CORPS OF ENGINEERS, U. S. ARMY
VICKSBURG DISTRICT
VICKSBURG, MISSISSIPPI

OUACHITA RIVER BASIN
CADDO RIVER, ARKANSAS
RESERVOIR REGULATION MANUAL
DEGRAY DAM AND RESERVOIR

SEPTEMBER 1969

ENGCW-EY (25 Sep 69) 1st Ind
SUBJECT: DeGray Reservoir, Arkansas, Reservoir Regulation Manual

DA, Office of the Chief of Engineers, Washington, D.C. 20314 22 December 1969

TO: Division Engineer, Lower Mississippi Valley

The subject manual is approved for use during the initial years of operation, as recommended by the District and Division Engineers. The plan of operation should be reviewed systematically as operating experience is gained, giving due consideration to any major changes in existing or anticipated conditions that warrant adjustments in the plan. Any major changes proposed should be submitted to the Chief of Engineers for approval or comment.

FOR THE CHIEF OF ENGINEERS:

1 Incl
dupe wd

WENDELL E. JOHNSON
Chief, Engineering Division
Civil Works

LMVED-H (VD 25 Sep 69) 2d Ind

DA, Lower Mississippi Valley Division, Corps of Engineers, Vicksburg, Miss. 39180 6 Jan 70

TO: District Engineer, Vicksburg, ATTN: LMKED-H

G.B.D.

DEPARTMENT OF THE ARMY
VICKSBURG DISTRICT, CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI 39180

LMKED-H 25 September 1969

SUBJECT: DeGray Reservoir, Arkansas, Reservoir Regulation Manual

THRU: Division Engineer, Lower Mississippi Valley

TO: Chief of Engineers
ATTN: ENGCW-EY

1. The DeGray Reservoir Regulation Manual is submitted in accordance with EM 1110-2-3600. This is the first regulation manual for the project. It is believed to be in sufficient detail for the initial years of project operation.

2. Approval is requested.

FOR THE DISTRICT ENGINEER:

1 Incl (sext)
Regulation Manual

W. H. ROTH
Executive Assistant

OUACHITA RIVER BASIN
CADDO RIVER, ARKANSAS
RESERVOIR REGULATION MANUAL
DEGRAY RESERVOIR

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CADDO RIVER, ARKANSAS

PERTINENT DATA - DeGRAY DAM

Item	Unit	
RIVER MILE	-	7.9
DRAINAGE AREA	sq. mile	453
ONE-INCH RUNOFF	acre-feet	24,160
MINIMUM POOL		
Elevation	ft m.s.l.	367.0
Area	acres	6,400
Storage	acre-ft.	261,500
Equivalent runoff	inches	10.8
JOINT USE POWER AND WATER SUPPLY POOL		
Elevation	ft. m.s.l.	408.0
Area	acres	13,400
Storage	acre-ft.	393,200
Equivalent runoff	inches	16.3
Firm water supply release	c.f.s.	387
FLOOD CONTROL POOL		
Elevation	ft. m.s.l.	423.0
Area	acres	17,000
Storage	acre-ft.	227,200
Equivalent runoff	inches	9.4
Maximum regulated outflow	c.f.s.	6,000
Tailwater elevation for a discharge of 6,000 c.f.s.	ft. m.s.l.	223.0
SURCHARGE POOL		
Elevation	ft. m.s.l.	447.5
Area	acres	23,800
Storage	acre-ft.	495,100
Equivalent runoff	inches	20.5
Design flood		
Average rainfall	inches	28.4
Runoff	inches	26.0
Peak inflow	c.f.s.	397,200
Peak outflow		
Spillway	c.f.s.	67,000
Outlet works (Power release)	c.f.s.	5,000
Total	c.f.s.	72,000
Maximum tailwater elevation for a discharge of 72,000 c.f.s.	ft. m.s.l.	240.0

PERTINENT DATA - DeGRAY DAM (con)

Item	Unit	
STANDARD PROJECT FLOOD		
Elevation	ft. m.s.l.	429.1
Peak inflow	c.f.s.	210,900
Peak outflow	c.f.s.	12,000
Average rainfall	inches	18.1
Runoff	inches	15.1
Tailwater elevation for a discharge of 12,000 c.f.s.	ft. m.s.l.	226.0
OUTLET STRUCTURE - FLOOD CONTROL		
Number of Conduits	-	1
Diameter of Conduits	ft.	29.0
Slide Gate, Number and Size	ft., wxh	1, 6 x 11.5
Intake invert elevation	ft. m.s.l.	345.0
Gate capacity at flood control pool, elevation 423.0	c.f.s.	6,700
Maximum regulated outflow	c.f.s.	6,000
SPILLWAY		
Type-Uncontrolled broad-crested (saddle)		
Crest elevation	ft. m.s.l.	423.0
Crest length	ft.	200
DAM		
Type - Earthfill		
Crest elevation	ft. m.s.l.	453.0
Length	ft.	3,400
Freeboard	ft.	5.5
Height above streambed	ft.	243
SADDLE DIKES		
Crest elevation	ft. m.s.l.	453.0
Length	miles	2.5
Freeboard	ft.	5.5
Maximum height	ft.	98
POWER		
Installation - units	kw	68,000
Number of units	-	2
Conventional	kw	40,000
Reversible	kw	28,000
Number of penstocks, branch type	-	2
Penstock diameter, number and size	ft.	1, 15' - 9" 1, 13' - 2"

PERTINENT DATA - DeGRAY DAM (con)

Item	Unit	
POWER (con)		
Turbine discharge (rated capacity at design head 171 feet)		
Conventional unit	c.f.s.	3,100
Reversible unit	c.f.s.	2,200
Gross head at max. power pool	ft.	188
Average net head	ft.	175
Design head	ft.	171
Critical net head	ft.	153
Minimum net head	ft.	144
Drawdown	ft.	41
Prime capacity continuous	kw	6,900
Dependable capacity	kw	62,000
Average annual energy	kwh	91,100,000 1/
Energy required for pumping	kwh	19,300,000 1/
Average operating tailwater elevation	ft. m.s.l.	220
GUIDE TAKING LINE		
Fee purchase		
Elevation	ft. m.s.l.	408.0*
Area	acres	28,000
Flowage easement		
Elevation	ft. m.s.l.	428.0
Area	acres	2,700
Total project area	acres	30,700

* Guideline for acquisition of fee title has been set at a horizontal distance of 300 feet from the edge of the top of power and water supply pool elevation (408.0).

1/ 100,500,000 kwh may be obtained by increasing pump-back during period of intiial water supply requirement of 152 c.f.s. Pumping energy required is estimated at 29,151,000 kwh per year.

DeGRAY DAM AND RESERVOIR
CADDO RIVER, ARKANSAS

PERTINENT DATA - REREGULATING DAM

Item	Unit	
RIVER MILE	-	4.8
DRAINAGE AREA		
Reregulating dam to DeGray Dam	sq. mile	27
MINIMUM POOL		
Elevation	ft. m.s.l.	209.0
Area	acres	90
Storage	acre-ft.	600
WATER SUPPLY AND PUMPING POOL		
Joint use		
Elevation	ft. m.s.l.	217.0-221.0
Area	acres	430
Storage	acre-ft.	1,600
Water supply only (weekend periods of nongeneration)		
Elevation	ft. m.s.l.	209.0-217.0
Area	acres	290
Storage	acre-ft.	1,400
SURCHARGE POOL		
Standard project flood		
Elevation	ft. m.s.l.	232.0
Area	acres	830
Storage	acre-ft.	6,800
50-year frequency flood		
Elevation	ft. m.s.l.	228.5
Area	acres	700
Storage	acre-ft.	4,200
SPILLWAY		
Type-concrete gravity		
Crest elevation	ft. m.s.l.	221.0
Crest length	ft.	300
Peak discharge		
Standard project flood	c.f.s.	45,000
50-year frequency flood	c.f.s.	25,000
SLUICES		5
Number		
Size, W x H	ft.	5 x 9
Intake invert elev.	ft. m.s.l.	197.0
Total capacity at top of water supply and pumping pool, elevation 221.0	c.f.s.	4,400

DeGRAY DAM AND RESERVOIR

PERTINENT DATA - REREGULATING DAM (con)

Item	Unit	
DAM		
Crest elevation	ft. m.s.l.	235.0
Freeboard		
Standard project flood	ft.	3.0
50-year frequency flood	ft.	6.5
Height above streambed	ft.	40

CADDO RIVER, ARKANSAS
DEGRAY DAM AND RESERVOIR
RESERVOIR REGULATION MANUAL

AUTHORITY

1. Authority and scope. This report is submitted in accordance with EM 1110-2-3600. It contains initial plans for the regulation of DeGray Reservoir, downstream reregulating dam, and information pertaining thereto.

DESCRIPTION OF CADDO RIVER BASIN

2. Project location. The Caddo River has its source in the mountains of Montgomery County, Arkansas, and flows in a southeasterly direction a distance of 78 miles to its junction with the Ouachita River at mile 426.0 above the mouth of Black River, and approximately 5.4 miles above Arkadelphia, Arkansas. The DeGray Damsite is located about 7.9 miles above the mouth of Caddo River. The general locations of the Caddo River watershed and the DeGray Damsite are shown on Plate 1.

3. Topography. The watershed of the Caddo River is chiefly mountainous, with elevations ranging from a maximum of 2,200 feet, mean sea level, near the headwaters to 186 feet, mean sea level, at the mouth. The total drainage area of the Caddo River is 490 square miles, and the area above the DeGray Damsite is 453 square miles. The DeGray Reservoir will control about 92 percent of the Caddo River drainage area. In the upper reaches of the Caddo River above mile 56, the valley averages about 2,000 feet in width, while the valley downstream from mile 56 averages a little over 1,000 feet in width, with several reaches averaging as little as 400 to 700 feet. The stream slopes range from about 40 feet per mile in the headwaters to 4 feet per mile near the mouth.

4. Population and industries. The population in the Ouachita River Basin has been undergoing considerable change in the last 50 years. Table 1 shows population trends over a 50-year period, 1910-1960, for major municipalities within the Ouachita River Basin.

Table 1
Population of Major Municipalities
Ouachita River Basin, Arkansas and Louisiana, 1910-1960

Arkansas	1910	1920	1930	1940	1950	1960
Arkadelphia	2,745	3,311	3,380	5,078	6,819	8,041
Fordyce	2,794	2,996	3,206	3,429	3,754	3,921
Camden	3,995	3,238	7,273	8,975	11,372	15,686
El Dorado	4,202	3,887	16,421	15,858	23,076	25,168
Warren	2,057	2,145	2,523	2,516	2,615	6,661
Crossett	2,038	2,707	2,811	4,891	4,619	5,353
Malvern	2,778	3,864	5,115	5,290	8,072	9,518
Louisiana						
Bastrop	854	1,216	5,121	6,636	12,769	15,175
Ruston	3,377	3,387	4,400	7,107	10,372	13,940
Monroe	10,209	12,675	26,028	28,309	38,572	51,931
West Monroe	1,127	2,240	6,566	8,560	10,302	14,656

The principal agricultural products of the Caddo River Basin and of the Ouachita River Basin downstream from the mouth of the Caddo River are corn, hay, and pasture, with minor acreages devoted to cotton, oats, soybeans, and rice. Within the Caddo River Basin, the rugged terrain prevents extensive farming, and in the Ouachita River Basin downstream from the Caddo River, the farming areas are generally confined to the so-called second bottomlands which are located on the benches adjacent to the hills, and average 3 to 5 feet above the elevation of the Ouachita River flood plain proper. The principal natural resource of the Caddo River Basin and the Ouachita River Basin downstream from the mouth of Caddo River is timber. The timber is generally hardwood, but extensive stands of pine are found in the higher, better-drained portions of the flood plain. Other resources of the area consist of petroleum, clays, and sand and gravel. Minor mining operations are carried on in the area for the production of novaculite, quartz, slate, chalk, manganese, and lead sulphate. The principal industries of the Caddo River Basin and the Ouachita River Basin downstream from the Caddo River have, for years, been farming and lumbering. However, in recent years, the growth of other industries, including the production of timber

products, the processing of petroleum, and manufacture of aluminum products, and ceramics, has shown rapid expansion. This expansion is probably attributable to the availability of raw materials and adequate labor supply, and to the development of hydroelectric power. Other than the DeGray Project, there are two Federal hydroelectric projects (Blakely Mountain Dam on the Ouachita River and Narrows Dam on the Little Missouri River) and two privately owned hydroelectric plants (Carpenter and Remmel Dams on the Ouachita River upstream from the mouth of the Caddo River) in the immediate area. These projects are shown on Plate 1. The water supply provisions in the DeGray Project will enhance an additional growth of industry within the Ouachita River Basin. The area is served by a well-developed network of highways, railroads, and improved slack-water navigation on the Ouachita River from Camden, Arkansas, downstream to the mouth of the Black River.

5. Channel capacities. The minimum channel capacity of the Caddo River below the DeGray Damsite is about 6,000 c.f.s. The channel capacity of the Ouachita River is about 20,000 c.f.s. at Arkadelphia and Camden, Arkansas.

6. Climate. The climate for the basin is generally mild. The summers are usually long with temperatures of 100° F. or higher being recorded within the area nearly every summer. The winters are usually short and moderate, although occasional temperatures below zero have been recorded. The average annual temperature in this area is 62° F. and the average monthly temperatures range from 43° F. in December and January to 81° F. in July and August. The maximum and minimum observed temperatures in the vicinity were 116° F. on 10 August 1936 and -21° F. on 2 February 1951 at Mount Ida, Arkansas.

7. Precipitation and runoff. The average annual rainfall over the Caddo River Basin is approximately 52 inches. The annual rainfall has ranged from a minimum of about 31 inches in 1936 to about 83 inches in 1957. The largest monthly rainfalls occur in April and May, and the smallest in September and October. Snowfall occurs on an average of one to four times a year but rarely stays on the ground more than a few days at a time. Plate 18 shows the location and type of precipitation stations in and adjacent to the watershed. Infiltration rates were computed for the watershed above the stream gaging station on the

Caddo River near Alpine (Runyan Bridge), Arkansas, in accordance with the method outlined in EM 1110-2-1405, "Flood-Hydrograph Analyses and Computations." The infiltration rates for the seven storms studied varied from 0.02 to 0.43 inch per hour. Over 80 percent of the runoff occurs during the winter and spring months, depending on antecedent conditions and rainfall distribution and intensity. Runoff factors vary from 50 to 90 percent for individual storms. Average monthly rainfall and runoff for the watershed area above the damsite are shown in Table 2.

Table 2
Average Monthly Rainfall and Runoff
Over Watershed Above
DeGray Damsite

Month	Flow at Damsite c.f.s.	Rainfall Inches	Runoff Inches	Runoff Percent
Jan	1,283	5.29	3.27	62
Feb	1,267	4.38	2.91	66
Mar	1,231	5.21	3.14	60
Apr	1,380	5.35	3.40	64
May	1,237	5.38	3.15	59
Jun	399	3.44	0.98	28
Jul	185	4.35	0.47	11
Aug	86	3.06	0.22	7
Sep	174	3.14	0.43	14
Oct	239	3.43	0.61	18
Nov	505	4.37	1.25	29
Dec	909	4.60	2.31	50
Annual	739	52.00	22.11	43

8. Floods. Within the period of available streamflow records, major floods have occurred in the Ouachita River Basin during the years 1927, 1938, 1942, 1945, 1949, 1950, 1958, 1964, and 1968. Isohyets for the storms producing the floods of 1927, 1945, 1949, 1950, 1958, and 1968 are shown on Plate 3.

9. Flood of April 1927. This dual-peak flood was centered in the Upper Ouachita River Basin above Hot Springs, Arkansas. Ground conditions due to antecedent rainfall were ideal for high runoff. The storms were the result of quasi-stationary frontal action that occurred when most of the streams were near bankfull. The first peak of this flood was produced by the storm of 11-14 April, which centered north of the basin at Danville,

Arkansas, with 11.7 inches of rainfall. The second storm, which occurred on 20-21 April, was centered in the vicinity of Story, Arkansas, where a total rainfall of 11.8 inches fell in 24 hours. The Ouachita River at Arkadelphia, Arkansas, reached a stage of 29.2 feet on 21 April as a result of this flood.

10. Flood of March 1945. The storm producing this flood occurred during 28 March-2 April. Glenwood and Mount Ida reported 10.9 and 10.3 inches of rainfall, respectively. The average rainfall above the damsite was about 10.0 inches. The peak stage at Runyon Bridge, estimated from a high water mark, was 30.2 feet on 30 March, while the Ouachita River at Arkadelphia reached a stage of 30.3 feet on 30 March.

11. Flood of May 1958. The May 1958 storm approached the magnitude of the 1945 flood for the Ouachita River Basin as a whole. The period of heavy rainfall extended from 25 April to 20 May with 24.5 inches recorded at Lock and Dam No. 8 below Camden, Arkansas. Glenwood, Arkansas, reported 18.6 inches, while Narrows Dam and Arkadelphia, Arkansas, reported 19.3 inches and 16.8 inches, respectively. The flood produced peak stages of 17.3 feet at Glenwood and 27.7 feet at Arkadelphia. It is estimated that the stage at Arkadelphia would have been 30.2 feet without Blakely Mountain Dam. Had DeGray Dam been in operation, it is estimated that the stage at Arkadelphia, Arkansas, would have been lowered an additional 1.7 feet.

12. Flood of April-May 1968. The months of April and May 1968 were months in which violent and unusual weather occurred throughout Arkansas. Ten recordbreaking days of heavy rainfall began on 8 May and produced spectacular totals for the month with over 20 inches in the mountainous headwaters of the Caddo and Little Missouri Rivers. The storm period of 8-14 May, climaxed by extremely heavy rainfalls of up to 10 inches of 13-14 May, contributed directly to peak stages on the upper Ouachita River and its tributaries. Record stages were also recorded on the Caddo and Saline Rivers. In the two-day period of 13-14 May, Glenwood reported 8.9 inches of rainfall, while Mt. Ida and Hopper, Arkansas, reported 8.1 and 10.9 inches, respectively. These amounts of rainfall occurred in approximately 20 hours. This storm

produced record stages at Glenwood, Arkansas, and at Runyon Bridge (near Alpine) of 31.4 feet and 35.6 feet, respectively. A peak stage of 30.1 was observed at Arkadelphia, Arkansas. The stage at Arkadelphia would have been about 34 feet without Blakely Mountain and DeGray Dams. DeGray accounted for about 1 foot of the reduction. It is estimated that had DeGray Dam been completed, the stage at Arkadelphia would have been lowered an additional 2.7 feet.

13. Flood damages. The DeGray Dam will control the runoff of the Caddo River and reduce flooding on 193,000 acres (24,000 acres cleared) subject to flooding along the Ouachita River between the mouth of Caddo River and the mouth of Smackover Creek. The effect of DeGray Dam below the mouth of Smackover Creek is considered negligible. The average annual flood damages prevented are estimated at $12,000, while enhancement amounts fo $431,000. Overflow, stage-area curves for the Ouachita River above the mouth of Smackover Creek are shown on Plate 4.

HISTORY AND DESCRIPTION OF DEGRAY RESERVOIR PROJECT

14. Project authorization. The DeGray multiple-purpose flood control and power reservoir was included in Senate Document Numbered 117, Eighty-first Congress, first session, as a feature of the comprehensive plan of improvement for the Ouachita River and Tributaries, Arkansas and Louisiana. The projects included in this document were authorized by the River and Harbor Act of 1950. The inclusion of municipal and industrial water supply as one of the project purposes was authorized by the "Water Supply Act of 1958," approved 3 July 1958, as amended by the "Federal Water Pollution Control Act Amendment of 1961," approved 20 July 1961.

15. History of DeGray Reservoir Project. The DeGray Project consists of a multipurpose reservoir with project purposes of flood control, power, water supply, recreation, and navigation. A downstream reregulating dam is included for the reregulation of flows for continuous water supply and pump-back storage for power. Initial construction of the project began 29 June 1962. River diversion was made in May 1966. Construction of the main dam, intake structure, tunnel and dikes is essentially complete. Construction of the powerhouse and appurtenances

are about 20 percent completed. The first generation of electric power is scheduled for August 1971 with full capability by November 1971. Construction of the reregulating dam began in July 1969 with completion due during FY 1971.

16. Pertinent features of the project. The DeGray Project consists of a main dam of earthfill construction with a spillway, intake structure, earth dikes along the reservoir rim, hydroelectric power generating facilities consisting of one conventional unit and one reversible pump turbine unit, a conduit for power and flood control release, penstocks, power house, switchyard, appurtenant structures, and a downstream reregulating dam. The project was designed for flood control, the production of electric energy, and to provide continuous water supply.

17. The Reservoir. The reservoir will have a total capacity of 881,900 acre-feet of storage below spillway crest, of which 261,500 acre-feet will be below the minimum power pool; 393,200 acre-feet will be for water supply and power production; and 227,200 acre-feet will be for flood control. The dual-purpose power and water-supply pool will be contained between elevations 267.0 and 408.0 feet, mean sea level, with average annual fluctuations of about 10 feet below elevation 408. This storage will provide power generation and also water supply for municipal, industrial, and pollution-control use. The flood control pool will have sufficient storage to control the flood of record, and its operation will eliminate flooding along Caddo River below the dam and reduce flood stages on Ouachita River from the mouth of Caddo River to the mouth of Smackover Creek. Pertinent data for the reservoir are shown on pages vi, vii, and viii.

18. Main dam and dikes. The main dam will be of earthfill construction, extending approximately 243 feet in height above the streambed. The dam will be 3,400 feet in length at the crest elevation of 453 feet, mean sea level. Plate 2 shows the location of the dam. A 29-foot diameter tunnel, 1,650 feet in length, is located in the right abutment for diversion of flows during construction and for use later to pass both power and flood control discharges. Intake for power and flood control flows will be through a single intake tower

at the upstream end of the tunnel. The intake will have provisions for admitting flow at different elevations for temperature control. An earthfill dike, approximately 2.5 miles in length, is located on the drainage divide between Bayou DeRoche and the Caddo River. Crest of the dike will be at elevation 453 feet, mean sea level, and maximum height will be approximately 100 feet. General plan and profile and Typical Section of the Main Dam are shown on Plates 5 and 6. Plan and profile of Dike Sections are shown on Plate 7.

19. Outlet works. Flood control storage will normally be released by power generation, which will permit the release of about 6,000 c.f.s. at maximum power pool. One 6' x 11½' gate is located on the outlet end of power and flood control tunnel. Location of the gate is shown on Plate 9, Tunnel Profile. A rating curve for this gate is shown on Plate 32. An emergency low-level gated outlet is located in the tunnel immediately upstream from the intake tower. Water below elevation 345 can be released through this outlet in case of emergency.

20. Spillway. An uncontrolled spillway will be located in a saddle in the ridge approximately 4,000 feet east of the left abutment of the dam. The spillway will have a width of 200 feet and a crest elevation of 423 feet, mean sea level. The spillway site is at the head of a valley which will serve as an outlet channel. This valley discharges into the reregulating basin approximately 0.6 mile downstream from the centerline of the dam. Due to the infrequent operation of the spillway, no special provisions for outlet channel protection will be made. Details of the spillway are shown on Plate 8. Spillway design flood hydrographs are shown on Plate 37.

21. Reregulating dam. The reregulating dam will be approximately 3 miles downstream from the main dam. It will be an earthfill type with a crest elevation of 235 feet, mean sea level, and a height of approximately 40 feet above the streambed. Plate 1 shows the location of the reregulating dam. The uncontrolled spillway section will be of concrete. Spillway Plan is shown on Plate 14. Gated sluices will regulate downstream flow when the pool is below the spillway crest. The reregulating

basin, required for the operation of a pumped-storage hydroelectric unit, and utilized for the reregulation of downstream flows for water supply, has a total storage of 3,600 acre-feet, of which 600 acre-feet are in the minimum pool and 3,000 acre-feet are in the water supply and pumped-storage pool. Pertinent data are shown on pages ix and x. Pumping will be accomplished between elevations 217.0 feet and 221.0 feet, mean sea level, and this portion of the pool will contain 1,600 acre-feet. The pool may be drawn to elevation 209.0 feet because of weekend water supply releases with maximum water supply demands and when generation is at a minimum. Plates 11 through 14 show plan, profile, and sections for the reregulating dam and spillway.

