

Memorandum for Resource Manager, CELRH-ORB-B, and Water Control Manual Holders

Subject: Administrative update to Beech Fork Lake Water Control Manual

1. Enclosed are updates to the Beech Fork Water Control Manual. These updates are administrative in nature and include updates to after-hours contacts, the lake stage/storage rating curve and multiple storage references, abbreviation of history of the land the project is near, expound upon of regulation problems and modifications to regulations, update channel floodway characteristics, update hydrologic forecasts, clarify operations as per Lavallette, update pertinent data and Appendix B, Instructions to Damtender.

2. The following pages shall be replaced by the corresponding enclosed pages:

- Page iv (Emergency Contacts)
- Pages 2-1, 2-2
- Pages 3-4, 3-5, 3-6
- Page 4-13
- Pages 6-1, 6-2, 6-3, 6-4, 6-5, 6-6, 6-7
- Pages 7-2, 7-3, 7-6, 7-7, 7-14, 7-15, 7-16, 7-17, 7-18, 7-19, 7-20, 7-21, 7-22, 7-23, 7-24
- Pages A-1, A-2 (Pertinent Data)
- Plate 7-1]
- Instruction to Damtender in its entirety

3. This memorandum shall be placed in the front of the Water Control Manual to document the changes.

4. These updates address the issue for which the district was cited for non-compliance for operation as per the Water Control Plan. This issue was with regards to operation of Beech Fork Lake for the town of Lavallette. While the Districts current operations falls within the scope of the Water Control Plan, these operations were not described in the correct section of the Water Control Manual and did not include an additional gage which was added to the system.

Steven W. Foster
Chief, Water Management Section

Encl
Beech Fork WCM Update 2024.pdf

Memorandum for Resource Managers and Water Control Manual holders

Subject: Modification of Huntington District Water Control Reporting Procedures.

1. Reference CELRH-EC-WM Memorandum to Kent Browning, dated 20 January 2004, Subject: Modification of Huntington District Water Control Reporting Procedures.

2. The referenced memorandum modifies certain reporting procedures. Since that memorandum was issued, improvements in technology have resulted in the National Weather Service providing detailed snow analyses data in graphical maps via the internet. This data satisfies Water Managements needs, and therefore an additional modification is necessary.

3. Modify Instructions to Dam Tender, Section 2 – Precipitation at Project, sub-section: Snow Depth and Moisture Content:

Replace the section in its entirety with the following:

"Report snow data to Water Management only when directed to do so. Measure and record the water content of the snow at least as often as indicated below.

- (1) Each day when rain falls on existing snow cover
- (2) Twice a week on Mondays and Thursdays when there is snow cover on the ground if condition (1) does not require more frequent measurement.

4. This change in reporting instructions does not modify the Project's requirement to store this data on site.

5. This memorandum shall be placed in the front of the Water Control Manual to document the change.



Timothy W. Curran, P.E.
Chief, Water Management Section

Memorandum for Resource Managers and Water Control Manual holders

Subject: Modification of Huntington District Water Control Reporting Procedures.

1. Reference CELRH-EC-WM Memorandum to Kent Browning, dated 20 January 2004,
Subject: Modification of Huntington District Water Control Reporting Procedures.

2. The referenced memorandum modifies certain reporting procedures, and this memorandum makes an additional change. Some Water Control Manuals have been revised with the new procedures the "Instructions to Resource Manager" or "Instructions to Dam Tender" section. Manuals that have not been revised should have the referenced memorandum placed in the front of the manual. Make handwritten changes to the memorandum or the Water Control Manual, as appropriate. This memorandum shall be placed in the front of the Water Control Manual to document the change.

3. Modify Instructions to Dam Tender, Section 4 – Regular Reports, sub-section: Weekly Precipitation Report, second and third sentences:

Replace the text "This report must be filled out and transmitted every Monday morning by 0800 hours. If Monday is a holiday, it shall be filled out on the next work day by 0800 hrs." with "This report is no longer required to be completed on a weekly basis. It shall only be filled out and submitted if required by special directive."



Timothy W. Curran, P.E.
Chief, Water Management Section

MEMORANDUM FOR RECORD

CELRH-EC-WM

Special Directive No. 391

To:
Resource Manager
Corps of Engineers
Beech Fork Lake
5441 Beech Fork Road
Lavalette, WV 25535

From:
Ch, Water Res Eng Br

Date: 04 Nov 04
Mr. Schray /5604

JS

Confirmation of Special Directive No. 391 issued by telephone by Mr. Schray and acknowledged by Mr. Trautwein at 1110 hours, 04 November 2004.

"In order modify the Water Control Manual and the Instructions to Dam Tender, effective at 0900 hours, when the Lavalette gauge is below 14.00 feet, the authorized Maximum without a Directive is increased from 5.4 and 6.2 feet in MIANO and DEMIA respective to 6.5 feet year round. Please place a copy of this directive in the front of the Water Control Manual."


THOMAS G. MACFARLAND, P.E.
Chief, Water Management Section

3/16/04
ell
20 January 2004
Schray/5604

Memorandum for Kent Browning, OR Water Management POC.

Subject: Modification of Huntington District Water Control Reporting Procedures.

1. Please distribute this memorandum to all Huntington District Flood Control Project Managers, direct them to place this memorandum in the front of the Water Control Manual, and make notes in the text which has been superseded.

2. As directed by the QC, EC-WM is implementing the recommendations of the Reservoir Reporting Process Action Team. As such, the following changes shall be made to the water control manuals and the associated processes:

The following sections are modified as noted.

Instructions to Dam Tender, Section 2 - Precipitation at Project, sub-section: Snow Depth and Moisture Content

Measure and report to EC-WM by 0900 hours the water content of the snow at least as often as indicated below.

- (1) Each day when rain falls on existing snow cover
- (2) Twice a week, on Mondays and Thursdays, when there is snow cover on the ground if condition (1) does not require more frequent measurements.

Instructions to Dam Tender, Section 2 - Precipitation at Ohio River Network Stations

Reports to the National Weather Service are carried out by agreement between the Project and the Weather Service and at their direction. The project is not required to gather or submit any additional data to Water Management beyond what is described previously in section 2 and what is detailed in section 4.

Sub-Sections a, b, and c are therefore no longer relevant except as to describe how to gather and provide data to the National Weather Service.

Instructions to Dam Tender, Section 4 - Regular Reports, sub-section: Weekly Report, ORH 14

This section is rescinded in its entirety and is replaced by sub-section: Historical Files.

Projects are required to maintain a permanent hard copy at the project of all water control data required for daily operation. This data shall be comprised of the information the project has historically gathered using the ORH 14 and 13 reports and shall be gathered at 0730 on days when the project is staffed, at other times as directed by the Schedule for Reading Gages and the Project Manager and when data is requested by Water Management Section. It shall include but not be limited to: Precipitation, Current Weather conditions, Lake Stage Levels, Outflow Stage Levels, Gate Settings, Gate Operations and time performed, Snowfall, Snow on the Ground, Total Moisture Content as directed in Section 2, and all Upstream and Downstream gauge readings which are utilized by project personnel for gate operation decision making.

This information may be maintained either on the historical reports or a new project developed format.

Instructions to Dam Tender, Section 4 - Regular Reports,
sub-section: Daily Morning Report

This sub-section is modified to note that: Generation and transmission of the daily morning report (also call the intranet report which replaced the ORH-13 Daily report) is only required when requested by the Water Management Section. Automatic daily transmissions are no longer necessary.

Note: Atwood, Bolivar, Clendening, Piedmont, Tappan, and Tom Jenkins are still required to report all gate operations to EC-WM by phone. Extra emphasis will be placed on these phone calls as Water Management will no longer be able to look up the previous day's gate operations every morning.

Instructions to Dam Tender, Section 4 - Regular Reports,
sub-section: Gate Operations Report

This sub-section is modified to note that: Generation and transmission of the gate operations report is only required when requested by the Water Management Section. Neither daily transmissions nor transmissions after every gate operation are necessary any longer.

Instructions to Dam Tender, Section 4 - Regular Reports,
sub-section: Weekly Precipitation Report

This sub-section shall be added after the Water Quality Report sub-section.

A fourth report available from the Index Page is the Weekly Precipitation Report. This report must be filled out and transmitted every Monday morning by 0800 hours. If Monday is a holiday, it shall be filled out on the next work day by

0800 hours.

Upon accessing the Weekly Precip Report link on the Index Page, fill in the daily precipitation for the past week. When all data for the week is filled in, save the spread sheet and exit. This record will be saved for the entire year and can be viewed through the link used to modify it.

On days when the project is not staffed, place a "NS" in that day's field and report the combined day's precipitation in the next day when the project is staffed. I.e. If the project does not staff the weekend, place a "NS" in the field for Saturday and Sunday and report the 72 hour precipitation record on Monday morning.

Instructions to Dam Tender, Section 4 - Regular Reports,
sub-section: Additional Comments

This sub-section shall be added after the Weekly Precipitation Report sub-section.

A fifth link available on the Index Page is the Additional Comments link. It shall be used when ever the Project has special information or questions that it wants to bring to the immediate attention of the Water Management team. Snow Moisture shall be reported using this link.

Upon accessing the Additional Comments link on the Index page, a blank email to the Water Management Team will be generated. Please note in the subject line, the nature of the issue and then provide supplemental data in the text block of the message. After the email has been completed click on the submit/send button to send the message.

Instructions to Dam Tender, Schedule for Reading Gages

The last sentence of the top paragraph "Stream gages and the precipitation gage (all gages) shall be read at least as often as shown in the table below", shall be replaced with: "Reading and recording of gages shall be carried out as defined under Schedule A except when gage levels/precipitation are such that the Resource Manager or their Acting anticipates that problems may result, at which point the relevant schedule B, C, or D shall be followed for reading and recording of all required gages. Transmission of project gage data will be at the request of EC-WM.

Modify the chart as follows:

SL, SO, and DCO shall be read in all schedules monthly as a check

Modify the footnotes as follows:

(1) When any one of the conditions listed under schedule A, B, C is exceeded and problems are anticipated, place the next higher schedule into effect. When conditions are such that would place schedules C or D into effect, notify by phone one of the Water Control personnel.

Timothy W. Curran, P.E.
Chief, Water Management Section

CF:EC-WH



DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
502 EIGHTH STREET
HUNTINGTON, WEST VIRGINIA 25701-2070

14 January 2003

REPLY TO
ATTENTION OF:

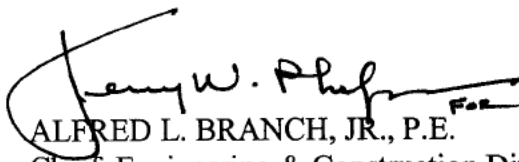
Engineering & Construction Division
Water Resources Engineering Branch

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Updates for the Beech Fork Lake Water Control Manual

1. EC-WW has identified outdated information in the referenced Water Control Manual.
2. Please replace the following pages with the attached pages: 6-3 (main text), Plate No. 7-3 (Plate Section), and 1-3 (Exhibit B, Instructions to Damtender).
3. Any questions should be directed to Mr. Charles Brown at [REDACTED]
4. Place this page in the front of the manual.

Encl


ALFRED L. BRANCH, JR., P.E.
Chief, Engineering & Construction Division

CELRD-ET-W (2)
CELRH-OR
CELRH-OR-BBF (2)
CELRH-OR-BSA
CELRH-EC-WW (2)
CELRH-EC-WH

U.S. ARMY ENGINEER DISTRICT, HUNTINGTON
CORPS OF ENGINEERS
HUNTINGTON, WEST VIRGINIA

**BEECH FORK
TWELVEPOLE CREEK BASIN
WEST VIRGINIA**

**PROJECT MANUAL
FOR WATER CONTROL MANAGEMENT
BEECH FORK LAKE – TWELVEPOLE CREEK**

PREPARED BY
CORPS OF ENGINEERS
HUNTINGTON DISTRICT
WATER RESOURCES ENGINEERING BRANCH

AUGUST 2000

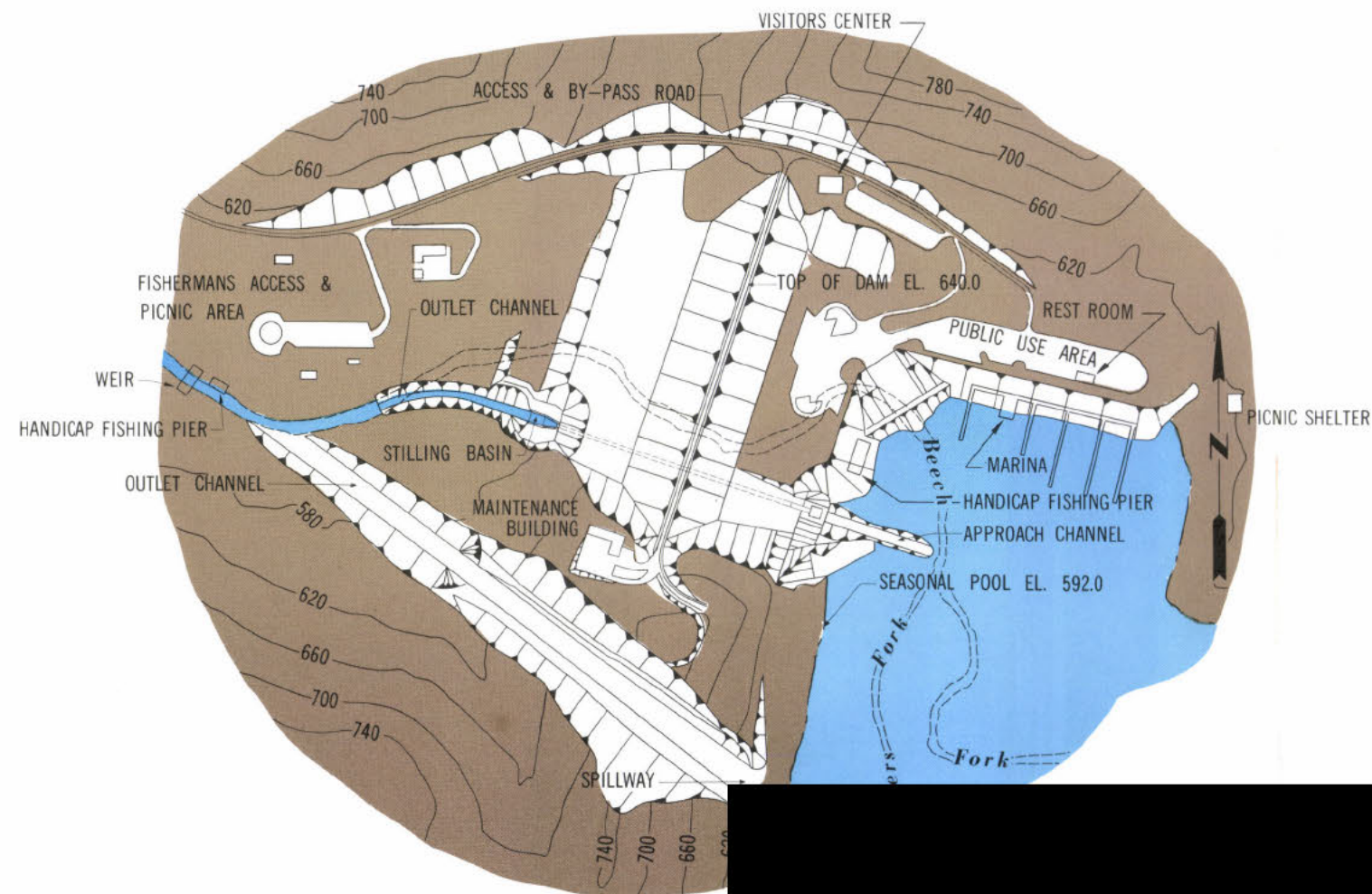


BEECH FORK LAKE

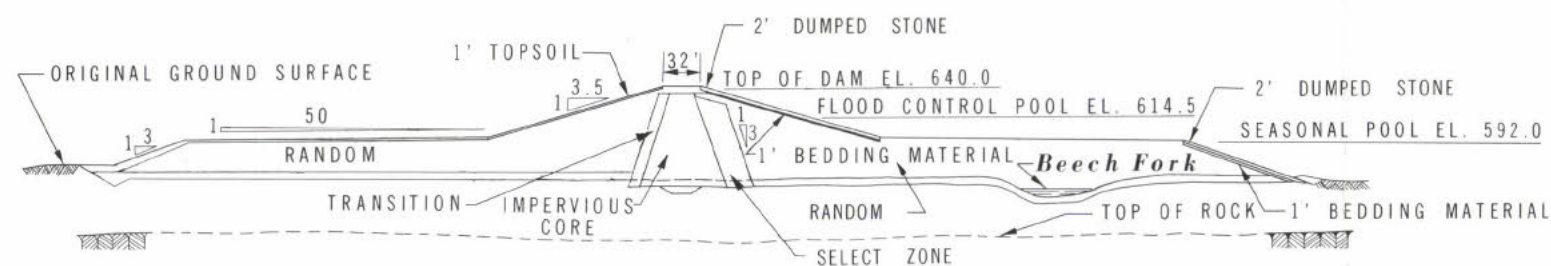
BEECH FORK F/C 75-A



VICINITY MAP
SCALE IN MILES
50 0 50 100 150



PLAN
SCALE IN FEET
500 250 0 500 1000



TYPICAL SECTION-VALLEY FLOOR
SCALE IN FEET
160 80 0 160 320

TWELVEPOLE CREEK
BEECH FORK LAKE PROJECT
DAM AND SPILLWAY
PLAN, PROFILE AND SECTION
HUNTINGTON DISTRICT, HUNTINGTON, W. VA.
Revised: 30 SEPTEMBER 1988

NOTICE TO USERS OF THIS MANUAL

Regulations require that this Water Control Manual be published in a hard backed 3-ring binder with the text in loose leaf form. In this way, only those sections or parts thereof requiring changes need be revised and printed. Therefore, this copy should be preserved in good condition in order that single page inserts can be made to keep the manual current. Changes to individual pages must carry the date of revision, which is the Great Lakes and Ohio River Divisions' approval date.

REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during non-duty hours, communications can be achieved by contacting, in the order listed, one of the following.

During normal business hours (0700-1600 hrs, Monday through Friday):

BBF LAKE

Damtender: [REDACTED]

Address **Telephone**

3784 Beech Fork Road Telephone No. [REDACTED]
Lavalette, WV 25535-8819 Alternate No. [REDACTED]
 Fax No. [REDACTED]

For forecast and regulatory information, contact

Water Management at [REDACTED], or

[REDACTED]

Key Emergency Contacts After Hours:

Beech Fork Project Personnel				Water Management Personnel	
Name	Position	Home #	Cell #	Home Phone	Cell Phone
[REDACTED]	Resource Manager	-	[REDACTED]	[REDACTED]	
[REDACTED]	Maintenance Mechanic	-	[REDACTED]		
[REDACTED]	Maintenance Mechanic	-	[REDACTED]		
[REDACTED]	Park Ranger	-	[REDACTED]		
[REDACTED]	Lake Project Assistant	-	[REDACTED]		

Other Agencies

U. S. Geological Survey
Charleston, W. Va.

[REDACTED]

National Weather Service
WFO Charleston, W. Va
After Hours

[REDACTED]

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8-11	DISSOLVED OXYGEN
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8-13	TOTAL MANGANESE
8-14	OVERALL WATER QUALITY RATING MACROINVERTEBRATES
9-1	WATER CONTROL MANAGEMENT - NORMAL ORGANIZATION
9-2	FLOOD EMERGENCY ORGANIZATION
9-3	RELATION WITH OTHER AGENCIES

TABLE 9-1

HUNTINGTON DISTRICT REPORTS
BY
WATER RESOURCES ENGINEERING BRANCH

PERIODIC REPORTS - Computer reports keyed to forms formerly completed by hand as follows:

- Daily Computer report of observed and forecast stages and flows including:
- Morning reservoir pool elevation, outflow, outflow temperature and three-day pool and outflow forecast.
 - 24-hour rainfall, morning stage, flow and five-day flow forecast at Ohio River tributary gage points.
- Weekly Reservoir effects at Ohio River tributary gage points.
- Monthly Record of District reservoirs available on request.
- Annually Summary of significant reservoir regulation activities for the year and of programs proposed for the next year.

SPECIAL REPORTS

Daily or more frequent briefing of District Engineer and Chief Engineer during flood or other emergencies containing hydrologic, meteorologic, and operational information, when and as requested.

Information relevant to flooded area or situation to the Emergency Operations Center (when functioning) such as pertinent data about the area, copies of reservoir morning and extra reports, relay of any verbal reports, relevant NWS zone forecasts and special bulletins, and computer-generated isohyetal map of the District.

Reports on reservoir operations to OCE during flood emergencies including inflow, outflow, pool elevation, predicted crest, and maximum storage utilization to date.

Post-flood reports.

Budget requests for water control management activities to OCE.
Snow-melt runoff and flood potential letter report to OCE.

Narrative summaries of major drought or lowflow conditions likely to call for regulations of District reservoirs.

Master plans for water control data systems and significant revisions thereto are submitted to HQDA (DAEN-CWE-HY) Washington, DC 20314, for review and approval of engineering.

PERTINENT DATA

BEECH FORK LAKE, WEST VIRGINIA

LOCATION OF DAM: On Beech Fork of Twelvepole Creek in Wayne County, WV, 3.7 miles above the mouth and 2 miles southeast of Lavalette.

DRAINAGE AREA ABOVE DAM: 78 square miles.

DAM: Type - rolled earthfill; maximum height 86', crest length 1,080'.

SPILLWAY: Uncontrolled concrete lined spillway with crest length of 80' at elevation 614.5 NGVD discharging into a 313-foot long raceway and stilling basin.

OUTLET WORKS: Intake structure with two gated sluices 4'6" wide by 10'0" high discharging through a 8'6" x 11'3" split circle conduit 720' long into a stilling basin. Dual selective withdrawal system with each half system composed of two 4'x4' gated inlets, one at invert elevation 582 and one at elevation 573 (left) or elevation 564 (right), with discharge from each half system controlled by a 2'6" x 3'0" hydraulically operated gate.

LAND ACQUIRED: 12,609.68 ACRES FEE
144.10 ACRES EASEMENT

TWELVEPOLE CREEK BASIN
WEST VIRGINIA
PROJECT MANUAL
FOR
WATER CONTROL MANAGEMENT
BEECH FORK LAKE - BEECH FORK OF TWELVEPOLE CREEK
SECTION I - INTRODUCTION

1-01 PROJECT AUTHORIZATION

Beech Fork Lake was authorized by the Flood Control Act of 1962, H.R. 13273, Public Law No. 87-874, 87th Congress, second session. The project was authorized for flood control and allied purposes which include water conservation for general recreation and fish and wildlife management. Inclusion of storage for water quality control was authorized by the Federal Water Pollution Control Act of 1948 as amended under Section 2 of Public Law 87-88, July 1961.

1-02 AUTHORITY, PURPOSE AND SCOPE OF WATER CONTROL MANUAL

This manual is prepared in accordance with ER 1110-2-8156, dated 31 August 1995, ER 1110-2-240, dated 8 October 1982, and ETL 1110-2-251, dated 14 March 1980, which provides for submission of regulation manuals in accordance with instructions contained in "Guide for Preparing Water Control Manuals" as prepared by SWD, dated October 1977.

The purpose of this manual is to furnish detailed schedules for the regulation of Beech Fork Lake. The manual will serve two functions; first as documentation of the plan for water control, and second, as a reference source for higher authority and for office and field personnel responsible for water control management throughout the life of the project. The manual additionally contains background information necessary for understanding the objectives and application of the water management schedules, as well as results of optimal simulation of project operation for specific purposes and conditions.

1-03 RELATED MANUALS AND REPORTS

<u>Title</u>	<u>Date</u>
1. Twelvepole Creek Survey Report, Chief of Engineers to Congress under authority of Section 10, Flood Control Act of May 1928.	June 1933
2. Survey Report on Ohio River, House Document No. 306. 74th Congress, First Session.	August 1935

- | | |
|--|----------------|
| 3. Committee Document No. 1, 75 th Congress,
1 st session. | February 1937 |
| 4. Twelvepole Creek Survey Report, House
Document No. 520, 87 th Congress , 2 nd session. | December 1961 |
| 5. Design Memoranda: | |
| No. 1 Hydrology | November 1965 |
| No. 1-A Site Selection | April 1967 |
| No. 2 General Design Memorandum | December 1967 |
| No. 3 Real Estate - Dam Site - Part I | April 1967 |
| No. 3-A Real Estate - Lake, Part II | January 1969 |
| No. 3-B Real Estate - Lake, Part III | January 1970 |
| No. 5-A Land Requirements Plan, Public Use | May 1969 |
| No. 6 Dam, Spillway, and Outlet Works | October 1969 |
| No. 6-A Instrumentation | September 1969 |
| No. 7 Concrete Aggregates | February 1969 |
| No. 8 Relocations - Schools | May 1969 |
| No. 9 Relocations - Gas Lines | August 1969 |
| No. 10 Relocations - Power and Telephone | January 1970 |
| No. 11 Public Use Plan | September 1970 |
| No. 12 Master Plan - Operations | January 1974 |
| No. 13 Sediment Range Layout and Supplement
No. 1, Report of the 1974 Sedimentation
Reconnaissance | October 1976 |
| 6. Preliminary Project Manual For Water Control
Management for Beech Fork Lake. | January 1978 |

7. Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures * September 1968

Periodic Inspections, Beech Fork Lake	
Periodic Inspection Report No. 1	April 1976
Periodic Inspection Report No. 2	April 1978
Periodic Inspection Report No. 3	April 1979
Periodic Inspection Report No. 4	April 1980
Periodic Inspection Report No. 5	October 1982
Periodic Inspection Report No. 6	June 1984
Periodic Inspection Report No. 7	May 1987
Periodic Inspection Report No. 8	April 1989
Periodic Inspection Report No. 9	April 1994
 8. Operations and Maintenance Manual January 1978
 9. Final Environmental Impact Statement July 1974
 10. Appendices to the Master Plan

Appendices A - Resource Management Plan	January 1982
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- 1/ Not Authorized
 * Month of Court Clearance

1-04 PROJECT OWNER

The United States Government has full title, ownership, and fee control of all Huntington District, Corps of Engineers reservoir and lake lands, including Beech Fork Lake. The United States Government reimbursed the private property owners for most of the surrounding land and now owns the dam and operating structures.

1-05 OPERATING AGENCY

Beech Fork Lake is staffed, attended, and operated continuously by the Huntington District, Corps of Engineers.

The mailing address is:
 Beech Fork Lake
 5441 Beech Fork Road
 Lavalette, WV 25535-0600

The Resource manager(Damtender) is:
 [REDACTED]
 2206 Lenora Street
 Milton, WV 25535

Telephone No: [REDACTED]

The Huntington District, Water Resources Engineering Branch has various responsibilities as specified in Ohio River Division Regulation 1110-2-27, dated 12 January 1976. These responsibilities include the primary overall water control management of all Huntington District projects, technical evaluations of performance of these projects, and developing plans and manuals for the reservoir systems

within the District, such as the Beech Fork Lake Project. An index map of the Huntington District and locations of all Corps of Engineers Flood Control Projects is shown on Plate No. 1-1.

Guidelines for routine operations under identified conditions are included in standard operation instructions. Special Directives issued and signed by the Chief of the Water Control Section provide direction for operations needed for all other situations, low-flow control, or flood regulation. Any operations which might deviate from the approved water control plan as presented in this manual are coordinated with the Great Lakes and Ohio River Division Water Management Branch.

1-06 REGULATING AGENCY

The operating and regulating responsibility is exercised under the following regulations:

- (1) EM 1110-2-3600, 30 November 1987,
Subject: Management of Water Control Systems.
- (2) ER1110-2-1400, DAEN-CWE-Y, 24 April 1970,
Subject: Reservoir Control Centers.
- (3) ER1110-2-240, DAEN-CWE-Y, 8 October 1982,
Subject: Reservoir Control Centers.
- (4) ORDR 1110-2-27, 12 January 1976,
Subject: Water Control Management Activities.
- (5) ER1130-2-415, DAEN-CWE-Y, 28 October 1976,
Subject: Water Quality Data Collection,
Interpretation, and Application Activities.
- (6) ORDR1110-2-26, 5 February 1979, ORDED-W,
Subject: Water Quality Investigations and Control Activities.
- (7) ER 1110-2-208, DAEN-CWE-Y, 30 July 1979,
Subject: Water Control Management.

SECTION II - DESCRIPTION OF PROJECT

2-01 LOCATION

Beech Fork dam is located on Beech Fork, a tributary of Twelvepole Creek, 3.7 miles above the mouth of Beech Fork, 16.4 miles above the confluence of Twelvepole Creek and the Ohio River at Ceredo, WV, and approximately 2 miles southeast of the town of Lavalette, WV. The dam site is about 6.5 air miles south of the city of Huntington, WV.

The lake is located in the western portion of West Virginia, mostly in the northeast corner of Wayne County, WV with a small portion of the lake in the southwest corner of Cabell County. The Twelvepole Creek Basin Drainage Map, Plate No. 2-1, shows the location of the project, along with other important features. The general project plan and layout is shown on Plate No. 2-2.

2-02 PROJECT PURPOSES

a. General. Beech Fork Lake is authorized for flood control and allied purposes in a comprehensive plan for the Ohio River Basin. Project purposes are flood control, general recreation, and fish and wildlife conservation. Benefits from specific project purposes serve not only local interests in the Twelvepole Creek Basin but are widespread throughout the Ohio River Basin.

b. Flood Control. The extent of headwater flooding and resultant damages in the Twelvepole Creek Basin are directly due to the rugged topography of the basin and relatively low capacity of stream channels. The irregular winding ridges and deep narrow valleys are conducive to rapid runoff and rapid rises in the stream, whose brush and tree-grown banks restrict flow. Headwater floods of major proportions have occurred throughout the basin in all seasons. The lower 10 miles of Twelvepole Creek are usually capable of containing moderate headwater floods within banks but are subject to backwater inundation from Ohio River floods which occur mostly during late winter and early spring. Benefits in this backwater area are considered part of the Ohio River benefits.

The principal flood control benefits provided by Beech Fork Lake in the Twelvepole Creek Basin accrue to residential areas and summer camps, including a residential area in the town of Lavalette, and to agricultural areas. Along the Ohio River, the industrial development is mostly outside the flood walls and levees of Huntington and Ceredo-Kenova while the major parts of the cities are inside the flood walls.

Accordingly, this industrial development and some towns and cities suffer from floods of all stages. Beech Fork Lake assists in the reduction of flooding on the Ohio River below the mouth of Twelvepole Creek.

Floods in the basin are the direct result of either summer-type or winter-type storms, with those caused by winter storms being the more frequent. Summer rains usually result from thunderstorms of conventional frontal activity of convectional or orographic origin. They are usually confined to relatively small areas and are of short duration with high intensity with the greatest probability of occurrence in June or July. Precipitation in late fall, winter, and early spring generally results from the passage of a low-pressure system over the basin, usually in a northeastward direction. Occasional stagnation and stationary developments produce prolonged precipitation. The average annual snowfall over the Beech Fork Basin is about 25 inches and represents only a minor portion of the total average annual precipitation. Floods in the Twelvepole Creek basin are of short duration, seldom remaining above flood stage for more than 24 to 36 hours unless flooding in the lower reaches is prolonged by backwater from the Ohio River.

c. Recreation. The recreation purpose can be stated as the realization of the full recreational potential for the project. This purpose was implemented by planning for a well-balanced recreational complex. Planning followed guidance contained in EM 1130-2-302 and in comments by West Virginia Department of Natural Resources, Bureau of Outdoor Recreation, Federal Water Pollution Control Administration (EPA), and U.S. Fish and Wildlife Service. Beech Fork Lake was planned to supply the following activities: picnicking, hiking, camping, sightseeing, nature observance, hunting, low-speed boating, and fishing. Sites to support these activities are listed in Table No. 2-2, page 2-12.

1. Lake. Prior to the construction of the Beech Fork and East Lynn Lake projects the Twelvepole Creek Basin did not have a sizable body of water available for full recreational utilization by the public. The area was significantly lacking in non-urban, public recreation facilities and there was an apparent need for such facilities. All Beech Fork lake recreation sites were located with respect to the seasonal pool elevation of 592 feet NGVD and to utilize natural features appropriate for the desired activities. The Visitor's Center, Boat Launch, and Marina Area are accessible by automobile on Beech Fork Road (State Secondary Route 13) from State Route 152 at Lavalette. The Stowers Branch Area is reached via the road which crosses the top of the dam from Route 13 with additional access provided by Secondary Routes 15/2 and 52/4 from State Route 152. Access to the Bowen Recreation Complex from east Huntington is from Interstate 64 via State Route 10 and Hughes Branch Road. The Bowen Recreation Complex can also be reached by using Secondary Route 17 from State Route 152 near Wayne.

2. Downstream. The Tailwater Fishing Area is located downstream from the dam and provides picnicking and access for fisherman to the tailwaters. The area is accessed by automobile on Beech Fork Road (Secondary Route 13) from State Route 152 at Lavalette, West Virginia.

3. Management. The Corps of Engineers has responsibility for maintenance and management of all fee-owned land and water areas of the Beech Fork Lake project, including all equipment and structures, except telephones and the marina concession. Corps personnel collect camping fees and enforce campground rules and regulations under Title 36, Code of Federal Regulations. By contract with the Wayne County Sheriff's Department, from mid-May through mid-September the Sheriff provides eight hours of area patrol daily and Sunday, to handle the more serious infractions. The Corps of Engineers proposed a 10-horsepower limit on boat engines with four lake zones that were approved by the joint commission of West Virginia Department of Natural Resources and Corps of Engineers personnel. The four zones delineated are, Boats Prohibited, Idling-No Wake Speed, Unlimited Speed, and Hazardous Area. The West Virginia Department of Natural Resources administers state boating, fishing and hunting regulations on the project water and land areas.

d. Fish and Wildlife Conservation. Generally, the goals under this project purpose are the long-term health of populations of plants and animals native to the project area and the maximum sustained enjoyment of these populations by the public. Programs to promote fulfillment of these goals were developed in coordination with the U.S. Fish and Wildlife Service and the West Virginia Department of Natural Resources. The recommendations of these two agencies influenced fish and wildlife conservation plans put into effect at the project.

1. Fisheries. Prior to project construction fisheries in Beech Fork of Twelvepole Creek were of low value. The U.S. Fish and Wildlife Service conservation and development report for Beech Fork Lake attributed the low value to irregular stream flows, low fertility of the water, and high turbidity. The USGS stream gage at Wayne, West Virginia, which is representative of the area, has shown a number of periods when the streamflow in Twelvepole Creek has been extremely low. Prior to construction of the dam the stream supported a small number of smallmouth bass, various sunfish, and bullhead catfish. Average fisherman use of the stream above the dam site was about 240 man-days and use in the 3.7 mile downstream reach amounted to around 110 fisherman-days per year.

The downstream fishery, at times beset by periods of low-flow, benefits greatly from the 5 cfs minimum discharge. The increased capacity can be attributed to the more stable flows, both flood and drought, decreases in turbidity, increases in available food material (plankton and forage size fish lost from the pool through the intakes of the selective withdrawal system) and the presence of some catchable size game fish similarly lost from the pool into the tailwater. Because the project can be operated to stabilize flows by moderating storm impacts and because it functions to reduce turbidity downstream, the post-impoundment downstream waters provide a better habitat during most spawning periods for forage and sport species. Additionally, plankton loss from the lake provides an increase in available food material for fry during this critical period in their life cycle, which probably increases both survival and growth rates of species spawned in this area. Estimated fisherman use for the downstream fishery after completion of the project is 6,350 man-days per year.

Populations of largemouth and spotted bass, crappie, bluegill and other sunfish and channel catfish should develop in the lake by natural reproduction. West Virginia Department of Natural Resources has stocked the lake with walleye pike, channel catfish, largemouth bass, and black crappie.

Conditions in stream reaches above the seasonal pool elevation have not been affected by Corps ownership; however, the Fish and Wildlife Service report projected fisherman use on the lake to average around 16,000 fisherman-days per year. The lake fishery will be maintained and improved by the placement of fish attractors and by maintaining areas where standing timber has not been destroyed.

2. Wildlife Resources and Management. The U.S. Fish and Wildlife Service reported that principal game species in the land to be purchased for the project consist of gray and fox squirrels, cottontails, ruffed grouse, bobwhites, raccoons, and white-tailed deer. Trapping activity in the basin is insignificant. The report contained estimates that the area provided annual hunter use of 3,100 man-days for small game, but hunting pressure on White-tailed deer was negligible. It is expected that hunting pressure will not change materially over the period of analysis. The low to moderate hunter use of the project area is a result of the poor habitat for wildlife. Most of the bottom lands and adjacent hillsides are cleared and were heavily grazed.

In November of 1983, the Department of the Army granted license to the West Virginia Department of Natural Resources to use and occupy 7,531 acres of land in the Beech Fork Lake project area for fish, wildlife and forest management purposes. The license duration was for a period of twenty years.

A large number of activities take place each year at Beech Fork Lake to improve the wildlife habitat and populations. During each summer, after animals have produced young and the young are old enough to maneuver for themselves, many areas are strip mowed to provide improved habitat in various stages of succession. Other management practices include, providing fields supporting highly desirable foods; managing abandoned roads for wildlife purposes; managing woodlands to provide optimum habitat for indigenous wildlife species through implementation of agriculture practices which maximize vegetative diversity; building and placing nesting boxes for waterfowl, denning mammals and various birds where it has been determined that these devices will overcome deficiencies in the existing habitat; and conducting surveys for populations of endangered species. Operations personnel also maintain established fruit trees by pruning and controlling pests and disease and generally supervise the project lands. Fire trails and access roads have been laid out and improved as needed.

e. Low-Flow and Temperature Control. Purposes of the low-flow control system are to provide adequate control of volume and quality of discharged water up to the capacity of the control valves and to moderate summer flood discharges. The two 2'-6" x 3'-0" low-flow control gates provide a finer outflow control than the two 4'-6" x 10'-0" bottom sluice gates. This facilitates metering discharges to desired flow and thus conserves dry weather inflows for maintenance of the pool elevation for recreation interests.

The low-flow control system was designed with the understanding that the lake would be stratified during the summer, with warm, oxygenated water on the surface and colder water with very little or no oxygen on the bottom. Therefore, two upper level inlets were placed at elevation 582 feet NGVD and the lower inlets were placed at elevation 573 and 564 feet NGVD. They allow withdrawal of water from any level or combination of levels, or from any combination of levels and either

or both of the bottom sluices. In this manner, a wide range of temperature adjusted outflows is available to provide for the needs of the downstream aquatic environment.

At seasonal pool elevation of 592 feet NGVD there is enough water to provide an augmented flow of about 210 cfs. This upper layer of water is 15-20 degrees warmer than the bottom water, and it is well saturated with oxygen; therefore, it is a much better quality water than the bottom water, and is to be used to warm and refresh the sluice discharge of the summer releases. Exercise of the water quality factor of the low-flow control purpose largely meets the need of downstream aquatic communities for normal habitat, particularly as to temperature, dissolved oxygen and chemical sediment. (See 7-05a(2) for discussion of the potential for iron hydroxide fouling of downstream benthic habitat.) The natural water temperature for the time of year is desirable and is incorporated in the operations criteria as explained in 7-07b.

f. Special Purposes. Within the sphere of project influence, a wide range of public needs involving water flow or stage become special purposes that are evaluated for translation into regulation. The expressed need may be for a low stage downstream to allow a search for a drowning victim, fording, or construction work; medium stage for a sporting event such as canoeing; a high stage due to an emergency in the lake area or an important construction need requiring drawdown; or any of a multitude of other situations generating a request for special operation. Emergency needs are met as quickly as possible, however, requests for deviation from normal regulation must be evaluated with respect to the hydrometeorological outlook and the other project purposes and must be coordinated with the Water Control Center in the Division Office. After evaluation and coordination, the Chief of the Water Control Section either directs regulation to answer the need or denies the request. A sample of form ORD 1018R, Record of Deviation from Approved Plan, is shown in a later section.

2-03 PHYSICAL COMPONENTS

a. Embankment. The dam consists of a rolled random fill (earth and rock) with a central impervious core and is founded on overburden. A 5-foot thick impervious blanket is located beneath the upstream random fill and connected with the central impervious core. A 12-foot wide inclined drain is located against the downstream face of the core. Five-foot by ten-foot finger drains, spaced 50 feet on centers, extend from the inclined drain to the toe drain located 25 feet outside of the toe of the downstream berm. Seepage from the toe drain flows through a vee-notch weir for measuring seepage quantities. The central impervious core is protected against loss of fines by the inclined drain downstream and by a 24-foot wide zone of select material placed upstream of the core. Each abutment is protected from seepage by a grout curtain that extends 60 feet vertically into the bedrock of the abutments. Eighteen inches of stone slope protection placed on nine inches of bedding are used to protect the upstream

slopes of the dam, the buttresses and the downstream slope of the dam below elevation 585 feet NGVD (5 feet above maximum tailwater). The downstream embankment slopes and the berms were seeded. The Dam Embankment Plan is Plate No. 2-3 and Embankment Sections are Plate No. 2-4. The basic embankment dimensions are Top or Crest Length of 1,080 feet, Maximum Height or elevation above streambed (640 to 552) 88 feet, Crest Width 32 feet, and Maximum Width at toe of slope 997 feet.

b. Spillway. The spillway is located about 500 feet landward from the left abutment of the dam. It is broad crested, uncontrolled, concrete lined and has a stilling basin. The approach channel to the spillway is approximately 400 feet long, 80 feet wide and is flared at its upstream end. The spillway itself is trapezoidal in shape with a base crest width of 80 feet and a crest elevation of 614.5 feet NGVD. The spillway is 605 feet long and is cut through predominantly soft to moderately hard indurated clay with layers of soft to hard claystone, siltstone, sandstone, and limestone. The stilling basin is a jump type equipped with streamlined baffles and is 100 feet long by 60 feet wide. The stilling basin is founded on indurated clay which is protected by a 12-inch layer of lean concrete. The outlet channel from the stilling basin slopes 700 feet to Beech Fork. The first 100 feet of the outlet channel runs through sandstone and requires no erosion protection while the remainder of the channel is protected by rock slope protection. The spillway plan and profile views are given on Plate No. 2-5.

c. Outlet Works. The outlet works consist of an approach channel, intake structure, service bridge, tunnel transition, tunnel, stilling basin, and outlet channel. Details for the outlet works plan and profile are shown on Plate No. 2-6. The intake structure is a rectangular, concrete wet-well type and is 117 feet high. The substructure is approximately 45 feet by 50 feet 6 inches and contains the two 4'-6" x 10'-0" outflow sluices and the two selective withdrawal wells along with all associated operating machinery. The intake structure is reached by way of an access road on the upstream berm of the dam or by way of the service bridge from the left abutment. The service bridge is a three span, 370 foot long, concrete deck bridge that carries a single 9'-0" wide roadway with two 1'-3" safety curbs and guard rails. Entrances to the intake structure are via ladder from the service platform up to the operating chamber at elevation 615 feet NGVD or via the service bridge to the operating floor at elevation 640 feet NGVD.

The operating chamber atop the substructure, at elevation 615 feet NGVD, is rectangular and contains the hydraulic operating equipment for the 4'-6" x 10'-0" slide gate openings and ladder access to the lower levels of the intake structure. The operating floor at elevation 640 feet NGVD, contains the hydraulic control system, hydraulic power unit with oil storage tanks and pumps and the overhead traveling crane used for raising and lowering the emergency gate. Detail drawings for the intake structure approach channel, general elevations, selective withdrawal system, and operating equipment are shown on Plate Nos. 2-7, 2-8, 2-9, 2-10, and 2-11.

Discharges from the sluice gates and the low-flow system are released through a 8'-6" x 11'-3" split circle tunnel 776 feet long that discharges into a jump type stilling basin. The stilling basin is 79 feet long, 25 feet wide and 21 feet high and is designed with a sill height that will contain the hydraulic jump within the basin for all design flows from the outlet system. Details for the tunnel, stilling basin, and outlet channel are shown on Plate Nos. 2-12 thru 2-15.

d. Operating Machinery. Operating machinery for water control purposes consists of control gates and associated mechanisms.

(1) Slide Gates. The two tractor type gates are sized to fit the 4'6" x 10' sluice openings and designed structurally to withstand and operate under the head of the maximum flood control pool at 614.5 feet NGVD without exceeding normal design stresses. The gates are controlled from the operating floor elevation of 640 feet NGVD and the hydraulic operating machinery is mounted on the floor of the operating chamber at elevation 615 feet NGVD. Each gate assembly consists of gate frames, gate leaf, seal strips, gate leaf stem, hoist, and hydraulic pump, cylinders and pistons for hydraulic operation. A single transferable emergency gate, designed to withstand the maximum pool elevation of 614.5 feet NGVD in accordance with EM 1110-2-2, is provided for closing off either of the two sluices and is handled by the overhead service crane. A single transferable maintenance bulkhead is provided for use in either sluice-way whenever inspection or maintenance of an emergency gate is required.

(2) Low-Flow System. The two low-flow intake wells are located on either side of the outflow sluices in the intake structure. Each low-flow well has two 5'0" x 4'0" inlets and one 2'6" x 3'0" discharge outlet. Well number 1 has inlet invert elevations at 582.0 and 573.0 feet NGVD and well No. 2 has inlet invert elevations at 582.0 and 564.0 feet NGVD. The low-flow wells discharge into the right and left sluices downstream of the service gates. The inlet openings and the intake well discharge are controlled by hydraulically operated slide gates. A single transferable bulkhead is provided to be placed in a slot upstream of either of the low-flow sluice gates so that maintenance of the low-flow gates can be done in the dry. The hydraulic operators for the low-flow gates are located on the service platform at elevation 596.0 feet NGVD and the controls are located on the operating floor at elevation 640.0 feet NGVD. Selected views of the low-flow system are shown on Plate No. No. 2-10.

(3) Auxiliary Power Unit. The standby power unit engine consists of a diesel engine mounted directly to a 60 KW alternating current generator, both mounted on a common base. The diesel engine is a liquid-cooled, cold-starting type and is easily battery started. The power is sufficient for any conceivable need.

2-04 RELATED CONTROL FACILITIES

Beech Fork Lake is closely linked for control purposes with nearby East Lynn Lake. East Lynn Lake is somewhat larger and located on East Fork of Twelvepole Creek about 10 miles above the mouth of East Fork of Twelvepole Creek. It is located about two miles south of East Lynn, West Virginia, 6 air miles south-southwest of Wayne, West Virginia, and about 12 air miles east of Louisa, Kentucky. During flood conditions the two reservoirs usually maintain close contact with each other in order to achieve better water control management for the Twelvepole Creek Basin and the Ohio River. For control purposes the two flood control projects in the Twelvepole Creek Basin are normally placed with the same Water Control Section forecaster as the adjacent Big and Little Sandy River Basins.

2-05 RESERVOIR DESCRIPTION

Beech Fork Lake lies in the northeast corner of Wayne County, West Virginia with a small portion of the lake in the southwest corner of Cabell County. The drainage basin above the dam site is irregularly or inverted pear shaped and is about 14 miles long and 9 miles wide, with the longest dimension in a general northwest-southeast direction. The basin is situated on the western slopes of the Appalachian Mountains and is characterized by moderately rugged and hilly terrain, steep sided valleys and narrow flood plains on alternate sides of meandering river valleys.

The seasonal pool and lake covers the flood plain over much of the length of the lake up the main stem and lower tributaries.

The lake is dendrite in shape, with a shoreline length of 31 miles at seasonal pool elevation of 592 feet NGVD. At seasonal pool, the lake extends up the Beech Fork 9.2 miles and up Millers Fork 4.0 miles above the mouth. Mean breadth of the lake is around 800 feet with a maximum depth of 40 feet. Beech Fork Lake pool and storage data is shown above in Table No. 2-1, page 2-2, and project details appear in Supplementary Pertinent Data, Plate No. 2-16.

2-06 REAL ESTATE ACQUISITION

Acquisition policies during the acquisition program were based upon the fee acquisition of a 300-foot minimum horizontal guide line. Minimum requirements usually included all of the valuable bottom land and the lower hill slopes which included all improvements. Residual portions of these properties were hill lands of relatively low value. All roads in the area were also within the minimum acquisition area, which added to the necessity for acquiring these areas. Good real estate practices dictated that entire properties be acquired to preclude demands for access or the payment of severance that would closely equal the land values. The circumstances led to a "blocked out" program that was consistent with established policy.

Access reevaluation studies determined which lands were left without adequate access due to flooding and where provision of such access would cost more than acquisition. In this case they were purchased; however, in the case of Beech Fork Lake it was determined that for around 800 acres originally slated for acquisition it was more cost effective to provide access. The total acquisition of 12,610 acres in fee and 147 acres in easement included all lands required for construction, sites designated for public use, rights-of-way for relocated highways, and the areas cut off by the lake.

In accordance with the approved plan of coal lands acquisition, the Corps acquired fee to the coal in all project lands. All oil and gas interests for the entire project area were also acquired in fee.

2-07 RECREATION AND PUBLIC USE FACILITIES

Listed in Table No. 2-2, page 2-12, are recreational sites in operational condition in the summer of 1983 and those proposed for future development. Future sites will be constructed as joint funding is arranged with another governmental agency, such as West Virginia Department of Natural Resources. Recreation site locations are shown on the Land Use Plan, Plate No. 2-17.

a. Corps Operated Sites. Project personnel operate and maintain the following public use and recreation areas:

(1) Tailwater Fisherman Access and Picnic Area. Twenty-seven acres are provided below the dam for use by fishermen and picnickers. Facilities include a parking lot, restroom, 2 picnic shelters, walkways and a fishing platform for the handicapped.

(2) Dam Overlook and Visitors Center. The combined Visitors Center, parking lot, and Operations Office is located on the right abutment. The area includes a 30-car parking lot for visitors and employees. The Visitors Center has clean with restrooms, drinking fountains, vending machines, and features interesting displays on the locality. A deck around the second floor of the two-story building will provide a panoramic view of the area.

(3) Beech Fork Boat Launch. This site contains around 20 acres in the vicinity of the dam. The Corps of Engineers developed the site with an access road, an eight-lane boat launching ramp, a restroom, a fisherman's access platform at the boat launch area, and a parking lot which will accommodate 60 cars and 94 car-trailer combinations. Also located in the same area is the marina which is operated as a private concession and is described below.

(4) Stowers Branch Area. The Stowers Branch Area is a six-acre swimming beach constructed and maintained by the Corps on Stowers Branch, a short distance from the dam site. Facilities include a sandy beach, a gravel parking lot for 157 cars, picnic areas, portable toilets and two temporary change houses. Future

facilities will include a bathhouse, an asphalt parking lot for 293 cars and a graveled overflow parking area for 104 cars to handle peak usage.

(5) Mary Davis Branch Lodge/Day-Use Complex. This area has been planned as a large resort type recreation facility which will be constructed as a joint effort by the State of West Virginia and the Corps of Engineers. The future of the area depends on the availability of funding through the two agencies. The planned complex will cover about 20 acres at the mouth of Mary Davis Branch. The day use area will consist of a one lane boat launch ramp with car and trailer parking, 170 parking spaces for cars, 50 picnic units, game courts, a boat dock, picnic shelters, restrooms and utilities. The lodge complex will feature a lodge with 150 rooms, dining rooms, convention hall, swimming pool, park offices, tennis courts and 290 car parking spaces. The lodge will also have 30 deluxe cabins for rent. The complex will be operated by the State of West Virginia as a part of the Beech Fork State Park.

b. State Operated Sites. The State of West Virginia Department of Natural Resources has a lease for use of 3,860 acres of land and water for park and recreation purposes and for fish management. Included in this area, which is known as Beech Fork State Park, is the large 130 acre Bowen Recreation Complex located on the Beech Fork arm of the lake approximately 5 miles from the dam. Access is provided by State Highways 13, 17 and 43. The complex is composed of four recreation sites, the Lower Bowen Camping Area, the Upper Bowen Camping Area, and the Upper Beech Fork Camping Area.

The Lower Bowen Camping Area was developed by the Corps and contains 275 campsites, parking for 192 cars and 62 car-trailer combinations, a 2-lane launching ramp, eight restrooms and four washhouses, and a sewage treatment plant. The State has constructed a camp store and concession building, two ball fields, a picnic shelter and parking lot. The other three sites in this complex will be developed by the State and may include additional camping, restrooms, washhouses, ball fields, tennis courts and other day use facilities.

c. Privately Operated Sites. This site consists of the marina which is part of the Dam Site Area and contains 4.7 acres. The marina operator, Lavalette Sports Barn, has provided the floating docks with slips for approximately 200 boats and a floating concession building and fueling area.

TABLE NO. 2-2

RECREATION SITES AT BEECH FORK LAKE

Name	Status
Tailwater Fisherman Access and Picnic Area	Functional plus construction
Dam Overlook and Visitors Center	Complete
Beech Fork Boat Launch and Marina	Complete
Stowers Branch Day-Use Area	Functional plus future construction
Bowen Recreation Complex	Functional plus future construction
Mary Davis Branch Lodge and Day-Use Area	Future; pending funding

SECTION III - GENERAL HISTORY OF THE TWELVEPOLE CREEK BASIN

3-01 AUTHORIZATION

The Beech Fork Lake project became eligible for construction by the Corps of Engineers as a unit in the comprehensive plan for flood control in the Ohio River Basin as a result of the Flood Control Act of 1962, H.R. 13273, Public Law 87-874, 87th Congress, 2nd Session. Legislative authority includes the authorizing act; the Flood Control Act of 1944, as amended; the Fish and Wildlife Coordination Act of 1958; the Forest Conservation Act as amended; the Federal Water Project Recreation Act; and, the Water Resources Planning Act. The Flood Control Act of 1962, 87th Congress, Second Session authorized Beech Fork Lake on Beech Fork of Twelvepole Creek for flood control, general recreation, fish and wildlife enhancement, and allied purposes. The general map of the Corps of Engineers, Huntington District showing the Twelvepole Creek basin is shown as Plate No. 1-1.

3-02 GENERAL BACKGROUND HISTORY

The history and development of the water resources of the Ohio River-Twelvepole Creek began even before the European explorers discovered America. Centuries later as the self-sufficient hardy settlers slowly extended up Twelvepole Creek, or came over the mountains, the strong need for food, security, protection, transportation, and future access to eastern cities for markets and imports became apparent. This led to the first trail marking, clearing, crude wagon paths, ferries, wells, forts, and rare new villages. From these early settlements and growth came the dependence and use of the surface waterways for personal, farm and city consumption, basic transportation, and primitive water power.

The new settlers or the old Indians of the Twelvepole Creek Basin did not cause the annual spring floods or fall droughts. The first damaging floods were there long before settlement, but very little record was made of these events. The first major Ohio River recorded floods were at Fort Pitt or Pittsburgh in 1762 and 1763, and Cincinnati in 1773, 1792, and 1793. The terrible floods of the previous century are recorded in old newspaper stories and military records; and were all very destructive at East Lynn, Wayne, Lavalette and Ceredo, and to agriculture and farm lands all along the valley. The floods usually came about every two or three years with the record flood in February 1861. Lesser floods came in August 1875, March 1907, March 1913, March 1917, January 1918, December 1926, March 1929, May 1932, March 1934, February 1939, January 1946, February 1948, March 1955, January 1957, May 1958, March 1963, April 1977, and November 1981.

The early leaders quickly saw the obvious need for safe water access and supply, flood protection or control, open river channels, and water resource development along the narrow floodplain of the Twelvepole Creek valley as the tiny communities grew from a wilderness. However, the first known settler on Beech Fork is unknown.

Water management in the Twelvepole Creek Basin played a crucial role in economic development. As in most basins, the twin problems of excess water during floods and inadequate water supply in the summer for

personal, urban, and industrial development had to be solved. Although the potential for severe flooding in the Twelvepole Creek Basin had long been recognized, federal investigations made prior to the 1930's were generally concerned with improvements for commercial navigation. In the 1920's and 30's, it became even more apparent that major flooding events were basin-wide problems that could not be controlled by communities or local protection structures.

During these years the country found itself in the midst of a very severe stock market crash and worldwide economic depression and at the same time came a very severe drought. The 1930-31 record drought, one of the most severe in the basin history, nearly destroyed the basins agriculture base. These two crisis, financial shortage and water drought, were drastic, and they in turn created wide support for any organized emergency water management by any agency. Upstream farms and mines experienced severe water shortages, and the Wayne water public water system could not function during the drought. Further downstream very low streamflow contributed to pollution problems, and led to the haunting fear that water shortages might stifle the coal industry's recovery, expansion, and growth even more than the 1929-33 world economic depression. Later in 1932 the Huntington District, Corps of Engineers "308 Report" came to essentially this conclusion for any large water project in any major basin, "The total costs would far exceed local financial resources." The only apparent solution was massive Federal Aid, which was not readily available.

Because of the depressed economy at the time, it appeared that extensive Federal aid for flood control, would be possible only on the Mississippi River. However, the election of a president, political party, and congress who were more receptive to proposals for public works programs and water resources development opened the door for the needed assistance. The severe droughts of 1930,31, and 1934; the 1926, 27, 29, 30, and 1933 floods; coupled with the national economic and financial recovery crisis; and the 1932 and 1934 elections culminated in a broader public support for Federal Public Works program, which included the adoption of a national flood control policy independent of the policy of navigation improvement. One of the early acts of the new administration in 1933 was to organize the Public Works Administration for emergency means of combating unemployment. The gradual overall economic recovery began and many people credited the increased public works programs for partially assisting the national growth and recovery.

The Ohio River Basin was first evaluated in 1933 in the "308" report (House Document No. 245, Seventy-fourth Congress, first session) with 39 reservoirs proposed in the Ohio River Basin to provide flood control for the Mississippi River. During the same congressional session, the Ohio River "308" report (House Document No. 306) presented a plan for controlling floods on the Ohio River and lower Mississippi Valley. The first report on the Twelvepole Creek Basin for flood control was submitted by the Chief of Engineers on 16 June 1933 to the Secretary of the War for transmission to congress under authority of Section 10 of the Flood Control Act of 15 May 1928. The report concluded that a flood control plan for Twelvepole Creek was not justified at that time.

None of the Twelvepole Creek reservoirs were justified and, therefore, another twenty-five years before any reservoir would be authorized for

construction on Beech Fork of the Twelvepole Creek Basin.

While this was transpiring another report was submitted by the Chief of Engineers on 14 August 1935 on the Ohio River, but not published until 1936, House Document No. 306, 74th Congress, first session - the unprinted Ohio River "308 Report. This report planned for a total of 39 flood control reservoirs to be built for the Ohio River Basin and its tributaries. This report closed with an unfavorable recommendation for the East Lynn reservoir in the Twelvepole Creek Basin.

The record Ohio Valley flood of January 1937 established the need for a comprehensive plan for flood control in the Twelvepole Creek Basin. House Document No.1, 75th Congress, 1st Session, presented a number of flood control reservoirs and local protection projects in the Ohio River Basin, but there was no recommendation for the construction of East Lynn Lake.

During 1937, basin-wide investigations were conducted to modify and enlarge the comprehensive plan for flood control in the Ohio River Basin, as set forth in the Flood Control Committee Document No. 1 which included a review of House Document 306. As a result of this review of House Document No. 306, the Great Lakes and Ohio River Division Engineer prepared a report setting forth a revised and enlarged flood-relief plan for the Ohio River and major tributaries. This report, "Comprehensive Flood-Control Plan for the Ohio River Basin," dated 12 November 1937, had a full plan of flood control projects, but again there was no recommendation for the construction of East Lynn Reservoir.

Within a few days an unpublished report compiled by the Great Lakes and Ohio River Division Engineer recommended the addition of East Lynn Dam to the comprehensive flood control plan for the Ohio River Basin. This report was a review, addition, and amplification of the above mentioned House Flood Control Committee Document No. 1.

The surprise intervention of Pearl Harbor and World War II postponed any further planning or reservoir construction for the duration of the war. World War II consumed all national effort and all federal money went to war plans and production. However, during the intervening war years the first preliminary plans for the Guyandotte River project was changed somewhat and updated.

The Corps of Engineers was requested by House Resolution adopted 13 June 1956 to review reports on Twelvepole Creek to determine whether improvement in the interest of flood control was advisable at that time. Potential reservoir sites were selected for study utilizing the following considerations: location and effectiveness with regard to areas of flood damage; physical and practical capacities with respect to drainage areas controlled; improvements in the reservoir areas which would affect project costs; and the possibilities for multiple purpose development for other uses such as water supply, pollution abatement and recreation. The Survey Report which followed was published as House Document No. 520, 87th Congress, 2nd Session, 1962. This report considered a 3-reservoir system consisting of the originally authorized East Lynn Project on East Fork, Cabwaylingo Reservoir on West Fork and Beech Fork Reservoir on Beech Fork about 3.3 miles above its mouth.

The system of three reservoirs was economically justified by a benefit to cost ratio of 1.5 to 1; however, when Cabwaylingo Reservoir was considered incrementally it was not economically justified because of a 0.9 to 1 benefit-to-cost ratio. Therefore, the Cabwaylingo Reservoir was dropped from consideration and the Survey Report recommended construction of East Lynn Reservoir and authorization of the Beech Fork Reservoir. This two-reservoir system was economically justified by a ratio of benefits to costs of 1.7 to 1.

