BLACK WARRIOR-TOMBIGBEE RIVER BASIN

RESERVOIR REGULATION MANUAL

JOHN HOLLIS BANKHEAD RESERVOIR

APPENDIX E

BLACK WARRIOR RIVER, ALABAMA

AUGUST 1975

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PREFACE

This manual was prepared in 1974 and a draft was submitted to SAD and OCE on 30 January 1975. It reflects conditions as of that time, particularly with regard to the new single left lock. The new lock was placed in operation on 9 June 1975 and the old lock has since been abandoned, the gates removed, the chamber partially filled with rock and concrete and a concrete plug poured across the middle miter sill.

PERTINENT DATA

GENERAL

Location of dam, navigation miles above Mobile	365.5
Drainage area above dam, square miles	3,990

RESERVOIR

Pool elevation, feet msl	
Maximum operating pool	255.0
Minimum operating pool	252.0
Maximum pool, standard project flood	260.5
Maximum pool, spillway design flood	270.4
Reservoir area, acres	
Maximum operating pool (elev. 255.0)	9,245
Minimum operating pool (elev. 252.0)	8,730
Spillway crest (elev. 241.5)	6,975
Reservoir storage volume, acre feet	
Maximum operating pool (elev. 255.0)	296,215
Minimum operating pool (elev. 252.0)	269,170
Spillway crest (elev. 241.5)	179,290
Upper miter sill (elev.239.0)	169,320
Minimum tailwater elevation, feet msl	186.0
Length of reservoir, river miles (including three forks)	87

STREAM FLOW

Flows at Tuscaloosa, Alabama, cfs	
Average annual flow (1895-1970)	7,653
Maximum mean monthly flow (Mar. 1900)	52,891
Minimum mean monthly flow (Oct. 1898)	93
Maximum flow (21 Feb. 1961)	224,000
Minimum flow (23 Oct. 1953)	37
Flows at damsite	
Maximum flow (Mar. 1951), cfs	183,000
Standard project flood peak inflow, cfs	341,200
Spillway design flood peak inflow, cfs	670,700
Bankfull stage below dam, feet msl	188.5

DOUBLE-CHAMBERED LOCK

Nominal size each chamber, feet	52 by 285
Usable length each chamber, feet	285
Maximum lift, upper chamber, feet	35.5
Maximum lift, lower chamber, feet	33.5
Elevation of minimum intermediate pool, feet above msl	219.5
Elevation of upper miter sill, feet above msl	229.0

PERTINENT DATA (Cont'd)

DOUBLE-CHAMBERED LOCK (Cont'd)

Elevation of intermediate miter sill, feet above msl	205.0
Elevation of lower miter sill, feet above msl	173.5
Elevation of upper floor, feet above msl	204.5
Elevation of lower floor, feet above msl	173.0
Elevation of top of upper-chamber walls, feet above msl	257.0
Elevation of top of lower-chamber walls, feet above msl	223.5
Elevation of top of upper guide wall, feet above msl	257.0
Elevation of top of lower guide wall, feet above msl	190.0
Height of upper miter gate, feet	28
Height of intermediate miter gate, feet	52
Height of lower miter gate, feet	50
Culvert size, feet	6 by 7
Type of filling-and-emptying system	port
Average time for one complete lockage, minutes	48

SINGLE-LIFT LOCK

Nominal size of chamber, feet	110 by 600
Distance center to center of gate pintles, feet	670
Maximum lift, feet	69
Elevation of upper stoplog sill, feet above msl	239
Elevation of upper miter sill, feet above msl	239
Elevation of lower stoplog sill, feet above msl	173
Elevation of lower miter sill, feet above msl	173
Elevation of chamber floor, feet above msl	172
Elevation of top of floor culverts, feet above msl	172
Elevation of top of upper guard wall, feet above msl	262
Elevation of top of upper guide wall, feet above msl	272
Elevation of top of upper gate blocks, feet above msl	272
Elevation of top of chamber walls, feet above msl	262
Elevation of top of lower approach walls, feet above msl	194
Percent of time inoperative	negligible
Type of upper gate	horizontally framed miter
Height of upper gate, feet	33
Type of lower gate	horizontally framed miter
Height of lower gate, feet	89
Type of culvert valves	reverse tainter
Dimensions of culverts at valves, feet	14 x 14
Elevation of culvert ceilings between valves, feet above msl	176
Minimum submergence of culvert valves, feet	10
Type of filling-and-emptying system	floor culverts
Type of emergency dams	stoplogs
Elevation of top of upstream emergency dam, feet above msl	259
Type of operating machinery	hydraulic oil pressure
Average time for one lockage, minutes	30
Total volume of lock chamber, dsf	60

PERTINENT DATA (Cont'd)

SPILLWAY

Total spillway length, feet	1,170.8
Overflow crest length, feet	1,022.5
Elevation of crest, feet above msl	241.5
Type of crest gates	vertical lift
Number of gates	22
Height of gates, feet	13.5
Length of gates, feet between piers,	
20 gates	49
2 gates	21.25
Number of piers	23
Width of piers, feet:	
End pier at lock	5.3
21 intermediate piers	6.5
End pier at powerhouse	6.5
Service bridge deck, feet above msl	292.1
Bottom of crest gates in raised position, feet above msl	272.5

APPROACH CANAL

Maximum length, upstream upper gate pintle, feet	4,825
Minimum width, feet	300
Closest distance to existing lock, feet	500
Maximum elevation bottom of canal, feet above msl	241
Minimum excavated elevation bottom of canal, feet above msl	239
Maximum height of excavated cut, feet	200

NONOVERFLOW DAM AT END OF EXISTING SPILLWAY

Type	concrete, earth and rockfill
Length, concrete portion, feet	240
Length, earth and rockfill portion, feet	190
Minimum top width, concrete portion feet	15
Minimum top width, earth and rockfill portion feet	33
Top elevation, feet above msl	273.5
Side slopes, earth and rockfill portion	1 on 3

NONOVERFLOW DAM AT LEFT ABUTMENT OF NEW LOCK

Type	earth and rockfill
Length, feet	330
Top width, esplanade, feet	153
Top elevation, feet above msl	272
Upstream side slope	1 on 2
Downstream side slope	contained in land wall backfill

PERTINENT DATA (Cont'd)

POWER PLANT

Elevation - feet, msl	
Low point of draft tube	135.0
Centerline of distributor	190.0
Generating units	
Number	1
Speed - rpm	103
Turbines	
Type	fixed-blade propellor, vertical shaft
Capacity at full gate, 66.5 foot design-head, horsepower	63,200
Generators	
Capacity, kilowatts (nameplate)	45,125
Average annual energy output, kilowatt hours	160,000,000

CHAPTER I

INTRODUCTION

RESERVOIR REGULATION MANUAL

Authorization
Purpose and scope
Related manuals

DESCRIPTION OF PROJECT

Location
General features
Gated spillway
Double-chambered lock
Single-lift lock
Control station
Non-overflow dams
Powerhouse
Reservoir
Taking line for land acquisition
Recreational development

HISTORY OF PROJECT

Authorization
Planning and design
Construction

1-1. Authorization. This reservoir regulation manual is prepared in accordance with ER 1110-2-240 and paragraphs 6-01 through 6-03 of EM 1110-2-3600, "Reservoir Regulation".

1-2. Purpose and scope. This manual presents the reservoir regulation plan for the Bankhead project. Included are descriptions of physical components of the lock and dam, operating procedures, historical facts and other pertinent data. Also presented are general characteristics of the area including; flood frequencies, meteorology, examples of reservoir regulation and a discussion on river forecasting. Details of coordinated operations of Bankhead Lock and Dam within the multiple project system of the Black Warrior-Tombigbee River basin are presented to insure optimum benefits consistent with the physical characteristics and purposes for which the system was authorized.

1-3. In conjunction with the Master Reservoir Regulation Manual for the entire Black Warrior-Tombigbee River basin, this manual provides a reference source for higher authority and for the training of new personnel.

1-4. Related manuals. While the intent of this manual is to document reservoir regulation procedures and certain other pertinent information concerning Bankhead Lock and Dam, other manuals are prepared to furnish guidance in operation and maintenance of the project. The "Operation and Maintenance Manual" for Bankhead Lock and Dam is for this purpose.

1-5. The "Black Warrior-Tombigbee River Basin Reservoir Regulation Manual", of which this manual is an appendix, contains general information for the entire basin. Other appendices to the basin master manual are prepared for all reservoir projects within the basin for which one or more project functions are the responsibility of the U. S. Army Corps of Engineers.

DESCRIPTION OF PROJECT

1-6. Location. Bankhead Lock and Dam, on the Black Warrior River in the upper reach of the Holt Rrservoir, is at navigation mile 365.5 above Mobile, Alabama, about 149 miles above the confluence of the Black Warrior and Tombigbee Rivers. The total project is located in Tuscaloosa, Jefferson and Walker Counties with the lock and dam about 32 miles west of Birmingham, Alabama, in Tuscaloosa County. The reservoir covers about 9,245 acres at elevation 255.0 and provides navigable depths to navigation mile 22 on the Locust Fork and to navigation mile 46 on Mulberry Fork. Drainage area above Bankhead Lock and Dam is approximately 3,990 square miles. Location of the project is shown on chart 1.

1-7. General features. Bankhead Lock and Dam consists of a concrete spillway section, with 22 crest gates, extending across the riverbed; a double-chambered lock; a single lift lock; a hydropower plant and appurtenances; and non-overflow dikes connecting the project to high ground. Principal features are described in subsequent paragraphs and plans and sections are shown on charts 1 through 6.

1-8. Gated spillway. The gated spillway stretches across the main stream of the Black Warrior River and provides controlled release of flow over the crest. This is a reinforced concrete gravity structure with 20 gates, 52 feet wide by 13.5 feet high and 2 gates, 24 feet wide by 13.5 feet high. The gates are supported by 23 piers, each 6.5 feet wide except for the end pier next to the lock which is 5.3 feet wide. The gates are recessed into the piers on each side so that the openings for the larger gate bays are 49 feet wide and for the smaller bays the openings are 21.25 feet wide. Total length of the spillway is 1,170.8 feet with the 1,022.5 feet in the clear between piers. Crest of the spillway is at elevation 241.5 feet above msl and the bottom of the gates, in fully raised position, are at elevation 272.5 feet above msl which is approximately 2.1 feet above the maximum computed pool for the spillway design flood. Top of the retaining wall next to the double-lift lock is at elevation 257.0 feet above msl ~~while at the other end of the dam top of the retaining~~ wall is at elevation 270.0 feet above msl. After completion of the new single-lift lock a new non-overflow dam will be built from the spillway across the double-lift lock to high ground with a top elevation of 273.5 feet above msl. The deck of the spillway service bridge and the support platform for the gate hoisting machinery are at the same elevation, 292.1 feet above msl. Each of the 22 vertical lift gates is operated by a locally controlled 5-horsepower pump and motor. Typical plan elevations and sections for the spillway are shown on charts 2 and 3.

1-9. Double-chambered lock. The double-lift lock located on the left bank adjacent to the spillway provides a maximum total lift of 69 feet with upper and lower pools at elevation 255.0 and 186.0 respectively. Top of lock walls for the lower chamber are at elevation 223.5 feet above msl and for the upper chamber the top of lock walls are at elevation 257.0 feet above msl. The upper and lower guide walls are at elevations 257.0 feet above msl and 190.0 feet above msl respectively. Minimum clearance over the miter sill is 12.5 feet. Nominal dimensions of each chamber are 52 feet by 285 feet. The lock chambers are filled and emptied through a system of ports located in the lock walls and normal time for complete lockage of a single tow is about 48 minutes. Plan and sections of the double-lift lock are shown on chart 4.

1-10. Upon completion of a new single lift lock, now under advanced stages of construction, use of the old double-lift lock will be discontinued. The upper chamber of the old lock will be utilized as a boat basin for small Government craft and a barge on which stoplogs will be stored for use on the upper end of the new lock. The boat basin will be provided by removing the upper miter gate and providing a watertight concrete cutoff wall across the lock walls and intermediate gate sill. Several small openings will be provided in the river wall of the upper chamber to prevent stagnation of the water within the chamber. The lower chamber of the old lock will be filled with excavated sandstone material and grassed. The lower guard wall will be removed for aesthetic reasons.

1-11. Single-lift lock. The replacement lock is located in the left bank about 2,000 feet downstream from the centerline of the old double-lift lock and is situated at the end of a canal excavated around the old lock. Nominal dimensions of the lock chamber are 110 feet wide by 600 feet long with upper and lower guide walls having usable lengths approximately equal to the length of the lock chamber. The tops of the upper guide wall and the lock walls at the upper gate blocks are at elevation 272.0 feet above msl while the lock walls are at elevation 262.0 feet above msl downstream from the gate blocks. Elevation of the lower approach walls are at elevation 194.0 feet above msl which is equal to the maximum known flood at this location. The upper and lower miter sills are at elevations 239.0 feet above msl and 173.0 feet above msl respectively providing a minimum clearance of 13 feet for navigation. Both the upper and lower miter gates are horizontally framed.

1-12. The filling and emptying system consists of manifold-type intake ports located immediately upstream from upper gate blocks on the channel sides of the guide and guard walls, a longitudinal culvert in each lock wall, a system of longitudinal floor culverts in the chamber, and two emptying ports that discharge into the river just downstream of the lower gate. Flow in each culvert is controlled by two reverse-tainter valves. Lockage time is estimated to be about 30 minutes and the volume of water needed for an average lockage is about 60 dsf. Plan and sections of the single-lift lock are shown on chart 5.

1-13. <u>Control station</u>. The control station for the new single-lift lock is a single story, reinforced concrete building located on the river wall of the lock just downstream of the upper miter gate. The control station has a basement formed within the lock wall with the floor at elevation 255.7. The building houses a standby generator, a switchboard for the lock, operating equipment for the lock, a rest room and an electric elevator for access to the road to the spillway and to the upstream gallery.

1-14. <u>Non-overflow dams</u>. Two non-overflow dams are required, one connecting the land wall of the new lock to the left abutment and one connecting the left end of the existing spillway to high ground. The connection for the spillway cannot be made until the old double-lift lock is retired from use but will consist of a concrete cutoff wall extending from the spillway end pier across the walls of the intermediate sill and about 130 feet landward. An impervious earth core, protected by rockfill will wrap around the concrete dam and will extend landward to high ground. Top of the dam will be at elevation 273.5 feet above msl and will have a minimum width of 15 feet to provide a roadway to the spillway.

1-15. The non-overflow dam at the new lock will connect the upper gate block to the left abutment and will consist of an impervious earth core protected by a rockfill. Top of the dam adjacent to the lock will be at elevation 272.0 feet above msl and will be paved to form an esplanade.

1-16. <u>Powerhouse</u>. The powerhouse and hydroelectric power plant at Bankhead Lock and Dam are located on the right bank at the end of the spillway. The powerhouse is approximately 135 feet by 77 feet and contains one 45,000 kw turbo-generator. The power facilities are an addition to the original project being built and operated by the Alabama Power Company under provisions of Federal Power Commission License No. 2165 dated 12 September 1957. Construction of the plant was initiated in February 1961 and it was placed in operation in July 1963. The power plant was built to take advantage of the regulated flow from the Alabama Power Company's upstream storage reservoir, the Lewis M. Smith project, also built under FPC License No. 2165 and described in Apprndix A. General sections through the powerhouse are shown on chart 6.

1-17. <u>Reservoir</u>. The Bankhead Reservoir at normal pool, elevation 255.0 feet above msl, covers an area of 9,245 acres and has a total storage of 296,215 acre-feet. At this elevation the reservoir extends to about navigation mile 22 on the Locust Fork and to about navigation mile 46 on the Mulberry Fork. Practically the entire reservoir is contained within the steep banks of the river channel with little overbank inundation. Drainage area above Bankhead Lock and Dam is about 3,990 square miles. Area and capacity curves and tables are shown on chart 8.

1-18. Taking line for land acquistion. Flowage easements have been acquired the full length of Bankhead Reservoir for all areas below elevation 257.0 feet above msl. The flowage easements permit inundation of all lands up to elevation 257.0.

1-19. Recreational development. Except for the areas adjacent to the lock and dam the areas surrounding Lake Bankhead are largely in private ownership. There are scattered public access points, launching ramps and lake-side housing but they are privately owned and operated. Plans are presently being formulated to develop the lock mound area and along the bank of Big Indian Creek for such activities as picnicking and sightseeing. The provision of recreational facilities for water contact activities along the canal or the impoundment of Big Indian Creek is not deemed practicable due to the hazard from navigation operations.

HISTORY OF PROJECT

1-20. Authorization. In 1874, Congress approved the first act authorizing an examination and survey of the Black Warrior River from its mouth to the junction of Mulberry and Locust Forks.

1-21. The River and Harbor Acts of 2 March 1907, and 22 August 1911, authorized construction of locks and dams 14 through 17 on the Black Warrior River above Tuscaloosa. Lock and Dam No. 17, later named Bankhead Lock and Dam, would have a double lock and provide sufficient lift to extend slack-water navigation to mile 46 on Mulberry Fork and to mile 22 on Locust Fork.

1-22. The River and Harbor Act approved 30 August 1935, increased the authorized channel depth to 9 feet from Mobile to the upper limits of the project. This would be accomplished by channel improvement, by raising various dams and by construction of crest gates at Bankhead Dam.

1-23. Modernization of the Black Warrior-Tombigbee Waterway system is accomplished under provisions of the River and Harbor Act approved 3 March 1909, which authorized reconstruction of obsolete structures, modified in plan and location, to provide efficient and economical maintenance and operation.

1-24. Planning and design. The original project at Bankhead Lock and Dam was designed to provide for the needs of navigation by providing a 6-foot channel to points on the Mulberry and Locust Forks. This was accomplished in 1915 by the completion of a fixed crest spillway and a double-chambered lock. In 1936 the project was modified by the addition of crest gates to increase the channel depth to 9 feet.

1-25. Funds to initiate studies for a report on replacement of the lock at Bankhead Lock and Dam were allotted in the Fiscal Year 1963 Operation and Maintenance Budget for the Black Warrior-Tombigbee Waterway. The report was completed and submitted by the District Engineer on 23 June 1964. During the course of the studies for the report, a preliminary investigation was made to determine the adequacy of the spillway and the results were presented in a letter dated 18 March 1964 on the subject, "Reports on Investigation of Dangerous Conditions at the John Hollis Bankhead Dam (Dam 17), Black Warrior River, Alabama". The Chief of Engineers approved the request of the District Engineer to make more detailed studies of the spillway and, in the second indorsement to a Mobile District letter dated 7 October 1964 on the subject, "Request for Authority to Prepare Project Report on John Hollis Bankhead Dam (Dam 17), Black Warrior River, Alabama", advised that the lock report was being returned so that it could be combined with the report on the spillway. The spillway studies for this combined report were of sufficient scope to proceed directly into the preparation of plans and specifications with the waiver of requirements for design memoranda.

1-26. In connection with modernization of Bankhead Lock and Dam by replacement of the double-chambered lock the following reports and design memoranda have been submitted.

Memorandum No.	Title	Date of Submittal
-	Project Report on Modernization of Black Warrior River between Tuscaloosa and John Hollis Bankhead Lock and Dam	14 Mar. 1958
-	Modernization of the Lock at John Hollis Bankhead Dam, Black Warrior River, Alabama	23 Jun. 1964
-	Modernization of the Lock and Spillway at John Hollis Bankhead Dam, Black Warrior River, Alabama	15 Jun. 1965
1	Basic Hydrology	1 May 1968
2	Site Selection Report for New Lock	13 Sep. 1968
3	General Design	30 Dec. 1968
4	Construction Area (Real Estate)	17 Dec. 1968
5	Relocation of Alabama Power Company Transmission and Service Lines	15 Aug. 1969
6	Left Bank Access Road	17 Jan. 1969
8	Sources of Construction Materials	10 Aug. 1970
9	Geology	12 Nov. 1970
10	Approach Channel and Temporary Cofferdam	14 Sep. 1970
	Letter Supplement to Design Memorandum No. 10	6 Nov. 1970
11	Replacement Lock and Non-overflow Dams	24 Dec. 1970
12	Closed Circuit Television System for Lock Surveillance	10 Aug. 1971

1-27. Construction. The original project at Bankhead Lock and Dam was completed in 1915 with Hardaway Construction Company acting as prime contractor. Except for the new lock the most recent major undertaking at the Bankhead project was the rehabilitation of the spillway. This was accomplished in two phases by Standard Construction Company and involved strengthening the existing spillway through the use of steel rods anchored into bedrock beneath the structure and raising the piers and bridge supporting the crest gates. Work on this project was in progress from May 1968 through March 1969. Work on the new lock and associated dikes was begun in July 1972 by Martin K. Ely Construction Company and is now in advanced stages of construction.

CHAPTER II

HYDROMETEOROLOGY

DESCRIPTION OF RIVER BASIN

2-1. General characteristics. The Black Warrior River basin above Bankhead Lock and Dam is an area of rugged topography ranging from hilly to mountainous. Maximum length of the basin is about 70 miles and the average width is about 80 miles. Drainage area of the basin is 3,990 square miles.

2-2. The Black Warrior River is formed about 20 miles northwest of Birmingham, Alabama, by the union of Locust Fork and Mulberry Fork. The Black Warrior River and its major tributaries above Bankhead Lock and Dam flow through deep cuts or gorges and reaction to heavy rainfall is almost immediate. A map of the drainage area is shown on chart 18.