22. Hydroelectric facilities. The project will have an installed capacity of 68,000 kilowatts, consisting of one conventional unit of 40,000-kilowatt capacity and one reversible turbine with a 28,000-kilowatt motor generator with the usual control, switching, transforming, and operating equipment. Power facilities will be remotely controlled from the Blakely Mountain powerhouse. More detailed information on design is contained in Design Memorandum No. 8, Hydropower Capacities.

23. Water supply. The project is designed to provide an ultimate continuous water supply of 250 million gallons per day or 387 cubic feet per second. The Public Health Service has determined that 152 c.f.s. of this release will be required for water quality control and 235 c.f.s. will be available for municipal and industrial water supply. The municipal and industrial water may be taken directly from the reregulating reservoir or released via the downstream watercourse. The municipal and industrial water supply will be furnished in accordance with the contractual demands of the Ouachita River Water District. The water district has estimated that it will require no water during the first 10 years of project operation and that its requirements will then begin and will increase uniformly during the next 90 years until the full 235 c.f.s. municipal and industrial water is required in 100 years after project operation. The Fish and Wildlife Service has estimated that a minimum continuous release of 100 c.f.s. from the

reregulating reservoir would be needed to maintain proper flow conditions for the downstream fishery. Recognizing the need for a minimum release from the reservoir, and since 152 c.f.s. is designated for water quality control for which no local contribution is required, it is planned to release 152 c.f.s. minimum continuous flow from the reregulating basin upon initial project completion. This minimum release will be interrupted only during flood periods or when it is obvious that the flow is not needed. Gate settings will be made at the reregulating dam to maintain this minimum flow as well as releasing additional power flows at a rate to maintain as nearly as possible uniform outflows. Operating details are contained in paragraph 43, Instructions to Operators.

24. Recreation. The reservoir area will provide an expanse of clear water, surrounded by a very irregular and heavily wooded shoreline. This scenic reservoir will lend itself to the development of an unusually attractive recreational facility. The climate, accessibility, adaptability of sites to development, vegetative cover, wildlife, and an expanse of water will combine to provide continuous use for fishing, picnicking, camping, swimming, water skiing, and simple relaxation. Visitation at DeGray is expected to reach 2,000,000 annually within three years after project completion.

RELATED PROJECTS IN THE OUACHITA RIVER BASIN AREA

25. Flood control and power. Narrows Dam on the Little Missouri River and Blakely Mountain Dam on the Ouachita River have been in operation for control of floods and generation of power since May 1950 and October 1955, respectively. The River and Harbor Act of 17 May 1950 authorized construction of Murfreesboro Reservoir on Muddy Fork Creek for flood control. No funds have been appropriated for its construction. The Arkansas Power and Light Company owns and operates two power dams, Carpenter and Remmel, located just below Blakely Mountain Dam. The power operations of the four dams and water releases during flood times are coordinated.

26. Navigation. An improved 9-foot navigation project, consisting of four locks and dams with associated river improvements, has been authorized and is currently under construction to provide slack-water

navigation on the Ouachita and Black Rivers below Camden, Arkansas. DeGray Project, with its water supply provision, will augment flows for navigation and will ultimately contribute about 40 percent of the estimated minimum flow of 1,000 c.f.s. at Monroe, Louisiana.

DISTRICT ORGANIZATION FOR RESERVOIR REGULATION

27. Organization. The Reservoir Regulation Section of the Hydraulics Branch, Engineering Division, predicts runoff, reservoir pool levels, and river stages downstream from the reservoir. Upon receipt of current rainfall, reservoir and river stage data, and weather forecasts, this section consolidates, evaluates, and correlates these data into a plan of operation which is recommended to the District Engineer through Engineering Division channels. In actual practice, approval of routine matters within established policies is made by civilian engineers without reference to the District Engineer. Normally, any part of the decision requiring action at the dam is relayed to the Project Manager through Operations Division channels. On occasions requiring restrictions on power releases and flood control operations which occur outside of regular working hours, instructions are furnished directly to project operators by personnel of the Reservoir Regulation Section to facilitate speedy action at the Dam. Copies of these instructions are furnished the Operations Division in Vicksburg as soon thereafter as practicable. The normal organization of the Vicksburg District concerned with reservoir regulation is shown on Plate 15. Personnel of the Reservoir Regulation Section, Hydrology Section, and Hydraulics Section are shown on Plate 16. During flood times, trained personnel of the Hydraulics and Hydrology Sections are available for use in the Reservoir Regulation Section as required. A full flood emergency organization of these sections is also shown on Plate 16. The organization for the operation of DeGray Dam is shown on Plate 17. The operation of DeGray Dam does not normally require personnel of the Reservoir Regulation Section on 24-hour duty. Project operators at the dam are furnished the home telephone numbers of key personnel of the Reservoir Regulation Section and one or more of these are available

at all times. During nonwork days, one member of the section is assigned the responsibility of obtaining information on weather conditions and river stages throughout the District from the Weather Bureau Office in Jackson, Mississippi. When appreciable rainfall or flooding occurs, personnel of the Reservoir Regulation Section are on duty during nonwork days as required.

COLLECTION OF DATA

28. Weather forecasts. Quantitative rainfall forecasts are received daily from the U. S. Weather Bureau in Jackson, Mississippi. During flood periods more detailed interpretations of these forecasts are obtained from Weather Bureau Offices in Little Rock and Jackson.

29. Hydrologic network.

a. Rainfall. Rainfall reports are received from 38 stations in and adjacent to the Ouachita River Basin. This network is operated in cooperation with the Weather Bureau and provides sufficient rainfall coverage to forecast stages on the Ouachita River and tributaries as far downstream as Camden, Arkansas. There are 23 reporting network stations, Weather Bureau stations only, and the stations at Narrows, Blakely Mountain, and DeGray Dams. Hourly incremental rainfall amounts are obtained directly from the Narrows, Blakely Mountain, and DeGray Dams as required. Weather Bureau stations report stage and precipitation at least daily, and more often when stages are above bankfull. Network stations report at 7 a.m., 1 p.m., and 7 p.m. when 0.50-inch or more precipitation is measured and continue reporting at these hours until there has been a break of 24 hours with no rainfall. Data from stations of the lower Arkansas River reporting network, which joins the Ouachita Basin on the north, are available at the Little Rock Weather Bureau for use as desired. Reports are received from the rainfall stations as shown on Plate 18. The locations of the reporting rainfall stations and all rain gages operated in and adjacent to the basin are shown on Plate 19.

b. Stream gages. Special stream gage reports will be received from Ouachita River near Arkadelphia for stages above 17 feet. A telemark gage is installed at this location. Reports are received from Remmel Dam when flood discharges are being released. Plate 20 lists the

gages on Ouachita River and tributaries and shows the type of gage and report. The locations of these and other stations in the upper Ouachita River Basin are shown on Plate 21. Pool stages, tailwater stages, and discharges from DeGray Dam will be included on the daily operation report of DeGray Dam, Plate 22. These data are also received in the District Office by radio or telephone as required.

FLOOD PREDICTIONS

30. Predictions. All reports from rainfall stations, stream gaging stations, and the reservoir are received in the Reservoir Regulation Section where they are consolidated and tabulated on forms similar to Plates 23, 24, and 25. With these data, continuous predictions of reservoir inflow, reservoir pool levels, and river stages are made. Based on these observed data and predictions, reservoir regulation is reviewed and recommendations are made as necessary. Under normal conditions, operation is reviewed and observed stages and predictions are reported once a week as shown on Plate 27. During periods of heavy rainfall and high runoff, operation is reviewed and observed stages and predictions are reported daily. Charts showing reservoir inflow, outflow, pool levels, and rainfall will be prepared biweekly and furnished interested personnel in the District. A typical operation chart is shown as Plate 28.

31. Runoff. A method for estimating runoff from rainfall for the area above DeGray Dam is shown on Plate 29. The infiltration method is the basis for the rainfall runoff curves and similar losses are used for the local areas from the dam to Camden. Additional data pertaining to infiltration rates and runoff are contained in paragraph 7.

32. Distribution of runoff. Runoff is distributed by unit graphs which have been computed from past floods. Unit graphs for inflow into DeGray Reservoir and the flow from local area between DeGray Dam and Arkadelphia are shown on Plate 30. Flows for Little Missouri River above Boughton and Ouachita River above Camden are obtained similarly for the operation of Narrows and Blakely Mt. Reservoir. The unit graphs for these areas are contained in Reservoir Regulations Manuals, Narrows Reservoir, Arkansas, and Blakely Mt. Reservoir, Arkansas.

33. Reservoir forecasts. Based on predicted inflow, anticipated power generation, and flood control releases, forecasts of reservoir pool stages are made daily during flood periods and weekly during low-flow periods. Reservoir area and capacity curves for the Main Dam and Reregulating Dam are shown on Plate 31. Turbine water use curves and rating curves for the flood control gates at the main dam are shown on Plate 32. Discharge curves for the Reregulating Dam are shown on Plate 33.

34. River stage forecasts. A streamflow routing method has been developed for the Ouachita River and Tributaries above Camden, Arkansas, for use in forecasting stages, computing the effects of flood control works and improving reservoir regulation. Discharge rating curves for Arkadelphia and Camden are shown on Plate 34. The Progressive Average-Lag Method of flood routing, as described in Engineering Manual, Civil Works Construction, Part CXIV, Chapter 8, will be used for routing through downstream reaches. DeGray outflows will be combined with computed flows from the local area between DeGray Dam and the reregulating dam. Outflow from the reregulating dam will be added to the computed local between the reregulating dam and Arkadelphia, Arkansas. Routed flows from upstream reaches will be combined with the routed Arkadelphia flow and routed to Camden. Tabulations illustrating routing procedures for stage predictions at Arkadelphia and Camden are shown on Plates 35 and 36, respectively. Discharge rating curves for Arkadelphia and Camden are shown on Plate 34. Flows at Boughton and Remmel Dam are obtained from routings made in connection with the operation of Narrows and Blakely Mt. Reservoirs.

FLOOD CONTROL OPERATION

35. Plan of operation. The flood control pool of DeGray Reservoir was designed to control the dual peak of the 1927 flood, the maximum storm volume of record in the upper Ouachita Basin, with the power and water supply pool full at the beginning of the storm and the average daily power flow limited to 2,000 cubic feet per second, when the flow of Ouachita River exceeds 20,000 cubic feet per second. After flows

have receded at Arkadelphia, the release from DeGray will be regulated so as not to exceed a flow of 20,000 cubic feet per second at Arkadelphia or a maximum of 6,000 cubic feet per second from the dam. The power discharge will be sufficient to provide a firm water supply yield of 250 million gallons per day, or 387 cubic feet per second. Storage in the reregulating reservoir is sufficient to provide continuous water supply during weekend periods with power generation limited to five days per week. Studies show that the method of operation as outlined above will give the optimum control of floods while maintaining sufficient releases to satisfy pumping and water supply requirements. Estimated stage reductions at Arkadelphia and Camden, Arkansas, for the 1927, 1945, 1958, and 1968 floods with Narrows, Blakely Mt., and DeGray Reservoirs operating are shown below.

Table 3
Stage Reductions Due to Flood Control Works

	Uncontrolled	With Blakely Mt. & Narrows	With Blakely Mt., Narrows, and DeGray	Reduction from DeGray
1927 Flood				
Arkadelphia	29.2(obs)	25.8	24.2	1.6
Camden	41.9(obs)	39.3	38.5	0.8
1945 Flood				
Arkadelphia	30.3(obs)	27.0	24.3	2.7
Camden	44.8(obs)	43.4	43.0	0.4
1958 Flood				
Arkadelphia	30.2	27.7(obs)	26.0	1.7
Camden	44.7	43.9(obs)	43.0	0.9
1968 Flood				
Arkadelphia	34.0	30.1(obs)	27.4	2.7
Camden	45.0	43.1(obs)	42.1	1.0

Spillway design flood hydrographs are shown on Plate 37.

36. Flood control restrictions. Limitations applying to the operation of the project during floods are:

a. The power release from DeGray Dam will be limited to the capacity of one unit (approx. 2,000 c.f.s.) when the discharge at Arkadelphia exceeds 20,000 c.f.s.

b. Releases for both power and flood control may be increased to a maximum of 6,000 c.f.s., but regulated so as not to increase the flow at Arkadelphia above 20,000 c.f.s.

37. Automatic operating schedules. Schedules of automatic flood control operation and automatic reregulating dam operation as shown in Appendix A are furnished the Project Manager.

POWER OPERATION

38. General. The power and water supply pool between elevation 367.0 and 408.0 feet, mean sea level, contains 383,000 acre-feet of storage, which will provide power generation and water supply. The installed hydropower capacity of 68,000 kilowatts includes one conventional unit of 40,000 kilowatts and one reversible turbine with a 28,000-kilowatt motor-generator. Based on the most critical dry period during the period of record, 1923 through 1968, the project will provide prime continuous power of 6,900 kilowatts or a dependable capacity of 62,000 kilowatts when operated at an 11-percent load factor, at the same time providing a dependable water supply release of 250 million gallons per day. The average annual energy is estimated as 91,100,000 kilowatt-hours and the energy required for pumping as 19,300,000 kilowatt-hours per year. During the initial period of operation, with a water supply requirement of 152 c.f.s., an average annual energy of 100,500,000 kilowatt-hours may be obtained with a corresponding pumping energy requirement of 29,151,000 kilowatt-hours per year. The rule curve, Plate 38, has been developed to provide optimum power generation during the period of initial water supply requirements. Power operation graphs showing pool elevation, power output, power flow, and pump-back for years 1923-1966 based on rule-curve operation are shown on Plate 39, sheets 1 through 3.

The monthly inflows used in power studies are tabulated on Plate 41. The reregulating dam below the main dam will provide a uniform flow for water supply and provide capacity for pumped storage. The reregulating basin contains sufficient capacity to provide water supply releases during the weekends, when generation is at a minimum.

39. Sale of power. The contract for the sale of power has not been completed as of September 1969. The power produced at DeGray will, however, be integrated into the A.L.M.N.O. system as is the power at Blakely Mountain and the two privately-owned Carpenter and Remmel Dams.

Power generation and pump-back will be scheduled by the customer according to load requirements, and subject to any necessary flood control restrictions. The contract for sale of power will require generation to meet water supply demands.

40. Rule curve. A rule curve and method of operation has been developed to make the most advantageous use of the available streamflow at DeGray Dam. The rule curve shown on Plate 38 is based on power generation according to rule curve load factors with maximum pumping rates averaging about 33 hours per week. Rule-curve generation will provide ample flow to satisfy the initial continuous water supply requirement from the reregulating dam.

WATER SUPPLY OPERATION

41. General. The inclusion of municipal and industrial water supply as one of the project purposes was authorized by the "Water Supply Act of 1958," approved 3 July 1958, as amended by the "Federal Water Pollution Control Act Amendment of 1961," approved 20 July 1961.

42. Water supply requirements. Local interests (Ouachita River Valley Association and Ouachita River Water District) have conducted parallel investigations with the Department of Health, Education, and Welfare and have developed the potential needs in the tributary area of 250 million gallons per day. The initial release of 152 c.f.s. will be increased, as required by the Ouachita River Water District, to the ultimate provision of 250 million gallons per day (387 cubic feet per second). The DeGray Project has 393,200 acre-feet of storage allocated between elevation 367.0, m.s.l., and 408.0, m.s.l., for the dual purposes of: (1) generation of electric power and (2) providing a dependable supply of 250 million gallons of water per day, or 387 cubic feet per second, for municipal, industrial, and pollution-control use.

43. Operation of reregulating dam. The initial minimum water requirement to be supplied from the reregulating reservoir is 152 c.f.s. and the ultimate requirement is 387 c.f.s. Up to 400 c.f.s. can be released from the pool during the pump-back cycle without lowering the pool below elevation 217.0. Releases of 400 c.f.s. over the weekend nongeneration period will lower the pool to elevation 209. The five

5' x 9' sluice gates can be operated locally or by remote control from the Blakely Mountain Dam powerhouse to regulate outflows and minimize fluctuations in the reregulating dam pool and in tailwater elevations. The gates may be positioned at 0.1-foot intervals from zero to full open. Gate settings are to be determined from reregulating dam pool elevation and the predicted 24-hour generation and pump-back amounts. A hypothetical pump-back operation is shown on Plate 40. The minimum downstream requirement will be released continuously. Minimum releases during the pumping cycle will maintain sufficient storage capacity for pump-back. Immediately following pump-backs, based on anticipated generation, the gates will be adjusted for desired outflows during the generation cycle and required stages in the reregulating pool. A daily operation worksheet for computing and recording pertinent data for the reregulating dam is shown as Plate 26. Plate 40 also shows a hypothetical operation when not pumping back. Sluice gate discharge curves, tailwater rating curve, and spillway rating curve are shown on Plate 33. Appendix B contains automatic operating procedures to be followed by operating personnel at the dam.

44. Instruction to Operators. Operating instructions for releasing flood storage and other gate settings not covered by automatic operating schedules will be furnished by the Reservoir Regulation Section through Operations Division channels. The instructions will be furnished direct to operating personnel at the dam when necessary during nonwork periods to expedite the operation. Operations Division personnel will be notified of such action as soon as practicable. Normally, operating decisions will be made in the Reservoir Regulation Section, Hydraulics Branch, of the Engineering Division. Unusual and important operating decisions will be cleared with the District Engineer. Automatic operating instructions setting forth standing procedures to be followed by the Project Managers without instructions from the District office are shown on appendixes as follows:

a. Automatic Flood Control Operation - Appendix A
b. Automatic Reregulating Dam Operation - Appendix B
c. Automatic Temperature Control Operation - Appendix C

LOW WATER CONTROL

45. Low water control. When the DeGray Project is placed in operation, a minimum flow of about 450 c.f.s. is anticipated in the Ouachita River at Arkadelphia below the confluence of the Caddo River. This anticipated minimum is based on assured minimum releases of 250 c.f.s. from Remmel Dam, 152 c.f.s. from DeGray Dam and a contribution of about 50 c.f.s. from the intervening drainage area.

HEALTH CONTROL

46. Mosquito control. Liaison will be maintained with the Arkansas State Board of Health concerning the need for larvae and adult mosquito surveillance, and measures for their control. Because of the absence of endemic malaria in Arkansas, the State Board of Health does not recommend a mosquito-surveillance program at the present time.

47. Proposed health control measures. All planning and development of public and private water supply and sewage disposal, as well as sanitary regulations for watercraft, boathouses, and docking facilities will be fully coordinated with the Arkansas State Board of Health and will conform to the requirements of the State of Arkansas.

TEMPERATURE CONTROL

48. Temperature control. The intake control structure consists of a tower with multiple-level intake so that the temperature of water released to the downstream fishery can be regulated. The intake consists of four 21' x 21' openings controlled by movable baffle gates and trash racks which can be positioned at three different levels. Water intake centerlines for the three levels are 395.0, 380.0, and 355.5. Details of the intake structure are shown on Plate 10 and the Tunnel Profile on Plate 9. A minimum of 1,000 square feet opening below the water surface will assure sufficient opening to furnish maximum power flows without excessive velocities through the gate passages. Normally, water will be drawn from the uppermost water level. Instructions for other openings to provide water temperature recommended by the Fish and Wildlife Service of the U. S. Department

of the Interior will be issued from the District office. Automatic Temperature Control Operation is shown as Appendix C.

RECREATION FACILITIES

49. Proposed development. In order to obtain maximum recreational benefits from the project, eighteen areas, including the damsite, have been selected for initial development. The areas are fairly evenly distributed around the reservoir and they are easily accessible. Development of the areas will include access and circulation roads, launching ramps, family camping facilities, water supply, sanitation facilities, safety devices, and markers.

SEDIMENTATION PROGRAM

50. Sedimentation program. Sedimentation ranges in DeGray Reservoir are shown on Plate 2-A. It is planned to make surveys at intervals of about 5 years or after all major floods that indicate reservoir silting.

EFFECTS OF RESERVOIR OPERATION

51. Effects of reservoir operation. Stage reductions as shown in Table 3, page 15, are indicative of the effects of the operation of DeGray Dam. Reductions in stage due to DeGray Dam will be computed for all floods of consequence after the project is placed in operation.

COOPERATION WITH OTHER AGENCIES

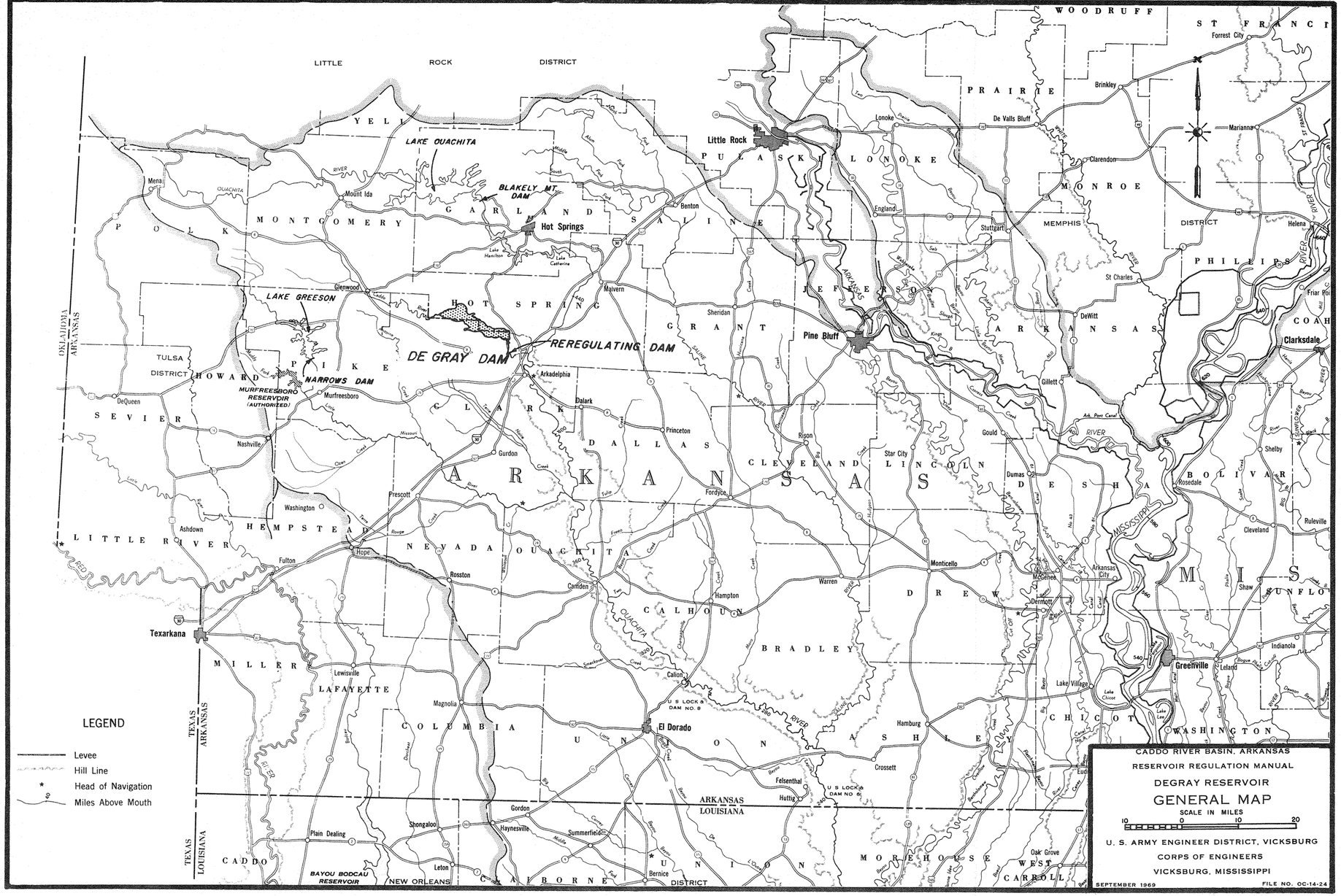
52. Cooperation with other agencies. The Ouachita Reporting Rainfall Network is operated in connection with the U. S. Weather Bureau. Quantitative rainfall forecasts and other weather predictions are received from the Weather Bureau Offices at Little Rock and Jackson. The contract for the sale of power is negotiated by the Southwestern Power Administration. Power benefits are furnished by the Federal Power Commission. The Corps furnishes the U. S. Geological Survey reservoir contents data and reservoir discharge for publication. The Corps cooperates with the U.S.G.S. regarding discharge data at other stations in the Ouachita River Basin.

