

BROKEN BOW LAKE
MOUNTAIN FORK RIVER, OKLAHOMA

WATER CONTROL MANUAL

APPENDIX E
PART III

TO

WATER CONTROL MASTER MANUAL

RED RIVER BASIN

February 2000

U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

SPECIAL NOTICE TO USERS OF THIS MANUAL

This manual contains sections that concern special unresolved issues. First, a reallocation of uncontracted water supply storage to the Oklahoma Department of Wildlife Conservation (ODWC) has been authorized but not yet completed. Funds requested to support to reallocation have not yet been granted. Regardless, the ODWC trout fishery is in full operation and is supported by Tulsa District and Southwestern Power Administration. The exact quantity reallocated has not yet been determined by ODWC and the other agencies. Therefore, the amount reallocated is shown as "XX,XXX acre-feet throughout the manual. Upon approval of the official reallocation, the appropriate quantity will be sent to all holders of this manual. Along with the quantity amount will be a revised Exhibit D, Memorandum of Understanding, Broken Bow Trout Fishery, and a revised water supply accounting procedure approved by Tulsa District, Southwestern Power Administration and the ODWC, which are unavailable at this time. Otherwise, this manual has been updated to include current approved water control procedures for Broken Bow Lake as well as useful historical data concerning the lake operations and the Mountain Fork basin.

NOTICE TO USERS OF THIS MANUAL

Regulations specify that this Water Control Manual be used in looseleaf form, and only those sections, or parts thereof, requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that inserts can be made to keep the manual current. Changes to individual pages must carry the date-of-revision, which is the Division's approval date. All elevations referenced to in this manual, unless noted otherwise, are in feet, NGVD (National Geodetic Vertical Datum).

EMERGENCY REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during duty hours and at various hours during weekends and holidays, contact can be made by telephone to the Water Control Section, Tulsa District Office (918) 669-7131, or the District VHF-FM radio (call signal WUI-3, Hydraulics). If the above office cannot be contacted, assistance can be achieved by contacting, in the order listed, one of the persons shown below. Chapter 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 chapter. A separate copy of this chapter has been provided the project office and must be displayed on the bulletin board at all times.

EMERGENCY PERSONNEL ROSTER

**CORPS PROJECTS - Red River
(October 1999)**

TITLE/NAME

OFFICE

HOME

(b) (6)

*Chief, Water Control Section
Tulsa, OK*

** Telephone numbers with asterisk are for project use.*



BROKEN BOW LAKE

BROKEN BOW DAM AND RESERVOIR
MOUNTAIN FORK RIVER, OKLAHOMA

WATER CONTROL MANUAL
APPENDIX E
PART III
TO
WATER CONTROL MASTER MANUAL
RED RIVER BASIN

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PERTINENT DATA
BROKEN BOW DAM AND RESERVOIR

LOCATION: On the Mountain Fork River, a tributary of the Little River, at river mile 20.3, in McCurtain County, Oklahoma.

DRAINAGE AREA: 754 square miles above the dam.

DAM:

Type:	Rolled Earthfill
Length:	2,750 feet (not including spillway)
Top of Dam:	645 feet, NGVD
Maximum Height:	225 feet above streambed
Crest Width:	32 feet

SPILLWAY:

Location:	7000 feet NW of right abutment
Type:	Concrete , gated ogee weir
Crest Elevation:	587.5 feet, NGVD
Length:	376 feet (320 feet opening)
Control:	8 tainter gates, 40' x 40'
Hoists:	Individual electric motors

DIKE:

Location:	One on right abutment near the embankment
Type:	Earthfill
Maximum Height:	45 feet
Crest Width:	10 feet
Length:	900 feet

OUTLET WORKS:

Type and size:	One 17-foot diameter concrete-lined diversion tunnel (Discharges into old river channel) One 24-inch corrugated metal pipe near tunnel
Location:	Through main embankment
Control:	Four 5- by 7- foot hydraulic slide gates placed in tandem in each of two openings
Use:	Discharge outlet below elevation 559.0

WATER SUPPLY FACILITIES: A 4- by 4-foot sluice low flow supply line extends through the spillway weir (this is used to help meet daily downstream flow requirements). A parallel 24-inch water supply pressure conduit is included and is located parallel to the sluice.

HYDROPOWER FACILITIES: Power penstock is a 25-foot-diameter, 1820-foot steel-lined tunnel which extends from the intake structure, near the left abutment of the dam, to the powerhouse. Power is generated with two 50,000-kW generators.

**PERTINENT
LAKE INFORMATION
ELEVATIONS, AREAS, AND STORAGES**

Feature	Elevation (feet NGVD)	Lake Area (acres)	Lake Capacity			Spillway Capacity (cfs)
			Accumulative (Acre-feet)	Runoff ⁽²⁾ (inches)	Incremental (Acre-feet)	
<u>Initial Development</u>						
Top of Dam	645.0					
Maximum Pool	639.7	20492	1601493	39.82	140753	443000
Surcharge Pool	632.5	18850	1460740	36.31	92440	340000
Top of Flood Control Pool	627.5	17930	1368300	34.03	450056	283000
Top of Conservation Pool	599.5	14183	918244	22.83	—	40000
Spillway Crest	587.5	12603	757574	18.84	—	0
Top of Inactive Pool	559.0	9220	448457	11.15	—	—
Flood Control Storage (3)	559.5-627.5	—	450056	11.19	—	—
Conservation Storage	559.0-559.5	—	469820	11.68	—	—
Streambed at Dam (1)	420.0	—	—	—	—	—

(1) 317,320 acre-feet (hydropower), xx,xxx (water supply), xx,xxx acre-feet (trout fishery) (Presently 152,500 acre-feet total water supply and trout fishery use)

(2) Runoff from uncontrolled drainage basin area 754 square miles.

(3) Varies with seasonal pool plan (April – September)

BROKEN BOW LAKE
MOUNTAIN FORK RIVER, OKLAHOMA

APPENDIX E
PART III
TO
WATER CONTROL MASTER MANUAL
Red RIVER BASIN

I - INTRODUCTION

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

1-02. Purpose and Scope. The purpose of this manual is to document the water control plan, to present detailed information pertinent to the regulation of Broken Bow Lake, and to give guidance to personnel who are concerned with or responsible for regulation of the lake during the life of the project.

1-03. Related Manuals. This manual is Appendix E, Part III to the Red River Water Control Master Manual. Other related manuals are:

- a. Design Memorandum No. 2 (Hydrology) (Jan 60)
- b. Design Memorandum No.4B (Broken Bow Lake, Master Plan (Updated)) (Jun 79)
- c. Operation and Maintenance Manual Volume II, Flood Emergency Plan (Nov 84)
- d. Lower Red River Drought Contingency Plan (Jan 93)
- e. 11 other various design manuals (DM's)

The locations of existing, under construction, and authorized projects in the Tulsa District are shown on Plate 1-1.

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

1-05. Operating Agency. The Corps of Engineers is the operating agency for Broken Bow Lake. The Pine Creek Lake Manager, under the Hugo Project Manager of the Operations Division, Tulsa District, is responsible for the operation of the project. (b) (7) (F)

(b) (7)(F)

(b) (7)(F)

However, when the project is in flood control operations, project personnel will closely monitor the project and the downstream river reaches. The project office is furnished a list of Hydrology and Hydraulics Branch personnel to contact when necessary (page ii). The Powerhouse Superintendent will furnish the Water Control Section with a current list of project personnel to contact during non-duty hours for emergency operations.

1-06. Regulating Agencies. The Corps of Engineers is the regulatory agency for Broken Bow Lake. The Water Control Section of the Hydrology and Hydraulics Branch, Tulsa District is responsible for regulating the lake according to the water control plan.

II - DESCRIPTION OF PROJECT

2-01. Location. Broken Bow Dam is located at river mile 20.3 on the Mountain Fork River about 9 miles north of Broken Bow, Oklahoma. The dam and reservoir are located in McCurtain County. The location and vicinity of the project is shown on Plate 2-1. Supplementary Pertinent data for Broken Bow Lake is given in Exhibit A.

2-02. Purpose. Broken Bow Dam and Reservoir is a multi-purpose project authorized for flood control, hydropower, water supply, recreation, and fish and wildlife. The project was designed to provide maximum flood protection on the Mountain Fork and Little River when operated in conjunction with the other flood control projects in the Little River Basin.

2-03. Physical Components.

a. Embankment. The main embankment is a 2,750-foot rolled earthfill structure consisting of random and impervious fill with an impervious core. The crest of the embankment is at elevation 645.0 with a maximum height of 225 feet above the streambed. The width of the embankment at crest height is 32 feet, including 24 feet of roadway paving with 4-foot double bituminous shoulders, which extends across the top of the dam. A rolled earthfill dike is located 1,400 feet north of the main dam on the right abutment and is 900 feet long. The dike has a top width of 10 feet and a top elevation of 645.0 feet. The upstream slopes of the embankment are protected by 2 feet of dumped riprap on 9 inches of crushed rock backing material. The downstream slopes are grass and gravel covered. A general plan and a section of the embankment and dike are shown on Plate 2-2.

b. Spillway. The spillway is a gated, concrete gravity, ogee weir structure

located in a saddle topographic feature about 7,000 feet northwest of the right abutment of the dam. The gross width is 376 feet with a net overflow width of 320 feet and a crest elevation of 587.5. Flows over the spillway are controlled by eight 40-foot wide by 40-foot high tainter gates, which are operated by individual hoists powered by electric motors. The rate of travel for each gate is approximately one foot of arc per minute. A diesel generator is located at the project as an emergency back-up power source and is capable of operating one gate at a time. A sloping apron, which terminates in a flip bucket, extends 150 feet downstream from the weir axis. A section through the spillway is shown on Plate 2-2.

c. Outlet Works.

(1). Low flow facilities consist of a 4-foot square conduit and a 24-inch water supply pressure conduit, which are parallel to one another in the spillway weir. The 4-foot conduit extends through the weir and discharges onto the sloping spillway apron. Two motorized operated slide gates control it. Opening is physically measured by the number of shaft rotations observed through a special window in the structure. The upstream gate is predominately reserved for emergency use. The conduit is predominately used to make low flow releases from the lake above elevation 551.0 to support the downstream fishery. The intake for the 24-inch pipe is adjacent to the 4-foot conduit and ends in a manhole behind the right training wall. Presently, the City of Broken Bow uses the 24-inch line to access its water supply which is pumped to a nearby treatment plant.

(2). A 17-foot diversion tunnel through the left abutment of the main embankment (dam) acts as an emergency low level outlet facility to discharge water below elevation 559.0. This low level outlet is operated by four 5 feet by 7 feet hydraulic slide gates placed two in tandem in each of two openings. The two upstream gates are reserved for emergency use and are not routinely operated. The tunnel

discharges into the old river channel. General location of the outlet works is shown on Plate 2-2.

d. Powerhouse. The powerhouse is located about 1,800 feet south of the dam. The power penstock is a 25-foot diameter tunnel, which extends from the intake structure near the left abutment of the dam, a distance of 1,820 feet south across the river loop, to the powerhouse. The powerhouse contains two 50,000-kW, vertical Francis-type turbines. Flow through the penstock tunnel is controlled by two 12 foot by 24 foot tractor gates located in a concrete gate tower at the tunnel entrance and two hydraulically operated butterfly valves located at the powerhouse. The tailrace is an excavated channel 100 feet wide and 400 feet long with reinforced concrete retaining walls on both sides and concrete paving to elevation 390.0. A section through the powerhouse is shown on Plate 2-2.

e. Reregulation Dam. The reregulation dam is located on the Mountain Fork River at river mile 11.6, which is 8.7 river miles downstream of Broken Bow Dam. The location of the reregulation dam is shown on plates 2-1 & 2-4. General Plan & Elevation is shown on plate 2-3.

(1) Hydraulic design. The dam is a concrete gravity ogee weir designed to discharge releases over its entire length at elevation 398.5. It is about 810 feet long with a maximum height of 37.5 feet. A flip bucket with a 20-foot radius is provided downstream of the dam to direct flows away from the structure. The flip bucket ends in an end sill that is 3.5 feet above the bucket invert. Five 8.5-foot wide by 5.0-foot high uncontrolled sluices pass through the dam near the right abutment. The inverts of the sluices are at elevation 387.5. Storage is provided for continuous low flow requirements of at least 100 cfs. A full reregulation pool can sustain this discharge for 3-4 days with no discharge from Broken Bow Lake. Four 24-inch uncontrolled low flow pipes pass through the weir near the center of the streambed. These pipes have

an invert elevation of 363.0 and are sized to provide a minimum discharge of 200 cfs, which was, in 1960, a discharge recommendation from the former Public Health Service. However, actual discharge is somewhat less due to continuous clogging of the low flow pipes by rocks and other debris. In 1972, the Environmental Protection Agency ended any requirement for water quality releases to offset pollution discharge practices in the area. At that time, the only other requirement was 100 cfs as noted by U.S. Fish and Wildlife Service (October 1960). The project is regulated according to the U.S. Fish and Wildlife Service recommendation. No effort will be made to clear the pipes unless it appears that a minimum flow of 100 cfs cannot be maintained.

(2) Reregulation Requirements. The reregulation dam is required to satisfy low flow requirements of the U.S. Fish and Wildlife Service and smooth fluctuations caused by variable power releases. Conditions which will be satisfied by the reregulation dam are described below.

f. Sedimentation and Degradation Ranges. As expected, sediment deposition in the reservoir has been extremely light. Sediment ranges have not been established. Cross sections have been taken throughout the reservoir area and sediment ranges will be established if a need develops.

g. Water Supply Facilities. Currently, the City of Broken Bow withdraws contracted water supply through the spillway weir as described in 2-03 c. to a pump house on the right bank of the channel. This water is then pumped to a treatment plant, owned by the City of Broken Bow, 3 miles west of Broken Bow Lake.

h. Project Office. The Broken Bow project office was turned over to the State of Oklahoma on 1 October 1995. The Broken Bow powerhouse falls under the control of the Hugo Area Office and is the only Corps office at the lake.

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

2-05. Real Estate Acquisition. The fee taking line is a blocked perimeter to elevation 632.0. This was established from the envelope curve of backwater effects of the 50-year flood with 50 years of estimated sedimentation. Generally, the fee taking line is not closer than a minimum distance of 300 feet horizontally from the static full pool, elevation 627.5. There is a small amount of flowage easement in the upper reaches of the reservoir and on the tributaries. The fee taking line is shown on plate 2-4.

2-06. Public Facilities.

a. The Corps of Engineers maintains two small public use areas, which consist of one overlook area near the spillway and one near the main embankment. The other park near the reregulation structure was turned over to the State of Oklahoma in 1995. The reregulation park has campsites with sanitary facilities, drinking water and, electricity available. Also available are several public boat ramps, and swimming beaches above and below the dam. On the upper end of the reservoir is Broken Bow Marina which is maintained and operated by a private vendor.

b. The State of Oklahoma also maintains Mountain Fork State Park, Hochatown State Park, and Beaver's Bend State Park, a modern 50-room lodge on the lake and a game management area through a lease from the Government. Plate 2-4 is a map of the reservoir and the location of the various public use areas.

III - HISTORY OF PROJECT

3-01. Authorization. Broken Bow Dam was authorized for construction by the Flood Control Act of 3 July 1958 (Public Law 85-500, HD 170, 85th Congress) and the Flood Control Act approved 23 October 1962, SD 137, 87th Congress, 2nd Session. Modifications to this were made by the Water Resources Development Act of 1996 (WRDA 96) (Exhibit E)

3-02. Planning and Design. The Chief of Engineers first made recommendations for the Little River and tributary reservoirs for flood control, navigation, power, and irrigation in the comprehensive report on the Red River, published in 1936 as House Document No. 378, 72nd Congress, 2nd Session. At that time it was recommended that Federal participation in further flood control in the region be limited to contribution of a portion of the backwater levee costs as provided under existing law. A possible reservoir was considered on the Mountain Fork River in House Document No. 602, 79th Congress, 2nd Session, but no recommendations for construction were made. A need for further studies of upstream reservoirs in the Little River watershed, including the Mountain Fork River, was recognized in HD 488, 83rd Congress, 2nd Session. The 85th Congress recommended that consideration be given to Broken Bow Lake along with Pine Creek, Lukfata, DeQueen, Gillham, Dierks, and a smaller Millwood project. At this session of the 85th Congress, House Document No. 170 presented a study of the Little River Basin. It recommended construction of Broken Bow Lake along with Pine Creek, Lukfata, Dequeen, Gillham, Dierks, and a modified Millwood Lake. The project plan was deferred pending completion of additional investigations to determine if a project could be developed at a downstream site. A series of design memorandums were prepared in connection with planning and construction of Broken Bow Dam, Powerhouse and Reservoir. These reports cover the site selection, hydrology,

structural features, relocation of roads and utilities, and real estate.

3-03. Construction Activities. A summary of construction activities for Broken Bow Lake is presented in Table 3-1.

TABLE 3-1

SUMMARY OF CONSTRUCTION ACTIVITIES

<u>Activity</u>	<u>Date</u>
Construction Began	27 October 1961
Date of Diversion	4 September 1964
Final Storage Began	3 October 1968
Conservation Pool Filled	25 April 1970

3-04. Related Projects. Broken Bow Lake is an integral component of a six reservoir system, which includes Pine Creek, Dequeen, Gillham, Dierks and Millwood Lakes, that provides flood control and other multiple purpose benefits to the Little River Basin. A seventh reservoir on Lukfata Creek at Cedar Point was originally authorized as part of the system, but has not been constructed. The six completed projects are operated as a system to control flooding in the Little and Red Rivers. Millwood Lake receives flow from the other five lakes

3-05. Modification to Regulations.

a. Temporary Deviations from the top of conservation pool in support of manipulation plans were implemented starting in 1994 to benefit the trout fishery below the lake on the Mountain Fork River. The seasonal pool plan, shown on Plate 7-18, was first implemented as a temporary deviation in 1998 and 1999 following a public

meeting in September 1997. The Water Resources Development Act of 1999 (Exhibit G) modified the project to include this seasonal pool plan providing the adjustment is made at no cost to the Government with adequate protection of water and related resources. These items are currently under review. The seasonal pool plan will be adopted permanently once the studies of effect on historical sites and endangered species are completed.

b. Regulating stage at Horatio has changed several times in the past 25 years. Originally it was set at 20.0 feet after preliminary reconnaissance in 1970; it was permanently changed to 21.5 feet, as approved by SWD in 1981. In 1994, the stage was changed via long-term deviation to 20.5 feet to improve access on one county road, which affected one family that lived on a stilted house directly on the Little River at Horatio. This is the current approved regulating stage until such time that Red River system studies are conducted and public meeting are held.

3-06. Principal Regulation Problems.

a. The principal regulating problem for Broken Bow Lake is the trout fishery below the dam. The fishery requires relatively cool temperatures to sustain the non-native trout through the hot and dry Oklahoma summer. Daily automated and manual monitoring of the water and air temperature at several locations is used to determine release levels (spill and hydropower) to sustain the fishery. This is accomplished through a constant spillway release and a hydropower generation schedule, which varies according to changes in water and air temperatures.

b. A second problem is a series of bridges below the spillway. Releases above 1,100 c.f.s. will exceed the capacity of the box culvert on the first bridge below the spillway. Should hydropower units be unavailable during a flood, releases will be made through the spillway to evacuate the flood control pool. The other bridges have stop logs, which should be removed if high spillway releases are anticipated. Currently, the

Powerhouse personnel and State of Oklahoma personnel share in the effort to remove stoplogs.

c. Also, a few residents have encroached the natural flood plain near Horatio, Arkansas. One resident lives in a home on stilts which directly overlooks the main Little River channel. When releases and uncontrolled runoff exceed a stage of approximately 20.5 feet at Horatio, some of these residents cannot safely access their homes due to water over access roads. The National Weather Service in Shreveport, maintains a warning call list which includes several residents who live near the river at Horatio, Arkansas.

IV - WATERSHED CHARACTERISTICS

4-01. General Characteristics. The Mountain Fork River rises in the mountainous country of Le Flore County in southeast Oklahoma. It is 96.4 miles long. From its headwaters in the Ouachita National Forest, it flows easterly from Le Flore County, into Polk County, Arkansas. At a point approximately 7 miles west of Mena, Arkansas, the Mountain Fork turns southwest to return to Oklahoma at the extreme northeast corner of McCurtain County. Near Smithville, Oklahoma, the river bends in a southerly direction for 35 miles, where it empties into the Little River at river mile 87.1. This point of confluence is 6 miles south of Eagletown, Oklahoma. The total drainage area of the Mountain Fork River is 842 square miles.

4-02. Topography. Most of the drainage area is located in the heavily timbered and mountainous hill country of the Ouachita Mountain Physiographic Province. The elevation of the headwaters of the Mountain Fork is in excess of 1,700 feet. From this point the land descends to about elevation 290 at the mouth of the Mountain Fork River on the Little River. There is a considerable overflow area near the mouth of the river. The channel slope varies from about 12 feet per mile in the upper reaches to 4 feet per mile in the lower reach. A stream profile of Mountain Fork River and its principal tributaries is shown on plate 4-1.

4-03. Geology and Soils. Bedrock at the dam is Stanley Shale formation of Mississippian-Pennsylvanian Age. This formation consists of hard quartzite sandstones and hard sandy shales.

4-04. Sediment. The lake inflow carries only a small amount of sediment from the heavily forested upper Mountain Fork River. Should land use change due to increased harvesting for the local paper mills then the sediment load may increase in the future.

There have been no new sediment surveys since impoundment and none are scheduled until sedimentation rates increase to significant levels.

4-05. Climate. The Mountain Fork River watershed lies in a region characterized by moderate winters and comparatively long summers of relatively high temperatures. The average annual temperature at Broken Bow Dam of approximately 61 degrees F is representative of the watershed above and below the dam. Average monthly temperatures range from approximately 41 degrees F in January to 79 F in July. The mean annual precipitation over the watershed is 53 inches. The average annual snowfall is light and averages about 3 inches. The prevailing winds are from the south, with the greatest wind movement occurring during the spring months. Climatic characteristics for the basin are shown in the following tabulation. The average monthly and annual rainfall and runoff data are shown in Table 4-1.

TABLE 4-1
AVERAGE MONTHLY AND ANNUAL RAINFALL AND RUNOFF
UPSTREAM OF BROKEN BOW DAM

Month	(1) Basin average rainfall (inches)	Percent average annual rainfall	Average Runoff (2)		Percent average annual runoff
			(acre-feet)	(inches)	
January	3.46	6.6	106,800	2.66	11.1
February	3.63	6.9	116,600	2.90	12.1
March	4.60	8.7	141,000	3.51	14.7
April	5.31	10.0	130,300	3.24	13.6
May	6.41	12.1	144,000	3.58	15.0
June	4.36	8.2	51,900	1.29	5.4
July	4.45	8.4	27,800	0.69	2.9
August	3.48	6.6	13,000	0.32	1.3
September	4.28	8.1	21,600	0.54	2.3
October	4.41	8.3	41,300	1.03	4.3
November	4.37	8.3	65,800	1.64	6.9
December	4.16	7.8	100,100	2.49	10.4
Total	52.92	100.0	960,200	23.89	100.0

(1) Period of record: 1930-1994.

(2) Contributing drainage area above Broken Bow Dam = 754 square miles.

a. Temperature.

Mean annual at Broken Bow Dam (1962-1994)	61.2 degrees F
Maximum (Smithville, OK 10 August 1936)	115 degrees F
Minimum (Smithville, OK, 2 February 1951)	-22 degrees F

b. Precipitation. (basin average above Broken Bow)

Mean annual (1930-1994)	52.9 inches
Maximum annual (1968)	68.2 inches
Minimum annual (1956)	29.8 inches
Percent during growing season (April-September)	54.0 percent

c. Snowfall. The mean annual snowfall in the basin upstream of Broken Bow dam is 3.0 inches.

d. Evaporation. The estimated monthly pan evaporation at Broken Bow Dam is shown in Table 4-2.

e. Wind. The prevailing wind during most times of the year is from a southerly direction with the highest winds occurring during the spring months.

TABLE 4-2
AVERAGE MONTHLY PAN EVAPORATION
BROKEN BOW DAM

Evaporation (inches) (1)		
	<u>Average</u>	<u>Drought Periods</u>
January	1.83	2.13
February	2.37	3.33
March	4.00	4.79
April	5.02	6.33
May	5.70	6.75
June	7.12	8.28
July	8.28	10.10
August	7.70	9.49
September	6.18	7.78
October	4.07	5.30
November	2.44	3.27
December	<u>1.85</u>	<u>2.18</u>
Annual	56.56	69.73

(1) National Weather Service Class "A" Pan (1980-1994)

4-06. Storms and Floods. Most of the flood-producing rain events over the Mountain Fork River watershed have duration of 2 to 10 days. The longer duration storms usually consist of two or three periods of intense precipitation with moderate periods of intervening precipitation, resulting in high percentages of runoff. The heaviest rainfall is generally in March, April, and May with a noticeable decrease in runoff during the latter part of June. On the average the winter months have low rainfall totals and few major runoff-producing storms. The largest flood of record on the Mountain Fork River measured at Eagletown gage below Broken Bow Dam occurred in May 1960, before the dam was built. The peak stage was 26.73 feet with a flow of 101,000 c.f.s. on 20 May 1960. An intense three-day storm contributed to the record flow at Eagletown. The peak monthly volume past the dam site was 629,000 acre-feet, which occurred in

March 1945. In November 1971, Broken Bow Lake received a peak inflow of 152,000 c.f.s., which is the highest peak flow in the period of record near the damsite. Since the dam has been built, the largest flood producing storms occurred in the spring of 1990. On 23 May 1990, Broken Bow reached its record pool of elevation 622.66. Major storms with a basin average precipitation of 5 inches or more above Broken Bow Reservoir are shown in Table 4-3. The average rainfall amounts were computed from records of stations in the watershed area and do not necessarily record the center of intense storms. Major floods at gages below Broken Bow Dam are presented in Table 4-4.

TABLE 4-3
MAJOR STORMS
JANUARY 1930 THROUGH DECEMBER 1996

BROKEN BOW DAM

Inclusive Dates	Average Basin Rainfall (inches)	Inclusive Dates	Average Basin Rainfall (inches)
02-06 May 1935	6.50	21-22 Sep 1965	5.50
14-18 Jun 1935	7.36	23-30 Apr 1966	5.99
20-24 Jan 1938	9.76	11-15 Aug 1966	5.20
14-18 Feb 1938	6.93	30 Oct- 03 Nov 1967	5.20
14-24 Apr 1941	5.26	28 Jan- 02 Feb 1968	5.08
29 Apr - 3 May 1944	5.49	08-14 May 1968	8.82
19-21 Feb 1945	5.08	16-22 Apr 1971	5.60
29-30 Mar 1945	8.74	14-24 Oct 1971	7.00
10-14 Jun 1945	5.19	02-10 Dec 1971	14.50
25-29 Sep 1945	9.42	03-26 Apr 1973	8.50
23-25 May 1946	5.00	01-05 May 1973	5.75
02-07 Nov 1946	8.54	14-17 Nov 1978	7.25
10-12 Dec 1946	5.22	24-30 Sep 1980	9.41
12-18 May 1947	5.78	30 Jun -09 Jul 1981	5.00
28-29 Aug 1947	5.85	12 May - 31 May 1982	11.63
31 Dec - 01 Jan 1948	5.22	10-26 Oct 1984	9.74
23-28 Jan 1949	7.57	17-21 May 1990	6.32
12-13 Feb 1950	5.37	12-18 Apr 1991	8.99
12-17 Sep 1950	7.81	25 Oct - 01 Nov 1991	10.16
10-15 May 1953	5.33	19-22 Sep 1992	5.44
20-22 Jul 1953	6.40	17 Oct - 05 Nov 1993	17.35
28 Sep - 02 Oct 1954	8.94	07 Jul - 18 Jul 1994	6.40
23-27 Apr 1957	5.79		
22-26 May 1957	5.34		
19-21 May 1960	5.33		
22-25 Jun 1965	5.05		

4-07. Runoff Characteristics. The Mountain Fork watershed above Broken Bow Dam is composed of one major drainage basin of 754 square miles. To the west, Pine Creek Lake controls the runoff from 635 square miles at the upper end of the Little River basin. Flows from Pine Creek Lake, the unregulated Glover River, the Mountain Fork River (regulated by Broken Bow Lake) and Rolling Fork (regulated by Dequeen Lake) combine near Horatio, Arkansas which is the principal downstream regulation point for Broken Bow Lake. The hilly, forested region of southeast Oklahoma comprises most of the watershed above Broken Bow Lake. This region is largely devoted to the timber industry. A significant amount of trees are harvested and processed into paper products in this remote area. The steep slopes and rocky soils in the basin contribute to high runoff if antecedent rainfall is above normal. The resultant hydrographs generally have high peak flows of short duration. Travel time for runoff from the upper Mountain Fork River to Broken Bow Lake is approximately 18-24 hours. The inflow volume frequencies for each month are shown in Table 4-5. Plate 4-2 shows the flow duration curve for inflow and outflow to the Lake. Estimated monthly and annual average flows (1930-1995) are shown in Table 4-6 on pages T 4-1 & T 4-2.

TABLE 4-5
INFLOW VOLUME FREQUENCY
(1930-1995)

Exceedance Frequency (percent)	Monthly Inflows in Thousands of Acre-Feet											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
50	72	96	122	103	104	29	9	5	7	13	43	71
20	147	182	211	185	203	81	36	18	27	63	123	166
10	211	243	273	251	282	135	72	34	56	137	197	246
5	279	303	335	323	381	204	127	55	100	254	280	332
2	377	379	415	428	493	320	238	96	191	494	400	454

4-08. Water Quality. The quality of water in Broken Bow Lake is considered good,

requiring only conventional treatment to be suitable for domestic and industrial use. The lake was authorized in part to provide water supply for the adjoining communities. Presently, there is 152,500 acre-feet of water supply storage (pending reallocation) in Broken Bow Lake. Of this amount, 8,355 acre-feet is under contract for water supply (4,301 acre-feet in present use, 4,054 acre-feet in future use). The balance of uncontracted water supply storage (144,145 acre-feet) is utilized for hydropower on an interim basis as authorized by Congress. *(XX,XXX acre-feet of uncontracted water supply was reallocated to the trout fishery in 200X)*. The water is considered very good for temperature and dissolved oxygen for the downstream trout fishery, which is maintained by the State of Oklahoma.

4-09. Channel and Floodway Characteristics. The regulating channel capacity below Broken Bow Dam is currently 8,000 c.f.s.. The regulating channel capacity increases to approximately 11,400 c.f.s. at the Eagletown gage located 11.4 river miles downstream of the dam. Travel time for releases from the dam/powerhouse area to the Eagletown gage is approximately two and one half-hours. The current regulating channel capacity increases to 16,300 c.f.s. or 20.50 feet at Horatio, Arkansas. This is a regulating stage is a temporary deviation approved in 1994 by SWD and which is subject to results of a Red River System Study. The regulating stage has varied between 20.00 feet (1973) and 21.50 feet (1974-1994) over the years. Encroachment into the flood plain currently restricts regulated flows to about 20.50 feet at Horatio. The NWS uses a flood stage of 26 feet at Horatio, Arkansas. Travel time from Broken Bow Dam to Horatio gage is approximately 18 hours. Pertinent data for stream gaging stations above and below the dam are presented in Table 4-7 and the discharge rating curves for Horatio and Eagletown are on Plates 4-3 and 4-4. Plate 4-5 shows the time of crest travel times between gaging stations along the Mountain Fork and Little Rivers.

TABLE 4-7
PERTINENT DATA FOR STREAM GAGING STATIONS

<u>Stream and Station</u>	<u>Miles Above Mouth</u>	<u>Drainage Area (sq. miles)</u>	<u>Gage Datum (ft NGVD)</u>	<u>Flood Stage (ft)</u>	<u>Bank Full Capacity (cfs)</u>	<u>Maximum Flood of Record</u>		
						<u>Date</u>	<u>Stage (ft)</u>	<u>Discharge (cfs)</u>
Mountain Fork River								
Smithville, OK	55.6	320	664.70	NA	NA	12-15-93	22.58	29,100
Eagletown, OK	8.9	787	333.87	9.0	11,400	5-20-60	26.73	101,000

Little River

Horatio, AR	72.0	2,662	272.89	20.5	17,300	3-30-45	37.70	120,000
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2nd Largest Flood of Record

3rd Largest Flood of Record

<u>Stream and Station</u>	<u>Date</u>	<u>2nd Largest Flood of Record</u>		<u>3rd Largest Flood of Record</u>		<u>Period of Record</u>	
		<u>Stage (ft)</u>	<u>Discharge (cfs)</u>	<u>Date</u>	<u>Stage (ft)</u>		<u>Discharge (cfs)</u>
Mountain Fork River							
Smithville, OK	NA	NA	NA	NA	NA	1991-1995	
Eagletown, OK	2-12-50	25.66	91,500	3-29-45	25.80	88,500	1930-1995
Little River							
Horatio, AR	01-25-38	36.93	110,000	02-19-38	36.65	106,000	1930-1995

4-10. Upstream Structures. There are no operational structures upstream of Broken Bow Dam and Reservoir.

4-11. Downstream Structures. Operational structures downstream of Broken Bow Dam include the Reregulation structure on the Mountain Fork, Millwood Lake on the Little River and the five locks and dams on the lower part of Red River.

4-12. Economic Data.

a. Population. The population of the Arkansas and Oklahoma counties and their major cities that are transversed by the Mountain Fork/Little River Basin are shown in Table 4-8. The population of most of these counties has been increasing since the 1960's.

TABLE 4-8

POPULATION OF ARKANSAS AND OKLAHOMA COUNTIES AND CITIES
MOUNTAIN FORK RIVER BASIN 1960-1990

County or City	1960	1970	1980	1990	% Change 1970-1990
Le Flore County	29,106	32,137	Note 1	43,270	+35%
McCurtain County	25,851	28,642		33,433	+17%
(Broken Bow)	(2,087)	(2,980)		(3,961)	+33%
(Idabel)	(4,967)	(5,946)		(6,957)	+17%
OKLAHOMA TOTAL	54,957	60,779		76,703	+26%
Polk County	11,981	13,041		17,347	+33%
(Mena)	(4,388)	(4,481)		(5,475)	+22%
ARKANSAS TOTAL	11,981	13,041		17,347	+33%
BASIN TOTAL	66,938	73,820		94,050	+27%

Note 1: 1980 Census Data Unavailable for this area

b. Agriculture. The timber industry is the major legal agricultural product in the Mountain Fork River drainage basin. The production and annual value of crops in the Mountain Fork River valley from Broken Bow Dam to Millwood Lake are shown in Table 4-9.

c. Industry. The chief industry in the Mountain Fork River basin is related to the timber/paper industry. Recreation at the area lakes, rivers and camp grounds is also a major contributor to this area. In general, the area is experiencing a declining economy.

TABLE 4-9
ANNUAL PRODUCTION AND VALUE OF CROPS
BROKEN BOW DAM TO MILLWOOD RESERVOIR
 (1996 Normalized Prices)

Crops	Acres	\$ Value
Alfalfa Hay	2313	\$657,000
Commercial Timber	6990	\$245,000
Soybeans/Wheat	700	\$115,000
Pasture		
Open	12,832	\$1,582,000
Woods	9,088	\$ 560,000
Total	31,930	\$3,159,000

Wheat and Soybeans alternate annually

d. Flood Damages. Table 4-10 shows the estimated average annual flood damages prevented from Broken Bow Dam to the upper limits of Millwood Lake. Based on flood damage calculations from 1970 to 1996, Broken Bow Lake has

prevented approximately \$19,800,000 in flood damages. Structural loss and area curves are shown on Plates 4-6 through 4-8.

TABLE 4-10

FLOOD DAMAGES PREVENTED

ESTIMATED AVERAGE ANNUAL

<u>Year</u>	<u>Damages Prevented (Dollars)</u>
FY 89	1,063,000
FY 90	1,158,000
FY 91	737,000
FY 92	186,000
FY 93	94,000
FY 94	844,000
FY 95	0
FY 96	0
FY 97	0
Cumulative (1970-1997)	19,819,000

V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01. Hydrometeorological Stations.

a. Facilities. The Hydrology-Hydraulics Branch, Tulsa District Office; the National Weather Service (NWS); and the U.S. Geological Survey (USGS) cooperate to collect data and maintain a reliable communication network. All pertinent reporting observation stations for Broken Bow Lake are again shown on Plate 2-1.

The important stream gaging stations on the Mountain Fork and Little Rivers have automated gages, which consist of floatwells, or bubble gages geared to digital recorders on Data Collection Platforms (DCP). The DCPs record and transmit the data to the Hydrology-Hydraulics Branch computer through a system of satellites and downlinks. The stream gage used in forecasting inflows into Broken Bow Lake is located on the Mountain Fork River near Smithville. The stream gages used to regulate flows downstream of the dam are located on the Mountain Fork River near Eagletown, Oklahoma on the Highway 70 bridge and on the Highway 41 bridge near Horatio, Arkansas. The USGS maintains all of the automated stream gages along the Mountain Fork and Little Rivers and takes streamflow measurements periodically to develop accurate rating curves. Powerhouse personnel occasionally take low-flow spill measurements below the spillway to determine the adequacy of releases for the fishery.

Automated precipitation gages are located at the entire automated stream gaging stations along the Mountain Fork and Little Rivers. These gages are connected to a DCP that records and transmits the precipitation data along with the stage data. Automated precipitation stations with DCPs are also located above Broken Bow Reservoir near Honobia, Oklahoma. Pine Creek Lake, Dequeen Lake, Broken Bow

Lake, Smithville stream gage, Eagletown stream gage, and Horatio stream gage also have automated precipitation gages and DCPs. The NWS maintains a network of local rainfall observers throughout the Mountain Fork and Little River Basins who report precipitation to the NWS on a daily basis. Weather stations located at the Pine Creek Lake and at the Broken Bow Powerhouse have equipment for monitoring precipitation and evaporation. Evaporation is also calculated, using various hydrometeorological variables, each day by the Water Control Section for each project.

Water temperature is continuously monitored on the lower Mountain Fork River and transmitted via DCP. The four current stations are shown on Table 5-1. This is of great use in monitoring the trout fishery. The Oklahoma Department of Wildlife Conservation (ODWC), Tulsa District, and Southwestern Power Administration all monitor water and air temperatures at the fishery. ODWC normally requests modifications, through Tulsa District, to water release plans in order to sustain the fishery. Penstock temperatures are read by powerhouse personnel upon request. These temperatures vary greatly depending upon amount of water being used for hydropower generation and are useful in monitoring the trout fishery.

An automated gage and a data logger located in a gage house on the dam monitor pool elevations at Broken Bow Lake. A DCP is connected to the gage to record and transmit the pool elevation and precipitation data via satellite. A wire weight gage is located near the dam and can be used to verify the elevations recorded at the automated gage or as backup during equipment failures.

b. Reporting. The NWS maintains a network of rainfall and stream observers in the basin that report directly to the NWS on a daily basis. Observer reports are put into the Automated Field Observing Station (AFOS) computer network by the NWS. All

C AFOS data is directly accessed by the Hydrology-Hydraulics Branch computer network located at the District office. Hourly precipitation, stream, and pool gage readings from the automated gaging stations are transmitted every four hours or when a threshold value is exceeded via GOES satellite to a downlink owned and operated by the National Oceanic and Atmospheric Administration (NOAA) near Washington, D.C. Data is then transmitted to a domestic satellite (DOMSAT) which in turn passes the data to Tulsa District via a downlink. This data is automatically put into the database on the computer network in the Hydrology-Hydraulics Branch and is also available via modem (918-669-7110) or on Tulsa Districts INTERNET site (www.swt-wc.usace.army.mil). The reporting criteria for the pertinent precipitation and stream gaging stations are shown in Table 5-1. Rainfall is collected and recorded by the project personnel at the Broken Bow Powerhouse office. District Office personnel can be contacted at: telephone 918-669-7131, and VHF-FM radio, call signal WUI-3. Detailed instructions on project reporting criteria are presented in paragraph 2 (Page C-1) of Exhibit C, "Standing Instructions to Project Manager."

TABLE 5-1

REPORTING CRITERIA FOR PERTINENT STATIONS

Station	Report to	Times of Report
<u>Rainfall Stations</u> Airport Stations	National Weather Service	6-hour rainfall as of 6 a.m., 12 noon, 6 p.m., and 12 midnight
Corps of Engineers Dams	Corps of Engineers	Reporting criteria as listed in paragraph 5-07.d. (1-4)
Automated Gages	Data Collection Platform	Hourly or as needed
Observer Stations	National Weather Service	At 7:00 a.m. and additionally every 6 hours as directed by the NWS
<u>Stream Gaging Stations</u>		
Mountain Fork River Smithville Re-Reg Structure Eagletown	Data Collection Platform Data Collection Platform Data Collection Platform	Hourly readings transmitted every 4 hours; random transmissions triggered when set threshold values are exceeded
Little River Wright City Idabel Horatio	Data Collection Platform Data Collection Platform Data Collection Platform	Hourly or as needed
Glover River Glover	Data Collection Platform	" " " " " "
Water Temperature Stations		
Mountain Fork River Swim Beach Re-Reg Dam Presbyterian Falls Eagletown (Hwy 70)	Data Collection Platform Data Collection Platform Data Collection Platform Data Collection Platform	Hourly readings; transmitted every 4 hours

c. Maintenance. The maintenance and repair of the automated stream and precipitation stations in the Mountain Fork River Basin is the responsibility of both the Corps of Engineers and the USGS. Both the Corps of Engineers and the USGS have stream-gaging equipment and the Corps has contracted with the USGS for maintenance of the Corps owned stream and precipitation gaging equipment in the Little River Basin. The maintenance and repair of the observer weather stations is the responsibility of the NWS.

d. Automation. The reporting of data from lake, stream and precipitation gaging stations has been automated through the use of Data Collection Platforms (DCP). The DCPs collect and transmit hourly and random (if triggered) data to the GOES satellite which is then received by a downlink to a central computer operated by the National Oceanic and Atmospheric Administration (NOAA). The data is then retransmitted to a DOMSAT satellite and is received by a downlink directly into the computer network located in the Hydrology-Hydraulics Branch at the Tulsa District Office. The DCP data is then processed by the Hydrology-Hydraulics Branch computers and put into a database to be used for regulation of the district reservoir systems. Observer rainfall data is currently received automatically from the AFOS network through a dedicated line from the Hydrology-Hydraulics Branch computer to the Tulsa River Forecast Center computer. This data is automatically encoded into the Hydrology-Hydraulics computer database for use in forecasting river flows and reservoir inflows. Weather forecasts, river forecasts, radar depictions, and other weather information is also received automatically from the AFOS network.

5-02. Water Quality Stations.

a. Facilities. Water temperature is the only water quality parameter, which is

currently recorded permanently in the Mountain Fork/Little River Basin (see para 5-01).

b. Reporting. Water quality data from the water quality samples and measurements in the Mountain Fork River are published annually by the USGS in the publication titled "Water Resources Data, Oklahoma". The Tulsa District Corps of Engineers, Planning Division publishes periodic reports of water quality in Broken Bow Lake.

c. Maintenance. Currently there are no permanent water quality reporting facilities that require maintenance in the Mountain Fork River Basin. Maintenance and repair of the water quality sampling and analysis equipment is the responsibility of the operating agency.

5-03. Sediment Stations.

a. Facilities. There are no specified sedimentation ranges upstream of Broken Bow Dam which are used for sedimentation measurements (paragraph 2-03.f.).

b. Reporting. Sediment resurveys are documented and published by the Hydrology-Hydraulics Branch, Tulsa District Corps of Engineers. No sediment resurveys have been completed at Broken Bow Reservoir since impoundment.

c. Maintenance. Maintenance of any future sediment and degradation ranges is the responsibility of the Corps of Engineers.

5-04. Recording Hydrologic Data. Hydrologic information is recorded on a computer database as the Water Control Section, Hydrology-Hydraulics Branch, receives it as follows:

a. Stage, Flow, Elevation and Storage. Hourly river stage and pool elevation data is received automatically through a satellite downlink into the computer network in the Hydrology-Hydraulics Branch. The computer decodes the transmissions and puts the data in a database to be used in various water control programs for regulating the Tulsa District reservoirs. The computer converts river stage to river flow at each gage using a stage-flow rating curve. Lake storage is computed with elevation-capacity tables. All the hourly data from river and Lake Gages is stored on the network database and archived on tape for permanent storage. Lake elevations, discharges, gate settings and changes, and hydropower information are reported on a daily basis by the project to the Water Control Section. Water Control Section personnel enter the project data and computed daily inflows into the network computer database every morning.

b. Precipitation. Precipitation data from the DCP stations and the projects are combined with NWS observer precipitation data and stored in the network rainfall database. Computer programs for plotting the rainfall distribution, determining basin average rainfall, and forecasting runoff (see Chapter VI) can then access this data. Radar estimated rainfall can also be plotted with observed rainfall to calibrate areas where there are no precipitations gages reports.

c. Water Quality Data. Currently, the Corps of Engineers or USGS permanently maintains no recording water quality stations in the Mountain Fork River Basin. Random water quality data is gathered and reported by the USGS as described

in paragraph 5-02.b. USGS reports are received and kept on file at the Hydrology-Hydraulics Branch, Tulsa District Corps of Engineers.

d. Radar and Satellite Reports. Currently, radar images received by the Hydrology-Hydraulics Branch are furnished by Weather Systems Incorporated (WSI). The Weather Channel and Internet sources are also being used to view real time hydrometeorological images from the NWS, USGS and others. Radar summaries, quantitative precipitation forecasts, and weather forecasts are received through a direct connection to the NWS AFOS network. Radar estimated rainfall data is also received from the NWS on a real time basis for comparison with data from precipitation stations.

e. Water Temperature Data. Temperature data from the four Mountain Fork recording stations are also received automatically as a satellite downlink and data is recorded on computer network located in Hydraulics and Hydrology Branch. One station, at the reregulation structure monitors water temperature at three different elevations within the pool. The top level is often exposed to the air as the pool drops.

f. Air Temperature Data. Air temperature is monitored at the reregulation dam and transmitted with the water temperature data via DCP.

5-05. Communication Network. Wire facilities at Broken Bow Reservoir include local and long distance telephone service. Radio communication is by a VHF-FM fixed station (call signal WUI-340) capable of reaching local mobile stations, the Tulsa District Office, and other stations in the District via repeater relay. Maintenance of the telephone lines is the responsibility of the company leasing the lines to the Government. Radio equipment is tested periodically in transmitting and receiving the hydrologic data and civil works activities. The District radio technician makes quarterly

inspections of the project's fixed equipment and makes repairs as conditions warrant. To alert the public of impending gate changes, a warning horn is located near the powerhouse and at four locations between the dam and the reregulation structure. The horns sound for 60 seconds upon activation of either of the two hydropower units.

5-06. Communication With Project.

a. Between Regulating Office and Project Office. Instructions for the storage and release of water from the lake will be communicated by the Water Control Section to the responsible project operating personnel (at the powerhouse) for the implementation of the provisions set forth in Chapter IX of this manual. This communication will normally be made by long distance telephone but could on occasion be made by VHF-FM radio. The reports by the project office, described in paragraph 5-07 and Exhibit C of this manual, will be communicated directly to the Water Control Section at the Tulsa District Office. Should communication between the project and the district offices be disrupted, the Project Manager will, on his own initiative, direct regulation of the lake in accordance with the emergency regulations as required in Chapter VII and Exhibit C of this manual. An organization chart for Flood Control Regulation at Broken Bow Lake is shown on Plate 5-1.

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

c. Between Robert S. Kerr Project Office and Project Office. The Broken Bow powerhouse has telephone, fax and microwave communication capability with Robert S. Kerr Project Office. Robert S. Kerr currently furnishes Broken Bow Powerhouse personnel with hydropower generation information for the preceding non-work period(s). This in turn is added to morning report and faxed to the Water Control Section.

5-07. Project Reporting Instructions. Daily lake data from Broken Bow Reservoir (see Plate 5-2) will be submitted to the Water Control Section, Hydrology-Hydraulics Branch, Tulsa District Office (telephone 918-669-7131 or VHF-FM radio, call signal WUI-3). The Water Control Section office is manned from 7:00 a.m. to 4:30 p.m. weekdays and various hours on weekends and holidays. Should unusual conditions arise during nonworking hours, one of the persons listed on page ii of this manual should be contacted. The following data should be included in the daily report.

a. As of 8 a.m. The current 8 a.m. pool elevation; the current gate setting and any gate changes during the previous 24 hours; the current tailwater elevation; and precipitation in inches for the preceding 24 hours (7 a.m. to 7 a.m.).

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

c. Power releases. Hourly power releases (midnight to midnight), 8 a.m. instantaneous power discharge, 8 a.m. total discharge, 24-hour average (midnight to midnight) power release, 24-hour average total release, and the 24-hour net power generation will be reported daily.

d. During Flood Periods. In addition to subparagraph a. and b. above, the Water Control Section personnel may request additional reports of Lake Elevations during flood periods?

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

- (1) At 8 a.m. all precipitation that occurred during the preceding 24 hours (7 a.m. to 7 a.m.) as shown on the Lake Data Report (Plate 5-2).
- (2) At 1 p.m. when 0.50 inches or more of precipitation has occurred since 7 a.m. or if it has continued to rain since the 8 a.m. report.
- (3) At 7 p.m. when 0.50 inches or more of precipitation has occurred since the 7 a.m. report and no 1 p.m. report was made, or if it has continued to rain since reporting at 1 p.m.
- (4) Report at once the occurrence of 2.00 inches or more of precipitation that occurs during a period of 6 hours or less. During nonworking hours, the report will be made to one of the persons listed on page ii of this manual.

5-08. Warnings. It is the responsibility of the Project Manager to maintain a list of the current status of residents and property owners who would be endangered or inconvenienced by large or prolonged releases. If damaging releases are expected to occur, notification will be made by telephone or oral warning by Corps employees. Notification will be made in accordance with the Tulsa District supplements to ER 500-1-1. This would include radio, television, telephone, citizen band radio, use of law enforcement and civil defense agencies and their communication systems, and Army National Guard Units, supplemented by oral warning from Corps employees. Studies have been made to determine the possible downstream flood conditions, which could exist in the event of a maximum spillway release or failure of the dam at maximum pool. Approximate water surface profiles and flooded area maps are found in Operation and Maintenance Manual, Volume II, Flood Emergency Plan, November 1984. These maps are kept at the Broken Bow Powerhouse Office and the Tulsa District Office. In every case when a gate change is made a horn is blown to give warning to people immediately downstream of the dam.

5-09. Frequency of Gate Changes. During flood periods, the Water Control Section may direct gate changes at any time. When the floodwaters significantly rises into the flood control pool, gate changes can be expected two or three times daily. When the pool level is at or above the top of the flood control pool, gate changes may occur every hour. Only under the most unusual circumstances will changes be ordered more frequently than once every hour. Frequency of gate changes during low flow operation will generally be less than once a week.

