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

REPLY TO
ATTENTION OF:
CESWD-RBT

06 April 2017

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

SUBJECT: Tenkiller Ferry Lake Water Control Manual Approval

1. Reference emails from CESWT-EC-H; 01 Apr 2014, 03 Feb 2017, 07 Feb 2017, and 03 Mar 2017 (SWT Commander Request). Also reference Southwestern Power Administration (SWPA) comment resolution letter dated 29 Dec 2016. Subject as above. SWD sent written comments on 20 Jan 2015. Approval reference from (b) (6) based on resolution of SWD written comments by teleconference on Wed. 23 Nov 2016. Final approval reference email by SWD dated Thurs. 06 Apr 2017.

2. Review of the subject Tenkiller Ferry Lake Water Control Manual has been completed. The Water Control Manual (WCM) is approved as submitted to SWD by traditional mail on 15 Mar 2017. The Water Control Manual (DCP) is approved for distribution.

Encl

PETE G. PEREZ, P.E.
Director, Regional Business Directorate

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, TULSA DISTRICT
1645 SOUTH 101st EAST AVENUE
TULSA, OKLAHOMA 74128-4609

CESWT-EC-H

21 February 2017

MEMORANDUM FOR Commander, U.S. Army Corps of Engineers Southwestern Division, ATTN: CESWD-RBT-(b) (6) 1100 Commerce Street, Suite 831, Dallas, Texas 75242-1317

SUBJECT: Water Control Manual, Tenkiller Ferry Lake, Illinois River in the Arkansas River Basin, Oklahoma

1. Reference ER, 1110-2-8156, 31 August 1995, subject: Preparation of Water Control Manuals

2. The last time the Tenkiller Ferry Lake Water Control Manual was updated was July 1976. Since 1976, the following major change has occurred in the operation of Tenkiller Ferry Dam and Lake:

a. In the early 1980s, the Tenkiller Ferry Lake project was studied to address the necessity of increasing the high level spillway capacity and meet present criteria and standards under the Dam Safety Assurance Program. In 1982 the Hydraulics and Hydrology Section concluded in the Reconnaissance Report that the existing spillway could pass only 85% of the new spillway design flood without overtopping the dam. The recommended auxiliary spillway design called for additional tainter gates constructed adjacent to the existing spillway.

b. The addition of the auxiliary spillway to the project was authorized under the Dam Safety Assurance Program by Acting Assistant Secretary of the Army (Civil Works) with a 22 February 1994 letter.

c. In 1986, a General Design Memorandum was written. After internal review additional details were recommended for proposed auxiliary spillway designs, which were included in the resubmittal, Design Memorandum No. 2 dated February 1987. Based on this data, in 1988 the Dam Safety Assurance Reconnaissance Report (Revised) was submitted to incorporate the latest techniques available for evaluating remedial measures for hydrologic capacity deficiencies.

d. In 1996 the Tenkiller Ferry Lake Design Memorandum No. 2, Auxiliary Spillway and Existing Spillway Modifications was submitted and approved.

e. The construction of the auxiliary spillway was completed In September 2007. The additional release capacity and the configuration of the auxiliary spillway changed the operation of the project for flood events which fill the flood pool.

3. The Tenkiller Ferry Lake Water Control Manual has been completed and reviewed by the Southwestern Power Administration.

4. All comments have been addressed and resolved between the District and Division and the District requests approval by the Division for this Tenkiller Ferry Lake Water Control Manual. If you have any questions please call Ms. Jody Stringer at 918-669-7152.

Gregory D. Estep

Encl
2017 Tenkiller Ferry Lake
Water Control Manual

GREGORY D. ESTEP
Chief, Hydrology and Hydraulics Division
Engineering and Construction Division

Christopher A. Hussin

Agree X CAH
Disagree _____
Date 3 MAR 17

CHRISTOPHER A. HUSSIN
Colonel, EN
Commanding

(b) (6) USARMY CESWD (US) SWD Approval Correspondence (06 Apr 2017)

From: (b) (6) CIV USARMY CESWD (US)
Sent: Thursday, April 06, 2017 2:09 PM
To: (b) (6) CIV USARMY CESWD (US)
Cc: (b) (6) CIV USARMY CESWT (US); Henderson, Scott A CIV USARMY CESWT (US); (b) (6) CIV USARMY CESWT (US)
Subject: RE: Tenkiller Ferry Water Control Manual (SWD approval of WCM)

(b) (6) Based on resolution of comments by the Tulsa District during the teleconference with SWD on Wed. 23 Nov 2016, I recommend approval of the Tenkiller Ferry Lake Water Control Manual as submitted to SWD on 15 Mar 2017.

/r,

(b) (6)
Branch Chief, Water Management & Infrastructure Safety
Regional Business Technical Division
Southwestern Division
(b) (6)

-----Original Message-----
From: (b) (6) CIV USARMY CESWD (US)
Sent: Friday, February 03, 2017 3:33 PM
(b) (6)

Subject: RE: Tenkiller Water Control Manual (minor comments needing resolution)

(b) (6) I have gone through the SWD comments that have been resolved and it looks like everything is in great shape. The Tenkiller WCM is ready for approval based on all comments having been addressed. However, I do have 1 minor editorial comment that was overlooked and 1 question that will need to be addressed.

1. Table of Contents. The Plate number and the Title are bunched up. Therefore a tab spacing or some spaces are needing to move the "Titles" over to the right from the Plate numbers. This spacing change is needed on pages "g" and "h".

2. Refer to comment #122 concerning Plate 7-11, Power Discharge Curves - One Unit. I noticed that the SWT resolution to the comment (phone conversation) would be to take out the sentence referring to the "Gibson Test". However the whole Plate has been eliminated. My question is: are these Power Discharge Curves not correct for the current hydropower units? Also is there a reason that this Plate was deleted?

These are the only two minor items that need addressing based on the latest WCM version submittal (3rd submittal - 18 Jan 2017 version). Also, based on the resolution of the existing SWD comments done in the 2nd submittal, sent 30 Nov 2016, the Tenkiller WCM is ready for approval and will need the Memo sent to SWD asking for approval. Reference the Memo letter for the Canton WCM as a go-by (see (b) (6) (b) (6)). If you have any questions concerning my 2 comments or anything else, then give us a call here at SWD. Thanks,

(b) (6) Water Management Team
Hydraulic Engineer - SWD
(b) (6)

-----Original Message-----
From: (b) (6) CIV USARMY CESWT (US)
Sent: Wednesday, January 18, 2017 3:14 PM
To: (b) (6)
Cc:
Subject: RE: Tenkiller Water Control Manual (draft comments from SWPA)

(b) (6)

The updated file has been placed on the server at the following location.

(b) (7)(F)

Please let me know if I need to make additional changes or if it is ready to submit for signatures.

Thanks.

(b) (6)

-----Original Message-----
From: (b) (6)
Sent: Wednesday, January 18, 2017 9:46 AM
To: (b) (6)
Cc:
(b) (6)
Subject: FW: Tenkiller Water Control Manual (draft comments from SWPA)

(b) (6) We would like a final draft copy of the Tenkiller WCM after you have entered the respective SWPA comments in. Thanks,

(b) (6) - Water Management Team
(b) (6) SWD

-----Original Message-----
From: (b) (6) CIV USARMY CESWT (US)

Sent: Tuesday, January 17, 2017 2:39 PM
To: (b) (6)
Subject: Tenkiller Water Control Manual

(b) (6)

SPA sent in some additional comments after you and I went through the draft the last time. Attached are their comments and how I addressed them.

Let me know if you want to see another draft before we submit the manual for signature.

Thanks.

(b) (6)
Hydraulic Engineer
U.S Army Corps of Engineers - Tulsa District
Hydrology & Hydraulics Branch
Tulsa District
Office: (b) (6)
Cell: (b) (6)

SWPA Correspondence 29 Dec 2016

Department of Energy
Southwestern Power Administration
One West Third Street
Tulsa, Oklahoma 74103-3502

December 29, 2016

(b) (6)
U.S. Army Corps of Engineers, Tulsa District
ATTN: Water Management Section
1645 S. 101st East Avenue
Tulsa, OK 74128

Dear (b) (6)

Thank you for the opportunity to comment on the update of the Tenkiller Lake Water Control Manual (WCM). As the Federal agency responsible for scheduling and marketing the hydroelectric power and energy from the Tenkiller project, Southwestern Power Administration (Southwestern) has comments regarding the update to the WCM.

Our comments on the WCM are enclosed. Southwestern appreciates the opportunity to provide input for the WCM update. If you have any questions or comments, please contact (b) (6) at (b) (6)

Sincerely,
(b) (6)

For
Fritha Ohlson
Director
Division of Resources and Rates

Enclosures

December 29, 2016

Southwestern Comments on the
Tenkiller Ferry Lake Draft Water Control Manual
Dated November 2016

(Note that paragraphs are numbered from the beginning of the referenced section or sub-section.)

1. General Comment. Please ensure the manual is consistent in the formatting of the chapter headings. Currently the headings have a mix of bold/non-bold, all-caps/normal case, underlined/not underlined. — Done
2. General Comment. Several tables in the document are missing a bottom border. — ?
3. Page 2-2, II – DESCRIPTION OF PROJECT, 2-03. Physical Components, e. Outlet Works, first paragraph. Suggest deleting the sentences referencing the water line coming from the surge tank as the line is referenced in h. Water Supply Facilities and moving the last sentence in the paragraph regarding the location of the outlet works to the end of Paragraph 1. — Rewrote paragraph
4. Page 2-2, II – DESCRIPTION OF PROJECT, 2-05. Real Estate Acquisition, first paragraph, fifth sentence. Suggest capitalizing "government." — Done
5. Page 2-3, II – DESCRIPTION OF PROJECT, 2-06. Public Facilities. Suggest underlining the entire section title (2-06. Public Facilities) including the number to be consistent with the other titles. — Done
6. Page 3-1, III – HISTORY OF PROJECT, 3-01. Authorization, first paragraph, second sentence. Suggest deleting the period after "Law" in "Public Law. 761." — Done
7. Page 4-1, CHAPTER IV – WATERSHED CHARACTERISTICS, 4-01. General Characteristics, first paragraph, third sentence. Suggest spelling out "OK" as "Oklahoma" to be consistent with the rest of the paragraph. — Done
8. Page 4-2, CHAPTER IV – WATERSHED CHARACTERISTICS, 4-05. Climate, b. Precipitation, Maximum annual (1973, Muskogee, OK). Please delete the space in "7 0.2". — Done
9. Page 4-5, CHAPTER IV – WATERSHED CHARACTERISTICS, 4-06. Storms and floods, TABLE 4-3, MAJOR STORMS (MAY 1909 THORUGH OCTOBER 2011) ILLINOIS RIVER BASIN UPSTREAM OF TENKILLER FERRY DAM, 1950, 7–11 May 1950. Please delete the redundant "1950" at the end of the date for the May 1950 flood. — Done
10. Page 4-6, CHAPTER IV – WATERSHED CHARACTERISTICS, 4-06. Storms and floods, TABLE 4-4, MAXIMUM POOL ELEVATIONS. Suggest including "Tenkiller Ferry Lake" in the table heading for clarity and consistency with the other tables. — No, too many changes
11. Page 4-6 to 4-7, CHAPTER IV – WATERSHED CHARACTERISTICS, 4-06. Storms and floods, TABLE 4-5, MAJOR FLOODS OF RECORD AT UPSTREAM GAGE SITES and MAJOR FLOODS OF RECORD AT OTHER RELATED GAGE SITES. Suggest providing separate table numbers for the two tables since they have separate headings and represent two separate groups of gages (upstream gages vs. "other related" gages). — No room for footnotes
12. Page 4-7, Chapter IV – WATERSHED CHARACTERSTICS, 4-06. Storms and Floods, Table 4-5 (Continued). For the Arkansas River at Van Buren, only one digit of the year is showing in the "Date" column. — Done

No
13. Page 4-10, CHAPTER IV – WATERSHED CHARACTERISTICS, 4-07. Runoff Characteristics, TABLE 4-7, INFLOW VOLUME FREQUENCY (1923-2010). Suggest including "Tenkiller Ferry Lake" in the table heading for clarity and consistency with the other tables.

Done
14. Page 4-14, CHAPTER IV – WATERSHED CHARACTERISTICS, 4-12. Economic Data, a. Population, TABLE 4-9, POPULATION OF COUNTIES AND CITIES BELOW TENKILLER FERRY DAM. Suggest right-justifying the population numbers in the table for readability.

Done
15. Page 4-16, CHAPTER IV – WATERSHED CHARACTERISTICS, 4-12. Economic Data, c. Industry, TABLE 4-11, 2009 ECONOMIC CENSUS FOR BENTON COUNTY, AR. The total value in the "Annual Payroll ($1,000)" column is misaligned. Please correct.

Done
16. Pages 4-16 to 4-21, CHAPTER IV – WATERSHED CHARACTERISTICS, 4-12. Economic Data, c. Industry, Tables 4-11 through 4-16, Economic Census data. Suggest utilizing commas in the values greater than 1,000 for readability.

Done
17. Pages 4-16 to 4-21, CHAPTER IV – WATERSHED CHARACTERISTICS, 4-12. Economic Data, c. Industry, Tables 4-11 through 4-16, Economic Census data. It is unclear what the non-numeric values (A, B, C, etc.) in place of values represent. Suggest including notes following the tables to explain.

no
18. Page 4-22, CHAPTER IV – WATERSHED CHARACTERISTICS, 4-12. Economic Data, d. Flood Damages, Tables 4-17 and 4-18, Flood damages prevented data. Suggest including "Tenkiller Ferry Lake" in the table heading for clarity and consistency with the other tables.

Done
19. Page 4-22, CHAPTER IV – WATERSHED CHARACTERISTICS, 4-12. Economic Data, d. Flood Damages, TABLE 4-18, TOP FIVE FLOOD DAMAGES PREVENTED YEARS. Suggest right-justifying the values in the "Damages" column for readability.

No
20. Page 5-1, CHAPTER V – DATA COLLECTION AND COMMUNICATION NETWORKS, 5-01. Hydrometeorological Stations, a. Facilities, second and third paragraphs. Suggest spelling out the state names in the text ("OK" = "Oklahoma", "AR" = "Arkansas") for readability and consistency.

Done
21. Page 5-2, CHAPTER V – DATA COLLECTION AND COMMUNICATION NETWORKS, 5-01. Hydrometeorological Stations, b. Reporting, third paragraph, first sentence. Suggest including "of the NWS" after "River Forecast Center" as in Chapter 9 for clarity.

Done
22. Page 5-8, Chapter V – DATA COLLECTION AND COMMUNICATION NETWORKS, 5-07. Project Reporting Instructions, a. As of 8 a.m. Each Weekday, 6. The correct acronym for Megawatt hours is (MWh). Please correct in this instance and on Page B-1. Southwestern is aware that the MOU and Operating Agreement use the acronym MWH.

Done
23. Page 6-1, CHAPTER VI – HYDROLOGIC FORECASTS, 6-01. General, b. Role of Other Agencies, first paragraph, second sentence. Should "AFOCS" be "AFOS?" Please check and correct if necessary.

Done
24. Page 7-1, CHAPTER VII – WATER CONTROL PLAN, 7-02. Major Constraints. Suggest deleting the extra line between the third and fourth paragraphs.

Done
25. Page 7-3, CHAPTER VII – WATER CONTROL PLAN, 7-05. Flood Control, a. Normal Flood Control Regulations, first paragraph, third sentence. Please delete the paragraph break from the middle of the sentence.

SWD's request
26. Page 7-3, CHAPTER VII – WATER CONTROL PLAN, 7-05. Flood Control, c. Constraints, first paragraph, first and second sentences. Suggest deleting "ht." from the sentences or spelling it out (Presumably "height").

27. Pages 7-5 to 7-6, CHAPTER VII – WATER CONTROL PLAN, 7-05. Flood Control, a. Normal Flood Control Regulations, TABLE 7-1, NORMAL FLOOD CONTROL REGULATION SCHEDULE. Suggest deleting all occurrences of "ht" or spelling them out (Presumably "height"). SWD's request
28. Page 7-8, Chapter VII – WATER CONTROL PLAN, 7-09. Water Supply, b. Accounting Procedures for Conservation Storage, first sentence. Suggest defining SWD in this first occurrence and removing later definitions of SWD in 7-16 and 7-16 a. Done
29. Page 7-11, CHAPTER VII – WATER CONTROL PLAN, 7-09. Water Supply, TABLE 7-3, CONTRACTS FOR WATER SUPPLY STORAGE. Suggest including "Tenkiller Ferry Lake" in the table heading for clarity and consistency with the other tables. No
30. Page 8-3, CHAPTER VIII – EFFECT OF WATER CONTROL PLAN. Suggest deleting the extra line between 8-08. Navigation and 8-09. Flood Emergency Action Plans. Done
31. Pages T-4-8-1 to T-4-8-3, APPENDIX G, SUPPLEMENTAL TABLES, Table 4-8, Estimated Monthly and Annual Inflows in Acre-Feet. Suggest including "Tenkiller Ferry Lake" in the table heading for clarity and consistency with the other tables. No
32. EXHIBIT A, SUPPLEMENTAL PERTINENT DATA. The title page of the exhibit says "SUPPLEMENTAL" while the next two pages say "SUPPLEMENTARY." Suggest consistent use of one term. Done
33. Page A-1, EXHIBIT A, SUPPLEMENTAL PERTINENT DATA, 1-GENERAL INFORMATION, Operating Agency. Shouldn't the operating agency be the US Army Corps of Engineers? The information provided does not specify an agency. Please review and correct as necessary. Done
34. Page A-1, EXHIBIT A, SUPPLEMENTAL PERTINENT DATA, 1-GENERAL INFORMATION, Other inter-agency agreement. Please change "19980" to "1980." done
35. Page A-4, EXHIBIT A, SUPPLEMENTAL PERTINENT DATA, 1-GENERAL INFORMATION, TABLE A-2, CONTRACTS FOR WATER SUPPLY STORAGE. Suggest including "Tenkiller Ferry Lake" in the table heading for clarity and consistency with the other tables. No
36. Page A-5, EXHIBIT A, SUPPLEMENTAL PERTINENT DATA, 2-LAKE INFORMATION ELEVATIONS, AREAS AND STORAGES. Suggest right justifying the numbers in the "Area" and "Storage" columns for readability. Done
37. Page A-14, EXHIBIT A, SUPPLEMENTAL PERTINENT DATA, 8-HYDROELECTRIC POWER FACILITIES, Power on-line date. Please use consistency in the date formats. Suggest deleting the comma from the Unit 1 on-line date. done
38. Page A-14, EXHIBIT A, SUPPLEMENTAL PERTINENT DATA, 8-HYDROELECTRIC POWER FACILITIES, Turbine discharge. Please use consistency in the numeric formats. Suggest including commas for all values greater than 1,000. Done
39. EXHIBIT B, STANDING INSTRUCTIONS TO POWER PLANT SPECIALIST, TABLE OF CONTENTS. Please change the page title from "SUPPLEMENTARY PERTINENT DATA" to "STANDING INSTRUCTIONS TO POWER PLANT SPECIALIST." Done
40. Page B-4, EXHIBIT B, STANDING INSTRUCTIONS TO POWER PLANT SPECIALIST, II – REGULATION PROCEDURES 2. During Emergency Events, first paragraph, fourth sentence. Suggest changing "Southwest" to "Southwestern." Done

41. Pages B-5 to B-6, EXHIBIT B, STANDING INSTRUCTIONS TO POWER PLANT SPECIALIST, II – REGULATION PROCEDURES, TABLE B-1, NORMAL FLOOD CONTROL REGULATION SCHEDULE. Suggest deleting all occurrences of "ht" or spelling them out (Presumably "height").

SWD's request

42.

US Army Corps of Engineers
Tulsa District

TENKILLER FERRY LAKE
ILLINOIS RIVER, OKLAHOMA
WATER CONTROL MANUAL

APPENDIX G
TO
WATER CONTROL MASTER MANUAL
ARKANSAS RIVER BASIN

REVISED – JANUARY 2017

PREVIOUS EDITION - JULY 1976

DEPARTMENT OF THE ARMY
TULSA DISTRICT, CORPS OF ENGINEERS
OKLAHOMA

TENKILLER FERRY LAKE
ILLINOIS RIVER, OKLAHOMA
WATER CONTROL MANUAL

APPENDIX G
TO
WATER CONTROL MASTER MANUAL
ARKANSAS RIVER BASIN

REVISED – JANUARY 2017

PREVIOUS EDITION - JULY 1976

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 water control manual, unless otherwise noted, are in feet, National Geodetic Vertical Datum of 1929 (NVGD29). Add 0.312 feet to the NVGD29 elevation to obtain the NAVD88 elevation for Tenkiller Ferry Lake. This information was taken from the Comprehensive Evaluation of Projects Datums report dated 23 February 2008.

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. A separate copy of this section has been provided to the powerhouse office and must be displayed on the bulletin board at all times.

EMERGENCY PERSONNEL ROSTER (March 2016)

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

TENKILLER FERRY LAKE
ILLINOIS RIVER, OKLAHOMA
WATER CONTROL MANUAL APPENDIX G
TO
WATER CONTROL MASTER MANUAL ARKANSAS RIVER BASIN

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III - HISTORY OF PROJECT

IV - WATERSHED CHARACTERISTICS

TABLE OF CONTENTS (CONT)

Paragraph **Title** **Page**

V - DATA COLLECTION AND COMMUNICATION NETWORKS

VI - HYDROLOGIC FORECASTS

TABLE OF CONTENTS (CONT)

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VIII - EFFECT OF WATER CONTROL PLAN

IX - WATER CONTROL MANAGEMENT

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EXHIBIT INDEX

PLATE INDEX

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PLATE INDEX (CONT)

PERTINENT DATA TENKILLER FERRY LAKE

LOCATION:	Illinois River at river mile 12.8, about 7 miles northeast of Gore and about 22 miles southeast of Muskogee in Cherokee and Sequoyah Counties, Oklahoma.
DRAINAGE AREA:	1610 square miles (all contributing)

DAM:

Type:	Non-overflow earth-fill
Length:	3,000 feet
Top of Dam:	677.2 feet, NGVD29
Maximum Height:	197 feet above streambed
Crest Width:	25 feet

MAIN SPILLWAY:

Location:	In a saddle near the right abutment, 800 feet west of dam
Type:	Gate controlled, concrete gravity ogee weir
Crest Elev.	642.0 feet, NGVD29
Width:	500 feet
Control:	Ten 50' x 25' Tainter gates

AUXILIARY SPILLWAY:

Location:	East of the main spillway
Type:	Gate controlled, concrete gravity ogee weir
Crest Elev.	632.0 feet, NGVD29
Width:	250 feet
Control:	Five 50' x 35' Tainter gates

OUTLET WORKS:

Location:	Between powerhouse and main spillway
Type and Size:	One 19' diameter conduit
Intake Invert:	500.0 feet, NGVD29
Control:	Two 9' x 19' tractor gates

POWER FEATURES:

Location:	Approximately 3000' northwest of the right abutment
Installed Capacity:	39,100 kW
No. of Units:	2
Penstock Intake Invert Elev.:	500.0 ft., NGVD29
Penstock Inlet Dimension:	19' diameter tunnel
Penstock Outlet Dimension:	19' diameter tunnel

Note: The elevations listed on the pertinent data sheet are based on the datum of NGVD29. Add 0.312 feet to the NVGD29 elevation to obtain the NAVD88 elevation for Tenkiller Ferry Lake.

LAND ACQUISITION: Taking line: Blocked perimeter which includes all land below elevation 670.0 feet, NGVD29 which is the flood control pool plus three feet of freeboard.

ELEVATIONS, AREAS, AND STORAGES

	Elevation Ft., NGVD29	Area Acres	Storage (Cumulative) Acre-Feet	Runoff, in.	Conduit Capacity, cfs	Main Spillway Capacity, cfs	Auxiliary Spillway Capacity, cfs
Top of Dam	677.2	23,348	1,458,162	16.98			
Maximum Pool	674.1	22,494	1,391,678	16.21	23,800	314,500	245,000
Top of Induced Surcharge	671.0	21,511	1,323,200	15.41	23,592	272,000	219,600
Top of Flood Control Pool	667.0	20,231	1,238,583	14.42	23,315	218,000	187,950
Main Spillway Crest	642.0	14,660	806,840	9.40	21,516	0	29,900
Auxiliary Spillway Crest	632.0	12,988	668,191	7.78	20,750		0
Top of Conservation Pool	632.0	12,988	668,191	7.78	20,750		0
Top of Inactive Pool	594.5	7340	299,103	3.48	17,600		
Streambed at Dam	480.2						
			Incremental Storage Acre-Feet	Runoff, in.			
Flood Control Storage	632.0-667.0		570,392	6.64			
Power Storage	594.5-632.0		343,688	4.00			
Water Supply Storage	594.5-632.0		25,400	0.30			

1. Area and Capacity figures based on 2015 bathymetric survey and 2010 flood pool LiDAR survey.
2. Runoff from drainage area of 1610 square miles.
3. Both Main and Auxiliary spillways gates begin operating as pool rises above elevation 667.0, NVGD29.
4. The catwalk on the main spillway gates will be flooded when the pool reaches elevation 670.5, NVGD29.

Note: The elevations listed on the pertinent data sheet are based on the datum of NGVD29. Add 0.312 feet to the NVGD29 elevation to obtain the NAVD88 elevation for Tenkiller Ferry Lake.

TENKILLER FERRY LAKE
ILLINOIS RIVER, OKLAHOMA

WATER CONTROL MANUAL APPENDIX G
TO
WATER CONTROL MASTER MANUAL
ARKANSAS RIVER BASIN

I – INTRODUCTION

1-01. Authorization. This manual is submitted in accordance with ER 1110-2-240, Water Control Management, dated 30 May 2016, and is prepared in accordance with ER 1110-2-8156, Engineering and Design, Preparation of Water Control Manuals, dated 31 August 1995.

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 G to the Arkansas River Water Control Master Manual. Other related manuals which impact water management at Tenkiller Ferry Lake in this District are:

Appendix D--- Hulah
Appendix E---- Pensacola (Part I)
Markham Ferry (Lake Hudson) (Part II)
Fort Gibson (Part III)
Appendix F --- Birch
Appendix L --- Oologah
Appendix M --- Keystone
Appendix N --- Eufaula
Appendix T --- Kaw
Appendix V --- Wister
Appendix W -- Copan
Appendix Y ----Skiatook
Appendix DCP-3 --- Drought Contingency Plan

The locations of existing projects in the Tulsa District are shown on Plate 1-1.

Design Manuals include the following:

Table 1-1

PERTINENT REPORTS AND DESIGN MEMORANDA
FOR TENKILLER FERRY LAKE

Memorandum No.	Title	Date Submitted
	Definite Project Report	December 1940
	Definite Project Report, Appendix I, Hydrology	December 1940
	Definite Project Report, Appendix II, Geology	December 1940
	Definite Project Report, Appendix III, Soil Analysis	December 1940
	Definite Project Report, Appendix IV, Structural Design	December 1940
	Definite Project Report, Appendix V, Hydraulic Design	December 1940
	Definite Project Report, Appendix VI, Relocations	December 1940
	Definite Project Report, Appendix VII, Hydroelectric Power	December 1940
	Definite Project Report, Appendix VIII, Economic Data	December 1940
	Definite Project Report, Appendix IX, Views and Recommendations of Consultants	December 1940
	Analysis of Design for Construction of Access Road	May 1947
	Analysis and Design for Construction of Spillway and Outlet Works	October 1948
	Analysis of Design for Completion of Embankment	December 1949
	Foundation Report	July 1950
	Foundation Report	February 1952

Table 1-1 Continued

PERTINENT REPORTS AND DESIGN MEMORANDA
FOR TENKILLER FERRY LAKE

Memorandum No.	Title	Date Submitted
1	Design Memorandum for Construction of Operators Quarters	February 1954
	Operation and Maintenance Manual	November 1956
	Report of Cost Allocations	July 1957
1C	Design Memorandum, Master Plan	September 1962
1C	Design Memorandum, Master Plan, Appendix I	September 1962
1C	Design Memorandum, Master Plan, Appendix II	September 1962
1C	Design Memorandum, Master Plan, Update	August 1978
	Operations and Maintenance Manual	May 1980
	Dam Safety Assurance Program Reconnaissance Report	July 1982
	Operations and Maintenance Manual, Vol. II	September 1982
	Dam Safety Assurance Program Alternative Studies	December 1984
	Dam Safety Assurance Program Reconnaissance Report	June 1986
2	Design Memorandum – Auxiliary Spillway and Existing Spillway Modifications	September 1987
1C	Design Memorandum, Master Plan – Supplement 9	September 1987
	Dam Safety Assurance Program Reconnaissance Report	September 1988
	Wister, Tenkiller and Fort Gibson Drought Contingency Plan	January 1990

Table 1-1 Continued

PERTINENT REPORTS AND DESIGN MEMORANDA
FOR TENKILLER FERRY LAKE

Memorandum No.	Title	Date Submitted
	Operation and Maintenance Manual, Vol. I	July 1992
2	Design Memorandum – Auxiliary Spillway and Existing Spillway Modifications, Vol. I	September 1995
2	Design Memorandum – Auxiliary Spillway and Existing Spillway Modifications, Vol. 3	September 1995
2	Design Memorandum – Auxiliary Spillway and Existing Spillway Modifications, Vol. 2	February 1996
	Supplemental Operations and Maintenance Manual Auxiliary Spillway	November 2008
	Operation and Maintenance Manual, Vol. II Flood Emergency Plan	July 2011

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

1-05. Operating Agency. The Corps of Engineers is the operating agency for Tenkiller Ferry Lake. The Power Plant Specialist, operating through the Powerhouse Superintendent, Fort Gibson Lake, the Area Engineer at the Eastern Area Office and the Operations Division, Tulsa District, has the responsibility for project operations concerning discharge releases. The Lake Manager, Tenkiller Ferry Lake, operating through the Operations Division, Tulsa District, has the responsibility for project operations dealing with lands and recreation. The project is placed under daily surveillance when the lake level is above 650.0. The project is placed under 24-hour surveillance when the lake level is above elevation 653.0. Below elevation 650.0, 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 week. However, when the project is in flood control regulation, operating personnel will closely monitor the project and the downstream river reaches. The power plant office is furnished a list of the Hydrology and Hydraulics Branch personnel to contact when necessary. The Tenkiller Power Plant Specialist will furnish the Water Management Section a list of home telephone numbers of project personnel who can be contacted during non-duty hours to make gate changes.

1-06. Regulating Agencies. The Corps of Engineers is the regulatory agency for Tenkiller Ferry Lake and the Water Management Section, Hydrology and Hydraulics Branch, Tulsa District is responsible for the regulation. The Southwestern Power Administration (SWPA) is the responsible Federal Agency for marketing hydroelectric power and energy from the project. SWPA schedules the generation from the project and coordinates releases with the Water Management Section.

II - DESCRIPTION OF PROJECT

2-01. Location. Tenkiller Ferry Dam is located at river mile 12.8 on the Illinois River and is approximately 22 miles southeast of Muskogee, Oklahoma, and about 7 miles northeast of Gore, Oklahoma. The reservoir is located in Cherokee and Sequoyah Counties, OK. The project area is shown on Plate 2-1.

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

2-03. Physical Components.

a. Embankment. The embankment is a rolled, earth-filled structure consisting of impervious and semi-pervious fill. The crest of the embankment is at elevation 677.2 feet, NGVD29. The maximum height of the structure is 197 feet, and the width of the embankment at crest height is 25 feet. A cutoff trench, excavated to top of rock, extends the full length of the embankment. The upstream slopes of the embankment are protected by dumped riprap, while the downstream slopes are protected by rock spalls. Plan and section views of the embankment, main spillway and penstock are shown on Plate 2-2.

b. Dike. An earth-fill dike, 1,350 feet long, 35 feet high, and a crest width of 25 feet, and similar in construction to the embankment, extends from the right abutment of the embankment to the main spillway.

c. Main Spillway. The main spillway is a gated, concrete, gravity, ogee weir located in a saddle near the right abutment. It has a gross length of 590 feet and a net overflow length of 500 feet, with a crest elevation of 642.0 feet, NGVD29. Flows over the spillway are controlled by 10 - 50' x 25' high tainter gates, which are operated by individual electric powered hoists. The rate of travel for each gate is approximately one foot of arc per minute. An emergency gasoline-powered generating unit is located at the project to provide electricity in case normal electric service is interrupted. The concrete slab stilling basin has two rows of baffles and a 6-foot high end sill. A general plan and section through the spillway is shown on Plate 2-2.

d. Auxiliary Spillway. The auxiliary spillway is a gated, concrete, ogee weir. The spillway begins at approximately 1500 feet left of the main spillway and ends at approximately 500 feet from the existing dam embankment. See Plate 2-3 for the general plan and section views. The spillway has 5 - 50’ x 35’ high tainter gates with four 10 feet intermediate piers. It has a crest elevation of 632.0, a gross width of 290 feet, and a net overflow width of 250 feet. The length of the spillway is 309 feet from the upstream face of the tainter gates to the toe of the flip bucket. Concrete chute training walls vary in height from 24.80 to 15.50 feet and extend from the end pier trunnion anchorage to the toe of the

flip bucket. See Plate 2-3 for a general plan.

e. Outlet Works. The outlet works consist of one 19-foot-diameter concrete-lined tunnel approximately 607 feet long. Flows are controlled by two 9- by 19-foot vertical lift gates. Two emergency gates that can be installed in either the outlet or penstock tunnels are provided.

f. Sedimentation and Degradation Ranges. The initial sediment survey of 30 sedimentation ranges was completed in 1952. The ends of each range are marked by permanent monuments, which have known vertical and horizontal positions. Eight degradation ranges were established across the Illinois River flood plain in order to provide information on the river channel below the dam. The locations of sedimentation and degradation ranges are shown on Plates 2-4 and 2-5, respectively.

g. Hydroelectric Power. Hydroelectric power, which is generated at the dam, is scheduled and marketed by SWPA. The powerhouse is located about 3,000 feet northwest of the right abutment of the dam. The power penstock is a 19-foot-diameter concrete-lined tunnel adjacent to the outlet works tunnel and is approximately 629 feet long. Near the outlet end, the penstock tunnel wyes out into two 13.5-foot-diameter pipes, which carry flows past the two 19,550-kW Francis-type turbines. Flows through the tunnel are controlled by two 9- by 19-foot vertical lift gates located in the gate tower and two butterfly valves located at the powerhouse. A section through the penstock is shown on Plate 2-2.

h. Water Supply Facilities. Two 24-inch diameter water supply intakes are located in the gate tower. One intake is at elevation 557.8 and the other is at 575.5 feet NGVD29. A 16-inch diameter water supply line for the Sequoyah Fuels Plant is connected to the penstock surge tank. All water supply pipelines meet with a series of valves between the power house and the surge tank. The 12” water supply lines for the Cities of Gore and Webbers Falls tee off the 16” supply line extending to the Sequoyah Fuels Plant near Gore .

2-04. Related Control Facilities. There are no related control facilities.

2-05. Real Estate Acquisition. The fee taking line for Tenkiller Ferry Lake is a blocked perimeter encompassing elevation 670.0 feet, NGVD29 which is the flood control pool plus three feet of freeboard. Total acres acquired is 31,037.54. Fee acres is 30,077.68. The remainder is "less than fee", which can be easements of different varieties. Most are road easements for relocation of county roads. Some fee land may be subsequently disposed of with the U.S. Government retaining some flowage easement over the disposed lands. In the upper reaches the flowage easement encompasses the flood of record, assumed to fall on a filled flood control pool (elevation 667.0) with freeboard of 3 feet added to the envelope curve in the flat pool (to elevation 670.0 NGVD) for possible operation for induced surcharge, accompanied by wave action and shoreline erosion.

2-06. Public Facilities. A public overlook shelter is located on the upstream side of the right abutment. The Corps of Engineers maintains eight parks and the State of Oklahoma maintains two parks. The public use areas are shown on Plate 2-6.

III - HISTORY OF PROJECT

3-01. Authorization. The general comprehensive plan for flood control and other purposes in the Arkansas River Basin is set forth in Flood Control Committee Document No. 1, 75th Congress, 1st Session. Tenkiller Ferry Dam and Lake was authorized for flood control by the Flood Control Act approved June 28, 1938 (Public Law 761, 75th Congress, Chapter 795, 3rd Session, H.R. 10618) and amended by the Flood Control Act of 1941. The hydropower features of the project were authorized by the Rivers and Harbors Act of July 24, 1946 (Public Law 525, 79th Congress, Chapter 595, 2nd Session, H.R. 6407).

3-02. Planning and Design. The Definite Project Report was submitted to the Chief of Engineers by letter dated December, 1940. Studies made for this report resulted in the selection of two plans for detailed study and presentation. The general plan of improvement recommended in the report was approved by the Rivers and Harbors Act of July 24, 1946. The survey report entitled "Arkansas River and Tributaries, Arkansas and Oklahoma", was published in 1947 as House Document No. 758, 79th Congress, 2nd Session. This report included consideration of Tenkiller Ferry Lake as a unit in the comprehensive development of the Arkansas River Basin for flood control, hydroelectric power, navigation and other uses.

3-03. Construction. A summary of construction activities for Tenkiller Ferry Lake is presented in Table 3-1.

TABLE 3-1

RESUME OF CONSTRUCTION ACTIVITIES

Activity	**Date**
Construction began	3 June 1947
Date of diversion	12 July 1951
Final Storage began	1 July 1952
Conservation Pool filled (El. 630.0)	May 1955
Conservation Pool raised (El. 632.0)	September 1972
Construction of Auxiliary Spillway	January 2009

3-04. Related Projects. Tenkiller Ferry Lake is a component of the multi-purpose Arkansas River Basin flood control and navigation system. Included in this system are completed projects in the Verdigris, Arkansas, Canadian, Grand, Caney and Poteau River Basins.

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

3-06. Principal Regulation Problems. The principal regulating constraint for Tenkiller Ferry Lake is the downstream channel capacity of 14,580 cfs. The channel capacity immediately downstream of the dam and at the Gore gage is the same.

Other regulation problems include flooding the draft tube electrical system when the tailwater reaches elevation 505.0, NVGD29, approximately 55,000 cfs. The power house floods at a tailwater elevation of 518.0, NVGD29, approximately 151,000 cfs.

Recreational areas upstream of the dam begin flooding at elevation 637.0, NVGD29. Daily surveillance of the dam begins at pool elevation 650.0, NVGD29, and twenty-four hour surveillance begins at pool elevation 653.0 feet, NGVD29.

The catwalk to operate the main spillway gates is at elevation 670.5 NVGD29. The top of the surcharge is at elevation 671.00 NVGD29. The electric motors that operate the main spillway tainter gates are at elevation 671.5, NVGD29. If the pool is forecasted to rise above elevation 670.50 NVGD29, the gates should be fully open prior to the pool flooding the catwalk. If the pool rises above the elevation 670.50 NVGD29, it should be assumed that the motors for operating the gates will be inoperable for a period of time. The gates can be lowered using the manual brakes, but this must be coordinated with the Operations Division as early as possible.

IV - WATERSHED CHARACTERISTICS

4-01. General Characteristics. The Illinois River rises in the Boston Mountains in Washington County, Arkansas about 15 miles southwest of Fayetteville. From its source, the river flows in a northerly direction for a distance of approximately 27 miles, then in a westerly direction for approximately 29 miles to its junction with Flint Creek. The river then flows in a southwesterly direction to its confluence with the Arkansas River about 2 miles southeast of Webbers Falls, Oklahoma. The Illinois River and its tributaries drain an area about 77 miles long, with a maximum width of 36 miles in the upper portion and a width of about 6 miles in the lower portion. The Illinois River basin above Tenkiller Ferry Lake drains an area of 1,610 square miles, of which 760 square miles are in northwest Arkansas and 850 square miles are in northeastern Oklahoma.

4-02. Topography. The basin lies within the interior highlands region of Arkansas and Oklahoma. The terrain is rugged with elevations varying from about 2,500 to 1,250 feet, NGVD29. The highest ridges and peaks are capped with sandstone and shales of Pennsylvanian age. The deeply eroded valleys are cut into the underlying Mississippian limestone and Ordovician dolomite. The soils of this region have a high infiltration rate. and vary widely in fertility, structure and use. The majority of the soils are stony in texture and well drained. To the north of the project, the Illinois River and its principal tributaries flow through heavily wooded deeply dissected hillsides surrounded by low and gently rolling fields. Natural cover consists of hardwood forests with grasses present in the medium to open forest canopy areas. Pine tree forests can be found in the rolling hill areas. The average elevation of the tablelands is about 1,250 feet. The valley slopes are steep and rocky, and most of the area is covered with a light growth of timber and underbrush. The average fall of the Illinois River is about 8 feet per mile, varying from approximately 20 feet per mile in the upper reaches to approximately 3 feet per mile in the lower reaches. The valley averages one-half mile in width, while the river channel varies in width from 200 to 600 feet. The riverbanks average 10 feet in height. The principal tributaries are Sager Creek, Osage Creek, Flint Creek, Barren Fork, and Caney Creek. All of these tributaries enter the Illinois River above Tenkiller Ferry Dam, with the Barren Fork being the largest and most important. A stream profile of the river is shown on Plate 4-1. See Plate 5-1 for details on the drainage basin.

4-03. Geology and Soils. The dam site is designated to be within the interior highlands division of the Ouachita physiographic geomorphic division and within the Ozark Uplift geologic province. Bedrock is sedimentary and Pennsylvanian in age, principally consisting of the Atoka formation (Des Moinesian Series). Regional dip is westward 40 to 60 feet per mile. The rugged topography is due to westward and southwest trending folds and faults related to the Ozark dome uplift exposing underlying formations that have an unequal resistance to erosion with sandstone capping elongated ridges and limestone forming the valleys. The overlaying materials consist mainly of Pleistocene terraces and Holocene or Recent alluvium. The Pleistocene deposits are mainly gravel, sand and silty clay.

4-04. Sediment. The Definite Project Report, Appendix I, Hydrology states that "The Illinois River is not considered to be a heavy silt-bearing stream." During the design phase, comparisons were made to the Spavinaw and Taneycomo Reservoir watersheds in Oklahoma and Missouri respectively. The sediment expected to be deposited in Tenkiller Ferry Lake was estimated to be approximately 20,000 acre-feet over 50 years. A bathymetric survey was conducted in 2015. This survey revealed more storage (13,945 acre-feet) in the inactive pool than was previously documented. The difference is attributed to better technology. A LiDAR survey of the flood pool was conducted in 2010 and the Elevation-Area-Capacity curves have been updated.

Based on the updated Elevation-Area-Capacity curves, the storage is distributed as follows: 46.05 percent flood pool (570,392 acre-feet), 29.80 percent conservation pool (369,088 acre-feet), and 24.15 percent inactive pool (299,103 acre-feet). See Plate 7-9 for updated curves.

4-05. Climate. The Illinois River Basin lies in a region characterized by moderate winters and comparatively long summers. Summer temperatures are relatively high, while subzero temperatures are uncommon during the winter. The average normal temperature over the basin is about 60 degrees Fahrenheit and varies from about 38 degrees Fahrenheit in January to about 81 degrees Fahrenheit in July and August. Local thunderstorms with high intensities occur over the basin during the spring, summer and fall months. Wind movements can be of considerable magnitudes in the spring months. There is a comparatively high percentage of sunshine and evaporation across the basin. Data concerning the climatic characteristics above Tenkiller Ferry Dam are shown in the following tabulation. The basin average monthly and annual rainfall and runoff data are shown in Table 4-1.

a. Temperature.

Mean annual (Muskogee, OK)	60	degrees F
Maximum recorded (Muskogee, 1954)	114	degrees F
Minimum recorded (Muskogee, 1977)	–9	degrees F

b. Precipitation.

Mean annual (1905 – 2010, Muskogee, OK)	46.8 inches
Maximum annual (1973, Muskogee, OK)	70.2 inches
Minimum annual(1) (1963, Climate Div. 6)	23.2 inches
Percent occurring during growing season. (Apr-Sep, Muskogee, OK)	56%

(1) Minimum annual precipitation – NOAA, Period of Record, 1895-2010

c. Snowfall.

Mean annual (Muskogee, OK)	7.3 inches
Maximum (1924, Muskogee, OK)	20.6 inches
Minimum (several years, Muskogee, OK)	0 inches

(2) All other data-NOAA, Period of Record, January 1905-September 2011

d. Evaporation. Following construction, evaporation was collected from an evaporation pan on site. In 1996, the Tulsa District migrated from physical evaporation measurements to an empirical formula, based on meteorological data collected on site. The formula incorporates electronically collected data for solar radiation, wind speed, relative humidity and air temperature. Average monthly pan evaporation values shown in Table 4-2 are for the period of November 1979 through October 2011. The data was taken from the monthly charts. Beginning in January 2013, the evaporation is calculated using the weather data collected at the Cookson Hills Mesonet Site.

e. Wind. The prevailing wind is from a southerly direction, with the greatest wind movements occurring in the spring months. Wind velocity data indicate the highest wind speed for one hour duration is 43 miles per hour.

4-06. Storms and floods. Major flood producing storms over the Illinois River watershed have mostly been 1 to 2 weeks in duration. The longer storms have generally been made up of two or three periods of intense precipitation, with the moderate precipitation on the intervening days saturating the watershed and resulting in a high percentage of runoff from subsequent periods of heavy precipitation. Major storms most often occur in the spring and fall months, although severe storms can occur at any time of the year. The largest flood in the 88 years of record was produced by a frontal type storm, extending over a period of 7 days. The April 22 – 28, 2011 storm produced a basin average rainfall of 11.24 inches.

Major storms in the basin are listed in Table 4-3. Maximum pool elevations for given dates are listed in Table 4-4. Major floods at three upstream gage sites are presented in Table 4-5. Also presented in Table 4-5 are floods at three other gage sites that are related to the system evacuation plan. Pertinent data for stream gaging stations in the Illinois River basin are given in Table 4-6.

TABLE 4-1

AVERAGE MONTHLY AND ANNUAL RAINFALL
AND RUNOFF ABOVE TENKILLER DAM

Month	Average Rainfall, (inches [1])	Percent of Average Annual Rainfall	Average Runoff [2]		Percent of Average Annual Runoff
			(acre-feet)	(inches)	
January	2.15	5.0	92,370	1.08	8.0
February	2.61	6.1	10,235	1.19	8.8
March	3.58	8.4	147,560	1.72	12.7
April	4.42	10.3	172,290	2.01	14.9
May	5.53	12.9	175,270	2.04	15.1
June	4.61	10.8	115,720	1.35	10.0
July	2.97	6.9	52,000	0.61	4.5
August	3.30	7.7	35,690	0.42	3.1
September	4.20	9.8	38,230	0.45	3.3
October	3.69	8.6	57,700	0.67	5.0
November	3.21	7.5	79,560	0.93	6.9
December	2.57	6.0	89,690	1.04	7.7
Total	42.84	100.0	1,198,430	13.51	100.0

(1) Period of record - 1930 through 2010. Source: SWT Annual Report.
(2) Runoff from drainage area above dam of 1,610 square miles. Period of record - 1923 through 2010. Source: SWT Annual Report.

4-07. Runoff Characteristics. The Illinois River watershed resides on the western side of the Ozark Plateau region of Arkansas and eastern Oklahoma. With thick hardwood forest and substantial grasslands, well drained soils over sandstone capture significant amounts of precipitation within the soil profile. Significant rainfall intensity and prolonged antecedent conditions are required for substantial stream flow to occur. Once runoff has begun, this mountainous region creates rapid runoff in the basin headwaters and small tributaries. As the main stem and channel geometry becomes well defined mid-basin there is a defined overbank that allows for flood wave attenuation.

Precipitation volumes captured in the soil profile are released over several months providing substantial base flow to the stream. Tributary and main stem channels contain gravel and rock outcrops providing additional outfalls for soil profile drainage.

The estimated monthly and annual flows in acre-feet at Tenkiller Ferry Dam for the period January 1923 through December 2010 are shown in Table T-4-8. The inflow volume frequency by months is shown in Table 4-7. The inflow duration curve is shown on Plate 4-2.

TABLE 4-2.

ESTIMATED MONTHLY PAN EVAPORATION
TENKILLER LAKE (NOV 1979 – OCT 2011)

Month	Evaporation, (1) (inches)
January	1.74
February	2.31
March	3.99
April	5.31
May	5.99
June	7.03
July	8.31
August	7.77
September	5.62
October	3.97
November	2.57
December	1.83
Total	**56.44**

(1) National Weather Service Class “A” pan until 1996. Empirical estimate of pan evaporation since 1996. Data taken from monthly charts Oct 1979 – Sept 2011.

TABLE 4-3.