STUDIES PLANNED

53. Studies planned. Computations of river stage reductions due to the operation of the project will be made for all major storms. Also, it is planned to continue studies to improve the methods of determining runoff from rainfall, the distribution of runoff, and reservoir and river stage forecasting. Power studies will be made as required.

CORPS OF ENGINEERS

U. S. ARMY



CADDO RIVER BASIN, ARKANSAS

RESERVOIR REGULATION MANUAL

DEGRAY RESERVOIR

GENERAL MAP

SCALE IN MILES

10 0 10 20

U. S. ARMY ENGINEER DISTRICT, VICKSBURG

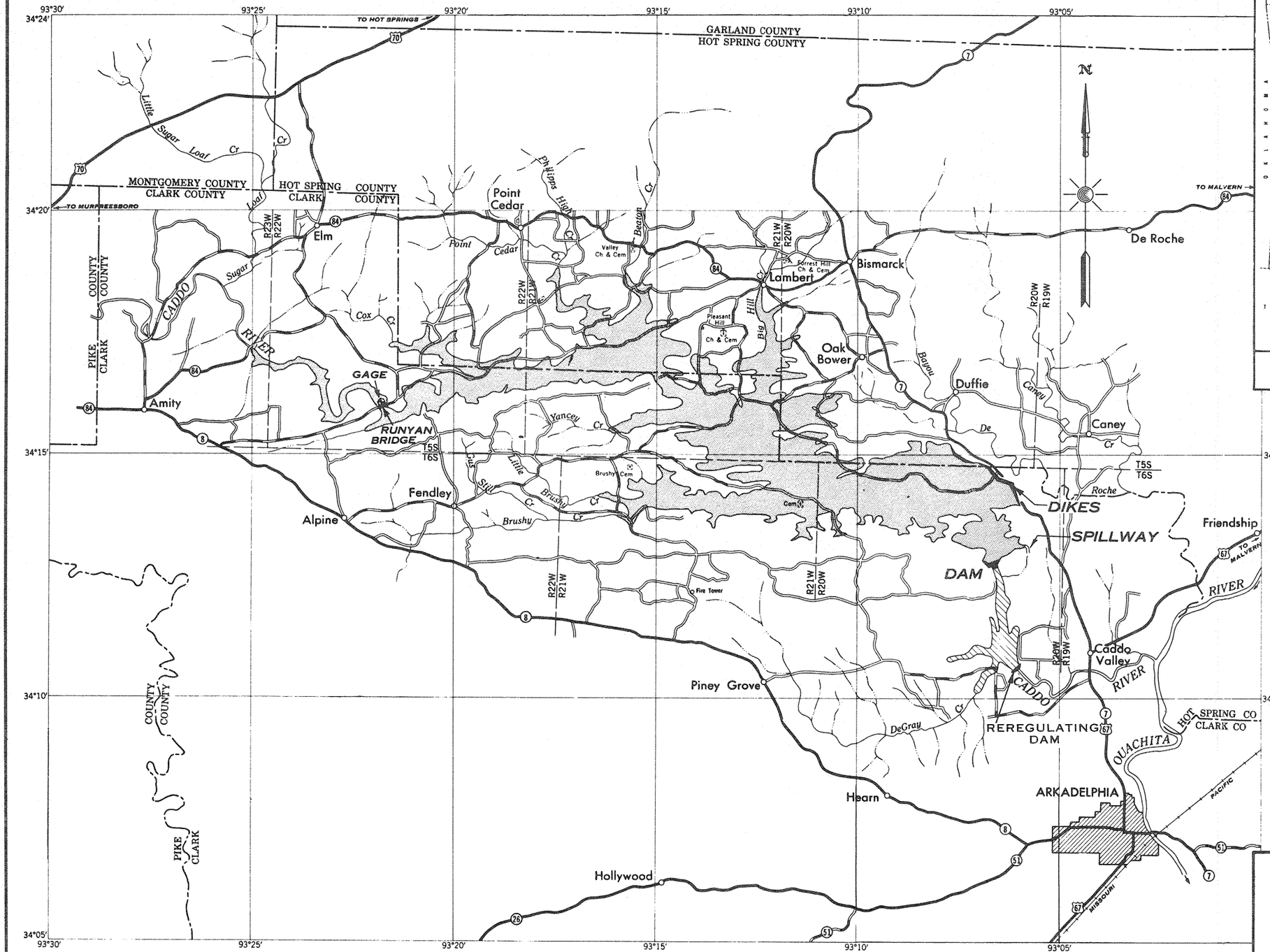
CORPS OF ENGINEERS

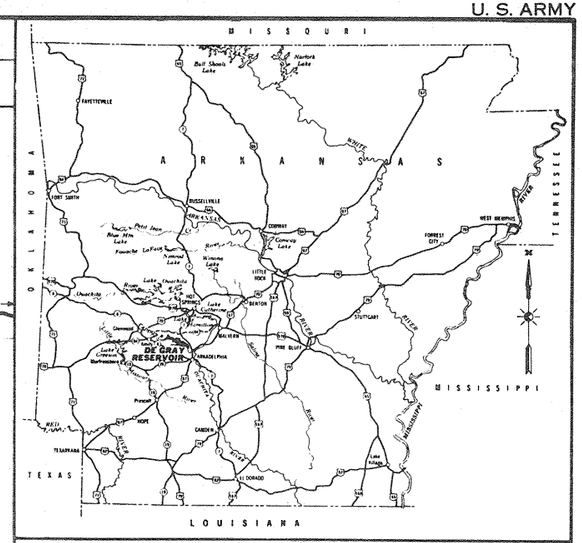
VICKSBURG, MISSISSIPPI

SEPTEMBER 1969

FILE NO. OC-14-24

PLATE 1





VICINITY MAP
SCALE OF MILES

LEGEND

- Pool At Elev. 428.0 M.S.L.
- Regulating Pool Elev. 221.0 M.S.L.
- Hard Surface Roads
- Gravel Roads
- Dirt Roads

OUACHITA RIVER AND TRIBUTARIES
ARKANSAS AND LOUISIANA

DE GRAY RESERVOIR

CADDO RIVER, ARKANSAS

RESERVOIR REGULATION MANUAL

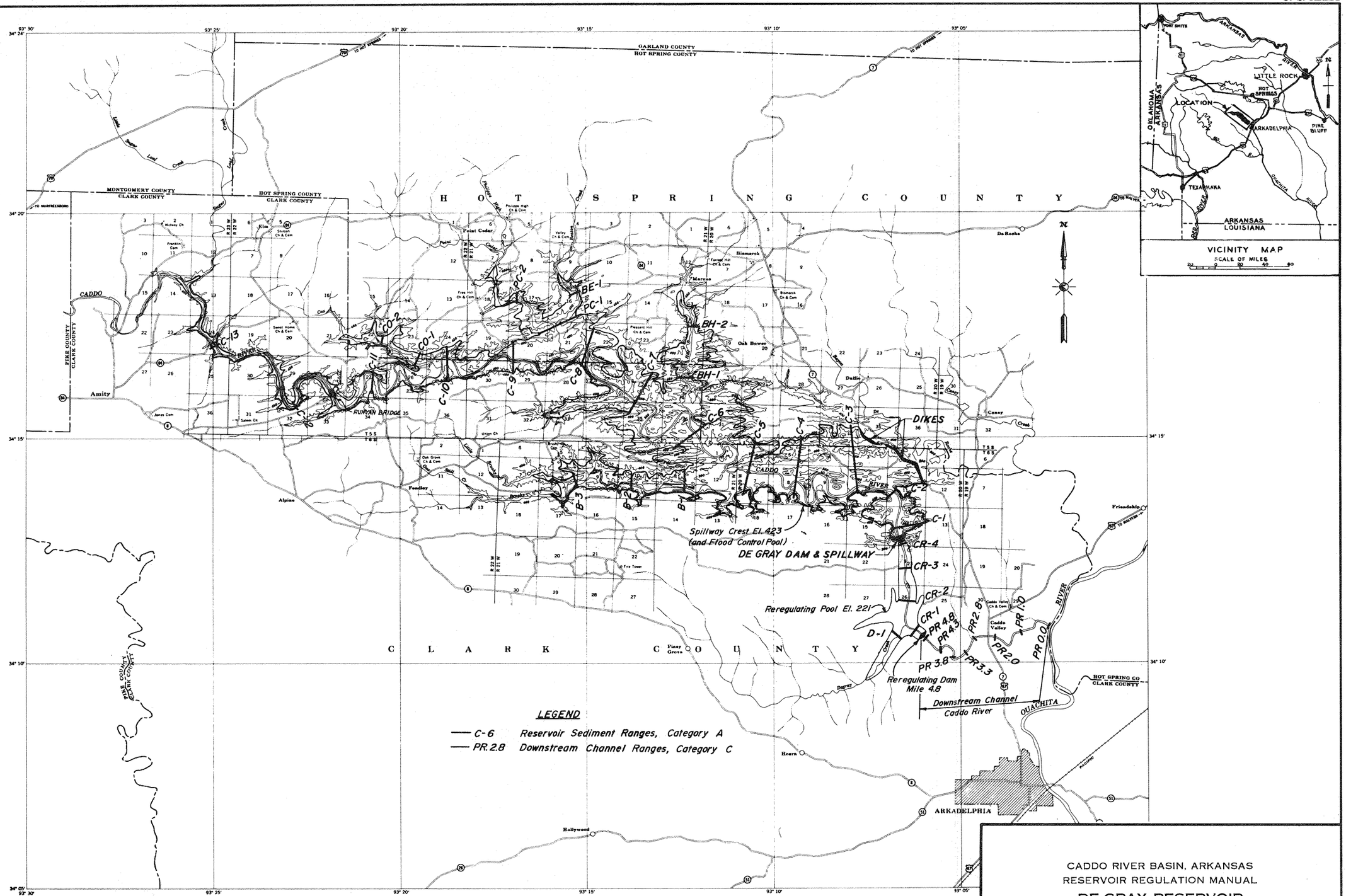
RESERVOIR AREA

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

SEPTEMBER 1969 FILE NO. OC-14-24

PLATE 2



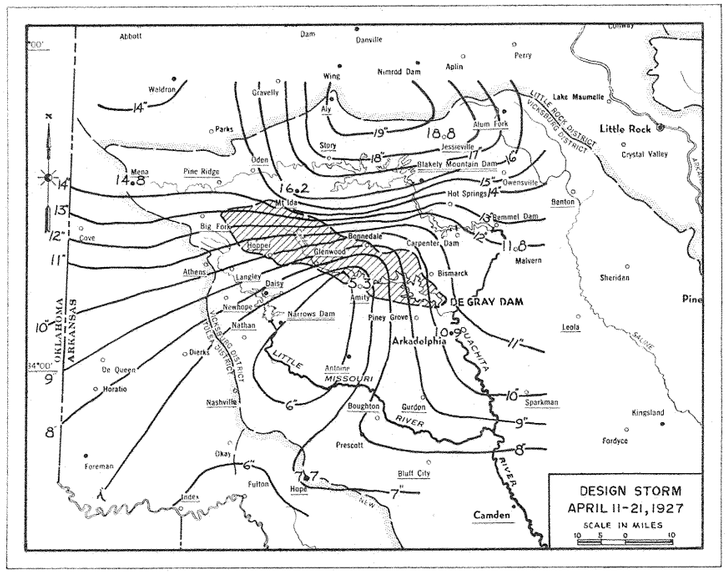
CADDO RIVER BASIN, ARKANSAS
RESERVOIR REGULATION MANUAL

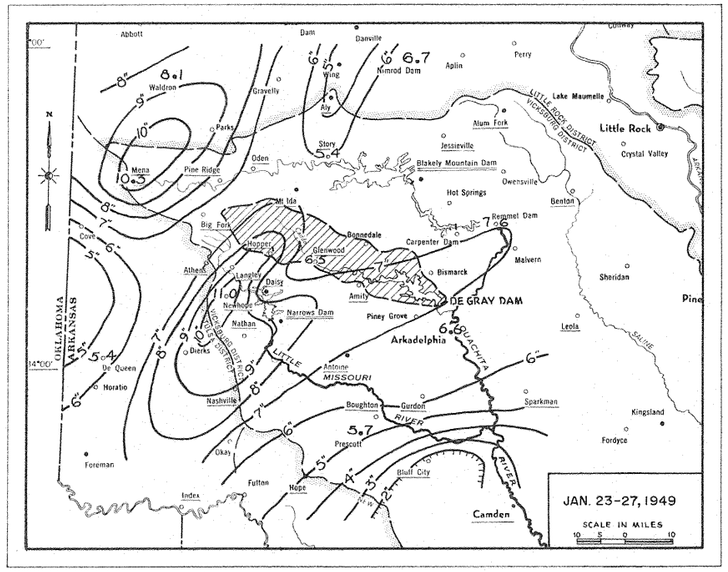
DE GRAY RESERVOIR

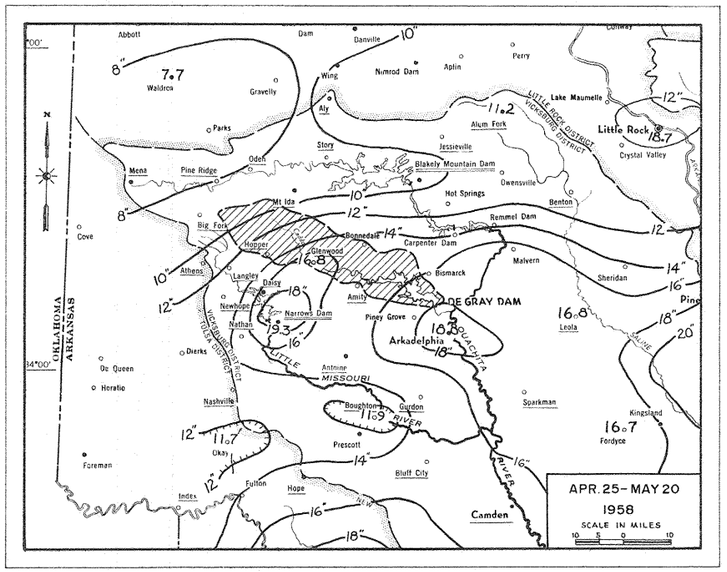
SEDIMENT RANGES

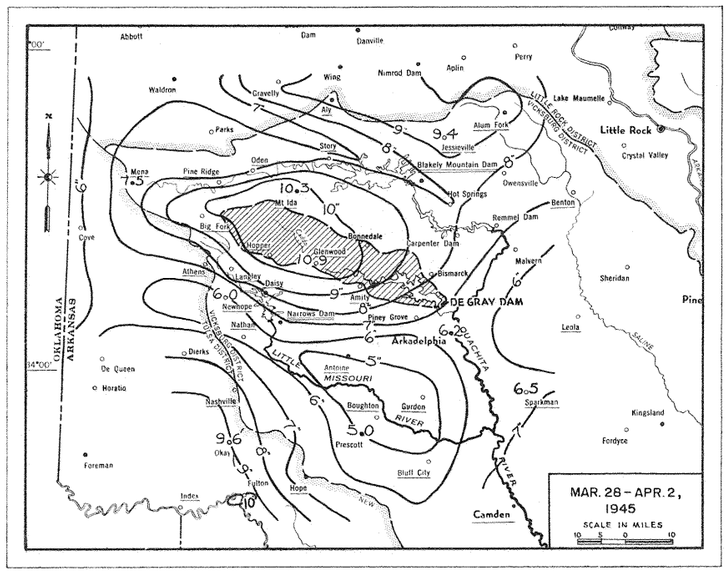
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