3-03 PROJECT FORMULAION AND DESIGN

The recommended size and scope of the Beech Fork Lake Project was determined by maximization, where applicable, of the net benefits of joint operation with East Lynn Lake, the other authorized reservoir project in the Twelvepole Creek Basin. All major phases of water resources development were considered in establishing the scope of the project including flood control, water supply, water quality control, hydroelectric power, fish and wildlife enhancement, and general recreation. Federal agencies were requested to conduct studies and report their findings of the need for project features other than flood control. The Federal Water Pollution Control Administration (now EPA) stated that allocation of storage was not warranted for industrial or municipal water supply or for streamflow regulation for water quality control. The Federal Power Commission stated that provision of hydroelectric power was not warranted. The Bureau of Outdoor Recreation concurred with the Corps plan to provide facilities for a major water recreation complex at Beech Fork Lake and noted the agreement of the Corps plan with the regional recreation concept of West Virginia Department of Natural Resources. Conflict between purposes within the project was resolved by economic efficiency criteria.

As proposed in the Twelvepole Creek Survey Report, the Beech Fork Dam was of rolled earth-fill located on Beech Fork of Twelvepole Creek 3.3 miles above its mouth, 19.2 miles above the mouth of Twelvepole Creek and 6.5 air miles south of the city of Huntington. Design Memorandum A, Site Selection, recommended moving the dam upstream 0.4 miles to provide the most favorable arrangement of the required structures, desirable economic consideration involving relocations and a greater potential for the development of recreational facilities and public use areas at the dam site.

Investigation of flood control storage requirements were made with a view toward providing sufficient storage capacity to effectively control not only historic floods but also floods which might reasonably be expected to occur in the future.

Requirement for a storage volume to serve as winter habitat for aquatic communities in the lake and space for accumulation of sediment is met by a minimum pool with surface elevation of 583.5 feet NGVD 29.

The planning phase indicated that the recreation facilities at Beech

Fork Lake would supplement the facilities at other areas in or adjacent to the recreation zone of influence which is the area from which a motorist can reach the lake in a maximum driving time of one hour. Benefits and visitations assumed for economic studies were based on a seasonal pool level at 592 feet NGVD 29. Diminution of benefits due to drawdown of seasonal pool caused by water quality control augmentation was deemed to be negligible.

3-04 CONSTRUCTION

In June 1970 work began with the construction of the access by-pass road. The project was to take four construction seasons however notice to proceed on the dam and appurtenant works did not begin until February 1973. Work on the dam finished in November 1976 with final acceptance coming in February 1977.

The relocation program began in June of 1970 with the beginning of the cemetery removal. In all 39 cemeteries consisting of 712 graves were relocated. Relocation also included: relocating 2.69 miles of State highways and roads, abandoning and removing approximately 20.5 miles of telephone lines and construction of 3.0 miles of new lines, relocating 9.2 miles of gas pipe lines and abandoning approximately 12.1 miles of existing pipe lines, and replacement of Bowen Elementary School.

The project was placed in operation in January 1978 when closure was made to raise the pool level. On May 22, 1978, Beech Fork Lake reached seasonal pool elevation of 592.0 feet NGVD.

The summary and final phase of Twelvepole Creek water resources development is that many public and private groups now use the water of Twelvepole Creek for personnel and municipal use.

The exploration, settlement, and expansion of the rugged Twelvepole Creek began both before and after the American Revolution over 200 years ago. The economic, industrial, and water resources expansion and development of the basin began immediately and continues today. The future of the Twelvepole Creek and southern West Virginia will always be linked with extensive water resources and mineral development.

3-05 RELATED PROJECTS.

As previously mentioned, Beech Fork and East Lynn lakes are the only flood control projects in the Twelvepole Creek Basin. These two lakes are operated in close conjunction with each other and with all upstream flood control lakes; and especially with the six lakes in the adjacent Big Sandy River Basin and Grayson Lake in the Little Sandy Basin. These lakes are operated in such a manner that releases of stored waters from the reservoirs, with proper allowance for time of travel, will not cause stages in excess of the control stages. Gates are closed and all reservoir inflow stored for partial control of Ohio River floods when a

crest stage above 50 feet at Huntington is forecast by the U.S. Weather Bureau.

3-06 REGULATION PROBLEMS

When the Beech Fork Lake project began operations, after the first major flood there was little or no regulation problems. However, with additional growth downstream at Lavalette certain problems developed. First, home encroachments directly below the project on Beech Fork required a temporary decrease in the maximum release to prevent flooding of basements and electrical mechanical units. These issues were resolved within the first 12 years of the project's operations. Additionally, expansion of the Lavalette Public Service District water system resulted in impacts to the system at stages greater than 19.0 ft at the Lavalette gage for a time. The project operated to prevent those impacts long enough that a number of residences were constructed along Twelvepole Creek below the confluence with Beech Fork at an elevation where the ground structure confluence occurs at or about a stage of 19 feet on the Lavalette gage. Finally, a few of the Northern Wayne County Public Service District sewer lift stations electrical panels become impacted between a stage of 21.0 and 22.5 feet on the Lavalette gage.

3-07 MODIFICATIONS TO REGULATIONS

The control for Lavalette (the confluence of Beech Fork and Twelvepole creeks) was originally an indirect control utilizing the Wayne gage. A control stage of 16 feet and rising on Twelvepole Creek at Wayne was established as an indicator stage on which to regulate Beech Fork Lake because that gage was the only gage on Twelvepole Creek. This stage was set by reference to the Wayne gage readings taken at times approximately 3 and 9 hours respectively prior to field observations of Twelvepole Creek and Beech Fork during the flood of April 1977.

In the early 1990's, control for Lavalette was modified to a direct control at the newly established Lavalette gage. Control was set to a stage of 19 ft as this was the level at which a private wastewater treatment facility (it's subsequent replacement, a series of lift stations serviced by the Northern Wayne County Public Service District) were impacted. In addition, as the area has developed, a handful of residences were constructed for which ground structure intersection was at a stage of 19 ft on the Lavalette gage.

SECTION IV - WATERSHED CHARACTERISTICS

4-01 GENERAL CHARACTERISTICS

The Twelvepole Creek Basin is a 441 square mile basin lying between Four Pole Creek and the Guyandotte River Basin on the east and the much larger Big Sandy River and Tug Fork Basin on the west and south. The basin is situated on the western slopes of the Appalachian Mountains and is characterized by moderately rugged and hilly terrain, steep sided valleys and narrow flood plains on alternate sides of meandering river valleys. Beech Fork is a small tributary of the Twelvepole Creek basin and lies in Wayne and Cabell Counties in southwestern West Virginia. Beech Fork heads in moderately rugged, hilly terrain near the Wayne-Lincoln County boundary line and flows northwestward to its confluence with Twelvepole Creek near Lavalette, West Virginia, 16.4 miles upstream from the mouth at Ceredo, WV. The valley width varies from slightly more than the stream width in the headwaters to more than 2,000 feet near its mouth.

The Beech Fork drainage basin contains about 82 square miles; and the 78 square mile area above the dam site is irregularly or somewhat inverted pear shaped, about 14 square miles long and 9 miles wide, with the longest dimension in the a general northwest-southeast direction. The stream fall from source to mouth is 440 feet, an average of 15.9 feet per mile. Millers Fork, the largest tributary of Beech Fork, drains about 26 percent of the area, has a length of 8.6 miles, and an average fall of 38.4 feet per mile. Drainage areas of the Beech Fork and principal tributaries above the dam site are given in Table No. 4-1, next page. The Beech Fork area map is shown on Plate No. 4-1, and Streambed profiles of Beech Fork and its principal tributaries above the dam site are shown in Plate No. 4-2.

Beech Fork Lake is located in the western portion of West Virginia, mostly in the northeast corner of Wayne County, WV, with a small portion of the lake in the southwest corner of Cabell County. The lake is dendrite in shape, with a shoreline length of 31 miles at seasonal pool elevation 592 feet NGVD. The lake covers the flood plain over much of the length of the lake up the main stem and lower tributaries. At seasonal pool, the lake extends up the Beech Fork 9.2 miles and up Millers Fork 4.0 miles above the mouth. Mean breath of the lake is around 800 feet with a maximum depth of 40 feet.

4-02 TOPOGRAPHY

The Beech Fork drainage basin lies within the maturely dissected Appalachian Plateau of the Kanawha physical graphic province. This physical section is characterized by a mature plateau of fine texture with moderate to strong relief. Numerous hills and ridges ranging in elevation from 800 to 1500 feet above NGVD. are capped with near level resistant rock strata which manifests an ancient plateau.

TABLE NO. 4-1
DRAINAGE AREAS OF BEECH FORK
AND PRINCIPAL TRIBUTARIES ABOVE DAM SITE

<u>Stream</u>	<u>Location</u>	<u>Beech Fork (miles)</u>	<u>Drainage Area (sq. mi.)</u>
Beech Fork	Above mouth of Raccoon Creek	15.9	20.7
Raccoon Creek	At mouth	15.9	6.9
Beech Fork	Above mouth of Bowen Creek	14.5	29.4
Bowen Creek	At mouth	14.5	5.8
Beech Fork	Above mouth of Millers Fork	3.8	59.5
Millers Fork	At mouth	3.8	19.4
Beech Fork	At dam site	3.6	79.0
Beech Fork	At mouth	0.0	83.2
Twelvepole Creek	At Beech Fork	16.4	401.5
Twelvepole Creek	At Mouth	0.0	442.3

The older streams are entrenched from 400 to 450 feet below the plateau level and meander in narrow valleys between moderately steep walls. The relief is about 500 feet in the project area. In general, the terrain is hilly to mountainous, with rolling foothills, relatively steep slopes and narrow valleys. The flood plains are narrow alluvial strips on alternate sides of meandering streams at several levels.

4-03 GEOLOGY AND SOILS

The Beech Fork Basin is underlain by sedimentary strata of Permian and Pennsylvanian age. Sedimentation took place upon a broad, constantly subsiding basin and great thickness of shallow water sediments were accumulated. The bedrock in descending geologic order consists of three series, the Conemaugh, Allegheny, and Pottsville which are conformable, lying upon one another in parallel order. The Conemaugh Series constitutes bedrock in the basin's ridges above approximate elevation 850 feet NGVD and is underlain by 225 to 350 feet of rock comprising the Allegheny Series. Beneath the Allegheny Series, the Pottsville Series varies in thickness from 250 to 2,000 feet. The Conemaugh series in this region is characterized by many sand stones of irregular thickness and extent with several thick roadbed sequences and a few thin marine limestone horizons and coals. The Allegheny and Pottsville series consist mainly of massive sandstone beds with thin shale and coal. Both of the intervals lack the well defined red beds that occur in the overlying Conemaugh.

Observations of rock outcrops show the sandstone and shale vary in resistance to weathering. The sandstone are generally very resistant, and the shale weather rapidly on exposures, especially where they are not sandy or interbedded with siltstone and sandstone laminations.

Differential weathering occurs when sandstone and pure shale are in contact, with the shale frequently undermining an overlying sandstone stratum.

The formations encountered in the basin area are relative impervious. The outcropping siltstone and sandstone are slightly permeable along joints, fractures, and bedding contact.

The soils on the higher valley slopes are residual in origin; below that level, the soils are a mixture of colluvial soil formed by the weathering of underlying sandstone and shale and alluvium deposited by Beech Fork. Some overburden has slipped downhill from the weak shale layers to accumulate in narrow benches on the tops of alternating resistant sandstone layers. The thickness of overburden on the valley slopes varies from 0 to a maximum of approximately 50 feet with an average of 40 feet.

The overburden in the flood plain is a combination of both colluvium and alluvium deposited by Beech Fork. The materials in the valley range from Lean Clay to Silty Sand.

4-04 EROSION AND SEDIMENT YIELD

Most of the Beech Fork Basin is wooded and consists largely of second-growth timber, only a small portion of the area is cultivated or cleared for urban development. Logging of the wooded portion of the basin is actively practiced. Beech Fork Lake is located within productive coal and gas fields. The coal seams exhibit continuity and can be regarded as a reserve of favorable future production. Natural gas is produced from wells located in the area and are of economic importance.

In the past, the stream has not appeared to carry a heavy sediment load; however, no actual samples have been taken to determine the amount of sediment carried. A summary of reservoir sediment deposition surveys made in the United States through 1960 was published by the U.S. Department of Agriculture in "Miscellaneous Publication No. 964". The information contained in this publication was used to estimate the amount of sedimentation that might be expected to occur in Beech Fork Lake. Utilizing the data relative to the reservoirs in the basins adjacent to Twelvepole Creek, it appeared that a sedimentation rate of 0.376 acre-foot per square mile of controlled drainage area per year would be a representative value for Beech Fork Lake.

A total of 4,200 acre-feet of storage is provided in the minimum pool area, below elevation 583.5 feet NGVD, for fish and wildlife conservation and sedimentation reserve. Assuming that sedimentation occurred at an annual rate of 0.376 acre-foot per square mile of contributing drainage area, or 29.3 acre-feet per year, and all the material were deposited in the minimum pool area, the minimum pool would have a life of about 143 years.

Increasing energy needs and increasing emphasis on coal production to fill those needs could result in future mining in the drainage basin. An increase in sediment-producing activities in the drainage basin above Beech Fork Lake could increase the rate of sedimentation in the lake. The methods used in mining the coal and reclaiming the land after mining will affect the quantities of sediment reaching Beech Fork Lake.

4-05 WATER QUALITY

Beech Fork Lake is located on Beech Fork of Twelvepole Creek of the Ohio River in Wayne County, West Virginia. It was authorized for flood control, general recreation, fish and wildlife conservation, and water quality control. The lake is formed by a rolled earth-fill dam located 3.7 miles above the mouth of Beech Fork. The drainage area above the dam is 78 square miles. At seasonal pool elevation of 592 feet NGVD the lake extends about 8 miles above the dam and covers a surface area of 720 acres. The volume of water in the lake at seasonal pool is about 9,200 acre-feet.

The outlet works include a dual wet well selective withdrawal structure with three release elevations; one at invert elevation 582 feet NGVD, another at invert elevation 573 feet NGVD, and the other at invert elevation 564 feet NGVD. Water temperature rule curves for releases from the project were established between the state of West Virginia and the Corps of Engineers to match "normal" stream temperatures prior to construction of the lake. The project is operated to meet those temperature objectives whenever possible.

The average hydraulic residence time through the lake is approximately 43 days based on summer pool elevation of 592 feet NGVD. This could be as long as a year during time of low-flow and as short as a day during times of high flow.

During the majority of the recreation season, the lake is stratified with warmer, oxygenated water in the upper levels (epilimnion) and colder water, devoid of oxygen in the lower levels (hypolimnion). Iron and manganese levels in the hypolimnion are present at high concentrations due to the anoxic conditions and existing watershed problems. Nutrient levels appear to be normal with an occasional algal bloom confined to the upper end of the lake. In terms of major ions and descriptive parameters, water in the basin above the Lake is classified as a calcium-carbonate type. This represents a balanced condition.

Water quality data collected by the Corps of Engineers from 1973 to 1995 indicated that water quality in the basin reflects the watershed conditions.

4-06 CLIMATE

a. General. The climate of the Beech Fork Basin is typical of the central temperate zone, having highly variable temperatures between the summer and winter seasons. The entire basin is affected by frontal airmass activity and is subject to both continental polar and maritime tropical airmasses. Frequent and rapid changes in weather occur due to the passage of fronts associated with general low-pressure areas. The prevailing wind direction is from the southwest.

Meteorological data used in hydrologic studies for Beech Fork Lake were available from eleven National Weather Service stations located adjacent to the drainage basin.

b. Temperature. One station located within the Twelvepole Creek Basin, Cabwaylingo State Forest, had 13 years of temperature records before being discontinued in 1961. However, Huntington, adjacent to the basin, has records extending more than 90 years to the present. Temperature has varied at Huntington from -24°F in February 1899 to 108°F in July 1930. The average annual temperature is about 55°F; the average summer temperature is 73°F. The growing season, or the period between the last killing frost of spring to the first killing frost of autumn, usually runs from mid-April to mid-October. The latest portion of the Huntington record is from the Huntington Tri-State Airport and this is included in Table No. 4-2, Table Section, which presents a temperature summary for two representative stations in the Twelvepole Creek Basin.

c. Precipitation. The normal annual precipitation of approximately 43.5 inches is nearly uniform over the Twelvepole Creek Basin. Average monthly, maximum monthly, minimum monthly and maximum 24-hour precipitation list in Table No. 4-3, Table Section, for two representative stations.

The Twelvepole Creek Basin extends generally north and south. Consequently, the basin lies directly in the path of extensive meteorological disturbances, which in winter and spring generally travel from southwest to northeast. Storms likely to produce major flooding in the basin can be classified in two types: the summer-type and the winter-type. The summer-type storm usually occurs during the period from May through October with the greatest probability of occurrence during June and July. Winter-type storms, which can occur in the period between December and April, are most likely to occur in March and April.

Summer-type rains usually result from thunderstorms of conventional frontal activity with convectional or orographic origins. They are characterized by rainfall of high intensity, short duration, and relatively small areal extent.

Winter-type storms are differentiated from the summer-type storm by their less intensive and more evenly distributed rainfall of longer

duration and wider areal extent. These storms are generally caused by cold airmasses, originating in the region of Alaska, which interact with warm moist air masses sweeping northward from the Gulf of Mexico and southern Atlantic Ocean. Occasional stagnation and stationary development produces prolonged precipitation. Snow cover, saturated or frozen ground, or combinations thereof, may greatly increase runoff rates and volume. The direction of travel of the storm system is usually northeastward.

A comparison of area precipitation and natural flows at the Beech Fork project during the March 1967 flood and that of July 1980 illustrates a major difference between effects of winter and summer storms. Table No. 4-4 below, contains rainfall amounts recorded by the four area weather stations reporting during both events and that recorded at the project in July 1980. Natural flows computed for the two projects as produced by the two sequences of rainfall are given in Table No. 4-5 below.

TABLE NO. 4-4

TWELVEPOLE CREEK AREA PRECIPITATION DURING MARCH 1967 AND JULY 1980

March 1967						July 1980					
Rainfall reported - date(in.)						Rainfall reported - date (in.)					
Date	4	5	6	7	Total	Date	8	9	10	11	Total
T	1.40	2.54	0.23		4.17	Huntington	0.54	T	2.94	-	3.48
						Airport					
	0.05	0.10	1.95	0.18	2.23	Dunlow	-	0.72	1.12	0.58	2.42
T		-	1.83	2.00	3.83	Hamlin	-	0.83	1.03	1.30	3.16
-		-	2.13	2.05	4.18	Branchland	-	0.68	2.02	1.02	3.72
						East Lynn Lake	-	1.75	1.69	2.74	6.18
						Beech Fork Lake	-	0.72	2.42	0.75	3.89

TABLE NO. 4-5

NATURAL FLOWS AT BEECH FORK LAKE CAUSED BY RAINFALL OF TABLE NO. 4-4

March 1967			July 1980		
Natural flows - cfs			Natural flows - cfs		
Date	Time	Beech Fork Lake	Date	Time	Beech Fork Lake
6	0730	1370	9	1930	28
	1330	2570	10	0130	281
	1930	2500		0730	868
7	0130	2420		1330	912
	0730	2520		1930	1099
	1330	2070	11	0130	1113
	1930	1000		0730	679
8	0130	700		1330	276
	0730	530		1930	230
	1330	400	12	0130	254
	1930	330		0730	108
9	0130	300		1330	133
	0730	260		1930	442

Total rainfall reported at the four area stations is not radically lower for the 1980 event than in 1967. Also, the rainfall recorded at the projects indicates the possibility of other higher, unrecorded, rainfall amounts in the drainage basins during the 1967 event. In March 1967, a widespread relatively warm rain fell on snow covering the upper two-thirds of the Ohio River Basin. This augmented the runoff over frozen soil and produced the 61 foot Ohio River stage at Ashland, Kentucky. Some of the 1967 rain fell rapidly, 0.83 inch between 0300 and 0600 hours on 6 March at Griffithsville, West Virginia and 1.13 inches between 0700 and 1000 hours at Huntington Airport on 5 March. However, these values are dwarfed by the 2.42 inches recorded in 4 hours at Beech Fork Lake on 10 July 1980 and the 1.69 inches during the same period at East Lynn Lake. These heavy rains falling on summer vegetation and receptive soil produced the comparatively flashy natural hydrograph at Beech Fork Lake given in Table No. 4-5, previous page, showing the peak 6-hour average value of 1,113 cfs. This runoff is contrasted with the 2,570 cfs peak 6-hour average of the broader natural hydrograph from the storm in 1967. Meteorological studies indicate that the summer-type storm has possibilities of producing the maximum flood. However, meteorological records show that winter-type storms occur more frequently and produce more major floods than the summer-type storms. Average annual snowfall over the Twelvepole Creek is about 20 inches and represents only a minor portion of the total average annual precipitation. Average monthly and annual snowfall list in Table No. 4-3, Table Section, for two representative stations.

d. Evaporation and Wind. Evaporation losses occurring at Beech Fork Lake were calculated from NOAA Technical Report NWS 33, published by the National Weather Service from data obtained jointly by the US Weather Service, Corps of Engineers and other organizations. Average values for monthly, seasonal, and annual evaporation losses from the lake are shown in Table No. 4-6 next page, - Lake Evaporation Losses - Summary. The evaporation records at Clarksburg, West Virginia, (1923-1964) were used to determine the maximum seasonal (May-October) evaporation losses.

Annual average wind direction over the Twelvepole Creek Basin is southwesterly. Southerly winds, however, prevail from July through October, change to southwesterly during November and December, and become near-westerly in January and February. The direction then gradually becomes and remains southwesterly during March, April, May and June. During the seasonal period of maximum evaporation, the lowest average wind speed, 4 mph, occurs in August and the highest, 7 mph, in May.

4-07 STORMS AND FLOODS

a. General. Floods in the basin are not limited to any specific month, although winter and spring floods are more frequent than summer floods. The occurrence of summer-type storms over the basin has produced local floods without affecting adjacent areas. The

lower 23 miles of Twelvepole Creek along with Beech Fork below the dam are subject to backwater flooding from the Ohio River as well as headwater flooding, or a combination of both. Ohio River floods are caused by winter-type storms that occur between December and April; these storms are more widespread and of longer duration.

Large floods in the past, such as the 1913 and 1937 floods, which occurred before construction of the flood control reservoirs, produced high stages on the Ohio River at Huntington, West Virginia, that backed water up Twelvepole Creek as far as 25 miles. Table No. 4-7 next page, shows potential crest stages, backwater distance with low-flow in Twelvepole Creek and Beech Fork, and probable frequency of occurrence under present day conditions.

TABLE NO. 4-6

LAKE EVAPORATION LOSSES - SUMMARY

Maximum Seasonal Evaporation (1930) - inches* 26.0

Average Annual Evaporation - inches* 29.8

Average Seasonal Evaporation (May-October) - inches* 22.2

Average Monthly Evaporation Losses,		
Month	Inches	Ac-ft#
May	4.03	242
June	4.27	256
July	4.49	269
August	4.06	244
September	2.95	177
October	2.40	144
Seasonal Total	22.20	1,332

(*) Vertical distance

(#) 1-inch loss from seasonal pool (elevation 592.0 NGVD, surface area 720 acres) = 60 acre-feet.

* Information on wind direction and speed is taken from "Climatic Atlas of the United States," June 1968, published by Environmental Science Services Administration of the U.S. Department of Commerce.

The topography of the basin, consisting of winding, narrow-crested ridges and deep narrow valleys, is conducive to the rapid concentration of runoff, resulting in fast rises of the stream. Floods on Beech Fork above the dam site are generally of relatively short duration and seldom remain above flood stage more than 24 hours. Flooding in the lower reaches of Beech Fork can last longer when influenced by Ohio River floods.

TABLE NO. 4-7

OHIO RIVER BACKWATER EFFECTS ON TWELVEPOLE CREEK AND BEECH FORK

Flood Crest Elevation Ft. NGVD	Distance (Low Water) Miles		Frequency (Present Day Conditions) Return Period - Years
	Twelvepole	Beech Fk.	
558.5	24.3	3.6(dam)	700
546.8	20.2	2.4	100
544.6	19.4	2.0	50
541.4	18.3	1.4	20
538.8	17.3	0.8	10
535.8	16.3	-	5
531.2	14.7	-	2
526.7	13.2	-	1

The flooding characteristics of the basin are illustrated by the list of high-water data on Twelvepole Creek at Wayne presented in Table No. 4-8, page 4-10. The stage of 16 feet and rising on the gage at Wayne is the flooding indicator stage used by the project and District offices in regulating for protection of Lavalette property owners. For clarity, water year has been changed to calendar year in the table where appropriate. In December 1966 the Wayne gage was moved to a location below town near the high school.

In order to make flows and stages comparable, flows occurring before December 1966 have been adjusted to the larger drainage area and applied to USGS Rating No. 9 of the new gage. Stages after the gage was moved, but before regulation of East Lynn Lake, are recorded peaks and were applied to ratings current at the time of occurrence of the flows given. Flows after beginning of regulation of East Lynn Lake in March 1972 are computed naturals and were applied to ratings relevant to the time of occurrence.

b. Storm and flood of January-February 1939. The flood of January - February 1939 was the greatest flood of record in the Twelvepole Creek Basin. The flood was caused by two distinct storms. On 29 January, the first storm released approximately 1.5 inches of rainfall over the basin which saturated the soil and caused the streams to rise. The second storm occurred during the period of 1-3 February and resulted in rainfall averaging approximately 3.5 inches over the basin above Beech Fork dam site. The rainfall measured at the gage at Wayne was 2.84 inches and heavier amounts probably fell at upstream points. This was the most destructive flood that ever occurred in the Twelvepole Creek Basin. The flood reached crest stage of 31.0 feet at Wayne with an estimated discharge of 22,000 cfs, Transposed to the new gage below Wayne, these values would be 39.9 feet and 22,660 cfs.

TABLE NO. 4-8
TWELVEPOLE CREEK AT WAYNE, WEST VIRGINIA
HIGH-WATER DATA - NATURAL CRESTS

Date	Gage Height feet	Discharge cfs
02 February 1939	39.9	22,660
09 December 1978	39.1	21,800
22 February 1962	33.5	16,330
30 June 1928	31.8	14,420
30 December 1942	31.6	14,100
02 February 1951	30.9	13,400
05 March 1955	29.8	12,370
01 February 1950	29.7	12,260
12 March 1957	29.7	12,250
11 January 1974	29.6	12,120
05 April 1977	29.5	12,060
26 January 1978	28.4	10,990
28 November 1973	28.1	11,100
26 February 1972	28.2	10,800
30 January 1932	27.7	10,400
14 April 1948	27.6	10,300
23 March 1952	27.6	10,300
08 March 1967	27.6	10,300
04 March 1997	27.3	10,000
29 March 1975	26.6	9,450
22 January 1926	26.4	9,280
19 March 1933	25.7	8,780
14 March 1956	25.6	8,700
08 January 1946	25.3	8,530
13 March 1968	25.0	8,400
21 March 1976	24.5	7,990
22 December 1926	24.4	7,940
27 December 1928	24.4	7,920
14 December 1956	23.7	7,500
06 April 1936	23.5	7,420
24 August 1942	23.4	7,370
28 March 1965	23.4	7,340
08 May 1958	23.3	7,250
31 December 1969	23.1	7,140
12 August 1938	23.0	7,100
12 April 1944	22.9	7,060
13 March 1963	21.9	6,460
02 February 1945	21.4	6,290
12 May 1925	21.3	6,140
15 July 1961	20.8	5,920
19 May 1995	19.9	5,470
18 October 1929	19.7	5,340
23 January 1937	19.6	5,300
06 February 1971	19.5	5,250
31 March 1940	18.6	4,800
20 April 1964	18.3	4,630
04 March 1934	17.7	4,380
16 February 1949	17.4	4,250
01 May 1966	16.9	4,050
23 April 1931	16.2	3,800
21 January 1947	15.7	3,590
08 January 1953	15.5	3,500
19 April 1969	14.1	3,000

c. Storm and flood of April 1977. The storm causing this flood began the evening of 2 April. Although there was an 18-24 hour break in the rainfall on Sunday, 3 April, this set the stage for greater runoff when the rain began again Sunday evening. A series of disturbances moved from the southern plains states into the Appalachians on 4 April. Heavy thunderstorms formed ahead of the disturbance in the lower Mississippi Valley and moved rapidly northeastward along a stationary front into the southern Appalachians. Three bursts of heavy rainfall occurred in the Beech Fork Basin during the 4th amounting to nearly 3.0 inches at the project.

The Beech Fork project was not in operation at the time of this flood, but some regulation of the slide gates was used to minimize the effects of headwater flooding on Twelvepole Creek at Lavalette. Twelvepole Creek at Wayne crested at 18.7 feet, 3.3 feet below control stage, around 0400 hours on 5 April.

d. Storm and flood of December 1978. The main storm causing this flood began 7 December with heavy rains general over the Ohio and West Virginia portions of the Ohio River Basin. These rains fell on saturated soils caused by the lighter rainfall of 3-4 December. The main storm released between 2.2 and 3.5 inches in eastern Ohio and northwestern West Virginia, with amounts increasing going southward. The largest amount reported in the region was 7.14 inches at Genoa, WV, about 13 miles southwest of the Beech Fork dam site. Rainfall amounts at Dunlow and Dingess, WV were 6.93 and 6.99 inches respectively. Twelvepole Creek at Wayne crested at 27.9 feet, with a computed reduction of 11.2 feet for East Lynn Lake. A corresponding reduction in stage on Twelvepole Creek below Beech Fork resulted from the operation of Beech Fork Lake. The computed natural flow was the second highest ever for Wayne.

e. Storm and flood of January 1979. The flood of January 1979 came on the heels of the extremely damaging storm and flood that occurred in December 1978. Rain began falling around 2300 hours on 19 January and ended 24 hours later with an accumulation at the project of 1.71 inches. Minimum discharge from Beech Fork Lake was used to reduce flooding on Twelvepole Creek and then the accumulated storage was released at a less-than-channel-capacity rate to provide a slow drawdown requested by the Geotechnical Branch.

f. Flood of March 1997. The month of February preceding the storm of March 1997 was a very dry month, with only 0.45 inches of rainfall in the last half, or 14 days of the month to saturate the ground. The only real antecedent rainfall was .25 inches on February 25th. The extra heavy March storm was able to do this and more. There was very heavy rainfall every day for a 6-day storm of 6.0 inches of rain with over 5 inches of runoff, and even heavier rainfall south of Wayne. The major storm began about midnight on 1 March with 3.19 inches of rainfall, followed by 0.73 inches the next day, then came 1.13 inches of rainfall on 3 March. The final day was 0.84 inches of rainfall on 5 March. When runoff began from the heavy rains early on 1 March, the lake level was at elevation 584 NGVD and was being held there for the winter flood season. The lake level began to rise that

morning, and on through the afternoon and night as the inflow increased rapidly above the channel capacity discharge. The project was already closed to the near minimum flow because of maintaining the winter conservation pool. The Beech Fork Lake level crested at 608.25 feet NGVD the pool of record, storing 27,055 acre-feet of flood water, or equivalent to about 68 percent storage utilization. Twelvepole Creek at Wayne crested at 27.3 feet, with an estimated reduction of about 11.0 feet for East Lynn Lake. A corresponding reduction in stage on Twelvepole Creek below Beech Fork resulted from the operation of Beech Fork Lake. Table No. 4-8, page 4-10, shows compilation of the recorded and/or computed crests of Twelvepole Creek at Wayne.

4-08 RUNOFF CHARACTERISTICS

The headwater portion of the Beech Fork Basin is characterized by narrow valleys with steep sloping sides. Runoff from these slopes is flashy and tends to collect rapidly in the stream channel resulting in fast rises of the stream. Infiltration losses are generally low due to the relatively shallow depth and high clay content of the soils.

TABLE NO. 4-9
MONTHLY AND ANNUAL AVERAGE RUNOFF
BEECH FORK AT BEECH FORK DAM
BASED ON GAGE RECORDS

Month	Normal		Maximum		Minimum	
	average cfs	flow inches	average cfs	flow inches	average cfs	flow inches
January	136	2.01	303	4.47	21.6	0.32
February	150	2.00	255	3.40	21.4	0.29
March	168	2.48	272	4.02	69.8	1.03
April	170	2.43	279	3.99	63.3	0.91
May	109	1.61	257	3.80	31.1	0.46
June	58	0.83	158	2.26	2.4	0.03
July	34	0.50	86	1.27	5.7	0.08
August	42	0.62	99	1.46	6.8	0.10
September	20	0.29	103	1.47	0	0
October	35	0.52	96	1.42	1.8	0.03
November	65	0.93	139	1.99	13.0	0.19
December	148	2.19	472	6.98	47.5	0.70

ANNUAL	95	16.41	210	36.53	23.7	4.14

Basin runoff is highest during the late winter and early spring months. During this period, snow cover, saturated or frozen ground in combination with rainfall, can greatly increase runoff rates and volumes. The runoff is lowest in the late summer and early fall when the ground is dry and infiltration rates are high. However, precipitation during these seasons may be quite heavy and of sufficient intensity to more than make up for the higher infiltration rates. Consequently, the critical season for major flood occurrences

in this area is the summer season. It is during the late summer and early fall periods when stream-flows in the basin drop to very low levels. Table No. 4-9 previous page, presents monthly and annual average runoff for the watershed upstream from the Beech Fork dam site, based on 7 years of record at the USGS gage below the dam site.

4-09 CHANNEL AND FLOODWAY CHARACTERISTICS

The regulation channel capacity, or control stage in Beech Fork below Beech Fork Lake is 10.1 feet in the winter and 8.5 feet in the summer to accommodate farming in the flood plain. A control stage of 19 feet on Twelvepole Creek at Lavalette has been established to regulate Beech Fork Lake. This stage was set based on minimum impact to structures in the Lavalette area. Flood time of travel of Beech Fork Lake discharge to Lavalette is 1.5 hours; to the Ohio River, 4.5 hours; and to Ashland on the Ohio River, 30 hours.

Twelvepole Creek follows a meandering course over the 16.4-mile length between the junction with Beech Fork and the mouth. It has generally stable banks and relatively low turbidity except after hard rains. The streambed is mostly sand and gravel and varies in width from about 90 feet at the junction with Beech Fork to 180 feet at the mouth. The valley width of Twelvepole Creek is about 1,500 feet from the junction to mile 13 where it narrows to about 600 feet and continues at that width to the mouth. The streambed width and valley width of Beech Fork from the dam site to the mouth are 50 feet and 900 feet respectively.

4-10 ECONOMIC DATA

a. Population. The Beech Fork Basin above Beech Fork Dam has an estimated population of 2,330 persons in a predominantly rural environment. Above dam population centers are small, less than 50 persons. Except for Ceredo, the entire Twelvepole Creek Basin contains only two population centers. The 1990 census listed for the town of Wayne a population of 1,495 and the village of Lavalette 600 people. The total population of the Twelvepole Creek Basin was approximately 30,400 in 1980 with 7.5 percent of the total located in urban areas.

b. Industry and Agriculture. The major industry in Twelvepole Creek Basin is coal mining. Others are extraction of gas and oil, timbering, and farming with a large portion of the working population commuting outside the basin for employment. There are many producing oil and gas wells in the basin.

There were 181 farms in Wayne County in 1977, averaging 150 acres, which made up 8 percent of the land area. Fifty-one of the farms in Wayne County had annual sales of over \$2,500. With a total value of sales of \$800,000. Crop growing is confined generally to the narrow bottom lands, the steeper hillsides being utilized for pasture and timber growing.

c. Flood Damages. No flood damages prevented along Beech Fork below the dam and along Twelvepole Creek from its confluence with Beech Fork to the Ohio River have been assigned to the project since this area is subject to Ohio River backwater flooding. Future benefits of \$26,000 annually along Beech Fork below the dam site were assigned to the project because of building that can take place on 64 acres of the floodplain that have been rendered flood-free by the project. This annual amount has been updated to \$100,005 for October 1983.

Frequency-damage computations have also been done for the Ohio River, and the average annual damages prevented by Beech Fork Lake were estimated to be \$23,370 in the Huntington District and \$64,980 in the Louisville District for October 1967 price levels. These average annual amounts have been updated to \$107,900 and \$286,900, respectively for October 1983.

Damages were updated to October 1983 by considering escalation of construction costs between October 1967 and October 1983 and a given annual growth rate in the flood plain between October 1967 and June 1972 when flood insurance requirements took effect. The annual growth rates used were 4.0 percent along the Ohio River in the Huntington District and 3.0 percent along the Ohio River in the Louisville District. Average annual damage prevented values can be updated by applying an appropriate ratio of "U.S. 20 Cities Average" construction cost index from Engineering News Record. Crop damages can be updated by applying the appropriate ratio of "Prices Received by Farmers" from Survey of Current Business a publication of the U.S. Department of Commerce, Bureau of Economic Analysis.

The updating formulas are as follows:

CROP	NON-CROP
Prices in period desired Prices in July 1983	ENR for month desired ENGR-for-October 1983
X Table Value	X Table Value
= Updated Damage Value	= Updated Damage Value

Where Prices are "Prices received by farmers", average of monthly index values for "all farm products" in Survey of Current Business, monthly publication of Bureau of Economic Analysis, U.S. Department of Commerce and the value for July 1983 is 599; and ENR is the "U.S. 20 Cities Average" monthly index of construction costs from Engineering News Record and the ENR for October 1983 is 4131.

Potential flood damages along Twelvepole Creek caused by backwater from the Ohio River were estimated by a contractor for the Corps of Engineers as one part of a five-part study of the counties abutting the Ohio River from mile 290.3 to mile 366.3. From investigations beginning in June 1975, damage data were tabulated for each of 4 hypothetical floods under each of 14 categories in each of 47 reaches. The peak elevations of a 20-year frequency, 50-year frequency, 100-year frequency, and 700-year frequency (January 1937) flood were chosen to cover a large range of severity of flooding possible under present day conditions.

SECTION V - DATA COLLECTION AND COMMUNICATIONS NETWORKS

5-01 GENERAL

Data collection and communication has been accomplished in the past largely by manual and voice methods. For example, observers reporting precipitation to projects or the National Weather Service (NWS) by telephone, observers and/or project personnel obtaining stream gage readings from telemarks over telephone lines and verbal submission of daily reports over the district radio network.

Recently, the Water Resources Engineering Branch acquired a state of the art computer to be programmed and used as a District Water Control System. Since that time, numerous changes have been made in the methods of data collection with anticipated future improvements to take place as to data collection, analysis and use.

All daily reservoir reports are now received through the Water Control System via INTRANET. Each project is equipped with a portable computer terminal with memory. The project report is entered into the terminal offline and then transmitted directly to the computer over telephone lines. The district radio network is still used as backup when needed.

Data from NWS is received by the water control system via network connections. Project data is also disseminated back to NWS by the water control system.

Data Collection Platforms (DCPs) have been installed throughout the district at various stream gaging and precipitation stations. Installations at stations in the Twelvepole Creek Basin are described in Table Nos. 5-1 and 5-2 in Table Section. The DCPs transmit hydrometeorological data, via the Geostationary Operational Environmental Satellite (GOES), to various receive sites. The data is then obtained directly by the District Water Control System for processing. Some stream gaging stations have voice DCPs, capable of answering a telephonic call and responding with the current updated information by synthesized voice.

All the data entered into the Water Control System is stored in a data base and used by water control software programs, allowing more timely and efficient water management decisions and generation of required reports.

5-02 HYDROMETEOROLOGICAL STATIONS

a. Streamgaging. Several stream gaging stations, designed for the collection of hydrologic data are located at strategic sites in the Twelvepole Creek Basin. Data from these stations are necessary for execution of the water control plan.

- (1) Stream Cooperative Program. The Corps of Engineers

participates in the U.S. Geological Survey's Federal-State Cooperative Water Resources Program under which the Survey installs, rates, and maintains the gages at locations desired by the cooperating entity, except at Corps projects where the lake and outflow gages are originally installed by the Corps. Under the program, the Survey maintains six stations in the Twelvepole Creek Basin: Eloise near Dunlow, East Lynn Lake, East Fork below East Lynn Dam, Twelvepole Creek at Wayne, Beech Fork Lake, and Beech Fork below Beech Fork Dam. Gage locations are shown in Plate No. 5-1, Hydrologic Network; and pertinent data about them is listed in Table No. 5-1, Table Section Stream Gage Data. Plate Nos. 5-2 and 5-3 are Stage-Discharge Tables for Twelvepole Creek at Wayne and Beech Fork below Beech Fork Dam. Plate Nos. 5-4 and 5-5 are revised Flow Frequency Curves for Twelvepole Creek at Wayne and Beech Fork at Beech Fork Dam. Plate No. 5-6 is for Flow Duration below Beech Fork Dam.

(2) Collecting and Reporting Facilities. Early-model stage detection devices, i.e. staff sections and wire weight gages, are now used as primary references for setting modern measuring and recording instruments. Strip chart recorders provide a graphical record of stream stage and a backup for Analog-to-Digital Recorder (ADR) devices. Shaft encoders are now being used to digitally record water levels. The data collection platforms mentioned above have been installed at basin gages as listed in Table No. 5-1, Table Section. The platforms store stage and precipitation data and, every four hours, transmit to the LRD computer downlink via the GOES satellite. The Water Resources Engineering Branch Water Control System receives data automatically from the LRD water control system on an hourly basis.

Another type of DCP is now available that has the capability of reporting in response to a telephone query from a computer or terminal. The query can be initiated any time from the Water Control System, project office or the home of a selected individual during off-duty hours. The voice synthesizer gives stage as "level" to 0.1 feet when dialed. These DCP's can also dump to a computer terminal giving several readings over a period of hours. These DCPs are being installed at critical locations such as inflow, lake and outflow stations, along with some control point stations.

(3) Reports. Currently, morning reports from the Beech Fork Lake project containing stage, precipitation, operational and temperature data, are received in the Water Control Section as computer printouts from the Water Control System. Stage data are converted to flow, and the values are used in the forecasting process. Frequency of reporting is dependent on the degree of urgency imposed by the weather and/or flooding conditions. The frequency ranges from daily (5 days per week) at about 0730 hours under Normal Condition to hourly under Major Flood Condition when the lake level approaches or threatens spillway elevation.

(4) Maintenance. Routine daily first level maintenance for all mechanical stream gaging equipment in the Twelvepole Creek Basin will be performed by the assigned project personnel. Advanced higher level maintenance, particularly for any electronic equipment malfunction, will be performed by a Corps trained technician. The

nearest advanced instrument technician station is:

U.S. Army, Corps Of Engineers
Resident Engineer
Robert C. Byrd Locks
P.O. Box 9
Apple Grove, West Virginia 25502
Attn: [REDACTED]
Water Quality Laboratory

Telephone [REDACTED]

b. Precipitation Stations.

(1) ORN Program. The Ohio River Reporting Network, a division-wide cooperative program with the National Weather Service, involves interchanges of information between the Weather Service and the Corps of Engineers that utilize the respective installations and experience of the two agencies. The Corps requests locations and the Weather Service recruits, trains, equips, pays the observers; and records all submitted data. The Weather Service also provides weather and stream stage data, Ohio River and tributary forecasts, regular and requested special forecasts, radar and other special reports on request. The Huntington District no longer reimburses NWS for direct costs on Corps behalf; the Huntington District provides NWS with all precipitation, snow cover, and stage information received in the Water Resources Engineering Branch from reservoir reports. Also included are three day pool and outflow forecasts, and depth reports from the Corps of Engineers Snow Cover Reconnaissance. The extent and intensity of the ORN program is shown by the fact that in addition to the project morning report data, all data received by NWS in West Virginia are from Corps financed satellite stations.

(2) Collecting and Reporting Facilities. Normal equipment is the 8-inch Standard Rain Gage (SRG) with a metal support. The station at Wayne has this type of gage. The data is accessed by the water control system as needed. At unattended stations, the "tipping bucket" measuring gage is interfaced to a DCP. The DCP receives the signal from the gage and transmits it to the computer downlink via the GOES satellite. Station locations are shown on the Hydrologic Network Map, Plate No. 5-1, and data collection protocols and communications equipment utilized at each are listed in Table No. 5-2, in Table Section, Precipitation Gage Data.

(3) Reports. The Beech Fork project personnel transmit these values along with other morning report data transmitted by micro-computers to Water Control Section Intranet servers. The LRD water control system accesses AFOS through NWS River Forecast Center in Wilmington and includes this data in the hourly disseminations to the District water control system. Use of the data from these reports and data exchanged with the NWS is as described below.

While primary dependence is on morning report information, Water Control Section personnel use Weather Service data, available between 0900 and 0930 hours, in forecasting and computing average

precipitation over the basin, area, and District. The data is used to fill in, by implication, for missing data and for confirmation or refutation of doubtful readings. Weather Service coverage of areas lacking Corps projects, when plotted on the District Isohyetal Map, provides basis for better understanding of storm movement and areal intensity, which contributes to improved water management decisions. Radar images on the NWS screen at Charleston, WV, and Wilmington, Ohio, provide valuable information for regulation and forecasting. The NWS Hydrologist analyzes for position, direction, speed and estimated precipitation amounts in storms and relays this analysis by telephone on request. Ohio River and tributary stage and forecasts provided by the NWS are used to answer telephone calls from the public and particularly from local bargaining concerns.

A large portion of the total precipitation information received by NWS comes through the cooperative ORN program. Complete District morning-report data accessed from the Water Resources Engineering Branch mini-computer (water control system) is reorganized by NWS personnel into downstream format and inserted into the NWS Eastern data bank. The data is widely used by NWS elements such as those producing short, medium and long range forecasts, infiltration indices and the River Forecast Center in Wilmington, which produces Ohio River and tributary stage and flow forecasts. The Charleston office utilizes the data early in the mid-morning weather report including any updating forecast that may be indicated.

Data from the unattended, tipping-bucket precipitation stations, which are served by DCPs, are collected and processed in the Water Control System along with stage data from the DCP reported stream gages. The primary mode of receiving data is from the DCPs mentioned above. Morning reports from Beech Fork Lake project personnel is via computer terminal over telephone lines directly into the water control system. Radio is the primary mode of emergency backup communication between the District Office and projects. Standard procedures require radios to be turned on at all times during working hours. During military emergency or national disaster, the Emergency Operations Manager may assign protected commercial telephone lines or special radio frequencies to Big Sandy River projects. The radio backup is via the Communication Section operator typist in the District Office.

The DCP-satellite system described above currently provides complete backup, through redundancy, of lake and outflow stage data collection and reporting. Precipitation data are similarly duplicated at the Beech Fork Lake Project.

(4) Maintenance. Routine daily first level maintenance for all mechanical stream gaging equipment in the Twelvepole Creek Basin will be performed by the assigned project personnel. Advanced higher level maintenance, particularly for any electronic equipment malfunction, will be performed by a Corps trained technician. The nearest advanced instrument technician station is:

U.S. Army, Corps of Engineers
Resident Engineer
Robert C. Byrd Locks
P.O. Box 9

Apple Grove, West Virginia 25502

Attn: [REDACTED]
Water Quality Laboratory

Telephone [REDACTED]

5-03 WATER QUALITY STATIONS

a. Facilities. A network of twenty-seven water quality sampling stations was established at Beech Fork Lake. Primary stations located on the lake are shown in Plate No. 5-7. All primary stations within the basin are described in Table No. 5-3, below.

TABLE NO. 5-3
Description by Location of Beech Fork Lake
Primary Water Quality Sampling Stations

Station	Distance From the Dam		
BBF0101	0.2	Miles	Below
BBF0102	0.1	Miles	Above
BBF0103	1.8	Miles	Above
BBF0105	2.1	Miles	Above
BBF0106	2.8	Miles	Above
BBF0107	9.8	Miles	Above
BBF0108	7.7	Miles	Above
BBF0109	7.1	Miles	Above
BBF0110	5.3	Miles	Above
BBF0111	4.2	Miles	Above
BBF0112	1.4	Miles	Below
BBF0113	3.0	Miles	Below
BBF0115	3.5	Miles	Above
BBF0116	4.3	Miles	Above
BBF0117	5.0	Miles	Above
BBF0118	5.8	Miles	Above
BBF0119	7.1	Miles	Above
BBF0122	0.7	Miles	Above
BBF0125	0.9	Miles	Above

b. Reporting. Water quality data collected at Beech Fork Lake is used to meet such objectives as:

(1) Establish baseline conditions and monitor subsequent changes;

(2) Identify water quality environmental problems;

(3) Study special problems or develop criteria for such solutions as modification of reservoir regulation procedures aimed at controlling or enhancing environmental conditions and meeting water quality objectives; and

(4) Provide a database adequate for understanding project conditions and for coordination with state agencies in regard to implementing any needed watershed pollution control.

Parameters to be measured, frequency of collection, and number of data

collection stations at any one time are determined by specific project conditions. The water quality program design for Beech Fork Lake was structured to describe the various factors affecting water quality over the long term. Data collected are used for applications such as identification of trends indicating problem conditions and reporting existing conditions. Basic studies consist of 5 essential components:

TABLE NO. 5-4

Standard Physical/Chemical Tests

<u>Type of Test</u>	<u>Reason for Testing</u>
Calcium (Ca)	Major Cations - Ionic Balance, ratios and relationships
Magnesium (Mg)	
Sodium (Na)	
Potassium (K)	
Sulfate (SO ₄)	Major Anions - Ionic Balance, ratios and relationships
Chloride (Cl)	
Nitrogen (N)	Nutrient
Nitrate + Nitrite	
Ammonia	
Total Kjeldahl	
Total Organic Carbon (TOC)	Nutrient
Phosphorous (P)	Nutrient
Total Filterable	
Solids	Equivalent Ambient Values, Correlation with optical measurements
Total	
Suspended	
Dissolved	
Hardness	Evaluate buffer capacity and characteristics
Alkalinity	
Metals	Important for hypolimnetic and outflow evaluations during stratification
Iron (Fe)	
Manganese (Mn)	
Dissolved Oxygen	<u>insitu</u> parameters used to evaluate conditions for project operation
Temperature	
pH	
Specific Conductance	

(1) In-situ measurements to evaluate distribution of various properties

(2) Wet chemistry and various types of solids for both immediate and long-term use

(3) Indirect but rapidly obtainable indicators of productivity such as chlorophyll and carbon

(4) Benthic organisms to monitor long-term quality of streams

(5) Other biological measurements such as plankton and seston

Standard physical/chemical tests and reasons for testing are presented in Table No. 5-4, below.

c. Maintenance. Sediment and water samples are collected from Beech Fork Lake once every 5 years. Water samples are also collected every 10 years each month for the months April through September. During emergency or under adverse conditions, water quality samples are collected on an as-needed basis. In all cases data are collected for one or more of the following reasons:

- (1) long term analysis
- (2) problem identification or solution
- (3) cause and effect relationships
- (4) mathematical modeling
- (5) predictive capability

Present sampling programs are oriented toward existing or potential effects and are structured to describe various factors that affect water quality.

5-04 SEDIMENT STATIONS

a. General. In order to monitor and assist in carrying out the authorized purposes of flood control, recreation, and fish and wildlife conservation at Beech Fork Lake, a sediment monitoring program has been established at Beech Fork Lake.

The program designed for Beech Fork Lake has been structured to measure and describe, either separately or in combination, the various factors affecting sedimentation. Results are used for project regulation activities, and to safeguard the integrity of project purposes. The program is described as follows.

b. Lake.

(1) Facilities. Sediment range monuments for 19 sediment ranges were established at Beech Fork Lake as part of an aerial photography, ground control, and mapping contract during the summer of 1965. The sediment ranges established above Beech Fork Lake were designated category "A" ranges and they were marked with monuments referenced to the existing triangulation control system or to permanent land marks. The ground profile of each range was measured at that time and several years later the sediment range was adopted by the Chief of Engineers. During the design phase of the project the damsite was moved about 0.4 mile upstream, and during the construction

period sediment ranges 1 and 2 were buried with concrete. Near the completion time of the dam the two buried ranges were reestablished just upstream of the dam and below range 3-A, and two more ranges, 20-A and 21-A, were established in the Price Creek area to provide better monitoring of the sediment. The 21 lake or category "A" ranges are shown in Plate No. 5-8.

The current sediment range network now consists of 24 ranges; 21-"A" ranges upstream of the dam and 3-"C" ranges downstream of the dam. The three downstream ranges below the dam were numbered C-1, C-2, and C-3.

(2) Reporting. In order to monitor the rate of deposition of sediment in the lake, reconnaissance scope survey of selected ranges are conducted every five years unless an earlier survey is indicated by natural causes, such as a major flood or by increased sediment producing activities in the basin. The original ground profiles along the original network of 19 sediment ranges at Beech Fork Lake were taken during the summer of 1965. The first step for reporting and monitoring the sediment network was the certification and adoption of the sediment range network. This report was published in 1978. The sediment network was revised and extended with two additional ranges on Price Creek during completion of the dam.

The winter pool was reached for the first time on 1 February 1978 and full regulation began. The first re-survey of 16 sediment ranges located within the seasonal pool at Beech Fork Lake was conducted in October 1982. Partial lake bottom profiles were obtained upstream of the dam, lake by using a fathometer. The fathometer data consisted of a series of lake bottom elevations for which stationing along the sediment range was not determined, however, the minimum elevation at each sediment range was recorded. At the remaining three sediment ranges the minimum elevation was determined by stadia methods. Comparison of data from the 1982 sedimentation reconnaissance survey indicated that the sedimentation rate at Beech Fork Lake was not excessive. Plate No. 5-9 is a sedimentation profile of Beech Fork Lake.

A selected range sedimentation survey was conducted at Beech Fork Lake with the mean date of survey being 23 September 1987. Re-surveyed profiles were obtained at 13 sediment ranges in the seasonal pool area and at 3 sediment ranges downstream of the dam. One of the downstream ranges, C-3, could not be located in the field, therefore, a new C-3 range was established at approximately the same location. Monuments were set near the top bank on both sides of the stream and a profile was established. State plane coordinates were not obtained for the monuments and elevations for the range monuments at A-1 were determined. Sediment range monument data are shown as Table No. 5-5, this page. Profiles of the minimum elevation for the upstream ranges are shown on Plate No. 5-9.

The volume of sediment at Beech Fork Lake calculated to be deposited in the seasonal pool below elevation 592 feet NGVD, at the time of the 1987 sedimentation survey was computed to be about 201 acre-feet. An increase in lake capacity was considered as negative sediment. The annual rate of sedimentation at Beech Fork Lake was computed to be 0.27 acre-feet per square mile of contributing drainage area during

the 9.73 years between the date storage began and the mean date of re-survey in September 1987. This rate of sedimentation is not considered excessive.

TABLE NO. 5-5
DESCRIPTION AND LOCATION OF
BEECH FORK LAKE
SEDIMENT RANGE MONITORING STATIONS

	Range	Beech Fork Mile Point	Distance Above or Below Dam		
	DAM	0.0			
1.	I BBF 1-A	3.87	0.17	Miles	Above
2.	1 BBF 2-A	3.986	0.286	Miles	Above
3.	1 BBF 3-A	4.557	0.757	Miles	Above
4.	1 BBF 4-A	5.314	1.614	Miles	Above
5.	1 BBF 5-A	6.555	2.855	Miles	Above
6.	1 BBF 6-A	7.053	3.353	Miles	Above
13.	1 PCR 13-A	7.443 Price Cr	3.844	Miles	Above
20.	1 PCR 20-A	-	4.361	Miles	Above
21.	1 PCR 21-A	-	4.294	Miles	Price C
7.	1 BBF 7-A	8.604	4.904	Miles	Above
8.	1 BBF 8-A	10.30	6.60	Miles	Above
12.	1 CCR 12-A	11.059 Camp Cr	11.453	Miles	Camp Br
9.	1 BBF 9-A	11.149	7.449	Miles	Above
10.	I BBF 10-A	12.39	8.69	Miles	Above
11.	I BBF 11-A	14.463	10.763	Miles	Above
14.	1 MFBF14-A	3.927 Miller Fk	0.361	Miles	Above
15.	1 MFBF15-A	-	1.137	Miles	Above
16.	1 MFBF16-A	-	1.754	Miles	Above
17.	1 MFBF17-A	-	2.826	Miles	Above
18.	1 MFBF18-A	-	3.963	Miles	Above
19.	1 MFBF19-A	-	5.107	Miles	Above
22.	1 BBF 1-C	2.94	0.765	Miles	Below
23.	1 BBF 2-C	1.44	2.258	Miles	Below
24.	1 BBF 3-C	0.60	3.101	Miles	Below

If the annual rate of sedimentation at Beech Fork lake were to continue at the rate of 0.27 acre-feet per square miles of contributing drainage area, and all the sediment were deposited in the minimum pool, the minimum pool would still have a life expectancy in excess of the 100-year economic life of the project.

The re-survey of two sediment ranges downstream of the dam indicated no significant change in the channel in this area. One downstream range could not be located and a new range was established and a new profile recorded. The original stream bottom profile for Beech Fork Lake and the upstream tributaries is shown on Plate No.5-9.

(3) Maintenance. Project personnel and the survey party members should regularly and periodically check the sediment range markers so the damaged monuments can be replaced and any obscuring undergrowth can be removed.

c. Downstream.

(1) Facilities. After a multipurpose dam has been constructed and placed in operation, flow characteristics downstream are different from the natural, and the discharge carries generally less silt than did the natural stream. These factors together can cause unpredictable channel changes due to both degradation and aggradation, and the changes can cause anxiety in downstream property owners where they occur. In order to monitor any such changes that may occur, the Corps normally installs and surveys sediment ranges along the stream below the dam and designates them category "C" ranges. Three additional sediment ranges were established as category "C" ranges; however, one of the ranges could not be located and had to be reestablished. The sediment range network now consists of 24 ranges as shown on Plate No. 5-8.

(2) Reporting. In order to determine the character and extent of any channel changes below the dam, monitoring of the downstream ranges is carried out by field survey methods on a selective basis at the time of a sedimentation reconnaissance or during a detailed survey. A detailed survey may be performed when recommended by a reconnaissance scope effort or in the event of the lodging of a complaint about a channel change.

(3) Maintenance. As with the lake sediment ranges, periodic maintenance of downstream sediment range markers, by the project personnel and by the survey party at the time of the lake sediment survey should take place.

5-05 COMMUNICATION NETWORK

Communication between Beech Fork Lake, the Big Sandy Area Office, the District Office, etc., is carried primarily by telephone (FTS). District radio network provides a backup when telephone service is interrupted. Data collection platforms (DCPs) are installed at stream gaging stations and precipitation stations for collection of hydrometeorological data. Many of the DCPs can be accessed by phone and data retrieved by the water control system, the portable terminal at the project office or by listening to the synthesized voice. Plate No. 5-10 graphically illustrates the communication network throughout the Twelvepole Creek Basin.

5-06 COMMUNICATION WITH PROJECTS

Telephone is the primary mode for most communication between the Water Control Section and the multipurpose projects and area offices and between projects and respective area offices. Lines of communication for the Twelvepole Creek Basin are illustrated on Plate No. 5-11. District Radio is used for secondary backup communication, while mobile radio, State Police, courier, etc. is utilized during an emergency when neither the telephone or district radio is operational. Inter-project communication is mostly by radio with some telephone for

privacy. Water Control Section personnel use the telephone to request and receive additional operations information and weather information and to give operational guidance and directives. The U.S. Postal Service is utilized for letter reports from projects to the Water Resources Engineering Branch, other voluminous or detailed information, pictorial material, confirmation of Special Directives, and any other formal communication between the Water Resources Engineering Branch and the projects. Occasional visits to the projects afford an opportunity for office and project personnel to discuss ideas, problems, new procedures, etc.

5-07 COMMUNICATIONS WITH OTHERS

a. District Staff. Major flood conditions may require daily or more frequent briefings for key staff members. During floods or other disasters when the Emergency Operations Center is in operation, Water Control Section personnel distribute copies of all reports received for critical and adjoining areas to the Center, District Engineer, Chief Engineer and Executive Officer. Storm analysis and critical situations and operational information are provided to pertinent key staff as determined to be informational or necessary. The Public Affairs Office is kept advised to ensure proper public notification.

b. Emergency Management Division. The Water Resources Engineering Branch, has no regular communication with Emergency Management Division except as mentioned above when the Emergency Operations Center is in operation. When storms occur in the district or high precipitation is shown on a NWS Quantitative Precipitation Forecast, Water Resources Engineering Branch telephones to pass on the information. Frequently EMD personnel will visit the Water Control Section in person for further briefing. When EMD personnel learn of approaching storms in or near the Huntington District, they visit Water Resources Engineering Branch for evaluation and determination of impact. During these meetings, all involved participants view Quantitative Precipitation Forecasts, NWS forecasts, District isohyetal (precipitation) Maps, morning reports, and all current information, etc.

c. Great Lakes and Ohio River Division Water Management Branch. All normal communications between the Water Resources Engineering Branch and the Water Control Center are carried by telephone lines and the U.S. mails. Radio is used as backup in emergency situations. Telephone conversation communicates most items of short information and discussion while voluminous reports, confirmations, plans, blueprints and other pictorial material are sent by mail. A weekly report of reservoir holdouts, flood data and the Monthly Report are included in the "report" material mentioned above. When desired, pictorial, handwritten or printed material can be transmitted in a matter of minutes over telephone lines by facsimile machine.

Personnel of the District Water Control Section insert stage and flow information on weekdays into a computer file for accessing by Water Control personnel. The first group of information so transferred is from ORH Form 2347A, the reservoir morning report, and consists of pool elevations and outflow for each reservoir. The second group of

information, from ORD Form 85, consists of morning stage, 24-hour rainfall, and flow at District gages on the Ohio River and lowermost gages on main tributaries, and forecast flows in the tributaries for the next five days. The third and last item thus transmitted, LRH Form 2347B, is a 3-day forecast of pool elevations and discharges for the reservoirs. All other communication with the RCC, other than mail correspondence, is by telephone. Water Resources Engineering Branch briefs WCC personnel who call three times weekly, normally Monday, Wednesday, and Friday, for an update on any and all special operations in the district. A Report of Deviation, revised operation at Beech Fork Lake outside the approved plan of regulation. A copy of a Report of Deviation is included as Plate No. 5-12.

d. Operations Division Area Office. Administration of the Beech Fork Lake project is placed under the Big Sandy area office at Louisa, Kentucky. Normal communication between Water Resources Engineering Branch and the Area Office is by telephone, mail transfer of disposition forms, reports, maps, drawings and other pictorial material, and occasional visits by Water Resources Engineering Branch personnel. Emergency communication is by radio.

e. National Weather Service. Communication with National Weather Service (NWS) begins with cooperative arrangements for the ORN program discussed earlier in 5-02 b(1). Communication from such ORN observers is by telephone.