VI - HYDROLOGIC FORECASTS

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

a. Role of Corps of Engineers. Hydrologic forecasts are made by the Tulsa District, Hydrology-Hydraulics Branch for use in regulation of lakes for flood control, other authorized purposes, for the benefit of Corps of Engineers construction projects, and flood fighting activities. As distinguished from the National Weather Service (NWS) which furnishes weather and flood forecasts to the public, the Corps furnishes current information on lake levels, weather, streamflow, or any other available information on observed conditions, along with technical advice. Current lake levels and discharges are available to the public on a recorded message that can be reached at telephone number 918-669-7521 which is listed in the Tulsa, Oklahoma telephone directory. Further information on water control operations is available by speaking directly with Water Control Section personnel. General news releases are made by the Public Affairs Office, which is kept fully informed of the hydrologic situation as appropriate. In addition, the Tulsa District Homepage is available to INTERNET users at <http://www.swt-wc.usace.army.mil>. This includes the Tulsa District Water Control Data System, which displays a variety of real time and archived information concerning the lakes and rivers located in Tulsa District.

b. Role of Other Agencies. The National Weather Service (NWS), River Forecast Center, Tulsa, Oklahoma, is the official agency making flood forecasts available to the public. This information is distributed to subscribing government agencies and the news media. Through a direct line to the NWS-AFOS network, the Tulsa District, Hydrology-Hydraulics Branch receives weather and flood forecasts as

well as radar depictions, flood and storm warnings, weather summaries and statements, and observed precipitation. The NWS issues routine scheduled reports including the following information:

- (1) Daily and extended weather forecasts.
- (2) Weather summaries and statements of current conditions.
- (3) Quantitative Precipitation Forecasts (QPF) for the next 6, 12, 24, and 48 hours.
- (4) 5-day precipitation outlooks.
- (5) 3 and 4-day river stage forecasts.
- (6) Rainfall required to produce bankfull stages (weekly).
- (7) Urgent priority messages such as severe weather warnings, watches, forecasts, and statements and instructions from Civil Defense during emergency conditions are transmitted immediately. The following reports are sent any time the circuit is idle.
 - (a) Damage reports.
 - (b) Road information and winter weather conditions.
 - (c) River and flood warning bulletins, forecasts, and statements.
 - (d) 30-day forecast.

6-02. Flood Condition Forecasts.

a. Requirements. Flood condition forecasts are necessary whenever substantial rainfall has fallen in the Mountain Fork River Basin above or below Broken Bow Dam in order to regulate the discharge from the dam and powerhouse. The Tulsa District, Hydrology-Hydraulics Branch makes forecasts for inflow into Broken Bow Reservoir and forecasts for river flow on the Mountain Fork River below the dam using the basin subdivisions shown on Plate 6-1.

b. Methods. The Hydrology-Hydraulics Branch currently uses the HEC-1 forecasting program to make flood condition forecasts. In this program, runoff hydrographs are developed for each sub-basin depending on the amount of rainfall. These hydrographs are then routed in the river channels to control points where the estimated flow is compared to data from the gaging stations. The resulting volume of runoff in the river is then routed to the reservoir to determine the amount of flood control storage that will be used. Release rates from the dam are determined by routing trial releases to the downstream control points and combining the flow with the runoff from rainfall below the dam using the HEC-1 forecasting program. Regulated flows in the rivers are not to exceed the established regulating flow at any control point downstream of the dam.

(1) Forecasting River Stages. The official forecasts of river stages are made by the National Weather Service (NWS). Release schedules from all the Tulsa District reservoirs are communicated to the NWS for putting into their official river stage forecasts. While NWS forecasts are helpful in regulating reservoir flood operations, forecasts made by the Hydrology-Hydraulics Branch are used for forecasting reservoir inflow volumes and for determining release rates from the dams.

(2) Forecasting Flows and Pool Elevations. Two HEC-1 forecast models are currently being used to forecast the river flows above and below Broken Bow Dam. The upstream model is used to determine the inflow rate and volume into the reservoir. The downstream model is used to determine release rates from Broken Bow Dam, Pine Creek Dam and Dequeen Dam as well as to assist Little Rock District in determining the inflow into Millwood Lake. Pool elevation forecasts are developed from the inflow forecast model using the release schedule determined from the downstream model. Sample input and output from the Broken Bow Lake HEC-1 inflow model is shown in Plates 6-2, 6-3 and 6-4. A sample discharge and inflow computation is shown in Plate 6-5. Unit hydrographs for the area above and below Broken Bow Lake are shown in Plates 6-6 and 6-7.

6-03. Conservation Purpose Forecasts.

a. Requirements. Conservation forecasts may be required to predict pool levels for fish spawning season, downstream trout fishery requirements, special recreation events, and water supply.

b. Methods. Forecasts for conservation purposes during non-flood periods would depend largely on statistical interpretation of historical data. The flow duration curve on Plate 4-2 and the inflow volume frequency data in Table 4-5 would be considered in conjunction with NWS forecasts in making conservation forecasts during non-flood periods. Each weekday, Tulsa District provides the Southwestern Power Administration with 4-day projected inflows for the District lakes with hydropower facilities.

6-04. Long-Range Forecasts.

a. Requirements. Long-range forecasts are required for the evacuation of floodwater stored in the reservoir, for sustaining yield during low flow periods, and for maintaining constant conservation pool levels. These forecasts are made with a known volume of water in the reservoir and an estimated volume and rate of inflow to the reservoir.

b. Methods. Floodwater evacuation forecasts are determined from a known storage volume, allowable discharge rates, and an estimate of future inflows. Estimates of long-range inflows can be made using historical records of streamflows on the Mountain Fork River and the current groundwater conditions. Reliable methods for long-range inflow forecasts are not presently available. Long-range yield and conservation forecast methods also depend on the inflow forecast. The NWS publishes an "Average Monthly Weather Outlook" semi-monthly, which is an estimate of the trend of the weather but may not be reliable for forecasting reservoir inflows. The NWS forecasts described in paragraph 6-01.b. are only useful for short-range forecasts.

6-05. Drought Forecasts. Dependable methods of drought forecasting do not exist as this time.

VII - WATER CONTROL PLAN

7-01. General Objectives. The primary objectives of Broken Bow Dam and Lake are flood control, hydropower, and water supply. Recreation and benefits to fish and wildlife are also authorized purposes of the Lake. Broken Bow, Pine Creek and DeQueen Lakes make up a three-Lake system for flood control in the Little River Basin above Millwood Lake, which is operated as part of the overall flood control system for the Red River Basin. Broken Bow, Pine Creek, and DeQueen Lakes serve as the primary flood control projects for the Little River from Pine Creek Dam to the upper limits of Millwood Lake. The entire Little River Basin also includes two additional reservoirs, Gillham and Dierks, which flow directly into Millwood Reservoir. Flood releases from the Lakes will be made in accordance with the predicted runoff from the uncontrolled area downstream, the allowable stages for the downstream control points, and the predicted volume of inflow into the lake (Method A, paragraph 3-3c(2)(b) of EM 1110-2-3600, 30 Nov 87). Coordination will be made with flood control operations at Pine Creek (Tulsa District) and DeQueen Lakes (Little Rock District), as well as Millwood Lake (Little Rock District) when necessary. Generally, available channel capacity is divided between the three upstream projects (Pine Creek, Broken Bow and DeQueen) based on a balancing scheme, which maintains the flood control pools within 5 percent of each other. In this case, Broken Bow, Pine Creek and DeQueen share available channel capacity at Horatio, Arkansas gage, as follows: 50 percent, 40 percent and 10 percent respectively. When the system is unbalanced, priority of releases (provided downstream conditions allow) is given to the Lake with the greatest percentage of flood control storage in use. With joint agreement, significant differences in predicted inflow may affect the distribution of channel capacity. Currently, the regulating stage is 20.5 feet (SWD deviation 1994) as measured at Horatio, Arkansas gage. Balanced system conditions between the three lakes will be checked daily based on real time information available.

Millwood, DeQueen, Gillham and Dierks Lakes are operated by Little Rock District, U.S. Army Corps of Engineers telephone (501) 324-6238.

7-02. Major Constraints. The major constraints to flood control operations at Broken Bow Lake are the channel capacity of the Mountain Fork River downstream of the dam and the channel capacity at Horatio, Arkansas.

a. The non-damaging channel capacity immediately below Broken Bow Dam is currently 8,000 c.f.s. which is greater than the full hydropower discharge (i.e. some spill releases) from the two powerhouse units.

b. Spillway releases above 1,100 c.f.s. will most likely damage a road and box culvert located a short distance below the spillway. In addition to the culvert there are two other bridges between the spillway and the powerhouse, which have stop logs to impound small pools. Powerhouse personnel should coordinate with the State of Oklahoma to remove the stop logs prior to making flood releases in excess of 1,100 c.f.s. from the spillway.

c. The regulating stages at the downstream control points are also limiting because of the slow recession of floodwaters in the lower Little River Basin.

d. There has been some encroachment into the natural flood plain near Horatio, Arkansas. An access road is affected above a stage of 20.5 feet at Horatio, but homes are generally unaffected below a stage of 26.0 feet, which is the flood stage identified by the National Weather Service. The current regulating stages and corresponding discharges for the regulating stations below Broken Bow Dam are shown in Table 7-1.

TABLE 7-1

REGULATING STAGES AND DISCHARGES

Station	River	Regulating Stage (feet)	Discharge (c.f.s.)
Below Dam	Mountain Fork	-	8,000
Eagletown	Mountain Fork	9.0	11,200
Horatio	Mountain Fork	20.5*	17,300

* 20.0 feet, 1970-1981 (Lake Regulation Manual 74)
 21.5 feet, 1981-1994 (approved SWD July 81)
 20.5 feet, 1994-Present (deviation approved SWD Mar 94)

7-03. Overall Plan for Water Control.

a. General. Broken Bow Lake is regulated as a unit in a multi-purpose system for the benefit of water resources in the Red River Basin as discussed in the Red River Basin Master Manual.

b. System Regulation. Broken Bow Lake is regulated in conjunction with Pine Creek, DeQueen, Gillham, Dierks and Millwood Lakes for flood control on the Little River from Pine Creek Dam to Fulton, Arkansas, and will provide benefits on the lower Red River. Flood control operations are coordinated with Millwood, Gillham, and Dierks Lakes in Little Rock District when necessary to benefit flood control on the Little and Red River Systems. When floodwaters are being accumulated in the Little River Basin, each lake in the system shall be regulated to retain equivalent flood control capabilities, as much as possible. Generally, available channel capacity is divided between the three upstream projects (Pine Creek, Broken Bow and DeQueen) based on a balancing scheme, which maintains the flood control pools within 5 percent of each other. In this case, Broken Bow, Pine Creek and DeQueen share available channel capacity at Horatio, Arkansas gage, as follows: 50 percent, 40 percent and 10

percent respectively. When the system is unbalanced, priority of releases (provided downstream conditions allow) is given to the Lake with the greatest percentage of flood control storage in use. With joint agreement, significant differences in predicted inflow may affect the distribution of channel capacity. Currently, the regulating stage is 20.5 feet as measured at Horatio, Arkansas gage (1). Balanced system conditions between the three lakes will be checked daily based on real time information available. Priority for releases will be given to the lake with the least amount of flood storage available considering present and forecasted inflows into the lake and downstream conditions.

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

1 Horation Regulating Stage set at 20.5 feet via SWD deviation approved 1994.

7-05. Flood Control.

a. Normal Flood Control Regulations. Broken Bow Lake will be regulated for maximum flood reductions on the Mountain Fork and Little Rivers from the dam to the upper limits of Millwood Lake. Releases will also be directly coordinated with the flood control operations of Pine Creek, DeQueen, Gillham, Dierks, and Millwood Lakes to provide maximum flood control benefits on the Mountain Fork, Little, and Red River Basins. Under most circumstances, release rates of Pine Creek, Broken Bow and DeQueen Lakes are based on equivalent flood control capability, described in paragraph 7-01 and 7-3(b), and the available downstream channel capacity at Idabel, Oklahoma and Horatio, Arkansas. Under extreme flood events release rates may be restrained based on allowable Millwood releases into the Red River and available channel capacity at Fulton, Arkansas. In this case, maintaining equivalent flood control capability of all projects is desired. Under normal flood control operations, releases will not exceed the maximum rate permissible, which is the release that when combined with local flows will not exceed the channel capacity on the Mountain Fork River below the dam and the Little River at Horatio, Arkansas. Releases may exceed the maximum rate permissible only when the Lake is above or is forecasted to rise above the top of the flood control pool, elevation 627.5. Whenever possible, during flood control operations, the spillway tainter gates will be operated with no more than 1 foot difference in opening between the gates and the top of tainter gates will be kept at least .25 foot above the water surface. The following regulations included in Table 7-2 will govern releases under normal flood control operations.

TABLE 7-2

NORMAL FLOOD CONTROL REGULATION SCHEDULE

Pool Elevation and Condition	Regulation
a. Below 599.5 (or top of seasonal conservation pool) and Rising	<p>When the pool level rises and is expected to crest between 559.5 and the top of zone "II" of Plate 7-14, releases will normally be made through the hydroelectric power units and will be governed by the power generation requirements explained in para 7-11. If the lake level is not forecasted to rise above zone "II", releases will be made only such that through power generation the lake recedes to elevation 599.5 (or the seasonal conservation pool) according to schedule shown on Plate 7-14.</p> <p>If the pool is forecasted to crest above the top of zone "II" and below the top of flood control pool 627.5, releases may be made at the maximum rate permissible. Hydropower and spill releases will not exceed the maximum rate permissible which is the release combined with local and regulated flows from Pine Creek and DeQueen that will not exceed the channel capacity at Horatio (currently 17,300 c.f.s.), 8,000 c.f.s. below the dam and 11,200 c.f.s. at Eagletown.</p>
b. Predicted crest above 627.5 (top of flood control pool)	<p>Releases will not be less than the maximum rate permissible which is the release that when combined with local flows will not exceed channel capacity below the dam. When the lake approaches or rises above elevation 627.5 (top of flood control pool), all spillway gates will be operated at a uniform setting with at least the top .25 feet of the gates out of the water. If the Lake level is forecasted to exceed the top of flood control pool, elevation 627.5, releases may be increased above the maximum rate permissible in order to minimize the peak discharge during induced surcharge operations or in order to crest the pool at or below elevation 632.5 (top of surcharge pool), if possible. Plate 7-1, Spillway Gate Regulation Schedule, will be used as a</p>

TABLE 7-2 (CONT)
NORMAL FLOOD CONTROL REGULATION SCHEDULE

guide for determining releases. Plate 7-2 can be used to calculate lake inflow for use on Plate 7-1.

c. 627.5 to 632.5 and Rising

Releases will be made by induced surcharge operation in order to crest the pool at or below elevation 632.5, if possible. At a minimum, releases shall be made by operating all spillway gates at a uniform opening with a margin of at least 0.25 feet between the pool level and the top of the gates. Plate 7-1, Spillway Gate Regulation Schedule and Plate 7-2, inflow versus rate of rise nomograph will be used as a guide for determining releases. If, during the induced surcharge operation, the Lake level rises to elevation 632.5, open the spillway gates as necessary to pass inflow or until the gates are fully opened. Releases will be made by operating all the spillway gates at uniform openings.

d. Above 632.5 and Rising

The spillway gates will be maintained fully opened and held in such position.

e. Above 632.5 and Falling

The maximum gate openings attained during rising pool conditions will be maintained until the pool level recedes to elevation 632.5.

f. 632.5 to 627.5 and Falling

The maximum gate openings attained during rising pool conditions will be maintained until the pool level recedes an amount sufficient to permit lowering all the spillway gates one-half foot without lowering the discharge below inflow. Releases shall be made by operating all spillway gates at a uniform opening with a margin of at least 0.25 feet between the pool level and the top of the gates.

TABLE 7-2 (CONT)
NORMAL FLOOD CONTROL REGULATION SCHEDULE

g. 627.5 to 599.5 (or top of seasonal conservation pool) and Falling

Releases will be made at the maximum rate permissible, which is the release that when combined with local flows will not exceed the channel capacity below the dam.

b. Emergency Flood Control Regulations. When communication with the Tulsa District Office is disrupted, the Project Manager will, on his own initiative, direct flood control operation of the Lake in accordance with Table 7-3 until communications are restored. In addition, the Project Manager will make every effort to re-establish communications with the Tulsa District Office and will send information to the Tulsa District Office by any means possible. In the event that communications are disrupted, releases shall not be changed until 12 hours has elapsed or until the pool rises above elevation 621.0 (approximately 75 percent of the flood control pool), at which time releases will be made in accordance with Table 7-3. Plate 7-17 had been included to meet EM 1110-2-3600 requirements and should only be used as a last alternative. At no time during emergency flood control operations shall releases be decreased if the pool is rising. The spillway gates will be operated with no more than 1 foot difference in opening between the gates during emergency flood control operations. The following regulations included in Table 7-3 will govern releases under emergency flood control operations.

TABLE 7-3

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE

Pool Elevation and Condition	Regulation
a. Below 599.5 (or top of seasonal conservation pool) and Rising	Maintain current releases until communication is restored.
b. 599.5 (or top of seasonal conservation pool) to 621.0 and Rising	Maintain current releases until either communication is restored, or if communication is not restored after 12 hours, increase or maintain releases in accordance with Plate 7-1, Spillway Gate Regulation Schedule. Adjust release every 2 hours based on the previous 2-hour inflow as computed from Plate 7-2. Do not decrease releases while the pool is rising.
c. 621.0 to 627.5 and Rising	When communications are disrupted and the lake level is at or above elevation 621.0, the Project shall start releases in accordance with Plate 7-1, spillway gate regulation schedule. Adjust releases every 2 hours based on the previous 2-hour inflow as computed from Plate 7-2.
d. 627.5 to 632.5 and Rising	Increase or maintain releases in accordance with Plate 7-1 based on the current elevation and the previous 2-hour inflow as computed on Plate 7-2. If the current release, including power generation, is less than 8,000 c.f.s., increase the total combined hydropower and spillway releases to 8,000 c.f.s. immediately. Releases shall be made by operating all spillway gates at a uniform opening with a margin of at least 0.25 feet between the top of the gates and the pool level. Adjust releases every 2 hours based on the previous 2-hour inflow as computed on Plate 7-2. Do not decrease releases while the pool is rising. Elevation 632.5 will be maintained, if possible, by opening the spillway gates as necessary to pass inflow or until the gates are fully opened.

TABLE 7-3 (CONT)
EMERGENCY FLOOD CONTROL REGULATION SCHEDULE

e. Above 632.5 and Rising

The spillway gates will be maintained fully opened and held in such position.

f. Above 632.5 and Falling

Maintain current releases until the pool level recedes to elevation 632.5.

g. 632.5 to 627.5 and Falling

Maintain current releases until the pool level recedes an amount sufficient to permit lowering all the spillway gates one-half foot without lowering the discharge below inflow or 8,000 c.f.s. whichever is larger. Releases shall be made by operating all spillway gates at a uniform opening with a margin of at least 0.25 feet between the pool level and the top of the gates.

h. 627.5 to 599.5 (or top of seasonal conservation pool) and Falling

Adjust releases every 2 hours to equal the previous 2-hour inflow or 8,000 c.f.s., whichever is greater. When the pool is within 2 feet of elevation 599.5, decrease releases by amounts not to exceed 1,300 c.f.s. in 3 hours so that outflow is equal to inflow by the time the pool level recedes to elevation 599.5.

c. Rate of Release Change. The increase and decrease in spillway releases from the Lake shall be accomplished in a manner which minimizes bank erosion and danger to human and animal lives, whenever possible. Releases should be increased and decreased in increments of 1,300 c.f.s. or less, with a minimum of 3 hours between changes. Situations will arise which will not allow an orderly increase or decrease in releases. Examples of these situations are shutting off releases to minimize downstream flooding, drownings, and other downstream emergencies.

7-06. Recreation. Although recreation is an authorized project purpose, no storage is provided specifically for that purpose and no special regulations are made for recreational activities.

7-07. Water Quality. Water quality is not an authorized project purpose. Continuous low flow releases and power generation are currently used to satisfy minimum flow requirements monitored at Eagletown, Oklahoma which were recommended by U.S. Fish and Wildlife prior to dam construction. The minimum flow requirements at Eagletown is listed in Table 7-4.

TABLE 7-4
MINIMUM FLOW REQUIREMENTS
(Mountain Fork River at Eagletown, OK)

Period	Minimum Flow (c.f.s.)
January-December	100

The reregulation dam described in 2-03 (e) is used to ensure minimum flow requirements at Eagletown. During periods of no generation (usually weekends) the reregulation pool provides storage for continuous releases from the low flow pipes located in the bottom of the structure. Provided the reregulation is recharged to full storage, it can provide enough water to meet downstream requirements over a 3-5 day period without hydropower generation.

7-08. Fish and Wildlife.

a. Fish and wildlife is an authorized project purpose. *(Xx,xxx acre-feet of storage has been reallocated from water supply to support the trout fishery below the dam as

required by the Water Resources Development Act of 1996 (WRDA 96).)* Major deviations to the water control plan have been approved in the past at the request of the State of Oklahoma to manipulate pool levels for the benefit of fish and wildlife habitat—specifically water for the trout fishery below the dam (WRDA 99 authorizes a seasonal pool—Exhibit G). Currently, management of the fish and wildlife resources at and below the Lake is under the direction of the Oklahoma Department of Wildlife Conservation (ODWC). An interagency Memorandum of Understanding (MOU) (exhibit D), developed by ODWC, Southwestern Power Administration (SWPA) and Tulsa District, describes coordination and the trout fishery operation.

b. The trout fishery was established in 1989 by ODWC and used uncontracted water supply storage from 1989 through 1997, to provide sport fishing in the Mountain Fork River below the dam to the Highway 70 bridge . The cold water fishery is supplied with both spill and power generation water to maintain water temperatures at an acceptable level. The specific release requirements are based on both air and water temperatures at several locations. *(Xx,xxx acre-feet of uncontracted water supply storage was reallocated in 200X to supply the trout fishery)*. This reallocation was authorized by WRDA 96. An excerpt copy of this legislation is found in Exhibit E.

c. A seasonal pool plan in effect on an annual basis since 1994, (Plate 7-18) was developed to partly offset lost hydropower benefits in the summer by increasing total storage April-September. The Water Resources Development Act of 1999 (Exhibit G) modified the project to include this seasonal pool plan providing the adjustment is made at no cost to the Government with adequate protection of water and related resources. These items are currently under review. Table 7-5 shows the general spillway release schedule to support the trout fishery. Releases can be increased or decreased should water and air temperatures allow. The ODWC monitors the fishery and is responsible for making recommendations to increase or decrease spillway releases. ODWC has determined that water temperatures exceeding 70 degrees F for extended periods are

harmful to the fishery. Changes in air temperature are used as trigger points for changing water release requirements. Increases in spillway or hydropower discharge require coordination with SWPA, ODWC, Tulsa District and Southwestern Division.

TABLE 7-5

General Spillway Release Schedule

15 May to 31 May	80 c.f.s.
1 June to 15 October	140 c.f.s.
16 October to 31 October	decrease to 14 c.f.s. in steps
31 October - 15 May	14 c.f.s. minimum at all times

Table 7-6 shows the current power generation guide to support the trout fishery. This schedule will vary depending on water temperature. Steps are agreed upon by ODWC, SWPA and Tulsa District prior to implementation. These criteria may change periodically.

TABLE 7-6

Minimum Power Generation Schedule - GUIDE

May - October

Step I.

This condition occurs when air temperatures begin to exceed 85 degrees F on a consistent basis. A three-day per week hydropower generation schedule is requested. The schedule will include Monday and Friday with the third day at SWPA's discretion. Power generation desired is 1 unit at 1/2 load (1,700 c.f.s.), 3-hour minimum duration

run.

Step II.

This condition usually occurs when water temperatures consistently exceed 70 degrees F and air temperatures begin to exceed 90 degrees F on a consistent basis. A four-day per week hydropower generation schedule is requested. The schedule should include Monday, Wednesday, Friday and one weekend day at 1 unit at 1/2 load (1,700 c.f.s.), 3 hour minimum duration run.

Step III.

This condition usually occurs when water temperatures exceed 70 degrees F and air temperatures begin to exceed 93 degrees F on a consistent basis. A six-day per week hydropower generation schedule is requested. The schedule should include all weekdays and a weekend day of choice by SWPA. Power generation desired is 1 unit at 1/2 load (1,700 c.f.s.), 3-hour minimum duration run. At SWPA's discretion any weekend generation requirement can be split between both Saturday and Sunday.

Step IV.

This condition usually occurs when water temperature exceeds 70 degrees F and air temperatures begin to exceed 96 degrees F on a consistent basis. Increase step III generation requirements to 1 unit at 1/2 load (1,700 c.f.s.), 5 hour minimum duration run.

Step V.

Decrease requirement to step III requirements when the weekly mean of daily maximum air temperatures decrease to below 96 degrees F and water temperatures fall below 70 degrees F on a consistent basis.

Step VI.

Decrease requirement to step II requirements when weekly mean of daily maximum air temperatures decrease to below 93 degrees F and water temperature fall below 70 degrees on a consistent basis.

Step VII.

After the third week in September when two consecutive weekly recording periods indicate mean daytime air temperatures at or below 85 degrees F and mean nighttime air temperatures approach 55 degrees F, the weekend generation schedule should be discontinued. The revised schedule would then include Monday and Friday with day three scheduled by SWPA based on hydropower demand. Hydropower generation requested is 1 unit at 1/2 load (1,700 c.f.s.), 3-hour minimum. Spillway releases are reduced below 140 c.f.s. in mid-September. Spillway releases are usually reduced to 14 c.f.s. in mid-October. These changes are recommended by ODWC.

7-09. Water Supply.

a. General. Water supply is an authorized purpose of Broken Bow Lake. The Lake originally had an estimated water supply yield of 175 million gallons per day (m.g.d.) from a storage of 152,500 acre-feet, which is 32.44 percent of the conservation storage. *(In year 200X, xx,xxx acre-feet of water supply storage was reallocated to support ODWC's trout fishery as stated in 7-08. This reduced the total water supply storage to xx,xxx with an estimated yield of xx m.g.d.)* Presently, 8,295 acre-feet (4,054 acre-feet for future storage) of the water supply storage is under contract with the City of Broken Bow. The Oklahoma Department of Tourism and Recreation has contracted 60 acre-feet. A copy of the water supply contracts are shown in Exhibit B.

b. Regulation Procedures. The City of Broken Bow has contracted for 8,295 acre-feet of the water supply storage (present and future use) in Broken Bow Lake from the Government. Water is taken from the Lake through the spillway weir and is pumped directly to a treatment facility just north of the access road to Broken Bow Lake. The facility is approximately 3 miles west of Broken Bow Dam.

c. Accounting Procedures. An accounting procedure for conservation storage in multiple purpose Lakes has been developed by the Tulsa District and approved by the Southwestern Division to regulate the withdrawal of water from lakes by water supply users during critical periods. At Broken Bow, there are three types of users; water supply, hydropower, and the trout fishery storages. Losses are charged to each user in proportion to their average remaining storage. Inflows, after deductions for downstream water rights, are credited to the storage account of the user in proportion to its contracted storage. When a user has 50 percent or less of contracted storage remaining, the contracting officer will be notified in order to advise the user of this storage on a monthly basis, or more frequently if necessary, throughout the critical period. Should the storage of a user be depleted, no additional withdrawal from storage will be made. Storage accounting generally will not be necessary for inflows above the conservation pool level. An example of the water supply storage accounting procedure is shown on Plate 7-3.

7-10. Water Rights.

a. General. The Oklahoma Water Resources Board issues water rights on the Mountain Fork River downstream of Broken Bow Dam. Active water right holders on the Mountain Fork River below Broken Bow Dam are listed in Table 7-7.

b. Regulation Procedure for Water Rights. Releases from inflow to satisfy downstream water rights will be made at the request of the Oklahoma Water Resources Board. Inflows will generally be determined on a weekly basis taking into account the net change in storage, the outflow, and evaporation from the Lake. Releases from calculated inflow will generally take place during the succeeding week.

TABLE 7-7

Active Water Right Holders

Water User	Location (City or County)	Use	Permit No.	Amount (ac-ft/yr)
Mt. Fork Water Supply Corporation	McCurtain	Municipal	I 68-98	1,173
"	"	"	71-83	538
(b) (6)	McCurtain	Irrigation	80-144	4
(b) (6)	McCurtain	Irrigation	86-19	25
(b) (6)	"	"	67-786	3
Oklahoma State University	McCurtain	Experimental	67-91	3
(b) (6)	McCurtain	Irrigation	89-11	180
Andersen, Inc	McCurtain	Industrial	72-420	246
(b) (6)	McCurtain	Irrigation	93-33	80

7-11. Hydroelectric Power. Hydroelectric power is a project purpose. Power generated by Broken Bow Powerhouse's two 50-MW hydropower units is marketed by the Southwestern Power Administration in an interconnected system. Power releases will vary, subject to power demand. Each turbine is capable of effectively using 2,000 to 4,000 c.f.s. depending on lake elevation and desired load (See plate 7-13). Operational rule curves for Hydropower at Broken Bow Lake are shown on Plate 7-14. These zones are fully described in Exhibit F.

a. Hydropower releases will be used as much as practical to satisfy release requirements during times of flooding. Tulsa District will strive to provide SWPA with required daily release volumes required in order to best meet peak demands. In addition, reservoir regulators will ensure that hydropower releases are reduced so that downstream regulating points are not exceeded. Communication and coordination between the SWPA and Tulsa District regulators is critical to meeting regulating capacities downstream.

b. To assure that lake levels will be compatible with recreation drawdown limits have been established to be applied when the lake level is within the conservation pool. Those limits are as follows:

7-day - 2.0 feet maximum, 4-week - 6.0 feet maximum

These limits may be modified by methods described in para 7-15.

7-12. Navigation. Navigation is not a project purpose and there is no storage allocated for it. There is no improved navigation in the Mountain Fork or Little River from the dam to the upper end of Millwood Lake.

7-13. Drought Contingency Plans. A drought contingency plan for the lower Red River basin including Sardis, Hugo, Pat Mayse, Pine Creek and Broken Bow Lakes was

approved in January 1993. This plan identifies water uses and needs within the basin and outlines the steps and coordination to be taken during drought conditions. Copies of this plan are kept in the Hydrology-Hydraulics Branch, Tulsa District Office.

7-14. Flood Emergency Action Plans. A flood emergency action plan is outlined in the Operation and Maintenance Manual, Volume II, for Broken Bow Dam approved November 1984. The manual specifies the procedures to follow in order to protect the public from possible damage or loss of life as a result of uncontrolled releases of water due to failure or severe damage to the dam or to its appurtenant works. The manual includes dambreach and maximum spillway discharge water surface profiles and potential flooded area maps. Copies of this manual are kept at the project, district, and division offices.

7-15. Deviation From Normal Regulation. The District Commander is occasionally requested to deviate from normal regulation of the lake. Prior approval for a deviation is obtained from the Southwestern Division Office except as noted in subparagraph a. below. Deviation requests usually fall into the following categories:

- a. Emergencies. Some emergencies that can be expected are as follows: drowning and other accidents, failure of operation facilities, and flushing of pollution where water quality is not a project purpose. Necessary action under emergency conditions is taken immediately unless such action would create equal or worse conditions. The Southwestern Division is informed as soon as is practicable. A written confirmation showing the deviation and conditions will be furnished to CESWD-ETE-P on Form SWD 898, shown on

Plate 7-4 or preferably using electronic mail with the following format for emergency or unplanned deviations:

1. Identify the source requesting the deviation.
2. Note current conditions and state the requested action of deviation.
3. Note the positive and negative impacts of those actions requested.
4. Note the parties involved in the action and give a general assessment.
5. Identify what conditions will trigger the end of the deviation.
6. State whom at SWD give verbal approval of the requested deviation.

b. Unplanned Minor Deviations. There are unplanned instances that create a temporary need for minor deviations from the normal regulation of the lake, although they are not considered emergencies. Construction accounts for the major portion of the incidents and includes utility stream crossing, bridge work, and major construction contracts. Changes in releases are sometimes necessary for maintenance and inspection. Deviation of release rates is generally requested for 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 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 for the authorized purposes. Approval for these minor deviations will normally be obtained from the Southwestern Division Office by telephone. A written confirmation showing the deviation and conditions will be furnished via electronic mail to CESWD-ETE-P.

c. Planned Deviations. Other instances include anticipated or planned deviations. Each condition should be analyzed on its own merits. Sufficient data on

flood potential, lake 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, facsimile or e-mail to Southwestern Division along with Tulsa District recommendations for review and approval.

7-16. Rate of Release Change. Hydropower releases vary as required to meet operational power requirements. Spillway releases changes will not exceed 1,300 c.f.s.. However, special care such as reduced rate of release changes of spillway releases will be required to avoid damage to roads and bridges in the spillway flow path.

7-17. Operational Curves. The spillway rating curve for partial and full gate openings are shown on Plates 7-5 and 7-6 and the spillway sluice rating curve is shown on Plate 7-7. The 17-foot Diversion Tunnel rating curve is shown on Plate 7-8. The tailwater rating curve below the powerhouse is shown on Plate 7-12. Evaporation curves relating daily pan evaporation to the average daily evaporation rate in cubic feet per second (c.f.s.) are shown on Plate 7-15. Curves relating elevation to reregulation dam area and capacity are shown on Plate 7-16. Area and capacity data for Broken Bow Lake is presented in Table 7-8. Plates 7-9, 7-10 and 7-11 provide discharge rating curves for the reregulation dam.

VIII - EFFECT OF WATER CONTROL PLAN

8-01. General. The effects of flood control regulations on the spillway design flood, standard project flood, and one major flood, March - April 1945 are presented in the following paragraphs. The 1945 flood was selected to show the effects of normal and emergency flood control regulations for Broken Bow Lake.

8-02. Flood Control.

a. Spillway Design Flood. The spillway design flood developed during the original project design was used as the maximum flood for evaluation of the effects of emergency flood control regulations. The development and routing of this flood is described in Design Memorandum No. 2, Hydrology, for Broken Bow Dam and Lake, dated January 1960. The spillway design flood has a total runoff volume of 1,243,000 acre-feet with a peak inflow of 583,000 c.f.s. The flood was routed through Broken Bow Lake on full and empty flood control pools using the emergency flood control regulations outlined in Table 7-3. The full pool regulation resulted in a peak outflow of 443,000 c.f.s. and a maximum pool elevation of 639.7. The operational hydrographs resulting from the emergency regulations of the spillway design flood on a full and empty flood control pool are shown on Plate 8-1.

b. Standard Project Flood. The standard project flood was developed during the original project design by routing the resultant runoff from 50 percent of the spillway design storm rainfall to the Lake. The resulting flood has a total runoff volume of 621,500 acre-feet with a peak inflow of 291,000 c.f.s. The flood was routed through Broken Bow Lake on full and empty flood control pools using the emergency flood control regulations outlined in Table 7-3. The full pool regulation resulted in a peak

outflow of 289,100 c.f.s. and a maximum pool elevation of 632.5. The operational hydrographs resulting from the emergency regulations of the standard project flood on a full and empty flood control pool are shown on Plate 8-2.

c. Flood of March-April 1945. The flood of March-April 1945 was the maximum flood of record on the Little River measured at Horatio gage (120,000 c.f.s. on 30 March). The storm consisted of three periods of heavy rain separated by 2 or 3 days of no rain. The peak flow past the present Broken Bow Dam site was 88,500 c.f.s. on 29 March and the total volume of the flood from 18 February - 10 April was 989,400 acre-feet, which is equivalent to 24.6 inches of runoff. The storm produced a 19-day volume at Horatio, Arkansas of 1,500,000 acre-feet, which is equivalent to 10.46 inches of runoff over the drainage basin above the gage. This flood was routed through Broken Bow Lake on full and empty flood control pools using the emergency flood control regulations outlined in Table 7-3. The full pool regulation resulted in a peak outflow of 60,000 c.f.s. and a maximum pool elevation of 629.94. The operational hydrographs resulting from the normal and emergency regulations of the 1945 flood on a full and empty flood control pool are shown on Plate 8-3.

d. Flood of May 1990 (not illustrated). The flood of May 1990 was the largest flood at Broken Bow Lake since the project was completed for full flood control operation in October 1968. The month of May was preceded by an extremely wet period, the basin averaged a total of 9.17 inches of rainfall in April 1990. The basin averaged 18.49 inches of rainfall during the month of May. The total inflow volume of the flood from 1 May to 23 May was 480,500 acre-feet (equivalent to almost 12 inches of runoff) with a peak average daily inflow of 76,600 c.f.s. on 3 May (instantaneous peak inflow was 103,000 c.f.s.). The maximum pool attained (elevation 622.64) was well within the flood control pool. The actual regulations resulted in a peak outflow of

8,500 c.f.s. (approximately 1,000 c.f.s. more than maximum power discharge capability).

8-03. Recreation. The Government and the State of Oklahoma have developed public use areas. However, the downstream trout fishery creates the greatest impact to Broken Bow's water control plan.

a. Public use areas include an overlook area near the dam, boat ramps, camping and picnic areas, sanitary facilities, drinking water, and a swimming beach. There are privately operated concession services at Broken Bow. A lake concession, Beaver's Bend Marina, is privately owned and operated. High pool elevations affect some of the public use areas and facilities. Starting at elevation 605.0 feet, the marina must take routine actions to accommodate the rise. A swim beach is located below the dam and is operated by the State of Oklahoma.

b. Beaver's Bend State Park, operated below the dam, is the most popular park in the area. Hochatown State Park is located at Broken Bow Lake. The State of Oklahoma also manages a game preserve of 5,420 acres which borders the Lake. Holly Cove and Mountain Fork State Park are additional recreation areas. These areas and others are shown on Plate 2-4.

c. As mentioned in para 7-08 the Oklahoma Department of Wildlife Conservation manages a trout fishery on the Mountain Fork River below the dam. Stocking takes place regularly at several locations. The future of the fishery has been endorsed through Congressional legislation (WRDA 96) which allowed reallocation, at no cost to Oklahoma, from uncontracted water supply storage to provide storage to supply the ODWC trout fishery.

d. Special spill and hydropower release schedules discussed in 7-08 have been developed to accommodate the fishery. In addition, a permanent seasonal lake operational plan (plate 7-18) was implemented to increase storage to partially offset the significant release requirements during the summer and fall months. This 3-foot plan began in 1998 and will continue on a permanent basis (as legislated by WRDA 99, Exhibit G). The seasonal plan provides additional storage is partially offset releases as required during the hot summer months. This reduces the occurrence of pool reductions.

8-04. Water Quality. The quality of water in Broken Bow Lake is considered good, requiring only conventional treatment to be suitable for domestic and industrial use. At least 100 c.f.s. is maintained at all times below the reregulation structure as recommended by the U.S. Fish and Wildlife Service. During low flow and drought periods, a minimum spill release for Beavers Bend State Park (14 c.f.s.) and hydropower releases from the dam are made to maintain the flow requirements at Eagletown gage.

8-05. Fish and Wildlife. Broken Bow Lake provides benefits in the lake and the Mountain Fork River to fish and wildlife. The lake fishery provides sport fishing. The availability of cool water in the river is now very dependable with the dam in place and supports the trout fishery. Prior to the dam, the seasonal warm water fishery naturally diminished during hot, dry periods of zero flow for several months at a time on the Mountain Fork River. While some wildlife habitat was inundated due to impoundment of the Lake, wildlife management of lake perimeter lands has helped to replace these losses. A state game preserve management area is located on the upper, north end of

C the Lake.

8-06. Water Supply. Currently, the total water supply storage in Broken Bow Lake is 152,500 acre-feet. *(This reflects xx,xxx acre-feet reallocated for the trout fishery in 200X)*. There are two small contracts totaling 8,355 acre-feet (4,054 acre-feet for future use) with the City of Broken Bow and Oklahoma Tourism and Recreation Department (OTRD). To date, withdrawals for water supply storage have not had a major effect on the operation of the Lake. The Water Resources Development Act of 1996 (Exhibit E) authorizes the reallocation of a "sufficient quantity of water supply storage space to support the trout fishery". *(This quantity was reallocated from uncontracted water supply in 200X)*. The balance of the uncontracted water supply remains available for purchase.

8-07. Hydroelectric Power.

a. Hydroelectric power at Broken Bow Dam is produced as needed to meet power demands. During normal operations, the generation of hydroelectric power will maintain the pool elevation at or below the top of conservation pool. The conservation storage between 559.0 and 599.5, or top of seasonal conservation pool, (less 152,500 acre-feet) for water supply and trout fishery water is allocated to hydropower.

b. Prior to 1996, Congress had authorized that any uncontracted water supply in Broken Bow Lake be used for hydropower on an interim basis until such time the water supply is contracted. *(The uncontracted water supply was reduced by reallocation of xX,XXX acre-feet to support the ODWC trout fishery)*. The balance of uncontracted water supply storage, presently 144,145 acre-feet, is available to SWPA for hydropower generation.

c. According to reports published by SWPA, the reallocation decreases Federal

revenue from loss of capacity and increases SWPA's customers total energy costs. However, it must be remembered that this was only interim use until contracted.

8-08. Navigation. There is no navigation storage in Broken Bow Lake. However, Broken Bow releases impact navigation on improved lengths of the Red River during both high and low flow release periods.

8-09. Drought Contingency Plans. The Drought Contingency Plan for the Lower Red River addresses the problems encountered during drought conditions at Broken Bow, Pine Creek, Sardis, Pat Maybe and Hugo Lakes. It provides a plan for implementing actions necessary for conservation of water supply and hydropower storage depending on the severity of the drought and the Lake level. This plan enables the Hydrology-Hydraulics Branch to effectively coordinate with the public and other district elements during drought conditions.

8-10. Flood Emergency Action Plans. The Flood Emergency Plan for Broken Bow Lake is contained in the Operation and Maintenance Manual, Volume II, Contingency Plan for Emergencies. This manual specifies the procedure to be used for protecting the public during flood emergencies by means of coordination between the Water Control Section and other district elements and communication with local governments and media.

8-11. Frequencies.

a. Peak Inflow Probability. Annual peak daily inflows for Broken Bow Lake were derived for the period 1938 to 1995 from historical hydrographs (1938-1963),

monthly charts (1964-1979), and daily computations (1979-1995). The annual peak inflows were used in computing a peak inflow probability curve in accordance with the methods described in Bulletin 17B, Guidelines for Determining Flood Flow Frequency, September 1981 and Hydrologic Engineer Center's Flood Frequency Analysis (FFA) program. The peak daily inflow probability curve is shown on Plate 8-4. The peak inflow in May 1990 of 103,000 c.f.s has approximately a 5 percent (20-year) recurrence probability. The peak inflow for the standard project flood of 291,000 c.f.s. has approximately less than a .2 percent (500-year) recurrence probability. The spillway design flood is beyond the limits of the calculated probability curve.

b. Pool Elevation Duration and Frequency. Pool elevation duration and frequency data for the period 1938-1990 at Broken Bow Lake was calculated by the "SUPER" model run R92XO3. The "SUPER" model routes period of record flows through the Little River System using existing regulations and conditions. The pool elevation probability curve is shown on Plate 8-5. The data shows that the top of the flood control pool elevation of 627.5 has an average recurrence interval of approximately 50 years. Plate 8-6 shows the pool elevation duration curve. The curve shows that the top of the conservation pool elevation 599.5 is exceeded approximately 36 percent of the time.

c. Key Control Points. Discharge rating curves for the stream gages used in the regulation of outflow from Broken Bow Dam are shown on Plates 4-3 through 4-4. These key control points include the gages on the Mountain Fork River near Eagletown and the Little River near Horatio. Table 7-1 shows the current regulating stage and flow for the key control points.

8-12. Other Studies.

a. Improvements in Forecasting. Studies have been made to improve the forecasting techniques presented in Section VI of this manual. Computer models have been developed to forecast Lake inflows and pool elevations and flows at downstream control points. Revision of the models continues to be done to take advantage of improved rainfall distribution data and improved computer capabilities.

b. Lake Manipulation Plans and Trout Demonstration .

(1). Several lake manipulation plans have been implemented on a trial basis (1994-1997). An intensive study was completed to determine the amount of conservation storage required for the trout demonstration project based on various climatic conditions. The storage requirement due to the spill requirement was a simple calculation. However, the amount of required hydropower storage and benefits foregone due to beyond "normal" generation requirements was complex. The storage required for the trout fishery and specific accounting procedures are pending.

(2). The United States Congress authorized (Water Resources Development Act of 1996, Exhibit E) the reallocation of required water from uncontracted water supply at no cost to the State of Oklahoma. A memorandum of understanding (MOU) covering the trout fishery is found in Exhibit D.

(3). The main effect of supporting the trout fishery is reduced hydropower benefits due to lower heads, increased spill and "forced" hydropower generation at specific, off peak, times to support water temperature requirements in the fishery. Another effect is the loss of future water supply storage and reduced lake levels in the summer and fall .

The intent of the 3-foot seasonal pool plan is to help alleviate losses to hydropower and partially reduce the impact or pool drawdowns. The 3-foot seasonal pool plan is authorized by WRDA 99 (Exhibit G).

c. Water Supply Reallocation to the State of Oklahoma (ODWC) Trout Fishery.
TDB (Exhibit H)

IX - WATER CONTROL MANAGEMENT

9-01. Responsibilities and Organizations.

a. Corps of Engineers. The U.S. Government owns Broken Bow Dam. The Tulsa District of the Corps of Engineers is the operating agency. Broken Bow Dam and Lake is the responsibility of the Broken Bow Project manager operating through the Hugo Project Manager, Operations Division, Tulsa District Office. Project reporting instructions and an organization chart are presented in Chapter V of this manual. Project regulating instructions are presented in Chapter VII of this manual.

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

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

(b) Investigation and refinement of regulation procedures.

1. Analyses of past floods.

2. Reconnaissance to determine channel capacities.

3. Improvement of forecasting techniques.

4. The planning and coordination of the hydrologic reporting network with the National Weather Service (NWS) and the U.S. Geological Survey (USGS).

(c). Training of personnel in flood control duties.

1. Periodic visits to projects by personnel of the section to familiarize themselves with regulation facilities, to become acquainted with the operating personnel, to discuss emergency regulation procedures with operating personnel, to provide background information for improving facilities and methods, and to receive feedback from project personnel.

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

(d) Preparation of reports on lake regulation.

1. Recurring reports.

2. Water control manuals.

3. Postflood reports.

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

(a) Evaluation of current hydrologic and meteorologic data.

(b) Presentation of storm and flood analyses to the District Commander and other interested District personnel.

Necessary, furnishing personnel to assist project operating personnel in flood regulations

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

(e) Furnishing information to higher authority.

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

2. Provide hydrologic data for situation reports.

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

(3) Assignment of Personnel. During non-flood periods, instructions for the routine regulation of the Lake are administered by the Water Control Section. However, during flood periods, assistance of other personnel may be required to maintain effective regulation of the Lake. Plate 5-1 shows the organization of flood control regulation for Broken Bow Lake. The area and magnitude of the flood will determine the number of people engaged in each activity.

(4) Provision for 24-Hour Alert. The National Weather Service and project personnel are provided with a list of names, addresses, and telephone numbers of key personnel of the Engineering Division with instructions to provide warning if unusual conditions occur. Responsible personnel are on duty at the Tulsa District Office 24 hours a day whenever basin 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 Project Manager. The Project Manager will regulate the Lake according to instructions issued by personnel of the Water Control Section. These instructions follow the "Normal Regulations for Flood Control" included in Chapter VII and in paragraph II-2 of Exhibit C. If the Project Manager loses communication with the District Office, he will immediately make every effort to reestablish communication with the District Office while initiating emergency regulations for flood control as included in Chapter VII and paragraph II-3 of Exhibit C. The Project Manager will make daily observations as directed in paragraph 5-07.

b. Other Federal Agencies. The National Weather Service and the U.S. Geological Survey cooperate together and with the Hydrology-Hydraulics Branch, Tulsa District, to accumulate rainfall and streamflow data. SWPA and Tulsa District exchange data on a regular basis via telephone, fax, and computer links..

c. State Agencies. Management of the fish and wildlife resources at Broken Bow Lake is coordinated by the ODWC. ODWC monitors flows and temperatures on the Mountain Fork River below the dam and requests water releases as necessary to sustain the trout fishery. The Oklahoma Water Resources Board determines release of inflow to the Lake during low flow periods to satisfy downstream water rights.

d. Private Organizations. Presently, there are no private organizations with regulatory responsibilities at Broken Bow Lake.

9-02. Interagency Coordination.

a. Local Press and Corps Bulletins. The Corps of Engineers, the National Weather Service (NWS), River Forecast Center (RFC), and the U.S. Geological Survey (USGS) coordinate in determining river stages, streamflow, and pool elevations. Local press will be provided with information of flood forecasts as furnished by the NWS, which is officially responsible for issuing flood warnings. This information will be supplemented by Corps of Engineers bulletins on Lake conditions and with technical advice to enable local interests, within the limits of their capabilities, to obtain optimum flood protection and to perform rescue and relief functions. The Corps of Engineers further assists in flood fighting through the Office of Emergency Management, which furnishes sandbags and other necessary equipment based on equipment on hand and need.

b. National Weather Service. The Tulsa District Office and the National Weather Service, River Forecast Center exchange hydrometeorological data and reports in order to prevent duplication of effort in obtaining and disseminating data. This exchange of data is discussed in greater detail in Chapter VI of this manual.

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. Future (30 days out) operation of Broken Bow Lake's hydropower facilities is coordinated monthly with the Southwestern Power Administration

to determine appropriate generation plan for routine and special operations. In addition, the Water Control Section coordinates the power operations with SWPA routinely during flood periods and when supporting the trout fishery.

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

9-03. Interagency Agreements. A memorandum of understanding (MOU) between the State of Oklahoma, Oklahoma Water Resources Board, and the U.S. Department of the Army concerning the Broken Bow Trout Fishery was first signed in 1989. The program originally was effective for a period of 3 years. SWPA first entered this agreement in 1991. Yearly extensions of this MOU were granted through October 1996 to allow the affected agencies to measure the economic impacts for inclusion into the final report. An interim operating agreement was adopted in xxx, reflecting the Water Resources Development Acts of 1996 and 1999, which allowed reallocation of a "sufficient quantity", yet undetermined, of uncontracted water supply to Trout Fishery water. The latest memorandum of understanding is presented as Exhibit D.

9-04. Commissions, River Authorities, Compacts, and Committees. A committee was established to coordinate and monitor the operation of the Broken Bow Trout Fishery. Members include Tulsa District Corps of Engineers Water Control, Project, Planning, and Operations personnel; Oklahoma Department of Wildlife Conservation; Southwestern Power Administration and Congressional Staffers. The purposes of this committee are:

a. To evaluate the trout fishery impacts and make recommendations to better

operate the fishery in a manner acceptable to all involved parties.

b. To facilitate cooperation of the Federal and State agencies of Oklahoma in the continued development of water resources in the Mountain Fork River Basin.

c. 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 Report. In accordance with TDR 1130-2-12, the Water Control Section prepares Daily Reports to cover a period of 24 hours, except on Saturday, Sunday, and holidays. The report provides data for use by personnel whose work requires information pertaining to the regulation of Lakes, field investigations, stream gaging, construction of flood control projects affected by releases from Lakes, the answering of public inquiries, and the preparation of public press releases. The report includes a summary of hydrologic conditions as of 8 a.m. of that date and lake data for the previous and present days. The report is completed and dispatched from the Hydrology-Hydraulics Branch by 10 a.m. daily under normal conditions.

b. Monthly Lake Reports. The Water Control Section prepares monthly lake reports in accordance with EM 1110-2-3600 and ER 1110-2-240. These reports are records of daily hydrologic data for all flood control, navigation, and multiple-purpose storage lakes under supervision of or of direct interest to the Tulsa District Office. Supplemental information on the regulation of the Lakes such as explanations of deviations from approved schedules is added as a note or as an attachment to the reports. 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.

c. Flood Situation Reports. The Water Control 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 relative to the floods. Pertinent data specifically required for Lakes are as follows: name of Lake, Lake elevation, predicted maximum elevation, rates of inflow and outflow in c.f.s., percent of flood control storage utilized to date and at predicted maximum elevation, and any special information particularly pertinent to the flood situation.

d. Post Flood Reports. This report is prepared in accordance with ER 500-1-1 and OM 500-1-6 as soon as practicable after a flood which 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 considered to be essential for flood control and flood plain studies or in the review of possible claims against the United States for damages. The report should be completed within approximately 3 months of the time of flooding.

e. Annual Reports. These reports are prepared by the Water Control Section. Each report contains a summation of the district water control activities including project visitations, special operations, water quality, sedimentation, navigation, hydropower production, lake attendance, water supply, flood damages prevented as well as hydrologic conditions of the Arkansas and Red River basins and the individual projects in the District for the preceding fiscal year. The report is forwarded to the Southwestern Division Reservoir Control Center for inclusion in the Annual Report.