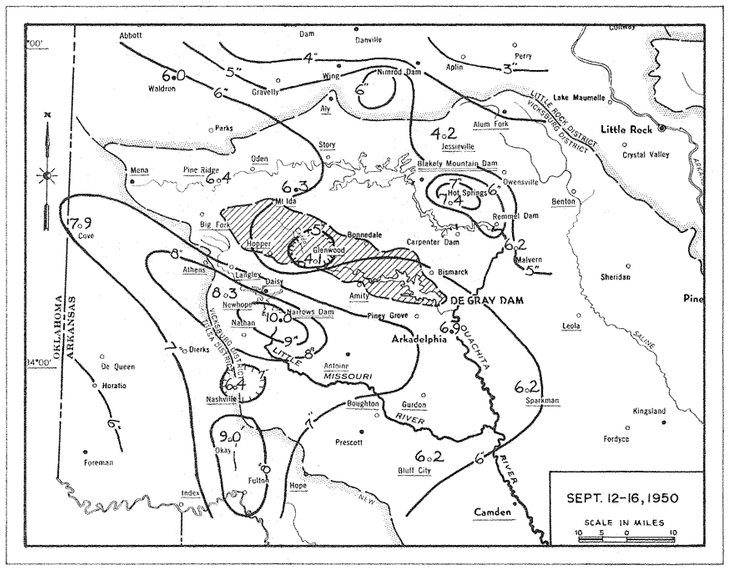
SEPTEMBER 1969 FILE NO. 0C-14-24

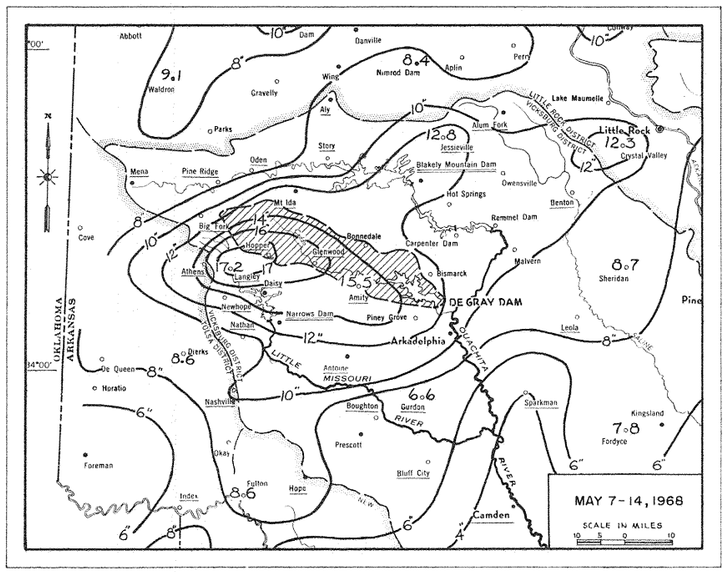








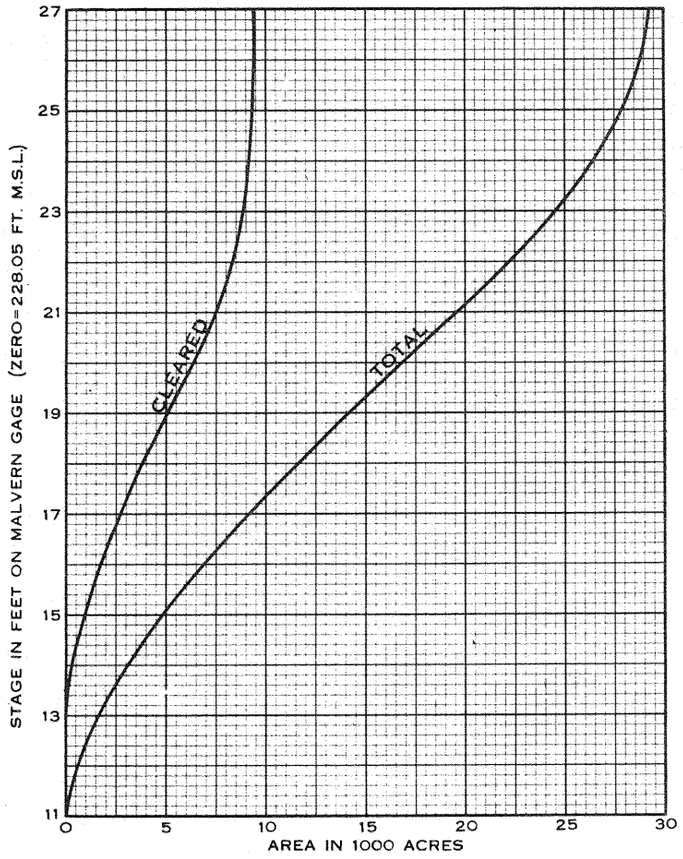




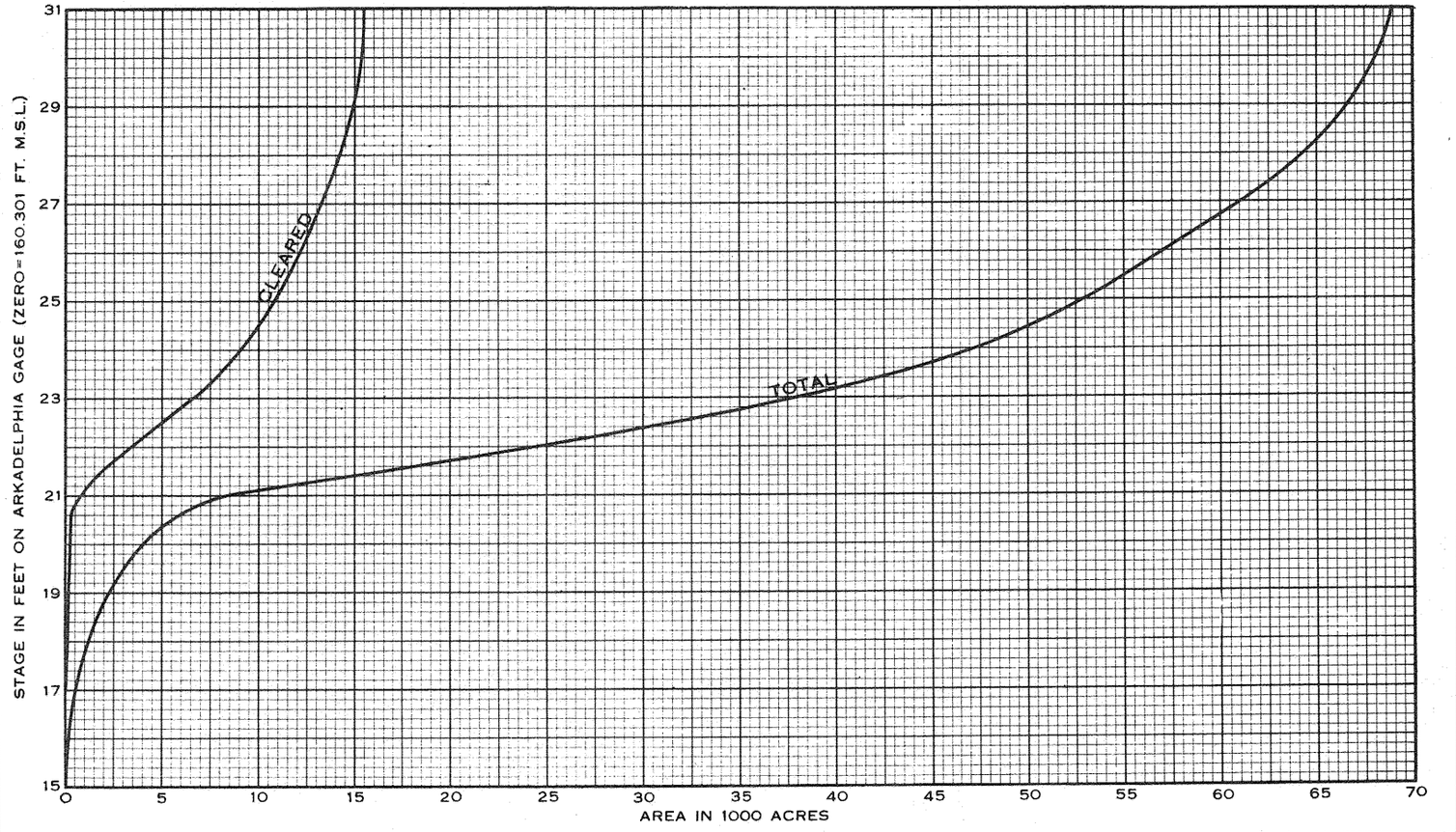
LEGEND

MALVERN 4.8	RAINFALL STATION
—6"—	ISOHYETAL LINE
~~	DRAINAGE BASIN LIMITS, CADDO RIVER
	DE GRAY RESERVOIR DRAINAGE AREA

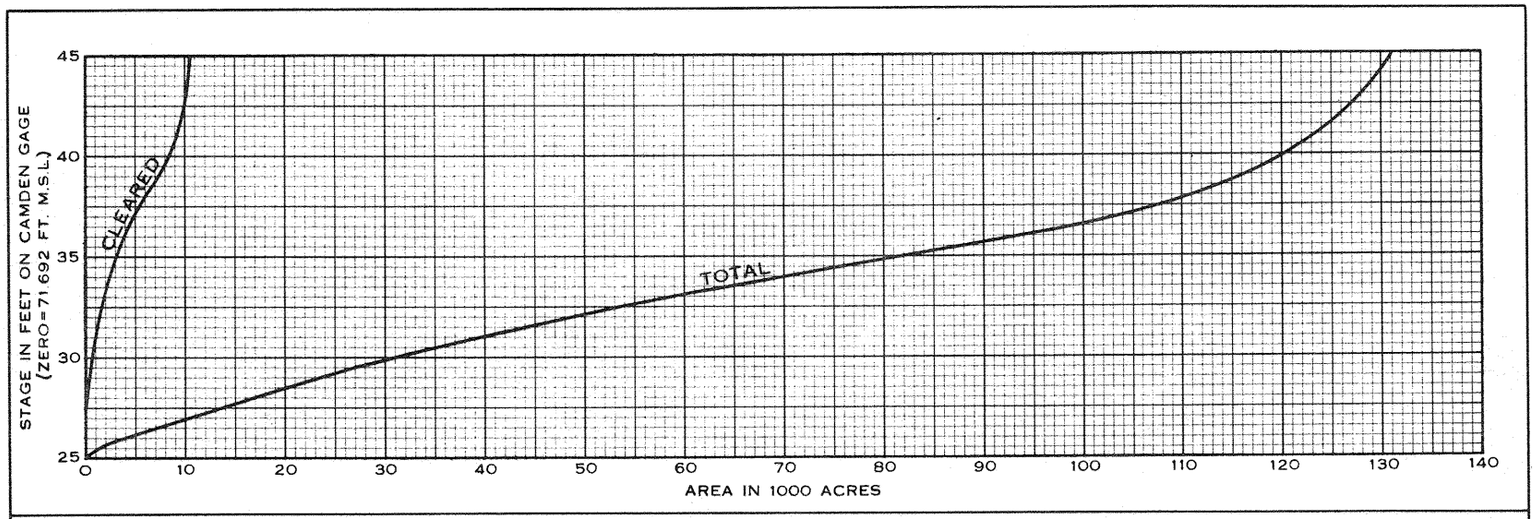
CADDO RIVER BASIN, ARKANSAS
RESERVOIR REGULATION MANUAL
DE GRAY RESERVOIR
STORM ISOHYETS
SCALE IN MILES
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI
SEPTEMBER 1969 FILE NO. OC-14-24



MALVERN TO CADDO RIVER



CADDO RIVER TO LITTLE MISSOURI RIVER



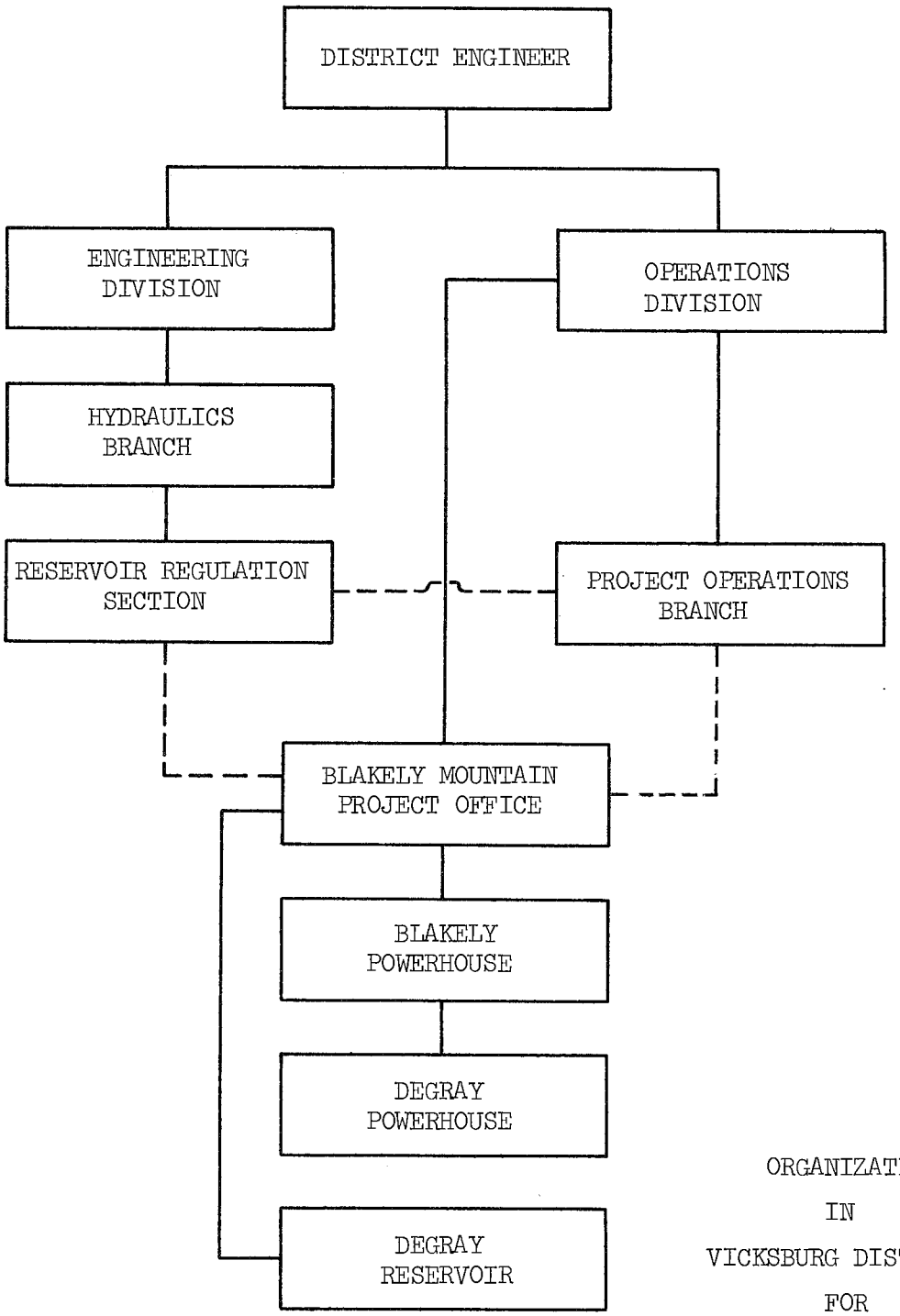
LITTLE MISSOURI RIVER TO SMACKOVER CREEK

CADDO RIVER BASIN, ARKANSAS
RESERVOIR REGULATION MANUAL
DEGRAY RESERVOIR

OUACHITA OVERFLOW STAGE - AREA CURVES

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

SEPTEMBER 1960 FILE NO. OC-14-24



ORGANIZATION
IN
VICKSBURG DISTRICT
FOR
RESERVOIR REGULATION

PLATE 15

PRECIPITATION STATIONS

IN AND ADJACENT TO

LITTLE MISSOURI RIVER BASIN

Station	Type	Type of Report	Station	Type	Type of Report
Amity	NR	A	Hot Springs	NR	E
Arkadelphia	R	D	Langley	NR	A
Athens	NR	A	Malvern	NR	E
Big Fork	NR	A	Mena	R	A
Bismark	R	A	Mt. Ida	R	A
Blakely Mt. Dam	R	C	Narrows Dam	R	C
Bonnerdale	NR	A	Oden	NR	A
Carpenter Dam	R	E	Piney Grove	R	A
DeGray Dam	R	C	Pine Ridge	NR	A
Glenwood	NR	A	Remmel Dam	NR	E
Hopper	NR	A	Story	NR	A

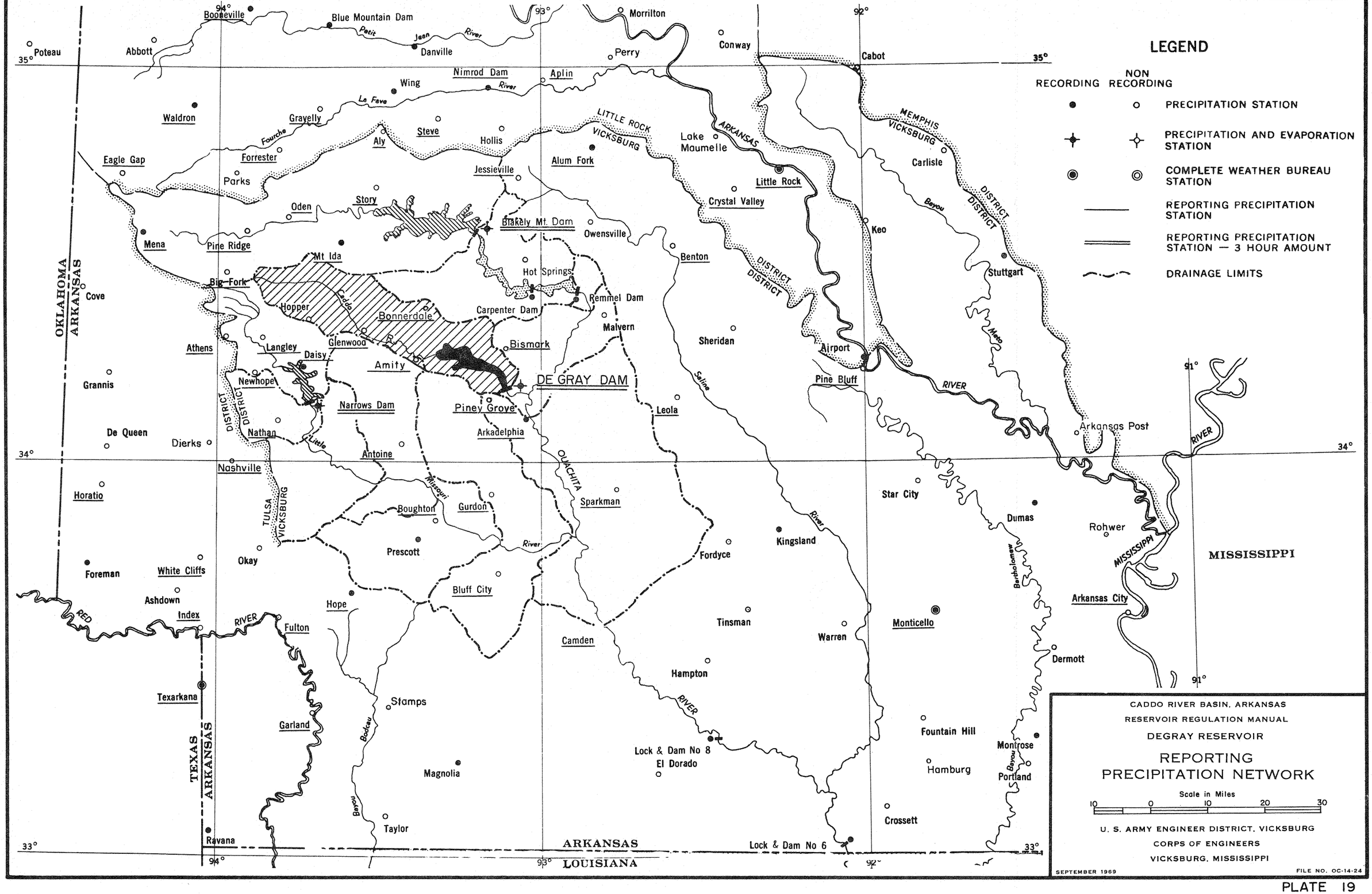
A - Rainfall amounts in excess of 0.50 inch are reported as follows.

At 7 a.m. when .50 inch or more precipitation is measured at 7 a.m. (for 24 hours ending 7 a.m.)
At 1 p.m. when .50 inch or more precipitation is measured between 7 a.m. and 1 p.m.
At 7 p.m. when .50 inch or more precipitation is measured between 7 a.m. and 7 p.m.
After the initial amount of .50 inch rainfall has occurred, reports are continued at 7 a.m., 1 p.m., and 7 p.m. until there is a break of 24 hours with no rainfall. These special reports are phoned from the observer to the USWB office at Little Rock, Arkansas, where they are assembled and forwarded to the Vicksburg District office by telephone or relayed through Weather Bureau teletype.
Daily cards mailed to USWB at Little Rock and forwarded to this office.

C - Rainfall and evaporation reports are included on daily operation report. Reports are received by telephone as required.

D - USWB river-rainfall reports are available daily on SR report and more often during times when bankfull stages are exceeded.

E - Monthly reports available from USWB.



CADDO RIVER BASIN, ARKANSAS
RESERVOIR REGULATION MANUAL
DEGRAY RESERVOIR

REPORTING PRECIPITATION NETWORK

Scale in Miles
10 0 10 20 30

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

SEPTEMBER 1969 FILE NO. OC-14-24

PLATE 19

STREAM GAGES

IN AND ADJACENT TO

CADDO RIVER BASIN

Station	Agency	Type Station	Type Report
Caddo River			
DeGray Pool	CE	Rec.	Daily Operation Rpt. and radiogram
DeGray Tailwater	CE	Rec. - Rated	
Glenwood	CE-WB	Rec.	USWB-SR report & weekly chart
Little Missouri River			
Narrows Pool	CE	Rec.	Daily Operation Rpt. and radiogram
Narrows Tailwater	CE	Rec. - Rated	
Murfreesboro	GS	Rec. - Rated	Monthly chart (1)
Delight-Prescott	CE	Rec.	Monthly chart
Boughton	CE-WB	Rec. - Rated	(2)
Whelan Springs	CE	Rec.	Weekly chart
Muddy Fork Creek			
Murfreesboro	CE	Rec.	Weekly chart
Ozan Creek			
McCaskill	CE	Rec.	Monthly chart
Antoine Creek			
Antoine	GS	Rec. - Rated	Monthly chart
Terre Noire Creek			
N. Gurdon	CE	Rec.	Weekly chart
N. Ditch	CE	Rec.	Weekly chart
S. Ditch	CE	Rec.	Weekly chart
E. Gurdon	CE	Rec.	Monthly chart
Ouachita River			
Near Mt. Ida	GS	Rec. - Rated	Monthly chart (1)
S. Fork at Mt. Ida	GS	Rec. - Rated	Monthly chart
Blakely Mt. Pool	CE	Rec.	Daily Operation Rpt. and radiogram
Blakely Mt. Tailwater	CE	Rec. - Rated	
Carpenter Dam (2 gages)	AP&L	Rec.	(3)
Remmel Dam (2 gages)	AP&L	Rec.	(3)
Malvern	GS	Rec. - Rated	Monthly chart
Arkadelphia*	CE-WB	Rec. - Rated	USWB-SR Rpt & monthly chart
Camden	CE-WB	Rec. - Rated	USWB-SR Rpt & weekly chart

* Telemark installation.

(1) Stages obtained by personnel at dam as required.

(2) Stages above 14 feet reported to dam. USWB-SR report and weekly chart.

(3) Stages obtained by personnel at Blakely Mt. Dam as required.

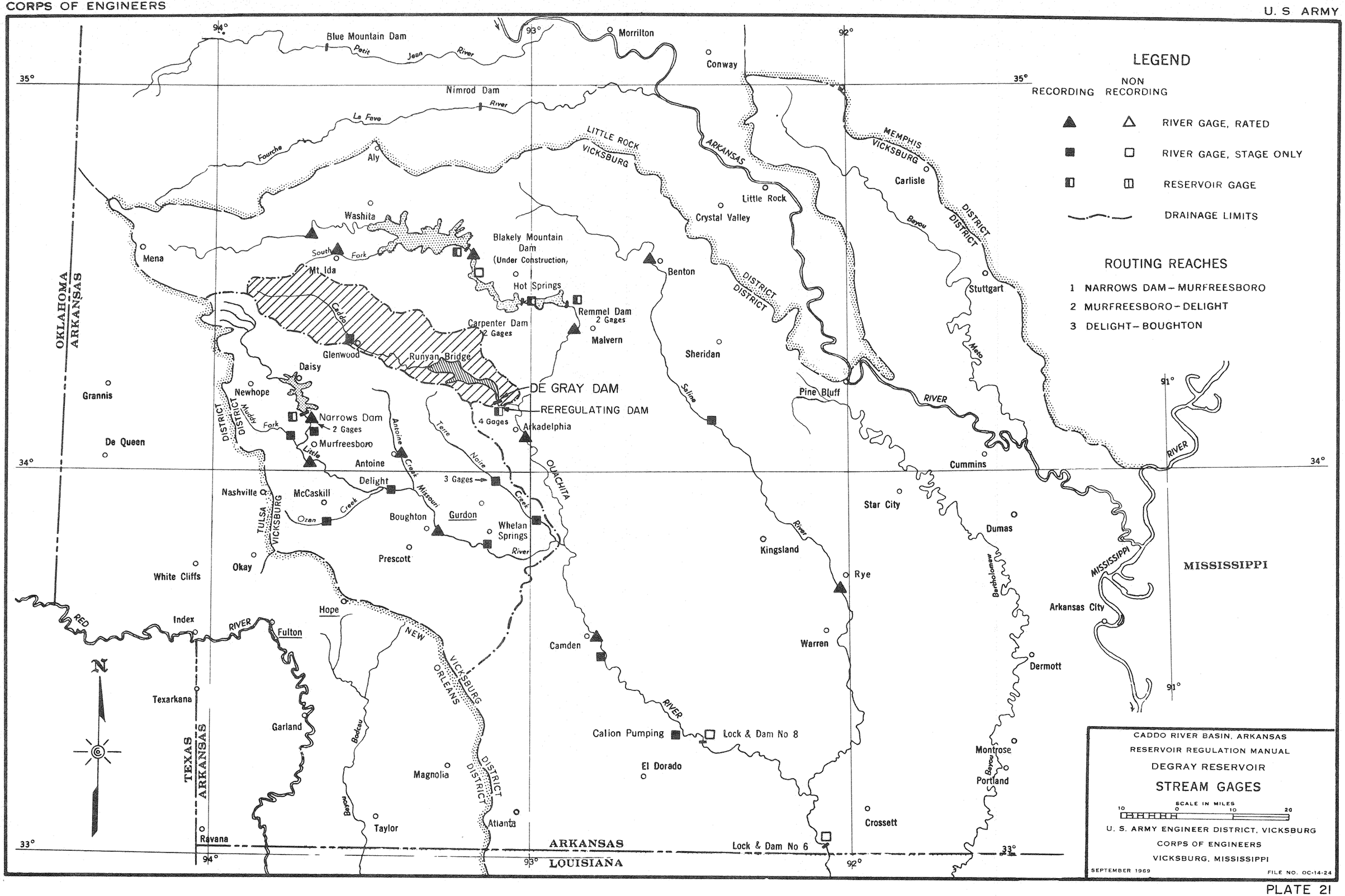

LEGEND
NON RECORDING
RECORDING
RIVER GAGE, RATED
RIVER GAGE, STAGE ONLY
RESERVOIR GAGE
DRAINAGE LIMITS
ROUTING REACHES
1 NARROWS DAM – MURFREESBORO
2 MURFREESBORO – DELIGHT
3 DELIGHT – BOUGHTON
Blue Mountain Dam
Petit Jean River
Nimrod Dam
La Fave River
Fourche
Aly
Morrilton
Conway
LITTLE ROCK VICKSBURG
ARKANSAS
MEMPHIS VICKSBURG
Carlisle
Little Rock
Crystal Valley
Washita
Mena
Blakely Mountain Dam (Under Construction)
South Fork
Mt. Ida
Hot Springs
Benton
Remmel Dam 2 Gages
Carpenter Dam 2 Gages
Malvern
Glenwood
Caddo
Runyan Bridge
Sheridan
Stuttgart
Bayou Meto
DISTRICT
Daisy
Newhope
Grannis
DE GRAY DAM
REREGULATING DAM
4 Gages
Arkadelphia
Pine Bluff
RIVER
Saline
Narrows Dam 2 Gages
Muddy Fork
Little
De Queen
Murfreesboro
Antoine
Antoine Creek
Terre Noire Creek
3 Gages
Delight
Nashville
McCaskill
Ozan Creek
Missouri
Boughton
Gurdon
Whelan Springs
OUACHITA River
TULSA VICKSBURG
Prescott
Okay
White Cliffs
Kingsland
Star City
Cummins
Dumas
Bartholomew Bayou
Rye
MISSISSIPPI
Arkansas City
Index
RED RIVER
Fulton
Hope
NEW ORLEANS VICKSBURG
Camden
Warren
Dermott
Texarkana
Garland
TEXAS ARKANSAS
Bodcau Bayou
Magnolia
Calion Pumping
Lock & Dam No 8
El Dorado
Montrose
Portland
Taylor
Atlanta
Crossett
Ravana
Lock & Dam No 6
ARKANSAS
LOUISIANA
OKLAHOMA ARKANSAS
94°
93°
92°
91°
35°
34°
33°
N
CADDO RIVER BASIN, ARKANSAS
RESERVOIR REGULATION MANUAL
DEGRAY RESERVOIR
STREAM GAGES
SCALE IN MILES
10 0 10 20
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI
SEPTEMBER 1969
FILE NO. OC-14-24

PLATE 21

DAILY OPERATION REPORT

DE GRAY POWER PLANT
VICKSBURG DISTRICT, CORPS OF ENGINEERS

DATE

HR. END	GEN. 1 METER OUT	GEN. 1 MWH	GEN. 2 METER OUT	GEN. 2 MWH	TOTAL GEN. MWH	ELEVATION POOL	ELEVATION TAILRACE
MN							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12N							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12MN							

	1	2	T
TOTAL TODAY			
PREVIOUS TOTAL			
TOTAL THIS MO.			

