COPAN LAKE
LITTLE CANEY RIVER, OKLAHOMA
WATER CONTROL MANUAL

APPENDIX W
TO
WATER CONTROL MASTER MANUAL
ARKANSAS RIVER BASIN

ORIGINAL EDITION – FEBRUARY 1983
REVISED EDITION – FEBRUARY 2011

DEPARTMENT OF THE ARMY
TULSA DISTRICT, CORPS OF ENGINEERS
OKLAHOMA

NOTICE TO USERS OF THIS MANUAL

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

EMERGENCY REGULATION ASSISTANCE PROCEDURES

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

EMERGENCY

PERSONNEL

ROSTER

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

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LOOKING NORTH AT COPAN DAM AND TAINTER GATES

COPAN LAKE, LITTLE CANEY RIVER, OKLAHOMA
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TABLE OF CONTENTS

Section Title **Page**

Section Title — Page

Section Title **Page**

Section Title — Page

Section Title **Page**

TABLES

EXHIBITS

PLATES

PERTINENT DATA

LOCATION:
Copan Dam and lake are located in Washington County, OK and Chautauqua and Montgomery Counties, KS, RM 7.4 on the Little Caney River, about 9 miles north of Bartlesville, OK.

DRAINAGE AREA:
505 square miles above dam
One inch of runoff = 26,930 acre-feet

DAM:
Type: Rolled Earth fill Embankment
Length: 7,730 feet (including spillway)
Max Height: 73 feet above streambed
Top Width of Embankment: 32 feet

SPILLWAY:
Crest Elevation: 696.5 feet, NGVD
Length: 32 feet gross, 200 feet net
Type: Ogee
Control: Four 50’ wide by 35.5’ high tainter gates

LAND ACQUISITION:

	Guide Contour	Area (acres)
Fee Simple	736.0	15,685
Easement	(1)	1,550

(1) Flowage easements were required in some reaches affected by backwater

WATER SUPPLY: 12-inch diameter pipe

LOW FLOW: 36-inch diameter pipe with butterfly valve (invert at 675.5 feet, NGVD)

OUTLET WORKS: None

POWER FEATURES: None

Feature	Elevation Feet NGVD	Lake area (acres)	Lake Capacity			Spillway Capacity (c.f.s.) 4 gates
			Accumulative (acre-feet)	Runoff (inches)	Incremental (acre-feet)	
Top of Dam	745.0					
Maximum Pool	739.1	17,593	325,200	12.08	106,100	199,070
Top of Flood Control Pool	732.0	13,116	219,100	8.14	184,100	150,000
Top of Conservation Pool	710.0	4,449	35,000	1.30	30,300	32,200
Spillway Crest	696.5	975	4,700	0.17	3,900	0
Top of Inactive Pool	687.5	130	750	0.03		
Streambed	672.0					

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I - INTRODUCTION

1-01. Authorization. This manual is submitted in accordance with ER 1110-2-240 and prepared in accordance with EM 1110-2-3600 and ER 1110-2-8156. The name Copan Reservoir was changed to Copan Lake by ER 1120-2-111, dated 11 February 1971.

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

1-03. Related Manuals. This manual is Appendix W to the Arkansas River Basin Water Control Master Manual. Other related manuals in this District are:

Appendix B - Heyburn
Appendix D - Hulah
Appendix E - Fort Gibson
Appendix F - Birch
Appendix G - Tenkiller
Appendix J - Wister
Appendix L - Oologah
Appendix M - Keystone
Appendix N - Eufaula
Appendix S - Navigation System
Appendix Y - Skiatook

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

TABLE 1-1

PERTINENT REPORTS AND DESIGN MEMORANDA
FOR COPAN DAM AND LAKE

Memorandum No.	Title	Date Submitted
1	Hydrology - Part I	2-Jun-64
1	Hydrology - Part II	10-Sep-65
2	General Design	16-Jun-66
3A	Preliminary Master Plan	6-Jul-66
3B	Master Plan (Revised)	17-Feb-76
4-1	Real Estate - Dam site, Work Area, and Access Roads	9-Sep-66
4-7	Real Estate - Remainder of Lake and Public Use Areas	14-Aug-72
6	Embankment	31-Jan-67
7	Spillway	10-Apr-67
8	Construction Materials (Concrete Aggregates)	3-Aug-66
9	Protection of Caney, Kansas	21-Oct-66
10	Project Buildings	8-Jul-66
11	Reservoir Clearing	22-Aug-74
12	Relocation - Oklahoma Highway 10	3-Feb-69
13	Relocation - CRA, Inc., Facilities	26-Oct-66
14	Relocation - Atchison, Topeka and Santa Fe Railway	28-Aug-73
15	Relocation - US Highway 75	22-Nov-71
16	Relocation - Washington County Roads	27-Feb-76
17	Relocation - Missouri Pacific Railroad	28-Aug-75
18	Relocation - Copan Municipal Facilities	15-Jun-76
19	Relocation - Bigheart Pipe Line Corp. Facilities	15-Oct-73
20	Relocation - Public Service Co Facilities	23-Jul-73
21	Relocation - Williams Bros. Pipe Line Co. Facilities	10-Jul-73
22	Relocation - ARCO Pipe Line Co. Facilities	12-Mar-73
24	Relocation - Facilities Operated by Cities Service Gas Co.	6-Oct-10

TABLE 1-1 (continued)

Memorandum No.	Title	Date Submitted
25	Relocation - Facilities Operated by Union Gas System, Inc.	20-Oct-10
26	Relocation - Verdigris Valley Rural Electric Coop., Inc., Facilities	5-Jul-74
27	Relocation - Kansas Gas and Electric Co. Facilities	19-Nov-75
28	Relocation - Southwestern Bell Telephone Co. Facilities	6-Oct-76
29	Relocation - Caney Municipal Facilities	18-Dec-75
32	Relocation - Montgomery and Chautauqua County Roads	11-Jan-77
34	Sedimentation and Degradation Ranges	10-Jan-74
35	Instrumentation and Inspection	10-Jan-74
36	Relocation - Caney Valley Electric Cooperative Assoc. , Inc., Facilities	16-Jun-77
37	Plugging Oil and Gas Wells	25-Sep-78
38	Alteration of Jackson - Falleaf Cemetery	14-Aug-78
39	Relocation - Busby Cemetery	29-Aug-78
40	Initial Filling Plan	17-Jun-82

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

1-05. Operating Agency. The U.S. Army Corps of Engineers is the operating agency for Copan Lake. The Lake Manager, Copan Lake, through the Operations Lake Manager, Northern Area Office, and the Operations Division, Tulsa District, has the responsibility for project operations. The project will be manned 24 hours a day when the lake level is above elevation 729.0 feet, National Geodetic Vertical Datum (NGVD). Below elevation 729.0 feet, the project will be manned during normal work hours each day through the recreational season. When the recreational season is over, the project will be manned for the normal 5-day work week. However, when the project is in a flood control regulation, operation personnel will closely monitor the project and the downstream river reaches. The project is furnished a list of the Water Management Section personnel to contact when necessary. The Lake Manager will furnish the Water Management Section a list of project personnel, giving their office and home telephones and addresses. The Lake Manager resides as close to the project as is considered prudent to carry out his official duties.

1-06. Regulating Agencies. The regulating agency for Copan Lake is the Corps of Engineers, with the lake's regulation being the responsibility of the Water Management Section, Hydrology-Hydraulics Branch, Tulsa District. Presently, there are no other agencies involved in the functional responsibilities of Copan Lake.

II - DESCRIPTION OF PROJECT

2-01. Location. Copan Dam is located at river mile 7.4 on the Little Caney River about 2 miles southwest of the town of Copan in Washington County, Oklahoma. The project location is shown on Plate 2-1.

2-02. Purpose. Copan Lake is a multiple-purpose project for flood control, water supply, water quality, fish and wildlife, and recreation. The project was designed and will be regulated to provide for maximum flood protection on Little Caney, Caney and Verdigris Rivers when operated in conjunction with Hulah Lake and Oologah Lake.

2-03. Physical Components.

a. Embankment. The embankment is rolled earth fill construction. It is 7,730 feet long (including spillway) and has a maximum height of 73 feet above the streambed. The top of dam is at elevation 745.0 feet. A 32-foot crest width was required to accommodate the relocation of Oklahoma Highway 10 across the dam, based on class "C" standards. The embankment contains an impervious core with a top width of 10 feet at elevation 740.0 feet and a maximum base width of 90 feet. Compacted random fill was placed on each side of the impervious core. The upstream slope of the embankment is protected by 12-inch rock spall from elevation 707.0 feet to elevation 713.0 feet and 24-inch riprap from elevation 727.0 feet to the top of the dam. The downstream slope of the embankment is protected by grass sod. Wraparounds were provided where the embankment connects to the non-overflow sections of the spillway and consist of an impervious interior zone and an outer rock-fill zone. Spur dikes extend upstream from each wraparound to redirect lateral flows approaching the spillway. The effects of these dikes reduce the abutment contraction and thereby improve the spillway discharge capability. The general plan is shown on Plate 2-2. The typical embankment sections are shown on Plate 2-3.

b. Spillway. The spillway is on the right abutment of the dam and contains four 50-foot by 35.5-foot tainter gates. A bridge, with a 28-foot roadway, 4-foot walks and supported by 8-foot-wide piers, spans the spillway. The weir crest is at elevation 696.5 feet. The left and right non-overflow Sections of the spillway are 149 and 114 feet long, respectively. The overall length of the spillway is 495 feet. The plans and elevations of the spillway are shown on Plates 2-4 and 2-5 with the spillway sections shown on Plate 2-6.

c. Water Supply. Facilities for providing the water quality and water supply requirements include a 36-inch diameter water quality pipe with a butterfly valve and a 12-inch diameter water supply pipe with space for future installation of valves. A multi-level intake is not provided.

d. Sedimentation and Degradation Ranges. The measurement of sedimentation deposition in the lake will be accomplished by periodic sediment surveys. Twenty-four sediment ranges were established in and above the lake area, their ends marked with

permanent monuments. Sediment surveys will be made by District personnel periodically for the purpose of computing sediment deposition and new lake area and lake capacity data. The locations of the sedimentation and degradation ranges are shown on Plate 2-7. Six degradation ranges were established below Copan Dam to provide information on the downstream channel condition. Four ranges are located on the Little Caney River and two on the Caney River, the last being in the northern part of Bartlesville, Oklahoma.

2-04. Related Control Facilities. The city of Caney, Kansas, located at the upper end of the lake, is protected from high water on the Little Caney River by a 17,100-foot-long levee. The elevation of the top of levee varies from 742.5 feet for the south section to 743.5 feet for the north portion. Roads crossing the levee were raised to the elevation of the top of the levee. Railroad crossings were raised to about elevation 742 feet in the north portion of the levee and elevation 741 feet in the south portion. The general plan of the Caney levee is shown on Plate 2-8.

2-05. Real Estate Acquisition. The acquisition guideline, elevation 736.0 feet, was approved by 6th endorsement, ENGCW-EZ, 19 July 1968, to letter, SWTSD, 16 June 1966, subject: Copan Dam and Reservoir, Little Caney River, Oklahoma and Kansas, Design Memorandum No. 2, General Design. The acquisition guideline is 4 feet above the flood control pool and 2.8 feet above the 50-year flood pool. Fee land is acquired to elevation 726.0 feet for the ponding area behind the Caney levee as set out in Design Memorandum No. 9, Protection for Caney, Kansas. The guideline in the upper reaches of the lake is elevation 736.0 feet or the envelope curve of backwater effects of the 50-year flood after 100 years of sedimentation, whichever is greater. The envelope curve of backwater effects of the 50-year flood with 100 years of sedimentation is shown on Plate 2-9.

2-06. Public Facilities. Five public use areas have been developed. They are: (1) Post Oak Park, (2) Osage Plains, (3) Copan Point, (4) Washington Cove, and (5) Anglers Point, as shown on Plate 2-10. Facilities provided at these areas consist of roads parking areas, boat ramps, camping and picnicking facilities, walkways, sanitation facilities, and potable water.

III - HISTORY OF PROJECT

3-01. Authorization. Copan Lake was authorized for construction by the Flood Control Act approved 23 October 1962 (Public Law 87-874, 87th Congress, House Resolution 13273), in accordance with the plan outlined in House Document No. 563 (87th Congress, 2d session).

3-02. Planning and Design. Senate Document No. 13, 85th Congress, 1st Session, published in 1957, considered the water use and control problems in the Arkansas-White-Red River Basins and presented a long-range plan of improvement for the three-basin area. This report included a multi-purpose plan for improvement of the lower Verdigris River Basin, designated as the Caney-Bird-Verdigris Project. House Document No. 563, 87th Congress, 2d Session, published in 1962, presented studies made on the Verdigris River Basin in Oklahoma and Kansas. It recommended construction of Copan, Sand, Skiatook, Birch, and Candy Lakes. This recommended plan of improvement was authorized by the Flood Control Act of 1962. A series of design memoranda have been prepared covering hydrology, recreation and wildlife, structural features of the plan, sedimentation and degradation ranges, reservoir clearing, relocation of roads and utilities, and real estate.

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

TABLE 3-1

RESUME OF CONSTRUCTION ACTIVITIES

Activity	Date
Construction began	November 1972
Date of diversion	July 18, 1980
Final storage scheduled	April 1983
Conservation pool filling	March 1984

3-04. Related Projects. Copan Lake is an integral unit of the multiple-purpose plan for flood control, generation of hydroelectric power, navigation, and other beneficial water uses on the Arkansas River and its tributaries in Kansas, Arkansas, and Oklahoma. In particular, Copan is operated in conjunction with Hulah Lake to control flooding on the Caney River and in conjunction with Birch and Skiatook Lakes on tributaries of Bird Creek and with Oologah Lake on the Verdigris to regulate floods and navigation flows on the Verdigris River.

3-05. Modification to Regulations - Temperature Regulation. Multiple-level intakes into a wet well were not provided for temperature regulation.

3-06. Principle Regulation Problems. No problems have been encountered to date in the regulation of Copan Lake.

IV - WATERSHED CHARACTERISTICS

4-01. General Characteristics. The Little Caney River watershed is roughly elliptical in shape, with a maximum length of about 40 miles and a maximum width of about 16 miles. The drainage area above the Copan dam site is 505 square miles, all of which is considered to contribute to runoff. The total drainage area of the Little Caney River is 516 square miles. The Copan Lake watershed consists of Middle Caney Creek, North Caney Creek, Bee Creek, and the Little Caney River in Kansas. Cotton Creek, located in Oklahoma, also drains to Copan Lake. The Little Caney River has its confluence with the Caney River at river mile 77.1, about 3.1 miles downstream of Copan dam.

The basin ranges in elevation from about 670 feet to 1,250 feet, NGVD. The vegetation consists of pasture, cultivated crops and considerable woodlands. The stream pattern consists of one principal stream with several major left bank tributaries. Slopes may vary from 2 feet per mile to about 150 feet per mile on some of the tributaries. One possible upstream damage center is at Caney, Kansas, which is protected by a levee with a minimum crest elevation of 742.5 feet. Bartlesville, Oklahoma, is located on the Little Caney River downstream of the Copan Dam near river mile 68.7. The Caney and Little Caney River streambed profiles are shown on Plate 4-1.

4-02. Topography. The watershed terrain is rolling to hilly and characterized by sandstone-capped cuestas with gentle slopes, matured streams, and valleys with broad alluvial plains. The drainage pattern of the area is dendritic with Little Caney River as the main stem. Land use consists of ranching, crop production, limited timber production and extraction of oil and gas.

4-03. Geology and Soils. Copan Lake is in the Osage Plains subdivision of the Interior Lowlands physiographic province. Sandstones and shales of the Pennsylvanian age are the predominate rocks. The overburden depth at the dam site ranges for 30 feet near the left abutment to 50 feet near the right abutment. The abutments have only a relatively thin soil mantle. Rocks explored at the site belong to the Wann and Torpedo formations, in ascending order. The Wann formation occurs as the top of rock near the base of both abutments and in the floodplain. The hard sandstones and sandy shales of the Torpedo formation are the abutment bedrocks. Alluvial soil in the flood plain ranges in thickness from 10 to 35 feet while residual soil in the uplands exists as a thin mantle.

4-04. Sediment. The drainage basin above Copan Lake contributes relatively little sediment because of good ground cover and a clay type soil. The sediment inflow is further reduced by the 38 Natural Resource Conservation Service dams upstream. Design studies estimated that sediment deposition would be 124 acre-feet annually, with 79 percent of the 100-year accumulation being deposited below the top of conservation pool. The 2003 sediment survey report indicates that approximately 8,900 acre-feet of sediment has accumulated in the conservation pool.

4-05. Climate. The watershed above the Copan dam site lies in a region characterized by moderate winters and comparatively long summers with relatively high temperatures. The summer rains usually occur as thundershowers with intense rainfall, short duration and limited aerial coverage. The winter rains are generally of low intensity but cover large areas. Climatic characteristics for the basin are shown in the following tabulation.

a. Temperature. (Period of Record is 1905 through 2009)

Mean annual	58 degrees F
Maximum recorded (Copan, Oklahoma, 15 July 1954)	115 degrees F
Minimum recorded (Copan, Oklahoma, 30 January 1949)	-15 degrees F

b. Precipitation. (Period of Record is 1930 through 2009)

Mean Annual (Oct 1930 – Sept 2009)	35 inches
Maximum annual (1961)	55 inches
Minimum annual (1956)	22 inches
Percent during growing season (April through September)	67 %

c. Snowfall. (Period of Record is 1930 through 2009)

Maximum Storm (March 16-17,1970 at Nowata, OK)	21 inches
Minimum (Several years)	Zero
Mean Annual	12 inches

The average monthly and annual rainfall and runoff data are shown in Table 4-1. The locations of the precipitation and stream gaging stations used in the forecasting process are shown on Plate 5-1.

TABLE 4-1

AVERAGE MONTHLY AND ANNUAL RAINFALL
AND RUNOFF UPSTREAM OF COPAN DAM

	Average Rainfall (inches)	% of Total	Average Runoff (acre-feet)	Average Runoff (inches)	% of Total
January	1.23	3	9,750	0.36	4
February	1.28	3	13,440	0.50	5
March	2.56	7	29,990	1.11	12
April	3.43	10	34,150	1.27	14
May	5.00	14	46,390	1.72	19
June	4.84	14	39,970	1.48	16
July	3.23	9	16,830	0.62	7
August	3.07	9	4,080	0.15	2
September	3.90	11	9,830	0.36	4
October	3.15	9	17,130	0.64	7
November	2.30	7	15,130	0.56	6
December	1.36	4	10,440	0.39	4
Total	35.35	100	247,130	9.16	100

(1) Drainage area above Copan Dam = 505 square miles.
(2) Period of Record - October 1935 through December 2009.

d. Evaporation. Following the construction of the Copan project, evaporation data was collected from an evaporation pan on site. In 1996, the Tulsa District migrated from using an evaporation pan to using an empirical formula, which is based on meteorology data collected on site. The formula incorporates electronically collected data for solar radiation, wind speed, air temperature and relative humidity. The estimated monthly evaporation at Copan Lake is shown in Table 4-2 for the period 1981 through 2009.

TABLE 4-2

ESTIMATED MONTHLY EVAPORATION
COPAN LAKE

Month	Evaporation (inches) [1]
January	1.8
February	2.4
March	4.2
April	6.2
May	6.5
June	7.8
July	9.4
August	8.7
September	6.1
October	4.4
November	2.8
December	1.9
Annual Total	62.2

[1] National Weather Service Class "A" pan.
Period of Record is January 1981 through December 2009

e. Wind. The prevailing wind is from a southerly direction, with the greatest wind movements occurring in the spring months. A study of available wind velocity data indicates that for 1-minute and 1-hour durations, the highest wind velocities that can reasonably be expected are 78 and 56 miles per hour.

4-06. Storms and Floods. Most of the flood-producing storms over the watershed and above the Copan dam site have been from 2 to 4 days in duration. The maximum storm during the 74-year period of record was 12.71 inches of rain occurring from Sep 21 – Sep 30, 1945. Storms with an average precipitation of 3 inches or more over the drainage area above the dam site are shown in Table 4-3. About 78 percent of these storms occurred during the months April through September. The averages were computed from available published records which do not necessarily show the actual center of intense storms over small areas. 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. Conversely, longer storms of greater amounts of recorded rainfall may cause only minor flooding. Major floods at the Copan, Bartlesville, Ramona and Claremore gages are shown in Table 4-4, located on page 4-7.

TABLE 4-3

COPAN DAM SITE MAJOR STORMS
OCTOBER 1935 THROUGH DECEMBER 2009
LITTLE CANEY RIVER BASIN

Storm Dates	Average Basin Rainfall (inches)	Storm Dates	Average Basin Rainfall (inches)
Oct 17 - 21, 1935	3.22	July 27 - Aug 2, 1950	3.50
Sep 16 - 19, 1936	4.73	Jun 29 - 30, 1951	6.56
Oct 6 - 9, 1936	6.00	Jul 12 - 14, 1951	3.28
Jul 9 - 19, 1937	7.17	Sep 3 - 13, 1951	5.42
Sep 5 -10, 1937	3.84	Apr 29 - May 2, 1954	4.98
Mar 27 - 31, 1938	3.09	Oct 10 - 12, 1954	3.46
May 18 - 23, 1938	3.30	May 7 - 12, 1955	3.63
Aug 15 - 16, 1938	3.49	May 24 - 28, 1955	3.10
Sep 12 - 14, 1938	3.16	Sep 25 - Oct 5, 1955	7.99
Jun 9 - 11, 1940	3.15	May 8 - 19, 1957	4.92
Aug 13 - 17, 1940	4.55	May 22 - 25, 1957	3.56
Nov 19 - 26, 1940	4.25	Jun 12 - 13, 1958	4.79
Apr 13 - 19, 1941	4.40	Jul 3 - 7, 1958	3.36
Jun 6 - 10, 1941	5.20	Jul 12 - 17, 1959	6.92
Sep 8 - 9, 1941	3.57	Sep 30 - Oct 5, 1959	6.68
Sep 28 - Oct 4, 1941	4.62	May 3 - 6, 1961	3.72
Oct 29 - 31, 1941	3.06	May 7 - 8, 1961	3.75
Apr 6 - 10, 1942	3.12	Sep 12 - 13, 1961	5.35
Apr 19 - 21, 1942	3.11	Oct 29 - Nov 3, 1961	3.96
Jun 15 - 22, 1942	4.06	Aug 25 - 29, 1964	4.12
Sep 3 - 9, 1942	4.24	Nov 15 - 19, 1964	4.42
May 6 - 10, 1943	7.80	Apr 2 - 3, 1965	4.86
May 16 - 20, 1943	7.20	Jun 5 - 7, 1966	4.20
Sep 28 - Oct 1, 1943	3.93	Jun 10 - 11, 1967	4.20
Apr 8 - 10, 1944	7.10	May 30 - Jun 1, 1969	3.90
Aug 21 - 26, 1944	3.14	Sep 14 - 16, 1969	3.98
Sep 27 - 28, 1944	5.51	Oct 11 - 13, 1969	4.30
Oct 1 - 4, 1944	3.85	Jul 1 - 6, 1971	4.74
Apr 14 - 17, 1945	3.10	Oct 18 - 20, 1971	3.07
Sep 21 - 30, 1945	12.71	Jul 18 - 19, 1972	3.61
Oct 31 - Nov 6, 1946	3.72	Mar 9 - 11, 1974	6.45
Apr 8 - 16, 1947	4.86	May 22 - 26, 1974	3.22
May 15 - 21, 1947	3.98	Jun 4 - 9, 1974	3.61
Jun 20 - 28, 1948	5.70	Nov 2 - 6, 1974	4.20
Jul 14 - 18, 1948	3.87	Aug 14 - 16, 1975	3.52
Aug 7 - 16, 1948	6.10	Jul 2 - 3, 1976	6.23
May 15 - 21, 1949	3.20	May 20 - 21, 1977	3.02
May 25 - Jun 3, 1950	5.31	Jun 22 - 27, 1977	7.85
Jul 5 - 10, 1950	3.28	May 18 - 22, 1978	4.09
Jul 16 - 21, 1950	6.68	Jun 18 - 22, 1978	5.50

TABLE 4-3 (continued)

COPAN DAM SITE MAJOR STORMS
OCTOBER 1935 THROUGH DECEMBER 2009
LITTLE CANEY RIVER BASIN

Storm Dates	Average Basin Rainfall (inches)	Storm Dates	Average Basin Rainfall (inches)
Oct 17 - 22, 1983	6.50	Apr 22 - 23, 1996	3.13
Oct 13, 1984	3.87	Feb 20 - 22, 1997	4.24
Dec 13 - 16, 1984	3.08	Sep 23 - 25, 1997	3.35
Feb 21 - 24, 1985	5.82	Mar 16 - 20, 1998	3.96
Nov 13 - 15, 1985	4.39	Apr 26 - 28, 1998	3.44
Jul 13 - 14, 1986	3.82	May 25 - 27, 1998	3.05
Aug 8 - 9, 1986	5.30	Sep 13 - 14, 1998	3.82
Sep 16 - 17, 1986	3.43	Oct 5, 1998	4.09
Sep 12 - 14, 1938	3.16	Apr 25 - 27, 1999	3.58
Sep 29 – Oct 1, 1986	8.40	May 4 - 6, 1999	3.14
May 24 - 25, 1987	3.10	Jun 19 - 25, 1999	4.61
Apr 1 - 2, 1988	3.85	May 9, 2000	3.75
Sep 18 - 19, 1988	3.55	Mar 18 - 20, 2003	3.61
Jun 11 - 14, 1989	8.64	May 16 - 17, 2003	3.65
Oct 28 - 30, 1989	3.20	Aug 28 - Sep 2, 2003	6.46
Mar 10 - 12, 1990	3.75	Mar 3 - 5, 2004	4.13
Nov 12, 1992	3.00	Apr 29 - May 1, 2006	3.20
Dec 13 - 15, 1992	3.17	Mar 20 - 21, 2007	3.53
May 8 - 12, 1993	4.08	May 6 - 9,2007	3.52
Sep 25, 1993	3.28	Jun 10 - 12, 2007	7.87
Apr 10 - 12, 1994	7.98	Jun 23 - Jul 2, 2007	9.81
Nov 4 - 6, 1994	3.84	Jun 9 - 10, 2008	3.73
Nov 20, 1994	3.08	Jun 13 - 18, 2008	4.03
Jun 3 - 6, 1995	3.42	Sep 11 - 14, 2008	3.54
Jun 9 - 10, 1995	5.10	Apr 30 - May 3, 2009	3.13
Jul 3 - 4, 1995	3.80	Aug 17 - 20, 2009	4.14
Aug 1 - 4, 1995	3.90	Oct 6 - 9, 2009	3.58
		Jul 4 - 9,2010	6.18

TABLE 4-4

TOP TWENTY ANNUAL PEAK FLOWS AT STREAM GAGES

Copan Gage			Bartlesville Gage (2)			Ramona Gage			Claremore Gage (3)		
DATE	DISCHARGE (c.f.s.)	STAGE (ft.)	DATE	DISCHARGE (c.f.s.)	STAGE (ft.)	DATE	DISCHARGE (c.f.s.)	STAGE (ft.)	DATE	DISCHARGE (c.f.s.)	STAGE (ft.)
4-11-1944	43100	29.30	10-4-1986	94500	27.70	5-21-1943	(1)	39.80	5-21-1943	182000	55.05
1951	43000	(1)	10-3-1926	(1)	25.30	1935	29000	33.50	5-11-1961	116000	50.06
3-10-1974	33200	25.30	5-19-1943	(1)	23.40	10-13-1936	18000	32.05	4-13-1944	85200	47.23
5-9-1961	23700	24.94	7-2-2007	39400	21.57	4-2-1938	18000	32.05	4-21-1945	81400	47.14
1950	19100	(1)	3-11-1974	(1)	20.90	10-5-1986	85600	31.16	10-4-1945	73000	46.98
1957	18500	(1)	9-30-1986	21100	18.25	10-3-1945	38500	30.12	6-6-1951	74900	46.95
1945	17600	(1)	4-11-1994	10000	16.75	3-11-1974	38400	30.12	11-2-1941	64200	46.60
1946	15300	(1)	5-9-1993	15100	16.54	7-24-1959	22300	29.76	6-27-1948	61000	46.41
1948	14400	(1)	6-9-2008	9500	16.38	6-12-1957	36700	29.69	June 1935	64200	46.20
4-4-1965	13500	24.04	3-5-2004	16000	16.19	5-10-1961	23400	29.52	10-5-1959	60500	45.76
6-25-1977	13000	23.88	5-9-2000	15700	15.97	6-27-1969	15900	29.51	10-12-1986	78400	44.99
1954	12800	(1)	7-3-1995	12600	15.25	10-6-1959	16200	29.46	4-20-1947	53000	44.51
10-15-1959	12200	23.93	3-11-1990	6570	14.99	4-17-1973	16200	29.45	4-22-1941	48200	44.46
11-4-1974	12100	23.80	4-1-1988	8490	14.56	7-23-1950	21800	29.42	6-25-1959	47200	43.53
1958	11700	(1)	6-19-1999	9420	13.55	6-26-1948	19900	29.30	5-29-1938	39900	42.10
11-3-1961	11100	23.72	6-11-1989	8700	12.16	4-19-1945	21600	29.28	10-11-1936	38700	41.20
1947	9890	(1)	2-21-1997	11200	11.70	5-2-1970	14900	29.16	7-23-1950	37200	40.13
7-4-1976	8760	23.35	3-17-1998	9110	9.66	9-29-1986	43000	29.14	2-17-1949	31000	39.03
11-21-1979	8700	25.26	6-13-2005	8340	9.17	6-5-2007	32700	29.07	5-4-1954	32900	38.12
1949	8390	(1)	5-13-2006	6570	7.85	7-5-1951	15700	29.02	7-6-2008	59000	37.80
Flood Stage = 21.0 feet Period of Record is May 1981 – Aug 2010			Flood Stage = 13.0 feet Period of Record is July 1958 – Aug 2010			Flood Stage = 26.0 feet Period of Record is Sep 1945 – Aug 2010			Flood Stage = 35.0 feet Period of Record is Oct 1935 – Aug 2010		

(1) Value is unknown. Discontinuation of service between 19 Nov 1949 and 17 July 1958.
(2) Bartlesville flows are modified by Hulah Lake since 1951 and Copan Lake since 1983.
(3) Claremore flows are modified by Oologah Lake since 1963, Fall River Lake since 1949, Toronto Lake since 1960, Elk City Lake since 1966 and Big Hill Lake since 1983.

4-07. Runoff Characteristics. During design studies, it was determined that the time to peak discharge at the Copan gage was about 28 hours from the time of the most intense rainfall. The time to peak inflow into Copan Lake should be less than this value; however, these times are highly dependent on the storm pattern. Storm studies indicate that 1/4 to 2 inches of rainfall generally was needed to satisfy initial losses before significant runoff begins, depending on antecedent rainfall. Pertinent data for stream gaging stations used for regulation of Copan Lake are given in Table 4-5. Estimated monthly and annual flows past the Copan Dam are shown in Table 4-6, located in the Supplemental Tables Section. The inflow volume frequency by months is shown in Table 4-7. The flow duration curve is shown on Plate 4-2.

4-08. Water Quality. Copan Lake provides good quality water for municipal supplies and downstream releases. Naturally occurring conditions may lead to water quality deterioration near the bottom of the lake for short periods in mid-summer; however, surface water remains of good quality. Water quality control is a project purpose, and downstream conditions may require the release of water for this purpose. Natural constituents of the soil in the area can cause high values of calcium carbonate, chloride, iron, and manganese in the surface waters. Nutrients such as phosphates and nitrogen are sufficient to support algal blooms. The hardness of the impounded water will probably be in the moderate to hard range. Historical data reveals that some water quality criteria has been exceeded. With the exception of iron and manganese, all parameter means were well below established criteria. In well oxygenated lakes, iron and manganese form precipitates which fall into bottom deposits. During short periods in mid-summer, Copan Lake will weakly stratify. The lake may become anoxic near the bottom. High concentrations of iron, manganese, ammonia, and hydrogen sulfide may be expected in the anoxic zone. This may become a problem since the water quality and water supply intake is near the bottom of the lake. To avoid anoxic releases, the low-flow releases should be made through the spillway during these periods. Water withdrawn for municipal supplies should be taken from above the anoxic zone, otherwise water quality criteria will be exceeded. Generally, the anoxic water will cause only esthetic problems such as unpleasant taste and odors, and staining in water basins. A system for continuous monitoring of water quality parameters is not in place for Copan Lake. Determination of the quality of water at various levels is done by sampling and analysis on an as needed basis.

4-09. Channel and flooding characteristics. The estimated channel capacity of the Little Caney River below the Copan dam is about 3,000 c.f.s. The stream is winding and lined with a heavy growth of trees and brush which could cause degradation in the channel capacity. Also, because of the proximity of the Caney River, large releases from Hulah Lake could reduce the channel capacity on the Little Caney River as a result of the back water. The limiting non-damaging flow on the Caney River at the critical point downstream from the confluence with the Little Caney River is about 7,000 c.f.s. which is visually monitored as needed. The channel capacities at the Bartlesville and Ramona gages are 12,600 c.f.s. and 14,700 c.f.s. respectively.

TABLE 4-5

PERTINENT DATA FOR STREAM GAGING STATIONS

STATION	STREAM	MILES ABOVE MOUTH	GAGE ZERO (ft.,NGVD)	FLOOD STAGE (ft.) (1)	DRAINAGE AREA (sq. mi.)	MAXIMUM FLOOD OF RECORD		
						DATE	STAGE (ft.)	DISCHARGE (c.f.s.)
Copan, OK	Little Caney R.	8.8	672.23	21.0	502	4-11-1944	29.30	43,100
Bartlesville, OK	Caney River	69.2	653.33	13.0	1392	10-4-1986	27.70	94,500
Ramona, OK	Caney River	32.0	586.43	26.0	1955	5-21-1943	39.80	(2)
Claremore, OK	Verdigris River	76.0	536.62	35.0	6534	5-21-1943	55.05	182,000

STATION	STREAM	2ND LARGEST FLOOD OF RECORD			3RD LARGEST FLOOD OF RECORD			PERIOD OF RECORD
		DATE	STAGE (ft.)	DISCHARGE (c.f.s.)	DATE	STAGE (ft.)	DISCHARGE (c.f.s.)	(FLOW AND/OR STAGE)
Copan, OK	Little Caney R.	1951	(2)	43,000	3-10-1974	25.30	33,200	10-1-58 – 9-29-81 (Discontinued)
Bartlesville, OK	Caney River	10-3-1926	25.30	(2)	5-19-1943	23.40	(2)	(3)
Ramona, OK	Caney River	1935	33.50	29,000	10-13-1936	32.05	18,000	8-29-1944 -- Present
Claremore, OK	Verdigris River	5-11-1961	50.06	116,000	4-13-1944	47.23	85,200	10-1-1935 -- Present

(1) Regulating Flood Stages
(2) Not Determined
(3) Intermittent stages by Bartlesville Water Co. from Aug 1, 1926 through Oct. 20, 1937. Then from Oct. 20, 1937 through Nov. 19, 1949 by Corps of Engineers. Discontinued from Nov. 20, 1949 through Jul. 16, 1958. Re-established Jul. 17, 1958. Currently in service.

TABLE 4-7

MONTHLY INFLOW VOLUME FREQUENCY
INFLOW IN ACRE-FEET
(Jan 1936 - Dec 2009)

	Frequency of Occurrence (years)				
Month	2	5	10	25	50
January	2,100	14,700	30,400	62,500	91,400
February	2,460	16,100	42,900	74,800	128,100
March	12,300	55,500	99,500	152,900	208,100
April	17,300	56,700	100,700	155,200	209,600
May	24,200	72,400	122,100	171,000	281,700
June	26,100	82,700	122,500	195,600	294,300
July	2,550	20,000	54,000	105,100	171,700
August	1,000	5,300	11,300	22,900	32,250
September	2,470	16,000	43,400	78,400	134,300
October	2,600	20,600	55,600	107,700	172,900
November	2,500	19,900	53,700	90,100	163,000
December	2,050	14,500	29,300	59,800	89,600

The channel capacity on the Verdigris River below the mouth of the Caney River at the Claremore gage is 40,000 c.f.s. (The Claremore gage is not a regulating point for Copan Lake). Discharge rating curves for the Bartlesville and Ramona gages on the Caney River are shown on Plates 4-3 and 4-4, respectively, and are valid for rough use only. Discharge rating curves used by the Water Management Section are adjusted for changing conditions and are maintained in a current status. Crest travel times for the Verdigris River basin are shown on Plate 4-5. 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.

4-10. Upstream Structures. Located upstream of Copan Lake are thirty eight (38) Natural Resource Conservation Service (NRCS) structures. There are thirty six (36) flood retarding structures and two (2) multipurpose structures. Total flood control storage is about 43,000 acre-feet with an additional storage of about 7,000 acre-feet for sediment. Flood control releases are made through uncontrolled outlet works and spillways. The total area above the NRCS structures is 216 square miles.

4-11. Downstream Structures. Structures in the Verdigris River Basin below Copan Lake include Hulah Lake on the Caney River with a drainage area of 732 square miles; Oologah Lake on the Verdigris River with a drainage area of 4,339 square miles; Birch Lake on Birch Creek with a drainage area of 66 square miles; Skiatook Lake on Hominy Creek with a drainage area of 354 square miles; and the McClellan-Kerr Arkansas River Navigation System on the Verdigris and Arkansas Rivers. All the lakes are regulated by the U.S. Army Corps of Engineers.

4-12. Economic Data.

a. Population. The population of counties traversed by the Caney River below Copan Dam and larger cities in the basin are shown in Table 4-8.

b. Agriculture. Agriculture has long been an important factor in the economy of the Caney River Basin. The climate, topography, and soil are all suitable for diversified farming, with the uplands used principally for grazing livestock and for hay production. Principal crops grown in the region are alfalfa, wheat, soybeans, sorghums, corn, pecans, pasture and wood pasture. Production and annual value of the major crops in the floodplain below Copan Dam are shown in Table 4-9.

c. Industry. Health Care and Social Assistance is the largest industry in the region followed by Retail Trade. The primary manufacturing industries of the area are Pumping Equipment, Machine Manufacturing, and Fabricated Metal Manufacturing. The largest companies in the area are located in Bartlesville and Tulsa, Oklahoma and are involved with the oil and natural gas industries. Tables 4-10A through 4-10D display the major industries in the City of Bartlesville along with Washington, Tulsa, Osage, and Rogers counties including corresponding data on number of establishments, sales, annual payroll, and employees.

d. Flood Damages. The estimated average annual flood damages prevented by Copan Dam on the Caney River are presented in Table 4-11 while the top five flood events, in terms of flood damages prevented, to pass through Copan Dam are presented in Table 4-12. Plates 4-6 through 4-8 show the Structural Loss and Area curves for the Copan dam site to mouth, Little Caney River to Sand Creek, and Sand Creek to mouth of Caney River areas, respectively.

TABLE 4-8

POPULATION OF COUNTIES AND CITIES
BELOW COPAN DAM

County	Major Cities	U.S. Census Population			% Change (1990-2000)
		1990	2000	2008*	
Kansas					
Montgomery		38,816	36,252	34,395	-6.61%
	Caney	2,062	2,092	1,976	1.45%
Chautauqua		4,407	4,359	3,768	-1.09%
	Sedan	1,306	1,342	1,168	2.76%
Oklahoma					
Osage		41,645	44,437	45,489	6.70%
	Pawhuska	3,825	3,629	3,426	-5.12%
	Skiatook	4,910	5,396	6,820	9.90%
Washington		48,066	48,996	50,452	1.93%
	Bartlesville	34,256	34,748	35,914	1.44%
	Ramona	508	564	581	11%
Tulsa		503,341	563,299	591,982	11.91%
	Tulsa	367,302	393,049	385,755	7.01%
	Collinsville	3,612	4,077	5,039	12.87%
Rogers		55,170	70,641	84,300	28.04%
	Claremore	13,280	15,873	17,458	19.53%
1990 Census, 2000 Census, *2007 or 2008 Population Estimates http://factfinder.census.gov/					

TABLE 4-9

ANNUAL VALUE OF CROPS
BELOW COPAN DAM

Caney River								
Crops	**Little Caney River to Sand Creek**		**Sand Creek to the Mouth**		**Copan Dam Site to the Mouth**		**Total**	
	Acres	**Value $**	**Acres**	**Value $**	**Acres**	**Value $**	**Acres**	**Value $**
Corn	430	94,400	3,850	-	170	-	4,450	94,400
Alfalfa	-	-	3,080	783,400	-	2,272,200	3,080	3,055,500
Wheat	430	55,100	2,690	1,300,500	350	3,779,500	3,470	5,135,100
Grain Sorghum	210	44,000	1,930	1,623,600	110	4,733,000	2,250	6,400,500
Soybeans	-	-	1,930	268,500	70	9,700	2,000	278,200
Pecans	530	404,400	1,930	-	170	-	2,630	404,400
Pasture	6,400	625,900	15,400	1,640,300	1,730	4,780,200	23,530	7,046,400
Used Pasture	3,200	312,900	12,820	456,400	1,040	1,337,200	17,060	2,106,600
Total	11,200	1,536,600	43,630	5,804,200	3,640	16,902,100	58,470	24,242,800
Yield Rates from Oklahoma State University Crop Enterprise Budgets 2009 2009 Current Normalized Prices								

TABLE 4-10A

2002 ECONOMIC CENSUS FOR
THE CITY OF BARTLESVILLE, OK

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue ($1,000's)	Annual Payroll ($1,000's)	Number of Employees
31-33	Manufacturing	30	117,100	40,200	1,030
42	Wholesale trade	26	D	D	b
44-45	Retail trade	186	475,200	45,600	2,590
51	Information	16	N	D	c
53	Real estate & rental & leasing	45	D	D	c
54	Professional, scientific, & technical services	87	41,500	17,200	567
56	Administrative & support & waste management & remediation service	50	84,500	72,900	693
61	Educational services	8	D	D	b
62	Health care & social assistance	132	158,600	71,900	2,347
71	Arts, entertainment, & recreation	22	D	D	e
72	Accommodation & food services	95	49,400	15,500	1,601
81	Other services (except public administration)	80	29,100	7,900	491

Source: U.S. Bureau of the Census, 2002 Economic Census, * 2006 County Business Patterns
Key to table:
e = 250 – 499 employees
N = Not available or not comparable
D = Withheld to avoid disclosing data for individual companies; data are included in higher totals
b = 20 – 99 employees
c = 100 – 249 employees

TABLE 4-10B

2002 ECONOMIC CENSUS FOR TULSA COUNTY, OK

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue ($1,000's)	Annual Payroll ($1,000's)	Number of Employees
31-33	Manufacturing	1,103	9,713,800	1,530,600	41,309
42	Wholesale trade	1,341	9,859,700	690,000	16,650
44-45	Retail trade	2,458	7,298,300	709,900	36,958
51	Information	374	N	D	j
53	Real estate & rental & leasing	849	740,900	156,800	5,733
54	Professional, scientific, & technical services	2,294	1,752,400	716,900	16,900
56	Administrative & support & waste management & remediation service	981	1,256,700	550,500	27,828
61	Educational services	123	102,500	38,900	1,561
62	Health care & social assistance	1,766	3,088,400	1,254,100	37,415
71	Arts, entertainment, & recreation	224	186,900	48,500	3,278
72	Accommodation & food services	1,337	962,300	280,900	24,653
81	Other services (except public administration)	1,194	696,900	183,400	7,744

Source: U.S. Bureau of the Census, 2002 Economic Census,
* 2006 County Business Patterns
Key to table:
j = 10,000 to 24,999 employees
N = Not available or not comparable
D = Withheld to avoid disclosing data for individual companies; data are included in higher totals

TABLE 4-10C

2002 ECONOMIC CENSUS FOR OSAGE COUNTY, OK

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue ($1,000's)	Annual Payroll ($1,000's)	Number of Employees
31-33	Manufacturing*	22	-	9,700	272
42	Wholesale trade	17	17,800	2,200	76
44-45	Retail trade	101	101,800	9,800	699
51	Information	5	N	D	b
53	Real estate & rental & leasing	13	2,300	500	25
54	Professional, scientific, & technical services	34	7,700	2,200	133
56	Administrative & support & waste management & remediation service	12	D	D	b
61	Educational services	2	D	D	a
62	Health care & social assistance	45	21,400	10,500	671
71	Arts, entertainment, & recreation	9	D	D	b
72	Accommodation & food services	43	13,900	4,000	548
81	Other services (except public administration)	23	6,000	1,400	95

Source: U.S. Bureau of the Census, 2002 Economic Census,
* 2006 County Business Patterns
Key to table:
N = Not available or not comparable
D = Withheld to avoid disclosing data for individual companies; data are included in higher totals
a = 0 – 19 employees
b = 20 – 99 employees

TABLE 4-10D

2002 ECONOMIC CENSUS FOR ROGERS COUNTY, OK

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue ($1,000's)	Annual Payroll ($1,000's)	Number of Employees
31-33	Manufacturing	136	1,248,500	193,200	4,950
42	Wholesale trade	50	229,100	17,500	482
44-45	Retail trade	198	550,500	48,900	2,413
51	Information	22	N	4,400	135
53	Real estate & rental & leasing	46	21,200	5,600	339
54	Professional, scientific, & technical services	89	25,700	9,300	343
56	Administrative & support & waste management & remediation service	61	24,900	9,000	598
61	Educational services	8	D	D	b
62	Health care & social assistance	146	140,000	57,400	2,102
71	Arts, entertainment, & recreation	12	D	D	e
72	Accommodation & food services	104	47,800	13,500	1,437
81	Other services (except public administration)	85	33,900	9,500	452

Source: U.S. Bureau of the Census, 2002 Economic Census,
* 2006 County Business Patterns
Key to table:
e = 250 – 499 employees
N = Not available or not comparable
D = Withheld to avoid disclosing data for individual companies; data are included in higher totals
b = 20 – 99 employees

TABLE 4-11

AVERAGE ANNUAL FLOOD DAMAGES PREVENTED
BELOW COPAN DAM

Average Annual Flood Damages Prevented by Copan Dam		
Years in Operation	**Cumulative Damages (2008 $ 1,000's)**	**Average Annual Damages (2008 $ 1,000's)**
26	754,000	29,000

TABLE 4-12

TOP FIVE FLOOD EVENTS
BELOW COPAN DAM

Top Five Flood Events		
Year	**Damages ($ 1,000's)**	**Damages (2008 $1,000's)**
2007	47,100	49,100
1989	30,600	55,100
1990	36,900	64,900
1987	72,300	136,400
1993	88,500	141,200

V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01. Hydrometeorological Stations.

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

All stream gaging stations are automated gages consisting of float wells or bubbler gages connected to digital recorders and data collection platforms. There are three gages upstream of Copan Lake: a precipitation gage at Caney Levee, a precipitation gage at Havana, Kansas, and a stream gage located on Middle Caney Creek at Sedan, Kansas. The gages designated for regulation below Copan Dam are: the Caney River near Bartlesville and the Caney River at Ramona, Oklahoma. (The Claremore stream gage is not a regulating point for Copan Lake.)

Automated stream gaging stations are equipped with automated rain gages that provide precipitation data transmitted along with stage data. The NWS also maintains a network of local observer stations throughout the district (see Plate 5-1).

b. Reporting. The reporting procedures for precipitation and stream gaging stations are on a cooperative basis with the NWS and the USGS. The reporting of data from pool elevation and stream gaging stations has been automated by using Data Collection Platforms (DCP's) which record data hourly and transmit the data every hour or when a threshold value is exceeded. The data is transmitted via Geostationary Operational Environmental Satellite (GOES) to a downlink and computer facility owned and operated by the National Oceanic and Atmospheric Administration (NOAA) near Washington, D.C. The data is then transmitted to a domestic satellite (DOMSAT) which in turn passes the data to the Tulsa District's Receive Only Terminal (DROT). The data from the NOAA computer facility may also be transferred via the Internet. When received, the river stage is converted to flow and lake elevation is converted to storage. All the data are then stored in a database on the Tulsa District Water Control Data System (WCDS) for access when needed. Data Collection Platforms also report rainfall data in the same way. Besides DCP data, observer rainfall data is collected and stored in the computer system for use in forecasting. Observers telephone the NWS offices in this region and the NWS then encodes the data into a Standard Hydrologic Exchange Format (SHEF). This data is then transferred to the WCDS by electronic data transmission from the Arkansas-Red Basin River Forecast Center. Once the data is received, it is decoded and handled similarly to the DCP data. Informative display of all data is possible by using several versatile computer programs developed for use on the WCDS. Table 5-1 contains a list of automated stream gage and rainfall stations.

