

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

CELRH-EC-WM

20 January 2004  
Schray/5604

3/16/04  
elle

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

CELRH-EC-WM

26 April 2005  
Hazelett /5186


MEMORANDUM FOR RECORD

From: Charlotte L. Hazelett

To: Charles Hauptert, Project Manager, Leesville Lake

Subject: Discharge Rating Table

1. Due to the Ohio USGS issuing an updated rating table, EC-WM has replaced the outflow rating table found in the Leesville Lake Water Control Manual.
2. Please replace Rating No. 24, found on Plate No. 7-6, with the attached new Rating No. 25.



Charlotte L. Hazelett  
CELRH-EC-WM

Attachments: As stated

Copies furnished: Muskingum Area Office



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

20 December 2002

REPLY TO  
ATTENTION OF:

Engineering & Construction Division  
Water Resources Engineering Branch

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Updates for the Leesville Lake Water Control Manual

1. Reference is made to Memorandum for Distribution dated 11 December 2002.
2. Paragraph 2 makes reference to Annex I, this should have been Exhibit B. Replace the revised attached sheet in the reference manual.
3. 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-LEM (2)  
CELRH-OR-MUR  
CELRH-EC-WW (2)  
CELRH-EC-WH

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Updates for the Leesville 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: 7-4, 7-5, 7-8 (main text), and 1-3 (Exhibit B), and Plate No. 7-6.
3. Place this page in the front of the manual.



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

11 December 2002

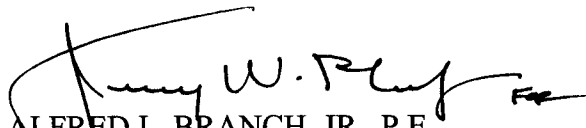
REPLY TO  
ATTENTION OF:  
Engineering & Construction Division  
Water Resources Engineering Branch

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Updates for the Leesville 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: 7-4, 7-5, and 7-8 (main text), and 1-3 (Annex I), and Plate No.7-6.
3. 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-LEM (2)  
CELRH-OR-MUR  
CELRH-EC-WW (2)  
CELRH-EC-WH

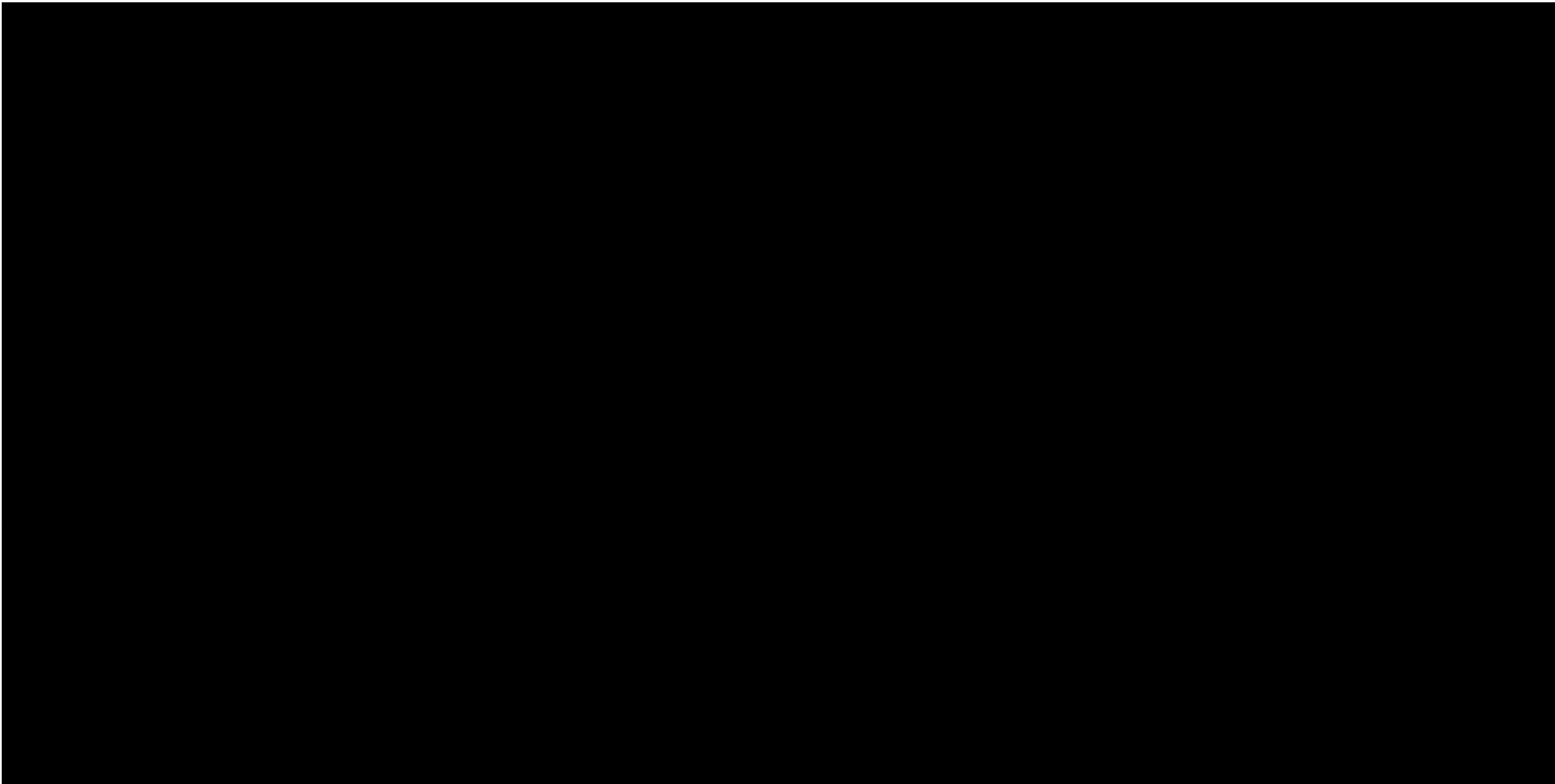
WATER CONTROL MANUAL  
LEESVILLE LAKE  
MCGUIRE CREEK OF CONOTTON CREEK, TUSCARAWAS RIVER  
MUSKINGUM RIVER BASIN  
OHIO

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

SEPTEMBER 2006

Leesville Lake





MUSKINGUM RIVER  
LEESVILLE LAKE  
DAM AND SPILLWAY  
PLAN, PROFILE AND SECTION  
HUNTINGTON DISTRICT, HUNTINGTON, W. VA.  
Revised: 30 SEPTEMBER 1986

NOTICE TO USERS OF THIS MANUAL

Regulations specify that this Water Control Manual be published in a hard copy binder with the text in looseleaf form, and only those sections or parts thereof requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that 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, communications can be achieved by contacting, in the order listed, one of the following persons

**Contact During Normal Hours**

**Mailing Address**

Leesville Lake Project Office  
██████████ Project Supervisor  
5037 Deer Road SW  
Bowerstown, Ohio 44695-9621

**Telephone Numbers**

Project: ██████████  
Fax: ██████████  
Cell: ██████████

**Mailing Address**

Muskingum Area Office  
██████████ Area Manager  
5336 State Route 800, NE  
Dover, OH 44622-6910

**Telephone Numbers**

Office: ██████████  
Office: ██████████  
Fax: ██████████  
Cell: ██████████

**Contact After Hours**

Project Supervisor: ██████████ Home: ██████████  
Area Manager: ██████████ Home: ██████████  
Chief, Water Management Section:  
██████████ Home: ██████████  
Chief, Water Resources Branch:  
██████████ Home: ██████████

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LEESVILLE LAKE

MUSKINGUM RIVER LAKE, OHIO

PERTINENT DATA

LOCATION:

The Leesville Lake damsite is located in Carroll County, Ohio, on McGuire Creek near the junction of McGuire Creek and North Fork of McGuire Creek, approximately 1.4 miles above the confluence of McGuire Creek with Conotton Creek and 196.4 miles above the mouth of the Muskingum River. The dam is located approximately 17 miles east of New Philadelphia and 1.5 miles northeast of Leesville, Ohio.

TYPE OF PROJECT:

Multi-purpose; flood control, recreation, fish and wildlife conservation.

DRAINAGE AREA ABOVE DAM:

48 square miles. 1 Inch of runoff results in 2,560 acre-feet of storage.

RESERVOIR DATA

Elevations (Feet above ngvd)

Streambed at Damsite	920
Designated Minimum Pool*	958
Conservation Pool	963
Flood Control Pool	977.5
Spillway Design Flood	990.1

Capacities

	Acre-Feet		Inches-Runoff	
	Net	Gross	Net	Gross
Designated Minimum pool*	14,850	14,850	5.8	5.8
Conservation Pool	4,650	19,500	1.8	7.6
Flood Control Pool				
Above Designated Minimum	22,550	37,400	8.8	14.6
Above Conservation	17,900	37,400	7.0	14.6
Total storage		37,400		14.6

\* Subject to change by MWCD

Note: Additional information can be found in Appendix A.

MUSKINGUM RIVER BASIN  
OHIO

PROJECT MANUAL  
FOR  
WATER CONTROL MANAGEMENT

**LEESVILLE LAKE - McGUIRE CREEK**

SECTION I - INTRODUCTION

1-01. AUTHORIZATION OF WATER CONTROL MANUAL

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

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

The purpose of this manual is to present the general plan and detailed schedules of regulation for Leesville Lake in the Muskingum River Basin. The manual serves as documentation of the plan for water control, and also as a reference source for higher authority and for personnel responsible for water control management during the life of the project. The manual contains background information pertinent to objectives and applications of water management schedules, as well as results of project operation simulations for specific purposes and conditions.

1-03. RELATED MANUALS AND REPORTS.

The following manuals and reports concerning Leesville Lake or the Muskingum River projects have been previously completed.

	<u>Report Title</u>	<u>Date</u>
1.	Report On Main River In Vicinity Of Mouth (Navigation)	1879
2.	Report On Main River (Navigation)	1884
3.	Report On Main River (Navigation)	1886
4.	Report On Main River, Zanesville To Dresden (Navigation)	1889
5.	Report On Main River, Zanesville To Dresden (Navigation)	1895
6.	Report On Main River From Zanesville To Coshocton (Navigation)	1902

<u>Report Title</u> (continued)	<u>Date</u>
7. Report On Main River In Vicinity Of The Mouth (Navigation)	1905
8. Report On Main River And All Tributaries (Flood Control)	1916
9. Report On Mohican River And Tributaries (Flood Control)	1931
10. Official Plan For The Muskingum Watershed Conservancy District, Volumes I and II	October 1934 Amended April 1935 Revised June 1935
11. Muskingum River 308 Report	December 1934 Revised Jan. 1942
12. Comprehensive Report On Reservoirs In Mississippi River Basin	August 1935
13. Ohio River 308 Report	August 1935
14. Major Dams And Hydro-Projects In The Huntington, West Virginia And Zanesville, Ohio Engineer Districts	November 1937
15. Analysis Of Design	Revised 1937
16. History And Development Of The Muskingum Watershed Conservancy District Project	March 1938 Revised March 1939 Revised July 1952
17. Analysis Of Hydrologic Data For Index Areas - Muskingum River Basin, Ohio	April 1942
18. Flood Control Operation - Flood Of Dec. 1942-Jan. 1943 - Muskingum River Reservoirs, Ohio	February 1943
19. Channel Capacity Investigation Muskingum River, Ohio	May 1944
20. An Experience History Of The Muskingum River Reservoir System	October 1951
21. Instructions to Project Supervisor, Leesville Lake	November 1953 March 1954
22. Water Inventory Of The Muskingum River Basin And Adjacent Ohio River Tributary Area	1968
23. Periodic Inspection, Leesville Dam	
Report No. 1	August 1968
Report No. 2	July 1973
Report No. 3	July 1978
Report No. 4	July 1983
Report No. 5	July 1988
Report No. 6	July 1993
Report No. 7	July 1998

Report No. 8

July 2003

<u>Report Title</u> (continued)	<u>Date</u>
24. Muskingum Area, Emergency Operation Plan	March 1970
25. Post-Flood Report, Muskingum River Basin, Ohio - Flood Of July 1969	April 1970
26. Instructions To Project Supervisor	November 1970
27. Operations And Maintenance Manual	January 1973
28. Muskingum River Basin, Ohio - Basin Report	September 1973
29. Muskingum River Dams, Spillway Adequacy Study	April 1975
30. Muskingum River Basin, Ohio -Interim Feasibility Report For Water Resources Development	November 1975 Revised March 1976 Revised Feb. 1977
31. Muskingum River Reservoirs General Plan Of Reservoir Regulation	October 1976 Revised Oct. 1984
32. A Valley Renewed - The History Of The Muskingum Watershed Conservancy District	1976
33. Southeast Ohio Water Plan	September 1978
34. The Construction of the Precast Concrete Wall Panel and Roadwork, Leesville Lake	July 1983
35. History of Remedial Measures	February 2000
36. Dam Safety Training Program Manual, Leesville Lake	2003
37. Report on 2001 Sedimentation Survey Supplement No. 31 to Design Memorandum	20 April 2004
38. <a href="#">MWCD Amendment to the Official Plan</a>	11 Jun 2005
39. <a href="#">Muskingum River Basis Systems Operation Study</a>	March 2006

#### 1-04. PROJECT OWNER.

The Muskingum Watershed Conservancy District originally had full title, ownership, and fee control of all Muskingum Reservoirs lands, including Leesville Lake. The United States Government reimbursed the MWCD for most of the surrounding land and now owns the dam and operating structures.

#### 1-05. OPERATING AGENCY.

The Huntington District, Water Resources Engineering Branch has various responsibilities as specified in [Great Lakes and 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 Leesville 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 Management 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.

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

<b>Contact Information</b>	
Leesville Lake 5037 Deer Road, SW Bowerstown, Ohio 44695-9621	Telephone: (██████████) Fax: ██████████ Damtender's Cell Phone: ██████████

1-06. REGULATING AGENCIES.

The Huntington District, Water Management Section is responsible for regulating the project under the following regulations:

- (1) [EM 1110-2-3600](#) 30 November 1987  
Subject: Management of Water Control Systems.
- (2) [ER 1110-2-1400](#) DAEN-CWE-Y, 30 September 1993  
Subject: Reservoir Control Centers.
- (3) [ER 1110-2-240](#) DAEN-CWE-Y, 8 October 1982  
Subject: Reservoir Control Centers.
- (4) [ORDR 1110-2-27](#) 12 January 1976  
Subject: Water Control Management Activities.
- (5) [ER 1110-2-8154](#) DAEN-CWE-Y, 31 May 1995  
Subject: Water Quality and Environmental Management for Corps Civil Works Projects,
- (6) [ORDR 1110-2-26](#) ORDED-W, 5 February 1979  
Subject: Water Quality Investigations and Control Activities.
- (7) [ER 1110-2-240](#) DAEN-CWE-Y, 8 October 1982

Subject: Water Control Management.

## SECTION II - DESCRIPTION OF PROJECT

## 2-01. LOCATION

The Leesville Lake damsite is located in Carroll County, Ohio, on McGuire Creek near the junction of McGuire Creek and North Fork of McGuire Creek, approximately 1.4 miles above the confluence of McGuire Creek with Conotton Creek and 196.4 miles above the mouth of the Muskingum River. The dam is located approximately 17 miles east of New Philadelphia and 1.5 miles northeast of Leesville, Ohio. The Leesville Lake drainage area is shown on [Plate No. 2-1](#). The McGuire Creek drainage basin is shown on [Plate 2-2](#).

## 2-02. PROJECT PURPOSES

Leesville Lake was authorized for flood control and allied purposes by the Official Plan for the Muskingum Watershed Conservancy District and was authorized for construction by the Public Works Administration on 20 February 1934 under the provisions of the National Industrial Recovery Act. The allied purposes include water conservation for general recreation, and fish and wildlife management. The Flood Control Act of 1939 contained a provision that the Muskingum River Basin dams and reservoirs be included in the comprehensive flood control plan for the Ohio River Basin. Benefits from specific project purposes serve not only local interests in the Tuscarawas River Basin, but also the overall Muskingum and Ohio River Basins.

## 2-03. PHYSICAL COMPONENTS.

a. General. Flood control structures at Leesville Lake include a rolled fill earth dam with the outlet works located in the right abutment and an uncontrolled concrete lined spillway located in the left abutment. General details of the dam, spillway, and outlet works are shown on [Plate No. 2-3](#).

b. Embankment. The embankment is a rolled earthfill structure with impervious core and a maximum height of 74 feet. The crest length is 1695 feet at an average elevation of 990.0. The upstream earthen embankment slopes vary from 1 on 2 to 1 on 4½. Dumped riprap slope protection is provided to an elevation 5 feet above the conservation pool level, with grass above that level. The downstream slope varies from 1 on 2 to 1 on 3. A rock toe is provided for seepage control and protection against tailwater. The entire downstream slope above the rock toe has grass protection. The embankment details are shown on [Plate No. 2-4](#). In 1984, a 4 to 5 foot high concrete parapet wall was added to the upstream crest of the dam, raising the effective top of dam to elevation 995.1. The details of the 1984 addition are shown on [Plate No. 2-5](#).

c. Spillway. The spillway is located in a natural saddle to the left of the left abutment. It is a trapezoidal open cut lined with concrete anchored into rock. The spillway is 70 feet wide at the base, and the entrance is flared at the crest to a width of 150 feet. Weep holes are provided in the concrete walls. A pilot trench 6 feet wide with random materials on each side directs the low flows in the center of the channel. Details of the spillway are shown on [Plate No. 2-6 and 2-7](#).

d. Outlet Works. The outlet works are located in the right abutment and consist of an approach channel, an intake tower, a concrete-lined tunnel 430 feet long, an open cut conduit section, a stilling basin, and an outlet channel to return water to the original stream below the dam. To maintain the conservation pool, two 1.5 foot diameter siphons are located in front of the two outer gates, discharging into the middle conduit below the gates. General details of the outlet works are shown on [Plate No. 2-8](#).

The intake structure consists of a reinforced concrete substructure and brick and stone superstructure which house the gate operating machinery. Access to the intake structure is provided by a service bridge from the embankment. The intake structure contains three 3.5-foot x 7-foot slide-type service gates which discharge into a 7-foot diameter horseshoe tunnel. Details of the outlet works are shown in [Plates No. 2-9, 2-10 and 2-11](#).

The stilling basin structure is a shallow pool constructed in a trapezoidal cut. Below the tunnel, the channel is flared to reduce the depth of flow at the entrance of the stilling basin. The stilling basin is concrete lined with its floors and walls anchored into rock. Two rows of baffle piers were constructed for energy dissipation, and drain holes were provided to relieve uplift pressures. Details of the stilling basin are shown on [Plate No. 2-12](#).

e. Operating Machinery.

(1) Slide Gates. The three 3.5 foot x 7 foot sluice gates are raised and lowered by means of a threaded shaft and geared revolving nut driven by a 7.5 hp, 220 Volt AC, 3 phase, 60 Hertz electric motor. The hoist is controlled by a magnetic reversing controller which is energized by the raise-stop-lower push button control assembly mounted on the hoist. A gate position indicator is located on the gate stem extension cover, visible from the operator position at the controls. General layout of the operating house and machinery is shown on [Plate No. 2-13](#).

(2) Auxiliary Power Unit. The standby emergency diesel generator is located on [REDACTED]  
[REDACTED] This was put into operation 9 December 2004.

2-04. RELATED CONTROL FACILITIES. N.A.

2-05. REAL ESTATE ACQUISITION.

Real estate purchases for the Muskingum River Basin projects were initiated by the Muskingum Watershed Conservancy District (MWCD) in 1935. Lands needed for construction were purchased initially, followed by those lands that would be damaged most quickly by operation of the dams for flood control. The money for these land purchases came from a combination of funds appropriated by the state, and from the sale of Conservancy District warrants issued in anticipation of the assessments to be made on benefited property. In general, lands purchased in fee title included all lands within the limits of the conservation pool level, all lands to be used for construction purposes, those lands adjacent to the conservation pool on which the directors wished to control development, and lands which would be subject to frequent flooding due to the operation of the dams. In cases where a large portion of a farm unit was subject to the conservation pool or frequent flooding, the whole farm unit was purchased in fee title. Flowage easements were generally acquired on lands that were outside the limits of the conservation pools. In the Leesville Lake area, the Muskingum Watershed Conservancy District owns approximately 3,627 acres in fee title, and the Corps of Engineers owns approximately 161 acres at the damsite in fee title. Figures for the acreage acquired for easements by MWCD are not available, but the Corps of Engineers has acquired easements for approximately 4,001 acres at Leesville Lake.

2-06. RECREATION AND PUBLIC USE FACILITIES.

All recreational facilities are controlled by the Muskingum Water Conservancy District. The waters and the lands surrounding them are the property of MWCD. Recreational activities available at Leesville Lake include camping, fishing, boating, canoeing, picnicking, hunting and trapping. Leesville Lake has over 200 public campsites in quiet wooded areas, most with electric hookups. Fishing cabins are also available at Leesville Lake. There are two marinas offering boat and motor sales, service and rental, as well as boating supplies, lunch counter, bait and tackle, licenses, boat docking and free public launching ramps. Tables and grills are available at picnic areas near the dam. Additional facilities include an expansive sandy swimming beach with changing rooms and a wooded nature trail.

Boating activities include motorboating, sailing, waterskiing and fishing. Leesville Lake has a full service marina with boat and motor sales, service and rental, as well as food service, boating supplies, bait and tackle, and licenses. The marina offers boat docking, and nearby free public launching ramps.

The boating, fishing, and water related activities normally occur on the summer conservation pool at elevation 963.0. The reservoir has a summer surface area of 1,000 acres and a capacity of 19,500 acre-feet. The backwater along McGuire Creek at this elevation is 4.6 miles. During the winter the normal pool is lowered to elevation 958, giving additional flood storage at the maximum flood control pool elevation 977.5. The maximum 977.5 pool inundates 1,470 acres, and has a total capacity of 37,400 acre-feet, with a length along McGuire Creek at elevation 977.5 of approximately 5.5 miles. This pool elevation has never been approached as the pool of record for Leesville Lake is elevation 969.6 during the April 1948 flood.

Above Leesville Lake on the larger fork of McGuire Creek are two related upstream recreation lakes. These two small lakes, Stoney Lake and Vocross Lake are private fishing lakes which drain into Leesville Lake.

MWCD lands at Leesville Lake are open for Ohio hunting seasons between Labor Day and Memorial Day. No hunting is permitted at highly developed areas such as parks and cottage areas. A strip of MWCD land, 100-feet wide adjacent to the shoreline and all islands are perpetually dedicated to public use. The recreational facilities at Leesville Lake are administered by the Muskingum Watershed Conservancy District. The locations of recreational facilities at Leesville Lake are shown on [Plate No. 2-14](#).

## SECTION III - HISTORY OF PROJECT

## 3-01. AUTHORIZATION

Leesville Lake was authorized for flood control and allied purposes in the Huntington District by the Flood Control Act of 1938, 75th Congress, 3rd session Public Law No. 75-874. The preceding legislation was accompanied by House of Representatives Report No. 2353, which included a previous report titled "Comprehensive Flood Control Plan, Ohio River Basin", submitted 12 November 1937 by the Ohio River Division Engineer.

Additional legislative authority includes the authorizing act; the Flood Control Act of 1944, PL78-354 as amended; the Fish and Wildlife Coordination Act of 1958, PL85-624; the Federal Water Supply Act of 1958, PL85-500; the Forest Conservation Act as amended; the Federal Water Project Recreation Act; and, the Water Resources Planning Act. The general map of the Corps of Engineers, Huntington District, showing the Muskingum River Basin and the Leesville Lake project is shown as [Plate No. 3-1](#).

## 3-02. PLANNING AND DESIGN.

The first inhabitants of the area were the Fort Ancient, the Adena, and the Hopewell mound builders and later the Delaware and Tuscarawas tribes. Most of the villages were located near a good water supply, connected with trails used for portage between rivers. The first Europeans in the area were French explorers, including Robert LaSalle in 1669. LaSalle called the great river simply "The Belle Riviere". The Iroquois name was "Oyo" or "Beautiful River" which became corrupted to "Ohio". Canada and the "Ohio Country" soon became the prize overseas fur trading paradise in a bitter, intermittent, century long, world-wide power struggle and war between France and England. Through a series of treaties, trades, trickery, treachery, trinkets, rum, and raids the English finally eliminated French control of the area in 1763. Until this time most Europeans in the "Ohio Country" had been traveling missionaries and explorers, like Christopher Gist and Johnny Appleseed, scattered fur trappers, and a few French or English soldiers. Before the 1770s the so called "Ohio Country" was still a wilderness.

German speaking Moravian missionaries John Heckewelder and Frederick Christian Post came to convert the indigenous population in the early 1760's. Frederick C. Post had built a cabin near the present site of Bolivar, and later John Heckewelder founded the village of "Gnadenhutten". In March 1771 the third Moravian, David Zeisberger, preached the first protestant sermon west of the Allegheny Mountains to a Delaware Tribe near present day Newcomerstown. On 24 August 1772 Zeisberger laid out "Schoenbrunn", the first village and church in the Ohio territory, near New Philadelphia. Soon a school opened and records indicate that over four hundred native Americans attended classes and church at Schoenbrunn.

During the Revolutionary War the peaceful Moravian villages tried to remain neutral, but they were constantly harassed by other more warlike pro-British tribes. Because of the unstable situation Schoenbrunn village had to be abandoned in 1777. In 1778 General Lachian McIntosh built an American fort in the Ohio territory at nearby Bolivar. Despite the fort by 1781 the Moravians and their followers had to leave the Tuscarawas valley for the more secure Sandusky valley. In March 1782 they were permitted to return to the Gnadenhutten area to harvest the leftover crops. After gathering their corn the native Americans were attacked by a group of Pennsylvania soldiers and 96 were brutally murdered. The shock and aftermath of this Gnadenhutten massacre kept the Moravians and the converts away from the area until 1797.

The Colonists battled the English for seven years from (1775-1782), and aided by the French, finally won at Yorktown (1782) leaving the eastern colonies in control of all the land west of the mountains to the

Mississippi, and south of the Great Lakes. Following the Revolutionary War this great mass of land between the Great Lakes and the Ohio River was first organized by the Continental Congress Ordinance of 1784 and by a stronger second ordinance on 13 July 1787 into the vast Northwest Territory.

The first permanent American settlement in the territory was the landing of a group of 48 people led by General Rufus Putnam in the "Adventure Galley or Mayflower" at the mouth of the Muskingum River at Fort Harmar, now the city of Marietta, on 7 April 1788, one year before George Washington was inaugurated as President. The post-war westward land rush began, and soon there were 125,000 pioneers west of the Allegheny and Appalachian Mountains.

As the settlements extended up the tributary streams from Lake Erie and the Ohio River food was provided locally, with course salt the major imported item. The strong need for security, protection, transportation, and access to eastern cities for markets and imports became obvious. This led to the first trail marking and clearing, later wagon paths, haul roads, wharfs, ferries, wells, forts, and new villages.

In the northern Tuscarawas Basin settlement was mostly by New England colonists and Revolutionary War veterans, seeking good cheap land in the Western Land Reserve, bestowing old and new names such as Dover, Kent, and Bath. In the middle and southern portion of the Tuscarawas Basin the settlers came along the old Braddocks and Forbes Roads from western Pennsylvania and Maryland, to East Liverpool and Steubenville; then up Beaver or Yellow Creek and over the divide to Sandy and "Indian Fork of Kannotten Creek" now Conotton Creek. These were the Pennsylvania Germans, "Deutsche or Dutch", Scottish, Swiss, Welsh, and Amish farmers that brought with them the careful farming and road building practices still found today in Carroll County. An early pioneer, Jesse Palmer, settled on or near the mouth of "Kannotten Creek" now Conotton Creek about 1800. Eventually the new Congress authorized the frontier explorer Ebenezer Zane to mark or blaze a trail across "Ohio" from Wheeling, Virginia to Maysville, Kentucky. Where this trail crossed the Muskingum River, at the Licking River junction became Zanesville, founded in 1796, and the Hocking River crossing became Lancaster. By 1804 John Knisely founded the village of New Philadelphia and Michael Uhrich settled on a 1,500 acre tract on Stillwater Creek. Two years later Uhrich built a dam and sawmill which attracted several settlers who called it Uhrichville. In 1805 settlements upstream on Nimishillan Creek became Osnaburg, later East Canton, and Canton proper. The next year Bazarell Wells, the village patron platted Canton on Nimmeshillan Creek. The next year came settlements downstream at Dover, and just outside the basin at Middlebury or later East Akron on the Little Cuyahoga River, along with Kent, Steubenville, and Ravenna. Then came the founding of two huge counties, Tuscarawas and Stark, both in 1808. Stark county was created first on 13 February, a month before Tuscarawas County on 15 March. However, Tuscarawas County was organized immediately with a county seat at New Philadelphia and while Stark County had to wait till the next year to organize at Canton. The village nearest the dam, Leesville, began in August 1812. Soon came Centerville, later to be Carrollton, in October 1815, and then the new German religious village of Zoar in 1817. The city of Akron started in 1825, and then Massillon in 1826.

By this time several leaders on upper Conotton Creek wanted the local center of government to be closer to home, instead of 20 miles away at New Lisbon. Isaac Atkinson had moved to Centerville about 1820, a village that had been founded by Peter Bohart in 1815. Upon Mr. Boharts death in 1825 Isaac bought his estate and began his great legal quest for a new county. The new county would come from small parts of five adjoining big counties (Stark, Tuscarawas, Harrison, Belmont, and Columbiana) with the county seat at Centerville. This new county was formed on Christmas Day, 25 December 1832, with the new county name and county seat, Carroll and Carrollton, taken from Charles Carroll of Carrollton, the oldest living signer of the Declaration of Independence. The bulk of the legal and lobby work was accomplished by Isaac Atkinson, who spent about \$7,000 (1830 dollars) of his own money for the many trips to Columbus to

pressure, persuade, or "lobby" the state legislature.

The population of the new county was about 15,000 in 1830, with the 1840 census returning 18,108. The population growth was very slow by modern trends, however it had a 70 percent growth in 160 years to 25,000 in 1980. This would indicate that many of the residents were transients waiting for the ideal time for the next move further west or to a big city.

From this early settlement, expansion, and growth came the dependence and use of the surface waterways for personal, agricultural and urban consumption, transportation, and primitive water power. The early narrow dirt trails followed the native trails, but when they were widened into logged-out haul roads they were only passable for a light horse wagon in warm dry weather. During wet weather the mud holes were axle deep. These log-roads needed steady maintenance and protection for public travel, and there was none. The only alternative, especially for heavy freight, was by packhorse or boat. Therefore, the early Muskingum settlers quickly saw the obvious need for water resource development, safe water access and supply, flood protection, and open river channels as the communities grew from a wilderness.

The development of the Tuscarawas Basin water resources came in four overlapping phases. The first phase following settlement and the location of a water supply was the building of water powered grist mills which led to the construction, peaking, and then quick decline of the inland barge canal system. The first Muskingum Dam was built at Zanesville in 1816 by the Zanesville Canal and Manufacturing Company for water power and navigation. The work on making the Muskingum River navigable to Zanesville began with a new steamboat, aptly named the "Rufus Putnam", making the first trip to Zanesville on 9-10 January, 1824. After five more years the steamer "Mary Han", soon followed by the "Tuscarawas" and the "Zanesville-Dresden Packet", maneuvered up to Coshocton and the Muskingum River was conquered.

At the same time as the first steamboat trip to Zanesville plans for the Ohio Canal Commission quickly evolved in order to copy the Erie Canal in New York. The work was begun on 4 July 1825, and was opened for horse-drawn boats on 1 December 1832, about ten months after the record February 1832 flood. This is the same time period as the development of Carroll County by Isaac Atkinson. The mighty Ohio Canal cost about \$7.9 million, employed about 28,000 people during full operation, and was considered a great project for that day, rivaling the mighty Erie Canal from Albany to Buffalo. The Ohio canal connected Lake Erie to the Ohio River and was a tremendous boost for many Ohio cities including Tuscarawas-Carroll County. The Canal Commission adopted a book of 139 by-laws for canal operation including a top speed limit of 4 miles per hour, strictly enforced.

Because of all the new canal activity the canal lock stations soon became shipping centers which attracted settlers and then became villages like Port Washington, Port Clinton, and Lockbourne; while 25 year old Dover changed its name to Canal Dover. The Carroll County-Conotton Creek tributary was close to Lock 13 or Lockport, with Sandy Creek at Lock 7, or Bolivar.

While the Ohio Canal was being built, the same people began developing the Muskingum River for slackwater steam navigation. By 1828 the merchants of Zanesville wanted another dam built whose pool would connect with Dresden and the new Ohio Canal. The Ohio State Canal Commission authorized this in 1832 and two years later the dam was built at Symmes Creek. This led to the next major phase of water resources development in the Muskingum-Tuscarawas Basin with a series of ten dams and eleven locks and channels being built from Marietta to Zanesville. The settlers of Carroll County would connect with the steamboats by poling down Conotton Creek, take the canal to Coshocton and Dresden, and ride a steamboat to the outside world.

The Ohio Canal soon created such enormous enthusiasm and prosperity that everyone wanted a canal. This desire for improved canal transportation caused the state to begin spending heavily for additional and even unnecessary canal construction. Unfortunately, none of the latter canals were as successful as the Ohio Canal.

The biggest dinosaur type canal was the Sandy Creek-Beaver Canal through northern Carroll County. This canal was a "wasted nightmare or dream too late" that cost about \$2.0 million (1840 dollars) and only had one boat make the trip from Bolivar to East Liverpool the first year, about 1850.

The Inland Ohio barge canal system expanded rapidly when many canals began using the flatbottom steamboat. The small steam boat would make the canal trip from Cleveland to Portsmouth in one-half the time, and soon the horse-drawn boat was an antique. Ohio Canal traffic and the port cities climbed and peaked and then about 1850 just as suddenly declined.

The canal was a victim of progress and was soon abandoned for the steam powered railroad. Today the remnants of the canal are still visible, several of the locks have been restored, and Roscoe Village is a restored canal tourist area at Coshocton. The Carroll County railroad started about 1849 and after four years of hard work the first horse-drawn, later steam-powered, rail car made the 10 mile trip from Oneida, where it connected with Cleveland and other northern cities. The iron horse on rails soon spread all over Ohio and the new top speed limit was about 40 MPH instead of the old 4 MPH.

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 Muskingum Basin floods of the nineteenth century are recorded in old newspaper stories and were destructive at Dover, Massillon, New Philadelphia, Newcomerstown, Coshocton, Zanesville, Dresden, Philo, and Marietta, and to agriculture and farm lands all along the valley. The first major recorded flood occurred at Zanesville in November 1810 and about every three or four years thereafter.

Following the record 1913 flood, which destroyed the Ohio Canal System, and resulted in nearly \$200 million in flood losses and the loss of 415 lives in the Ohio River Basin (14 million dollars in the Muskingum Basin), the state legislature on 18 February 1914 passed the Conservancy Act of Ohio. This Act began the third phase of Water Resources development and authorized the creation of conservancy districts which would have the power to plan, construct, administer flood control and conservation projects, issue bonds, purchase land, levy assessments and enter into cooperative contracts with the state and Federal Government for any necessary work. This was the beginning of modern basin planning, flood control, and water conservation.

Subsequently, various organizations such as the Muskingum-Tuscarawas Improvement Association, the Miami Conservancy District, and the Scioto-Sandusky Conservancy District were formed and they began promoting water resources management programs both for there basin and for the entire state.

Water resources in the Muskingum-Tuscarawas Basin now played a crucial role in economic development. As in most basins, the twin problems of excess water during winter 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 Muskingum and Ohio River Basins had long been recognized, federal investigations 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 structures built mainly for navigation purposes.

The next real step came in 1927 when two of the basin cities, Zanesville and Marietta, rather independently of each other, began a study of municipal flood control. The dominant personality at Marietta was George Maxwell, while the leader at Zanesville was Bryce C. Browning. One of the first acts of the Zanesville committee was to retain the Dayton Morgan Engineering firm to make a flood plan for the city of Zanesville. Their report concluded that it was not economically feasible to provide satisfactory flood protection for the city of Zanesville alone, but that a flood control system designed for the entire basin would also protect Zanesville. Public response to the Morgan recommendation was mediocre because of the unwillingness of upstream interests to fully participate in developing a flood control program that mainly benefited the downstream area. However, by 1930 Bryce Browning and George Maxwell had merged their studies and effort.

Prior to this time Maxwell was convinced that an integrated program of water management was needed, including land treatment measures, and small impounding structures in the upper reaches of the basin to provide flood and erosion control and water conservation. Maxwell's efforts were aided greatly by 1930-31 record drought, one of the most severe in the basin history.

Upstream cities, towns, and farms experienced severe water shortages. Low streamflow contributed to pollution problems, and led to the haunting fear that water shortages might stifle industrial recovery and regional expansion and growth even more than the 1929-33 world economic depression. All of these fears spurred a demand throughout the basin for organized integrated water management by someone to do something.

The Muskingum-Tuscarawas Improvement Association was organized in 1930 with Robert N. Wilkins, an attorney, as President and Bryce Browning as executive secretary. This revitalized organization was successful in arranging for the full study of the control and use of the water of the major Ohio River financed by the Ohio Department of Public Works in 1930.

The ODPW engaged the same Dayton Morgan Engineering Company to make a detailed survey to be completed in 1931. Major findings of this study were that a comprehensive program of water conservation and flood control for the Muskingum Basin was feasible, but it would cost over 50 million dollars, far more than could be borne by the basin population, by the State or by both. The report strongly suggested that Federal Aid be sought for the project. Flood control and water conservation, because of increasing demands for municipal and industrial water conservation, were emphasized, but pollution abatement, reforestation, and soil erosion control were also stressed in the report. Certain other phases such as irrigation, water power, or navigation facilities were given a low priority.

The study indicated that a comprehensive reservoir system would have a measurable effect in reducing flood crests and improving navigation on the Ohio River. Later, these findings had an important bearing on Federal participation in the project. The study further concluded that benefits from a comprehensive program of flood control and water conservation would accrue not only to individual property owners and municipalities, but also to the state and nation. It was also determined that the pooling of resources within cities, towns and counties within the Muskingum River Basin would not be adequate to finance a major project, and that vast state or Federal aid would be necessary. This meant that a conservancy district would be the most promising agency for developing and executing the needed program. Later in 1932 the Huntington District, Corps of Engineers, in a "308 Report" on the Muskingum Basin, came to essentially the same conclusion. "The total costs would far exceed local financial resources". The Ohio Department of Public Works, after reviewing the Morgan Report concluded that the state had a substantial interest in the program, but could not initiate it or assume primary responsibility for it. In spite of the Morgan report's strong recommendation to seek massive Federal Aid, the general mood of congress was not receptive,

therefore, the Muskingum system was still just an after dinner dream. In the meantime the country found itself in the midst of a deep stock market crash and worldwide economic depression. Because of the severely depressed economy, extensive Federal aid for flood control, other than on the Mississippi River, was an impossible dream. However, the election of a president, political party, and congress which 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, 1931, and 1934; the 1926, 1927, 1929, 1930 and 1933 floods; coupled with the national economic and financial recovery crisis; and the 1932 and 1934 elections culminated in a much broader public and legal 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 as an emergency means of combating unemployment. The Muskingum Group was one of the very first to request Federal Aid for water management. PWA officials encouraged the project, but advised that if the Muskingum project were approved, the PWA would require some legally constituted authority with which to contract for construction and operation of the project. After many frustrations, including controversy over such questions as to the exact authority to be granted and the extent of financial obligations to be assumed, the Muskingum Watershed Conservancy District was formed by court decree on 3 June 1933.

This was accomplished under the provisions of the Conservancy Act by a special common pleas court, which included a judge from each of the 18 counties in the District, and by raising \$25,000 locally for expenses. The MWCD District provided the legal process required to secure the necessary financial cooperation between the State of Ohio, the Federal Government, and communities and property owners of the District. The MWCD retained C.C. Chambers, formerly with the Miami Conservancy District, as Chief Engineer and was given broad authority to engage in all the water control functions stated in the Conservancy District Act plus such other functions as water check dams and control works to prevent soil erosion and avoid clogging of stream channels. The MWCD's authority was widened even further in 1937 to permit all phases of water management.

In August 1933, the Muskingum Watershed Conservancy District submitted a preliminary plan for the project to the Federal Emergency Administration of Public Works. The project was approved in December 1933, and the project and money was allocated to the expanding Corps of Engineers who were to oversee the construction. The approval was subject, however, to the execution of a contract between the U.S. Government and the Muskingum Watershed Conservancy District. That agreement was finalized on 6 March 1934 and signed on 29 March 1934. On this day an office was formally opened and immediately the Corps of Engineers began working on the Muskingum River.

Because of the enormous size and scope of the Muskingum Project a separate Corps of Engineers District was created solely for this job at Zanesville under the command of Colonel Joseph D. Arthur. Approximately 151 sites in the Muskingum River Basin were studied initially, with fourteen of the best sites, including Leesville Dam, selected to provide the maximum degree of flood protection and conservation improvement for the available funds. Construction of the two or three next best projects was delayed indefinitely.

The official plan was prepared in six months by the Corps of Engineers, submitted on 6 October 1934, and approved by the MWCD on 19 November 1934. The total cost of the project would be a staggering \$34 million, of which \$22 million was to be paid by the PWA. The MWCD agreed to assume the remaining \$12 million state and local costs for lands, easements, relocations, and miscellaneous administrative expenses.

The Muskingum Basin was divided into four smaller sub-basins located in the Walhonding River, Tuscarawas River, Licking River, and Wills Creek Basins. Dover Dam, with 1,405 square miles of drainage,

was originally designed to be the key reservoir in the Tuscarawas River Basin, with consideration originally given to have it provide the entire control of the Tuscarawas River. However, due to the valuable property involved and the local benefits that could be provided upstream, Dover Reservoir was designed as a large dry dam, with seven additional reservoirs selected on major tributaries of the Tuscarawas River, to provide local flood protection and reduce flood flows into and below the Dover Dam. The two major tributaries selected for upstream secondary control were Sandy Creek and Conotton Creek which contribute about 790 sq. miles or 56% of the Dover drainage area. Atwood and Leesville Lakes were built on forks of Conotton Creek, and Bolivar Dam was built on Sandy Creek, all to control flows into Dover Dam. Wolfe Creek and Chippewa Creek were bypassed. The two tributaries selected below Dover Dam were Sugar Creek and Stillwater Creek which contribute about 842 sq. miles or 71% of the downstream area. Beach City Lake was built on Sugar Creek and Tappan, Piedmont, and Clendening Lakes were built on Stillwater Creek.

The Leesville Lake site was one of four sites analyzed to provide control of the Conotton Creek Basin. One of the other three sites was the current Atwood Lake site. The other two sites were located on Conotton Creek; one at Valley Junction near the mouth of Conotton Creek, and the other near the village of New Cumberland. The Valley Junction and New Cumberland sites were abandoned due to excessive costs. A thorough reconnaissance of the lower reaches of McGuire Creek indicated that the current Leesville Lake dam site was the only feasible location for the dam. The site was located approximately 1.4 miles upstream from the mouth of McGuire Creek near the confluence of North Fork and McGuire Creek.

Studies of site surveys, foundation explorations and available construction materials indicated that the most feasible structure would consist of a rolled earth fill dam across the valley with the outlet works located in the right abutment and saddle spillway in the left abutment. Borrow pits containing sufficient quantities of suitable materials for embankment construction existed adjacent to the site. Firm rock suitable for the foundation of the outlet works existed in the right abutment. The structure and outlet works were designed to provide sufficient capacity to store 7.0 inches of runoff from the watershed between the conservation pool and spillway crest elevations.

The Federal Government, through the Corps of Engineers, was directly responsible for the construction of the 14 reservoirs and relocations of railroads and other public utilities. The Ohio Highway Department, financially aided by the Federal Bureau of Public Roads, was responsible for the relocations of highways, roads and streets. The Conservancy District purchased lands, easements and rights-of-way needed for the reservoirs, and was subsequently reimbursed for these expenditures by the Federal Government.

### 3-03. CONSTRUCTION

Construction of Leesville Lake began on 13 June 1935, with closure of the dam being accomplished on 15 October 1936. Project construction was completed on 22 October 1937. The principal contractor was Culbertson Construction Company of Cleveland, Ohio.

During construction of the embankment and outlet works, McGuire Creek was relocated to a diversion channel excavated upstream of the dam to join the North Fork channel, which was used for both forks until the outlet works was completed. An upstream cofferdam was then constructed to divert the stream through the outlet works until closure was made. Necessary relocations in the reservoir area consisted of 2.2 miles of telephone lines, 0.5 mile of electric power lines and 5.4 miles of secondary roads. The total cost of the project was \$941,000, which included portions of the cost of the Official Plan.

In 1984, the top of dam elevation was raised by adding a concrete parapet wall 4.1 feet high across the top of

the dam and by raising the road across the left abutment by 2 feet. The purpose of this construction was to correct a spillway deficiency revealed by current revised hydrologic and hydraulic design criteria. The contract for construction was awarded on 13 December 1983, and the project was completed and accepted in August 1985. The cost of the additional project was \$431,210.

### 3-04. RELATED PROJECTS

Along with the work on the Leesville project similar and concurrent work began on the 13 other dams, plus ten railroad relocations and forty-one utility gasoline relocations. Another disastrous record summer flood occurred in August 1935 which devastated most of the agriculture in central Ohio. The damage from this flood caused more people to support any possible method for flood control. Private contractors, who performed construction under the Corps supervision, were required to employ as many laborers as possible from relief rolls, because an important project purpose was to aid in recovery from the National Depression. About 58 percent of the funds on this project were paid to site labor, not including the labor necessary to produce the cement, steel and other purchased materials. The original 14 reservoirs were completed by 1938, dedicated, and the structures and facilities were deeded to the Corps of Engineers for operation on 11 August 1939 at a cost of about \$41 million, well over the original estimate. The Conservancy District retained fee title to much of the project land, while fee title to the lands required specifically for construction of the 14 dams and appurtenant structures was conveyed to the United States. The United States acquired flowage easements over the remaining reservoir land from the Conservancy District and directly from property owners. The Flood Control Act, approved 11 August 1939, contained a provision that the dams and reservoirs be included in the comprehensive flood control plan for the Ohio River Basin. The Conservancy District, assisted by the National Park Service, prepared a master plan for comprehensive development of the areas surrounding the pools for recreation and conservation use.

Two additional flood control reservoirs have been added to the Muskingum River Basin system since the 1930's. Dillon Lake was completed in 1961 and North Branch of Kokosing Lake was completed in 1972. Final settlement of cost distribution was not resolved until October 1955, although construction of the original project was completed in 1938. The MWCD retained about 36,190 acres of land adjoining the projects and were left with a final obligation of only about \$1.5 million because of changes in Federal law regarding requirements for local participation in flood control projects. The Ohio Highway Department, financially aided by the Federal Bureau of Public Roads, was responsible for the relocations of highways, roads and streets. The State of Ohio contributed about \$7 million in highway relocations and cash.

Muskingum Reservoir system now has sixteen reservoirs and five local protection projects with a total of 1,604,000 acre-feet of storage and 5,020 square miles of controlled drainage area or 62.5 percent of the total basin. Leesville Lake has a winter flood control storage area of 22,350 acre-feet. The partially completed dams were used for the first time in the great Ohio valley flood of 1937 and until 2005 the multi-reservoir system prevented or was credited with saving about \$6.4 billion. This is a cumulative year to year total figure, and the detailed process of benefit allocations to individual reservoirs is often vague and misleading. However, based on storage allocations of 1.25% for Leesville Lake the accumulated benefit total would be about \$80 million. In 2005, Leesville prevented an estimated \$11 million of flood damages. The overall benefits for the Muskingum system and the Tuscarawas River are overwhelming. Obviously, all of the Muskingum Lakes have paid for themselves on flood control alone, many times over, plus many other benefits have accrued to each project.

The final post war phase of development in the Tuscarawas River Basin was the solid growth of recreation and vacation resorts at the lakes and rivers in the area. This phase was only lightly considered when the original Muskingum Reservoirs were built, but the MWCD later built and developed elaborate facilities that

draw enormous crowds at the Atwood and Leesville Lake resorts during the summer which has produced a new industry for the basin called tourism and recreation. This led to the creation of the Ohio Department of Natural Resources in 1949 and they have coordinated with the Corps of Engineers on many water projects in this final phase of water resources and recreation development.

Before the recreational phase of the Muskingum River Basin was initiated, the National Park Service assisted the Muskingum Watershed Conservancy District in the 1940's in estimating the recreational value of the Muskingum River Basin projects. The value was estimated to be \$807,000 per year. In 2005, the value of these recreation benefits would be about \$273 million per year. Because of the proximity of Leesville Lake to nearby Canton the daily and weekend visitation is high, usually about 1.5% of the 5.5 million basin total visits. Based on the 1.5% ratio the average annual recreational benefits from Leesville Lake would be about \$4 million.

The summary and final phase of Tuscarawas River-Conotton Creek water resources development is that many public and private groups now depend on the multipurpose water projects, including Leesville and Atwood Lakes, that were developed by the COE and MWCD. The water supply of several villages, towns, and many homes within the Tuscarawas Basin now come from both underground and surface streams and lakes. Carroll county has built Lake Mohawk and the nearby city of Canton or Stark County has built Nimishilla, Cable, Meyers, and Willowdale Lakes. Barberton has built Dorothy Lake and Barberton Reservoir. Surface waters are also used by railroad, coal mining, manufacturing, and lumbering industries for producing steam, processing material, and washing coal. In addition, several villages in the Tuscarawas River Basin also have a municipal sewerage treatment plant. However, there is still a strong need for additional water supply each summer for optimum basin crop growth.

### 3-05. MODIFICATIONS TO REGULATIONS

Instructions for regulation when communications with Water Management were disrupted which were in effect at the dam inception gave Damtenders specific gate settings for releases. These instructions were modified to use Plate 7-5, the Gate Rating Curve, rather than gate settings to allow the Damtender to choose a setting closest to the desired outflow. The previous instructions are referenced as Tables 3-1, Operation Instructions to Project Supervisor, Leesville Lake, DEMIA Storms and 3-2, Operation Instructions to Project Supervisor, Leesville Lake, MIANO storms.

TABLE 3-1

**Operation Instructions to Project Supervisor, Leesville Dam, for DEMIA Storms (1 Dec to 15 Apr)  
November 1953**

**SUPERSEDED BY MAY 2006 INSTRUCTIONS LOCATED IN SECTION VII  
and  
APPENDIX B**

When a storm of flood-producing magnitude occurs, every effort, even to the extent of hiring a messenger, should be made to contact the Area Office, in order that the programs at all reservoirs may be coordinated. Use this schedule from the beginning of a rise until specific instructions are received, and also in case of emergency when communications are disrupted.

If communications are broken after receiving some instructions from Hydrology and Hydraulics Branch during high water, those instructions should be followed for as long a time as indicated when they were given, but not longer than 24 hours after they were received, or until additional heavy rain or snowmelt occurs, whichever is first. Then terminate operation in accordance with the instructions from Hydrology and Hydraulics Branch and start operation in accordance with the schedule below. Regulate the outflow according to the reservoir elevation at the "Intake" gage. When the reservoir surface rises or falls enough to shift into another range, change the outflow regulation to agree with the new range.

Range of Reservoir Elevation at 'I' Gage	Outflow Regulations to be Maintained	
	Reservoir Rising	Reservoir Falling
Below 962.5(gage height 34.5 feet)	Elevation 917.16 (gage height 2.16 feet) at W gage	Elevation 917.16 (gage height 2.16 feet) at W gage
962.5 to 963.2 (gage height 34.5 to 35.2)	All gates closed. Allow lake siphons to regulate flow	All gates closed. Allow lake siphons to regulate flow
963.2 to 963.5 (gage height 35.2 to 35.5)	Gates #1 and 3 closed. Gate #2 open 1.6 feet	Gates #1 and 3 closed. Gate #2 open 1.6 feet
963.5 to 970.5 (gage height 35.5 to 42.5)	Gates #1 and 3 closed. Gate #2 open 3.4 feet	Gates #1 and 3 closed. Gate #2 open 1.6 feet
970.5 to 977.5 (gage height 42.5 to 49.5)	Gates #1 and 3 closed. Gate #2 open 4.6 feet	Gates #1 and 3 closed. Gate #2 open 1.6 feet
977.5 (gage height 49.5 feet)	Open gates enough to hold reservoir at this elevation*	
*When reservoir surface ceases rising, decrease outflow gradually so as to hold reservoir elevation stationary, until the gate opening given in "Reservoir Falling" column is reached.		

TABLE 3-2

**Operation Instructions to Project Supervisor, Leesville Dam, for MIANO Storms (1 Dec to 15 Apr)  
March 1951**

**SUPERSEDED BY MAY 2006 INSTRUCTIONS LOCATED IN SECTION VII**

**and**

**APPENDIX B**

Maintain all gates closed allowing siphons to regulate flow except when operating in accordance with a special directive or the following instructions. When the reservoir rises to between 963.2 and 963.2 (I gage heights 35.2 and 35.5), gradually increase the outflow but do not exceed a total gate opening of 1.0 feet nor exceed elevation 919.9 (gage height 4.1 feet) at W gage. When the reservoir rises above elevation 963.5 (I gage height 35.5 feet) and until it again falls below 963.2 (I gage height 35.2 feet) regulate the outflow to maintain elevation 919.1 (gage height 4.1 feet) on the W gage as nearly as possible without exceeding a total gate opening of 1.0 feet.

If the reservoir rises above spillway elevation 977.5 (I gage height 49.5 feet), maintain elevation 919.1 (gage height 4.1 feet) at W gage as nearly as possible, adjusting gates as necessary to compensate for flow over the spillway.

If heavy rainfall occurs after receipt of a special directive when the reservoir is below elevation 976.5 (gage height 39.5 feet) operate the dam in accordance with these instructions provided for summer storms provided the outflow is not greater than directed by the special directive.

When a storm of flood-producing magnitude occurs, every effort, even to the extent of hiring a messenger, should be made to contact headquarters, in order that progress at all reservoirs may be coordinated. Use this schedule from the beginning of the rise until specific instructions are received, and also in case of emergency when communications are disrupted.

If communication is broken after receiving some instructions from headquarters during high water, those instructions should be followed for as long a time as indicated when they were given, but not longer than 24 hours after the last contact with headquarters or additional heavy rain occurs, whichever is first. Then terminate operation in accordance with instructions from headquarters and start operation in accordance with these instructions,

During periods of low flow when the reservoir falls below elevation 962.5 feet (I gage height 34.5 feet) open one gate enough to maintain the stage at the W gage at elevation 917.16 (gage height 2.16 feet)

### 3.06. PRINCIPAL REGULATION PROBLEMS

Problems associated with the regulation of the water control plan at Bolivar Dam include interests both upstream and downstream of the dam which are affected by higher than normal pool elevations. Maximum allowable outflows restrict the total outflow that can be discharged from Bolivar Dam during normal operations to protect various interests downstream of Bolivar Dam.

## SECTION IV - WATERSHED CHARACTERISTICS

## 4-01. GENERAL CHARACTERISTICS

The Leesville Lake drainage basin lies in Carroll County in northeastern Ohio, about 6 miles downstream and west is adjacent Tuscarawas County. The basin is generally oval in shape and lies in a general east-west direction. The maximum length of the basin is about 10 miles and the maximum width is about 6 miles with a 48 square mile drainage area. A map of the drainage area is shown on [Plate No. 2-1](#) and stream data for most of the Tuscarawas-Muskingum River are shown on **Table No. 4-1**.

The two largest forks of Conotton Creek are Indian Fork and McGuire Creek. Both forks now have a reservoir with Atwood dam on the larger Indian Fork and Leesville dam located at the confluence of McGuire Creek and North Fork of McGuire Creek. Both forks of Conotton Creek flow in a westerly to southwesterly direction with numerous smaller tributaries flowing into them from a north-south direction to form an overall dendritic stream pattern for the basin.

From its source at elevation 1230 to the dam at elevation 924, McGuire Creek has a total fall of 306 feet in a distance of about 10 miles. This represents an average slope of 30.6 feet per mile. North Fork of McGuire Creek has a total fall of 291 feet in a distance of 12.6 miles, which represents an average slope of 23.1 feet per mile. From Leesville Lake, McGuire Creek flows northwesterly for approximately 1.4 miles to its confluence with Conotton Creek. A profile of McGuire Creek is shown on [Plate No. 4-1](#).

The land cover in the Leesville Lake basin is mostly deciduous forest and cropland with a smaller percentage of evergreen forest.

## 4-02. TOPOGRAPHY

The Leesville Lake watershed lies within the unglaciated portion of the Appalachian Plateau physiographic province in the northeastern portion of the Muskingum River Basin. The topography is well dissected and mature, with rugged hills and broad, flat-bottomed valleys in which flood plains and terraces are prominent. At the Leesville Lake damsite the valley floodplain is about 850 feet wide. The valley walls rise on moderately steep slopes for approximately 175 feet to a well dissected upland plain.

During Pleistocene time, a series of ice sheets advanced southward over a portion of the Muskingum River Basin, with the furthest advance occurring about 18,000 years ago. The glacial border extended across the northern portion of the watershed along a line extending from just south of Canton, through Millersburg to Loudonville and then south to just west of Zanesville. The effects of glaciation on the topography and drainage of the basin were marked. Streams at that time flowed northward and were blocked by the ice, creating temporary reservoirs into which large quantities of glacial and land waste materials were deposited from the melting ice. Drainage along the main valleys was reversed, and in some places new valleys were cut into old rock divides.

The topography of the unglaciated areas is significantly different from that of the glaciated areas, although the transition between the two is rather gradual.

TABLE 4-1

**STREAM CHARACTERISTICS OF MUSKINGUM RIVER  
AND PRINCIPAL TRIBUTARIES**

<b>Station or Tributary</b>	<b>Drainage Area (mi<sup>2</sup>)</b>	<b>Elevation At Source (ft NGVD)</b>	<b>Length of Stream (mi)</b>	<b>Slope (ft/mi)</b>
Wolf Creek	77.0	1,019	13.1	5.0
Tuscarawas River at Clinton	165	1,140	28.8	7.1
Chippewa Creek	188	1,096	26.7	5.9
Tuscarawas River at Massillon	526	1,140	43.9	5.1
Sandy Creek	503.1	1,299	41.3	10.0
Conotton Creek	286	1,240	38.7	9.5
McGuire Creek	49.6	1,230	11.8	26.3
Leesville Lake	48.3	1,230	11.8	26.3
N. Fork McGuire Cr.	26.6	1,218	12.6	23.1
Indian Fork	70.3	1,116	18.9	12.1
Atwood Lake	70	1,126	18.9	12.1
Tuscarawas River below Dover Dam	1405	1,140	69.6	4.0
Sugar Creek	357	1,115	45	6.3
Tuscarawas River at New Philadelphia	1814	1,140	76.1	3.9
Stillwater Creek	485	1,180	63.5	5.4
Tuscarawas River at Newcomerstown	2443	1,140	108.6	3.3
Tuscarawas River at Coshocton	2596	1,140	129.9	3.1
Walhonding River at Coshocton	2256	1,326 <sup>1</sup>	87.7 <sup>1</sup>	6.0 <sup>1</sup>
Muskingum River near Coshocton	4859	738	2	6.5
Wills Creek	853	1,039	92.2	3.5
Watatomika Creek	234	1,105	42.6	9.3
Muskingum River at Dresden	5993	738	24	1.9
Licking River at Dillon	753	1,292	64	9.5
Licking River	779	1,292	67.5	9.1
Muskingum River at Zanesville	6850	738	44.6	1.6
Moxahala Creek	302	999	29.2	11.0
Salt Creek	145	1,020	27.1	13.1
Muskingum River at McConnellsville	7422	738	61.9	1.4
Meigs Creek	142	843	21.2	10.7
Wolf Creek	234	1,017	47.4	8.5
Muskingum River at Marietta junction with Ohio River	8051	738	111.9	1.3

<sup>1</sup> Walhonding River data includes Mohican River and Clear Fork.

Data based on published USGS Compilation, USGS Water Supply Paper, and Gazetteer of Ohio Streams.

The unglaciated areas are generally rugged and hilly with broad, flat-bottomed valleys in which flood plains and terraces are prominent. Glaciated areas show a much flatter to gently rolling topography.

Although the Leesville Lake watershed lies within the unglaciated region, effects of past glaciation are evident in the watershed. The McGuire Creek valley prior to glacial time was deeper than it is today. The valley is filled with silt and sand derived from land wastes which were deposited when the drainage outlets for the region were blocked by the ice to the northwest. At the site of the dam, the preglacial stream bed is approximately 80 feet below the existing bottom.

#### 4-03. GEOLOGY AND SOILS

The consolidated rocks now appearing at the surface in the Muskingum drainage area above Zanesville are of sedimentary origin and belong to the Mississippian and Pennsylvanian geologic systems. They dip to the southeast at the rate of about 20 feet to the mile. The Pennsylvanian formations overlie the Mississippian and occupy the eastern two-thirds of the watershed. They are made up of sandstone, shale and coal, with a few thin beds of limestone. The Leesville Lake dam site is underlain by Pennsylvanian rocks.

The valley fill at the dam site from the surface downward consists of a 6 to 8 foot silt blanket, 8 to 10 feet of silty fine sand, 6 to 14 feet of clayey silt, and 50 to 60 feet of fine to medium silty sand containing minor amounts of gravel. The spillway rests on bedrock consisting of soft to moderately hard stratified shale and indurated clay. Below these interbedded rock members lies a 30-foot bed of moderately hard, medium to coarse grained sandstone, which in turn is underlain by shale. The right abutment is made up of two thick beds of sandstone separated by 5 to 8 feet of shale.

Soils in the Leesville Lake watershed are primarily of the Gilpin-Dekalb Association. It consists of well-drained, deep and shallow upland soils which are sloping to steep. These unglaciated soils are underlain by siltstone and sandstone. More than half the area of this association is forested.

#### 4-04. EROSION AND SEDIMENT YIELD

The amount of sediment generated by a watershed depends on a number of factors including land use, physiography, rainfall and size and shape of the drainage basin. Rainfall dislodges soil particles from the earth, the first step in the erosion sedimentation process. High intensity rainfalls with large-sized raindrops produce the highest concentrations of sediment. Steep sloping land and land with poor vegetation produces high erosion and sedimentation. Larger drainage basins generally produce less sediment per square mile from a given storm than smaller basins because of the variation in land uses and rainfall rates. And the shape of a drainage basin is an indicator of the amount of bottom land available for sediment deposition before it reaches the reservoir.

Because the Leesville Lake Basin lies in an unglaciated portion of the Muskingum River Basin, its topography is generally steep, thus creating the potential for high erosion and sedimentation in the basin. However, as a result of the Muskingum Watershed Conservancy District's reforestation program, soils in the Leesville Lake Basin are being conserved and restored. Slope erosion and lake siltation are sharply reduced by these programs.

In March 1938, the Soil Conservation Service (SCS), in cooperation with the Muskingum Watershed Conservancy District, surveyed 35 sediment ranges at Leesville Lake. Monuments were installed at the range ends and ground profiles were obtained along each range. This was the initial sediment range network

at Leesville Lake. A subsequent reconnaissance sedimentation by SCS in 1939 disregarded the previously surveyed ranges, with sediment depths being measured at five new range locations in the lake area. An annual sedimentation rate of 0.26 acre-foot per square mile of contributing drainage area was estimated from this survey. A second sedimentation survey was completed at Leesville Lake in 1945 by the Corps of Engineers. Seventeen of the original ranges were resurveyed, with the profiles being compared to the original profiles. From this survey, the annual sedimentation rate was estimated to be 0.22 acre-foot per square mile of contributing area.

The next sedimentation reconnaissance study at Leesville Lake was undertaken in 1984. Lake bottom profiles within the conservation pool area were obtained at eight of the locations surveyed in 1945 in order to compare the area inundated by the summer conservation pool. Water depth was determined by fathometer, but horizontal control was not maintained. A comparison of the data from the 1984 sedimentation reconnaissance to the original ground profile data indicated that sedimentation in the conservation pool was not excessive.

The rate of sedimentation in the seasonal pool area of Leesville Lake calculated using the DTM \ Bed Contour Methods for the 64.8 year period, from October, 1936 to August, 2001 was computed to be 0.84 acre-feet per year per square mile for the 48.3 square miles of drainage area. At this rate it would take approximately 445 years to deplete the remaining capacity below the seasonal pool elevation of 963 feet. The current indicated rate of sedimentation in Leesville Lake does not appear excessive.

Topographic information collected during the 2001 resurvey extended further upstream on the south limb of the lake than the original topographic information. Survey point data at the upstream limits of the 2001 resurvey indicate the lake bottom elevation to be approximately 962.98 feet, which is the approximate seasonal pool elevation. The DTM generated for the 2001 resurveyed lake condition extends to the limits of the resurvey data, consequently, sediment volumes and resurvey lake capacity within the seasonal pool may be slightly overestimated.

Some mounding of sediment or creation of bars was noted based on the results of the August 2001 resurvey.

#### 4-05. CLIMATE

a. General. Southeast Ohio has a continental climate characterized by moderate extremes of temperature and precipitation. It is in the path of rain producing storms which move across the country in a general west-to-east direction. The storms often converge in the Great Lakes region and move through the St. Lawrence River Valley. Extreme amounts of precipitation and long periods of drought are relatively uncommon.

Climatological data for three representative locations within or near the Leesville Lake Basin are presented in **Table No. 4-2**.

b. Temperature. There are no climatological stations within the Leesville Lake Basin that record temperature data. However, temperature data is recorded at Millport, located just north of the basin.

**Table 4-2**  
**CLIMATIC SUMMARY**  
**Conotton Creek Basin**

1951 through 1960

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
<b>Normal Monthly and Annual Precipitation (Inches)</b>													
Cambridge	3.06	2.49	3.60	3.33	3.75	4.12	4.43	3.41	2.80	2.47	2.63	2.81	38.90
Cadiz	3.16	2.48	3.57	3.47	3.62	3.94	4.49	3.35	2.95	2.68	2.72	2.79	39.22
New Philadelphia	2.94	2.35	3.44	3.64	3.78	4.18	4.08	3.42	2.86	2.44	2.63	2.55	38.31
Leesville Lake	2.78	2.36	3.52	3.39	3.65	4.15	4.34	3.76	3.14	2.46	2.52	2.60	38.67
Carrollton	2.57	2.23	3.40	3.30	3.44	3.87	4.47	3.52	3.00	2.48	2.55	2.46	37.30
Millport	2.78	2.29	3.54	3.40	3.92	3.71	4.23	3.25	2.95	2.58	2.70	2.74	38.09
<b>Normal Monthly and Annual Temperature (degrees F)</b>													
Cambridge	29.30	31.20	40.90	51.00	61.00	69.40	73.10	71.40	65.30	53.90	42.20	32.60	51.80
Cadiz	29.10	30.30	39.50	50.20	61.00	69.70	73.30	71.80	65.60	54.50	41.80	31.40	51.50
New Philadelphia	24.50	26.90	38.20	48.20	59.00	68.00	71.80	70.50	63.70	51.40	41.50	30.80	49.50
Millport	25.30	27.60	37.20	48.30	57.90	66.50	70.30	69.10	62.50	51.10	40.30	30.10	48.80
<b>Normal Monthly and Annual Snowfall (Inches)</b>													
Cambridge	6.90	5.50	3.70	1.00	T	0.00	0.00	0.00	0.00	0.20	1.60	6.00	24.90
Millport*	8.00	6.80	5.40	1.40	0.10	0.00	0.00	0.00	0.00	0.10	2.70	6.30	30.80
Cadiz	10.40	8.40	6.90	2.10	T	0.00	0.00	0.00	0.00	0.30	3.60	7.70	39.40
New Philadelphia	9.10	7.20	5.00	0.80	0.00	0.00	0.00	0.00	0.00	0.10	2.00	6.20	30.40

\*Snowfall data for Millport is from 1893 to 1985

The average annual temperature at Millport is 48.8 degrees, with monthly averages ranging from 25.3 degrees in January to 70.3 degrees in July. The length of the growing season at Cadiz, east of the Leesville basin, is approximately 135 days, extending from the middle of May to the end of September. A non-recording air temperature gage associated with the H2S gage is available at the dam.

c. Precipitation. Precipitation data is recorded at Leesville Lake, Carrollton and Millport. Normal annual precipitation at Leesville Lake is 38.67 inches, with normal monthly precipitation ranging from 2.36 inches in February to 4.34 inches in July. Annual precipitation values at Carrollton and Millport are 37.30 and 38.09 inches, respectively. Snowfall data is not officially measured at any location within the Leesville Lake Basin, but data is available at Millport, northeast of the Leesville Lake basin. Based on 102 years of data taken through 1995, average annual snowfall at Millport is 30.8 inches.

d. Evaporation and Wind. For most Muskingum River Basin reservoirs, the amount of water lost by evaporation is quite small. The amount of loss attributable to evaporation from the lake surface is the difference between actual evaporation from the lake surface and the evapotranspiration from that area before

the reservoir was constructed. The average annual lake evaporation over the Leesville Lake Basin is about 32 inches. Comparison of the water surface evaporation with the water loss shows that the average increase in loss, or augmented evaporation due to the reservoir, is about seven or eight inches per year. Evaporation loss data for Leesville Lake and McGuire Fork are presented in **Table No. 4-3**.

Prevailing winds in the area are from the south and southwest for most of the year; in February and March prevailing winds are from the northwest. The mean annual wind speed, based on data from the Akron-Canton Airport, is 9.9 miles per hour. The maximum mean monthly wind speeds average between 11 and 12 miles per hour during the period November through April; minimum mean monthly wind speed is 7.4 miles per hour in August. Damaging windstorms are mostly associated with heavy thunderstorms, squall lines or large area storms.

<b>TABLE 4-3</b>		
<b>LEESVILLE LAKE EVAPORATION LOSSES SUMMARY</b>		
Average Annual Evaporation 33.1 inches <sup>1</sup>		
Average Seasonal Evaporation (May-October) 24.46 inches <sup>1</sup>		
<b>Average Monthly Evaporation Losses</b>		
<b>Month</b>	<b>Inches<sup>1</sup></b>	<b>Acre-Feet<sup>2</sup></b>
May	4.17	348
June	5.00	417
July	5.13	430
August	4.53	370
September	3.28	274
October	2.35	196
<b>Seasonal Total</b>	<b>24.46</b>	<b>2043</b>
<sup>1</sup> Vertical distance		
<sup>2</sup> 1-inch loss from conservation pool elevation 963.0, surface area 1000 acres)=82.0 acre-feet.		

#### 4-06. STORMS AND FLOODS

a. General. Most floods in Ohio are caused by precipitation of unusual intensity or of unusual duration and extent. Floods may also result from a series of ordinary storms which follow one another in rapid succession, or from rain falling at relatively high temperatures on snowcovered areas. At times, though infrequently, flood conditions are caused or aggravated by ice jams, especially in the tributary streams. Severe thunderstorms frequently cause local flash flooding. General flooding occurs most frequently during January to March, but it can occur at any time of the year.

