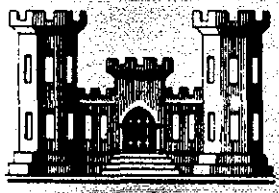
CONNECTICUT RIVER BASIN

MASTER MANUAL OF RESERVOIR REGULATION

APPENDIX H
WESTFIELD RIVER WATERSHED

MASSACHUSETTS App H



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

JUNE 1967

SUPPLEMENT TO LITTLEVILLE LAKE
REGULATION PROCEDURES - JANUARY 1974

SOP FOR WATER SUPPLY SYSTEM

a. General. The important physical components of the water supply system consists of an intake tower, a 48-inch concrete pipeline and a low flow diversion structure.

b. Intake tower. The water supply intake tower is located at the upstream toe of the dam adjacent to the old streambed. The tower is a wet well with four 36-inch diameter gated intakes at different elevations so that water can be drawn from the level having the best quality. The 36-inch sluice gates are on the inside face of the tower and are controlled by motor-operated hoists in the operating room where the floor elevation is 597.0. These gates are numbered from 1 to 4 beginning with the top gate. The gates are located at the following elevations:

Gate	Invert Elevation
(Top of water supply reservoir =	518.0)
1	502.2
2	483.8
3	465.4
4	447.0

These gates will ordinarily remain wide open which means that the water level in the tower is about the same as the reservoir. Gate 5 is a 48-inch butterfly valve with invert at elevation 432.0 which allows water to run from the intake tower into the 48-inch pipeline. This gate will ordinarily be wide open (see plate 1) and is controlled by a motor-operated hoist in the heater room where the floor elevation is 584.0.

The basement of the tower contains two other gated openings. One gate is a 48-inch sluice for a 48-inch square opening in the upstream face of the tower. This gate which is normally closed is on the inside

face and controlled by a manually operated hoist located on the floor at elevation 446.0. The gate was installed to permit drainage of the lake and should be cracked open for inspection purposes whenever the pool is at or below elevation 446.0 feet.

The other gate is a 12-inch sluice gate ("mud gate") on a 12-inch diameter pipe. The gate is on the inside face of the downstream side of the tower and is controlled by a manually operated wheel at floor elevation 446.0. The 12-inch pipe (invert 432.0) goes through the tower wall and into the diversion tunnel to allow drainage of the tower. The gate is presently cracked open to allow a small flow and prevent stagnation of water in the tower. This small flow seeps out of the diversion tunnel and into the ground at the old outlet portal. The flow eventually discharges into the river at the diversion structure.

c. Water supply pipeline. The 48-inch diameter concrete pipe was constructed inside the 9-foot arch-shaped concrete diversion conduit. Initially, the pipeline terminated at the outlet portal at the toe of the dam. In 1968 the city of Springfield extended the pipeline to a pumping station in Huntington, constructed a low flow diversion structure and installed a 48-inch hand operated gate valve on the 48-inch pipeline about 215 feet downstream of the toe of the dam (see plate 1).

The pipeline between the dam and the pumping station contains several air valves. The valves were installed to remove air trapped in the line and to admit air to the line to prevent its collapse under vacuum.

The 48-inch valve downstream of the dam is normally fully open. The pipeline is therefore under pressure from the dam to the pumping station. A hydrant system is connected to the pipeline at a school in Huntington for fire protection purposes. In the event it is necessary to close the 48-inch valve at the diversion structure, the Huntington Fire Department will be notified by the project manager.

The city of Springfield visualizes an additional future need for water which may be obtained by constructing a dam and reservoir at Dayville, three miles upstream of Littleville. The lower part of the intake tower has been constructed to accommodate the installation of future valves and pipelines. The 48-inch pipe extends through the tower to the upstream face and is sealed with a cast iron bulkhead.

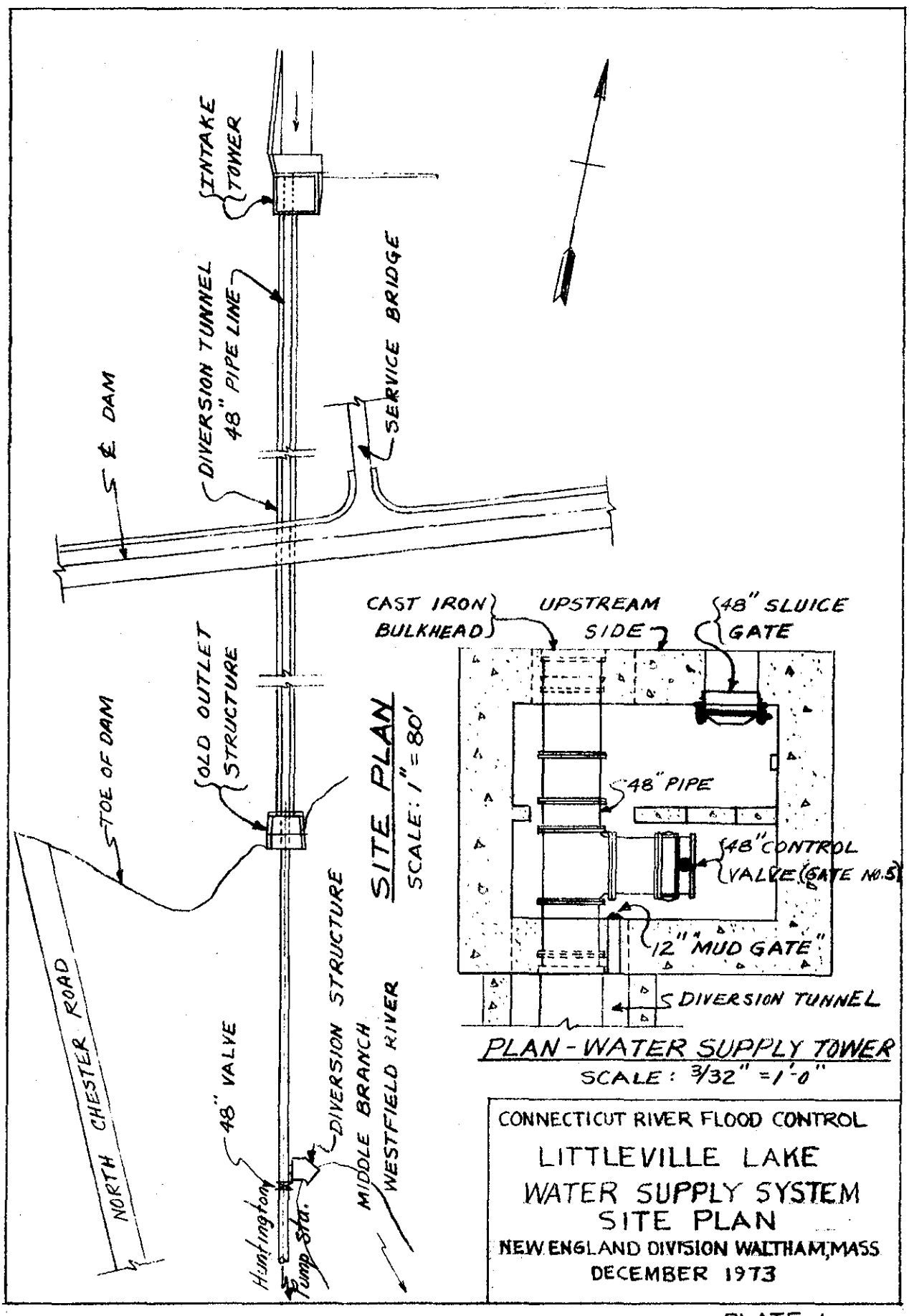
d. Low flow diversion structure. This structure is located about 210 feet downstream of the dam and adjacent to the 48-inch pipeline. Within the structure is a 12-inch pipe for low flow augmentation and a 24-inch pipe to drain the lake below elevation 518 feet msl.

The 12-inch pipe contains a manually operated butterfly valve, a self-regulating valve set to discharge a minimum release of 5 cfs, a flowmeter and a flow recorder (see plate 2). The 24-inch pipe also contains a manually operated butterfly valve.

e. Project problems. Yearly maintenance inspections of the water intake tower by Corps personnel requires draining the tower. This is done by closing gates 1, 2, 3 and 4 in the tower, closing the 48-inch hand-operated valve (near the diversion structure) and opening the 24-inch valve in the diversion structure.

During the inspection of 1969, the 48-inch valve was not closed and as a result the pipeline drained from the first air valve back to the diversion structure. While refilling the pipe, this air valve did not reseat properly causing it to leak water into a manhole which overflowed onto a street. The city of Springfield then requested that the 48-inch valve be closed whenever the tower is to be drained.

f. Operating agency. The city of Springfield, Water Department is responsible for operation and maintenance of the water supply facilities, which they have installed. All appurtenant structures and equipment provided by the Corps of Engineers will be maintained and operated by Corps personnel (Operations Division). All O&M expenses will be defrayed by the Government until the city elects to use the water supply. At this time, or after the interest free period of 10 years (1978), whichever occurs first, the city will share in the cost of operation and maintenance in accordance with the terms of the water supply agreement.



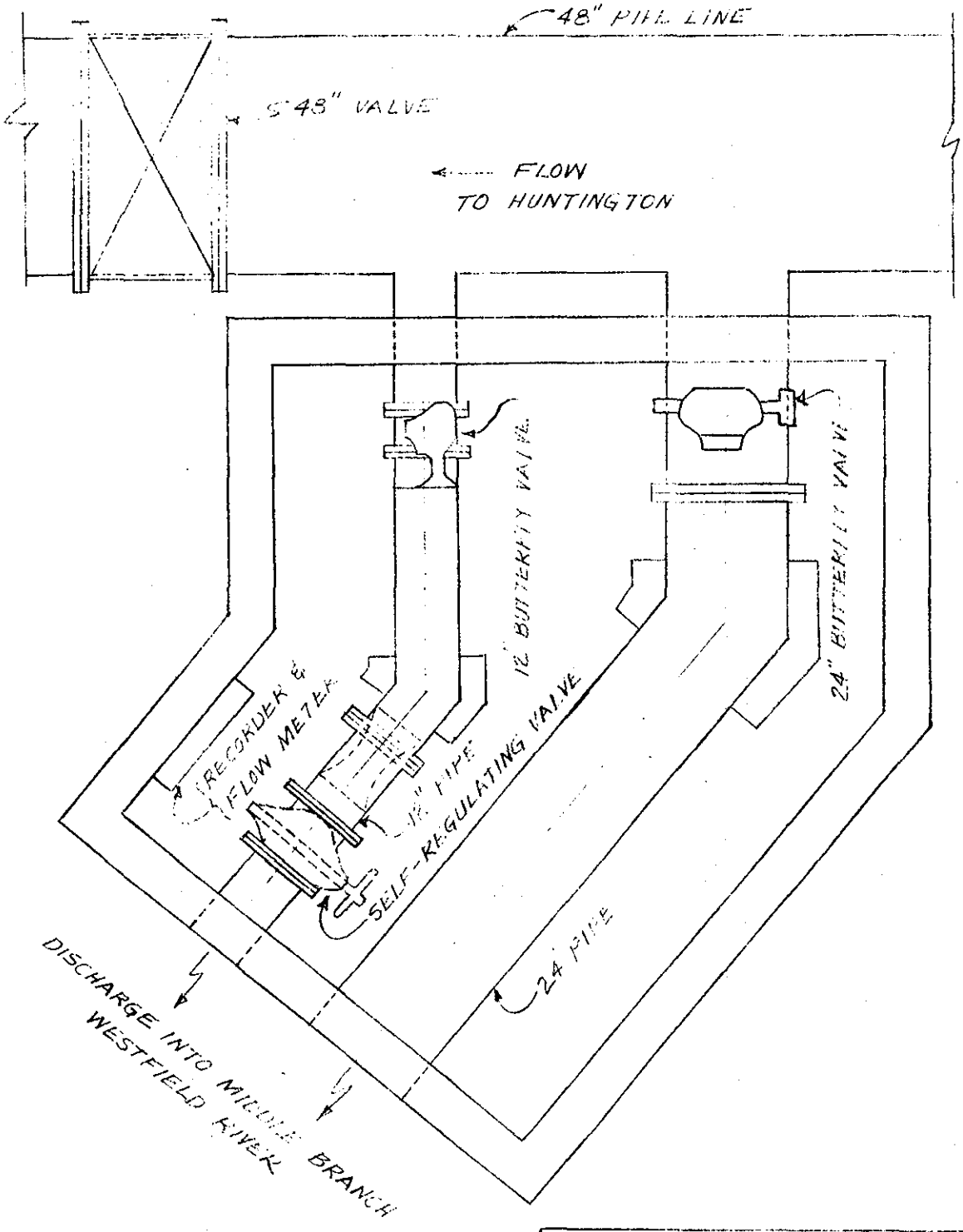
CONNECTICUT RIVER FLOOD CONTROL

LITTLEVILLE LAKE WATER SUPPLY SYSTEM SITE PLAN

NEW ENGLAND DIVISION WALTHAM, MASS

DECEMBER 1973

PLATE 1



DIVERSION STRUCTURE
SCALE: 3/8" = 1'-0"

CONNECTICUT RIVER FLOOD CONTROL
LITTLEVILLE LAKE
WATER SUPPLY SYSTEM
DIVERSION STRUCTURE
NEW ENGLAND DIVISION WALTHAM, MASS
DECEMBER 1973

PLATE 2

CONNECTICUT RIVER FLOOD CONTROL

MASTER MANUAL
OF
RESERVOIR REGULATION

Appendix	Watershed	Reservoirs	Status
Master Manual	Connecticut River	-	Not Started
A	Ompompanoosuc River	Union Village	Completed 1950
B	Ottauquechee River	North Hartland	SOP Only
C	Black River	North Springfield	SOP Only
D	West River	Ball Mountain	Completed 1965
		Townshend	Completed 1965
E	Ashuelot River	Surry Mountain	Completed 1962
		Otter Brook	Completed 1962
F	Millers River	Birch Hill	Completed 1950
		Tully	Completed 1950
G	Chicopee River	Barre Falls	Completed 1964
		Conant Brook	Not Started
H	Westfield River	Knightville	Completed 1967
		Littleville	Completed 1967
I	Farmington River	Mad River	Not Started
		Colebrook River	Not Started

PREFACE

The Westfield River basin comprises an area of 517 square miles and is located in Massachusetts and Connecticut. The coordinated flood control plan for the basin, described in this manual, includes two dams and reservoirs and two local protection projects.

This Appendix of the Connecticut River Master Regulation Manual and attachments include a description of the basin, statistical, climatological and flood data, project descriptions, and the standard operating procedures for reservoir regulation. The manual, in addition to setting forth a method of reservoir regulation, will serve as a reference source for future studies. Pertinent data and detailed information on reservoirs and local protection projects are contained in the main appendix. Detailed regulating procedures for regulation of the reservoirs are contained in Attachment I. Attachment II contains details of operational procedures and maintenance of hydrologic equipment.

This manual is organized in a manner that enables the reader to obtain desired general and background information in the main appendix. The attachments contain the pertinent information and detailed procedures necessary for actually regulating the protective works.

MANUAL OF RESERVOIR REGULATION
WESTFIELD RIVER BASIN
MASSACHUSETTS

APPENDIX "H"

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LIST OF TABLES

LIST OF PLATES

LIST OF PLATES (cont.)

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H-19	Littleville Reservoir Master Plan for Recreation Development
H-20	Knightville Dam Reservoir Map
H-21	Knightville Dam Plan and Sections
H-22	West Springfield Dike General Plan and Operations Chart
H-23	Riverdale Dike General Plan and Operations Chart
H-24	Westfield Local Protection General Plan
H-25	Westfield Local Protection Flood Profiles
H-26	Westfield Local Protection Plan and Profiles
H-27	Westfield Local Protection Interior Drainage Plan
H-28	Westfield Local Protection Project Hydrographs

MANUAL OF RESERVOIR REGULATION
WESTFIELD RIVER BASIN
MASSACHUSETTS

AUTHORITY AND SCOPE

1. AUTHORITY

This report is submitted pursuant to authority contained in ER 1110-2-240, dated 25 March 1963 (Reservoir Regulation) which requires that manuals of reservoir regulation for flood control, navigation or multiple-purpose reservoirs be prepared whenever storage allocated to one or more of the functions is the responsibility of the Corps of Engineers.

2. PURPOSE AND SCOPE

This manual serves as a guide and reference source for higher authority and reservoir regulation personnel in the New England Division office, as well as respective flood control dam operators, and personnel who will become concerned with or responsible for regulation of the reservoirs and local flood protection projects in the Westfield River basin. Included in this manual are:

a. A history of conditions which led to the authorization of the Westfield River basin projects.

b. A general description of the drainage basin including topographic features and statistical data relative to population, industry and agriculture.

c. A general coverage of the hydrometeorological data for the basin which includes temperature, precipitation, snowfall, snow cover, storms, streamflow and floods.

d. The coordinated plan of improvement developed for the basin consisting of flood control dams and local protection projects.

e. Hydrologic and hydraulic design criteria for important features of each project.

f. Instructions for operating the flood control reservoir systems.

g. The effectiveness of the regulation of the flood control projects on the maximum recorded flood and standard project flood.

HISTORY OF FLOOD CONTROL IN WESTFIELD RIVER BASIN

3. GENERAL

The Westfield River basin has a long history of flooding, particularly on the main river within the city of Westfield and the town of West Springfield. Action was taken in the city of Westfield as early as December 1878 when, following severe flooding that year, a town meeting was held and a committee was appointed to study ways of protecting the town from future floods. One project undertaken by local interests was the construction of dikes along the Westfield River. These dikes were overtopped in future floods notably in September 1938 and August 1955.

Following severe flooding in West Springfield in November 1927, a dike system was built by local interests to the approximate elevation of the 1927 flood. This system was overtopped by as much as 6 feet in the flood of March 1936.

First studies by the Federal Government were reported in 1935 and the first flood control projects were authorized in 1938. These projects consisted of the construction of Knightville Reservoir on the Westfield River and the heightening of the dikes at West Springfield. Presently the flood control system for the basin consists of two completed reservoirs, the completed West Springfield Local Protection and an authorized Local Protection Project for Westfield.

4. PUBLISHED REPORTS

Recommendations for flood control of the Westfield River have been presented in the following published Connecticut River basin reports:

a. "308 Report". A report dated 28 February 1935 and printed as House Document 412, 74th Congress, 2nd session, covered

navigation, water power, flood control and irrigation in the Connecticut River basin. An initial plan for Connecticut River flood control was recommended, consisting of 10 reservoirs located in Vermont and New Hampshire. The plan was authorized by Public Law 738, 74th Congress, approved 22 June 1936, as amended by Public Law 111, 75th Congress. approved 25 May 1937.

b. 1937 Report. A survey report dated 20 March 1937 and printed as House Document 455, 75th Congress, 2nd session, reviewed previous reports on flood control for the Connecticut River basin. A revised comprehensive plan for flood control was recommended which consisted of 20 reservoirs and dikes at 7 localities, including the Knightville Reservoir on the Westfield River and a dike at West Springfield along the Westfield and Connecticut Rivers. This plan was authorized by Public Law 761, 75th Congress, approved 28 June 1938.

c. 1940 Interim Report. An interim report dated 29 January 1940 and printed as House Document 653, 76th Congress, 3rd session, considered revisions of authorized local protection works at 7 localities, including West Springfield, along the Westfield and Connecticut Rivers. This report recommended the authorized plan be modified to provide for construction of the local works in accordance with revised plans. The plan was authorized by Public Law 228, 77th Congress, approved 18 August 1941.

d. NENYIAC Report. Flood control and allied water uses in the Westfield River watershed were discussed in part 2, chapter XXI, Connecticut River Basin, of "The Resources of the New England-New York Region," a comprehensive survey of the land, water and related resources of the New England-New York region. Prepared by the New England-New York Interagency Committee, the report was submitted to the President of the United States by the Secretary of the Army on 27 April 1956. The flood control plan set forth in this report included two flood control reservoirs in the Westfield River watershed; namely, Knightville and Littleville. Part I and chapter I of part 2 are printed as Senate Document 14, 85th Congress, 1st session.

e. 1956 Interim Report. An interim report dated 30 April 1956 and printed as Senate Document 17, 85th Congress, 1st session, reviewed the need for additional flood control reservoirs in the Westfield River watershed and recommended that the authorized plan for flood control in the Connecticut River basin be revised to include the Littleville Dam and Reservoir on the Middle Branch of the Westfield River. This project was authorized by the Flood Control Act of 1958 (Public Law 85-500, 85th Congress), approved 3 July 1958.

f. 1959 Interim Report. An interim report dated 6 November 1959 and printed as Senate Document No. 109, 86th Congress, 2nd session, again reviewed the flood problems of the Westfield River watershed and recommended that the authorized plan for flood control in the Connecticut River basin be revised to include the Westfield Local Protection Project.

5. UNPUBLISHED REPORT

A preliminary examination report, dated 9 February 1949, considered low-flow regulation of the Westfield River. The report found that it was not feasible to utilize any of the flood control capacity of the existing Knightville Reservoir for low-flow regulation. It further found that the cost of raising the Knightville Dam or developing new storage reservoirs to provide low-flow regulation would substantially exceed the annual benefits.

GENERAL DESCRIPTION

6. WESTFIELD RIVER BASIN

The Westfield River basin, the fifth largest watershed in the Connecticut River basin, covers a large portion of the eastern slopes of the Berkshires in western Massachusetts. The basin is located primarily within the confines of Berkshire, Franklin, Hampden and Hampshire Counties with a small portion extending into Hartford County, Connecticut. The watershed has an approximate length in a north-south direction of 48 miles, an average width of about 11 miles and a total drainage area of 517 square miles. The elevation of the watershed varies from 2,505 feet msl at Bordon Mountain in the headwaters to about 40 feet msl at the confluence with the Connecticut River in Agawam and West Springfield, Massachusetts. The topography of the upper portion of the Westfield River basin, above the city of Westfield, is rough and rocky and is drained by many small streams. About two miles downstream of Westfield the flood plain is bisected by a row of hills, Provin and East Mountains, which are a section of the Holyoke range. Maps of the Connecticut River basin and the Westfield River watershed are shown on Plates H-1 and H-2.

7. WESTFIELD RIVER

a. Main stream. The Westfield River rises in the town of Savoy, Hampshire County, Massachusetts at an elevation in excess of 2,000 feet above mean sea level. The river follows a generally southeasterly course for about 57 miles, joining the Connecticut River between the towns of West Springfield and Agawam, Massachusetts, opposite the southern limits of the city of Springfield, about 75 miles above Long Island Sound. The Westfield River has a total fall of about 2,000 feet. Profiles of the Westfield River and its principal tributaries are shown on Plate H-3.

b. Tributaries. The three principal tributaries of the Westfield River are the Little River, the West Branch and the Middle Branch.

(1) The Little River has its source in Cobble Mountain Reservoir, a water supply and hydroelectric power reservoir in the towns of Blandford and Granville. From its source the river flows in an easterly direction for about 12 miles to its confluence with the Westfield River in the city of Westfield. It has a drainage area of 84 square miles and a total fall of about 830 feet.

(2) The West Branch, Westfield River has its origin in the northern section of the town of Becket and flows in a general southeast direction for about 17 miles to its confluence with the Westfield River in the southwest corner of the town of Huntington. It has a drainage area of 96 square miles and a total fall of about 860 feet.

(3) The Middle Branch, Westfield River originates at the Peru-Worthington town line in the northwest corner of Worthington and flows in a south-southeasterly direction for about 16 miles to its confluence with the Westfield River at Goss Heights in the town of Huntington. It has a drainage area of 53 square miles and a total fall of about 1,140 feet.

DEVELOPMENT IN THE WESTFIELD RIVER BASIN

8. GENERAL

There are 28 Massachusetts cities and towns and 2 Connecticut towns lying wholly or partly within the Westfield River basin. The 1960

population of the basin, based on Bureau of the Census figures for that year, is estimated at 64,500. This represents a population increase in the entire watershed of about 25 percent since 1950. Population of the basin is about 65 percent urban and 35 percent rural, with all of the urban population being concentrated in the city of Westfield and the town of West Springfield.

Manufacturing plays a major role in the economy of the basin, with one of every five persons living in the basin employed in manufacturing. Most of this activity is concentrated in the city of Westfield and the town of West Springfield, the two accounting for approximately 89 percent of the employed manufacturing workers in the basin.

Agriculture is of minor importance in the basin. Only 15 percent of the basin area is devoted to agriculture, and less than one-fifth of this land is used for cultivated crops. The city of Westfield and West Springfield contain most of the intensively cultivated land in the basin, the principal crops being tobacco, truck, corn for silage and hay.

HYDROLOGY

9. CLIMATOLOGY

a. General. The Westfield River basin has a variable climate. The lower basin is relatively mild, typical of the lower Connecticut River Valley while the upper watershed has a more severe climate due to its rough topography and higher elevation. The temperature within the basin ranges from a summertime high in the nineties to subzero, occurring for short periods in the winter. In the upper basin, snow covers the ground from December until the spring melting season in late March to mid-April.

b. Temperature. The mean annual temperature in the Westfield River basin varies from about 44° F. in the mountainous regions to about 50° F. in the valleys. Recorded temperature extremes at representative stations within or adjacent to the Westfield River watershed have varied from a maximum of 102° F. in the lower elevations to a minimum of -30° F. in the headwaters. Freezing temperatures may occur from the latter part of October until late in April. Table H-I shows the mean, maximum and minimum monthly and annual temperatures at Westfield, Knightville Dam and West Cummington, Massachusetts.

c. Precipitation. The average annual precipitation over the Westfield River basin is approximately 46 inches, uniformly distributed throughout the year. Table H-II summarizes the monthly precipitation at Peru, Knightville Dam, Chester and Westfield, Massachusetts.

d. Snow. The mean monthly and annual snowfall at Knightville Dam, Chester, Chesterfield and Peru in Massachusetts are shown in Table H-III. Knightville Dam and Chester are considered representative of the lower basin having elevations of 630 and 600 feet msl, respectively, while Chesterfield, elevation 1,425 feet msl and Peru, elevation 1,860 feet msl, are typical of the headwater region. The location of these stations are shown on Plate H-2.

e. Snow cover. Snow surveys have been taken in the Westfield River watershed above Knightville Dam since 1950. These surveys indicate that the water content of the snow normally reaches a maximum about the middle of March. The recorded mean, maximum and minimum average basin water content of the snow in March are: 3.2 inches, 7.8 inches, and less than 0.5 inch, respectively. Moderately high springtime discharges occur frequently as a result of melting snow but runoff from this source alone has been insufficient to cause a major flood. Heavy rainfall in conjunction with snowmelt runoff is a possibility about every year, however, the peak flow is generally of lesser magnitude than one resulting from an intense summer type storm.

f. Storms. The Westfield River watershed has experienced storms of four general types, namely:

(1) Extratropical continental storms which move across the basin under the influence of the "prevailing westerlies."

(2) Extratropical maritime storms which originate and move northward along the eastern coast of the United States.

(3) Storms of tropical origin some of which attain hurricane magnitude.

(4) Thunderstorms produced by local convective action or by more general frontal activity.

The most severe storms have been of tropical origin which occur during the late summer and early autumn. The six notable recent storms in the Westfield River basin occurred in November 1927, March

TABLE H-I

MONTHLY TEMPERATURES
(Degrees Fahrenheit)

Month	Westfield, Mass. Elevation 220 feet msl Period of Record-21 yrs			Knightville Dam, Mass. Elevation 630 feet msl Period of Record-13 yrs			West Cummington, Mass. Elevation 1181 feet msl Period of Record-15 yrs		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	26.5	71	-16	22.8	60	-24	20.2	59	-29
February	24.9	65	-27	25.9	63	-24	23.3	61	-30
March	35.6	86	-11	31.7	69	-14	30.5	81	-22
April	46.7	92	18	45.3	84	10	43.0	88	5
May	58.6	92	29	55.1	90	23	53.8	89	20
June	67.3	101	36	64.7	99	32	62.3	93	29
July	72.0	98	42	69.6	99	40	66.3	95	35
August	69.8	98	38	67.1	100	38	64.5	97	30
September	62.9	94	27	59.4	100	24	58.0	96	22
October	52.4	90	18	49.7	88	17	48.1	84	14
November	40.8	82	- 2	38.1	81	2	37.3	78	1
December	29.2	65	-16	26.9	61	-19	24.8	62	-24
Annual	49.2	101	-27	46.3	100	-24	44.3	97	-30

TABLE H-II

MONTHLY PRECIPITATION
(Depth in Inches)

	Westfield, Mass. Elevation 220 feet msl Period of Record-56 yrs			Knightville Dam, Mass. Elevation 630 feet msl Period of Record-21 yrs			Chester, Mass. Elevation 600 feet msl Period of Record-44 yrs			Peru, Mass. Elevation 1860 feet msl Period of Record-28 yrs		
Month	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	3.17	7.52	0.77	3.12	6.40	0.75	3.53	6.83	0.91	3.80	7.31	1.00
February	3.39	6.75	1.24	2.90	5.11	1.24	3.16	5.18	1.69	3.26	6.58	1.27
March	3.87	9.71	0.27	3.92	10.18	1.28	3.91	10.49	0.21	4.47	10.32	1.25
April	4.11	8.72	0.75	3.74	5.75	0.82	3.83	8.37	0.75	3.90	6.43	1.17
May	3.81	7.08	0.88	3.93	6.73	0.95	3.93	7.77	1.15	4.34	7.77	1.75
June	4.02	8.73	0.39	3.29	6.23	0.57	4.11	9.15	0.23	4.37	10.55	1.53
July	3.92	10.06	1.27	3.87	7.33	1.12	3.99	8.49	1.01	4.48	10.88	1.73
August	4.26	26.85	0.71	3.37	15.27	1.15	3.99	18.44	0.50	3.93	14.07	0.78
September	4.07	12.41	0.24	3.75	8.06	1.38	3.94	12.61	0.40	4.85	12.36	0.68
October	3.61	12.50	0.05	3.48	16.95	1.19	3.65	17.51	0.00	3.56	14.37	0.76
November	4.12	9.79	0.40	4.37	7.18	0.81	4.37	11.01	1.00	4.18	8.35	1.13
December	3.69	7.50	0.60	3.65	6.21	0.65	3.59	9.19	0.76	3.94	10.37	1.14
Annual	46.04	70.33	33.35	43.39	62.26	32.15	45.90	67.50	32.23	49.08	65.42	36.15

TABLE H-III

MEAN MONTHLY SNOWFALL
(Average Depth in Inches)

Month	Knightville Dam, Mass. Elevation 630 feet msl Period of Record-14 yrs	Chester, Mass. Elevation 600 feet msl Period of Record-20 yrs	Chesterfield, Mass. Elevation 1425 feet msl Period of Record-26 yrs	Peru, Mass. Elevation 1860 feet msl Period of Record-21 yrs
January	12.9	13.3	16.8	15.7
February	13.2	14.1	17.9	16.0
March	14.4	10.2	14.9	17.7
April	4.6	1.9	5.4	5.3
May	0	0	0.1	0.2
June	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	0	0	0.1	0.4
November	2.6	4.2	5.2	5.2
December	7.5	8.9	11.4	12.8
Annual	55.2	52.7	74.4	73.3

1936, September 1938, December 1948, August and October 1955. Of these, the storms of November 1927, September 1938, August and October 1955 were of tropical origin. The August 1955 storm, accompanying hurricane Diane, dumped nearly 20 inches of rain in Westfield in about 48 hours. Mass curves of rainfall and isohyetal maps for storms of September 1938 and August 1955 are shown on Plate H-4.

10. RUNOFF

a. Discharge records. The U. S. Geological Survey has published records of river stages and streamflow at 8 locations in the Westfield River basin for various periods since 1905. At the present time, this agency maintains 5 gaging stations in the basin. A summary of discharge records for these stations is shown in Table H-IV. The mean daily discharges of the Westfield River at the U. S. Geological Survey gaging station near Westfield, Massachusetts for the period of record are shown on Plate H-28.

b. Streamflow data. The average annual runoff for the period of record through September 1961 for the Westfield River near Westfield, Massachusetts has varied from 45.30 inches in 1955 to 14.82 inches in 1941 with a mean of 26.12 inches. A summary of the mean, maximum and minimum monthly and annual runoff in inches for the period of record at the Westfield gage is shown in Table H-V.