TABLE 5-1

AUTOMATED GAGES

Station	Operating Agency	Tulsa ID	USGS ID	SHEF ID
Automated Stream Gages				
Caney River near Bartlesville, OK	USGS		07174400	BVLO2
Caney River near Ramona, OK	USGS		07175500	RAMO2
Middle Caney Crk at Sedan, KS	USGS		07173300	SDNK1
Verdigris River near Claremore, OK	USGS		07176000	CLRO2
Little Caney River below Copan Dam near Copan, OK	USGS		07174310	CPLO2
Automated Pool Gages				
Copan Lake	COE	COPA	07174300	CAYO2
Automated Rainfall Gages Used in the Copan Lake Forecast Model				
Bartlesville, Oklahoma	USGS		07174400	BVLO2
Hulah Dam, Oklahoma	USGS		07172500	HULO2
Copan Dam, Oklahoma	USGS		07174300	CAYO2
Barnsdall, Oklahoma	USGS		07176460	BIRO2
Foraker, Oklahoma	USGS		07176460	--
Nowata, Oklahoma	USGS		07171100	--
Dexter, Kansas	USGS		07148090	DEXK1
Elgin, Kansas	USGS		07172000	ELGK1
Cedar Vale, Kansas	USGS		07171600	CDVK1
Grenola, Kansas	USGS		07171590	GRLK1
Sedan, Kansas	USGS		07173300	SDNK1
Atlanta, Kansas	USGS		07147580	ATLK1
Caney, Kansas (Levee)	COE			
Coffeeville, Kansas	USGS		07170990	COFK1
Elk City, Kansas	USGS		07170050	ECLK1
Elk Falls, Kansas	USGS		07169800	ELFK1
Havana, Kansas	USGS		07173550	HVAK1
Independence, Kansas	USGS		07170500	INDPK1
Nowata, Oklahoma	MESO	NTSO2	--	--
Claremore, Oklahoma	MESO	CLSO2	--	--
Copan, Oklahoma	MESO	CPSO2		
Foraker, Oklahoma	MESO	PWSO2		
Hugo, Oklahoma	MESO	HGSO2		

Detailed instructions on reporting criteria are presented in paragraph 2. of Exhibit B, Standing Instructions to Lake Manager.

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

5-02. Water Quality Stations.

a. Facilities. Water quality samples have been taken at Ramona, Claremore, Bartlesville, Foraker, Oologah, and Copan, Oklahoma, and Dexter, Elgin, Sedan, and Cedar Vale, Kansas. Water quality sample data have not been recorded for Copan Lake with any regularity. These data are reported directly to the Tulsa District Office.

b. Reporting. Water quality samples taken by Corps of Engineers personnel will be reported directly to the Tulsa District Office.

c. Maintenance. No permanent facilities exist to maintain.

5-03. Sediment Stations.

a. Facilities. The Corps has established 24 sedimentation ranges above Copan Dam and six degradation ranges below Copan Dam to be used for sedimentation and degradation measurements (paragraph 4-04). These ranges are surveyed periodically to compute sediment deposition and new lake area/capacity data. The ranges are shown on Plate 2-7.

b. Reporting. Sediment surveys are made infrequently for Copan Lake. The last sediment survey was done in 2003.

c. Maintenance. Maintenance on the sediment ranges is performed by the Tulsa District.

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

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

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

c. Water Quality Data. Water quality data has not been recorded with regularity for Copan Lake.

5-05. Communication Network. Wire facilities at the Copan Lake Office consist of local and long-distance telephone service. Radio communication is by a VHF-FM fixed station (call signal WUI-307) capable of reaching local mobile stations, the Tulsa District Office, stations on the local loop of the District and other stations on the north and south loop of the District via repeater relay. Maintenance of the telephone lines is the responsibility of the company leasing the lines to the Government. The District radio technician makes quarterly inspections of the project's fixed equipment and makes repairs as conditions warrant. To alert the public of impending gate changes, warning horns are located on the conduit gate tower, on the downstream end of the conduit, and on the spillway. Control buttons for these devices are found on the gate control panels.

5-06. Communication with Project.

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

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

5-07. Project Reporting Instructions. Most of the daily lake data from Copan Lake (see Plate 5-3) will be obtained from the WCDS database. Weather data and other data collected by the Copan Lake Project will be submitted to the Water Management Section, Hydrology-Hydraulics Branch, Tulsa District Office (telephone 918-669-7539 or VHF-FM radio, call signal WUI-3). The Water Management Section office is manned from 7:00 a.m. to 4:30 p.m. daily and various hours on weekends and holidays, as needed. Data for nonworking days will be read and submitted the following workday.

Should unusual conditions arise during nonworking hours, one of the persons listed on page i should be contacted. The following data should be included in the daily report.

a. As of 8:00 a.m. Each Weekday.

(1) The total precipitation amounts for the previous 24-hour periods (7:00 a.m. to 7:00 a.m.).

(2) The current wind direction and wind speed (Beaufort scale).

(3) Number of water supply pumps in operation.

(4) The current gate setting and any gate changes made during the past 24-hour period including the time and pool elevation when the change was made.

b. As of 8:00 a.m. Each Monday.

(1) The same data as required in a. above.

(2) The current pool elevation readings from the pool gage and data logger. If wind or weather prevents readings on Monday, then these readings can be taken on the next day that weather permits.

(3) Wire weight reading to confirm accuracy of DCP data.

c. Weekends and Holidays.

(1) Daily reports are not required on weekends and holidays except during flood periods.

(2) During flood periods, weekend and holiday reports should include the same data as required in a. above plus the 8:00 a.m. pool elevation from the pool gage.

d. During Flood Periods. Besides the data in a. and b. above, additional reports of lake elevations may be requested by the Water Management Section personnel during flood periods.

e. Rainfall Reports. Rainfall reports will be made as follows:

(1) At 8:00 a.m. all precipitation that 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) Report at once the occurrence of 2.00 inches or more of precipitation that occurs during a period of six hours or less. During nonworking hours, the report should be made to one on the persons listed on Page i.

5-08. Warnings. It is the responsibility of the Lake Manager to initiate a warning to the Oklahoma Civil Defense Department and local law enforcement agencies if emergency situations develop. They have the responsibility to properly recognize emergency situations and to seek assistance from supervisory offices, if time permits. They must be knowledgeable of conditions that constitute an emergency such as a dam failure possibility. The downstream population should be notified as early as possible of a potential problem. Minimum notification procedures are as follows: A “General Alert” should be issued by the Lake Manager to the Civil Defense when life-threatening high releases from a dam failure or flooding are predicted to reach the downstream population at risk within 6 hours; An “Evacuation Warning” should be issued by the Lake Manager when analysis of the threatening event and reservoir response indicate that life-threatening floodwaters will reach the downstream population in 4 hours or less. The Copan Lake project personnel have compiled a list of downstream contacts for use in emergency situations.

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

VI - HYDROLOGIC FORECASTS

6-01. General. Hydrologic forecasts are necessary in predicting stream flow above and below Copan Lake to determine if and when releases should be made.

a. Role of Corps of Engineers. Hydrologic forecasts are made by the Forecasting Section, Tulsa District, for use in the regulation of lakes for flood control and other authorized purposes and for the benefit of Corps of Engineers' construction projects and flood control activities. As distinguished from the National Weather Service (NWS), who furnishes weather and flood forecasts to the public, the District furnishes information on current and forecasted lake levels and lake releases, along with technical advice. The Water Management Section (lake levels recording), telephone No. 918-669-7521, is listed in the Tulsa telephone directory to provide the public a means of obtaining current lake information such as pool levels and discharges. General news releases are made by the Public Affairs Office which is kept fully informed of the hydrologic situation as appropriate. Further discussion of the role of the Corps of Engineers in hydrologic forecasts is presented in Section V of the Reservoir Regulation Master Manual for the Arkansas River Basin.

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

(1) Weather forecasts (daily, severe weather, and 5-day extended).

(2) National weather summaries and additional details for the five south-central states (four times daily).

(3) Quantitative precipitation forecasts (four times daily – one 24-hour and one 48-hour quantitative precipitation forecast and two 6-hour quantitative precipitation forecasts).

(4) Three-day river stage forecasts (when available).

(5) Rainfall required to produce bank full stages (weekly).

(6) Urgent priority messages such as severe weather warnings, watches, forecasts and statements, and instructions from Civil Defense during emergency conditions are transmitted immediately, regardless of scheduled traffic. Unscheduled traffic, including the following, is sent when appropriate.

(a) Damage reports.
(b) Road information and winter weather conditions.

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

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

6-02. Flood Conditions Forecasts.

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

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

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

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

(4) Releases from Copan Lake, including projected releases, from time of forecast until the end of the forecast period.

b. Methods. Inflow forecasts are made using a slightly modified HEC-1 computer program. Precipitation data is received from the NWS observers, the Data Collection Platforms (DCP) by the water control computer, the Oklahoma Mesonet, and also the NWS Stage III digital radar. The average precipitation over the project basin is computed by a computer program called VIEWRAIN. The VIEWRAIN program takes the DCP data and plots isohyetal maps of 24-hour rainfall. The VIEWRAIN program also computes the basin and subbasin average rainfalls for input into the HEC-1 forecasting model. The HEC-1 program uses the hourly DCP rainfalls to distribute the subbasin average rainfalls. Beginning loss rates are chosen based upon historical storm reproductions. Rainfall excess is computed by subtracting the applicable losses from the incremental rainfall amounts. One-hour unit hydrographs are computed using Snyder's coefficients or are entered directly into the data file for each subarea. Flood hydrographs are computed by applying the rainfall excess to the unit hydrographs. Computed flood hydrographs are compared with observed flood hydrographs for gages listed in Table 5-1. Loss rates are adjusted and the HEC-1 model is rerun until the computed and observed hydrographs converge. Calibrated loss rates are applied to ungaged subareas and flood hydrographs are combined and routed to compute an inflow hydrograph. Using projected releases from Copan Lake, the inflow hydrograph is routed through the lake to determine elevations. Flood control releases are projected based upon conditions on the Arkansas River System and following procedures described in section V of the Arkansas River Basin Water Control Master Manual. Unit hydrographs are presented on Plates 6-2 through 6-4.

6-03. Conservation Purpose Forecasts.

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

b. Methods. Forecasts for conservation purposes during non-flood periods would rely largely on statistical interpretation of historical data. The flow duration curve, Plate 4-2, and the peak inflow probability curve, Plate 8-9, would be considered with NWS forecasts in making conservation forecasts during non-flood periods.

6-04. Long-Range Forecasts.

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

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

VII - WATER CONTROL PLAN

7-01. General Objectives. The primary objectives of the Copan project are flood control, water supply, water quality, recreation and fish and wildlife. Copan Lake will be operated as a unit in a multiple-purpose system for optimum flood control benefits and is to provide benefits on the Arkansas River Basin. Flood releases from Copan Lake will be made in accordance with the predicted runoff from the uncontrolled area downstream, the allowable stage for the downstream control points, the predicted volume of inflow into the lake, and the proportion of available storage remaining in the various lakes in the system. All of the flood control storage will be utilized to provide optimal benefits, categorized as method “A” in paragraph 3-02 of EM 1110-02-3600.

7-02. Major Constraints. The channel capacity immediately downstream from the dam is about 3,000 c.f.s. while the spillway gates are capable of discharging 32,200 c.f.s. at elevation 710.0 feet (top of conservation pool). The invert of the low flow outlet is at elevation 675.5 feet which is the lowest elevation water can be released from the dam. A major constraint will be to monitor the recession of the floodwaters on the Little Caney and Caney Rivers below Copan and Hulah Dams so as to coincide releases from the dams with the natural recession of the rivers to below bank-full capacity. The limiting non-damaging flow at Bartlesville is about 12,600 c.f.s. (stage of 13.0 feet) and is about 14,700 c.f.s. at Ramona (stage of 26.0 feet).

7-03. Overall Plan for Water Control.

a. General. Copan Lake is regulated as a unit in a multipurpose system for the benefit of water resources in the Arkansas River Basin. Development of these water resources is discussed in the Arkansas River Basin Water Control Master Manual, while the specific purposes of each of the various projects are detailed in the appropriate appendix. The Natural Resource Conservation Service has a program of soil and water conservation, flood prevention, and channel improvement within the upper reaches of the Little Caney River watershed but they have not been recognized as a deterrent to flood-flow in this report.

b. System Regulation. Copan Lake will be regulated for (1) Control of floods on the Little Caney River; (2) In a system operation with Hulah Lake for control of floods on the Caney River; (3) In a system operation with Oologah Lake for control of floods on the Verdigris River; and (4) In the total Arkansas River system for control of floods on the Arkansas River to Van Buren, Arkansas. When the floodwaters are being accumulated in the system, each lake shall be regulated to retain equivalent flood control capabilities, as much as possible, with priority for releases as shown on curve "C" Plate 7-54 of the Arkansas River Basin Water Control Master Manual, being made from the lake with the least amount of flood storage available and considering predicted inflow into the lake and conditions downstream. Section VII of the Arkansas River Basin Water Control Master Manual provides detailed information on the Arkansas River System operation. Although Copan Lake is not specifically referred to in Section VII of

the Master Manual, it will be operated in accordance with the system guidelines. This essentially means that Copan Lake can make flood releases when the system has available channel capacity. In addition, Copan Lake will be regulated for the development of fish and wildlife, water quality and water supply, and other environmental enhancements downstream. The project will be regulated to obtain maximum benefits downstream which include flood damage reduction.

c. Copan and Hulah Lakes Sub-system Regulation. Releases from Copan and Hulah Lakes are essentially as described in the previous paragraph. When the equivalent flood control storage of the two lakes is unbalanced, the lake with the highest equivalent flood control storage utilized will be given priority to available channel capacity of the Caney River. If the release from the lake with the highest flood storage utilized is limited by immediate downstream channel capacity, the remaining capacity of the Caney River will be available for releases from the lake with the lower flood storage utilized. After balancing their flood control storage is achieved, each lake will share the channel of the Caney River proportionate to the equivalent flood control storage utilized and the limitations below each lake.

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

7-05. Flood Control.

a. Normal Flood Control Regulations. Copan Lake will be regulated for optimal flood reductions on the Little Caney River from the dam to its confluence with Caney River and from that point in conjunction with flood control releases from Hulah Lake and other systems on the Verdigris and Arkansas Rivers. The following regulations as shown in Table 7-1 will govern releases from Copan Lake. During flood control regulation the spillway gates are to be operated in a uniform setting with no more than 1 foot difference in opening.

TABLE 7-1

NORMAL FLOOD CONTROL REGULATION SCHEDULE
COPAN LAKE
LITTLE CANEY RIVER, OKLAHOMA & KANSAS

Lake Stage	Pool Conditions	Regulation
Below 710.0	Rising	Releases will be made to maintain elevation 710.0 but will not be less than the downstream low-flow requirements defined in paragraph 7-07.
710.0 - 732.0	Rising	Make releases using the following schedule as a guide, except that the release when combined with intervening flow downstream, will not exceed channel capacities. The channel capacities are currently estimated to be 3,000 c.f.s. below the dam, 7,000 c.f.s. downstream of the confluence of the Little Caney River and Caney River, a 13-foot stage (12,600 c.f.s.) on the Caney River at the Bartlesville gage, and a 26-foot stage (14,700 c.f.s.) on the Caney River at the Ramona gage. Regulated releases may be made at less than the maximum rate permissible if the rate of release is such that the flood control pool will be empty in approximately 3 days. Releases will be modified to meet target discharges specified by the requirements in Chapter 7 of the Arkansas River Basin Water Control Master Manual for the operation of the Arkansas River System. NOTE: When the predicted volume of runoff from the area above the dam exceeds the available flood control storage, the release schedule may be modified by the District Commander, if available, his designated representative, or the highest ranking official available in the Engineering Division, to obtain maximum benefits under conditions existing in the lake area and in the downstream reaches of the river. The Spillway Gate Regulation Schedule-Inflow Parameter" Plate 7-5 will be used as a guide for making releases.

TABLE 7-1 (continued)

Release Schedule

Pool Stages	Normal Maximum Release Rates (c.f.s.)
710.0 – 711.0	750
711.0 – 713.5	1,150
713.5 – 715.0	2,500
715.0 – 732.0	3,000

Lake Stage	Pool Conditions	Regulation
732.0 - 738.0	Rising	Releases will be based on inflow forecasts and made such that the pool elevation will not exceed elevation 738.0, if possible. Plate 7-5, Spillway Gate Regulation Schedule Inflow Parameter, will be used as a guide for determining releases so that the lake will not rise beyond the induced surcharge limits. Elevation 738.0 will be maintained, if possible, by opening the spillway gates as necessary to pass inflow or until the gates are fully opened. Releases will be made by operating all the spillway gates at uniform openings.
738.0 or above	Rising	Gates shall be opened to maintain elevation 738.0 or until the gates are in the full opened position.
736.0 or above	Falling	The maximum gate opening attained shall be held until the pool elevation recedes to elevation 736.0.

TABLE 7-1 (continued)

Lake Stage	Pool Conditions	Regulation
736.0 - 732.0	Falling	The maximum gate opening attained shall be held until the pool level recedes an amount sufficient to permit lowering the spillway gates one-half foot without lowering the discharge below inflow. A margin of not less than one-fourth foot between the lake level and the top of the spillway gates shall be maintained at all times. This regulation shall be repeated until the lake level nears elevation 732.0, at which time the outflow shall be made equal to the inflow or the maximum release permissible (as stated below), whichever is greater.
732.0 - 710.0	Falling	Make releases using following schedule as a guide, except that the release, when combined with the intervening area flows downstream, shall not exceed those stages listed under the above rising pool conditions. Target discharges specified by the Arkansas River Basin Water Control Master Manual will always supersede any other designated discharges.

Release Schedule

Pool Stages	Maximum Allowable Release Rates (c.f.s.)
732.0 - 715.0	3,000
715.0 - 713.5	2,500 + Inflow*
713.5 - 712.0	1,150 + Inflow*
712.0 - 711.0	750 + Inflow*
711.0 - 710.0	Transition to downstream low-flow requirements defined in paragraph 7-07

*Forecasted inflow over a 2 to 5 day period, with total release not to exceed 3,000 c.f.s.

b. Emergency Flood Control Regulations. When communication with the Tulsa District Office is disrupted, the Lake Manager will, on his or her own initiative, direct regulation of the lake in accordance with the following schedule (see Table 7-2) until communication is restored. In addition, the Lake Manager will immediately make every effort to re-establish communication with the Tulsa District Office. Plate 7-6 Inflow vs. Rate of Rise Nomograph, will be used by the Lake Manager during emergency flood operations to determine the 2-hour inflow. Using this inflow, a release will be determined from Plate 7-4. Plate 7-11 has been included to meet EM 1110-2-3600 requirements and should only be used as a last alternative. The spillway gates shall be operated at a uniform opening as discussed in paragraph 7-05.a.

c. Constraints. The regulation schedules provide that the channel capacity of 3,000 c.f.s. immediately below the dam is not to be exceeded insofar as practicable; however, the channel capacity in the vicinity of Bartlesville, Oklahoma, is 12,600 c.f.s. (regulating stage of 13.0 feet) and 14,700 c.f.s. (regulating stage of 26.0 feet) at Ramona, Oklahoma. Floodwaters will be released as rapidly as practicable with consideration given to minimizing flooding of low-water crossings and low-lying farmland. The significance of the stages or discharges is shown on the stage-damage curves at the control points (see Plates 4-6 through 4-8).

d. Operational Curves. Elevation-area-capacity curves, expanded spillway rating curve for partial openings, spillway rating curves for partial and full openings (one and four gates opened), spillway gate regulation schedule curves – inflow parameter, inflow nomograph and calculations example, low flow rating curves, evaporation curves, and tailwater rating curves are shown on Plates 7-1 through 7-9. Rating curves used by the Water Management Section are adjusted for changing conditions and are maintained in current status to the extent practical. Table 7-3, located on pages T7-3-1 through T7-3-9 in the Supplemental Tables section, shows the elevation-area-capacity data for Copan Lake.

TABLE 7-2

EMERGENCY FLOOD CONTROL
REGULATION SCHEDULE FOR COPAN LAKE
LITTLE CANEY RIVER, OKLAHOMA & KANSAS

Lake Stage	Pool Conditions	Regulation
Below 710.0	Rising	Continue the releases being made at the time of communication failure.
710.0 - 732.0	Rising	If the lake level is below elevation 728.0, maintain current releases as long as the pool remains below 728.0 or until communication is restored. When lake elevation reaches 728.0, the release will be the maximum of 1) The current release, or 2) The release obtained from the minimum discharge curve on Plate 7-5 (Spillway Gate Regulation Schedule – Inflow Parameter). For determining the minimum discharge in 2), inflows would be determined by using Plate 7-6 (Inflow vs. Rate of Rise Nomograph). The rate of rise of the lake and the average discharge will be computed every 2 hours for the preceding 2 hours. The determined releases will be increased as appropriate, by operating all the spillway gates at uniform openings until all gates are fully open. At no time when the lake is over 728.0 and rising will releases be decreased.
732.0 - 738.0	Rising	Releases shall be made in accordance with the Inflow Parameter Curves on Plate 7-5. (Inflows will be determined by using the Inflow vs. Rate of Rise Nomograph, Plate 7-6).
738.0 or above	Rising	Releases shall be increased by raising the spillway gates to maintain elevation 738.0 or all gates are fully open.
736.0 or above	Falling	Maximum spillway gate openings attained shall be maintained until the lake level recedes to elevation 736.0.

TABLE 7-2 (continued)

Lake Stage	Pool Conditions	Regulation
736.0 - 732.0	Falling	The maximum spillway gate opening attained shall be held until the lake level recedes an amount sufficient to permit lowering the spillway gates one-half foot without lowering the release below inflow. A margin of not less than one-fourth foot between the lake level and the top of the spillway gates shall be maintained at all times. This operation shall be repeated until the lake level recedes to elevation 732.0, or the release is 3,000 c.f.s.
732.0 - 711.0	Falling	If the maximum release rate exceeded 3,000 c.f.s., releases will be adjusted by lowering the spillway gates one-half foot without causing the pool to rise. If the pool begins to rise set the gates back to the previous opening. This operation will be repeated until the release is 3,000 c.f.s.. If the maximum release was less than 3,000 c.f.s., this release will be maintained until the lake level reaches 711.0.
711.0 - 710.0	Falling	Begin a gradual reduction of the release rate (Not to exceed 500 c.f.s. per 2-hour period) so that releases are equal to inflow (the pool is steady) at elevation 710.0.

7-06. Recreation. Recreation is included as a project purpose; however, there is no storage or releases specifically designated for recreation. Requests for special releases will be considered as the situation warrants. All recreation area access roads are constructed above the top of the flood control pool, elevation 732.0 feet. Some campsite facilities could be inundated above elevation 713.0 feet. Locations of the public facilities are listed in paragraph 2-06 of this manual and shown on Plate 2-10. Recreational features at the project include camping, picnicking, swimming, boating, hiking, and fishing. Management of the fish and wildlife resources are under the direction of the Oklahoma Department of Wildlife Conservation and the Kansas Fish and Game Commission.

7-07. Water Quality.

a. General. The quality of water in Little Caney River is considered excellent, and requires minimum treatment to be suitable for municipal and industrial use. In addition to the 3 m.g.d. for water supply, the estimated ultimate conservation storage of 33,600 acre-feet provides a maximum dependable yield of 16 m.g.d. toward meeting the water quality needs of the area as projected by the US Public Health Service. Dependable flows in the Little Caney River below Copan Dam vary from 5 c.f.s. during the winter months to about 8 c.f.s. during the summer months. Actual water quality releases vary in accordance with downstream runoff to produce the minimum downstream flow. Low flow augmentation by water quality releases is beneficial to the stream fishery, decomposition of natural debris, and the respiratory demands of the biota degrade water quality of the stream.

b. Regulation Procedure for Water Quality. The 26,100 acre-feet of water quality storage in Copan Lake, based on 20-year frequency drought, has an average yield of 16 m.g.d. (24.8 c.f.s.). The average annual downstream water quality requirement at the city of Bartlesville, Oklahoma, at the present time is about 6.8 m.g.d., or 10.5 c.f.s. Table 7-4 shows the present low-flow requirements at the Bartlesville gage. Minimum releases from Copan for water quality control will be made in accordance with monthly flow requirements for present conditions shown in Table 7-5. These minimum flows are necessary to meet present water quality requirements on the Little Caney River below Copan. Should additional flow above the minimum be required to satisfy the requirement at Bartlesville, it will be provided by releasing about 80 percent from Copan and 20 percent from Hulah. The role of the Corps of Engineers with respect to water quality is to regulate the low-flow releases to provide the recommended discharge and to make additional studies of the low-flow requirements to determine if a modification of the requirements is needed. Water quality and water supply releases shall not be made that will reduce the pool elevation in Copan Lake below elevation 687.5 feet.

Additional releases shall be made as necessary to alleviate or respond to emergency conditions such as fish kills and flow augmentation for pollution abatement or aesthetics.

TABLE 7-4

LOW-FLOW REQUIREMENTS
(BARTLESVILLE GAGE)

Period	Flows (c.f.s.)
January – May	10
June	11
July – August	13
September – December	10

TABLE 7-5

COPAN AND HULAH LAKES
MINIMUM LOW-FLOW RELEASES (CURRENT TIME)

Months	Copan Monthly Rate (c.f.s.)	Hulah Monthly Rate (c.f.s.)
January – May	5	2
June – August	8	4
September – December	5	2
Average Annual	5.75	2.50

7-08. Fish and Wildlife. Fish and wildlife is included as a project purpose pursuant to Public Law 85-624; however, no storage or releases are specifically provided in the project. Copan Lake is regulated to achieve the low-flow release schedule shown in Table 7-4. The low flow pipe has one inlet at elevation 675.5 and is unable to draw and mix water from different levels when releases are being made. Low flow releases from Copan Lake cannot be regulated to achieve the average water temperature of the natural stream flow because multi-level intakes are not provided. In the event lake level manipulation for fisheries management is required, the Tulsa District will coordinate with the Oklahoma Department of Wildlife Conservation and other interested agencies to accomplish the program at a time and in a manner compatible with other project purposes.

7-09. Water Supply.

a. General. Copan Lake has a dependable yield of 3 million gallons per day (m.g.d.) for water supply and a storage of 7,500 acre-feet. The Copan Public Works Authority contracted 15 September 1981 for 5,000 acre-feet with a yield of 2 m.g.d. for water supply. The water supply intake is in the upstream face of the second pier from the left looking downstream at invert elevation 680.25 and terminates at a blind flange located in the water supply manhole. The following lists the Water Supply Requirements for Copan:

User	Total User Storage (Ac-Ft)
Copan Public Works Authority	5,000
Not Under Contract	2,500
Total	7,500

b. Regulation Procedure for Water Supply. Withdrawals for municipal and industrial water supply are released through a 12-inch diameter water supply pipe. The flow is metered and read by the user and reported to the water supply specialist by the 5th day of the month following usage.

c. Accounting Procedure for Water Supply. Accounting procedures for conservation storage in multipurpose projects have been developed by the Tulsa District and approved by the Southwestern Division to regulate the withdrawal of water from lakes by each water supply user. No accounting is necessary where all conservation storage is contracted for by one user or when the Corps is not the contracting agency. Losses are charged to each user in proportion to the user's average remaining storage. Inflows, after deductions for downstream water rights and users with vested rights and no storage, are credited to the storage account of the user in proportion to his contracted storage. Any inflow above the conservation storage will not be accounted for. When a user has 50 percent or less of contracted storage remaining, the contracting officer will be notified and will advise the user of this storage on a monthly basis, or more frequently if necessary, throughout the critical period. Should the storage of a user be depleted, no additional withdrawal from storage will be made. An example of the water storage accounting procedures is shown on Plate 7-10.

7-10. Water Rights.

a. General. The Oklahoma Water Resources Board (OWRB) has issued water rights on the Caney River below Copan Lake. The City of Copan has been issued 250 acre-feet of water supply storage, with an additional 4,750 acre-feet possible in future storage. The City of Copan holds a water right permit from the OWRB for 2,240 acre-

feet. Before the City of Copan can exercise their full future water storage contract, they will have to upgrade their water rights permit to 5,000 acre-feet.

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

7-11. Hydroelectric Power. The entire stream yield has been allocated to water supply and water quality, so installation of hydroelectric power at Copan Lake is not being pursued at this time.

7-12. Navigation. Copan Lake, when regulated for flood control in conjunction with the navigation system of reservoirs, will help provide a tapered recession of flows along the Arkansas River navigation channel.

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

7-14. Drought Contingency Plans. The Drought Contingency Plan for the Lower Verdigris River, including Copan Lake, dated April 2003, was prepared by the Water Management Section.

7-15. Flood Emergency Action Plans. A flood emergency action plan is outlined in the Copan Lake, Little Caney River, Oklahoma, Operation and Maintenance Manual, Volume II, Flood Emergency Plan, dated October 2000, with December 2009 updates. The purpose of the manual is to specify procedures to protect the public from possible property damage or loss of life as a result of uncontrolled releases of water due to failure, or severe damage to the dam appurtenant works.

7-16. Deviation From Normal Flood Control Regulation. Deviation from normal flood control regulation of the reservoir is occasionally necessary. Prior approval for a deviation is obtained from the Corps of Engineers Southwestern Division (SWD) except as noted in subparagraph 7-15.a, shown below. Deviation requests fall into the following categories:

a. Emergencies. The water control plan is subject to temporary modification by the Corps if found necessary in time of emergency. Request for and actions on such modifications may be made by the fastest means of communication available. Also, the Lake Manager may temporarily deviate from the water control plan in the event an immediate short-term departure is deemed necessary for emergency reasons to avoid serious hazards. The Lake Manager may deviate from the water control plan whenever necessary to protect the safety of the dam. Such actions shall be immediately reported by the fastest means of communication available. Actions shall be confirmed in writing as soon as possible to the Water Management

feet. Before the City of Copan can exercise their full future water storage contract, they will have to upgrade their water rights permit to 5,000 acre-feet.

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

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

7-14. Drought Contingency Plans. The Drought Contingency Plan for the Lower Verdigris River, including Copan Lake, dated March 1990, was prepared by the Water Management Section.

7-15. Flood Emergency Action Plans. A flood emergency action plan is outlined in the Copan Lake, Little Caney River, Oklahoma, Operation and Maintenance Manual, Volume II, Flood Emergency Plan, dated October 2000, with December 2009 updataes.. The purpose of the manual is to specify procedures to protect the public from possible property damage or loss of life as a result of uncontrolled releases of water due to failure, or severe damage to the dam appurtenant works.

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a. Emergencies. The water control plan is subject to temporary modification by the Corps if found necessary in time of emergency. Request for and actions on such modifications may be made by the fastest means of communication available. Also, the Lake Manager may temporarily deviate from the water control plan in the event an immediate short-term departure is deemed necessary for emergency reasons to avoid serious hazards. The Lake Manager may deviate from the water control plan whenever necessary to protect the safety of the dam. Such actions shall be immediately reported by the fastest means of communication available. Actions shall be confirmed in writing as soon as possible to the Water Management Section and shall include justification for

the action. Continuation of the deviation will require the express approval of the Southwestern Division (SWD). A written confirmation showing the deviation and conditions will be furnished by the Water Management Section to SWD.

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

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

d. Planned Deviations. Advance approval of the Southwestern Division water control manager is required prior to any deviation from the plan of regulation prescribed or approved by the Corps in the interest of flood control, except in emergency conditions provided for in subparagraph 7-15a. Each condition will be analyzed on its own merits. When conditions appear to warrant a prolonged deviation from the approved plan, the Water Management Section will investigate and evaluate the proposed deviation to insure that the overall integrity of the plan would not be unduly compromised. Approval of prolonged deviations will not be granted unless such investigation and evaluations have been conducted to the extent deemed necessary by the Southwestern Division water control manager.

7-17. Rate of Release Change. The increase and decrease in releases from the lake shall be accomplished in a manner which minimizes damage to the reservoir area and

downstream channel as shown in Table 7-6. Every reasonable precaution will be made to eliminate, if possible, bank sloughing, undercutting, excessive erosion, and 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 flood releases, as described in paragraph 7-05, and drownings that occur downstream of the dam.

TABLE 7-6

RELEASE RATE CHANGES
INCREASING RELEASES TO CHANNEL CAPACITY [1]

Current Release Range (c.f.s.)	Maximum Increase (c.f.s.)	Minimum Time Between Changes (hours)
0 – 3,000	500	2

DECREASING RELEASES BELOW CHANNEL CAPACITY [1]

Current Release Range (c.f.s.)	Maximum Increase (c.f.s.)	Minimum Time Between Changes (hours)
3,000 - 0	500	3

[1] See paragraph 7-05.a. for releases that will exceed channel capacity and also decrease in releases above channel capacity

VIII - EFFECT OF WATER CONTROL PLAN

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

8-02. Flood Control.

a. Spillway Design Flood. The spillway design flood was developed from the probable maximum precipitation storm in accordance with Hydrometeorological Report No. 33. These criteria were adopted for the 505-square-mile drainage area above Copan dam site, and a reduction of the probable maximum precipitation was used for basin shape factor and maximum storm enveloping effects. The inflow into full pool was obtained by applying rainfall excess to the unit hydrograph for the reservoir area, the area immediately surrounding the reservoir on each side and the upper portion or the remaining area, and combining the resultant unit hydrographs together. The resulting flood has a peak inflow of 232,000 c.f.s. and a total volume of 569,500 acre-feet including base flow. The maximum flood volume stored is 110,500 acre-feet above the top of the flood pool and the maximum discharge of 199,070 c.f.s at the maximum pool elevation of 739.1 is based on the lake being operated under normal regulations. When the flood was routed through the reservoir on a full pool, it reached a maximum elevation of 739.55 feet and discharged a peak flow of 201,600 c.f.s. When the flood was routed through the reservoir on an empty pool, it reached a maximum elevation of 738.8 feet and discharged a peak flow of 196,000 c.f.s. Plate 8-1 shows the operational hydrographs of the spillway design flood routed through Copan Lake operated under emergency regulations on empty and full flood control pool.

b. Standard Project Flood. The standard project flood was developed in accordance with Civil Works Engineering Bulletin No. 52-8, dated 26 March 1952. The resulting flows were routed through the lake and were operated under emergency regulations on full flood control pool. The peak inflow was 103,800 c.f.s with a volume of 270,400 acre-feet. The maximum flood volume stored is 91,300 acre-feet above the top of the flood pool at maximum pool elevation of 738.1 and a peak discharge of 81,500 c.f.s. When the flood was routed through the reservoir on a full pool, it reached a maximum elevation of 738.1 feet and discharged a peak flow of 81,500 c.f.s. When the flood was routed through the reservoir on an empty pool, it reached a maximum elevation of 734.7 feet and discharged a peak flow of 27,000 c.f.s. Hydrographs for the standard project flood routed through Copan Lake under emergency regulations on empty and full flood control pools are shown on Plate 8-2.

c. Flood of September - October 1986. The September – October 1986 flood was chosen as an example to route through the lake and to make releases downstream in conjunction with Hulah Lake. Copan and Hulah Lakes must share the channel below the junction of Caney and Little Caney Rivers. The channel capacities below the Copan and Hulah dams are 3,000 c.f.s. and 6,500 c.f.s, respectively, and the channel capacity at the confluence of the Caney and Little Caney Rivers is limited to 7,000 c.f.s. The September – October 1986 flood had a peak inflow into Copan Lake of 56,600 c.f.s and a volume of 369,700 acre-feet. The maximum pool elevation operated under emergency regulations was 735.15 and the peak outflow was 40,000 c.f.s. Normal regulation of Hulah Lake and emergency regulations of Copan Lake during this flood reduced the Ramona stage from 33.42 feet to 29.19 feet. Plate 8-3 shows the operational hydrograph, regulated by using both normal and emergency regulations for Copan Lake. Plates 8-4 and 8-5 show the results of normal and emergency regulation operations at the Ramona gage and at Bartlesville, respectively for the 1986 flood.

d. Flood of June -- July 2007. The June - July 2007 flood was chosen as an example to route through the lake and to make releases downstream in conjunction with Hulah Lake. Copan and Hulah Lakes must share the channel below the junction of Caney and Little Caney Rivers. The channel capacity below the dams is 3,000 and 6,500 c.f.s., respectively. This flood had a peak inflow into Copan Lake of 48,000 c.f.s. and a volume of 80,200 acre-feet. The maximum pool elevation was 732.84 and the peak outflow was 10,000 c.f.s. Normal regulation of Hulah Lake and emergency regulations of Copan Lake during this flood reduced the Ramona stage from 31.2 feet to 28.0 feet. Plate 8-6 shows the operational hydrograph, regulated by using both normal and emergency regulations for Copan Lake. Plates 8-7 and 8-8 show the results of normal and emergency regulation operations at the Ramona gage and at Bartlesville, respectively, for the 2007 flood.

8-03. Recreation. Rock bluffs, rolling hills, and the timbered creeks make the lake an area of unique appeal for recreation. Five public use areas have been developed around the lake, which has 4,850 acres of surface area at the top of the conservation pool. Some areas start being inundated at elevation 713.0, and by elevation 732.0 all of the areas would be affected by the water. The minimum elevation for the top of boat ramps is elevation 722.0. Releases for water supply, water quality, and fish and wildlife during drought conditions will cause the pool to be drawn.

8-04. Water Quality. In an effort to maintain the quality of the water in the Little Caney River, a low flow pipe has been provided. Before the lake was built there were periods of zero flow at the dam site during the drier summer months. With the lake, however, the present minimum flow has been about 5 cubic feet per second.

8-05. Fish and Wildlife. Copan Lake replaced the existing stream fishery with an improved reservoir-type fishery. The impoundment provides an excellent fishery and, being located in a scenic area, attracts fishermen from a widespread area. The downstream fishery is improved by releases from the lake. Minimum releases required for water quality also aid the downstream fishery in periods of low flow. Waterfowl

habitat will increase and the lake will provide hunting opportunities for these species. There are some losses of squirrel and deer habitat. However, because of the vast acreages of these habitat types in the general area, the minor loss does not have a significant effect on the hunting of these species in the area. The lake provides a greater diversification of fish and wildlife habitat and specific losses are replaced by wildlife management of the lake perimeter lands.

8-06. Water Supply. The quality of water in the Little Copan River is considered excellent, requiring only minimum treatment to be suitable for domestic and industrial use. Conservation storage has been provided to supply an estimated 3 million gallons per day for municipal water supply. Since the intake of the 12-inch-diameter water supply pipe is near the bottom of the lake, during periods of stratification the quality of water at this level may be poor. (See paragraph 4-08.)

8-07. Hydroelectric Power. Although hydropower is not a project purpose, incidental benefits may accrue to downstream hydropower projects as a result of the leveling effect on flows due to the flood control operation of Copan Lake.

8-08. Navigation. Like hydropower, navigation is not a project purpose of Copan Lake; however, incidental benefits may accrue to the downstream navigation system as a result of normal operations.

8-09. Frequencies.

a. Peak Inflow Probability. Estimated natural flows taken from "RiverWare" run 2010-01 at the dam site for the period January 1940 through December 2008 were used to compute the maximum annual peak inflow probability. The inflow probability was derived in accordance with Bulletin 17B, "Guidelines for Determining Flood Flow Frequency," dated June 2006. The peak inflow probability curve (natural conditions) is shown on Plate 8-9.

b. Pool Elevation Duration and Probability. The pool elevation hydrographs resulting from the Arkansas River system routing of the computed flows at the dam site were used to compute maximum and minimum annual pool elevations which were converted to partial duration series. The computations were made using the general procedures presented in ER 1110-2-1450, dated 10 October 1962. The annual series was converted to a partial duration series by Langbein's conversion Table described in "Transactions American Geophysical Union," Volume 30, December 1949. Plate 8-10 shows the pool elevation probability curve and Plate 8-11 shows the pool elevation duration curve. Plates 8-12 through 8-18 show pool elevations from simulated and actual operational hydrographs for the period of record January 1940 through August 2010.

c. Key Control Points. Discharge rating curves used in the regulation of Copan Lake are shown on Plates 4-3 and 4-4.

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c. Key Control Points. Discharge rating curves used in the regulation of Copan Lake are shown on Plates 4-3 and 4-4.

8-10. Other Studies.

a. Examples of Regulation. Studies are in progress to improve the forecasting techniques presented in Section VI of this manual. Computer programs have been developed to forecast inflows into the lake, the resulting pool elevations, and the effects of releases at the downstream gage. Use of these programs has greatly shortened the reaction time in preparing regulation schedules.

b. Channel and Floodway Improvement. No channelization projects exist below Copan Lake with the exception of the navigation system. Ground and aerial reconnaissance is made as required to determine if revised channel capacities and maximum discharge limits are warranted.

IX - WATER CONTROL MANAGEMENT

9-01. Responsibilities and Organizations.

a. Corps of Engineers. Copan Lake is a Corps of Engineers 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 Corps. Project reporting instructions and an organization chart are presented in Chapter V, and project regulating instructions are presented in Chapter VII of this manual.

(1) Responsibilities and Duties During Normal Operations. The Water Management 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) Routine regulation of lakes and distribution of routine data.

(b) Investigations and refinement of regulation procedures.

1). Analysis of past floods.

2). Reconnaissance to determine channel capacities.

3). Improvement of forecasting techniques.

4). Plan and coordinate the hydrologic reporting network with the National Weather Service and the U.S. Geological Survey.

(c) Train personnel in flood control duties.

1). Make periodic visits to projects by Section personnel to familiarize themselves with regulation facilities, become acquainted with the operating personnel, discuss emergency regulation procedures with operating personnel, and provide the background for improving facilities and methods.

2). Instruct personnel of the Hydrology-Hydraulics Branch in flood control procedures to supplement the Water Management Section during flood emergencies, when necessary.

(d) Prepare reports on lake regulation.

1). Recurring reports.

2). Water control manuals.

3). Post-flood reports.

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

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

(b) Performing or obtaining reservoir forecasts.

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

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

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

(f) Furnish information to higher authority.

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

2). Provide hydrologic data for situation reports.

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

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

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

flood emergencies. Responsible personnel will be on duty at the project or on call at all times.

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

b. Other Federal Agencies. The NWS and the U.S. Geological Survey (USGS) cooperate with the Water Management Section, Hydrology-Hydraulics Branch, Tulsa District Office, to accumulate rainfall and stream flow data. The Environmental Protection Agency, together with the State of Oklahoma, establishes the standards for water quality releases.

c. State Agencies. Management of the fish and wildlife resources of the Copan project is the responsibility of the Oklahoma Department of Wildlife Conservation.

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

9-02. Interagency Coordination. Cooperative arrangements with other Federal agencies, State agencies and local interests are discussed in the following subparagraphs.

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

b. National Weather Service. The Tulsa District Office and the Arkansas-Red Basin River Forecast Center (NWS) exchange hydrometeorological data and reports to prevent duplication of effort in obtaining and distributing data. This exchange of data is discussed in greater detail in Chapter VI of this manual. The NWS is the responsible agency for issuing public forecasts of stream stages.

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

d. Power Marketing Agency. Presently, hydropower is not a project purpose.

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

9-03. Interagency Agreements. There are presently no agreements.

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

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

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

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

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

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

e. To facilitate the cooperation of the water administration agencies of Arkansas and Oklahoma and Kansas and Oklahoma in the total development and management of the water resources of the Arkansas River Basin.

The Arkansas River Basin Coordinating Committee is made up of State and Federal agencies interested in the water resources development within the Arkansas River Basin. The committee meets annually to discuss the previous year's activities and to exchange information and ideas to better serve specific project purposes.

9-05. Reports.

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

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

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

d. Post Flood Reports. This report is prepared according to ER 500-1-1 and OM 500-1-6 when practicable after a flood that had caused major damages. The report describes flood emergency operations by the Corps of Engineers and others. Included in summary form are: available hydrologic information, damage estimates, and other engineering data as are considered essential for flood control and flood plain studies or in the review or possible claims against the United States for damages. The District Office Planning Division personnel, using information compiled and prepared by the Water Management Section prepare the report. The report should be completed within approximately three months of the time of flooding, including a statement of final damages.

e. Annual Reports. The Water Management Section prepares this report. The report contains a summation of the general conditions of the river basins and the individual projects in the District for the preceding fiscal year. The report also presents

the activities and accomplishments of the Water Management Section for the past year. The report is forwarded to the SWD Water Management Section for inclusion in the Division's annual report.