2-3. Other structures. The Bankhead project is the uppermost project in an overall navigation system consisting of 6 locks and dams. The dams are situated in step-like fashion along the Black Warrior River and lower Tombigbee River. Each dam raises the water surface elevation sufficiently to provide navigable depths to the next project upstream.

2-4. Alabama Power Company has built a large storage reservoir, Lewis Smith Dam, on Sipsey Fork, a headwater tributary to the Black Warrior River. Alabama Power Company also owns the power plants at Bankhead and Holt Locks and Dams and operates them as peaking plants. The power company coordinates the releases from all three projects to optimize their generating potential. Locations of these projects are shown on chart 18.

CLIMATE AND RUNOFF

2-5. Temperature. The average annual temperature in the basin above Bankhead Lock and Dam is about 62 degrees. This figure is based on records at 3 long-term stations. These stations, Birmingham, Cordova and St. Bernard are considered representative of the area. Normal monthly temperature ranges from about 45 degrees in January to about 80 degrees in July. Extreme temperatures for this region are a low of -17 degrees and a high of 110 degrees. The normal frost-free period of seven months lasts from April to October.

2-6. Precipitation. The Black Warrior River and its tributaries lie in a region of heavy annual rainfall which is fairly well distributed throughout the year. The normal annual precipitation is about 54.5 inches of which about 41 percent occurs during the 4-month wet period (January through April) and about 18 percent occurs during the 3-month dry period (September through November). The normal monthly and annual precipitation for the basin above Bankhead is shown in table 2-1. The amounts shown are the arithmetic means of the normals of 8 stations in and adjacent to the basin. These stations are listed in table 2-2 along with their maximum, minimum and normal annual precipitation.

2-7. Moderate snowfall occurs in the basin during October through April, but seldom covers the ground for more than a few days at a time and has not been an important contributing factor in any major flood recorded in the basin.

2-8. Flood producing storms may occur over the Black Warrior basin at anytime during the year but are much more frequent in the winter and early spring. Major storms in the winter are usually of the frontal type and the summer storms of the hurricane type.

2-9. Runoff characteristics. Annual runoff from the Black Warrior Watershed averages about 21.6 inches per year or about 40 percent of the annual precipitation. The average runoff varies considerably with the seasons, being high during winter and early spring and low during late summer and autumn. Ice and snow are not uncommon in the basin but have little effect on runoff. In general, streams above Bankhead Lock and Dam are flashy with quick rises and recessions.

2-10. Channel conditions. From the headwater tributaries of the Black Warrior River to about Tuscaloosa, Alabama, the main stream is situated in deep narrow valleys or gorges and the river in this reach has an average slope of about 2.7 feet per miles. Because of the high banks, both above and below Bankhead Reservoir, extremely high stages are required to cause major flood losses.

Table 2-1

Normal monthly and annual precipitation
Black Warrior River basin above Bankhead Lock and Dam

Month	Normal precipitation Inches	Normal precipitation Percent of normal annual
January	5.49	10.07
February	5.51	10.11
March	6.09	11.17
April	4.75	8.72
May	3.91	7.17
June	4.10	7.52
July	5.30	9.72
August	4.36	8.00
September	3.06	5.61
October	2.90	5.32
November	3.78	6.92
December	5.28	9.67
Annual	54.51	100.00

Table 2-2

Maximum, minimum and normal annual precipitation for
selected stations in Black Warrior basin above
Bankhead Lock and Dam

Station	Period of record (years)	Normal annual precipitation (inches)	Maximum annual precipitation		Minimum annual precipitation	
			inches	year	inches	year
Albertville	47	53.21	78.58	1946	39.04	1958
Birmingham	35	53.05	81.82	1929	34.32	1904
Cordova	59	53.44	76.40	1964	36.61	1933
Fayette	47	54.92	75.76	1923	31.12	1954
Haleyville	34	58.01	77.69	1964	39.96	1952
Oneonta	65	56.91	88.85	1900	40.70	1943
St. Bernard	64	54.08	72.78	1946	35.02	1943
Tuscaloosa-Oliver Dam	44	52.46	73.17	1932	32.87	1954

2-11. Spillway design and standard project floods. The spillway design flood was computed to reach a peak elevation of 270.4 feet above msl at Bankhead Lock and Dam. This is about 2.1 feet below the bottom of the spillway gates in fully raised position and about 0.4 foot above the non-overflow section connecting the spillway section to the powerhouse.

2-12. The standard project flood was computed to reach a peak pool elevation of 260.5 feet above msl. Effects of reservoir regulation on the standard project and spillway design floods are shown on charts 25 and 26.

2-13. Floods of record. The maximum observed tailwater elevation and discharge at Bankhead Lock and Dam were 194.0 feet above msl and 183,000 cfs during the flood of March 1951. The peak tailwater and discharge for the February 1961 flood were 193.8 feet above msl and 176,000 cfs, however, during this flood Lewis Smith reservoir was being filled and there was no outflow from that project. Had Lewis Smith not been built the tailwater elevation and discharge for the 1961 flood would have exceeded those for the 1951 flood. The pre-record flood of April 1900 has been determined from investigations among local inhabitants to be of even greater magnitude than the 1961 flood.

2-14. There is no flood control at Bankhead Lock and Dam therefore during floods inflow equals outflow up to full spillway capacity with the pool remaining constant at approximately elevation 255.0 feet above msl. All of the floods of record had peak flows less than 199,000 cfs, the spillway capacity at elevation 255.0, so they could be passed without raising the pool level.

FLOWS AND FREQUENCIES

2-15. Streamflow. Streamflow has been measured at Tuscaloosa, Alabama, about 26 miles downstream from Bankhead Lock and Dam since 1894. Records for this station are published by the U. S. Geological Survey. Hydrographs of the average daily flows at Tuscaloosa for the period 1928-1964 are shown in Appendix B to the "Black Warrior - Tombigbee Reservoir Regulation Manual" which comprises the regulation plan for Holt Lock and Dam. Table 2-3 of this manual shows the mean monthly and annual flow for the period 1895 through 1970 at Tuscaloosa.

2-16. Once daily river stages at Bankhead Lock and Dam have been recorded since 1911. Records of these stages are maintained at the U. S. Army Corps of Engineers' office in Mobile, Alabama, and they are published by the National Weather Service. Stage hydrographs of once daily stages at the Bankhead tailwater gage are shown on charts 14 through 17.

2-17. Frequencies and durations. Discharge and stage frequencies have been computed for Bankhead damsite with and without Lewis Smith Dam operating. The discharge frequencies were developed using Beard's analytical method for the period 1938 through 1966. The stage frequencies were obtained by applying the tailwater rating curve to the discharge frequencies. Frequency curves are shown on chart 23.

2-18. The stage duration curve at Bankhead Lock and Dam was developed by applying the tailwater rating curve to the discharge duration determined for Lock 13. This stage duration is based on records for 1940 through 1966. The stage duration curve for Bankhead tailwater is shown on chart 24.

2-19. Rating curves. The tailwater rating curve at Bankhead Lock and Dam was developed with Holt Lock and Dam in operation and maintaining a pool elevation of 187 feet above msl until a discharge of 393,000 cfs is reached. Above this flow the Holt Reservoir elevation varies according to the spillway rating. The tailwater rating curve for Bankhead is shown on chart 22. Charts 9 through 13 give the gate operating schedule and discharge values over the spillway during periods of controlled releases. A headwater rating curve for all gates fully open is also shown on chart 22.

TABLE 2 - 3

MEAN MONTHLY AND ANNUAL FLOWS
AT TUSCALOOSA, ALABAMA

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	MAXIMUM MONTHLY	MINIMUM MONTHLY
1894										261	255	1960			
1895	25464	7603	39977	6895	5511	2133	3581	1098	883	233	488	2021	7990	39977	233
1896	5981	19161	12996	6072	7420	2910	1232	478	201	157	307	955	4822	19161	157
1897	3493	8409	52883	9657	3600	715	1809	701	295	93	115	5549	7276	52883	93
1898	16577	3902	3626	15620	1766	303	549	1783	252	880	1626	3763	4220	16577	252
1899	18118	30923	35308	11901	2092	448	1111	963	200	130	721	8880	9232	35308	130
1900	9857	18356	27105	52891	3702	32614	10952	1674	1580	3382	3701	5119	14244	52891	1580
1901	22938	15094	11947	17370	4355	3217	1210	7117	2626	1536	712	13293	8451	22938	712
1902	12712	21987	36776	18707	2349	648	311	477	1444	3393	3136	8353	9191	36776	311
1928								2490	3780	1480	2120	1520			
1929	12000	13800	49600	9490	23700	2540	1290	694	2170	2250	39700	12400	14136	39700	694
1930	9840	9040	17600	5690	12500	2360	7220	1290	1680	596	8510	6140	6872	17600	596
1931	8430	5960	6890	10000	2000	471	601	982	267	233	398	14200	4202	14200	233
1932	21700	32700	6340	9720	5020	2360	8540	3650	2380	17300	9260	35800	12897	35800	2360
1933	11400	18700	12900	12400	4340	1020	1500	1170	1190	578	748	2171	5676	18700	578
1934	8635	4465	19880	4861	1804	4133	3619	3144	811	12660	2876	4860	5979	19880	811
1935	9668	9361	27620	15470	9357	2339	771	817	288	376	1817	3095	6748	27620	233
1936	25130	27440	9414	17180	1876	477	2493	2238	786	505	470	2894	7575	27440	470
1937	38460	13560	10210	7895	16910	1246	1105	1346	3331	4029	1215	2694	8500	38460	1105
1938	8376	5255	19740	32010	3570	2176	4635	4401	519	191	1309	1233	6951	32010	191
1939	9361	31590	19700	10950	4671	11530	2813	7039	2583	650	755	1202	8570	31590	650
1940	6852	25460	15910	12670	3050	3071	22680	1175	521	435	1104	5083	8167	25460	435
1941	7343	6097	10680	5517	1010	346	2554	8603	661	925	1233	7985	4412	10680	346
1942	5017	13980	16300	3653	1402	3228	1060	3561	1240	545	898	16570	5620	16570	545
1943	6820	9927	24690	12150	1916	784	1042	872	757	176	382	858	5031	24690	176
1944	3280	19870	29650	21040	5915	1733	557	1942	1162	435	460	2483	7377	29650	435
1945	10960	26150	19570	10280	7609	1079	890	815	353	829	1713	8187	7369	26150	353
1946	33950	39330	16440	4933	7953	3599	5281	2782	5131	1356	12810	8774	11861	39330	1356
1947	38090	7793	19850	14620	4988	3597	854	785	282	303	1820	5004	8165	38090	282
1948	5827	36040	19540	15850	1554	892	938	1156	406	356	21740	18490	10269	36040	356
1949	39310	29130	17590	10760	8877	5024	3790	1210	2511	1470	2181	4856	10559	39310	1210
1950	23010	18730	27220	5455	5015	2900	4620	2763	5795	961	1361	4022	8487	27220	961

TABLE 2 - 3

MEAN MONTHLY AND ANNUAL FLOWS
AT TUSCALOOSA, ALABAMA

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	MAXIMUM MONTHLY	MINIMUM MONTHLY
1951	10250	21720	33240	21860	2420	1006	2018	597	1091	566	3370	28360	10541	33240	566
1952	12900	10630	16710	4586	1459	1189	288	1852	527	785	562	4226	4642	16710	288
1953	20300	23600	11980	7521	13590	967	1748	361	192	189	234	4421	7091	23600	189
1954	22700	5591	8343	7157	3117	1254	418	388	139	206	562	3183	4421	22700	139
1955	8761	23710	12910	14330	3309	1858	3846	1173	387	318	1690	1983	6189	23710	318
1956	1154	29240	16090	20510	4137	1398	1462	728	587	747	904	9646	7216	29240	587
1957	12280	22750	11560	13060	2630	1813	1620	706	2668	3395	22230	12410	8926	22750	706
1958	7777	13620	13540	12380	9584	1408	4818	1695	2217	1661	2287	2480	6122	13620	1661
1959	11650	14670	13420	9715	7779	7819	1079	675	2672	2294	6315	8235	7193	14670	675
1960	16960	14310	25910	6621	3453	1176	782	1418	1277	1200	1535	2895	6461	25910	782
1961	4280	40180	21140	12370	3462	2175	4038	1400	1694	1032	1792	27040	10091	40180	1032
1962	31420	17490	15360	24220	3248	1784	1499	1539	1816	1360	2702	1422	8655	31420	1360
1963	7250	8478	15320	5449	9215	3365	3483	2505	1464	1053	1277	3702	5213	15320	1277
1964	12660	10490	30810	39730	11300	1930	4581	2281	1945	3248	4111	11310	11199	39730	1930
1965	9733	20380	18540	13030	2947	3918	2397	1742	1800	2236	3565	3141	6952	20380	1742
1966	5400	16280	10760	10420	13150	2278	1982	2704	3125	2915	3183	3977	6347	16280	1982
1967	5681	11730	6559	3331	6048	2387	4465	8240	3921	2309	5056	29210	7452	29210	2309
1968	28790	5550	9848	10360	10240	2239	3651	3329	2050	1207	1223	5462	6995	28790	1207
1969	11720	16620	10080	13410	12610	3074	1956	1567	1563	1468	1506	5430	7167	18410	1468
1970	9852	5057	24470	19960	6012	5246	2490	2953	1805						
AVERAGE	14202	17238	19290	13354	5911	2963	2948	2099	1549	1703	3726	7628	7717		
MAXIMUM	39310	40180	52883	52891	23700	32614	22680	8603	5795	17300	39700	35800			
MINIMUM	1154	3902	3626	3653	1010	303	288	477	139	93	115	858			

CHAPTER III

DATA COLLECTION AND COMMUNICATION

GENERAL

Role of regulation office
Role of lockmaster

DATA COLLECTION AND REPORTING

Hydrometeorologic stations
River-stage reporting network
Rainfall reporting network
Sedimentation surveys
Water quality monitors
Communication network

3-1. Role of regulation office. It is the responsibility of the Reservoir Control and Meteorology Section of the Mobile District Office to develop operating procedures for both flood and non-flood conditions. Plans are developed to most fully utilize the water resources potential of each project within the constraints of authorized functions. Time is devoted to maintaining up-to-date information on current and anticipated conditions, and to the collection of data on precipitation and river stages to provide the background necessary for best overall operation.

3-2. A continuous program of hydrologic investigation is conducted relative to improvement of water control management techniques. The preparation and up-dating of regulation manuals and reports is carried on as part of the routine operation of the section.

3-3. Arrangements are made by the Reservoir Control and Meteorology Section for communication channels to the Lockmaster and other necessary personnel. Instructions pertaining to reservoir regulation are issued to the Lockmaster, and a plan for delivery of all important messages concerning emergency regulation is developed.

3-4. Role of lockmaster. The Lockmaster should be completely familiar with the approved operating plan for the project. Training sessions should be held, as needed, to insure that an adequate number of other lock operating personnel are informed of proper operating procedures for reservoir regulation. The Lockmaster is expected to maintain and furnish records requested from him by the Reservoir Control and Meteorology Section. Unforseen or emergency conditions at the project that require unscheduled manipulation of the reservoir should be reported to the Reservoir Control and Meteorology Section as soon as practicable.

3-5. Hydrometeorological stations. Within the Mobile District there is a comprehensive network of hydrometeorologic stations. Changes and additions to this network are made on a routine basis to insure adequate hydrologic data for reservoir operations and for planning.

3-6. In or adjacent to the Black Warrior River basin, above Bankhead Lock and Dam, there are presently 10 active river-stage stations and 32 active rainfall stations. Records for other hydrometeorological parameters are available for selected points within the basin. These parameters include temperatures, evaporation, wind movement, humidity and sedimentation and water quality. A general hydrologic map, showing the location of stations within the basin above Bankhead Lock and Dam, is shown on chart 18.

3-7. River-stage reporting network. The Reservoir Control and Meteorology Section receives daily river-stage reports from 4 stations in the Black Warrior River basin above Bankhead Lock and Dam. These stations along with pertinent data concerning them are listed in table 3-1 and their locations are shown on chart 19. Other stations within the general hydrologic network do not report daily but records are available on a periodic basis. All active river-stage stations within the basin are shown on chart 18 and are also listed in table 3-1.

3-8. Alabama Power Company's Load Dispatching office at Magella receives reports directly from stations at Lewis Smith Dam, Cordova and Bankhead Powerhouse and these reports are relayed to the Reservoir Control and Meteorology Section each morning by telephone. Corps of Engineers stations report to the Lockmaster at Demopolis and these data are relayed to the District Office by radio or telephone.

3-9. Normally the river stage at approximately 7:00 a.m. at each of the reporting stations is reported to the District Office each morning. Readings at Lewis Smith Dam are reported automatically each hour to the Alabama Power Company and these readings are available to the District Office upon request. The Cordova gage, installed and maintained by the Corps of Engineers in connection with the flood control operations of Lewis Smith Dam, is equipped with a telemark and an unattended station relay to permit interrogation by telephone at anytime by either the Alabama Power Company or the Corps of Engineers. Additional reports can be received from all of the locks and dams by contacting the Lockmasters at the individual projects by means of the District radio network or by telephone.

3-10. All stations listed in table 3-1 as being operated by the U. S. Geological Survey or the Corps of Engineers are included in the cooperative stream gaging program between these two agencies.

Table 3-1

River-stage Reporting Network
and Other Stations in
Black Warrior River basin above Bankhead Lock and Dam

STREAM	STATION (1)	RIVER MILES ABOVE MOUTH	DRAINAGE AREA (Sq.Mi.)	GAGE ZERO ELEV. (Ft.MSL)	FLOOD STAGE REPORTING STATIONS (Feet)	TYPE GAGE (3)	OPERATED BY (4)
Sipsey Fork	LEWIS M. SMITH DAM, AL	13.8	944	0.0	(2)	R	APC
Mulberry Fork	Garden City, Al	79.2	368	380.5		R	USGS
Mulberry Fork	CORDOVA, AL	30.8	1,927	243.6	16	R	CofE
Mulberry Fork	Gorgas Steam Pt., Al	13.0	2,000	0.0		S	APC
Dorsey Creek	Arkadelphia, Al	8.0	13	430.0		R	USGS
Blackwater Creek	Manchester, Al	20.0	188	401.0		R	USGS
Locust Fork	Cleveland, Al	98.6	309	536.9		R	USGS
Locust Fork	Trafford, Al	67.4	625	309.1		R	USGS
Locust Fork	Sayre (Dora), Al	33.9	889	258.6		R	USGS
Turkey Creek	Morris, Al	4.0	81.5	345.2		R	USGS
Black Warrior River	BANKHEAD L&D, AL (5)	153.6	3,990	173.5	188.5	R	CofE
Black Warrior River	BANKHEAD L&D, AL (5)	153.6	3,990	0.0		R	APC

NOTES:
(1) Reporting stations indicated by capital letters.
(2) Not available.
(3) R - Recorder; S - Staff
(4) APC - Alabama Power Company;
USGS - United States Geological Survey;
C of E - Corps of Engineers.
(5) Both headwater and tailwater gages at these locations.

Table 3-2

Rainfall Reporting Network
Black Warrior River Basin above Bankhead Lock and Dam

DRAINAGE	STATION	LATITUDE AND LONGITUDE	ELEV. (Ft., MSL)	TYPE	OBSERVER
Sipsey Fork	Addison	34°13' 87°11'	795	R	Prof Palmer Godsey
Sipsey Fork	Arley 3S	34°04' 87°13'	500	N-R	Mrs Dora R. Davis
Sipsey Fork	Saint Bernard	34°12' 86°47'	802	N-R	St. Bernard College
Mulberry Fork	Jasper 4N	33°54' 87°16'	525	N-R	James A. Britain
Sipsey Fork	Lewis Smith Dam	33°56' 87°06'	(1)	N-R	Alabama Power Company
Mulberry Fork	Falkville 1E	34°22' 86°53'	625	N-R	John M. Dunaway
Mulberry Fork	Garden City, Al	34°01' 86°45'	500	R	Mrs G. McKenzie
Mulberry Fork	Cordova, Al	33°46' 87°11'	334	N-R	Mrs C. Gresham
Blackwater Creek	Haleyville	34°14' 87°37'	950	R	James E. Eidson
Lost Creek	Carbon Hill, Al	33°54' 87°32'	430	N-R	Mrs A. M. Garrison
Mulberry Fork	Gorgas, Al	33°39' 87°13'	300	N-R	Alabama Power Company
Locust Fork	Boaz, Al	34°13' 86°10'	1070	R	Robert L. Wheeler
Locust Fork	Oneonta, Al	33°57' 86°29'	870	N-R	Lonnie R. Norris
Locust Fork	Warrior	33°49' 86°57'	640	R	G. C. Yarbrough
Locust Fork	Sayre (Dora), Al	33°43' 86°58'	304	N-R	Mrs M. W. Pridmore
Village Creek	Birmingham WSO AP	33°34' 86°45'	620	R	NAT. Weather Service
Valley Creek	Magella, Al	33°30' 86°51'	654	N-R	Alabama Power Company
Valley Creek	Bessemer 3 SSW	33°22' 87°01'	540	N-R	Robert P. Mosses
Black Warrior River	Bankhead L&D	33°29' 87°20'	280	N-R	Corps of Engineers
Black Warrior River	Bankhead L&D	33°29' 87°20'	(1)	N-R	Alabama Power Company

NOTES:
(1) Not available
N-R Non-recording
R Recording

3-11. Rainfall reporting network. Of the 32 active rainfall stations within the Black Warrior River basin above Bankhead Lock and Dam, 20 are included in the Mobile District rainfall reporting network. Reports from these stations are received daily by the Reservoir Control and Meteorology Section and are tabulated each morning to give an overall picture of runoff conditions. The portion of the rainfall tabulation form pertaining to the basin above Bankhead Lock and Dam is shown on chart 21. The rainfall reporting network above Bankhead Lock and Dam is listed in table 3-2 and station locations are shown on chart 19.