11. FLOODS OF RECORD

a. Historic floods. Damaging floods have occurred along the Westfield River and its tributaries since the founding of the first settlements in the basin. Although there is little reliable information on the magnitudes of most of the early floods, available records indicate that the floods of October 1869 and December 1878 were severe and caused considerable damage. The 1878 flood occurred on 10 December when 6 to 8 inches of snow fell on frozen ground, followed by rain and rapidly rising temperatures, producing an exceedingly high rate of runoff. A great amount of damage was done throughout the valley, particularly at Westfield. Other known floods in the Westfield River basin prior to 1900 occurred in March 1776, September 1826, February 1840, January 1841, April 1843, May 1854, April 1862, April 1869, September 1879, January 1880, April 1895, March 1896 and February 1909.

TABLE H-IV

STREAM FLOW RECORDS THRU WATER YEAR 1961
WESTFIELD RIVER BASIN

Location of Gaging Station	Drainage Area (sq.mi.)	Period of Record	Discharge Mean	Discharge Maximum[1] (cfs)	Discharge Minimum
Westfield River at Knightville, Mass.[4]	162	1909-1961	326	37,900[2]	4
Sykes Brook at Knightville, Mass.	1.64	1945-1961	2.76	680[3]	0.03
Middle Branch Westfield River at Goss Heights, Massachusetts	52.6	1910-1961	105	19,900[2]	0
West Branch Westfield River at Huntington, Massachusetts	93.7	1935-1961	191	26,100[3]	3.3
Westfield River near Westfield, Mass.	497	1914-1961	956	70,300[3]	9

(1) Instantaneous discharge
(2) Occurred September 1938
(3) Occurred August 1955
(4) Affected by Knightville Reservoir since 1941

TABLE H-V

MONTHLY RUNOFF
(Inches)

Westfield River Near
Westfield, Massachusetts
Drainage Area - 497 sq. mi.

Month	Mean	Maximum	Minimum
January	2.05	5.17	0.46
February	1.77	3.89	0.58
March	4.21	12.91	1.45
April	5.44	11.10	1.91
May	2.95	5.77	1.30
June	1.62	4.09	0.52
July	0.92	3.16	0.27
August	0.89	3.53	0.19
September	0.97	6.67	0.22
October	1.20	11.41	0.26
November	1.99	7.55	0.46
December	2.11	5.10	0.52
Annual	26.12		

Maximum	-	1955	45.30
Minimum	-	1941	14.82

b. Recent floods. Reliable records of flood stages in the Westfield River watershed have been kept since 1909. Minor floods are frequent in the basin and flood stages in the lower portion of the basin occur nearly every spring, usually due to melting snow, sometimes in combination with heavy rains. Floods develop very rapidly in the basin and experience gained from regulation of Knightville Reservoir indicates that floods on the principal branches of the Westfield River crest about 4 hours after intense rainfall. At Westfield, the time of concentration is about 8 hours following heavy precipitation. Six major floods have occurred in the basin since 1927, and are briefly described in the following paragraphs.

c. November 1927. Rainfall in the previous month was almost double the normal amount, saturating the ground and filling the streams and ponds. A flood resulted from heavy rains which fell on the previously saturated ground almost continually for 26 to 30 hours between 2 and 4 November.

d. March 1936. From 9 to 13 March a heavy rainfall combined with relatively high temperatures caused a portion of the snow blanket to melt and a high runoff resulted. This broke up the ice cover on the rivers and serious ice jams resulted in the lower section of the basin. A second rainstorm of greater intensity occurred on 18 and 19 March, melting the remaining snow blanket and causing the already swollen rivers to overflow their banks.

e. September 1938. The second most damaging flood of record resulted from heavy rainfall accompanying a tropical hurricane which swept over New England. The flood stage on the Westfield River exceeded that of the 1936 flood by almost 3 feet at several places. The principal cause of flooding was a 4-day storm totaling 10 to 12 inches of rainfall on ground which had been saturated by rains earlier in the month, and reaching its greatest intensity during the night of 20 September.

f. December 1948. This flood resulted from heavy rains, averaging about 9 inches, falling on frozen ground. Runoff was augmented by some snowmelt. Knightville Reservoir, which had been completed in 1941, was completely filled during this flood.

g. August 1955. The maximum flood of record was caused by 3 storm centers which passed over Massachusetts, one of them directly over the Westfield River basin. Heavy rains, totaling almost 20 inches

around Westfield, fell on ground already saturated by 6 to 9 inches of rain during the previous week. The combination of saturated soil, relatively high level of streams, and great intensity of rainfall produced major flooding throughout the lower basin.

h. October 1955. This flood was caused by a slow-moving continental storm passing over New England and depositing up to 13 inches of rain in the basin. The Knightville Reservoir was almost completely filled during this flood.

12. FLOOD PROFILES

Profiles of the Westfield River and its tributaries, Little River, West Branch and Middle Branch are shown on Plate H-3. High water data are indicated on the profiles for the floods of 1927, 1936, 1938 and 1955.

13. FLOOD FREQUENCIES

The frequency or percent chance of occurrence of discharges in the Westfield River basin were determined at the U. S. Geological Survey gaging stations on the Westfield River at Westfield, the West Branch at Huntington, the Middle Branch at Goss Heights and the Little River at Stevens Paper Company lower dam. Frequency analyses were made in accordance with procedures described in ER 1110-2-1450, "Hydrologic Frequency Estimates," dated 10 October 1962. Discharge-frequency data for the selected locations are shown on Table H-VI.

14. ANALYSIS OF FLOODS

a. General. The major floods of record in the Westfield River basin have been analyzed to determine the hydrologic development of floods and the tributary components contributing to flood peaks at respective index stations on the Westfield River as well as the major damage centers on the Connecticut. The progressive-average-lag method of flood routing was adopted for all hydraulic reaches except in Westfield where, due to the large amount of flood plain storage, a storage routing was utilized.

b. Analysis of floods. The flood of March 1936, considered to be a general basin flood, produced tributary peak discharges equivalent to approximately 160 cfs/square mile. The flood of September 1938, which was the maximum of record on the Middle Branch and the upper Westfield

TABLE H-VI

WESTFIELD RIVER BASIN
NATURAL PEAK DISCHARGE FREQUENCY DATA
(Discharge in cfs)

Expected Probability Percent Chance	Years	Westfield River at Westfield	West Branch at Huntington	Middle Branch at Goss Heights	Little River at Stevens Paper Company
0.50	200	127,000	35,500	27,000	24,500
1.00	100	95,000	27,000	20,000	18,400
2.00	50	70,500	20,000	14,500	13,700
4.00	25	52,000	14,700	10,900	10,300
5.00	20	47,500	13,300	9,500	9,200
10.00	10	34,500	9,700	6,900	6,700
20.00	5	25,000	6,900	4,900	4,800
50.00	2	16,300	4,650	3,350	2,680
60.00	1.7	15,000	4,350	3,100	2,300
70.00	1.4	14,000	4,150	2,850	2,100
80.00	1.25	13,000	4,000	2,650	1,900
90.00	1.13	12,200	3,890	2,500	1,740
95.00	1.06	11,800	3,795	2,450	1,670
99.00	1.02	11,500	3,550	2,400	1,570
99.90	1.+	11,400	3,350	2,400	1,530

River, is classified as an upper basin flood. At Westfield on the Westfield River, 78 percent of the peak discharge (55,500 cfs) was produced by the tributary areas above Huntington, which is equivalent to 65 percent of the watershed above Westfield. The flood of December 1948 also originated in the upper portion of the basin and Knightville Reservoir, completed in 1941, was completely filled during this flood. Without Knightville Reservoir, it is estimated that the observed peak flow of 32,200 cfs at Westfield would have been 52,500 cfs.

The maximum flood of record in the lower Westfield River basin occurred in August 1955 when peak flows in excess of 600 cfs/square mile were experienced on many tributary streams. Sixty-three percent of the observed peak discharge at the Westfield gage was produced by runoff from the tributary area below the confluence of the West Branch, which comprises 39 percent of the total drainage area above the Westfield gage. The flood of October 1955, an upper basin flood, had two distinct peaks separated by approximately 18 hours. The pool at Knightville Reservoir rose to within 2 feet of the spillway crest, with most of the runoff produced during the initial rise. The observed peak at the USGS gage near Westfield was 31,000 cfs. Without Knightville Reservoir the peak at Westfield would have been 44,500 cfs. Analyses of the September 1938 and August 1955 floods are shown graphically on Plate H-5. Relative timing of flood crests in the Westfield River and Connecticut River are shown in Table H-VII.

The following general conclusions were derived from these detailed studies:

(1) Severe flooding can be produced in the Westfield River basin from various storm orientations, since any of the major tributaries are capable of generating flows of flood magnitude at downstream damage centers.

(2) Large reservoirs and lakes, such as Cobble Mountain Reservoir and Congamond Lakes, can be effective in the control of minor and moderate floods in their respective tributaries. Large floods, however, like the flood of August 1955, overtax the modifying effect of the reservoirs and high rates of spillway discharge may contribute to the flood crest on the main river.

(3) The Westfield River basin has a relatively high flood potential at all seasons of the year because of its runoff characteristics and its vulnerability from various meteorological events such as intense localized rainfall, rapid snowmelt, rainfall combined with snowmelt, or rainfall associated with hurricanes.

c. Effect of Westfield River on Connecticut River floods. The Westfield River has generally been a substantial contributor to flood flows in the Connecticut River. Table H-VIII shows the relative contributions of the Westfield River to Connecticut River flows at Thompsonville and Middletown, Connecticut.

15. DESIGN FLOODS

a. Standard Project Flood. A standard project flood for the Westfield River, Massachusetts was developed from standard project storm rainfall, as described in Civil Engineer Bulletin No. 52-8 and unit hydrographs derived from analysing recorded floods in the Westfield River basin.

The 24-hour standard project storm volume averaged 8.80 inches over the basin and losses totaled 1.40 inches yielding a rainfall excess volume of 7.40 inches. Regulation of the reservoirs and natural and modified hydrographs at Westfield for this flood are shown on Plate H-6. The adopted unit hydrographs are shown on Plate H-7.

b. Spillway Design Floods. The spillway design flood for Littleville and a revised one for Knightville was developed using procedures prescribed in EM 1110-2-1405, dated 31 August 1959. Regulation of the two reservoirs for such floods is shown on Plates H-8 and H-9. It was assumed that both reservoirs were filled to spillway crest at the beginning of the flood. The peak discharge of the revised flood for Knightville was more than twice the original spillway design flood peak developed in 1940. The 5 feet of freeboard included in the original design was completely used in the routing of this much larger flood. (See par. 21, p. I-18)

16 FLOOD DAMAGES

a. General. Though Knightville Reservoir prevented $6,480,000 damages on the Westfield and Connecticut rivers, the record flood of August 1955 resulted in an estimated residual loss in the Westfield basin of nearly $14 million. Approximately 70 percent of this loss was experienced in the main damage zones of the lower watershed area between the West Branch and the Connecticut River tailwater, with about $8 million occurring in the city of Westfield. Damage surveys conducted shortly after the flood, augmented by later surveys and studies in the Westfield local protection project area, indicated that over 750 buildings were damaged in the lower watershed area.

Losses in the Westfield area accounted for over 97 percent of the total urban loss in the lower watershed area and about 80 percent of the

TABLE H - VII

RELATIVE PEAK TIMING
FLOOD CRESTS
WESTFIELD AND CONNECTICUT RIVERS

Location	River Mile	Drainage Area (sq.mi.)	Timing of Peak (1) March 1936	Sept. 1938	Aug. 1955
Westfield River					
Middle Branch	26.0(2)	52.6	-8½	-5½	-3½
West Branch	24.7(2)	93.7	-8	-5	-3
Westfield at Knightville	28.3(2)	162	-6	-3	-
Westfield at Westfield	7.8(2)	497	0	0	0
Connecticut River					
Holyoke, Mass.	82.0(3)	8284	+26	-	-
Springfield, Mass.	72.0(3)	9587	+30	+22	-
Thompsonville, Conn.	65.0(3)	9637	+32	+23	+11½

(1) Time in hours, before (-) and after (+) peak of Westfield River at Westfield, Mass.
(2) Above mouth of Westfield River
(3) Above mouth of Connecticut River

TABLE H - VIII

CONTRIBUTION OF WESTFIELD RIVER
TO CONNECTICUT RIVER DISCHARGES

Flood	Conn. River Discharge (cfs)	Maximum Discharge at Westfield (cfs)	Contribution to Conn. River Discharge (cfs)	Percent Contribution (1)	Percent Contribution (2)
Connecticut River at Thompsonville					
Mar 1936	282,000	48,200	13,270	4.7	
Sept 1938	236,000	55,500	26,050	11.0	
Dec 1948	138,000	32,200	20,700	15.0	
Aug 1955	174,000	70,300	38,200	21.9	
Oct 1955	92,300	31,000	26,600	28.8	
Connecticut River at Middletown					
Mar 1936	267,500	48,200	15,290	5.7	
Sept 1938	239,000	55,500	17,870	7.5	
Dec 1948	139,000	32,200	13,780	9.9	
Aug 1955	177,000	70,300	22,000	12.4	
Oct 1955	114,000	31,000	(Not Determined)		

(1) Westfield River drainage basin at Westfield is 5.2 percent of Connecticut River drainage area at Thompsonville

(2) Westfield River drainage basin at Westfield is 4.6 percent of Connecticut River drainage area at Middletown

total industrial loss. Scattered industrial losses were experienced in Russell and West Springfield. Important agricultural losses occurred in the Westfield area, largely in the lower reaches of the Little River. Lengthy transportation and communication disruptions were widespread in the lower watershed area. Highway losses accounted for over half of the total transportation-utility loss of about $1,100,000. Table H-IX presents the 1955 experienced flood losses in the main damage zones of the lower watershed area, tabulated by river zone, town and type of loss.

The major flood of September 1938, the previous flood of record in the Westfield River basin, caused damages amounting to nearly $1,400,000 in the lower watershed area downstream from the West Branch, Westfield River. Approximately $400,000 of this loss occurred along the Westfield main stem in Westfield. Major damage centers in the 1938 flood were Westfield and Russell in the lower watershed area, and Cummington and Huntington in the upper watershed area.

b. Recurring Losses. A recurrence of the August 1955 flood stages along the Westfield River would cause damages estimated at $11,975,000 if no flood protection is provided. The operation of Knightville and Littleville Reservoirs would prevent an estimated $5,350,000 downstream of the West Branch. The recurring losses would be reduced by another $5,695,000 by the Westfield local protection project.

Stage damage curves were developed for the Westfield River using flood damage information that was obtained during the period from 1955 through 1963 and adjusting to the 1965 price level. The curves shown on Plate No. H-10 are intended to provide approximate damage figures only. It is assumed that additional detailed surveys would supplement this data as required.

FLOOD CONTROL PLAN

17. GENERAL

The flood control plan for the Westfield River basin consists of two completed reservoirs and two local protection projects, one which is completed and one which is authorized. The reservoirs are operated primarily to reduce flooding on the Westfield River and to desynchronize flood flows on the Connecticut River. The operation of the reservoirs

TABLE H-IX

AUGUST 1955 FLOOD LOSSES - WESTFIELD RIVER BASIN

MAIN DAMAGE ZONES DOWNSTREAM FROM WEST BRANCH
(Losses in $1,000)

AREA	TOWN	URBAN	RURAL	INDUSTRIAL	UTILITY	HIGHWAY	RAILROAD	TOTAL
I	Russell	-	-	400	-	300	90	790
	Westfield	20	20	-	-	-	-	40
	Subtotal	20	20	400	-	300	90	830
II	Agawam	-	20	10	-	-	-	30
	Westfield	400	130	990	-	120	240	1,880
	W. Springfield	100	-	280	-	260	-	640
	Subtotal	500	150	1,280	-	380	240	2,550
III	Westfield	3,550	560	1,540	100	30	-	5,780
IV	Westfield	-	260	100	-	-	-	360
	Total	4,070	990	3,320	100	710	330	9,520

DESCRIPTION OF AREAS

I Westfield River from West Branch to Elm Street bridge at Westfield, outside of proposed local protection area.

II Westfield River area outside of proposed local protection works, extending from Elm St. bridge to Connecticut River backwater, and including backwater effect on the Little River upstream to New York, New Haven & Hartford RR bridge and backwater effect on Powdermill Brook upstream to North Elm St. bridge.

III Protection area within proposed dikes along Westfield River right bank (from 6,000' upstream of Elm St. bridge to Springfield Rd bridge) and along Little River left bank (between Stevens Paper Mills lower dam and mouth of proposed channel cutoff at Springfield Rd bridge).

IV Little River area outside of proposed local protection works, extending from Stevens Paper Mills lower dam to railroad bridge.

is coordinated with other reservoirs in the Connecticut River basin to obtain maximum reduction in over-all flood damages. A brief description of the flood control reservoir projects and local protection projects in the Westfield River basin is given in the following paragraphs. The locations of the projects are shown on Plate H-2.

18. RESERVOIRS

a. Littleville Dam and Reservoir

(1) Authority. Littleville Dam and Reservoir was authorized by the Flood Control Act of 3 July 1958 (Public Law No. 85-500, 85th Congress) in accordance with recommendations set forth in Senate Document No. 17, 85th Congress. Inclusion of provisions for future water supply in the Littleville flood control reservoir was authorized under the Water Supply Act of 1958, Public Law 85-500, dated 3 July 1958. Construction of the dam was initiated in June 1962 and completed in October 1965.

(2) Project location. The Littleville Reservoir project is located on the Middle Branch of the Westfield River within the towns of Huntington and Chester in western Massachusetts at the westerly side of the Connecticut River basin. The dam site is about 1 mile upstream of the confluence of the Middle Branch and the Westfield River and about 2.7 miles north of the town of Huntington. A general plan and vicinity map of the Littleville Dam and Reservoir are shown on Plate No. H-11.

(3) Description of project. The Littleville project consists of a rolled earth dam, a concrete weir controlled chute spillway and two separate outlet works. At spillway crest Littleville Reservoir has a total capacity of 32,400 acre-feet, of which 9,400 acre-feet is reserved for water supply and 23,000 acre-feet for flood control. The flood control storage is equivalent to 8.2 inches of run-off from the drainage area of 52 square miles. When filled to spillway crest, the reservoir will extend upstream along the Middle Branch for a distance of approximately 3.7 miles and have a surface area of 510 acres.

(a) Dam. The dam consists of rolled earth fill approximately 1,360 feet long with a maximum height of 164 feet above streambed at centerline of dam (Plates H-12 and H-13). The top of the dam at elevation 596 feet msl provides for 15 feet of spillway surcharge and 5 feet of freeboard. The top of the dam is 25 feet wide with an 18-foot wide paved access road. The upstream embankment slope is 1 on 3 and the downstream 1 on 2.5.

(b) Earth dike. A rolled earth fill dike is located on the left abutment of the dam to close a natural saddle between the left abutment of the spillway and high ground. The dike is 935 feet long with a maximum height of 46 feet and all of the dike is well above the elevation of the water supply pool. A plan view of the dike is shown on Plate H-13.

(c) Spillway. The spillway consists of a 7-foot high concrete ogee weir located on a bedrock plateau on the left bank and a chute type spillway in a bedrock cut. The weir has a length of 400 feet with a crest elevation at 576 feet msl. The discharge channel width varies from 372 feet at the foot of the curved weir to 50 feet at a distance of 440 feet downstream. The total length of the excavated spillway channel is 1,250 feet and the bottom slopes vary from 5 to 21.5 percent. The excavated approach area has a 1 percent slope towards the reservoir. A plan and profile of the spillway is shown on Plates H-14 and H-15.

(d) Outlet works. The Littleville project has two separate reservoir outlet works. One outlet works is for the purpose of diversion for water supply and the other is for flood control.

1. Water supply outlet works. The main components of the water supply outlet works are a 17.5 foot wide intake channel with invert at elevation 432 feet msl, an intake structure consisting of a wet well tower with four 36 inch diameter gates at different elevations so that water can be drawn from various levels, an operating house on top of the tower, an outlet conduit and a 20-foot wide outlet channel. The outlet conduit consists of a 9-foot wide arch-shaped conduit 800 feet long with a 48-inch diameter concrete water supply conduit installed within the arch. A plan of the water supply outlet works is shown on Plate H-16.

2. Flood control outlet works. The flood control outlet works consist of an intake channel, gates, tower and an outlet tunnel. The intake channel is 20-feet wide, excavated in rock to elevation 515 feet msl. Near the intake structure the channel widens to 30 feet to accommodate a 30-foot concrete weir with crest elevation at 518 feet msl, the elevation of the water supply pool.

From the weir a concrete-lined channel extends 88.5 feet to the gate structure. Flows are regulated by two 4 x 8 foot sluice gates and from the gate structure, flows are conducted to the outlet in a 370-foot long, 8-foot diameter concrete-lined "horseshoe" tunnel. A plan of the flood control outlet works is shown on Plate H-17.

(e) Recreation. In the interim prior to use of the reserved storage at Littleville for domestic water supply, the use of the storage will be under the jurisdiction of the Massachusetts Water Resources Commission. It is anticipated that a full water supply pool will be maintained during the summer for recreational use and drawn down in the fall and winter to augment industrial water supply to downstream users. Recreational facilities consist of picnic tables, fireplaces, parking, boat ramps and camp sites. Recreation management will be by the Commonwealth of Massachusetts pending a license with Massachusetts Division of Fish and Game. The plan for recreational development is shown on Plates H-18 and H-19.

(f) Effectiveness of project. Hydrographs of the 1938, 1955 and standard project flood are shown on Plates H-5 and H-6. Also shown is the effect of Littleville in conjunction with Knightville on the standard project flood discharge at Westfield, the major damage zone in the basin. Table H-X summarizes the modifying effect of Littleville on the above-mentioned floods at Westfield. With a recurrence of the record basin flood of August 1955, the reservoir would prevent $4.3 million in damages after reductions by Knightville.

(g) Regulation Procedure - (See Attachment I)

TABLE H-X

EFFECT OF RESERVOIR REGULATION ON FLOODS AT WESTFIELD, MASS.

Flood	Natural Flow (cfs)	Modified by Knightville	Modified by Knightville & Littleville
Sept 1938	55,500	42,300	32,500
Aug 1955	81,000	70,300	62,500
SPF	180,000	126,000	101,000

b. Knightville Dam and Reservoir.

(1) Authority. Knightville Dam and Reservoir was authorized as a project for the Westfield River basin in the Flood Control Act of 28 June 1938 (Public Law No. 761, 75th Congress) and set forth in House Document No. 455, 75th Congress, 2d session. Construction of the dam was initiated in August 1939 and completed in December 1941.

(2) Project location. The Knightville Dam is located in west central Massachusetts on the main branch of the Westfield River, 4 miles north of the town of Huntington, Massachusetts and about 27.5 miles above the confluence of the Westfield River with the Connecticut in West Springfield, Massachusetts. A general plan and vicinity map of the Knightville Dam and Reservoir are shown on Plate H-20.

(3) Description of project. Major project components consist of a hydraulic earthfill dam, a weir spillway and an outlet works. At spillway crest Knightville Reservoir has a capacity of 49,000 acre-feet, which is equivalent to about 5.6 inches of run-off from the drainage area of 162 square miles. When filled to spillway crest, the reservoir is about 6 miles long with a surface area of about 960 acres.

(a) Dam. The dam consists of a hydraulic earth fill embankment 1,200 feet long with a maximum height of 160 feet above the riverbed (Plate No. H-21). The top of the dam at elevation 630 feet msl provides for 15 feet of surcharge and 5 feet of freeboard. The top width of the dam is 30 feet and the side slopes vary from 1 on 2.5 to 1 on 3.0.

(b) Spillway. The spillway is located on the right abutment adjacent to the dam. The spillway is an uncontrolled curved concrete ogee weir with a fixed crest at elevation 610 feet msl and a length of 400 feet.

(c) Outlet works. The outlet works are in the right abutment and consist of an intake channel 280 feet in length and a 16-foot diameter tunnel through rock. The tunnel is 605 feet long and is controlled by three 6 x 12 foot broome gates mechanically operated through a control tower from a gatehouse above. Provision for the installation of a penstock for the development of hydroelectric power is included.

(d) Recreation. Principal recreational activities at Knightville are picnicking, hiking, hunting and sightseeing. Present facilities consist of 13 picnic tables, 10 fireplaces and 2 parking areas.

(e) Effectiveness of project. Hydrographs of the 1938, 1955 and standard project flood are shown on Plates H-5 and H-6. Also shown is the effect of Knightville on the standard project flood discharge at Westfield, the major damage zone in the basin. Table H-X summarizes the modifying effect of Knightville on the above-mentioned floods at Westfield. Since completion of the project, there have been 57 significant reservoir operations which prevented damages of $17,195,000. The most significant of these operations were those of January 1949 when 100 percent of storage was utilized, August 1955 when 58 percent of storage was utilized, and October 1955 when 96 percent of storage was utilized. Operation of the project would prevent damages of $7,830,000 in a recurrence of the March 1936 basin flood of record and $2.6 million in a recurrence of the August 1955 flood, the flood of record in most of the Westfield River watershed.

(f) Regulation Procedure - (See Attachment I)

19. LOCAL PROTECTION PROJECTS

a. West Springfield local protective works.

(1) Authorization.

(a) West Springfield dike. Work by the Corps of Engineers was initiated in fiscal year 1937 under provisions of the Emergency Relief Appropriation Act of 22 June 1936. Funds available were sufficient for raising the existing line of protection, which had been overtopped in the 1936 flood, to an elevation slightly above the 1936 flood line throughout except that no work was done on the section of dike on the Westfield River extending 6,100 feet downstream from Agawam bridge. This section was brought to design grade in fiscal year 1938 under the provisions of the Emergency Relief Appropriation Act of 29 June 1937. The balance of the dike system was raised to design grade under authorization of the Flood Control Act approved 28 June 1938 (Public Law No. 761, 75th Congress) (House Document 455, 75th Congress, 2d session) and modified by the Flood Control Act of 18 August 1941 (Public Law No. 228, 77th Congress) (House Document 653, 76th Congress, 3d session). This authorization also covers a foundation treatment to a section of the dike extending about 6,100 feet along the Westfield River downstream of the Agawam bridge. The foundation treatment included the installation of seepage relief wells, a drainage system at the landside toe of dike and partial sheet pile cutoffs at two locations at the riverside toe of the dike.

(b) Riverdale dike. The Riverdale section of protection was included in the second Interim Report on the control of floods in the Connecticut River basin which was published as House Document 724, 76th Congress, 3d session. It was approved by the Flood Control Act of 18 August 1941 (Public Law No. 228, 77th Congress, 1st session).

(2) Location. West Springfield is located in west-central Massachusetts on the west bank of the Connecticut River at the mouth of the Westfield River. The northerly end of the West Springfield dike is on the west bank of the Connecticut at river mile 78. From this point the project runs southerly about 2 miles to the confluence of the Connecticut and Westfield Rivers, thence westerly and northerly along the Westfield River for nearly 3 miles. The Riverdale dike extends from high ground on the south bank of Goldfine Brook to high ground on the north bank of Bagg Brook, a distance of 12,900 feet.

(3) Description. The West Springfield dike is, in general, constructed to project flood grade, with the exception of concrete walls constructed in 1936-1937 at grades slightly below project grade. The system is composed of the following:

4,800 linear feet of concrete floodwalls
15,000 linear feet of earth dike
3 pumping stations
3 stoplog structures
14 drainage structures through walls

The Riverdale dike system protects the Riverdale section of West Springfield and is composed of:

13,000 linear feet of earth dike
2 pumping stations
3 stoplog structures
8 drainage structures through walls

General plans and operation charts for the West Springfield local protection projects are shown on Plates H-22 and H-23. The town of West Springfield is responsible for maintenance with Corps of Engineers inspection by the Littleville dam operator.

(4) Effectiveness of project. Operation of the projects has prevented $18,140,000 in flood damages since their completion. With recurrence of the March 1936 basin flood of record, the projects would prevent $10,630,000 in damages.

b. Westfield local protection project.

(1) Authorization. The Westfield local protection project was authorized by the Flood Control Act approved 14 July 1960, Public Law 645, 86th Congress, 2d session, as recommended in Senate Document No. 109. The project is presently in an inactive status.

(2) Location. The Westfield local protection project is located in the city of Westfield, Hampden County, Massachusetts along the south bank of the Westfield River and along the north bank of the Little River. The city of Westfield is located about 11 miles west of Springfield, Massachusetts, about 43 miles east of Pittsfield, Massachusetts and about 30 miles north of Hartford, Connecticut.

(3) Description. The total land area of the city of Westfield is 29,984 acres, of which 3,100 are subject to flooding by the standard project flood modified by Knightville and Littleville Reservoirs. Concentrated within this flooded area are 1,900 residential properties, 260 commercial establishments, 30 public buildings, 27 industrial firms and 20 farms.

The project provides for the construction of earth dikes and floodwalls along the Westfield and Little Rivers, excavation of cut off channels on both rivers, construction of a pumping station and appurtenant works. Plans and profiles of the project are shown on Plates H-24, H-25, H-26 and H-27.

Approximately 31,700 feet of dike will be required for the protective works; 17,500 feet will be along the right bank of the Westfield River and its new channel and 14,200 feet will be along the left bank of the Little River and its new channel. Two new channels will eliminate the oxbow on the Westfield River and straighten the Little River.

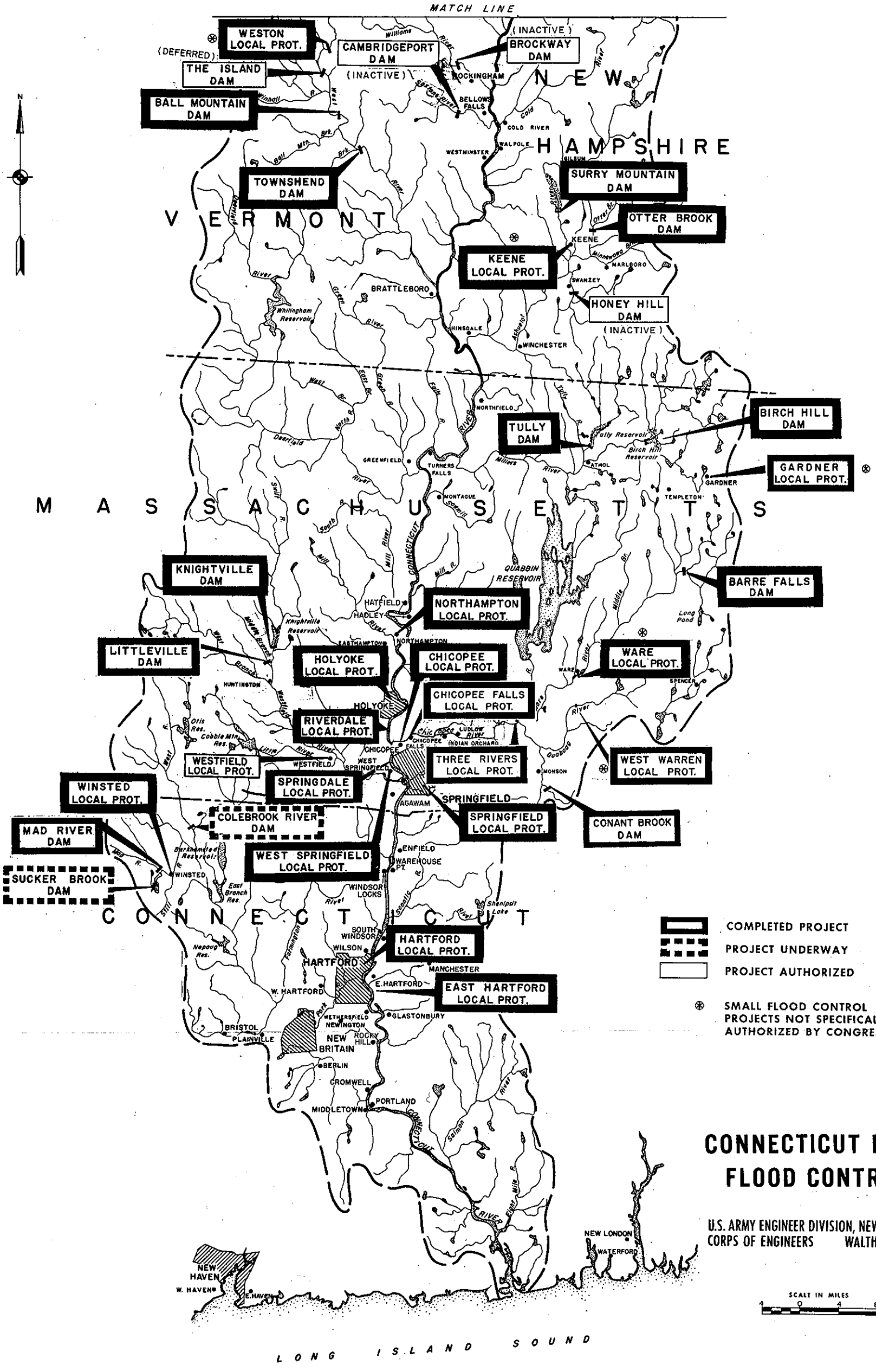
Two street gates will be required where the dike crosses existing ways, one within the Little River dike and the other in the Westfield River dike. A 2-foot high sandbag structure will be installed where the NYNH&H railway crosses the Westfield dike.