The Water Resources Engineering Branch intends to implement a direct link between the District Water Control System and the NWS Automated Field Operating System (AFOS) after AFOS becomes fully operational. The system will speed and improve data handling within NWS by reducing the amount of manual repetition and transcription with its attendant possible errors. AFOS and the link with the District Water Control System should improve the quality of data for NWS and speed its acquisition by Water Resources Branch for use in regulation decisions.

f. U.S. Geological Survey. Communication between Water Resources Branch and U.S. Geological Survey (USGS) is varied and affected by the meshing of interests of the two entities. A large portion of the communication surrounds the stream cooperative program discussed in 6-02a(1) involving telephone discussion and mailed information on gage location, ratings, and rating extensions. Telephone requests are made by Water Resources Engineering Branch for the USGS to repair a gage critical to regulation of a reservoir in flood condition. Occasional meetings between USGS personnel and Water Resources Engineering Branch personnel are held as needed at convenient times and locations to discuss the program.

The USGS keeps the flow record for the continental United States. The USGS conducts studies of sediment carried by streams. These study results are available electronically to the Water Control System by accessing the USGS data bank or by mail in answer to spoken or written request. The USGS compiles drainage areas and lengths of streams in a basin and binds them into paperback volumes.

g. State and Local Agencies. The Water Resources Engineering Branch coordinates with the West Virginia Department of Natural

Resources about regulation for authorized purposes including timing of spring filling and fall drawdown. Other concerns include fish and wildlife enhancement, recreation activities, and probable height of a rise. During an emergency, the West Virginia Department of Natural Resources representative in the West Virginia Office of Emergency Services is contacted.

Huntington District Water Quality Section personnel meet with Department fisheries personnel in the winter to seek their input and comments on the proposed District water sampling and testing program for the coming season. In certain instances, Water Resources Branch or the Department confirms telephone conversations or transmits information and data by mail.

The Huntington District Water Quality Section maintains contact, during the period of lake stratification, with the West Virginia Department of Natural Resources by mailing to the assigned contact point copies of the weekly water quality profile for Beech Fork Lake. If a potentially or currently serious situation develops, the Water Quality Section chief telephones the Department Fisheries Biologist assigned to Beech Fork Lake to advise and discuss the situation. If necessary, the Water Quality Section may begin a special study to determine the cause and/or remedy. Any time an unusual water quality situation occurs, an investigation is made into causes and ramifications to the extent warranted by the situation and the availability of manpower.

Beech Fork Lake personnel coordinate in person and by telephone with Department personnel concerning the forest fire protection agreement with the Forestry Division, stocking of the lake and tailwaters, enforcement of fish and game licensing, and boating safety. The State Highway Department coordinates details of road maintenance with the project office by telephone and in person. The West Virginia State park ranger staff provides law enforcement at Beech Fork Lake area.

County offices with which project personnel communicate are the Sheriff's and Health Departments, the first in conjunction with assistance with the state ranger staff, and the second concerning periodic inspections of the Marina in compliance with provisions of the Corps of Engineers lease.

h. General Public and Commercial Interests. The Water Resources Engineering Branch receives telephone calls from the general public about Beech Fork Lake; some concern timing of filling in spring or drawdown in fall, and others concern fishing information.

The project offices answer many calls on such subjects as water surface area, maximum and average depth, extent of drawdown, and shoreline length of the lake, temperature of the lake and outflow, water clarity, and fishing success. Others concern locations of picnic and other recreational areas, and downstream flooding potential. An information tape updated by project personnel answers a published telephone number at Beech Fork Lake. The tape gives such data as lake and outflow levels and temperatures, water clarity and

sometimes fishing success.

Neither the project nor Water Resources Engineering Branch receives any calls from commercial interests except that the project does advise the Marina operator of probable height of a rise and timing of pool filling and drawdown.

There are no interests downstream from the dam that are vulnerable to flooding at discharge rates up to the channel capacity. However, in order to advise recreators below the dam of impending increases in outflow, a discharge warning horn is sounded at the outlet works whenever the total gate opening is to be increased. Water Level Warnings at Project Lake Areas, Table No. 5-6 Table Section, lists communication by project personnel concerning actual or potential high water situations and filling and drawdown operations.

SECTION VI - HYDROLOGIC FORECASTS

6-01 GENERAL

Hydrologic forecasts of lake elevations and stream flows in Beech Fork of the Twelvepole Creek Basin are vitally important for Water Control Management as these forecasts provide information which enable the optimal regulation of the projects. These forecasts are conducted under low-flow, normal flow, and flood conditions and are primarily developed by the Corps of Engineers and the National Weather Service on a daily basis.

a. Corps of Engineers.

(1) District Office. In accordance with ORDR 1110-2-27, dated 12 January 1976, Subject: Water Control Management Activities, the Water Control Section performs water control management activities for multi-purpose projects throughout the Huntington District. These activities include the preparation of forecasts for lake inflows, lake levels, project outflows, water quality, outflow temperature, and flows at downstream stations to ensure the safe and efficient operation of the district projects. River forecasts prepared by the Corps of Engineers are generally used for its own responsibilities and are not normally issued to the general public unless the National Weather Service is willing to make the release or agrees to such a release.

(2) Division Office. The Water Management Division at the Great Lakes and Ohio River Division Office utilizes the 5-day tributary forecasts prepared by the individual districts to derive its own 5-day flow forecasts for stations along the Ohio River.

b. National Weather Service. The National Weather Service (NWS) has the official responsibility for preparing forecasts of Ohio River stages and flows, and for transmitting data, forecasts, watches, and warnings to users and the general public. NWS also collects and evaluates weather data from a variety of sources to prepare short and long-term weather forecasts.

6-02 FLOOD CONDITION FORECAST

a. Requirements. Whenever "flood threat" conditions approach, as defined by the Schedule for Reading Gages in the Instruction to Dam Tender, forecasting effort primarily focuses on area rainfall, downstream flood control points, and the lake elevation. The basin forecast is computed using one hour data and it normally takes one hour to complete the forecast of the Twelvepole Creek Basin. The model is executed repeatedly during the flood event as additional data becomes available. The forecast data is used to predict the anticipated pool crest, downstream flood crests, necessary storage releases, and probable duration of flood period.

b. Methods. In order to achieve the most efficient water control management possible, a Corps Water Management System CWMS model, developed for Water Resources Engineering Branch by the Model Mapping and Consequence Center (MMC), was adapted and calibrated for use in water management of the Twelvepole Creek Basin. The basin computer model is the major part of the District water control system, uses real time data from the Corps of Engineers' satellite-platform network in and adjacent to the basin. The modeling process includes reviewing and editing of all data, estimation of future flows, development and review of multiple lake outflow plans, and determining the optimal method of operation to decrease downstream flooding while still insuring the projects viability.

A typical modeling sequence of events leading to water control management decisions is described as follows:

1. Satellite data, both stage and precipitation, are received from the LRD downlink, decoded and added to the resident data base. This is done automatically each hour.

2. Observed precipitation and flow data are reviewed graphically to insure integrity. Any necessary corrections are made and any missing data are added when available from supplementary sources.

3. The precipitation-runoff model is executed based on observed data up to the time of forecast. If precipitation is occurring at the time of forecast then future precipitation is considered in the model execution at the request of Division.

4. The small basin hydrograph forecast is then reviewed and modified if necessary. The second part of the model is then executed to route, blend and combine flows. The flows are reviewed, the lake outflows modified if necessary, and the second part of the model is recomputed.

5. Step 3 is repeated to obtain subsequent forecasts that consider any additional precipitation (QPF), special regulation or other hypothetical analyses that may be required.

The CWMS modeling program makes extensive use of small-area unit hydrographs, infiltration rates, discharge rating tables, routing coefficients, and graphical review of flood hydrographs and profiles. The computer program assimilates the total precipitation over a 3-day time period and analyzes the storm in detail. By using predetermined basin rainfall infiltration rates and runoff percentages the program computes the antecedent rainfall, base flow, and storm runoff.

By applying the computed storm runoff to the appropriate unit-hydrographs a computed hydrograph is developed. The computer then uses routing coefficients with routing and combining methods to route the flood downstream and through Beech Fork Lake. With this computer program and practical experience the Water Control Section is able to produce a reliable forecast for the Twelvepole Creek Basin.

The small area 3-hour adopted unit-hydrographs for the various Beech Fork - Twelvepole Creek forecast areas are shown on Table No. 6-1; and the Discharge Rating Tables for the key points in the Twelvepole Creek Basin are shown on Plate Nos. 5-2 and 5-3.

TABLE NO. 6-1

ADOPTED THREE-HOUR UNIT-HDROGRAPHS FOR
PRINCIPAL POINTS IN BEECH FORK LAKE

Time Hours 3-hours	Natural Unit Graph 79.0	Inflow Unit Graph 79.0	1-A Pool Head 60.0	#2 Around Pool 16.0	#3 Pool Area 3.0
0	0	0	0	0	0
3	155	660	590	150	340
6	805	2400	1270	400	340
9	1540	3200	2170	500	
12	2235	3300	2480	560	
15	2685	3000	1890	595	
18	2640	2300	1175	610	
21	2095	1550	710	600	
24	1540	1050	445	560	
27	1150	750	290	510	
30	760	550	180	430	
33	580	400	110	340	
36	400	375	65	255	
39	305	220	45	175	
42	210	150	25	120	
45	155	100	15	85	
48	100	55	10	60	
51	75	35	5	40	
54	50	20		30	
57	35	10		10	
60	25	5			
63	15				
66	5				

Stream and lake forecasting is accomplished with data stored and processed through the Ohio River Reporting Network. This network is a division-wide cooperative program with the National Weather Service, which involves interchanges of information between the Weather Service and the Corps of Engineers that utilize the respective installations and experience of the two agencies. All weather stations in the Twelvepole Creek Basin are automated DCP stations. The Weather Service also provides weather and stream stage data, Ohio River and tributary forecasts, regular and requested special forecasts, radar and other special reports on request.

In addition to reimbursing NWS for direct costs on Corps behalf, the Huntington District provides NWS with all precipitation, snow cover, and stage information received in the Water Resources Engineering Branch from reservoir reports. Also included are three day pool and outflow

forecasts, and depth reports from the Twelvepole Creek Basin projects areas. The extent and intensity of the ORN program is shown by the fact that in addition to the project morning report data, all data received by NWS in the Twelvepole Creek Basin are from Corps financed satellite stations.

The data collection platforms mentioned above store stage and precipitation data and, every four hours, transmit to the LRD computer downlink via the GOES satellite. The Water Resources Engineering Branch Water Control System receives data automatically from the LRD water control system on an hourly basis. All the data entered into the Water Control System is stored in a data base and used by water control software programs, allowing more timely and efficient water management decisions and generation of required reports.

While primary dependence is on morning report information, Water Control Section personnel use Weather Service data, available between 0900 and 0930 hours, in forecasting and computing average precipitation over the basin, area, and District. The data is used to fill in, by implication, for missing data and for confirmation or refutation of doubtful readings. Weather Service coverage of areas lacking Corps projects, when plotted on the District Isohyetal Map, provides basis for better understanding of storm movement and areal intensity, which contributes to improved water management decisions. Radar images on the NWS screen at Charleston and Wilmington provide valuable information for regulation and forecasting. The NWS Hydrologist analyzes for position, direction, speed and estimated precipitation amounts in storms and relays this analysis by telephone on request. Ohio River and tributary stage and forecasts provided by the NWS are used to answer telephone calls from the public and particularly from local barging concerns. Data from NWS is received by the water control system via network connection. Project data is also disseminated back to NWS by the water control system.

6-03 CONSERVATION PURPOSE FORECASTS.

a. Requirements. Conservation forecasts are executed in conjunction with the flood control forecast. They are executed on a daily basis for the next five days and on a weekly basis for the next 30 days. The main focus of the conservation forecast is to maintain seasonal pool at Beech Fork Lake in order to provide fish and wildlife habitat, recreation, and water supply. At the present time, operations for water temperature and quality are based on observations rather than forecast.

b. Methods. The methods and procedures for non-flood streamflow projection are the same as mentioned previously for the flood forecasting except the concern of the modeler is the low-flow analysis. The repetitive process is utilized to operate the reservoir in order to provide downstream low-flow requirements and then to evaluate their impact on the lake pool.

6-04 LONG RANGE FORECASTING.

a. Requirements. Long range forecasts assist the Huntington District and the Great Lakes and Ohio River Division in water control management in the Twelvepole Creek Basin. Long range forecast of a dry spring can allow earlier than normal filling during late winter or early spring to reach summer conservation pool levels in time for the beginning of the recreational season. If a drought is projected, conservation pool may be raised to store additional water for later release downstream. Long-range forecasts are required by the Division Headquarters Water Management Branch (WMB) as they utilize them to inform the Mississippi Valley Division (MVD) of probable future conditions and to suggest specific items of water control management to the districts.

b. Methods. The Water Control Section produces a weekly 30-day forecast utilizing the same method as used for flood forecast. This forecast assumes no future rain. Lower than normal precipitation forecasts are produced by the National Weather Service.

6-05 DROUGHT FORECASTS.

a. Requirements. The Huntington District now uses the drought forecast of the National Weather Service. The Corps summer drought forecast was discontinued in lieu of the regular NWS forecast.

b. Methods. The long range and conservation forecast address all forecasting concerns that would be raised by a drought. No extra forecast activities are planned for this time.

c. Reference Documents. Many of the basic documents for drought forecast are in Water Resources Engineering Branch files for the Huntington District, Huntington, WV. These files contain records prepared by the West Virginia Department of Natural Resources and the West Virginia USGS for past drought periods, Water Availability Studies for the Twelvepole Creek Basin, and the Ohio River Basin Comprehensive Study, prepared by the Great Lakes and Ohio River Division, Cincinnati, Ohio. The national and state weekly drought forecasts are included with the Palmer Index summaries for the current and preceding drought periods. During a drought period the low-flow records and reference books are used to prepare a weekly drought information bulletin for distribution to all concerned groups.

6-06 NORMAL CONDITION FORECASTS

a. Requirements. Normal conditions, as defined by the Schedule for Reading Gages, Exhibit B, cover all hydrologic conditions from drought to the beginning of high water conditions labeled "Flood Threat". The various conditions are based on the quantity of water a project is required to handle in comparison with design quantities. Other forecasts that are used for management of the Twelvepole Creek Basin projects include water quality and outflow temperature. The Water Control Center

in the Great Lakes and Ohio River Division Office requires daily 3-day pool-and-outflow forecasts and a 5-day forecast of tributary inflows to the Ohio River in order to implement its 5-day forecast of flow in the Ohio River and into the Mississippi River.

b. Methods. The forecast procedures described in paragraph 6-04 are used to produce forecasts for normal ranges of flows. A basin forecaster, assigned to the Twelvepole Creek Basin, utilizes the Water Control System computer model each day and couples the results from the model with knowledge and experience with the basin to produce the required daily forecasts. The computerized forecast is then made available for distribution to interested parties and groups.

(1) Low-Flows - The procedures outlined in 6-04 are used in low-flow conditions. If forecasts indicate a continued low-flow condition leading to a drawdown of the lake level below seasonal pool, the Damtender is appraised of the condition. Marina operators and other affected parties are in turn notified of the changing situation by the Damtender.

(2) Water Quality - Routine water quality sampling has shown that concentrations of manganese and iron are present in the lower portions of Beech Fork Lake. These constituents are not harmful, but when released downstream under summer stratification conditions they can cause taste and odor problems. The results of chemical tests on water samples are not returned soon enough for emulation purposes; however, the concentration of manganese and iron are known to increase with the depletion of oxygen in the lower lake portions during stratification. Therefore, the weekly dissolved oxygen profiles taken during the summer months are used as a forecast of weekly conditions within the pool and as an indicator of when releases should be confined to the upper level selective withdrawal outlets.

(3) Temperature-During stratification periods, daily outflow temperatures are monitored and the selective withdrawal gates are adjusted in an effort to maintain water release temperatures within $\pm 2^{\circ}\text{F}$ of the natural stream temperature. Weekly temperature profiles are used as an indicator of weekly temperature conditions in the lake. If the trend of the outflow temperature appears to soon exceed allowable criteria, gate adjustments are made to offset the trend and remain within allowable temperature limits.

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TABLE NO. 6-4

ADOPTED THREE-HOUR UNIT-HDROGRAPHS FOR
PRINCIPAL POINTS IN BEECH FORK LAKE

Time Hours 3-hours	Natural Unit Graph 79.0	Inflow Unit Graph 79.0	1-A Pool Head 60.0	#2 Around Pool 16.0	#3 Pool Area 3.0
0	0	0	0	0	0
3	155	660	590	150	340
6	805	2400	1270	400	340
9	1540	3200	2170	500	
12	2235	3300	2480	560	
15	2685	3000	1890	595	
18	2640	2300	1175	610	
21	2095	1550	710	600	
24	1540	1050	445	560	
27	1150	750	290	510	
30	760	550	180	430	
33	580	400	110	340	
36	400	375	65	255	
39	305	220	45	175	
42	210	150	25	120	
45	155	100	15	85	
48	100	55	10	60	
51	75	35	5	40	
54	50	20		30	
57	35	10		10	
60	25	5			
63	15				
66	5				

SECTION VII - WATER CONTROL PLAN

7-01 GENERAL OBJECTIVES.

In accordance with ER 1110-2-240 and ORDR 1110-2-27, the plan of water control management and regulation as discussed in the subsequent paragraphs reflects optimal consideration of each project purpose, namely flood control, lake and downstream recreation, and fish and wildlife conservation. In developing the plan of regulation, the following general requirements were considered and evaluated in relation to the most effective water control management plan for the project, the Twelvepole Creek Basin and the Ohio River Basin. The water control plan utilizes the Area Capacity, Percent Storage, and Outflow "O" gage rating tables shown on Plate Nos. 7-1, 7-2, and 7-3, respectively. Plate Nos. 7-4, 7-5, and 7-6 are the Spillway Release, Slide Gate, and Low-Flow system curves for water control management.

a. Prevention or reduction of serious flood damages to communities, crops, and properties below the dam along Beech Fork and Twelvepole Creek to the greatest extent consistent with safe operation of the project.

b. Maximum retention of flows that would add to flood crests on the Ohio River at Ashland, Kentucky.

c. Maintenance of a minimum discharge of 5 cfs which is designed to be adequate to sustain downstream aquatic environment.

d. Maintenance of a minimum pool at or near elevation 583.5 feet NGVD to support fish populations, to provide minimum outflow as required, and for sediment reserve.

e. Maintenance of seasonal pool elevation 592.0 feet NGVD for recreation and fish and wildlife conservation subject to flood control, water quality control, and minimum discharge purposes. The year-round overall pool storage and release schedule is shown on Plate No. 7-7, Beech Fork Rule Curve for Regulation.

f. Establishment of a maximum allowable discharge to avoid downstream damage during flood releases.

g. During minor rises when releases are less than downstream channel capacity, limitation of release rates to the maximum flow that would have occurred if the project had not been constructed.

h. Controlling discharge temperature to add downstream aquatic communities in maintaining normal states of equilibrium.

i. Sensitivity to reasonable requests for operational changes from other agencies.

j. Concern for safety and well being of humans, fish and wildlife, man-made structures and stream banks downstream in discharge controls. Concern for safety of humans and property at recreation sites in the lake area.

k. Limitation of the rate of change of stage at the outflow gage station to a value no greater than that, which would occur naturally.

7-02 MAJOR CONSTRAINTS

Operation of Beech Fork Lake must be within the confines or constraints of the Beech Fork Lake water control plan. The various project purposes may at times strongly conflict; therefore priorities must be established and followed. Flood control is the primary project purpose, but this function can be inhibited by restrictions on the hourly rate of gate change, the lack of storage volume because of the construction in the lake area, or the inability to discharge storage as quickly as planned because of floodplain encroachment or downstream construction. Activation of the summer recreation function and maintaining the recreation pool can be inhibited by restrictions on inflow due to lack of upstream rainfall or high priority water supply releases.

Operational limitations for flood control, recreation, water supply, low-flow and water quality, and fish and wildlife conservation are listed on **Table 7-1** below.

Table 7-1							
BEECH FORK LAKE ELEVATIONS AND STORAGES							
	Surface		Backwater	Storage			
	Elevation	Area	Main Stream	Acre-ft		Inches runoff	
Pool	FT (NGVD 1929)	Acres	Miles	Net	Gross	Net	Gross
Streambed	557	0	0	0	0	0	0
Minimum/Winter	583.5	405	6.7	3,392	3,393	0.82	0.82
Summer	592	719	8.3	4,744	8,136	1.14	1.96
Flood Control Storage:							
Winter+	614.5	1,847	13.2	33,113	36,505	7.96	8.78
Summer#	614.5	1,847	13.2	31,761	36,505	7.64	8.78
Extreme Event Storage:							
Maximum Surcharge	635	2,946	-	-	85,479	-	20.55

Top of Dam	640	3,231	-	-	99,924	-	24.02
+ Between elevations 583.5 and 614.5 feet NGVD 29							
# Between elevations 592.0 and 614.5 feet NGVD 29							

7-03 OVERALL PLAN FOR WATER CONTROL

Beech Fork Lake is one of two authorized and operating flood control reservoirs in the basin, and regulation procedures are therefore very closely coordinated with the other basin project (East Lynn). Although it is possible to have a heavy thunderstorm over only one of the reservoirs, ordinarily both will be operated for all major storms. The purpose of this coordination is to maintain a roughly equivalent utilization of flood control storage capacity between the projects. In order to accomplish seasonal goals and missions of Beech Fork Lake several conflicting interests must be fully considered. Due consideration must also be given to local concerns and requirements.

Most of the conflicting interests and purposes were resolved by practical planning and allocation of the lake storage volume into pools as listed on **Table 7-1**, page 7-2 (see WCM). The total storage capacity of Beech Fork Lake is estimated to be 36,505 acre-feet. During the detailed project-planning phase, this storage was divided and allocated for various project purposes based on a maximum efficiency basis. Storage capacity allocation in the lake for minimum pool includes year-round equivalent storage volume for sediment accumulation, provision of minimum flow during an unusually dry winter, and satisfactory winter habitat for the large population of fish. The sedimentation pool was established at elevation 583.5 feet NGVD, containing 3,392 acre-feet of storage and covering 405 acres. Based on data from other reservoirs in the basins adjacent to Beech Fork Lake the sediment storage was estimated to be adequate to contain 148 years accumulation of sediment when the project was designed. The remainder of the allocated pool storage, or the difference between maximum flood control pool storage, elevation 614.5 feet NGVD 29, and the sediment pool storage, elevation 583.5 feet NGVD 29, is 33,113 acre-feet, equivalent to 8.0 inches of runoff from the drainage area above the dam. The detailed review of the storage allocation established the year round minimum pool at elevation 583.5 NGVD 29, the same as the sediment pool level, and the summer recreation pool elevation 592.0 NGVD 29 covering 720 acres and storing 4,744 acre-feet of water. The remaining storage to elevation 614.5 feet NGVD 29, storing 31,761 acre-feet was allocated for flood control.

7-04 STANDING INSTRUCTIONS TO THE DAMTENDER

The Beech Fork Damtender and staff operate the project in accordance with the general instructions and special directives issued by the Water Control Section.

7-3

a. General Instructions. The general instructions apply at all times except when instructed by special directives applicable for a

specific operation or period of time. General instructions provide for routine reservoir regulation including discharge limits at project initiation, details of gate operation techniques, and collection and transmission of hydrologic and stream flow data. Included are reservoir regulation procedures at the start of a flood before contact can be made with the Huntington District Office, and emergency regulation in the event that all communications fail during a flood. These instructions are contained in Exhibit B, "Instructions to the Damtender", Beech Fork Lake, along with plates and schedules pertaining to their use. Emergency flood level observations are established by "The Schedule for Reading Gages", Exhibit B. This plan is designed to ensure that any necessary gate operation will be promptly executed and that special reports will be initiated by the damtender before reservoir and stream conditions reach critical limits. If extra work is required after normal duty hours for the collection and transmission of hydrologic data, or the execution of necessary gate operations, any necessary overtime is authorized.

b. Special Directives. Special Directives are issued by telephone and confirmed by mail by the Water Control Section to record all substantive guidance to the project pertaining to water control activities not covered by the general instructions. The following list of subjects or purposes of Special Directives is representative of types issued.

(1) Flood Control

(a) Outflow reduction for Twelvepole Creek Basin streams or Ohio River control.

(b) Release of flood storage and adjustments in rate of release.

(c) Above channel capacity discharge when inflow hydrograph is greater than available storage capacity.

(2) Low-Flow release less than minimum flow to avoid loss of pool in extremely dry weather.

(3) Special regulations for:

(a) Downstream construction affected by flow.

(b) Stream cleanup activities.

(c) Emergency drowning or pollutant spill.

(d) Special pool levels for fish spawning.

(e) Above seasonal pool levels for drought relief in summer and fall.

(f) Stocking tailwaters stable flow 24-48 hours.

(g) Complete closure for inspection on an emergency or periodic basis.

(4) Temperature control inlet gate operations and low-flow valve adjustments.

(5) Spring filling, fall drawdown beginning and adjustments to discharge rate in order to control rate of rise or fall in lake level.

(6) Begin and terminate temperature dissolved oxygen profiles in the lake.

(7) Change in general instructions.

(8) Any and all other pertinent operations as deemed necessary by Water Control Section.

c. Regulations. The above mentioned general instructions and Special Directives are written in accordance with the following regulations:

(1) EM 1110-2-3600, 25 May 1959, Subject: Reservoir Regulation.

(2) ER 1110-2-1400, DAEN-CWE-Y 24 April 1970, Subject: Reservoir Control Centers.

(3) ORDR 1110-2-27, 12 January 1976, Subject: Water Control Management Activities.

(4) ER 1110-2-240, DAEN-CWE-Y, 24 April 1970, Subject: Reservoir Control Centers.

(5) ER 1130-2-415, DAEN-CWE-Y, 28 October 1976, Subject: Water Quality Data Collection, Interpretation and Application Activities.

(6) ORDR 1110-2-26, 5 February 1979, ORDED-W, Subject: Water Quality Investigations and Control Activities.

(7) ER 1110-2-208, DAEN-CWE-Y, 30 July 1979, Subject: Water Control Management.

7-05 FLOOD CONTROL

The primary objective of Beech Fork Lake is to reduce downstream flood damage by storing excessive runoff from major storms. Flood damages occurring along Beech Fork to Twelvepole Creek and from Lavalette to the Ohio River primarily involve residences, utilities, highways, and commercial and extractive industries; damages to agriculture is slight. The most valuable agricultural products are livestock, which

sustain only slight damage from flooding. Greatest flood damages in the past have occurred to residences in the community of Lavalette, as well as individual residences along the river. Furthermore, the villages of Lavalette and Shoals are both subject flooding due to the impacts of backwater from the Ohio River.

The optimal method of regulation coordinates operations between Beech Fork and East Lynn on the basis of comparative storage utilization.

Operation for Beech Fork and Twelvepole Creek is based on stages at the Beech Fork outflow gage and the USGS gage at Lavalette and Ashland, Ky. The control stages are listed in **Table 7-2**, next page.

a. Requirements. The operation of Beech Fork Lake is best accomplished by not exceeding the control stages on Beech Fork, Twelvepole Creek, and the Ohio River, shown in **Table 7-2**, next page. Control stages were established by close correlation with damage survey curves and result in only minimal damage in the control areas.

Control stages at the outflow gage were established by a channel capacity investigation during the flood of April 1977. A stage of 10.1 feet does not endanger any buildings, other structures, or access roads; higher stages were deemed potentially dangerous during the release of stored water. Summer control stage at the "O" gage has been set at 8.5 feet. These control levels require a SPECIAL DIRECTIVE from the Water Control Section. **Table 7-2**, , shows the control stages at key river stations below Beech Fork Lake.

Table 7-2 Control Stages And Travel Times				
TABLE NO. 7-2				
CONTROL STAGES AND FLOWS AT KEY RIVER STATIONS				
		Summer	Winter	Time of travel From dam to Station - hours
		Stage	Stage	
Station	Stream	Feet	Feet	
Beech Fork	Beech Fork	8.5	10.1	Outflow
Lavalette	Twelvepole	19	19	1.5 hour
Ashland	Ohio River	52	52	30 hours@
@Operational time prior to crest stage in excess of 52 feet. Flows can be found by using the rating tables found in the plates.				

b. Normal Plan. The plan of operation is based on having adequate flood forecasting and flood warning systems in effect. Stream flow and lake data are obtained from the data collection platform-satellite network and the Beech Fork Lake morning report. Precipitation amounts in and near the Beech Fork Basin on the morning report come from project gages. Additional precipitation data are received through the platform-satellite system and from NWS in Charleston. Using this data Water Control Section personnel prepare a detailed analysis of current and forecast rainfall, soil and foliage conditions, and stream stage data as input to the water control system. Lake and stream stage forecasts are then prepared for the key downstream control stations. These forecasts are then used by the Water Control Section to operate the lake and issue special directives utilizing the following operational guidelines. These forecasts are supplemented by the forecasts from the NWS River Forecast Center in Wilmington.

(1) It is desirable to empty the lake of flood storage as quickly as possible, considering any special operations, in view of the possibility of a major flood occurring at a time when the lake is partly filled.

(2) All inflow is to be released up to that causing a stage at the outflow gage not exceeding 10.1 feet during the period of 1 December - 15 April or 8.5 feet (during the period of 16 April - 30 November. These outflows require a SPECIAL DIRECTIVE from the Water Control Section. The exceptions being when critical flood conditions prevail or are predicted at downstream control points, or when the Water Control Section has directed special operations.

(3) All inflow will be stored, subject to the minimum flow requirement, which will contribute to stages in excess of the designated control stages at the key stations along Beech Fork, Twelvepole, and the Ohio River as listed in **Table 7-2**.

(4) All inflow will be stored, subject to the minimum flow requirement, beginning at time 30 hours in advance of the predicted time of reaching a forecast crest stage in excess of 52 feet on the Ohio River at Ashland, Kentucky. After a complete assessment of Ohio River conditions and trends of continued falling stages, releases will be scheduled so as not to add to actual crests above 52 feet on the Ohio River at Ashland.

(5) If the river stage at Ashland is not indicative of flooding conditions further downstream along the Ohio River, recommendations from LRD Water Control Center may suggest the storage of inflows in order to provide some benefit to these downstream areas. In such special cases, a complete assessment will be made of all current and anticipated hydrologic conditions in the Twelvepole Creek Basin to establish an operational scheme that will benefit the downstream Ohio River areas and not prove detrimental to the Twelvepole Creek Basin flood control objectives.

(6) Release of accumulated flood storage will be based on determinations by the Water Control Section after a complete evaluation of all hydrologic conditions that impact effective management of the project for optimal flood control benefits. Each individual flood event will be evaluated including consideration of percent storage utilization by other reservoirs in the Twelvepole Creek Basin and special directives issued for the release of stored water.

(7) Slide Gates will be regulated so that the rate of change of stage at the outflow gage will not exceed 0.5 foot per hour except under emergency conditions.

(8) The water control plan for major floods provides for increases in reservoir outflow when there are indications that the available storage will be insufficient to control the flood completely. Ordinarily, lake regulation will be based on the forecast inflow hydrograph predicted from reports of rainfall depths above the dam, the relationship of the inflow unit hydrograph to the updated inflow hydrograph calculated from pool change and outflow values, and the updated inflow hydrograph. After the inflow hydrograph has been predicted, Water Control Section personnel will determine the outflow required to utilize all the storage available. If the required discharge is equal to or greater than the downstream channel capacity, it is imperative that the outflow be increased to the required value as soon as possible in order to avoid the necessity of releasing even greater flows later. If the required discharge is considerably less than channel capacity, it may be desirable to delay releases to avoid synchronization of the outflow with peak flows from uncontrolled areas below the dam.

c. Emergency Plan. During a major flood, all communications between Beech Fork Lake and the Huntington District Office may be disrupted. In this rare event, Water Control Section will utilize all available data, e.g. satellite platform data, to keep informed of project conditions and to be prepared to resume regulation instructions

when communication is restored. The Damtender will assume regulation of the lake during a communication blackout, and follow the measures listed below. In addition, the Damtender will immediately make every effort to reestablish communications with the District Office.

In the event of failure of normal means of communication (radio and telephone), and the lake level is above elevation 605.0 feet NGVD and rising, a constant check shall be made on the rate of rise of the lake level. The lake "L" gage shall be read every hour, on the hour, and rise in pool level computed for the previous hour. Should the rate of rise in lake level indicate to the project manager that the available storage capacity of the project may be insufficient to completely control a given flood, thus gate settings greater than those being maintained from previous instructions are required, recheck the latest Special Directive and prepare to make a gate movement.

(1) During a complete communication failure or, if contact with the Water Control Section has been lost for three-hours or more, and lake level is approaching spillway elevation 610.0 feet NGVD, the Beech Fork project personnel are authorized to gradually increase the outflow up to channel capacity for the season while maintaining surveillance on the flood prone areas of Lavalette. In this Emergency Situation, when communication is lost, the Project Manager is further authorized to make any additional gate movements as required, regardless of the resultant rate of rise on the stage of the "0" gage.

(2) In such an emergency situation, if the pool level rises to elevation 613.0 feet NGVD, full channel capacity discharge must be maintained regardless of downstream conditions. After making the required gate movement, continue all efforts to contact the Water Control Section for guidance in making future gate movements and follow the following guidelines.

(3) If the slide gates are open when the lake level approaches elevation 614.5 feet NGVD, gradually close both gates, in order to prevent exceeding the designated downstream control stage. When the spillway discharge equals the downstream control stage, then completely close both slide gates to curtail additional downstream damage.

(4) If the pool continues to rise to elevation 619.0 feet NGVD, gradually open both slide gates so that they will be fully when the pool level approaches elevation 620 feet NGVD, the elevation of the Real Estate Taking Line.

(5) Assuming both continued pool rise and communication failure, when the lake has crested and recedes to elevation 620.0 feet NGVD, gradually reduce the gate settings in order to prevent exceeding the downstream control stage as the pool approaches 619.0 feet NGVD.

(6) Assuming continuation of communication loss, the Damtender Instructions direct a reversal of the regulation scheme for recession of the lake. Initially begin to reduce gate settings at elevation 620 feet NGVD toward the same settings established for channel capacity prior to spillway discharge. When elevation 619 feet NGVD is reached maintain these settings until the lake recedes to elevation 613 feet NGVD. After recession to elevation 610 feet NGVD, project personnel are to adjust outflow to maintain the approximate pool elevation 610

feet NGVD until communications are reestablished and the Water Control Section is able to provide guidance.

7-06 RECREATION

a. Lake.

(1) Requirements. Recreational activities in the lake area begin with fishing in March which increases through the spring filling in April and May and continues through summer and fall. Boating begins in late April and increases through May with the opening of camping on 1 May. Water skiing is popular when the water is warm. None of these activities require any special regulation.

For all water related recreation purposes it is desirable to maintain the pool level as constant as possible. Rapid fluctuation of pool level can produce anxiety in visitors for lack of information as to cause, and concern as to the possible impact of the fluctuation. Instability of banks and hillsides can cause failure and slippage upon rapid drawdown of lakes during release of flood storage, although any bank slippage during drawdown from spillway elevation to minimum pool elevation would probably be minimal at the maximum channel capacity rate of discharge with zero inflow.

High water levels change the view from normal and cause anxiety to boat operators due to danger from newly inundated obstacles or potential snags near shore edges and cove areas. High levels also cause difficulty in launching and retrieving boats; the difficulty increases as the water level increases with respect to the elevation of the top of the ramp. Special techniques are required when the water surface is near the top of the ramp or higher. Top-of-ramp elevations in feet above NGVD are 600.5 at the Beech Fork Dam boat launch ramp and 598.5 at the Lower Bowen Camping Area boat launch ramp. High water levels can render camping and day use areas useless due to flooding of access roads, sanitary facilities, or grounds. The low end of the parking lot for the boat launch at the dam is at elevation 601.5 feet NGVD. Many of the campsites at Lower Bowen Camping Area are at elevation 597 feet NGVD, the floors of the comfort stations are at 599 feet NGVD.

Lowered levels, i.e., below seasonal pool elevation of 592 feet NGVD, may occur during dry years due to the 5 cfs minimum discharge. Lowered levels may cause snagging problems because previously well covered objects are now closer to the surface. When lowered levels occur, they are likely to last longer than high levels and may require setting buoys and/or other action's.

(2) Control Plan. The water control plan for lake area recreation is to hold the pool level as close as possible to the summer seasonal elevation of 592 feet NGVD throughout the recreation season. This requires close attention to the normal flood control plan, which is to pass excess inflow up to the downstream channel capacity, along with water supply requirements. This procedure prevents unnecessary buildup of lake level and thus allows full enjoyment of lake centered

activities. At times, however, heavy rains may cause runoff to an extent requiring reduction of discharge to prevent downstream flooding, thus causing a consequent rise in lake level. Such a reduction in outflow during the recreation season may infrequently be occasioned by an Ohio River flood or by an emergency downstream. Part of the plan of regulation is the daily determination of a 3-day forecast of lake level elevation and outflow rate. This information is available to project personnel for their use and understanding and for dissemination to the National Weather Service and the marina operators.

b. Downstream.

(1) Requirements. Fishing begins at the tail-waters in March and continues through the summer and into the fall. Picnicking is not affected by regulation, but fishing is affected because of the high velocity of large discharges through the narrow channel. The rapid flow pulls a fishing line downstream and to the bank too quickly for pleasure or success. Channel capacity discharge does not pose any threat to visitors or property at the Below Dam Fishing Access Area.

Project personnel must maintain an awareness of downstream use along Beech Fork for both recreation and other purposes since safety of these interests is of prime importance to lake regulation. Any interest accustomed to using the stream at low water should be notified of impending high discharge.

(2) Control Plan. In order to be aware of downstream activities, project personnel make occasional surveys during both low water and high water to observe potentially hazardous situations. In the interest of downstream safety of life and property and integrity of stream banks, the water control plan limits the rate of increase or decrease of discharge to a change in stage at the outflow gage of 0.5 foot per hour. Emergency measures may exceed this rate of change. A warning horn is always sounded just before increasing total gate opening. If a spillway flood should occur during which the discharge rate will be greater than the channel capacity, project personnel would evacuate downstream recreation areas and remove any equipment that could be injured by high discharge.

7-07 LOW-FLOW AND WATER QUALITY CONTROL

a. Requirements. Prior to construction of Beech Fork Lake, summer flows in Beech Fork at the dam site often decreased to less than 1 cfs, nearly zero, and occasionally remained there for a week or more, creating stagnant or near stagnant conditions that were harmful to fish and food chain organisms. Modern new environmental policies were developed to resolve these severe problems, and these national policies and guidelines were soon applied regionally to the Twelvepole Creek Basin.

In accordance with the new national environmental policy objectives, water quality evaluation and reporting of water quality control

activities are a required part of the overall water quality control management activity at Beech Fork Lake. Responsibility for quality of impounded waters was assigned to the Corps of Engineers by Public Law 87-88, enacted by Congress on 20 July 1961. The Chief of Engineers delegated this responsibility to the various divisions as an ongoing function. Guidelines for water quality activities associated with water control management were established and described in ER 1130-2-415.

Stream fisheries need flowing, oxygenated water at normal temperatures. In order to fill this need provisions were made to increase flows below the dam and regulate outflow temperatures for fisheries benefit. The discharge rate was selected after a study to determine the maximum rate that does not exceed the maximum acceptable drawdown in the driest year. The West Virginia State Department of Natural Resources, Division of Fish and Game, has worked with the Corps to develop optimum outflow temperatures and allowable ranges of variation for use at Beech Fork Lake. These guidelines have been correlated with natural stream temperatures.

b. Water Quality Plan. Water quality control has two major aspects: flow augmentation for downstream needs and low-flow temperature adjustments. Water quality augmentation needs for Beech Fork were evaluated by the Federal Water Pollution Control Administration (later changed to EPA).

(1) Selective Withdrawal System. The low-flow selective withdrawal system was designed for a lake that stratifies during the summer, with warm, oxygenated water in the epilimnion and colder water with little or no oxygen in the hypolimnion. The low-flow selective withdrawal system is normally used to maintain the designated minimum flow, but, it may also be used as a fine tuning control on the quantity of discharge from the slide gate system. The selective withdrawal system further provides a wide range of water temperatures downstream, and adequate control of volume and quality of discharged water up to the capacity of the control valves. The low-flow system dimensions are discussed in Section II main text. As previously mentioned there are two low-flow wells, (WL and WR), with an upper and lower inlet window for each well. Two upper level inlets (IL10 and IR10) were placed at elevation 582.0 feet NGVD, one lower inlet(IL19) was placed at elevation 573.0 feet NGVD, and one inlet(IR28)at elevation 563. These low-flow gates allow withdrawal of water from any of three levels, or simultaneously from all three levels, or a mixture of the three. In this manner a wide range of temperature adjusted high quality outflow water is provided for the needs of the downstream aquatic environment.

(2) Low-Flow Release. Low-flow augmentation meets the need of downstream aquatic communities or normal habitat, particularly with regard to temperature, dissolved oxygen, and chemical sediment. The minimum continuous flow rate selected by the State of West Virginia for downstream fisheries maintenance was 5.0 cfs. This discharge is to be maintained at all times, even during closure for flood control. The discharge rate was selected after a study to determine the maximum rate

that does not exceed the maximum acceptable pool drawdown in the driest year. Routine release volumes through the Low-Flow Gate as shown on Slide Gate Rating Curve, Plate No. 7-5, and the Low-Flow Gate Rating extension curves for both intakes on Plate No. 7-6. Maximum capacity of each low-flow control well with both inlets open is about 215 cfs, or 430 cfs using both wells, with slight adjustment for pool elevation. The Rule Curve for Reservoir Regulation, Plate No. 7-7, is normally followed for all low-flow release from the lake.

(3) Temperature Profiling. Outflow water temperature regulation is possible through the use of the selective withdrawal system. The State of West Virginia Department of Natural Resources, Division of Fish and Game, has worked with the Corps to develop optimum outflow temperatures and allowable ranges of variation for use at Beech Fork Lake. These guidelines have been correlated with natural stream temperatures. Regulation of outflow temperature requires a current assessment of lake temperatures and levels of dissolved oxygen available for withdrawal. Weekly temperature and dissolved oxygen profiles must be taken in the lake during the seasonal stratification period. Visual reference to the appropriate profile and the temperature regulation curve will frequently indicate an obvious choice of one level for withdrawal. At times, however, mixing water from more than one level will be necessary to release outflow water near the natural water temperature. Consideration of dissolved oxygen levels may also affect proper gate selection. The Outflow Temperature Objective Curve is shown on Plate No. 7-8 and the Fish Spawning Schedule is on Plate No. 7-9.

Project personnel take data on Monday for a temperature dissolved oxygen profile of the lake, which includes temperature and dissolved oxygen concentration at the surface and at 2-foot depth intervals to the bottom. This data is transmitted to the Water Control Section where it is computer plotted to produce the Water quality Assessment. Water Quality Personnel use this assessment in conjunction with daily outflow temperature and Outflow Temperature Objective, Plate No. 7-8, to determine which combination of the selective withdrawal inlets to use to obtain the desired temperature downstream. If the bottom water has a dissolved oxygen concentration of 1.0 milligrams per liter or greater, it may be carefully metered through a slide gate into the outflow. At these times, the discharge must be monitored in the stilling basin for the possible appearance of red-iron hydroxide see 7-07b color in the water and/or the smell of hydrogen sulfide. The regulation scheme is transmitted to the project as a Special Directive.

7-08 FISH AND WILDLIFE CONSERVATION

a. Requirements.

(1) Lake. In accordance with State Code, the West Virginia Department of Natural Resources is responsible for fish and wildlife conservation and boating safety at Beech Fork Lake. The Department shares the Corps conservation goal of the long-term well-being of the populations of water and land species of plant and animal life common to the area and the maximum sustained enjoyment of these populations by the public, as stated in subsection 4-04. Lake area conservation requirements are met by various features of the Department management program. This includes stocking of the lake; imposing size limits as necessary; monitoring populations, reproductive success, and size distribution within species; maintaining a conservation officer at the lake to conduct creel surveys and fisherman interviews; and administering licensing regulations for sport fishermen.

Fish need a fairly stable pool level for successful spawning, but at other times the level is of little importance. The normal spawning temperatures for the species of fish living in Beech Fork Lake are given in Plate No. 7-9. Also, ground-nesting birds, small mammals and reptiles, whose habitats are near lakeside, need a stable water pool.

Dry weather pool drawdown may expose normal cover and muddy lake sides, and the slight erosion of boat waves can produce turbid water conditions an appreciable distance from the bank. Pool drawdown may also expose normal cover. This is the normally fertile littoral area and fish populations are negatively affected as a result.

(2) Downstream. Needs of the downstream aquatic community for habitat maintenance, i.e., the continuous flow of clean water at proper temperature, constitutes the conservation needs related to reservoir outflow. The selective withdrawal system provides a wide range of released water temperatures downstream, and adequate control of volume and quality of discharged water that meet these conservation needs. Guideline curves of maximum, minimum and optimum temperatures for warm water fisheries were provided by the Fisheries Section of the Wildlife Division of the West Virginia Department of Natural Resources. A smooth curve of target outflow temperatures is shown, with 2°F± upper and lower limit companion curves, in Plate No. 7-8.

Lower food chain members that live on the bottom are dependent on clean rocks, gravel, and sand for normal habitat. Water in lower zones of the lake contains iron, which is soluble when it is subjected to reducing conditions common during stratification. When this water is released and aerated in the stilling basin, the iron is changed to an insoluble oxide by oxidation and then is hydrolyzed to the hydroxide mentioned above. Silt and iron hydroxide, particularly under summer low-flow conditions, can coat this habitat. This suppresses the lower members of the food chain and depresses populations of higher members until the habitat is improved, such as by the flushing action of higher flows

which allows the population of lower members in the food chain to become reestablished.

b. Control Plan. As explained in paragraph 7-06 a(2), the normal mode of regulation for both recreation and flood control, with the guiding principle of conserving storage capacity for possible early flood control needs, fosters a stable pool; however, downstream flooding may require gate closure and consequent pool rise.

The Water Control Section exhibits flexibility in spring filling on behalf of fish spawning. When the West Virginia Department of Natural Resources requests maintenance of a special pool level during a spawn, the Water Control Section will normally honor the request if it does not interfere with other project purposes. The Water Control Section would consider a request from the Department of Natural Resources for holding an intermediate pool level during a spawnin period and then raising the level to the seasonal elevation later. During a normal filling operation, lake discharge between 8 and 10 cfs is maintained, thereby providing more than minimum flow for downstream fishery benefits.

The minimum continuous flow rate selected by the State of West Virginia for downstream fisheries maintenance was 5.0 cfs. The discharge rate was selected after a study to determine the maximum rate that does not exceed the maximum acceptable pool drawdown in the driest year. This discharge is to be maintained at all times, even during closure for flood control, hopefully without lowering the seasonal pool more than six inches, except in dry years, extreme drought, or other emergency condition. In extremely dry years, the Water Control Section personnel may direct reduction of discharge to inflow volumes after assessing all hydro-meteorological and recreational factors.

This flow, or the equivalent stage at the outflow gage, is maintained as a minimum at all times, the low-flow selective withdrawal system was designed for a lake that stratifies during the summer. The low-flow system is normally used to maintain the designated minimum flow, but it may also be used as a fine-tuning control on the quantity of discharge from the slide gate system. The selective withdrawal system further provides a wide range of water temperatures downstream, and adequate control of volume and quality of discharged water up to the capacity of the control valves. The low-flow gates allow withdrawal of water from either shallow or deep-water level, or simultaneously from both levels for a mixture of the two. In this manner a wide range of temperature adjusted high quality outflow water is provided for the needs of the downstream aquatic environment to achieve a designated discharge and/or outflow temperature requirement. Maximum capacity of the low-flow control system with both inlets open is about 430 cfs, with slight adjustment for pool elevation.

Routine release volumes through the Slide Gates are shown on Slide Gate Rating Curve, Plate No. 7-5, and the Low-Flow Gate rating extension for both intakes on Plate No. 7-6. The Rule Curve for Reservoir Regulation, Plate No. 7-7, is normally followed for lake operation.

7-09 WATER SUPPLY

Beech Fork Lake is required to provide water below the dam for low-flow augmentation, water quality, and local water supply. At Beech Fork Lake the functions have been combined into one purpose, and the lake has been partitioned accordingly. The total storage capacity of Beech Fork Lake is estimated to be 37,500 acre-feet. This storage was divided and allocated for various purposes during the planning phase of the project.

a. Requirements. Prior to construction of Beech Fork Lake, summer flows in Beech Fork and Twelvepole Creek below the dam site often decreased to less than 1 cfs, nearly zero, and occasionally remained there for a week or more, creating stagnant or near stagnant conditions that were harmful to fish and food chain organisms. Stream fisheries need flowing, oxygenated water at normal temperatures. In order to fill this need provisions were made to increase flows below the dam and regulate outflow temperatures for fisheries benefit. Modern new environmental policies were developed to resolve these severe problems.

When the first modern new environmental policies were developed nationwide, they were soon applied regionally to the Twelvepole Creek Basin to resolve water shortage problems. Therefore, a guaranteed continuous minimum flow is a project purposes required of Beech Fork Lake for the State of West Virginia. The discharge rate for fishery and water supply maintenance of 5.0 cfs. was selected after a study to determine the maximum rate that does not exceed the maximum acceptable drawdown in the driest year. This discharge is to be maintained at all times, even during closure for flood control. The summer water supply and recreation pool of 592 feet NGVD 29 and the winter minimum pool of 583.5 feet NGVD 29 were planned to supply an estimated need of 5 cfs continuously for the State of West Virginia.

The Beech Fork low-flow system is used for all releases up to the capacity of the system. Routine release volumes through the Low-Flow Gates are shown on Low-Flow Gate Rating Curve, Plate No. 7-2, and the Low-Flow Gate rating extension for both intakes on Plate No. 7-3. If evacuation of the minimum pool below elevation 583.5 feet NGVD 29, or lower is ever required, it will be accomplished by using the two 3'x 2.5' multilevel low-flow gate outlets that empty at elevation 557.0 feet NGVD 29. Maximum capacity of the low-flow control system with all inlets open and both gate outlets open 80 percent is about 430 cfs, with slight adjustment for pool elevation.

b. Control Plan. On or about 1 April, when the normal flood season has passed, the Water Control Section directs the beginning of filling. It is desirable for the lake level to reach 592.0 feet NGVD 29 soon as possible after 1 April in order to maximize recreation benefits and to facilitate activities of early spawning fish. These benefits would be quickly produced by reducing outflow to a minimum discharge of 5 cfs; however, the Special Directive for filling specifies a stage at

the outflow gage equivalent to 8-10 cfs to fully support the downstream fishery. In a dry season, the filling directive specifies the minimum flow required at the outflow gage. During an exceptional dry season, the West Virginia Department of Natural Resources may report to the Water Control Section that the outflow is inadequate for the spawning season and request more water. The request is fulfilled by retarding the filling rate or holding the pool temporarily at some elevation between 583.5 and 592.0 feet NGVD 29. Special Directives from the Water Control Section supply guidance to the project for these water control actions.

When pool elevation 592 feet NGVD 29 is reached, it is maintained, subject to flood control and minimum flow requirements, throughout the recreation season. If suggested by CELRD, the Water Control Section may direct storage of water above elevation 592 feet NGVD 29 for later release to augment flows in the Ohio River or Mississippi River.

Around 1 September, the Water Control Section assesses all hydrometeorological and recreational factors and determines whether to maintain the pool at seasonal level for continued recreation benefit or to begin releasing water after Labor Day for downstream beneficial use. In any case, drawdown is begun by 1 November and completed by 30 November. The Water Control Section issues appropriate directives to the Damtender for beginning drawdown including initial "0" gage setting with equivalent discharge value and as frequently as necessary thereafter to maintain the desired schedule for pool elevations, all subject to maximum allowable discharge and flood control operation. The winter minimum water level at elevation 583.5 feet NGVD 29 is maintained through the flood season until 1 April, subject to regulation for flood control and minimum flow requirements.

c. Storage Allocations.

(1) Minimum Pool. Storage capacity allocation in the lake for minimum pool includes year-round equivalent storage volume for sediment accumulation, provision of minimum flow during an unusually dry winter, and satisfactory winter habitat for the large population of fish. Sediment storage was estimated to contain 92 years accumulation of sediment based on data from other reservoirs in the basins adjacent to Beech Fork Lake. The minimum pool was established at elevation 583.5 feet NGVD 29, containing 3,392 acre-feet of storage and covering 405 acres.

(2) Summer Water Supply and Recreation Pool. In order to provide for maximum recreation during late spring, summer and early fall, the summer recreation and water supply pool was established at elevation 592.0 feet NGVD 29 and covering 719 acres. This pool contains 4744 acre-feet of water, which supports aquatic life, recreational activities high in monetary benefits, and provides the 5 cfs minimum flow during dry periods to maintain and support water supply.

7-10 HYDROELECTRIC POWER - N.A.

7-11 NAVIGATION - N.A.

7-12 DROUGHT CONTINGENCY PLAN - See ANNEX I

7-13 FLOOD EMERGENCY ACTION PLANS

Extremely high lake levels and/or sudden release of large volumes of water or any emergency condition affecting operation of Beech Fork Lake could result in a hazard to life and/or nearby property. Early identification of the existence or potential for occurrence of such conditions is essential as a basis for initiating emergency operations and/or repairs and for issuing appropriate notifications to higher authority and potentially affected parties.

a. Definitions.

(1) Pre-Emergency. A Pre-Emergency condition occurs when some impending or existing threat to the safe operation of the dam or lake is identified, but no significant hazard to life or property is expected to occur. Pre-Emergency declaration is internal to the Corps of Engineers and does not require notification of other parties or warnings to evacuate.

(2) Emergency. An emergency condition occurs when a significant hazard to life and/or property is possible or certain to occur. Conditions justifying declaration of an emergency condition may be imminent or longer term. An emergency condition declaration requires notification of others and issuance of warnings to evacuate potentially hazardous areas.

b. Declaration of Pre-Emergency and Emergency Conditions. Pre-Emergency and Emergency declarations will be made by the District Engineer. The Chiefs of the Engineering-Construction Division, Geotechnical and Water Resources Engineering Branch, Design Branch, Operational and Readiness Division and the Emergency Management Branch will provide input onto the decision making process.

(1) Responsibility. The district is responsible for the declaration of "Pre-Emergency" or "Emergency" conditions in all but extreme cases where the loss of communications or the speed of onset of a situation prevents the Dam Operator from conferring with the district.

(2) Conditions Warranting Declaration. Not every situation requiring the declaration of a pre-Emergency, or an emergency condition can be specified. All personnel must exercise proper initiative and judgement, and each situation is evaluated individually on the basis of all relevant factors.

c. Pre-Emergency. Examples of circumstances warranting declaration of a pre-emergency condition include:

(1) Malfunction of flood control gate system during flood operations which impedes release of water and creates potential for spillway flow.

(2) Minor seepage problems including unexplained increases or decreases in amount, cloudy appearance of seepage or presence of fines, development of new seepage areas as indicated by soft, boggy areas or new or lush vegetation, and substantial unexplained fluctuation in piezometer readings.

(3) Minor slope failures including tension cracks at crest or in slopes of embankment, small bulges in slopes or in foundation near toe of slope, small depressions or sags in crest or slopes, changes in horizontal crest alignment, and gullies forming in or near embankment or junction of the embankment or abutments.

(4) Threats of sabotage or occurrence of sabotage of non-critical project features.

d. Emergency. Examples of conditions warranting declaration of an emergency condition include:

(1) Emergency Drawdown. Extremely high lake levels and/or sudden release of large volumes of water or any emergency condition affecting operation of Beech Fork Lake could result in a hazard to life and/or nearby property. Early identification of the existence or potential for occurrence of such conditions is essential as a basis for initiating emergency drawdown operations and/or repairs and for issuing appropriate notifications to higher authority and potentially affected parties. The emergency drawdown schedule for Beech Fork Lake is shown on Plate No. 7-10.

(2) Major seepage problems including large increases in piezometer readings movement of large amounts of material in existing or new seeps, pipes in embankment or foundation materials, slippage at higher elevations on downstream face of dam or in abutment areas, and big increases in normal seepage amounts (especially when associated with movement of material from embankment or foundation).

(3) Major slope failures including appreciable depressions or sloughs in the crest or slopes of the dam or bulges in the slopes or foundation, large gullies developing and continuing to erode in the embankment or at the junction of the embankment and abutments, displacement of structures or instrumentation on the dam and continuing expansion of tension cracks after their appearance on the dam crest or slope.

(4) Threats of sabotage or occurrence of sabotage to critical project features.

e. Action upon declaration.

(1) Project Damtender

- (i) Monitor telephones on 24-hour basis;
- (ii) Notify key personnel in Big Sandy Area Office;
- (iii) Notify District Dam Safety Officer (Chief of Engineering-Construction Division);
- (iv) Maintain 24-hour monitoring surveillance of situation responsible for declaration;
- (v) Perform non-routine observations and tasks as directed by District; and
- (vi) If Area Office personnel cannot be contacted, notify key personnel listed in the Regulation Assistance Procedures on page iv or on the Red or Yellow sheets in the Emergency Action Plan.

(2) Big Sandy River Basin Area Manager

- (i) Monitor telephones on 24-hour basis;
- (ii) Notify key personnel, Table No. 7-2, page 7-22;
- (iii) Place all personnel on standby for emergency duty.

(3) District

- (i) Activate Emergency Operations Center;
- (ii) Monitor telephones on 24-hour basis;
- (iii) Test radio communications;
- (iv) Place key staff on emergency duty;
- (v) Provide detailed instructions to Damtender for any needed non-routine observations and tests;
- (vi) Dispatch personnel to dam site as required to provide expert evaluation of situation and to assist Damtender as needed; and

(vii) Make any necessary notifications concerning declared situation.

f. Communications System

(1) Normal. Communications between the District, Damtender (Resource Manager), and Big Sandy Area Office will be by land line telephone. Telephones at the project office, Big Sandy Area Office and District Emergency Operations Center will be manned on a 24-hour basis whenever a Pre-Emergency or Emergency condition is in effect at Beech Fork Lake or at another site that can be affected by operation of Beech Fork Lake. Office and home phone numbers of key Huntington District, Beech Fork Lake, Big Sandy Area Office and other federal agency personnel are listed in the Regulation Assistance Procedures on page iv.

(2) Alternate. The cell and satellite phones will be used to backup telephone communications. Office and home phone numbers of key Huntington District, Beech Fork Lake, Big Sandy Area Office and other federal agency personnel are listed in the Regulation Assistance Procedures on page iv. on the Red or Yellow sheets in the Emergency Action Plan.

(3) Disaster Blackout. During a situation when all communications between the District Office and the Big Sandy Area Office or project office is lost, others equipped with other communication facilities will be called on for assistance.

g. Notification Plan.

Extreme conditions affecting operation of Beech Fork Lake could result in a hazard to life and/or property due to high lake levels and/or sudden release of large volumes of water. Should an emergency drawdown of Beech Fork Lake become necessary Plate No. 7-10 shows the Emergency Drawdown Schedule for the lake.

7-14 OTHER PLANS

The Water Resources Engineering Branch has prepared Inundation Maps for Beech Fork Lake that delineate the areas both upstream and downstream of the dam that have potential for flooding in the highly unlikely event of an enormous flood of the Spillway Design Flood category or a large release of water. The maps were prepared in accordance with ER 1130-2-419, with the possibility of dam failure and dam retention. The maps also show the time factors associated with the movement of the hypothetical flood waves downstream of the dam. The effects of dam failure while the pool is being maintained at maximum flood control elevation and while at seasonal elevation were also modeled as part of the inundation studies but were not delineated on the maps. Flood profiles for all four conditions have been prepared as part of a Study Summary Report and are on file in the Water Resources Engineering Branch. Computation efforts were accomplished using the dam break computer program programs developed by the National Weather Service. U.S. Geological Survey Quadrangle maps were used as a base in developing the inundation map plates.

The Beech Fork Lake inundation maps have been provided to the district Emergency Management Office for use in developing an Emergency Plan for Beech Fork Lake and for contact with State and local authorities. The State and local authorities are provided the maps for their use in developing evacuation plans for the affected areas.

