (natural river conditions), Plate 8-4, would also be considered in conjunction 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 reservoir.

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.

VII - WATER CONTROL PLAN

7-01. General objectives. The primary objectives of Foss Reservoir are to store, regulate and convey water for irrigation and municipal use; provide fish and wildlife resources; provide outdoor recreation opportunities; downstream flow regulation; and to control floods. The flood control storage provided by Foss Reservoir can contain 2.26 inches of runoff from the drainage area upstream of the dam.

7-02. Major constraints. Foss Reservoir is operated to the top of conservation pool elevation 1642.0 feet NGVD to contain 80% of the PMF. The seepage is being controlled by the installation of a system of drains and pressure-relief wells. The system is currently in operation and is being monitored. During the life of the project, the reservoir has only temporarily been above elevation 1642.0 feet and never to elevation 1652.0 feet NGVD. Since construction of the seepage control system, the reservoir volume between elevations 1642.0 feet and 1652.0 feet is being used for flood control purposes. This flood control volume (elevation 1642.0 to 1662.2 feet NGVD) will be evacuated to elevation 1642.0 feet, as determined by the Corps under CFR 208 regulations as downstream channel conditions permit. The major constraints are the seepage through the embankment, the inadequate spillway capacity and safety of the dam concern, and the limited channel capacity downstream of the dam. The channel capacity has reduced from the original 3,000 cfs to the current 1,000 cfs. Low level releases over extended periods and rare flood control releases have caused sediment deposition and vegetative encroachment in the channel.

7-03. Overall plan for flood control.

a. General. Foss Reservoir is operated by the District under the direction of Reclamation. Under the provisions of Section 7 of the Flood Control Act of 1944, the Secretary of the Army prescribes regulations for the use of storage allocated for flood control at all lakes constructed wholly or in part with Federal funds provided on the basis of such purposes. Foss Reservoir will be regulated for control of floods on the Washita River in a manner to maximize downstream benefits and to meet authorized purposes from the conservation pool. The resource development to be accomplished by the Red River system is discussed in the Reservoir regulation Master Manual Red River Basin, while the specific purposes of the various projects are detailed in the appropriate appendices. The specific objectives and regulation procedures for the various project purposes at Foss Reservoir are discussed in the following paragraphs.

b. System regulation. Foss Reservoir will be regulated in conjunction with Fort Cobb and Arbuckle Reservoirs for benefits on the Washita River and will obtain incidental benefits on the Red River. Flood control releases from Foss, Fort Cobb, and Arbuckle Reservoirs will share the downstream channel capacity. The reservoir with the highest percent of flood control storage utilized will be given priority to use of available channel capacity.

7-04. Standing instructions to the damtender. During flood periods, the reservoir will be regulated in accordance with the normal regulations for flood control as directed in subparagraph 7-05a. and Exhibit E of this manual. Instructions for the storage and discharge of floodwater from the flood control pool will be issued by the Reservoir Control Section, Tulsa District. In the event that communications with the Tulsa District Office are disrupted, the reservoir will be regulated in accordance with the schedule of loss of communication (emergency) regulations for flood control instructions in subparagraph 7-05b and Exhibit E. In addition, the damtender will immediately make every effort to reestablish communications with the Tulsa District Office. The damtender will make daily records of the weather station and pool level data and report those

data, as directed in paragraph 5-06 and repeated in Exhibit E. Should an emergency exist, such as inoperable gates, drowning accident, excessive trash in the gates, broken buoy line, embankment boils, or power outage, the Reservoir Control Section will be notified immediately.

7-05. Flood control.

a. Normal flood control regulations. Foss Reservoir is regulated to provide flood reductions on the Washita River from Foss Dam to the confluence of Cobb (Pond) Creek and in conjunction with Fort Cobb and Arbuckle Reservoirs on the Washita River. The following regulations will govern releases from Foss Reservoir (see Table 7-1).

TABLE 7-1
NORMAL FLOOD CONTROL REGULATION SCHEDULE
FOSS RESERVOIR

Reservoir Elevation (FT, NGVD) Pool Condition	Regulations
Below 1642.0 Rising or Falling	Releases scheduled by the Foss Reservoir Master Conservancy District. Releases are not to exceed channel capacity downstream of the dam (currently estimated to pass approximately 1,000 cfs) or when combined with local flows are not to exceed a stage of 18 feet (currently estimated to pass approximately 1,900 cfs) at the Clinton, Oklahoma gage.
1642.0 - 1662.2 Rising	Make releases according to the following schedule except that releases when combined with uncontrolled runoff downstream will not exceed channel capacity (currently estimated to pass approximately 1,000 cfs) immediately downstream of the dam; 18-foot stage (currently estimated to pass approximately 1,900 cfs) at the Clinton, Oklahoma gage; 23-foot stage (currently estimated to pass approximately 6,000 cfs) at the Carnegie, Oklahoma gage. If the flows exceed any of the stages listed above, no releases will be made that will contribute to flooding.

TABLE 7-1 (CONTINUED)

NORMAL FLOOD CONTROL REGULATION SCHEDULE
FOSS RESERVOIR

Reservoir Elevation (FT, NGVD) Pool Condition	Regulations	
	Forcasted % Flood Storage	Release Schedule Maximum Release Rates (cfs)
Rising Pool Elevation		
1662.2	15 - 100	1,000
1645.8	10 - 15	750
1644.6	5-10	500
1643.3	0-5	300
1642.0		

NOTE: Reclamation is responsible for regulating the project when the pool exceeds elevation 1662.2 feet NGVD. When the predicted volume of runoff upstream of the dam exceeds the available flood control storage but does not endanger the safety of the dam, the releases may be modified to obtain downstream benefits.

Above 1662.2 Rising or Falling	Reclamation, is responsible for directing release of water when the pool is above the top of flood control pool elevation 1662.2 feet NGVD.
1662.2 - 1660.8 Falling	Evacuate flood storage at the maximum rate possible to maintain a steady or falling stage at the Clinton gage.
1660.8 - 1642.0 Falling	Make releases according to the following schedule, except that the release, when combined with uncontrolled flows downstream, will not exceed those flood stages listed under rising pool conditions.

Release Schedule

Falling Pool Elevation	Forecasted % Flood Storage	Release Schedule Maximum Release Rates (cfs)
1660.8	15 - 80	1,000
1645.8	10 - 15	750 + Inflow [1], Not to Exceed 1,000 cfs
1644.6		

TABLE 7-1 (CONTINUED)

NORMAL FLOOD CONTROL REGULATION SCHEDULE
FOSS RESERVOIR

Reservoir Elevation (FT, NGVD) Pool Condition		Regulations
	5 - 10	500 + Inflow [1], Not to Exceed 750 cfs
1643.3		
	2 - 5	300 + Inflow [1], Not to Exceed 500 cfs
1642.5		
	0 - 2	TRANSITION TO CLOSURE
1642.0		

[1] Forecasted Average Inflow over a 2- to 4-day period.

b. Loss of communications. When communication with the Tulsa District Office is disrupted, the damtender will, on his own initiative, direct regulation of the reservoir in accordance with the following schedule (see Table 7-2) until communication is restored. In addition, the damtender will immediately make every effort to reestablish communication with the Tulsa District Office. The river outlet gates shall be operated at uniform openings.

TABLE 7-2

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE
LOSS OF COMMUNICATION WITH RESERVOIR CONTROL SECTION
FOSS RESERVOIR

Reservoir Elevation (FT, NGVD) Pool Condition	Regulations
Below 1642.0	Releases scheduled by the Foss Reservoir Master Conservancy District. Releases are not to exceed channel capacity downstream of the dam (currently estimated to pass approximately 1,000 cfs) or when combined with local flows are not to exceed a stage of 18 feet (currently estimated to pass approximately 1,900 cfs) at the Clinton, Oklahoma gage.

TABLE 7-2 (CONTINUED)

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE
LOSS OF COMMUNICATION WITH RESERVOIR CONTROL SECTION
FOSS RESERVOIR

Reservoir Elevation (FT, NGVD) Pool Condition	Regulations
1642.0 - 1662.2 Rising	Maintain current release rate for 12 hours. Then if the release is less than 1,000 cfs, increase the release rate by 250-cfs increments every 2 hours until the release rate is 1,000 cfs. Hold this release rate until communication is reestablished, or the pool level starts falling, or the pool exceeds 1662.2 feet NGVD.
Above 1662.2 Rising	Reclamation is responsible for directing reservoir releases above pool elevation 1662.2 feet NGVD. Increase release rates by 500 cfs every 2 hours until both outlet works gates are full open.
Above 1662.2 Falling	Reclamation is responsible for directing reservoir releases above pool elevation 1662.2 feet NGVD. Maintain current outlet works gate opening until pool recedes to elevation 1662.2 feet NGVD.
1662.2 - 1645.8 Falling	If discharge is 1,000 cfs or less, maintain that release. If discharge is more than 1,000 cfs, reduce the discharge by 500-cfs increments every 12 hours making sure the pool continues to fall until the total release is equal to 1,000 cfs.
1645.8 - 1642.0 Falling	Reduce the discharge every 6 hours by 170-cfs increments making sure the pool continues to fall.

c. Constraints. The regulation schedules provide that the currently estimated channel capacity of 1,000 cfs in the reach from the dam to the vicinity of the Clinton gage 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 (which have an estimated capacity of about 300 cfs) and low-lying farmland.

7-06. Recreation. Recreation is an authorized project purpose at Foss Reservoir although no storage or releases are specifically provided or to be used for this purpose.

7-07. Water quality.

a. General. Water quality control is not an authorized project purpose at Foss Reservoir, and there is no storage or release specifically provided for it. However, the occasional flood control releases and releases for dilution of the water treatment plant effluent will aid in maintaining flow in the Washita River.

b. Regulation procedure for water quality. Responsibility for releases to be made to alleviate or respond to emergency conditions such as fish kills and flow augmentation for pollution abatement or aesthetics will be with Reclamation through the District. Wastewater from the water treatment plant flows for about one mile to the Washita River where it is mixed with releases of water from the reservoir to dilute its mineral content before proceeding downstream. Mixing of the water treatment facility effluent with the Washita River flow occurs rapidly. River sampling has shown a salt concentration very similar to the water in Foss Reservoir. Prior to construction of the treatment plant and the need to dilute the plant effluent, water released from Foss Dam was intermittent.

7-08. Fish and wildlife. Fish and wildlife conservation is an authorized project purpose at Foss Reservoir although no storage is specifically provided for this purpose.

7-09. Water supply.

a. General. All water supply-related activities are the responsibility of the District. Municipal and industrial water supply facilities at Foss Reservoir consist of a water treatment plant and a 55-mile water supply pipeline to Hobart, Oklahoma (See Exhibit A).

b. Regulation procedure for water supply. The withdrawal of raw water from Foss Reservoir can be made from one or more of four withdrawal levels in the reservoir (See Exhibit A). The withdrawal is made directly to the water treatment plant. The plant presently has a capacity of 3 million gallons per day. Effluent from the plant is treated as described in subparagraph 7-07b. The District has contracts with the cities of Clinton, Cordell, Hobart and Bessie, Oklahoma, for 18,000 acre-feet annually.

7-10. Downstream Water rights. Downstream water rights are the responsibility of the Oklahoma Water Resources Board. Any release for downstream water rights is the responsibility of the District and Reclamation.

7-11. Hydroelectric power. Hydroelectric power production is not a project purpose of Foss Reservoir and is not being pursued at this time.

7-12. Navigation. Navigation is not considered in the regulation of Foss Reservoir at the present time.

7-13. Sedimentation. There are no regulation procedures for sediment.

7-14. Deviation from normal flood control regulation. Deviation from normal flood control regulation of the reservoir is occasionally necessary. Prior approval for a deviation is obtained from the SWD except as noted in subparagraph 7-14a. 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. The action shall be confirmed in writing the same day to Reclamation (the project owner) and to the District (the operator) and shall include justification for the action. Also, the project owner or operator may temporarily deviate from the water

control plan in the event an immediate short-term departure is deemed necessary for emergency reasons to protect the safety of the dam, or to avoid other serious hazards. 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 Corps by Reclamation or the District and shall include justification for the action. Continuation of the deviation will require the express approval of the Corps.

b. Unplanned minor deviations. There are unplanned instances that create a temporary need for minor deviations from the normal regulations of the reservoir, although they are not considered emergencies.

Construction accounts for the major portion of the incidents and include utility stream crossings, bridge work, and major construction contracts. Changes in releases are sometimes necessary for maintenance and inspection. Requests for changes of release rates are generally from a few hours to a few days. Each request is analyzed on its own merits. Consideration is given to upstream watershed conditions, potential flood threat, conditions of the lakes, and possible alternative measures. In the interest of maintaining good public relations, the requests are complied with providing there are no adverse effects on the overall operation of the project (or projects) for the authorized purposes. Approval for these minor deviations will normally be obtained from the Corps by telephone. A written confirmation showing the deviation and condition will be furnished to the Corps by Reclamation.

c. Planned deviations. Advance approval of the Corps 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 situations provided for in subparagraph 7-14a. above. Each condition will be analyzed on its own merits. When conditions appear to warrant a prolonged deviation from the approved plan, Reclamation and the Corps will jointly 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 Corps.

7-15. Operational curves. The elevation versus area and capacity curves, the evaporation curves, the uncontrolled spillway rating curve, the river outlet works conduit rating curve (gates fully open), the total discharge rating curve for the outlet works fully open and spillway, and the river outlet works (partial gate openings) are shown on Plates 7-1 through 7-7. The Cheyenne, Clinton, Carnegie and Anadarko rating curves are shown on Plates 4-3 through 4-6. Rating curves provided by the USGS and used by the Reservoir Control Section are adjusted for changing conditions and are maintained in current status to the extent practical. Tables 7-3 and 7-4, located on pages T7-1 through T7-8, show elevation versus area and elevation versus capacity for Foss Reservoir, respectively.

7-16. Rate of release change. The increase and decrease in releases from the reservoir shall be accomplished in a manner which minimizes damage to the reservoir area and downstream channel as shown in Table 7-5. Every reasonable precaution will be made to minimize bank sloughing, undercutting, erosion, and eliminate, if possible, danger to human and animal lives. Situations will arise which will not allow an orderly increase and/or decrease in releases. Examples of these situations are large releases as described in paragraph 7-05, and drownings which occur downstream of the dam.

TABLE 7-5

RELEASE RATE CHANGES
FOSS RESERVOIR

INCREASING RELEASES TO CHANNEL CAPACITY [1]		
Current Release Range (cfs)	Maximum Increase (cfs)	Minimum Time Between Changes (Hours)
0 - 1,000	250	2

DECREASING RELEASES BELOW CHANNEL CAPACITY [1]		
Current Release Range (cfs)	Maximum Decrease (cfs)	Minimum Time Between Changes (Hours)
1,000 - 0	170	3

(1) See paragraph 7-05(a) for releases that will exceed channel capacity and decrease of releases in excess of channel capacity.

VIII - EFFECT OF WATER CONTROL PLAN

8-01. General. In addition to the general benefits from the project, the effects of flood control regulations on the inflow design flood and an example of the normal and loss-of-communication regulations applied to a major flood are discussed in the following paragraphs.

8-02. Flood control.

a. General. The flood control storage incorporated in Foss Reservoir was based on a study of transpositions of the Cheyenne storm (SWD storm number SW 2-11) and the Meeker storm (SW 2-7) and a study of major floods of record, as discussed in Appendix II of the "Comprehensive Survey Report" for Red River, Louisiana, Arkansas, Oklahoma, and Texas (above Fulton, Arkansas), dated 15 January 1948.

b. Inflow design flood. The inflow design flood (a percentage of the probable maximum flood series) can be routed through the reservoir and not overtop the dam. The American Meteorological Society (AMS) defines the probable maximum precipitation (PMP) as "the theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage basin at a certain time of year" (AMS, 1959). The probable maximum storm was developed using procedures and criteria from NWS Hydrometeorological Reports No. 51 and 52 (HMR51 and HMR52) (Schreiner and Riedel, 1978; Hansen, Schreiner and Miller, 1982).

The probable maximum flood is identified as a hypothetical flood that combines the most critical meteorologic and hydrologic conditions reasonably possible at a specific location. Reclamation adopted a flood series as the critical event in determining the safety of Foss Dam. The critical event (PMF series) contains a 100-year antecedent flood followed by the PMF, assuming 4 days between the end of the 100-year storm and the start of the PMP.

Foss Dam was originally designed for an inflow design flood having a peak inflow of 300,000 cfs and a 4-day volume of 500,000 acre-feet. Reclamation's updated hydrologic studies approved in January 1989 for Foss Reservoir resulted in a revised PMF with a peak inflow of 423,700 cfs and a 300-hour volume of 957,900 acre-feet (including the antecedent flood).

The main system for passing flows at Foss Dam is the "uncontrolled" spillway and the gated river outlet works. The spillway is designed for a discharge of 3,260 cfs when the water surface is at elevation 1694.2 feet NGVD. The river outlet works has a capacity of 4,500 cfs at elevation 1694.2 feet NGVD.

Based on revised PMF studies by Reclamation, failure of the dam due to overtopping could occur. The potential for failure, however, is estimated to be less than one in 2,000 years.[1] Failure of Foss Dam during the PMF could result in an estimated breach outflow of about 3,000,000 cfs. The magnitude of this breach outflow is largely independent of the inflow to the reservoir at the time of failure. This flow attenuates to about 340,000 cfs at Anadarko, Oklahoma, approximately 107 miles downstream of the dam. Failure of the dam could expose about 5,000 persons to the discharge and could result in the estimated loss of 46 lives. Potential downstream property loss or damage is estimated at about $130 million. The hazards of potential downstream flooding include loss of life, personal injury, property damage, and environmental damage. Loss of project benefits would also occur. Cities that would be affected between Anadarko and Foss Dam include Washita, Fort Cobb, Carnegie,

[1] Reclamation estimate in comparison to PMF probabilities.

Mountain View, Clinton, and Stafford. Under the PMF, other communities farther downstream such as Chickasha, Pauls Valley, and Lindsay may be subjected to high levels of flooding.

The inflow design flood (IDF) developed by Reclamation for Foss Reservoir is 78.9% of the critical event flood series. This flood has a peak inflow of 334,300 cfs and a 300-hour volume of 755,800 acre-feet. The flood routing started at the top of conservation pool at elevation 1642.0 feet NGVD. Releases were limited by the flood control criteria contained in Chapter 7 until the pool exceeded elevation 1662.2 feet NGVD (top of flood control pool).

Above elevation 1662.2 feet NGVD, the river outlet works were fully opened in 6 hours. In this manner, the river outlet works and uncontrolled spillway would release full capacity above elevation 1668.6 feet NGVD (crest of the uncontrolled spillway). The maximum pool elevation was 1694.2 feet NGVD with a maximum discharge of 7,760 cfs. Plate 8-1 shows the operational hydrograph for the IDF, and Plate 8-2 shows the operation hydrograph for the 100-year flood.

c. Other floods. The flood of April 1934 is the maximum flood of record on the upper Washita River. This flood had an estimated peak discharge of 167,000 cfs and an estimated 3-day volume of 180,000 acre-feet. The peak pool elevation reached from the routing was 1661.7 feet NGVD, with a maximum outflow of 1,000 cfs. The operational hydrograph is shown on Plates 8-3 and 8-4 for Foss Reservoir and the Clinton gage, respectively.

8-03. Recreation.

a. General. The Foss Reservoir area includes approximately 1,500 acres of land and 5,000 acres of water surface for recreational purposes in the lower reservoir area. There are also about 4,500 acres of land and 3,700 acres of water surface designated as a wildlife refuge in the upper reservoir area. The recreation area is administered by the OTRD, and the wildlife refuge area is administered by the FWS. Project lands and waters, from a recreation standpoint, are considered to be of State importance rather than of national significance. Recreational activities at the project include boating, fishing, sightseeing, picnicking, public hunting, and camping. Most of the visitation and recreational use occurs between Memorial Day and Labor Day. Recreational use of project resources is currently managed by the OTRD. Approximately 1,560 acres of the 6,848 acres of total project lands have been developed for recreational use. Although the reservoir was originally designed for a conservation pool of 8,800 surface acres (elevation 1,652.0 feet NGVD), the reservoir has been limited to elevation of 1,642.0 feet NGVD (6,800 surface acres). This limited lake elevation has not adversely affected annual visitation. The following tabulation lists recent annual visitation data obtained from the OTRD:

ANNUAL VISITATION

Year	Visitor-Day*	Year	Visitor-Day*
1980	115,368	1986	173,705
1981	186,280	1987	116,096
1982	302,415	1988	126,407
1983	214,827	1989	190,031
1984	225,557	1990	143,563
1985	161,868		

*One person participating in one or more recreational activities during all or any portion of 1 calendar day.

Visitation at Foss Reservoir is estimated as approximately 70% "local" and 30% "other." In general, a comparison of types of visitation reveal about 30% of the recreation use at Foss Reservoir is associated with boating activities (fishing, water skiing, and pleasure boating).

Foss Reservoir recreational areas provide a variety of day-use activities as well as overnight camping activities. Three campground areas with electrical hook-ups are located around the lake with trailer and tent campsites, tables, and shelters. There are also two primitive areas available. One swimming beach is located on the north side of the reservoir. Seven boat ramps currently are usable, with three ramps of concrete construction and four ramps constructed of asphalt. These ramps are adequate to accommodate current levels of use. A marina, 38 docking spaces, and a marina concession provide boat services and supplies.

The reservoir shoreline is flat and treeless, without exceptionally spectacular vistas. The water and land setting, however, does provide a change from the lands surrounding the recreational boundary which are largely utilized as cropland. Downstream of the dam, lands are flat to rolling and most vistas include the river with adjacent farmland or grazing land.

b. Air quality and noise. Because of the distance from heavy population centers and industry, the air quality of the area is excellent, and conditions for air stagnation are not likely. Noise levels are also considered to be low.

8-04. Water quality. No specific storage is provided for water quality control; however, releases are made to mix with the effluent from the water treatment plant to dilute the mineral content before proceeding downstream. Mixing of the effluent with the Reservoir releases occurs rapidly, and sampling has shown a mineral concentration similar to the natural river conditions. Most of the flow on the Washita River immediately downstream from Foss Dam is from the water released from the reservoir and the flow collected by the seepage control system.

8-05. Fish and wildlife.

a. Wildlife. There are about 4,500 acres of land and 3,700 acres of water surface for wildlife purposes in the upper reservoir area designated as the Washita National Wildlife Refuge (NWR) which is administered by the FWS.

The 8,271-acre Washita NWR was established in 1961 at the northern end of Foss Reservoir and provides protected wintering and feeding habitat for migratory waterfowl and other marsh and water birds. The refuge is one of three federally operated waterfowl refuges in western Oklahoma and is a link in the chain of refuges along the Central Flyway (other refuges are the Optima and Salt Plains NWRs).

As many as 20 different species of waterfowl are found on the refuge during the fall migration. During November and December, total duck and geese populations may reach 120,000 (peak total number). Sandhill crane populations average 8,000 to 15,000 during October to early December. The highest waterfowl concentrations normally occur in the November through February period.

Milo and wheat are the main crops grown on approximately 2,100 acres of cropland on the refuge. These crops provide high-protein food and tender green browse for migrating waterfowl during both spring and fall migrations. Lands surrounding the refuge and reservoir boundary are predominantly agricultural in nature and are generally planted in wheat.

From 15 March through 15 October, visitors are welcome to visit and tour the refuge. After 15 October, visitor use to the refuge interior is restricted in order to provide a protected, undisturbed area for migrating waterfowl. Over 2,000 acres of the refuge area are opened to bobwhite quail and cottontail rabbit hunting each fall.

The bald eagle winters at Foss Reservoir from mid-November to March. Surveys conducted by refuge personnel reported 10 bald eagles at Foss Reservoir in January 1979, 29 in January 1980, 9 in 1981, 4 in 1982, 4 in 1983, and 2 in 1984. The major roosting area at Foss is located west of Pitts Creek about 5 miles from the north end of the dam in a row of tall elms. Primary prey species are Canada geese, miscellaneous ducks, cottontail rabbits, and gizzard shad. Area-use patterns of bald eagles reveal little, if any, time spent downstream from the dam.

Foss Reservoir is located within the western extremities of the flyway corridor of the whooping crane. The whooping crane makes only brief stops in Oklahoma, primarily at Salt Plains NWR in Alfalfa County, which was designated critical habitat on 15 May 1978 (43 FR 20938). The spring migration generally occurs during March and April and the fall migration generally during October and November. Records of whooping cranes at Foss Reservoir include a pair sighted in October 1966; a pair in October 1969; a pair on 1 May 1980; three on 31 October 1980; a pair on 21 October 1981; and a single bird that remained from 24 October to 28 October 1984.

b. Fisheries.

(1) Reservoir fishery. Foss Reservoir has relatively flat, undeveloped surrounding lands with prevalent winds which keep the lake well mixed. Fish habitat is limited, and lake runoff and water levels have been low during the early 1980s. Consequently, the reservoir fishery is suffering from the effects of long-term water level reductions. Habitat conditions for spawning, survival, and growth are limited at Foss relative to other Oklahoma lakes. Low water is probably responsible for poor production of young shad that are required to sustain most of the predators each year. Recent increases in water levels should help improve the fishery. Concentrations of dissolved solids are high (about 1,700 mg/l) but are not considered detrimental to the fishery.

The dominant, emergent aquatic plant at Foss Reservoir is the cattail (*Typha* spp.). The dominant submerged vegetation is Sago pondweed (*Potamogeton pectinatus*). These plants provide most of the cover and predator feeding sites in the reservoir. Spawning areas for walleye are provided exclusively by the riprap face of the dam. The reservoir lacks sufficient fish shelters for cover and resting areas.

Recent fish surveys by the State indicated that largemouth bass numbers are below the regional average. Bass reproduction, recruitment, and angling will remain poor until runoff floods much needed cover and cove areas. Crappie populations are low and also dependent on better water levels, cover, and forage for expansion. The walleye population density at Foss has decreased recently, and recruitment has been poor. White bass have been abundant in recent surveys. Channel catfish have been of average abundance in recent years with angling success fair.

(2) River fishery. The Washita River downstream from Foss Reservoir is typical of western Oklahoma streams. Steep-banked in many places, it meanders through the cropland that has encroached leaving only a narrow belt of riparian grass and sparse tree cover. Except for periods following large releases from the reservoir, the channel downstream of the dam is heavily silted. Since impoundment of the reservoir, the Washita River downstream has always had some flow. Low flows have been variable and largely in the range of 4 to 12 cfs.

Anglers report catches of primarily channel catfish with flathead catfish, bullhead catfish, largemouth bass, bluegill, and other sunfish. The river also supports populations of carp, carpsuckers, and various minnows. The segments of the Washita River from Foss Reservoir to Lake Texoma have been given high value ratings in an assessment of the relative value of stream fishery resources in Oklahoma by the Oklahoma Department of Wildlife Conservation.

8-06. Water supply. Foss Reservoir contains 165,480 acre-feet of storage in the conservation pool between elevation 1642.0 feet NGVD (top of conservation pool) and elevation 1597.2 feet NGVD (top of inactive pool). This storage will provide municipal and industrial water supplies for the cities of Clinton, Cordell, Hobart, Arapaho, Butler, Sentinel and Bessie, Oklahoma. There are also several rural water users obtaining water from these cities.

8-07. Hydroelectric power. Hydroelectric power is not a project purpose of Foss Reservoir.

8-08. Navigation. Navigation is not a project purpose of Foss Reservoir.

8-09. Frequencies.

a. Peak inflow probability. Peak inflows taken from the monthly inflow computation records for the period 1961 through 1990 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" (USGS, 1981). The peak inflow probability curve is shown on Plate 8-5.

b. Pool elevation duration and frequency. The maximum and minimum annual pool elevations were taken from the Foss Reservoir records for the period 1977 through 1990. This record was chosen to reflect actual regulation of the project with the top of conservation pool established at elevation 1642.0 feet NGVD. The frequency computations were made using the procedures presented in ER 1110-2-1450 dated October 1962. Plate 8-6 shows the pool elevation probability curve.

The pool elevation-duration curve was also taken from the Foss Reservoir records for the period 1977 through 1990, as stated above. The pool elevation-duration curve is shown on Plate 8-7.

The actual pool elevation may vary from these projections because the project was not regulated for flood releases above elevation 1642.0 feet NGVD since this elevation was considered a temporary condition to 1990.

c. Key control points. Discharge rating curves used in the regulation of Foss Reservoir are shown on Plates 4-3 through 4-6 for the USGS stream gages near Cheyenne, Clinton, Carnegie and Anadarko, respectively.

8-10. Other studies.

a. Examples of regulation. Computer programs have been developed to forecast inflows to the lake, the resulting pool elevations, and the effects of releases at downstream gages. Use of these programs during real-time flood regulation greatly enhances the Corps' ability to achieve significant flood reductions.

Reclamation studied various alternatives related to the safety of Foss Dam and recommended that the top of the conservation pool be lowered by 10 feet to elevation 1642.0 feet NGVD and that the same flood control storage be retained with an increase in the amount of surcharge storage.

This modification, with the "Upstream Flood Detection System and Downstream Warning and Evacuation Program," will mitigate possible consequences of the hydrologic deficiencies relative to the safety of dams issue identified at Foss Dam.

b. Channel and floodway improvements. The limiting non-damaging flow used in regulation is currently estimated to be 1,000 cfs based on observations of the limited releases since the top of the conservation pool was lowered to elevation 1642.0 feet NGVD.

IX - WATER CONTROL MANAGEMENT

9-01. Responsibilities and organizations.

a. Corps of Engineers. Foss Reservoir is a Reclamation project, with the Tulsa District Corps prescribing and directing the flood control releases. Operation and maintenance, as well as regulation of the conservation storage, will be the responsibility of the District acting through a damtender. Regulation of flood waters in excess of the flood control storage is the responsibility of Reclamation. Project reporting instructions are presented in Chapter 5, and project regulating instructions are presented in Chapter 7 of this manual.

(1) Responsibilities and duties during normal operations. The Reservoir Control Section, Hydrology-Hydraulics Branch, Tulsa District Office, is charged with the following responsibilities and duties under general supervision of the Engineering and Construction Division.

(a) Normal flood control of reservoirs and dissemination of routine data.

(b) Investigations and refinement of flood control regulation procedures.

1. Analysis of past floods.

2. Reconnaissance to determine downstream damages and recommend channel capacities (maximum controlled release rates).

3. Improvement of hydrologic forecasting techniques.

4. Planning and coordinating the hydrometeorologic reporting network with Reclamation, NWS, and the USGS.

(c) Training personnel in flood control duties.

1. Periodic visits to projects by personnel of the Reservoir Control Section to familiarize themselves with water control facilities, become acquainted with the operating personnel, discuss emergency regulation procedures, and provide the onsite information for improving facilities and operational methods.

2. Instruction of personnel of the Hydrology-Hydraulics Branch in flood control procedures to supplement the Reservoir Control Section during flood emergencies.

(d) Preparation of reports on lake regulations.

1. Recurring reports.

2. Water control manuals.

3. Providing information for post flood reports.

(2) Responsibilities and duties during flood emergencies. During flood emergencies, the Reservoir Control Section is responsible for the following:

(a) Evaluation of current hydrologic, hydraulic and meteorologic data and determination of appropriate release schedules.

(b) Presentation of storm and flood analysis to the District Engineer and other District personnel as required.

(c) When necessary, furnishing personnel to assist project operating personnel in flood regulations.

(d) Regulation of lakes in accordance with flood control regulation schedules.

(e) Furnishing information to higher authority.

1. Initial reports to the SWD and Office of the Chief of Engineers by means of the fastest communication channels available.

2. Situation data provided to EOC.

(f) Furnishing information to the public information center.

(g) Furnishing information to Reclamation.

The duties of the damtender under flood conditions are set forth in Chapter 7 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, instructions for the routine regulation of the reservoir are accomplished by the Foss Reservoir Master Conservency District. However, during flood periods, the Reservoir Control Section with the assistance of other Corps personnel are responsible for providing flood control regulation of the reservoir. Plate 5-2 shows the organization chain of command for Reservoir Control during a flood. The area, magnitude and duration of the flood will determine the staffing requirements for each event.

(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 and Construction Division, Hydrology and Hydraulics Branch, with instructions to provide warning if unusual conditions occur. Responsible personnel are on duty at the Tulsa District Office 24 hours a day whenever basin and/or project conditions warrant and during flood emergencies. Responsible personnel will be on duty or on call at the project at all times.

(5) Role of damtender. The damtender will operate the reservoir during flood periods according to instructions issued by personnel of the Reservoir Control Section. The instructions follow the "Normal Regulations for Flood Control," included in Chapter 7 and paragraph 2 of Exhibit D. If the damtender loses communication with the District Office, he will immediately make every effort to reestablish communication with the District Office while initiating "Emergency Regulations for Flood Control", as included in Chapter 7 and Exhibits C and E of this manual. The damtender will make observations at the weather station and report those observations as directed in paragraph 5-07.

b. Other federal agencies.

(1) Reclamation is responsible for regulation of the conservation storage for irrigation and municipal water supply. Reclamation is also responsible for the reservoir's regulation once the flood control storage has been exceeded. However, at the request of Reclamation, during these surcharge operations, the Corps will provide assistance by continuing to make hydrologic forecasts and suggesting release rates and producing other pertinent information requested by Reclamation. The information provided by the Corps will be used at the

discretion of Reclamation as the safety of the structure remains the responsibility of Reclamation.

(2) The NWS and the USGS cooperate with the Reservoir Control Section to accumulate rainfall and streamflow data.

c. State agencies. The Tulsa District Office exchanges information with State government officials, the State Department of Transportation, Oklahoma Highway Patrol, and other agencies during time of flood emergencies. The Oklahoma Water Resources Board has the responsibility to protect the waters from pollution and to coordinate procedures.

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 and the NWS cooperate in forecasting flood stages and making streamflow measurements. Local press will be provided with flood forecasts by the Tulsa River Forecast Center and the NWS (officially responsible for issuing flood warnings). This information will be supplemented by the Corps bulletins on observed conditions and with technical advice to enable local interests, within the limits of their capabilities, to obtain optimum flood protection and to perform rescue and relief functions. The Corps further assists in flood fighting through the office of the Emergency Management/Security Division, which furnishes sandbags and other necessary equipment based on need and on the equipment on hand. To facilitate the distribution of these data, a Reservoir Information Control Center (RICC) is in operation when conditions warrant.

b. National Weather Service. The Tulsa District Office, the Tulsa River Forecast Center and the NWS exchange hydrometeorologic information to prevent duplication of effort in obtaining and disseminating data. This exchange of information is discussed in detail in Chapter 6 of this manual.

c. U.S. Geological Survey. The Corps 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 and the USGS coordinate field activities to maximize the number of stream discharge measurements.

d. Power marketing agency. Power is not a project purpose at Foss Reservoir.

e. Bureau of Reclamation. The Corps keeps Reclamation advised of the situation during the flood control operations as the conditions warrant.

9-03. Interagency agreements. A Letter of Understanding (see Exhibit B) and a Water Control Agreement (see Exhibit C) have been agreed upon and signed by the District, Reclamation, and the Corps.

9-04. Commissions, river authority, compacts and committees. A Red River Compact Commission was established, and a compact was ratified by all the states on 12 May 1978 and passed Congress as PL 96-564 on 22 December 1980.

9-05. Reports.

a. General. Much of the project and watershed data collected in real-time are stored in an automated data system. The data are used to regulate projects, provide public information and prepare reports. The

following reports are prepared to summarize real-time water management activities.

b. Project operators' reports. Project operators are required to monitor climatological data of reservoir conditions and any changes in project status and report to the Reservoir Control Section, Tulsa District. Specific details are outlined in Chapter 5 of this manual.

c. Morning report. This management type report is used to evaluate watershed and project conditions. This report is the principal means of informing all personnel having a need to know the prevailing conditions. The report is formulated from several sources of information on project and hydrometeorological conditions that have been entered into a data base management system each day.