The flooding characteristics of the McGuire Creek Basin can be partially described by comparing the highest annual floods above 1000 cfs. These are shown in **Table No. 4-4** for the water years 1944 through 2005 at the McGuire Creek below Leesville Lake gaging station. Although flows in McGuire Creek are regulated by the operation of the Leesville Lake Project, the flows in **Table No. 4-4** represent the natural flows that

would have occurred without the regulation of Leesville Lake. Annual peaks for the table are based on the water year period of October through September.

Flooding characteristics of McGuire Creek below Leesville Lake can also be described by a flow frequency curve. Such a curve for McGuire Creek at the Leesville Lake gaging station is given in [Plate No. 4-2](#). A discharge rating curve for this station is also given in [Plate No. 4-3](#). Flow duration curves for the basin just below Leesville Lake are in Plate No. 4-4, and a stream profile for McGuire Creek is shown on Plate No. 4-5. Regulation of the Leesville Lake Project has been simulated from the beginning of its operation in 1937 to 1997. Hydrographs of inflow, outflow, and pool elevation are shown in annual segments to facilitate review and understanding. The regulated outflow hydrographs derived from this study for 1962 to 1997 are shown in [Plate No. 4-4](#).

b. [Storm and Flood of March 1913](#). The storm causing this flood was general over the northern half of the Ohio River Basin, with the heaviest precipitation in the States of Indiana and Ohio. Rainfall of 1 to 1.5 inches occurred on 20 and 21 March throughout the Ohio Valley and thoroughly saturated the ground, so that an unusually large percentage of subsequently heavy rain of the main storm, on 23 to 27 March, produced rapid runoff. All flood records on the southerly flowing tributaries of the Ohio River in Ohio and Indiana were broken.

In the Muskingum River Basin the rain storm commenced just before noon on 23 March, with the rain becoming increasingly heavy for the next two days, and then continued on the 26th and in some portions of the basin also on the 27th. The total rainfall during the five days, most of which occurred in a period of 96 hours or less at individual points, averaged 6.55 inches over the Tuscarawas River Basin. No rainfall measurements are available within the Leesville Lake Basin, but at Cadiz, total rainfall for the 5-day period was 5.67 inches. As a result of the exceedingly heavy rain falling on ground already saturated by antecedent precipitation, the maximum floods of record occurred on practically all major streams in the Muskingum River Basin, and the main stream rose to unprecedented heights. The March 1913 flood caused the loss of 367 lives and damages amounting to \$14.0 million (1913 dollars) in the Muskingum River Basin.

<b>TABLE NO. 4-4</b>	
<b>McGUIRE CREEK BELOW LEESVILLE LAKE</b>	
<b>MAXIMUM ANNUAL NATURAL FLOWS (above 1000 cfs)</b>	
<b>Water Year</b>	<b>Discharge (cfs)</b>
1964	2420
1991	2300
2005	2259
1963	2210
1980	1900
1959	1655
1989	1600
1979	1580
1975	1580
1981	1530
1952	1510
1956	1500
1976	1400
1957	1300
1948	1255
1955	1190
1971	1160
1961	1120
1945	1120
1966	1115
1990	1100
1947	1100
1950	1100
1986	1035
1978	1010
1951	1000
1982	1000

c. Storm and Flood of August 1935. The storm and flood of 6-7 August 1935 was one of the largest general summer floods to occur in the Muskingum River Basin. Streams were previously raised and soil retention capacities were minimized due to heavy local showers which occurred in the basin between 31 July and 4 August. As a result, the intense rains which followed on 6-7 August produced large volumes of runoff in the watershed. This storm occurred during the construction of Leesville Dam and increased public interest for flood protection in the Muskingum Basin.

Storm rainfall averaged 4.1 inches over the entire Muskingum River Basin, with more than 8 inches falling over a 400 square-mile area in the central portion of the basin near New Comerstown, and more than 12.8 inches recorded unofficially at the storm center. This storm produced the highest summer stages of record on the Tuscarawas River below Dover, and on the Muskingum River mainstem.

d. Storm and Flood of January 1937. A series of abnormally heavy rains in late December 1936 and most of January 1937 caused a major series of floods in the middle and lower portions of the Ohio River Valley. Tributary streams in the Tuscarawas River Basin experienced successions of flood rises which moved out of the smaller rivers to accumulate in the larger rivers, resulting in increasingly higher stages and discharges after each storm. The heavy general rainfall continued periodically for almost an entire month and concluded with the heaviest storm from 14 to 25 January in which 7.93 inches fell over the Muskingum River Basin. The partially completed flood control reservoirs helped decrease the peak stages and discharges by acting as retarding basins, and again increased public support for flood protection in the Muskingum Basin.

e. Storm and Flood of February 1979. Antecedent conditions prior to moderate rainfalls near the end of February 1979 were mainly responsible for flooding conditions in the basin. Soils were frozen and a snowcover persisted over most of the Muskingum River Basin from early January to the onset of the major rainfall on 25-26 February. Snowcover on the basin ranged from approximately 6 inches in the northern part of the basin to 20 inches at McConnelsville. Based on data from Dover Dam, Carrollton, Senecaville Lake and Barnesville, the snowcover on the Leesville Lake Basin prior to the initial thaw of 20 February was estimated to be about 13 inches. Temperatures rose to above freezing for the first time in nearly 4 weeks on 20 February and, combined with rainfalls of less than 0.5 inch on 21-22 February, created rapid melting of snow and runoff and rising stages along the basin's streams. Continued thawing combined with heavier precipitation of approximately 1.5 inches over the basin on 25-26 February produced heavy runoff and considerable flooding in the Muskingum River Basin. Total precipitation at Leesville Lake for the period of 22-26 February was 1.63 inches. The basin reservoirs were utilized efficiently to reduce downstream flows and stages.

f. Storm and Flood of August 1980. Heavy rainfalls falling on saturated ground were mainly responsible for the flooding conditions experienced in many portions of the Muskingum River Basin in August 1980. The basin experienced average rainfalls approximately 150% of normal during June and July 1980. Widespread, intense thunderstorms produced the bulk of the basin's precipitation in August, with a large portion of the basin receiving more than 10 inches of rain during the month. Leesville Lake received 8.09 inches of rainfall in August. Heavy rainfalls exceeding 1-2 inches were common in the Muskingum River Basin during the storms of 2-6 August, 9-12 August, 17-19 August, and 21-22 August. Rainfalls at Leesville Lake for these storm periods were 1.85 inches, 2.64 inches, 1.78 inches, and 1.33 inches, respectively. The most notable storm in the Muskingum River Basin occurred on 10-11 August in Guernsey, Belmont, Licking, and Muskingum Counties, south of the Leesville Lake Basin. The Cambridge area received nearly 8 inches of rain in about 18 hours, and most stations in these counties received at least 3.5 inches of rain from the storm.

g. Storm and Flood of January 2005. The January flood began in late December when up to 18" of snow fell across the Scioto and Muskingum basins. This was followed by warm temperatures which caused the snow pack to at least partially melt and saturate the ground. Between 3 and 14 January 5 to 8 inches of rain fell on up to 6 inches of the remaining snow pack and already saturated ground. The storms were followed by warm temperatures, which melted the snow and produced further flooding.

## 4-07. RUNOFF CHARACTERISTICS

The McGuire Creek watershed lies in an unglaciated section of the Appalachian Plateau, and is characterized by rugged, hilly country with broad valleys which are conducive to a faster concentration of runoff. Basin runoff is highest during the winter months when storm rainfall may combine with snow melt and when frozen or saturated ground can result in very low infiltration rates. Runoff is lowest during late summer and early fall when the ground is dry and infiltration losses are high. **Table 4-5** presents average normal, maximum and minimum runoff from the watershed just below the Leesville Lake damsite, based on 55 years of record (1939 through 1993) at the USGS gage. Flow is completely regulated by Leesville Lake. A flow frequency curve is given in [Plate No. 4-2](#) and flow duration curves are shown on [Plate No. 4-4](#). The downstream natural and modified stages and flows are shown on **Table Nos. 8-2** and **8-4**, and downstream rating curves are shown on [Plate Nos. 4-7, 4-8](#), and [4-9](#).

TABLE NO. 4-5			
MONTHLY AND ANNUAL RUNOFF McGUIRE CREEK BELOW LEESVILLE LAKE			
	Average Flow (cfs)		
Month	Normal	Maximum	Minimum
January	64.2	182.3	11.5
February	67.9	210.5	10.7
March	93.8	241.6	15.5
April	95.4	219.2	31
May	68.9	158.8	21.7
June	45.5	124.3	11.2
July	27.2	92.9	5.5
August	18.3	58.3	5.8
September	17.4	48.6	3.6
October	22.3	57.8	4.9
November	58.9	128.3	8.1
December	66.6	147.2	10.9
Annual	53.9	99.2*	24.7*
*Est.			

## 4-08. WATER QUALITY

Leesville Lake was built in 1937 on McGuire Creek, a tributary of Conotton Creek, with a drainage area of 48 square miles. The lake backs water for 4.6 miles at a seasonal pool elevation of 963.0 feet (m.s.l.).

Bedrock of McGuire Creek basin is of the Pennsylvanian Period and belongs to the Allegheny Formation. It consists of sandstones, shales, and indurated clays. The valleys of the McGuire Creek basin are pre-glacial features that have been filled with silt and sand materials. Since the acidic soils of the Western Allegheny Plateau were formed over sandstone and shale, they are low in natural fertility and organic matter, and have a severe erosion potential when disturbed. The drainage basin is underlain by the lower and middle Kittanning coal beds, Ohio's major coal seam. Land use in the area was devoted primarily to woodland and farming.

Water quality data collected by the Corps of Engineers from 1974 to 1995 indicated that water quality of the basin reflected the above conditions.

#### 4-09. CHANNEL AND FLOODWAY CHARACTERISTICS

McGuire Creek has a winding flat bottom with rather steep walls that rise to a well dissected upland country. At the dam site, McGuire Creek flows westward on a flood plain approximately 900 feet wide with a general elevation of 924 feet. The creek has a normal width of 50 feet, a water surface elevation of 916 and flows close to the right wall of the valley. Time of travel of Leesville Lake dam discharge to Dover Dam is approximately 21 hours and to Marietta is 92 hours.

#### 4-10. ECONOMIC DATA

a. Population. The McGuire Creek drainage basin above Leesville Lake lies entirely within Carroll County. There are no population centers within the Leesville Lake watershed. Carrollton is the county seat of Carroll County. Based on 2000 census data, the population of Carroll County was 28,836. The town of Leesville has a population of 184.

b. Industry and Agriculture. Carroll County is one of the leading producers of evergreen trees in Ohio. Agricultural items include crops, dairy products and cattle.

Carroll County has a total land area of 25,560 acres. Of this area, approximately 41% is devoted to agriculture and 56% to woodlands. The total land and water area within the Leesville Lake recreational area is approximately 3,627 acres, or approximately 1.5% of the county area.

c. Flood Damages. Areas subject to flooding downstream of Leesville Lake along McGuire Creek consist of small farms, rural residences, and the communities of Sherrodsville, New Cumberland and Somerdale.

Damage studies have been compiled for these villages along Conotton Creek and the Tuscarawas River that indicate the average annual flood damages total about \$2.6 million (2005 dollars, converted from a value of \$540,000 1971 dollars).

Muskingum Reservoir system now has sixteen reservoirs and five local protection projects with a total of 1,604,000 acre-feet of storage and 5,020 square miles of controlled drainage area or 62.5 percent of the total basin. Leesville Lake has a winter flood control storage area of 22,350 acre-feet. The partially completed dams were used for the first time in the great Ohio valley flood of 1937 and until 2005 the multi-reservoir system prevented or was credited with saving about \$6.4 billion. Based on storage allocations of 1.25% for Leesville Lake the accumulated benefit total would be about \$80 million. In 2005, Leesville prevented an estimated \$11 million of flood damages.

SECTION V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01 HYDROMETEOROLOGICAL STATIONS.

a. Facilities. Data Collection Platforms (DCP's) located throughout the district are used to provide stream gaging and precipitation data to the Water Control System. Data Collection stations in the Leesville Lake area are described in **Tables No. 5-1** and **5-2** and shown on **Plate 2-1**. The DCPs transmit hydrometeorological data every four hours, via the (GOES) Geostationary Operational Environmental Satellite, to various receiver sites such as the one operated by Great Lakes and Ohio River Division in Cincinnati, Ohio. Satellite data from the LRD receive site is automatically sent to the District Water Control Section via the internet from LRD Water Control System at least once per hour. The District Water Management Section also has the capability of initiating a retrieval of satellite data from the LRD Water Control System. All the data entered into the Water Control System is stored in a data base and used by water control software programs, allowing timely and efficient water management decisions and generation of required reports.

Table 5-1 LEESVILLE LAKE PRECIPITATION GAGES	
Location	Symbol
Dover Dam	DOTOF
Leesville Lake	LEMD6
New Philadelphia	NPTD6
Tappan Lake	TALOF
Precipitation equipment same at all platform reported stations: Tipping bucket gage and data collection platform.	
All platforms record hourly data to be transmitted by satellite every 4 hours.	
All reporting precipitation station data can be found at <a href="https://cwms.lrh.usace.army.mil/databases/briefing/mus.htm">https://cwms.lrh.usace.army.mil/databases/briefing/mus.htm</a> or <a href="http://www.lrh-wc.usace.army.mil/wc/mus.htm">http://www.lrh-wc.usace.army.mil/wc/mus.htm</a>	

Table 5-2

**LEESVILLE LAKE  
STREAM GAGES**

<b>Gage</b>	<b>Location</b>	<b>Symbol</b>	<b>Equipment</b>	<b>Telephone Number<sup>1</sup></b>	<b>Gage Datum<sup>2</sup></b>
Lake	Gate House	LEMD6	DCP	[REDACTED]	928.0
Lake			Staff		928.0
Outflow	Left side of outflow channel	LEMOF	DCP	[REDACTED]	915.0
Outflow			Staff		915.0

<sup>1</sup>These phone numbers are For Official Use Only and should not be released to the public  
<sup>2</sup>Feet above Mean Sea Level, NGVD

Times reported are Greenwich Mean Time. To convert to Eastern Daylight or Standard Time, subtract 4 or 5 hours, respectively

DCP Data Collection Platform

All gages record hourly data to be transmitted by satellite every 4 hours

All reporting station data can be found at <https://cwms.lrh.usace.army.mil/dbases/briefing/mus.htm>  
or  
<http://www.lrh-wc.usace.army.mil/wc/mus.htm>

Staff sections on the side of the gate house, at the sill on the stilling basin wall and adjacent to the outflow building at the base of the weir are used as the primary reference for bubbler-type gage installations. Water levels are transmitted to satellite and recorded in a database.

DCPs have the capability of responding to direct telephone queries with a synthesized voice that gives the latest or current readings. The platform will list a series of readings or just the last updated reading for computers. If the platform senses that the call is not from a computer or terminal, the platform will tell the caller, using a voice synthesizer, the latest data collected at the site. These platforms have been installed at critical locations such as inflow, lake, and outflow stations along with some control point stations.

Leesville Lake project information, as requested per the Schedule for Reading Gages, is collected and submitted electronically via the internet directly to the District Water Control System and the Water Management Section of the Water Resources Engineering Branch. Data from Corps of Engineers projects is disseminated to NWS by the District Water Control System.

b. Reporting. Stage data are converted to flow, and the values are used in the forecasting process. Frequency of manual data collection and reporting is dependent on the degree of urgency imposed by the weather and/or flooding conditions as specified in Schedule for Reading Gages. 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.

Under the water control plan, Water Management personnel receive data on the runoff patterns in the Muskingum Basin from the stream gaging network and then use the water control software to analyze the data and detect impending flood danger. Predicted recessions or rises that can be used in conjunction with rainfall or snowmelt data in formulating a regulation scheme are also determined using the water control software and data from the stream gaging stations in the Leesville River Basin.

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. The Corps of Engineers and NWS cooperatively exchange stage information along with weather information as detailed in Section 5-02(b). The Corps of Engineers has installed and maintains the Leesville Lake outflow gage. In addition the National Weather Service maintains precipitation gaging stations at Tappan, Bowerstown, Jewett, Leesville Lake, Dover lake, Uhrichsville, New Philadelphia, Massilon, Genoa, Alliance and East Sparta.

Leesville project personnel include weather information with report data transmitted to the Water Management Section. The LRD water control system accesses [AWIPS](#) through NWS [River Forecast Center](#) and includes this data in nearly real-time disseminations to the District water control system. Use of the data from these reports and data exchanged with the NWS is described below.

While primary dependence is on data from the DCP network, Water Management Section personnel use National 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 aerial intensity, which contributes to improved water management decisions.

Radar images available over the internet and through the National Weather Service provide valuable information for regulation and forecasting. [QPFs](#) (Quantitative Precipitation Forecasts) issued by the NWS are available over the internet. Ohio River and tributary stage and forecasts provided by the NWS are used to answer telephone calls from the public.

c. Maintenance. Routine daily first level maintenance and repair of the stream gages is a part of the normal work assignment of the operation staff at Leesville Lake. Advanced maintenance, particularly for a mechanical breakdown, for the electronic recording equipment will be performed by the Huntington District trained technicians coordinated through the Water Management Section.

## 5-02 WATER QUALITY STATIONS

a. Facilities. A network of 7 water quality sampling stations were established at the Leesville Lake project. All primary stations within the basin are described in **Table No. 5-3**.

TABLE NO. 5-3	
Leesville Lake	
Primary Water Quality Sampling Station Locations	
Station	Distance From the Dam
LEM0001	30 Meters Below
LEM0002	60 Meters Above
LEM0003	5.9 Kilometers Above
LEM0004	8.6 Kilometers Above
LEM0005	2.0 Kilometers Above
LEM0006	4.3 Kilometers Above
LEM0007	4.0 Kilometers Above

b. Reporting. Water quality data collected at Leesville 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 Leesville Lake was structured to describe the various factors which affect water quality over the long term. Data collected are used for applications such as identification of trends which indicate problem conditions and reporting existing conditions. Basic studies consist of 5 essential components:

- (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 inflows and outflow
- (5) other biological measurements such as plankton and seston

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

c. Maintenance. Sediment and water samples are collected from Leesville 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 at the project which affect water quality.

TABLE NO. 5-4	
Leesville Lake	
Water Quality Standard Physical/Chemical Tests	
Type of Test	Reason for Testing
Calcium(Ca)	Major Cations - Ionic Balance, ratios and relationships
Magnesium(Mg)	
Sodium(Na)	
Potassium(K)	
Sulfate(SO <sub>4</sub> )	Major Anions - Ionic Balance, ratios and relationships
Chloride (Cl)	
Nitrogen (N)	Nutrient
Nitrate + Nitrite	
Ammonia	
Total Kjeldahl	
Total Organic Carbon	
Phosphorous(P)	Nutrient
Total Filterable	
Solids	Equivalent Ambient Values, Correlation with optical measurements
Total	
Suspended	
Dissolved	
Hardness	Evaluate buffer capacity and Alkaline characteristics
Metals	Important for hypolimnetic and outflow
Iron (Fe)	
Manganese (Mn)	
Dissolved Oxygen	Insitu parameters used to evaluate conditions for project operation
pH	
Specific Conductance	

#### 5-03 SEDIMENT STATIONS.

Sediment stations are no longer maintained at Leesville Lake. Sedimentation studies are conducted using GPS and sonar.

#### 5-04 RECORDING HYDROLOGIC DATA.

Each morning a full report of the previous days activities at the project will be made. This report will be sent to the Muskingum Area Office and to the Water Control Section. The Area Office then forwards a combined morning report by email to the Huntington District Office. A copy of the report is retained as a part of the permanent file at the project.

#### 5-05 COMMUNICATION NETWORK.

Telephones are installed at the District Office, Area Offices, construction field offices, and navigation lock and dam installations. These installations also have commercial cell phone service. Data collection DCP's are installed at several stream gaging stations and precipitation stations in the Muskingum River Basin. The DCP's transmit data (several readings over a period of hours) via the Geostationary Operational Environmental Satellite (GOES) to a computer downlink that is accessed by the Water Resources Engineering Branch water control system. As outlined in **Table No. 5-2**, voice DCP's have been added to streamgaging stations. Operation of the DCP-satellite network is discussed in more detail in sub-sections 5-01 and 5-02.

#### 5-06 COMMUNICATION WITH PROJECTS.

a. Regulating Office with Project Office. The telephone, fax and email are utilized for normal communications by the Water Resources Engineering Branch, Muskingum Area Office, and project personnel. District communications with individual projects normally occur through the Area Office. Cell phones are used for emergency backup communications; standard procedures require cell phones to be turned on at all times during working hours. During military emergency or national disaster, protected commercial telephone lines with the Muskingum River Basin projects may be assigned by the Emergency Operations Manager. Mobile radio, State Police, couriers, or other available means are utilized during an emergency normal lines of communication are disrupted. The U.S. Postal Service is utilized for letters, reports, or other voluminous information, pictorial material, confirmation of Special Directives and other formal communication. Occasional visits to the projects afford an opportunity for office and project personnel to discuss ideas, problems, new procedures, etc.

b. Between Project Office and Others. The Damtender communicates directly with representatives of the Muskingum Water Conservancy District in matters regarding MWCD's ownership of the waters and lands at Leesville Lake. Other communications are coordinated between the Damtender and the Area Office.

#### 5-07. PROJECT REPORTING INSTRUCTIONS.

a. Operations and Readiness Division Area Office. Leesville Lake is, for administrative purposes, included with the Muskingum River Reservoirs under the Muskingum Area Office, at New Philadelphia, Ohio. 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 Branch personnel. Emergency communication is by telephone.

b. National Weather Service. Project personnel removes a punch tape from the recording gage at the NWS precipitation station and sends it to the NWS. NWS provides mailing materials.

c. State and Local Agencies. Leesville Lake personnel coordinate in person and by telephone with MWCD personnel concerning maintenance of the lake and tailwaters. The State Highway Department coordinates details of road maintenance with the Project Office by telephone and in person.

#### 5-08. WARNINGS

At all Muskingum Reservoir Projects including Leesville Lake any anticipated disaster or sudden adverse development or problem, such as a tornado, fire, serious accident, or drowning should be reported immediately to local law enforcement agencies, local emergency services, and to both the area office and the Huntington District Water Resources Engineering Branch. Water level warnings concerning the actions of the project personnel at Leesville Lake have been compiled based on past floods.

## SECTION VI - HYDROLOGIC FORECASTS

### 6-01. GENERAL

Hydrologic forecasts of stream flows above and below Leesville Lake are vitally important to Water Control Management. These forecasts provide information which enable the optimal regulation of the projects. These forecasts are conducted under low-flow, normal flow, and flood conditions for the McGuire Creek-Conotton Creek Basin and are primarily developed by the Corps of Engineers and the National Weather Service on a daily basis. The role of the Corps and other agencies is as follows:

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 Management 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 (LRD) 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 and tributary 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 FORECASTS

a. Requirements. Whenever "flood threat" conditions approach, as defined by the [Schedule for Reading Gages](#), Plate No.B3-1, forecasting efforts primarily focus 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 Muskingum River Basin. Parts of the model are 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. During the planning stage the original reservoir storage data was computed and [area-capacity](#) and [storage](#) curves were compiled. The reservoir storage data used in the forecast model program is summarized in **Table No. 6-1**. The control stages and flows for the Muskingum River Basin are summarized in **Table 6-2**.

Table No. 6-1 Leesville Lake Elevations and Storages							
Pool	Surface Elevation	Area		Storage		Inches Runoff	
		Acres	Stream Miles	Acre-Ft Gross	Acre-Ft Net	Net	Gross
<b>Year Round Storage</b>							
Minimum (Winter)	958.0	857	4.6	14,850	14,850	5.8	5.8
<b>Seasonal Storage</b>							
Conservation (Summer)	963.0	1000	5.0	19,500	4,650	1.8	7.6
<b>Flood Control Storage</b> <sup>1</sup>	977.5	1,470	5.5	37,400	37,400	7.0	14.6

b. Methods. In order to achieve the most efficient water control management possible the [Hydrologic Engineering Center](#) (HEC) developed CWMS (Corps Water Management Software), a real-time computer model, which was adapted and calibrated for use in water management of the Muskingum River Basin. The basin computer model is a major part of the District water control system. It uses real time data from the Corps of Engineers' satellite-platform network in and adjacent to the basin, in conjunction with the tables used to interpret this data. 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 project's viability.

Table No. 6-2 Control Stages and Travel Times					
		MIANO (16 Apr-30 Nov)		DEMIA (1 Dec-15 Apr)	
Station	Stream	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)
With a Special Directive from Water Management					
Leesville Lake (LEMD6)	McGuire	4.1	205.3	4.4	261.7
Without a Special Directive From Water Management					
Leesville Lake (LEMD6)	McGuire	3.6	96.0	3.8	140.0

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 data from this model is used to route, blend and combine flows. The flows are reviewed. Outflows based upon programmed rules are modified if necessary, and this part of the model is recomputed.

5. Steps 3 and 4 are repeated to obtain subsequent forecasts that consider any additional precipitation ([QPF](#)), special regulation or other hypothetical analyses that may be required.

The real time 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 an event and analyzes the storm in detail. By using predetermined basin rainfall infiltration rates and flows the program computes the antecedent rainfall, base flow, and storm runoff.

By combining the computed storm runoff to existing flows a computed inflow hydrograph is developed. The model uses routing coefficients with routing and combining methods to route the flood through Leesville Lake and downstream. With this computer program and practical experience the Water Management Section is able to produce a reliable forecast for the Muskingum River Basin.

Stream and lake forecasting is accomplished with data stored and processed through the Ohio River Hydrologic Forecasting Center. 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 Muskingum River 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 Muskingum River Basin projects areas. The extent and intensity of the ORHFC program is shown by the fact that in addition to the project report data, all data received by NWS in the Muskingum River 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. All the data entered into the Water Control System is stored in a data base and used by water control software programs, allowing timely and efficient water management decisions and generation of required reports.

Water Control Section personnel use National Weather Service data, available between 0800 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. National 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 [QPFs](#). 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 Leesville 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 Muskingum River 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 it 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 Management Section produces weekly 30-day forecasts utilizing the same method as used for flood forecast. This forecast assumes no future rain. Lower than normal precipitation forecasts are produced by the Nation 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 Ohio Division of Natural Resources and the USGS for past drought periods, [Water Availability Studies](#) for the Muskingum River 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.

SECTION VII – WATER CONTROL PLAN  
LEESVILLE LAKE

7-01. GENERAL OBJECTIVES

The plan of water control management and regulation reflects the optimal consideration of each project purpose stated in Section 2-02: flood control, recreation, and fish and wildlife conservation. In developing the plan of regulation, the following general requirements were considered and evaluated in relation to the overall effective water control plan for the project, the Tuscarawas River Basin, the Muskingum River Basin and the Ohio River Basin:

- a. Prevent or reduce serious damages to the lands along McGuire Creek and Conotton Creek between the outlet of the dam and the upper pool area of Dover Dam.
- b. Control flooding in the Tuscarawas, Muskingum and Ohio River Basins in tandem with Dover Dam.
- c. In conjunction with Atwood Lake and Bolivar Dam, reduce pool elevations at Dover Dam.
- d. Reduce agricultural losses from minor floods on McGuire Creek and Conotton Creek to the greatest extent consistent with the safe operation of the lake.
- e. Establish a maximum allowable discharge and channel capacity to avoid downstream damages during flood releases.
- f. Limit the rate of change of the stage at the outflow station to a value no greater than that which would have occurred naturally.
- g. Maintain a continuous minimum flow in McGuire Creek to assure water quality in the stream down to the junction with Conotton Creek.
- h. Maintain a designated conservation and recreation pool of 963.0 in the summer and drawdown in the winter for flood control and vegetative control as per the annual proposal by the MWCD.
- i. Maintain concern for the safety of people, fish and wildlife habitats and the area downstream which can be affected by discharge control.
- j. During minor rises when releases are less than downstream channel capacity, limit the release rate to the maximum flow that would have occurred if the project had not been constructed.
- k. Minimize the possibility of erosion along the reservoir banks.
- l. Maintain sensitivity to reasonable requests for operational changes from other agencies.

7-02. CONSTRAINTS

The various project purposes and goals may, at times, conflict, therefore priorities have been established. Flood control is the primary project purpose followed by low flow control, fish and wildlife conservation, then recreation.

During drawdown, if possible, Atwood Lake and Leesville Lake should drawdown at different times. When both lakes are drawing down at once, Conotton Creek runs approximately half-full. Any rain results in both lakes having to close back for flood control and increases the amount of time spent in drawdown.

There is a flowage easement pin for Dover Dam at the Azalea Road Bridge one half mile below the Leesville Dam. There is a gauge on the bridge crossing the Conotton Creek on State Route 212, which the Leesville Damtender uses to remain informed about downstream conditions during high water events.

<b>Table 7-1 Leesville Impact Elevations</b>
<b>This table is current as of 1 December 2005. For updates, please refer to the Leesville Lake Water Control web page.</b>
Below 954.50: South Fork boat launch ramp unusable
Below 959.50: Clow's Marina - South Fork closes
Below 960.50: Petersburg boat landing and private docks at Hensols Landing unusable
Below 961.50: Petersburg boat landing toe exposed
Below 962.45: Petersburg boat landing in low water
Above 965.50: Launch Ramp- South Fork unusable
Above 966.00: Launch Ramp - Petersburg unusable
Above 966.90: Sewage Treatment Plant at Camp NEOSA flooded.
Above 967.00: Dock at both marinas flooded; water reaches Co. Road 22 (Petersburg Marina)
Above 969.50: South Fork Campgrounds flooded
Above 970.75: Access Road to South Fork flooded
Above 975.50: Access Road to Petersburg Marina flooded

7-03. OVERALL PLAN FOR WATER CONTROL

Leesville Lake controls discharge from the dam to the confluence of McGuire Creek with Conotton Creek. With Atwood Lake, it controls flooding along Conotton Creek to Dover Dam. In tandem with Atwood Lake, Dover Dam, Bolivar Dam and Beach City Lake, it controls flooding along the Tuscarawas River.

The lakes and dams of the Tuscarawas Basin, along with 10 other lakes and dams, form part of the flood control network for the Muskingum Basin. The Muskingum Basin, in turn, is part of the flood control network for the Ohio River.

Regulation procedures must be correlated with the operation of the other Muskingum reservoirs to the fullest extent possible. Regulation is directed to maintain roughly equal flood control storage capacity between involved projects to maximize the ability of the reservoir systems to meet potential flood threats.

Conservation pool was established during project design at 963.0 feet. In the early 1960's, it was determined vegetation in the lake threatened to decrease the overall capacity of the reservoir. In an effort to control the growth of vegetation, it was determined the lake should be drawn down to a level set by the MWCD, usually near 958.0 feet. This will cause the vegetation in the lake to die back. Once the level of vegetation has been decreased, the lake begins refill to summer pool.

Table 7-2 Leesville Lake Storage		
	<b>Lake Elevation (feet)</b>	<b>Storage Capacity (acre-feet)</b>
Streambed	920.0	0
Minimum Pool (DEMIA)	958.0 <sup>1</sup>	14,850
Conservation Pool (MIANO)	963.0	19,500
Alert Pool	967.0	23,750
Spillway Elevation	977.5	37,400
Maximum Surcharge Level	990.1	
Top of Dam	995.1	
<sup>1</sup> This elevation is determined yearly by MWCD		

7-04. STANDING INSTRUCTIONS TO THE DAMTENDER

The Leesville Lake Resource Manager (Damtender) and staff operate the project in accordance with general instructions found in Exhibit B of this manual and Special Directives issued by the Water Management Section.

- a. Regulations. The general instructions and Special Directives are written in accordance with the following regulations:
  - (a) EM 1110-2-3600 SUBJECT; Management of Water Control Systems, dated 30 November 1987
  - (b) ER 1110-2-1400 SUBJECT: Reservoir/Water Control Centers, dated 30 September 1993
  - (c) ORDR 1110-2-27 SUBJECT: Water Control Management Activities, dated 12 January 1976
  - (d) ER 1110-2-240 SUBJECT: Water Control Management, dated 8 October 1982

b. General Instructions. The general instructions apply at all times except when superseded by Special Directives that will be applicable for a specific operation or period of time. General instructions provide for routine reservoir regulation including discharge limit, details of gate operation techniques, collection and transmission of data, reservoir regulation techniques at the start of a flood before contact can be made with the District Office and emergency regulation in the event all communications fail during a flood. These instructions are also contained in Exhibit B, "Instructions to the Damtender", along with plates and schedules pertaining to their use.

c. Special Directives. Special Directives issued by telephone and confirmed by both fax and emailed signed digital copies to record all substantive guidance given the project by the Water Management Section pertaining to water control activities not covered by the general instructions. Special Directives can be issued for:

1. Flood Control
  - a. Above half of channel capacity discharge when justified by the inflow hydrograph and downstream conditions
  - b. Outflow reduction if Dover Dam is closed for downstream flood control
  - c. If directed to reduce outflow, a Directive to increase the outflow after conditions at Dover Dam warrant
2. Special Regulation for:
  - a. Construction activities
  - b. Stream clean up
  - c. Emergencies such as drowning or pollution spills
  - d. Special pool levels for fish spawning
  - e. Above season pool levels for drought relief
  - f. Inspections
  - g. Dam safety concerns
3. Spring fill or fall drawdown
4. Change in general instructions
5. Any other pertinent operation deemed necessary by the Water Management Section

#### 7-05. FLOOD CONTROL

Leesville Lake is part of the flood control system for the Tuscarawas, Muskingum and Ohio River Basins. The role of the Corps of Engineers is to decrease the peak flood stages if possible in order to reduce damage downstream from the dam. Control stages have been established at gaged locations. These control stages are shown in Table 7-3. They were determined through a channel capacity investigation which used topographic maps, aerial photos and field inspections to determine stages during high flow conditions.

TABLE 7-3 DOWNSTREAM CONTROLS				
LEESVILLE OUTFLOW ON MCGUIRE CREEK				
	MIANO		DEMIA	
	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)
Minimum Release	2.07	1.50	2.07	1.50
Maximum Release <b>WITHOUT</b> a Special Directive	3.60	96.00	3.80	140.00
Maximum Release <b>WITH</b> a Special Directive	4.10	205.30	4.40	261.70
The outflow gage is located on McGuire Creek, directly below the stilling basin on the left side of the outflow channel, about 30 yards from the end walls of the stilling basin				
Zero Elevation of the Leesville Outflow gage on McGuire Creek is 915.0' NGVD				

a. Normal Plan. The plan of operation is to gather stream flow, precipitation and lake data from the data collection platform-satellite network and the Leesville Lake project report when required. Using this data, Water Management Section personnel analyze current rainfall, soil and foliage conditions and formulate forecasts of lake pool elevations and downstream conditions. These forecasts are used by the Water Management Section to determine lake operations.

Lake operations are based on the following rules:

- 1) Subject to flood control and low flow requirements, outflow will be regulated by siphons and gates as necessary to maintain the conservation lake elevation of 963.0 feet.
- 2) Subject to flood control, the outflow is regulated to release conservation storage by drawing down to winter pool at a constant daily rate according to the MWCD schedule during the proposed period for drawdown.
- 3) Subject to flood control and low flow requirements, the outflow will be regulated to maintain a winter pool near the elevation proposed in the schedule between the proposed dates.
- 4) The pool level is raised to the summer conservation elevation according to the MWCD schedule.
- 5) For the reach below Leesville Lake, the no damage stage is set at 4.1 feet (elevation 919.1) MIANO and 4.4 feet (elevation 919.4) DEMIA on the outflow gage. All releases from the dam will be limited to these control stages. The Damtender, in consultation with the Facility

Manager, has the authority to release half of the downstream channel capacity without a Special Directive from Water Management Section (see Table 7-3) to pass flood storage if the downstream conditions allow or to begin to release flood storage if the gates have been closed to regulate the downstream stages.

- 6) In order to reduce storage at Dover Dam, when the Dover Dam pool elevation is greater than 878.0 feet, close Leesville Lake outflow to minimum.
- 7) The taking line for acquisition of lands within the Leesville Lake project area is at spillway elevation, 977.5 feet MSL. If flood damage assessment determines that damage to the upstream properties caused by the use of surcharge storage would be more than compensated by the reduction in flood damages below the dam along Conotton Creek, and the Tuscarawas, Muskingum and Ohio Rivers then surcharge storage in the pool should be utilized.
- 8) Flood control operation releases in excess of established downstream damage control elevations is within the District's discretionary authority when prudent operation requires it to protect the public from increased risk to the public due to safety concerns with the integrity of the project or the lack of ability to store additional water. The releases will be authorized through Special Directives
- 9) Following utilization of the reservoir, it is desirable to empty the reservoir of flood storage as quickly as possible, in view of the possibility of a major flood occurring at a time when the reservoir is partially filled. The lake drawdown should not exceed 3 feet per day change in pool elevation without a special directive. If the pool elevation changes more than one foot per day, monitor the reservoir rim and embankment. Report any erosion to Water Control Section.
- 10) The outflow should not be increased or decreased more than 1 foot per hour for downstream safety to control erosion along the downstream banks unless conditions indicate dam integrity is at risk as indicated in the Dam Safety Emergency Plan.

The Area and Capacity Curve and Table and Percent Utilization Tables for Leesville Lake are on [Plate 7-1](#). The gate rating curve, siphon rating curve and spillway discharge rating curve are on [Plates No. 7-2, 7-3](#) and [7-4](#), respectively. The outflow rating table is on [Plate 7-5](#). The emergency drawdown schedule is on [Plate 7-6](#).

b. Emergency Plan. In the event that all communications between Leesville Lake and the Huntington District Office are disrupted, the Water Management Section will use all available data, e.g. satellite platform data, to keep informed of project conditions and to be prepared to resume regulation instructions when communications are resumed.

If communications are disrupted, the Damtender will make every effort to reestablish communication with the Facility Manager, the Area Manager or the Water Management Section. The Damtender will assume regulation of the lake until communications are reestablished:

The project personnel operate the reservoir in accordance with the instructions below, which are also found in Exhibit B, Instructions to the Damtender.

The Damtender shall continue to operate the project in accordance with normal operating procedures outlined in Section 7-05(a), however if there is no clear knowledge of conditions at Dover Dam, Leesville should remain closed until there is positive knowledge of Dover Dam's conditions until Leesville's pool elevation approaches 977.5.

If the project was under a Special Directive, this Directive will remain in effect until the Directive has been completed, **or** 24 hours have elapsed since the last contact with the Area or Facility Managers, **or** additional heavy rainfall occurs. If these conditions cause the Special Directive to no longer be valid, the Damtender shall monitor the pool and operate in accordance with normal operating procedures outlined in Section 7-05(a), taking into account conditions at Dover Dam.

If the dam is rising and expected to exceed 977.5 and the project is not releasing channel capacity, gradually open the slide gates until the maximum seasonal outflow channel capacity of 4.1 feet in the summer or 4.4 feet in the winter in an effort to pass the inflow and keep the pool from going through the spillway.

If the pool level rises above the spillway level of 977.5 feet operate to maintain the pool elevation, opening all gates to maximum if necessary. Maintain this discharge until the pool level recedes to spillway elevation 977.5 feet then adjust the discharge to hold at 977.5 feet until communication is reestablished with the Facility Manager, Area Manager or Water Management Section.

#### 7-06. RECREATION

The observed recreation uses at Leesville Lake have included fishing, sightseeing, camping, boating, swimming, picnicking and hunting. Fishing occurs all year with increased use with lake fill in the spring. Boating occurs all year, becoming significant with the lake fill. The marina opens in April. Campgrounds open May 1<sup>st</sup>.

For all recreation purposes, it is desirable to keep the pool level as close to the seasonal level as possible. Rapid fluctuation in the pool level can result in danger from newly inundated or exposed obstacles and potential snags near shorelines and cove areas, cause difficulty in launching and retrieving boats, render camping and day use areas unusable due to flooding of access roads, sanitary facilities or grounds.

Below seasonal pool elevations may occur during any dry years due to minimum discharge and above seasonal pool elevations occur regularly with flood control operations. Project personnel evacuate recreation areas when necessary.

## 7-07. WATER QUALITY

a. **USACE Role.** Responsibility for the 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 the 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 dated 28 October 1976 which has been superseded by ER 1110-2-8154 SUBJECT: Water Quality and Environmental Management for Corps Civil Works Projects, dated 31 May 1995. Army Regulation 200-1, dated 21 Feb 1997, provides guidance on Water Management for Environmental Protection and Enhancement. Compliance with Public Law 92-500 requires that all Federal facilities be managed, operated, and maintained to protect and enhance the quality of water and land by conforming with applicable Federal, State, Interstate, and local substantive standards. Refer to Section IX for Responsibilities and Organization of Federal, State, and local agencies associated with this project.

b. **Project Operation.** An interdisciplinary approach is used to manage Leesville Lake which is a multi-purpose project that was authorized for flood control, recreation, and fish and wildlife conservation. While flood control is the primary project purpose, the other secondary purposes determine how the project is managed most of the time. Operating to achieve optimum water quality conditions is the best way to manage for secondary purposes as each has a direct relationship to the quality of the water. Unfortunately the outlet structure at Leesville Lake was not designed with maintenance or improvement of water quality, so the quality of release water is not regulated. Due to problems with water quality in the downstream area, a retrofit of the outlet structure to allow for selective withdrawal is being considered.

Monitoring water quality parameters serves as a quality assurance indicator for secondary project purposes. Water quality data is collected and reviewed by Water Management staff who make operational decisions pertaining to water quality. Current and/or expected water quality conditions for Leesville Lake are posted on the internet at <http://www.lrh-wc.usace.army.mil/home.html> for public use.

Leesville Lake elevation is maintained at 963 feet NGVD during the spring and summer. Winter drawdown normally occurs in November. Drawing the lake down any earlier could degrade habitat in the downstream areas because of temperature differences between the stream and the lake.

c. **Low Flow Augmentation:** Although low flow augmentation is not a project purpose, all federal facilities are managed to protect water quality in order to comply with Public Law 92-500. Fish and other aquatic organisms in lakes and streams require a continuous flow of oxygenated water to assure normal vitality. Prior to construction, the U.S. Public Health Service stated that natural flows in the stream below Leesville Lake were sufficient that, with primary treatment of sewage and a reasonable treatment of industrial wastes, the stream could be maintained in satisfactory condition.

Therefore a minimum discharge of 1.5 cfs was deemed sufficient as an aid to the natural flows in habitat maintenance and beneficial under dry conditions when natural flows were diminished.

Low flow control is accomplished by siphons in the outlet works when the pool level is at or above 962.25 feet. A 1.5 foot diameter siphon is located in each of the two outer conduits and both siphons discharge into the middle conduit below the gate. A rating for the siphons is provided in Plate 7-6. The siphons were designed to maintain the conservation pool under low-flow conditions without operating the gates. At winter pool elevation or other times when the pool level is below the invert of the siphons, low-flow control must be provided by partially opening the slide gate to produce a 1.5 cfs discharge.

d. **Winter Drawdown:** The timing of winter drawdown should be balanced between the need for additional flood storage and environmental needs of the watershed. It is normally scheduled to start sometime after Labor Day and finish by Dec 1.

#### 7-08. FISH AND WILDLIFE CONSERVATION

b. **Responsibilities.** In accordance with the state code, the Ohio Department of Natural Resources (ODNR) accepted responsibility for fish and wildlife conservation at Leesville Lake. ODNR shares the Corps' conservation goal of long-term well being of populations of aquatic and terrestrial species of flora and fauna common to the area and the maximum sustained enjoyment of these populations by the public.

c. **Lake.** ODNR meets the conservation requirements in the lake by: stocking of the lake; imposing size limitations as necessary; monitoring populations, reproductive success and size distribution within a species; providing a conservation officer at the lake to conduct creel surveys and fishermen interviews; and administering licensing regulations for sport fishermen.

The fish and wildlife are negatively impacted by an unstable pool during spawning, loss of pool, poor quality water and unnatural water temperatures. A stable or rising pool is necessary for fish spawning. Rises in the pool level can affect ground nesting animals living near the pool. Drawdowns affect waterfowl and mammals through elimination of shallow-area feeding grounds. Drawdowns can affect hunters, especially during duck season when shallow marsh areas are drained. Dry weather drawdowns may expose muddy lake sides and boat waves can then produce turbid water conditions an appreciable distance from the bank. This is the fertile littoral area into which fishermen cast. Fishing success suffers because the lures are not readily visible.

d. **Downstream.** Habitat maintenance, including continuous flow of clean water at proper temperature constitutes the conservation needs of the downstream aquatic community as to reservoir outflow. Lower food chain members who live on the bottom are dependant on clean rocks, gravel and sand for normal habitat. Silt and iron hydroxide, particularly under summer low flow conditions can coat this habitat, making it unsuitable. This suppresses a basic portion of the food chain and depresses populations of higher members until the habitat is improved, as by flushing, and populations of lower members are reestablished. Water in the lower zones of the lake, subject to reducing conditions common during stratification, contains iron which is soluble

in the reduced state. When this water is released and aerated in the stilling basin, the iron is changed to insoluble iron oxide by oxidation and hydrolyzed to the hydroxide mentioned above. Fish and wildlife habitat can be aided by fluctuations in the stage and flow of the stream.

e. Control Plan. In order to assist ODNR and prevent negative impacts, Leesville Dam operates the project as described in Sections 7-05b and 7-06, which fosters a stable pool. The project is operated as described in Section 7-07 to insure a minimum of 1.5 cfs of water as a stable outflow. Downstream flooding may require gate closures which would lead to a pool rise and that during an extreme drought, the lake level may fall below conservation pool elevations in order to maintain a 1.5 cfs outflow. The lake may hold an intermediate pool elevation during filling for spawning. This is coordinated between ODNR, the Corps and MWCD, and a schedule is provided to Water Management Section by MWCD each year.

7-09 . WATER SUPPLY – N.A.

7-10 . HYDROELECTRIC POWER – N. A.

7-11 . NAVIGATION – N.A.

7-12 . DROUGHT CONTINGENCY PLANS

Drought contingency plans are available in Water Management Section. Final approval for the drought contingency plan has not been received.

7-13 . FLOOD EMERGENCY PLANS

The Dam Safety Emergency Action Plan (DSEAP) for Leesville Lake is located in the project office with a copy in ED-GD. This plan includes inundation maps for spillway floods and there are standard responses to floods and other emergencies in the district. These responses are dependant upon whether or not the integrity of the dam is threatened.

a. Inundation Maps. Inundation maps have been prepared for Leesville Lake for both upstream and downstream affected areas with and without a dam failure. The maps show the time and stage associated with a hypothetical flood wave at points of interest around the dam.

b. Floods Without Dam Integrity Problems. In the course of a flood which does not threaten the integrity of a dam, the lake operations will be governed as described in Section 7-05. The Emergency Operations Center (EOC) will respond, based on the Commander's initiative, to the situation as described in policies contained in ER 500-1-1 SUBJECT: Emergency Employment of Army and Other Resources Civil Emergency Management Program, dated 30 September 2001. The EOC may ask for periodic updates of the river situation from Water Management Section and the Commander may be briefed.

Water Management Personnel will contact the Dam Safety Officer when the lake reaches the alert pool of 967.0 and will keep the National Weather Service informed of any abnormal operation of the project. The Dam Safety Officer is responsible for convening the Crisis Management Team. The District Engineer, the head of the Crisis Management Team, will open the EOC if it is determined to be necessary.

Unless embankment failure is imminent or existing, do not exceed a stage of 4.1 feet MIANO or 4.4 feet DEMIA on the outflow gage.

c. Floods With Dam Integrity Problems. When a condition occurs which requires the project to operate to protect the integrity of the dam and is, or has the potential to be, a significant hazard to life and property, the observing personnel will elevate the awareness of the situation to the appropriate individuals as designated on the “Dam Failure in Progress Condition Field Notification Chart” (the Red Sheet). Project Personnel will use the Leesville Lake DSEAP to determine what events initiate this action and which individuals to contact. The Water Management Section will be kept informed of the situation as a result of reporting requirements as defined in Exhibit B Section 3-02 (c). In the event of an existing or imminent bank failure, open all gates as rapidly as possible. Emergency drawdown schedules are graphically illustrated on [Plate 7-6](#).

#### 7-14 . OTHER PLANS

Directory of Key Emergency Personnel is located one page before the Table of Contents in this manual and can be found on the Water Management Leesville Lake web page.

Leesville Lake does not require an operational change to handle mosquitoes, debris, ice jams or the local ground water table. If necessary, these and other issues are addressed in Section 7-15.

#### 7-15 . DEVIATION FROM NORMAL REGULATION

The Huntington District Engineer is occasionally requested to deviate from the normal regulation of Leesville Lake. Approval and notification of procedures are required when deviations from the normal water control plan are deemed necessary. Prior approval for major deviations is required from the Division Engineer except as noted below. Deviation requests normally fall into one of the following categories:

a. Emergencies. Emergencies may require major or minor deviations. Normally they begin as minor deviations and, if necessary, are elevated to major deviations. The most common emergency that can be expected to occur at a project is a downstream drowning for which decreased flow may be needed while searching for the victim or increased flow which may be needed to dislodge the body. Other common accidents occurring at the project are failure of the operation facilities, search and rescue, chemical spills, treatment plant failures and other temporary pollution problems. Water control actions necessary to abate the problem are taken immediately unless such actions would result in worse conditions.

b. Minor Deviations. There are instances that create a temporary need for minor deviations from the normal regulation plan, although they are not considered emergencies. Construction accounts for the major portion of these incidents and typical examples include utility stream crossings, bridge work, and major construction contracts. Deviations are sometimes necessary to carry out maintenance and inspection of facilities. Requests for changes in release rates or pool elevations generally involve time periods ranging from a few hours to a few days. Each request is analyzed on its own merits. In evaluating the proposed deviation, consideration must be given to upstream watershed conditions, potential flood threat and the condition of the

lake, and alternative measures that can be taken. In the interest of maintaining good public relations, requests generally are complied with providing there are no foreseen adverse effects on the overall regulation of the project (or projects) for the authorized purposes. Approval for these minor deviations normally will be obtained from the Water Management Branch. Written confirmation explaining the deviation and its cause will be furnished to the division water control manager.

c. Major Deviations. A change in the normal operation of the project that does not meet the definition of a minor deviation. A minor deviation is approved by the Water Management Branch based on the authority of the Division. Change in the normal operation of the project for a period of time greater than 5 days or an elevation change greater than 2 feet. A major deviation is approved at the Division level.

Purposes for major deviations typically include anticipated drought periods which may require maintenance of additional storage in the lake for later release for downstream benefit and special pool levels for fishery enhancement. Measures such as holding a specific higher pool level during and after spawning to foster recruitment may be requested by ODNR to benefit certain species. There is typically a 2 to 3 week slow drawdown from the lake rise in May for bass spawning and a special lake drawdown in the fall for species adjustment. Each condition should be analyzed on its merits. All requests for special releases for recreation such as canoeing, whitewater or other special functions involve coordination between the Water Management Section and ODNR for evaluation. Required data on flood potential, lake and watershed conditions, possible alternative measures, benefits to be expected and probable effects on other authorized and useful purposes as mentioned above shall be analyzed and presented by digital signed copy to either the Division office or Water Resources Management Branch Chief, along with recommendations for review and approval. Except in the case of an emergency, confirmation is necessary before Water Management Section may grant a request.

#### 7-16. RATE OF RELEASE CHANGE

Outflow from regulated lakes are adjusted to reproduce flows or stages that would have been found if the lake were not regulating the flow in order to minimize downstream bank erosion. Changes in flows from Leesville Lake may not cause more than a 1.0 foot per hour change in the outflow stage below the dam. During drawdown, the lake elevation should decrease by no more than 3.0 feet per day to prevent erosion of the banks around the lake.

#### 7-17. PUBLIC NOTIFICATION AND WARNING

Public notifications of emergency releases 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 Corporate Board. The Corporate Board will authorize the release of information through the Public Affairs Office (PAO) to local news media and through the Site Manager/Dam Operator to the local immediate downstream county Emergency Operations Center. It is the intent of the District to give maximum notification to the immediate downstream County EOC when the pool elevation is forecasted to exceed the spillway elevation, when there is a dam safety issue immediately downstream, or when releases will quickly contribute to stages exceeding control immediately downstream. The Site Manager/Dam Operator will contact the immediate downstream County Emergency Operations Center at least

daily to provide an operational update or as directed by the Corporate Board. This update will include the following notification points:

- a. Status of dam and current gate positions (i.e., dam is safe and performing as designed, all gates are currently closed)
- b. Downstream condition (current O-gage reading, and any known downstream controls that are exceeded, etc)
- c. Expected stage and time of crests (lake and downstream)
- d. Remaining storage capacity of lake (in inches of precip)
- e. Critical elevations (i.e., roads, buildings) that are considered threatened by rising lake and/or downstream levels

When Water Management and the Site Manager/Dam Operator determine that the pool level will impact critical elevations, the Site Manager/Dam Operator will notify the immediate upstream county EOC to provide an operational update or as directed by the Corporate Board using same points identified above. In the event communications are lost between the project and the district office, the Site Manager/Dam Operator is authorized to make notifications based upon the Water Control Manual or for dam safety at the direction of geotechnical personnel who may be at the project.

Once the flood event has passed, and the project begins making releases, the County EOC 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.

Information primarily of public interest such as lake conditions and outflow elevations is available via the Water Management web page:

<http://www.lrh-wc.usace.army.mil/index.html>

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 its accuracy.

## 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 enhancement at Leesville Lake are presented in the following paragraphs and referenced plates. Regulation for various hypothetical design floods and for representative actual floods demonstrate the capability of the project to control and pass runoff from the drainage basin. The same capability is described in probability terms by [Plate No. 7-7](#), Frequency of Filling, and [Plate No. 8-2](#), Duration of Filling. [Plate No. 7-7](#) shows that the lake is likely to be filled to spillway elevation 977.5 once in 200 years. Effects of the water control plan on recreation, fish, and wildlife are also presented in later paragraphs.

## 8-02. FLOOD CONTROL

a. Spillway Design Flood. During the 1930's the Leesville Lake spillway was designed for a Project Design Flood with a natural peak of 28,100 cfs based on 16.7 inches of runoff, a peak outflow of 14,800 cfs, a surcharge of 10.5 feet, and 2.5 feet of freeboard. At the time of construction the present concept of a Spillway Design Flood (SDF) or a Standard Project Flood (SPF) had not yet been developed. Several years later, when the program or concept of the Spillway Design Storm (SDS) was developed and defined as the theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage area at a certain time of year, the criteria was informally applied, on an after the fact basis, to Leesville Lake. Later still, the contract for an evaluation and study of the entire Muskingum System for Spillway Adequacy and Replacement was awarded to the Dodson-Lindbloom Company of Columbus, Ohio. This detailed study was undertaken in 1975 with the overall plan of evaluating and comparing the original Muskingum System of 14 reservoirs, plus 2 added, by current 1975 criteria. The 1975 study was based on Hydromet Bulletin No. 33, defined as the theoretically greatest depth of precipitation or probable maximum 48 hour storm or SDS over a particular drainage area at a certain time of year in the eastern United States. Detailed unit hydrographs were developed from individual storms and the SDS rainfall was applied, with the storm centered over the uncontrolled area above Leesville Lake. The first pool routings were on a full pool elevation 977.5 and the second routing on a 50% half pool. The SDF was based on 22.59 inches of runoff that developed a "C" inflow hydrograph crest of 40,200 cfs, a full pool crest of 990.8 that overtopped the dam by 7-8 inches, and a peak outflow of 22,250 cfs. The half pool crest was 989.6, or 4-5 inches below top of dam, with a peak outflow of 20,050 cfs. The 1975 study shows the original Leesville Dam and Spillway is only capable of safely passing about 45.0 percent of the Hydromet No. 33 (SDF) on a full pool. Therefore, the 1975 Dodson-Lindbloom study recommended in order to safely pass the Hydromet No. 33 SDF, with a 3.0 feet freeboard, the top of the dam should be raised by 3.8 feet.

Following the 1975 Dodson-Lindbloom study the National Weather Service compiled a new design criteria for Probable Maximum Precipitation (PMP) entitled Hydromet Reports 51 and 52. Probable Maximum Precipitation (PMP) was defined as the theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage area at a certain time of year. Using the criteria from Hydromet No. 51 and 52, with a Hopbrook reduction factor, a new Spillway Design Flood was compiled for Leesville Lake by the Huntington District, Corps of Engineers. This SDF was based on 23.85 inches of runoff, a natural crest of 27,000 cfs, a "C" inflow hydrograph crest of 41,000 cfs, a pool crest of 990.1 on a 50% pool of 971.0, and a outflow crest of 21,200 cfs. This storm was the basis for the 1981 "General Design Memorandum For Correction of Spillway Deficiency" which indicated the Leesville Lake spillway was inadequate and should be raised by 5.1 feet in order to pass the SDF and have a safe 5.0 ft. freeboard.

The 1982 SDF operational hydrograph based on Hydromet 51 and 52 with a Hopbrook reduction has been adopted for this manual as shown on [Plate No. 8-4](#).

The 1982 Spillway Study was the basis for an addition of a concrete parapet wall to the upstream crest of the dam, raising the top of dam to elevation 995.1, thus correcting the obvious spillway deficiency disclosed by the 1982 (PMP) study.

Later in 1983, Dodson-Lindbloom Associates of Columbus performed a dam break study for Leesville Lake. Flood waves were determined for failure of the dam during the 1982 Spillway Design Flood (SDF) with the reservoir level at elevation 977.5 NGVD. Flood waves were also determined for the SDF without failure. The study provided estimated wave heights and arrival times at several locations downstream of Leesville Lake as well as maps of the areas inundated during the SDF with and without failure.

Current Corps criteria specify that the Spillway Design Flood (SDF) be based on the runoff from the Probable Maximum Precipitation (PMP), as indicated in Hydromet Reports 51 and 52. The CELRD further requires that a PMP used for a dambreak study must be used with an antecedent storm of 39%(PMP) for 72 hours followed by a 120 hour dry period. Leesville Lake has never been fully operated for this storm, however, the SDF-PMP operational hydrograph will be issued when it is available.

b. Standard Project Flood. At the time of design of Leesville Lake the concept of a Standard Design Flood (SDF) or a Standard Project Flood (SPF) had not yet been developed. When the SDF concept was developed, the latest criteria was informally applied, on an after the fact basis, to Leesville Lake. The Standard Project Flood concept was developed for Corps use as an overall comparison and evaluation for all projects and areas. The Standard Project Storm is defined as the theoretically greatest depth of precipitation for a given duration that is, excluding very rare possibilities, within the realm of being reasonably probable over a particular drainage area at a certain time of year in the eastern United States. The SDF was based on generalized rainfall for small drainage areas up to 1,000 square miles east of 105 degrees longitude as presented in EM 1110-2-1411, or Standard Project Flood. Later still, the Corps of Engineers made a detailed study of the maximum probable storm and flood (SPF) for all gaging stations in the Muskingum Basin of 1,000 square miles drainage area or less. This detailed study was undertaken in 1966 with the plan of overall evaluating and comparing the original Muskingum System of 14 reservoirs, by current criteria. Detailed unit hydrographs were developed from individual storms and the SPF rainfall was applied. The Leesville SPF with about 12.5 inches of runoff and an inflow peak of about 15,000 cfs, was routed on a full summer pool of elevation 963 NGVD to a crest near elevation 982 NGVD. Therefore, the original Leesville Lake and dam is capable of safely passing, within the required freeboard and with the concrete spillway, the SPF on a summer pool of 963.0 NGVD.

c. Other Floods

(1) Official Plan Flood. The Official Plan Flood ([Plate 8-3](#)) or the Reservoir Design Flood, and the Project Design Flood were part of the original criteria utilized for the design and construction of Leesville Lake. The Official Plan Flood was assumed to be the largest general flood that could occur in the Muskingum River Basin. The record 1913 storm from the Walhonding River Basin was adjusted with a proportional isohyetal rainfall pattern and converted to the Official Plan Flood for Leesville Lake. It consisted of 10.0 inches of rainfall over a period of 5 days, with a runoff factor of 90 percent.

One criterion used to determine the capacity of the outlets was the ability to pass, with one gate closed, an average of 50 percent in excess of the 500 cfs required by the desired operation of the outlets during the

Official Plan Flood. The consideration of one gate being closed was to allow for the possibility of one gate becoming immovable in the closed position, or of the inlet becoming obstructed with debris. The 50 percent increase in capacity gave a greater flexibility of operation and was considered as a safety-factor in case a large flood was not detected in advance, resulting in excess storage of flow in the early stages of the flood. The average excess in capacity was determined to be 169 percent during the Official Plan Flood, which was far above the requirements of that criterion. The operational hydrograph for routing the Official Plan Flood with current guidelines is shown on [Plate No. 8-3](#) with a pool crest of 978.1 NGVD. The key control stations, times, and guidelines for the Tuscarawas River are shown on **Table 8-1**.

TABLE NO. 8-1						
TUSCARAWAS RIVER BASIN KEY STATIONS CONTROL STAGES AND FLOWS						
Station	River	MIANO		DEMA		Time of Travel (hrs)
		Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	
Atwood	Indian Fk	10.0	670	11.0	925	
Leesville	McGuire Ck	4.1	205	4.4	262	
Bolivar	Sandy Ck	17.0	2,400	18.0	3,000	
Dover "D" Gage	Tuscarawas	6.5	4,864	7.5	6,077	0.1
Beach City	Sandy Ck	6.2	1,968	7.2	2,681	
New Philadelphia	Tuscarawas	6.5	7,563	7.0	8,379	2.2
Clendening	Brushy Ck		540		540	
Tippecanoe	Stillwater Ck	10.5	1,140	13.0	1,710	0.5
Tappan	Little Stillwater	6.5	450	6.8	590	
Urichsville	Stillwater Ck	3.5	2,230	5.0	3,090	5.5
Piedmont	Stillwater Ck	5.5	445	7.3	730	
Newcomerstown	Tuscarawas	9.5	13,580	11.0	16,690	20
Coshocton	Muskingum	15.5	21,810	18.0	30,660	30
Dresden	Muskingum	16.0	22,960	18.5	29,650	41
Zanesville	Muskingum	19.5	38,200	21.5	47,231	45
McConnelsville	Muskingum	10.0	35,100	11.0	41,290	51
Marietta	Ohio	35.0	60,000	35.0	60,000	72

The adequacy of the outlets for passing flood flows without overtopping the spillway crest was further investigated by their ability to handle the maximum flows resulting from three other hypothetical floods:

(a) A 5-day Storm Flood. This was a flood resulting from a 5-day storm which was proportional to the Official Plan Flood. The natural duration of the flood at the dam site was about 8 days, with a total runoff of 12.9 inches.

(b) A 3-day Storm Flood. This was a flood resulting from a 3-day storm, with a rainfall distribution of 25 percent the first day, 52.5 percent the second day, and 22.5 percent the third day. The natural duration of the flood at the dam site was about 6 days, with a total runoff of 11.5 inches.

(c) A 3-day Inflow Flood. This was an inflow flood with a duration arbitrarily set

at 3 days and with a hydrograph that was roughly triangular with a total runoff of 10.0 inches.

(2) Representative Floods.

(a) General. The historical floods which were selected for illustration of the water control plan are the floods of March 1913, August 1935 and January 1937. Also selected were the floods of January 1959, February 1979, and August 1980 which illustrate floods actually regulated according to the water control plan. The flood of March 1913 was caused by widespread heavy rains which resulted in record stages along the Tuscarawas River. The flood of August 1935 was caused by widespread heavy rains falling on saturated ground, and resulted in record peaks for a summer storm on many streams. The flood of January 1937, which occurred when the Muskingum River Basin reservoir system was under construction, stemmed from a series of severe storms and resulted in record stages along the Ohio River. The flood of January 1959 resulted from generalized rains with high runoff due to the saturated, frozen and snow-covered ground. The flood of February 1979 was caused by antecedent snowmelt and moderate rainfall falling on snow-covered and frozen ground. The flood of August 1980 resulted from a series of locally intense random thundershowers falling on saturated ground and already rain-swollen streams. The effects or reductions of the Muskingum system for the six floods are shown on **Tables No. 8-2, 8-3, and 8-4.**

TABLE NO. 8-2		
FREQUENCY SUMMARY McGUIRE CREEK AT LEESVILLE OUTFLOW		
Exceedence Interval (years)	Flow (cfs)	
	Natural	Modified
100	2,760	240
50	2,420	240
20	2,000	240
10	1,700	240
5	1,410	240
2	1,100	240
1	900	240

TABLE NO. 8-3	
LEESVILLE LAKE POOL ELEVATION DEVIATION	
Exceedence Interval (years)	Elevation
350	977.5
200	974.2
100	971.9
50	971.0
20	968.2
10	968.0
5	967.1
2	965.6
1	965.0

TABLE NO. 8-4				
FREQUENCY SUMMARY TUSCARAWAS RIVER AT NEWCOMERSTOWN, OHIO				
ALL SEASONS (Modified by 8 Reservoirs)				
Exceedence Interval (years)	Flow (cfs)		Stage (ft)	
	Natural	Modified	Natural	Modified
1000	137,000	66,000	25.0	18.6
500	118,000	50,100	23.5	17.0
200	94,600	33,100	21.4	14.8
100	79,500	24,100	20.0	13.2
50	66,300	18,100	18.7	11.5
20	51,500	15,000	17.1	10.4
10	41,500	15,000	15.9	10.4
5	33,500	15,000	14.8	10.4
2	25,000	15,000	13.3	10.4
1	19,200	15,000	11.8	10.4

(b) Flood of March 1913. The flood of March 1913 resulted from excessive precipitation over a comparatively large area enabling great volumes of water to be dumped into the streams throughout the Tuscarawas River Basin. The rain was exceptionally heavy through the northern sections of Ohio, amounting to 10 inches or more in some areas. Since the winter had been mild, the ground was without snow, not frozen and already saturated from the heavy rains of January and the first portion of March. In the Tuscarawas River Basin, the main storm began just before noon on 23 March, became increasingly heavy the next two days, and continued on the 26th and in some portions of the basin on the 27th. Total rainfall during the five days, most of which occurred in a 96-hour period or less at individual locations, averaged

6.55 inches over the Tuscarawas River Basin. No rainfall information is available within the Leesville Lake Basin for the storm, but at Cadiz total rainfall was 5.67 inches. The resulting flood attained record stages which still stand along the Tuscarawas River.

Neither Leesville Lake nor any of the flood control dams in the Muskingum River Basin was built at the time, but the flood has been reconstituted. The computed inflow crest at Leesville Lake was approximately 1,450 cfs on 26 March. In the reconstituted operation of Leesville Lake, the gates were assumed to be closed during the entire storm, and outflow was limited to that which passed through the uncontrolled siphons. The maximum pool level calculated for this flood at Leesville Lake was elevation 971.21 ngvd. Results of regulation of this flood are shown on [Plates No. 8-5](#) and [8-6](#).

The hydrographs shown in this and subsequent plates labeled "natural" represent the flow conditions that would exist without the Leesville Lake Project, and those labeled "modified" represent the inflow conditions that exist with the project. The outflow hydrograph represents the regulated outflow from Leesville Lake.

(c) Flood of August 1935. The flood of 6-7 August 1935 is one of the largest general summer floods to affect the Muskingum River Basin. A series of storms from the end of July through 4 August raised basin streams and decreased soil retention capacities. Heavy rainfalls fell on 6 and 7 August, averaging 4.1 inches in less than 12 hours in the Muskingum River Basin. Extreme rainfall intensities of 8.7 inches were recorded near Newcomerstown, and below the Conotton Creek Basin, near the storm center an unofficial measurement indicated 12.8 inches of rainfall in the 12-hour period. As a result this storm created large runoff volumes which produced the highest summer stages of record on the Tuscarawas River below Dover and on the main stem of the Muskingum River.

Construction at Leesville Lake had just begun when the flood occurred, but the flood has been reconstituted. Two major inflow peaks occurred at the dam; one of approximately 1,370 cfs on 3 August and a smaller one of approximately 1,220 on 7 August. In the reconstituted operation of the dam, the gates were opened to pass the MIANO channel capacity during the first inflow peak, then closed on 4 August to limit outflow to that which passed through the siphons during the second inflow peak. The gates were then reopened on 12 August to the MIANO channel capacity to draw down the flood pool. The maximum pool level calculated for this flood was elevation 967.95 on 10 August. Results of regulation of this flood at Leesville Lake are shown on [Plates No. 8-7](#) and [8-8](#) for Dresden, Ohio.

(d) Flood of January 1937. A series of abnormally heavy rains, centered largely in the middle and lower portions of the Ohio River Valley, began late in December 1936 and continued through most of January 1937. These rains caused a series of floods along the Ohio River that were greater than any known since the settlement of white men. The Tuscarawas River Basin, which was situated to the northeast of the center of maximum precipitation, experienced less severe flooding. Tributary streams experienced successions of flood rises which moved out of the smaller rivers to accumulate in the larger rivers and caused increasingly higher stages and discharges in them. The heavy general rainfall continued for almost one month and concluded with the heaviest rainfall of the period in the storm of 14 to 25 January in which 7.93 inches fell over the Muskingum River Basin and produced damaging floods. The flood control reservoirs in the Muskingum System were partially completed and helped to decrease the peak stages and discharges downstream by acting as automatic retarding basins.

The flood of January 1937 has been reconstituted at Leesville Lake. The computed inflow peak of approximately 4,200 cfs occurred on 24 January, with smaller inflow peaks of 1,000 - 2,100 cfs occurring on 14, 18, and 21 January. In the reconstituted operation of the dam, the gates were opened to pass the DEMIA

channel capacity discharge for the peaks of 14 and 18 January, then closed on 21 January to store inflow from the remaining two inflow peaks of 21 and 24 January. At the time the gates were closed on 21 January, the pool had risen from the minimum designated pool elevation past the conservation pool elevation, and outflow from that point was limited to that which passed through the siphons. The gates were then reopened on 26 January to begin drawing down the flood pool. The maximum pool level calculated for this flood was elevation 971.69 on 26 January. Results of regulation of this flood are shown on [Plates No. 8-9](#) and [8-10](#).

(e) Flood of January 1959. The flood of January 1959 is generally regarded as one of the highest of record along most tributaries in the Tuscarawas River Basin. The conditions prior to the generalized rains of 20 and 21 January contributed greatly to the flood stages throughout the basin. Severe cold weather during December 1958 caused the ground to freeze to depths ranging from 6 to 18 inches. In addition, a storm occurring between 14-17 January deposited from 0.50 to 1.84 inches of precipitation over the basin. The ground was thus saturated, frozen and covered with varying amounts of snow, all of which greatly contributed to the high percentage of runoff encountered after the generalized rain began. Most of the flood producing rains fell between midnight on 20 January and noon on 21 January. Rainfall at Leesville Lake for the storm was 2.08 inches, and snow on the ground prior to the storm was approximately 5.8 inches. The peak inflow observed at Leesville Lake was approximately 2,330 cfs on 21 January. The gates were closed at Leesville Lake during the storm, such that outflow was limited to that which passed through the siphons. The gates were opened on 5 February to begin drawing down the flood pool. The maximum observed pool level at Leesville Lake for this flood was elevation 966.87 on 24 January. The 1959 operation hydrographs are shown on [Plates No. 8-11](#) and [8-12](#).