3-12. The Alabama Power Company operates stations at Lewis Smith Dam, Gorgas, Magella and Bankhead Lock and Dam. Stations at Birmingham and Tuscaloosa Airports are National Weather Service Airways Stations and the Corps of Engineers operates stations at Bankhead, Holt, Oliver and Warrior Locks and Dams. All other stations are operated by the National Weather Service.

3-13. The Alabama Power Company's stations report directly to the Load Dispatching Office at Magella. These reports are relayed by the dispatcher to the Mobile District Office by telephone or over the Company's communication facilities described in paragraph 3-21. Reports from Corps of Engineers' stations are relayed, through Demopolis Lock and Dam, to the Mobile District Office by means of the voice radio or telephone. Reports from the Airways stations are relayed by the National Weather Service to the Reservoir Control and Meteorology Section over one of their regular teletype circuits or by telephone. The observers at all other stations report by telephone or telegraph to one of the National Weather Service offices located in the Mobile District and these messages are also relayed to the District Office by telephone or teletype.

3-14. The Airways stations report every 6 hours. Stations of the Alabama Power Company and the Corps of Engineers report once daily except during periods of heavy rainfall when more frequent reports are made as requested by the Reservoir Control and Meteorology Section. All other stations report in accordance with Standard Weather Service Reporting Instructions, WB Form 612-20 shown on chart 20. These instructions call for an initial report at 7:00 a.m., 1:00 p.m. or 7:00 p.m., whenever rainfall since last measurement totals 0.50 inch or more and thereafter at 7:00 a.m., 1:00 p.m. and 7:00 p.m. until the rain stops.

3-15. Sedimentation surveys. A network of 13 ranges was established during the months of May and June 1959 to monitor the rate of sediment deposition in the reservoir and its effects on the project. The first 5 ranges are positioned along the 19.9-mile reach of the reservoir below the junction of the Mulberry and Locust Forks. Five ranges, numbers 6 through 10 are located on the Mulberry Fork and the remaining 3, numbers 11 through 13 are located on the Locust Fork. The river mile of each range site is listed below and is shown on chart 7.

RANGE NUMBER	RIVER MILE
1	373.70
2	380.00
3	383.44
4	389.70
5	393.14
6	400.12
7	409.86
8	415.55
9	424.31
10	437.50
11	394.55
12	402.55
13	406.88

3-16. Several ranges that were selected to give the typical deposition amounts for the reservoir were resurveyed in 1963. At that time only a small decrease in cross sectional area was found indicating that the reduction of the overall reservoir capacity was not occurring at a serious rate.

3-17. Detailed sedimentation studies including the resurveying of all ranges are scheduled to be made in approximately 15-year intervals. The results of these detailed studies will provide the necessary information to monitor and to periodically revise pertinent project data that are subject to change due to sedimentation effects.

3-18. Water quality monitors. The Corps of Engineers operates two water quality monitoring stations on the Black Warrior River, one below Warrior Lock and Dam and one below Bankhead Lock and Dam. The water quality parameters monitored are dissolved oxygen, temperature, pH, conductivity and turbidity. Each monitor has the capability to include three additional parameters if needed for future expansion.

3-19. Communication network. Communication between the District Office and Bankhead Lock and Dam is by telephone or two-way voice radio. The radio installation at the dam is part of the Mobile District radio communication network. For local communication within the Black Warrior and Tombigbee system there is a VHF radio network consisting of 7 fixed stations, one at the Tuscaloosa Area Office and one at each of the 6 dams within the system. There are also a varying number of mobile stations within the network located in automobiles and boats. The number of mobile units in an area at any time depends upon the activities within that area.

3-20. Reports from the National Weather Service are transmitted to the Reservoir Control and Meteorology Section either by teletype or telephone. The Reservoir Control and Meteorology Section maintains teletype receivers on two of the National Weather Service's nationwide teletype circuits, Service C and RAWARC, as well as a facsimile recorder for receiving reports from the National Weather Service's Meteorological Center.

3-21. Emergency communication between the Mobile District Office and the Alabama Power Company's load dispatching office at Magella is available through the Company's operational communication system which has a terminal in Mobile in the Control Center of the Company's Royal Street substation. Generally, in an emergency Control Center personnel will relay messages between the Reservoir Control and Meteorology Section and the System Load Dispatcher. However, if local telephone service is disrupted someone from the Reservoir Control and Meteorology Section will go to the substation Control Center which is located one block from the District Office.

CHAPTER IV

WATER CONTROL PLAN

REGULATION PLAN

REGULATION PLAN

4-1. General objectives. The Bankhead project was originally opened in 1915 to provide navigable depths to points on Mulberry and Locust Forks. In 1963 the project function was expanded to include the production of electrical power with the completion of Alabama Power Company's hydrogenerating unit. Completion of the new single-lift lock now under construction should reduce travel time for river borne commerce. There is no flood control provided by the Bankhead Lock and Dam project.

4-2. Major constraints. Limiting elevations for reservoir power operations at Bankhead Lock and Dam are 255.0 and 252.0. However, because of extensive development of the lake area by private owners the Alabama Power Company normally restricts the drawdown for its power operations to elevation 254.0. Because of navigation requirements the pool must not be drawn down below elevation 252.0 feet above msl. The upper limit of elevation 255.0 will not be exceeded except during floods when the inflow exceeds the full discharge capacity of the project, spillway plus turbine.

4-3. Reservoir operation for power. The power plant at Bankhead Lock and Dam is owned and operated by the Alabama Power Company to help meet load demand on its system. The plant is remotely controlled and is normally operated as a peaking plant utilizing the one foot pondage between elevation 254.0 and 255.0 to reregulate the inflow. Power operations shall be scheduled so that the pool will be at or below elevation 255.0 at all times except when flooding is occurring. In most cases the power plant will utilize all available flow up to capacity of the turbine. When the pool is at elevation 252.0 no power releases in excess of the inflow will be permitted.

4-4. When inflows to Bankhead Reservoir are 10,000 cfs or lower the pool elevation can be controlled by the power plant operations. When the inflow is larger than 10,000 cfs or when the power unit is out of operation the spillway gates will be used to maintain the pool at or below elevation 255.0. Extracts from the Federal Power Commission License, Project No. 2165, are presented in Attachment I, following the charts.

4-5. Regulation during floods. During floods the reservoir will be operated to keep it from exceeding elevation 255.0 by passing the inflow through the spillway gates and/or power plant until full discharge capacity is reached. The gated spillway will discharge up to 199,000 cfs at elevation 255.0 and the power plant about 10,000 cfs for a total of 209,000 cfs. With proper manipulation of the gates and full power plant discharge the pool can be maintained at elevation 255.0 for all flows up to 209,000 cfs. For greater flows the gates will be fully opened with no control of the outflow. Once opened to the fully open position the gates will remain there until the pool peaks and recedes to elevation 255.0, at which time they will be operated as necessary to keep the pool from exceeding elevation 255.0.

4-6. Operation of spillway gates. The spillway gates will be operated as directed by the Lockmaster in order to maintain the reservoir at or below elevation 255.0 except during floods with inflows in excess of discharge capacity. During floods the Lockmaster will maintain contact with the Reservoir Control and Meteorology Section for the exchange of hydrologic data which may be helpful in anticipating gate operating requirements. He will also keep informed of changes in power generating schedules which might require a change in spillway discharge.

4-7. When inflow and pool conditions require operation of the spillway, the gates will be opened in the order and increments of openings shown on charts 9 through 13. The 22 spillway gates are numbered in sequence beginning at the left bank or east end of the spillway, adjacent to the double-lift lock. Gate adjustments will be made as necessary and as specified by the above mentioned charts to maintain the pool at or below elevation 255.0. For inflows in excess of spillway capacity the gates will be left in the fully open position until the pool has peaked and recedes to elevation 255.0. When the pool has receded to elevation 255.0 the operator will begin adjusting the gates to pass any inflow in excess of power plant and lock operation discharges necessary to keep the pool within the established limits.

4-8. Passage of drift. Particular care should be taken when passing trash through the spillway to avoid serious erosion downstream. Gate opening for the passage of trash should be made when the tailwater has been raised by operation of the power plant and/or other gates. The gate under which trash is passed should not be raised any higher than is necessary to permit the trash to pass.

4-9. Mosquito-control operations. Because of the recreational development around Bankhead Reservoir controlled fluctuations of the pool in excess of the one-foot power pondage is undesirable. Therefore water-level management is not considered as part of the mosquito-control program. Mosquito-control operations will consist primarily of clearing the reservoir of undesirable debris and vegetation, periodic inspections for adult mosquitos and larva, the application of larvicides as necessary, aquatic plant control and drift removal operations.

4-10. Water quality control. Water quality control is not an authorized function of Bankhead Reservoir and no provisions have been made for any special operations or releases in this connection. If future studies indicate that water quality benefits can be achieved without violating authorized project functions then these benefits will be incorporated into the operating plan for the project.

4-11. Fish and wildlife. The 9,200 acre lake created by Bankhead Lock and Dam has substantially improved the habitat for game and sport fish. Backwaters of the reservoir provide good catches of bream, crappie, bass and catfish. Other wildlife around the reservoir include deer, turkey, small game and waterfowl.

CHAPTER V

HYDROLOGIC FORECASTING

GENERAL

Forecast of reservoir inflow
Responsibility for issuing stage forecasts to public

5-1. Forecast of reservoir inflow. In order to keep abreast of expected river conditions and to meet other intraoffice needs, a forecasting procedure has been developed by reservoir regulation personnel for the Bankhead project. This procedure involves the use of rainfall-runoff relations and unit hydrographs for the areas above Bankhead Dam. Normally, however, forecasts prepared by the National Weather Service in Atlanta, Georgia, are used and in all cases where general public is involved, reference is made to the forecasts prepared by the National Weather Service.

5-2. Responsibility for issuing stage forecasts to public. The issuing to the general public of stage forecasts is the legal responsibility of the National Weather Service. For the Black Warrior River basin forecasts are prepared by the Weather Service's River Forecast Center in Atlanta, Georgia, and issued through their Birmingham, Alabama, office. The Reservoir Control and Meteorology Section maintains close liaison with the River Forecast Center and other Weather Service offices at all times, and particularly during floods, with mutual exchange of information.

CHAPTER VI

WATER RESOURCE MANAGEMENT

GENERAL

Project owner
Correlation with other projects
Studies in progress and future plans

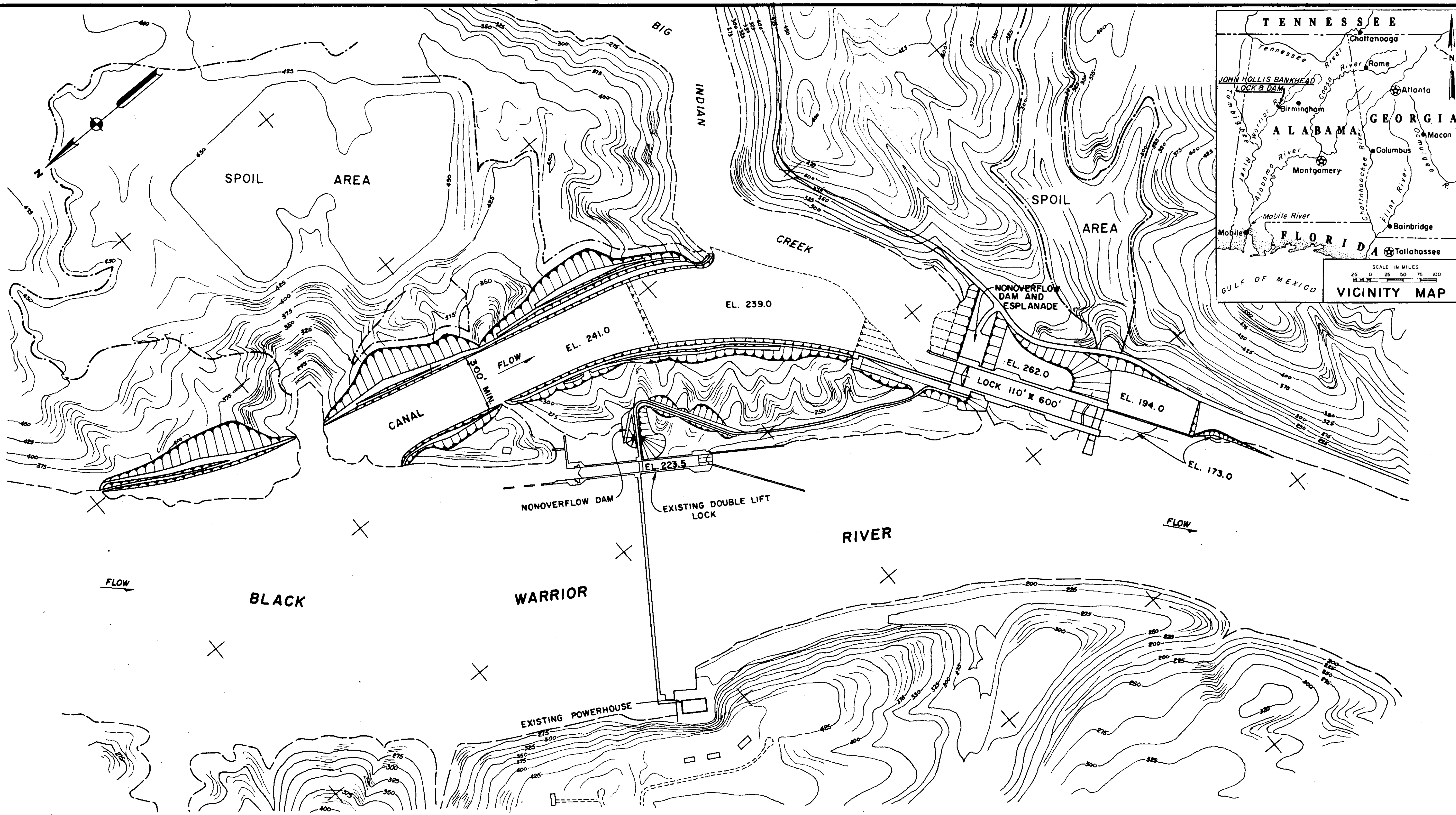
6-1. Project owner. The Bankhead project is owned and operated by the U. S. Army Corps of Engineers. It is part of an overall navigation project consisting of 6 dams along the lower Tombigbee River and the Black Warrior River.

6-2. Within the Mobile District, reservoir operations are under the supervision of Operations Division, and operating instructions are normally issued through the Chief of that Division. The Reservoir Control and Meteorology Section, of Engineering Division, monitors the projects for compliance to the approved plan of operation and is responsible for flood control operations. During flood emergencies, instruction can be issued by the Reservoir Control and Meteorology Section directly to the Lockmaster at Bankhead Lock and Dam.

6-3. Correlation with other projects. Each of the Corps of Engineers' projects in the Black Warrior-Tombigbee River basin is a vital link in the navigation system of the basin. Bankhead Lock and Dam is located in the upper end of the Holt Reservoir and provides navigable depths to the upper end of the overall navigation project on Locust and Mulberry Forks. Bankhead Reservoir's function in the navigation system is accomplished by maintaining the pool level between the controlling elevations of 252.0 and 255.0, however, there is continuing communication between the Bankhead project, the Holt project and the Reservoir Control and Meteorology Section for the exchange of hydrologic data. This exchange of information aids in the operation of Holt Lock and Dam by providing an indication of expected inflows. The Alabama Power Company also coordinates its power generation at Bankhead and Holt Dams with power operations at its Smith Dam.

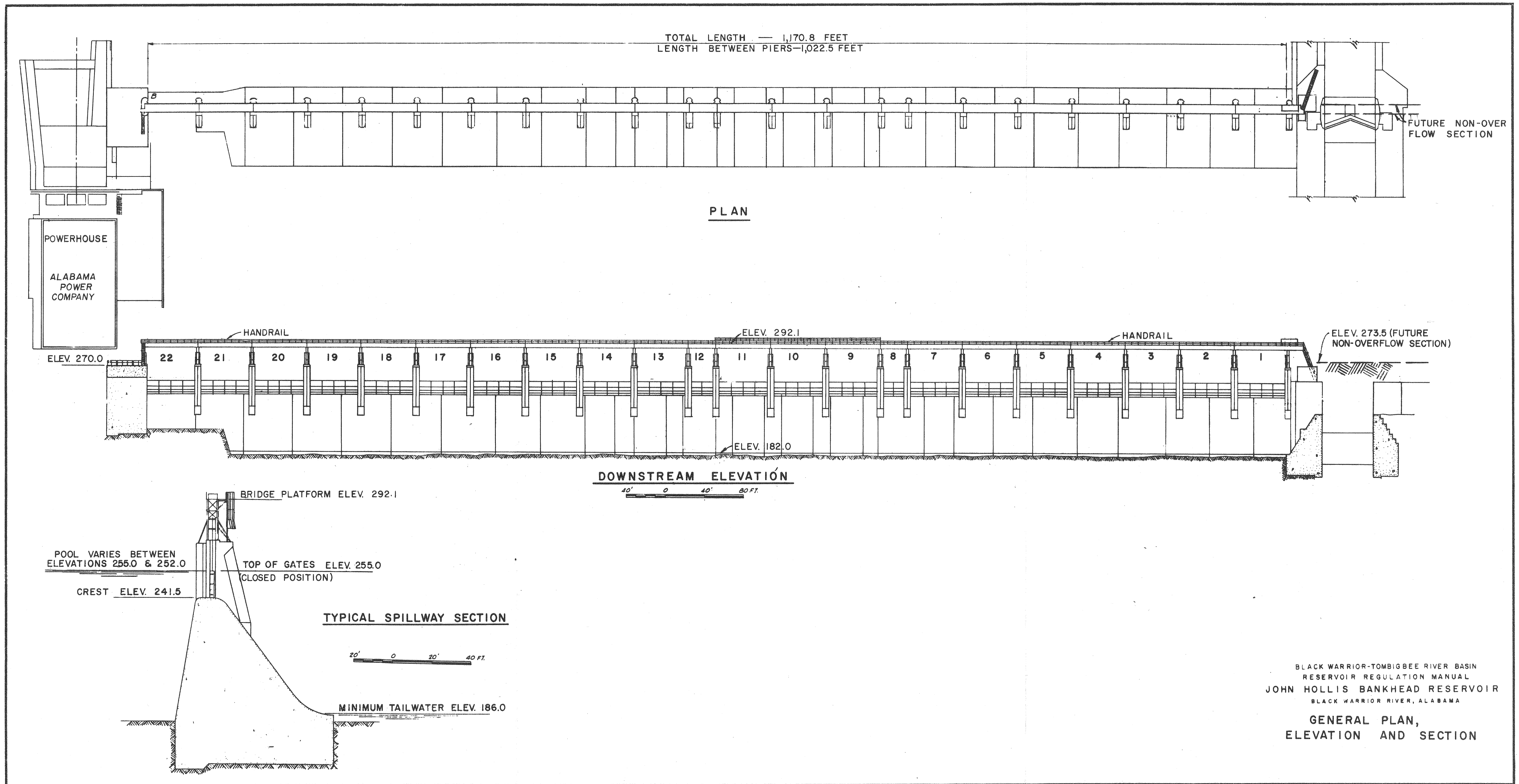
6-4. Studies in progress and future plans. Continued increases in the use of water resources demand constant monitoring and evaluation of reservoir operations and reservoir systems to insure their most efficient use. Studies for the Black Warrior River, including the Bankhead project, are continually in progress for possible improvement in the regulation plan or operating techniques which would result in additional benefits without violating authorized project functions.