This report is prepared by the Reservoir Control Section daily, except Saturday, Sunday, and holidays, to cover a period of 24 hours. The report provides information for use by personnel whose work requires knowledge pertaining to the regulation of reservoirs, field investigations, stream gaging, construction of flood control projects affected by releases from reservoirs, answering public inquiries, and preparing public releases. The report includes a summary of hydrologic conditions as of 8 a.m. of that date; weather forecast, including the extended outlook for the next four days; quantitative precipitation forecasts or general rainfall data; and lake data for the previous and present days. The report is completed and distributed by 10 a.m. daily, insofar as possible.

d. Flood situation reports. The Reservoir Control Section provides daily information to the Emergency Management Division for situation reports during floods in accordance with ER 500-1-1. The information contains various types of information relative to the floods. Pertinent data specifically required for reservoirs are as follows: name of reservoir, reservoir stage, forecasted maximum stage and date, rates of inflow and outflow in cfs, percent of flood control storage utilized to date, the forecast of maximum stage, and any special information pertinent to the flood situation.

e. Post flood reports. This report is prepared in accordance with ER 500-1-1 as soon as practicable after a flood causing major damage. The report describes flood emergency operation by the Corps and others. Included in summary form are: available hydrologic information, damage estimates, and other engineering data considered to be essential for flood control and flood plain studies or in the review of possible claims against the United States. The report is prepared by the Tulsa District Office Planning Division personnel, using information compiled and prepared by the Reservoir Control Section. The report should be completed within approximately three months of the time of flooding, including statement of final cost.

f. Monthly water control charts. A monthly record of reservoir regulation data is prepared and maintained by the Reservoir Control Section. These data are a tabular record of hydrometeorological conditions, inflows, storages and releases each day of the month. Summary data are also available. The data is maintained in a form readily available for transmittal to the Chief of Engineers, or others, upon request.

g. Annual reports. This report is prepared by the Reservoir Control Section and includes project accomplishments, annual report on water quality activities and a status report of water control documents, with a schedule for their initial preparation and revision. (The report also presents the activities and accomplishments of the Reservoir Control

Section for the past year). The report is forwarded to the SWD Reservoir Control Center for inclusion of the SWD's annual report.

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

TABLE 9-1

TABULATION OF REPORTS

Name of Report	When Required	Regulation Requiring Reports
Morning Report (CESWT-EC-H)	Daily, except Saturday, Sunday, and holidays	OM 1130-2-12 EM 1110-2-3600
Flood Situation Report (Special Advisories)	During floods	EM 500-1-1 EM 1110-2-3600
Post Flood Report	Following a flood	EM 500-1-1 EM 1110-2-3600
Annual Report	Annually	ER-1110-2-240
Monthly Water Control Charts	Monthly	ER-1110-2-240

TABLES

TABLE 7-3
FOSS RESERVOIR
AREA TABLE IN ACRES
ELEVATION INCREMENT IS ONE TENTH FOOT

ELEV. FEET	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1590	672	680	689	698	706	714	723	732	740	748
1591	757	767	777	787	797	806	816	826	836	846
1592	856	867	879	890	901	912	924	935	946	957
1593	969	981	992	1004	1015	1027	1039	1050	1062	1073
1594	1085	1093	1102	1110	1119	1128	1136	1144	1153	1162
1595	1170	1180	1189	1199	1209	1218	1228	1238	1248	1257
1596	1267	1275	1282	1290	1298	1306	1313	1321	1329	1336
1597	1344	1351	1359	1366	1373	1381	1388	1396	1403	1411
1598	1418	1426	1434	1442	1450	1458	1466	1474	1482	1490
1599	1498	1506	1515	1523	1531	1540	1548	1556	1564	1573
1600	1581	1591	1601	1610	1620	1630	1640	1650	1659	1669
1601	1679	1688	1696	1704	1713	1722	1730	1738	1747	1755
1602	1764	1772	1780	1788	1796	1804	1812	1820	1828	1836
1603	1844	1853	1862	1871	1880	1889	1898	1907	1916	1925
1604	1934	1944	1953	1963	1973	1982	1992	2002	2012	2021
1605	2031	2038	2046	2053	2060	2068	2075	2082	2089	2097
1606	2104	2112	2119	2126	2134	2142	2149	2156	2164	2172
1607	2179	2187	2195	2203	2211	2219	2227	2235	2243	2251
1608	2259	2267	2275	2283	2291	2299	2307	2315	2323	2331
1609	2339	2346	2354	2361	2368	2376	2383	2390	2397	2405
1610	2412	2423	2434	2445	2456	2467	2479	2490	2501	2512
1611	2523	2534	2545	2556	2567	2578	2589	2600	2611	2622
1612	2633	2644	2656	2667	2678	2690	2701	2712	2723	2735
1613	2746	2756	2767	2778	2788	2798	2809	2820	2830	2840
1614	2851	2864	2876	2889	2902	2914	2927	2940	2953	2965
1615	2978	2989	3000	3012	3023	3034	3045	3056	3068	3079
1616	3090	3103	3116	3128	3141	3154	3167	3180	3192	3205
1617	3218	3231	3243	3256	3268	3281	3294	3306	3319	3331
1618	3344	3358	3373	3387	3402	3416	3430	3445	3459	3474
1619	3488	3502	3516	3531	3545	3559	3573	3587	3602	3616

TABLE 7-3 CONTINUED
FOSS RESERVOIR
AREA TABLE IN ACRES
ELEVATION INCREMENT IS ONE TENTH FOOT

ELEV. FEET	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1620	3630	3641	3653	3664	3675	3686	3698	3709	3720	3732
1621	3743	3756	3769	3782	3795	3808	3821	3834	3847	3860
1622	3873	3885	3898	3910	3923	3935	3947	3960	3972	3985
1623	3997	4008	4019	4030	4041	4052	4062	4073	4084	4095
1624	4106	4117	4129	4140	4152	4164	4175	4186	4198	4209
1625	4221	4232	4243	4254	4265	4275	4286	4297	4308	4319
1626	4330	4341	4353	4364	4376	4387	4398	4410	4421	4433
1627	4444	4457	4470	4483	4496	4508	4521	4534	4547	4560
1628	4573	4585	4598	4610	4623	4636	4648	4660	4673	4685
1629	4698	4710	4722	4735	4747	4759	4771	4783	4796	4808
1630	4820	4836	4852	4867	4883	4899	4915	4931	4946	4962
1631	4978	4993	5008	5023	5038	5053	5068	5083	5098	5113
1632	5128	5143	5159	5174	5190	5206	5221	5236	5252	5268
1633	5283	5301	5318	5336	5353	5371	5389	5406	5424	5441
1634	5459	5476	5492	5509	5525	5542	5559	5575	5592	5608
1635	5625	5638	5651	5664	5677	5690	5703	5716	5729	5742
1636	5755	5769	5783	5797	5811	5825	5839	5853	5867	5881
1637	5895	5911	5927	5943	5959	5975	5991	6007	6023	6039
1638	6055	6071	6087	6103	6119	6135	6152	6168	6184	6200
1639	6216	6234	6251	6268	6286	6304	6321	6338	6356	6374
1640	6391	6410	6429	6447	6466	6485	6504	6523	6541	6560
1641	6579	6601	6623	6646	6668	6690	6712	6734	6757	6779
1642	6801+	6823	6845	6866	6888	6910	6932	6954	6975	6997
1643	7019	7040	7060	7081	7102	7122	7143	7164	7185	7205
1644	7226	7249	7273	7296	7319	7342	7366	7389	7412	7436
1645	7459	7476	7493	7511	7528	7545	7562	7579	7597	7614
1646	7631	7651	7672	7692	7712	7732	7753	7773	7793	7814
1647	7834	7854	7874	7895	7915	7935	7955	7975	7996	8016
1648	8036	8056	8077	8097	8117	8138	8158	8178	8198	8219
1649	8239	8259	8279	8300	8320	8340	8360	8380	8401	8421

+ Top of conservation pool.

TABLE 7-3 CONTINUED
FOSS RESERVOIR
AREA TABLE IN ACRES
ELEVATION INCREMENT IS ONE TENTH FOOT

ELEV. FEET	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1650	8441	8458	8476	8493	8511	8528	8545	8563	8580	8598
1651	8615	8633	8652	8670	8689	8708	8726	8744	8763	8782
1652	8800	8822	8844	8866	8888	8910	8932	8954	8976	8998
1653	9020	9042	9064	9086	9108	9130	9152	9174	9196	9218
1654	9240	9265	9289	9314	9338	9363	9388	9412	9437	9461
1655	9486	9507	9529	9550	9572	9593	9614	9636	9657	9679
1656	9700	9725	9750	9775	9800	9825	9850	9875	9900	9925
1657	9950	9976	10002	10028	10054	10080	10106	10132	10158	10184
1658	10210	10239	10268	10297	10326	10355	10384	10413	10442	10471
1659	10500	10529	10559	10588	10618	10647	10676	10706	10735	10764
1660	10794	10821	10848	10874	10901	10928	10955	10982	11008	11035
1661	11062	11086	11110	11134	11158	11182	11206	11230	11254	11278
1662	11302	11329	11357+	11384	11412	11440	11467	11494	11522	11549
1663	11577	11603	11629	11655	11681	11707	11734	11760	11786	11812
1664	11838	11864	11890	11916	11942	11968	11995	12021	12047	12073
1665	12099	12127	12156	12184	12213	12242	12270	12298	12327	12355
1666	12384	12413	12442	12471	12500	12529	12558	12587	12616	12645
1667	12674	12703	12733	12762	12792	12822	12851	12880	12910	12940
1668	12969	12998	13026	13055	13083	13112	13141	13169	13198	13226
1669	13255	13284	13314	13344	13373	13402	13432	13462	13491	13520
1670	13550	13586	13623	13660	13696	13732	13769	13806	13842	13878
1671	13915	13947	13979	14011	14043	14075	14108	14140	14172	14204
1672	14236	14270	14304	14338	14372	14406	14440	14474	14508	14542
1673	14576	14610	14644	14678	14712	14746	14781	14815	14849	14883
1674	14917	14953	14989	15025	15061	15097	15133	15169	15205	15241
1675	15277	15313	15349	15385	15421	15458	15494	15530	15566	15602
1676	15638	15672	15706	15740	15774	15808	15842	15876	15910	15944
1677	15978	16011	16044	16077	16110	16143	16176	16209	16242	16275
1678	16308	16343	16378	16413	16448	16483	16519	16554	16589	16624
1679	16659	16700	16741	16782	16823	16864	16905	16946	16987	17028

+ Top of flood control pool.

TABLE 7-3 CONCLUDED
FOSS RESERVOIR
AREA TABLE IN ACRES
ELEVATION INCREMENT IS ONE TENTH FOOT

ELEV. FEET	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1680	17069	17098	17127	17156	17185	17214	17243	17272	17301	17330
1681	17359	17394	17429	17464	17499	17534	17570	17605	17640	17675
1682	17710	17748	17786	17824	17862	17900	17938	17976	18014	18052
1683	18090	18126	18162	18198	18234	18270	18306	18342	18378	18414
1684	18450	18485	18520	18555	18590	18625	18660	18695	18730	18765
1685	18800	18837	18874	18911	18948	18985	19022	19059	19096	19133
1686	19170	19204	19238	19272	19306	19340	19374	19408	19442	19476
1687	19510	19545	19580	19615	19650	19685	19720	19755	19790	19825
1688	19860	19892	19924	19956	19988	20020	20053	20085	20117	20149
1689	20181	20214	20247	20280	20313	20346	20379	20412	20445	20478
1690	20511	20547	20583	20619	20655	20691	20726	20762	20798	20834
1691	20870	20904	20938	20972	21006	21040	21074	21108	21142	21176
1692	21210	21245	21280	21315	21350	21385	21419	21454	21489	21524
1693	21559	21594	21629	21664	21699	21734	21768	21803	21838	21873
1694	21908	21943	21979	22014	22050	22085	22121	22156	22192	22227
1695	22263									

TABLE 7-4
FOSS RESERVOIR
CAPACITY TABLE IN 1000'S OF ACRE FEET
(ELEVATION INCREMENT IS ONE TENTH FOOT)

ELEV. FEET	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1590	5.06	5.13	5.20	5.26	5.33	5.41	5.48	5.55	5.63	5.70
1591	5.78	5.85	5.93	6.01	6.09	6.17	6.25	6.34	6.42	6.50
1592	6.59	6.68	6.76	6.85	6.94	7.03	7.13	7.22	7.31	7.41
1593	7.51	7.60	7.70	7.80	7.90	8.00	8.10	8.21	8.31	8.41
1594	8.52	8.63	8.74	8.84	8.95	9.06	9.18	9.29	9.40	9.52
1595	9.63	9.75	9.87	9.99	10.11	10.23	10.35	10.47	10.60	10.72
1596	10.85	10.97	11.10	11.23	11.36	11.49	11.62	11.75	11.88	12.02
1597	12.15	12.28	12.42	12.56	12.69	12.83	12.97	13.11	13.25	13.39
1598	13.53	13.67	13.81	13.96	14.10	14.25	14.39	14.54	14.69	14.84
1599	14.99	15.14	15.29	15.44	15.60	15.75	15.91	16.06	16.22	16.38
1600	16.53	16.69	16.85	17.01	17.18	17.34	17.50	17.67	17.83	18.00
1601	18.17	18.34	18.50	18.67	18.84	19.02	19.19	19.36	19.54	19.71
1602	19.89	20.06	20.24	20.42	20.60	20.78	20.96	21.14	21.32	21.51
1603	21.69	21.88	22.06	22.25	22.44	22.62	22.81	23.00	23.19	23.39
1604	23.58	23.77	23.97	24.16	24.36	24.56	24.75	24.95	25.15	25.35
1605	25.55	25.76	25.96	26.16	26.37	26.57	26.78	26.99	27.20	27.40
1606	27.61	27.83	28.04	28.25	28.46	28.68	28.89	29.11	29.32	29.54
1607	29.76	29.97	30.19	30.41	30.63	30.86	31.08	31.30	31.52	31.75
1608	31.97	32.20	32.43	32.66	32.88	33.11	33.34	33.58	33.81	34.04
1609	34.27	34.51	34.74	34.98	35.22	35.45	35.69	35.93	36.17	36.42
1610	36.66	36.90	37.15	37.39	37.64	37.89	38.14	38.39	38.64	38.89
1611	39.14	39.40	39.65	39.91	40.16	40.42	40.68	40.94	41.20	41.46
1612	41.72	41.99	42.25	42.52	42.78	43.05	43.32	43.59	43.86	44.14
1613	44.41	44.68	44.96	45.24	45.51	45.79	46.07	46.35	46.64	46.92
1614	47.20	47.49	47.78	48.06	48.35	48.64	48.93	49.23	49.52	49.82
1615	50.11	50.41	50.71	51.01	51.31	51.61	51.92	52.22	52.53	52.83
1616	53.14	53.45	53.76	54.08	54.39	54.70	55.02	55.34	55.66	55.98
1617	56.30	56.62	56.94	57.27	57.59	57.92	58.25	58.58	58.91	59.25
1618	59.58	59.92	60.25	60.59	60.93	61.27	61.61	61.96	62.30	62.65
1619	63.00	63.35	63.70	64.05	64.40	64.76	65.12	65.47	65.83	66.19

TABLE 7-4 CONTINUED
FOSS RESERVOIR
CAPACITY TABLE IN 1000'S OF ACRE FEET
(ELEVATION INCREMENT IS ONE TENTH FOOT)

ELEV. FEET	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1620	66.56	66.92	67.28	67.65	68.02	68.39	68.76	69.13	69.50	69.87
1621	70.24	70.62	71.00	71.37	71.75	72.13	72.52	72.90	73.28	73.67
1622	74.05	74.44	74.83	75.22	75.61	76.00	76.40	76.79	77.19	77.58
1623	77.98	78.38	78.78	79.18	79.59	79.99	80.39	80.80	81.21	81.62
1624	82.03	82.44	82.85	83.26	83.68	84.09	84.51	84.93	85.34	85.77
1625	86.19	86.61	87.03	87.46	87.88	88.31	88.74	89.17	89.60	90.03
1626	90.46	90.90	91.33	91.77	92.21	92.65	93.09	93.53	93.97	94.41
1627	94.86	95.30	95.75	96.20	96.65	97.10	97.55	98.00	98.46	98.91
1628	99.37	99.83	100.28	100.74	101.21	101.67	102.13	102.60	103.06	103.53
1629	104.00	104.47	104.94	105.41	105.89	106.36	106.84	107.32	107.79	108.27
1630	108.76	109.24	109.72	110.21	110.69	111.18	111.67	112.16	112.66	113.15
1631	113.65	114.15	114.65	115.15	115.65	116.15	116.66	117.17	117.67	118.18
1632	118.70	119.21	119.72	120.24	120.76	121.28	121.80	122.32	122.84	123.37
1633	123.90	124.43	124.96	125.49	126.02	126.56	127.10	127.63	128.18	128.72
1634	129.26	129.81	130.36	130.90	131.46	132.01	132.56	133.12	133.68	134.24
1635	134.80	135.36	135.92	136.49	137.06	137.62	138.19	138.76	139.34	139.91
1636	140.48	141.06	141.64	142.22	142.80	143.38	143.96	144.55	145.13	145.72
1637	146.31	146.90	147.49	148.09	148.68	149.28	149.88	150.48	151.08	151.68
1638	152.29	152.89	153.50	154.11	154.72	155.34	155.95	156.57	157.18	157.80
1639	158.43	159.05	159.67	160.30	160.93	161.56	162.19	162.82	163.46	164.10
1640	164.74	165.38	166.02	166.66	167.31	167.96	168.61	169.26	169.91	170.57
1641	171.22	171.88	172.54	173.21	173.87	174.54	175.21	175.88	176.55	177.23
1642	177.90+	178.58	179.27	179.95	180.64	181.32	182.02	182.71	183.40	184.10
1643	184.80	185.50	186.20	186.91	187.62	188.33	189.04	189.75	190.47	191.19
1644	191.91	192.63	193.36	194.09	194.82	195.55	196.28	197.02	197.75	198.49
1645	199.23	199.98	200.72	201.47	202.22	202.97	203.72	204.48	205.24	206.00
1646	206.76	207.52	208.29	209.06	209.83	210.60	211.37	212.15	212.92	213.70
1647	214.49	215.27	216.05	216.84	217.63	218.42	219.22	220.01	220.81	221.61
1648	222.41	223.22	224.02	224.83	225.64	226.45	227.27	228.08	228.90	229.72
1649	230.55	231.37	232.20	233.02	233.85	234.69	235.52	236.35	237.19	238.03

+ Top of conservation pool.

TABLE 7-4 CONTINUED
FOSS RESERVOIR
CAPACITY TABLE IN 1000'S OF ACRE FEET
(ELEVATION INCREMENT IS ONE TENTH FOOT)

ELEV. FEET	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1650	238.87	239.72	240.56	241.41	242.26	243.11	243.96	244.81	245.67	246.53
1651	247.39	248.25	249.11	249.98	250.84	251.71	252.58	253.46	254.33	255.21
1652	256.09	256.97	257.85	258.74	259.62	260.51	261.40	262.30	263.19	264.09
1653	264.99	265.89	266.80	267.71	268.61	269.53	270.44	271.35	272.27	273.19
1654	274.12	275.04	275.97	276.90	277.83	278.76	279.70	280.64	281.58	282.52
1655	283.47	284.41	285.37	286.32	287.27	288.23	289.19	290.15	291.12	292.08
1656	293.05	294.03	295.00	295.98	296.95	297.94	298.92	299.91	300.89	301.88
1657	302.88	303.87	304.87	305.87	306.88	307.88	308.89	309.91	310.92	311.94
1658	312.96	313.98	315.01	316.04	317.07	318.11	319.14	320.18	321.23	322.27
1659	323.32	324.37	325.43	326.49	327.55	328.61	329.67	330.74	331.82	332.89
1660	333.97	335.05	336.13	337.21	338.30	339.39	340.48	341.58	342.68	343.78
1661	344.88	345.99	347.09	348.20	349.32	350.43	351.55	352.67	353.79	354.92
1662	356.05	357.18	358.31+	359.45	360.59	361.73	362.87	364.02	365.17	366.32
1663	367.48	368.63	369.79	370.96	372.12	373.29	374.46	375.63	376.81	377.99
1664	379.17	380.35	381.54	382.73	383.92	385.11	386.31	387.51	388.71	389.92
1665	391.12	392.34	393.55	394.76	395.98	397.21	398.43	399.66	400.89	402.12
1666	403.36	404.60	405.84	407.09	408.33	409.58	410.84	412.10	413.35	414.62
1667	415.88	417.15	418.42	419.70	420.97	422.25	423.54	424.82	426.11	427.40
1668	428.70	430.00	431.30	432.60	433.91	435.21	436.53	437.84	439.16	440.48
1669	441.80	443.13	444.46	445.79	447.13	448.47	449.81	451.15	452.50	453.85
1670	455.20	456.56	457.91	459.28	460.64	462.01	463.39	464.76	466.14	467.52
1671	468.91	470.30	471.69	473.09	474.49	475.89	477.30	478.71	480.12	481.54
1672	482.96	484.38	485.81	487.24	488.68	490.11	491.55	493.00	494.45	495.90
1673	497.35	498.81	500.27	501.74	503.21	504.68	506.16	507.64	509.12	510.61
1674	512.10	513.59	515.09	516.59	518.09	519.60	521.11	522.62	524.14	525.66
1675	527.19	528.72	530.25	531.79	533.33	534.87	536.42	537.97	539.52	541.08
1676	542.64	544.20	545.77	547.34	548.92	550.49	552.08	553.66	555.25	556.84
1677	558.43	560.03	561.63	563.24	564.85	566.46	568.07	569.69	571.31	572.94
1678	574.56	576.20	577.83	579.47	581.11	582.76	584.41	586.06	587.71	589.37
1679	591.04	592.70	594.37	596.04	597.72	599.40	601.09	602.77	604.46	606.16

+ Top of flood control pool.

TABLE 7-4 CONCLUDED
FOSS RESERVOIR
CAPACITY TABLE IN 1000'S OF ACRE FEET
(ELEVATION INCREMENT IS ONE TENTH FOOT)

ELEV. FEET	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1680	607.86	609.56	611.26	612.97	614.68	616.40	618.12	619.84	621.56	623.29
1681	625.03	626.76	628.50	630.25	632.00	633.75	635.50	637.26	639.02	640.79
1682	642.56	644.33	646.10	647.88	649.67	651.46	653.25	655.04	656.84	658.64
1683	660.45	662.26	664.07	665.88	667.70	669.53	671.36	673.19	675.02	676.86
1684	678.70	680.55	682.40	684.25	686.11	687.97	689.83	691.70	693.57	695.44
1685	697.32	699.20	701.09	702.98	704.87	706.76	708.66	710.57	712.47	714.38
1686	716.30	718.22	720.14	722.06	723.99	725.92	727.85	729.79	731.73	733.68
1687	735.63	737.58	739.53	741.49	743.45	745.41	747.38	749.35	751.33	753.31
1688	755.29	757.27	759.26	761.25	763.25	765.24	767.25	769.25	771.26	773.27
1689	775.29	777.31	779.33	781.35	783.38	785.42	787.45	789.49	791.53	793.58
1690	795.63	797.68	799.74	801.80	803.86	805.93	808.00	810.07	812.15	814.23
1691	816.31	818.40	820.49	822.58	824.68	826.78	828.88	830.99	833.10	835.22
1692	837.34	839.46	841.58	843.71	845.84	847.98	850.12	852.26	854.41	856.56
1693	858.71	860.86	863.02	865.19	867.35	869.53	871.70	873.88	876.06	878.24
1694	880.43	882.62	884.82	887.02	889.22	891.42	893.63	895.85	898.06	900.28
1695	902.50									

Source: USGS File No. 7-3243 (referred to incorrectly as Table 1 from this file.)

EXHIBITS

E X H I B I T A

SUPPLEMENTARY PERTINENT DATA

FOSS DAM AND RESERVOIR

EXHIBIT A

SUPPLEMENTARY PERTINENT DATA

FOSS DAM AND RESERVOIR

TABLE OF CONTENTS

SUPPLEMENTARY PERTINENT DATA
FOSS DAM AND RESERVOIR
1 - GENERAL INFORMATION

OTHER NAMES FOR PROJECT:	Foss Lake
LOCATION:	Red River Basin, Washita River Mile 474.4, about 7 miles north of Foss, Oklahoma, State of Oklahoma
TYPE OF PROJECT:	Dam and reservoir
OBJECTIVES OF REGULATION:	Multipurpose - flood control, irrigation, water supply, fish and wildlife, recreational benefits, and flow regulation
PROJECT OWNER:	U.S. Department of Interior, Bureau of Reclamation
OPERATING AGENCY:	Foss Reservoir Master Conservancy District under supervision of the Bureau of Reclamation, Great Plains Region. Damtender lives at dam and is on call 24 hours a day.
REGULATING AGENCY:	U.S. Army Corps of Engineers, Tulsa District, for flood control purposes. Foss Reservoir Master Conservancy District under supervision of the Bureau of Reclamation, Great Plains Region, for conservation and dam safety purposes and Bureau of Reclamation for dam safety purposes.
CODE OF FEDERAL REGULATIONS, TITLE 33:	Part 208.11, Code of Federal Regulations, Chapter II, July 1, 1989, Edition (included as Exhibit D of this manual).
WATER SUPPLY CONTRACTS:	Foss Reservoir Master Conservancy District with the cities of Clinton, Cordell, Hobart, and Bessie, Oklahoma, for 18,000 acre-feet annually.
OTHER INTERAGENCY AGREEMENTS:	Letter of Understanding and Water Control Agreement between the Corps of Engineers, Bureau of Reclamation, and Foss Reservoir Master Conservancy District.
WATER RIGHTS:	Appropriated by the Oklahoma Resources Board
PROJECT COST:	$14,410,000.00
CLOSURE DATE:	13 February 1961
SPECIAL PROJECT FEATURES:	Damtender residence provided at dam. Water treatment plant located at downstream side of dam.

2 - RESERVOIR INFORMATION
ELEVATIONS, AREAS AND STORAGES

Feature	Elevation (ft. NGVD)	Area (Acres)	Storage[5] Accumulative (Acre-Feet)	Storage[5] Runoff[1] (Inches)	Storage[5] Incremental (Acre-Feet)
OPERATIONAL CONDITIONS					
Maximum Operational Pool	1694.2	21,980	884,820	11.09	448,290
Spillway Crest	1668.6	13,140	436,530	5.47	78,220
Operational Top of Flood Control Pool	1662.2	11,360	358,310	4.49	180,410
Operational Top of Conservation Pool	1642.0	6,800	177,900	2.23	165,480
Top of Inactive Pool[2]	1597.2	1,360	12,420	0.16	12,420
Streambed	1563.0	0	0	0	0
Operational Flood Control Storage to Maximum Storage	1662.2-1694.2	--	526,510	6.60	--
Flood Control Storage	1642.0-1662.2	--	180,410[3]	2.26	--
Irrigation and Water Supply Storage[4]	1597.2-1642.0	--	165,480	2.07	--
Sediment Storage (not Distributed)	1563.-1597.2	--	12,420	--	--
AS-AUTHORIZED CONDITIONS					
Top of Dam	1697.0	--	--	--	--
Maximum Design Pool	1691.0	20,870	816,890	10.24	380,080
Authorized Top of Flood Control Pool and Spillway Crest	1668.6	13,140	436,810	5.47	180,590
Authorized Top of Conservation Pool	1652.0	8,800	256,220	3.21	243,810
Top of Inactive Pool[2]	1597.2	1,360	12,410	0.16	12,420
Streambed	1563.0	0	0	0	0
Design Flood Control to Maximum Storage	1668.6-1691.0	--	380,080	4.76	--
Design Flood Control Storage	1652.0-1668.6	--	180,590[3]	2.26	--
Design Irrigation and Water Supply Supply Storage[4]	1597.2-1652.0	--	243,810	3.06	--

(1) Drainage area 1,496 square miles
(2) Invert elevation of river outlet works intake structure
(3) Includes 3,500 acre-feet sediment storage
(4) Jointly used to meet irrigation and municipal requirements
(5) Using capacity table from USGS file No. 7-3243 (incorrectly called Table Number 1).

MAJOR FLOODS PAST DAMSITE [1]

PEAK DATE	FLOW (cfs)	VOLUME (Acre-Feet)	RUNOFF (Inches[2])
3-7 April 1934	110,000	134,000	1.26
16-20 May 1951	66,800	90,300	0.85
5-9 June 1936	26,900	63,100	0.59
26-31 May 1959	22,200	54,200	0.51
30 April - 4 May 1954	13,100	24,100	0.23

No Major Floods Since Reservoir in Operation

(1) Flood data on Washita River near Clinton, Oklahoma, river mile 447.4 with a drainage area of 1,997 square miles.

(2) At Clinton, Oklahoma, one inch of runoff = 106,440 acre-feet.

REAL ESTATE TAKING LINE FOR FEE TITLE: Reservoir land was purchased in fee to a blocked perimeter encompassing elevation 1654.5 feet NGVD (5-year flood frequency pool). There are 14,040 acres in fee. Land was also purchased in fee for recreational purposes - 150 acres, fish and wildlife refuge purposes - 603 acres, and fish and wildlife mitigation purposes - 888 acres.

REAL ESTATE TAKING LINE FOR EASEMENT: Flowage easements were acquired for the 1,562-acre area between the lands purchased in fee simple and (as a general rule) the contour of the top of the flood control pool (between elevations 1654.5 and 1668.6 feet NGVD).

RANGE OF CLEARING: The reservoir area was cleared to top of design conservation pool (elevation 1652.0 feet NGVD).

POOL ELEVATION CORRESPONDING TO DISCHARGE CAPABILITY OF MAXIMUM NONDAMAGING FLOW RATE DOWNSTREAM: Nondamaging channel capacity downstream of Foss Dam is currently estimated to be approximately 1,000 cfs. This flow can be discharged through the river outlet works when the reservoir level is at or above elevation 1602.0 feet NGVD.

RESERVOIR LENGTH AT TOP CONSERVATION POOL:	10 miles
SHORELINE LENGTH AT TOP CONSERVATION POOL:	63 miles
SAFETY ASPECTS POSSIBLY REQUIRING WARNING:	Seepage control and safety of dam with respect to PMF. An emergency action plan has been developed and will be implemented upon being given an evacuation notice.
EMERGENCY DRAWDOWN:	The lowest invert usable for reservoir drawdown is elevation 1597.2 feet at the river outlet works. The storage remaining at this elevation is 12,420 acre-feet. Making releases through the river outlet works would require 91 days at 1,000 cfs, 25 days with outlets wide open to evacuate the flood control storage with no inflow during the period.

3 - HYDROLOGY

DRAINAGE AREA:	1,496 square miles
INFLOW DESIGN FLOOD:	
MAXIMUM WATER SURFACE ELEVATION:	1694.2 feet NGVD
PEAK INFLOW:	334,300 cfs
TOTAL STORM RUNOFF:	9.47 inches
VOLUME:	755,800 acre-feet
MAXIMUM OUTFLOW:	7,760 cfs
FLOOD DURATION:	13 days
100-YEAR FLOOD:	
MAXIMUM WATER SURFACE ELEVATION:	1650.9 feet NGVD
PEAK INFLOW:	75,700 cfs
TOTAL STORM RUNOFF:	0.95 inches
VOLUME:	75,600 acre-feet
MAXIMUM OUTFLOW:	1,000 cfs
FLOOD DURATION:	7 days
CLIMATE:	Subhumid, bordering on semi-arid
ONE-INCH RUNOFF:	79,787 acre-feet
STORM TYPES:	Frontal action between cold polar air masses and warm, moist gulf air masses, thunderstorms, and occasional storms from residual hurricanes.
FLOOD SEASONS:	Spring and fall
LOW FLOW SEASON:	July through mid-September, although low flows can occur at any time during the year.
MINIMUM DAILY FLOW:	0 (415 times during period of record)
MINIMUM MONTHLY FLOW:	0 (at times)
MINIMUM ANNUAL FLOW:	14,230 acre-feet (1972)

AVERAGE ANNUAL FLOW:	64,860 acre-feet
MAXIMUM ANNUAL FLOW:	225,800 acre-feet (1934)
MAXIMUM MONTHLY FLOW:	180,000 acre-feet (April 1934)
MAXIMUM DAILY FLOW:	82,000 cfs (April 1934) (estimated)
MAXIMUM INSTANTANEOUS FLOW:	167,000 cfs (April 1934) (estimated)
MAXIMUM FLOOD VOLUME:	180,000 acre-feet (April 1934) (estimated)
NAME AND LOCATION OF KEY STREAM-FLOW STATIONS:	Washita River near Clinton, OK, at RM447.4, and near Cheyenne, OK, at RM 5439
TYPE OF HYDROMETEOROLOGIC DATA RECORDED AT DAMSITE:	Pool elevation, air temperature, rainfall, evaporation, wind direction and velocity
NUMBER OF PRECIPITATION STATIONS USED IN HYDROLOGIC FORECASTING:	Up to 13
NUMBER OF SEDIMENT RANGES:	46

4 - EMBANKMENT

LOCATION:	Washita River at river mile 474.4
PURPOSE:	Municipal and industrial water supply, irrigation, flood control, fish and wildlife, recreation, and flow regulation
TYPE:	Rolled earthfill
SLOPE PROTECTION:	Riprap upstream and sod downstream
HEIGHT (Above Streambed):	134 feet
LENGTH:	18,120 feet
TOP WIDTH:	30 feet
TOP ELEVATION:	1697.0 feet NGVD
DESIGN FLOOD:	Inflow design flood
FREEBOARD:	3.0 feet
USED FOR ROADWAY:	State Highway 44
ELEVATION OF STREAMBED:	1563.0 feet NGVD

5 - SPILLWAY

LOCATION:	Near right abutment
TYPE:	Uncontrolled, circular drop inlet
CREST ELEVATION:	1668.6 feet NGVD
CONDUIT DIAMETER:	9-foot 6-inch, circular conduit upstream and modified horseshoe conduit downstream
INDUCED SURCHARGE:	None
MAXIMUM HEAD ABOVE SPILLWAY CREST:	25.4 feet
DISCHARGE CAPACITY AT MAXIMUM POOL ELEVATION 1694.0 FEET NGVD:	3,260 cfs
TYPE ENERGY DISSIPATOR:	Stilling basin with baffle blocks, separate from river outlet works stilling basin.
RECURRENCE INTERVAL OF POOL ATTAINING CREST ELEVATION:	With a limited period of record available, the recurrence interval can not be determined accurately; however, it is estimated to be greater than 100 years.
SPILLWAY ACTIVATION:	No occurrence to date.

6 - OUTLET FACILITIES

A - RIVER OUTLET WORKS

LOCATION:	Near right abutment
PURPOSE:	Flood control
TYPE OF OUTLET AND SIZE:	11-foot diameter pressure concrete conduit upstream and a modified horseshoe conduit downstream with an 8-inch bypass.
INTAKE INVERT ELEVATION:	1597.2 feet NGVD
TYPE OF SERVICE GATES:	Two 6'H x 7'6"W high-pressure gates

	Discharge	Elevation
AT MAXIMUM POOL	4,500 cfs	1694.2 feet NGVD
AT TOP OF DESIGN FLOOD CONTROL POOL	3,990 cfs	1668.6 feet NGVD
AT TOP OF OPERATIONAL FLOOD CONTROL POOL	3,840 cfs	1662.2 feet NGVD
AT TOP OF DESIGN CONSERVATION POOL	3,600 cfs	1652.0 feet NGVD
AT TOP OF OPERATIONAL CONSERVATION POOL	3,350 cfs	1642.0 feet NGVD

MINIMUM TIME TO OPEN/CLOSE GATES:	25-30 minutes
TYPE EMERGENCY CLOSURE AND TIME REQUIRED:	Two 6'H x 7'6"W high-pressure gates in tandem with service gates; closure time not available.
TYPE ENERGY DISSIPATOR:	Stilling basin with baffle blocks separate from uncontrolled spillway outlet stilling basin.