(f) Flood of February 1979. Subfreezing temperatures and a major snowcover persisted over the Muskingum River Basin during most of January and February 1979. Rising temperatures and light rainfall on 21-22 February created thawing conditions which persisted until moderate precipitation on 25-26 February, combined with rapid snowmelt, created flooding conditions in the Muskingum River Basin. Precipitation averaged only approximately 1.5 inches but combined with snowmelt from 6-20 inches of snowcover on the basin. At Leesville Lake, the snowcover of about 13 inches disappeared with the initial thaw and rainfall prior to the main storm of 25-26 February. However, saturated soil conditions resulted in a high percentage of runoff from the 1.44 inches of precipitation that fell on 25-26 February.

Leesville Lake was near the designated minimum pool level at the onset of the initial thaw. The gates were operated to maintain the designated minimum pool level on 21 February and the morning of 22 February. The gates were then operated to pass minimum flow and begin storing inflow on the afternoon of 22 February by orders of a Special Directive. When the pool level had risen to the invert of the siphons on 26 February, the gates were closed completely to restrict outflow to that which passed through the siphons. Since a large portion of the runoff from this event was utilized to raise the pool level from the designated minimum pool to the conservation pool level, the Leesville Lake project was not significantly affected by this flood. Because the gates remained closed after this event, the pool level continued to rise in response to runoff associated with minor storms in early March, until gate operations began on 8 March to reduce the pool level. Results of actual regulation of this flood are shown on [Plates No. 8-13](#) and [8-14](#).

(g) Flood of August 1980. Heavier than normal rainfall over the Muskingum River Basin during June and July 1980 created saturated soil conditions in many areas. Subsequent widespread and intense thunderstorm activity in August thus resulted in substantial runoff, causing major rises in river levels during the month. Rainfalls of 1 to 2 inches were common from storms occurring on 2-6 August, 9-12 August, 17-19 August and 21-22 August. Rainfalls for these 4 storm periods at Leesville Lake were 1.85 inches, 2.64 inches, 1.78 inches, and 1.33 inches, respectively. The most intense of these storms occurred during the late evening hours of 17 August, when 0.9 inch of rain fell within an hour at the Leesville Lake

dam, and 0.5 inch fell within a 15-minute period at nearby Millport. The major inflow peak into Leesville Lake occurred during the early morning hours of 18 August, with a peak of approximately 3,200 cfs. During the first half of the month, outflow was regulated mainly by the siphons, with some additional minor outflow passing through one slightly opened gate. The gate was closed during the early morning of 18 February and outflow for the storms of 17-19 August and 21-22 August was limited to that which passed through the siphons. Gate operations resumed on 26 February to begin drawing down the flood pool. The maximum pool level observed during August 1980 was elevation 967.62 on 24 August. Results of regulation of this flood for the period of 10-27 August at Leesville Lake are shown on [Plate No. 8-15](#).

(h) Flood of January 2005. The January flood began in late December when up to 18” of snow fell across the Scioto and Muskingum basins. This was followed by warm temperatures which caused the snow pack to at least partially melt and saturate the ground. Between 3 and 14 January 5 to 8 inches of rain fell on up to 6 inches of the remaining snow pack and already saturated ground. The storms were followed by warm temperatures, which melted the snow and produced further flooding. Pools or record were reached at Atwood Lake, Bolivar Dam, Charles Mill Lake, Dillon Lake, Dover Dam, Mohawk Dam, and Wills Creek Lake. Results of regulation of this flood are shown on [Plates No. 8-16](#) and [8-17](#)

TABLE NO. 8-5												
FLOOD STAGE REDUCTION BY THE MUSKINGUM SYSTEM												
Feet												
Flood Date	Newcomerstown (Tuscarawas)		R.P.1 Gage (Walhonding)		Coshocton (Muskingum)		Dresden (Muskingum)		Zanesville (Muskingum)		McConnelsville (Muskingum)	
	Nat	Mod	Nat	Mod	Nat	Mod	Nat	Mod	Nat	Mod	Nat	Mod
March 1913	20.5	13.8	26.5	20.8	29.6	19.5	45.0	28.6	52.4	30.5	33.0	17.3
January 1937	17.0	11.0	19.0	11.4	22.4	13.9	33.0	21.3	38.0	21.5	22.5	13.0
January 1959	17.1	9.8	23.6	14.6	24.1	13.6	33.8	18.9	39.6	21.0	22.0	11.8
July 1969	16.8	9.0	22.0	17.8	25.0	14.4	33.0	20.1	35.0	19.1	19.9	10.1
February 1979	14.2	8.2	15.5	9.5	19.0	10.0	26.6	16.5	30.0	18.2	17.7	11.5
August 1980												
First Rise	9.8	8.8	11.4	9.0	12.9	11.4	23.7	18.8	26.3	18.8	16.6	12.8
Second Rise	12.5	8.8	4.7	4.3	10.5	9.0	17.8	15.5	17.2	15.8	9.3	8.6
Third Rise	9.1	8.6	8.6	6.8	12.5	10.0	19.9	16.7	21.5	17.8	13.4	11.0
January 2005	17.7	10.3	21.0	12.1	28.8	19.5	33.7	21.8	38.5	23.0	22.0	13.8

The overall success of the recreational phase of the project, as measured by the number of visitors, has been excellent. Although no actual head count is made of the number of visitors at any of the Muskingum River Basin recreational facilities, the number of visitors is estimated from registration lists and from auto-mobile counts. It is therefore estimated that more than 5.5 million visitor-days are made to the Muskingum River Basin lakes and parks each year. By October 2006, 4640 vehicle visits to the day use launch ramp area had been recorded.

Before the recreational phase of the Muskingum River Basin was initiated, the National Park Service assisted the Muskingum Watershed Conservancy District in the 1940's in estimating the recreational value of the Muskingum River Basin projects. The value was estimated to be \$807,000 per year. Thirty years later, conservative estimates placed the annual value in excess of \$5 million. The 2005 value of these recreation benefits would be about \$273 million per year based on increased visits and inflation. The total investment in recreational facilities at the Muskingum River Basin projects has been estimated at approximately \$10 million. The present cost of duplicating the recreation facilities provided by the Huntington District is in excess of \$150 million.

Table 8-7 Leesville Lake Economic Impact 2000 – 2005	
2000	\$2.92M
2001	\$2.07M
2002	\$3.06M
2003	\$3.41M
2004	\$4.29M
2005	\$0.49M*
*Flooding in the Muskingum Basin in 2005 reduced visitation	

Because of the proximity of Leesville Lake to the nearby Akron-Canton area the daily and weekend visitation is higher than some lakes located further away from the population centers. However, seasonal changes in pool level tend to slightly diminish recreational benefits by affecting boating, camping, hunting and fishing interests at Leesville Lake. Because of this some of the nearby Tuscarawas Lakes have passed Leesville in the attendance figures. Public campgrounds and roads around Leesville Lake are susceptible to damages caused by high water levels.

It is estimated 2/3s of visitors to Leesville come for fishing, with an additional 20% of visitors coming to hunt.

8-04 WATER QUALITY

An interdisciplinary approach was used to evaluate the physics, chemistry, and biology of the Leesville Lake watershed. The following interpretations are based on data collected between 1983 and 2006.

a. **Special Problems.** Leesville Lake is classified as impaired by EPA. The primary concerns are (1) nutrients, (2) organic enrichment, (3) low dissolved oxygen, and (4) habitat alterations. Hydrogen sulfide is a problem in the tailwater area during the recreation season.

b. **Project Operation.** Since the outlet works were not designed for maintenance of water quality, the quality of the release is not regulated. All water released from the project came from the bottom layer

(hypolimnion) of the lake. When the lake was stratified (May through September) this water was anoxic.

A typical water quality operation at Leesville Lake was to maintain a minimum release of 1.5 cfs. Thus, from late spring thru early fall, anoxic water with a high concentration of hydrogen sulfide was released from the project. This created unsafe conditions which lead to closing the tailwater area to the public and restricting access to project personnel (Standard Operating Procedures in Response to Periodic Release of Hydrogen Sulfide Gas at Muskingum Area Lake Projects - June 30, 2005). Lake Turnover was normally at the end of September, but sometimes extended into early October. At this time the restrictions to the tailwaters were lifted.

c. **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 Leesville Lake was classified as a Calcium Carbonate type. This represents a balanced condition.

d. **Temperature.** 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.

Leesville Lake like most lakes in this part of the country remained nearly isothermal during the winter months. During spring as air temperatures started to increase, so did water temperatures near the lake surface. This created a warm surface layer which is called the epilimnion. Water temperatures near the bottom or hypolimnion remained cool because they were not exposed to sunlight or warmer air temperatures. The layer in the middle is referred to as the metalimnion or transition layer. Plate 8 - 11 shows a typical temperature profile of the lake during the summer.

In the fall season, as air temperatures started to cool, surface water temperature also cooled which caused a mixing effect with the layers below at the same temperature. This process continued until water temperature in the epilimnion was the same as the hypolimnion and the lake was once again mixed.

Downstream water temperatures were unregulated and subject to the design of the outlet works. Under normal conditions, water temperatures in a stream will increase during spring and summer and decrease during the fall. Water temperature in the downstream area below Leesville Lake remained cold during spring and into the summer. This had a negative impact on the aquatic community. Aquatic insect life cycles are based on temperature changes. By the time the stream had warmed to a summer time temperature, it was late fall and air temperatures were cooling which caused the stream temperatures to rapidly decline. Thus the summer season was virtually eliminated for the downstream aquatic community.

e. **Retention.** The calculated average retention time for Leesville Lake was 182.4 days, which would normally affect the stratification pattern, but with the design of the outlet structure (bottom level release), stratification patterns were weak. As shown in exhibit 8 - 11, there was a weak thermal stratification, with no defined layers. Specific conductance did not indicate any density layers in the lake which usually result from interflows through the lake during the summer months. Thus water entering the lake remained there, on the average, for 5 to 6 months before it was released to the downstream area. This

is an average number, since during the summer, when flows were low, water remained in the lake for a longer time and during the spring, when flows were high, water remained in the lake for a shorter time.

f. **Dissolved Oxygen.** Dissolved oxygen levels are extremely important in water quality characterization. They depend on the physical, chemical, and biological activities that occur in water. In well-mixed epilimnetic waters, relatively high levels of dissolved oxygen occur and water is usually of acceptable quality. In contrast, 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 Leesville Lake were constant throughout the water column prior to the spring season. The mixed condition remained so until around April when the lake began to stratify. At that time, dissolved oxygen levels in the hypolimnion declined until anoxic conditions were reached. Dissolved oxygen in the metalimnion transitioned from levels greater than 5.0 mg/l in the epilimnion to levels of 0 mg/l in the hypolimnion.

About 66% of the lake had oxygen levels above 5 mg/l during stratification. Dissolved oxygen is one of the key parameters for fishing. Thus this provides an indication of the amount of lake available for fish habitat during the latter half of the stratification season (August – October). Plate 8 - 11 shows typical dissolved oxygen concentrations during the summer months.

McGuire Creek and North Fork of McGuire Creek are the major inflows to Leesville Lake. Dissolved oxygen concentrations at the inflows had an average saturation value of 108% while the tailwaters saturation value was 100%. The outlet works were not designed to allow for regulation of the quality of the outlet water, thus during the stratification season dissolved oxygen levels in the tailwaters should resemble those in the lake hypolimnion. But, the data indicated that the tailwater and headwater areas had similar conditions. This implied that there was significant aeration in the stilling basin and that there should be a dissolved oxygen “sag point” further downstream.

g. **Nutrients.** Concentrations of nutrients in a lake are an indicator of productivity. Low productivity results in fewer littoral plants and low density of phytoplankton, whereas littoral plants and abundant phytoplankton populations characterize highly productive lakes.

Nutrients are transported with sediments. As water enters a lake, its velocity decreases and the sediments settle to the bottom. Because of this phenomenon, it is common to see algal blooms (high productivity) at the upper end of a lake. The lake fishery is directly related to the amount of productivity. Sufficient quantities of phosphorous, nitrogen, and carbon are needed to have a productive lake. Leesville Lake was considered moderately productive with phosphorous as the limiting nutrient. Phosphorous concentrations averaged 0.03 mg/l in the inflows and 0.03 mg/l in the outflow which indicated that there was available phosphorous in the tailwaters.

h. **pH.** pH is a measure of the hydrogen ion concentration. It can be increased 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. An acceptable range for pH for surface waters is between 6 & 9. As shown in Plate 8 – 11, pH values for Leesville Lake were well within this range.

An average of the pH values found in the database for the headwater station was 7.8 and for the tailwater station it was 7.6. The numbers indicated near neutral conditions in both the headwaters and the tailwaters. Long-term trends indicated no significant pattern in pH values over the 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 76 mg/l CaCO<sub>3</sub> in the headwaters and 60 mg/l CaCO<sub>3</sub> in the tailwaters. These numbers indicate limited, but sufficient buffering capacity in the system.

i. **Hardness.** Water hardness is the sum of calcium and magnesium concentrations expressed in terms of mg/l calcium carbonate. It is 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 of the main inflow streams was 105 mg/l calcium carbonate and was 72 mg/l calcium carbonate in the tailwater. This range is classified as moderately hard to soft based on U.S. Geological Survey classifications.

Concentration CaCO <sub>3</sub> (mg/l)	Classification
< 75	Soft water
75 – 150	Moderately hard
150 – 300	Hard
> 300	Very hard

j. **Metals.** 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 main inflow to Leesville Lake averaged 144 ug/l, but increased to 500 ug/l in the tailwater. This was most likely due to the fact, that iron particles are usually attached to suspended sediment. Once the water entered the lake, its velocity decreased and the sediment settled to the lake bottom. During anoxic conditions, the iron was released from the sediment to the water column. Since the lake released water from the bottom, the additional iron was detected in the tailwater area. Long-term trends indicated no significant change in iron concentrations.

Concentrations of manganese in the headwaters were well below a standard of 1000 ug/l, with an average of 120 ug/l. During lake stratification, manganese levels were sometimes over 4000 ug/l in the hypolimnion, but for the same reasons described above, the average tailwater concentration was 511 ug/l. Long-term trends indicated no significant change in manganese concentrations.

k. **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 are dependent upon many factors, such as temperature, oxygen, light, nutrients and flow. All freshwater algae contain the green pigment chlorophyll. Chlorophyll *a* concentrations greater than 8.0 milligrams per cubic meter indicate a potential for overproduction, while concentrations in excess of 20.0 milligrams per cubic meter exist during algae blooms and indicate eutrophic conditions. Therefore, measuring chlorophyll can monitor the productivity of aquatic habitats.

Algal productivity was low in headwater streams with an average chlorophyll concentration of 2.5 ug/l while productivity on the lake was considered high with an average chlorophyll concentration of 11.2 ug/l. This indicates high nutrient loading within the watershed which is not unusual for a farming watershed.

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 the overall water quality conditions of North Fork of McGuire Creek at the main inflow station (LEM-03), and McGuire Creek at the outflow station (LEM-01) and the secondary inflow station (LEM-04).

Overall Quality Rating (OQR) is derived from the Biological Monitoring Working Party score (BMWP) and the Average Score per Taxon (ASPT). The BMWP 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  $OQR=X+Y/2$ .

The OQR and interpretation for the above water quality stations are presented in plate 8-14, which is based on limited data. The outflow station had **poor** quality, while the inflow stations had **poor to moderate to moderate** overall quality.

The most common groups of macroinvertebrates collected in benthic samples from the outflow station were black flies (62%) and chironomid midges (28%). No stoneflies were collected. Mayflies and caddisflies were rare accounting for less than one percent of the total. The common groups collected at the two inflow stations were: North Fork of McGuire Creek -- caddisflies (14%), aquatic beetles (26%) and midges (34%); and McGuire Creek -- caddisflies (44%), and midges (38%). A total of 26 families of benthic organisms have been collected at the outflow station, 33 families from the McGuire Creek inflow station, and 46 families from the North Fork station.

#### 8-05. FISH AND WILDLIFE

Requirements of a constant or rising pool for fish spawning are incorporated into the water control plan at Leesville Lake. Spawning periods at Leesville Lake begin in early to mid-April with muskellunge, walleye, and perch spawning; by this time, spring refilling has normally been completed. Floodwater carrying large sediment loads into Leesville Lake between April and June are most likely to cause spawning problems in the lake. The water plan at Leesville Lake will therefore normally provide adequate pool conditions for fish spawning. During the summer months, a severe thermocline develops in Leesville Lake; below depths of about 14 feet, water becomes devoid of oxygen. However, no fish kills have been associated with this problem. One of the minor defects of the water control plan at Leesville Lake is disturbing fish and wildlife by pool level fluctuations in the lake and outflow from the outlet works.

#### 8-06 WATER SUPPLY

Conotton Creek recorded several very low flow or "no flow days" during the dry years preceding and following the construction of Leesville Lake. When this occurred the residents of the area requested the restoration of some water by any method. The low-flow water supply pool at Leesville Lake releases 1.5 cfs year round. This guaranteed flow is used to keep the stream flowing, prevent mosquitoes from breeding in stagnant pools, provide water for personal use, and support fish and wildlife downstream.

#### 8-07 NAVIGATION. N.A.

#### 8-08 DROUGHT CONTINGENCY PLANS

Drought contingency plans are available in Water Management Section. Final approval for the drought contingency plan has not been received. These plans have not yet been needed.

#### 8-09 FLOOD EMERGENCY ACTION PLANS

The Dam Safety Emergency Action Plan (DSEAP) for Atwood Lake is located in the project office with a copy in ED-GD. This plan includes inundation maps for spillway floods and there are standard responses to floods and other emergencies in the district. These responses are dependant upon whether or not the integrity of the dam is threatened. These plans have not yet been needed.

#### 8-10 FREQUENCIES

a. Natural Discharge-Frequency and Duration at the Outflow Gage. The natural discharge-frequency curve for McGuire Creek at the Leesville 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. A Log-Pearson Type III distribution was fitted to the annual event series at gaging stations in the Muskingum River Basin. This enabled generalized relationships to be derived which relate frequency curve characteristics, mean, standard deviation and skew to individual basin factors. These data were utilized to make flow frequency estimates for the project drainage area.

The curve derived by plotting probable maximum flow to be expected at Leesville Lake against exceedence interval in years is shown as [Plate No. 4-2](#). Flow values for selected exceedence intervals from 1 year to 100 years are given in **Table No. 8-8**.

TABLE NO. 8-8		
FREQUENCY SUMMARY		
McGUIRE CREEK AT LEESVILLE LAKE OUTFLOW GAGE		
ALL SEASONS		
Exceedence Interval (years)	Natural Discharge (cfs)	Modified Discharge (cfs)
100	2,760	240
50	2,420	240
20	2,000	240
10	1,700	240
5	1,410	240
2	1,100	240
1	900	240

Since 1937, flows in the McGuire Creek have been regulated by Leesville Lake. A computer study of the duration of flow at the outflow gage was conducted using the U.S. Geological Survey record of flow past the gage for the period 1938 through 1978. Percent of total elapsed time during which the flow was at or above certain selected values was calculated. These flow values were then plotted against the percent of time as calculated for the full year and for each month to produce the Annual and Monthly Flow Duration curves for McGuire Creek below Leesville Lake.

b. Pool Elevation Frequency and Duration. Peak pool elevation for all significant rises during the actual operation of Leesville Lake through 1988 have been analyzed using graphical frequency procedures. The annual curve derived from this study is shown on [Plate No. 7-7](#), Frequency of Filling. Durations of selected pool elevations have been derived from historical pool elevations recorded at the Leesville Lake project for the same period ending in 1988. Duration curves for average and maximum number of days per year derived from this study are shown on [Plate No. 8-2](#), Duration of Filling. A frequency summary of Leesville Lake pool elevation deviations is shown on [Table No. 8-9](#).

TABLE NO. 8-9	
FREQUENCY SUMMARY	
LEESVILLE LAKE POOL ELEVATION	
ALL SEASONS	
Exceedence Interval (years)	Elevation (ft ngvd)
350	977.5
200	974.2
100	971.9
50	971.0
20	968.2
10	968.0
2	967.1
5	965.6
1	965.0

c. Downstream Control Points. Downstream control points have been determined as the no-damage elevations at the Leesville Outflow gage and at several key gages further downstream. These no damage elevations for the Leesville Outflow gage are 918.1 in summer and 918.4 during winter. The Newcomerstown USGS gage is often used as a downstream control point because it is modified by all eight of the Tuscarawas River projects. Flow values for selected exceedence intervals from 1 year to 100 years are given in **Table No. 8-2**.

## 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 laws passed since the original project authorization. The Huntington District, Corps of Engineers is the operating agency for the project, with the administrative control under the Muskingum Area Office within 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 interdistrict, interdivision and interagency water resource needs. As established in accordance with ER 1110-2-1400, the Great Lakes and Ohio River Division Water Management Branch is responsible for administration of the Division Engineer's policy for water control management.

d. Huntington District. District Engineers have 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 Resources Engineering Branch, within the Engineering Division, is the responsible element for all water control activities which include the following reservoir project functions:

- (1) Flood control.
- (2) Fish and wildlife enhancement.
- (3) Recreation.
- (4) Water Supply.

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 are developed to conform with objectives and specific provisions of project authorizing legislation and applicable Corps of Engineers' projects. They include any applicable authorities established after project construction. The water control plans are prepared giving appropriate consideration to all applicable Congressional Acts relating to operation of Federal facilities, i.e., Fish and Wildlife Coordination Act (P.L. 85-624), Federal Water Project Recreation Act-Uniform Policies (P.L. 89-72), National Environmental Policy Act of 1969 (P.L. 91-190), and Clean Water Act of 1977 (P.L. 95-217). Thorough analysis and testing studies are made as necessary to establish the optimum water control plans possible within prevailing constraints.

Water Resources Engineering Branch is 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-OR-ET-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-OR-ET-W, of any significant deviations from routine regulation plans. The communication mode for the advisory is commensurate with the urgency of the situation and transmitted before a plan of action is implemented by the district. The Recreation-Resource Management Branch and the Muskingum Area Office are responsible for supervision of the operation and maintenance of the dam and operations area. The Damtender regulates the project in accordance with general instructions and Special Directives issued by the Water Control Section through the Muskingum Area Office. General instructions are included in "Instructions to Damtender", Exhibit B of this manual and Special Directives are issued and signed by the Chief, Water Control Section, for dissemination through the Area Office to the Damtender 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 is involved in the following activities pertaining to water control management:

- (a) Routine regulation of the lakes and dissemination of pertinent data.
- (b) Investigations and refinement of regulation procedures such as analysis of past floods, channel investigations, improvement of forecasting, and planning programs with other agencies.
- (c) Training personnel in flood control duties with visits to projects and instructing Water Resources Engineering Branch personnel from other sections.
- (d) Development and application of mathematical modeling to complex reservoir systems.
- (e) Operation of the Branch hydrologic data collection and water control management system, including computers and field equipment.
- (f) Developing and conducting effective public information programs to inform and educate the public regarding Corps of Engineers' water control management activities.
- (g) Preparing and submitting reports on lake regulations such as daily reports, weekly reports, monthly reports, annual reports, weekly briefings, and post-flood reports.
- (h) 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:

- (a) Evaluation and dissemination of current and forecast hydrologic, hydraulic and meteorological data.
- (b) Presentation of storm and flood analysis to the District Engineer and pertinent staff members.
- (c) Providing liaison personnel to support Emergency Operations Center when it is operational.
- (d) Regulation of all projects and systems in accordance with approved plans.
- (e) Furnishing information to others such as reports to higher authority, status to Emergency Operations Center and data to Public Affairs Office.

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 and other emergencies, assistance of other Water Resources Engineering Branch 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 Lake project personnel are provided with a list of names of Water Control Section 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 and project personnel are on duty or on call at all times.

The Huntington District also works in cooperation with other Federal, State, local and private organizations and agencies, as has been illustrated throughout this report.

## 9-02. INTERAGENCY COORDINATION AND COOPERATION

a. Local Press and Corps Bulletins. 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 advice to enable local interests, within the limits of their capabilities, to obtain optimum flood protection, and to perform rescue and relief functions.

The Public Affairs Office in the Huntington 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. Many such varied articles are printed in Castle Comments, the District newsletter; and Engineer Update, the newsletter from the Corps of Engineers.

b. 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. 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.

c. U. S. Geological Survey. The Cooperative Stream Gaging Program (ER 1110-2-1455) was established about 1940 through cooperative arrangements between the Corps of Engineers and the United

States Geological Survey (USGS) 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 USGS 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 annual program is formulated by the Water Resources Engineering Branch in collaboration with appropriate District Chiefs of the USGS. The Corps of Engineers and the local representative of the USGS 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.

The Geological Survey coordination and cooperation with the Corps provides the Water Management Section with a system for obtaining reliable stage and flow information, which is necessary for efficient water control management.

d. Ohio Department of Natural Resources. The Huntington District Water Management Section cooperates fully with the Ohio Department of Natural Resources about fish and wildlife enhancement in the Ohio lakes and downstream areas by coordinating proper timing of spring filling and fall drawdown, forecast of pool elevation and forecast outflow.

The Ohio 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 ODNR 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 ODNR to coordinate with the organization making the request.

e. 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 or from groups that coordinate with ODNR 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 disasters, 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 Leesville Lake, the District Emergency Operations Manager coordinates with the Ohio Office of Emergency Services. 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 public's varied interests in reservoir regulation and accordingly perfecting that regulation to the maximum extent possible.

Water Management Section personnel send 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.

### 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 9-02a 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 Ohio with the Ohio Division 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, Ohio Division 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 Ohio Division of Natural Resources.

The 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 resource concerns.

### 9-04. COMMISSIONS, RIVER AUTHORITIES, COMPACTS, and COMMITTEES

a. Ohio River Basin Commission(ORBC). This commission has an active interest in the operation of Leesville Lake and acts in a consultative capacity to both governmental and private interests in the basin. The commission members are representatives of Federal and State leaders in Water Resources. The commission's purpose is to provide a forum for the Ohio River border states to study, discuss, and develop regional policies and positions on common interstate issues concerning water and related land issues.

b. Ohio River Valley Water Sanitation Commission(ORSANCO). This commission, created in 1948, coordinates the water quality programs of member states, and promulgates regulations to prevent and mitigate water quality problems on the Ohio River and its tributaries. The states of New York, Ohio, Indiana, Illinois, Pennsylvania, Ohio, Kentucky, and Virginia are represented on this commission.

c. Ohio Department of Natural Resources(ODNR). This agency has interest in water related

issues as they affect fishery resources and boating opportunities in the state. Through its several divisions, the ODNR regulates water appropriation and all activities with direct impact on public streams and lakes in the state of Ohio.

e. District Drought Monitoring Committee(DDMC). This is an ad hoc committee consisting of Huntington District Corps of Engineers personnel from the Planning, Operation and Readiness, and Engineering and Construction divisions; the Office of Counsel; and the Public Affairs Office. The purpose of this committee is to review guidelines, develop and implement functional drought contingency plans, and to keep the CDMC informed on drought status and drought related topics and issues.

f. Corps Drought Management Committee(CDMC). The CDMC is an ad hoc committee composed of personnel from the Planning, Operation and Readiness, and Engineering and Construction divisions; the Office of Counsel; and the Public Affairs Office. The purpose of the committee is to represent the broad range of Federal interests and to establish and direct the water management policy for the Huntington District during a drought. Where possible, the Chief of the Engineering Division uses guidelines from this committee in developing and justifying deviations from approved water management plans and procedures.

g. Inter-agency Drought Management Committee(IDNMC). The IIDMC is composed of local, state, and Federal agency directors that have the authority to represent all user water needs within the Muskingum Basin. Federal members include the Huntington District Commander who serves as the Chairmen, and agency heads or their designees from the Federal Emergency Management Committee Agency, U.S. Fish and Wild Life Service, Environmental Protection Agency, National Weather Service, U.S. Geological Survey, and Soil Conservation Service. State members include department heads or their designees from the Ohio Department of Environmental Protection and the Ohio Emergency Management Agency. Local members include representatives from the area counties. The purpose of the committee is to review the status of Districts lake storage and operations, review drought related water needs and requests, develop proposed action plans for meeting consolidated and coordinated user needs, and set priorities and define actions on these needs.

#### 9-05. NON-FEDERAL HYDROPOWER – N.A.

#### 9-06. HUNTINGTON DISTRICT REPORTS

Table No. 9-1 contains a listing of the various Periodic and Special reports provided by the District Water Management Section.

##### a. Periodic.

(1) Daily. Districts are required to report current hydrologic data as prescribed by the Division Office. A daily report is prepared by the Water Management Section of the Water Resources Engineering Branch. It is prepared and formatted in a computer file. After review, the report is sent electronically to the Great Lakes and Ohio River Division 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 are 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 Wednesday a 30 day forecast of 24-hour reservoir effects at tributary gage points, which gives flows in cfs held out from or added to the natural flow, is transmitted to LRD. All of the key gage points are reported for the Muskingum and Ohio River Basins. The main stem points are located at McConnellsville and Marietta.

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

(3) Monthly. ER 1110-2-240, dated 8 October 1982 requires that a monthly record of reservoirs operated by the District be promptly prepared by the Water Management 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 Management Section summarize and compare weather experienced with long-term normal and actual streamflows 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 September 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 reports on major accomplishments concerning personnel, training, model application and data reporting and analysis, and general improvements in reservoir regulation activities.

By Executive Order 13148, the President ordered that “[t]he head of each Federal agency is responsible for ensuring that all necessary actions are taken to integrate environmental accountability into agency day-to-day decision making and long-term planning processes, across all agency missions, activities, and functions”. An annual Division Water Quality report is required by ORDR-2-26. The report is submitted in two parts. The first part addresses the divisions 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 Management Section, 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 of Reservoir Effects. 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 both Muskingum and the Ohio River. Reservoir effects include evaluation of the stage reductions at key stations, estimates of damages prevented by the projects, and precipitation maps will be included in the post-flood reports required by ER 500-1-1. Conclusions are discussed with regard to adequacy of operating technique, performance of structures, and benefits derived from operations during the flood. Tabular and graphic data are used to calculate stage reductions at the following gaging stations pertinent to Leesville Dam: Muskingum River at Logan, Branchland, and Ohio River at Huntington, WV. The outline of a typical post flood report is given below.

I- Authority, Purpose And Scope

II- Basin Description

Basin Flood Control works

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, if necessary. 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 droughts. 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 MANAGEMENT SECTION**

**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. 5-1

LEESVILLE LAKE  
 MCGUIRE CREEK BASIN STREAM GAGING NETWORK - PERTINENT DATA

Stream and Station	Zero Gage Elevation Feet m. s. l.	Drainage Area Sq. Mi.	Date Established Month/Year	Existing Station Facilities	Method of Obtaining Data
McGuire Creek at Leesville Lake	928.0	48	Apr 1938	Stevens continuous recorder, called strip chart, Data Collection Platform (shortened to DCP). Other gages include an electric reference tape, and a staff. Hydrologger to be installed in future.	Project personnel view strip chart and include readings in regular and extra reports. DCP transmits via satellite to downlink and data retrieved by water control system.
McGuire Creek below Leesville Lake	915.0	48	Oct 1938	Analog-to-digital recorder, called ADR, strip chart, Voice DCP, hydrologger. Other gages include an electric reference tape, a staff, and tipping bucket precipitation gage.	Project personnel view remotod readout and include readings in regular and extra reports.

TABLE NO. 5-2

PRECIPITATION STATIONS IN AND NEAR  
LEESVILLE LAKE BASIN - PERTINENT DATA

<u>Record From</u>	<u>Station</u>	<u>Equipment</u>	<u>Method of Obtaining Data</u>	<u>Reporting Criteria</u>
4/38	Leesville Lake	8-inch SRG	Project personnel read gage and include reading in morning reports. Extra reports by telephone to Area Office.	Daily at 0730 amount of precipitation collected in previous 24 hours. Extra at 1330 if 0.5 inch or more collected after 0730.
10/83	Leesville Lake outflow	Tipping bucket gage with heater and data collection platform.	Platform transmits via satellite to receiver each 4 hours. Water control system retrieves data.	Data collection interval 60 minutes.
7/92	Millport	8-inch SRG	Observer calls Muskingum Area Office about 0730 hours. Additional reports (including weekends and holidays) also called in to Area Office personnel or to office recorder.	0.5 inch precipitation collected in 24 hours prior to 0700 or in 12 hours prior to 1900. Any subsequent precipitation reported each 12 hours until told to stop or after first report of zero. Each report is of precipitation since previous 0700 reading.
5/86	Millport	Tipping bucket gage with heater and data collection platform.	Platform transmits via satellite to receiver each 4 hours. Water control system retrieves data.	Data collection interval 60 minutes.

TABLE 7-4  
LEESVILLE LAKE  
SIPHON RATING

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Pool Elev.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
962.0				2	4	6	13	41	59	70
963.0	80	90	99	109	117	120	122	123	124	124
964.0	124	124	124	124	125	125	125	125	126	126
965.0	126	126	126	127	127	127	127	127	128	128
966.0	128	128	128	129	129	129	129	129	130	130
967.0	130	130	130	130	131	131	131	131	131	132
968.0	132	132	132	132	132	133	133	133	133	133
969.0	134	134	134	134	134	134	135	135	135	135
970.0	135	135	136	136	136	136	136	136	137	137
971.0	137	137	137	138	138	138	138	138	138	139
972.0	139	139	139	139	139	139	140	140	140	140
973.0	140	140	140	141	141	141	141	141	141	142
974.0	142	142	142	142	142	143	143	143	143	143
975.0	143	144	144	144	144	144	144	144	145	145
976.0	145	145	145	145	145	146	146	146	146	146
977.0	146	146	147	147	147	147	147	147	147	148
978.0	148	148	148	148	148	148	149	149	149	149
979.0	149	149	149	150	150	150	150	150	150	150
980.0	151	151	151	151	151	151	151	151	151	151

This siphon is used as a self-regulating low-flow system that holds the pool near El. 963 during routine operations.

TABLE 7-2

LEESVILLE LAKE  
PERCENT STORAGE UTILIZATION - WINTER

ELEV	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
957	0.00	0.35	0.71	1.07	1.43	1.79	2.15	2.52	2.89	3.26
958	3.63	4.02	4.40	4.79	5.17	5.56	5.94	6.32	6.71	7.09
959	7.48	7.86	8.25	8.63	9.02	9.40	9.79	10.17	10.56	10.94
960	11.32	11.70	12.08	12.46	12.84	13.22	13.61	13.99	14.38	14.78
961	15.17	15.57	15.97	16.37	16.77	17.17	17.58	17.99	18.40	18.82
962	19.23	19.66	20.09	20.51	20.94	21.37	21.79	22.22	22.65	23.08
963	23.50	23.92	24.34	24.76	25.19	25.61	26.04	26.47	26.91	27.34
964	27.78	28.22	28.66	29.10	29.55	29.99	30.44	30.90	31.35	31.81
965	32.27	32.74	33.21	33.68	34.15	34.62	35.09	35.56	36.03	36.50
966	36.97	37.43	37.89	38.35	38.82	39.29	39.76	40.23	40.71	41.19
967	41.67	42.16	42.65	43.14	43.63	44.12	44.62	45.11	45.60	46.09
968	46.58	47.06	47.55	48.03	48.52	49.01	49.50	50.00	50.50	50.99
969	51.50	52.00	52.50	53.01	53.52	54.03	54.55	55.06	55.58	56.10
970	56.62	57.15	57.68	58.20	58.74	59.27	59.80	60.34	60.88	61.42
971	61.97	62.52	63.08	63.63	64.19	64.74	65.30	65.86	66.41	66.97
972	67.52	68.07	68.62	69.17	69.72	70.27	70.83	71.39	71.95	72.51
973	73.08	73.65	74.23	74.81	75.38	75.96	76.54	77.12	77.69	78.27
974	78.85	79.41	79.98	80.55	81.13	81.70	82.28	82.86	83.44	84.03
975	84.62	85.20	85.80	86.39	86.98	87.58	88.18	88.78	89.39	89.99
976	90.60	91.21	91.82	92.44	93.05	93.67	94.29	94.91	95.54	96.17
977	96.80	97.44	98.08	98.72	99.36	100.00	0.00	0.00	0.00	0.00

TABLE7-1

LEESVILLE LAKE  
PERCENT STORAGE UTILIZATION - SUMMER

ELEV	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
963	0.00	0.55	1.09	1.65	2.20	2.76	3.32	3.88	4.45	5.02
964	5.59	6.16	6.74	7.32	7.90	8.48	9.07	9.66	10.26	10.85
965	11.45	12.07	12.68	13.30	13.91	14.53	15.14	15.75	16.37	16.98
966	17.60	18.20	18.80	19.41	20.02	20.64	21.25	21.87	22.49	23.12
967	23.74	24.39	25.03	25.67	26.31	26.96	27.60	28.24	28.88	29.53
968	30.17	30.80	31.43	32.07	32.70	33.35	33.99	34.64	35.29	35.94
969	36.59	37.25	37.91	38.57	39.24	39.91	40.58	41.26	41.93	42.61
970	43.30	43.98	44.67	45.36	46.06	46.75	47.45	48.16	48.86	49.57
971	50.28	51.01	51.73	52.46	53.18	53.91	54.64	55.36	56.09	56.82
972	57.54	58.26	58.97	59.69	60.41	61.14	61.87	62.60	63.33	64.09
973	64.80	65.56	66.31	67.07	67.82	68.58	69.33	70.08	70.84	71.59
974	72.35	73.09	73.83	74.58	75.33	76.08	76.84	77.60	78.36	79.12
975	79.89	80.66	81.43	82.21	82.98	83.76	84.55	85.33	86.12	86.92
976	87.71	88.51	89.31	90.11	90.92	91.73	92.54	93.35	94.17	94.99
977	95.81	96.65	97.49	98.32	99.16	100.00	0.00	0.00	0.00	0.00

TABLE 7-5

LEESVILLE LAKE  
AREA AND CAPACITY TABLES

DRAINAGE AREA = 48 SQ. MI.

1 IN. RUNOFF = 2560 AC. FT.

Pool Elev.	Capacity		Area	Pool Elev.	Capacity		Area
	Ac.Ft.	Inches	in Acres		Ac.Ft.	Inches	in Acres
915	0	0.00	0	947	6,920	2.70	591
916	0	0.00	1	948	7,520	2.94	616
917	2	0.00	1	949	8,150	3.18	643
918	4	0.00	3	950	8,810	3.44	668
919	8	0.00	5	951	9,490	3.70	689
920	14	0.01	8	952	10,180	3.97	712
921	24	0.01	12	953	10,900	4.26	733
922	38	0.02	17	954	11,650	4.55	754
923	58	0.02	23	955	12,400	4.84	777
924	86	0.03	32	956	13,200	5.15	803
925	124	0.05	43	957	14,000	5.47	829
926	174	0.07	58	958	14,850	5.79	857
927	242	0.10	77	959	15,750	6.15	885
928	329	0.13	97	960	16,650	6.50	913
929	437	0.17	120	961	17,550	6.85	940
930	569	0.22	145	962	18,500	7.22	969
931	727	0.28	172	963	19,500	7.61	1,000
932	913	0.36	201	964	20,500	8.00	1,030
933	1,130	0.44	233	965	21,550	8.41	1,065
934	1,380	0.54	263	966	22,650	8.83	1,095
935	1,660	0.65	291	967	23,750	9.27	1,130
936	1,960	0.77	315	968	24,900	9.73	1,160
937	2,290	0.90	340	969	26,050	10.18	1,190
938	2,640	1.03	364	970	27,250	10.67	1,225
939	3,020	1.18	387	971	28,500	11.12	1,260
940	3,410	1.33	410	972	29,800	11.63	1,290
941	3,840	1.50	438	973	31,100	12.14	1,325
942	4,290	1.68	462	974	32,450	12.68	1,355
943	4,760	1.86	488	975	33,800	13.20	1,390
944	5,260	2.06	513	976	35,200	13.75	1,420
945	5,790	2.26	538	977	36,650	14.30	1,455
946	6,340	2.48	565	978	38,150	14.90	1,490
				979	39,650	15.49	1,530
				980	41,200	16.09	1,550

TABLE NO. 7-6

NOTIFICATION AND LOCATION OF IMPORTANT PERSONNEL

DISTRICT PERSONNEL	Telephone		Radio	
	<u>Office</u>	<u>Residence</u>	<u>Freq.</u>	<u>Call</u>
<u>WATER RESOURCES ENGINEERING BRANCH</u>				
<u>WATER CONTROL SECTION</u>				
[REDACTED] Muskingum Forecaster	[REDACTED]	[REDACTED]		
[REDACTED], Chief	[REDACTED]	[REDACTED]		
[REDACTED] Chief, Water Resources Engineering Branch	[REDACTED]	[REDACTED]		
<u>GEOTECHNICAL BRANCH</u>				
[REDACTED]	[REDACTED]	[REDACTED]		
<u>MUSKINGUM AREA OFFICE</u>				
Dover, Ohio				
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
<u>ENGINEERING MANAGEMENT DIVISION</u>				
[REDACTED] Staff Duty Officer	[REDACTED]	[REDACTED]		
<u>OPERATIONS DIVISION</u>				
[REDACTED]	[REDACTED]	[REDACTED]		

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

The mailing address is:  
 Leesville Lake  
 5037 Deer Road, SW  
 Bowerston, Ohio 44695-9621  
 Telephone [REDACTED]

The Damtender is:  
 [REDACTED]  
 9489 Lakeview Road  
 Mineral City, Ohio  
 44656

TABLE NO. 7-6 (cont'd)

NOTIFICATION AND LOCATION OF IMPORTANT PERSONNEL

DISTRICT PERSONNEL	Telephone		Radio	
	<u>Office</u>	<u>Residence</u>	<u>Freq.</u>	<u>Call</u>

STATE AND LOCAL AGENCIES

State Highway Patrol  
 Dover Area Office  
 Carroll County  
 Sheriff  
 Tuscarawas County  
 Sheriff  
 Dover City Police



Pertinent telephone numbers which may be of value during a flood emergency are listed below:

HUNTINGTON DISTRICT OFFICE

Water Resources Engineering Branch

Normal Work Hours  
 0700 to 1600 hrs



Additional Extensions  
 Nights, Weekends, and Holidays



Other Agencies

U.S. Geological Survey  
 New Philadelphia, Ohio  
 Nights, Weekends, Holidays



Commercial  
 From HDO



National Weather Service

Forecast Office  
 Cleveland, Ohio  
 Hydrology Section

Forecast Office  
 Coraopolis, Pennsylvania

TABLE NO. 8-1

TUSCARAWAS-MUSKINGUM RIVER BASIN KEY STATIONS  
CONTROL STAGES AND FLOWS

Tuscarawas River Station	Stream	Crop Season <sup>1/</sup>		Winter Season <sup>2/</sup>		Closure Time Dam to Station (hrs)
		Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	
Atwood	Indian Fork	894.	670	895.	925	--
Leesville	McGuire Crk.	4.1	202	4.4	252	--
Bolivar	Sandy Crk.	900.	2,400	901.	3,000	--
Dover O.F."D"gage	Tuscarawas	6.5	4,832	7.5	6,026	0.1
Beach City	Sugar Creek	934.2	1,820	935.2	2,550	
New Philadelphia	Tuscarawas	6.5	8,700	7.0	9,700	2.2
Clendening Tippecanoe	Brushy Fork Stillwater		540 1,140		540 1,440	0.5
Tappan Uhrichsville	L. Stillwater Stillwater C.	867.5 3.5	450 2,230	867.8 5.0	590 3,090	5.5
Piedmont	Stillwater C.	877.5	445	877.8	590	
Newcomerstown	Tuscarawas	9.5	13,200	11.0	16,250	20
<u>Muskingum River</u>						
Coshocton	Muskingum	15.5	21,810	18.0	30,660	30
Dresden	Muskingum	16.0	23,420	18.5	32,000	36
Zanesville	Muskingum	19.5	38,200	21.5	48,000	46
McConnelville	Muskingum	10.0	35,600	11.0	41,600	59
Marietta	Ohio	35.0	260,000	35.0	260,000	<u>72</u> <sup>4</sup>

<sup>1/</sup> 16 April through 30 November  
damage begins at 6.0 feet.  
<sup>2/1</sup> December through 15 April  
damage begins at 7.1 feet.

<sup>4/</sup> Dover or Mohawk operational  
time prior to forecasted crest  
stage of 35 feet

TABLE NO. 8-5

PEAK FLOOD STAGE REDUCTION (FEET) BY MUSKINGUM BASIN RESERVOIRS

Flood Date	Tuscarawas River at Newcomerstown		Walhonding River at R.P.1 Gage		Muskingum River at Coshocton		Muskingum River at Dresden		Muskingum River at Zanesville		Muskingum River at McConnellsville	
	Nat.	Mod.	Nat.	Mod.	Nat.	Mod.	Nat.	Mod.	Nat.	Mod.	Nat.	Mod.
March 1913	20.5	13.8	26.5	20.8	29.6	19.5	45.0	28.6	52.4	30.5	33.0	17.3
January 1937	17.0	11.0	19.0	11.4	22.4	13.9	33.0	21.3	38.0	21.5	22.5	13.0
January 1959	17.1	9.8	23.6	14.6	24.1	13.6	33.8	18.9	39.6	21.0	22.0	11.8
July 1969	16.8	9.0	22.0	17.8	25.0	14.4	33.0	20.1	35.0	19.1	19.9	10.1
February 1979	14.2	8.2	15.5	9.5	19.0	10.0	26.6	16.5	30.0	18.2	17.7	11.5
August 1980												
1st Rise	9.8	8.8	11.4	9.0	12.9	11.4	23.7	18.8	26.3	18.8	16.6	12.8
2nd Rise	12.5	8.8	4.7	4.3	10.5	9.0	17.8	15.5	17.2	15.8	9.3	8.6
3rd Rise	9.1	8.6	8.6	6.8	12.5	10.0	19.9	16.7	21.5	17.8	13.4	11.0

**TABLE NO. 8-6**

PEAK FLOOD DISCHARGE REDUCTION (1000 CFS) BY MUSKINGUM BASIN RESERVOIRS

Flood Date	Tuscarawas River at Newcomerstown		Walhonding River at R.P.1 Gage		Muskingum River at Coshocton		Muskingum River at Dresden		Muskingum River at Zanesville		Muskingum River at McConnelsville	
	Nat.	Mod.	Nat.	Mod.	Nat.	Mod.	Nat.	Mod.	Nat.	Mod.	Nat.	Mod.
March 1913	84.4	27.8	125.5	56.0	203.0	80.2	228.0	87.7	251.5	82.2	272.0	95.2
January 1937	50.0	16.8	41.5	11.8	92.7	33.6	107.0	44.0	125.0	45.5	132.0	56.0
January 1959	51.8	13.8	84.0	20.8	108.0	32.5	117.8	39.5	140.5	86.3	133.0	82.0
July 1969	50.0	12.1	69.5	35.5	119.3	46.1	111.0	38.1	112.2	36.8	109.6	35.6
February 1979	30.3	10.9	24.0	10.0	52.1	20.4	68.3	27.3	89.3	35.2	91.0	45.4
August 1980												
1st Rise	14.4	10.9	13.0	9.6	29.5	23.4	49.5	33.5	71.0	35.8	81.8	53.2
2nd Rise	22.0	10.9	4.6	4.3	20.6	15.7	30.4	22.0	30.5	26.1	30.5	27.2
3rd Rise	12.4	10.5	8.9	6.7	27.5	20.0	38.0	26.5	48.5	32.5	58.0	41.2

## LEESVILLE LAKE

### McGUIRE CREEK OF CONOTTON CREEK - TUSCARAWAS RIVER BASIN

#### PERTINENT DATA

##### LOCATION

The Leesville Lake damsite is located in Carroll County, Ohio, on McGuire Creek near the junction of McGuire Creek and North Fork of McGuire Creek, approximately 1.4 miles above the confluence of McGuire Creek with Conotton Creek and 196.4 miles above the mouth of the Muskingum River. The dam is located approximately 17 miles east of New Philadelphia and 1.5 miles northeast of Leesville, Ohio.

##### TYPE OF PROJECT

Multi-purpose; flood control, recreation, fish and wildlife conservation.

##### AUTHORITY

The Muskingum Watershed Conservancy District was created on 3 June 1933 for the purpose of developing a plan for flood control, water conservation, and water use in the Muskingum River Basin. A general plan was prepared, and application for approval of the project system and a request for financial cooperation was filed with the Federal Emergency Administration of Public Works in August 1933. The Public Works Administration approved the project system in December 1933 and allocated funds to the Corps of Engineers in financing the construction of the project.

The Corps of Engineers initiated investigations following execution of a contract between the United States of America and the Muskingum Watershed Conservancy District on 29 March 1934. The Official Plan was proposed by the COE and was approved by the Conservancy District on 19 November 1934.

The Flood Control Act, approved 11 August 1939, contained a provision that the dams and reservoirs be included in the comprehensive Flood Control Plan for the Ohio River Basin. Operation and maintenance of the 14-reservoir system (which includes Leesville Lake) have been responsibilities of the Corps of Engineers since that date.

##### PURPOSES

The project was initially authorized for reduction of flood heights on the Tuscarawas and Muskingum Rivers. As noted in the paragraph above, the project was later included in the Comprehensive Ohio River Flood Control Plan. In addition to flood control, other major purposes are general recreation and fish and wildlife conservation.

STREAMFLOW DATA (Cubic Feet Per Second)

Average annual flow just below damsite	53.9
Maximum peak discharge at damsite	2,300
Minimum Discharge just below damsite	0

DRAINAGE AREAS (Square Miles)

McGuire Creek at Leesville Lake	48.3
McGuire Creek at mouth	49.6
Conotton Creek above McGuire Creek	92.4
Conotton Creek at mouth	286
Tuscarawas River above Conotton Creek	1,115
Tuscarawas River at Dover Dam	1,404
Tuscarawas River at mouth	2,596
Muskingum River at mouth	8,051

RESERVOIR DATAElevations (Feet above ngvd)

Streambed at Damsite	920
Designated Minimum Pool*	958
Conservation Pool	963
Flood Control Pool	977.5
Spillway Design Flood	990.1

Capacities

	Acre-Feet		Inches-Runoff	
	Net	Gross	Net	Gross
Designated Minimum pool*	14,850	14,850	5.8	5.8
Conservation Pool	4,650	19,500	1.8	7.6
Flood Control Pool				
Above Designated Minimum	22,550	37,400	8.8	14.6
Above Conservation	17,900	37,400	7.0	14.6
Total storage	37,400		14.6	

\* Subject to change by MWCD

Surface Areas (Acres)

Designated Minimum pool	---
Conservation pool	1,000
Flood Control Pool	1,470

Backwater Along Main Stream (Miles)

Designated Minimum Pool	---
Conservation Pool	4.6
Flood Control Pool	5.5

DAM

Type - Rolled earth fill with impervious core.

Maximum height, feet	74
Top length, feet	1,695
Top width, feet	25
Base width, feet	450

Parapet Wall 4.1' on top of dam with a top elev. of 995.1'

SPILLWAY

Type - Uncontrolled saddle spillway adjacent to left (south) abutment.

Crest length, feet	150
Crest elevation, feet above ngvd	977.5
Design discharge, cfs	14,800
Surcharge, feet	12.6
Freeboard, feet	5.0

OUTLET WORKS

Type - Intake structure with tunnel, conduit and stilling basin.

Intake structure - Reinforced concrete with tunnel, conduit section, siphons, and control gates.

Siphons - To maintain conservation pool, 1'-6" diameter siphons are located in front of the gates of the two outer sluices and discharging into the center sluice.

Invert elevation of siphons, feet above msl	962.25
Number of control gates	3
Size of control gates	3'-6"x7'
Invert elevation of control gates, ngvd	928
Maximum outlet discharge, cfs, at spillway elevation, all gates open	1,550

TUNNEL

Type - horseshoe, concrete lined  
Number of tunnels 1  
Size, feet 7  
Length, feet 432

CONDUIT

Type - horseshoe, concrete extension of tunnel  
Number of conduits 1  
Size, feet 7  
Length, feet 138

STILLING BASIN

Type - Conventional jump type with curved and stepped apron discharging onto baffle blocks and an end sill  
  
Width, feet 20  
Length, including outlet transition, feet 110

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

MUSKINGUM RIVER BASIN  
OHIO

PROJECT MANUAL  
FOR  
WATER CONTROL MANAGEMENT  
JUNE 1998

INSTRUCTIONS TO DAMTENDER  
LEESVILLE LAKE

EXHIBIT B

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INSTRUCTIONS TO DAMTENDER

## LEESVILLE LAKE

### SECTION 1 - GENERAL OPERATION INSTRUCTIONS

#### 1-01 GENERAL

Follow instructions given in this section under one or more of the sub-sections at all times, except when other operations are required by Special Directive issued by Water Resources Engineering Branch of the Huntington District Office and normally transmitted through the Muskingum Area Office. In the event contact cannot be made with personnel of the Area Office, Water Control Section personnel will issue Special Directives directly to the project.

a. In order to maintain downstream aquatic environment, the outflow shall never be permitted to fall below 1.5 cfs or an elevation of 917.1 on the outflow gage for both MIANO (acronym for "Mid-April through November") and DEMIA (acronym for "December to mid-April").

b. Instructions contained in Special Directives will be applicable for a specific operation or for a stated period of time. After the instructions specified have been executed, resume operations in accordance with the following general instructions. Any time the reservoir pool level exceeds alert elevation 968.0 ngvd the Damtender should contact the Water Control Section for further instructions.

#### 1-02 GATE REGULATION FACILITIES

a. General. Facilities provided for water control include a concrete operations tower near the north abutment of the dam which contains three slide type sluice gates for storing routine flood waters, three rectangular conduits controlled by slide gates for passing routine flood flows, and a concrete lined horseshoe tunnel through the north abutment connecting to a stilling basin. In the opposite or south abutment is a concrete lined emergency spillway for passing high flood flows. Sequence and method of operation where applicable, appear in subsequent paragraphs. Gates are to be opened or closed in such a manner as to prevent the stage at the outflow gage from changing more than 1.0 foot per hour unless directed by Water Resources Engineering Branch or under emergency procedure of 1-06 below.

b. Outlet Works. The outlet works is located in the operations tower near the north abutment and consists of a reinforced concrete substructure and concrete superstructure which houses the gates and operating machinery. Access to the outlet structure is provided by means of a short roadway and service bridge from the main road on the top of the earthen embankment.

The main components of the inlet-outlet works are a short approach channel, intake tower and tunnel connecting with the primary spillway tunnel, a concrete-lined open cut channel, a concrete lined horseshoe shaped tunnel, connecting with a concrete stilling basin, and an outlet channel. The outlet structure contains three low-level slide type sluice gates, 3.5 feet by 7 feet in size and open from sills at elevation 957.0 feet ngvd. The three gates

discharge into a concrete lined horseshoe tunnel 7 feet in diameter and 570 feet long which in-turn leads to a stilling basin. Stop-log grooves are provided at the downstream end of the intake.

The three 3.5'x 7' slide type gates are operated by electric motors mounted on gate operating stands at floor level of the gate house. Each gate is also equipped for manual operation. One emergency gate is provided which is capable of being inserted in front of any of the service gates. The slide gates are the self-closing tractor type and are raised or lowered by means of an electrically driven hoist mounted on the crane in the superstructure of the gate house.

The gates are numbered from left to right, looking downstream, and opened sequentially beginning on the left with No. 1, No. 2 is in the center, and then No. 3 on the right, and they are closed in reverse order. Gates are to be opened or closed in such a manner as to prevent the stage at the outflow gage from changing more than 1.0 foot per hour unless directed by Water Resources Engineering Branch or under emergency procedure of 1-06 below. The normal operating position for the gates is usually completely closed in the summer or during a major flood with a very small opening during the winter.

The stilling basin is a reinforced concrete structure of conventional jump design. The embankment side of the basin is formed by a gravity retaining wall with four vertical cutoff walls extending into the adjoining embankment from the retaining wall to prevent contact seepage. The abutment side of the basin is formed by a reinforced concrete slab anchored to the bedrock face. The slab is topped by a three-foot training wall. The slab and training wall form the final drop in the adjacent terraced spillway. The bottom of the basin is paved with a heavy reinforced concrete slab anchored into rock. Baffle piers and an end sill are provided for energy dissipation. Preformed gravel-filled floor and wall drains discharging through 3-inch weep holes are provided to relieve uplift pressures.

c. Orifices. Normal summer pool discharge is regulated by two uncontrolled orifices placed at and above normal summer pool elevation of 962.25 feet. These orifices are designed to provide automatic pool control under normal circumstances. The orifices are self-regulating openings on the sides of the intake tower. The elevation of the lip of the two 2.7'x 2.5' orifice openings is 962.25.

d. Spillway. The uncontrolled concrete lined overflow spillway is located adjacent to the opposite or south abutment. The structure consists of a concrete lined section 150 feet wide with a crest elevation of 977.5 feet. The upstream approach channel to the spillway is a curved transition section; and the outflow channel discharges downstream into McGuire Creek. The design discharge is 19,700 cfs with a surcharge of 12.5 feet and a freeboard of 5.0 feet.

#### 1-03 ROUTINE OPERATION

For operation at normal conditions the lake is self-regulated by the pair of orifices at summer pool elevation 963 feet, and by occasional use of the

low-flow gates to release storm inflows or storage during the winter or when the pool elevation is below 962 feet ngvd.

Regulation under normal conditions (not under Special Directive) may be determined by Muskingum Area Office staff; however, releases shall not exceed 918.6 ft or 84 cfs during MIANO, and to elevation 918.8 ft or 120 cfs during DEMINA unless specifically directed by the Water Resources Engineering Branch. However, releases may extend to 919.1 ft ngvd or 183 cfs during MIANO, and to 919.4 feet ngvd or 245 cfs during DEMINA, on ORDER from the Water Control Section. After rainfall or when there is a general stream rise, guidance presented in the following paragraphs shall be used to maintain proper project conditions.

#### 1-04 REGULATION FOR DOWNSTREAM CONTROL

a. McGuire Creek. During routine reservoir regulation activity, the maximum discharge from Leesville Lake of 84 cfs or an outflow gage reading of 918.6 feet ngvd during MIANO, and 120 cfs or an outflow gage reading of 918.8 feet ngvd during DEMIA can be maintained during light to medium rainfall without causing any appreciable damage downstream along McGuire and Conotton Creek assuming Atwood Lake discharges are not higher than control rates. In order to exceed these maximum control discharges for the MIANO or DEMIA season, there must be authorization by Special Directive from Water Resources Engineering Branch except as noted in 1-06 below.

b. Conotton Creek, Tuscarawas, Muskingum and Ohio River. Leesville Lake is operated cooperatively with Atwood and Bolivar Lakes when Dover Lake is operated for regulation of one or all of these streams. Discharges from Leesville Lake are to be coordinated with other Muskingum Basin projects to prevent adding to flow crests on McGuire Creek and Conotton Creek, Tuscarawas, Muskingum and Ohio Rivers.

#### 1-05 OPERATION DURING COMMUNICATION FAILURE

If both telephone and radio facilities fail, solicit the cooperation of local radio and television stations, amateur and citizens band radio operators, or the State Police. The emergency procedure outlined below shall be followed during periods when the Water Resources Engineering Branch or the Area Office cannot be contacted by any method or means.

a. If a Special Directive from the Water Resources Engineering Branch was in effect prior to communications failure, follow the operating instructions contained in the Special Directive until:

(1) the specific operation given in the directive has been completed, or

(2) twenty-four hours have elapsed since last contact with Water Resources Engineering Branch either through the Area Office or otherwise, or

(3) sufficient rainfall or snowmelt occurs which causes the lake or streams in the vicinity to raise rapidly.

b. Whenever any of the foregoing conditions, (1), (2) or (3) occurs or if not under Special Directive and either of conditions (2) or (3) applies, follow operating instructions contained in sub-sections 1-03 or 1-04, whichever is applicable.

#### 1-06 EMERGENCY OPERATION

During communication failure, project personnel should make frequent efforts to make contact with proper authority. If the pool level rises to spillway elevation 977.5 feet, use all additional gate discharge up to full capacity in order to stabilize the pool at that elevation or reduce further rise. If the pool rises above elevation 977.5, maintain maximum discharge until the pool crests and recedes to elevation 977.5 and adjust discharge to hold elevation 977.5 until communication is reestablished with Water Resources Engineering Branch.

For lake elevations less than spillway elevation 977.5, Plate 1-1 contains instructions for most summer storms or pool elevations above 963.0 and Plate 1-2 has instructions for winter storms or pool levels below 962.3 ngvd.

#### 1-07 EMERGENCY RESPONSE

Should emergency drawdown become necessary, various procedures such as surveillance of the dam or notification of key personnel may be placed into effect, depending on the cause and its severity. Detailed information concerning these emergency actions can be found in the Flood Emergency Plan for Leesville Lake.

#### 1-08 PUBLIC NOTIFICATION OF UNUSUAL RELEASES

Operation of 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, Leesville Lake Project Damtender must stay informed and inform the Water Resources Engineering Branch of any and all developments along McGuire Creek, Conotton Creek, and along the section of Tuscarawas River between the mouth of Conotton Creek and Dover Dam.

If required by unusual release patterns, obtain directions from Water Resources Engineering Branch will coordinate the release with Public Affairs Office for public notification procedures. Unusual release patterns include closure for maintenance purposes, special increases or decreases for downstream requests and requirements, and emergency, above channel capacity, discharges. Notification of large releases is to afford those likely to be affected an opportunity to take remedial measures in advance of the arrival of the release so as to prevent damage to or loss of their property.

## SECTION II - COLLECTION OF HYDROMETEOROLOGIC DATA

### 2-01 PRECIPITATION

a. General. Obtain precipitation data by direct observation of the rain gage at the damsite. Instructions for preparation and transmission of hydrologic reports are contained in Section IV.

b. Official Precipitation Gage. The standard National Weather Service (non-recording) rain gage at the damsite is designated as the gage for official use.

c. Regular Readings. Measure and discard precipitation contained in the standard gage between 0730 hours daily. Observe and record the times of beginning and ending of precipitation. Instructions for the preparation and transmission of precipitation reports are contained in Section IV. These instructions are for Corps of Engineers purposes and are not to be considered as superseding observation instructions received from the National Weather Service.

d. Special and Extra Readings. Take special readings of the precipitation gage when requested by Water Resources Engineering Branch through the Muskingum Area Office and extra readings whenever required by the Schedule for Reading Gages, Plate 1-1. When taking these readings, do not empty the gage at any time except the regular time. Report the total which has fallen since the regular time of reading even though a portion of it may have been reported in a previous extra reading. The regular reading on the morning following any extra readings should always include the amounts reported in the extra readings. Instructions pertaining to the transmission of extra and special precipitation readings are contained in Section IV.

e. Satellite Platform Stations. Several precipitation stations at or near Leesville Lake have tipping-bucket rain gages reported by data collection platforms, including Leesville Lake, Dover, Newcomerstown, Atwood Lake, Dover Dam, Bolivar Dam, and Beach City Lake. The platforms transmit every four hours to the GOES satellite. The GOES satellite transmissions are received by DOMSAT downlinks at CELRH and CELRD, and by a GOES downlink at CELRD. The CELRH DOMSAT downlink passes data to the Water Resources Engineering Branch, Water Control System (WCS) several times hourly. CELRD WCS receives from the downlinks and disseminates hourly to the data base of Water Resources Engineering Branch WCS as backup for the LRH downlink. From the data base it is available for use in water control management and dissemination and is accessible by computer terminal as described in sub-section 3-04.

f. Snow Depth and Moisture Content. During the winter, make regular measurement of snowfall and snow depth about 0730 hours daily. Measurements of the water content of the snow on the ground are required in order to determine the amount of water which may run off during a warm spell or with any wind and rainfall which may occur. To determine the water content of the snow, obtain a representative snow sample at an undisturbed location by forcing the outside container of the rain gage through the snow to the ground surface. Then, using a shovel or thin sheet of metal to hold the snow cover within the container, remove the container from the ground. The water content of the sample can be

measured by placing the outside container in a vessel of warm water, and then pouring the melted snow into the inside container of the gage for a reading with the measuring stick. On no account should the vessel containing the snow be exposed to extreme heat because of the possibility of loss by evaporation. Measure water content of the snow at least as often as indicated below.

- (1) Each day when any new snowfall occurs.
- (2) Each day when rain falls on existing snow cover.
- (3) Twice a week when there is snow cover if neither condition (1) nor (2) requires more frequent measurements.
- (4) By special request from Water Resources Engineering Branch.

SECTION III - COLLECTION OF STREAMFLOW DATA

3-01 GENERAL

Obtain lake and outflow gage readings by telephoning the Hydrologger at each station and recording the value in the log book. Add the zero of the lake gage, 951.75 feet, to lake readings to make elevation before recording. The necessary frequency for reading the gages at the project is set forth in the Schedule for Reading Gages, Plate 3-1. Instructions regarding the transmission of regular, extra and special reports of gage readings are contained in Section IV.

3-02 GAGES PERTINENT TO REGULATION OF LEESVILLE LAKE

a. Gage Listing. Information about gages of importance to operation of the project appears in Table No. 3-1.

b. Reading and Recording Gage Heights. List all gage readings in the records in order that complete data on the effect of the lake on natural flows will be available. Record lake gage readings in terms of elevation above mean sea level but record the gages in feet above gage datum, or zero of the gage. Gage datums are listed in Table No. 3-1.

TABLE NO. 3-1

PERTINENT GAGE DATA  
LEESVILLE LAKE  
MCGUIRE AND CONOTTON CREEK OF TUSCARAWAS RIVER

<u>Gage</u>	<u>Location</u>	<u>Code Symbol</u>	<u>Eqpt</u>	<u>Reference Gages</u>		<u>Recorder</u>	<u>Datum of Gage</u>
				<u>Staff</u>	<u>Other</u>		
Lake	Gate House	LVMD6	DCP	SL		RL	951.75
Outflow	100 feet below dam	LVMOF	DCP,H	SO	TO	RO,PO	915.0

- S - Staff
- T - Electric tape
- DCP - Data collection platform
- Hydrologger, answers telephone by giving stage in synthesized voice
- R - Strip chart recorder
- SB - Stilling Basin
- W - Wire Weight
- V - Voice module with data collection platform to answer telephone as the Hydrologger above
- P - ADR or Punch-tape type stage recorder

### 3-03 TELEPHONIC GAGES

In order to facilitate collection of stage information, a data collection platform was installed at the lake station to transmit lake levels to CELRD downlink via satellite for dissemination to CELRH Water Resources Engineering Branch. A Hydrologger was installed at the outflow station and one is to be installed later at the lake station to allow personal or computer interrogation for stage information by telephone line. To obtain reports from a Hydrologger, call the station telephone number. After a few seconds of high pitched tone, the Hydrologger will repeat by synthesized voice the unit identification, the time and current reading of the gage. Elevation and stage are called "level."

The message ends with a short pause and notification to "Enter command" which is to be ignored. One should note that the time given by the Hydrologger is Greenwich Mean Time (GMT). To convert to Eastern Daylight or Eastern Standard Time, subtract four or five hours, respectively. When interrogated by computer, a Hydrologger will give any portion or all of the stored readings specified.

The telephone numbers of these gages are classified as "Restricted" in order to avoid indiscriminate calls by unauthorized persons. The necessary frequency for obtaining reports from the telephonic gages is set forth in "Schedule for Reading Gages," Plate 1-1. Instructions pertaining to transmission of regular, extra and special reports of gage readings are contained in Section IV. Telephone numbers and code symbols assigned to the lake and outflow gages appear in Table No. 3-2.

TABLE NO. 3-2

#### STREAM GAGE TELEPHONE NUMBERS

Gage	*Code Symbol	Telephone Number of Device	Type
Leesville Lake	LEMD6		
Leesville Outflow	LEMOF		Telemark

\* Project abbreviation plus location on District Isohyetal Map

### 3-04 DATA COLLECTION

At times specified in the Schedule for Reading Gages and at other times requested, go to the lake and outflow stations and read stages from the strip chart recorders, adding gage zero to the lake reading to convert to elevation above mean sea level. Record values in the daily log and give to Muskingum Area Office when called for in morning and extra reports. Gate settings and operations are noted in the log and on Form 14 and the settings are included in morning and extra reports to the Area Office. The Area Office calls for reports from projects by the WITS computer beginning at 0800 hours according to the same alphabetical sequence in which furnished to Water Resources

Engineering Branch. Data are given by Leesville Lake personnel as detailed in Section IV below and as shown in Plate 3-1.

The data collection platforms mentioned in 3-03 above report outflow stage and lake elevation by transmitting to the CELRD downlink via satellite every four hours. The CELRD Water Control System retrieves from the downlink and disseminates hourly to Water Resources Engineering Branch WCS data base. By use of the WITS system with the portable terminal assigned, Area Office or Project personnel can access the most recent readings, or series of readings from area stations that are reported by platform.

SECTION IV - INSTRUCTIONS FOR COMPLETION AND  
TRANSMISSION OF REPORTS

4-01 REGULAR REPORTS

a. Weekly Report, ORH Form 14. To reduce the probability of error in transcribing data from other forms, enter gage readings through the week on a copy of Form 14. Obtain lake gage elevation and outflow gage readings for every six hours (0130, 0730, 1330, and 1930) during periods when the project is attended and record on the form. When gate changes are made, record them on the form immediately. The Schedule for Reading Gages, Plate 3-1, defines conditions for taking more frequent readings of gages. After each time of entering a reading on the form, check the correctness of the reading as recorded. If doubt arises, investigate to the extent necessary to be certain of the reading. During normal conditions, the 1930 and 0130 readings will not have been recorded on the form; therefore, take them from the recorder charts at the time of taking the 0730 readings. After any period when the project was not attended, obtain all missed readings from the recorder charts and record on Form 14. If it is necessary to turn the charts back in order to obtain readings, use instructions contained in Plate 3-2 for doing so and resetting properly after recording readings. On Monday morning, or Tuesday if the project was not attended on Monday, after recording any missed readings and the 0730 readings, type the data on a fresh Form 14 and check for accuracy. Make a copy for project files and mail to the District Office marked "Attention Water Resources Engineering Branch." A sample Form 14, Plate 4-1, is included at the end of this section.

b. Daily WITS Report. The regular morning readings at the project, including precipitation, readings of the lake "L" gage, outflow "K" gage, gate positions, river stages, gate operations and supplemental data shall be transmitted via WITS computer terminal to the Water Resources Engineering Branch by approximately 0800 hours each day on which the project is attended. The proper manner of reporting these data is shown in a printout of a WITS report at the end of this section as Plate 4-2. Further information concerning the WITS system is found in the WITS software package manual developed and published in May 1990, by Paul E. Cook and Lee Adkins of the Water Resources Engineering Branch, Huntington District Office. This system is computerized menu driven with a convenient auto-prompt feature. The system was further revised in May 1993 and installed at the dam.

Each report for Tuesday, Wednesday, and Thursday morning at the end of the regular information, shall have a supplemental report consisting of four 6-hour lake and outflow readings, starting with the 1330 hours values from the previous day and ending with the 0730 hour readings for the current day. There is no water quality stratification function at Leesville Lake, hence there is no weekly temperature dissolved oxygen profile in the supplemental report.