MAJOR STORMS IN THE ILLINOIS RIVER BASIN UPSTREAM OF TENKILLER FERRY DAM (MAY 1909 THORUGH OCTOBER 2011)

Date of Storm	Average Basin Rainfall, (inches)	Date of Storm	Average Basin Rainfall, (inches)
1927, 07–21 Apr	12.64	1950, 7–11 May	7.60
1927, 30 May–7 Jun	8.74	1957, 21–26 May	6.80
1927, 23 Sep–2 Oct	7.39	1960, 21–25 Jul	6.75
1933, 30 Aug–4 Sep	6.76	1973, 20–26 Nov	8.34
1938, 14–19 Feb	7.71	1974, 5–9 Jun	7.29
1943, 08–11 May	10.38	1986, 27 Sep–2 Oct	9.08
1945, 11–16 Apr	7.48	1990, 14 Apr–13 May	14.94
1945, 24 Sep–1 Oct	7.58	1991, 24 Oct–2 Nov	7.30
1946, 01–06 Nov	7.00	2011, 22–28 Apr	11.24

TABLE 4-4

MAXIMUM POOL ELEVATIONS [1]

Date	Pool Elevation
05 Jun 1957	666.36
09 Oct 1986	665.25
29 Apr 2011	663.34
25 Apr 1973	663.16

(1) SWT Records

TABLE 4-5

MAJOR FLOODS OF RECORD AT UPSTREAM GAGE SITES [1]

Illinois River Near Watts Flood Stage = 13.0			Illinois River Near Tahlequah Flood Stage = 11.0			Baron Fork River at Eldon [3] Flood Stage = 18.0		
Date	**Discharg (c.f.s.)**	**Stage (ft.)**	**Date**	**Discharge (c.f.s.)**	**Stage (ft.)**	**Date**	**Discharg (c.f.s.)**	**Stage (ft.)**
04/26/11	119,940	28.60	05/10/50	150,000	27.94	04/26/11	62,914	28.41
07/25/60	68,000	25.96	01/1916	112,000(7)	26.00	06/21/00	54,700	26.77
05/24/11	56,595	25.19	04/27/11	86,006	25.97	05/03/90	50,600	25.91
05/03/90	58,500	25.08	05/11/43	93,200	25.37	10/01/86	50,000	25.78
03/19/08	53,289	24.73	04/15/45	68,800	23.60	04/15/45	(5)	23.80
04/03/57	49,000	24.73	04/16/45	66,100	23.22	11/19/85	34,300	23.23
10/01/86	42,300	24.47	06/09/74	66,400	23.02	04/10/08	37,269	22.98
05/07/61	51,600	24.32	10/01/86	56,800	22.54	04/24/04	36,448	22.80
11/25/73	47,600	23.96	04/1927	60,000(7)	22.30	04/20/76	36,400	22.73
06/16/82	35,400	22.91	03/20/08	61,802	22.29	03/19/08	32,222	21.79
04/24/04	34,700	22.73	11/26/73	52,300	21.73	10/09/09	32,177	21.77
04/10/08	37,270	22.98	04/04/57	55,400	21.60	01/04/98	31,600	21.61
04/20/76	31,700	22.38	05/04/90	54,900	21.47	02/21/97	31,600	21.60
06/22/00	30,700	22.01	05/08/61	54,200	21.38	04/17/90	27,200	21.59
10/09/09	32,129	22.00	03/20/45	51,000	21.12	11/25/73	28,200	21.23
06/09/74	32,200	21.99	05/25/11	45,131	21.12	10/27/70	36,200	21.13
11/19/85	26,100	21.94	07/26/60	48,600	20.72	04/23/04	27,700	20.49
05/23/57	31,400	21.93	12/22/84	45,700	20.35	04/03/57	37,600	20.33
01/30/69	31,400	21.90	02/18/38	39,400	19.67	08/14/48	34,400(7	19.80
05/25/57	31,400	21.86	04/20/41	41,400	19.56	05/24/11	25,946	19.80

TABLE 4-5 (Continued)

MAJOR FLOODS OF RECORD AT OTHER RELATED GAGE SITES [1]

Illinois River Near Gore [4] Flood Stage = 17.0 [6]			Arkansas River near Muskogee Flood Stage = 28.0			Arkansas River at Van Buren Flood Stage = 22.0		
Date	**Discharge (c.f.s.)**	**Stage (ft.)**	**Date**	**Discharge (c.f.s.)**	**Stage (ft.)**	**Date**	**Discharge (c.f.s.)**	**Stage (ft.)**
05/11/50	180,000	30.2	05/21/43	700,000	48.20	04/16/45	850,000	38.10
04/15/45	118,000	25.38	05/1898	384,000(8)	39.50	04/12/43	850,000	38.10
05/11/43	110,000	24.50	05/26/57	366,000	39.03	06/1833	850,000	38.00
03/20/45	58,500	18.30	05/11/43	340,000	38.32	05/05/90	401,000	36.14
06/10/45	45,900	16.28	10/31/41	304,000	37.23	11/03/41	485,000	35.70
04/20/41	43,900	16.18	04/18/45	326,000	36.65	04/16/27	(5)	35.00
08/16/48	40,200	15.09	04/15/27	325,000	36.50	10/09/86	357,000	34.74
11/01/41	38,900	14.95	04/15/45	306,000	35.47	06/19/35	418,000	34.10
04/28/42	35,900	14.26	06/1923	295,000(8)	34.70	02/19/38	375,000	32.71
12/29/42	32,200	13.37	10/07/59	286,000	34.00	10/07/59	418,000	32.55
12/12/46	30,900	13.16	04/21/41	248,000	32.72	11/25/73	(5)	31.63
03/20/44	29,200	12.81	05/09/61	295,000	32.70	06/15/95	(5)	31.38
02/22/51	27,200	12.50	05/22/57	259,000	31.85	05/11/93	(5)	31.12
11/01/42	27,100	12.20	05/15/29	249,000	31.50	04/30/42	328,000	31.00
05/27/46	22,000	11.83	05/20/29	248,000	31.40	05/13/50	402,000	30.90
03/04/45	25,000	11.71	10/06/26	248,000	31.40	06/26/48	330,000	30.61
05/21/49	24,900	11.70	07/17/51	240,000	31.40	04/22/41	311,000	30.58
05/21/43	21,800	11.62	07/05/51	242,000	30.83	10/02/45	287,000	29.42

NOTES: USGS Stages and Flow Records

(1) Watts: 08/17/55 to 9/30/2011
(2) Tahlequah: 10/15/28 to 08/31/32 and 12/14/35 to 9/30/2011
(3) Eldon: 11/07/48 to 04/24/04
(4) Gore: 03/25/24 - 04/01/26; 04/15/39 - 02/19/52 and 02/19/52 - 09/30/2011
(5) High water mark or stages only.
(6) Gore Gage:
  a. Flood Stage 8/15/1989 to present is 17.0 feet.
  b. Flood Stage 2/19/1952 to 8/15/1989 was 13.0 feet.
  c. Flood stage dated 04/15/39 through 02/19/52 was 10.0 Ft.
(7) Annual Peak only.
(8) Based on comparative elevations of floods in 1898 and 1927 at site 4 miles downstream.
(9) Muskogee is not a rated gage from 09/30/70 to 06/1983.
(10) Flow records are intermittent for Van Buren after 09/30/70, official record station was moved to Lock and Dam 13 on 10/01/70.

TABLE 4-6

PERTINENT DATA FOR STREAM GAGING STATIONS

Station	Stream	Miles Above Mouth	Gage Datum (ft. NGVD)	Flood Stage (ft.)	Bank Full Capacity (c.f.s.)	Maximum Flood of Record		
						Date	Discharge, (c.f.s.)	Stage, (ft.)
Watts, OK	Illinois River	106.2	893.78	13.0	9290	04/26/2011	119,940	28.60
Tahlequah, OK	Illinois River	55.8	664.14	11.0	11,600	05/10/1950	150,000	27.94
Eldon, OK	Baron Fork River	8.8	701.14	18.0	20,300	04/26/2011	62,914	28.41
Gore, OK	Illinois River	8.5	473.00	17.0	14,580	05/11/1950	180,000	30.20

		2nd Largest Flood of Record			3rd Largest Flood of Record			Period of Record
Station	Stream	Date	Discharge (c.f.s.)	Stage (ft.)	Date	Discharge (c.f.s.)	Stage (ft.)	
Watts, OK	Illinois River	07/25/1960	68,000	25.96	05/24/2011	56,595	25.19	Aug1955-Oct 2011
Tahlequah, OK	Illinois River	01/1916	112,000	26.0	04/27/2011	86,006	25.97	Oct1928-Aug1932 Dec 1935-Oct 2011
Eldon, OK	Baron Fork River	06/21/2000	54,700	26.77	05/03/1990	50,600	25.91	Nov1948-Oct 2011
Gore, OK	Illinois River	04/15/1945	118,000	25.38	05/11/1943	110,000	24.50	Mar 1924-Apr 1926 Apr 1939-Feb 1952 Feb 1952-Oct 2011

TABLE 4-6 (Continued)

PERTINENT DATA FOR STREAM GAGING STATIONS

Station	Stream	Miles Above Mouth	Gage Datum (ft. NGVD)	Flood Stage (ft.)	Bank Full Capacity (c.f.s.)	Maximum Flood of Record		
						Date	Discharge, (c.f.s.)	Stage, (ft.)
Muskogee, OK	Arkansas River	457.8	471.38	28.0	120,000	05/21/1943	700,000	48.20
Van Buren, AR	Arkansas River	316.6	372.36	22.00	135,000-150,000	04/16/1945	850,000	38.10

		2nd Largest Flood of Record			3rd Largest Flood of Record			Period of Record
Station	Stream	Date	Discharge (c.f.s.)	Stage (ft.)	Date	Discharge (c.f.s.)	Stage (ft.)	
Muskogee, OK	Arkansas River	05/1898	384,000	39.5	05/26/57	366,000	39.03	Aug 1925-Oct 2011(1)
Van Buren, AR	Arkansas River	04/12/1943	850,000	38.10	06/1833	850,000	38.00	Apr 1927-Oct 2011

(1) Gage recorded stage only 09/30/1970 to 06/1983.
(2) Peak flows are rounded to the nearest hundredth value.

TABLE 4-7

INFLOW VOLUME FREQUENCY
(1923-2010)

Frequency of Occurrence (%)	**Monthly Inflow in Thousands of Acre-Feet**											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
50 (2 years)	61	72	105	123	126	73	34	22	23	28	41	54
20 (5 years)	140	146	212	242	251	167	75	48	54	78	113	132
10 (10 years)	209	206	299	335	359	258	115	75	87	139	196	213
4 (25 years)	321	293	422	464	525	414	180	119	144	267	362	353
2 (50 years)	422	356	517	569	676	599	243	165	200	372	552	493
1 (100 years)	503	422	636	671	840	749	315	220	268	627	792	658

4-08. Water Quality. The State of Oklahoma Water Quality Standards (Title 785: Chapter 45) designate beneficial uses of Tenkiller Ferry Lake as *Public and Private Water Supply*, *Fish and Wildlife Propagation for Warm Water Aquatic Community*, *Agriculture*, *Recreation for Primary Body Contact*, and *Aesthetics*. The lake and watershed are designated as *High Quality Waters*, implying that historic water quality and physical habitat provide conditions suitable for the support of sensitive and intolerant climax communities of aquatic organisms, and support high levels of recreational opportunities.

Additionally, Tenkiller Ferry Lake and the contributing watershed are designated as a *Nutrient Limited Watershed* implying that certain beneficial uses of the water body and watershed are adversely affected by excess nutrients. Because of significant differences in lake morphology between the upper and lower parts of the lake, the State of Oklahoma differentially assesses beneficial use support in the upper (Tenkiller Ferry Lake, Illinois River Arm), and lower (Tenkiller Ferry Lake) portions of the lake.

The beneficial lake use *Public and Private Water Supply* is assessed in part based on levels of the algal pigment chlorophyll-*a*. This beneficial use criterion for chlorophyll-*a*, a plant pigment indicating algal biomass and general lake productivity, of 10 µg/l is specifically designated for Tenkiller Ferry Lake. Average Tenkiller Ferry Lake chlorophyll-*a* concentrations are usually highest in the upper riverine portion of the lake, diminishing moving downstream toward the dam. Concentrations in the upper portions of the lake are typically greater than 10 µg/l with spring peaks of 20 µg/l or higher. Average chlorophyll-*a* concentrations near the dam are usually in the range of 5 µg/l or less. The values greater than 10 µg/l frequently observed in the upper portions of the lake lead the State to list the upper portion (Tenkiller Ferry Lake, Illinois River Arm) as 'not supporting' for *Public and Private Water Supply*.

Water clarity in Tenkiller Ferry Lake, assessed as turbidity and Secchi depth transparency, generally improves from 'good' in the upper riverine portion to 'excellent' downstream toward the dam. Relatively high concentrations of the plant nutrients nitrogen and phosphorus follow the same general trend with highest average concentrations in the upper riverine portion of the lake gradually diminishing moving downstream toward the dam.

Alkalinity and hardness are relatively static longitudinally. Alkalinity levels indicate the lake is well buffered against sudden pH changes. Hardness levels indicate the lake water is moderately hard and acceptable for a variety of municipal and industrial uses. Levels of pH are typically within the range of 6.5 to 9.0 designated for *Fish and Wildlife Propagation*.

Average specific conductance levels, and chloride and sulfate concentrations, are typically moderate to low and fully support the *Agricultural* beneficial use. Concentrations of metals iron and manganese are typically low with highest concentrations at depth during periods of thermal stratification. Analyses for priority pollutant metals (arsenic,

cadmium, chromium, lead, and mercury) are consistently below detection limits. Bacterial indicators (*E. coli, Enterococci*) are typically at low levels and fully support the *Recreation for Primary Body Contact* beneficial use.

The lake does typically thermally stratify on an annual basis. Beginning in mid to late spring in the deepest portions of the lake, and advancing upstream through mid-lake areas as the season progresses, temperature, and hence, density differences between surface (warm) and bottom (cool) waters prevent mixing until fall. When the lake is thermally stratified, the lower cooler waters (hypolimnion) consume oxygen at a rate proportional to the amount of organic material present. The consumption of oxygen leads to a depletion of dissolved oxygen concentrations in the hypolimnion. Dissolved oxygen concentrations less than 2 mg/l are stressful to most warm water fishes. In Tenkiller Ferry Lake an anoxic hypolimnion, with dissolved oxygen concentrations less than 2 mg/l, can account for 50 to 70% of the water column. This effect leads the State Of Oklahoma to list the lake as 'not supporting' for *Fish and Wildlife Propagation*, *Warm Water Aquatic Community*, for both segments of the lake.

4-09. Channel and Floodway Characteristics. The regulating channel capacity on the Illinois River below Tenkiller Dam is 14,580 c.f.s. and is the same at the Gore gage. Rating curves for the Watts and Tahlequah gages on the Illinois River are found on Plates 4-3 and 4-4, respectively. The rating curve for the Eldon gage on the Baron Fork River upstream of Tenkiller Lake is presented on Plate 4-5. The rating curve for the Gore gage on the Illinois River downstream of the dam is presented in Plate 4-6. The rating curves for the Muskogee and Van Buren gages on the Arkansas River are presented in Plates 4-7 and 4-8, respectively. Rating curves used by the Water Management Section are adjusted to reflect changing channel conditions and are continuously maintained. Estimated crest time of travel from Tenkiller Dam to Van Buren, Arkansas is about 13 hours. A simplified diagram showing crest travel time is presented in Plate 4-9. Travel time varies with magnitude of the flood therefore this diagram should be used as a guide only.

4-10. Upstream Structures. There are a few city lakes and small dams constructed by the Natural Resource Conservation Service throughout the drainage basin. However, most of the watershed is uncontrolled.

4-11. Downstream Structures. Structures downstream of Tenkiller Ferry Lake in the Arkansas River Basin include Robert S. Kerr and W. D. Mayo Lock and Dams on the Arkansas River.

4-12. Economic Data.

a. Population. The population of the counties and cities traversed by the Illinois River below Tenkiller Ferry Dam is shown in Table 4-9. Although varying proportions of the counties listed lie within the watershed boundary, the entire population of each county is included.

b. Agriculture. Agriculture has long been an important factor in the economy of the Illinois River Basin. The major crops grown are improved pasture land, soybeans, corn and fall vegetables. Table 4-10 includes the amount of acres and the annual value of the crops in the floodplain.

c. Industry. The top three industries in the region are Health Care and Social Assistance, and Professional, Manufacturing, and Accommodation and Food Service. Tables 4-11 through 4-16 display the major industries in Benton and Washington Counties in Arkansas and Delaware, Adair, Cherokee, and Sequoyah Counties in Oklahoma along with corresponding data on number of paid employees, first quarter and annual payrolls, and total number of establishments.

d. Flood Damages. – The estimated average annual flood damages prevented by Tenkiller Ferry Dam on the Illinois River are presented in Table 4-17. The top five flood events, in terms of flood damages prevented, to pass through Tenkiller Ferry Dam are presented in Table 4-18. Plate 4-10 shows the Structural Loss and Flooded Area Curves on the Illinois River. Plate 4-11 shows the Structural Loss and Flooded Area Curves on the Arkansas River from the Illinois River to Ft. Smith, AR.

TABLE 4-9

POPULATION OF COUNTIES AND CITIES BELOW TENKILLER FERRY DAM

County	Major Cities	U.S Census Population			% Change (2000-2010)
		1990	2000	2010	
Arkansas					
Benton		97,000	153,000	221,000	44%
	Bentonville	11,000	19,000	35,000	79%
Washington		113,000	158,000	203,000	29%
	Fayetteville	42,000	58,000	74,000	27%
Oklahoma					
Delaware		28,000	37,000	41,000	12%
Adair		18,000	21,000	23,000	8%
Cherokee		34,000	43,000	47,000	11%
	Tahlequah	10,000	14,000	16,000	9%
Sequoyah		34,000	39,000	42,000	9%
	Sallisaw	7,000	8,000	9,000	11%
http://quickfacts.census.gov, 2010 Census, 2000 Census, 1990 Census					

TABLE 4-10

ANNUAL VALUE OF CROPS BELOW TENKILLER FERRY DAM
2011 DOLLARS

Crops	Tenkiller Dam to Arkansas River		Arkansas River to Robert S. Kerr		Robert S. Kerr to Vicinity of Fort. Smith, AR		Total	
	Acres	**Value**	**Acres**	**Value**	**Acres**	**Value**	**Acres**	**Value**
Corn	186	$ 62,000	281	$ 94,000	3,633	$ 1,211,000	4,100	$ 1,366,000
Fall Vegetables	19	$ 5,000	37	$ 10,000	2,539	$ 711,000	2,595	$ 727,000
Soybeans	209	$ 44,000	438	$ 91,000	9,999	$ 2,077,000	10,646	$ 2,211,000
Pasture, Improved	468	$ 45,000	1,781	$ 172,000	9,747	$ 940,000	11,996	$ 1,157,000
Wheat	81	$ 15,000	337	$ 62,000	3,551	$ 659,000	3,969	$ 736,000
Alfalfa	-	$ -	101	$ 22,000	180	$ 39,000	281	$ 61,000
Sorghum	-	$ -	217	$ 34,000	79	$ 12,000	296	$ 47,000
Cotton	-	$ -	-		79	$ 19,000	79	$ 19,000
Total	**963**	**$ 171,000**	**3,192**	**$ 485,000**	**29,807**	**$ 5,668,000**	**33,962**	**$ 6,324,000**

Note: Acreage data from Arkansas River Navigation Study, Draft Feasibility Report, Volume 2, April 2005.

TABLE 4-11

2009 ECONOMIC CENSUS FOR BENTON COUNTY, AR

NAICS code	Industry Description	Paid Employees	First Quarter Payroll ($1,000)	Annual Payroll ($1,000)	Number of Establishments
11	Forestry, fishing, hunting, and Agriculture Support	A*	D*	D*	7
21	Mining, quarrying, and oil and gas extraction	C*	D*	D*	6
22	Utilities	292	$ 5,155	$ 17,707	11
23	Construction	3,368	$ 29,196	$ 121,681	477
31	Manufacturing	9,944	$ 82,620	$ 335,588	175
42	Wholesale trade	5,136	$ 75,618	$ 300,882	330
44	Retail trade	9,928	$ 54,509	$ 231,241	683
48	Transportation and warehousing	10,264	$ 105,974	$ 434,345	163
51	Information	1,577	$ 33,412	$ 101,307	88
52	Finance and insurance	2,599	$ 33,695	$ 124,170	303
53	Real estate and rental and leasing	848	$ 5,716	$ 23,061	256
54	Professional, scientific, and technical services	5,149	$ 97,211	$ 330,365	574
55	Management of companies and enterprises	J*	D*	D*	676
56	Administrative and Support and Waste Management and Remediation Services	4,476	$ 38,064	$ 145,062	223
61	Educational services	1,533	$ 6,011	$ 23,752	44
62	Health care and social assistance	6,966	$ 55,351	$ 235,536	448
71	Arts, entertainment, and recreation	794	$ 3,677	$ 16,667	65
72	Accommodation and food services	7,852	$ 23,610	$ 99,334	374
81	Other services (except public administration)	3,498	$ 20,557	$ 77,846	413
99	Industries not classified	23	$ 84	$ 405	9
	Total for all sectors	92,837	$ 1,412,301	$ 4,392,886	5325
Source: 2009 County Business Patterns, http://www.census.gov/econ/cbp/index.html					

*See note below Table 4-16.

TABLE 4-12

2009 ECONOMIC CENSUS FOR WASHINGTON COUNTY, AR

NAICS code	Industry Description	Paid Employees	First Quarter Payroll ($1,000)	Annual Payroll ($1,000)	Number of Establishments
11	Forestry, fishing, hunting, and Agriculture Support	B*	D*	D*	3
21	Mining, quarrying, and oil and gas extraction	98	$ 2,334	$ 5,955	6
22	Utilities	488	$ 8,632	$ 28,785	9
23	Construction	3,816	$ 35,196	$ 148,662	440
31	Manufacturing	13,034	$ 102,904	$ 439,435	208
42	Wholesale trade	3,140	$ 38,685	$ 153,695	277
44	Retail trade	10,931	$ 58,803	$ 244,325	757
48	Transportation and warehousing	3,867	$ 34,854	$ 153,308	143
51	Information	1,480	$ 14,159	$ 62,412	88
52	Finance and insurance	2,631	$ 30,041	$ 113,112	302
53	Real estate and rental and leasing	2,404	$ 12,979	$ 59,091	238
54	Professional, scientific, and technical services	3,183	$ 30,063	$ 124,614	568
55	Management of companies and enterprises	4,424	$ 71,708	$ 305,354	44
56	Administrative and Support and Waste Management and Remediation Services	3,179	$ 15,795	$ 68,152	203
61	Educational services	337	$ 1,394	$ 5,987	38
62	Health care and social assistance	12,622	$ 117,527	$ 550,959	531
71	Arts, entertainment, and recreation	841	$ 3,279	$ 14,474	62
72	Accommodation and food services	9,037	$ 25,943	$ 109,595	494
81	Other services (except public administration)	3,535	$ 19,347	$ 79,201	430
99	Industries not classified	A*	D*	D*	4
	Total for all sectors	79,069	$ 623,775	$ 2,667,704	4845
Source: 2009 County Business Patterns, http://www.census.gov/econ/cbp/index.html					

*See note below Table 4-16.

TABLE 4-13

2009 ECONOMIC CENSUS FOR DELAWARE COUNTY, OK

NAICS code	Industry Description	Paid Employees	First Quarter Payroll ($1,000)	Annual Payroll ($1,000)	Number of Establishments
11	Forestry, fishing, hunting, and Agriculture Support	5	$ 34	$ 127	3
21	Mining, quarrying, and oil and gas extraction	A*	D*	D*	2
22	Utilities	B*	D*	D*	4
23	Construction	462	$ 2,797	$ 14,626	96
31	Manufacturing	714	$ 4,514	$ 20,088	27
42	Wholesale trade	B*	$ 547	$ 2,647	21
44	Retail trade	1,341	$ 6,472	$ 27,431	137
48	Transportation and warehousing	91	$ 475	$ 2,032	22
51	Information	65	$ 774	$ 3,164	11
52	Finance and insurance	280	$ 2,348	$ 9,499	51
53	Real estate and rental and leasing	79	$ 506	$ 2,795	32
54	Professional, scientific, and technical services	C*	$ 1,340	$ 4,979	47
55	Management of companies and enterprises	B*	D*	D*	3
56	Administrative and Support and Waste Management and Remediation Services	185	$ 675	$ 2,911	27
61	Educational services	6	$ 20	$ 91	3
62	Health care and social assistance	1,282	$ 9,430	$ 40,528	75
71	Arts, entertainment, and recreation	947	$ 7,555	$ 29,982	14
72	Accommodation and food services	815	$ 2,018	$ 9,012	64
81	Other services (except public administration)	448	$ 1,698	$ 7,119	86
	Total for all sectors	7,070	$ 42,237	$ 180,748	725
Source: 2009 County Business Patterns, http://www.census.gov/econ/cbp/index.html					

*See note below Table 4-16.

TABLE 4-14

2009 ECONOMIC CENSUS FOR ADAIR COUNTY, OK

NAICS code	Industry Description	Paid Employees	First Quarter Payroll ($1,000)	Annual Payroll ($1,000)	Number of Establishments
21	Mining, quarrying, and oil and gas extraction	A*	D*	D*	1
22	Utilities	B*	D*	D*	2
23	Construction	43	$ 188	$ 717	15
31	Manufacturing	1,072	$ 6,928	$ 30,797	14
42	Wholesale trade	142	$ 1,181	$ 5,085	9
44	Retail trade	528	$ 2,164	$ 9,342	54
48	Transportation and warehousing	68	$ 586	$ 219	6
51	Information	A*	D*	D*	1
52	Finance and insurance	129	$ 1,004	$ 4,020	20
53	Real estate and rental and leasing	A*	D*	D*	9
54	Professional, scientific, and technical services	44	$ 303	$ 1,186	15
56	Administrative and Support and Waste Management and Remediation Services	C*	D*	D*	8
62	Health care and social assistance	481	$ 2,945	$ 13,132	19
71	Arts, entertainment, and recreation	A*	D*	D*	2
72	Accommodation and food services	223	$ 534	$ 2,328	18
81	Other services (except public administration)	74	$ 251	$ 998	33
99	Industries not classified	A*	D*	D*	1
	Total for all sectors	3,023	$ 17,227	$ 75,647	227
Source: 2009 County Business Patterns, http://www.census.gov/econ/cbp/index.html					

*See note below Table 4-16.4-18

TABLE 4-15

2009 ECONOMIC CENSUS FOR CHEROKEE COUNTY, OK

NAICS code	Industry Description	Paid Employees	First Quarter Payroll ($1,000)	Annual Payroll ($1,000)	Number of Establishments
11	Forestry, fishing, hunting, and Agriculture Support	A*	D*	D*	1
21	Mining, quarrying, and oil and gas extraction	A*	D*	D*	1
22	Utilities	B*	D*	D*	4
23	Construction	282	$ 1,975	$ 8,806	62
31	Manufacturing	208	$ 1,370	$ 3,282	22
42	Wholesale trade	F*	D*	D*	23
44	Retail trade	1,665	$ 7,485	$ 31,377	128
48	Transportation and warehousing	23	S*	$ 318	9
51	Information	97	$ 593	$ 2,609	12
52	Finance and insurance	341	$ 2,455	$ 10,379	65
53	Real estate and rental and leasing	255	$ 1,323	$ 5,791	39
54	Professional, scientific, and technical services	137	$ 618	$ 2,489	51
55	Management of companies and enterprises	413	$ 2,728	$ 10,245	5
56	Administrative and Support and Waste Management and Remediation Services	E*	$ 1,611	$ 6,973	27
61	Educational services	155	$ 1,005	$ 4,141	10
62	Health care and social assistance	2,361	$ 19,370	$ 83,334	108
71	Arts, entertainment, and recreation	E*	D*	D*	16
72	Accommodation and food services	1,119	$ 2,776	$ 11,883	82
81	Other services (except public administration)	545	$ 1,757	$ 7,273	75
	Total for all sectors	9,100	$ 51,780	$ 217,521	740
Source: 2009 County Business Patterns, http://www.census.gov/econ/cbp/index.html					

*See note below Table 4-16.4-18

TABLE 4-16

2009 ECONOMIC CENSUS FOR SEQUOYAH COUNTY, OK

NAICS code	Industry Description	Paid Employees	First Quarter Payroll ($1,000)	Annual Payroll ($1,000)	Number of Establishments
11	Forestry, fishing, hunting, and Agriculture Support	A*	$ 101	$ 370	4
21	Mining, quarrying, and oil and gas extraction	B*	D*	D*	5
22	Utilities	B*	D*	D*	2
23	Construction	220	$ 1,303	$ 5,590	60
31	Manufacturing	304	$ 2,819	$ 8,400	23
42	Wholesale trade	106	$ 541	$ 1,945	20
44	Retail trade	1,347	$ 5,886	$ 24,609	114
48	Transportation and warehousing	279	$ 2,486	$ 10,683	22
51	Information	61	$ 409	$ 1,807	7
52	Finance and insurance	F*	D*	D*	54
53	Real estate and rental and leasing	B*	S*	$ 563	15
54	Professional, scientific, and technical services	155	$ 967	$ 3,933	46
55	Management of companies and enterprises	B*	D*	D*	4
56	Administrative and Support and Waste Management and Remediation Services	104	$ 565	$ 2,391	20
62	Health care and social assistance	1,902	$ 9,390	$ 38,130	83
71	Arts, entertainment, and recreation	E*	D*	D*	10
72	Accommodation and food services	802	$ 2,038	$ 9,972	54
81	Other services (except public administration)	204	$ 849	$ 3,583	62
99	Industries not classified	A*	D*	D*	1
	Total for all sectors	6,673	$ 35,348	$ 144,049	606
Source: 2009 County Business Patterns, http://www.census.gov/econ/cbp/index.html					

*A: 0-9 employees, B: 20-99 employees, C: 100-249 employees, D: Withheld to avoid disclosing data for individual companies; data are included in higher level totals, E: 250-499 employees, F: 500-999 employees, J: Withheld to avoid disclosing data for individual companies, S: Withheld because estimate did not meet publication standards.

TABLE 4-17

AVERAGE ANNUAL FLOOD DAMAGES PREVENTED

Years in Operation	Total Damages December 2011 (2011 Dollars)	Average Annual Damages December 2011 (2011 Dollars)
60	$ 244,416,000	$ 4,074,000

TABLE 4-18

TOP FIVE FLOOD DAMAGES PREVENTED YEARS

Year	Damages	Damages December 2011 (2011 Dollars)
1993	$ 31,116,000	$ 54,777,000
2011	$ 21,913,000	$ 21,913,000
2008	$ 10,714,000	$ 11,825,000
2002	$ 8,581,000	$ 12,038,000
1990	$ 7,400,000	$ 14,343,000

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 and active reporting observation stations are shown on Plate 5-1. Pool elevation data are provided by a float gage located in a 36-inch wet well in the intake tower. Tailwater readings are provided by a float gage in a wet well located in the powerhouse generator bay. Both gages are connected to a digital recorder and wired to a transmitting type data collection platform (DCP) located in the power house.

All stream gaging stations are automated gages consisting of float wells or bubbler gages connected to digital recorders and DCPs. Five stream gages used in forecasting are located on the Illinois River; the Tahlequah gage near Tahlequah, OK, the Chewy gage near the intersection of Chewy Road and State Highway 10, the Watts gage near Watts, OK, the Siloam Springs gage south of Siloam Springs, AR and the Savoy gage near Savoy, AR. One stream gage used in forecasting is located on Osage Creek in northwestern Arkansas; the Elm Springs gage near Elm Springs, AR. Two stream gages used in forecasting are located on the Baron Fork River; the Eldon gage near Eldon, OK and the Dutch Mills gage near Dutch Mills, AR. One gage used in forecasting is located on Flint Creek; the Kansas gage near Kansas, OK.

The gages designated for regulation are the Gore gage at Gore, OK on the Illinois River and the gage at Van Buren, AR on the Arkansas River.

b. Reporting. The reporting procedure for precipitation and stream gaging stations is on a cooperative basis with the NWS and the USGS. The reporting on data from pool elevation and stream gaging stations has been automated by using high data rate DCPs 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 data are then stored in a database on the Tulsa District Water Control Data System (WCDS) for access when needed. DCPs also report rainfall data in the same way.

Besides DCP data, observer rainfall data 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 of the NWS. Once the data is received, it is decoded and handled similarly to the DCP data. Informative displays 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. Detailed instruction on reporting criteria are presented in paragraph 2 of Exhibit B, Standing Instruction to Power House Specialist.

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 Illinois River basin. The Technical Services 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. USGS maintains a stream gage at Gore, OK, and began collecting and recording Dissolved Oxygen data in July 2011. This data is stored in the WCDS database. Other water quality sampling stations maintained by the Oklahoma Water Resources Board (OWRB) and the Tulsa District are shown on Plate 5-2.

b. Reporting. Water quality samples taken by the Corps of Engineers personnel will be reported directly to the Tulsa District Office. USGS does not take water quality samples in Tenkiller Ferry Lake.

c. Maintenance. The stream gage at Gore, OK, is maintained by the USGS. No other permanent facilities exist.

5-03. Sediment Stations.

a. Facilities. The Corps has established 30 sedimentation ranges above Tenkiller Dam and 8 degradation ranges below Tenkiller Dam to be used for sedimentation measurements. These ranges are surveyed periodically to compute sediment deposition and new lake/area capacity data. The ranges are shown on Plates 2-4 and 2-5 respectively.

b. Reporting. The Illinois River watershed is not considered to be a heavy silt-bearing stream so sediment surveys are made infrequently for Tenkiller Ferry Lake. The flood pool was resurveyed in March 2010 using LIDAR data. A bathymetric survey was complete in March 2015.

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

TABLE 5-1

AUTOMATED STREAM GAGE AND RAINFALL STATIONS

DATA COLLECTION PLATFORM (DCP) PRECIPITATION GAGES					
USGS STATION	**LOCATION:**	**SWT ID**	**SHEF ID**	**LAT**	**LON**
07197360	Caney Creek nr Barber, OK	BARB	BCCO2	354706	945122
07050500	Kings River nr Berryville, AR	BERR	BRYA4	362534	933724
07049691	White River at Beaver Lake, AR	BEVR	BVGA4	362820	934555
07196090	Illinois River at Chewey Road	CHEW	CWYO2	360615	944657
07178660	Chouteau Lock and Dam nr Wagoner, OK	CHOU	WAGO2	355128	952218
071912213	Spavinaw Creek nr Colcord, OK	COLC	CCDO2	361921	944106
07196900	Baron Fork at Dutch Mills, AR	DUTC	DMLA4	355248	942911
07197000	Baron Fork nr Eldon, OK	ELDN	ELDO2	355516	945018
USACE gage	Osage Creek nr Elm Springs, AR	ELMO	ELSA4	362275	942881
07195000	Osage Creek nr Elm Springs, AR	ELMS	ELMA4	361319	941718
07244800	Eufaula Lake Dam, OK	EUFA	EUFO2	351824	952130
07048600	White River at Fayetteville, AR	FAYE	FYGA4	360423	940452
0719300	Ft Gibson Dam, OK	FGIB	GIBO2	355115	951345
07198000	Illinois River nr Gore, OK	GORE	GORO2	353423	950407
07165570	Arkansas River nr Haskell, OK	HASK	HSKO2	354915	953819
07191400	Markham Ferry Dam, Lake Hudson, OK	HUDS	MFDO2	361354	951136
07196000	Flint Creek nr Kansas, OK	KANS	KNSO2	360154	944230
07188885	Indian Creek nr Lanagan, MO	LANA	INCM&	363557	942658
07191160	Spavinaw Creek nr Maysville, AR	MAYS	MSVA4	362152	943304
07252000	Mulberry River at Mulberry, AR	MULB	MLBA4	353437	940055
07165610	Arkansas River at Muskogee, OK	MUSK	MKGO2	354610	951755
07178620	Newt Graham Lock and Dam, OK	NEWT	INLO2	360943	953707

TABLE 5-1 (CONTINUED)

AUTOMATED STREAM GAGE AND RAINFALL STATIONS

DATA COLLECTION PLATFORM (DCP) PRECIPITATION GAGES					
USGS	**LOCATION:**	**SWT ID**	**SHEF ID**	**LAT**	**LON**
07188653	Bit Sugar Creek near Powell, MO	POWE	BSGM7	363657	941057
07246400	Robert S. Kerr Lock and Dam & Reservoir, OK	ROBE	KERO2	352045	944638
07251500	Frog Bayou at Rudy, AR	RUDY	RDYA4	353132	941618
07195400	Illinois River at HWY 16 nr Siloam Springs, AR	SILS	SLSA4	360841	942941
07191300	Lake Spavinaw at Spavinaw, OK	SPAV	SPAO2	362259	950259
07194906	Spring Ck @ Sanders Ave, Springdale, AR	SPRD	SGCA4	361956	941358
07195800	Flint Creek near Springtown, AR	SPRI	SPRA4	361520	942550
07191220	Spavinaw Creek at Sycamore. OK	SYCA	SYCO2	362007	943824
07196500	Illinois River near Tahlequah, OK	TAHL	TALO2	355522	945524
07197500	Tenkiller Ferry Lake Dam, OK	TENK	TENO2	353348	950257
07189000	Elk River near Tiff City, MO	TIFF	TIFM7	363750	943512
07250000	Lee Creek, Van Buren, AR	VANL	VBRA4	353000	942700
07195500	Illinois River near Watts, OK	WATT	WTTO2	360748	943412

TABLE 5-1 (CONTINUED)

AUTOMATED STREAM GAGE AND RAINFALL STATIONS

STATE OF OKLAHOMA MESONET GAGES				
Proximity:	**SWT ID**	**SHEF ID**	**LAT**	**LON**
3.1 miles ESE of Inola	INSO2	INSO2	360832	952702
4 miles N of Jay	JYSO2	JYSO2	362855	944658
2.5 miles W of Clarksville	PESO2	PESO2	354932	953335
5 miles S of Adair	POSO2	POSO2	362208	951616
2 miles SSW of Sallisaw	SSSO2	SSSO2	352617	944752
7 miles NNW of Marble City	TKSO2	TKSO2	354048	945056
4 miles N of Tahlequah	TQSO2	TQSO2	355820	945912
1.5 miles S of Webbers Falls	WFSO2	WFSO2	352920	950723

TABLE 5-1 (CONTINUED)

AUTOMATED STREAM GAGE AND RAINFALL STATIONS

DATA COLLECTION PLATFORM (DCP) POOL GAGES					
USGS STATION	**LOCATION:**	**SWT ID**	**SHEF ID**	**LAT**	**LON**
07197500	Tenkiller Ferry Lake Dam, OK	TENK	TENO2	353348	950257

TABLE 5-1 (CONTINUED)

AUTOMATED STREAM GAGE AND RAINFALL STATIONS

DATA COLLECTION PLATFORM (DCP) STREAM GAGES					
USGS STATION	**LOCATION:**	**SWT ID**	**SHEF ID**	**LAT**	**LON**
07197360	Caney Creek nr Barber, OK	BARB	BCCO2	354706	945122
07196090	Illinois River at Chewey Road	CHEW	CWYO2	360615	944657
07196900	Baron Fork at Dutch Mills, AR	DUTC	DMLA4	355248	942911
07197000	Baron Fork nr Eldon, OK	ELDN	ELDO2	355516	945018
07195000	Osage Creek nr Elm Springs, AR	ELMS	ELMA4	361319	941718
07198000	Illinois River nr Gore, OK	GORE	GORO2	353423	950407
07196000	Flint Creek nr Kansas, OK	KANS	KNSO2	360154	944230
07195865	Sager Creek near West Siloam Springs, OK	SAGE	WSCO2	361206	943618
07194800	Illinois River nr Savoy, AR	SAVO	SVYA4	360611	942039
07195430	Illinois River South of Siloam Springs, AR	SILO	SLOA4	360631	943200
07195400	Illinois River at HWY 16 nr Siloam Springs, AR	SILS	SLSA4	360841	942941
07195800	Flint Creek nr Springtown, AR	SPRI	SPRA4	361522	942601
07196500	Illinois River near Tahlequah, OK	TAHL	TALO2	355522	945524
07195500	Illinois River near Watts, OK	WATT	WTTO2	360748	943412

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 Branch. 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 Tenkiller Ferry Lake. The Dissolved Oxygen data gathered hourly at the Gore gage is stored in the same manner as the stage and discharge information and is also available on the USGS' webpage, http://waterdata.usgs.gov/ok.

5-05. Communication Network. Wire facilities at Tenkiller Lake are local and long distance telephone service. Radio communication is by VHF-FM fixed station (call signal WUI-313) capable of reaching local mobile stations, the Tulsa District, and other stations on the local, north, and south loops of the District via repeater relay. Maintenance of the telephone lines is the responsibility of the company leasing the line to the Government. The District radio technician makes quarterly inspections of the project's fixed equipment and makes repairs as conditions warrant. To alert the public of impending gate changes, warning horns, located on top of the powerhouse, are activated before each tainter gate, sluice gate or power house generation change. The horn is operated from the powerhouse control room. The horn is blown for 5 minutes before any changes in releases are made. The horn is activated automatically from the powerhouse control room or remotely from the Fort Gibson powerhouse when power releases are initiated.

5-06. Communication with Project.

a. Water Management Section with the Power House. Instructions for the storage and release of water from the lake will be communicated by the Water Management Section to the responsible operating personnel at the Fort Gibson powerhouse for the implementation of the provisions set forth in section IX of this manual. This communication will normally be made by long distance telephone but on occasion could be made by VHF-FM radio. The call sign for Fort Gibson is WUI 316. The reports by the powerhouse, 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 Power Plant Specialist will, on his/her own initiative, direct regulation of the lake in accordance with the emergency rules of regulation as required in Chapter VII and Exhibit B of this manual. A chart, "Organization for Flood Control Regulation, Tenkiller Lake," is shown on Plate 5-3.

b. Between Power House and Others. Communication between project personnel and other Federal, State, and local agencies will be sufficient to effect the coordination described in Section IX of this manual.

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

The following data should be included in the daily report to the Water Management Section from all flood control storage projects with hydropower. Data are typically reported by telephone, fax or email. Data collected will be reviewed and input into the Water Management Section's data base before 10 a.m. and published to the lake data morning report located at http://www.swt-wc.usace.army.mil/old_resvrept.htm by 10 a.m. See Plate 5-4 for lake data reporting details.

a. As of 8 a.m. Each Weekday

1. Pool elevations at 12 noon, 4 p.m., and 12 midnight of the previous day and the current 8 a.m. pool elevation and tailwater elevation (if available).

2. The total precipitation amounts for the previous 24-hour period (7 a.m. to 7 a.m. time period).

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

4. Water supply withdrawal or release for previous day (if available).

5. The average power discharge in dsf for the previous 24-hour period (midnight to midnight).

6. The net power generation in Megawatt Hours (MWh) for the previous 24-hour period (midnight to midnight.)

7. The total discharge in dsf for the previous 24-hour period (midnight to midnight).

8. The 8 a.m. instantaneous power discharge in cfs.
9. The 8 a.m. instantaneous total discharge in cfs.

10. The total hourly discharge in cfs for the previous 24-hour period (midnight to midnight).

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

b. As of 8 a.m. Each Monday

1. The same data from the weekend as required in 5-07.a. above.

c. Weekends and Holidays

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

d. During Flood Periods

1. During flood periods, weekend and holiday reports should include the same data as required in a. above as well as the 8 a.m. pool elevation from the pool gage.

2. In addition to the data in 5-07.a., 5-07.b, and 5-07.c. above additional reports of lake elevations may be requested by Water Management Section personnel.

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 of the persons listed on page i.

5-08. Warnings. It is the responsibility of the Power Plant Specialist to initiate a warning to the Tulsa District and local law enforcement agencies if emergency situations develop. They have the responsibility to properly recognize emergency situation and to seek assistance from supervisory offices, if time permits. They must be knowledgeable of

conditions that constitute an emergency such as a dam failure possibility. The downstream population should be notified as early as possible of a potential problem. Initial notification by project personnel will include (listed by priority), Chief of Operations, Chief of Operations Technical Support, Chief of Engineering and Construction, Chief of Emergency Management, as set forth in the Operations and Maintenance Manual Volume II, Flood Emergency Plan, dated July 2011. The Tenkiller Lake Office personnel have compiled a list of downstream contacts for use in emergency situations.

5-09. Frequency of Gate Changes. During flood periods, gate changes may be directed by the Water Management Section at any time. When the flood waters 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 gate 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.

VI - HYDROLOGIC FORECASTS

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

a. Role of Corps of Engineers. Hydrologic forecasts are made by the Water Management Section, Tulsa District, for use in the regulation of lakes for flood control and other authorized purposes and for the benefit of Corps of Engineers' construction projects and flood-fighting activities. In contrast to the NWS which furnishes weather and flood forecasts to the public, the District furnishes information on current lake levels and lake releases, along with technical advice. The Water Management Section (lake levels recording), telephone number 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 Water Control Master Manual for the Arkansas River Basin.

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

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

2. National weather summaries and additional details for the five south-central states.

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 flash floods.

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

Damage reports.
Road information and winter weather conditions.
River and flood warning bulletins, forecasts and statements.
Thirty-day forecast.

6-02. Flood Condition Forecasts.

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

1. Rainfall for stations listed in Tables 5-1 and 5-2.

2. Tenkiller Ferry Lake pool elevation for time of forecast.

3. Flood hydrographs for gages listed in Table 4-5.

4. Releases from Tenkiller Ferry Lake, including projected releases, from the time of the forecast until the end of the forecast period. Projected releases must be evaluated in accordance with the Water Control Master Manual for the Arkansas River Basin.

b. Methods. Inflow forecasts are made using a slightly modified HEC-1 computer program. Precipitation data is received from the NWS observers, the DCPs by the water control computer, the Oklahoma Mesonet, and also the NWS Stage III digital radar. The average precipitation over the project basin is computed by a computer program called VIEWRAIN. The VIEWRAIN program takes the DCP data and plots isohyetal maps of 24-hour rainfall. The VIEWRAIN program also computes the basin and sub basin average rainfalls for input into the HEC-1 forecasting model. The HEC-1 program uses the hourly DCP rainfalls to distribute the sub basin 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 to 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 Tenkiller Ferry Lake, the inflow hydrograph is routed through the lake to determine elevations. Flood control releases are projected based upon conditions of 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 6-5. A sample inflow computation is shown on Plate 6-6.

6-03. Conservation Purpose Forecasts.

a. Requirements. Conservation forecasts may be requested to predict pool levels for special recreation events and water supply. Forecasts may also be required for water quality.

b. Methods. Forecasts for conservation purposes during the 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 8-6; 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 6-01.b. are more useful in a shorter range.

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

VII - WATER CONTROL PLAN

7-01. General Objectives. The primary objectives of the Tenkiller Ferry Lake project are flood damage reduction, water supply, hydropower production, and providing benefits to recreation, fish and wildlife, and navigation. Tenkiller Ferry Lake will be operated as a unit in a multiple-purpose system for flood control providing benefits on the Illinois and Arkansas Rivers. Flood releases from Tenkiller Ferry 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 in accordance with Section VII of the Water Control Master Manual for the Arkansas River Basin. All of the flood control storage will be utilized to provide optimal benefits, categorized as Method A in paragraph 3-3c.(2)(b) of EM 1110-02-3600, dated 30 Nov 1987.

7-02. Major Constraints. The major constraints on the operation of Tenkiller Ferry Lake include the channel capacity below the dam and the stage of the Arkansas River at Van Buren, Arkansas. The non-damaging flood release on the Illinois River below the dam and at the Gore gage is currently estimated to be 14,580 cfs; stage of 17.0 feet at the Gore gage. This release should not be exceeded unless inflow forecasts show that the available flood storage in the lake is inadequate or emergency instructions calling for higher releases are issued. Flood stage at the Van Buren gage is 22.0 feet. The Van Buren gage is ordinarily the primary control for system flood releases. Releases will be made so that, when combined with discharges from other lakes and intervening area runoff, the target flows at all locations specified by the Arkansas River Basin Water Control Master Manual will not be exceeded.

The sill of the main spillway tainter gates is at elevation 642.0 feet, NGVD29, 10 feet above conservation pool. The main spillway tainter gates are capable of discharging 218,000 cfs at the top of flood pool, elevation 667.0 feet, NGVD29.

The sill of the auxiliary spillway gates is at the top of the conservation pool, elevation 632.0, NVGD29. The auxiliary spillway tainter gates are capable of discharging 187,950 cfs at the top of flood pool, elevation 667.0 feet, NGVD29. On the right side of the auxiliary spillway gates, there is an opening above the concrete wall over which water could flow if the pool is high enough. The elevation of the top of the wall is 673.41. The auxiliary spillway tainter gates, except for periodic maintenance, are activated only during surcharge operations. During normal flood operations or normal conditions, discharges are released through the main spillway tainter gates, the powerhouse and/or the conduit.

Other regulation problems include flooding the draft tube electrical system when the tailwater reaches elevation 505.0, NVGD29, approximately 55,000 cfs. The power house floods at a tailwater elevation of 518.0, NVGD29, approximately 151,000 cfs.

The catwalk to operate the main spillway gates is at elevation 670.5 NVGD29. The top of the surcharge is at elevation 671.00 NVGD29. The electric motors that operate the main spillway tainter gates are at elevation 671.5, NVGD29. If the pool is forecasted to rise above elevation 670.50 NVGD29, the gates should be fully open prior to the pool flooding the catwalk. If the pool rises above the elevation 670.50 NVGD29, it should be assumed that the motors for operating the gates will be inoperable for a period of time. The gates can be lowered using the manual brakes, but this must be coordinated with the Operations Division as early as possible.

The invert of the sluice gate and the penstock is elevation 500.0 feet, NGVD29.

7-03. Overall Plan for Water Control.

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

b. System Regulation. Tenkiller Ferry Lake will be regulated for control of floods on the Illinois River downstream from the Tenkiller Dam and in the total Arkansas River system for control of floods on the Arkansas River to Van Buren, Arkansas. Priority for releases, as shown on curve "B" Plate 7-57 of the Arkansas River Basin Water Control Master Manual, will be given to the lake with the least amount of flood storage available, depending on predicted inflows into the lake and conditions downstream. Section 7 of the Arkansas River Basin Water Control Master Manual provides detailed information on the Arkansas River System operation, necessary to determine the allowable flood releases from Tenkiller Ferry Lake. In addition, Tenkiller Ferry Lake will be regulated for navigation and hydropower.

7-04. Standing Instructions to Power Plant Specialist. During flood periods the lake will be regulated in accordance with the normal regulations for flood control operations 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 Power Plant Specialist and will be regulated in accordance with subparagraph 7-05b and Exhibit B of this manual. In addition, the Power Plant Specialist will immediately make every effort to reestablish communications with the Tulsa District Office. The Power Plant Specialist 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. Tenkiller Ferry Lake will be regulated for optimum flood reductions on the Illinois River from the dam to its confluence with Arkansas River and from that point to Van Buren, Arkansas. The regulations as shown in Table 7-1 will govern releases from Tenkiller Ferry Lake. During flood control regulation the spillway gates generally are operated in a uniform setting with no more than 1 foot difference in opening between any two gates.

Note: When the pool is forecasted to rise above elevation 636.0 NGVD29, the Water Management Section will notify the Powerhouse personnel so the platform in the gate house can be readied for being flooded. Only Power house personnel are authorized to make gate changes.

b. Emergency Flood Control Regulations. When communication with the Tulsa District Office is disrupted, the Power Plant Specialist, will, on his/her own initiative, direct regulation of the lake in accordance with the schedule shown in Table 7-2 until communication is restored. In addition, the Power Plant Specialist will make every effort to reestablish communication with the Tulsa District Office, and if necessary, send information to the Tulsa District Office by any means necessary.

c. Constraints. Releases, when combined with the uncontrolled runoff downstream in the Illinois River, will not exceed a stage ht. of 17.0 feet at the Gore gage (14,580 cfs). Releases when combined with the flows in the Arkansas River shall not exceed a stage ht. of 22.0 feet at Van Buren, Arkansas (approximately 135,000 to 150,000 c.f.s.). The releases will be gradually increased from full power discharge (3,600 cfs) to 14,580 cfs by increments of 2,200 cfs or less and then decreased in the same manner. If the 14,580 cfs release must be exceeded, the stage-damage curves shown on Plates 4-10 and 4-11 should be used as a guide in determining the effects. Floodwater shall be released in a manner to maximize benefits. Releases may be determined by the requirements in Chapter 7 of the Arkansas River Basin Water Control Master Manual.

d. Operational Curves. The “Spillway Gate Regulation Schedule – Inflow Parameter” is shown on Plate 7-1. The “Inflow vs. Rate of Rise Nomo graph” is shown on Plate 7-2. The conduit gate rating curves, one and two gates, are shown on Plates 7-3 and 7-4 respectively. The spillway rating curves for partial and full gate openings (one gate) for the main and auxiliary spillways are shown on Plates 7-5 and 7-6 respectively. The tailwater rating curves are shown on Plates 7-7 and 7-8. Elevation versus Area and Capacity data are compiled in Table 7-5, shown in the Supplemental Tables Section. The Elevation vs. Area and Capacity curves are shown on Plate 7-9. The Evaporation curves are shown on Plate 7-10. The Power Discharge curves are shown on Plate 7-11. Rating curves used by the Water Management Section are adjusted for changing conditions and are maintained in current status.

7-06. Recreation. No storage or releases are designated for recreation at Tenkiller Ferry Lake. Recreation features at the project include camping, picnicking, swimming, boating, hiking, and fishing. Recreational areas begin to flood as the pool rises above elevation 637.0 feet, NGVD29. Recreation activities are also affected when the lake level falls below normal due to drought and hydropower releases. Most of the ramps will be unusable if the lake drops below pool elevation 623.0 feet, NGVD29, due to drought and hydropower releases. The location of public facilities is shown on Plate 2-6 of this manual.

7-07. Water Quality. Currently, there is no storage allocated for water quality. If the Oklahoma Department of Wildlife Conservation (ODWC) requests releases to help with temperature and dissolved oxygen issues downstream of the dam, they must have storage donated or acquired in some other manner and a current water rights permit from the Oklahoma Water Resources Board (OWRB) before water is released at their request. If the pool is above elevation 632.0, NVGD29, and ODWC requests a release, this can be accommodated if it does not adversely impact other authorized project purposes.

7-08. Fish and Wildlife. Fish and wildlife is included as an authorized project purpose; however, no storage or releases are specifically provided for this purpose. In the past, leakage from the sluice gates has provided enough flow to maintain fish habitat in the sluice pool.

ODWC operates a put and take trout fishery downstream of the dam. In the past, ODWC has obtained donated water supply storage from a current water supply storage contract holder. In this situation, releases can be made from this storage volume to improve downstream water quality conditions for the put and take trout fishery. To assist with making small well controlled releases, a low flow bypass system was installed at the project and is tied into the surge tank.

At the same time the low flow system was installed, a Supersaturated Dissolved Oxygen System (SDOX) was purchased to ensure the sluice gate stilling basin did not become anoxic. The ODWC is responsible for monitoring water quality in the stilling basin and operating the SDOX if needed to prevent a fish kill.