B - CANAL OUTLET WORKS

LOCATION:	Near left abutment
PURPOSE:	Irrigation water supply
TYPE OF OUTLET AND SIZE:	One 5-foot diameter concrete conduit upstream and a free-flow modified 8-foot horseshoe conduit downstream, with 4-inch bypass
TYPE OF SERVICE GATES:	Two 2'9"H x 2'9"W high-pressure gates
INTAKE INVERT ELEVATION:	1602.0 feet NGVD
DISCHARGE AT MAXIMUM POOL ELEVATION, 1694.2 FEET NGVD:	700 cfs
MINIMUM TIME TO OPEN/CLOSE GATES:	Not available
TYPE EMERGENCY CLOSURE AND TIME REQUIRED:	Two 2'9"H x 2'9"W high-pressure emergency gates in tandem with service gates; closure time not available.
TYPE ENERGY DISSIPATOR:	Stilling basin with baffle blocks, separate from uncontrolled spillway outlet stilling basin.

C - MUNICIPAL WATER SUPPLY OUTLET WORKS

LOCATION:	Near left abutment
PURPOSE:	Municipal and industrial water supply
TYPE OF OUTLET AND SIZE:	Four trashracked intake structures with 4 concrete-encased 24-inch steel pipes, and downstream modified horseshoe tunnel with 26-inch steel outlet pipe
INTAKE INVERT ELEVATIONS:	1642.0 feet NGVD 1627.0 feet NGVD 1612.0 feet NGVD 1597.2 feet NGVD
TYPE OF GATES:	Four 24-inch wedge gate valves
TYPE OF EMERGENCY CLOSURE AND TIME REQUIRED:	Stop-log slot provided in each intake structure; closure time not available.
DISCHARGE CAPACITY:	11 million gallons per day

7 - CONTROL POINTS

A - CLINTON GAGE

LOCATION:	Washita River near Clinton, OK, at river mile 447.4, on U.S. Highway 183 bridge
PURPOSE OF GAGE:	Used by U.S. Geological Survey as source of public record, by Corps of Engineers for regulation of Foss Reservoir.
CHANNEL AND FLOOD PLAIN:	Channel is straight for about 1,100 feet upstream and about 900 feet downstream from gage. The river channel downstream from the dam is sediment choked but well-defined. There is dense growth of cottonwood and willow vegetation along most of the river between the dam and Clinton. Banks are sandy soil and are subject to overflow. Flood plain is broad and sandy.
UNCONTROLLED DRAINAGE AREA:	501 square miles
TREATMENT OF UNCONTROLLED RUNOFF:	Contributes to flood control target stages
TARGET FLOW RATE:	Operational stage 18 feet, 1,900 cfs (see Plate 4-4.)
TIME OF CREST TRAVEL:	12 hours from Foss Dam to the Clinton gage
MONITORING PROVISIONS:	Water surface elevation is recorded by water-stage recorder with satellite data collection platform. Discharge measurements are made on schedule and as needed.
CHANNEL USAGE:	Fishing

B - CARNEGIE GAGE

LOCATION:	Washita River near Carnegie, OK, at river mile 353.9, on State Highway 9 bridge
PURPOSE OF GAGE:	Used by U.S. Geological Survey as source of public record, by Corps of Engineers for regulation of Foss Reservoir.
CHANNEL AND FLOOD PLAIN:	Channel is controlled at all stages. Bed is of soft mud and shifts considerably. Sharp curve to left about 400 feet downstream will possibly be partial control below flood stage. Banks are soft and tend to slough after high stages. Tributaries deposit silt in channel during rises.
UNCONTROLLED DRAINAGE AREA:	1,633 square miles
TREATMENT OF UNCONTROLLED RUNOFF:	Contributes to flood control target flows
TARGET FLOW RATE:	Operational stage 23 feet, 6,000 cfs (see Plate 4-5.)
TIME OF CREST TRAVEL:	48 hours from the Clinton gage to the Carnegie gage
MONITORING PROVISIONS:	Water surface elevation is recorded by water-stage recorder with satellite data collection platform. Discharge measurements are made on schedule and as needed.
CHANNEL USAGE:	Fishing

C - ANADARKO GAGE

LOCATION:	Washita River near Anadarko, OK, at river mile 305.2, 35 feet upstream from U.S. Highway 281 bridge
PURPOSE OF GAGE:	Used by U.S. Geological Survey as source of public record, by Corps of Engineers for regulation of Foss and Fort Cobb Reservoirs.
CHANNEL AND FLOOD PLAIN:	Natural channel controlled at all stages by permanent rock riffle streambed. Channel is straight 400 feet upstream and 1,000 feet downstream. Banks lightly wooded, patchy underbrush with cultivation on left upstream and right downstream. Stream strikes bridge at slight angle.
UNCONTROLLED DRAINAGE AREA:	2,160 square miles
TREATMENT OF UNCONTROLLED RUNOFF:	Contributes to flood control target flow
TARGET FLOW RATE:	Operational stage 19 feet, 5,600 cfs, (see Plate 4-6.)
TIME OF CREST TRAVEL:	24 hours from the Clinton gage to the Anadarko gage
MONITORING PROVISIONS:	Water surface elevation is recorded by water-stage recorder with satellite data collection platform. Discharge measurements are made on schedule and as needed.
CHANNEL USAGE:	Fishing

E X H I B I T B

LETTER OF UNDERSTANDING

FOSS DAM AND RESERVOIR

OF THE WASHITA RIVER BASIN PROJECT, OKLAHOMA

LETTER OF UNDERSTANDING

FOSS RESERVOIR

OF THE WASHITA RIVER BASIN PROJECT, OKLAHOMA

The Corps of Engineers, the Bureau of Reclamation, and the Foss Reservoir Master Conservancy District hereby set forth this agreement to carry out the provision of Section 7 of the 1944 Flood Control Act for the operation of the Foss Reservoir.

WHEREAS, Foss Reservoir of the Washita River Basin Project, on the Washita River in Custer County, Oklahoma, was authorized by Public Law 419, 84th Congress, 2nd Session. The project was constructed by the Bureau of Reclamation with 180,410 acre-feet of flood control storage which will be regulated in accordance with Section 7 of the 1944 Flood Control Act.

WHEREAS, Section 7 of the Flood Control Act of 1944, Public Law 78-534, 58 Stat 890, 33 USC 709 directs the Secretary of the Army to prescribe regulations for the use of storage allocated for flood control or navigation at all reservoirs constructed wholly or in part with Federal funds.

WHEREAS, 33 CFR 208.11, Part 208 further prescribes the policy and procedures for regulating the use of storage allocated for flood control or navigation purposes at all reservoirs capable of such regulation and constructed wholly or in part with Federal funds provided on the basis of such purposes.

THEREFORE, this Letter of Understanding, along with the Water Control Agreement, supersedes the paragraph 208.28 (26 FR 6982, August 3, 1961) and is added under 208.11(e).

THEREFORE, this Letter of Understanding shall consummate the provisions of Section 7 of the 1944 Flood Control Act for Foss Reservoir. In addition to the responsibilities of the project owner, Bureau of Reclamation, and the Corps of Engineers in accordance with 33 CFR 208.11, it is agreed or understood that:

a. The Bureau of Reclamation (hereinafter called Reclamation) has a contract with the Foss Reservoir Master Conservancy District (hereinafter referred to as the District) which, among other things, delegates to the District the responsibility of the physical operation of the flood control facilities at the direction of the Corps of Engineers (hereinafter called the Corps) for the purpose of releasing flood waters between elevations 1,642.0 and 1,662.2 feet National Geodetic Vertical Datum (NGVD).

b. The Corps is responsible for directing real-time implementation of the flood control plan and until further notice shall direct the regulation of the project for storage and release of flood waters in the exclusive flood control pool (1,642.0 to 1,662.2 feet) in accordance with the approved "Water Control Agreement."

c. The Corps will continue to operate and maintain the stream stage gaging stations on the Washita River near Cheyenne, Oklahoma, as an upstream condition advisory point, and near Clinton and Carnegie, Oklahoma, both used as the downstream control points during flood control releases from Foss Reservoir.

d. Reclamation shall be responsible for directing storage and release of all waters when the reservoir stage is above the top of the flood control pool, elevation 1,662.2 feet NGVD. Corps assistance in evaluating the real-time flood runoff situation will be available to Reclamation.

e. Reclamation shall operate and maintain the hydrometeorological instrumentation and weather equipment at the project. This automated equipment and the reporting transmissions will be maintained compatible with the Corps' Southwestern Division automated data collection system by the District.

f. The District shall be responsible for directing storage and release of all waters in the conservation pool (below elevation 1,642.0).

g. The District shall be responsible for the physical operation of the flood control facilities. The District shall maintain full flood control capabilities of the outlet works and the uncontrolled spillway in accordance with the construction specifications and the "as built" drawings.

h. The District will record and transmit daily hydrometeorological and lake data to the Corps office in Tulsa, Oklahoma, in the format provided by the Corps. These reports will be made as requested by the Corps and shall be made by 9:00 a.m. on normal working days, and on weekends and holidays at Corps request during flood situations. The format used will show the lake elevations, precipitation, evaporation, wind velocity, daily municipal pumpage, gate settings at 8 a.m., and gate changes. The lake elevations will be from the chart recorder for readings at noon, 4 p.m. and midnight of the previous date, and 8 a.m. of the report date. Precipitation in inches shall be reported for the six-hour periods ending at 1 p.m. and 7 p.m. of the previous date, and at 1 a.m. and 7 a.m. of the report date. The total 24-hour precipitation ending at 7 a.m. of the report date shall also be given. Wind velocity data shall consist of direction, as a compass heading from which the wind is proceeding, and speed using the Beaufort scale. Daily municipal pumpage shall be reported for the 24-hour period ending at 8 a.m. of the report date. Gate changes will be given chronologically for the report date since 8 a.m. of the previous date. The information provided for each gate change shall consist of the date and time, rounded to the nearest 5 minutes, lake elevation, settings of all gates prior to change, and settings at all gates after change was made. All changes in the gate settings affecting channel discharge shall also be reported immediately via telephone to the Corps by the District.

i. The flood control regulations under the water control plan, insofar as they govern use of the exclusive flood control storage capacity between elevation 1,642.0 and 1,662.2 feet NGVD, are subject to temporary deviations by the Corps in times of floods. Such deviations would be consistent with emergency requirements for protecting the dam and reservoir from major damage. The modification shall be communicated by the Corps to the representative of the District in immediate charge of operation at Foss Dam and to Reclamation, by the fastest available means of communication. The modification shall be confirmed in writing under date of the same day by the Corps to Reclamation and a copy sent to the District.

j. Reclamation or the District may temporarily deviate from the flood control regulations for emergency reasons to protect the safety of the dam or to avoid other serious hazards. In the event an immediate short-term departure is deemed necessary, such action shall be immediately reported to the Corps by the fastest means of communication available. Actions shall be confirmed in writing the same day by the District to the Corps and shall include justification for the action. Continuation of the deviation will require the express approval of the Corps. Advance approval of the Corps will be acquired prior to any deviation from the plan of regulation prescribed or approved by the Corps in the interest of flood control and/or navigation except in the emergency situations mentioned above. When conditions appear to warrant a prolonged deviation from the approved plan, Reclamation and the Corps will jointly investigate and evaluate the proposed deviation to insure that the overall integrity of the plan will not be unduly compromised. Approval of prolonged deviations will not be granted unless such investigations and evaluations have been conducted to the extent deemed necessary by the Corps to fully substantiate the deviation.

k. Flood control regulation shall not restrict municipal and industrial uses and downstream releases for authorized users as determined by Reclamation or others.

l. The Corps, Reclamation, and the District shall provide warnings that will start immediately when a water condition is expected that could produce severe damage to property and be potentially dangerous to life. The following paragraphs identify the action to be taken by each agency:

(1) Corps. The Corps shall furnish Reclamation and the District with the projected reservoir levels and flood control releases, when requested. The Corps shall furnish available pertinent hydrologic facts concerning Foss Reservoir and known conditions downstream of Foss Dam, as requested for use in warning the public around and downstream of Foss Reservoir. The Corps will dispatch personnel to the Foss Dam and Reservoir area to assist Reclamation and the District as required, insofar as possible.

(2) Reclamation. Reclamation shall alert the following public officials concerning projected reservoir levels and flood control releases: the Civil Defense for the area downstream of Foss Dam; the City Manager and Police and Fire Chiefs for the City of Clinton, Oklahoma; the appropriate State Police and the National Weather Service at Norman, Oklahoma; and the River Forecast Center at Tulsa, Oklahoma. Reclamation will dispatch personnel to the Foss Dam and Reservoir area to assist the Corps and the District as required.

(3) District. The District shall release information furnished by the Corps to the public in the reservoir area and will advise the public downstream of the dam. The District shall alert and assist Reclamation and the Corps by providing the current status of seepage flows and foundation pressures of Foss Dam.

m. The Water Control Manual for Foss Reservoir will contain the Letter of Understanding and the Water Control Agreement. In addition, the manual will contain instructions for reporting data necessary for flood control regulations of Foss Reservoir, communications procedures between the District, Reclamation, and the Corps, and instructions to be followed for flood control regulation. The manual will serve as a detailed guide to personnel involved in the flood control regulation of Foss Reservoir during the life of the project. Portions of the manual will be updated as conditions warrant. Revisions to the Water Control Manual and all associated documents will be in accordance with the provisions of 33 CFR 208.11 (d)(10).

WITNESS OUR HANDS in the capacities on the dates shown below and effective on the last signature date.

(Signature)

James P. King
Colonel, U.S. Army
Acting Commander
Southwestern Division
Corps of Engineers
Authorized Representative of the
Chief of Engineers

4-26-93
Date

D.S. LAUVER
(Signature)

For Neil Stessman
Regional Director
Great Plains Region
Bureau of Reclamation
United Sates Department
of the Interior

8-6-93
Date

Charles Touchstone
(Signature)

Charles Touchstone
Superintendent, Foss Reservoir
Master Conservancy District
Authorized Representative of
the Conservancy

7-13-93
Date

E X H I B I T C

WATER CONTROL AGREEMENT
FOSS DAM AND RESERVOIR
OF THE WASHITA RIVER BASIN
PROJECT, OKLAHOMA

WATER CONTROL AGREEMENT

FOSS RESERVOIR

OF THE WASHITA RIVER BASIN PROJECT, OKLAHOMA

Pursuant to Section 7 of the Act of Congress approved December 22, 1944 (58 Stat 890, 33 USC 709), and further prescribed in 33 CFR 208.11 (d)(5)(i), the following water control release schedules will govern the use of the water storage at Foss Dam and Reservoir, Washita River Basin Project, Custer County, Oklahoma.

The regulation of this section, insofar as it governs use of the flood control storage capacity above elevation 1,642.0, are subject to temporary modification by the Corps in time of flood, if found desirable on the basis of conditions at the time. Action on modifications along with justification shall be communicated immediately to Reclamation.

Flood control operation shall not restrict releases necessary for municipal and industrial uses.

Releases made in accordance with these regulations are subject to the condition that releases shall not be made at rates or in a manner that would be inconsistent with emergency requirements for protecting the dam and reservoir from major damage.

Reclamation may temporarily deviate from this water control plan if it determines that short-term departure is necessary for emergency reasons to protect the safety of Foss Dam. In such event, it will so advise the Corps immediately, with justification, and furnish written confirmation thereof. Continuation of the deviation will require the express approval of the Corps. When conditions appear to warrant a prolonged deviation from the approved plan, Reclamation and the Corps will jointly investigate and evaluate the proposed deviation to insure that the overall integrity of the plan would not be unduly compromised.

The discharge characteristics of the controlled river outlet works (capable of discharging approximately 3,840 c.f.s., with reservoir level at elevation 1,662.2) shall be maintained in accordance with the construction plans, to wit: Bureau of Reclamation Specification No. DC-5100 as modified by the "as built" drawings.

All elevations stated in this section are at Foss Reservoir and are referred to the datum in use at that location.

Schedules are shown in tabular form for both the "Normal" and "Emergency" Flood Control Regulations, specifically, Tables C-1, C-2, and C-3, and are attached hereto and incorporated herein in compliance with the regulations.

WITNESS OUR HANDS in the capacities on the dates shown below and effective on the last signature date.

(Signature)

James P. King
Colonel, U.S. Army
Acting Commander
Southwestern Division
Corps of Engineers
Authorized Representative of the
Chief of Engineers

4-26-13
Date

D.S. LAUVER
(Signature)

For Neil Stessman
Regional Director
Great Plains Region
Bureau of Reclamation
U.S. Department of the Interior

8-6-93
Date

Charles Touchstone
(Signature)

Charles Touchstone
Superintendent, Foss Reservoir
Master Conservancy District
Authorized Representative of
the Conservancy

7-13-93
Date

TABLE C-1

Reservoir Allocations

Foss Reservoir, Oklahoma

	Elevation (feet, NGVD)	Storage Allocation (acre-feet)	Total Storage (acre-feet)
Top of Inactive and Dead Pool	1,597.2	12,420	12,420
Top of Conservation Pool	1,642.0	165,480	177,900
Top of Flood Pool	1,662.2	180,410	358,310

a. Flood Control Storage. Flood control storage capacity allocation shall include the storage capacity between elevation 1642.0 and 1662.2 feet (presently amounting to 180,410 acre-feet).

b. Active Conservation Storage. The active conservation storage capacity allocation shall include the storage capacity between elevation 1597.2 and 1642.0 feet (presently amounting to 165,480 acre-feet).

c. Inactive and Dead Storage. The inactive and dead storage capacity allocation shall include the storage capacity between the streambed and elevation 1597.2 feet NGVD (presently amounting to 12,420 acre-feet.)

TABLE C-2

NORMAL FLOOD CONTROL REGULATION SCHEDULE

FOSS RESERVOIR

Reservoir Elevation (ft. NGVD) Pool Condition	Regulations

Below 1642.0
Rising or Falling

Releases scheduled by the Foss Reservoir Master Conservancy District. Releases are not to exceed channel capacity downstream of the dam (currently estimated to pass approximately 1,000 cfs) or when combined with local flows are not to exceed a stage of 18 feet (currently estimated to pass approximately 1,900 cfs) at the Clinton, Oklahoma gage.

1642.0 - 1662.2
Rising

Make releases according to the following schedule except that releases when combined with uncontrolled runoff downstream will not exceed channel capacity (currently estimated to pass approximately 1,000 cfs) immediately downstream of the dam; 18-foot stage (currently estimated to pass approximately 1,900 cfs) at the Clinton, Oklahoma gage; 23-foot gage (currently estimated to pass approximately 6,000 cfs) at the Carnegie, Oklahoma gage. If the flows exceed any of the stages listed above, no releases will be made that will contribute to flooding.

Rising Pool Elevation	Forecasted % Flood Storage	Release Schedule Maximum Release Rates (cfs)
1662.2	15 - 100	1,000
1645.8	10 - 15	750
1644.6	5 - 10	500
1643.3	0 - 5	300
1642.0		

NOTE: Reclamation is responsible for regulating the project when the pool exceeds elevation 1662.2. When the predicted volume of runoff upstream of the dam exceeds the available flood control storage but does not endanger the safety of the dam, the releases may be modified to obtain downstream benefits.

TABLE C-2 (Continued)

NORMAL FLOOD CONTROL REGULATION SCHEDULE

FOSS RESERVOIR

Reservoir Elevation (ft. NGVD) Pool Condition	Regulations

Above 1662.2
Rising or Falling

Reclamation is responsible for directing release of water when the pool is above the top of flood control pool elevation 1662.2 feet NGVD.

1662.2 - 1660.8
Falling

Evacuate flood storage at the maximum rate possible to maintain a steady or falling stage at the Clinton gage.

1660.8 - 1642.0
Falling

Make releases according to the following schedule, except that the release, when combined with uncontrolled flows downstream, will not exceed those flood stages listed under rising pool conditions.

Release Schedule

Falling Pool Elevation	Forecasted % Flood Storage	Release Schedule Maximum Release Rates (cfs)
1660.8		
	15 - 80	1,000
1645.8		
	10 - 15	750 + Inflow [1], Not to Exceed 1,000 cfs
1644.6		
	5 - 10	500 + Inflow [1], Not to Exceed 750 cfs
1643.3		
	2 - 5	300 + Inflow [1], Not to Exceed 500 cfs
1642.5		
	0 - 2	TRANSITION TO CLOSURE
1642.0		

[1] Forecasted Average Inflow over a 2- to 4-day period.

TABLE C-3

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE
LOSS OF COMMUNICATION WITH RESERVOIR CONTROL SECTION

FOSS RESERVOIR

Reservoir Elevation (ft. NGVD) Pool Condition	Regulations
Below 1642.0	Releases scheduled by the Foss Reservoir Master Conservancy District. Releases are not to exceed channel capacity downstream of the dam (currently estimated to pass approximately 1,000 cfs) or when combined with local flows are not to exceed a stage of 18 feet (currently estimated to pass approximately 1,900 cfs) at the Clinton, Oklahoma gage.
1642.0 - 1662.2 Rising	Maintain current release rate for 12 hours. Then if the release is less than 1,000 cfs, increase the release rate by 250-cfs increments every 2 hours until the release rate is 1,000 cfs. Hold this release rate until communication is reestablished, the pool level starts falling, or the pool exceeds 1662.2 feet NGVD.
Above 1662.2 Rising	Reclamation is responsible for directing reservoir releases above pool elevation 1662.2 feet NGVD. Increase release rates by 500 cfs every 2 hours until both outlet works gates are fully open.
Above 1662.2 Falling	Reclamation is responsible for directing reservoir releases above pool elevation 1662.2 feet NGVD. Maintain current outlet works gate opening until pool recedes to elevation 1662.2 feet NGVD.
1662.2 - 1645.8 Falling	If discharge is 1,000 cfs or less, maintain that release. If discharge is more than 1,000 cfs, reduce the discharge by 500-cfs increments every 12 hours making sure the pool continues to fall until the total release is equal to 1,000 cfs.
1645.8 - 1642.0 Falling	Reduce the discharge every 6 hours by 170-cfs increments making sure the pool continues to fall.

E X H I B I T D

STANDING INSTRUCTIONS TO DAMTENDER

FOSS DAM AND RESERVOIR

EXHIBIT D
STANDING INSTRUCTIONS TO DAMTENDER
FOSS DAM AND RESERVOIR

TABLE OF CONTENTS

EXHIBIT D

STANDING INSTRUCTIONS TO DAMTENDER
FOSS DAM AND RESERVOIR

I - GENERAL

1. Instructions. Detailed instructions to the District and/or Reclamation project personnel at Foss Reservoir are presented below.

a. Standing instructions to the damtender. During flood periods, the reservoir will be regulated in accordance with the normal regulations for flood control as directed in subparagraph 7-05a. and Exhibit E of this manual. Instructions for the storage and discharge of floodwater from the flood control pool will be issued by the Reservoir Control Section, Tulsa District. In the event that communications with the Tulsa District Office are disrupted, the reservoir will be regulated in accordance with the schedule of loss of communication (emergency) regulations for flood control instructions in subparagraph 7-05b and Exhibit E. In addition, the damtender will immediately make every effort to reestablish communications with the Tulsa District Office. The damtender will make daily records of the weather station and pool level data and report those data, as directed in paragraph 5-06 and repeated in Exhibit E. Should an emergency exist, such as inoperable gates, drowning accident, excessive trash in the gates, broken buoy line, embankment boils, or power outage, the Reservoir Control Section will be notified immediately.

b. Project reporting instructions. Daily lake data from Foss Reservoir (see Plate 5-3) will be submitted to the Reservoir Control Section by telephone (see the Emergency Personnel Roster, page ii of the Corps Water Control Manual) during normal working hours. The Reservoir Control Section is normally manned from 7:45 a.m. to 4:30 p.m. daily and various hours during flood control operations and weekends and holidays. Data for nonworking days shall be read from the recorder chart and submitted the following workday. Should unusual conditions arise during nonworking hours, one of the persons listed in the Emergency Personnel Roster on page ii should be contacted. Reports should be transmitted by 9:00 a.m. via telephone. The following data should be included in the daily report.

(1) As of 8:00 a.m. Pool elevations at 8:00 a.m. and for the previous day at 12 noon, 4:00 p.m., and 12 midnight (all values should be read from the recorder chart); number of river outlet gates open, with the height of the openings; municipal and industrial release volumes for the preceding 24 hours ending at midnight; precipitation and evaporation in inches for the preceding 24 hours (7:00 a.m. to 7:00 a.m.); wind velocity and direction (at 8:00 a.m.).

(2) Each gate operation. Date and time of gate operation, number and height of gates open before and after gate operation, and lake elevation. Confirmation of gate changes shall be made immediately after completion of the change. Complaints about pool elevations or releases, operating machinery failure and out-of-service times for maintenance shall be reported to the Reservoir Control Section as they occur.

(3) During flood periods. In addition to subparagraphs a and b above, reports should also be made at 1:00 p.m. and 7:00 p.m. or as instructed by Reservoir Control Section.

(4) Rainfall reports. Rainfall reports shall be made as follows:

a. At 8:00 a.m. all precipitation that has occurred during the preceding 24 hours, 7:00 a.m. to 7:00 a.m. as shown on Plate 5-3 (covered by routine report on working days).

b. At 1:00 p.m. when 0.50 inch or more of precipitation has occurred since 7:00 a.m. or if it has continued to rain since reporting at 8:00 a.m.

c. At 7:00 p.m. when 0.50 inch or more of precipitation has occurred since the 8:00 a.m. report and no 1:00 p.m. report was made, or if it has continued to rain since reporting at 1:00 p.m.

d. Report at once the occurrence of 2.00 inches or more of precipitation that occurs during a period of 6 hours or less.

e. During non-normal working hours, the report should be made to one of the persons listed on the Emergency Personnel Roster, page *ii*; however, if no contact can be made, rainfall reports should be made to the NWS, Tulsa, Oklahoma (see Supplemental Telephone Listing, page iv of Corps Water Control Manual).

c. 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 shall be reported immediately to the Water and Land Operations Division, Regional Office, Bureau of Reclamation, Billings, Montana, by telephone. The following unusual occurrences require a report:

(1) Rainfall of 2.0 inches or more in a 6-hour period or inflow which results in reservoir storage approaching elevation 1642.0 feet NGVD and conditions (current rate of inflow, probable duration, continuing or predicted precipitation) which will probably require initiation of flood control operations.

(2) Settlement, movement, or cracking of the dam embankment, earth dikes, abutments, or concrete in the outlet works or spillway.

(3) Any unusual change in seepage rates or development of new seepage areas.

(4) Failure or mechanical malfunction of hoists, gates,or any related appurtenances required to operate the outlet works.

(5) Landslides, rockslides, or indication of any impending movement.

(6) Occurrences which would indicate any degree of jeopardy to safety of the dam or adjacent structures or that would affect safety of the public.

(7) The construction, failure, or malfunction of any upstream facility in the Foss Dam watershed which would adversely affect the quality of water in storage in the reservoir.

d. Warnings. It is the responsibility of Reclamation, the District, the Corps, and other Federal and State agencies, depending on the urgency of the situation, to provide warnings when release conditions are expected that could produce severe property damage and/or be potentially dangerous to life. This will be performed in accordance with the Letter of Understanding (see Exhibit B). The damtender and the District or Reclamation project personnel authorized to make gate changes will maintain a list of current residents and/or property which could be endangered or inconvenienced by releases and give them adequate warning of impending releases.

II - REGULATION PROCEDURES

a. Normal flood control regulations. Foss Reservoir is regulated to provide flood reductions on the Washita River from Foss Dam to the confluence of Cobb (Pond) Creek and, in conjunction with Fort Cobb and Arbuckle Reservoirs, to Lake Texoma. The normal flood control schedule as shown in table C-2, Exhibit C, will govern releases from Foss Reservoir.

b. Loss of communications. When communication with the Tulsa District Office is disrupted, the damtender will, on his own initiative, direct regulation of the reservoir in accordance with the emergency flood control regulation schedule shown in Table C-3, Exhibit C, until communication is restored. In addition, the damtender will immediately make every effort to reestablish communication with the Tulsa District Office. The river outlet gates shall be operated at uniform openings.

c. During emergency events. The damtender 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 the dam, or by the fastest means of communication available. Actions shall be confirmed in writing the same day to Reclamation and the Conservancy and shall include justification for the action. Continuation of the deviation will require the express approval of the Reservoir Control Section.

d. Constraints. The regulation schedules provide that the channel capacity (currently estimated to pass approximately 1,000 cfs) in the reach from the dam to the vicinity of the Clinton gage 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 (which have an estimated capacity of about 300 cfs) and low-lying farmland.

E X H I B I T E

SECTION 7 FLOOD CONTROL REGULATION

EXTRACTED FROM CODE OF FEDERAL
REGULATIONS, TITLE 33, CH. II (7-1-89 EDITION)

§ 208.11 Regulations for use of storage allocated for flood control or navigation and/or project operation at reservoirs subject to prescription of rules and regulations by the Secretary of the Army in the interest of flood control and navigation.

(a) *Purpose.* This regulation prescribes the responsibilities and general procedures for regulating reservoir projects capable of regulation for flood control or navigation and the use of storage allocated for such purposes and provided on the basis of flood control and navigation, except projects owned and operated by the Corps of Engineers; the International Boundary and Water Commission, United States and Mexico; and those under the jurisdiction of the International Joint Commission, United States, and Canada, and the Columbia River Treaty. The intent of this regulation is to establish an understanding between project owners, operating agencies, and the Corps of Engineers.

(b) *Responsibilities.* The basic responsibilities of the Corps of Engineers regarding project operation are set out in the cited authority and described in the following paragraphs:

(1) Section 7 of the Flood Control Act of 1944 (58 Stat. 890, 33 U.S.C. 709) directs the Secretary of the Army to prescribe regulations for flood control and navigation in the following manner:

Hereafter, it shall be the duty of the Secretary of War to prescribe regulations for the use of storage allocated for flood control or navigation at all reservoirs constructed wholly or in part with Federal funds provided on the basis of such purposes, and the operation of any such project shall be in accordance with such regulations: *Provided*, That this section shall not apply to the Tennessee Valley Authority, except that in case of danger from floods on the lower Ohio and Mississippi Rivers the Tennessee Valley Authority is directed to regulate the release of water from the Tennessee River into the Ohio River in accordance with such instructions as may be issued by the War Department.

(2) Federal Energy Regulatory Commission (formerly Federal Power Commission (FPC)) licenses.

(i) Responsibilities of the Secretary of the Army and/or the Chief of Engineers in Federal Energy Regulatory Commission (FERC) licensing actions are set out in the Federal Power Act. Pertinent sections of that Act are cited herein. The Commission may also stipulate, as part of license conditions, that the licensee enter into an agreement with the Department of the Army providing for operation of the project during flood times, in accordance with rules and regulations prescribed by the Secretary of the Army.

(A) Section 4(e) of the Federal Power Act requires approval by the Chief of Engineers and the Secretary of the Army of plans of dams or other structures affecting the navigable capacity of any navigable waters of the United States, prior to issuance of a license by the Commission as follows:

The Commission is hereby authorized and empowered to issue licenses to citizens * * * for the purpose of constructing, operating, and maintaining dams, water conduits, reservoirs, powerhouses, transmission lines, or other project works necessary or convenient for the development and improvement of navigation and for the development, transmission, and utilization of power across, along, from or in any of the streams or other bodies of water over which Congress has jurisdiction * * * *Provided further*, That no license affecting the navigable capacity of any navigable waters of the United States shall be issued until the plans of the dam or other structures affecting navigation have been approved by the Chief of Engineers and the Secretary of the Army.

(B) Sections 10(a) and 10(c) of the Federal Power Act specify conditions of project licenses including the following:

(1) Section 10(a). That the project adopted * * * shall be such as in the judgment of the Commission will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for the use of benefit of interstate or foreign commerce, for the improvement and utilization of waterpower development, and for other beneficial public use * * *.

(2) Section 10(c). That the licensee shall * * * so maintain and operate said works as not to impair navigation, and shall conform to such rules and regulations as the Commission may from time to time prescribe for the protection of life, health, and property.* * *

(C) Section 18 of the Federal Power Act directs the operation of any navigation facilities built under the provision of that act, be controlled by rules and regulations prescribed by the Secretary of the Army as follows:

The operation of any navigation facilities which may be constructed as part of or in connection with any dam or diversion structure built under the provisions of this Act, whether at the expense of a licensee hereunder or of the United States, shall at all times be controlled by such reasonable rules and regulations in the interest of navigation; including the control of the pool caused by such dam or diversion structure as may be made from time to time by the Secretary of the Army, * * *

(ii) Federal Power Commission order No. 540 issued October 31, 1975, and published November 7,1975 (40 FR 51998), amending section 2.9 of the Commission's general policy and interpretations prescribed standardized conditions (forms) for inclusion in preliminary permits and licenses issued under Part I of the Federal Power Act. As an example, Article 12 of Standard Form L-3, titled: "Terms and Conditions of License for Constructed Major Projects Affecting Navigable Waters of the United States," sets out the Commission's interpretation of appropriate sections of the Act, which deal with navigation aspects, and attendant responsibilities of the Secretary of the Army in licensing actions as follows:

The United States specifically retains and safeguards the right to use water in such

amount, to be determined by the Secretary of the Army, as may be necessary for the purposes of navigation on the navigable waterway affected; and the operation of the Licensee, so far as they affect the use, storage and discharge from storage of waters affected by the license, shall at all times be controlled by such reasonable rules and regulations as the Secretary of the Army may prescribe in the interest of navigation, and as the Commission may prescribe for the protection of life, health, and property, * * *, and the Licensee shall release water from the project reservoir at such rate * * *, as the Secretary of the Army may prescribe in the interest of navigation, or as the Commission may prescribe for the other purposes hereinbefore mentioned.

(3) Section 9 of Pub. L. 436, 83d Congress (68 Stat. 303) provides for the development of the Coosa River, Ala. and Ga., and directs the Secretary of the Army to prescribe rules and regulations for project operation in the interest of flood control and navigation as follows:

The operation and maintenance of the dams shall be subject to reasonable rules and regulations of the Secretary of the Army in the interest of flood control and navigation.

NOTE: This Regulation will also be applicable to dam and reservoir projects operated under provisions of future legislative acts wherein the Secretary of the Army is directed to prescribe rules and regulations in the interest of flood control and navigation. The Chief of Engineers, U.S. Army Corps of Engineers, is designated the duly authorized representative of the Secretary of the Army to exercise the authority set out in the congressional acts. This regulation will normally be implemented by letters of understanding between the Corps of Engineers and project owner and will incorporate the provisions of such letters of understanding prior to the time construction renders the project capable of significant impoundment of water. A water control agreement signed by both parties will follow when deliberate impoundment first begins or at such time as the responsibilities of any corps-owned projects may be transferred to another entity. Promulgation of this regulation for a given project will occur at such time as the name of the project appears in the FEDERAL REGISTER in accordance with the requirements of § 208.11(d)(11). When agreement on a water control plan cannot be reached between the corps and the project owner after coordination with all interested parties, the project name will be entered in the FEDERAL REGISTER and the Corps of Engineers plan will be the officials water control plan until such time as differences can be resolved.

(c) *Scope and terminology.* This regulation applies to Federal authorized flood control and/or navigation storage projects, and to non-Federal projects which require the Secretary of the Army to prescribe regulations as a condition of the license, permit or legislation, during the planning, design and construction phases, and throughout the life of the project. In compliance with the authority cited above, this regulation defines certain activities and responsibilities concerning water control management throughout the Nation in the interest of flood control and navigation. In carrying out the conditions of this regulation, the owner and/or operating agency will comply with applicable provisions of Pub. L. 85-624, the Fish and Wildlife Coordination Act of 1958, and Pub. L. 92-500, the Federal Water Pollution Control Act Amendments of 1972. This regulation does not apply to local flood protection works governed by § 208.10, or to navigation facilities and associated structures which are otherwise covered by Part 207 (Navigation Regulations) of Title 33 of the code. Small reservoirs, containing less than 12,500 acre-feet of flood control or navigation storage, may be excluded from this regulation and covered under § 208.10, unless specifically required by law or conditions of the license or permit.

(1) The terms "reservoir" and "project" as used herein include all water resource impoundment projects constructed or modified, including natural lakes, that are subject to this regulation.

(2) The term "project owner" refers to the entity responsible for maintenance, physical operation, and safety of the project, and for carrying out the water control plan in the interest of flood control and/or navigation as prescribed by the Corps of Engineers. Special arrangements may be made by the project owner for "operating agencies" to perform these tasks.