Reports for Saturdays, Sundays, and holidays on which the project is attended will be transmitted as on regular work days. Reports for unattended days will be transmitted after submission of the current report for the first working day which follows. Each regular WITS report shall also include any gage readings obtained visually or by telephone since the previous report. If conditions are such that the daily report cannot be transmitted to WITS by 0830 hours,

transmit via radio to the Water Resources Engineering Branch at that time. Instructions relative to arrangement and transmission of the WITS report are as follows:

(1) Logging On. Give WITS the qualifier and user number prescribed for Leesville Lake.

(2) Column 1 - Station Abbreviation. This column identifies the station. The first three letters comprise the abbreviation of the station name and the last letter and figure are a key to its location on the District Isohyetal Map. The entire five member group constitutes the abbreviation for the station and should always be used when asked by the menu. Follow the example shown on Plate 4-2 or refer to the WITS handbook.

(3) Column 2 - Precipitation, Beginning and Ending. Report the amount of precipitation at the time of observation in this column. Include the time of beginning and ending if it is available. When either the time of beginning or ending is unknown, read it from the recorder.

(4) Column 3 - Lake Elevation. Use this column for reporting the lake "I" gage, in feet ngvd, to the nearest hundredth foot, in a six digit group and for reporting stream gage readings, also to the nearest hundredth foot. Please include decimal points as asked by the menu.

(5) Column 4 - Outflow Stage. Use this column for reporting the reading at the "K" gage, in elevation to the nearest hundredth foot, in a six digit group. For example, record and report 2.29 feet as 917.29 and 4.00 feet as 921.0. This is done by adding the zero elevation of 915.0 to the stage reading. See the example shown in Plate 4-2 or follow the WITS handbook.

(6) Column 5 - Flow. Use this column for reporting the corresponding flow at the outflow gage in 1,000 cfs or K cfs.

(7) Column 6 and 7 - Snow and Amount. Report the amounts of snow and the water content in these columns. Where a station does not make this report or no precipitation has been reported, send NIL in place of this group.

The first three figures give the snow since the last 0730 report, but not to exceed a period of 24 hours. This will be in inches and hundredths. Indicate a trace by 00T. The fourth figure in this group is the amount of snow to the nearest whole inch which has fallen since the last 0730 report. The last figure in this group is the total depth of snow cover on the ground to the nearest whole inch. If there are ten inches or more of precipitation, snowfall or snow cover, report the amounts in a supplementary message. Always report the figures for snowfall and snow since the last report. In summer and at other seasons when there is zero snowfall and snow cover both at the time of the current and previous observations, omit the fourth and fifth figures in this group. The example form is shown on Plate 4-2 and the WITS handbook.

(8) Column 8,9 - Weather Description. The last two columns in this group are used to report the weather code and indicate the state of the weather at the time of observation, in accordance with the following code:

MM - missing or unknown    DR - drizzle or fine rain    HS - heavy snow  
FA - fair or clear            LR - light to moderate rain    MI - mist of fog

CL - cloudy  
snow PC - partly cloudy

HR - heavy rain  
SL - sleet or hail

LS - light to moderate

When there has been no precipitation to report, show this whole group as NIL.

(9) Slide Gate Settings - Column 1,2,and 3. Use these columns for reporting the amount of opening of the slide gates, starting with the number one gate on the left and then number two at the time of observation. The menu requests gate opening to the nearest tenth of a foot in four-digit notation. For example, record 2.5 feet as 2.50, 6 feet as 6.00 and closed as .00. In the WITS report, transmit gate openings in four-digit groups including decimal points. Include any operation of the by-pass conduit on this page in column 7.

(10) Selective Withdrawal Settings. There is no water quality selective withdrawal system at Leesville Lake, therefore daily stratification, water quality, and sediment data are not required, at this time.

(11) Gate Operation. Record all gate operations since the previous report and transmit with each regular, extra, or special report, listing them in chronological order. There is no selective withdrawal system at Leesville Lake, therefore there is no selective withdrawal data. Enter the data on the form in the following manner. Use column one for the gate designation and columns two through six, successively for initial gate opening, final gate opening, date, beginning time, and ending time. See the example in Plate 4-2 or the WITS handbook.

(12) Supplemental Lake and Outflow Data. Place the supplemental lake and outflow readings in the daily WITS reports for Tuesday, Wednesday and Thursday as follows: Use column one for the project abbreviation; column two, time of the readings; column three, precipitation; column four, lake elevation; column five and six, snow depth and water equivalent; and column seven and eight, weather code and status description. Read all gages at the dam as near the same time as possible, reporting as the time of observation the approximate mean of the times the gages were read. When more than one report from a gage is available at the scheduled time of transmission of the regular report, include the additional readings on the form, listing chronologically, adjacent to the regular report from that station. In composing this report prior to transmission, list the stations in the order requested by the menu: Leesville Lake, Dover, Newcomerstown, Coshocton, Zanesville, McConnellsville, and Marietta. Follow the example shown on Plate 4-2 or the WITS manual.

(13) Supplementary Messages. Report additional data in message form at the end of the WITS report. Include any or all of the following, as appropriate, in such messages:

(a) Precipitation and snow cover amounts when either is ten (10) inches or more.

(b) Moisture content of snow cover, when requested.

(c) Precipitation at the dam during the past 24 hours, when greater than one (1) inch, by 6-hour periods.

#### 4-02 EXTRA REPORTS

Extra reports, as indicated by Schedule for Reading Gages should always be transmitted to WITS via computer in the same way as the regular morning WITS report. If some circumstance prohibits, such as for example, malfunction of the computer or lack of computer competency by personnel on duty, attempt to telephone the report to Water Resources Engineering Branch in the District Office. Failing this attempt, telephone the report to one of the Water Resources Engineering Branch personnel in the order listed below in paragraph 4-03c.

#### 4-03 SPECIAL REPORTS

a. Reporting Criteria. Special reports include any report not regularly scheduled. A special report should be made when an event occurs concerning the project that Water Resources Engineering Branch should have knowledge of or when requested by the Branch.

b. Special Report Data. The following types of occurrences or information are examples of occasions for or subjects of special reports.

- (1) Heavy precipitation after 0730 hours.
- (2) Extraordinary meteorological event such as a tornado or blizzard.
- (3) Gate positions and/or operations.
- (4) Flooding upstream or downstream.
- (5) Request for special operation.
- (6) Catastrophe such as drowning.
- (7) Moisture content of snow.
- (8) Air temperature at times other than 0730 hours if significant.
- (9) Local weather forecast.

c. Transmission of Special Reports. All special reports should be made at any time of day or night, including weekends and holidays, or when requested by Water Resources Engineering Branch. During office hours, submit them by telephone; however, if it is impossible by telephone, utilize the District radio network. When making telephone calls after hours or during weekends or holidays, unless advised that the Water Resources Engineering Branch will be on duty, place a person-to-person call to one of the following Water Resources Engineering Branch personnel, in the order listed:

#### 4-04 RADIO AS BACKUP COMMUNICATION

Keep the radio turned on at all times when anyone is on duty at the project office, including overtime periods, since Area Office and District Office operators are sometimes on duty outside of regular office hours. Also, messages may be relayed through other projects. When there is difficulty in transmitting reports to the Area Office via radio or telephone, attempt to transmit by radio either direct to the District Office or by relay through another project which has contact with the District Office. Failing the above, telephone Corps of Engineers listings in 4-03c as appropriate.

If the radio is used for a morning report the data must be ready for radio transmission by 0800 when Muskingum Area Office begin calling the projects for these reports. The regular morning data at the dam include precipitation, water levels at lake and outflow gages, gate positions, depth of snow cover, if any, beginning and ending times of precipitation with current weather, and water content of snow if previously requested. After transmitting reports, projects must monitor the radio in order to receive any special instruction until given the "Clear" signal. An example of special instruction would be to be prepared to make extra reports, and if so, whether water content of snow would be required. In order to simplify and expedite transmission and copying the data in the Area Office, it is directed that the normal sequences or groupings be observed.

#### 4-05 LETTER REPORTS

a. General. All letter reports pertaining to water control management will be addressed to the District Engineer, Attention: Water Resources Engineering Branch.

b. Downstream Channel Conditions. At the request of Water Resources Engineering Branch, inspection of critical areas downstream from the dam as far as Dover will be made for conditions listed below:

(1) Channel encroachment and/or indiscrete utilization of low-lying areas during moderate rainfall when project discharge is at minimum for the season.

(2) If complaints of flooding are received, notify Area Office immediately; then make any inspection requested by Area Office of the specific area as soon as practicable.

(3) At any other times, as requested by Water Resources Engineering Branch, and under (2) above, the essential items to note and report are: (a) persons or communities involved, (b) nature of complaint or encroachment, and (c) extent and depth of flooding. Make a letter report, containing pictures, cross sections or sketches of the findings as soon as practicable if required after a brief initial report via telephone to Area Office or Water Resources Engineering Branch.

(4) The Water Resources Engineering Branch should be informed concerning applications of chemicals to the water or to surrounding land. This includes fertilizers and pesticides.

c. Low Flow Releases. During periods of low flow release, downstream observations shall be made of stream depth, fish and wildlife, water odor, and discoloration, if any, as directed by the Water Resources Engineering Branch.

Stream gages, rain gages and temperature equipment shall be periodically checked for proper functioning and performance or when directed by the Water Resources Engineering Branch. During periods of stratification, outflow temperature requirements will be maintained according to directives issued by the Water Resources Engineering Branch.

d. Functioning of the Dam. Functioning of the dam shall be observed at all times, including performance of gates, valves, machinery and outlet structure and the presence of any leakage. During flood storage periods when the lake level reaches or exceeds the Alert Elevation, 968 feet ngvd, for Leesville Lake, daily observations are made and reported under provisions of the Dam Operations Management Policy in addition to the normal weekly and monthly observations made under the Policy. At these times, or other times requested by Water Resources Engineering Branch for a particular use, forward a copy of such observations as soon as practicable to Water Resources Engineering Branch as a letter report.

e. Water Quality Reports. Any unusual water conditions should be reported to the Water Resources Engineering Branch, particularly:

(1) Floating debris, oil, scum and other floating materials from municipal, industrial, or other discharges such as from agricultural practices in such amounts that they are unsightly or detrimental to wildlife or public health.

(2) Unusual color, odor or other conditions in such degree as to be a nuisance.

(3) Any fish kills, plankton blooms or insects to the degree that they are a nuisance should be reported.

(4) The Water Resources Engineering Branch should be informed concerning applications of chemicals to the water or to surrounding land. This includes fertilizers and pesticides.

CORPS OF ENGINEERS

Water Resources Engineering Branch Personnel

Home Telephone Number

[REDACTED]  
Chief, Water Control Section

[REDACTED]

[REDACTED]  
Water Control Section

[REDACTED]

[REDACTED]  
Chief, Water Resources Engineering Branch

[REDACTED]

Pertinent telephone numbers which may be of value during a flood emergency are listed below:

Huntington District Office, Water Resources Engineering Branch

Normal Work Hours, Nights,  
Weekends, and Holidays

[REDACTED]  
[REDACTED]

Muskingum Area Office,  
New Philadelphia, Ohio

Normal Work Hours,

[REDACTED]

Night, weekend  
Holiday, NWS observers  
Person-to-Person, at home

[REDACTED]

[REDACTED]

[REDACTED]

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

The mailing address is:  
Leesville Lake  
5037 Deer Road, SW  
Bowerston, Ohio 44695-9621  
Telephone [REDACTED]

The Damtender is:  
[REDACTED]  
9489 Lakeview Road  
Mineral City, Ohio  
44656

Other Agencies

U.S. Geological Survey,  
New Philadelphia, Ohio  
Nights, Weekends, Holidays

[REDACTED]

[REDACTED]

[REDACTED]

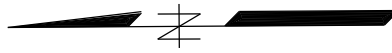
N.W.S. Forecast Office  
Cleveland, Ohio  
Hydrology Section

[REDACTED]

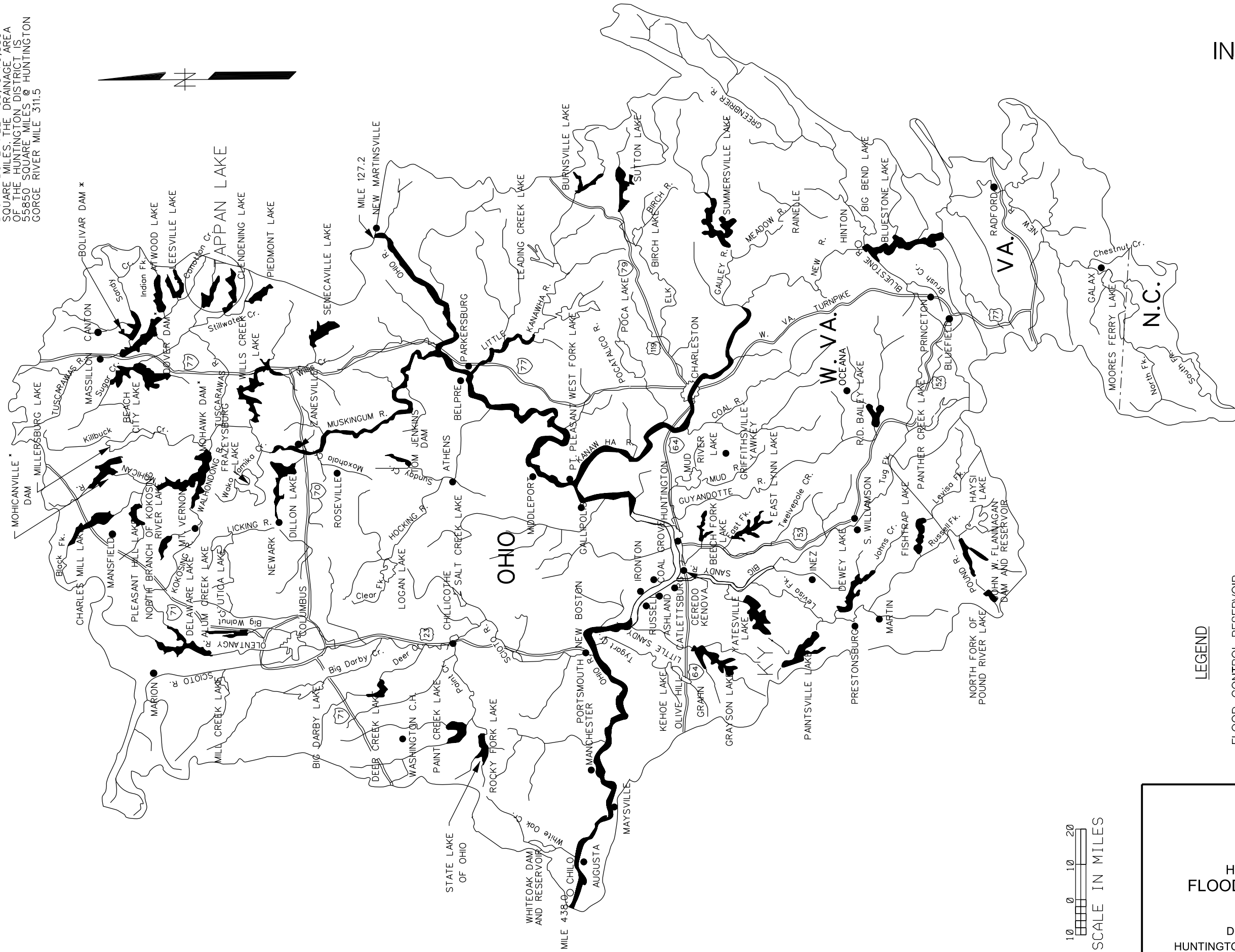
[REDACTED]

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, W.VA.) AND MILE 438.0 (3.5 MILES DOWNSTREAM FROM CHILO, OHIO) BELOW PITTSBURGH, PA. AND THE DRAINAGE AREAS 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 55,850 SQUARE MILES @ HUNTINGTON GORGE RIVER MILE 311.5



# 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



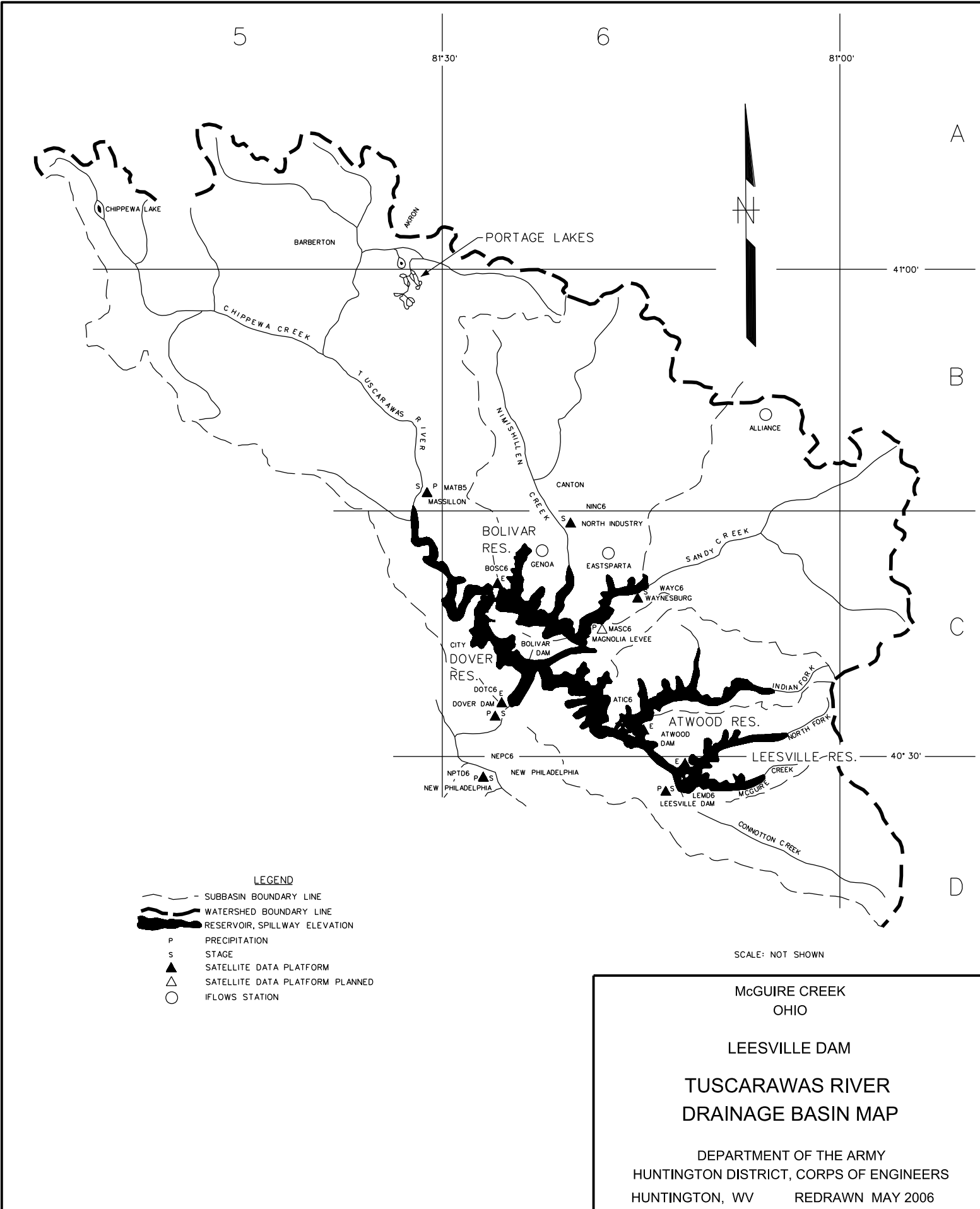
McGUIRE CREEK  
OHIO

LEESVILLE DAM

HUNTINGTON DISTRICT  
FLOOD CONTROL PROJECTS

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV      REDRAWN MAY 2006

\* DRY DAM, WITH FLOOD CONTROL POOL OUTLINED.



5

6

81°30'

81°00'

A

41°00'

B

C

D

**LEGEND**

- - - SUBBASIN BOUNDARY LINE
- WATERSHED BOUNDARY LINE
- RESERVOIR, SPILLWAY ELEVATION
- P PRECIPITATION
- S STAGE
- ▲ SATELLITE DATA PLATFORM
- △ SATELLITE DATA PLATFORM PLANNED
- IFLOWS STATION

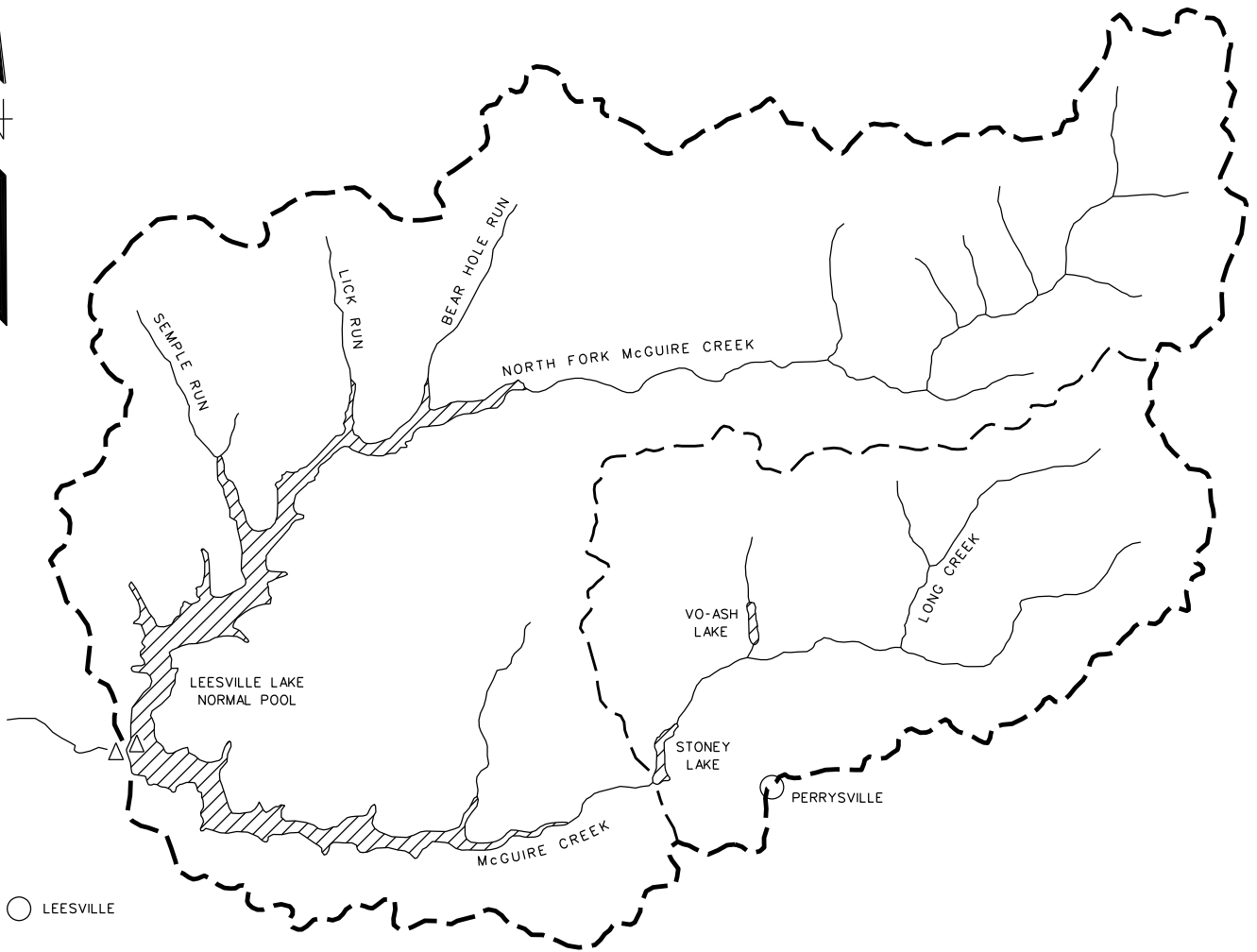
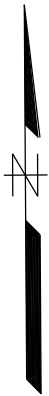
SCALE: NOT SHOWN

McGUIRE CREEK  
OHIO

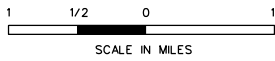
LEESVILLE DAM

**TUSCARAWAS RIVER  
DRAINAGE BASIN MAP**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN MAY 2006



○ LEESVILLE



SCALE IN MILES

△ GAUGING STATION

McGUIRE CREEK  
OHIO

LEESVILLE DAM

DRAINAGE BASIN

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV      REDRAWN MAY 2006

McGUIRE CREEK  
OHIO

LEESVILLE DAM

PLAN AND ELEVATION OF DAM

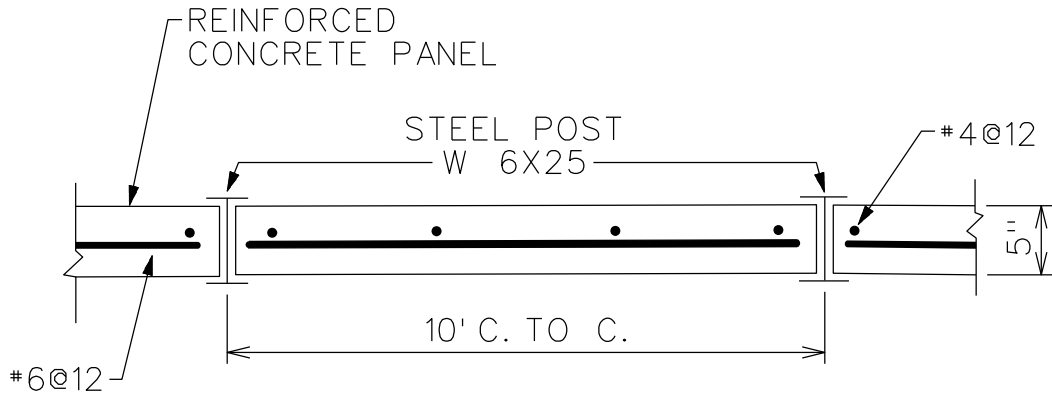
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV      REDRAWN MAY 2006

McGUIRE CREEK  
OHIO

LEESVILLE DAM

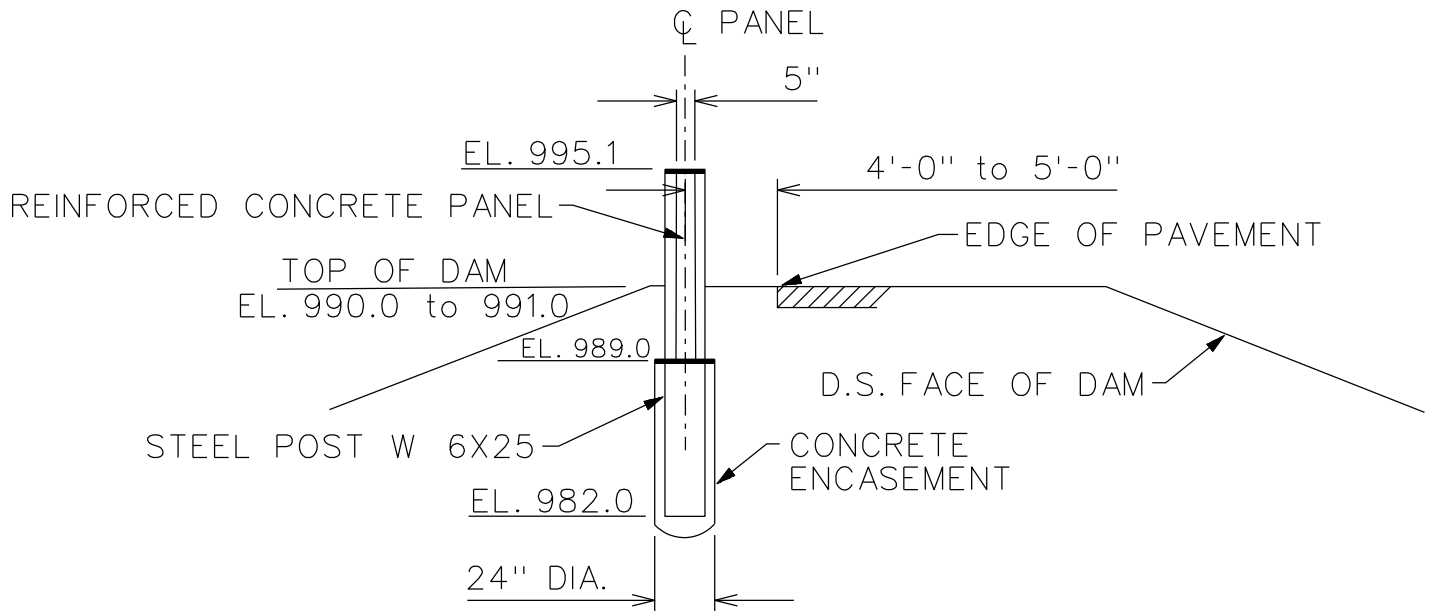
**EMBANKMENT DETAILS**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV      REDRAWN MAY 2006



SECTION B-B

NOT TO SCALE



SECTION A-A

NOT TO SCALE

McGUIRE CREEK  
OHIO

LEESVILLE DAM  
CORRECTION OF SPILLWAY  
DEFICIENCY - DETAILS OF PRECAST  
CONCRETE PANEL WALL

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN MAY 2006

McGUIRE CREEK  
OHIO

LEESVILLE DAM

SPILLWAY PLAN AND PROFILE

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN MAY 2006

NOTE:  
FIGURES IN CIRCLES INDICATE ITEM UNDER WHICH PAYMENT WAS MADE.

McGUIRE CREEK  
OHIO

LEESVILLE DAM

**DETAILS AND SECTIONS**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV      REDRAWN MAY 2006

McGUIRE CREEK  
OHIO

LEESVILLE DAM

OUTLET WORKS  
AND TUNNEL SECTION

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN MAY 2006

McGUIRE CREEK  
OHIO

LEESVILLE DAM

**INTAKE - PLAN AND ELEVATION**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV      REDRAWN MAY 2006

McGUIRE CREEK  
OHIO

LEESVILLE DAM

**INTAKE - PLAN AND DETAILS**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV      REDRAWN MAY 2006

McGUIRE CREEK  
OHIO

LEESVILLE DAM

**INTAKE - SECTIONS**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV      REDRAWN MAY 2006

McGUIRE CREEK  
OHIO

LEESVILLE DAM

**STILLING BASIN - PLAN AND SECTIONS**

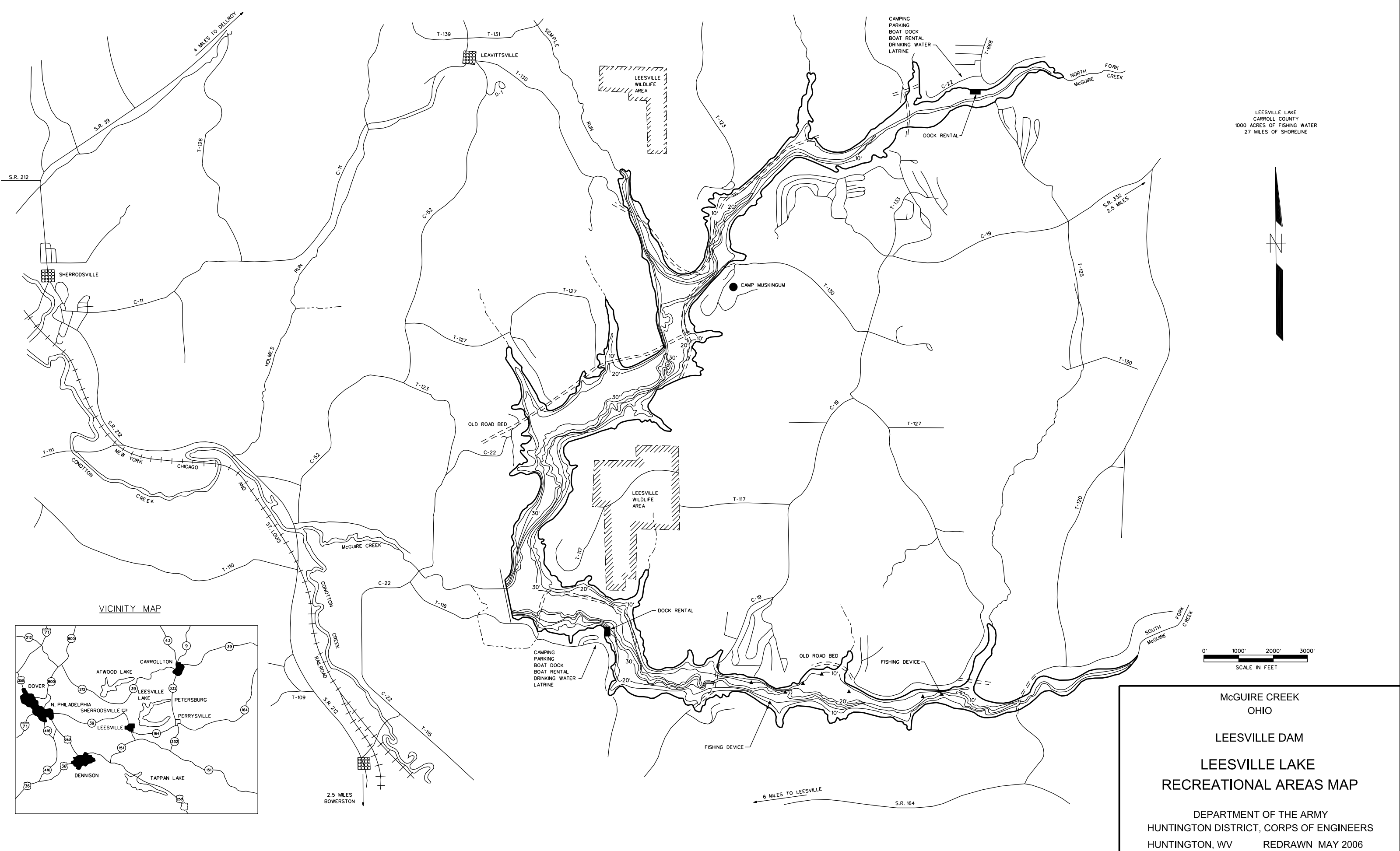
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV      REDRAWN MAY 2006

McGUIRE CREEK  
OHIO

LEESVILLE DAM

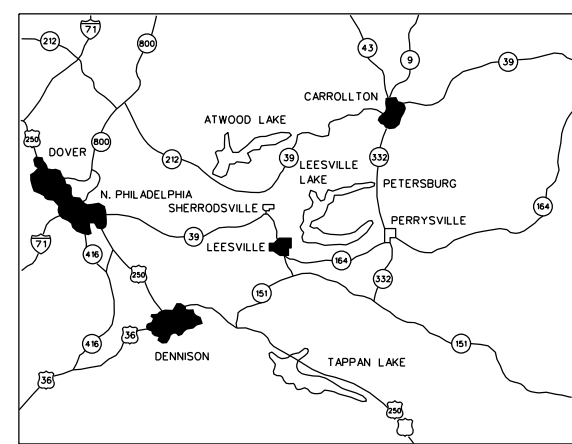
OPERATING HOUSE -  
PLANS AND ELEVATION

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV      REDRAWN MAY 2006



LEESVILLE LAKE  
 CARROLL COUNTY  
 1000 ACRES OF FISHING WATER  
 27 MILES OF SHORELINE

VICINITY MAP

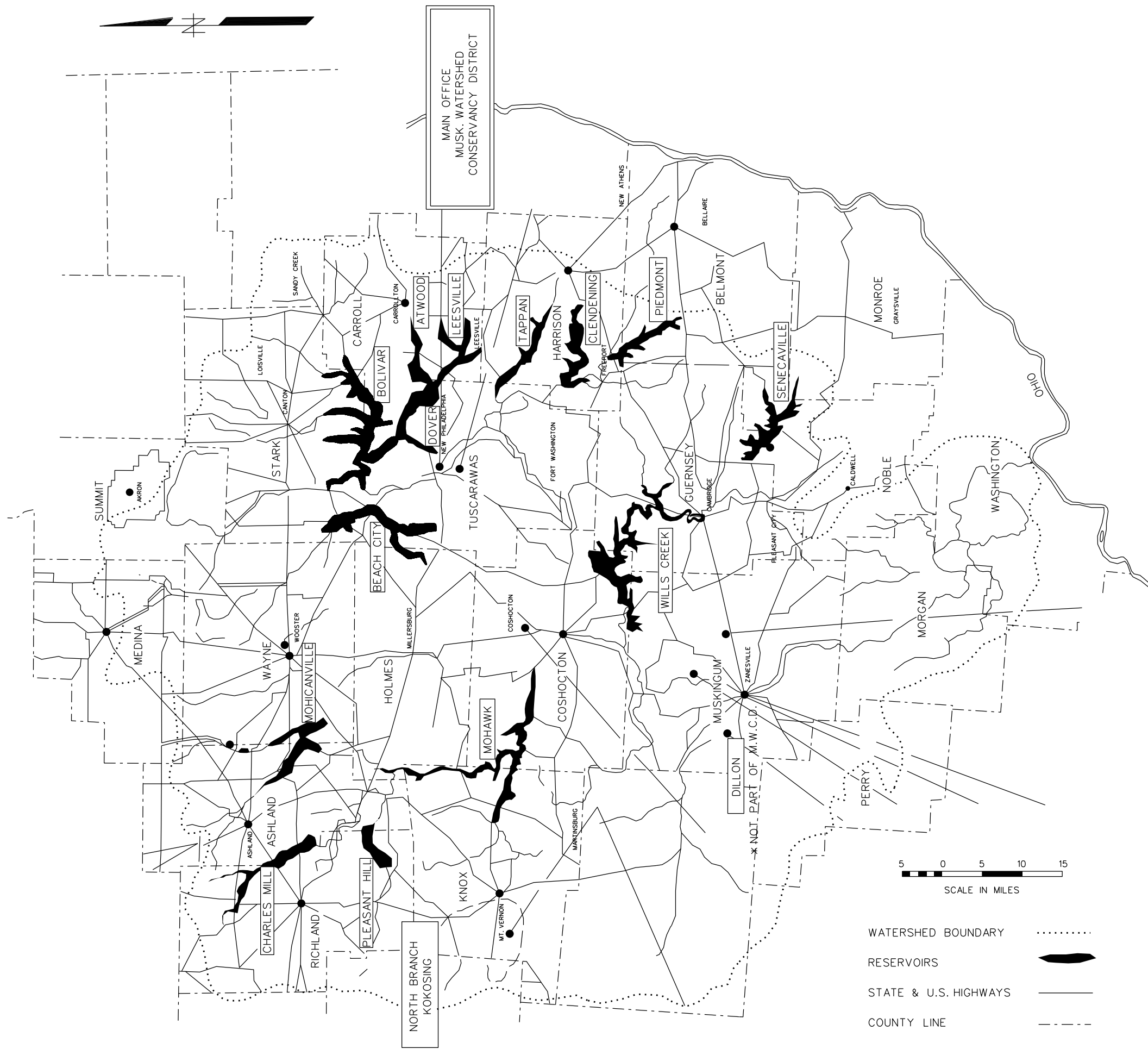


McGUIRE CREEK  
 OHIO

LEESVILLE DAM

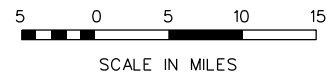
LEESVILLE LAKE  
 RECREATIONAL AREAS MAP

DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, WV REDRAWN MAY 2006

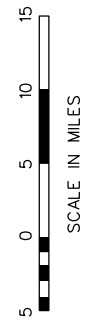


MAIN OFFICE  
MUSK. WATERSHED  
CONSERVANCY DISTRICT

NORTH BRANCH  
KOKOSING



- WATERSHED BOUNDARY ..... (dotted line)
- RESERVOIRS (black shape)
- STATE & U.S. HIGHWAYS (solid line)
- COUNTY LINE (dashed line)



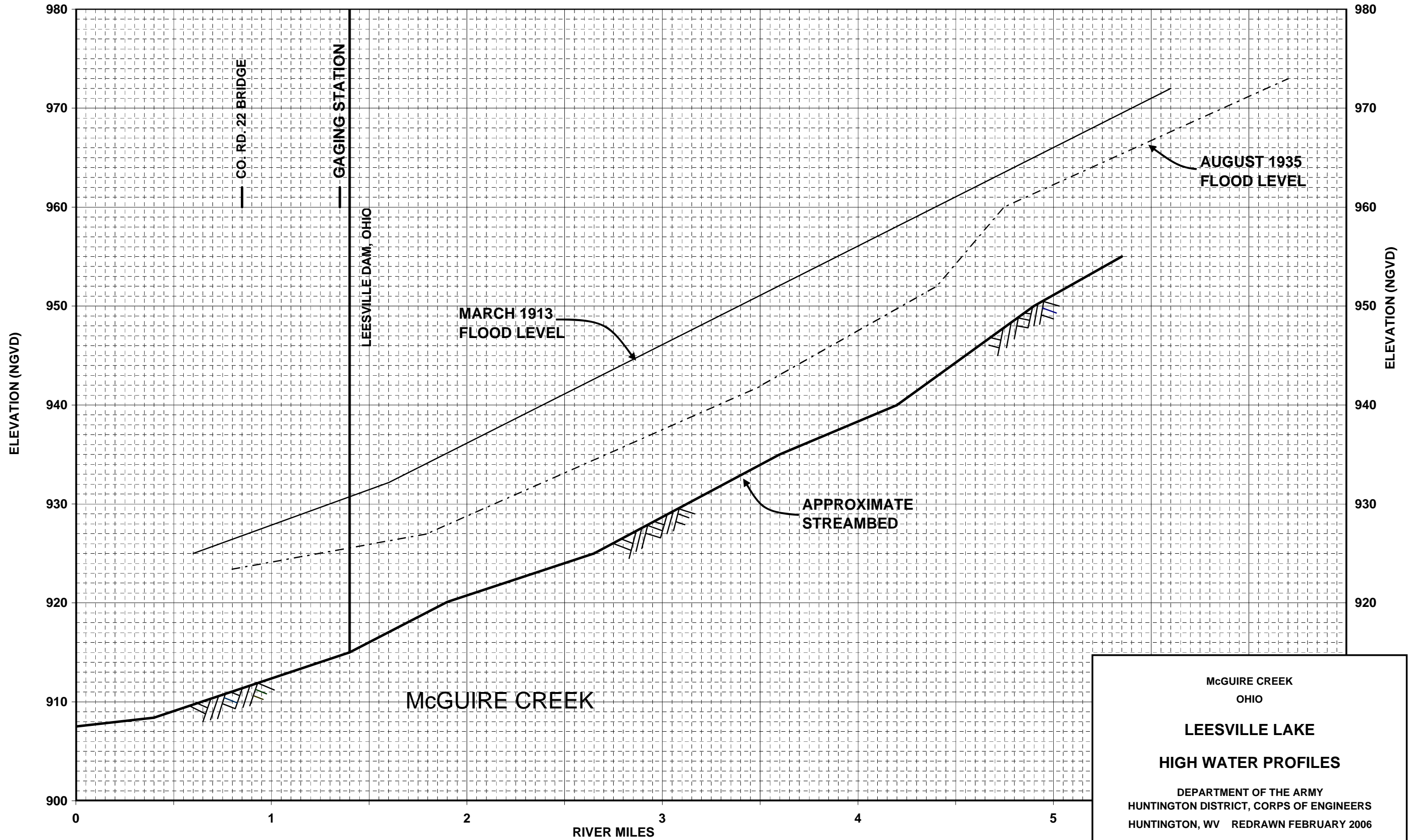
- WATERSHED BOUNDARY ..... (dotted line)
- RESERVOIRS (black shape)
- STATE & U.S. HIGHWAYS (solid line)
- COUNTY LINE (dashed line)

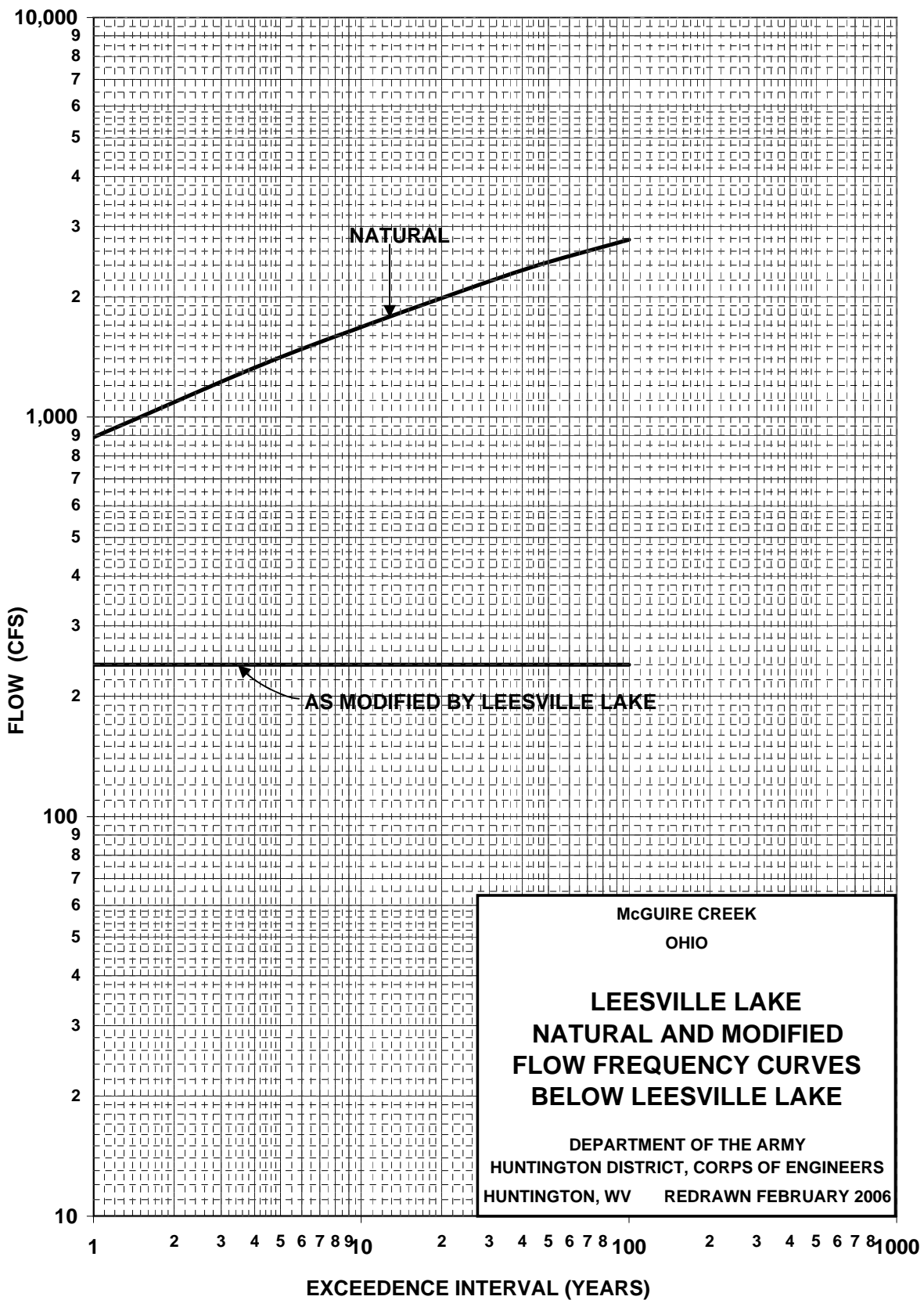
McGUIRE CREEK  
OHIO

LEESVILLE DAM

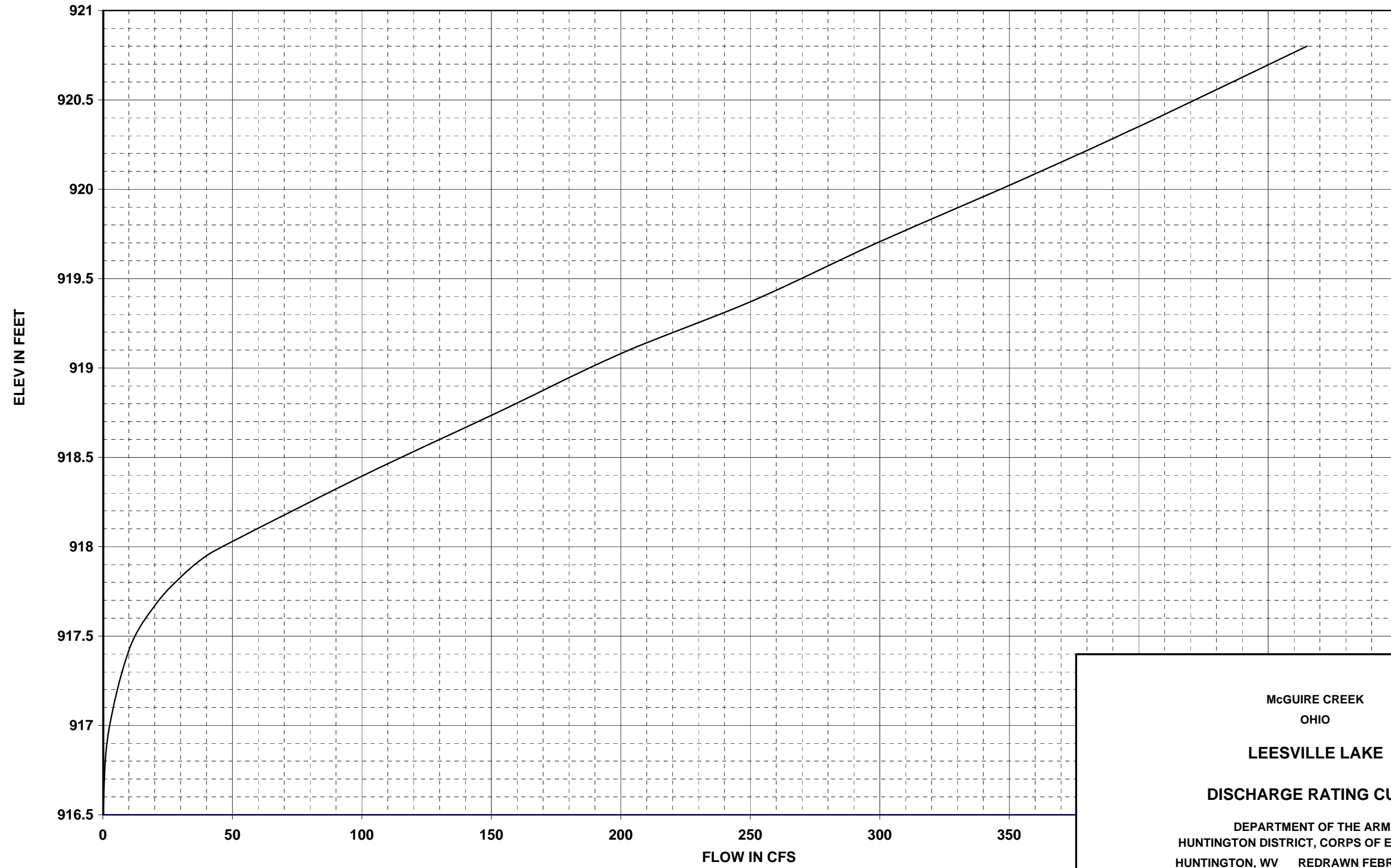
**MUSKINGUM WATERSHED  
RESERVOIRS**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN MAY 2006



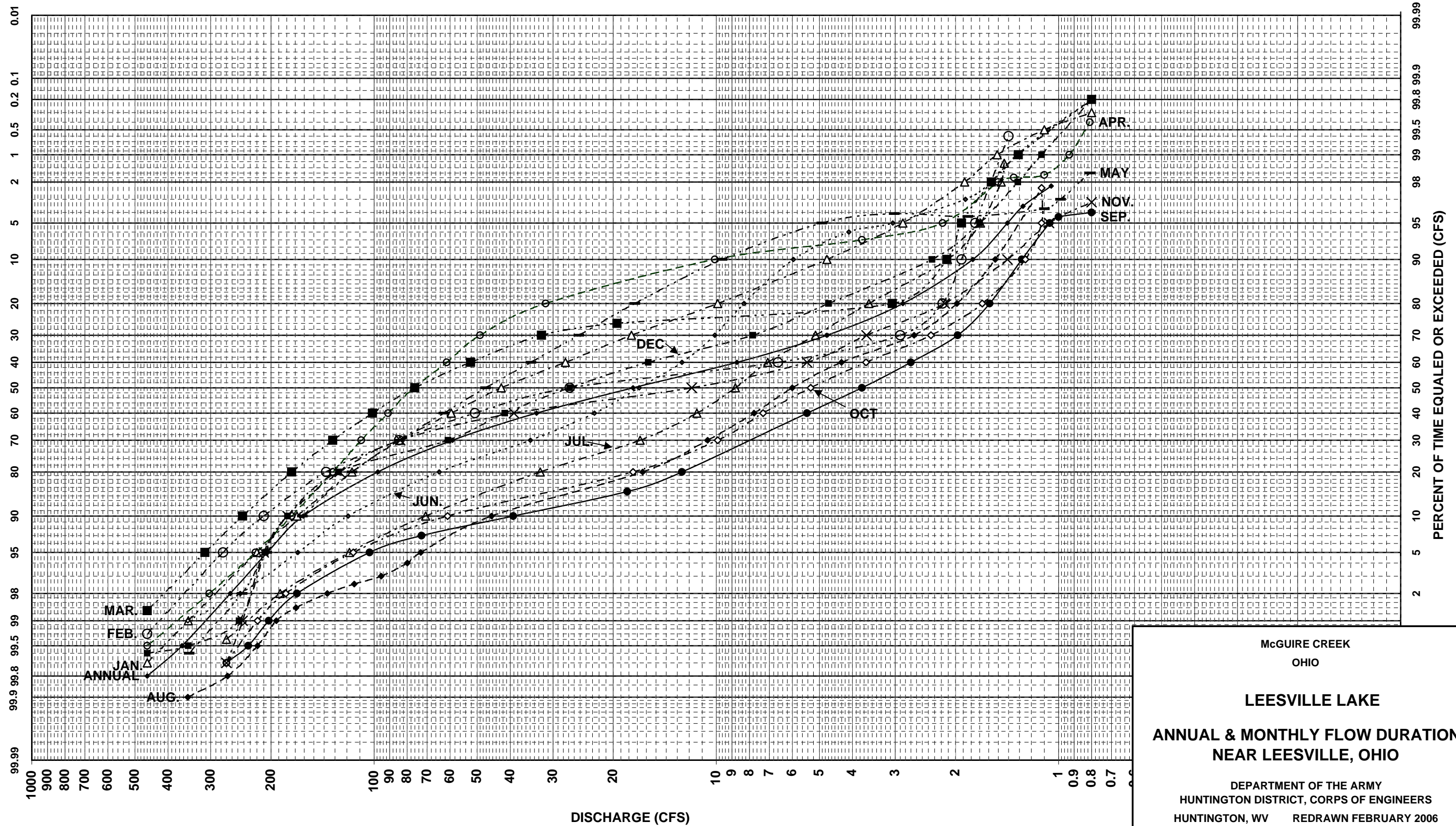


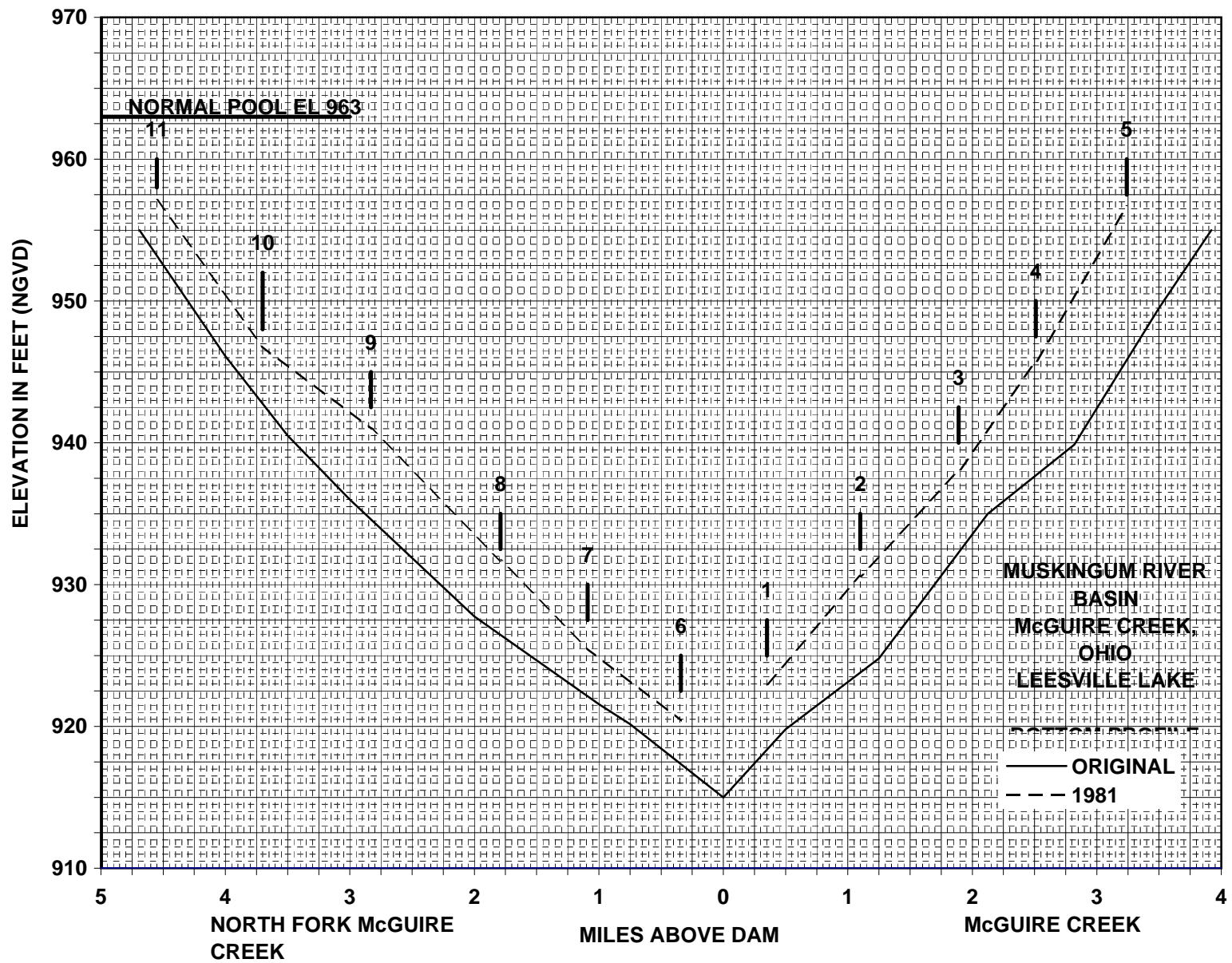
# MUSKINGUM



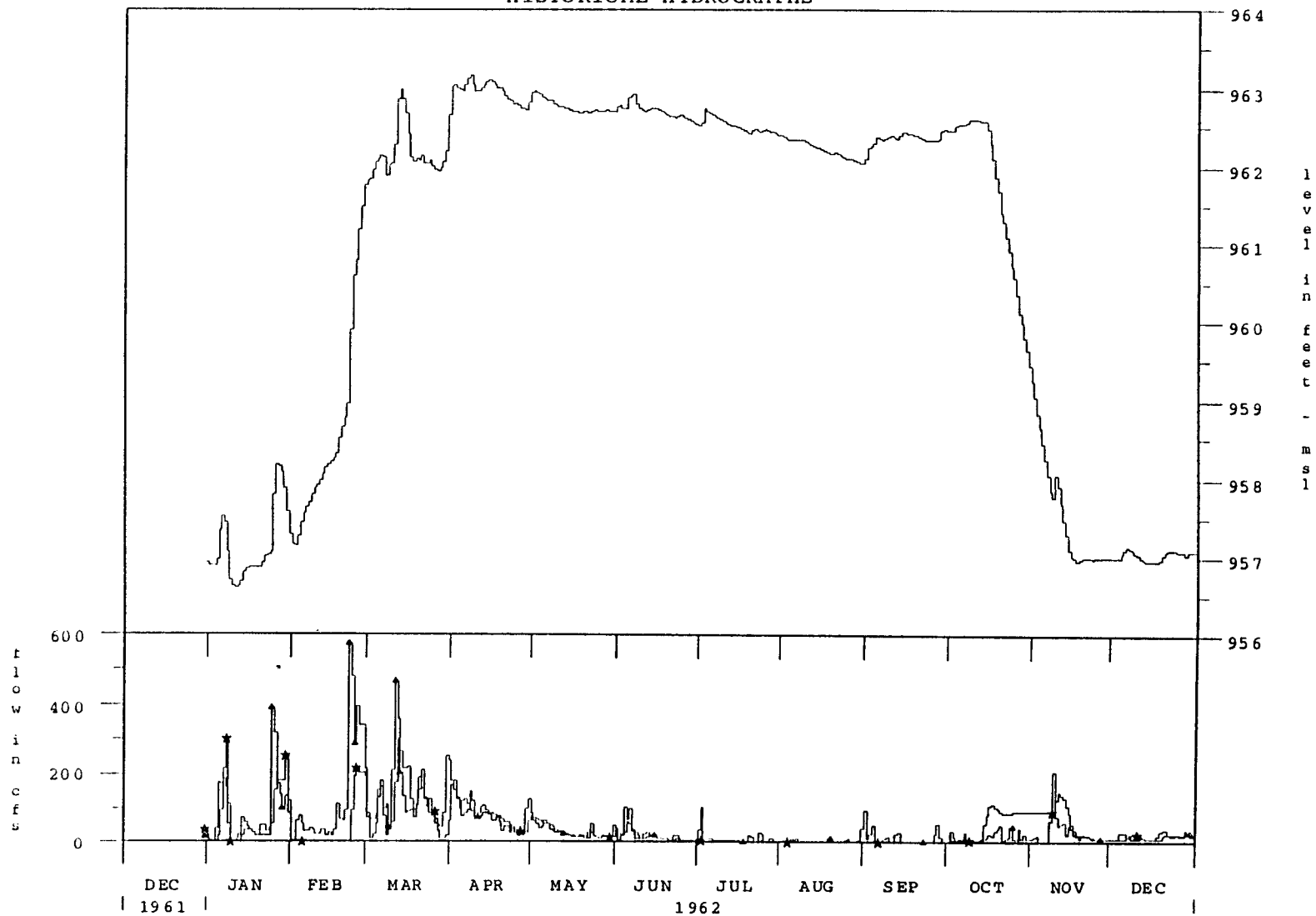
— LEMOF RES OUT FLOW USGS TABLE NO. 23

McGUIRE CREEK  
OHIO  
**LEESVILLE LAKE**  
**DISCHARGE RATING CURVE**  
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN FEBRUARY 2006



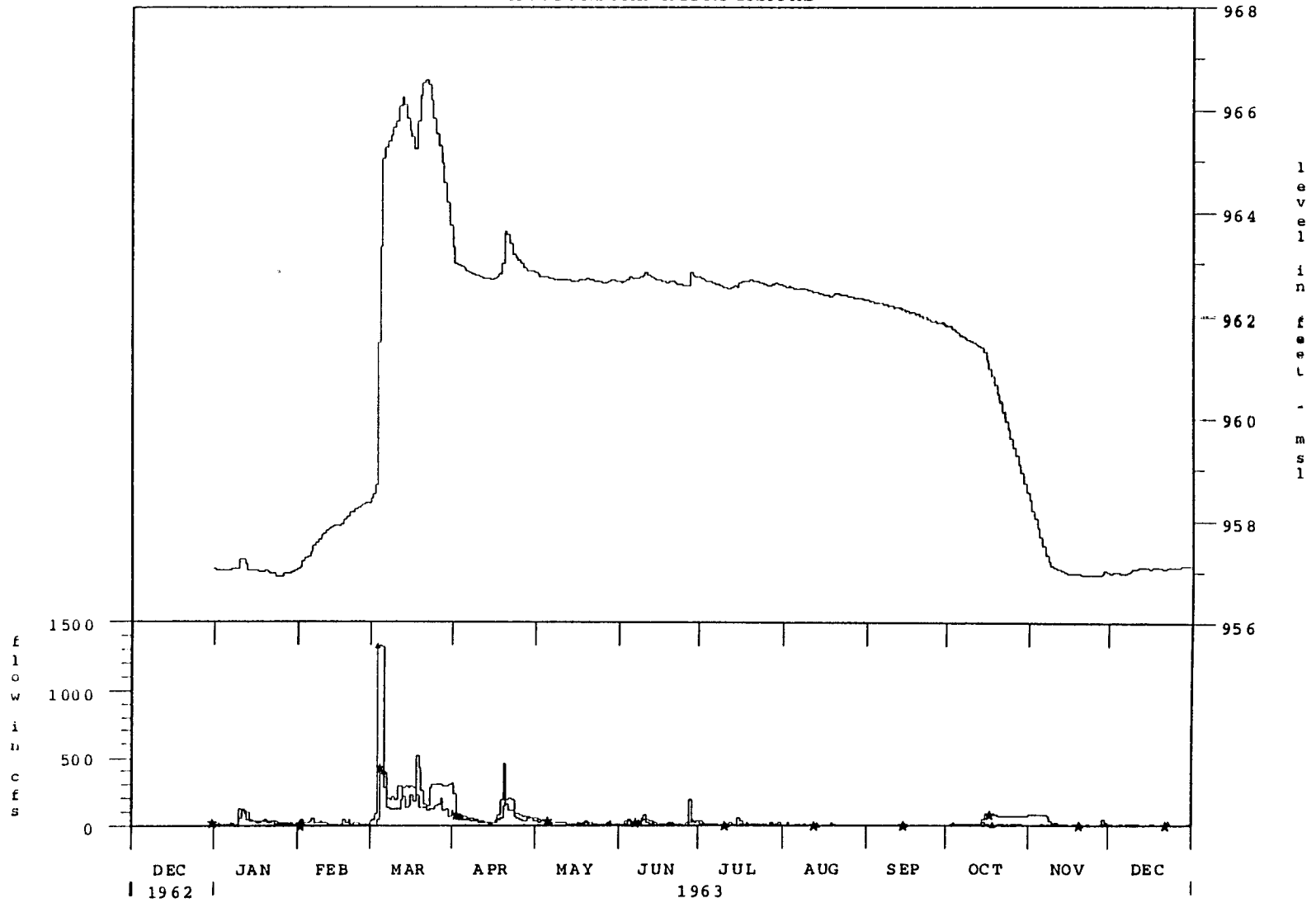


# HISTORICAL HYDROGRAPHS



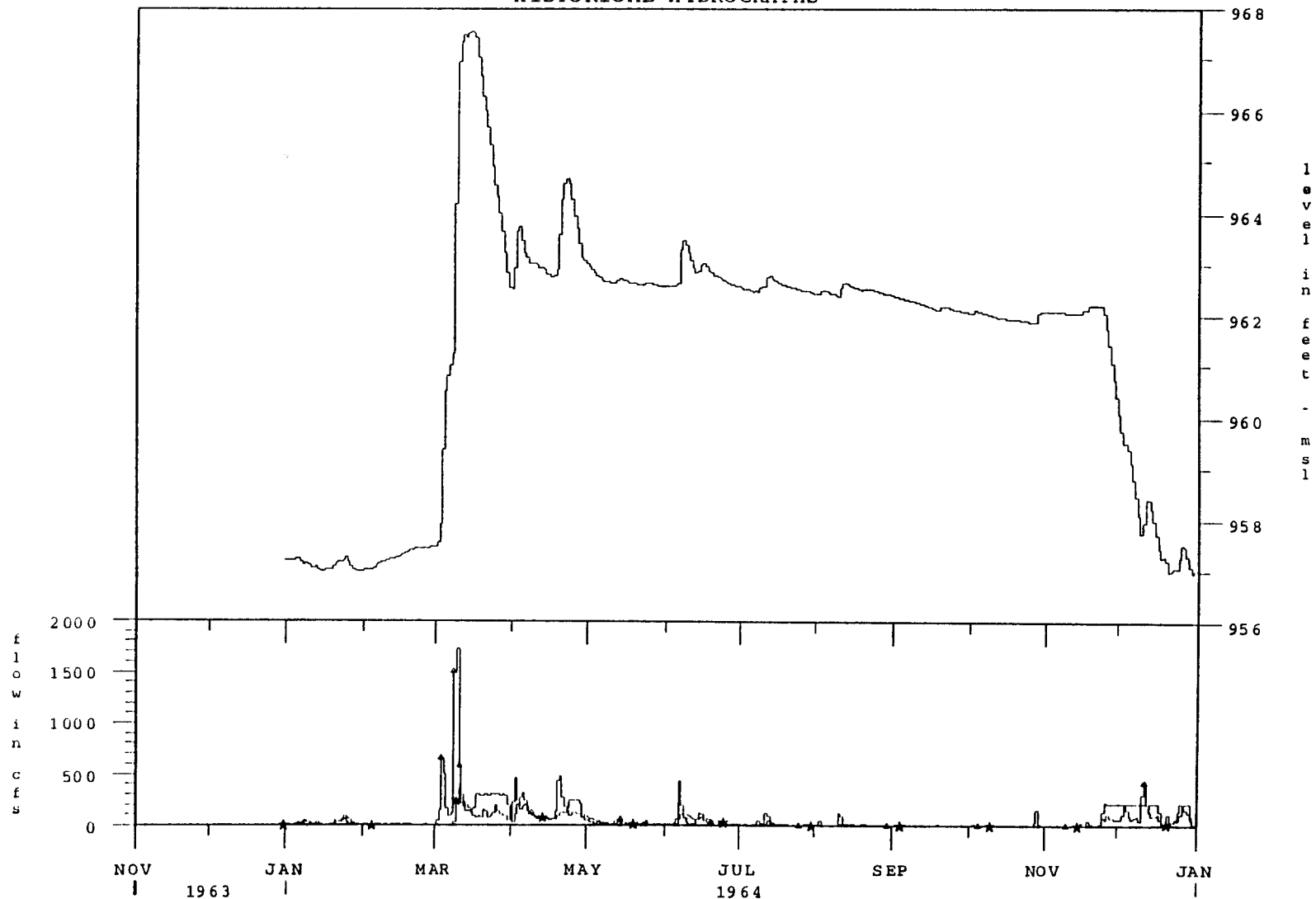
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 —★— LEESVILLE LAKE OUTFLOW  
 — LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