TABLE 7-1

NORMAL FLOOD CONTROL REGULATION SCHEDULE

Pool Elevation	Pool Condition	Regulation
632.0 & Below	---	Releases are made through the turbines for hydroelectric power generation as determined by SWPA, to meet downstream water rights as requested by OWRB, or as requested by water rights holders with water supply storage contracts
632.0 - 636.4 and not forecasted to exceed 636.4.	Rising	Releases of 3,800 cfs (maximum power release) will be made if, when combined with local flow below the dam, will not produce flows that exceed a stage ht of 17.0 feet (approx. 14,580 cfs) at the Gore gage or a stage ht of 22.0 ft. (approx. 135,000 to 150,000 c.f.s.) at Van Buren , AR.
632.0 - 667.0 and forecasted not to exceed 667.0	Rising	Releases, when combined with the uncontrolled runoff downstream, will not exceed a stage ht of 17.0 feet (approx. 14,580 cfs) at the Gore gage. Releases will first be made using the power house and conduit gates if possible. Additional releases will be made using the Main Spillway tainter gates. Releases when combined with the flows in the Arkansas River shall not exceed a stage ht of 22.0 (approx. 135,000 – 150,000 cfs) feet at Van Buren, AR. Releases may be superseded by the requirements in Chapter 7 of the Arkansas River Basin Water Control Master Manual.

Note: All elevations referred to in Chapter 7, unless otherwise noted, are in feet, National Geodetic Vertical Datum of 1929 (NVGD29). Add 0.312 feet to the NVGD29 elevation to obtain the NAVD88 elevation for Tenkiller Ferry Lake.

TABLE 7-1 (CONTINUED)

NORMAL FLOOD CONTROL REGULATION SCHEDULE

Pool Elevation	Pool Condition	Regulation
Above 667.0 (1)	Rising	Releases shall be made using uniform gate openings for all tainter gates such that the pool elevation will not exceed 671.0 if possible. Releases shall be made to keep the top of all gates a minimum of 6" above the pool at all times. If the forecasted inflow will cause the pool to exceed elevation 671.0 (top of induced surcharge), Plate 7-1, Spillway Gate Regulation Schedule, Inflow Parameter, can be used as a guide to determine releases. If the pool rises above elevation 671.0, releases will be made equal to the inflow as long as possible, at which time all gates shall be fully opened and held until the pool level recedes to elevation 671.0. (1)
671.0 - 667.0 (1)	Falling	When the pool level is falling between elevations 671.0 and 667.0, 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. Freeboard of at least 6" shall be maintained between the pool level and top of spillway gates at all times. This regulation shall be repeated until the lake recedes to approximately elevation 667.0, at which time the outflow shall be made equal to either inflow or the downstream regulating point (stage ht of 17.0 feet at the Gore gage with an approximate capacity of 14,580 cfs) whichever is greater.
667.0 - 632.0	Falling	Releases, when combined with the uncontrolled runoff downstream in the Illinois River, will not exceed a stage ht of 17.0 feet (approx. 14,580 cfs) at the Gore gage. Releases when combined with the flows in the Arkansas River shall not exceed a stage ht of 22.0 feet (approx. 135,000 to 150,000 cfs) at Van Buren, AR. Releases may be superseded by the requirements in Chapter 7 of the Arkansas River Basin Water Control Master Manual.

(1) Catwalk to operate main spillway tainter gates is at elevation 670.5 NVGD29. See Section 7-02.
Note: All elevations referred to in Chapter 7, unless otherwise noted, are in feet, National Geodetic Vertical Datum of 1929 (NVGD29). Add 0.312 feet to the NVGD29 elevation to obtain the NAVD88 elevation for Tenkiller Ferry Lake.

TABLE 7-2

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE

Pool Elevation	Pool Condition	Regulation
632.0 to 667.0	Rising	If the lake level is below elevation 660.0, maintain current release until communication is restored. If, after 12 hours, communication has not been restored or the pool is above or rises to elevation 660.0 at any time within the 12 hour period, determine inflows using Plate 7-2. Use Plate 7-1 to determine required releases. Use the minimum discharge curve for emergency operations to determine the minimum release. The rate of rise of the lake and the average discharge will be computed every hour using the preceding two hours data. At no time will releases be decreased while the pool is rising. Releases will first be made using the power plant and conduit gates. Additional releases will be made using the Main Spillway tainter gates.
667.0 to 671.0 (1)	Rising	Releases will be made in accordance with Plate 7-1. Both main and auxiliary spillway tainter gates will be used. At no time will releases be decreased while the pool is rising. Releases will be adjusted every hour in accordance with Plate 7-1. All tainter gates will be operated in a manner that keeps the top of all spillway gates at approximately the same elevation and a minimum of 6" above the pool.
671.0 or Above(1)	Rising	Releases will be increased by raising all the tainter gates so that the discharge is equal to inflow and until the pool begins to fall.
671.0 or Above(1)	Falling	Releases will not be decreased until the pool elevation recedes to elevation 671.0.
671.0 to 667.0(1)	Falling	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 or 14,580 cfs, whichever is larger. The top of the all spillway gates shall be kept a minimum of 6" above the lake level at all times.

(1) Catwalk to operate main spillway tainter gates is at elevation 670.5 NVGD29. See Section 7-02.
Note: All elevations referred to in Chapter 7, unless otherwise noted, are in feet, National Geodetic Vertical Datum of 1929 (NVGD29). Add 0.312 feet to the NVGD29 elevation to obtain the NAVD88 elevation for Tenkiller Ferry Lake.

TABLE 7-2 (CONTINUED)

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE

Pool Elevation	Pool Condition	Regulation
667.0 to 632.0	Falling	If the maximum release rate is less than 14,580 cfs, this release will be maintained until the pool nears 632.0. If the maximum release rate exceeds 14,580 cfs, releases will be made equal to the previous 2-hour inflow or 14,580 cfs whichever is greater.

Note: All elevations referred to in Chapter 7, unless otherwise noted, are in feet, National Geodetic Vertical Datum of 1929 (NVGD29). Add 0.312 feet to the NVGD29 elevation to obtain the NAVD88 elevation for Tenkiller Ferry Lake.

7-09. Water Supply.

a. General. Tenkiller Ferry Lake has a total of 369,088 acre-feet (between elevations 594.5 and 632.0) of conservation storage which includes 25,400 acre-feet of water supply storage, with an approximate yield of 26.740 mgd. The Corps of Engineers issues contracts for this storage. The OWRB issues water rights permits to withdraw water from the lake and the Illinois River downstream of the lake. Table 7-3 lists current contracts for storage in Tenkiller Lake. Copies of the water storage contracts are maintained by the Water Supply Specialist in the Tulsa District.

b. Accounting Procedures for Conservation Storage. Accounting procedures for conservation storage in multipurpose projects have been developed by the Tulsa District and approved by Southwestern Division (SWD) to account for the withdrawal of water from lakes by each water supply user including Hydropower releases. Losses are charged to each user in proportion to their average remaining storage. Inflows, after deductions for downstream water rights and vested rights, are credited to the storage account of the user in proportion to their contracted storage. Inflows occurring when the lake is above the conservation pool are passed through the lake, and even though they may be satisfying an annual water right, they will not affect the conservation pool accounting procedure. When conservation storage falls to 75%, monthly accounting of water supply is initiated. Each user will periodically be notified of their remaining, water supply storage, and when a user's storage is depleted, no withdrawals from storage are made for that user. No accounting is necessary where all conservation storage is contracted for by one user or when the Corps is not the contracting agency.

7-10. Water Rights.

a. General. The OWRB has issued water rights on the Illinois River above and below Tenkiller Dam. The water rights applicants and authorized amounts are presented in Table 7-4. The OWRB should be contacted for updated water rights summaries.

b. Regulation Procedure for Water Rights. Releases from inflow to satisfy downstream water rights will be made at the request of the OWRB. 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 contract storage allocated in the lake.

7-11. Hydroelectric Power. Tenkiller Ferry Lake contain 369,088 ac-ft. of storage in the conservation pool between elevations 594.5 and 632.0. Of the 369,088 ac-ft. in the conservation pool, 25,400 ac-ft. is allocated for water supply. This leaves 343,688 ac-ft. for hydroelectric power generation and sediment storage.

The powerhouse contains two–19,550 kW hydroelectric power units with a full power discharge of about 3,600 cfs. The turbines are used in conjunction with the spillway and outlet works for flood control releases. Flood control releases of 3,600 cfs or less are made through the turbines, if operable. The Water Management Section will notify SWPA of the daily outflow volume required through turbines for flood releases. The release of water from the power storage (elevation 594.5 to 632.0 feet, NGVD29) will be for the production of hydroelectric power and will be determined by SWPA.

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

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

7-14. Drought Contingency Plan. A Drought Contingency Plan, dated January 1990, for projects in the Lower Arkansas River basin, including Tenkiller, has been completed, in accordance with ER 1110-2-240, 8 October 1982, and ER 1110-2-1941, 15 September 1981. The Plan has been published as Appendix DCP-3 to the Water Control Master Manual, Arkansas River Basin. This plan identifies water uses and needs within the basin and outlines steps which can be taken to alleviate the problems encountered during a drought. The document provides a basic reference for the Tulsa District Corps of Engineers during a climatologically-induced water shortage in the Illinois River basin. Copies of the plan are kept at the Tenkiller Project Office and at the Tulsa District Office.

7-15. Flood Emergency Action Plans. A flood emergency action plan is outlined in the Operation and Maintenance Manual, Volume II, for Tenkiller Ferry Dam, Illinois River, Oklahoma, dated March 2000 and updated May 2011. The purpose of the manual is to specify procedures to protect the public from possible property damage or loss of life as a result of uncontrolled releases of water due to failure, or severe damage to the dam appurtenant works.

TABLE 7-3

CONTRACTS FOR WATER SUPPLY STORAGE

User	Storage Allocated AC-FT.	Yield M.G.D.
Tenkiller Utilities Authority (1)	4000	4.193
Sequoyah County Water Assn. (1)	9629	10.009
Lake Region Electric	371	0.389
Cherokee County RWD #2	99	0.104
Stickross Mountain	584	0.618
Tahlequah PWA	4300	4.5
Cherokee County RWD #13	132	0.138
(b) (6)	2	0.002
Tenkiller Development Company	3	0.003
Sunny Heights Water System	10	0.01
Burnt Cabin Rural Water District	12	0.013
Woodhaven Water Company, Inc.	15	0.016
Lake Region Electric	30	0.031
(b) (6)	2	0.002
Indian Hills Estates Company	3	0.003
The Dutchman's	6	0.006
Sixshooter Water System	2	0.002
Fin & Feather Resort, Inc.	12	0.13
Pettit Bay Water Association	5	0.005
Tenkkiller Water Company, Inc.	34	0.035
Gore Public Works Authority	480	0.503
Strayhorn Marina	17	0.017
Mongold Water Company	5	0.005
Lake Region Electric	38	0.039
(b) (6)	1	0.001
Lake Tenkiller Associates	200	0.21
Sequoyah County Water Assn.	220	0.231
Summit Water, Inc.	140	0.147
Sequoyah County Water Assn.	2200	2.306
RWD #13	100	0.105
Cherokee County RWD #2	100	0.105
East Central OK Water Authority	300	0.314
Pettit Mountain Water Assoc.	10	0.01
Greenleaf Nursery Company (2)	2038	2.223
Greenleaf Nursery Company #1(2)	300	0.315
TOTAL	**25,400**	**26.740**

Note: Storage Allocations are for storages between elevations 594.5 to 632.0.
(1) Pending Contracts.
(2) Interim Use Irrigation.

TABLE 7-4

WATER RIGHTS BELOW TENKILLER FERRY LAKE TO CONFLUENCE WITH R.S. KERR RESERVOIR ON THE ARKANSAS RIVER

Diversion Point Legal Description

Water Right #	Name	¼	¼	¼	Section	Township	Range	County	AMT (af/yr)	Primary Purpose	Date Filed	Date Issued
19530623	(b) (6)	NE	NE	SW	16	12N	21E	Sequoyah	570.0	Irrigation	08/04/1953	08/09/1966
19610136			NE	NW21	21	12N	21E	Sequoyah	271.0	Irrigation	10/02/1961	08/09/1966
19800015		SE	SE	NW	16	12N	21E	Sequoyah	320.0	Irrigation	02/04/1980	05/13/1980
19860038	Sequoyah Co. Rural Water District #5	NE	NW	NE	33	13N	21E	Sequoyah	320.0	Public Water Supply	07/28/1986	11/21/1986
19980012	(b) (6)	NE	SW	NW	21	12N	21E	Sequoyah	222.0	Irrigation	05/05/1998	06/08/1999

7-16. Deviation From Normal Regulation. The District Engineer may occasionally request to deviate from normal regulating procedures at the projects. Prior approval is obtained from SWD, in accordance with ER 1110-2-240, except in emergencies as noted in paragraph 7-16.a. below. These deviations are normally in 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 Power Plant Specialist 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 Power Plant Specialist may deviate from the water control plan whenever necessary to protect the safety of the dam. Such actions shall be immediately reported by the fastest means of communication available. Actions shall be confirmed in writing as soon as possible to the Water Management Section and shall include justification for the action. Continuation of the deviation will require the express approval of SWD. A written confirmation showing the deviation and conditions will be furnished by the Water Management Section to SWD.

b. Unplanned Minor Deviations. There are unplanned instances that create a temporary need for minor deviations from the normal regulations of the reservoir, although they are not considered emergencies. Construction accounts for the major portion of the incidents and include utility stream crossings, bridge work, and major construction contracts. Deviations 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. A written confirmation showing the deviation and conditions will be furnished to CESWD-RBT, usually by email.

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 SWD Water Control Manager.

d. Planned Deviations. Advance approval of the SWD Water Control Manager is required prior to any deviation from the plan of regulation prescribed or approved by the Corps in the interest of flood control, except in emergency conditions provided for in subparagraph 7-15. 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 unduly compromise the project's ability to meet its authorized purposes. Sufficient data on flood potential, pool and watershed conditions, possible alternative measures, benefits to be expected, and probable effects on other authorized and useful purposes will be presented by letter, telephone, email, or facsimile to SWD along with Tulsa District recommendations for review or approval. Approval of prolonged deviations will not be granted unless such investigation and evaluations have been conducted to the extent deemed necessary by the SWD Water Control Manager.

7-17. Rate of Release Change. Gradual increases and decreases in releases will be made when possible in order to minimize erosion, bank sloughing, undercutting, and danger to human and animal life. Normally, releases should be increased and decreased in increments no greater than 2,200 cfs with no more than 3 gate changes in a 24 hour period.

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, the immediate potential for downstream flooding, and drownings which occur downstream of the dam.

VIII - EFFECT OF WATER CONTROL PLAN

8-01. General. The effects of emergency flood control regulations on the spillway design flood and the standard project flood are presented in the following paragraphs. Normal and emergency regulation applied to the floods of May-June 1957, October 1986 and April-May 2011 are also presented in the following paragraphs. These floods were selected to show the effects of the flood control regulations for Tenkiller Ferry Lake for a variety of possible flood conditions.

8-02. Flood Control.

a. Probable Maximum Flood. The spillway design flood was developed from the probable maximum precipitation storm in accordance with Hydrometeorological Report No. 52. Rainfall distribution was based on EM 1110-2-1411 (Civil Works Engineer Bulletin No. 52-8, 26 March 1952, revised March 1965) and SWDED-XW letter, 15 February 1974, subject: Maximum Six-Hour Rainfall Distribution for Standard Project and Probable Maximum Storms. Average basin rainfall for the 72-hour storm is 23.93 inches and the maximum 6-hour period of rainfall is 17.84 inches. The rainfall excess was applied against the unit hydrograph to determine the spillway design flood into a full pool. The duration of the flood is 3.75 days with a peak inflow of 683,170 cfs and a total volume of 1,367,600 ac-ft. At the time the auxiliary spillway was designed, the peak discharge was calculated at 541,400 cfs with a peak pool elevation of 674.1, NVGD29. In 2010, the flood pool was re-surveyed. Using the updated Elevation-Area-Capacity table, the peak discharge is 536,270 cfs with a maximum pool elevation of 673.02, NVGD29. Plate 8-1 shows the operational hydrograph of the probable maximum flood routed through Tenkiller Ferry Lake under emergency and normal regulations on an empty and full flood pool.

b. Spillway Design Flood. The total inflow volume was 1,220,000 acre-feet over a 6.6 day period. The peak inflow was 349,000 cfs, the peak discharge was 349,000 cfs, and the peak pool elevation was 670.86 feet, NGVD29. Plate 8-2 presents the operational hydrographs and pool elevations for this flood using the emergency regulations. This operational hydrograph also utilizes the updated Elevation-Area-Capacity Table.

c. Flood of May-June 1957. The operational hydrograph for this flood event is shown in Plate 8-3. This event lasted over a considerable length of time. The peak inflow was 44,500 cfs. The maximum release was 11,500 cfs under both the normal and emergency regulations. The peak pool elevation under normal regulations was 669.93, NVGD29. The peak pool elevation under emergency regulations was 667.41, NVGD29. The starting pool elevation under normal regulations was 628.2, NVGD29. The starting pool elevations under emergency regulations was 659.2, NVGD29.

Flood of October 1986. The operational hydrograph for this flood event is shown in Plate 8-4. The majority of the inflow occurred in the first 7 days of the flood. The peak daily average inflow was 95,250 dsf. The maximum pool elevation using normal regulations was 665.25, NVGD29. The hydrograph shows both the historical operation as well as emergency operations outlined in Chapter 7. The peak pool elevation using emergency regulations was 658.96, NVGD29.

e. Flood of April-May 2011. The operational hydrograph for this flood event is shown in Plate 8-5. The peak daily average inflow was 106,039 dsf and the maximum pool elevation was 663.34, NVGD29. The hydrograph shows the historical operation as well as the emergency operation outlined in Chapter 7. Early in the storm event, forecasting efforts indicated that the pool would rise sharply, so releases with peak discharge of 14,000 cfs, were started earlier than the emergency operating regulations would indicate. This caused the historic maximum pool (elevation 663.34, NVGD29) to be lower than the maximum pool elevation under emergency operations (elevation 664.19, NVGD29). During the second peak inflow, the historic releases were decreased to prevent downstream flooding whereas emergency regulations would have continued the full channel release of 14,580 c.f.s. This is the reason for the higher historic pool elevation on 28 May 2011.

8-03. Recreation. Recreation features at the project include camping, picnicking, swimming, boating, hiking, and fishing. Recreational areas begin to flood as pool rises above elevation 637.0 feet, NGVD29. Recreation activities are also affected when the lake level falls below normal pool due to drought and hydropower releases. Most of the ramps will be unusable if the lake drops below elevation 623.0 feet, NGVD.

8-04. Water Quality. The lake does typically thermally stratify on an annual basis. Beginning in mid to late spring in the deepest portions of the lake, and advancing upstream through mid-lake areas as the season progresses, temperature, and hence, density differences between surface (warm) and bottom (cool) waters prevent mixing until fall. When the lake is thermally stratified, the lower cooler waters (hypolimnion) consume oxygen at a rate proportional to the amount of organic material present. The consumption of oxygen leads to a depletion of dissolved oxygen concentrations in the hypolimnion. Dissolved oxygen concentrations less than 2 mg/l are stressful to most warm water fishes.

In Tenkiller Ferry Lake an ‘anoxic’ hypolimnion, with dissolved oxygen concentrations less than 2 mg/l, can account for 50 to 70% of the water column. This effect leads the State Of Oklahoma to list the lake as ‘not supporting’ for *Fish and Wildlife Propagation*, *Warm Water Aquatic Community*, for both the upper and lower parts of the lake. The thermal stratification also impacts the dissolved oxygen concentrations in the releases which in turn impact the downstream trout fishery.

8-05. Fish and Wildlife. Fish and wildlife are included as an authorized project purpose; however, no storage or releases are specifically provided for in the project. ODWC does operate a put and take trout fishery downstream of the dam. If the pool is below elevation 632.0 NVDG29 and ODWC requests releases to help maintain the trout fishery, they must have storage donated or acquired in some other manner and a current water rights permit from the OWRB before water is released. If the pool is above elevation 632.0, NVGD29, and ODWC requests a release, this can be accommodated if it does not adversely impact other authorized project purposes.

8-06. Water Supply. Withdrawals for water supply purposes will have no major effect on the operation of the lake.

8-07. Hydroelectric Power. During normal operations, releases will be made primarily through the turbines to maintain the pool at elevation 632.0 feet, NGVD29, or below, depending on inflow and power demand. 343,688 acre-feet of the conservation storage from elevation 594.5 to 632.0 feet, NGVD29, is allocated to hydroelectric power generation. During flood operations, discharges will be made through the hydroelectric turbines as long as possible. At a discharge of approximately 20,000 cfs, the tailwater at elevation 505.0, impacts the electrical systems for the draft tubes. At discharges greater than 150,000 cfs the tailwater approaches the powerhouse parking lot at elevation 518.0 and sandbagging of the powerhouse entrances may be required.

8-08. Navigation. The coordination of releases from Tenkiller Ferry Lake with other reservoirs (discussed in Chapter VII of the Arkansas River Basin Water Control Master Manual) will significantly benefit navigation along the Kerr-McClellan Navigation system by providing a tapered recession of flows along the system. The controlled recession will enable navigation to continue while shoals are removed from the navigation channel.

8-09. Flood Emergency Action Plans. The Flood Emergency Plan is outlined in the Operations and Maintenance Manual, Volume II, dated March 2000, updated July 2011, for Tenkiller Ferry Lake. Copies of the FEP for Tenkiller Ferry Lake can be found in the Powerhouse and Project offices. The purpose of the manual is to specify procedures to protect the public from possible property damage and/or loss of life as a result of uncontrolled releases of water due to failure or severe damage to the dam or appurtenant works.

8-10. Frequencies.

a. Peak Inflow Probability. Estimated natural flows from the RiverWare computer model 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 and ER 1110-2-1450, dated 31 August 1994. The peak inflow probability curve (natural conditions) is shown on Plate 8-6.

b. Pool Elevation Frequency and Duration Curves. The pool elevation hydrographs from the RiverWare computer model using data from January 1940 through December 2008 were used to determine the maximum and minimum annual series pool elevations. A graphical frequency analysis using equation 2-2a from EM 1110-2-1415, dated 5 March 1993 was used to determine the plotting position. Plate 8-7 shows the Pool Elevation Probability curve. Plate 8-8 shows the Pool Elevation Duration curve which uses the daily pool elevations from the RiverWare computer model. Plates 8-9 through 8-14 show the Pool Elevation Hydrographs for the period of record, July 1952 through October 2013. Data for Plates 8-9 through 8-14 was taken from the monthly charts.

c. Key Control Points. The key control points below Tenkiller Ferry Lake are the Gore gage on the Illinois River and Van Buren gage on the Arkansas River. The stage-discharge curves for these gages are shown on Plates 4-6 and 4-8, respectively. Flood stage at the Gore gage is 17.0 feet, currently 14,580 cfs. Flood stage at the Van Buren gage is 22.0 feet.

8-11. Other Studies.

a. Forecasting. The forecasting methods for the Tenkiller Ferry basin have been updated and improved since the previous Water Control Manual was approved. Currently the Water Management Section uses an HEC-1 forecast model which has been calibrated to historic storms, yet allows the forecaster to change parameters to calibrate the model to a specific storm. Currently an effort is being made to update the forecast models to HEC's Hydrologic Modeling System, HMS, and integrate them into the national Corps Water Management System, CWMS.

b. Stream Gages and Routing Reaches. There are currently 6 stream gages on the main stem of the Illinois River upstream of the lake project. There is one gage each on Osage and Sager Creeks. There are two gages on Flint Creek. Five of main stem gages are forecast points in the model. There is one forecast point on both Flint and Osage Creeks. There are two forecast points on the Baron Fork. The Gore gage is the only downstream gage. See Plate 5-1. Measurements are taken on all the stream gages as needed to maintain rating curves.

c. Auxiliary Spillway Numerical Model Study. In December 1994, a study was completed that evaluated the capability of Tenkiller Ferry Dam to safely accommodate the various flood events up to and including the PMF. It also evaluated the potential for loss of life and property damage if the dam were to fail as compared to that during various flood events without dam failure. It discussed the possible modifications to the dam to prevent failure by overtopping or to minimize loss of life and property damage if failure were to occur. This study concluded that the construction of the auxiliary spillway was beneficial in reducing the potential for loss of life and property damage.

d. Arkansas River Basin Water Control Master Manual. In October 2007, the final operating plan for the Arkansas River Basin was completed and incorporated into the Arkansas River Basin Water Master Control Manual.

IX – Water Control Management

9-01. Responsibilities and Organizations.

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

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

(a) Routine regulation of lakes and distribution of routine data.

(b) Investigations and refinement of regulation procedures.

1). Analysis of past floods.

2). Reconnaissance to determine channel capacities.

3). Improvement of forecasting techniques.

4). Plan and coordinate the hydrologic reporting network with the NWS and the USGS.

(c) Train personnel in flood control duties.

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

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

(d) Prepare reports on lake regulation.

1). Recurring reports.

2). Water control manuals.

3). Post flood reports.

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

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

(b) Performing or obtaining lake forecasts.

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

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

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

(f) Furnish information to higher authority.

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

2). Provide hydrologic data for situation reports.

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

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

4. Provision for 24-hour Alert. The NWS and project personnel are provided with a list of names, addresses, and telephone numbers of key personnel from the Water Management Section and Engineering Division with instructions to provide warnings if unusual conditions occur. Responsible personnel will be on duty at the Tulsa District 24 hours a day whenever basin and/or project conditions warrant and during flood emergencies. Responsible personnel will be on duty at the project or on call at all times.

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

b. Other Federal Agencies. The NWS and the USGS cooperate with the Water Management Section, Hydrology-Hydraulics Branch, Tulsa District, to accumulate rainfall and stream flow data. SWPA coordinates with the Water Management Section for hydropower releases (see section 9-02.d.).

c. State Agencies. The management of the fish and wildlife resources is the responsibility of the Oklahoma Department of Wildlife Conservation (ODWC).

d. Private Organizations. Presently, there are no privately owned flood control protection facilities at Tenkiller Ferry 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, the Reservoir Info Control Center (RICC) is in operation when conditions warrant.

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

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

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

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

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

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

9-04. Commissions, River Authorities, Compacts, and Committees. 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 when conditions warrant 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 lakes, field investigations, stream gaging, and construction of flood control projects affected by releases from lakes, answering public inquiries, and preparing public releases. The report includes information on pool elevation, flood control storage, releases, inflow and rainfall. The report is completed and dispatched from the Water Management Section, Hydrology-Hydraulics Branch by 10:00 a.m. daily under normal conditions.

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

monthly lake reports are also available on the Tulsa District Web Page from 1994 to the present at www.swt-wc.usace.army.mil/TENKcharts.html.

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

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

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

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

TABLE 9-1

SUMMARY 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

TENKILLER FERRY LAKE
ILLINOIS RIVER, OKLAHOMA
WATER CONTROL MANUAL
APPENDIX G
TO THE
WATER CONTROL MASTER MANUAL
ARKANSAS RIVER BASIN

SUPPLEMENTAL TABLES

Table 4-8
Estimated Monthly and Annual Inflows in Acre-Feet

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1923	41320	100078	182372	49450	502353	408258	19738	6518	24040	165580	78962	209203	1787872
1924	61672	40495	61180	193686	216990	166850	59766	27485	28800	15126	15412	64808	952270
1925	36093	71587	30867	49269	43410	10770	7686	13712	23683	129062	62122	25948	504209
1926	64377	37154	65792	81878	22197	49388	10514	15556	129481	374336	63015	175977	1089665
1927	177207	73976	233900	933024	134596	164350	191657	409815	178393	204815	86935	161651	2950319
1928	134043	90652	129124	327987	147693	394691	98319	116642	21898	26009	50757	117503	1655318
1929	192087	116183	126295	400522	480402	225283	174563	28653	28502	24042	31359	54171	1882062
1930	134535	154171	26378	6248	189997	40701	17831	11437	2202	16847	18149	100102	718598
1931	20540	93747	81296	148939	94691	83663	33080	40459	18565	62348	57659	60012	794999
1932	317400	141271	62164	36654	19553	21719	18168	14019	9104	6395	8628	252038	907113
1933	141175	49706	57675	111213	215821	35048	20537	35417	25527	15802	12615	17585	738121
1934	61795	9441	12750	32073	22259	11841	2890	2951	35286	18631	81818	78089	369824
1935	113383	61331	315124	104727	144373	760462	35294	27423	15293	24902	127815	121622	1851749
1936	34925	24964	33511	25230	19553	8033	3935	1107	28086	55093	57897	42611	334945
1937	303441	122460	68866	120020	39659	64800	32219	22136	73190	17893	15828	57060	937572
1938	69419	435356	214960	190354	182618	115319	27731	19860	14281	9838	21243	13896	1314875
1939	18446	94136	94322	94909	97765	36952	20352	8362	3749	9162	12853	12236	503244
1940	12113	13632	15187	91398	69542	22493	27608	38922	40582	11129	32549	77351	452506
1941	235436	122848	53125	314182	48391	44688	13466	13896	11365	211517	286571	97642	1453127
1942	57306	83972	68866	336972	202479	109845	36585	28223	32251	60012	407306	232300	1656117
1943	94629	35377	62963	134658	773514	119306	29698	12482	9164	19184	14579	15618	1321172
1944	25456	56658	377903	163458	197068	136681	26747	37507	23147	31113	14459	22689	1112886
1945	19553	223426	746459	818776	220371	338995	93031	29391	88840	125066	39213	24902	2768023
1946	144373	214540	93277	62241	312295	115497	87620	17462	10830	11806	210526	350479	1630946
1947	61365	26436	32957	169706	255665	204635	37077	12543	17970	11129	21600	23611	874694
1948	50235	82254	288131	105148	84976	131980	91432	357058	38797	18511	21659	49497	1319678
1949	179421	251584	151936	102407	348819	257074	139700	26624	48438	34187	28859	44456	1613505
1950	233776	179941	107050	126327	774129	73547	93277	96508	61646	41996	19398	16848	1824443
1951	30375	390427	160544	80866	65853	89613	108526	23365	19339	23796	95028	69419	1157151
1952	66284	83865	177576	195530	95244	34274	12113	19983	7855	5780	11722	14265	724491
1953	13712	12662	157162	198030	178990	22552	23611	11129	4700	8854	7974	9838	649214
1954	15618	17716	22566	34393	183417	11544	7317	16356	4582	19000	11306	33818	377633
1955	47468	125125	173272	81461	76982	100800	24472	13404	7260	10945	6248	6579	674016
1956	7563	29336	19500	25349	112092	65395	19615	5412	1309	2828	11246	15679	315324
1957	46054	92469	41432	525243	673289	398618	68559	48206	58433	20106	100681	42918	2116008
1958	40459	91747	136625	131326	224491	68370	246135	98011	30704	19800	31775	20844	1140287
1959	19307	27158	127525	154235	174838	75332	98626	28223	14817	160360	163220	57798	1101439

Table 4-8
Estimated Monthly and Annual Inflows in Acre-Feet

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1960	91924	60972	116642	108119	395392	70036	171058	42672	14459	14204	13031	58290	1156799
1961	33695	44874	107726	105858	557508	101573	213362	128755	60635	53002	119365	152797	1679150
1962	91371	72976	123221	186129	83685	46354	34986	57552	40344	69604	39868	32957	879047
1963	33449	20660	38491	40284	35417	17256	9162	10145	8450	3935	4046	7071	228366
1964	6825	8916	37323	59504	64623	24456	6948	21152	39094	17954	28026	12728	327549
1965	58598	55870	82024	287821	62656	38678	17770	15249	23088	5534	5712	14696	667696
1966	47407	164501	180282	159769	116949	36357	9408	21582	8093	3136	6307	8485	762276
1967	11191	13607	18815	77415	79257	22493	29145	6220	8926	17217	54744	137117	476147
1968	92600	208800	274542	218321	188828	86995	66776	23119	22314	18692	116985	192272	1510244
1969	219265	198823	182803	158102	116642	78069	29453	13097	4760	76736	21183	34372	1133305
1970	72986	40709	151444	193805	256649	85329	16356	9162	129481	299875	145130	47591	1448517
1971	115635	110712	76046	39545	116776	38976	24863	14564	12972	46011	27256	198461	821817
1972	36688	32670	22604	134718	95640	33065	102865	10785	8740	44201	217346	65543	804865
1973	190100	175883	467097	481308	190518	293094	61380	28742	108430	125189	423066	283145	2827952
1974	77248	88087	159705	138349	129777	398922	25393	30641	195150	70915	452926	94757	1861870
1975	122498	246396	353060	135997	141347	126791	43467	37722	102012	30453	39250	153961	1532954
1976	52420	28188	105618	351855	98618	65696	33162	19467	14690	14111	12841	21760	818426
1977	17032	24194	151103	81192	22743	14501	25093	17637	28312	28976	39402	37395	487580
1978	21776	77118	255564	144734	221056	162082	31899	13860	12515	6030	16100	15537	978271
1979	22100	45200	126300	164200	150500	76700	32800	32500	7760	10214	29652	16740	714666
1980	14826	22115	63907	55239	62449	26211	4889	1745	5335	2846	6089	11365	277016
1981	6882	12654	25685	31963	90783	67610	52442	43051	9917	72555	82022	26479	522043
1982	78545	171054	73517	41157	96684	231964	23484	16066	6743	8528	18347	200330	966419
1983	52561	83107	74776	142214	123768	43636	16066	6862	3867	13289	18049	21818	600013
1984	15471	28561	224132	173553	117024	35801	9719	19834	8330	140826	152925	351867	1278043
1985	207074	210446	282842	171371	133090	144793	24991	35008	19239	92826	290380	213619	1825679
1986	45818	91041	91041	306247	182280	124363	25785	38876	117123	531173	95801	45917	1695465
1987	134578	129719	283834	116033	73884	50280	26975	17355	27371	24198	110975	443504	1438706
1988	145884	68925	337090	202909	43834	20826	21034	10740	12456	8330	28958	26578	927564
1989	57322	225917	221553	92330	113057	194380	42842	22016	31933	11999	9838	9322	1032509
1990	92231	192595	405619	452033	608528	128528	33520	23900	34115	42446	40066	120991	2174572
1991	259834	54347	84892	202512	102942	29057	9619	11801	26479	94512	241983	261421	1379399
1992	73289	72595	52601	66604	77335	230380	61368	93599	46314	21123	215880	411768	1422856
1993	198545	193884	185157	315094	379537	148264	61785	25388	134082	118512	233851	120793	2114892
1994	58210	119600	309120	162250	99870	39970	39110	31580	26810	22414	206403	100068	1215405
1995	240202	72596	153325	183474	358121	247739	82018	24298	24794	20529	17554	33124	1457774

Table 4-8
Estimated Monthly and Annual Inflows in Acre-Feet

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1996	80133	30149	38480	182383	117721	39968	28265	17762	133073	39620	371113	149397	1228064
1997	39372	224334	196426	137605	54229	80629	45888	31270	18347	37994	43597	143665	1053356
1998	399715	86064	304705	115588	71555	40781	19795	11941	26192	103925	59128	87076	1326465
1999	44609	130256	220129	192687	318451	158680	132994	19141	25587	12546	21719	52860	1329659
2000	39968	36744	77257	44331	118316	576901	109787	21184	14876	26281	97687	63571	1226903
2001	101258	374485	119208	56728	83555	76761	24397	14380	22017	50778	48001	202119	1173687
2002	51720	104035	206086	250020	119903	76861	26876	62877	10413	13091	14083	30496	966461
2003	38976	43240	70712	36992	95704	57918	18645	12476	24992	24000	47544	46811	518010
2004	75274	55141	165126	360799	102944	57522	222747	58761	12893	17256	144696	110481	1383640
2005	402353	81224	76166	131308	52563	32827	15868	12397	8926	5871	6149	7636	833288
2006	11405	9322	23108	25805	133142	24397	8380	12774	45343	16959	52810	153788	517233
2007	244704	84636	47763	49211	88464	67003	80550	16225	38837	63373	19438	52920	853124
2008	48338	138290	471974	517376	118871	168838	156935	91578	206145	66170	33739	42725	2060979
2009	58315	134442	87869	219573	360104	70870	27194	31895	143586	366769	108517	50311	1659445
2010	74213	127995	170125	101238	154356	52801	77277	12932	55855	18169	17415	19795	882171
Maximum	402353	435356	746459	933024	774129	760462	246135	409815	206145	531173	452926	443504	2950319
Minimum	6825	8916	12750	6248	19553	8033	2890	1107	1309	2828	4046	6579	228366
Mean	92373	102347	147560	172290	175273	115720	52001	35689	38231	57590	79613	90788	1159474

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
490	0.007	0.008	0.008	0.009	0.009	0.010	0.010	0.011	0.011	0.012
	0.009	0.010	0.011	0.012	0.013	0.014	0.014	0.015	0.016	0.017
491	0.012	0.013	0.013	0.014	0.015	0.016	0.016	0.017	0.018	0.018
	0.018	0.020	0.021	0.023	0.024	0.026	0.028	0.029	0.031	0.032
492	0.019	0.020	0.021	0.022	0.023	0.024	0.025	0.026	0.027	0.028
	0.034	0.036	0.039	0.041	0.044	0.046	0.048	0.051	0.053	0.056
493	0.029	0.030	0.032	0.033	0.034	0.036	0.037	0.038	0.039	0.041
	0.058	0.062	0.065	0.069	0.072	0.076	0.079	0.083	0.086	0.090
494	0.042	0.044	0.046	0.047	0.049	0.051	0.053	0.055	0.056	0.058
	0.093	0.098	0.103	0.108	0.113	0.119	0.124	0.129	0.134	0.139
495	0.060	0.063	0.066	0.069	0.072	0.076	0.079	0.082	0.085	0.088
	0.144	0.151	0.159	0.166	0.174	0.181	0.188	0.196	0.203	0.211
496	0.091	0.094	0.097	0.101	0.104	0.107	0.110	0.113	0.117	0.120
	0.218	0.229	0.240	0.251	0.262	0.273	0.283	0.294	0.305	0.316
497	0.123	0.125	0.127	0.129	0.131	0.133	0.134	0.136	0.138	0.140

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	0.327	0.340	0.354	0.367	0.381	0.394	0.407	0.421	0.434	0.448
498	0.142	0.144	0.146	0.147	0.149	0.151	0.153	0.155	0.156	0.158
	0.461	0.476	0.491	0.506	0.521	0.537	0.552	0.567	0.582	0.597
499	0.160	0.162	0.163	0.165	0.166	0.168	0.170	0.171	0.173	0.174
	0.612	0.629	0.646	0.662	0.679	0.696	0.713	0.730	0.746	0.763
500	0.176	0.178	0.180	0.182	0.184	0.186	0.187	0.189	0.191	0.193
	0.780	0.799	0.817	0.836	0.854	0.873	0.892	0.910	0.929	0.947
501	0.195	0.198	0.200	0.203	0.205	0.208	0.210	0.213	0.215	0.218
	0.966	0.987	1.007	1.028	1.049	1.070	1.090	1.111	1.132	1.152
502	0.220	0.222	0.225	0.227	0.230	0.232	0.234	0.237	0.239	0.242
	1.173	1.196	1.219	1.243	1.266	1.289	1.312	1.335	1.359	1.382
503	0.244	0.246	0.248	0.250	0.252	0.254	0.256	0.258	0.260	0.262
	1.405	1.430	1.456	1.481	1.507	1.532	1.557	1.583	1.608	1.634
504	0.264	0.266	0.268	0.270	0.272	0.274	0.275	0.277	0.279	0.281
	1.659	1.686	1.714	1.741	1.769	1.796	1.823	1.851	1.878	1.906

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
505	0.283	0.285	0.287	0.289	0.291	0.293	0.295	0.297	0.299	0.301
	1.933	1.962	1.992	2.021	2.050	2.080	2.109	2.138	2.167	2.197
506	0.303	0.305	0.307	0.309	0.311	0.313	0.314	0.316	0.318	0.320
	2.226	2.257	2.288	2.320	2.351	2.382	2.413	2.444	2.476	2.507
507	0.322	0.324	0.326	0.328	0.330	0.332	0.334	0.336	0.338	0.340
	2.538	2.571	2.604	2.638	2.671	2.704	2.737	2.770	2.804	2.837
508	0.342	0.344	0.347	0.349	0.351	0.354	0.356	0.358	0.360	0.363
	2.870	2.905	2.941	2.976	3.011	3.047	3.082	3.117	3.152	3.188
509	0.365	0.367	0.370	0.372	0.375	0.377	0.379	0.382	0.384	0.387
	3.223	3.261	3.298	3.336	3.374	3.412	3.449	3.487	3.525	3.562
510	0.389	0.392	0.394	0.397	0.400	0.403	0.405	0.408	0.411	0.413
	3.600	3.640	3.680	3.721	3.761	3.801	3.841	3.881	3.922	3.962
511	0.416	0.419	0.422	0.425	0.428	0.431	0.433	0.436	0.439	0.442
	4.002	4.045	4.088	4.131	4.174	4.217	4.260	4.303	4.346	4.389

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
512	0.445	0.448	0.451	0.454	0.457	0.460	0.462	0.465	0.468	0.471
	4.432	4.478	4.524	4.570	4.616	4.662	4.708	4.754	4.800	4.846
513	0.474	0.477	0.480	0.482	0.485	0.488	0.491	0.494	0.496	0.499
	4.892	4.941	4.990	5.039	5.088	5.137	5.185	5.234	5.283	5.332
514	0.502	0.505	0.507	0.510	0.513	0.516	0.518	0.521	0.524	0.526
	5.381	5.433	5.484	5.536	5.587	5.639	5.690	5.742	5.793	5.845
515	0.529	0.532	0.536	0.539	0.542	0.546	0.549	0.552	0.555	0.559
	5.896	5.951	6.005	6.060	6.114	6.169	6.223	6.278	6.332	6.387
516	0.562	0.566	0.570	0.574	0.578	0.582	0.586	0.590	0.594	0.598
	6.441	6.499	6.557	6.615	6.673	6.732	6.790	6.848	6.906	6.964
517	0.602	0.606	0.610	0.614	0.618	0.622	0.626	0.630	0.634	0.638
	7.022	7.084	7.147	7.209	7.271	7.334	7.396	7.458	7.520	7.583
518	0.642	0.646	0.650	0.653	0.657	0.661	0.665	0.669	0.672	0.676
	7.645	7.711	7.777	7.843	7.909	7.976	8.042	8.108	8.174	8.240
519	0.680	0.684	0.688	0.692	0.696	0.701	0.705	0.709	0.713	0.717

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	8.306	8.376	8.446	8.516	8.586	8.656	8.726	8.796	8.866	8.936
520	0.721	0.725	0.729	0.733	0.737	0.742	0.746	0.750	0.754	0.758
	9.006	9.080	9.154	9.229	9.303	9.377	9.451	9.525	9.600	9.674
521	0.762	0.767	0.771	0.776	0.780	0.785	0.789	0.794	0.798	0.803
	9.748	9.826	9.905	9.983	10.062	10.140	10.218	10.297	10.375	10.454
522	0.807	0.812	0.816	0.821	0.825	0.830	0.835	0.839	0.844	0.848
	10.532	10.615	10.698	10.781	10.864	10.947	11.030	11.113	11.196	11.279
523	0.853	0.858	0.863	0.868	0.873	0.879	0.884	0.889	0.894	0.899
	11.362	11.450	11.538	11.625	11.713	11.801	11.889	11.977	12.064	12.152
524	0.904	0.969	0.975	0.981	0.987	0.993	0.998	1.004	1.010	1.016
	12.240	12.333	12.427	12.520	12.613	12.707	12.800	12.893	12.986	13.080
525	0.963	0.969	0.974	0.980	0.985	0.991	0.997	1.002	1.008	1.013
	13.173	13.272	13.371	13.470	13.569	13.668	13.767	13.866	13.965	14.064
526	1.019	1.025	1.031	1.037	1.043	1.050	1.056	1.062	1.068	1.074
	14.163	14.268	14.373	14.478	14.583	14.688	14.792	14.897	15.002	15.107

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
527	1.080	1.087	1.094	1.101	1.108	1.116	1.123	1.130	1.137	1.144
	15.212	15.324	15.435	15.547	15.658	15.770	15.882	15.993	16.105	16.216
528	1.151	1.158	1.165	1.172	1.179	1.186	1.193	1.200	1.207	1.214
	16.328	16.447	16.565	16.684	16.802	16.921	17.040	17.158	17.277	17.395
529	1.221	1.229	1.236	1.244	1.251	1.259	1.267	1.274	1.282	1.289
	17.514	17.640	17.766	17.891	18.017	18.143	18.269	18.395	18.520	18.646
530	1.297	1.305	1.313	1.322	1.330	1.338	1.346	1.354	1.363	1.371
	18.772	18.906	19.039	19.173	19.307	19.441	19.574	19.708	19.842	19.975
531	1.379	1.387	1.396	1.404	1.413	1.421	1.429	1.438	1.446	1.455
	20.109	20.251	20.393	20.535	20.677	20.820	20.962	21.104	21.246	21.388
532	1.463	1.472	1.480	1.489	1.498	1.507	1.515	1.524	1.533	1.541
	21.530	21.681	21.831	21.982	22.132	22.283	22.433	22.584	22.734	22.885
533	1.550	1.560	1.569	1.579	1.588	1.598	1.608	1.617	1.627	1.636
	23.035	23.195	23.355	23.514	23.674	23.834	23.994	24.154	24.313	24.473

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
534	1.646	1.656	1.665	1.675	1.684	1.694	1.704	1.713	1.723	1.732
	24.633	24.802	24.972	25.141	25.311	25.480	25.649	25.819	25.988	26.158
535	1.742	1.752	1.763	1.773	1.783	1.794	1.804	1.814	1.824	1.835
	26.327	26.506	26.686	26.865	27.044	27.224	27.403	27.582	27.761	27.941
536	1.845	1.855	1.866	1.876	1.887	1.897	1.907	1.918	1.928	1.939
	28.120	28.310	28.499	28.689	28.879	29.069	29.258	29.448	29.638	29.827
537	1.949	1.960	1.970	1.981	1.991	2.002	2.013	2.023	2.034	2.044
	30.017	30.217	30.418	30.618	30.819	31.019	31.219	31.420	31.620	31.821
538	2.055	2.065	2.075	2.085	2.095	2.105	2.114	2.124	2.134	2.144
	32.021	32.231	32.442	32.652	32.863	33.073	33.283	33.494	33.704	33.915
539	2.154	2.164	2.175	2.185	2.195	2.206	2.216	2.226	2.236	2.247
	34.125	34.346	34.566	34.787	35.007	35.228	35.449	35.669	35.890	36.110
540	2.257	2.266	2.276	2.285	2.294	2.304	2.313	2.322	2.331	2.341
	36.331	36.561	36.792	37.022	37.253	37.483	37.713	37.944	38.174	38.405
541	2.350	2.359	2.368	2.377	2.386	2.395	2.404	2.413	2.422	2.431

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	38.635	38.875	39.114	39.354	39.593	39.833	40.072	40.312	40.551	40.791
542	2.440	2.449	2.459	2.468	2.478	2.487	2.496	2.506	2.515	2.525
	41.030	41.279	41.527	41.776	42.025	42.274	42.522	42.771	43.020	43.268
543	2.534	2.543	2.552	2.560	2.569	2.578	2.587	2.596	2.604	2.613
	43.517	43.775	44.033	44.290	44.548	44.806	45.064	45.322	45.579	45.837
544	2.622	2.631	2.640	2.648	2.657	2.666	2.675	2.684	2.692	2.701
	46.095	46.362	46.628	46.895	47.161	47.428	47.695	47.961	48.228	48.494
545	2.710	2.719	2.727	2.736	2.744	2.753	2.762	2.770	2.779	2.787
	48.761	49.036	49.312	49.587	49.863	50.138	50.413	50.689	50.964	51.240
546	2.796	2.804	2.813	2.821	2.830	2.838	2.846	2.855	2.863	2.872
	51.515	51.799	52.082	52.366	52.650	52.934	53.217	53.501	53.785	54.068
547	2.880	2.889	2.897	2.906	2.915	2.924	2.932	2.941	2.950	2.958
	54.352	54.644	54.937	55.229	55.522	55.814	56.106	56.399	56.691	56.984
548	2.967	2.976	2.985	2.994	3.003	3.012	3.021	3.030	3.039	3.048
	57.276	57.577	57.878	58.179	58.480	58.782	59.083	59.384	59.685	59.986

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
549	3.057	3.066	3.074	3.083	3.091	3.100	3.108	3.117	3.125	3.134
	60.287	60.597	60.907	61.217	61.527	61.837	62.147	62.457	62.767	63.077
550	3.142	3.150	3.159	3.167	3.175	3.184	3.192	3.200	3.208	3.217
	63.387	63.705	64.024	64.342	64.660	64.979	65.297	65.615	65.933	66.252
551	3.225	3.235	3.244	3.254	3.263	3.273	3.283	3.292	3.302	3.311
	66.570	66.897	67.224	67.552	67.879	68.206	68.533	68.860	69.188	69.515
552	3.321	3.332	3.343	3.353	3.364	3.375	3.386	3.397	3.407	3.418
	69.842	70.179	70.517	70.854	71.191	71.529	71.866	72.203	72.540	72.878
553	3.429	3.441	3.452	3.464	3.476	3.488	3.499	3.511	3.523	3.534
	73.215	73.564	73.913	74.261	74.610	74.959	75.308	75.657	76.005	76.354
554	3.546	3.557	3.567	3.578	3.588	3.599	3.610	3.620	3.631	3.641
	76.703	77.063	77.423	77.783	78.143	78.503	78.863	79.223	79.583	79.943
555	3.652	3.663	3.674	3.685	3.696	3.708	3.719	3.730	3.741	3.752
	80.303	80.674	81.044	81.415	81.786	82.157	82.527	82.898	83.269	83.639

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
556	3.763	3.774	3.785	3.797	3.808	3.819	3.830	3.841	3.853	3.864
	84.010	84.392	84.774	85.156	85.538	85.920	86.301	86.683	87.065	87.447
557	3.875	3.887	3.898	3.910	3.921	3.933	3.945	3.956	3.968	3.979
	87.829	88.222	88.616	89.009	89.402	89.796	90.189	90.582	90.975	91.369
558	3.991	4.002	4.012	4.023	4.034	4.045	4.055	4.066	4.077	4.087
	91.762	92.167	92.571	92.976	93.380	93.785	94.190	94.594	94.999	95.403
559	4.098	4.108	4.117	4.127	4.137	4.147	4.156	4.166	4.176	4.185
	95.808	96.223	96.637	97.052	97.467	97.882	98.296	98.711	99.126	99.540
560	4.195	4.205	4.214	4.224	4.233	4.243	4.252	4.262	4.271	4.281
	99.955	100.379	100.804	101.228	101.652	102.077	102.501	102.925	103.349	103.774
561	4.290	4.300	4.309	4.319	4.329	4.339	4.348	4.358	4.368	4.377
	104.198	104.632	105.065	105.499	105.933	106.367	106.800	107.234	107.668	108.101
562	4.387	4.397	4.407	4.416	4.426	4.436	4.446	4.456	4.465	4.475
	108.535	108.979	109.422	109.866	110.309	110.753	111.197	111.640	112.084	112.527
563	4.485	4.495	4.505	4.514	4.524	4.534	4.544	4.554	4.563	4.573

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	112.971	113.424	113.878	114.331	114.785	115.238	115.691	116.145	116.598	117.052
564	4.583	4.592	4.602	4.611	4.620	4.630	4.639	4.648	4.657	4.667
	117.505	117.968	118.431	118.894	119.357	119.820	120.283	120.746	121.209	121.672
565	4.676	4.686	4.695	4.705	4.714	4.724	4.733	4.743	4.752	4.762
	122.135	122.607	123.080	123.552	124.024	124.497	124.969	125.441	125.913	126.386
566	4.771	4.781	4.790	4.800	4.809	4.819	4.829	4.838	4.848	4.857
	126.858	127.340	127.822	128.304	128.786	129.268	129.749	130.231	130.713	131.195
567	4.867	4.877	4.888	4.898	4.908	4.919	4.929	4.939	4.949	4.960
	131.677	132.169	132.660	133.152	133.644	134.136	134.627	135.119	135.611	136.102
568	4.970	4.981	4.991	5.002	5.012	5.023	5.033	5.044	5.054	5.065
	136.594	137.097	137.599	138.102	138.604	139.107	139.609	140.112	140.614	141.117
569	5.075	5.084	5.093	5.102	5.111	5.121	5.130	5.139	5.148	5.157
	141.619	142.131	142.643	143.155	143.667	144.179	144.691	145.203	145.715	146.227
570	5.166	5.175	5.183	5.192	5.201	5.210	5.218	5.227	5.236	5.244
	146.739	147.260	147.781	148.302	148.823	149.344	149.864	150.385	150.906	151.427