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

TABLE 9-1

SUMMARY OF REPORTS

Name of Report	When Required	Regulation
Morning Report	Daily, except Saturday, Sunday, and holidays	TDR 1130-2-12
Monthly Lake Report	Monthly	EM 1110-2-3600 ER 1110-2-240
Flood Situation Report	During floods	OM 500-1-6 ER 500-1-1
Postflood Report	Following a flood causing major damage	OM 500-1-6 ER 500-1-1
Annual Reports	Annually	ER 1110-2-1400

EXHIBIT A
SUPPLEMENTARY PERTINENT DATA
BROKEN BOW DAM AND RESERVOIR

EXHIBIT A
SUPPLEMENTARY PERTINENT DATA
BROKEN BOW DAM AND RESERVOIR

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1. GENERAL INFORMATION

Other names for project None

Location Mountain Fork River at river mile 20.3, approximately
9 miles north northwest of Broken Bow in McCurtain County
Oklahoma

Type of project Dam, lake and powerhouse

Objectives of regulation Multipurpose - Flood control, hydropower, water supply, fish
and wildlife, and recreation

Project owner U. S. Government

Operating agency U. S. Army Corps of Engineers. The working hours of
operation for weekdays and normal conditions are 6:30 a.m.
to 4:45 p.m.; working hours for weekends, holidays, and
nights vary; working hours during flood emergency
conditions are 24 hours a day.

Regulating agency U. S. Army Corps of Engineers

Water supply contracts	<u>User</u>	<u>Amount</u> <u>(Acre-feet)</u>
	City of Broken Bow	8,295 (4,054 future)
	State of Oklahoma	60

Water Rights 2,252 acre-feet per year (See Table 7-7)

Project cost \$41,222,400

Closure date Final storage began 3 October 1968. The power pool was filled 25 April 1970.

2. LAKE INFORMATION

ELEVATIONS, AREAS, AND STORAGES

<u>Feature</u>	<u>Elevation ft. NGVD</u>	<u>Area (Acres) 1</u>	<u>Accumulative Storage</u>	
			<u>(Acre-feet) 1</u>	<u>(Inches) 2</u>
Top of Dam	645.0			
Maximum Pool	639.7	20,492	1,601,493	39.82
Surcharge Pool	632.5	18,850	1,460,172	36.31
Flood Control Pool	627.5	17,930	1,368,300	34.03
Conservation Pool	599.5	14,183	918,244	22.83
Spillway Crest	587.5	12,603	757,574	18.84
Top of inactive	559.0	9,170	448,457	11.15
Streambed at Dam	420.0	--	--	--
Flood Control				
Storage	599.5-627.5	--	450,056	11.19
Conservation				
Storage (3) (4)	559.0-599.5	--	469,820	11.68

- (1) Based on original survey
- (2) Runoff from uncontrolled drainage area of 754 square miles
- (3) Water supply & fishery (152,500 acre-feet), hydropower (317,320 acre-feet)
- (4) Top of conservation pool varies seasonally from 599.5 to 602.5 feet

Real estate taking line: Blocked perimeter encompassing elevation 632.0, which is .5 feet below the surcharge pool. This was established from the envelope of backwater effects of the 50-year flood after 50 years of sedimentation. A small amount of flowage easement was acquired in the upper reaches of the reservoir and on the tributaries. The fee taking line is shown on plate 2-4.

Range of clearing 600.0 in most areas. Northern portion of the reservoir was left uncleared.

Pool elevation at which downstream channel capacity can be achieved (with no hydropower) Channel capacity at Eagletown, OK, approximately 5 river miles below the dam, is 11,200 c.f.s. This discharge can be achieved at elevation 592.5 NGVD through the tainter gates.

Reservoir length at top of conservation pool 18 miles (32 river miles)

Shoreline length at top of conservation pool 180 miles

Safety aspects possibly requiring warning Starting at elevation 602.0 some of the public use area roads, boat ramps, and facilities require barricades, signs or closing by the State of Oklahoma. Hydropower releases require sounding of horn at the powerhouse. A warning system is also in place at the

reregulation dam. A horn will automatically sound when the pool rises to elevation 587.5 (invert of sluices) and when water is about to discharge over the spillway.

Emergency drawdown

Spillway crest is at elevation 587.5 feet, NGVD. Minimum required time to safely empty from top of conservation to the spillway crest is 10.0 days. Below the spillway crest, one-4'x4' sluice is available for drawdown at a rate of approximately 1200 acre-feet per day (Plate 7-07). For extraordinary emergencies, water can be discharged down to elevation 430.0, NGVD, through the 17-foot concrete diversion tunnel (Plate 7-08).

3. HYDROLOGY

Drainage area

754 square miles uncontrolled

MAJOR FLOODS at THE DAM SITE

Date of Peak	Flow (c.f.s.) (2)	Volume (Acre-feet)	Runoff (Inches) (1)
17 Jan - 28 Feb 1938	88,700	618,700	15.39
18 Feb - 10 April 1945	88,500	989,400	24.60
28 Aug - 31 Aug 1947	90,900	123,900	3.08
17 Jan - 2 Feb 1949	84,100	367,000	9.13
1 Jan - 21 Feb 1950	94,700	727,300	18.09
19 May - 31 May 1960	101,000	212,000	15.27
8 Dec - 10 Dec 1971	152,046	427,900	10.63
29 Oct - 07 Nov 1972	101,970	325,000	8.10
2 May - 20 May 1990	103,000	417,300	10.37

(1) Runoff from uncontrolled drainage basin area of 754 square miles

(2) Peak instantaneous flow

Spillway Design Flood - Full Pool

Maximum water

surface elevation

639.7 feet, NGVD

Peak inflow	583,000 c.f.s.
Total runoff	30.91 inches
Volume	1,243,000 acre-feet
Maximum outflow	443,000 c.f.s.
Flood duration	5 days

Standard Project Flood - Full Pool

Maximum water

surface elevation	632.5 feet, NGVD
Peak inflow	291,000 c.f.s.
Total runoff	15.44 inches
Volume	621,500 acre-feet
Maximum outflow	289,100 c.f.s.
Flood duration	4 days

Climate Moderate

One inch runoff 40,213 acre-feet (based on uncontrolled drainage basin of 754 square miles)

Storm types Primarily thunderstorms produced by cold fronts

Flood season Primary, flood periods occur March through June and October through December; however, floods are possible in any month of the year.

Low flow season	Primarily June-November, low flow can occur at any time of year (Table 4-6).
Minimum daily flow	0 c.f.s. (Occurred during 50 different days 1938-1995)
Minimum monthly flow	0 acre-feet (5 months 1930-1995)
Minimum annual flow	270,010 acre-feet (1963)
Average annual flow	951,560 acre-feet (1930 - 1995)
Maximum daily flow	101,000 c.f.s. (10 December 1971)
Maximum instantaneous flow	152,000 c.f.s. (10 December 1971)
Maximum monthly flow	629,600 acre-feet (Mar 1945)
Maximum annual flow	1,831,900 acre-feet (1945)
Maximum flood volume	989,400 acre-feet (18 Feb - 10 April 1945)

Name and location of key streamflow stations:

Mountain Fork River:
Rereg Structure (river mile 11.6)
Eagletown (river mile 8.9)

Little River:

Horatio (river mile 72.0)

Type of hydrometeorological data recorded at the dam:

Pool and tailwater elevations, rainfall, pan evaporation, wind speed and direction, lake water conditions, and weather conditions

Number of precipitation stations used in hydro - logic forecasting of Broken Bow Lake:

11 DCP recording

Number of sediment ranges: 0

Number of degradation ranges: 0

Number of stream temperature probes:

4 - R.M. 16.6 (Swim Beach near powerhouse))
R.M. 11.6 (Reregulation Dam)
R.M. 10.1 (Presbyterian Falls)
R.M. 8.9 (Eagletown gage, on HWY 70 bridge)

4. EMBANKMENT

Location	Mountain Fork River at river mile 20.3
Purpose	Multipurpose - Flood control, hydropower, water supply, fish and wildlife, and recreation
Type	Nonoverflow embankment
Type of fill	Rolled earthfill
Slope protection	Riprap upstream and grass cover downstream
Height	225 feet above streambed
Length(Dam, Dike, Spillway)	4,026 feet (including 376 feet of spillway)
Top elevation	645.0 feet, NGVD
Design flood	Spillway design flood
Freeboard	5.3 feet above maximum pool elevation
Used for roadway	Project access road, asphalt paved

Elevation of streambed 420.0 feet, NGVD

5. SPILLWAY

Location Located in saddle 7000 feet northwest of the right abutment of the dam.

Type Concrete, gated ogee weir

Crest elevation 587.5 feet, NGVD

Net overflow width 320 feet

Number and size of gates 8 gates, 40-foot by 40-foot

Type of gates Tainter

Top of gate elevation 627.5 feet, NGVD

Induced surcharge 5 feet

Maximum discharge capacity 443,000 c.f.s. (at 639.7 feet, NGVD)

Bridge deck elevation 645 feet, NGVD

Type energy dissipater Sloping apron which terminates in a flip bucket 150 feet

downstream

Time required to open and close all gates

Gates raise and lower at a rate of approximately 1-foot per minute

Type of emergency closure

Bulkhead (made of 4-sections) requires two 20-ton capacity cranes for installation and removal.

Spillway activation

When hydropower releases cannot meet channel capacity, tainter gates are used to attain channel capacity (8,000 cfs).
Note: tainter gate releases above 1,100 cfs will damage an access road and box culvert below the spillway.

6. OUTLET FACILITIES

Location

Through spillway (one 24-inch pipe)
Through spillway (one 4'x4' sluice)
Through main embankment (17-foot tunnel)

Purpose

Water Supply
Low Flow releases
Pool drawdown/Low level outlet

Type of outlet

One 24-inch circular pipe (water supply)
One 4-foot rectangular conduit (low flow)
One 17-foot diversion tunnel (low level outlet)

Type of valves One motor operated butterfly valve
One 4x4 sluice gate (one emergency)
Four 5x7 hydraulic slide gates (two in tandem in each
of two openings).

Entrance invert elevation:

559.0 feet, NGVD (24 inch water supply)
551.0 feet, NGVD (4'x4' Sluice)
430.0 feet, NGVD (Low level diversion tunnel)

Max Discharge at Bottom of Conservation (559.0): 250 c.f.s.
pertinent elevations Spillway Crest (587.5): 600 c.f.s.
(1- 4'x4'Sluice): Top of Conservation (599.5) : 700 c.f.s.
Top of Flood Pool (627.5): 900 c.f.s.

Minimum pool elevation 551.0 feet, NGVD
inoperative (sluice):

Minimum time required to Approximately 2 minutes
open or close gates:

Type energy dissipater: Stilling basin below spillway for Sluice
None below main embankment for low level outlet

7. HYDROELECTRIC POWER FACILITIES

Location: River mile 16.8 Mountain Fork River, about 1,800 feet

	south of the dam
Type:	Used for energy peaking operations
Installed capacity:	Two 50,000-kW vertical Francis-type turbines
Power-on-line (date):	June 1970
Number/size of Penstocks:	One 25-foot tunnel controlled by two 12x24 foot tractor gates located in gate tower at the tunnel entrance (plate 2-02)
Turbine Discharge(max)	7,000-8,000 c.f.s. (2 units)
Average Head, net (feet)	176.0
Average net head	
Power Pool, full	187.0
Power Pool, empty	144
Critical Hydroperiod	166
Dependable capacity	102,000 kW (SWPA study of 1928-1992 period)
Average annual energy (kWh)	165,467,500 (1970-1996)
Primary	68,500,000
Secondary	60,500,000
Total	129,000,000
Annual Firm energy (AVG)	8,600 kW
Specific hydroelectric	
Power storage:	559.0-599.5 (317,320 acre-feet)
Seasonal storage/Joint Use	Hydropower uses xx,xxx acre-feet of uncontracted water supply on an interim basis. A seasonal

conservation pool provides additional hydropower storage (see Plate 7-18)

Pumpback capability

None

Type of emergency dissipater:

Tail Race

Constraints:

Area below dam is heavily fished and requires use of a warning system of sirens and lights at six locations.

8. CONTROL POINTS

a. Below the Dam

Channel Capacity

8,000 c.f.s.

b. Mountain Fork River at Eagletown

Location

McCurtain County, on right downstream bank on U.S. Highway 70, 2.0 miles west of Eagletown, 10.7 miles downstream of Broken Bow Dam, at river mile 8.9.

Purpose

Provide stage, precipitation, water temperature and air temperature data and serve as a control point for flood releases

Channel description

The channel is well defined and fairly straight in the vicinity

Drainage Area	of the gage. The flood plain is narrow with steep rocky hills. 787 square miles
Uncontrolled drainage area	33 square miles
Bankfull stage and flow	9.0 feet, 11,200 c.f.s.
Time of water travel	Broken Bow Dam to Eagletown, 4 hours, approximate
Monitoring provisions	Stage, water temperature and precipitation data is recorded by a Sutron Data Collection Platform (DCP)
Zero of gage	333.87 feet, NGVD
Maximum stage of record	26.4 feet (flood of August 15, 1915)
Maximum flow of record	92,500 c.f.s. (August 15, 1915)
Channel usage	Water supply, fishing, camping

c. Little River at Horatio

Location Sevier County, near left bank on downstream side of bridge on State Highway 41, 0.9 miles downstream from Rolling Fork, 2.0 miles southwest of Horatio, 28.5 miles upstream from Cossatot River, and at river mile 72.

Purpose	Provide stage and precipitation data and serve as a control point for flood releases
Channel description	The channel is well defined and curvy in the vicinity of the gage. The banks are thick with brush and trees and the floodplain is crop and pasture land. Some homes are found directly on the river banks. Most homes are undamaged until a stage of 26 feet is reached. A county access road is covered at a stage just above 20.5 feet.
Drainage Area	2,663 square miles
Uncontrolled drainage area	1,104 square miles
Bankfull stage and flow	20.5 feet, 17,300 c.f.s
Time of water travel	Broken Bow Dam to Horatio gage, 12-18 hours, approximate
Monitoring provisions	Stage and precipitation data is recorded on a Sutron Data Collection Platform (DCP)
Zero of gage	272.89 feet, NGVD
Maximum stage of record	38.0 feet (August 1915)

Maximum flow of record 124,000 c.f.s. (August 1915)

Channel usage Water supply, irrigation, fishing

d. Reregulation Dam Information:

Location River mile 11.6 on the Mountain Fork River, 3 miles north of U. S. Highway 70 bridge and approximately 5 miles below the Broken Bow Powerhouse

Purpose Provide storage for constant release of water in Mountain Fork River and to meet low flow recommendations made by U.S. Fish and Wildlife Service. Also, attenuates short duration power releases from Broken Bow Powerhouse.

Monitoring Stage, precipitation, air and water temperature (3 water depths) data is recorded on a Sutron Data Collection Platform (DCP)

Time of water travel Broken Bow Dam to reregulation dam, 2 hours, approximate

C

EXHIBIT B
WATER SUPPLY AGREEMENTS

O

CONTRACT BETWEEN THE UNITED STATES OF AMERICA
AND
THE BROKEN BOW PUBLIC WORKS AUTHORITY
FOR
WATER STORAGE SPACE IN BROKEN BOW LAKE

THIS CONTRACT, entered into this 2 day of FEB, 1990 by and between THE UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and Broken Bow Public Works Authority (hereinafter called the "User");

WITNESSETH THAT:

WHEREAS, the Flood Control Act, approved 3 July 1958, (Public Law 85-500, 85th Congress, 2d Session), as modified by the Flood Control Act, approved 23 October 1962, (Public Law 87-874, 87th Congress, 2d Session), authorized the construction, operation, and maintenance of Broken Bow Lake on the Mountain Fork River, Oklahoma, (hereinafter called the "Project"); and,

WHEREAS, the User desires to contract with the Government for the use of storage included in the Project for municipal and industrial water supply, and for payment of the cost thereof in accordance with the provisions of the Water Supply Act of 1958, as amended (43 U.S.C. 390b-f, et seq.); and,

WHEREAS, the User is empowered to contract with the Government and is vested with all necessary powers of accomplishment of the purposes of this contract;

NOW THEREFORE, the Government and the User agree as follows:

ARTICLE 1 - Water Storage Space.

(a) Project Construction. The Government, subject to the directions of Federal law and any limitations imposed thereby, has designed and constructed the Project so as to include therein space for the storage of water by the User.

(b) Rights of User.

(1) 8,295 acre-feet. The User shall have the right to utilize an undivided 1.766 percent (estimated to contain 8,295 acre-feet after adjustment for sediment deposits) of the usable storage space in the Project between elevations 559.0 feet National Geodetic Vertical Datum and 599.5 feet National Geodetic Vertical Datum, which usable conservation storage space is estimated to contain 469,820 acre-feet after adjustment for sediment deposits.

This storage space is to be used to impound water for present and anticipated future demand or need for municipal and industrial water supply. 51.13 percent (an estimated 4,241 acre-feet) of the space which User has a right to utilize is for present use water storage and 48.87 percent (an estimated 4,054 acre-feet) is for future use water storage.

(2) Water Withdrawal. The User shall have the right to withdraw water from the lake, or to order releases to be made by the Government through the outlet works in the Dam, subject to the provisions of Article 1(c) and to the extent the aforesaid storage space will provide; and shall have the right to construct all such works, plants, pipelines, and appurtenances as may be necessary and convenient for the purpose of diversion or withdrawals, subject to the approval of the Contracting Officer as to design and location. The grant of an easement for right-of-way, across, in and upon land of the Government at the Project shall be a separate instrument in a form satisfactory to the Secretary of the Army, without additional cost to the User, under the authority of and in accordance with the provisions of 10 U.S.C. 2669 and such other authorities as may be necessary. Subject to the conditions of such easement, the User shall have the right to use so much of the Project land as may reasonably be required in the exercise of the rights and privileges granted under this contract.

(3) Cost of Screen and 24-Inch Water Supply Valve. Subsequent Users are not limited to the conduit as a means of withdrawing water from the Project. If, however, they choose to make use of the conduit, they will be required to reimburse this User for a proportional share, upon terms mutually agreed to, of the cost and maintenance of the screen and associated appurtenances necessary for the screen installation and the 24-inch water supply valve installed in the dam structure and its appurtenances. Permission to use the screen and valve shall not be unreasonably withheld by this User and all agreements regarding their use as well as the costs involved must be approved by the Contracting Officer.

(c) Rights Reserved. The Government reserves the right to control and use all storage in this Project in accordance with authorized Project purposes. The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property, including the right not to make downstream releases during such periods of time as are deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

(d) Quality or Availability of Water. The User recognizes that this contract provides storage space for raw water only. The Government makes no representations with respect to the quality or availability of water and assumes no responsibility therefor, or for the treatment of the water.

(e) Sedimentation Surveys.

(1) Surveys. Sedimentation surveys will be made by the Contracting Officer during the term of this contract at intervals not to exceed fifteen (15) years unless otherwise agreed to in writing by both parties. When, in the opinion of the Contracting Officer, the findings of such survey indicate any Project purpose will be affected by unanticipated sedimentation distribution, there shall be an equitable redistribution of the sediment reserve storage space among the purposes served by the Project including municipal and industrial water supply. The total available remaining storage space in the Project will then be divided among the various Project features in the same ratio as was initially utilized. Adjusted pool elevations will be rounded to the nearest one-half foot. Such findings and the storage space allocated to municipal and industrial water supply shall be defined and described as an exhibit which will be made a part of this contract and the reservoir regulation manual will be modified accordingly.

(2) Deviations. The Government assumes no responsibility for deviations from estimated rates of sedimentation, or the distribution thereof. Such deviations may cause unequal distribution of sediment reserve storage greater than estimated, and/or encroachment on the total storage at the Project.

ARTICLE 2 - Regulation of and Right to Use of Water. The regulation of the use of water withdrawn or released from the aforesaid storage space shall be the sole responsibility of the User. The User has the full responsibility to acquire in accordance with State laws and regulations, and, if necessary, to establish or defend, any and all water rights needed under State law for utilization of the storage provided under this contract. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies involving the use of the storage space by the User except as such controversies may affect the operations of the Project by the Government.

ARTICLE 3 - Operation and Maintenance. The Government shall operate and maintain the Project and the User shall pay to the Government a share of the costs of such operation and maintenance as provided in Article 5. The User shall be responsible for operation and maintenance of all installations and facilities which it may construct for the diversion or withdrawal of water, and shall bear all costs of construction, operation and maintenance of such installations and facilities.

ARTICLE 4 - Measurement of Withdrawals and Releases. The User agrees to furnish and install, without cost to the Government, suitable meters or measuring devices satisfactory to the Contracting Officer for the measurement of water which is withdrawn from the Project by any means other than through the Project outlet works. The User shall furnish to the Government monthly statements of all such withdrawals. Prior to the construction of any facilities for withdrawal of water from the Project, the User will obtain the Contracting Officer's approval of the design, location

and installation of the facilities including the meters or measuring devices. Such devices shall be available for inspection by Government representatives at all reasonable times. Releases from the water supply storage space through the Project outlet works shall be made in accordance with written schedules furnished by the User and approved by the Contracting Officer and shall be subject to Article 1(c). The measure of all such releases shall be by means of a rating curve of the outlet works, or by such other suitable means as may be agreed upon prior to use of the water supply storage space.

ARTICLE 5 - Payments. In consideration of the right to utilize the aforesaid storage space and the specific water supply facilities in the Project for municipal and industrial water supply purposes, the User shall pay the following sums to the Government:

(a) Project Investment Costs.

(1) Investment Cost to User. The User shall repay to the Government, at the times and with interest on the unpaid balance as hereinafter specified, the amounts stated below which, as shown in Exhibit "A" attached to and made a part of this contract, constitute the entire actual amount of the construction costs, including interest during construction, allocated to the water storage and the specific water supply facilities right acquired by the User under this contract. The interest rate to be used for purposes of computing interest during construction and interest on the unpaid balance was determined by the Secretary of the Treasury on the basis set forth in the Water Supply Act of 1958, as amended. For the Project, construction of which was initiated in FY 1962 this interest rate is 2.742 percent. The User shall repay:

5.4393 percent of the construction cost of specific water supply facilities,	\$ 6,038
0.9598 percent of the total Project joint-use construction costs,	\$198,659
Interest during construction,	<u>\$ 21,656</u>
Total amount of Project investment costs allocated to water supply	\$226,353

(2) Present Use Investment Cost. The Project investment costs allocated to the storage space indicated in Article 1(b)(1) as being provided for present demand and the specific water supply facilities is \$118,768, on the basis of the costs presented in Exhibit "A". Interest at the rate provided above will be compounded annually on the amount of the Project investment costs, allocated to the storage and the specific water supply facilities from 31 October 1978, the end of the 10-year interest-free period,

until the date of the first principal payment and added to the investment cost. The amount of the Project investment costs allocated to the storage for present demand shall be paid within the life of the Project in not to exceed 30 years from 28 September 1988, the date the first contract for water supply storage space in the Project was approved by the Secretary of the Army. Prior to use of the water storage space the User must complete design and construction of its water supply facilities. Pending completion of design and construction, the Government shall reserve for the User 8,295 acre-feet of storage for municipal and industrial water supply purposes for a period of up to 24 months. For this privilege, the User shall pay the Government \$1.00 per acre-foot per year or \$16,590. The payment shall be due and payable within 30 days after the User is notified by the Contracting Officer that the contract has been approved. This payment will preclude the requirement for any other payments prior to first use or the end of the 24-month period. All operation, maintenance, and replacement costs, including major rehabilitation and major replacement costs incurred subsequent to first use or the expiration of the 24-month period must be shared by the User. The investment cost payments shall be in equal consecutive annual installments, the first of which shall be due and payable within 24 months after the contract has been approved by the Secretary of the Army or within 30 days of first use of the storage space by the User whichever occurs first. Annual installments thereafter will be due and payable on the anniversary date of the date the first payment is due. Except for the first annual payment which will be applied solely to the retirement of principal all installments shall include accrued interest on the unpaid balance at the rate provided above. The last annual installment shall be adjusted upward or downward when due to assure repayment of all of the investment costs allocated to the storage for present demand and specific water supply facilities within 30 years from the above date.

(3) Future Use Investment Cost. The Project investment costs allocated to the storage space indicated in Article 1(b)(1) as being provided for future demand, is \$107,585 on the basis of the costs presented in Exhibit "A". The amount to be paid for any portion of such storage which is used shall be determined by multiplying the percentage of the total storage for future water supply which is placed in use by the total amount of the Project investment costs allocated to future water supply. Interest at the rate provided above will be charged on the amount of Project investment costs allocated to the storage for future water supply which is not being used from the tenth (10th) year following the plant-in-service date, 1 November 1968, until the date of the first annual payment established in Article 5(a)(2) and added to the investment cost. Thereafter, the User will annually pay the interest as it becomes due through the payment anniversary date following first use of each storage portion. When any portion of the storage for future water supply is used, payment of both

principal and interest for the portion used must be started, and the amount of the Project investment costs allocated thereto, with interest on the unpaid balance as provided above, shall be paid within the life of the Project in not to exceed 30 years from the date established in Article 5(a)(2). The payment for each portion shall be in equal consecutive annual installments with the first payment for each portion due and payable on the next anniversary of the first payment date as stipulated in Article 5(a)(2) following first use of each portion. Annual installments thereafter will be due and payable on the anniversary date of the date of first annual payment. Except for the first annual payment which will be applied solely to the retirement of principal, all installments shall include accrued interest on the unpaid balance at the rate provided above. The last annual installment for any portion of the storage for future water supply shall be adjusted upward or downward when due to assure repayment of all of the investment costs allocated to such portion within the repayment period.

(4) Payment Schedules. Subsequent to approval of the Secretary of the Army and prior to the first annual payment, Exhibit A will be adjusted to reflect the actual accrued interest from the end of the 10-year interest free period to the date of the first annual payment and the repayment period. A schedule of annual payments for the present use water supply storage and the specific water supply facilities will be furnished the User by the Contracting Officer at that time. The annual payments as provided therein shall be made subject to Article 6. Payment schedules for the storage provided for future water supply demand will be furnished by the Contracting Officer when use of such storage is started and will be subject to Article 6.

(b) Major Replacement Cost.

(1) Allocations. The User will be required to pay 5.4393 percent of the cost for any major replacement of specific water supply facilities. In addition, the User will be required to pay 0.426 percent of the cost of joint-use major replacement items.

(2) Payment. Payments of major replacement costs, including interest during construction, shall be made either incrementally during construction or in lump sum upon completion of construction at User's option.

(c) Annual Operation and Maintenance (O&M) Expense.

(1) Allocations. The User will be required to pay 5.4393 percent of the annual O&M expense of specific water supply facilities. In addition, the User will be required to pay 1.082 percent of the annual experienced joint-use O&M expense of the Project.

(2) Payment. Payments for O&M expense are due and payable in advance on the date for payment of Project investment costs as set forth in Article 5(a)(2) and shall be based on O&M expense for the Project in the Government fiscal year most recently ended. The amount of each annual payment will be the actual experienced O&M expense (specific plus allocated joint-use) for the preceding fiscal year or an estimate thereof when actual expense information is not available.

(d) Major Rehabilitation Program Costs. For costs associated with the major rehabilitation program, the percentages of specific and joint-use costs which the User will be required to pay will be in accordance with Article 5(c)(1). Payments for the costs associated with the program shall be in accordance with Article 5(b)(2).

(e) Prepayment. The User shall have the right at any time it so elects to prepay the indebtedness under this Article, subject to redetermination of costs as provided for in Article 6, in whole or in part, with accrued interest thereon to the date of such repayment.

(f) Delinquent Payments. If the User shall fail to make any of the aforesaid payments when due, then the overdue payments shall bear interest compounded annually until paid. The interest rate to be used for overdue payments due under the provisions of Articles 5(a), 5(b), 5(c) and 5(d) above shall be that determined by the Department of Treasury's Treasury Fiscal Requirements Manual (1 TFRM 6-8000, "Cash Management"). The amount charged on payments overdue for a period of less than one year shall be figured on a monthly basis. For example, if the payment is made within the first month after being overdue after a 15-day grace period from the anniversary date of the first payment date as stipulated in Article 5(a)(2), one month's interest shall be charged. Thereafter a month's interest will be charged for any portion of each succeeding month that the payment is delinquent. This provision shall not be construed as giving the User a choice of either making payments when due or paying interest, nor shall it be construed as waiving any other rights of the Government, at law or in equity, which might result from any default by the User.

(g) Credit. If storage under this future-use contract is used for other beneficial purposes prior to the time water supply use is initiated by the User and the Federal Government receives payments for such interim use, then the User shall be credited with an appropriate share of payments made under Article 5(b) and 5(c).

ARTICLE 6 - Adjustment to Project Investment Cost. The investment cost shown in this contract and the exhibits is based on actual final construction costs of the Project. Any further investment cost accruing to the User's water storage right shall be repaid under major replacement costs if capitalized or under operation and maintenance expense if not capitalized.

ARTICLE 7 - Duration of Contract. This contract shall become effective when approved by the Secretary of the Army or his duly authorized representative and shall continue in full force and effect for the life of the Project.

ARTICLE 8 - Permanent Rights to Storage. Upon completion of payments by the User, as provided in Article 5(a) herein, the User shall have a permanent right, under the provisions of the Act of 16 October 1963 (Public Law 88-140, 43 U.S.C. 390e), to the use of the water supply storage space and the specific water supply facilities in the Project as provided in Article 1, subject to the following:

(a) Operation and Maintenance. The User shall continue payment of annual operation and maintenance costs allocated to water supply.

(b) Additional Costs. The User shall bear the costs allocated to water supply of any necessary reconstruction, rehabilitation, or replacement of Project features which may be required to continue satisfactory operation of the Project. Such costs will be established by the Contracting Officer and repayment arrangements shall be in writing in accordance with the terms and conditions set forth in Article 5(b) for Major Replacement Costs, and be made a part of this contract.

(c) Storage Redetermination. Upon completion of payments by the User as provided in Article 5(a), the Contracting Officer shall redetermine the storage space for municipal and industrial water supply in accordance with the provisions of Article 1(e). Such redetermination of reservoir storage capacity may be further adjusted from time to time as the result of sedimentation resurveys to reflect actual rates of sedimentation and the exhibit revised to show the revised storage space allocated to municipal and industrial water supply.

(d) Permanent Rights. The permanent rights of the User under this contract shall be continued so long as the Government continues to operate the Project. In the event the Government no longer operates the Project, such rights may be continued subject to the execution of a separate contract, or additional supplemental agreement providing for:

(1) Continued Operation. Continued operation by the User of such part of the facility as is necessary for utilization of the water supply storage space allocated to it;

(2) Public Interest. Terms which will continue to protect the public interest;

(3) Absolvement of Government. An effective absolvement of the Government by the User from all liability in connection with the User's continued operation; and

(4) Existing Contract. The continuation of the terms and conditions of this contract.

ARTICLE 9 - Release of Claims. The User shall hold and save the Government, including its officers, agents and employees harmless from liability of any nature or kind for or on account of any claim for damages which may be filed or asserted as a result of the storage in the Project, or withdrawal or release of water from the Project, made or ordered by the User or as a result of the construction, operation, or maintenance of the water supply facilities and appurtenances thereto owned and operated by the User, except for damages due to the fault or negligence of the Government or its contractors.

ARTICLE 10 - Assignment. The User shall not transfer or assign this contract nor any rights acquired thereunder, nor suballot said water supply storage space or any part thereof, nor grant any interest, privilege or license whatsoever in connection with this contract, without the approval of the Secretary of the Army, or his duly authorized representative provided that, unless contrary to the public interest, this restriction shall not be construed to apply to any water that may be obtained from the water supply storage space by the User and furnished to any third party or parties, nor any method of allocation thereof.

ARTICLE 11 - Officials Not to Benefit. No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

ARTICLE 12 - Covenant Against Contingent Fees. The User warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the User for the purpose of securing business. For breach or violation of this warranty the Government shall have the right to annul this contract without liability or in its discretion to add to the contract price or consideration, or otherwise recover the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 13 - Environmental Quality. During any construction, operation, and maintenance by User of any facilities, specific actions will be taken to control environmental pollution which could result from such activity and to comply with applicable Federal, State, and local laws and regulations concerning environmental pollution. Particular attention should be given to (1) reduction of air pollution by control of burning, minimization of dust, containment of chemical vapors, and control of engine exhaust gases, and of smoke from temporary heaters; (2) reduction of water pollution by control of sanitary facilities, storage of fuels and other contaminants, and control of turbidity and siltation from erosion; (3) minimization of noise levels; (4) onsite and offsite disposal of waste and spoil; and (5) prevention of landscape defacement and damage.

ARTICLE 14 - Federal and State Laws.

(a) Compliance. In acting under its rights and obligations hereunder, the User agrees to comply with all applicable Federal and State laws and regulations, including but not limited to the provisions of the Davis-Bacon Act (40 U.S.C. 276a et seq.); the Contract Work Hours and Safety Standards Act (40 U.S.C. 327-333); Title 29, Code of Federal Regulations, Part 3; and Sections 210 and 305 of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646).

(b) Civil Rights Act. The User furnishes, as part of this contract, an assurance (Exhibit B) that it will comply with Title VI of the Civil Rights Act of 1964 (78 Stat. 241, 42 U.S.C. 2000d, et seq.) and Department of Defense Directive 5500.11 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations.

(c) Regulatory Program. Any discharges of water or pollutants into a navigable stream or tributary thereof resulting from the User's facilities and operations undertaken under this contract shall be performed only in accordance with applicable Federal, State, and local laws and regulations.

ARTICLE 15 - Definitions.

(a) Project investment costs - The initial cost of the Project, including: land acquisition; construction; interest during construction on the value of land, labor, and materials used for planning and construction of the Project.

(b) Interest during construction - An amount of interest which accrues on expenditures for the establishment of Project services during the period between the actual outlay and the time the Project is first made available for water storage.

(c) Specific costs - The costs of Project features normally serving only one particular Project purpose.

(d) Joint-use costs - The costs of features used for any two or more Project purposes. All costs not included as specific costs.

(e) Plant-in-service date - This date is the date that the Project is physically available to initiate deliberate impoundment for water supply purposes. For the Project, the plant-in-service date is November 1, 1968.

(f) Annual operation and maintenance (O&M) expense - Annual expenses funded under the O&M, General account. These expenses include the daily Project O&M costs as well as those O&M costs which are not capitalized.

FmHA hereby agrees to assume all of the responsibilities of the User and abide by all the terms and provisions of said contract if and when this conditional agreement shall become absolute, including the requirements of approval of the Secretary of the Army, or his authorized representative, for all subsequent assignments in accordance with Article 10 of the contract.

The conditional agreement shall become effective upon approval of the Secretary of the Army or his authorized representative.

FARMERS HOME ADMINISTRATION

BROKEN BOW PUBLIC WORKS AUTHORITY

By: *P. Wilson*
for State Director

By: *[Signature]*

Date: 1/29/90

Date: Dec. 7, 1989

APPROVED:

Patrick J. Kelly
Director of Civil Works
U.S. Army Corps of Engineers

Date: 16 Feb 90

REPRODUCED AT GOVERNMENT EXPENSE

CONDITIONAL
TRANSFER AND ASSIGNMENT OF A CONTRACT BETWEEN THE
UNITED STATES OF AMERICA
AND THE BROKEN BOW PUBLIC WORKS AUTHORITY
FOR WATER STORAGE SPACE IN BROKEN BOW LAKE

WITNESSETH THAT:

WHEREAS, the Broken Bow Public Works Authority (hereinafter called the "User") entered into Contract No. DACW56-90-C-0036 with the United States of America on 2 February 1990 for water supply storage space and facilities in Broken Bow Lake; and,

WHEREAS, said contract will be part of the security for a Farmers Home Administration (hereinafter called "FmHA") loan to the Broken Bow Public Works Authority; and,

WHEREAS, Article 10 of said contract provides for transfer or assignment of the contract subject to the approval of the Secretary of the Army or his authorized representative; and,

WHEREAS, said contract can be assigned to FmHA in accordance with financial arrangements upon agreement by said agency to assume all the responsibilities of the contract terms and approval of the Secretary of the Army or his authorized representative as provided in a said contract.

NOW, therefore, in consideration of the initial sum of \$ 41,222,400, the receipt whereof is hereby acknowledged, and any subsequent amounts loaned not exceeding 15 percent, the User does hereby transfer and assign unto FmHA, its successors and assigns, all of its rights, title and interest in and to the said Contract No. DACW56-90-C-0036 with the United States of America dated 2 February 1990.

This transfer and assignment is intended as a conditional transfer and assignment to secure the payment of a certain promissory note or notes of even date herewith for \$41,222,400, due 40 years from date of loan closing, made to FmHA, or order, payable at monthly intervals, with 2.742 percent interest per annum, and executed by the User.

If the User shall pay or cause to be paid to FmHA, its successors and assigns, the sum of money in the above-described note, together with the interest thereon according to the terms and tenor of said note, then these presents shall be wholly discharged and void. If said sums of money or any part thereof is not paid when due, FmHA, its successors or assigns, may elect to declare the whole sum and interest thereon due and payable at once and proceed to collect said debt including attorney's fees, and to foreclose this conditional transfer and assignment and shall become entitled to all rights and interests in and under said contract.

The User hereby waives notice of election to declare the whole debt due as above and also benefit of stay, valuation or appraisal laws.

SECTIONS IV AND VII DEPARTMENT OF DEFENSE DIRECTIVE 5500.11

IV. POLICY

A. GENERAL. No person in the United States shall, on the ground of race, color, or national origin be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program to which this Directive applies.

B. SPECIFIC DISCRIMINATORY ACTIONS PROHIBITED.

1. A recipient under any program to which this Directive applies may not, directly or through contractual or other arrangements, on the ground of race, color, or national origin:

a. Deny an individual any service, financial aid, or other benefit provided under the program;

b. Provide any service, financial aid, or other benefit to an individual which is different, or is provided in a different manner, from that provided to others under the program;

c. Subject an individual to segregation or separate treatment in any matter related to his receipt of any service, financial aid, or other benefit under the program;

d. Restrict an individual in any way in the enjoyment of any advantage or privilege enjoyed by other receiving any service, financial aid, or other benefit under the program;

e. Treat an individual differently from others in determining whether he satisfies any admission, enrollment, quota, eligibility, membership or other requirement or condition which individuals must meet in order to be provided any service, financial aid, or other benefit provided under the program.

f. Deny an individual an opportunity to participate in the program through the provision of services or otherwise or afford him an opportunity to do so which is different from that afforded others under the program.

2. A recipient, in determining the types of services, financial aid, or other benefits, or facilities which will be provided under any such program, or the class of individuals to whom, or the situations in which, such services, financial aid, other benefits, or facilities will be provided under any such program, or the class of individuals to be afforded an opportunity to participate in any such program, may not, directly or through contractual or other arrangements, utilize criteria or methods of administration which have the effect of subjecting individuals to discrimination because of their race, color, or national origin, or have the effect of defeating or substantially impairing accomplishment of the objectives of the program as respect individuals of a particular race, color, or national origin.

3. As used in this Section the services, financial aid, or other benefits provided under a program receiving Federal financial assistance shall be deemed to include any service, financial aid, or other benefit provided in or through a facility provided with the aid of Federal financial assistance.

4. The enumeration of specific forms of prohibited discrimination in this Subsection does not limit the generality of the prohibition in Subsection IV. A. of this Section.

VII. Compliance Information

A. Cooperation and Assistance. Each responsible Department official shall to the fullest extent practicable seek the cooperation of recipients in obtaining compliance with this Directive and shall provide assistance and guidance to recipients to help them comply voluntarily with this Directive.

B. Compliance Reports. Each recipient shall keep such records and submit to the responsible Department official timely, complete and accurate compliance reports at such times, and in such form and containing such information, as the responsible Department official may determine to be necessary to enable him to ascertain whether the recipient has complied or is complying with this Directive. In the case of any program under which a primary recipient extends Federal assistance to any other recipient, such other recipient shall also submit compliance reports to the primary recipient as may be necessary to enable the primary recipient to carry out its obligations imposed pursuant to this Directive.

C. Access to Sources of Information. Each recipient shall permit access by the responsible Department official during normal business hours to such of its books, records, accounts, and other sources of information, and its facilities as may be pertinent to ascertain compliance with this Directive. Where any information required of a recipient is in the exclusive possession of any other institution or person and this institution or person shall fail or refuse to furnish this information, the recipient shall so certify in its report and shall set forth what efforts it has made to obtain the information.

D. Information to Beneficiaries and Participants. Each recipient shall make available to participants, beneficiaries, and other interested persons such information regarding the provisions of this Directive and its applicability to the program under which the recipient receives Federal financial assistance, and make such information available to them in such manner, as the responsible Department official finds necessary to apprise such persons of the protections against discrimination assured them by the Act and this Directive.

(g) Major replacement cost - Costs funded under the Operation and Maintenance, General, or Construction, General accounts but not associated with initial Project investment costs.

(h) Fiscal Year - Refers to the Government's fiscal year. This year begins on 1 October and ends on 30 September. The September calendar year corresponds to the fiscal year.

(i) Life of the Project - This is the physical life of the Project.

(j) Major Rehabilitation - This program is to facilitate accomplishment of significant, costly infrequent rehabilitation work at the Project without unduly distorting the Operation and Maintenance, General budget.

ARTICLE 16 - Approval of Contract. This contract shall be subject to the written approval of the Secretary of the Army or his duly authorized representative and shall not be binding until so approved.

IN WITNESS WHEREOF, the parties have executed this contract as of the day and year first above written.

APPROVED:

Patrick J. Kelly
Director of Civil Works
U.S. Army Corps of Engineers

THE UNITED STATES OF AMERICA

By *F.L. Smith, Jr.*
F.L. SMITH, JR.
Colonel, U.S. Army
District Engineer
Contracting Officer

DATE: 16 Feb 90

DATE: 90 FEB 02

TECHNICAL REVIEW

By *[Signature]*

BROKEN BOW PUBLIC WORKS AUTHORITY

By *[Signature]*
Chairman

DATE: Dec. 13, 1989

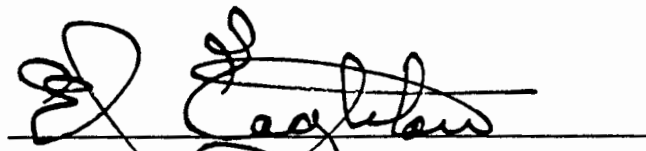
Reviewed for Legal Sufficiency

By *K45*

CERTIFICATION

I, F J Eagleton, Attorney for the Broken Bow Public Works Authority, named as the User herein, hereby certify that the foregoing agreement executed by D P Hewitt, Chairman of the User is within the scope of his authority to act upon behalf of said User, and that in my capacity as Attorney for the User, find that the User is legally and financially capable of entering into the contractual obligations contained in the foregoing agreement and that, upon acceptance, it will be legally enforceable.

Given under my hand, this 18 day of Dec, 1989



Attorney for the Broken Bow Public
Works Authority

CONTRACT NO.

CONTRACT BETWEEN THE UNITED STATES OF AMERICA

AND

OKLAHOMA TOURISM AND RECREATION DEPARTMENT, DIVISION OF STATE PARKS

FOR

WATER STORAGE SPACE IN BROKEN BOW LAKE 28 Sep 88

THIS CONTRACT, entered into this ~~13th~~ day of July, 1988 by and between THE UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and the OKLAHOMA TOURISM AND RECREATION DEPARTMENT, DIVISION OF STATE PARKS hereinafter called the "User");

WITNESSETH THAT:

WHEREAS, the Flood Control Act approved 3 July 1958, (Public Law 85-500, 85th Congress, 2d Session), as modified by the Flood Control Act, approved 23 October 1962, (Public Law 87-874, 87th Congress, 2d Session), authorized the construction, operation, and maintenance of the Broken Bow Lake on the Mountain Fork River, Oklahoma, (hereinafter called the "Project"); and

WHEREAS, the User desires to contract with the Government for the use of storage included in the Project for municipal and industrial water supply, and for payment of the cost thereof in accordance with the provisions of the Water Supply Act of 1958, as amended (43 U.S.C. 390b-f); and

WHEREAS, the User is empowered to contract with the Government and is vested with all necessary powers of accomplishment of the purposes of this contract;

NOW THEREFORE, the Government and the User agree as follows:

ARTICLE 1 - Water Storage Space.

(a) Project Construction. The Government, subject to the directions of Federal law and any limitations imposed thereby, has designed and constructed the Project so as to include therein space for the storage of water by the User.

(b) Rights of User.

(1) The User shall have the right to utilize an undivided 0.013 percent (estimated to contain 60 acre-feet after adjustment for sediment deposits) of the usable storage space in the Project between elevations 559.0 feet National Geodetic Vertical Datum and 599.5 feet National Geodetic Vertical Datum, which usable

conservation storage space is estimated to contain 469,820 acre-feet after adjustment for sediment deposits. This storage space is to be used to impound water for present demand or need for municipal and industrial water supply.

(2) The User shall have the right to withdraw water from the lake, or to order releases to be made by the Government through the outlet works in the Dam, subject to the provisions of Article 1(c) and to the extent the aforesaid storage space will provide: and shall have the right to construct all such works, plants, pipelines, and appurtenances as may be necessary and convenient for the purpose of diversion or withdrawals, subject to the approval of the Contracting Officer as to design and location. The grant of an easement for right-of-way, across, in and upon land of the Government at the Project shall be a separate instrument in a form satisfactory to the Secretary of the Army, without additional cost to the User, under the authority of and in accordance with the provisions of 10 U.S.C. 2669 and such other authorities as may be necessary. Subject to the conditions of such easement, the User shall have the right to use so much of the Project land as may reasonably be required in the exercise of the rights and privileges granted under this contract.

(c) Rights Reserved. The Government reserves the right to control and use any future water supply storage and/or any water supply storage not under contract in accordance with authorized Project purposes. The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property, including the right not to make downstream releases during such periods of time as are deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

(d) Quality or Availability of Water. The User recognizes that this contract provides storage space for raw water only. The Government makes no representations with respect to the quality or availability of water and assumes no responsibility therefor, or for the treatment of the water.

(e) Sedimentation Surveys.

(1) Sedimentation surveys will be made by the Contracting Officer during the term of this contract at intervals not to exceed fifteen (15) years unless otherwise agreed to in writing by both parties. When, in the opinion of the Contracting Officer, the findings of such survey indicate any Project purpose will be affected by unanticipated sedimentation distribution, there shall be an equitable redistribution of the sediment reserve storage space among the purposes served by the Project including municipal and industrial water supply. The total available remaining storage space in the Project will then be divided among the various Project features in the same ratio as was initially utilized. Adjusted pool elevations will be rounded to the nearest

one-half foot. Such findings and the storage space allocated to municipal and industrial water supply shall be defined and described as an exhibit which will be made a part of this contract and the reservoir regulation manual will be modified accordingly.

(2) The Government assumes no responsibility for deviations from estimated rates of sedimentation, or the distribution thereof. Such deviations may cause unequal distribution of sediment reserve storage greater than estimated, and/or encroachment on the total storage at the Project.

ARTICLE 2 - Regulation of and Right to Use of Water. The regulation of the use of water withdrawn or released from the aforesaid storage space shall be the sole responsibility of the User. The User has the full responsibility to acquire in accordance with State laws and regulations, and, if necessary, to establish or defend, any and all water rights needed for utilization of the storage provided under this contract. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies involving the use of the storage space by the User except as such controversies may affect the operations of the Government.

ARTICLE 3 - Operation and Maintenance. The Government shall operate and maintain the Project and the User shall pay to the Government a share of the costs of such operation and maintenance as provided in Article 5. The User shall be responsible for operation and maintenance of all installations and facilities which it may construct for the diversion or withdrawal of water, and shall bear all costs of construction, operation and maintenance of such installations and facilities.

ARTICLE 4 - Measurement of Withdrawals and Releases. The User agrees to furnish and install, without cost to the Government, suitable meters or measuring devices satisfactory to the Contracting Officer for the measurement of water which is withdrawn from the Project by any means other than through the Project outlet works. The User shall furnish to the Government monthly statements of all such withdrawals. Prior to the construction of any facilities for withdrawal of water from the Project, the User will obtain the Contracting Officer's approval of the design, location and installation of the facilities including the meters or measuring devices. Such devices shall be available for inspection by Government representatives at all reasonable times. Releases from the water supply storage space through the Project outlet works shall be made in accordance with written schedules furnished by the User and approved by the Contracting Officer and shall be subject to Article 1(c). The measure of all such releases shall be by means of a rating curve of the outlet works, or by such other suitable means as may be agreed upon prior to use of the water supply storage space.

ARTICLE 5 - Payments. In consideration of the right to utilize the aforesaid storage space and the water supply conduit in the Project for municipal and industrial water supply purposes, the User shall pay the following sums to the Government:

(a) Project Investment Costs.

(1) The User shall repay to the Government in a lump sum payment, \$2,209, which, as shown in Exhibit "A" attached to and made a part of this contract, constitute the entire actual amount of the construction costs, including interest during construction and accrued interest from the end of the 10-year interest free period, 1 November 1978, plus the present worth of the estimated annual operation and maintenance of the Project over a 40-year period, allocated to the water storage and the water supply conduit right acquired by the User under this contract. The interest rate to be used for purposes of computing interest during construction and accrued interest was determined by the Secretary of the Treasury on the basis set forth in the Water Supply Act of 1958, as amended. For the Project, construction of which was initiated in FY 1962 this interest rate is 2.742 percent.

(2) Interest at the rate provided above will be compounded annually on the amount of the Project investment costs, allocated to the storage for future water supply and the water supply conduit from 1 November 1978, the end of the 10-year interest free period, until the date of contract approval and added to the principal amount. The interest rate to be used for purposes of computing the present worth of the joint-use costs of major replacement and operation and maintenance shall be at the rate of 10.371 percent per annum, the rate computed by the Secretary of the Treasury in accordance with the Water Supply Act of 1958, as amended, for the 1988 fiscal year. Should the contract not be approved during the 1988 fiscal year, the amounts to be repaid will be adjusted to reflect the application of the interest rate, computed in accordance with said Water Supply Act of 1958, in effect during the year in which the contract is approved. The lump sum payment shall be due and payable within thirty (30) days after the date the User is notified that this contract is approved by the Secretary of the Army.

(3) Subsequent to contract approval, Exhibit A will be adjusted to reflect the actual accrued interest from the end of the 10-year interest free period to the date of approval and the present worth of 40 years of joint-use costs of operation and maintenance.

(b) Major Replacement Cost. The User shall pay 0.039 percent of the cost for any major replacement of specific water supply facilities when incurred. In addition, the User will also be required to pay 0.003 percent of the cost of joint-use major replacement items when incurred. Payment of major replacement costs, including interest during construction, shall be made either during construction or in lump sum upon completion of construction.

(c) Annual Operation and Maintenance (O&M) Expense. The User shall, after expiration of 40 years from the effective date of this contract, resume and continue to pay 0.039 percent of the annual O&M expense of

specific water supply facilities. In addition, at the time the User will also be required to pay 0.008 percent of the annual experienced joint-use O&M expense of the Project. Future payments for O&M expense will be due and payable in advance on the anniversary date of the effective date of this contract and shall be based on O&M expense for the Project in the Government fiscal year most recently ended. The amount of each annual payment will be the actual experienced O&M expense (specific plus allocated joint-use) for the preceding fiscal year or an estimate thereof when actual expense information is not available.