(3) The term "letter of understanding" as used herein includes statements which consummate this regulation for any given project and define

the general provisions or conditions of the local sponsor, or owner, cooperation agreed to in the authorizing legislative document, and the requirements for compliance with section 7 of the 1944 Flood Control Act, the Federal Power Act or other special congressional act. This information will be specified in the water control plan and manual. The letter of understanding will be signed by a duly authorized representative of the Chief of Engineers and the project owner. A "field working agreement" may be substituted for a letter of understanding, provided that the specified minimum requirements of the latter, as stated above, are met.

(4) The term "water control agreement" refers to a compliation of water control criteria, guidelines, diagrams, release schedules, rule curves and specifications that basically govern the use of reservoir storage space allocated for flood control or navigation and/or release functions of a water control project for these purposes. In general, they indicate controlling or limiting rates of discharge and storage space required for flood control and/or navigation, based on the runoff potential during various seasons of the year.

(5) For the purpose of this regulation, the term "water control plan" is limited to the plan of regulation for a water resources project in the interest of flood control and/or navigation. The water control plan must conform with proposed allocations of storage capacity and downstream conditions or other requirements to meet all functional objectives of the particular project, acting separately or in combination with other projects in a system.

(6) The term "real-time" denotes the processing of current information or data in a sufficiently timely manner to influence a physicial response in the system being monitored and controlled. As used herein the term connotes * * * the analyses for and execution of water control decisions for both minor and major flood events and for navigation, based on prevailing hydrometeorological and other conditions and constraints, to achieve efficient management of water resource systems.

(d) *Procedures*—(1) *Conditions during project formulation.* During the planning and design phases, the project owner should consult with the Corps of Engineers regarding the quantity and value of space to reserve in the reservoir for flood control and/or navigation purposes, and for utilization of the space, and other requirements of the license, permit or conditions of the law. Relevant matters that bear upon flood control and navigation accomplishment include: Runoff potential, reservoir discharge capability, downstream channel characteristics, hydrometeorological data collection, flood hazard, flood damage charateristics, real estate acquisition for flowage requirements (fee and easement), and resources required to carry out the water control plan. Advice may also be sought on determination of and regulation for the probable maximum or other design flood under consideration by the project owner to establish the quantity of surcharge storage space, and freeboard elevation of top of dam or embankment for safety of the project.

(2) *Corps of Engineers involvement.* If the project owner is responsible for real-time implemenetation of the water control plan, consultation and assistance will be provided by the Corps of Engineers when appropriate and to the extent possible. During any emergency that affects flood control and/or navigation, the Corps of Engineers may temporarily prescribe regulation of flood control or navigation storage space on a day-to-day (real-time) basis without request of the project owner. Appropriate consideration will be given for other authorized project functions. Upon refusal of the project owner to comply with regulations prescribed by the Corps of Engineers, a letter will be sent to the project owner by the Chief of Engineers or his duly authorized representative describing the reason for the regulations prescribed, events that have transpired, and notification that the project owner is in violation of the Code of Federal Regulations. Should an impasse arise, in that the project owner or the designated operating entity persists in noncompliance with regulations prescribed by the Corps of

Engineers, measures may be taken to assure compliance.

(3) *Corps of Engineers implementation of real-time water control decisions.* The Corps of Engineers may prescribe the continuing regulation of flood control storage space for any project subject to this regulation on a day-to-day (real-time) basis. When this is the case, consultation and assistance from the project owner to the extent possible will be expected. Special requests by the project owner, or appropriate operating entity, are preferred before the Corps of Engineers offers advice on real-time regulation during surcharge storage utilization.

(4) *Water control plan and manual.* Prior to project completion, water control managers from the Corps of Engineers will visit the project and the area served by the project to become familiar with the water control facilities, and to insure sound formulation of the water control plan. The formal plan of regulation for flood control and/or navigation, referred to herein as the water control plan, will be developed and documented in a water control manual prepared by the Corps of Engineers. Development of the manual will be coordinated with the project owner to obtain the necessary pertinent information, and to insure compatibility with other project purposes and with surcharge regulation. Major topics in the manual will include: Authorization and description of the project, hydrometeorology, data collection and communication networks, hydrologic forecasting, the water control plan, and water resource management functions, including responsibilities and coordination for water control decisionmaking. Special instructions to the dam tender or reservoir manager on data collection, reporting to higher Federal authority, and on procedures to be followed in the event of a communication outage under emergency conditions, will be prepared as an exhibit in the manual. Other exhibits will include copies of this regulation, letters of understanding consummating this regulation, and the water control agreements. After approval by the Chief of Engineers or his duly authorized representative, the manual will be furnished the project owner.

(5) *Water control agreement.* (i) A water control diagram (graphical) will be prepared by the Corps of Engineers for each project having variable space reservation for flood control and/or navigation during the year; e.g., variable seasonal storage, joint-use space, or other rule curve designation. Reservoir inflow parameters will be included on the diagrams when appropriate. Concise notes will be included on the diagrams prescribing the use of storage space in terms of release schedules, runoff, nondamaging or other controlling flow rates downstream of the damsite, and other major factors as appropriate. A water control release schedule will be prepared in tabular form for projects that do not have variable space reservation for flood control and/or navigation. The water control diagram or release schedule will be signed by a duly authorized representative of the Chief of Engineers, the project owner, and the designated operating agency, and will be used as the basis for carrying out this regulation. Each diagram or schedule will contain a reference to this regulation.

(ii) When deemed necessary by the Corps of Engineers, information given on the water control diagram or release schedule will be supplemented by appropriate text to assure mutual understanding on certain details or other important aspects of the water control plan not covered in this regulation, on the water control diagram or in the release schedule. This material will include clarification of any aspects that might otherwise result in unsatisfactory project performance in the interest of flood contol and/or navigation. Supplementation of the agreement will be necessary for each project where the Corps of Engineers exercises the discretionary authority to prescribe the flood control regulation on a day-to-day (real-time) basis. The agreement will include delegation of the responsibility. The document should also cite, as appropriate, section 7 of the 1944 Flood Control Act, the Federal Power Act and/or other congressional legislation authorizing

construction an/or directing operation of the project.

(iii) All flood control regulations published in the FEDERAL REGISTER under this section (Part 208) of the code prior to the date of this publication which are listed in § 208.11(e) are hereby superseded.

(iv) Nothing in this regulation prohibits the promulgation of specific regulations for a project in compliance with the authorizing acts, when agreement on acceptable regulations cannot be reached between the Corps of Engineers and the owner.

(6) *Hydrometeorological instrumentation.* The project owner will provide instrumentation in the vicinity of the damsite and will provide communication equipment necessary to record and transmit hydrometeorological and reservoir data to all appropriate Federal authorities on a real-time basis unless there are extenuating circumstances or are otherwise provided for as a condition of the license or permit. For those projects where the owner retains responsibility for real-time implementation of the water control plan, the owner will also provide or arrange for the measurement and reporting of hydrometeorological parameters required within and adjacent to the watershed and downstream of the damsite, sufficient to regulate the project for flood control and/or navigation in an efficient manner. When data collection stations outside the immediate vicinity of the damsite are required, and funds for installation, observation, and maintenance are not available from other sources, the Corps of Engineers may agree to share the costs for such stations with the project owner. Availability of funds and urgency of data needs are factors which will be considered in reaching decisions on cost sharing.

(7) *Project safety.* The project owner is responsible for the safety of the dam and appurtenant facilities and for regulation of the project during surcharge storage utilization. Emphasis upon the safety of the dam is especially important in the event surcharge storage is utilized, which results when the total storage space reserved for flood control is exceeded. Any assistance provided by the Corps of Engineers concerning surcharge regulation is to be utilized at the discretion of the project owner, and does not relieve the owner of the responsibility for safety of the project.

(8) *Notification of the general public.* The Corps of Engineers and other interested Federal and State agencies, and the project owner will jointly sponsor public involvement activities, as appropriate, to fully apprise the general public of the water control plan. Public meetings or other effective means of notification and involvement will be held, with the initial meeting being conducted as early as practicable but not later than the time the project first becomes operational. Notice of the initial public meeting shall be published once a week for 3 consecutive weeks in one or more newspapers of general circulation published in each county covered by the water control plan. Such notice shall also be used when appropriate to inform the public of modifications in the water control plan. If no newspaper is published in a county, the notice shall be published in one or more newspapers of general circulation within that county. For the purposes of this section a newspaper is one qualified to publish public notices under applicable State law. Notice shall be given in the event significant problems are anticipated or experienced that will prevent carrying out the approved water control plan or in the event that an extreme water condition is expected that could produce severe damage to property or loss of life. The means for conveying this information shall be commensurate with the urgency of the situation. The water control manual will be made available for examination by the general public upon request at the appropriate office of the Corps of Engineers, project owner or designated operating agency.

(9) *Other generalized requirements for flood control and navigation.* (i) Storage space in the reservoirs allocated for flood control and navigation purposes shall be kept available for those purposes in accordance with the water control agreement, and the plan of regulation in the water control manual.

(ii) Any water impounded in the flood control space defined by the water control agreement shall be evacuated as rapidly as can be safely accomplished without causing downstream flows to exceed the controlling rates; i.e., releases from reservoirs shall be restricted insofar as practicable to quantities which, in conjunction with uncontrolled runoff downstream of the dam, will not cause water levels to exceed the controlling stages currently in force. Although conflicts may arise with other purposes, such as hydropower, the plan or regulation may require releases to be completely curtailed in the interest of flood control or safety of the project.

(iii) Nothing in the plan of regulation for flood control shall be construed to require or allow dangerously rapid changes in magnitudes of releases. Releases will be made in a manner consistent with requirements for protecting the dam and reservoir from major damage during passage of the maximum design flood for the project.

(iv) The project owner shall monitor current reservoir and hydro- meteorological conditions in and adjacent to the watershed and downstream of the damsite, as necessary. This and any other pertinent information shall be reported to the Corps of Engineers on a timely basis, in accordance with standing instructions to the damtender or other means requested by the Corps of Engineers.

(v) In all cases where the project owner retains responsibility for real-time implementation of the water control plan, he shall make current determinations of: Reservoir inflow, flood control storage utilized, and scheduled releases. He shall also determine storage space and releases required to comply with the water control plan prescribed by the Corps of Engineers. The owner shall report this information on a timely basis as requested by the Corps of Engineers.

(vi) The water control plan is subject to temporary modification by the Corps of Engineers if found necessary in time of emergency. Requests for and action on such modifications may be made by the fastest means of communication available. The action taken shall be confirmed in writing the same day to the project owner and shall include justification for the action.

(vii) The project owner may temporarily deviate from the water control plan in the event an immediate short-term departure is deemed necessary for emergency reasons to protect the safety of the dam, or to avoid other serious hazards. Such actions shall be immediately reported by the fastest means of communication available. Actions shall be confirmed in writing the same day to the Corps of Engineers and shall include justification for the action. Continuation of the deviation will require the express approval of the Chief of Engineers, or his duly authorized representative.

(viii) Advance approval of the Chief of Engineers, or his duly authorized representative, is required prior to any deviation from the plan of regulation prescribed or approved by the Corps of Engineers in the interest of flood control and/or navigation, except in emergency situations provided for in paragraph (d)(9)(vii) of this section. When conditions appear to warrant a prolonged deviation from the approved plan, the project owner and the Corps of Engineers will jointly 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 investigations and evaluations have been conducted to the extent deemed necessary by the Chief of Engineers, or his designated representatives, to fully substantiate the deviation.

(10) *Revisions.* The water control plan and all associated documents will be revised by the Corps of Engineers, as necessary, to reflect changed conditions that come to bear upon flood control and navigation, e.g., reallocation of reservoir storage space due to sedimentation or transfer of storage space to a neighboring project. Revision of the water control plan, water control agreement, water control diagram, or release schedule requires approval of the Chief of Engineers or his duly authorized representative. Each such revision shall be effective upon

the date specified in the approval. The original (signed document) water control agreement shall be kept on file in the Office, Chief of Engineers, Department of the Army, Washington, D.C. Copies of the agreement shall be kept on file and may be obtained from the office of the project owner, or from the office of the appropriate Division Engineer, Corps of Engineers.

(11) *Federal Register.* The following information for each project subject to section 7 of the 1944 Flood Control Act and other applicable congressional acts shall be published in the FEDERAL REGISTER prior to the time the projects becomes operational and prior to any significant impoundment before project completion or * * * at such time as the responsibility for physical operation and maintenance of the Corps of Engineers owned projects is transferred to another entity:

(i) Reservoir, dam, and lake names,

(ii) Stream, county, and State corresponding to the damsite location,

(iii) The maximum current storage space in acre-feet to be reserved exclusively for flood control and/or navigation purposes, or any multiple-use space (intermingled) when flood control or navigation is one of the purposes, with corresponding elevations in feet above mean sea level, and area in acres, at the upper and lower limits of said space,

(iv) The name of the project owner, and

(v) Congressional legislation authorizing the project for Federal participation.

(e) *List of projects.* The following tables, "Pertinent Project Data—Section 208.11 Regulation," show the pertinent data for projects which are subject to this regulation.

LIST OF PROJECTS

[Pertinent project data]

[Footnotes at end of table]

Project name [1]	State, county and stream [1]	Exclusive-use					Multiple-use					Project owner [1]	Authorizing legislation [1]
		Flood control/navigation					Flood control/navigation						
		Storage (1,000 AF)	Elevation limits (feet, m.s.l.)		Area (acres)		Storage (1,000 AF)	Elevation limits (feet, m.s.l.)		Area (acres)			
			Upper	Lower	Upper	Lower		Upper	Lower	Upper	Lower		
Alpine Dam	IL, Winnebago, Keith Cr	0.6	796.0	764.0	52	0						City of Rockford, IL.	PWA Proj.
Agency Valley Dam & Res.	OR, Malheur, N. Fork Malheur R.						60.0	3,340.0	3,263.2	1,900	0	USBR	PL 68-292.
American Falls Dam & Res.	ID, Power, Snake River						1,700.0	4,343.2	4,295.6	56,100	0	USBR	FERC 2259.
Anderson Ranch Dam & Res.	ID, Elmore, S. Fk. Boise River						423.2	4,196.0	4,043.0	4,740	1,150	USBR	Act of 1939, 53 Stat 1187.
Arrowrock Dam & Res.	ID, Elmore, Boise River						286.6	3,216.0	2,967.0	3,100	200	USBR	Act of 1902, 32 Stat 388.
Bear Cr Dam	MO, Marion Rails, Bear Cr	8.7	546.5	520.0	540	0						City of Hannibal, MO.	PL 83-780.
Bear Swamp Pumped Storage.	MA, Franklin, Deerfield R Trib											New England Pwr Co.	Fed Pwr Act.
Big Dry Creek and Div.	CA, Fresno, Big Dry Cr & Dog Cr.	16.2	425.0	393.0	1,530	0						Reclamation Board of CA.	PL 77-226.
Bocu Dam & Res	CA, Nevada, Little Truckee R					41	5,605.0	5,596.4	980	873		USBR	PL 61-269, PL 68-292.
Bonny Dam & Res	CO, Yuma, S. Fork Republican R.	126.8	3,710.0	3,672.0	5,036	2,042						USBR	PL 78-534.
Boysen Dam & Res	WY, Fremont, Wild River	146.0	4,732.0	4,725.0	22,100	19,560	146.1	4,725.0	4,717.0	19,560	16,955	USBR	PL 78-534.
Brownlee Dam & Res	OR, Baker, ID, Washington, Snake River.						980.3	2,077.0	1,976.0	13,840	6,650	Idaho Pwr Co	FERC No 1971-C.
Bully Cr Dam & Res	OR, Malheur, Bully Creek						31.6	2,523.0	2,456.8	1,082	140	USBR	PL 86-248.
Camanche Dam & Res.	CA, San Joaquin, Mokelumne R.						200.0	235.5	205.1	7,600	5,507	East Bay Mun Util Dist.	PL 86-645.
Canyon Ferry Dam & Lk.	MT, Lewis, Clark, Missouri R						799.1	3,797.0	3,770.0	34,435	24,126	USBR	PL 78-534.
Cedar Bluff Dam & Res.	KS, Trego, Smoky Hill River	191.9	2,166.0	2,144.0	10,790	6,869						USBR	PL 78-534.
Clark Canyon Dam & Res.	MT, Beaverhead, Beaverhead River.	79.1	5,560.4	5,546.1	5,903	5,160	50.4	5,546.1	5,535.7	5,160	4,496	USBR	PL 78-534.

Del Valle Dam & Res	CA, Alameda, Alameda Cr	37.0	745.0	703.1	1,060	710	1.0	03.1	702.2	710	700	CA Dept of Wtr Rec.	PL 87-874.
Don Pedro Dam & Lk	CA, Tuolumne, Tuolumne R						340.0	830.0	802.0	12,900	11,260	Modesto & Turlock Irr.	PL 78-534.
East Canyon Dam & Res.	UT, Morgan, East Canyon Creek.						48.0	5,705.5	5,577.0	684	127	USBR	PL 81-273.
Echo Dam & Res	UT, Summit, Weber River						74.0	5,560.0	5,450.0	1,455	0	USBR	PL 81-273.
Emigrant Dam & Res	OR, Jackson, Emigrant Cr	39.0	2,241.0	2,131.5	801	80						USBR	PL 83-606.
Enders Dam & Res	NB, Chase, Frenchman Cr	30.0	3,127.0	3,112.3	2,405	1,707						USBR	PL 78-534.
Folsom Dam & Lk	CA, Sacramento, American R						400.0	466.0	427.0	11,450	9,040	USBR	PL 81-356.
Friant Dam & Millerton LK.	CA, Fresno, San Joaquin River						390.0	578.0	466.3	4,850	2,101	USBR	PL 75-392, PL 76-868.
Gaston-Roanoke Rapids Dam Res.	NC, Northhampton, Halifax, Roanoke R.	63.0	203.0	200.0	22,500	20,300						VA Elec & Pwr Co.	Fed Pwr Act.
Glen Elder Dam & Waconda Lk.	KS, Mitchel, Solomon R	722.3	1,488.0	1,455.6	33,682	12,602						USBR	PL 78-534, PL 79-526.
Glendo Dam & Res	WY, Platte, N. Platte R	271.9	4,853.0	4,653.0,	17,996	12,385						USBR	PL 78-534.
Grand Coulee Dam, FDR Lk.	WA, Okanogan, Grant, Columbia R.						5,185.5	1,290.0	1,208.0	82,280	45,592	USBR	PL 89-561.
H. Neely Henry	AL, Calhoun, St. Clair, Coosa River.						49.7	508.0	502.5	11,235	7,632	Alabama, Pwr Co.	PL 83-436.
Heart Butte Dam & Lk Tschida.	ND, Grant, Heart River	150.0	2,094.5	2,064.5	6,625	3,400						USBR	PL 78-534.
Hells Canyon Dam & Res.	OR, Wallowa, ID, Adams, Snake River.						11.7	1,888.0	1,883.0	2,380	2,280	Idaho Pwr Co	FERC No 1971-A.
Hoover Dam & Lake Mead.	NV, Clark, AZ, Mohave, Colorado R.	1,500	1,229.0	1,219.8	162,700	156,500	15.8	1,219.8	1,083.0	156,500	83,500	USBR	PL 70-642.
Hungry Horse Dam & Res.	MT, Flathead, S. Fork Flathead R.	2,982.0	3,560.0	3,336.0	23,800	5,400						USBR	PL 78-329.
Indian Valley Dam & Res.	CA, Lake, N. Fork Cache Creek.						40.0	1,485.0	1,474.7	3,975	3,749	Yolo Cty Fl Cont & Wtr.	PL 84-984 Cons Dist.
Jamestown Dam & Res.	ND, Stutsman, James River	185.4	1,454.0	1,432.7	13,206	2,555	6.6	1,432.7	1,429.8	2,555	2,085	USBR	PL 78-534.
Kerr Dam, Flathead Lk.	MT, Lake, Flathead R						1,219.0	2,893.0	2,883.0	125,560	120,000	Montana Pwr Co.	FERC No 5.
Keyhole Dam & Res	WY, Crook, Belle Fourche River.	140.2	4,111.5	4,099.3	13,686	9,394						USBR	PL 78-534.
Kirwin Dam & Res	KS, Phillips, N. Fork Solomon R.	215.1	1,757.3	1,729.3	10,640	5,073						USBR	PL 78-534.
Lemon Dam & Res	CO, La Plata, Florida R						39.0	8,148	8,023	622	62	USBR	PL 84-485
Lewis M. Smith Dam & Res.	AL, Walker, Culman, Sipsey Fork Black Warrior River.	260.0	522.0	510.0	25,700	21,200						Alabama Pwr Co.	Fed Pwr Act.
Little Wood	ID, Blain, Little Wood River	30.0	5,237.3	5,127.8	574	0						USBR	PL 84-993.
Logan Martin Dam & Res.	AL, Talladega, Coosa River	245.3	477.0	465.0	28,310	15,260						Alabama Pwr Co.	PL 83-436.
Los Banos Dam & Detention.	CA, Merced, Los Banos Cr						14.0	353.5	327.8	619	467	USBR	PL 86-488.

LIST OF PROJECTS—Continued

[Pertinent project data]

[Footnotes at end of table]

Project name [1]	State, county and stream [1]	Exclusive-use					Multiple-use					Project owner [2]	Authorizing legislation [3]
		Flood control/navigation					Flood control/navigation						
		Storage (1,000 AF)	Elevation limits (feet, m.s.l.)		Area (acres)		Storage (1,000 AF)	Elevation limits (feet, m.s.l.)		Area (acres)			
			Upper	Lower	Upper	Lower		Upper	Lower	Upper	Lower		
Lost Creek Dam & Res.	UT, Morgan, Lost Creek						20.0	6,005.0	5,912.0	365	93	USBR	PL 81-273.
Lovewell Dam & Res	KS, Jewell, White Rock Cr	50.5	1,595.3	1,582.6	5,025	2,986						USBR	PL 78-534.
Markham Ferry Dam, Lake Wash E. Hudson.	OK, Mayes, Grand Neosho River.	244.2	636.0	619.0	18,000	10,900						Grand R Dam Authority.	PL 76-476.
Mayfield Dam & Res	WA, Lewis, Cowlitz River						21.4	425.0	415.0	2,070	1,825	City of Tacoma.	FPC No 2016-A.
Medicine Cr Dam Harry Strunk Lk.	NB, Frontier, Medicine Cr	52.2	2,386.2	2,366.1	3,465	1,850						USBR	PL 78-534.
Mossyrock Dam Davisson Lk.	WA, Lewis, Cowlitz River						1,397.0	778.5	621.5	11,800	5,000	City of Tacoma.	FERC No 2016-B.
Navajo Dam & Res	NM, San Juan, Arriba, Rio, San Juan R.						1,036.1	6,085.0	5,990.0	15,610	7,400	USBR	PL 84-485.
New Exchequer Dam & Lake.	CA, Tuolumne, Merced River						400.0	867.0	799.7	7,110	4,849	Merced Irr	PL 86-645.
New Melones Dam & Lk.	CA, Tuolumne, Calaveras, Stanislaus R.						450.0	1,088.0	1,049.5	12,500	10,900	USBR	PL 87-874.
Norton Dam Res	KS, Norton, Prairie Dog Cr	96.8	2,331.4	2,304.3	5,316	5,316						USBR	PL 78-534.
Ochoco Dam & Res	OR, Crook, Ochoco Creek	51.4	3,136.2	3,048.1	1,150	120						USBR	PL 84-992.
Oroville Dam & Lake	CA, Butte, Feather River						750.0	900.0	848.5	15,800	13,346	CA Dept of Wtr Rsc.	PL 85-500.
Oxbow Dam & Res	OR, Baker, ID, Adams, Snake River.						5.0	1,805.0	1,800.0	1,165	1,115	Idaho Pwr Co	FERC No 1971-B.
Pactola Dam & Res	SD, Pennington, Rapid Creek	34.0	4,621.5	4,580.2	1,232	880						USBR	PL 78-534.
Palisades Dam & Res	ID, Bonneville, Snake River	1,202.0	5,820.0	5,452.4	16,100	2,170						USBR	PL 81-864.
Paonia Dam & Res	CO, Gunnision, Muddy Creek						17.0	6,447.5	6,373.0	334	120	USBR	PL 80-177, PL 84-485.
Pineview Dam & Res	UT, Weber, Odgen River						110.0	4,900.0	4,818.0	2,874	0	USBR	PL 81-273.
Platoro Dam & Res	CO, Conejos, Conejos R	6.0	10,034.0	10,027.5	947	920	54.0	10,027.5	9,911.0	920	0	USBR	PL 76-640.
Priest Rapid Dam & Res.	WA, Grant, Columbia R						44.0	488.0	481.0	7,100	6,500	Grant County PUD No 2.	FERC No 2114-A.
Pineville Dam & Res	OR, Crook, Crooked Cr	153.0	3,234.8	3,112.0	2,990	120						USBR	PL 84-992.
Prosser Cr & Res	CA, Nevada, Prosser Cr						20.0	5,741.2	5,703.7	745	334	USBR	PL 84-858.

Pueblo Dam & Res	CO, Pueblo, Arkansaw R	27	4,696.7	4,893.8	5664	5350	66.0	4,893.8	4,880.6	5,350	4,641	USBR	PL 87-590
Red Willow Dam, Hugh Butler Lk.	NB, Frontier, Red Willow	48.9	2,604.0	2,561.8	2,682	1,629						USBR	PL 78-534, PL 85-783.
Ririe Dam & Res	ID, Bonneville, Willow Cr						99.0	5,119.0	5,023.0	1,560	360	USBR	PL 87-874.
Rocky Reach Dam Lk Entiat.	WA, Chelan, Columbia R						37.0	707.0	703.0	9,600	0	Chelan Cnty PUD No 1.	FERC No 2145.
Ross Dam & Res	WA, Whatcom, Skagit R						530.5	1,602.5	1,475.0	6,000	2,166	City of Seattle	FERC No 553-C.
Sanford Dam & Lk Meredith.	TX, Hutchison, Canadian R	462.1	2,965.0	2,941.3	21,640	17,320						USBR	PL 81-898.
Savage River Dam & Res.	MD, Garrett, Savage R						16.0	1,468.5	1,400.0	366	127	Upper Potomac R Commission.	PL 78-534.
Shadehill Dam & Res	SD, Perkins, Grand R	217.7	2,302.0	2,272.0	9,900	4,800						USBR	PL 78-534.
Shasta Dam & Lake	CA, Shasta, Sacramento R						1,300.0	1,067.0	1,018.6	29,570	23,894	USBR	PL 75-392.
Smith Mtn & Leesville Dam & Res.	VA, Bedford, Compbell, VA, Pittsylvania, Roanoke River.						(4)	(4)	(4)	(4)	(4)	Appalachian Pwr Co.	Fed Pwr Act.
Stampede Dam & Res.	CA, Sierra, Little Truckee R						226.5	5,948.7	5,942.1	3,430	3,230	USBR	PL 84-858.
Trenton Dam & Res	NB, Hitchcock, Republican R	133.6	2,773.0	2,752.0	7,975	4,974						USBR	PL 78-534.
Twitchell Dam & Res	CA, Santa Barbara, Cuyama River.	89.0	651.5	623.0	3,690	2,650						USBR	PL 83-774.
Upper Baker Dam, Baker Lk.	WA, Whatcom, Baker River						220.6	724.0	655.0	4,890	0	Puget Sound Pwr Light Co.	PL 89-298, FERC 2150-B.
Vallecito Dam & Res	CO, La Plata, Los Pinos R						115.4	7,665	7,600	2,723	693	USBR	PL 81-288, PL 88-292.

LIST OF PROJECTS—Continued

[Pertinent project data]

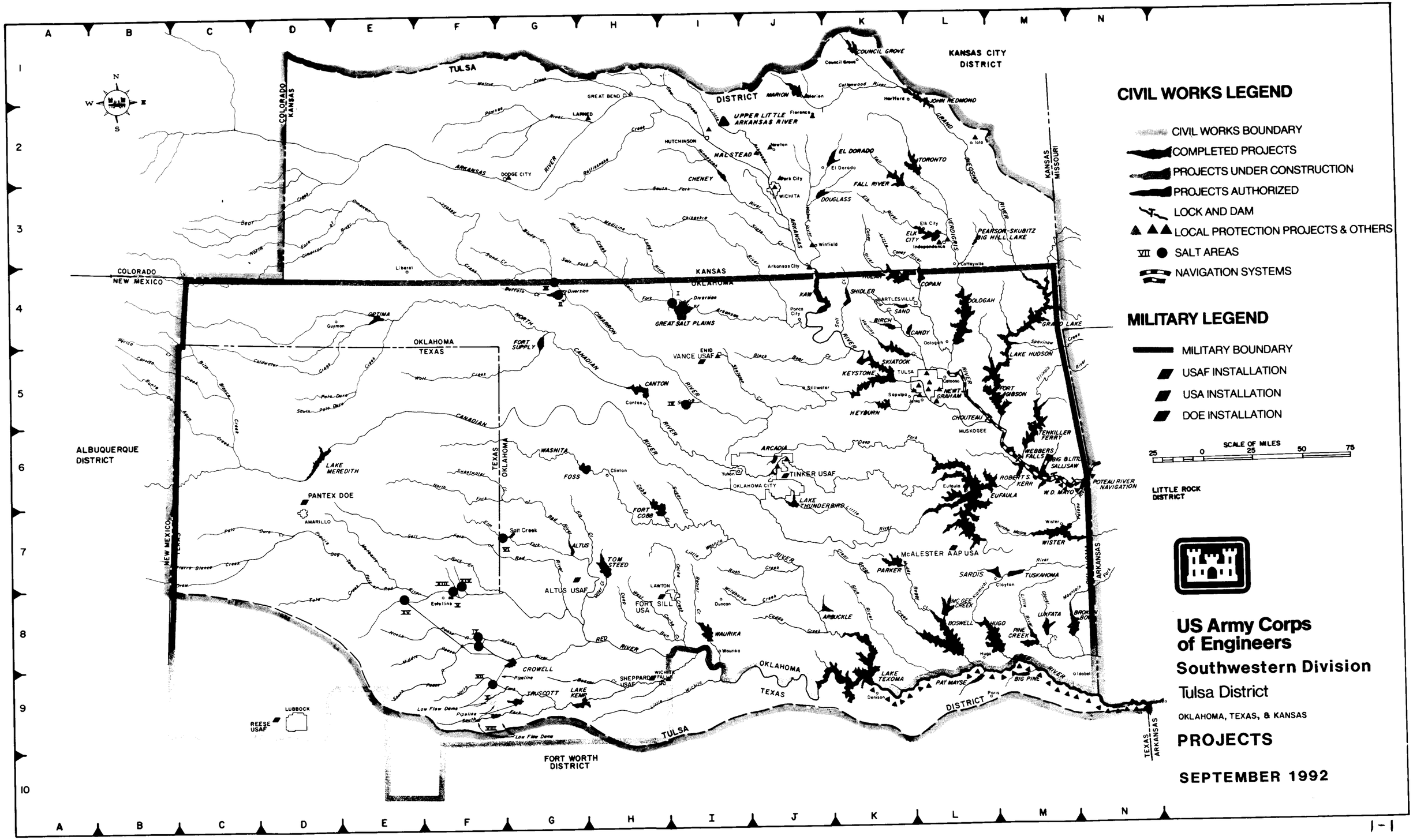
[Footnotes at end of table]

Project name [1]	State, county and stream [1]	Exclusive-use					Multiple-use					Project owner [2]	Authorizing legislation [3]
		Flood control/navigation					Flood control/navigation						
		Storage (1,000 AF)	Elevation limits (feet, m.s.l.)		Area (acres)		Storage (1,000 AF)	Elevation limits (feet, m.s.l.)		Area (acres)			
			Upper	Lower	Upper	Lower		Upper	Lower	Upper	Lower		
Wanapum Dam & Res.	WA, Grant, Columbia R						151.6	571.5	560.0	14,400	9,600	Grant Cnty PUD No 2.	FERC No 2114–B.
Wanship Dam & Rockport.	UT, Summit, Weber River						61.0	6,037.0	5,930.0	1,077	121	USBR	PL 81-273.
Warm Springs Dam & Res.	OR, Malheur, Middle Fork Malheur R.						191.0	3,406.0	3,327.0	4,600	90	50% Vale Irr 50% USBR.	
Waterbury Dam & Res.	VT, Washington, Little River	27.2	617.5	592.0	1,330	690						State of VT	PL 78-534.
Weiss Dam & Res.	AL, Cherokee, Coosa River	397.0	574.0	564.0	50,000	30,200						Alabama Pwr Co.	PL 83-436.
Wells Dam Lk Paterns.	WA, Douglas, Columbia R						74.0	799.0	711.0	10,700	7,700	Douglas Cnty PUD No 1.	FERC No 2149.
Webster Dam & Res.	KS, Rocks, S. Fork Solomon R.	183.4	1,923.7	1,892.45	8,480	3,766						USBR	PL 534 78-2.
Yellowtail Dam & Bighorn Lk.	MT, Big Horn, Bighorn R	259.0	3,657.0	3,640.0	17,298	12,685	250.0	3,640.0	3,614.0	12,685	7,410	USBR	PL 78-534.

Footnotes:
[1] Res—Reservoir; Lk—Lake; Div—Division; R—River; Cr—Creek.
[2] USBR—United States Bureau of Reclamation; Irr—Irrigation District; Mun—Muncipal; Fl—Flood; Rsc—Resources.
[3] PL—Public Law; HD—House Document; FERC—Federal Energy Regulatory Commission (formerly Federal Power Commission (FPC)).
[4] No specific FC/Nav. storage allocation.