RESERVOIR & WEATHER	
AVERAGE POOL ELEVATION	FT.
AVERAGE OPER. T.W. ELEV.	FT.
AVERAGE GROSS HEAD	FT.
TURBINE 1 DISCHARGE	DSF
TURBINE 2 DISCHARGE	DSF
TOTAL POWER DISCHARGE	DSF
FLOOD CONTROL DISCHARGE	DSF
SPILLWAY DISCHARGE	DSF
EST. TURBINE LEAKAGE	DSF
TOTAL DISCHARGE	DSF
PUMP-BACK	DSF
EVAPORATION	DSF
STORE	DSF
DRAWDOWN	DSF
COMPUTED INFLOW	DSF
STORAGE MN	AC.FT.
RAINFALL	IN.
PAN EVAPORATION	IN.
WIND TRAVEL	MI.
TEMPERATURE 8:00 A.M.	F°
MAXIMUM TEMPERATURE	F°
MINIMUM TEMPERATURE	F°

PLANT HOURS SUMMARY	
AS GENERATOR	AS CONDENSER

	TODAY	THIS MO.	60 MIN. PLANT PEAK TIME	60 MIN. PLANT PEAK MW
UNAVAILABLE UNIT 1				
UNAVAILABLE UNIT 2				

DEMAND METER PEAK	TIME	KWH
1 HR. PEAK		

UNIT NO. 1 (40,000 KW CONVENTIONAL)

	GENERATOR TIME	GENERATOR HRS.	CONDENSER TIME	CONDENSER HRS.	METER IN	MWH
ON						
OFF						
ON						
OFF						
ON						
OFF						
ON						
OFF						
ON						
OFF						
TOTAL TODAY						
PREVIOUS TOTAL						
TOTAL THIS MO.						

UNIT NO. 2 (28,000 KW REVERSIBLE)

	GENERATOR TIME	GENERATOR HRS.	PUMP-BACK MOTOR TIME	PUMP-BACK MOTOR HRS.	METER IN	MWH
ON						
OFF						
ON						
OFF						
ON						
OFF						
ON						
OFF						
ON						
OFF						
TOTAL TODAY						
PREVIOUS TOTAL						
TOTAL THIS MO.						

STATION SERVICE NO. 1

ON OFF	GENERATED TIME	GENERATED MWH	RECEIVED METER	RECEIVED MWH	RECEIVED TIME	ON OFF
TOTAL TODAY						
PREVIOUS TOTAL						
TOTAL THIS MO.						

STATION SERVICE NO. 2

ON OFF	GENERATED TIME	GENERATED MWH	RECEIVED METER	RECEIVED MWH	RECEIVED TIME	ON OFF
TOTAL TODAY						
PREVIOUS TOTAL						
TOTAL THIS MO.						

REMARKS:

PLATE 22

RAINFALL DATA

DEGRAY RESERVOIR

May 1 - 15, 1968

Date	Bismark	Bonner-dale	Glen-wood	Piney Grove	Big Fork	Hopper	Mt. Ida	Amity	Average (100)
1 7A 1P 7P	0	0	0	0	0	0	0	0	0
2 7A 1P 7P	0	0	0	0	0	0	0	0	0
3 7A 1P 7P	0	0	0	0	0	0	0	0	0
4 7A 1P 7P	0	.20	.19	.09	.54	.22	.38	.09	.18
5 7A 1P 7P	0	0	0	0	0	0	0	0	0
6 7A 1P 7P	0	0	0	0	0	0	0	0	0
7 7A 1P 7P	0	0	0	0	0	0	0	0	0
8 7A 1P 7P	1.25	1.45	1.31	1.30	.56	1.80	1.51	1.25	1.42
9 7A 1P 7P	0	0	.04	0	.06	.57	1.02	T	.22
10 7A 1P 7P	.94	1.15	2.01	1.46	.62	1.35	1.00	1.42	1.34
11 7A 1P 7P	1.97	3.00	3.16	1.90	1.00	2.11	1.06	2.85	2.33
12 7A 1P 7P	.50	1.15	1.08	.53	.92	.40	.88	.52	.70
13 7A 1P 7P	.52	2.75	2.34	.03	1.34	5.20	1.83	--	2.29
14 7A 1P 7P	7.20	5.20	6.53	7.99	6.87	5.65	6.29	9.45	6.71
15 7A 1P 7P	0	0	0	T	0	0	0	T	0

PLATE 23

STREAM GAGE DATA

OUACHITA RIVER BASIN

11-25 May 1968

Date	LITTLE MISSOURI R.		CADDO R.	SALINE R.	OUACHITA RIVER		
	Murfreesboro	Boughton	Glenwood	Benton	Arkadelphia	Camden	Monroe
May 8A	6.1	18.8	10.8	22.2	20.5	20.9	32.3
11 4P	7.2			23.1			
8A	5.8	22.6	10.0	17.7	21.5	26.5	32.3
12 4P	5.6						
8A	9.5	19.2	31.4*	11.2	17.4	29.8	32.5
13 4P	14.5*						
8A	12.0	23.3*	16.9	27.8*	28.0	33.1	32.6
14 4P	9.2				30.1*		
8A	5.6	23.1	10.0	20.1	27.9	36.4	32.7
15 4P	5.4						
8A	5.7	20.3	9.2	12.8	24.5	39.9	32.7
16 4P	5.6						
8A	10.4	19.9	10.1	14.1	18.8	42.8	32.8
17 4P	10.5						
8A	7.2	22.2	10.0	17.6	20.5	43.0	33.1
18 4P	6.7					43.1*	
8A	6.1	20.9	9.1		18.8	41.9	33.3
19 4P	5.9						
8A		18.1	8.5	9.5	15.4	40.5	33.4
20 4P							
8A		13.7	8.1	8.4	12.0	39.5	34.0
21 4P							
8A		10.7	7.9	7.8	12.5	38.0	34.5
22 4P							
8A		10.3	7.7	7.1	13.3	36.3	35.4
23 4P							
8A		9.6	7.5	7.0	13.0	34.6	36.5
24 4P							
8A		10.6	7.4	6.7	12.2	33.2	37.7
25 4P							

*Peak Stage

PLATE 24

RESERVOIR DATA

De Gray Reservoir - Caddo River

MAIN DAM

DATE	TIME	RAIN	INFLOW SFD	EVAP SFD	POOL ELEV. FEET	STORAGE SFD	STORAGE CHANGE SFD	TAIL-WATER ELEV. FT.	F.C. GATE FT.	F.C. GATE Q	GENERATION DAILY KWH	GENERATION ACCUM KWH	GENERATION POWER Q SFD	LEAKAGE & SEEPAGE SFD	TOTAL DISCH. SFD
	8														
	4														
	12														
	8														
	4														
	12														
	8														
	4														
	12														
	8														
	4														
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	8														
	4														
	12														
	8														
	4														
	12														
	8														
	4														
	12														

REREGULATING DAM

DATE	TIME	LOCAL INFLOW SFD	EVAP SFD	POOL ELEV. FEET	STORAGE SFD	STORAGE CHANGE SFD	TAIL-WATER ELEV. FT.	SLUICE GATES FEET OPEN 1	SLUICE GATES FEET OPEN 2	SLUICE GATES FEET OPEN 3	SLUICE GATES FEET OPEN 4	SLUICE GATES FEET OPEN 5	SLUICE GATES DISCH SFD	SPILL-WAY DISCH SFD	TOTAL DISCH SFD	PUMP-BACK SFD
	8															
	4															
	12															
	8															
	4															
	12															
	8															
	4															
	12															
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	12															
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	4															
	12															
	8															
	4															
	12															

DE GRAY REREGULATING DAM

DAILY OPERATION WORKSHEET

DATE _____

HR ENDING	ELEVATION		GATES FT					GATE DISCHARGE SFD	SPILLWAY DISCHARGE SFD	REMARKS - TIME OF GATE SETTING ETC.
	POOL	TW	1	2	3	4	5			
MN										
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12N										
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12N										

24 HR SUMMARY

(1) INFLOW FROM MAIN DAM _____ SFD
(2) STORAGE, MN. YDA _____ SFD
(3) STORAGE, MN. TDA _____ SFD
(4) GATES DISCHARGE _____ SFD
(5) SPILLWAY DISCHARGE _____ SFD
(6) PUMP - BACK _____ SFD
(7) EVAPORATION _____ SFD
(8) LOCAL INFLOW * _____ SFD

* LOCAL INFLOW = (3)-(2)-(1)+(4)+(5)+(6)+(7)
CONTAINS INACCURACES OF FLOW MEASUREMENTS.

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
Vicksburg, Mississippi

LMKGH

Date 17 May 1968

SUBJECT: Ouachita River Basin Observed Stages and Predictions

TO: All Concerned

RESERVOIR DATA

Station	Maximum Stages		Observed Data					Predicted Stages	
	Record	Current Year	8 AM Stage M.S.L.	24-Hr. Change Ft.	Discharge Power c.f.s.	Discharge F.C. c.f.s.	Rain In.	Stage Ft.	Date
Narrows Dam	557.8 (1953;58)	563.8 (17 May 68)	563.8	+0.6	900	300**	1.49	564.3	5/18
Blakely Mt. Dam	584.0 (1957)	587.9 (17 May 68)	587.9	+0.4	5,900	0	0.91	588.5	5/19
DeGray Dam		329.4 (14 May 68)	243.7	-29.3	-	5,000	1.09	Slight rise	

GENERATION

Narrows Dam — Total Generation this year 17,819,700 KWH
Blakely Mountain Dam — Total Generation this year 95,051,000 KWH
DeGray Dam — Total Generation this year _____ KWH

RIVER STAGE DATA

Station	Flood Stage	Maximum of Record Stage (Ft.)	Maximum of Record Year	Observed Data 7 AM Stage (Ft.)	Observed Data 24-Hr. Change (Ft.)	Observed Data Rain (In.)	Predicted Stages Stage (Ft.)	Predicted Stages Date
ARKANSAS RIVER								
Little Rock	23	34.4	1927	19.6	-0.2	0.82	Fall	
Pine Bluff*	47	50.7	1957	40.4	+1.0	0.68	Fall	
CADDO RIVER								
Glenwood	20	31.4	1968	10.0	-	1.33	Little change	
L.MISSOURI RIVER								
Boughton	20	27.2	1945	19.9	-0.4	3.70	C = 22.0'	5/18
OUACHITA RIVER								
Arkadelphia	17	30.3	1945	18.8	-5.7	1.65	Little change	
Camden	26	44.8	1945	42.8	+2.9	2.45	C = 43.5'	5/18
Monroe	40	50.45	1958	32.8	+0.1	-	C = 42.0'	5/27
Jonesville	50	58.5	1945	43.7	+0.1		C = 46.0'	5/23
Calion				89.2	+1.7		C = 97.0'	5/19

USWB QUANTITATIVE
Rainfall Forecast:

Date	Amount
17 May	Showers 0.50" - 1.00"
18 May	Showers 0.50"

LMK FL-61
3-1-63

** Spillway

* Jefferson Free Bridge
# Data for _____
Data for _____

RALPH E. MARSHALL
Hydraulics Branch
Ext 573

PLATE 27

CORPS OF ENGINEERS

U.S. ARMY

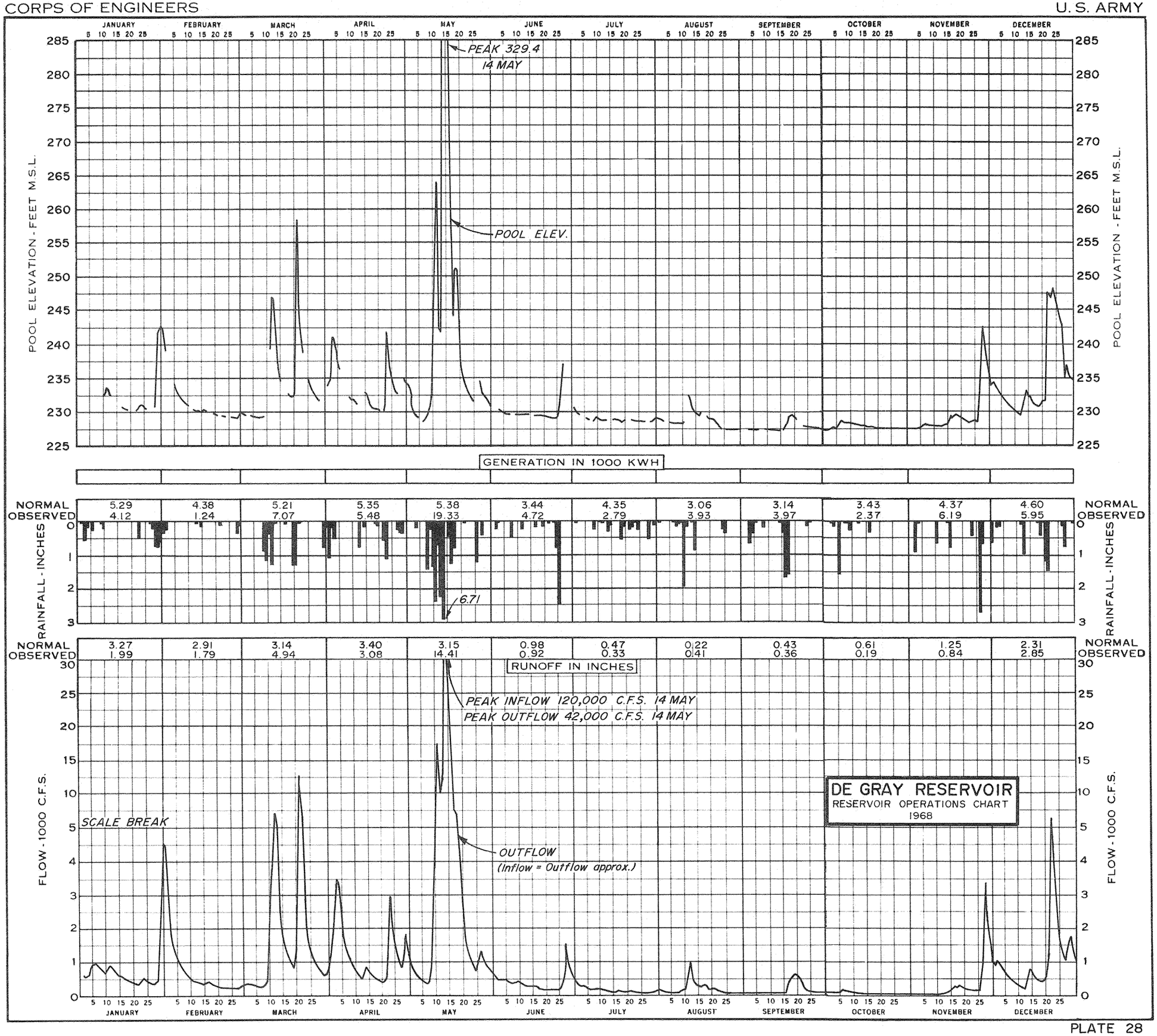
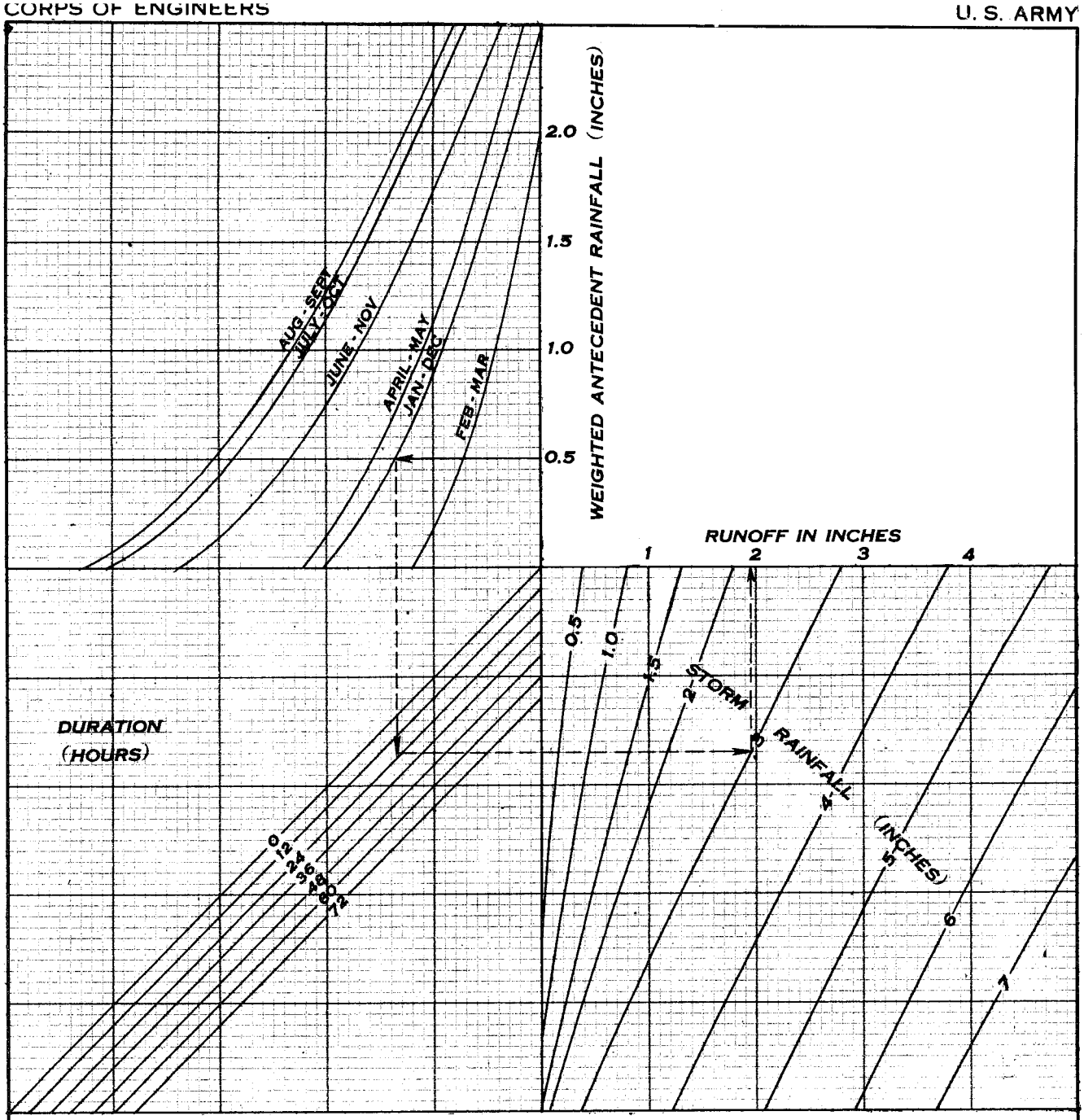


PLATE 28



Note: Weighted antecedent rainfall is rainfall for preceeding 5 days, reduced by 20% per day prior to storm.

CADDO RIVER BASIN, ARKANSAS
RESERVOIR REGULATION MANUAL
DEGRAY RESERVOIR

RAINFALL - RUNOFF FORECASTING CHARTS

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

SEPTEMBER 1969 FILE NO. OC-14-24

PLATE 29

UNIT HYDROGRAPHS

CADDO RIVER BASIN

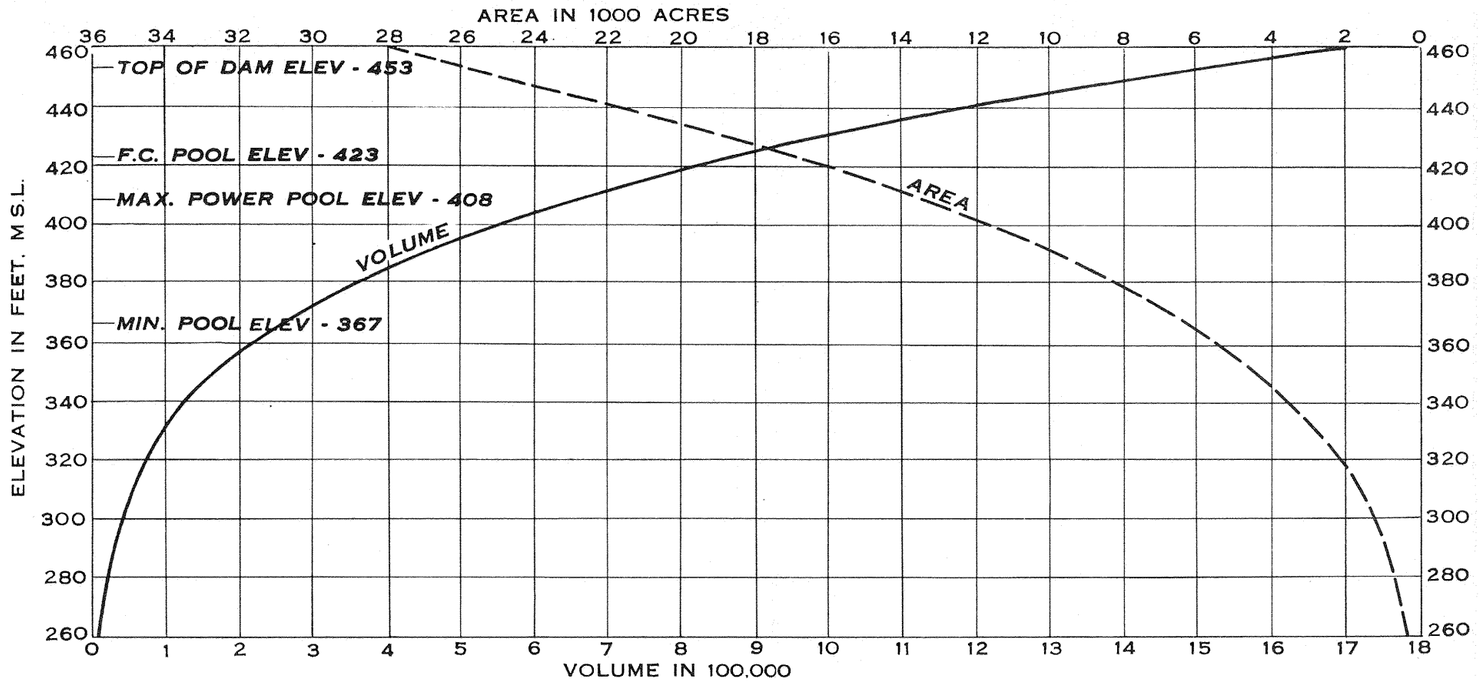
Days	Period	Above DeGray Dam (D.A. 453 Sq. Mi.)		Local DeGray Dam to Reregulating Dam (D.A. 27 Sq. Mi.)	Local Remmel Dam & Reregulating Dam to Arkadelphia (D.A. 315 Sq. Mi.)	Local Arkadelphia & Boughton to Camden (D.A. 2,012 Sq. Mi.)	
		½ SFD 1/	½ SFD 2/	½ SFD	½ SFD	½ SFD 1/	½ SFD 2/
1	1	2,500	2,500	800	2,100	0	0
	2	12,500	18,200	1,900	7,200	200	200
2	1	7,400	3,500	200	3,600	700	700
	2	1,600	100		2,100	1,800	2,000
3	1	300			1,000	3,200	5,500
	2				500	4,400	12,600
4	1				300	5,800	14,600
	2				200	7,400	13,800
5	1					9,200	12,800
	2					10,500	11,200
6	1					9,200	9,600
	2					7,800	8,000
7	1					6,800	6,500
	2					5,900	4,900
8	1					5,200	3,400
	2					4,600	1,800
9	1					4,100	400
	2					3,600	200
10	1					3,200	
	2					2,700	
11	1					2,500	
	2					2,100	
12	1					1,800	
	2					1,500	
13	1					1,200	
	2					1,000	
14	1					800	
	2					500	
15	1					300	
	2					200	

1/ Use for general rainfall under 2" in 24 hours.

2/ Use for more intense rainfall or extreme runoff conditions. (Tentative)

NOTE: Unit rainfall duration, tr, = 12 hrs.