CORPS OF ENGINEERS U. S. ARMY



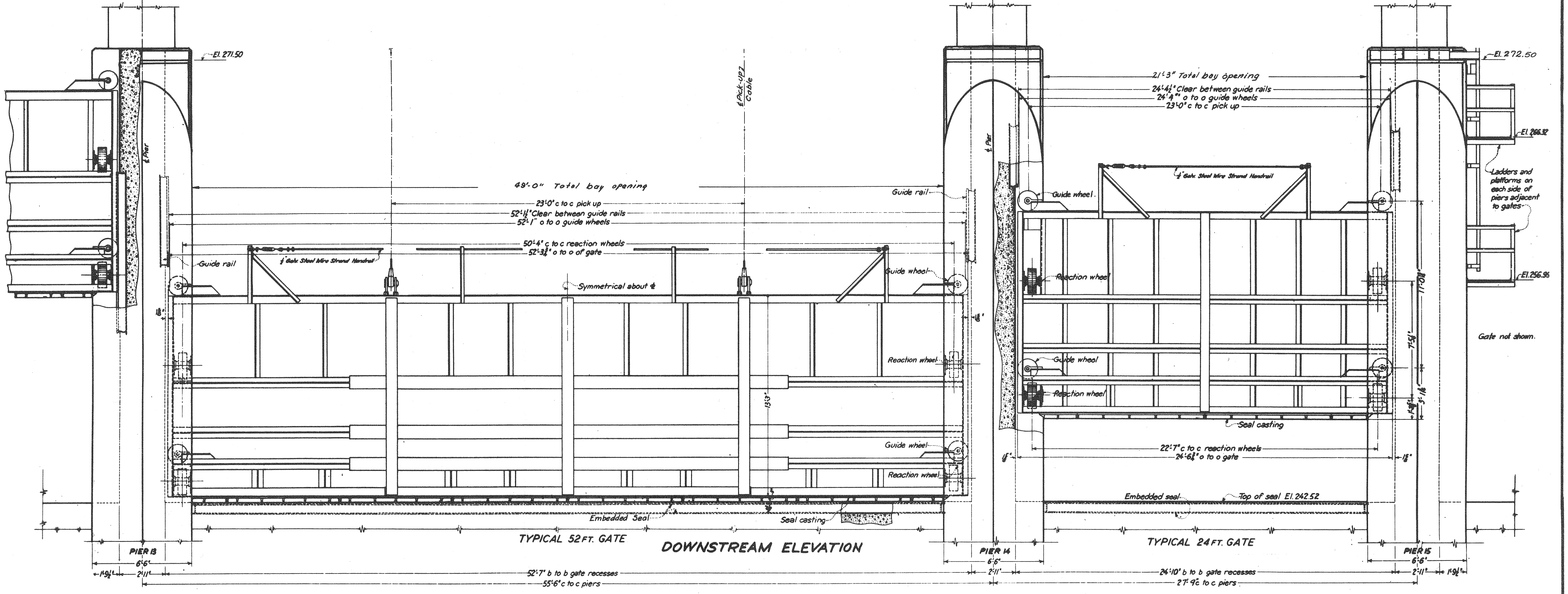
BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

GENERAL PLAN



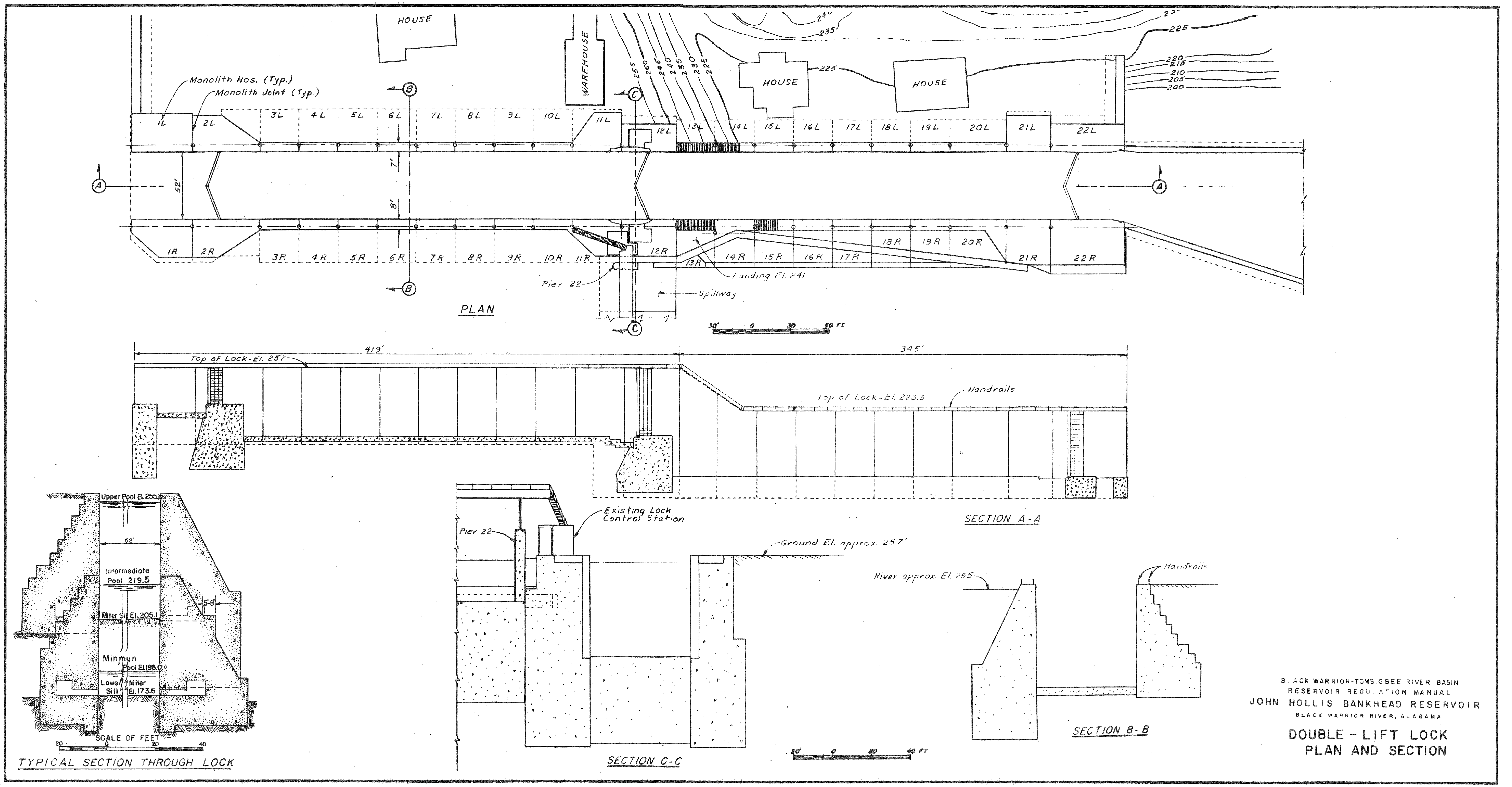
BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

GENERAL PLAN,
ELEVATION AND SECTION



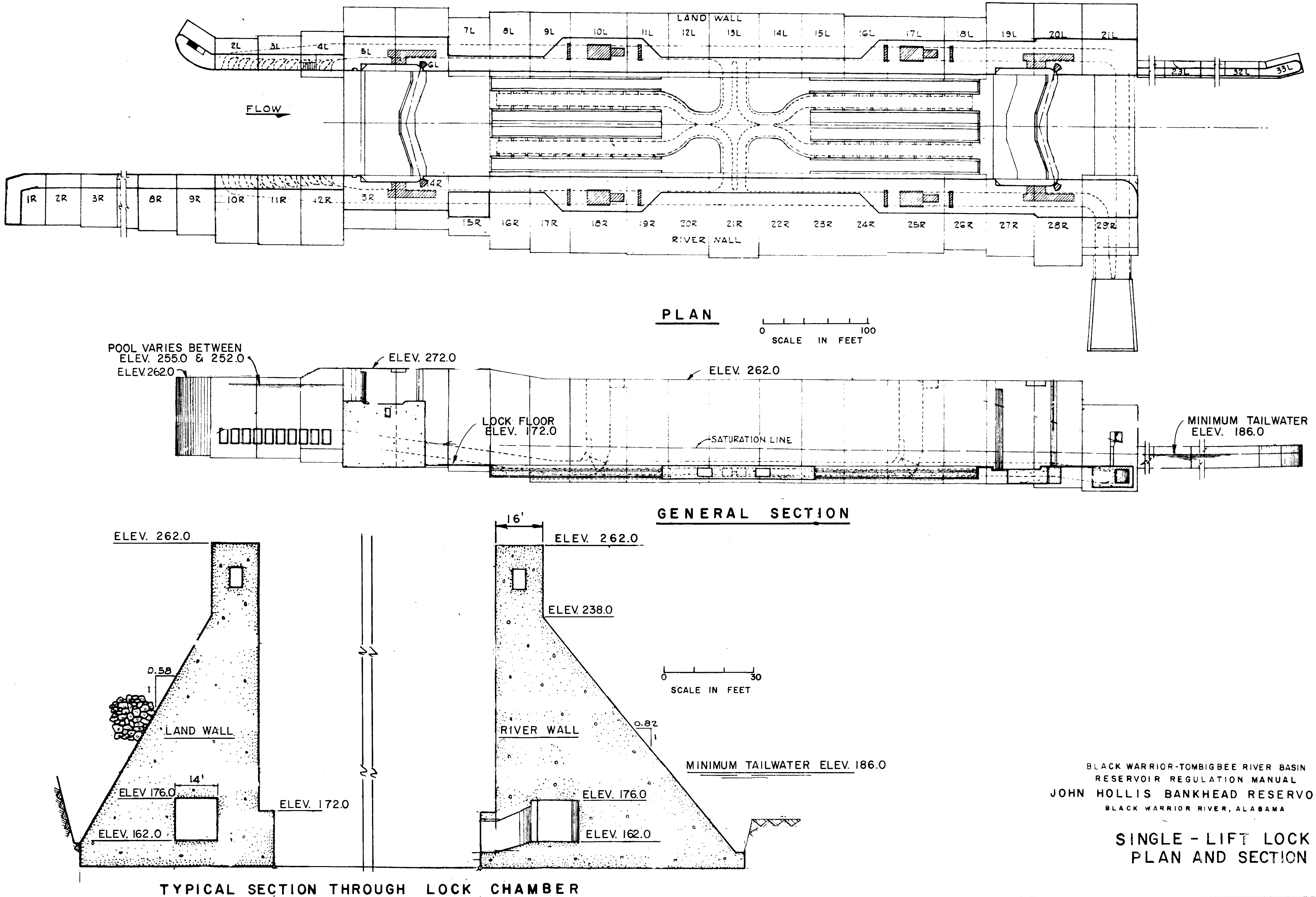
BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

TYPICAL GATE ELEVATION



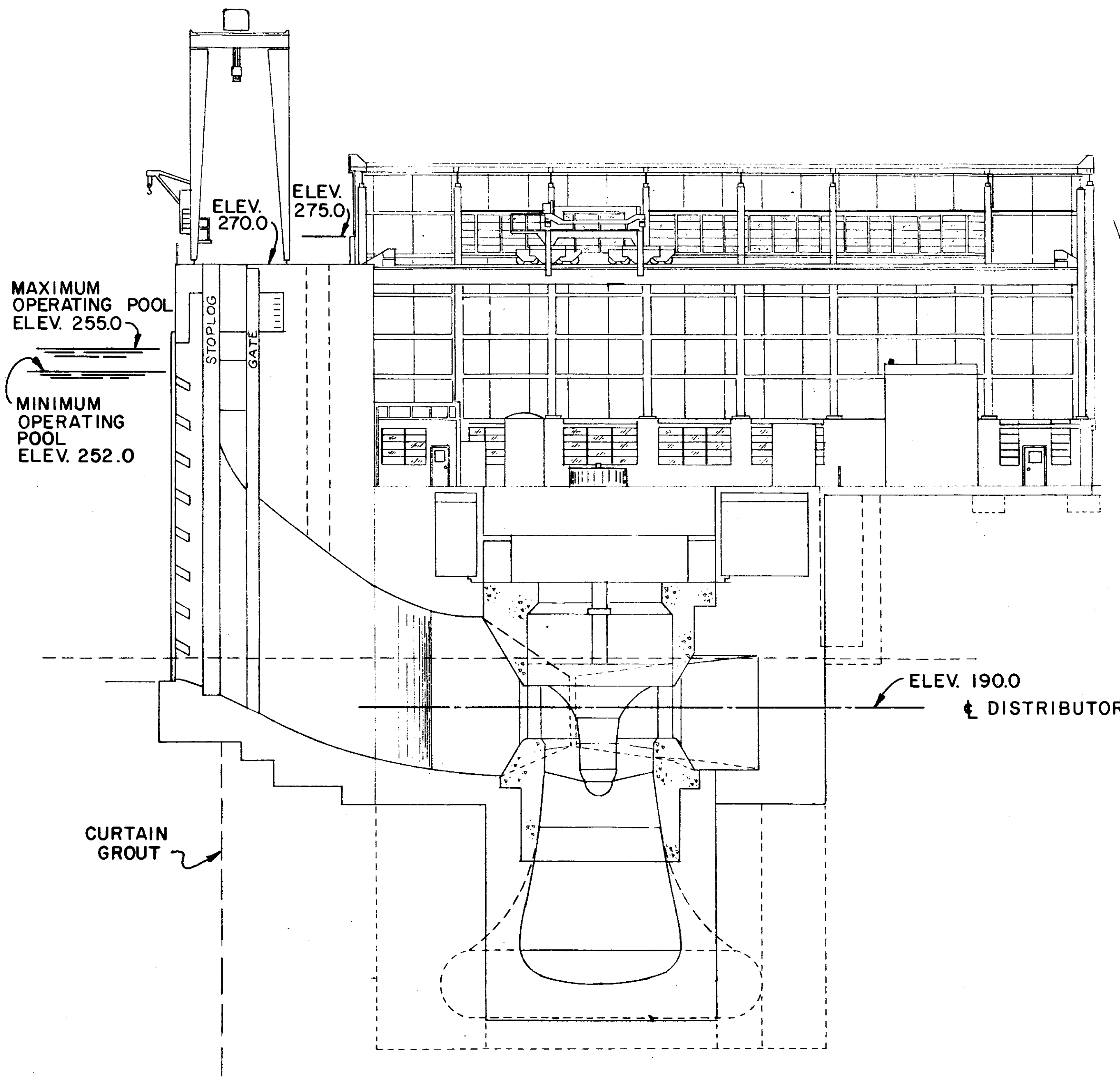
BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