(d) Major Rehabilitation Program Costs. For costs associated with the major rehabilitation program, the percentages of specific and joint use costs which the User will be required to pay will be in accordance with Article 5(c). Payments for the costs associated with the program shall be in accordance with Article 5(b).

(e) Delinquent Payments. If the User shall fail to make any of the aforesaid payments when due, then the overdue payments shall bear interest compounded annually until paid. The interest rate to be used for overdue payments due under the provisions of Articles 5(a), 5(b), 5(c) and 5(d) above shall be that determined by the Department of Treasury's Treasury Fiscal Requirements Manual (1 TFRM 6-8000, "Cash Management"). The amount charged on payments overdue for a period of less than one year shall be figured on a monthly basis. For example, if the payment is made within the first month after being overdue after a 15-day grace period from the anniversary date of the date of notification, one month's interest shall be charged. Thereafter a month's interest will be charged for any portion of each succeeding month that the payment is delinquent. This provision shall not be construed as giving the User a choice of either making payments when due or paying interest, nor shall it be construed as waiving any other rights of the Government, at law or in equity, which might result from any default by the User.

J/BSF

JS Sep 8/88

ARTICLE 6 - Adjustment to Project Investment Cost. The investment cost shown in this contract and the exhibits is based on actual final construction costs of the Project. Any further investment cost accruing to the User's water storage right shall be repaid under major replacement costs if capitalized or under operation and maintenance expense if not capitalized.

ARTICLE 7 - Duration of Contract. This contract shall become effective when approved by the Secretary of the Army or his duly authorized representative and shall continue in full force and effect for the life of the Project.

ARTICLE 8 - Permanent Rights to Storage. Upon completion of payments by the User, as provided in Article 5(a) herein, the User shall have a permanent right, under the provisions of the Act of 16 October 1963 (Public Law 88-140, 43 U.S.C. 390e), to the use of the water supply storage space and the water supply conduit in the Project as provided in Article 1, subject to the following:

(a) The User shall continue payment of their annual operation and maintenance costs allocated to water supply.

(b) The User shall bear the costs allocated to water supply of any necessary reconstruction, rehabilitation, or replacement of Project features which may be required to continue satisfactory operation of the Project. Such costs will be established by the Contracting Officer and repayment arrangements shall be in writing in accordance with the terms and conditions set forth in Article 5(b) for Major Replacement Costs, and be made a part of this contract.

(c) Upon completion of payments by the User as provided in Article 5(a), the Contracting Officer shall redetermine the storage space for municipal and industrial water supply in accordance with the provisions of Article 1(e). Such redetermination of reservoir storage capacity may be further adjusted from time to time as the result of sedimentation resurveys to reflect actual rates of sedimentation and the exhibit revised to show the storage space allocated to municipal and industrial water supply.

(d) The permanent rights of the User under this contract shall be continued so long as the Government continues to operate the Project. In the event the Government no longer operates the Project, such rights may be continued subject to the execution of a separate contract, or additional supplemental agreement providing for:

(1) Continued operation by the User of such part of the facility as is necessary for utilization of the water supply storage space allocated to it;

(2) Terms which will protect the public interest; and

(3) Effective absolvment of the Government by the User from all liability in connection with such continued operation.

ARTICLE 9 - Release of Claims. The User shall hold and save the Government, including its officers, agents and employees harmless from liability of any nature or kind for or on account of any claim for damages which may be filed or asserted as a result of the storage in the Project, or withdrawal or release of water from the Project, made or ordered by the User or as a

result of the construction, operation, or maintenance of the water supply facilities and appurtenances thereto owned and operated by the User, except for damages due to the fault or negligence of the Government or its contractors.

ARTICLE 10 - Assignment. The User shall not transfer or assign this contract nor any rights acquired thereunder, nor suballot said water supply storage space or any part thereof, nor grant any interest, privilege or license whatsoever in connection with this contract, without the approval of the Secretary of the Army, or his duly authorized representative provided that, unless contrary to the public interest, this restriction shall not be construed to apply to any water that may be obtained from the water supply storage space by the User and furnished to any third party or parties, nor any method of allocation thereof.

ARTICLE 11 - Officials Not to Benefit. No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

ARTICLE 12 - Covenant Against Contingent Fees. The User warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the User for the purpose of securing business. For breach or violation of this warranty the Government shall have the right to annul this contract without liability or in its discretion to add to the contract price or consideration, or otherwise recover the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 13 - Environmental Quality. During any construction, operation, and maintenance by User of any facilities, specific actions will be taken to control environmental pollution which could result from such activity and to comply with applicable Federal, State, and local laws and regulations concerning environmental pollution. Particular attention should be given to (1) reduction of air pollution by control of burning, minimization of dust, containment of chemical vapors, and control of engine exhaust gases, and of smoke from temporary heaters; (2) reduction of water pollution by control of sanitary facilities, storage of fuels and other contaminants, and control of turbidity and siltation from erosion; (3) minimization of noise levels; (4) onsite and offsite disposal of waste and spoil; and (5) prevention of landscape defacement and damage.

ARTICLE 14 - Federal and State Laws.

(a) In acting under its rights and obligations hereunder, the User agrees to comply with all applicable Federal and State laws and regulations, including but not limited to the provisions of the Davis-Bacon Act (40 U.S.C. 276a et seq.); the Contract Work Hours Safety Standards Act (40 U.S.C. 327-333); Title 29, Code of Federal

Regulations, Part 3; and Sections 210 and 305 of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (PL91-646).

(b) The User furnishes, as part of this contract, an assurance (Exhibit B) that it will comply with Title VI of the Civil Rights Act of 1964 (78 Stat. 241, 42 U.S.C. 2000d, et seq.) and Department of Defense Directive 5500.11 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations.

(c) Any discharges of water or pollutants into a navigable stream or tributary thereof resulting from the User's facilities and operations undertaken under this contract shall be performed only in accordance with applicable Federal, State, and local laws and regulations.

ARTICLE 15 - Definitions.

(a) Project investment costs The initial cost of the Project, including: land acquisition; construction; interest during construction on the value of land, labor, and materials used for planning and construction of the Project.

(b) Interest during construction - An amount of interest which accrues on expenditures for the establishment of Project services during the period between the actual outlay and the time the Project is first made available for water storage.

(c) Specific costs - The costs of Project features normally serving only one particular Project purpose.

(d) Joint-use costs - The costs of features used for any two or more Project purposes.

(e) Plant-in-service date - This date is the date that the Project is physically available to initiate deliberate impoundment for water supply purposes.

(f) Annual operation and maintenance (O&M) expense - Annual expenses funded under the O&M, General account. These expenses include the daily Project O&M costs as well as those O&M costs which are capitalized.

(g) Major replacement cost - Costs funded under the Operation and Maintenance, General, or Construction, General accounts but not associated with initial Project investment costs.


(h) Fiscal Year Refers to the Government's fiscal year. This year begins on 1 October and ends on 30 September. The September calendar year corresponds to the fiscal year.

(i) Life of the Project - This is the physical life of the Project.

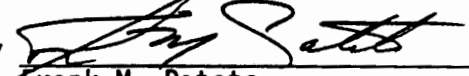
(j) Major Rehabilitation - This program is to facilitate accomplishment of significant, costly infrequent rehabilitation work at the Project without unduly distorting the Operation and Maintenance, General budget.

ARTICLE 16 - Approval of Contract. This contract shall be subject to the written approval of the Secretary of the Army or his duly authorized representative and shall not be binding until so approved.

IN WITNESS WHEREOF, the parties have executed this contract as of the day and year first above written.

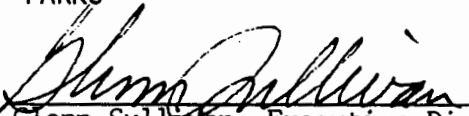
APPROVED: 
Robert W. Page
Assistant Secretary of the Army
(Civil Works)

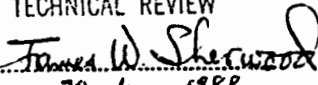
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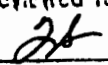
THE UNITED STATES OF AMERICA
By 
Frank M. Patete
Colonel, Corps of Engineers
District Engineer
Contracting Officer

DATE: 13 Jul 1988

OKLAHOMA TOURISM AND RECREATION
DEPARTMENT, DIVISION OF STATE
PARKS

By 
Glenn Sullivan, Executive Director
DATE: June 10, 1988

TECHNICAL REVIEW
By 
20 June 1988

Reviewed for Legal Sufficiency
By  7/7/88

CERTIFICATION

I Hugh H. Collum, Attorney for the Oklahoma Tourism and Recreation Department, Division of State Parks, named as the User herein, hereby certify that the foregoing agreement executed by Celenn Sullivan, of the User is within the scope of his authority to act upon behalf of said User, and that in my capacity as Attorney for the User, I have considered the legal effect of Section 221 of the 1970 Flood Control Act (Public Law 91-611) and find that the User is legally and financially capable of entering into the contractual obligations contained in the foregoing agreement and that, upon acceptance, it will be legally enforceable.

Given under my hand, this 31st day of May 1988.

Hugh H. Collum
 Attorney for the Oklahoma Tourism
 and Recreation Department, Division
 of State Parks

CHH#
1819

Ass't At. Gen.

EXHIBIT C
STANDING INSTRUCTIONS TO PROJECT MANAGER

EXHIBIT C
STANDING INSTRUCTIONS TO PROJECT MANAGER
BROKEN BOW DAM
MOUNTAIN FORK RIVER, OKLAHOMA

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I - GENERAL INSTRUCTIONS

1. Operation. During flood periods, the lake will be regulated in accordance with the normal flood control regulations as directed in Chapter VII of this manual or paragraph 2 of Section II this Exhibit. Instructions for the storage and discharge of floodwater will be issued by the Water Control Section. In the event communications with the Tulsa District Office are disrupted, the lake will be regulated in accordance with the schedule of emergency flood control regulations as directed in Chapter VII of this manual or paragraphs 3 and 5 of Section II of this Exhibit. In addition, the Project Manager will immediately make every effort to re-establish communications with the Tulsa District Office.

2. Data Reporting Instructions. Lake data from Broken Bow Lake will be submitted each day the Water Control Section, Hydrology-Hydraulics Branch, Tulsa District Office (telephone 918-669-7131 or VHF-FM radio, call signal WUI-3). The Water Control Section office is manned from 7:00 a.m. to 4:30 p.m. daily and various hours on weekends and holidays. Data for nonworking days shall be read from the recorder chart and submitted the following workday. Should unusual conditions arise during nonworking hours, one of the persons listed on page I of this manual should be contacted. The following data should be included in the daily report.

a. As of 8 a.m. The current day 8 a.m. pool elevation; number, type, and height of gate openings; tailwater elevation at 8 a.m.; and precipitation in inches for the preceding 24 hours (7 a.m. to 7 a.m.).

b. Each gate operation. Date and time of operation, number and heights of

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

c. Power Releases. Hourly power releases (midnight to midnight), 8 a.m. instantaneous power discharge, 8 a.m. total discharge, 24-hour average (midnight to midnight) power release, 24-hour average total release, and the 24-hour net power generation will be reported daily.

d. During Flood Periods. In addition to paragraphs a and b above, additional reports may be required by the Water Control Section personnel during flood periods..

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

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

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

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

(4) Report at once the occurrence of 2.00 inches or more of precipitation

that occurs during a period of 6 hours or less. During nonworking hours, the reports should be made to one of the persons listed on page I of this manual. If no contact with Water Control Section personnel can be made, rainfall reports should be made to the National Weather Service, Shreveport, Louisiana, 1-318-635-7345.

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 a settlement, movement, or cracking of the earth embankment or abutments; unusual change in seepage rates or development of new seepage areas; mechanical malfunction or failure; structural settlement, movement, cracking, or vibration; landslides, rockslides, or indication 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 Control Section, Hydrology-Hydraulics Branch.

4. Warnings. It is the responsibility of the Project Manager to maintain a list in current status of residents and property owners who would be endangered or inconvenienced by large or prolonged releases. If damaging releases are expected to occur, notification will be made by telephone or oral warning by Corps employees. Notification will be made in accordance with the Tulsa District supplements to ER 500-1-1. This would include radio, television, telephone, Citizen Band radio, use of law enforcement and Civil Defense agencies and their communication systems, National Guard and Reserve Units, supplemented by oral warning from Corps employees in Government vehicles. Approximate water surface profiles and flooded area maps that would result from maximum spillway releases or dam failure are found in the Broken

Bow Dam, Operation and Maintenance Manual, Volume II, Contingency Plan for Emergencies. A warning horn will be blown when gate changes are made to give warning to people immediately downstream who are within hearing distance of the horn blast.

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

II - REGULATION PROCEDURES

1. Regulating River Stages and Discharges. The regulation schedules provide that the channel capacity downstream of Broken Bow Dam is not to be exceeded insofar as practicable. The current regulating flow below the Dam is 8,000 c.f.s.. Flood waters 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 Lake during a rise, general climatic conditions, season of the year with respect to the probability of floods, and status of crops in low-lying farmlands.

2. Normal Flood Control Regulations. Under normal procedures, instructions for the storage and release of water for conservation and flood control will be issued by the Water Control Section, Hydrology-Hydraulics Branch. Gate changes and other instructions are to be confirmed back to the Water Control Section as soon as the required action is completed. Instructions originating from any other source should not be processed. Broken Bow Lake will be operated for maximum flood reductions on the Mountain Fork and Little River from the dam to the upper limits of Millwood Lake. Releases will also be coordinated with the flood control operations at Pine Creek, and Dequeen Lakes to provide maximum flood control benefits on the Mountain Fork and Little River Basins.

3. Emergency Flood Control Regulations. When communication with the Tulsa District Office is disrupted, the Project Manager will, on his own initiative, direct flood control operation of the Lake in accordance with Table C-1 until communications are restored. In addition, the Project Manager will make every effort to establish communications with the Tulsa District Office and will send information to the Tulsa District Office by any means possible. In the event that communications are disrupted, releases shall not be changed until 12 hours has elapsed or until the pool rises to elevation 621.0 (approximately 75 percent of the flood control pool storage), at which time releases will be made in accordance with Table C-1. Plate 7-17 has been included to meet EM 1110-2-3600 requirements and should only be used as a last resort. At no time during emergency flood control operations shall releases be decreased if the pool is rising. The spillway gates will be operated with no more that one foot difference in opening between the gates during emergency flood control operations.

4. Rate of Release Change. The increase and decrease in spillway releases from the Lake shall be accomplished in a manner which minimizes bank erosion and danger to human and animal lives whenever possible. Releases should be increased and decreased in increments of 1,300 c.f.s. or less with a minimum of 3 hours between changes. Situations will arise which will not allow an orderly increase or decrease in spillway and hydropower releases. Examples of these situations are shutting off releases to minimize downstream flooding, drownings, and other downstream emergencies.

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

TABLE C-1
EMERGENCY FLOOD CONTROL REGULATION SCHEDULE

Pool Elevation and Condition	Regulation
-------------------------------------	-------------------

a. Below 599.5 (or top to seasonal conservation pool) and Rising

Maintain current releases until communication is restored.

b. 599.5 (or top of seasonal conservation pool) to 621.0 and Rising

Maintain current releases until either communication is restored, or if communication is not restored after 12 hours, increase or maintain releases in accordance with Plate 7-1, Spillway Gate Regulation Schedule. Adjust releases every 2 hours based on the previous 2-hour inflow as computed from Plate 7-2. Do not decrease releases while the pool is rising.

c. 621.0 to 627.5 and Rising

When communications are disrupted and the lake level is at or above elevation 621.0, the Project shall start releases in accordance with Plate 7-1, spillway gate regulation schedule. Adjust releases every 2 hours based on the previous 2-hour inflow as computed from Plate 7-2.

TABLE C-1 (CONT)

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE

d. 627.5 to 632.5 and Rising

Increase or maintain releases in accordance with Plate 7-1 based on the current elevation and the previous 2-hour inflow as computed on Plate 7-2. If the current release, including power generation, is less than 8,000 c.f.s., increase the total combined hydropower and spillway releases to 8,000 c.f.s. immediately. Releases shall be made by operating all spillway gates at a uniform opening with a margin of at least 0.25 feet between the top of the gates and the pool level. Adjust releases every 2 hours based on the previous 6-hour inflow as computed on Plate 7-2. Do not decrease releases while the pool is rising. Elevation 632.5 will be maintained, if possible, by opening the spillway gates as necessary to pass inflow or until the gates are fully opened.

e. Above 632.5 and Rising

The spillway gates will be maintained fully opened and held in such position.

f. Above 632.5 and Falling

Maintain current releases until the pool level recedes to elevation 632.5.

g. 632.5 to 627.5 and Falling

Maintain current releases until the pool level recedes an amount sufficient to permit lowering all the spillway gates one-half foot without lowering the discharge below inflow or 8,000 cfs whichever is larger. Releases shall be made by operating all spillway gates at a uniform opening with a margin of at least 0.25 feet between the pool level and the top of the gates.

h. 627.5 to 599.5 or top of seasonal conservation pool) and Falling

Adjust releases every 2 hours to equal the previous 2-hour inflow or 8,000 c.f.s., whichever is greater. When the pool is within 2 feet of elevation 599.5, decrease releases by amounts not to exceed 1,300 c.f.s. in 3 hours so that outflow is equal to inflow by the time the pool level recedes to elevation 599.5.

EXHIBIT D

MEMORANDUM OF UNDERSTANDING

(TROUT FISHERY)

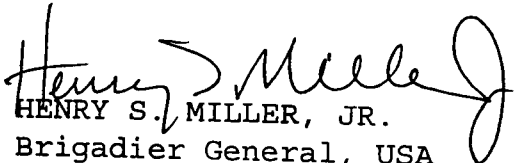
CESWD-ETO-R (CECW-ON\3 Sep 96) 1st End Mr. Bogue/7-2432
SUBJECT: Memorandum of Understanding for a Put and Take Trout
Fishery Below Broken Bow Dam, Oklahoma

CDR, U.S. Army Corps of Engineers, Southwestern Division,
1114 Commerce Street, Dallas, TX 75242 18 SEP 1996

FOR CDR, Tulsa District

The subject memorandum of understanding has been approved and signed by the Assistant Secretary of the Army. In the future, provide agreements in draft form for review by ASA(CW) prior to signature(s) by the local sponsor(s).

Encl


HENRY S. MILLER, JR.
Brigadier General, USA
Commanding



DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CECW-ON

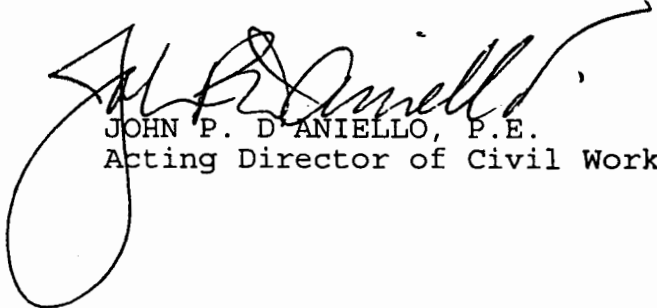
03 SEP 1996

MEMORANDUM FOR COMMANDER, SOUTHWESTERN DIVISION

SUBJECT: Memorandum of Understanding for a Put and Take Trout
Fishery Below Broken Bow Dam, Oklahoma

1. The Assistant Secretary of the Army (Civil Works) (ASA(CW)) approved the subject Memorandum of Understanding (MOU) on 2 July 1996. I request you forward the MOU to the Tulsa District for their action.
2. We are concerned that the MOU was signed by three parties prior to forwarding the document to anyone at the Secretariat level for review and approval. Standard policy requires that all agreements of this type be forwarded to that office in draft, prior to signature by the local sponsor(s).
3. In the future, please provide these types of agreements to this office in draft form to avoid embarrassing situations for the U.S. Army Corps of Engineers and the Secretariat.

Encl


JOHN P. D'ANNELLO, P.E.
Acting Director of Civil Works

**MEMORANDUM OF UNDERSTANDING
BETWEEN
THE U.S. DEPARTMENT OF THE ARMY
AND
THE U.S. DEPARTMENT OF ENERGY
ACTING THROUGH
THE SOUTHWESTERN POWER ADMINISTRATION
AND
THE STATE OF OKLAHOMA
ACTING THROUGH
THE OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION
AND
THE OKLAHOMA WATER RESOURCES BOARD
FOR A
PUT AND TAKE TROUT FISHERY BELOW BROKEN BOW DAM,
OKLAHOMA**

SUBJECT: Water Releases for a Trout Stream Fishery below Broken Bow Lake, Oklahoma.

1. This Memorandum of Understanding (MOU), entered into this 1st day of May 1996, between the U.S. Department of Army, hereafter termed Corps, and the U.S. Department of Energy acting through the Southwestern Power Administration (Southwestern) and the State of Oklahoma acting through the Oklahoma Department of Wildlife Conservation (ODWC), and the Oklahoma Water Resources Board (OWRB) is for a trout stream fishery below the Broken Bow Lake Project. Water releases will be made through the spillway from uncontracted water supply storage and/or seasonal flood control storage and through special hydro-electric power generation schedules from power storage as specified in this MOU.
2. The releases will be made subject to the following conditions:
 - a. The OWRB shall not grant water rights or withdrawal permits to any potential downstream user for the additional stream flow which shall occur with the releases unless the user contracts with the Corps under existing water supply authorities.
 - b. Spillway releases requested by ODWC for the trout demonstration program shall not exceed a rate of 140 cubic feet per second nor a total volume of 42,500 acre-feet, unless additional temporary releases (up to 250 cfs) are needed to sustain trout life. The trout demonstration program does not place any restrictions on the maximum spillway release rate or volume nor on the maximum hydroelectric power generation rate or energy production at the project.
 - c. The Corps shall monitor the spillway releases continuously for their impacts on the authorized purposes of the Broken Bow Lake Project. Should the spillway releases result in significant impacts on authorized project purposes, the spillway releases shall be suspended for whatever timeframe is necessary, or if necessary, terminated without prior notice at the sole

discretion of the Corps. The Corps may terminate or suspend the spillway releases without prior notice when downstream flooding or other emergency situations occur. Spillway releases shall be terminated at the sole discretion of the Corps should the Corps incur any unexpected, significant costs as a result of the operational change for the spillway releases or should studies or other circumstances reveal the continuation of the spillway releases is not desirable.

d. The ODWC shall undertake the necessary public involvement to ensure that the public is fully aware the Broken Bow Trout Fishery program is a demonstration and that any releases or special operational considerations in support of the demonstration shall not continue beyond 31 October 1996.

e. The ODWC shall give highest priority to possible safety problems associated with the releases and be responsible for taking appropriate action to respond to and provide notice of such problems.

f. The ODWC shall have primary responsibility for prohibiting all unauthorized uses along the whitewater area created by releases in the 1.5 stream miles from the spillway to the State Park lease boundary. This can be accomplished by reimbursing the Corps for any enforcement costs incurred. Problems arising from unauthorized uses in this area shall be reason for termination of spillway releases, upon prior notification to ODWC.

g. The ODWC shall hold and save the Corps and Southwestern free and harmless from all damages arising from any construction, operation, or maintenance during the demonstration program, except for damages due to the fault or negligence of the United States.

h. Southwestern shall work within the flexibility of available power resources at the project and within Southwestern's electrical system and actual system electrical loads to meet special generation schedules. Requests by the ODWC for such special generation that cannot be used to meet Southwestern's firm energy obligations will be evaluated by Southwestern on a case-by-case basis.

i. Spillway releases and special power generation shall be from the date of the signing of this MOU through 31 October 1996, unless terminated earlier as provided in this MOU. Spillway releases and special power generation request dates shall be generally within the timeframe of 15 May through 31 October 1996. Spillway releases and special power generation shall not be guaranteed at any time during the period of the trout demonstration program.

j. Any activities of the ODWC or OWRB which require the grant of a real estate interest in Federal lands shall be governed by Federal real estate policies and procedures.

k. The Corps shall keep an accurate account of any and all expenses that are incurred or are projected to be incurred by the Corps which are in excess of normal operating expenses and are directly attributable to the trout demonstration program. Such expenses shall be reported to the ODWC in writing on a quarterly basis. The ODWC shall reimburse the Corps for any actual expenses the Corps has incurred attributable to the demonstration. In the event such actual and projected expenses are forecast to exceed \$1,000, the ODWC and the Corps shall consult on continuing the demonstration program at ODWC expense through modification of this MOU. Should ODWC decline to pay such demonstration program expenses in excess of \$1,000, the Corps shall discontinue the trout demonstration program releases without prior notice. The ODWC shall remain liable, however, for all demonstration program expenses incurred by the Corps up to \$1,000.

l. The trout stream is a result of a demonstration project, pursuant to the Energy and Water Development Appropriations Act, Public Law 102-104, 105 Stat. 517, approved 17 August 1991, that has been completed. A final report, as required by letter of 22 January 1993, from the Chief of Engineers, is being finalized pursuant to Water Resources Development Act of 1992, Public Law 102-580, Section 102(v), approved 31 October 1992. However; a final determination as to the continuance of the trout stream fishery is not anticipated to be resolved before water releases are needed in 1996. If a final determination is made before the expiration of this MOU it will take precedence.

m. This MOU shall become effective upon signatures by all parties and shall expire without further notice on 31 October 1996.

THE UNITED STATES
DEPARTMENT OF THE ARMY

H. Martin Lancaster JUL 1996
H. MARTIN LANCASTER (date)
Assistant Secretary of the
Army (Civil Works)

THE STATE OF OKLAHOMA

Greg D. Duffy
GREG D. DUFFY (date)
Director, Oklahoma
Department of Wildlife
Conservation

THE UNITED STATES
DEPARTMENT OF ENERGY

Michael A. Deihl 3/28/96
MICHAEL DEIHL (date)
Administrator,
Southwestern Power
Administration

THE STATE OF OKLAHOMA

Duane H. Smith 4/24/96
DUANE SMITH (date)
Assistant Director,
Oklahoma Water Resources
Board

EXHIBIT E

WATER RESOURCES DEVELOPMENT ACT OF 1996

(WRDA 96)

CECW-PC

MEMORANDUM FOR Commander, Southwestern Division, ATTN: CESWD-ETP

SUBJECT: Guidance for Implementing Sections 338, 339 and 560 of the Water Resources Development Act of 1996

Guidance is provided in the enclosure for your implementation of Section 338, Broken Bow Lake, Red River Basin, Oklahoma; Section 339 Wister Lake Project, LeFlore County, Oklahoma; and Section 560 Grand Lake, Oklahoma.

Enclosure

G. EDWARD DICKEY
Chief, Planning Division
Directorate of Civil Works

CF: CECW-P
CECW-PE (b) (6)
CECW-PC
CECW-MA (2)
CECW-AA
CECW-OM
CECW-ON
CECW-BC
OASA(CW)
RET to: CECW-PC

MFR: Cleared for distribution by the OASA(CW) _____

(b) (6)

**CECW-PC
GUIDANCE FOR IMPLEMENTING CERTAIN PROVISIONS OF THE WATER RESOURCES
DEVELOPMENT ACT OF 1996**

SECTION: 338 Broken Bow Lake, Red River Basin, Oklahoma

CITATION: The project for flood control and water supply, Broken Bow Lake, Red River Basin, Oklahoma, authorized by section 203 of the Flood Control Act of 1958 (72 Stat. 309) and modified by section 203 of the Flood Control Act of 1962 (76 Stat. 1187) and section 102(v) of the Water Resources Development Act of 1992 (106 Stat. 4808), is further modified to provide for the reallocation of a sufficient quantity of water supply storage space in Broken Bow Lake to support the Mountain Fork trout fishery. Releases of water from Broken Bow Lake for the Mountain Fork trout fishery as mitigation for the loss of fish and wildlife resources in the Mountain Fork River shall be carried out at no expense to the State of Oklahoma.

SYNOPSIS: Broken Bow Lake is in the southeast corner of Oklahoma on the Mountain Fork River, a tributary of the Little River which is a tributary of the Red River. The lake is part of a seven-lake system providing flood control in the Little River watershed and the Red River. The project was authorized for flood control, hydroelectric power, water supply, recreation, and fish and wildlife by the Flood Control Act of 1958. Flood Control Act of 1962 authorized the interim use of uncontracted water supply storage for hydropower production. The project was completed in 1970. The Oklahoma Department of Wildlife Conservation (ODWC) manages the project fishery and 5,400 acres of project land for wildlife.

The Corps of Engineers cooperated with an ODWC demonstration program to release flows from Broken Bow Lake for the downstream trout fishery that began in 1989. The primary objective was to determine the timing and amount of releases required to maintain the cold water temperatures needed for trout survival. Releases for the fishery were made from uncontracted water supply and seasonal flood control storage. Terms were defined in a series of interim MOU's. ASA(CW) required a review of a State evaluation of the project prior to considering long-term continuation of the program. CESWT received the demonstration evaluation report in January 1996.

Section 102(v) of WRDA 1992 authorized Broken Bow Lake to reallocate a sufficient amount of existing and available water supply storage space to support the Mountain Fork trout fishery with releases of water for the fishery undertaken under terms and conditions acceptable to the Secretary. As interpreted, an unspecified amount of uncontracted M&I water supply storage space may be reallocated to the trout fishery. This is recreation and not fish and wildlife habitat restoration because trout were not indigenous to this stream prior to the project.

Section 338 of WRDA 1996 authorizes the reallocation of a sufficient quantity of water supply storage space for the downstream fishery and states the releases shall be carried out as fish and wildlife mitigation and at no expense to the State. A Memorandum of Understanding (MOU) will be needed with ODWC to define the terms of a permanent reallocation and releases for the downstream fishery. The MOU must be supported by an incremental analysis justifying the reallocation alternative selected, an analysis of the impacts on other project purposes (including any impacts on existing project cost-sharing agreements), and environmental (NEPA) compliance for the changed operation. Also, modifications to license/agreements governing the

hydropower operations may also be necessary if storage is reallocated.

Preliminary information indicates storage reallocation alternatives range from 43,500 acre-feet to 87,100 acre-feet with the storage cost ranging from \$1,932,000 to \$3,867,000. Annual costs include O&M range from \$119,000 to \$238,000. Preliminary estimates indicate the conversion reduces flood control storage about ten percent. Due to limited damageable property in the downstream area most affected by flood control operations, there appeared to be no significant impacts except for large flood events. No detailed analysis has been done.

CESWT has indicated that releases to sustain the trout fishery will be needed as early as May 1997 and that the Congressional delegation lead by Senator Nickles expects releases to be made as needed. Also, ODWC has already requested reallocation.

IMPLEMENTATION GUIDANCE: An MOU with ODWC and an approved reallocation report are necessary to implement a permanent change in project operations. This requirement does not preclude continuing releases for the fishery on a temporary basis. The MOU development and reallocation study may be proposed for implementation consistent with applicable program and budget guidance. The reallocation report must justify a recommended reallocation alternative, assess impacts on other project purposes and any related cost-sharing agreements, and document environmental compliance. The report and draft MOU will be submitted to CECW-AR for processing to ASA(CW) for approval.

EXHIBIT F

DESCRIPTION OF USE OF
RULE CURVES

BROKEN BOW LAKE- EXHIBIT F

DESCRIPTION OF USE OF RULE CURVES
(Rule Curves Shown On Plate 7-14)

ZONE I

1. Description. Flood Control Zone Above Zone II.
2. Operational Objectives.
 - a. Protect downstream reaches.
 - b. Minimize damages within flood pool
 - c. Restore flood control capability as soon as possible.

3. Operation Constraints.

Releases will be made to control floods on the Mountain Fork River and in conjunction with other units of the system, for flood control on Little River and Red River.

4. Declaration of Energy Available.
 - a. Downstream not limiting - 24 hours per day at plant capacity (daily).
 - b. Downstream limiting - Up to allowable release but usually not less than firm energy daily).
5. Frequency of Contact with SWPA.
 - a. Daily or more often if needed - furnish SWPA best forecast of inflows, pool elevations, and constraints, if limited by downstream channel capacity.
 - b. Try to give at least 48 hours notice of the following conditions:
 - (1) Time to change from firm energy to full gate or vice versa.
 - (2) Time pool will fall into Zone II.
6. Degree of Corps Control. Absolute.

ZONE II

1. Description. Transition zone from flood control to conservation operation.
2. Operation objectives.
 - a. Supplement hydropower and purposes other than flood control when possible through moderate power releases.
 - B. Minimize damage to downstream channel banks due to rapid reduction of flow when banks are saturated.
 - c. Increase energy production by eliminating unnecessary spills.
 - d. Control minor rises into flood control pool without spill or short duration releases at high flood control release rates.
3. Operation Constraints.
 - a. Limit duration in transition zone to minimize damages to lake shore and recreation developments.
 - b. Above elevation 600.5, release will be made at plant capacity (approx. 7,300 cfs) or as allowed by available downstream capacity. Between top of conservation pool and elevation 600.5, releases will be made as rapidly as scheduling for peak power will allow provided the pool can be drawn down to top of conservation pool within approximately 5 days.
4. Declaration of Energy Available.

Compute energy equivalent of releases required to meet operational constraints (daily).
5. Frequency of Contact with SWPA.
 - a. Daily - furnish SWPA best forecast of inflows, pool elevations, and constraints.
 - b. Try to give at least 48-hour notice of the following conditions:
 - (1) Time pool will rise into Zone I.
 - (2) Time pool will fall into Zone III

ZONE II (Cont)

- c. Daily - Obtain SWPA power schedule.
6. Degree of Corps Control. Absolute.

ZONE III

1. Description. Flexible Conservation Zone.
2. Operational Objectives.
 - a. Exercise best judgement in achieving conservation storage benefits.
 - b. Allow maximum utilization of power production potential which will not adversely affect other project uses.
 - c. Supplement flood control potential, when possible.
3. Operational Constraints.
 - a. Exercise minimum amount of constraint on operations based on best judgement.
 - b. Sufficient generation to satisfy downstream minimum flow requirement to 100 cfs at the Eagletown gage.
 - c. Limit draw down to a maximum of one foot per week.
4. Declaration of Energy Available. Allocation will be plant capacity or estimated inflow plus a maximum of one foot draw down per week, whichever is less, unless exceeded by firm energy.
5. Frequency of Contact with SWPA.
 - a. Daily - furnish SWPA with best forecast of inflows and send by noon.

ZONE III (Cont)

- b. Daily - obtain SWPA power schedule via computer link.
 - c. Weekly - furnish SWPA with recommended maximum energy production.
 - d. Monthly - furnish SWPA with recommended energy production and discuss production plans at monthly power schedule meeting.
6. Degree of Corps control.
- a. On energy production - normally negotiable
 - b. Flood Control - absolute

Zone IV

1. Description. Design Purpose Conservation Storage Zone.
2. Operational Objectives.
 - a. Operate the project as nearly as possible to meet the design power while recognizing other project uses.
 - b. Monitor all competitive uses of conservation storage to assure equity.
3. Operational Constraints.
 - a. Cumulative use by competitors for conservation storage must fall within reasonable limits, although seasonal or short-term flexibility may be allowed.
 - b. Weekly generation must be scheduled in a manner that will satisfy minimum downstream flow requirement of 100 cfs at the Eagletown gage.
4. Declaration of energy Available.
 - a. Allocation will be the firm energy the project could produce under current conditions (lake capacities, monthly distribution of firm energy, tailwater elevations, etc.) for the critical hydro period.
 - b. Declare energy available on a monthly basis according to subparagraph a, minus

ZONE IV (Cont)

any cumulative over production or plus any cumulative under production since first entering Zone IV.

5. Frequency of Contact with SWPA.

- a. Daily or more often as needed - furnish SWPA with best forecast of inflows.
- b. Daily - obtain SWPA power schedule.
- c. Monthly - furnish SWPA declaration of energy according to firm capability of the project.
- d. Monthly - discuss cumulative deviations of actual generation from firm or primary capability and encourage rectification of this deviation.

6.. Degree of Corps Control. Negotiable to the extent that the only hydropower made over and above allocation would be due to extenuating circumstances such as all possible purchase of power from other sources has been exhausted. Corps maintains absolute control over minimum releases.

EXHIBIT G

WATER RESOURCES DEVELOPMENT ACT
(Sec. 343. Broken Bow Lake, Red River Basin, Oklahoma)

WRDA 1999

SEC. 340. NEW YORK CITY WATERSHED.

Section 552 of the Water Resources Development Act of 1996 (110 Stat. 3779) is amended—

(1) in subsection (d), by striking “for the project to be carried out with such assistance” and inserting “, or a public entity designated by the State director, to carry out the project with the assistance, subject to the project’s meeting the certification requirement of subsection (c)(1)”; and

(2) in subsection (i), by striking “\$22,500,000” and inserting “\$12,500,000”.

SEC. 341. NEW YORK STATE CANAL SYSTEM.

Section 553(e) of the Water Resources Development Act of 1996 (110 Stat. 3781) is amended by striking “\$8,000,000” and inserting “\$18,000,000”.

SEC. 342. FIRE ISLAND INLET TO MONTAUK POINT, NEW YORK.

The project for combined beach erosion control and hurricane protection, Fire Island Inlet to Montauk Point, Long Island, New York, authorized by section 101(a) of the River and Harbor Act of 1960 (74 Stat. 483) and modified by the River and Harbor Act of 1962, the Water Resources Development Act of 1974, and the Water Resources Development Act of 1986, is further modified to direct the Secretary, in coordination with the heads of other Federal departments and agencies, to complete all procedures and reviews expeditiously and to adopt and submit to Congress, not later than 120 days after the date of enactment of this Act, a mutually acceptable shore erosion plan for the Fire Island Inlet to Moriches Inlet reach of the project.

SEC. 343. BROKEN BOW LAKE, RED RIVER BASIN, OKLAHOMA.

The project for flood control and water supply, Broken Bow Lake, Red River Basin, Oklahoma, authorized by section 203 of the Flood Control Act of 1958 (72 Stat. 309) and modified by section 203 of the Flood Control Act of 1962 (76 Stat. 1187), section 102(v) of the Water Resources Development Act of 1992 (106 Stat. 4808), and section 338 of the Water Resources Development Act of 1996 (110 Stat. 3720), is further modified to require the Secretary to make seasonal adjustments to the top of the conservation pool at the project, if the Secretary determines that the adjustments will be undertaken at no cost to the United States and will adequately protect affected water and related resources, as follows:

(1) Maintain an elevation of 599.5 from November 1 through March 31.

(2) Increase elevation gradually from 599.5 to 602.5 during April and May.

(3) Maintain an elevation of 602.5 from June 1 to September 30.

(4) Decrease elevation gradually from 602.5 to 599.5 during October.

SEC. 344. WILLAMETTE RIVER TEMPERATURE CONTROL, MCKENZIE SUBBASIN, OREGON.

(a) **IN GENERAL.**—The project for environmental restoration, Willamette River Temperature Control, McKenzie Subbasin, Oregon, authorized by section 101(a)(25) of the Water Resources Development Act of 1996 (110 Stat. 3665), is modified to authorize the Secretary to construct the project substantially in accordance with the Feature Memorandum dated July 31, 1998, at a total cost of \$64,741,000, if the Secretary determines that the project as modified is technically sound and environmentally acceptable.

(b) **REPORT.**—Not later than 90 days after the date of enactment of this Act, the Secretary shall submit to Congress a report that—

(1) states the reasons for the increase in the cost of the project;

(2) outlines the steps that the Corps of Engineers is taking to control project costs, including the application of value engineering and other appropriate measures; and

(3) includes a cost estimate for, and recommendations on the advisability of, adding fish screens to the project.

SEC. 345. CURWENSVILLE LAKE, PENNSYLVANIA.

Section 562 of the Water Resources Development Act of 1996 (110 Stat. 3784) is amended—

(1) by striking “The Secretary” and inserting the following:

“(a) **IN GENERAL.**—The Secretary”; and

C

TABLES

C

TABLE 4-6

ESTIMATED MONTHLY AND ANNUAL FLOWS IN ACRE-FEET
BROKEN BOW LAKE

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1930	155100	90800	58800	13500	374600	6800	340	20	580	12800	45100	71800	830240
1931	4600	146500	113100	28700	39700	7800	61500	10200	2000	14800	37200	135900	602000
1932	472900	202800	57300	55700	25500	38300	142200	2800	590	1200	5200	165900	1170390
1933	166500	86900	147800	100700	102900	6300	4400	12600	50900	28100	23200	60900	791200
1934	61100	17300	113100	125300	17000	1400	60	0	16000	12400	93000	58700	515360
1935	222300	38900	241800	165100	393700	268400	9100	1400	3700	30800	88500	120000	1583700
1936	15100	21200	54800	9600	46900	2500	9700	100	16500	55500	43200	119400	394500
1937	296700	45300	92200	117100	95100	39700	2800	38700	2500	35800	79000	99700	944600
1938	366300	326000	147300	176700	56500	41200	4500	2400	420	40	1200	10600	1133160
1939	37200	192900	140300	293300	59700	16500	4800	5800	240	1800	4800	19200	776540
1940	19900	32400	25500	140600	229100	52700	103900	63500	5500	1300	81700	109800	865900
1941	76900	104200	52600	149100	48500	85300	11400	2400	3800	97700	109000	94100	835000
1942	63200	66800	126300	197700	89000	24000	5500	11000	11800	1300	64900	100700	762200
1943	25600	16900	75100	98500	41300	21400	1400	60	0	1100	17300	58700	357360
1944	56300	254700	198300	123100	258100	44900	3000	1300	2700	120	24100	116600	1083220
1945	52400	308600	629600	110100	185300	202900	15800	35900	133100	104800	26500	26900	1831900
1946	232900	230500	121000	129400	329000	63400	4500	1100	200	440	193800	190600	1496840
1947	40300	14500	77000	130900	219900	9800	1900	124400	29800	20700	75500	184900	929600
1948	164600	178500	140100	56300	132200	5200	5700	6500	770	290	5500	35600	731260
1949	377200	149800	146700	70100	149200	139500	32200	5500	5000	47900	11400	110000	1244500
1950	403500	359500	74800	55700	261700	18300	128200	107600	186400	16600	9200	5100	1626600
1951	34700	226300	75500	65300	41200	126300	145500	5700	10100	21000	123700	90500	965800
1952	98700	68600	117500	418600	46100	6600	780	130	1	0	66700	76200	899911
1953	80200	95400	200800	307000	246300	4400	145100	8000	1000	100	1000	20100	1109400
1954	143200	88800	18400	70000	140800	4500	300	2	6700	164900	26600	55300	719502
1955	59300	112400	147100	105100	64200	11500	5000	5500	15900	27400	2300	5000	560700
1956	16400	204000	48800	28300	65400	3100	520	180	250	5	15500	42200	424655
1957	119100	110200	170200	468700	290600	133100	5100	2600	33200	10000	112600	55800	1511200
1958	94000	32400	206600	147200	214500	53200	13600	13800	15500	20800	151000	25800	988400
1959	29900	61700	126300	77400	41000	16900	52300	9500	9800	84100	28700	202700	740300
1960	141100	89700	80700	40600	299400	41000	89400	36600	4900	5700	10600	231100	1070800
1961	60700	91200	177400	87900	155600	17100	52300	23300	18200	26100	128000	146400	984200
1962	165800	99000	102200	102000	24100	13800	1300	2800	10900	107200	41800	28800	699700
1963	39200	10200	130600	54700	24500	2200	4000	2600	1100	20	0	890	270010
1964	940	18900	150900	170900	28300	2700	120	31000	47700	19600	73400	36500	580960
1965	74300	200200	74800	46400	159000	106400	8600	810	23600	11700	6100	12100	724010

T4-2

1966	31200	151100	30900	115700	125200	2500	440	35200	8600	1000	1100	6700	509640
1967	10800	12600	56300	151100	186900	75400	46200	1600	14300	52300	50900	178700	837100
1968	162300	110500	328500	376700	390100	24600	6900	4600	4300	4400	97000	178200	1688100
1969	212600	166600	94000	84400	117600	103700	20900	5900	1800	12700	51900	93200	965300
1970	64200	89300	215100	215600	31400	12200	1300	8900	21700	143000	37000	34000	873700
1971	81900	76200	74200	69700	51900	14000	18800	16400	4900	59200	17600	496400	981200
1972	44600	34000	38900	50900	26600	4000	2100	700	1900	200500	225600	75200	705000
1973	149800	108300	379100	320700	141700	209100	31700	2300	50200	72600	134100	147600	1747200
1974	88200	34900	148700	128800	76000	123400	1200	21500	280100	63300	269100	123400	1358600
1975	61800	144100	211600	67800	121000	112900	8900	3500	6700	760	2800	60600	802460
1976	20100	20200	98000	80300	71800	39900	5100	180	4100	50900	40600	84500	515680
1977	81700	79100	339300	69000	19400	4000	4200	7800	890	4800	26000	14200	650390
1978	44400	67300	193900	74500	112100	23200	4100	750	950	1200	67000	97200	686600
1979	98500	180900	263400	160500	283600	69100	64800	25900	3700	12200	18500	141100	1322200
1980	59600	73600	41100	90300	128500	34700	1100	360	65500	35800	17000	74200	621760
1981	6100	83700	98100	49700	159700	175100	66000	9200	4300	63500	61200	24800	801400
1982	110600	115900	122800	72300	304500	126000	6600	1300	2500	2800	112400	276800	1254500
1983	25900	67800	122200	88600	267300	40100	116500	970	820	11800	401000	109000	1251990
1984	26300	156300	273700	70100	151400	13000	13400	3900	46200	456200	265400	215100	1691000
1985	83300	176500	169600	148200	45900	31000	11400	250	160	17200	194200	76500	954210
1986	8300	167400	22500	176700	96400	111700	4500	5100	15100	30100	70800	62500	771100
1987	66400	84500	161100	15800	33600	17700	5800	0	5000	14200	145900	315100	865100
1988	70000	73800	101200	118300	7300	4300	14600	28400	4700	2700	118100	69700	613100
1989	140600	229700	116800	41300	190800	79500	101600	8400	3500	1040	360	480	914080
1990	111810	169190	216100	188890	511690	62930	27270	10120	9730	147830	32150	112880	1600590
1991	166610	38680	111270	377450	136860	16140	35710	14930	23900	174430	166020	295060	1557060
1992	87470	118890	125550	58040	44890	114590	38660	23570	191720	4960	120150	244170	1172660
1993	190210	107310	151240	148160	181390	22260	2100	4210	5530	280660	125360	181680	1400110
1994	172410	70910	114840	40660	140230	17290	76140	5910	6640	24397	194383	152630	1016440
1995	191993	29257	88861	121291	184763	42298	15273	484	3838	1047	526	17187	696818
MEAN	105978	112401	137595	124053	138662	50355	27498	12540	22133	44021	73766	104304	951560
MAXIMUM	472900	359500	629600	468700	511690	268400	145500	124400	280100	456200	401000	496400	1831900
MINIMUM	940	10200	18400	9600	7300	1400	60	0	0	0	0	480	270010

TABLE 7-8
Elevation-Area-Capacity Table

BROKEN BOW LAKE, OKLAHOMA

29 MAY 1997

STATION FILE NO. 07338900

BASED ON ORIGINAL E-A DATA

(CAPACITY IN ACRE-FEET)

TABLE NO. 2

POOL ELEV [FT. NGVD]	(CAPACITY IN ACRE-FEET)									
	CAPACITY [1000'S OF ACRE-FEET]					AREA [1000'S OF ACRES]				
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
420.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
421.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
422.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
423.0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
424.0	.000	.000	.000	.000	.000	.000	.000	.001	.001	.001
	.000	.000	.001	.001	.001	.001	.001	.002	.002	.002
425.0	.001	.001	.002	.002	.002	.002	.003	.003	.003	.004
	.002	.002	.002	.003	.003	.003	.003	.004	.004	.004
426.0	.004	.005	.005	.005	.006	.006	.007	.007	.008	.008
	.004	.004	.004	.004	.004	.005	.005	.005	.005	.005
427.0	.009	.009	.010	.010	.011	.011	.012	.013	.013	.014
	.005	.005	.005	.006	.006	.006	.006	.007	.007	.007
428.0	.015	.015	.016	.017	.018	.018	.019	.020	.021	.022
	.007	.007	.007	.008	.008	.008	.008	.009	.009	.009
429.0	.023	.024	.024	.025	.026	.027	.028	.029	.030	.031
	.009	.009	.009	.009	.009	.010	.010	.010	.010	.010
430.0	.032	.033	.034	.035	.037	.038	.039	.040	.042	.043
	.010	.011	.011	.012	.012	.013	.013	.014	.014	.015
431.0	.045	.046	.048	.049	.051	.053	.055	.056	.058	.060
	.015	.016	.016	.017	.017	.018	.018	.019	.019	.020
432.0	.062	.064	.066	.069	.071	.073	.076	.079	.081	.084
	.020	.021	.022	.023	.024	.025	.026	.027	.028	.029
433.0	.087	.090	.093	.097	.100	.103	.107	.111	.114	.118
	.030	.031	.032	.033	.034	.035	.036	.037	.038	.039
434.0	.122	.126	.130	.135	.139	.143	.148	.153	.157	.162
	.040	.041	.042	.043	.044	.045	.046	.047	.048	.049
435.0	.167	.172	.177	.183	.188	.193	.199	.205	.210	.216
	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059
436.0	.222	.228	.234	.241	.247	.253	.260	.267	.273	.280
	.060	.061	.062	.063	.064	.065	.066	.067	.068	.069
437.0	.287	.294	.301	.309	.316	.323	.331	.339	.346	.354
	.070	.071	.072	.073	.074	.075	.076	.077	.078	.079
438.0	.362	.370	.378	.387	.395	.403	.412	.421	.429	.438
	.080	.081	.082	.083	.084	.085	.086	.087	.088	.089
439.0	.447	.456	.465	.475	.484	.493	.503	.513	.522	.532
	.090	.091	.092	.093	.094	.095	.096	.097	.098	.099

BASED ON ORIGINAL E-A DATA

(CAPACITY IN ACRE-FEET)
CAPACITY [1000'S OF ACRE-FEET]
AREA [1000'S OF ACRES]