7-15 DEVIATION FROM NORMAL OPERATIONS

The District Commander or his designee occasionally requested to deviate from the WCP from the Division Commander (the approving authority for the WCP.) Approval and notification procedures fall under three categories: Emergencies, Unplanned, and Planned.

a. Planned Deviations

Situations will arise which operation of the project as defined by the WCP is not in the federal or public interest. These situations have the potential to create significant impacts on the normal regulation of the project and possibly other projects in the basin. Each request is a major change to the WCP and should be analyzed on its own merits. Sufficient data on flood potential, lake and watershed conditions, possible alternative measures, benefits to be expected, probable effects on other authorized and useful purposes, and environmental evaluation, together with the district recommendation, are presented to the Division Water Management Staff and subsequently the MSC commander or their designee in writing for review and approval prior to action.

b. Unplanned Deviations

Situations will arise, as describe in the section above, which operation of the project as defined by the WCP is not in the federal or public interest but the time frame prior to the necessary action is too

short to completely staff a deviation request. Each request is a major change to the WCP and should be analyzed on its own merits. Sufficient data on flood potential, lake and watershed conditions, possible alternative measures, benefits to be expected, probable effects on other authorized and useful purposes, and environmental evaluation, together with the district recommendation, are presented to the Division Water Management Staff and subsequently the MSC commander or their designee verbally for review and approval prior to action. As per USACE Quality Management Document: (4214) LRD - Reservoir Regulation Deviation Policy (08720), within 30 days a written request will be submitted.

c. Emergencies

Water control actions necessary to abate emergency situations are taken immediately unless such actions would create equal or worse conditions. Districts must inform their division office as soon as practicable and prepare written confirmation of the deviation and description of the cause and furnish it to the division water control manager.

7-16 RATE OF RELEASE CHANGE

The Beech Fork Lake outflow is to be regulated in such a manner that the rate of release and the resulting stream level does not change more than 0.5 feet per hour on the Outflow "O" gage.

7-17 NOTIFICATION OF IMPENDING RELEASES

Notification of the public of an enormous water release is carried out by the project, the Water Resources Engineering Branch, National Weather Service and by the district Public Affairs Office. These units utilize various types of mass media, telephone, radio, personal visitation, and the Weather Service dissemination system, depending on the type, urgency and target of the information. Information on planned additions to or changes in lake regulation such as for recreation or fishery enhancement are disseminated by the Public Affairs Office from detailed statements by the Water Resources Engineering Branch. Information of interest primarily to anglers, such as water condition of the lake and outflow, are disseminated by the project via an automatic telephone answering machine tape that is updated as necessary by project personnel. Daily reservoir and rainfall data are disseminated to the Weather Service via the District Water Control System. This information appears along with other weather and stage information provided by the Weather Service to mass media and county, State, and Federal agencies.

The Damtender (Resource Manager) at Beech Fork Lake will keep informed and inform the Water Resources Engineering Branch of all developments upstream and downstream along Beech Fork to Lavalette. Arrangements should be made with the Water Resources Engineering Branch for public notification of water release operations that are of an unusual nature or substantially different from the established release pattern

whenever such releases might cause damage to equipment or facilities located downstream. The objective of this program is to afford those likely to be affected an opportunity to take appropriate remedial action in advance of the arrival of the releases to prevent damage to or loss of property. Warnings of any unusual releases will be transmitted downstream by project personnel in person and by telephone.

News of impending gate opening operations is transmitted to persons downstream, primarily anglers, by means of the Below Project Warning System which consists of a warning horn remotely controlled from the project office. At Beech Fork Lake, the horn is installed on the top of the dam, and is audible for a one mile radius. Important public service messages concerning regulation of the lake are handled by the Public Affairs Office and disseminated via radio, newspapers, and television.

7-16 RATE OF RELEASE CHANGE

The Beech Fork Lake outflow is to be regulated in such a manner that the rate of release and the resulting stream level does not change more than 0.5 feet per hour on the Outflow "0" gage.

7-17 NOTIFICATION OF IMPENDING RELEASES

Notification of the public of an enormous water release is carried out by the project, the Water Resources Engineering Branch, National Weather Service and by the district Public Affairs Office. These units utilize various types of mass media, telephone, radio, personal visitation, and the Weather Service dissemination system, depending on the type, urgency and target of the information. Information on planned additions to or changes in lake regulation such as for recreation or fishery enhancement are disseminated by the Public Affairs Office from detailed statements by the Water Resources Engineering Branch. Information of interest primarily to anglers, such as water condition of the lake and outflow, are disseminated by the project via an automatic telephone answering machine tape that is updated as necessary by project personnel. Daily reservoir and rainfall data are disseminated to the Weather Service via the District Water Control System. This information appears along with other weather and stage information provided by the Weather Service to mass media and county, State, and Federal agencies.

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SECTION VIII - RESULTS OF WATER CONTROL PLAN

8-01 GENERAL

The results of regulation for the authorized purposes of flood control, recreation, and fish and wildlife conservation are presented in the following paragraphs and exhibits mentioned. Flood control benefits are discussed in 8-03 and stage and flow reductions are listed in Table No. 8-1, page 8-4. Regulations for various hypothetical design floods and for representative actual floods have demonstrated the capability of the project to control and pass runoff from the drainage basin. The same capability is described in probability terms by Frequency of Filling, Plate No. 8-1, and Duration of Filling, Plate No. 8-2. Plate No. 8-1 shows that the lake is likely to be filled to maximum flood control pool elevation, 614.5 feet NGVD, once in 187 years. Some of the effects of regulation on recreation and fish and wildlife are discussed.

Recently, the Water Control Section completed a district-wide study involving simulation of project operations from 1950 to 1998. These regulated hydrographs for Beech Fork Lake, from 1978 when project operation began, to 1998, are on file with the Water Control Section.

8-02 FLOOD CONTROL

Beech Fork Lake controls 78 square miles or 94 percent of the total Beech Fork drainage area above Lavalette and is only one hour flood travel time above the gage. Therefore, regulation of the project has been effective in almost eliminating headwater flood damages along Beech Fork to the Town of Lavalette and, in combination with East Lynn Lake, in greatly reducing damages along Twelvepole Creek below Lavalette. Application of the adopted water control plan to two hypothetical floods, two historical floods and two large recent floods as they occurred, are discussed in subsequent paragraphs.

a. Hypothetical Floods. Two hypothetical floods developed in the Hydrology Design Memorandum (Design Memorandum No. 1 - November 1965) consist of the following:

- (1) Spillway Design Flood
- (2) Standard Project Flood

The spillway design flood is the basis for determination of the spillway capacity required to provide safety of the dam during the most critical flood runoff over the basin. The standard project flood constitutes a standard for design of structures that will provide a high degree of protection as determined by flood potentialities of the drainage area involved without regard to economic or physical limitations. The standard project flood is usually based on the August rainfall as it is the most intense.

(1) Spillway Design Flood. Estimates of this storm and flood were made in accordance with EM 1110-2-1405 using maximum probable precipitation shown in NWS Hydrometeorological Report No. 33. A 48-hour storm in August was chosen as most critical. Operation for the flood is shown in Plate No. 8-3. At the onset of the storm it was assumed that the flood storage between seasonal pool elevation and spillway crest elevation in the lake would be half utilized. This means that the pool would be at elevation 605.7 feet NGVD, which is probably the worst condition of the pool that could happen in August. If surcharge storage at elevation 620 feet NGVD is also considered as available storage, the 605.7 feet NGVD beginning elevation would represent a 36.1 percent full condition. Initially, the slide gates would be closed and remain closed as the inflow caused the pool level to rise until it reached the real estate upper guide taking contour at elevation 620 feet NGVD at hour 41. Then the slide gates would be gradually opened and kept open until the lake crested at hour 52 and receded to 620 feet elevation. At that time the slide gates would be gradually closed and remain closed until the lake level had receded nearly to the spillway crest elevation of 614.5 feet NGVD. The slide gates would then be adjusted to regulate the discharge according to downstream requirements. As soon as allowed by downstream conditions, The Water Control Section would issue special directives to the project providing for discharges at the maximum safe rate up to the summer control outflow of 1,410 cfs until the pool had receded to seasonal pool elevation of 592 feet NGVD.

The maximum pool level that would have been reached during this flood would be elevation 634.7 feet NGVD which represents a rainfall excess of 23.48 inches and 47,960 acre-feet of storage being utilized above the flood control pool elevation of 614.5 feet NGVD. The maximum outflow would have been 27,100 cfs of which 3,500 cfs would have been discharged through the slide gates.

(2) Standard Project Flood. This theoretical flood would result from a storm probably in July or August designed to equal the worst combination of meteorologic and hydrologic conditions considered reasonably characteristic of the area. It was determined from generalized rainfall criteria and procedures outlined in EM 1110-2-1411. Operation of Beech Fork Lake for the flood is shown in Plate No. 8-4. A review of summer-type storms indicated that a minimum infiltration rate of 0.05 inch per hour might be experienced and this value was adopted in determining the rainfall excess. Based on studies of streamflow records for Twelvepole Creek Basin, a base flow of 1 cfs per square mile was adopted. At the start of the flood the reservoir would have been regulated to maintain seasonal pool elevation of 592.0 feet NGVD with the outflow rate reaching channel capacity of 1,410 cfs at hour 42. At hour 54 when a crest stage forecast in excess of 52 feet had been predicted for the Ohio River at Ashland, Kentucky, the outflow from the lake would be reduced to the minimum flow of 5 cfs. By hour 74, the lake level would have reached maximum flood control pool elevation of 614.5 feet NGVD. When the pool level reached the real estate upper guide taking line at elevation 620 feet NGVD the slide gates would be opened to augment

spillway discharge and prevent or reduce further rise in lake level. After the pool level crested and receded to 620 feet NGVD, the slide gates would be closed until the pool level receded to near 614.5 feet NGVD. As soon as downstream conditions permitted, the Water Control Section would direct discharge of flood storage at rates up to crop season maximum allowable discharge of 1,410 cfs which would be maintained until the lake level to seasonal pool elevation of 592 feet NGVD at which time normal operations would be resumed.

The total excess rainfall for this flood would be 12.67 inches. Maximum pool contents would be 51,070 acre-feet which includes 13,530 acre-feet of surcharge storage above elevation 614.5 feet NGVD. The maximum pool elevation, 621.5 feet NGVD would occur at hour 88 with maximum regulated discharge of 6,750 cfs which compares to the natural peak discharge of 31,700 cfs for a reduction due to the project of 25,000 cfs.

b. Representative Floods.

(1) General. The historical floods which were selected for illustration of the water control plan are the floods of February 1939, and April 1977. Also selected are the floods of December 1978 and January 1979 since they exhibit regulation according to the water control plan, for large floods as they occurred. Table No. 8-1, next page shows the effects of Beech Fork regulation on 12 selected Ohio River floods.

(2) Flood of February 1939. The flood of 1939 was the greatest flood of record in the Twelvepole Creek Basin. The flood was caused by two distinct storms. On 30 January, the first storm dumped approximately 1.5 inches of rainfall over the basin, saturating the soil and causing the streams to rise. The second storm, occurring over the period of 1 to 3 February, resulted in rainfall averaging around 3.5 inches over the basin above the Beech Fork dam site. If these storms had occurred after Beech Fork Lake was in operation, the operation would have been as follows and as shown on Plate No. 8-5.

The runoff from the previous would have caused the pool to rise a little over two feet and the discharge would be maintained at winter channel capacity until the pool was lowered to minimum elevation of 583.5 feet NGVD at which time the outflow would have been regulated to pass the inflow. After the main storm began and the pool level started rising, the project would release the inflow until 1400 hours on 2 February when winter channel capacity of 1,710 cfs was reached. The discharge would be held at that level subject to the local indicator stage at Lavalette and the control stage of 18 feet and rising at Wayne. On 3 February at 2300 hours a Special Directive would be issued to close Beech Fork to minimum flow because of Ohio River flooding. The minimum flow would be maintained until 1100 hours on 6 February when the Ohio River would have crested and the Water Control Section would issue a Special Directive to raise the discharge to the channel capacity of 1,710 cfs at a rate not to exceed 0.5 foot per hour on the outflow gage.

The pool would have crested at 598.77 feet NGVD after the discharge had been increased to release storage, meaning that 25.9 percent of the flood storage was used. The natural peak flow at the dam site of 6,275 cfs would have been reduced to the winter channel capacity of 1,710 cfs.

TABLE NO. 8-1
REDUCTIONS EFFECTED DURING TWELVE SELECTED
OHIO RIVER FLOODS AT ASHLAND KENTUCKY

Flood	Modified Stage* (feet)	Stage with Beech Fork Lake (feet)	Reduction for Beech Fork Lake (feet)
January 1927	53.8	53.77	0.03
March 1933	55.9	55.89	0.01
March 1936	56.3	56.23	0.07
January 1937	64.5	64.46	0.04
February 1939	56.1	56.06	0.04
April 1940	56.0	55.98	0.02
December 1942	60.8	60.79	0.01
March 1945	59.8	59.79	0.01
April 1948	62.7	62.67	0.02
January 1950	46.8	46.80	0.00
January 1952	55.8	55.77	0.03
March 1955	59.0	58.97	0.03

* As modified by Group "A" reservoirs (existing, under construction or advanced planning, FY 1965)

(3) Flood of April 1977. Runoff causing the flood of April 1977 came from a series of disturbances that moved across the Beech Fork Basin beginning in the evening of 2 April. Rain was intermittent through the evening of 3 April and then began in earnest and accumulated more than 3.5 inches at the dam site before tapering off on 5 April. The project was not in operation at the time so both slide gates were fully open at the beginning of the flood. Twelvepole Creek at Wayne crested at 18.7 feet around 0400 hours on 5 April and the morning report (0800 hours) indicated local flooding at Wayne and in Lavalette. Therefore, the Water Control Section issued a Special Directive to limit discharge to a stage of 10.1 feet on the outflow gage, until further notice, in order to reduce downstream flooding. The gate openings were reduced from 10 feet to 4 feet at 0845 hours and then to 3 feet at 0915 hours. The outflow gage reading was 10.25 feet at 0915 hours and had not changed by 1330 hours leading to the conclusion that the outflow gage was being affected by backwater from Twelvepole Creek. Thus, even though the outflow gage showed no change, the gate discharge based on the slide gate rating curves decreased from approximately 1,560 cfs to around 460 cfs between 0845 and 1330 hours. The gate openings were maintained until all the storage had been discharged and the gates were then returned to the fully open position.

The natural flow at the dam site peaked at around 3,750 cfs on 5 April at about 0300 hours and would have produced a stage of 18.3 feet on the outflow gage. Reduction due to the operation of Beech Fork Lake was around 8 feet on the outflow gage and caused the pool level to rise from the streambed to crest at elevation 579.90 feet NGVD. The flood operation is illustrated in Plate No. 8-6.

(4) Flood of December 1978. Soil conditions resulting in near-record runoff in the Beech Fork Basin were caused by a storm, occurring on 3 and 4 December, which saturated the soil and caused area streams to rise. Three days later on 7 December the main storm struck the basin with heavy rains beginning at 1000 hours. Beech Fork Lake reported 4.75 inches over the next two days and East Lynn lake reported 5.52 inches for the same period. These amounts would have caused severe flooding in the Twelvepole Creek Basin if not for the operation of both Beech Fork Lake and East Lynn Lake. Operation of the Beech Fork project during the flood is shown in Plate No. 8-7.

As the pool began receding from the crest of the storm of 3-4 December the Water Control Section issued a Special Directive at 1520 hours on 4 December to release storage at a rate not to exceed 5.0 feet on the outflow gage and to maintain that rate until further notice. Further Special Directives were issued on 6 December at 1500 hours and 7 December at 0745 hours to reduce the discharge to stages of 3.5 feet and 3.0 feet respectively. These Special Directives were not for flood regulation, but were requested by the Geotechnical-Branch to prevent possible bank slippage due to rapid drawdown. The pool began rising from the heavy rains on the afternoon of 7 December and beginning at 1800 hours on 8 December the discharge was reduced to 10 cfs and maintained at that level awaiting the crest and recession of the Ohio River. The Ohio River crest for Ashland was 57.8 feet at 0700 hours on 12 December and had fallen 1 foot by 2100 hours that day. A Special Directive was issued by the Water Control Section in the morning of 12 December to begin drawdown of the pool by gradually increasing the outflow to a stage of 7.0 feet on the outflow gage. The pool crested at a record elevation of 602.94 feet NGVD at 0730 on 12 December. Flood storage utilization was 47 percent and the outflow was reduced to a maximum of 1,099 cfs as compared to the natural flow of 6,135 cfs that would have occurred without the project.

(5) Flood of January 1979. The higher than normal precipitation trend which began in December 1978 continued through January 1979 with sporadic rain throughout the early part of the month. Rainfall totaling over 1.7 inches began on 19 January and ended around 2300 hours on 20 January. The stage at Wayne began rising rapidly the morning of 21 January and a Special Directive was issued at 0930 hours to close to minimum discharge. Since the stage at Wayne did not continue to rise but fell instead, another Special Directive was issued at 1000 hours on 22 January to release storage at a rate not exceed 3.5 feet on the outflow gage. This lower than channel capacity rate was again requested by the Geotechnical Branch to prevent bank slippage due to an overly rapid drawdown. The pool level crested at 594.15 feet NGVD and the discharge was increased to

5.2 feet at the outflow gage on 23 January and 6.1 feet on 24 January. The peak natural discharge at the dam site would have been 3,100 cfs or 15.0 feet as shown on Plate No. 8-8. This discharge was reduced 8.9 feet to 6.1 feet or 875 cfs by Beech Fork Lake.

(6) Flood of March 1997. The month of February preceding the storm of March 1997 was a very dry month, with only 0.45 inches of rainfall in the last half, or 14 days of the month. The only real antecedent rainfall was 0.25 inches on 25 February which partially saturated the ground, but the very heavy March storm was able to do this and more. There was very heavy rainfall every day for a 6-day storm of 6.0 inches of rain with over 5 inches of runoff, and even heavier rainfall south of Wayne. The major storm began about midnight on 1 March with 3.19 inches of rainfall, followed by a heavy 0.73 inches the next day, then came 1.13 inches of rainfall on 3 March. The final day was 0.84 inches of rainfall on 5 March. When runoff began from the heavy rains early on 1 March, the lake level was at elevation 584 feet NGVD and was being held there for the winter flood season. The lake level began to rise that morning, and on through the afternoon and night as the inflow increased rapidly above the channel capacity discharge. The project was already closed to the near minimum flow because of maintaining the winter conservation pool. The Ohio River was rising at Ashland with a forecast to reach 55 feet at 1900 hours on 2 March. Operational time of 30 hours closure before the Ohio River reaches the 52 feet flood stage at Ashland required closing Beech Fork Lake late on 1 March. The Twelvepole Creek stage at Wayne crested at 27.3 feet at 1200 hours on 2 March and reached 30.6 feet at Lavalette on 1530 hours, 2 March.

Twelvepole Creek receded below control stage in the afternoon of 3 March before the Ohio River at Ashland at 2400 hours at 61.0 feet on 4 March. By 6 March, the Ohio River had fallen about three feet and continued recession was assured; therefore a Special Directive was issued to Beech Fork Lake at 0820 hours to gradually increase discharge to channel capacity in order to release flood storage. Beech Fork Lake level crested at 608.25 feet NGVD the pool of record, storing 27,055 acre-feet of flood water, or equivalent to about 68 percent storage utilization. Table No. 4-8, page 4-10, shows the natural and computed crests of Twelvepole Creek at Wayne.

c. Benefits. Financial results, or annual monetary benefits of operation of the lake for the three (3) project purposes were updated as necessary and are shown graphically in Dollar Benefits of Operation for Authorized Purposes, Plate No. 8-9. Updating of flood control benefits along the Ohio River is described in paragraph 5-10C. The accumulated flood control benefits for the twenty-two years of Beech Fork operation are estimated to be about \$17,541,000 dollars; or a yearly average of \$800,000 dollars per year. The flood control values shown, \$394,800 per year along the Ohio River, constitute damages that would be occurring in Ohio River Basin if the project were not operating.

8-03 RECREATION

Success of the recreational purpose of the project, as measured by the number of visitors, has been fair to good. Forecasts of annual initial and ultimate visitation at the project were 590,000 and 1,000,000 respectively. The actual visitations were somewhat depressed at first, but they have gradually increased to near the full projection. The relatively low values of recreation use may be a result of economic factors as well as the fact that the recreation facilities planned for the project have not been completed at the rate originally assumed. Some of the planned areas have been cancelled and improvements at other areas have been delayed or cancelled. Visitations calculated from traffic counts are below in Table No. 8-2.

Pool rises due to flood control operations tend to diminish recreation benefits and they may have had an effect on the above figures. The lake level begins to affect camping at elevations above 597 feet NGVD. Within this elevation range water comes into campsites in Lower Bowen Campgrounds and threatens the electrical systems. These and other flooding elevations at recreation sites are shown in Table No. 8-3, page 8-8, with probable frequency of occurrence. Plate No. 8-1, Frequency of Filling, shows the probable time between occurrences of elevations of the pool and Plate No. 8-2, Duration of Filling, shows the probable length of time of each occurrence.

TABLE NO. 8-2

VISITATION AT BEECH FORK LAKE

<u>Years</u>	<u>Visitors</u>
1978	108,600
1979	272,400
1980	391,900
1981	403,300
1982	426,000
1983	426,000
1984	525,300
1985	515,300
1986	519,900
1987	555,000
1988	603,800
	<u>Visitor Hours</u>
1989	3,733,300
1990	3,843,900
1991	4,503,000
1992	6,690,000
1993	6,506,700
1994	6,506,700
1995	6,762,200
1996	6,053,300
1997	5,395,200
1998	6,244,400

High water levels affect boating by causing difficulty in launching and recovery, which increases as the water level approaches the top of the ramp. Special techniques are required when the level is above the ramp top. Plate No. 8-1 shows a 9-year exceedence interval for a pool elevation of 600 feet NGVD which is above the top of ramp elevation at both the Beech Fork boat launch and at the Bowen boat launch. Newly inundated obstacles cause anxiety and potential danger to boaters and water skiers. Hiking is not affected by pool levels up to flood control pool elevation, 614.5 feet NGVD.

Drawdown of the lake during dry weather due to the 5 cfs minimum discharge will occur infrequently, but any significant drawdown will produce detriments to recreation interests. Such items as mud slicks, vegetation uncovering, unsightly shorelines, concessionaire-related problems, and boating restrictions will occur as the pool level is lowered. Low pool levels are expected to be of longer duration when they do occur and may require placing of bouys and/or other warning devices. Hiking, picnicking and camping are largely unaffected by drawdown.

TABLE NO. 8-3

FLOODING ELEVATIONS AND FREQUENCIES AT BEECH FORK LAKE SITES

Area	Item	Flooding Elevation ft. NGVD	Frequency, yrs between occurrences
Dam Overlook	Maximum pool elevation	N/A	
Dam Site	Boat launch and parking	601	19.5
Bowen Recreation	Campground	597	4.2
Area	Boat launch and parking	601	19.5
	Comfort station floors	599	6.9
Stowers Branch	Beach	594	2.2

When the Beech Fork Lake project was planned, U.S. Senate Document 86 was followed in assigning the benefit value of \$1.00 per visitor-day common during that period. Currently, U.S. Water Resources Council "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies", dated March 1983, may be used to assign benefit values. The Principles give points of incremental value based on characteristics of recreation possibilities in comparison with the ideal and availability of alternative facilities. Points thus determined for Beech Fork Lake indicate \$3.10/visitor-day for general recreation and \$3.50/day for fishing or hunting. The portion of total 1988 visitation, 603,800, in Table No. 8-2, page 8-7 calculated for general recreation was \$327,200. Therefore, the value of general recreation benefits for calendar year 1982 is shown as \$1,014,300 in Benefits of Operation for Authorized Purposes, Plate No. 8-9.

8-04 WATER QUALITY

Special Problems. The most significant water quality problem affecting Beech Fork Lake was related to excessive levels of iron and manganese in the lake hypolimnion during summer and fall seasons. This caused problems when trying to meet temperature objectives during that timeframe. During fall turnover, concentrations of manganese in the lake were high. This resulted from high levels of manganese in the lake hypolimnion mixing with the rest of the lake. Demand on dissolved oxygen was also high during the summer months. Available dissolved oxygen only extended to a depth of about 6 feet in the lake. Anoxic conditions existed deeper than 6 feet.

Data Interpretation and Results. An interdisciplinary approach is used to evaluate the physics, chemistry, and biology of inflow streams, the lake, and the outflow. The following interpretations are based on data collected between 1973 and 1995.

Physical/Chemical. The chemical composition of water may be defined by grouping substances, which compose the dissolved solids. Relationships among groups of chemicals determine the type of water. In terms of major ions and descriptive parameters, water in Beech Fork Lake is classified as a calcium carbonate type. This represents a balanced condition.

Biological. In a freshwater community, algae are the primary producers. They serve as the basis of the food chain and are the primary food source for most aquatic animals. The quantity and types of algae present in a stream or lake is dependent upon many factors, such as temperature, oxygen, light, nutrients and flow. All freshwater algae contain the green pigment chlorophyll. Therefore, measuring chlorophyll can monitor the productivity of aquatic habitats. Algal productivity was low in headwaters with average chlorophyll concentration of 3.8 ug/l in Beech Fork and 4.0 ug/l in Millers Fork. Productivity on the lake was considered normal with average chlorophyll concentrations of 10.2 ug/l.

Impounded waters are in more or less dynamic states. The governing factor in water quality development is the temporal and spatial behavior of the density of this water. In most fresh water systems, water temperature is the predominant factor in determining density. Temperature variations in water masses are capable of creating strata of water of greatly different characteristics. Such differing characteristics have direct implications with regard to lake-releases.

Normal lake structure will typically cycle from a mixed condition (Temperature same from top to bottom) to a stratified or layered condition (Temperature changes with depth). This is the result of thermal energy from the atmosphere gained and lost during the year. During the winter, water temperatures are the same from top to bottom and the lake is considered mixed. During spring as air temperatures start to warm, so do surface water temperatures. This creates a surface layer called the epilimnion. Water temperatures near the

bottom remain cool because they are not exposed to the sunlight or warmer air temperatures. This layer is called the hypolimnion. The layer in the middle is referred to as the metalimnion or transition layer. During the fall season when air temperatures start to cool the surface water temperature also cools and mixes with water below at the same temperature. This process continues until water temperature in the epilimnion is the same as the hypolimnion and the lake is once again mixed.

Beech Fork Lake remains nearly isothermal during the winter months. In the spring, under normal conditions, the lake stratifies and remains so until November. At that time the lake mixes and becomes isothermal again. In an attempt to increase the available volume of the lake for fishing, the lake was de-stratified using mechanical mixing pumps. The pumps pushed high quality water to the bottom of the lake which, in turn, caused poor quality water at the bottom to move to the surface. Once the water reached the surface it absorbed oxygen and the quality improved. This also caused the lake to warm as cold water was moved to the surface where it gained heat. As shown in Plate No. 8-10, Water Temperature, a weak thermal stratification pattern remained. Specific conductance data did not indicate the existence of a density layer resulting in inter-flows through the lake during the summer months with or without the mechanical mixing. The, water entering the lake remained there for about 1.5 months before it was released to the downstream area. This is an average number. Water remains in the lake longer in the summer during times of low-flow and shorter in the spring during times of high flow.

Dissolved oxygen levels are extremely important in water quality characterization. They depend on the physical, chemical, and biological activities that occur in water. Dissolved oxygen saturation limits are directly related to temperature. Thermal stratification can result in zones that exhibit greatly different characteristics. In well-mixed epilimnetic waters, relatively high levels of dissolved oxygen occur and water is usually of acceptable quality. Water in the hypolimnion may become void of oxygen, as a result of various oxygen demanding processes. Therefore a concomitant decrease in water quality can occur after stratification becomes established. Concentrations of dissolved oxygen in Beech Fork Lake remained constant throughout the water column after fall mixing completed, sometime in November, and remained so until around April when the lake would normally stratify. At that time, dissolved oxygen levels in the hypolimnion declined rapidly until anoxic conditions were reached. Mechanical mixing of the lake reduced thermal stratification, but not chemical stratification. Under normal conditions, dissolved oxygen remained above 5.0 mg/l in the epilimnion and then dropped to 0.0 mg/l in the metalimnion and hypolimnion. This meant that about 41% of the lake had oxygen levels above 5 mg/l. Mechanical mixing increased that to about 52%. Dissolved oxygen is one of the key parameters for fishing and this represented the maximum amount of lake available for fishing during most of the stratification season. Mechanical mixing provided some improvement, but not enough to warrant the cost of the mixing and the changes to the tailwater

area. Plate 8-11, Dissolved Oxygen, shows typical dissolved oxygen content during the summer months with and without mechanical mixing.

Beech Fork and Millers Fork are the major inflows to Beech Fork Lake. Dissolved oxygen concentrations in Beech Fork average 85% saturation, in Millers Fork average 84% saturation, and in the outflow average 91% saturation. The outflow system was designed to allow some regulation of the quality of the water during low-flow conditions. The data indicated an improved condition in the tailwater when compared to the inflow.

Concentrations of nutrients in a lake are an indicator of productivity. Low productivity results in fewer littoral plants and low density of phytoplankton, whereas highly productive lakes are characterized by littoral plants and abundant phytoplankton populations. The amount of productivity is directly related to the lake fishery. Sufficient quantities of phosphorous, nitrogen, and carbon are needed to have a productive lake. Beech Fork Lake is considered productive with phosphorous as the limiting nutrient. Nutrients are transported with sediments. As water enters a lake, its velocity decreases and the sediments settle to the bottom. Because of this phenomena, it is common to see algal blooms at the upper end of a lake. Phosphorous concentrations averaged 0.03 mg/l in the inflows and 0.04 mg/l in the outflow which indicates that there was available phosphorous in the tailwaters.

The pH is a measure of the hydrogen ion concentration. It can be raised by adding a base or removing carbon dioxide from a solution such as in photosynthetic assimilation. By definition, pH ranges from 1 to 14 and a pH value of 7.0 is considered neutral. Mean pH values in the headwaters to Beech Fork Lake were around 7.1 and 6.9 in the tailwaters. The average numbers indicate near neutral conditions. Long-term trends indicate no significant pattern in pH values over the entire watershed.

While pH is a measure of concentration, alkalinity is a measure of capacity. The capacity of a solution to neutralize acids or bases is called buffering capacity. Average alkalinity, a factor buffering pH, was around 56 mg/l CaCO_3 in the headwaters and 42 mg/l CaCO_3 in the tailwaters. These are low numbers and indicate little buffering capacity to resist shifts in pH within the basin.

Water hardness is the sum of calcium and magnesium concentrations expressed in terms of mg/l calcium carbonate. It is the largely a result of geological formations at the water source. Calcium and magnesium form an insoluble residue with soap and leave deposits on surfaces that come in contact with the water. The ring around a bathtub is a well known example of these deposits. Detergents were introduced to reduce this problem. High hardness (hard water) results in high soap consumption as well as objectionable scale in heating vessels and pipes. Public acceptance of hardness varies. Many consumers will object to water harder than 150 mg/l calcium carbonate (Water Supply and Pollution control). Average water hardness at the

main inflows was 68 mg/l calcium carbonate and was 55 mg/l calcium carbonate in the tailwater. This range is classified as moderately hard to soft based on U.S. Geological Survey classifications.

Iron is an abundant element on the earth, but usually occurs as an insoluble form in water and at low concentrations. Concentrations of iron in the headwaters of Beech Fork Lake averaged 1041 ug/l in Beech Fork and 646 ug/l in Millers Fork. This average increased to 1286 ug/l in the tailwaters, most likely due to the fact, that releases from the lake are unregulated for water quality during storm events. The amount of water available in the epilimnion to dilute water in the hypolimnion is not sufficient to lower the iron levels below 1000 ug/l, which is the West Virginia standard. During the stratification season, iron levels remained below 100 ug/l in the lake epilimnion and metalimnion, but exceeded 4000 ug/l in the hypolimnion, Total Iron, Plate No. 8-12. This was the result of anaerobic conditions in the hypolimnion during that season. High levels of iron imply a potential problem for the aquatic community. Releases from the hypolimnion could cause impacts to the tailwater area. Regulating these releases prevents the high concentrations of iron in the tailwaters most of the time. Long-term trends indicated no significant changes in iron concentrations.

Concentrations of manganese in the headwaters were above a standard of 1000 ug/l. Manganese averaged 2743 ug/l in Beech Fork and in Millers Fork averaged 2970 ug/l. During lake stratification, manganese levels were above 2000 ug/l shown on Plate No. 8-13, Total Manganese. The high concentrations of manganese in the hypolimnion were not reflected in tailwater readings. This was the result of regulating releases using the selective withdrawal structure. Average manganese levels were similar to inflow concentrations. Long term trends indicated no significant change in manganese concentrations.

Freshwater macroinvertebrates (aquatic insects and worms, crayfish, mussels, etc.) serve as a useful tool for evaluating environmental impacts that occur over time. Because of their limited mobility and their relatively long life span, these organisms are subjected to the environmental conditions of their immediate aquatic habitat. Macroinvertebrates have been used as an assessment parameter to evaluate overall water quality conditions for the inflow stations on Millers Fork and Beech Fork, and the outflow station below Beech Fork dam.

Overall Quality Rating: OQR is derived from the BMWP score and the ASPT. The BMWP (Biological Monitoring Working Party) was designed to give a broad indication of the biological condition of rivers and streams. Identification of organisms, from macroinvertebrate samples, is made to the family level. Each family is given a score, between 1 and 10, depending on their susceptibility to pollution. Taxa least tolerant, such as families of mayflies and stoneflies, are given the highest scores. The BMWP score is the sum of the family scores. The BMWP score is then divided by the number of families to produce the Average Score Per Taxon (ASPT). The calculated BMWP score (X) and ASPT (Y) are then give a rating between 1 and 7, depending on whether the

site or station is classed as a habitat-rich riffle, or a habitat-poor riffle/pool. The overall quality rating is derived as $QQR=X+Y/2$.

Results: The OQR and interpretation for the above water quality stations are presented on Overall Quality Rating for Macroinvertebrates on Plate No. 8-14. Data is based on benthic samples collected from 1978 through 1995. The two inflow stations had moderate quality, while the outflow station had poor overall quality.

The most common groups of macroinvertebrates collected in the benthic samples from the outflow station were black flies (40%) and chironomid midges (30%). Mayflies, stoneflies, and caddisflies accounted for less than 7 percent of the total. The common groups collected at the two inflow stations were: Millers Fork -- mayflies (25%), stoneflies (12%), caddisflies (18%), and midges (23%); and Beech Fork -- mayflies (26%), stoneflies (10%), caddisflies (33%), and midges (21%).

8-05 FISH AND WILDLIFE

Effects of water control management on fish and wildlife are those associated with pool level fluctuations in the lake area and those of the outflow on downstream fisheries. Spawning season, usually from May through the middle of June, is a time when these fluctuations are critical. When the pool level builds up two feet or more during rainfall runoff and is returned to seasonal elevation, 592 feet NGVD, in from two to five days, spawning success suffers among black bass and other species. Black bass numbers reported by West Virginia Department of Natural Resources, Fisheries Section, from studies at various lakes seem to reflect the often reported positive correlation between pool stability and spawning success. The correlation was noted particularly with regard to the largemouth variety which is the black bass species most caught in the lake. Numbers of young-of-the-year largemouth bass counted are always in rough proportion to the degree of stability of the pool, or in inverse proportion to the amount of variation in pool level. In early 1985, Fisheries Section personnel stated that none of their data indicate any bad effects in spawning success in Beech Fork Lake due to pool level fluctuations.

Stratification effects on the lake fishery stem from the difference between values of temperature and concentration of dissolved oxygen in upper and lower levels in the water column discussed in subsection 7-04. Low temperatures and concentrations occur at lower levels and higher values at upper levels. Fish species seek out their most desirable habitat. During the period of most severe stratification, the depth of water containing desirable oxygen concentration becomes shallower in the deepest areas of the lake. Then fish migrate up-lake to shallower areas resulting in a temporary lateral displacement of populations within the lake.

Major benefits to wildlife of Corps occupancy of lands purchased, but not submerged or utilized for recreation areas, were claimed for fire control efforts and the vegetation changes occurring during reversion

of farm lands to forest. The range appears to be healthy for forest animals with white-tailed deer experiencing a steady growth in population.

Each year food plots in the Stowers Branch area are planted with corn, sorghum, millet and buckwheat to provide new sources of food for both game and non-game species. During each summer, after animals have bred and produced young and the young are old enough to maneuver for themselves, improved habitat in approximately 150 acres are strip mowed to provide various stages of succession. Fire trails and access roads have been laid out and improved as needed. Opening up of clearings that have been lost to succession is carried out on about 150 acres each year by brush-hogging and mowing.

A license was granted in November 1983 from the Corps of Engineers to the West Virginia Department of Natural Resources under which WVDNR assumes all wildlife conservation management responsibilities on Beech Fork Project lands except for a belt or area of 1,375 acres surrounding the dam site.

The eggs and young of the year of ground-nesting birds, small-mammals and reptiles are lost during a rise of 10-15 feet, those closest to the lake during smaller rises. Such a rise also kills the herbaceous vegetation which is the food source of small mammals; however, losses of these animals are not as critical due to their fecundity. Although these rises reduce the carrying capacity, there has been little observable adverse effect of flood regulation on poolside wildlife.

Also, there has been negligible effect of drought-caused drawdown on fish and wildlife. Muddy banks cause turbidity in nearby water due to the lapping of water against the bank. Many fishermen believe this lessens the catch because fishes have difficulty seeing the bait or lure. A drawdown of 4 feet will likely expose or make too shallow some littoral zones which are the best fishing grounds. Losses will be sustained among aquatic insects and other members of the fish food chain whose habitat is the shallow mud of these zones. Such a drawdown is likely to force fry and young of the year out of thick, normal cover into unprotected areas where they are more easily utilized as food by larger fishes. A portion of the food chain may be impaired if mud flats are exposed into which amphibians and invertebrates have burrowed for body temperature control.

Extremes of high and low-flows downstream from the dam are not as great as before the project (1 year frequency natural flow at the damsite is 2,500 cfs from Plate No. 5-2); but the lesser flushing action of channel capacity discharge, 1,410 cfs, for several days while releasing flood storage has similar effects. In either case, temporarily, fish populations are displaced and food supplies diminished. The minimum discharge helps maintain the downstream fishery against the increased fishing pressure. The major adverse effect of high discharges from the lake may be the frustration of fishermen at the tailwaters because of the fast current pulling their lines downstream too quickly.

Temperature of the downstream aquatic habitat has been controlled fairly smoothly along the Outflow Temperature Regulation Curves of Plate No. 7-9. Since the curves were designed to approximate natural temperatures common in area streams, this factor of the habitat has been much more favorable to native species than if temperature control were not practiced and outflow was limited to bottom discharge.

Beech Fork Lake fishing and hunting opportunities were recently analyzed according to U.S. Water Resources Council "Principles" of March 1983 and the analysis yielded points indicating \$3.50/visitor-day benefits for fishing or hunting at the project. The portion of total recreation visitation at Beech Fork Lake in calendar year 1982 determined to be involved in fishing or hunting was 99,000. Therefore, the fish and wildlife benefit for the year is \$346,500 as graphed in Benefits of Operation for Authorized Purposes, Plate No. 8-9. These benefits are expected to continue under state management of wild life areas.

8-06 WATER SUPPLY

Prior to construction of Beech Fork Lake, summer flows in Beech Fork and Twelvepole Creek below the dam site often decreased to less than 1 cfs, nearly zero, and occasionally remained there for a week or more, creating foul stagnant or near stagnant conditions that were harmful to fish and food chain organisms. Stream fisheries need flowing, oxygenated water at normal temperatures. When the first modern new environmental policies were developed nationwide they were soon applied regionally to the Twelvepole Creek Basin to resolve water shortage problems. Accordingly, Beech Fork Lake was planned to provide water for both low-flow augmentation and municipal water supply, and the two functions have been combined into one purpose. The lake was designed and partitioned to guarantee the summer water supply and recreation pool of 592 feet MGVD and the winter minimum pool of 583.5 feet NGVD that would supply an estimated need of 5 cfs continuously for the State of West Virginia. This rate was selected after a study to determine the maximum rate that does not exceed the maximum acceptable drawdown in the driest year, and this discharge is to be maintained at all times, even during closure for flood control.

Beech Fork Lake inflow normally exceeds the design minimum discharge of 5 cfs plus the evaporation except during the driest periods. The increase in minimum flow below the dam discussed in 7-03a is the basis of the statement in 8-05 of benefit to the fisheries downstream, and is a large benefit to the fisheries downstream. The characteristic downstream low-flow in dry periods is indicative of very low inflows at those times, and when coupled with evaporation from the 720 acre summer lake may cause lowered lake levels in dry weather.

Maintaining the summer pool level has been possible most of the time; however, during the long dry spring and summer of 1999 the seasonal pool could only be raised to elevation 588 feet NGVD before the long summer drawdown began to about elevation 586. Near the end of August a

strong summer storm raised the pool to near elevation 590, and later in October the pool was raised to about elevation 591, but no more. As a result the normal November 1999 winter pool reduction was not fully needed. The pool elevations in Table No. 2-1 page 2-2, are predicated on projections of historic hydrologic conditions and the assumption that the entire allocated water supply storage will be utilized daily. It should be noted, however, that for the Beech Fork Lake Project, water for the user area generally is properly regulated, making related drawdown conditions much more suited to recreational activities.

8-07 EMERGENCY DRAWDOWN

When reservoir discharge is limited to maximum summer no-damage channel capacity of 1,410 cfs and inflow is constant at 160 cfs (2 cfs per square mile of controlled drainage area), the time required to empty the flood control pool at elevation 614.5 feet NGVD to seasonal elevation 592 feet, NGVD is 11.4 days. The time required to empty the flood control pool to minimum elevation, 583.5 feet NGVD, is 10.7 days with the same inflow and maximum winter discharge of 1,780 cfs. In both cases, channel conditions downstream are assumed capable of accommodating the discharge without damage. With the same inflow and all slide gates fully open, the emptying time to elevation 583.5 feet NGVD would be 6.8 days, as shown on Plate No. 7-10, Emergency Drawdown Curve.

8-08 SPECIAL PURPOSE RELEASES

Examples of deviations from the approved plan of regulation which might be requested and granted were listed in 7-06. Special purpose regulation can involve either higher or lower than normal discharges. Both types of special purpose regulations have occurred at Beech Fork Lake. Lower than normal discharges have been approved to: aid in the search for scientific equipment lost in the stream, permit construction work below the dam, allow fording of the stream by farm animals, allow for maintenance work in the outlet works, aid a West Virginia Department of Natural Resources fish study, and to conserve storage in anticipation of future drought. Higher than normal discharges have been approved to aid construction in the lake area and to lower the lake level to allow the lake to be used for military training exercises. Each of the special purpose deviations from approved plan accomplished its desired effect. None of them adversely impacted any authorized purpose.

8-09 FREQUENCIES AND DURATIONS

a. Natural Discharge Frequency and Duration at the Outflow Gage. The natural discharge-frequency curve for Beech Fork at the Beech Fork Lake outflow gage was developed on a regional basis in accordance with methods outlined in "Statistical Methods in Hydrology," by Leo R. Beard dated January 1962 and Bulletin 17A,

"Guidelines for Determining Flood Flow Frequency," published by the United States Water Resources Council and dated March 1976. The analysis was based on stream flow records for the Twelvepole Creek gage at Wayne, West Virginia. Since the stream is ungaged in the vicinity of Beech Fork dam site, regression methods were used to determine a flow frequency curve. A regional multiple linear correlation study had previously been made to relate both the mean flow and the standard deviation of all surrounding gaging stations to various basin characteristics in the Big Sandy, Guyandotte and Twelvepole Creek Basins. As a result of this study, a separate regression equation was derived for the mean and standard deviation for the ungaged stations in the basins. Using these computed equations, an annual flow frequency curve was computed for Beech Fork dam site. A corresponding partial duration curve was determined analytically by the use of average criteria. The final curve was further adjusted, based on the actual record and the partial curve for the gaging station at Wayne.

The curve derived by plotting probable maximum flow to be expected at the dam site against exceedence interval in years, is shown as Plate No. 5-4. Flow values for certain exceedence intervals from 1 year to 100 years are given in Table No. 8-4, Frequency Summary, this page, Beech Fork at Beech Fork Lake Outflow Gage, All Season, Natural.

TABLE NO. 8-4
FREQUENCY SUMMARY
BEECH FORK AT BEECH FORK LAKE OUTFLOW GAGE
ALL SEASONS - NATURAL

Exceedence Interval Years	Discharge cfs
100	11,500
50	9,740
20	8,450
10	5,840
5	4,640
2	3,320
1	2,475

Since January 1978, flows in Beech Fork have been regulated by Beech Fork Lake. A computer study of the duration of flow at the outflow gage was conducted using the USGS record of flow past the gage for the period January 1978 to September 1982. Percent of total elapsed time during which the flow was at or above selected values was calculated. These flow values were then plotted against the percent of time as calculated for the full year to produce Flow Duration below Beech Fork Lake, Plate No. 5-3.

b. Pool Elevation Frequency and Duration. Frequency and duration of filling curves were developed for Beech Fork Lake based on USGS gage records for Twelvepole Creek at Wayne from 1915 to 1965 and then extended on the basis of historical flood data and observed meteorological records. The hydrographs were routed through the lake following the approved plan of water control and the peak pool elevation noted. Using the graphical analysis method described in Beard's work mentioned in 8-09a above, the pool elevation frequency was estimated and is shown in Frequency of Filling, Plate No. 8-1. Deviation from the minimum elevation, 583.5 feet NGVD was plotted as pool elevation probability of occurrence on the average once in a number of years, which is the exceedence interval, against the interval. Selected exceedence intervals with the respective maximum pool elevation expected to occur (on the average), once in that interval are listed in Table No. 8-5, below, Frequency Summary, Beech Fork Lake Pool Elevation Deviation, below. The Duration of Filling curve is shown as Plate No. 8-2.

c. Control Station - Wayne, West Virginia. The natural frequency of Twelvepole Creek below Wayne was estimated using nearly the same methods and techniques of data handling and calculation as were used for Beech Fork at the damsite. The major difference was that a 55-year record existed for the Wayne gage, making unnecessary the regional approach used for ungaged areas. The moving of the gage in December 1966 from the upper edge of Wayne to the lower end, below town, adding 9 square miles of drainage area, required adjusting the flow data accordingly.

TABLE NO. 8-5
FREQUENCY SUMMARY BEECH FORK LAKE
POOL ELEVATION DEVIATION

Exceedence Interval Years	Elevation Feet NGVD.
100	609.9
50	606.7
20	603.0
10	600.5
5	597.6
2	593.0
1	592.0

Maximum natural flows expected to occur, on the average, once in a certain period of years, which is the exceedence interval, were plotted against the respective intervals to produce a natural curve of flow frequency for Wayne. In order to estimate the modified frequencies at Wayne now that East Lynn lake is in operation, representative floods from the record prior to beginning operation of the East Lynn project were routed through the lake and reductions routed to the Wayne gage. These were applied to the actual (natural) and the resulting modified peaks noted. Flows for selected exceedence intervals from 1 year to 100 years are included in Table No. 8-6, below.

TABLE NO. 8-6
FREQUENCY SUMMARY
TWELVEPOLE CREEK BELOW WAYNE, WEST VIRGINIA

Exceedence Interval Years	Natural		Natural Modified by East Lynn Lake	
	Stage feet	Flow cfs	Stage feet	Flow cfs
100		24,200	30.3	12,800
50		21,200	28.7	11,200
20		17,300	26.2	9,200
10	31.9	14,500	24.0	7,700
5	29.1	11,600	21.4	6,200
2	24.7	8,100	18.1	4,550
1	21.2	6,100	16.8	4,000

SECTION IX - WATER CONTROL MANAGEMENT

9-01 RESPONSIBILITIES AND ORGANIZATION

a. Corps of Engineers. General authorities for allocation and regulation of reservoir storage in projects owned and operated by the Corps of Engineers are contained in legislative authorization Acts and referenced project documents. These public laws and project documents usually contain provisions for development of water control plans, and appropriate revisions thereto, under the discretionary authority of the Chief of Engineers. Some modifications in project operation are permitted under congressional enactment subsequent to original project authorization; regardless, Beech Fork Lake is fully owned and operated by the U.S. Government. The Huntington District, Corps of Engineers is the operating agency under administrative control of the Big Sandy Area office within the Operations and Readiness Division.

b. OCE Role in Water Control Activities. OCE will establish policies and guidelines applicable to all field offices and for such actions as are necessary to assure a reasonable degree of consistency in basic policies and practices in all Division areas. Assistance will be provided to field offices during emergencies and upon special request.

c. Great Lakes and Ohio River Division. The Division Engineer has primary responsibility and authority for direct action with respect to all phases of reservoir regulation, including: (a) basic policies, criteria, and concepts that determine operating plans; (b) technical evaluations; (c) field operation; and (d) review and approval of reservoir regulation plans and manuals and related activities. The Division Office will coordinate water control management activities associated with inter-district, inter-division and interagency water resource needs. As established in accordance with ER 1110-2-1400, the Great Lakes and Ohio River Division Water Control Center is responsible for administration of the Division Engineer's policy for water control management.

d. Huntington District. The District Engineer has the primary responsibility for: (a) general management of reservoir regulation activities within their respective areas; (b) technical evaluations and performance of operations associated therewith; and (c) developing plans and manuals required for reservoirs and interrelated systems within their respective district area. The Water Control Section, within Engineering Division, is the responsible element for all water control activities which include the following reservoir project functions.

- (a) Flood Control;
- (b) Regulation of flows for water supply and water quality control;

- (c) Navigation-stage regulation;
- (d) Hydropower;
- (e) Recreation;
- (f) Fish and Wildlife enhancement;
- (g) Alleviation of sediment and erosion problems affected by reservoirs.

Water control plans include coordinated reservoir regulation schedules for project/system operation and such additional provisions as may be required to collect, analyze and disseminate basic data, prepare detailed operating instructions, assure project safety and carry out regulation of projects in an appropriate manner. Water control plans will be developed utilizing objectives and specific provisions of project authorizing legislation and applicable Corps of Engineers reports. They will include any applicable authorities established after project construction. All water control plans will be prepared with appropriate consideration to all applicable congressional acts relating to operation of Federal facilities. Included are the Fish and Wildlife Coordination Act (PL 85-624), Federal Water Project Recreation Act - Uniform Policies (PL 89-72), National Environmental Policy Act of 1969 (PL 91-190), and Clean Water Act of 1977 (PL 95-217). Thorough analysis and testing studies will be made as necessary to establish the optimum water control plans possible within prevailing constraints.

Water Resources Engineering Branch is further delegated the responsibility to coordinate the operation of specific projects with Federal and State agencies, local entities, and the general public. The Division Engineer, ATTN: CELRD-EC-W, is advised, as soon as possible, of any coordination activities which may require a study, public hearing, or revision in operating plans. Districts are required to alert the Division Engineer, ATTN: CELRD-EC-W, of any significant deviations from routine regulation plans. The communication mode for the advisory is commensurate with the urgency of the situation and is transmitted before the district implements a plan of action. An organizational chart is shown on Plate No. 9-1 for Water Control Management in the Twelvepole Creek Basin. As shown on the chart, the Recreation-Resource Management Branch and the Big Sandy Area Office are responsible for supervision of the operation and maintenance of the dam and operations area at Beech Fork Lake. The Damtender at each project regulates the project in accordance with general instructions and Special Directives issued by the Water Control Section. General instructions are included in Instructions to Damtender, Exhibit B of this manual. Special Directives are issued and signed by the Chief, Water Control Section, for dissemination through the Project Office, as necessary to efficiently regulate the project for optimal water control management for all project purposes.

During normal operations, the Water Control Section of the Water Resources Engineering Branch are involved in the following activities pertaining to water control management:

(1) Routine regulation of the lakes and dissemination of pertinent data.

(2) Investigations and refinement of regulation procedures such as analysis of past floods, channel investigations, improvement of forecasting, and planning programs with other agencies.

(3) Training personnel in flood control duties with visits to projects and instructing Water Resources Engineering Branch personnel from other sections.

(4) Development and application of mathematical modeling to complex reservoir systems.

(5) Operation of the Branch hydrologic data collection and water control management system, including computers and field equipment.

(6) Developing and conducting effective public information programs to inform and educate the public regarding Corps of Engineers' water control management activities.

(7) Preparing and submitting reports on lake regulations such as daily reports, weekly reports, monthly reports, annual reports, weekly briefings, and post-flood reports.

(8) Preparing and updating water control manuals for individual projects and master manuals for basins.

During flood or other emergencies, Water Resources Engineering Branch personnel are responsible for the following activities in regard to water control management:

(1) Evaluation and dissemination of current and forecast hydrologic, hydraulic and meteorologic data.

(2) Presentation of storm and flood analysis to the District Engineer and pertinent staff members.

(3) Providing liaison personnel to support Emergency Operations Center when it is operational.

(4) Regulation of all projects and systems in accordance with approved plans.

(5) Furnishing information to others such as reports to higher authority, status to Emergency Operations Center and data to Public Affairs Office.

During a FLOOD EMERGENCY SITUATION the lines of communication between the various office elements are shown on Plate No. 9-2. Details and responsibilities of other elements are indicated in the overall district plan in the Emergency Operations Center Plan and ER 500-1-1, ER 500-2-1 and all annexes to these two ER's.

During normal non-flood periods, water control management activity is accomplished by personnel of the Water Control Section. During flood conditions, assistance of other Water Management Engineering Branch and other emergencies personnel may be required to maintain effective water control management within the Huntington District. The area affected and magnitude of the flood determines the number of people engaged in each particular activity and assigned to each sub-basin or major river basin.

The National Weather Service and project personnel are provided with a list of names of Water Resources Engineering Branch personnel and home telephone numbers with instructions to contact them during off-duty hours if unusual conditions occur or a project is in a particular reporting schedule. During emergency conditions or flood regulation, Water Resources Engineering Branch staff are available from 18 to 24 hours daily, depending on the magnitude of a particular event. At each project, responsible personnel are on duty or on call at all times.

e. Other Federal Agencies. The National Weather Service and the U.S. Geological Survey cooperate and coordinate activity with the Water Resources Engineering Branch in regard to accumulation of rainfall and streamflow data, as well as river forecasts and discharge measurements. The Corps of Engineers is required by the Fish and Wildlife Coordination Act (48 Stat. as amended) to coordinate all plans affecting Fish and Wildlife with the U.S. Fish and Wildlife Service. The service is required to present the plans to the relevant State Agency, in this case, the West Virginia Department of Natural Resources, for their comments and recommendations. The Service then presents a combined report to the Corps including its comments and recommendations and those of the West Virginia Department of Natural Resources.

The Huntington District also works in cooperation with other Federal, State, local and private organizations and agencies, as has been illustrated throughout this report. A summary of the major relationships is shown on Plate No. 9-3.

f. Local and State Agencies. No local or state agency has funding or operational responsibilities in the Huntington District multipurpose reservoirs except in leased recreational areas. The State of West Virginia constitutionally holds in trust all wild animal life in the state on both public and private lands, and all aquatic life in public waters. The State Department of Natural Resources, as mandated by State Code, has the responsibility for conservation of fish and wildlife and for boating safety at the project lakes. The Game Protection Division of the Department of Natural Resources enforces hunting regulations and licenses on the reservoir lands. The State has

undertaken fish management at the project lakes and the Corps of Engineers cooperates in the lake level manipulation and maintenance of downstream flow requirements to enhance fisheries management.

g. Private Organizations. There are no private interests presently involved with Beech Fork Lake or any of the adjacent Big Sandy or Twelvepole Basin lakes.

9-02 INTERAGENCY COORDINATION AND COOPERATION

a. National Weather Service. An agreement between the National Weather Service (NWS) and The Corps of Engineers provides for collection and dissemination of current precipitation data for the Ohio River Basin. By joint agreement, the NWS installs, maintains and operates all stations in the Ohio River Network, except those operated by the Corps of Engineer personnel at flood-control and navigation projects. Where there is a mutual need for the data, station costs are shared by both the NWS and the Corps of Engineers. Costs of stations required for reservoir regulation are borne entirely by the Corps of Engineers. In either case, an annual transfer of funds from the Corps of Engineers to NWS is made to cover the required expenditures. As described in paragraph 6-02b, NWS provides a range of tributary stage information and forecasts. The Corps reciprocates, providing NWS with all precipitation, snow cover, and stage information from reservoir and other reports, pool level and outflow forecasts, and depth reports from the District Snow Cover Reconnaissance.

b. U.S. Geological Survey. The Cooperative Stream Gaging Program was established about 1940 through cooperative arrangements between the Corps of Engineers and the U.S. Geological Survey in order that sufficient stream flow water would be available to meet special needs in connection with the Corps water resources responsibilities. This is in keeping with the Chief of Engineers policy of fully utilizing the facilities and services of other Federal Agencies in obtaining many types of basic data. Accordingly, arrangements were made for the Geological Survey to operate specific stations for the Corps on an advance of funds basis. Although the Corps of Engineers requires the basic data, many other Federal, State, and private agencies and individuals interested use the water data. The data are published by the survey assuring maximum availability and use of all data.

The Geological Survey coordination and cooperation with the Corps, described in paragraph 6-20a, provides the Water Resources Engineering Branch with a system for obtaining reliable stage and flow information which is necessary for efficient water control management.

The annual program is formulated by the Water Resources Engineering branch in collaboration with appropriate District Chiefs of the Geological Survey. The Corps of Engineers and the local representative of the U.S. Geological Survey determine the necessary stations to provide the data for publication and the Corps is requested to furnish

an estimate of the costs of installing and/or operating each station. The District Engineer forwards the selected program through the Division Engineer to the Chief of Engineers. Any supplemental instructions of a current nature necessary in connection with preparation of the report are issued annually by the Chief of Engineers.

c. West Virginia Department of Natural Resources. Functional agreements, meetings, and contacts with various divisions of the Department of Natural Resources are discussed below. They are important to operation of the project in accordance with project purposes and with the recommendations of the West Virginia Department of Natural Resources and the U.S. Fish and Wildlife Service.

The West Virginia Department of Natural Resources maintains an Office of Corps Liaison for the purpose of coordinating special releases from Corps Lakes for recreational or other purposes. This office receives all requests for special regulation and, after examining the request and appending to it any WVDNR comments, sends the request to the District Office. Using the Corps based guidance policies and criteria a determination is then made, and this decision is then sent back to the WVDNR to coordinate with the organization making the request.

Water Control Section cooperates with the Recreation and Parks Division of WVDNR by manipulation lake levels as needed.

The Huntington District cooperates with the Fisheries Section of the Division of Wildlife of the West Virginia Department of Natural Resources in lake level manipulation by making special efforts to maintain constant pool elevations during April, May, June for spawning benefit.

The West Virginia Division of Forestry at Charleston, all project lake Corps Personnel, and project lake state park personnel cooperates in fire-fighting activities to suppress fires that threaten or are burning on project lands. Project personnel cooperates by taking training in fire suppression techniques, reporting such fires to the WVDNR District Forester, fighting the fires before State personnel arrive and by assisting their suppression efforts after arrival.

The Parks and Recreation Division will enforce the Boating safety and water regulations, while hunting and fishing licensure procedure enforcement is by the Division of Wildlife. There is frequent day-to-day contact between project personnel and WVDNR personnel through much of the year.

d. Other State, Federal, Local or Private Agencies. The Corps of Engineers receives requests for information, aid, or cooperation from many parties or groups. All legitimate responsible requests from Federal, State, local, or private organizations receive appropriate attention and consideration. Accuracy of information transmitted and the proper level or amount of aid or cooperation given is commanded by District policy. Huntington District reacts quickly in disaster

situations, allocating material and man power when needs are in Corps areas of responsibility and expertise. In certain cases, such as potential downstream flooding concerns or emergency complications involving regulation of Beech Fork Lake, the District Emergency Operations Manager coordinates with the West Virginia Disaster Services Agency. An example of cooperation with a State entity is an occasion when the Corps studies damages and reconstruction costs due to a flood or other disaster for the office of the Governor to use in applying for Federal assistance.

In accord with the Corps of Engineers statutory responsibility for operation of its reservoirs in the public interest, the Great Lakes and Ohio River Division Engineer organized the Reservoir Operation Coordinating Group for the Ohio River Basin as a vehicle for perceiving, interpreting, and prioritizing that interest. The Group is composed of the twelve basin states, the Tennessee Valley Authority, six Federal Agencies, and two regional commissions, which are Ohio River Oriented. The Group meets three times yearly and provides a mechanism for a two-way communication through various levels of government and among various agencies of government and other organizations, which serve the public. Meetings of the Group have the stated mission of bringing focus to the publics varied interests in reservoir regulation and accordingly perfecting that regulation to the maximum extent possible.

Water Resources Engineering Branch personnel sends to each meeting a report which summarizes hydrologic and meteorologic situations in the district for the preceding three month or six month period highlighting pertinent events, flood control activity, and special operations by each project.

e. Press Releases. Huntington District Office and the National Weather Service, coordinate in forecasting flood stages. Local press is provided with information of flood forecasts as furnished by the National Weather Services (officially responsible for issuing flood warnings). This information will be supplemented by the Corps with available information on observed conditions and with technical advise to enable local interests, within the limits of their capabilities, to obtain optimum flood protection, and to perform rescue and relief functions.

The District Office releases various other items to the press for public dissemination. Some of these are in the public interest such as drawdown announcements or notification of a change in or opening of a new facility or service at a reservoir. Some releases are to enlist public cooperation and some, such as reports of flood damages saved by regulation of certain reservoirs, are to inform the public of the benefits derived from Corps-built projects.

9-03 INTERAGENCY AGREEMENTS, MEETINGS AND ORGANIZATIONS

Agreements among the Corps of Engineers, the U.S. Geological Survey, and the National Weather Service are mentioned and outlined in paragraphs 6-02a and b. An annual meeting is held with each of the State branches of the Geological Survey cooperating in the Stream Gaging Program. The Corps and Weather Service mutually agree upon scheduling of meetings concerning the Ohio River Network on an as-needed basis.

In the interest of fire protection for visitors, employees, property and animal and plant life, the District executed a memorandum of understanding covering all Corps reservoir projects in West Virginia with the West Virginia Department of Natural Resources to be administered by the Division of Forestry. The understanding includes cooperative warning and suppression of fires on or threatening Corps owned lands, West Virginia Department of Natural Resources maintenance of a standard cache of fire-fighting tools at the project, and payment by the Corps of extinguishment costs incurred by the West Virginia Department of Natural Resources.