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

TABLE 9-1

TABULATION OF REPORTS

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

COPAN LAKE, LITTLE CANEY RIVER, OKLAHOMA
WATER CONTROL MANUAL
APPENDIX W
TO
WATER CONTROL MASTER MANUAL
ARKANSAS RIVER BASIN

SUPPLEMENTAL TABLES

TABLE 4-6

COPAN DAM SITE MONTHLY INFLOWS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1936	2,400	1,040	795	274	7,100	12,290	4,730	6	17,200	65,310	7,910	2,050	121,105
1937	12,850	6,150	3,650	10,220	6,350	24,400	30,190	2,090	4,720	135	109	224	101,088
1938	311	3,400	30,110	17,260	64,490	31,310	1,000	1,080	520	32	67	61	149,641
1939	87	67	1,350	6,750	7,300	2,720	377	28	0	0	0	0	18,679
1940	0	18	36	5,090	2,330	29,120	7,360	2,550	2,460	0	3,930	2,940	55,834
1941	8,090	7,450	4,810	52,690	21,580	63,030	595	1,170	6,440	82,230	47,030	13,770	308,885
1942	5,460	14,260	21,010	103,200	11,180	41,970	2,350	5,360	51,570	12,800	7,110	18,280	294,550
1943	6,540	7,720	6,970	4,960	236,800	20,870	2,040	704	294	1,300	89	434	288,721
1944	676	1,280	14,370	175,400	46,760	11,200	603	5,170	24,760	61,820	1,240	40,240	383,519
1945	3,440	4,330	65,100	79,630	12,500	18,250	39,710	321	93,550	33,850	1,230	1,040	352,951
1946	31,820	16,270	22,330	3,770	1,400	772	1,010	12	4,030	46	7,500	781	89,741
1947	573	220	7,330	106,400	51,730	20,410	343	24	139	10	6	60	187,245
1948	36	73	4,780	13,910	11,780	79,610	121,500	58,490	526	89	1,990	514	293,298
1949	58,450	67,810	19,120	47,440	40,680	16,240	670	11,720	8,700	524	968	18,520	290,842
1950	2,930	1,630	3,070	3,750	6,670	51,930	133,400	51,930	23,110	1,560	724	774	281,478
1951	1,170	6,420	3,960	9,150	45,500	86,640	121,500	1,650	11,840	6,970	39,680	10,880	345,360
1952	10,840	7,990	54,460	27,240	3,550	2,330	506	192	0	0	12	14	107,134
1953	16	60	1,490	2,630	16,790	4,020	3,410	2	4,480	10	2,230	865	36,003
1954	16	83	24	1,590	47,050	1,970	0	0	0	17,080	135	192	68,140
1955	2,550	1,560	1,870	708	56,220	2,030	103	0	18	11,220	10	8	76,297
1956	16	24	16	10	32	30	944	4	0	0	24	4	1,104
1957	2	6	327	20,360	167,900	165,700	4,750	137	99	65	1,380	327	361,053
1958	1,050	1,810	83,110	48,600	22,020	1,130	7,320	270	1,520	69	34	38	166,971
1959	145	248	885	5,420	22,050	3,650	70,400	1,390	1,150	105,700	5,610	6,700	223,348
1960	10,000	13,930	33,400	23,210	15,120	3,050	391	4,360	157	1,260	1,310	7,380	113,568
1961	403	1,100	11,140	53,410	248,400	18,710	3,110	3,820	87,720	28,700	96,040	27,260	579,813
1962	16,090	6,530	8,420	5,490	1,540	1,490	512	28	17,960	6,010	1,390	1,590	67,050
1963	10,520	1,130	11,240	1,350	1,180	390	44	44	4	0	0	0	115,902
1964	1	32	26	1,930	2,710	4,850	12	5,450	1,030	16	16,500	4,300	36,857
1965	5,310	1,710	5,680	81,890	14,500	31,270	7,520	349	28,440	708	110	1,230	178,717
1966	655	1,790	6,090	1,550	1,740	30,690	113	344	189	0	0	37	43,198
1967	215	141	62	1,740	6,980	42,540	15,740	638	2,680	4,520	3,250	2,170	80,676
1968	3,170	2,560	17,270	19,900	24,730	5,950	8,770	11,720	2,870	11,070	28,160	21,570	157,740
1969	11,890	16,120	35,870	49,780	17,420	96,770	3,310	272	16,280	41,020	4,070	4,090	296,892
1970	1,440	966	6,280	81,860	23,010	38,330	623	98	1,670	715	52	555	155,599
1971	8,270	10,620	4,210	565	1,090	3,490	10,590	142	5,260	19,880	1,930	37,790	103,837
1972	6,060	2,140	2,270	5,330	4,780	132	7,110	385	2,520	7,640	52,140	15,200	105,707
1973	77,450	18,440	149,100	94,010	35,140	7,540	1,980	176	17,450	18,020	34,640	44,330	498,276
1974	27,110	26,480	153,000	8,230	63,530	59,370	463	6,430	16,670	17,650	136,800	19,370	535,103
1975	28,510	71,490	59,860	21,340	43,710	31,890	955	4,080	145	1,020	241	804	264,045

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1976	353	321	5,190	11,800	8,180	2,280	86,020	461	836	3,280	259	212	119,192
1977	346	586	1,140	1,690	30,430	89,830	7,300	12,570	24,970	4,010	49,600	2,450	224,922
1978	1,113	22,618	24,355	27,023	98,875	49,907	2,007	206	60	0	714	117	226,995
1979	5,891	11,921	20,113	16,449	4,556	12,944	7,571	4,699	325	75	60,614	2,368	147,526
1980	1,065	6,932	42,959	47,973	9,894	2,396	93	56	36	436	16	494	112,350
1981	137	163	278	294	11,750	8,618	980	678	278	4,673	15,005	5,107	47,961
1982	4,036	9,957	27,463	4,036	82,700	95,187	6,288	1,093	460	181	141	8,975	240,517
1983	7,825	37,587	42,575	85,438	89,708	17,449	873	212	698	34,340	2,652	2,198	321,555
1984	1,745	11,157	114,476	84,793	52,879	19,557	426	1,609	413	16,572	5,256	58,771	367,654
1985	24,168	97,150	74,499	40,611	56,469	90,823	6,218	6,902	28,764	40,829	85,547	N.A.	551,980
1986	6,198	5,553	11,702	35,652	115,537	55,527	51,917	4,958	68,231	332,449	61,884	42,892	792,500
1987	27,203	85,031	81,778	17,454	77,871	34,889	26,142	2,955	932	353	19,549	58,274	432,431
1988	33,917	7,100	81,778	159,173	18,069	2,241	3,237	599	13,031	505	7,011	2,727	329,388
1989	2,519	4,790	35,563	20,885	34,284	206,340	20,499	6,714	14,261	45,302	12,505	1,388	405,050
1990	13,636	22,442	154,115	43,438	88,264	21,560	952	1,150	1,438	833	2,459	813	351,100
1991	1,914	99	218	16,950	23,474	11,375	723	138	1,035	1,090	2,796	19,878	79,690
1992	3,143	12,099	6,813	5,434	2,876	43,983	31,279	4,085	833	128	67,041	85,487	263,201
1993	58,204	32,757	47,276	37,943	167,038	29,652	17,623	1,820	24,793	1,769	9,074	9,014	436,963
1994	2,181	21,342	12,535	153,818	70,115	1,420	20,390	1,434	1,051	914	46,274	5,355	336,829
1995	2,658	1,845	31,944	20,757	126,357	195,411	64,701	16,324	69	0	12	754	460,832
1996	337	298	754	6,159	2,281	2,073	0	1,319	14,717	11,276	46,959	17,792	103,965
1997	3,540	74,707	14,083	36,337	33,094	62,182	9,590	2,688	2,132	3,104	1,111	41,464	284,032
1998	43,369	6,367	102,357	50,936	22,235	2,460	3,045	60	2,243	139,864	50,469	25,140	448,545
1999	15,967	46,493	71,722	95,147	102,565	157,150	71,028	1,339	1,821	4	212	14,331	577,779
2000	976	11,623	61,567	18,793	50,311	72,460	5,266	0	0	1,527	1,269	387	224,179
2001	11,167	59,197	47,931	15,808	4,336	1,501	2	0	20	601	159	440	141,162
2002	1,428	762	186	333	88,322	35,385	2,876	980	2,872	232	0	1,031	134,407
2003	272	1,555	31,319	19,855	134,717	34,612	1,954	6,188	12,347	10,750	4,413	17,276	275,258
2004	24,020	15,779	75,808	54,684	26,132	10,592	22,602	547	10	7,567	29,980	9,630	277,351
2005	60,030	17,464	26,707	7,200	15,550	101,633	1,021	1,646	5,359	1,736	883	615	239,844
2006	1,051	347	1,557	16,810	50,945	387	367	1,091	300	60	696	1,379	74,990
2007	1,636	897	36,625	33,858	104,876	226,403	117,570	520	1,388	7,755	664	2,350	534,542
2008	3,273	23,385	34,889	61,587	80,251	164,886	15,447	40,840	24,298	9,570	15,164	13,577	487,167
2009	1,676	19,101	37,329	106,711	126,268	1,676	7,835	4,116	7,660	28,007	12,813	3,134	356,326
MIN	0	6	16	10	32	30	0	0	0	0	0	0	1,104
MEAN	9,778	13,440	29,926	34,512	46,305	39,633	16,620	4,225	9,674	17,147	15,120	10,300	247,894
MAX	77,450	97,150	154,115	175,400	248,400	226,403	133,400	58,490	93,550	332,449	136,800	85,487	792,500

TABLE 7-3
ELEVATION - AREA - CAPACITY DATA
COPAN LAKE, OKLAHOMA
2002 SURVEY

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

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
670	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
671	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
672	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
673	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
674	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001
	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001
675	0.001	0.001	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.004
	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.003	0.003
676	0.004	0.005	0.006	0.007	0.008	0.009	0.009	0.010	0.011	0.012
	0.003	0.004	0.004	0.005	0.006	0.007	0.007	0.008	0.009	0.009
677	0.013	0.014	0.016	0.017	0.019	0.020	0.021	0.023	0.024	0.026
	0.010	0.012	0.014	0.016	0.018	0.021	0.023	0.025	0.027	0.029
678	0.027	0.028	0.029	0.031	0.032	0.033	0.034	0.035	0.037	0.038
	0.031	0.034	0.037	0.041	0.044	0.047	0.050	0.053	0.057	0.060
679	0.039	0.040	0.040	0.043	0.044	0.046	0.047	0.048	0.049	0.051
	0.063	0.068	0.072	0.077	0.081	0.086	0.091	0.095	0.100	0.104

TABLE 7-3
ELEVATION - AREA - CAPACITY DATA
COPAN LAKE, OKLAHOMA
2002 SURVEY

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

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
680	0.052	0.053	0.054	0.055	0.056	0.058	0.059	0.060	0.061	0.062
	0.109	0.115	0.121	0.126	0.132	0.138	0.144	0.150	0.155	0.161
681	0.063	0.064	0.064	0.065	0.066	0.067	0.067	0.068	0.069	0.069
	0.167	0.174	0.180	0.187	0.193	0.200	0.207	0.213	0.220	0.226
682	0.070	0.071	0.071	0.072	0.073	0.074	0.074	0.075	0.076	0.076
	0.233	0.240	0.248	0.255	0.263	0.270	0.277	0.285	0.292	0.300
683	0.077	0.078	0.078	0.079	0.080	0.081	0.081	0.082	0.083	0.083
	0.307	0.315	0.323	0.331	0.339	0.348	0.356	0.364	0.372	0.380
684	0.084	0.085	0.086	0.086	0.087	0.088	0.089	0.090	0.090	0.091
	0.388	0.397	0.406	0.415	0.424	0.433	0.441	0.450	0.459	0.468
685	0.092	0.093	0.094	0.095	0.096	0.098	0.099	0.100	0.478	0.102
	0.477	0.487	0.496	0.506	0.516	0.526	0.535	0.545	0.555	0.564
686	0.103	0.105	0.106	0.108	0.110	0.112	0.113	0.115	0.117	0.118
	0.574	0.585	0.596	0.607	0.618	0.629	0.640	0.651	0.662	0.673
687	0.120	0.122	0.124	0.126	0.128	0.130	0.132	0.134	0.136	0.138
	0.684	0.697	0.710	0.723	0.736	0.749	0.762	0.775	0.788	0.801
688	0.140	0.143	0.145	0.148	0.150	0.153	0.155	0.158	0.160	0.163
	0.814	0.829	0.844	0.860	0.875	0.890	0.905	0.920	0.936	0.951
689	0.165	0.168	0.171	0.173	0.176	0.179	0.182	0.185	0.187	0.190
	0.966	0.984	1.002	1.019	1.037	1.055	1.073	1.091	1.108	1.126

TABLE 7-3
ELEVATION - AREA - CAPACITY DATA
COPAN LAKE, OKLAHOMA
2002 SURVEY

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

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
690	0.193	0.198	0.202	0.207	0.212	0.217	0.221	0.226	0.231	0.235
	1.144	1.166	1.187	1.811	1.230	1.252	1.273	1.295	1.316	1.338
691	0.240	0.250	0.260	0.269	0.279	0.289	0.299	0.309	0.318	0.328
	1.359	1.387	1.416	1.444	2.519	1.501	1.529	1.557	1.585	1.614
692	0.338	0.353	0.368	0.384	0.399	0.414	0.429	0.444	0.460	0.475
	1.642	1.683	1.724	1.765	1.806	1.847	1.888	1.929	1.970	2.011
693	0.490	0.508	0.526	0.543	0.561	0.579	0.597	0.615	0.632	0.650
	2.052	2.110	2.167	2.225	2.283	2.341	2.398	2.456	2.514	2.571
694	0.668	0.683	0.698	0.713	0.728	0.743	0.757	0.772	0.787	0.802
	2.629	2.704	2.779	2.853	2.928	3.003	3.078	3.153	3.227	3.302
695	0.817	0.829	0.840	0.852	0.863	0.875	0.887	0.898	0.910	0.921
	3.377	3.465	3.553	3.640	3.728	3.816	3.904	3.992	4.079	4.167
696	0.933	0.941	0.950	0.958	0.966	0.975	0.983	0.991	0.999	1.008
	4.255	4.353	4.450	4.548	4.645	4.743	4.841	4.938	5.036	5.133
697	1.016	1.025	1.034	1.043	1.052	1.062	1.071	1.080	1.089	1.098
	5.231	5.337	5.442	5.548	5.653	5.759	5.865	5.970	6.076	6.181
698	1.107	1.119	1.131	1.142	1.154	1.166	1.178	1.190	1.201	1.213
	6.287	6.404	6.520	6.637	6.753	6.870	6.987	7.103	7.220	7.336
699	1.225	1.237	1.248	1.260	1.271	1.283	1.294	1.306	1.317	1.329
	7.453	7.581	7.581	7.838	7.967	8.095	8.223	8.352	8.480	8.609

TABLE 7-3
ELEVATION - AREA - CAPACITY DATA
COPAN LAKE, OKLAHOMA
2002 SURVEY

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

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
700	1.340	1.355	1.369	1.384	1.398	1.413	1.427	1.442	1.456	1.471
	8.737	8.878	9.019	9.160	9.301	9.442	9.582	9.723	9.864	10.005
701	1.485	1.504	1.524	1.543	1.562	1.582	1.601	1.620	1.639	1.659
	10.146	10.303	10.460	10.617	10.774	10.932	11.089	11.246	11.403	11.560
702	1.678	1.706	1.734	1.762	1.790	1.818	1.846	1.874	1.902	1.930
	11.717	11.899	12.080	12.262	12.443	12.625	12.807	12.988	13.170	13.351
703	1.958	1.984	2.009	2.035	2.061	2.087	2.112	2.138	2.164	2.189
	13.533	13.742	13.952	14.161	14.370	14.580	14.789	14.998	15.207	15.417
704	2.215	2.239	2.263	2.286	2.310	2.334	2.358	2.382	2.405	2.429
	15.626	15.859	16.092	16.324	16.557	16.790	17.023	17.256	17.488	17.721
705	2.453	2.494	2.535	2.576	2.617	2.659	2.700	2.741	2.782	2.823
	17.954	18.217	18.481	18.744	19.008	19.271	19.534	19.798	20.061	20.325
706	2.864	2.902	2.939	2.977	3.014	3.052	3.090	3.127	3.165	3.202
	20.588	20.896	21.204	21.512	21.820	22.128	22.435	22.743	23.051	23.359
707	3.240	3.271	3.302	3.332	3.363	3.394	3.425	3.456	3.486	3.517
	23.667	24.006	24.345	24.685	25.024	25.363	25.702	26.041	26.381	26.720
708	3.548	3.590	4.428	3.674	3.716	3.758	3.799	6.523	3.883	3.925
	27.059	27.427	27.794	28.162	28.529	28.897	29.265	29.632	30.000	30.367
709	3.967	4.015	4.063	4.112	4.160	4.208	4.256	4.304	4.353	4.401
	30.735	31.125	31.515	31.905	32.295	32.685	33.074	33.464	33.854	34.244

TABLE 7-3
ELEVATION - AREA - CAPACITY DATA
COPAN LAKE, OKLAHOMA
2002 SURVEY

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

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
710	4.449	4.471	4.492	4.514	4.535	4.557	4.578	4.600	4.621	4.643
	34.634	35.090	35.545	36.001	36.457	36.912	37.368	37.823	38.279	38.735
711	4.665	4.686	4.708	4.729	4.751	4.772	4.794	4.815	4.837	4.858
	39.190	39.668	40.145	40.622	41.099	41.576	42.053	42.531	43.008	43.485
712	4.880	4.917	4.955	4.992	5.029	5.067	5.104	5.141	5.178	5.216
	43.962	44.469	44.975	45.482	45.988	46.495	47.001	47.508	48.014	48.521
713	5.253	5.290	5.328	5.365	5.402	5.440	5.477	5.514	5.551	5.589
	49.028	49.571	50.115	50.659	51.203	51.747	52.291	52.834	53.378	53.922
714	5.626	5.663	5.701	5.738	5.775	5.813	5.850	5.887	5.924	5.962
	54.466	55.047	55.628	56.209	56.791	57.372	57.953	58.534	59.115	59.696
715	5.999	6.035	6.071	6.107	6.142	6.178	6.214	6.250	6.286	6.322
	60.277	60.895	61.513	62.131	62.748	63.366	63.984	64.602	65.219	65.837
716	6.357	7.029	7.701	8.372	9.044	9.715	10.387	11.058	11.730	12.402
	66.455	67.108	67.762	68.416	69.069	69.723	70.376	71.030	71.683	72.337
717	6.716	6.752	6.787	6.823	6.859	6.895	6.931	6.967	7.003	7.038
	72.991	73.680	74.369	75.059	75.748	76.438	77.127	77.817	78.506	79.195
718	7.074	7.110	7.146	7.182	7.218	7.253	7.289	7.325	7.361	7.397
	79.885	80.610	81.335	82.061	82.786	83.511	84.236	84.962	85.687	86.412
719	7.433	7.468	7.504	7.540	7.576	7.612	7.648	7.683	7.719	7.755
	87	87.899	88.660	89.421	90.182	90.943	91.704	92.465	93.226	93.987

TABLE 7-3
ELEVATION - AREA - CAPACITY DATA
COPAN LAKE, OKLAHOMA
2002 SURVEY

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

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
720	7.791	7.833	7.875	7.916	7.958	8.000	8.042	8.083	8.125	8.167
	94.749	95.548	96.348	97.148	97.948	98.748	99.548	100.348	101.148	101.948
721	8.209	8.250	9.086	8.334	8.376	8.417	8.459	8.501	8.543	8.584
	102.747	103.589	104.431	105.272	106.114	106.956	107.797	108.639	109.481	110.322
722	8.626	8.668	8.710	8.751	8.793	8.835	8.877	8.919	8.960	9.002
	111.164	112.047	112.931	113.814	114.698	115.581	116.464	117.348	118.231	119.115
723	9.044	9.086	9.127	9.169	9.211	9.253	9.294	9.336	9.378	9.420
	119.998	120.923	121.849	122.774	123.699	124.624	125.549	126.474	127.400	128.325
724	9.461	9.503	9.545	9.587	9.628	9.670	9.712	9.754	9.795	9.837
	129.250	130.217	131.184	132.151	133.118	134.085	135.052	136.019	136.986	137.952
725	9.879	9.920	9.962	10.003	10.044	10.086	10.127	10.168	10.210	10.251
	138.919	139.928	140.936	141.945	142.953	143.962	144.970	145.979	146.987	147.996
726	10.293	10.334	10.375	10.417	10.458	10.499	10.541	10.582	10.623	10.665
	149.004	150.054	151.104	152.154	153.204	154.254	155.304	156.353	157.403	158.453
727	10.706	10.747	10.789	10.830	10.871	10.913	10.954	10.995	11.037	11.078
	159.503	160.594	161.685	162.777	163.868	164.959	166.050	167.142	168.233	169.324
728	11.120	11.161	11.202	11.244	11.285	11.326	11.368	11.409	11.450	11.492
	170.415	171.548	172.680	173.813	174.945	176.078	177.211	178.343	179.476	180.608
729	11.533	11.586	11.639	11.691	11.744	11.797	11.850	11.902	11.955	12.008
	181.741	182.920	184.100	185.279	186.459	187.639	188.818	189.998	191.177	192.357

TABLE 7-3
ELEVATION - AREA - CAPACITY DATA
COPAN LAKE, OKLAHOMA
2002 SURVEY

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

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
730	12.061	12.113	12.166	12.219	12.272	12.324	12.377	12.430	12.483	12.535
	193.537	194.769	196.001	197.234	198.466	199.698	200.931	202.163	203.395	204.628
731	12.588	12.641	12.694	12.746	12.799	12.852	12.905	12.957	13.010	13.063
	205.860	207.145	208.430	209.715	211.000	212.285	213.570	214.855	216.141	217.426
732	13.116	13.168	13.221	13.274	13.327	13.379	13.432	13.485	13.538	13.590
	218.711	220.049	221.386	222.724	224.062	225.400	226.738	228.076	229.413	230.751
733	13.643	13.666	13.690	13.713	13.736	13.760	13.783	13.806	13.830	13.853
	232.089	233.465	234.841	236.217	237.593	238.969	240.345	241.721	243.097	244.473
734	13.877	13.900	13.923	13.947	13.970	13.993	14.017	14.040	14.063	13.900
	245.849	247.248	248.647	250.047	251.446	252.845	254.245	255.644	257.043	258.442
735	14.110	14.195	14.280	14.365	14.450	14.535	14.620	14.705	14.790	14.874
	259.842	261.295	262.748	264.202	265.655	267.108	268.561	270.015	271.468	272.921
736	14.959	15.044	15.129	15.214	15.299	15.384	15.469	15.554	15.639	15.724
	274.374	275.913	277.451	278.989	280.527	282.065	283.604	285.142	286.680	288.218
737	15.809	15.894	15.979	16.064	16.149	16.234	16.319	16.403	16.488	16.573
	289.757	291.380	293.003	294.626	296.249	297.872	299.496	301.119	302.742	304.365
738	16.658	16.743	16.828	16.913	16.998	17.083	17.168	17.253	17.338	17.423
	305.988	307.696	309.405	311.113	312.821	314.529	316.237	317.945	319.653	321.361
739	17.508	17.593	17.678	17.763	17.847	17.932	18.017	18.102	18.187	18.272
	323.070	324.863	324.863	324.863	324.863	324.863	324.863	324.863	324.863	324.863

TABLE 7-3
ELEVATION - AREA - CAPACITY DATA
COPAN LAKE, OKLAHOMA
2002 SURVEY

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

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
740	18.357	18.442	18.527	18.612	18.697	18.782	18.867	18.952	19.037	19.122
	341.000	342.878	344.756	346.634	348.512	350.390	352.268	354.146	356.024	357.903
741	19.207	19.292	19.376	19.546	19.546	19.631	19.716	19.801	19.886	26.936
	359.781	361.744	363.706	365.669	367.632	369.595	371.558	373.521	375.484	377.447
742	20.056	20.111	20.165	20.220	20.275	20.329	20.384	20.439	20.494	20.548
	379.410	381.443	383.476	385.509	387.542	389.575	391.608	393.640	395.673	397.706
743	20.603	20.658	20.712	20.767	20.822	20.876	20.931	20.986	21.040	21.095
	399.739	401.827	403.914	406.002	408.089	410.177	412.265	414.352	416.440	418.527
744	21.150	21.204	21.259	21.314	21.369	21.423	21.478	21.533	21.587	21.642
	420.615	422.757	424.899	427.042	429.184	431.326	433.468	435.611	437.753	439.895
745	21.697	21.751	21.806	21.861	21.915	21.970	22.025	22.079	22.134	22.189
	442.037	444.234	446.431	448.628	450.825	453.022	455.219	457.416	459.613	461.810
746	22.244	22.298	22.353	22.408	22.462	22.517	22.572	22.626	22.681	22.736
	464.007	466.259	468.510	470.762	473.013	475.265	477.517	479.768	482.020	484.272
747	22.790	22.845	22.900	22.954	23.009	23.064	23.119	23.173	23.228	23.283
	486.523	488.830	491.136	493.442	495.749	498.055	500.361	502.668	504.974	507.280
748	23.337	23.392	23.447	23.501	23.556	23.611	23.665	23.720	23.775	23.829
	509.587	511.948	514.309	516.670	519.031	521.392	523.753	526.114	528.475	530.836
749	23.884	23.939	23.994	24.048	24.103	24.158	24.212	24.267	24.322	24.376
	533.197	535.612	538.028	540.444	542.860	545.275	547.691	550.107	552.522	554.938

TABLE 7-3
ELEVATION - AREA - CAPACITY DATA
COPAN LAKE, OKLAHOMA
2002 SURVEY

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

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
750	24.431									
	557.354									

TABLE 7-3
ELEVATION-AREA-CAPACITY
COPAN LAKE 17 May 2010

STATION FILE NO. 07174300
BASED ON 2003 SURVEY

AREA IN 1000'S OF AC

ELEV	0	1	2	3	4	5	6	7	8	9
670	.000	.000	.000	.000	.000	.001	.004	.013	.027	.039
680	.052	.063	.070	.077	.084	.092	.103	.120	.140	.165
690	.193	.240	.338	.490	.668	.817	.933	1.016	1.107	1.225
700	1.340	1.485	1.678	1.958	2.215	2.453	2.864	3.240	3.548	3.967
710	4.449	4.665	4.880	5.253	5.626	5.999	6.357	6.716	7.074	7.433
720	7.791	8.209	8.626	9.044	9.461	9.879	10.293	10.706	11.120	11.533
730	12.061	12.588	13.116	13.643	13.877	14.110	14.959	15.809	16.658	17.508
740	18.357	19.207	20.056	20.603	21.150	21.697	22.244	22.790	23.337	23.884
750	24.431	.000	.000	.000	.000	.000	.000	.000	.000	.000

CAPACITY IN 1000'S OF ACRE-FEET

ELEV	0	1	2	3	4	5	6	7	8	9
670	.000	.000	.000	.000	.000	.001	.003	.012	.032	.065
680	.110	.168	.234	.308	.388	.476	.574	.685	.815	.968
690	1.147	1.363	1.652	2.066	2.645	3.388	4.263	5.237	6.299	7.465
700	8.747	10.160	11.741	13.559	15.646	17.980	20.638	23.690	27.084	30.842
710	35.050	39.607	44.379	49.446	54.885	60.698	66.876	73.412	80.307	87.561
720	95.173	103.173	111.590	120.425	129.678	139.348	149.434	159.933	170.846	182.173
730	193.970	206.294	219.146	232.526	246.286	260.279	274.814	290.198	306.431	323.514
740	341.447	360.229	379.860	400.190	421.066	442.490	464.460	486.977	510.041	533.651
750	557.809	.000	.000	.000	.000	.000	.000	.000	.000	.000

TABLE 7-3
ELEVATION-AREA-CAPACITY

COPAN LAKE 17 May 2010

STATION FILE NO. 07174300
BASED ON 2003 SURVEY

TABLE NO. 1

POOL ELEV [FT. NGVD]	CAPACITY [1000'S OF ACRE-FEET]									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
670.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
671.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
672.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
673.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
674.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001
675.0	.001	.001	.001	.001	.001	.001	.002	.002	.002	.003
676.0	.003	.004	.004	.005	.005	.006	.007	.008	.009	.010
677.0	.012	.013	.014	.016	.018	.020	.022	.024	.026	.029
678.0	.032	.034	.037	.040	.043	.047	.050	.053	.057	.061
679.0	.065	.069	.073	.077	.081	.086	.090	.095	.100	.105
680.0	.110	.115	.121	.126	.132	.137	.143	.149	.155	.161
681.0	.168	.174	.180	.187	.193	.200	.207	.213	.220	.227
682.0	.234	.241	.248	.255	.263	.270	.277	.285	.292	.300
683.0	.308	.315	.323	.331	.339	.347	.355	.363	.371	.380
684.0	.388	.397	.405	.414	.422	.431	.440	.449	.458	.467
685.0	.476	.485	.495	.504	.514	.523	.533	.543	.553	.563
686.0	.574	.584	.595	.605	.616	.627	.638	.650	.661	.673
687.0	.685	.697	.710	.722	.735	.748	.761	.774	.788	.801
688.0	.815	.829	.844	.858	.873	.888	.904	.919	.935	.951
689.0	.968	.984	1.001	1.018	1.036	1.054	1.072	1.090	1.109	1.127
690.0	1.147	1.166	1.186	1.207	1.228	1.249	1.271	1.293	1.316	1.339
691.0	1.363	1.388	1.413	1.440	1.467	1.495	1.525	1.555	1.586	1.619
692.0	1.652	1.687	1.723	1.760	1.799	1.840	1.882	1.926	1.971	2.018
693.0	2.066	2.116	2.168	2.221	2.276	2.333	2.392	2.453	2.515	2.579
694.0	2.645	2.713	2.782	2.852	2.924	2.998	3.073	3.149	3.227	3.307
695.0	3.388	3.470	3.553	3.638	3.724	3.811	3.899	3.988	4.078	4.170
696.0	4.263	4.356	4.451	4.546	4.642	4.739	4.837	4.936	5.036	5.136
697.0	5.237	5.339	5.442	5.546	5.651	5.756	5.863	5.971	6.079	6.188
698.0	6.299	6.410	6.522	6.636	6.751	6.867	6.984	7.102	7.222	7.343
699.0	7.465	7.588	7.712	7.837	7.964	8.091	8.220	8.350	8.481	8.614

TABLE 7-3
ELEVATION-AREA-CAPACITY
COPAN LAKE 17 May 2010

STATION FILE NO. 07174300
BASED ON 2003 SURVEY

TABLE NO. 1
CAPACITY [1000'S OF ACRE-FEET]

POOL ELEV [FT. NGVD]	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
700.0	8.747	8.882	9.018	9.156	9.295	9.435	9.577	9.721	9.866	10.012
701.0	10.160	10.309	10.460	10.614	10.769	10.926	11.085	11.246	11.409	11.574
702.0	11.741	11.910	12.082	12.257	12.435	12.615	12.798	12.984	13.173	13.365
703.0	13.559	13.756	13.956	14.158	14.363	14.570	14.780	14.993	15.208	15.425
704.0	15.646	15.868	16.093	16.321	16.551	16.783	17.017	17.254	17.494	17.735
705.0	17.980	18.227	18.478	18.734	18.994	19.257	19.525	19.797	20.074	20.354
706.0	20.638	20.926	21.218	21.514	21.814	22.117	22.424	22.735	23.050	23.368
707.0	23.690	24.016	24.344	24.676	25.011	25.349	25.690	26.034	26.381	26.731
708.0	27.084	27.441	27.802	28.167	28.537	28.910	29.288	29.670	30.057	30.447
709.0	30.842	31.241	31.645	32.053	32.467	32.885	33.309	33.737	34.169	34.607
710.0	35.050	35.496	35.944	36.394	36.846	37.301	37.758	38.217	38.678	39.141
711.0	39.607	40.074	40.544	41.016	41.490	41.966	42.444	42.925	43.407	43.892
712.0	44.379	44.869	45.363	45.860	46.361	46.866	47.374	47.886	48.402	48.922
713.0	49.446	49.973	50.504	51.038	51.577	52.119	52.665	53.214	53.767	54.324
714.0	54.885	55.450	56.018	56.590	57.165	57.745	58.328	58.915	59.505	60.100
715.0	60.698	61.299	61.905	62.513	63.126	63.742	64.361	64.985	65.611	66.242
716.0	66.876	67.513	68.154	68.799	69.447	70.099	70.754	71.413	72.076	72.742
717.0	73.412	74.085	74.762	75.443	76.127	76.815	77.506	78.201	78.899	79.601
718.0	80.307	81.016	81.729	82.445	83.165	83.889	84.616	85.347	86.081	86.819
719.0	87.561	88.306	89.054	89.807	90.562	91.322	92.085	92.851	93.622	94.395
720.0	95.173	95.954	96.739	97.529	98.322	99.120	99.922	100.729	101.539	102.354
721.0	103.173	103.996	104.823	105.654	106.490	107.329	108.173	109.021	109.873	110.730
722.0	111.590	112.455	113.324	114.197	115.074	115.955	116.841	117.731	118.625	119.523
723.0	120.425	121.332	122.242	123.157	124.076	124.999	125.927	126.858	127.794	128.734
724.0	129.678	130.626	131.578	132.535	133.495	134.460	135.429	136.403	137.380	138.362
725.0	139.348	140.338	141.332	142.330	143.332	144.339	145.350	146.364	147.383	148.406
726.0	149.434	150.465	151.500	152.540	153.584	154.632	155.684	156.740	157.800	158.865
727.0	159.933	161.006	162.083	163.164	164.249	165.338	166.431	167.529	168.630	169.736
728.0	170.846	171.960	173.078	174.201	175.327	176.458	177.592	178.731	179.874	181.021
729.0	182.173	183.329	184.490	185.656	186.828	188.005	189.187	190.375	191.568	192.766

TABLE 7-3
ELEVATION-AREA-CAPACITY
COPAN LAKE 17 May 2010

STATION FILE NO. 07174300
BASED ON 2003 SURVEY TABLE NO. 1

POOL ELEV [FT. NGVD]	CAPACITY [1000'S OF ACRE-FEET]									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
730.0	193.970	195.178	196.392	197.612	198.836	200.066	201.301	202.541	203.787	205.038
731.0	206.294	207.556	208.822	210.094	211.372	212.654	213.942	215.235	216.533	217.837
732.0	219.146	220.460	221.780	223.105	224.435	225.770	227.111	228.456	229.808	231.164
733.0	232.526	233.891	235.259	236.629	238.002	239.376	240.754	242.133	243.515	244.899
734.0	246.286	247.674	249.066	250.459	251.855	253.253	254.654	256.057	257.462	258.869
735.0	260.279	261.694	263.118	264.550	265.991	267.440	268.898	270.364	271.839	273.322
736.0	274.814	276.314	277.822	279.340	280.865	282.399	283.942	285.493	287.053	288.621
737.0	290.198	291.783	293.376	294.979	296.589	298.208	299.836	301.472	303.116	304.770
738.0	306.431	308.101	309.780	311.467	313.162	314.866	316.579	318.300	320.030	321.768
739.0	323.514	325.269	327.033	328.805	330.585	332.374	334.172	335.978	337.792	339.615
740.0	341.447	343.287	345.135	346.992	348.857	350.731	352.614	354.505	356.404	358.312
741.0	360.229	362.154	364.087	366.029	367.979	369.938	371.906	373.882	375.866	377.859
742.0	379.860	381.868	383.882	385.902	387.926	389.956	391.992	394.033	396.080	398.132
743.0	400.190	402.253	404.321	406.395	408.475	410.559	412.650	414.746	416.847	418.954
744.0	421.066	423.184	425.307	427.436	429.570	431.709	433.855	436.005	438.161	440.323
745.0	442.490	444.662	446.840	449.023	451.212	453.406	455.606	457.811	460.022	462.238
746.0	464.460	466.687	468.920	471.158	473.401	475.650	477.905	480.165	482.430	484.701
747.0	486.977	489.259	491.546	493.839	496.137	498.440	500.750	503.064	505.384	507.710
748.0	510.041	512.377	514.719	517.066	519.419	521.777	524.141	526.511	528.885	531.265
749.0	533.651	536.042	538.439	540.841	543.248	545.661	548.080	550.504	552.933	555.368

TABLE 7-3
ELEVATION-AREA-CAPACITY

COPAN LAKE 17 May 2010

STATION FILE NO. 07174300
BASED ON 2003 SURVEY TABLE NO. 2

POOL ELEV [FT. NGVD]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES] .0	.1	.2	.3	.4	.5	.6	.7	.8	.9
670.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
671.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
672.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
673.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
674.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001
	.000	.000	.000	.000	.001	.001	.001	.001	.001	.001
675.0	.001	.001	.001	.001	.001	.001	.002	.002	.002	.003
	.001	.001	.002	.002	.002	.003	.003	.003	.004	.004
676.0	.003	.004	.004	.005	.005	.006	.007	.008	.009	.010
	.004	.005	.006	.007	.008	.009	.010	.010	.011	.012
677.0	.012	.013	.014	.016	.018	.020	.022	.024	.026	.029
	.013	.014	.016	.017	.019	.020	.022	.023	.024	.026
678.0	.032	.034	.037	.040	.043	.047	.050	.053	.057	.061
	.027	.028	.030	.031	.032	.033	.034	.036	.037	.038
679.0	.065	.069	.073	.077	.081	.086	.090	.095	.100	.105
	.039	.040	.042	.043	.044	.046	.047	.048	.049	.051
680.0	.110	.115	.121	.126	.132	.137	.143	.149	.155	.161
	.052	.053	.054	.055	.056	.058	.059	.060	.061	.062
681.0	.168	.174	.180	.187	.193	.200	.207	.213	.220	.227
	.063	.064	.064	.065	.066	.067	.067	.068	.069	.069
682.0	.234	.241	.248	.255	.263	.270	.277	.285	.292	.300
	.070	.071	.072	.072	.073	.074	.074	.075	.076	.076
683.0	.308	.315	.323	.331	.339	.347	.355	.363	.371	.380
	.077	.078	.079	.079	.080	.081	.081	.082	.083	.083
684.0	.388	.397	.405	.414	.422	.431	.440	.449	.458	.467
	.084	.085	.086	.086	.087	.088	.089	.090	.090	.091
685.0	.476	.485	.495	.504	.514	.523	.533	.543	.553	.563
	.092	.093	.094	.095	.097	.098	.099	.100	.101	.102

TABLE 7-3
ELEVATION-AREA-CAPACITY

COPAN LAKE 17 May 2010

STATION FILE NO. 07174300
BASED ON 2003 SURVEY TABLE NO. 2

POOL ELEV [FT. NGVD]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES] .0	.1	.2	.3	.4	.5	.6	.7	.8	.9
686.0	.574	.584	.595	.605	.616	.627	.638	.650	.661	.673
	.103	.105	.106	.108	.110	.112	.113	.115	.117	.118
687.0	.685	.697	.710	.722	.735	.748	.761	.774	.788	.801
	.120	.122	.124	.126	.128	.130	.132	.134	.136	.138
688.0	.815	.829	.844	.858	.873	.888	.904	.919	.935	.951
	.140	.143	.145	.148	.150	.153	.155	.158	.160	.163
689.0	.968	.984	1.001	1.018	1.036	1.054	1.072	1.090	1.109	1.127
	.165	.168	.171	.174	.176	.179	.182	.185	.188	.190
690.0	1.147	1.166	1.186	1.207	1.228	1.249	1.271	1.293	1.316	1.339
	.193	.198	.203	.207	.212	.217	.221	.226	.231	.235
691.0	1.363	1.388	1.413	1.440	1.467	1.495	1.525	1.555	1.586	1.619
	.240	.250	.260	.269	.279	.289	.299	.309	.319	.328
692.0	1.652	1.687	1.723	1.760	1.799	1.840	1.882	1.926	1.971	2.018
	.338	.353	.368	.384	.399	.414	.429	.444	.460	.475
693.0	2.066	2.116	2.168	2.221	2.276	2.333	2.392	2.453	2.515	2.579
	.490	.508	.526	.544	.561	.579	.597	.615	.632	.650
694.0	2.645	2.713	2.782	2.852	2.924	2.998	3.073	3.149	3.227	3.307
	.668	.683	.698	.713	.728	.743	.757	.772	.787	.802
695.0	3.388	3.470	3.553	3.638	3.724	3.811	3.899	3.988	4.078	4.170
	.817	.829	.840	.852	.863	.875	.887	.898	.910	.922
696.0	4.263	4.356	4.451	4.546	4.642	4.739	4.837	4.936	5.036	5.136
	.933	.941	.950	.958	.966	.975	.983	.991	.999	1.008
697.0	5.237	5.339	5.442	5.546	5.651	5.756	5.863	5.971	6.079	6.188
	1.016	1.025	1.034	1.043	1.053	1.062	1.071	1.080	1.089	1.098
698.0	6.299	6.410	6.522	6.636	6.751	6.867	6.984	7.102	7.222	7.343
	1.107	1.119	1.131	1.143	1.154	1.166	1.178	1.190	1.202	1.213
699.0	7.465	7.588	7.712	7.837	7.964	8.091	8.220	8.350	8.481	8.614
	1.225	1.237	1.248	1.260	1.271	1.283	1.294	1.306	1.317	1.329
700.0	8.747	8.882	9.018	9.156	9.295	9.435	9.577	9.721	9.866	10.012
	1.340	1.355	1.369	1.384	1.398	1.413	1.427	1.442	1.456	1.471
701.0	10.160	10.309	10.460	10.614	10.769	10.926	11.085	11.246	11.409	11.574
	1.485	1.504	1.524	1.543	1.562	1.582	1.601	1.620	1.640	1.659

TABLE 7-3
ELEVATION-AREA-CAPACITY

COPAN LAKE 17 May 2010

STATION FILE NO. 07174300
BASED ON 2003 SURVEY TABLE NO. 2

POOL ELEV [FT. NGVD]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES] .0	.1	.2	.3	.4	.5	.6	.7	.8	.9
702.0	11.741	11.910	12.082	12.257	12.435	12.615	12.798	12.984	13.173	13.365
	1.678	1.706	1.734	1.762	1.790	1.818	1.846	1.874	1.902	1.930
703.0	13.559	13.756	13.956	14.158	14.363	14.570	14.780	14.993	15.208	15.425
	1.958	1.984	2.010	2.035	2.061	2.087	2.112	2.138	2.164	2.189
704.0	15.646	15.868	16.093	16.321	16.551	16.783	17.017	17.254	17.494	17.735
	2.215	2.239	2.263	2.286	2.310	2.334	2.358	2.382	2.405	2.429
705.0	17.980	18.227	18.478	18.734	18.994	19.257	19.525	19.797	20.074	20.354
	2.453	2.494	2.535	2.576	2.618	2.659	2.700	2.741	2.782	2.823
706.0	20.638	20.926	21.218	21.514	21.814	22.117	22.424	22.735	23.050	23.368
	2.864	2.902	2.939	2.977	3.014	3.052	3.090	3.127	3.165	3.203
707.0	23.690	24.016	24.344	24.676	25.011	25.349	25.690	26.034	26.381	26.731
	3.240	3.271	3.302	3.332	3.363	3.394	3.425	3.456	3.487	3.517
708.0	27.084	27.441	27.802	28.167	28.537	28.910	29.288	29.670	30.057	30.447
	3.548	3.590	3.632	3.674	3.716	3.758	3.799	3.841	3.883	3.925
709.0	30.842	31.241	31.645	32.053	32.467	32.885	33.309	33.737	34.169	34.607
	3.967	4.015	4.063	4.112	4.160	4.208	4.256	4.305	4.353	4.401
710.0	35.050	35.496	35.944	36.394	36.846	37.301	37.758	38.217	38.678	39.141
	4.449	4.471	4.492	4.514	4.536	4.557	4.579	4.600	4.622	4.643
711.0	39.607	40.074	40.544	41.016	41.490	41.966	42.444	42.925	43.407	43.892
	4.665	4.687	4.708	4.730	4.751	4.773	4.794	4.816	4.837	4.859
712.0	44.379	44.869	45.363	45.860	46.361	46.866	47.374	47.886	48.402	48.922
	4.880	4.917	4.955	4.992	5.029	5.067	5.104	5.141	5.179	5.216
713.0	49.446	49.973	50.504	51.038	51.577	52.119	52.665	53.214	53.767	54.324
	5.253	5.290	5.328	5.365	5.402	5.440	5.477	5.514	5.551	5.589
714.0	54.885	55.450	56.018	56.590	57.165	57.745	58.328	58.915	59.505	60.100
	5.626	5.663	5.701	5.738	5.775	5.813	5.850	5.887	5.924	5.962
715.0	60.698	61.299	61.905	62.513	63.126	63.742	64.361	64.985	65.611	66.242
	5.999	6.035	6.071	6.107	6.142	6.178	6.214	6.250	6.286	6.321
716.0	66.876	67.513	68.154	68.799	69.447	70.099	70.754	71.413	72.076	72.742
	6.357	6.393	6.429	6.465	6.501	6.537	6.573	6.608	6.644	6.680
717.0	73.412	74.085	74.762	75.443	76.127	76.815	77.506	78.201	78.899	79.601
	6.716	6.752	6.788	6.824	6.859	6.895	6.931	6.967	7.003	7.038

TABLE 7-3
ELEVATION-AREA-CAPACITY

COPAN LAKE 17 May 2010

STATION FILE NO. 07174300
BASED ON 2003 SURVEY TABLE NO. 2

POOL ELEV [FT. NGVD]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES] .0	.1	.2	.3	.4	.5	.6	.7	.8	.9
718.0	80.307	81.016	81.729	82.445	83.165	83.889	84.616	85.347	86.081	86.819
	7.074	7.110	7.146	7.182	7.218	7.254	7.290	7.325	7.361	7.397
719.0	87.561	88.306	89.054	89.807	90.562	91.322	92.085	92.851	93.622	94.395
	7.433	7.469	7.505	7.541	7.576	7.612	7.648	7.684	7.720	7.755
720.0	95.173	95.954	96.739	97.529	98.322	99.120	99.922	100.729	101.539	102.354
	7.791	7.833	7.875	7.917	7.958	8.000	8.042	8.084	8.125	8.167
721.0	103.173	103.996	104.823	105.654	106.490	107.329	108.173	109.021	109.873	110.730
	8.209	8.251	8.292	8.334	8.376	8.418	8.459	8.501	8.543	8.584
722.0	111.590	112.455	113.324	114.197	115.074	115.955	116.841	117.731	118.625	119.523
	8.626	8.668	8.710	8.752	8.793	8.835	8.877	8.919	8.960	9.002
723.0	120.425	121.332	122.242	123.157	124.076	124.999	125.927	126.858	127.794	128.734
	9.044	9.086	9.127	9.169	9.211	9.253	9.294	9.336	9.378	9.419
724.0	129.678	130.626	131.578	132.535	133.495	134.460	135.429	136.403	137.380	138.362
	9.461	9.503	9.545	9.587	9.628	9.670	9.712	9.754	9.795	9.837
725.0	139.348	140.338	141.332	142.330	143.332	144.339	145.350	146.364	147.383	148.406
	9.879	9.920	9.962	10.003	10.045	10.086	10.127	10.169	10.210	10.252
726.0	149.434	150.465	151.500	152.540	153.584	154.632	155.684	156.740	157.800	158.865
	10.293	10.334	10.376	10.417	10.458	10.500	10.541	10.582	10.623	10.665
727.0	159.933	161.006	162.083	163.164	164.249	165.338	166.431	167.529	168.630	169.736
	10.706	10.748	10.789	10.830	10.872	10.913	10.955	10.996	11.037	11.079
728.0	170.846	171.960	173.078	174.201	175.327	176.458	177.592	178.731	179.874	181.021
	11.120	11.161	11.203	11.244	11.285	11.327	11.368	11.409	11.451	11.492
729.0	182.173	183.329	184.490	185.656	186.828	188.005	189.187	190.375	191.568	192.766
	11.533	11.586	11.639	11.691	11.744	11.797	11.850	11.903	11.955	12.008
730.0	193.970	195.178	196.392	197.612	198.836	200.066	201.301	202.541	203.787	205.038
	12.061	12.114	12.167	12.219	12.272	12.325	12.377	12.430	12.483	12.535
731.0	206.294	207.556	208.822	210.094	211.372	212.654	213.942	215.235	216.533	217.837
	12.588	12.641	12.694	12.747	12.799	12.852	12.905	12.958	13.010	13.063
732.0	219.146	220.460	221.780	223.105	224.435	225.770	227.111	228.456	229.808	231.164
	13.116	13.169	13.222	13.274	13.327	13.380	13.432	13.485	13.538	13.590
733.0	232.526	233.891	235.259	236.629	238.002	239.376	240.754	242.133	243.515	244.899
	13.643	13.667	13.690	13.713	13.737	13.760	13.783	13.807	13.830	13.854

TABLE 7-3
ELEVATION-AREA-CAPACITY

COPAN LAKE 17 May 2010

STATION FILE NO. 07174300
BASED ON 2003 SURVEY TABLE NO. 2

POOL ELEV [FT. NGVD]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES] .0	.1	.2	.3	.4	.5	.6	.7	.8	.9
734.0	246.286	247.674	249.066	250.459	251.855	253.253	254.654	256.057	257.462	258.869
	13.877	13.900	13.924	13.947	13.970	13.994	14.017	14.040	14.064	14.087
735.0	260.279	261.694	263.118	264.550	265.991	267.440	268.898	270.364	271.839	273.322
	14.110	14.195	14.280	14.365	14.450	14.535	14.620	14.704	14.789	14.874
736.0	274.814	276.314	277.822	279.340	280.865	282.399	283.942	285.493	287.053	288.621
	14.959	15.044	15.129	15.214	15.299	15.384	15.469	15.554	15.639	15.724
737.0	290.198	291.783	293.376	294.979	296.589	298.208	299.836	301.472	303.116	304.770
	15.809	15.894	15.979	16.064	16.149	16.234	16.319	16.403	16.488	16.573
738.0	306.431	308.101	309.780	311.467	313.162	314.866	316.579	318.300	320.030	321.768
	16.658	16.743	16.828	16.913	16.998	17.083	17.168	17.253	17.338	17.423
739.0	323.514	325.269	327.033	328.805	330.585	332.374	334.172	335.978	337.792	339.615
	17.508	17.593	17.678	17.763	17.848	17.933	18.017	18.102	18.187	18.272
740.0	341.447	343.287	345.135	346.992	348.857	350.731	352.614	354.505	356.404	358.312
	18.357	18.442	18.527	18.612	18.697	18.782	18.867	18.952	19.037	19.122
741.0	360.229	362.154	364.087	366.029	367.979	369.938	371.906	373.882	375.866	377.859
	19.207	19.292	19.377	19.462	19.547	19.632	19.716	19.801	19.886	19.971
742.0	379.860	381.868	383.882	385.902	387.926	389.956	391.992	394.033	396.080	398.132
	20.056	20.111	20.166	20.220	20.275	20.330	20.384	20.439	20.494	20.548
743.0	400.190	402.253	404.321	406.395	408.475	410.559	412.650	414.746	416.847	418.954
	20.603	20.658	20.712	20.767	20.822	20.877	20.931	20.986	21.041	21.095
744.0	421.066	423.184	425.307	427.436	429.570	431.709	433.855	436.005	438.161	440.323
	21.150	21.205	21.260	21.314	21.369	21.424	21.478	21.533	21.588	21.642
745.0	442.490	444.662	446.840	449.023	451.212	453.406	455.606	457.811	460.022	462.238
	21.697	21.752	21.806	21.861	21.916	21.971	22.025	22.080	22.135	22.189
746.0	464.460	466.687	468.920	471.158	473.401	475.650	477.905	480.165	482.430	484.701
	22.244	22.299	22.353	22.408	22.462	22.517	22.572	22.626	22.681	22.736
747.0	486.977	489.259	491.546	493.839	496.137	498.440	500.750	503.064	505.384	507.710
	22.790	22.845	22.899	22.954	23.009	23.064	23.118	23.173	23.228	23.282
748.0	510.041	512.377	514.719	517.066	519.419	521.777	524.141	526.511	528.885	531.265
	23.337	23.392	23.447	23.501	23.556	23.611	23.665	23.720	23.775	23.829
749.0	533.651	536.042	538.439	540.841	543.248	545.661	548.080	550.504	552.933	555.368
	23.884	23.939	23.993	24.048	24.103	24.158	24.212	24.267	24.322	24.376

EXHIBIT A

SUPPLEMENTARY PERTINENT DATA

COPAN LAKE

EXHIBIT A

SUPPLEMENTARY PERTINENT DATA

COPAN LAKE

TABLE OF CONTENTS

EXHIBIT A
SUPPLEMENTARY PERTINENT DATA COPAN LAKE

1 - GENERAL INFORMATION

Other names for project	None
Location	(State of Oklahoma) Caney River Basin, Little Caney Creek, river mile 7.4.
Type of Project	Dam and Lake
Objectives of Regulation	Multipurpose - Flood control, water supply, fish and wildlife, water quality, recreation and stream flow aesthetics.
Project Owner	US Government
Operating Agency	US Army Corps of Engineers. The normal working hours of operation for weekdays are 7:45 a.m. to 4:30 p.m. Working hours for weekends, holidays and nights vary. Working hours under flood emergency conditions are 24 hours.
Regulating Agency	US Army Corps of Engineers.
Water supply contract	Contract No. DACW56-81-C-0114 dated 15 September 1981 with the Copan Public Works Authority for 5,000 acre-feet of storage, with a yield of 2.0 m.g.d.
Water rights	At present, no water rights have been granted on the Little Caney River below Copan Dam. Downstream water rights of 37,025 acre-feet have been granted on the Caney River from the confluence with the Little Caney River to the confluence with the Verdigris River.
Code of Federal Regulations, Title 33 (applies to Section 7 Project)	Does not apply

Federal Power Commission License	No power recommended for this project
Other inter-agency agreement	None
Project cost to date (FY 09)	$99,719,143.36
Closure date	April 1983
Special project features	None
Other	None

2 - LAKE INFORMATION

ELEVATIONS, AREAS, AND STORAGES

Feature	Elevation (feet, NGVD)	Area (acres)	Storage (acre-feet)	Runoff (inches) (1)
Top of dam	745.0	-	—	—
Maximum design pool	739.1	17,593	325,200	12.08
Top of induced surcharge	738.0	16,658	306,400	11.38
Top of flood control pool	732.0	13,116	219,100	8.14
Top of conservation pool	710.0	4,449	35,000	1.30
Top of inactive pool	687.5	130	750	0.03
Top of dead storage	675.5	2	2	-
Streambed	672	-	-	-
100-year sediment	-	-	11,800(2)	-
Water supply storage	-	-	7,500(3)	-
Water quality storage	-	-	26,100(4)	-

(1) Drainage area is 505 square miles.
(2) 9,200 acre-feet in the conservation pool and 2,600 acre-feet in the flood control pool.
(3) 7,500 acre-feet has estimated yield of 3 m.g.d..
(4) 26,100 acre-feet has estimated yield of 16 m.g.d..