(Sec. 7, Pub. L. 78-534, 58 Stat. 890 (33 U.S.C. 709); the Federal Power Act, 41 Stat. 1063 (16 U.S.C. 791(A)); and sec. 9, Pub. L. 83-436, 68 Stat. 303)

[43 FR 47184, Oct. 13, 1978, as amended at 46 FR 58075, Nov. 30, 1981]



CIVIL WORKS LEGEND

- CIVIL WORKS BOUNDARY
- COMPLETED PROJECTS
- PROJECTS UNDER CONSTRUCTION
- PROJECTS AUTHORIZED
- LOCK AND DAM
- LOCAL PROTECTION PROJECTS & OTHERS
- VII SALT AREAS
- NAVIGATION SYSTEMS

MILITARY LEGEND

- MILITARY BOUNDARY
- USAF INSTALLATION
- USA INSTALLATION
- DOE INSTALLATION

US Army Corps of Engineers

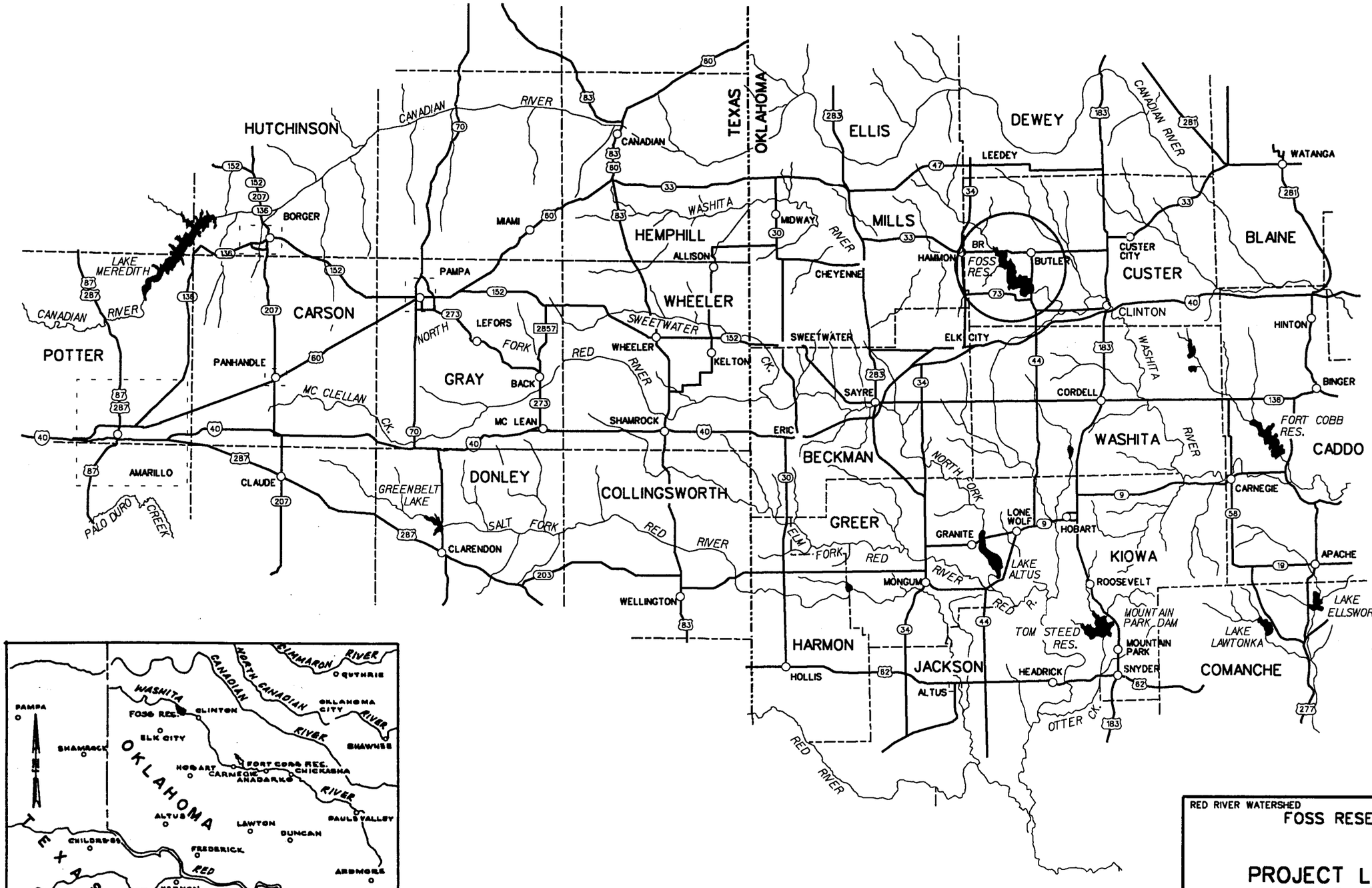
Southwestern Division

Tulsa District

OKLAHOMA, TEXAS, & KANSAS

PROJECTS

SEPTEMBER 1992



VICINITY MAP

RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

PROJECT LOCATION AND VICINITY MAP

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

2-1

(b) (7)(F)

RED RIVER WATERSHED WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

GENERAL PLAN & PROFILE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

2-2

(b) (7)(F)

DATA FURNISHED BY BUREAU OF RECLAMATION

RED RIVER WATERSHED WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

PLAN AND SECTIONS

UNCONTROLLED SPILLWAY AND RIVER OUTLET WORKS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

2-3

(b) (7)(F)

RED RIVER WATERSHED WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

PROFILES

UNCONTROLLED SPILLWAY AND
RIVER OUTLET WORKS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

2-4

(b) (7)(F)

RED RIVER WATERSHED WASHITA RIVER, OKLAHOMA

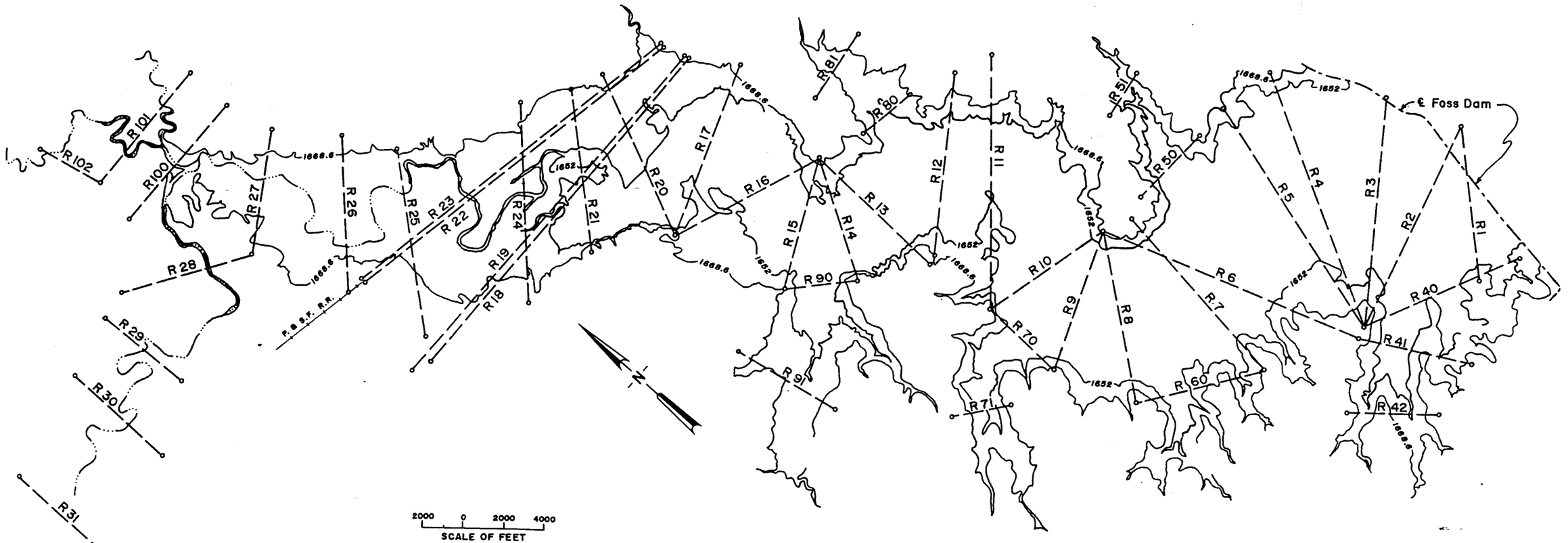
FOSS RESERVOIR

PLAN AND SECTIONS

CANAL AND MUNICIPAL
OUTLET WORKS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

2-5



LEGEND

1652 — Conservation pool

1668.6 — Flood control pool

— — — Sedimentation range

DATA FURNISHED BY BUREAU OF RECLAMATION

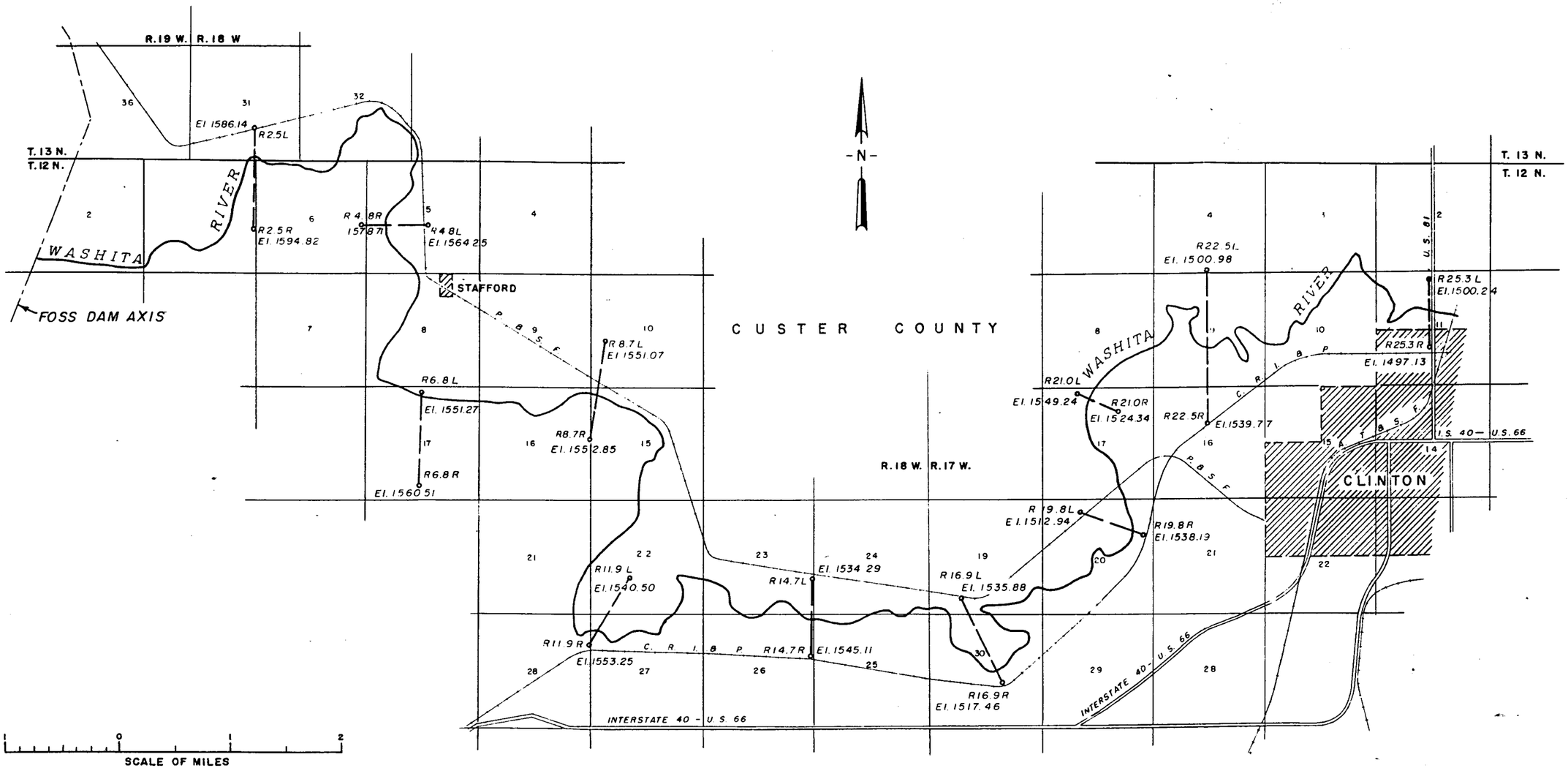
RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

SEDIMENTATION RANGES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

2-6



NOTE:

1. RANGE NUMBERS DESIGNATE APPROXIMATE RIVER MILES DOWNSTREAM FROM DAM AXIS.
2. DATA SHOWN IS FROM AUG 1962 UPDATE BUREAU OF RECLAMATION FILES.

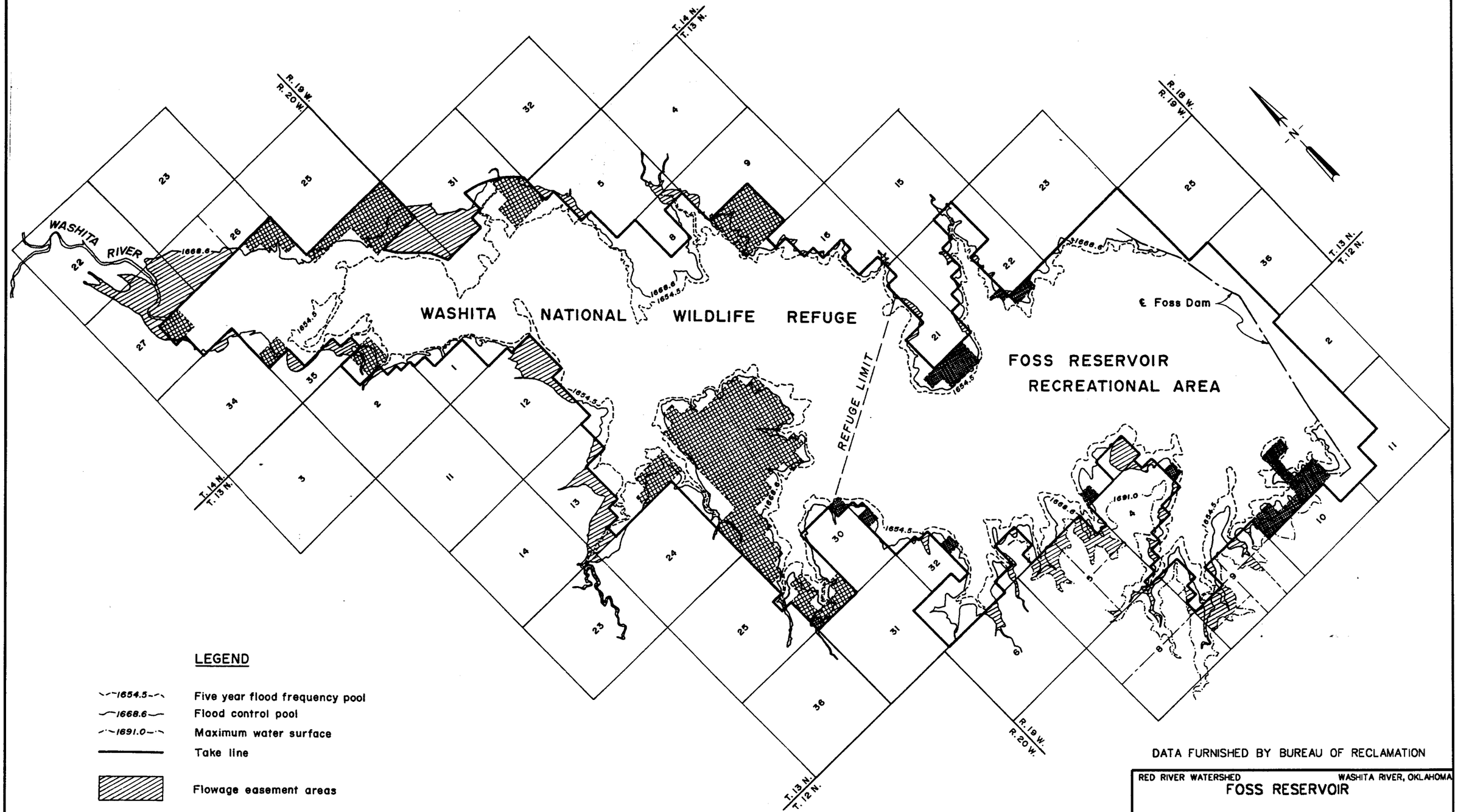
DATA FURNISHED BY BUREAU OF RECLAMATION

RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

DEGRADATION RANGES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



LEGEND

- 1654.5 — Five year flood frequency pool
- 1668.6 — Flood control pool
- 1691.0 — Maximum water surface
- Take line
- Flowage easement areas
- Fish and wildlife areas
- Public use areas

2000 0 2000 4000
SCALE OF FEET

DATA FURNISHED BY BUREAU OF RECLAMATION

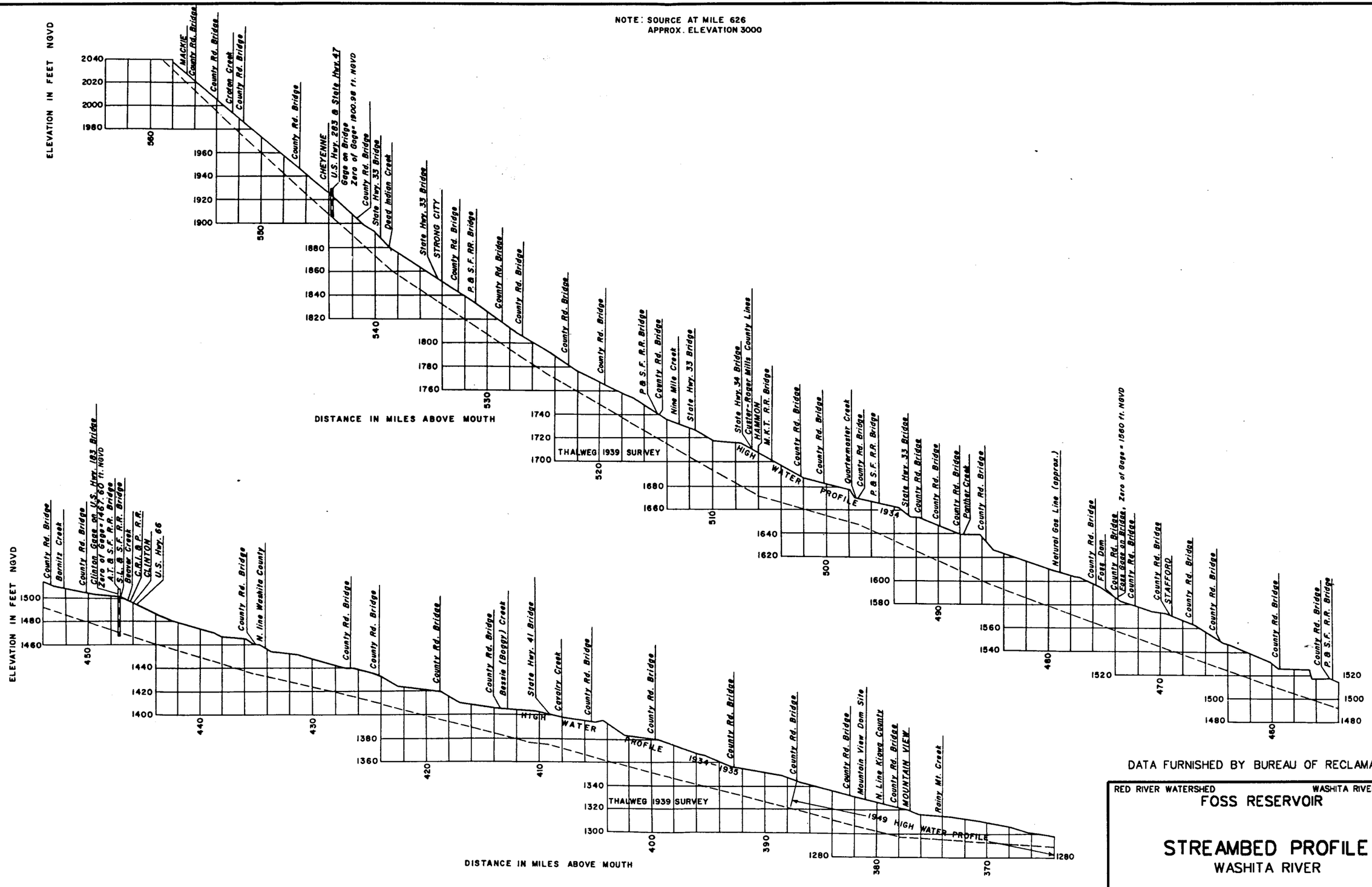
RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

TAKING LINE AND EASMENT AREAS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

NOTE: SOURCE AT MILE 626
APPROX. ELEVATION 3000



DATA FURNISHED BY BUREAU OF RECLAMATION

NOTE: DISTANCES IN MILES SHOWN ON THIS SHEET
FROM AWR DRAINAGE AREA DATA NOVEMBER, 1954

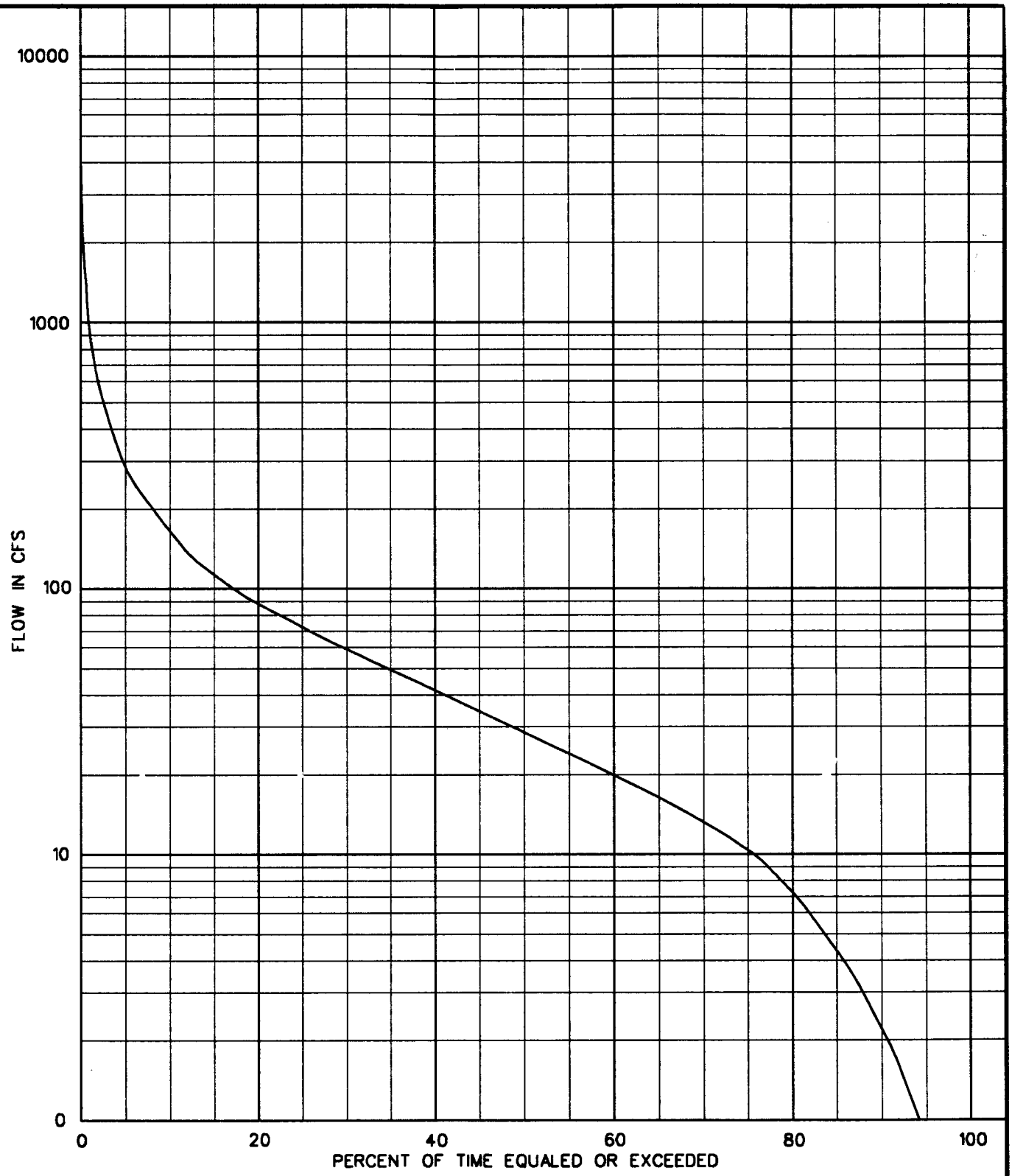
RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

STREAMBED PROFILE
WASHITA RIVER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

4-1



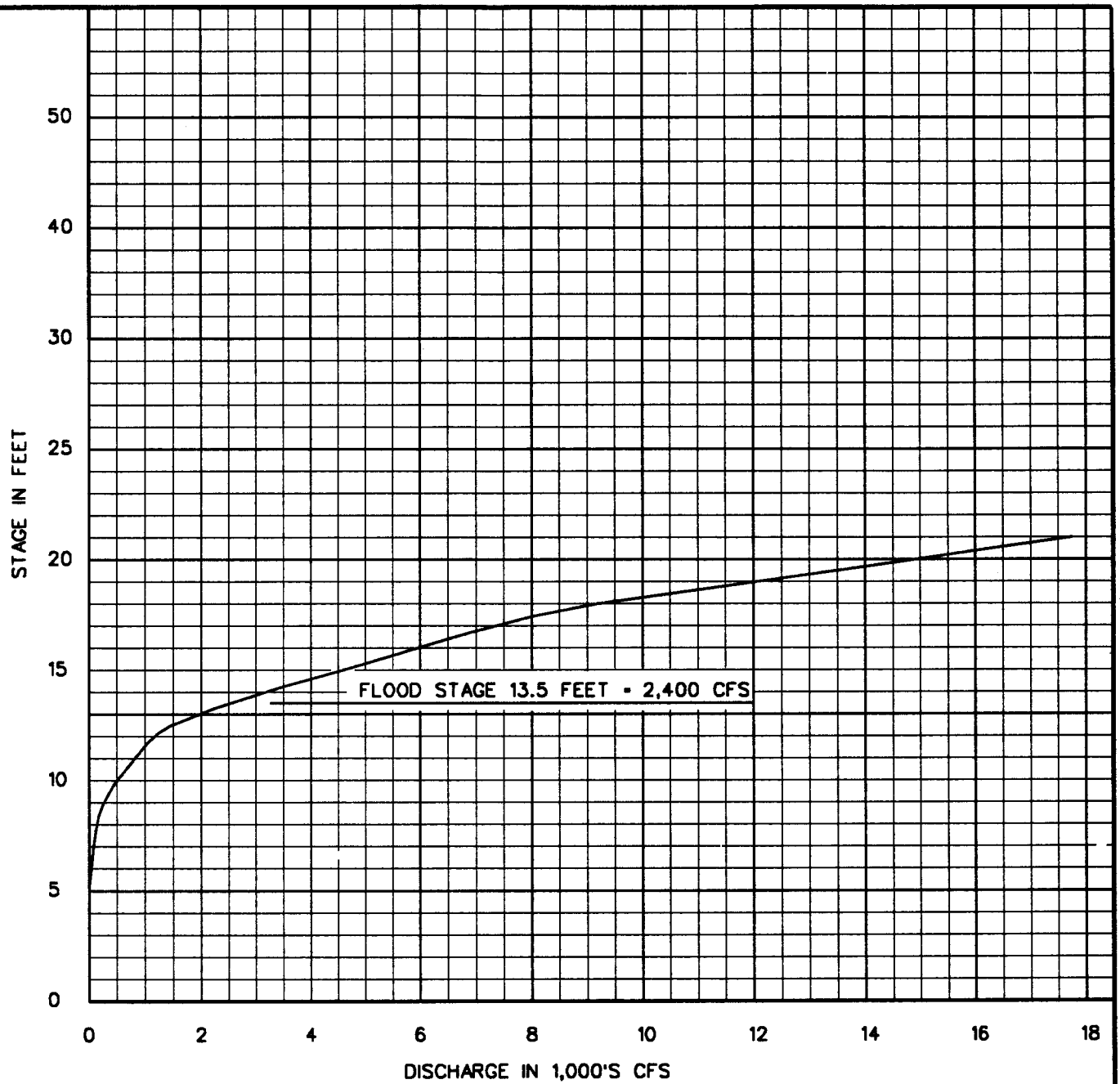
BASED ON ACTUAL INFLOWS
FOR PERIOD 1971-1990

RED RIVER WATERSHED WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

INFLOW DURATION CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



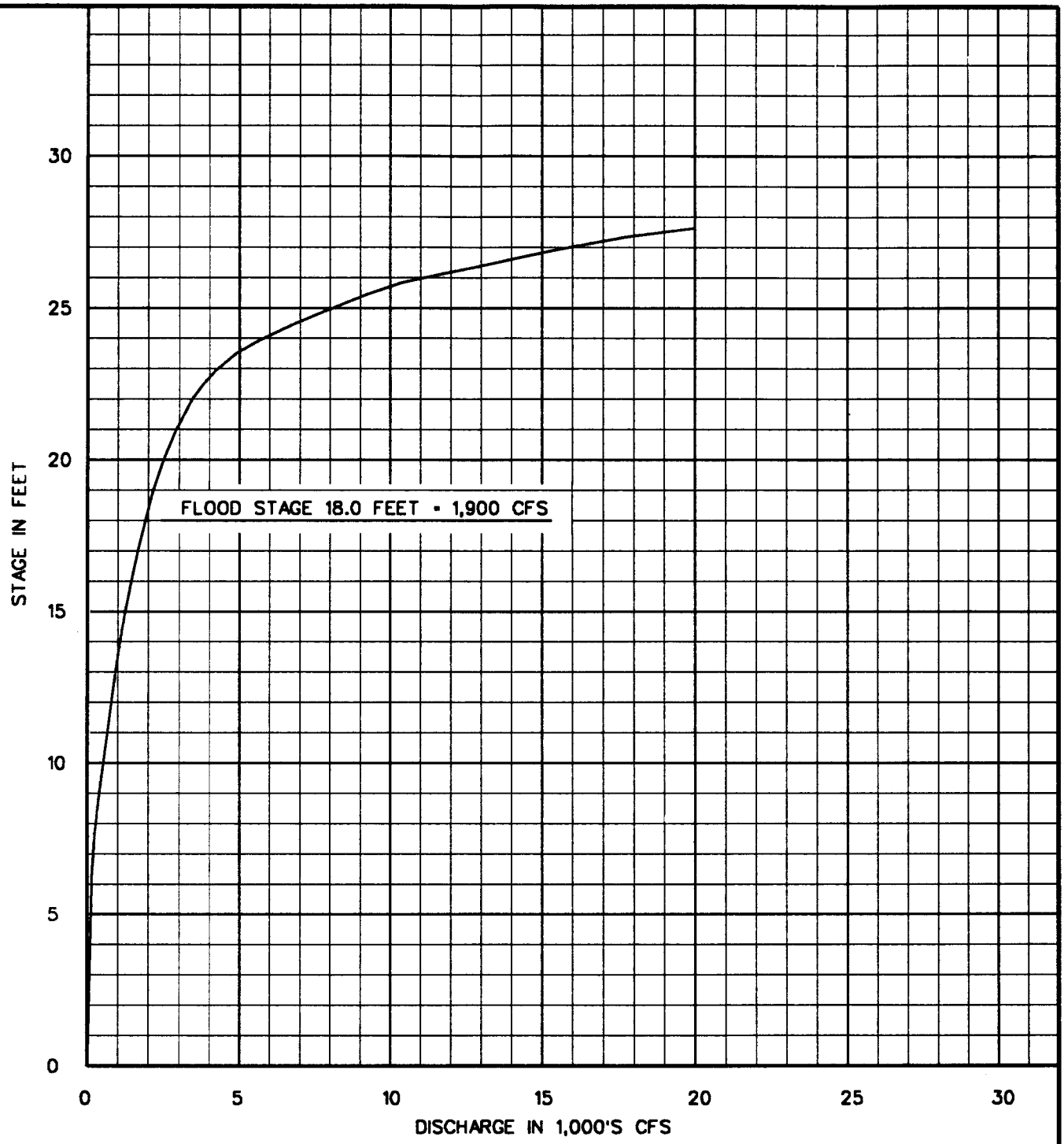
RED RIVER WATERSHED WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

DISCHARGE RATING CURVE

CHEYENNE GAGE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



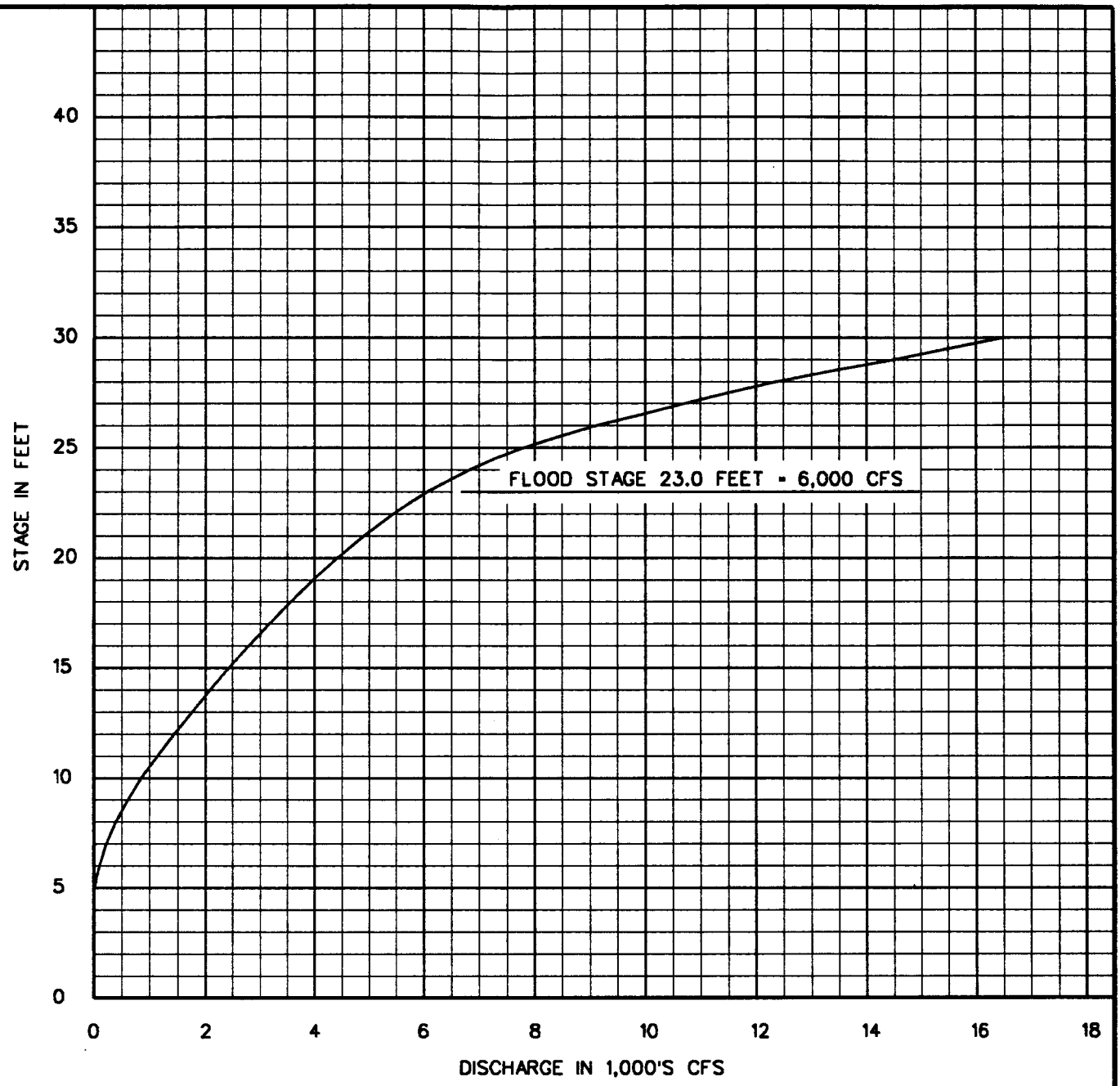
RED RIVER WATERSHED WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

DISCHARGE RATING CURVE

CLINTON GAGE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



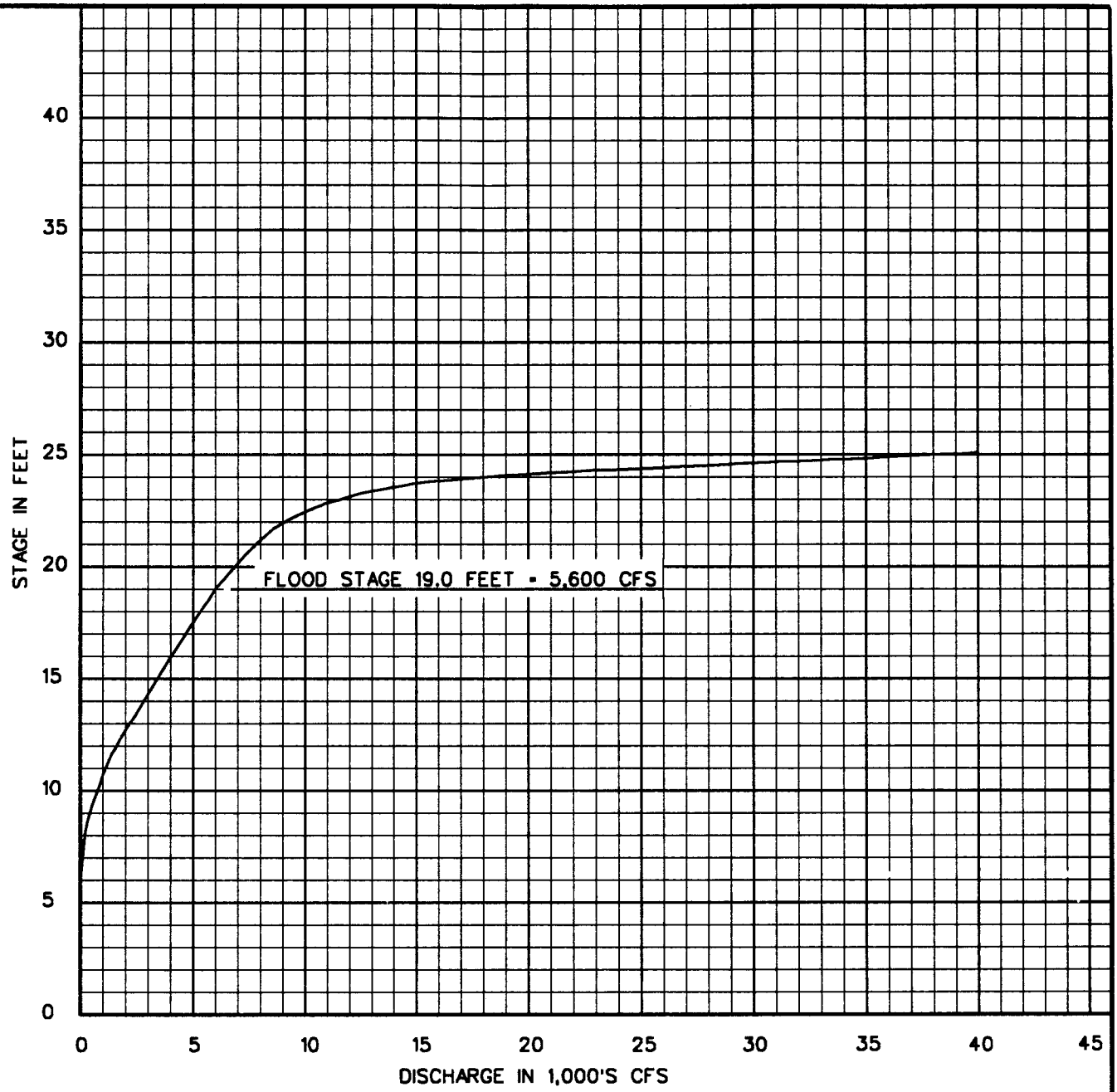
RED RIVER WATERSHED WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