Five ponding areas will be reserved within the protected area for temporarily storing interior run off. Each ponding area will be provided with gated conduits and the East Main Street ponding area will be provided with a pumping station.

(4) Effectiveness of project. The project, in conjunction with the Knightville and Littleville Reservoirs, will provide major protection for about 1,100 acres in Westfield. In a recurrence of the August 1955 flood, the record flood in most of the Westfield River watershed, an estimated $5,695,000 in damages would be prevented over and above those prevented by both reservoirs.

20. OTHER PROJECTS

The Soil Conservation Service of the U. S. Department of Agriculture has recommended construction of 13 flood retarding structures on tributaries of the West Branch River. The system as proposed would have a combined flood control storage of 9,395 acre-feet. Future studies will be made, in the event these projects are built, to determine if there is need for revision in the plan for reservoir regulation. The projects built by the above agency for flood control on Powdermill Brook, a tributary to the Westfield River at Westfield, were found to have a negligible effect on main stem floods.

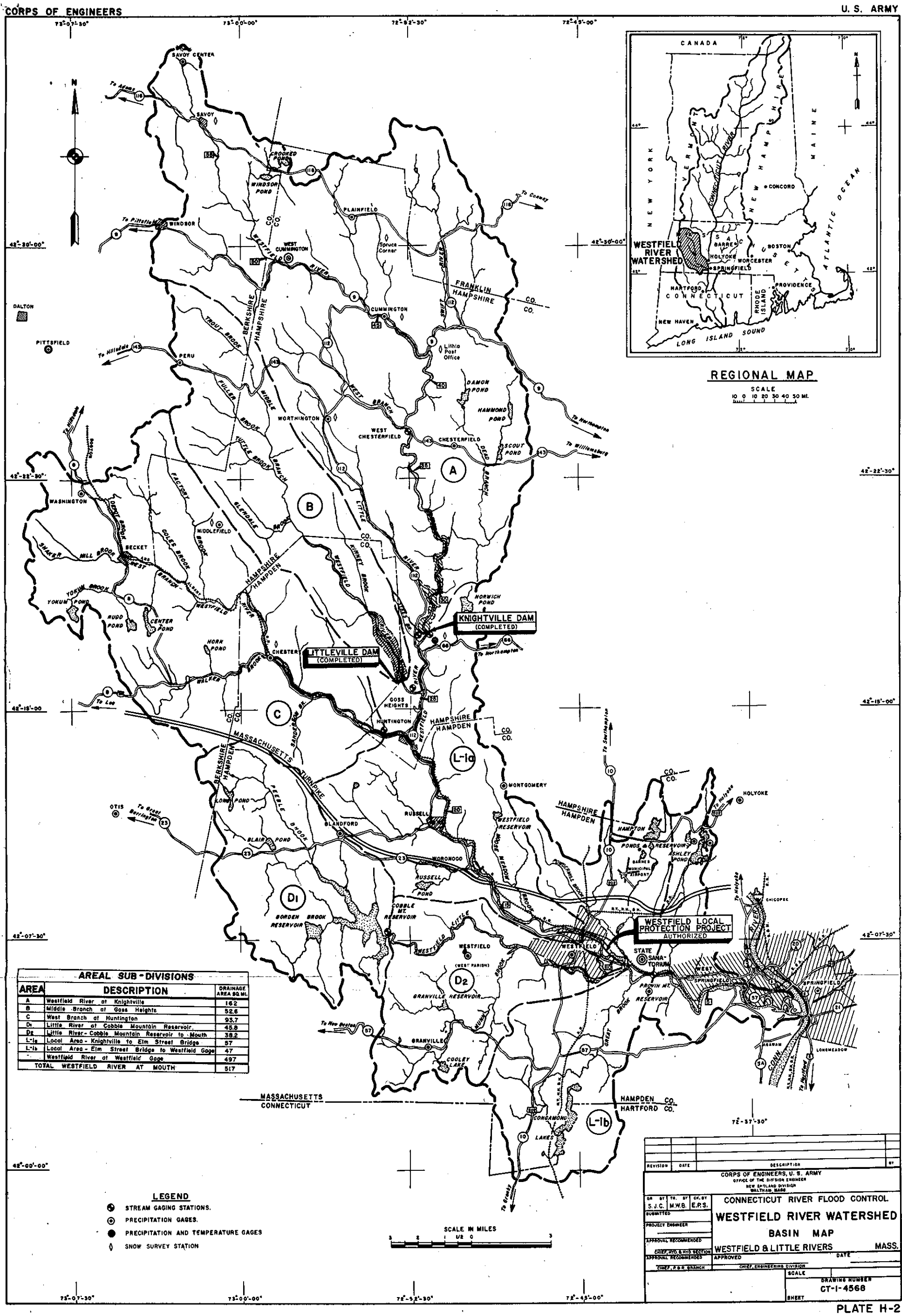


CONNECTICUT RIVER FLOOD CONTROL

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

PLATE H-1

CORPS OF ENGINEERS — U. S. ARMY



REGIONAL MAP

SCALE
10 0 10 20 30 40 50 MI.

AREAL SUB-DIVISIONS

AREA	DESCRIPTION	DRAINAGE AREA SQ. MI.
A	Westfield River at Knightville	162
B	Middle Branch at Goss Heights	52.6
C	West Branch at Huntington	93.7
D_1	Little River at Cobble Mountain Reservoir	45.8
D_2	Little River - Cobble Mountain Reservoir to Mouth	38.2
L-1a	Local Area - Knightville to Elm Street Bridge	57
L-1b	Local Area - Elm Street Bridge to Westfield Gage	47
-	Westfield River at Westfield Gage	497
TOTAL	WESTFIELD RIVER AT MOUTH	517

LEGEND

- STREAM GAGING STATIONS.
- PRECIPITATION GAGES.
- PRECIPITATION AND TEMPERATURE GAGES
- SNOW SURVEY STATION

SCALE IN MILES
3 2 1 1/2 0 3

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
WALTHAM, MASS.

DR. BY	TR. BY	CH. BY
S.J.C.	M.W.B.	E.P.S.

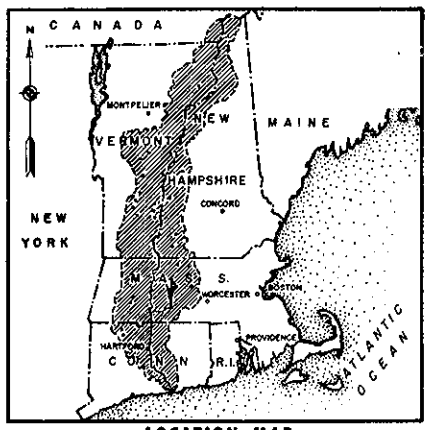
SUBMITTED
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, HYD. & HYD. SECTION
APPROVAL RECOMMENDED
CHIEF, P.B.R. BRANCH

CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD RIVER WATERSHED
BASIN MAP
WESTFIELD & LITTLE RIVERS MASS.

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE
DRAWING NUMBER
CT-1-4568
SHEET

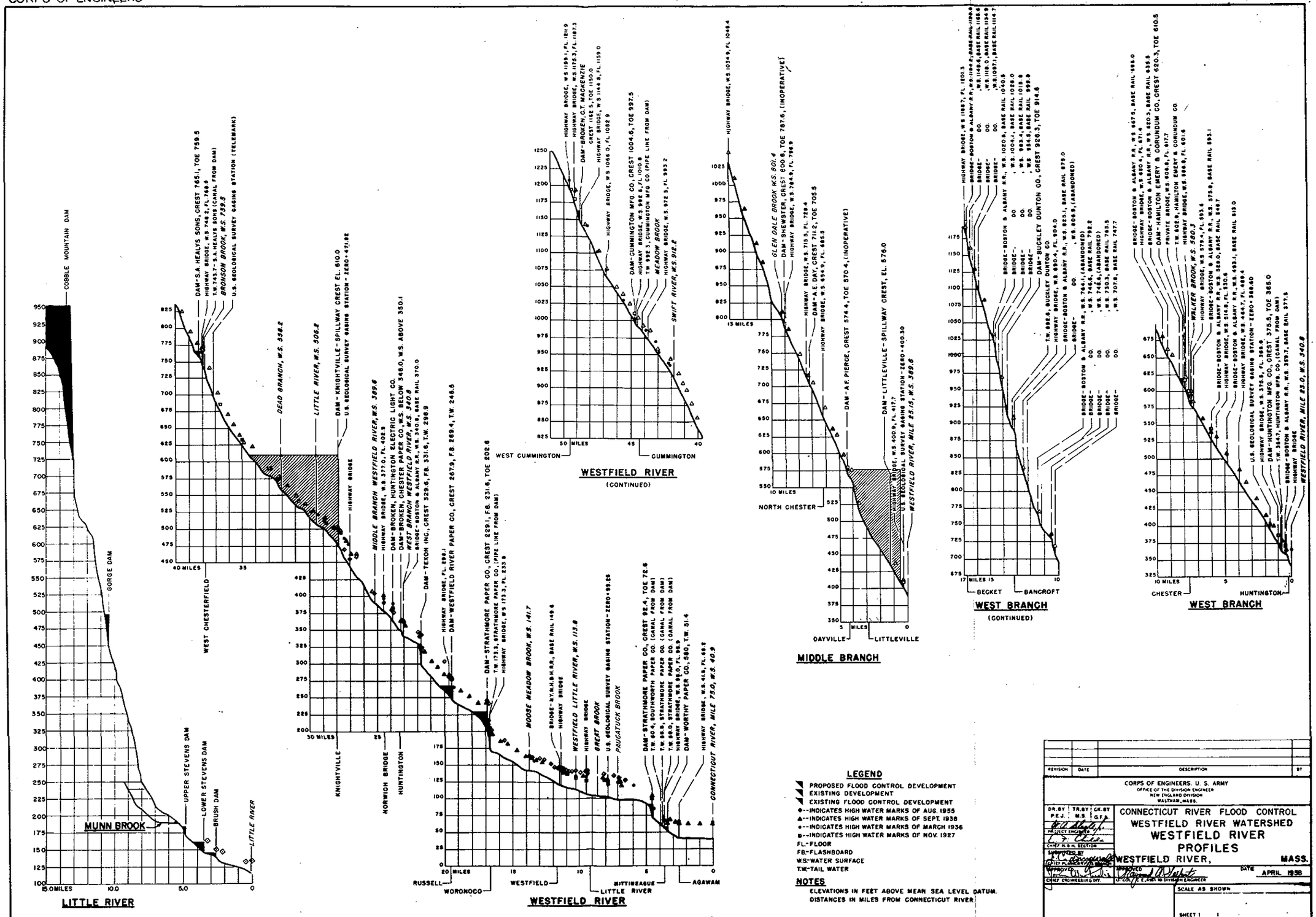
PLATE H-2



LOCATION MAP
SCALE IN MILES
25 0 25 50

CORPS OF ENGINEERS

U.S. ARMY



LEGEND

- PROPOSED FLOOD CONTROL DEVELOPMENT
- EXISTING DEVELOPMENT
- EXISTING FLOOD CONTROL DEVELOPMENT
- ●--INDICATES HIGH WATER MARKS OF AUG. 1955
- ▲--INDICATES HIGH WATER MARKS OF SEPT. 1938
- ●--INDICATES HIGH WATER MARKS OF MARCH 1936
- ■--INDICATES HIGH WATER MARKS OF NOV. 1927
- FL-FLOOR
- FB-FLASHBOARD
- W.S-WATER SURFACE
- T.W.-TAIL WATER

NOTES

ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL DATUM.
DISTANCES IN MILES FROM CONNECTICUT RIVER.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
P.E.J.	M.S.	G.F.P.

PROJECT ENGINEER
CHIEF H. & H. SECTION
SUPERVISED BY
CHIEF PLANNING BRANCH
APPROVED
CHIEF ENGINEERING DIV.

CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD RIVER WATERSHED
WESTFIELD RIVER PROFILES
WESTFIELD RIVER, MASS.

RECOMMENDED
Lt. Col., C.E., Asst. to Division Engineer

DATE APRIL 1956

SCALE AS SHOWN

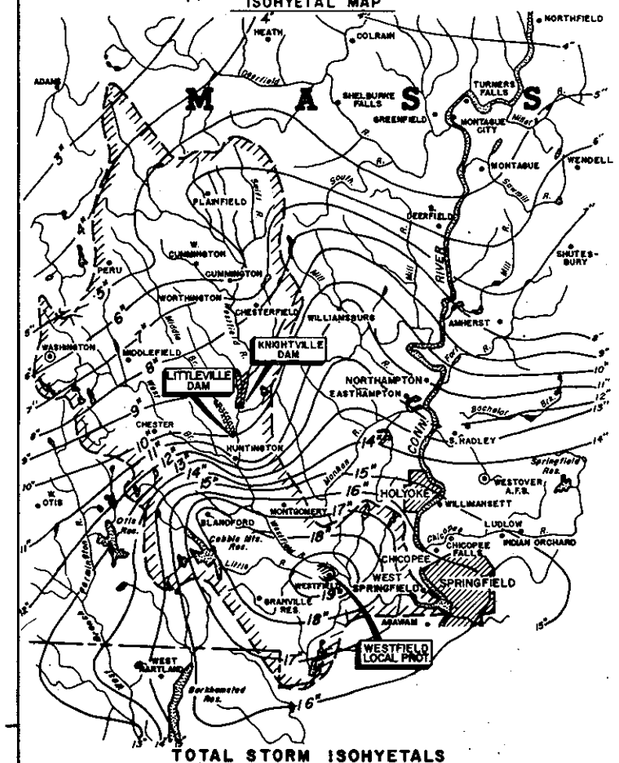
SHEET 1

PLATE H-3

CORPS OF ENGINEERS

U.S. ARMY

ISOHYETAL MAP



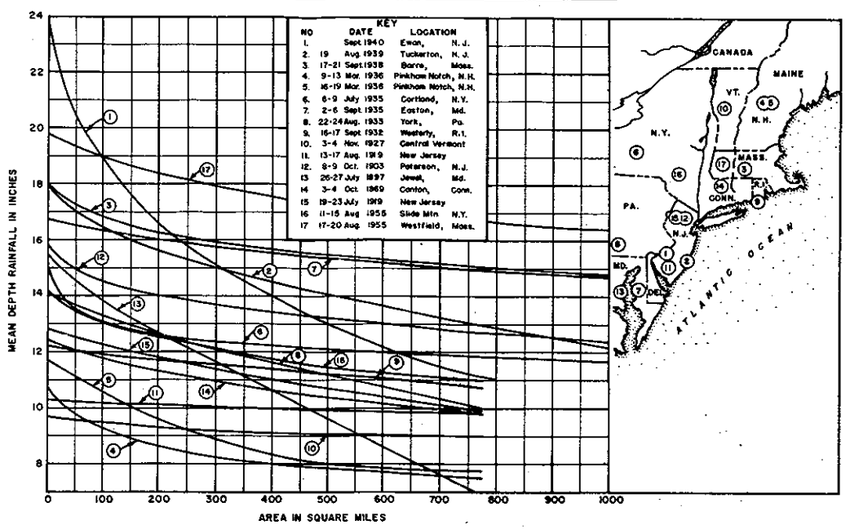
TOTAL STORM ISOHYETALS

AUGUST 17-20 1955

(HURRICANE "DIANE")

AREA-DEPTH CURVES

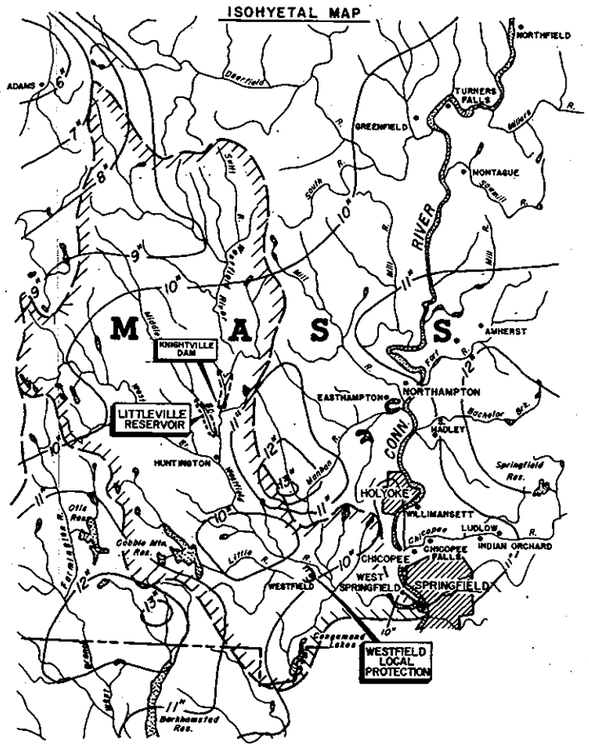
AND LOCATION OF STORM CENTERS



STORMS OF RECORD

NORTHEASTERN UNITED STATES

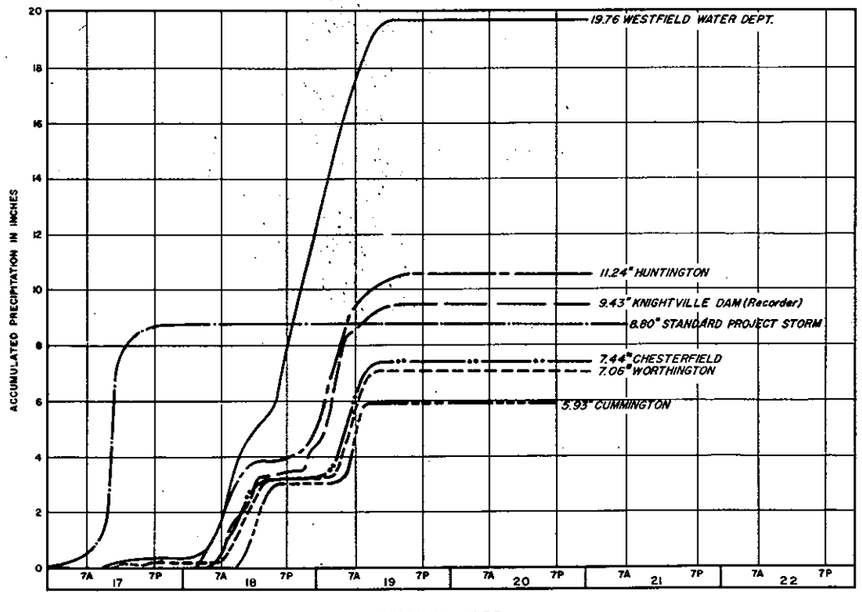
ISOHYETAL MAP



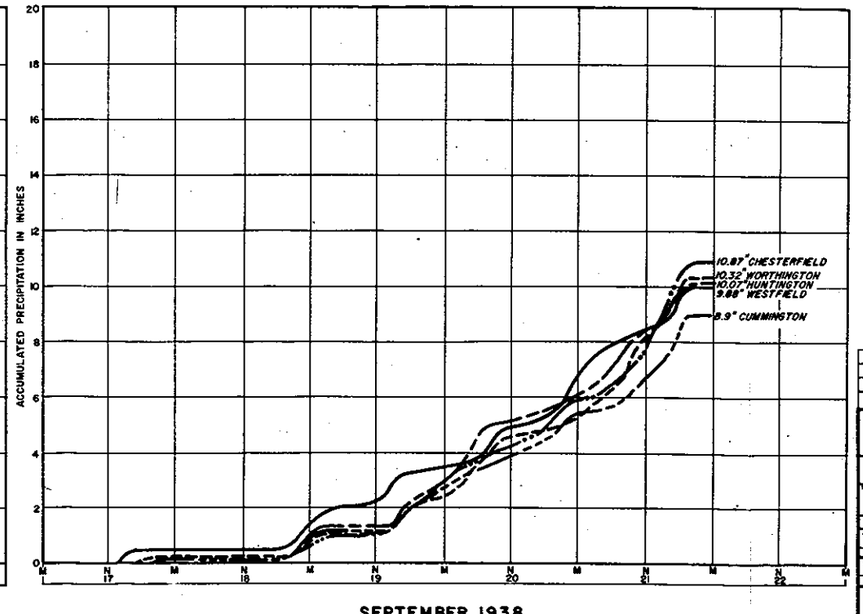
TOTAL STORM ISOHYETALS

SEPTEMBER 17-22, 1938

MASS CURVES



AUGUST 1955



SEPTEMBER 1938

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
SUBMITTED	S.J.C.	E.P.S.
PROJECT ENGINEER		
APPROVAL RECOMMENDED		
CHIEF, HYD. & HYD. SECTION		
APPROVAL RECOMMENDED		
CHIEF P. & R. BRANCH		

CONNECTICUT RIVER FLOOD CONTROL

WESTFIELD LOCAL PROTECTION

HYDROLOGIC DATA FOR RECORD STORMS

WESTFIELD & LITTLE RIVERS MASS.

APPROVED DATE OCTOBER 1963

CHIEF ENGINEERING DIVISION

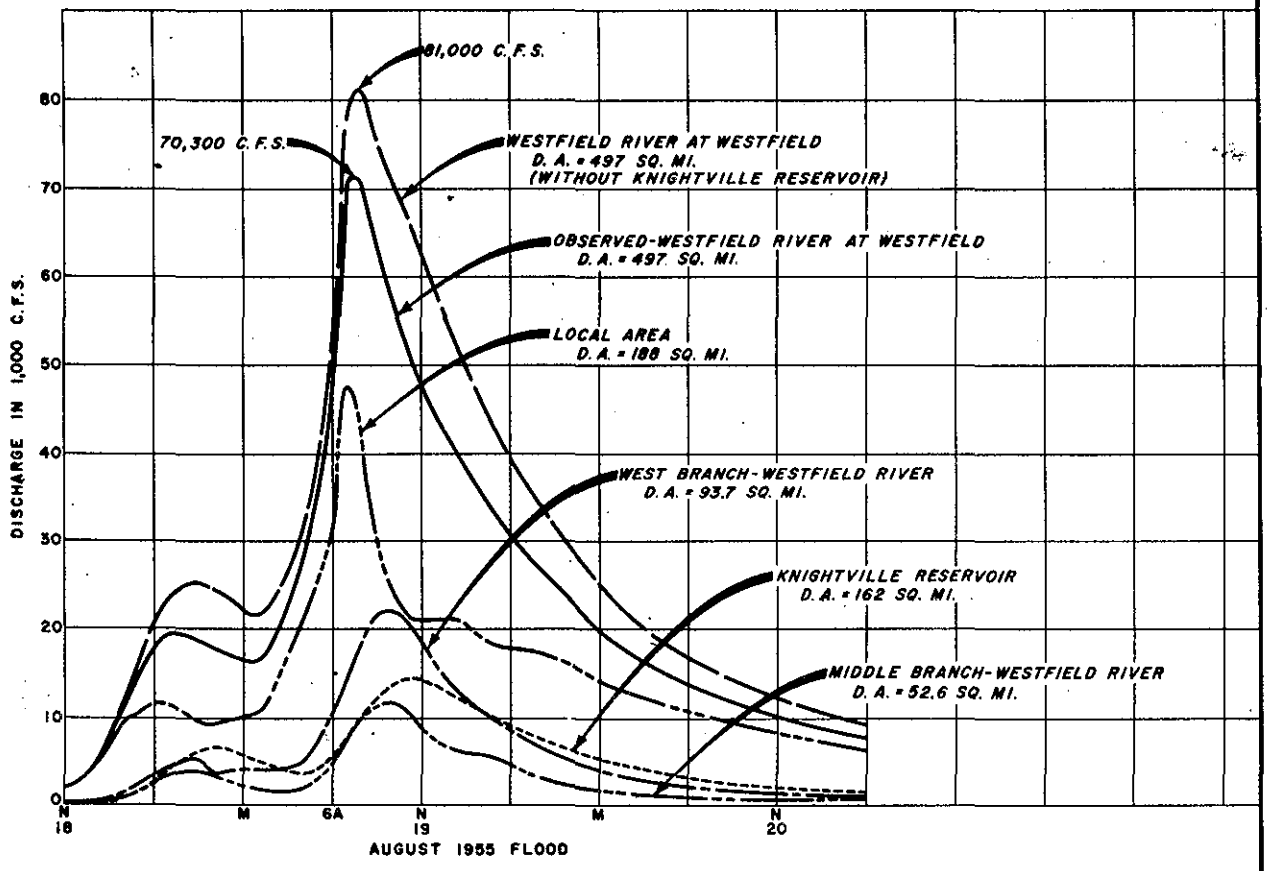
SCALE AS NOTED.

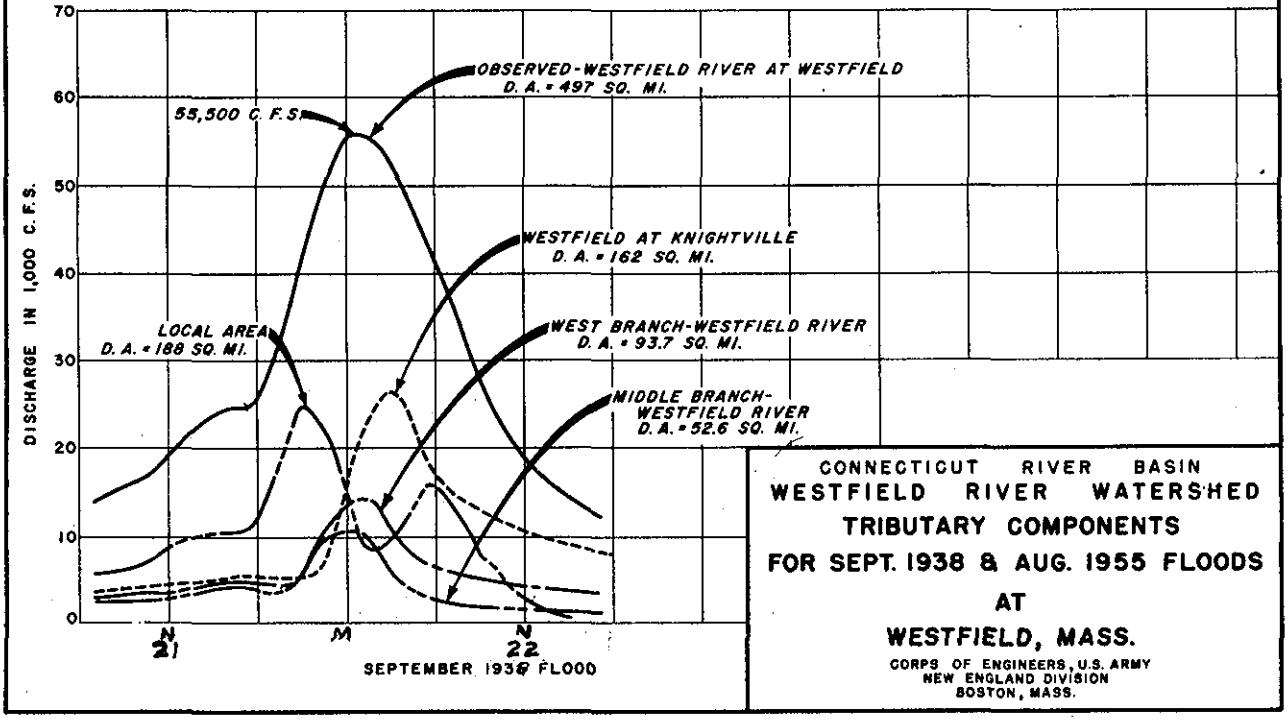
DRAWING NUMBER

CT-1-4571

SHEET 1 OF 1

PLATE H-4





CONNECTICUT RIVER BASIN

WESTFIELD RIVER WATERSHED

TRIBUTARY COMPONENTS

FOR SEPT. 1938 & AUG. 1955 FLOODS

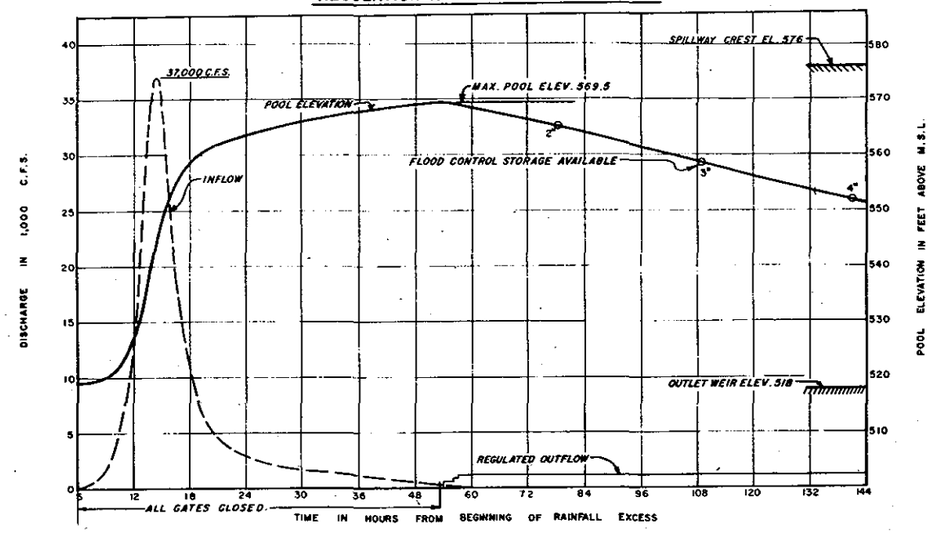
AT

WESTFIELD, MASS.

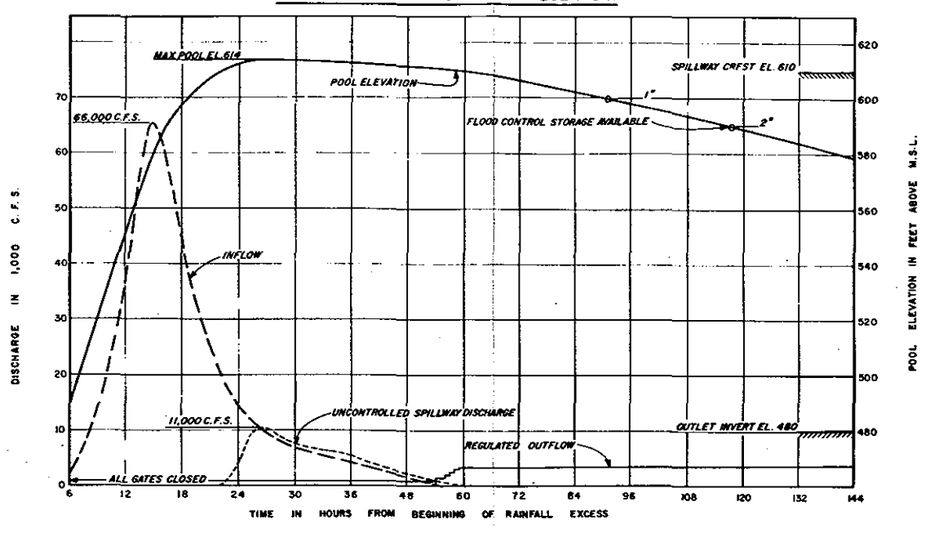
CORPS OF ENGINEERS, U.S. ARMY
NEW ENGLAND DIVISION
BOSTON, MASS.