Federal Power Commission License	No power recommended for this project
Other inter-agency agreement	None
Project cost	$67,600,000 Scheduled
Closure date	April 1983
Special project features	None
Other	None

2 - LAKE INFORMATION

ELEVATIONS, AREAS, AND STORAGES

Feature	Elevation (feet, NGVD)	Area (acres)	Storage (acre-feet)	Runoff (inches) (1)
Top of dam	745.0	-	_	_
Maximum design pool	739.1	17,593	325,200	12.08
Top of induced surcharge	738.0	16,658	306,400	11.38
Top of flood control pool	732.0	13,116	219,100	8.14
Top of conservation pool	710.0	4,449	35,000	1.30
Top of inactive pool	687.5	130	750	0.03
Top of dead storage	675.5	2	2	-
Streambed	672	-	-	-
100-year sediment	-	-	11,800(2)	-
Water supply storage	-	-	7,500(3)	-
Water quality storage	-	-	26,100(4)	-

(1) Drainage area is 505 square miles.
(2) 9,200 acre-feet in the conservation pool and 2,600 acre-feet in the flood control pool.
(3) 7,500 acre-feet has estimated yield of 3 m.g.d..
(4) 26,100 acre-feet has estimated yield of 16 m.g.d..

MAJOR FLOODS PAST DAMSITE

Date	Peak flow (c.f.s.)	Volume (acre-feet)	Runoff (inches) (1)
16 May-25 June 1957	1 5,600	293,000	10.88
7-21 May 1943	33,300	226,000	8.39
1-13 May 1961	23,700	188,000	6.98
29 Sep – 4 Oct 1986	139,100	415,800	10.75
26 Jun – 5 Jul 2007	48,000	195,600	7.26

(1) One inch of runoff = 26,930 acre-feet.

Real estate taking for land fee title	Fee simple title has been acquired to land required for construction of the dam and for operation and maintenance purposes in the area designated as the dam site and public-use area. In the reservoir area, the acquisition guideline is elevation 736.0 feet, NGVD. The fee purchase limits in the main body of the lake generally encompass the acquisition guideline with a minimum distance of 300 feet measured horizontally from the top of conservation pool, elevation 710.0 feet, NGVD. This contains 15,685 acres.
Real estate taking for Easement	Flowage easements were obtained in some extreme upper reaches encompassing 1,550 acres.
Range of clearing	Lower limit - 696 feet, NGVD. Upper limit - 711 feet, NGVD.
Pool elevation corresponding to discharge capability of maximum non-damaging flow rate downstream	Non-damaging channel capacity immediately below Copan Dam is estimated at 3,000 c.f.s. This flow rate can be discharged when the lake level is at elevation 699.3 and above.
Reservoir length at top of conservation pool	6 miles

Reservoir length at top of flood pool	9 miles
Shoreline length at top of conservation pool	30 miles
Safety aspects, possibly requiring warning	All access roads are constructed above elevation 732. Some campsite facilities such as picnic facilities, wood vault toilets and change-houses will be inundated above elevation 720 (about 2-year flood frequency). The Lake Manager will make every effort to inform campsite users when roads and campsites are closed.
Emergency drawdown	Copan Lake has one 36-inch low flow pipe with a butterfly valve with an invert elevation at 675.5. The minimum time required to empty from the spillway crest (elevation 696.5), to top of inactive pool (elevation 687.5) is 15 days.

3 – HYDROLOGY

Drainage area	505 square miles
<u>Spillway Design Flood</u>	
Maximum water surface elev.	739.1 feet, NGVD
Peak inflow (into full pool)	232,000 c.f.s.
Peak inflow (natural channel flow)	169,000 c.f.s.
Total storm runoff (into full pool)	20.58 inches
Volume (into full pool)	554,000 acre-feet
Maximum outflow	199,070 c.f.s.
Duration of flood	4 days
<u>Standard Project Flood</u>	
Maximum water surface elev.	738.1 feet, NGVD
Peak inflow (into full pool)	103,800 c.f.s.
Total storm runoff	10.04 inches
Volume (into full pool)	270,400 acre-feet
Maximum outflow	81,500 c.f.s.
Duration of flood	4 days

Climate	Moderate
One inch of runoff	26,930 acre-feet
Storm types	Mainly thunderstorms
Flood Seasons	Primary flood period March through July with a secondary flood period of September through November; however, floods have occurred in every month of the year.
Low flow season	August, December through February; however, low flow can occur at any time of the year.
Minimum daily flow	Period 1935 through 2009 zero flow has occurred on many occasions.
Minimum monthly flow	Period 1936 through 2009 zero flow has occurred on many occasions.
Average annual flow	247,900 acre-feet (1936-2009)
Maximum annual flow and year	792,500 A.F. 1986 from records (1926-2009)
Maximum monthly flow and date	332,400 acre-feet in Oct 1986
Maximum annual flow and date	792,500 acre-feet in 1986
Maximum instantaneous flow and date	139,100 c.f.s. on 4 October 1986
Maximum flood volume and date	293,000 acre-feet flood of May-June 1957
Name and location of key stream flow stations	Bartlesville, Oklahoma, Caney River (River mile 68.6). Ramona, Oklahoma, Caney River (river Mile 32.0). Claremore, Oklahoma, Verdigris River (River mile 76.0).

Type of hydrometeorological data recorded at dam site	Maximum and minimum temperatures, recording and standard rainfall measurements, wind speed and direction, pool elevations (recording), and tail water stages (recording and staff).
Number of precipitation stations used in hydrologic forecasting inflow	Six recording, eight non-recording.
Number of sediment ranges	24
Number of degradation ranges	6

4 – EMBANKMENT

Location	Little Caney, river mile 7.4.
Purpose	Flood control, water supply, fish & wildlife, water quality, recreation and stream flow aesthetics
Type	Non-overflow embankment
Type of fill	Rolled earth fill with impervious core
Slope Protection	Riprap on upstream face; grassed on downstream face.
Height	73 feet above streambed
Length	7,730 feet
Top Elevation	745.0 feet, NGVD
Design Flood	Probable Maximum Flood
Freeboard	5.9 feet above maximum pool

Used for Roadway	Yes, a 24-foot-wide double bituminous surfaced roadway across the embankment and spillway.
Elevation of stream bed	672.0 feet, NGVD

5 – SPILLWAY

Location	Near right abutment
Type	Controlled concrete valley ogee weir
Crest Elevation	696.5 feet, NGVD
Net overflow length	200 feet
Induced Surcharge	6 feet above top of flood pool, 738 feet, N.G.V.D.
Design head	42.5 feet
Maximum discharge capacity	199,070 c.f.s.
Bridge deck elevation	745.0 feet, N.G.V.D.
Time required to open and close all gates	Gates raise or lower separately or together at a rate of 1 foot per minute with stops every 1/2 foot from closed to intermediate position (elevation 713.48), then continuous to fully open.

6 – LEVEE

Location	West side of city of Copan, KS
Purpose	Urban protection
Type	Non-overflow, rolled earth levee
Type of fill	Impervious (riverside)
Slope protection	Riprap on riverside and grass on inside
Height (maximum)	24 feet
Length	17,100 feet
Top of dam elevation	742.5 south end; 743.5 north end
Design flood	Standard Project Flood
Freeboard	3 to 3.5 feet
Flood closure structure	None
Drainage structures	Two 42-inch-diameter CMP gravity drains with flap gates. Three 24-inch-diameter steel pump lines with three 13,500-gpm, 150-HP pumps.

7 - OUTLET FACILITIES

WATER SUPPLY

Location	Through pier, monolith No. 7
Type of outlet and size	Circular, 12-inch diameter
Type of gate	Deferred (pipe blind flanged)
Entrance invert elevation	680.25 feet, N.G.V.D.

WATER QUALITY

Location	Through pier, monolith No. 7
Type of outlet and size	Circular, 36-inch diameter
Entrance invert elevation	675.5 feet, N.G.V.D.
Capacity at top of conservation pool	210 c.f.s.

8 - CONTROL POINTS

a. BARTLESVILLE GAGE

Location	At SH 123 bridge, north part of Bartlesville at low water dam, river mile 69.2.
Purpose of gage	Used by Corps of Engineers to regulate Copan and Hulah Lakes and determine benefits.
Channel and floodplain description	The channel is well defined, crooked and laden with drift along its sloping, caving, and sloughing sides. The flood plain is broad, with trees, cultivated crops, oil wells and some urban development.
Uncontrolled drainage area	155 square miles
Treatment of uncontrolled runoff	Contributes to flood control target flows
Target flow rate	Bank-full stage 13.0 feet, 12,600 c.f.s. (current rating).
Time of crest travel	Copan Dam to Bartlesville gage -24 hours.
Monitoring provisions	Water surface elevation is recorded by electronic logger. The gage can be polled by satellite platform (8-202-899-6595). Sediment measurements are also made.

a. RAMONA GAGE

Location	Washington County road bridge, 4-1/2 miles southeast of Ramona, Oklahoma, at river mile 32.0
Purpose of gage	Used by US Geological Survey as source of published record; by National Weather Service for flood forecasting; by Corps of Engineers for regulation of Copan and Hulah Lakes and computation of benefits.
Channel and floodplain description	Channel is relatively narrow and deep, with heavily wooded banks and is normal to bridge for about 800 feet upstream and 1,000 feet downstream. The flood plain is in excess of 1 mile wide and is composed of agricultural land and some heavily wooded areas.
Uncontrolled drainage area	718 square miles
Treatment of uncontrolled runoff	Contributes to flood control target flow
Target flow rate	Bank-full stage in the reach is 26 feet, 14,700 c.f.s. (current rating).
Time of crest travel	Copan Dam to Ramona gage - 48 hours.
Monitoring provisions	An electronic logger is used to monitor the water elevation. The record is processed to compile the published record of stages and flows. Water quality and sedimentation samples are taken on a regular schedule. Discharge measurements are made on schedule and as needed.
Channel usage	Fishing and fish spawning

b. RAMONA GAGE

Location	Washington County road bridge, 4-1/2 miles southeast of Ramona, Oklahoma, at river mile 32.0
Purpose of gage	Used by US Geological Survey as source of published record; by National Weather Service for flood forecasting; by Corps of Engineers for regulation of Copan and Hulah Lakes and computation of benefits.
Channel and floodplain description	Channel is relatively narrow and deep, with heavily wooded banks and is normal to bridge for about 800 feet upstream and 1,000 feet downstream. The flood plain is in excess of 1 mile wide and is composed of agricultural land and some heavily wooded areas.
Uncontrolled drainage area	718 square miles
Treatment of uncontrolled runoff	Contributes to flood control target flow
Target flow rate	Bank-full stage in the reach is 26 feet, 14,700 c.f.s. (current rating).
Time of crest travel	Copan Dam to Ramona gage - 48 hours.
Monitoring provisions	An electronic logger is used to monitor the water elevation. The record is processed to compile the published record of stages and flows. The gage is polled by satellite platform (8-202-899-6595). Water quality and sedimentation samples are taken on a regular schedule. Discharge measurements are made on schedule and as needed.
Channel usage	Fishing and fish spawning

EXHIBIT B

STANDING INSTRUCTIONS TO LAKE MANAGER

COPAN LAKE

EXHIBIT B

STANDING INSTRUCTIONS TO LAKE MANAGER

COPAN LAKE

TABLE OF CONTENTS

TABLE INDEX

EXHIBIT B
STANDING INSTRUCTIONS TO LAKE MANAGER
COPAN LAKE

I - GENERAL

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

2. Data Reporting Instructions. Daily lake data from Copan Lake will be submitted to the Water Management Section, Hydrology-Hydraulics Branch, Tulsa District Office (telephone 918-669-7539 or VHF-FM radio, call signal WUI-3). The Water Management Section office is manned from 7:00 a.m. to 4:30 p.m. daily and various hours on weekends and holidays. Data for nonworking days shall be read from the recorder chart and submitted the following workday. Data will be submitted in accordance with the form shown on Plate 5-3. Should unusual conditions arise during nonworking hours, one of the persons listed on page i should be contacted. The following data should be included in the daily report:

a. As of 8 a.m. Pool elevations at 8 a.m., and 12 noon, 4 p.m., and 12 midnight of the previous day; number of gates open; amount of gate opening; outflow stage at 8 a.m.; precipitation and pan evaporation in inches for the preceding 24 hours (7 a.m. to 7 a.m.); and wind velocity and direction (at 8 a.m.).

b. Each Gate Operation. Date and time of gate operation, number of gates open and amount of gate opening before and after gate operation, 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 Water Management Section as they occur.

c. During Flood Periods. In addition to subparagraphs a and b above, additional reports may be required by the Water Management Section.

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

(1) At 8 a.m. all precipitation that has occurred during the preceding 24 hours, 7 a.m. to 7 a.m. (covered by routine report on working days).

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

(3) At 7 p.m. when 0.50 inch or more of precipitation has occurred since the 8 a.m. report and no 1 p.m. report was made, or if it has continued to rain since reporting at 1 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. During non-working hours, the report should be made to one of the persons listed on page i.

(5) After office hours, rainfall reports should be made as indicated in sub-section (4) above; however, if no contact with the Water Management Section personnel can be made, rainfall reports should be made to the National Weather Service, Tulsa, Oklahoma at telephone 1-800-722-2778.

3. Reporting Unusual Events. Events or conditions not normally encountered in the routine operation of the dam and lake which might endanger the dam or necessitate temporary or permanent revision of the operating procedures such as settlement, movement, or cracking of the earth embankment or abutments; unusual change in seepage rates, or development of new seepage areas; mechanical malfunction or failure; structural settlement, movement, cracking, or vibration; landslides, rockslides, or indications of an impending movement; or an occurrence indicating any degree of jeopardy to the safety of the dam, or to the safety of the public shall be reported promptly to the Water Management Section, Hydrology-Hydraulics Branch.

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

Emergencies. In every case, when a gate change is made a horn is blown to give warning to people immediately downstream of Copan Dam.

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

II - REGULATION PROCEDURES

1. Regulating River Stages and Discharges. The regulation schedules provide that the channel capacity of 3,000 c.f.s. is not to be exceeded insofar as practicable. Floodwaters will be released as rapidly as practicable with consideration given to minimizing flooding of low-water crossing and low-lying farmland. Factors considered in the determination of releases are: maximum inflow into the lake during a rise, general climatic conditions, season of the year with respect to the probability of floods, status of crops in low-lying farmlands, and maximum non-damaging stages or discharges

a. Normal flood control regulations. Copan Lake is regulated to provide flood reduction on the Little Caney River from Copan Dam to the confluence of Little Caney River with the Caney River, and on the Caney River to Lake Hulah, and is coordinated with the flood control regulation of the Arkansas River reservoir system. The following regulations will govern releases from Copan Lake (see Table B-1).

b. Emergency flood control regulations. When communication with the Tulsa District Office is disrupted, the Lake Manager shall, on his own initiative, direct regulation of the lake in accordance with the following schedule (see Table B-2) until communication is restored. In addition, the Lake Manager will immediately make every effort to re-establish communication with the Tulsa District Office. The conduit gates shall be operated at a uniform opening.

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

TABLE B -1

NORMAL FLOOD CONTROL REGULATION SCHEDULE
COPAN LAKE
LITTLE CANEY RIVER, OKLAHOMA & KANSAS

Lake Stage	Pool Conditions	Regulation
Below 710.0	Rising	Releases will be made to maintain elevation 710.0 but will not be less than the downstream low-flow requirements defined in paragraph 7-07.
710.0 - 732.0	Rising	Make releases using the following schedule as a guide, except that the release when combined with intervening flow downstream, will not exceed channel capacities. The channel capacities are currently estimated to be 3,000 c.f.s. below the dam, 7,000 c.f.s. downstream of the confluence of the Little Caney River and Caney River, a 13-foot stage (12,600 c.f.s.) on the Caney River at the Bartlesville gage, and a 26-foot stage (14,700 c.f.s.) on the Caney River at the Ramona gage. Regulated releases may be made at less than the maximum rate permissible if the rate of release is such that the flood control pool will be empty in approximately 3 days. Releases will be modified to meet target discharges specified by the requirements in Chapter 7 of the Arkansas River Basin Water Control Master Manual for the operation of the Arkansas River System. NOTE: When the predicted volume of runoff from the area above the dam exceeds the available flood control storage, the release schedule may be modified by the District Commander, if available, his designated representative, or the highest ranking official available in the Engineering Division, to obtain maximum benefits under conditions existing in the lake area and in the downstream reaches of the river. The Spillway Gate Regulation Schedule-Inflow Parameter" Plate 7-5 will be used as a guide for making releases.

RELEASE SCHEDULE

Pool Stages	Maximum Allowable Release Rates (c.f.s.)
710.0 – 711.0	750
711.0 – 713.5	1,150
713.5 – 715.0	2,500
715.0 – 732.0	3,000

TABLE B -1 (Continued)

Lake Stage	Pool Conditions	Regulation
732.0 - 738.0	Rising	Releases will be based on inflow forecasts and made such that the pool elevation will not exceed elevation 738.0, if possible. Plate 7-5, Spillway Gate Regulation Schedule Inflow Parameter, will be used as a guide for determining releases so that the lake will not rise beyond the induced surcharge limits. Elevation 738.0 will be maintained, if possible, by opening the spillway gates as necessary to pass inflow or until the gates are fully opened. Releases will be made by operating all the spillway gates at uniform openings.
738.0 or above	Rising	Gates shall be opened to maintain elevation 738.0 or until the gates are in the full opened position.
736.0 or above	Falling	The maximum gate opening attained shall be held until the pool elevation recedes to elevation 736.0.

TABLE B -1 (Continued)

Lake Stage	Pool Conditions	Regulation
736.0 - 732.0	Falling	The maximum gate opening attained shall be held until the pool level recedes an amount sufficient to permit lowering the spillway gates one-half foot without lowering the discharge below inflow. A margin of not less than one-fourth foot between the lake level and the top of the spillway gates shall be maintained at all times. This regulation shall be repeated until the lake level nears elevation 732.0, at which time the outflow shall be made equal to the inflow or the maximum release permissible (as stated below), whichever is greater.
732.0 - 710.0	Falling	Make releases using following schedule as a guide, except that the release, when combined with the intervening area flows downstream, shall not exceed those stages listed under the above rising pool conditions. Target discharges specified by the Arkansas River Basin Water Control Master Manual will always supersede any other designated discharges.

RELEASE SCHEDULE

Pool Stages	Maximum Allowable Release Rates (c.f.s.)
732.0 – 715.0	3,000
715.0 – 713.5	2,500 + Inflow*
713.5 – 712.0	1,150 + Inflow*
712.0 – 711.0	750 + Inflow*
711.0 – 710.0	Transition to downstream low-flow requirements defined in paragraph 7-07

*Forecasted inflow over a 2 to 5 day period, with total release not to exceed 3,000 c.f.s.

TABLE B - 2

EMERGENCY FLOOD CONTROL REGULATION
SCHEDULE

COPAN LAKE, LITTLE CANEY RIVER,
OKLAHOMA & KANSAS

Lake Stage	Pool Conditions	Regulation
Below 710.0	Rising	Continue the releases being made at the time of communication failure.
710.0 - 732.0	Rising	If the lake level is below elevation 728.0, maintain current releases as long as the pool remains below 728.0 or until communication is restored. When lake elevation reaches 728.0, the release will be the maximum of 1) The current release, or 2) The release obtained from the minimum discharge curve on Plate 7-5 (Spillway Gate Regulation Schedule – Inflow Parameter). For determining the minimum discharge in 2), inflows would be determined by using Plate 7-6 (Inflow vs. Rate of Rise Nomograph). The rate of rise of the lake and the average discharge will be computed every 2 hours for the preceding 2 hours. The determined releases will be increased as appropriate, by operating all the spillway gates at uniform openings until all gates are fully open. At no time when the lake is over 728.0 and rising will releases be decreased.
732.0 - 738.0	Rising	Releases shall be made in accordance with the Inflow Parameter Curves on Plate 7-5. (Inflows will be determined by using the Inflow vs. Rate of Rise Nomograph, Plate 7-6).
738.0 or above	Rising	Releases shall be increased by raising the spillway gates to maintain elevation 738.0 or all gates are fully open.
736.0 or above	Falling	Maximum spillway gate openings attained shall be maintained until the lake level recedes to elevation 736.0.

TABLE B-2 (continued)

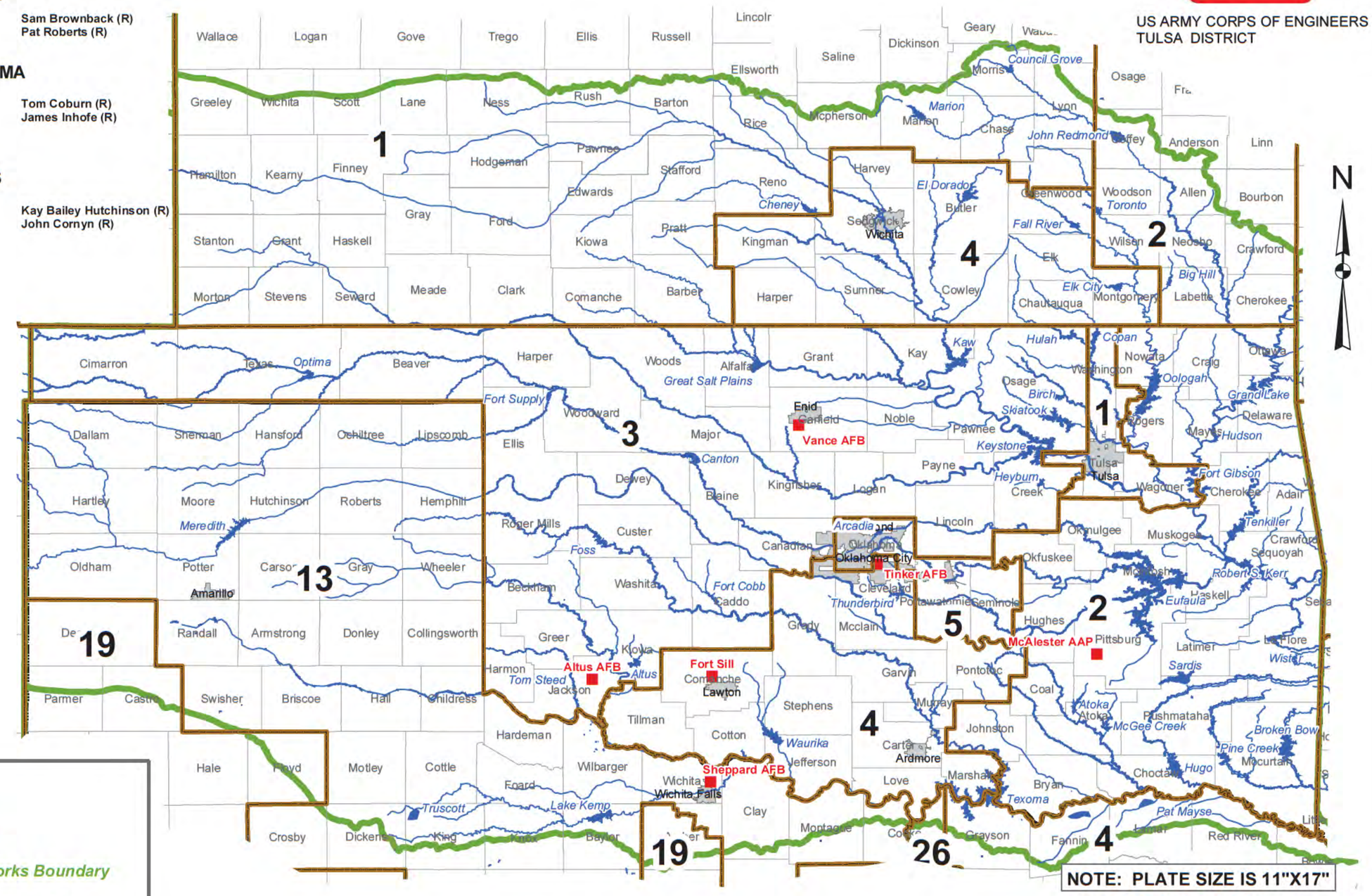
Lake Stage	Pool Conditions	Regulation
736.0 - 732.0	Falling	The maximum spillway gate opening attained shall be held until the lake level recedes an amount sufficient to permit lowering the spillway gates one-half foot without lowering the release below inflow. A margin of not less than one-fourth foot between the lake level and the top of the spillway gates shall be maintained at all times. This operation shall be repeated until the lake level recedes to elevation 732.0, or the release is 3,000 c.f.s..
732.0- 711.0	Falling	If the maximum release rate exceeded 3,000 c.f.s., releases will be adjusted by lowering the spillway gates one-half foot without causing the pool to rise. If the pool begins to rise set the gates back to the previous opening. This operation will be repeated until the release is 3,000 c.f.s.. If the maximum release was less than 3,000 c.f.s., this release will be maintained until the lake level reaches 711.0.
711.0 - 710.0	Falling	Begin a gradual reduction of the release rate (Not to exceed 500 c.f.s. per 2-hour period) so that releases are equal to inflow (the pool is steady) at elevation 710.0.

PLATES AND DRAWINGS

COPAN LAKE

US ARMY CORPS OF ENGINEERS
TULSA DISTRICT

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



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

COPAN LAKE
TULSA DISTRICT PROJECTS

PLATE 1 - 1

Grenola
99
Elk
County
CANEY R
N CANEY CR
CANEY CR
BEE CR
Elk City
Elk City Lake
160
N
Copan Lake Basin
Tulsa
Oklahoma City
VICINITY MAP
160
Liberty
Montgomery
County
169
Sedan
Cedar Vale
166
75
Havana
Peru
Niotaze
166
COPAN LAKE
Dearing
Coffeyville
166
Tyro
Chautauqua
County
Chautauqua
Caney
LITTLE CANEY R
KANSAS
South Coffeyville
OKLAHOMA
Watershed Boundary
Elgin
COTTON CR
Nowata
County
Osage
County
CANEY R
Hulah Lake
99
75
Copan
Wann
10
Washington
County
Dewey
0 2 4 8 12 Miles
Note: Plate size is 11" x 17"
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA
COPAN LAKE
PROJECT LOCATION
AND VICINITY MAP
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 2 - 1

(b) (7)(F)

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

GENERAL PLAN

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

PLATE 2 - 2

(b) (7)(F)

COPAN LAKE

TYPICAL EMBANKMENT SECTIONS

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

PLATE 2 - 3

(b) (7)(F)

COPAN LAKE

SPILLWAY PLAN

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

PLATE 2 - 4

(b) (7)(F)

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

SPILLWAY ELEVATIONS

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

PLATE 2 - 5

(b) (7)(F)

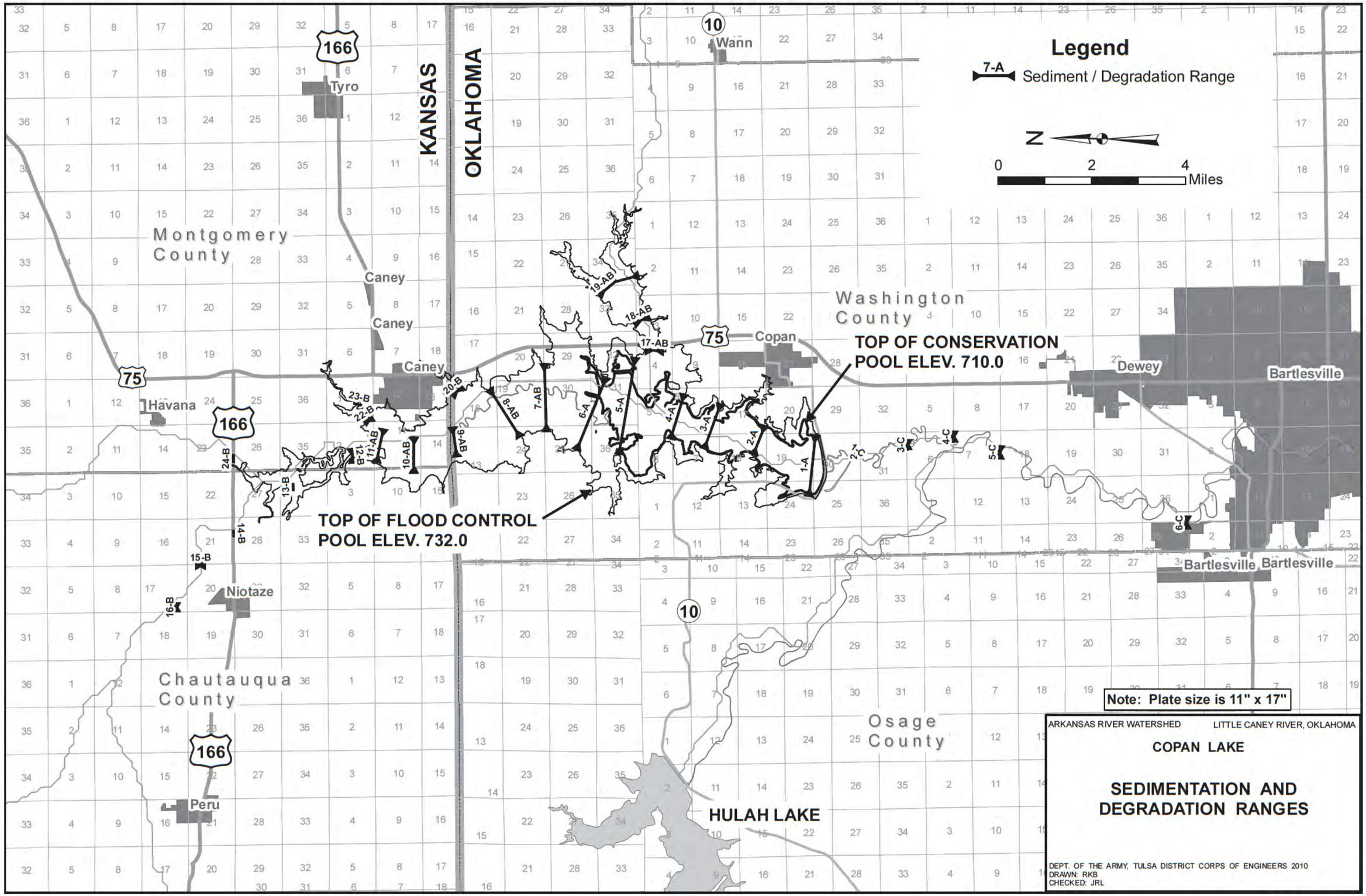
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

SPILLWAY SECTIONS

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

PLATE 2 - 6



Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED — LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

SEDIMENTATION AND DEGRADATION RANGES

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

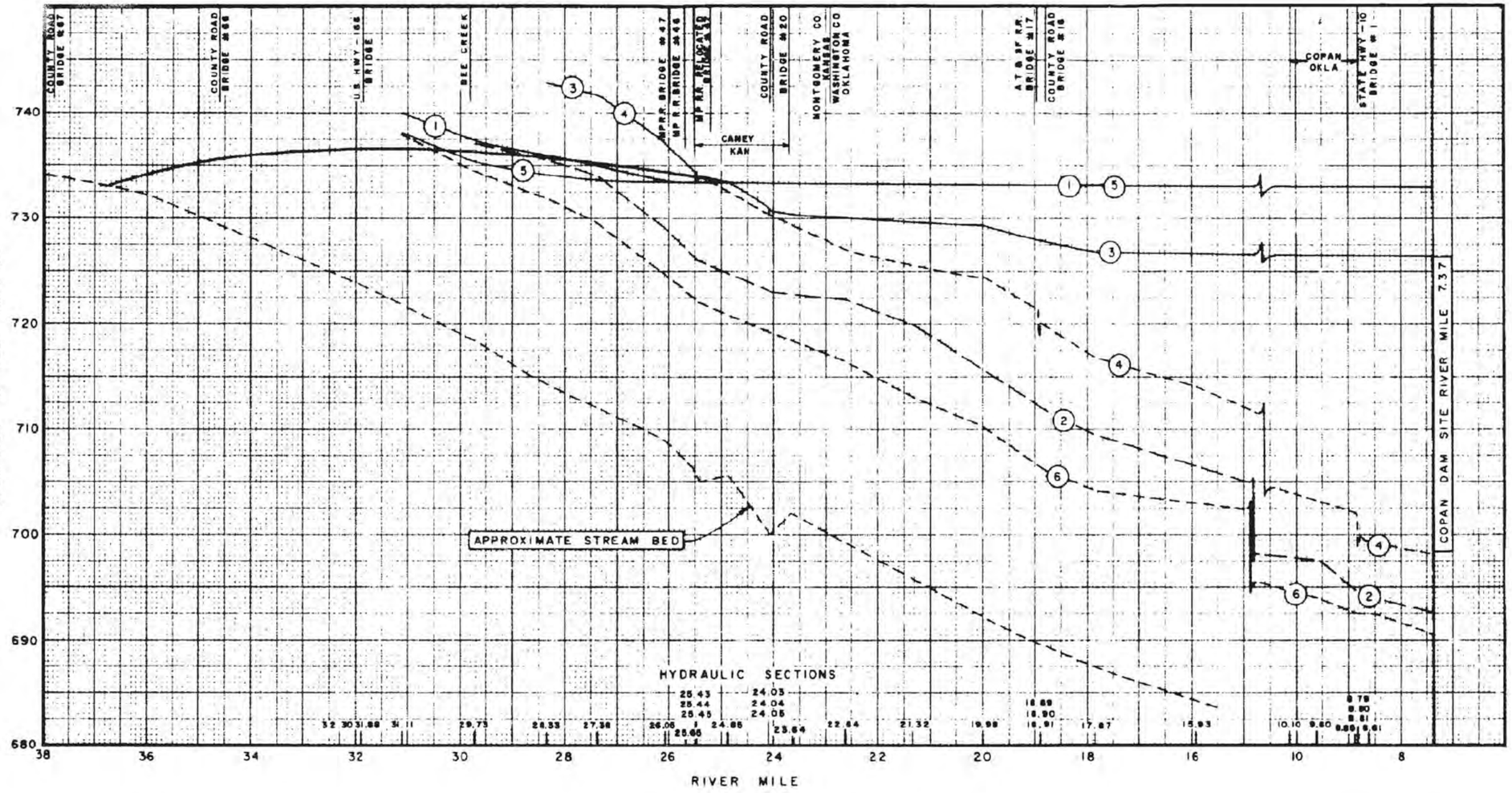
(b) (7)(F)

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

CANEY LEVEE
GENERAL PLAN

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



PROFILE NUMBER	DISCHARGE IN C.F.S.	REMARKS
1	9,150	50 YEAR FLOOD AT MAXIMUM POOL ELEV. 733.2
2	9,150	50 YEAR FLOOD FLOW COINCIDENT WITH MAX. POOL NAT.
3	50,800	50 YEAR FLOOD MAXIMUM FLOW ON POOL ELEV. 726.7
4	50,800	50 YEAR FLOOD UNDER NATURAL CONDITIONS
5	4,000	SELECTED DISCHARGE ON MAXIMUM POOL ELEV 733.2
6	4,000	SELECTED DISCHARGE UNDER NATURAL CONDITIONS

LEGEND

- NATURAL PROFILE
- PROFILE WITH DAM IN PLACE
- ENVELOPE CURVE OF BACKWATER EFFECTS

Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED — LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

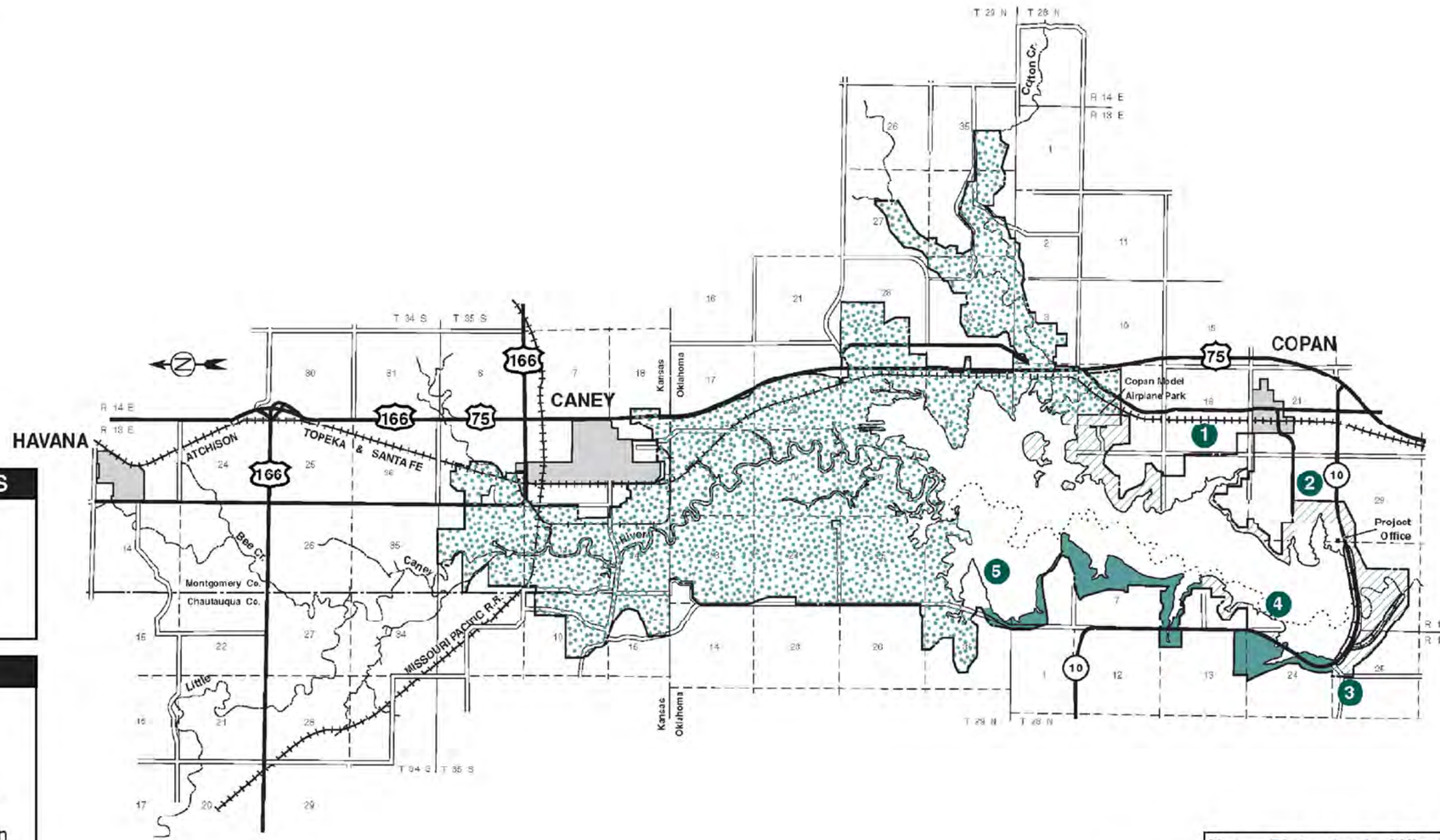
ENVELOPE CURVE OF BACKWATER EFFECTS 50-YEAR FLOOD WITH 100-YEAR SEDIMENTATION

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

PLATE 2 - 9

COPAN LAKE

PUBLIC HUNTING AREA



PUBLIC USE AREAS

1. Washington Cove
2. Copan Point
3. Anglers Point
4. Post Oak Park
5. Osage Plains

LEGEND

- Paved Road
- Improved Road
- Dirt Road
- Project Boundary
- Corps Areas Open For Hunting
- State Areas Open For Hunting
- See Restrictions

4000 0 4000

Scale of Feet

RESERVOIR DATA
Top of conservation pool El. 710.0
30 shoreline miles at El. 710.0
Total project land & water acreage 15932

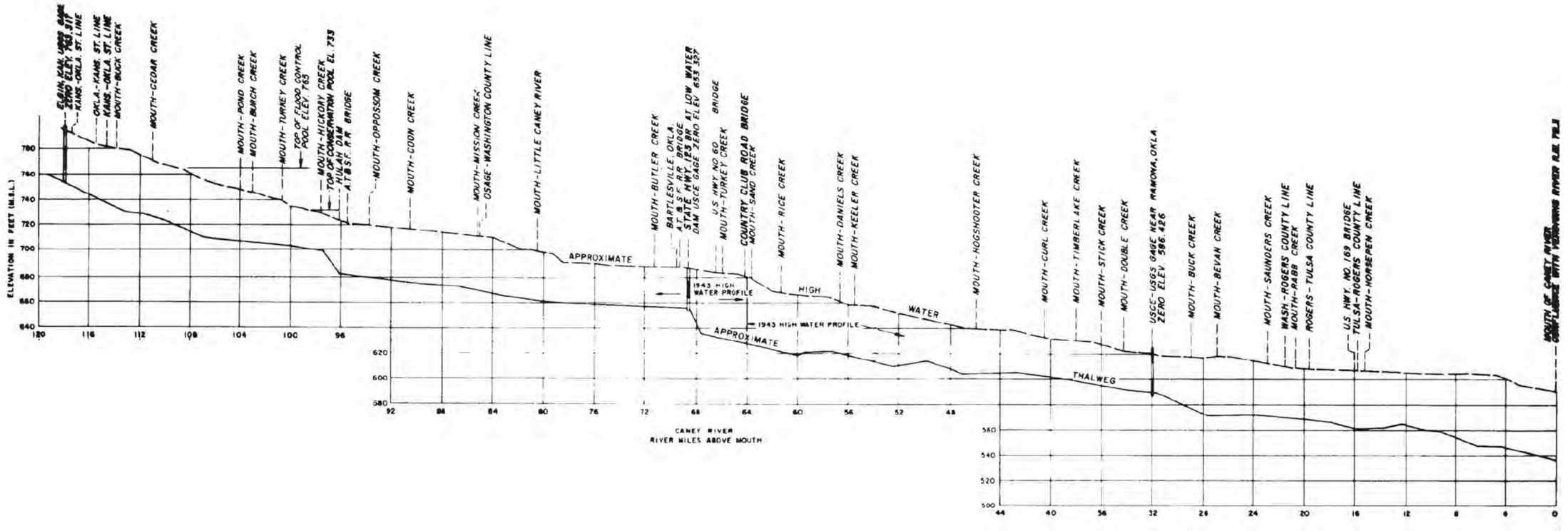
Note: Plate size is 11" x 17"

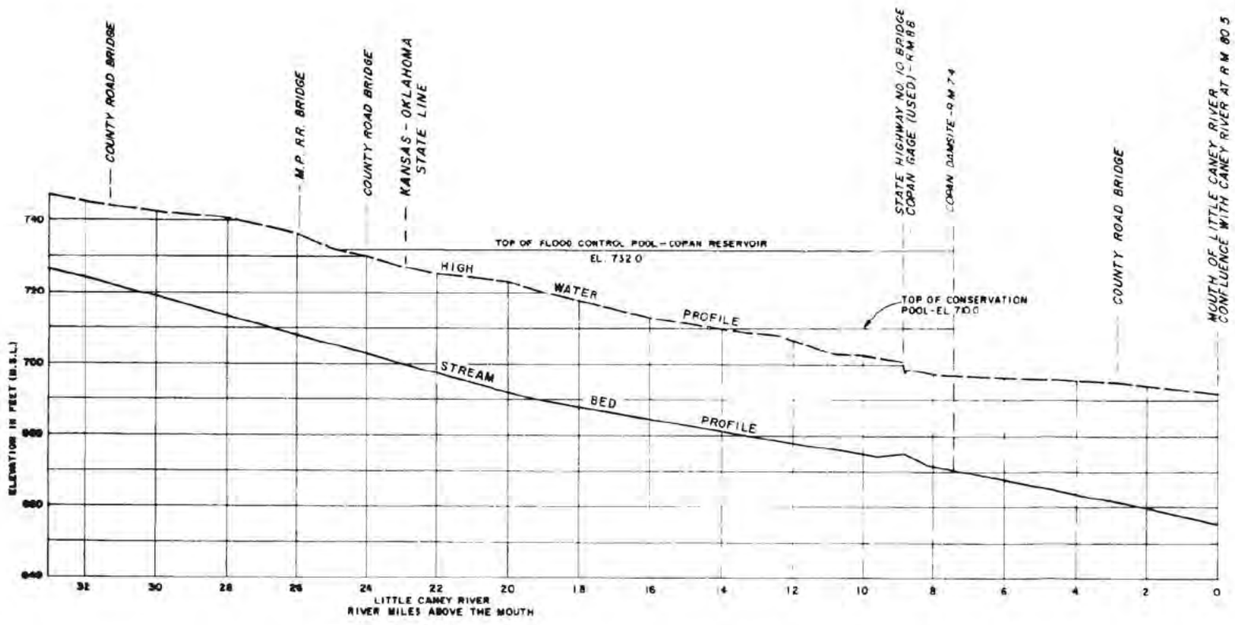
ARKANSAS RIVER WATERSHED — LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

PUBLIC USE SITES

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





Note: Plate size is 11" x 17"

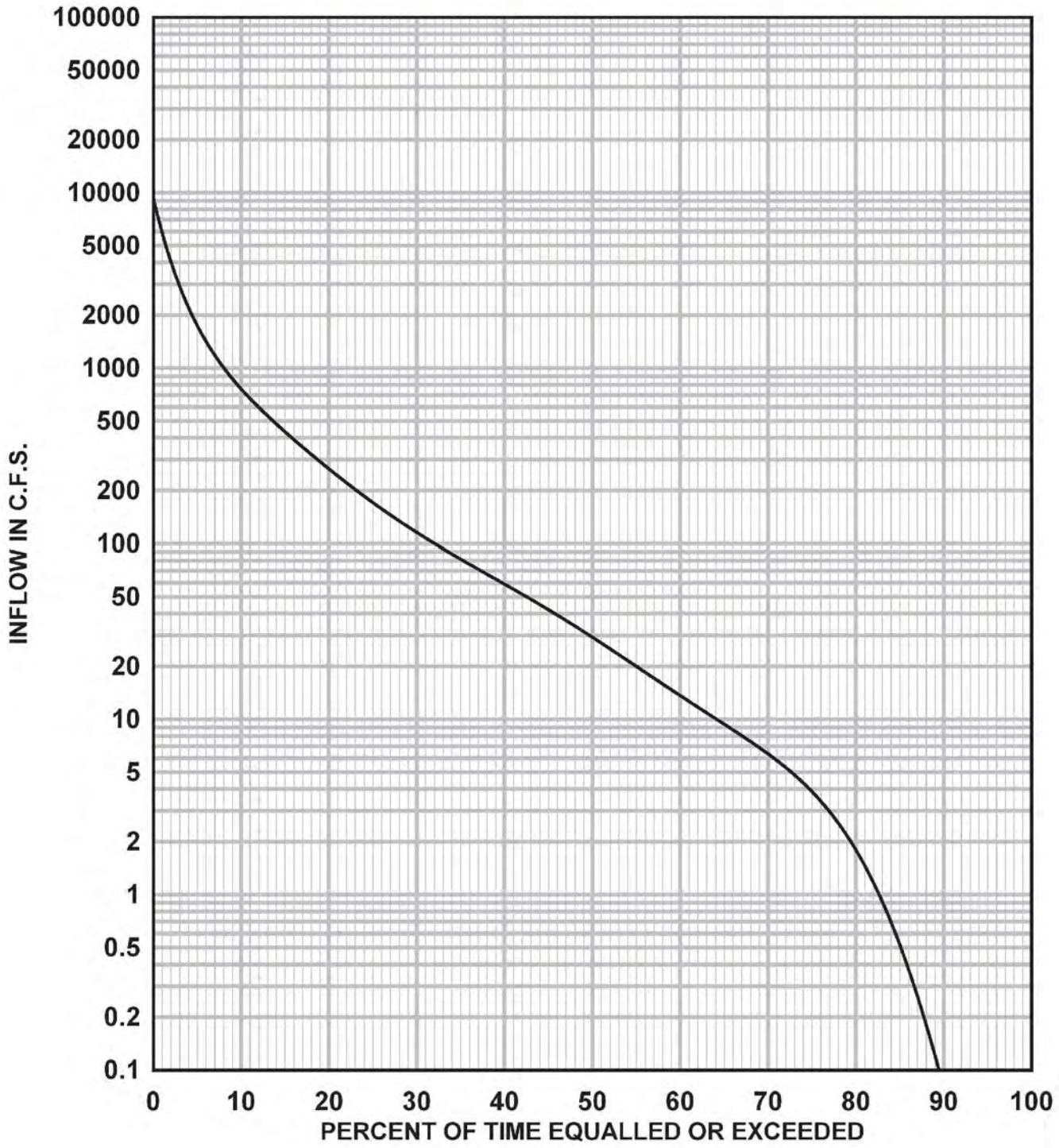
ARKANSAS RIVER WATERSHED — LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