DISCHARGE RATING CURVE

CARNEGIE GAGE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



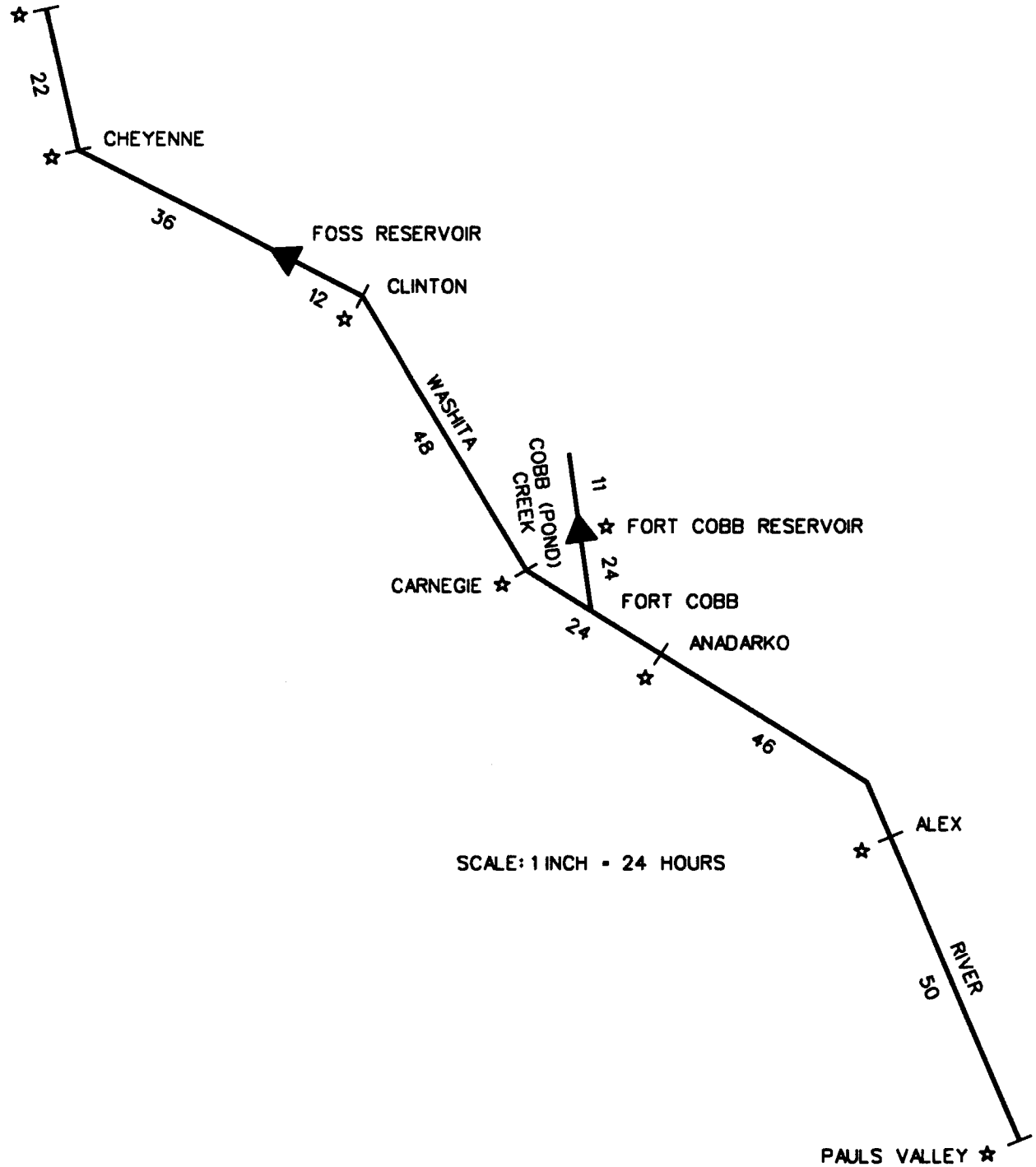
RED RIVER WATERSHED WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

DISCHARGE RATING CURVE

ANADARKO GAGE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



NOTE:

1. TIME OF TRAVEL IN HOURS FOR LARGE RISES IS SHOWN:

   ☆24☆

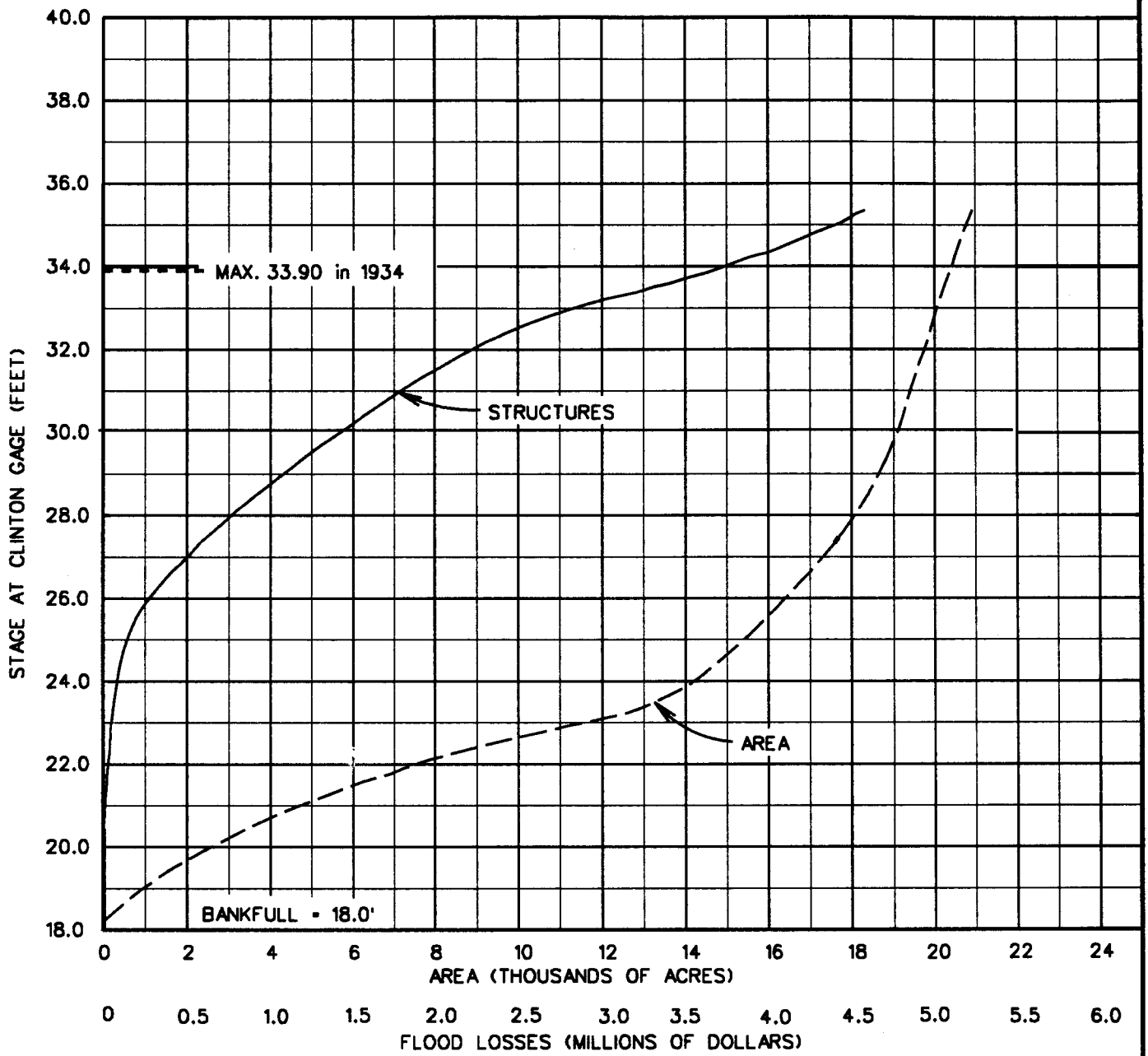
2. TIME SHOWN ABOVE UPSTREAM STATION IS AVERAGE TIME TO CREST AFTER BEGINNING OF RUNOFF.

RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

TIME OF CREST TRAVEL

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



JAN. 1990 PRICES (4672-66)

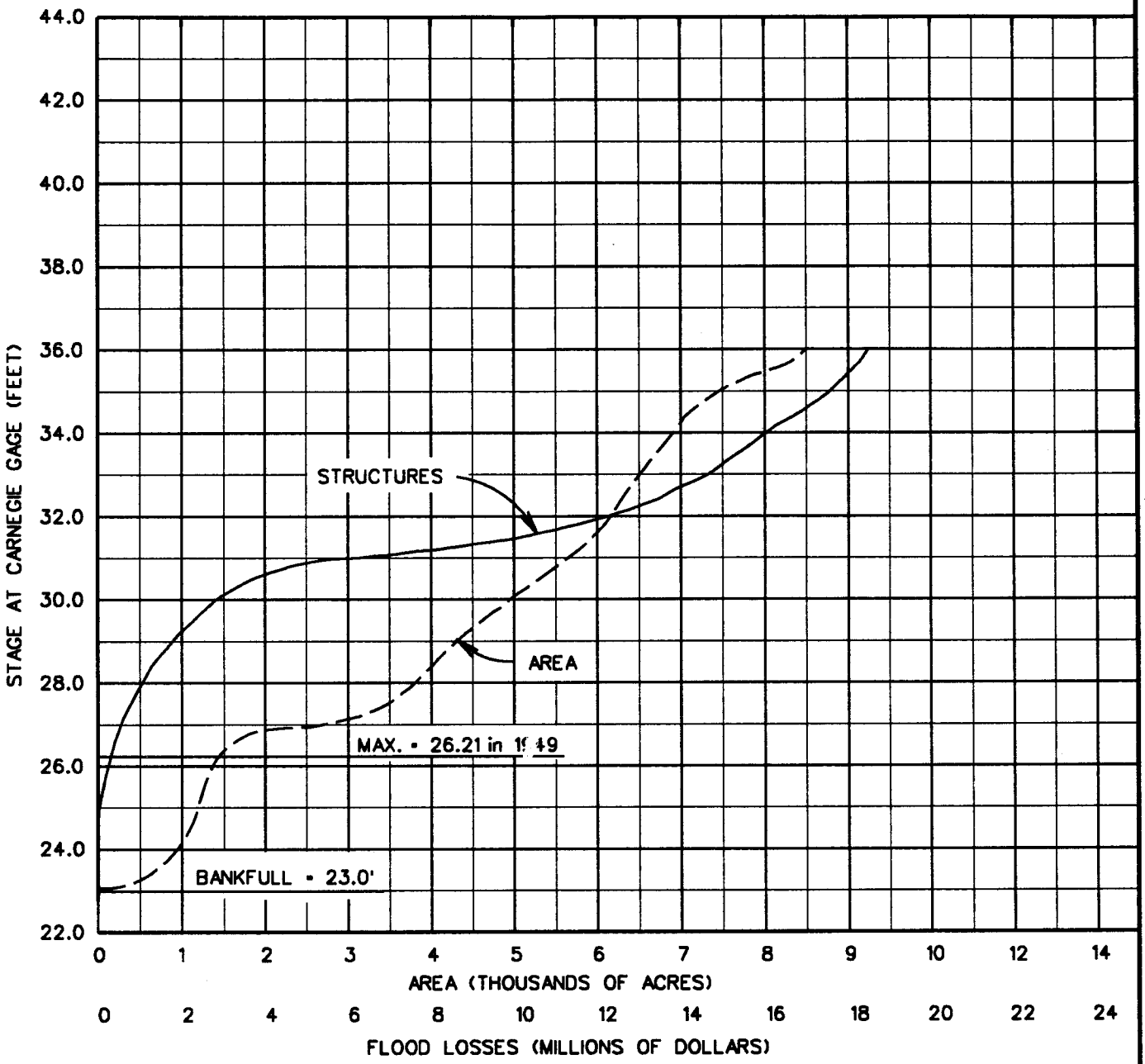
RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

STRUCTURAL LOSS AND AREA CURVES

FROM FOSS DAM TO MT. VIEW DAM SITE ON WASHITA RIVER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



JAN. 1990 PRICES (4672-66)

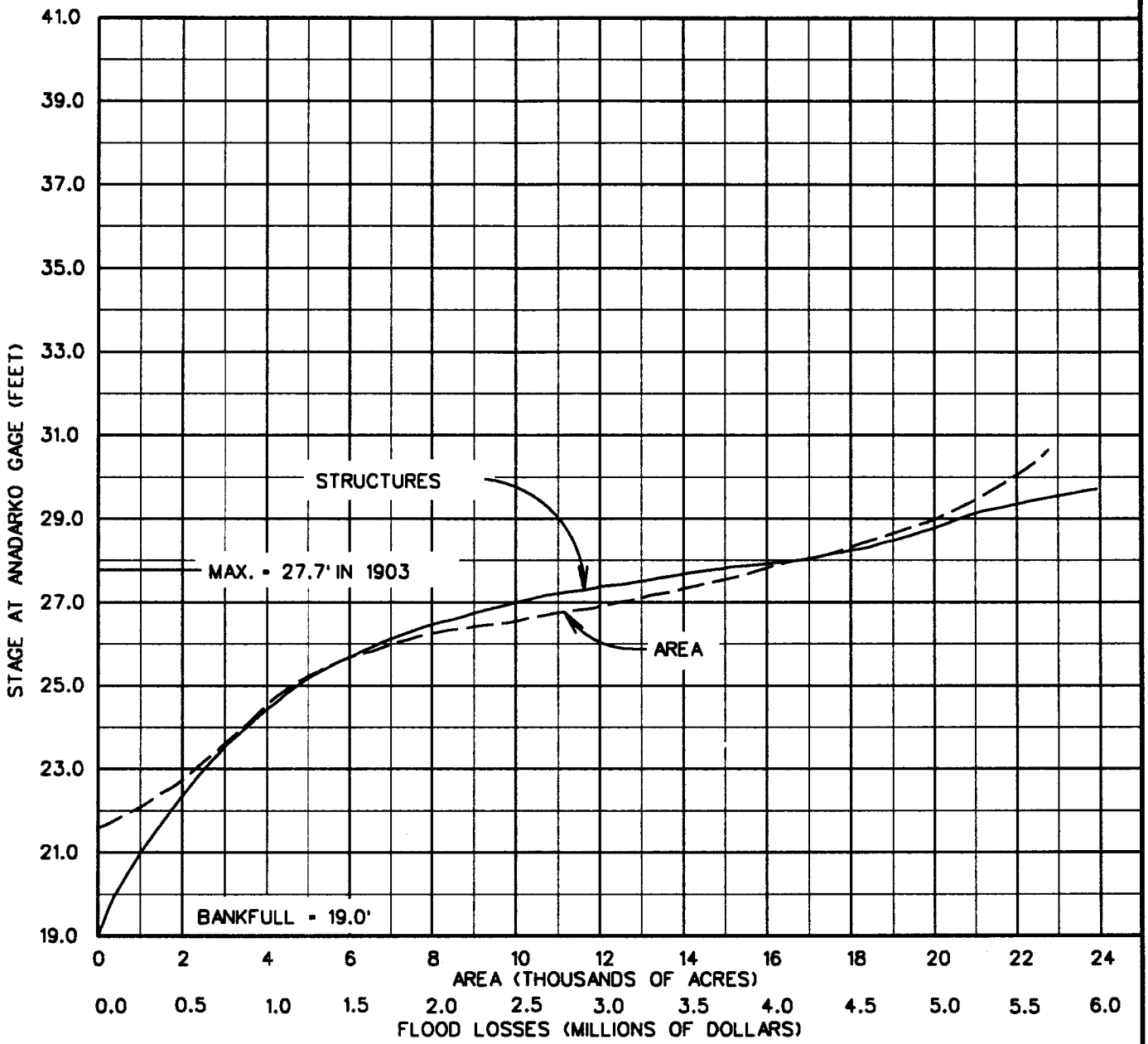
RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

STRUCTURAL LOSS AND AREA CURVES

FROM MT. VIEW DAM SITE TO MOUTH OF COBB (POND) CREEK ON WASHITA RIVER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



JAN. 1990 PRICES (4672-66)

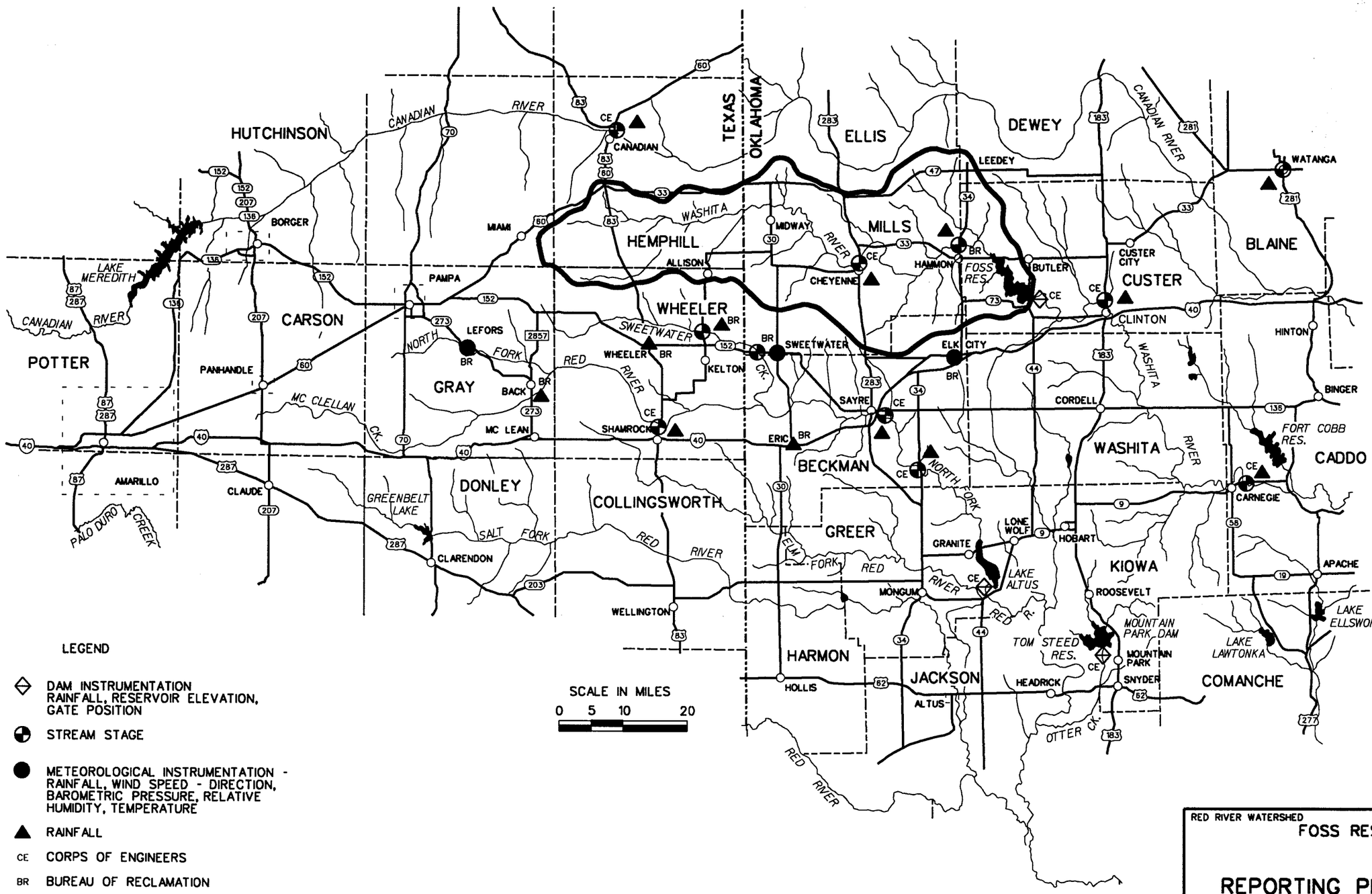
RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

STRUCTURAL LOSS AND AREA CURVES

FROM MOUTH OF COBB (POND) CREEK TO GARVIN-GRADY CO. LINE ON WASHITA RIVER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



LEGEND

- DAM INSTRUMENTATION RAINFALL, RESERVOIR ELEVATION, GATE POSITION
- STREAM STAGE
- METEOROLOGICAL INSTRUMENTATION - RAINFALL, WIND SPEED - DIRECTION, BAROMETRIC PRESSURE, RELATIVE HUMIDITY, TEMPERATURE
- RAINFALL
- CE CORPS OF ENGINEERS
- BR BUREAU OF RECLAMATION

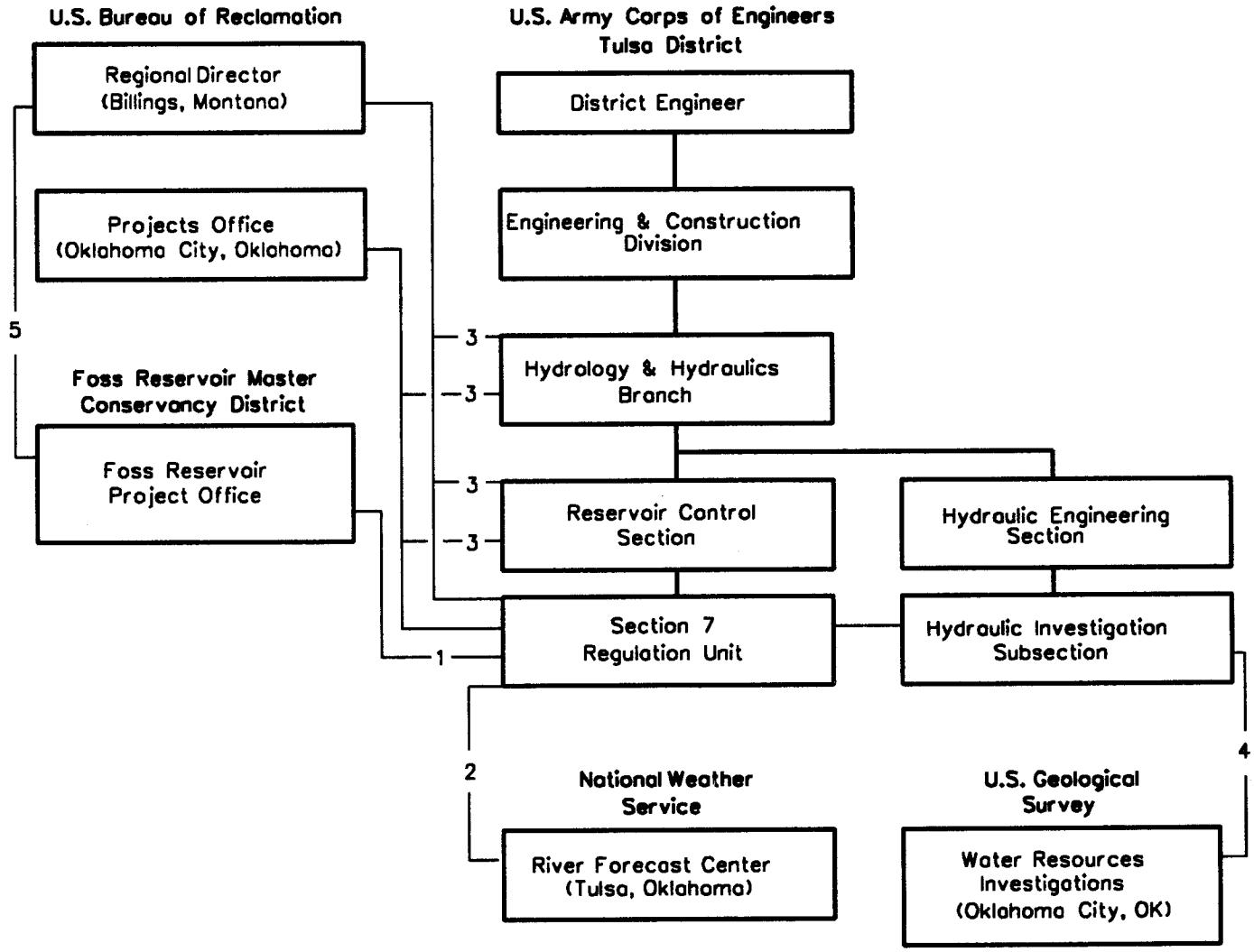
RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

REPORTING PRECIPITATION AND STREAM GAGING STATIONS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

5-1



1. Direct communications are maintained between the project and Reservoir Control Section for transmission of Reservoir data, regulations, and instructions.
2. Precipitation and stream gage data are shared with the National Weather Service, River Forecast Center.
3. During critical flood control operations, communication is maintained with higher echelons between agencies.
4. Measurement and maintenance of gages is performed by U.S.G.S.
5. Operations directed by U.S.B.R. when pool level exceeds or is forecasted to exceed top of flood pool, or when safety of dam is in jeopardy.

RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

ORGANIZATION FOR FLOOD CONTROL REGULATION

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

PROJECT FOSS RESERVOIR

LAKE DATA

JUNE, 1990

ITEM NUMBER	ITEM	TIME	2	3	4	5	6	
1	POOL ELEVATION	12 N	1643.29	1643.43	1643.44	1643.44	1643.34	.
2		4 PM	.33	.43	.44	.44	.34	.
3		12 M	.47	.44	.44	.42	.48	.
4		8 AM	.43	.44	.44	.34	.48	.
5	TAILWATER ELEVATION	8 AM						
12:13	LAKE : WEATHER	8 AM	0 : 0	0 : 0	0 : 0	0 : 0	0 : 0	0 : 0
		1 PM						
B	PRECEDING	7 PM						
C	PRECIPITATION	1 AM						
D		7 AM						
15	TOTAL 24-HOUR PRECIPITATION	7 AM						
16	COMMENTS ON PRECIP. DIST.							
17	EVAPORATION 24-HOURS	8 AM	.19	.37	.24	.36	.50	
18:19	WIND DIR : VEL	8 AM	N : B-3	N : B-1	S : B-1	S : B-2	N : B-1	: B-
20	WATER SUPPLY							
21	GATE SETTING NO.,TYPE,OPENING	8 AM	CLOSED	CLOSED	2CG.40'	2CG.62'	2CG.62'	
22	GATE CHANGE 1	DATE TIME			6-3-90 900	6-4-90 930		
23		POOL ELEV			1643.43	1643.44		
		FROM			CLOSED	2CG.40'		
		TO			1CG.40'	2CG.62'		
26	GATE CHANGE 2	DATE TIME			6-3-90 1000			
27		TIME ELEV			1643.43			
28		FROM			1CG.40'			
29		TO			2CG.40'			
30	GATE CHANGE 3	DATE TIME						
31		POOL ELEV						
32		FROM						
33		TO						
34	GATE CHANGE 4	DATE TIME						
35		POOL ELEV						
36		FROM						
37		TO						
38	RIVER STAGE LOW FLOW WEIR							

TEST OF SWT FORM 813B
JUN 1990

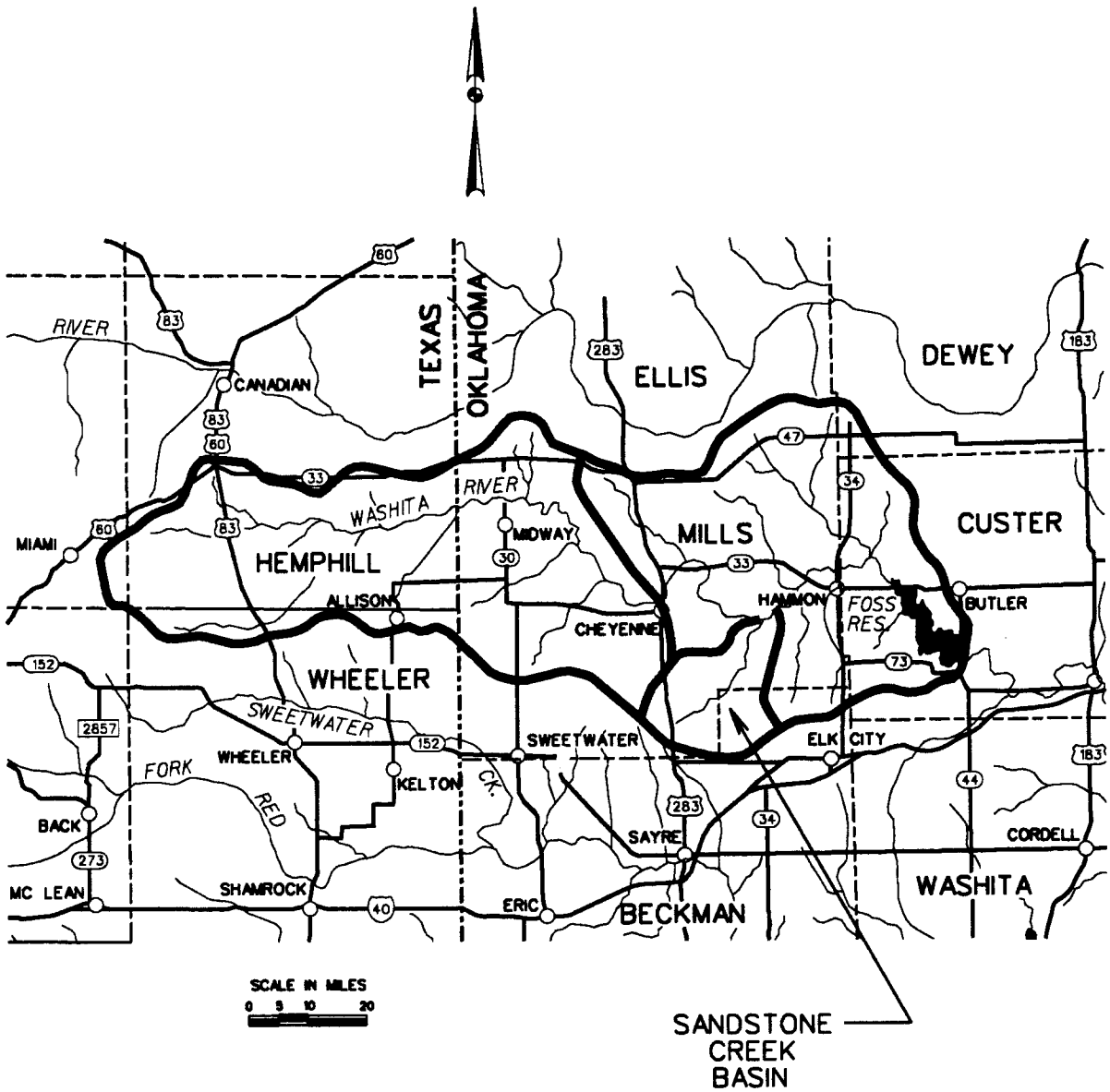
PROPONENT CESWT-EC-HR.

RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

LAKE DATA

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

FORECASTING REACHES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

```
ID      FOSS RESERVOIR FORECAST                                  MARK SWIFT
ID      2-HR UNIT HYDROGRAPHS FROM FORECAST MANUAL               3 APRIL 81
ID      MODIFIED FOR DSS ZREAD AND ZWRITE  NOV84   BSM
ID      MODIFIED FOR TOTDSS RELEASES SEPTEMBER 1989 MAD
*FREE
IT   120                      100
IO     5
VSFOSSIN    FOSS  FOSOUT
VV  2.11    7.11    2.11
VSWASHTA  SANDST     FOS
VV  5.11    5.11    5.11
FP     1
KKWASHTA     SUBAREA 1   COMPUTED HYDROGRAPH AT CHEYENNE ON WASHITA RIVER
BA   754
* L           LOSS RATE CARD FOR WASHTA SUBBASIN
LU     0       0
PB     0
ZR-PI   A-FOSS LAKE B-WASHTA C-PRECIP-INC F-ADJUST
UI  1612    4231    9178   13155   14137   15798   17265   18296   19060   20466
UI 21558   19303   14896   11627    9020    6996    5419    4194    3249    2509
UI  1927    1479    1139     872     666
ZW    A-WASHITA B-CHEY C-FLOW-LOC CUM F-CALC
KK     3     ROUTE   CHEYENNE HYDROGRAPH TO FOSS RESERVOIR
RS     6       0      -1
SV     0    2850    9850   17050   29900   50450   67550   82800   96700  127750
SQ     0    1000    5000   10000   20000   40000   60000   80000  100000  150000
KKSANDST     SUBAREA 2   COMPUTED HYDROGRAPH AT CHEYENNE ON SANDSTONE CREEK
BA  65.7
* L         LOSS RATE FOR SANDST SUBBASIN
LU     0       0
PB     0
ZR-PI   A-FOSS LAKE B-SANDST C-PRECIP-INC F-ADJUST
UI     4     384    1780    3362    3486    2708    2103    1632    1266     982
UI   761     590     456     353     274     211     163     126      97      74
UI    57      44      32
KK     3     ROUTE   CHEYENNE HYDROGRAPH TO FOSS RESERVOIR
RS     4       0      -1
SV     0    2000    6800   11650   20350   33700   46650   54400   63250   82900
SQ     0    1000    5000   10000   20000   40000   60000   80000  100000  150000
KK  LAKE     SUBAREA 3   COMPUTED HYDROGRAPH AT FOSS RESERVOIR
BA   493
* B
BF     0                                          -.25  1.03
* L           LOSS RATE FOR LAKE SUBBASIN
LU     0       0
PB     0
ZR-PI   A-FOSS LAKE B-LAKE C-PRECIP-INC F-ADJUST
UI  3450    9372   14063   17330   17688   15852   14174   13014   11455    9348
UI  7258    5636    4372    3386    2623    2026    1565    1208     929     715
UI   548     421     317     238     182     135      95      63      39      23
UI     7
KKFOSSIN     COMBINE   ALL HYDROGRAPHS AT FOSS RESERVOIR
HC     3
ZW    A-WASHITA B-FOSS C-FLOW-RES IN F-CALC
KKFOSOUT     RELEASES FROM FOSS RESERVOIR
BA     1
ZR--QI   A-POSITIVE B-FOSS C-FLOW-RES OUT F-OBS
KK  COMB     COMBINE TO GET NET INFLOW
HC     2
KK  FOSS     INFLOW HYDROGRAPH AT FOSS RESERVOIR ROUTED THROUGH THE LAKE
* R          FOSS RESERVOIR
RS     1    ELEV    1597
SV 12150   19890   29760   41720   56300   74050   94860  118700  146310  177900
SV214490  256090  302880  356050  415880  482960  558430  642560  735630  837340
SE  1597    1602    1607    1612    1617    1622    1627    1632    1637    1642
SE  1647    1652    1657    1662    1667    1672    1677    1682    1687    1692
SQ     0       0
SE  1597    1602
ZW    A-WASHITA B-FOSS C-ELEV F-CALC
ZZ
```

RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

SAMPLE INPUT

HEC-1 MODEL

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1991
DRAWN: E.H.&A.
CHECKED: W.L.S.