PLATE NO. H-5

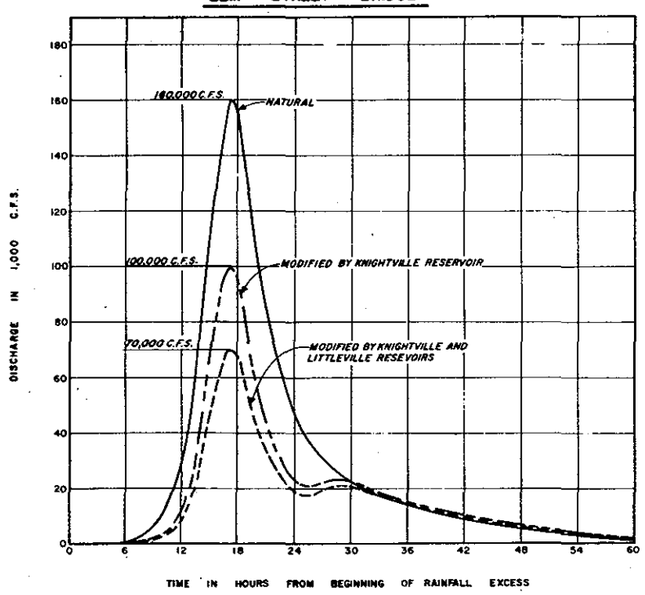
REGULATION AT LITTLEVILLE RESERVOIR



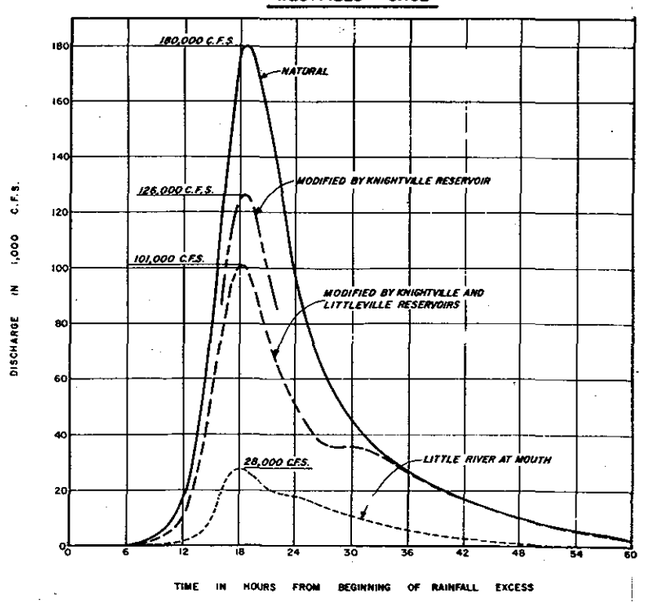
REGULATION AT KNIGHTVILLE RESERVOIR



WESTFIELD RIVER AT ELM STREET BRIDGE



WESTFIELD RIVER AT WESTFIELD GAGE



REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
E.P.S.	M.M.B.	E.P.S.

SUBMITTED

PROJECT CHIEF

APPROVAL RECOMMENDED

CHIEF, HYD. & HYD. SECTION
APPROVAL RECOMMENDED

CHIEF PLANNING & REPORTS BR.

CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD RIVER BASIN
RESERVOIR REGULATION
STANDARD PROJECT FLOOD
MIDDLE BRANCH WESTFIELD RIVER, MASS.

APPROVED DATE APRIL 1961

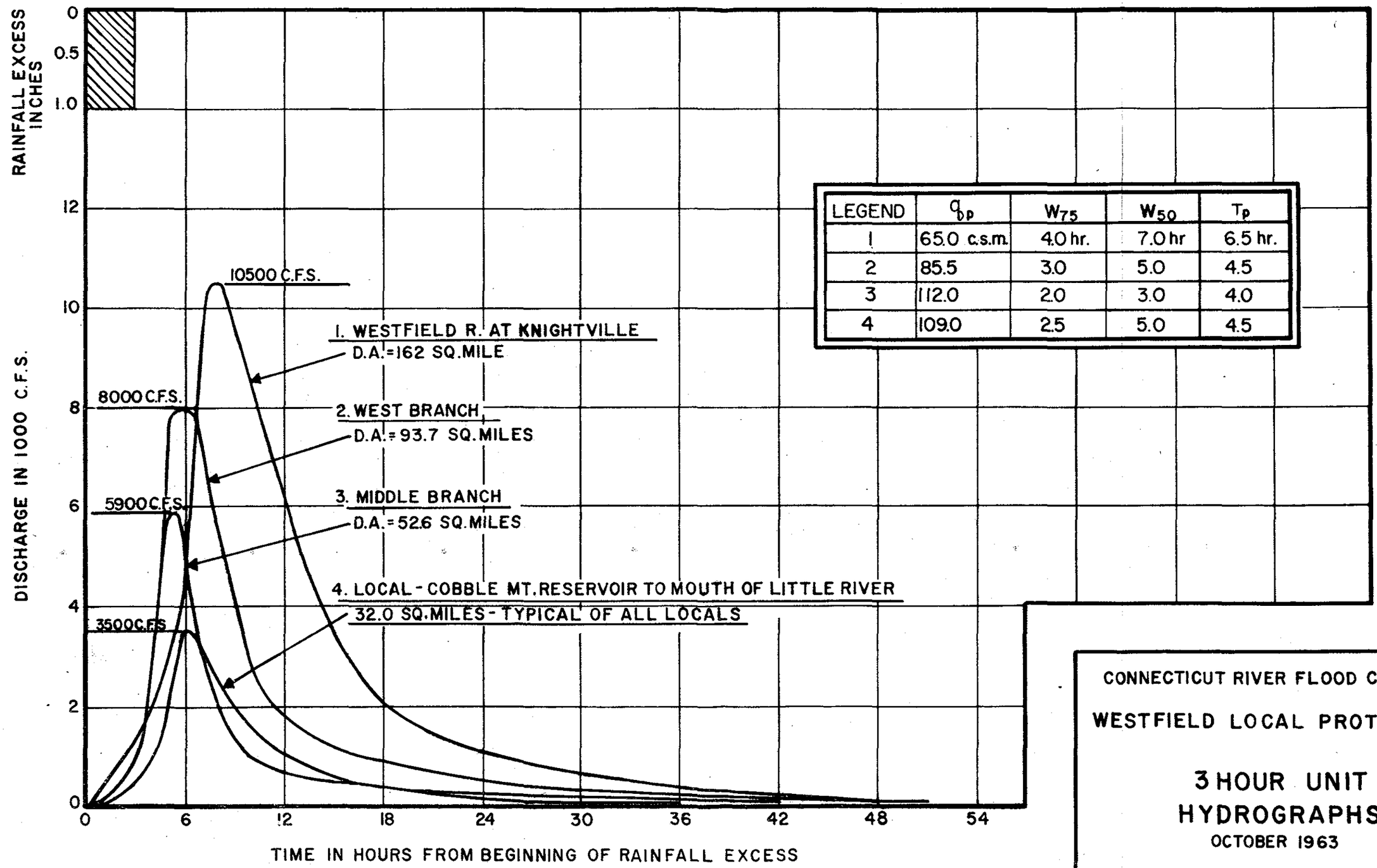
CHIEF ENGINEERING DIVISION

SCALE AS NOTED

DRAWING NUMBER
CT-1-4572

SHEET 1 OF 1

PLATE NO. H-6



LEGEND	q_{pp}	W_{75}	W_{50}	T_p
1	65.0 c.s.m.	4.0 hr.	7.0 hr	6.5 hr.
2	85.5	3.0	5.0	4.5
3	112.0	2.0	3.0	4.0
4	109.0	2.5	5.0	4.5

CONNECTICUT RIVER FLOOD CONTROL

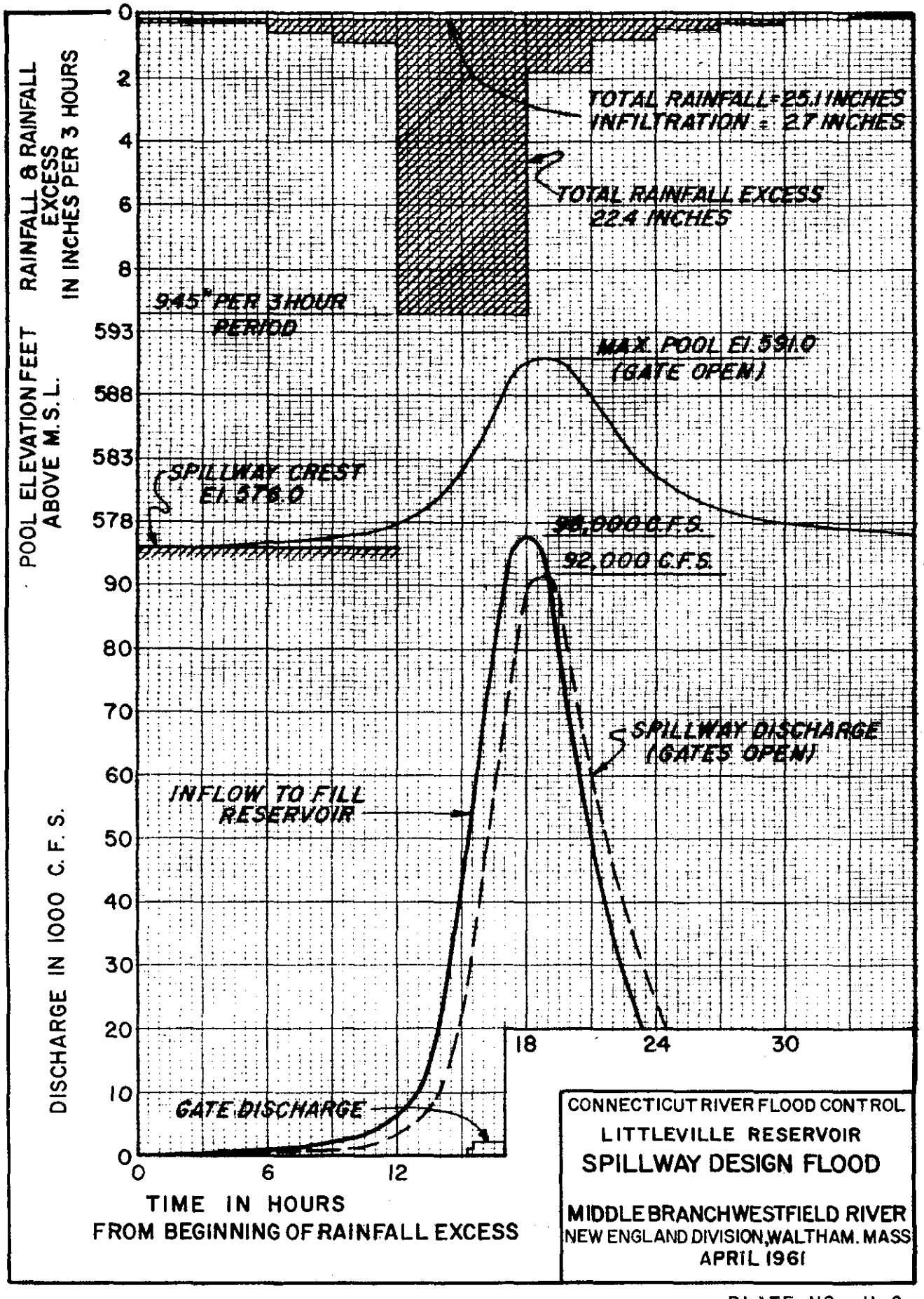
WESTFIELD LOCAL PROTECTION

3 HOUR UNIT HYDROGRAPHS

OCTOBER 1963

WESTFIELD & LITTLE RIVERS MASS

PLATE H-7



CONNECTICUT RIVER FLOOD CONTROL

LITTLEVILLE RESERVOIR

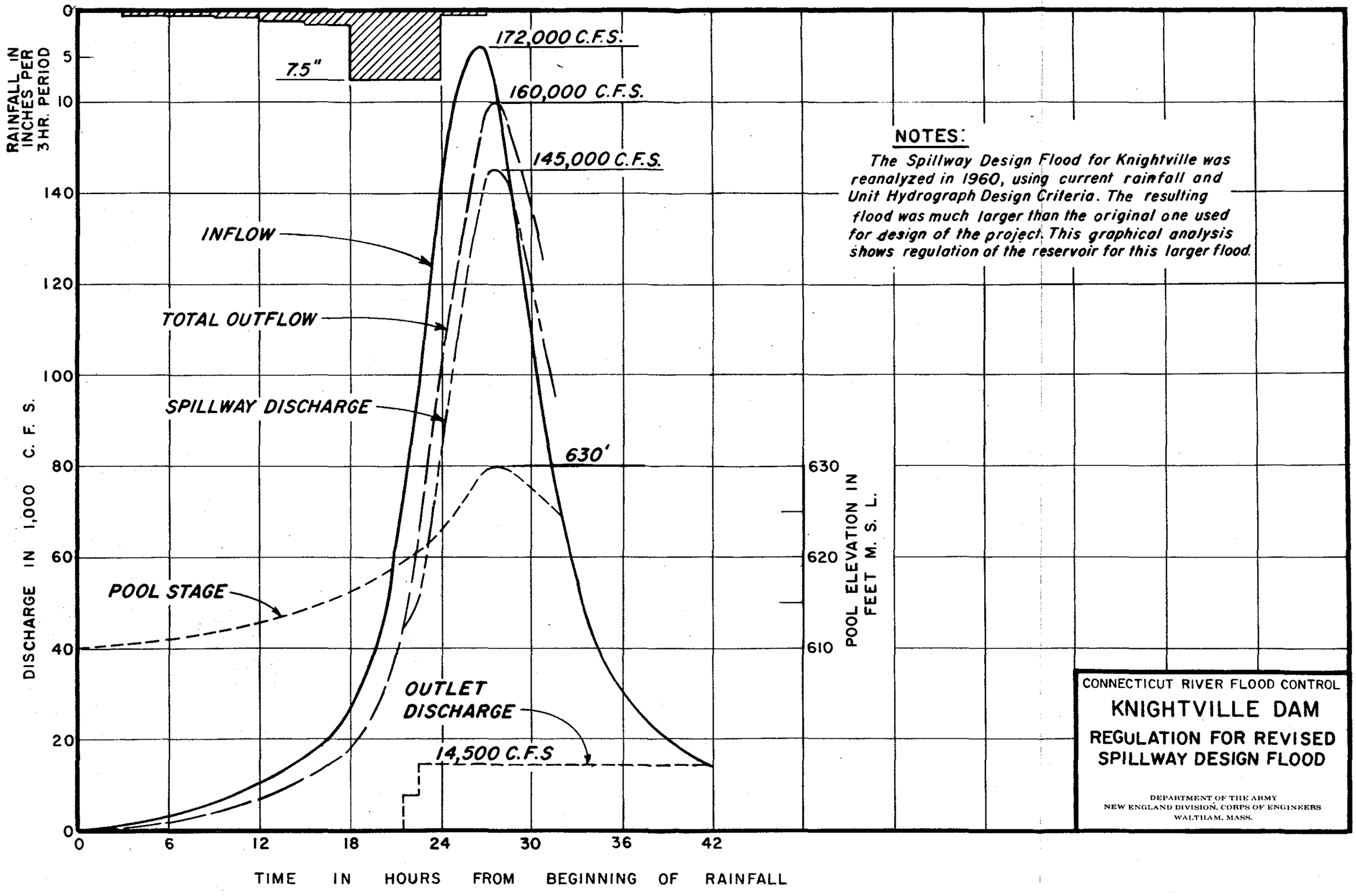
SPILLWAY DESIGN FLOOD

MIDDLE BRANCH WESTFIELD RIVER

NEW ENGLAND DIVISION, WALTHAM, MASS

APRIL 1961

PLATE NO. H-8



NOTES:

The Spillway Design Flood for Knightville was reanalyzed in 1960, using current rainfall and Unit Hydrograph Design Criteria. The resulting flood was much larger than the original one used for design of the project. This graphical analysis shows regulation of the reservoir for this larger flood.

CONNECTICUT RIVER FLOOD CONTROL

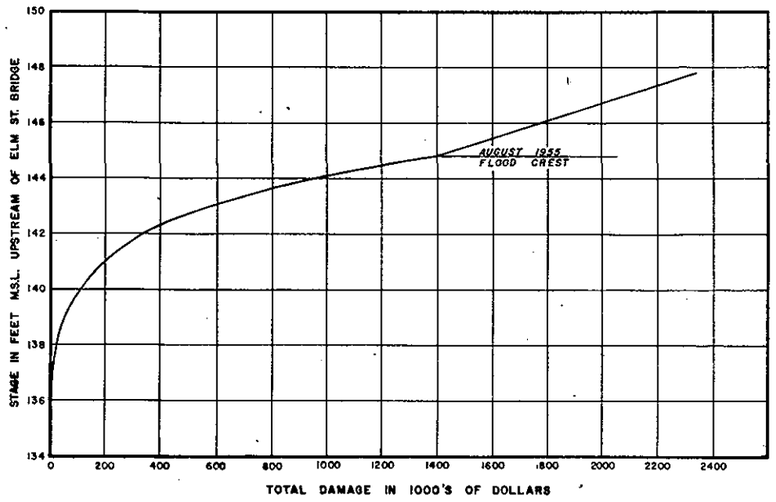
KNIGHTVILLE DAM

REGULATION FOR REVISED SPILLWAY DESIGN FLOOD

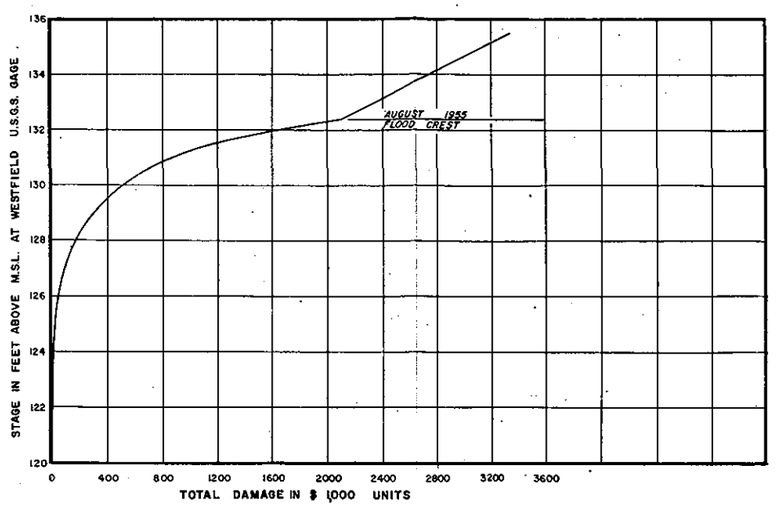
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

PLATE NO. H-9

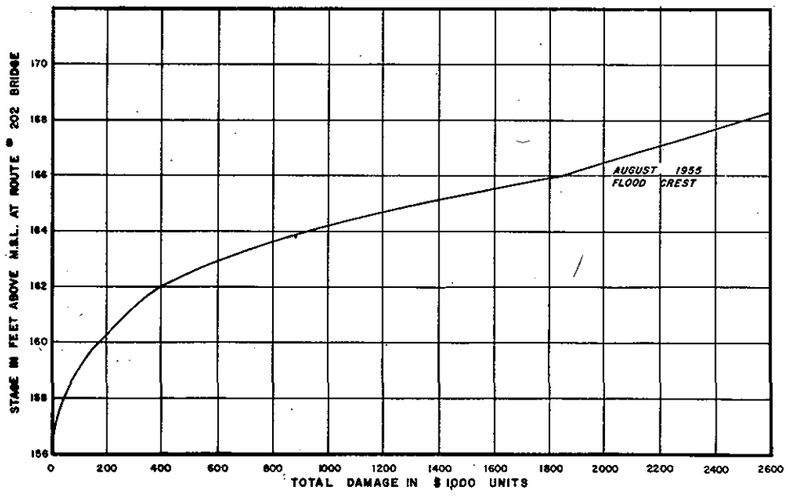
CORPS OF ENGINEERS — U. S. ARMY



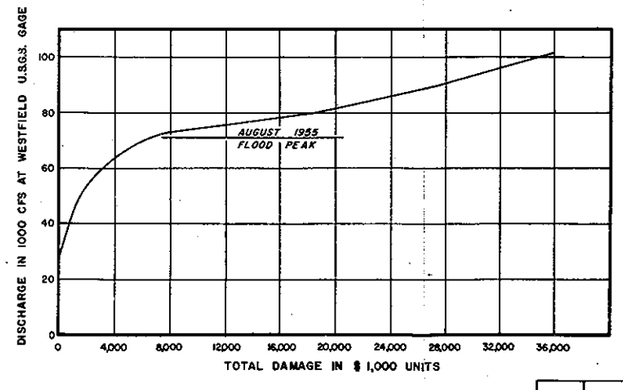
STAGE DAMAGE CURVE - WESTFIELD RIVER
MOUTH OF WEST BRANCH TO ELM ST. BRIDGE, WESTFIELD



STAGE DAMAGE CURVE - WESTFIELD RIVER
ELM ST. BRIDGE WESTFIELD TO MOUTH OF RIVER



STAGE DAMAGE CURVE, LITTLE RIVER, WESTFIELD RIVER BASIN



DISCHARGE DAMAGE CURVE INSIDE AUTHORIZED
LOCAL PROTECTION AREA

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J.T.D. | DR. BY | CK. BY
SUBMITTED:
CHIEF, BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVED:
CHIEF, DESIGN BRANCH

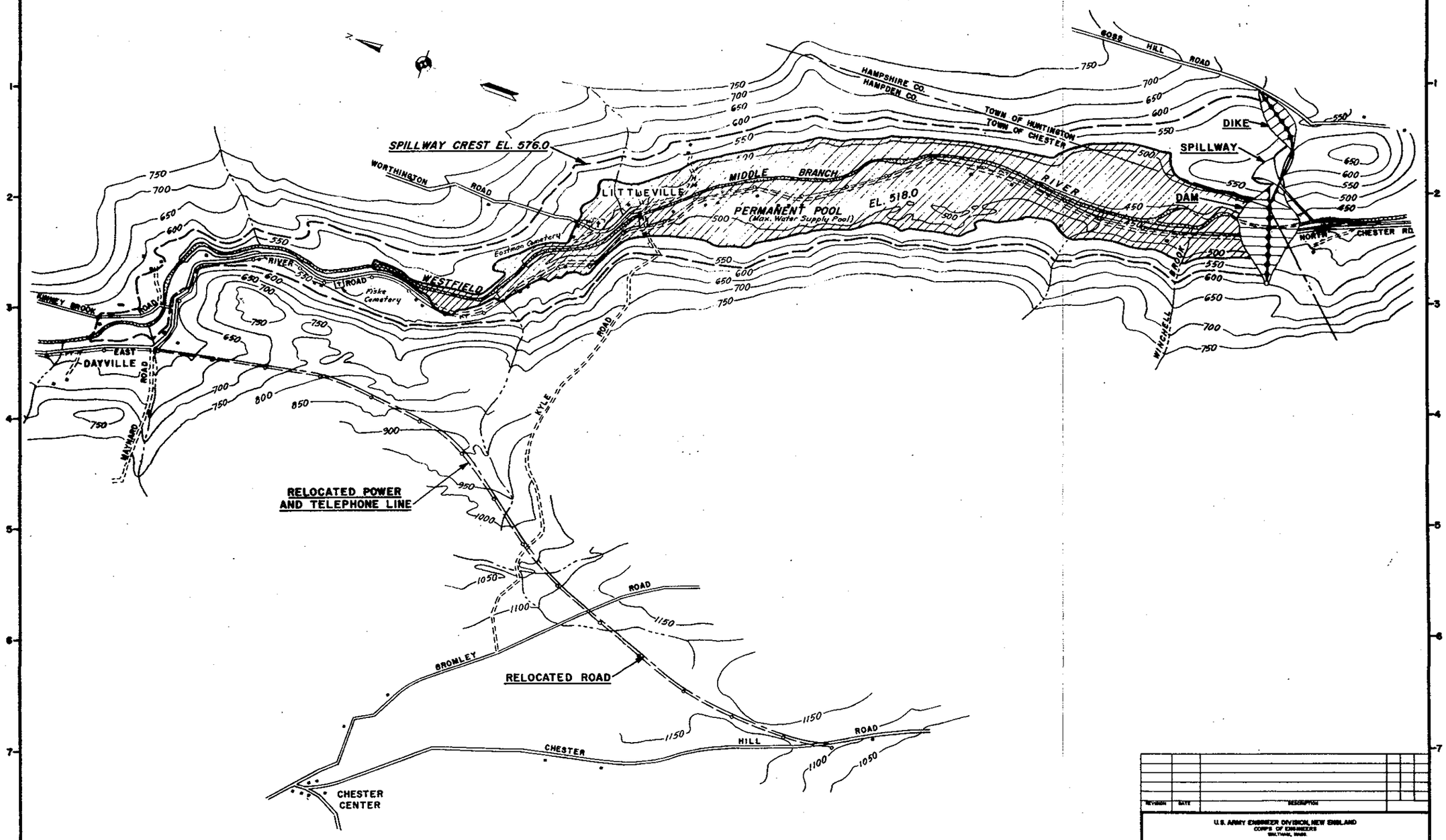
CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD RIVER BASIN
FLOOD DAMAGE CURVES
1965 PRICE LEVEL

APPROVED
CHIEF, ENGINEERING DIVISION
DATE

SCALE
SPEC. NO. CIV. ENG. 19-010-
DRAWING NUMBER
SHEET

PLATE H-10

CORPS OF ENGINEERS — U.S. ARMY



REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J.H. | DE. BY | CH. BY R.N.L.

CONNECTICUT RIVER FLOOD CONTROL

LITTLEVILLE DAM

RESERVOIR MAP

MIDDLE BRANCH WESTFIELD RIVER, MASS.

DATE APRIL 1961

SCALE: 1" = 500' | SPEC. NO. CW. ENG. 19-018-

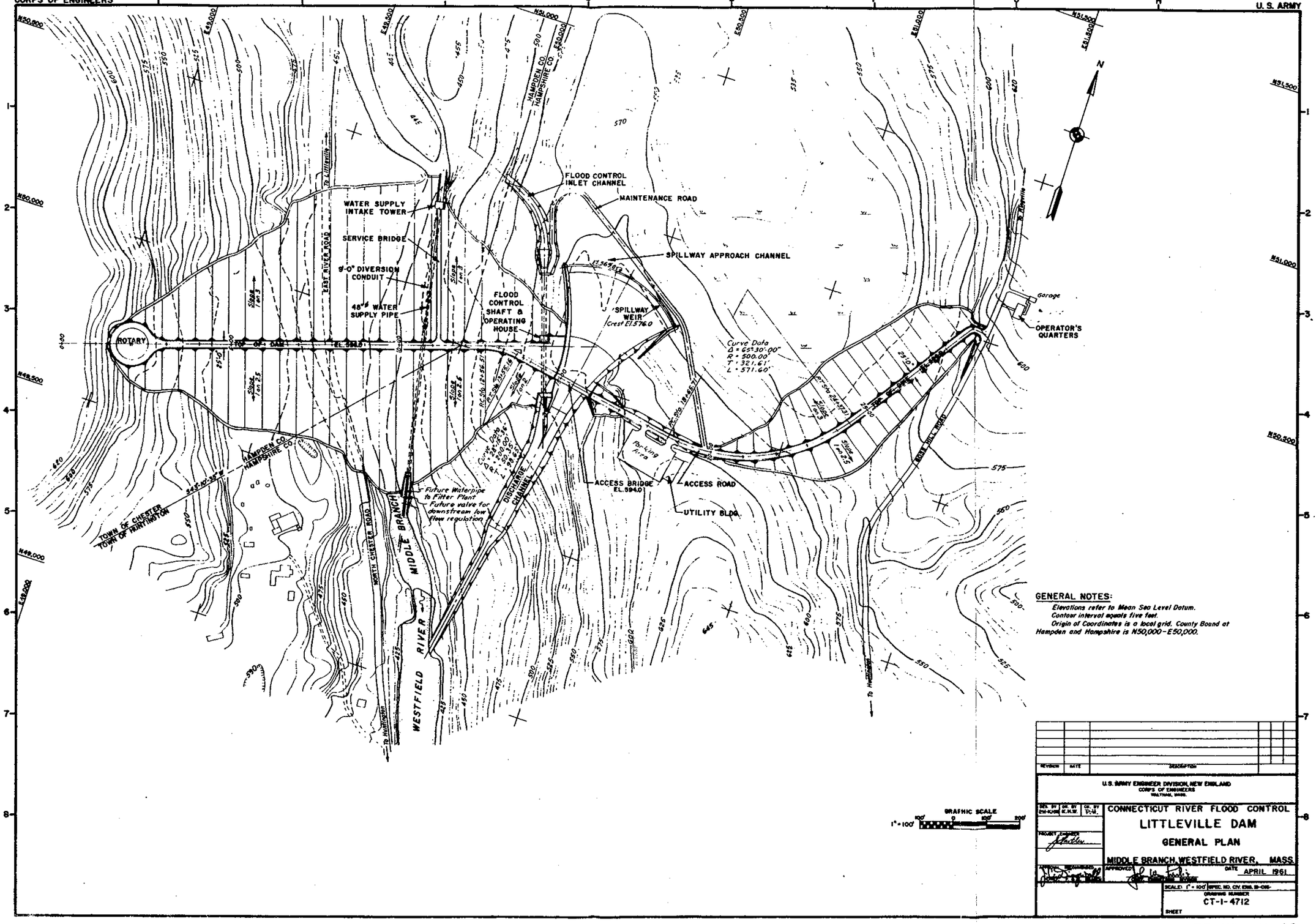
DRAWING NUMBER
CT-1-4711

SHEET

PLATE H-11

CORPS OF ENGINEERS

U. S. ARMY



GENERAL NOTES:

Elevations refer to Mean Sea Level Datum.
Contour interval equals five feet.
Origin of Coordinates is a local grid. County Bound at Hampden and Hampshire is N50,000-E50,000.

GRAPHIC SCALE
1" = 100'

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY EHS-KUHS | DR. BY K.H.M. | CK. BY T.F.W.

CONNECTICUT RIVER FLOOD CONTROL
LITTLEVILLE DAM
GENERAL PLAN
MIDDLE BRANCH WESTFIELD RIVER, MASS.