CANEY AND LITTLE CANEY RIVER STREAMBED PROFILE

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

PLATE 4 - 1



NOTE:

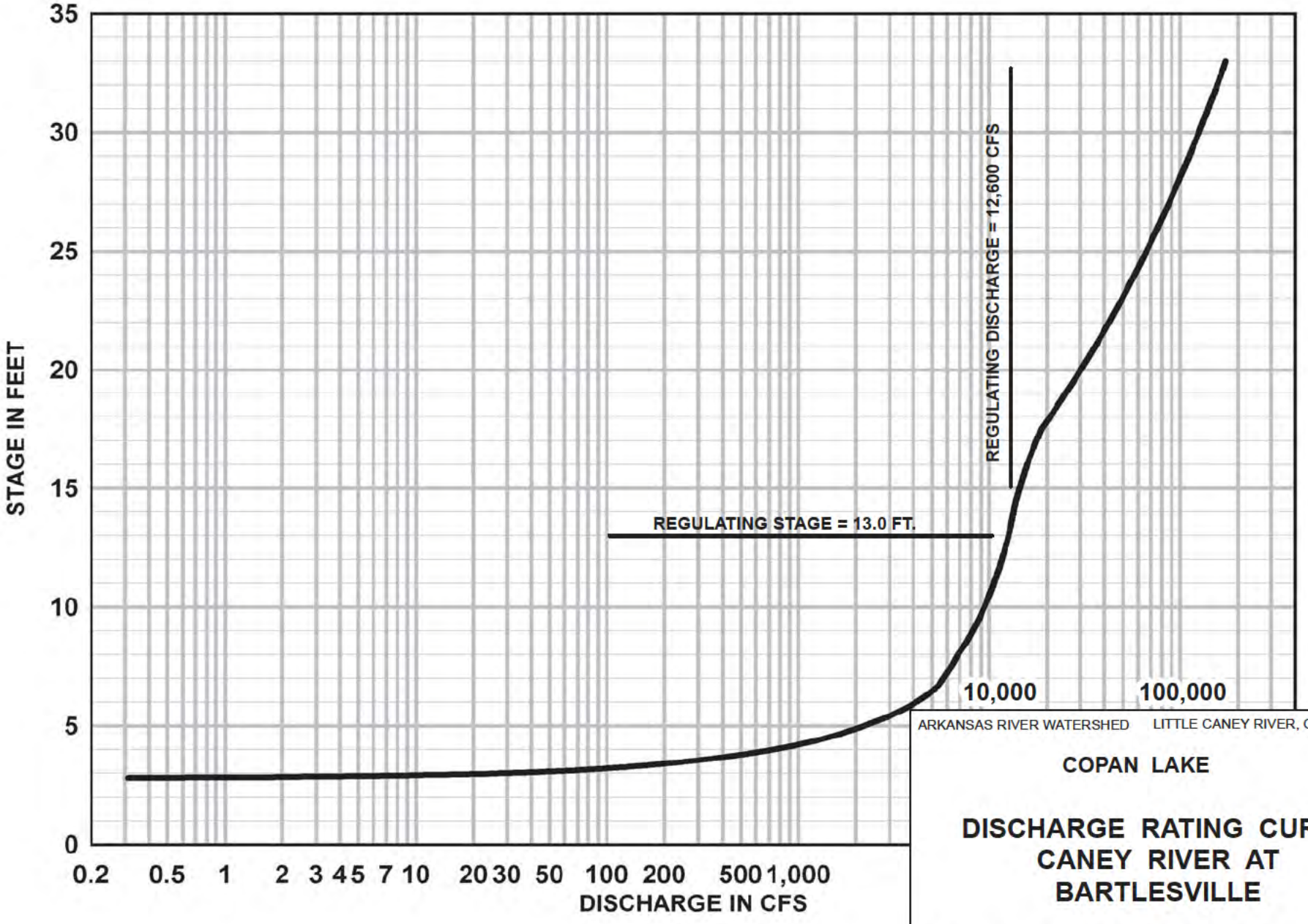
BASED ON PERIOD OF RECORD JAN 1940 THRU DEC 2008 FROM RIVERWARE MODEL 5.2.4

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

FLOW DURATION CURVE

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



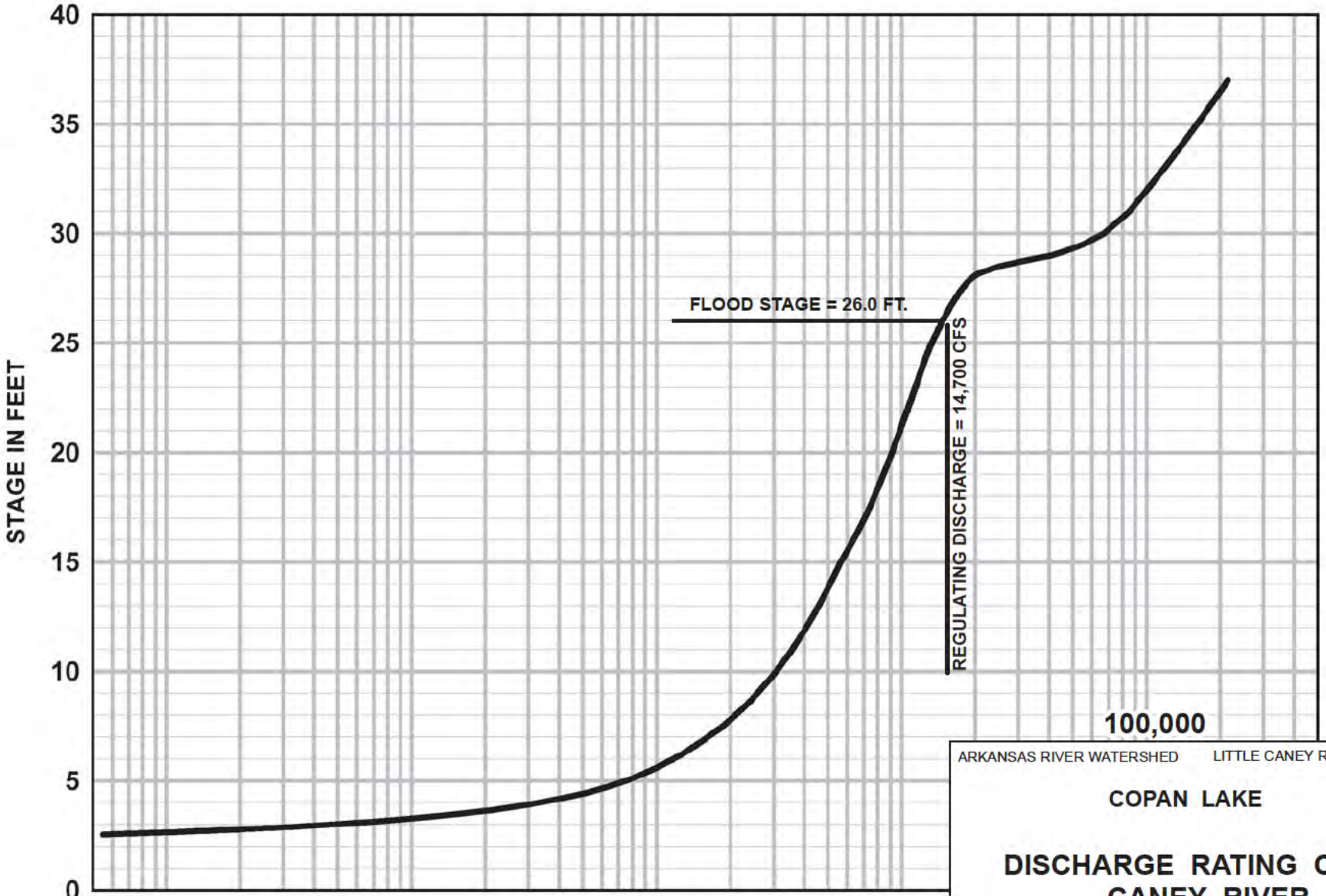
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

DISCHARGE RATING CURVE CANEY RIVER AT BARTLESVILLE

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

PLATE 4 - 3



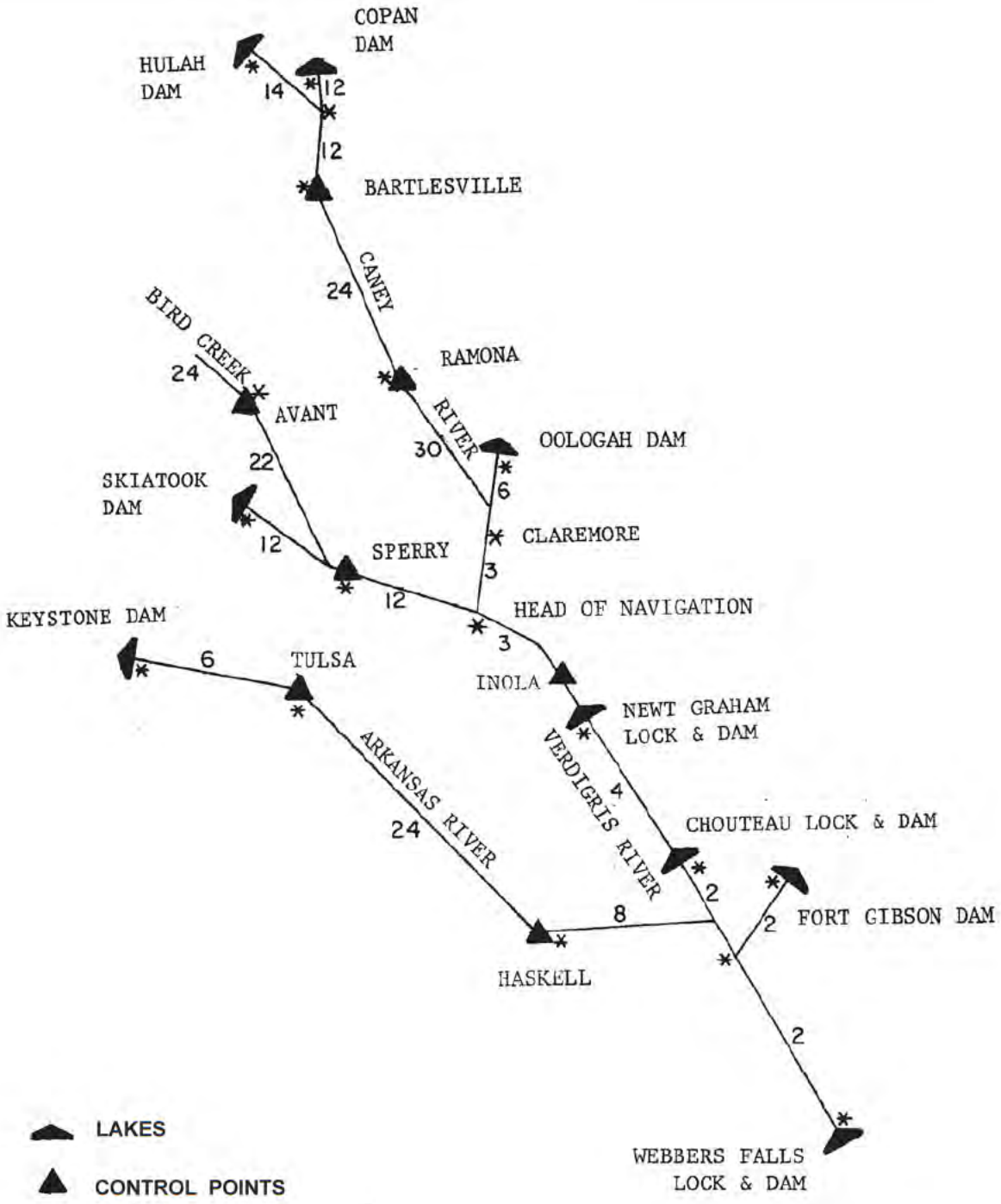
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

DISCHARGE RATING CURVE
CANEY RIVER
NEAR RAMONA

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

PLATE 4 - 4



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.**

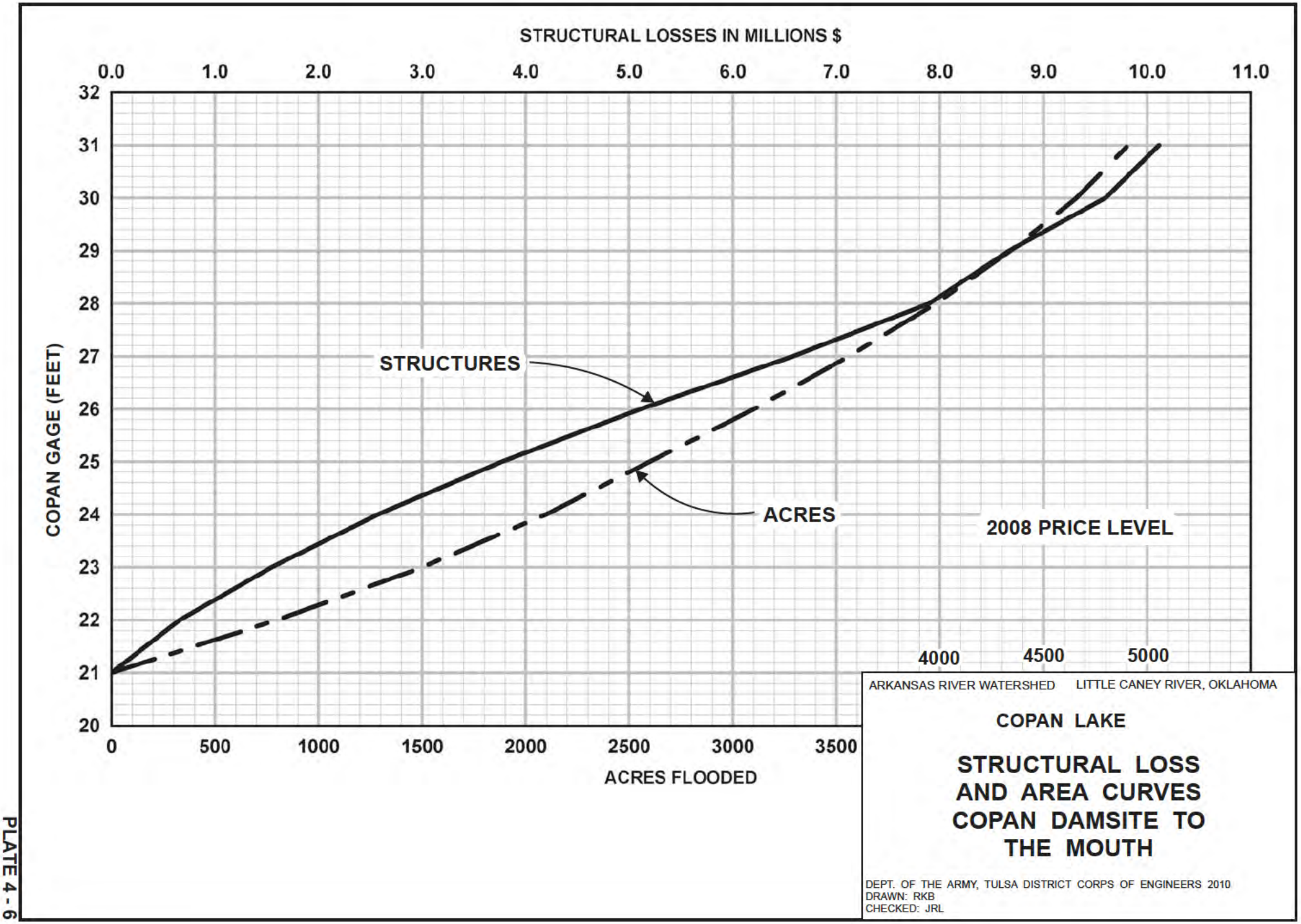
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

TIME OF CREST TRAVEL

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

PLATE 4 - 5



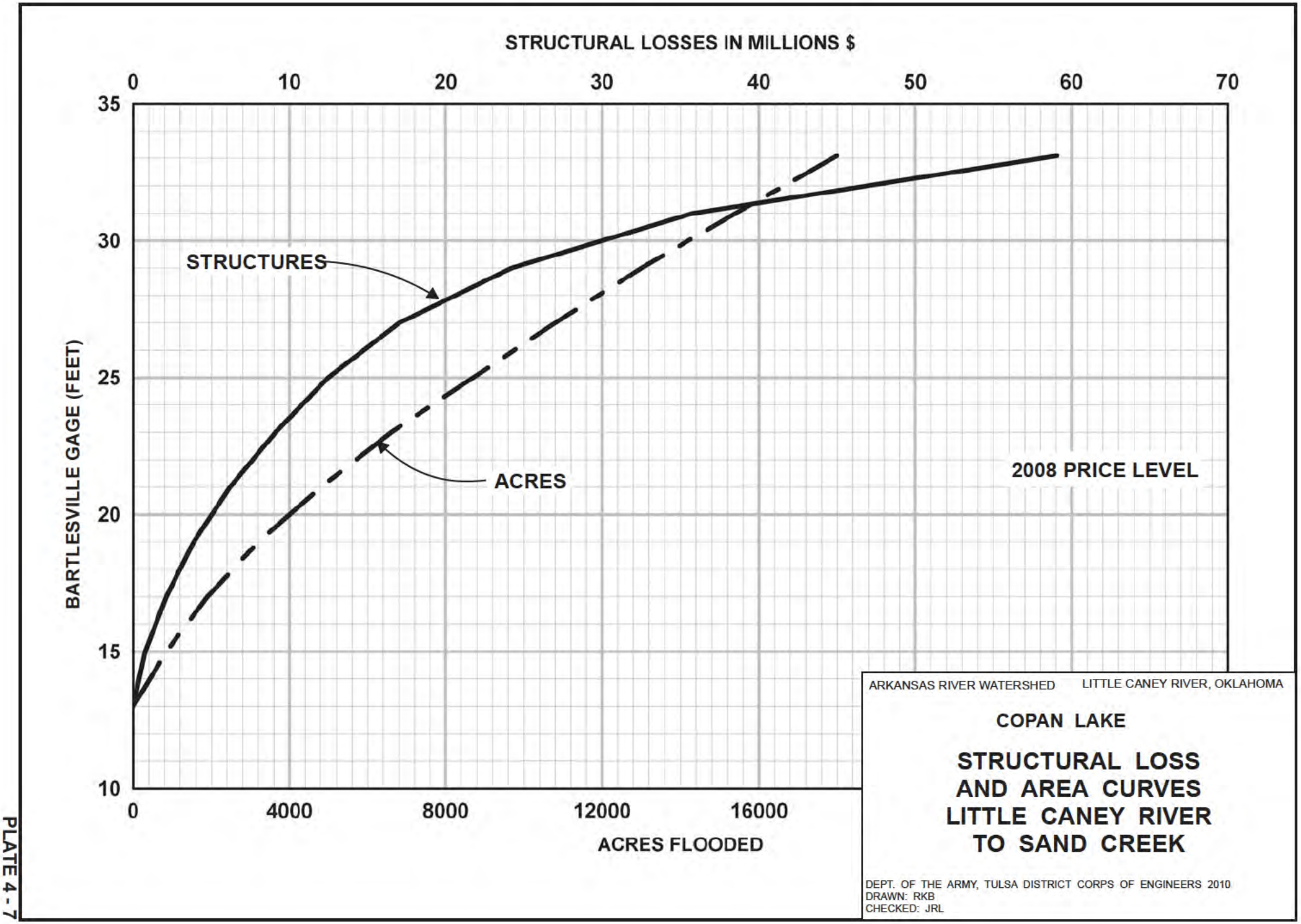
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

STRUCTURAL LOSS AND AREA CURVES COPAN DAMSITE TO THE MOUTH

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

PLATE 4 - 6



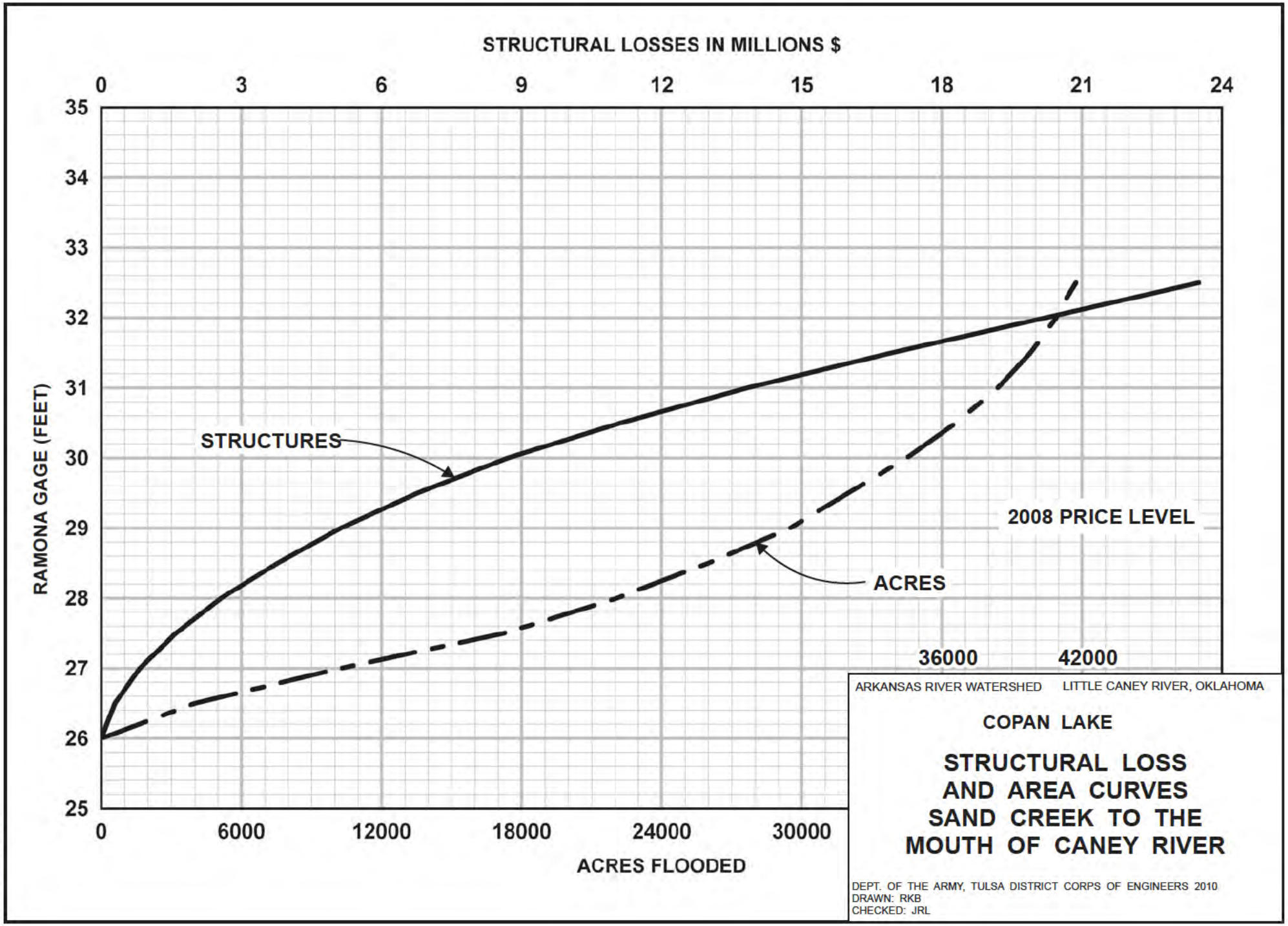
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

STRUCTURAL LOSS AND AREA CURVES LITTLE CANEY RIVER TO SAND CREEK

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

PLATE 4 - 7



ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

STRUCTURAL LOSS AND AREA CURVES SAND CREEK TO THE MOUTH OF CANEY RIVER

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

PLATE 4 - 8

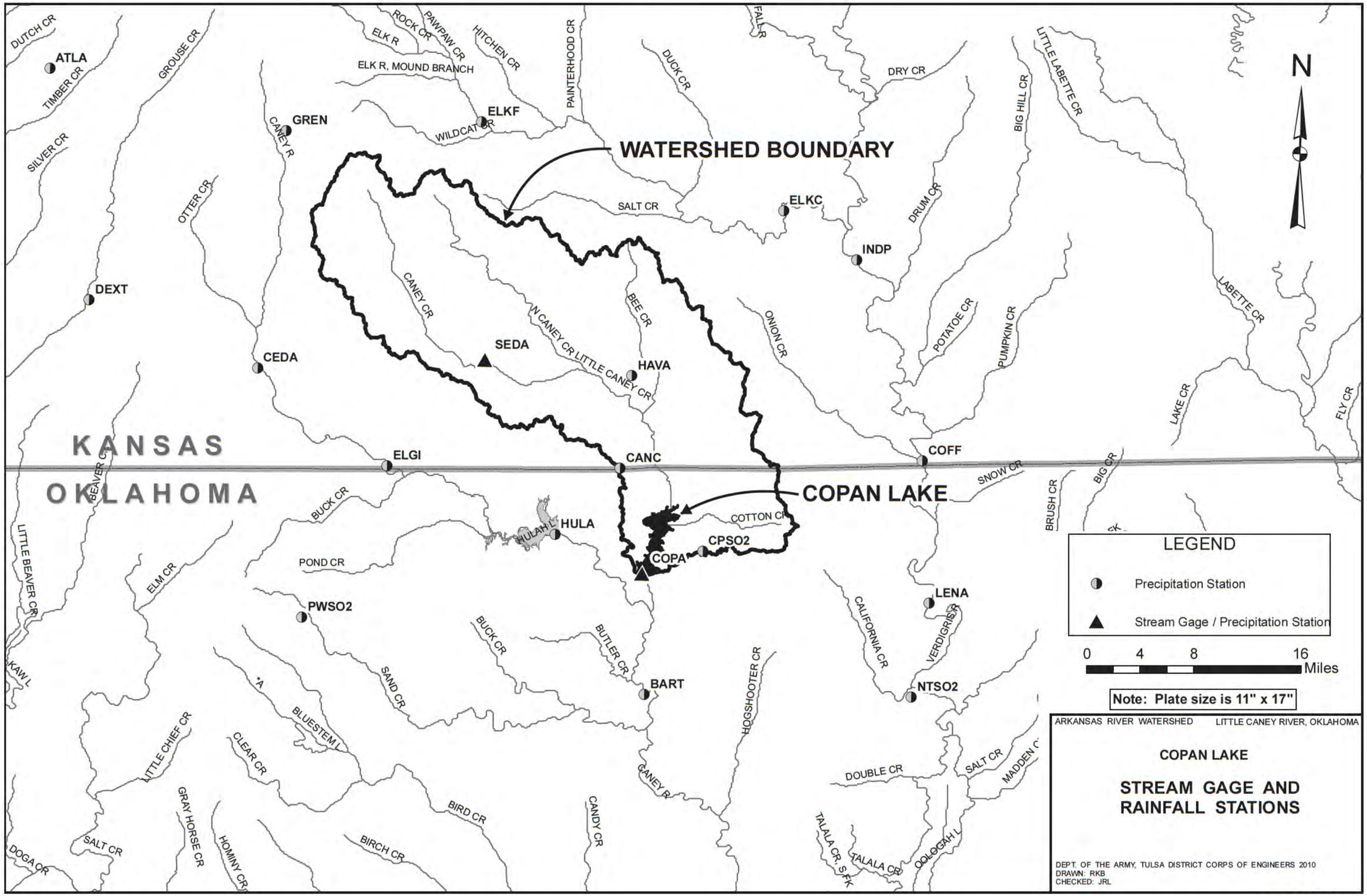
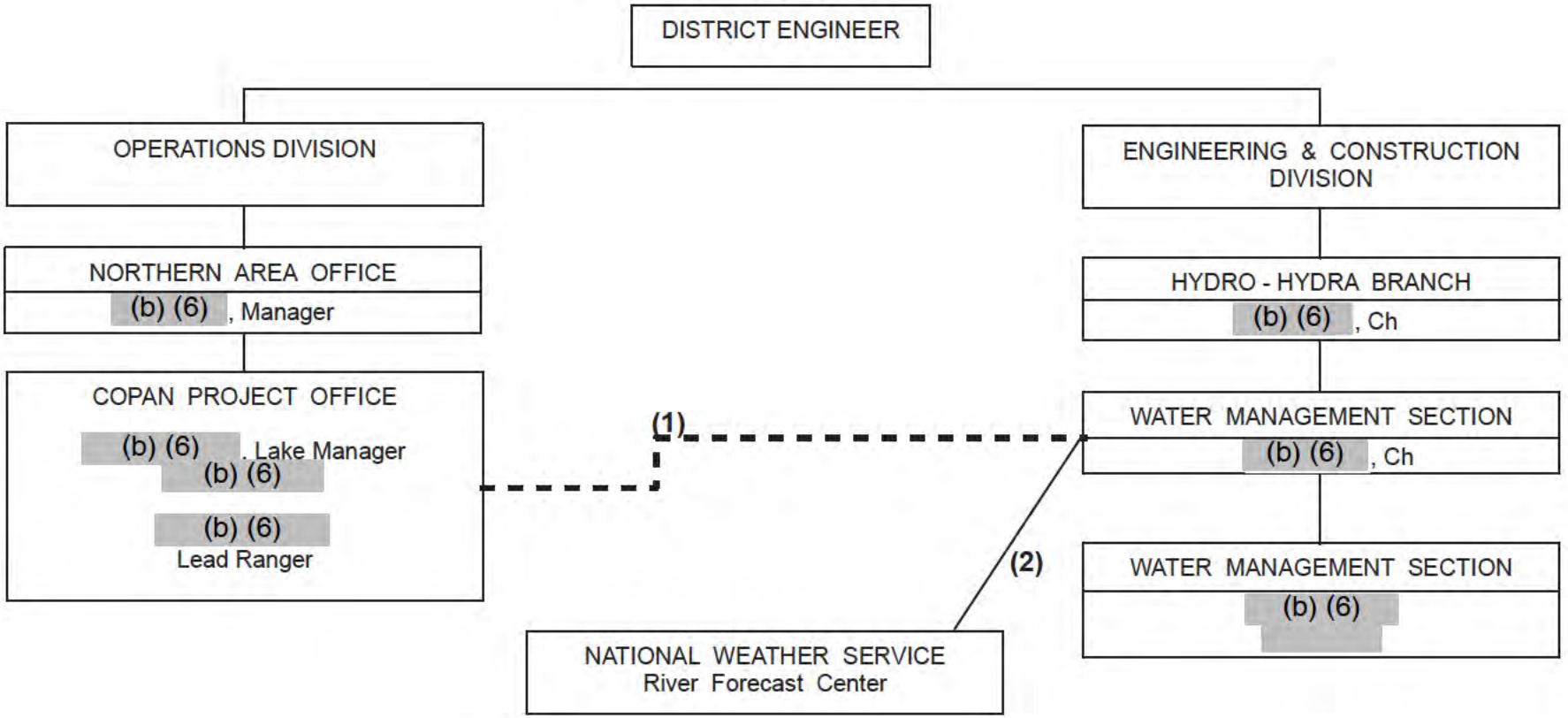

N
WATERSHED BOUNDARY
COPAN LAKE
KANSAS
OKLAHOMA
ATLA
GREN
ELKF
ELKC
INDP
DEXT
CEDA
SEDA
HAVA
ELGI
CANC
COFF
HULA
CPSO2
COPA
LENA
PWSO2
BART
NTSO2
DUTCH CR
TIMBER CR
GROUSE CR
SILVER CR
OTTER CR
CANEY R
ELK R
ROCK CR
PAWPAW CR
HITCHEN CR
ELK R, MOUND BRANCH
WILDCAT CR
PAINTERHOOD CR
FALL R
DUCK CR
DRY CR
BIG HILL CR
LITTLE LABETTE CR
SALT CR
DRUM CR
CANEY CR
N CANEY CR
LITTLE CANEY CR
BEE CR
ONION CR
POTATOE CR
PUMPKIN CR
LABETTE CR
LAKE CR
FLY CR
SNOW CR
BIG CR
BRUSH CR
COTTON CR
HULAH L
BEAVER CR
BUCK CR
LITTLE BEAVER CR
ELM CR
POND CR
KAW L
*A
BLUESTEM L
SAND CR
BUTLER CR
HOGSHOOTER CR
CALIFORNIA CR
VERDIGRIS R
LITTLE CHIEF CR
CLEAR CR
GRAY HORSE CR
HOMINY CR
BIRD CR
BIRCH CR
CANDY CR
CANEY R
DOUBLE CR
SALT CR
MADDEN C
TALALA CR, S FK
TALALA CR
OOLOGAH L
DOGA CR
SALT CR
LEGEND
Precipitation Station
Stream Gage / Precipitation Station
0 4 8 16
Miles
Note: Plate size is 11" x 17"
ARKANSAS RIVER WATERSHED
LITTLE CANEY RIVER, OKLAHOMA
COPAN LAKE
STREAM GAGE AND RAINFALL STATIONS
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 5 - 1

U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT



1. DIRECT COMMUNICATIONS ARE MAINTAINED BETWEEN COPAN PROJECT OFFICE AND THE WATER MANAGEMENT SECTION FOR TRANSMISSION OF RESERVOIR DATA, REGULATIONS AND INSTRUCTIONS.

2. PRECIPITATION AND STREAM GAGE DATA ARE SHARED BY THE NATIONAL WEATHER SERVICE, RIVER FORECAST CENTER.

ARKANSAS RIVER WATERSHED — LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

ORGANIZATION FOR FLOOD CONTROL REGULATION

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

PLATE 5 - 2

SAMPLE MORNING REPORT FOR COPAN LAKE

15 APRIL 19 79

Item No.	ITEM	TIME	COPAN
1	Pool Elevation	12 Noon	711.80
2	Pool Elevation @	: PM	711.61
3	Pool Elevation	12 Mid.	711.46
4	Pool Elevation	8 AM	711.30
5	Power Discharge 24 hr Average to	12 Mid	
	Gen No. 1 Hrs of use		
6	Gen No. 2 Hrs of use		
	Gen No. 3 Hrs of use		
7	Gen No. 4 Hrs of use		
8	Power Discharge Instantaneous at	8AM	
9	Total Discharge Instantaneous	8AM	1700
10	Gates - Type No. & Opening	8AM	TAINTER 1-2'
11	Gates - Type No. & Opening	8AM	
12	Gate Changes - Date Time		14 APR 4P
13	Pool Elevation		711.61
14	From - Type of Gates No. & Opening		TAINTER 2-2'
15	To - Type of Gates No. & Opening		TAINTER 1-2'
16	Gate Changes - Date Time		
17	Pool Elevation		
18	From - Type of Gates No. & Opening		
19	To - Type of Gates No. & Opening		
20	Lake Conditions at (Muddy, Murky or Clear)	8AM	MURKY
21	Weather Conditions at	8AM	CLOUDY
22	Total Preceding 6 Hour Rainfall Ending at	1PM	1.86
		7PM	.34
		1AM	.26
		7AM	.60
23	Total Preceding 24 Hour Rainfall Ending at	7AM	3.06
24	Comments on Rainfall Distribution		
25	Evaporation - 24 hrs. to	8AM	0.18
26	Wind Direction at	8AM	SW
27	Wind Velocity at	8AM	B-2
28	River Stages: Madison		
29	Copan		
30	Ramond		
31	Panama		
32	Watts		
33	Coyville		
34	Fredonia		
35	Canton		
36	Wister		
37	Durwood		
38	Gainesville		
39	Belzoni		
40	Terral		
41	Low-Flow Weirs - River		

PLATE 5 - 3

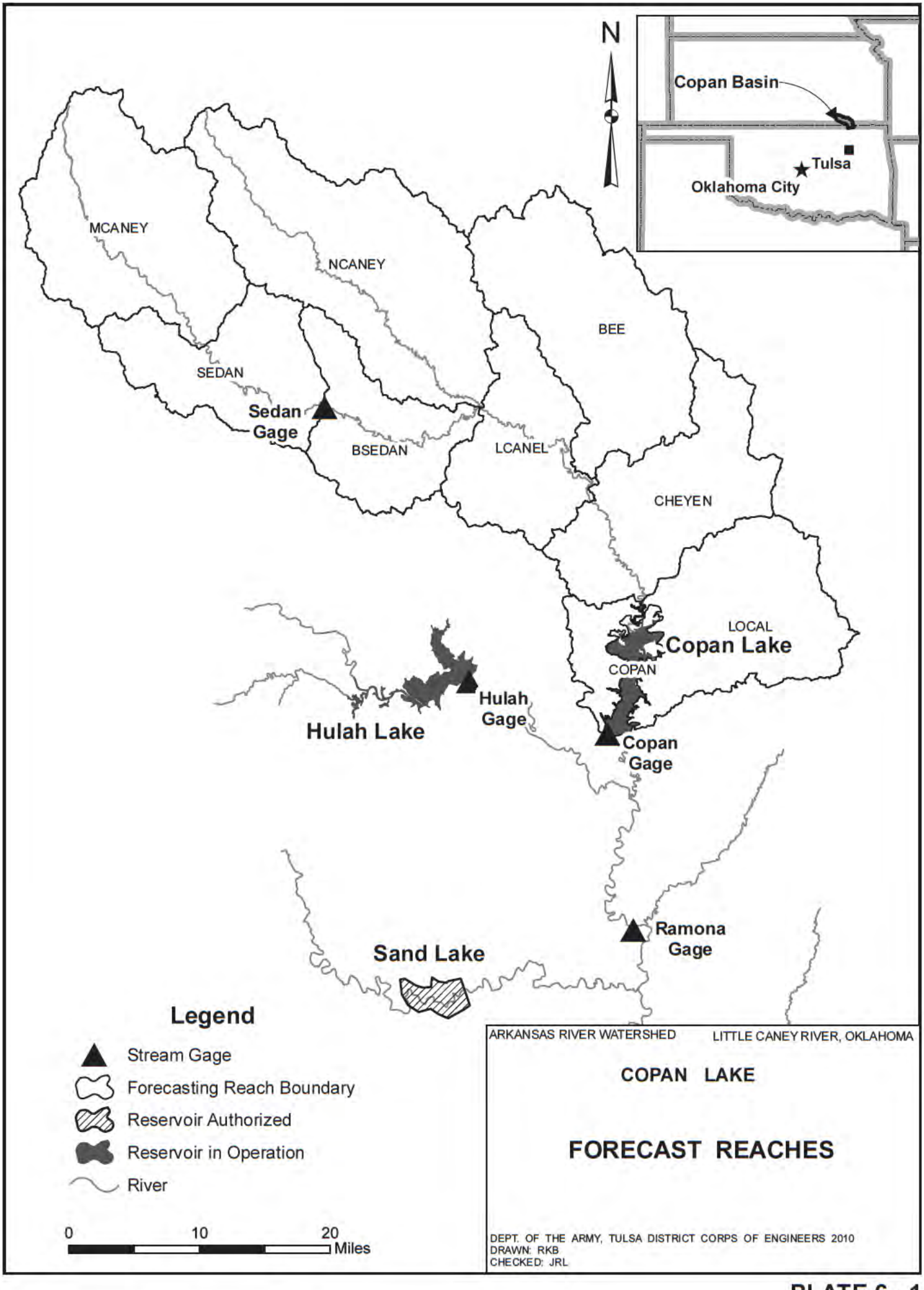
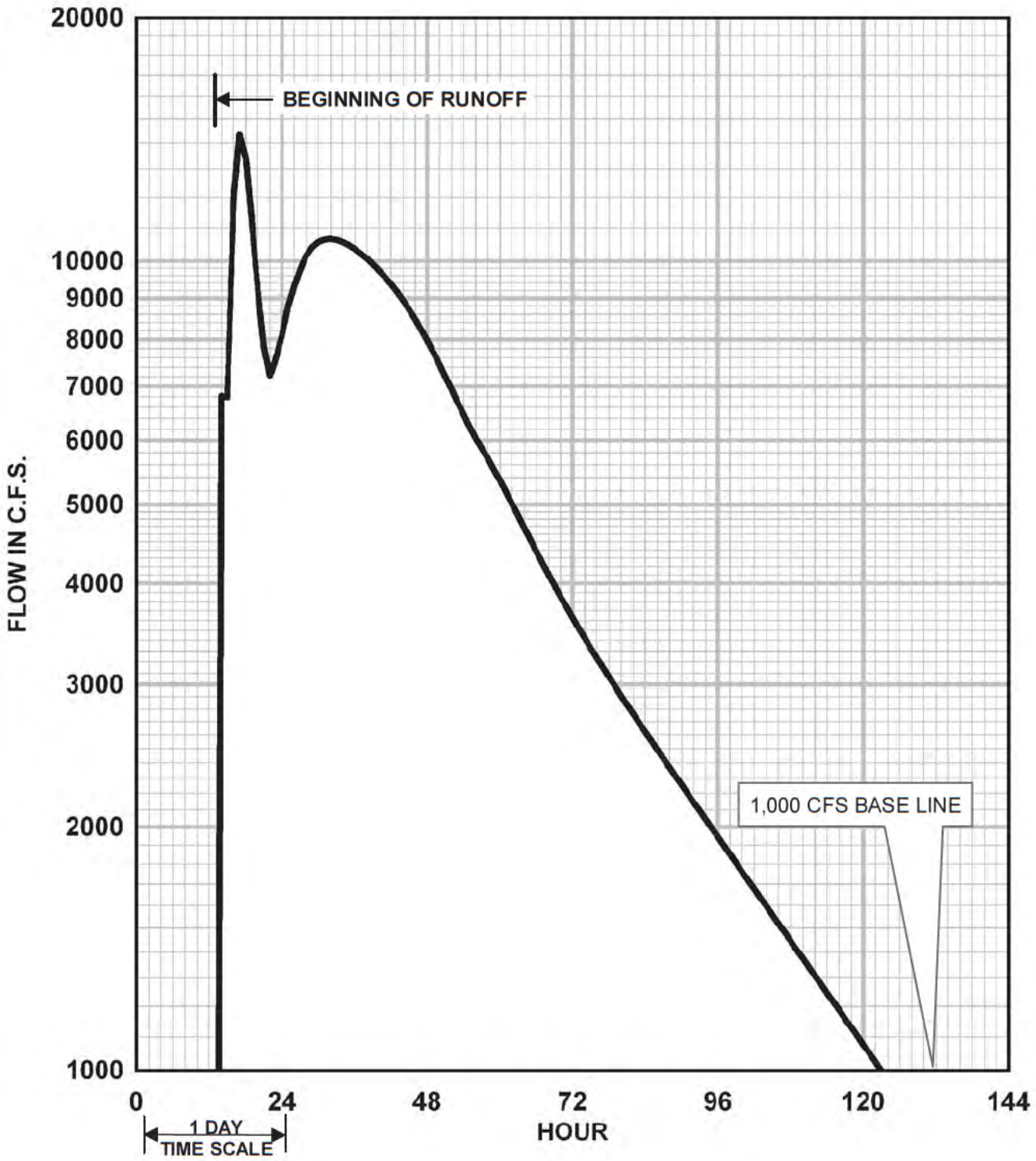

N
Copan Basin
Tulsa
Oklahoma City
MCANEY
NCANEY
BEE
SEDAN
Sedan Gage
BSEDAN
LCANEL
CHEYEN
LOCAL
Copan Lake
COPAN
Hulah Gage
Hulah Lake
Copan Gage
Ramona Gage
Sand Lake
Legend
Stream Gage
Forecasting Reach Boundary
Reservoir Authorized
Reservoir in Operation
River
0
10
20
Miles
ARKANSAS RIVER WATERSHED
LITTLE CANEY RIVER, OKLAHOMA
COPAN LAKE
FORECAST REACHES
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 6 - 1



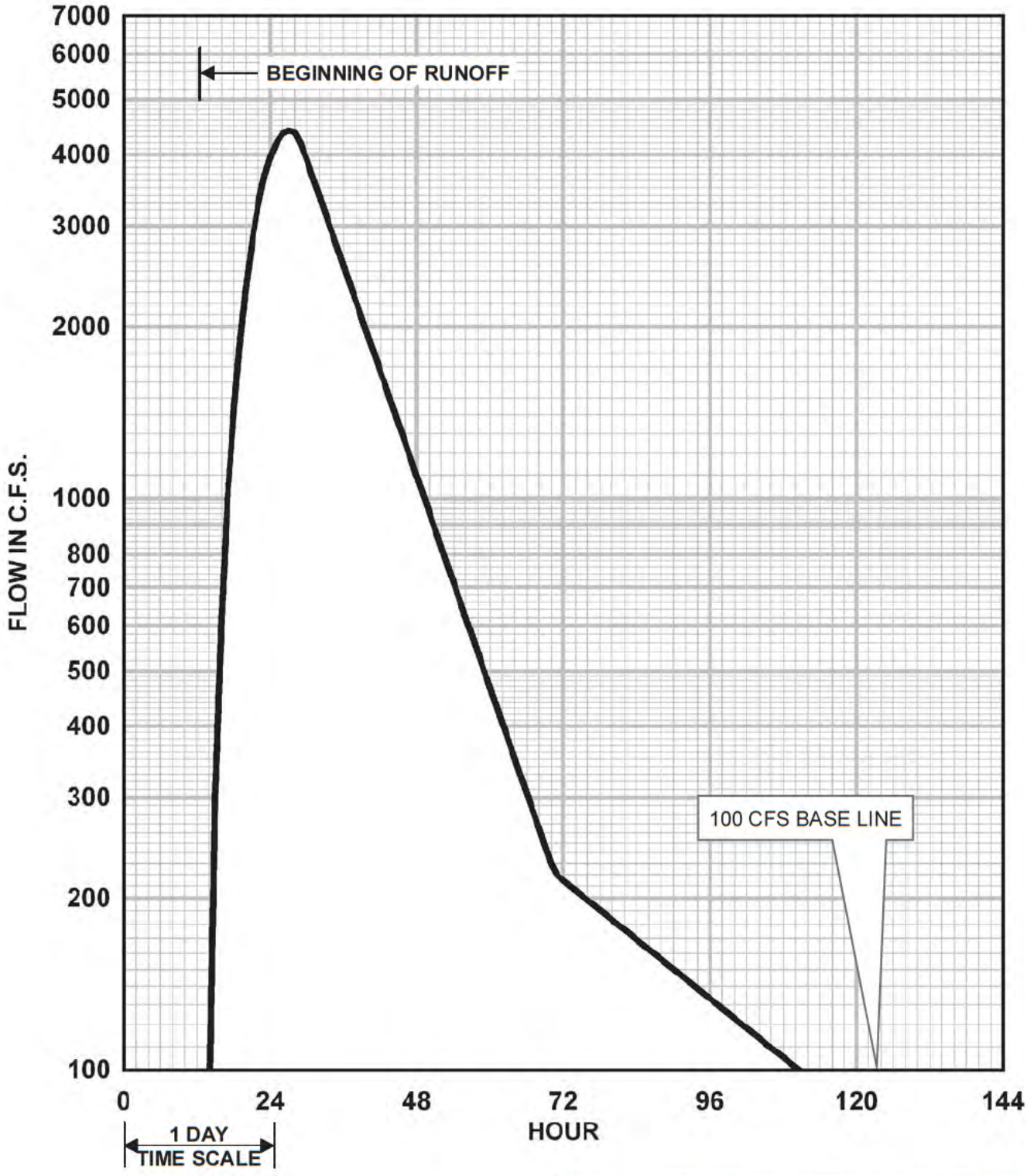
DRAINAGE AREA = 505 SQ. MI.
1" RUNOFF = 26,930 AC.FT.
PEAK FLOW = 14,338 C.F.S.