DOUBLE - LIFT LOCK
PLAN AND SECTION

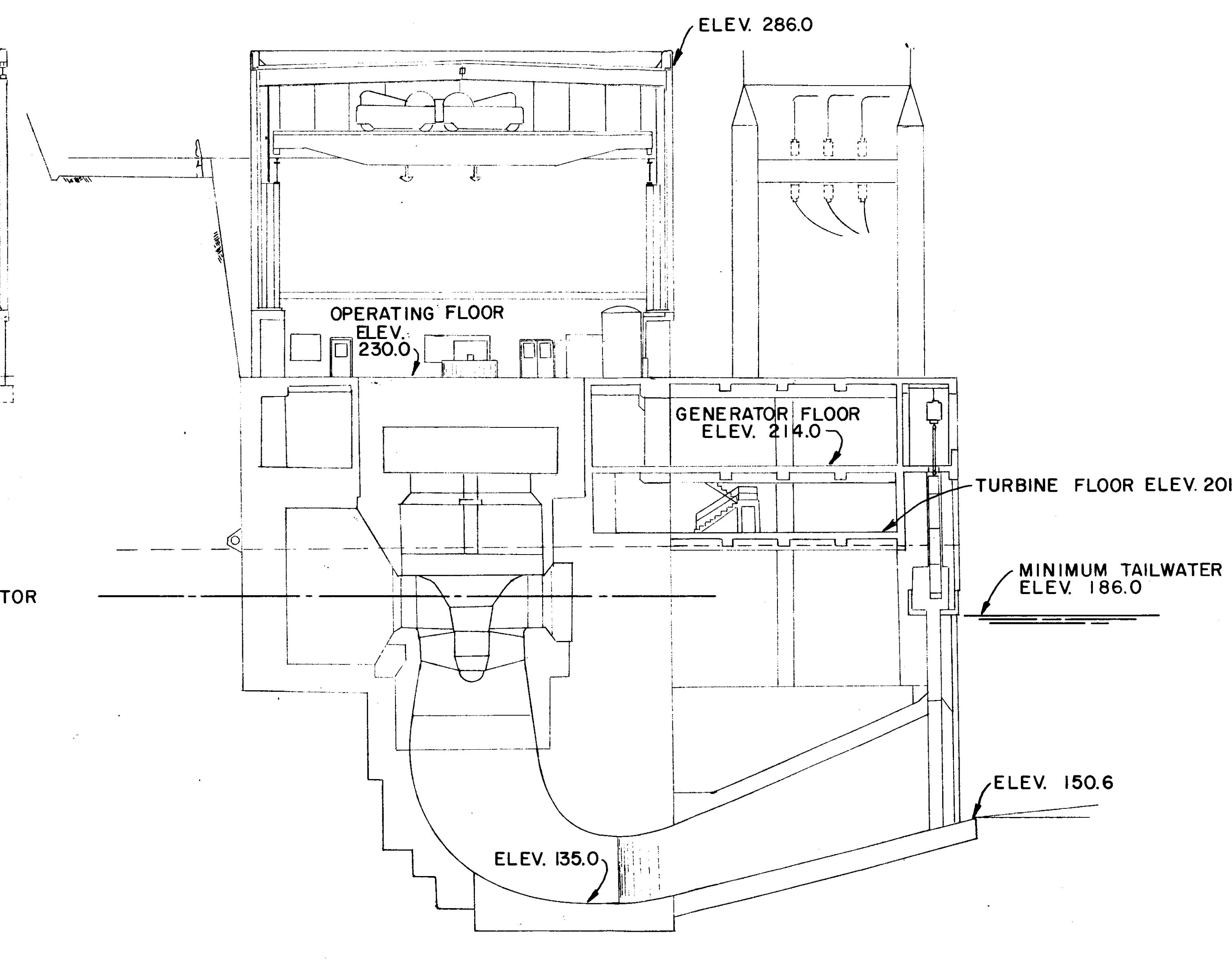


BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

SINGLE - LIFT LOCK
PLAN AND SECTION



SECTION THROUGH INTAKE

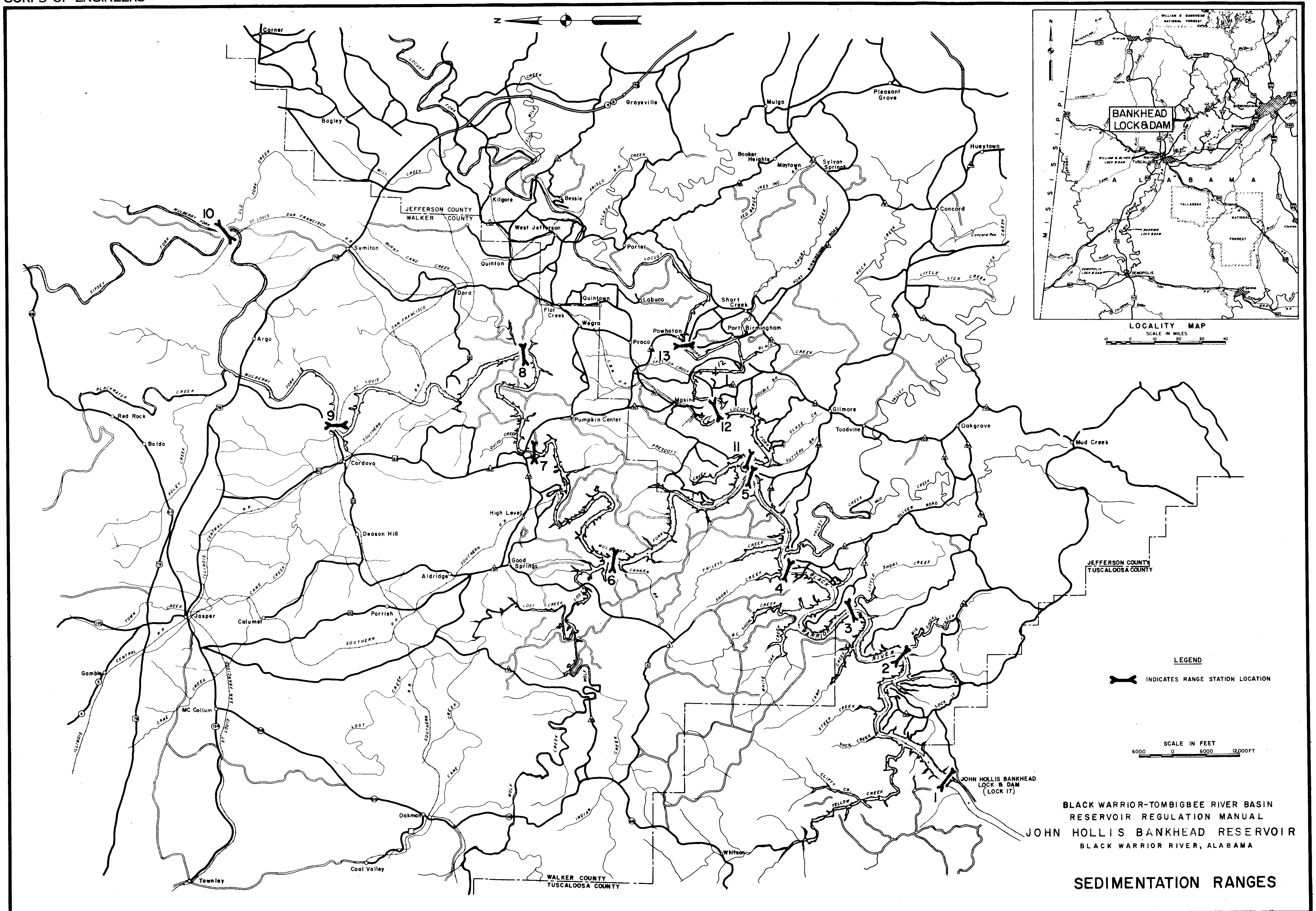


SECTION THROUGH DRAFT TUBE

0 10 20 30 40 50
SCALE IN FEET

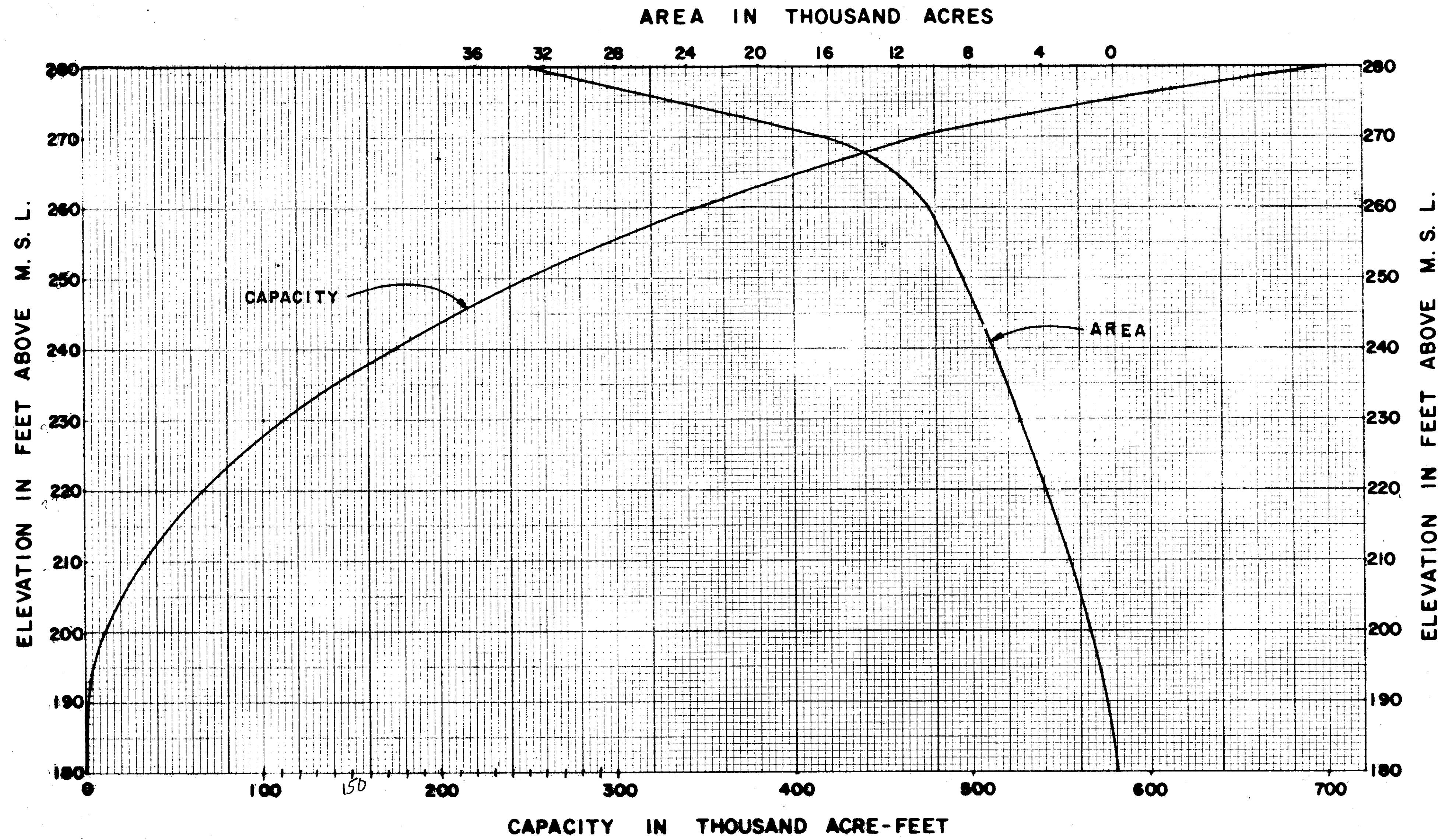
BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

GENERAL SECTIONS
THROUGH POWERHOUSE



BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

SEDIMENTATION RANGES



SELECTED AREA AND CAPACITY VALUES

Elevation feet, msl	Area, acres	Capacity, acre-feet	Elevation feet, msl	Area, acres	Capacity, acre-feet
180	0	0	253	8,900	278,070
190	600	2,620	254	9,070	286,970
200	1,530	13,090	255 **	9,245	296,215
210	2,700	34,080	256	9,420	305,460
220	4,000	67,400	257	9,630	315,090
230	5,390	114,030	258	9,840	324,720
240	6,900	175,460	259	10,095	334,815
250	8,400	252,040	260	10,350	344,910
251	8,565	260,605	270	16,050	471,630
252 *	8,730	269,170	280	32,700	704,580

* Minimum operating pool
** Maximum operating pool

BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

AREA AND CAPACITY
CURVES AND TABLE

JOHN HOLLIS BANKHEAD DAM
GATE OPERATING SCHEDULE

STEP NO.	GATE NO. FROM	GATE NO. TO	OPENING IN FEET	GATE NO. FROM	GATE NO. TO	OPENING IN FEET	POOL ELEVATION 252.0	252.5	253.0	253.5	254.0	254.5	255.0	255.5	256.0	256.5
1	1		1	2	21	CLOSED	910	930	950	970	990	1010	1030	1050	1070	1090
2	1	2	1	3	21	CLOSED	1810	1860	1900	1940	1990	2030	2070	2110	2150	2180
3	1	3	1	4	21	CLOSED	2720	2790	2850	2920	2980	3040	3100	3160	3220	3280
4	1	4	1	5	21	CLOSED	3630	3720	3800	3890	3970	4060	4140	4210	4290	4370
5	1	5	1	6	21	CLOSED	4530	4650	4760	4860	4970	5070	5170	5270	5360	5460
6	1	6	1	7	21	CLOSED	5440	5580	5710	5830	5960	6080	6200	6320	6440	6550
7	1	7	1	8	21	CLOSED	6350	6500	6660	6810	6950	7100	7240	7380	7510	7640
8	1	8	1	9	21	CLOSED	6740	6900	7070	7230	7380	7540	7690	7840	7980	8110
9	1	9	1	10	21	CLOSED	7640	7830	8020	8200	8380	8550	8720	8890	9050	9210
10	1	10	1	11	21	CLOSED	8550	8760	8970	9170	9370	9560	9760	9940	10130	10300
11	1	11	1	12	21	CLOSED	9460	9690	9920	10140	10360	10580	10790	11000	11200	11390
12	1	12	1	13	21	CLOSED	9850	10090	10330	10560	10790	11020	11240	11460	11670	11860
13	1	13	1	14	21	CLOSED	10760	11020	11280	11540	11790	12030	12270	12510	12740	12950
14	1	14	1	15	21	CLOSED	11660	11950	12230	12510	12780	13050	13310	13560	13820	14040
15	1	15	1	16	21	CLOSED	12570	12880	13180	13480	13770	14060	14340	14620	14890	15140
16	1	16	1	17	21	CLOSED	13480	13810	14140	14450	14770	15070	15380	15670	15960	16230
17	1	17	1	18	21	CLOSED	14380	14740	15090	15430	15760	16090	16410	16720	17030	17320
18	1	18	1	19	21	CLOSED	15290	15670	16040	16400	16750	17100	17440	17780	18110	18410
19	1	19	1	20	21	CLOSED	16210	16610	16990	17370	17750	18120	18480	18820	19170	19510
20	1	20	1		21	CLOSED	17110	17540	17940	18340	18740	19130	19510	19880	20240	20610
21	1	21	1				18020	18470	18890	19320	19730	20140	20550	20930	21320	21700
22	1		2	2	21	1	18880	19360	19800	20250	20680	21110	21550	21950	22360	22760
23	1	2	2	3	21	1	19740	20250	20710	21180	21640	22090	22540	22970	23390	23810
24	1	3	2	4	21	1	20610	21140	21620	22120	22590	23060	23540	23980	24430	24870
25	1	4	2	5	21	1	21470	22020	22530	23050	23540	24040	24540	25000	25470	25930
26	1	5	2	6	21	1	22330	22910	23440	23980	24500	25020	25530	26020	26510	26980
27	1	6	2	7	21	1	23200	23800	24350	24910	25450	25990	26530	27040	27540	28040
28	1	7	2	8	21	1	24060	24680	25260	25850	26410	26970	27530	28050	28580	29100
29	1	8	2	9	21	1	24430	25060	25660	26260	26830	27390	27960	28490	29030	29560
30	1	9	2	10	21	1	25290	25950	26570	27190	27780	28360	28950	29510	30070	30620

NOTES:
GATE NO. 22 REMAINS CLOSED UNTIL ALL OTHER GATES ARE FULLY OPEN.

GATES ARE NUMBERED IN SEQUENCE BEGINNING WITH NO. 1 GATE ADJACENT TO THE DOUBLE-LIFT LOCK.

BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

GATE OPERATING SCHEDULE

SHEET 1 OF 5 SHEETS

JOHN HOLLIS BANKHEAD DAM
GATE OPERATING SCHEDULE

STEP NO.	GATE NO. FROM	GATE NO. TO	OPENING IN FEET	GATE NO. FROM	GATE NO. TO	OPENING IN FEET	POOL ELEVATION 252.0	252.5	253.0	253.5	254.0	254.5	255.0	255.5	256.0	256.5
31	1	10	2	11	21	1	26160	26840	27480	28120	28740	29340	29950	30530	31090	31670
32	1	11	2	12	21	1	27020	27720	28390	29050	29690	30310	30940	31540	32140	32730
33	1	12	2	13	21	1	27390	28100	28790	29460	30110	30730	31360	31980	32590	33190
34	1	13	2	14	21	1	28250	28990	29700	30400	31060	31710	32370	33000	33630	34250
35	1	14	2	15	21	1	29120	29880	30610	31330	32020	32690	33370	34020	34670	35300
36	1	15	2	16	21	1	29980	30760	31520	32260	32970	33660	34360	35040	35700	36360
37	1	16	2	17	21	1	30840	31650	32430	33190	33930	34640	35360	36060	36740	37420
38	1	17	2	18	21	1	31710	32540	33340	34120	34880	35610	36360	37070	37780	38470
39	1	18	2	19	21	1	32570	33430	34250	35060	35840	36590	37350	38090	38810	39530
40	1	19	2	20	21	1	33440	34320	35150	35980	36780	37570	38350	39110	39850	40600
41	1	20	2		21	1	34310	35210	36060	36910	37730	38550	39350	40130	40890	41630
42	1	21	2				35170	36100	36970	37840	38690	39520	40340	41150	41930	42690
43	1		4	2	21	2	36780	37760	38670	39590	40490	41370	42230	43090	43910	44710
44	1	2	4	3	21	2	38380	39410	40380	41340	42290	43210	44120	45030	45890	46730
45	1	3	4	4	21	2	39980	41060	42080	43090	44090	45060	46010	46960	47870	48750
46	1	4	4	5	21	2	41580	42720	43780	44850	45890	46900	47910	48900	49850	50770
47	1	5	4	6	21	2	43180	44370	45490	46600	47690	48750	49800	50830	51830	52790
48	1	6	4	7	21	2	44780	46020	47190	48350	49490	50600	51690	52770	53810	54810
49	1	7	4	8	21	2	46380	47680	48900	50100	51290	52440	53580	54700	55780	56830
50	1	8	4	9	21	2	47070	48390	49640	50860	52070	53240	54400	55540	56640	57710
51	1	9	4	10	21	2	48680	50040	51340	52620	53870	55090	56290	57480	58620	59740
52	1	10	4	11	21	2	50280	51690	53040	54370	55670	56940	58180	59410	60600	61760
53	1	11	4	12	21	2	51880	53350	54750	56120	57470	58780	60070	61350	62580	63780
54	1	12	4	13	21	2	52570	54060	55490	56880	58250	59580	60890	62190	63440	64660
55	1	13	4	14	21	2	54170	55710	57190	58630	60050	61430	62790	64130	65420	66680
56	1	14	4	15	21	2	55770	57360	58890	60380	61850	63270	64680	66060	67400	68700
57	1	15	4	16	21	2	57370	59020	60600	62140	63650	65120	66570	68000	69380	70720
58	1	16	4	17	21	2	58980	60670	62300	63890	65450	66970	68460	69930	71350	72740
59	1	17	4	18	21	2	60580	62320	64000	65640	67250	68810	70350	71870	73330	74760
60	1	18	4	19	21	2	62180	63980	65710	67390	69050	70660	72240	73800	75310	76780

NOTES:

GATE NO. 22 REMAINS CLOSED UNTIL ALL OTHER GATES ARE FULLY OPEN.

GATES ARE NUMBERED IN SEQUENCE BEGINNING WITH NO. 1 GATE ADJACENT TO THE DOUBLE-LIFT LOCK.

BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

GATE OPERATING SCHEDULE

SHEET 2 OF 5 SHEETS

JOHN HOLLIS BANKHEAD DAM
GATE OPERATING SCHEDULE

STEP NO.	GATE NO. FROM	GATE NO. TO	OPENING IN FEET	GATE NO. FROM	GATE NO. TO	OPENING IN FEET	POOL ELEVATION 252.0	252.5	253.0	253.5	254.0	254.5	255.0	255.5	256.0	256.5
61	1	19	4	20	21	2	63780	65640	67410	69150	70850	72500	74130	75730	77290	78800
62	1	20	4		21	2	65380	67290	69110	70900	72650	74350	76020	77660	79270	80820
63	1	21	4				66980	68950	70820	72650	74450	76200	77920	79600	81250	82850
64	1		6	2	21	4	68430	70450	72380	74270	76120	77930	79690	81430	83120	84770
65	1	2	6	3	21	4	69870	71960	73940	75890	77790	79650	81470	83260	84990	86690
66	1	3	6	4	21	4	71320	73460	75510	77510	79470	81380	83240	85080	86870	88610
67	1	4	6	5	21	4	72760	74970	77070	79120	81140	83100	85020	86910	88740	90530
68	1	5	6	6	21	4	74200	76470	78630	80740	82810	84830	86800	88730	90620	92450
69	1	6	6	7	21	4	75650	77970	80190	82360	84480	86550	88570	90560	92490	94370
70	1	7	6	8	21	4	77090	79480	81750	83980	86150	88280	90350	92380	94360	96290
71	1	8	6	9	21	4	77720	80130	82430	84680	86880	89020	91120	93180	95170	97120
72	1	9	6	10	21	4	79160	81630	84000	86300	88560	90740	92890	95010	97050	99050
73	1	10	6	11	21	4	80610	83130	85560	87910	90230	92460	94670	96830	98920	100970
74	1	11	6	12	21	4	82050	84640	87120	89530	91900	94190	96440	98660	100800	102890
75	1	12	6	13	21	4	82680	85290	87800	90230	92630	94930	97210	99460	101610	103720
76	1	13	6	14	21	4	84120	86790	89360	91850	94300	96650	98990	101280	103480	105640
77	1	14	6	15	21	4	85570	88300	90920	93470	95970	98380	100770	103110	105350	107560
78	1	15	6	16	21	4	87010	89800	92480	95080	97650	100100	102540	104930	107230	109480
79	1	16	6	17	21	4	88460	91300	94050	96700	99320	101830	104320	106760	109100	111400
80	1	17	6	18	21	4	89900	92810	95610	98320	100990	103550	106090	108590	110970	113320
81	1	18	6	19	21	4	91340	94310	97170	99940	102660	105280	107870	110410	112850	115250
82	1	19	6	20	21	4	92790	95810	98730	101570	104320	107010	109640	112230	114720	117170
83	1	20	6		21	4	94230	97320	100290	103180	106000	108740	111420	114050	116600	119090
84	1	21	6				95670	98820	101850	104800	107670	110460	113200	115880	118470	121010
85	1		8	2	21	6	96980	100200	103300	106320	109260	112110	114910	117650	120300	122890
86	1	2	8	3	21	6	98290	101590	104760	107850	110850	113760	116630	119420	122130	124770
87	1	3	8	4	21	6	99610	102980	106220	109370	112440	115410	118340	121190	123960	126660
88	1	4	8	5	21	6	100920	104360	107680	110900	114030	117060	120050	122970	125780	128540
89	1	5	8	6	21	6	102240	105750	109130	112420	115620	118720	121760	124740	127610	130420
90	1	6	8	7	21	6	103550	107140	110590	113590	117210	120370	123480	126510	129440	132310

NOTES:

GATE NO. 22 REMAINS CLOSED UNTIL ALL OTHER GATES ARE FULLY OPEN.

GATES ARE NUMBERED IN SEQUENCE BEGINNING WITH NO. 1 GATE ADJACENT TO THE DOUBLE-LIFT LOCK.

BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

GATE OPERATING SCHEDULE

SHEET 3 OF 5 SHEETS

JOHN HOLLIS BANKHEAD DAM
GATE OPERATING SCHEDULE

STEP NO.	GATE NO. FROM	GATE NO. TO	OPENING IN FEET	GATE NO. FROM	GATE NO. TO	OPENING IN FEET	POOL ELEVATION 252.0	252.5	253.0	253.5	254.0	254.5	255.0	255.5	256.0	256.5
91	1	7	8	8	21	6	104860	108530	112050	115470	118800	122020	125190	128280	131270	134190
92	1	8	8	9	21	6	105430	109140	112680	116130	119490	122740	125930	129050	132060	135010
93	1	9	8	10	21	6	106750	110520	114140	117660	121080	124390	127640	130820	133880	136890
94	1	10	8	11	21	6	108060	111910	115600	119180	122670	126040	129350	132590	135710	138770
95	1	11	8	12	21	6	109380	113300	117050	120710	124260	127700	131070	134360	137540	140660
96	1	12	8	13	21	6	109950	113910	117680	121370	124950	128420	131810	135130	138330	141480
97	1	13	8	14	21	6	111260	115300	119140	122890	126540	130070	133520	136900	140160	143360
98	1	14	8	15	21	6	112570	116680	120600	124420	128130	131720	135230	138670	141980	145240
99	1	15	8	16	21	6	113890	118070	122060	125940	129710	133370	136940	140440	143810	147120
100	1	16	8	17	21	6	115200	119460	123510	127470	131300	135030	138660	142210	145640	149010
101	1	17	8	18	21	6	116520	120850	124970	128990	132890	136680	140370	143990	147470	150890
102	1	18	8	19	21	6	117830	122230	126430	130520	134430	138330	142080	145760	149290	152770
103	1	19	8	20	21	6	119140	123610	127890	132040	136070	139980	143800	147520	151130	154650
104	1	20	8		21	6	120460	125000	129340	133570	137660	141630	145520	149290	152960	156540
105	1	21	8				121770	126390	130800	135090	139250	143290	147230	151060	154790	158420
106	1		FULL	2	21	8	121950	126570	131360	136070	140600	145020	149380	153650	157760	161790
107	1	2	FULL	3	21	8	122130	126740	131920	137050	141940	146750	151530	156230	160730	165160
108	1	3	FULL	4	21	8	122300	126910	132470	138030	143290	148490	153670	158820	163700	168530
109	1	4	FULL	5	21	8	122480	127090	133030	139010	144630	150220	155820	161410	166670	171900
110	1	5	FULL	6	21	8	122660	127260	133590	139990	145970	151950	157970	164000	169640	175270
111	1	6	FULL	7	21	8	122840	127430	134150	140970	147320	153690	160120	166590	172610	178640
112	1	7	FULL	8	21	8	123010	127610	134710	141950	148660	155420	162270	169170	175580	182010
113	1	8	FULL	9	21	8	123080	127680	134950	142370	149240	156170	163200	170300	176870	183470
114	1	9	FULL	10	21	8	123260	127850	135500	143360	150590	157900	165340	172890	179840	186840
115	1	10	FULL	11	21	8	123440	128020	136060	144340	151930	159640	167490	175480	182810	190210
116	1	11	FULL	12	21	8	123620	128200	136620	145320	153280	161370	169640	178070	185780	193580
117	1	12	FULL	13	21	8	123690	128270	136860	145740	153860	162120	170570	179200	187070	195040
118	1	13	FULL	14	21	8	123860	128440	137420	146720	155200	163850	172720	181780	190040	198410
119	1	14	FULL	15	21	8	124040	128610	137980	147700	156540	165590	174860	184370	193020	201780
120	1	15	FULL	16	21	8	124220	128790	138530	148680	157890	167320	177010	186960	195990	205150

NOTES:
GATE NO. 22 REMAINS CLOSED UNTIL ALL OTHER GATES ARE FULLY OPEN.

GATES ARE NUMBERED IN SEQUENCE BEGINNING WITH NO. 1 GATE ADJACENT TO THE DOUBLE-LIFT LOCK.

BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

GATE OPERATING SCHEDULE

SHEET 4 OF 5 SHEETS

JOHN HOLLIS BANKHEAD DAM
GATE OPERATING SCHEDULE

STEP NO.	GATE NO. FROM	GATE NO. TO	OPENING IN FEET	GATE NO. FROM	GATE NO. TO	OPENING IN FEET	POOL ELEVATION 252.0	252.5	253.0	253.5	254.0	254.5	255.0	255.5	256.0	256.5
121	1	16	FULL	17	21	8	124400	128960	139090	149660	159230	169050	179160	189550	198960	208520
122	1	17	FULL	18	21	8	124580	129130	139650	150640	160580	170790	181310	192130	201930	211890
123	1	18	FULL	19	21	8	124760	129300	140210	151620	161920	172520	183460	194720	204900	215270
124	1	19	FULL	20	21	8	124940	129490	140770	152660	163280	174250	185600	197300	207860	218640
125	1	20	FULL		21	8	125120	129660	141320	153600	164620	175990	187750	199890	210830	222010
126	1	21	FULL				125300	129830	141880	154580	165960	177720	189900	202470	213800	225380
127	1	22	FULL				131600	136350	149030	162370	174320	186680	199450	212640	224550	236720

NOTES:

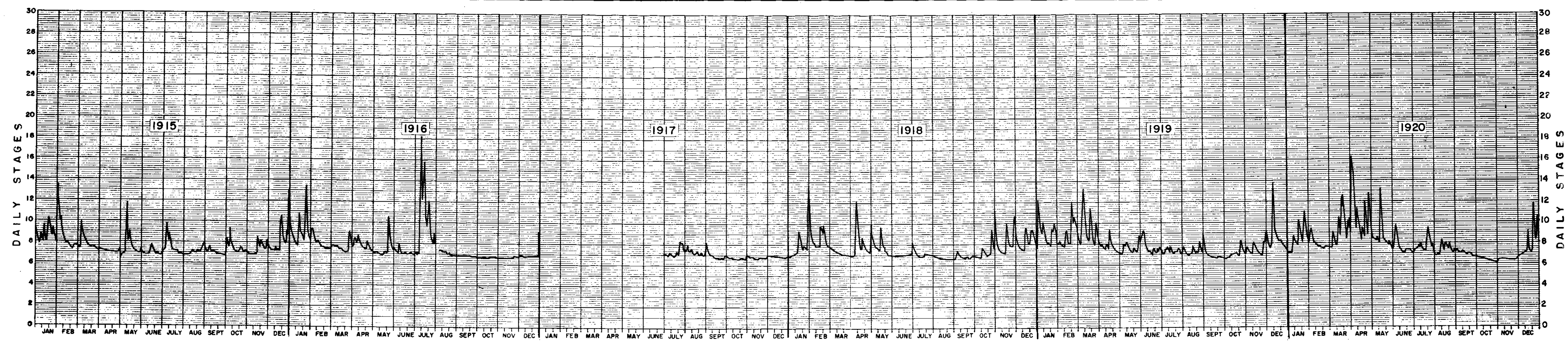
GATE NO. 22 REMAINS CLOSED UNTIL ALL OTHER GATES ARE FULLY OPEN.

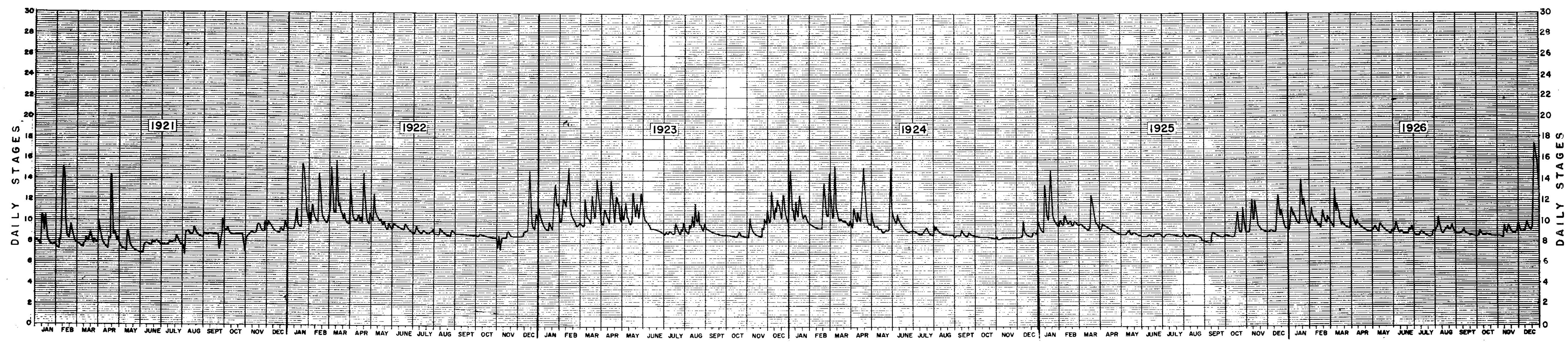
GATES ARE NUMBERED IN SEQUENCE BEGINNING WITH NO. 1 GATE ADJACENT TO THE DOUBLE-LIFT LOCK.

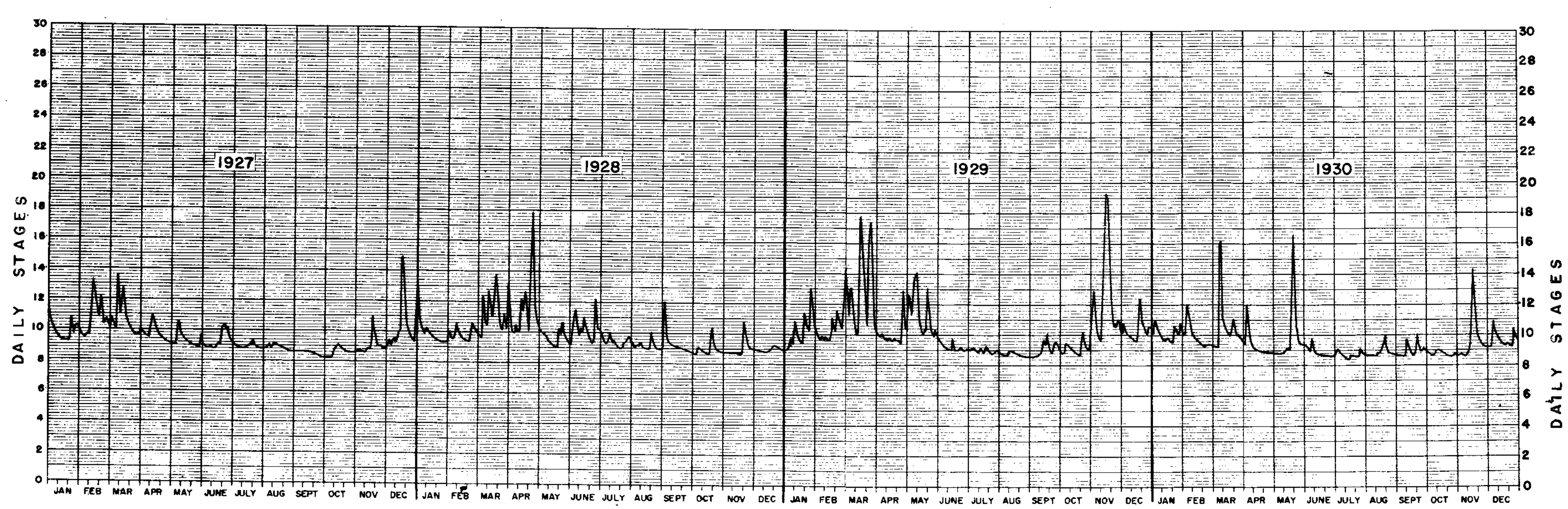
BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

GATE OPERATING SCHEDULE

SHEET 5 OF 5 SHEETS







GAGE ZERRO = 173.5 FEET M. S. L.

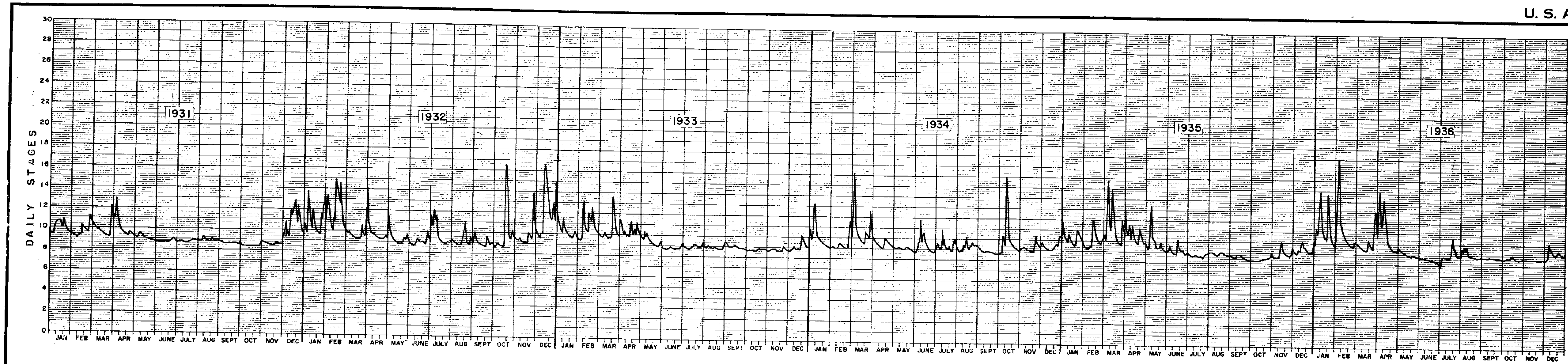
NOTE:

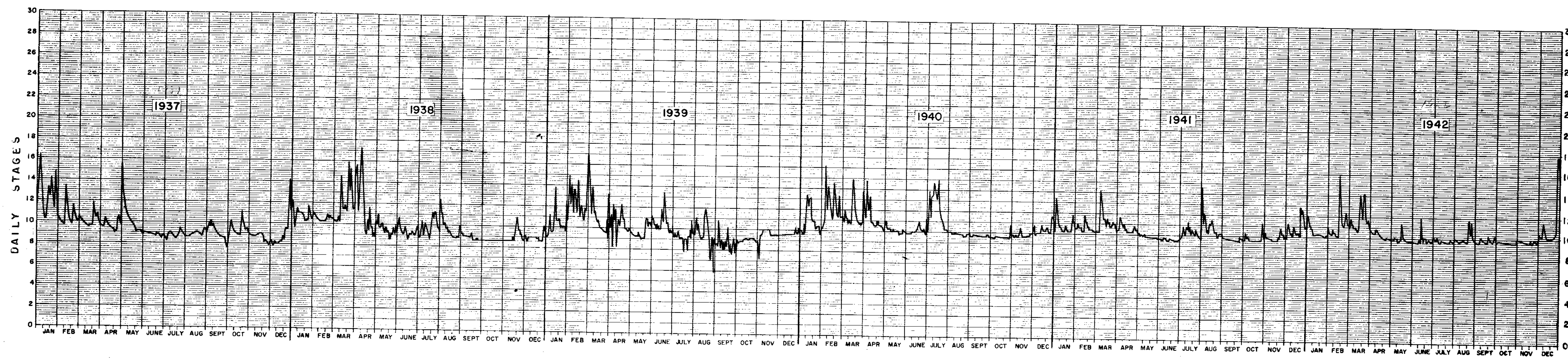
WITH THE COMPLETION OF HOLT LOCK AND DAM IN 1968 THE MINIMUN TAILWATER STAGE HAS BEEN INCREASED TO 12.5 FEET.

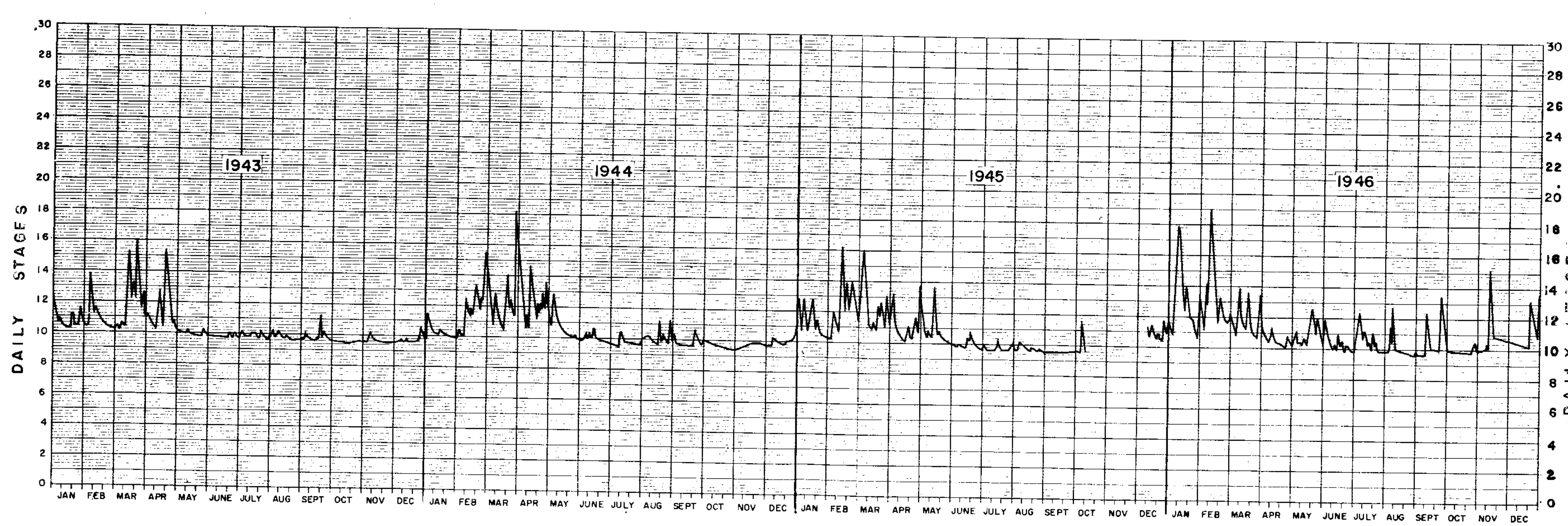
BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA
HYDROGRAPHS
ONCF DAILY STAGES AT DAMSITE

SHEET 1 OF 4 SHEETS

U. S. ARMY







GAGE ZERO = 173.5 FEET M. S. L.

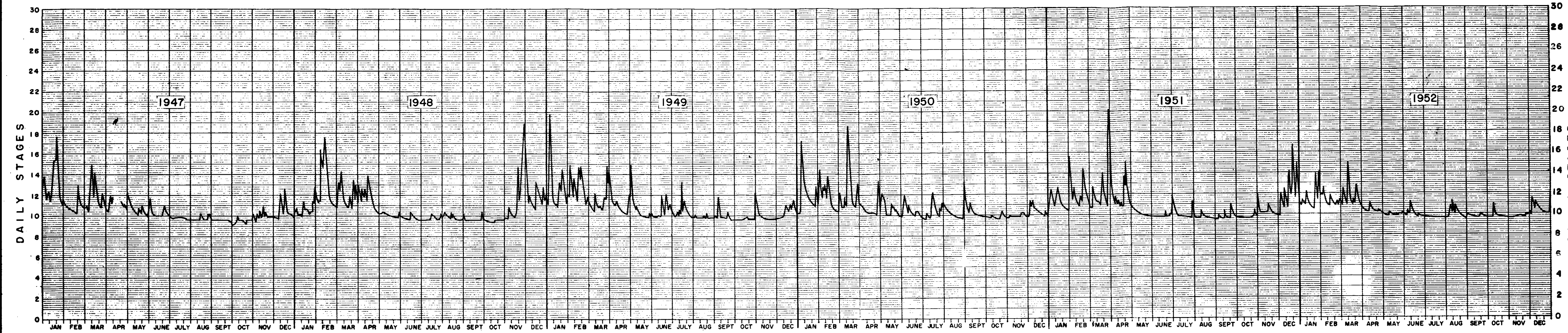
NOTE:

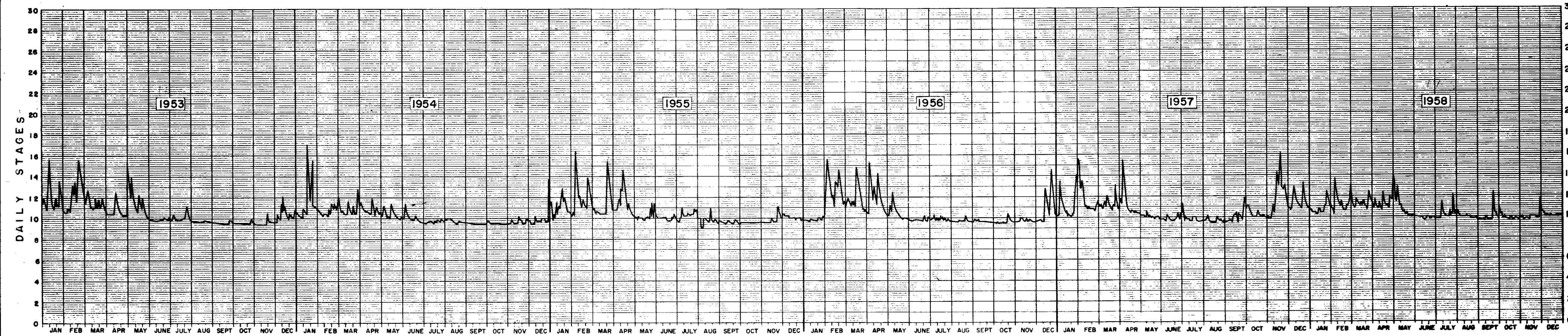
WITH THE COMPLETION OF HOLT LOCK AND DAM IN 1968 THE MINIMUN TAILWATER STAGE HAS BEEN INCREASED TO 12.5 FEET.

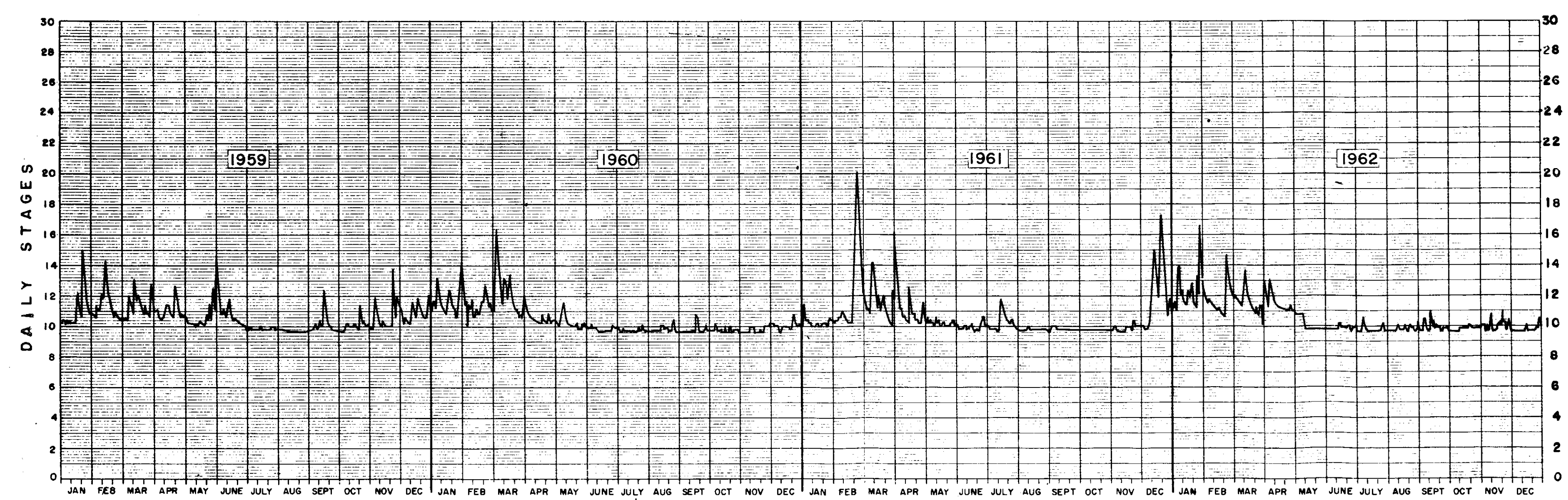
BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA
HYDROGRAPHS
ONCE DAILY STAGES AT DAMSITE

SHEET 2 OF 4 SHEETS

APPENDIX E CHART NO. 15







GAGE ZERO = 173.5 FEET M. S. L.

NOTE:

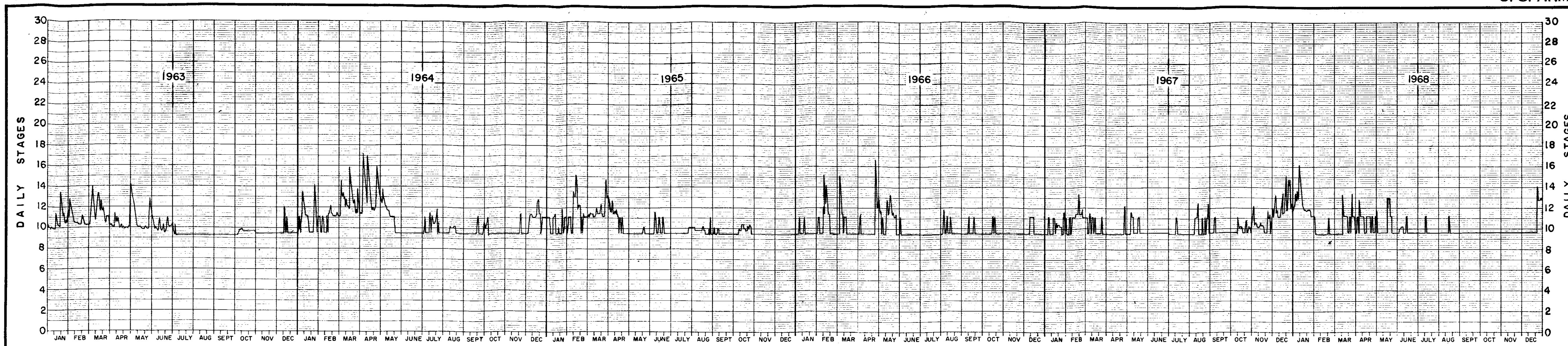
WITH THE COMPLETION OF HOLT LOCK AND DAM IN 1968 THE MINIMUN TAILWATER STAGE HAS BEEN INCREASED TO 12.5 FEET.