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
571	5.253	5.262	5.270	5.279	5.287	5.296	5.305	5.313	5.322	5.330
	151.948	152.478	153.007	153.537	154.066	154.596	155.126	155.655	156.185	156.714
572	5.339	5.347	5.355	5.364	5.372	5.380	5.388	5.396	5.405	5.413
	157.244	157.782	158.320	158.858	159.396	159.934	160.472	161.010	161.548	162.086
573	5.421	5.429	5.437	5.445	5.453	5.462	5.470	5.478	5.486	5.494
	162.624	163.170	163.716	164.262	164.808	165.355	165.901	166.447	166.993	167.539
574	5.502	5.510	5.518	5.526	5.534	5.543	5.551	5.559	5.567	5.575
	168.085	168.639	169.193	169.748	170.302	170.856	171.410	171.964	172.519	173.073
575	5.583	5.591	5.599	5.607	5.615	5.623	5.630	5.638	5.646	5.654
	173.627	174.189	174.751	175.314	175.876	176.438	177.000	177.562	178.125	178.687
576	5.662	5.670	5.678	5.686	5.694	5.702	5.710	5.718	5.726	5.734
	179.249	179.819	180.389	180.960	181.530	182.100	182.670	183.240	183.811	184.381
577	5.742	5.751	5.759	5.768	5.777	5.786	5.794	5.803	5.812	5.820
	184.951	185.530	186.108	186.687	187.265	187.844	188.422	189.001	189.579	190.158

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
578	5.829	5.837	5.845	5.854	5.862	5.870	5.878	5.886	5.895	5.903
	190.736	191.323	191.910	192.497	193.084	193.671	194.258	194.845	195.432	196.019
579	5.911	5.919	5.927	5.935	5.943	5.952	5.960	5.968	5.976	5.984
	196.606	197.201	197.796	198.392	198.987	199.582	200.177	200.772	201.368	201.963
580	5.992	6.000	6.008	6.016	6.024	6.032	6.040	6.048	6.056	6.064
	202.558	203.161	203.764	204.367	204.970	205.574	206.177	206.780	207.383	207.986
581	6.072	6.080	6.088	6.096	6.104	6.113	6.121	6.129	6.137	6.145
	208.589	209.200	209.811	210.423	211.034	211.645	212.256	212.867	213.479	214.090
582	6.153	6.162	6.171	6.179	6.188	6.197	6.206	6.215	6.223	6.232
	214.701	215.321	215.940	216.560	217.180	217.800	218.419	219.039	219.659	220.278
583	6.241	6.250	6.260	6.269	6.278	6.288	6.297	6.306	6.315	6.325
	220.898	221.527	222.155	222.784	223.413	224.042	224.670	225.299	225.928	226.556
584	6.334	6.343	6.353	6.362	6.372	6.381	6.390	6.400	6.409	6.419
	227.185	227.823	228.461	229.099	229.737	230.376	231.014	231.652	232.290	232.928
585	6.428	6.438	6.448	6.458	6.842	6.479	6.489	6.499	6.509	6.519

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	233.566	234.214	234.862	235.510	236.158	236.806	237.453	238.101	238.749	239.397
586	6.529	6.539	6.549	6.559	6.569	6.579	6.589	6.599	6.609	6.619
	240.045	240.703	241.361	242.019	242.677	243.335	243.992	244.650	245.308	245.966
587	6.629	6.640	6.651	6.662	6.673	6.685	6.696	6.707	6.718	6.729
	246.624	247.293	247.961	248.630	249.298	249.967	250.635	251.304	251.972	252.641
588	6.740	6.750	6.760	6.770	6.780	6.790	6.800	6.810	6.820	6.830
	253.309	253.988	254.667	255.346	256.025	256.704	257.383	258.062	258.741	259.420
589	6.840	6.849	6.859	6.868	6.877	6.887	6.896	6.905	6.914	6.924
	260.099	260.788	261.476	262.165	262.854	263.543	264.231	264.920	265.609	266.297
590	6.933	6.942	6.951	6.959	7.294	6.977	6.986	6.995	7.003	7.012
	266.986	267.684	268.381	269.079	269.777	270.475	271.172	271.870	272.568	273.265
591	7.021	7.030	7.039	7.048	7.057	7.066	7.075	7.084	7.093	7.102
	273.963	274.670	275.376	276.083	276.789	277.496	278.203	278.909	279.616	280.322
592	7.111	7.120	7.129	7.138	7.147	7.157	7.166	7.175	7.184	7.193
	281.029	281.745	282.460	283.176	283.892	284.608	285.323	286.039	286.755	287.470

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
593	7.202	7.211	7.220	7.229	7.238	7.248	7.257	7.266	7.275	7.284
	288.186	288.911	289.635	290.360	291.085	291.810	292.534	293.259	293.984	294.708
594	7.293	7.302	7.312	7.321	7.330	7.340	7.349	7.358	7.367	7.377
	295.433	296.167	296.901	297.635	298.369	299.103	299.837	300.571	301.305	302.039
595	7.386	7.396	7.406	7.416	7.426	7.436	7.446	7.456	7.466	7.476
	302.773	303.516	304.260	305.003	305.747	306.490	307.233	307.977	308.720	309.464
596	7.486	7.498	7.509	7.521	7.532	7.544	7.556	7.567	7.579	7.590
	310.207	310.961	311.715	312.470	313.224	313.978	314.732	315.486	316.241	316.995
597	7.602	7.613	7.624	7.635	7.646	7.657	7.668	7.679	7.690	7.701
	317.749	318.515	319.281	320.046	320.812	321.578	322.344	323.110	323.875	324.641
598	7.712	7.723	7.734	7.745	7.756	7.768	7.779	7.790	7.801	7.812
	325.407	326.184	326.960	327.737	326.184	329.290	330.067	330.843	331.620	332.396
599	7.823	7.836	7.849	7.861	7.874	7.887	7.900	7.913	7.925	7.938
	333.173	333.961	334.750	335.538	336.326	337.115	337.903	338.691	339.479	340.268

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
600	7.951	7.964	7.977	7.990	8.003	8.017	8.030	8.043	8.056	8.069
	341.056	341.858	342.659	343.461	344.262	345.064	345.866	346.667	347.469	348.270
601	8.082	8.096	8.110	8.124	8.138	8.152	8.166	8.180	8.194	8.208
	349.072	349.887	350.702	351.518	352.333	353.148	353.963	354.778	355.594	356.409
602	8.222	8.235	8.248	8.262	8.275	8.288	8.301	8.314	8.328	8.341
	357.224	358.053	358.882	359.711	360.540	361.369	362.197	363.026	363.855	364.684
603	8.354	8.368	8.368	8.395	8.408	8.422	8.435	8.449	8.462	8.476
	365.513	366.355	367.197	368.039	368.881	369.724	370.566	371.408	372.250	373.092
604	8.489	8.502	8.514	8.527	8.540	8.553	8.565	8.578	8.591	8.603
	373.934	374.789	375.645	376.500	377.355	378.211	379.066	379.921	380.776	381.632
605	8.616	8.629	8.641	8.654	8.666	8.679	8.692	8.704	8.717	8.729
	382.487	383.355	384.223	385.090	385.958	386.826	387.694	388.562	389.429	390.297
606	8.742	8.756	8.771	8.785	8.799	8.814	8.828	8.842	8.856	8.871
	391.165	392.046	392.927	393.808	394.689	395.570	396.450	397.331	398.212	399.093
607	8.885	8.900	8.915	8.929	8.944	8.959	8.974	8.989	9.003	9.018

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	399.974	400.870	401.766	402.663	403.559	404.455	405.351	406.247	407.144	408.040
608	9.033	9.046	9.058	9.071	9.083	9.096	9.109	9.121	9.134	9.146
	408.936	409.846	410.755	411.665	412.574	413.484	414.394	415.303	416.213	417.122
609	9.159	9.172	9.185	9.198	9.211	9.225	9.238	9.251	343.637	9.277
	418.032	418.954	419.877	420.799	421.722	422.644	423.566	424.489	425.411	426.334
610	9.290	9.303	9.315	9.328	9.340	9.353	9.365	9.378	9.390	9.403
	427.256	428.191	429.126	430.062	430.997	431.932	432.867	433.802	434.738	435.673
611	9.415	9.428	9.441	9.454	9.467	9.480	9.492	9.505	9.518	9.531
	436.608	437.556	438.504	439.452	440.400	441.348	442.295	443.243	444.191	445.139
612	9.544	9.558	9.572	9.586	9.600	9.614	9.627	9.641	9.655	9.669
	446.087	447.048	448.009	448.971	449.932	450.893	451.854	452.815	453.777	454.738
613	9.683	9.697	9.711	9.725	9.739	9.753	9.767	9.781	9.795	9.809
	455.699	456.674	457.650	458.625	459.601	460.576	461.551	462.527	463.502	464.478
614	9.823	9.837	9.851	9.865	9.879	9.894	9.908	9.922	9.936	9.950
	465.453	466.442	467.432	496.121	469.410	470.400	471.389	472.378	473.367	474.357

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
615	9.964	9.978	9.991	10.005	10.019	10.033	10.046	10.060	10.074	10.087
	475.346	476.349	477.352	478.356	516.477	480.362	481.365	482.368	483.372	484.375
616	10.101	10.115	10.129	10.144	10.158	10.172	10.186	10.200	10.215	10.229
	485.378	486.395	487.412	488.429	489.446	490.464	491.481	492.498	493.515	494.532
617	10.243	10.259	10.275	10.291	10.307	10.323	10.339	10.355	10.371	10.387
	495.549	496.581	497.613	498.646	499.678	500.710	501.742	502.774	503.807	504.839
618	10.403	10.420	10.437	10.453	10.470	10.487	10.504	10.521	10.537	10.554
	505.871	506.920	507.968	509.017	510.065	511.114	512.163	513.211	514.260	515.308
619	10.571	10.588	10.605	10.622	10.639	10.656	10.672	10.689	10.706	10.723
	516.357	517.423	518.488	519.554	520.620	521.686	522.751	523.817	524.883	525.948
620	10.740	10.757	10.774	10.791	10.808	10.825	10.841	10.858	10.875	10.892
	527.014	528.096	529.179	530.261	531.344	532.426	533.508	534.591	535.673	536.756
621	10.909	10.925	10.941	10.956	10.972	10.988	11.004	11.020	11.035	11.051
	537.838	538.937	540.036	541.135	542.234	543.333	544.431	545.530	546.629	547.728

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
622	11.067	11.082	11.098	11.113	11.129	11.144	11.159	11.175	11.190	11.206
	548.827	549.941	551.056	552.170	553.284	554.399	555.513	556.627	557.741	558.856
623	11.221	11.238	11.254	11.271	11.287	11.304	11.320	11.337	11.353	11.370
	559.970	561.100	561.100	563.361	564.491	565.622	566.752	567.882	569.012	570.143
624	11.386	11.403	11.420	11.436	11.453	11.470	11.487	11.504	11.520	11.537
	571.273	572.420	573.567	574.714	575.861	577.008	578.154	579.301	580.448	581.595
625	11.554	11.571	11.587	11.604	11.621	11.638	11.654	11.671	11.688	11.704
	582.742	583.906	585.070	586.234	587.398	588.562	589.725	590.889	592.053	593.217
626	11.721	11.738	11.754	11.771	11.787	11.804	11.821	11.837	11.854	11.870
	594.381	596.759	599.137	601.516	603.894	606.272	608.650	611.028	613.407	615.785
627	11.887	11.906	11.925	11.943	11.962	11.981	12.000	12.019	12.037	12.056
	618.163	618.163	618.163	618.163	618.163	618.163	618.163	618.163	618.163	618.163
628	12.075	12.097	12.119	12.141	12.163	12.186	12.208	12.230	12.252	12.274
	618.163	619.381	620.600	621.818	623.037	624.255	625.473	626.692	627.910	629.129
629	12.296	12.315	12.334	12.354	12.373	12.392	12.411	12.430	12.450	12.469

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	630.347	631.586	632.825	634.065	635.304	636.543	637.782	639.021	640.261	641.500
630	12.488	12.509	12.530	12.551	12.572	12.594	12.615	12.636	12.657	12.678
	642.739	643.998	645.257	646.516	647.775	649.035	650.294	651.553	652.812	654.071
631	12.699	12.728	12.757	12.786	12.815	12.844	12.872	12.901	12.930	12.959
	655.330	656.616	657.902	659.188	660.474	661.761	663.047	664.333	665.619	666.905
632	12.988	12.999	13.209	13.020	13.030	13.041	13.051	13.734	13.072	13.083
	668.191	669.564	670.936	672.309	673.682	675.055	676.427	677.800	679.173	680.545
633	13.093	13.111	13.129	13.147	13.165	13.184	13.202	13.220	13.238	13.256
	681.918	683.236	684.554	685.872	687.190	688.509	689.827	691.145	692.463	693.781
634	13.274	13.292	13.309	13.327	13.344	13.362	13.379	13.397	13.414	13.432
	695.099	696.437	697.776	699.114	700.453	701.791	703.129	704.468	705.806	707.145
635	13.449	13.465	13.481	13.498	13.514	13.530	13.546	13.562	13.579	13.595
	708.483	709.837	711.190	712.544	713.897	715.251	716.604	717.958	719.311	720.665
636	13.611	13.628	13.645	13.662	13.679	13.696	13.712	13.729	13.746	13.763
	722.018	723.392	724.766	726.141	727.515	728.889	730.263	731.637	733.012	734.386

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
637	13.780	13.795	13.810	13.826	13.841	13.856	13.871	13.886	13.902	13.917
	735.760	737.143	738.526	739.909	741.292	742.675	744.058	745.441	746.824	748.207
638	13.932	13.950	13.967	13.985	14.002	14.020	14.038	14.055	14.073	14.090
	749.590	750.989	752.388	753.787	755.186	756.586	757.985	759.384	760.783	762.182
639	14.108	14.126	14.143	14.161	14.178	14.196	14.214	14.231	14.249	14.266
	763.581	764.998	766.415	767.833	769.250	770.667	772.084	773.501	774.919	776.336
640	14.284	15.731	17.178	18.625	20.072	21.519	22.965	24.412	25.859	27.306
	777.753	779.196	780.638	782.081	783.523	784.966	786.409	787.851	789.294	790.736
641	14.469	14.488	14.507	14.526	14.545	14.565	14.584	14.603	14.622	14.641
	792.179	793.645	795.111	796.577	798.043	799.510	800.976	802.442	803.908	805.374
642	14.660	14.680	14.699	14.719	14.738	14.758	14.777	14.797	14.816	14.836
	806.840	808.315	809.790	811.265	812.740	814.216	815.691	817.166	818.641	820.116
643	14.855	14.874	14.893	14.911	14.930	14.949	14.968	14.987	15.005	15.024
	822	823.078	824.565	826.051	827.538	829.025	830.512	831.999	833.485	834.972

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
644	15.043	15.062	15.081	15.100	15.119	15.138	15.157	15.176	15.195	15.214
	836.459	837.979	839.500	841.020	842.540	844.061	845.581	847.101	848.621	850.142
645	15.233	15.252	15.628	15.289	15.308	15.327	15.346	15.365	15.383	15.402
	851.662	853.198	854.734	856.270	857.806	859.342	860.877	862.413	863.949	865.485
646	15.421	15.440	15.460	15.479	15.499	15.518	15.537	15.557	15.576	15.596
	867.021	868.581	870.141	871.702	873.262	874.822	876.382	877.942	879.503	881.063
647	15.615	15.634	15.653	15.673	15.692	15.711	15.730	15.749	15.769	15.788
	882.623	884.182	885.741	887.299	888.858	890.417	891.976	893.535	895.093	896.652
648	15.807	15.826	15.845	15.863	15.882	15.901	15.920	15.939	15.957	15.976
	898.211	899.811	901.411	903.011	904.611	906.211	907.810	909.410	911.010	912.610
649	15.995	16.016	16.036	16.057	16.078	16.099	16.119	16.140	16.161	16.181
	914.210	915.822	917.433	919.045	920.657	922.269	923.880	925.492	927.104	928.715
650	16.202	16.223	16.243	16.264	16.284	16.305	16.326	16.346	16.367	16.387
	930.327	931.955	933.583	935.211	936.839	938.467	940.095	941.723	943.351	944.979
651	16.408	16.429	16.449	16.470	16.490	16.511	16.532	16.552	16.573	16.593

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	946.607	948.268	949.929	951.589	953.250	954.911	956.572	958.233	959.893	961.554
652	16.614	16.634	16.654	16.674	16.694	16.714	16.733	16.753	16.773	16.793
	963.215	964.879	966.543	968.207	969.871	971.536	973.200	974.864	976.528	978.192
653	16.813	16.834	16.855	16.877	16.898	16.919	16.940	16.961	16.983	17.004
	979.856	981.558	983.259	984.961	986.662	988.364	990.065	991.767	993.468	995.170
654	17.025	17.048	17.071	17.095	17.118	17.141	17.164	17.187	17.211	17.234
	996.871	998.577	1000.282	1001.988	1003.693	1005.399	1007.104	1008.810	1010.515	1012.221
655	17.257	17.281	17.305	17.328	17.352	17.376	17.400	17.424	17.447	17.471
	1013.926	1015.678	1017.429	1019.181	1020.933	1022.685	1024.436	1026.188	1027.940	1029.691
656	17.495	17.517	17.540	17.562	17.585	17.607	17.629	17.652	17.674	17.697
	1031.443	1033.200	1034.957	1036.714	1038.471	1040.229	1041.986	1043.743	1045.500	1047.257
657	17.719	17.743	17.767	17.791	17.815	17.840	17.864	17.888	17.912	17.936
	1049.014	1050.806	1052.599	1054.391	1056.183	1057.976	1059.768	1061.560	1063.352	1065.145
658	17.960	17.984	18.008	18.033	18.057	18.081	18.105	18.129	18.154	17.984
	1066.937	1068.747	1070.556	1072.366	1074.176	1075.986	1077.795	1079.605	1081.415	1083.224

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
659	18.202	18.226	18.250	18.273	18.297	18.321	18.345	18.369	18.392	18.416
	1085.034	1086.868	1088.702	1090.536	1092.370	1094.204	1096.037	1097.871	1099.705	1101.539
660	18.440	18.464	18.489	18.513	18.537	18.562	18.586	18.610	18.634	18.659
	1103.373	1105.216	1107.060	1108.903	1110.747	1112.590	1114.433	1116.277	1118.120	1119.964
661	18.683	18.708	18.733	18.758	18.783	18.809	18.834	18.859	18.884	18.909
	1121.807	1123.700	1125.593	1127.485	1129.378	1131.271	1133.164	1135.057	1136.949	1138.842
662	18.934	18.958	18.983	19.007	19.032	19.056	19.080	19.105	19.129	19.154
	1140.735	1142.646	1144.558	1146.469	1148.381	1150.292	1152.203	1154.115	1156.026	1157.938
663	19.178	19.204	19.229	19.255	19.281	19.307	19.332	19.358	19.384	19.409
	1159.849	1161.770	1161.770	1161.770	1161.770	1161.770	1161.770	1161.770	1161.770	1161.770
664	19.435	19.461	19.487	19.512	19.538	19.564	19.590	19.616	19.641	19.667
	1179.055	1181.013	1182.971	1184.929	1186.887	1188.845	1190.802	1192.760	1194.718	1196.676
665	19.693	19.719	19.746	19.798	19.798	19.825	19.851	19.877	19.903	22.086
	1198.634	1200.617	1202.599	1204.582	1206.564	1208.547	1210.530	1212.512	1214.495	1216.477

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
666	19.956	19.984	20.011	20.039	20.066	20.094	20.121	20.149	20.176	20.204
	1218.460	1220.472	1222.485	1224.497	1226.509	1228.522	1230.534	1232.546	1234.558	1236.571
667	20.231	20.258	20.286	20.313	20.341	20.368	20.395	20.423	20.450	20.478
	1238.583	1240.624	1242.665	1244.706	1246.747	1248.789	1250.830	1252.871	1254.912	1256.953
668	20.505	20.536	20.566	20.597	20.627	20.658	20.688	20.719	20.749	20.780
	1258.994	1261.077	1263.161	1265.244	1267.327	1269.411	1271.494	1273.577	1275.660	1277.744
669	20.810	20.841	20.872	20.904	20.935	20.966	20.997	21.028	21.060	21.091
	1279.827	1281.947	1284.066	1286.186	1288.305	1290.425	1292.545	1294.664	1296.784	1298.903
670	21.122	21.161	21.200	21.239	21.278	21.317	21.355	21.394	21.433	21.472
	1301.023	1303.241	1305.458	1307.676	1309.894	1312.112	1314.329	1316.547	1318.765	1320.982
671	21.511	21.544	21.577	21.610	21.643	21.677	21.710	21.743	21.776	21.809
	1323.200	1325.386	1327.571	1329.757	1331.942	1334.128	1336.314	1338.499	1340.685	1342.870
672	21.842	21.873	21.904	21.936	21.967	21.998	22.029	22.060	22.092	22.123
	1345.056	1347.262	1349.469	1351.675	1353.881	1356.088	1358.294	1360.500	1362.706	1364.913
673	22.154	22.185	22.216	22.247	22.278	22.309	22.339	22.370	22.401	22.432

TABLE 7-5

ELEVATION - AREA - CAPACITY DATA

TENKILLER LAKE, OKLAHOMA

ORIGINAL (1952) CONSERVATION POOL SURVEY AND 2010 FLOOD POOL LIDAR SURVEY

AREA IN 1000'S OF ACRES

CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	1367.119	1369.348	1371.577	1373.806	1376.035	1378.265	1380.494	1382.723	1384.952	1387.181
674	22.463	22.494	22.525	22.556	22.587	22.618	22.648	22.679	22.710	22.741
	1389.410	1391.678	1393.946	1396.213	1398.481	1400.749	1403.017	1405.285	1407.552	1409.820
675	22.772	22.801	22.830	22.858	22.887	22.916	22.945	22.974	23.002	23.031
	1412.088	1414.385	1416.682	1418.979	1421.276	1423.573	1425.870	1428.167	1430.464	1432.761
676	23.060	23.089	23.118	23.146	23.175	23.204	23.233	23.262	23.290	23.319
	1435.058	1437.368	1439.679	1441.989	1444.300	1446.610	1448.920	1451.231	1453.541	1455.852
677	23.348									
	1458.162									

EXHIBIT A

SUPPLEMENTAL PERTINENT DATA

TENKILLER FERRY LAKE

EXHIBIT A

SUPPLEMENTAL PERTINENT DATA

TENKILLER FERRY LAKE

TABLE OF CONTENTS

Note: All elevations referred to in Appendix A, unless otherwise noted, are in feet, National Geodetic Vertical Datum of 1929 (NVGD29). Add 0.312 feet to the NVGD29 elevation to obtain the NAVD88 elevation for Tenkiller Ferry Lake.

EXHIBIT A
SUPPLEMENTAL PERTINENT DATA
TENKILLER FERRY LAKE

1- GENERAL INFORMATION

Other names for project	None
Location	Illinois River at river mile 12.8 in Cherokee and Sequoyah Counties, OK. Approximately 7 miles northeast of Gore and about 22 miles southeast of Muskogee, OK.
Type of project	Dam and Lake.
Objectives of regulation	Multi-purpose - Flood Control, Hydropower, Water Supply, Fish and Wildlife, Recreation and Navigation.
Project owner	U.S. Government
Operating agency	US Army Corps of Engineers. Lake Office is manned from 7:00 am to 4:30 pm daily. The Powerhouse is manned 8 hours a day, 5 days a week. Working hours during flood conditions can vary from several hours on weekends and holidays to 24 hours a day.
Regulating agency	US Army Corps of Engineers.
Code of Federal Regulations Title 33 (applies to Section 7 Projects)	Does not apply
Federal power distributing and marketing	Southwestern Power Administration (SWPA)
Other inter-agency agreement	Memorandum of Understanding (MOU) between the Corps of Engineers and SWPA dated 23 July 1980

1- GENERAL INFORMATION (CONTINUED)

Water rights	Water rights have been granted in the Illinois River between Tenkiller Ferry Dam and the confluence with the Arkansas River in the amount of 1,703 acre-feet per year. Releases may be required from Tenkiller Ferry Lake to meet some of these water rights. (See Table A-1)
Water supply	Total available storage for water supply is 25,400 acre-feet. (See Table A-2)
Project cost	First Cost: $ 26.3 Million (1965 $) Auxiliary Spillway Cost: $ 50.2 Million (2009 $)
Closure date	July 1952.
Special project features	None.
Other	None

TABLE A-1

WATER RIGHTS BELOW TENKILLER LAKE TO CONFLUENCE WITH R.S. KERR RESERVOIR ON THE ARKANSAS RIVER

Diversion Point Legal Description

Water Right #	Name	¼	¼	¼	Section	Township	Range	County	AMT (af/yr)	Primary Purpose	Date Filed	Date Issued
19530623	(b) (6)	NE	NE	SW	16	12N	21E	Sequoyah	570.0	Irrigation	08/04/1953	08/09/1966
19610136			NE	NW21	21	12N	21E	Sequoyah	271.0	Irrigation	10/02/1961	08/09/1966
19800015		SE	SE	NW	16	12N	21E	Sequoyah	320.0	Irrigation	02/04/1980	05/13/1980
19860038	Sequoyah Co. Rural Water District #5	NE	NW	NE	33	13N	21E	Sequoyah	320.0	Public Water Supply	07/28/1986	11/21/1986
19980012	(b) (6)	NE	SW	NW	21	12N	21E	Sequoyah	222.0	Irrigation	05/05/1998	06/08/1999

Total Downstream Rights 1,703 acre-feet/year

TABLE A-2

CONTRACTS FOR WATER SUPPLY STORAGE

User	Storage Allocated AC-FT.	Yield M.G.D.
Tenkiller Utilities Authority (1)	4000	4.193
Sequoyah County Water Assn. (1)	9629	10.009
Lake Region Electric	371	0.389
Cherokee County RWD #2	99	0.104
Stickross Mountain	584	0.618
Tahlequah PWA	4300	4.5
Cherokee County RWD #13	132	0.138
(b) (6)	2	0.002
Tenkiller Development Company	3	0.003
Sunny Heights Water System	10	0.01
Burnt Cabin Rural Water District	12	0.013
Woodhaven Water Company, Inc.	15	0.016
Lake Region Electric	30	0.031
(b) (6)	2	0.002
Indian Hills Estates Company	3	0.003
The Dutchman's	6	0.006
Sixshooter Water System	2	0.002
Fin & Feather Resort, Inc.	12	0.13
Pettit Bay Water Association	5	0.005
Tenkkiller Water Company, Inc.	34	0.035
Gore Public Works Authority	480	0.503
Strayhorn Marina	17	0.017
Mongold Water Company	5	0.005
Lake Region Electric	38	0.039
(b) (6)	1	0.001
Lake Tenkiller Associates	200	0.21
Sequoyah County Water Assn.	220	0.231
Summit Water, Inc.	140	0.147
Sequoyah County Water Assn.	2200	2.306
RWD #13	100	0.105
Cherokee County RWD #2	100	0.105
East Central OK Water Authority	300	0.314
Pettit Mountain Water Assoc.	10	0.01
Greenleaf Nursery Company (2)	2038	2.223
Greenleaf Nursery Company #1(2)	300	0.315
TOTAL	**25,400**	**26.740**

Note: Storage Allocations are for storages between elevations 594.5 to 632.0.
(1) Pending Contracts.
(2) Interim Use Irrigation.

2 - LAKE INFORMATION ELEVATIONS, AREAS AND STORAGES

Feature	Elevation (Feet, NGVD29)	Area (Acres)	Storage	
			Cumulative (Acre-Feet)	Runoff (Inches)
Top of Dam	677.2	23,348	1,458,162	16.98
Maximum Pool	674.1	22,494	1,391,678	16.21
Top of Surcharge Pool	671.0	21,511	1,323,200	15.41
Top of Flood Control Pool	667.0	20,231	1,238,583	14.42
Main Spillway Crest	642.0	14,660	806,840	9.40
Top of Conservation Pool	632.0	12,873	668,191	7.78
Auxiliary Spillway Crest	632.0	12,873	668,191	7.78
Top of Inactive Pool	594.5	7373	299,103	3.48
Streambed at Dam	480.2			

		Storage	
		Incremental (Acre-Feet)	Runoff (Inches)
Flood Control Storage	632.0-667.0	570,392	6.64
Power Storage	594.5-632.0	343,688	4.00
Water Supply Storage	594.5-632.0	25,400	0.30

Note: Area and Capacity figures based on a 2010 LiDAR survey of the flood pool and a 2015 bathymetric survey.

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

Real estate taking line for fee title land	The fee taking line for Tenkiller Lake is a blocked perimeter to elevation 670.0 feet, NVGD, and contains 30,077.48 acres.
Real estate flood easement	The flood easement consists of acquiring most of the land subject to the maximum effects of back water in the upper reaches of the reservoir. The flowage easement encompasses the flood of record, elevation 667.0, NVGD29, plus 3 feet of freeboard for wave action. This easement acquisition was up to elevation 670.0, NVGD29, which encompassed 30,589 acres of purchased land (fee title) and an additional 167 acres for flowage easements.
Range of clearing	The area below elevation 630.0 NVGD29 was completely cleared. Partially clearing was done between elevations 630.0 and 667.0 NVGD29.
Channel capacity downstream of dam	The non-damaging channel capacity immediately below Tenkiller is currently estimated to be 14,580 cfs. This flow rate can be discharged when the lake level is at elevation 559.30 and above.
Reservoir length at top of conservation pool	35 miles
Shoreline length at top of conservation pool	130 miles
Reservoir length at top of flood control pool	33 miles
Shoreline length at top of flood control pool	272 miles

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

Safety aspects, possibly requiring warning	At elevation 637.0 NVGD29, road closures in some parks begin. Downstream of the dam, a warning siren will sound before releases are changed.
Emergency drawdown	The minimum time to empty the pool from the main spillway crest to the top of the conservation pool (elevation 632.0) using a maximum release of 14,580 cfs is about 5 days. The minimum time required to empty the pool from the top of the conservation pool (elev. 632.0 NVGD29) to the invert of the conduit (elev. 502.0 NVGD29) with a maximum release of 14,580 cfs is 24 days.

3 – HYDROLOGY

Drainage area	1610 sq. mi.
Probable maximum flood	
Max. water surface elev.	674.10 feet, NVGD29
Peak inflow	683,170 cfs
Inflow volume	1,367,600 ac-ft. (15.9” of runoff)
Maximum outflow	541,400 cfs
Flood duration	3.75 days
Standard project flood	
Max. water surface elev.	670.86 feet, NVGD
Peak inflow	349,000 cfs
Inflow volume	1,220,000 ac-ft. (14.2” of runoff)
Maximum outflow	290,400
Flood duration	6.6 days
Climate	Moderate
One inch of runoff	85,867 ac-ft.
Storm types	Primarily thunderstorms
Flood seasons	Primary flood period is March through June with a secondary flood period of September through November; however, floods have occurred in every month of the year.
Low flow season	Primarily August and December through February; however, low flow can occur at any time of year.
Min. daily flow	No flow – Frequent occurrence
Min. monthly inflow & date	1107 ac-ft. - Aug 1936
Min. annual inflow & date	228,366 ac-ft. - 1963
Average annual inflow	1,159,474 ac-ft.
Max. annual inflow & date	2,950,319 ac-ft. – 1927

3 – HYDROLOGY (CONTINUED)

Max. monthly inflow & date	933,024 ac-ft. – Apr 1927
Max. daily inflow & date	216,218 ac-ft. – April 26, 2011
Max. instantaneous inflow & date	145,100 cfs – April 26, 2011
Key gage control points	Illinois River at Gore, OK Arkansas River at Van Buren, AR
Type of hydrometeorologic data	Pool and tailwater elevations, rainfall, and weather conditions are recorded at the dam site.
Number of precipitation stations used in the hydrologic forecasting of Tenkiller Ferry Lake	15 DCP recorders 5 Mesonet Stations
Number of sediment ranges	30
Number of degradation ranges	8

4 – DAM EMBANKMENT

Location	Illinois River, mile 12.8
Purpose	Flood Control, Hydroelectric power, water supply, navigation, recreation, and fish and wildlife
Type	Non-over flow
Type of fill	Rolled, earth-filled embankment
Slope protection	Riprap upstream, rock spalls
Height	197 feet above streambed
Length	3,000 feet (including spillway and powerhouse)
Top elevation	677.2 feet, NVGD
Design flood	Probable Maximum Flood
Freeboard	3.1 feet above design flood
Used for roadway	Yes
Elevation of streambed	480.2 feet, NVGD

5 – MAIN SPILLWAY

Location	In saddle near the right abutment, about 800 feet west of the dam axis
Type	Gate controlled, concrete gravity ogee weir
Crest elevation	642.0 feet, NVGD29
Net overflow length	500 feet
Number and size of gates	Ten, 50 ft wide X 25 ft high
Type of gates	Tainter, operated by individual electric motors
Top of gate elevation	667.0 feet, NVGD29 in closed position
Induced surcharge	4 feet
Design head	32.1 feet
Discharge capacity (max. pool elev.)	Main spillway, 314,500 cfs at 674.1 feet, NVGD29 Auxiliary spillway, 245,000 cfs at 674.1 feet, NVGD29
Bridge deck elevation	680.5 feet, NVGD29
Type of energy dissipater	Stilling basin
Time required to open & close all gates	Gates raise or lower separately or together at a rate of 1.0 foot per minute. Range of opening is 23 feet.
Type of emergency closure	Bulkheads are provided for tainter gates and penstocks.
Spillway activation	Tainter gates, except for periodic maintenance, are activated only during flood conditions. During normal conditions, discharges are released through the powerhouse and/or the conduit.

6 – AUXILIARY SPILLWAY

Location	East of the existing spillway
Type	Gate Controlled concrete gravity ogee weir
Crest elevation	632.0 feet, NVGD29
Net overflow length	250 feet
Number & size of gates	Five, 50 feet wide x 35 feet high
Type of gates	Tainter, operated by individual electric motors
Top of gate elevation	667.0, feet, NVGD29, in closed position
Induced surcharge	4 feet
Design head	42.1 feet
Discharge capacity (max. pool elevation)	Main Spillway, 314,500 cfs at 674.1 feet, NVGD29 Auxiliary Spillway, 245,000 cfs at 674.1 feet, NVGD29
Bridge deck elevation	680.5 feet, NVGD29
Type of energy dissipater	Flip Bucket
Time required to open & close all gates	Gates raise or lower separately or together at a rate of 1.0 foot per minute. Range of opening is 32 feet.
Type of emergency closure	Bulkheads are provided for tainter gates and penstocks
Spillway activation	The tainter gates, except for periodic maintenance, are activated only during surcharge operations. During normal flood operations or normal conditions, discharges are released through the powerhouse and/or the conduit.

7 – OUTLET WORKS

Purpose	Flood control and low flow releases
Type of outlet	Concrete round conduit
Size of outlet	19 ft diameter tunnel
Type of service gates	Tractor gates
Number & size of gates	Two, 9 feet wide x 19 feet high
Entrance invert elevation	500.0 feet, NVGD29
Exit invert elevation	485.0 feet, NVGD29
Discharge at pertinent elev.	23,315 cfs at elevation 667.0, NVGD29 (top of flood pool) 21,516 cfs at elevation 642.0, NVGD29 (auxiliary spillway crest) 20,750 cfs at elevation 632.0, NVGD29 (top of conservation pool) 17,600 cfs at 594.5 feet, NVGD29 (top of inactive pool)
Maximum time required to open/close service gates	19 minutes. Service gates will raise or lower independently at the rate of 1 minute per foot.
Type of emergency closure and time required	Hydraulically operated wheel gates which require 19 minutes to close
Type of energy dissipater	Tunnel Deflector and stilling basin.

8 – HYDROELECTRIC POWER FACILITIES

Location	Approx. 3,000 feet northeast of right abutment
Type	Storage
Installed capacity	39,100 kW
Number & capacity	Two 19,550 kilowatt Francis units
Power on-line date	Unit 1 - November 1953 Unit 2 - December 1953
Number and size of penstocks	One 19-foot diameter inlet Two 13.5-foot diameter outlet
Turbine discharge Design head at top of conservation pool	1,800 cfs for one unit 3,600 cfs with two units 4,140 cfs with 15% overload
Design head (net head)	132 feet
Max net head for power	181 feet
Average net head Conservation pool full Conservation pool empty	 145.0 feet 107.5 feet
Minimum flow required for continuous power	1,760 cfs
Draw down	37.5 feet
Minimum net head	103.5 feet
Critical drawdown	1962-1964
Dependable capacity	29,200 kW
Average annual energy Primary Secondary	 71,700,000 kWh 28,800,000 kWh
Specific hydroelectric power storage	369,088 acre–feet (includes 25,400 acre–feet of water supply)
Critical tailwater elevation	491.0 ft. NVGD29

9 – CONTROL POINTS/RIVER REACHES

A. Gore Gage (Illinois River)

Location	River, 4 miles northeast of Gore, OK; 4.5 miles downstream of Tenkiller Ferry Dam.
Purpose	Provide stage, dissolved oxygen, water temperature, and precipitation data and serve as a control point for flood releases from Tenkiller Ferry Dam.
Channel description	Channel is fairly straight 1,000 ft above and below the gage and is composed of loose rock and gravel. Control consists of a rock riffle and gravel bar, approximately 1,000 ft below the gage.
Drainage area	1626.0 sq. mi.
Uncontrolled drainage area	16 sq. mi.
Target flow rate	14,580 cfs (current rating curve)
NWS flood stage	17.0 feet, 14,580 cfs (current rating curve)
Corps regulating stage	17.0 feet, 14,580 cfs (current rating curve)
Time of water travel Tenkiller Ferry dam to gage	2 hours.
Description of equipment	Water surface elevation, water temperature, and dissolved oxygen are recorded by an electronic logger.
Zero of gage	Unknown, 24 March 1924 to 01 April 1926 482.60 feet, 15 April 1939 to18 February 1952 473.00 feet, 19 February 1952 to 15 August 1989 468.0 feet, 15 August 1989 to present
Maximum stage of record	25.5 feet, 10 May 1943
Maximum flow of record	281,000 cfs, 10 May 1943
Channel usage	Water supply, fishing and fish spawning

9 – CONTROL POINTS/RIVER REACHES (CONTINUED)

B. Van Buren Gage (Arkansas River)

Location	Near left bank of upstream side of U.S. Highway 64 bridge at Van Buren, AR, at navigation mile 300.4 on the Arkansas River.
Purpose	Provide stage and precipitation data and serve as a control point for flood releases from Tenkiller Ferry Lake and other upstream projects.
Channel description	The channel is will defined and straight downstream of the gage. The left bank is high and the right bank is a combined levee and floodwall that protects the properties on the right overbank.
Drainage area	150,483 sq mi of which 22,241 sq mi are non-contributing.
Uncontrolled drainage area	7,249 sq. mi.
Target Flow	135,000 to 150,000 cfs (current rating curve)
NWS flood stage	22.0 feet, 135,000 to 150,000 cfs (current rating curve)
Corps regulating stage	22.0 feet, 135,000 to 150,000 cfs (current rating curve)
Time of water travel Tenkiller Ferry Dam to gage	9 hours.
Description of equipment	Water surface elevation is recorded by a Sutron data collection platform.
Zero of Gage	380.24 feet, NVGD29
Maximum Stage of record	38.10 feet, 16 April 1945
Maximum Flow of Record	850,000 cfs, 16 April 1945
Channel usage	Navigation, water supply, fishing and fish spawning.

EXHIBIT B

STANDING INSTRUCTIONS TO POWER PLANT SPECIALIST

TENKILLER FERRY LAKE

EXHIBIT B

STANDING INSTRUCTIONS TO POWER PLANT SPECIALIST

TENKILLER FERRY LAKE

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TABLE INDEX

EXHIBIT B

STANDING INSTRUCTIONS TO POWER PLANT SPECIALIST

TENKILLER FERRY DAM

I – GENERAL INSTRUCTIONS

1. Operation. The lake will be regulated in accordance with the normal regulations for flood control operations 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 communication with the Tulsa District Office is disrupted, the lake will be regulated in accordance with the schedule of emergency regulations for flood control (see Section VII of the manual or paragraph II-1.b. of this Exhibit). In addition, the Power Plant Specialist will immediately make every effort to reestablish communications with the Tulsa District Office.

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

The following data will be submitted in the daily report to the Water Management Section, Hydrology-Hydraulics Branch, Tulsa District Office. Data is typically reported by telephone, fax, or email. 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 a.m. Each Weekday

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

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

B. As of 8 a.m. Each Monday
1. The same data from the weekend as required in A above.

C. Weekends and Holidays
1. Daily reports are not required to be submitted on weekends and holidays except during flood periods.

D. During Flood Periods
1. During flood periods, weekend and holiday reports should include the same data as required in Section A above as well as the 8 a.m. pool elevation from the pool gage.
2. In addition to the data in Sections A, B, and C above additional reports of lake elevations may be requested by Water Management Section personnel.

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 5-4 (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 of the persons listed on page i.

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 abutment; 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. The Power Plant Specialist and the project personnel who are authorized to make gate changes will maintain a list in current status of residents and/or property which might be endangered or inconvenienced by in-channel releases and will give them notification of impending releases. This notification will be made by telephone or oral warning by Corps employees.

It is the responsibility of the Power Plant Specialist to initiate a warning to the Oklahoma Civil Defense Department and local law enforcement agencies if emergency situations develop.

Tulsa District Lake or Powerhouse Personnel have the responsibility to properly recognize emergency situation(s) 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 Power Plant Specialist to the Civil Defense when a 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 Power Plant Specialist 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 Tenkiller Powerhouse project personnel have compiled a list of downstream contacts for use in emergency situations.

During routine gate changes a warning siren is blown to warn people immediately downstream of the dam.

5. Frequency of Gate Changes. During flood periods, gate changes may be directed by the Water Management Section at any time. When the flood waters 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 gate 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 14,580 cfs is not to be exceeded insofar as practicable. Floodwaters will be released as rapidly as practicable with consideration given to minimizing flooding of low-water crossings and low-lying farmland. Factors considered in the determination of releases are: maximum inflow into the reservoir during a rise, general climatic conditions, season of the year with respect to the probability of floods, status of crops in low-lying farmlands, and maximum non-damaging stages or discharges.

a. Normal Flood Control Regulations. Under normal procedures, instruction for storage and release of water for conservation and flood control will be issued by the District Office Water Management Section (in accordance with Table B-1). Implementation of the instructions is to be confirmed back to the Water Management Section as soon as the required action is completed. Instructions originating from any other source should not be processed. Tenkiller Ferry Lake will be regulated for optimal flood reductions on the Illinois River from the dam downstream to the Arkansas River, and on the Arkansas River downstream to Van Buren, Arkansas.

b. Emergency Flood Control Regulations. Should communication with the Tulsa District Office be disrupted or lost, the Power Plant Specialist, will, on his/her own initiative, direct regulation of the lake in accordance with the rules of regulation shown in Table B-2 until communication is restored. In addition, the Power Plant Specialist will make every effort to reestablish communication with the Tulsa District Office. The spillway gates will be operated at a uniform opening.

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

TABLE B-1

NORMAL FLOOD CONTROL REGULATION SCHEDULE

Pool Elevation	Pool Condition	Regulation
632.0 & Below	---	Releases are made through the turbines for hydroelectric power generation as determined by SWPA, to meet downstream water rights as requested by OWRB, or as requested by water rights holders with water supply storage contracts
632.0 - 636.4 and not forecasted to exceed 636.4.	Rising	Releases of 3,800 cfs (maximum power release) will be made if, when combined with local flow below the dam, will not produce flows that exceed a stage ht of 17.0 feet (approx. 14,580 cfs) at the Gore gage or a stage ht of 22.0 ft. (approx. 135,000 to 150,000 c.f.s.) at Van Buren , AR.
632.0 - 667.0 and forecasted not to exceed 667.0	Rising	Releases, when combined with the uncontrolled runoff downstream, will not exceed a stage ht of 17.0 feet (approx. 14,580 cfs) at the Gore gage. Releases will first be made using the power house and conduit gates if possible. Additional releases will be made using the Main Spillway tainter gates. Releases when combined with the flows in the Arkansas River shall not exceed a stage ht of 22.0 (approx. 135,000 – 150,000 cfs) feet at Van Buren, AR. Releases may be superseded by the requirements in Chapter 7 of the Arkansas River Basin Water Control Master Manual.
Above 667.0 (1)	Rising	Releases shall be made using uniform gate openings for all tainter gates such that the pool elevation will not exceed 671.0 if possible. Releases shall be made to keep the top of all gates a minimum of 6” above the pool at all times. If the forecasted inflow will cause the pool to exceed elevation 671.0 (top of induced surcharge), Plate 7-1, Spillway Gate Regulation Schedule, Inflow Parameter, can be used as a guide to determine releases. If the pool rises above elevation 671.0, releases will be made equal to the inflow as long as possible, at which time all gates shall be fully opened and held until the pool level recedes to elevation 671.0. (1)

(1) Catwalk to operate main spillway tainter gates is at elevation 670.5 NVGD29. See Section 7-02.

TABLE B-1 (CONTINUED)

NORMAL FLOOD CONTROL REGULATION SCHEDULE

Pool Elevation	Pool Condition	Regulation
671.0 - 667.0 (1)	Falling	When the pool level is falling between elevations 671.0 and 667.0, 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. Freeboard of at least 6” shall be maintained between the pool level and top of spillway gates at all times. This regulation shall be repeated until the lake recedes to approximately elevation 667.0, at which time the outflow shall be made equal to either inflow or the downstream regulating point (stage ht of 17.0 feet at the Gore gage with an approximate capacity of 14,580 cfs) whichever is greater.
667.0 - 632.0	Falling	Releases, when combined with the uncontrolled runoff downstream in the Illinois River, will not exceed a stage ht of 17.0 feet (approx. 14,580 cfs) at the Gore gage. Releases when combined with the flows in the Arkansas River shall not exceed a stage ht of 22.0 feet (approx. 135,000 to 150,000 cfs) at Van Buren, AR. Releases may be superseded by the requirements in Chapter 7 of the Arkansas River Basin Water Control Master Manual.

(1) Catwalk to operate main spillway tainter gates is at elevation 670.5 NVGD29. See Section 7-02.

TABLE B-2

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE

Pool Elevation	Pool Condition	Regulation
632.0 to 667.0	Rising	If the lake level is below elevation 660.0, maintain current release until communication is restored. If, after 12 hours, communication has not been restored or the pool is above or rises to elevation 660.0 at any time within the 12 hour period, determine inflows using Plate 7-2. Use Plate 7-1 to determine required releases. Use the minimum discharge curve for emergency operations to determine the minimum release. The rate of rise of the lake and the average discharge will be computed every hour using the preceding two hours data. At no time will releases be decreased while the pool is rising. Releases will first be made using the power plant and conduit gates. Additional releases will be made using the Main Spillway tainter gates.
667.0 to 671.0 (1)	Rising	Releases will be made in accordance with Plate 7-1. Both main and auxiliary spillway tainter gates will be used. At no time will releases be decreased while the pool is rising. Releases will be adjusted every hour in accordance with Plate 7-1. All tainter gates will be operated in a manner that keeps the top of all spillway gates at approximately the same elevation and a minimum of 6" above the pool.
671.0 or Above(1)	Rising	Releases will be increased by raising all the tainter gates so that the discharge is equal to inflow and until the pool begins to fall.
671.0 or Above(1)	Falling	Releases will not be decreased until the pool elevation recedes to elevation 671.0.
671.0 to 667.0(1)	Falling	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 or 14,580 cfs, whichever is larger. The top of the all spillway gates shall be kept a minimum of 6" above the lake level at all times.

(1) Catwalk to operate main spillway tainter gates is at elevation 670.5 NVGD29. See Section 7-02.

TABLE B-2 (CONTINUED)

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE

Pool Elevation	Pool Condition	Regulation
667.0 to 632.0	Falling	If the maximum release rate is less than 14,580 cfs, this release will be maintained until the pool nears 632.0. If the maximum release rate exceeds 14,580 cfs, releases will be made equal to the previous 2-hour inflow or 14,580 cfs whichever is greater.

(1) Catwalk to operate main spillway tainter gates is at elevation 670.5 NVGD29. See Section 7-02.

EXHIBIT C

MEMORANDUM OF UNDERSTANDING

CORPS OF ENGINEERS & SOUTHWESTERN POWER ADMINISTRATION

CONTRACT NUMBER
DE-(AM)75-80SW00058

COPY

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

WITNESSETH:

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

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

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

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

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

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

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

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

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

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

2. Availability of Hydroelectric Generation.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

UNITED STATES OF AMERICA

Department of Energy

By _____
Administrator
Southwestern Power Administration

Approved as to Legal Form and Sufficiency

Chief Counsel
Southwestern Power Administration

Department of the Army

By _____
Division Engineer, Southwestern Division
Corps of Engineers

Projects of the Corps

(Completed and Under Construction)

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

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

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

Stockton Lake
Harry S. Truman Dam and Reservoir

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

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

EXHIBIT A

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

REPLY TO ATTENTION OF

October 30, 1986

SWPA OFFICIAL COPY

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

Water Management Branch
Engineering Division

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

Dear Mr. Wilkerson:

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

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

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

Sincerely,

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

Enclosure

Copies Furnished:

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

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

OCT 23 1986

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

Dear General Hilmes:

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

Sincerely,

Ronald H. Wilkerson

Ronald H. Wilkerson
Administrator

20 OCT 86

DRAFT

EXHIBIT "B" OF

CONTRACT NO. DE-GMIS-80 SW 00058

OPERATING ARRANGEMENT

BETWEEN THE SOUTHWESTERN DIVISION

OF THE CORPS OF ENGINEERS AND THE

SOUTHWESTERN POWER ADMINISTRATION

EXHIBIT "B"

OPERATING ARRANGEMENT

TABLE OF CONTENTS

TABLES

Exhibit "B"

OPERATING ARRANGEMENT
(Reservoir Regulation and Power Scheduling)

1. Authority. This Arrangement states the principles and procedures relating to reservoir regulation and power scheduling of Corps of Engineers Hydroelectric Projects within the Southwestern Division (SWD) and the Southwestern Power Administration (SWPA). This Arrangement was developed in compliance with Paragraph 4 of the Memorandum of Understanding (MOU) dated 23 July 1980 and the authority therein.

2. Revision or Termination. This Operating Arrangement shall be effective commencing on the date of execution and shall remain in effect until terminated upon 90 days prior written notice by either party. It is provided further, that this Operating Arrangement may be amended with the mutual written consent of both parties.

3. Obligations. SWD and SWPA agree on the following obligations:

a. Obligations of SWPA:

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

(2) The preparation of monthly estimates of generation requirements for each SWD project.

(3) The scheduling of power plants to meet system requirements.

(4) To contract for the sale of power generated at SWD projects.

b. Obligations of SWD:

(1) The regulation of SWD projects for authorized purposes and in accordance with Presidential directives.

(2) The daily operation and maintenance of electric generation and switchyard facilities at each SWD power plant.

(3) The planning of hourly, daily and monthly regulations of SWD projects.

(4) The preservation of project integrity.

c. SWD and SWPA agree to consult on load and resource requirements.

d. SWD and SWPA agree to undertake improvements in their respective computer facilities.

4. Procedures.

a. Power Allocations and Monthly Meetings.

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

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

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

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

b. Operation.

(1) General.

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

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

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

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

(2) Flood Control Operations.

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

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

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

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

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

(3) Conservation Operation.

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

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

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

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

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

(4) Special Operations.