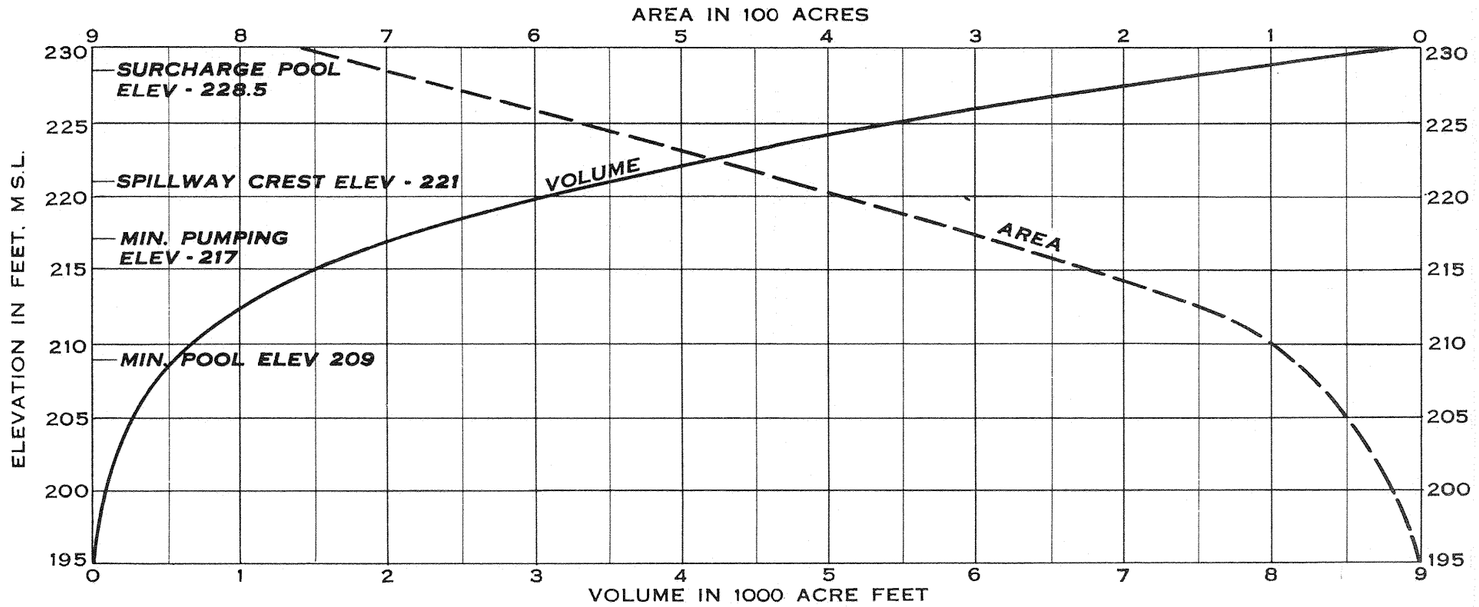
PLATE 30



DE GRAY RESERVOIR

DEGRAY RESERVOIR

Elev. Feet MSL	Area in Acres	Storage in Ac. Ft.	Elev. Feet MSL	Area in Acres	Storage in Ac. Ft.	Elev. Feet MSL	Area in Acres	Storage in Ac. Ft.
225	58	310	379	8,080	348,200	414	14,770	739,400
230	100	700	380	8,230	356,300	415	15,000	754,200
240	180	2,090	381	8,380	364,600	416	15,240	769,400
250	275	4,360	382	8,540	373,000	417	15,470	784,700
260	390	7,660	383	8,690	381,600	418	15,710	800,200
270	530	12,230	384	8,850	390,400	419	15,950	816,100
280	700	18,330	385	9,020	399,300	420	16,200	832,200
290	990	26,380	386	9,180	408,400	421	16,450	848,500
300	1,280	37,350	387	9,350	417,700	422	16,700	865,100
305	1,490	44,280	388	9,520	427,100	423	16,950	881,900
310	1,710	52,280	389	9,690	436,800	424	17,210	899,000
315	1,970	61,480	390	9,860	446,600	425	17,470	916,300
320	2,250	72,030	391	10,040	456,600	426	17,730	933,900
325	2,550	84,020	392	10,220	466,700	427	17,990	951,800
330	2,870	97,550	393	10,400	477,000	428	18,250	969,900
335	3,220	112,800	394	10,580	487,500	429	18,510	988,300
340	3,590	129,800	395	10,760	498,200	430	18,780	1,007,000
345	4,010	148,700	396	10,950	509,000	431	19,040	1,026,000
350	4,470	169,900	397	11,140	520,100	432	19,300	1,045,000
355	4,980	193,500	398	11,330	531,300	433	19,570	1,064,000
360	5,540	219,800	399	11,520	542,700	434	19,830	1,084,000
365	6,140	249,000	400	11,720	554,300	435	20,100	1,104,000
366	6,270	225,200	401	11,920	566,100	436	20,370	1,124,000
367	6,400	261,500	402	12,130	578,100	437	20,640	1,145,000
368	6,530	268,000	403	12,340	590,300	438	20,920	1,166,000
369	6,660	274,600	404	12,550	602,700	439	21,190	1,187,000
370	6,800	281,300	405	12,760	615,400	440	21,480	1,208,000
371	6,930	288,200	406	12,980	628,200	441	21,760	1,230,000
372	7,070	295,200	407	13,200	641,300	442	22,050	1,252,000
373	7,210	302,400	408	13,420	654,700	443	22,350	1,274,000
374	7,350	309,700	409	13,640	668,200	444	22,650	1,296,000
375	7,490	317,100	410	13,860	682,000	445	22,960	1,319,000
376	7,640	324,700	411	14,090	696,000	446	23,270	1,342,000
377	7,780	332,400	412	14,310	710,300	447	23,590	1,365,000
378	7,930	340,200	413	14,540	724,700	448	23,920	1,389,000



REREGULATING BASIN

REREGULATING BASIN

Elev. Feet MSL	Area in Acres	Storage in Ac. Ft.	Elev. Feet MSL	Area in Acres	Storage in Ac. Ft.	Elev. Feet MSL	Area in Acres	Storage in Ac. Ft.
195	0	0	210	100	700	225	550	5,960
196	6	3	211	120	800	226	600	6,140
197	12	10	212	142	940	227	630	6,750
198	18	30	213	168	1,090	228	670	7,400
199	24	50	214	196	1,270	229	715	8,090
200	30	80	215	226	1,480	230	750	8,820
201	36	110	216	258	1,730	231	790	9,590
202	42	150	217	290	2,000	232	830	10,400
203	48	190	218	400	2,340			
204	55	240	219	415	2,750			
205	60	300	220	425	3,170			
206	67	370	221	430	3,600			
207	75	440	222	460	4,040			
208	82	520	223	490	4,520			
209	90	600	224	520	5,020			

QUACHITA RIVER BASIN

DE GRAY DAM AND RESERVOIR

CADDO RIVER, ARKANSAS

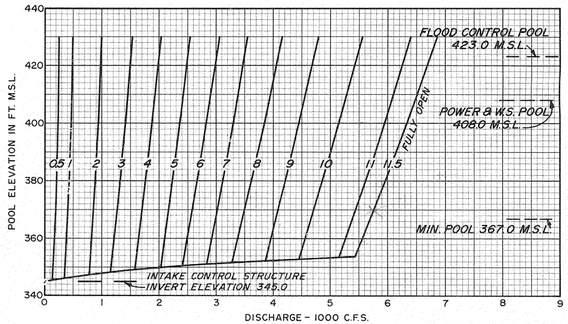
RESERVOIR REGULATION MANUAL

AREA VOLUME CURVES

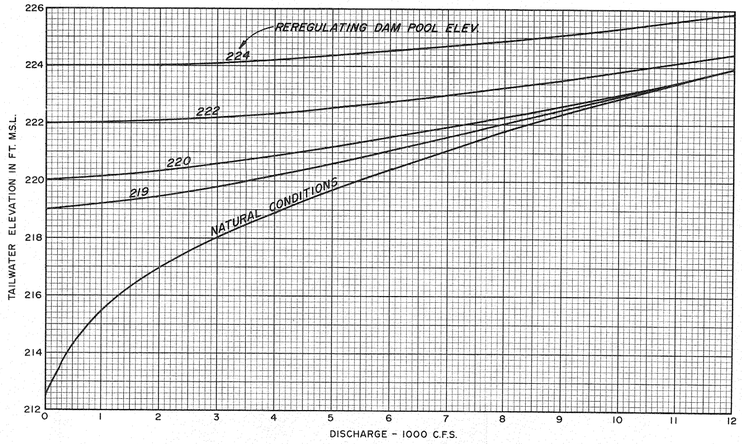
SCALES AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

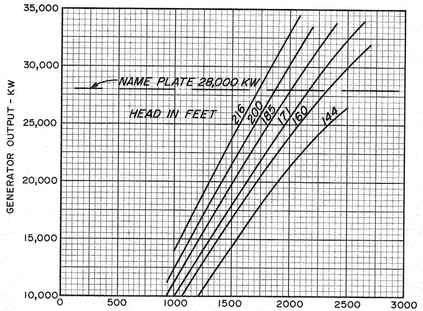
SEPTEMBER 1969 FILE NO. OC-14-24



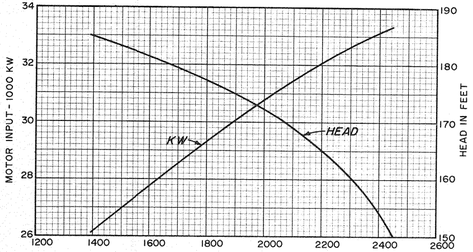
FLOOD CONTROL GATE



TAILWATER RATING CURVE



28,000 KW REVERSIBLE UNIT



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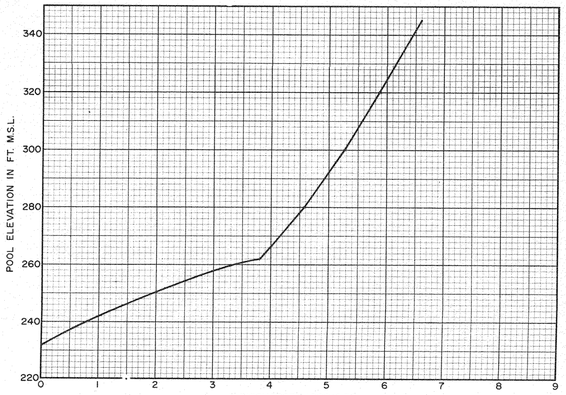
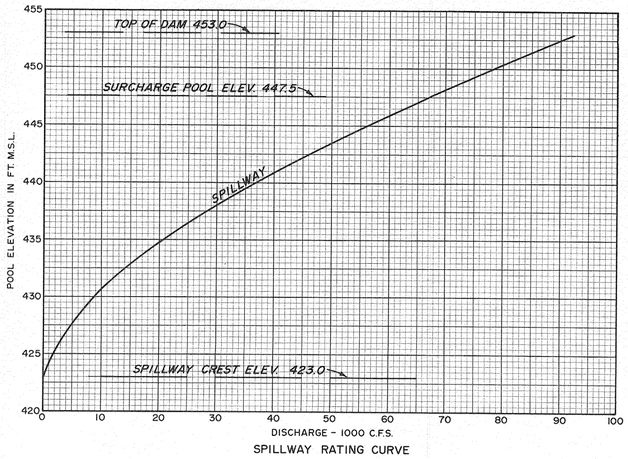
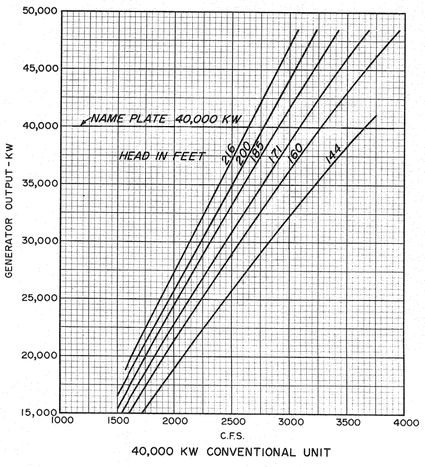


LOW LEVEL EMERGENCY OUTLET



SPILLWAY RATING CURVE



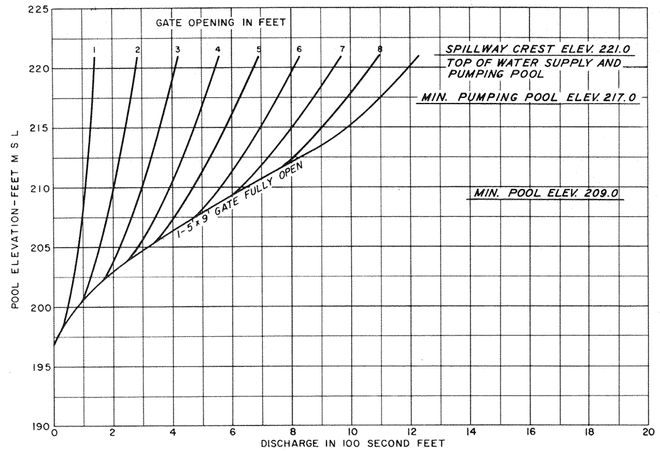
40,000 KW CONVENTIONAL UNIT

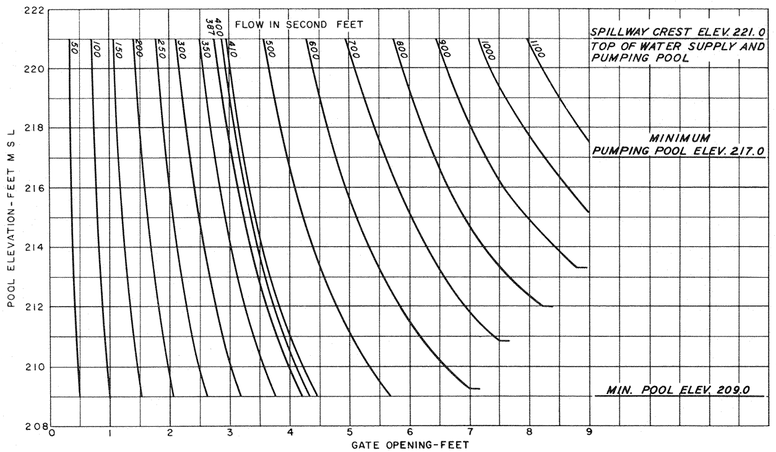
CADDO RIVER BASIN, ARKANSAS
RESERVOIR REGULATION MANUAL
DE GRAY RESERVOIR

DISCHARGE CURVES

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

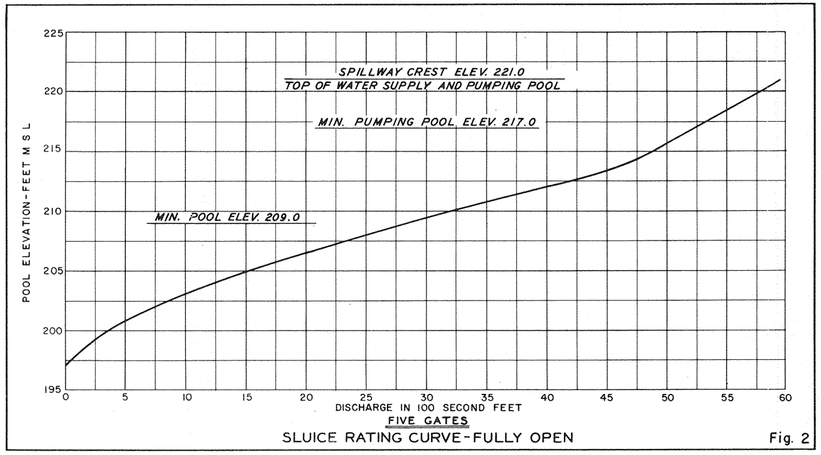
SEPTEMBER 1969 FILE NO. OC-14-24





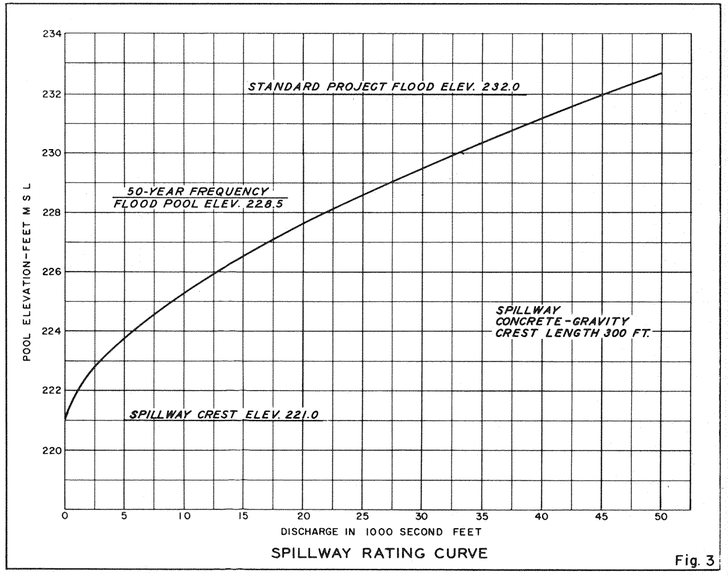
ONE GATE

SLUICE RATING CURVES-PARTIAL OPENINGS Fig. 1

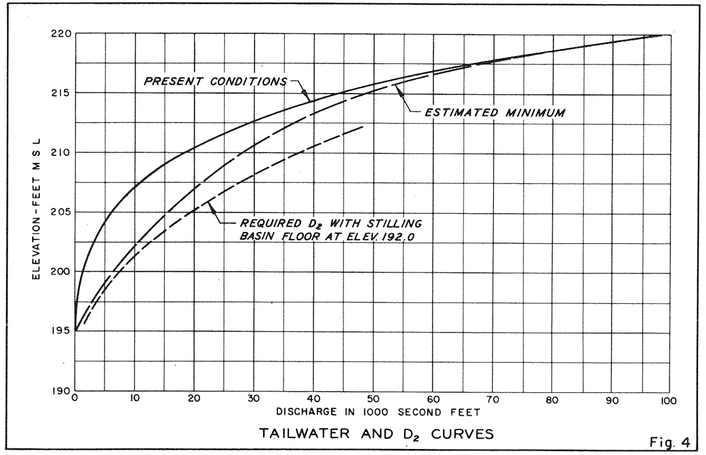


FIVE GATES

SLUICE RATING CURVE-FULLY OPEN Fig. 2



SPILLWAY RATING CURVE Fig. 3



TAILWATER AND D_2 CURVES Fig. 4

SLUICES

FIVE 5-FOOT BY 9-FOOT
INTAKE INVERT ELEVATION_____197.0
GATE SEAT ELEVATION_____196.5

OUACHITA RIVER AND TRIBUTARIES
ARKANSAS AND LOUISIANA

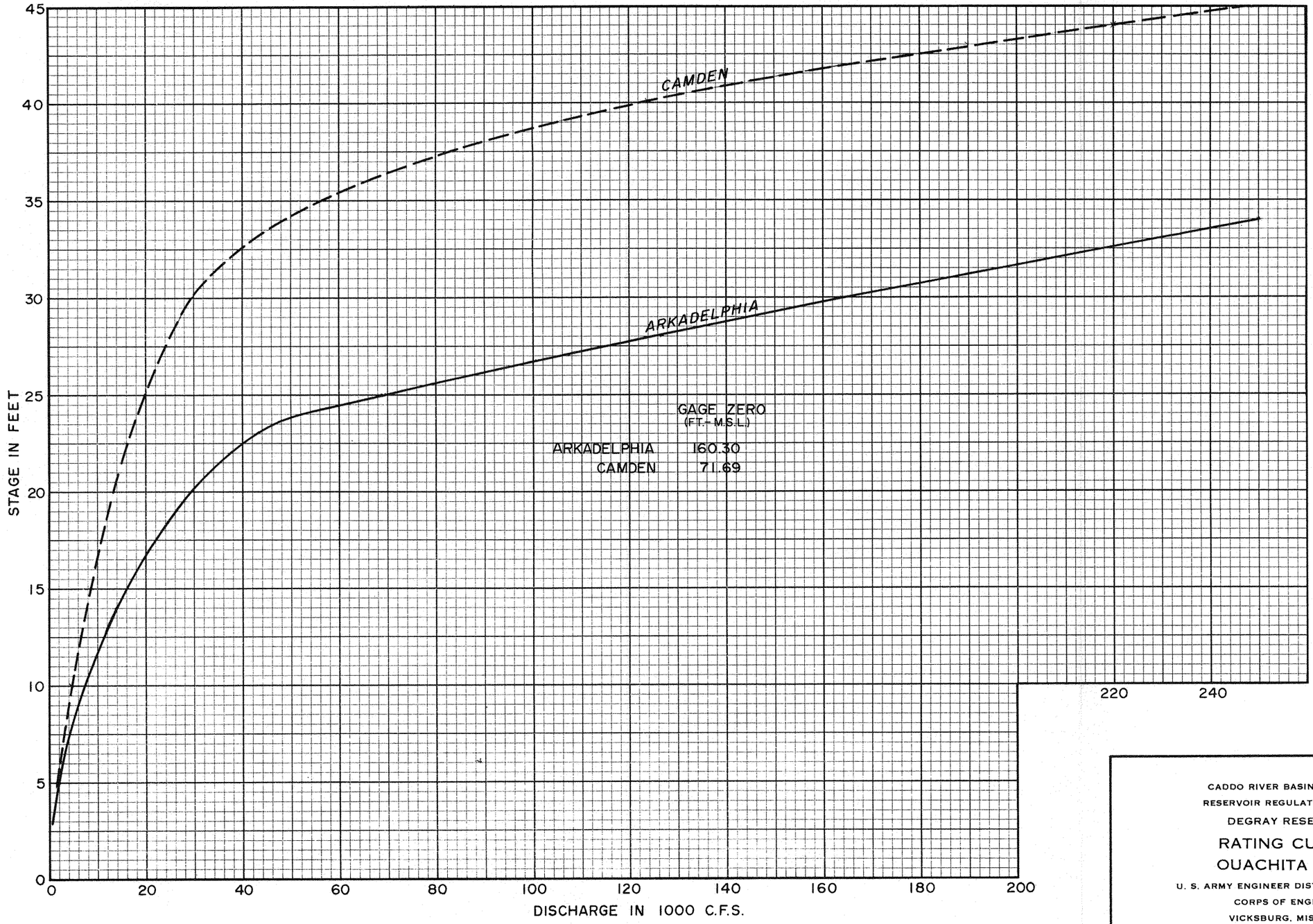
DE GRAY RESERVOIR

CADDO RIVER, ARKANSAS
RESERVOIR REGULATION MANUAL

REREGULATING DAM
DISCHARGE CURVES

SCALES AS SHOWN
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

SEPTEMBER 1969 FILE NO. OC-14-24



CADDO RIVER BASIN, ARKANSAS
RESERVOIR REGULATION MANUAL
DEGRAY RESERVOIR

RATING CURVES
OUACHITA RIVER

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

SEPTEMBER 1969 FILE NO. OC-14-24

RIVER FORECAST ROUTING

OUACHITA RIVER
AT
ARKADELPHIA, ARK.

February 1956

Day	Period	Remmel Discharge 1000 c.f.s.	Remmel Routed 2/1 1000 c.f.s. (1)	Estimated Outflow Reregulating Dam 1000 c.f.s. (2)	Unit Graph 1000 c.f.s.	Local Inflow Remmel & Reregulating Dam to Arkadelphia RF. In.	Re. In.	1000 c.f.s. SRO	Base	Total (3)	Computed Discharge Arkadelphia 1000 c.f.s. (1)+(2)+(3)
14	1	2.3		.5							
	2	2.3		.5							
15	1	4.0	2.3	2.0	2.1	1.0	0.3	.6	.2	.8	5.1
	2	12.5	3.2	2.0	7.2			2.2	.2	3.0	8.2
16	1	10.0	8.2	2.0	3.6	0.9	0.4	1.9	.2	2.1	12.3
	2	14.3	11.2	2.0	2.1			3.5	.2	3.7	16.9
17	1	12.3	12.2	2.0	1.0			1.7	.2	1.9	16.1
	2	12.4	13.3	2.0	.5			1.0	.2	1.2	16.5
18	1	12.0(a)	12.4	2.0	.3	1.2	1.0	2.6	.2	2.8	17.2
	2	10.0	12.2	2.0	.2			7.5	.2	7.7	21.9
19	1	8.0	11.0	2.0				3.7	.2	3.9	16.9
	2	8.0	8.0	2.0				2.2	.2	2.4	12.4
20	1	5.0(a)	6.5	2.0				1.0	.2	1.2	9.7
	2		5.0	2.0				.5	.2	.7	7.7
21	1		5.0	4.0				.3	.2	.5	9.5
	2		5.0	4.0				.2	.2	.4	9.4
22	1										
	2										
23	1										
	2										
24	1										
	2										

NOTES: This tabulation illustrates routing procedure to predict stages resulting from 18 February rain. Runoff from rains of 15 - 16 February are computed to establish flows from antecedent rain. Flows are in 1000 c.f.s. for 12-hour periods.