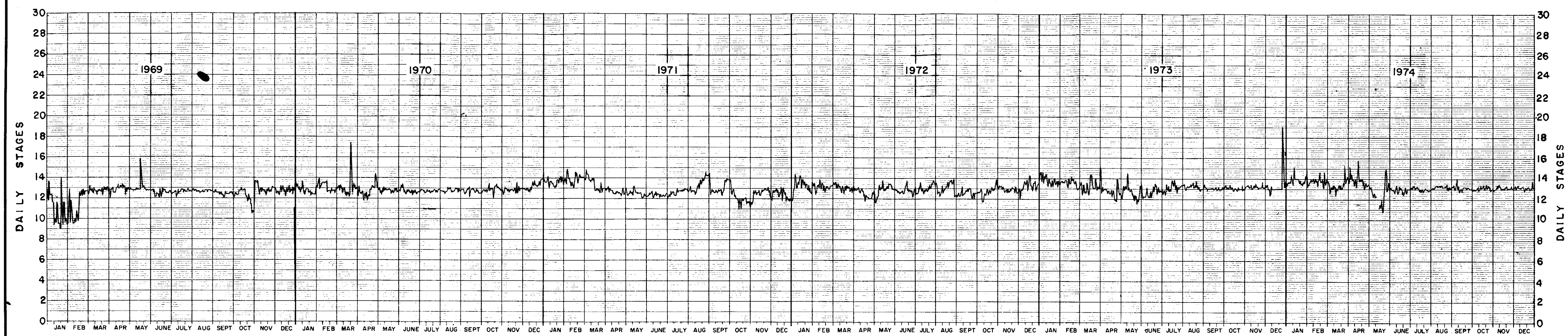
BLACK WARRIOR-TOMBIGBEE RIVER BASIN.
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA
HYDROGRAPHS
ONCE DAILY STAGES AT DAMSITE

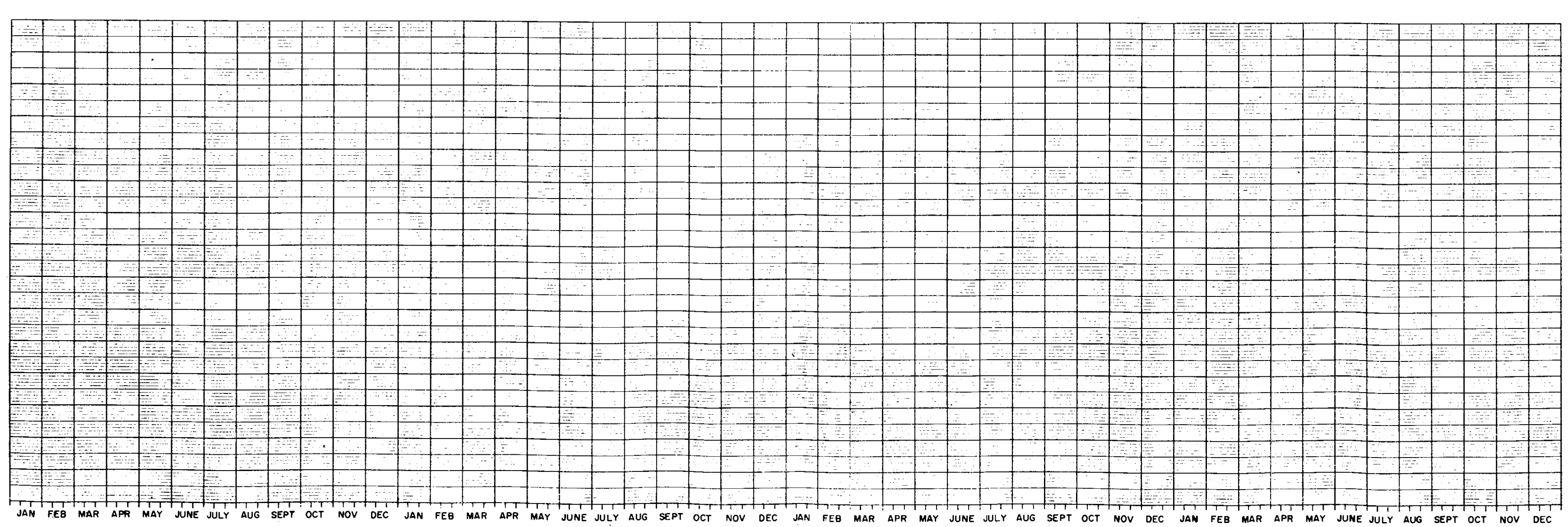
SHEET 3 OF 4 SHEETS

CORPS OF ENGINEERS

U. S. ARMY







GAGE ZERO = 173.5 FEET M. S. L.

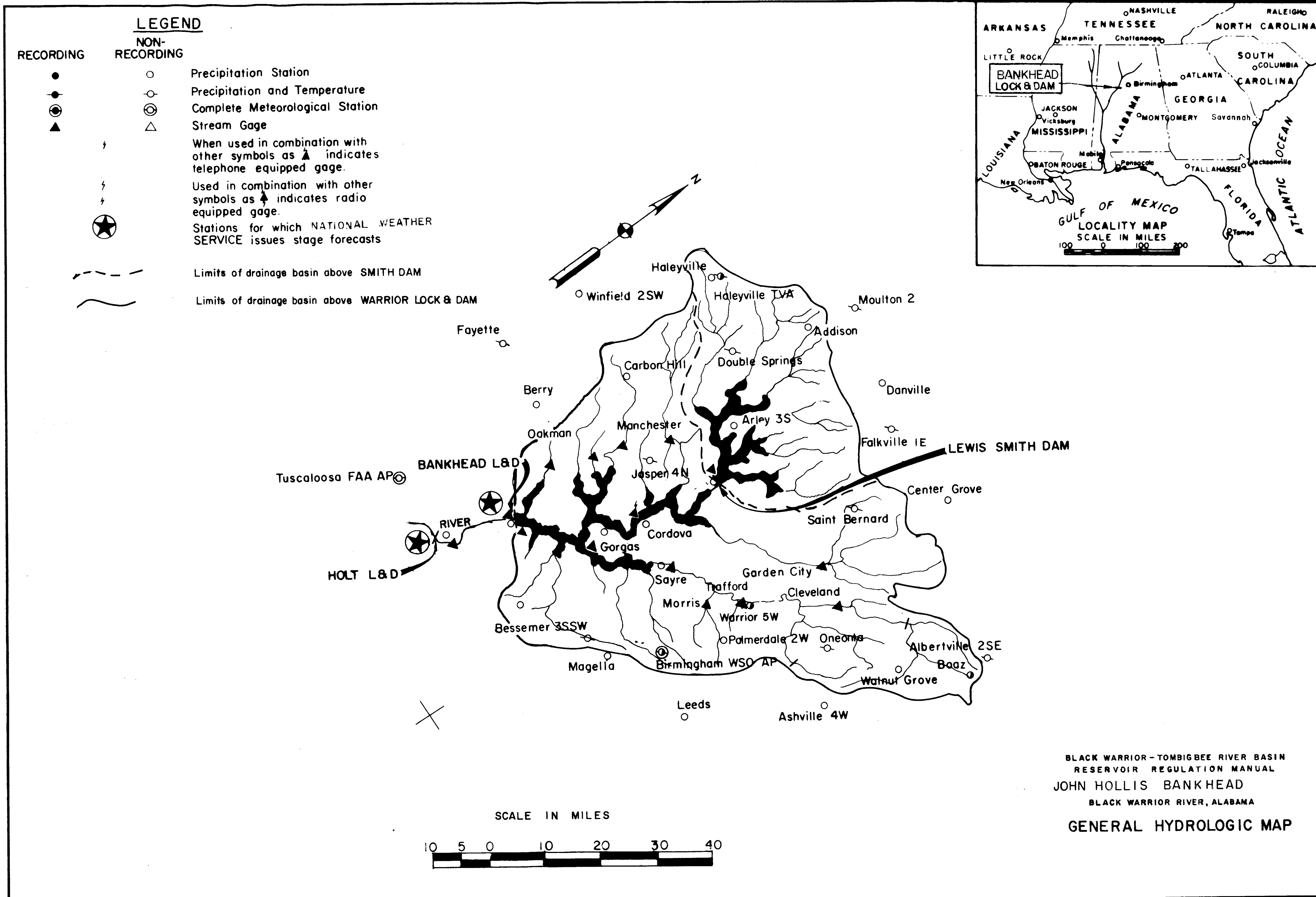
NOTE:

WITH THE COMPLETION OF HOLT LOCK AND DAM IN 1968 THE MINIMUM TAILWATER STAGE HAS BEEN INCREASED TO 12.5 FEET

BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA
HYDROGRAPHS
ONCE DAILY STAGES AT DAMSITE

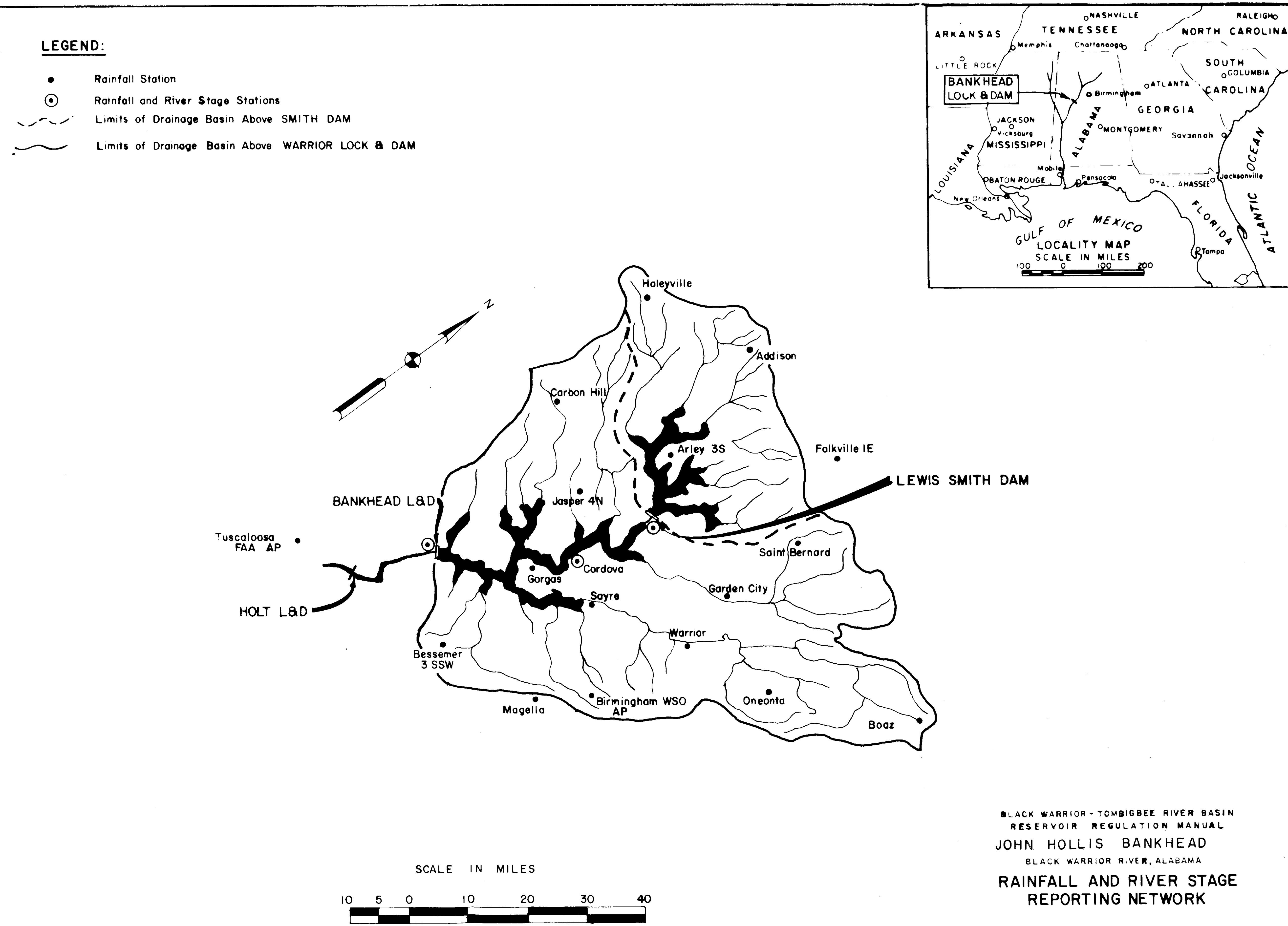
SHEET 4 OF 4 SHEETS

APPENDIX E CHART NO. 17



BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD
BLACK WARRIOR RIVER, ALABAMA

GENERAL HYDROLOGIC MAP



BLACK WARRIOR - TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD
BLACK WARRIOR RIVER, ALABAMA

RAINFALL AND RIVER STAGE REPORTING NETWORK

U. S. Department of Commerce—Weather Bureau

REPORTING INSTRUCTIONS

RAINFALL STATION

TIMES OF OBSERVATION

1. Your regular daily observation of precipitation should be taken at 7 a. m. each day. (EMPTY NON-RECORDING RAIN GAGE AFTER EACH 7 A. M. OBSERVATION.)

2. Special observations when made should be taken at 1 p. m., and 7 p. m. These special observations should be taken ONLY when a report is required in accordance with instructions (see below).

WHEN TO REPORT

1. Make an initial report at 7 a. m., 1 p. m., or 7 p. m., whenever 0.50 or more of precipitation has accumulated in the rain gage.

2. After the first report has been made CONTINUE REPORTING at each observation time (1 p. m., 7 p. m., 7 a. m.) as long as any additional precipitation has occurred since your previous report.

3. If you have made a final report, but it begins to rain again in less than 24 hours start reporting again, just as though you had not stopped. That is, you should not consider the storm to be over until there has been no precipitation for 24 hours.

WHAT TO REPORT

Your report should include the following information in the order listed (Numbers refer to WB Form 1089):

(1) Time of observation (hour).

(2) Amount of precipitation in gage at time of observation, in figures (inches and hundredths).

(3) Character of precipitation as it fell (rain, snow, sleet, etc.).

(4) Amount of precipitation measured at PREVIOUS 7 A. M. OBSERVATION, in figures (inches and hundredths). This information should be sent ONLY in your first report of a series of reports. The amount, when sent, should always be preceded by "Previous 7 a. m." In subsequent reports omit this section entirely.

(5) Weather at time of observation (clear, cloudy, raining, snowing, etc.).

(6) Depth of snow or ice on ground, in figures (nearest inch). The figure showing depth should always be followed by the word "Inch" or "Inches." If there is no snow on the ground omit this section entirely.

(12) Remarks. Any general comments which you feel would be of real value to the forecaster, such as: If snow is melting state whether slowly or rapidly. If thunderstorm or unusually heavy shower occurred within short period of time, give time of beginning and ending, etc. If instructed, include temperature readings.

(13) Last name of observer.

PREPARATION OF REPORT

1. The special River Rainfall Report card (WB Form 1089) furnished will assist you in arranging your report in the proper order. This form has numbered blocks for each of the items to be reported by river and rainfall observers.

2. You should enter the designated information in blocks 1 through 6, 12, and 13. Each report must be complete. Your report will then be ready for transmission in message form as follows (Indicate on card whether report has been telephoned or telegraphed).

Sample messages:

(First of a series)—"7 A. M. 0.75 SNOW PREVIOUS 7 A. M. 0.25 CLOUDY 6 INCHES MELTING RAPIDLY JONES"

(Subsequent reports)

"1 P. M. 0.30 RAIN CLOUDY 4 INCHES MELTING RAPIDLY JONES"

"7 P. M. 1.20 SHOWERS CLEAR THUNDERSTORM 4 P. M. JONES"

SENDING THE REPORT

1. If you report by telegram, address message to______
____

2. If you report by telephone, call__________________
____

3. All messages should be sent COLLECT.

4. If you customarily report by telegram, use telephone when telegraph office is closed.

5. If you customarily report by telephone and the lines are out of order, report by telegram, if possible.

6. In an emergency, when all land lines of communication are out, contact your local or state police who may be able to transmit your report by police radio.

NOTES

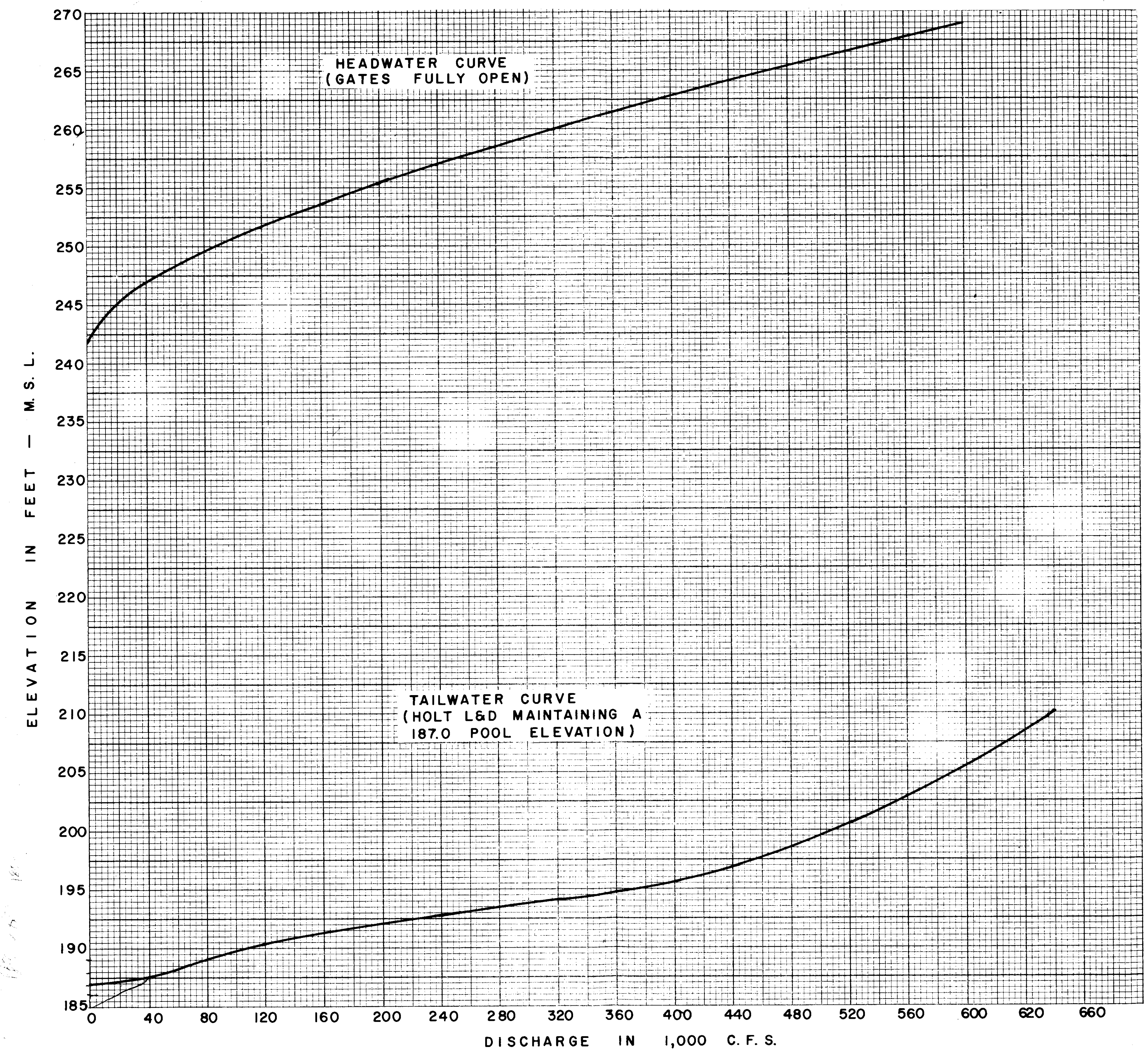
1. Promptly after each observation, mail the River Rainfall Report card which you have filled out, to_____
____