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

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

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

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

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

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

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

(iv) Would not infringe upon the vested property rights of third parties.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

TABLE 1
MINIMUM HYDROPOWER RELEASES
DURING FLOOD CONDITIONS

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

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

TABLE 2

WATER RELEASE REQUIREMENTS
FOR INTSTREAM FLOW NEEDS

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

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

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

TABLE 3

DESIRABLE
WATER RELEASE REQUIREMENTS
FOR INSTREAM FLOW NEEDS

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

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

TABLE 4

MAXIMUM DRAWDOWN
RATES IN CONSERVATION POOL

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

TABLE 5
RESPONSE TIME TO CHANGE IN GENERATION

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

Notes:

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

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

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

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

TABLE 6

WATER CONTROL MANUALS

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

TABLE 7

PROJECTS WITH PLANT EFFICIENCY CURVES

Beaver

Broken Bow

Bull Shoals (1)

Dardanelle

Denison

Eufaula

Fort Gibson

Greers Ferry

Keystone

Norfork (1)

Ozark

Sam Rayburn

Table Rock

Tenkiller Ferry (1)

Webbers Falls

Whitney

(1) Curves developed before units were rewound

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

UNITED STATES OF AMERICA
Department of Energy

By _____
Administrator
Southwestern Power Administration

Approved as to Legal
Form and Sufficiency

_____
Chief Counsel
Southwestern Power Administration

UNITED STATES OF AMERICA
Department of the Army

By _____
Division Commander
Southwestern Division
Corps of Engineers

Approved as to Legal
Form and Sufficiency

_____
Division Counsel
Southwestern Division
Corps of Engineers

EXHIBIT D

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

OPERATING PLAN

TABLE OF CONTENTS

ENCLOSURES

OPERATING PLAN

(Reservoir Regulation and Power Scheduling)

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

2. Activities. SWD and SWPA activities include:

2.1 Activities of SWD:

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

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

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

2.1.4 The preservation of project integrity.

2.2 Activities of SWPA:

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

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

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

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

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

3. Procedures.

3.1 Power Allocations and Monthly Meetings.

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

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

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

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

3.2 Operation.

3.2.1 General.

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

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

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

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

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

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

3.2.2 Flood Risk Management Operations.

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

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

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

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

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

3.2.3 Conservation Operation.

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

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

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

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

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

3.2.4 Special Operations

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

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

modification from previously agreed to schedules. These situations (short term emergencies) typica1ly involve overloaded facilities and/or low voltage and may arise slowly, as when due to high power demands, or suddenly, as when due to the loss of a line, station, or generator on the SWPA or a neighboring system. When possible, the response deemed necessary by the SWPA will be coordinated prior to scheduling with the appropriate SWD District Office. When the required response does not permit prior coordination, the power plant system controller will follow the direction of the SWPA dispatcher within limits specified in Table 5 and the safe operating limits of the generating, transforming and switching equipment, and the necessary coordination will begin as soon as practical. Table 5 lists the minimum time required for project to respond to a generation change under normal and emergency conditions.

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

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

(b) Would not conflict with the statutory requirements for the operation of said projects with regard to authorized purposes.

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

(d) Would not infringe upon the vested property rights of third parties.

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

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

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

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

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

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

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

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

TABLE 1

FIRM POWER RELEASES

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

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

TABLE 2

WATER RELEASE REQUIREMENTS FOR INSTREAM FLOW NEEDS

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

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

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

TABLE 3

DESIRABLE
WATER RELEASE REQUIREMENTS
FOR INSTREAM FLOW NEEDS

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

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

TABLE 4

MAXIMUM DRAWDOWN RATES IN CONSERVATION POOL

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

TABLE 5

RESPONSE TIME TO CHANGES IN GENERATION

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

Notes:

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

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

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

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

TABLE 6

WATER CONTROL MANUALS

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

FORM 1

Special Hydropower Operations Request
Southwestern Power Administration

Project: Date prepared:

Submitter
Name/District:
Phone: Cell Email:

Purpose:

Units affected/Proposed
Operation:

From: hours Month: Day:
To: hours Month: Day:

On-site contact
Person(s):
Agency/Organization:
Phone Number:
Cell Phone Number:

Comments:

Emailed to:

FORM 2

CORPS OF ENGINEERS (TULSA)

UNIT UNAVAILIBILITY REPORT

STATION:	
UNITS	TYPE OF OUTAGE:

GDFO: Generator Delayed Forced Outage. GFO: Generator Forced Outage. GSO: Generator Scheduled Outage.

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

RELAYS OPERATED:

BREAKERS TRIPPED:

ESTIMATED TIME TO RETURN TO SERVICE: HRS.

REPAIRS OR CORRECTIONS MADE

RESTORED	DATE	TIME:

TOTAL UNAVAILABLE TIME: HOURS MINUTES

POWER PLANT:

Name

Signature **Date**

Title

PLATES

TENKILLER FERRY LAKE

U.S. Representatives | U.S. Senators

KANSAS

1 Tim Huelskamp (R)
2 Lynn Jenkins (R)
4 Mike Pompeo (R)

Pat Roberts (R)
Jerry Moran (R)

OKLAHOMA

1 Jim Bridenstine (R)
2 Markwayne Mullin (R)
3 Frank Lucas (R)
4 Tom Cole (R)
5 James Lankford (R)

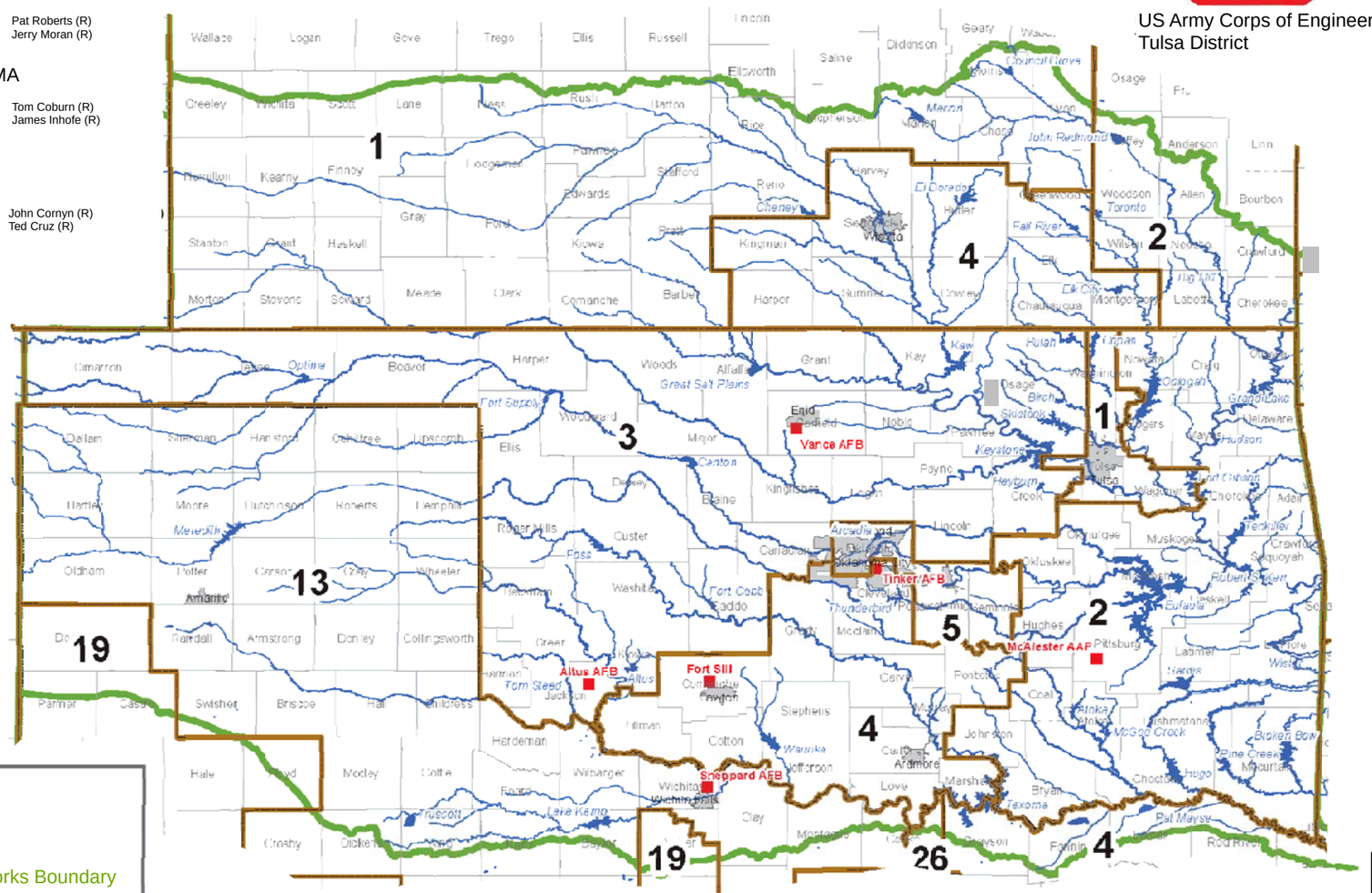
Tom Coburn (R)
James Inhofe (R)

TEXAS

4 Ralph Hall (R)
13 Mac Thornberry (R)
19 Randy Neugebauer (R)
26 Michael Burgess (R)

John Cornyn (R)
Ted Cruz (R)

US Army Corps of Engineers
Tulsa District



N

Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

TULSA DISTRICT PROJECTS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 1-1

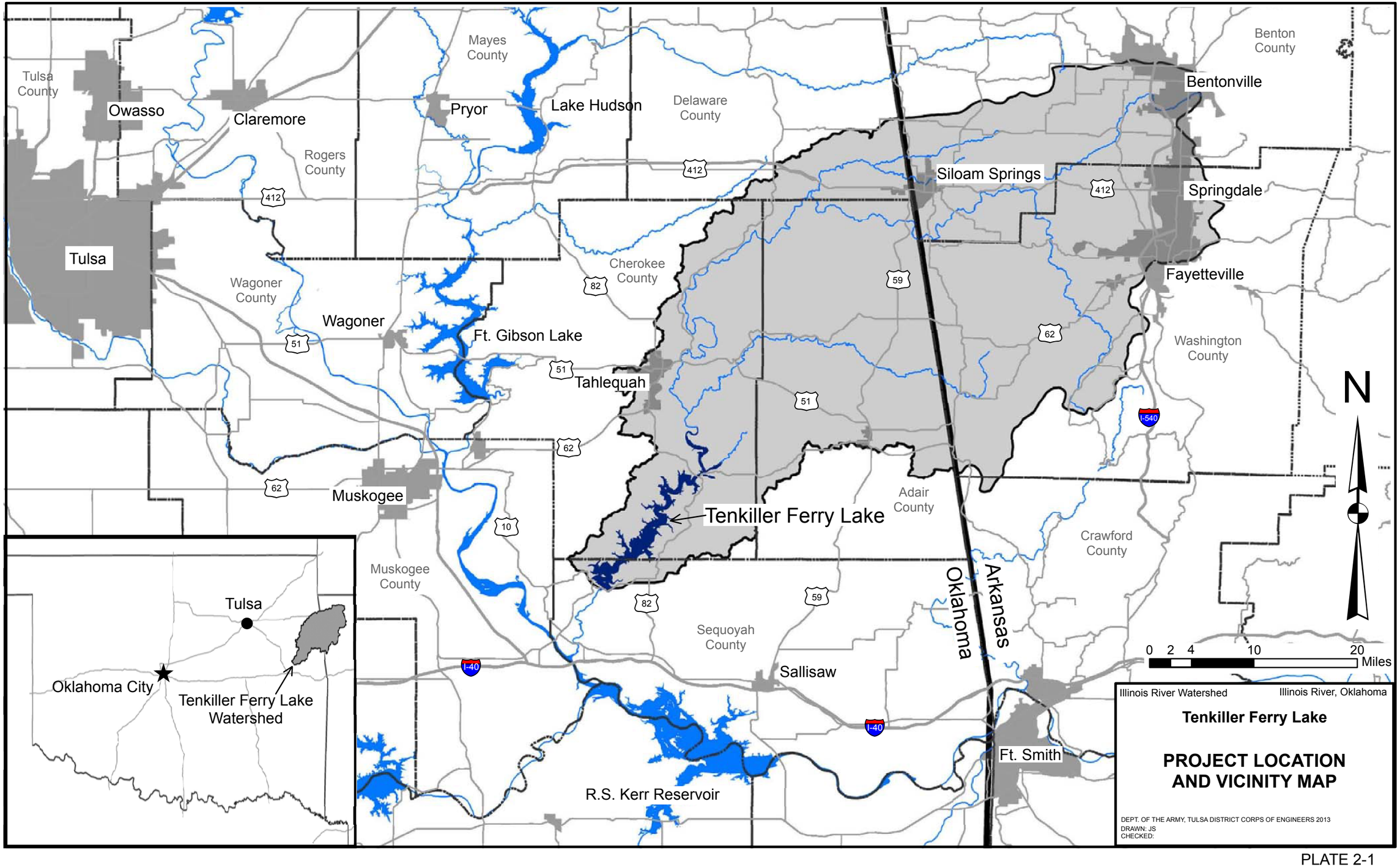

Tulsa County
Owasso
Claremore
Mayes County
Pryor
Lake Hudson
Delaware County
Benton County
Bentonville
Rogers County
412
Siloam Springs
Springdale
Tulsa
Wagoner County
Cherokee County
82
59
Fayetteville
Wagoner
Ft. Gibson Lake
51
62
Washington County
Tahlequah
N
I-540
Muskogee
Adair County
Tenkiller Ferry Lake
10
Crawford County
Muskogee County
Oklahoma
Arkansas
Sequoyah County
I-40
Sallisaw
0 2 4 10 20
Miles
Tulsa
Oklahoma City
Tenkiller Ferry Lake Watershed
R.S. Kerr Reservoir
Ft. Smith
Illinois River Watershed
Illinois River, Oklahoma
Tenkiller Ferry Lake
PROJECT LOCATION AND VICINITY MAP
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 2-1

(b) (7)(F)

(b) (7)(F)

Illinois River Watershed

Illinois River, Oklahoma

Tenkiller Ferry Lake

GENERAL PLAN AND SECTIONS EMBANKMENT, MAIN SPILLWAY AND PENSTOCK

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 2-2

(b) (7)(F)

(b) (7)(F)

Illinois River Watershed

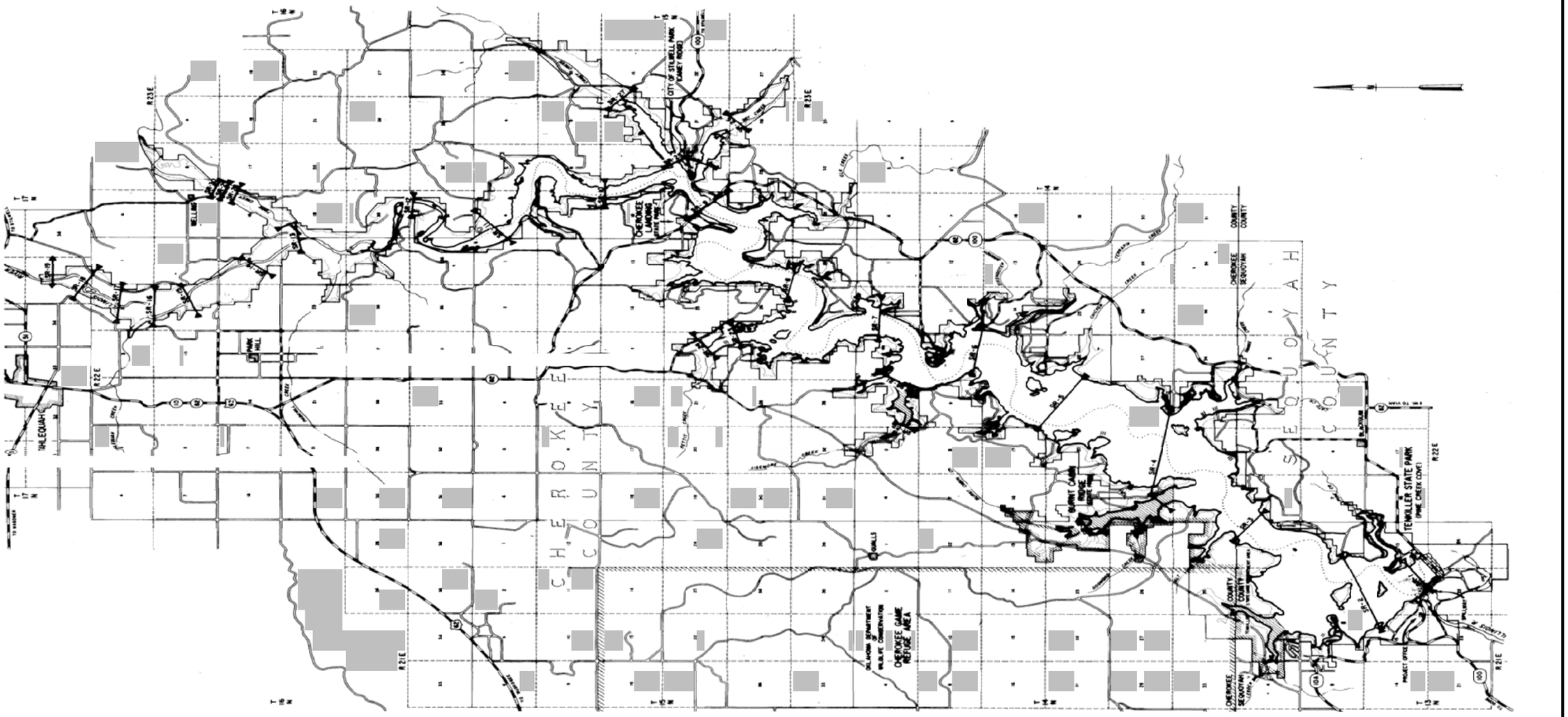
Illinois River, Oklahoma

Tenkiller Ferry Lake

GENERAL PLAN AND SECTIONS
AUXILIARY SPILLWAY

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 2-3



LEGEND

MAP SYMBOLS

- Paved Roads
- Gravel Roads
- Dirt Roads
- Area Not Cleared of Timber
- Brush Rows

El. 615-634 Flush Clearing Zone

PROJECT DATA

- Power Pool El. 632.0
- Flood Control Pool El. 667.0
- Project Boundary
- 12,984 Acres at Power Pool
- 20,231 Acres at Flood Comtrol Pool

Scale, Miles

0 1 2

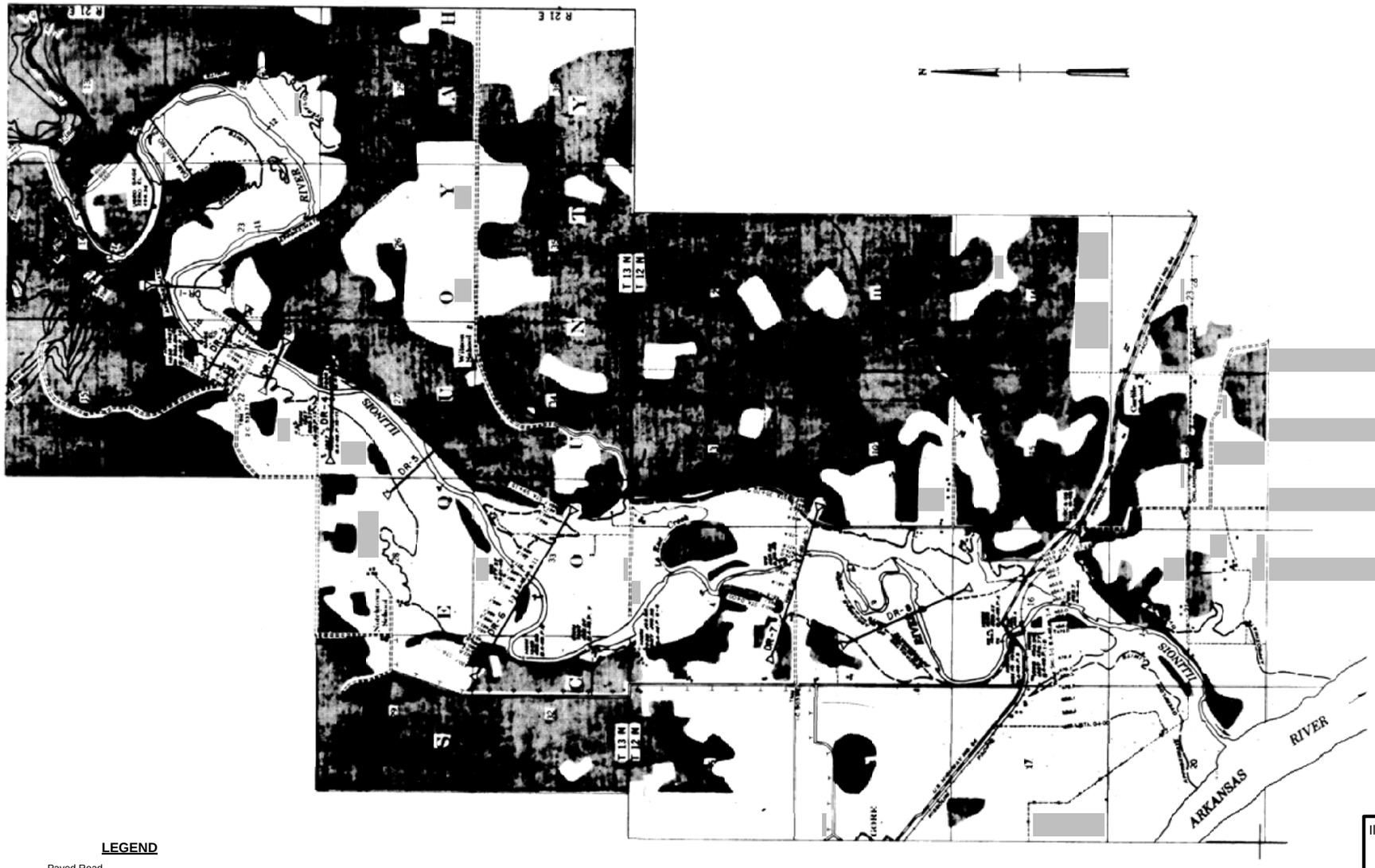
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

SEDIMENTATION RANGES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 2-4



LEGEND

- Paved Road
- Gravel Road
- Dirt Road
- Wooded Area
- Water Surface Elevation
- High Water Mark
- Approximate Overflow Limits

Illinois River Watershed — Illinois River, Oklahoma

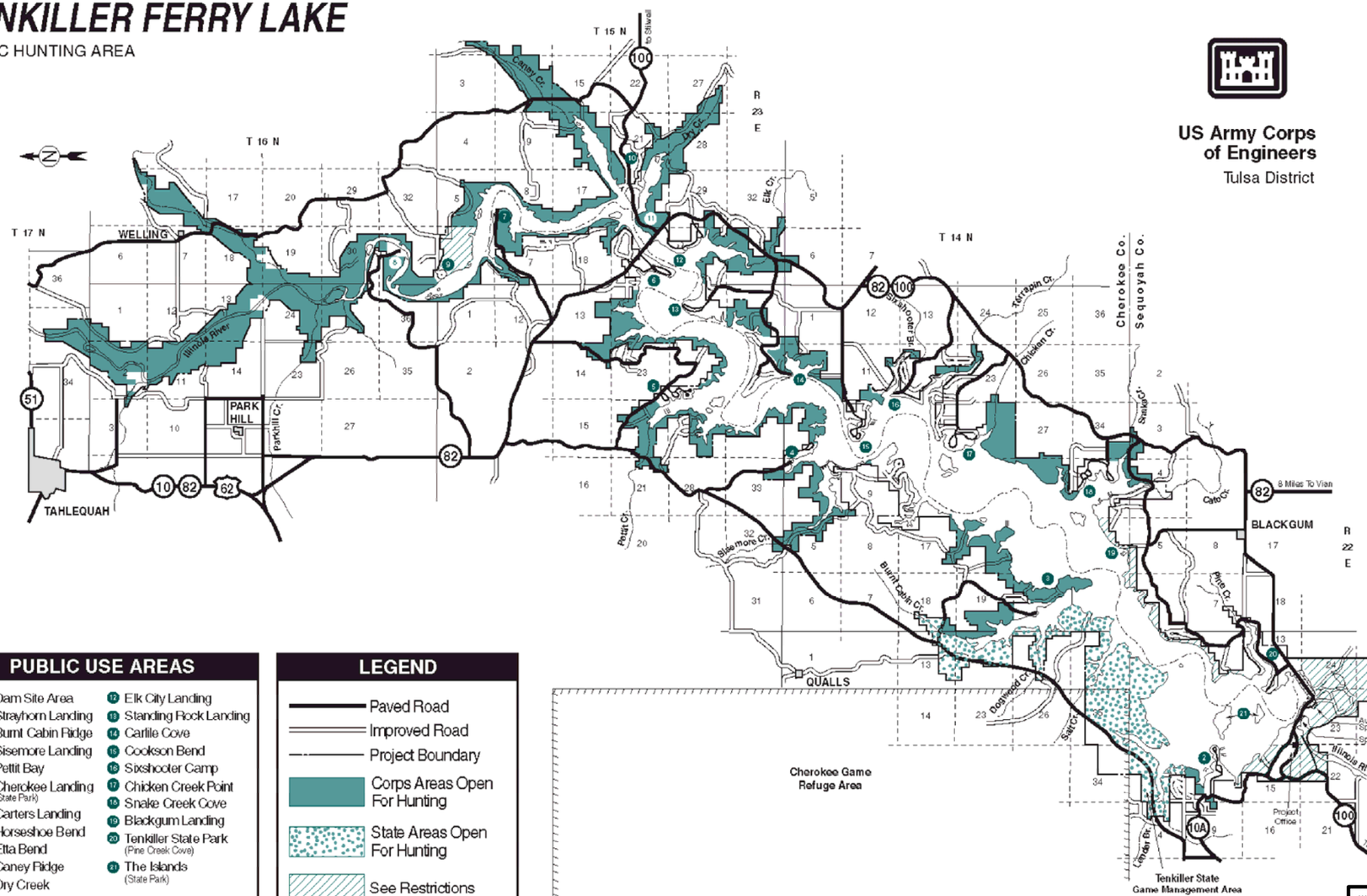
Tenkiller Ferry Lake

DEGRADATION RANGES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

TENKILLER FERRY LAKE

PUBLIC HUNTING AREA



US Army Corps of Engineers
Tulsa District

PUBLIC USE AREAS

1. Dam Site Area
2. Strayhorn Landing
3. Burnt Cabin Ridge
4. Sisemore Landing
5. Pettit Bay
6. Cherokee Landing (State Park)
7. Carters Landing
8. Horseshoe Bend
9. Etta Bend
10. Caney Ridge
11. Dry Creek
12. Elk City Landing
13. Standing Rock Landing
14. Carlile Cove
15. Cookson Bend
16. Sixshooter Camp
17. Chicken Creek Point
18. Snake Creek Cove
19. Blackgum Landing
20. Tenkiller State Park (Pine Creek Cove)
21. The Islands (State Park)

LEGEND

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

1 0 1 2
Scale of Miles

RESERVOIR DATA
Top of conservation pool El. 632.0
150 shoreline miles at El. 632.0
Total project land & water acreage 30634

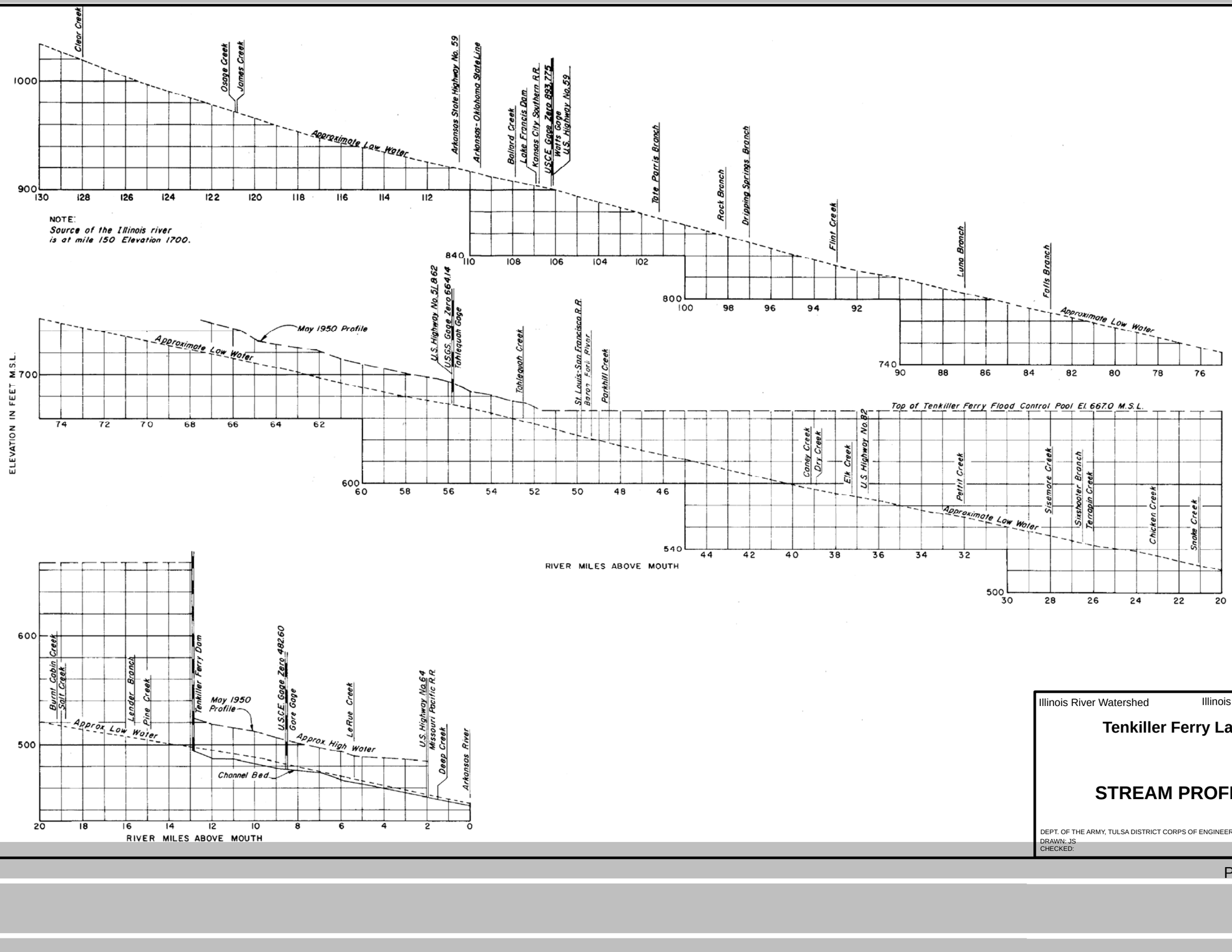
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

PUBLIC USE AREAS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 2-6



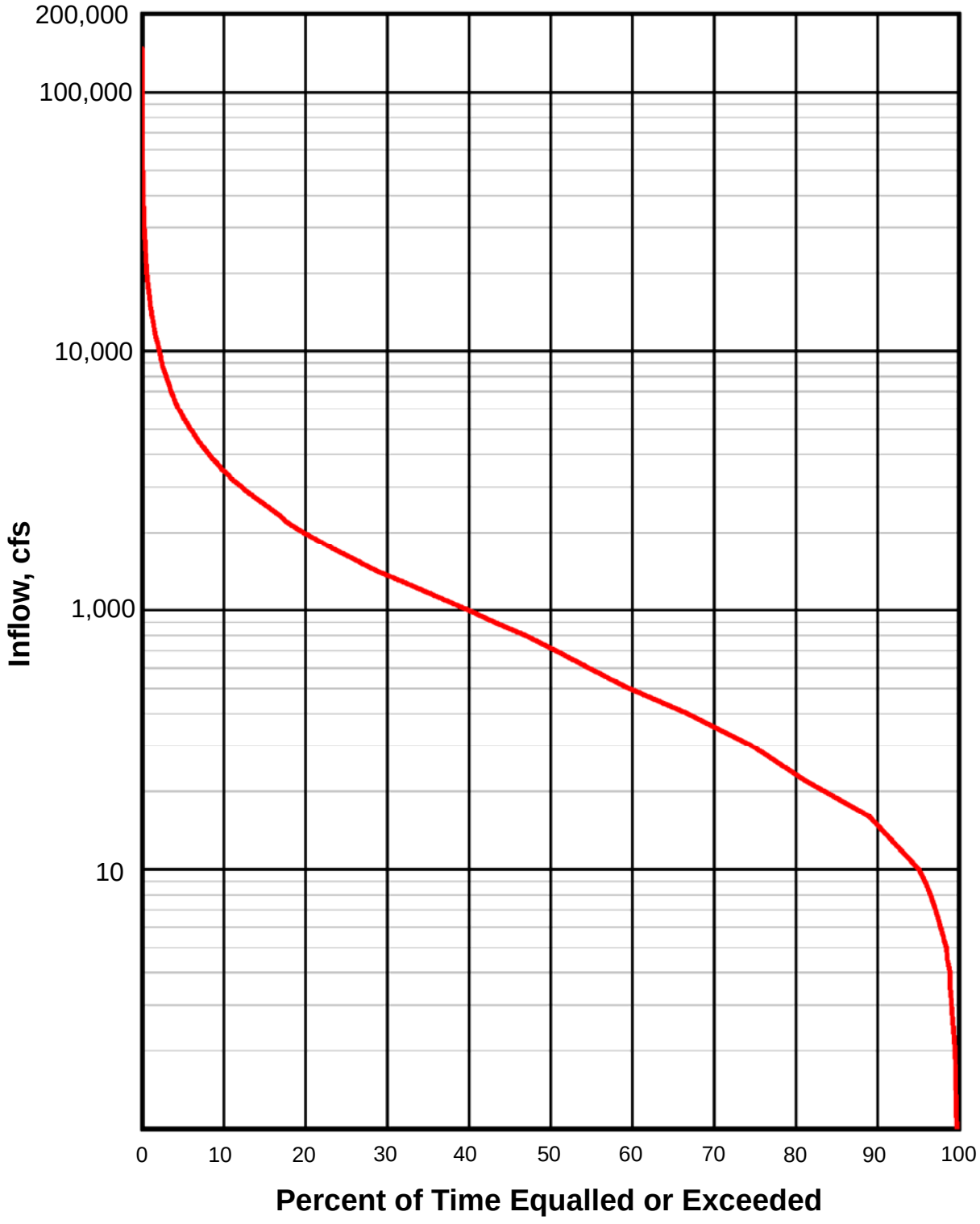
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

STREAM PROFILE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 4-1



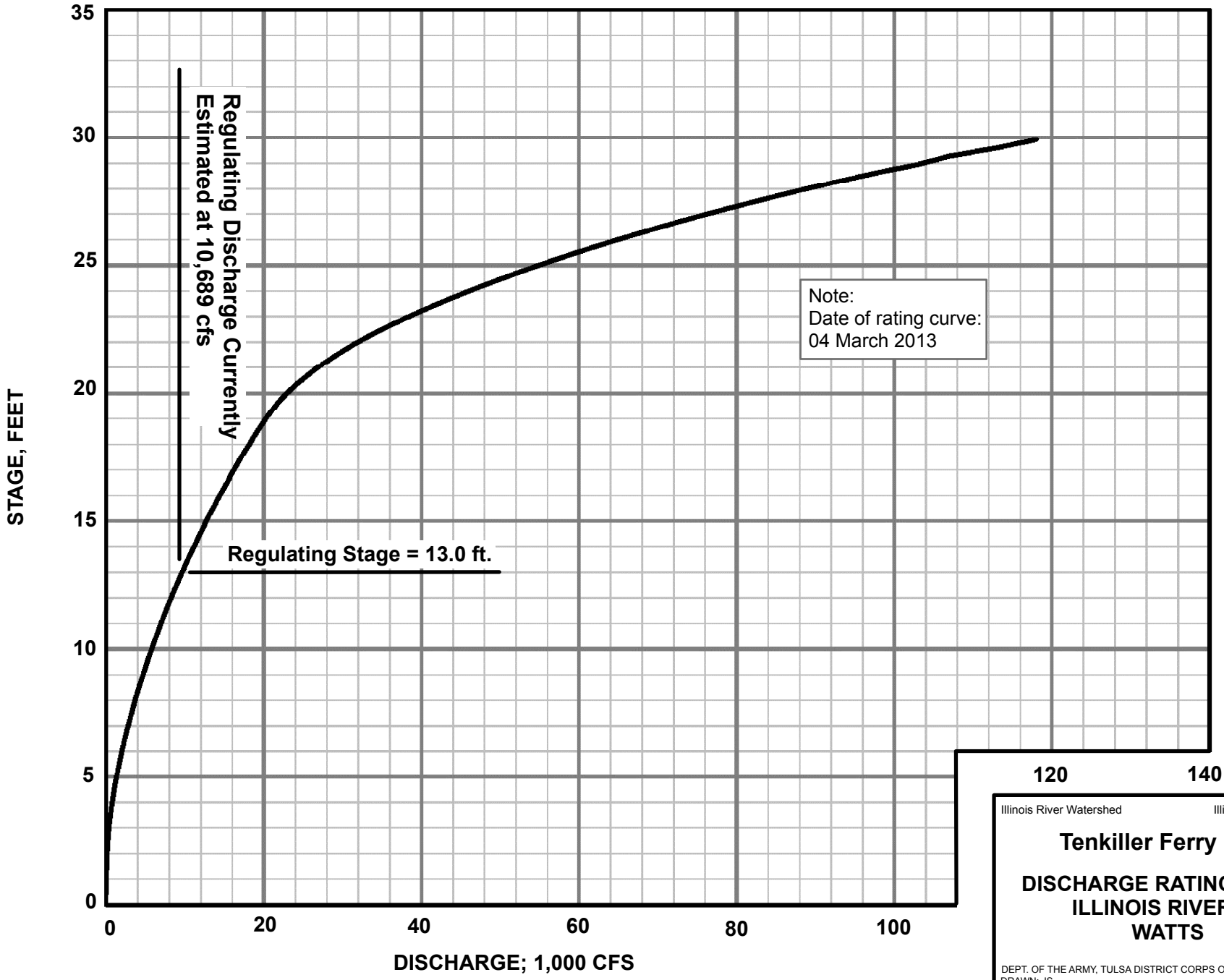
Note:
Period of Record
Jan 1940 through Dec 2008
RiverWare Model

Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

INFLOW DURATION CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:



Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

DISCHARGE RATING CURVE ILLINOIS RIVER AT WATTS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

Plate 4-3

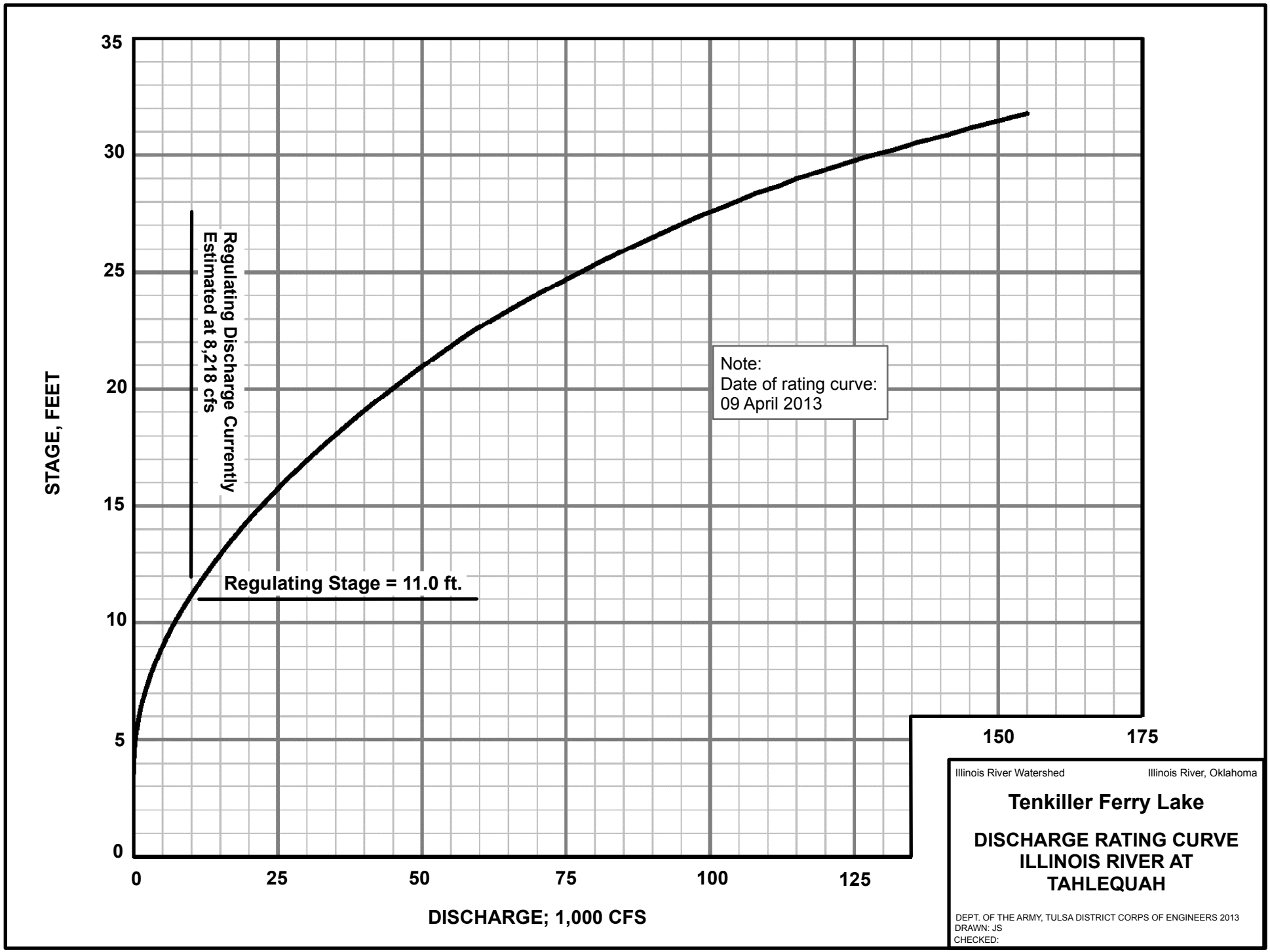
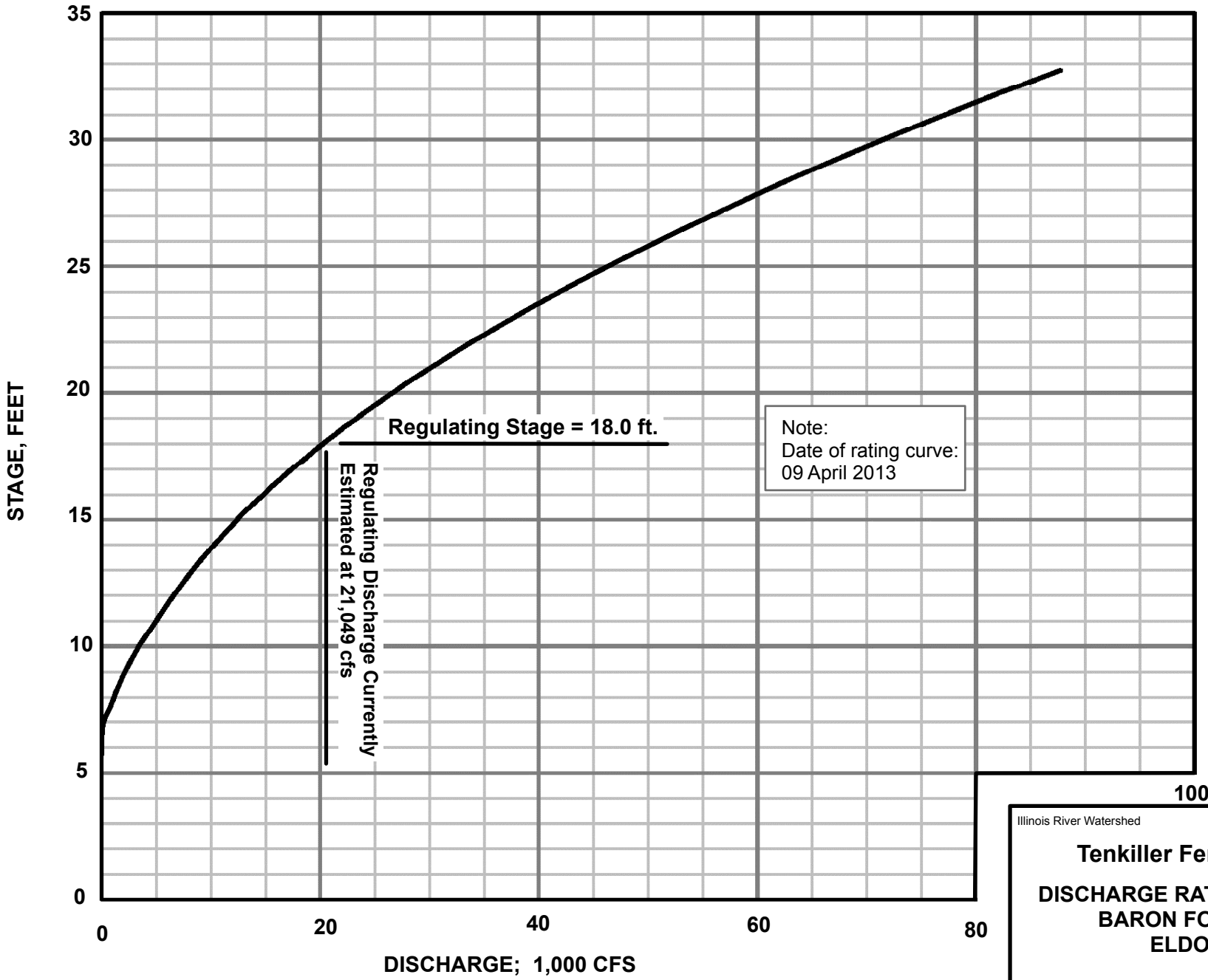

35
30
25
20
15
10
5
0
STAGE, FEET
Regulating Discharge Currently
Estimated at 8,218 cfs
Regulating Stage = 11.0 ft.
Note:
Date of rating curve:
09 April 2013
0
25
50
75
100
125
150
175
DISCHARGE; 1,000 CFS
Illinois River Watershed
Illinois River, Oklahoma
Tenkiller Ferry Lake
DISCHARGE RATING CURVE
ILLINOIS RIVER AT
TAHLEQUAH
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

Plate 4-4



Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

DISCHARGE RATING CURVE BARON FORK AT ELDON

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

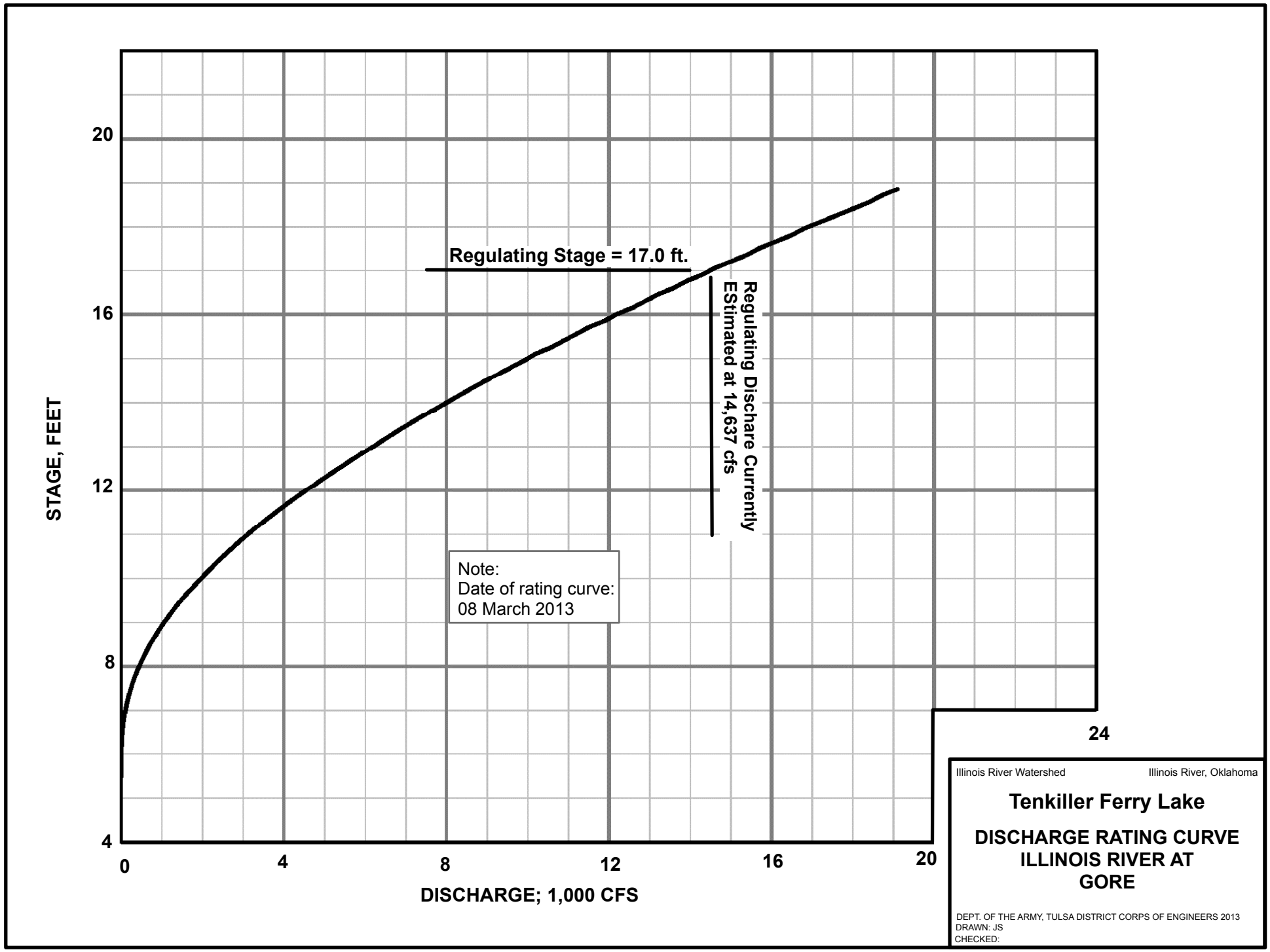

20
16
12
8
4
STAGE, FEET
Regulating Stage = 17.0 ft.
Regulating Dischare Currently
EStimated at 14,637 cfs
Note:
Date of rating curve:
08 March 2013
0
4
8
12
16
20
24
DISCHARGE; 1,000 CFS
Illinois River Watershed
Illinois River, Oklahoma
Tenkiller Ferry Lake
DISCHARGE RATING CURVE
ILLINOIS RIVER AT
GORE
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