TABLE NO. 2

POOL ELEV [FT. NGVD]	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
440.0	.542	.552	.562	.573	.583	.593	.604	.615	.625	.636
	.100	.101	.102	.103	.104	.105	.106	.107	.108	.109
441.0	.647	.658	.669	.681	.692	.703	.715	.727	.738	.750
	.110	.111	.112	.113	.114	.115	.116	.117	.118	.119
442.0	.762	.774	.787	.799	.812	.825	.838	.851	.865	.878
	.120	.122	.124	.126	.128	.130	.132	.134	.136	.138
443.0	.892	.906	.921	.935	.950	.965	.980	.995	1.011	1.026
	.140	.142	.144	.146	.148	.150	.152	.154	.156	.158
444.0	1.042	1.058	1.074	1.091	1.107	1.124	1.141	1.158	1.175	1.192
	.160	.162	.163	.165	.166	.168	.169	.171	.172	.174
445.0	1.210	1.227	1.245	1.263	1.281	1.299	1.317	1.336	1.354	1.373
	.175	.177	.178	.180	.181	.183	.184	.186	.187	.189
446.0	1.392	1.411	1.431	1.450	1.470	1.490	1.511	1.531	1.552	1.573
	.190	.193	.195	.198	.200	.203	.205	.208	.210	.213
447.0	1.595	1.616	1.638	1.660	1.683	1.705	1.728	1.751	1.775	1.798
	.215	.218	.220	.223	.225	.228	.230	.233	.235	.238
448.0	1.822	1.846	1.871	1.895	1.920	1.945	1.971	1.996	2.022	2.048
	.240	.243	.245	.248	.250	.253	.255	.258	.260	.263
449.0	2.075	2.101	2.128	2.155	2.183	2.210	2.238	2.266	2.295	2.323
	.265	.268	.270	.273	.275	.278	.280	.283	.285	.288
450.0	2.352	2.381	2.411	2.441	2.471	2.501	2.532	2.564	2.595	2.627
	.290	.294	.297	.301	.304	.308	.311	.315	.318	.322
451.0	2.660	2.692	2.725	2.759	2.792	2.826	2.861	2.896	2.931	2.966
	.325	.329	.332	.336	.339	.343	.346	.350	.353	.357
452.0	3.002	3.038	3.075	3.112	3.150	3.188	3.226	3.265	3.305	3.344
	.360	.365	.369	.374	.378	.383	.387	.392	.396	.401
453.0	3.385	3.425	3.466	3.508	3.550	3.593	3.636	3.679	3.723	3.767
	.405	.410	.414	.419	.423	.428	.432	.437	.441	.446
454.0	3.812	3.857	3.903	3.949	3.996	4.043	4.091	4.139	4.188	4.237
	.450	.455	.460	.465	.470	.475	.480	.485	.490	.495
455.0	4.287	4.337	4.388	4.439	4.491	4.543	4.596	4.649	4.703	4.757
	.500	.505	.510	.515	.520	.525	.530	.535	.540	.545
456.0	4.812	4.867	4.923	4.979	5.036	5.093	5.150	5.208	5.266	5.325
	.550	.555	.559	.564	.568	.573	.577	.582	.586	.591
457.0	5.385	5.444	5.504	5.565	5.626	5.688	5.750	5.812	5.875	5.938
	.595	.600	.604	.609	.613	.618	.622	.627	.631	.636
458.0	6.002	6.066	6.131	6.196	6.262	6.328	6.395	6.462	6.530	6.598
	.640	.645	.650	.655	.660	.665	.670	.675	.680	.685
459.0	6.667	6.736	6.806	6.876	6.947	7.018	7.090	7.162	7.235	7.308
	.690	.695	.700	.705	.710	.715	.720	.725	.730	.735

BASED ON ORIGINAL E-A DATA

(CAPACITY IN ACRE-FEET)
CAPACITY [1000'S OF ACRE-FEET]

TABLE NO. 2

POOL ELEV [FT. NGVD]	(CAPACITY IN ACRE-FEET) CAPACITY [1000'S OF ACRE-FEET]									
	AREA [1000'S OF ACRES]									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
460.0	7.382	7.456	7.531	7.606	7.682	7.758	7.835	7.912	7.990	8.068
	.740	.745	.750	.755	.760	.765	.770	.775	.780	.785
461.0	8.147	8.226	8.306	8.386	8.467	8.548	8.630	8.712	8.795	8.878
	.790	.795	.800	.805	.810	.815	.820	.825	.830	.835
462.0	8.962	9.046	9.131	9.216	9.301	9.387	9.473	9.560	9.647	9.734
	.840	.844	.848	.852	.856	.860	.864	.868	.872	.876
463.0	9.822	9.910	9.999	10.088	10.177	10.267	10.357	10.448	10.539	10.630
	.880	.884	.888	.892	.896	.900	.904	.908	.912	.916
464.0	10.722	10.814	10.907	11.000	11.094	11.188	11.283	11.378	11.474	11.570
	.920	.925	.930	.935	.940	.945	.950	.955	.960	.965
465.0	11.667	11.764	11.862	11.960	12.059	12.158	12.258	12.358	12.459	12.560
	.970	.975	.980	.985	.990	.995	1.000	1.005	1.010	1.015
466.0	12.662	12.764	12.867	12.970	13.074	13.178	13.282	13.387	13.493	13.598
	1.020	1.025	1.029	1.034	1.038	1.043	1.047	1.052	1.056	1.061
467.0	13.705	13.811	13.918	14.026	14.134	14.243	14.352	14.461	14.571	14.681
	1.065	1.070	1.074	1.079	1.083	1.088	1.092	1.097	1.101	1.106
468.0	14.792	14.903	15.015	15.127	15.240	15.353	15.466	15.580	15.694	15.809
	1.110	1.115	1.119	1.124	1.128	1.133	1.137	1.142	1.146	1.151
469.0	15.925	16.040	16.156	16.273	16.390	16.508	16.626	16.744	16.863	16.982
	1.155	1.160	1.164	1.169	1.173	1.178	1.182	1.187	1.191	1.196
470.0	17.102	17.222	17.343	17.465	17.587	17.710	17.833	17.957	18.081	18.206
	1.200	1.206	1.212	1.218	1.224	1.230	1.236	1.242	1.248	1.254
471.0	18.332	18.458	18.585	18.713	18.841	18.970	19.099	19.229	19.359	19.490
	1.260	1.266	1.272	1.278	1.284	1.290	1.296	1.302	1.308	1.314
472.0	19.622	19.755	19.888	20.022	20.156	20.292	20.429	20.566	20.704	20.843
	1.320	1.328	1.336	1.344	1.352	1.360	1.368	1.376	1.384	1.392
473.0	20.982	21.122	21.264	21.406	21.549	21.692	21.837	21.982	22.128	22.274
	1.400	1.408	1.416	1.424	1.432	1.440	1.448	1.456	1.464	1.472
474.0	22.422	22.570	22.720	22.869	23.020	23.171	23.324	23.476	23.630	23.784
	1.480	1.488	1.495	1.503	1.510	1.518	1.525	1.533	1.540	1.548
475.0	23.940	24.095	24.252	24.409	24.568	24.726	24.886	25.046	25.208	25.369
	1.555	1.563	1.570	1.578	1.585	1.593	1.600	1.608	1.615	1.623
476.0	25.532	25.696	25.860	26.025	26.191	26.357	26.524	26.693	26.862	27.031
	1.630	1.638	1.646	1.654	1.662	1.670	1.678	1.686	1.694	1.702
477.0	27.202	27.374	27.546	27.719	27.892	28.067	28.243	28.419	28.596	28.774
	1.710	1.718	1.726	1.734	1.742	1.750	1.758	1.766	1.774	1.782
478.0	28.952	29.132	29.312	29.493	29.674	29.857	30.041	30.225	30.410	30.596
	1.790	1.798	1.806	1.814	1.822	1.830	1.838	1.846	1.854	1.862
479.0	30.782	30.969	31.158	31.347	31.537	31.727	31.919	32.111	32.304	32.498
	1.870	1.878	1.886	1.894	1.902	1.910	1.918	1.926	1.934	1.942

BASED ON ORIGINAL E-A DATA

(CAPACITY IN ACRE-FEET)

TABLE NO. 2

POOL ELEV [FT. NGVD]	(CAPACITY IN ACRE-FEET)									
	CAPACITY [1000'S OF ACRE-FEET]									
	AREA [1000'S OF ACRES]									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
480.0	32.692	32.887	33.083	33.280	33.478	33.676	33.875	34.074	34.274	34.475
	1.950	1.957	1.964	1.971	1.978	1.985	1.992	1.999	2.006	2.013
481.0	34.677	34.879	35.082	35.286	35.491	35.696	35.902	36.108	36.315	36.523
	2.020	2.027	2.034	2.041	2.048	2.055	2.062	2.069	2.076	2.083
482.0	36.732	36.942	37.152	37.363	37.575	37.788	38.002	38.217	38.433	38.650
	2.090	2.099	2.108	2.117	2.126	2.135	2.144	2.153	2.162	2.171
483.0	38.867	39.086	39.305	39.525	39.746	39.968	40.191	40.415	40.640	40.866
	2.180	2.189	2.198	2.207	2.216	2.225	2.234	2.243	2.252	2.261
484.0	41.092	41.319	41.547	41.776	42.005	42.235	42.466	42.697	42.929	43.161
	2.270	2.277	2.283	2.290	2.296	2.303	2.309	2.316	2.322	2.329
485.0	43.395	43.628	43.863	44.098	44.334	44.570	44.807	45.045	45.283	45.522
	2.335	2.342	2.348	2.355	2.361	2.368	2.374	2.381	2.387	2.394
486.0	45.762	46.002	46.244	46.485	46.728	46.971	47.216	47.460	47.706	47.952
	2.400	2.408	2.415	2.423	2.430	2.438	2.445	2.453	2.460	2.468
487.0	48.200	48.447	48.696	48.945	49.196	49.446	49.698	49.950	50.204	50.457
	2.475	2.483	2.490	2.498	2.505	2.513	2.520	2.528	2.535	2.543
488.0	50.712	50.967	51.224	51.480	51.738	51.996	52.256	52.515	52.776	53.037
	2.550	2.558	2.565	2.573	2.580	2.588	2.595	2.603	2.610	2.618
489.0	53.300	53.562	53.826	54.090	54.356	54.621	54.888	55.155	55.424	55.692
	2.625	2.633	2.640	2.648	2.655	2.663	2.670	2.678	2.685	2.693
490.0	55.962	56.232	56.504	56.776	57.049	57.322	57.596	57.872	58.148	58.424
	2.700	2.708	2.716	2.724	2.732	2.740	2.748	2.756	2.764	2.772
491.0	58.702	58.980	59.260	59.540	59.820	60.102	60.384	60.668	60.952	61.236
	2.780	2.788	2.796	2.804	2.812	2.820	2.828	2.836	2.844	2.852
492.0	61.522	61.808	62.095	62.383	62.672	62.961	63.251	63.541	63.832	64.124
	2.860	2.867	2.874	2.881	2.888	2.895	2.902	2.909	2.916	2.923
493.0	64.417	64.710	65.005	65.299	65.595	65.891	66.188	66.485	66.784	67.082
	2.930	2.937	2.944	2.951	2.958	2.965	2.972	2.979	2.986	2.993
494.0	67.382	67.683	67.984	68.286	68.589	68.893	69.198	69.504	69.811	70.119
	3.000	3.009	3.018	3.027	3.036	3.045	3.054	3.063	3.072	3.081
495.0	70.427	70.737	71.047	71.358	71.670	71.983	72.297	72.612	72.928	73.245
	3.090	3.099	3.108	3.117	3.126	3.135	3.144	3.153	3.162	3.171
496.0	73.562	73.880	74.199	74.519	74.839	75.160	75.481	75.803	76.125	76.448
	3.180	3.186	3.192	3.198	3.204	3.210	3.216	3.222	3.228	3.234
497.0	76.772	77.096	77.421	77.747	78.073	78.400	78.727	79.055	79.383	79.712
	3.240	3.246	3.252	3.258	3.264	3.270	3.276	3.282	3.288	3.294
498.0	80.042	80.372	80.704	81.035	81.368	81.701	82.036	82.370	82.706	83.042
	3.300	3.308	3.315	3.323	3.330	3.338	3.345	3.353	3.360	3.368
499.0	83.380	83.717	84.056	84.395	84.736	85.076	85.418	85.760	86.104	86.447
	3.375	3.383	3.390	3.398	3.405	3.413	3.420	3.428	3.435	3.443

BASED ON ORIGINAL E-A DATA

(CAPACITY IN ACRE-FEET)
CAPACITY [1000'S OF ACRE-FEET]
AREA [1000'S OF ACRES]

TABLE NO. 2

POOL ELEV [FT. NGVD]	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
500.0	86.792	87.137	87.484	87.831	88.178	88.527	88.876	89.227	89.578	89.929
	3.450	3.458	3.466	3.474	3.482	3.490	3.498	3.506	3.514	3.522
501.0	90.282	90.635	90.990	91.345	91.701	92.057	92.414	92.773	93.132	93.492
	3.530	3.538	3.546	3.554	3.562	3.570	3.578	3.586	3.594	3.602
502.0	93.852	94.214	94.576	94.939	95.303	95.668	96.033	96.400	96.767	97.136
	3.610	3.619	3.627	3.636	3.644	3.653	3.661	3.670	3.678	3.687
503.0	97.505	97.875	98.245	98.617	98.989	99.363	99.737	100.112	100.488	100.865
	3.695	3.704	3.712	3.721	3.729	3.738	3.746	3.755	3.763	3.772
504.0	101.242	101.620	102.000	102.380	102.760	103.142	103.524	103.908	104.292	104.676
	3.780	3.788	3.796	3.804	3.812	3.820	3.828	3.836	3.844	3.852
505.0	105.062	105.449	105.836	106.224	106.612	107.002	107.393	107.784	108.176	108.568
	3.860	3.868	3.876	3.884	3.892	3.900	3.908	3.916	3.924	3.932
506.0	108.962	109.356	109.751	110.147	110.544	110.941	111.339	111.737	112.136	112.536
	3.940	3.947	3.954	3.961	3.968	3.975	3.982	3.989	3.996	4.003
507.0	112.937	113.338	113.741	114.143	114.547	114.951	115.356	115.761	116.167	116.574
	4.010	4.017	4.024	4.031	4.038	4.045	4.052	4.059	4.066	4.073
508.0	116.982	117.391	117.800	118.210	118.621	119.033	119.446	119.860	120.275	120.691
	4.080	4.089	4.098	4.107	4.116	4.125	4.134	4.143	4.152	4.161
509.0	121.107	121.525	121.943	122.362	122.782	123.203	123.625	124.048	124.472	124.897
	4.170	4.179	4.188	4.197	4.206	4.215	4.224	4.233	4.242	4.251
510.0	125.322	125.748	126.176	126.604	127.033	127.462	127.893	128.324	128.756	129.188
	4.260	4.268	4.276	4.284	4.292	4.300	4.308	4.316	4.324	4.332
511.0	129.622	130.057	130.492	130.928	131.365	131.802	132.241	132.680	133.120	133.561
	4.340	4.348	4.356	4.364	4.372	4.380	4.388	4.396	4.404	4.412
512.0	134.002	134.445	134.888	135.332	135.777	136.223	136.669	137.117	137.565	138.015
	4.420	4.429	4.437	4.446	4.454	4.463	4.471	4.480	4.488	4.497
513.0	138.465	138.916	139.367	139.820	140.273	140.728	141.183	141.639	142.096	142.554
	4.505	4.514	4.522	4.531	4.539	4.548	4.556	4.565	4.573	4.582
514.0	143.012	143.472	143.932	144.393	144.856	145.319	145.783	146.248	146.715	147.182
	4.590	4.600	4.609	4.619	4.628	4.638	4.647	4.657	4.666	4.676
515.0	147.650	148.119	148.589	149.059	149.531	150.004	150.478	150.952	151.428	151.905
	4.685	4.695	4.704	4.714	4.723	4.733	4.742	4.752	4.761	4.771
516.0	152.382	152.861	153.340	153.821	154.302	154.785	155.268	155.753	156.238	156.725
	4.780	4.790	4.800	4.810	4.820	4.830	4.840	4.850	4.860	4.870
517.0	157.212	157.701	158.190	158.681	159.172	159.665	160.158	160.653	161.148	161.645
	4.880	4.890	4.900	4.910	4.920	4.930	4.940	4.950	4.960	4.970
518.0	162.142	162.641	163.140	163.640	164.141	164.642	165.145	165.648	166.152	166.657
	4.980	4.988	4.996	5.004	5.012	5.020	5.028	5.036	5.044	5.052
519.0	167.162	167.669	168.176	168.684	169.193	169.702	170.213	170.724	171.236	171.749
	5.060	5.068	5.076	5.084	5.092	5.100	5.108	5.116	5.124	5.132

BASED ON ORIGINAL E-A DATA

(CAPACITY IN ACRE-FEET)
CAPACITY [1000'S OF ACRE-FEET]
AREA [1000'S OF ACRES]

TABLE NO. 2

POOL ELEV [FT. NGVD]	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
520.0	172.262	172.777	173.292	173.808	174.326	174.844	175.363	175.883	176.405	176.927
	5.140	5.150	5.159	5.169	5.178	5.188	5.197	5.207	5.216	5.226
521.0	177.450	177.974	178.499	179.024	179.551	180.079	180.608	181.137	181.668	182.200
	5.235	5.245	5.254	5.264	5.273	5.283	5.292	5.302	5.311	5.321
522.0	182.732	183.266	183.800	184.335	184.871	185.408	185.945	186.484	187.023	187.564
	5.330	5.339	5.347	5.356	5.364	5.373	5.381	5.390	5.398	5.407
523.0	188.105	188.647	189.189	189.733	190.277	190.823	191.369	191.916	192.464	193.013
	5.415	5.424	5.432	5.441	5.449	5.458	5.466	5.475	5.483	5.492
524.0	193.562	194.113	194.664	195.217	195.771	196.325	196.881	197.438	197.996	198.555
	5.500	5.511	5.521	5.532	5.542	5.553	5.563	5.574	5.584	5.595
525.0	199.115	199.676	200.238	200.801	201.365	201.930	202.497	203.064	203.632	204.202
	5.605	5.616	5.626	5.637	5.647	5.658	5.668	5.679	5.689	5.700
526.0	204.772	205.344	205.916	206.489	207.063	207.638	208.214	208.791	209.369	209.948
	5.710	5.719	5.728	5.737	5.746	5.755	5.764	5.773	5.782	5.791
527.0	210.527	211.108	211.689	212.271	212.854	213.438	214.023	214.609	215.196	215.784
	5.800	5.809	5.818	5.827	5.836	5.845	5.854	5.863	5.872	5.881
528.0	216.372	216.962	217.552	218.144	218.736	219.330	219.924	220.520	221.116	221.714
	5.890	5.900	5.910	5.920	5.930	5.940	5.950	5.960	5.970	5.980
529.0	222.312	222.912	223.512	224.114	224.716	225.320	225.924	226.530	227.136	227.744
	5.990	6.000	6.010	6.020	6.030	6.040	6.050	6.060	6.070	6.080
530.0	228.352	228.962	229.572	230.183	230.796	231.409	232.023	232.638	233.255	233.872
	6.090	6.100	6.109	6.119	6.128	6.138	6.147	6.157	6.166	6.176
531.0	234.490	235.109	235.729	236.349	236.971	237.594	238.218	238.842	239.468	240.095
	6.185	6.195	6.204	6.214	6.223	6.233	6.242	6.252	6.261	6.271
532.0	240.722	241.351	241.980	242.611	243.243	243.875	244.509	245.144	245.780	246.417
	6.280	6.291	6.301	6.312	6.322	6.333	6.343	6.354	6.364	6.375
533.0	247.055	247.694	248.334	248.975	249.617	250.260	250.905	251.550	252.196	252.844
	6.385	6.396	6.406	6.417	6.427	6.438	6.448	6.459	6.469	6.480
534.0	253.492	254.142	254.792	255.443	256.096	256.749	257.403	258.058	258.715	259.372
	6.490	6.500	6.509	6.519	6.528	6.538	6.547	6.557	6.566	6.576
535.0	260.030	260.689	261.349	262.009	262.671	263.334	263.998	264.662	265.328	265.995
	6.585	6.595	6.604	6.614	6.623	6.633	6.642	6.652	6.661	6.671
536.0	266.662	267.331	268.000	268.671	269.342	270.015	270.688	271.363	272.038	272.715
	6.680	6.690	6.700	6.710	6.720	6.730	6.740	6.750	6.760	6.770
537.0	273.392	274.071	274.750	275.431	276.112	276.795	277.478	278.163	278.848	279.535
	6.780	6.790	6.800	6.810	6.820	6.830	6.840	6.850	6.860	6.870
538.0	280.222	280.911	281.600	282.291	282.983	283.676	284.370	285.065	285.761	286.459
	6.880	6.891	6.902	6.913	6.924	6.935	6.946	6.957	6.968	6.979
539.0	287.157	287.857	288.557	289.259	289.962	290.666	291.371	292.077	292.784	293.493
	6.990	7.001	7.012	7.023	7.034	7.045	7.056	7.067	7.078	7.089

BASED ON ORIGINAL E-A DATA

(CAPACITY IN ACRE-FEET)
CAPACITY [1000'S OF ACRE-FEET]
AREA [1000'S OF ACRES]

TABLE NO. 2

POOL ELEV [FT. NGVD]										
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
540.0	294.202	294.913	295.624	296.337	297.051	297.765	298.481	299.198	299.916	300.635
	7.100	7.111	7.121	7.132	7.142	7.153	7.163	7.174	7.184	7.195
541.0	301.355	302.076	302.798	303.521	304.245	304.970	305.697	306.424	307.152	307.882
	7.205	7.216	7.226	7.237	7.247	7.258	7.268	7.279	7.289	7.300
542.0	308.612	309.344	310.076	310.810	311.544	312.280	313.017	313.755	314.494	315.234
	7.310	7.321	7.331	7.342	7.352	7.363	7.373	7.384	7.394	7.405
543.0	315.975	316.717	317.460	318.204	318.949	319.695	320.443	321.191	321.940	322.691
	7.415	7.426	7.436	7.447	7.457	7.468	7.478	7.489	7.499	7.510
544.0	323.442	324.195	324.948	325.703	326.458	327.215	327.973	328.732	329.492	330.253
	7.520	7.531	7.541	7.552	7.562	7.573	7.583	7.594	7.604	7.615
545.0	331.015	331.778	332.542	333.307	334.073	334.840	335.609	336.378	337.148	337.920
	7.625	7.636	7.646	7.657	7.667	7.678	7.688	7.699	7.709	7.720
546.0	338.692	339.466	340.240	341.016	341.792	342.570	343.348	344.128	344.908	345.690
	7.730	7.740	7.750	7.760	7.770	7.780	7.790	7.800	7.810	7.820
547.0	346.472	347.256	348.040	348.826	349.612	350.400	351.188	351.978	352.768	353.560
	7.830	7.840	7.850	7.860	7.870	7.880	7.890	7.900	7.910	7.920
548.0	354.352	355.146	355.940	356.736	357.533	358.331	359.131	359.931	360.733	361.536
	7.930	7.942	7.953	7.965	7.976	7.988	7.999	8.011	8.022	8.034
549.0	362.340	363.145	363.951	364.758	365.567	366.376	367.187	367.999	368.812	369.627
	8.045	8.057	8.068	8.080	8.091	8.103	8.114	8.126	8.137	8.149
550.0	370.442	371.259	372.076	372.895	373.715	374.536	375.358	376.181	377.005	377.831
	8.160	8.171	8.182	8.193	8.204	8.215	8.226	8.237	8.248	8.259
551.0	378.657	379.485	380.313	381.143	381.974	382.806	383.639	384.473	385.308	386.145
	8.270	8.281	8.292	8.303	8.314	8.325	8.336	8.347	8.358	8.369
552.0	386.982	387.821	388.660	389.501	390.344	391.187	392.032	392.878	393.725	394.573
	8.380	8.392	8.404	8.416	8.428	8.440	8.452	8.464	8.476	8.488
553.0	395.422	396.273	397.125	397.978	398.832	399.687	400.544	401.402	402.260	403.121
	8.500	8.512	8.524	8.536	8.548	8.560	8.572	8.584	8.596	8.608
554.0	403.982	404.845	405.708	406.573	407.439	408.306	409.174	410.043	410.913	411.785
	8.620	8.631	8.642	8.653	8.664	8.675	8.686	8.697	8.708	8.719
555.0	412.657	413.531	414.405	415.281	416.158	417.036	417.915	418.795	419.676	420.559
	8.730	8.741	8.752	8.763	8.774	8.785	8.796	8.807	8.818	8.829
556.0	421.442	422.327	423.212	424.099	424.987	425.876	426.766	427.657	428.549	429.443
	8.840	8.851	8.862	8.873	8.884	8.895	8.906	8.917	8.928	8.939
557.0	430.337	431.233	432.129	433.027	433.926	434.826	435.727	436.629	437.532	438.437
	8.950	8.961	8.972	8.983	8.994	9.005	9.016	9.027	9.038	9.049
558.0	439.342	440.249	441.156	442.065	442.975	443.886	444.798	445.711	446.625	447.541
	9.060	9.071	9.082	9.093	9.104	9.115	9.126	9.137	9.148	9.159
559.0	448.457	449.375	450.293	451.213	452.134	453.056	453.979	454.903	455.828	456.755
	9.170	9.181	9.192	9.203	9.214	9.225	9.236	9.247	9.258	9.269

BASED ON ORIGINAL E-A DATA

(CAPACITY IN ACRE-FEET)
CAPACITY [1000'S OF ACRE-FEET]
AREA [1000'S OF ACRES]

TABLE NO. 2

POOL ELEV [FT. NGVD]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES]									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
560.0	457.682	458.611	459.540	460.471	461.403	462.336	463.271	464.206	465.143	466.081
	9.280	9.292	9.303	9.315	9.326	9.338	9.349	9.361	9.372	9.384
561.0	467.020	467.960	468.901	469.843	470.787	471.731	472.677	473.624	474.572	475.522
	9.395	9.407	9.418	9.430	9.441	9.453	9.464	9.476	9.487	9.499
562.0	476.472	477.424	478.376	479.331	480.286	481.242	482.200	483.159	484.118	485.080
	9.510	9.522	9.534	9.546	9.558	9.570	9.582	9.594	9.606	9.618
563.0	486.042	487.006	487.971	488.936	489.904	490.872	491.842	492.813	493.785	494.758
	9.630	9.642	9.654	9.666	9.678	9.690	9.702	9.714	9.726	9.738
564.0	495.732	496.708	497.684	498.662	499.641	500.621	501.603	502.585	503.569	504.554
	9.750	9.762	9.773	9.785	9.796	9.808	9.819	9.831	9.842	9.854
565.0	505.540	506.527	507.515	508.504	509.495	510.486	511.479	512.473	513.468	514.465
	9.865	9.877	9.888	9.900	9.911	9.923	9.934	9.946	9.957	9.969
566.0	515.462	516.461	517.460	518.461	519.462	520.465	521.468	522.473	523.478	524.485
	9.980	9.990	10.000	10.010	10.020	10.030	10.040	10.050	10.060	10.070
567.0	525.492	526.501	527.510	528.521	529.532	530.545	531.558	532.573	533.588	534.605
	10.080	10.090	10.100	10.110	10.120	10.130	10.140	10.150	10.160	10.170
568.0	535.622	536.641	537.661	538.682	539.704	540.728	541.753	542.779	543.806	544.835
	10.180	10.193	10.205	10.218	10.230	10.243	10.255	10.268	10.280	10.293
569.0	545.865	546.896	547.928	548.962	549.997	551.033	552.070	553.109	554.149	555.190
	10.305	10.318	10.330	10.343	10.355	10.368	10.380	10.393	10.405	10.418
570.0	556.232	557.276	558.321	559.367	560.414	561.463	562.513	563.564	564.616	565.670
	10.430	10.443	10.455	10.468	10.480	10.493	10.505	10.518	10.530	10.543
571.0	566.725	567.781	568.838	569.897	570.957	572.018	573.080	574.144	575.209	576.275
	10.555	10.568	10.580	10.593	10.605	10.618	10.630	10.643	10.655	10.668
572.0	577.342	578.411	579.480	580.551	581.624	582.697	583.772	584.847	585.924	587.003
	10.680	10.692	10.704	10.716	10.728	10.740	10.752	10.764	10.776	10.788
573.0	588.082	589.163	590.244	591.327	592.412	593.497	594.584	595.671	596.760	597.851
	10.800	10.812	10.824	10.836	10.848	10.860	10.872	10.884	10.896	10.908
574.0	598.942	600.035	601.128	602.223	603.319	604.417	605.515	606.614	607.715	608.817
	10.920	10.932	10.943	10.955	10.966	10.978	10.989	11.001	11.012	11.024
575.0	609.920	611.024	612.129	613.235	614.343	615.451	616.561	617.672	618.784	619.898
	11.035	11.047	11.058	11.070	11.081	11.093	11.104	11.116	11.127	11.139
576.0	621.012	622.128	623.245	624.363	625.482	626.603	627.725	628.848	629.972	631.098
	11.150	11.163	11.175	11.188	11.200	11.213	11.225	11.238	11.250	11.263
577.0	632.225	633.353	634.482	635.613	636.745	637.878	639.012	640.148	641.285	642.423
	11.275	11.288	11.300	11.313	11.325	11.338	11.350	11.363	11.375	11.388
578.0	643.562	644.703	645.845	646.988	648.132	649.278	650.425	651.573	652.722	653.873
	11.400	11.413	11.425	11.438	11.450	11.463	11.475	11.488	11.500	11.513
579.0	655.025	656.178	657.332	658.488	659.645	660.803	661.962	663.123	664.285	665.448
	11.525	11.538	11.550	11.563	11.575	11.588	11.600	11.613	11.625	11.638

BASED ON ORIGINAL E-A DATA

(CAPACITY IN ACRE-FEET)
CAPACITY [1000'S OF ACRE-FEET]
AREA [1000'S OF ACRES]

TABLE NO. 2

POOL ELEV [FT. NGVD]	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES]									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
580.0	666.612	667.778	668.945	670.113	671.282	672.453	673.625	674.798	675.972	677.148
	11.650	11.663	11.675	11.688	11.700	11.713	11.725	11.738	11.750	11.763
581.0	678.325	679.503	680.682	681.863	683.045	684.228	685.412	686.598	687.785	688.973
	11.775	11.788	11.800	11.813	11.825	11.838	11.850	11.863	11.875	11.888
582.0	690.162	691.353	692.545	693.738	694.933	696.130	697.327	698.526	699.727	700.929
	11.900	11.914	11.928	11.942	11.956	11.970	11.984	11.998	12.012	12.026
583.0	702.132	703.337	704.543	705.750	706.959	708.170	709.381	710.594	711.809	713.025
	12.040	12.054	12.068	12.082	12.096	12.110	12.124	12.138	12.152	12.166
584.0	714.242	715.461	716.680	717.901	719.123	720.346	721.570	722.795	724.021	725.249
	12.180	12.191	12.202	12.213	12.224	12.235	12.246	12.257	12.268	12.279
585.0	726.477	727.707	728.937	730.169	731.402	732.636	733.871	735.107	736.344	737.583
	12.290	12.301	12.312	12.323	12.334	12.345	12.356	12.367	12.378	12.389
586.0	738.822	740.063	741.305	742.548	743.793	745.039	746.286	747.535	748.785	750.037
	12.400	12.414	12.427	12.441	12.454	12.468	12.481	12.495	12.508	12.522
587.0	751.290	752.544	753.799	755.056	756.314	757.574	758.835	760.097	761.361	762.626
	12.535	12.549	12.562	12.576	12.589	12.603	12.616	12.630	12.643	12.657
588.0	763.892	765.160	766.429	767.699	768.970	770.243	771.517	772.792	774.068	775.346
	12.670	12.683	12.695	12.708	12.720	12.733	12.745	12.758	12.770	12.783
589.0	776.625	777.905	779.186	780.469	781.753	783.038	784.324	785.612	786.901	788.191
	12.795	12.808	12.820	12.833	12.845	12.858	12.870	12.883	12.895	12.908
590.0	789.482	790.775	792.069	793.364	794.661	795.959	797.258	798.559	799.861	801.165
	12.920	12.934	12.947	12.961	12.974	12.988	13.001	13.015	13.028	13.042
591.0	802.470	803.776	805.083	806.392	807.702	809.014	810.327	811.641	812.957	814.274
	13.055	13.069	13.082	13.096	13.109	13.123	13.136	13.150	13.163	13.177
592.0	815.592	816.912	818.233	819.555	820.879	822.204	823.530	824.858	826.187	827.518
	13.190	13.204	13.217	13.231	13.244	13.258	13.271	13.285	13.298	13.312
593.0	828.850	830.183	831.517	832.853	834.190	835.529	836.869	838.210	839.553	840.897
	13.325	13.339	13.352	13.366	13.379	13.393	13.406	13.420	13.433	13.447
594.0	842.242	843.589	844.937	846.286	847.636	848.988	850.341	851.696	853.052	854.409
	13.460	13.473	13.486	13.499	13.512	13.525	13.538	13.551	13.564	13.577
595.0	855.767	857.127	858.488	859.850	861.214	862.578	863.944	865.312	866.681	868.051
	13.590	13.603	13.616	13.629	13.642	13.655	13.668	13.681	13.694	13.707
596.0	869.422	870.795	872.169	873.544	874.920	876.298	877.677	879.058	880.440	881.823
	13.720	13.733	13.746	13.759	13.772	13.785	13.798	13.811	13.824	13.837
597.0	883.207	884.593	885.980	887.368	888.757	890.148	891.540	892.934	894.329	895.725
	13.850	13.863	13.876	13.889	13.902	13.915	13.928	13.941	13.954	13.967
598.0	897.122	898.521	899.921	901.322	902.725	904.129	905.534	906.941	908.349	909.759
	13.980	13.994	14.007	14.021	14.034	14.048	14.061	14.075	14.088	14.102
599.0	911.170	912.582	913.995	915.410	916.826	918.244	919.663	921.083	922.505	923.928
	14.115	14.129	14.142	14.156	14.169	14.183	14.196	14.210	14.223	14.237

BASED ON ORIGINAL E-A DATA

(CAPACITY IN ACRE-FEET)

TABLE NO. 2

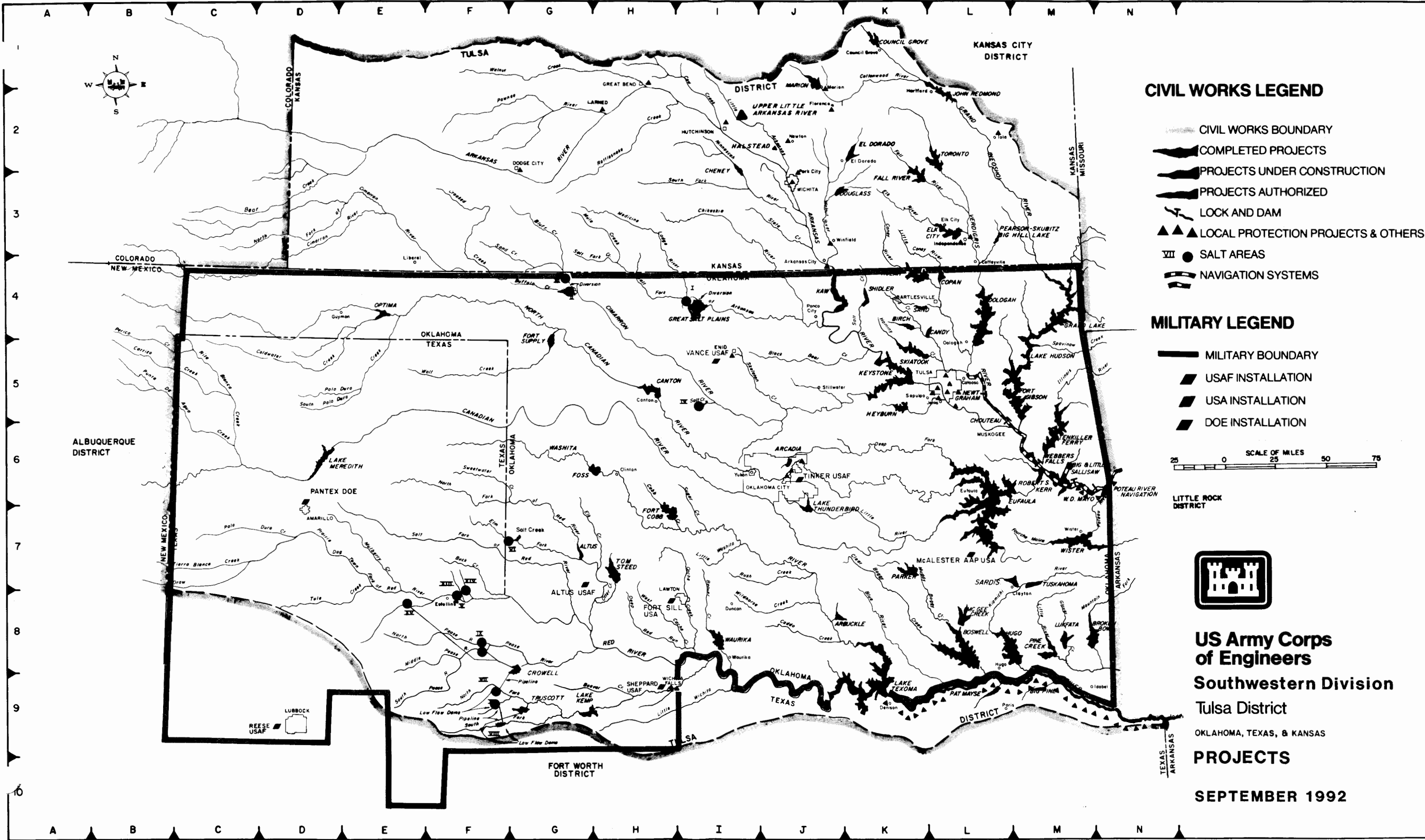
POOL ELEV [FT. NGVD]	(CAPACITY IN ACRE-FEET)									
	CAPACITY [1000'S OF ACRE-FEET] AREA [1000'S OF ACRES]									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
600.0	925.352	926.778	928.205	929.634	931.064	932.496	933.929	935.364	936.800	938.238
	14.250	14.265	14.280	14.295	14.310	14.325	14.340	14.355	14.370	14.385
601.0	939.677	941.118	942.560	944.004	945.449	946.896	948.344	949.794	951.245	952.698
	14.400	14.415	14.430	14.445	14.460	14.475	14.490	14.505	14.520	14.535
602.0	954.152	955.608	957.065	958.523	959.983	961.444	962.906	964.370	965.835	967.302
	14.550	14.564	14.577	14.591	14.604	14.618	14.631	14.645	14.658	14.672
603.0	968.770	970.239	971.709	973.181	974.654	976.129	977.605	979.082	980.561	982.041
	14.685	14.699	14.712	14.726	14.739	14.753	14.766	14.780	14.793	14.807
604.0	983.522	985.005	986.489	987.975	989.462	990.951	992.441	993.933	995.426	996.921
	14.820	14.835	14.850	14.865	14.880	14.895	14.910	14.925	14.940	14.955
605.0	998.417	999.915	1001.414	1002.915	1004.417	1005.921	1007.426	1008.933	1010.441	1011.951
	14.970	14.985	15.000	15.015	15.030	15.045	15.060	15.075	15.090	15.105
606.0	1013.462	1014.975	1016.489	1018.004	1019.520	1021.038	1022.557	1024.078	1025.600	1027.123
	15.120	15.133	15.146	15.159	15.172	15.185	15.198	15.211	15.224	15.237
607.0	1028.647	1030.173	1031.700	1033.228	1034.757	1036.288	1037.820	1039.354	1040.889	1042.425
	15.250	15.263	15.276	15.289	15.302	15.315	15.328	15.341	15.354	15.367
608.0	1043.962	1045.501	1047.041	1048.582	1050.125	1051.669	1053.214	1054.761	1056.309	1057.859
	15.380	15.394	15.407	15.421	15.434	15.448	15.461	15.475	15.488	15.502
609.0	1059.410	1060.962	1062.515	1064.070	1065.626	1067.184	1068.743	1070.303	1071.865	1073.428
	15.515	15.529	15.542	15.556	15.569	15.583	15.596	15.610	15.623	15.637
610.0	1074.992	1076.558	1078.124	1079.692	1081.261	1082.831	1084.403	1085.975	1087.549	1089.124
	15.650	15.662	15.673	15.685	15.696	15.708	15.719	15.731	15.742	15.754
611.0	1090.700	1092.277	1093.855	1095.434	1097.015	1098.596	1100.179	1101.763	1103.348	1104.935
	15.765	15.777	15.788	15.800	15.811	15.823	15.834	15.846	15.857	15.869
612.0	1106.522	1108.111	1109.700	1111.292	1112.884	1114.477	1116.072	1117.667	1119.265	1120.863
	15.880	15.892	15.904	15.916	15.928	15.940	15.952	15.964	15.976	15.988
613.0	1122.462	1124.063	1125.664	1127.267	1128.872	1130.477	1132.084	1133.692	1135.300	1136.911
	16.000	16.012	16.024	16.036	16.048	16.060	16.072	16.084	16.096	16.108
614.0	1138.522	1140.135	1141.749	1143.364	1144.981	1146.600	1148.219	1149.840	1151.463	1153.087
	16.120	16.134	16.148	16.162	16.176	16.190	16.204	16.218	16.232	16.246
615.0	1154.712	1156.339	1157.967	1159.596	1161.227	1162.860	1164.493	1166.128	1167.765	1169.403
	16.260	16.274	16.288	16.302	16.316	16.330	16.344	16.358	16.372	16.386
616.0	1171.042	1172.683	1174.325	1175.968	1177.612	1179.258	1180.905	1182.553	1184.202	1185.853
	16.400	16.413	16.425	16.438	16.450	16.463	16.475	16.488	16.500	16.513
617.0	1187.505	1189.158	1190.812	1192.468	1194.125	1195.783	1197.442	1199.103	1200.765	1202.428
	16.525	16.538	16.550	16.563	16.575	16.588	16.600	16.613	16.625	16.638
618.0	1204.092	1205.758	1207.425	1209.093	1210.763	1212.434	1214.106	1215.780	1217.455	1219.132
	16.650	16.664	16.677	16.691	16.704	16.718	16.731	16.745	16.758	16.772
619.0	1220.810	1222.489	1224.169	1225.851	1227.534	1229.219	1230.905	1232.592	1234.281	1235.971
	16.785	16.799	16.812	16.826	16.839	16.853	16.866	16.880	16.893	16.907

BASED ON ORIGINAL E-A DATA

(CAPACITY IN ACRE-FEET)

TABLE NO. 2

POOL ELEV [FT. NGVD]	(CAPACITY IN ACRE-FEET)									
	CAPACITY [1000'S OF ACRE-FEET]									
	AREA [1000'S OF ACRES]									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
620.0	1237.662	1239.355	1241.049	1242.744	1244.440	1246.138	1247.838	1249.538	1251.240	1252.943
	16.920	16.933	16.946	16.959	16.972	16.985	16.998	17.011	17.024	17.037
621.0	1254.647	1256.353	1258.060	1259.768	1261.477	1263.188	1264.901	1266.614	1268.329	1270.045
	17.050	17.063	17.076	17.089	17.102	17.115	17.128	17.141	17.154	17.167
622.0	1271.762	1273.481	1275.201	1276.922	1278.645	1280.369	1282.094	1283.821	1285.549	1287.279
	17.180	17.194	17.207	17.221	17.234	17.248	17.261	17.275	17.288	17.302
623.0	1289.010	1290.742	1292.475	1294.210	1295.946	1297.684	1299.423	1301.163	1302.905	1304.648
	17.315	17.329	17.342	17.356	17.369	17.383	17.396	17.410	17.423	17.437
624.0	1306.392	1308.138	1309.885	1311.633	1313.383	1315.134	1316.886	1318.640	1320.395	1322.152
	17.450	17.464	17.477	17.491	17.504	17.518	17.531	17.545	17.558	17.572
625.0	1323.910	1325.669	1327.429	1329.191	1330.954	1332.719	1334.485	1336.252	1338.021	1339.791
	17.585	17.599	17.612	17.626	17.639	17.653	17.666	17.680	17.693	17.707
626.0	1341.562	1343.335	1345.109	1346.884	1348.661	1350.440	1352.219	1354.000	1355.783	1357.567
	17.720	17.734	17.748	17.762	17.776	17.790	17.804	17.818	17.832	17.846
627.0	1359.352	1361.139	1362.927	1364.716	1366.507	1368.300	1370.093	1371.888	1373.685	1375.483
	17.860	17.874	17.888	17.902	17.916	17.930	17.944	17.958	17.972	17.986
628.0	1377.282	1379.083	1380.886	1382.690	1384.497	1386.305	1388.115	1389.927	1391.741	1393.557
	18.000	18.019	18.037	18.056	18.074	18.093	18.111	18.130	18.148	18.167
629.0	1395.375	1397.194	1399.015	1400.839	1402.663	1404.490	1406.319	1408.149	1409.982	1411.816
	18.185	18.204	18.222	18.241	18.259	18.278	18.296	18.315	18.333	18.352
630.0	1413.652	1415.490	1417.330	1419.172	1421.015	1422.861	1424.708	1426.558	1428.409	1430.262
	18.370	18.389	18.408	18.427	18.446	18.465	18.484	18.503	18.522	18.541
631.0	1432.117	1433.974	1435.833	1437.694	1439.556	1441.421	1443.287	1445.156	1447.026	1448.898
	18.560	18.579	18.598	18.617	18.636	18.655	18.674	18.693	18.712	18.731
632.0	1450.772	1452.648	1454.526	1456.406	1458.288	1460.172	1462.058	1463.946	1465.836	1467.728
	18.750	18.770	18.790	18.810	18.830	18.850	18.870	18.890	18.910	18.930
633.0	1469.622	1471.518	1473.416	1475.316	1477.218	1479.122	1481.028	1482.936	1484.846	1486.758
	18.950	18.970	18.990	19.010	19.030	19.050	19.070	19.090	19.110	19.130
634.0	1488.672	1490.588	1492.506	1494.427	1496.349	1498.274	1500.201	1502.130	1504.061	1505.994
	19.150	19.172	19.193	19.215	19.236	19.258	19.279	19.301	19.322	19.344
635.0	1507.930	1509.867	1511.807	1513.749	1515.693	1517.639	1519.587	1521.538	1523.490	1525.445
	19.365	19.387	19.408	19.430	19.451	19.473	19.494	19.516	19.537	19.559
636.0	1527.402	1529.361	1531.323	1533.287	1535.253	1537.221	1539.192	1541.166	1543.141	1545.119
	19.580	19.604	19.627	19.651	19.674	19.698	19.721	19.745	19.768	19.792
637.0	1547.100	1549.082	1551.067	1553.055	1555.044	1557.036	1559.031	1561.028	1563.027	1565.028
	19.815	19.839	19.862	19.886	19.909	19.933	19.956	19.980	20.003	20.027
638.0	1567.032	1569.038	1571.047	1573.059	1575.073	1577.090	1579.109	1581.131	1583.155	1585.182
	20.050	20.076	20.102	20.128	20.154	20.180	20.206	20.232	20.258	20.284
639.0	1587.212	1589.244	1591.279	1593.317	1595.357	1597.400	1599.445	1601.493	1603.543	1605.596
	20.310	20.336	20.362	20.388	20.414	20.440	20.466	20.492	20.518	20.544

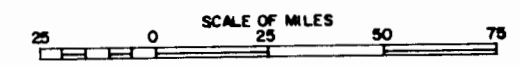


CIVIL WORKS LEGEND

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

MILITARY LEGEND

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

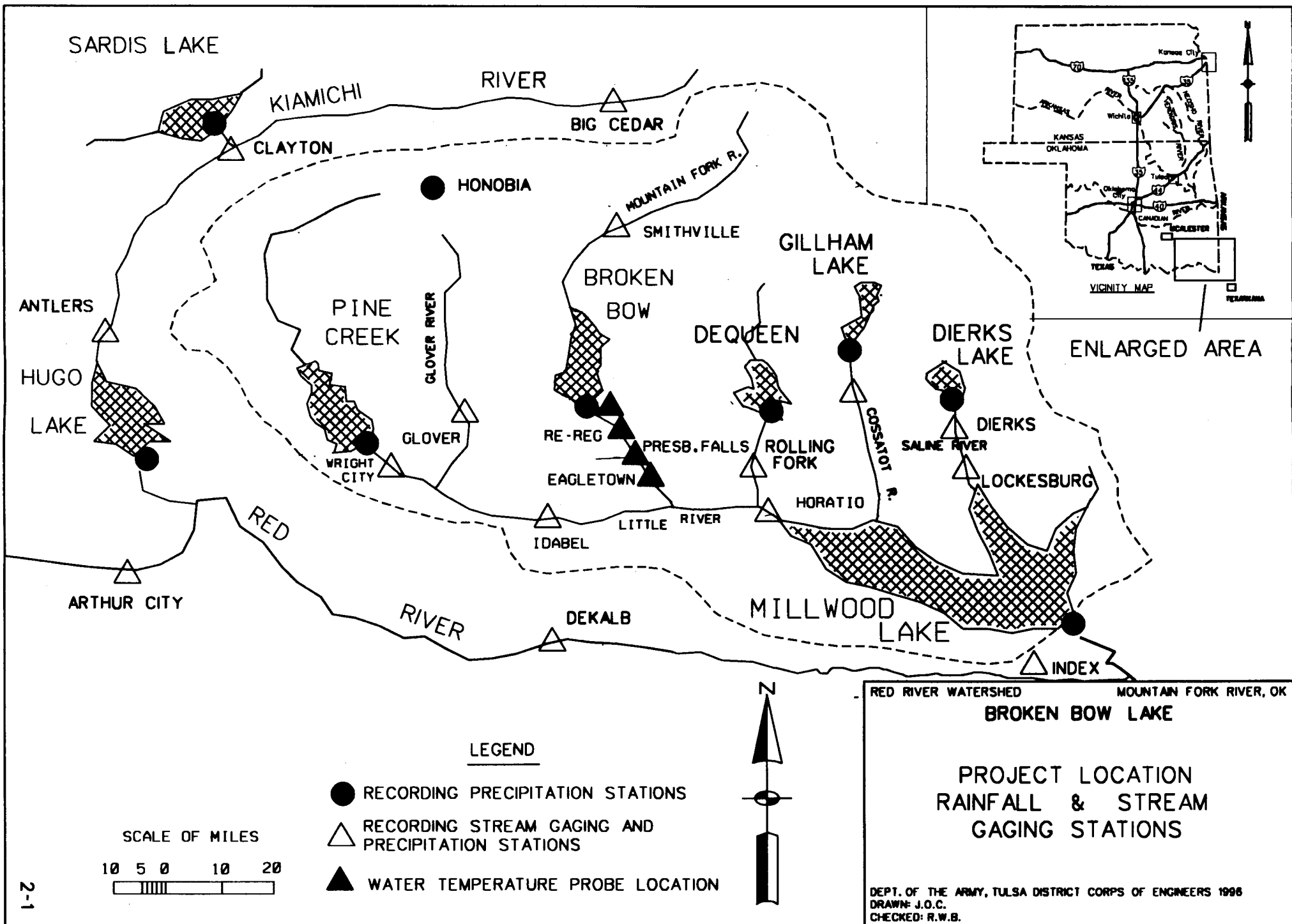


LITTLE ROCK DISTRICT



US Army Corps of Engineers
Southwestern Division
 Tulsa District
 OKLAHOMA, TEXAS, & KANSAS
PROJECTS

SEPTEMBER 1992



SARDIS LAKE

KIAMICHI RIVER

RIVER

BIG CEDAR

CLAYTON

HONOBIA

MOUNTAIN FORK R.

SMITHVILLE

GILLHAM LAKE

BROKEN BOW

DEQUEEN

DIERKS LAKE

ANTLERS

PINE CREEK

GLOVER RIVER

GLOVER

RE-REG

PRESB. FALLS

ROLLING FORK

SALINE RIVER

DIERKS

HUGO LAKE

WRIGHT CITY

EAGLETOWN

LITTLE RIVER

HORATIO

LOCKESBURG

RED RIVER

IDABEL

ARTHUR CITY

RIVER

DEKALB

MILLWOOD LAKE

INDEX

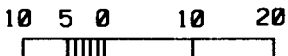
BROKEN BOW LAKE

PROJECT LOCATION
RAINFALL & STREAM
GAGING STATIONS

LEGEND

- RECORDING PRECIPITATION STATIONS
- △ RECORDING STREAM GAGING AND PRECIPITATION STATIONS
- ▲ WATER TEMPERATURE PROBE LOCATION

SCALE OF MILES



RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: J.O.C.
CHECKED: R.W.B.