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

UNIT HYDROGRAPH FOR AREA ABOVE COPAN DAM

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



DRAINAGE AREA = 155 SQ. MI.
1" RUNOFF =8,427 AC.FT.
PEAK FLOW = 4,413 C.F.S.

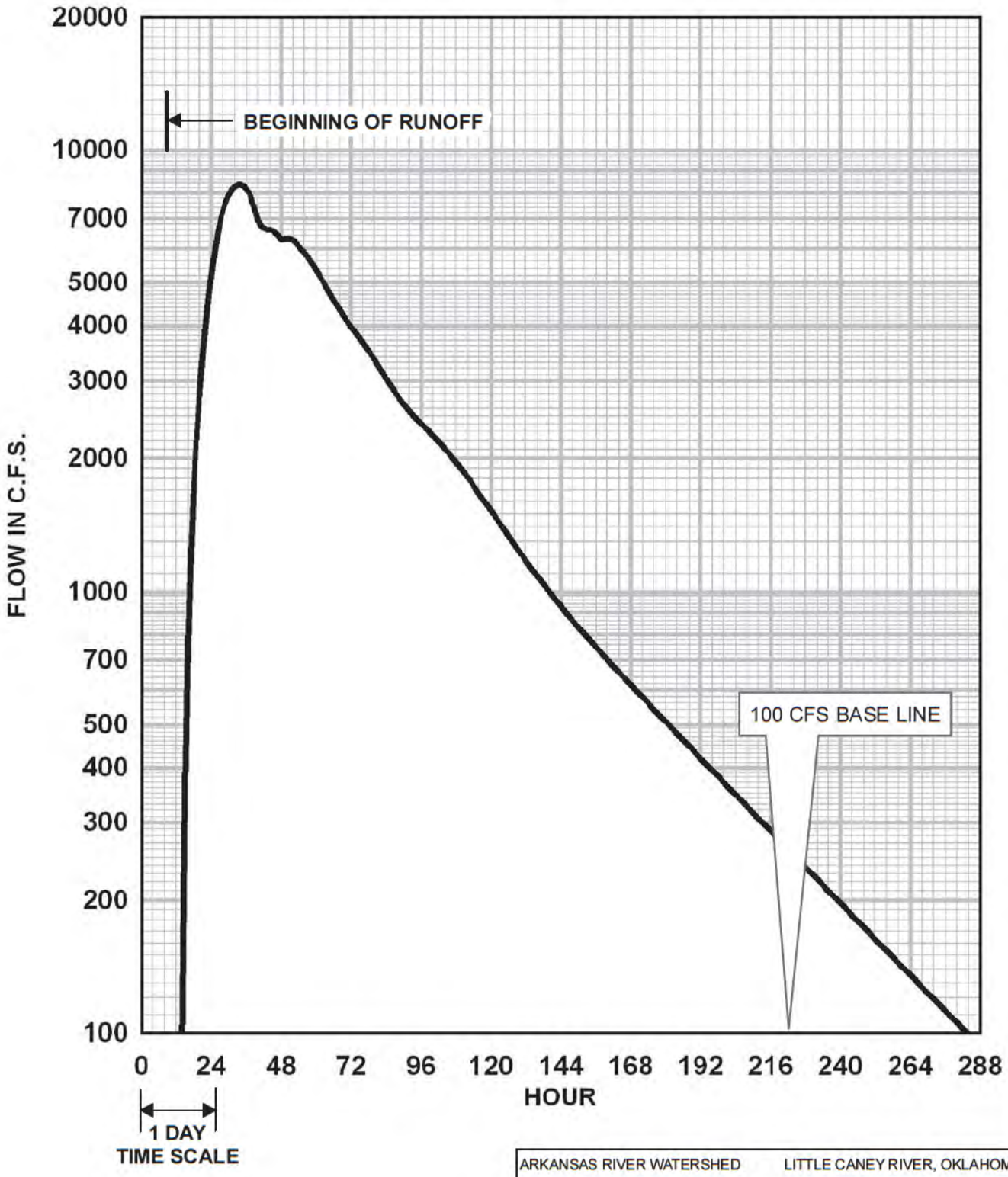
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

UNIT HYDROGRAPH FOR AREA ABOVE BARTLESVILLE AND BELOW HULAH DAM AND COPAN DAM

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

PLATE 6 - 3



DRAINAGE AREA = 563 SQ. MI.
1" RUNOFF = 30,027 AC.FT.
PEAK FLOW = 8,325 C.F.S.

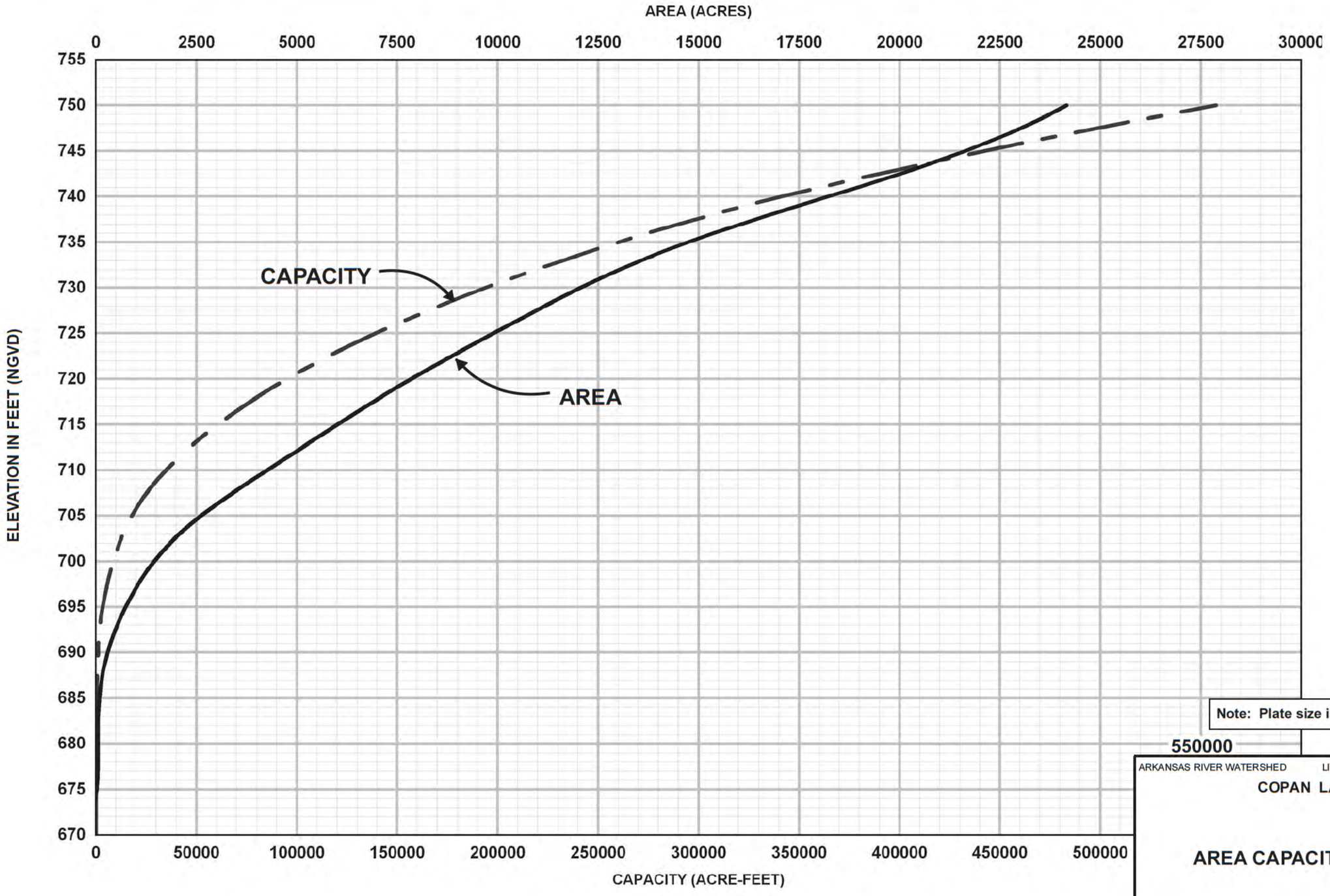
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

UNIT HYDROGRAPH FOR AREA ABOVE RAMONA AND BELOW BARTLESVILLE GAGE

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

PLATE 6 - 4



Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

AREA CAPACITY CURVES

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

PLATE 7 - 1

GATE OPENING IN FEET

0.25 0.50 0.75 1.0 1.5 2.0 2.5 3.0

POOL ELEVATION IN FEET, NGVD

740 735 730 725 720 715 710 705 700 695 690

TOP OF FLOOD CONTROL POOL ELEV. 732.0

TOP OF CONSERVATION POOL ELEV. 710.0

SPILLWAY CREST ELEV. 696.5

0 500 1,000 1,500 2,000 2,500 3,000 3,500 4,000 4,500 5,000

DISCHARGE IN C.F.S.

NOTE: CURVES ARE FOR ONE GATE ONLY.
4 GATES AVAILABLE

Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

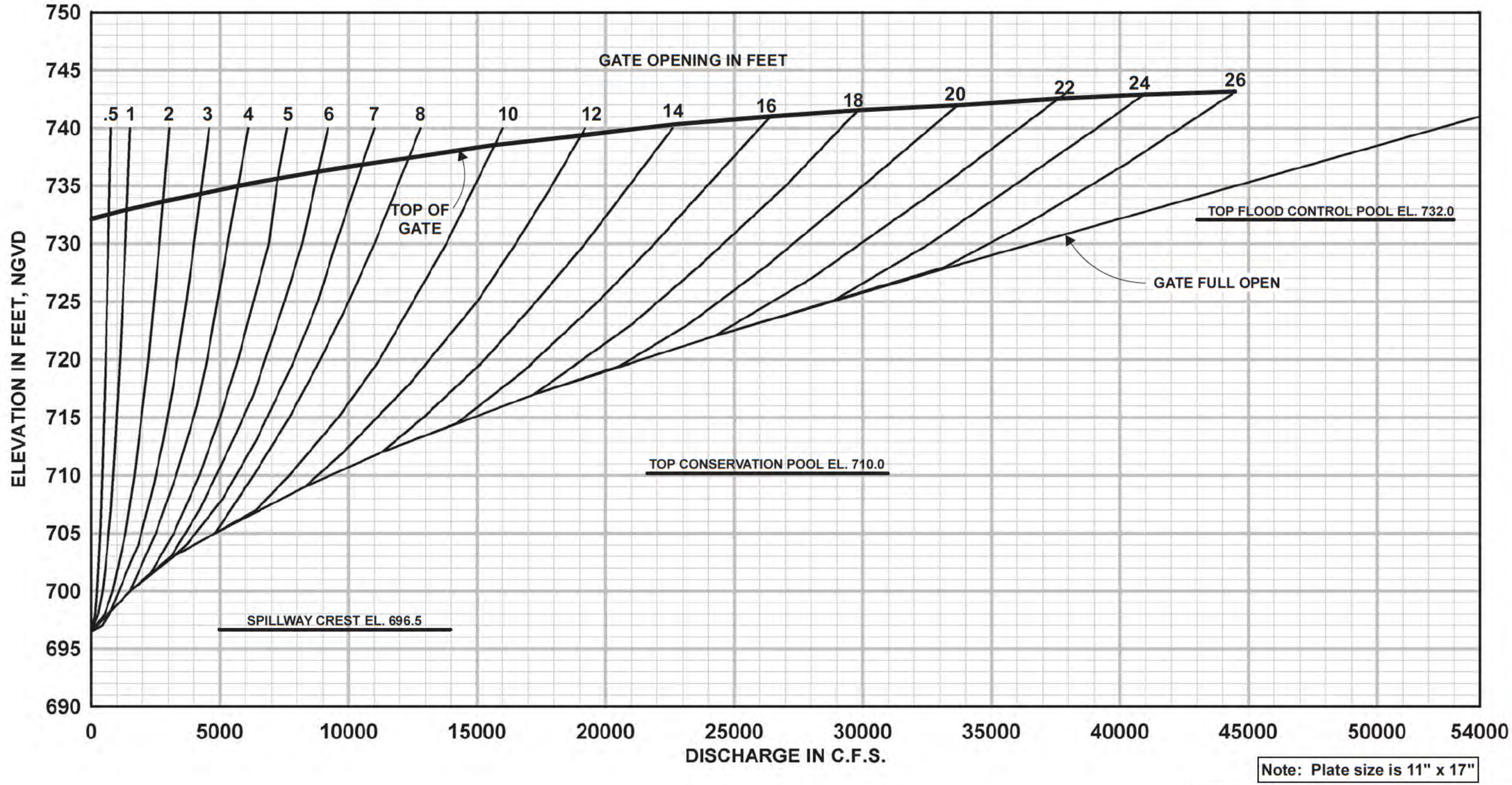
COPAN LAKE

EXPANDED SPILLWAY RATING CURVE PARTIAL OPENINGS

ONE 50' X 35.5' TAINTER GATE

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

PLATE 7 - 2



NOTE: RATING IS FOR ONE GATE
4 GATES AVAILABLE

Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

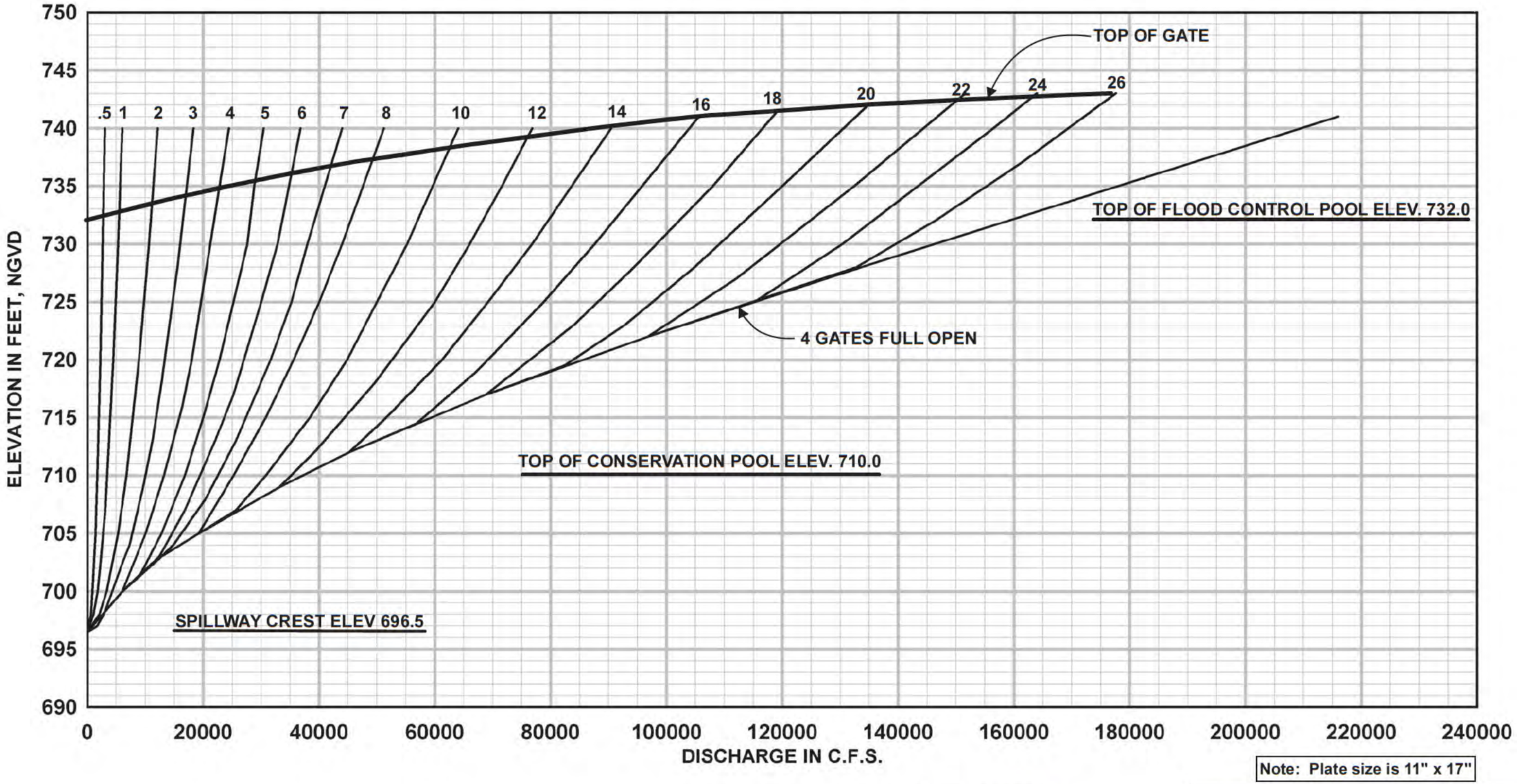
COPAN LAKE

SPILLWAY RATING CURVE PARTIAL AND FULL OPENINGS

ONE 50' X 35.5' TAINTER GATE

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

PLATE 7 - 3



Note: Plate size is 11" x 17"

4 GATES OPERATING

OPENING IN FEET IS DIAL SETTINGS

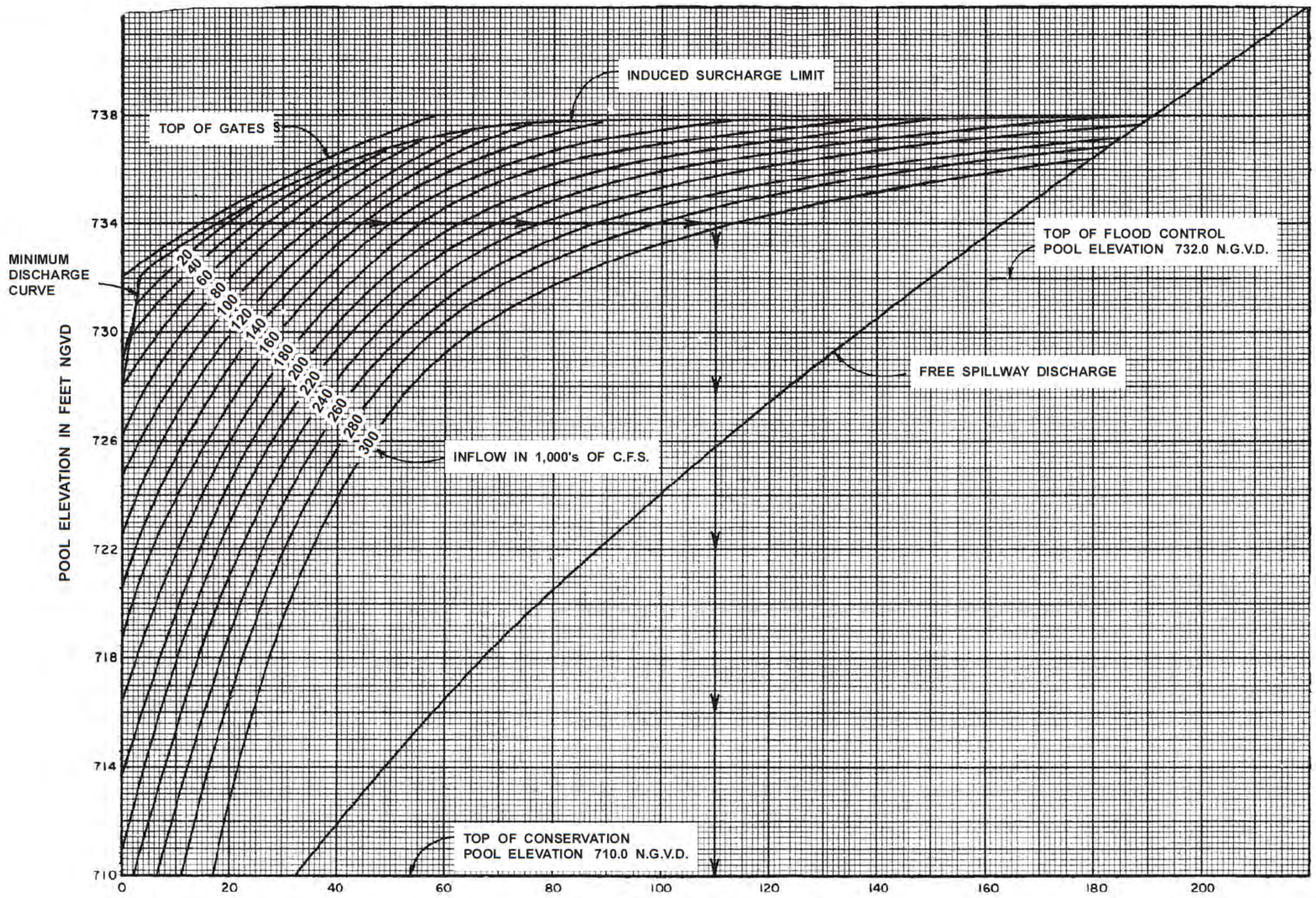
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

SPILLWAY RATING CURVE PARTIAL AND FULL OPENINGS

FOUR 50' X 35.5' TAINTER GATE

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



NOTE:
SPILLWAY CREST IS
ELEVATION 696.5 N.G.V.D.

NOTES:

1. THIS SCHEDULE IS USED IN ACCORDANCE WITH "NORMAL REGULATIONS FOR FLOOD CONTROL OPERATIONS OF COPAN LAKE."
2. THE DISCHARGE IS DETERMINED BY THE INFLOWS FOR 2-HOUR PERIOD AND THE POOL ELEVATION AT THE END OF THE PERIOD.

EXAMPLE:

TO DETERMINE DISCHARGE AT POOL ELEVATION 734.0 WITH A COMPUTED 2-HOUR INFLOW OF 295,000 C.F.S.

1. AT POOL ELEVATION 734.0, READ ACROSS TO INFLOW OF 295,000 C.F.S.
2. READ DOWN TO FIND DISCHARGE OF 110,000 C.F.S.
3. USING THE SPILLWAY RATING CURVE - PARTIAL GATE OPENINGS, FIND THE NEEDED OPENING FOR A DISCHARGE OF 110,000 C.F.S.

Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

SPILLWAY GATE REGULATION SCHEDULE INFLOW PARAMETER

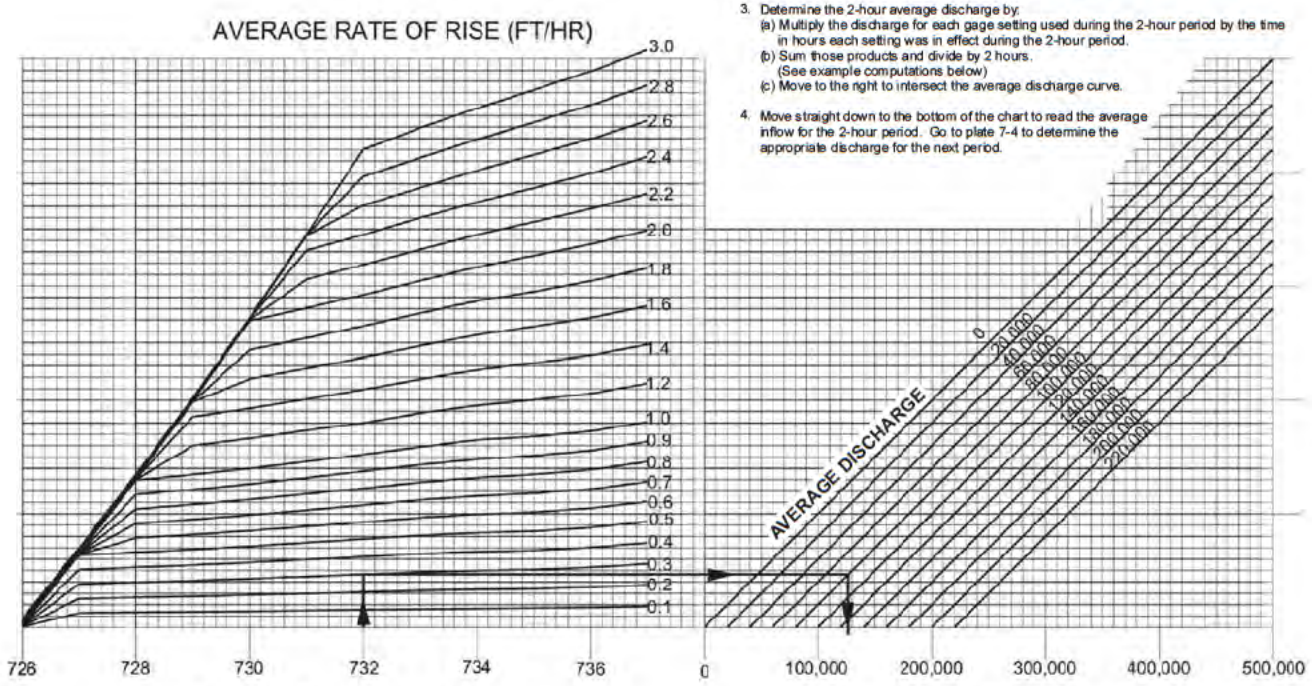
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 7 - 5

INSTRUCTIONS:

To determine the 2-hour inflow:

1. Locate the pool elevation at the end of the 2-hour period on the lower left portion of this chart.
2. Determine the rate of rise by subtracting the pool elevation at the beginning of the 2-hour period from the pool elevation at the end of the period and dividing by 2. Move straight up until you intersect the appropriate rate of rise curve.
3. Determine the 2-hour average discharge by:
   (a) Multiply the discharge for each gage setting used during the 2-hour period by the time in hours each setting was in effect during the 2-hour period.
   (b) Sum those products and divide by 2 hours.
   (See example computations below)
   (c) Move to the right to intersect the average discharge curve.
4. Move straight down to the bottom of the chart to read the average inflow for the 2-hour period. Go to plate 7-4 to determine the appropriate discharge for the next period.



EXAMPLE COMPUTATIONS:

1. Begin with a lake elevation of 732.00 ft. Two hours ago the elevation was 731.4 ft.
2. Rate of rise = (732.00 - 731.40)/ 2 hours = 0.6 ft/ 2 hrs = 0.3 ft/hr
3. Releases for last 2 hours were:
   1.0 hours at 60,000 cfs = 1 x 60,000 = 60,000 cfs
   1.0 hours at 100,000cfs = 1 x 100,000= 100,000 cfs
   Total for two hours 160,000 cfs
   Average release = 160,000 cfs / 2 hours = 80,000 cfs
4. The resulting 2 hour inflow is 127,000 cfs.

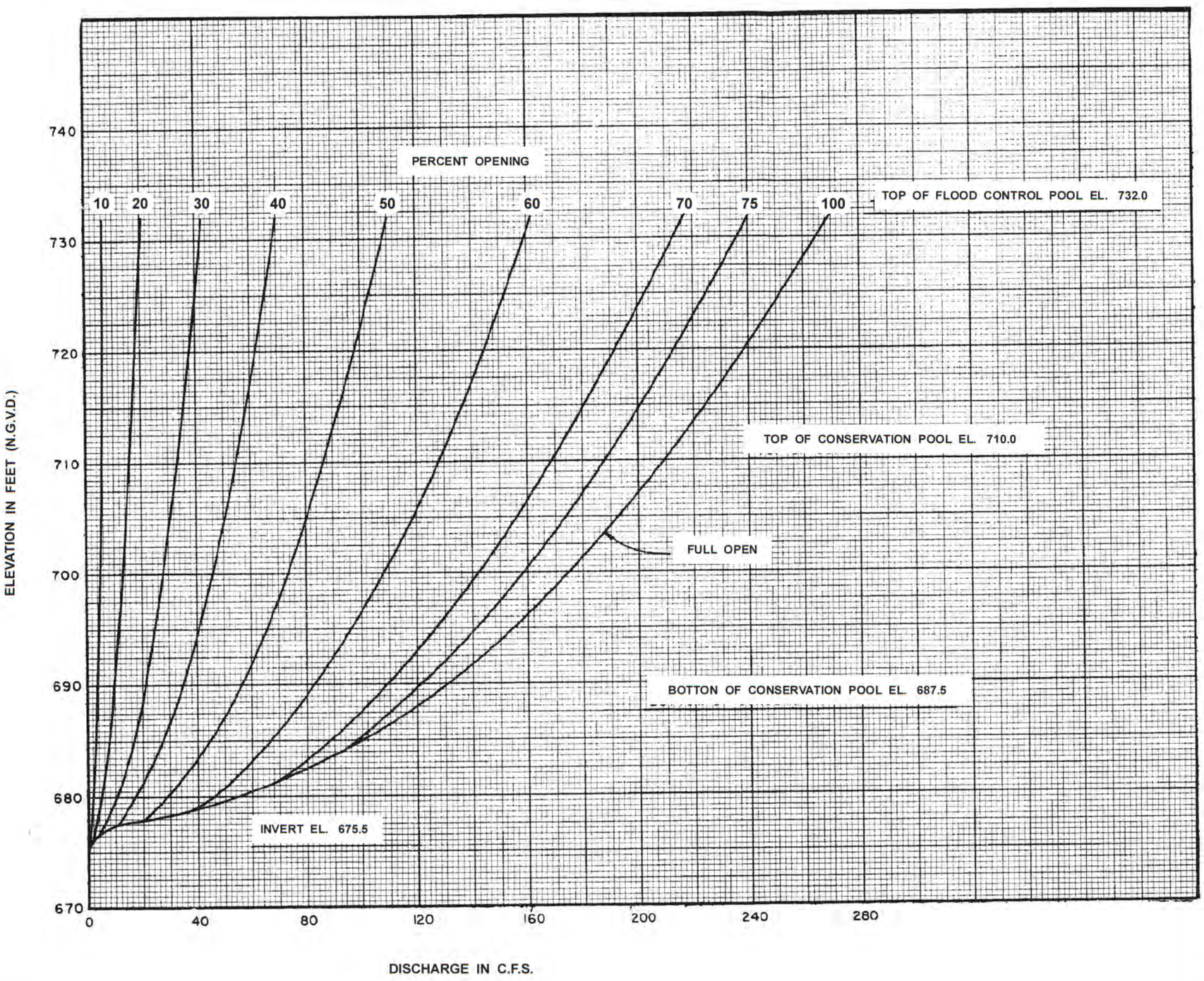
ARKANSAS RIVER WATERSHED — LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

INFLOW vs. RATE OF RISE NOMOGRAPH

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

PLATE 7 - 6



Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

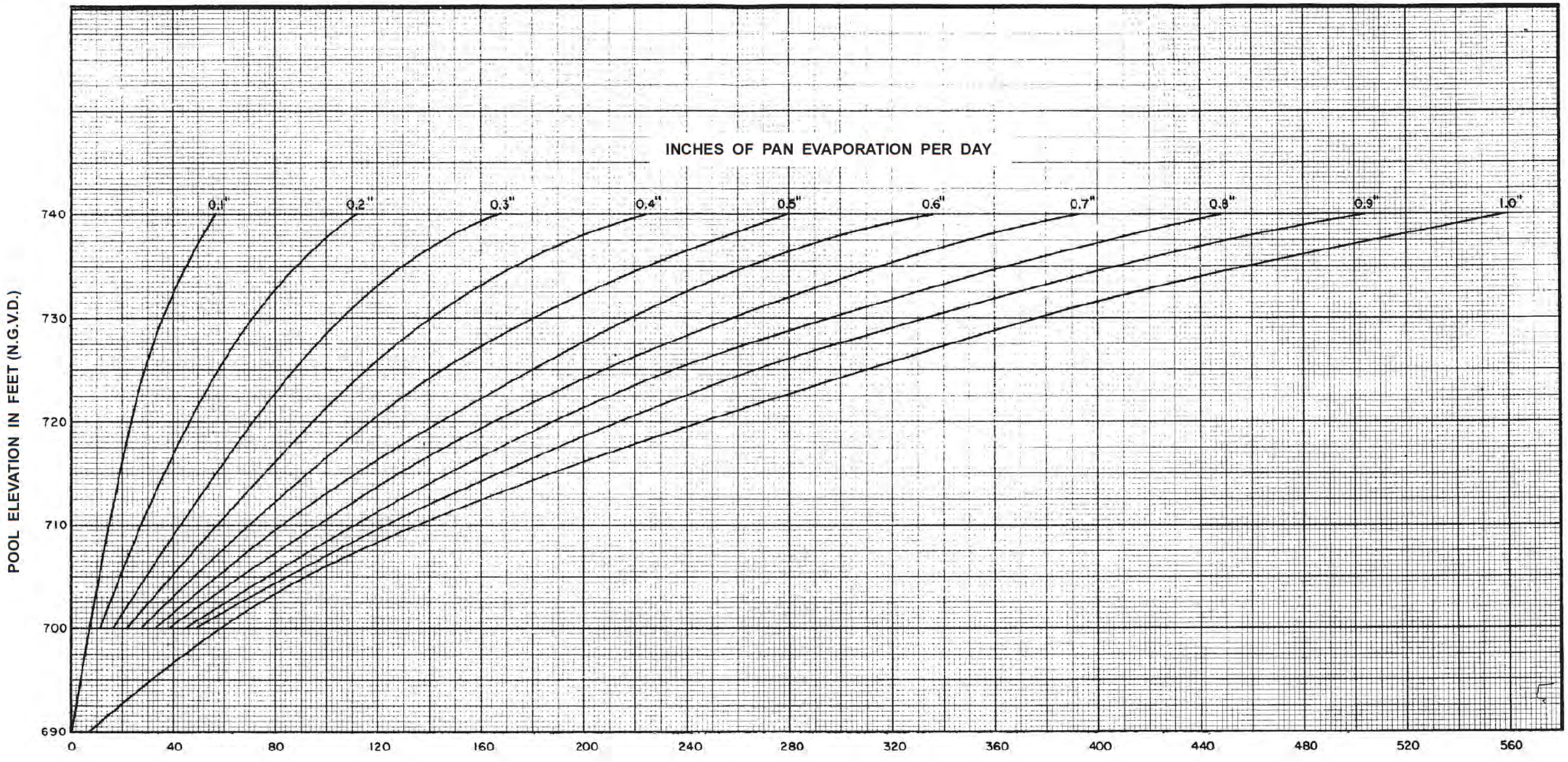
COPAN LAKE

DISCHARGE RATING CURVES

36" DIA. LOW FLOW PIPE
PARTIAL AND FULL OPENINGS

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

PLATE 7 - 7



Note: Plate size is 11" x 17"

NOTE: CURVES COMPUTED FOR 70% OF CLASS A PAN EVAPORATION.

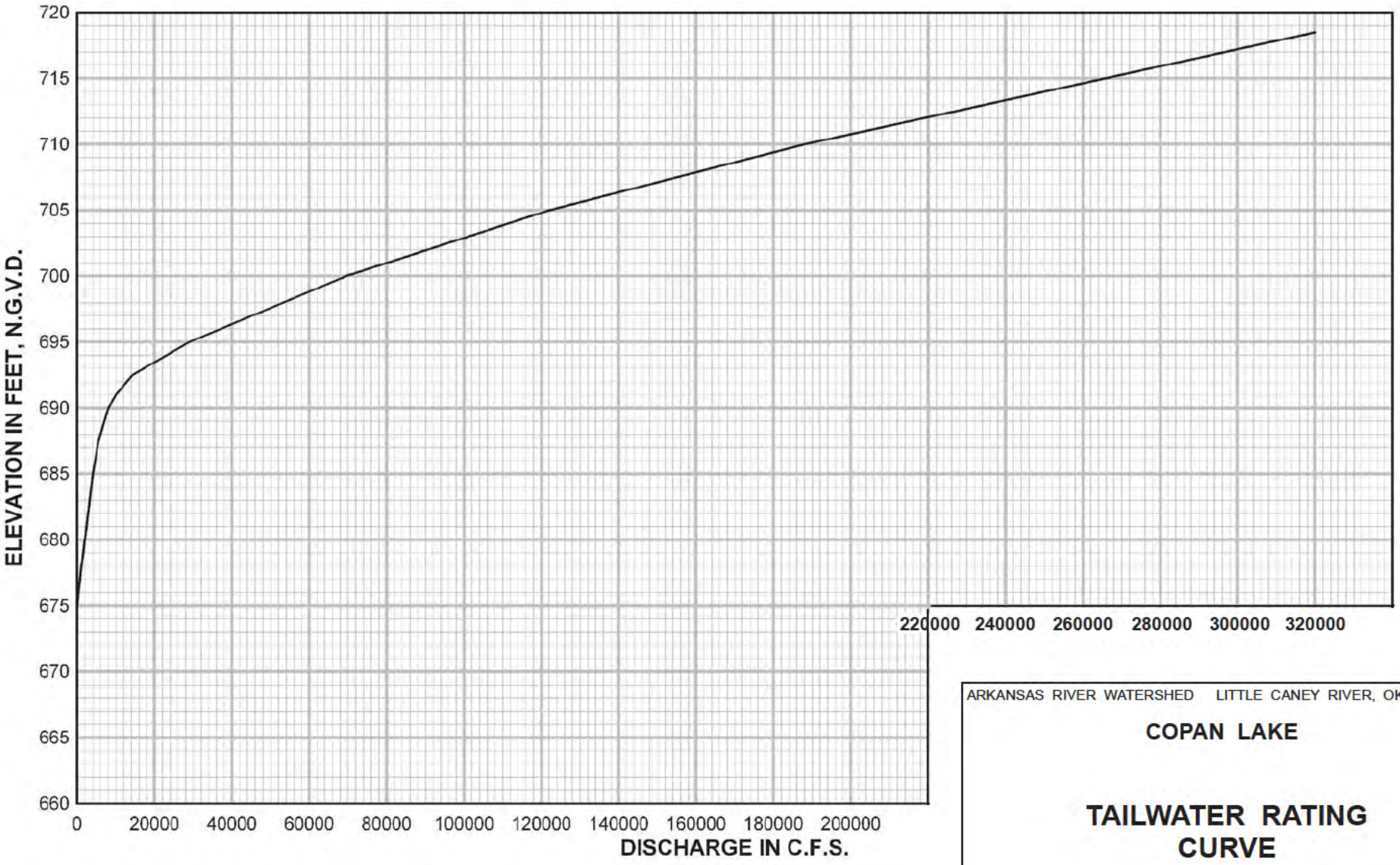
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

EVAPORATION CURVES

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

PLATE 7 - 8



ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

TAILWATER RATING CURVE

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

PLATE 7 - 9

WATER SUPPLY STORAGE ACCOUNTING
COPAN LAKE

CONSERVATION STORAGE	35,000 A.F.
CONTRACTED STORAGE USER #1	5,000 A.F.
CONTRACTED STORAGE USER #2	27,500 A.F.
CONTRACTED STORAGE USER #3	2,500 A.F.

MONTH	USER	BEGINNING STORAGE A.F.	INFLOW SHARE A.F.	TOTAL LOSSES A.F.	WITH-DRAWN A.F.	ENDING STORAGE A.F.
JAN	LAKE	35,000	0	1,253	497	33,250
	1	5,000	0	179	190	4,631
	2	27,500	0	985	307	26,208
	3	2,500	0	90	0	2,410
FEB	LAKE	33,250	0	1,153	447	31,650
	1	4,631	0	165	170	4,296
	2	26,208	0	906	277	25,025
	3	2,410	0	82	0	2,328
MAR	LAKE	31,650	0	933	497	30,220
	1	4,296	0	133	190	3,973
	2	25,025	0	733	307	23,985
	3	2,328	0	67	0	2,261
APR	LAKE	30,220	180	2,678	482	27,240
	1	3,973	27	383	185	3,432
	2	23,985	140	2,104	297	21,724
	3	2,261	13	191	0	2,083
MAY	LAKE	27,240	300	1,763	497	25,280
	1	3,432	45	252	190	3,035
	2	21,724	233	1,385	307	20,265
	3	2,083	22	126	0	1,979
JUN	LAKE	25,280	22,000	11,798	482	35,000
	1	3,035	3,811	1,661	185	5,000
	2	20,265	16,725	9,193	297	27,500
	3	1,979	1,464	743	0	2,500

*** USERS ARE EXAMPLE ONLY**

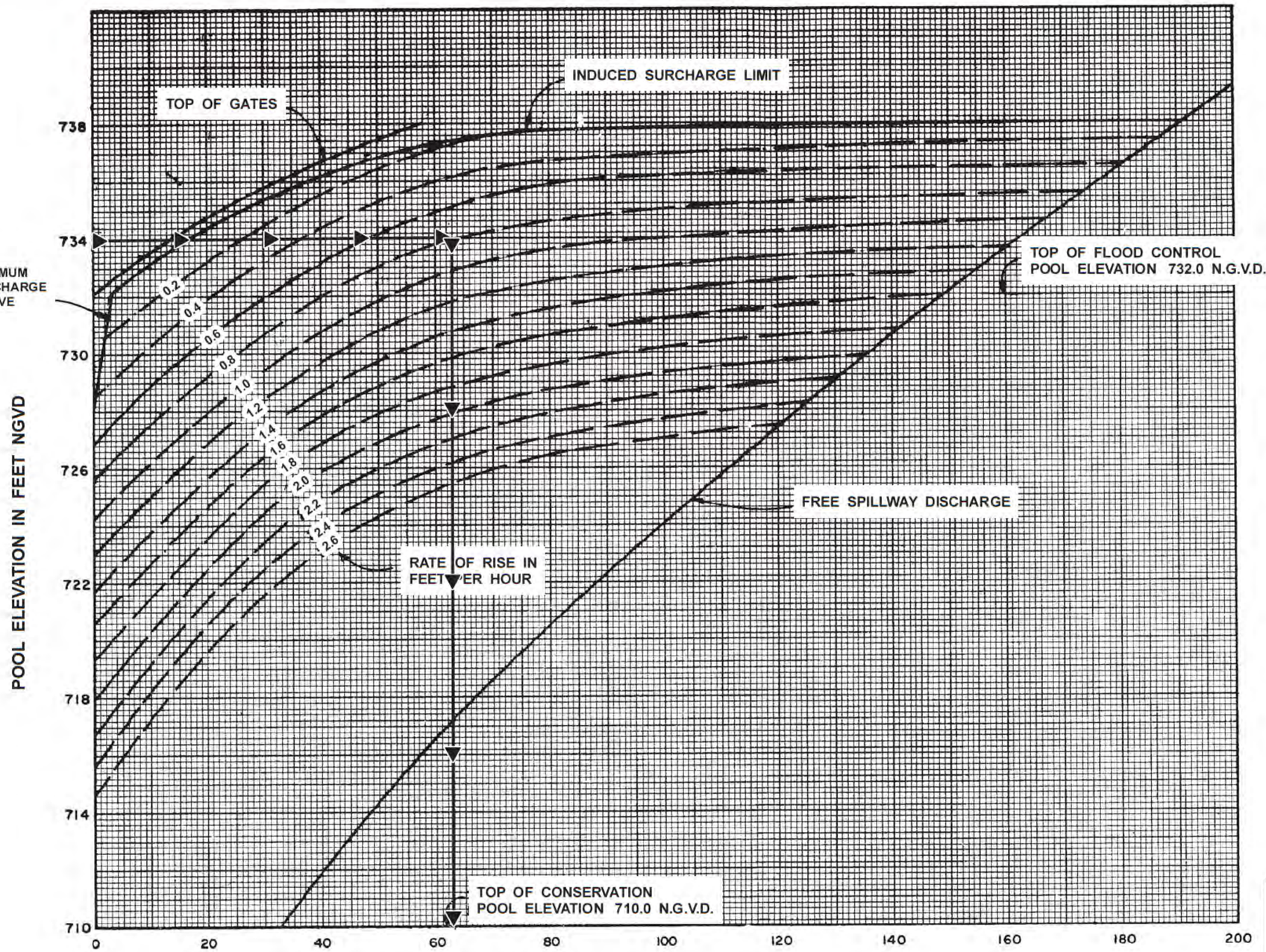
COPAN LAKE
Top of Inactive Pool 687.5 NGVD
Inactive Storage 750 Ac. - Ft.
Top of Cons. Pool 710.0 NGVD
Cons. Storage 35,000 Ac. - Ft.

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

EXAMPLE WATER SUPPLY STORAGE ACCOUNTING

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



NOTE:
SPILLWAY CREST IS
ELEVATION 696.5 N.G.V.D.

IMPORTANT:

THIS PLATE IS PRESENTED TO MEET EM 1120-2-3600 REQUIREMENTS AND SHOULD ONLY BE USED AS A LAST ALTERNATIVE.

THE RATE OF RISE PARAMATERS CURVE SHOULD ONLY BE USED AS A LAST RESORT IN CASES WHERE INFLOWS CANNOT BE DETERMINED

NOTES:

1. THIS SCHEDULE IS USED IN ACCORDANCE WITH "EMERGENCY REGULATIONS FOR FLOOD CONTROL OPERATIONS OF COPAN LAKE."
2. THE DISCHARGE IS DETERMINED BY THE RATE OF RISE FOR THE PREVIOUS TWO-HOUR PERIOD AND THE POOL ELEVATION AT THE END OF THE PERIOD.

EXAMPLE:

TO DETERMINE DISCHARGE AT POOL ELEVATION 734.0 WITH A RATE OF RISE OF .8 FEET PER HOUR

1. AT POOL ELEVATION 734.0, READ ACROSS TO RATE OF RISE CURVE .8.
2. READ DOWN TO FIND DISCHARGE OF 62,800 C.F.S.
3. USING THE SPILLWAY RATING CURVE - PARTIAL GATE OPENINGS, FIND THE NEEDED OPENING FOR A DISCHARGE OF 110,000 C.F.S.