PROJECT ENGINEER

APPROVED | DATE APRIL 1961

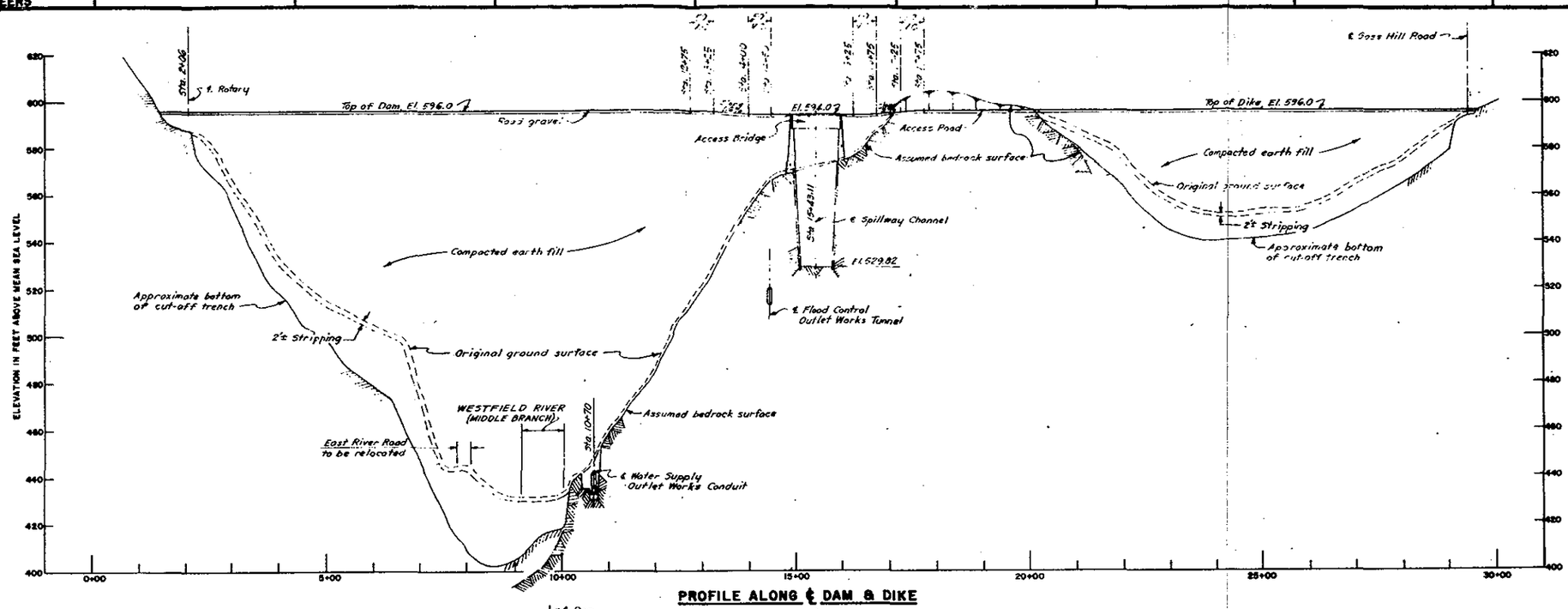
SCALE: 1" = 100' | SPEC. NO. CIV. ENG. 19-065-

DRAWING NUMBER
CT-1-4712

SHEET

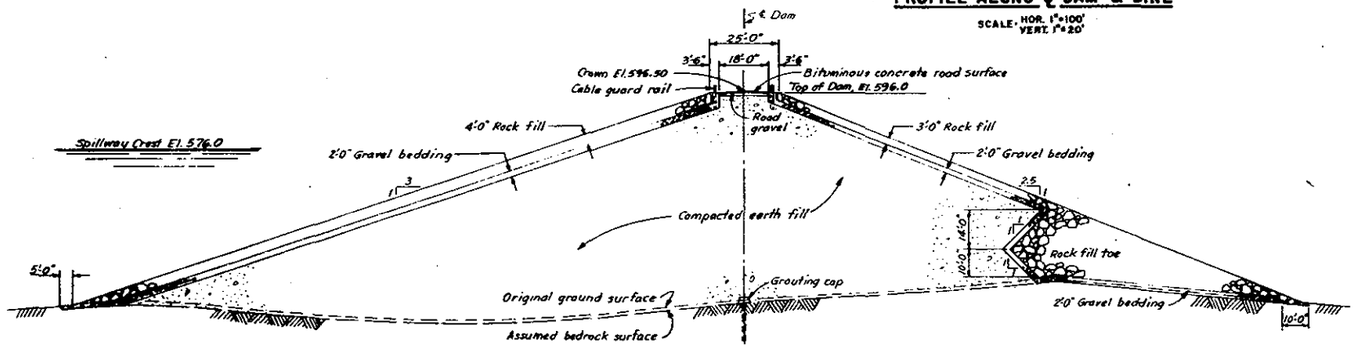
PLATE NO. H-12

CORPS OF ENGINEERS — U. S. ARMY



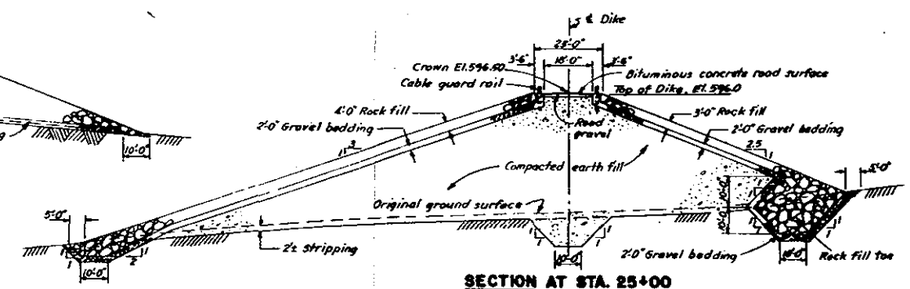
PROFILE ALONG ℄ DAM & DIKE

SCALE: HOR. 1"=100' VERT. 1"=20'



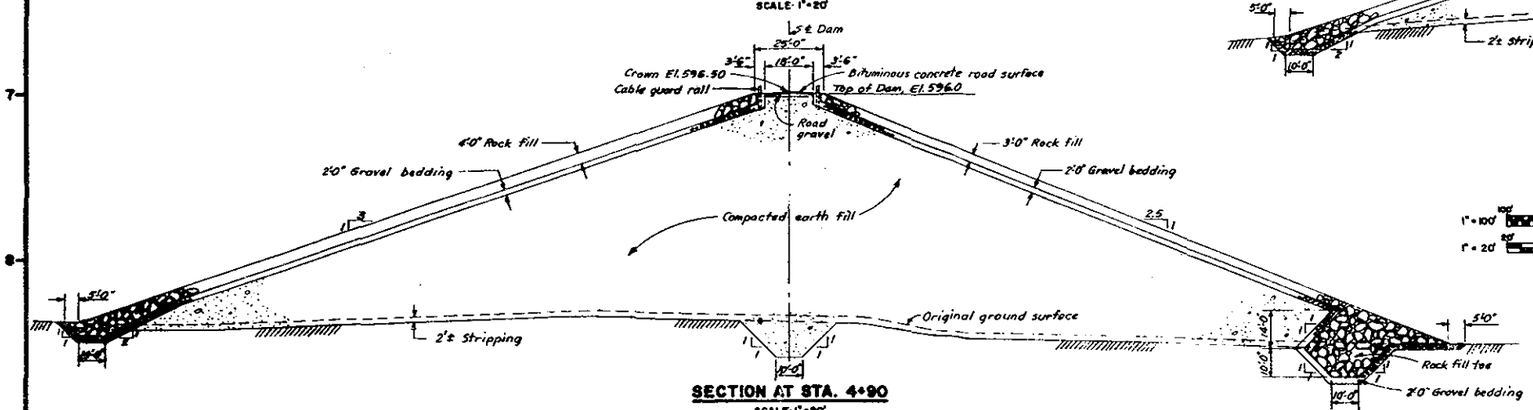
SECTION AT STA. 12+90

SCALE: 1"=20'



SECTION AT STA. 25+00

SCALE: 1"=20'



SECTION AT STA. 4+90

SCALE: 1"=20'

GRAPHIC SCALES

1" = 100'

1" = 20'

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS

CONNECTICUT RIVER FLOOD CONTROL

LITTLEVILLE DAM

DAM AND DIKE

PROFILE AND SECTIONS

MIDDLE BRANCH WESTFIELD RIVER, MASS.

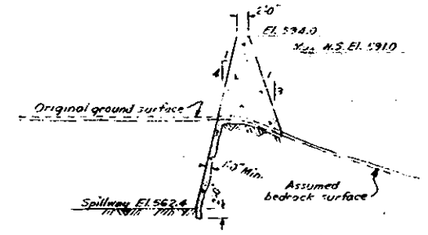
DATE APRIL 1961

CT-1-4713

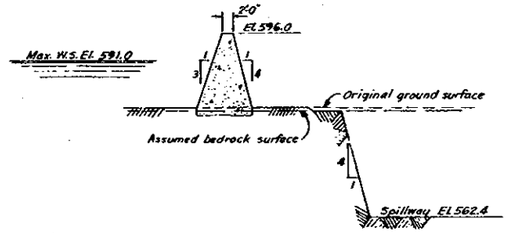
PLATE NO. H-13

CORPS OF ENGINEERS

U.S. ARMY



SECTION A-A
SCALE: 1" = 10'



SECTION B-B
SCALE: 1" = 10'

PLAN
SCALE: 1" = 50'

GRAPHIC SCALES
1" = 50'
1" = 10'

REVISED	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY L.A.B.	DR. BY K.H.W.	CK. BY T.H.

CONNECTICUT RIVER FLOOD CONTROL

LITTLEVILLE DAM
SPILLWAY AND FLOOD CONTROL OUTLET WORKS
PLAN AND SECTIONS
MIDDLE BRANCH, WESTFIELD RIVER, MASS.

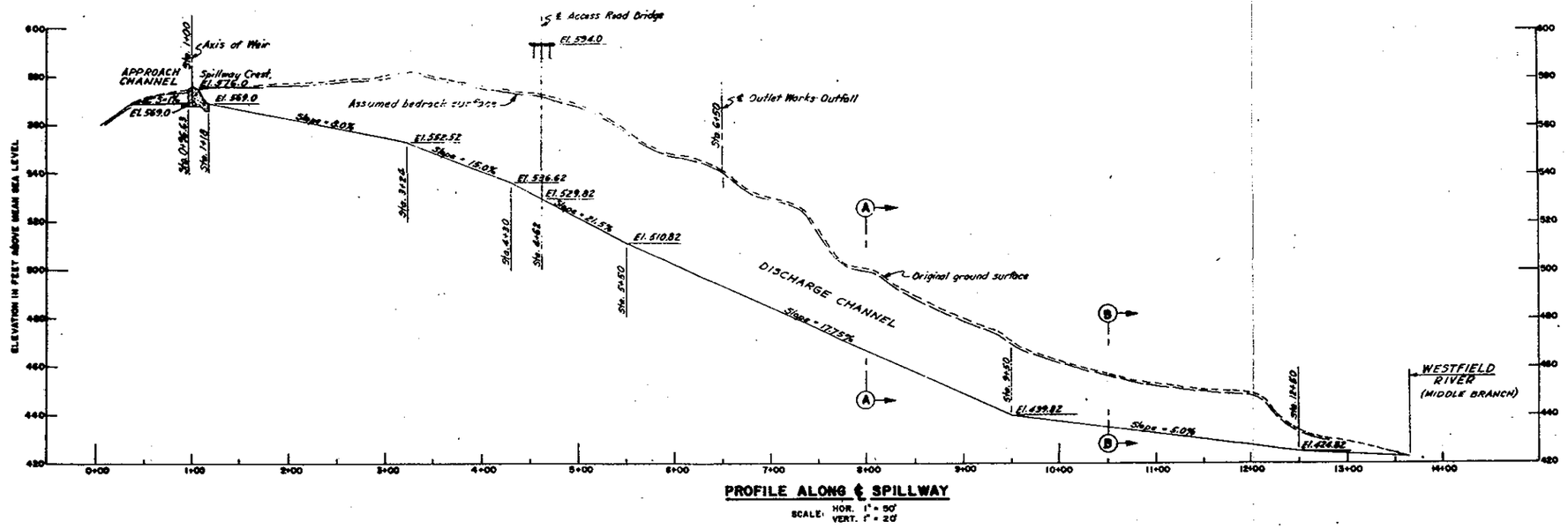
DATE APRIL 1961

DRAWING NUMBER
CT-1-4714

SHEET

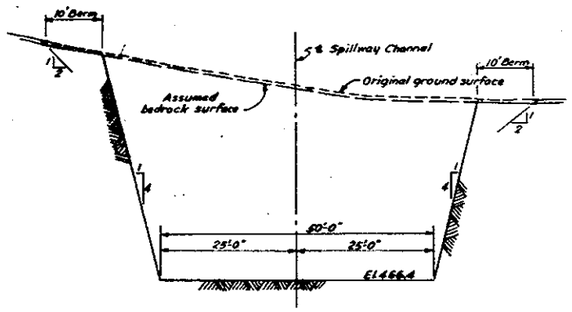
PLATE NO. H-14

CORPS OF ENGINEERS — U.S. ARMY



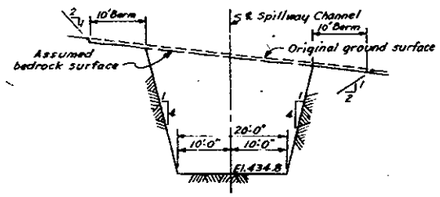
PROFILE ALONG ℄ SPILLWAY

SCALE: HOR. 1" = 50'
VERT. 1" = 20'



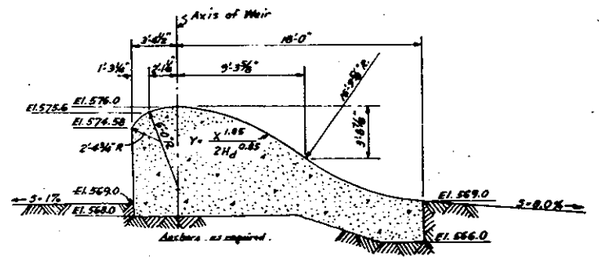
SECTION A-A

SCALE: 1" = 10'



SECTION B-B

SCALE: 1" = 10'



TYPICAL WEIR SECTION

SCALE: 1/4"=1'-0"

NOTE:
For general plan of Spillway, see Plate No. II-5.

GRAPHIC SCALES

1" = 50'
1" = 20'
1" = 10'
1/4" = 1'-0"

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

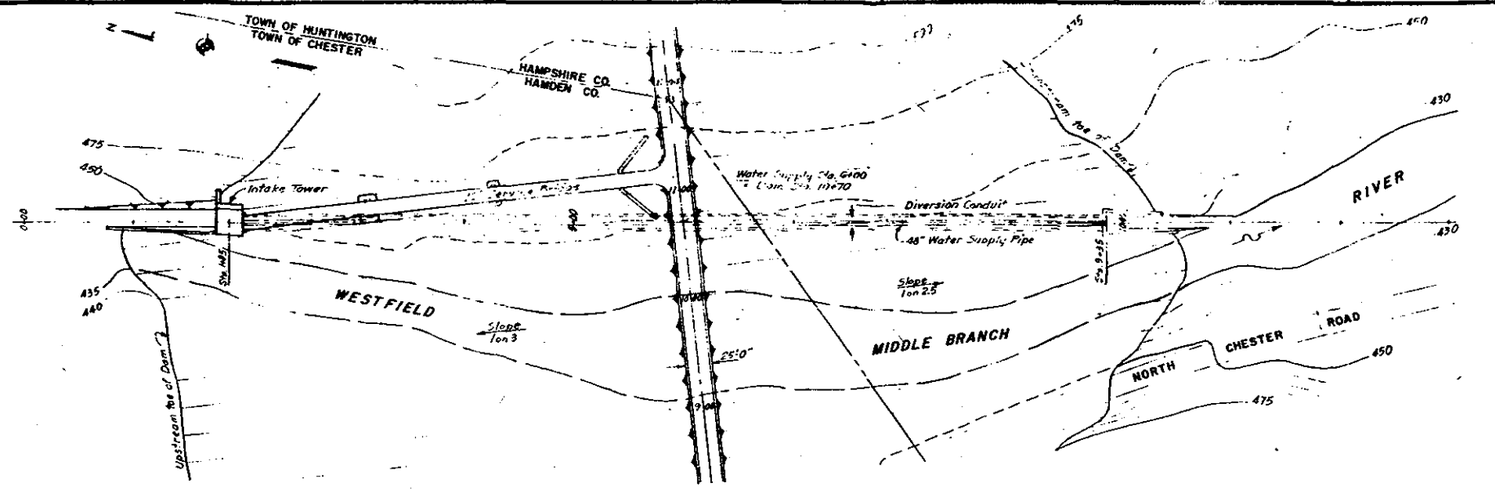
CONNECTICUT RIVER FLOOD CONTROL
LITTLEVILLE DAM
: SPILLWAY
PROFILE AND SECTIONS
MIDDLE BRANCH, WESTFIELD RIVER, MASS.

DATE APRIL 1961

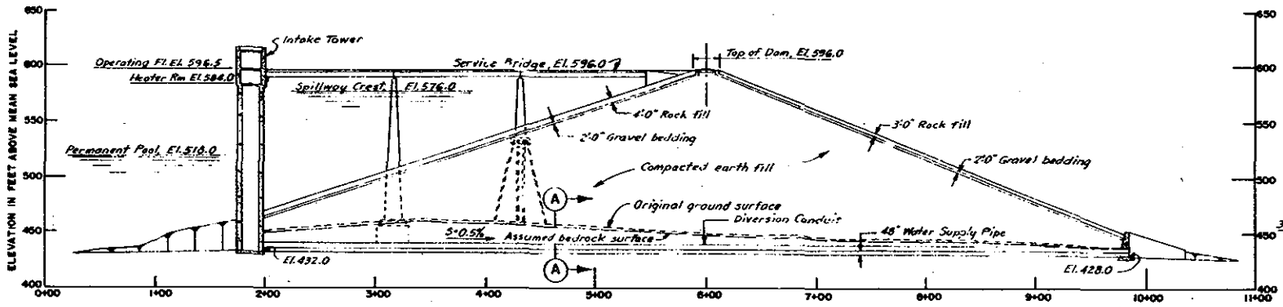
CT-1-4716

PLATE NO. H-15

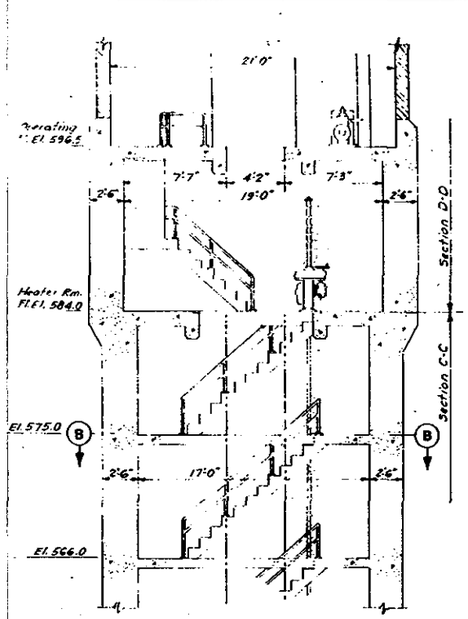
CORPS OF ENGINEERS — U.S. ARMY



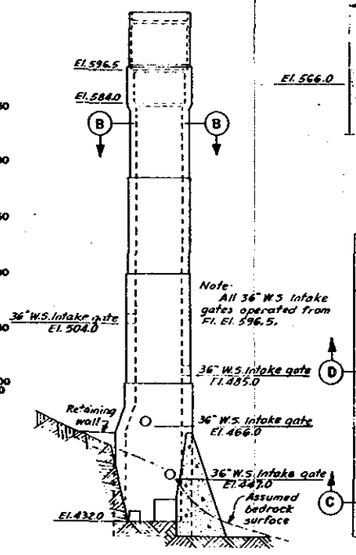
PLAN
SCALE: 1"=50'



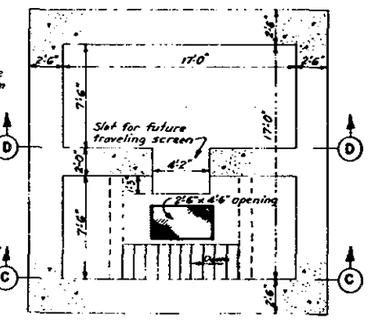
PROFILE ALONG ℄ CONDUIT
SCALE: 1"=50'



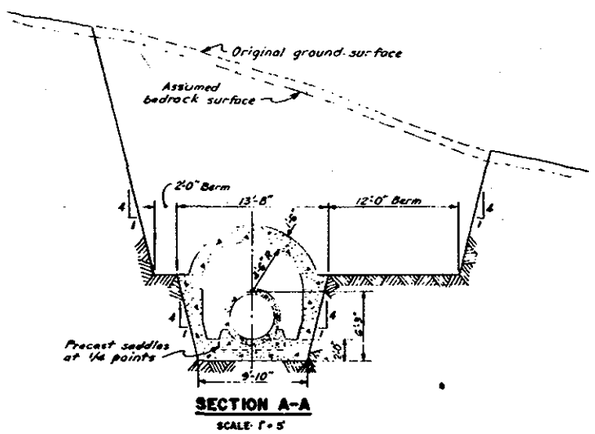
SECTION C-C & D-D
SCALE: 1/4"=1'-0"



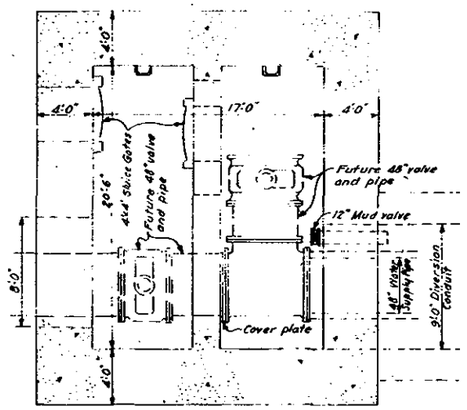
ELEVATION OF INTAKE TOWER
SCALE: 1"=20'



SECTION B-B
SCALE: 1/4"=1'-0"



SECTION A-A
SCALE: 1"=5'



SECTION AT EL. 443.0
SCALE: 1/4"=1'-0"

GRAPHIC SCALES
1"=50'
1"=20'
1"=5'
1/4"=1'-0"

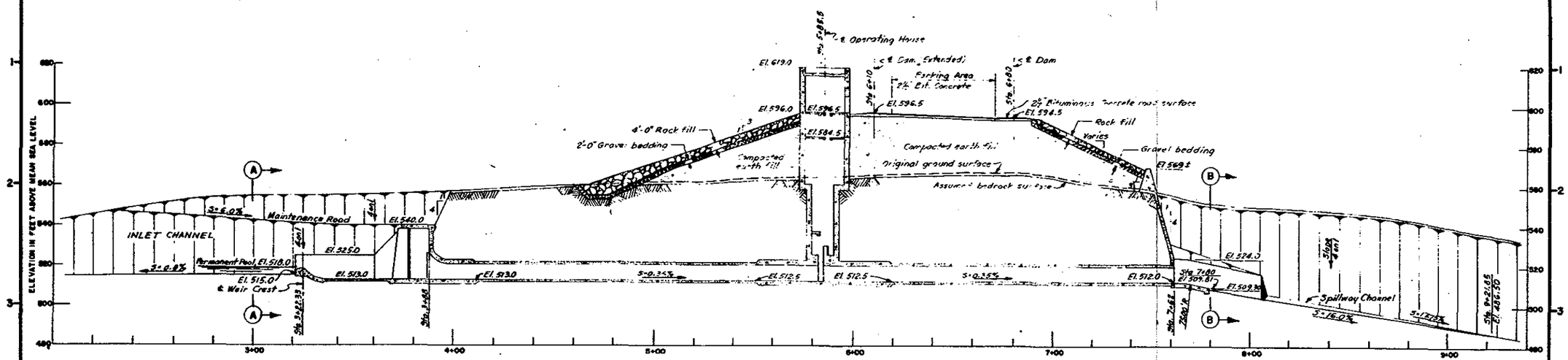
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

CONNECTICUT RIVER FLOOD CONTROL
LITTLEVILLE DAM
WATER SUPPLY OUTLET WORKS
PLAN, PROFILE AND SECTIONS
MIDDLE BRANCH WESTFIELD RIVER, MASS.
DATE APRIL 1961
DRAWING NUMBER CT-1-4717

PLATE NO. H-16

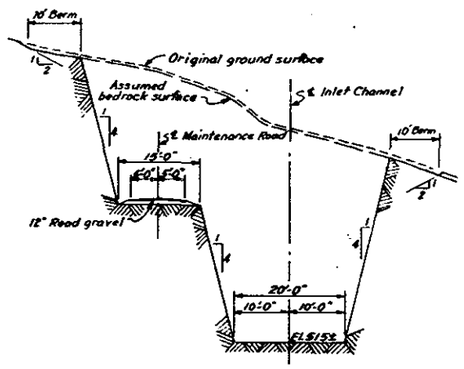
CORPS OF ENGINEERS

U. S. ARMY



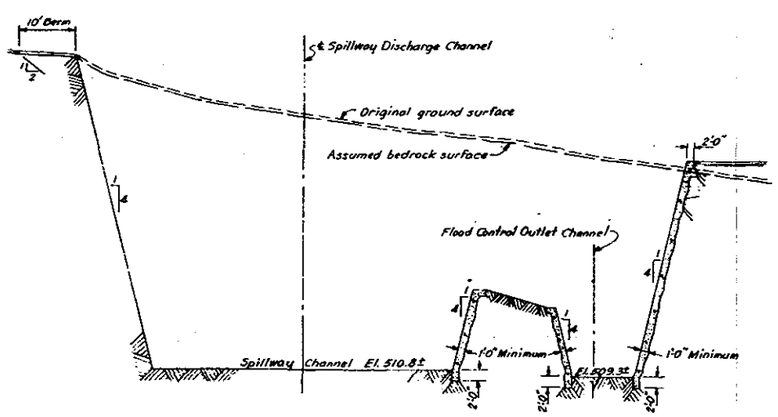
PROFILE ALONG ℄ OUTLET WORKS

SCALE: HOR. 1" = 20'
VERT. 1" = 20'



SECTION A-A

SCALE: 1" = 10'



SECTION B-B

SCALE: 1" = 10'

NOTE:
For general plan of Flood Control Outlet Works see Plate No. II-5.

GRAPHIC SCALES
1" = 20'
1" = 10'

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

CONNECTICUT RIVER FLOOD CONTROL

LITTLEVILLE DAM
FLOOD CONTROL OUTLET WORKS
PROFILE AND SECTIONS
MIDDLE BRANCH, WESTFIELD RIVER, MASS.

DATE APRIL 1961

CT-1-4715

PLATE NO. II-17

CORPS OF ENGINEERS

U.S. ARMY

FLOW LINE AT SPILLWAY CREST EL. 576.0

LIMIT OF LAND OWNED IN FEE

GOSS HILL ROAD

PERMANENT POOL

EL. 518.0 - 275 ACRES

(MAX. WATER SUPPLY POOL)

HUNTINGTON ACCESS AREA

18' ACCESS ROAD (PAVED SURFACE)

DIKE

TO HUNTINGTON

12' MAINTENANCE ROAD (PAVED SURFACE)

SPILLWAY CREST EL. 576.0

UTILITY BUILDING & REST ROOMS

PARKING (36 CARS)

FLOOD CONTROL OUTLET

CONTROL WEIR EL. 518.0

WATER SUPPLY INTAKE TOWER

PARKING (25 CARS)

RESERVE BRIDGE

DAM

WATER SUPPLY OUTLET

MIDDLE BRANCH WESTFIELD RIVER

TURNAROUND

OPERATOR'S QUARTERS

12' MAINTENANCE ROAD (PAVED SURFACE)

TURNAROUND

FLOW LINE AT SPILLWAY CREST EL. 576.0

LIMIT OF LAND OWNED IN FEE

LIMIT OF LAND OWNED IN FEE

LEGEND

FLOW LINE AT SPILLWAY CREST EL. 576.0

LIMIT OF LAND OWNED IN FEE

SCALE IN FEET

200' 0 200' 400'

CONNECTICUT RIVER FLOOD CONTROL

LITTLEVILLE RESERVOIR

MASTER PLAN

GENERAL DEVELOPMENT - LAND ALLOCATION

MIDDLE BRANCH, WESTFIELD RIVER, MASSACHUSETTS

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS. JAN. 1966
SCALE AS SHOWN

PLATE NO. H-18

CORPS OF ENGINEERS

U. S. ARMY

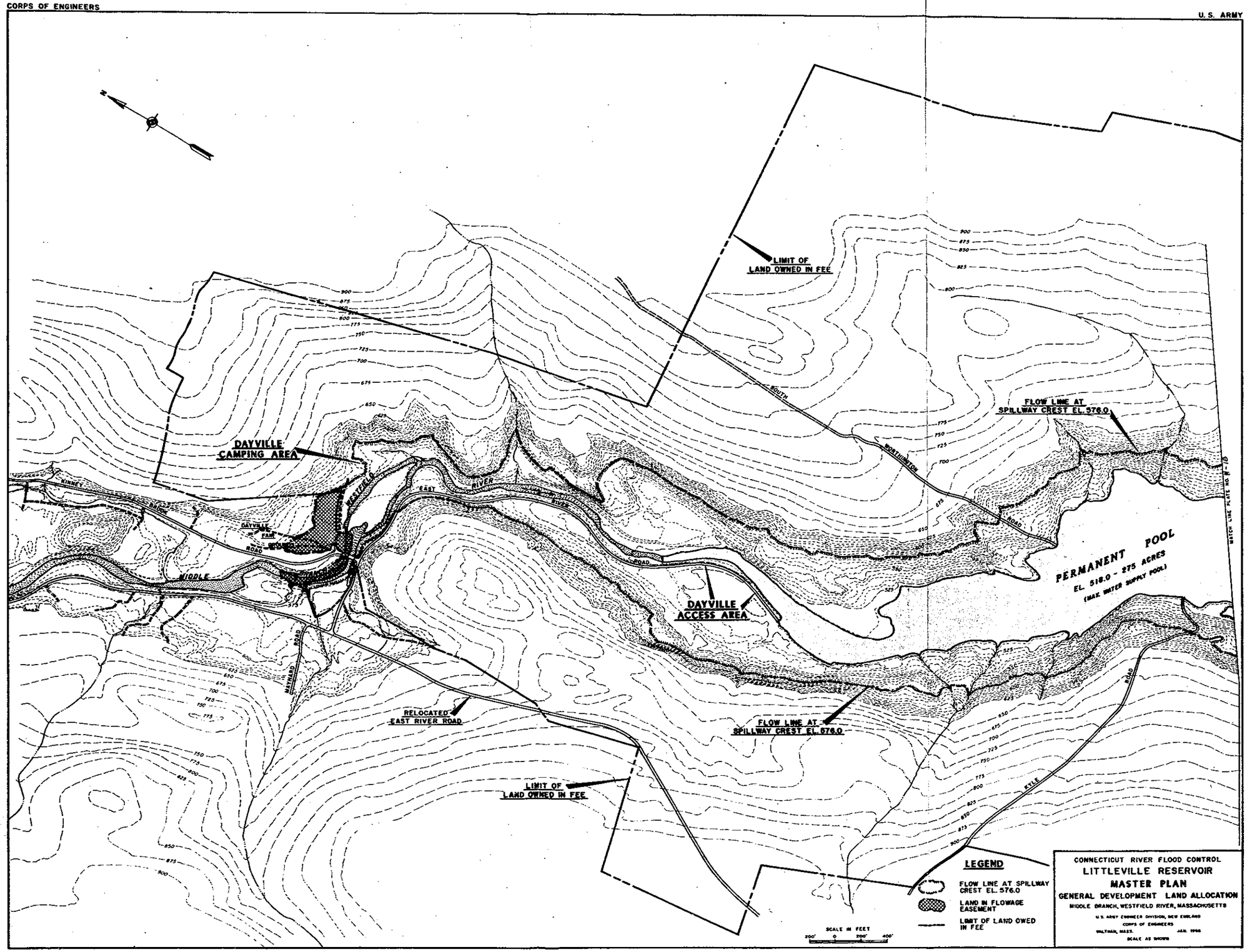
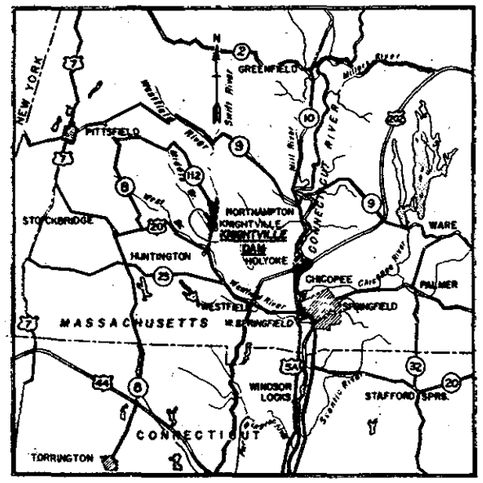


PLATE NO. H-19

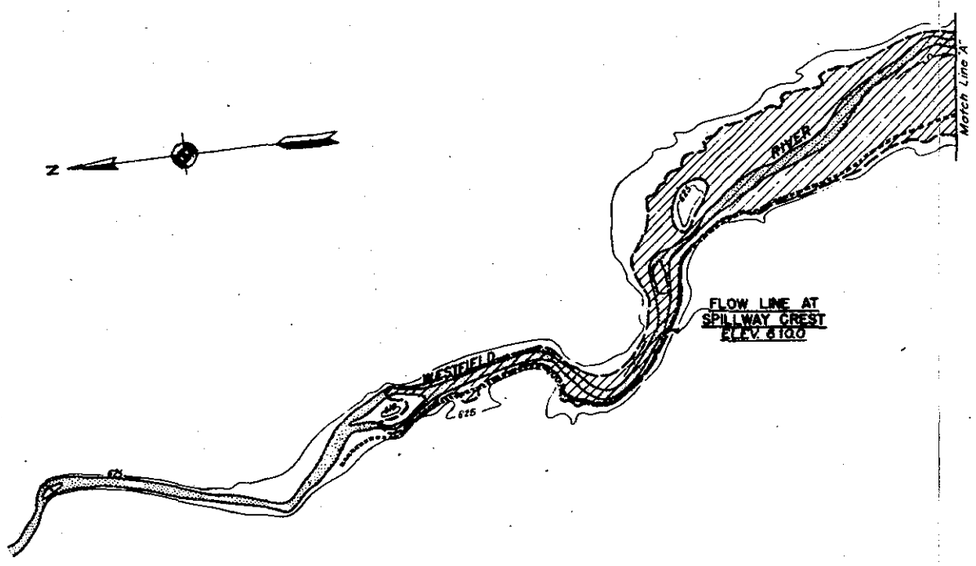
WAR DEPARTMENT

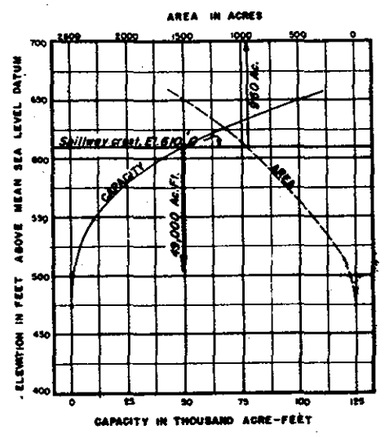
CORPS OF ENGINEERS, U. S. ARMY



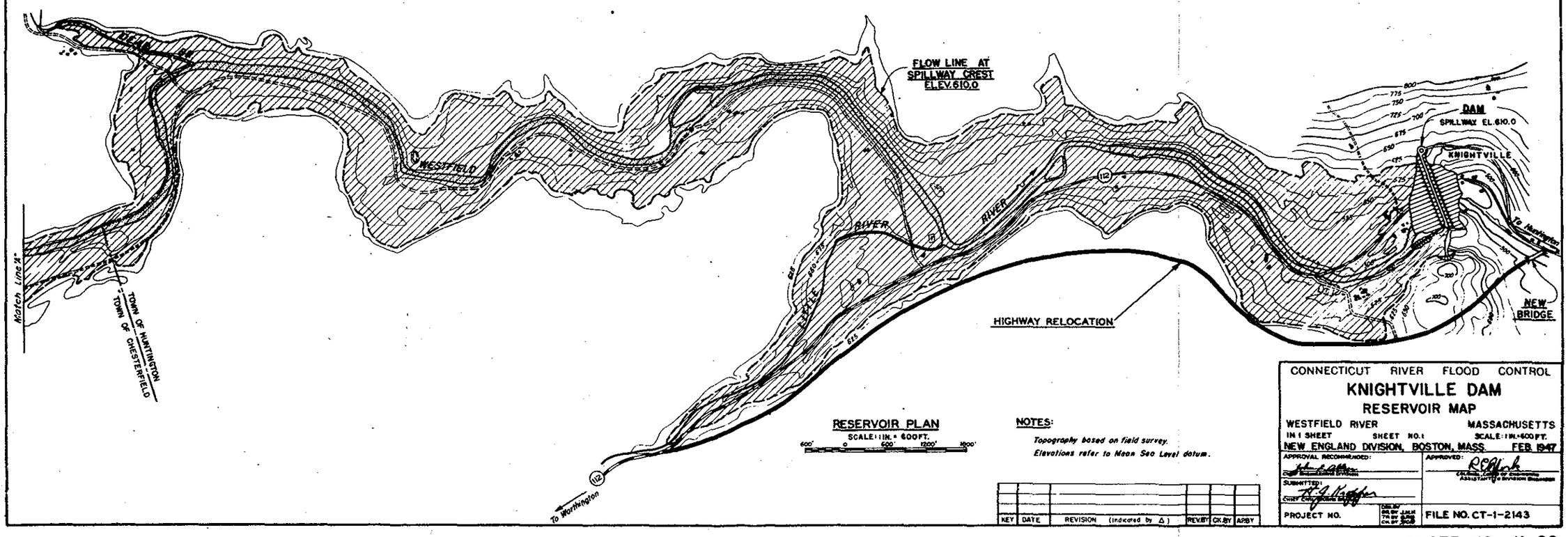
VICINITY MAP

SCALE: 1 IN. = 8 MI.