(b) (7)(F)

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

GENERAL PLANS AND SECTIONS

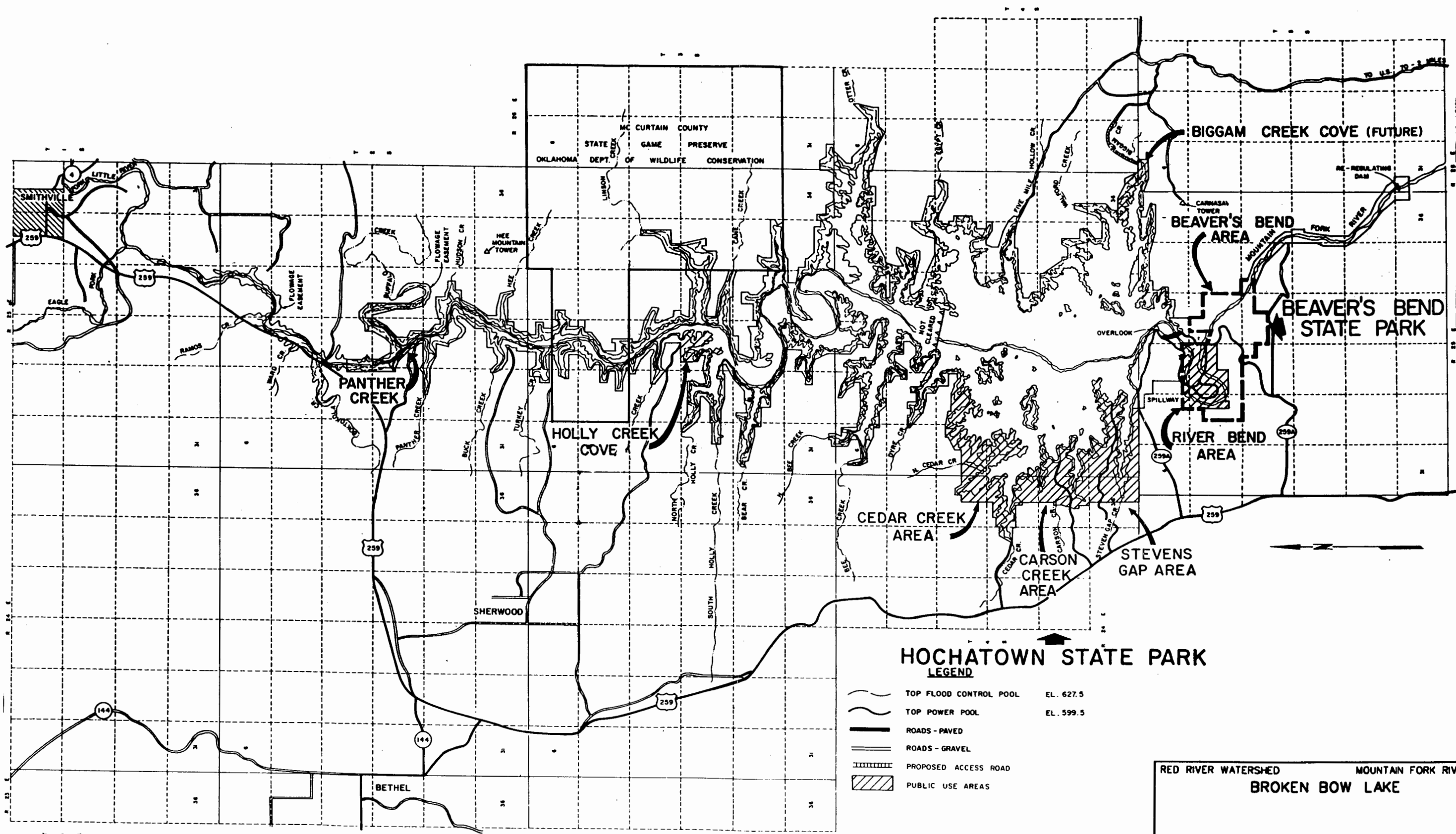
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: J.O.C.
CHECKED: R.W.B.

(b) (7)(F)







RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

**REREGULATION DAM
GENERAL PLAN & ELEVATION**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: J.O.C.
CHECKED: R.W.B.



HOCHATOWN STATE PARK
LEGEND

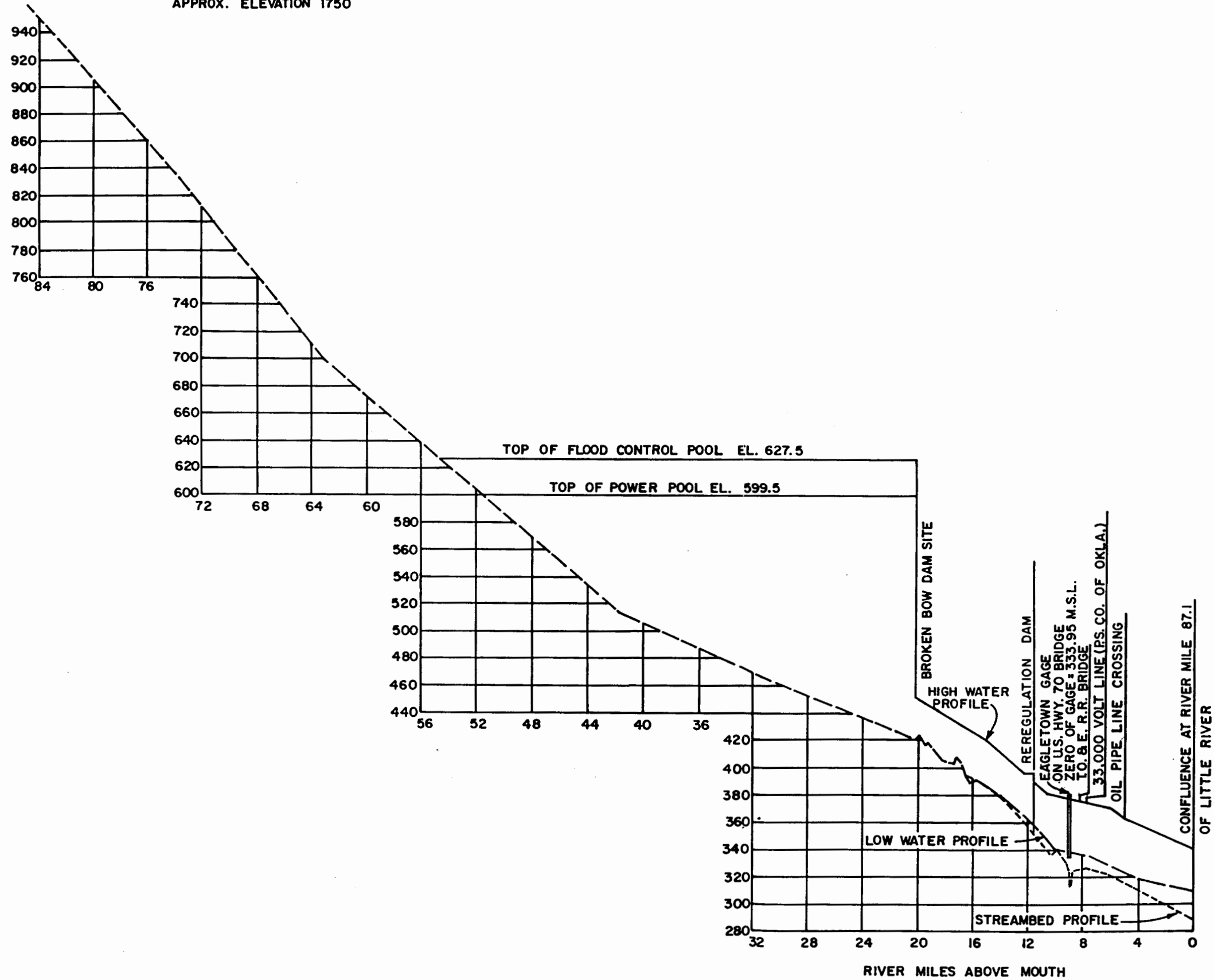
-  TOP FLOOD CONTROL POOL EL. 627.5
-  TOP POWER POOL EL. 599.5
-  ROADS - PAVED
-  ROADS - GRAVEL
-  PROPOSED ACCESS ROAD
-  PUBLIC USE AREAS

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

PUBLIC USE AREAS

NOTE: SOURCE AT MILE 96.4
APPROX. ELEVATION 1750

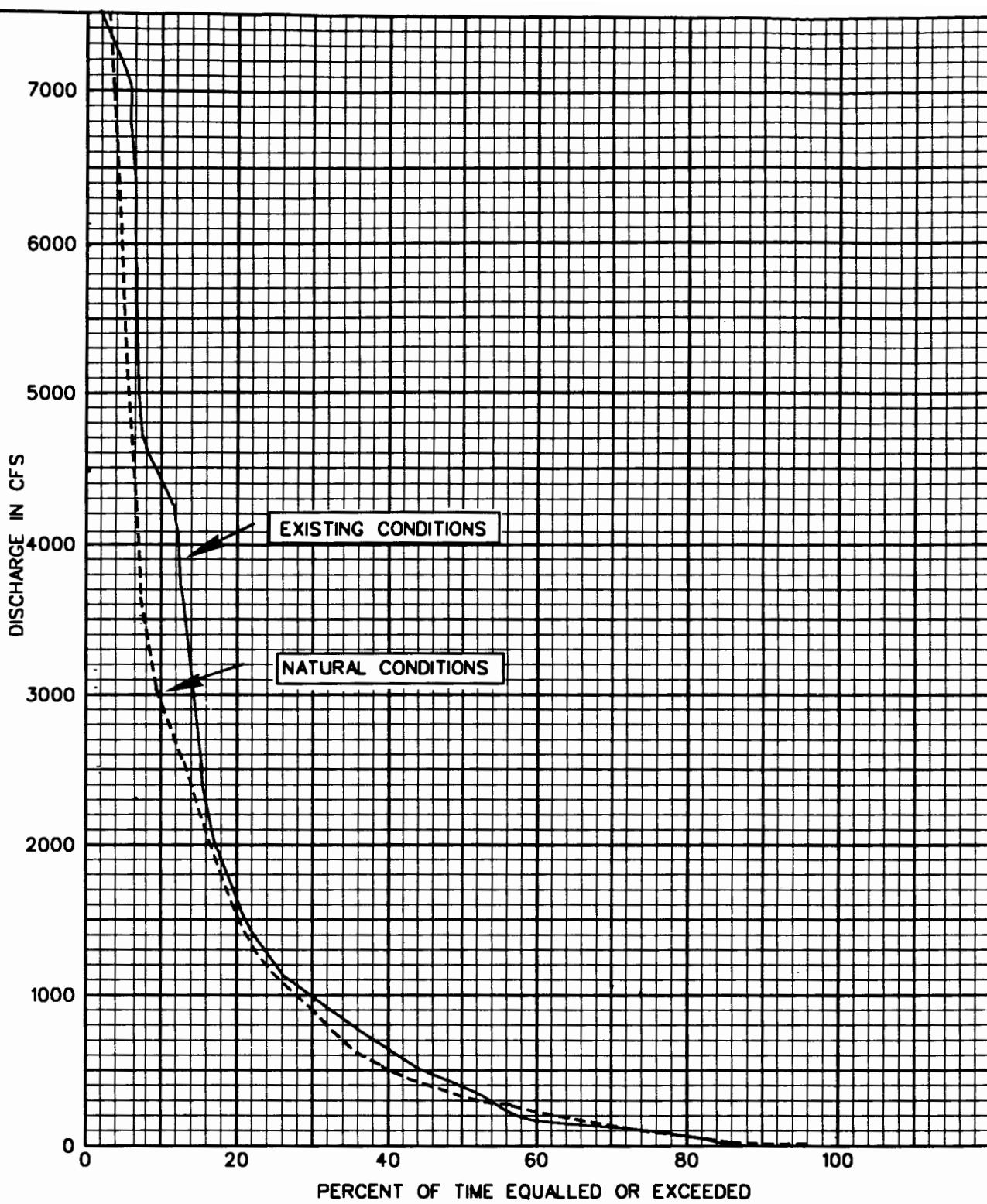
POOL ELEVATION IN FEET (NGVD)



RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

STREAMBED PROFILES
MOUNTAIN FORK RIVER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: J.O.C.
CHECKED: R.W.B.



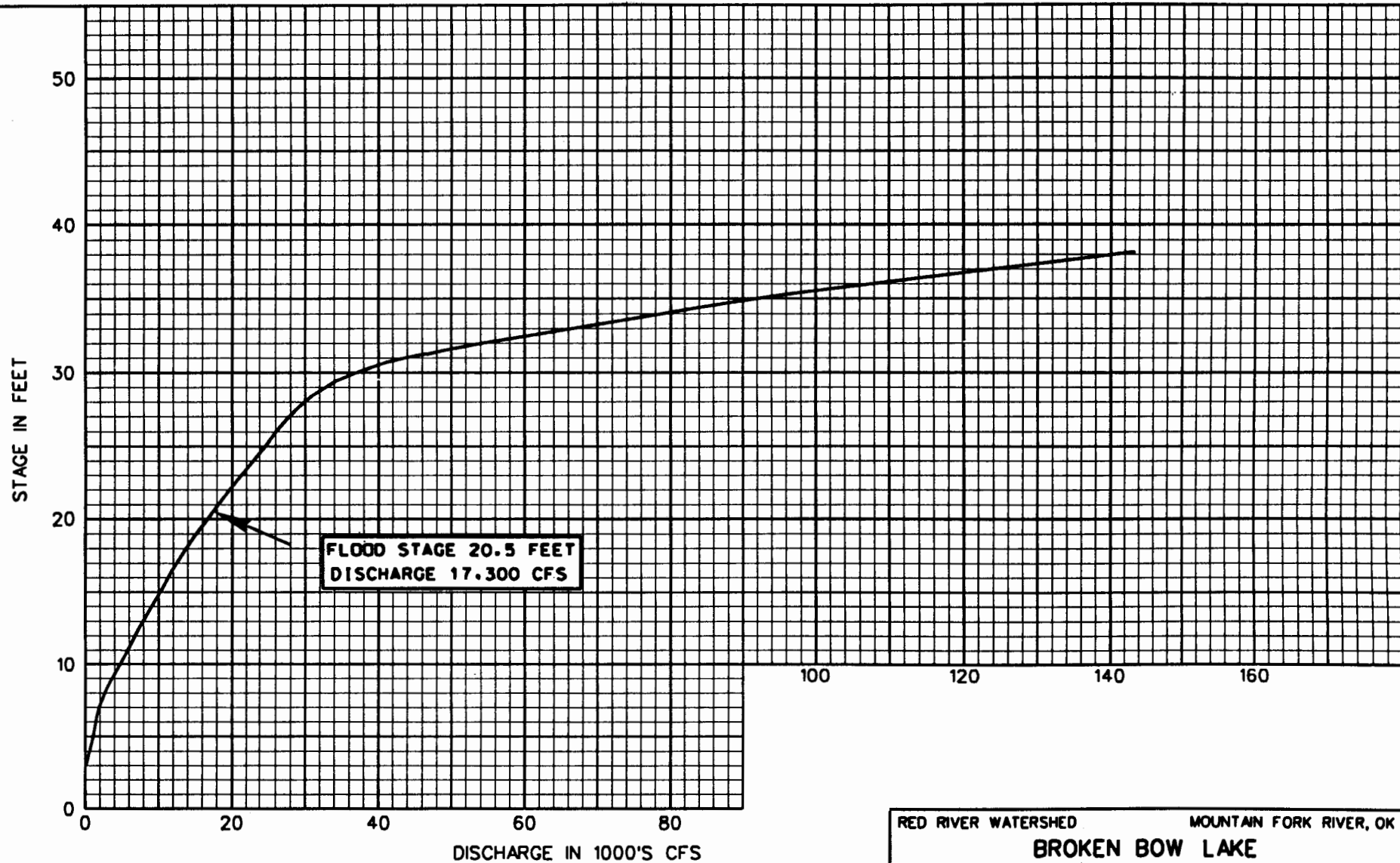
NOTE:
 BASED ON PERIOD OF RECORD JAN. 1938
 THRU DEC. 1990 FROM SUPER RUN R95X01.

NOTE:
 EXISTING CONDITIONS CURVE APPROACHES
 ZERO AT 8,333 CFS. NATURAL CONDITIONS
 CURVE APPROACHES ZERO AT 48,621 CFS.

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
 BROKEN BOW LAKE

FLOW DURATION CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C.
 CHECKED: R.W.B.



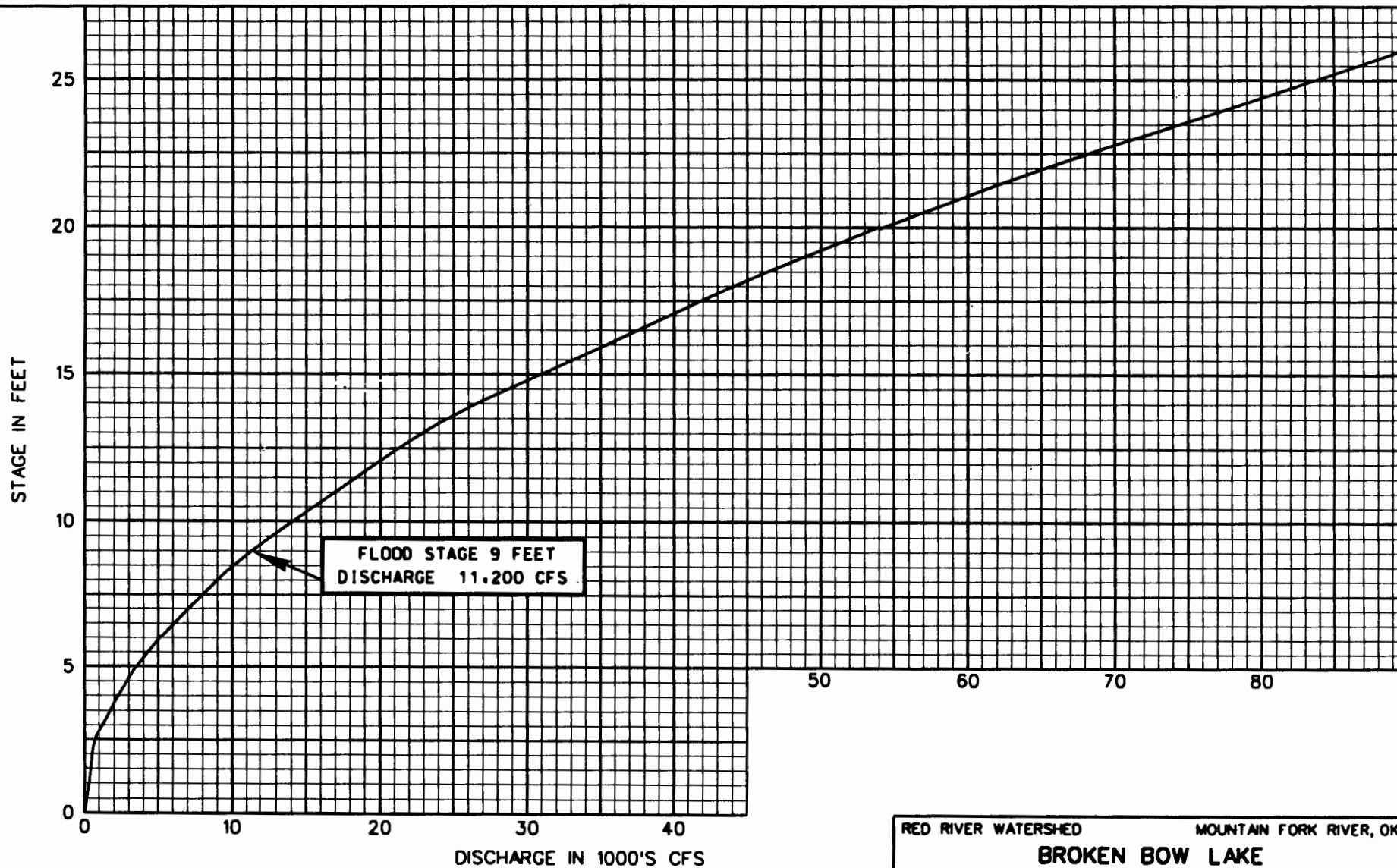
**FLOOD STAGE 20.5 FEET
DISCHARGE 17.300 CFS**

**NOTE:
CURVE DATA AS JANUARY 1996**

**RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE**

**DISCHARGE RATING CURVE
LITTLE RIVER
HORATIO, ARKANSAS**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: J.O.C.
CHECKED: R.W.B.

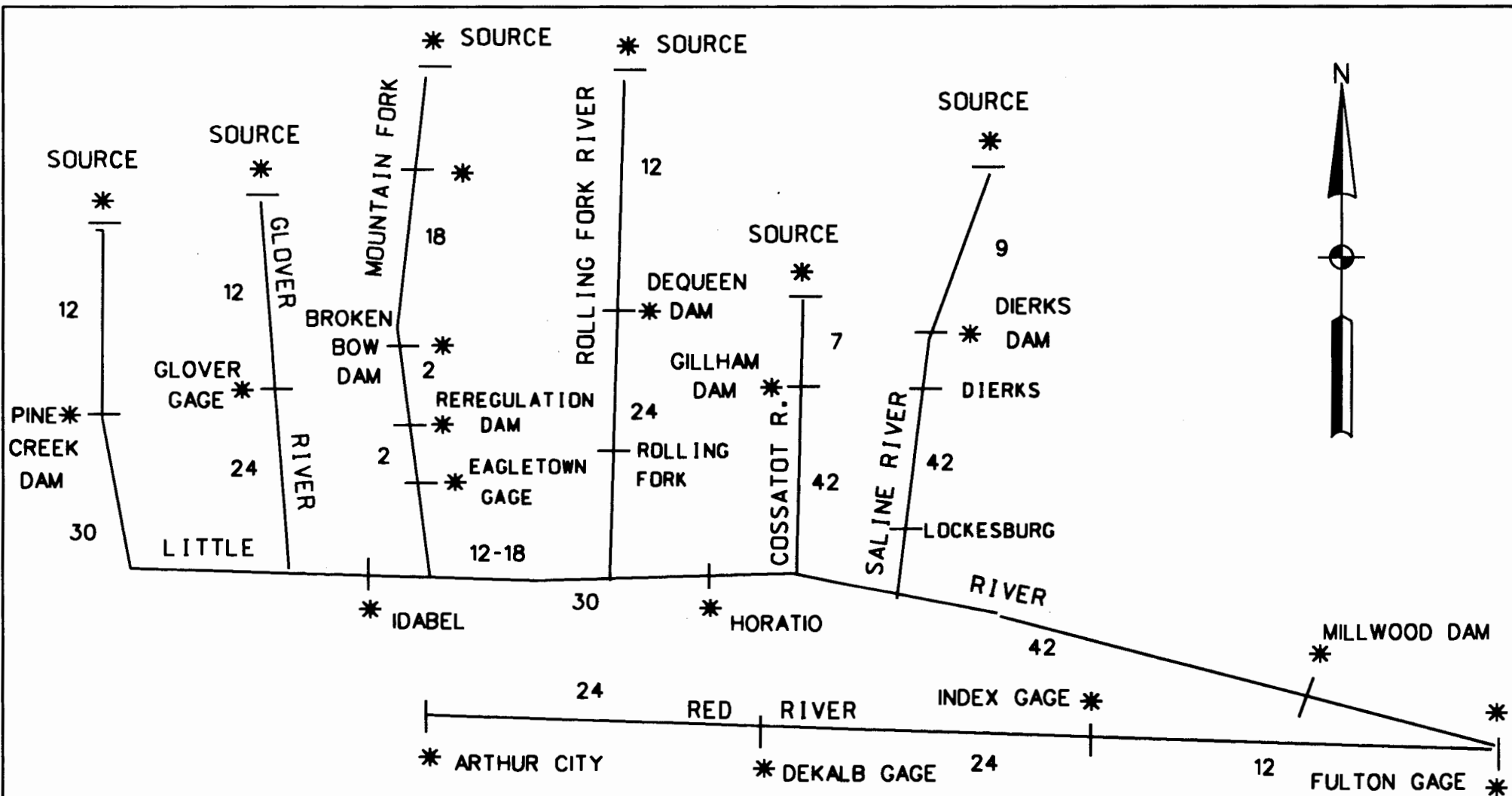


NOTE:
 CURVE DATA AS OF JANUARY 1996

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

DISCHARGE RATING CURVE
 MOUNTAIN FORK RIVER
 EAGLETOWN, OKLAHOMA

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C.
 CHECKED: R.W.B.



NOTES:

1. TIME OF TRAVEL IN HOURS FOR LARGE RISES IS SHOWN:
 • 24 •
2. TIME SHOWN ABOVE UPSTREAM STATION IS AVERAGE TIME TO CREST

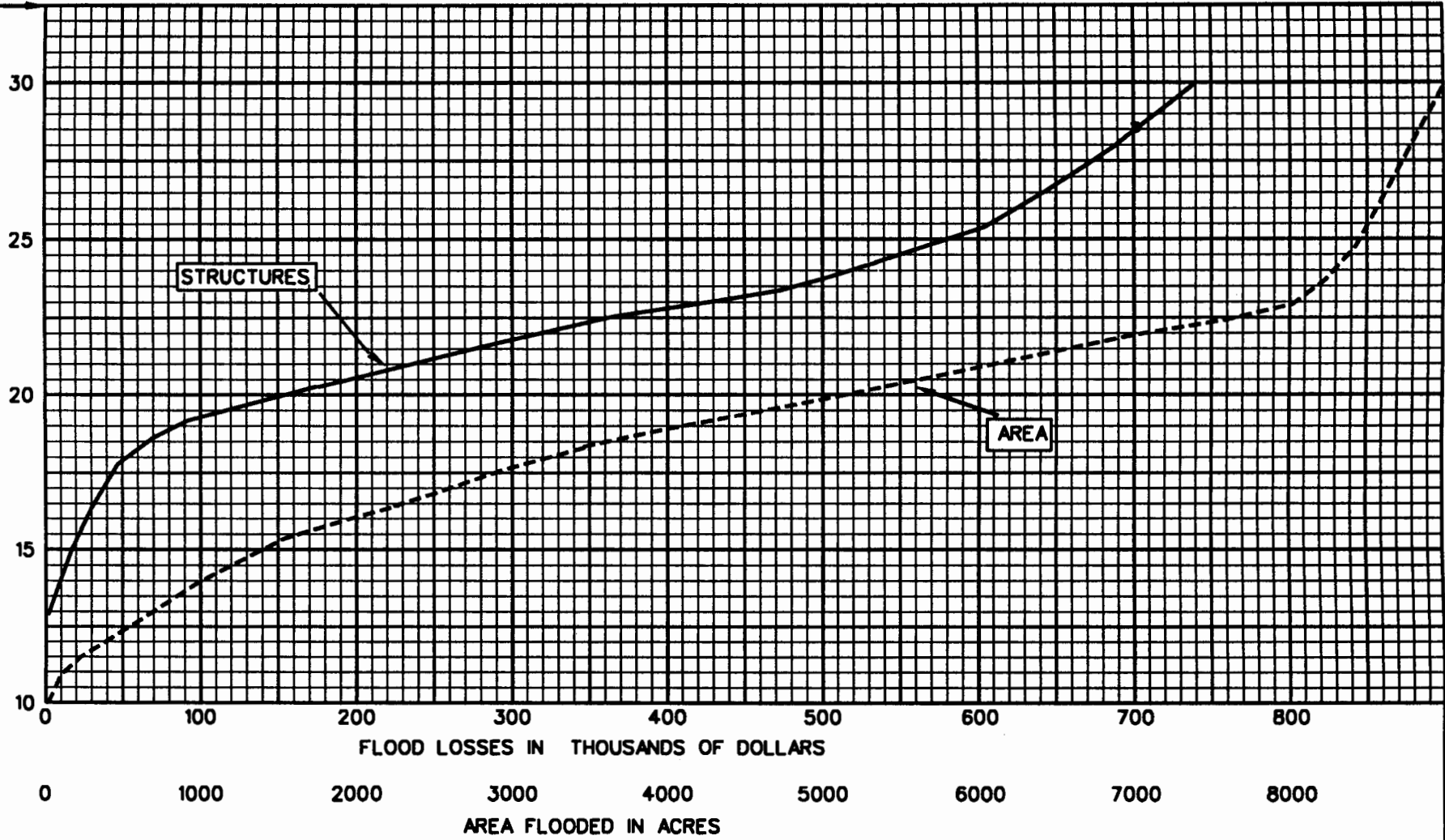
RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
 BROKEN BOW LAKE

TIME OF CREST TRAVEL

LITTLE RIVER BASIN

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C.
 CHECKED: R.W.B.

STAGE AT EAGLETOWN GAGE IN FEET

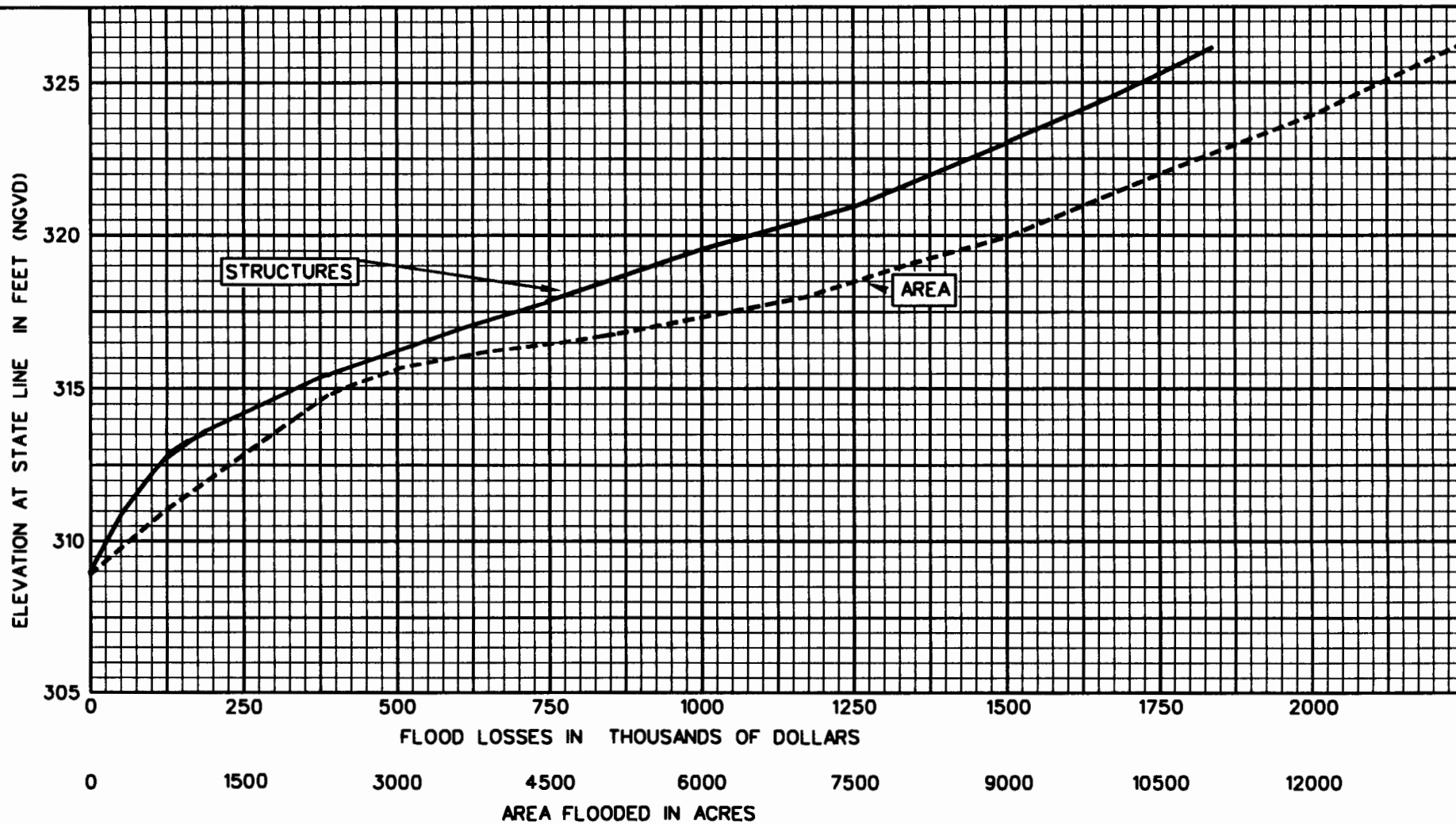


RED RIVER WATERSHED MOUNTAIN FORK RIVER, OKLAHOMA
BROKEN BOW LAKE

**STRUCTURAL LOSS AND
AREA CURVES**

BROKEN BOW DAM
TO MOUTH OF
MOUNTAIN FORK RIVER

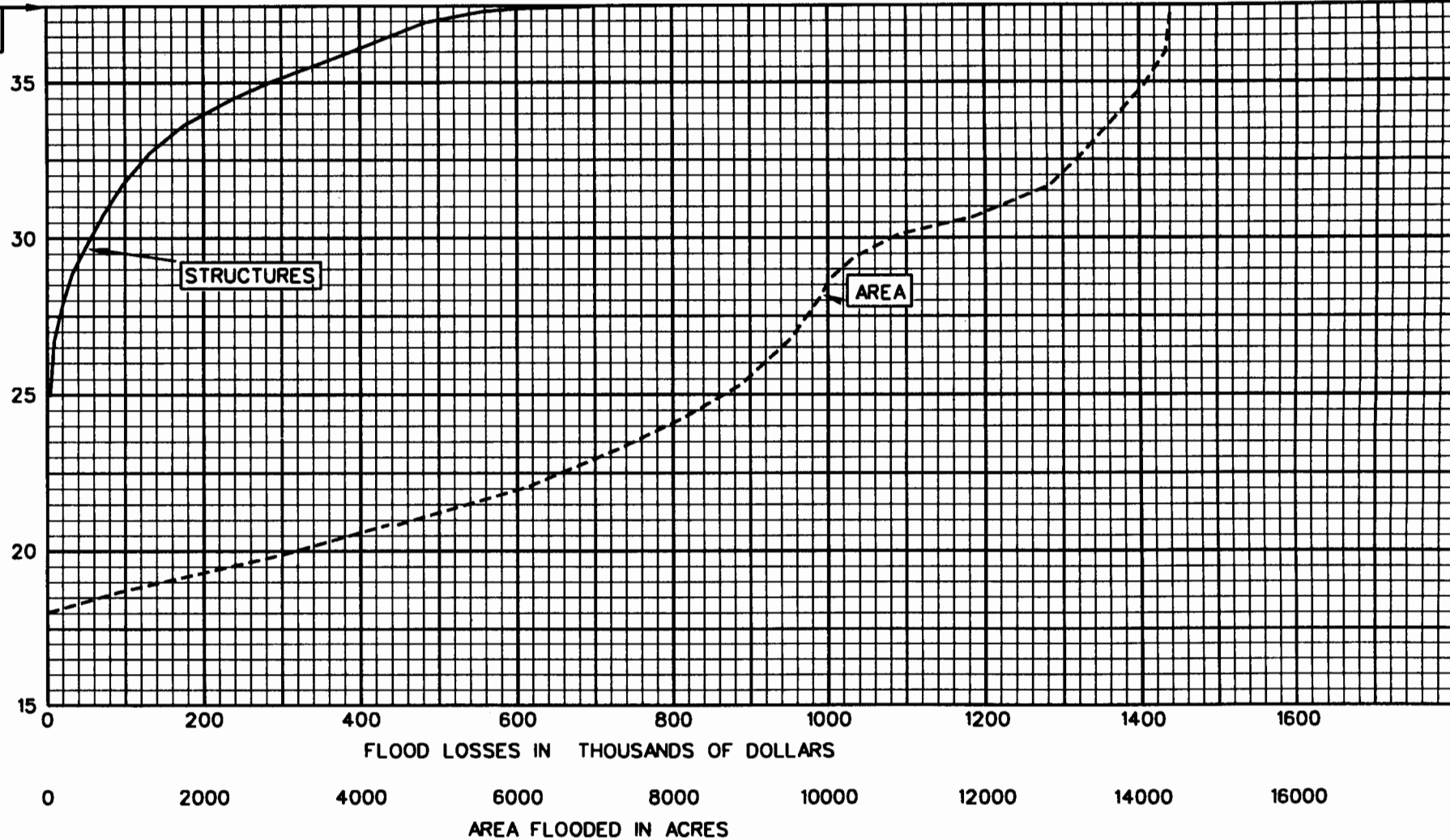
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: J.O.C.
CHECKED: R.W.B.



RED RIVER WATERSHED LITTLE RIVER, OKLAHOMA
BROKEN BOW LAKE
STRUCTURAL LOSS AND
AREA CURVES
 LITTLE RIVER FROM
 MOUNTAIN FORK
 TO ROLLING FORK
 DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
 DRAWN: J.O.C.
 CHECKED: G.D.E.

MAXIMUM 37.70
MARCH 1945

STAGE AT HORATIO GAGE IN FEET

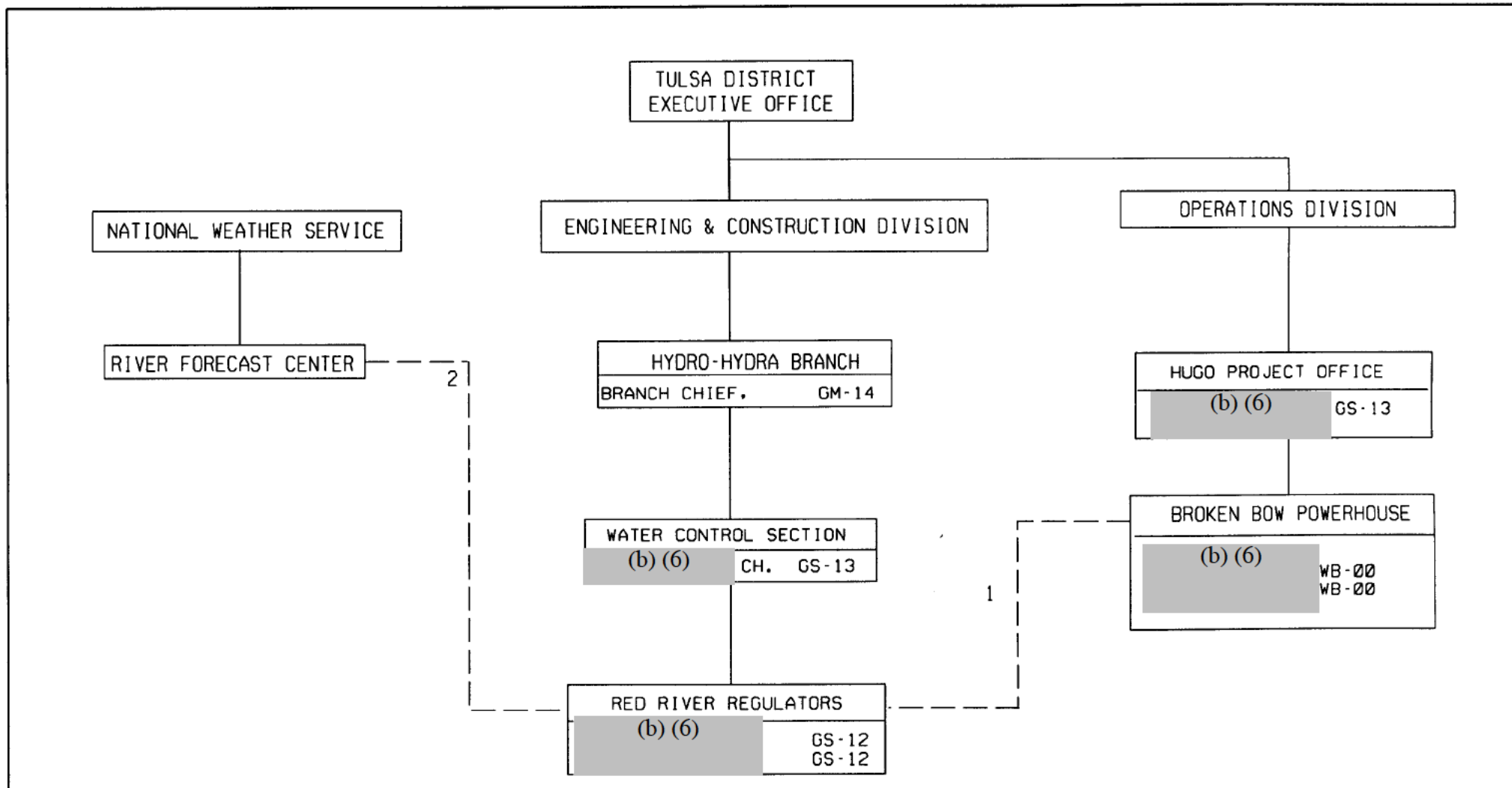


RED RIVER WATERSHED LITTLE RIVER, OKLAHOMA
BROKEN BOW LAKE

**STRUCTURAL LOSS AND
AREA CURVES**

LITTLE RIVER FROM
ROLLING FORK
TO HORATIO GAGE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: J.O.C.
CHECKED: G.D.E.



1. DIRECT COMMUNICATIONS ARE MAINTAINED BETWEEN THE LAKES AND THE RESERVOIR CONTROL SECTION FOR TRANSMISSION OF LAKE DATA AND INSTRUCTIONS.
2. PRECIPITATION AND STREAM GAGE DATA ARE FURNISHED BY THE NATIONAL WEATHER SERVICE, RIVER FORECAST CENTER.

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
 BROKEN BOW LAKE

ORGANIZATIONAL CHART

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
 DRAWN: J.O.C..
 CHECKED: R.W.B.

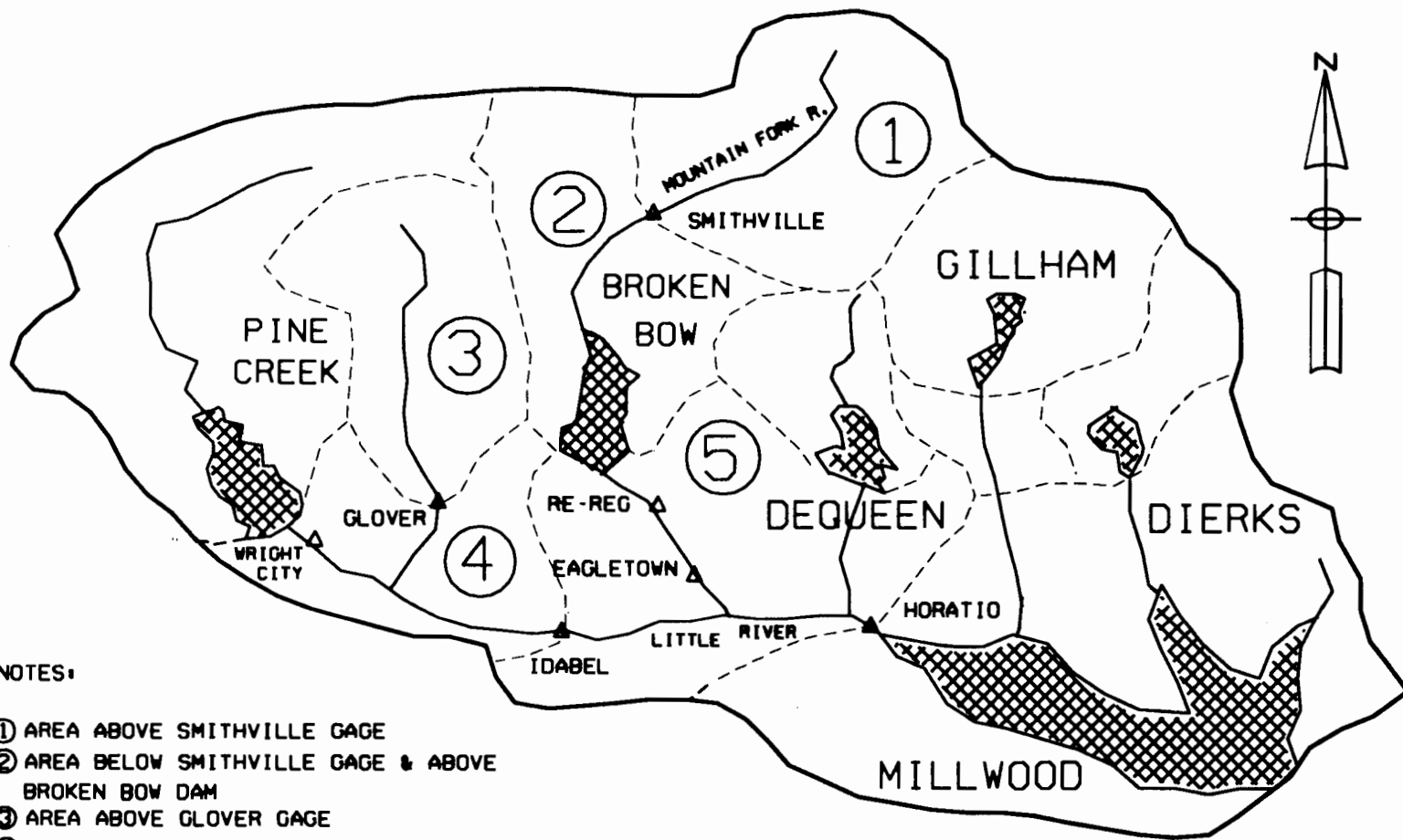
LAKE DATA

12 JUNE 1996

LINE NUMBER	ITEM	TIME	BROK										
1	POOL ELEVATION	12N	599.41										
2	POOL ELEVATION	4PM	599.42										
3	POOL ELEVATION	12M	599.37										
4	POOL ELEVATION	8AM	599.36										
5	TAILWATER ELEVATION	8AM	401.5										
6	24 HR AVE. POWER DISCHARGE	12M	249										
7	24 HR AVE. TOTAL DISCHARGE	12M	349										
8	NET POWER GENERATION	12M	74										
9	GEN•1 HRS IN USE	12M	0•50										
	GEN•2 HRS IN USE	12M	3•10										
	GEN•3 HRS IN USE	12M											
	GEN•4 HRS IN USE	12M											
10	INSTANTANEOUS POWER DISCHARGE	8AM	0										
11	INSTANTANEOUS TOTAL DISCHARGE	8AM	100										
12	LAKE CONDITIONS	8AM	0										
13	WEATHER COND.	8AM	0										
14	TOTAL PRECEDING 6 HOUR PRECIPITATION ENDING AT	1PM											
		7PM	0.15										
		1AM	0.05										
		7AM											
15	TOTAL 24 HOUR PRECIPITATION	7AM	0.20										
16	COMMENTS ON PRECIP. DIST.		5P-10P										
17	EVAPORATION 24 HOURS	8AM	0.19										
18	WIND DIRECTION	8AM	S										
19	WIND VELOCITY	8AM	B-2										
20	WATER SUPPLY												
21	GATE SETTINGS NO. TYPE•OPENING	8AM	1SG16%										
22	GATE CHANGES DATE TIME		6-11-91 1400										
23	POOL ELEVATION		599.40										
24	FROM: GATE SETTING		1SG 8%										
25	TO: GATE SETTING		1SG16%										
26	GATE CHANGES DATE TIME												
27	POOL ELEVATION												
28	FROM: GATE SETTING												
29	TO: GATE SETTING												
30	RIVER STAGE LOW FLOW WEIR												

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

LAKE DATA



NOTES:

- ① AREA ABOVE SMITHVILLE GAGE
- ② AREA BELOW SMITHVILLE GAGE & ABOVE
BROKEN BOW DAM
- ③ AREA ABOVE GLOVER GAGE
- ④ AREA ABOVE IDABEL GAGE AND BELOW PINE CREEK DAM & GLOVER GAGE
- ⑤ AREA ABOVE HORATIO GAGE AND BELOW BROKEN BOW DAM,
DEQUEEN DAM & IDABEL GAGE

△ STREAM GAGING STATIONS

SCALE OF MILES



RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

FORECASTING REACHES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1986
 DRAWN: J.O.C.
 CHECKED: R.W.B.

ID BROKEN BOW LAKE FORECAST MARK SWIFT
 ID UNIT HYDROGRAPHS BY SNYDERS COEFFICIENTS 24 AUG 81
 ID MODIFIED FOR DSS ZREAD AND ZWRITE NOV84 B. MCCORMICK
 ID MODIFIED FOR TOTDSS RELEASES MAY 1989 P.A.T.
 ID MONOBIA PRECIP GAGE ADDED AUG 1990 J.C.D.
 ID BIG CEDAR PRECIP GAGE ADDED APRIL 1991 J.C.D.
 ID SMITHVILLE, PAGE, CAUTHRON, & RED OAK GAGES ADDED APR92 MAD
 IT 120 02SEP95 0000 100
 IO 5
 VS MF BB BOW-IN BBOW BOWOUT
 VV 5.11 5.11 2.11 7.11 2.11
 KK MF COMPUTED HYDROGRAPH FOR MOUNTAIN FORK
 BA 596
 BF 0 -0.25 1.03
 * L LOSS RATE CARD FOR ENTIRE MODEL
 LU 0 0
 PB 0
 ZR =PI A=BROKEN BOW B=MFORK C=PRECIP-INC F=ADJUST
 US 12.0 0.75
 ZW A=LITTLE B=SMIT C=FLOW-LOC CUM F=CALC
 KK BB COMPUTED HYDROGRAPH FOR AREA SURROUNDING LAKE
 BA 130
 BF 0 -.25 1.03
 PB 0
 ZR =PI A=BROKEN BOW B=BBLAKE C=PRECIP-INC F=ADJUST
 US 2.5 0.63
 KK LAKE COMPUTED INFLOW FROM RAINFALL ON THE LAKE
 BA 24
 * B BASE FLOW INTO LAKE
 BF 0 0 0
 * L LOSS RATE FOR LAKE SURFACE
 LU 0 0
 PB 0
 ZR =PI A=BROKEN BOW B=BBLAKE C=PRECIP-INC F=ADJUST
 UI 7750
 KK BOW-IN COMBINE
 HC 3
 ZW A=LITTLE B=BROK C=FLOW-RES IN F=CALC
 KK BOWOUT OUTFLOW
 BA 1
 ZR =-QI A=POSITIVE B=BROK C=FLOW-RES OUT F=OBS
 KK 2 COMBINE
 HC 2
 KK BBOW INFLOW HYDROGRAPH ROUTED THROUGH THE LAKE
 * R BROKEN BOW LAKE
 RS 1 ELEV 599.50
 SV 448250 555990 666380 789330 925180 968600 1013320 1059280 1106390 1154620
 SV 1204E3 1254580 1306320 1359280 1413510 1469100 1526220 1584970 1604980
 SE 559 570 580 590 600 603 606 609 612 615
 SE 618 621 624 627 630 633 636 639 640
 SQ 0 0
 SE 559 640
 ZW A=LITTLE B=BROK C=ELEV F=CALC
 ZZ

RED RIVER WATERSHED

MOUNTAIN FORK RIVER, OK

BROKEN BOW LAKE

**SAMPLE INPUT
FOR HEC-1 MODEL**

DEPARTMENT OF THE ARMY, TULSA DISTRICT, CORPS OF ENGINEERS 1996

DRAWN BY: J.O.C.

CHECKED BY: R.W.B.