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS. AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	WASHTA	48506.	22.00	45904.	36499.	14878.	754.00		
ROUTED TO	3	40961.	32.00	40259.	32053.	14726.	754.00		
HYDROGRAPH AT	SANDST	7844.	10.00	6819.	3655.	1309.	65.70		
ROUTED TO	3	3759.	24.00	3691.	2846.	1300.	65.70		
HYDROGRAPH AT	LAKE	39798.	10.00	37482.	26085.	12271.	493.00		
3 COMBINED AT	FOSSIN	53009.	30.00	51883.	45094.	28105.	1312.70		
HYDROGRAPH AT	FOSOUT	0.	2.00	0.	0.	0.	1.00		
2 COMBINED AT	COMB	53009.	30.00	51883.	45094.	28105.	1313.70		
ROUTED TO	FOSS	0.	2.00	0.	0.	0.	1313.70	1661.83	198.00

RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

SAMPLE SUMMARY OUTPUT

HEC-1 MODEL

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

TABLE 1	STATION		FOSSIN FLOW	FOSS STAGE	FOSOUT FLOW
PER	DAY MON	HRMN			
1	8 MAY	0700	0.00	1642.00	0.00
2	8 MAY	0900	7762.54	1642.09	0.00
3	8 MAY	1100	21087.91	1642.41	0.00
4	8 MAY	1300	31649.92	1643.01	0.00
5	8 MAY	1500	39038.83	1643.81	0.00
6	8 MAY	1700	39994.84	1644.70	0.00
7	8 MAY	1900	36343.09	1645.56	0.00
8	8 MAY	2100	33929.98	1646.36	0.00
9	8 MAY	2300	34753.77	1647.12	0.00
10	9 MAY	0100	36896.56	1647.83	0.00
11	9 MAY	0300	39408.19	1648.59	0.00
12	9 MAY	0500	42359.67	1649.40	0.00
13	9 MAY	0700	45883.77	1650.27	0.00
14	9 MAY	0900	48362.64	1651.21	0.00
15	9 MAY	1100	51521.33	1652.18	0.00
16	9 MAY	1300	53009.48	1653.10	0.00
17	9 MAY	1500	52154.92	1654.03	0.00
18	9 MAY	1700	49447.54	1654.93	0.00
19	9 MAY	1900	45671.66	1655.77	0.00
20	9 MAY	2100	41009.28	1656.53	0.00
21	9 MAY	2300	36063.91	1657.19	0.00
22	10 MAY	0100	31388.35	1657.71	0.00
23	10 MAY	0300	27399.95	1658.17	0.00
24	10 MAY	0500	24381.88	1658.57	0.00
25	10 MAY	0700	21549.15	1658.93	0.00
26	10 MAY	0900	18869.13	1659.24	0.00
27	10 MAY	1100	16474.05	1659.52	0.00
28	10 MAY	1300	14439.82	1659.76	0.00
29	10 MAY	1500	12711.28	1659.97	0.00
30	10 MAY	1700	11150.40	1660.16	0.00
31	10 MAY	1900	9792.65	1660.32	0.00
32	10 MAY	2100	8646.53	1660.46	0.00
33	10 MAY	2300	7701.56	1660.59	0.00
34	11 MAY	0100	6811.19	1660.70	0.00
35	11 MAY	0300	5998.70	1660.80	0.00
36	11 MAY	0500	5278.84	1660.89	0.00
37	11 MAY	0700	4658.00	1660.97	0.00
38	11 MAY	0900	4133.70	1661.03	0.00
39	11 MAY	1100	3701.79	1661.10	0.00
40	11 MAY	1300	3349.38	1661.15	0.00
41	11 MAY	1500	3062.28	1661.20	0.00
42	11 MAY	1700	2841.62	1661.25	0.00
43	11 MAY	1900	2630.12	1661.29	0.00
44	11 MAY	2100	2429.30	1661.33	0.00
45	11 MAY	2300	2240.24	1661.36	0.00
46	12 MAY	0100	2063.63	1661.40	0.00
47	12 MAY	0300	1899.73	1661.43	0.00
48	12 MAY	0500	1748.49	1661.46	0.00
49	12 MAY	0700	1609.60	1661.48	0.00
50	12 MAY	0900	1482.52	1661.51	0.00

TABLE 1 (CONT.)	STATION		FOSSIN FLOW	FOSS STAGE	FOSOUT FLOW
PER	DAY MON	HRMN			
51	12 MAY	1100	1366.59	1661.53	0.00
52	12 MAY	1300	1261.05	1661.55	0.00
53	12 MAY	1500	1165.09	1661.57	0.00
54	12 MAY	1700	1077.90	1661.59	0.00
55	12 MAY	1900	998.65	1661.60	0.00
56	12 MAY	2100	926.59	1661.62	0.00
57	12 MAY	2300	860.99	1661.63	0.00
58	13 MAY	0100	801.18	1661.64	0.00
59	13 MAY	0300	746.55	1661.66	0.00
60	13 MAY	0500	696.55	1661.67	0.00
61	13 MAY	0700	650.69	1661.68	0.00
62	13 MAY	0900	608.52	1661.69	0.00
63	13 MAY	1100	569.66	1661.70	0.00
64	13 MAY	1300	533.78	1661.70	0.00
65	13 MAY	1500	500.56	1661.71	0.00
66	13 MAY	1700	469.75	1661.72	0.00
67	13 MAY	1900	441.12	1661.73	0.00
68	13 MAY	2100	414.47	1661.73	0.00
69	13 MAY	2300	389.62	1661.74	0.00
70	14 MAY	0100	366.41	1661.75	0.00
71	14 MAY	0300	344.71	1661.75	0.00
72	14 MAY	0500	324.39	1661.76	0.00
73	14 MAY	0700	305.36	1661.76	0.00
74	14 MAY	0900	287.50	1661.77	0.00
75	14 MAY	1100	270.74	1661.77	0.00
76	14 MAY	1300	255.00	1661.77	0.00
77	14 MAY	1500	240.21	1661.78	0.00
78	14 MAY	1700	226.30	1661.78	0.00
79	14 MAY	1900	213.21	1661.79	0.00
80	14 MAY	2100	200.90	1661.79	0.00
81	14 MAY	2300	189.31	1661.79	0.00
82	15 MAY	0100	178.40	1661.79	0.00
83	15 MAY	0300	168.12	1661.80	0.00
84	15 MAY	0500	158.45	1661.80	0.00
85	15 MAY	0700	149.33	1661.80	0.00
86	15 MAY	0900	140.74	1661.80	0.00
87	15 MAY	1100	132.65	1661.81	0.00
88	15 MAY	1300	125.03	1661.81	0.00
89	15 MAY	1500	117.84	1661.81	0.00
90	15 MAY	1700	111.07	1661.81	0.00
91	15 MAY	1900	104.69	1661.81	0.00
92	15 MAY	2100	98.68	1661.82	0.00
93	15 MAY	2300	93.01	1661.82	0.00
94	16 MAY	0100	87.67	1661.82	0.00
95	16 MAY	0300	82.64	1661.82	0.00
96	16 MAY	0500	77.89	1661.82	0.00
97	16 MAY	0700	73.42	1661.82	0.00
98	16 MAY	0900	69.21	1661.82	0.00
99	16 MAY	1100	65.23	1661.82	0.00
100	16 MAY	1300	61.49	1661.83	0.00
		MAX	53009.48	1661.83	0.00
		MIN	0.00	1642.00	0.00
		AVE	10665.93	1658.69	0.00

RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

SAMPLE RESERVOIR ROUTING
HEC-1 MODEL

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

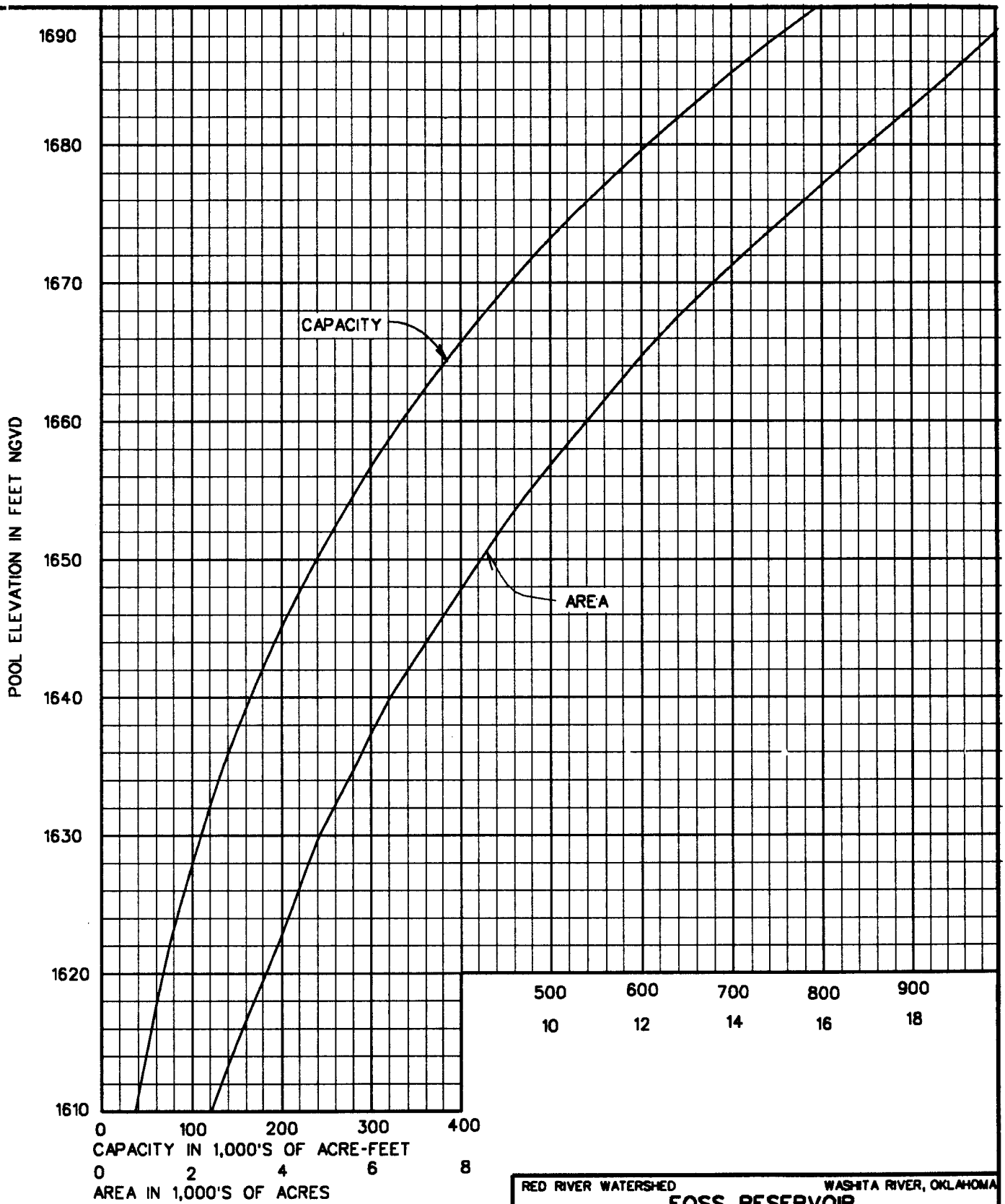
DATE	TIME	POOL ELEV	STORAGE AC-FT	CHANGE IN STORAGE DT/ AC-FT	CFS	GATES SET ILF 100.00		INSTANTANEOUS DISCHARGE FLOOD	OTHER	TOTAL	AVERAGE DISCHARGE FLOOD	OTHER	EVAP	TOTAL	INFLOW DT/ CFS
		WIND N B-1 PAN EVAPORATION • 0.37"													
3	800	1643.44	187928	8/ 0	0			10	0	10	10	0	77	87	8/ 87
3	900	1643.43	187857			1CG	0.40	96	0	96					
3	1000	1643.43	187857			2CG	0.40	192	0	192					
3	1200	1643.44	187928					192	0	192					
3	1600	1643.44	187928	8/ 0	0			192	0	192	157	0	50	207	8/ 207
3	2400	1643.44	187928	8/ 0	0			192	0	192	192	0	50	242	8/ 242
				24/ 0	0						120	0	50	170	24/ 170
		WIND S B-1 PAN EVAPORATION • 0.24"													
4	800	1643.44	187928	8/ 0	0			192	0	192	192	0	50	242	8/ 242
4	930	1643.44	187928			2CG	0.62	298	0	298					
4	1200	1643.44	187928					298	0	298					
4	1600	1643.44	187928	8/ 0	0			298	0	298	278	0	75	353	8/ 353
4	2400	1643.42	187786	8/ -142	-214			298	0	298	298	0	75	373	8/ 158
				24/ -142	-71						256	0	75	331	24/ 260
		WIND S B-2 PAN EVAPORATION • 0.36"													
5	800	1643.34	187217	8/ -569	-860			298	0	298	298	0	75	373	8/ -487
5	1200	1643.34	187217					298	0	298					
5	1600	1643.34	187217	8/ 0	0			298	0	298	298	0	104	402	8/ 402
5	2400	1643.48	188213	8/ 996	1506			298	0	298	298	0	104	402	8/ 1908
				24/ 427	215						298	0	104	402	24/ 617
		WIND N B-1 PAN EVAPORATION • 0.50"													
6	800	1643.48	188213	8/ 0	0			298	0	298	298	0	104	402	8/ 402
6	900	1643.48	188213			2CG	0.40	192	0	192					
6	1000	1643.48	188213			1CG	0.40	96	0	96					
6	1100	1643.48	188213			CLOSED		0	0	0					
6	1200	1643.48	188213					0	0	0					
6	1600	1643.48	188213	8/ 0	0	1CG	0.40	96	0	96	73	0	94	167	8/ 167
6	1700	1643.48	188213			2CG	0.40	192	0	192					

RED RIVER WATERSHED WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

SAMPLE DISCHARGE AND INFLOW COMPUTATION

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



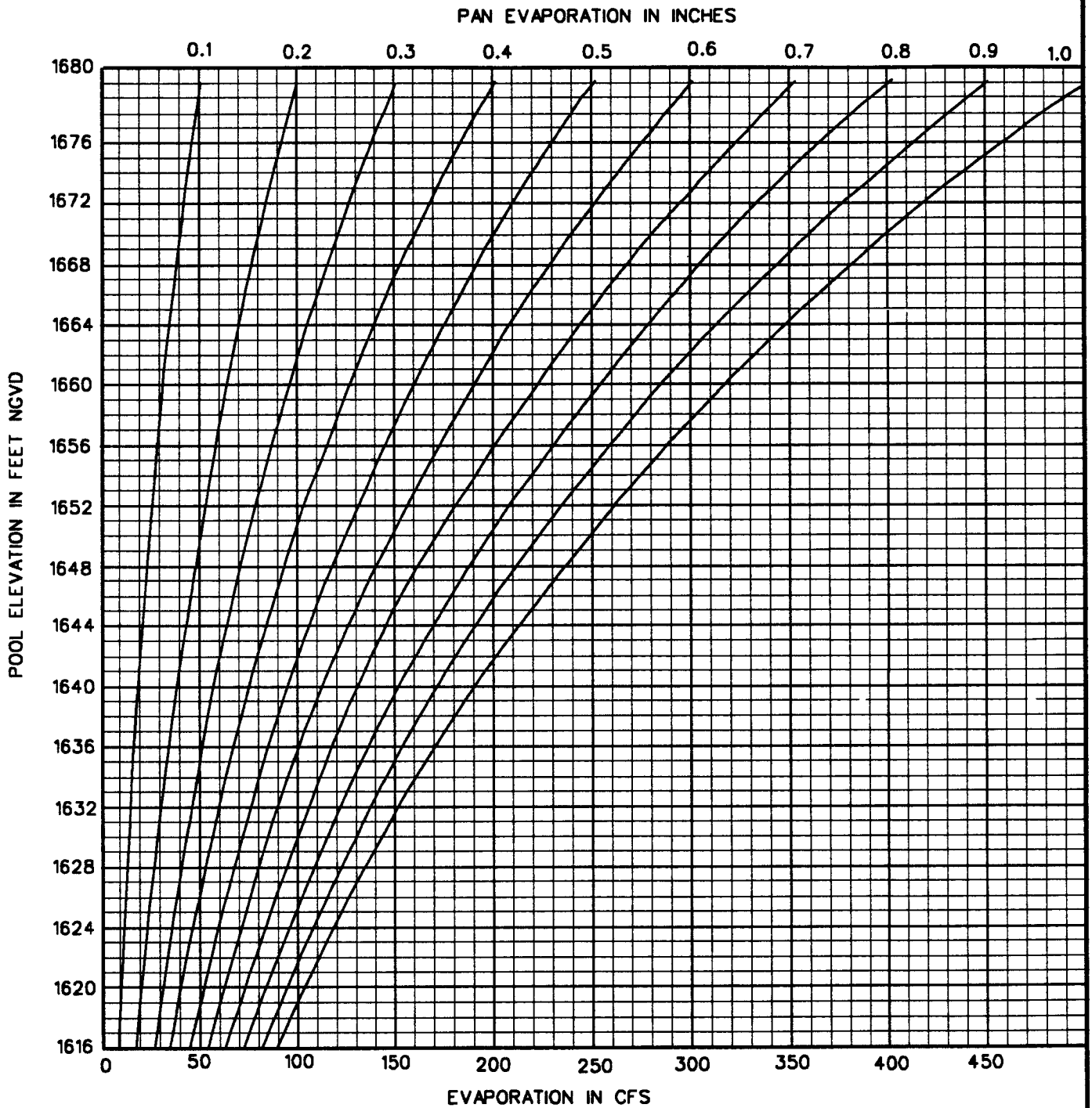
RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

AREA AND CAPACITY CURVES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

7-1



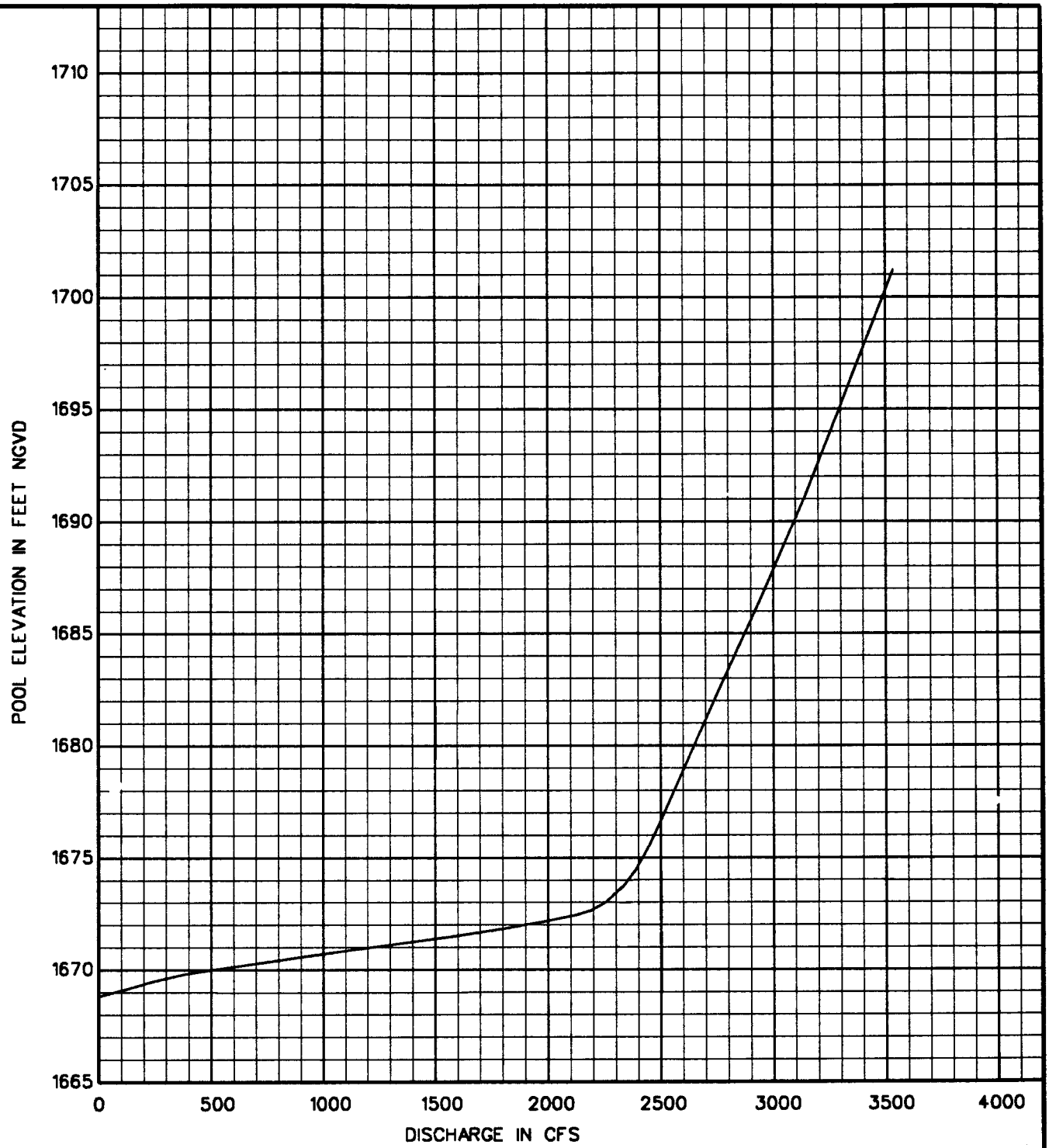
NOTE:
EVAPORATION IN C.F.S. COMPUTED FOR 70% OF TANK EVAPORATION AS SHOWN BY CURVES. DATA TAKEN FROM AREA-CAPACITY TABLE IN BUREAU OF RECLAMATION DEFINITE PLAN REPORT, VOL. II, FOSS DIVISION, WASHITA BASIN PROJECT, OKLAHOMA, DATED JANUARY 1958.

RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

EVAPORATION CURVES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



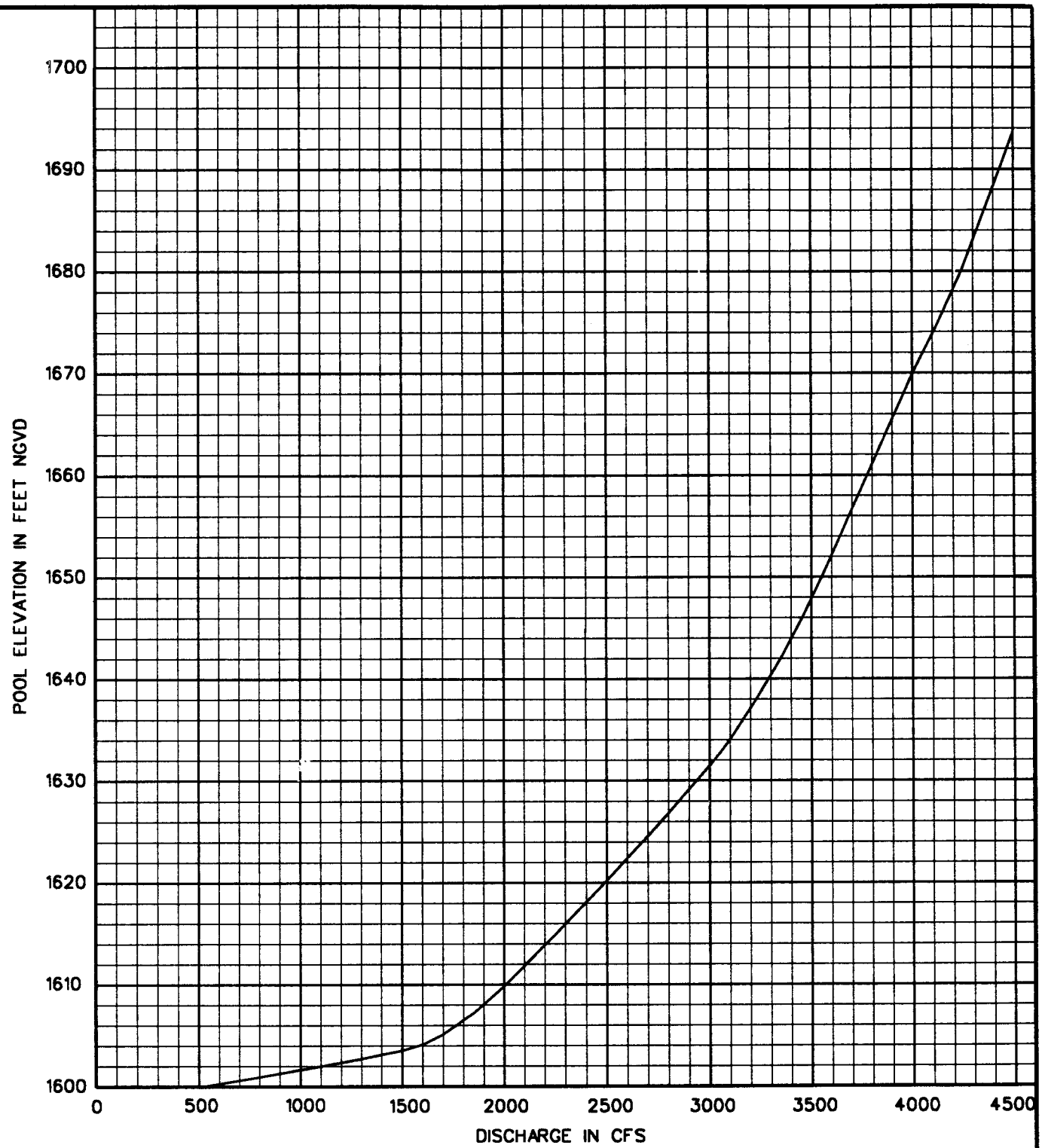
DATA FURNISHED BY BUREAU OF RECLAMATION

RED RIVER WATERSHED WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

DISCHARGE RATING CURVE UNCONTROLLED SPILLWAY

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



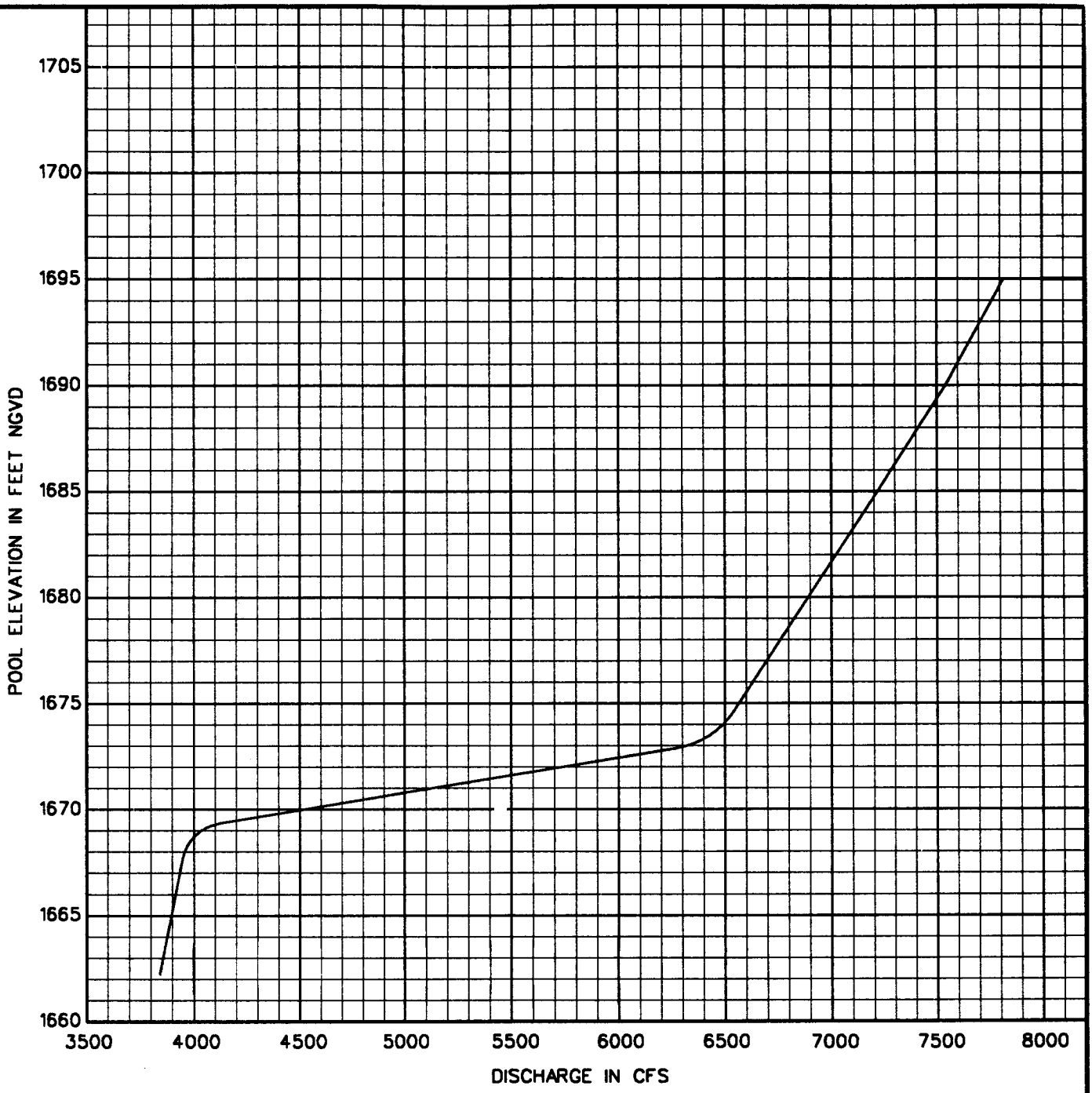
DATA FURNISHED BY BUREAU OF RECLAMATION

RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

DISCHARGE RATING CURVE
RIVER OUTLET WORKS
(BOTH GATES OPEN)

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

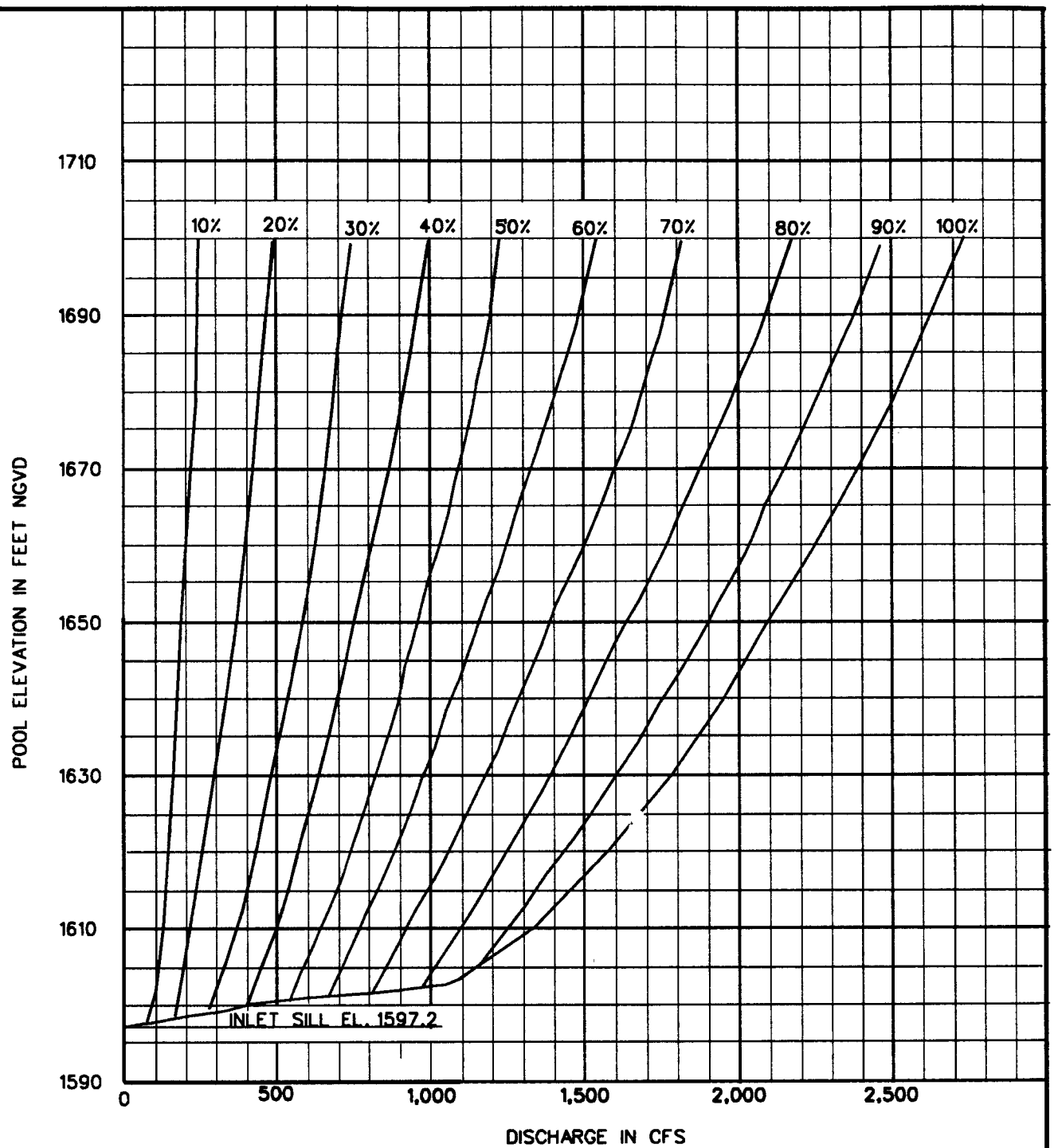


RED RIVER WATERSHED WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

DISCHARGE RATING CURVE RIVER OUTLET WORKS AND SPILLWAY

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



DATA FURNISHED BY BUREAU OF RECLAMATION

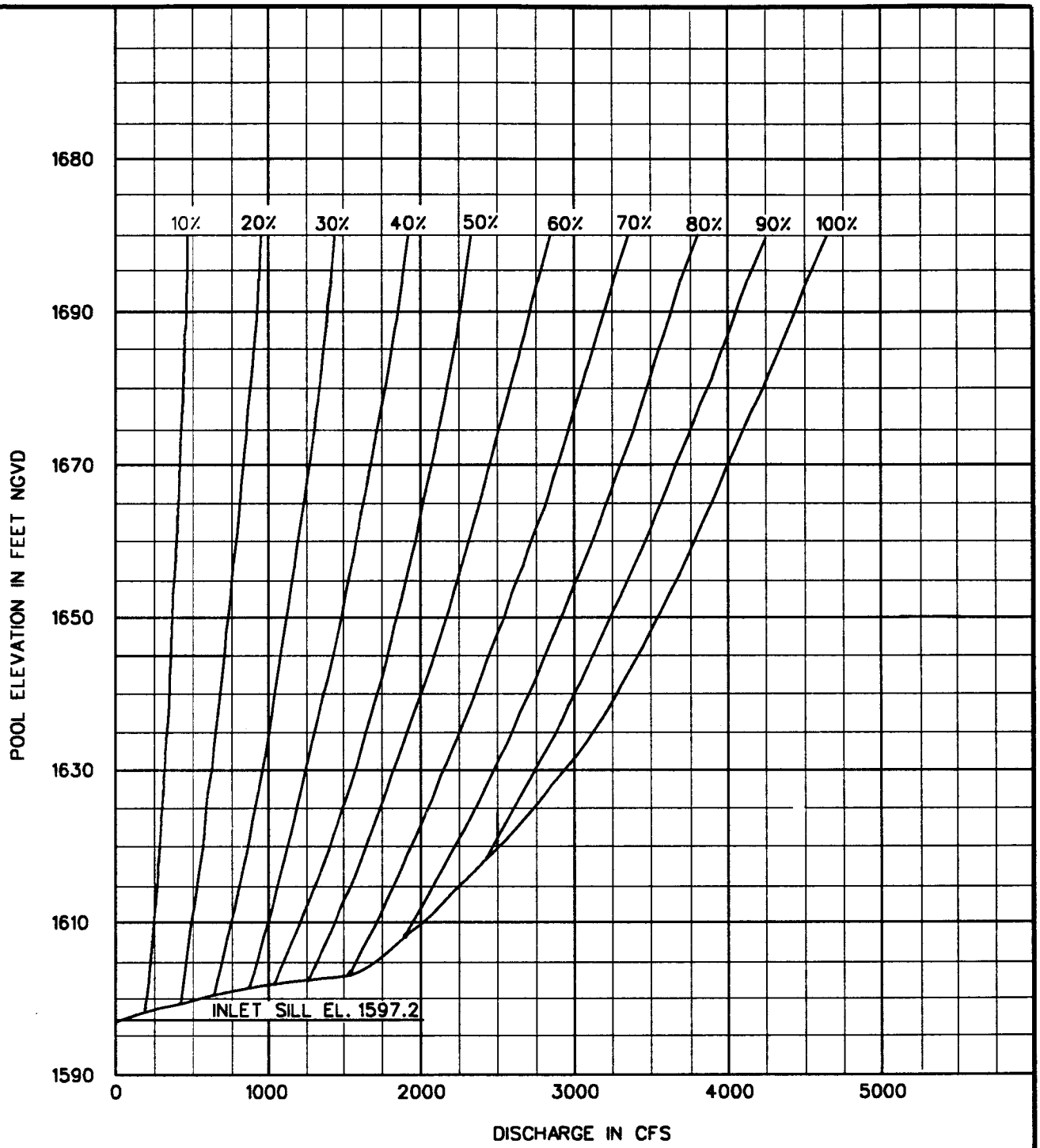
RED RIVER WATERSHED WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