Plate 4-6

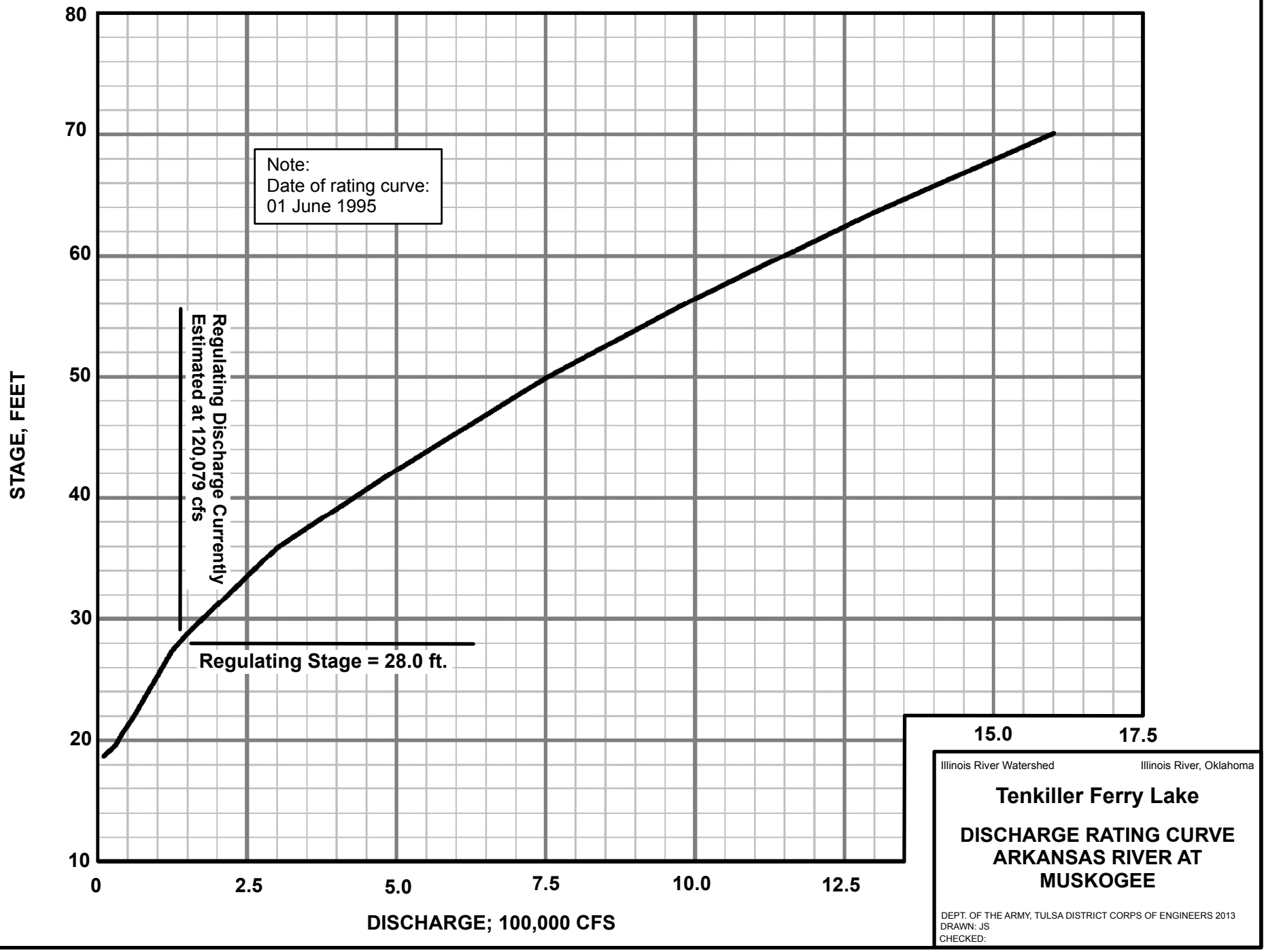

80
70
60
50
40
30
20
10
STAGE, FEET
Note:
Date of rating curve:
01 June 1995
Regulating Discharge Currently
Estimated at 120,079 cfs
Regulating Stage = 28.0 ft.
0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
DISCHARGE; 100,000 CFS
Illinois River Watershed
Illinois River, Oklahoma
Tenkiller Ferry Lake
DISCHARGE RATING CURVE
ARKANSAS RIVER AT
MUSKOGEE
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

Plate 4-7

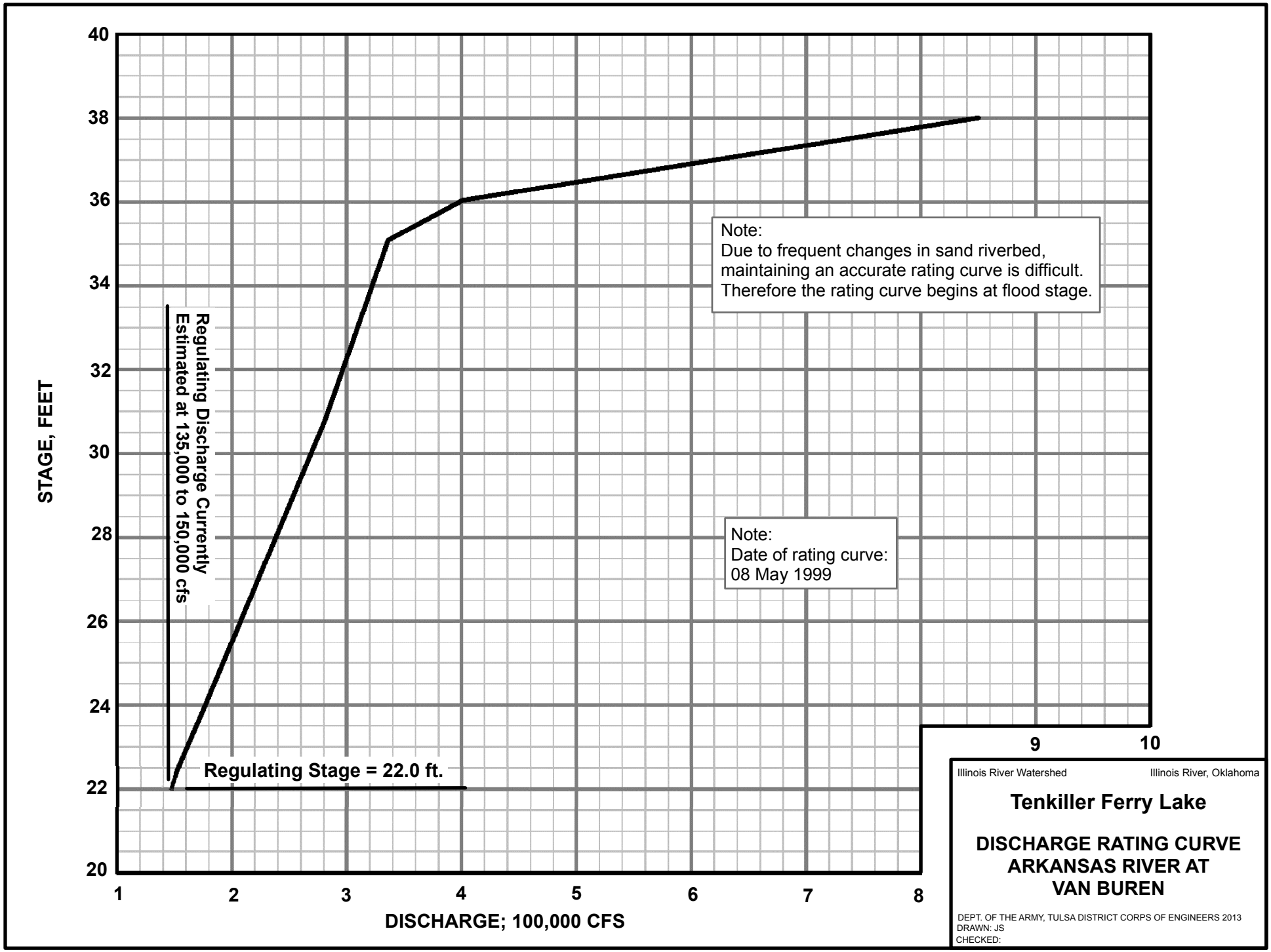
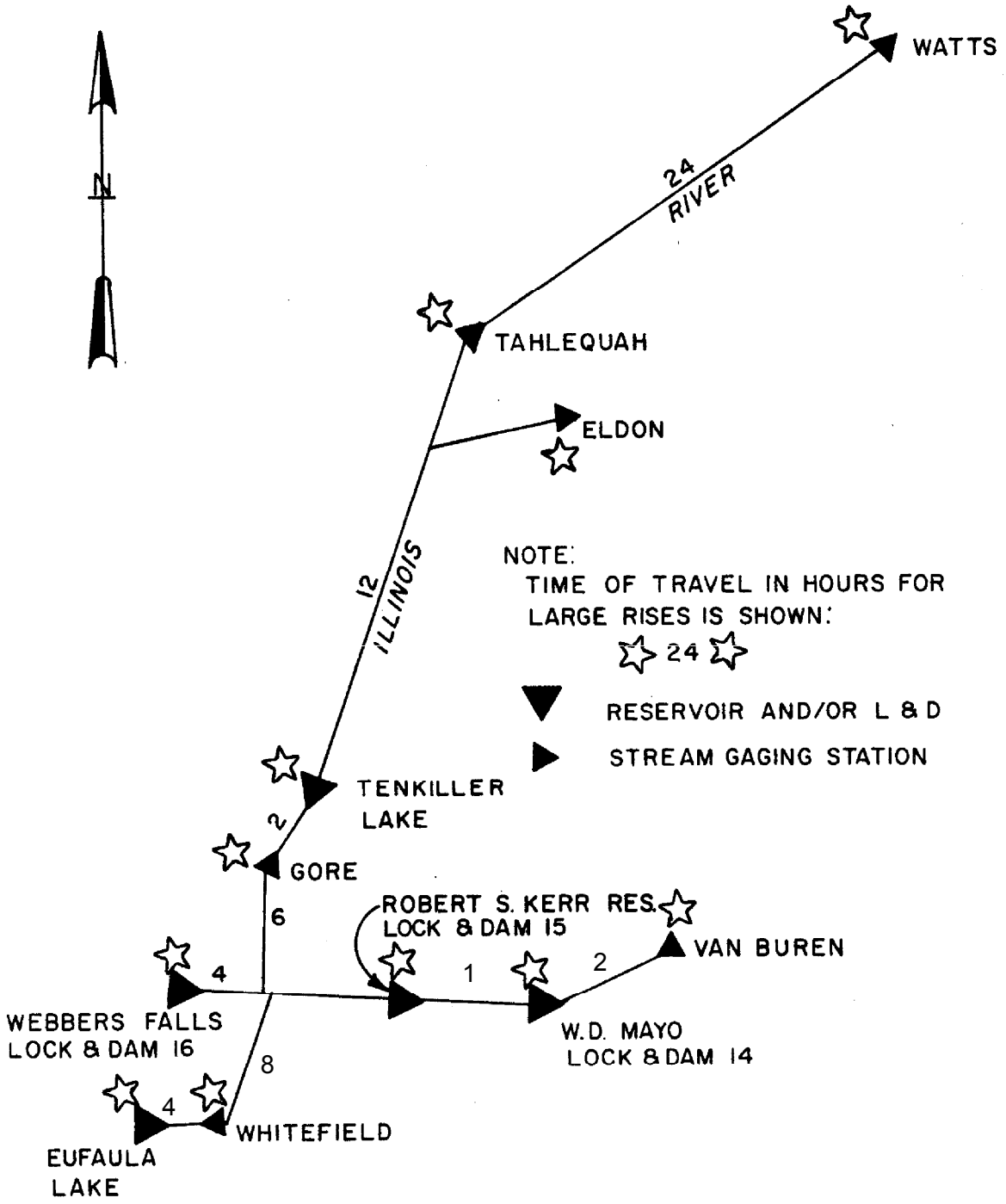

40
38
36
34
32
30
28
26
24
22
20
STAGE, FEET
1
2
3
4
5
6
7
8
9
10
DISCHARGE; 100,000 CFS
Regulating Discharge Currently
Estimated at 135,000 to 150,000 cfs
Regulating Stage = 22.0 ft.
Note:
Due to frequent changes in sand riverbed, maintaining an accurate rating curve is difficult. Therefore the rating curve begins at flood stage.
Note:
Date of rating curve:
08 May 1999
Illinois River Watershed
Illinois River, Oklahoma
Tenkiller Ferry Lake
DISCHARGE RATING CURVE
ARKANSAS RIVER AT
VAN BUREN
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

Plate 4-8

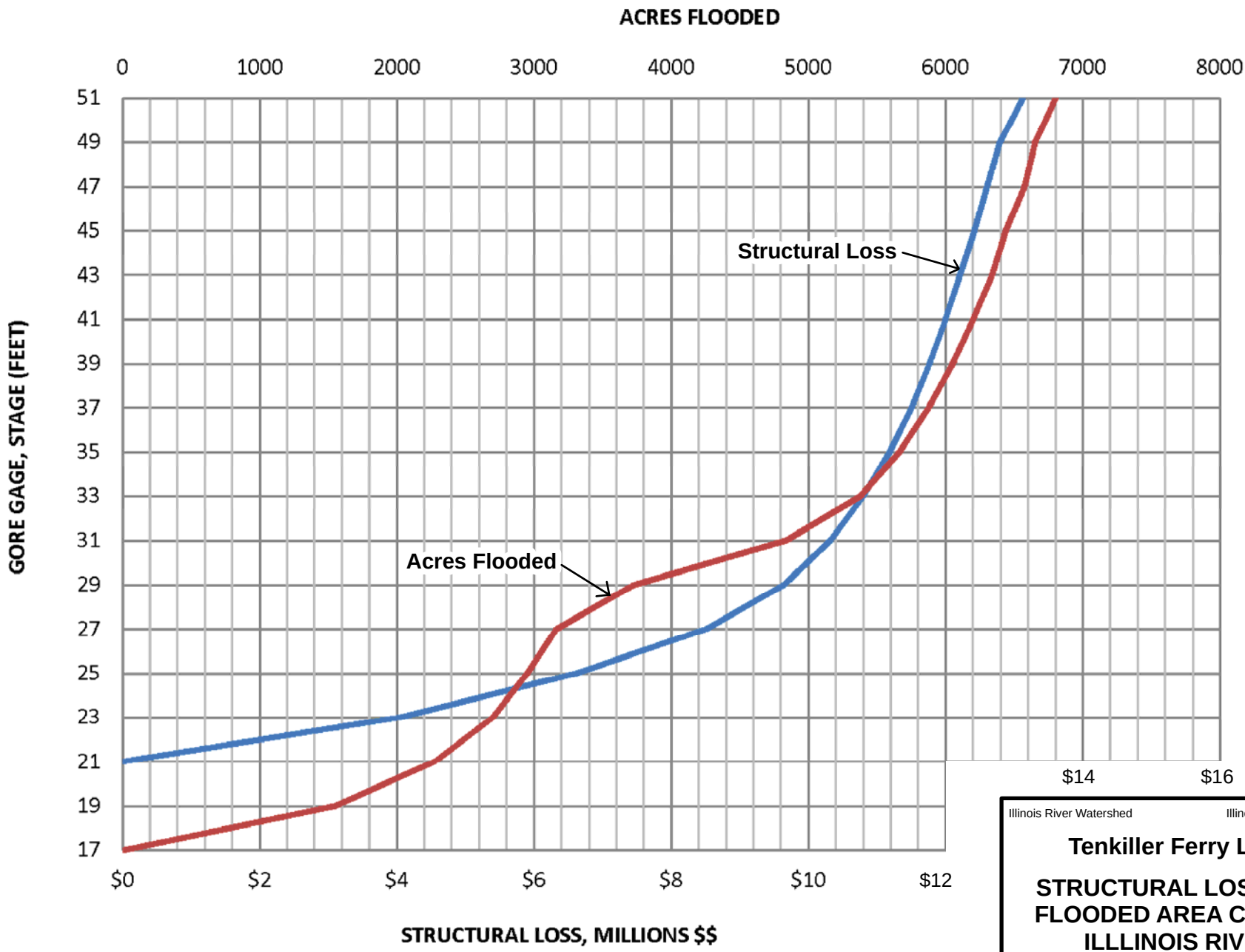


Illinois River Watershed | Illinois River, Oklahoma

Tenkiller Ferry Lake

TIME OF CREST TRAVEL

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:



December 2011 $'s

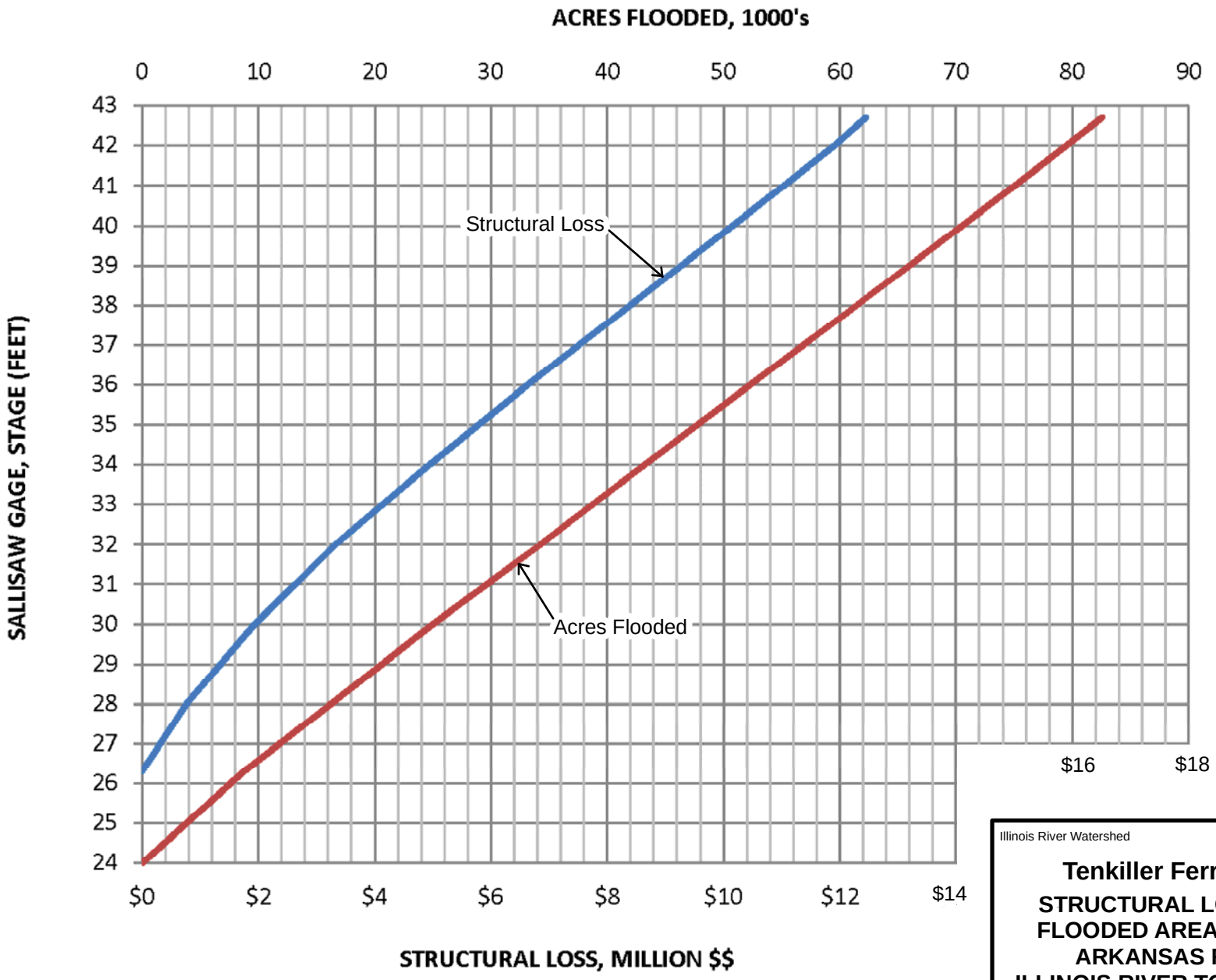
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

STRUCTURAL LOSS AND FLOODED AREA CURVES ILLLINOIS RIVER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 4-10



December 2011 $'s

Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

STRUCTURAL LOSS AND FLOODED AREA CURVES
ARKANSAS RIVER
ILLINOIS RIVER TO FT. SMITH

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 4-11

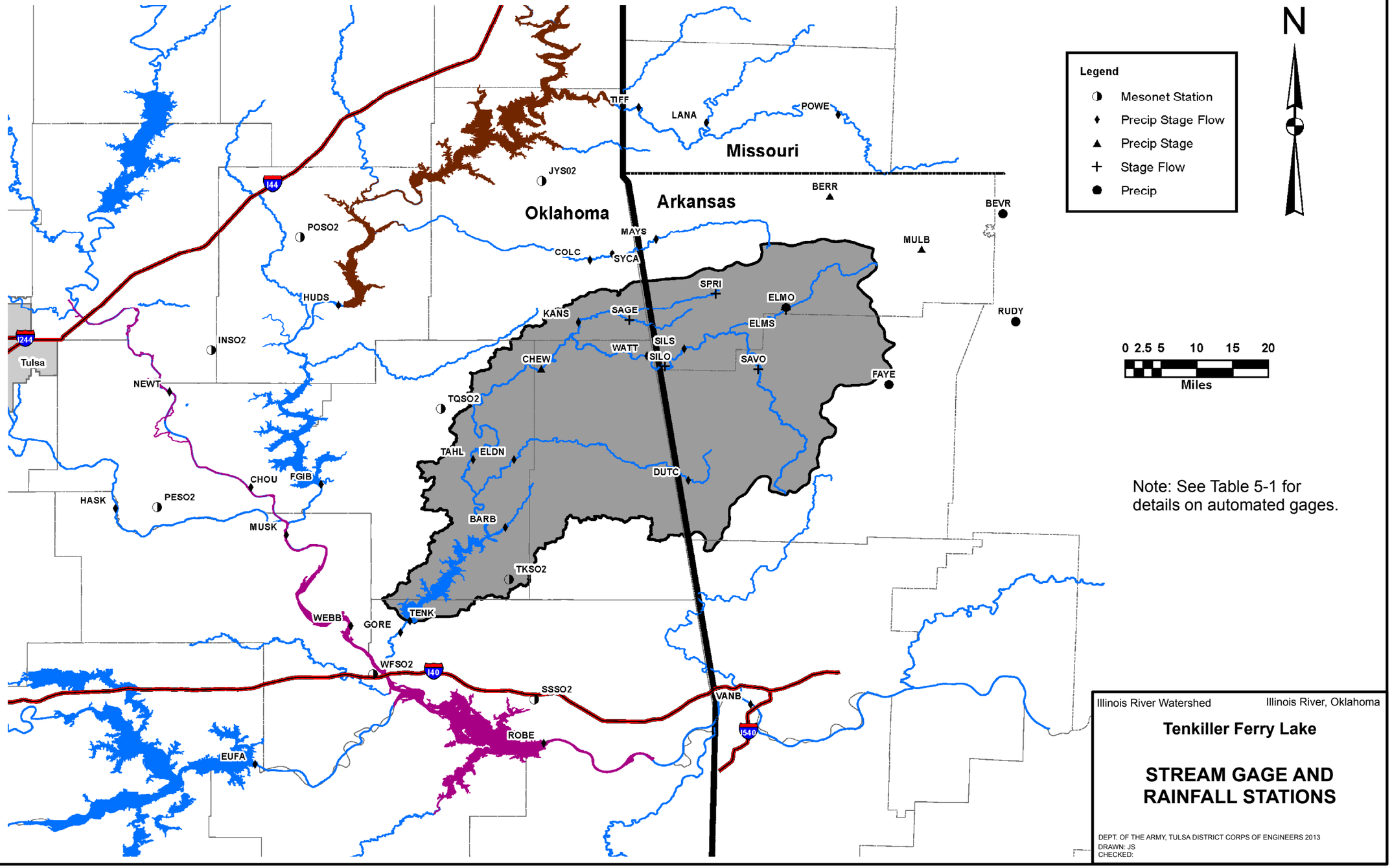
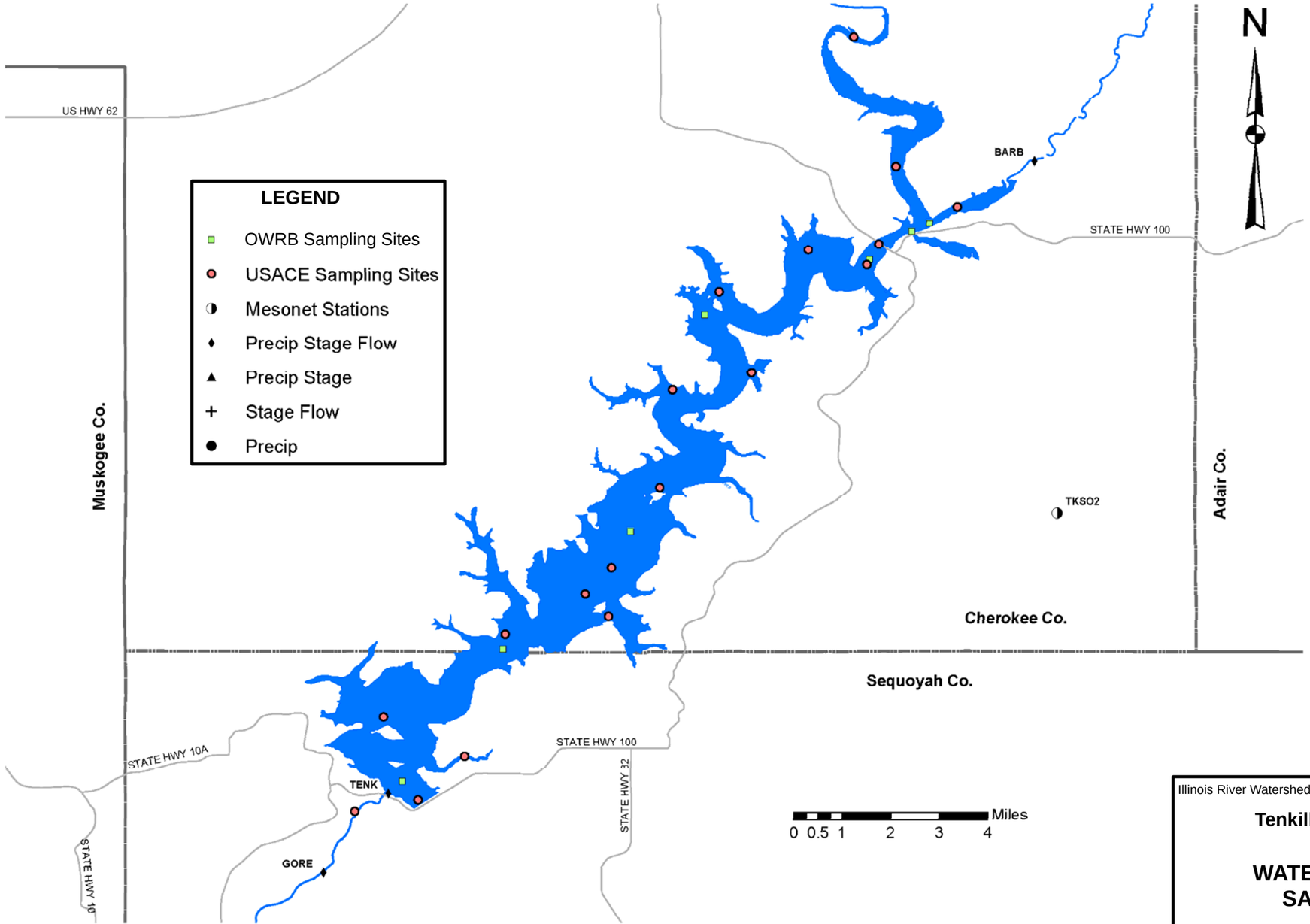

Legend
Mesonet Station
Precip Stage Flow
Precip Stage
Stage Flow
Precip
N
0 2.5 5 10 15 20
Miles
Missouri
Arkansas
Oklahoma
TIFF
LANA
POWE
JYS02
BERR
BEVR
MULB
MAYS
COLC
SYCA
POSO2
HUDS
SPRI
ELMO
KANS
SAGE
ELMS
RUDY
INSO2
SILS
WATT
SILO
SAVO
CHEW
FAYE
Tulsa
I244
NEWT
TQSO2
TAHL
ELDN
DUTC
CHOU
FGIB
HASK
PESO2
MUSK
BARB
TKSO2
WEBB
GORE
TENK
WFSO2
I40
SSSO2
VANB
I540
ROBE
EUFA
Note: See Table 5-1 for details on automated gages.
Illinois River Watershed
Illinois River, Oklahoma
Tenkiller Ferry Lake
STREAM GAGE AND RAINFALL STATIONS
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 5-1



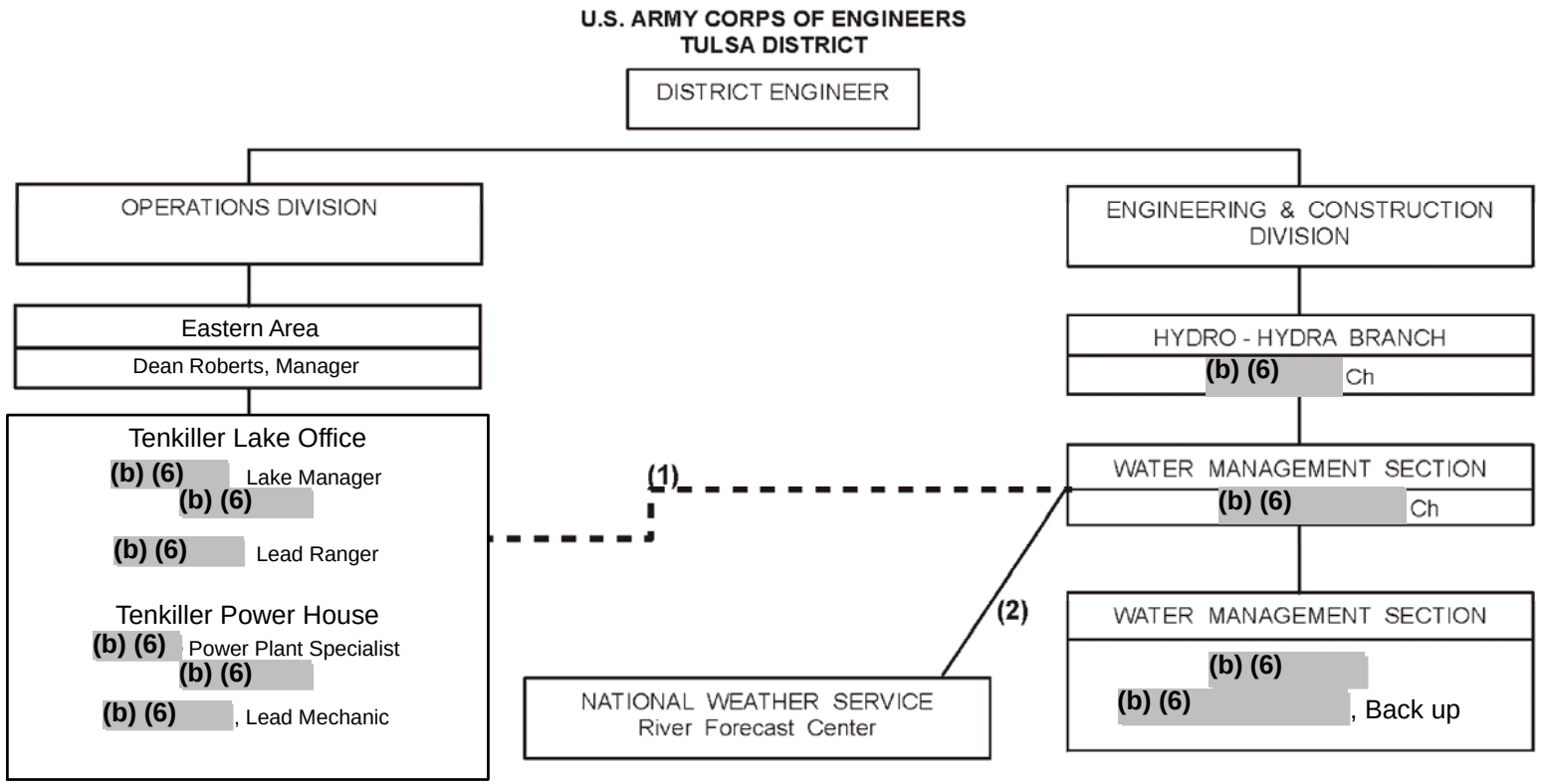
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

WATER QUALITY SATATIONS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 5-2



1. Direct communications are maintained between Tenkiller Ferry Project Offices 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.

Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

ORGANIZATION FOR FLOOD CONTROL REGULATION

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

TENKILLER LAKE DATA

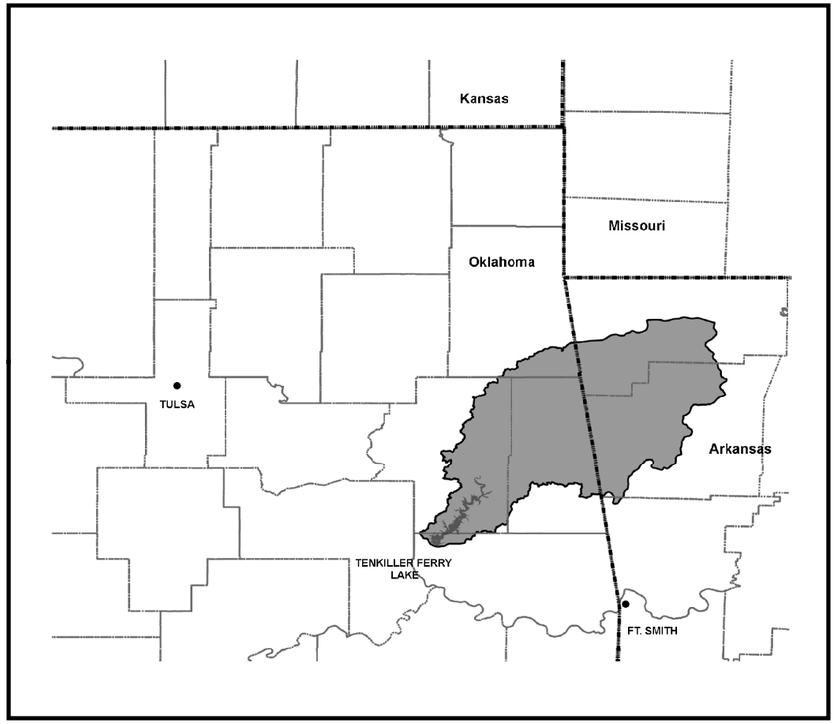
DATE		05/24/11		DAY	Tuesday		DATA ENTRY		(NEXT DAY - 0800)		
READINGS DATE:		05/23/11			Monday				0800 INSTANTANEOUS		
									0800	LAKE	0800
ITEM	TIME		TIME	TURBINE	SPILL	TOTAL DISCHARGE	HOUR	MWH	MWH	ELEVATION	ELEVATION
Pool Elevation	1200	637.19	0100	3,790	9,347	13,137	0100	42		637.86	
Pool Elevation	1600	636.99	0200	3,964	9,344	13,308	0200	44		637.77	
Pool Elevation	2400	637.60	0300	3,790	9,343	13,133	0300	42		637.73	
Pool Elevation	0800	638.46	0400	3,790	9,341	13,131	0400	42		637.67	
Tailwater Elevation	0800	490.99	0500	3,877	9,338	13,215	0500	43		637.61	
Net Gen	2400	1,017	0600	3,877	9,336	13,213	0600	43		637.55	
Hours Gen Today	2400	45:52	0700	3,790	9,335	13,125	0700	42		637.50	
24 Hr Power Discharge	2400	3,831	0800	3,790	9,333	13,123	0800	42		637.45	638.46
24 Hr Spill	2400	8,640	0900	3,877	9,331	13,208	0900	43		637.38	
24 Hr Total Discharge	2400	12,471	1000	3,877	9,329	13,206	1000	43		637.33	
Instantaneous Power Discharge	0800	3,892	1100	3,790	9,327	13,117	1100	42		637.26	
Instantaneous Spill	0800	5,095	1200	3,790	9,324	13,114	1200	42		637.19	
Instantaneous Total Discharge	0800	8,987	1300	3,790	9,322	13,112	1300	42		637.14	
Computed Inflow		10,595	1400	3,964	9,320	13,284	1400	44		637.07	
Total Precipitation			1500	3,790	9,320	13,110	1500	42		637.08	
0800 Gate Settings		1 slu. @ 8.0'	1600	3,790	7,483	11,273	1600	42		636.99	
GATE OPERATIONS			1700	3,790	7,482	11,272	1700	42		636.96	
Time	5/24/2011 6:00		1800	3,877	7,480	11,357	1800	43		636.89	
Pool Elevation	638.46		1900	3,877	7,479	11,356	1900	43		636.85	
From Gate Setting		1 slu. @ 12.4'	2000	3,790	7,477	11,267	2000	42		636.77	
To Gate Setting		1 slu. @ 8.0'	2100	3,756	7,487	11,243	2100	42		637.15	
GATE OPERATIONS			2200	3,930	7,490	11,420	2200	44		637.24	
Time			2300	3,790	7,494	11,284	2300	42		637.38	
Pool Elevation			2400	3,790	7,500	11,290	2400	42		637.60	
From Gate Setting											
To Gate Setting							Gross Gen	1,020			
GATE OPERATIONS											
Time											
Pool Elevation											
From Gate Setting											
To Gate Setting											

Illinois River Watershed — Illinois River, Oklahoma

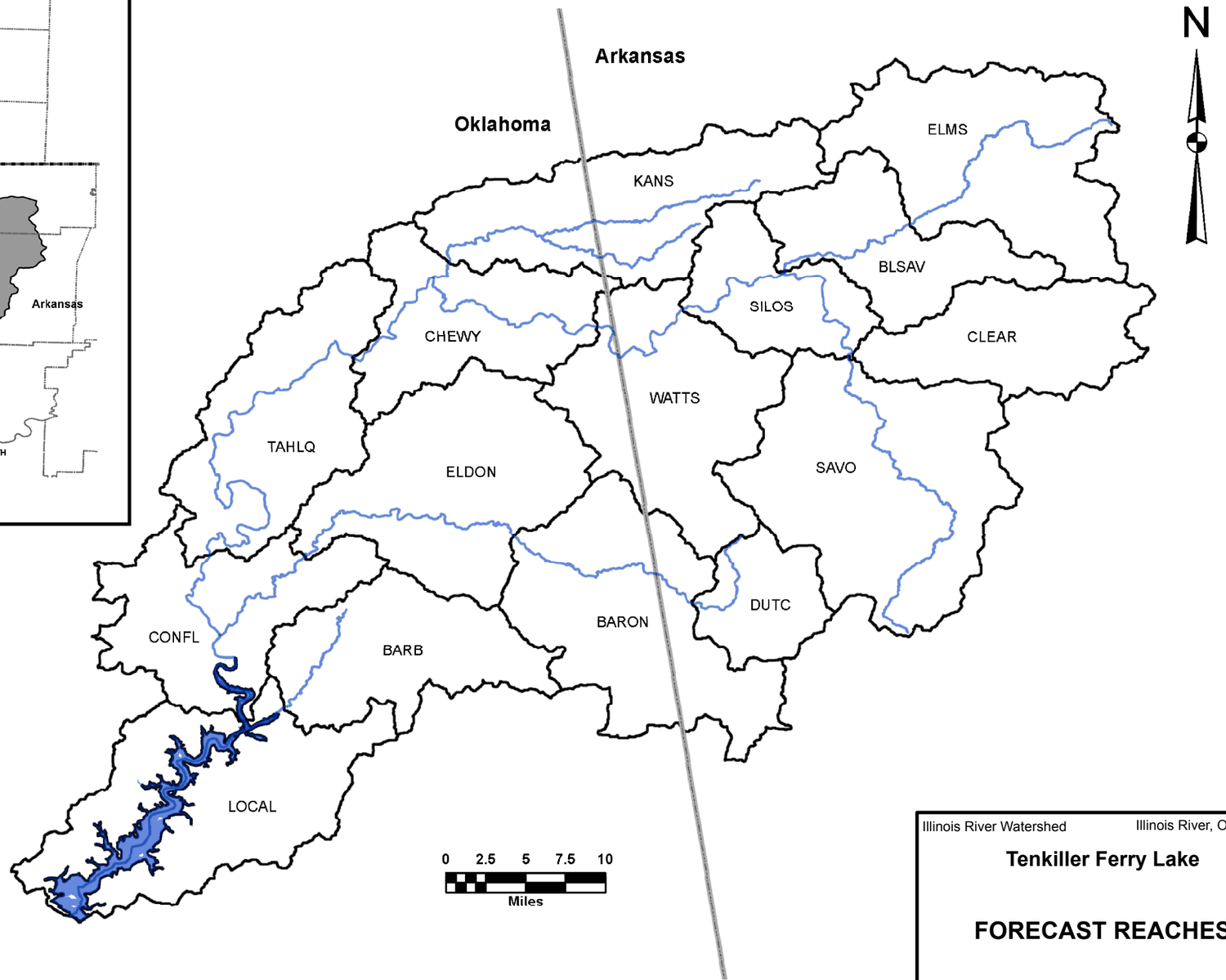
Tenkiller Ferry Lake

LAKE DATA

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:



Vicinity Map



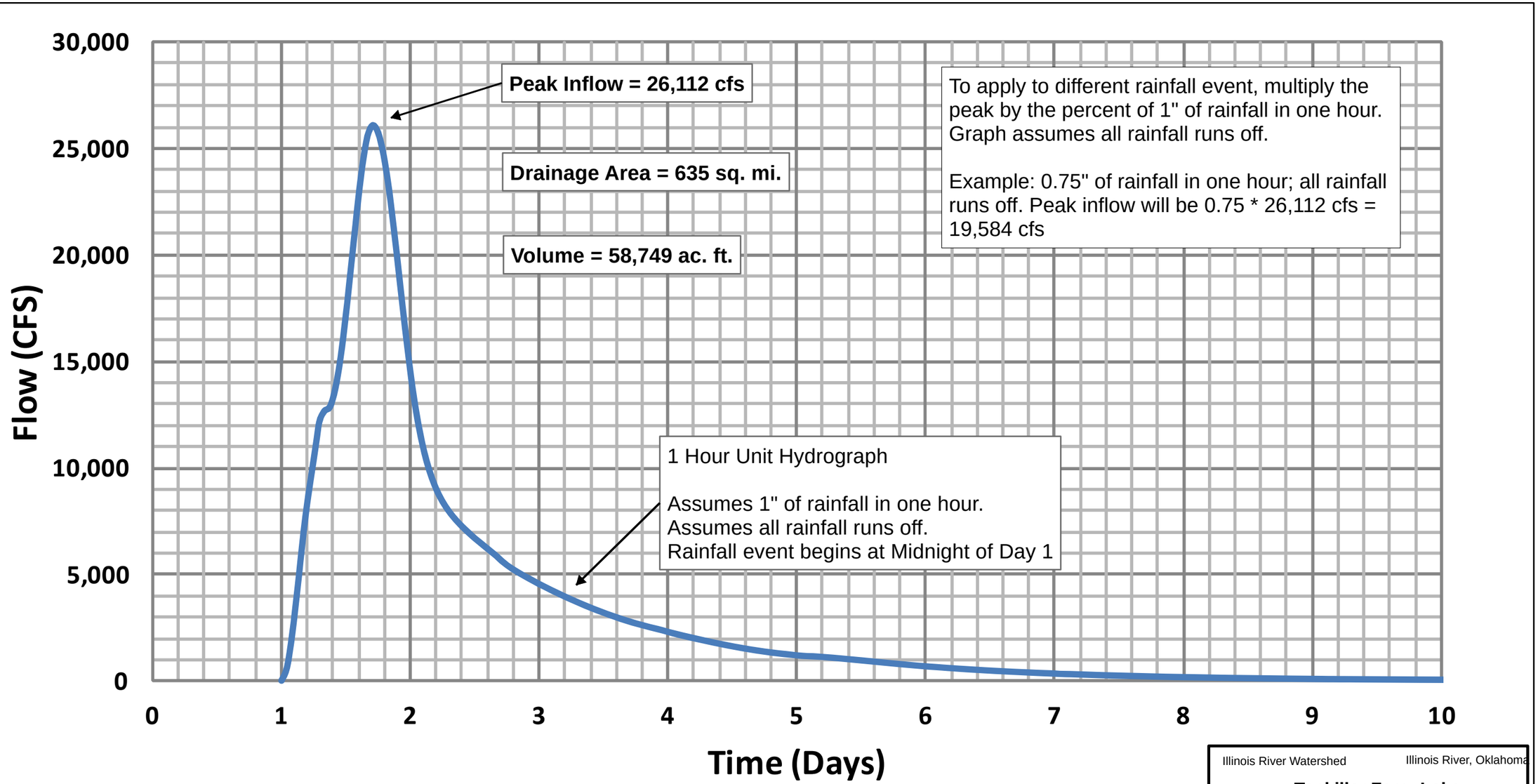
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

FORECAST REACHES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 6-1



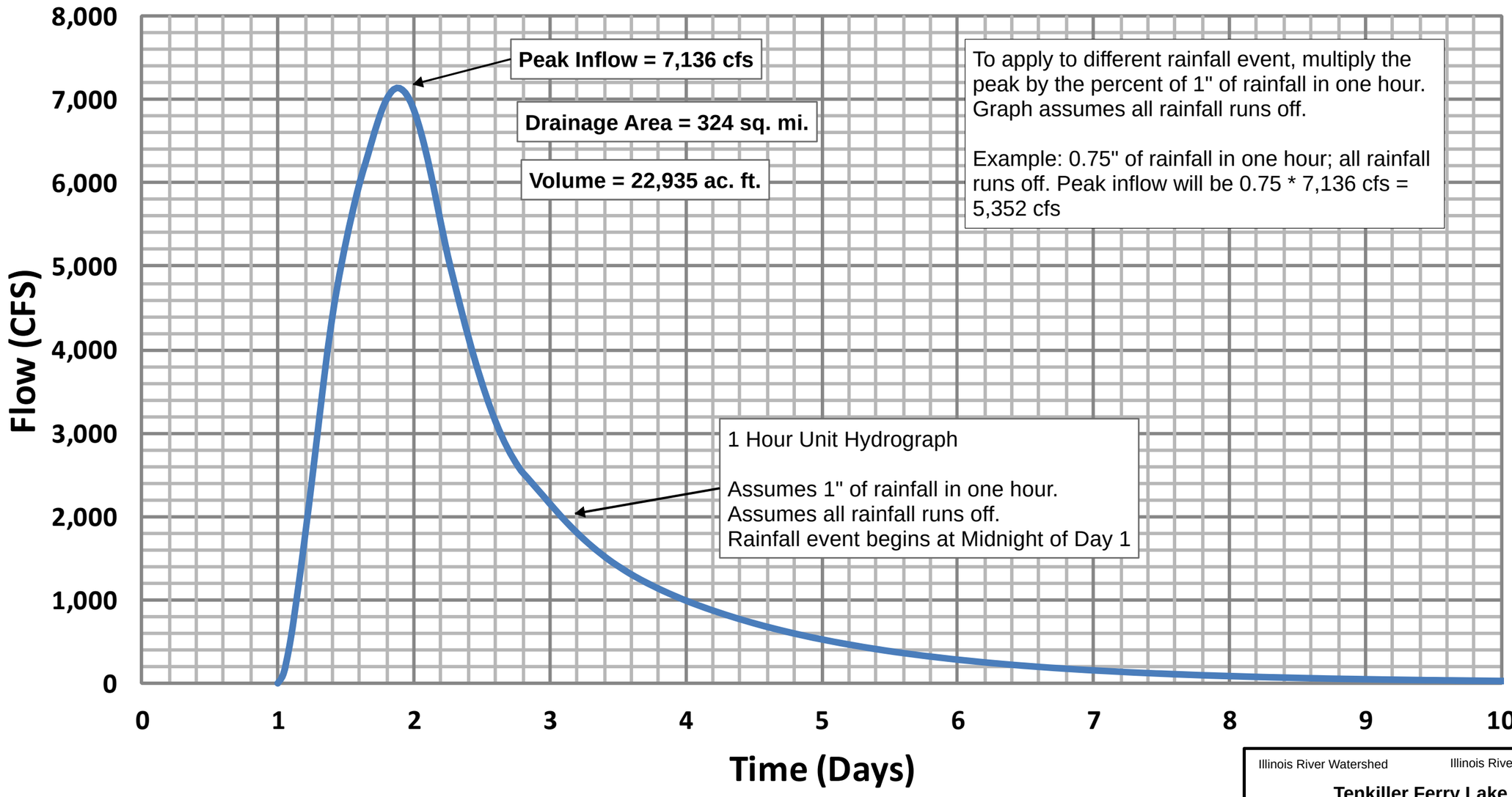
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

Unit Hydrograph - Upstream of Watts Gage

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 6-2



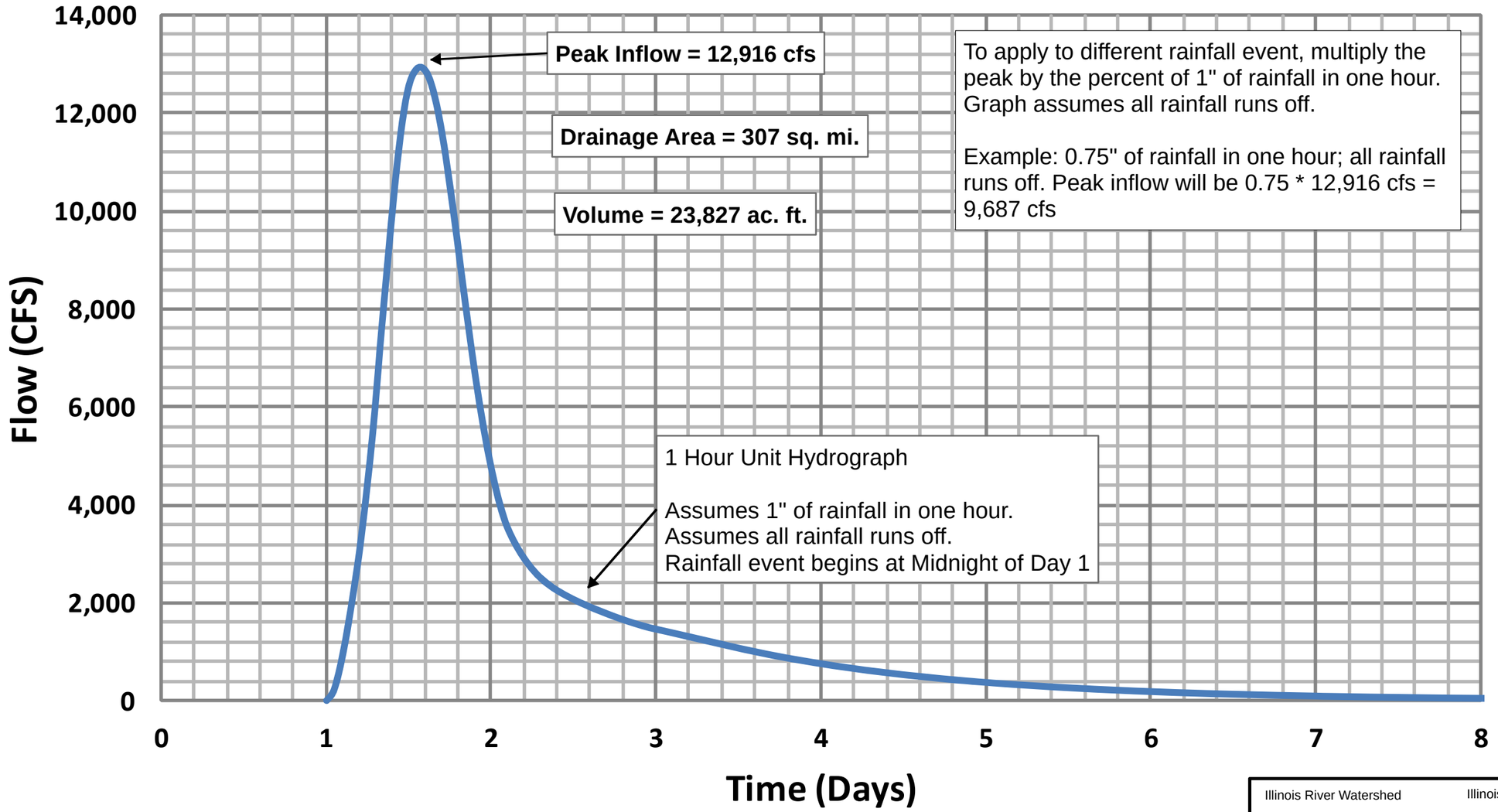
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

Unit Hydrograph - Watts to Tahlequah Gage

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 6-3



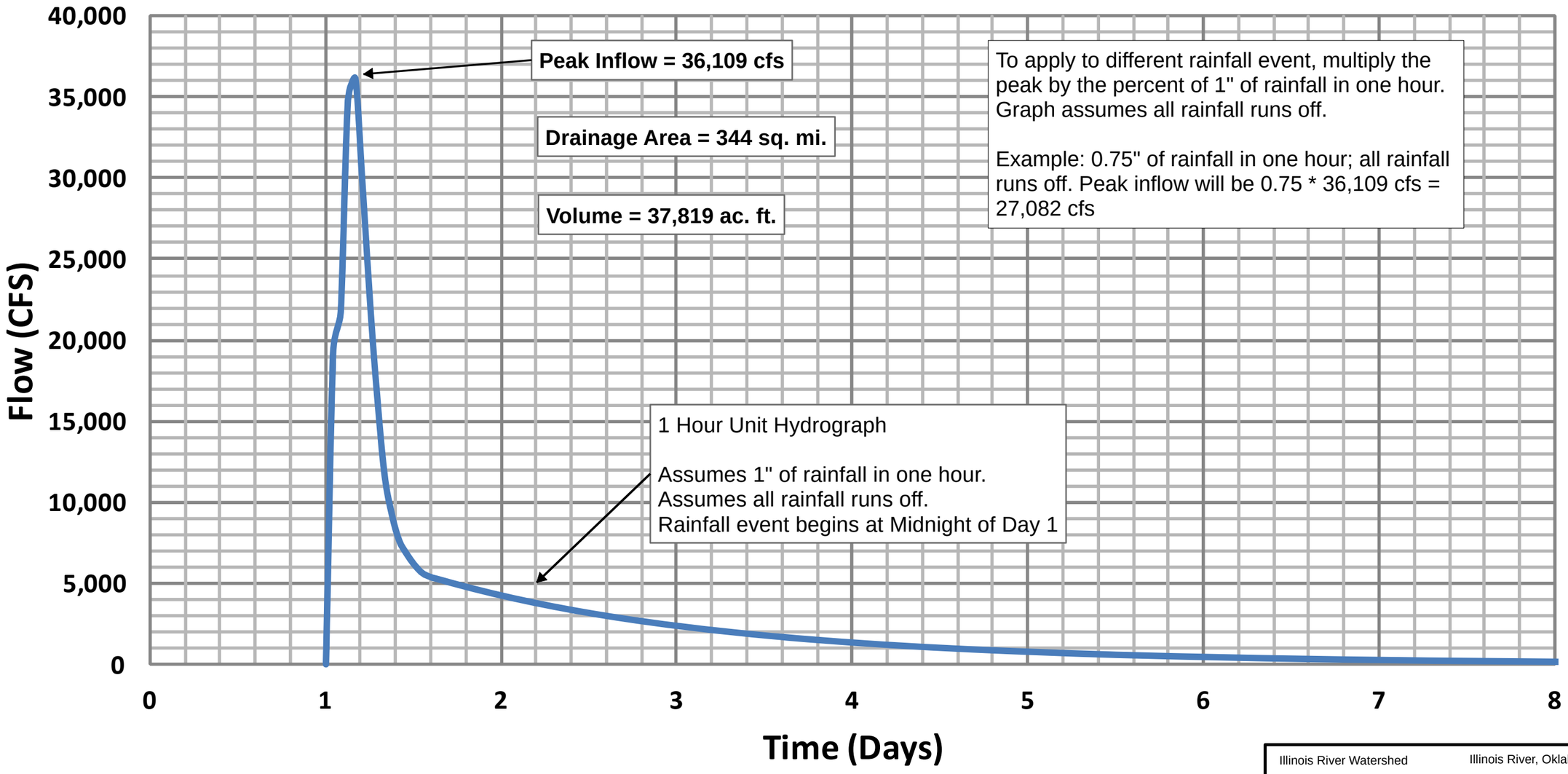
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

Unit Hydrograph - Upstream of Eldon Gage

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 6-4



Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

Unit Hydrograph - Tenkiller Dam to Tahlequah and Eldon Gages

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 6-5

INFLOW COMPUTATION SHEET

Project: | Computed By: | Date: | Checked By: | Date:

Date	Time	Pool Elevation	Storage, ac-ft.	2-Hr Change in Storage, ac-ft.	2-Hr Average Storage, cfs	Gate Info No., Type & Opening	Releases, Instantaneous Flow (cfs) Flood	Power	Total	2-hour Average (cfs) Flood Release	Power Release	Total Release	Inflow
				385	2,52					10,095	3,395	13,491	15,820
28-Apr-11	18:00	663.25	1,150,706		9	2 CG @ 7.5 ft.	10,096	3,395	13,491				
	19:00	663.25	1,150,706	193	1,168		10,096	3,390	13,486	10,096	3,393	13,488	14,656
	20:00	663.26	1,150,898	192	1,162		10,096	3,390	13,486	10,096	3,393	13,489	14,650
	21:00	663.26	1,150,898	192	1,162		10,096	3,390	13,486	10,096	3,390	13,486	14,648
	22:00	663.27	1,151,090	192	1,162		10,096	3,390	13,486	10,096	3,390	13,486	14,648
	23:00	663.27	1,151,090	192	1,162		10,096	3,390	13,486	10,096	3,390	13,486	14,648
29-Apr-11	0:00	663.28	1,151,282	192	1,162		10,096	3,390	13,486	10,096	3,390	13,486	14,648
	1:00	663.28	1,151,282	192	1,162		10,096	3,390	13,486	10,096	3,390	13,486	14,648
	2:00	663.29	1,151,474	192	1,162		10,096	3,390	13,486	10,096	3,390	13,486	14,648
	3:00	663.30	1,151,666	384	2,323		10,097	3,390	13,487	10,097	3,390	13,487	15,810
	4:00	663.31	1,151,858	384	2,323		10,097	3,385	13,482	10,097	3,388	13,484	15,807
	5:00	663.32	1,152,050	384	2,323		10,097	3,385	13,482	10,097	3,388	13,485	15,808
	6:00	663.32	1,152,050	192	1,162		10,097	3,385	13,482	10,097	3,385	13,482	14,644
	7:00	663.33	1,152,242	192	1,162		10,097	3,385	13,482	10,097	3,385	13,482	14,644
	8:00	663.33	1,152,242	192	1,162		10,097	3,385	13,482	10,097	3,385	13,482	14,644
	9:00	663.34	1,152,434	192	1,162		10,098	3,385	13,483	10,098	3,385	13,483	14,644
	10:00	663.34	1,152,434	192	1,162		10,098	3,385	13,483	10,098	3,385	13,483	14,644
	11:00	663.34	1,152,434	0	0		10,098	3,385	13,483	10,098	3,385	13,483	13,483
	12:00	663.34	1,152,434	0	0		10,098	3,385	13,483	10,098	3,385	13,483	13,483
	13:00	663.33	1,152,242	-192	-1,162		10,097	3,385	13,482	10,098	3,385	13,483	12,321
	14:00	663.33	1,152,242	-192	-1,162		10,097	3,385	13,482	10,098	3,385	13,483	12,321
	15:00	663.32	1,152,050	-192	-1,162		10,097	3,385	13,482	10,097	3,385	13,482	12,320
	16:00	663.31	1,151,858	-384	-2,323		10,097	3,385	13,482	10,097	3,385	13,482	11,159
	17:00	663.32	1,152,050	0	0		10,097	3,385	13,482	10,097	3,385	13,482	13,482
	18:00	663.30	1,151,666	-192	-1,162		10,097	3,390	13,487	10,097	3,388	13,485	12,323
	19:00	663.29	1,151,474	-576	-3,485		10,096	3,390	13,486	10,097	3,388	13,484	9,999
	20:00	663.27	1,151,090	-576	-3,485		10,096	3,390	13,486	10,097	3,390	13,487	10,002

Notes:

1. Record storage in acre-feet for each hourly elevation.

2. The 2-Hr Change in Storage equals the difference between the storage at the current time and the storage 2 hours earlier. If the pool is rising, the change in storage is positive. If falling, the change is negative.