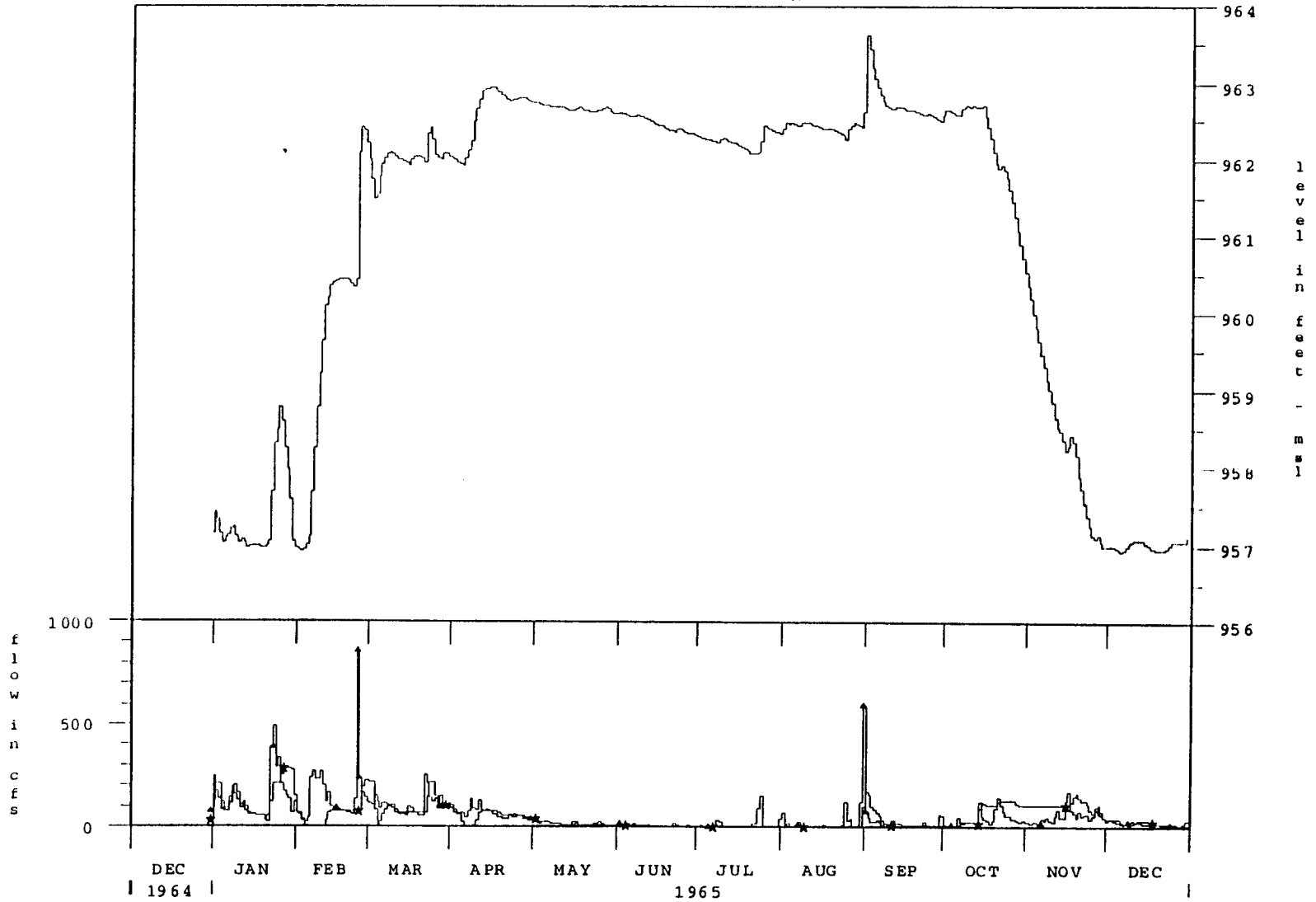
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 —▲— LEESVILLE LAKE OUTFLOW  
 ——— LEESVILLE LAKE LEVEL

HISTORICAL HYDROGRAPHS



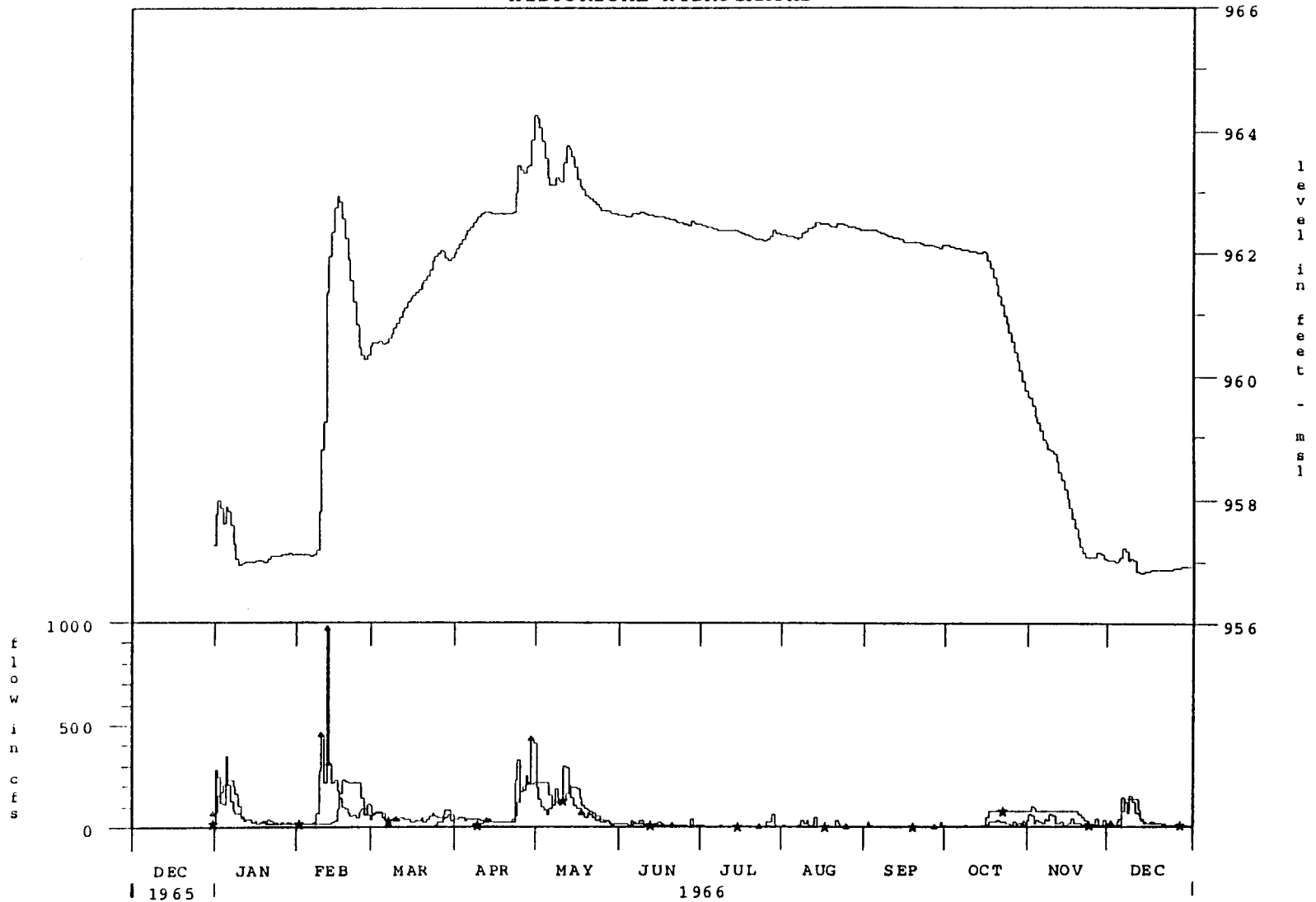
▲ ——— LEESVILLE LAKE INFLOW  
 ★ ——— LEESVILLE LAKE OUTFLOW  
 ——— LEESVILLE LAKE LEVEL

HISTORICAL HYDROGRAPHS



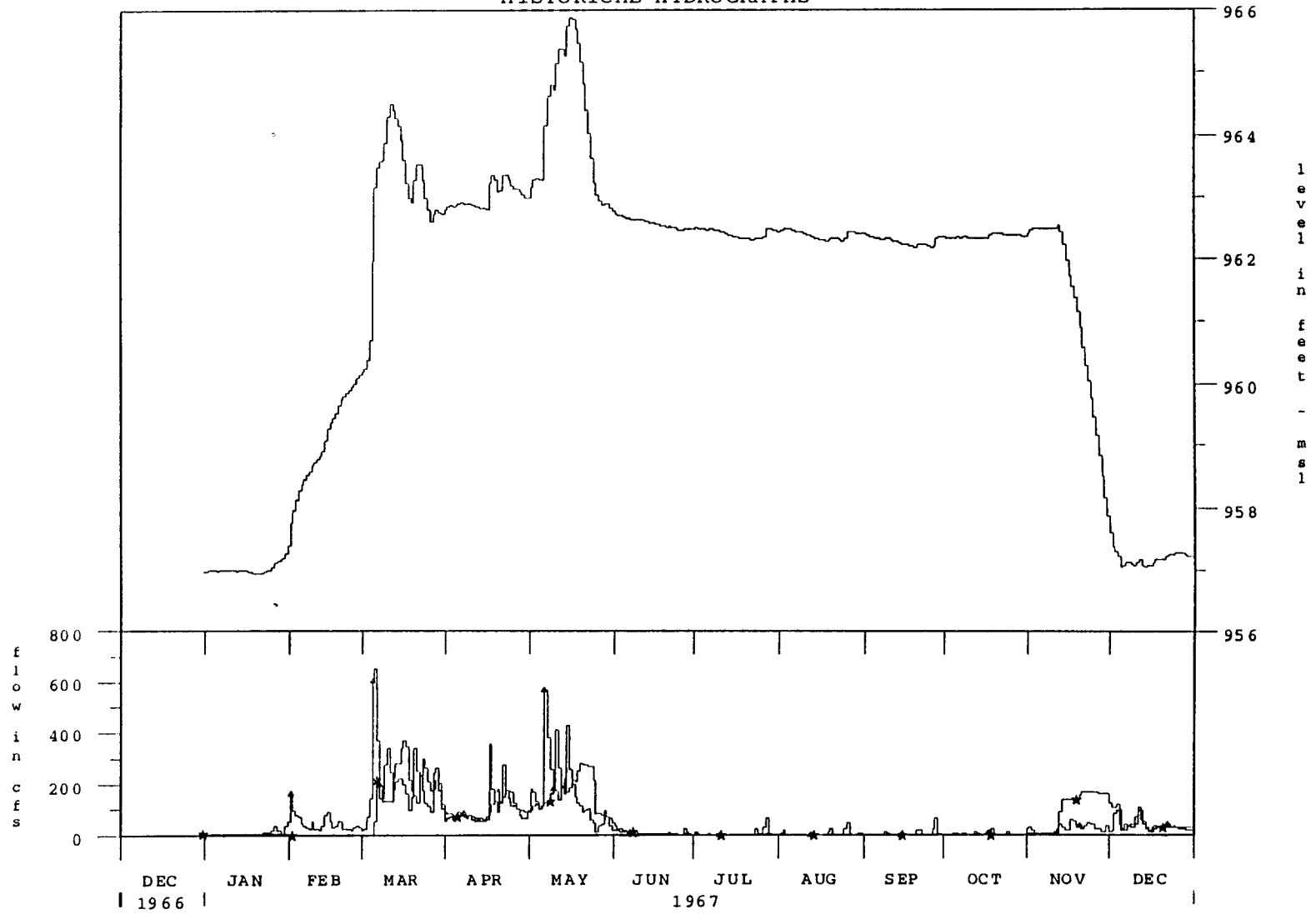
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—★— LEESVILLE LAKE OUTFLOW  
— LEESVILLE LAKE LEVEL

### HISTORICAL HYDROGRAPHS



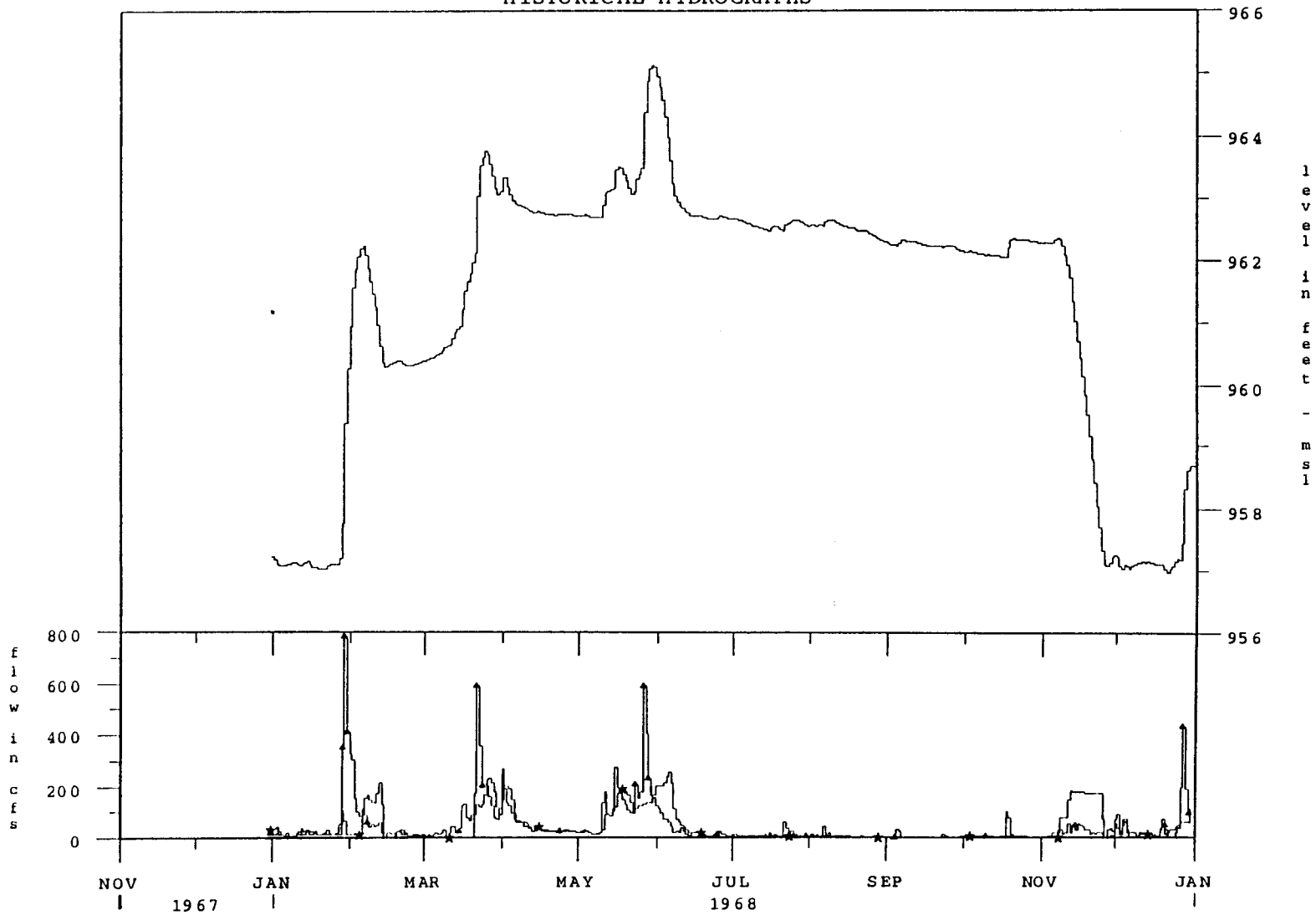
- - - \* - - - LEESVILLE LAKE INFLOW  
 - - - \* - - - LEESVILLE LAKE OUTFLOW  
 - - - - - LEESVILLE LAKE LEVEL

### HISTORICAL HYDROGRAPHS



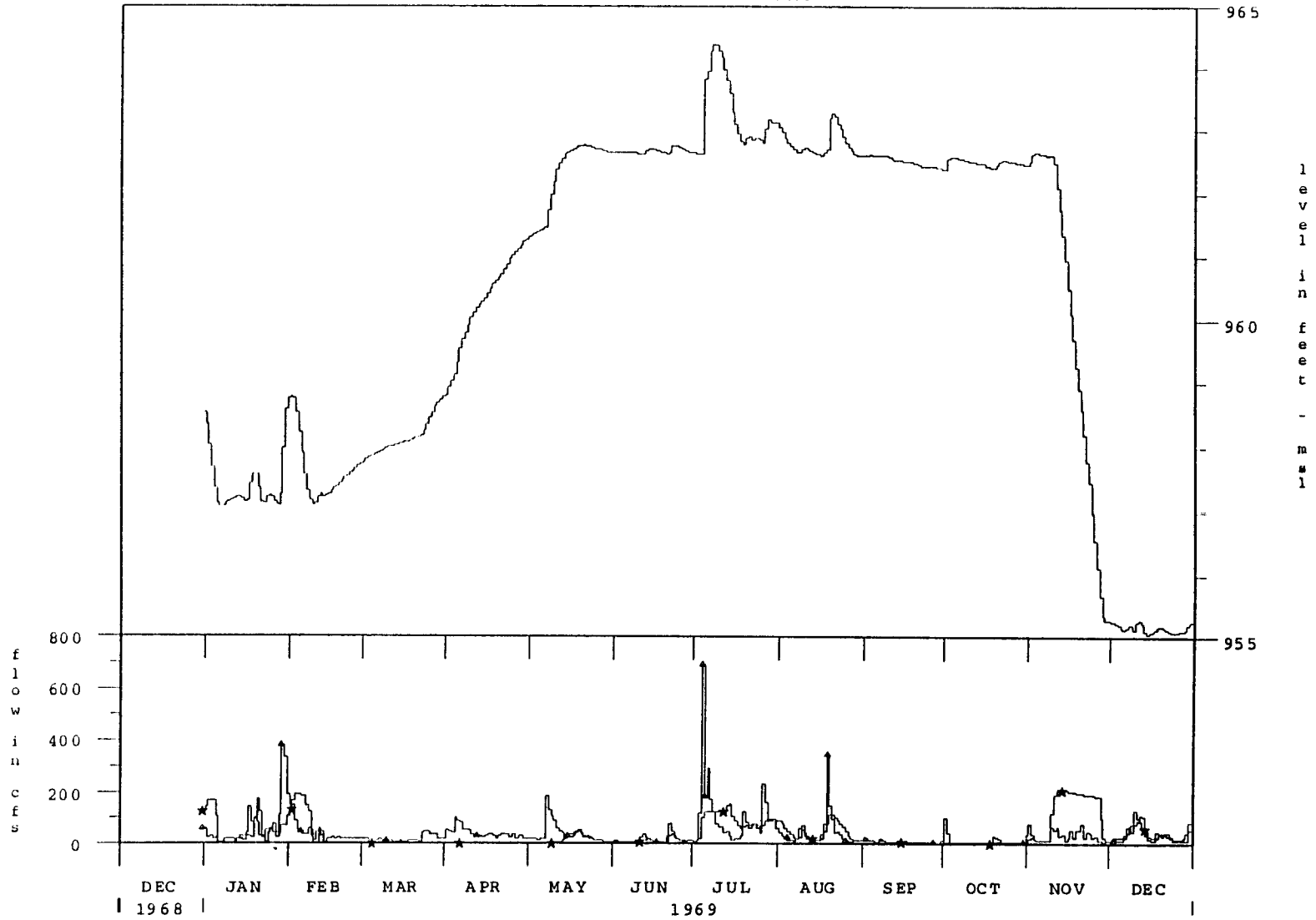
- LEESVILLE LAKE INFLOW
- ★— LEESVILLE LAKE OUTFLOW
- LEESVILLE LAKE LEVEL

HISTORICAL HYDROGRAPHS



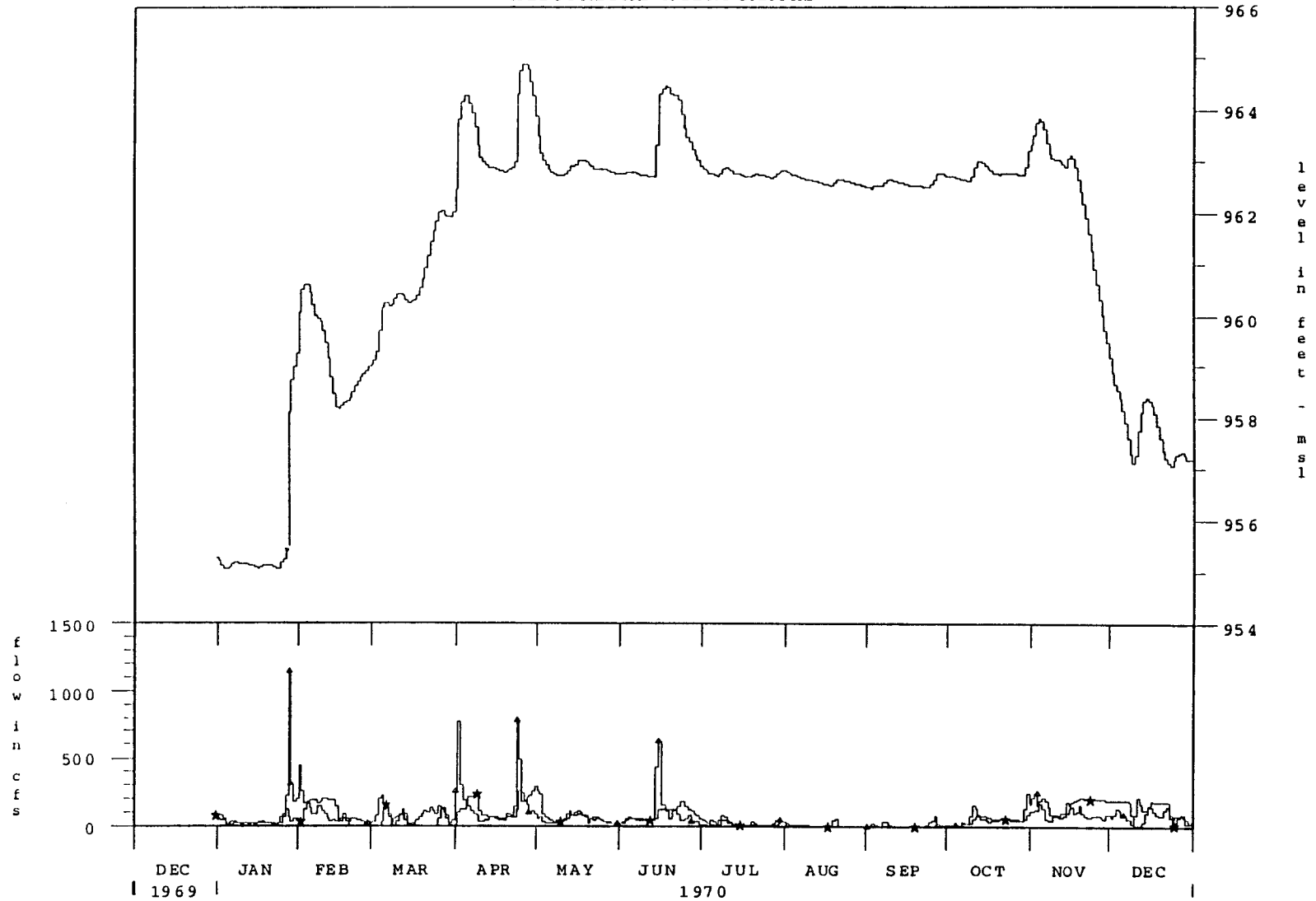
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 ★ ——— LEESVILLE LAKE OUTFLOW  
 ——— LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



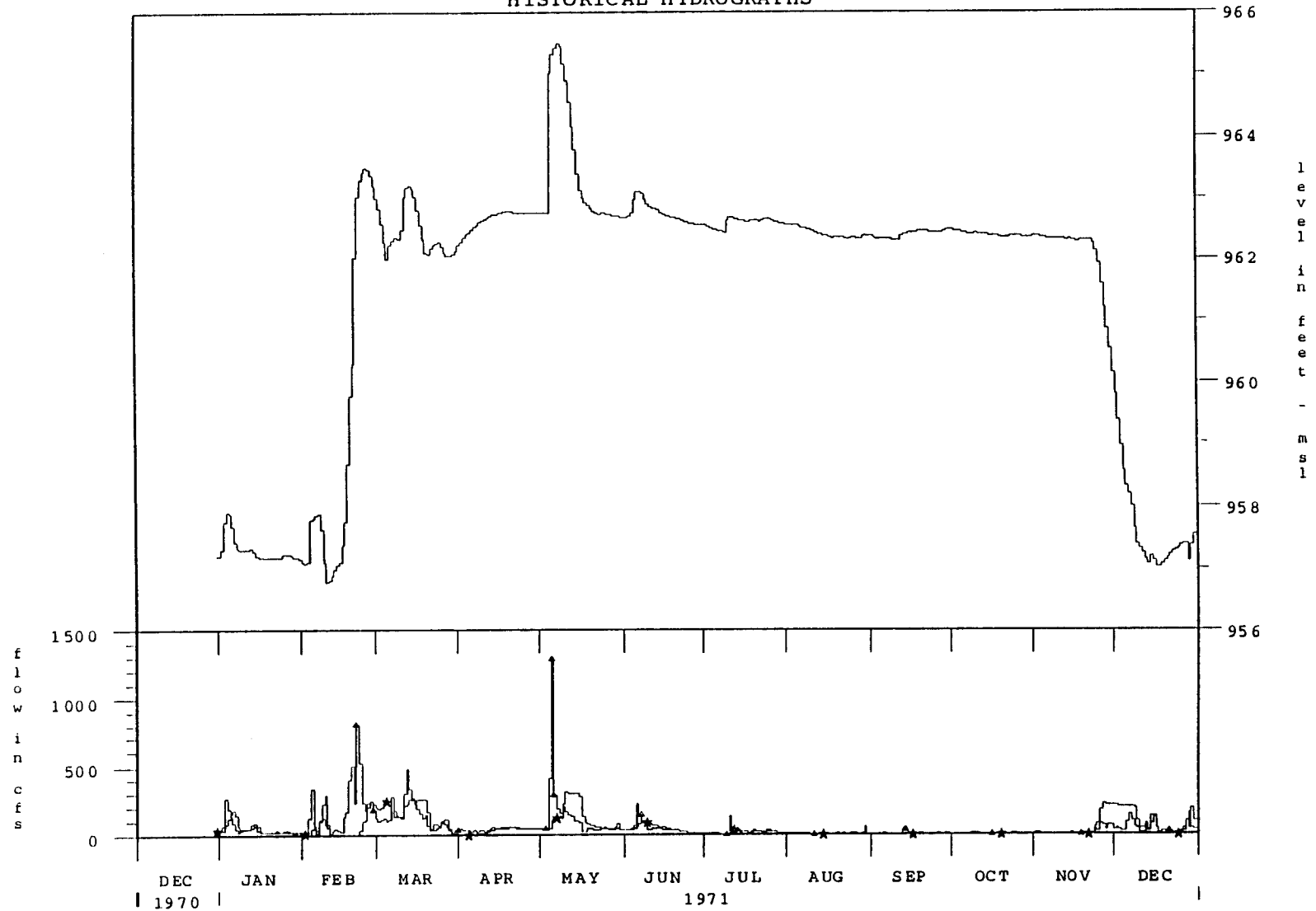
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 ★ ——— LEESVILLE LAKE OUTFLOW  
 ——— LEESVILLE LAKE LEVEL

### HISTORICAL HYDROGRAPHS



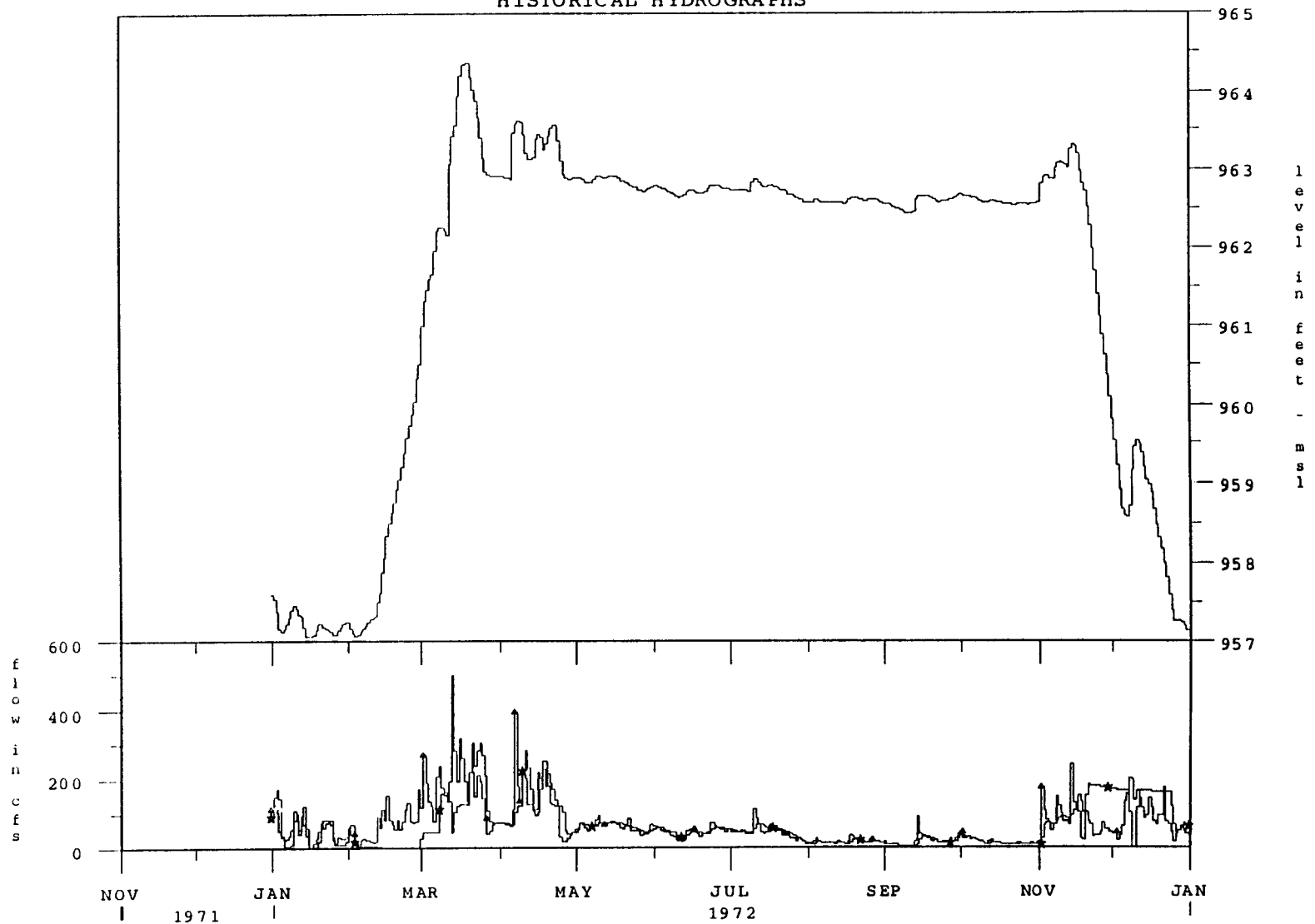
—◆—	LEESVILLE LAKE	INFLOW
—★—	LEESVILLE LAKE	OUTFLOW
—	LEESVILLE LAKE	LEVEL

# HISTORICAL HYDROGRAPHS



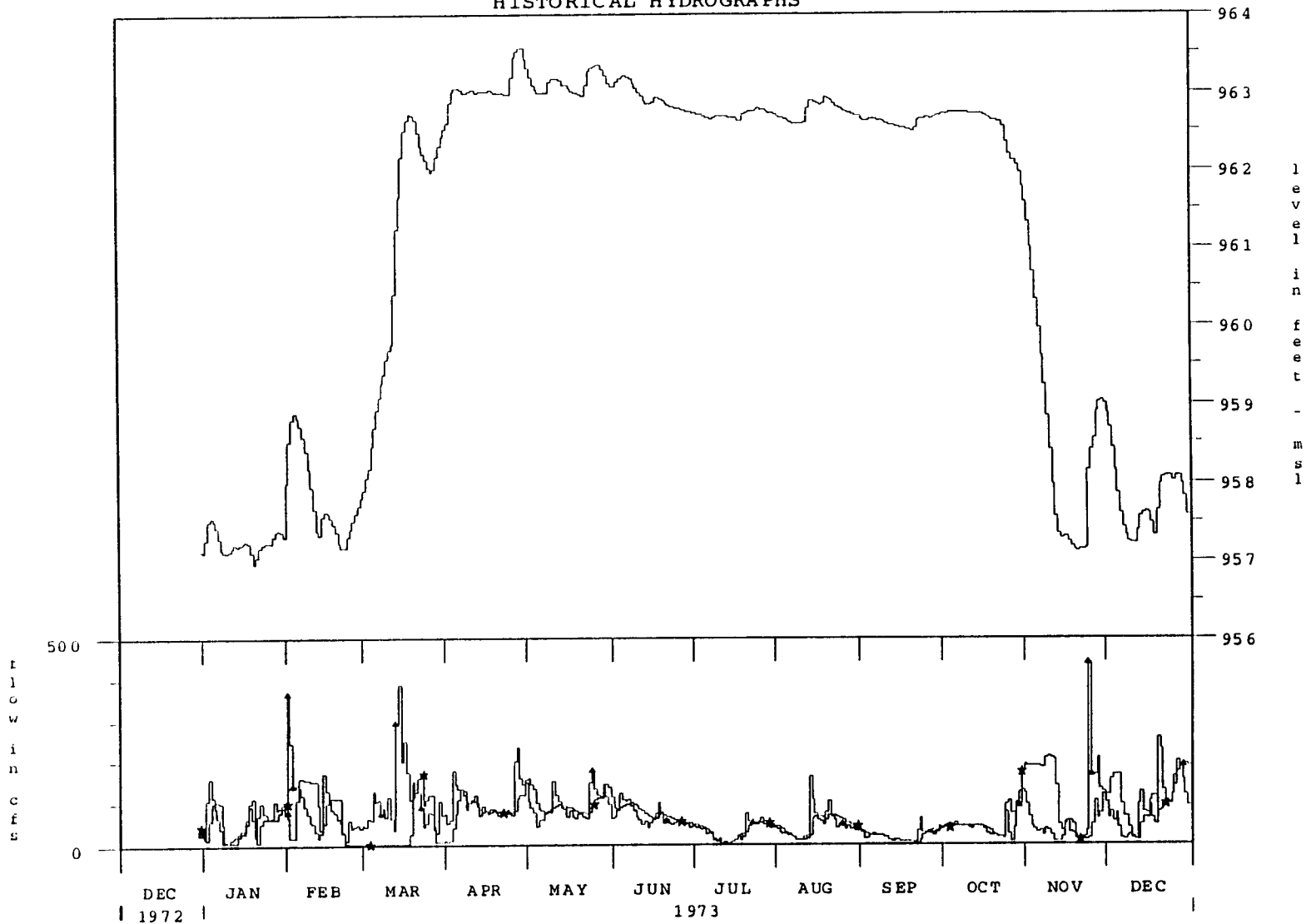
-▲- LEESVILLE LAKE INFLOW  
 -★- LEESVILLE LAKE OUTFLOW  
 - - - LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



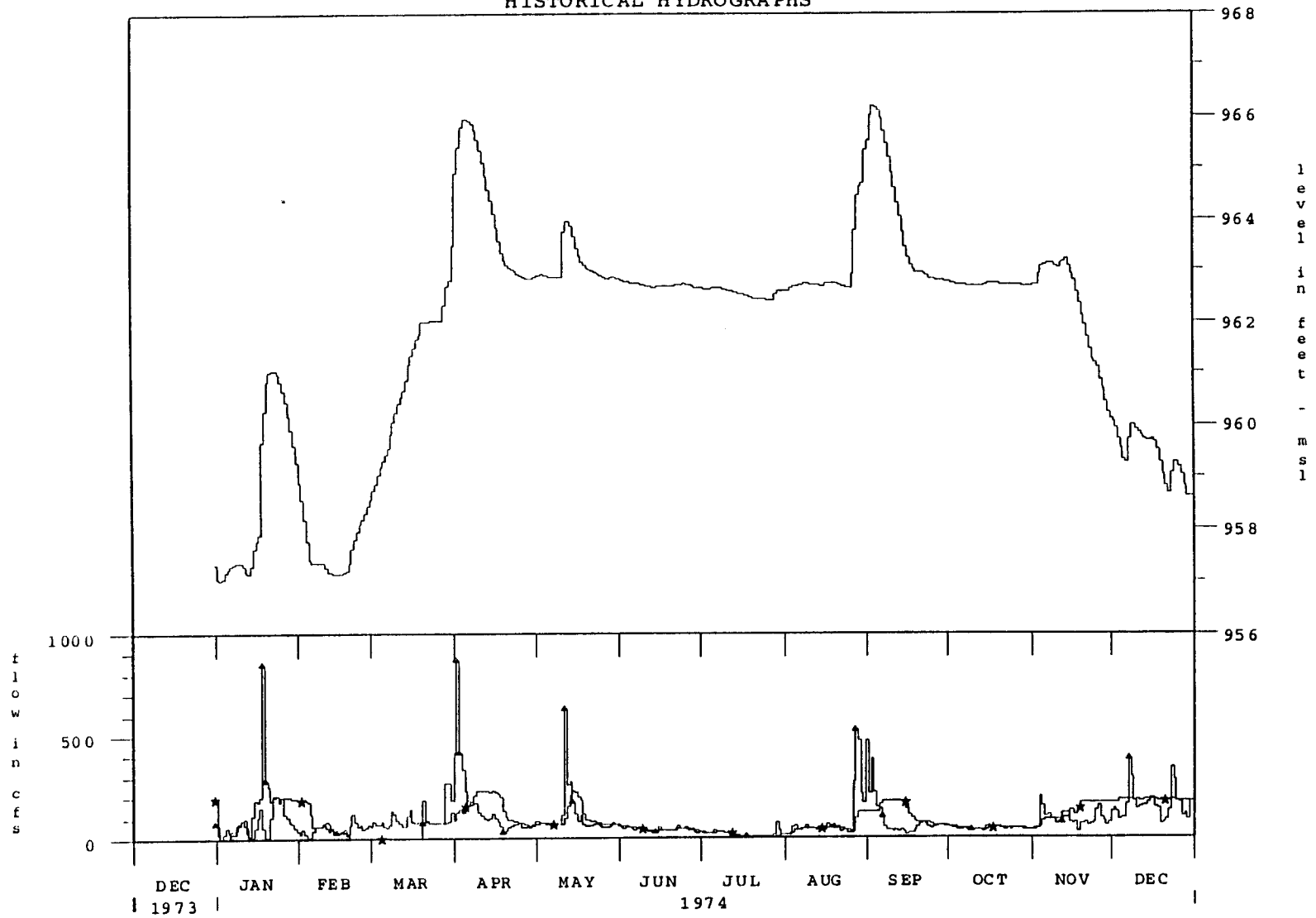
- - - - - \* - - - - - LEESVILLE LAKE INFLOW  
 - - - - - \* - - - - - LEESVILLE LAKE OUTFLOW  
 - - - - - LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



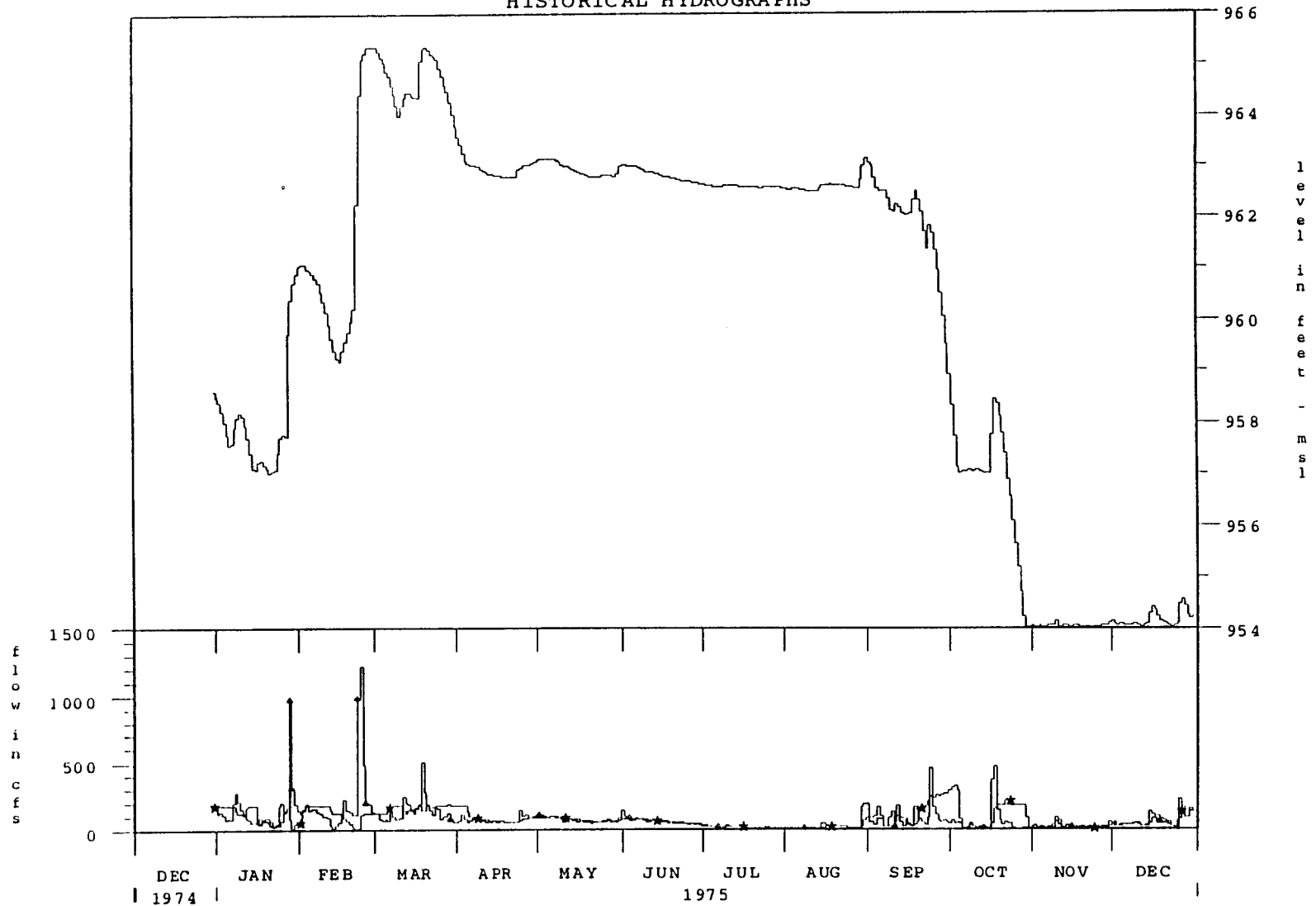
- - - - - ● - - - - - LEESVILLE LAKE INFLOW  
 - - - - - ★ - - - - - LEESVILLE LAKE OUTFLOW  
 - - - - - LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



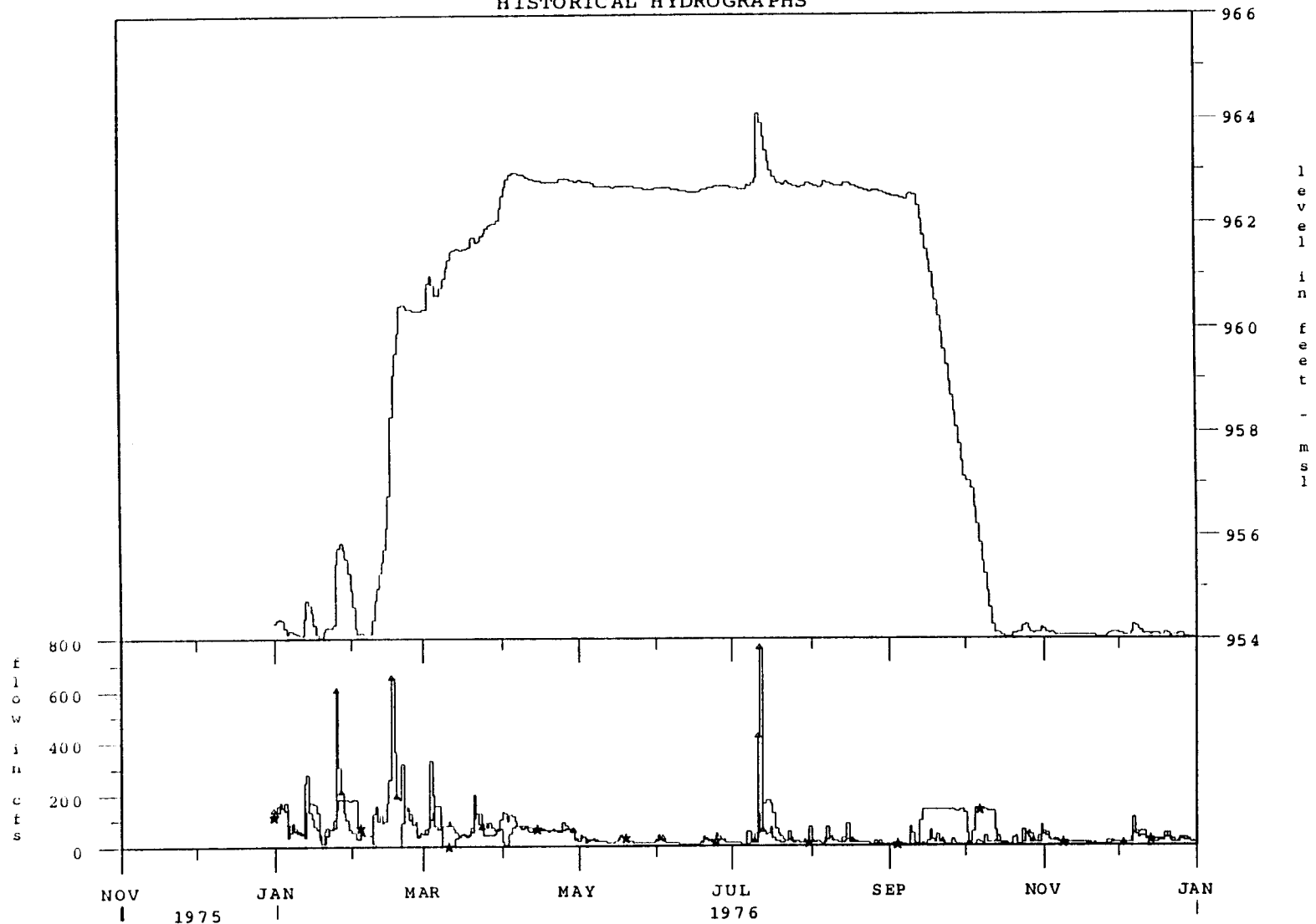
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 —★— LEESVILLE LAKE OUTFLOW  
 — LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



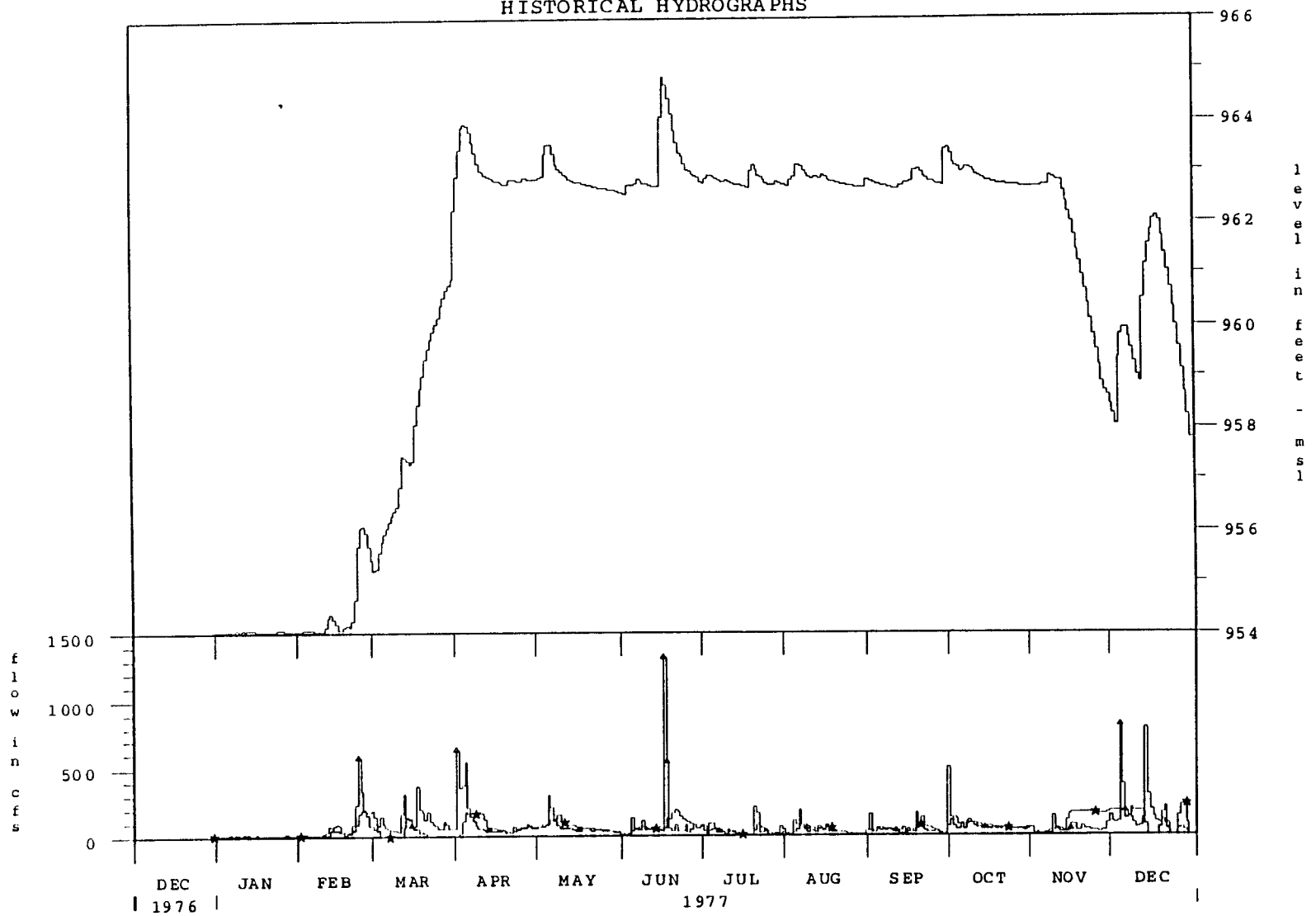
- - - - - ◆ - - - - - LEESVILLE LAKE INFLOW  
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 - - - - - - - - - - LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



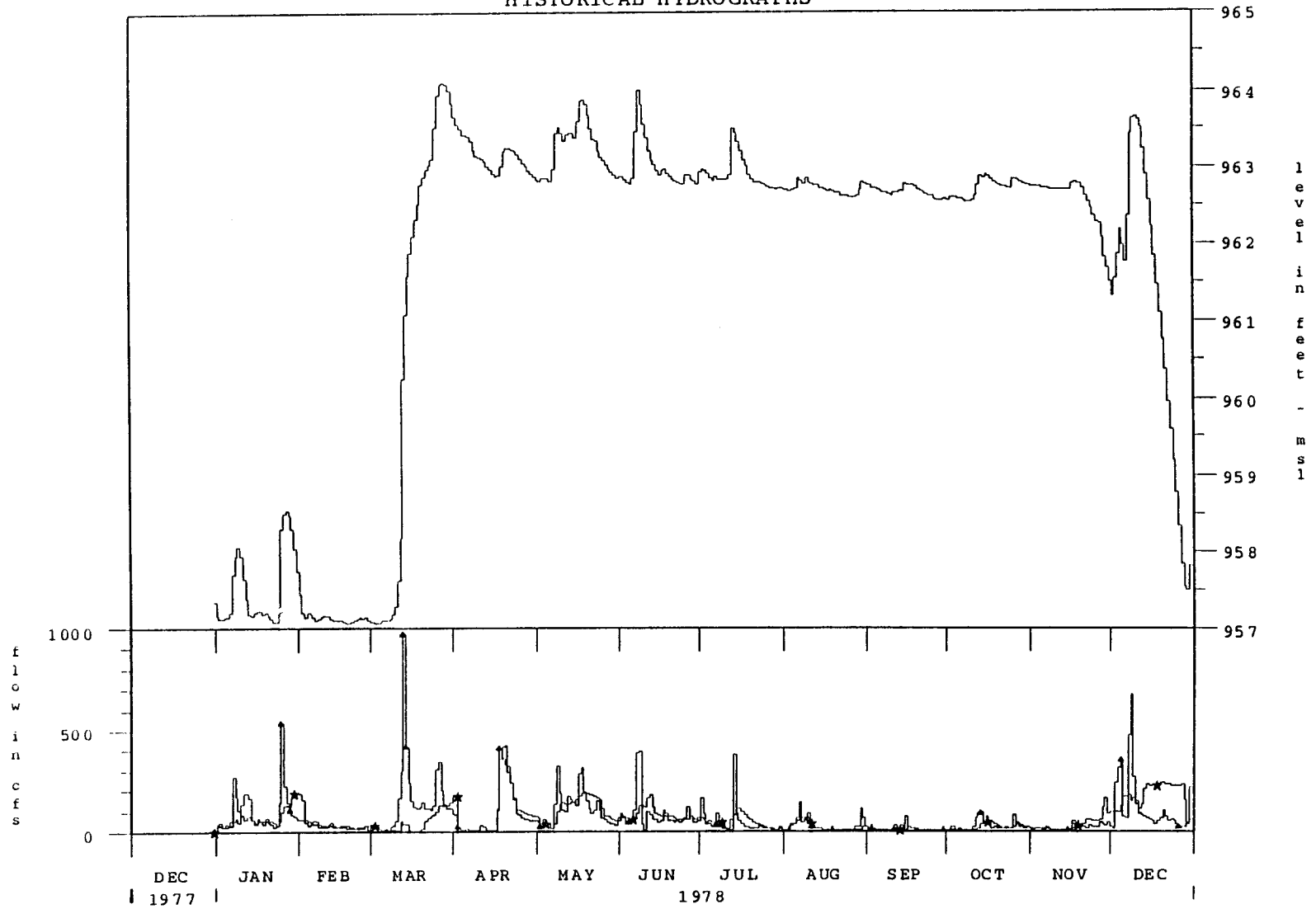
- - - - - LEESVILLE LAKE INFLOW  
 - - - - - LEESVILLE LAKE OUTFLOW  
 - - - - - LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



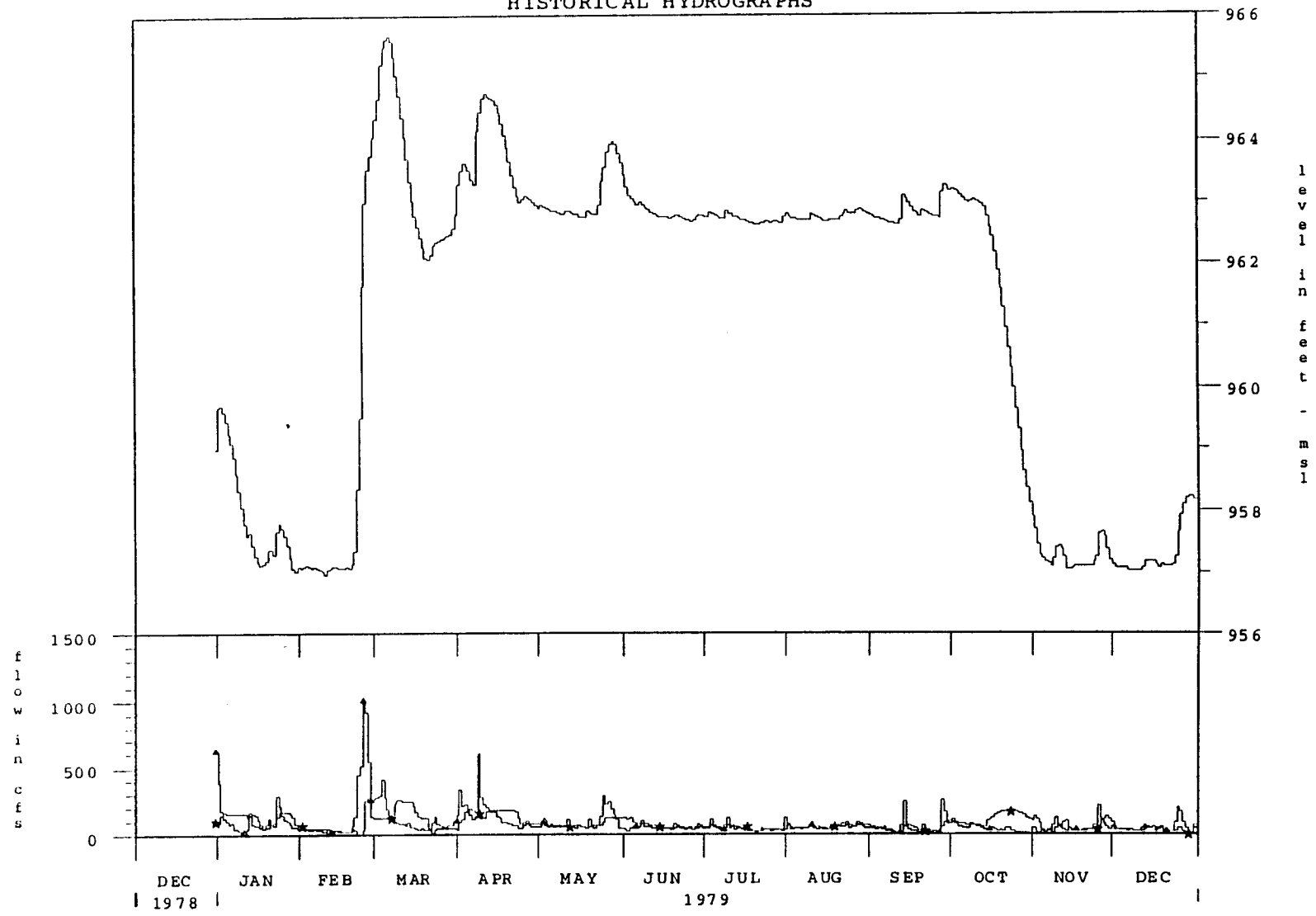
.....●..... LEESVILLE LAKE INFLOW  
 .....\*..... LEESVILLE LAKE OUTFLOW  
 \_\_\_\_\_ LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



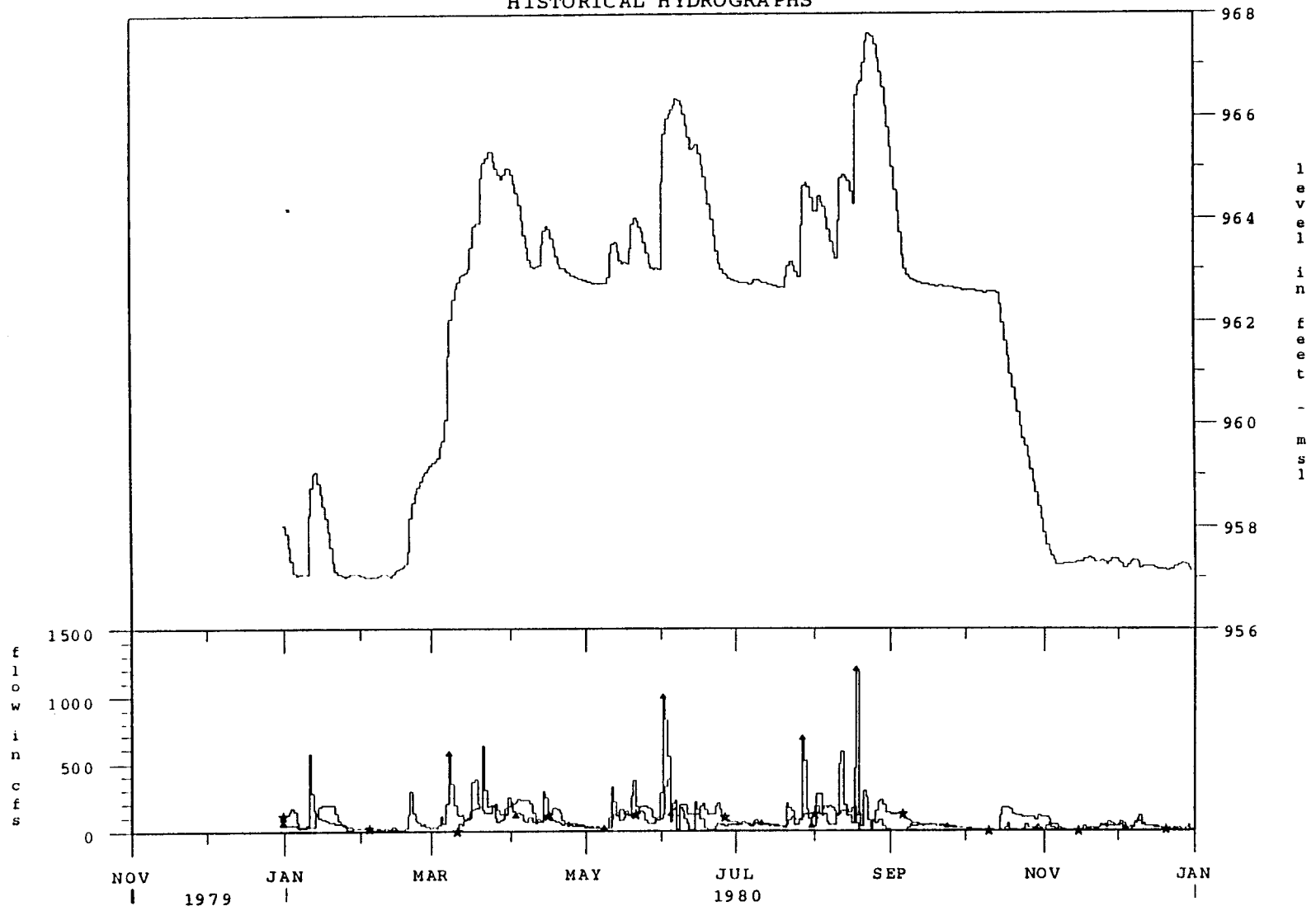
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 ★----- LEESVILLE LAKE OUTFLOW  
 - - - - - LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



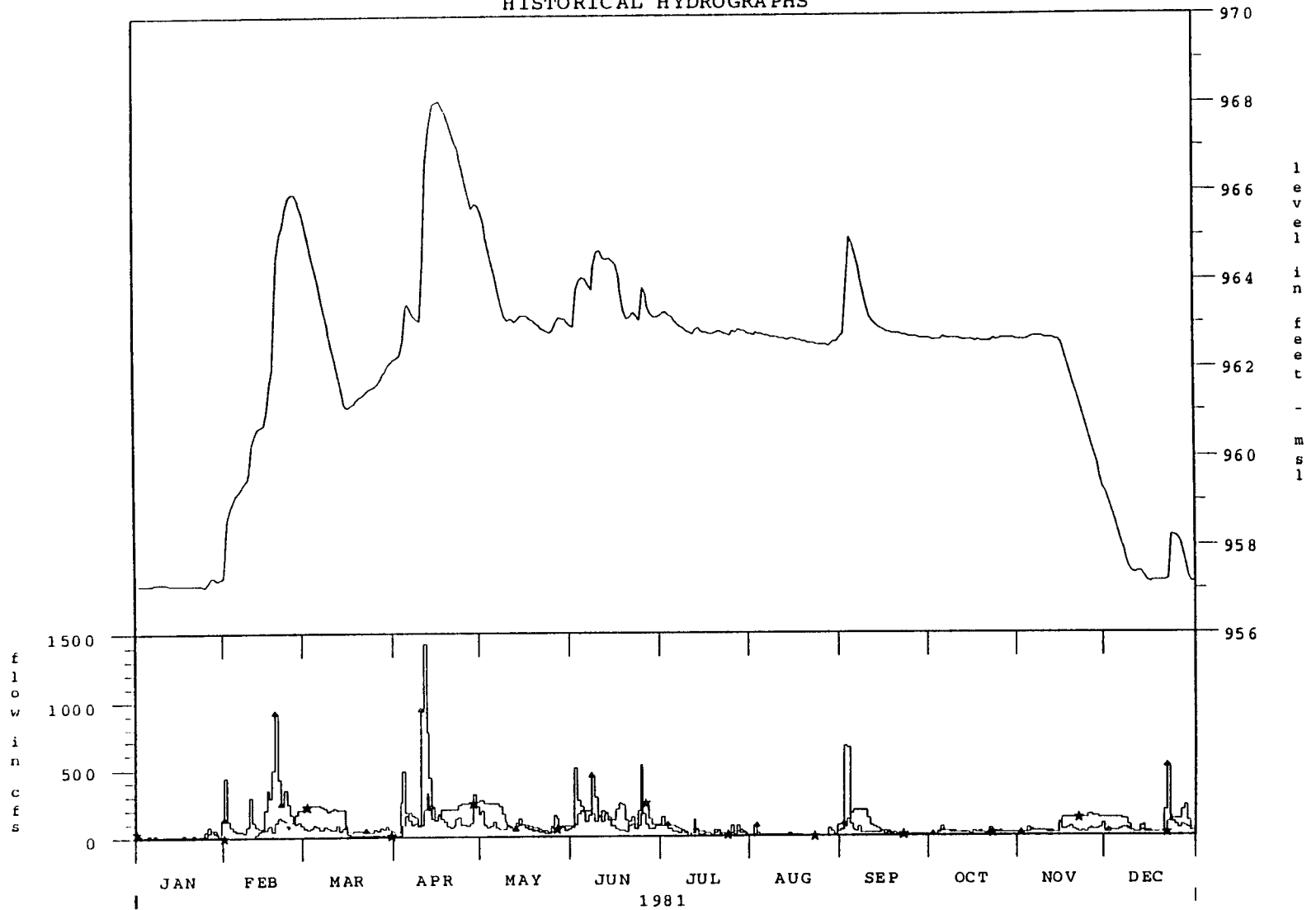
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 —★— LEESVILLE LAKE OUTFLOW  
 — LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



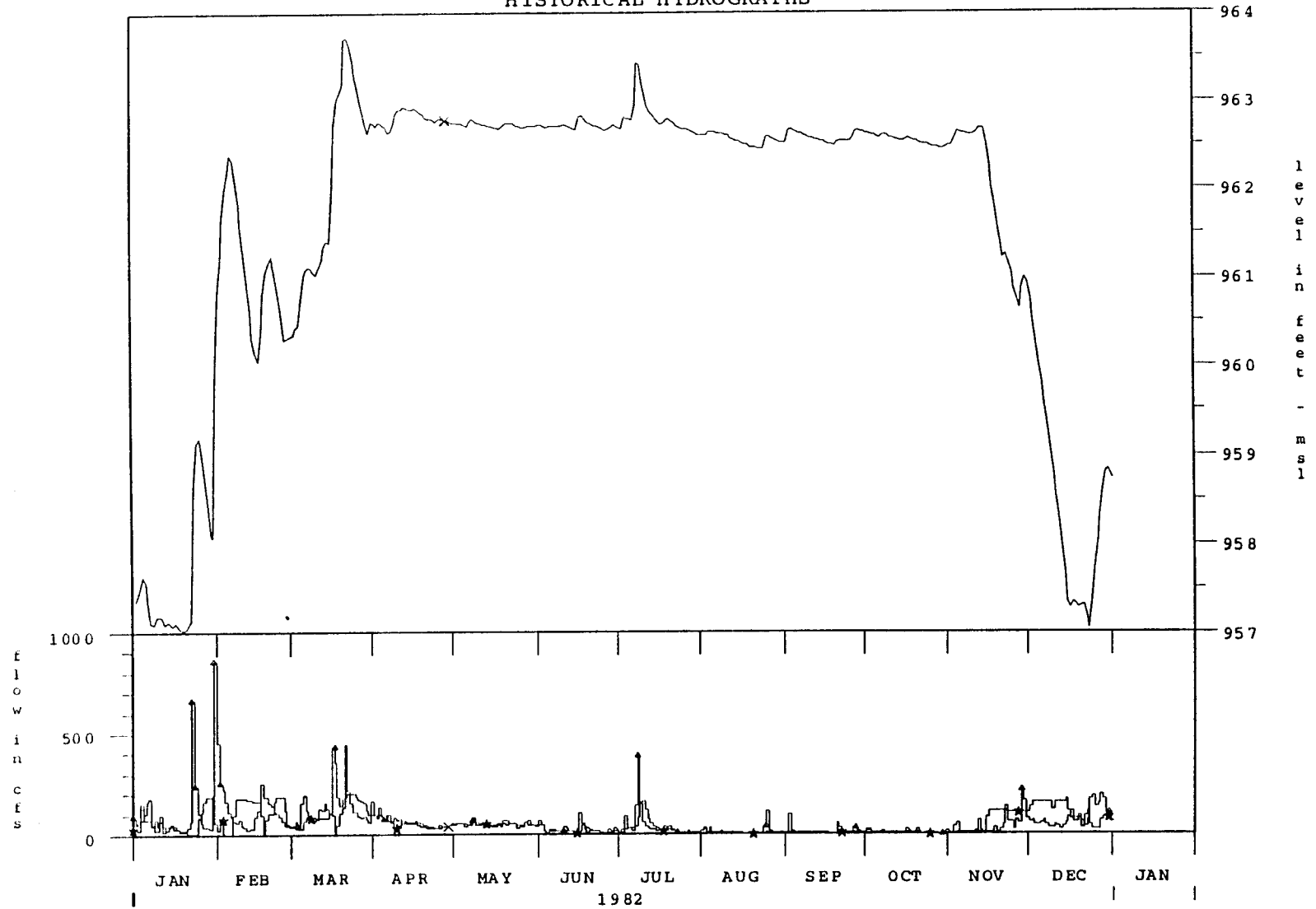
|     |                |         |
|-----|----------------|---------|
| —●— | LEESVILLE LAKE | INFLOW  |
| —★— | LEESVILLE LAKE | OUTFLOW |
| —   | LEESVILLE LAKE | LEVEL   |