DISCHARGE RATING CURVES RIVER OUTLET WORKS

PARTIAL GATE OPENINGS (ONE GATE)

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



DATA FURNISHED BY BUREAU OF RECLAMATION

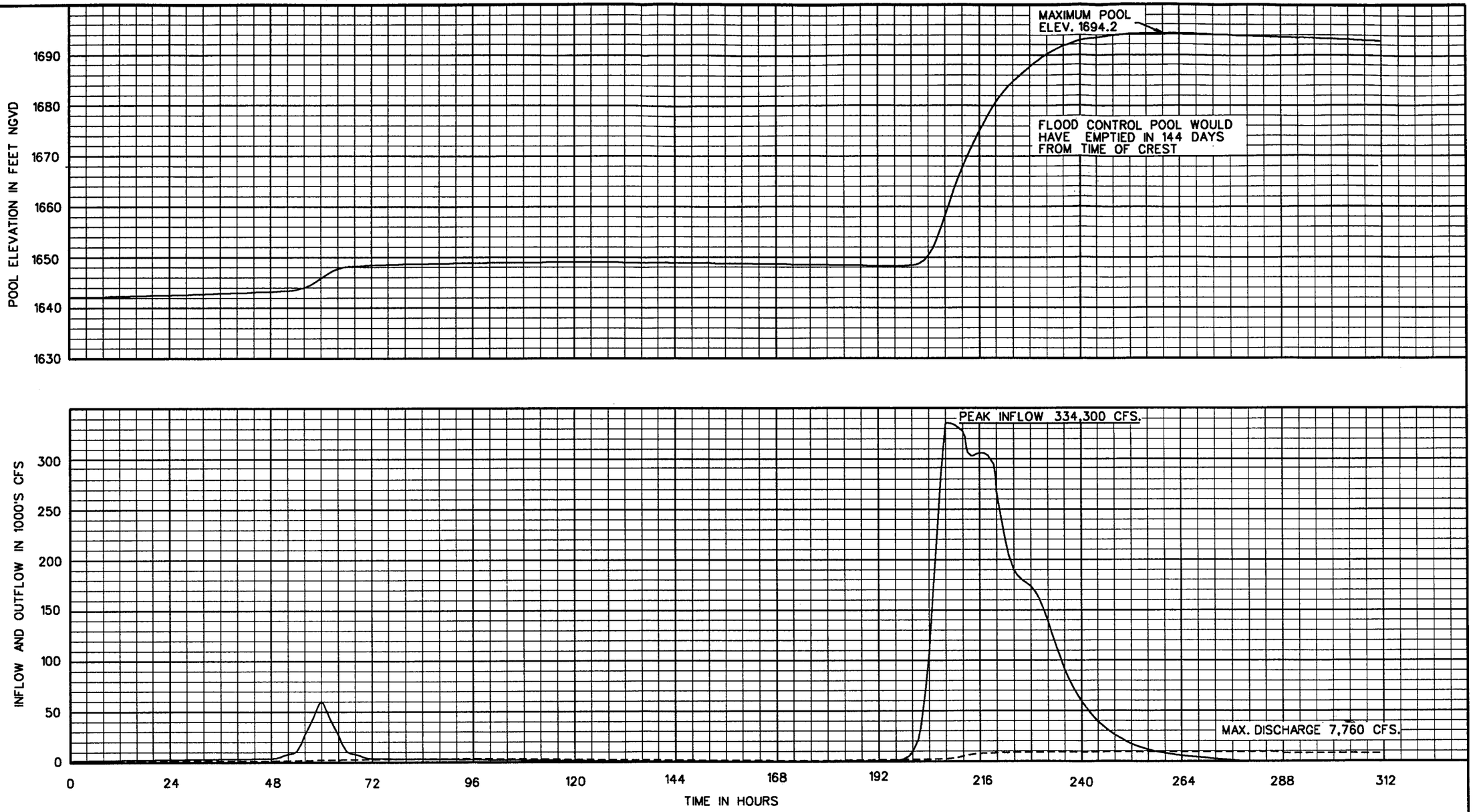
RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

DISCHARGE RATING CURVES RIVER OUTLET WORKS

PARTIAL GATE OPENINGS (TWO GATES)

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



INFLOW DESIGN FLOOD DATA
FURNISHED BY THE BUREAU OF RECLAMATION

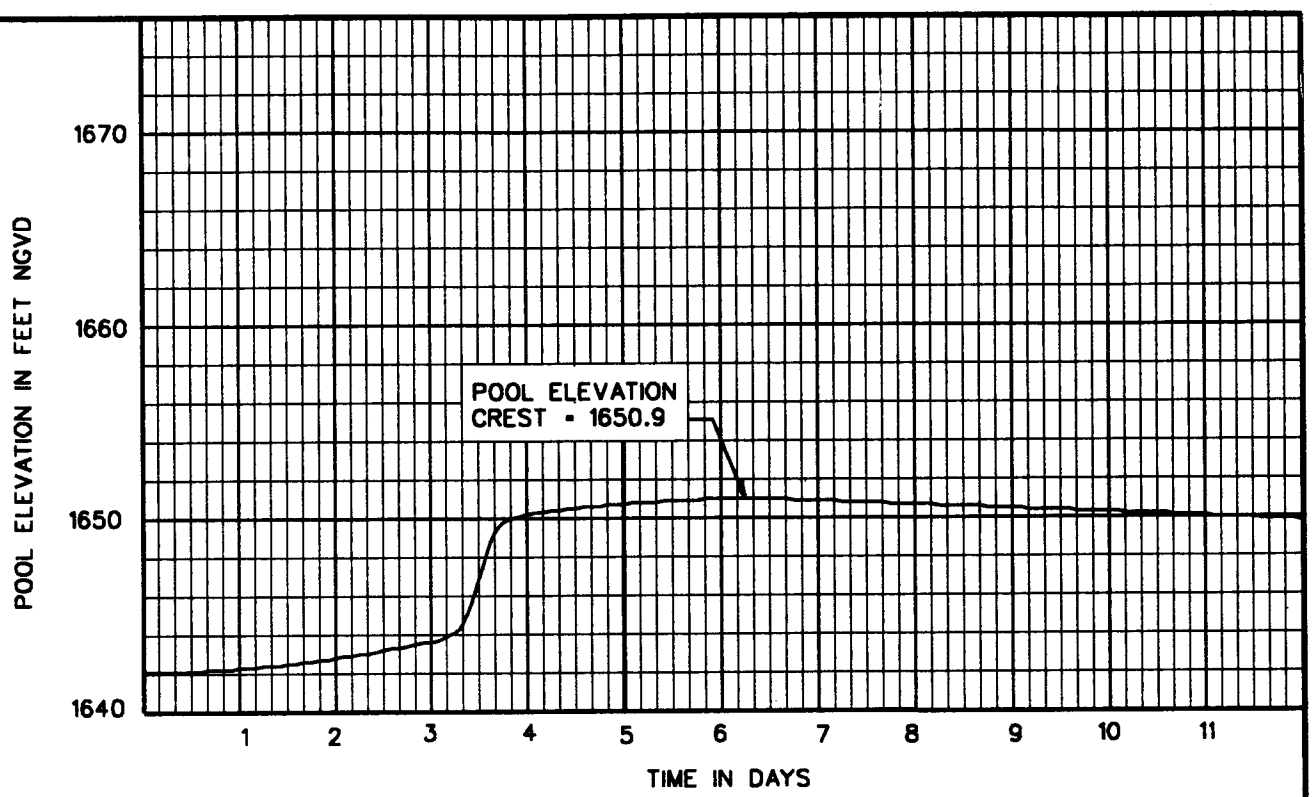
RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

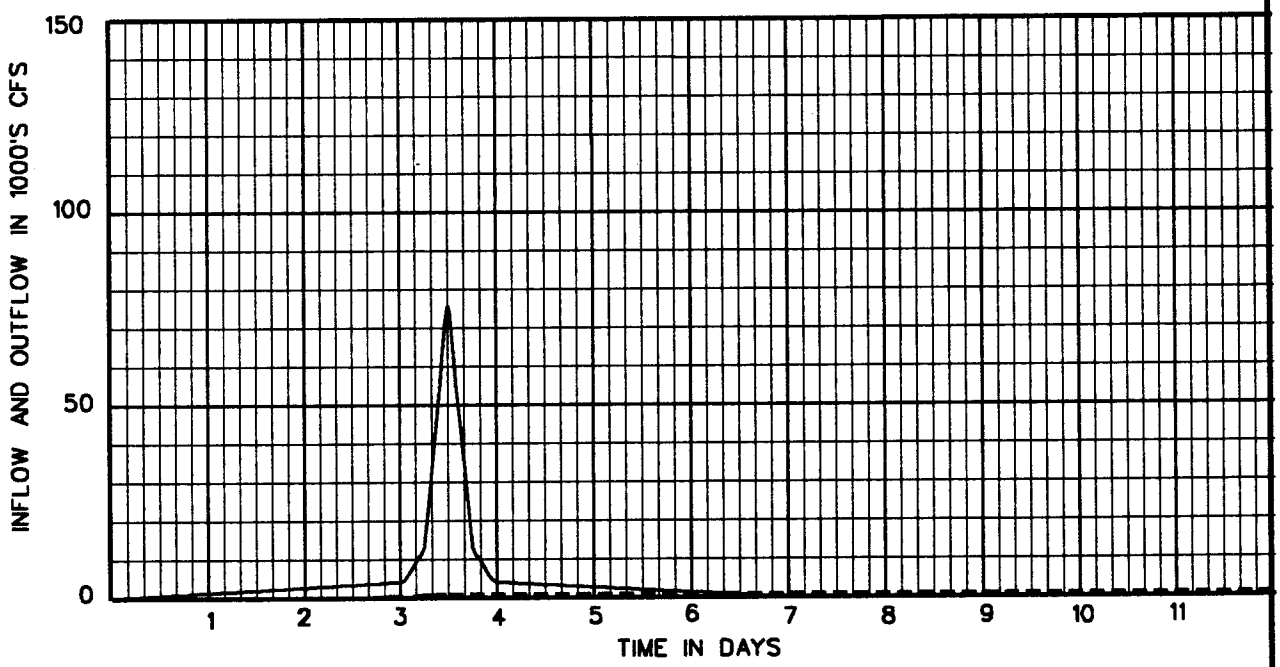
FOSS RESERVOIR

OPERATIONAL HYDROGRAPH
INFLOW DESIGN FLOOD

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.

8-1





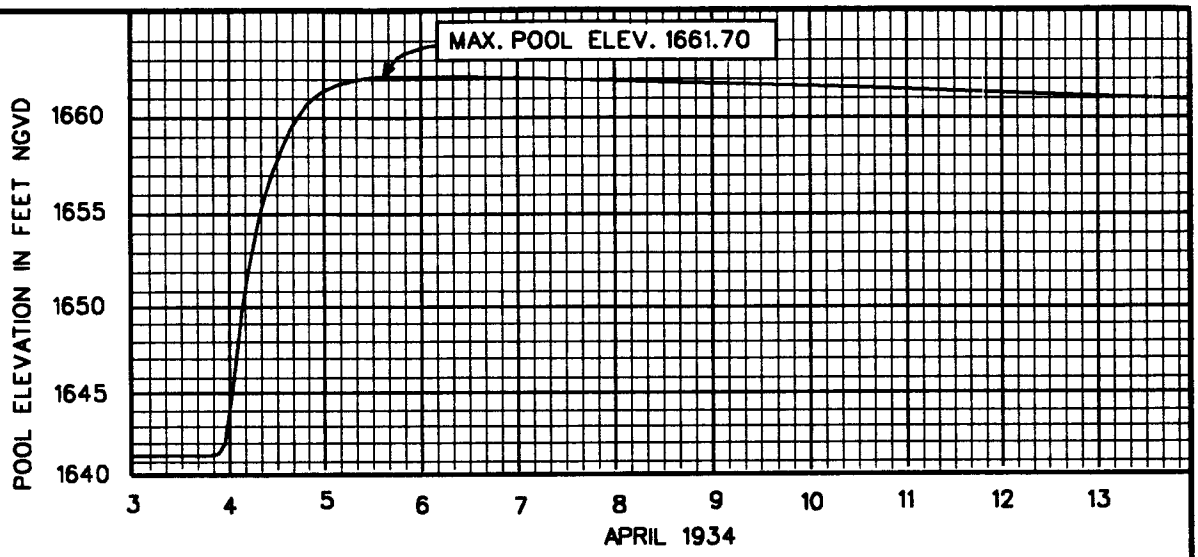
100-YEAR FLOOD DATA
FURNISHED BY THE BUREAU OF RECLAMATION

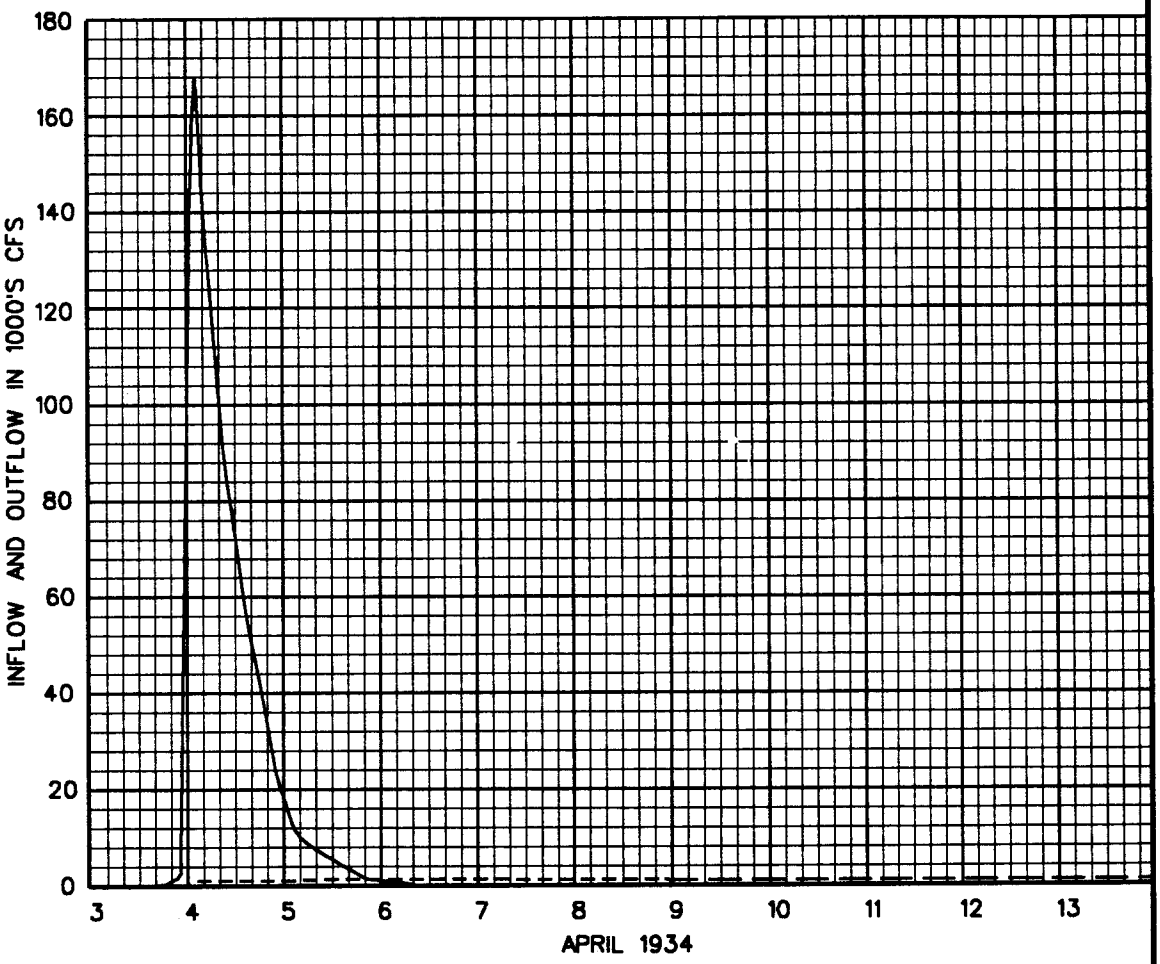
RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

OPERATIONAL HYDROGRAPH
100-YEAR FLOOD

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



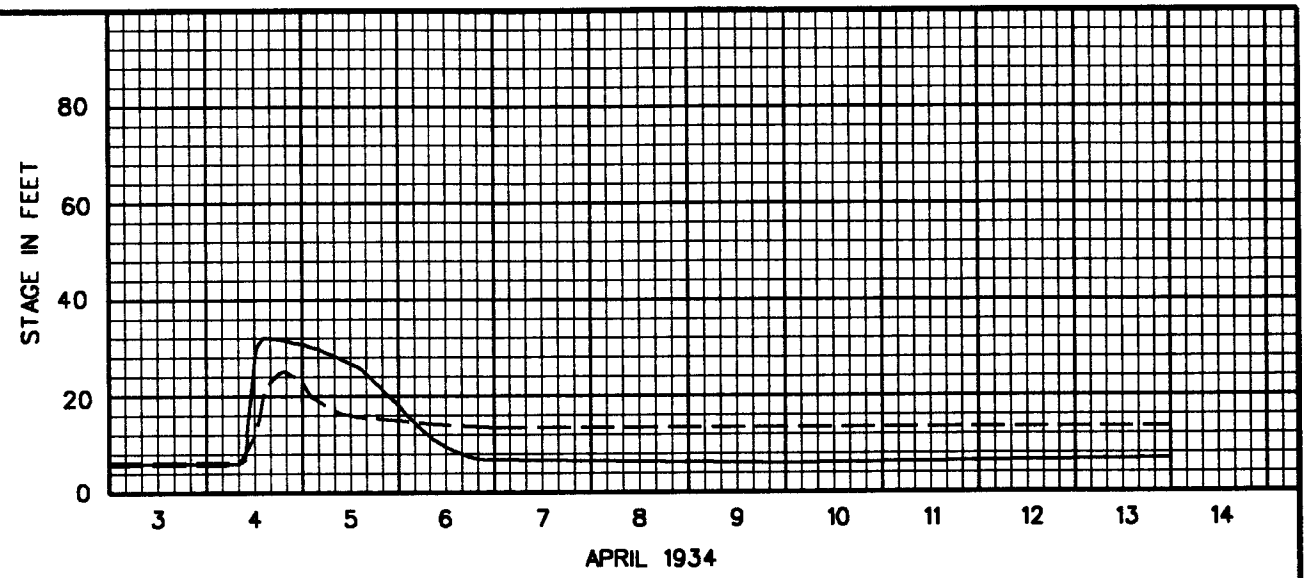


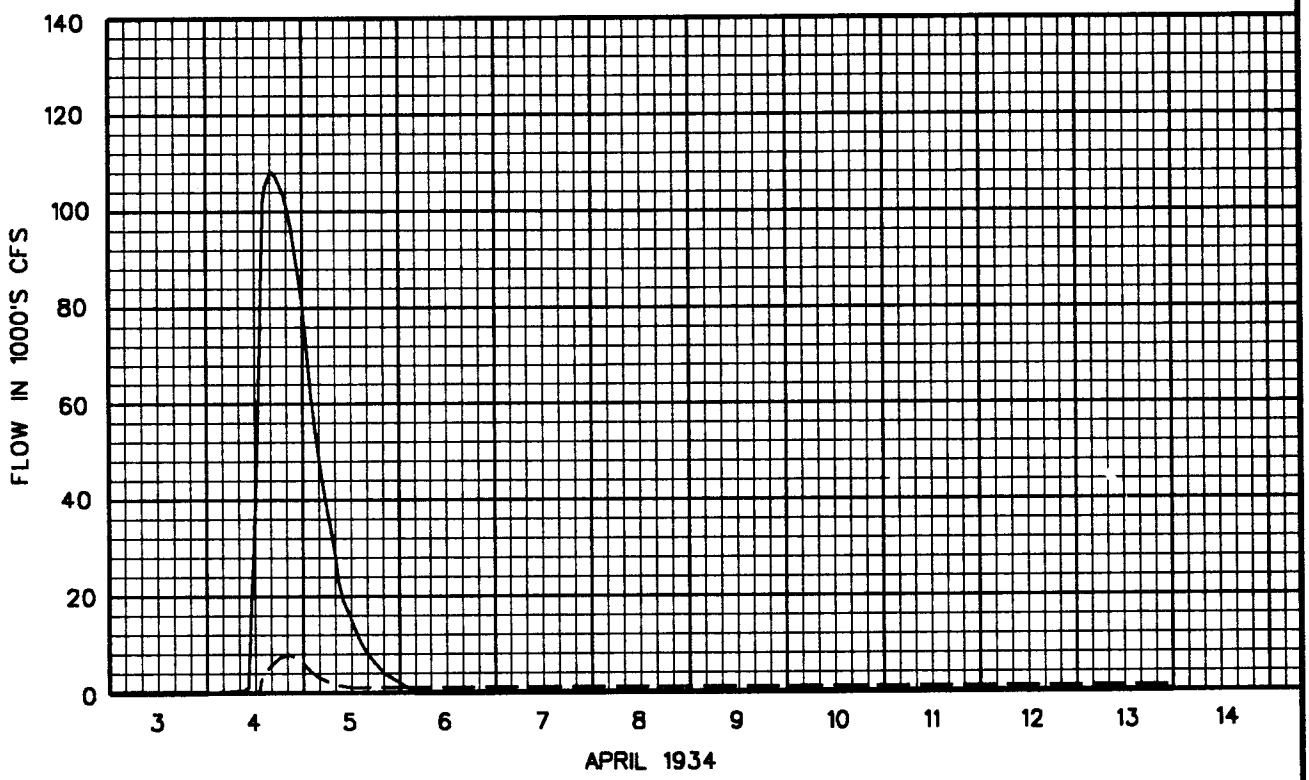
RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

OPERATIONAL HYDROGRAPH
FLOOD OF APRIL 1934

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&S.
CHECKED: W.L.S.





LEGEND

——— UNREGULATED

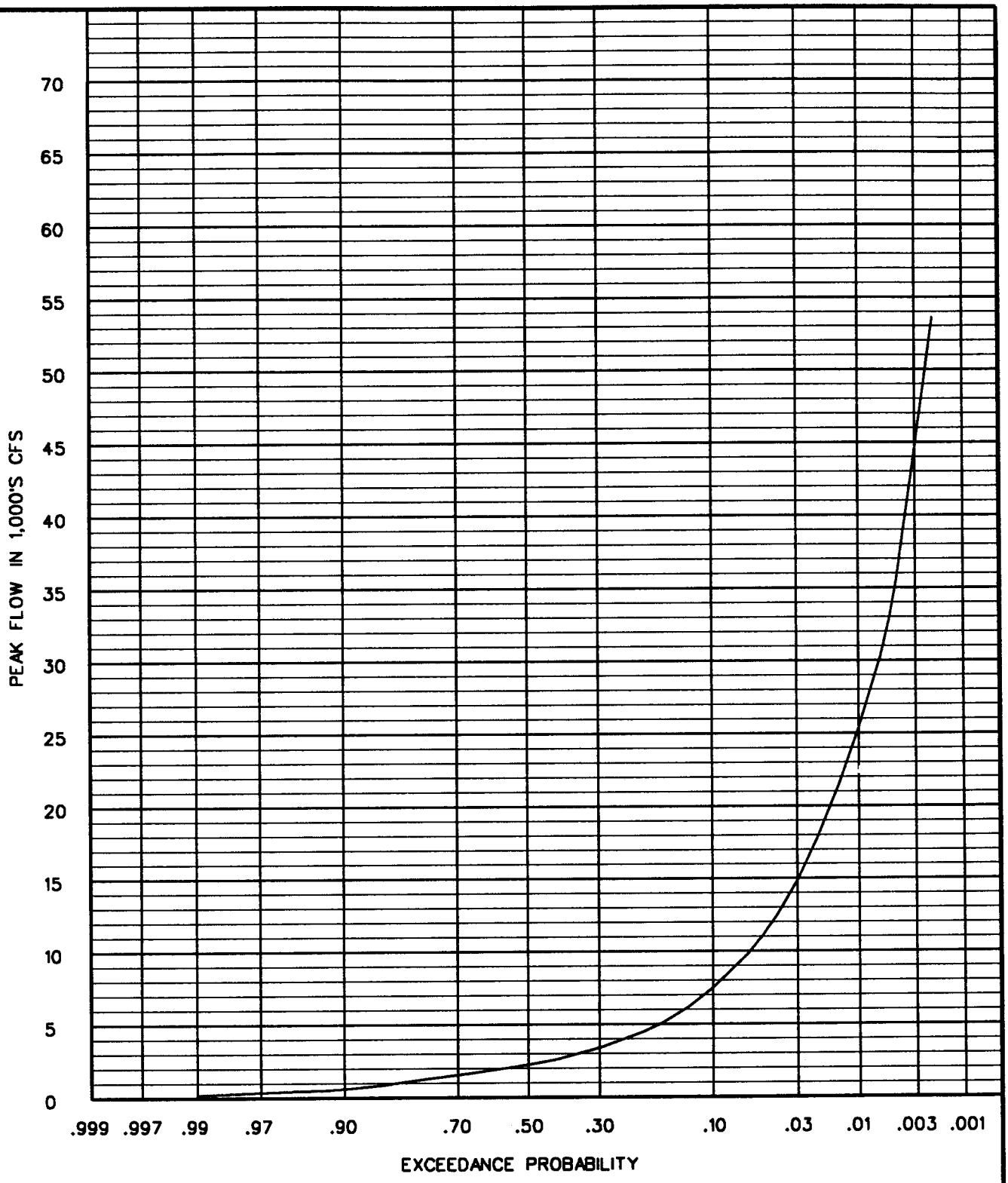
— — — REGULATED BY FOSS RESERVOIR

RED RIVER WATERSHED WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

OPERATIONAL HYDROGRAPH
CLINTON GAGE
FLOOD OF APRIL 1934

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



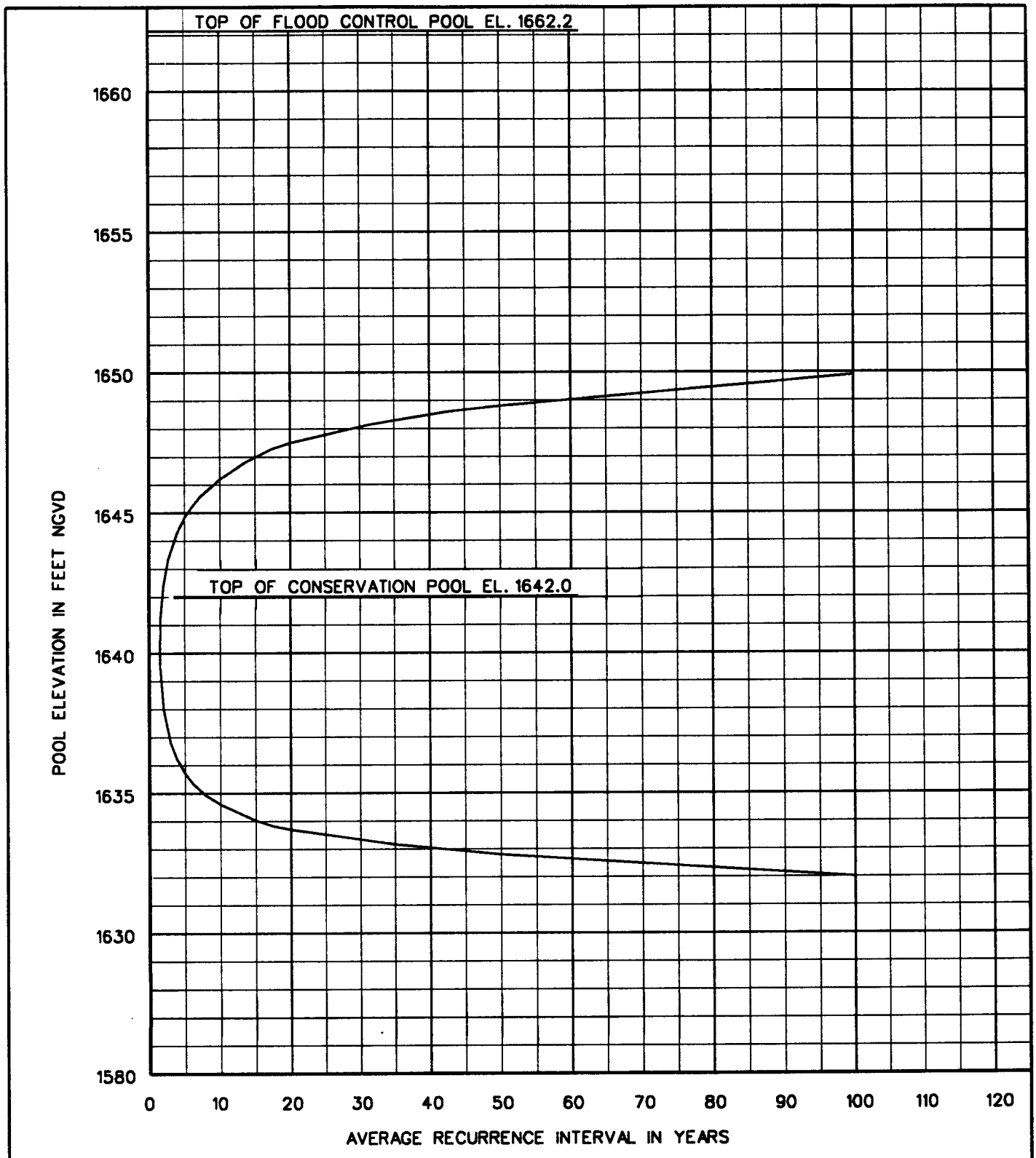
NOTE:
BASED ON HISTORICAL DATA FOR THE PERIOD 1961-1990 (INCLUDING THE HISTORICAL FLOOD OF 1934)

RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

PEAK INFLOW PROBABILITY CURVE
NATURAL CONDITIONS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



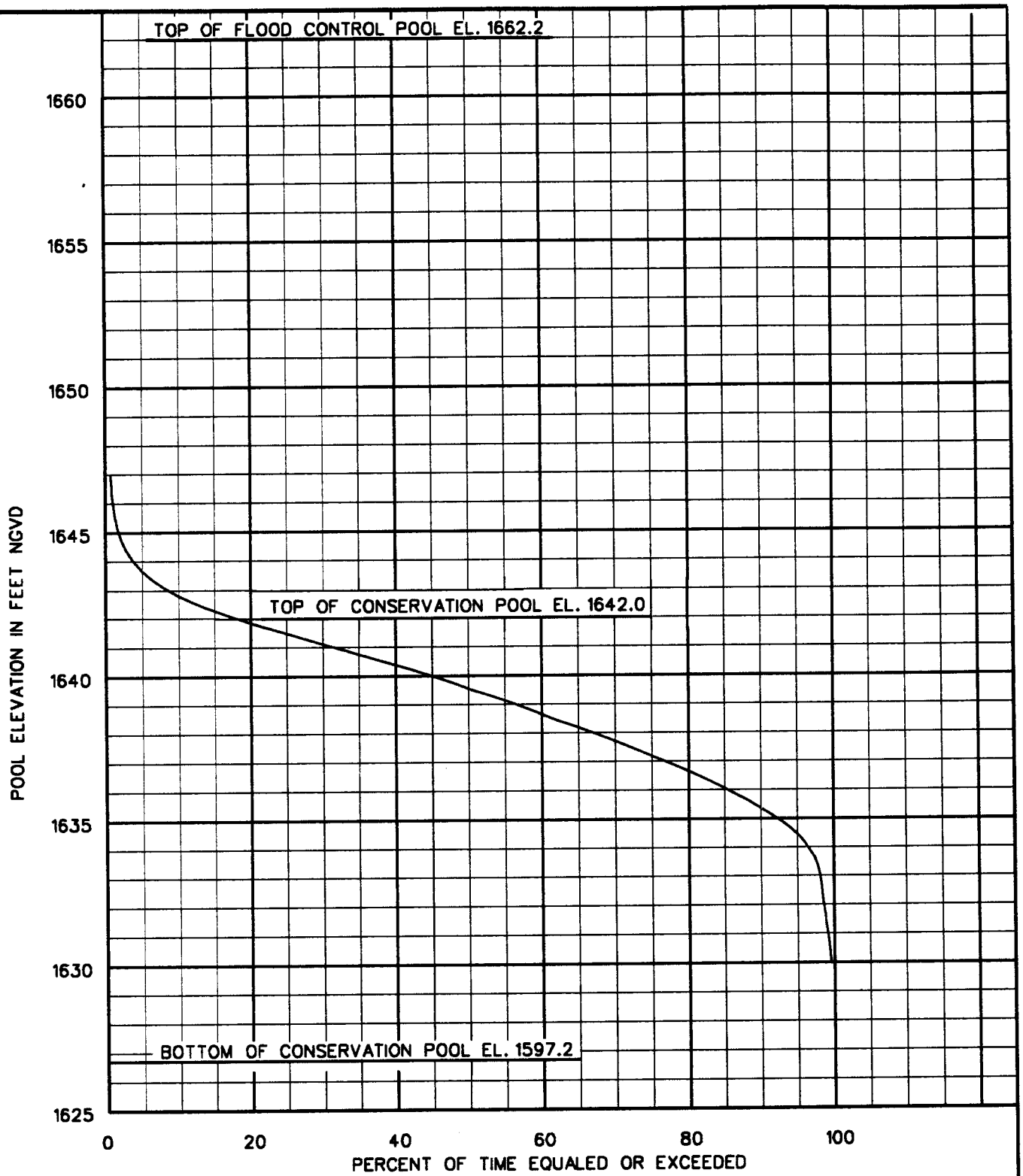
NOTE:
BASED ON ACTUAL OPERATION FOR PERIOD 1977-1990 (FIRST NEAR-FILLING OF CONSERVATION POOL IN 1977)

RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

POOL ELEVATION PROBABILITY CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.



NOTE:
BASED ON ACTUAL OPERATION FOR PERIOD 1977-1990 (FIRST NEAR-FILLING OF CONSERVATION POOL IN 1977)

RED RIVER WATERSHED — WASHITA RIVER, OKLAHOMA

FOSS RESERVOIR

POOL ELEVATION DURATION CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS, 1993
DRAWN: E.H.&A.
CHECKED: W.L.S.