Great Lakes and Ohio River Division Water Management Division holds a quarterly meeting of the Reservoir Operations Coordinating Group. The meeting is normally attended by representatives of Federal, Regional, and State agencies and commissions; along with Corps representatives of District and Division reservoir regulation elements. The purpose of the meeting is to exchange information and views on regional water recourse concerns.

9-04 HUNTINGTON DISTRICT REPORTS

Table No. 9-1 in table section contains a listing of the various Periodic and Special reports provided by the District Water Resources Engineering Branch.

a. Periodic.

(1) Daily. Districts are required to report current hydrologic data daily as prescribed by the Division Office. A daily report is prepared seven days per week by the Water Control Section of Water Resources Engineering Branch. It is prepared as detailed in subsection 8-03 and inserted into a computer file. After review, the report is sent over a leased line to the LRD water control system. The transmission includes morning lake elevation, rate and temperature of outflow, and 3-day forecast of lake and outflow for all reservoir projects. Ohio River morning stages and 24-hour rainfall, morning stage and flow and 5-day flow forecast for Ohio River tributary gage points complete the transmission and the report. The report items are prepared in accordance with ORDER 1110-2-20, CHORD-ED-W lt, 10 Jul 69, CHORD-ED-W lt, 23 Jan 67, and ORDER 1110-2-17.

Daily or more frequent briefings of the District Engineer and Chief Engineer containing pertinent hydrologic and meteorologic information are made during flood or other emergencies.

In carrying out water control activities, Corps of Engineers personnel must recognize and observe the legal responsibility of the National Weather Service (NWS) and the National Oceanic and Atmospheric Administration (NOAA) for issuing weather forecasts and flood warnings, including river discharges and stages. River forecasts prepared by the Corps of Engineers in the execution of its responsibilities should not be released to the general public, unless the NWS is willing to make the release or agrees to such dissemination. However, release to interested parties of factual information on current storms or river conditions and properly quoted NWS forecasts is permissible. District offices are encouraged to provide assistance to communities and individuals regarding the impact of forecasted floods. Typical advice would be to provide approximate water surface elevations at locations upstream and downstream of the NWS forecasting stream gages. Announcement of anticipated changes in reservoir release rates as far in advance as possible to the general public is the responsibility of Corps of Engineers' water control managers for projects under their jurisdiction.

(2) Weekly. Each week a list of 24-hour reservoir effects at tributary gage points is transmitted to LRD. The list, which gives flows in cfs held out from or added to the natural flow, shows the data for an entire week ending with the current day. All of the key gage points are reported for the Beech Fork Lake, Twelvepole Creek, and Ohio River Basin. The main stem points are located at Wayne and Ashland, Kentucky.

During any flood, drought or other emergency involving reservoirs, the Ohio River or other streams in the District, the Water Control Section provides all available information to the District Engineer, Chief of Engineers and interested elements as frequently as necessary.

(3) Monthly. Engineer Regulation No. 1110-2-240, dated 8 October 1982 requires that a monthly record of reservoirs operated by the District be promptly prepared by the Water Control Section according to 33 CFR 208.11 and maintained in tabular form readily available for transmittal to the Chief of Engineers or others on request.

(4) Quarterly Reservoir Operations. Each District provides a quarterly review of meteorological influences and water control management activities to each of the four yearly meetings of the Reservoir Operations Coordinating Group. Huntington District personnel of the Water Control Section summarize and compare weather experienced with long-term normal and actual stream flows to mean annual values. They describe seasonal features of operation such as spring filling, summer outflow temperature control or fall drawdown, frozen lakes and effect of river ice on navigation, in addition to any significant flood control operations and damages prevented.

(5) Annual. The Division Engineer is required by ORDR 1110-2-27 and CEORD-ED-W Ltr, 30 Sep 1977 to submit to OCE for approval an annual report on reservoir regulation activities of significance during the fiscal year ending and programs proposed for the year following. This report summarizes the water control activities throughout the Ohio River Basin. Therefore district input is mandatory. The following documentation of district programs and activities is requested by 1 November of each year:

(a) A brief summary highlighting the significant accomplishments attributed to each reservoir during the preceding fiscal year.

(b) Reservoir regulation manual submission schedule.

(c) Concise report on major accomplishments concerning personnel, training, model application, ADP use, data reporting and analysis, and general improvements in reservoir regulation activities.

By Executive Order 12088, the President ordered the head of each Executive Agency to be responsible for ensuring that all necessary actions are taken for prevention, control, and abatement of environmental pollution with respect to Federal facilities and activities under control of the agency. An annual Division Water Quality report is required by ORDR-2-26. The report is submitted in two parts. The first part addresses the division Water Quality management plan while the second part presents specific project information. A major objective of this report is to summarize information pertinent to overall water management responsibilities. An Annual Water Quality Report by Districts to LRD includes narrative and tabular summaries of water quality activities and conditions in the Districts. The District report contains a synopsis of activities, specific cases of interest, improvements during the year, and plans for future emphasis. The tabular portion includes an overview of water quality activities, an overview of water quality conditions, specific water quality control actions in coordination with the Water Control Section, special studies aimed at identification or solution of problems and problems requiring special studies with schedules for executing the studies. The annual water quality report is submitted by 1 December of each year.

b. Special Reports.

(1) Reports on Reservoir Operations During Flood Emergencies. Information on reservoir operations to be included in reports submitted to the Chief of Engineers during flood emergencies in accordance with ER 500-1-1 include rate of inflow and outflow in cfs, reservoir levels, predicted maximum level and anticipated date, and percent of flood control storage utilized to date. Maximum use should be made of computerized communication facilities in reporting project status to DAEN-CWO-E/CWE-HY in accordance with the requirements of ER 500-1-1.

(2) Post-Flood Report. Information on the operation of the affected reservoirs is gathered in accordance with ER 500-1-1. This report provides details on antecedent meteorologic and hydrologic conditions, description of the performance of the dam and appurtenant works, detailed analysis of the operating procedures, and effects of reservoir operation on Twelve Pole Creek and the Ohio River. Reservoir effects include evaluation of the stage reductions at key stations and estimates of damages prevented. Conclusions are discussed with regard to adequacy of operating technique, performance of structures, and benefits derived from operations during the flood. The outline of a typical post flood report is given below.

- I- Authority, Purpose And Scope
- II- Basin Description
 - Impact of Flood
- III- General Precipitation
 - Storms and Reservoirs
- IV- Damages and Flooding
- V- Antecedent Rainfall
 - Storm Rainfall and Runoff
- VI- General Method of Operation
 - Emergency and Standing Instructions
 - Flood Control Operations during Storms
 - Special Operations
 - Operations during Release Period
 - Results of Operation
 - Flood Damages Eliminated
- VII- Computer Programs Utilized
 - Special Flood Activity

(3) Fiscal year budget requests. Fiscal year budget requests for water control management activities are prepared and submitted to the Office of the Chief of Engineers in accordance with requirements established in Engineer Circular on Annual Budget Requests for Civil Works Activities. The total annual costs of all activities and facilities that support the water control functions (excluding physical operation of projects, but including flood control and regulation of navigation projects subject to 33 CFR 208.11) are reported. Information on the Water Control Data Systems and associated Communications Category of the Plant Replacement and Improvement Program is submitted with the annual budget. Reporting is in accordance with an Engineer Regulation and the annual Engineer Circular on Civil Works Operations and Maintenance, General Program.

(4) The Chief of Engineers. The Chief of Engineers and staff require information to respond to inquiries from members of Congress and others regarding runoff potentials. Therefore, the Division Engineer submits a snowmelt runoff and flood potential letter report covering the snow accumulation and runoff period, beginning generally in February and continuing monthly, until the potential no

longer exists. Dispatch of supplemental reports is determined by the urgencies of situations as they occur. The reports are forwarded as soon as hydrologic data are available, but not later than the 10th of the month. For further information on reporting refer to ER 500-1-1.

(5) Major drought situations. During major droughts or extreme low-flow conditions, narrative summaries of the situation should be furnished to alert the Chief of Engineers regarding the possibility of serious runoff deficiencies that are likely to precipitate actions associated with Corps of Engineers' reservoirs.

(6) Master Plans. Division water control managers will develop Master plans for water control data systems and significant revisions thereto. They are submitted to HQDA (DAEN-CWE-HY) Washington, DC 20314, for review and approval of engineering aspects. Engineering approval does not constitute funding approval. After engineering approval is obtained, equipment in the master plan is eligible for consideration in the funding processes described in ER 1125-2-301 and Engineering Circulars on the Annual Budget Request for Civil Works Activities. Master plans are maintained current and are updated as necessary to meet needs.

Modified master plans are submitted by 1 February if revisions are required to include equipment not previously approved or for changes in scope or approach. Submittal by the February date allows adequate time for OCE review and approval prior to annual budget submittals.

(7) Miscellaneous. Any additional or pertinent reports required from higher authority will be promptly compiled and transmitted.

TABLE NO. 9-1
HUNTINGTON DISTRICT REPORTS
BY
WATER RESOURCES ENGINEERING BRANCH

PERIODIC REPORTS - Computer reports keyed to forms formerly completed by hand as follows:

Daily Computer reports of observed and forecast stages and flows including:

Morning reservoir pool elevation, outflow, outflow temperature and three-day pool and outflow forecast.

24-hour rainfall, morning stage, flow and five-day flow forecasts at Ohio River tributary gage points.

Weekly Reservoir effects at Ohio River tributary gage points.

Monthly Records of District reservoirs available on request.

Annually Summary of significant reservoir regulation activities for the year and of programs proposed for the following year.

SPECIAL REPORTS

Daily or more frequent briefing of District Engineer and Chief Engineer during flood or other emergencies containing hydrologic, meteorologic, and operational information, when and as requested.

Information relevant to flooded area or situation to the Emergency Operations Center (when functioning) such as pertinent data about the area, copies of reservoir morning and extra reports, relay of any verbal reports, relevant NWS zone forecasts and special bulletins, and computer generated isohyetal maps of the District.

Reports on reservoir operations to OCE during flood emergencies including inflow, outflow, pool elevation, predicted crest, and maximum storage utilization to date.

Post-flood reports.

Budget requests for water control management activities to OCE.
Snowmelt runoff and flood potential reports to OCE.

Narrative summaries of major drought or low-flow conditions likely to require special regulation of District reservoirs.

Master plans for water control data systems and significant revisions thereto are submitted to HQDA (DAEN-CWE-HY) Washington, DC 20314, for review and approval of engineering.

Table No. 4-2

TEMPERATURE SUMMARY - TWELVEPOLE CREEK BASIN

<u>STATION</u>	<u>Yrs. of Record</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May.</u>	<u>Jun.</u>	<u>Jul.</u>	<u>Aug.</u>	<u>Sep.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Annual</u>
<u>Maximum Temperature - Degrees F.</u>														
Cabwaylingo State Forest, W.V.	13	79	78	90	90	101	98	102	101	101	93	85	78	102
Muntington, W.V. Airport	20	74	79	85	90	92	95	99	100	96	86	82	76	100
<u>Minimum Temperature - Degrees F.</u>														
Cabwaylingo State Forest, W.V.	13	-9	-10	0	18	28	41	46	43	32	15	5	-3	-10
Muntington, W.V. Airport	20	-15	-6	-2	22	27	40	46	43	35	16	8	-5	-15
<u>Average Monthly and Annual Temperature - Degrees F.</u>														
Cabwaylingo State Forest, W.V.	13	36.8	39.3	43.9	55.5	63.6	70.7	74.6	72.2	67.2	56.1	43.7	36.8	53.7
Muntington, W.V. Airport	20	31.4	34.2	45.8	55.3	63.8	71.1	74.7	73.7	67.6	55.9	45.9	36.7	54.6
<u>Average Maximum Monthly and Annual Temperature - Degrees F.</u>														
Cabwaylingo State Forest, W.V.	13	45.7	51.6	57.1	71.4	78.5	84.0	87.7	87.1	82.9	69.8	58.2	48.6	67.8
Muntington, W.V. Airport	20	40.0	43.4	56.2	66.8	75.3	82.0	84.8	83.6	77.8	67.0	55.1	45.1	64.8
<u>Average Minimum Monthly and Annual Temperature - Degrees F.</u>														
Cabwaylingo State Forest, W.V.	13	23.7	26.1	30.4	45.4	48.2	56.5	61.3	54.3	47.7	36.0	30.4	24.5	40.1
Muntington, W.V. Airport	20	22.9	25.1	35.3	43.8	52.3	60.1	64.7	63.8	57.3	44.7	36.6	28.4	44.6

Table No. 4-3

PRECIPITATION SUMMARY - TWELVEFOLZ CREEK BASIN

<u>STATION</u>	<u>Yrs. of Record</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May.</u>	<u>Jun.</u>	<u>Jul.</u>	<u>Aug.</u>	<u>Sep.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Annual</u>
<u>Maximum Monthly and Annual Precipitation.</u>														
Cabwaylingo State Park, W.V.	10.62	9.07	9.81	7.50	7.43	9.49	10.40	7.35	9.81	6.54	5.83	7.02	63.25	
Muntington, W.V. Airport	6.37	5.66	7.54	6.56	9.26	8.43	8.57	6.86	5.64	5.54	5.17	8.69	53.87	
<u>Minimum Monthly and Annual Precipitation</u>														
Cabwaylingo State Park, W.V.	1.84	1.72	1.29	2.11	2.24	1.99	1.24	2.30	0.82	0.26	1.53	1.64	39.11	
Muntington, W.V. Airport	1.12	0.53	1.12	0.74	0.93	0.41	1.37	0.68	0.58	T	0.73	0.31	29.99	
<u>Average Monthly and Annual Precipitation</u>														
Cabwaylingo State Park, W.V.	4.85	4.03	4.59	4.17	4.52	4.73	5.44	3.99	3.54	2.74	2.82	3.78	48.16	
Muntington, W.V. Airport	3.07	2.62	4.07	3.55	3.88	3.53	4.73	3.92	3.04	2.64	2.98	3.18	41.10	
<u>Average Monthly and Annual Snowfall</u>														
Cabwaylingo State Park, W.V.	Incomplete Record													
Muntington, W.V. Airport	9.2	7.3	3.5	0.1							T	1.5	3.6	25.2

Table No. 5-1

BEECH FORK BASIN
STREAMGAGING NETWORK - PERTINENT DATA

Stream and Station	Zero gage Elevation Feet m.s.l.	Drainage Area Sq. Mi.	Date Established Mo./Yr.	Existing Station Facilities	Method of Obtaining Data
Beech Fork of Twelvepole Creek below Beech Fork Lake	600.00	80.4	7/76	Strip chart and DCP with encoder. Other gages include a tape and staff and a tipping bucket precipitation gage.	Elevation remoted to digital readout in project office. Project personnel view readout and include in regular and extra reports. DCP transmits via GOES satellite to ORD downlink and data is retrieved by water control system.
Beech Fork of Twelvepole Creek at Beech Fork Lake	m.s.l.	78.0	1/78*	Strip chart, ADR, and DCP with encoder. Both recorders are operated by a water Servo-Manometer and referenced to outside staff.	Project personnel view remote lake gage readout and include in regular and extra reports. DCP transmits via GOES satellite to ORD downlink and data retrieved by water control system.

*Date of beginning of record in Water Resources Data for West Virginia

TABLE NO. 5-2
PRECIPITATION STATIONS
PERTINENT DATA
TWELVEPOLE CREEK BASIN

Record From	Station	Equipment	Method Of Obtaining Data	Reporting Criteria
4/82	Nestlow	Tipping bucket gage with heater and DCP.	DCP transmits via GOES satellite Every 4 hours. ORH WCS retrieves Data via ORD WCS.	Data collection interval 60 minutes.
11/72	Beech Fork Lake Project(1)	8-inch rain gage	Project personnel gage collector	Daily at 0730 amount of precipitation collected in previous report at 1330 if 0. Inch or more collected after 0730.
6/82	Beech Fork Intake structure	Tipping bucket gage with heater and DCP.	DCP transmits via GOES satellite Every 4 hours. ORH WCS retrieves Data via ORD WCS.	Data collection interval 60 minutes.
6/80	Wayne (2)	Tipping bucket gage with heater and DCP.	DCP transmits via GOES satellite Every 4 hours. ORH WCS retrieves Data via ORD WCS.	Data collection interval 30 minutes.
1940	Branch- land (2)	Tipping bucket gage with heater and DCP.	DCP transmits via GOES satellite Every 4 hours. ORH WCS retrieves Data via ORD WCS.	Data collection interval 30 minutes.

Table No. 5-6

WATER LEVEL WARNINGS AT BEECH FORK LAKE AREAS

<u>Area</u>	<u>Party Warned</u>	<u>Manner of Issuance</u>	<u>Criteria</u>	<u>Action Taken</u>	<u>Telephone Number</u>
Any work site	Person in charge	In person	Indication of probable change in lake level affecting work.	Advise person in charge to take necessary action in planning or executing work.	N/A
Marina	Marina Operator	Telephone	Beginning of spring filling.	Operator adjust winch cables as required.	
Marina	Marina Operator	Telephone	Forecast or actual rise to 594 feet during recreation season.	Operator adjust winch cables as required.	
Marina	Marina Operator	Telephone	Actual pool rise to 585 feet or forecast of 585.5 feet during winter season.	Operator travel to lake and adjust winch cables as required.	
Stowers Branch Area	Swimming beach visitors	In person	Actual pool rise to 593-594 feet elevation depending on wetness of access road and turf.	Day- Evacuate visitors. Replace barricade in access road. Night- Do not remove barricade.	N/A
Beech Fork Lake State Park	Park personnel	Telephone	Forecast or actual rise to 594 feet elevation or higher during recreation season. Lower Bowen campsites at 597 feet.	Park personnel consider closing Lower Bowen campground; prepare to remove ground fault intercepts and receptacles from electrical outlets at campsites.	
Beech Fork Lake State Park	Park Personnel	Telephone	Crest forecast 597 feet or above during recreation season. Comfort stations floor elevations in Lower Bowen camping areas are all at 599 feet.	Prepare to remove heaters from Bowen comfort stations and to tie down tables to fireplaces.	

PERTINENT DATA

BEECH FORK LAKE, WEST VIRGINIA

LOCATION OF DAM: On Beech Fork of Twelvepole Creek in Wayne County, WV, 3.7 miles above the mouth and 2 miles southeast of Lavalette.

AUTHORITY: Flood Control Act of 1962.

PURPOSES SERVED: Flood control, recreation, fish and wildlife.

DRAINAGE AREA ABOVE DAM: 78 square miles.

DAM: Type - rolled earth fill; maximum height 86', crest length 1,080'.

SPILLWAY: Uncontrolled concrete lined spillway with crest length of 80' at elevation 614.5 NGVD discharging into a 313-foot long raceway and stilling basin.

OUTLET WORKS: Intake structure with two gated sluices 4'6" wide by 10'0" high discharging through a 8'6" x 11'3" split circle conduit 720' long into a stilling basin. Dual selective withdrawal system with each half system composed of two 4'x4' gated inlets, one at invert elevation 582 and one at elevation 573 (left) or elevation 564 (right), with discharge from each half system controlled by a 2'6" x 3'0" hydraulically operated gate.

OTHER STRUCTURES: Maintenance building at the Dam and Bowen Camping facilities for 275 camp sites.

RELOCATIONS: State Route 17 at Booten and Bowen along with Route 43. Various power, telephone and pipeline relocations are complete.

LAND ACQUIRED: 12,609.68 ACRES FEE
144.10 ACRES EASEMENT

PERTINENT DATA (CONT'D)

BEECH FORK LAKE, WEST VIRGINIA

RESERVOIR DATA: Streambed elevation at dam: 557'.

BEECH FORK LAKE ELEVATIONS AND STORAGES							
	Surface		Backwater	Storage			
	Elevation	Area	Main Stream	Acre-ft		Inches runoff	
Pool	FT (NGVD 1929)	Acres	Miles	Net	Gross	Net	Gross
Minimum/Winter	583.5	405	6.7	3,392	3,392	0.82	0.82
Summer	592	719	8.3	4,744	8,136	1.14	1.96
Flood Control Storage:							
Winter+	614.5	1,847	13.2	33,113	36,505	7.96	8.78
Summer#	614.5	1,847	13.2	31,761	36,505	7.64	8.78

+ Net is between elevations 583.5 and 614.5 feet NGVD

Net is between elevations 592.0 and 614.5 feet NGVD

STATUS: The project is 100% complete. West Virginia Department of Commerce operates Beech Fork State Park. The state park presently has 275 camp sites at Bowen and includes 3,144 acres of Government land leased to the state. The State constructed a lodge at Mary Davis Branch, and plans a golf course at Winslow and other camping and day use facilities. Recreation at the Dam Site will be operated by the Government, which includes a beach at Stowers Branch. 7531 acres of land and 716 acres of lake are licensed to West Virginia DNR for fish and wildlife management.

COST: Estimated construction \$47,900,000
Expended through 30 Sep 1986 38,223,500
Balance to complete 9,676,158
O&M Expended through 30 Sept. 1988 6,030,158
O&M Expended from 1 Oct 1988 to 1 October 1993 averaged slightly less than a million dollars per year. From 1 Oct 1993 to present O&M averaged about \$1,065,000. dollars per year.

EXHIBIT B LRH

STANDING INSTRUCTIONS TO PROJECT OPERATOR

Beech Fork Lake

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B-01 BACKGROUND AND RESPONSIBILITIES

a. General Information

These standing instructions to the project operator for water control are written in compliance with Paragraph 9-2 of EM 1110-2-3600 and with ER 1110-2-240. A copy of these standing instructions must be kept on hand at the project site at all times. Follow these instructions listed below at all times, except when other operations are required by Special Directive issued by the Water Management Section.

b. Project Purposes

Beech Fork Lake is operated for flood risk management, conservation, recreation, and fish and wildlife conservation. Water control actions are in support of these project purposes and for purposes of the Twelvepole River and Ohio River systems.

c. Chain of Command

Project staff (B) report to the Big Sandy Area Office (B) who report to Operations Division (OR) (CELRH-ORB-B).

Water Management Staff (W) report to the Geotechnical and Water Resources Branch (G) who reports to the Engineering Division (EC) (CELRH-ECG-W).

Water Management Staff is responsible for oversight of pool elevation, and releases and guidance for water control activities. Water Management is responsible for issuing direction to Operations personnel with regard to water management activities.

d. Structure

Beech Fork Lake is located at river mile (RM) 3.7 on Beech Fork of the Twelvepole River in the Twelvepole River Basin, RM 16.4 above the mouth of the Twelvepole River. The dam is approximately 3.5 miles northeast of Lavalette, WV, in Wayne County (latitude: 38.3039, longitude: -82.4164). Figure 2-2 is a system map illustrating the location of the dam and its components.

The Beech Fork Lake Project includes a rolled random fill (earth and rock) embankment, a intake tower with selective withdrawal well, a split circle tunnel through the left abutment, a concrete lined uncontrolled chute spillway 500 feet landward from the left abutment, Exhibit 2-2 locates the physical components of Beech Fork Lake described in this section.

e. Operation and Maintenance

Operations staff is responsible for operations and maintenance of the project except for gage equipment which is maintained by the Water Management Section.

f. Role of the Project Operator

Corps Operations Division personnel are responsible for operation of all aspects of the project.

1) Normal Conditions

Project personnel are required to maintain an awareness of the hydrologic conditions above the dam, at the dam and downstream which are represented by the following gages:

- Beech Fork Lake and Outflow
- Lavalette, WV.

When hydrologic conditions significantly change at the project, project personnel inform Water Management. Significant changes in hydrologic conditions are listed in Section B-02c.

Project personnel are responsible for autonomous flood control operations as described in Section B-03a.

Water Management provides the project updates of the broader hydrologic conditions including lake and river forecast as necessary. During an event, this information is shared with the project via telephone and when necessary, project operation is directed through the issuance of a Special Directive. Special Directives are issued using any form of communication (telephone, text, or email) but require confirmation of receipt. Special Directives are issued for a specific period of time or until specific conditions are met and are followed until completed. If there is a question about the actions specified in a Special Directive Project personnel contact Water Management for clarification.

During normal conditions the Special Directive will specify outflow gage stage or flow targets not gate settings unless the direction pertains to water quality. Water quality directives may include gate settings and usage.

2) Emergency Conditions

Potential Emergency Situations are declared by the Dam Safety Officer. If there is a critical issue requiring a short reaction time, the declaration may be made by the Damtender. When this declaration is made, project personnel will man the telephones on a 24-hour basis and maintain 24 hour monitoring/surveillance of the situation responsible for the declaration.

During an emergency conditions Water Management will provide instructions as necessary minimally once a day, likely 4 times a day and potentially every hour. During Emergency Conditions, Special Directives are likely to include gate usage and settings.

(A) Dam Safety Emergency

If dam failure is imminent, use the red "Dam Failure in Progress" emergency contact sheet and notify downstream officials to keep the public safe, then call Water Management immediately.

(B) Imminent Loss of Life

If there is a critical issue involving an imminent loss of life requiring a short reaction time, project personnel have the authority to operate as necessary to abate the problem:

- IF taking an action will not result in the pool exceeding the Flood Control Pool (614.5 ft (NGVD 29)).
- AND IF such an action would not result in equal or worse conditions.

Call Water Management immediately after any such action.

(C) Communication Failure

The project should continue to follow the water control plan as detailed in these standing instructions. If flooding is occurring, the project should continue to make all efforts to contact the District Office including satellite phone and local law enforcement.

If the project is under a Special Directive at the time of a communications failure, follow the Special Directive until the specific operation in the Special Directive has been completed.

Initiate Emergency Operation Procedures as describe in Section B-03d if:

- It has been 24 hours since the last contact with the District Office or sufficient rainfall or snowmelt occurs which causes the lake and/or streams in the vicinity to rise rapidly, or
- Communications have been lost for more than three hours and a rise in the pool elevation indicates the available storage capacity of the project may be insufficient to control a flood.

B-02 DATA COLLECTION AND REPORTING

a. General

Due to the automation of gage reporting and proliferation of hydrologic resources on the web, project personnel are not required to provide a report of conditions to Water Management on a daily basis. Irregular reports are required to be submitted to Water Management as requested or for:

- Significantly changing hydrologic conditions
- Water quality profile data
- Piezometer readings
- Snow moisture accounting

In order to continue to document project conditions and facilitate the project monitoring data necessary for the operation, the project is required to keep a permanent hard-copy record of water control data required for daily operation. This information is maintained at the project office either on historical report forms or in a project developed format. It is gathered at 0730 on days when the project is staffed and at other times as requested by Water Management. It includes, but it not limited to:

- precipitation
- current weather conditions
- pool elevation
- outflow stage
- gate settings
- gate operations and the time performed
- snowfall
- snow depth and moisture content
- upstream and downstream stages

Hydro-Meteorological remote reporting gages in the Huntington District have been upgraded to hourly transmissions to the GOES satellite. This makes routine calling via telephone less necessary than it has been in the past for anyone who has access to the EC-WM Internet and Intranet sites.

The Internet EC-WM site should be the primary means of obtaining gage data and the telephone links need to be reserved as much as possible for project use especially during high water events. Project personnel who are closely monitoring minute-by-minute data for gate operations need to be able to call gages on the phone without reaching busy signals or gages that have been "Tangled-up" by other users who don't know the correct operating procedures for the new types of equipment.

If you must access Huntington District gage equipment via telephone and it answers by saying "Press Zero for the Menu," please disconnect correctly every time by waiting for the message to say "goodbye" before hanging up. Failure to do so causes the equipment to act erratically for the next caller and at the least will cause wasted time, and in some

cases, cause the gage to be unable to get a current reading until a full self-timed 15 or 30 minute cycle has passed.

The upstream and downstream gage information is found in *Table B-02.1*:

Table B-02.1 Gage Information

.Gage Name	Phone Number	Gage Function	Stage Reading	Precip Reading	Gage Datum
Lavalette, WV	[REDACTED]	Downstream Control	x		532.0 NAVD 88
Beech Fork Lake		Lake	x	x	500.0 NGVD 29
Beech Fork. Outflow		Outflow	x		550.0 NGVD 29

These phone numbers are For Official Use Only and must not be released to unauthorized personnel.

b. Daily Reporting

1) Water Management Request

Conditions will arise for which the automatic gage reporting system may fail or be unavailable. During these situations, Water Management may request the reporting of specific gage information or a copy of the daily project log. The request will detail how and at what frequency this data will be reported.

c. Significant Changes to Hydrologic Conditions

When hydrologic conditions significantly change at the project or abnormal activities occur, the Damtender is responsible for informing ECG-W by phone or MS Teams chat. Confirmation of a receipt of this notification should be received before communication efforts cease.

Significant changes in hydrologic conditions include:

- Downstream gages approaching their control stages.
- Pool elevation exceeding 601 ft NGVD 29.
- If noted, rain in the surrounding area greater than 1.5" in the winter or 2" in the summer in less than a 24 hour period.
- Gate outages.
- Upstream or downstream flooding or complaints of such.
- A catastrophe such as drowning.
- Unusual or abnormal water quality conditions in the lake, inflow streams, or a reasonable distance downstream of the project such as:
 - o Floating debris, oil, scum from municipal, industrial, or other discharges.
 - o Unusual color, odor, or other condition.
 - o Fish kills, plankton, or algae or insect blooms.
 - o Chemicals.
- Encroachment on the flood control pool or downstream flood plain.

d. Water Quality Profile Data

Temperature and dissolved oxygen profiles are to be taken in the lake as directed by the Water Management Team via Special Directive during the stratification period. The Special Directive will define the location and the time period for the profiles. The Water Quality Team will provide field personnel instrumentation and instruction in use of the equipment.

Report water quality profile data at J:\Projects\Water Management\Water Quality Profiles and gate settings at J:\Projects\Water Management\Gate Settings.

e. Piezometer Readings

The piezometers are read monthly when the pool elevation is below 601 feet NGVD 29. At the Daily Action Pool at elevation 601 feet NGVD 29, Dam Safety Section will request the piezometers be read daily while the pool is above 601 feet NGVD 29 and for 7 days after the pool recedes below 601 feet NGVD 29 or until notified by personnel from Dam Safety Section. Piezometers should be sounded annually. Readings will be reported as directed by Dam Safety.

f. Snow Moisture Accounting

New snowfall, snow moisture content, and snow depth is measured when new snow occurs, on Mondays and Thursdays if snow is on the ground but no new snowfall occurs, and when rain falls on existing snow cover. Snow measurements should occur by 0900 hours.

Snow moisture content is the amount of water in the snow that would have fallen as rain if it had been warmer. It's important to measure this since any melting will put the equivalent amount of runoff into the lake and streams. To measure this, take the outside container of the rain gage and force it through an undisturbed patch of snow to the ground. Use a shovel or other thin flat implement to hold the snow core inside the gage while picking it up. Put the container in a vessel of warm water to melt the snow- this minimizes evaporation during melting. Pour the melted snow into the inside container of the rain gage and read the resulting level as the snow moisture equivalent.

Report snowfall and snow moisture equivalent data as directed by water management, likely to be either via email or at <http://lrh-wmlocal1.lrh.usace.army.mil:8080/apex/f?p=58139:47>.

g. Gage Maintenance and Verification

Huntington District has a network of stream, lake and precipitation gages called data collection platforms (DCPs). All the gages are equipped with satellite data transmitters and information is recorded at least every 15 minutes and transmitted once an hour. Many gages also have telephone response abilities. Project personnel access gages by phone to maintain awareness of inflow to the lake, pool elevations and water quality, outflow and downstream conditions.

1) Gage Maintenance

Water Management has primary responsibility for the maintenance of gages but project personnel will often be the first to notice a problem during the course of their routine monitoring. When project personnel note a gage problem, a problem report should be submitted at:

[https://wm.lrh.ds.usace.army.mil:8243/LRH_ords/f?p=58139:63:11527929875302::: Trouble tickets for gage problems, including telephone problems, can be entered from the web page. Choose the "Report a Gage Problem" option in the "Gage" box on the main page. Use the "Report a Gage Problem" dialog box to select the gage, and enter the indicated information. Choose "other" as the repair person.](https://wm.lrh.ds.usace.army.mil:8243/LRH_ords/f?p=58139:63:11527929875302:::)

Gage problems fall under the following categories:

- Missing digital data in the database/website/project display
- Data not available via telephone or iridium
- Unreasonable data
- Redundant gage failure

Discrepancy between digital and redundant gage is reported through the gage verification process.

After a gage has been serviced, the gage readings should be observed with increased scrutiny until assured that the gage is reading water level changes in the correct direction and with the correct magnitude.

When a problem is reported, Water Management gage technicians may ask projects to work through procedures to either diagnose or fix a problem. This will usually help facilitate getting problems resolved and minimize risks and responsibilities for project personnel.

If there is a problem with a telephone connection, project personnel are asked to verify whether there is a dial tone at the gage.

- If the phone service is not working, after a problem report is submitted, the Water Management team will call ACE-IT and have the phone company restore service.
- If the phone service is active, then further investigation can be made in order to determine a problem. The Water Management Technician may call and ask for additional diagnostics.

Precipitation gages have sensors open at the top to receive rain or snow fall. They may also collect obstructions like leaves which inhibit the passing of water through the collector and this can often be easily remedied by cleaning the open area of the sensor. If personnel believe the precipitation amounts collected by the gage do not reflect reality, contact Water Management. Project personnel may be asked to further assess problems at gages close to the project.

Gages require a source of electricity. This may be either solar panels and batteries or a connection with an electric line, mostly for the purpose of charging batteries. If there are indications that power has failed at a gage, project personnel may be requested to visit the gage to look for problems. If a battery shows voltage constantly decreasing this

indicates that things are not being charged. Personnel may be asked to make sure breakers have not tripped.

h. Gage Verification

Verification is a process of comparing the water level recorded on the primary gage (the DCP, electronic equipment) to the elevation or stage value obtained on the redundant gage, which is usually either a staff gage, an electric tape gage or a wire weight gage. Verification is required:

- Once a week for gages located on project. Verification of these gages are project personnel responsibility.
- Once a year for gages located off of the project. Verification of these gages are Water Management responsibility.
- If there is an inquiry from the public with regards to abnormal water level conditions or a concern raised by an interested party.
- As requested during significant events to help communicate whether there are problems and to verify that systems are functioning properly, and the data being received is reliable.
- After a gage has been serviced.

The verification results are to be entered:

- In the APEX system
[https://wm.lrh.ds.usace.army.mil:8243/LRH_ords/f?p=58139:2000:11527929875302:::.](https://wm.lrh.ds.usace.army.mil:8243/LRH_ords/f?p=58139:2000:11527929875302:::)
- In the official gage log book at the gage station.

If there are any significant deviations (greater than 0.3 ft.) between primary gage and redundant gage reading readings, the "Bad Verification" button is selected in the Gage Verification dialog box. Do not report telephone only problems as Gage Verification Failure. In addition, the OR Project Manager should be notified of any gage verification failure.

At least one working redundant gage is required for successful gage verification. If all redundant gage(s) (staff, wire weight or electric tape) are damaged, missing, or unreadable, the verification fails and the verification report problem definition should state "damaged," "missing," or "unreadable" redundant gage.

An Official Gage Station Logbook is stored where the personnel who use the logbook will have easy access. Normally this should be in the gage house, or where the instrumentation is located. In the case of projects with remote instrumentation, an office location may be more convenient to the duty staff. It is used to document the periodic checks between the primary gage and the redundant gage. Information to be recorded should include date, time of entry, water elevation or stage reading from the primary gage, elevation or stage reading from the redundant gage (staff gage preferred), name of person making the reading, and remarks summarizing the verification. "Verified" and "OK" are acceptable short remarks when the gage is working properly. If a gage is missing a log book, please notify EC-WM. The logbook should be permanently bound with

pages of water resistant paper. The logbook should be kept in a light-colored waterproof and rodent-proof container, identified as property of the Corps of Engineers, and labeled "logbook."

Gage verification entries are to be made starting at the front of the book. Survey crews will be allowed to make Datum Verification entries into the logbook. Datum verification entries, if any, are to be made beginning at the back of the book. Both ends of the book are to be labeled, as appropriate, "Gage Verification" or "Datum Verification." When full of entries, the logbook is to be returned to EC-WM for archiving.

The logbook can be accompanied by the current USGS station data sheet where appropriate, with a listing of survey reference points and elevation for the gage. Additional materials deemed necessary by gage technicians can also be kept in the container.

i. Regional Hydro-meteorological Conditions

Water Management will brief the Project as necessary regarding wider basin conditions including necessary operations for Lavalette, WV. In the event of a communication outage, project personnel should coordinate releases with the East Lynn Lake Project and inform expected operation for Twelvepole Creek by gathering gage information at Lavalette, WV by phone, site visit, or from the internet.

B-03 WATER CONTROL AND REPORTING

a. Normal Conditions

These directions are based on the Water Control Plan defined by the Beech Fork Lake Water Control Manual.

The following directions are to be followed at all times **unless** there is a Special Directive in effect.

- Maintain a **minimum** outflow of **5 cfs**.
- Limit the maximum outflow to peak inflow.
- Set the outflow based on flows necessary to control pool over 24 hours to avoid pulsing releases.
- Limit the rate of change in stage at the outflow to a maximum of .5 ft. per hour.
- Maintain the pool within 1' above the seasonal pool elevation as defined in *Table B-03.1*.

Table B-03.1 Seasonal Pool Elevations

Seasonal Pool Elevations	
15 April - 30 November Summer (ft.)	1 December - 14 April Winter (ft.)
592	583.5

- Begin refill to the recreation (summer) pool on about April 1 based on hydrologic conditions with a goal to fill the pool as quickly as possible. A special directive will be issued to begin refill.
- Maintain the recreation pool until after Labor Day.
- Begin lake draw down to winter pool by about the first of November based on hydrologic conditions with a goal to reach winter pool by 01 December. A special directive will be issued to begin drawdown.
- Maintain winter pool until about the 1st of April.

Project personnel are authorized to maintain seasonal pool by releasing storage accumulations without instructions from Water Management if the directions above are followed and:

- the outflow stage does not exceed the Maximum Outflow Without a Special Directive as defined by *Table B-03.2*.
- Control Stages for any downstream gage are not exceeded as defined by *Table B-03.3*.

If operations are for some other reason than maintaining pool, consult with Water Management prior to modifying releases.

Releases more than Maximum Outflow Without a Special Directive will be authorized via Special Directives from Water Management who will

evaluate storages in other lakes in the basin and downstream controls fully.

Table B-03.2 Beech Fork Outflow Control Levels

Control Stages and Flows					
		Summer		Winter	
		Stage	Flow*	Stage	Flow*
Lavalette Stage	Stream	Feet	cfs	Feet	cfs
Any	Minimum	1.6	5	1.6	5
<14.0 ft	Maximum without Directive	6.5	960	6.5	960
>14.0 ft	Maximum without Directive	5.4	715	6.2	893
Any	Maximum with Directive	8.5	1426	10.1	1803

*Note: Rating Tables for the Outflow gage is found on Table B-03.5

Downstream control stages have been set at stages that did not cause any appreciable damage downstream of the project at the time of the project's construction.

Project personnel will reduce outflow as necessary so as not to exceed the control stages (Table B-03.3) unless it is operating under a Special Directive for which flood control is not superseded or as outlined in Operation Under Emergency Conditions.

Table B-03.3 Control Stages and Flows at Key River Stations

Control Stages and Flows at Key River Stations						
		Summer		Winter		Time of travel from dam to Station - hours
		Stage	Flow	Stage	Flow	
Station	Stream	Feet	cfs	Feet	cfs	
Lavalette	Twelvepole	19	7800	19	7800	1.5
Ashland	Ohio River	52*		52*		30 @*

*Note: Operations for Ashland, KY is based on the stage forecast by the National Weather Service

@Operational time prior to crest stage in excess of 52 feet.

b. Calculations to Assist Project Operation

When making calculations to determine gate changes, inflow, desired outflow etc, always remember that calculations are only to be used as a guideline. The calculations may not be accurate because conditions are only monitored at a few points.

INFLOW: A rough estimate of inflow may be calculated by computing the change in storage. The Area Capacity is found in Table Table B-03.4 and the Stage/Flow relationship at the outflow Table B-03.5.

To estimate inflow record the pool elevations 1 hour apart, estimate the storage for each pool using the Area Capacity rating table, then follow equations below.

Equation 1 [Change in Storage in cfs = $\frac{(\text{End hour Storage} - \text{beginning hour Storage(acre ft.)})}{47.52}$]

Equation 2 [Inflow (cfs)= (Outflow(cfs) during the hour) +(Change in Storage in cfs)]

OUTFLOW: To determine the necessary discharge to affect a change in the lake elevation over a period of hours, use the following formula:

Equation 1 [Target change in storage= (target elevation Storage(acre ft) - current elevation Storage(acre ft))]

Equation 2 [Desired discharge= current inflow +($\frac{\text{target change in storage}}{1.98 * (\text{desired hours to target elevation}/24)}$)]

Table B-03.4 Beech Fork Area Capacity Table

Beech Fork Lake, Twelevepole Creek, WV Area Capacity Table							
Drainage Area = 78 Sq Miles				1 In. Runoff = 4,160 Ac. Ft.			
Elevation	Capacity		Area	Elevation	Capacity		Area
Ft-NGVD29	Ac. Ft.	Inches	Acres	Ft-NGVD29	Ac. Ft.	Inches	Acres
557	0	0.00	0	601	16,398	3.94	1,148
558	1	0.00	1	602	17,571	4.22	1,198
559	3	0.00	2	603	18,793	4.52	1,246
560	7	0.00	4	604	20,063	4.82	1,295
561	13	0.00	6	605	21,383	5.14	1,345
562	23	0.01	9	606	22,753	5.47	1,395
563	35	0.01	12	607	24,173	5.81	1,446
564	50	0.01	15	608	25,645	6.16	1,497
565	69	0.02	19	609	27,167	6.53	1,546
566	94	0.02	23	610	28,742	6.91	1,601
567	131	0.03	31	611	30,369	7.30	1,646
568	183	0.04	42	612	32,052	7.70	1,710
569	256	0.06	56	613	33,789	8.12	1,765
570	346	0.08	74	614	35,581	8.55	1,820
571	459	0.11	96	614.5	36,505	8.78	1,847
572	587	0.14	124	615	37,428	9.00	1,874
573	735	0.18	154	616	39,327	9.45	1,925
574	893	0.21	182	617	41,278	9.92	1,976
575	1,076	0.26	210	618	43,279	10.40	2,026
576	1,276	0.31	237	619	45,330	10.90	2,077
577	1,503	0.36	257	620	47,433	11.40	2,129
578	1,738	0.42	281	621	49,590	11.92	2,184
579	1,998	0.48	303	622	51,803	12.45	2,241
580	2,266	0.54	324	623	54,072	13.00	2,298
581	2,561	0.62	346	624	56,398	13.56	2,354
582	2,866	0.69	368	625	58,780	14.13	2,410
583	3,210	0.77	393	626	61,216	14.72	2,463
583.5	3,392	0.82	405	627	63,704	15.31	2,514
584	3,574	0.86	418	628	66,244	15.92	2,565
585	3,987	0.96	445	629	68,835	16.55	2,617
586	4,433	1.07	473	630	71,479	17.18	2,670
587	4,948	1.19	501	631	74,175	17.83	2,723
588	5,506	1.32	535	632	76,926	18.49	2,778
589	6,135	1.47	568	633	79,701	19.16	2,833
590	6,782	1.63	601	634	82,590	19.85	2,889
591	7,468	1.80	636	635	85,479	20.55	2,946
592	8,136	1.96	719	636	88,368	21.24	3,003
593	8,883	2.14	754	637	91,257	21.94	3,060
594	9,646	2.32	792	638	94,146	22.63	3,117
595	10,459	2.51	834	639	97,035	23.33	3,174
596	11,317	2.72	882	640	99,924	24.02	3,231
597	12,225	2.94	934				
598	13,187	3.17	990				
599	14,203	3.41	1,044				

600	15,275	3.67	1,098			
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Table B-03.5 Beech Fork Outflow Rating Table

Beech Fork Outflow Rating Table (08Aug2017)					
Stage	Flow	Stage	Flow	Stage	Flow
(ft)	(cfs)	(ft)	(cfs)	(ft)	(cfs)
0.5	0.6	5	630	9.4	1,636
0.6	1	5.1	650.8	9.5	1,659
0.7	1.5	5.2	671.9	9.6	1,683
0.8	1.9	5.3	693.3	9.7	1,707
0.9	2.4	5.4	714.9	9.8	1,731
1	3.3	5.5	736.8	9.9	1,754
1.06	5	5.6	758.9	10	1,779
1.25	5.2	5.7	781.3	10.1	1,803
1.33	5.5	5.8	804	10.2	1,827
1.64	6.2	5.9	826.9	10.3	1,851
1.7	10	6	850	10.4	1,876
1.8	22	6.1	871.5	10.5	1,900
1.9	44	6.2	893.2	10.6	1,923
2	65	6.3	915.1	10.7	1,946
2.1	90	6.4	937.2	10.8	1,968
2.2	110	6.5	959.4	10.9	1,991
2.3	125	6.6	981.8	11	2,014
2.4	137	6.7	1,004	11.1	2,037
2.5	150	6.8	1,027	11.2	2,060
2.6	164	6.9	1,050	11.3	2,084
2.7	179	7	1,073	11.4	2,107
2.8	194	7.1	1,097	11.5	2,130
2.9	210	7.2	1,120	11.6	2,151
3	227	7.3	1,143	11.7	2,172
3.1	245	7.4	1,165	11.8	2,194
3.2	261.6	7.5	1,188	11.9	2,215
3.3	278.8	7.6	1,212	12	2,236
3.4	296.6	7.7	1,235	12.1	2,257
3.5	315.1	7.8	1,258	12.2	2,279
3.6	334.1	7.9	1,282	12.3	2,300
3.7	353.6	8	1,305	12.4	2,321
3.8	373.8	8.1	1,329	12.5	2,343
3.9	394.5	8.2	1,353	12.6	2,364
4	415.7	8.3	1,377	12.7	2,386
4.1	437.6	8.4	1,401	12.8	2,407
4.2	460	8.5	1,426	12.9	2,428
4.3	479.9	8.6	1,450	13	2,450
4.4	500.3	8.7	1,473	16.9	4,800
4.5	521	8.8	1,496	21.4	9,000
4.6	542	8.9	1,519		
4.7	563.5	9	1,542		
4.8	585.3	9.1	1,565		
4.9	607.5	9.2	1,589		
		9.3	1,612		

Table B-03.6 Lavalette Rating
Table

Lavalette Rating Table (18Apr2019)											
Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)
0	17	4.3	204	8.6	1,786	12.9	3,465	17.2	6,256	21.5	10,360
0.1	20	4.4	211	8.7	1,832	13	3,500	17.3	6,334	21.6	10,466
0.2	22	4.5	219	8.8	1,878	13.1	3,534	17.4	6,412	21.7	10,571
0.3	24	4.6	228	8.9	1,924	13.2	3,568	17.5	6,493	21.8	10,677
0.4	27	4.7	237	9	1,970	13.3	3,602	17.6	6,574	21.9	10,783
0.5	29	4.8	246	9.1	2,014	13.4	3,636	17.7	6,657	22	10,889
0.6	32	4.9	256	9.2	2,058	13.5	3,670	17.8	6,741	22.1	10,995
0.7	35	5	265	9.3	2,102	13.6	3,704	17.9	6,826	22.2	11,089
0.8	38	5.1	275	9.4	2,146	13.7	3,738	18	6,911	22.3	11,182
0.9	41	5.2	285	9.5	2,190	13.8	3,772	18.1	6,996	22.4	11,275
1	44	5.3	295	9.6	2,232	13.9	3,806	18.2	7,083	22.5	11,369
1.1	47	5.4	306	9.7	2,274	14	3,840	18.3	7,169	22.6	11,462
1.2	50	5.5	317	9.8	2,316	14.1	3,871	18.4	7,256	22.7	11,540
1.3	53	5.6	328	9.9	2,358	14.2	3,902	18.5	7,342	22.8	11,608
1.4	57	5.7	368	10	2,400	14.3	3,933	18.6	7,429	22.9	11,676
1.5	60	5.8	407	10.1	2,440	14.4	3,964	18.7	7,517	23	11,744
1.6	64	5.9	446	10.2	2,480	14.5	4,004	18.8	7,613	23.1	11,812
1.7	67	6	485	10.3	2,520	14.6	4,076	18.9	7,708	23.2	11,880
1.8	71	6.1	524	10.4	2,560	14.7	4,148	19	7,804	23.3	11,948
1.9	75	6.2	564	10.5	2,600	14.8	4,222	19.1	7,900	23.4	12,019
2	79	6.3	611	10.6	2,636	14.9	4,297	19.2	7,995	23.5	12,103
2.1	83	6.4	659	10.7	2,672	15	4,372	19.3	8,098	23.6	12,186
2.2	87	6.5	705	10.8	2,708	15.1	4,450	19.4	8,201		
2.3	92	6.6	750	10.9	2,744	15.2	4,530	19.5	8,304		
2.4	96	6.7	796	11	2,780	15.3	4,610	19.6	8,407		
2.5	101	6.8	841	11.1	2,818	15.4	4,693	19.7	8,510		
2.6	105	6.9	882	11.2	2,856	15.5	4,775	19.8	8,612		
2.7	110	7	940	11.3	2,894	15.6	4,861	19.9	8,715		
2.8	115	7.1	1,000	11.4	2,932	15.7	4,948	20	8,817		
2.9	120	7.2	1,060	11.5	2,970	15.8	5,036	20.1	8,919		
3	125	7.3	1,120	11.6	3,006	15.9	5,126	20.2	9,022		
3.1	130	7.4	1,170	11.7	3,042	16	5,217	20.3	9,127		
3.2	136	7.5	1,230	11.8	3,078	16.1	5,308	20.4	9,232		
3.3	141	7.6	1,290	11.9	3,114	16.2	5,400	20.5	9,338		
3.4	147	7.7	1,340	12	3,150	16.3	5,495	20.6	9,443		
3.5	152	7.8	1,390	12.1	3,185	16.4	5,589	20.7	9,545		
3.6	158	7.9	1,450	12.2	3,220	16.5	5,667	20.8	9,645		
3.7	164	8	1,500	12.3	3,255	16.6	5,743	20.9	9,744		
3.8	170	8.1	1,548	12.4	3,290	16.7	5,825	21	9,843		
3.9	177	8.2	1,596	12.5	3,325	16.8	5,930	21.1	9,942		
4	183	8.3	1,644	12.6	3,360	16.9	6,025	21.2	10,044		
4.1	190	8.4	1,692	12.7	3,395	17	6,102	21.3	10,150		
4.2	197	8.5	1,740	12.8	3,430	17.1	6,179	21.4	10,255		

c. Gate Regulation

Facilities provided for water control include

- Two rectangular 5.66 ft by 10.5 ft sluice gates controlled by slide gates to be used for releases in excess of 430 cfs.
- One uncontrolled chute spillway with invert elevation of 614.5 ft NGVD 29.
- Two well, tri-level selective inlet system for low-flow, temperature control, and normal discharge.
- An emergency bulkhead that can be set in either of the 2 sluices.

1) Slide Gates

The two slide gates are designated SL and SR with SL being on the left side and SR on the right side facing downstream from the intake structure. Each opens from a sill at 557.0. ft. NGVD 29. Either slide gate SR or SL shall be operated until an opening of 2.5 feet is achieved after which the other shall be operated for any additional discharge up to equal settings on both gates. If greater discharges are required, both gates shall be opened uniformly. In order to equalize wear, the slide gates should be alternated for routine operations. Gate S2 is opened first, then S1, or S3 alternating every month to equalize wear. *Table B-03.7* is a table of partial gate openings verses flow for one of the slide gates to be used to estimate necessary gate opening.

Table B-03.7 Discharge and Corresponding Openings of One Slide Gate

DISCHARGE AND CORRESPONDING OPENINGS OF ONE SLIDE GATE IN FEET											
Discharge	Outflow	Lake Elevation In Feet Above NGVD 29									
cfs	stage	584	586	588	590	592	596	600	605	610	615
20	1.10	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
50	1.63	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.2
80	1.98	0.6	0.6	6.6	0.5	0.5	0.5.	0.5	0.5	0.5	0.5
120	2.36	0.9	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.6	0.6
160	2.67	1.2	1.1	1.1	1.0	1.0	1.0	0.9	0.9	0.8	0.7
200	2.93	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.1	1.1	1.0
250	3.22	1.7	1.7	1.7	1.6	1.6	1.6	1.5	1.5	1.4	1.4
300	3.50	2.2	2.1	2.0	2.0	1.9	1.8	1.8	1.7	1.5	1.5
350	3.75	2.6	2.4	2.4	2.3	2.3	2.2	2.0	1.9	1.8	1.7
400	4.00	3.0	2.8	2.7	2.6	2.6	2.4	2.3	2.2	2.1	2.0
450	4.23	3.4	3.2	3.1	3.0	2.9	2.8	2.6	2.4	2.4	2.2
500	4.46	3.7	3.6	3.4	3.3	3.2	3.1	2.9	2.7	2.6	2.5
600	4.91	4.6	4.4	4.2	4.1	3.7	3.6	3.5	3.4	3.2	3.0
700	5.37	5.4	5.2	4.9	4.7	4.6	4.3	4.1	3.8	3.7	3.5
800	5.82	6.2	6.0	5.7	5.5	5.3	5.0	4.8	4.5	4.2	4.1
1000	6.70	7.9	7.5	7.2	6.9	6.7	6.3	5.9	5.6	5.4	5.1
1200	7.56	9.6	9.1	8.7	8.3	8.0	7.5	7.2	6.7	6.4	6.1
1400	8.44				9.8	9.4	8.8	8.3	7.8	7.3	7.0
1600	9.31						9.9	9.4	8.9	8.4	7.9
1800	10.17								9.7	9.3	8.9

2000	11.05									9.9	9.7
2100	11.48										9.8

2) Low Flow Gates

The selective withdrawal system consists of two near identical low-flow wells. The low-flow wells are used for flood control, low-flow, and temperature control by releasing small flows from three depth zones, elevation 582, 575, and 564 NGVD 29 in the lake. The two low-flow wells are designated IL and IR, with IL being on the left side of the intake structure and IR on the right side facing downstream.

The water enters the low-flow well inlets and is released at the bottom outlet gate. Both wells are approximately the same; each has two inlet gates and one outlet control gate. Both wells have the same upper inlet window at elevation 582 feet NGVD 29 and the same lower outlet control gate at elevation 557 feet NGVD 29. The only difference between the wells is the invert elevation for the right well middle inlet window is 9 feet lower than the matching left well middle inlet window.

During the period of lake stratification, when the lake level is below elevation 592 feet NGVD 29, use the low-flow system for all minimum releases up to 430 cfs. Releases up to approximately 215 cfs may be passed through either outlet gate, or 430 cfs through both wells by fully opening the low-flow outlet gates.

All low-flow gates are designated according to the invert depth below the summer pool of elevation 592 feet NGVD 29. Both wells have an upper inlet at elevation 582 feet NGVD 29, so designated IR10 and IL10; and both wells have a lower outlet control gate at elevation 557.88 feet NGVD 29 designated LFR and LFL. The right well has a middle inlet at elevation 564 feet NGVD 29 designated IR28; and the left well has a middle inlet 9 feet higher at elevation 573 feet NGVD 29 so designated IL19. At the bottom of both low-flow wells WL and WR are the two low-flow outlet control gates LFL and LFR, respectively. Each one is a 2'6" x 3'0" vertical lift slide gate, pressure-seating type, with invert at 557.88 feet NGVD 29, but they open to only 80 percent of the height or approximately 2'5".

Tables B- 3.8, 3.9, and 3.10 show openings of the low-flow control gate, LFC, in percent necessary at various pool elevations to effect desired stages and corresponding discharges at the "0" gage. Gate positions for each of the inlets, or both, are specified on each exhibit. The Water Control Section of the District office directs all temperature control operations according to Outflow Temperature Objective, (See Plate 7-9 in the Beech Fork Lake Water Control Manual), and the weekly temperature - dissolved oxygen profile.

Table B-03.8 Low Flow Control Gate Flow with Upper Intakes Open

DISCHARGE AND CORRESPONDING OPENINGS OF LOW FLOW CONTROL GATE IN PERCENT IL10 or IR10 FULLY OPEN		
Discharge	Outflow	Lake Elevation In Feet Above NGVD 29

cfs	stage		582	584	586	588	590	592
5	0.71			2	2	2	2	2
10	0.89			4	4	4	4	4
15	1.05			7	6	6	6	6
20	1.18			9	9	8	8	8
25	1.30			11	11	10	10	10
30	1.40			13	13	12	12	12
35	1.48			15	15	15	14	14
40	1.57			18	17	17	16	16
50	1.71				22	21	20	20
75	2.01				32	31	30	29
100	2.25				43	42	40	39
125	2.46				54	52	50	49
150	2.64				64	62	60	58
175	2.81				74	71	69	67
200	2.96						79	76
210	3.02							80

Table B-03.9 Low Flow Control Gate Flow with Lower Intakes Open

DISCHARGE AND CORRESPONDING OPENINGS OF LOW FLOW CONTROL GATE IN PERCENT IL19 or IR28 FULLY OPEN								
Discharge	Outflow	Lake Elevation In Feet Above NGVD 29						
cfs	stage	580	582	584	586	588	590	592
5	0.71	3	2	2	2	2	2	2
10	0.89	5	5	4	4	4	4	4
15	1.05	7	7	7	6	6	6	6
20	1.18	10	10	9	9	8	8	8
25	1.30	12	12	11	11	10	10	10
30	1.40	15	14	13	13	12	12	12
35	1.48	17	16	15	15	15	14	14
40	1.57	20	19	18	17	17	16	16
50	1.71	25	23	22	22	21	20	20
75	2.01	37	35	34	32	31	30	29
100	2.25	49	47	45	43	42	40	39
125	2.46	61	58	56	54	52	50	49
150	2.64	72	69	66	64	62	60	58
175	2.81		80	77	74	71	69	67
200	2.96						79	76
210	3.02							80

Table B-03.10 Low Flow Control Gate Flow with Lower and Upper Intakes Open

DISCHARGE AND CORRESPONDING OPENINGS OF LOW FLOW CONTROL GATE, IN PERCENT IL10 and IL19 or IR10 and IR28 FULLY OPEN								
Discharge	Outflow	Lake Elevation In Feet Above NGVD 29.						
cfs	stage	580	582	584	586	588	590	592

5	0.71	3	2	2	2	2	2	2
10	0.89	5	5	4	4	4	4	4
15	1.05	7	7	7	6	6	6	6
20	1.18	10	10	9	9	8	8	8
25	1.30	12	12	11	11	10	10	10
30	1.40	15	14	13	13	12	12	12
35	1.48	17	16	15	15	15	14	14
40	1.57	20	19	18	17	17	16	16
50	1.71	25	23	22	22	21	20	20
75	2.01	37	35	34	32	31	30	29
100	2.25	49	47	45	43	42	40	39
125	2.46	61	58	55	53	51	50	48
150	2.64	72	69	66	63	61	59	57
175	2.81		79	75	73	70	68	66
200	2.96					79	76	74
215	3.05							79

d. Regulation for Temperature and Water Quality

One of the aims of water control management is maintenance of natural temperature conditions downstream. To this end, and specifically to avoid thermal shock to downstream aquatic communities, outflow temperature is regulated within a 2°F band around the natural stream temperature. "Outflow Temperature Regulation Curves," (**Plate 7-9**, in the Beech Fork Lake Water Control Manual), is a yearlong graph of this band of desired outflow temperature by calendar day and Julian day and is to be found in the main manual.

During the period of lake stratification, approximately mid-April through mid-October, project personnel take weekly temperature and dissolved oxygen data in the lake and send it to Water Resources Engineering Branch where they are computer-plotted into Water Quality Profiles. Branch personnel, considering the depths of low-flow intakes in the lake, use the latest profile in conjunction with the target temperature for the day from **Plate 7-9** (middle curve, main text), and hourly outflow temperature readings to devise an acceptable scheme of regulation. Then a Special Directive is telephoned to the Project providing details of gate operation. Any and all gate changes for temperature control purposes require a Special Directive from the Water Control Section.

e. Emergency Conditions

During an emergency conditions Water Management will provide instructions as necessary minimally once a day, likely 4 times a day and potentially every hour. During Emergency Conditions, Special Directives are likely to include gate usage and settings.

1) Dam Safety Emergency

If dam failure is a concern, the Dam Safety Officer will convene the Crisis Management Team who will direct operations through Water Management. Notifications will proceed as defined in the Dam Safety Emergency Action Plan.

2) Imminent Loss of Life

Project personnel have the authority to operate as necessary to abate the problem as long as:

- IF taking an action will not result in the pool exceeding the Flood Control Pool (614.5 ft. NGVD 29)).
- AND IF such an action would not result in equal or worse conditions.

Water Management will be informed immediately after any such action and will provide guidance on additional actions.

3) Communication Failure

While the Project should continue to make all efforts to contact the District Office, project personnel are responsible to undertake the following emergency operations if flooding or significant inflow is occurring.

If the project was under Special Directive when communications failed, follow the operating instructions contained in the Special Directive until:

- The specific operation given in the directive has been completed, or
- Twenty-four hours have elapsed since last contact with the Water Resources Engineering Branch, or
- Sufficient rainfall or snowmelt occurs which causes the lake and/or streams in the vicinity to rise rapidly.

Whenever any of the foregoing conditions occurs, follow the operating instructions defined in Normal Operations or the section below whichever is applicable.