TABLE 1			STATION	MF	BB	BOW-IN	BBOW	BOWOUT
PER	DAY	MON	HR	EXCESS	EXCESS	FLOW	STAGE	FLOW
1	2	SEP	0000	.00	.00	.00	599.50	.00
2	2	SEP	0200	.00	.00	.00	599.50	.00
3	2	SEP	0400	.00	.00	.00	599.50	.00
4	2	SEP	0600	.00	.00	.00	599.50	.00
5	2	SEP	0800	.00	.00	.00	599.50	.00
6	2	SEP	1000	.00	.00	.00	599.50	.00
7	2	SEP	1200	.00	.00	.00	599.50	.00
8	2	SEP	1400	.00	.00	.00	599.50	.00
9	2	SEP	1600	.00	.00	.00	599.50	.00
10	2	SEP	1800	.00	.00	.00	599.50	.00
11	2	SEP	2000	.00	.00	.00	599.50	.00
12	2	SEP	2200	.00	.00	.00	599.50	.00
13	3	SEP	0000	.00	.00	.00	599.50	.00
14	3	SEP	0200	.00	.00	.00	599.50	.00
15	3	SEP	0400	.00	.00	.00	599.50	.00
16	3	SEP	0600	.25	.25	5026.91	599.53	.00
17	3	SEP	0800	.50	.50	16120.94	599.66	.00
18	3	SEP	1000	.25	.25	22427.75	599.89	.00
19	3	SEP	1200	.00	.00	21523.42	600.15	.00
20	3	SEP	1400	.00	.00	20723.73	600.39	.00
21	3	SEP	1600	.00	.00	24586.95	600.65	.00
22	3	SEP	1800	.00	.00	26597.71	600.94	.00
23	3	SEP	2000	.00	.00	26032.78	601.24	.00
24	3	SEP	2200	.00	.00	23003.55	601.52	.00
25	4	SEP	0000	.00	.00	18739.71	601.76	.00
26	4	SEP	0200	.00	.00	14782.23	601.95	.00
27	4	SEP	0400	.00	.00	11679.62	602.10	.00
28	4	SEP	0600	.00	.00	9298.43	602.22	.00
29	4	SEP	0800	.00	.00	7856.92	602.32	.00
30	4	SEP	1000	.00	.00	7405.90	602.41	.00
31	4	SEP	1200	.00	.00	6980.77	602.49	.00
32	4	SEP	1400	.00	.00	6580.05	602.57	.00
33	4	SEP	1600	.00	.00	6202.33	602.64	.00
34	4	SEP	1800	.00	.00	5846.29	602.71	.00
35	4	SEP	2000	.00	.00	5510.69	602.78	.00
36	4	SEP	2200	.00	.00	5194.35	602.84	.00
37	5	SEP	0000	.00	.00	4896.18	602.89	.00
38	5	SEP	0200	.00	.00	4615.12	602.95	.00
39	5	SEP	0400	.00	.00	4350.19	603.00	.00
40	5	SEP	0600	.00	.00	4100.47	603.05	.00
			MAX	.50	.50	26597.71	603.79	.00
			MIN	.00	.00	.00	599.50	.00
			AVE	.01	.01	3754.74	602.54	.00

RED RIVER WATERSHED

MOUNTAIN FORK RIVER, OK

BROKEN BOW LAKE

**SAMPLE SUMMARY OUTPUT
FROM HEC-1 MODEL**

DEPARTMENT OF THE ARMY, TULSA DISTRICT, CORPS OF ENGINEERS 1996

DRAWN BY: J.O.C.

CHECKED BY: R.W.B.

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	MF	23421.	42.00	22386.	14388.	6811.	596.00		
HYDROGRAPH AT	BB	14230.	34.00	10362.	5025.	2490.	130.00		
HYDROGRAPH AT	LAKE	3875.	32.00	2260.	646.	215.	24.00		
3 COMBINED AT	BOW-IN	26598.	42.00	25475.	19448.	9478.	750.00		
HYDROGRAPH AT	BOWOUT	0.	2.00	0.	0.	0.	1.00		
2 COMBINED AT	2	26598.	42.00	25475.	19448.	9478.	751.00		
ROUTED TO	BBOW	0.	2.00	0.	0.	0.	751.00	603.79	198.00

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK

BROKEN BOW LAKE

SAMPLE SUMMARY OUTPUT
FROM HEC-1 MODEL

DEPARTMENT OF THE ARMY, TULSA DISTRICT, CORPS OF ENGINEERS 1996

DRAWN BY: J.O.C.

CHECKED BY: R.W.B.

BROKEN BOW LAKE DISCHARGE AND INFLOW COMPUTATION

COMPUTED BY: JOC DATE : JUN 96 CHECKED BY : DATE : BOOK NO.

DATE	TIME	POOL ELEVATION	Σ STORAGE (1000'S A.F.)	Δ STORAGE		GATES OPERATING		DISCHARGE IN c.f.s.							INFLOW		
				ACRE FEET	c.f.s.	NO. & TYPE	OPENING	INSTANTANEOUS			AVERAGE						
								FLOOD CONTROL	POWER	TOTAL	FLOOD CONTROL	POWER	EVAP.	TOTAL			
22	2400	601.88	952.242			1 LF	1.25%	14									
23	0800	602.73	964.653						1359	1373							
	1200	603.02	974.365														
	1600	604.35	988.585												.12		
	2400	606.68	1023.649	24/71407	24/36001	1 LF	1.25%	14	0	14			24/560	52	626	24/3662	
24	0800	607.33	1033.566														
	1200	607.55	1036.936														
	1600	607.74	1039.847												.22		
	2400	608.04	1044.448	24/20799	24/10486	1 LF	1.25%	14	0	14			24/0	99	113	24/10599	
25	0800	608.25	1047.693	08/4200	08/6300												

(1) (2) (3) (4) (5) (6) (7)

- (1) RESERVOIR CAPACITY TABLE.
- (2) SUBTRACT STORAGE AT BEGINNING OF PERIOD FROM STORAGE AT END OF PERIOD. IF POOL IS RISING, CHANGE IN STORAGE IS POSITIVE (+), IF FALLING NEGATIVE (-).
- (3) $\frac{\text{CHANGE IN STORAGE (A.F.)} \times 12}{\text{NO. OF HOURS IN PERIOD}}$ - CHANGE IN STORAGE IN C.F.S.
- (4) FROM DISCHARGE RATING CURVES.
- (5) AVERAGE DISCHARGE DURING PERIOD.
- (6) PAN EVAPORATION APPLIED TO EVAPORATION CURVES.
- (7) $\text{INFLOW} + \text{CHANGE IN STORAGE (C.F.S.)} + \text{AVERAGE DISCHARGE} - \text{EVAPORATION}$.

NOTE : DURING FLOOD PERIODS EVAPORATION IS USUALLY NEGLECTED IN PRELIMINARY INFLOW CALCULATIONS. NUMBER OF HOURS FOR THE INFLOW PERIOD IS INDICATED BY

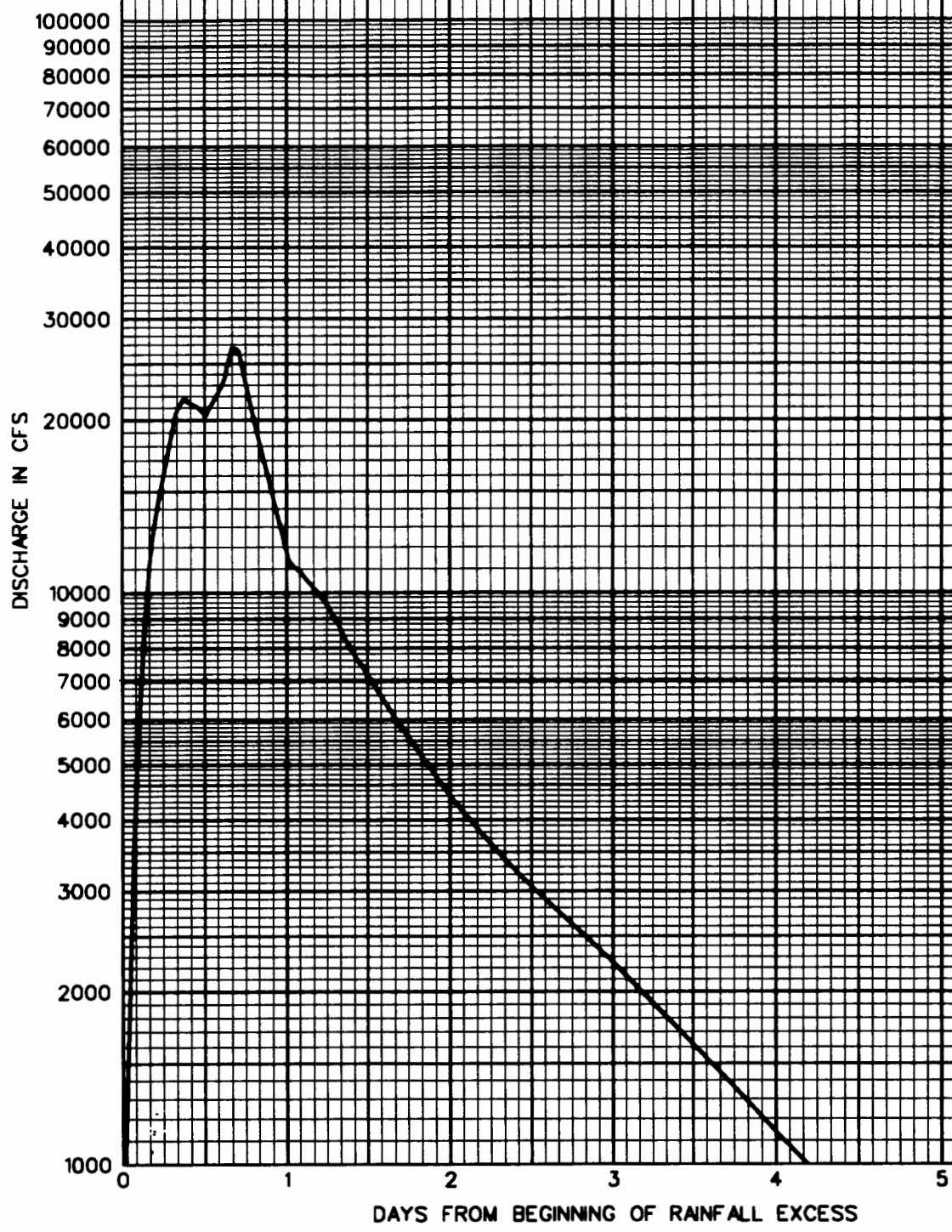
4/

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK

BROKEN BOW LAKE

SAMPLE DISCHARGE AND INFLOW COMPUTATION

Department of the Army, Tulsa District, Corps of Engineers 1996
 DRAWN BY: J.O.C.
 CHECKED BY: R.W.B.



DATA BASED ON:

DRAINAGE AREA - 754 SQ. MI.
 1" RUNOFF - 40,213 AC-FT
 2 HOUR UNIT HYDROGRAPH

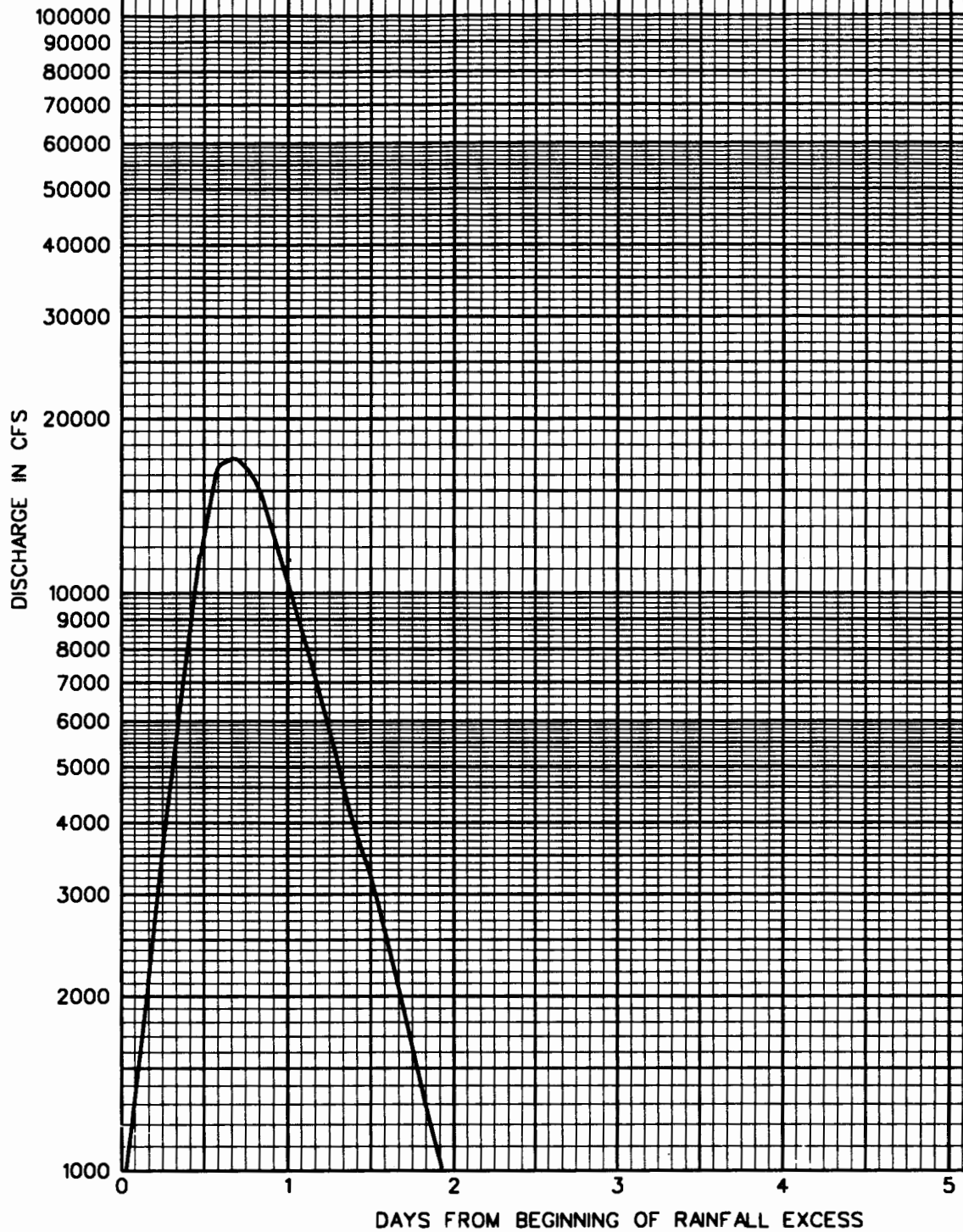
NOTE:

UNIT HYDROGRAPH OBTAINED BY APPLYING ONE INCH OF RUNOFF IN A TWO HOUR PERIOD TO THE FORECAST MODEL.

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

UNIT HYDROGRAPH
 FOR AREA ABOVE LAKE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C..
 CHECKED: R.W.B.



DATA BASED ON:

DRAINAGE AREA - 513 SQ. MI.
 1" RUNOFF - 27,360 AC-FT
 2 HOUR UNIT HYDROGRAPH

NOTE:

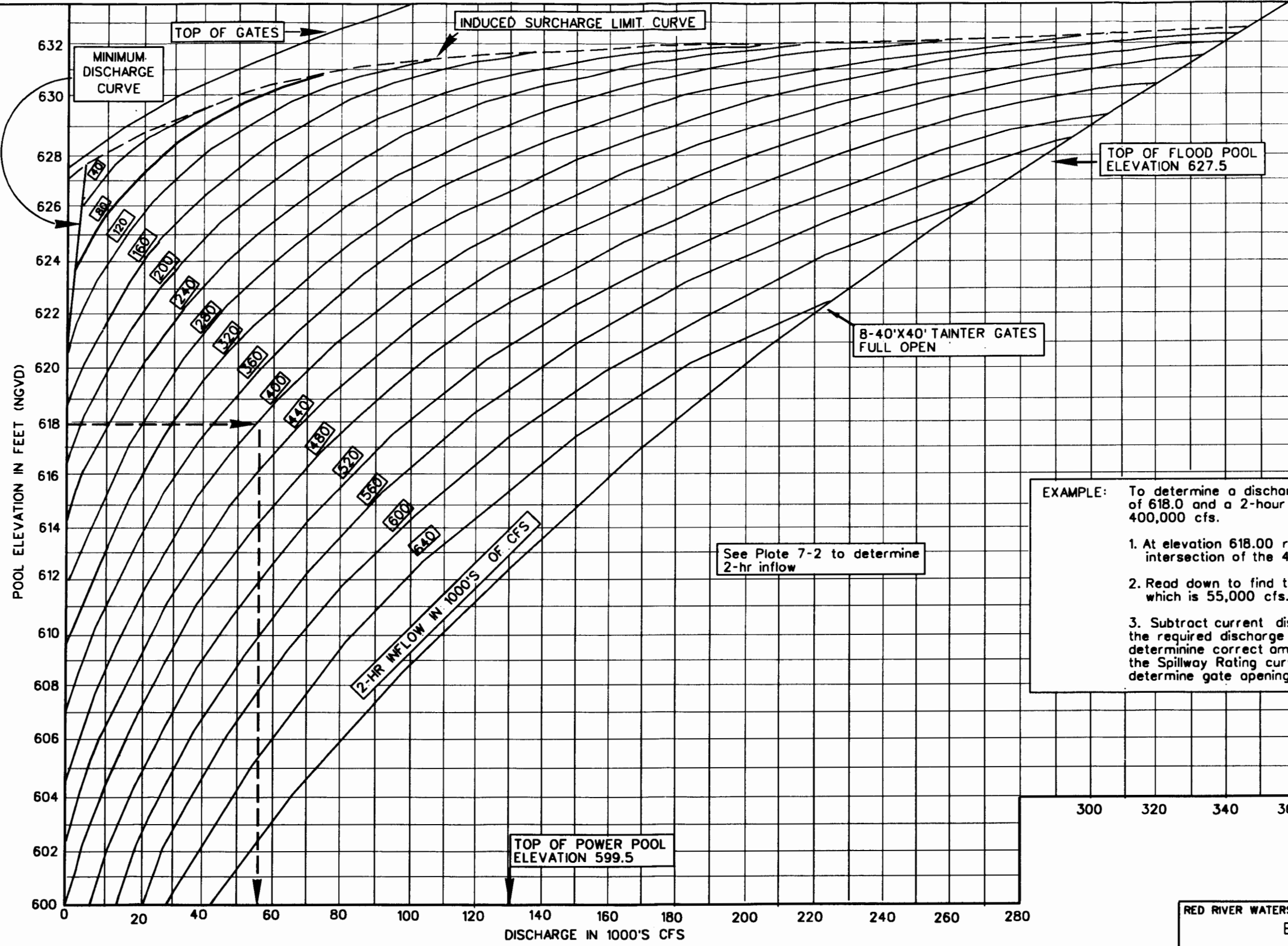
UNIT HYDROGRAPH OBTAINED BY APPLYING ONE INCH OF RUNOFF IN A TWO HOUR PERIOD TO THE FORECAST MODEL.

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

UNIT HYDROGRAPH

FOR AREA ABOVE HORATIO & BELOW IDABEL, BROKEN BOW DAM, AND DEQUEEN

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C..
 CHECKED: R.W.B.



EXAMPLE: To determine a discharge with a pool elevation of 618.0 and a 2-hour computed inflow of 400,000 cfs.

1. At elevation 618.00 read across to the intersection of the 400,000 inflow curve.
2. Read down to find the needed discharge which is 55,000 cfs.
3. Subtract current discharge from the required discharge of 55,000 cfs to determine correct amount of total spill. Use the Spillway Rating curve (Plate 7-5) to determine gate opening.

300 320 340 360

TOP OF POWER POOL
ELEVATION 599.5

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
 BROKEN BOW LAKE

**SPILLWAY GATE
 REGULATION SCHEDULE
 INFLOW PARAMETER**

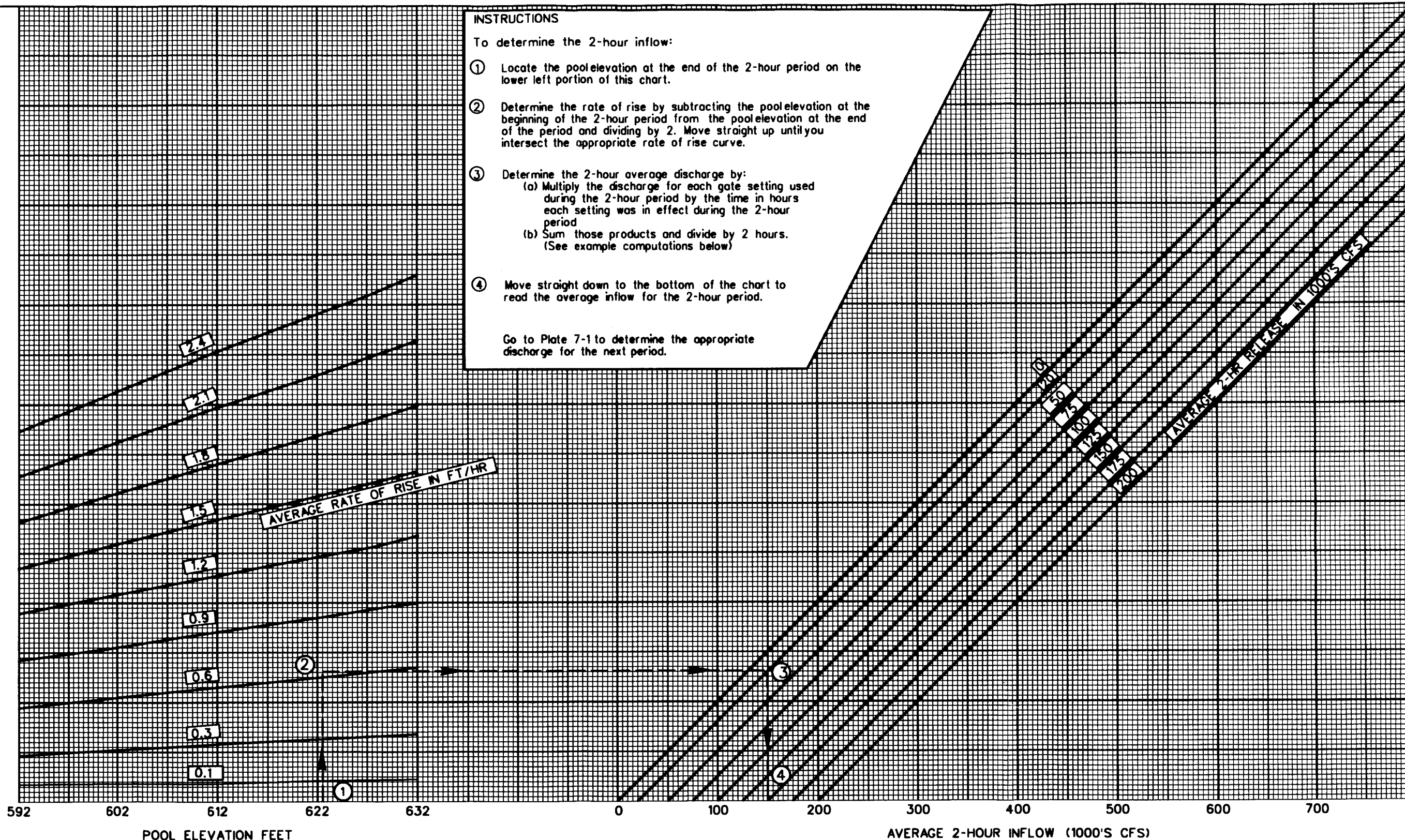
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1997
 DRAWN: J.O.C.
 CHECKED: R.W.B.

INSTRUCTIONS

To determine the 2-hour inflow:

- ① Locate the pool elevation at the end of the 2-hour period on the lower left portion of this chart.
- ② Determine the rate of rise by subtracting the pool elevation at the beginning of the 2-hour period from the pool elevation at the end of the period and dividing by 2. Move straight up until you intersect the appropriate rate of rise curve.
- ③ Determine the 2-hour average discharge by:
 - (a) Multiply the discharge for each 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 example computations below)
- ④ 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 622.50 feet. Two hours ago the elevation was 621.25 feet.
- ② Rate of rise = $(622.50 - 621.25) / 2 \text{ hrs} = 1.25 \text{ feet} / 2 \text{ hrs} = 0.625 \text{ ft/hr}$
- ③ Releases for last two hours were:

1.0 hr at 15,000 cfs
1.0 hr at 25,000 cfs

Average 2-hour release = $(15,000 \text{ cfs} + 25,000 \text{ cfs}) / 2 = 40,000 \text{ cfs} / 2 = 20,000 \text{ cfs}$ average 2 hour inflow
- ④ The resulting 2-hour inflow is 150,000 cfs.

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OKLAHOMA
BROKEN BOW LAKE

**INFLOW VS. RATE OF RISE
NOMOGRAPH**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1997
DRAWN: J.O.C.
CHECKED: R.W.B.

WATER SUPPLY STORAGE ACCOUNTING
BROKEN BOW LAKE

TOTAL CONSERVATION STORAGE 469,820

(ALL VALUES ARE IN ACRE-FEET)

TOTAL CONSERVATION STORAGE 469820
 UN-CONTRACTED STORAGE 144145
 CONTRACT STORAGE USER # 1 8295, CITY OF BROKEN BOW
 CONTRACT STORAGE USER # 2 60, OK TOURISM
 CONTRACT STORAGE USER # 3 317320, HYDROPOWER

PERIOD MO/YR	USER	BEGINNING STORAGE	INFLOW SHARE	TOTAL LOSSES	WITH- DRAWN	ENDING STORAGE
7/95	LAKE	422839	600	-7158	31250	399347
	U-C	129731	184	-2279	0	132195
	1	7466	11	-120	1200	6397
	2	54	0	0	50	5
	3	285588	405	-4755	30000	260750

RED RIVER WATERSHED

MOUNTAIN FORK RIVER, OK

BROKEN BOW LAKE

**WATER SUPPLY STORAGE
ACCOUNTING EXAMPLE**

DEPARTMENT OF THE ARMY, TULSA DISTRICT, CORPS OF ENGINEERS 1996

DRAWN BY: J.O.C.

CHECKED BY: R.W.B.

Mail to: Southwestern Division
ATTN: SWDED-WR

RECORD OF DEVIATION FROM APPROVED
WATER CONTROL PLAN

DATE _____

DEVIATION _____
(Lake, Reservoir, or System)

1. This is to confirm the following verbal request from

_____ to _____ via
(Name) (Name)

telephone for approval for a deviation from the approved water control
plan.

2. _____

SWD 898
1 NOV 77

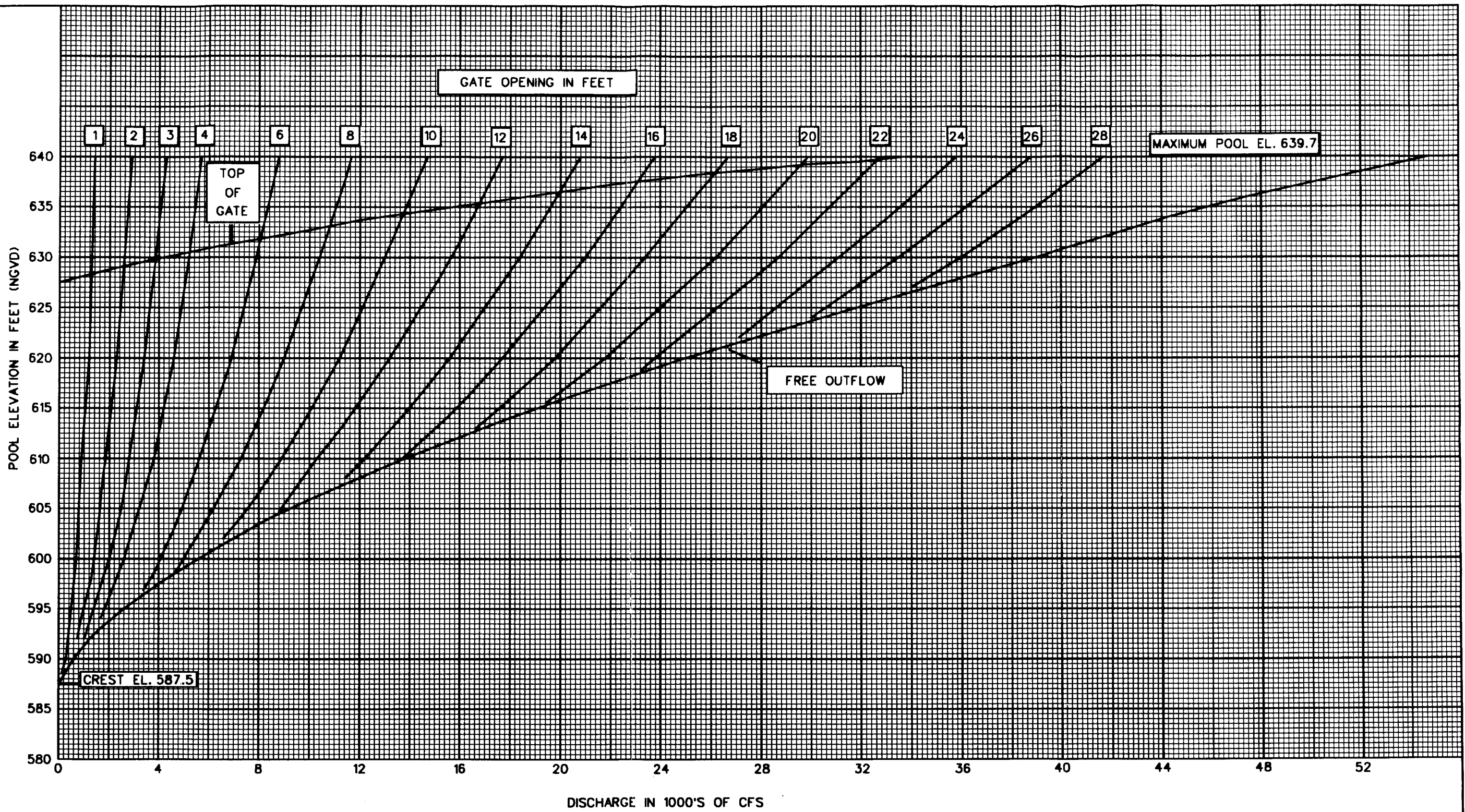
RED RIVER WATERSHED

MOUNTAIN FORK RIVER, OK

BROKEN BOW LAKE

RECORD OF DEVIATION
FROM APPROVED PLAN

DEPARTMENT OF THE ARMY, TULSA DISTRICT, CORPS OF ENGINEERS 1996
DRAWN BY: J.O.C.
CHECKED BY: R.W.B.



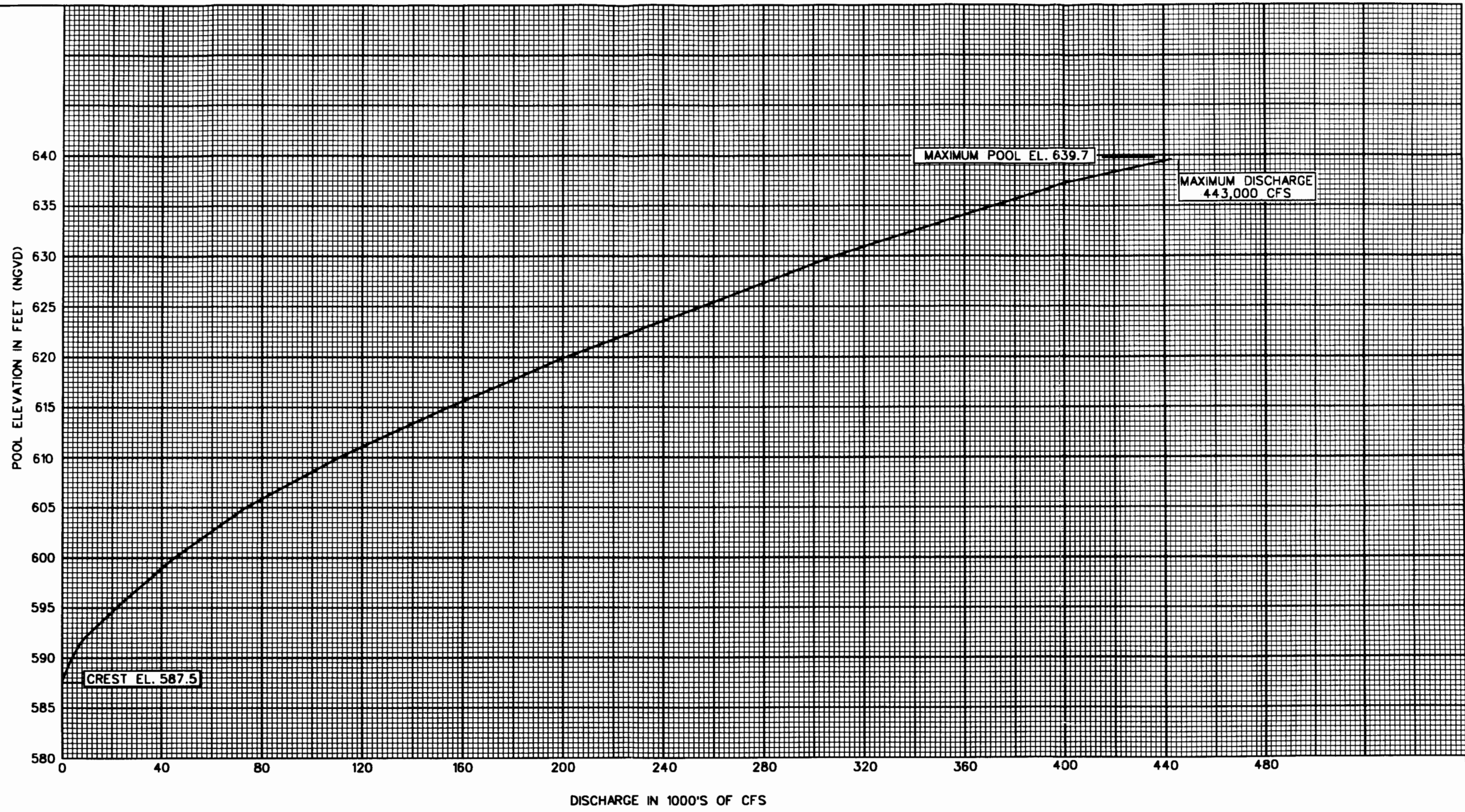
NOTE:

RATING IS FOR 1-40'X40' GATE

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
 BROKEN BOW LAKE

SPILLWAY RATING CURVE
 PARTIAL & FULL GATE OPENINGS
 (1 GATE)

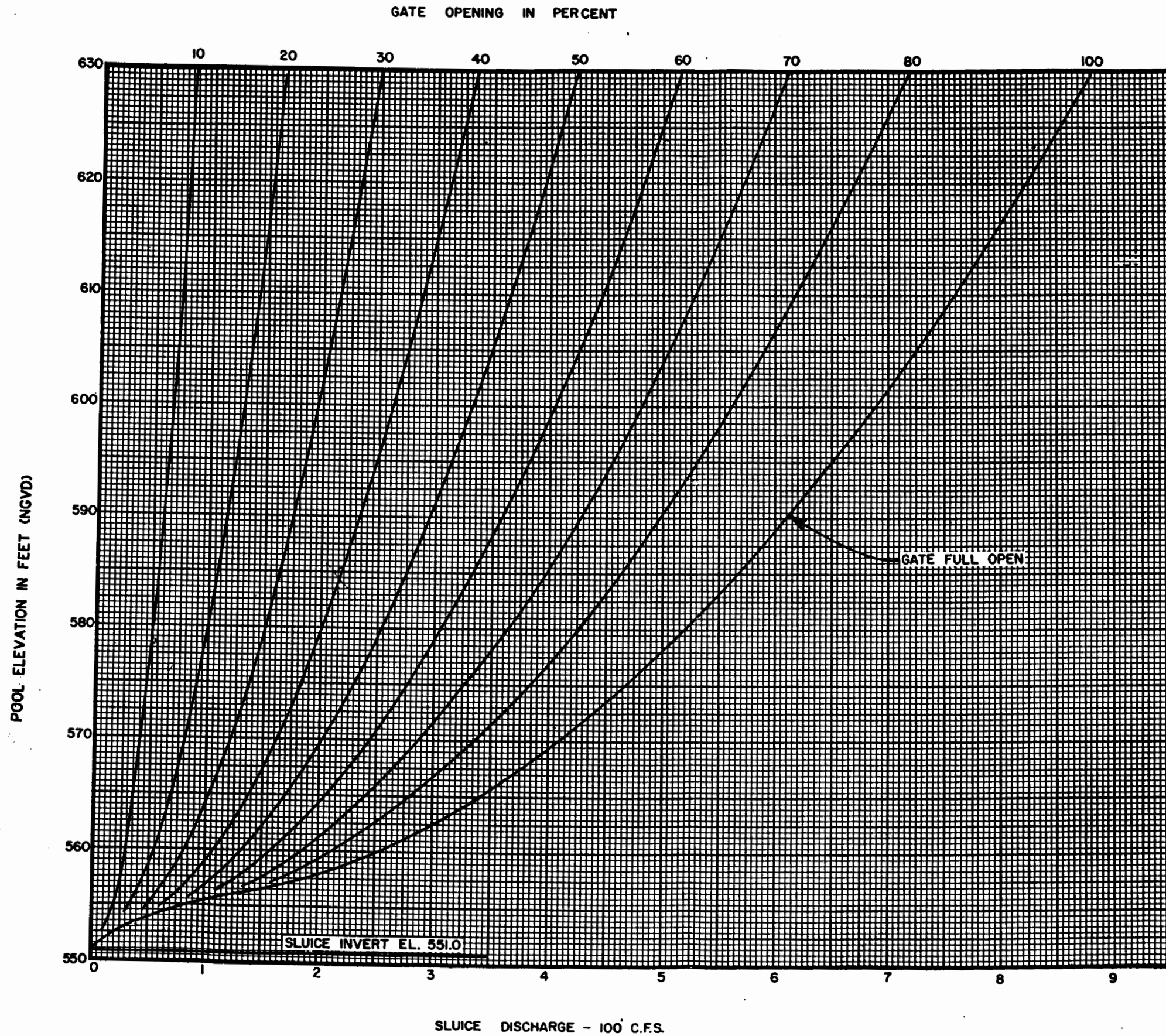
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C.
 CHECKED: R.W.B.



NOTE:

RATING IS FOR 8-40'X40' GATES

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE
 SPILLWAY RATING CURVE
 FULL GATE OPENINGS
 (8 GATES)
 DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C.
 CHECKED: R.W.B.



RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
 BROKEN BOW LAKE

**SPILLWAY SLUICE
 RATING CURVE
 FOR 4' x 4' SLUICE**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C.
 CHECKED: R.W.B.

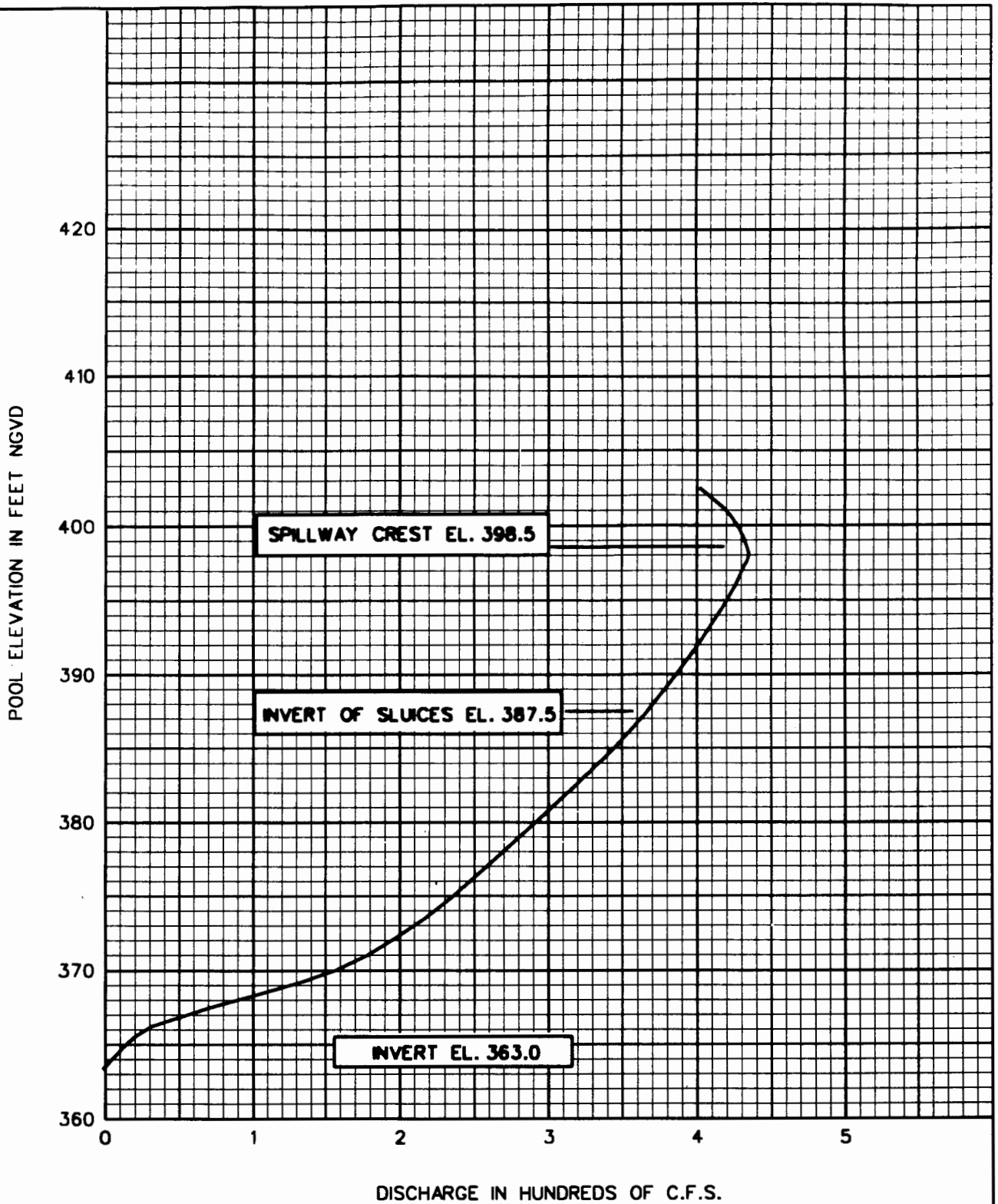


NOTES:

1. DIVERSION TUNNEL LOCATED IN LEFT BANK.
2. 17-FOOT CONCRETE TUNNEL.
3. FOUR 5'X7' SLIDE GATES.
4. TWO SLIDE GATES IN TANDEM IN EACH OPENING.

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
 BROKEN BOW LAKE

**LOW LEVEL OUTLET
 (DIVERSION TUNNEL)
 RATING CURVE
 2-5'X7' OPENINGS**

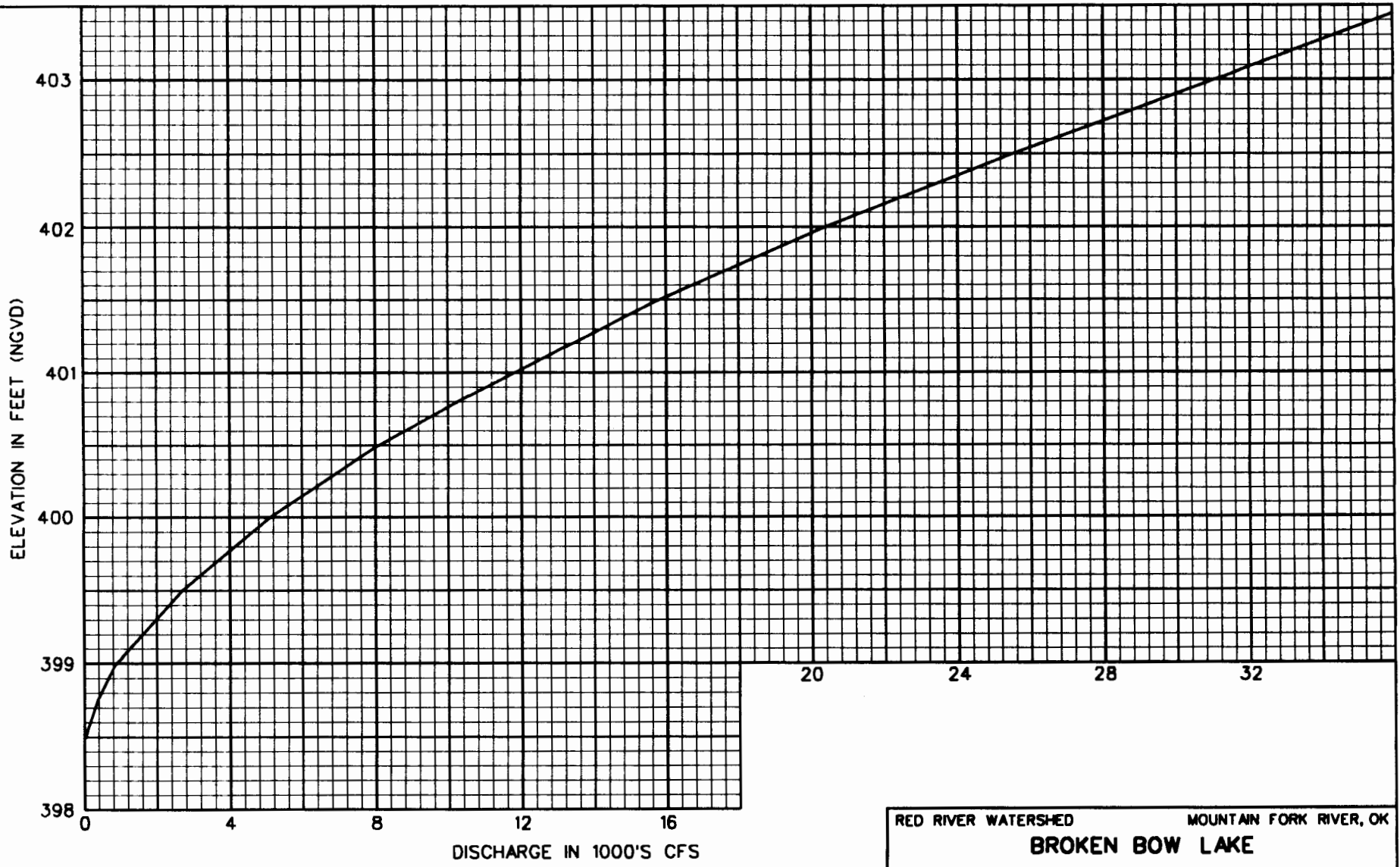


NOTE:

CURVE IS BASED UPON 4-24" UNOBSTRUCTED PIPES. ACTUAL EFFECTIVE FLOW WITH CURRENT 1996 BLOCKAGE IS ESTIMATED TO VARY BETWEEN 97 -113 CFS WHEN THE REREGULATION POOL IS BETWEEN EL. 384.77 AND 387.00. FLOW FROM THE REREG STRUCTURE IS MEASURED AT EAGLETOWN.

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE
REREGULATION DAM
RATING CURVE
4-24" LOW FLOW PIPES

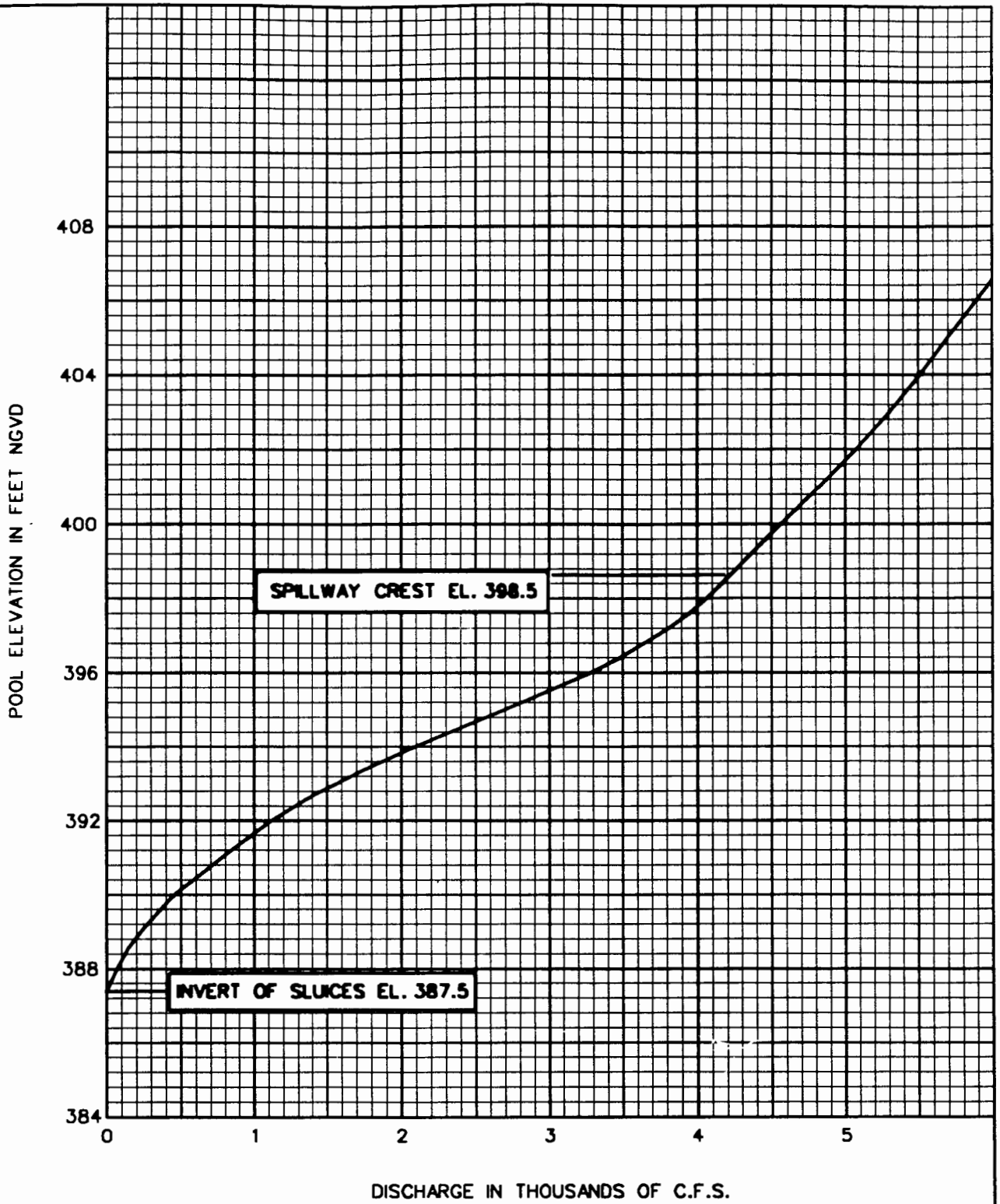
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C.
 CHECKED: R.W.B.



RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

REREGULATION DAM
SPILLWAY RATING CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C.
 CHECKED: R.W.B.