# HISTORICAL HYDROGRAPHS



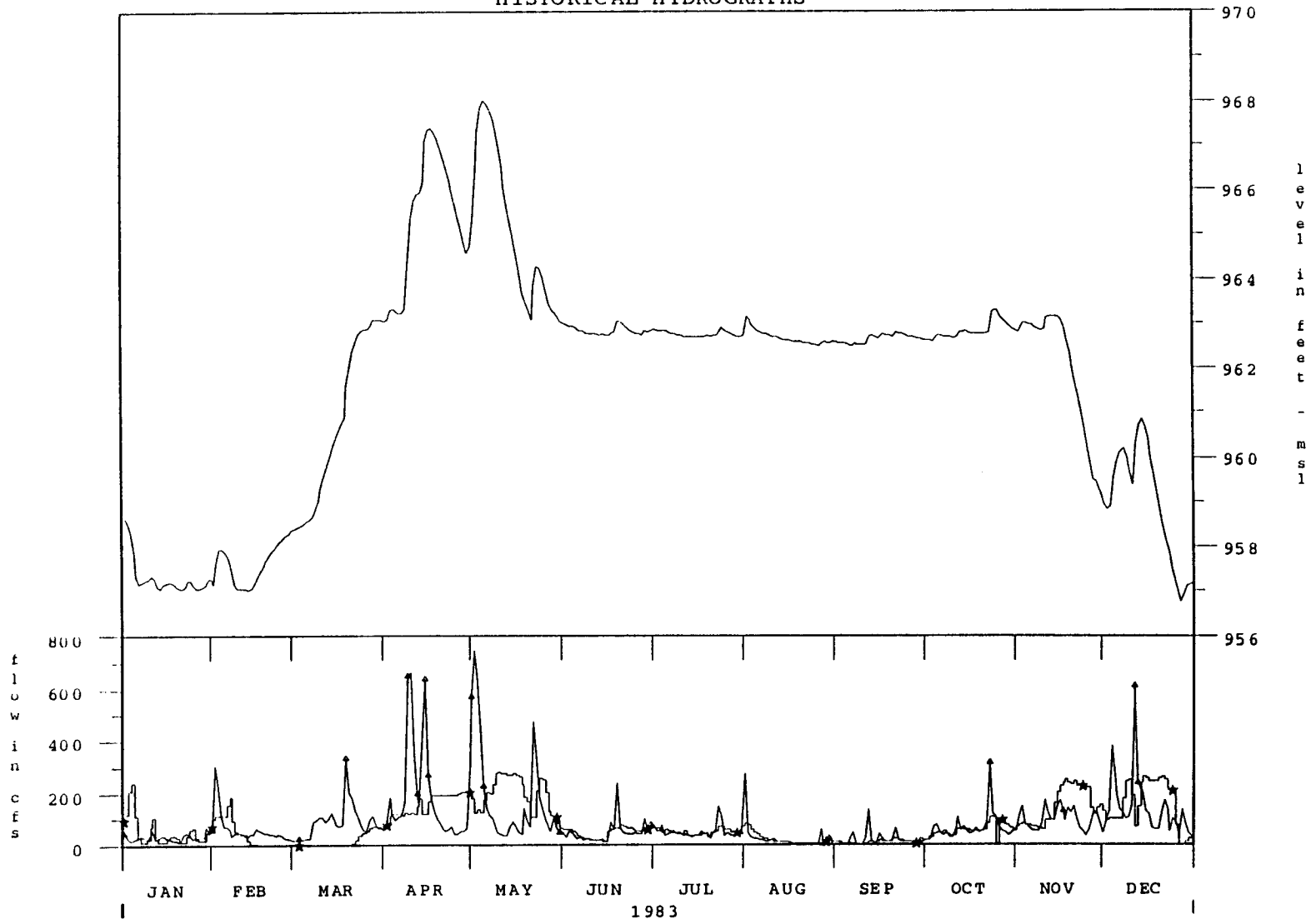
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 ★———— LEESVILLE LAKE OUTFLOW  
 ————— LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



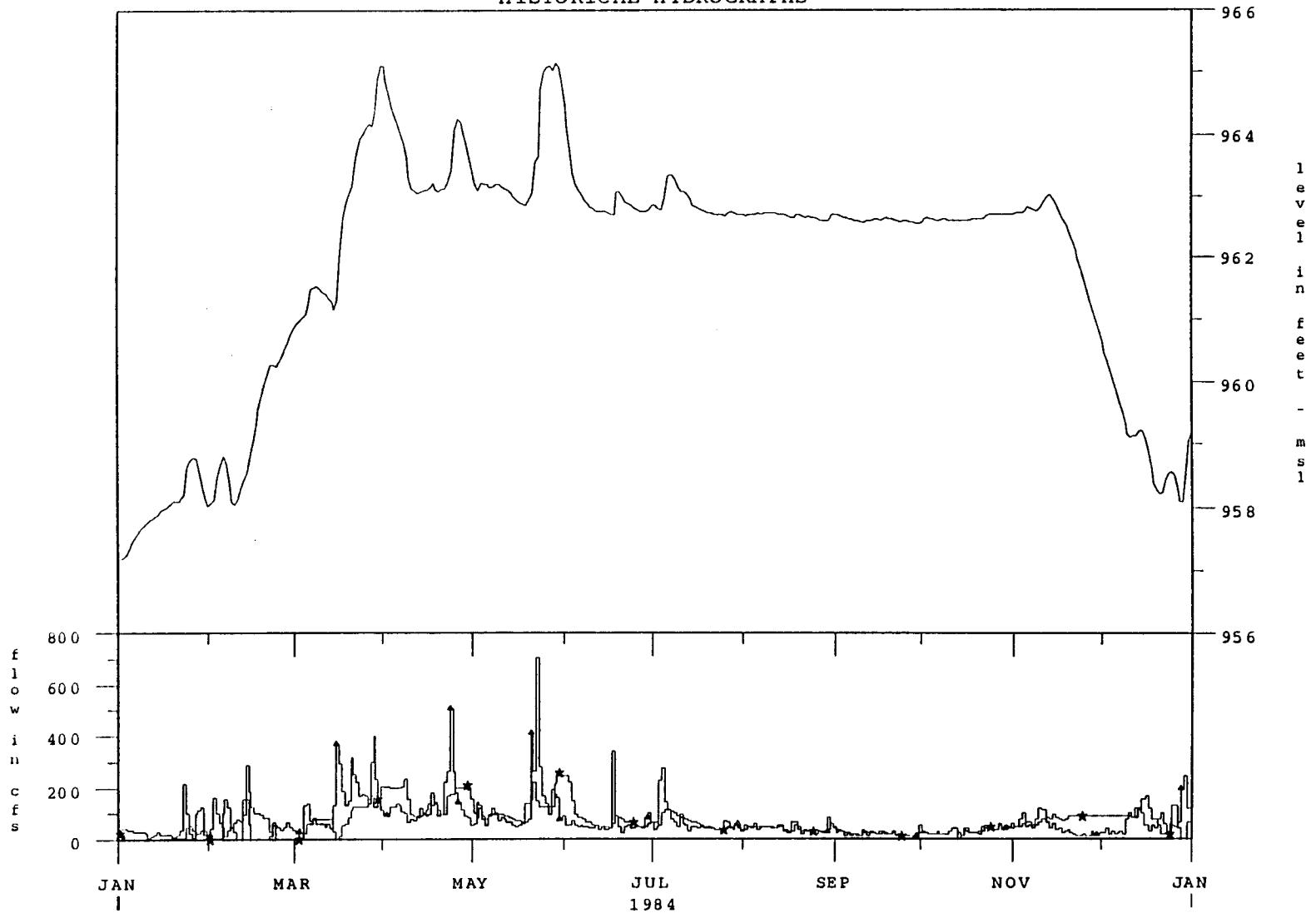
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 —\*— LEESVILLE LAKE OUTFLOW  
 — LEESVILLE LAKE LEVEL

HISTORICAL HYDROGRAPHS



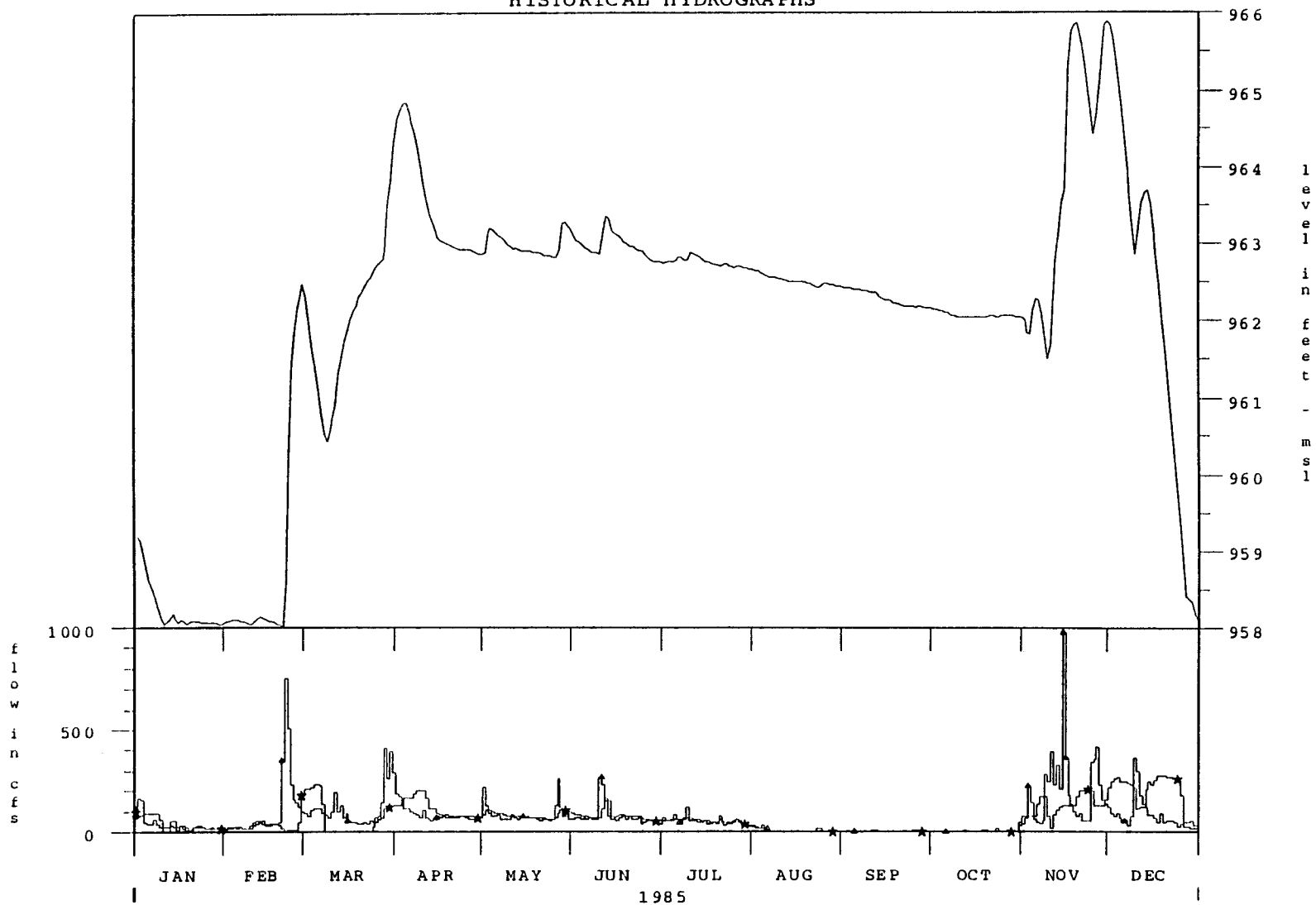
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- - - \* - - - LEESVILLE LAKE OUTFLOW  
—□— LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



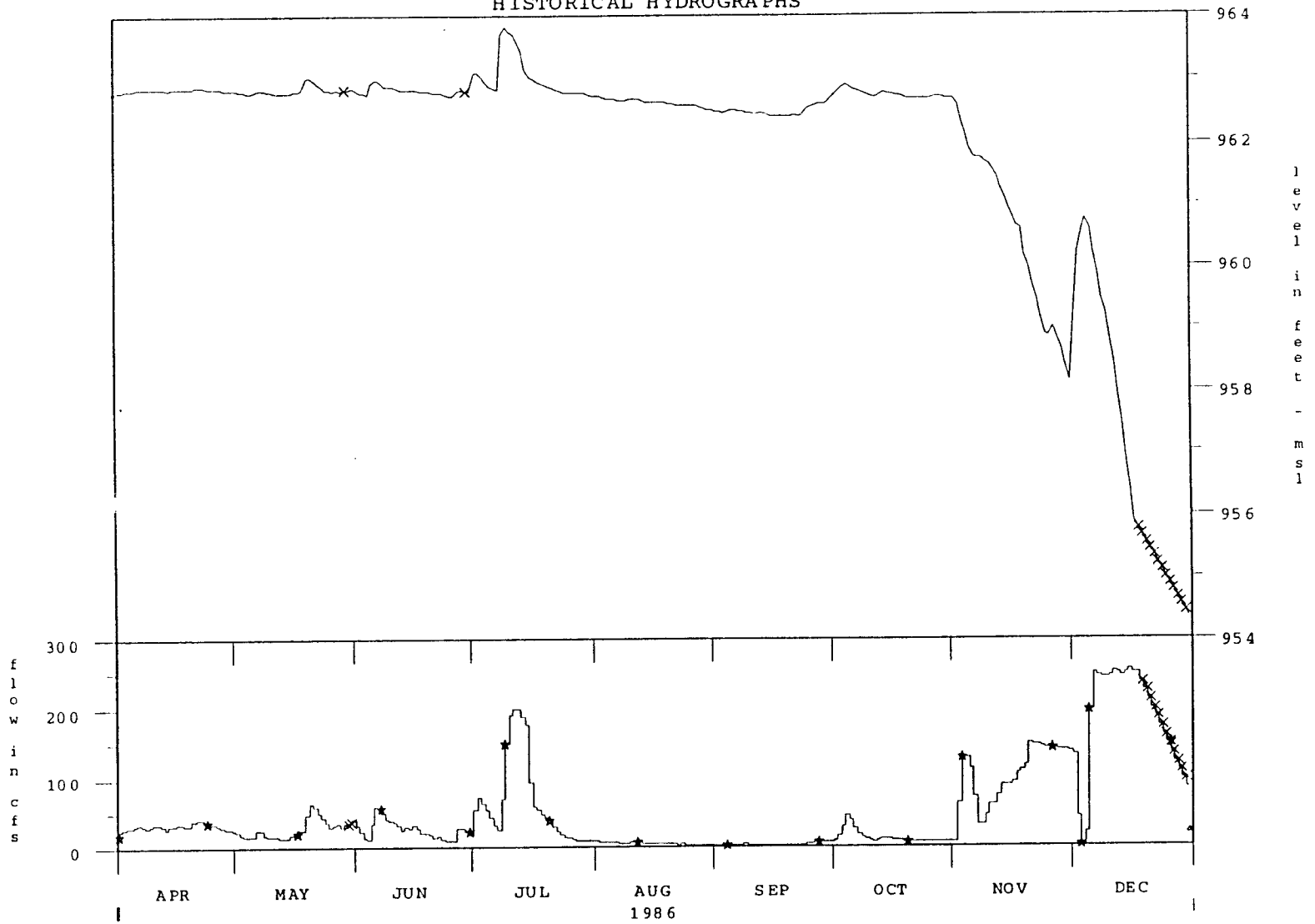
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- ★— LEESVILLE LAKE OUTFLOW
- LEESVILLE LAKE LEVEL

### HISTORICAL HYDROGRAPHS



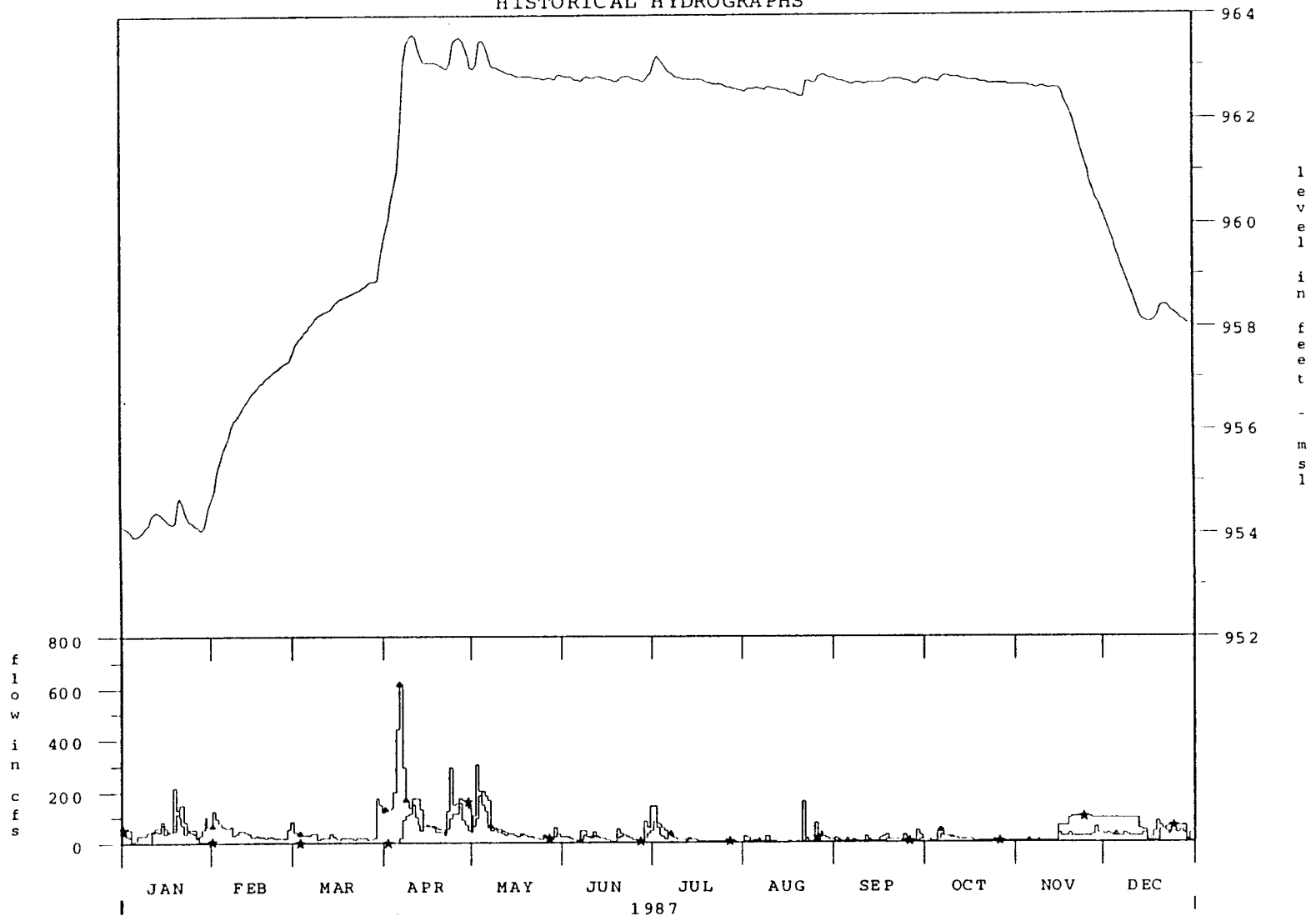
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 —★— LEESVILLE LAKE OUTFLOW  
 — LEESVILLE LAKE LEVEL

HISTORICAL HYDROGRAPHS



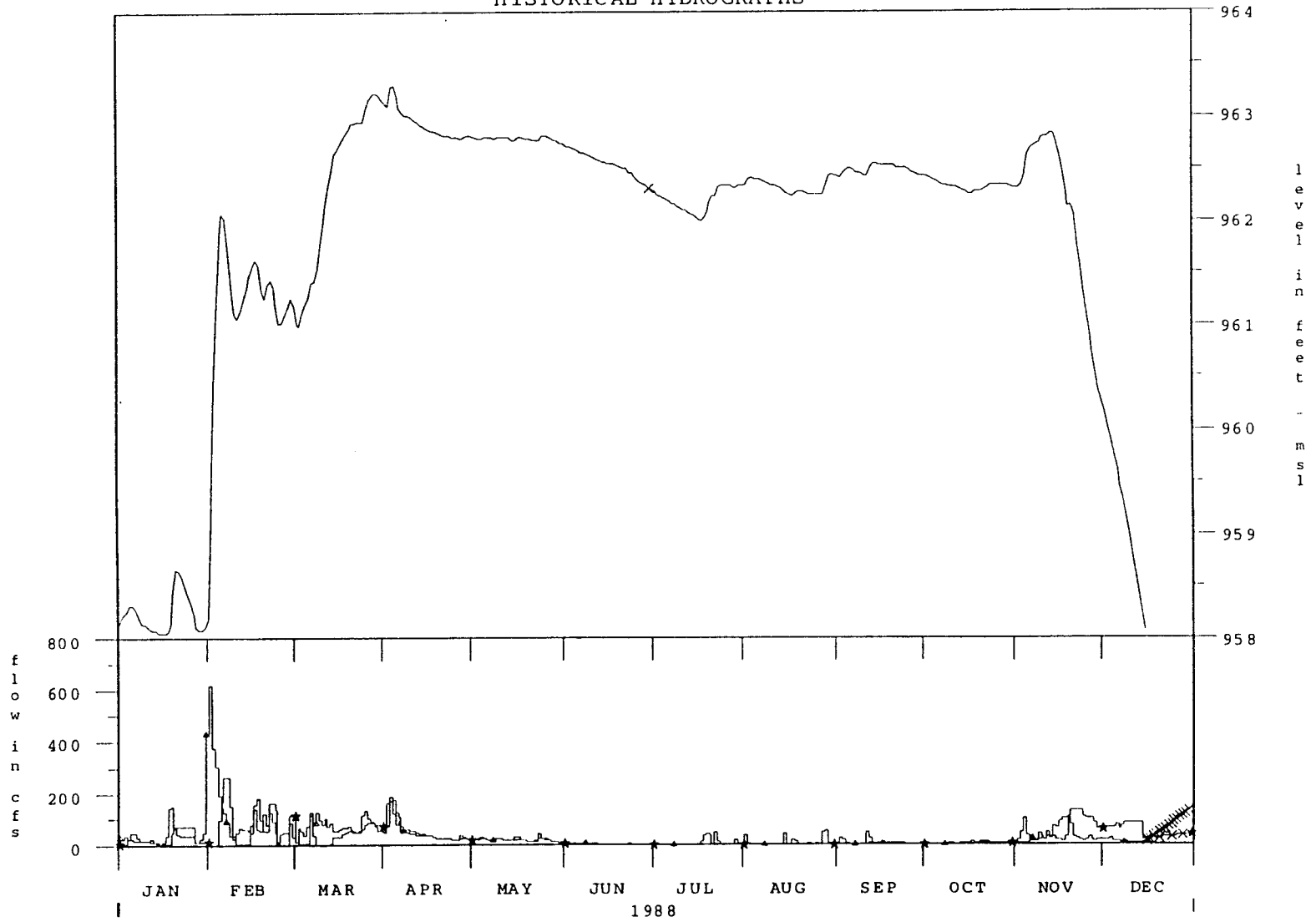
\*----- LEESVILLE LAKE INFLOW  
 .----- LEESVILLE LAKE OUTFLOW  
 ----- LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



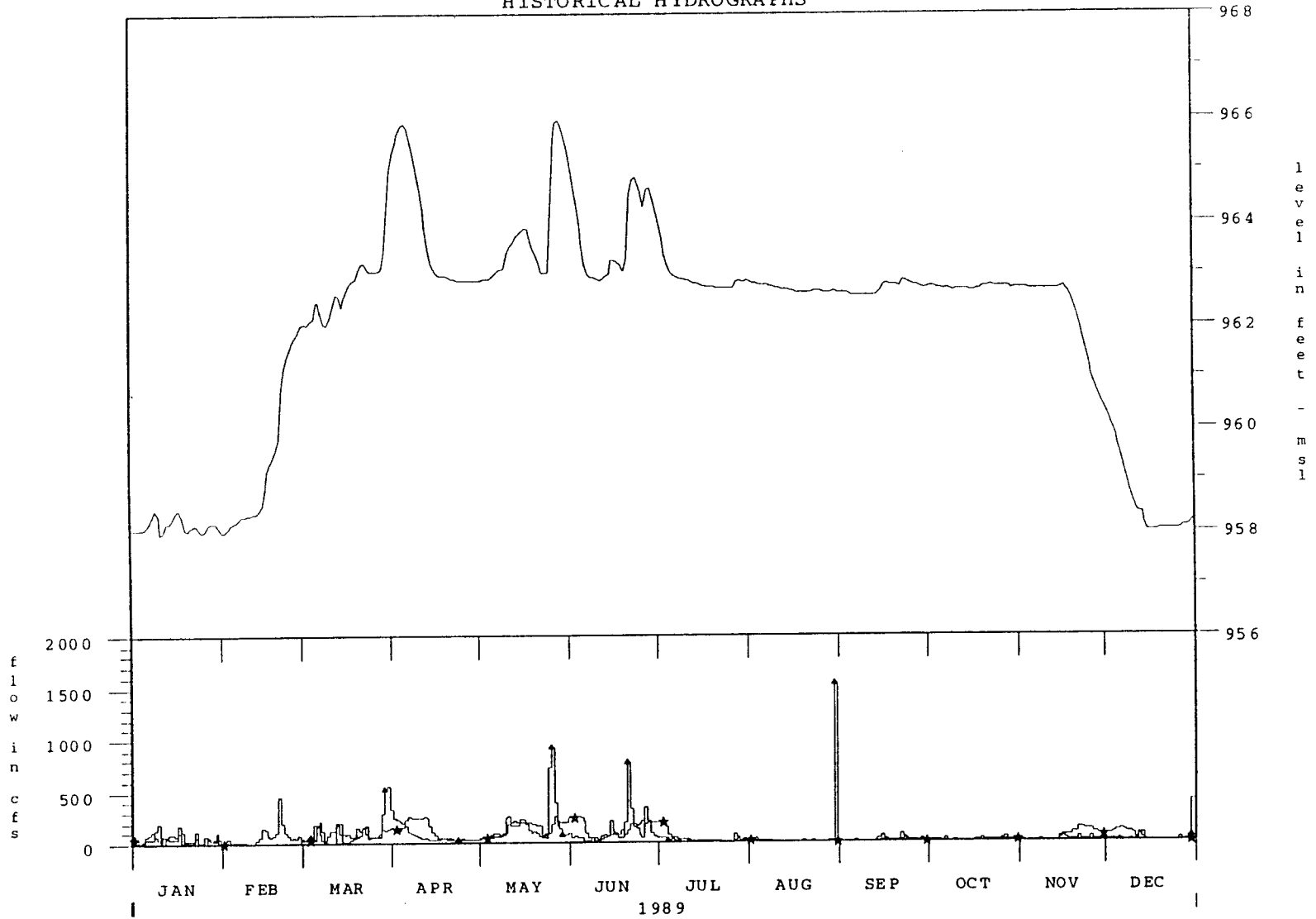
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 ★----- LEESVILLE LAKE OUTFLOW  
 ----- LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



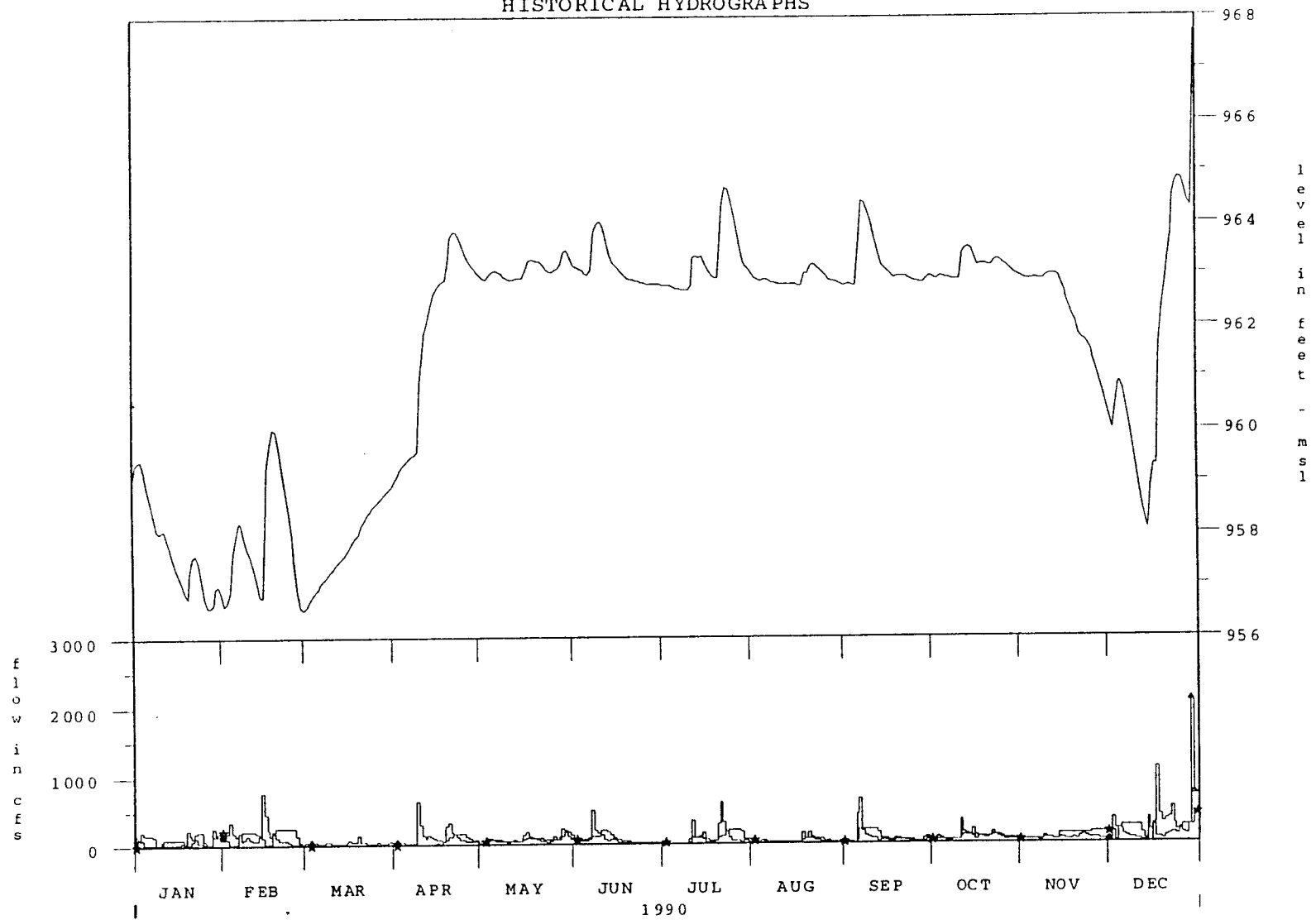
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 -★- LEESVILLE LAKE OUTFLOW  
 - - - LEESVILLE LAKE LEVEL

HISTORICAL HYDROGRAPHS



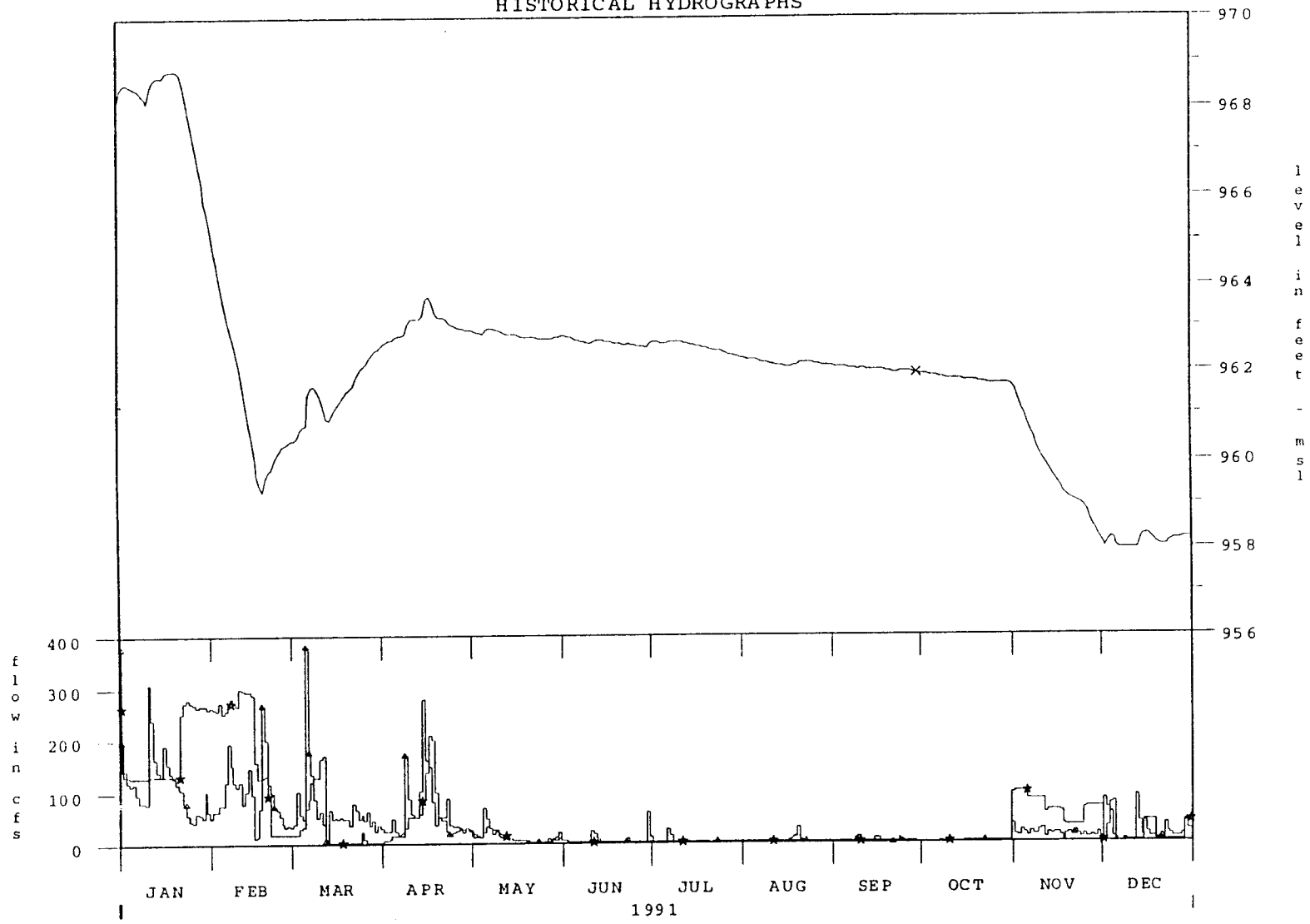
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 ★ ——— LEESVILLE LAKE OUTFLOW  
 ——— LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



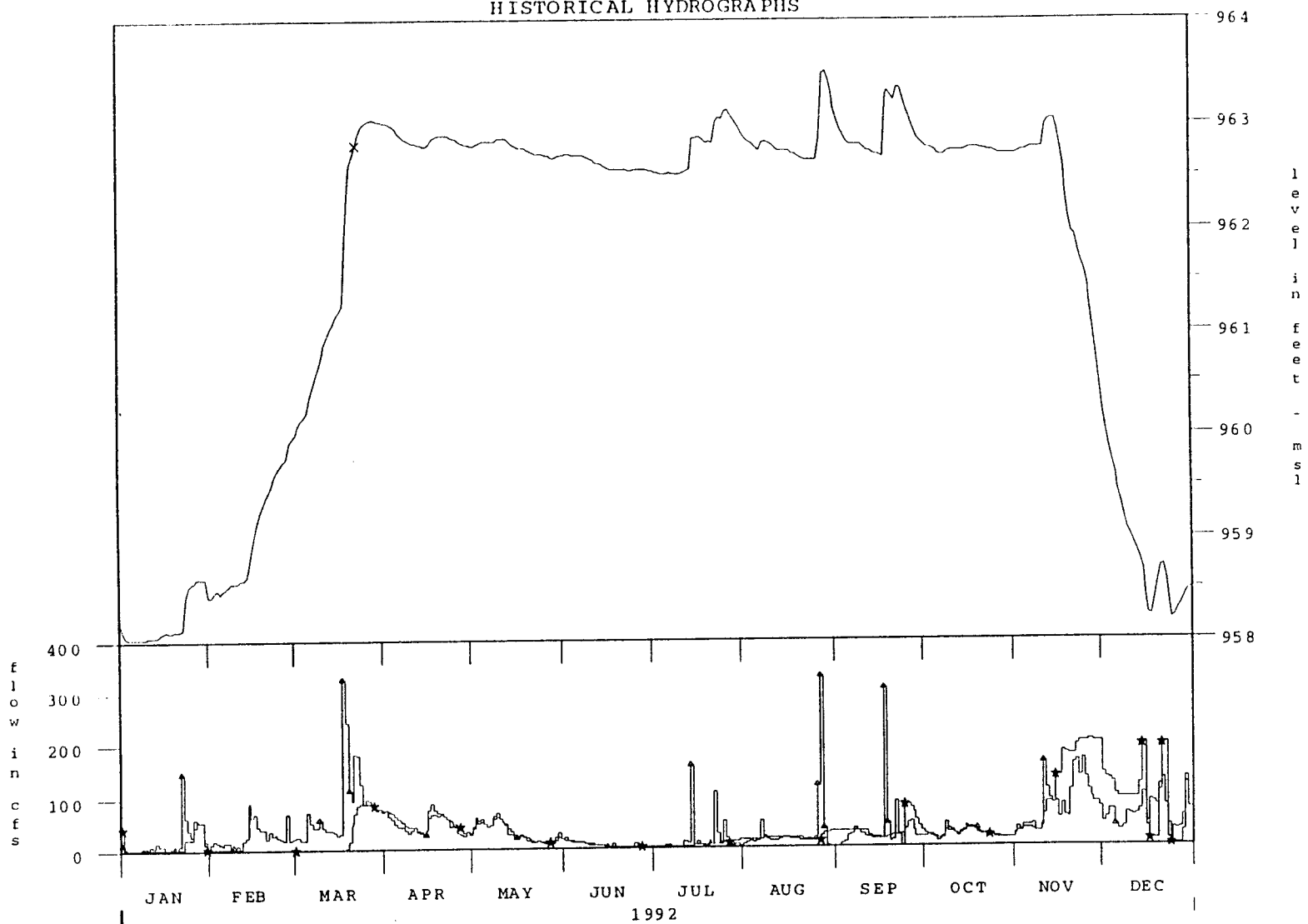
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 ★ LEESVILLE LAKE OUTFLOW  
 — LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



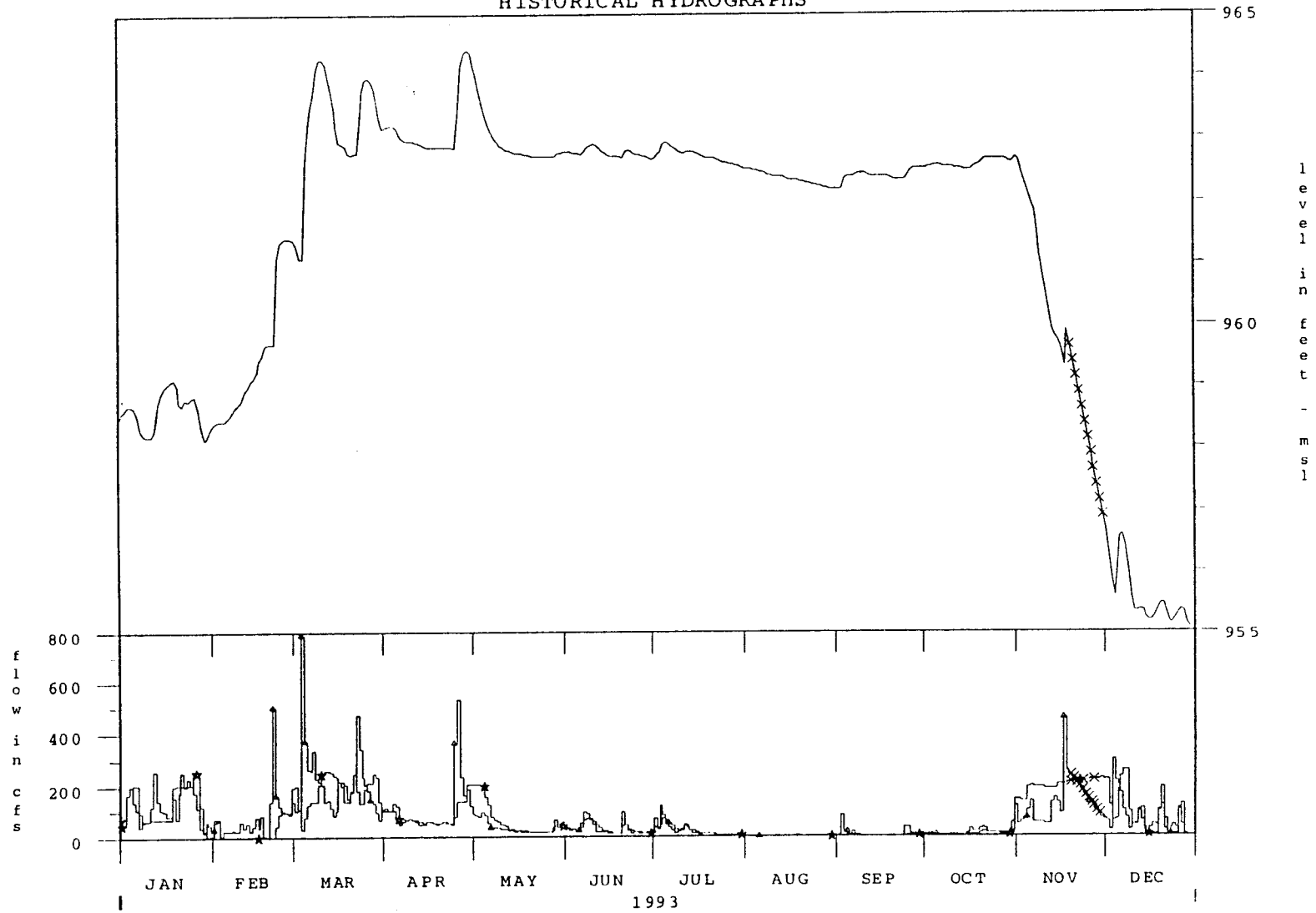
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 ★----- LEESVILLE LAKE OUTFLOW  
 ----- LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



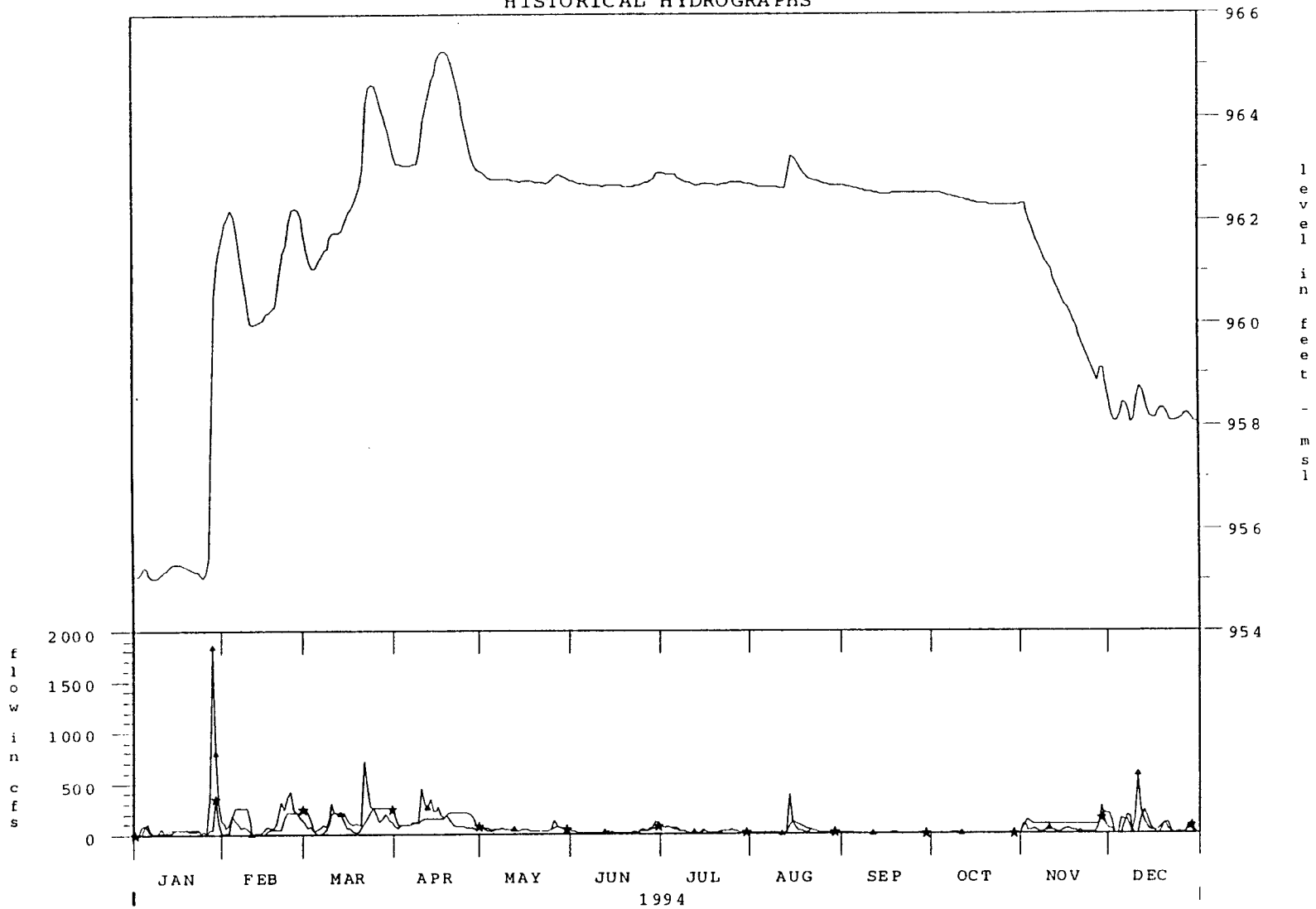
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- - -★- - - LEESVILLE LAKE OUTFLOW
- LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



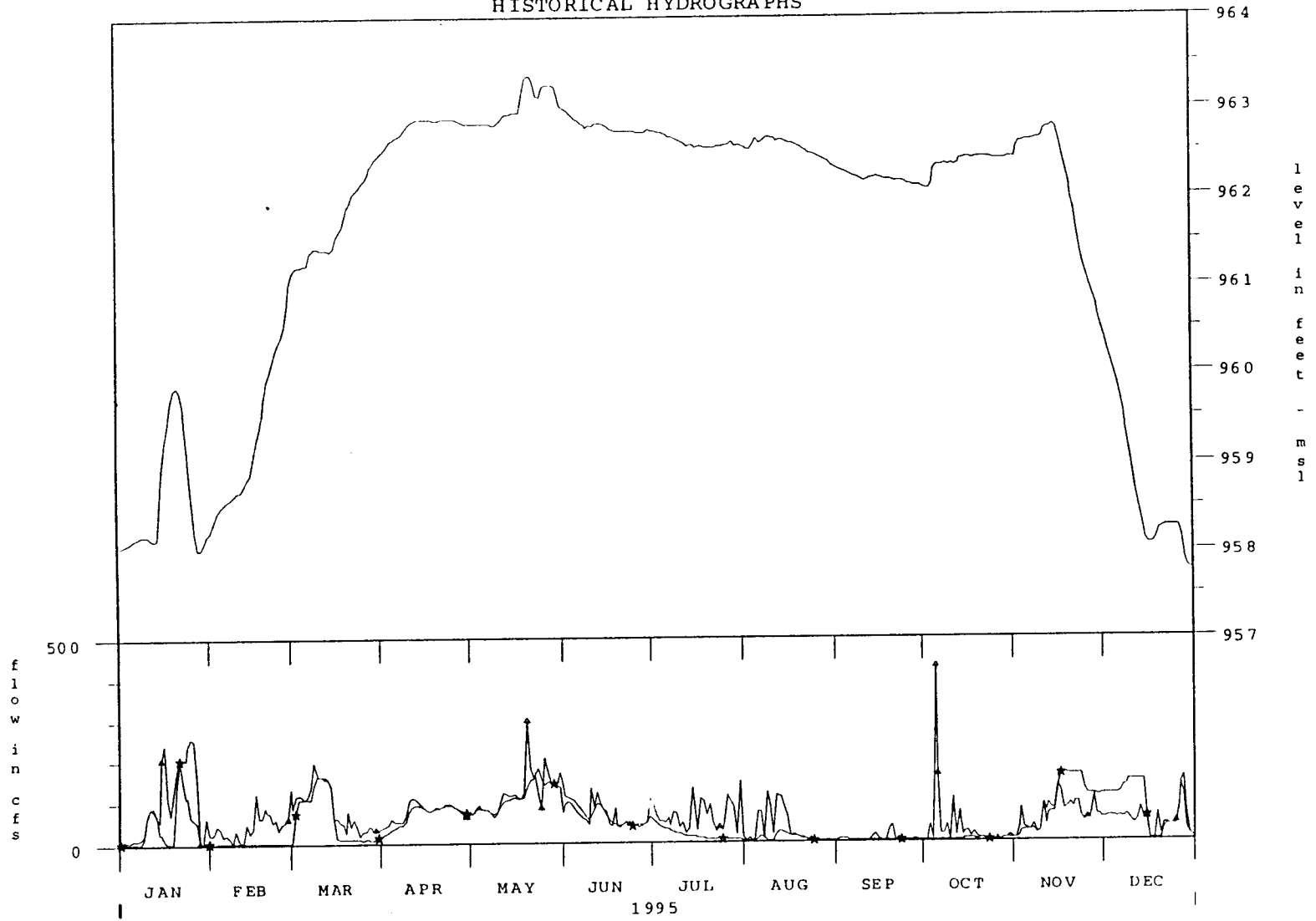
- LEESVILLE LAKE INFLOW
- ★— LEESVILLE LAKE OUTFLOW
- LEESVILLE LAKE LEVEL

HISTORICAL HYDROGRAPHS



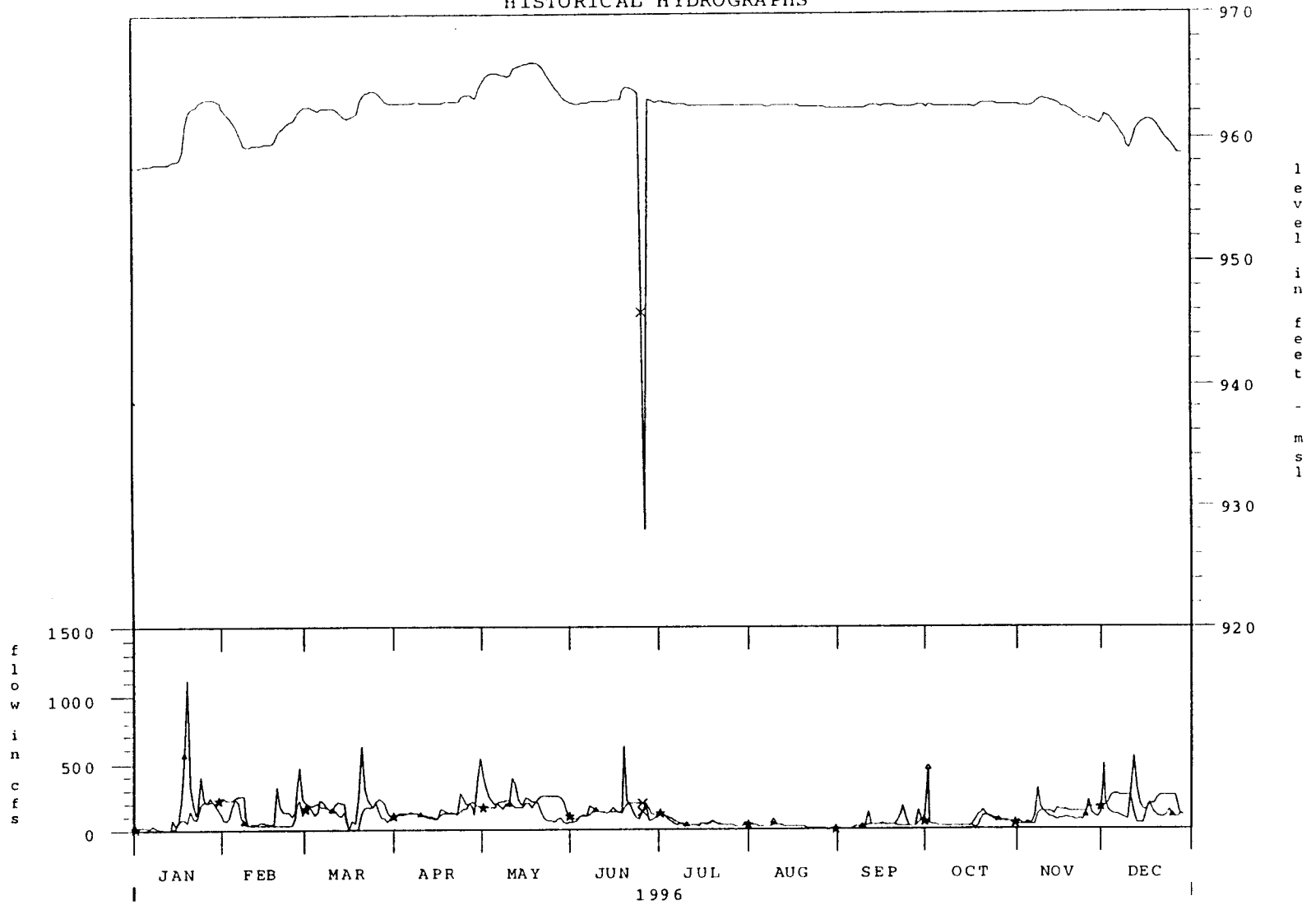
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 ★ ..... LEESVILLE LAKE OUTFLOW  
 — ..... LEESVILLE LAKE LEVEL

# HISTORICAL HYDROGRAPHS



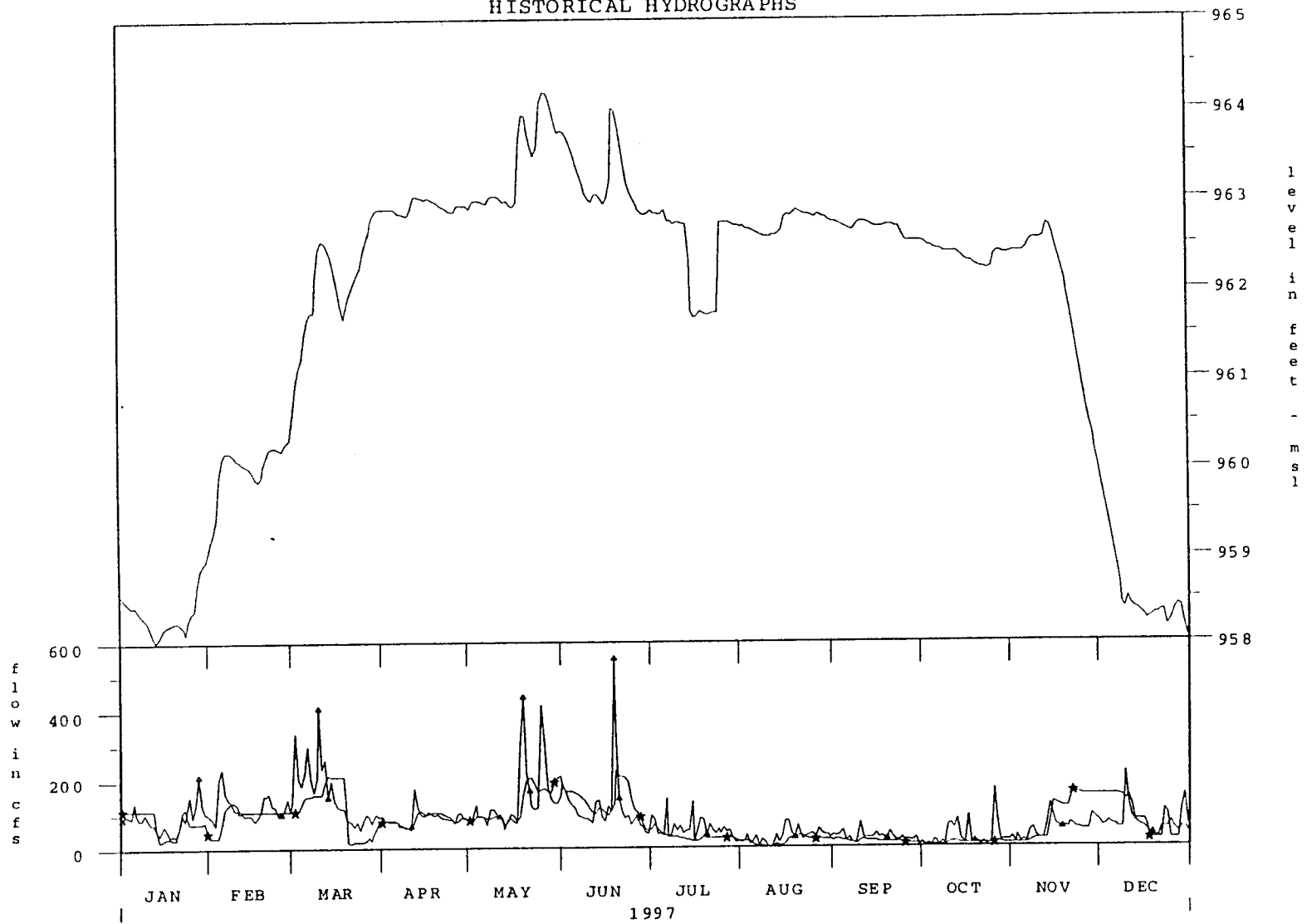
- LEESVILLE LAKE INFLOW
- ★— LEESVILLE LAKE OUTFLOW
- LEESVILLE LAKE LEVEL

HISTORICAL HYDROGRAPHS



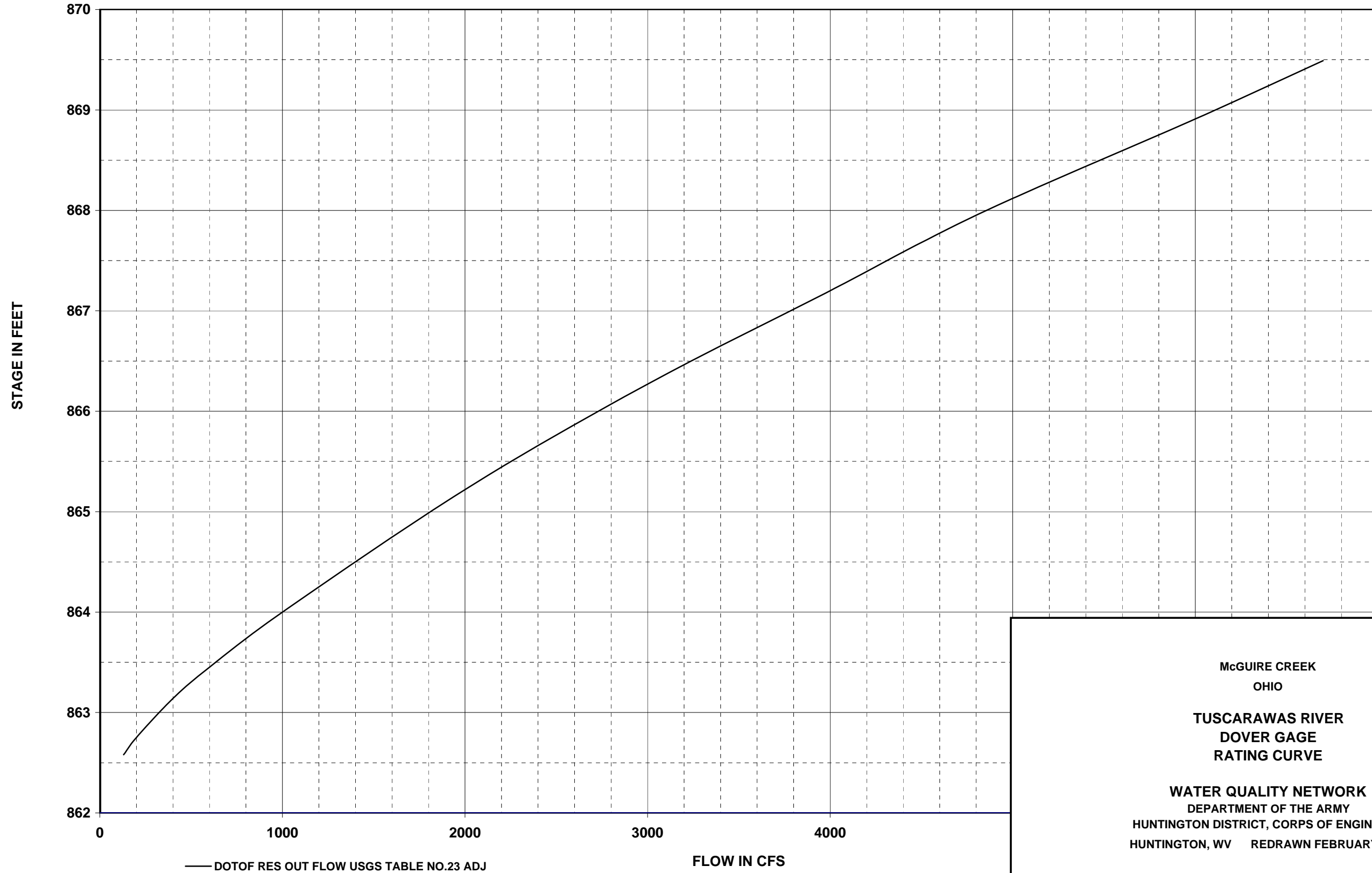
—◆— LEESVILLE LAKE INFLOW  
—★— LEESVILLE LAKE OUTFLOW  
—◆— LEESVILLE LAKE LEVEL

HISTORICAL HYDROGRAPHS



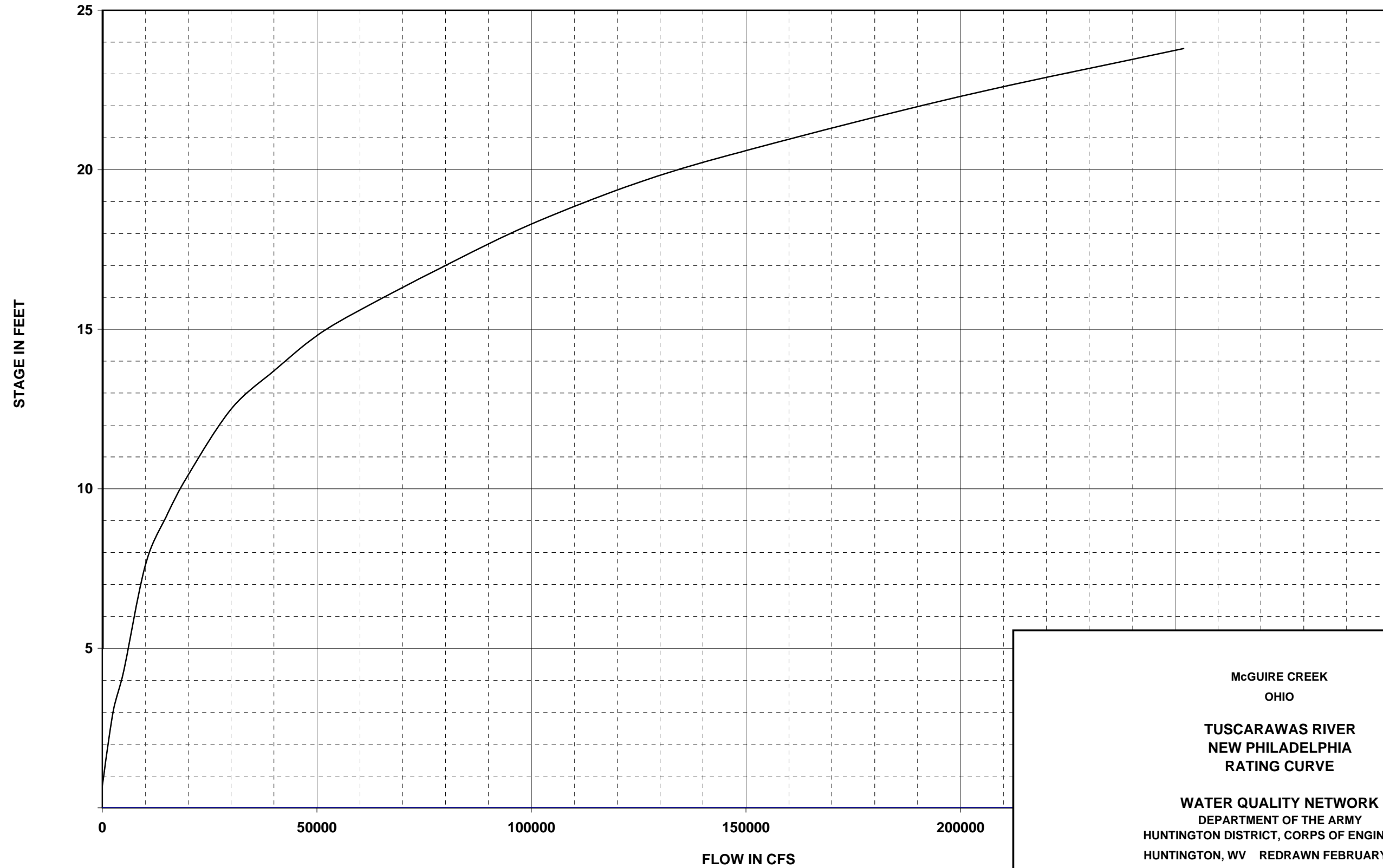
—▲— LEESVILLE LAKE INFLOW  
—★— LEESVILLE LAKE OUTFLOW  
— LEESVILLE LAKE LEVEL

# MUSKINGUM



McGUIRE CREEK  
OHIO  
TUSCARAWAS RIVER  
DOVER GAGE  
RATING CURVE  
WATER QUALITY NETWORK  
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN FEBRUARY 2006

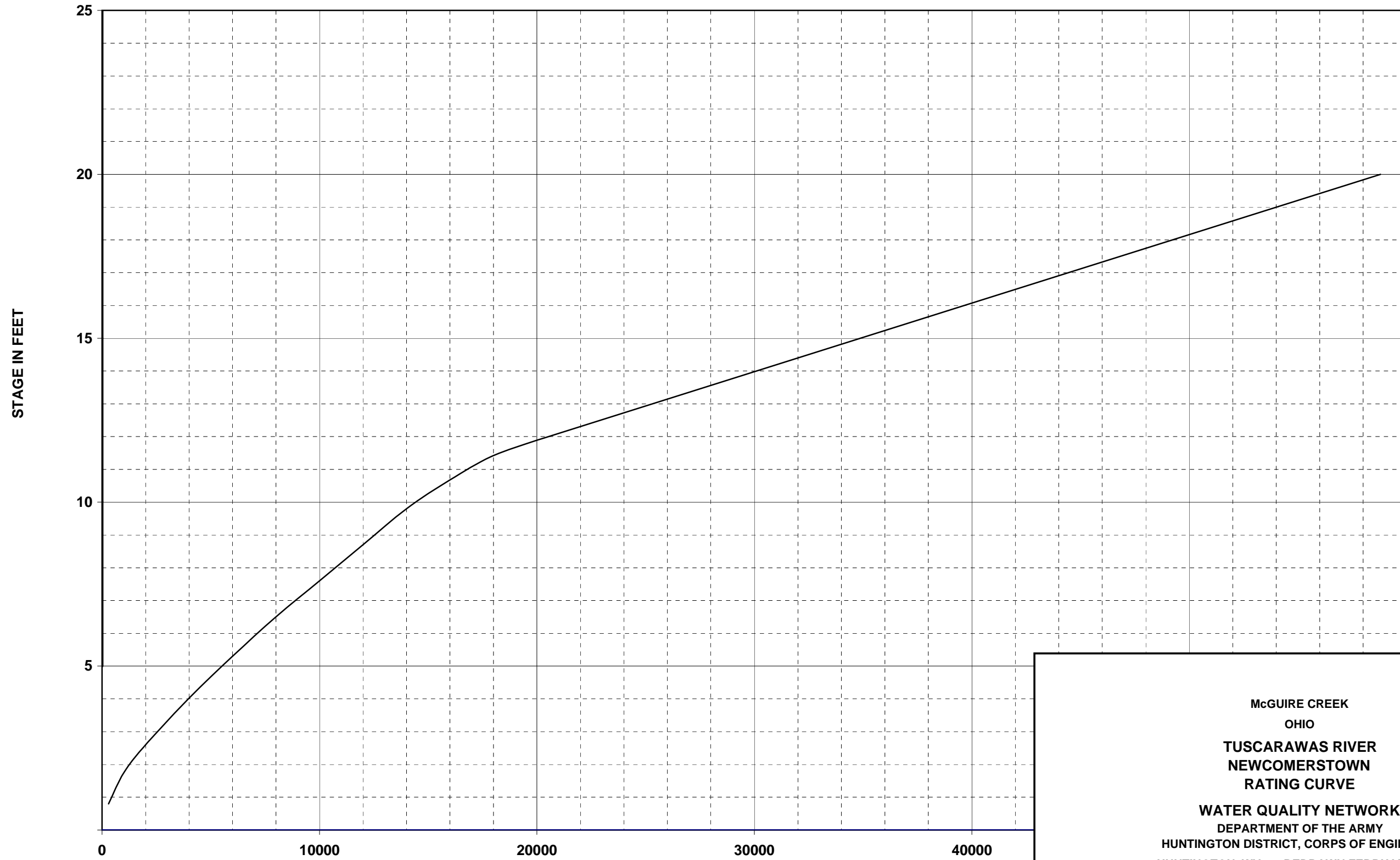
# MUSKINGUM



— NPTD6 FLOW USGS TABLE NO.02-ALT

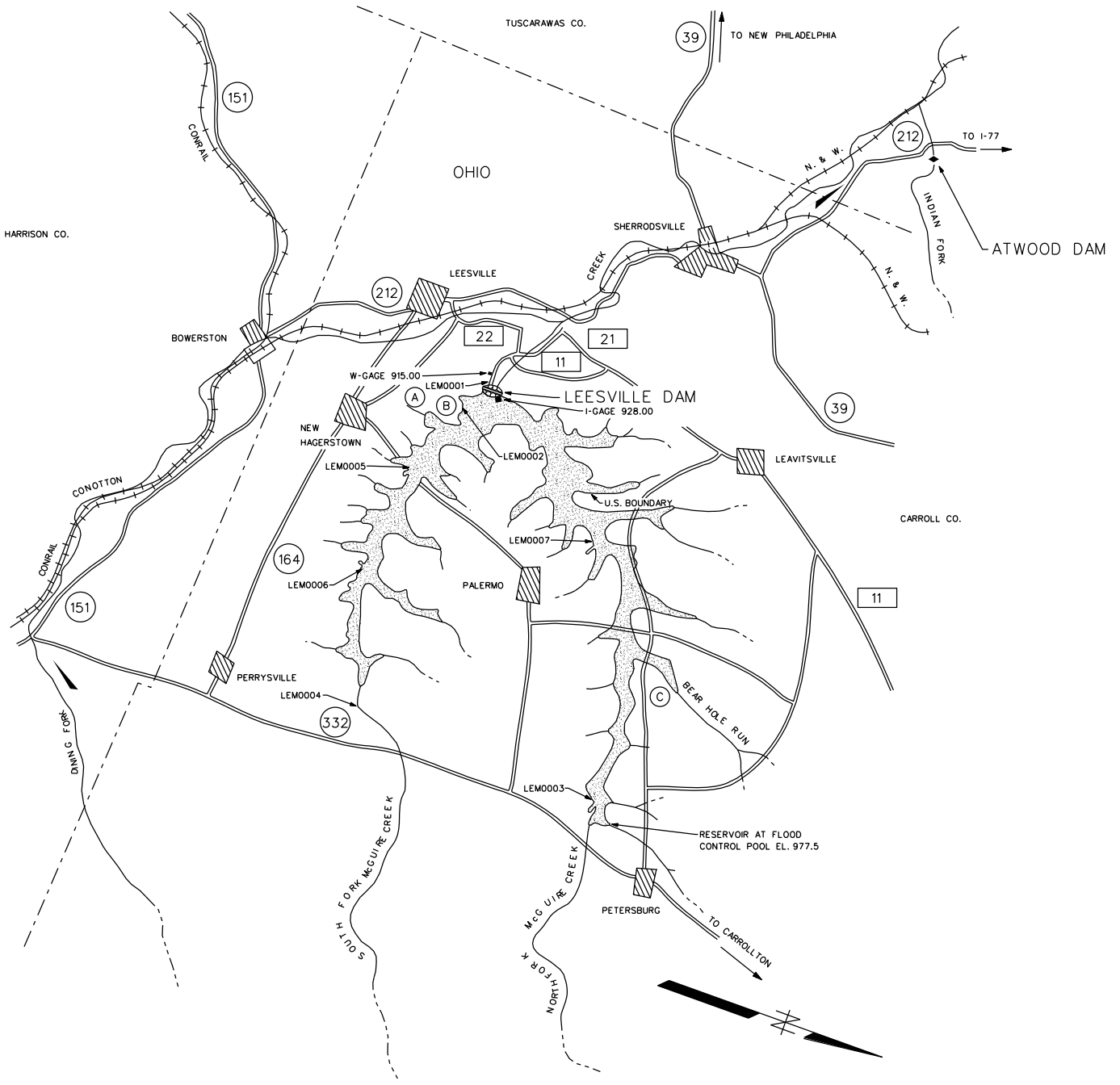
McGUIRE CREEK  
OHIO  
  
TUSCARAWAS RIVER  
NEW PHILADELPHIA  
RATING CURVE  
  
WATER QUALITY NETWORK  
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN FEBRUARY 2006

# MUSKINGUM



— NECD5 FLOW USGS TABLE NO.26

McGUIRE CREEK  
OHIO  
TUSCARAWAS RIVER  
NEWCOMERSTOWN  
RATING CURVE  
WATER QUALITY NETWORK  
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN FEBRUARY 2006



PUBLIC USE GUIDE

PARKING -  
CORPS OF ENGINEERS

(A)

MARINA, PARK, BEACH,  
PICNIC & CAMPING AREA - M.W.C.D.