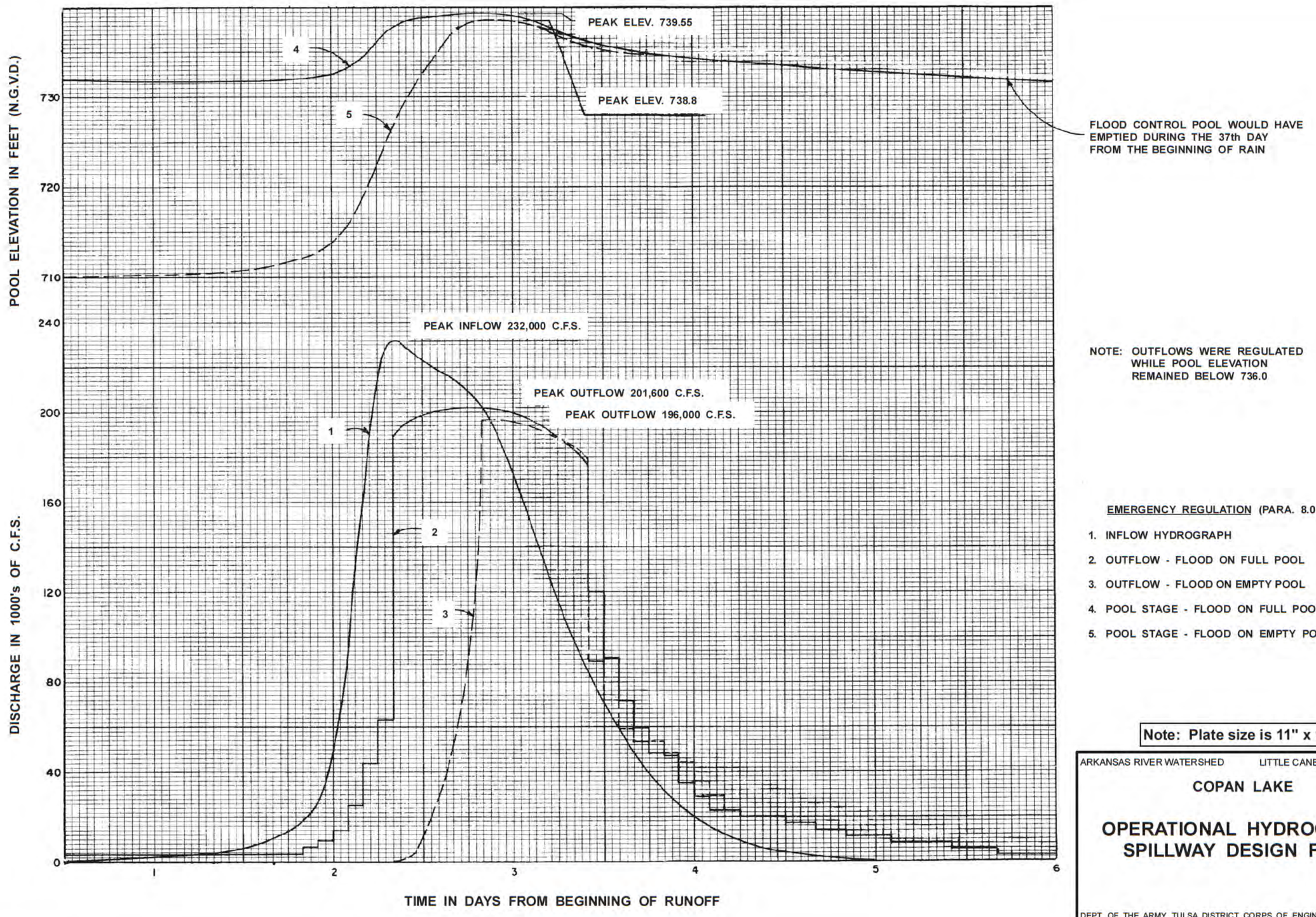
Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

SPILLWAY GATE REGULATION SCHEDULE RATE OF RISE PARAMETER

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



FLOOD CONTROL POOL WOULD HAVE EMPTIED DURING THE 37th DAY FROM THE BEGINNING OF RAIN

NOTE: OUTFLOWS WERE REGULATED WHILE POOL ELEVATION REMAINED BELOW 736.0

EMERGENCY REGULATION (PARA. 8.01)

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

Note: Plate size is 11" x 17"

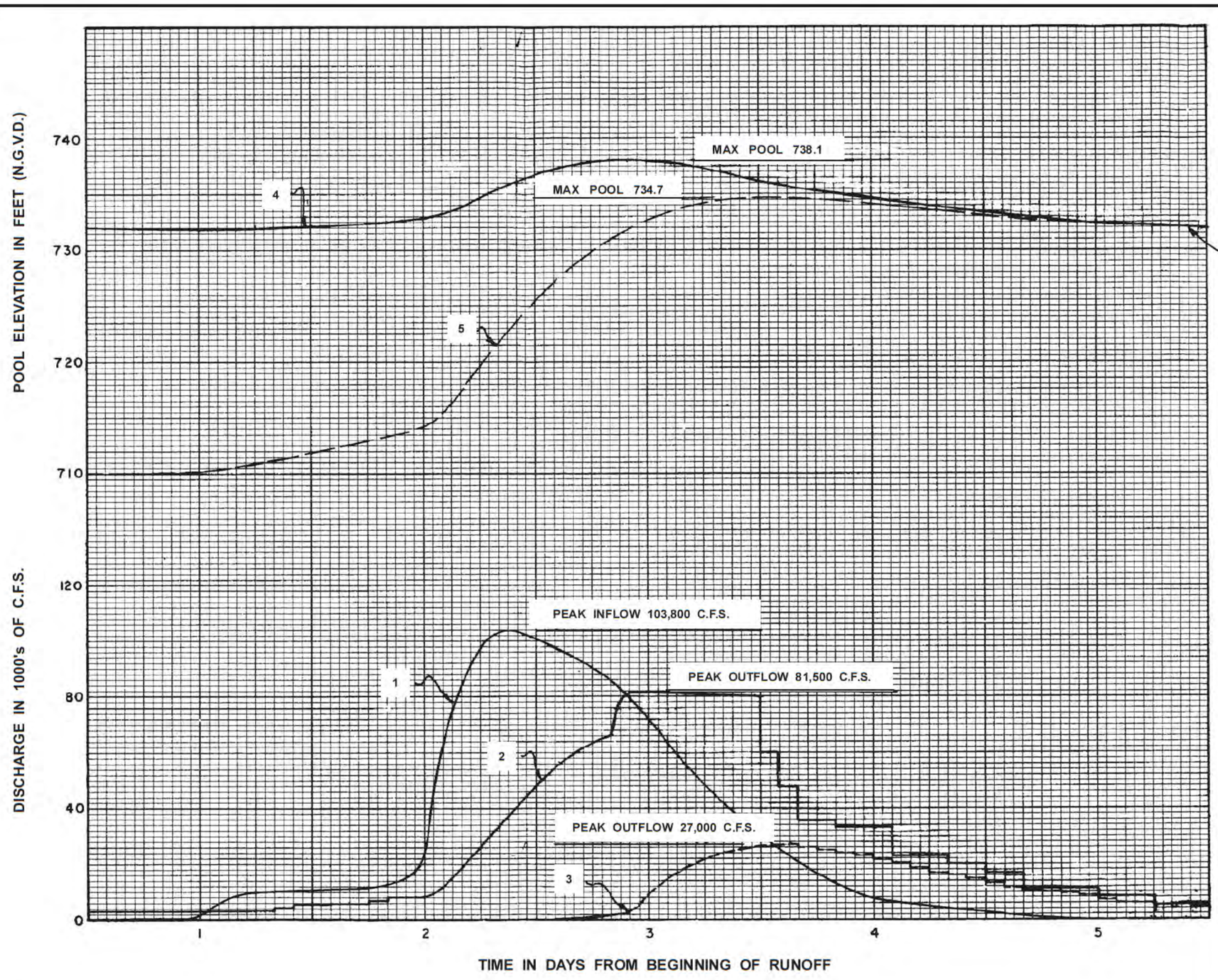
ARKANSAS RIVER WATERSHED — LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

OPERATIONAL HYDROGRAPHS SPILLWAY DESIGN FLOOD

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

PLATE 8 - 1



NOTE: OUTFLOWS WERE REGULATED WHILE POOL ELEVATION REMAINED BELOW 736.0

EMERGENCY REGULATION (PARA. 8.01)

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

Note: Plate size is 11" x 17"

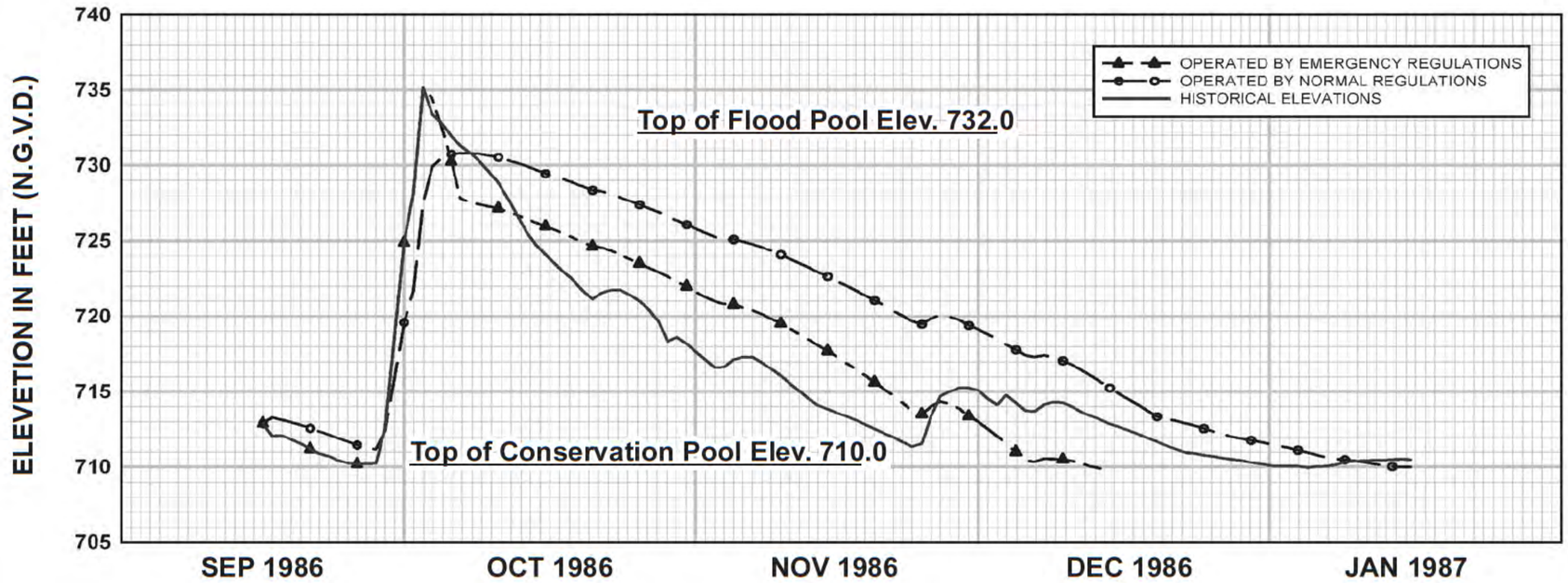
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

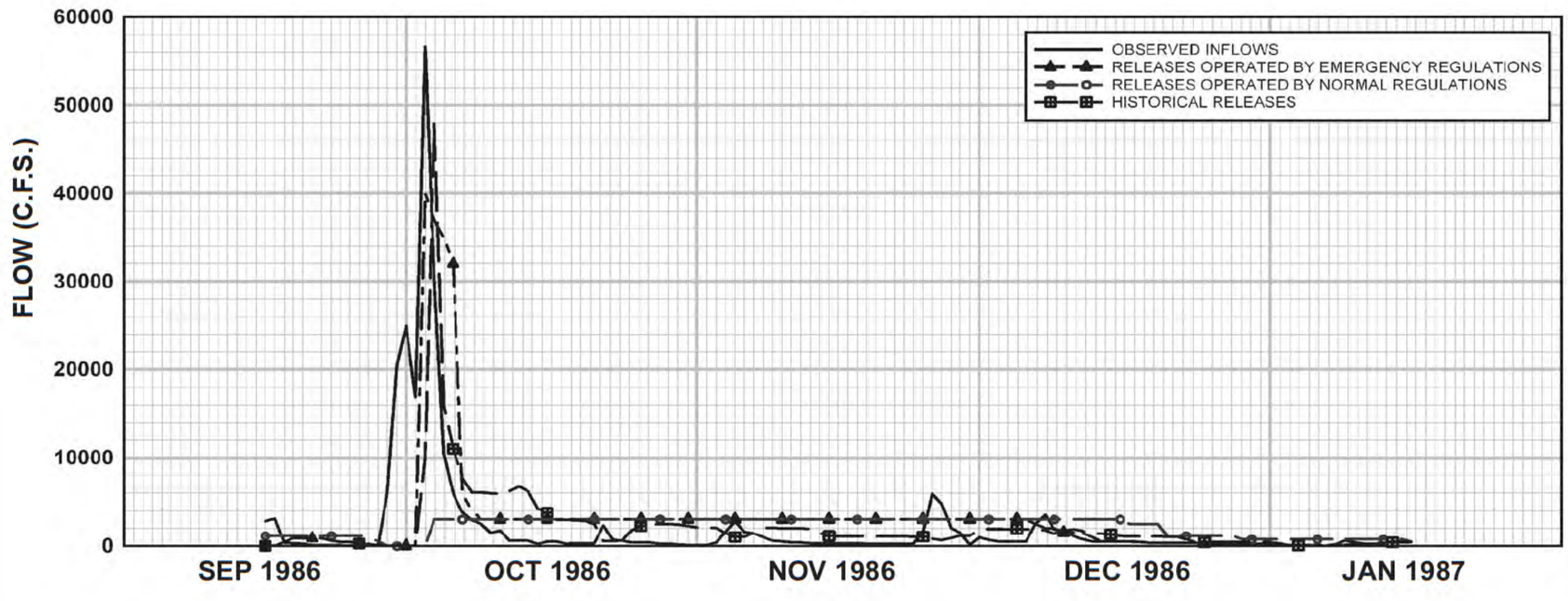
COPAN LAKE

OPERATIONAL HYDROGRAPHS STANDARD PROJECT FLOOD

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

PLATE 8 - 2





NOTES:

1. REGULATING CAPACITY IMMEDIATELY BELOW THE DAM IS 3,000 C.F.S.
2. EMERGENCY REGULATION RELEASES START ON 3 OCT 1986
3. EMERGENCY AND NORMAL REGULATION RELEASES ARE THE SAME BETWEEN 9 OCT AND 6 DEC 1986
4. WITH NORMAL REGULATION, THE FLOOD CONTROL POOL WOULD HAVE EMPTIED ON 16 JAN 1987
5. WITH EMERGENCY REGULATION, THE FLOOD CONTROL POOL WOULD HAVE EMPTIED ON 16 DEC 1986
6. FLOOD VOLUME BETWEEN 28 SEP AND 18 OCT 1986 IS 94,607 ACRE-FEET
7. FLOOD CONTROL POOL CONTAINS 164,077 ACRE-FEET

Note: Plate size is 11" x 17"

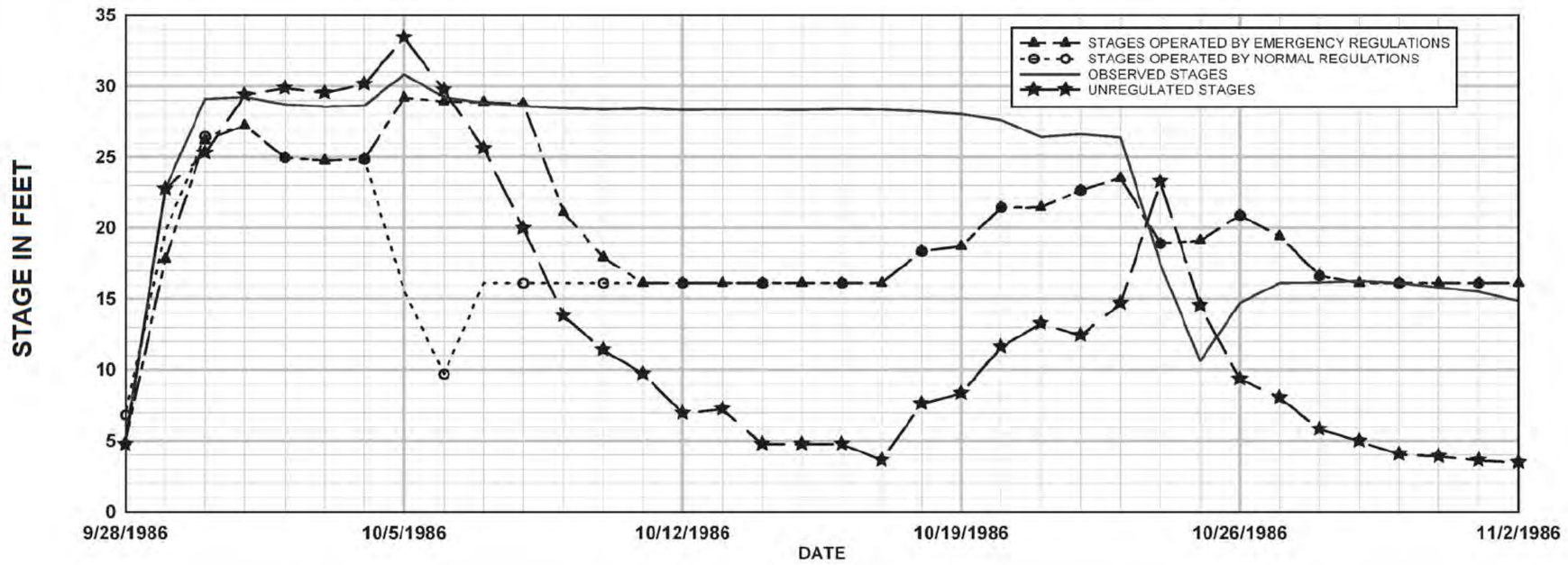
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

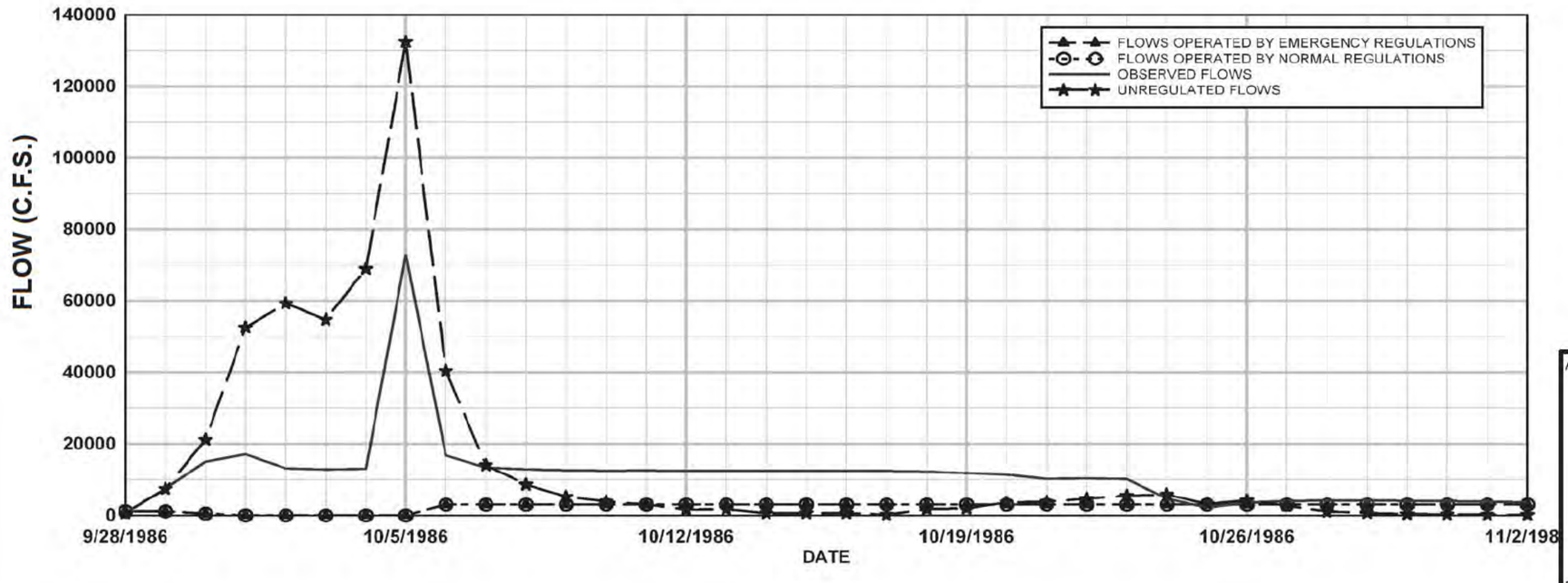
COPAN LAKE

OPERATIONAL HYDROGRAPH 1986 FLOOD AT COPAN DAMSITE

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

PLATE 8 - 3





NOTES:

1. EMERGENCY REGULATION CURVE IS WITH EMERGENCY REGULATION AT COPAN AND NORMAL REGULATION AT HULAH
2. NORMAL REGULATION CURVE IS WITH NORMAL REGULATION AT BOTH COPAN AND HULAH
3. EMERGENCY AND NORMAL REGULATION CURVES ARE THE SAME BETWEEN 12 OCT AND 8 DEC 1986.

Note: Plate size is 11" x 17"

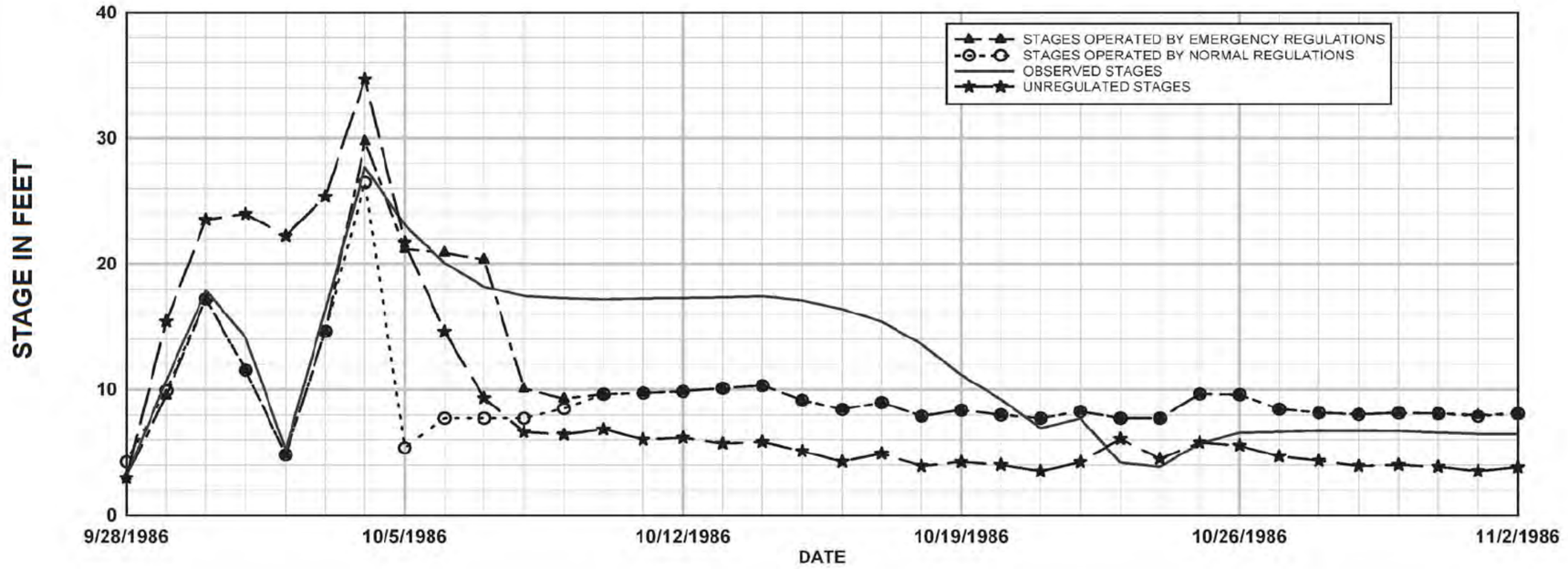
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

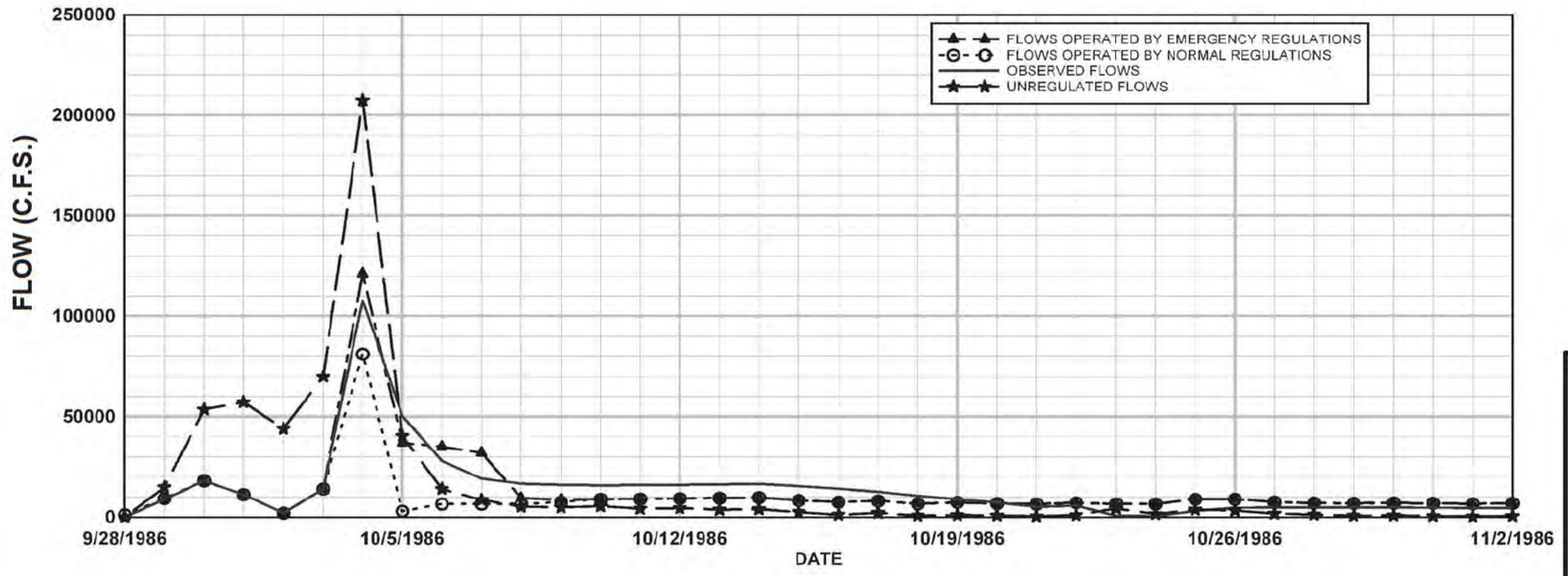
COPAN LAKE

OPERATIONAL HYDROGRAPH 1986 FLOOD AT THE RAMONA GAGE

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

PLATE 8 - 4





NOTES:

1. EMERGENCY REGULATION CURVE IS WITH EMERGENCY REGULATION AT COPAN AND NORMAL REGULATION AT HULAH
2. NORMAL REGULATION CURVE IS WITH NORMAL REGULATION AT BOTH COPAN AND HULAH
3. EMERGENCY AND NORMAL REGULATION CURVES ARE THE SAME BETWEEN 11 OCT AND 7 DEC 1986.

Note: Plate size is 11" x 17"

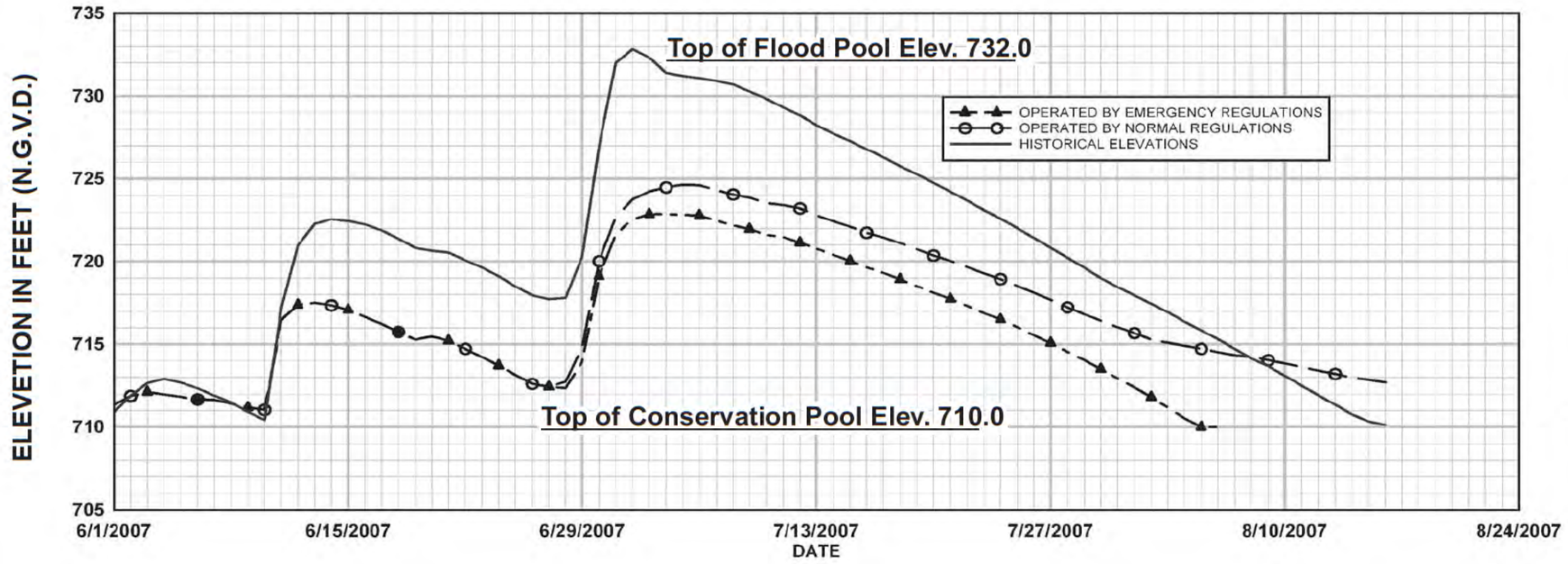
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

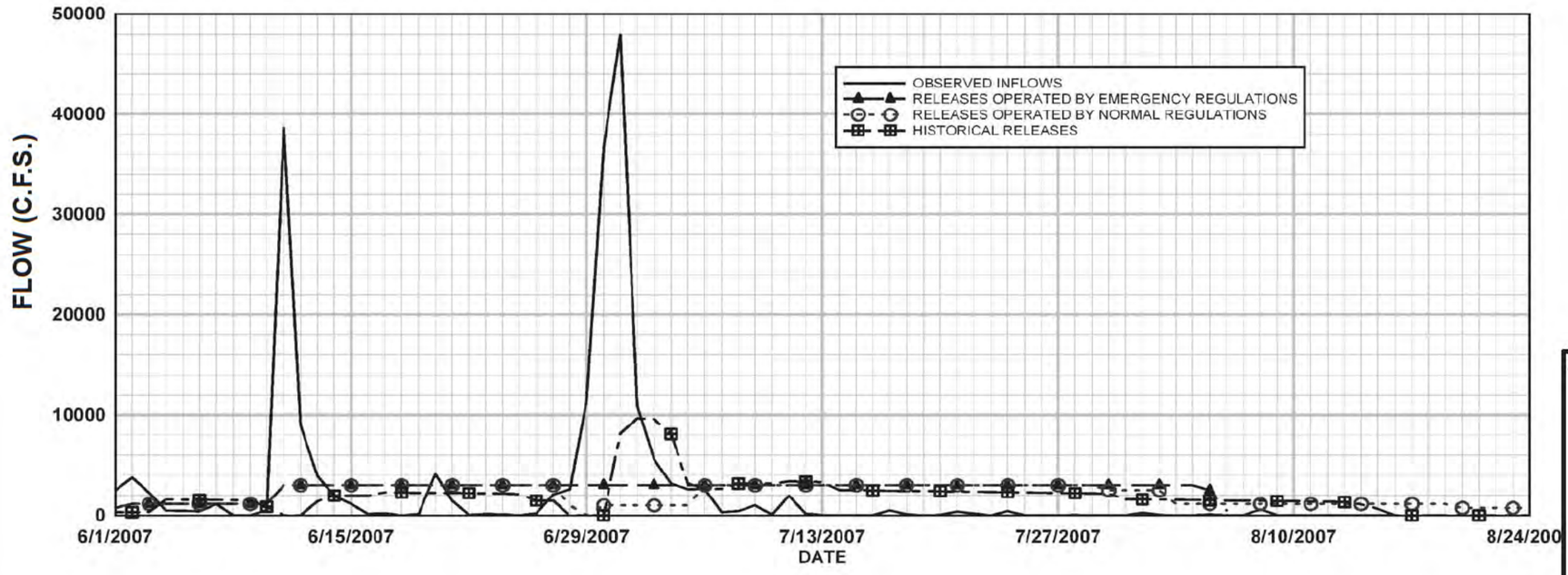
COPAN LAKE

OPERATIONAL HYDROGRAPH 1986 FLOOD AT BARTLESVILLE

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

PLATE 8 - 5





NOTES:

1. REGULATING CAPACITY IMMEDIATELY BELOW THE DAM IS 3,000 C.F.S.
2. MAXIMUM INFLOW WAS 47,963 C.F.S. ON 1 JUL 2007
3. MAXIMUM POOL ELEVATION WAS 732.84 ON 2 JUL 2007
4. FLOOD VOLUME FROM 10 JUN 2007 TO 10 JUL 2007 WAS 80,161 AC.-FT.
5. NORMAL OPERATIONS AT BOTH COPAN AND HULAH WOULD HAVE EMPTIED COPAN'S FLOOD CONTROL POOL ON 7 SEP 2007
6. EMERGENCY OPERATIONS STARTED ON 25 JUN 2007
7. EMERGENCY OPERATIONS AT COPAN WITH NORMAL OPERATIONS AT HULAH WOULD HAVE EMPTIED THE FLOOD CONTROL POOL ON 6 AUG 2007

Note: Plate size is 11" x 17"

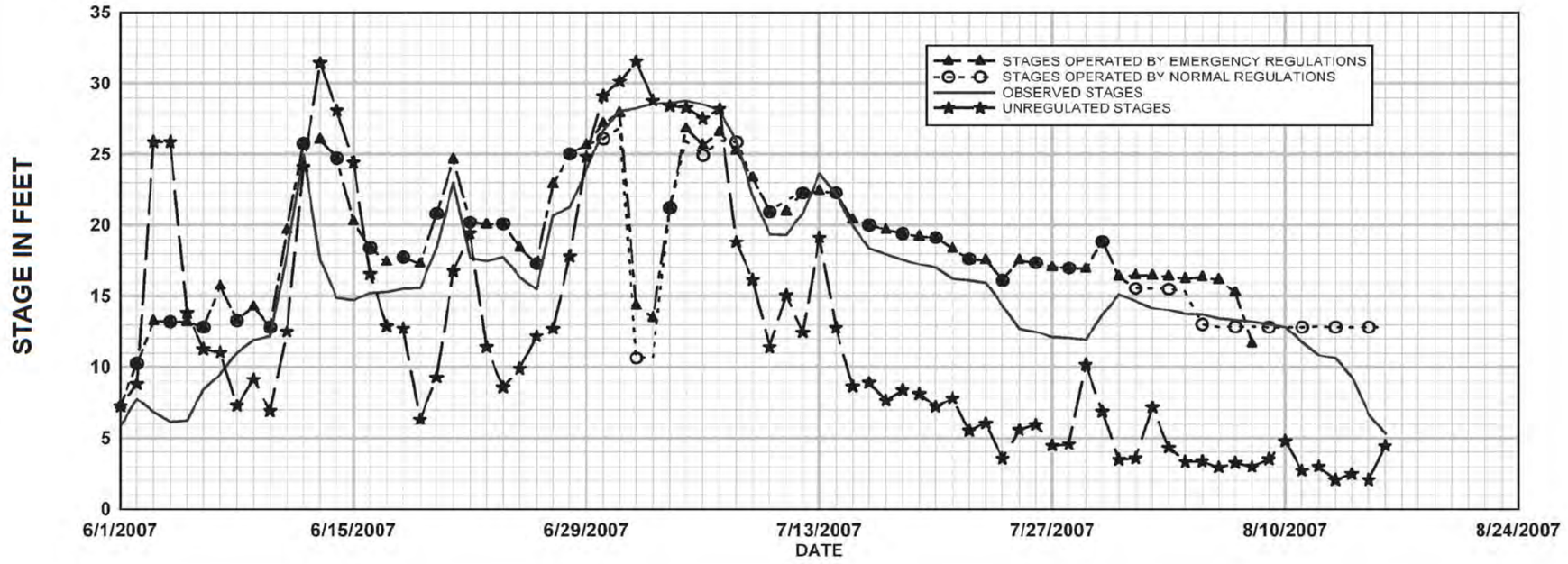
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

OPERATIONAL HYDROGRAPH 2007 FLOOD AT COPAN DAMSITE

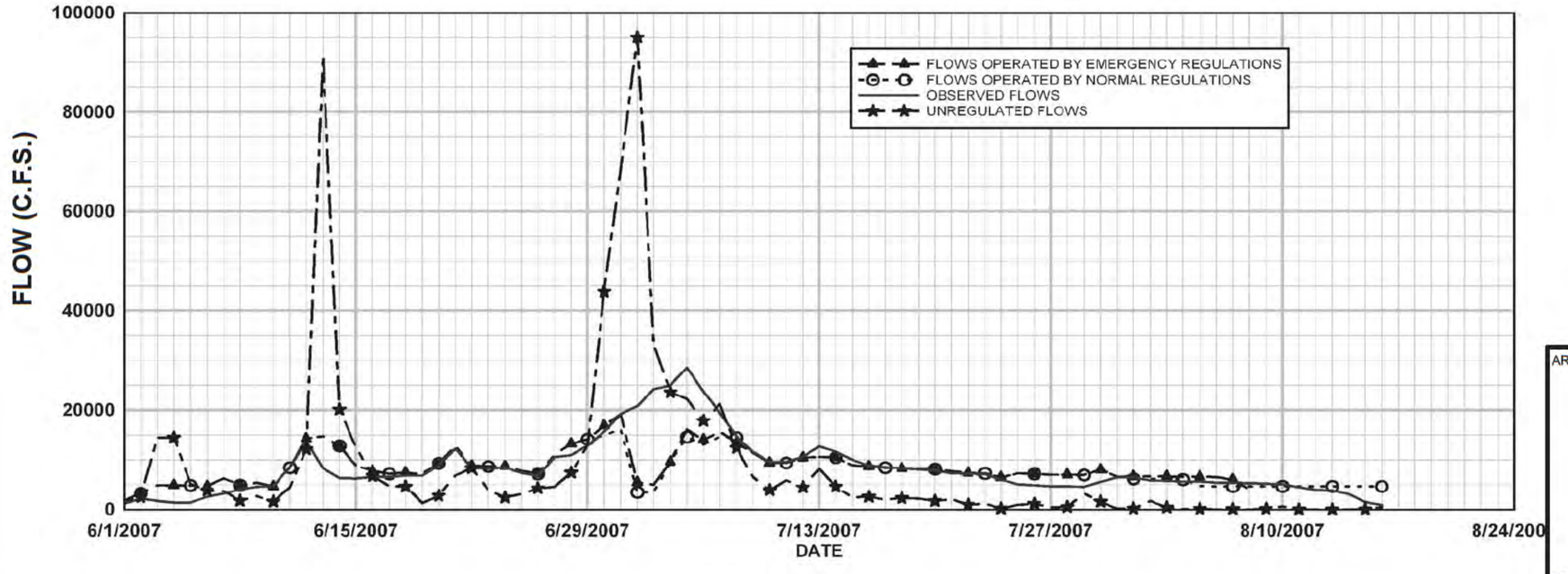
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 8 - 6



NOTE:

1. NORMAL OPERATIONS AT BOTH COPAN AND HULAH
2. EMERGENCY OPERATIONS AT COPAN, WITH NORMAL OPERATIONS AT HULAH, BEGIN ON 25 JUN 2007



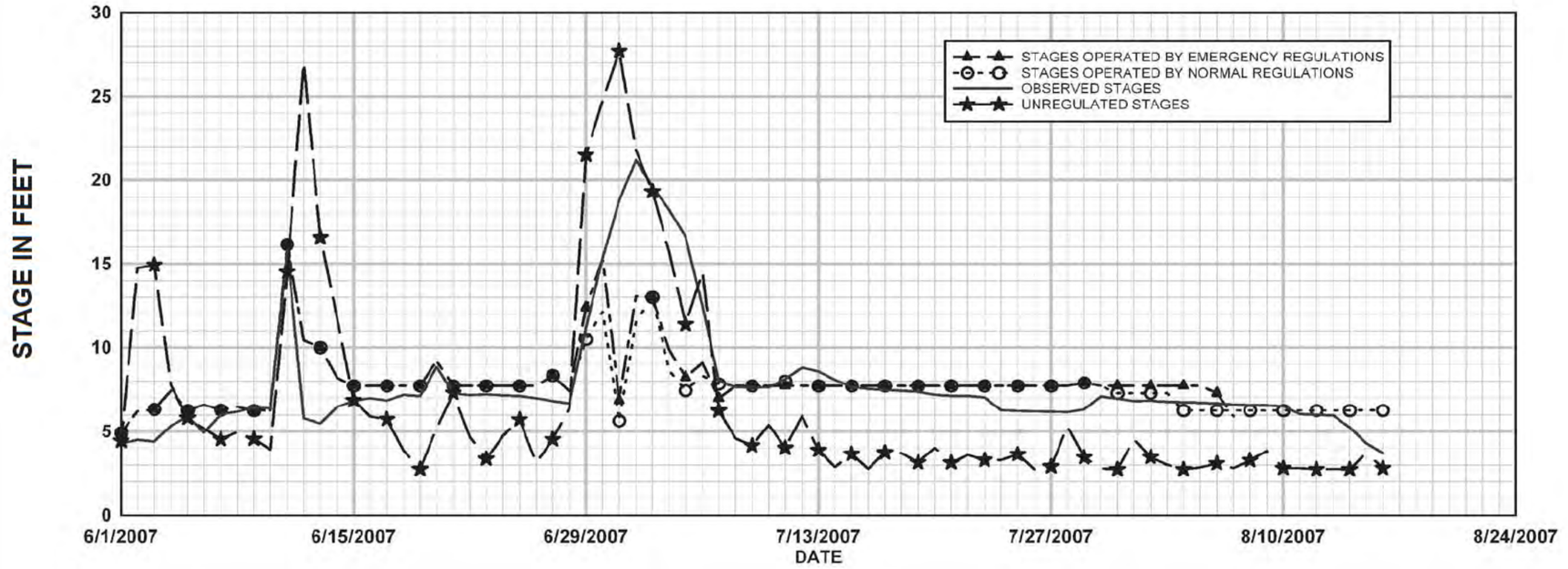
Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

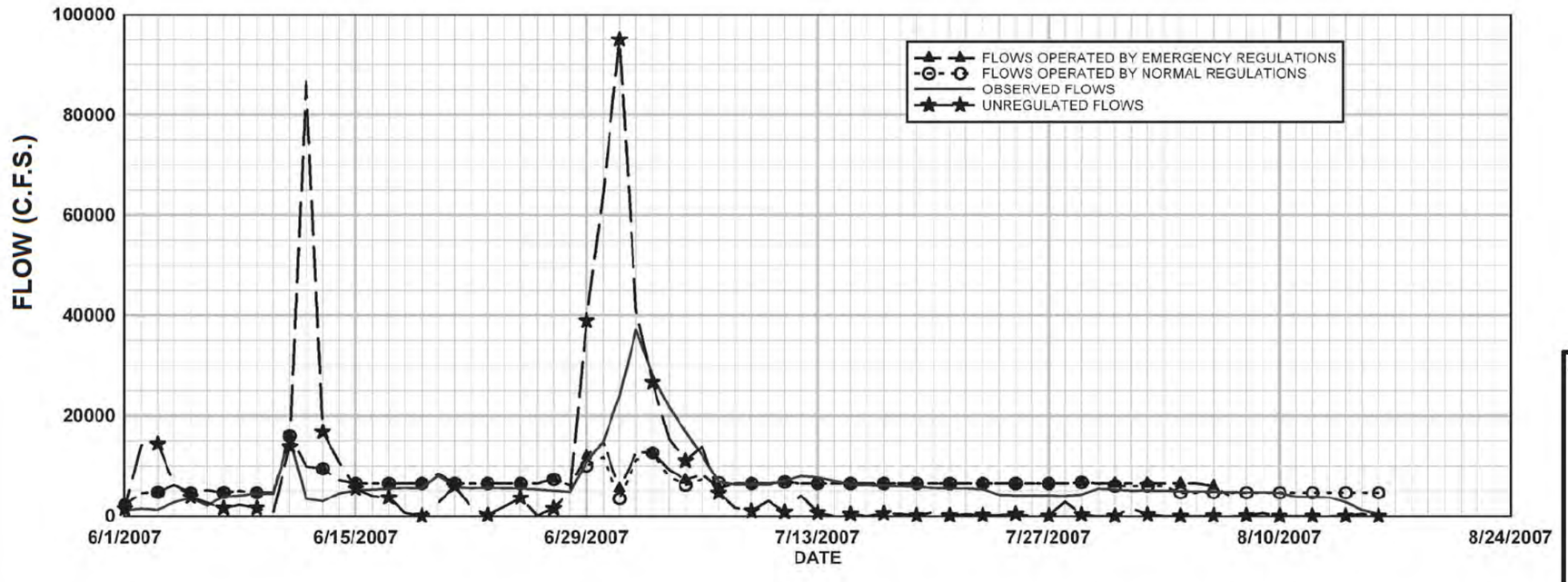
OPERATIONAL HYDROGRAPH 2007 FLOOD AT THE RAMONA GAGE

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



NOTES:

1. NORMAL OPERATIONS AT BOTH COPAN AND HULAH
2. EMERGENCY OPERATIONS AT COPAN, WITH NORMAL OPERATIONS AT HULAH, BEGAN ON 25 JUN 2007



Note: Plate size is 11" x 17"

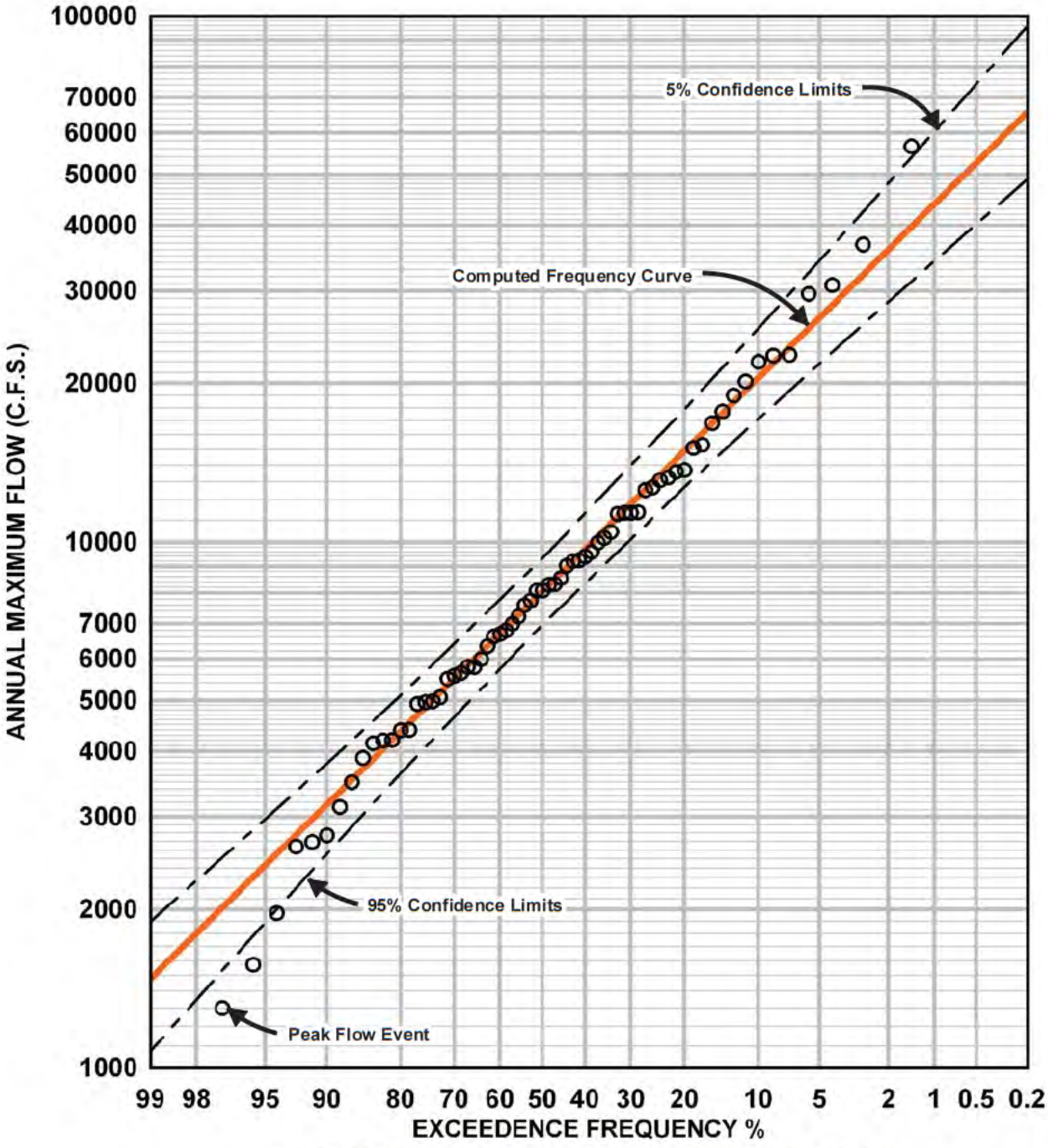
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

OPERATIONAL HYDROGRAPH 2007 FLOOD AT BARTLESVILLE

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

PLATE 8 - 8



CUMULATIVE FREQUENCY CURVE OF ANNUAL PEAK FLOWS

NOTES:

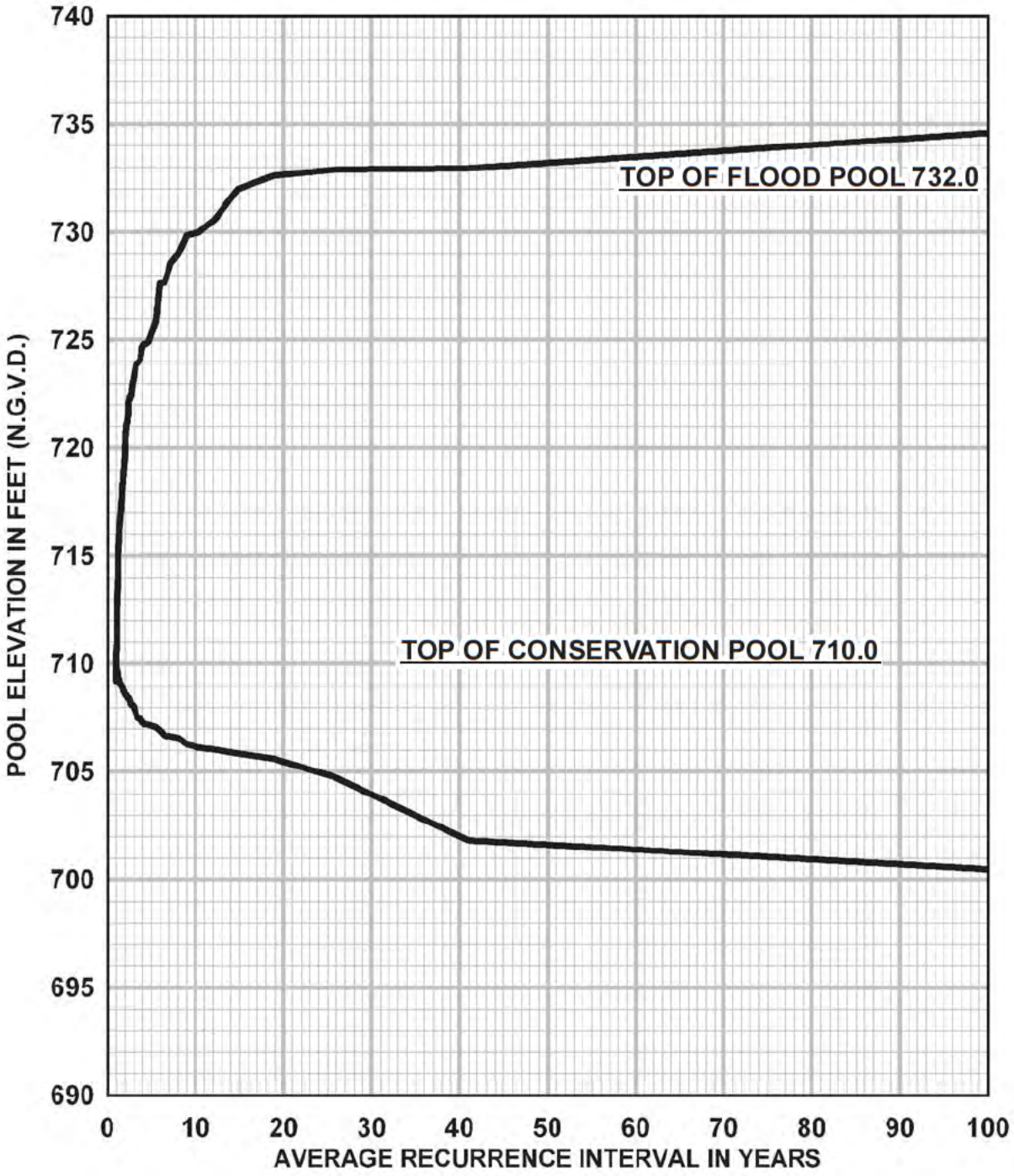
1. BASED ON METHODS OUTLINED IN "STATISTICAL METHODS IN HYDROLOGY," LEO R. BEARD JAN. 1962
2. BASIC DATA ARE COMPUTED ANNUAL PEAK DISCHARGE AT THE DAM SITE FROM JAN. 1940 THROUGH SEP. 2008

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

PEAK INFLOW PROBABILITY CURVE

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



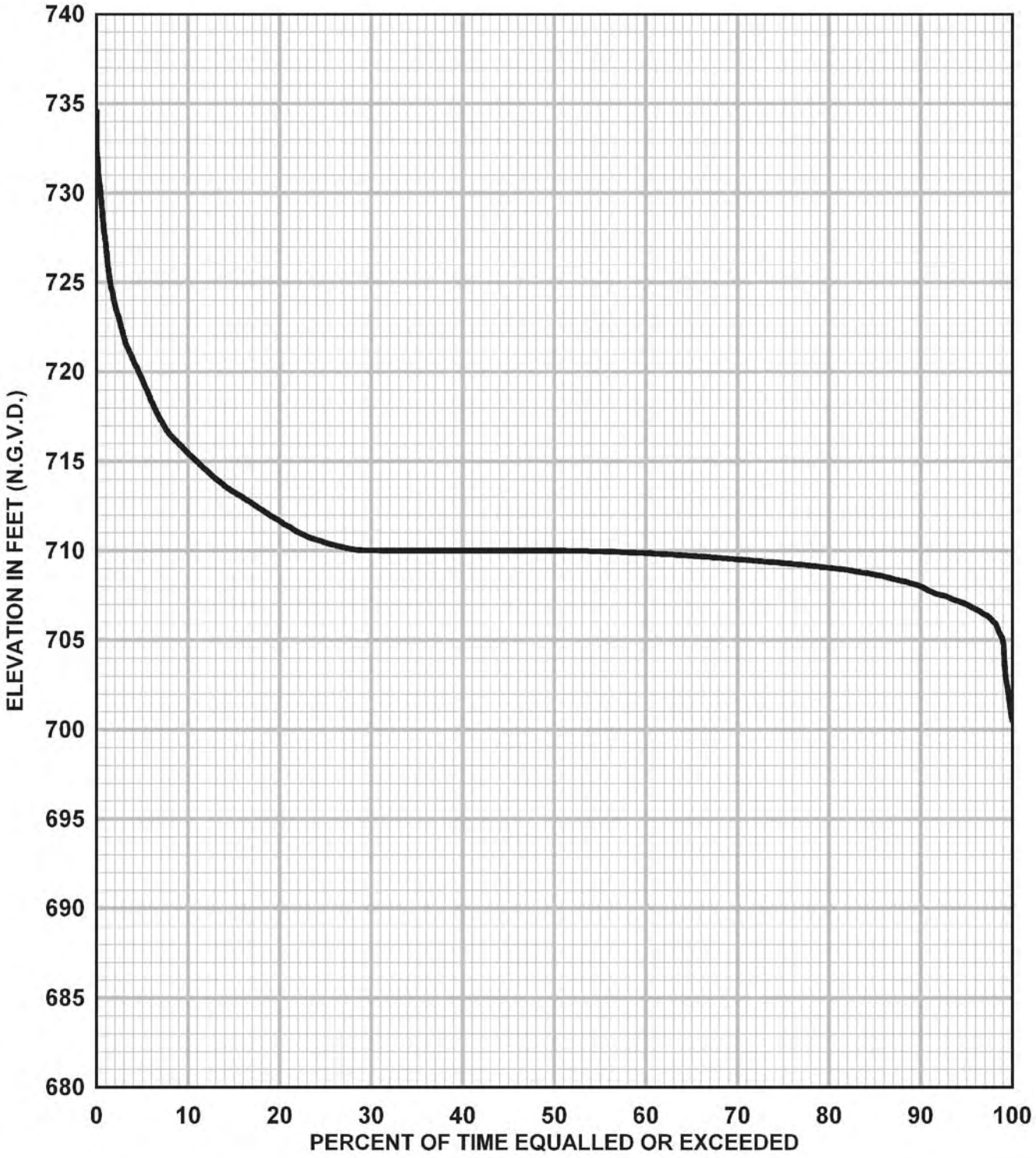
NOTE:
CURVE IS BASED ON PERIOD OF RECORD JAN 1940 THRU DEC 2008 WITH A WATER SUPPLY RELEASE OF 3.0 M.G.D. AND A WATER QUALITY RELEASE OF 16.0 M.G.D.