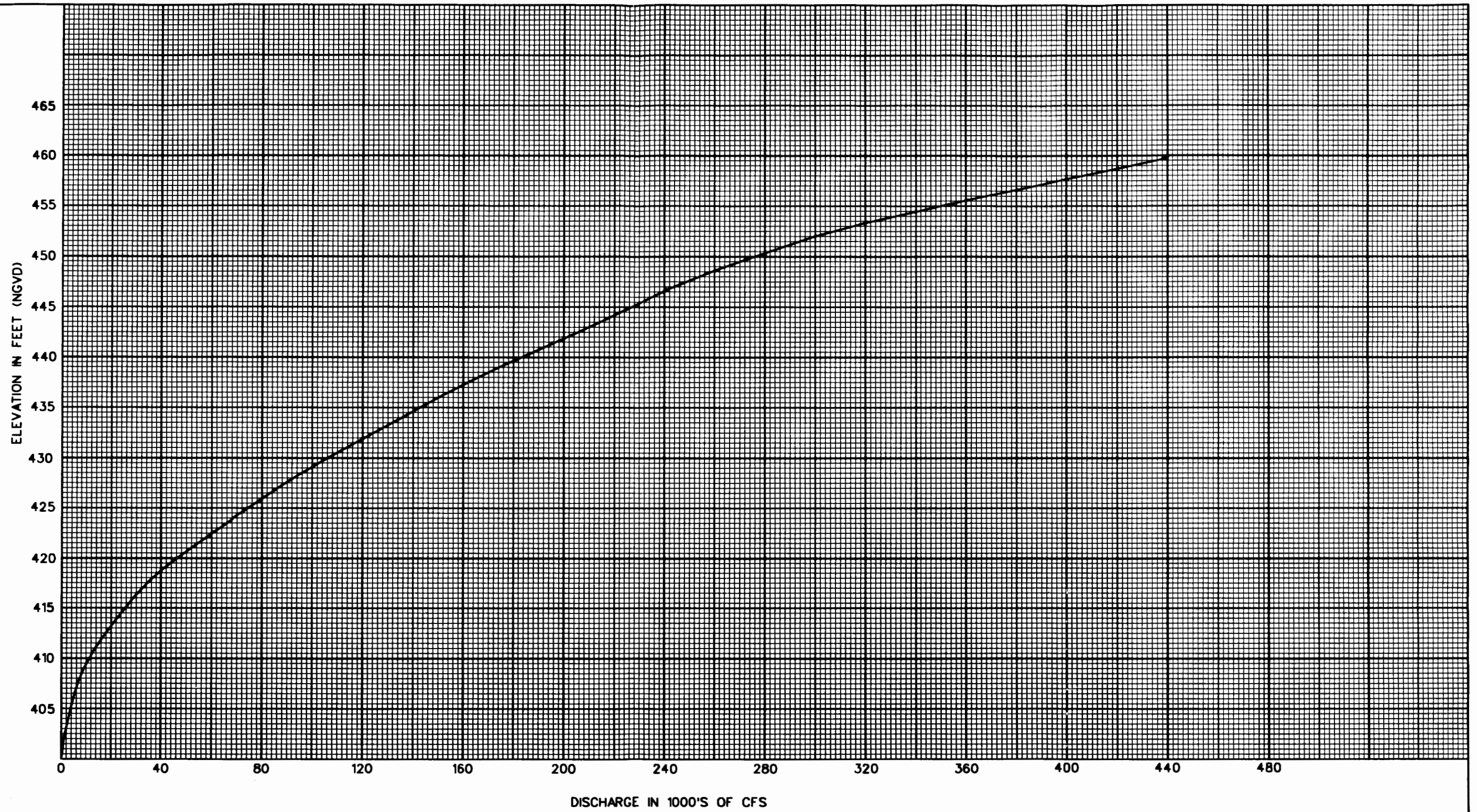


NOTE:
 RATING FOR 5-8.5' WIDE BY 5.0' HIGH SLUICES

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

REREGULATION DAM
 SLUICE RATING CURVE
 5-8.5' X 5.0' SLUICES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C.
 CHECKED: R.W.B.

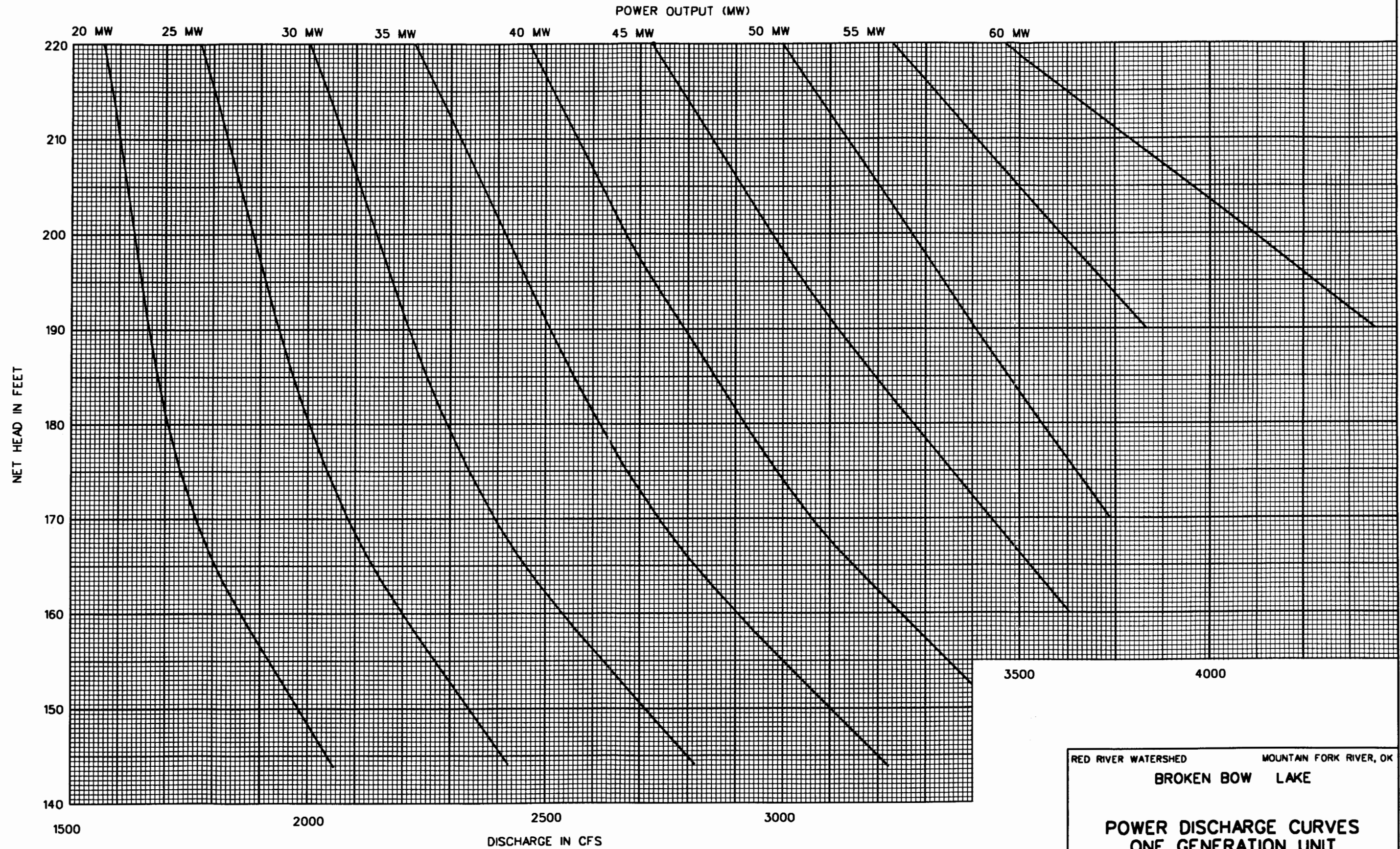


RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

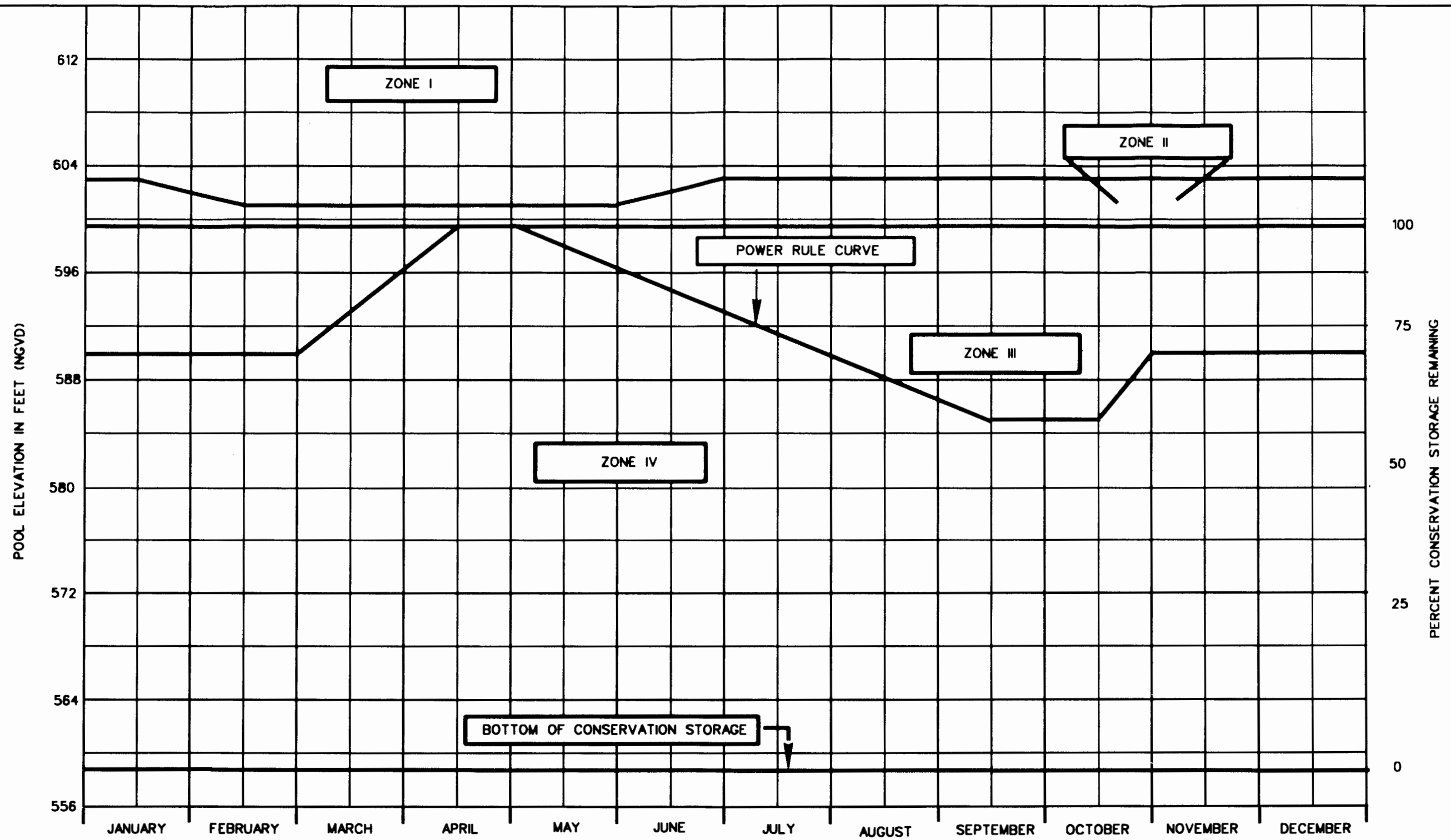
**TAILWATER RATING CURVE FOR
MOUNTAIN FORK**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: J.O.C.
CHECKED: R.W.B.

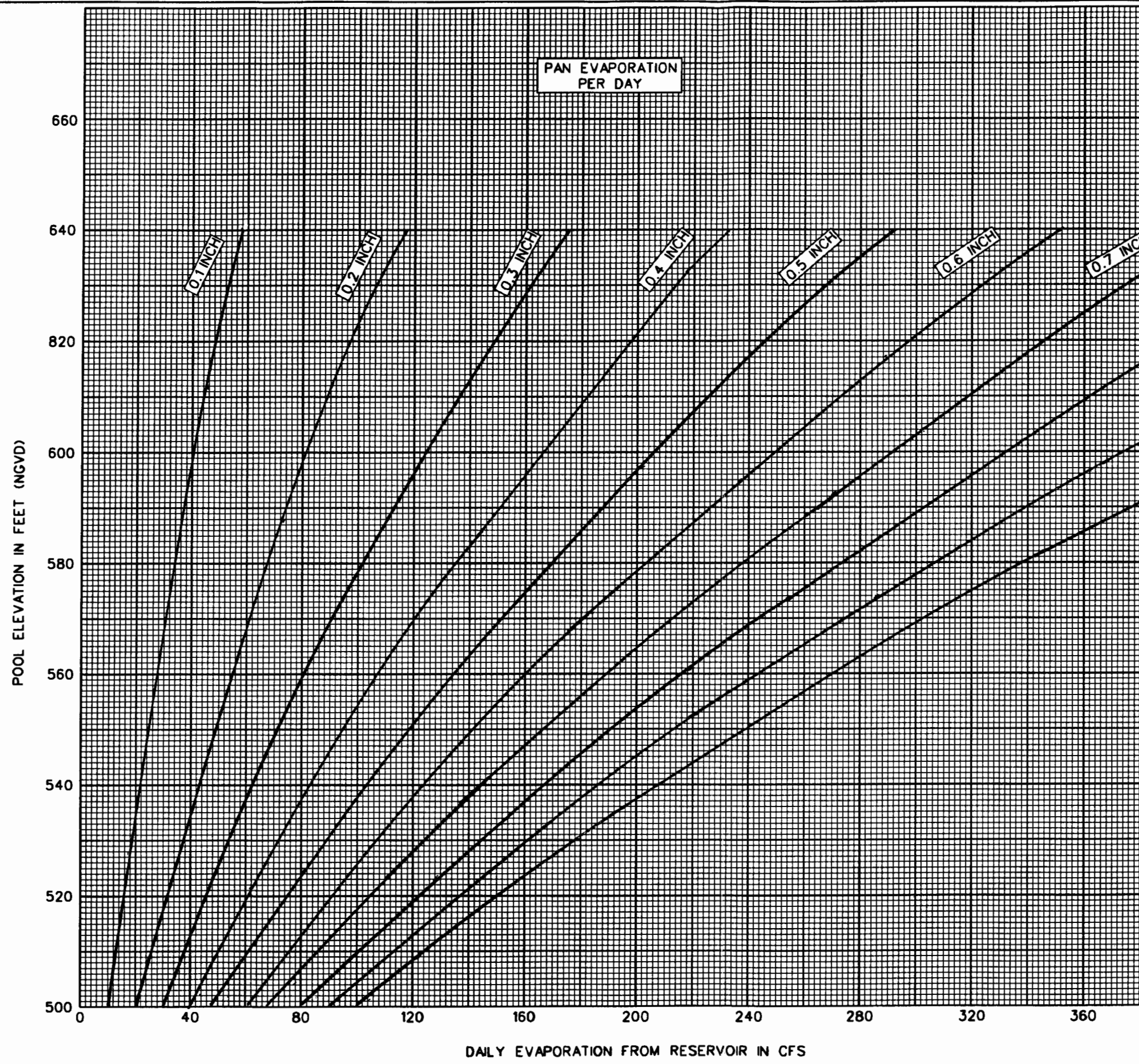
7-12



RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
 BROKEN BOW LAKE
**POWER DISCHARGE CURVES
 ONE GENERATION UNIT**
 DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C.
 CHECKED: R.W.B. 7-15



RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE
 OPERATIONAL GUIDE CURVES
 LAKE ZONES
 DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1997
 DRAWN: J.O.C.
 CHECKED: G.D.E. 7-14

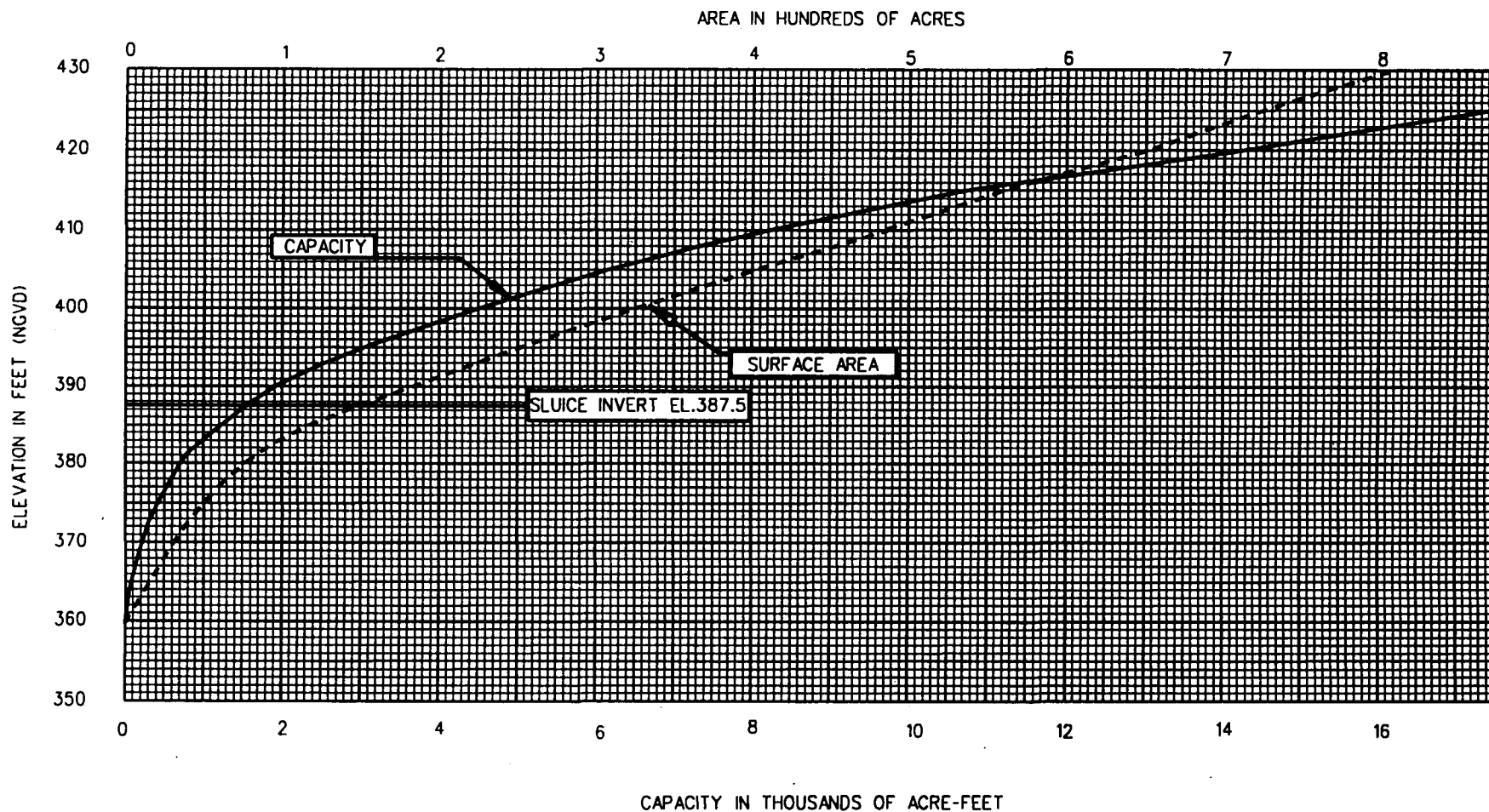


NOTE:
 CURVES COMPUTED FOR 70% OF
 N.W.S. CLASS "A" PAN EVAPORATION.

400 440 480 520

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
 BROKEN BOW LAKE

EVAPORATION CURVES



4-24" LOW FLOW PIPES

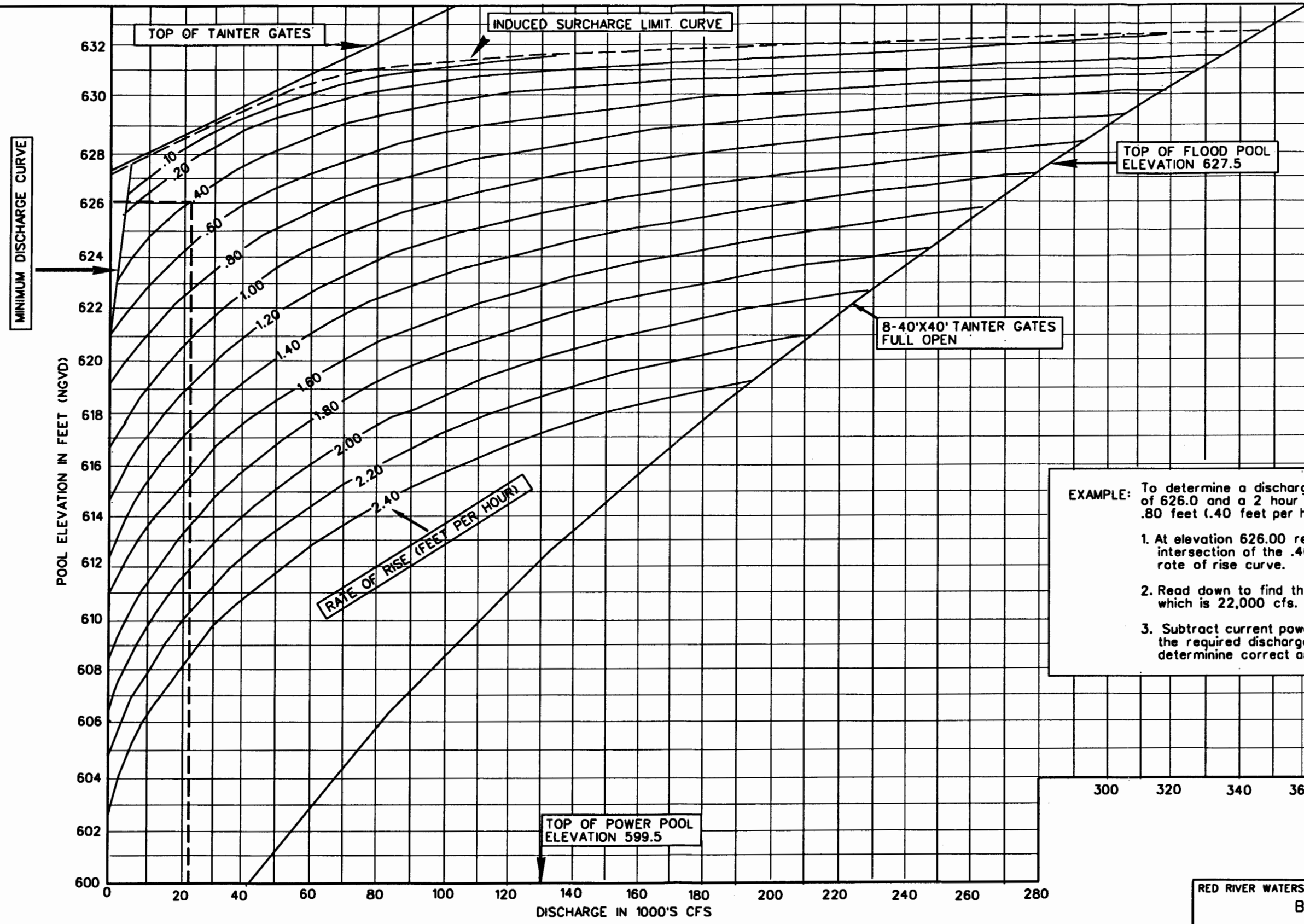
SPILLWAY CREST - EL 398.5

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK

BROKEN BOW LAKE

**REREGULATION DAM
AREA & CAPACITY CURVES**

DEPARTMENT OF THE ARMY, TULSA DISTRICT, CORPS OF ENGINEERS 1996
DRAWN BY: J.O.C.
CHECKED BY: R.W.B.



EXAMPLE: To determine a discharge with a pool elevation of 626.0 and a 2 hour observed rate of rise of .80 feet (.40 feet per hour).

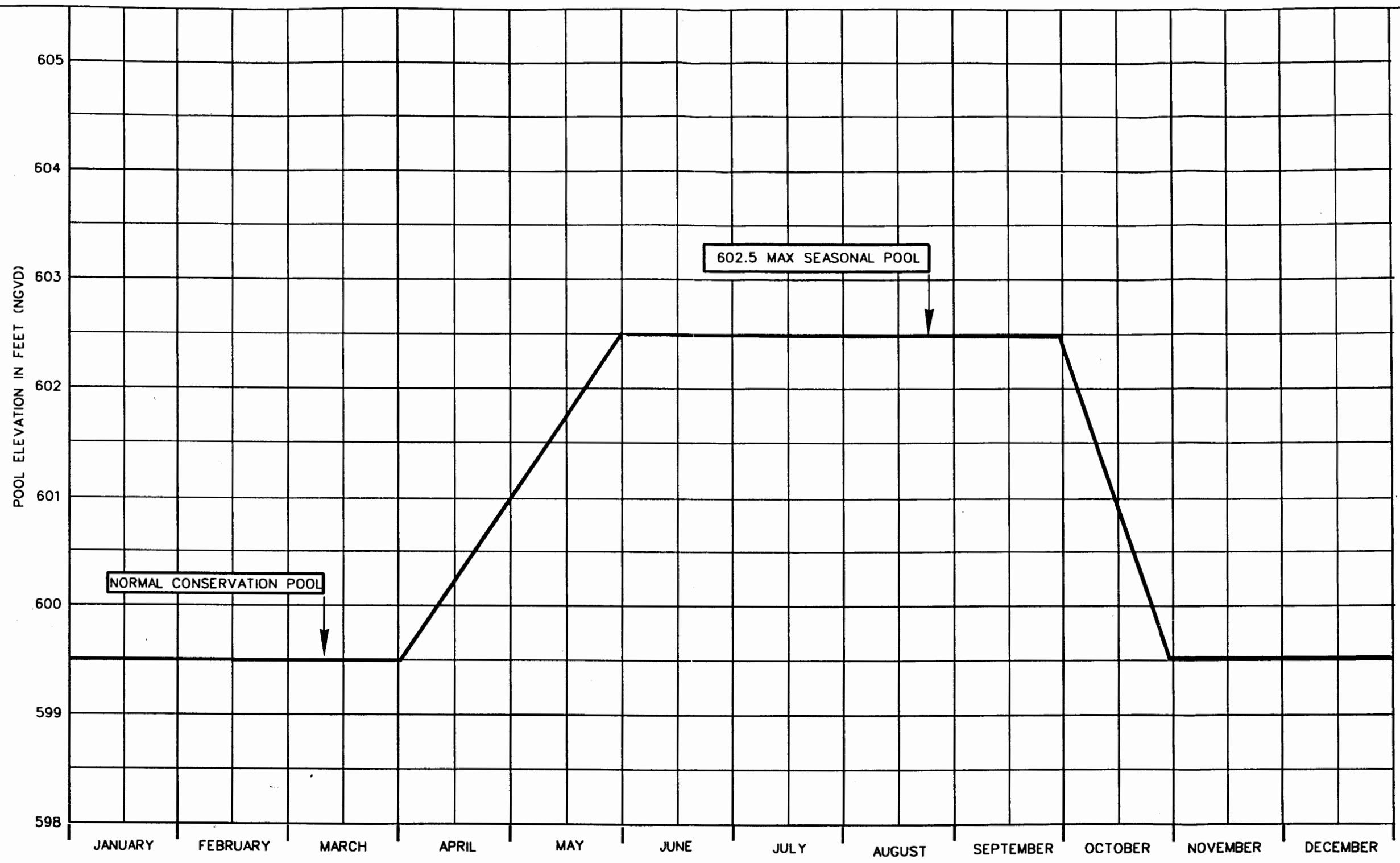
1. At elevation 626.00 read across to the intersection of the .40 feet per hour rate of rise curve.
2. Read down to find the needed total discharge which is 22,000 cfs.
3. Subtract current power discharge from the required discharge of 22,000 cfs to determine correct amount of total spill.

300 320 340 360

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
 BROKEN BOW LAKE

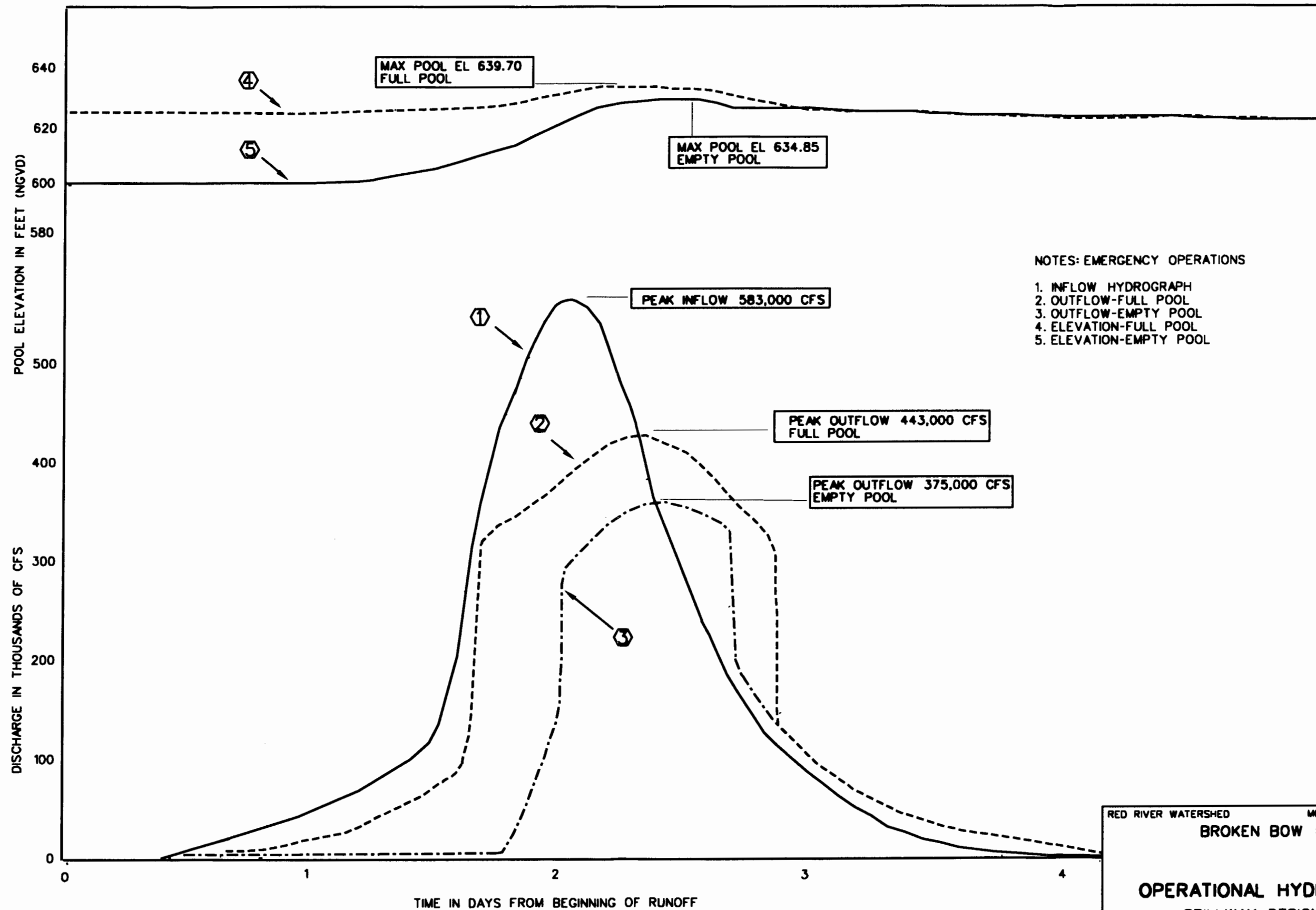
**SPILLWAY GATE
 REGULATION SCHEDULE
 RATE OF RISE PARAMETER**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1997
 DRAWN: J.O.C.
 CHECKED: R.W.B.



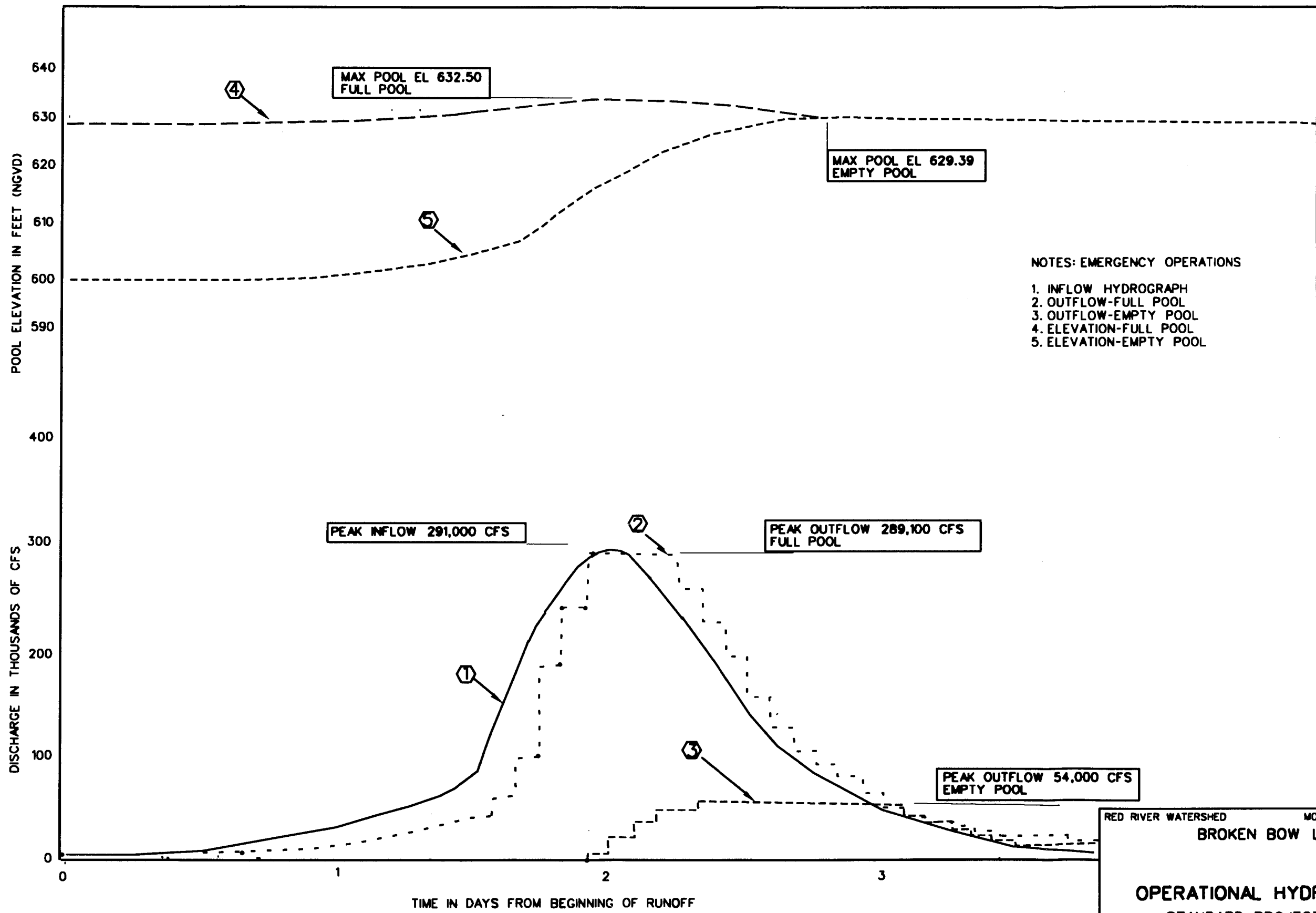
RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

**SEASONAL POOL OPERATION
 GUIDE CURVE**



NOTES: EMERGENCY OPERATIONS
 1. INFLOW HYDROGRAPH
 2. OUTFLOW-FULL POOL
 3. OUTFLOW-EMPTY POOL
 4. ELEVATION-FULL POOL
 5. ELEVATION-EMPTY POOL

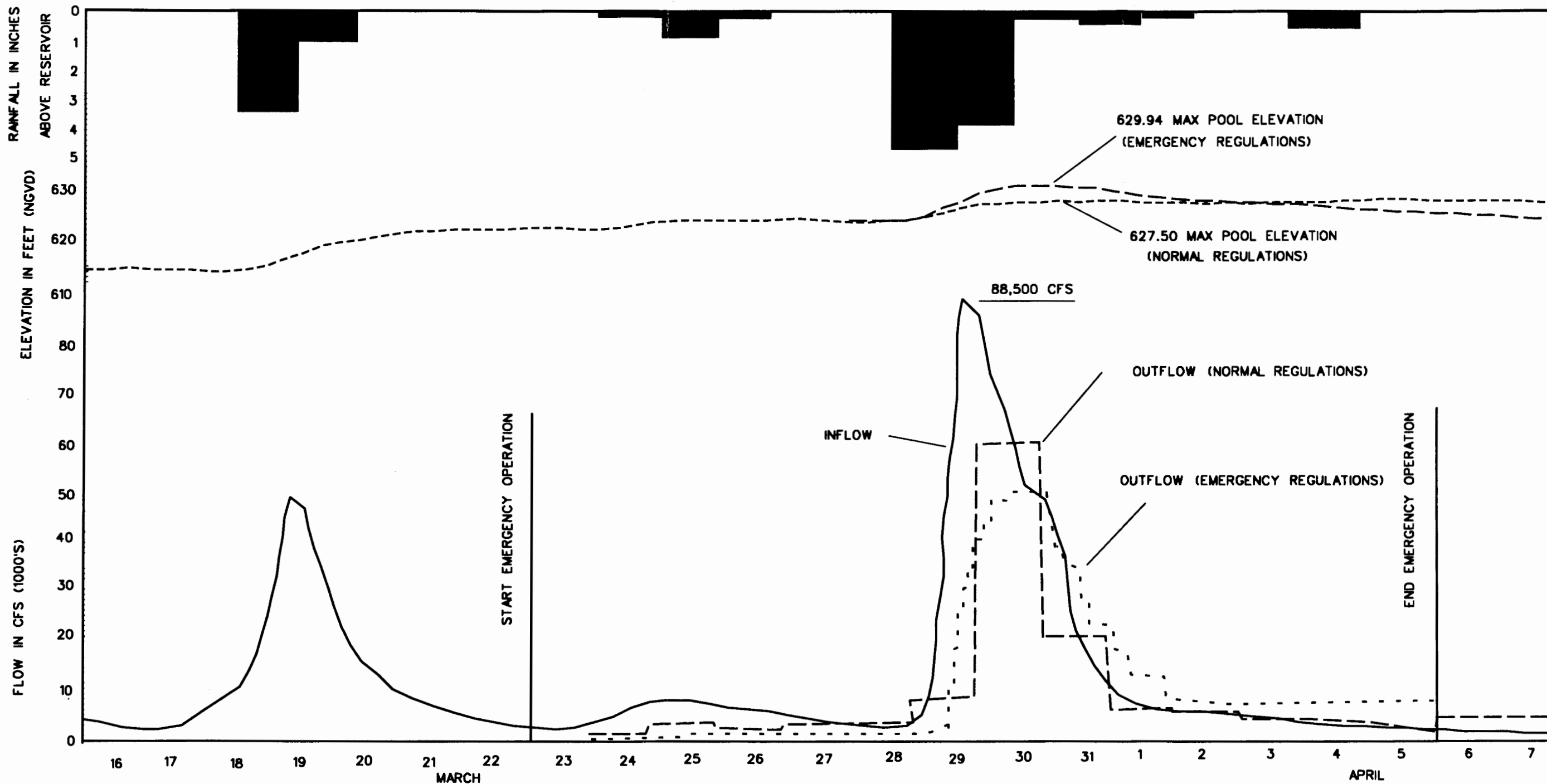
RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE
OPERATIONAL HYDROGRAPHS
 SPILLWAY DESIGN FLOOD
 DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C.
 CHECKED: R.W.B. 8-1



- NOTES: EMERGENCY OPERATIONS
1. INFLOW HYDROGRAPH
 2. OUTFLOW-FULL POOL
 3. OUTFLOW-EMPTY POOL
 4. ELEVATION-FULL POOL
 5. ELEVATION-EMPTY POOL

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
 BROKEN BOW LAKE

OPERATIONAL HYDROGRAPHS
 STANDARD PROJECT FLOOD
 (1/2 SPILLWAY DESIGN FLOOD)



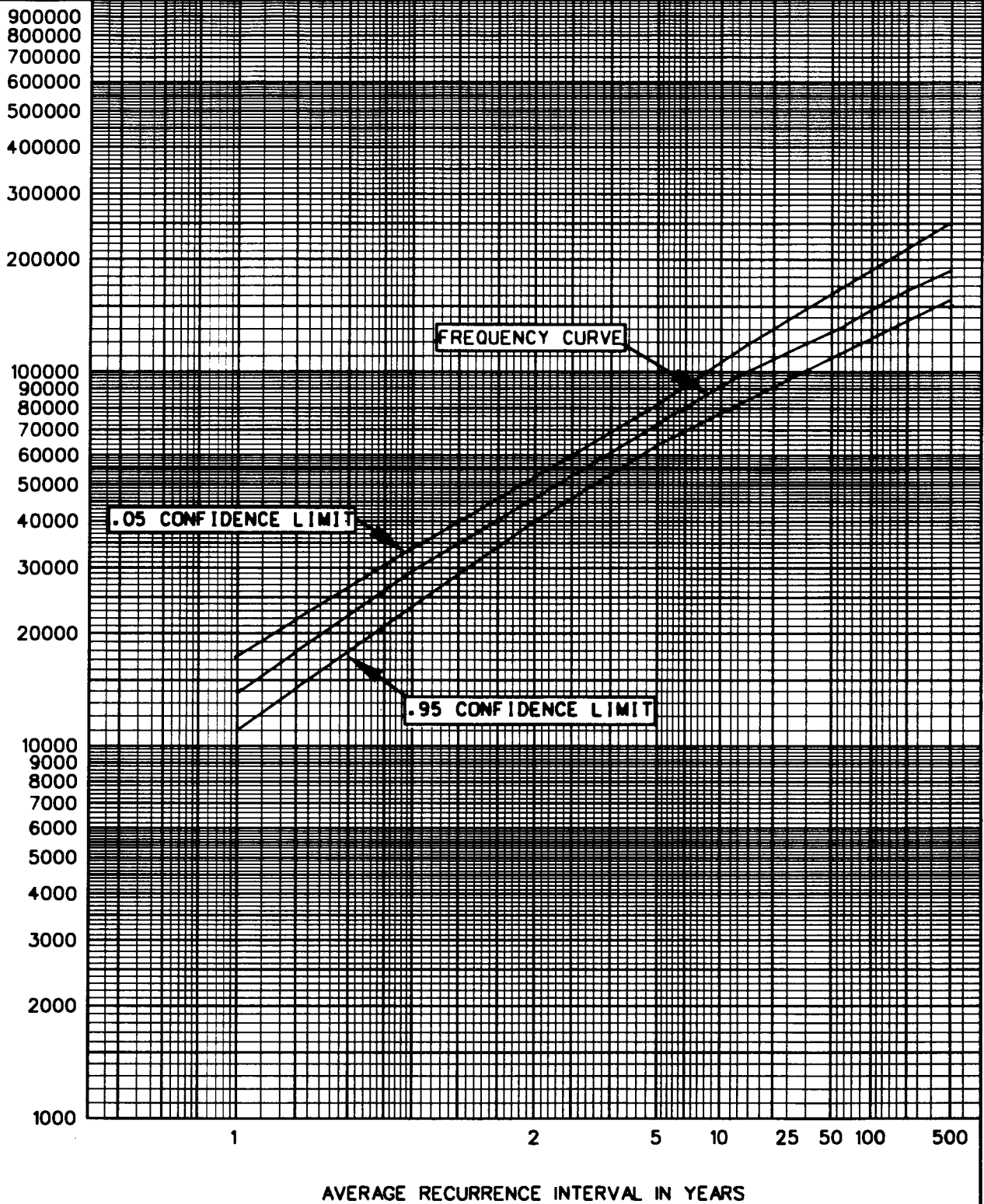
RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
 BROKEN BOW LAKE

**OPERATIONAL HYDROGRAPHS
 FLOOD OF MARCH-APRIL 1945**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1997
 DRAWN: J.O.C.
 CHECKED: R.W.B.

8-3

DISCHARGE IN CFS



— COMPUTED PEAK INFLOW PROBABILITY

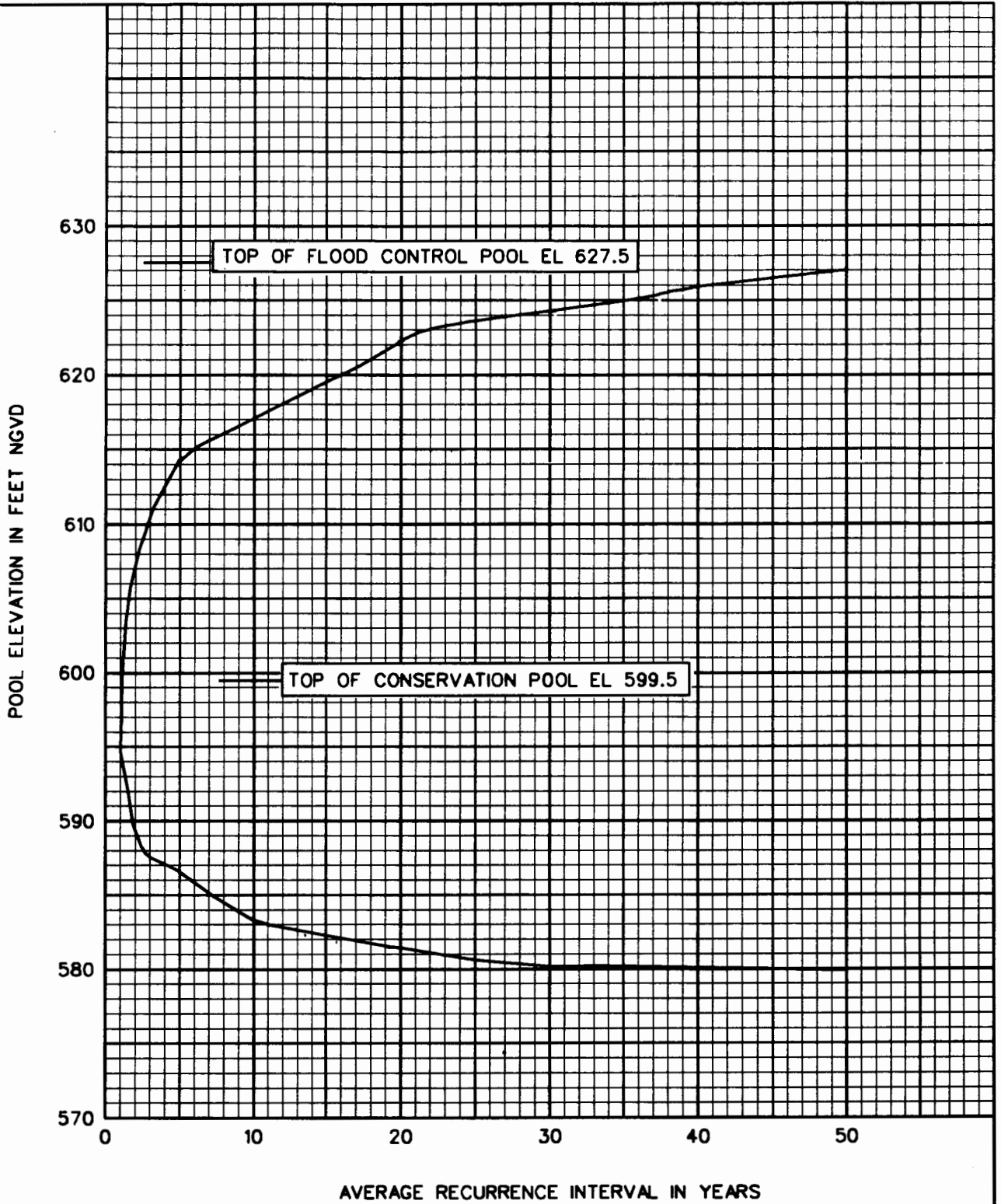
NOTE:

1. BASED ON PERIOD OF RECORD 1938 TO 1995.
2. ADOPTED SKEW COEFFICIENT OF -.40 WAS USED.

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

**PEAK INFLOW
PROBABILITY**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: J.O.C.
CHECKED: R.W.B.



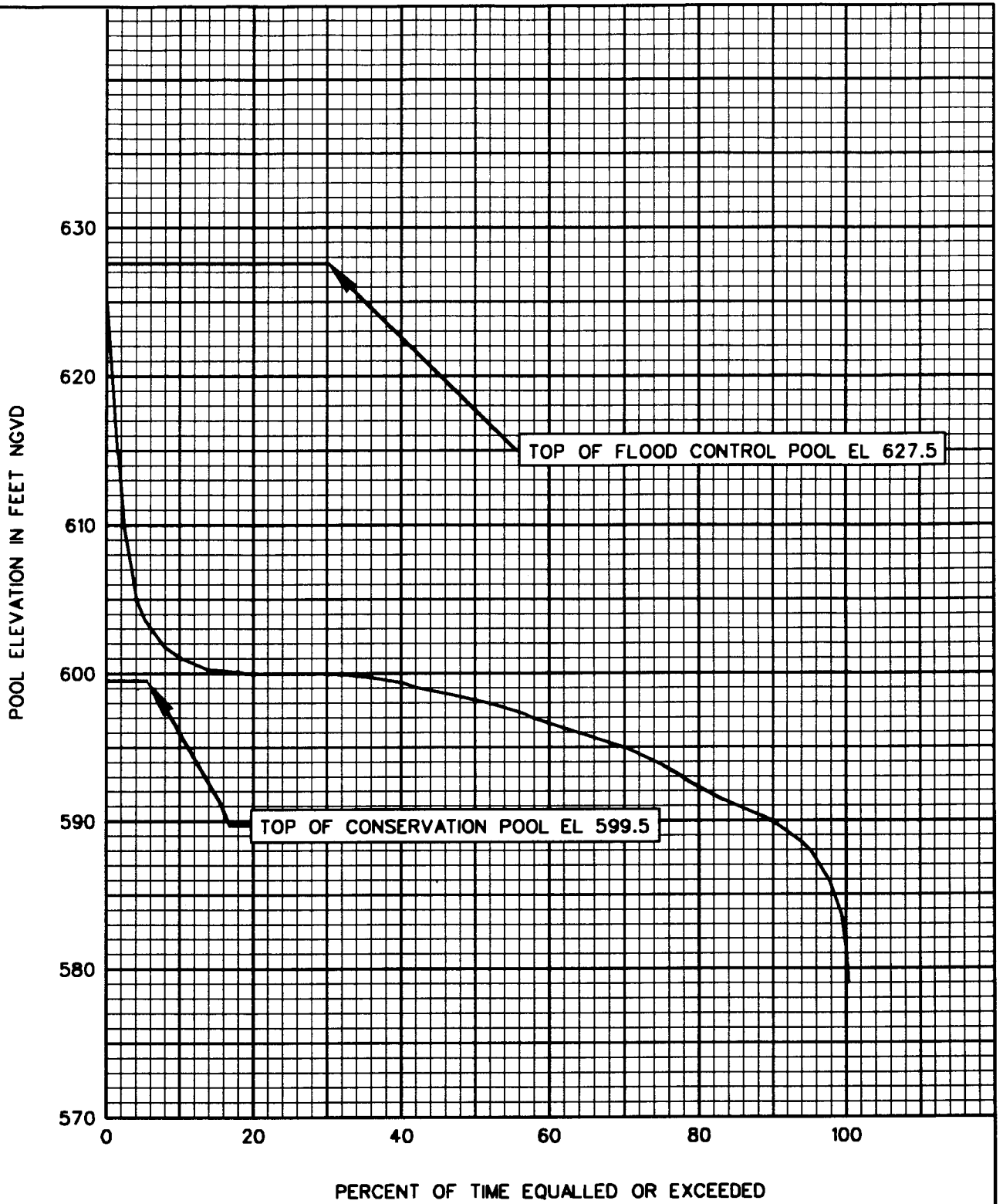
NOTE:

CURVE IS BASED UPON PERIOD OF RECORD JANUARY 1938 THRU DECEMBER 1990 FROM SUPER RUN R92X03.

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

**POOL ELEVATION
 PROBABILITY CURVE**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C.
 CHECKED: R.W.B.



NOTE:

CURVE IS BASED UPON PERIOD OF RECORD JANUARY 1938 THRU DECEMBER 1990 FROM SUPER RUN R92X03.

RED RIVER WATERSHED MOUNTAIN FORK RIVER, OK
BROKEN BOW LAKE

**POOL ELEVATION
 DURATION CURVE**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: J.O.C.
 CHECKED: R.W.B.