2. When additional supplies are needed, notify_______
____
____

3. SPECIAL INSTRUCTIONS: ____
____
____

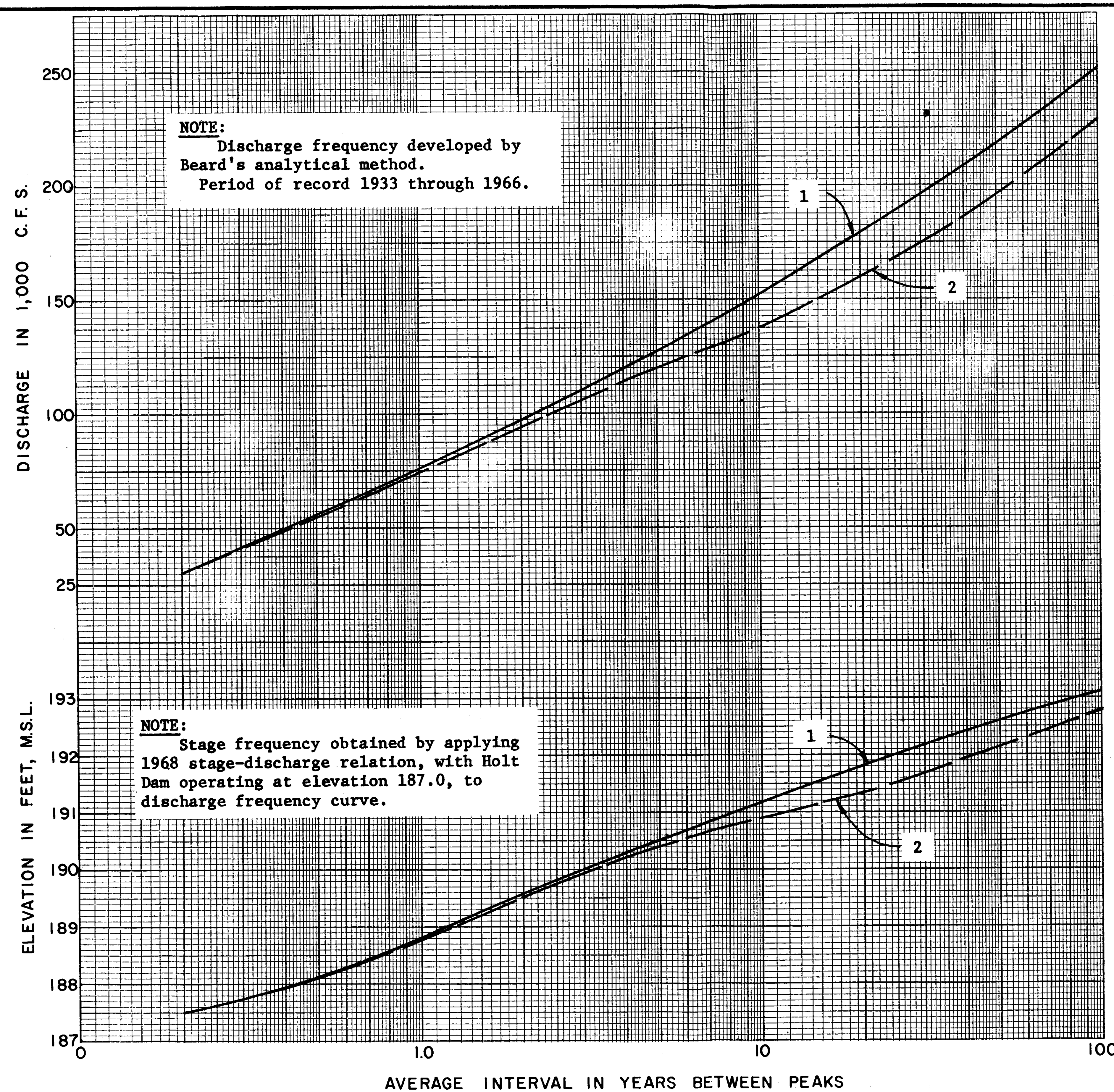
	DRAINAGE	IND. NO.	CODE	STATION		24 HOUR RAINFALL ENDING APPROXIMATELY 7:30 AM							STORM TOTAL
WARRIOR RIVER	Mulberry Fork	32		St.Bernard	Ala								
	Sipsey Fork	33		Addison	Ala								
	Sipsey Fork	34		Falkville	Ala								
	Sipsey Fork	35		Haleyville	Ala								
	Sipsey Fork	36		Arley	Ala								
	Sipsey Fork	37		Smith Dam	Ala								
	Mulberry Fork	38		Jasper	Ala								
	Mulberry Fork	39		Garden City	Ala								
	Mulberry Fork	40		Cordova	Ala								
	Mulberry Fork	41		Gorgas	Ala								
	Mulberry Fork	42		Carbon Hill	Ala								
	Locust Fork	43		Boaz	Ala								
	Locust Fork	44		Oneonta	Ala								
	Locust Fork	45		Warrior	Ala								
	Locust Fork	46		Sayre (Dora)	Ala								
		47											
	Village Cr	48	BHM	Birmingham (234)	Ala								
	Valley Cr	49		Magella (235)	Ala								
	Valley Cr	50		Bessemer (236)	Ala								
		51											
		52	BLAL	Bankhead L&D	Ala								
		53		Bankhead Dam (APC)	Ala								
		54											
		55											
		56											
		57											
		58											
		59											

BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA
RAINFALL REPORTING FORM



BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

HEADWATER AND TAILWATER RATING CURVES



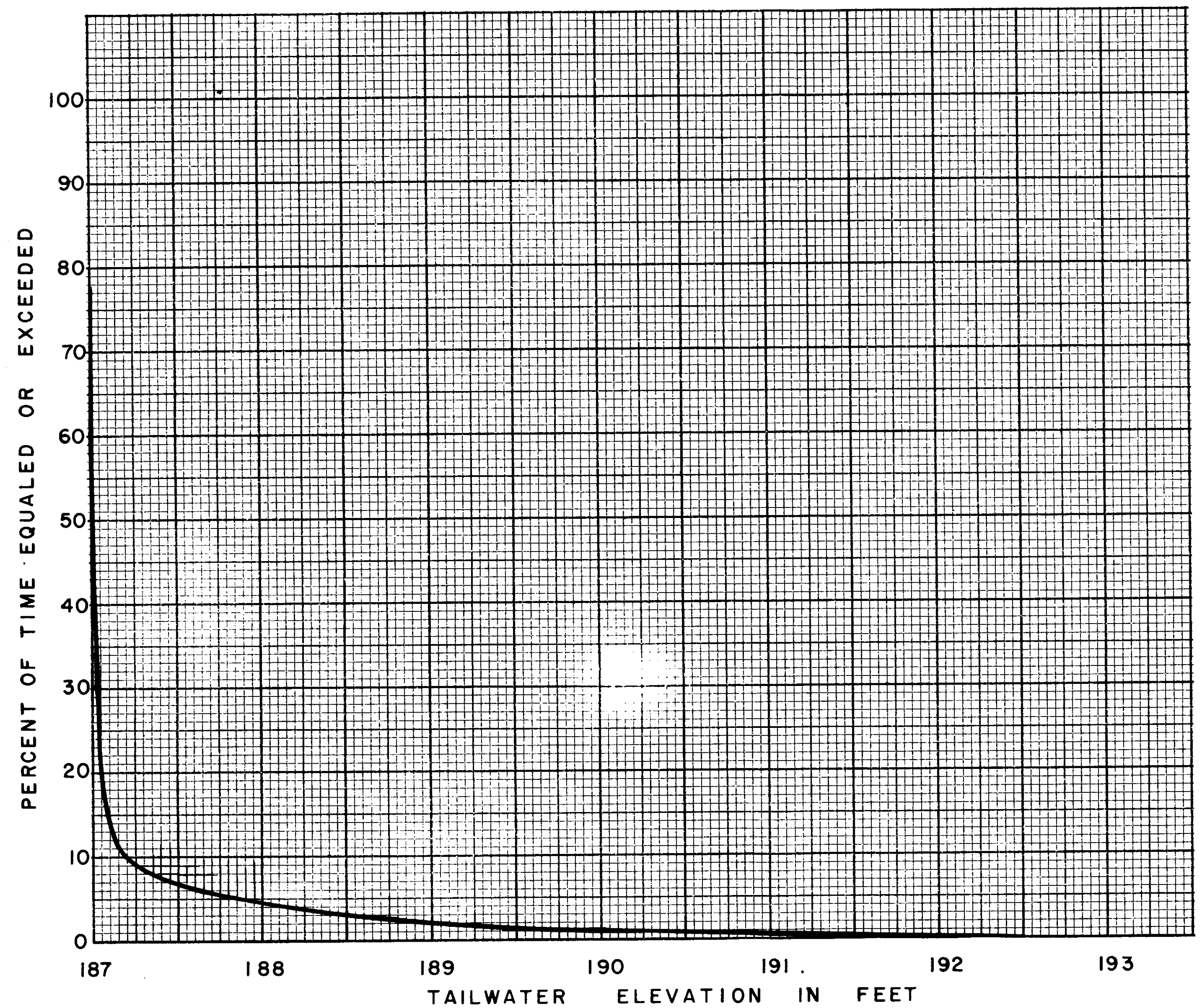
LEGEND

1 - Without Lewis Smith operating.

2 - With Lewis Smith operating.

BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA

STAGE AND DISCHARGE FREQUENCIES



NOTE:
LOCK 13 DISCHARGE DURATION TRANSFERRED TO BANKHEAD DAM BY DRAINAGE AREA RELATION.

PERIOD OF RECORD 1940 – 1966.

BLACK WARRIOR-TOMBIGBEE RIVER BASIN
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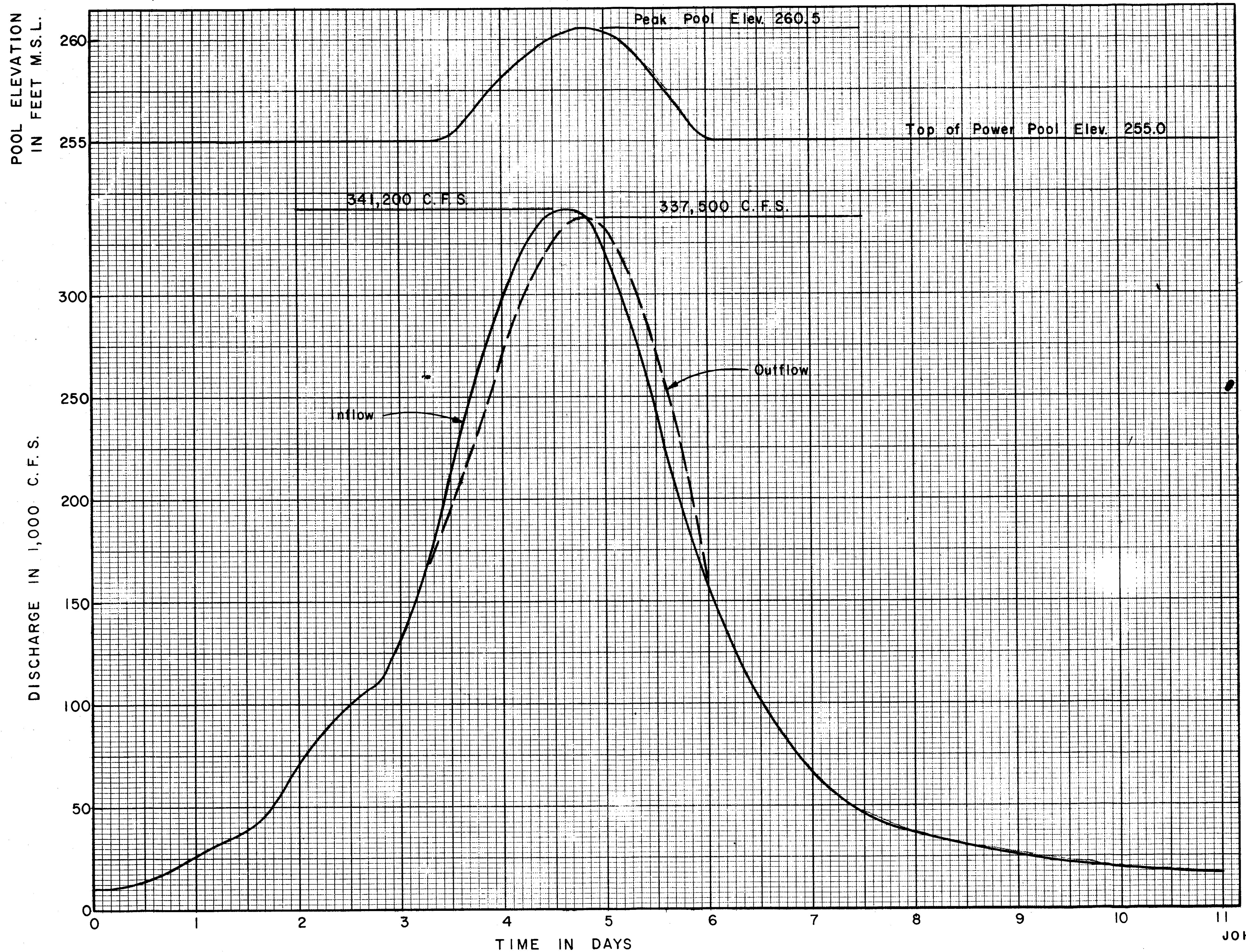
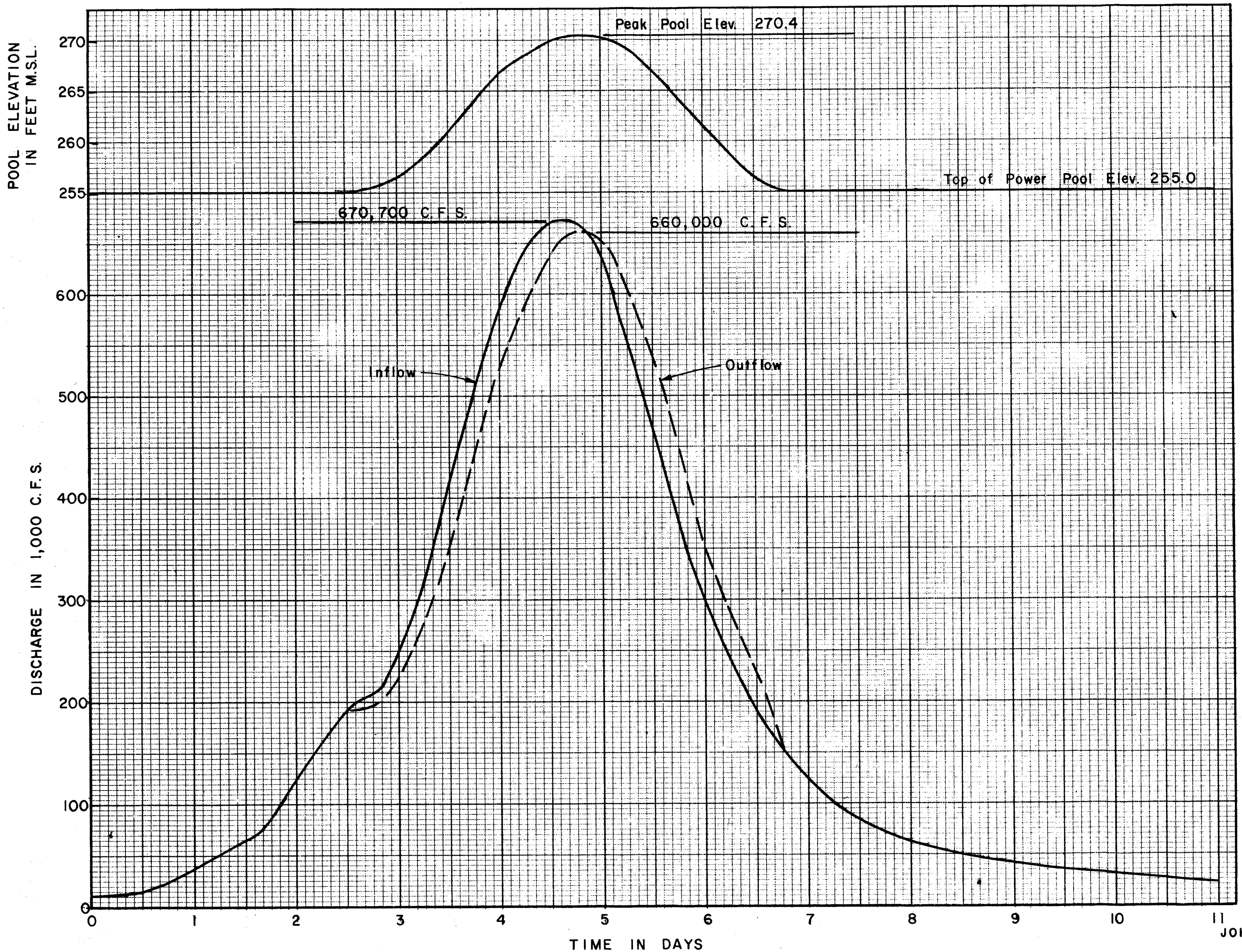
BLACK WARRIOR RIVER, ALABAMA

STAGE DURATION CURVE
TAILWATER GAGE



NOTE: Lewis Smith Dam in operation.

BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA
INFLOW-OUTFLOW-POOL STAGE RELATIONSHIPS FOR STANDARD PROJECT FLOOD



NOTE:
Lewis Smith Dam in operation.

BLACK WARRIOR-TOMBIGBEE RIVER BASIN
RESERVOIR REGULATION MANUAL
JOHN HOLLIS BANKHEAD RESERVOIR
BLACK WARRIOR RIVER, ALABAMA
INFLOW - OUTFLOW - POOL STAGE RELATIONSHIPS FOR SPILLWAY DESIGN FLOOD

EXTRACTS FROM PROJECT LICENSE

Federal Power Commission License for major project No. 2165, issued 12 September 1957, as amended, authorizes construction by Alabama Power Company of the Lewis M. Smith development on Sipsey Fork, and construction of a hydro-electric plant at the existing John Hollis Bankhead Lock and Dam on the Black Warrior River. Extracts from the project license especially pertinent to flood control, navigation, water use and reservoir regulation are quoted for guidance and reference purposes.

"Article 6. For the purposes of determining the stage and flow of the stream or streams from which water is to be diverted for the operation of the project works, the amount of water held in and withdrawn from storage, and the effective head on the turbines, the Licensee shall install and thereafter maintain such gages and stream-gaging stations as the Commission may deem necessary and best adapted to the requirements; and shall provide for the required readings of such gages and for the adequate rating of such stations. The Licensee shall also install and maintain standard meters adequate for the determination of the amount of electric energy generated by said project works. The number, character, and location of gages, meters, or other measuring devices, and the method of operation thereof, shall at all times be satisfactory to the Commission and may be altered from time to time if necessary to secure adequate determinations, but such alteration shall not be made except with the approval of the Commission or upon the specific direction of the Commission. The installation of gages, the ratings of said stream or streams, and the determination of the flow thereof, shall be under the supervision of, or in cooperation with, the District Engineer of the United States Geological Survey having charge of stream-gaging operations in the region of said project, and the Licensee shall advance to the United States Geological Survey the amount of funds estimated to be necessary for such supervision or cooperation for such periods as may be mutually agreed upon. The Licensee shall keep accurate and sufficient record of the foregoing determinations to the satisfaction of the Commission, and shall make return of such records annually at such time and in such form as the Commission may prescribe.

Article 7. So far as it is consistent with proper operation of the project, the Licensee shall allow the public free access, to a reasonable extent, to project waters and adjacent project lands owned by the Licensee for the purpose of full public utilization of such lands and waters for navigation and recreational purposes, including fishing and hunting, and shall allow to a reasonable extent for such purposes the construction of access roads, wharves, landings, and other facilities on its lands the occupancy of which may, in appropriate circumstances, be subject to payment of rent to the Licensee in a reasonable amount: Provided, that the Licensee may reserve from public access, such portions of the project waters, adjacent lands, and project facilities as may be necessary for the protection of life, health, and property and Provided further, that the Licensee's consent to the construction of access roads, wharves, landings, and other facilities shall not, without its express agreement, place upon the Licensee any obligation to construct or maintain such facilities.

*****

<u>Article 9</u>. Insofar as any material is dredged or excavated in the prosecution of any work authorized under the license, or in the maintenance of the project, such material shall be removed and deposited so it will not interfere with navigation, and will be to the satisfaction of the District Engineer, Department of the Army, in charge of the locality.

*****

<u>Article 15</u>. Whenever the United States shall desire to construct, complete, or improve navigation facilities in connection with the project, the Licensee shall convey to the United States, free of cost, such of its lands and its rights-of-way and such right of passage through its dams or other structures, and permit such control of pools as may be required to complete and maintain such navigation facilities.

<u>Article 16</u>. The Licensee shall furnish free of cost to the United States power for the operation and maintenance of navigation facilities at the voltage and frequency required by such facilities and at a point adjacent thereto, whether said facilities are constructed by the Licensee or by the United States.

<u>Article 17</u>. The operation of any navigation facilities, which may be constructed as part of or in connection with any dam or diversion structure constituting a part of the project works, shall at all times be controlled by such reasonable rules and regulations in the interest of navigation, including the control of the level of the pool caused by such dam or diversion structure, as may be made from time to time by the Secretary of the Army. Such rules and regulations may include the construction, maintenance, and operation by the Licensee, at it own expense, of such lights and signals as may be directed by the Secretary of the Army.

Article 18. The United States specifically retains and safeguards the right to use water in such amount, to be determined by the Secretary of the Army, as may be necessary for the purposes of navigation on the navigable waterway affected, and the operations of the Licensee, so far as they affect the use, storage and discharge from storage of waters affected by the license, shall at all times be controlled by such reasonable rules and regulations as the Secretary of the Army may prescribe in the interest of navigation, and as the Commission may prescribe for the protection of life, health, and property, and in the interest of the fullest practicable conservation and utilization of such waters for power purposes and for other beneficial public uses, including recreational purposes; and the Licensee shall release water from the project reservoir at such rate in cubic feet per second, or such volume in acre-feet per specified period of time, as the Secretary of the Army may prescribe in the interest of navigation, or as the Commission may prescribe for the other purposes hereinbefore mentioned.