(a) Predicted Remmel Outflows.

RIVER FORECAST ROUTING
OUACHITA RIVER
AT
CAMDEN, ARK.

FEBRUARY 1956

DAY	PERIOD	ARKADELPHIA 1/	BOUGHTON	TOTAL	RT. CON. 10/2	RT. CON. 8/2	UNIT GRAPH	RE IN.	RE IN.	RE 1000 CFS	BASE	COMPUTED CAMDEN DISCH. 1/
	1											
	2											
13	1	3.0	2.8	5.8								
	2	3.0	2.2	5.2								
14	1	3.0	1.7	4.7								
	2	3.0	1.5	8.5								
15	1	5.1	1.4	6.5								
	2	8.2	1.3	9.5								
16	1	12.3	1.2	13.5								
	2	18.7	1.6	20.3								
17	1	16.1	2.6	18.7		(7.0)					5.0	11.5
	2	16.5	3.9	20.4		(7.0)					4.5	11.5
18	1	19.2	5.0	24.5		9.2	0	1.0	0.5	0	4.0	13.2
	2	21.9	6.5	28.5		12.1	0.2			0.1	4.0	16.2
19	1	16.9	8.0	24.9		12.8	0.7			0.4	3.5	16.7
	2	12.4	8.5	20.9		14.8	1.8			0.9	3.0	18.7
20	1	9.7	7.5	17.2		17.3	3.2			1.6	3.0	21.9
	2	10.3	6.5	16.8		19.5	4.4			2.2	2.5	24.2
21	1	11.8	5.5	17.3		21.0	5.8			2.9	2.0	25.9
	2	11.5	4.5	16.0		21.4	7.4			3.7		25.1
22	1	11.0		15.5		21.0	9.2			4.6		25.6
	2					20.8	10.5			5.2		26.0
23	1					20.2	9.2			4.6		24.8
	2					19.0	7.8			3.9		22.9
24	1					16.1	6.8			3.4		19.5
	2					14.0	5.9			3.0		17.0
25	1						5.2			2.6		
	2						4.6			2.3		
26	1						4.1					
	2						3.6					
27	1						3.2					
	2						2.7					
28	1						2.5					
	2						2.1					
	1						1.8					
	2						1.5					
	1						1.2					
	2						1.0					
	1						0.8					
	2						0.5					
	1						0.3					
	2						0.2					
	1						0					
	2											
	1											
	2											
	1											
	2											

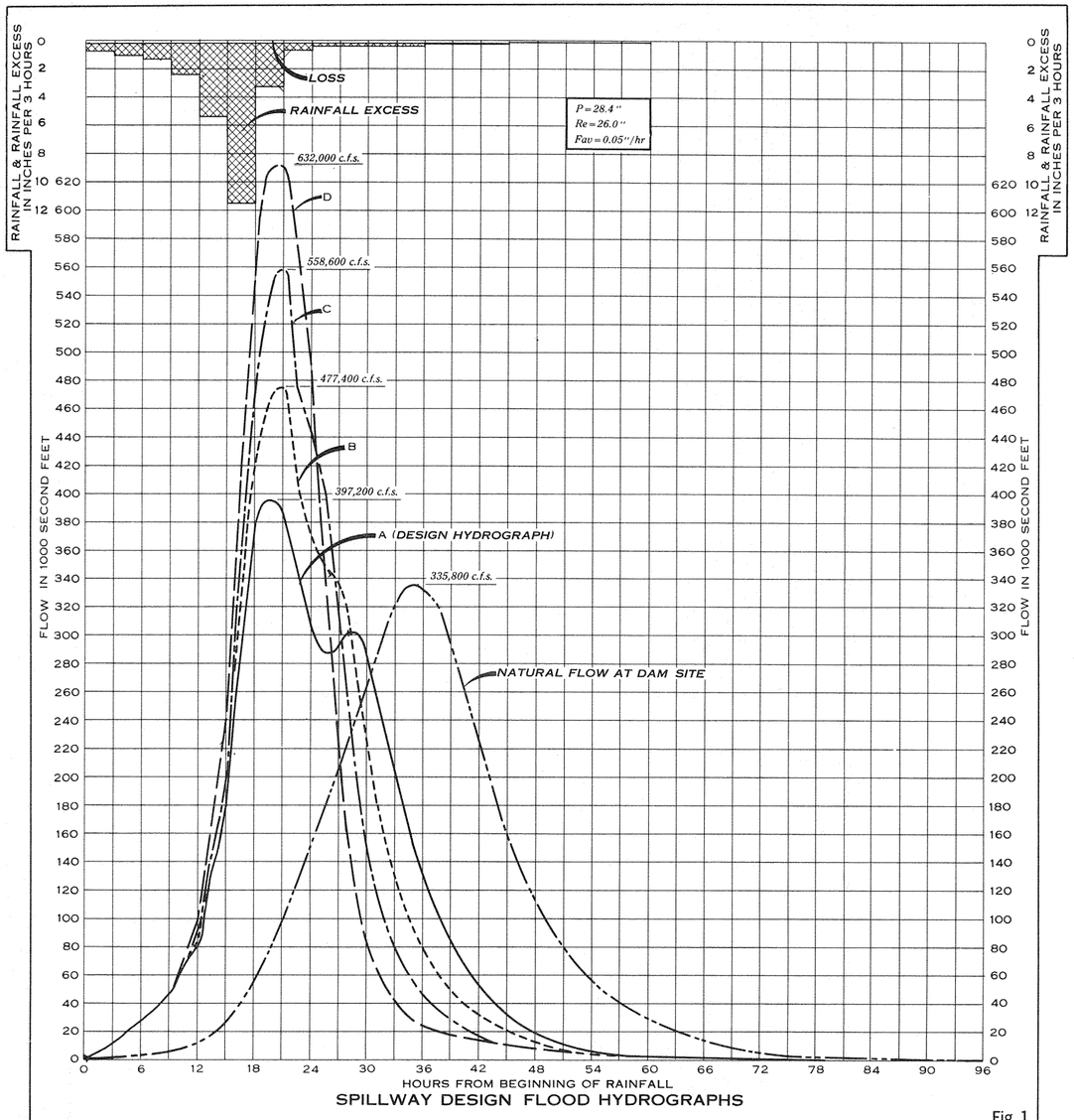
NOTES: Predicted Boughton flows are obtained by Average-Lag method similar to Arkadelphia.

* Select Routing constant by judgment of intensity and duration of storm.

1/ Computed flows.

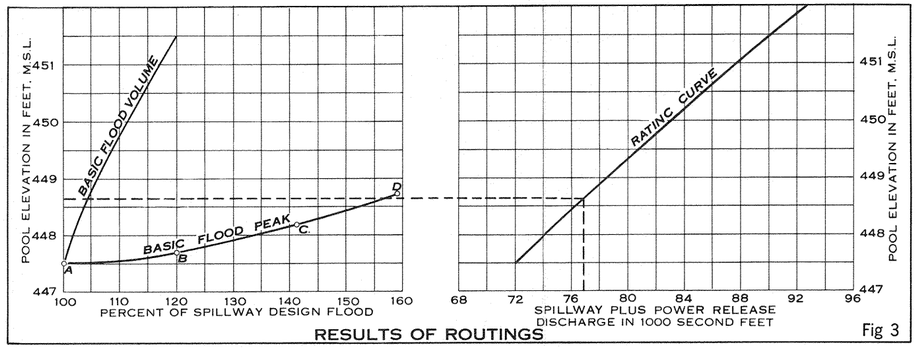
This tabulation illustrates routing procedure.

PLATE 36



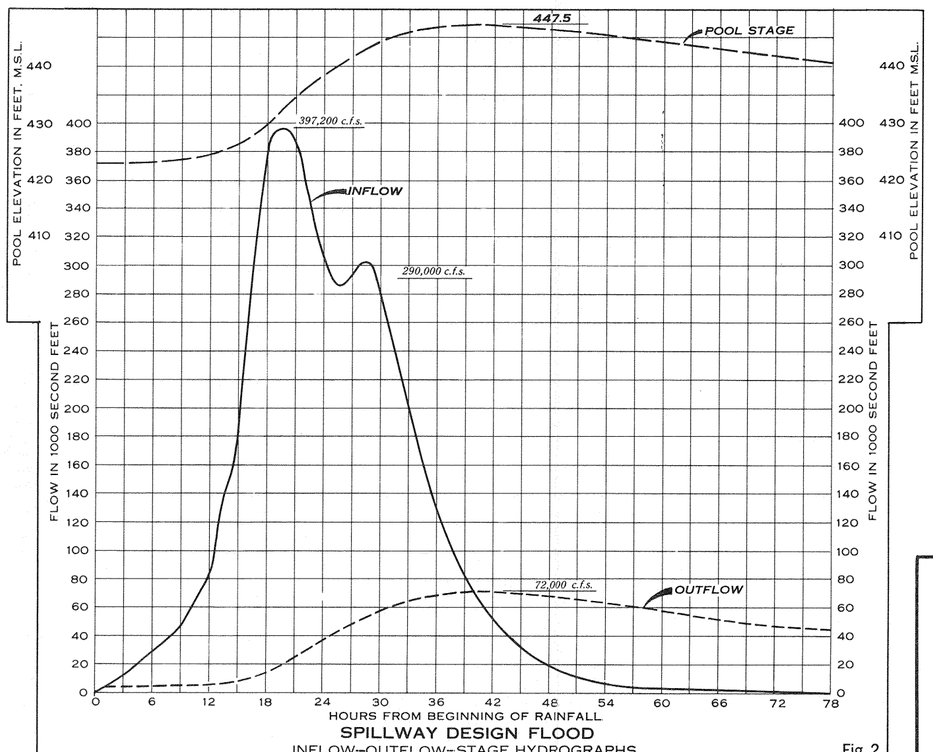
SPILLWAY DESIGN FLOOD HYDROGRAPHS

Fig 1



RESULTS OF ROUTINGS

Fig 3



SPILLWAY DESIGN FLOOD

INFLOW–OUTFLOW–STAGE HYDROGRAPHS

Fig 2

Note:

Drainage Area = 453 Squre Miles

Spillway
Crest Elevation - 423.0 feet m.s.l.
Crest Length - 200 feet

Reservoir level assumed to be at top of Flood Control Pool, Elevation 423.0 at beginning of flood.

Power release 5,000 c.f.s.

OUACHITA RIVER BASIN

DE GRAY DAM AND RESERVOIR

CADDO RIVER, ARKANSAS

RESERVOIR REGULATION MANUAL

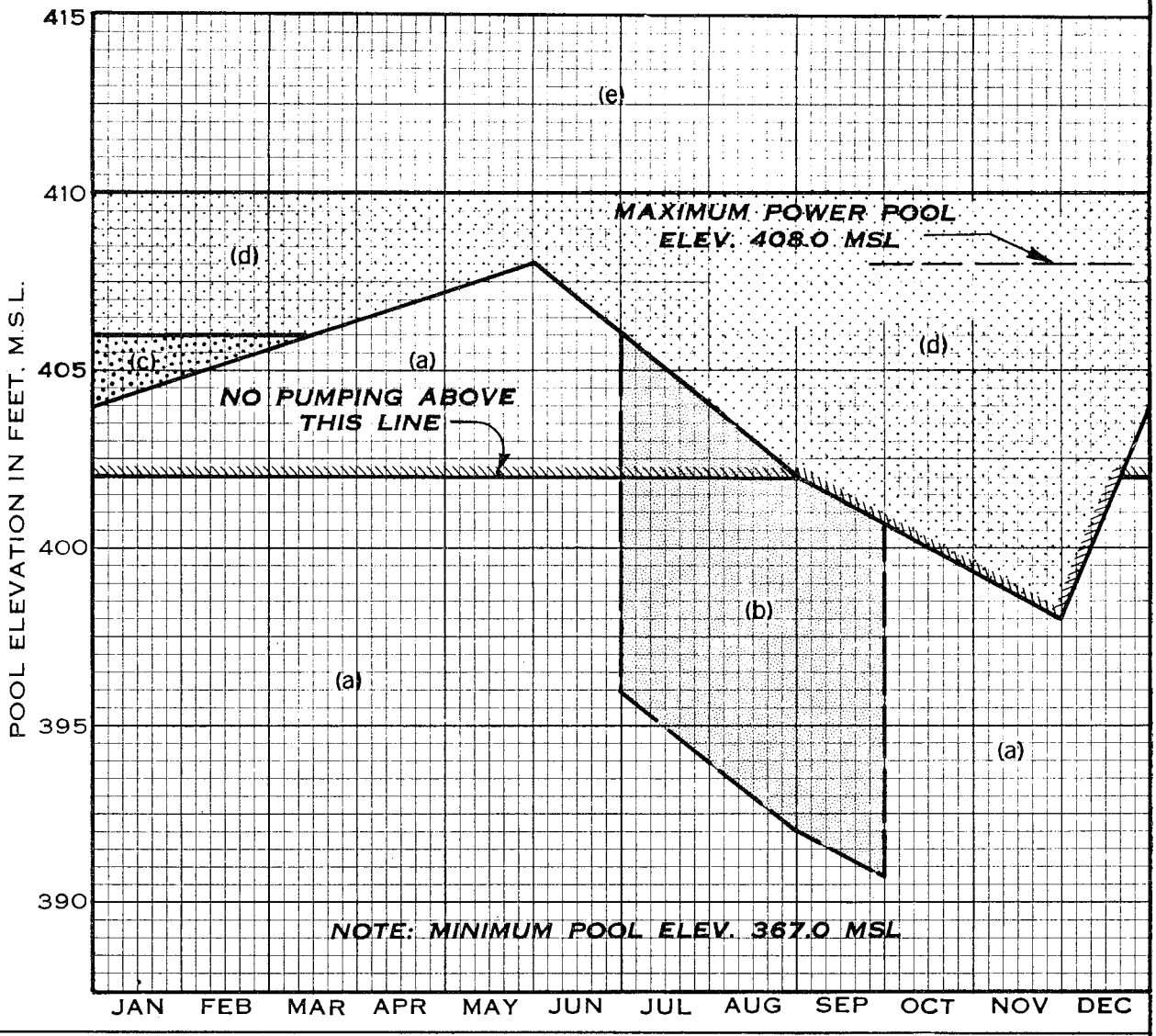
SPILLWAY DESIGN FLOOD

SCALES AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

SEPTEMBER 1969

FILE NO. OC-14-24



1. Below rule curve, areas (a), (b), and (c) generate as follows (or equivalent):

Jan. - May	;	68,000 KW at 10.03% L.F.
June	;	68,000 KW at 13.68% L.F.
Jul. - Sep.	;	68,000 KW at 18.24% L.F.
Oct.	;	68,000 KW at 13.68% L.F.
Nov. - Dec.	;	68,000 KW at 10.03% L.F.

2. Area (d), generate at plant capacity, 68,000 KW

3. Area (e), generate at plant capacity and waste to 6,000 C.F.S.

NOTES: Based on 152 cfs water supply and 33 hours per week pumping. Prime continuous power is 9,300 KW. Generation may be made at machine capability, not exceeding 115% of Nameplate capacity.