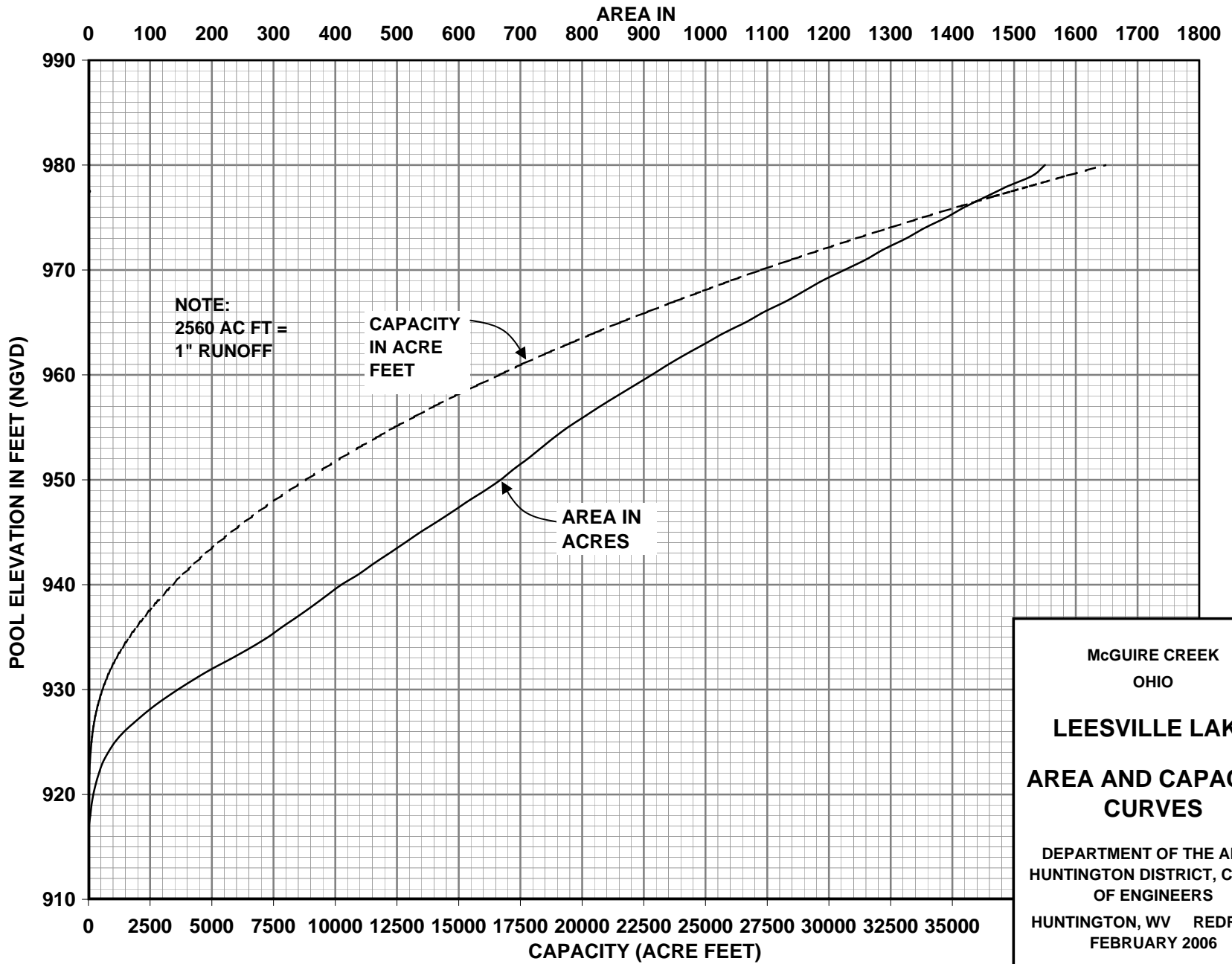
(B) (C)

McGUIRE CREEK  
OHIO

LEESVILLE DAM

LEESVILLE LAKE

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN MAY 2006



McGUIRE CREEK  
OHIO

**LEESVILLE LAKE**

**AREA AND CAPACITY  
CURVES**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS  
OF ENGINEERS  
HUNTINGTON, WV REDRAWN  
FEBRUARY 2006

# Leesville Lake

## Area and Capacity Tables

Drainage Area= 48 Sq Mi

1" Runoff= 2560 Ac Ft

| Pool<br>Elevation | Capacity    |             | Area<br>In Acres |  | Pool<br>Elevation | Capacity     |              | Area<br>In Acres |
|-------------------|-------------|-------------|------------------|--|-------------------|--------------|--------------|------------------|
|                   | Ac. Ft.     | Inches      |                  |  |                   | Ac. Ft.      | Inches       |                  |
| 915               | 0           | 0           | 0                |  | <b>950</b>        | <b>8810</b>  | <b>3.44</b>  | <b>668</b>       |
| 916               | 0           | 0           | 1                |  | 951               | 9490         | 3.7          | 689              |
| 917               | 2           | 0           | 1                |  | 952               | 10180        | 3.97         | 712              |
| 918               | 4           | 0           | 3                |  | 953               | 10900        | 4.26         | 733              |
| 919               | 8           | 0           | 5                |  | 954               | 11650        | 4.55         | 754              |
| <b>920</b>        | <b>14</b>   | <b>0.01</b> | <b>8</b>         |  | 955               | 12400        | 4.84         | 777              |
| 921               | 24          | 0.01        | 12               |  | 956               | 13200        | 5.15         | 803              |
| 922               | 38          | 0.02        | 17               |  | 957               | 14000        | 5.47         | 829              |
| 923               | 58          | 0.02        | 23               |  | 958               | 14850        | 5.79         | 857              |
| 924               | 86          | 0.03        | 32               |  | 959               | 15750        | 6.15         | 885              |
| 925               | 124         | 0.05        | 43               |  | <b>960</b>        | <b>16650</b> | <b>6.5</b>   | <b>913</b>       |
| 926               | 174         | 0.07        | 58               |  | 961               | 17550        | 6.85         | 940              |
| 927               | 242         | 0.1         | 77               |  | 962               | 18500        | 7.22         | 969              |
| 928               | 329         | 0.13        | 97               |  | 963               | 19500        | 7.61         | 1000             |
| 929               | 437         | 0.17        | 120              |  | 964               | 20500        | 8            | 1030             |
| <b>930</b>        | <b>569</b>  | <b>0.22</b> | <b>145</b>       |  | 965               | 21550        | 8.41         | 1065             |
| 931               | 727         | 0.28        | 172              |  | 966               | 22650        | 8.83         | 1095             |
| 932               | 913         | 0.36        | 201              |  | 967               | 23750        | 9.27         | 1130             |
| 933               | 1130        | 0.44        | 233              |  | 968               | 24900        | 9.73         | 1160             |
| 934               | 1380        | 0.54        | 263              |  | 969               | 26050        | 10.18        | 1190             |
| 935               | 1660        | 0.65        | 291              |  | <b>970</b>        | <b>27250</b> | <b>10.67</b> | <b>1225</b>      |
| 936               | 1960        | 0.77        | 315              |  | 971               | 28500        | 11.12        | 1260             |
| 937               | 2290        | 0.9         | 340              |  | 972               | 29800        | 11.63        | 1290             |
| 938               | 2640        | 1.03        | 364              |  | 973               | 31100        | 12.14        | 1325             |
| 939               | 3020        | 1.18        | 387              |  | 974               | 32450        | 12.68        | 1355             |
| <b>940</b>        | <b>3410</b> | <b>1.33</b> | <b>410</b>       |  | 975               | 33800        | 13.2         | 1390             |
| 941               | 3840        | 1.5         | 438              |  | 976               | 35200        | 13.75        | 1420             |
| 942               | 4290        | 1.68        | 462              |  | 977               | 36650        | 14.3         | 1455             |
| 943               | 4760        | 1.86        | 488              |  | 977.5             | 37400        | 14.6         | 1472.5           |
| 944               | 5260        | 2.06        | 513              |  | 978               | 38150        | 14.9         | 1490             |
| 945               | 5790        | 2.26        | 538              |  | 979               | 39650        | 15.49        | 1530             |
| 946               | 6340        | 2.48        | 565              |  | <b>980</b>        | <b>41200</b> | <b>16.09</b> | <b>1550</b>      |
| 947               | 6920        | 2.7         | 591              |  |                   |              |              |                  |
| 948               | 7520        | 2.94        | 616              |  |                   |              |              |                  |
| 949               | 8150        | 3.18        | 643              |  |                   |              |              |                  |

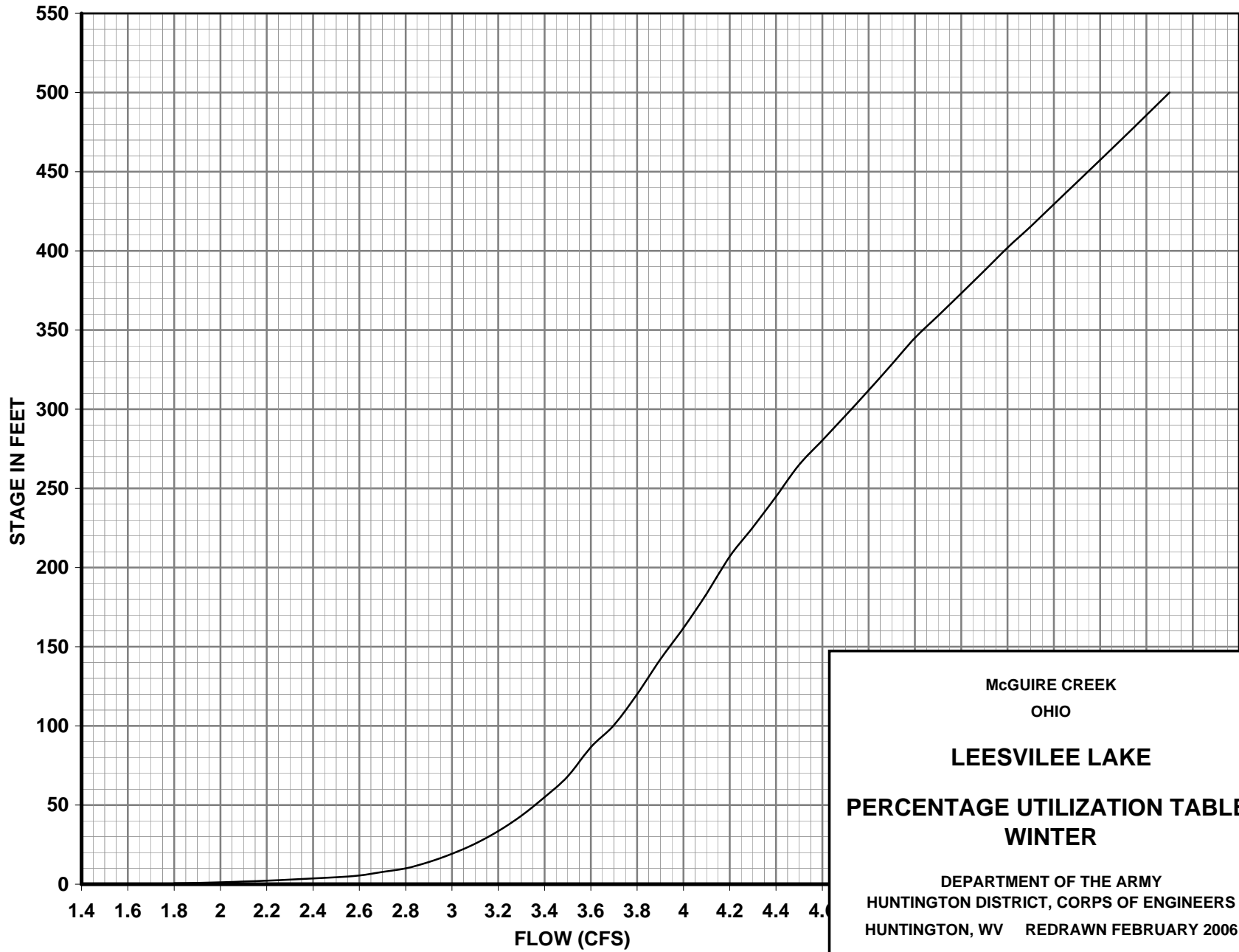
# Leesville Lake

## Percent Storage Utilization Table - Summer

| ELEV       | 0            | 0.1          | 0.2          | 0.3          | 0.4          | 0.5          | 0.6          | 0.7          | 0.8          | 0.9          |
|------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| 963        | 0.00         | 0.55         | 1.09         | 1.65         | 2.20         | 2.76         | 3.32         | 3.88         | 4.45         | 5.02         |
| 964        | 5.59         | 6.16         | 6.74         | 7.32         | 7.90         | 8.48         | 9.07         | 9.66         | 10.26        | 10.85        |
| <b>965</b> | <b>11.45</b> | <b>12.07</b> | <b>12.68</b> | <b>13.30</b> | <b>13.91</b> | <b>14.53</b> | <b>15.14</b> | <b>15.75</b> | <b>16.37</b> | <b>16.98</b> |
| 966        | 17.60        | 18.20        | 18.80        | 19.41        | 20.02        | 20.64        | 21.25        | 21.87        | 22.49        | 23.12        |
| 967        | 23.74        | 24.39        | 25.03        | 25.67        | 26.31        | 26.96        | 27.60        | 28.24        | 28.88        | 29.53        |
| 968        | 30.17        | 30.80        | 31.43        | 32.07        | 32.70        | 33.35        | 33.99        | 34.64        | 35.29        | 35.94        |
| 969        | 36.59        | 37.25        | 37.91        | 38.57        | 39.24        | 39.91        | 40.58        | 41.26        | 41.93        | 42.61        |
| <b>970</b> | <b>43.30</b> | <b>43.98</b> | <b>44.67</b> | <b>45.36</b> | <b>46.06</b> | <b>46.75</b> | <b>47.45</b> | <b>48.16</b> | <b>48.86</b> | <b>49.57</b> |
| 971        | 50.28        | 51.01        | 51.73        | 52.46        | 53.18        | 53.91        | 54.64        | 55.36        | 56.09        | 56.82        |
| 972        | 57.54        | 58.26        | 58.97        | 59.69        | 60.41        | 61.14        | 61.87        | 62.60        | 63.33        | 64.09        |
| 973        | 64.80        | 65.56        | 66.31        | 67.07        | 67.82        | 68.58        | 69.33        | 70.08        | 70.84        | 71.59        |
| 974        | 72.35        | 73.09        | 73.83        | 74.58        | 75.33        | 76.08        | 76.84        | 77.60        | 78.36        | 79.12        |
| <b>975</b> | <b>79.89</b> | <b>80.66</b> | <b>81.43</b> | <b>82.21</b> | <b>82.98</b> | <b>83.76</b> | <b>84.55</b> | <b>85.33</b> | <b>86.12</b> | <b>86.92</b> |
| 976        | 87.81        | 88.51        | 89.31        | 90.11        | 90.92        | 91.73        | 92.54        | 93.35        | 94.17        | 94.99        |
| 977        | 95.81        | 96.65        | 97.49        | 98.32        | 99.16        | 100.00       |              |              |              |              |

## Percent Storage Utilization Table - Winter

| ELEV       | 0            | 0.1          | 0.2          | 0.3          | 0.4          | 0.5          | 0.6          | 0.7          | 0.8          | 0.9          |
|------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| 957        | 0.00         | 0.35         | 0.71         | 1.07         | 1.43         | 1.79         | 2.15         | 2.52         | 2.89         | 3.26         |
| 958        | 3.63         | 4.02         | 4.40         | 4.79         | 5.17         | 5.56         | 5.94         | 6.32         | 6.71         | 7.09         |
| 959        | 7.48         | 7.86         | 8.25         | 8.63         | 9.02         | 9.40         | 9.79         | 10.17        | 10.56        | 10.94        |
| <b>960</b> | <b>11.32</b> | <b>11.70</b> | <b>12.08</b> | <b>12.46</b> | <b>12.84</b> | <b>13.22</b> | <b>13.61</b> | <b>13.99</b> | <b>14.38</b> | <b>14.78</b> |
| 961        | 15.17        | 15.57        | 15.97        | 16.37        | 16.77        | 17.17        | 17.58        | 17.99        | 18.40        | 18.82        |
| 962        | 19.23        | 19.66        | 20.09        | 20.51        | 20.94        | 21.37        | 21.79        | 22.22        | 22.65        | 23.08        |
| 963        | 23.50        | 23.92        | 24.34        | 24.76        | 25.19        | 25.61        | 26.04        | 26.47        | 26.91        | 27.34        |
| 964        | 27.78        | 28.22        | 28.66        | 29.10        | 29.55        | 29.99        | 30.44        | 30.90        | 31.35        | 31.81        |
| <b>965</b> | <b>32.27</b> | <b>32.74</b> | <b>33.21</b> | <b>33.68</b> | <b>34.15</b> | <b>34.62</b> | <b>35.09</b> | <b>35.56</b> | <b>36.03</b> | <b>36.50</b> |
| 966        | 36.97        | 37.43        | 37.89        | 38.35        | 38.82        | 39.29        | 39.76        | 40.23        | 40.71        | 41.19        |
| 967        | 41.67        | 42.16        | 42.65        | 43.14        | 43.63        | 44.12        | 44.62        | 45.11        | 45.60        | 46.09        |
| 968        | 46.58        | 47.06        | 47.55        | 48.03        | 48.52        | 49.01        | 49.50        | 50.00        | 50.50        | 50.99        |
| 969        | 51.50        | 52.00        | 52.50        | 53.01        | 53.52        | 54.03        | 54.55        | 55.06        | 55.58        | 56.10        |
| <b>970</b> | <b>56.62</b> | <b>57.12</b> | <b>57.68</b> | <b>58.20</b> | <b>58.74</b> | <b>59.27</b> | <b>59.80</b> | <b>60.34</b> | <b>60.88</b> | <b>61.42</b> |
| 971        | 61.97        | 62.52        | 63.08        | 63.63        | 64.19        | 64.74        | 65.30        | 65.86        | 66.41        | 66.97        |
| 972        | 67.52        | 68.07        | 68.62        | 69.17        | 69.72        | 70.27        | 70.83        | 71.39        | 71.95        | 72.51        |
| 973        | 73.08        | 73.65        | 74.23        | 74.81        | 75.38        | 75.96        | 76.54        | 77.12        | 77.69        | 78.27        |
| 974        | 78.85        | 79.41        | 79.98        | 80.55        | 81.13        | 81.70        | 82.28        | 82.86        | 83.44        | 84.03        |
| <b>975</b> | <b>84.62</b> | <b>85.20</b> | <b>85.80</b> | <b>86.39</b> | <b>86.98</b> | <b>87.58</b> | <b>88.18</b> | <b>88.78</b> | <b>89.39</b> | <b>89.99</b> |
| 976        | 90.60        | 91.21        | 91.82        | 92.44        | 93.05        | 93.67        | 94.29        | 94.61        | 95.54        | 96.17        |
| 977        | 96.80        | 97.44        | 98.08        | 98.72        | 99.36        |              |              |              |              |              |

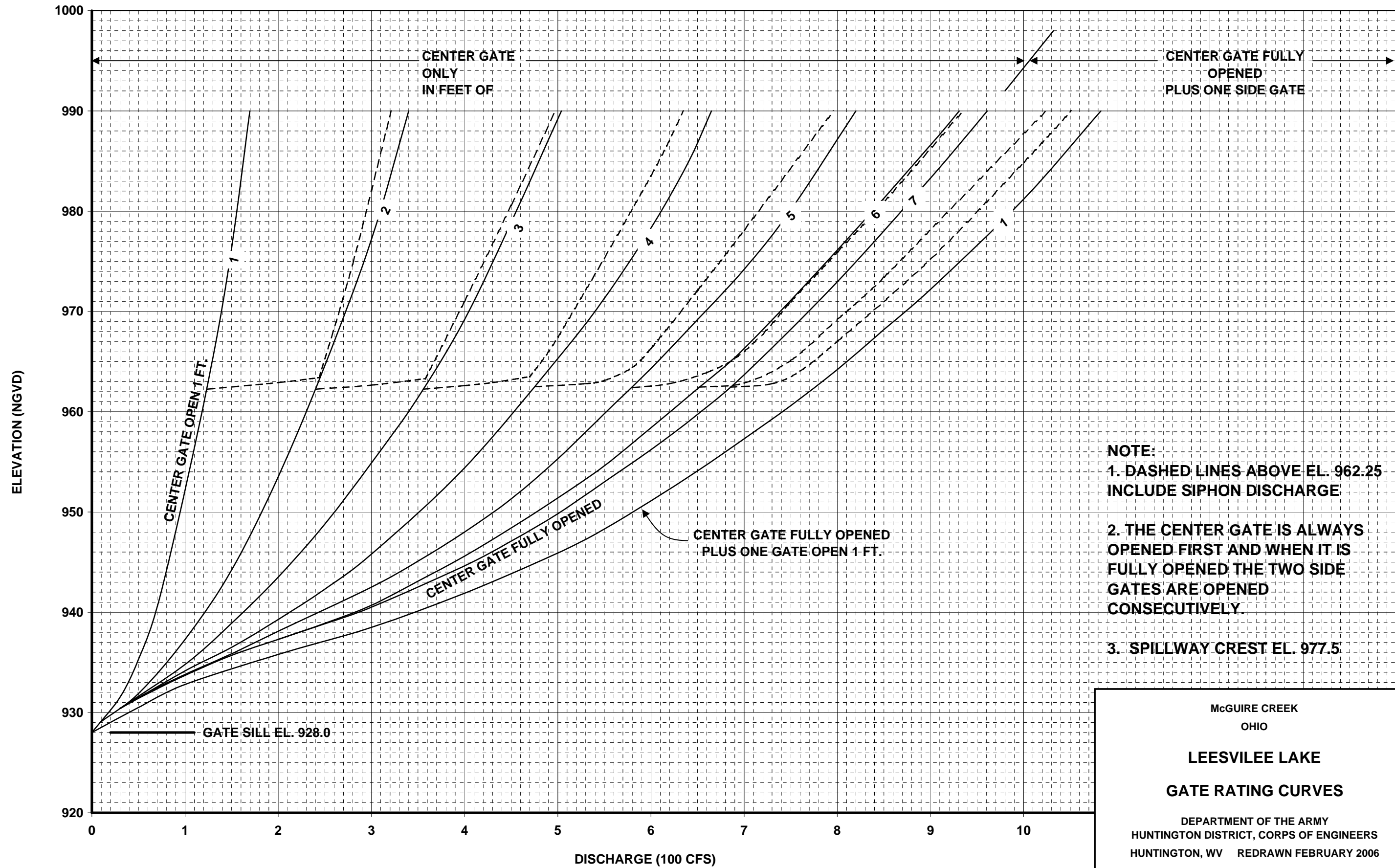


McGUIRE CREEK  
OHIO

**LEESVILLE LAKE**

**PERCENTAGE UTILIZATION TABLE-  
WINTER**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN FEBRUARY 2006

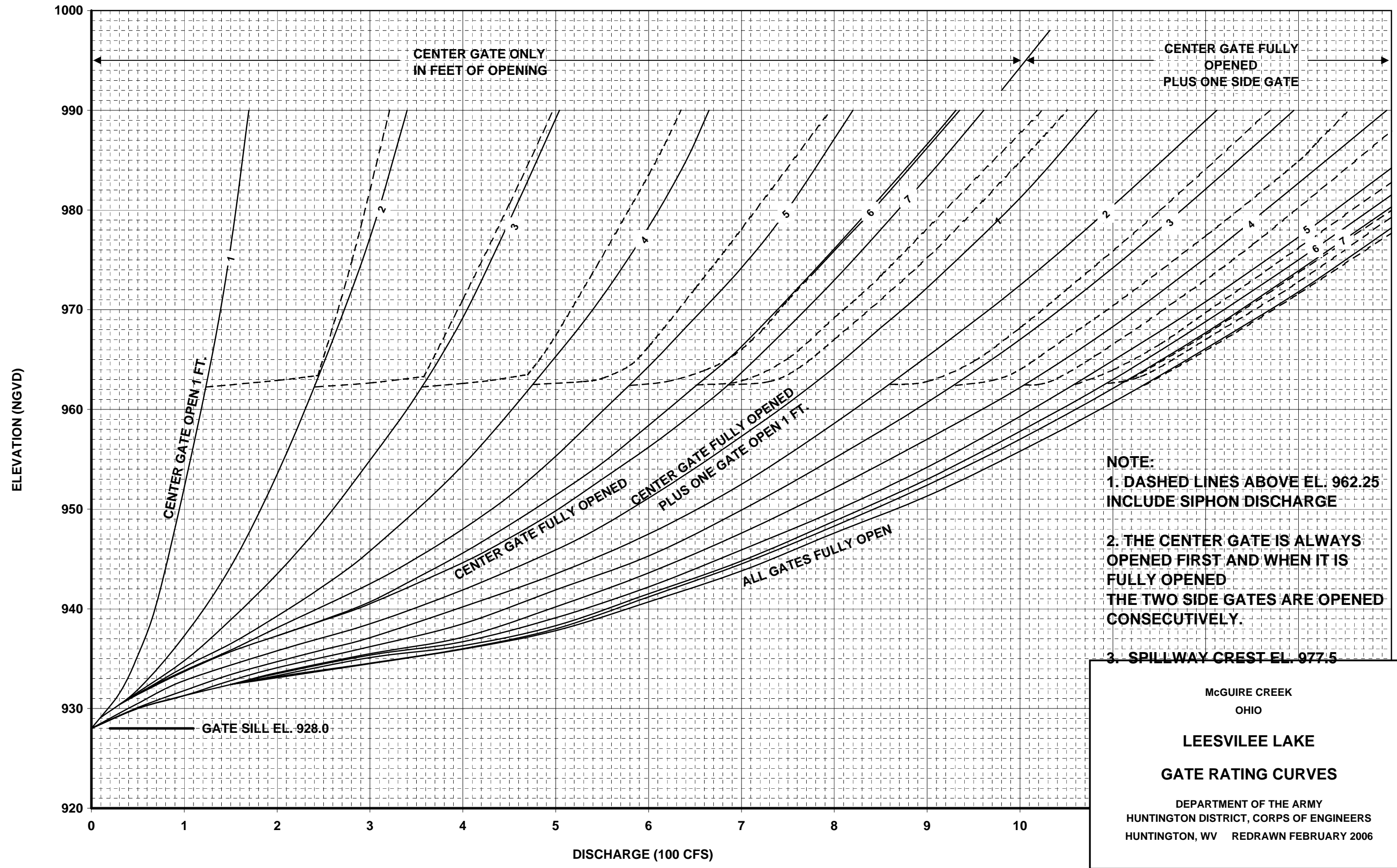


McGUIRE CREEK  
OHIO

**LEESVILLE LAKE**

**GATE RATING CURVES**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN FEBRUARY 2006



**NOTE:**

1. DASHED LINES ABOVE EL. 962.25 INCLUDE SIPHON DISCHARGE
2. THE CENTER GATE IS ALWAYS OPENED FIRST AND WHEN IT IS FULLY OPENED THE TWO SIDE GATES ARE OPENED CONSECUTIVELY.
3. SPILLWAY CREST EL. 977.5

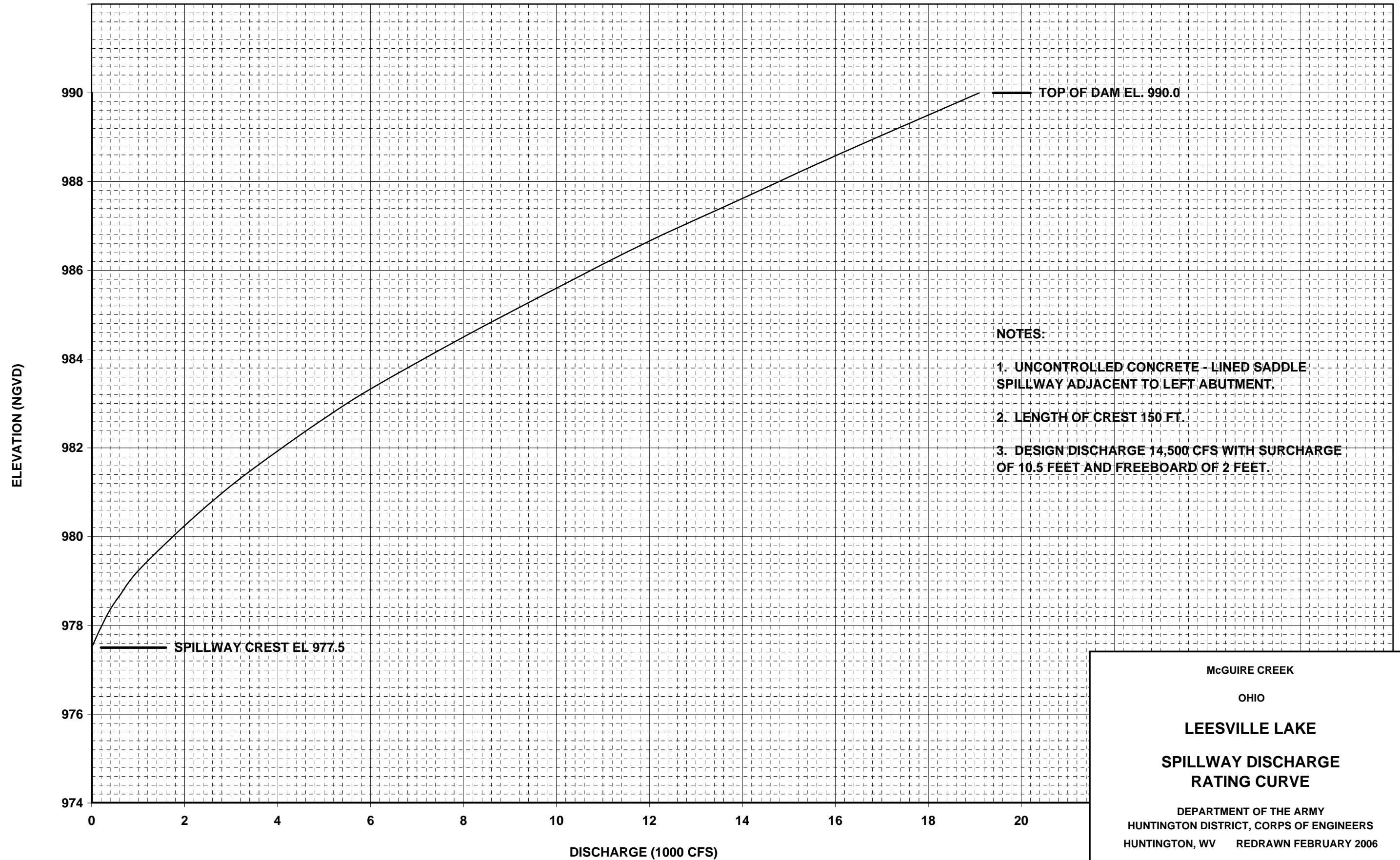
McGUIRE CREEK  
 OHIO  
  
**LEESVILLE LAKE**  
  
**GATE RATING CURVES**  
  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, WV REDRAWN FEBRUARY 2006

TABLE 7-4  
LEESVILLE LAKE  
SIPHON RATING

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| Pool Elev. | .0  | .1  | .2  | .3  | .4  | .5  | .6  | .7  | .8  | .9  |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 962.0      |     |     |     | 2   | 4   | 6   | 13  | 41  | 59  | 70  |
| 963.0      | 80  | 90  | 99  | 109 | 117 | 120 | 122 | 123 | 124 | 124 |
| 964.0      | 124 | 124 | 124 | 124 | 125 | 125 | 125 | 125 | 126 | 126 |
| 965.0      | 126 | 126 | 126 | 127 | 127 | 127 | 127 | 127 | 128 | 128 |
| 966.0      | 128 | 128 | 128 | 129 | 129 | 129 | 129 | 129 | 130 | 130 |
| 967.0      | 130 | 130 | 130 | 130 | 131 | 131 | 131 | 131 | 131 | 132 |
| 968.0      | 132 | 132 | 132 | 132 | 132 | 133 | 133 | 133 | 133 | 133 |
| 969.0      | 134 | 134 | 134 | 134 | 134 | 134 | 135 | 135 | 135 | 135 |
| 970.0      | 135 | 135 | 136 | 136 | 136 | 136 | 136 | 136 | 137 | 137 |
| 971.0      | 137 | 137 | 137 | 138 | 138 | 138 | 138 | 138 | 138 | 139 |
| 972.0      | 139 | 139 | 139 | 139 | 139 | 139 | 140 | 140 | 140 | 140 |
| 973.0      | 140 | 140 | 140 | 141 | 141 | 141 | 141 | 141 | 141 | 142 |
| 974.0      | 142 | 142 | 142 | 142 | 142 | 143 | 143 | 143 | 143 | 143 |
| 975.0      | 143 | 144 | 144 | 144 | 144 | 144 | 144 | 144 | 145 | 145 |
| 976.0      | 145 | 145 | 145 | 145 | 145 | 146 | 146 | 146 | 146 | 146 |
| 977.0      | 146 | 146 | 147 | 147 | 147 | 147 | 147 | 147 | 147 | 148 |
| 978.0      | 148 | 148 | 148 | 148 | 148 | 148 | 149 | 149 | 149 | 149 |
| 979.0      | 149 | 149 | 149 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| 980.0      | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 |

This siphon is used as a self-regulating low-flow system that holds the pool near El. 963 during routine operations.



McGUIRE CREEK  
 OHIO  
**LEESVILLE LAKE**  
**SPILLWAY DISCHARGE**  
**RATING CURVE**  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, WV REDRAWN FEBRUARY 2006

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION NUMBER 03120500 McGuires Creek near Leesville C SOURCE AGENCY USGS STATE 39 COUNTY 019  
 LATITUDE 402813 LONGITUDE 0811148 NAD27 DRAINAGE AREA 48.3 CONTRIBUTING DRAINAGE AREA 48.3 DATUM 915.00 NGVD29  
 Date Processed: 2004-09-27 08:22 By chawkins  
 Rating for Discharge FROM DCP, IN cfs  
 RATING ID: 25 TYPE: dependent, parameter EXPANSION: logarithmic STATUS: working  
 Created by chawkins on 09-27-2004 @ 08:22:07 EDT, Updated by chawkins on 09-27-2004 @ 08:22:07 EDT  
 Remarks:

OFFSET: 1.50

EXPANDED RATING TABLE

| Gag height, feet | Discharge IN cfs (EXPANDED PRECISION) |       |       |       |       |       |       |       |       |       | DIFF IN Y PER .1 UNITS |
|------------------|---------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------------------------|
|                  | .00                                   | .01   | .02   | .03   | .04   | .05   | .06   | .07   | .08   | .09   |                        |
| 1.80             | 0.600*                                | 0.620 | 0.640 | 0.660 | 0.680 | 0.700 | 0.720 | 0.740 | 0.760 | 0.780 | 0.200                  |
| 1.90             | 0.800*                                | 0.835 | 0.871 | 0.907 | 0.945 | 0.982 | 1.02  | 1.06  | 1.10  | 1.14  | 0.380                  |
| 2.00             | 1.18*                                 | 1.23  | 1.28  | 1.33  | 1.38  | 1.43  | 1.48  | 1.53  | 1.59  | 1.64  | 0.520                  |
| 2.10             | 1.70*                                 | 1.75  | 1.80  | 1.84  | 1.89  | 1.94  | 1.99  | 2.04  | 2.10  | 2.15  | 0.500                  |
| 2.20             | 2.20*                                 | 2.27  | 2.33  | 2.40  | 2.47  | 2.54  | 2.61  | 2.68  | 2.75  | 2.83  | 0.700                  |
| 2.30             | 2.90*                                 | 2.97  | 3.04  | 3.11  | 3.18  | 3.26  | 3.33  | 3.40  | 3.48  | 3.55  | 0.730                  |
| 2.40             | 3.63                                  | 3.71  | 3.79  | 3.87  | 3.95  | 4.03  | 4.11  | 4.19  | 4.27  | 4.36  | 0.810                  |
| 2.50             | 4.44*                                 | 4.54  | 4.65  | 4.76  | 4.87  | 4.98  | 5.09  | 5.20  | 5.32  | 5.43  | 1.11                   |
| 2.60             | 5.55*                                 | 5.71  | 5.87  | 6.04  | 6.21  | 6.38  | 6.56  | 6.74  | 6.92  | 7.11  | 1.75                   |
| 2.70             | 7.30*                                 | 7.54  | 7.79  | 8.04  | 8.30  | 8.57  | 8.84  | 9.12  | 9.41  | 9.70  | 2.70                   |
| 2.80             | 10.00*                                | 10.35 | 10.72 | 11.09 | 11.48 | 11.87 | 12.27 | 12.69 | 13.12 | 13.55 | 4.00                   |
| 2.90             | 14.00*                                | 14.46 | 14.94 | 15.43 | 15.93 | 16.44 | 16.97 | 17.50 | 18.06 | 18.62 | 5.20                   |
| 3.00             | 19.20*                                | 19.78 | 20.37 | 20.97 | 21.58 | 22.21 | 22.86 | 23.52 | 24.19 | 24.88 | 6.38                   |
| 3.10             | 25.58                                 | 26.30 | 27.04 | 27.79 | 28.55 | 29.34 | 30.13 | 30.95 | 31.78 | 32.63 | 7.92                   |
| 3.20             | 33.50*                                | 34.39 | 35.29 | 36.22 | 37.16 | 38.12 | 39.10 | 40.10 | 41.12 | 42.16 | 9.72                   |
| 3.30             | 43.22                                 | 44.30 | 45.40 | 46.53 | 47.67 | 48.84 | 50.02 | 51.23 | 52.47 | 53.72 | 11.78                  |
| 3.40             | 55.00*                                | 56.63 | 58.30 | 60.01 | 61.76 | 63.56 | 65.39 | 67.27 | 69.19 | 71.16 | 18.17                  |
| 3.50             | 73.17                                 | 75.23 | 77.34 | 79.50 | 81.70 | 83.95 | 86.26 | 88.61 | 91.02 | 93.49 | 22.83                  |
| 3.60             | 96.00*                                | 97.91 | 99.85 | 101.8 | 103.8 | 105.8 | 107.9 | 110.0 | 112.1 | 114.3 | 20.40                  |
| 3.70             | 116.4                                 | 118.6 | 120.9 | 123.2 | 125.5 | 127.8 | 130.2 | 132.6 | 135.0 | 137.5 | 23.60                  |
| 3.80             | 140.0*                                | 142.0 | 144.1 | 146.2 | 148.3 | 150.4 | 152.6 | 154.8 | 157.0 | 159.2 | 21.40                  |
| 3.90             | 161.4                                 | 163.7 | 165.9 | 168.2 | 170.6 | 172.9 | 175.3 | 177.7 | 180.1 | 182.5 | 23.60                  |
| 4.00             | 185.0*                                | 187.0 | 189.0 | 191.0 | 193.0 | 195.0 | 197.0 | 199.1 | 201.2 | 203.2 | 20.30                  |
| 4.10             | 205.3                                 | 207.4 | 209.6 | 211.7 | 213.8 | 216.0 | 218.2 | 220.4 | 222.6 | 224.8 | 21.70                  |
| 4.20             | 227.0*                                | 228.7 | 230.4 | 232.1 | 233.7 | 235.5 | 237.2 | 238.9 | 240.6 | 242.3 | 17.10                  |
| 4.30             | 244.1                                 | 245.8 | 247.5 | 249.3 | 251.0 | 252.8 | 254.6 | 256.4 | 258.1 | 259.9 | 17.60                  |
| 4.40             | 261.7                                 | 263.5 | 265.3 | 267.1 | 269.0 | 270.8 | 272.6 | 274.5 | 276.3 | 278.1 | 18.30                  |
| 4.50             | 280.0*                                | 281.6 | 283.2 | 284.8 | 286.5 | 288.1 | 289.7 | 291.4 | 293.0 | 294.6 | 16.30                  |
| 4.60             | 296.3                                 | 297.9 | 299.6 | 301.2 | 302.9 | 304.6 | 306.2 | 307.9 | 309.6 | 311.3 | 16.70                  |
| 4.70             | 313.0                                 | 314.6 | 316.3 | 318.0 | 319.7 | 321.4 | 323.1 | 324.8 | 326.6 | 328.3 | 17.00                  |
| 4.80             | 330.0*                                | 331.5 | 333.0 | 334.4 | 335.9 | 337.4 | 338.9 | 340.4 | 341.9 | 343.4 | 14.90                  |
| 4.90             | 344.9                                 | 346.4 | 347.9 | 349.4 | 350.9 | 352.4 | 353.9 | 355.4 | 357.0 | 358.5 | 15.10                  |
| 5.00             | 360.0*                                | 361.4 | 362.7 | 364.1 | 365.5 | 366.9 | 368.2 | 369.6 | 371.0 | 372.4 | 13.80                  |
| 5.10             | 373.8                                 | 375.1 | 376.5 | 377.9 | 379.3 | 380.7 | 382.1 | 383.5 | 384.8 | 386.2 | 13.80                  |
| 5.20             | 387.6                                 | 389.0 | 390.4 | 391.8 | 393.2 | 394.6 | 396.0 | 397.4 | 398.8 | 400.2 | 14.00                  |
| 5.30             | 401.6                                 | 403.0 | 404.4 | 405.9 | 407.3 | 408.7 | 410.1 | 411.5 | 412.9 | 414.3 | 14.20                  |
| 5.40             | 415.8                                 | 417.2 | 418.6 | 420.0 | 421.4 | 422.9 | 424.3 | 425.7 | 427.1 | 428.6 | 14.20                  |
| 5.50             | 430.0*                                | 431.2 | 432.3 | 433.5 | 434.6 | 435.8 | 437.0 | 438.1 | 439.3 | 440.5 | 11.60                  |
| 5.60             | 441.6                                 | 442.8 | 443.9 | 445.1 | 446.3 | 447.4 | 448.6 | 449.8 | 450.9 | 452.1 | 11.60                  |
| 5.70             | 453.2                                 | 454.4 | 455.6 | 456.7 | 457.9 | 459.1 | 460.2 | 461.4 | 462.6 | 463.7 | 11.70                  |

RATE 76 (10F2)

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION NUMBER 03120500 McGuire Creek near Leesville O. SOURCE AGENCY USGS STATE 39 COUNTY 019  
 LA. E 402813 LONGITUDE 0811148 NAD27 DRAINAGE AREA 48.30 CONTRIBUTING DRAINAGE AREA 48.3 DATUM 915.00 NGVD29  
 Date Processed: 2004-09-27 08:22 By chawkins  
 Rating for Discharge FROM DCP, IN cfs  
 RATING ID: 25 TYPE: dependent, parameter EXPANSION: logarithmic STATUS: working  
 Created by chawkins on 09-27-2004 @ 08:22:07 EDT, Updated by chawkins on 09-27-2004 @ 08:22:07 EDT  
 Remarks:

OFFSET: 1.50

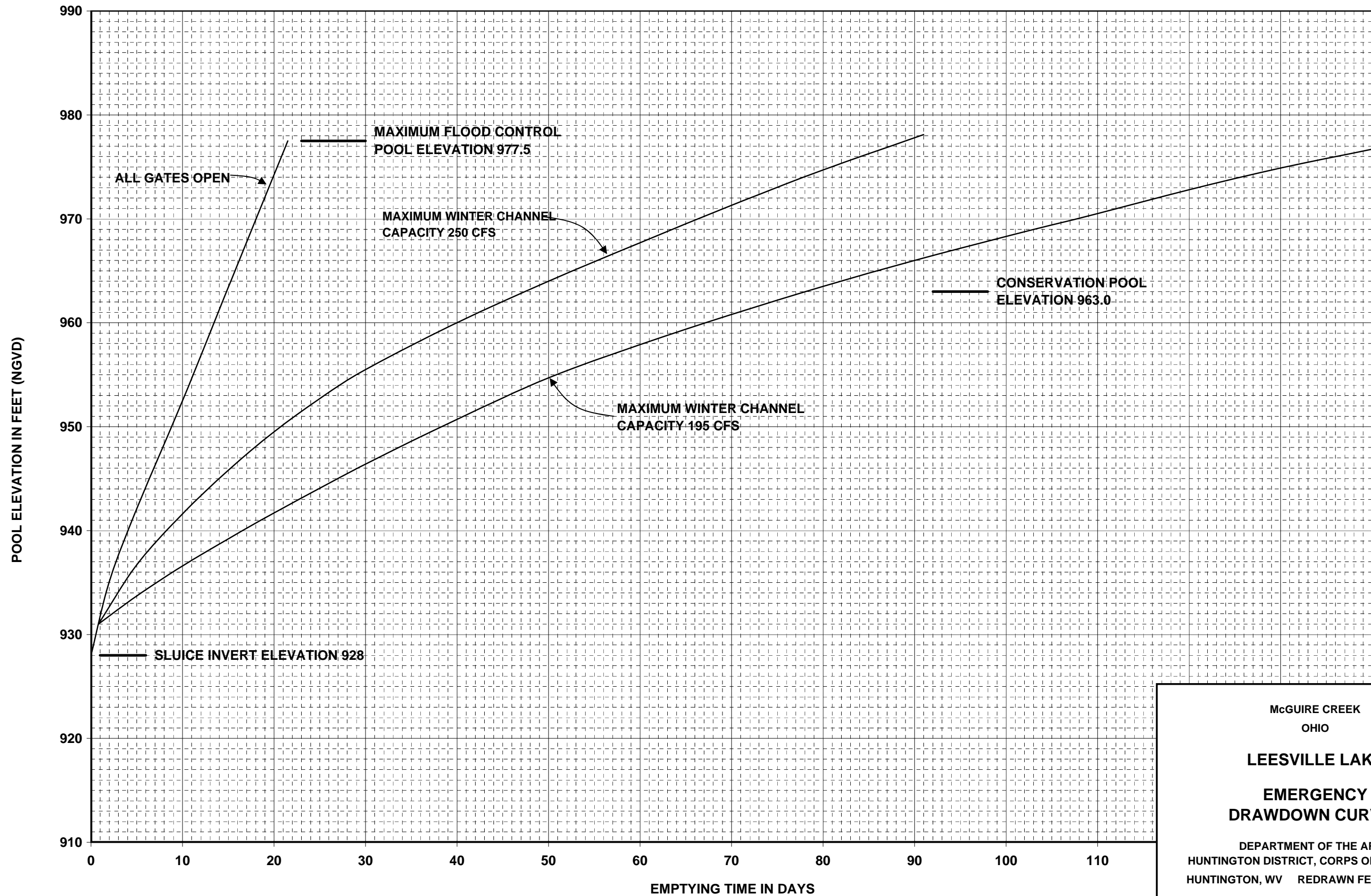
EXPANDED RATING TABLE

| Gag<br>height,<br>feet | Discharge IN cfs<br>(EXPANDED PRECISION) |       |       |       |       |       |       |       |       |       | DIFF IN Y<br>PER<br>.1 UNITS |
|------------------------|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|------------------------------|
|                        | .00                                      | .01   | .02   | .03   | .04   | .05   | .06   | .07   | .08   | .09   |                              |
| 5.80                   | 464.9                                    | 466.1 | 467.2 | 468.4 | 469.6 | 470.7 | 471.9 | 473.1 | 474.2 | 475.4 | 11.70                        |
| 5.90                   | 476.6                                    | 477.8 | 478.9 | 480.1 | 481.3 | 482.4 | 483.6 | 484.8 | 485.9 | 487.1 | 11.70                        |
| 6.00                   | 488.3                                    | 489.5 | 490.6 | 491.8 | 493.0 | 494.1 | 495.3 | 496.5 | 497.7 | 498.8 | 11.70                        |
| 6.10                   | 500.0*                                   | 501.2 | 502.5 | 503.7 | 505.0 | 506.2 | 507.5 | 508.7 | 510.0 | 511.2 | 12.40                        |
| 6.20                   | 512.4                                    | 513.7 | 514.9 | 516.2 | 517.4 | 518.7 | 519.9 | 521.2 | 522.4 | 523.7 | 12.50                        |
| 6.30                   | 524.9                                    | 526.2 | 527.4 | 528.7 | 529.9 | 531.2 | 532.4 | 533.7 | 534.9 | 536.2 | 12.50                        |
| 6.40                   | 537.4                                    | 538.7 | 540.0 | 541.2 | 542.5 | 543.7 | 545.0 | 546.2 | 547.5 | 548.7 | 12.60                        |
| 6.50                   | 550.0*                                   | 551.2 | 552.4 | 553.6 | 554.8 | 556.0 | 557.2 | 558.4 | 559.6 | 560.8 | 12.00                        |
| 6.60                   | 562.0                                    | 563.2 | 564.4 | 565.6 | 566.8 | 567.9 | 569.1 | 570.3 | 571.5 | 572.7 | 11.90                        |
| 6.70                   | 573.9                                    | 575.1 | 576.3 | 577.5 | 578.7 | 579.9 | 581.1 | 582.3 | 583.5 | 584.7 | 12.00                        |
| 6.80                   | 585.9                                    | 587.1 | 588.3 | 589.5 | 590.7 | 591.9 | 593.2 | 594.4 | 595.6 | 596.8 | 12.10                        |
| 6.90                   | 598.0                                    | 599.2 | 600.4 | 601.6 | 602.8 | 604.0 | 605.2 | 606.4 | 607.6 | 608.8 | 12.00                        |
| 7.00                   | 610.0*                                   |       |       |       |       |       |       |       |       |       |                              |

"\*" indicates a rating descriptor point

| Rating Type: |                           | Rating Type: dependent, parameter |          |
|--------------|---------------------------|-----------------------------------|----------|
| ID           | Starting Date             | Ending Date                       | Comments |
| 25           | 10-01-2003 @ 00:01:00 EDT | -----                             | W        |

Rate 1-5 (2002)

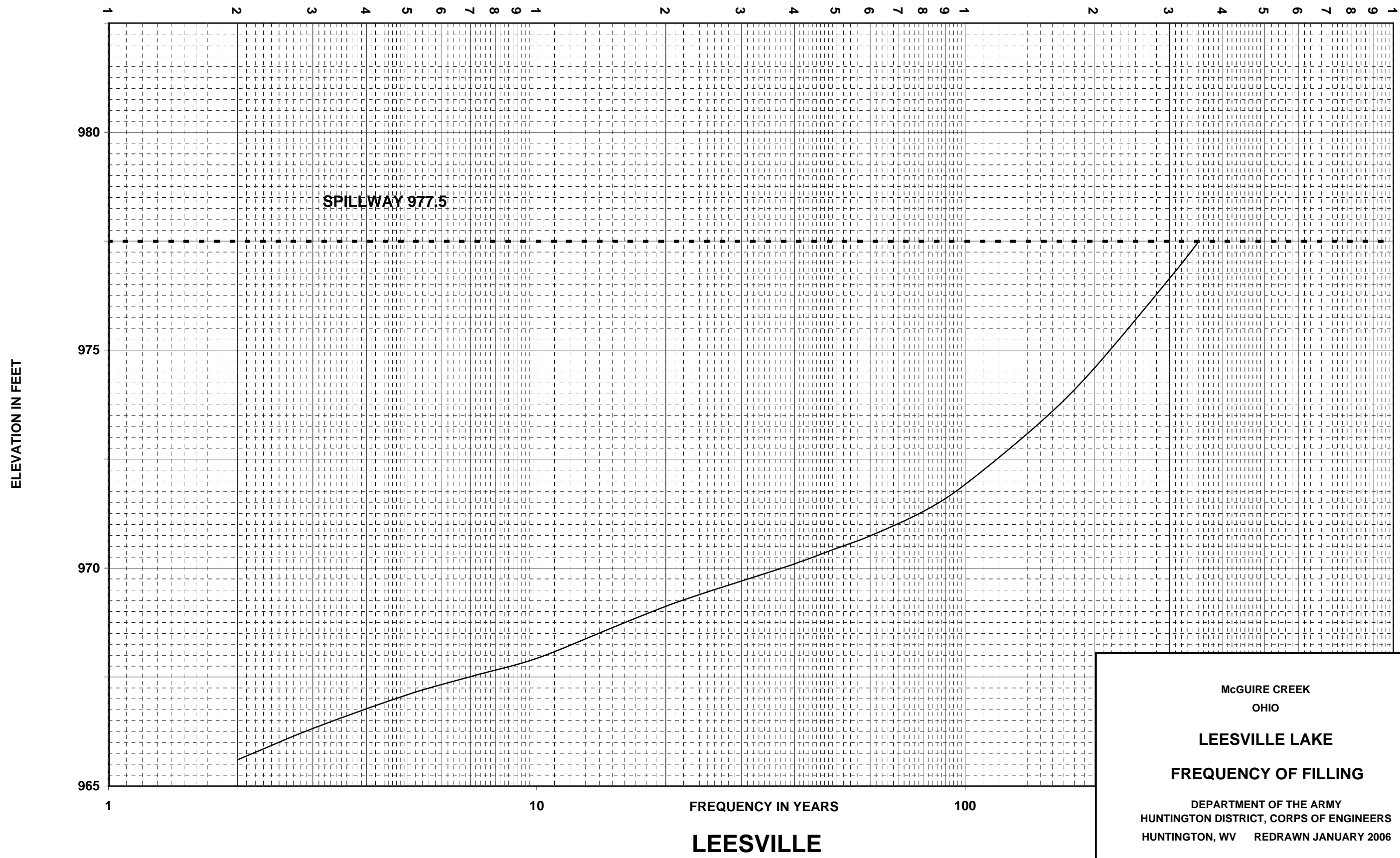


McGUIRE CREEK  
OHIO

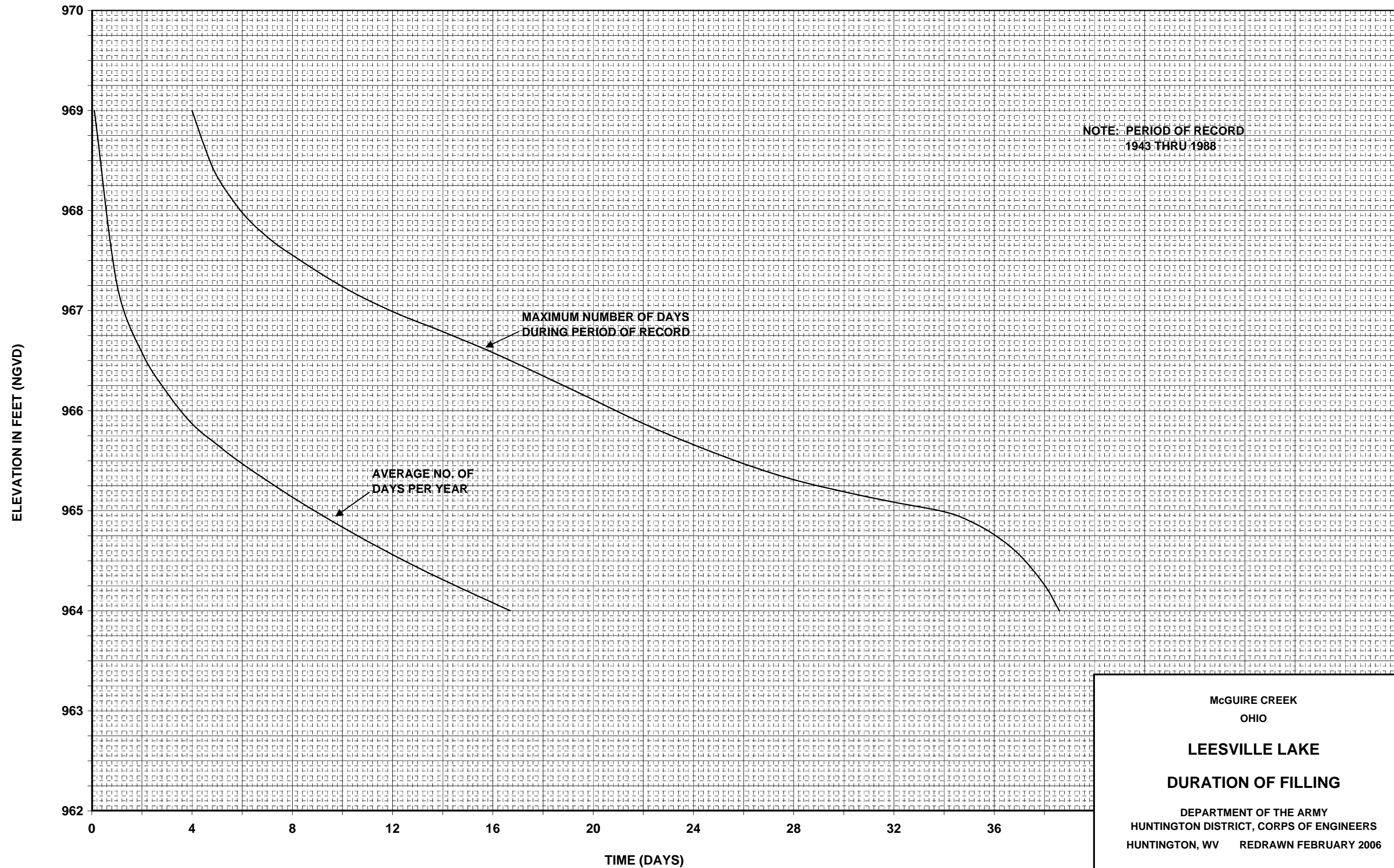
**LEESVILLE LAKE**

**EMERGENCY  
DRAWDOWN CURVES**

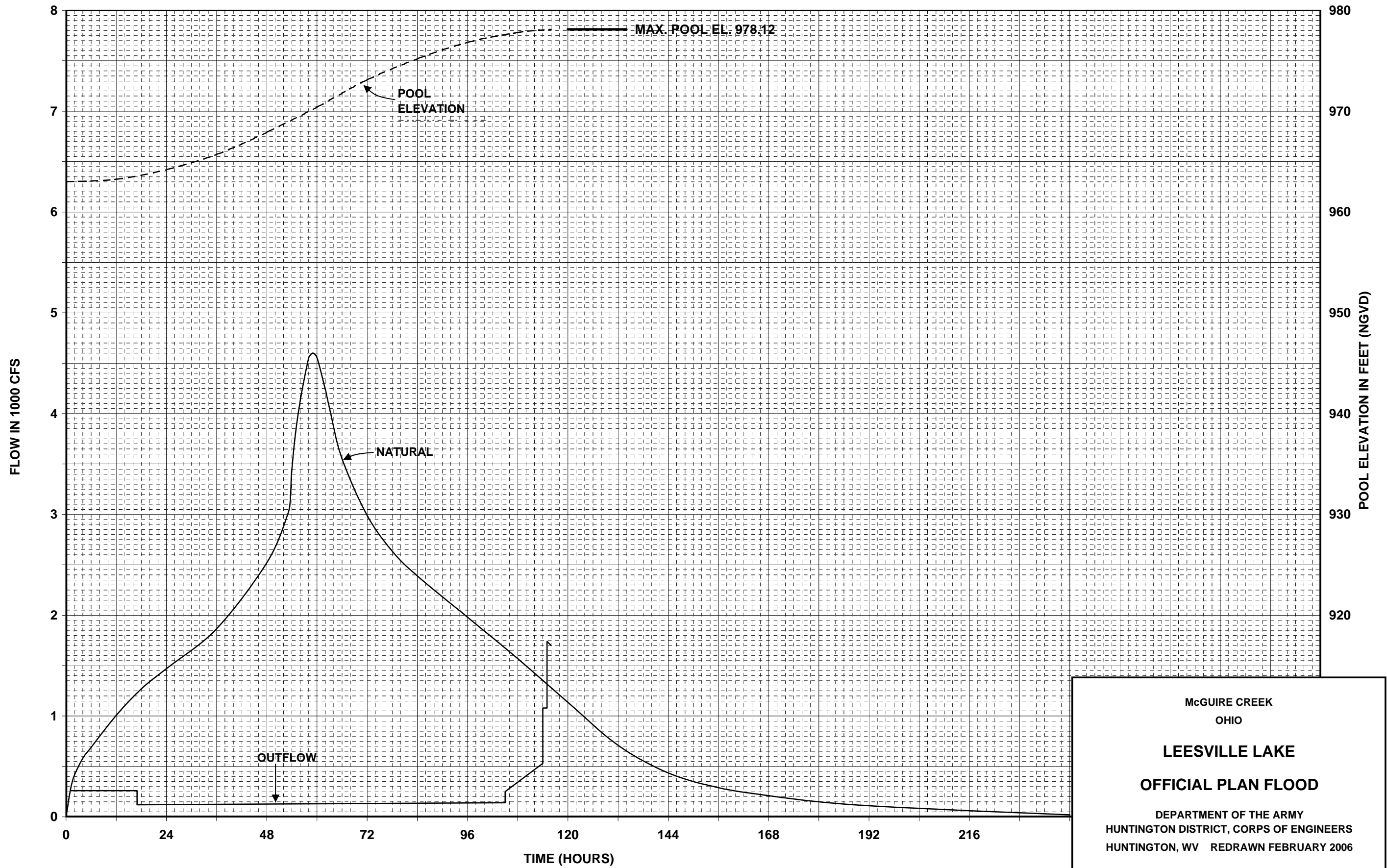
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN FEBRUARY 2006



McGUIRE CREEK  
 OHIO  
  
**LEESVILLE LAKE**  
**FREQUENCY OF FILLING**  
  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, WV REDRAWN JANUARY 2006



**McGUIRE CREEK**  
 OHIO  
**LEESVILLE LAKE**  
**DURATION OF FILLING**  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, WV REDRAWN FEBRUARY 2006