AREA AND CAPACITY CURVES



RESERVOIR PLAN

SCALE: 1 IN. = 600 FT.

600' 0 600' 1200' 1800'

NOTES:

Topography based on field survey.

Elevations refer to Mean Sea Level datum.

KEY	DATE	REVISION (indicated by Δ)	REV'BY	CK.BY	APP'BY

CONNECTICUT RIVER FLOOD CONTROL

KNIGHTVILLE DAM

RESERVOIR MAP

WESTFIELD RIVER — MASSACHUSETTS

IN 1 SHEET — SHEET NO. 1 — SCALE: 1 IN. = 600 FT.

NEW ENGLAND DIVISION, BOSTON, MASS. — FEB. 1947

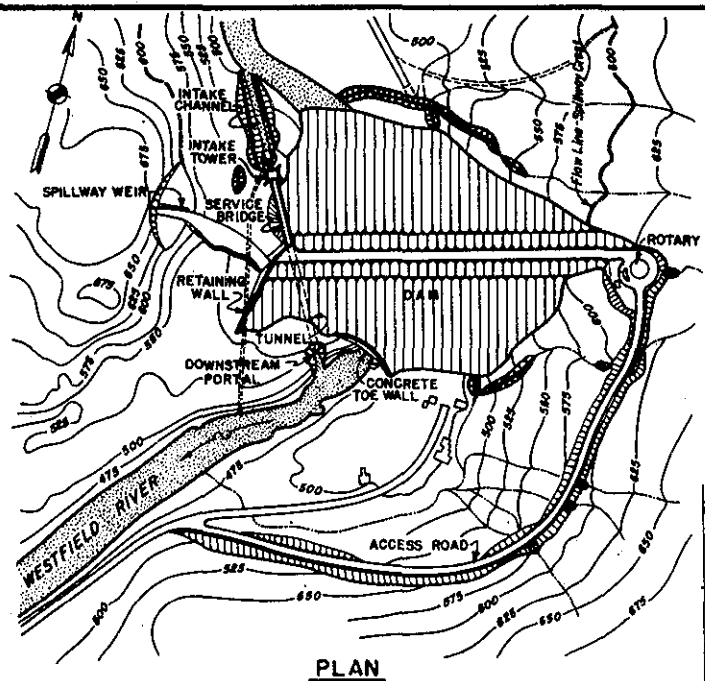
APPROVAL RECOMMENDED: — APPROVED:

SUBMITTED:

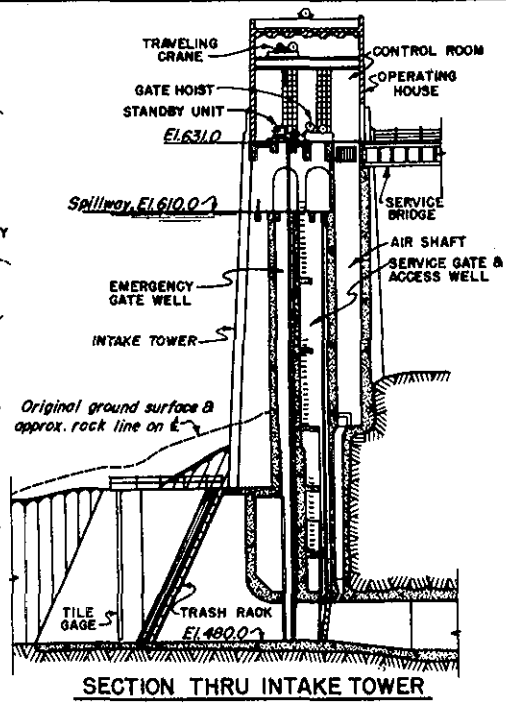
PROJECT NO. — DES. BY — DR. BY — TR. BY — CK. BY

FILE NO. CT-1-2143

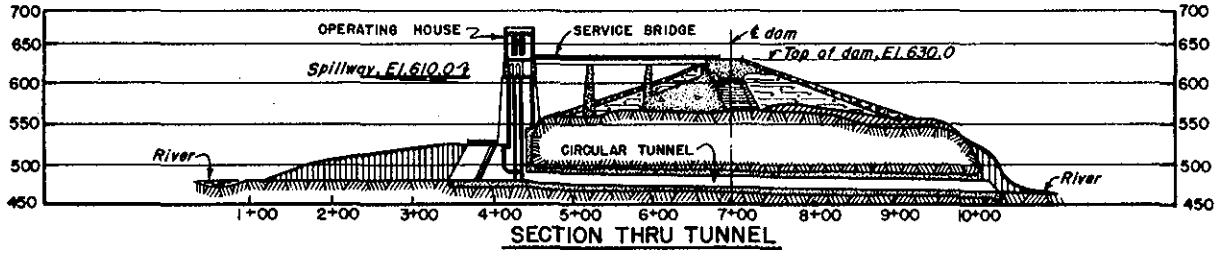
PLATE NO. H-20



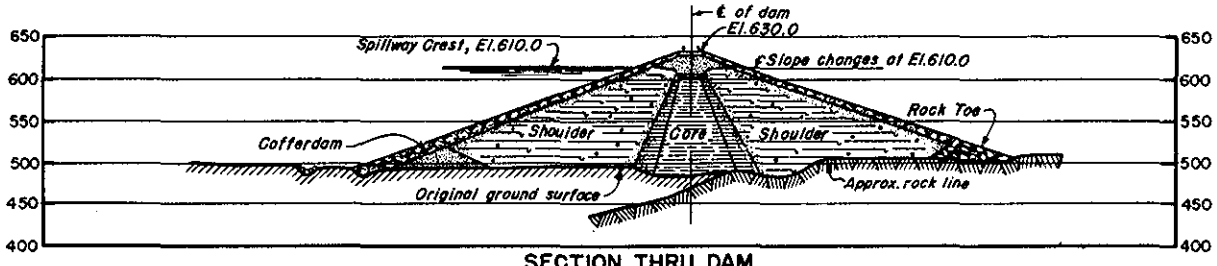
PLAN



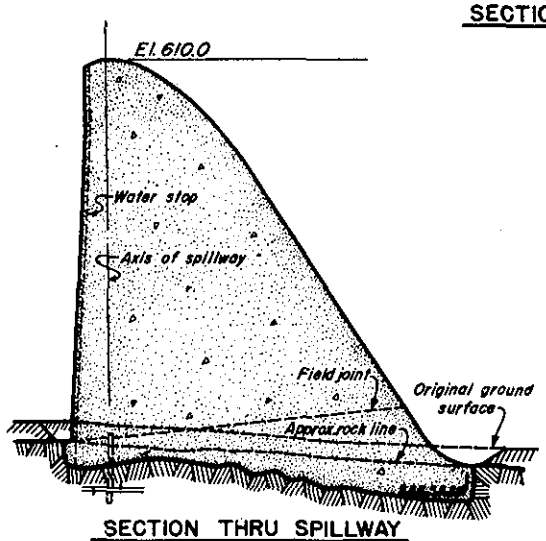
SECTION THRU INTAKE TOWER



SECTION THRU TUNNEL



SECTION THRU DAM



SECTION THRU SPILLWAY

CONNECTICUT RIVER FLOOD CONTROL PROJECTS

KNIGHTVILLE DAM

PLAN AND SECTIONS

JUNE 30, 1950

WESTFIELD RIVER MASSACHUSETTS

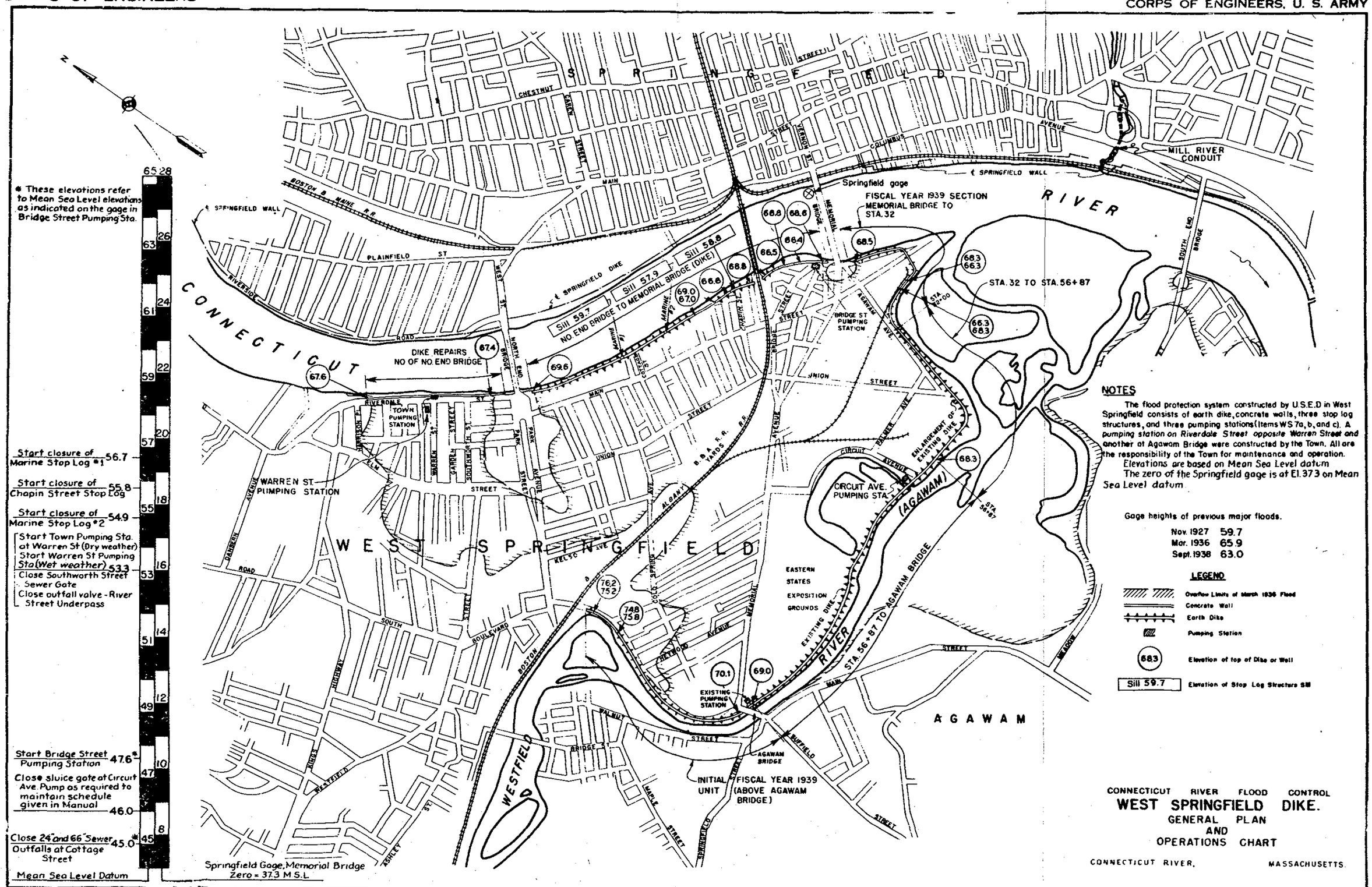
NOT TO SCALE

NEW ENGLAND DIVISION, BOSTON, MASS.

PLATE NO. H-21

CORPS OF ENGINEERS

CORPS OF ENGINEERS, U. S. ARMY



CONNECTICUT RIVER FLOOD CONTROL

WEST SPRINGFIELD DIKE.

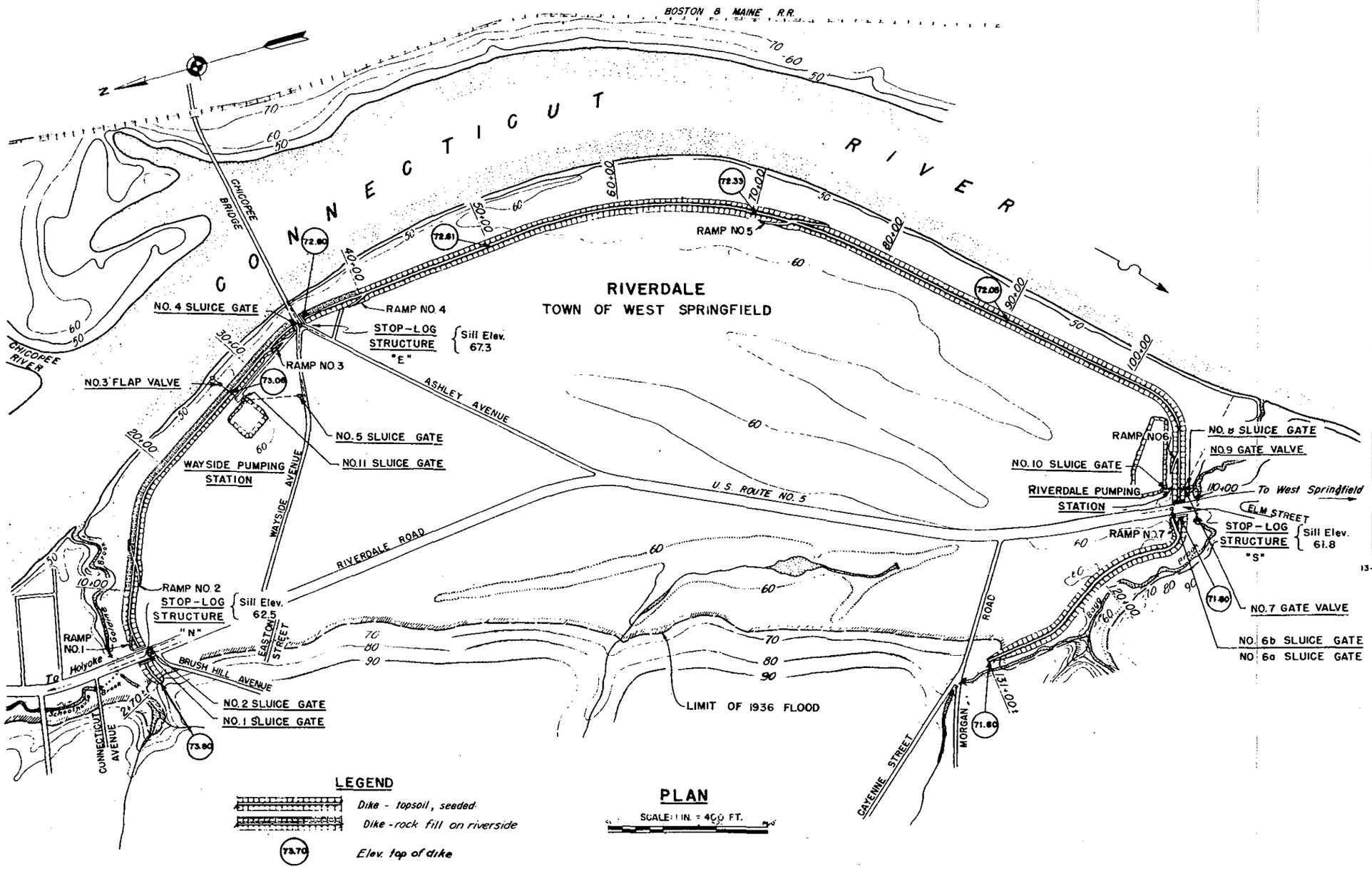
GENERAL PLAN AND OPERATIONS CHART

CONNECTICUT RIVER, MASSACHUSETTS.

PLATE NO. H-22

CORPS OF ENGINEERS

U. S. ARMY



LEGEND

Dike - topsoil, seeded.

Dike - rock fill on riverside

73.70 Elev. top of dike

PLAN

SCALE: 1 IN. = 400 FT.

NOTE

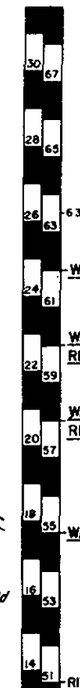
The flood protection system, constructed by the Corps of Engineers for the Riverdale section of West Springfield, consists of an earth dike, three stop-log structures and two pumping stations.

Heights of previous major floods on Springfield Memorial Bridge Gage.

Nov. 1927	22.4
Mar. 1936	28.6
Sept. 1938	25.75

NOTE

Elevations refer to river level recorders at the pumping stations as noted and are based on Mean Sea Level datum.



63.5 WAYSIDE — Close Stop-Log "E"

WAYSIDE — Close No. 1 Sluice gate

WAYSIDE — Complete closure Stop-Log "N"
RIVERDALE — Complete closure Stop-Log "S"

WAYSIDE — Close No.2 Sluice gate; Close east half Stop-Log "N"
RIVERDALE — Close east half Stop-Log "S"

WAYSIDE — Close No.11 Sluice gate; Open No.5 Sluice gate; Close No.4 Sluice gate; Start pumps as required

RIVERDALE — Check No.9 Gate valve for open position; Close No.10 Sluice gate; Check No.8 Sluice gate for open position; Close No.6a Sluice gate; Open No.6b Sluice gate; Start pumps as required; Close No. 7 Gate valve

50.00 MEAN SEA LEVEL

SPRINGFIELD GAGE - MEMORIAL BRIDGE ZERO = 37.27 M.S.L.

MEAN SEA LEVEL ELEVATIONS

As listed on M.S.L. graph above	Corresponding stages at Memorial Bridge & at Bridge St. Pump. Sta.
63.5 WAYSIDE	60.3
62.0 WAYSIDE	59.0
60.0 WAYSIDE	57.3
60.0 RIVERDALE	58.5
58.0 WAYSIDE	55.3
58.0 RIVERDALE	56.5
55.0 WAYSIDE	52.8
51.0 RIVERDALE	50.3

CONNECTICUT RIVER FLOOD CONTROL

RIVERDALE DIKE

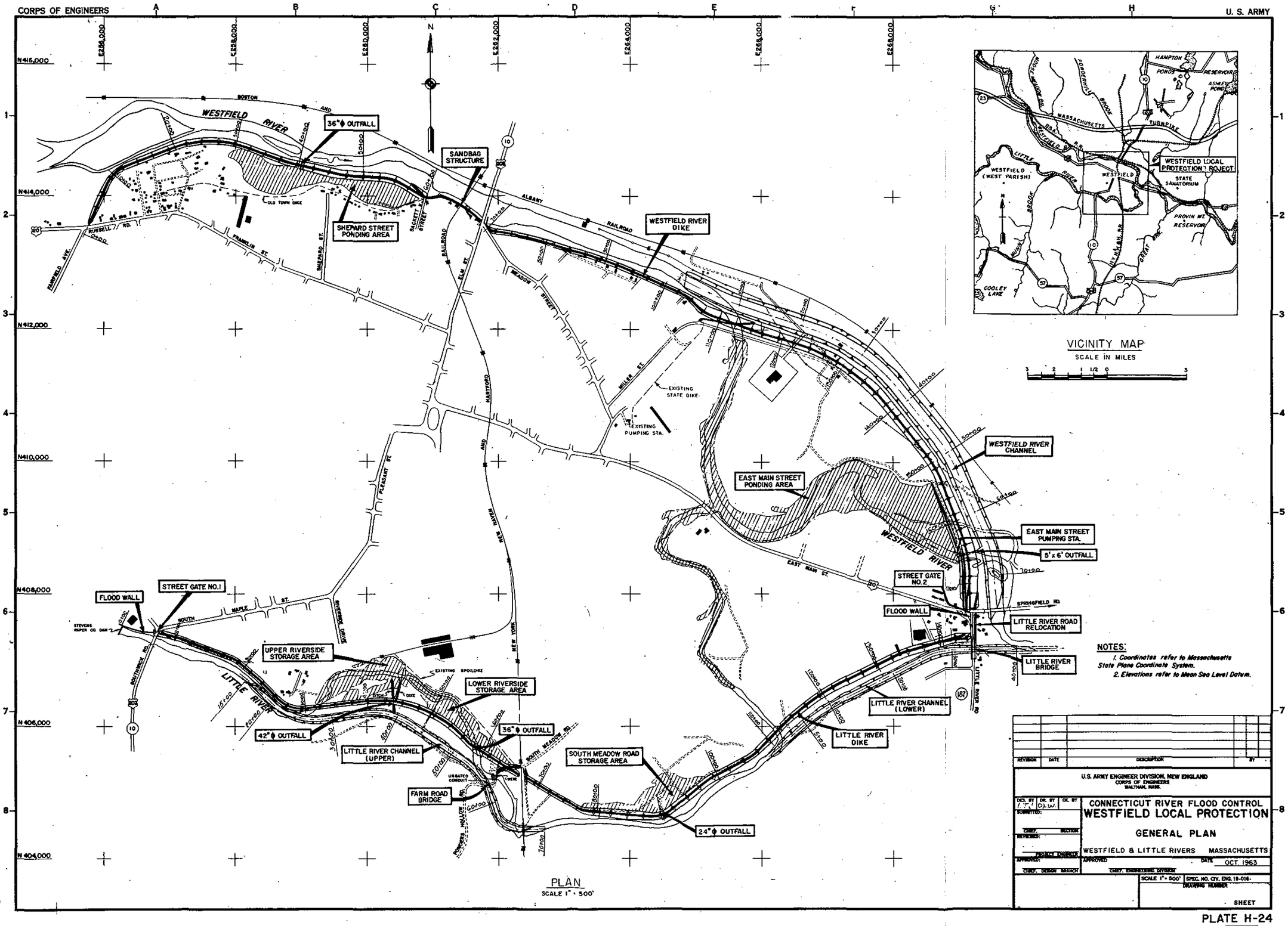
WEST SPRINGFIELD, MASS.

GENERAL PLAN AND OPERATIONS CHART

CONNECTICUT RIVER MASSACHUSETTS

PLATE NO. H-23

CORPS OF ENGINEERS — U. S. ARMY



PLAN
SCALE 1" = 500'

VICINITY MAP
SCALE IN MILES

NOTES:
1. Coordinates refer to Massachusetts State Plane Coordinate System.
2. Elevations refer to Mean Sea Level Datum.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
REVIEWED:
PROJECT ENGINEER
APPROVED:
CHIEF, DESIGN BRANCH

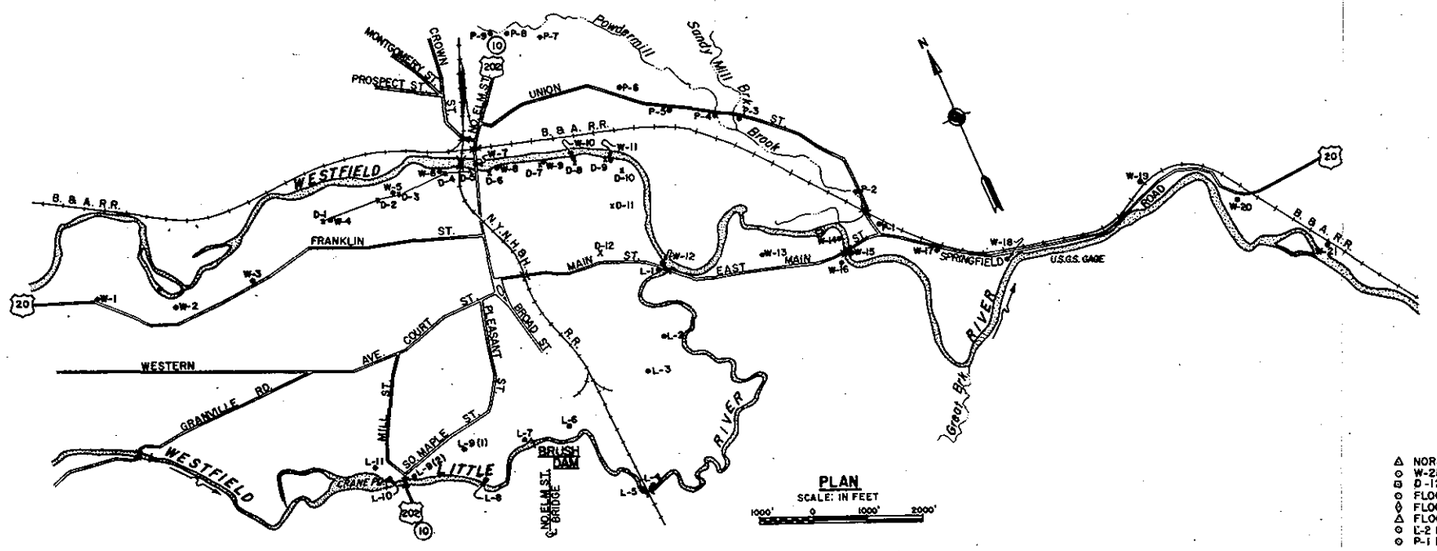
CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD LOCAL PROTECTION
GENERAL PLAN
WESTFIELD & LITTLE RIVERS MASSACHUSETTS
APPROVED DATE OCT. 1963
CHIEF, ENGINEERING DIVISION

SCALE 1" = 500' | SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE H-24

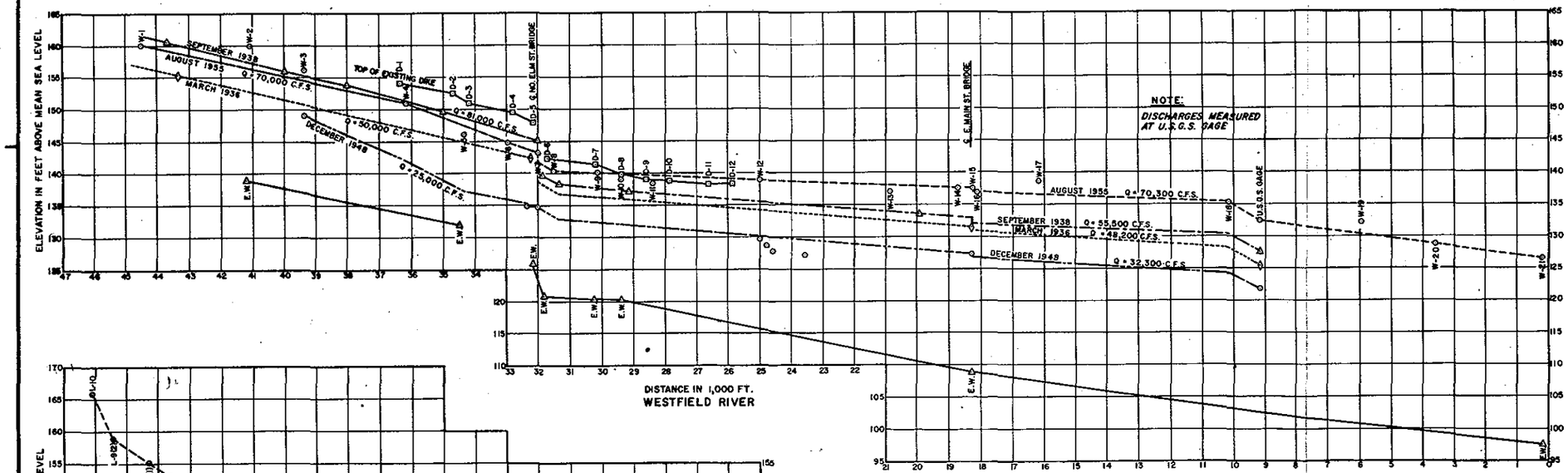
CORPS OF ENGINEERS

U. S. ARMY

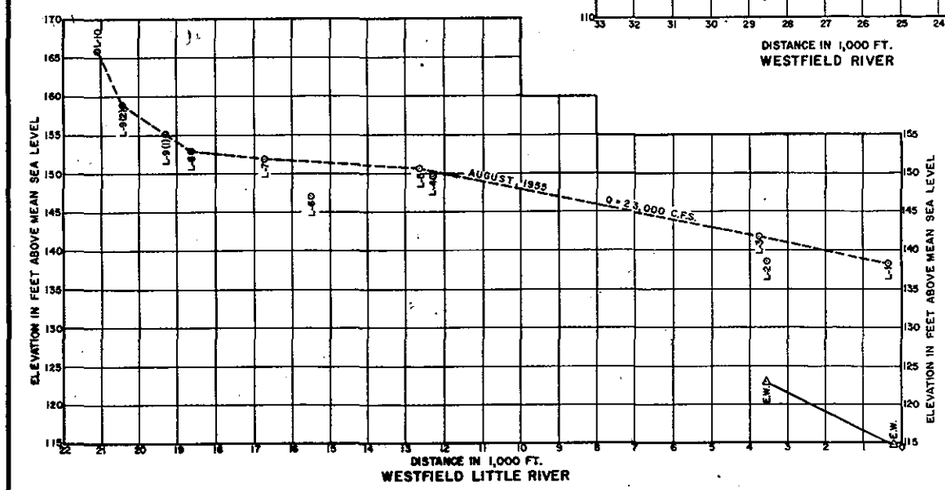


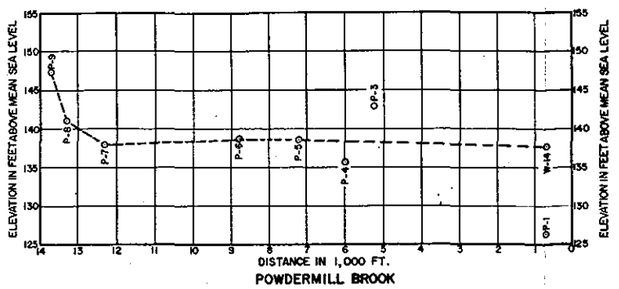
LEGEND

- △ NORMAL LOW WATER
- ○ W-21 FLOOD MARK AUGUST 1955
- ⊡ D-12 EXISTING DIKE ELEVATION
- ○ FLOOD MARK DECEMBER 1948
- ◇ FLOOD MARK MARCH 1936
- △ FLOOD MARK SEPTEMBER 1938
- ○ L-2 FLOOD MARK AUGUST 1955 (LITTLE RIVER)
- ○ P-1 FLOOD MARK AUGUST 1955 (POWDERMILL BROOK)



NOTE:
DISCHARGES MEASURED AT U.S.G.S. GAGE





REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY G.N.D. | CK. BY

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

CHIEF, PLANS & RPTS. BRANCH

CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD LOCAL PROTECTION
FLOOD PROFILES

WESTFIELD & LITTLE RIVERS MASS.