CADDO RIVER BASIN, ARKANSAS

DE GRAY DAM AND RESERVOIR
CADDO RIVER, ARKANSAS

RESERVOIR REGULATION MANUAL

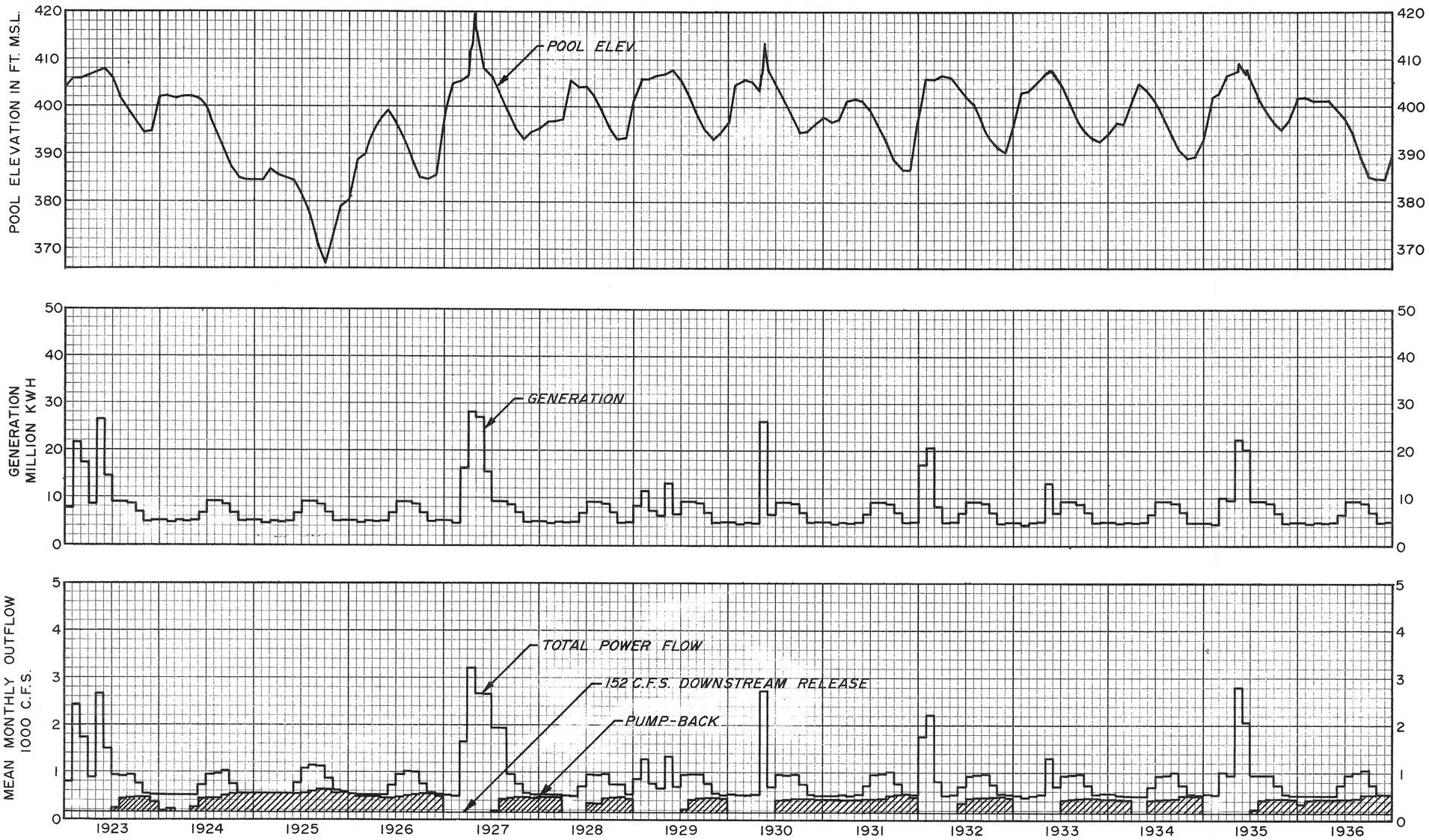
POWER RULE CURVE PUMPED STORAGE PROJECT

SCALES AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

SEPTEMBER 1969 FILE NO. OC-14-24

PLATE 38



OUACHITA RIVER BASIN

DE GRAY DAM AND RESERVOIR

CADDO RIVER, ARKANSAS

RESERVOIR REGULATION MANUAL

POWER GRAPHS

IN 3 SHEETS SHEET 1

SCALES AS SHOWN

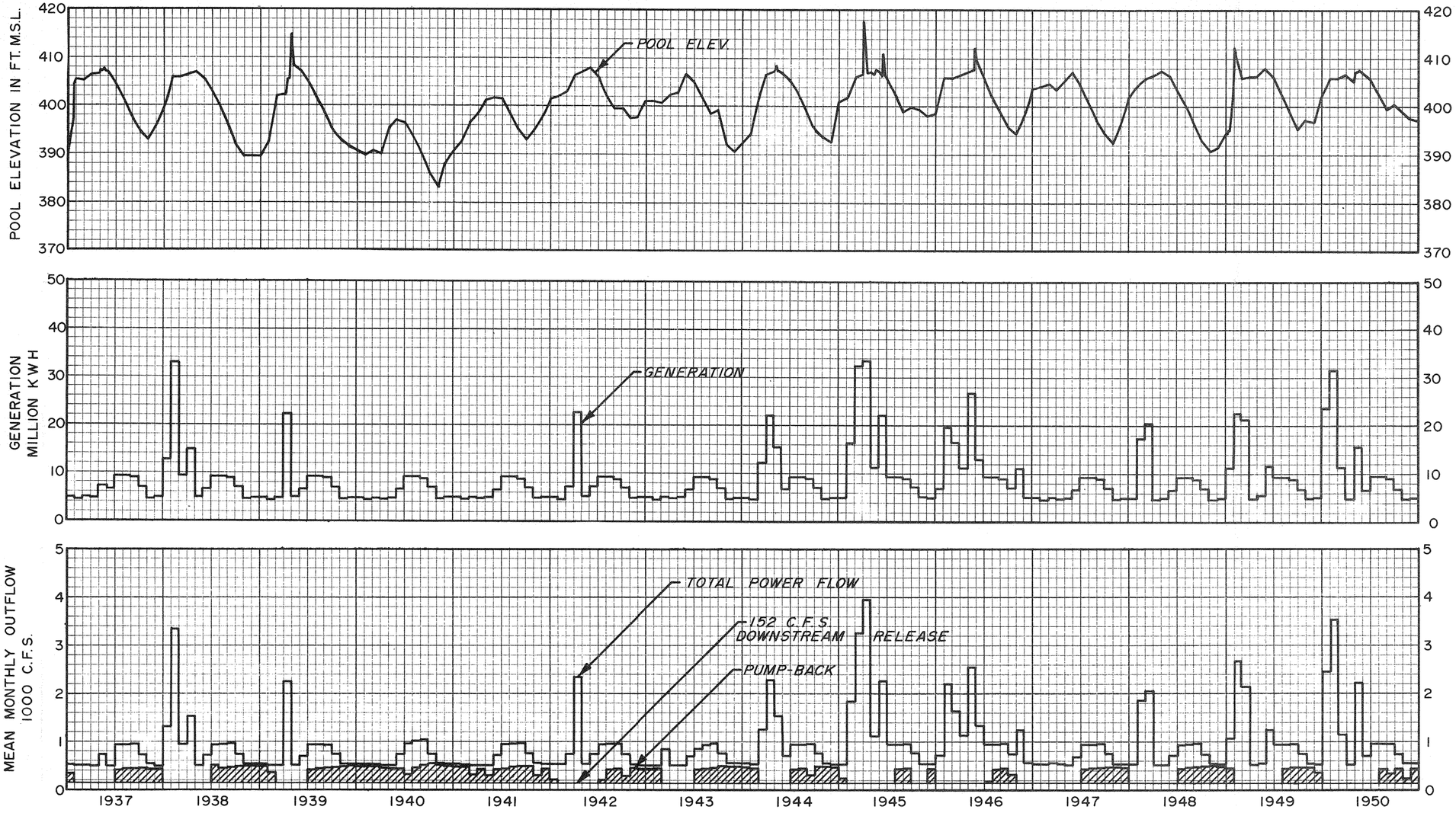
U. S. ARMY ENGINEER DISTRICT, VICKSBURG

CORPS OF ENGINEERS

VICKSBURG, MISSISSIPPI

SEPTEMBER 1969 FILE NO. OC-14-24

PLATE 39



OUACHITA RIVER BASIN

DE GRAY DAM AND RESERVOIR

CADDO RIVER, ARKANSAS

RESERVOIR REGULATION MANUAL

POWER GRAPHS

IN 3 SHEETS SHEET 2

SCALES AS SHOWN

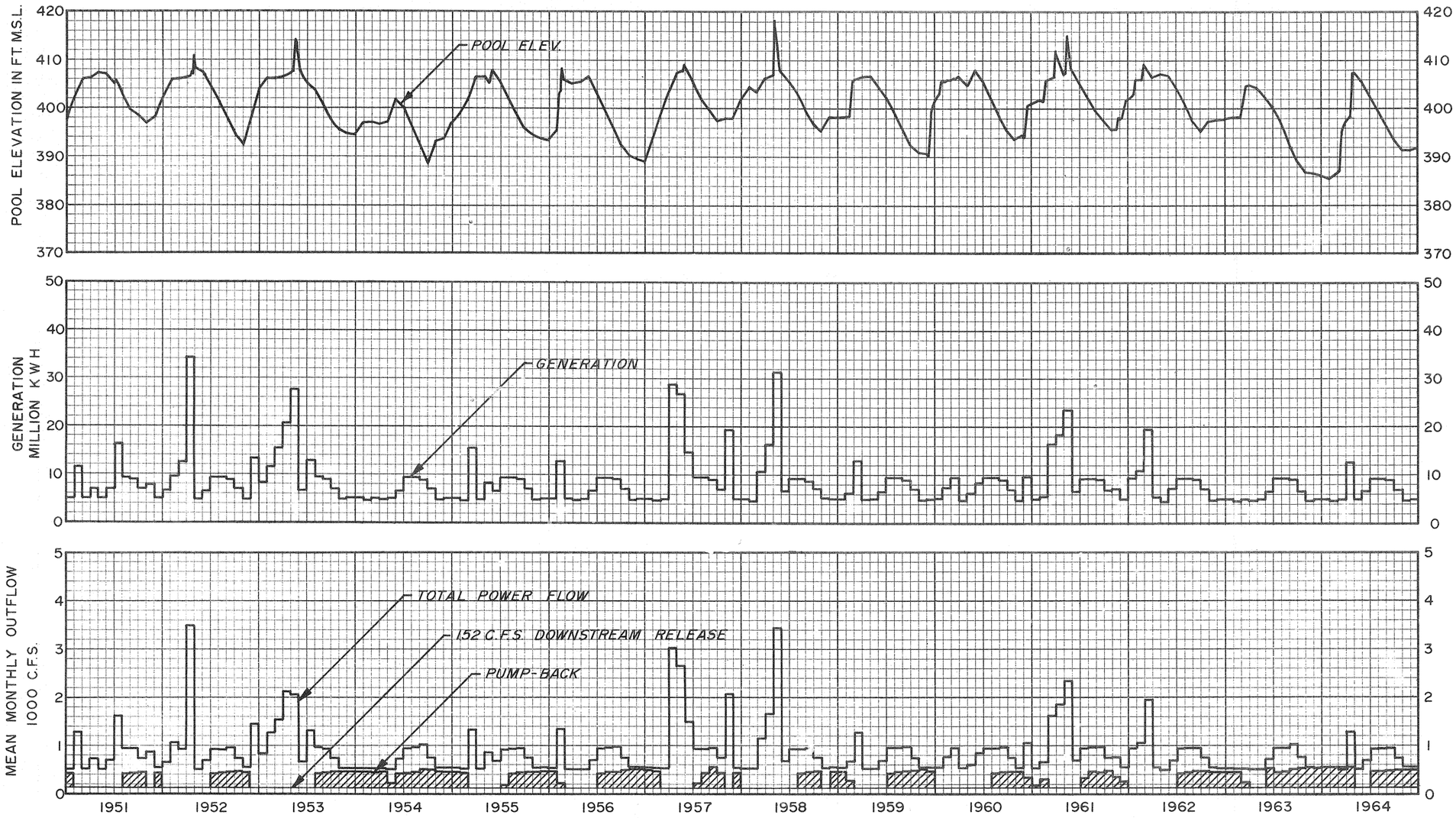
U. S. ARMY ENGINEER DISTRICT, VICKSBURG

CORPS OF ENGINEERS

VICKSBURG, MISSISSIPPI

SEPTEMBER 1969 FILE NO. OC-14-24

PLATE 39



OUACHITA RIVER BASIN

DE GRAY DAM AND RESERVOIR

CADDO RIVER, ARKANSAS

RESERVOIR REGULATION MANUAL

POWER GRAPHS

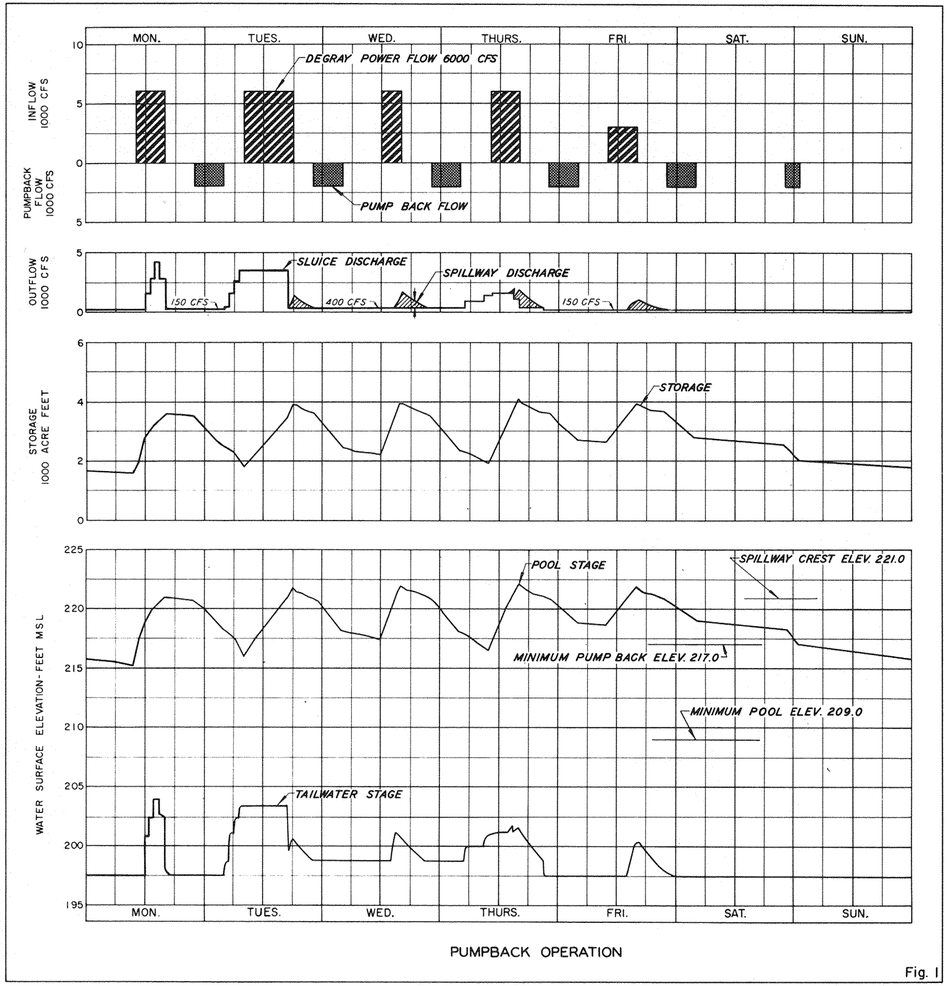
IN 3 SHEETS SHEET 3

SCALES AS SHOWN

U S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

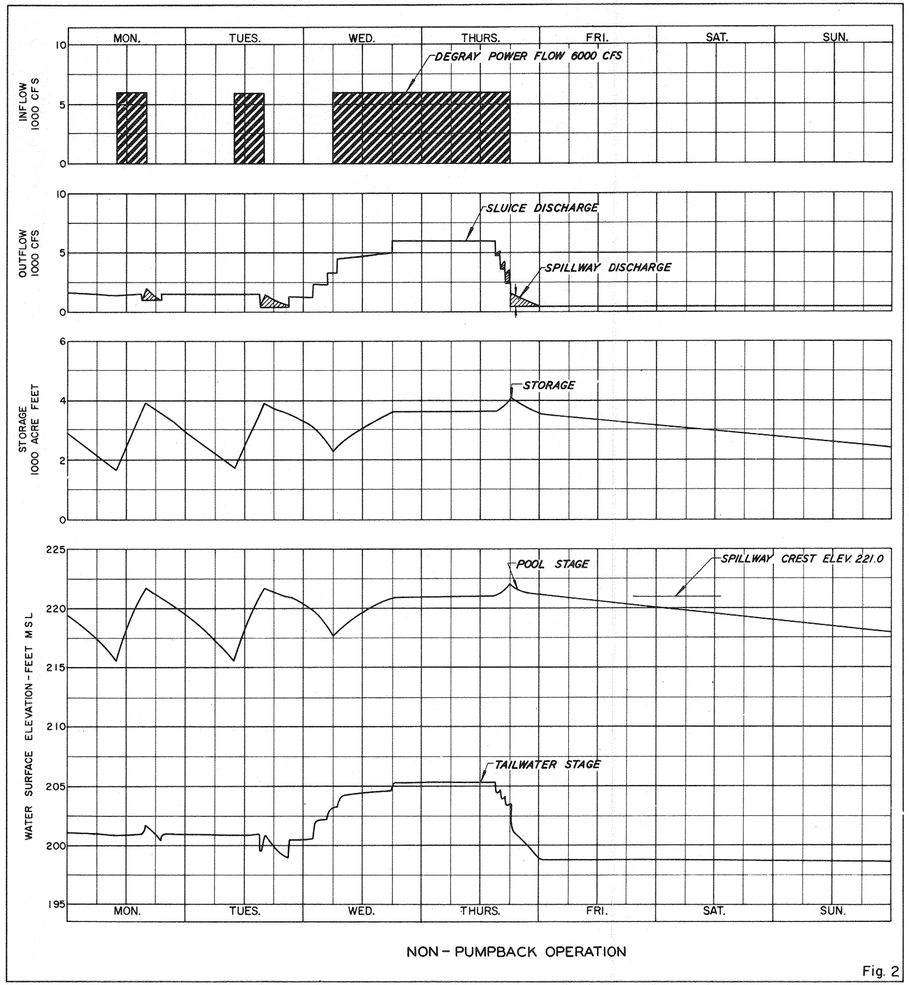
SEPTEMBER 1969 FILE NO. OC-14-24

PLATE 39



PUMPBACK OPERATION

Fig. 1



NON - PUMPBACK OPERATION

Fig. 2

OUACHITA RIVER AND TRIBUTARIES
ARKANSAS AND LOUISIANA

DE GRAY RESERVOIR

CADDO RIVER, ARKANSAS
RESERVOIR REGULATION MANUAL

REREGULATING DAM

OPERATIONAL HYDROGRAPHS

SCALES AS SHOWN

U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI

SEPTEMBER 1969

FILE NO. OC-14-24

CADDO RIVER AT DEGRAY DAM

MEAN MONTHLY FLOWS IN CUBIC FEET PER SECOND

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	YEAR
1925	782	753	142	120	177	63	129	45	207	1,035	990	342	325
1926	1,435	446	987	913	471	93	48	35	73	290	390	2,226	622
1927	1,897	696	1,848	5,517	884	1,260	171	97	43	135	410	481	1,116
1928	439	259	348	2,193	265	810	335	171	40	35	293	1,613	566
1929	1,835	1,286	845	907	1,539	307	129	32	110	65	440	668	678
1930	2,116	789	465	133	3,755	130	26	23	57	510	450	584	759
1931	26	361	955	430	235	83	77	97	73	87	203	1,981	386
1932	3,519	2,228	919	517	165	87	423	87	83	39	73	1,155	773
1933	1,845	711	806	1,127	1,464	107	39	48	103	139	187	494	590
1934	648	218	1,194	1,313	265	47	74	50	137	143	253	790	429
1935	2,068	789	1,713	1,233	3,012	1,689	103	90	210	294	693	1,065	1,084
1936	371	124	235	263	77	60	90	8	17	239	183	855	212
1937	3,368	414	826	607	867	187	61	35	120	139	840	932	705
1938	2,613	3,393	1,045	1,748	268	163	68	42	20	16	273	174	800
1939	674	2,268	623	3,700	371	190	77	200	22	31	43	74	673
1940	110	314	135	1,220	594	287	235	132	33	18	917	629	383
1941	568	1,021	513	817	600	417	106	113	323	797	940	900	589
1942	619	786	1,432	2,600	735	377	119	210	727	52	337	861	735
1943	277	171	832	727	1,387	387	55	10	10	45	117	339	365
1944	558	1,810	2,161	2,533	1,569	347	45	39	50	184	83	1,697	920
1945	697	2,750	5,971	1,464	1,268	1,982	200	139	867	684	340	323	1,382
1946	2,226	2,229	1,745	1,400	3,391	497	139	145	110	132	1,977	1,674	1,301
1947	574	257	752	863	992	110	68	42	113	145	893	1,365	517
1948	974	2,290	2,142	753	419	93	90	77	43	55	307	690	656
1949	4,405	1,204	2,265	560	994	847	194	90	73	755	183	1,306	1,079
1950	3,261	3,536	1,258	327	2,136	397	245	152	1,003	206	207	129	1,058
1951	1,184	2,204	577	1,023	490	370	1,197	87	443	181	1,123	1,026	815
1952	1,500	1,083	1,377	4,025	371	127	77	65	63	52	1,167	2,710	1,048
1953	1,268	1,307	1,655	2,390	3,294	90	1,152	97	117	58	93	152	973
1954	719	300	161	360	1,423	93	29	13	30	1,232	343	777	461
1955	571	936	2,332	590	1,201	207	232	77	187	206	103	148	566
1956	629	3,507	306	600	903	63	42	29	33	32	123	129	521
1957	1,145	1,221	1,416	3,813	3,040	953	113	303	263	542	2,107	1,026	1,324
1958	1,060	304	1,677	1,920	3,544	363	355	94	133	223	1,110	265	926
1959	309	2,238	1,411	630	181	228	175	85	85	148	183	2,220	649
1960	1,431	801	1,050	242	1,329	456	216	73	89	117	373	2,084	692
1961	638	1,411	2,735	1,074	2,496	172	131	184	415	120	972	1,250	966
1962	1,787	2,015	1,377	842	512	154	76	52	331	776	341	273	704
1963	287	289	1,715	402	209	89	81	65	72	37	144	121	294
1964	80	346	1,835	2,860	257	59	44	294	184	105	240	323	550
1965	1,359	1,804	820	369	246	355	163	51	235	70	90	112	464
1966	566	1,094	232	2,270	816	55	51	1,074	110	103	122	489	577
1967	359	319	723	962	2,908	416	263	122	127	134	246	958	633
1968	782	753	1,936	1,248	5,656	373	128	161	147	74	341	1,121	1,068
MEAN	1,218	1,205	1,261	1,355	1,290	355	179	117	176	238	483	876	726

PLATE 41

APPENDIX A

DEGRAY PROJECT
Automatic Flood Control Operation

The following automatic restrictions will be observed by the Project Manager:

(1) Power Restrictions. At any time the river stage of the Ouachita River at Arkadelphia exceeds 17 feet (approximately 20,000 c.f.s.), restrict power generation to 816,000 KWH daily which is equivalent to one-half plant capacity. Generation restriction periods will run from 8 a.m. to 8 a.m. while Arkadelphia is above 17 feet. If generation exceeds the restriction amount at the time the restriction is put in effect, no generation will be made during the remaining 24-hour period ending 8 a.m. No restriction on peaking is required.

(2) Flood Control Restrictions. At any time when flood control storage is being released:

(a) Close the flood control gate when the river stage of the Ouachita River at Arkadelphia exceeds 17 feet.

(b) Close the flood control gate when 1.00 inch of rain or more occurs at the dam in 24 hours or less.

(c) It is the responsibility of the superintendent at the dam to be sure the stage at Arkadelphia is below 17 feet when releasing flood storage.

(3) Notify the Reservoir Regulation Section of the District office of the restrictions as soon as practicable after the restriction has been put into effect. Personnel of the Reservoir Regulation Section are on duty Saturdays, Sundays, and holidays during storm periods. During nonwork hours, personnel of the Reservoir Regulations Section may be reached at one of the following phone numbers:

Reservoir Regulation Section office phone-----601-636-1320
Albert R. Duncan, home phone----------601-636-1356
Ralph E. Marshall, home phone----------601-636-5739
Fred Bayley, home phone----------601-638-1036

APPENDIX B

DEGRAY PROJECT
Automatic Reregulating Dam Operation

The following automatic operation will be affected by operating personnel at the dam:

(1) Minimum Low Flow Release. The minimum continuous release from the reregulating reservoir during the initial years of project operation is 152 c.f.s. The operator will maintain gate settings to provide this minimum flow as nearly as practicable. The schedule for 152 c.f.s. is as follows:

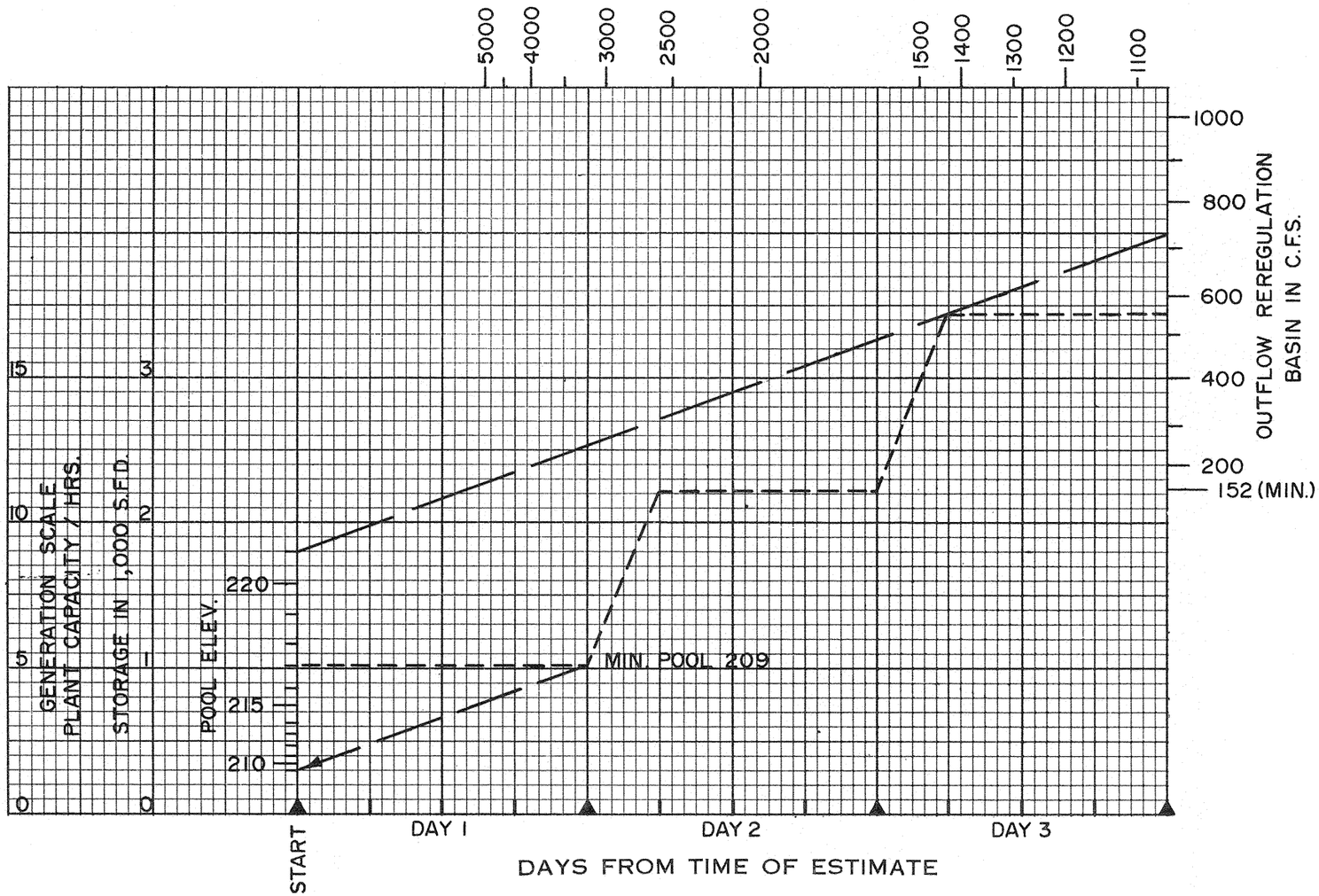
Pool Elevation Rereg. Dam ft	Gate Setting Two gates (#2 & #3) ft open
216 and above	.6
209-216	.8

No additional release will be made if pump-back is anticipated.

(2) Additional Release to Maintain Uniform Downstream Flows During Periods of No Pump-back. In addition to the continuous minimum flow provided by the above schedule additional gates may be opened to release anticipated inflow during periods of no pump-back. A study of the stilling basin generally indicated that the number of gates operating for sluice flows as listed below will give satisfactory performance with present tailwater conditions.

Flow in c.f.s.	No. Gates
100 - 400	2
400 - 1,000	3
1,000 - 2,000	4
2,000 - 6,000	5

Sluice flow will be less than 1,000 c.f.s. about 80 percent of the time and less than 2,000 c.f.s. about 85 percent of the time. A sluice flow of 6,000 c.f.s. will occur only about 2 percent of the time. It is not anticipated that the tailwater will be lowered to the estimated minimum conditions; however, the subbasin will provide additional energy dissipation in the event the tailwater is lowered below present conditions. These additional openings will be made when



EXAMPLE:
START AT OBSERVED POOL ELEVATION (217)
DRAW FLAT LINE THROUGH NON-GENERATION PERIOD
(SAY THROUGH DAY 1)
MEASURE UP ANTICIPATED GENERATION AMOUNTS
(SAY FIRST PERIOD, DAY 2, PLANT CAPACITY 6 HRS)
(SAY FIRST PERIOD, DAY 3, PLANT CAPACITY 6 HRS)
DRAW LINE FROM ELEV 221 ENVELOPING THE POINTS
ON THIS LINE.
FIND REQUIRED OUTFLOW (700 CFS IN THIS CASE)
THE MINIMUM POOL OBTAINED WITH THIS DRAFT
IS 209

CADDO RIVER BASIN, ARKANSAS
RESERVOIR REGULATION MANUAL
DEGRAY RESERVOIR
DEGRAY REREGULATING BASIN
ESTIMATE OF REQUIRED RELEASE
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI
SEPTEMBER 1969 FILE NO. OC-14-24

INCLOSURE B-1

APPENDIX C

DeGRAY PROJECT
Automatic Temperature Control Operation

The following operation of the baffle gates and trash racks in the intake tower will be made by the Project Manager.

(1) Normally, the trash rack sections will be set in position for the centerline intake indicated below and the baffle gates set in the alternative positions when the reservoir water surface elevations are at levels indicated below:

Pool Elevation Ft-M.S.L.	Gate Settings Centerline Intake
Above 392	395.0
377 - 392	380.0
Below 377	355.5

(2) Instructions for other settings to maintain water temperature control will be furnished by the Reservoir Regulation Section as normal operating instructions.