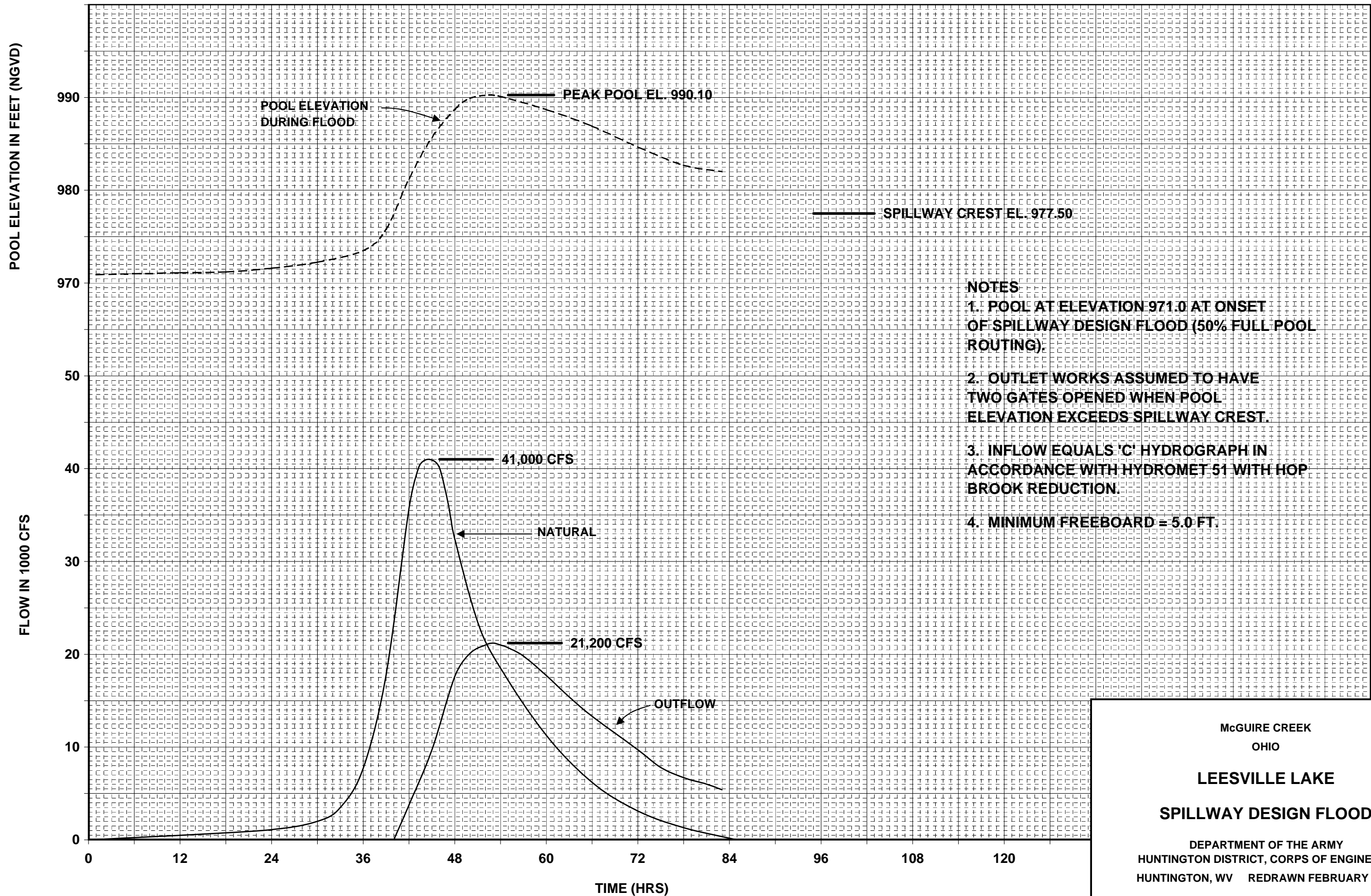


McGUIRE CREEK  
OHIO

**LEESVILLE LAKE**

**OFFICIAL PLAN FLOOD**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN FEBRUARY 2006

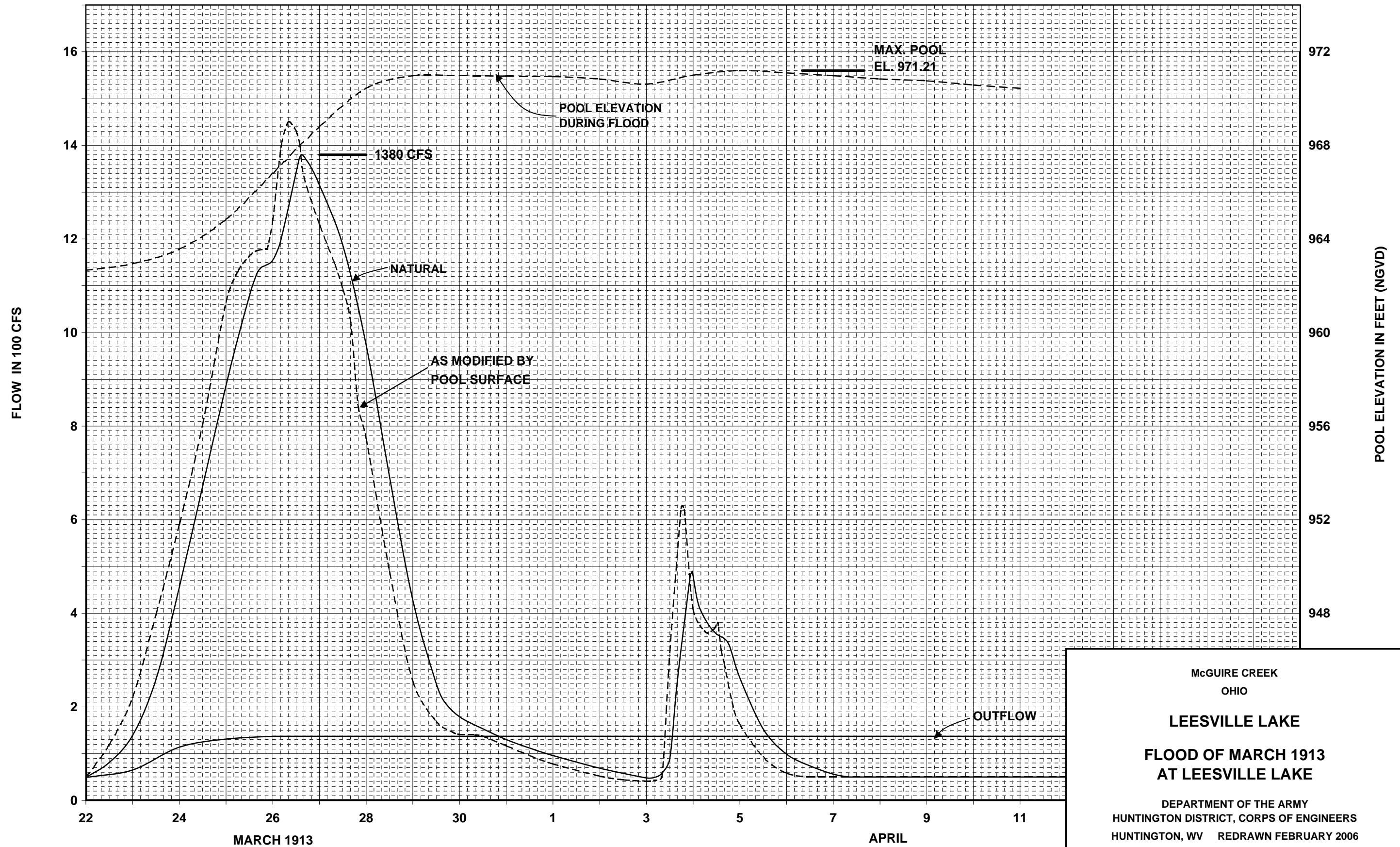


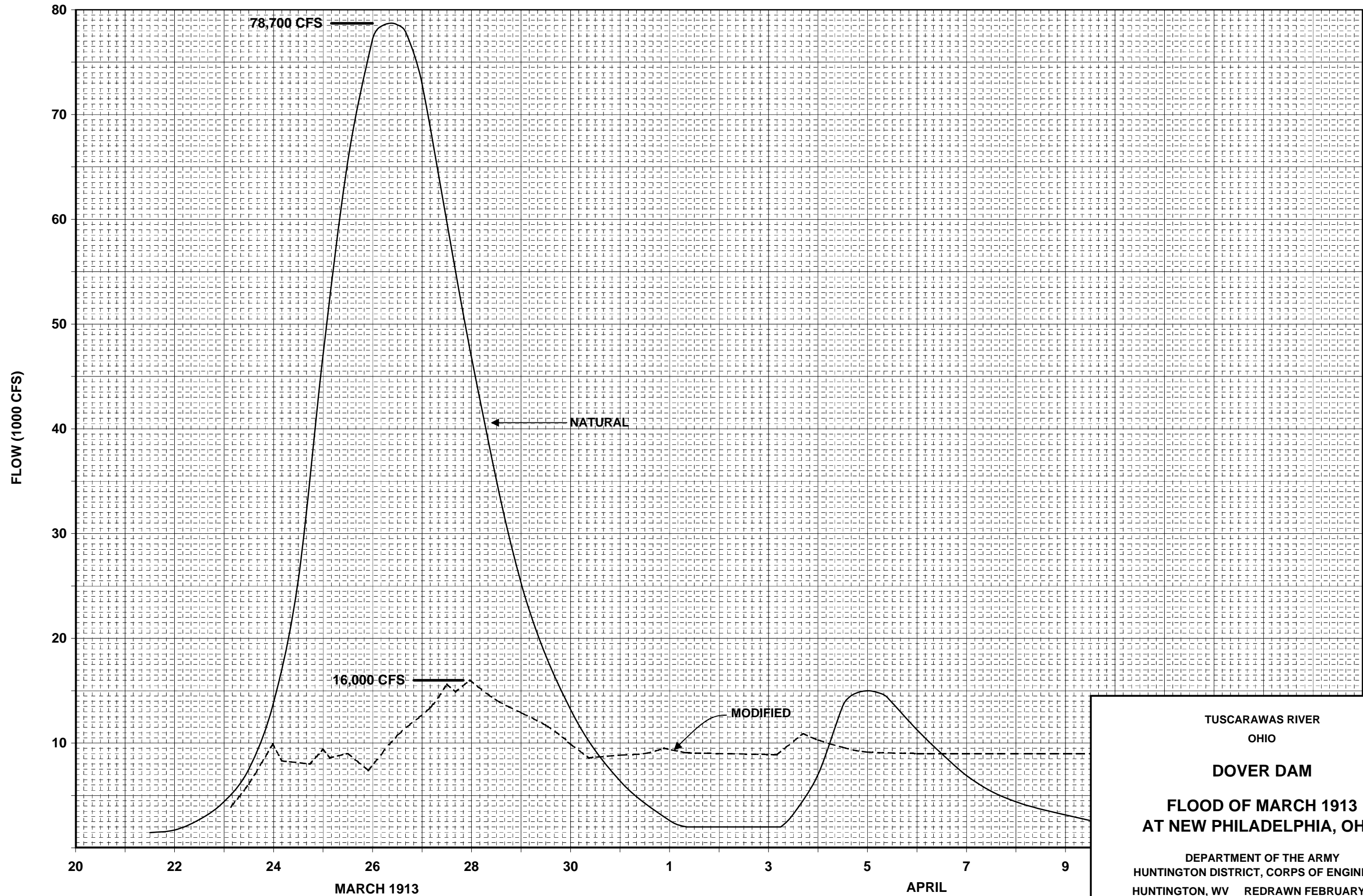
McGUIRE CREEK  
OHIO

**LEESVILLE LAKE**

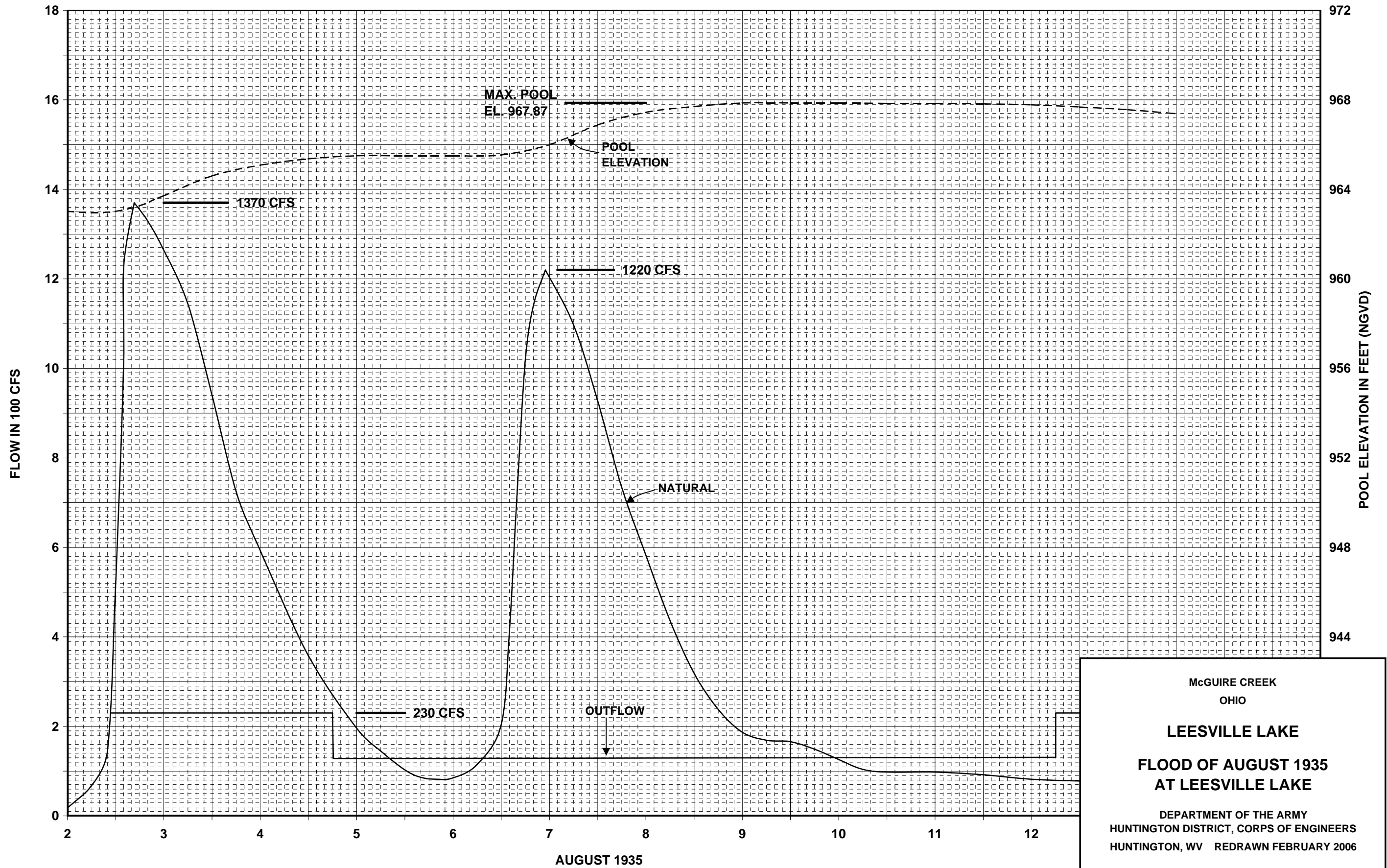
**SPILLWAY DESIGN FLOOD**

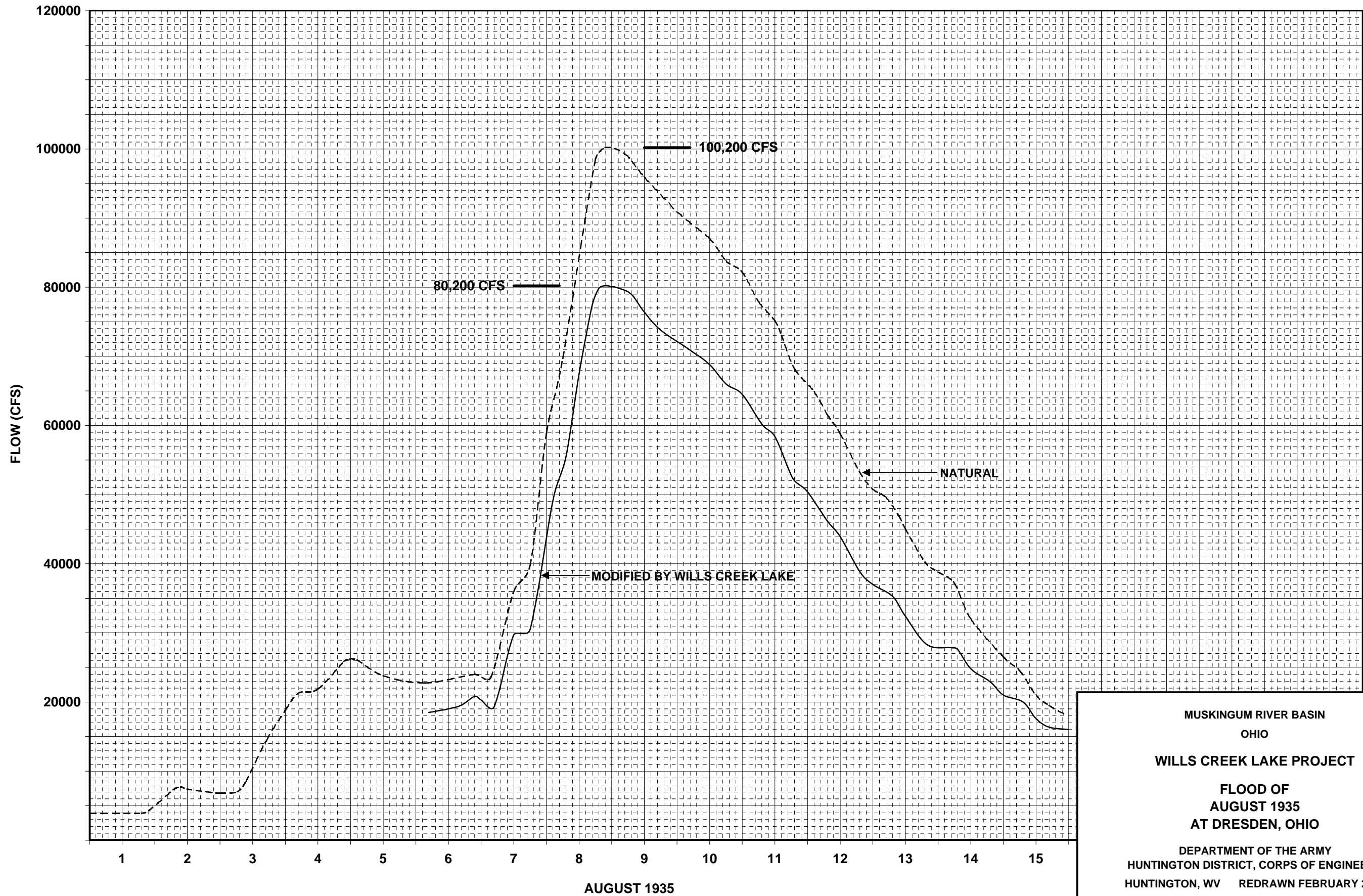
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN FEBRUARY 2006



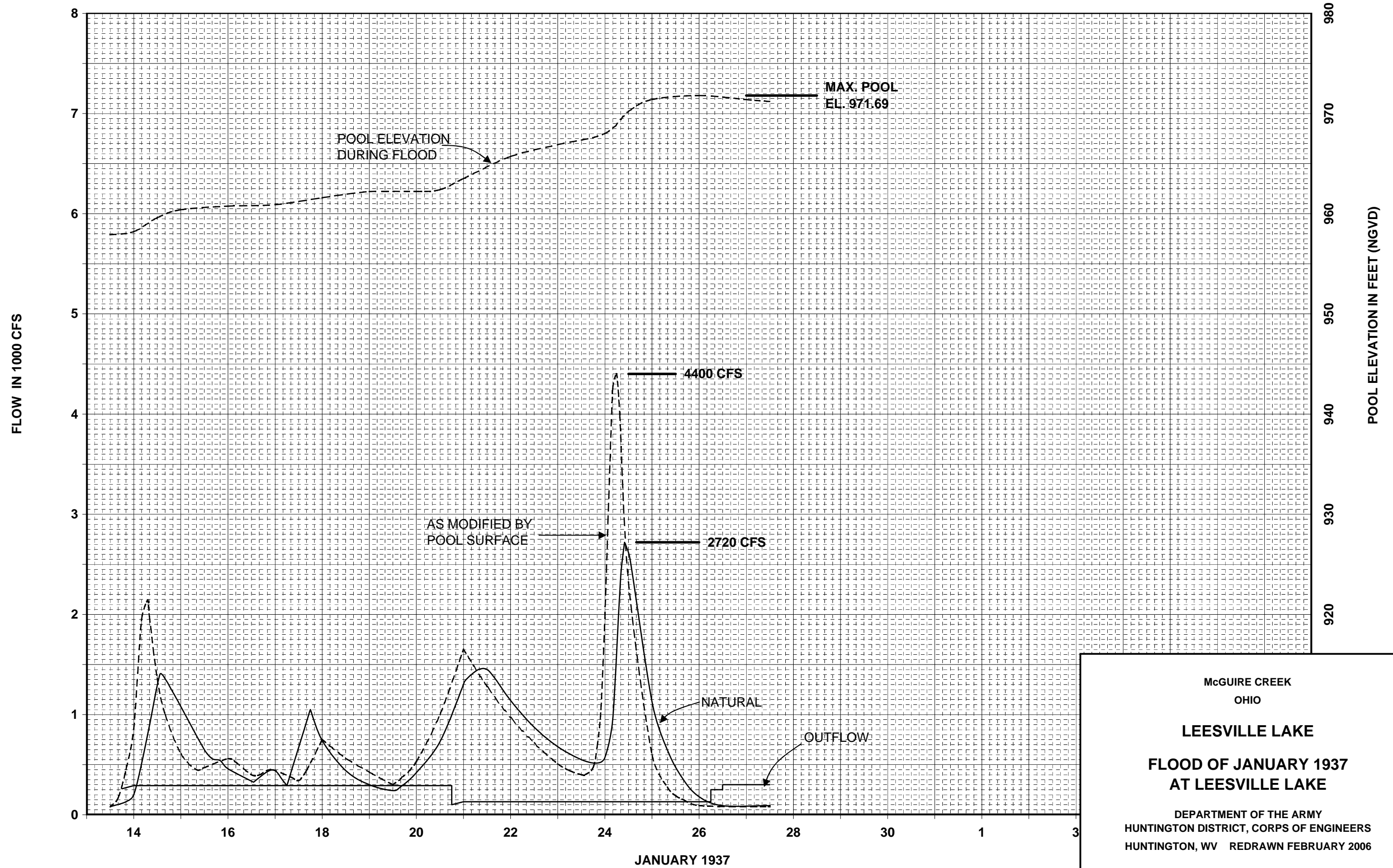


TUSCARAWAS RIVER  
 OHIO  
**DOVER DAM**  
**FLOOD OF MARCH 1913**  
**AT NEW PHILADELPHIA, OHIO**  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, WV REDRAWN FEBRUARY 2006





MUSKINGUM RIVER BASIN  
 OHIO  
**WILLS CREEK LAKE PROJECT**  
 FLOOD OF  
 AUGUST 1935  
 AT DRESDEN, OHIO  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, WV REDRAWN FEBRUARY 2006

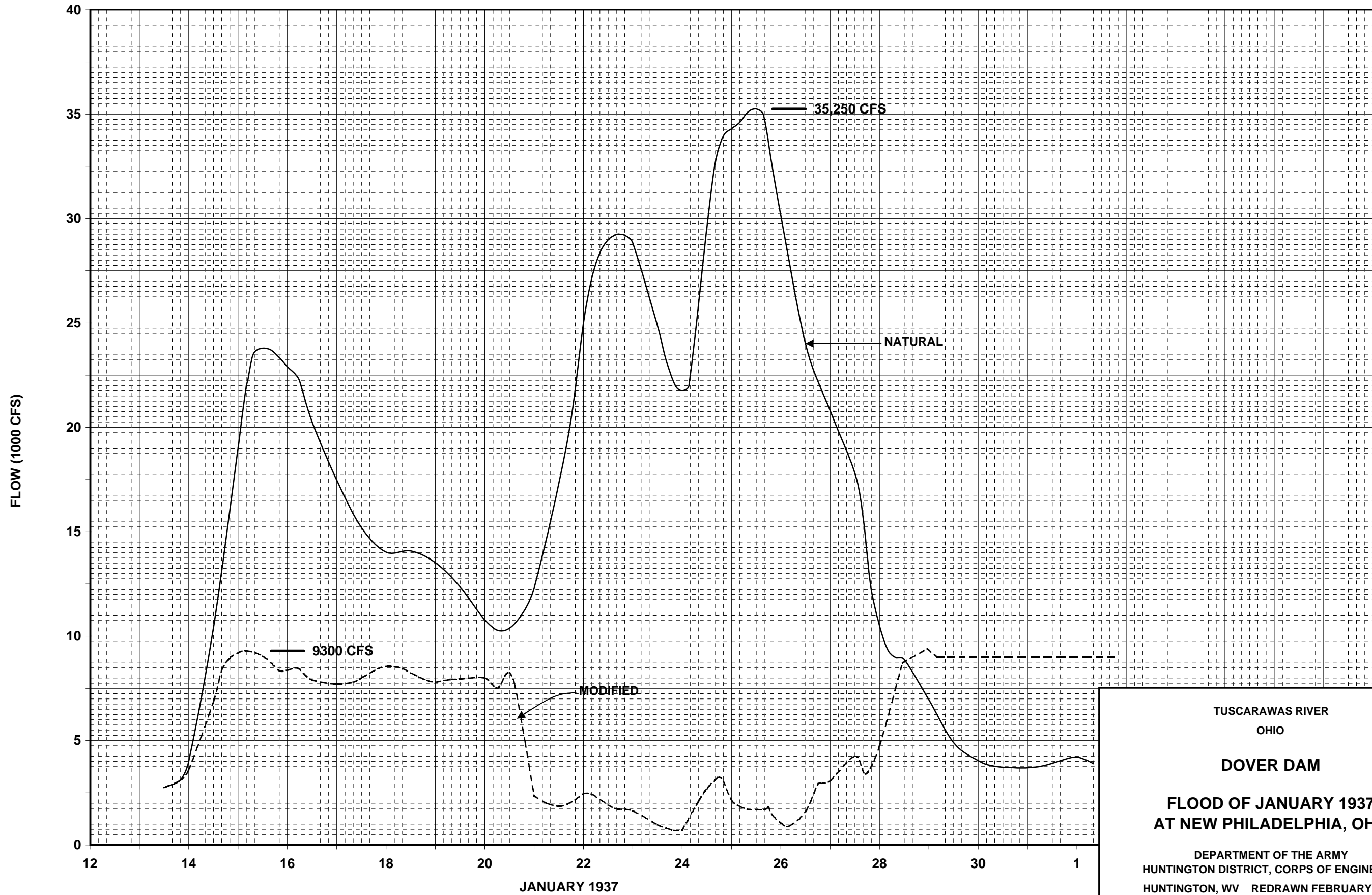


McGUIRE CREEK  
OHIO

**LEESVILLE LAKE**

**FLOOD OF JANUARY 1937**  
**AT LEESVILLE LAKE**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN FEBRUARY 2006

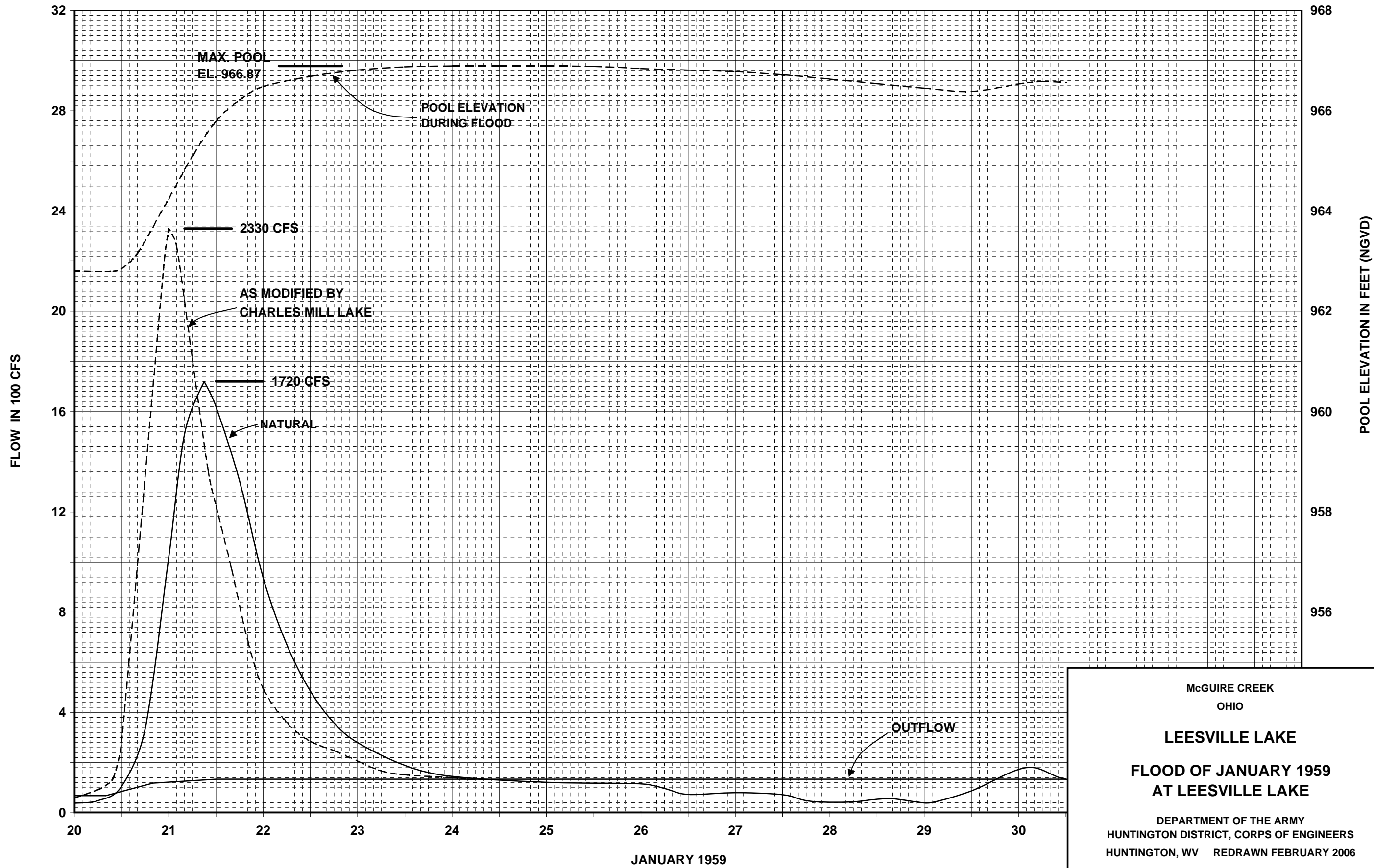


TUSCARAWAS RIVER  
OHIO

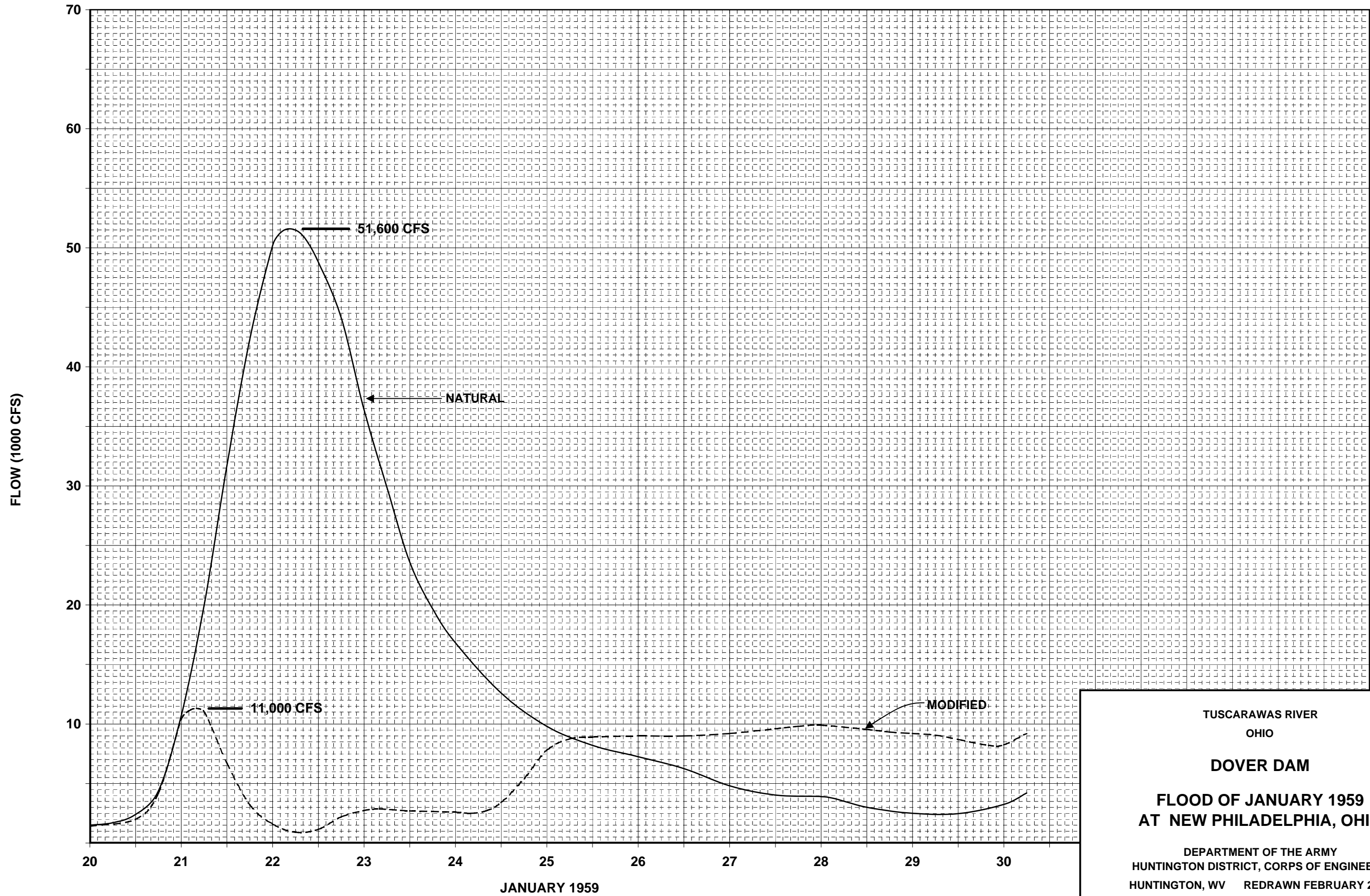
**DOVER DAM**

**FLOOD OF JANUARY 1937  
AT NEW PHILADELPHIA, OHIO**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN FEBRUARY 2006



MCGUIRE CREEK  
 OHIO  
**LEESVILLE LAKE**  
**FLOOD OF JANUARY 1959**  
**AT LEESVILLE LAKE**  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, WV REDRAWN FEBRUARY 2006

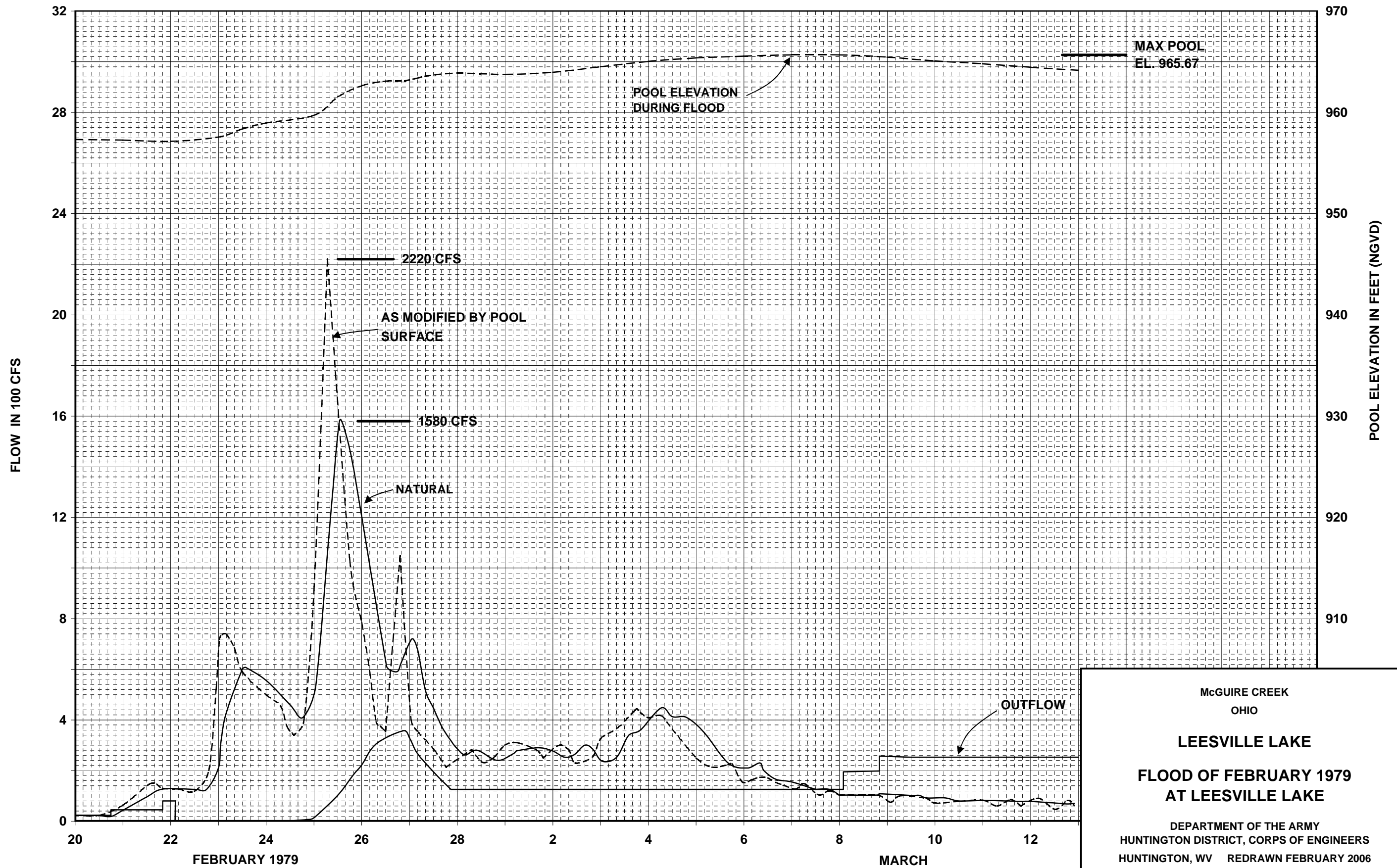


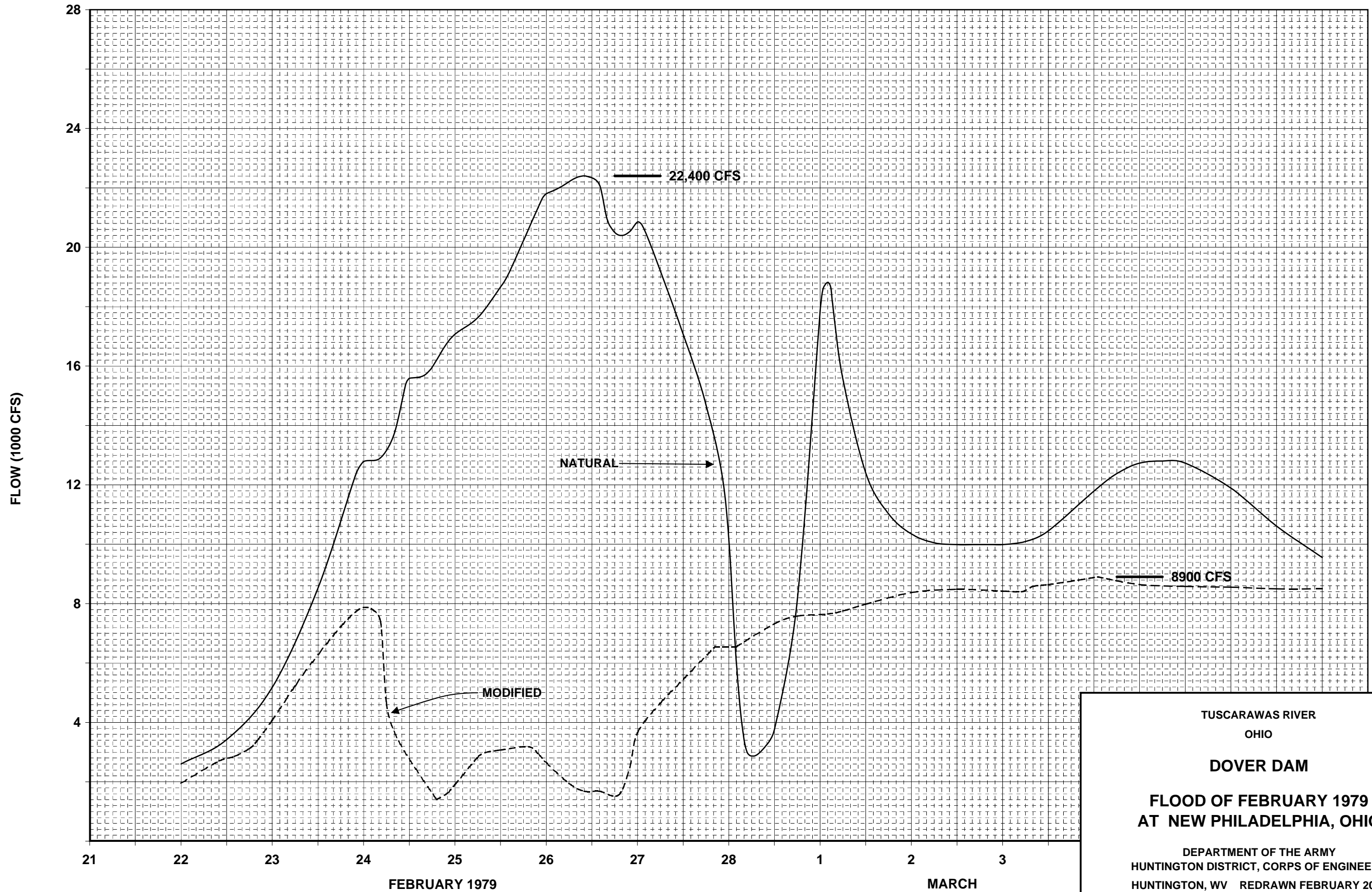
TUSCARAWAS RIVER  
OHIO

**DOVER DAM**

**FLOOD OF JANUARY 1959  
AT NEW PHILADELPHIA, OHIO**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN FEBRUARY 2006



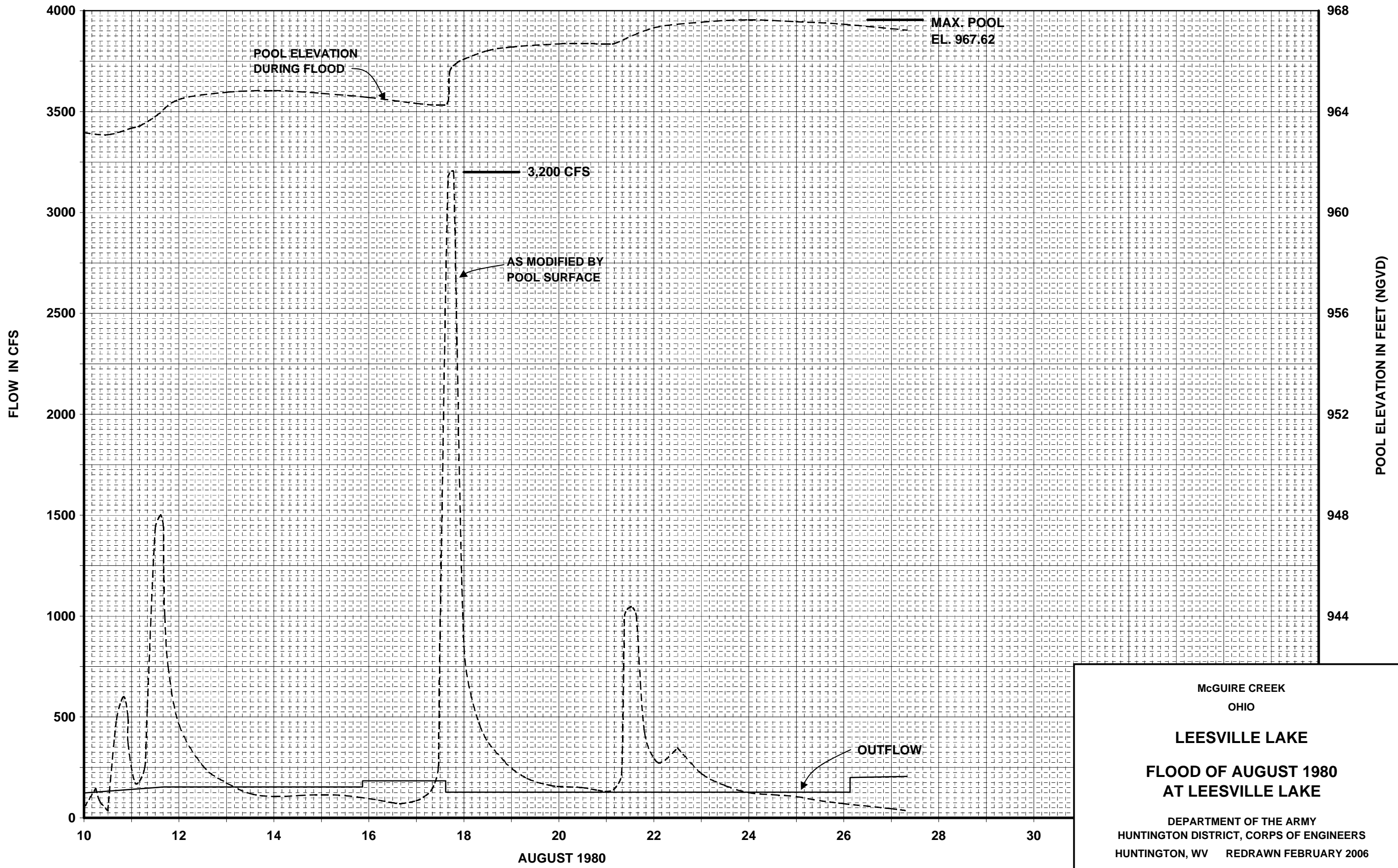


TUSCARAWAS RIVER  
OHIO

**DOVER DAM**

**FLOOD OF FEBRUARY 1979  
AT NEW PHILADELPHIA, OHIO**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN FEBRUARY 2006

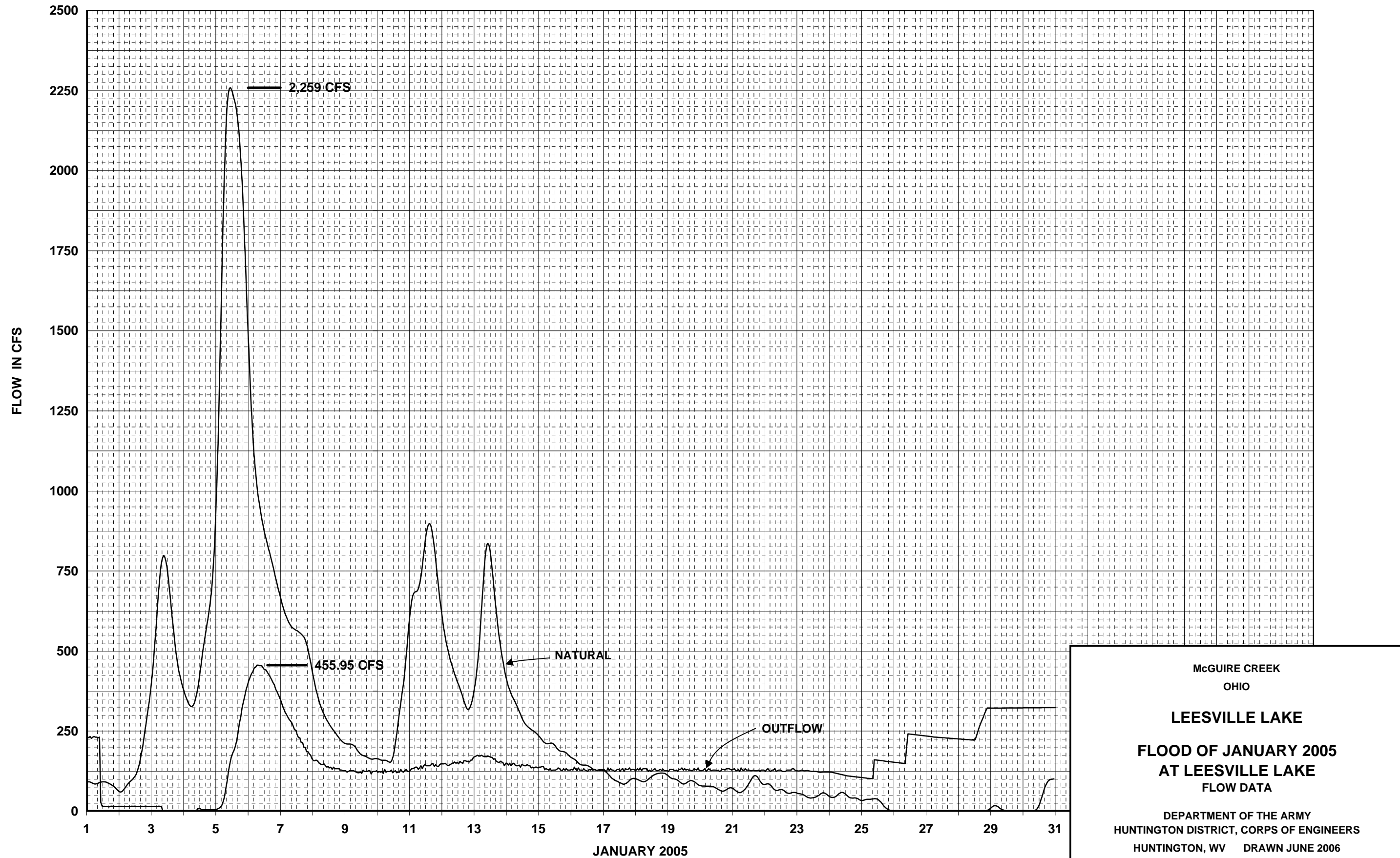


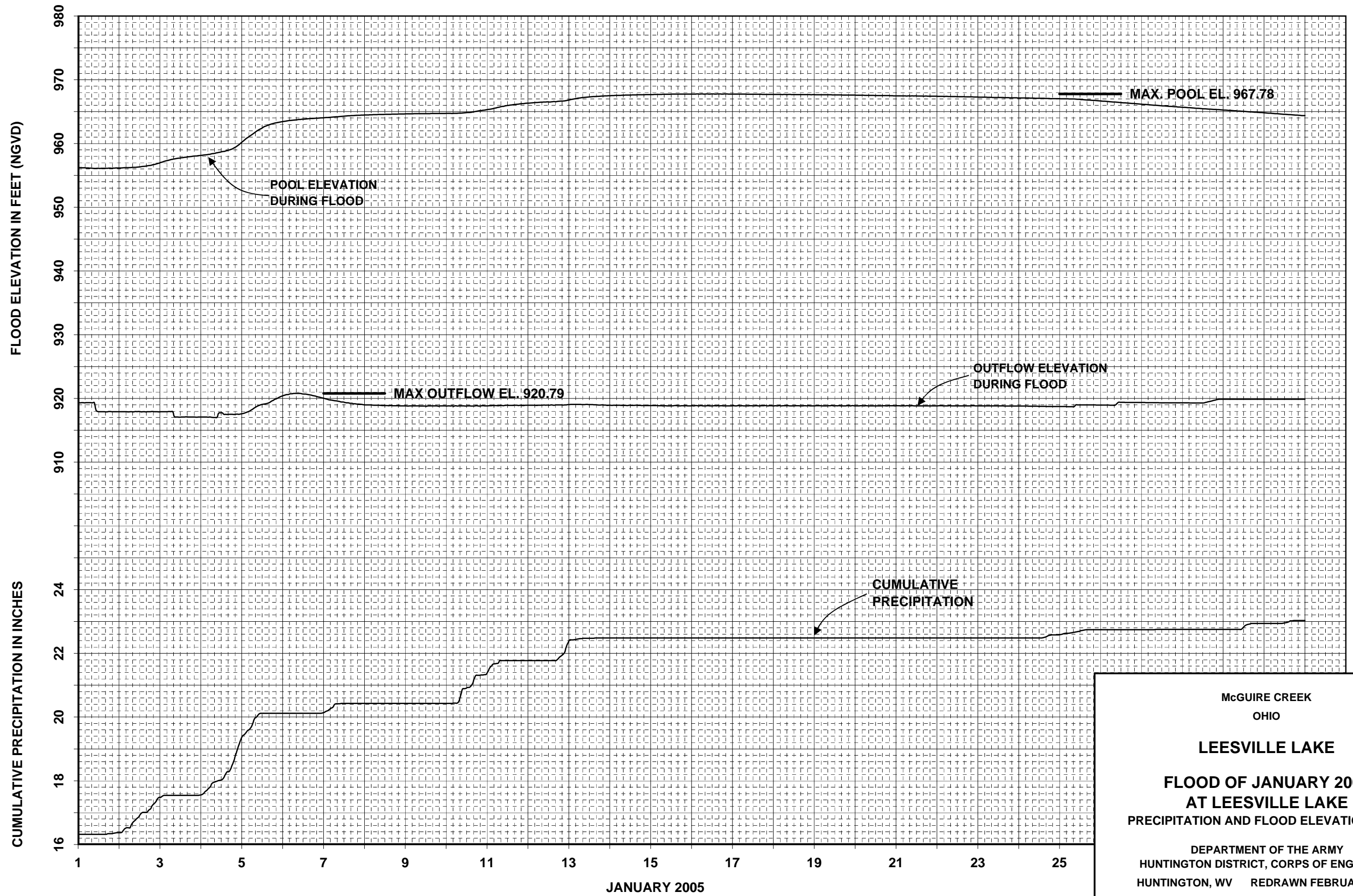
McGUIRE CREEK  
OHIO

**LEESVILLE LAKE**

**FLOOD OF AUGUST 1980  
AT LEESVILLE LAKE**

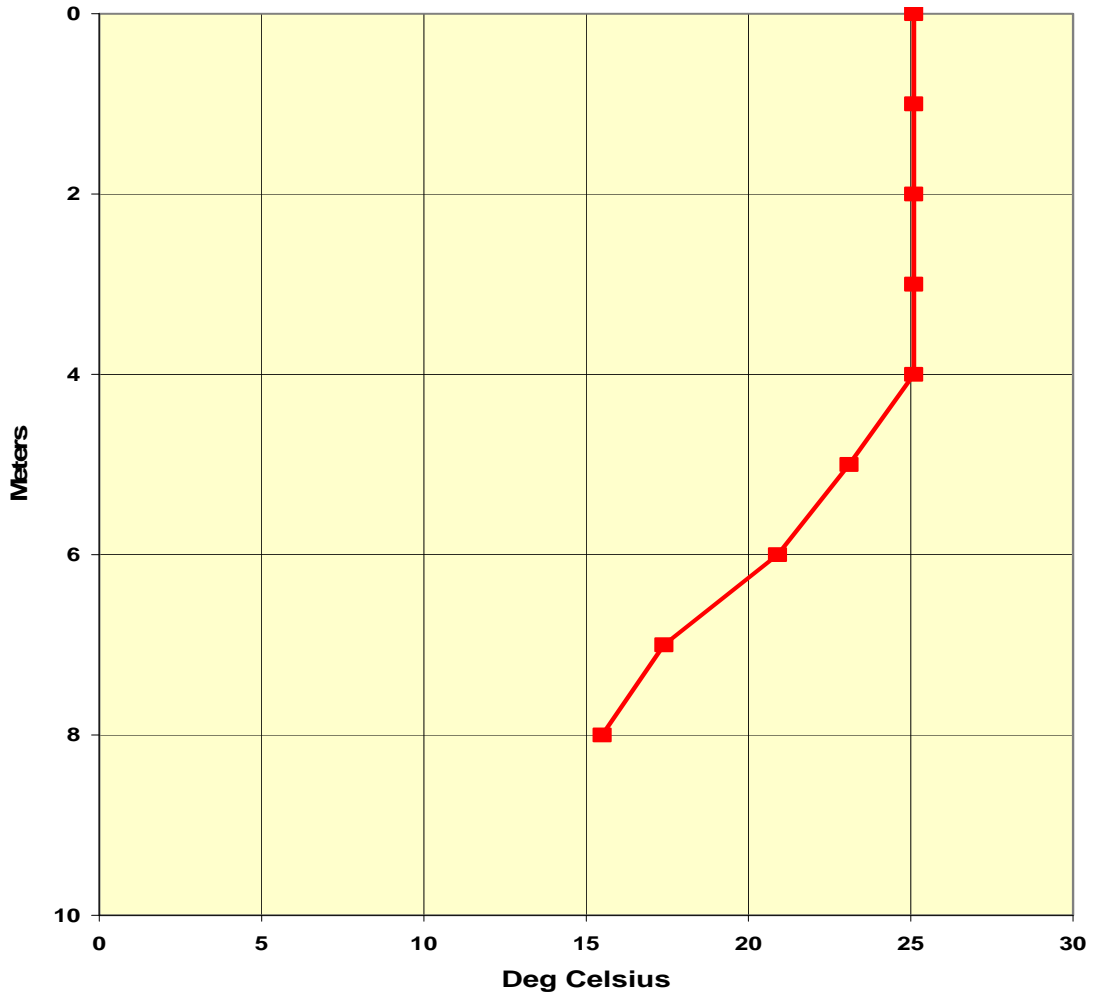
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN FEBRUARY 2006





McGUIRE CREEK  
 OHIO  
**LEESVILLE LAKE**  
**FLOOD OF JANUARY 2005**  
**AT LEESVILLE LAKE**  
 PRECIPITATION AND FLOOD ELEVATION DATA  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, WV REDRAWN FEBRUARY 2006

**Leesville Lake  
Water Temperature  
Jul 11, 2000**



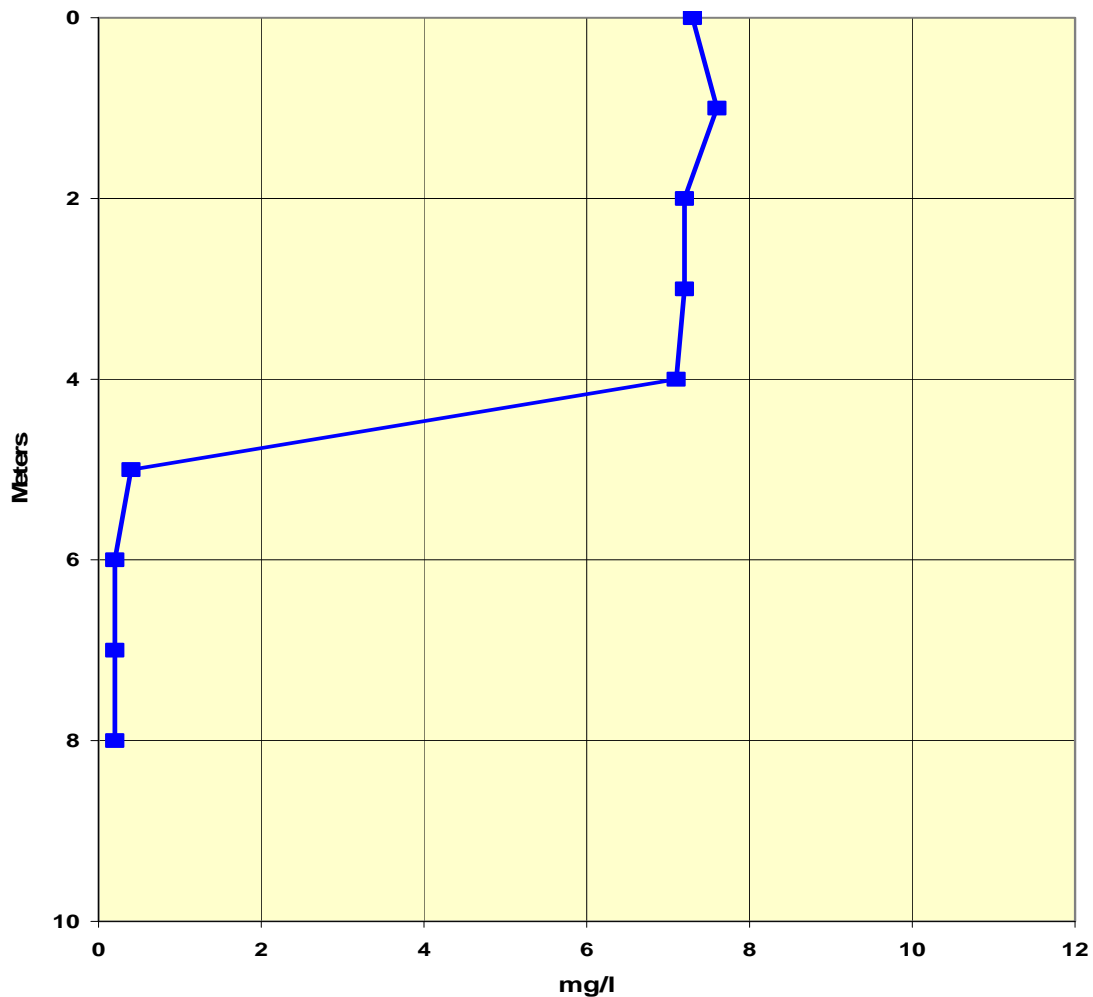
McGUIRE CREEK  
OHIO

**LEESVILLE LAKE**

**LAKE STRATIFICATION CURVE**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV                      SEPTEMBER 2006

Leesville Lake  
Dissolved Oxygen  
July 11, 2000



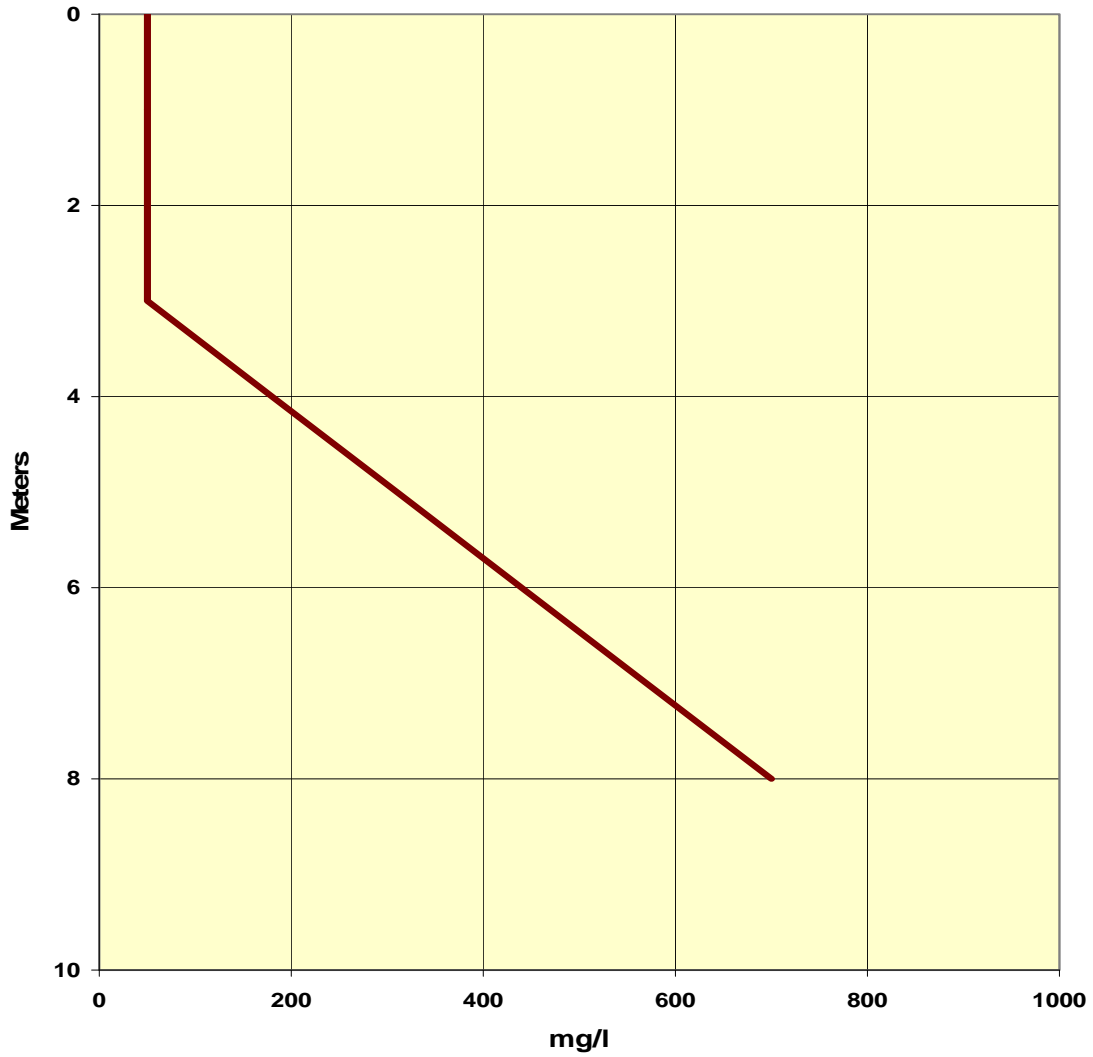
McGUIRE CREEK  
OHIO

**LEESVILLE LAKE**

**DISSOLVED OXYGEN CURVE**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV                      SEPTEMBER 2006

**Leesville Lake  
Total Iron  
July 11, 2000**



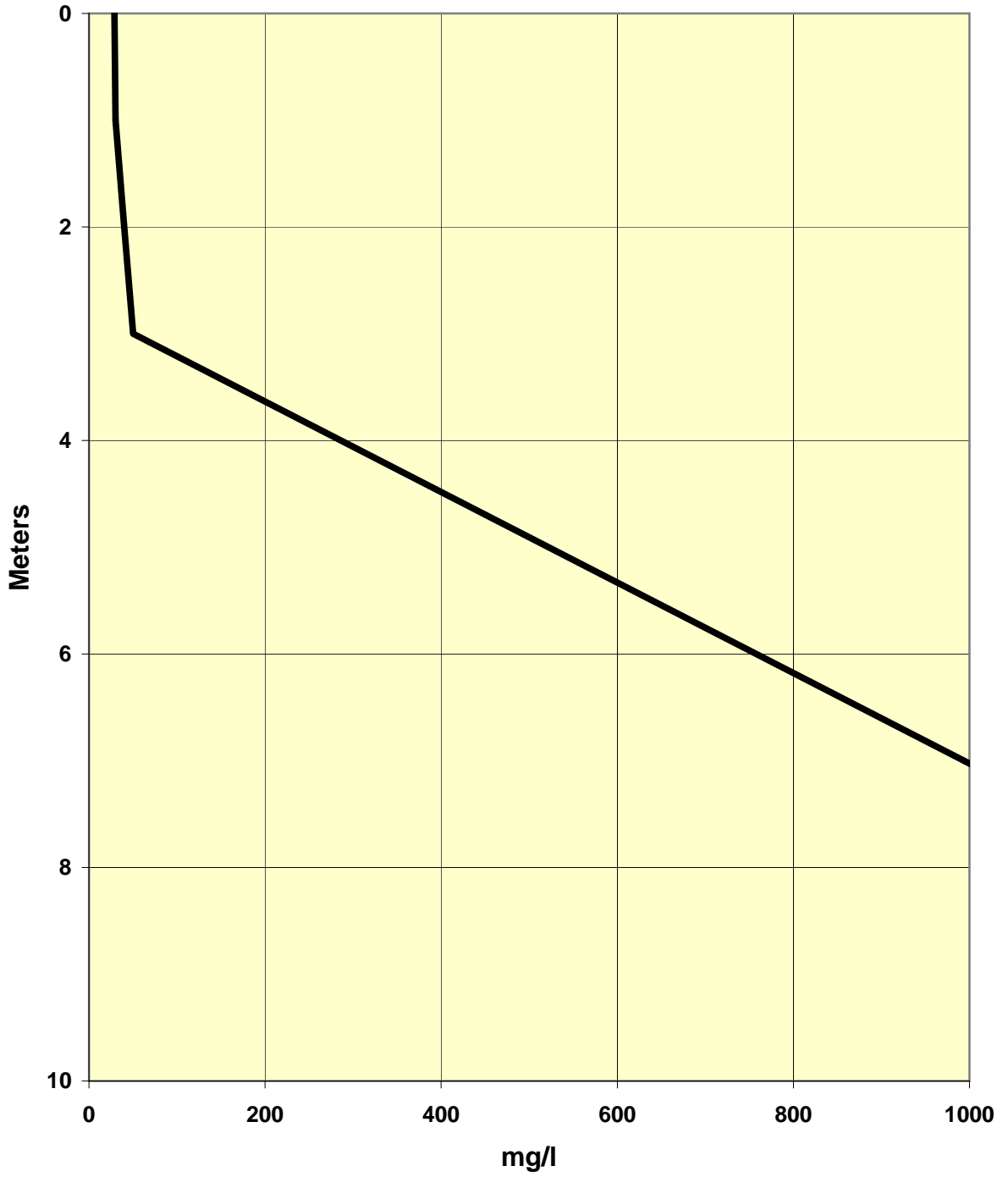
McGUIRE CREEK  
OHIO

**LEESVILLE LAKE**

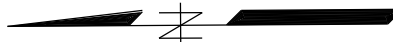
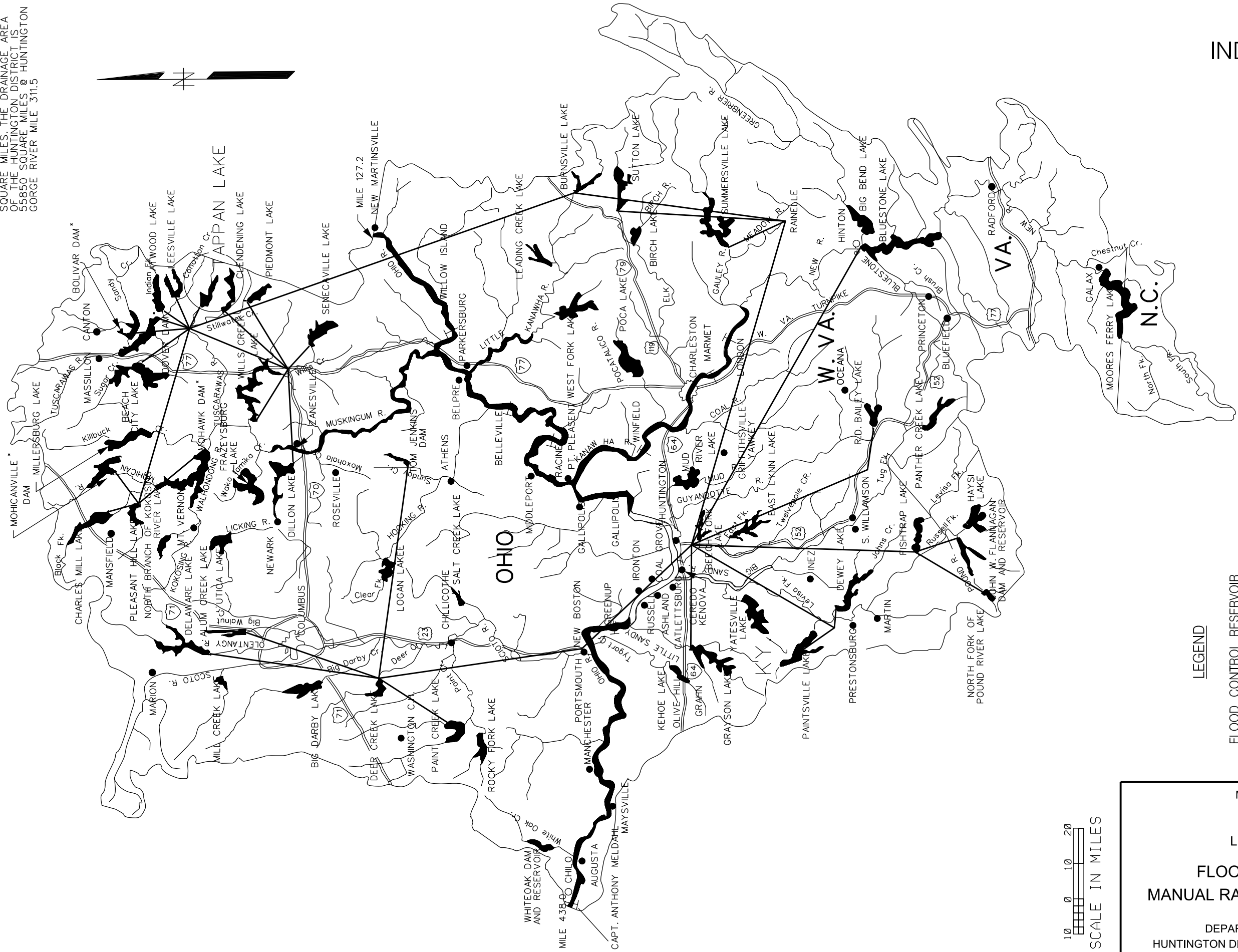
**DISSOLVED IRON CURVE**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV                      SEPTEMBER 2006

Leesville Lake  
Total Manganese  
July 11, 2000

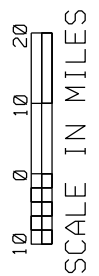


THE HUNTINGTON DISTRICT INCLUDES THE REACH OF THE OHIO RIVER BETWEEN RIVER MILE 127.2 (NEW MARTINSVILLE W.VA.) AND MILE 438.0 (3.5 MILES DOWNSTREAM FROM CHILO, OHIO) BELOW PITTSBURGH, PA. AND THE DRAINAGE AREAS OF ALL TRIBUTARIES ENTERING THE OHIO RIVER BETWEEN THESE TWO POINTS. THE TOTAL DRAINAGE AREA OF THE OHIO RIVER BASIN ABOVE MILE 438.0 IS 70,880 SQUARE MILES. THE DRAINAGE AREA OF THE HUNTINGTON DISTRICT IS 55850 SQUARE MILES @ HUNTINGTON GORGE RIVER MILE 311.5



# 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



McGUIRE CREEK  
OHIO

LEESVILLE DAM

**FLOOD EMERGENCY  
MANUAL RADIO COMMUNICATION**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV REDRAWN MAY 2006

\* DRY DAM, WITH FLOOD CONTROL POOL OUTLINED.

5

6

81°30'

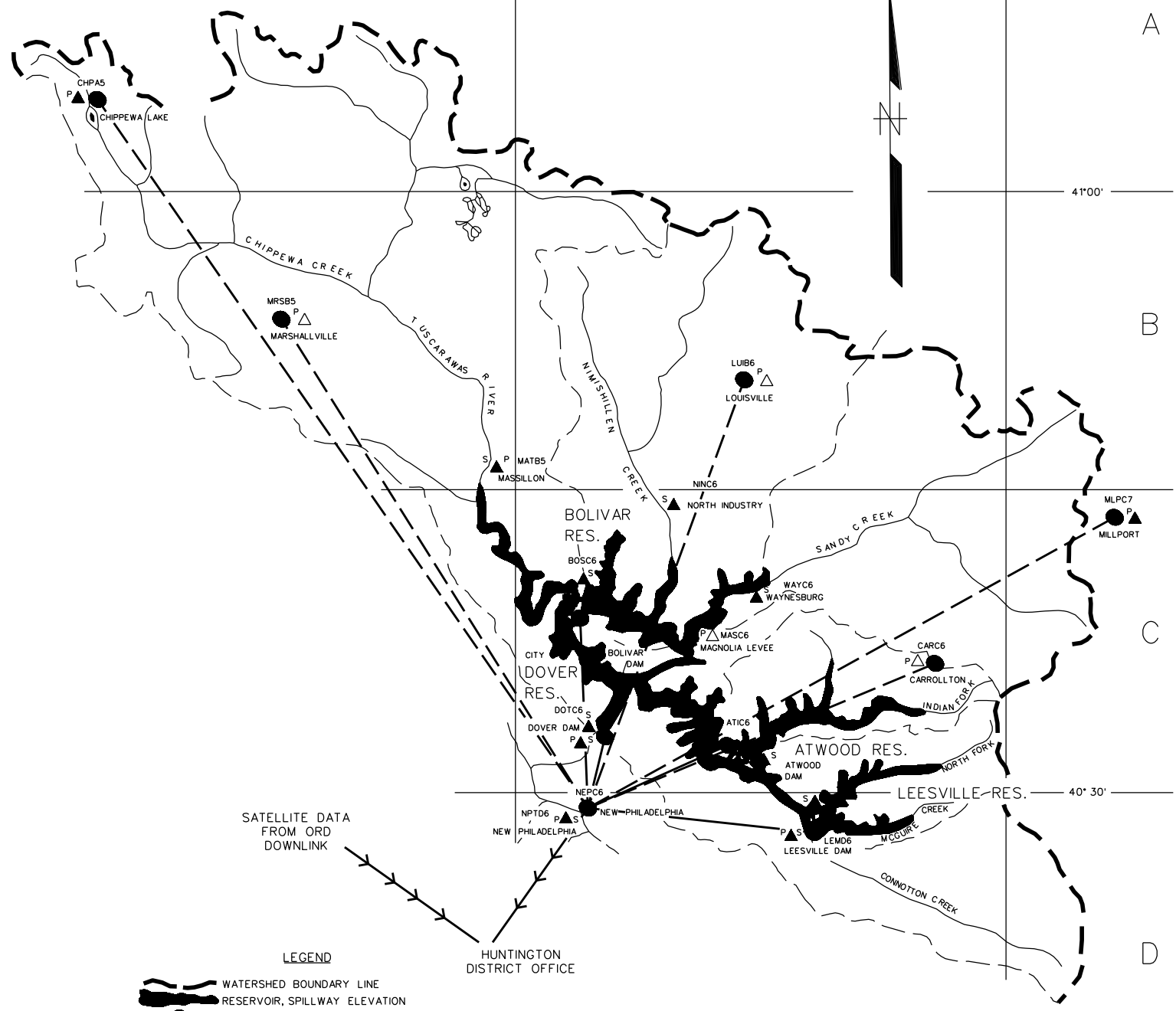
81°00'

A

B

C

D



SATELLITE DATA FROM ORD DOWNLINK

HUNTINGTON DISTRICT OFFICE

LEGEND

- WATERSHED BOUNDARY LINE
- RESERVOIR, SPILLWAY ELEVATION
- REPORTING PRECIPITATION STATION
- PRECIPITATION
- STAGE
- SATELLITE DATA PLATFORM
- SATELLITE DATA PLATFORM PLANNED
- TELEPHONE & RADIO BACKUP
- TELEPHONE OBSERVERS

SCALE: NOT SHOWN

McGUIRE CREEK  
OHIO

LEESVILLE DAM

**HYDROLOGIC NETWORK**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, WV      REDRAWN MAY 2006