APPROVED DATE

CHIEF ENGINEERS DIV.

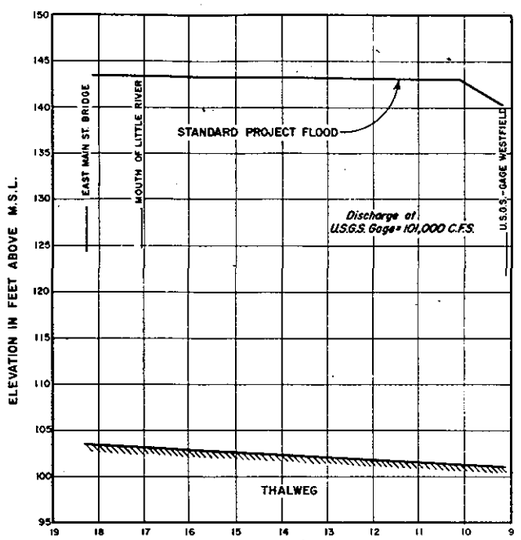
SCALE | SPEC. NO. CIV. ENG.-19-016-
DRAWING NUMBER

SHEET

PLATE H-25

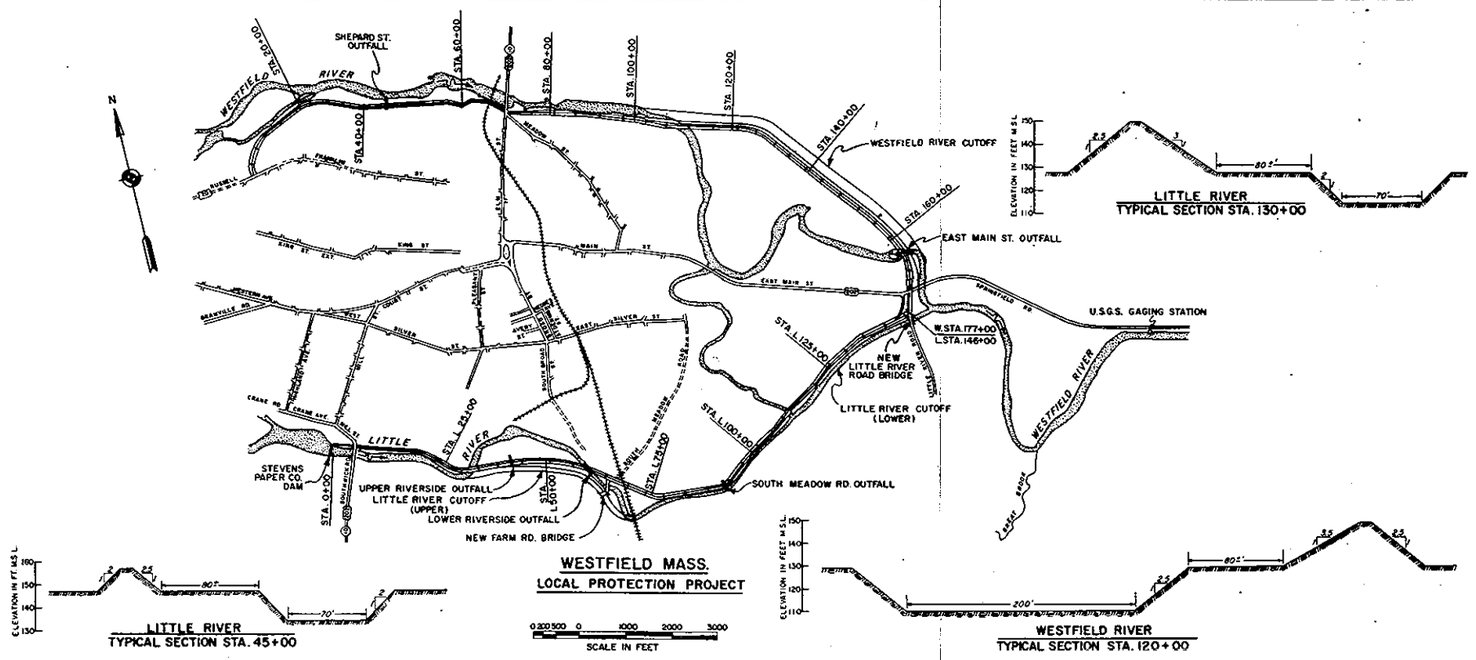
CORPS OF ENGINEERS

U.S. ARMY



WESTFIELD RIVER

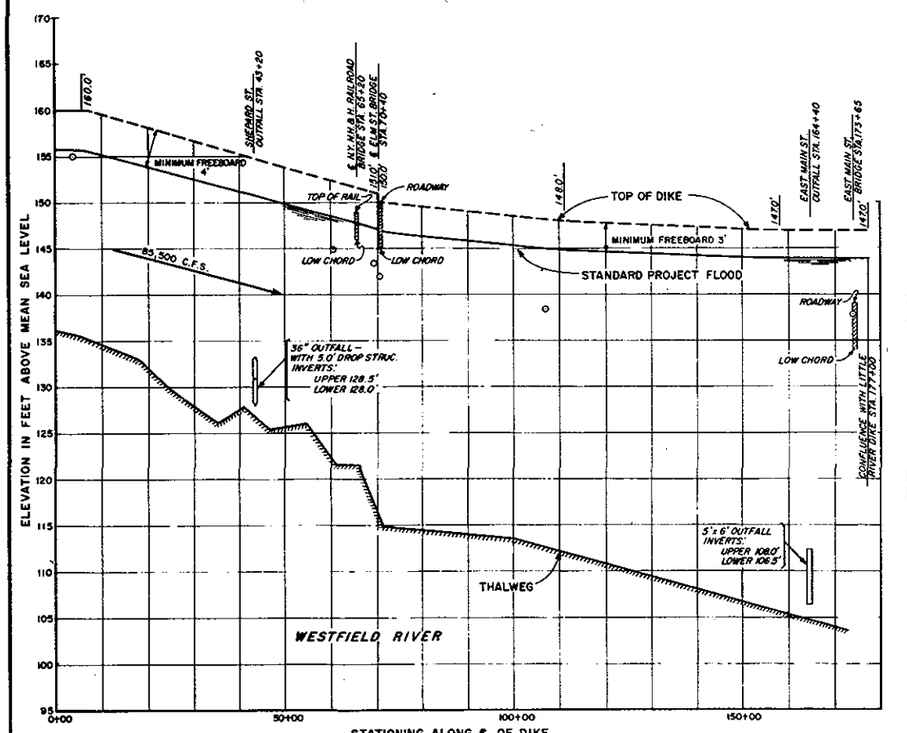
U.S.G.S. GAGE TO EAST MAIN ST. BRIDGE

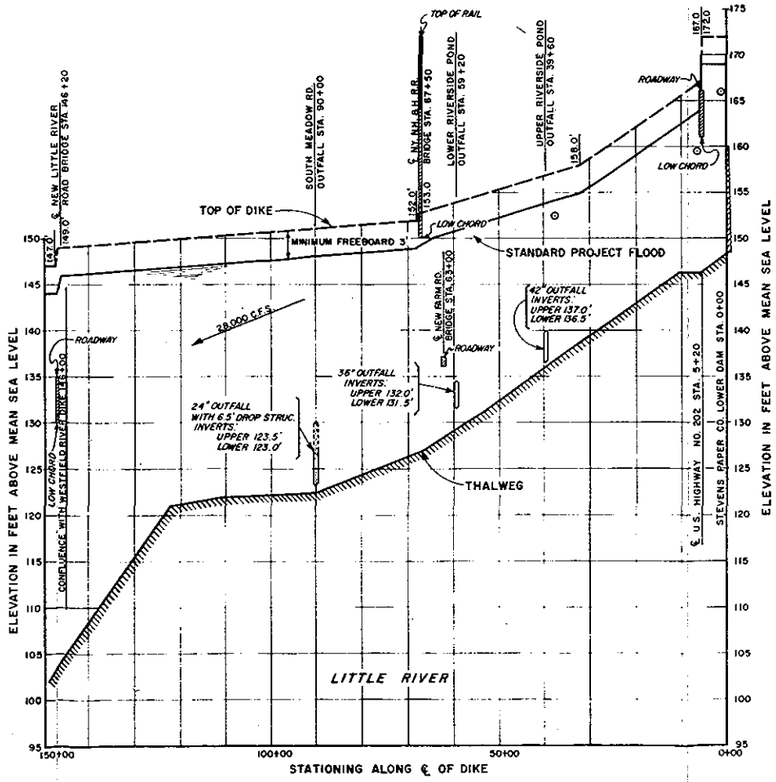


WESTFIELD MASS.

LOCAL PROTECTION PROJECT

SCALE IN FEET





WESTFIELD AND LITTLE RIVER PROFILES

LEGEND

- THALWEG
- STANDARD PROJECT FLOOD PROFILE
- TOP OF DIKE AND/OR FLOOD WALLS
- ⊙ FLOOD OF AUGUST 1955

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY G.H.D. | CK. BY

PROJECT ENGINEER

CHIEF BRANCH

SUBMITTED BY:

CHIEF, PLANN. & RPTS BRANCH

CONNECTICUT RIVER FLOOD CONTROL

WESTFIELD LOCAL PROTECTION PLAN AND PROFILES

WESTFIELD & LITTLE RIVERS MASS.

APPROVED:

CHIEF, ENGINEERING DIVISION

DATE OCTOBER 1963

SCALE: AS SHOWN

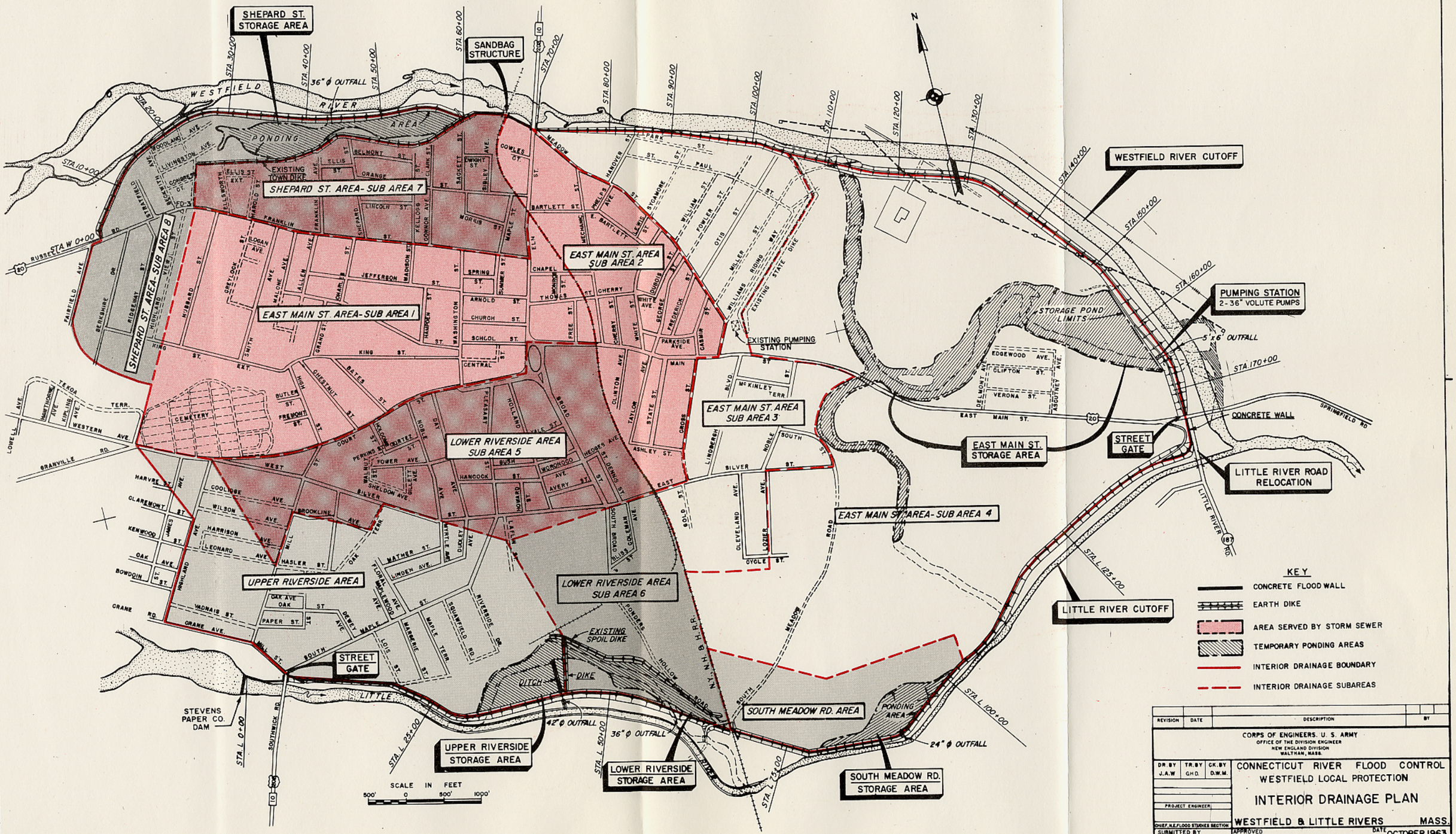
DRAWING NUMBER

SHEET 1 OF 1

PLATE H-26

CORPS OF ENGINEERS

U. S. ARMY



REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
J.A.W	G.H.D.	D.W.M.

PROJECT ENGINEER

CHIEF, N.E. FLOOD STUDIES SECTION
SUBMITTED BY

CHIEF, PLANN. & RPTS. BRANCH

CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD LOCAL PROTECTION

INTERIOR DRAINAGE PLAN

WESTFIELD & LITTLE RIVERS MASS.

APPROVED

CHIEF ENGINEERING DIV.

DATE OCTOBER 1963

TO ACCOMPANY REPORT DATED:

SCALE: 1" = 500'

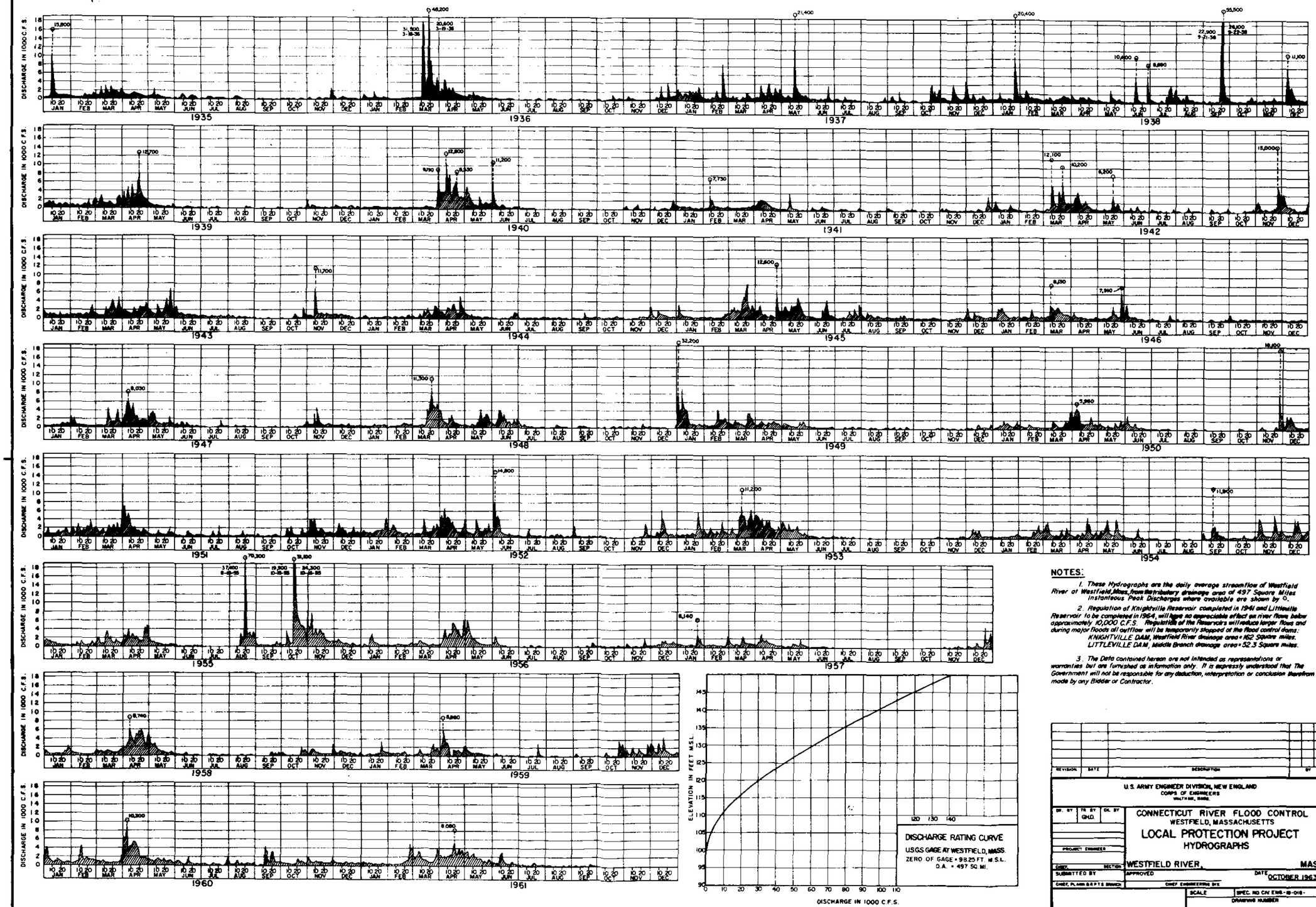
DRAWING NUMBER

SHEET 1 OF 1

PLATE H-27

CORPS OF ENGINEERS

U. S. ARMY



NOTES:

1. These Hydrographs are the daily average streamflow of Westfield River at Westfield, Mass. from the tributary drainage area of 497 Square Miles Instantaneous Peak Discharges where available are shown by ○.

2. Regulation of Knightville Reservoir completed in 1941 and Littleville Reservoir to be completed in 1964, will have an appreciable effect on river flows below approximately 10,000 C.F.S. Regulation of the Reservoirs will reduce larger flows and during major floods all outflow will be temporarily stopped at the flood control dams:
KNIGHTVILLE DAM, Westfield River drainage area = 162 Square miles.
LITTLEVILLE DAM, Middle Branch drainage area = 52.3 Square miles.

3. The Data contained hereon are not intended as representations or warranties but are furnished as information only. It is expressly understood that The Government will not be responsible for any deduction, interpretation or conclusion therefrom made by any Bidder or Contractor.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR BY	CK. BY
	GHD	

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

CHIEF, PLANS & RPTS BRANCH

CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD, MASSACHUSETTS
LOCAL PROTECTION PROJECT
HYDROGRAPHS
WESTFIELD RIVER, MASS.

APPROVED

DATE OCTOBER 1963

CHIEF ENGINEERING DIV.

SCALE

SPEC. NO CIV ENG-19-016-

DRAWING NUMBER

SHEET

PLATE H-28

ATTACHMENT I

RESERVOIR REGULATION

ATTACHMENT I

TABLE OF CONTENTS

LIST OF TABLES

ATTACHMENT I

LIST OF PLATES

Plate No.	Title
H-I-1	Organization Chart
H-I-2	Standard Operating Procedures
H-I-3	Guide Charts for Reservoir Regulation
H-I-4	Regulation Guide Curves for Flood Control
H-1-5	Littleville Reservoir Area and Capacity Curves
H-I-6	Littleville Reservoir Inflow Curves
H-I-7	Littleville Dam Outlet Rating Curves for Flood Gates
H-I-8	Littleville Reservoir Spillway Rating Curve
H-I-9	Littleville Reservoir Percent Storage Curve
H-I-10	Littleville Dam Outlet Rating Curves for Water Supply
H-1-11	Knightville Reservoir Area and Capacity Curves
H-I-12	Knightville Reservoir Curves for Determination of Inflow
H-I-13	Knightville Dam Outlet Rating Curves
H-I-14	Knightville Reservoir Spillway Rating Curve
H-I-15	Knightville Reservoir Percent Storage Curve
H-I-16	Westfield River Rating Curves
H-I-17	Connecticut River Rating Curves
H-I-18	Westfield River, Westfield, Mass. Stage Discharge Table

ATTACHMENT I (Cont.)

Plate No.	Title
H-I-19	West Branch Westfield River at Huntington, Mass. Stage Discharge Table
H-I-20	Middle Branch Westfield River at Goss Heights, Mass. Stage Discharge Table
H-I-21	Westfield River at Knightville, Stage Discharge Table
H-I-22	Connecticut River Stage Discharge Table

Sheet No.	
H-I-1	Log of Radio Reports - NED Form 477
H-I-2	Log of Reports & Instructions - NED Form 503
H-I-3	Gate Operation Record - NED Form 90

ATTACHMENT I

RESERVOIR REGULATION

1. ORGANIZATION

The Reservoir Regulation Section is responsible for regulation of the flood control reservoirs in the New England area. In the New England Division the Hydrology and Hydraulics Branch of the Engineering Division also functions as the Reservoir Regulation Section. In addition to its regular flood control duties, the Reservoir Regulation Section is also responsible for (a) monthly reports on reservoir regulations; (b) continuing studies of regulation procedures; (c) analyses of actual flood operations; (d) the establishment of data gathering and reporting network; (e) maintenance of hydrologic equipment; and (f) the training of personnel. The supervision of routine operations and maintenance activities comes under the jurisdiction of the Maintenance Branch of the Operations Division. An organization chart for reservoir regulation in the New England Division is shown on Plate H-I-1.

The Reservoir Regulation Section is subdivided into basin units, each responsible for receiving routine hydrometeorological reports and directing reservoir regulation within an assigned river basin. Each unit consists of a regulator in charge of the over-all operation in the basin, and project regulators who receive reports and issue regulation instructions to individual dams either from NED headquarters during normal work-hours or from their homes during nonwork-hours.

Whenever emergency conditions so require, the Reservoir Regulation Section staffs NED headquarters and the regulation units are organized to assure 24-hour operation as long as the emergency exists.

2. INSTRUCTIONS TO OPERATORS

All instructions to operators for regulation of the flood control reservoirs are given directly by the Reservoir Regulation Section with advisories forwarded to the Operations Division. When the flood control dam operators are unable to communicate with the Reservoir Regulation Section and the circumstances require immediate action, the Littleville operator has full authority and responsibility to promptly regulate the reservoirs in accordance with Emergency Operation Procedures (EOP), described in paragraph 19. Standard Operating Procedures and Guide Charts are shown on Plates H-I-2 and H-I-3.

3. COMMUNICATIONS

All communications between the flood control dam operator and the Reservoir Regulation Section are made via the NED radio network during normal work-hours or when NED headquarters is otherwise manned. Whenever the radio system is inoperative, communications are made by telephone. During the nonwork-hours, reports and regulation instructions are issued by telephone to or from the homes of the Reservoir Regulation Section personnel. The Littleville operator relays all information from both dams to the basin regulator whenever circumstances warrant a telephone report. In his absence the Knightville operator relays the pertinent information. A telephone directory is maintained and issued by the Reservoir Regulation Section for its specific use during flood operations. In the event of failure of the NED radio network and telephone service, emergency communications are attempted through State Police and Civil Defense radio facilities.

4. PRECIPITATION REPORTING NETWORK

In the Westfield River basin, reports of precipitation data are used primarily for the purpose of alerting regulation personnel and provide a basis for forecasting the severity of a storm. The River Forecast Center at Windsor Locks, Connecticut receives reports from USWB precipitation stations in the Westfield River basin which are made available to the RRS. In turn, the USWB data is supplemented by precipitation reports from Littleville and Knightville Reservoirs. The locations of the USWB and NED precipitation networks are shown on Plate H-2.

5. RIVER REPORTING NETWORK

a. Westfield River. The streamflow network for the Westfield River basin presently consists of USGS gaging stations at Westfield on the Westfield, at Knightville on the Westfield, at Goss Heights on the Middle Branch and at Huntington on the West Branch. All of these gages are either "telemark"-equipped and can be read remotely by telephone or read by a remote recorder at one of the dams. Records are also maintained of flows in the Little River at the outlet of Cobble Mountain Reservoir. The recording stations and their respective drainage areas are shown on Plate H-2 and are described in the following paragraphs. Rating curves are shown on Plate No. H-I-16.

(1) Westfield River near Westfield, Massachusetts. The USGS gaging station near Westfield is the primary gage of the Westfield River basin and measures run-off from 497 square miles of the total 517 square mile watershed of the basin. The gage is located on the left bank of the Westfield River, 0.7 mile downstream of the mouth of Great Brook and 3 miles east of the city of Westfield. The gage has been in operation almost continuously since 1914 and is telemark equipped.

(2) West Branch Westfield River at Huntington, Massachusetts. The USGS gage at Huntington is located on the left bank of the West Branch, 0.4 mile downstream from Roaring Brook and 1.5 miles upstream from the mouth. This gage records the run-off from 93.7 square miles or practically the entire contribution of the West Branch to the Westfield River. The gage has been in operation since September 1935. This gage is presently read at Knightville by a remote recorder.

(3) Middle Branch, Westfield River, Goss Heights, Massachusetts. The USGS gage at Goss Heights is located on the right bank of the Middle Branch on the upstream side of the highway bridge at Goss Heights, 0.35 mile upstream from the mouth and 1.7 miles north of Huntington, Massachusetts. This gage records the run-off from the Middle Branch drainage area of 52.6 square miles, of which 52.3 miles are controlled by the Littleville Reservoir. This gage has been in operation since July 1910. It is presently telemark equipped but it is anticipated that it will be replaced by a remote recorder at Littleville.

(4) Westfield River at Knightville, Massachusetts. The Knightville gage is located on the left bank of the Westfield River, 0.2 mile downstream from Knightville Dam, 0.2 mile upstream from Sykes Brook, 2.4 miles upstream from the mouth of the Middle Branch and 3.5 miles north of Huntington, Massachusetts. The gage records run-off from a drainage area of 162 square miles or the drainage area of the Knightville Reservoir and is read remotely at Knightville Dam. This gage has been in operation since August 1909.

b. Connecticut River. The following five gages on the Connecticut River are also referred to in the regulation of reservoirs on the Westfield River. Rating curves are shown on Plate No. H-I-17.

(1) Connecticut River at Montague City. The USGS gage at Montague City is located on the left bank of the river 75 feet downstream from the NYNH&H railroad bridge at Montague City, Franklin County and 1,000 feet downstream from the mouth of the Deerfield River. This

gage records the run-off from 7,865 square miles and has been in operation since 1904. This gage is presently telemark equipped.

(2) Connecticut River at Holyoke. A gage is maintained by the Holyoke Water Power Company at their dam on the Connecticut River in Holyoke, Massachusetts. The gage is equipped with a recorder and current stages can be obtained by contacting the Power Company. The gage measures run-off from a drainage area of 8,177 square miles and has been in operation since the year 1869.

(3) Connecticut River at Springfield. A staff gage is located on the pier of the Memorial Bridge in the city of Springfield, Massachusetts. This gage is maintained, and daily readings are made, by the city of Springfield. During flood periods, readings can be obtained from the Department of Streets and Engineering, Springfield, Massachusetts. This gage indicates run-off from a drainage area of 9,587 square miles and has been at this location since the year 1801.

(4) Connecticut River at Thompsonville. The USGS gage on the Connecticut River at Thompsonville, Connecticut is located on the right bank just upstream from Enfield Dam and 1 mile downstream from Thompsonville. This particular gage is a good indicator of flood stages from Thompsonville upstream to the dam in Holyoke. The station measures run-off from 9,661 square miles of drainage area and has been in operation since 1928. A telemark is presently located at this station.

(5) Connecticut River at Hartford, Connecticut. The U. S. Weather Bureau gage on the Connecticut River in Hartford, Connecticut is located on the abutment of Buckley Bridge in central Hartford. This gage is in a natural storage reach, resulting in hysteresis in the stage-discharge relationship. During flood periods it is suggested that this gage be used as an indicator of stage but not for determining discharge. The Connecticut River at this gage has a drainage area of 10,428 square miles and the gage has been in operation since 1902. The station is telemark equipped.

6. WEATHER AND RIVER FORECASTS

a. Precipitation forecasts. In addition to the normal periodic weather forecasts, quantitative precipitation forecasts prepared by the U. S. Weather Bureau are received daily over the Massachusetts Weather Teletype Network by the Reservoir Regulation Section. Supplemental weather information and forecasts are made available upon request by the U. S. Weather Bureau offices at Boston, Massachusetts.

b. USWB river forecasts. The U. S. Weather Bureau River Forecast Center at Windsor Locks, Connecticut is responsible for preparing and disseminating flood forecasts for the Connecticut River and some of its principal tributaries, one of which is the Westfield River at Westfield. The River Forecast Center at Windsor Locks, Connecticut also prepares and transmits by teletype to the Reservoir Regulation Section biweekly headwaters advisory forecasts, indicating the amount of 12-hour rainfall necessary to produce flood conditions for the Westfield River at Westfield. The same information is transmitted for the Passumpsic River at Passumpsic, Vermont; the White River at West Hartford, Vermont; the Chicopee River at Indian Orchard, Massachusetts; the Farmington River at Riverton, Connecticut; and the Park River in Hartford, Connecticut, all in the Connecticut River basin.

c. USCE flood forecasts. Guide curves, shown on Plate H-I-4, have been developed for estimating run-off from rainfall amounts for Corps of Engineers use only. The curves are based on rainfall-run-off relationships of experienced floods in the basin and will be checked and modified as more data and better means of flood forecasting become available.