Whenever the lake level is above elevation 605.0 feet NGVD 29 and rising, a constant check shall be made on the rate of rise of the lake level. The lake "L" gage shall be read every hour, on the hour, and rise in pool level computed for the previous hour. The purpose of this exercise is to determine if the rate of rise in lake level indicates to the project manager that the available storage capacity of the project may be insufficient to completely control a given flood.

If the pool elevation approaches 610.0 ft NGVD 29

- Increase the releases out of the Dam to a level not greater than the maximum outflow WITH a directive for the season or a flow that will not result exceedance of downstream control stages.
- In this Emergency Situation and for the length of the emergency, the Project Manager is further authorized to make any additional gate movements as required, regardless of the resultant rate of rise on the stage of the "O" gage.

If the pool elevation approaches 613.0 ft. NGVD 29

- Increase the releases out of the Dam to the maximum outflow WITH a directive for the season regardless of downstream conditions.

If the pool elevation exceeds 614.5 ft. NGVD 29 and continues to rise

- As spillway flow begins, gradually reduce the outflow in order to prevent the sluice releases and the spillway flow from exceeding the maximum outflow WITH a directive for the season.
- When spillway approaches 618 ft. (summer) and 618.5 ft. (winter) NGVD 29, sluice gates should be closed.

If the pool continues to rise to elevation 619.0 feet NGVD,

- gradually open both slide gates so that they both have 10.5 ft of gate opening when the pool level approaches elevation 620 ft NGVD, the elevation of the Real Estate Taking Line.

When the lake crests and recedes to elevation 620 ft. NGVD

- Gradually reduce the gate settings in order to prevent exceeding the downstream control stage as the pool approaches 619.0 feet NGVD.

During the recession,

- Gradually increase the openings on both slide gates to maintain approximate maximum outflow WITH a directive for the season.
- As the lake approaches elevation 613.0 feet NGVD, set the outflow to a level not greater than the maximum outflow WITH a directive for the season or a flow that will not result exceedance of downstream control stages.
- When the pool level recedes to elevation 610.0 NGVD, hold that elevation by adjusting the gate settings as necessary until communications are reestablished with the Water Control Section and flood operational guidance is available.

If another rise occurs, follow the instructions in the relevant section above.

f. Inquiries

Project personnel field many questions from the public and other agencies with regards to project operations. Situations will arise for which a question will be outside the purview of project personnel, or individuals/agencies are unwilling to accept the offered answer. Water Management is available to address any issues regarding water control procedures or actions. When such a situation arises provide contact information to the southern water management team lead.

g. Water Control Problems

Project personnel notify Water Management of issues which impact water management activities.

These include:

- Any Gate outages.
- Gage issues.
- Upstream or downstream flooding or complaints of such.
- A catastrophe such as drowning.
- Unusual or abnormal water quality conditions in the lake, inflow streams, or a reasonable distance downstream of the project,
- Encroachment on the flood control pool.
- Encroachment on downstream flood plain.
- All developments along Beech Fork.
- between the dam and Twelvepole River.
- Additional impacts of sedimentation of the conservation pool.

Locations impacted by Beech Fork Lake are listed in Table B-03.11.

Table B-03.11 Pool Impact Elevations

IMPACT ELEVATIONS		
Direction	Elevation	Impact Description
Below	574	Marina outer slips unusable
Below	580	Corps Launch Ramp unusable.
Below	583	State Launch Ramp unusable.
Below	589	Beach Closed.
Above	593.6	State Park Day Use Area.
Above	593.6	Launch Ramp top (courtesy) dock at Lower Bowen closed.
Above	594	Beach and Handicapped Fishing Platform closed.
Above	597	Campsites closed.
Above	597.6	Parking Lot at Lower Bowen Boat Ramp closed.
Above	599	Lower Bowen Comfort Stations (11-15) flooded.
Above	600	Picnic Shelter at Marina flooded.
Above	600.3	Parking Lot at Lower Bowen Boat Ramp closed.
Above	600.45	Intake Structure Parking Lot east side flooded.
Above	602	Lower Bowen Waste Treatment Plant sand filter and Upper Bowen Picnic Shelters flooded.
Above	603.5	Lower Bowen Administration Building Parking Lot flooded.
Above	606	Lower Bowen Waste Treatment Control Building flooded.
Above	621.67	Visitor Center Parking Lot flooded.
Above	630	Visitor Center flooded.

h. Abnormal Releases including Potential Spillway Discharge

Operating reservoir projects during major floods has on occasion resulted in water releases being made which damaged privately owned equipment or facilities located downstream and caused claims or damage suits to be filed against the government. To minimize the possibility of such claims or suits, the Damtender must keep informed and inform Water Resources Engineering Branch of all developments along Beech Fork. Between the dam and Twelvepole Creek. If required by unusual release patterns, obtain directions from Water Management Section which will coordinate with Public Affairs Office for public notification procedures. Unusual release patterns may include closure for maintenance purposes, special increases or decreases for downstream requests and requirements, and emergency, above channel capacity.

Public notifications of emergency releases in association with emergencies that threaten the integrity of the dam are covered by the Dam Safety Emergency Action Plan under "Dam Failure in Progress Condition Field Notification Chart" (the Red Sheet). Public notification of emergencies not threatening the integrity of the dam will be coordinated through the Crisis Management Team (CMT). The CMT will authorize the release of information through the Public Affairs Office (PAO) to local news media and through the Resource/Facility Manager to the local immediate downstream County Office of Emergency Management (OEM). It is the intent of the District to give maximum notification to the immediate downstream County OEM when the pool elevation is forecasted to exceed the spillway elevation, when there is a dam safety issue, when gates are closed for maximum flood reduction, or when releases will quickly contribute to stages exceeding control immediately downstream. Project Personnel will contact the immediate downstream OEM at least daily to provide an operational update or as directed by CMT. In the event communications are lost between the project and the district office, the Resource/Facility Manager is authorized to make notifications based upon the Water Control Manual or for dam safety at the direction of geotechnical personnel who will be at the project.

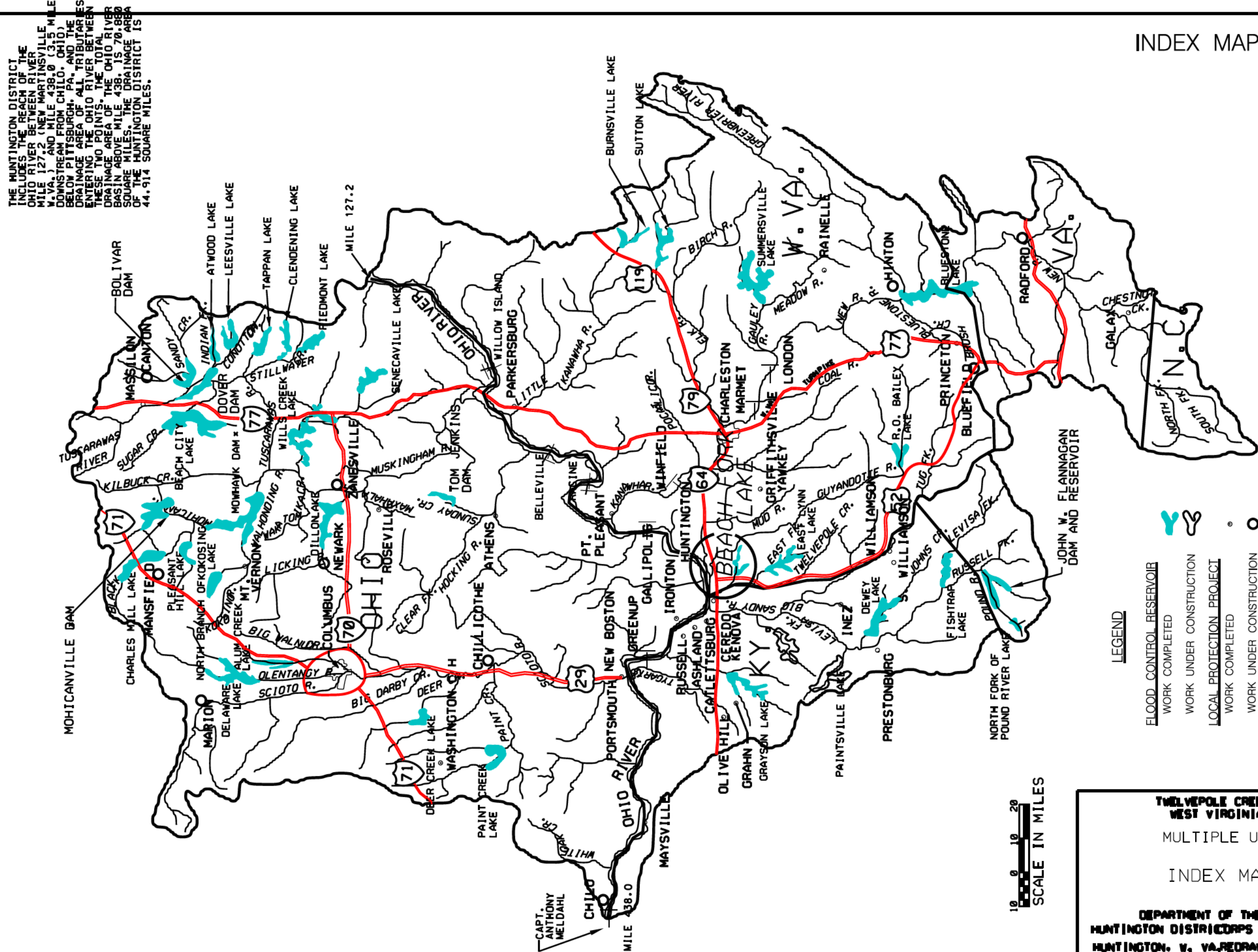
Once the flood event has passed, the OEM will also be advised of the estimated time that water will be released at control (near bank full) in order to reduce the water level behind the dam in order to restore the flood reduction capacity of the dam.

In non-emergency situations, PAO and Water Management Section coordinate to disseminate information about lake regulation and operation, recreation, fishery enhancement or flood control.

The National Weather Service is the official agency for disseminating river forecasts. Reservoir and rainfall data are provided by the Water Management Section to the National Weather Service daily via the District Water Control System. NWS forecasts may be made available to the public as long as the public is informed that the NWS is solely responsible for their accuracy.

UPON APPROVAL OF NEPA DOCUMENTATION, THE DROUGHT CONTINGENCY PLAN
WILL BE FURNISHED FOR ENCLOSURE IN THE WATER CONTROL MANUALS.

THE HUNTINGTON DISTRICT INCLUDES THE REACH OF THE OHIO RIVER BETWEEN RIVER MILE 127.2 (NEW MARTINSVILLE, VA.) AND MILE 438.0 (3.5 MILES DOWNSTREAM FROM CHILO, OHIO) BELOW PITTSBURGH, PA., AND THE DRAINAGE AREA OF ALL TRIBUTARIES ENTERING THE OHIO RIVER BETWEEN THESE TWO POINTS. THE TOTAL DRAINAGE AREA OF THE OHIO RIVER BASIN ABOVE MILE 438.0 IS 70,880 SQUARE MILES. THE DRAINAGE AREA OF THE HUNTINGTON DISTRICT IS 44,914 SQUARE MILES.



INDEX MAP

- LEGEND**
- FLOOD CONTROL RESERVOIR
 - WORK COMPLETED
 - WORK UNDER CONSTRUCTION
 - LOCAL PROTECTION PROJECT
 - WORK COMPLETED
 - WORK UNDER CONSTRUCTION
 - LOCKS AND DAMS
 - WORK COMPLETED
 - DISTRICT BOUNDARY

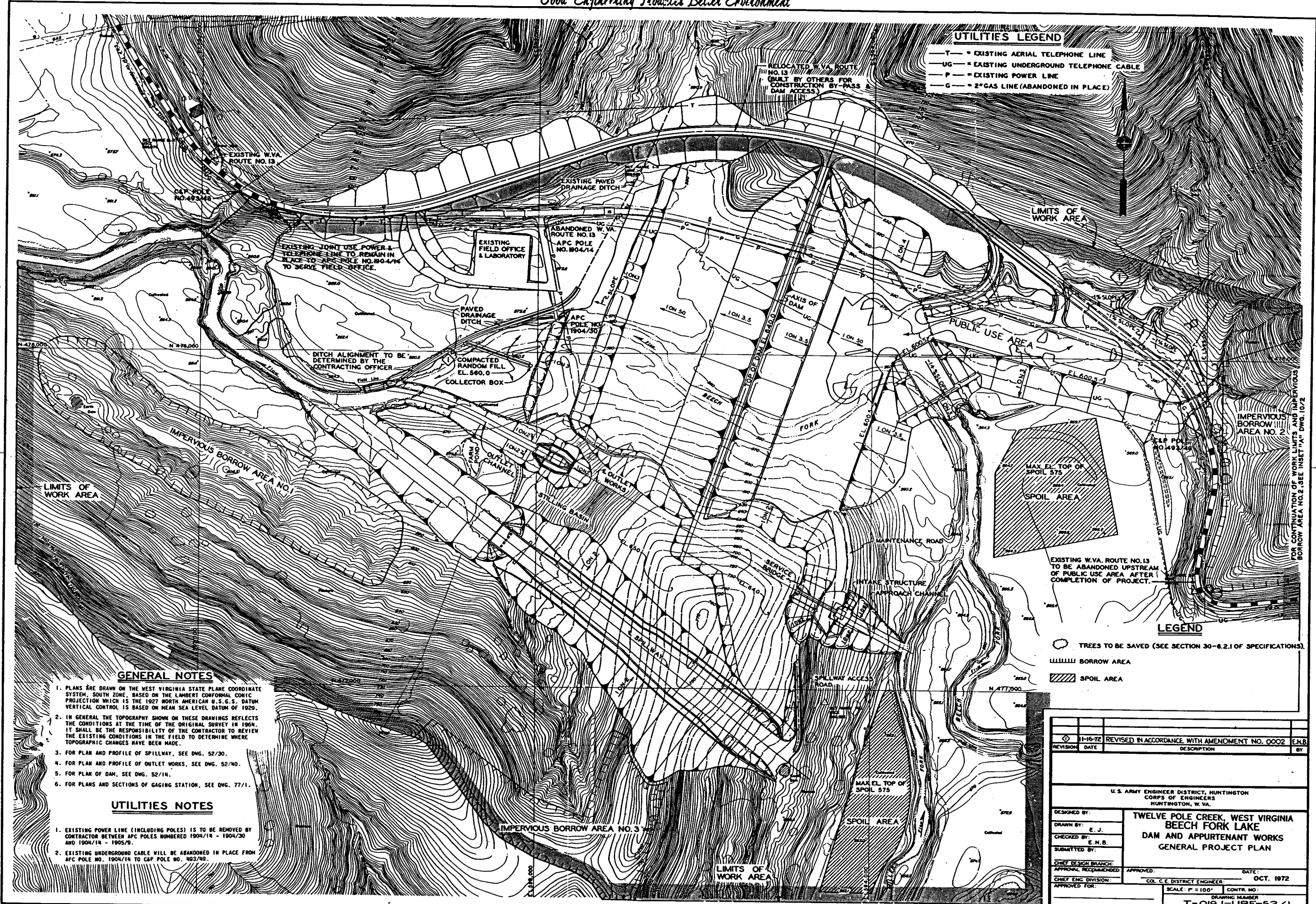
**TWELVEPOLE CREEK
WEST VIRGINIA**

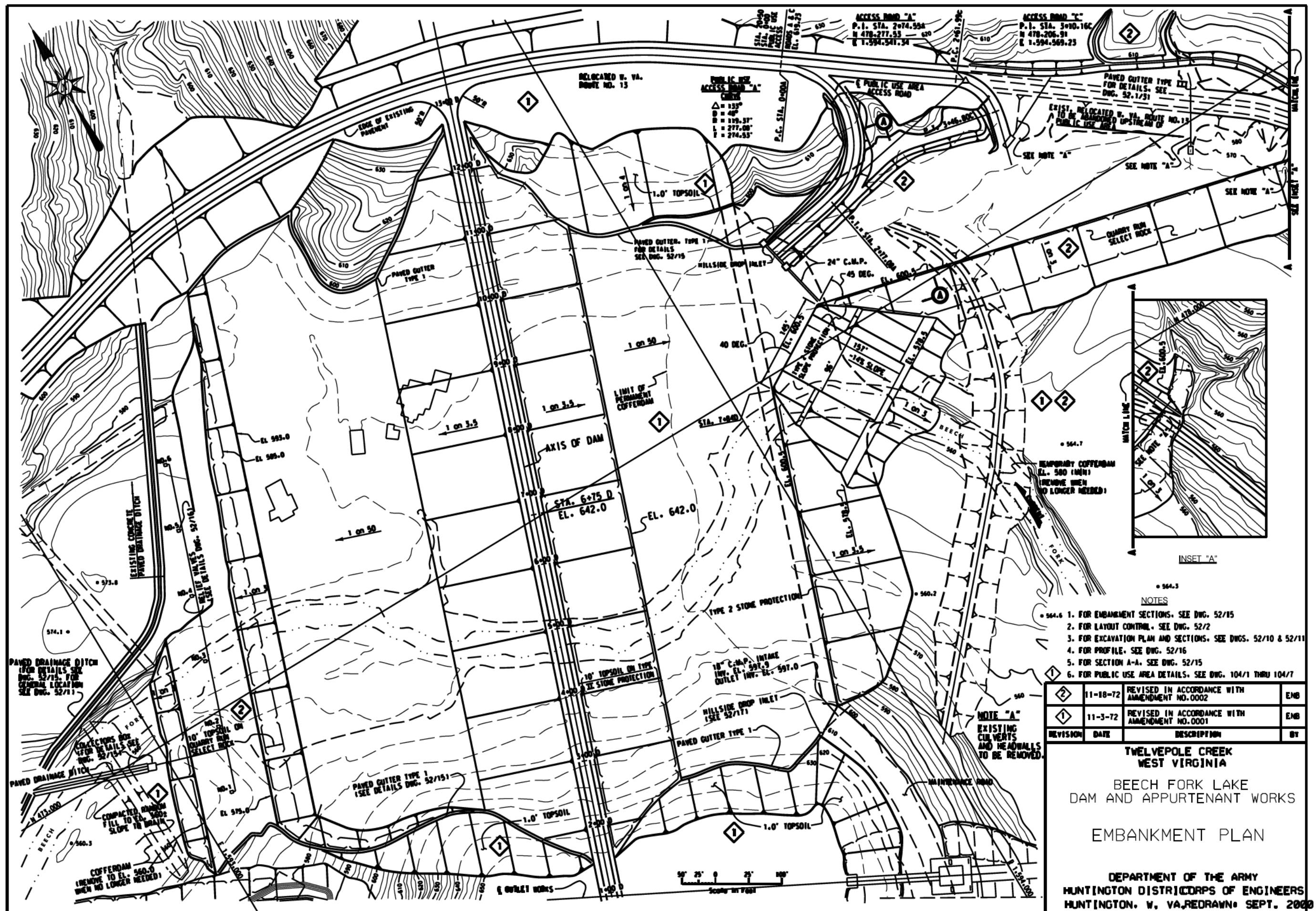
MULTIPLE USE

INDEX MAP

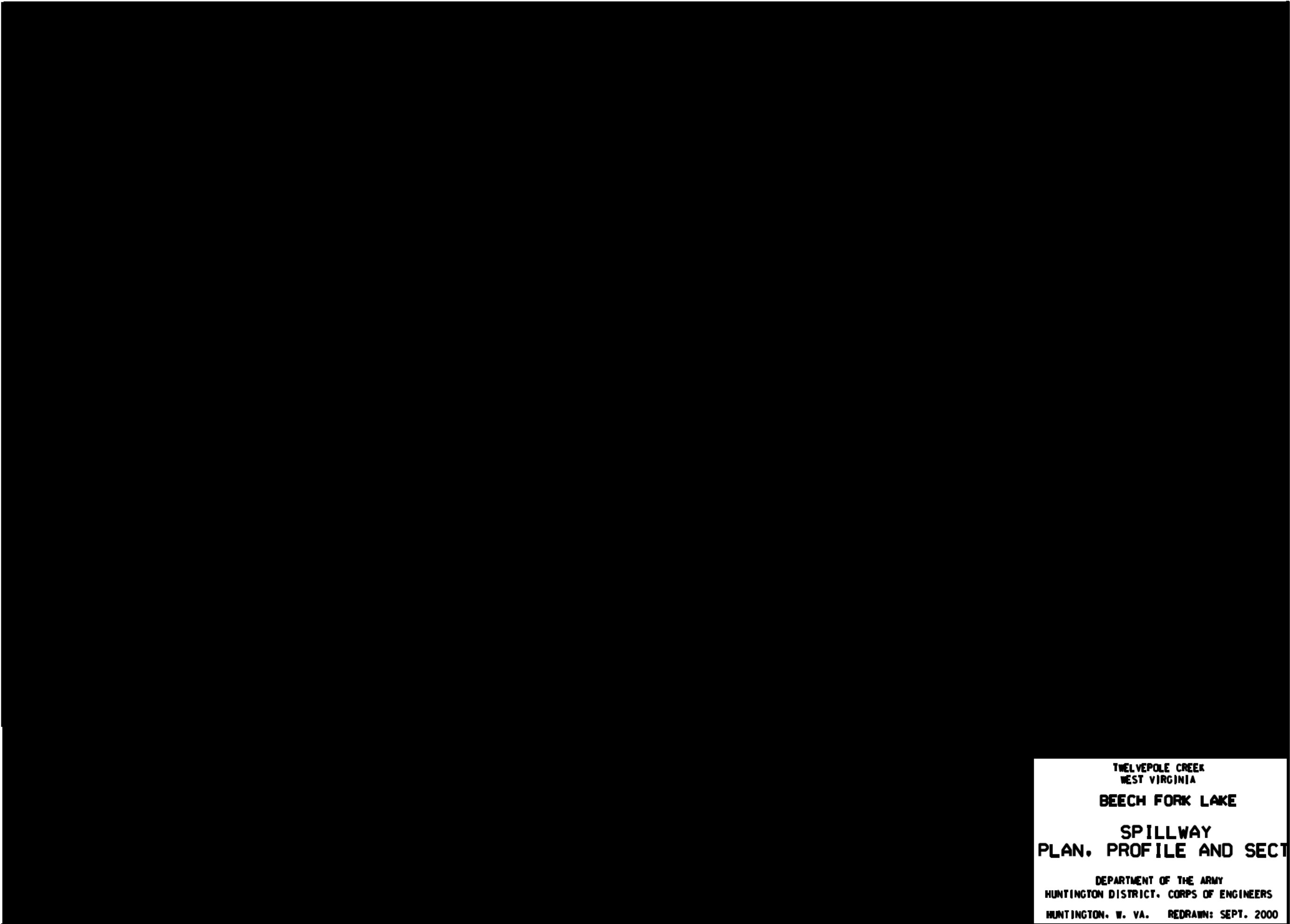
DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: SEPT. 20, 1960

* DRY DAM, WITH FLOOD CONTROL POOL OUTLINED.
** COMPLETED PROJECT WHERE FURTHER IMPROVEMENTS ARE IN PROGRESS OR AUTHORIZED.





TWELVEPOLE CREEK
WEST VIRGINIA
BEECH FORK LAKE
DAM AND APPURTENANT WORKS
DAM
EMBANKMENT SECTIONS
DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000



TWELVEPOLE CREEK
WEST VIRGINIA
BEECH FORK LAKE
SPILLWAY
PLAN, PROFILE AND SECTIONS
DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000



TWELVEPOLE CREEK
WEST VIRGINIA
BEECH FORK LAKE
OUTLET WORKS
PLAN, PROFILE AND TUNNEL
DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000

TWELVEPOLE CREEK
WEST VIRGINIA
BEECH FORK LAKE
DAM AND APPURTENANT WORKS
OUTLET WORKS EXCAVATION
INLET CHANNEL
DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000

TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE

INTAKE STRUCTURE
ELEVATION, SECTIONAL PLANS

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000

TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE

INTAKE STRUCTURE
ELEVATIONS

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000

DESIGNED BY: H.E.S.-R.P.W.	TWELVE POLE CREEK, WEST VIRGINIA BEECH FORK LAKE DAM AND APPURTENANT WORKS SELECTIVE WITHDRAWAL WELL INLET AND OUTLET GATES AND HYDRAULIC PIPING
DRAWN BY: B.A.R.	
CHECKED BY: H.E.S.-R.P.W.	
SUBMITTED BY:	
CHIEF DESIGN BRANCH:	
APPROVAL, RECOMMENDED:	APPROVED: _____ DATE: _____
CHIEF ENG. DIVISION:	COL. C.E. DISTRICT ENGINEER: _____ OCT. 1972
APPROVED FOR:	SCALE: AS SHOWN CONTR. NO:
DATE: _____	DRAWING NUMBER T-019.1-UBF-52.3/19 SHEET 18 OF 28

TWELVEPOLE CREEK
WEST VIRGINIA

**BEECH FORK LAKE
DAM AND APPURTENANT WORKS
MECHANICAL EQUIPMENT
GENERAL ARRANGEMENT**

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN SEPT. 2000

PLATE NO. 2-11

TWELVEPOLE CREEK
WEST VIRGINIA
BEECH FORK LAKE
DAM AND APPURTENANT WORKS
TRANSITION
MASONRY

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN SEPT. 2000

TWELVEPOLE CREEK
WEST VIRGINIA
BEECH FORK LAKE
DAM AND APPURTENANT WORKS
TUNNEL
PROFILE AND SECTIONS
DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000

**TWELVEPOLE CREEK
WEST VIRGINIA
BEECH FORK LAKE
OUTLET WORKS
STILLING BASIN & APPROACH WALLS**

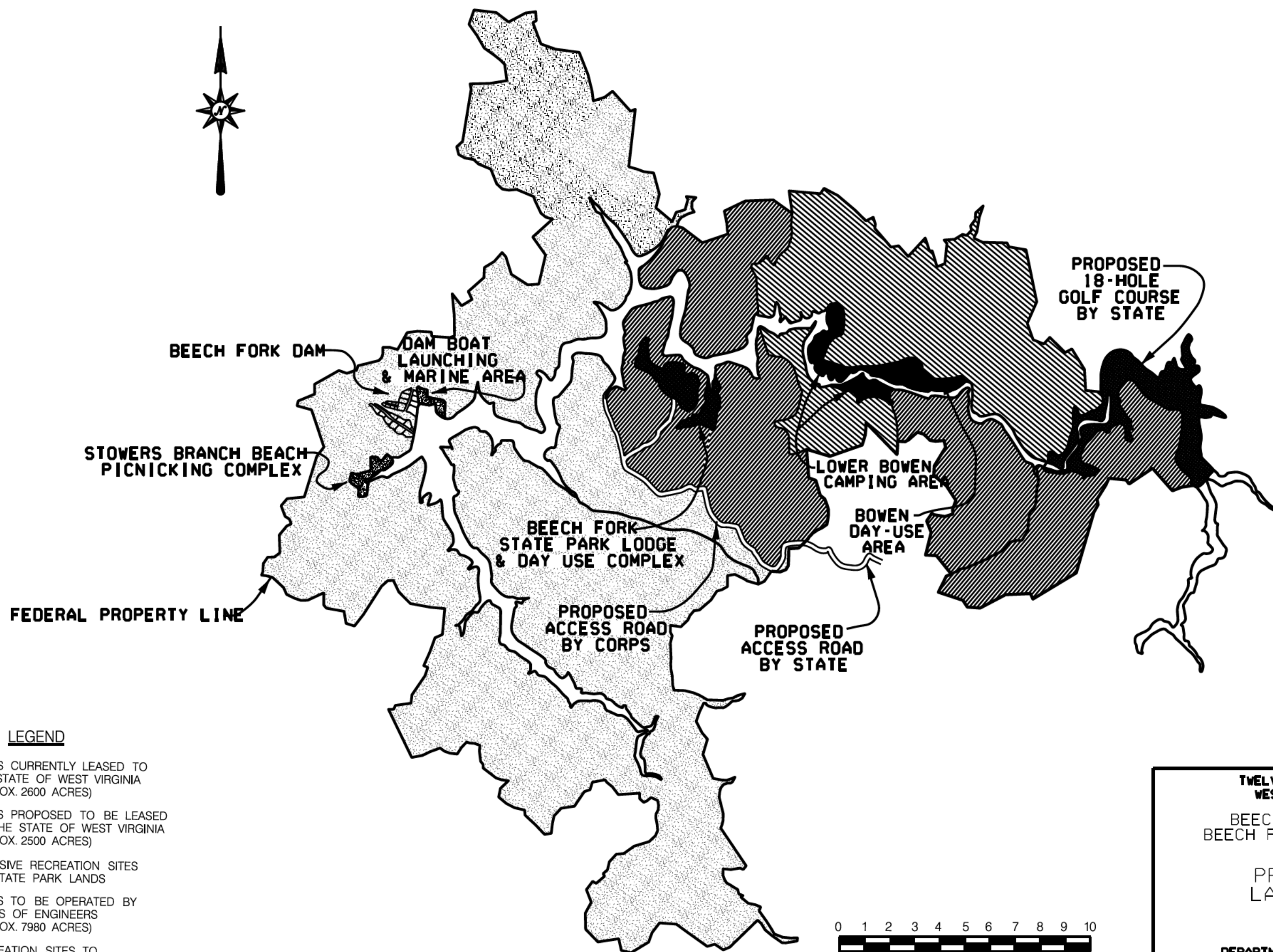
**DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000**

TWELVEPOLE CREEK
WEST VIRGINIA

**BEECH FORK LAKE
DAM AND APPURTENANT WORKS
OUTLET WORKS EXCAVATION
OUTLET CHANNEL**

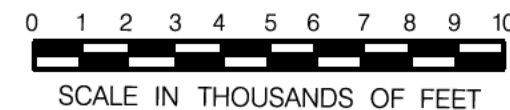
DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000

PLATE NO. 2-15



LEGEND

-  LANDS CURRENTLY LEASED TO THE STATE OF WEST VIRGINIA (APPROX. 2600 ACRES)
-  LANDS PROPOSED TO BE LEASED TO THE STATE OF WEST VIRGINIA (APPROX. 2500 ACRES)
-  INTENSIVE RECREATION SITES ON STATE PARK LANDS
-  LANDS TO BE OPERATED BY CORPS OF ENGINEERS (APPROX. 7980 ACRES)
-  RECREATION SITES TO BE OPERATED BY CORPS OF ENGINEERS

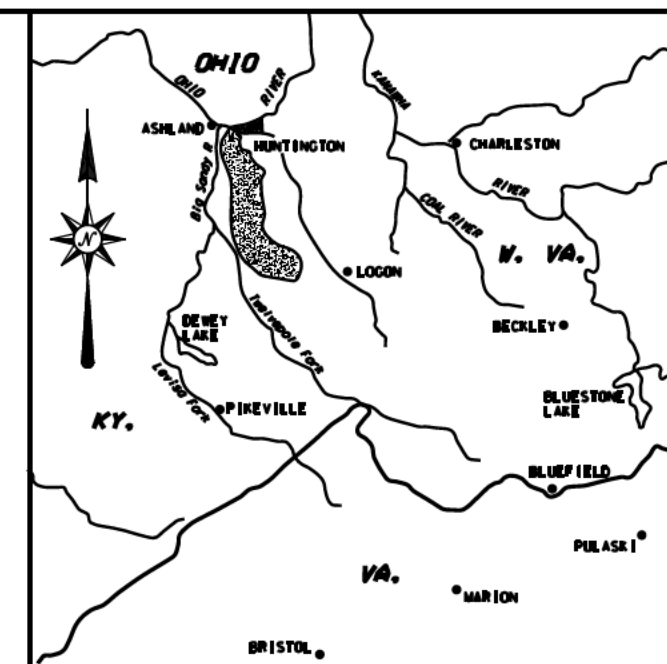
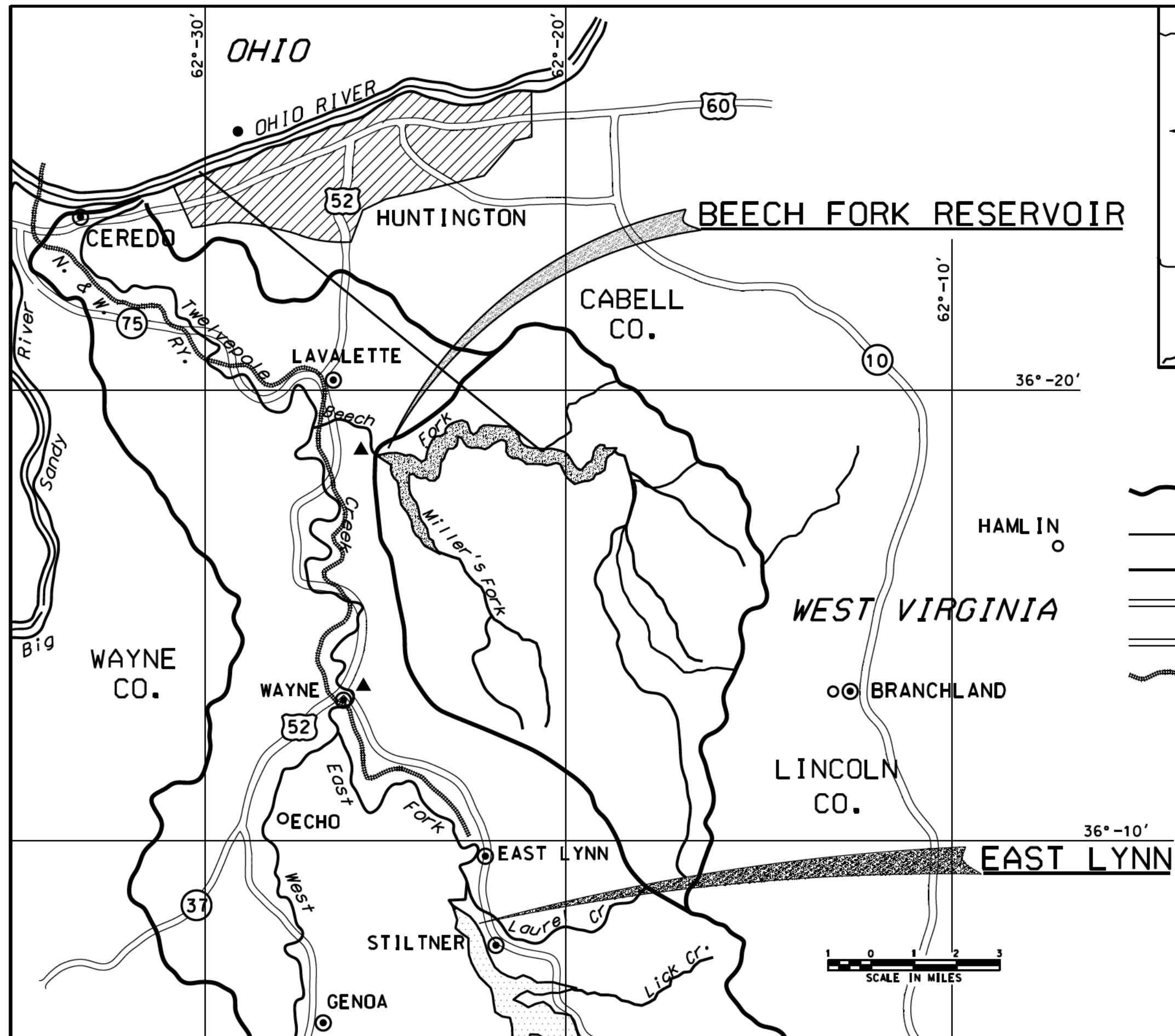


**TWELVEPOLE CREEK
WEST VIRGINIA**

BEECH FORK LAKE
BEECH FORK STATE PARK

PROJECT
LAND-USE

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN SEPT. 2000



VICINITY MAP

20 10 40 20 40
SCALE IN MILES

LEGEND

- DRAINAGE AREA BOUNDARY
- COUNTY BOUNDARY
- STATE BOUNDARY
- U.S. HIGHWAY
- STATE HIGHWAY
- RAILROAD
- RECORDING RAIN GAGE
- NON-RECORDING RAIN GAGE
- RECORDING STREAM GAGE
- TOWNS OR COMMUNITIES

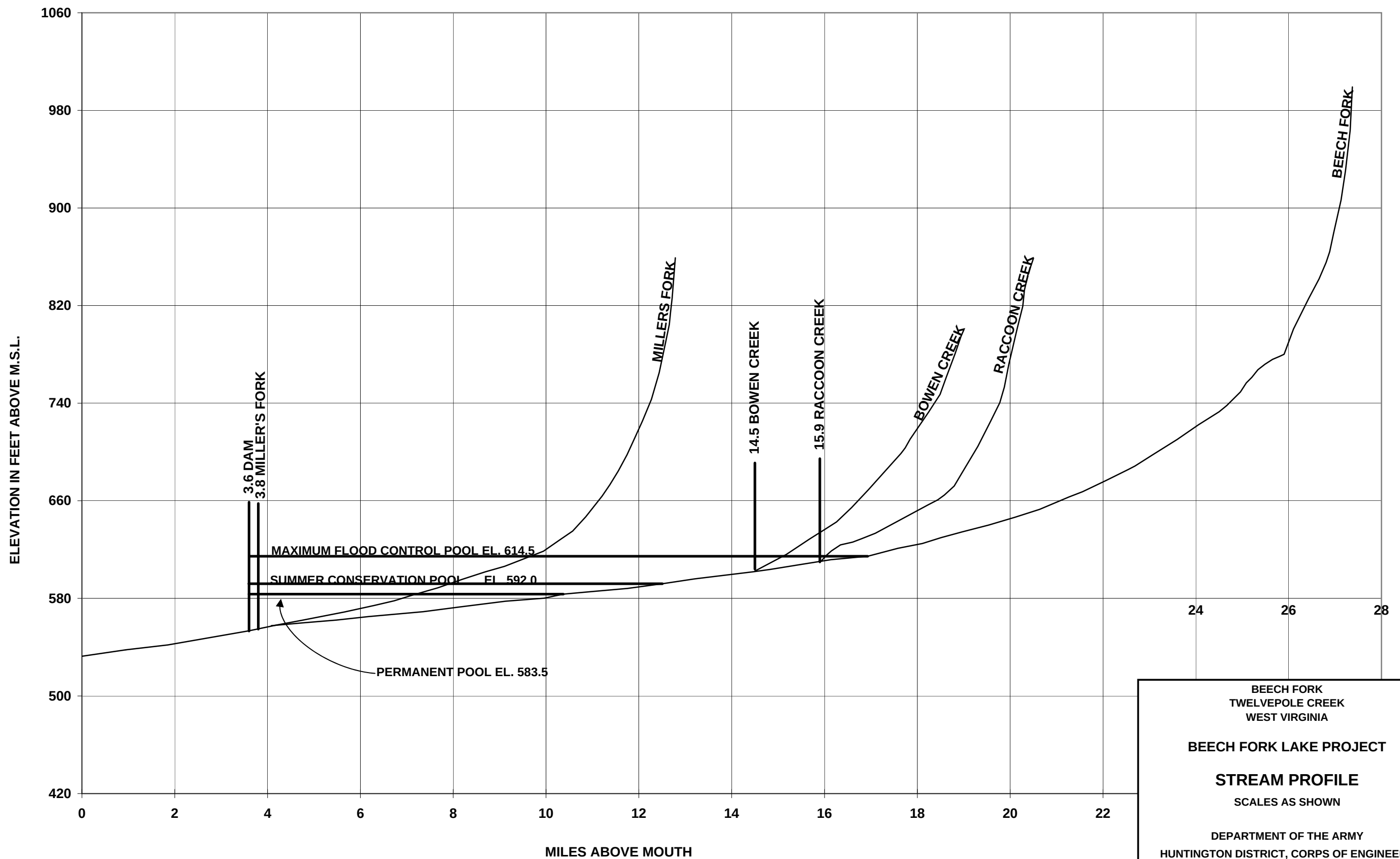
TWELVEPOLE CREEK BASIN
WEST VIRGINIA

BEECH FORK RESERVOIR PROJECT

DRAINAGE AREA

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000





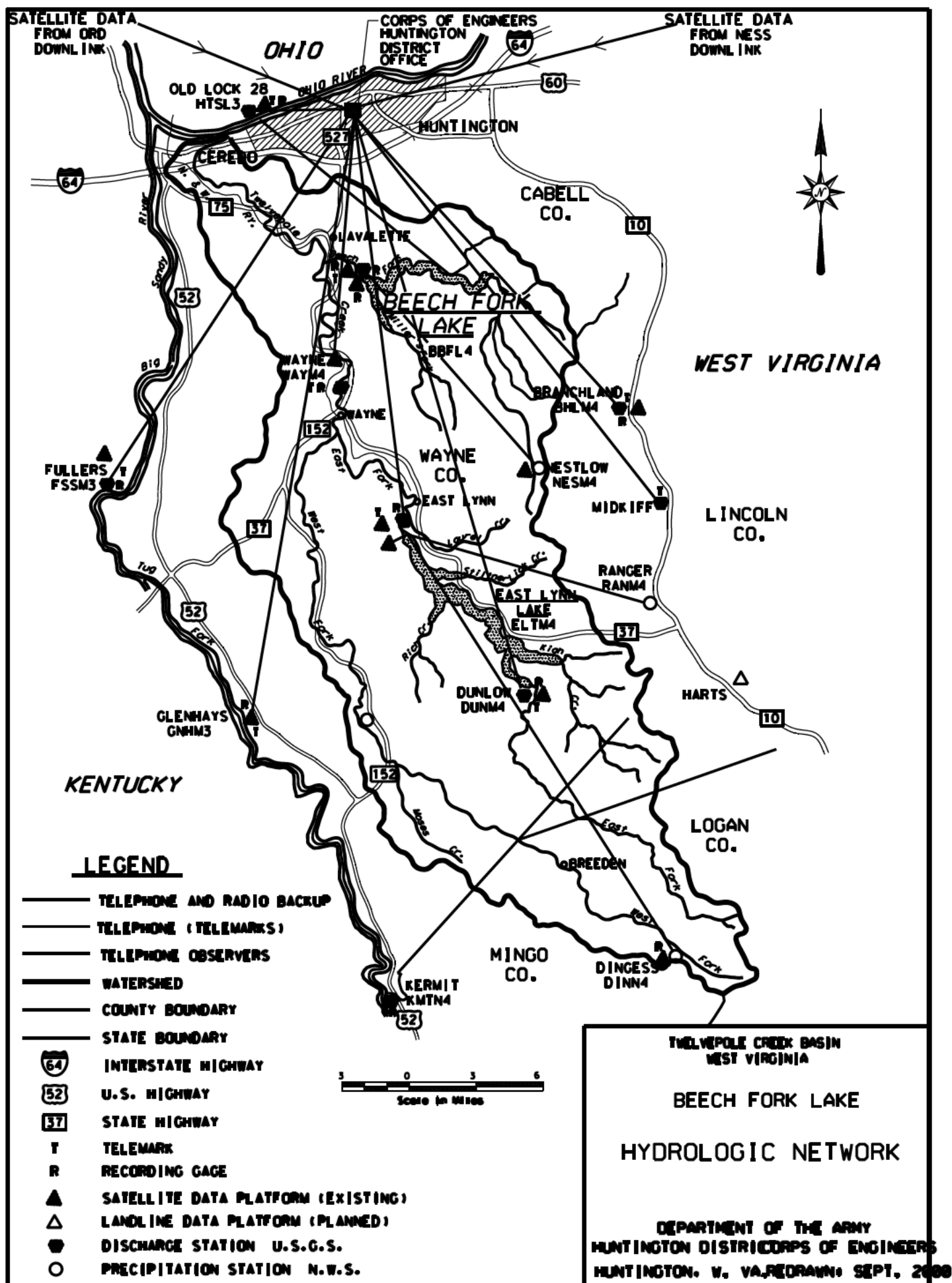
BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

STREAM PROFILE

SCALES AS SHOWN

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

EXPANDED RATING TABLE DATE PRINTED 06-21-83

03207020

TWELVEPOLE CREEK BELOW WAYNE, W. VA.

TYPE RECT RATING NO 10

BASED ON _____ DISCHARGE MEASUREMENTS, NO. _____, AND _____, AND IS _____ WELL DEFINED BETWEEN _____ AND _____

FROM 2-17-82 TO _____, FROM _____ TO _____

*COMP BY _____ DATE _____
*CKD. BY _____ DATE _____

GAGE HEIGHT IN FEET	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)										DIFF IN Q PER FOOT GM
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	
3.00	.000	.800	2.20	4.00	6.40	9.80	13.5	18.0	24.0	30.0	38.0
4.00	38.0	46.0	56.0	66.0	78.0	92.0	106.0	120.0	135.0	150.0	127.0
5.00	165.0	180.0	200.0	220.0	240.0	260.0	280.0	305.0	330.0	355.0	215.0
6.00	380.0	405.0	430.0	455.0	480.0	505.0	530.0	555.0	580.0	610.0	260.0
7.00	640.0	670.0	700.0	730.0	760.0	790.0	820.0	850.0	880.0	910.0	300.0
8.00	940.0	970.0	1000	1030	1060	1090	1120	1150	1180	1210	300
9.00	1240	1270	1300	1330	1360	1390	1420	1450	1480	1515	310
10.00	1550	1585	1620	1655	1690	1725	1760	1795	1830	1865	350
11.00	1900	1935	1970	2005	2040	2075	2110	2145	2180	2215	350
12.00	2250	2285	2320	2355	2390	2425	2460	2495	2530	2565	350
13.00	2600	2635	2670	2705	2740	2775	2810	2845	2880	2915	350
14.00	2950	2985	3020	3055	3090	3125	3160	3195	3230	3265	350
15.00	3300	3340	3380	3420	3460	3500	3540	3580	3620	3660	400
16.00	3700	3740	3780	3820	3860	3900	3940	3980	4020	4060	400
17.00	4100	4140	4180	4220	4260	4300	4340	4380	4420	4460	400
18.00	4500	4550	4600	4650	4700	4750	4800	4850	4900	4950	500
19.00	5000	5050	5100	5150	5200	5250	5300	5350	5400	5450	500
20.00	5500	5550	5600	5650	5700	5750	5800	5850	5900	5950	500
21.00	6000	6050	6100	6150	6200	6250	6300	6350	6400	6450	500
22.00	6500	6560	6620	6680	6740	6800	6860	6920	6980	7040	600
23.00	7100	7160	7220	7280	7340	7400	7460	7520	7580	7640	600
24.00	7700	7760	7820	7880	7940	8000	8060	8120	8180	8240	600
25.00	8300	8370	8440	8510	8580	8650	8720	8790	8860	8930	700
26.00	9000	9080	9160	9240	9320	9400	9480	9560	9640	9720	800
27.00	9800	9880	9960	10040	10120	10200	10280	10360	10440	10520	800
28.00	10600	10690	10780	10870	10960	11050	11140	11230	11320	11410	900
29.00	11500	11600	11700	11800	11900	12000	12100	12200	12300	12400	1000
30.00	12500	12600	12700	12800	12900	13000	13100	13200	13300	13400	1000
31.00	13500	13610	13720	13830	13940	14050	14160	14270	14380	14490	1100
32.00	14600	14710	14820	14930	15040	15150	15260	15370	15480	15590	1100
33.00	15700										

Plate No. 5-2

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

EXPANDED RATING TABLE L PRINTED 04-26-85

03207057

BEECH FORK BELOW BEECH FORK DAM, LV

TYPE RECT RATING NO 06

BASED ON _____ DISCHARGE MEASUREMENTS, NO. _____, AND _____, AND IS _____ WELL DEFINED BETWEEN _____ AND _____
 FROM 3-22-84 TO _____, FROM _____ TO _____
 *COMP BY _____ DATE _____
 *CKD. BY _____ DATE _____

GAGE HEIGHT IN FEET	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)										DIFF IN Q PER TENTH GH
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
0.30	1.50	1.64	1.78	1.92	2.06	2.20	2.34	2.48	2.62	2.76	1.40
0.40	2.90	3.06	3.22	3.38	3.54	3.70	3.86	4.02	4.18	4.34	1.60
0.50	4.50	4.70	4.90	5.10	5.30	5.50	5.70	5.90	6.10	6.30	2.00
0.60	6.50	6.75	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.75	2.50
0.70	9.00	9.25	9.50	9.75	10.0	10.3	10.5	10.8	11.0	11.3	2.5
0.80	11.5	11.8	12.1	12.4	12.7	13.0	13.3	13.6	13.9	14.2	3.0
0.90	14.5	14.9	15.3	15.7	16.1	16.5	16.8	17.3	17.6	18.1	4.0
1.00	18.5	18.8	19.4	19.8	20.3	20.6	21.1	21.6	22.1	22.5	4.5
1.10	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	5.0
1.20	28.0	28.5	29.0	29.5	30.0	30.5	31.0	31.5	32.0	32.5	5.0
1.30	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	5.0
1.40	38.0	38.5	39.0	39.5	40.0	40.5	41.0	41.5	42.0	42.5	5.0
1.50	43.0	43.5	44.0	44.5	45.0	45.5	46.0	46.5	47.0	47.5	5.0
1.60	48.0	48.7	49.5	50.2	51.0	51.7	52.5	53.2	54.0	54.7	7.5
1.70	55.5	56.2	57.0	57.7	58.5	59.2	60.0	60.7	61.5	62.2	7.5
1.80	63.0	63.9	64.8	65.7	66.6	67.5	68.4	69.3	70.2	71.1	9.0
1.90	72.0	73.0	74.0	75.0	76.0	77.0	78.0	79.0	80.0	81.0	10.0
2.00	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0	10.0
2.10	92.0	93.0	94.0	95.0	96.0	97.0	98.0	99.0	100.0	101.0	10.0
2.20	102.0	103.1	104.2	105.3	106.4	107.5	108.6	109.7	110.8	111.9	11.0
2.30	113.0	114.2	115.4	116.6	117.8	119.0	120.2	121.4	122.6	123.8	12.0
2.40	125.0	126.2	127.5	128.7	130.0	131.2	132.5	133.7	135.0	136.2	12.5
2.50	137.5	138.7	140.0	141.2	142.5	143.7	145.0	146.2	147.5	148.7	12.5
2.60	150.0	151.5	153.0	154.5	156.0	157.5	159.0	160.5	162.0	163.5	15.0
2.70	165.0	166.5	168.0	169.5	171.0	172.5	174.0	175.5	177.0	178.5	15.0
2.80	180.0	181.5	183.0	184.5	186.0	187.5	189.0	190.5	192.0	193.5	15.0
2.90	195.0	196.5	198.0	199.5	201.0	202.5	204.0	205.5	207.0	208.5	15.0
3.00	210.0	211.8	213.6	215.4	217.2	219.0	220.8	222.6	224.4	226.2	18.0
3.10	228.0	229.8	231.6	233.4	235.2	237.0	238.8	240.6	242.4	244.2	18.0
3.20	246.0	247.8	249.6	251.4	253.2	255.0	256.8	258.6	260.3	262.1	18.0
3.30	264.0	265.8	267.6	269.3	271.1	273.0	274.8	276.6	278.3	280.1	18.0
3.40	282.0	283.8	285.6	287.3	289.1	291.0	292.8	294.6	296.3	298.1	18.0
3.50	300.0	302.0	304.0	306.0	308.0	310.0	312.0	314.0	316.0	318.0	20.0
3.60	320.0	322.0	324.0	326.0	328.0	330.0	332.0	334.0	336.0	338.0	20.0
3.70	340.0	342.0	344.0	346.0	348.0	350.0	352.0	354.0	356.0	358.0	20.0
3.80	360.0	362.0	364.0	366.0	368.0	370.0	372.0	374.0	376.0	378.0	20.0
3.90	380.0	382.0	384.0	386.0	388.0	390.0	392.0	394.0	396.0	398.0	20.0
4.00	400.0	402.1	404.4	406.6	408.8	411.0	413.2	415.4	417.6	419.8	22.0
4.10	422.0	424.2	426.4	428.6	430.8	433.0	435.2	437.4	439.6	441.8	22.0

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

EXPANDED RATING TABLE

PRINTED 04-26-85

03207057

BEECH FORK BELOW BEECH FORK DAM, LV

TYPE RECT RATING NO 06

GAGE HEIGHT IN FEET	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)										DIFF IN Q PER TENTH GH
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
4.20	444.0	446.2	448.4	450.6	452.8	455.0	457.2	459.4	461.6	463.8	22.0
4.30	466.0	468.2	470.4	472.6	474.8	477.0	479.2	481.4	483.6	485.8	22.0
4.40	488.0	490.2	492.4	494.6	496.8	499.0	501.2	503.4	505.6	507.8	22.0
4.50	510.0	512.2	514.4	516.6	518.8	521.0	523.2	525.4	527.6	529.8	22.0
4.60	532.0	534.2	536.4	538.6	540.8	543.0	545.2	547.4	549.6	551.8	22.0
4.70	554.0	556.2	558.4	560.6	562.8	565.0	567.2	569.4	571.6	573.8	22.0
4.80	576.0	578.2	580.4	582.6	584.8	587.0	589.2	591.4	593.6	595.8	22.0
4.90	598.0	600.2	602.4	604.6	606.8	609.0	611.2	613.4	615.6	617.8	22.0
5.00	620.0	622.2	624.4	626.6	628.8	631.0	633.2	635.4	637.6	639.8	22.0
5.10	642.0	644.2	646.4	648.6	650.8	653.0	655.2	657.4	659.6	661.8	22.0
5.20	664.0	666.2	668.4	670.6	672.8	675.0	677.2	679.4	681.6	683.8	22.0
5.30	686.0	688.2	690.4	692.6	694.8	697.0	699.2	701.4	703.6	705.8	22.0
5.40	708.0	710.2	712.4	714.6	716.8	719.0	721.2	723.4	725.6	727.8	22.0
5.50	730.0	732.2	734.4	736.6	738.8	741.0	743.2	745.4	747.6	749.8	22.0
5.60	752.0	754.2	756.4	758.6	760.8	763.0	765.2	767.4	769.6	771.8	22.0
5.70	774.0	776.2	778.4	780.6	782.8	785.0	787.2	789.4	791.6	793.8	22.0
5.80	796.0	798.2	800.4	802.6	804.8	807.0	809.2	811.4	813.6	815.8	22.0
5.90	818.0	820.2	822.4	824.6	826.8	829.0	831.2	833.4	835.6	837.8	22.0
6.00	840.0	842.3	844.6	846.9	849.2	851.5	853.8	856.1	858.4	860.7	23.0
6.10	863.0	865.3	867.6	869.9	872.2	874.5	876.8	879.1	881.4	883.7	23.0
6.20	886.0	888.3	890.6	892.9	895.2	897.5	899.8	902.1	904.4	906.7	23.0
6.30	909.0	911.3	913.6	915.9	918.2	920.5	922.8	925.1	927.4	929.7	23.0
6.40	932.0	934.3	936.6	938.9	941.2	943.5	945.8	948.1	950.4	952.7	23.0
6.50	955.0	957.3	959.6	961.9	964.2	966.5	968.8	971.1	973.4	975.7	23.0
6.60	978.0	980.3	982.6	984.9	987.2	989.5	991.8	994.1	996.4	998.7	23
6.70	1001	1003	1006	1008	1010	1012	1015	1017	1019	1022	23
6.80	1024	1026	1029	1031	1033	1035	1038	1040	1042	1045	23
6.90	1047	1049	1052	1054	1056	1058	1061	1063	1065	1068	23
7.00	1070	1072	1075	1077	1079	1081	1084	1086	1088	1091	23
7.10	1093	1095	1098	1100	1102	1104	1107	1109	1111	1114	23
7.20	1116	1118	1121	1123	1125	1127	1130	1132	1134	1137	23
7.30	1139	1141	1144	1146	1148	1150	1153	1155	1157	1160	23
7.40	1162	1164	1167	1169	1171	1173	1176	1178	1180	1183	23
7.50	1185	1187	1190	1192	1194	1196	1199	1201	1203	1206	23
7.60	1208	1210	1213	1215	1217	1219	1222	1224	1226	1229	23
7.70	1231	1233	1236	1238	1240	1242	1245	1247	1249	1252	23
7.80	1254	1256	1259	1261	1263	1265	1268	1270	1272	1275	23
7.90	1277	1279	1282	1284	1286	1288	1291	1293	1295	1298	23
8.00	1300	1302	1305	1307	1309	1311	1314	1316	1318	1321	23
8.10	1323	1325	1328	1330	1332	1334	1337	1339	1341	1344	23
8.20	1346	1348	1351	1353	1355	1357	1360	1362	1364	1367	23
8.30	1369	1371	1374	1376	1378	1380	1383	1385	1387	1390	23

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

EXPANDED RATING TABLE DA1 TED 04-26-85

0320705/

BEECH FORK BELOW BEECH FORK DAM, WV

TYPE RECT RATING NO 06

GAGE HEIGHT IN FEET	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)										DIFF IN Q PER TENTH GH
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
8.40	1392	1394	1397	1399	1401	1403	1406	1408	1410	1413	23
8.50	1415	1417	1420	1422	1424	1426	1429	1431	1433	1436	23
8.60	1438	1440	1443	1445	1447	1449	1452	1454	1456	1459	23
8.70	1461	1463	1466	1468	1470	1472	1475	1477	1479	1482	23
8.80	1484	1486	1489	1491	1493	1495	1498	1500	1502	1505	23
8.90	1507	1509	1512	1514	1516	1518	1521	1523	1525	1528	23
9.00	1530	1532	1535	1537	1539	1541	1544	1546	1548	1551	23
9.10	1553	1555	1558	1560	1562	1564	1567	1569	1571	1574	23
9.20	1576	1578	1581	1583	1585	1587	1590	1592	1594	1597	23
9.30	1599	1601	1604	1606	1608	1610	1613	1615	1617	1620	23
9.40	1622	1624	1627	1629	1631	1633	1636	1638	1640	1643	23
9.50	1645	1647	1650	1652	1654	1656	1659	1661	1663	1666	23
9.60	1668	1670	1673	1675	1677	1679	1682	1684	1686	1689	23
9.70	1691	1693	1696	1698	1700	1702	1705	1707	1709	1712	23
9.80	1714	1716	1719	1721	1723	1725	1728	1730	1732	1735	23
9.90	1737	1739	1742	1744	1746	1748	1751	1753	1755	1758	23
10.00	1760	1762	1765	1767	1769	1771	1774	1776	1778	1781	23
10.10	1783	1785	1788	1790	1792	1794	1797	1799	1801	1804	23
10.20	1806	1808	1811	1813	1815	1817	1820	1822	1824	1827	23
10.30	1829	1831	1834	1836	1838	1840	1843	1845	1847	1850	23
10.40	1852	1854	1857	1859	1861	1863	1866	1868	1870	1873	23
10.50	1875	1877	1880	1882	1884	1886	1889	1891	1893	1896	23
10.60	1898	1900	1903	1905	1907	1909	1912	1914	1916	1919	23
10.70	1921	1923	1926	1928	1930	1932	1935	1937	1939	1942	23
10.80	1944	1946	1949	1951	1953	1955	1958	1960	1962	1965	23
10.90	1967	1969	1972	1974	1976	1978	1981	1983	1985	1988	23
11.00	1990	1992	1995	1997	1999	2001	2004	2006	2008	2011	23
11.10	2013	2015	2018	2020	2022	2024	2027	2029	2031	2034	23
11.20	2036	2038	2040	2043	2045	2047	2050	2052	2054	2057	23
11.30	2059	2061	2063	2066	2068	2070	2073	2075	2077	2080	23
11.40	2082	2084	2086	2089	2091	2093	2096	2098	2100	2103	23
11.50	2105	2107	2109	2112	2114	2116	2119	2121	2123	2126	23
11.60	2128	2130	2132	2135	2137	2139	2142	2144	2146	2149	23
11.70	2151	2153	2155	2158	2160	2162	2165	2167	2169	2172	23
11.80	2174	2176	2178	2181	2183	2185	2188	2190	2192	2195	23
11.90	2197	2199	2201	2204	2206	2208	2211	2213	2215	2218	23
12.00	2220	2222	2224	2227	2229	2231	2234	2236	2238	2241	23
12.10	2243	2245	2247	2250	2252	2254	2257	2259	2261	2264	23
12.20	2266	2268	2270	2273	2275	2277	2280	2282	2284	2287	23
12.30	2289	2291	2293	2296	2298	2300	2303	2305	2307	2310	23
12.40	2312	2314	2316	2319	2321	2323	2326	2328	2330	2333	23

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

EXPANDED RATING TABLE

PRINTED 04-26-85

03207057

BEECH FORK BELOW BEECH FORK DAM, WV

TYPE RECT RATING NO 06

GAGE HEIGHT IN FEET	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)										DIFF IN Q PER TENTH GH
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
12.50	2335	2337	2339	2342	2344	2346	2349	2351	2353	2356	23
12.60	2358	2360	2362	2365	2367	2369	2372	2374	2376	2379	23
12.70	2381	2383	2385	2388	2390	2392	2395	2397	2399	2402	23
12.80	2404	2406	2408	2411	2413	2415	2418	2420	2422	2425	23
12.90	2427	2429	2431	2434	2436	2438	2441	2443	2445	2448	23
13.00	2450										