3. The 2-Hr Average Storage in cfs is equal to:

   2-Hr Change in Storage * 43560 / 60 / 60 / 2

4. Record the releases from the project for every hour.

5. Average the releases for the current time and the releases for 2 hours prior to the current time.

6. Inflow is equal to:

   2-Hr Average Storage, cfs, + 2 Hour Average Total Release.

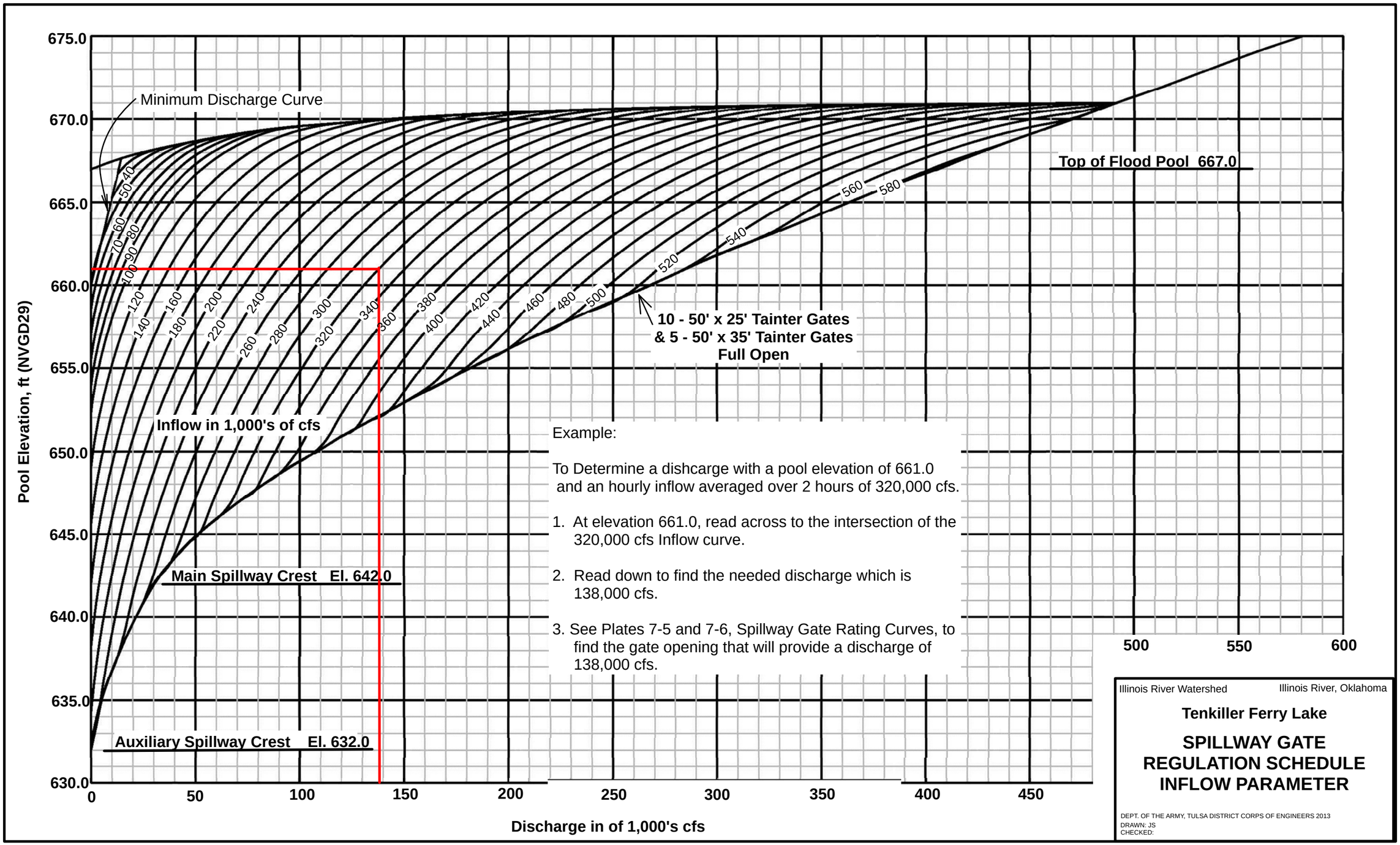
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

SAMPLE INFLOW COMPUTATION

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 6-6



Example:

To Determine a dishcharge with a pool elevation of 661.0 and an hourly inflow averaged over 2 hours of 320,000 cfs.

1. At elevation 661.0, read across to the intersection of the 320,000 cfs Inflow curve.

2. Read down to find the needed discharge which is 138,000 cfs.

3. See Plates 7-5 and 7-6, Spillway Gate Rating Curves, to find the gate opening that will provide a discharge of 138,000 cfs.

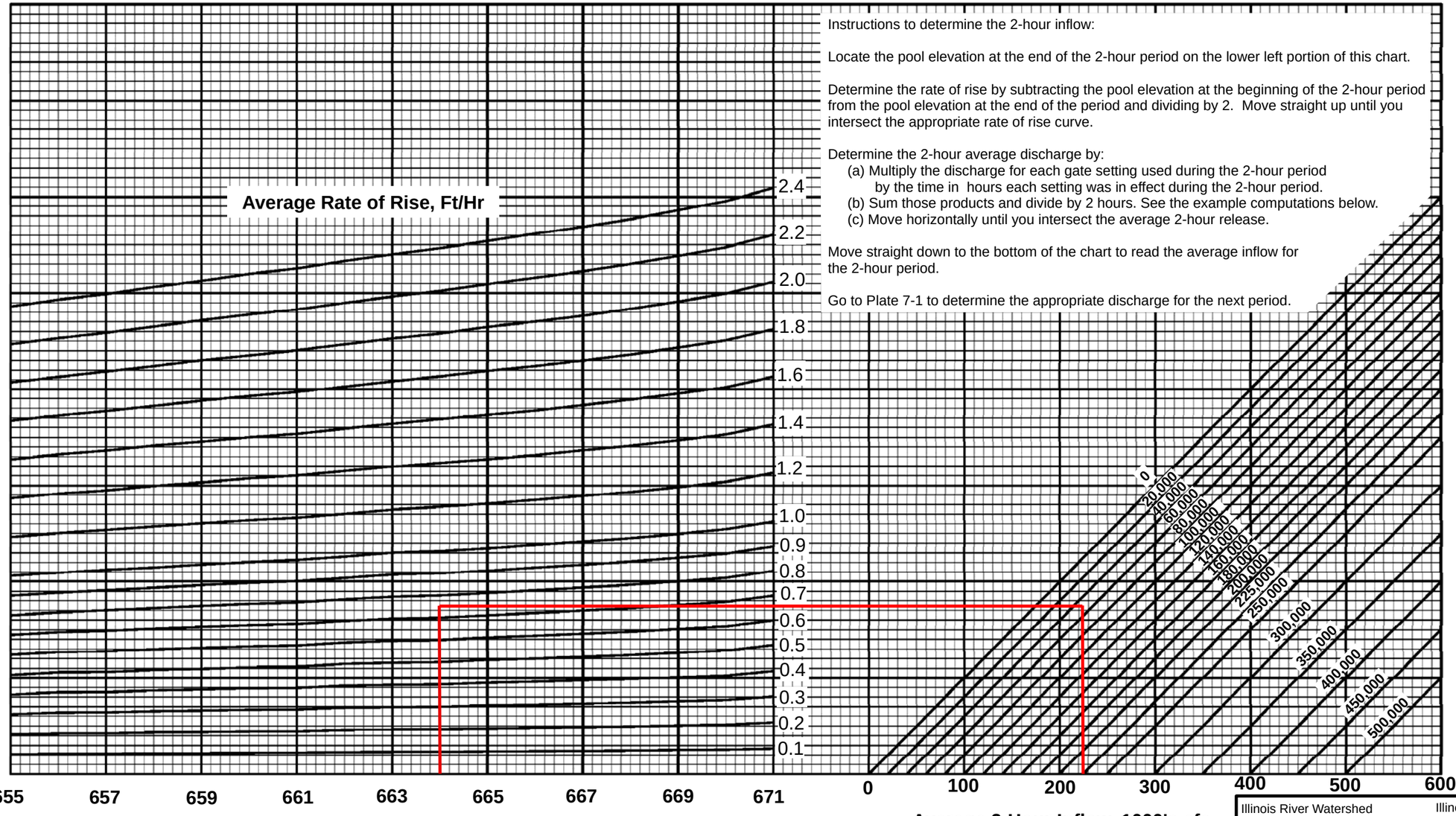
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

SPILLWAY GATE REGULATION SCHEDULE INFLOW PARAMETER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 7-1



Instructions to determine the 2-hour inflow:

Locate the pool elevation at the end of the 2-hour period on the lower left portion of this chart.

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.

Determine the 2-hour average discharge by:

(a) Multiply the discharge for each gate 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 the example computations below.
(c) Move horizontally until you intersect the average 2-hour release.

Move straight down to the bottom of the chart to read the average inflow for the 2-hour period.

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

EXAMPLE COMPUTATIONS:

1) Begin with a lake elevation of 664.0 ft. Two hours ago, the elevation was 662.5.

2) Rate of Rise = (664.0 - 662.5)/2 hrs = 1.5 ft /2 hrs = 0.75 ft/hr.

3) Releases for the last two hours were: 1.0 hrs at 40,000 cfs and 1.0 hrs at 60,0000 cfs.
The total for 2.0 hours is100,000 cfs. Dividing 100,000 cfs by 2 gives an average Release of 50,000 cfs.

4) The resulting 2-hour inflow is 225,000 cfs.

Note:
Based on 2010
Elevation-Area-Capacity Curve.

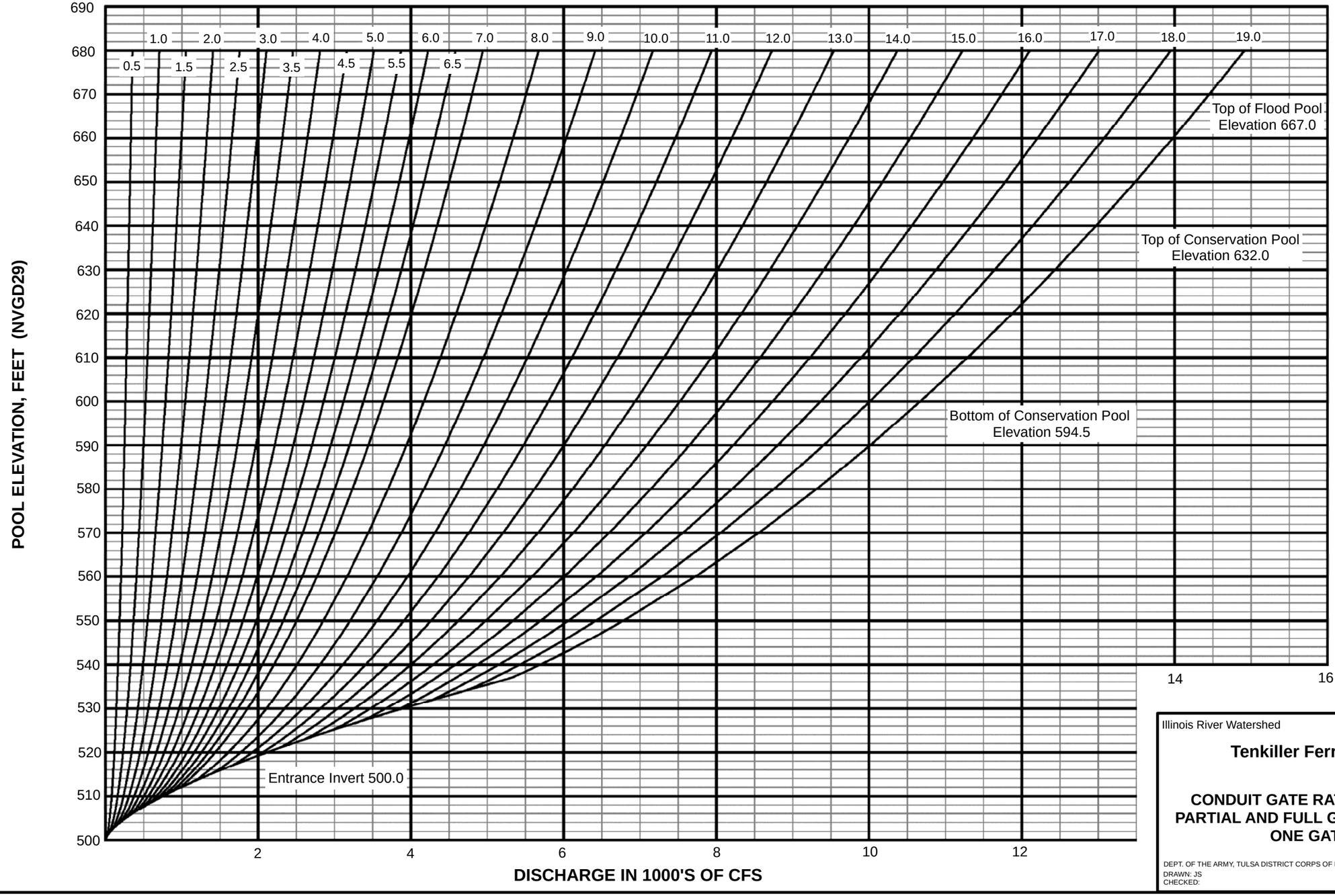
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

INFLOW VS. RATE OF RISE NOMOGRAPH

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 7-2



Gate Rating Curves Calculated by R. Barnes
November 2012

Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

CONDUIT GATE RATING CURVE
PARTIAL AND FULL GATE OPENING
ONE GATE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

Plate 7-3

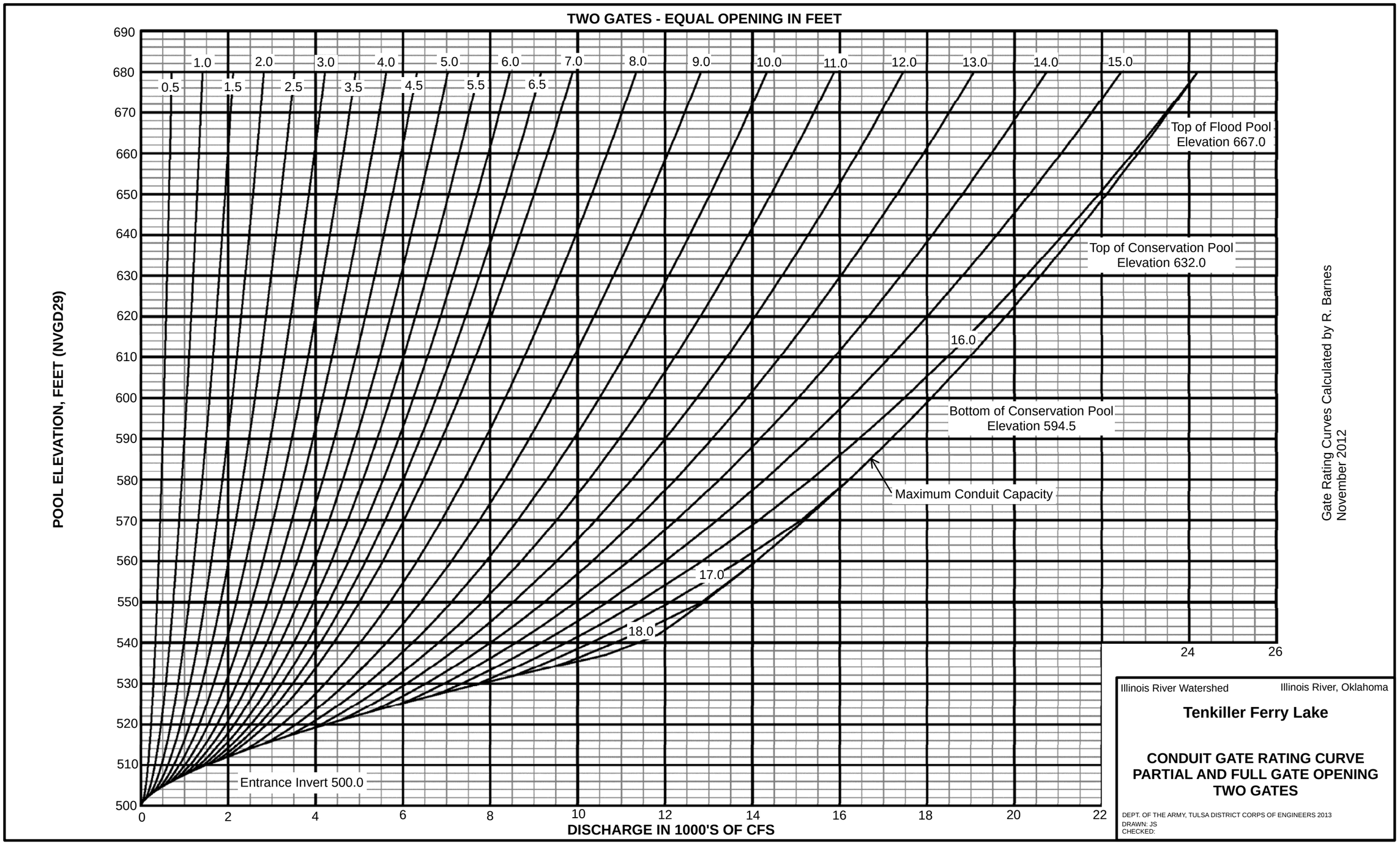

TWO GATES - EQUAL OPENING IN FEET
POOL ELEVATION, FEET (NVGD29)
DISCHARGE IN 1000'S OF CFS
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
0
2
4
6
8
10
12
14
16
18
20
22
24
26
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
Top of Flood Pool
Elevation 667.0
Top of Conservation Pool
Elevation 632.0
Bottom of Conservation Pool
Elevation 594.5
Maximum Conduit Capacity
Entrance Invert 500.0
Gate Rating Curves Calculated by R. Barnes
November 2012
Illinois River Watershed
Illinois River, Oklahoma
Tenkiller Ferry Lake
CONDUIT GATE RATING CURVE
PARTIAL AND FULL GATE OPENING
TWO GATES
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

Plate 7-4

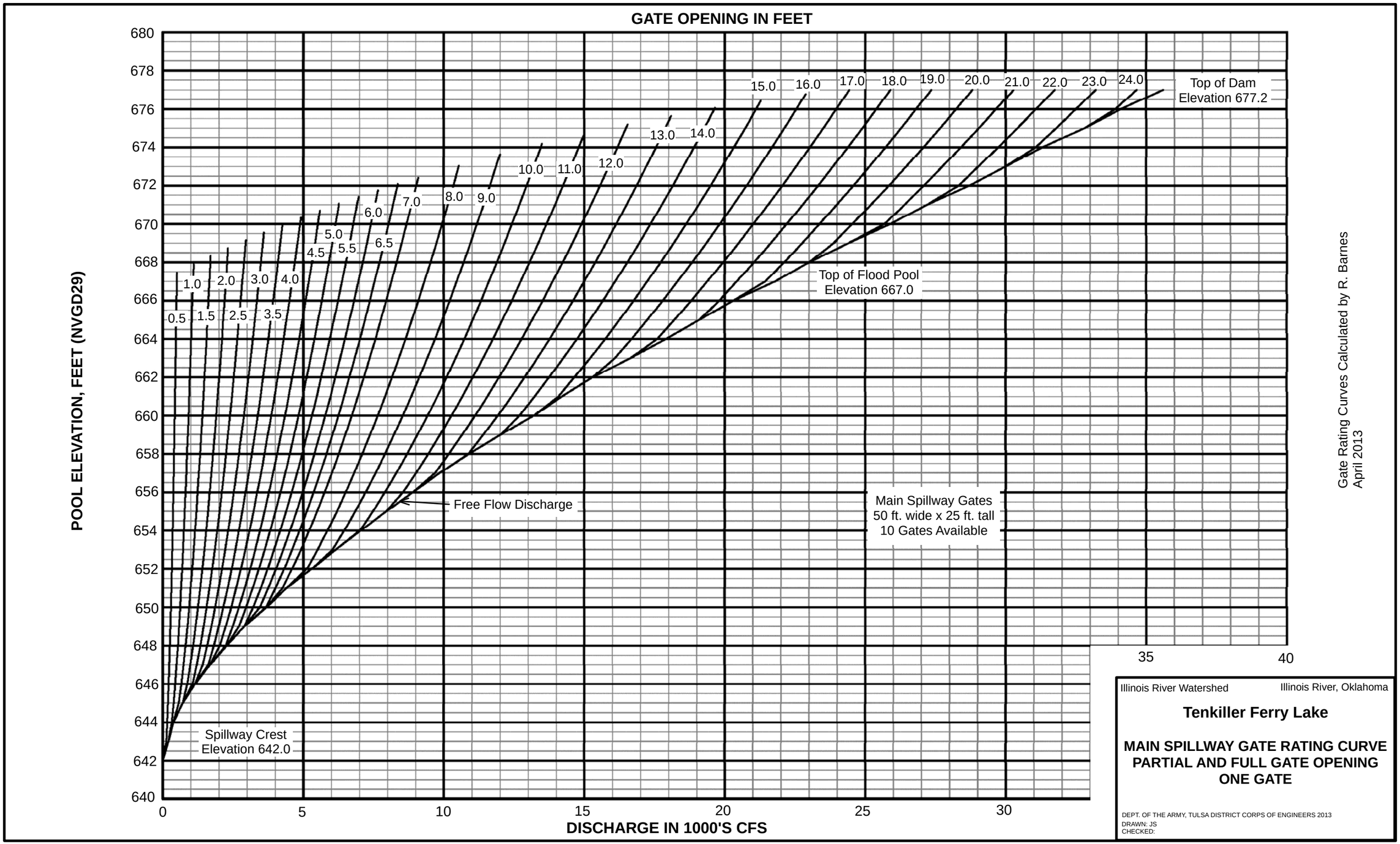

GATE OPENING IN FEET
POOL ELEVATION, FEET (NVGD29)
DISCHARGE IN 1000'S CFS
680
678
676
674
672
670
668
666
664
662
660
658
656
654
652
650
648
646
644
642
640
0
5
10
15
20
25
30
35
40
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
20.0
21.0
22.0
23.0
24.0
Top of Dam
Elevation 677.2
Top of Flood Pool
Elevation 667.0
Free Flow Discharge
Main Spillway Gates
50 ft. wide x 25 ft. tall
10 Gates Available
Spillway Crest
Elevation 642.0
Gate Rating Curves Calculated by R. Barnes
April 2013
Illinois River Watershed
Illinois River, Oklahoma
Tenkiller Ferry Lake
MAIN SPILLWAY GATE RATING CURVE
PARTIAL AND FULL GATE OPENING
ONE GATE
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

Plate 7-5

GATE OPENING IN FEET

POOL ELEVATION, FEET (NVGD29)

680
678
676
674
672
670
668
666
664
662
660
658
656
654
652
650
648
646
644
642
640
638
636
634
632
630

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

Top of Dam
Elevation 677.2

Top of Flood Pool
Elevation 667.0

Free Flow Discharge

Auxiliary Spillway Gates
50 ft. wide x 35 ft. tall
5 Gates Available

Spillway Crest
Elevation 632.0

0 5 10 15 20 25 30 35 40 45 50 55 60

DISCHARGE IN 1000'S CFS

Gate Rating Curves Calculated by R. Barnes
January 2012

Illinois River Watershed — Illinois River, Oklahoma

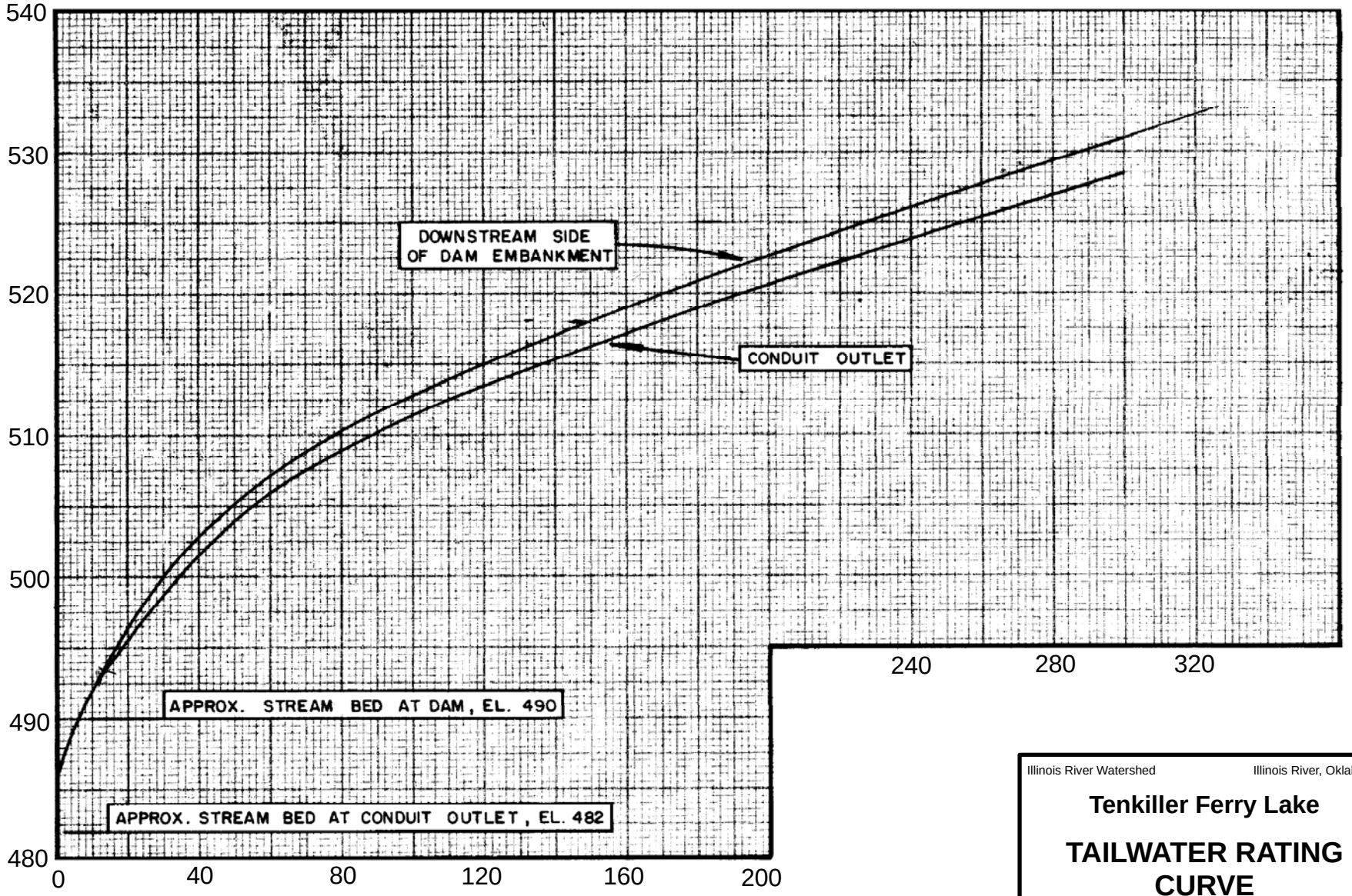
Tenkiller Ferry Lake

AUXILIARY SPILLWAY GATE RATING CURVE
PARTIAL AND FULL GATE OPENING
ONE GATE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

Plate 7-6

Rating curve based on design data. No newer information is available.



Illinois River Watershed — Illinois River, Oklahoma

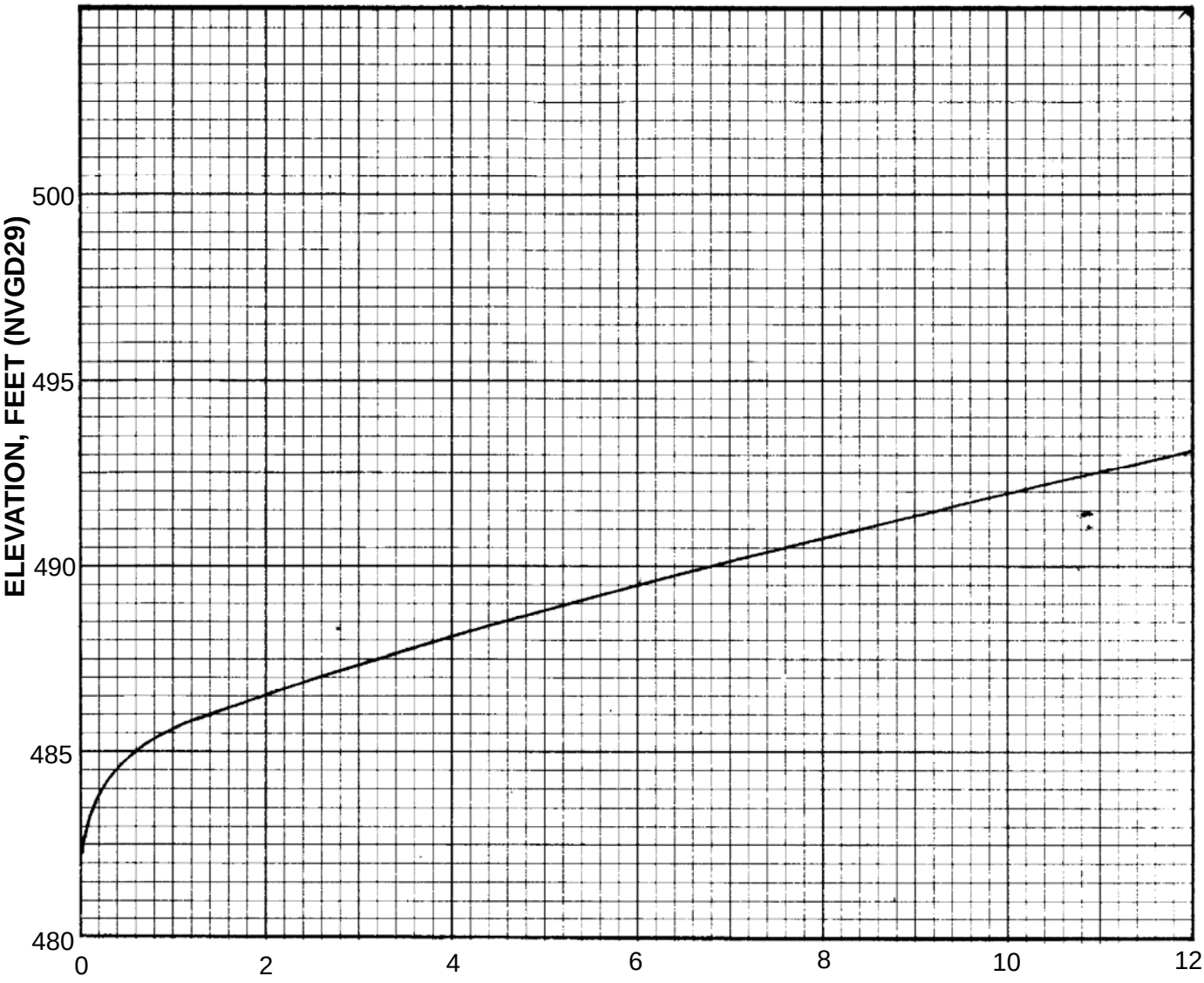
Tenkiller Ferry Lake

TAILWATER RATING CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 7-7

Note: Rating curve based on data from 1969 Power logs. No newer data is available.

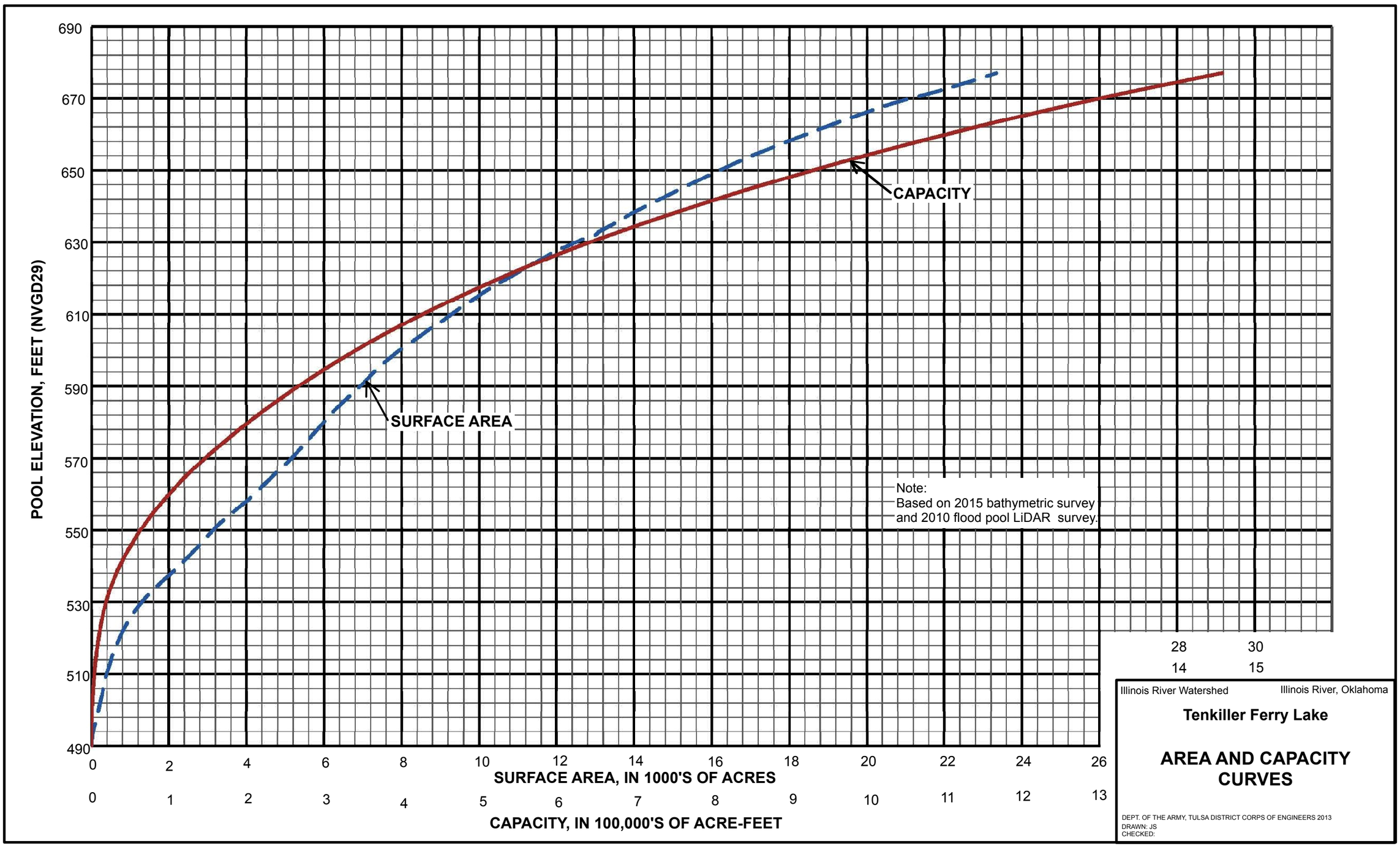


Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

POWERHOUSE TAILWATER RATING CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:



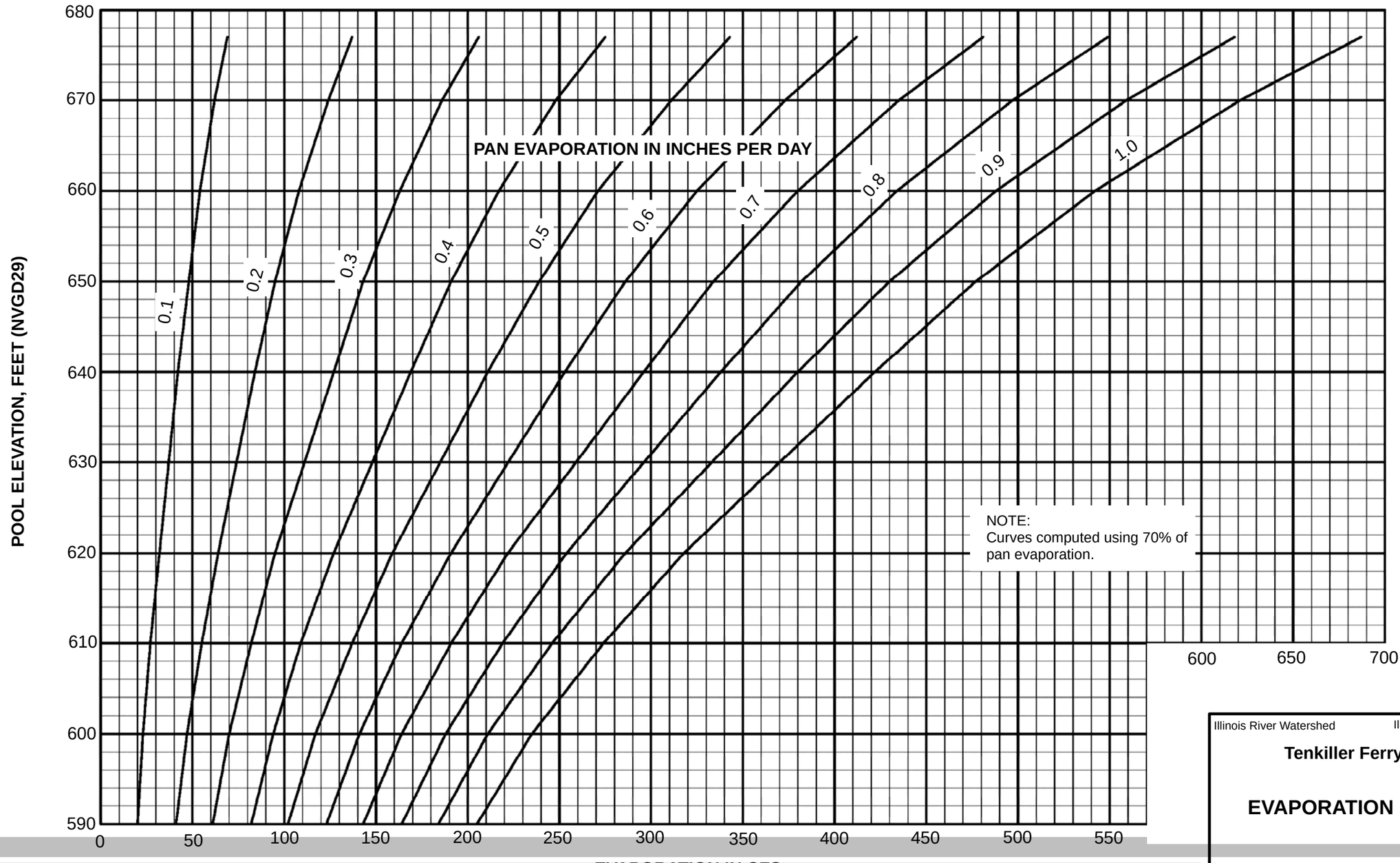
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

AREA AND CAPACITY CURVES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 7-9



Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

EVAPORATION CURVES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 7-10

Water Supply Storage Accounting

Tenkiller Ferry Lake

Conservation Storage	371146 ac-ft.
Contracted Storage User #1	345559 ac-ft.
Contracted Storage User #2	12400 ac-ft.
Contracted Storage User #3	3200 ac-ft.
Contracted Storage User #4	4700 ac-ft.
Contracted Storage User #5	5287 ac-ft.

Month	User	Beginning Storage, ac-ft.	Inflow Share, ac-ft.	Total Losses, ac-ft.	With-drawals, ac-ft	Ending Storage, ac-ft.
July	Lake	371146	10320	5410	44240	331816
	User 1	345559	9609	5037	41150	308981
	User 2	12400	345	181	2600	9964
	User3	3200	89	47	145	3097
	User 4	4700	131	69	150	4612
	User 5	5287	147	77	195	5162
August	Lake	331816	8540	6578	48102	285676
	User 1	308981	7951	6125	44560	266247
	User 2	9964	285	220	2980	7050
	User3	3097	74	57	160	2954
	User 4	4612	108	83	187	4450
	User 5	5162	122	94	215	4975
September	Lake	285676	16590	5110	38610	258546
	User 1	266247	15446	4758	35780	241156
	User 2	7050	554	171	2410	5023
	User3	2954	143	44	130	2923
	User 4	4450	210	65	127	4468
	User 5	4975	236	73	163	4975
October	Lake	258546	18097	3640	21976	251027
	User 1	241156	16849	3389	21120	233496
	User 2	5023	605	122	562	4944
	User3	2923	156	31	94	2954
	User 4	4468	229	46	82	4569
	User 5	4975	258	52	118	5063

Note:

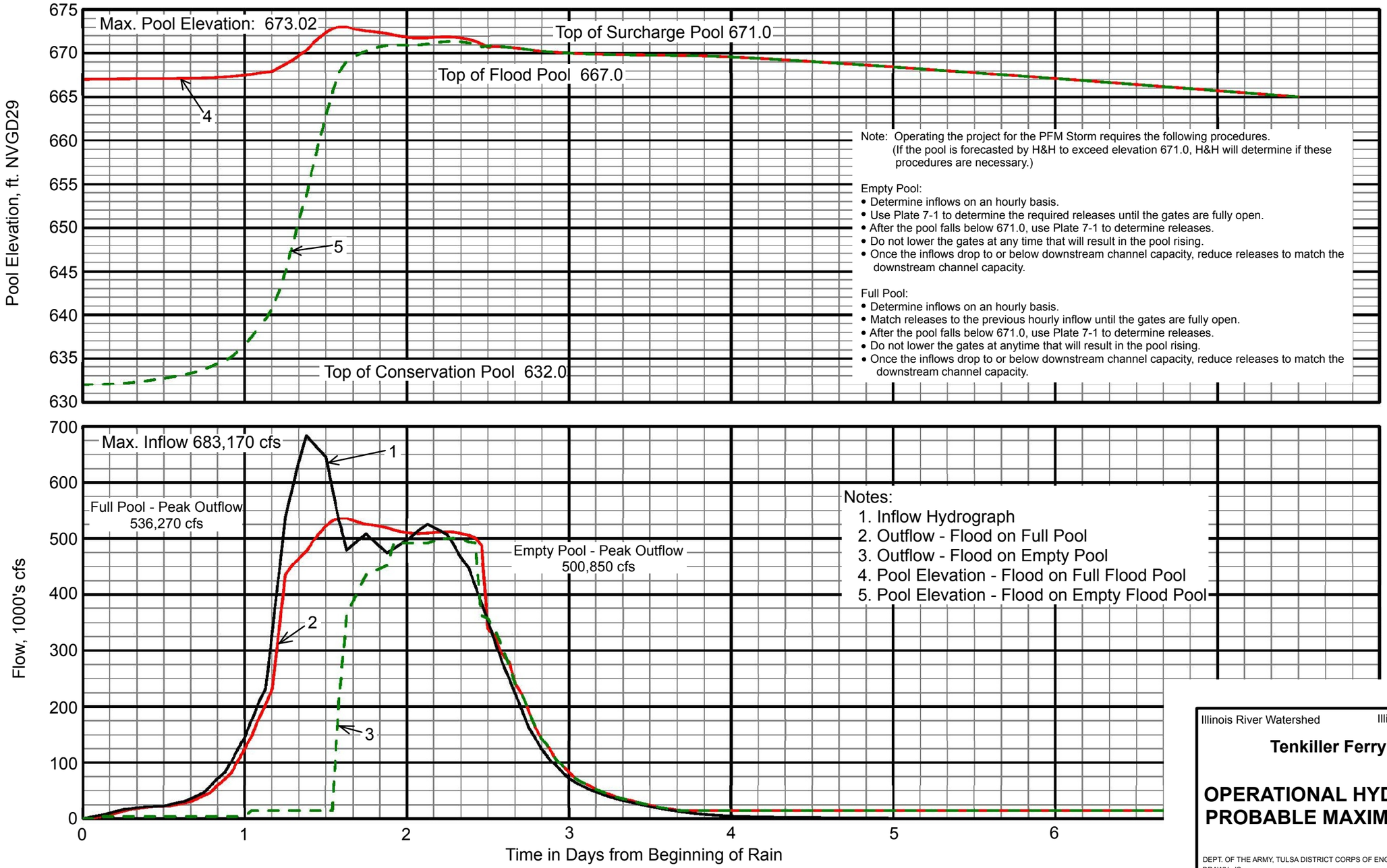
1. Useable conservation pool storage is 371,146 ac-ft.
2. Storage amounts are based on the initial pool survey and the 2010 flood pool LiDAR survey.
3. For actual water accounting, each user would be listed separately with inflow, losses and storage being calculated for each.

Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

EXAMPLE CALCULATIONS OF WATER SUPPLY ACCOUNTING

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:



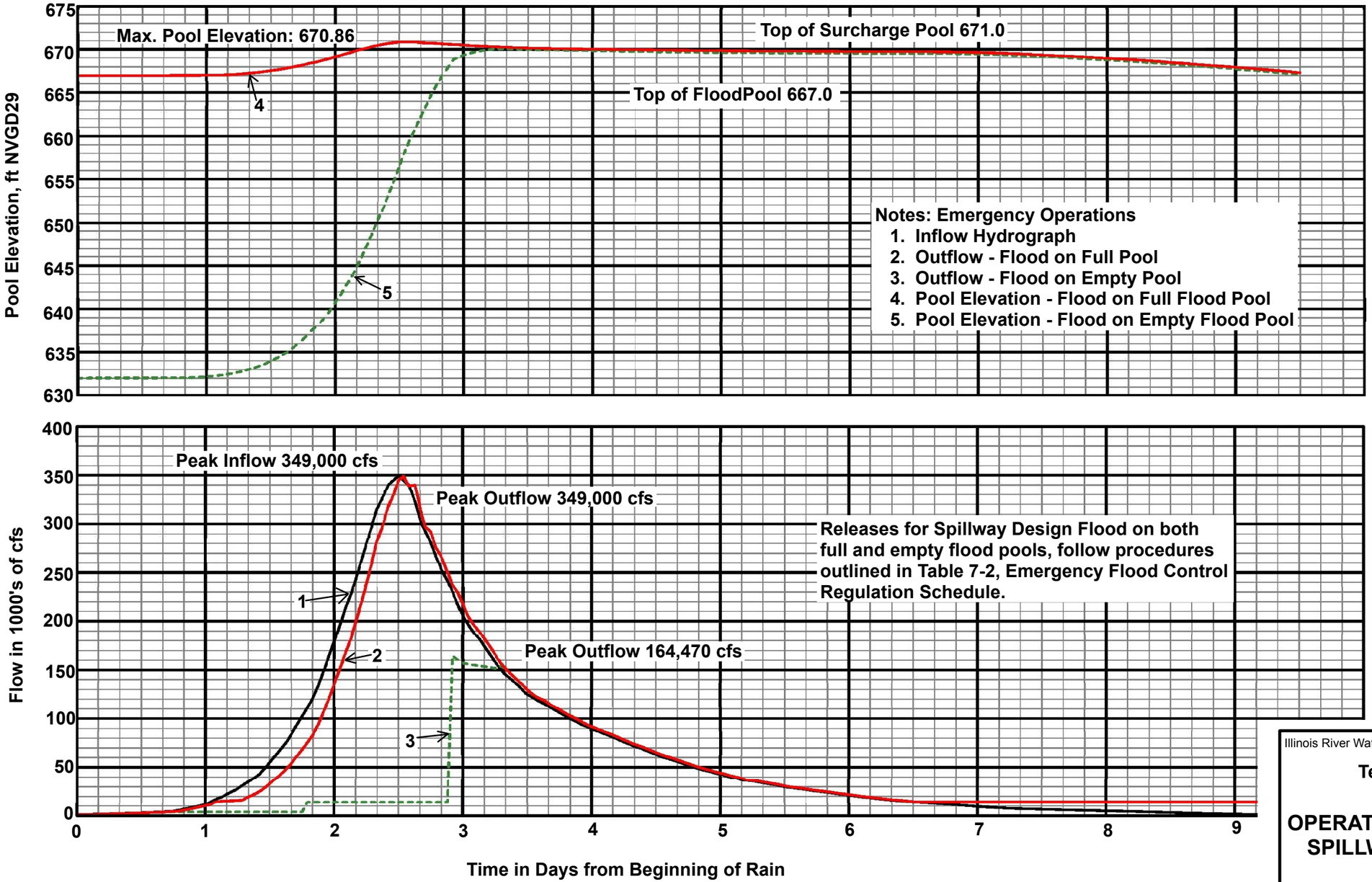
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

OPERATIONAL HYDROGRAPH PROBABLE MAXIMUM FLOOD

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 8-1



Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

OPERATIONAL HYDROGRAPH SPILLWAY DESIGN FLOOD

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 8-2

Average Rainfall Over Uncontrolled Drainage Area, Inches

0
1
2
3

Pool Elevation, Ft (NVGD29)

670
660
650
640
630

Top of Flood Control Pool El. 667.0

Top of Conservation Pool El. 632.0

Max Pool El. 669.93

Max. Pool El. 667.41

Discharge In 1000's CFS

50
40
30
20
10
0

44,500 cfs

Start Emergency Operation

End Emergency Operation

Inflow

Outflow

Peak Outflow = 11,300 cfs

15 | 19 | 20 | 24 | 25 | 29 | 30 | 3 | 4 | 8 | 9 | 13 | 14 | 18 | 19 | 23 | 24 | 28

May 1957 **June 1957**

NOTES:
1. Operating capacity immediately below the dam is 10,000 cfs.
2. Under normal regulations, the flood control pool would have emptied August 10th.
3. Under emergency regulations, the flood control pool would have emptied August 10th.
4. Flood control pool contains 576,700 acre-feet.

Legend
- Inflow
- Operated by normal regulation
- Operated by Emergency regulation

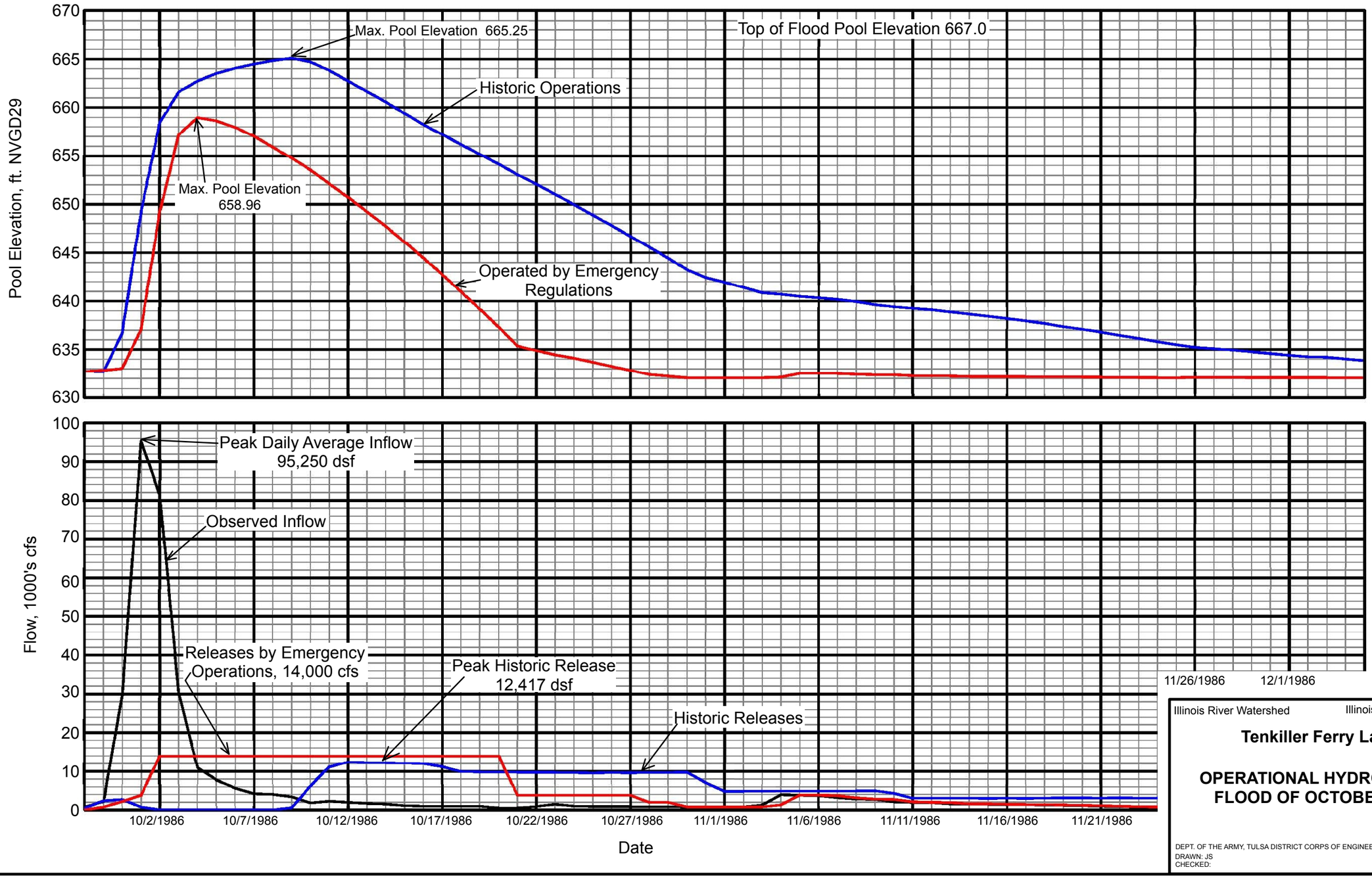
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

OPERATIONAL HYDROGRAPH FLOOD OF MAY-JUNE 1957

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 8-3



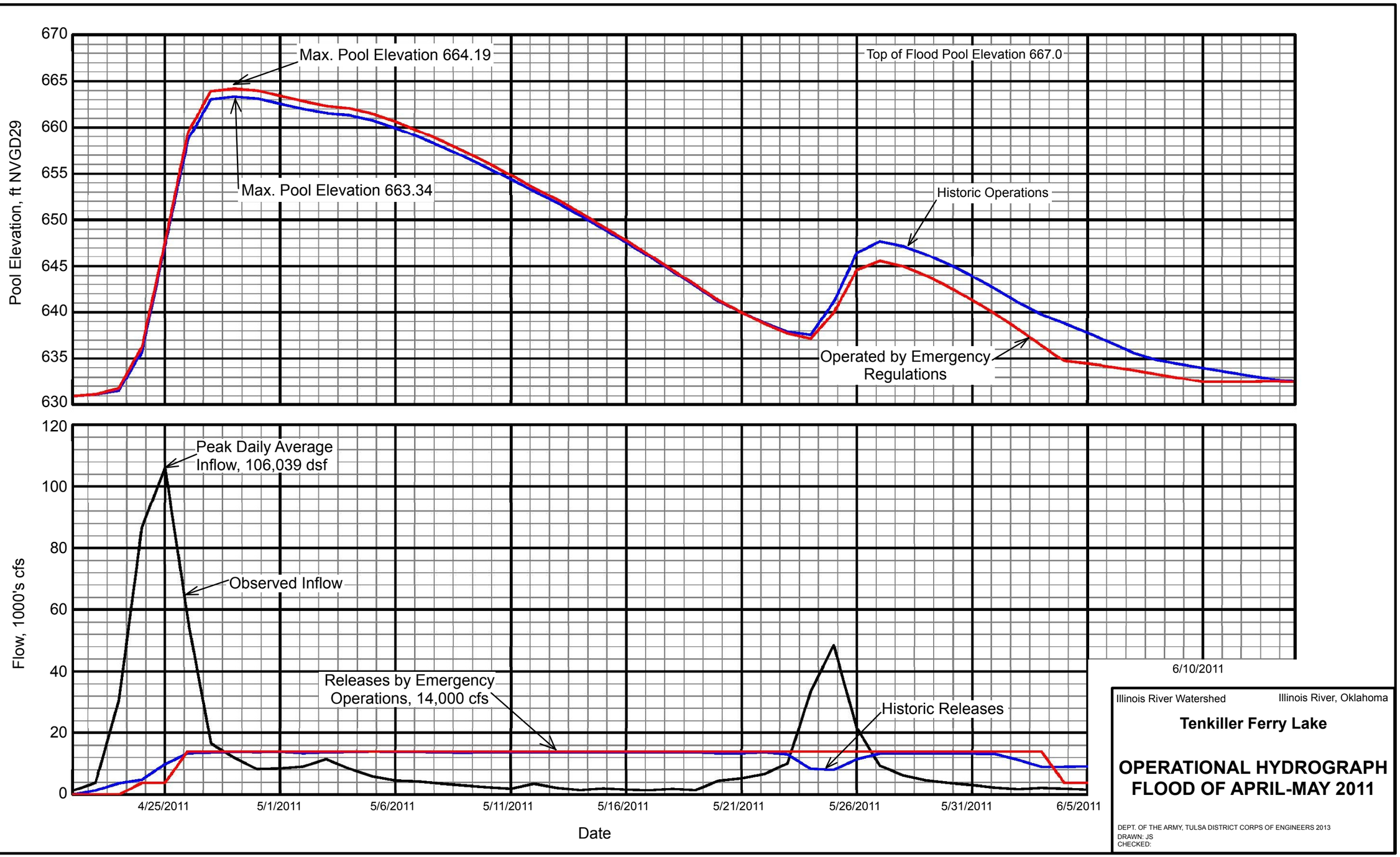
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

OPERATIONAL HYDROGRAPH
FLOOD OF OCTOBER 1986

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 8-4



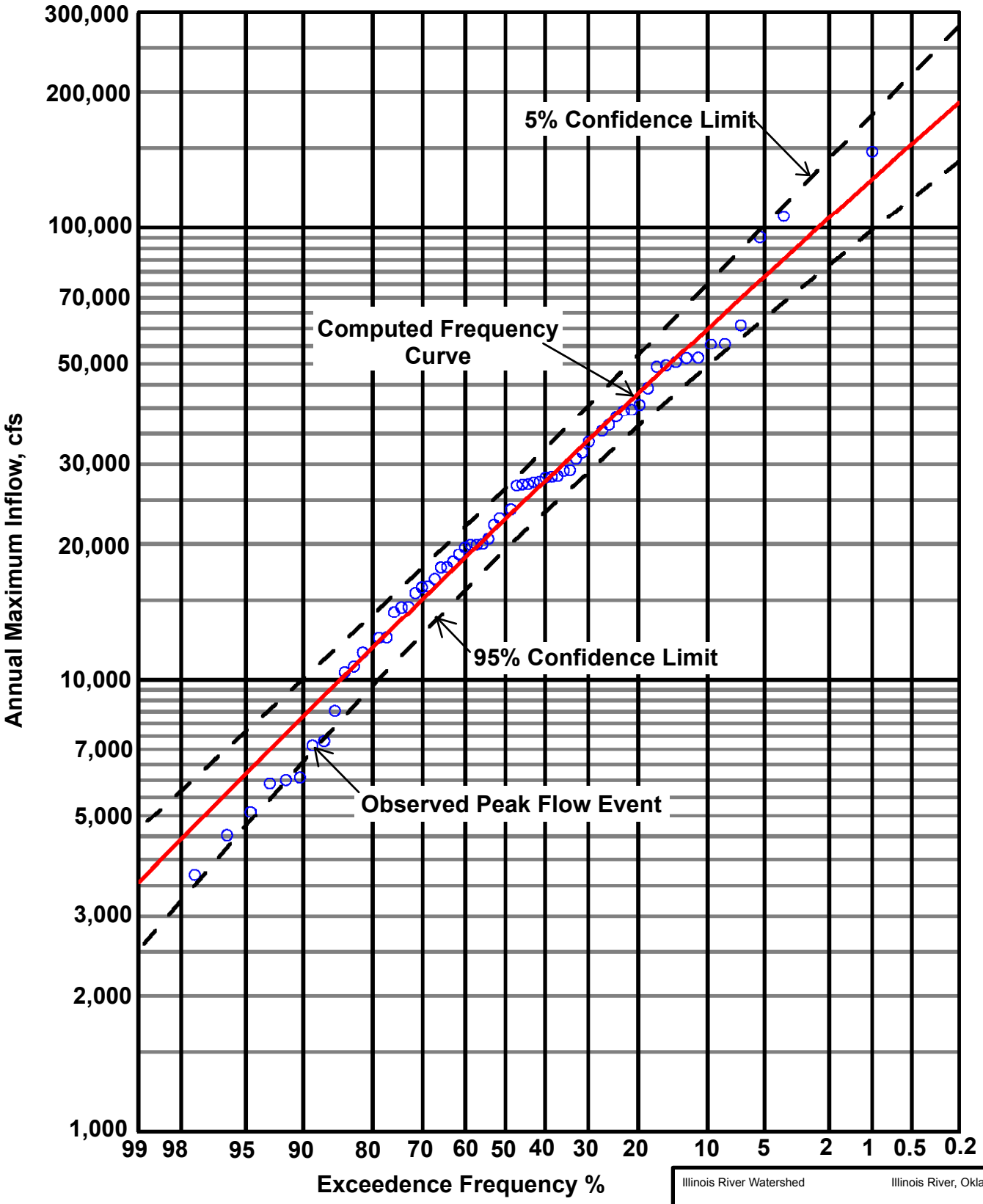
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

OPERATIONAL HYDROGRAPH FLOOD OF APRIL-MAY 2011

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 8-5



Note:

1. Based on period of record January 1940 through December 2008 from RiverWare computer run.

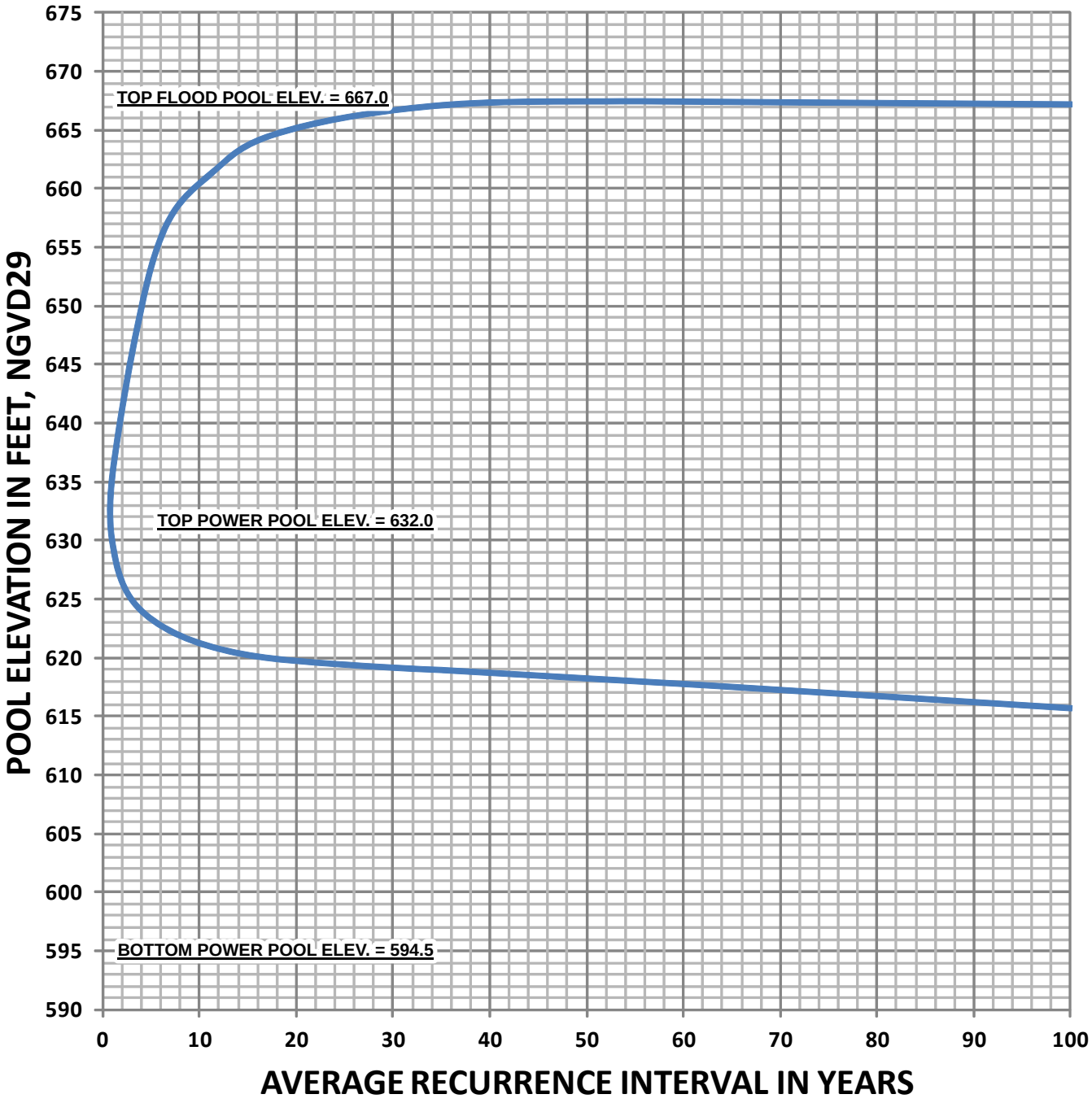
2. Bulletin No. 17B Flood Flow Frequency Guidelines were used.

Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

INFLOW PROBABILITY CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:



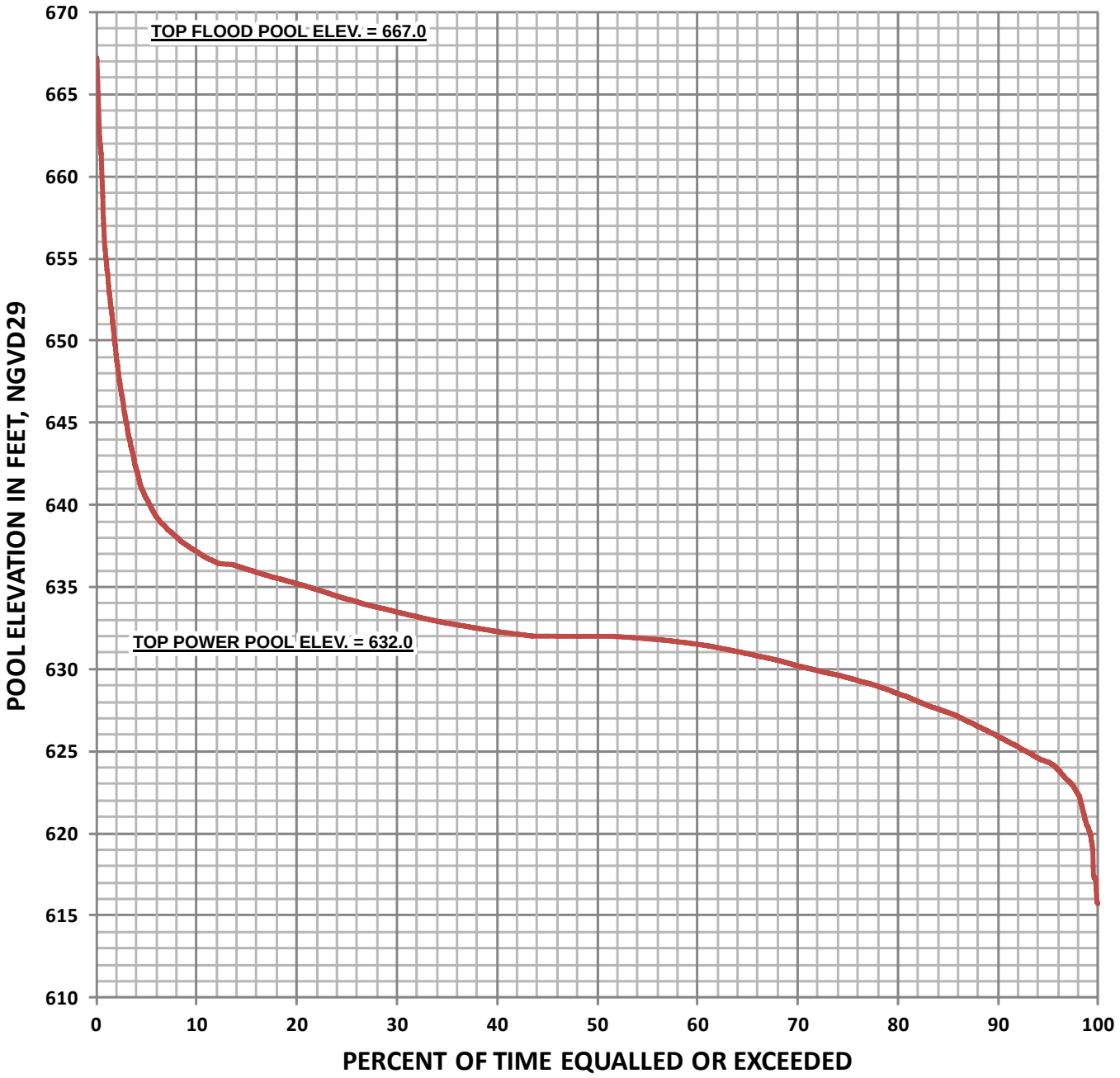
Note:
Period of Record
Jan 1940 through Dec 2008
RiverWare Model

Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

POOL ELEVATION PROBABILITY CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:



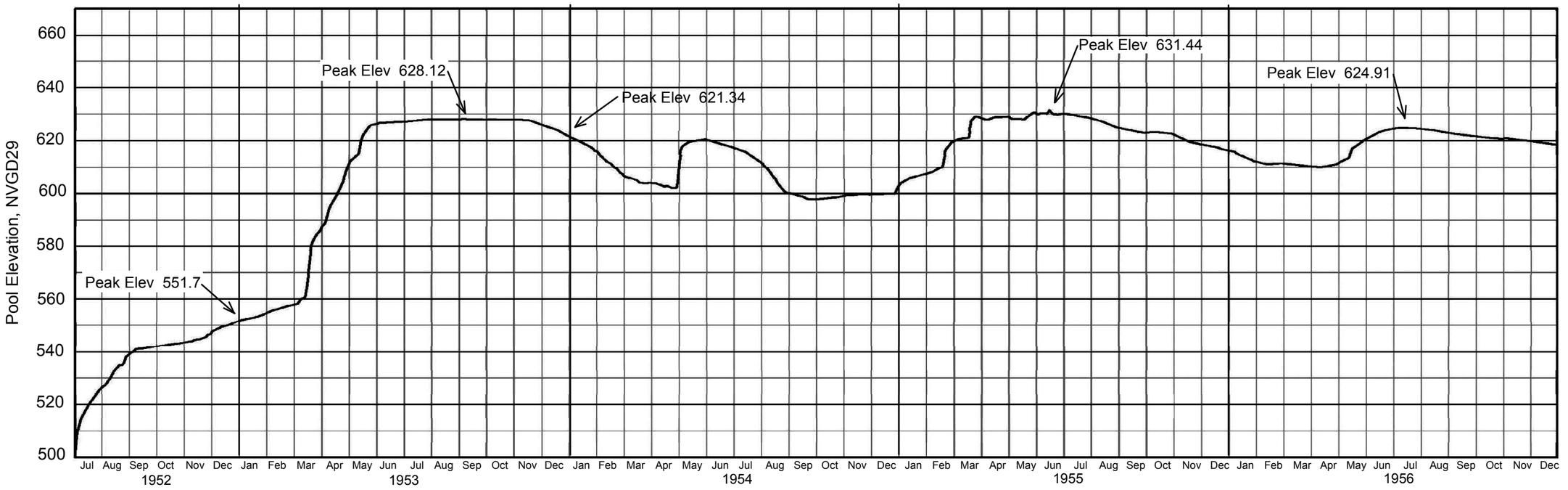
Note:
Period of Record
Jan 1940 through Dec 2008
RiverWare Model

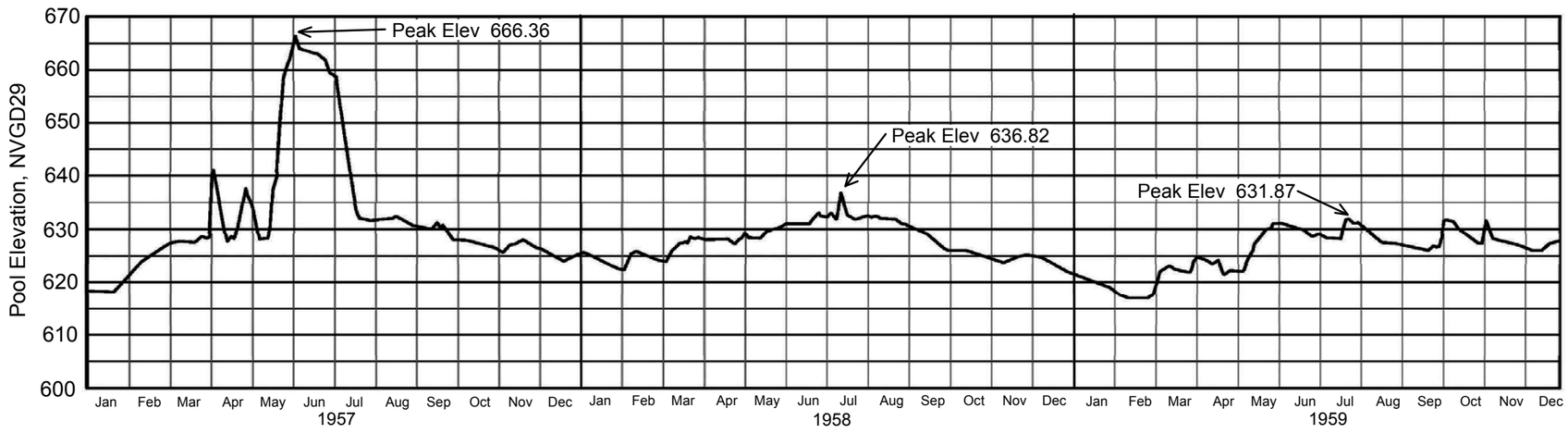
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

POOL ELEVATION DURATION CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:





Note:
Pool elevations were estimated from graphical monthly charts July 1952 through December 1959.

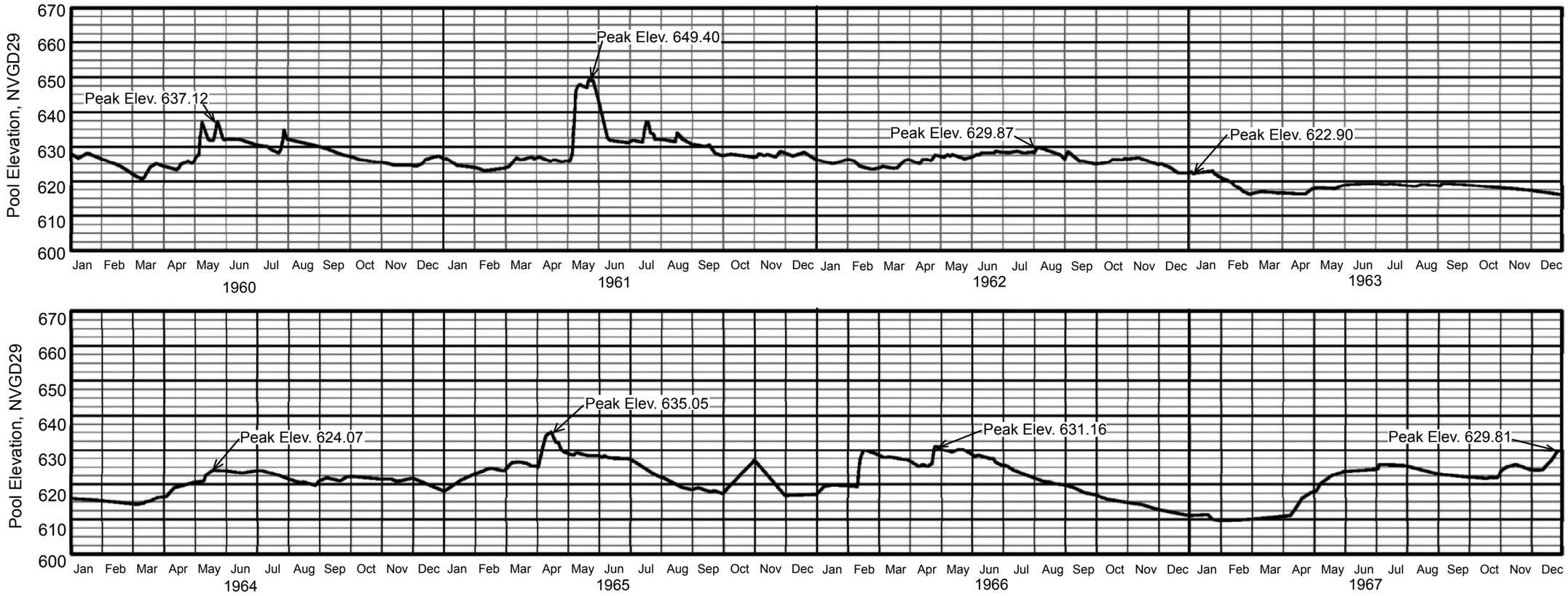
Illinois River Watershed — Illinois River, Oklahoma

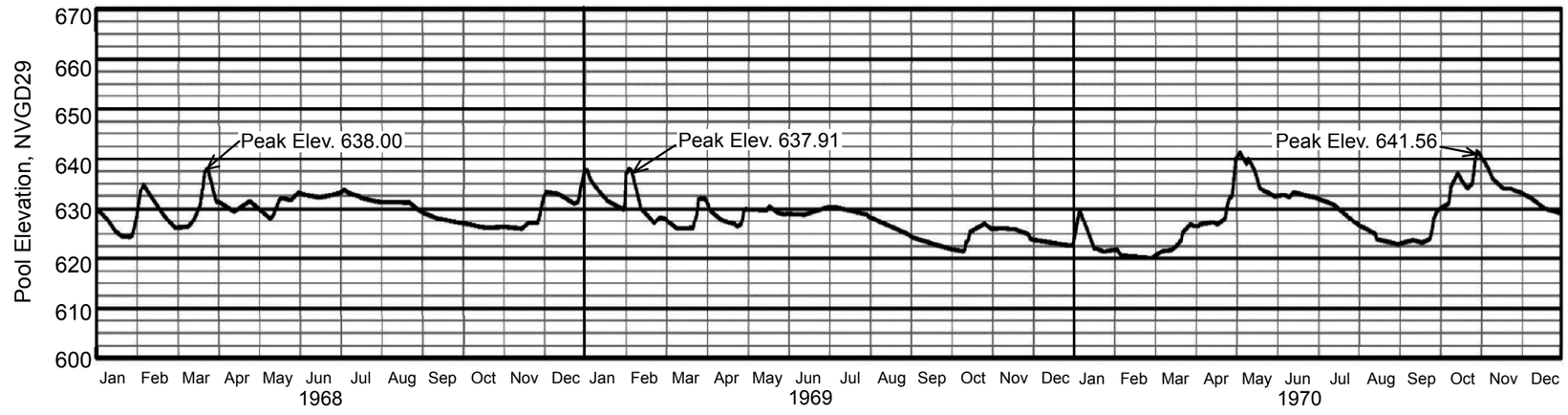
Tenkiller Ferry Lake

POOL ELEVATION HYDROGRAPHS 1952 - 1959

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 8-9





Note:
Pool elevations were estimated from graphcial monthly charts January 1960 through Decmber 1970.

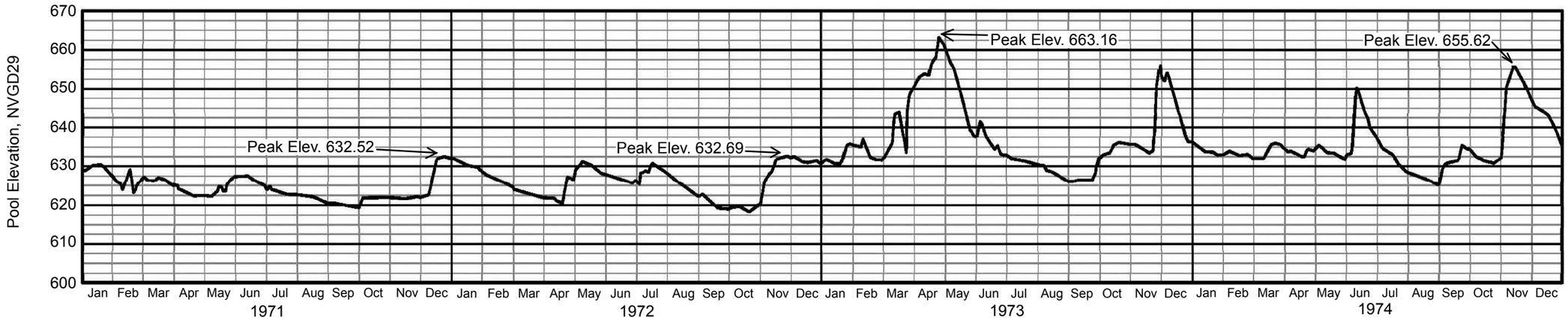
Illinois River Watershed — Illinois River, Oklahoma

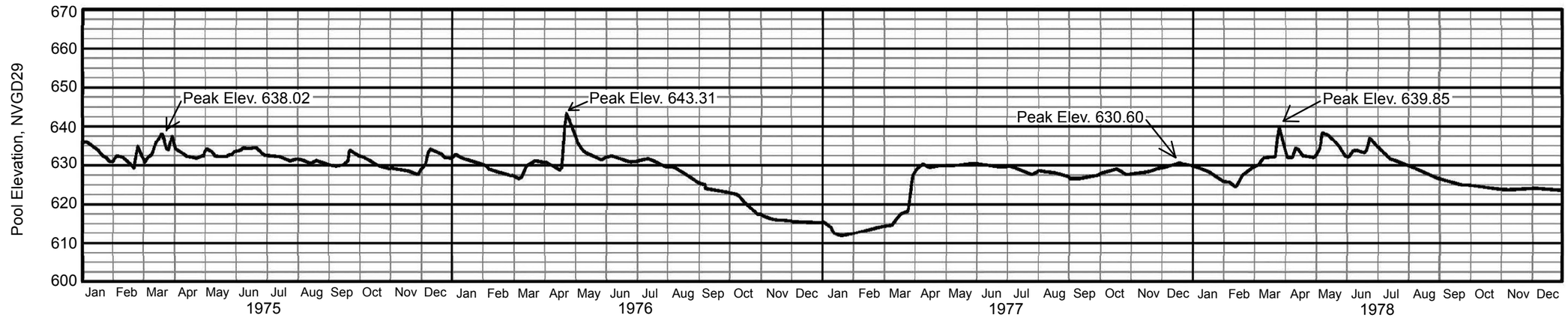
Tenkiller Ferry Lake

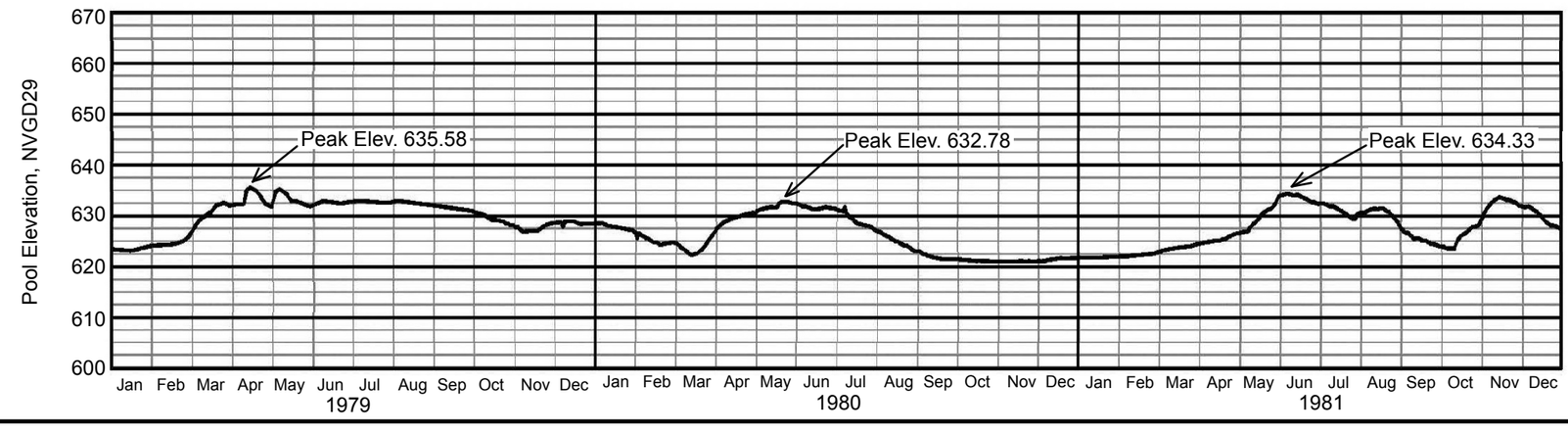
POOL ELEVATION HYDROGRAPHS 1960 - 1970

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 8-10







Note:
Pool elevations were estimated from graphical monthly charts January 1971 through September 1979.

Pool elevations were taken from computer generated monthly charts October 1979 through December 1981.

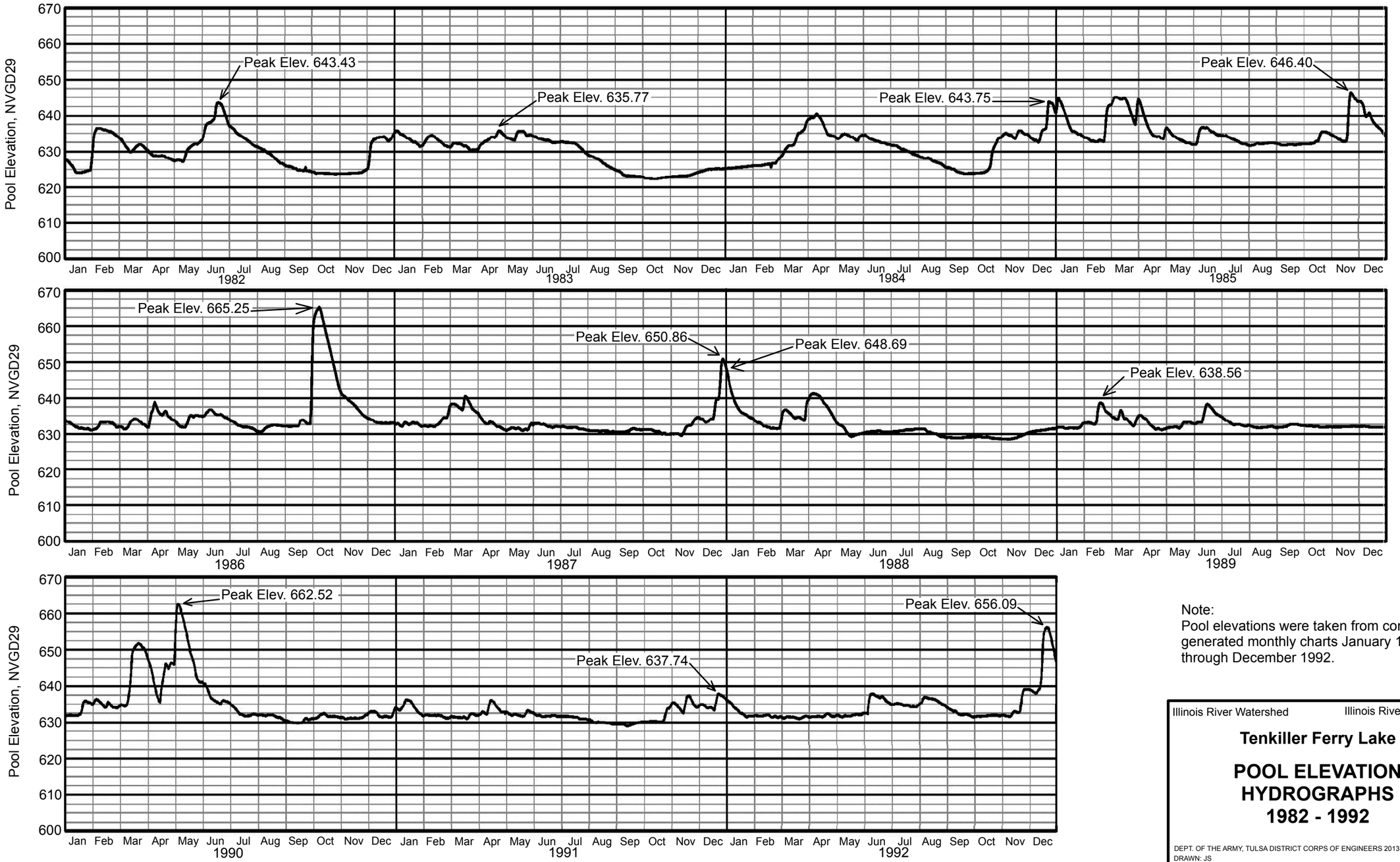
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

POOL ELEVATION HYDROGRAPHS 1971 - 1981

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 8-11



Note:
Pool elevations were taken from computer generated monthly charts January 1982 through December 1992.

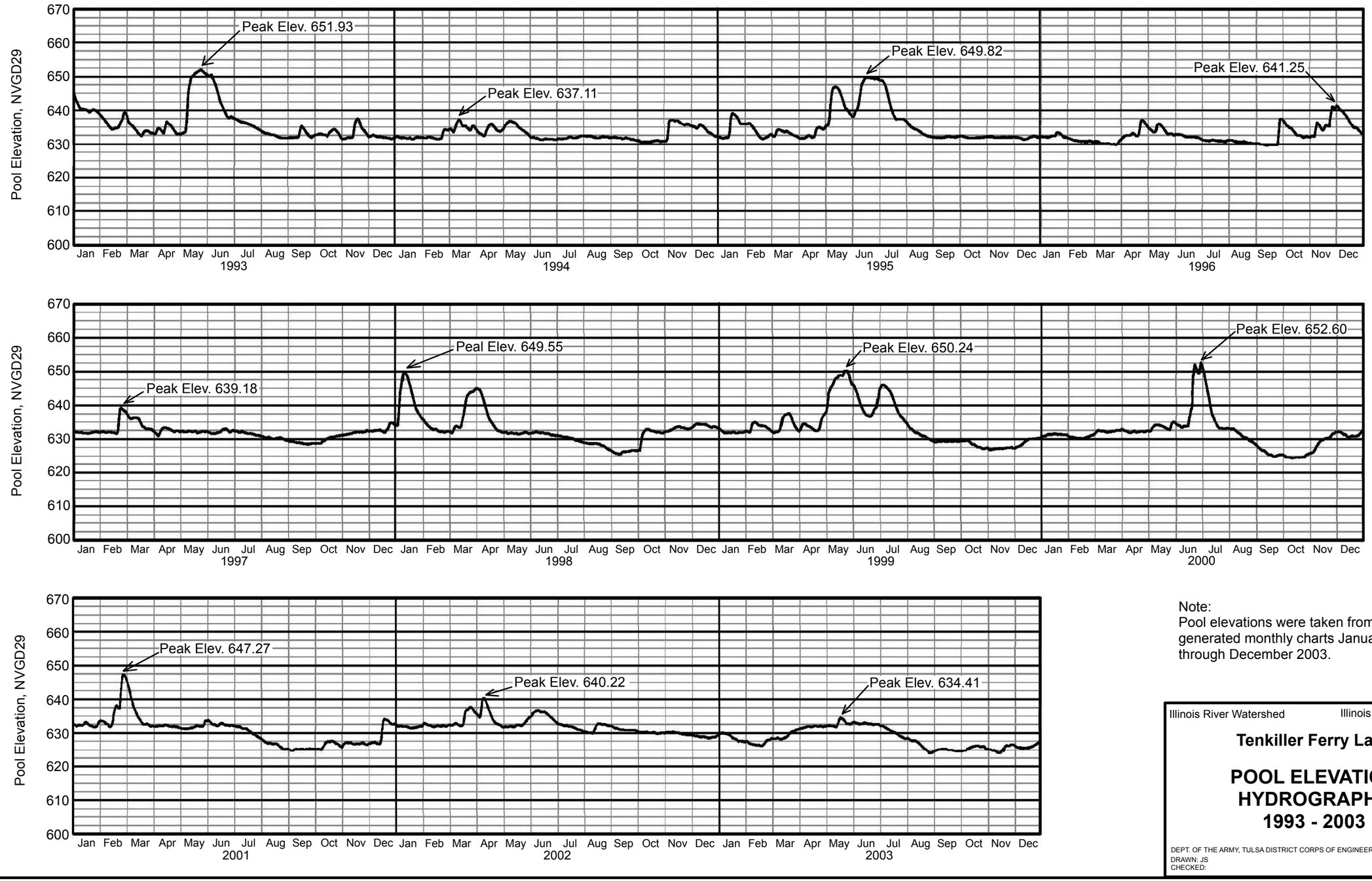
Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

POOL ELEVATION HYDROGRAPHS 1982 - 1992

DEPT. OF THE army, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 8-12



Note:
Pool elevations were taken from computer generated monthly charts January 1993 through December 2003.

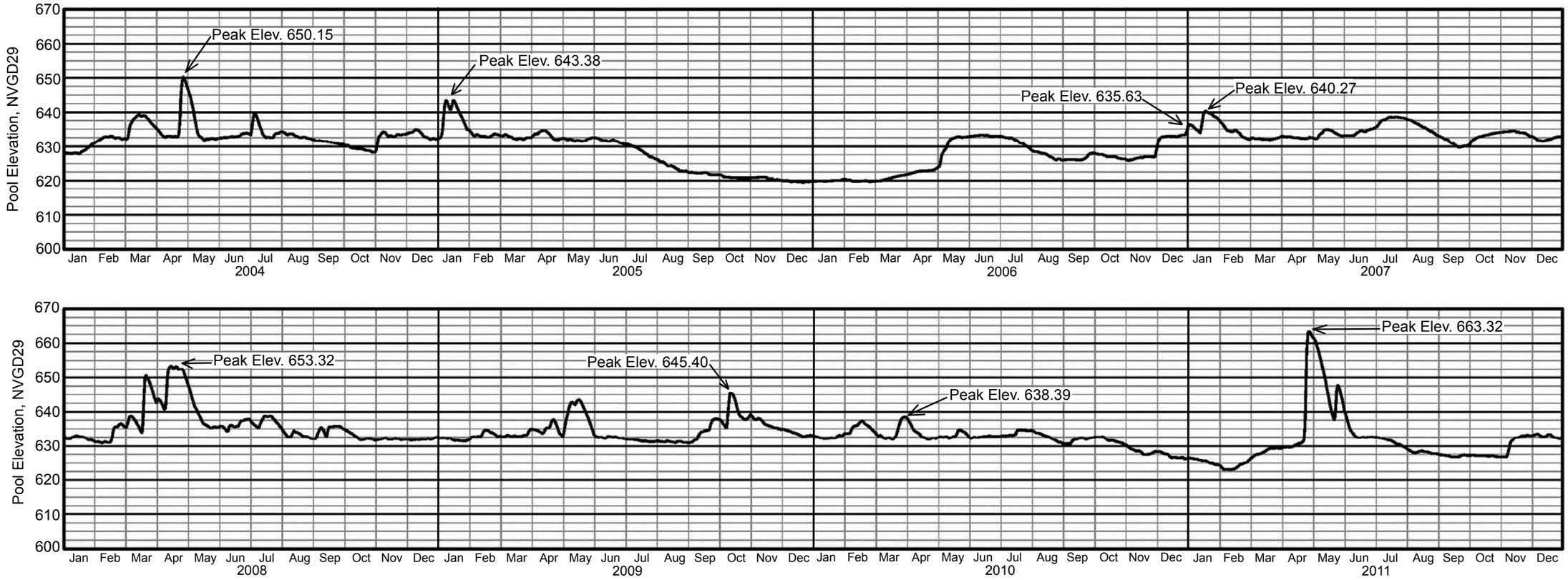
Illinois River Watershed — Illinois River, Oklahoma

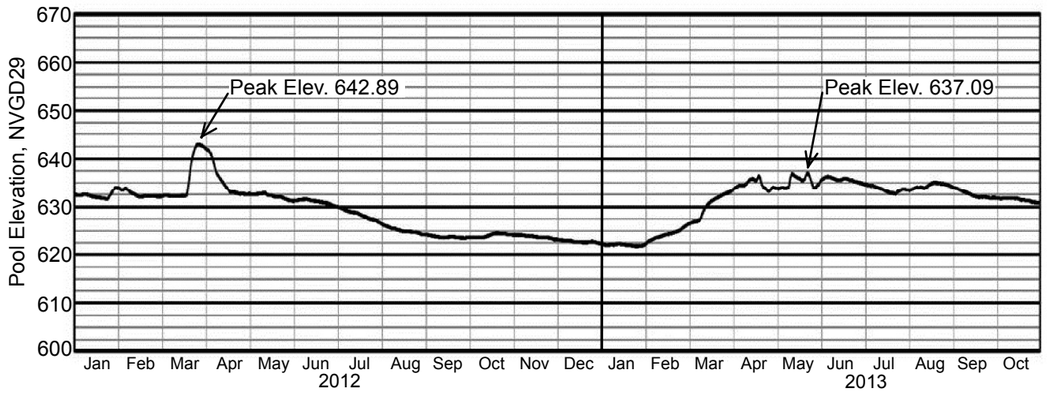
Tenkiller Ferry Lake

POOL ELEVATION HYDROGRAPHS 1993 - 2003

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 8-13





Note:
Pool elevations were taken from computer generated monthly charts January 2004 through October 2013.

Illinois River Watershed — Illinois River, Oklahoma

Tenkiller Ferry Lake

POOL ELEVATION HYDROGRAPHS 2004 - 2013

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2013
DRAWN: JS
CHECKED:

PLATE 8-14