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

POOL ELEVATION PROBABILITY CURVE

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



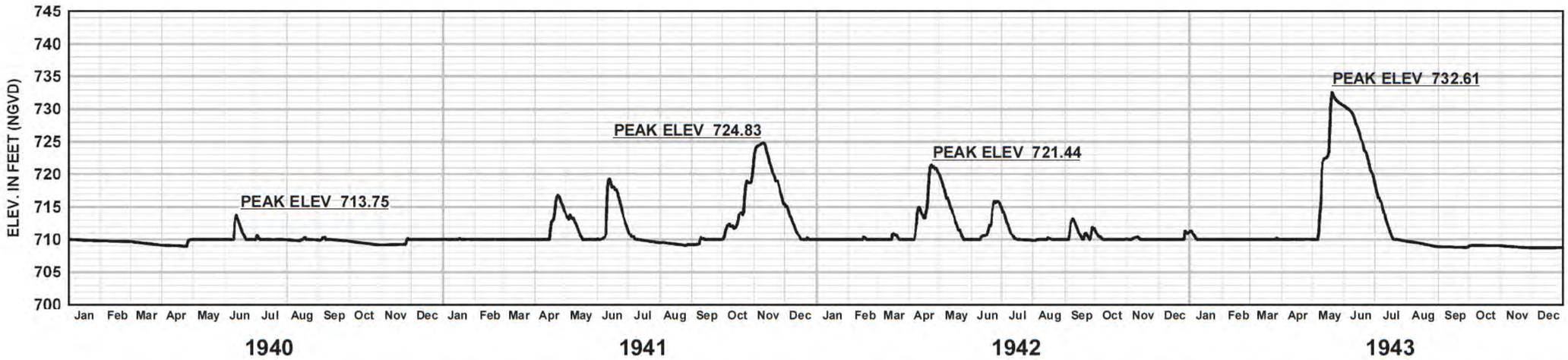
NOTE:
CURVE IS BASED ON PERIOD OF RECORD JAN 1940 THRU DEC 2008 FROM RIVERWARE PROGRAM 5.2.4.

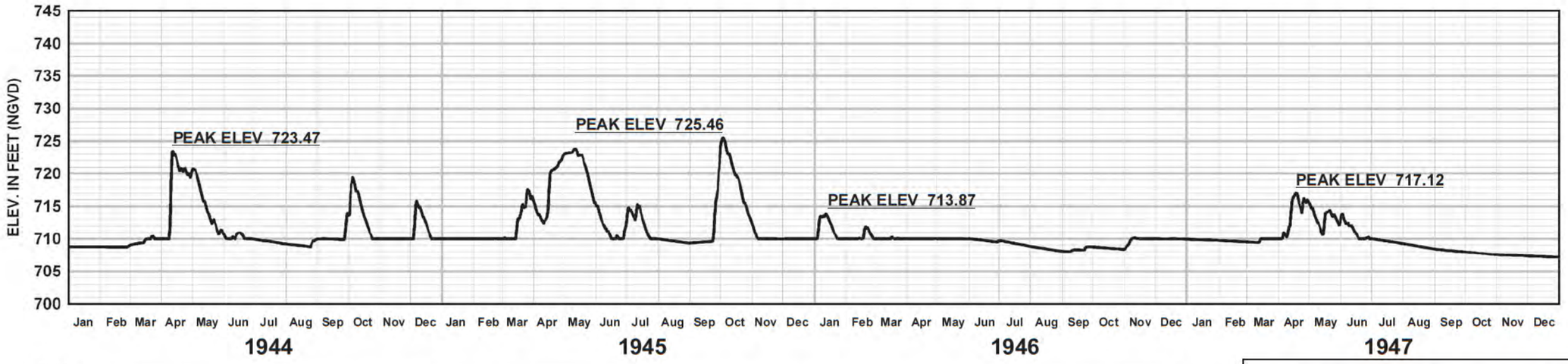
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

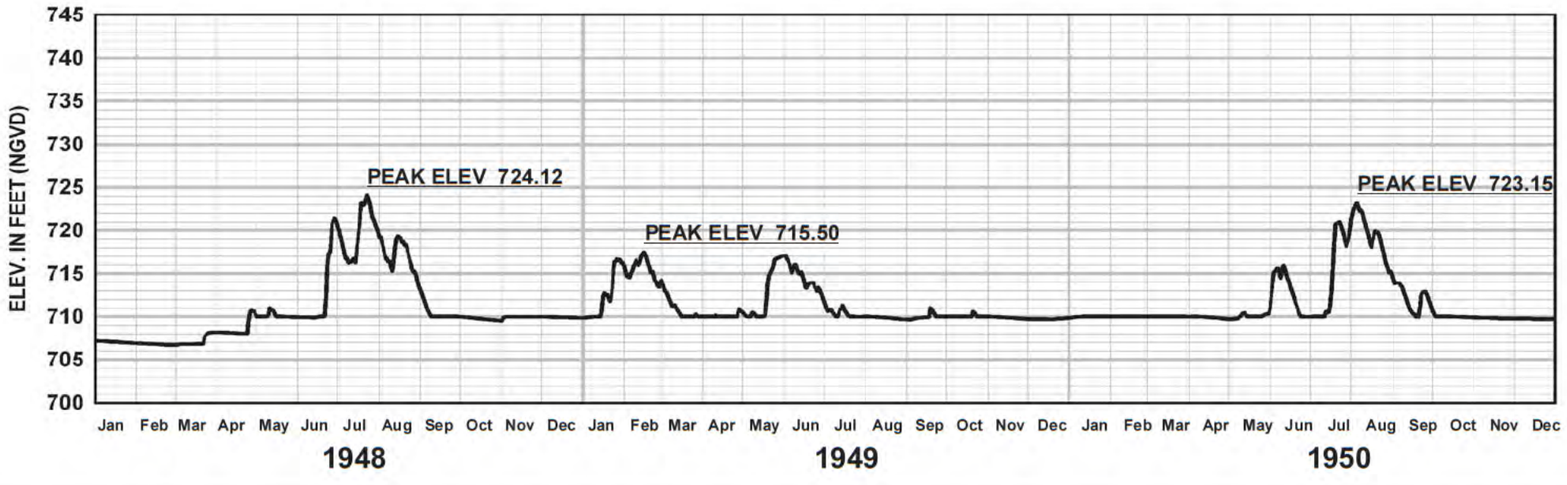
COPAN LAKE

POOL ELEVATION DURATION CURVE

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







NOTE: Pool elevations for Jan 1940 through Mar 1983 are based on a simulation using the RiverWare computer program. Elevations for Apr 1983 through Jun 2010 are actual historical values.

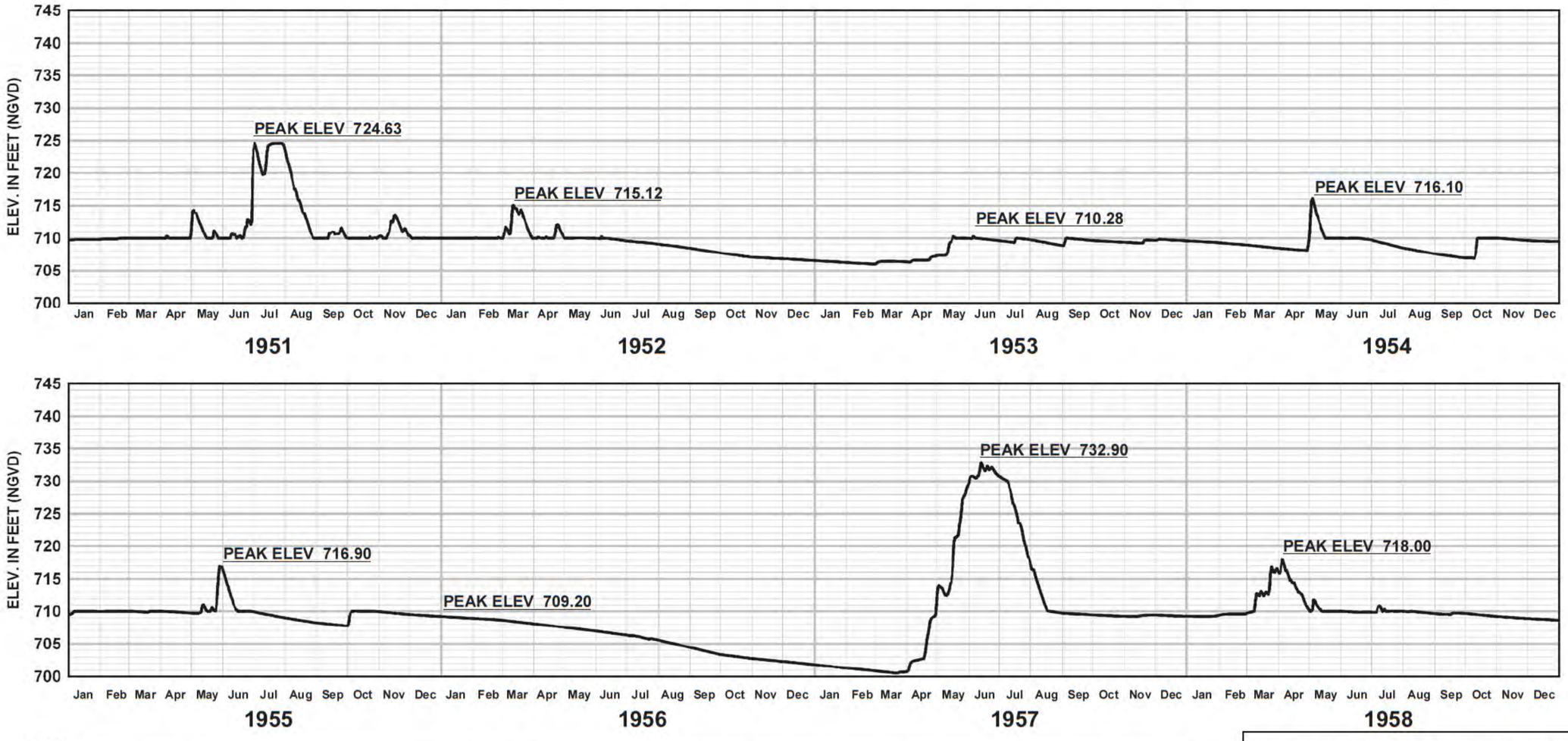
Note: Plate size is 11" x 17"

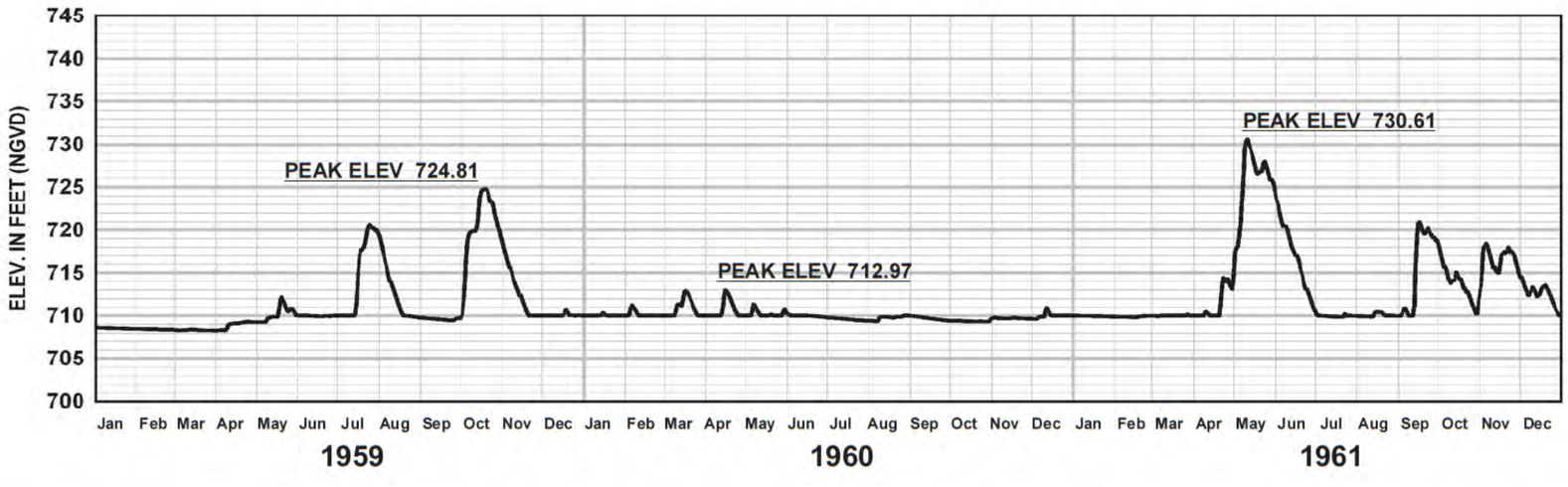
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

POOL ELEVATION HYDROGRAPHS 1940 - 1950

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





NOTE: Pool elevations for Jan 1940 through Mar 1983 are based on a simulation using the RiverWare computer program. Elevations for Apr 1983 through Jun 2010 are actual historical values.

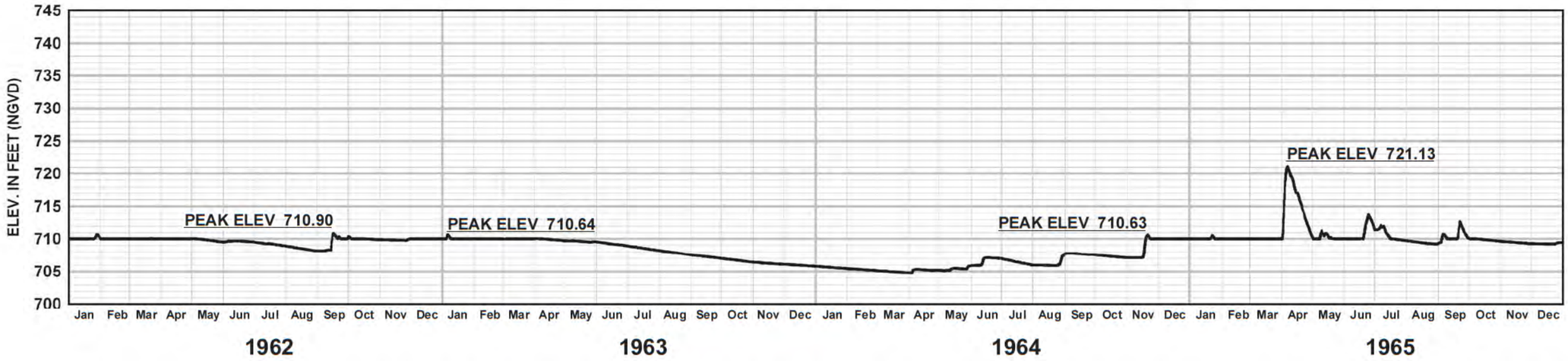
Note: Plate size is 11" x 17"

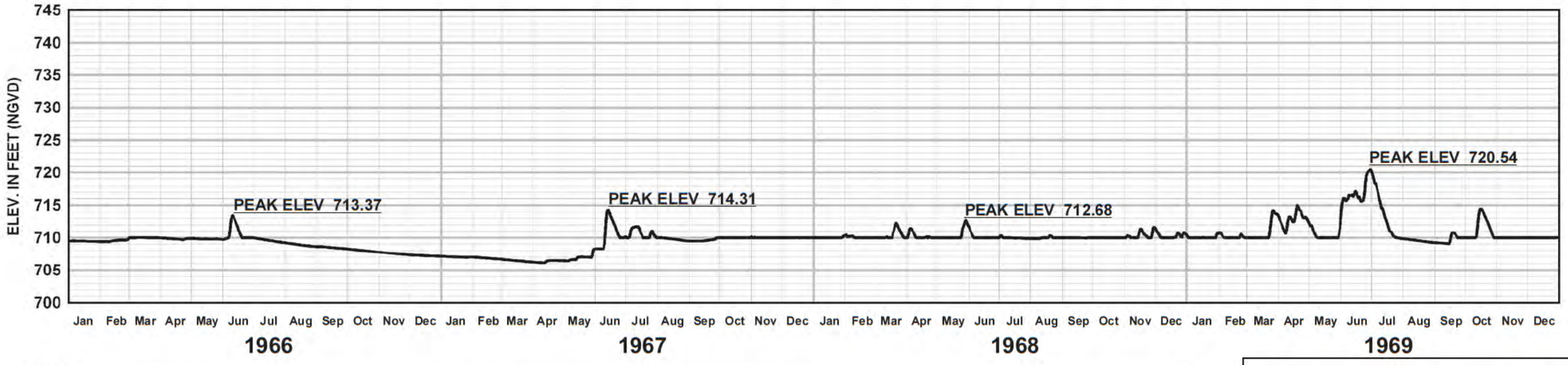
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

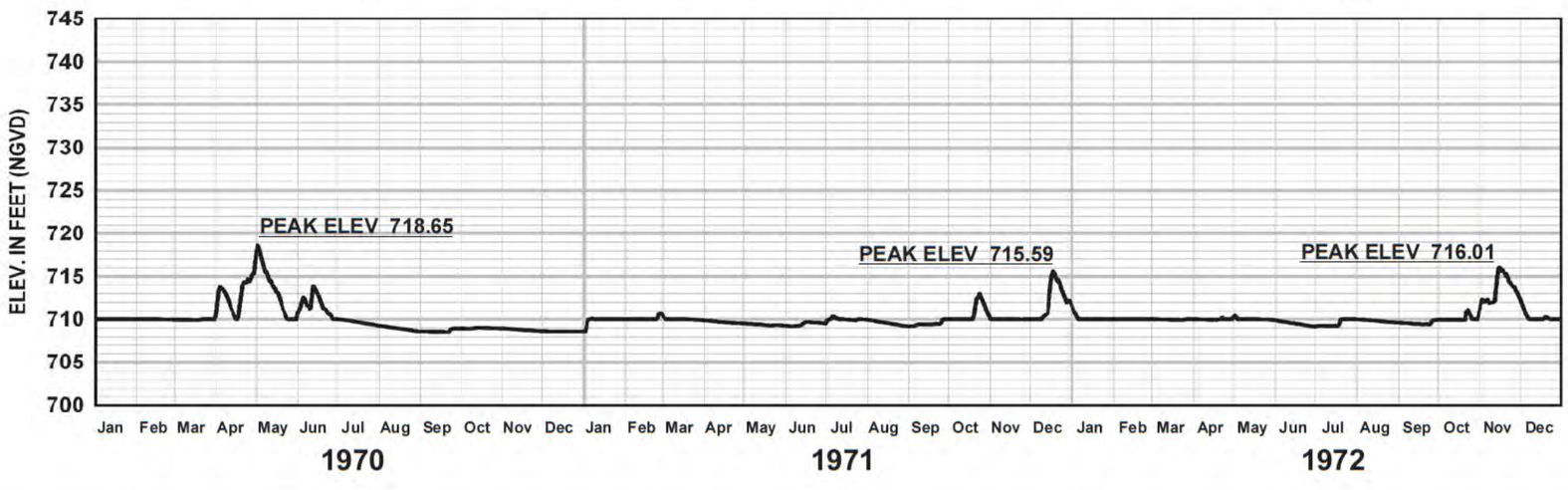
COPAN LAKE

POOL ELEVATION HYDROGRAPHS 1951 - 1961

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







NOTE: Pool elevations for Jan 1940 through Mar 1983 are based on a simulation using the RiverWare computer program. Elevations for Apr 1983 through Jun 2010 are actual historical values.

Note: Plate size is 11" x 17"

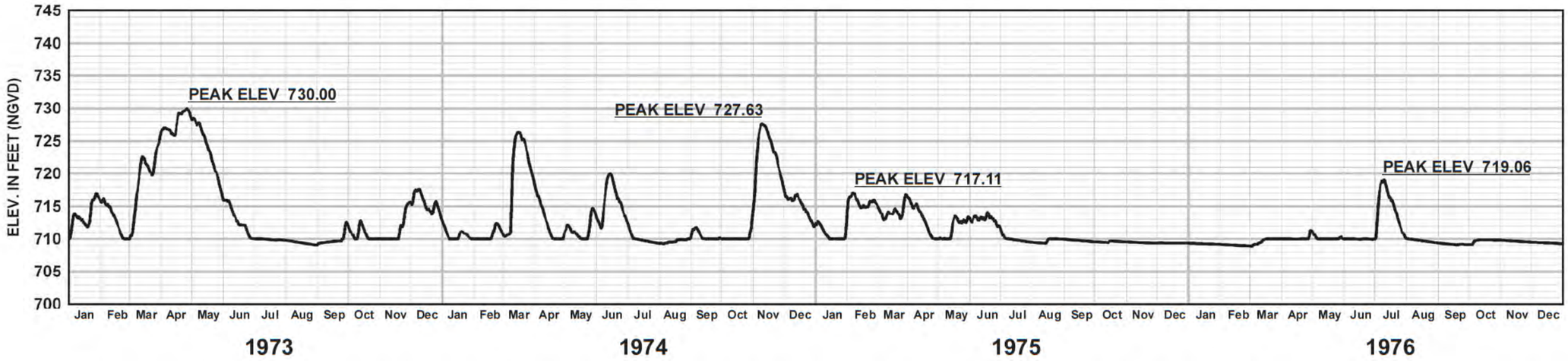
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

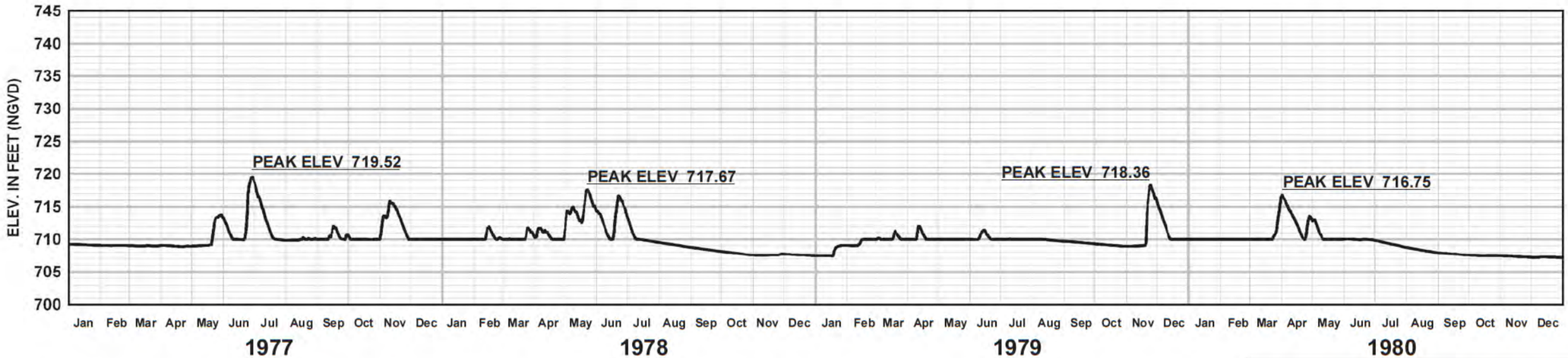
COPAN LAKE

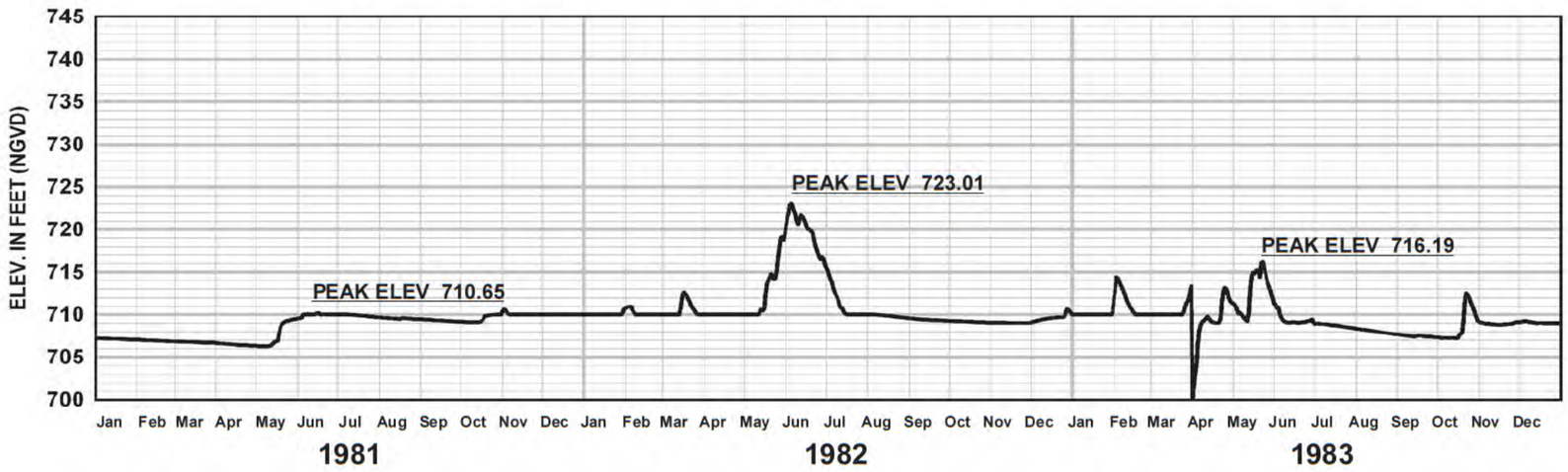
POOL ELEVATION HYDROGRAPHS 1962 - 1972

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

PLATE 8 - 14







NOTE: Pool elevations for Jan 1940 through Mar 1983 are based on a simulation using the RiverWare computer program. Elevations for Apr 1983 through Jun 2010 are actual historical values.

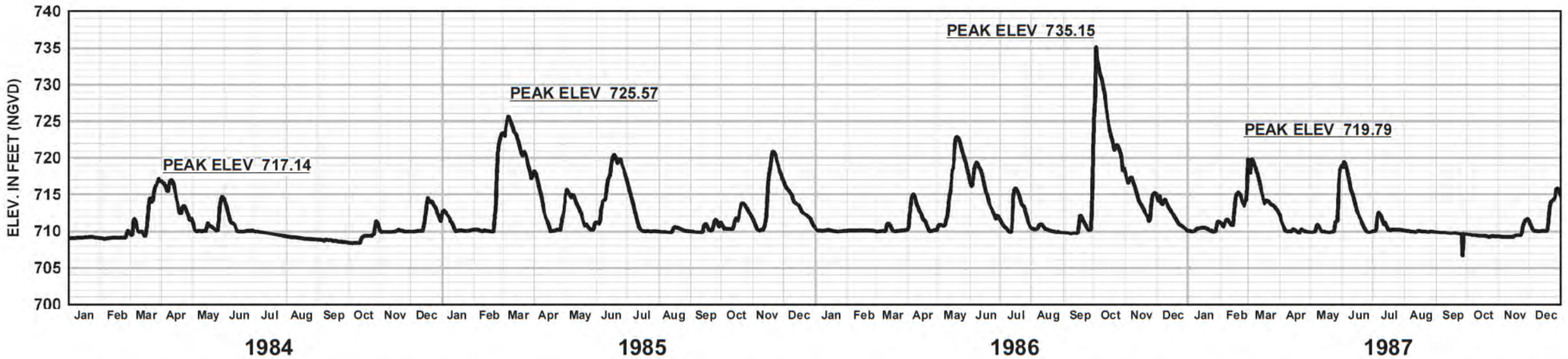
Note: Plate size is 11" x 17"

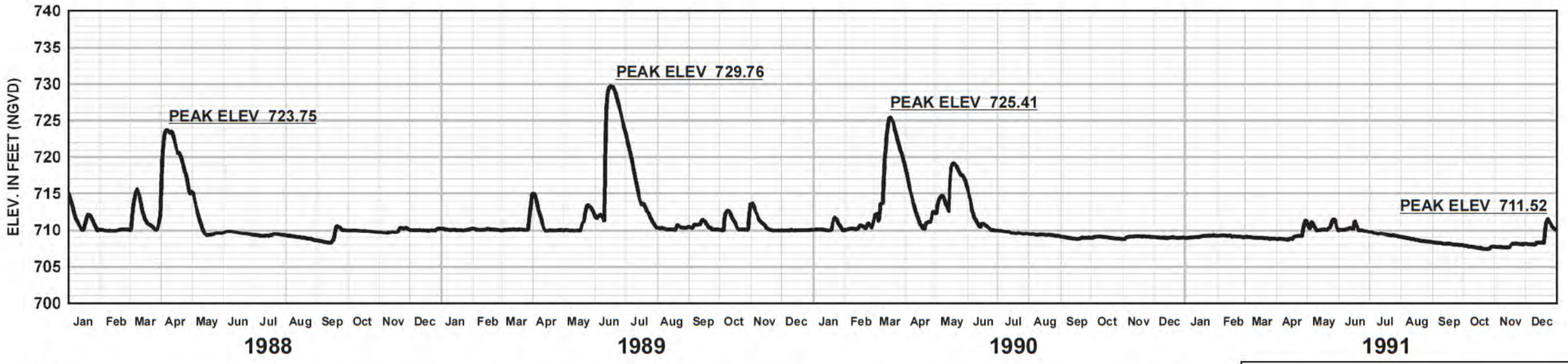
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

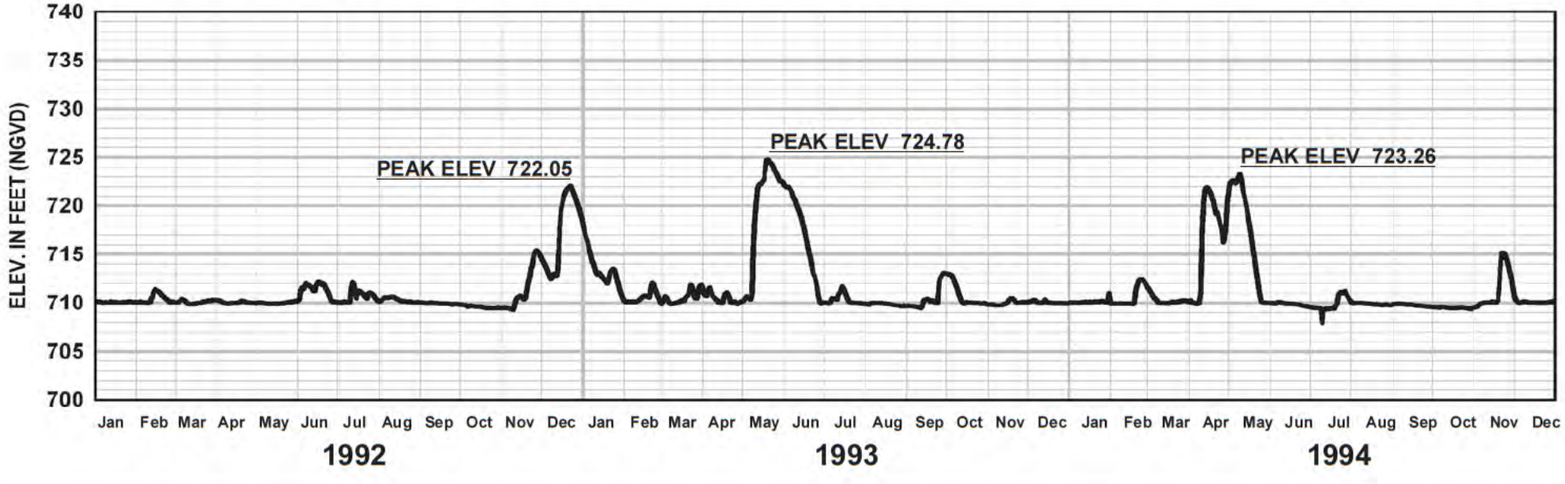
COPAN LAKE

POOL ELEVATION HYDROGRAPHS 1973 - 1983

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







NOTE: Pool elevations for Jan 1940 through Mar 1983 are based on a simulation using the RiverWare computer program. Elevations for Apr 1983 through Jun 2010 are actual historical values.

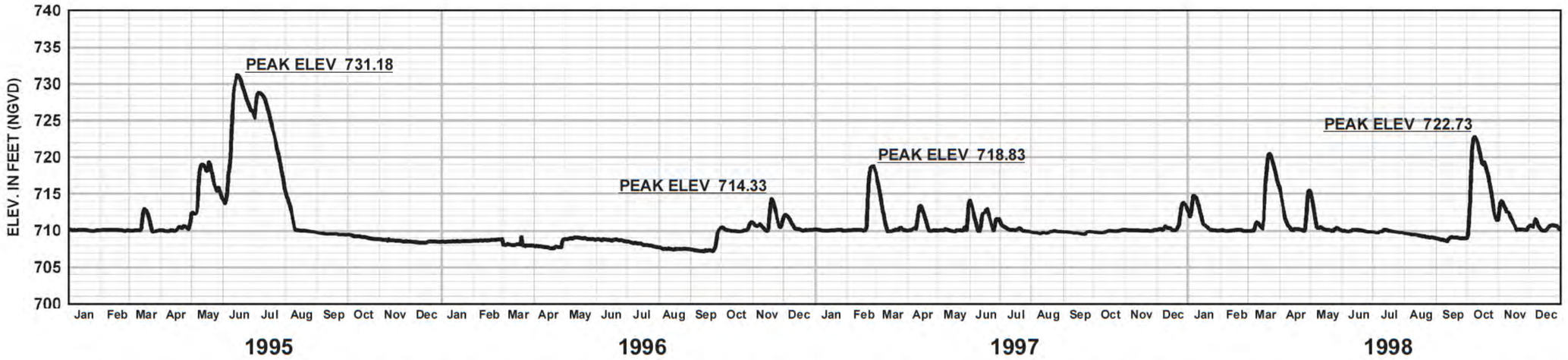
Note: Plate size is 11" x 17"

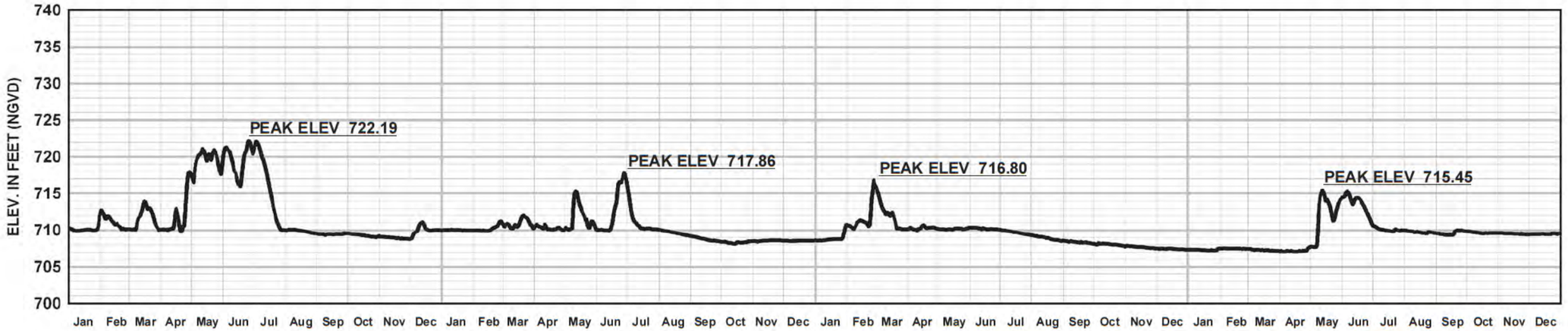
ARKANSAS RIVER WATERSHED — LITTLE CANEY RIVER, OKLAHOMA

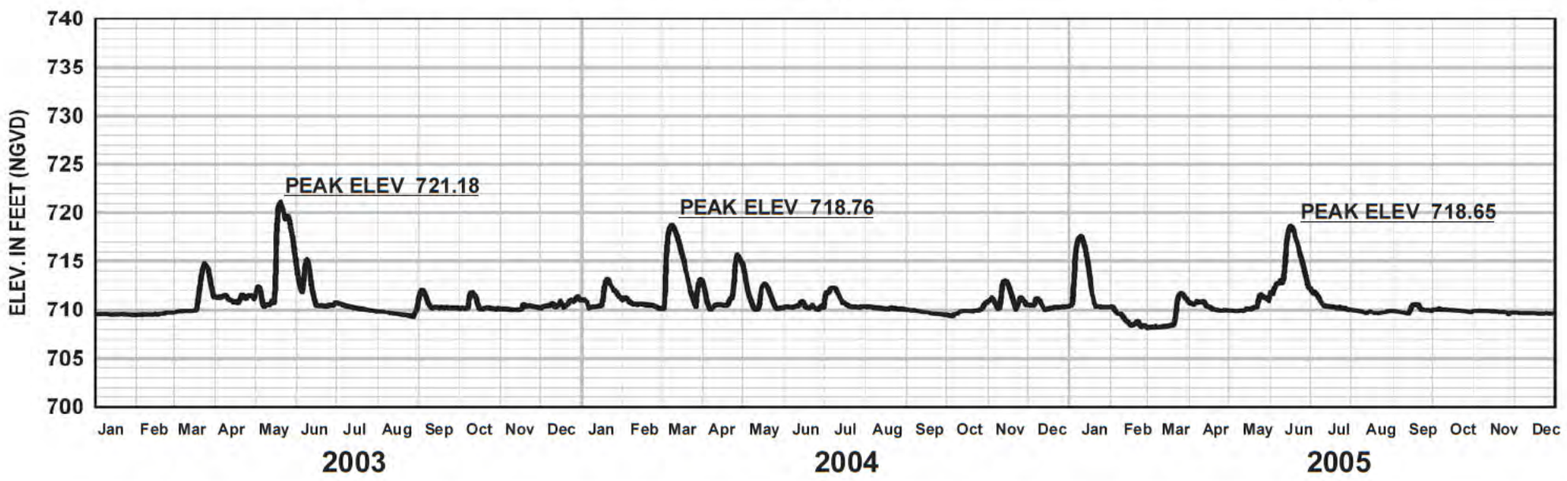
COPAN LAKE

POOL ELEVATION HYDROGRAPHS 1984 - 1994

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







NOTE: Pool elevations for Jan 1940 through Mar 1983 are based on a simulation using the RiverWare computer program. Elevations for Apr 1983 through Jun 2010 are actual historical values.

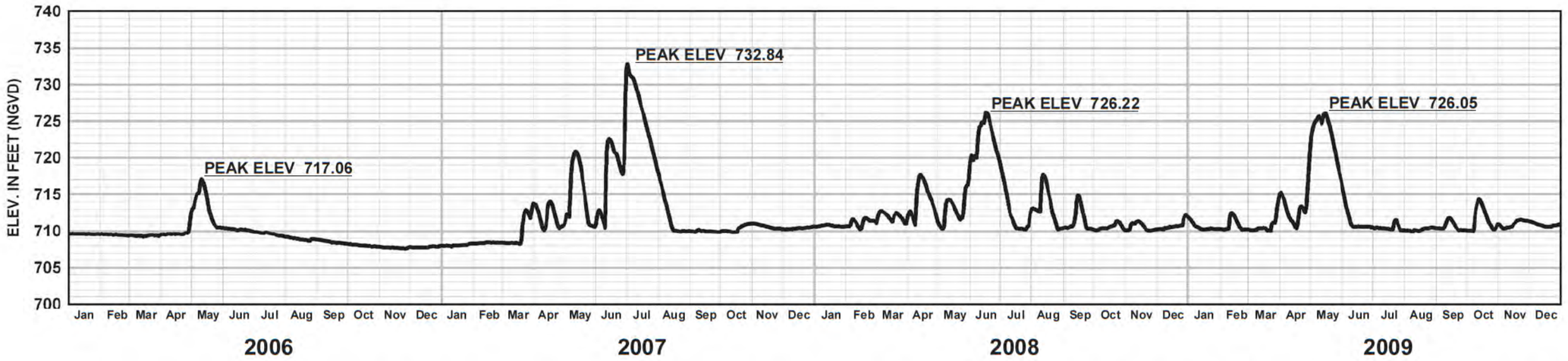
Note: Plate size is 11" x 17"

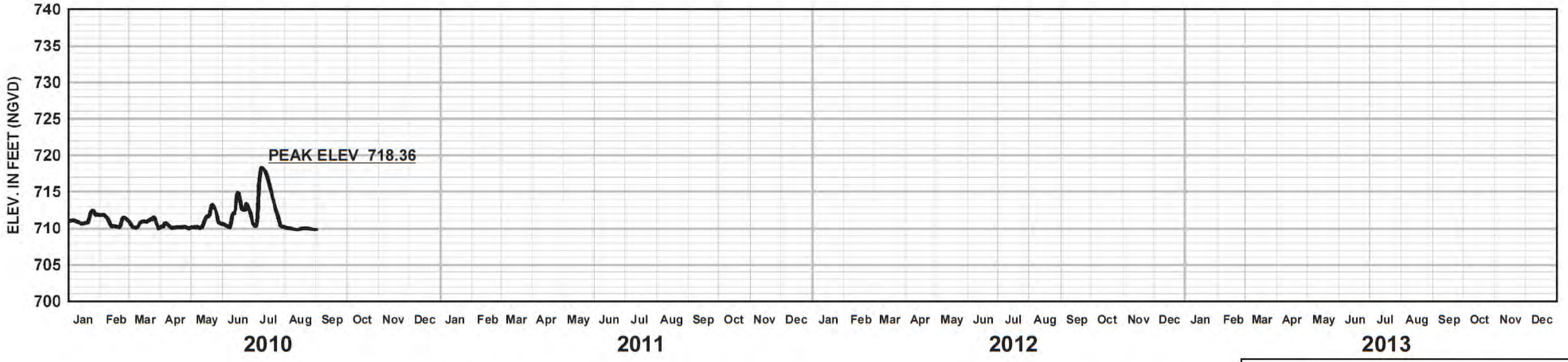
ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

POOL ELEVATION HYDROGRAPHS 1995 - 2005

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





NOTE: Pool elevations for Jan 1940 through Mar 1983 are based on a simulation using the RiverWare computer program. Elevations for Apr 1983 through Jun 2010 are actual historical values.

Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED LITTLE CANEY RIVER, OKLAHOMA

COPAN LAKE

POOL ELEVATION HYDROGRAPHS 2006 - 2010

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