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

EXPANDED RATING TABLE DA NTED 04-26-85

03207057

BEECH FORK BELOW BEECH FORK DAM, LV

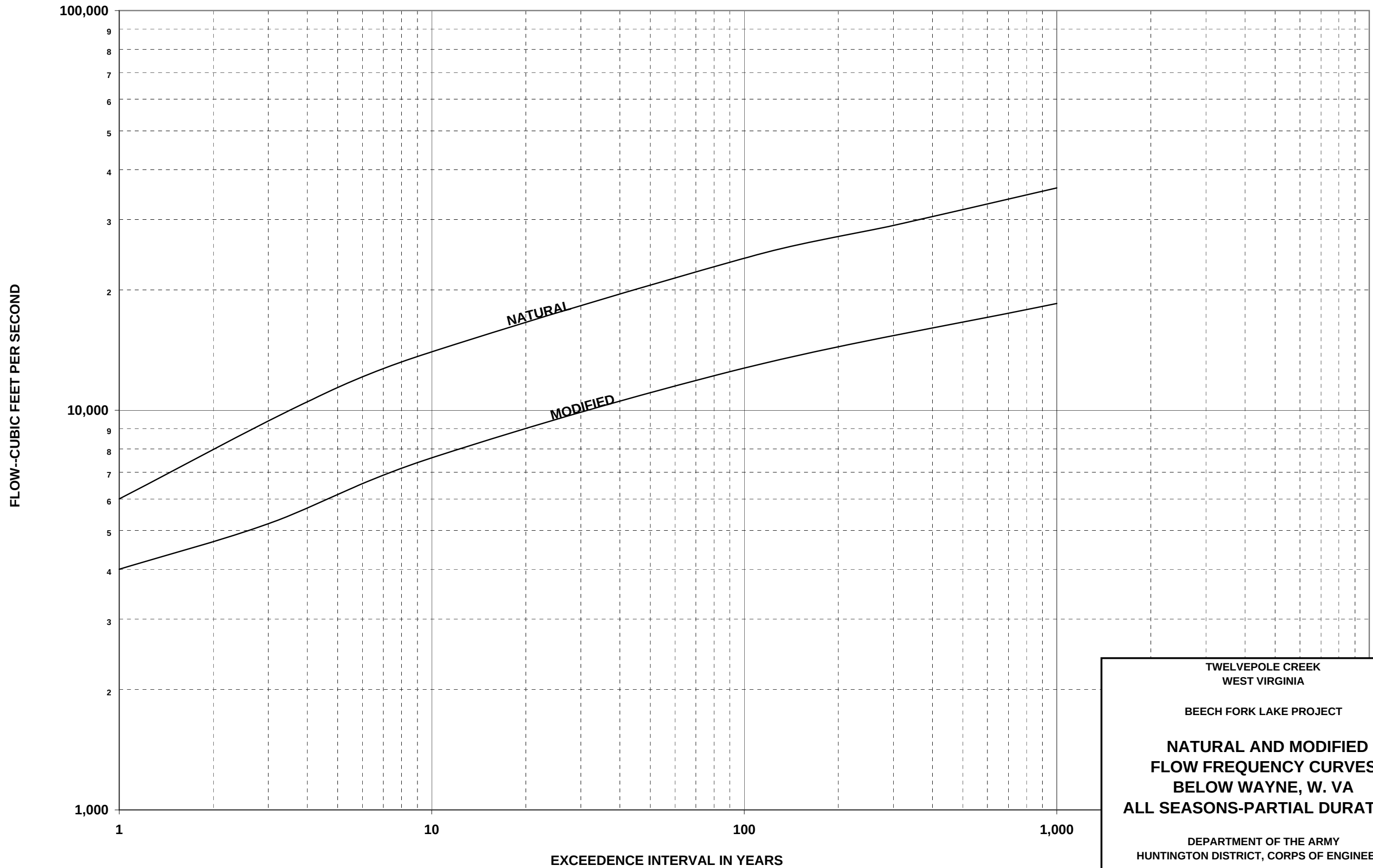
TYPE RECT RATING NO 06

BASED ON _____ DISCHARGE MEASUREMENTS, NO. _____, AND _____, AND IS _____ WELL DEFINED BETWEEN _____ AND _____

FROM _____ TO _____, FROM _____ TO _____

*COMP BY _____ DATE _____
*CKD BY _____ DATE _____

GAGE HEIGHT IN FEET	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)										DIFF IN Q PER FOOT GH
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	
0.00				1.50	2.90	4.50	6.50	9.00	11.5	14.5	
1.00	18.5	23.0	28.0	33.0	38.0	43.0	48.0	55.5	63.0	72.0	63.5
2.00	82.0	92.0	102.0	113.0	125.0	137.5	150.0	165.0	180.0	195.0	128.0
3.00	210.0	228.0	246.0	264.0	282.0	300.0	320.0	340.0	360.0	380.0	190.0
4.00	400.0	422.0	444.0	466.0	488.0	510.0	532.0	554.0	576.0	598.0	220.0
5.00	620.0	642.0	664.0	686.0	708.0	730.0	752.0	774.0	796.0	818.0	220.0
6.00	840.0	863.0	886.0	909.0	932.0	955.0	978.0	1001	1024	1047	230
7.00	1070	1093	1116	1139	1162	1185	1208	1231	1254	1277	230
8.00	1300	1323	1346	1369	1392	1415	1438	1461	1484	1507	230
9.00	1530	1553	1576	1599	1622	1645	1668	1691	1714	1737	230
10.00	1760	1783	1806	1829	1852	1875	1898	1921	1944	1967	230
11.00	1990	2013	2036	2059	2082	2105	2128	2151	2174	2197	230
12.00	2220	2243	2266	2289	2312	2335	2358	2381	2404	2427	230
13.00	2450										

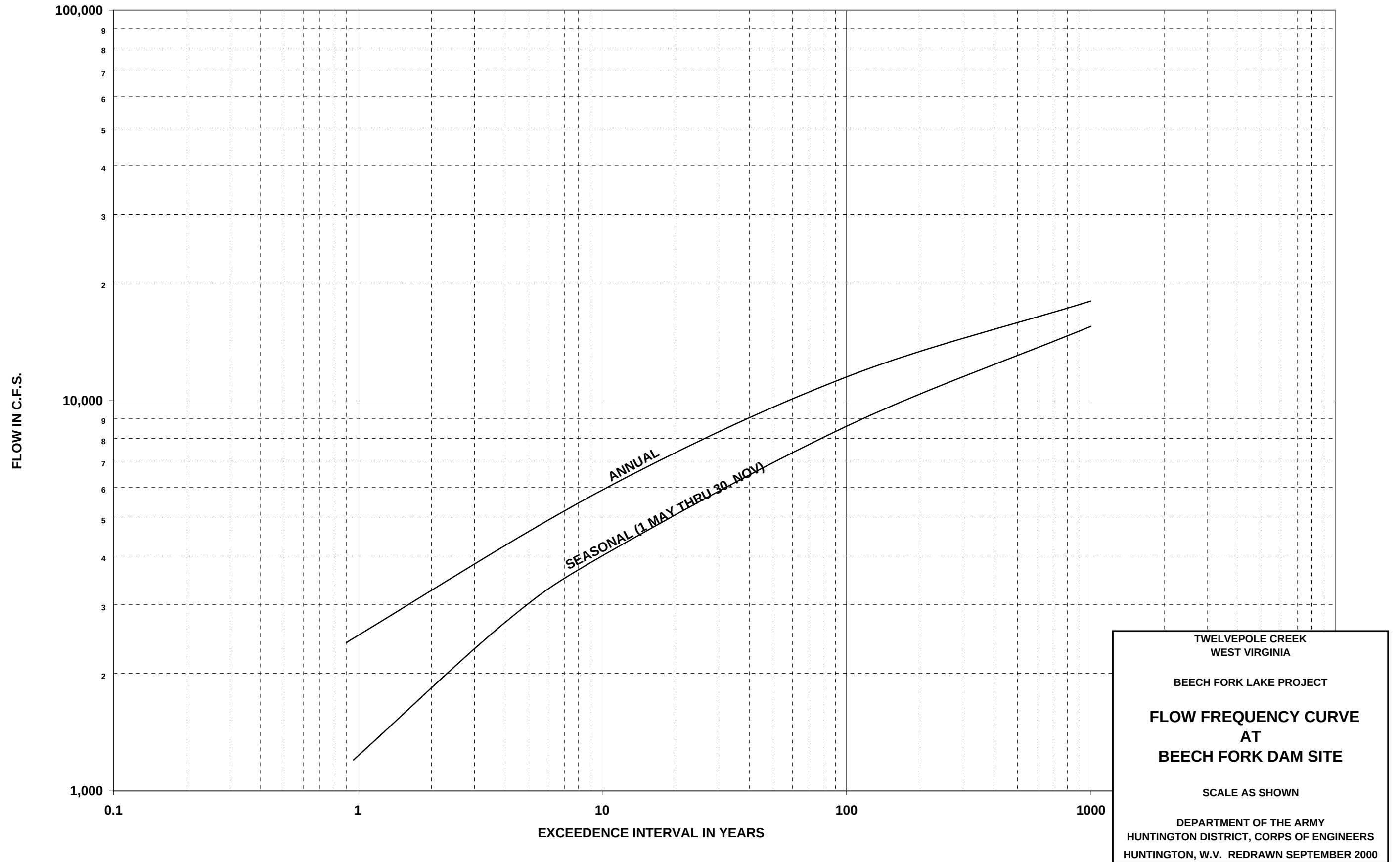


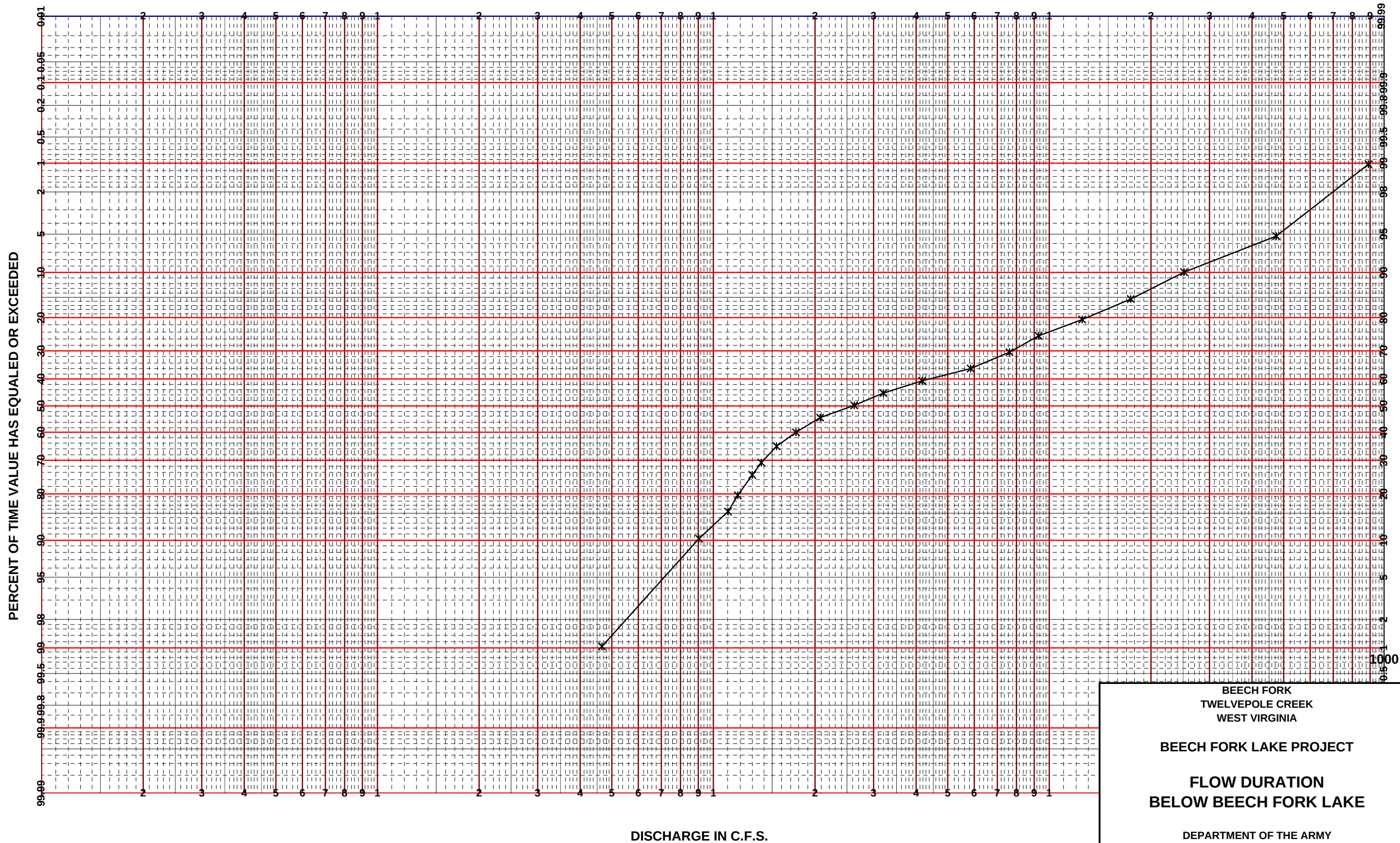
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

**NATURAL AND MODIFIED
FLOW FREQUENCY CURVES
BELOW WAYNE, W. VA
ALL SEASONS-PARTIAL DURATION**

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



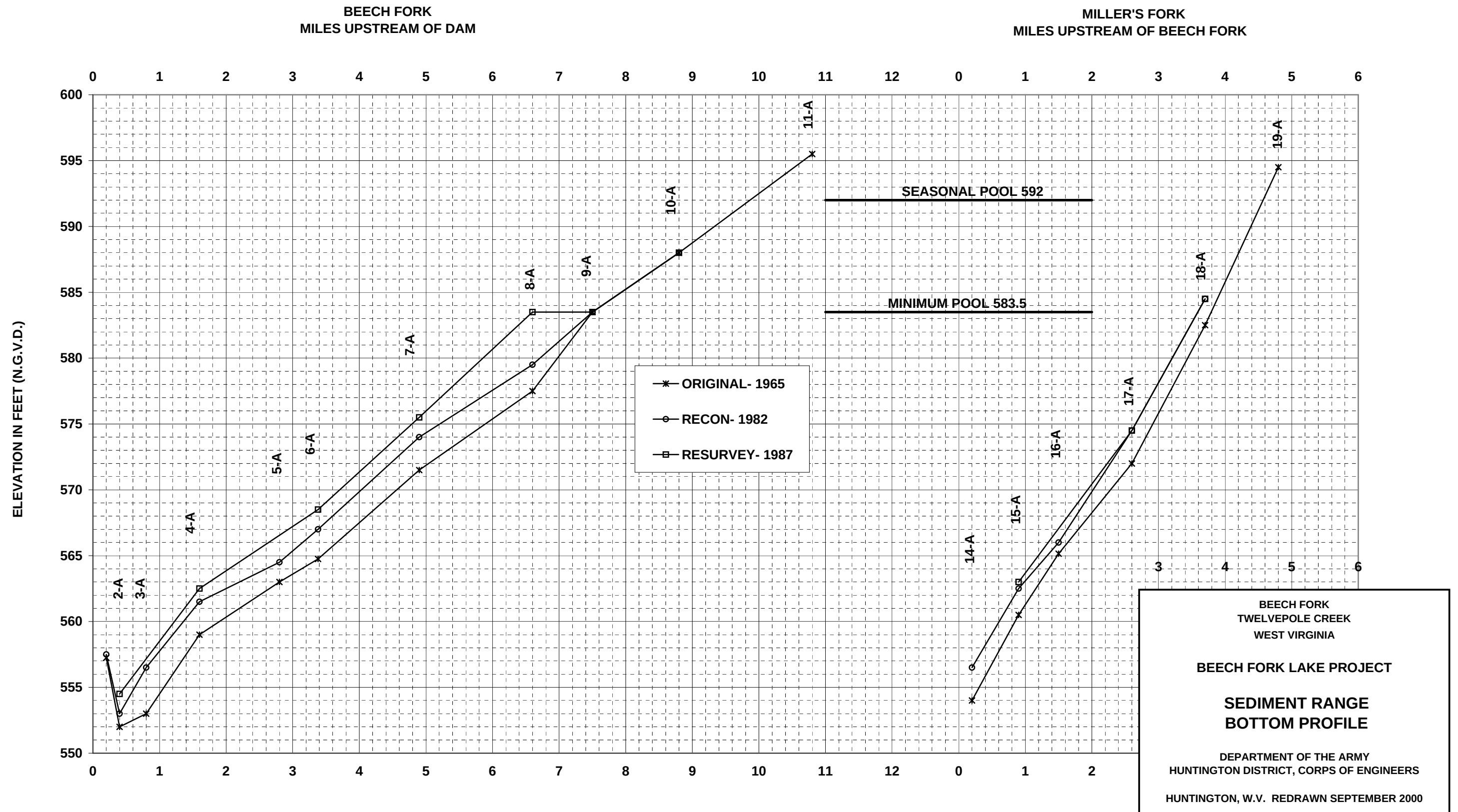


BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

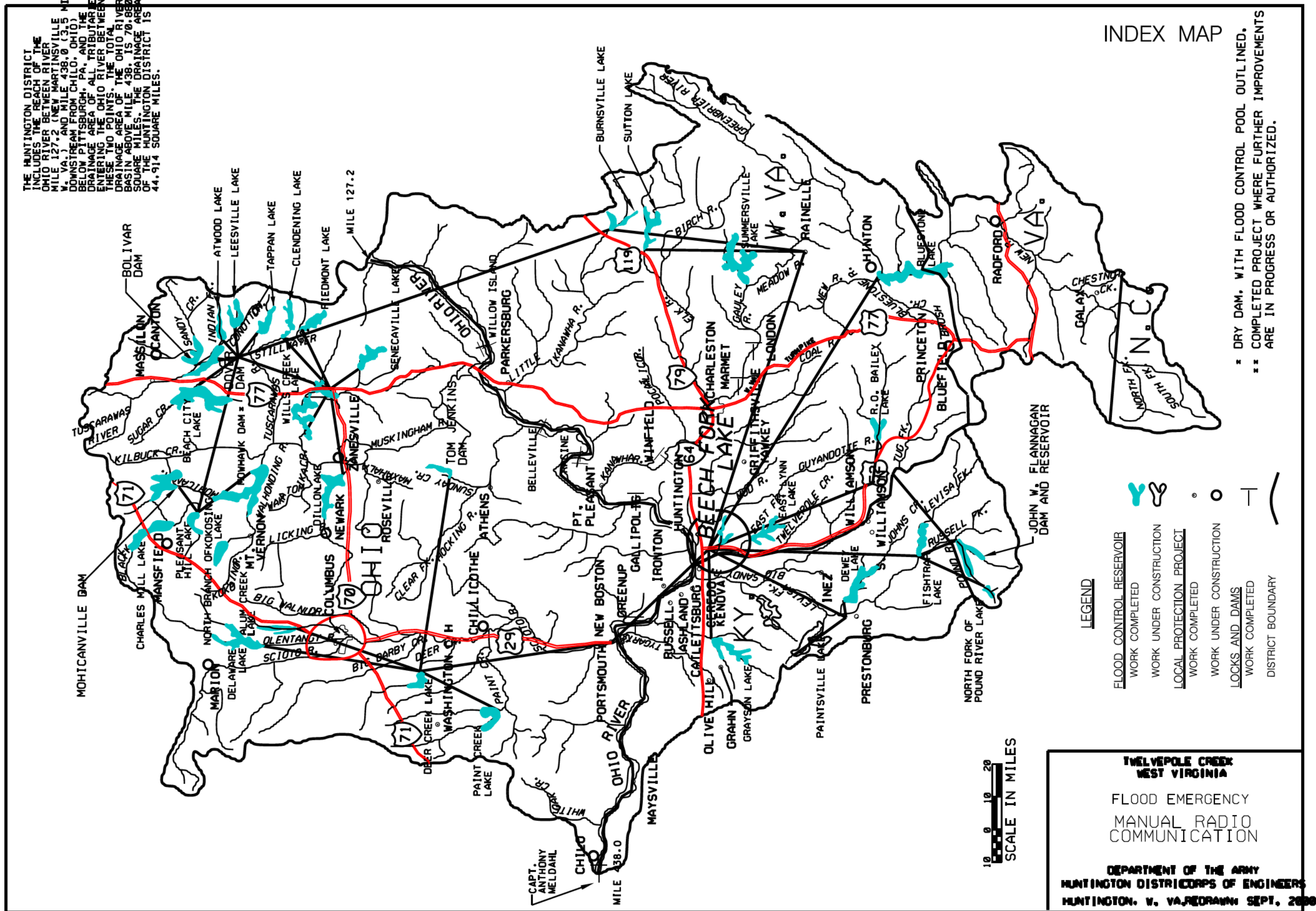
BEECH FORK LAKE PROJECT

FLOW DURATION
BELOW BEECH FORK LAKE

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON W. VA. REDRAWN SEPTEMBER 2000



THE HUNTINGTON DISTRICT INCLUDES THE REACH OF THE OHIO RIVER BETWEEN RIVER MILE 127.2 (NEW MARTINSVILLE, VA.) AND MILE 438.0 (3.5 MILES DOWNSTREAM FROM CHILO, OHIO.) BELOW PITTSBURGH, PA., AND THE DRAINAGE AREA OF ALL TRIBUTARIES ENTERING THE OHIO RIVER BETWEEN THESE TWO POINTS. THE TOTAL DRAINAGE AREA OF THE OHIO RIVER BASIN ABOVE MILE 438.0 IS 70,880 SQUARE MILES. THE DRAINAGE AREA OF THE HUNTINGTON DISTRICT IS 44,914 SQUARE MILES.



INDEX MAP

* DRY DAM, WITH FLOOD CONTROL POOL OUTLINED.
 ** COMPLETED PROJECT WHERE FURTHER IMPROVEMENTS ARE IN PROGRESS OR AUTHORIZED.

- LEGEND**
- FLOOD CONTROL RESERVOIR
 - WORK COMPLETED
 - WORK UNDER CONSTRUCTION
 - LOCAL PROTECTION PROJECT
 - WORK COMPLETED
 - WORK UNDER CONSTRUCTION
 - LOCKS AND DAMS
 - WORK COMPLETED
 - DISTRICT BOUNDARY

**TWELVEPOLE CREEK
 WEST VIRGINIA**

FLOOD EMERGENCY
 MANUAL RADIO
 COMMUNICATION

DEPARTMENT OF THE ARMY
 HUNTINGTON DISTRICT CORPS OF ENGINEERS
 HUNTINGTON, W. VA. REDRAWN SEPT. 2000

**WATER RESOURCES ENGINEERING BRANCH
WATER CONTROL SYSTEM**

BEECH FORK LAKE *

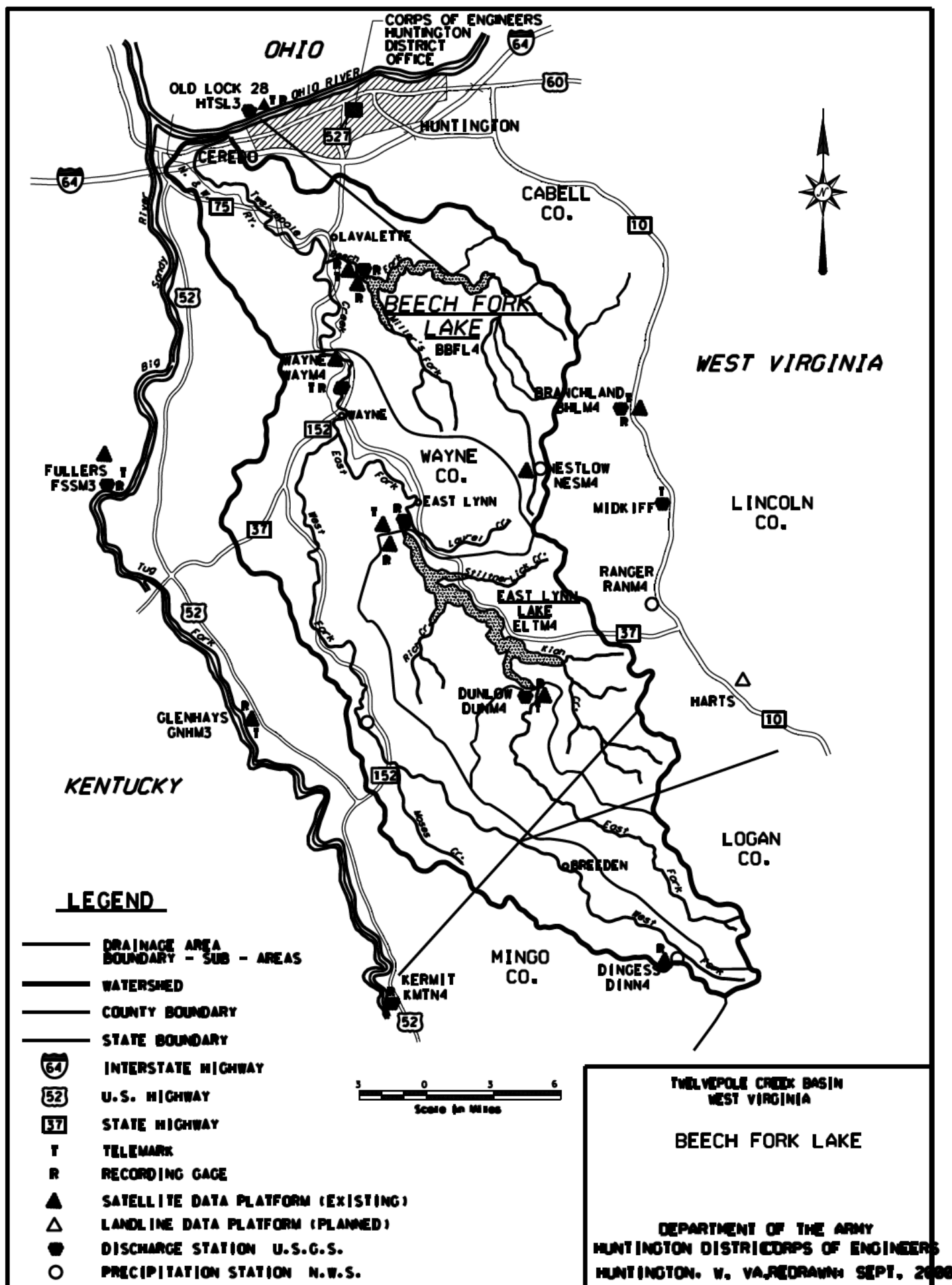
NESTLOW *

————— **TELEPHONE & RADIO BACKUP**

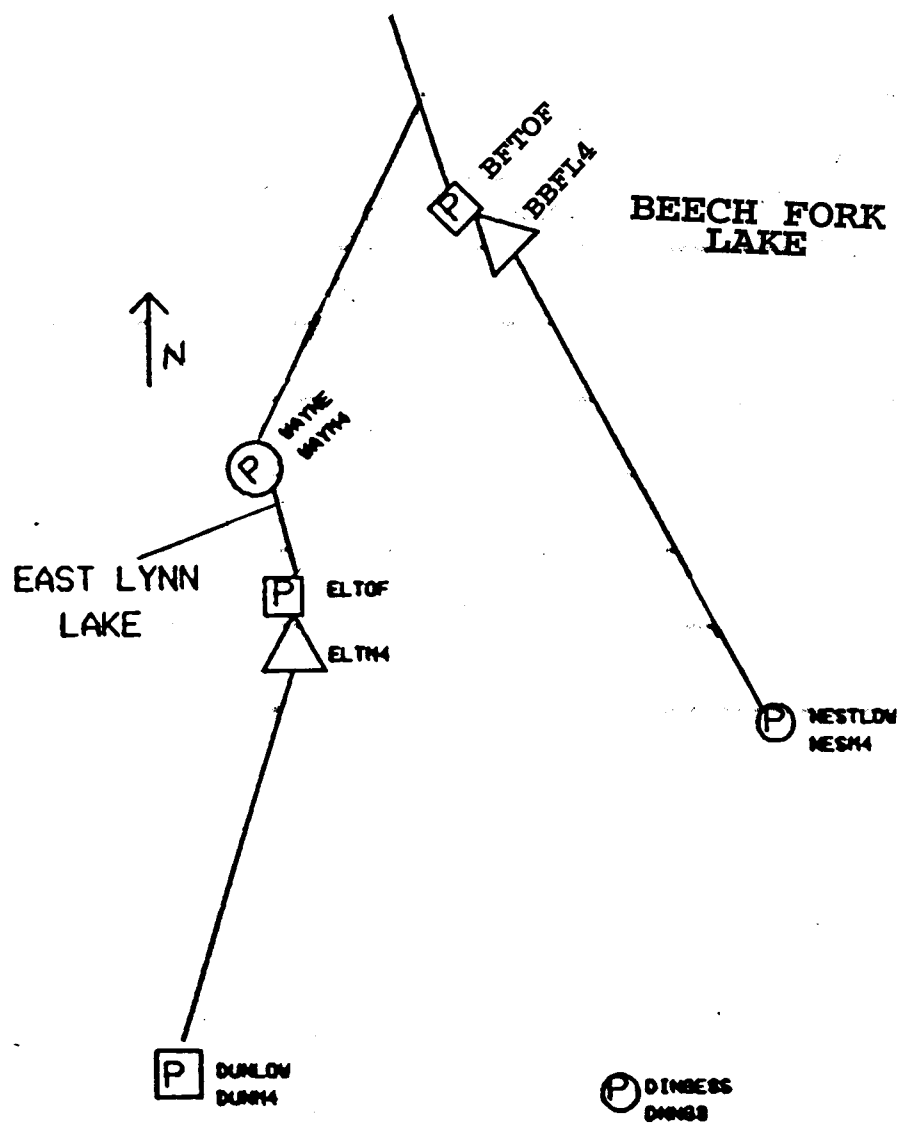
- - - - - **TELEPHONE ONLY**

* **SATELLITE DATA PLATFORM
INSTALLED AT STATION**

**LINES OF COMMUNICATION
TWELVEPOLE CREEK BASIN**



BEECH FORK LAKE - TWELVEPOLE CREEK
BASIN NETWORK CONFIGURATION



Beech Fork Lake, Twelevepole Creek, WV
Area and Capacity Tables

Drainage Area = 78 Sq Miles

1 In. Runoff = 4,160 Ac. Ft.

Elevation Ft-NGVD29	Capacity Ac. Ft.	Inches	Area Acres	Elevation Ft-NGVD29	Capacity Ac. Ft.	Inches	Area Acres
557	0	0.00	0	601	16,398	3.94	1,148
558	1	0.00	1	602	17,571	4.22	1,198
559	3	0.00	2	603	18,793	4.52	1,246
560	7	0.00	4	604	20,063	4.82	1,295
561	13	0.00	6	605	21,383	5.14	1,345
562	23	0.01	9	606	22,753	5.47	1,395
563	35	0.01	12	607	24,173	5.81	1,446
564	50	0.01	15	608	25,645	6.16	1,497
565	69	0.02	19	609	27,167	6.53	1,546
566	94	0.02	23	610	28,742	6.91	1,601
567	131	0.03	31	611	30,369	7.30	1,646
568	183	0.04	42	612	32,052	7.70	1,710
569	256	0.06	56	613	33,789	8.12	1,765
570	346	0.08	74	614	35,581	8.55	1,820
571	459	0.11	96	614.5	36,505	8.78	1,847
572	587	0.14	124	615	37,428	9.00	1,874
573	735	0.18	154	616	39,327	9.45	1,925
574	893	0.21	182	617	41,278	9.92	1,976
575	1,076	0.26	210	618	43,279	10.40	2,026
576	1,276	0.31	237	619	45,330	10.90	2,077
577	1,503	0.36	257	620	47,433	11.40	2,129
578	1,738	0.42	281	621	49,590	11.92	2,184
579	1,998	0.48	303	622	51,803	12.45	2,241
580	2,266	0.54	324	623	54,072	13.00	2,298
581	2,561	0.62	346	624	56,398	13.56	2,354
582	2,866	0.69	368	625	58,780	14.13	2,410
583	3,210	0.77	393	626	61,216	14.72	2,463
583.5	3,392	0.82	405	627	63,704	15.31	2,514
584	3,574	0.86	418	628	66,244	15.92	2,565
585	3,987	0.96	445	629	68,835	16.55	2,617
586	4,433	1.07	473	630	71,479	17.18	2,670
587	4,948	1.19	501	631	74,175	17.83	2,723
588	5,506	1.32	535	632	76,926	18.49	2,778
589	6,135	1.47	568	633	79,701	19.16	2,833
590	6,782	1.63	601	634	82,590	19.85	2,889
591	7,468	1.80	636	635	85,479	20.55	2,946
592	8,136	1.96	719	636	88,368	21.24	3,003
593	8,883	2.14	754	637	91,257	21.94	3,060
594	9,646	2.32	792	638	94,146	22.63	3,117
595	10,459	2.51	834	639	97,035	23.33	3,174
596	11,317	2.72	882	640	99,924	24.02	3,231
597	12,225	2.94	934				
598	13,187	3.17	990				
599	14,203	3.41	1,044				
600	15,275	3.67	1,098				

Based on 2023 capacity survey

Plate VII-1
Sheet 1 of 1

BEECH FORK LAKE

PERCENT STORAGE UTILIZATION - SUMMER

ELEV	0	1	2	3	4	5	6	7	8	9
592	0.00	0.25	0.51	0.77	1.02	1.28	1.54	1.81	2.07	2.33
593	2.60	2.86	3.13	3.40	3.67	3.94	4.22	4.49	4.77	5.05
594	5.32	5.60	5.88	6.17	6.45	6.74	7.03	7.31	7.60	7.90
595	8.19	8.49	8.78	9.08	9.38	9.68	9.98	10.29	10.60	10.91
596	11.22	11.53	11.84	12.16	12.47	12.79	13.11	13.44	13.76	14.09
597	14.42	14.75	15.08	15.42	15.75	16.09	16.43	16.77	17.12	17.46
598	17.81	18.16	18.51	18.86	19.22	19.58	19.94	20.30	20.66	21.03
599	21.39	21.76	22.13	22.51	22.88	23.26	23.64	24.02	24.40	24.79
600	25.17	25.56	25.95	26.34	26.73	27.13	27.53	27.93	28.33	28.73
601	29.13	29.54	29.95	30.35	30.77	31.18	31.59	32.01	32.43	32.85
602	33.27	33.69	34.11	34.54	34.97	35.40	35.83	36.26	36.70	37.13
603	37.57	38.01	38.46	38.90	39.34	39.79	40.24	40.69	41.14	41.60
604	42.05	42.51	42.97	43.43	43.90	44.36	44.83	45.29	45.76	46.24
605	46.71	47.18	47.66	48.14	48.62	49.10	49.59	50.07	50.56	51.05
606	51.54	52.03	52.53	53.02	53.52	54.02	54.52	55.02	55.53	56.04
607	56.55	57.06	57.57	58.08	58.60	59.12	59.64	60.16	60.68	61.21
608	61.74	62.26	62.79	63.33	63.86	64.40	64.93	65.47	66.01	66.56
609	67.10	67.65	68.20	68.75	69.30	69.86	70.41	70.97	71.53	72.09
610	72.66	73.22	73.79	74.36	74.93	75.50	76.07	76.65	77.23	77.81
611	78.39	78.98	79.56	80.15	80.74	81.34	81.93	82.53	83.13	83.73
612	84.33	84.93	85.54	86.14	86.75	87.37	87.98	88.59	89.21	89.83
613	90.45	91.08	91.70	92.33	92.96	93.59	94.22	94.85	95.49	96.13
614	96.77	97.41	98.06	98.71	99.35	100.00	0.00	0.00	0.00	0.00

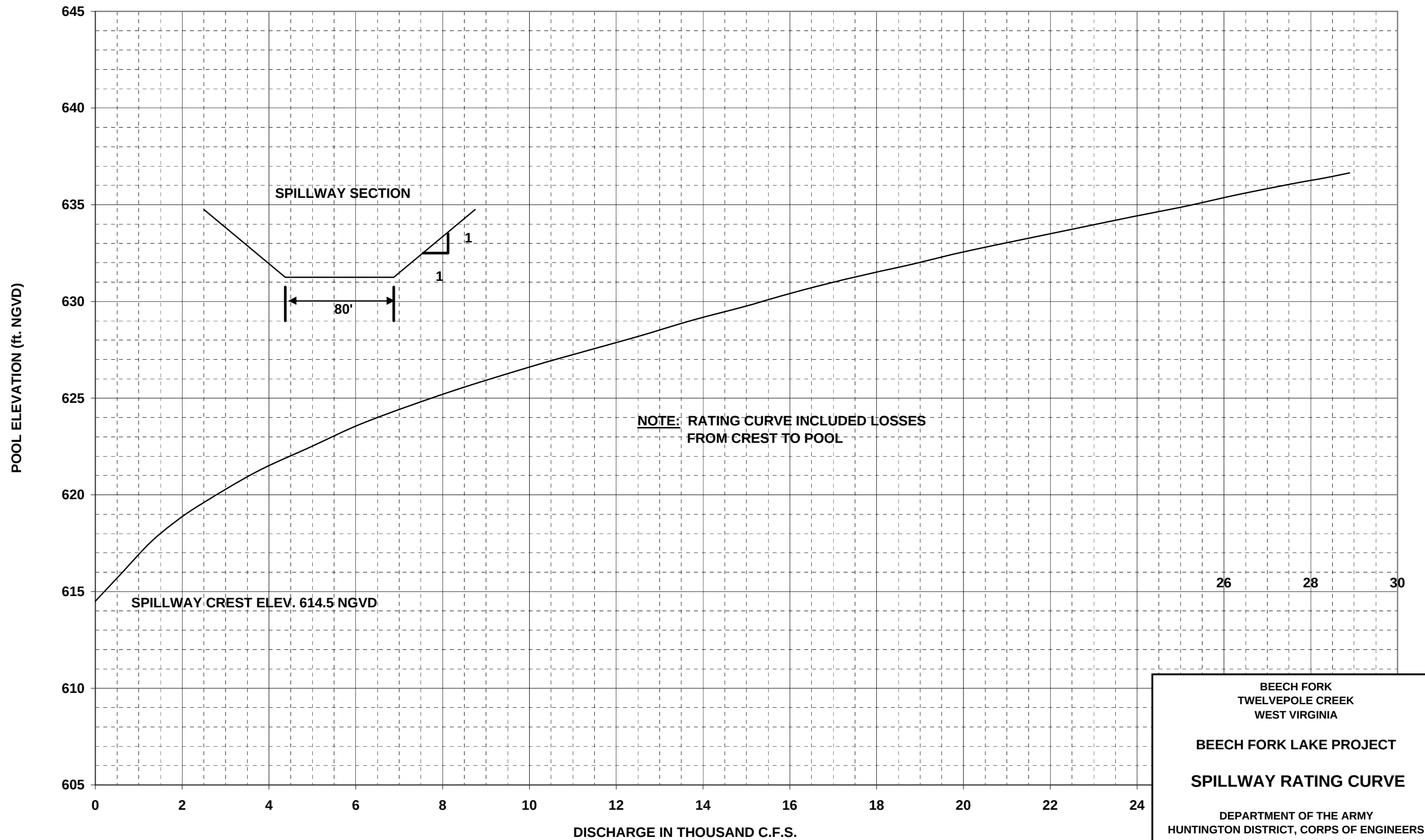
BEECH FORK LAKE

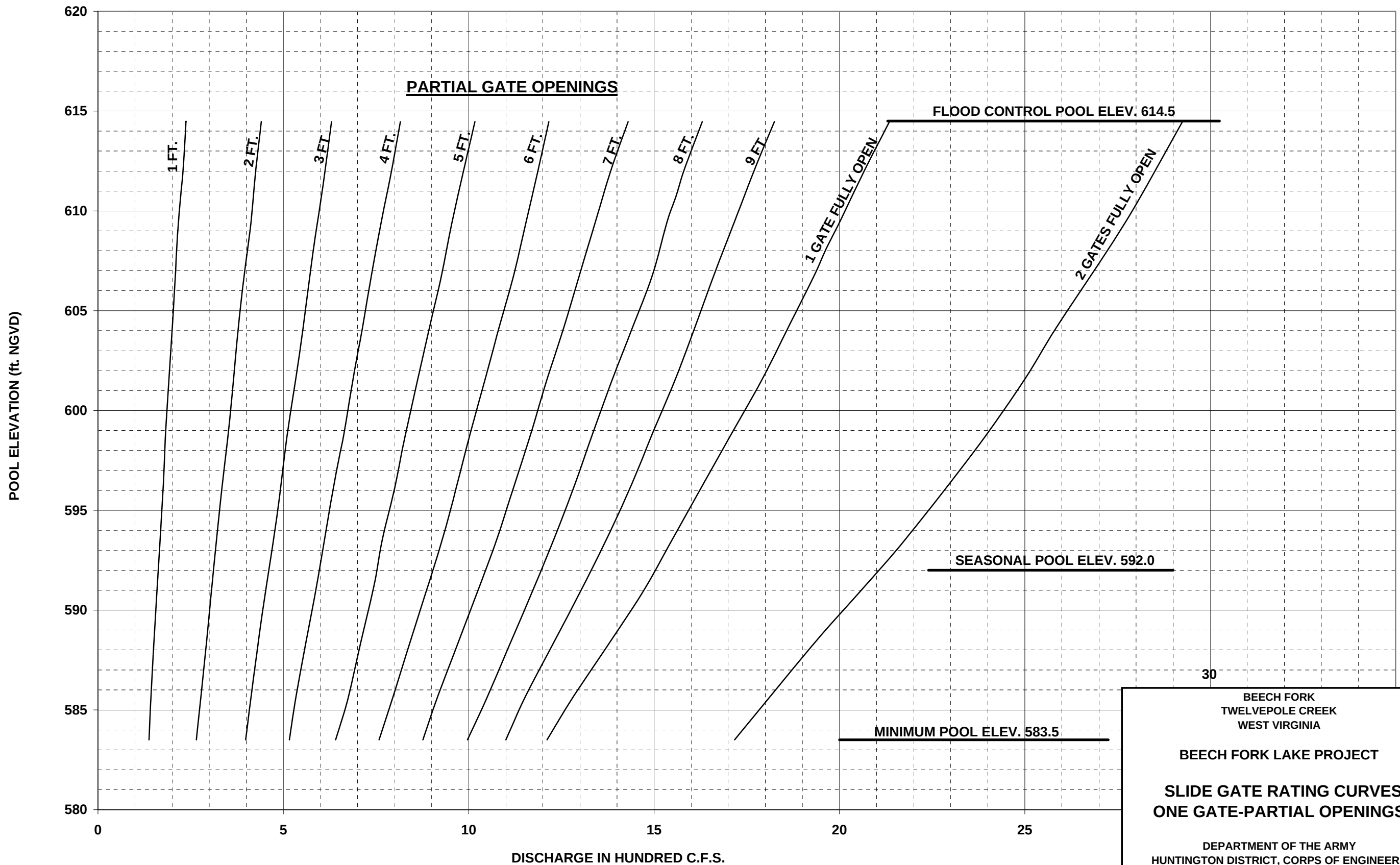
PERCENT STORAGE UTILIZATION - WINTER

ELEV	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
583	0.00	0.00	0.00	0.00	0.00	-0.01	0.13	0.27	0.41	0.55
584	0.69	0.83	0.98	1.12	1.27	1.41	1.56	1.71	1.85	2.00
585	2.15	2.31	2.46	2.61	2.76	2.92	3.07	3.23	3.39	3.55
586	3.71	3.87	4.03	4.19	4.35	4.51	4.68	4.84	5.01	5.18
587	5.34	5.51	5.68	5.85	6.02	6.19	6.37	6.54	6.72	6.89
588	7.07	7.25	7.42	7.60	7.78	7.97	8.15	8.33	8.52	8.70
589	8.89	9.07	9.26	9.45	9.64	9.83	10.02	10.21	10.41	10.60
590	10.80	10.99	11.19	11.39	11.59	11.79	11.99	12.19	12.40	12.60
591	12.80	13.01	13.22	13.43	13.63	13.84	14.06	14.27	14.48	14.70
592	14.91	15.13	15.34	15.56	15.78	16.00	16.22	16.45	16.67	16.90
593	17.12	17.35	17.58	17.81	18.04	18.27	18.50	18.73	18.97	19.20
594	19.44	19.68	19.92	20.16	20.40	20.64	20.89	21.13	21.38	21.63
595	21.88	22.13	22.38	22.64	22.89	23.15	23.41	23.67	23.93	24.19
596	24.45	24.72	24.99	25.26	25.53	25.80	26.07	26.34	26.62	26.90
597	27.18	27.46	27.74	28.03	28.31	28.60	28.89	29.18	29.48	29.77
598	30.07	30.36	30.66	30.96	31.26	31.57	31.87	32.18	32.49	32.80
599	33.11	33.43	33.74	34.06	34.38	34.70	35.02	35.35	35.67	36.00
600	36.33	36.66	36.99	37.32	37.66	38.00	38.33	38.67	39.01	39.36
601	39.70	40.04	40.39	40.74	41.09	41.44	41.79	42.15	42.50	42.86
602	43.22	43.58	43.94	44.30	44.67	45.03	45.40	45.77	46.14	46.51
603	46.88	47.26	47.63	48.01	48.39	48.77	49.15	49.54	49.92	50.31
604	50.69	51.08	51.47	51.87	52.26	52.66	53.05	53.45	53.85	54.25
605	54.66	55.06	55.47	55.87	56.28	56.69	57.10	57.52	57.93	58.35
606	58.77	59.18	59.61	60.03	60.45	60.88	61.30	61.73	62.16	62.59
607	63.03	63.46	63.90	64.33	64.77	65.22	65.66	66.10	66.55	66.99
608	67.44	67.89	68.34	68.80	69.25	69.71	70.16	70.62	71.08	71.54
609	72.01	72.47	72.94	73.41	73.88	74.35	74.82	75.30	75.78	76.25
610	76.73	77.21	77.70	78.18	78.67	79.15	79.64	80.13	80.63	81.12
611	81.62	82.11	82.61	83.11	83.62	84.12	84.63	85.13	85.64	86.15
612	86.66	87.18	87.69	88.21	88.73	89.25	89.77	90.30	90.82	91.35
613	91.88	92.41	92.94	93.47	94.01	94.54	95.08	95.62	96.16	96.71
614	97.25	97.80	98.35	98.90	99.45	100.00	0.00	0.00	0.00	0.00

/TWELVEPOLE/BBF OF/STAGE-FLOW//01OCT1985/table #1 adj/

STAGE	FLOW	STAGE	FLOW	STAGE	FLOW
0.5	0.26	4.9	607.5	9.3	1612
0.6	2.33	5	630	9.4	1636
0.7	4.39	5.1	650.8	9.5	1659
0.8	6.32	5.2	671.9	9.6	1683
0.9	8.21	5.3	693.3	9.7	1707
1	10.09	5.4	714.9	9.8	1731
1.1	10.7	5.5	736.8	9.9	1754
1.2	15.2	5.6	758.9	10	1779
1.3	23.6	5.7	781.3	10.1	1803
1.4	33.5	5.8	804	10.2	1827
1.5	42.77	5.9	826.9	10.3	1851
1.6	52.39	6	850	10.4	1876
1.7	62.2	6.1	871.5	10.5	1900
1.8	71.9	6.2	893.2	10.6	1923
1.9	81.3	6.3	915.1	10.7	1946
2	91.2	6.4	937.2	10.8	1968
2.1	101.8	6.5	959.4	10.9	1991
2.2	113.1	6.6	981.8	11	2014
2.3	125	6.7	1004	11.1	2037
2.4	137.6	6.8	1027	11.2	2060
2.5	150.9	6.9	1050	11.3	2084
2.6	164.8	7	1073	11.4	2107
2.7	179.4	7.1	1097	11.5	2130
2.8	194.8	7.2	1120	11.6	2151
2.9	210.8	7.3	1143	11.7	2172
3	227.5	7.4	1165	11.8	2194
3.1	245	7.5	1188	11.9	2215
3.2	261.6	7.6	1212	12	2236
3.3	278.8	7.7	1235	12.1	2257
3.4	296.6	7.8	1258	12.2	2279
3.5	315.1	7.9	1282	12.3	2300
3.6	334.1	8	1305	12.4	2321
3.7	353.6	8.1	1329	12.5	2343
3.8	373.8	8.2	1353	12.6	2364
3.9	394.5	8.3	1377	12.7	2386
4	415.7	8.4	1401	12.8	2407
4.1	437.6	8.5	1426	12.9	2428
4.2	460	8.6	1450	13	2450
4.3	479.9	8.7	1473	16.9	4800
4.4	500.3	8.8	1496	21.4	9000
4.5	521	8.9	1519	25	14000
4.6	542	9	1542	28.5	20000
4.7	563.5	9.1	1565	31	26000
4.8	585.3	9.2	1589	32	30000



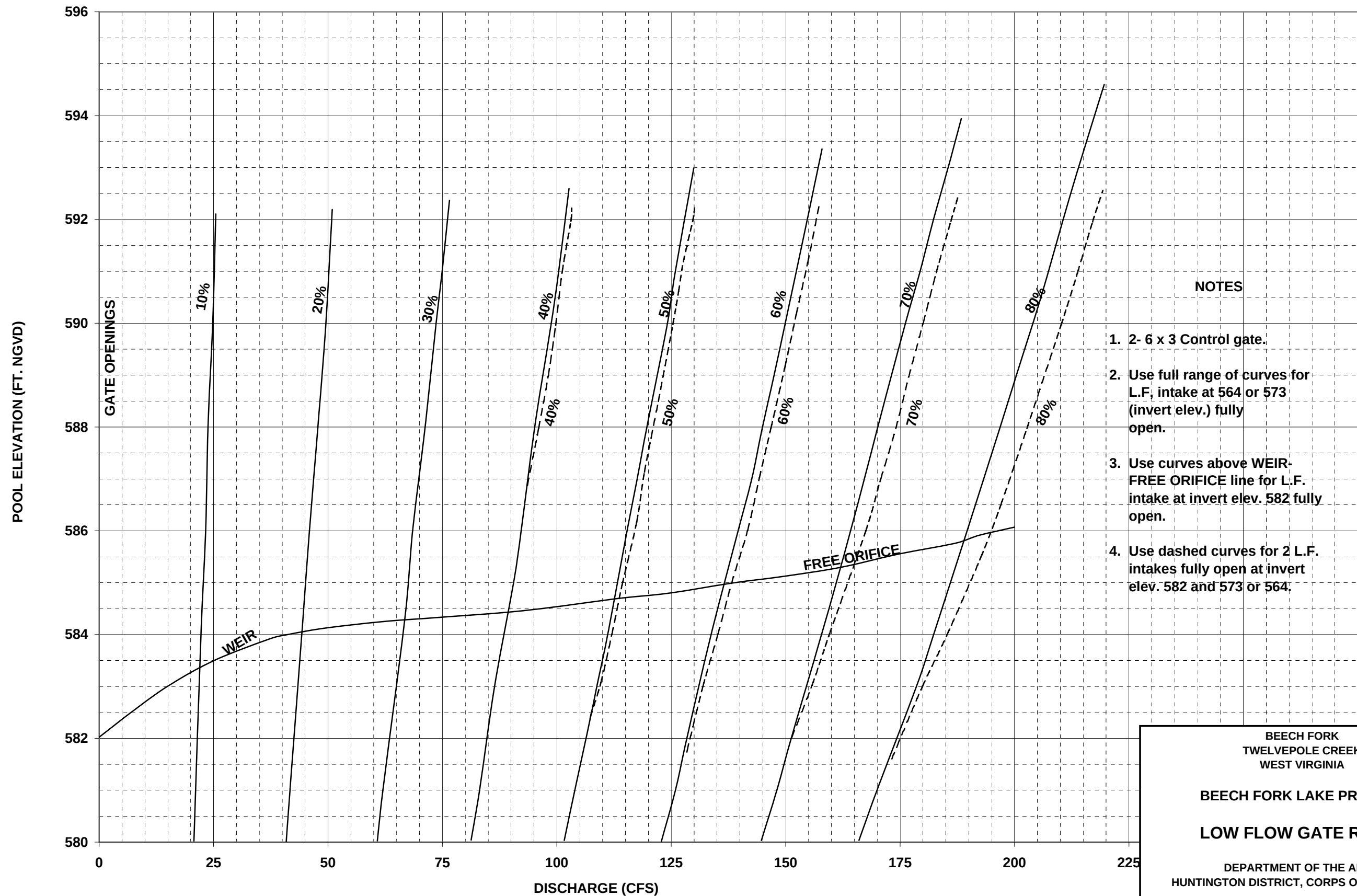


BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

SLIDE GATE RATING CURVES
ONE GATE-PARTIAL OPENINGS

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



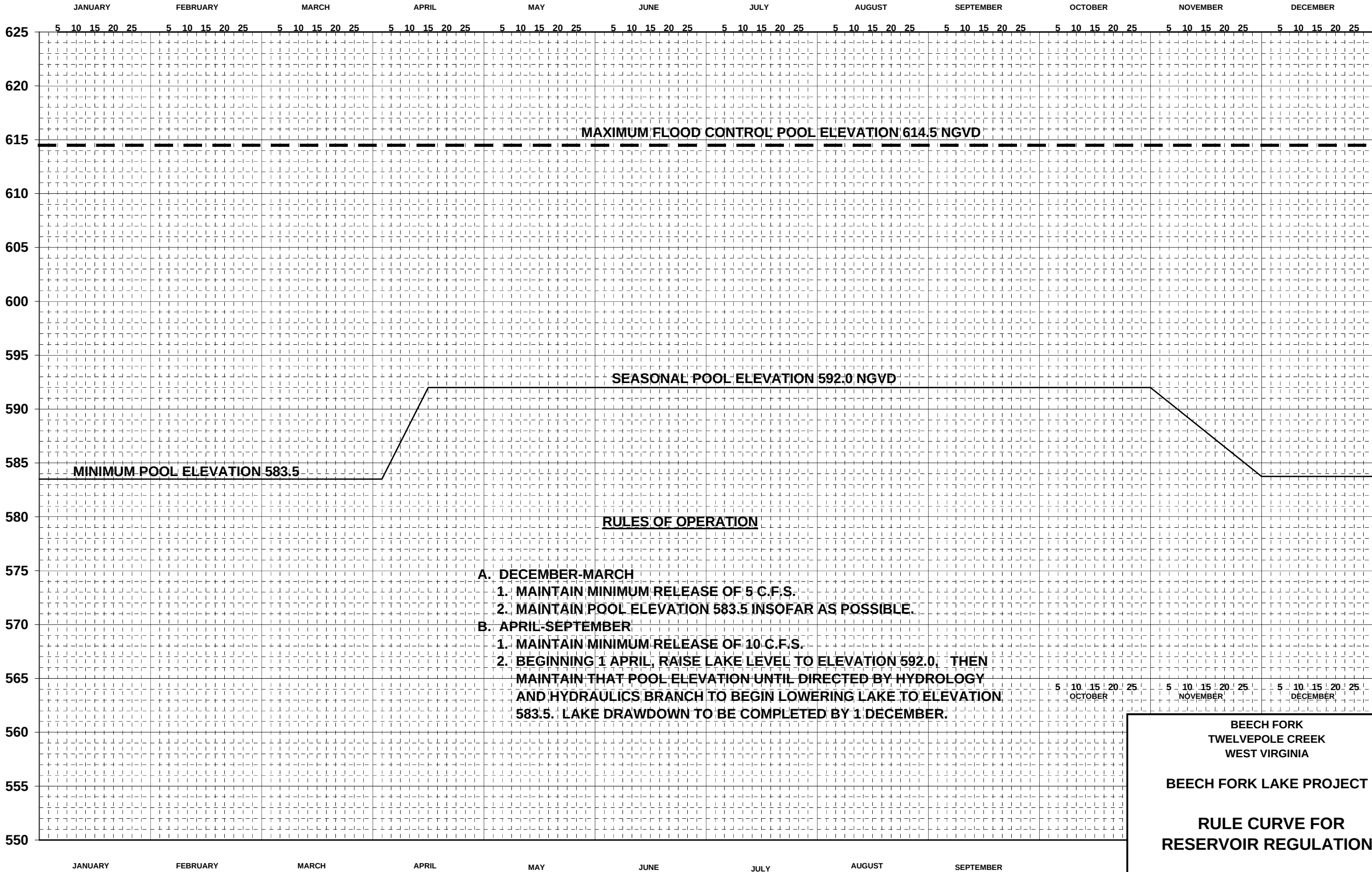
BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

LOW FLOW GATE RATING

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000

POOL ELEVATION (FT. NGVD)

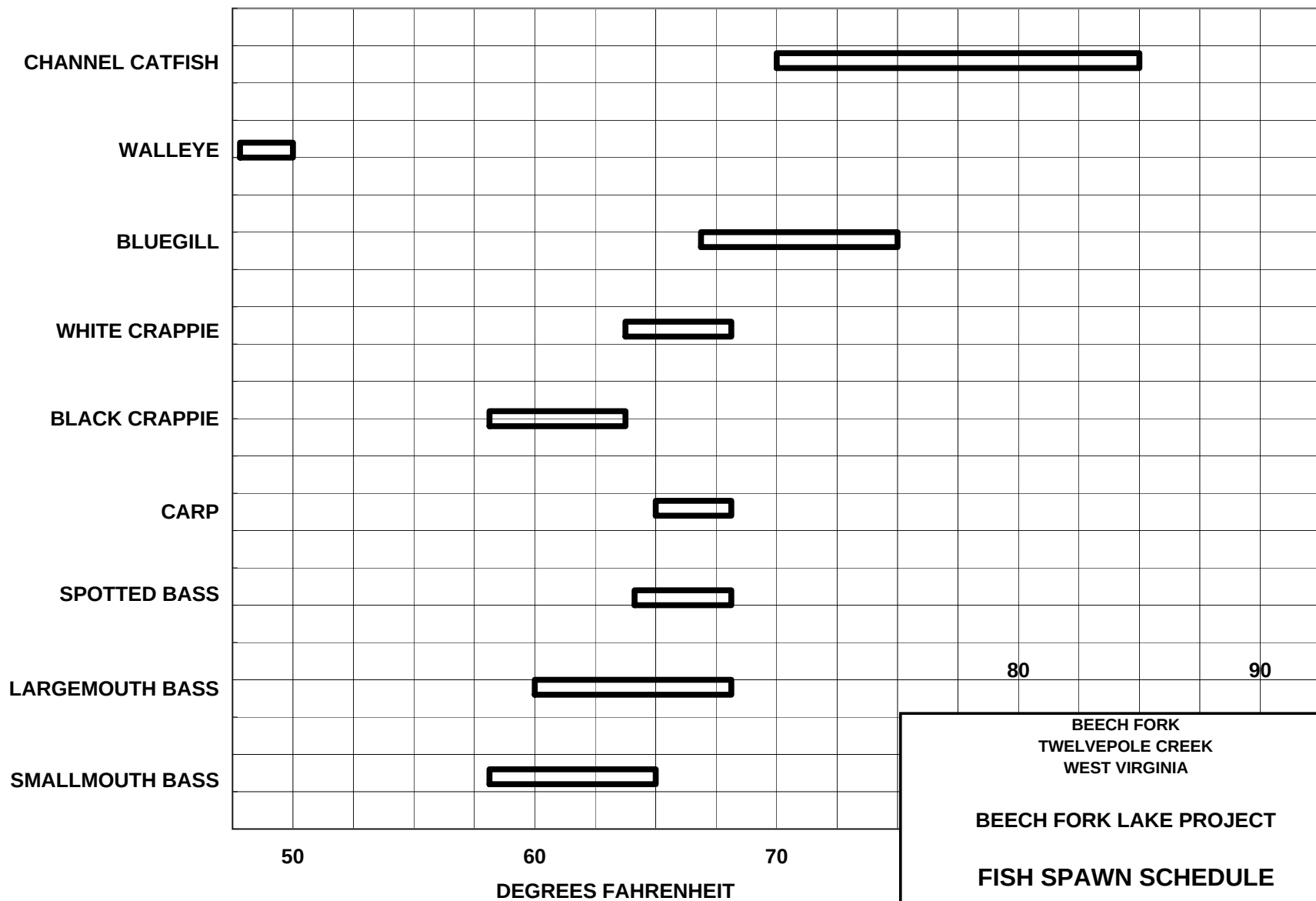


BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

**RULE CURVE FOR
RESERVOIR REGULATION**

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



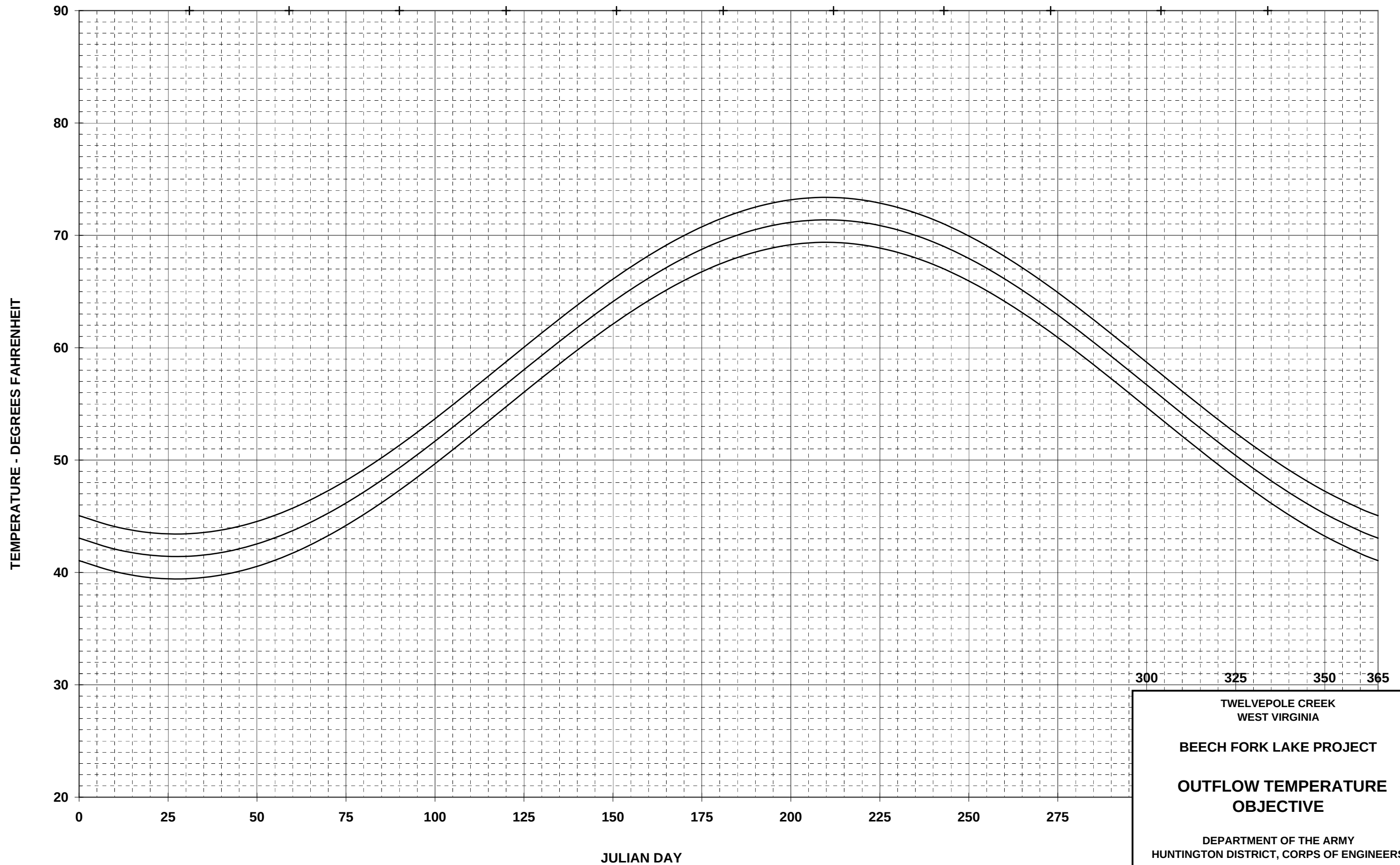
NOTE: SPAWNING NORMALLY OCCURS DURING MAY AND JUNE

BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

FISH SPAWN SCHEDULE

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

OUTFLOW TEMPERATURE
OBJECTIVE

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000

MAXIMUM FLOOD CONTROL POOL 614.5 NGVD

POOL ELEVATION IN FEET NGVD

610
605
600
595
590
585
580
575

SEASONAL POOL 592.0 NGVD

MINIMUM POOL 583.5 NGVD

③
②
①

TIME IN DAYS

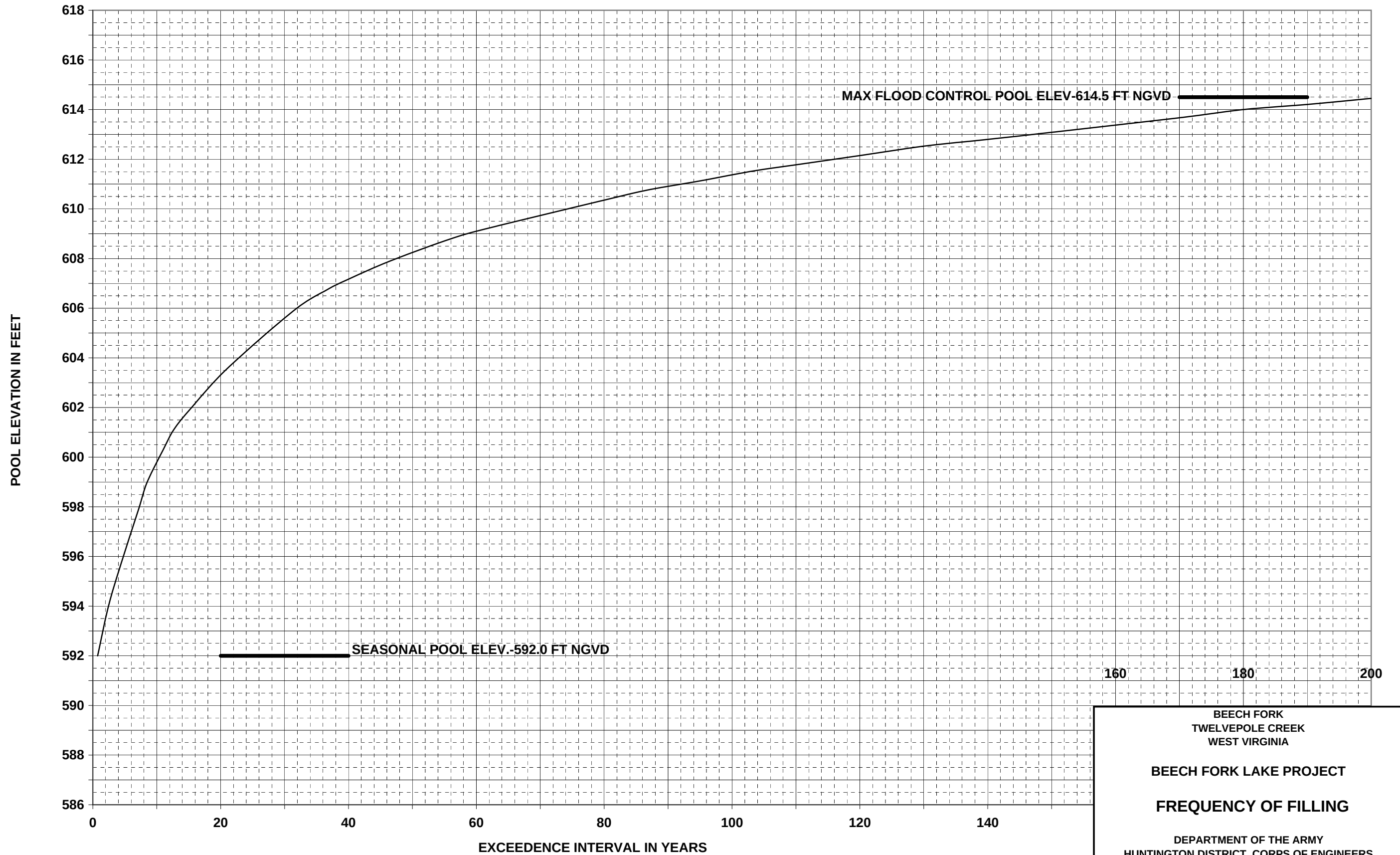
- Case 1. Maximum summer channel capacity of 1410 cfs and constant inflow of 2 cfs per SQ/MI or 160 cfs.
- Case 2. Maximum winter channel capacity of 1780 cfs and constant inflow of 2 cfs per SQ/MI or 160 cfs.
- Case 3. All slide gates fully open and constant inflow of 2 cfs per SQ/MI or 160 cfs.

BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA
BEECH FORK LAKE PROJECT
EMERGENCY DRAWDOWN
PLAN

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. V. DECEMBER 1983

47 1242

20 x 20 TO THE INCH • 10 x 15 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

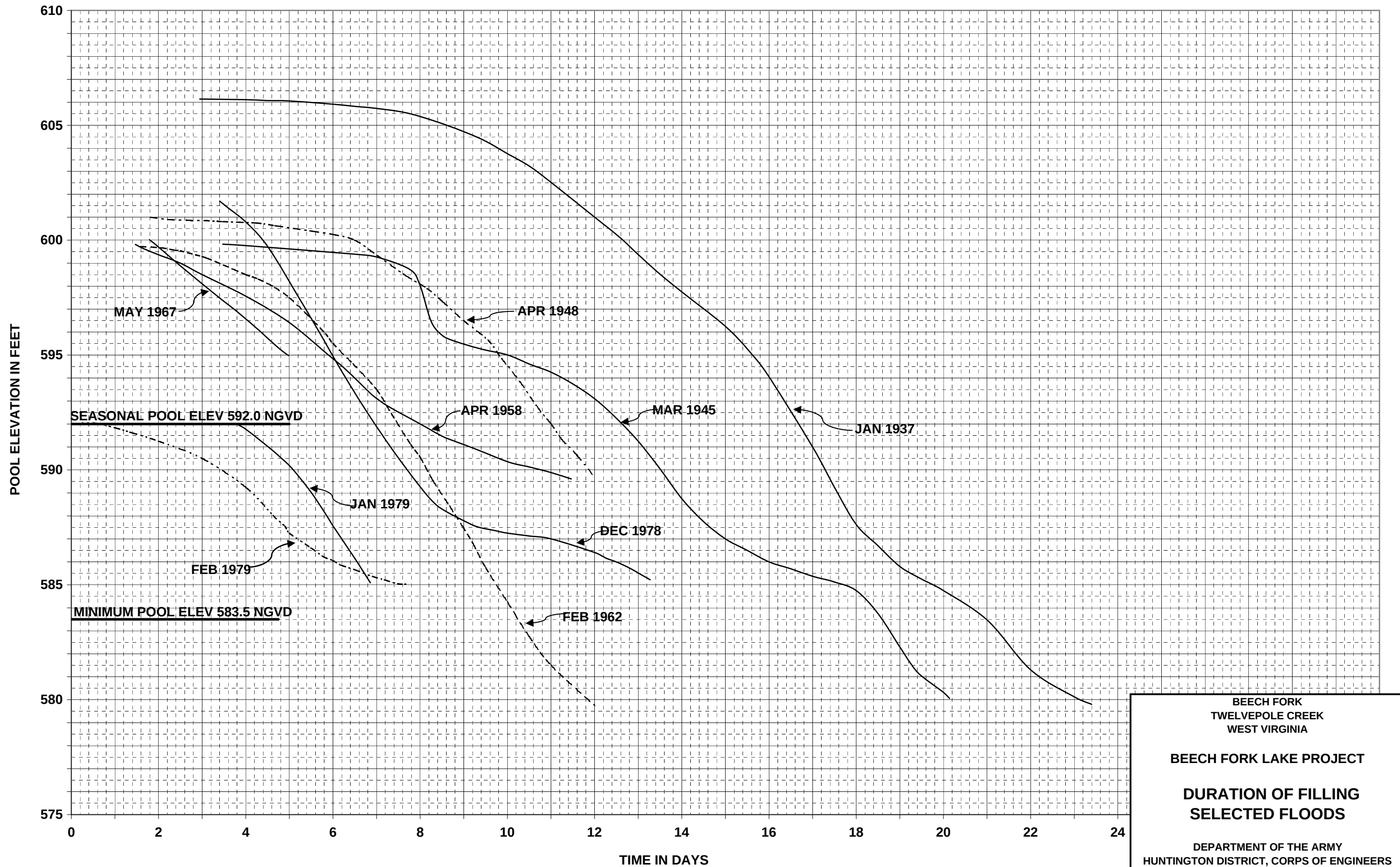


BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

FREQUENCY OF FILLING

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000

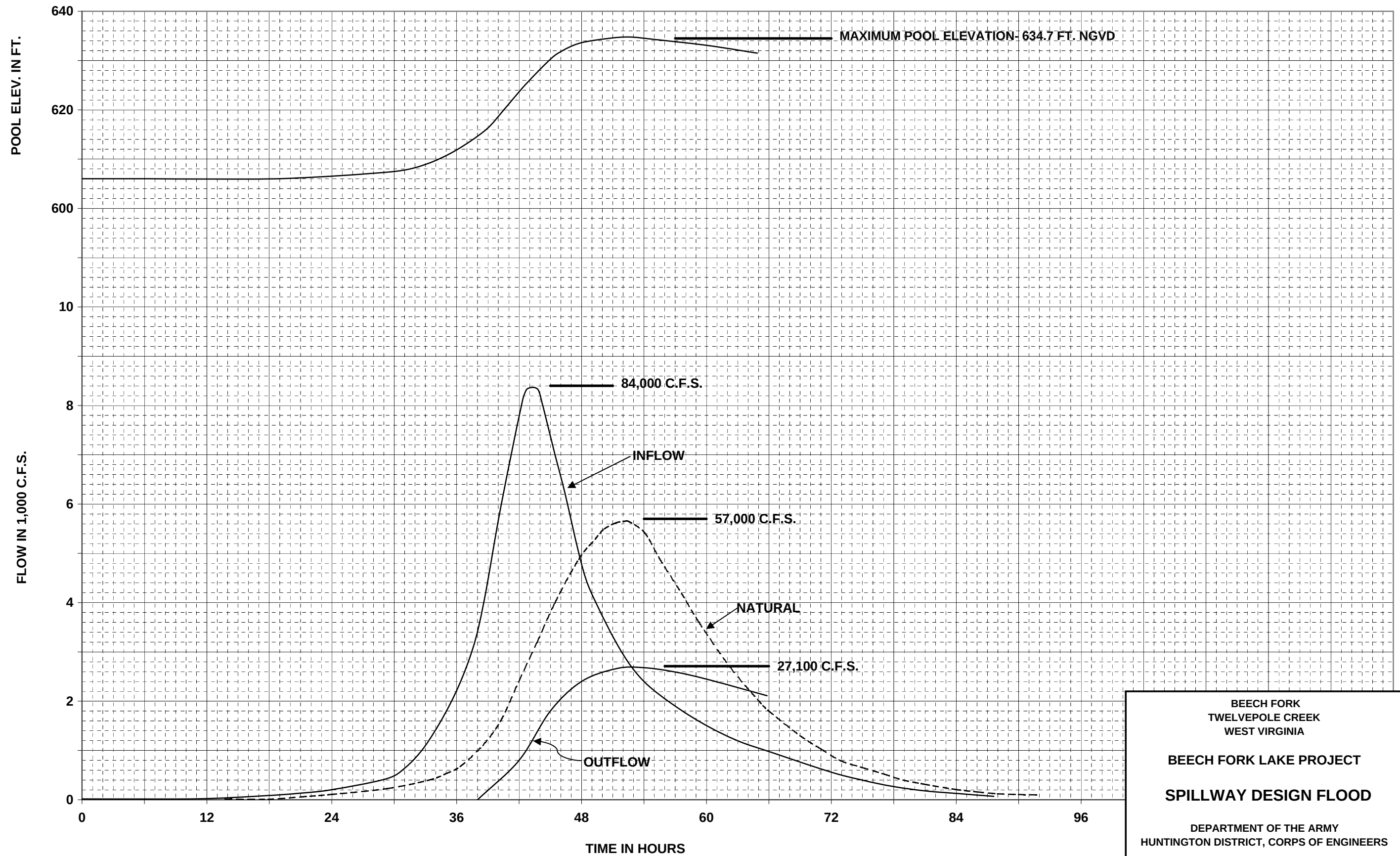


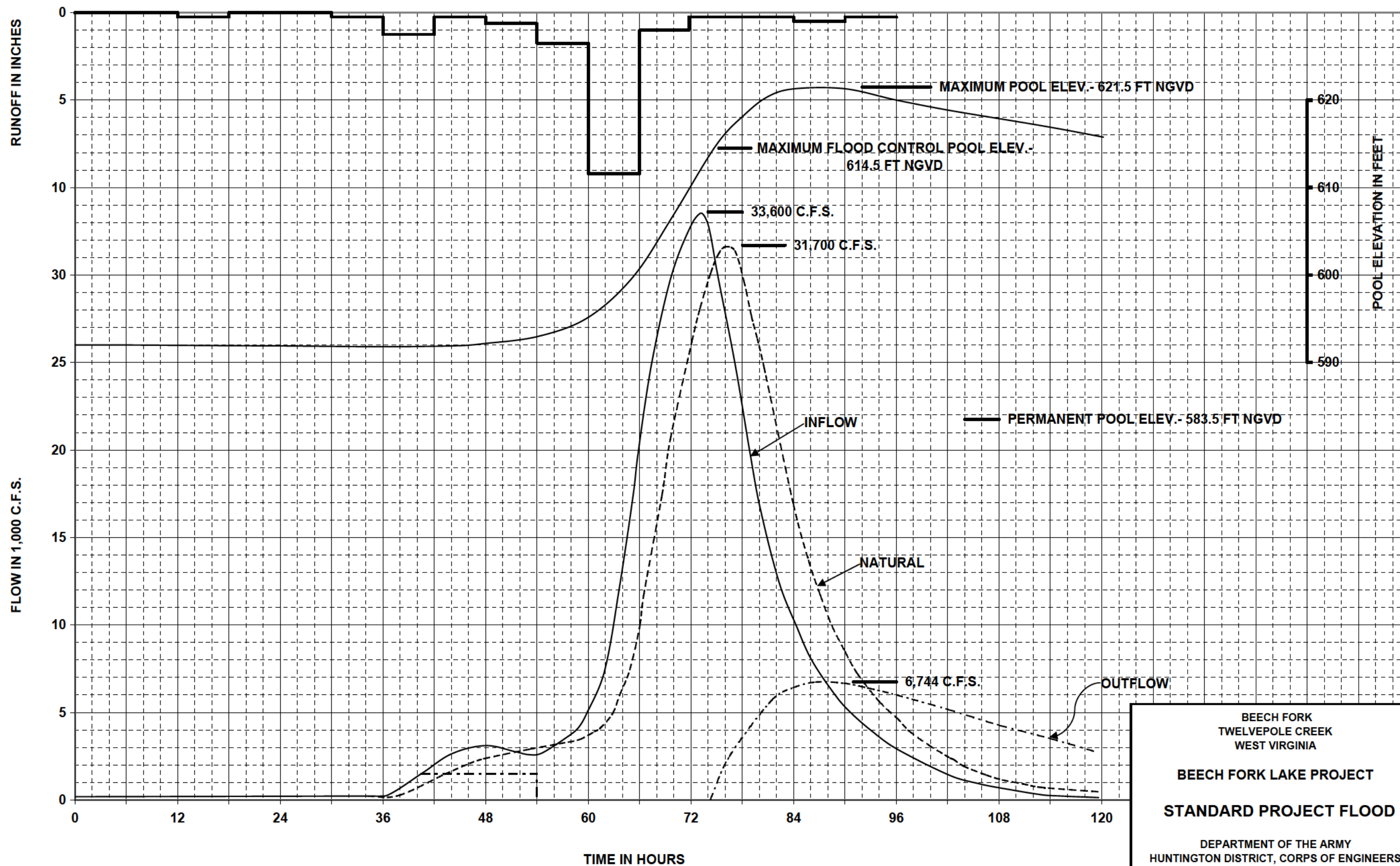
BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

**DURATION OF FILLING
SELECTED FLOODS**

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



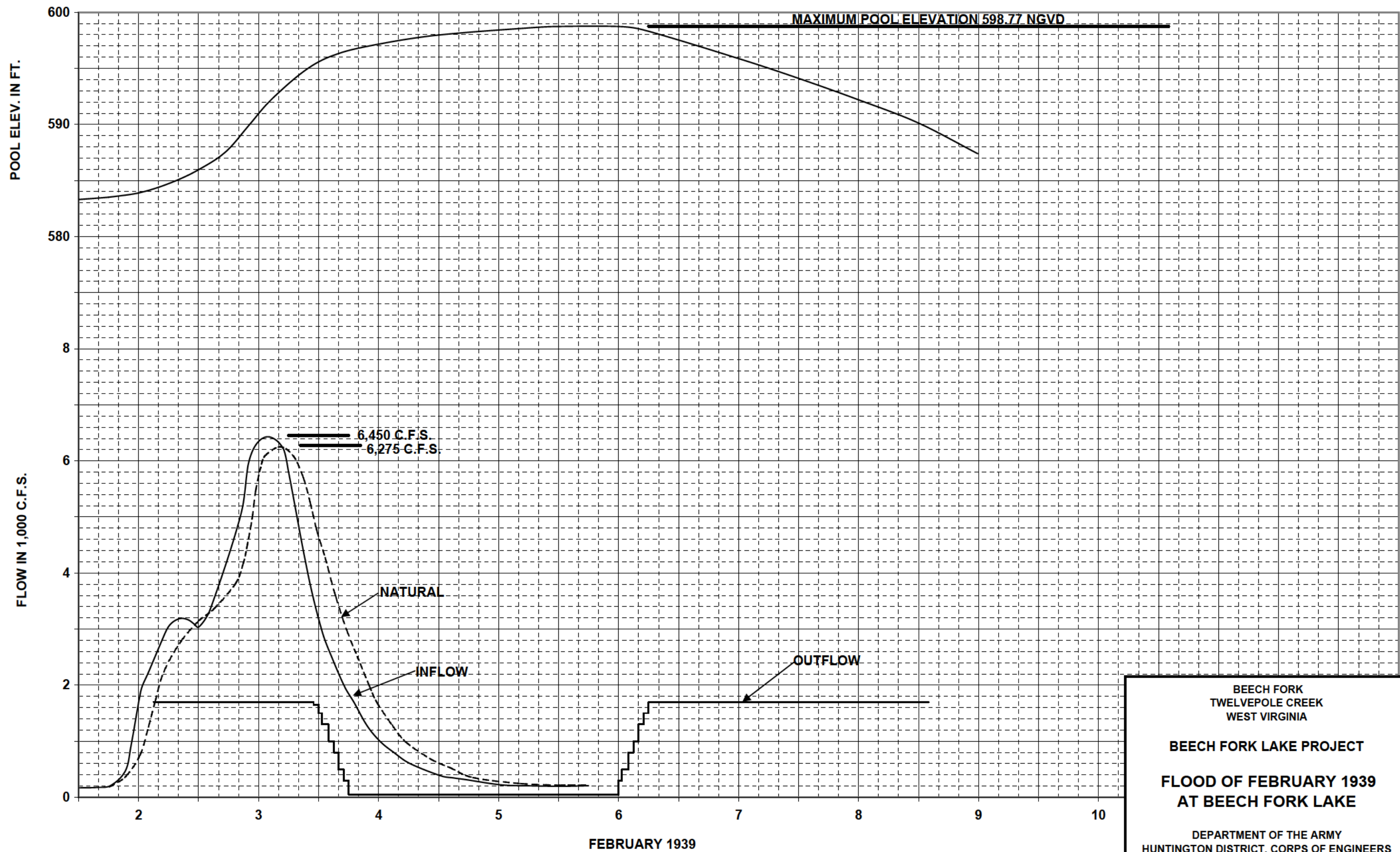


BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

STANDARD PROJECT FLOOD

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000

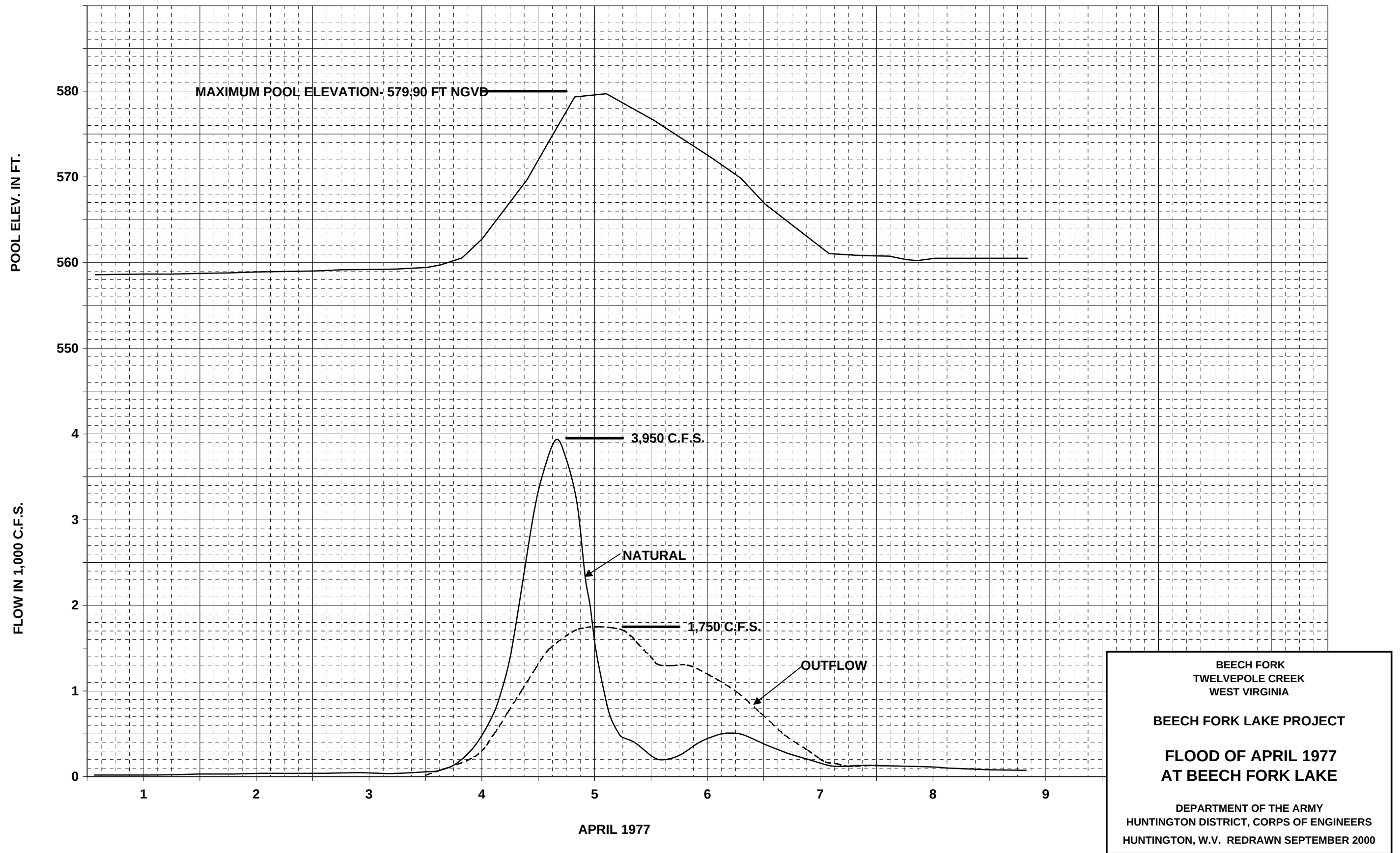


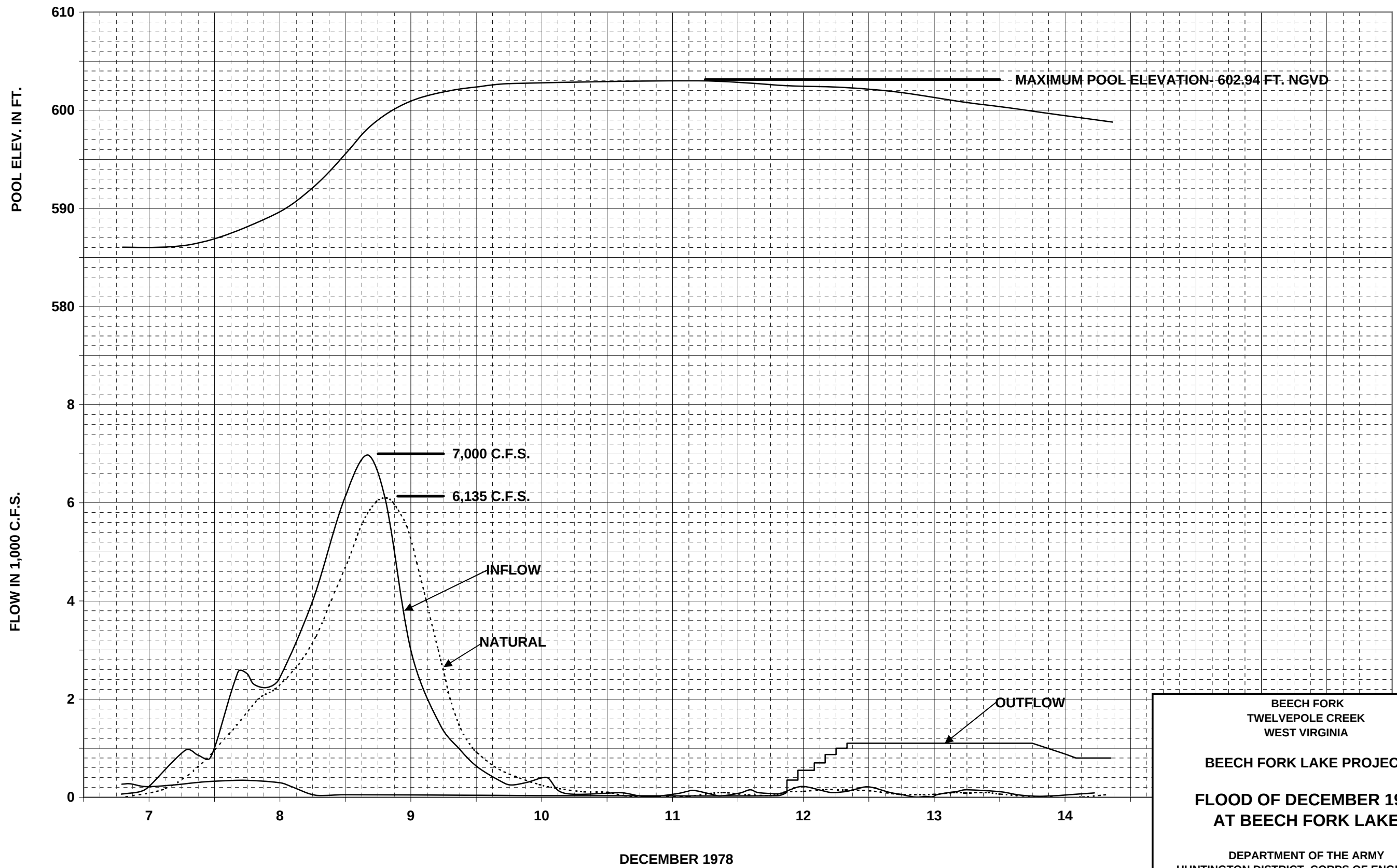
BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

**FLOOD OF FEBRUARY 1939
AT BEECH FORK LAKE**

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



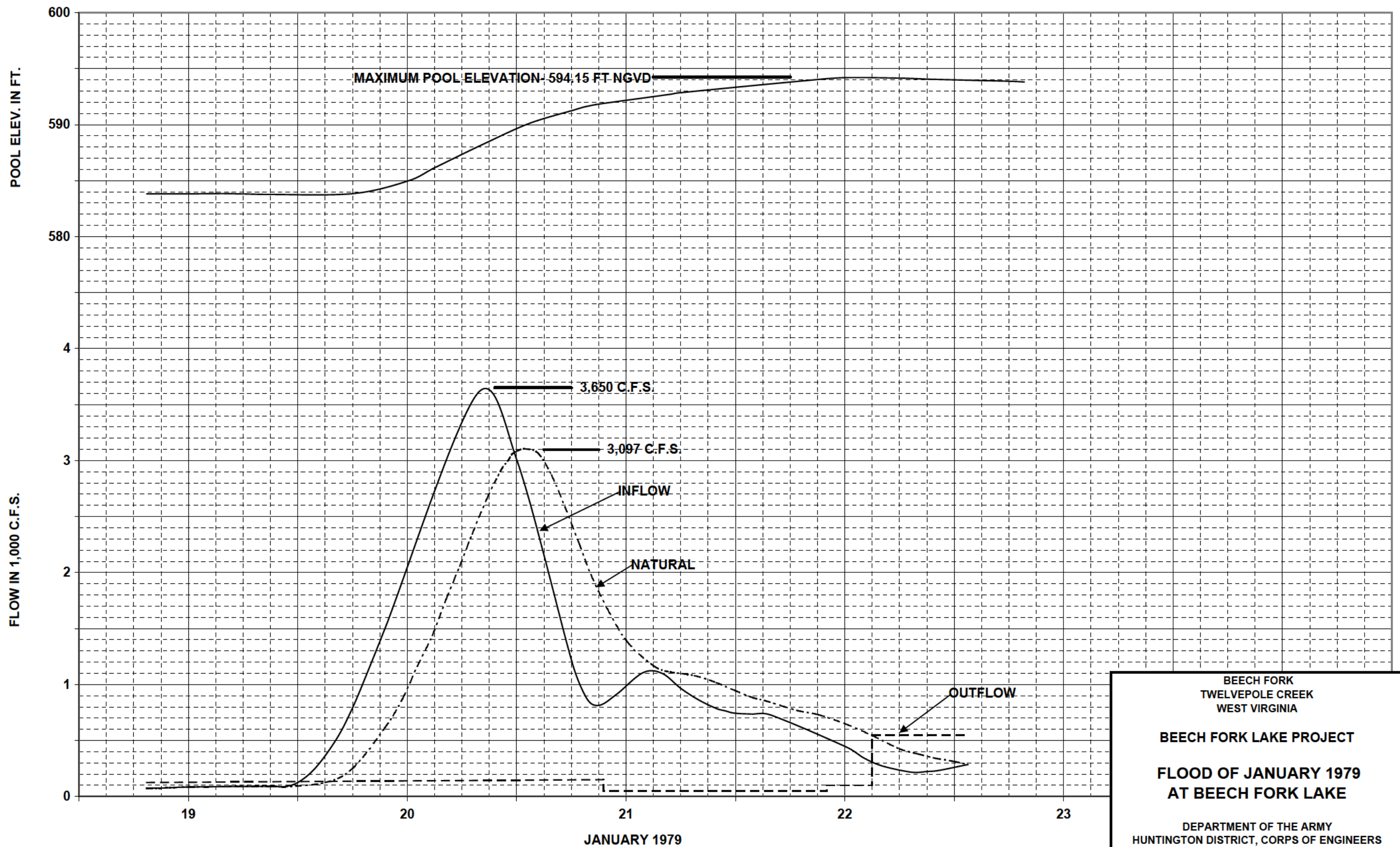


BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

**FLOOD OF DECEMBER 1978
AT BEECH FORK LAKE**

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000

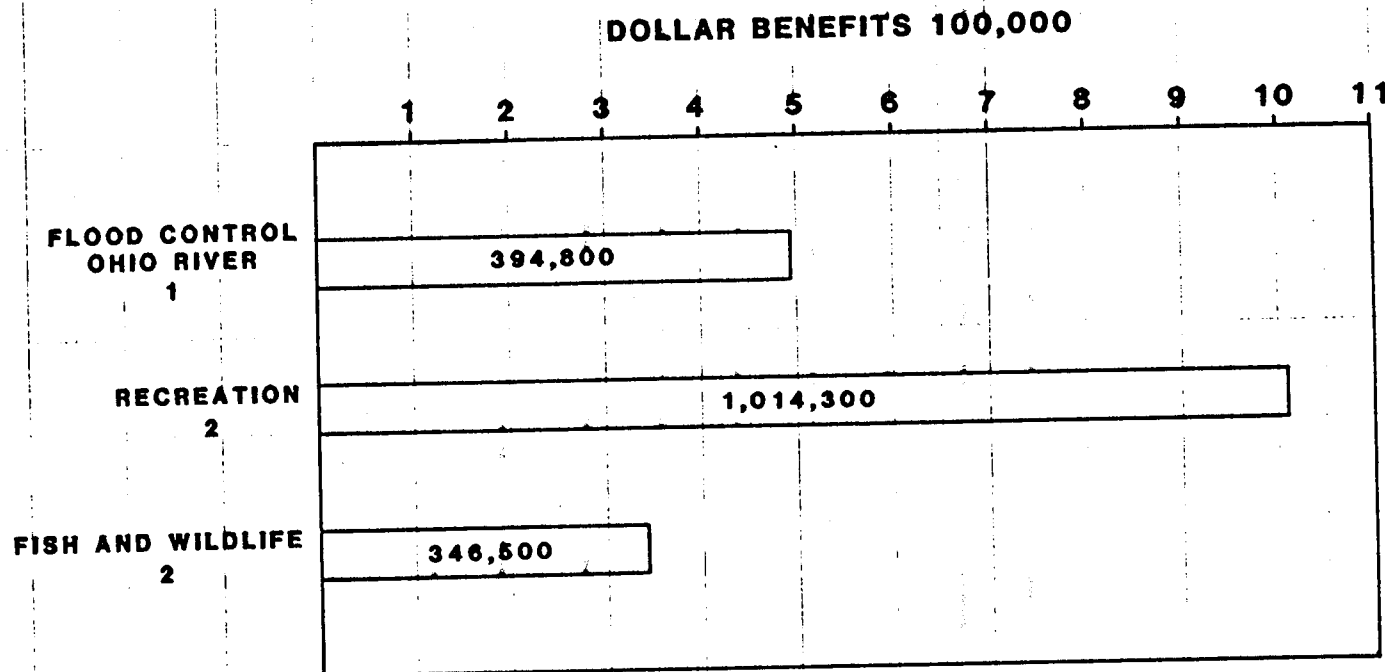


BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

**FLOOD OF JANUARY 1979
AT BEECH FORK LAKE**

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000

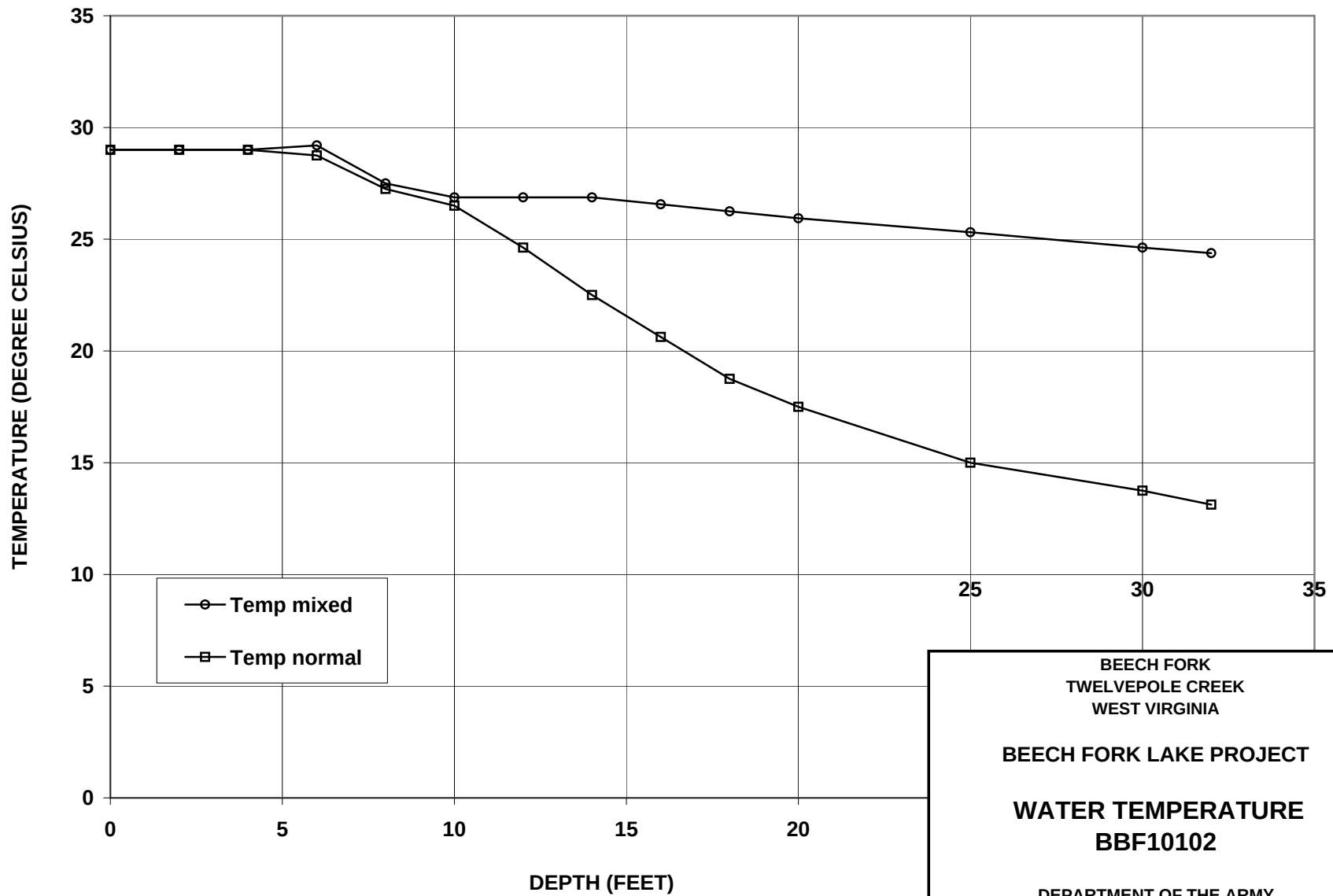


1 - AVERAGE ANNUAL BENEFITS
OCTOBER 1983 VALUATION

2 - BASED ON 1982 VISITATIONS

BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA
BEECH FORK LAKE PROJECT
BENEFITS OF OPERATION
FOR AUTHORIZED PURPOSE

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. V. JANUARY 1984

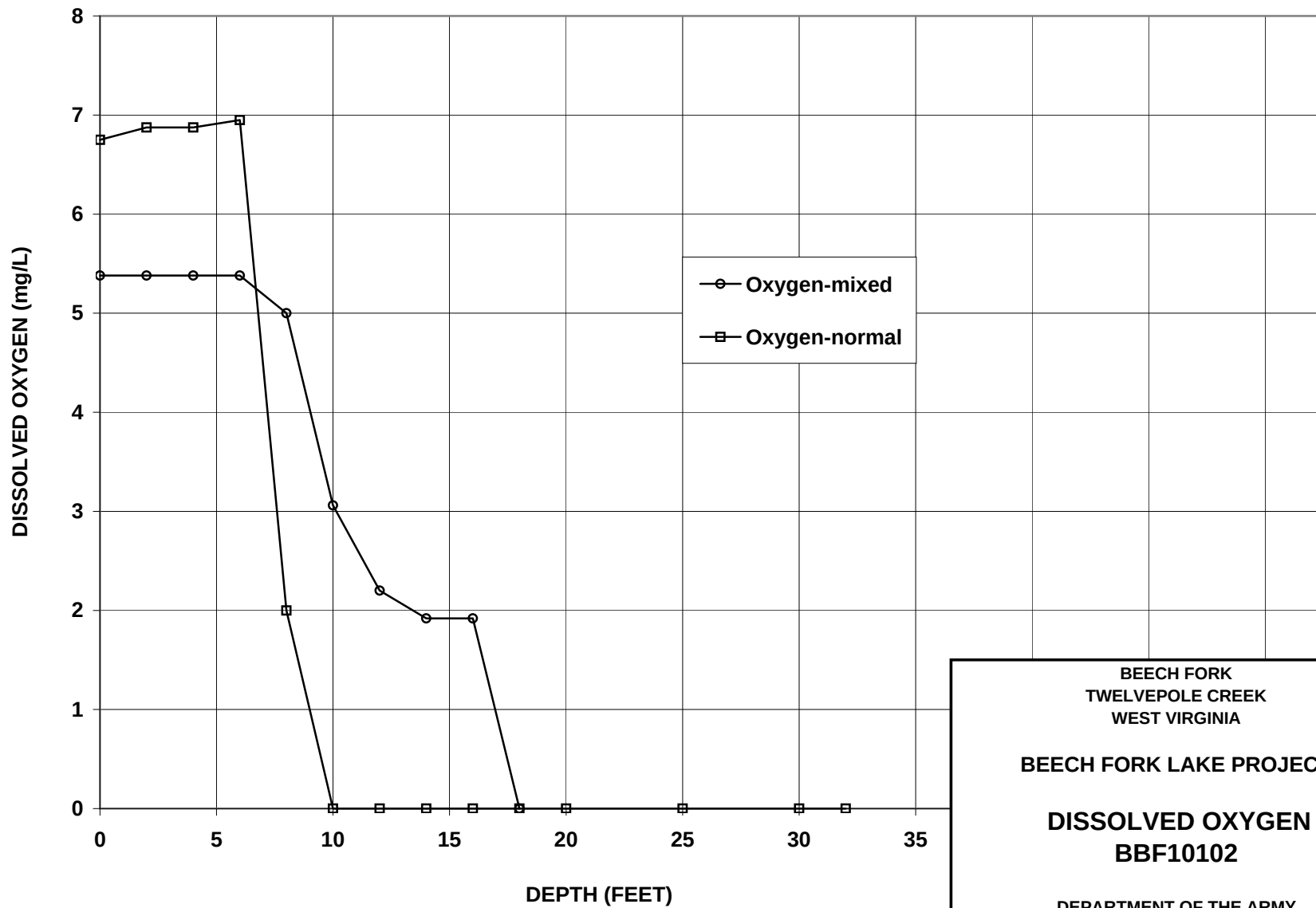


BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

WATER TEMPERATURE
BBF10102

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000

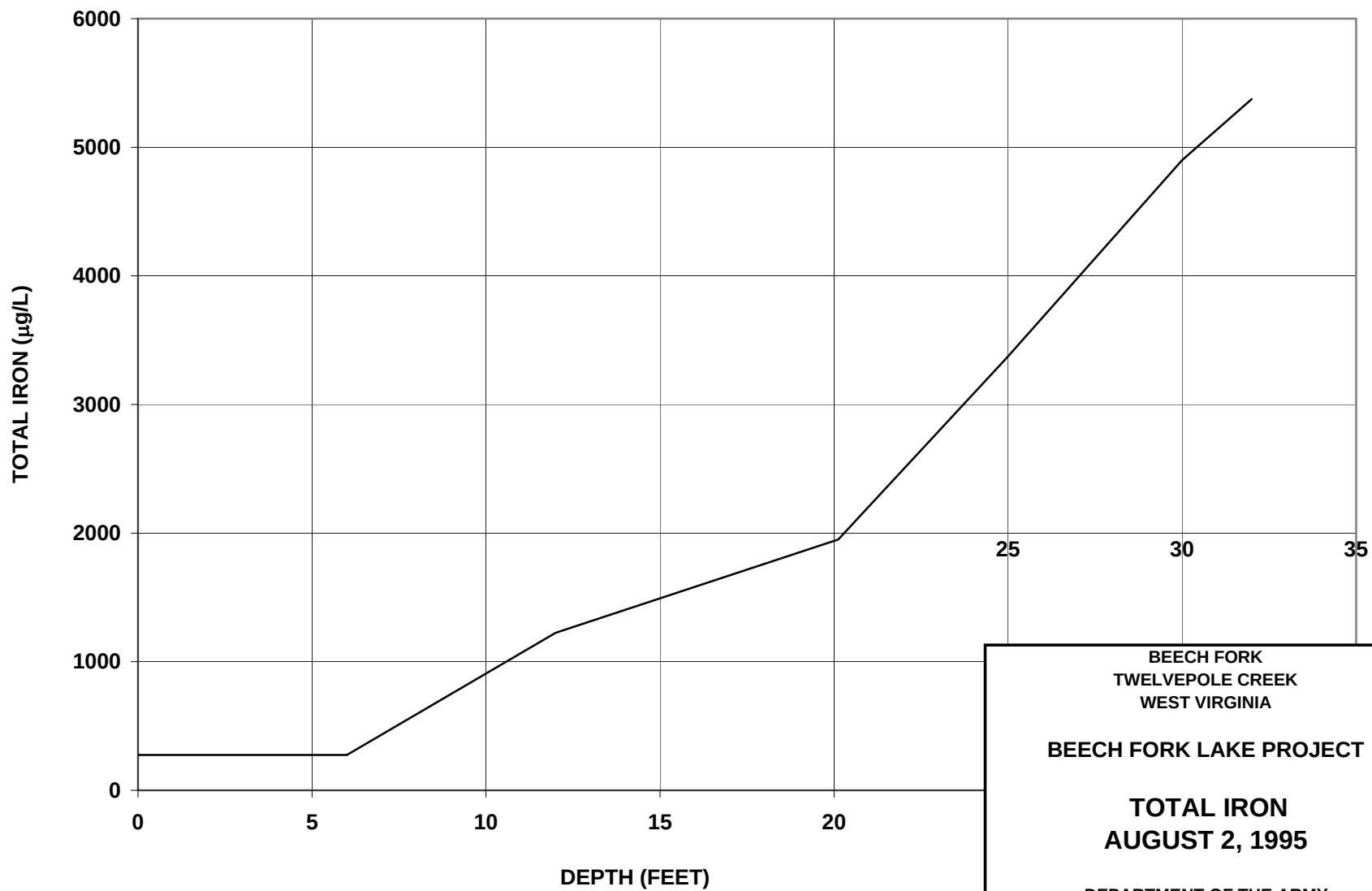


BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

DISSOLVED OXYGEN
BBF10102

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000

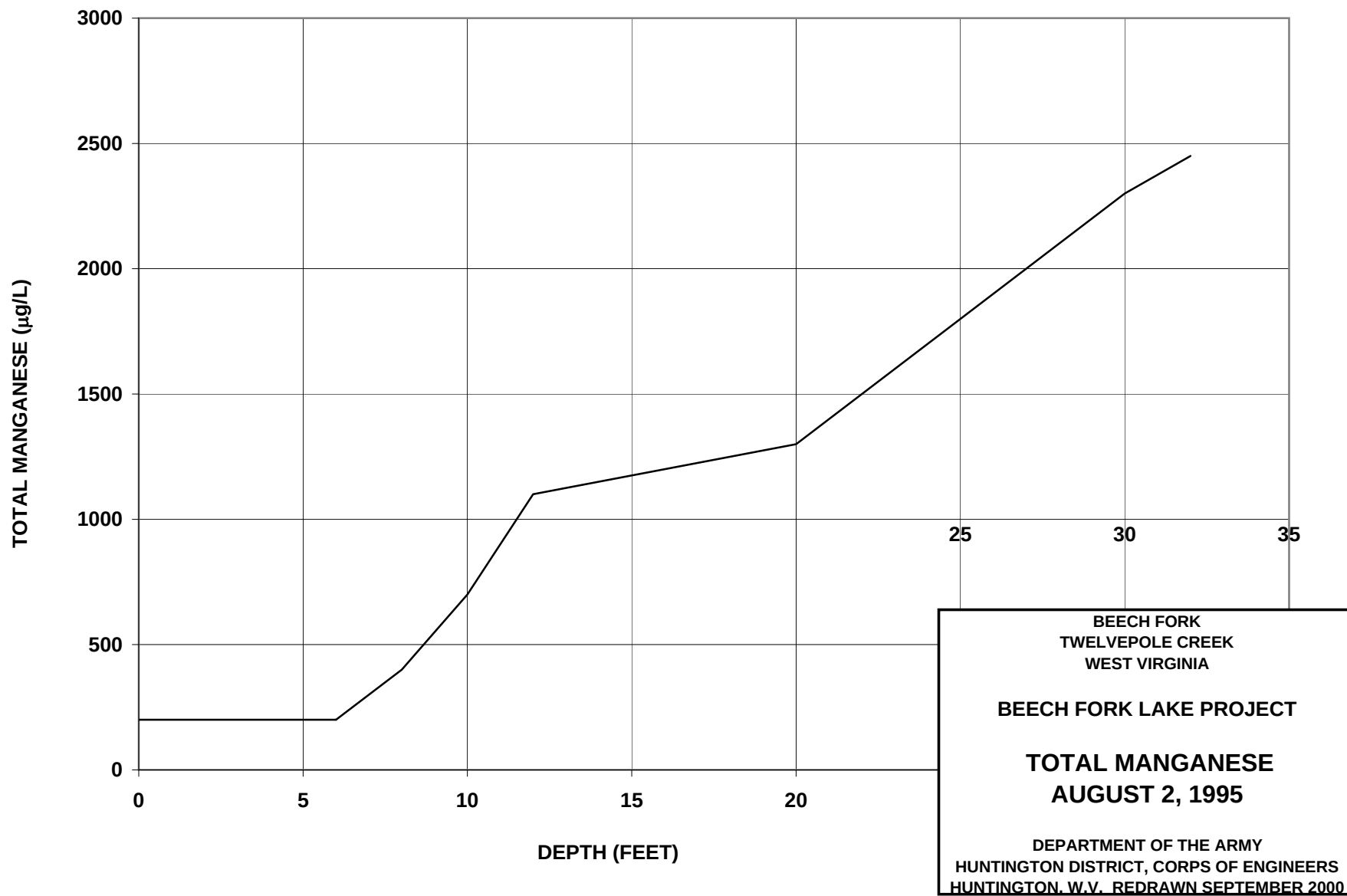


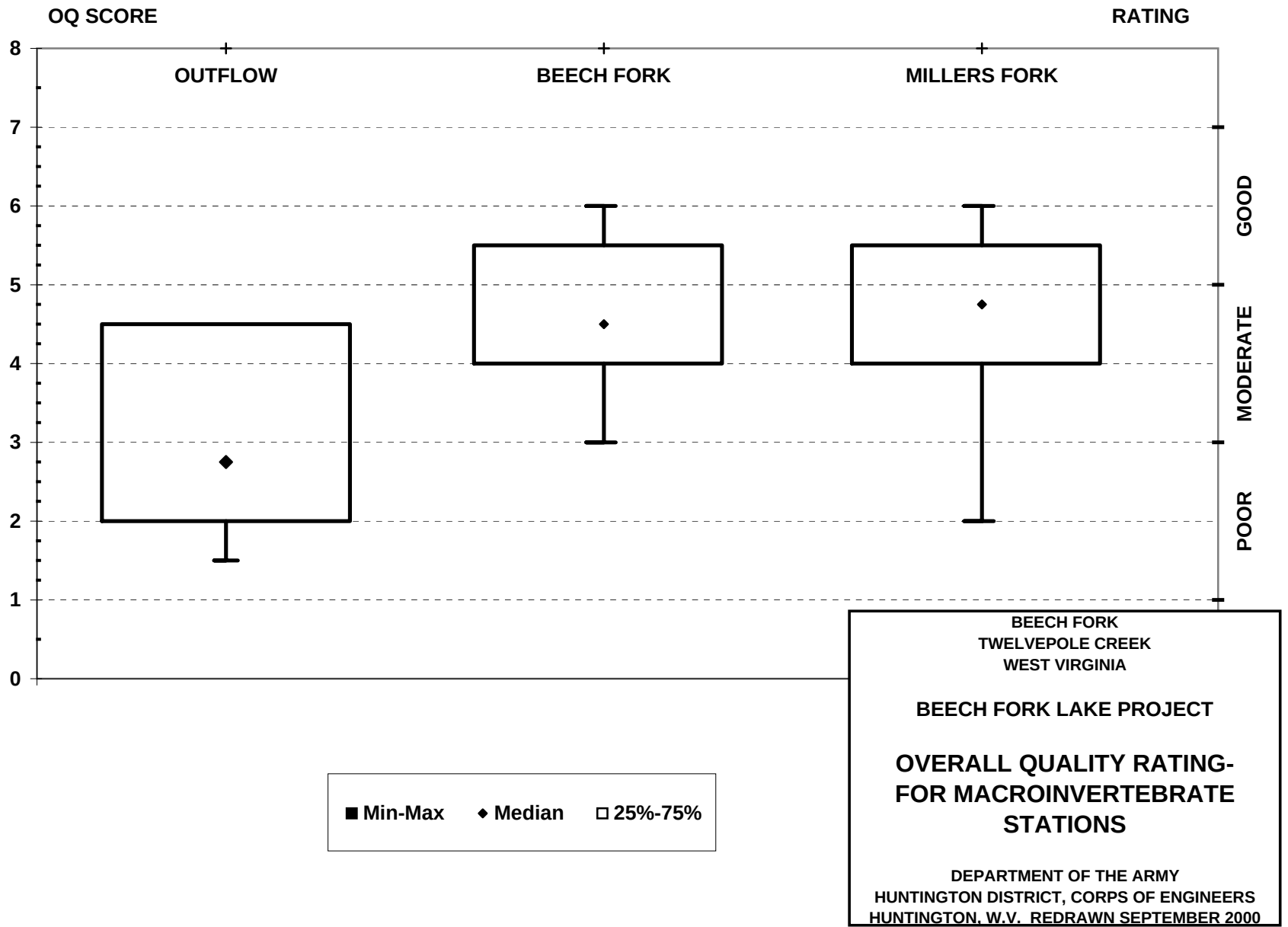
BEECH FORK
TWELVEPOLE CREEK
WEST VIRGINIA

BEECH FORK LAKE PROJECT

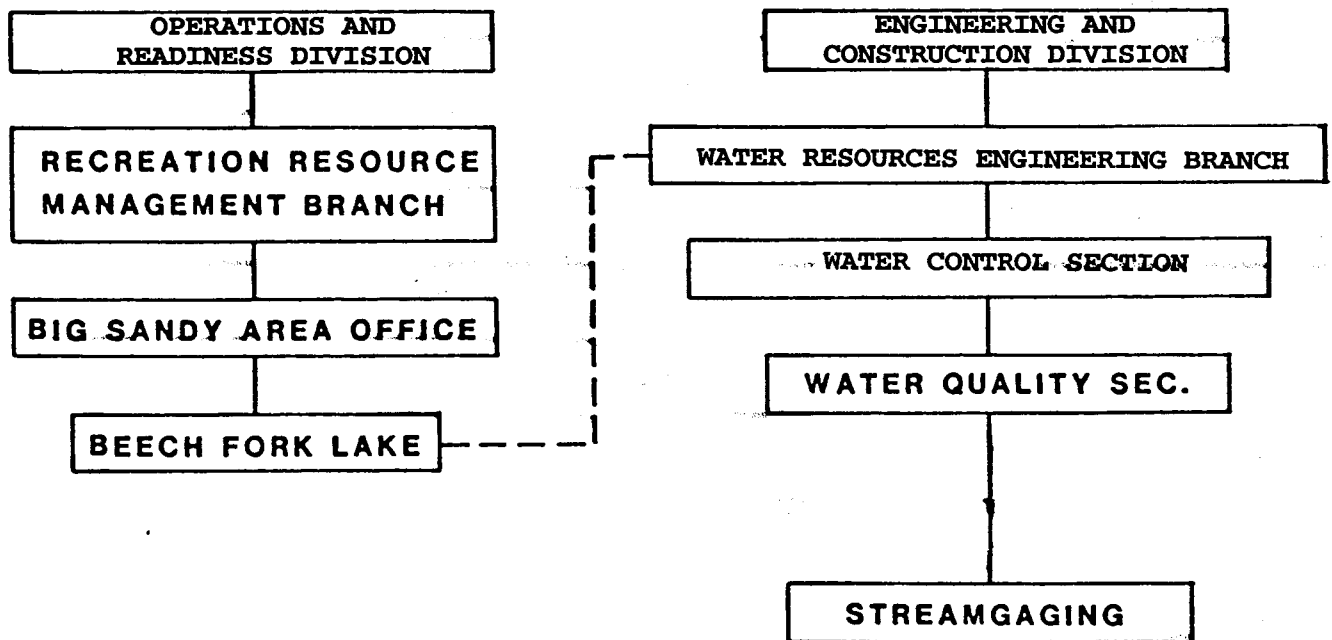
TOTAL IRON
AUGUST 2, 1995

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON W.V. REDRAWN SEPTEMBER 2000





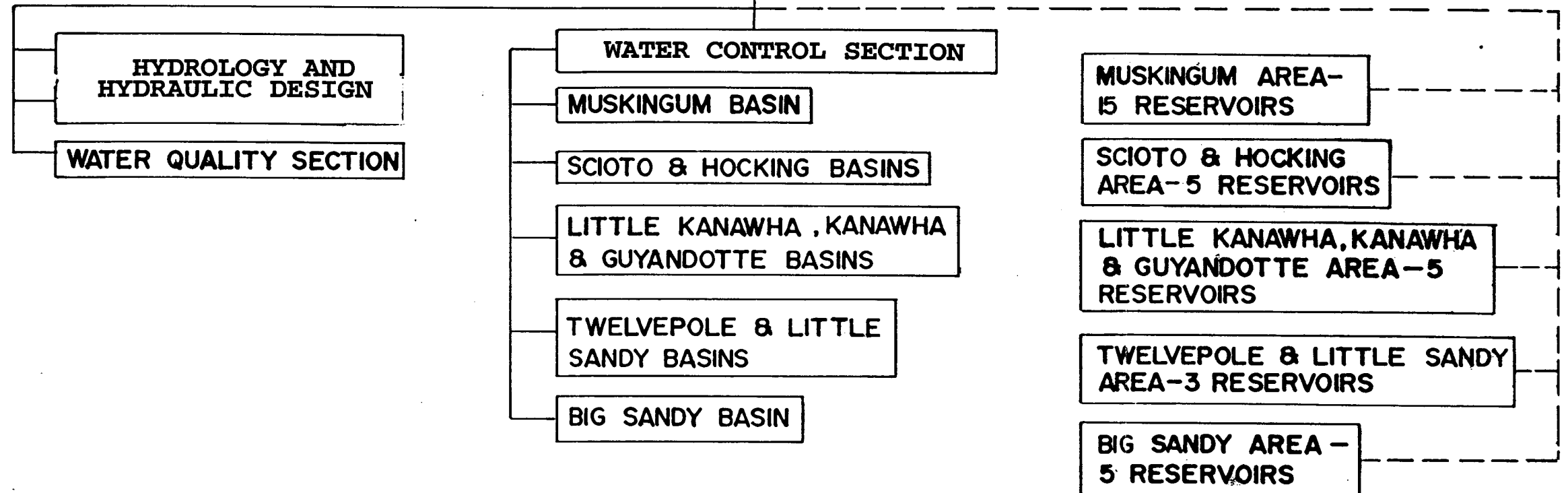
**WATER CONTROL MANAGEMENT
TWELVEPOLE CREEK BASIN
NORMAL ORGANIZATION**



**WATER CONTROL MANAGEMENT
NORMAL ORGANIZATION**

**WATER RESOURCES ENGINEERING BRANCH
FLOOD EMERGENCY ORGANIZATION**

CHIEF, WATER RESOURCES ENGINEERING BRANCH



**WATER RESOURCES ENGINEERING BRANCH
FLOOD EMERGENCY ORGANIZATION
SHEET 1 OF 2**

WATER RESOURCES ENGINEERING BRANCH
FLOOD EMERGENCY ORGANIZATION

CHIEF, WATER RESOURCES ENGINEERING BRANCH

CHIEF, WATER CONTROL SECTION

BEECH FORK LAKE

WATER RESOURCES ENGINEERING BRANCH
FLOOD EMERGENCY ORGANIZATION

SHEET 2 OF 2