7. REPORTS

a. Weekly reports. The flood control dam operator makes a routine report by radio or telephone to the Reservoir Regulation Section at 0815 each Friday. This report insures continuous contact between the operating personnel and the Reservoir Regulation Section and also serves as a communications test. The report includes the preceding 24-hour precipitation and current weather data, reservoir stage and regulation data, river conditions at index stations, and other miscellaneous data. A sample of the completed form is shown on sheet H-I-1.

b. Alerting reports. Whenever any of the following conditions occur during work-hours, the flood control dam operators at Knightville and Littleville will immediately notify the Reservoir Regulation Section:

(1) Precipitation. Occurrence of one inch during a 24-hour period at any precipitation station within the network.

(2) Reservoir stage. Whenever a rising stage of 522 feet msl is reached at Littleville or 25 feet at Knightville.

(3) River stage. A river stage at any one of the USGS gaging stations on the Westfield River as listed below:

(a) West Branch, a stage of 3.8 feet

(b) Westfield, a stage of 8.0 feet

An alerting report includes pertinent data that is readily available and a general appraisal of local conditions although complete data from all the rainfall and flood-index stations may not be available. Whenever conditions warrant an alerting report during nonworking hours, available basin data is compiled by the Littleville operator who will relay the information via telephone to the designated RRS regulator. In the absence of the Littleville operator, the Knightville operator will relay the pertinent data.

(4) Unusual conditions. Any unusual local conditions such as difficulty with gates, excessive debris, ice jams, etc. will be reported to RRS in the same manner as (3) above.

c. Flood reports. Supplemental radio or telephone reports (Second Alert) are made to the RRS by the flood control dam operator if heavy rainfall continues or if it appears that flood conditions might develop in the basin as the result of melting snow, heavy localized rainfall, dam failures, ice jams, etc. The time and frequency of these reports are dependent upon the severity of conditions and specific instructions from the Reservoir Regulation Section. Sheet H-I-2 shows a typical log of reports which indicates the data to be included in reports by the flood control dam operator during flood periods. Insofar as practicable, the following information is included in the flood report to the Reservoir Regulation Section:

(1) Precipitation at dam. The total amount of precipitation which has fallen up to the time of reporting and several intermediate amounts with the times of observation.

(2) Reservoir stage. The pool stage at the time of reporting and several previous readings with the corresponding times to determine the rate of rise of the pool and to define the inflow hydrograph. (Accurate readings of stage and time are very essential to facilitate computations made by the RRS).

(3) Gate positions. Gate openings and discharges at the time of reporting and at the beginning of the storm.

(4) Precipitation reports from observers. Precipitation reports received from cooperative observers.

(5) River stages. River stages at time of reporting of the Westfield at Westfield, the West Branch and Westfield at Huntington and the Middle Branch at Goss Heights.

(6) Snow cover. General snow cover which may affect run-off conditions throughout the basin.

(7) Miscellaneous data. Any other information which might be pertinent.

d. Special reports. A special report is submitted whenever unusual circumstances occur during a flood or if a special report is requested by the RRS. The report may be written in longhand and should describe the subjects outlined below if appropriate.

(1) Observations at dam. The flood control dam operator makes general observations of conditions occurring at the outlet works as listed below. The observations are entered in the log book at the dam. If possible, photographs are taken of any unusual conditions noting the date, time, the reservoir gage heights and position of the gates.

(a) Intake and portal. Extent and action of eddies and waves in the vicinity of the conduit intakes and portals.

(b) Outlet and spillway discharge channels. Extent and action of turbulence or eddies downstream of the spillway and outlet works.

(c) Ice and debris. Effect on the flow through the gates due to an accumulation of ice or debris at the intake.

(d) Gates. The pool elevation and position of the gates at which vibration may develop.

(e) Other. Any other unusual hydraulic phenomena that may occur.

(2) Observations at control points. During periods of reservoir regulation, particularly while emptying the reservoir, reconnaissance of the river is made by the flood control dam operator to obtain further data on the safe channel capacity of the Westfield River through principal damage areas. Critical stages at damage points are correlated with the concurrent stage at the nearest gaging station to obtain the corresponding discharge.

8. MAINTENANCE OF LOG

All reports, instructions, records of unusual circumstances at the dam, and information pertinent to regulation of the reservoir is entered in the logs. A log is maintained by both the flood control dam operator and the Reservoir Regulation Section.

9. GATE OPERATION RECORD

All gate operations are carefully noted on NED Form 90, a sample of which is shown on sheet H-I-3, and submitted monthly with recorder charts of reservoir stages. All operations are noted regardless of the duration of the change in gate position. The report includes date and time of day, gate opening, reservoir gage height, and reason for operation.

10. SPECIAL ADVISORIES

In accordance with regulations set forth in EM 500-1-1, Emergency Flood Control Activities, special advisories on flood potential and the progress of all threatening storms are submitted by RRS to the Division Engineer; Chief, Engineering Division; Emergency Operations Planning Office and to the Operations Division.

11. HYDROLOGIC EQUIPMENT

Operational procedures and maintenance of the hydrologic equipment for Knightville and Littleville Dams consisting of the precipitation gage, thermometer, reservoir stage recorder, telephone transmitters (telemarks) and snow sampling sets are contained in Attachment II.

12. SNOW SURVEYS

Snow courses have been established at selected locations within the reservoir watershed and are shown on Plate H-2. Weekly surveys are

made by the flood control dam operator during the winter and early spring to determine the depth of snow and its equivalent water content. The dates for surveys are determined each year by the Reservoir Regulation Section so as to correspond with the publication of the monthly bulletin of the U. S. Geological Survey.

13. ABSENCE FROM DAM

The Reservoir Regulation Section is notified whenever the flood control dam operator expects to be absent overnight from the dam.

14. RESERVOIR REGULATION - NORMAL PERIODS

a. Nonfreezing season. During the nonfreezing season all flood control gates at both Littleville and Knightville dams will be maintained at 3-foot openings.

b. Freezing season. During the winter months commencing about 1 December, the gates will be throttled and a pool maintained at between 15 and 20 feet at Knightville to prevent ice build-up in the gate structure. The pool will be developed gradually with some water being released continually. Once the pool is established the dam operator will make small adjustments (increments not to exceed 6 inches and maximum gate openings not to exceed 3 feet) in gate openings to maintain the pool at a relatively constant level. If a winter pool at Knightville continues to rise with 3-foot gate openings, the Reservoir Regulation Section will be notified immediately.

If ice build-up in the gate structure proves to be a problem at Littleville, gate operation similar to that at Knightville will be undertaken. The two flood control gates will be throttled sufficiently to maintain a pool at elevations between 520-522 feet msl.

c. Thawing season. About 15 March, upon instructions from the Reservoir Regulation Section, the winter pool at Knightville will be gradually emptied and the 3 gates will be opened to 3'-3'-3'. During this period reports will be made as requested by the Reservoir Regulation Section.

15. RESERVOIR REGULATION - FLOOD PERIODS

Regulation of flow from Littleville and Knightville Reservoirs may be considered in three phases during the course of a flood: Phase I,

the storm and run-off appraisal leading to the initial regulation during the development of a flood; Phase II, regulation during the flood period; and Phase III, emptying the reservoir following the downstream recession of the flood. The following paragraphs describe the methods of regulation during these various phases.

a. Phase I - Initial regulation of flow. Phase I is the most critical since it is necessary to collect rainfall and discharge data and to promptly recognize and appraise the development and magnitude of the flood in a short period of time. Gate operations at Littleville and Knightville are initiated for river stages on the Westfield and Connecticut Rivers and also for rainfall over the Westfield River basin.

(1) Westfield River. The USGS gage on the Westfield River at Westfield is the primary flood index station for the Westfield River. Flood damage starts at a stage of 12.0 feet which represents a flow of approximately 10,000 cfs in the Westfield River downstream of the mouth of the Little River. Because of the 4 to 6 hour lag time from the reservoirs to Westfield it is necessary to regulate the reservoirs, on the basis of flood potential indicators, well in advance of the occurrence of flood stages at Westfield. The discharge of the West Branch at Huntington is an indicator of flood development in the basin and is used as a guide for the regulation of the reservoirs in order to prevent later occurrence of flood stages at Westfield. An analysis of West Branch discharges and subsequent discharges at Westfield during past floods was made to develop a gate operation schedule based on West Branch discharges.

Guide curves for Phase I regulation of reservoirs depending on existing stage and rate of rise at both the Westfield and West Branch gages are shown on Plate H-I-4. Guide curve No. III is for use in proportioning the combined release from the two reservoirs during Phase I operation.

Gates at both Littleville and Knightville Reservoirs will be closed to minimum openings during Phase I in the event of any of the following occurrences in the Westfield River basin. (See Plate Nos. H-I-5 through H-I-15 for inflow, outflow and capacity curves for each reservoir.)

(a) The total discharge and rate of increase of the West Branch at Huntington are as follows:

Flow (cfs)	Rate of Increase (cfs/hour)
4,000	0
3,000	200
2,000	500

(b) The total discharge and rate of increase of the Westfield River at Westfield are as follows:

Flow (cfs)	Rate of Increase (cfs/hour)
8,000	0
7,000	200
6,000	400
5,000	700

(2) Connecticut River. Littleville and Knightville Reservoirs will be regulated during Phase I for floodflows on the Connecticut River in accordance with the following schedule:

Index Station	Stage (feet)	Discharge (cfs)	Restrict Total Reservoir Outflow To
Montague City	23.8	60,000 and rising	2,000 cfs
	26.0	70,000 " "	1,000 "
	28.0	80,000 " "	0 "
Holyoke Dam	7.0	60,000 and rising	2,000 cfs
	8.0	75,000 " "	1,000 "
	9.0	90,000 " "	0 "
Springfield	12.0	65,000 and rising	2,000 cfs
	13.6	80,000 " "	1,000 "
	15.7	100,000 " "	0 "
Thompsonville	5.0	65,000 and rising	2,000 cfs
	6.0	80,000 " "	1,000 "
	7.0	100,000 " "	0 "
Hartford	16.0		2,000 cfs
	18.6		1,000 "
	21.5		0 "

Generally, regulation of reservoirs is initiated based on stages at Montague City and Holyoke, in order to make allowance for travel time and provide optimum stage reductions at stations downstream of the mouth of the Westfield River. No regulation will be made for prognostications of river stages on the Connecticut River upstream of Montague City. Both reservoirs will be closed to minimum outflow (10± cfs) in the event of a forecast of pending flood stages at Springfield, Thompsonville or Hartford.

Guide curve No. IV is presented for use in the regulation of Knightville and Littleville Reservoirs for Connecticut River stages.

Table H-I-1 indicates warning and flood stages for key index stations along the Connecticut River. Included in the table are warning stages, flood stages, average peak travel time and maximum recorded stages.

(3) Rainfall. Past experience has indicated that, depending on antecedent conditions, 2 inches of rainfall over the Westfield River basin in 24 hours will produce a moderate rise in river stages. During Phase I, before the run-off potential of a storm is ascertained, initial regulation of the reservoirs may be made on the basis of 24-hour rainfall. Reservoir outflow will be restricted whenever the following rainfall has been recorded at either dam within a 24-hour period.

Rainfall-Inches (24-hour period)	Maximum Permissible Discharge	
	Knightville (cfs)	Littleville (cfs)
Less than 2	Gates in normal position	Gates in normal position
2 to 3	2,000	500
3 to 4	1,000	250
More than 4	Minimum	Minimum

b. Phase II - Continuation of regulation. During this phase of a flood the outflows from the reservoirs are regulated to alleviate, or reduce as far as practicable, downstream flood damages on the Westfield and Connecticut Rivers. The reservoirs will be regulated in coordination with other projects in the Connecticut River system to minimize tributary

TABLE H-I-1

WARNINGS AND FLOOD STAGES

CONNECTICUT RIVER

Index Station	Warning Stage (Gage Height in feet)	Flood Stage & Discharge (Gage Height in feet)	C.F.S.	Ave. Peak Travel Time (in hours)	Max. Recorded Stage (Gage Height in feet)	Date
White River Junction	17.0	20.0	51,000		35.0	11/4/27
North Walpole	26.0 (38,300)	30.0	95,000	9	43.8	3/19/36
Montague City	25.0 (65,800)	28.0	80,000	20	49.2	3/19/36
Holyoke	7.0 (60,000)	9.0	92,000	12	16.8	3/19/36
Springfield	12.0 (65,000)	20.0	151,000	6	28.6	3/20/36
Thompsonville	8.0 (120,000)	10.3	161,700	6	16.6	3/20/36
Hartford	16.0 (66,000)	22.0	114,000	7	37.6	3/21/36

contributions to peak flows on the Connecticut River. If the gates are completely closed, they remain in this position until the final phase of operation is initiated and emptying of the stored run-off may begin.

A secondary activity during the Phase II period is the collection of hydrologic and hydraulic data such as (a) precipitation amounts throughout the entire Westfield River basin; (b) snow cover and water content in case of a spring flood; (c) stage and discharge values at downstream control points; and (d) any other pertinent rainfall and run-off information of importance in the regulation of the reservoirs.

c. Phase III - Emptying the reservoirs. Following recession of the flood on the Westfield and Connecticut Rivers, Phase III is initiated and the reservoirs are emptied as rapidly as possible.

(1) Westfield River. Evacuation discharges from the reservoirs will not exceed Westfield River channel capacities. The channel capacity at Westfield is 10,000 cfs. Guide curve No. V is for use in proportioning the release from the two reservoirs on the basis of percent of storage utilized.

(2) Connecticut River. Phase III, the emptying of Littleville and Knightville, will not be initiated until the Connecticut River flood has crested at Hartford, Connecticut and river stages at all stations from Montague City to Thompsonville are falling. The amount of fall in stage necessary, before emptying the reservoirs, will depend on the magnitude of the Connecticut River flood and the percent of reservoir storage utilized. Guide curve No. VI is presented for making reservoir releases on the basis of Connecticut River stages. Evacuating discharge from the Westfield River reservoirs will be coordinated with releases from other projects in the system in a manner that will allow Connecticut River flood crests to continue to recede. This subject will be described in detail in the Master Regulation Manual. The combined rate of increase in reservoir discharge from the two reservoirs during the emptying period is not to exceed 1,000 cfs per hour. Secondary river rises during Phase III, due to either additional rainfall or snowmelt, may result in the regulation procedure reverting to Phase I or Phase II.

d. Spillway discharge. Ordinarily during a major flood, the gates will not be opened to avoid spillway discharge. Surcharge storage above the elevation of the spillway crest will be utilized whenever the downstream channel capacity continues to be exceeded by the run-off

from uncontrolled areas. However, the gates at the dam will be immediately operated with or without instructions from the RRS when their respective pools reach the following levels;

LITTLEVILLE DAM AND RESERVOIR

Pool Stage (feet)	Feet Above Spillway Crest	Operation	Required
580	10'	Both gates	4' open
582	12'	Both gates	8' open

KNIGHTVILLE DAM AND RESERVOIR

Pool Stage (feet)	Feet Above Spillway Crest	Operation	Required
620	10'	All gates	6' open
622	12'	All gates	12' open

e. Minimum discharge. During periods of flood regulation when reservoir outflow will be restricted, the operators will make releases, if necessary, to insure sufficient flow to maintain fish life. In many instances, local run-off, or leakage around the gates, will be adequate.

16. RESERVOIR REGULATION - WHITE WATER CANOE RACES

a. General. Organized racing on the Westfield River started in 1954 with less than 10 teams entered. It remained a small event until 1962 when there were 13 teams. In 1963, entries went to 29 and in 1964, 38 teams were entered. Race interest extends to New York, New Jersey, Connecticut and Pennsylvania. Race spectators in recent years have been estimated between 6,000 and 10,000 people.

Recently the Westfield River White Water Canoe Club has requested regulation at Knightville for a suitable weekend in April to provide flow conditions for canoeing in the Westfield River. NED has stipulated that

the races be conducted in early April as natural riverflows later often recede rapidly and holding storage from spring run-off for a later time is not desirable.

b. Regulation required. Because of the design of the outlet works and the nature of the operation of Littleville, regulation of this reservoir for canoe races is impractical. Therefore, all regulation for canoe races would be performed at Knightville Dam.

An outflow from Knightville of 1,200 cfs will provide optimum flow condition for racing. Analysis of 10 years of record at Knightville Dam indicates that:

(1) Twice during the period water in storage would be required to maintain the 1,200 cfs.

(2) Three times during the period flow would have had to be curtailed to limit the flow to 1,200 cfs.

(3) Five times during the period there would have been very little regulation required to maintain a flow of 1,200 cfs. Each year the necessary regulation depends on current conditions. Approximately 3 days prior to the race, an analysis must be made of the existing river-flow conditions and necessary regulations made to insure that optimum flow conditions can be provided for the duration of the race.

The three primary rules to be observed in the operation of Knightville for canoeing are:

(1) Any and all regulation of Knightville for canoeing must be approved by and under the jurisdiction of the Reservoir Regulation Section of the Corps of Engineers.

(2) No regulation will be made for canoeing during a pending flood situation.

(3) No more than 1,500 cfs will be released or more than 400 acre-feet stored - (1 percent of capacity) for purposes of the canoe races.

The following are also conditions to be met by the canoeing club:

(1) Notification of the public via public announcements (newspapers, radio, signs) that the water level may fluctuate on race day.

(2) Patrol the river on race day prior to the release or holding of water to warn anyone on the river of changing water conditions.

(3) Assist Army Engineers on race day in controlling people at the starting line (the scheduled starting line is on property controlled by the U. S. Government).

17. EXTRAORDINARY FLOOD CONDITIONS

It is conceivable that extraordinary and unpredictable flood conditions may arise - such as dam or bridge failures, highway or railroad washouts, ice jams, or debris deposits. Since the prime purpose of the reservoir is to prevent further damage, regulation during such unusual conditions may not follow the previously described rules but will be governed by the urgency of the circumstances. The Reservoir Regulation Section will be notified immediately of any unusual incident so that prompt action may be taken and the gates operated to provide maximum protection.

18. REGULATION WITH FAILURE OF COMMUNICATIONS

If the flood control dam operator is unable to communicate with the Reservoir Regulation Section by normal or emergency methods and conditions develop which appear to warrant regulation, he will operate the gates in accordance with instructions contained in the Emergency Operation Procedure (paragraph 19). However, possession of instructions contained in this manual does not relieve the operator of his responsibility for continued efforts to communicate with RRS. In cases of extreme emergency, the operator shall attempt to communicate with the Reservoir Regulation Section through the Massachusetts State Police and the Office of Civil Defense Mobilization radio networks. It should be emphasized that whenever communications fail, and due to lack of adequate reports it is impossible to fully appraise the run-off from an intense storm, it is preferable to immediately restrict or completely stop the reservoir discharge than to delay regulation and actually contribute to downstream flood conditions.

19. EMERGENCY OPERATION PROCEDURE

In the event the RRS cannot be contacted during a pending flood situation, the reservoirs will be operated as specified for Phase I operation and the regulation of both reservoirs will be under the jurisdiction

of the Littleville operator. During such a situation if any of the following stages are reached there will be no partial closures and the operators will close the gates of both Knightville and Littleville immediately to minimum openings.

EMERGENCY OPERATION PROCEDURE
STAGES FOR COMPLETE CLOSURE OF GATES

Location	Stage (feet)
West Branch at Huntington (USGS)	5.0 and rising
Westfield River at Westfield (USGS)	9.0 and rising
Montague City (USGS)	26.0
Hartford (USWB)	20.0

Both dams will also be closed whenever 3 inches of rainfall has fallen in the Westfield River basin in a 24-hour period.

No releases will be made from the reservoirs until contact has been established with RRS.

Whenever contact is lost between the dams and also the RRS, the operators will be responsible for regulation of their respective dams as described above. As soon as conditions permit, the Knightville operator will relay all pertinent information to the operator at Littleville.

20. COOPERATION WITH DOWNSTREAM WATER USERS

It is the policy of the Corps of Engineers to cooperate, whenever possible, with downstream water users and other interested parties or agencies. The flood control dam operator may be requested by downstream users to deviate from normal regulations for short periods of time. Whenever a request for such modification is received, the operator ascertains the validity of the request and obtains assurances from other downstream water users that they are agreeable to the proposed operations. The operator then relays the information to the RRS and requests instructions.

21. FUTURE STUDIES

Post flood studies will be made of each period of reservoir regulation to determine efficiency of the communications and reporting

networks, the applicability of regulation guides including stage-discharge relationships, discharge correlations and flood reductions at damage centers.

The Knightville spillway requirements were based on a design flood which was computed in the late 1930's. The S.D.F. had 16.4 inches of rainfall in 24 hours and combined with a 6-hour unit hydrograph (peak of 7800 cfs) resulted in a maximum inflow of 88,700 cfs, equivalent to about 550 csm.

Preliminary hydrologic studies in 1960 and studies associated with a report to OCE, dated May 31, 1967 concerning the "Review of Design Features of Existing Dams", EC 1110-2-34, indicate that the peaks of both the S.D.F. and related unit hydrograph are on the low side. In this report it is recommended that the spillway requirements of the Knightville project be thoroughly reviewed based on latest design criteria. Upon completion of the studies and any required structural changes in the project, necessary revisions will be made to the manual.

A revised S.D.F. (preliminary) has been completed and is shown on Plate No. H-9 for informational purposes.

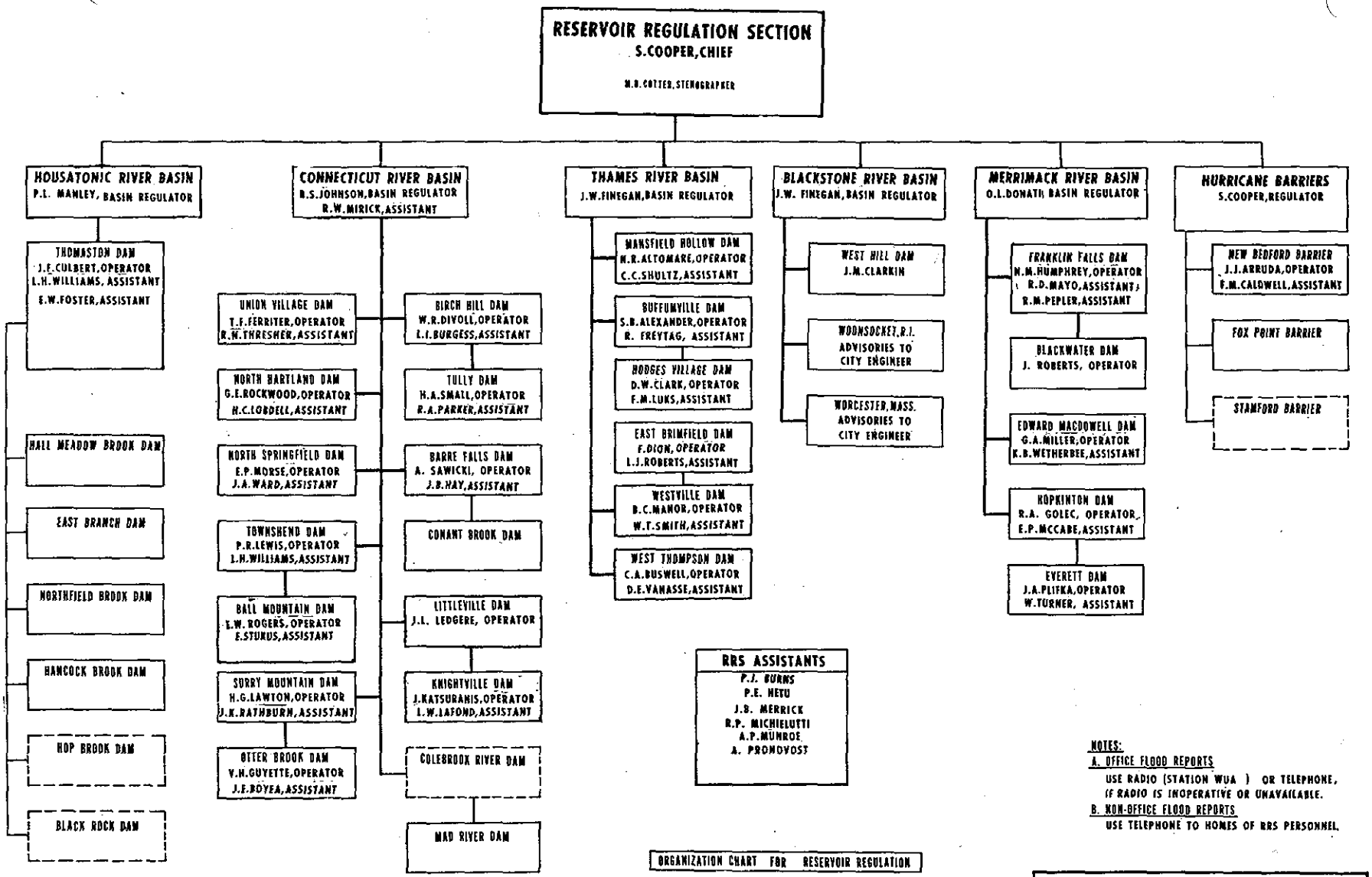

RESERVOIR REGULATION SECTION
S.COOPER, CHIEF
M.B.COTTER, STENOGRAPHER
HOUSATONIC RIVER BASIN
P.I. MANLEY, BASIN REGULATOR
THOMASTON DAM
J.F.CULBERT, OPERATOR
L.H.WILLIAMS, ASSISTANT
E.W.FOSTER, ASSISTANT
HALL MEADOW BROOK DAM
EAST BRANCH DAM
NORTHFIELD BROOK DAM
HANCOCK BROOK DAM
HOP BROOK DAM
BLACK ROCK DAM
CONNECTICUT RIVER BASIN
B.S.JOHNSON, BASIN REGULATOR
R.W.MIRICK, ASSISTANT
UNION VILLAGE DAM
T.F.FERRITER, OPERATOR
R.W.THRESHER, ASSISTANT
NORTH HARTLAND DAM
G.E.ROCKWOOD, OPERATOR
H.C.LORDELL, ASSISTANT
NORTH SPRINGFIELD DAM
E.P.MORSE, OPERATOR
J.A.WARD, ASSISTANT
TOWNSHEND DAM
P.R.LEWIS, OPERATOR
L.H.WILLIAMS, ASSISTANT
BALL MOUNTAIN DAM
L.W. ROGERS, OPERATOR
E.STURUS, ASSISTANT
SURRY MOUNTAIN DAM
H.G.LAWTON, OPERATOR
J.K.RATHBURN, ASSISTANT
OTTER BROOK DAM
V.H.GUYETTE, OPERATOR
J.F.BOYEA, ASSISTANT
BIRCH HILL DAM
W.R.DIVOLL, OPERATOR
L.I.BURGESS, ASSISTANT
TULLY DAM
H.A.SMALL, OPERATOR
R.A.PARKER, ASSISTANT
BARRE FALLS DAM
A. SAWICKI, OPERATOR
J.B.HAY, ASSISTANT
CONANT BROOK DAM
LITTLEVILLE DAM
J.L. LEDGERE, OPERATOR
KNIGHTVILLE DAM
J.KATSURAHIS, OPERATOR
L.W.LAFOND, ASSISTANT
COLEBROOK RIVER DAM
MAD RIVER DAM
THAMES RIVER BASIN
J.W.FINEGAN, BASIN REGULATOR
MANSFIELD HOLLOW DAM
N.R.ALTOMARE, OPERATOR
C.C.SHULTZ, ASSISTANT
BUFFUMVILLE DAM
S.B.ALEXANDER, OPERATOR
R. FREYTAG, ASSISTANT
HODGES VILLAGE DAM
D.W.CLARK, OPERATOR
F.M.LUKS, ASSISTANT
EAST BRIMFIELD DAM
F.DION, OPERATOR
L.J.ROBERTS, ASSISTANT
WESTVILLE DAM
B.C.MANOR, OPERATOR
W.T.SMITH, ASSISTANT
WEST THOMPSON DAM
C.A.BUSWELL, OPERATOR
D.E.VANASSE, ASSISTANT
BLACKSTONE RIVER BASIN
J.W. FINEGAN, BASIN REGULATOR
WEST HILL DAM
J.M.CLARKIN
WOONSOCKET, R.I.
ADVISORIES TO CITY ENGINEER
WORCESTER, MASS.
ADVISORIES TO CITY ENGINEER
MERRIMACK RIVER BASIN
O.L.DONATH BASIN REGULATOR
FRANKLIN FALLS DAM
N.M.HUMPHREY, OPERATOR
R.D.MAYO, ASSISTANT
R.M.PEPLER, ASSISTANT
BLACKWATER DAM
J. ROBERTS, OPERATOR
EDWARD MACDOWELL DAM
G.A.MILLER, OPERATOR
K.B.WETHERBEE, ASSISTANT
HOPKINTON DAM
R.A. GOLEC, OPERATOR
E.P.MCCABE, ASSISTANT
EVERETT DAM
J.A.PLIFKA, OPERATOR
W.TURNER, ASSISTANT
HURRICANE BARRIERS
S.COOPER, REGULATOR
NEW BEDFORD BARRIER
J.J.ARRUDA, OPERATOR
F.M.CALDWELL, ASSISTANT
FOX POINT BARRIER
STAMFORD BARRIER
RRS ASSISTANTS
P.J. BURNS
P.E. METU
J.B. MERRICK
R.P. MICHIELUTTI
A.P.MUNROE
A. PRONOVOST
NOTES:
A. OFFICE FLOOD REPORTS
USE RADIO (STATION WUA) OR TELEPHONE, IF RADIO IS INOPERATIVE OR UNAVAILABLE.
B. NON-OFFICE FLOOD REPORTS
USE TELEPHONE TO HOMES OF RRS PERSONNEL
ORGANIZATION CHART FOR RESERVOIR REGULATION
DIVISION ENGINEER
DISASTER CONTROL CENTER
ENGINEERING DIVISION
HYDROLOGY & HYDRAULICS BRANCH
RESERVOIR REGULATION SECTION
ORGANIZATION
CHART
RESERVOIR REGULATION SECTION
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
JUNE 1967

PLATE NO. H-I-1

STANDARD OPERATING PROCEDURE

PHASE I

FIRST ALERT

RAINFALL: ONE INCH IN 24 HOURS

RIVER STAGE:

WESTFIELD RIVER	
1. West Branch	3.8
2. Westfield	8.0
CONNECTICUT RIVER	
1. Montague	22.0
2. Holyoke	7.0
3. Springfield	12.0
4. Thompsonville	5.0
5. Hartford	16.0

SECOND ALERT

RAINFALL:

1. TWO INCHES UNDER CONDITIONS CONDUCIVE TO RUNOFF.
2. THREE INCHES UNDER DRY CONDITIONS DURING *VEGETATIVE SEASON.*
3. OR AS PRESCRIBED BY REGULATOR.

RIVER STAGE:

WESTFIELD RIVER	
1. West Branch	5.0
2. Westfield	9.0
CONNECTICUT RIVER	
1. Montague	25.0
2. Holyoke	8.0
3. Springfield	16.0
4. Thompsonville	7.0
5. Hartford	19.0

DUTIES OF DAMTENDER

1. Collect And Transmit To R.R.S. Rainfall And Stage Data.
2. Operate As Instructed By R.R.S.

DUTIES OF REGULATOR

1. Compile Data.
2. Coordinate Next Transmission.
3. Consult Guide Curves.
4. *Restrict Outflow As Necessary For Conditions On Westfield And Connecticut Rivers.*
5. Inform Basin Regulator of Actions.

PHASE II

FLOOD CONDITION

RAINFALL:

1. THREE INCHES IN 24 HOURS UNDER CONDITIONS CONDUCIVE TO RUNOFF.
2. FOUR INCHES IN 24 HOURS UNDER DRY CONDITIONS *DURING VEGETATIVE* SEASON.

FLOOD STAGE:

WESTFIELD RIVER	
1. West Branch	- -
2. Westfield	11.0
CONNECTICUT RIVER	
1. Montague	28.0
2. Holyoke	9.0
3. Springfield	20.0
4. Thompsonville	10.3
5. Hartford	22.0

DUTIES OF DAMTENDER

1. Close To Minimum Settings Upon Instruction From R.R.S.
2. Note All unusual Conditions At Dam, Downstream Channels, And Index Stations.
3. Collect And Transmit Rainfall And Stage Data At Minimum Of 3-Hour Intervals or as Directed By R.R.S.

DUTIES OF REGULATOR

1. Continue To Provide Regulation Instructions To F.C.D.O.
2. Consult With Basin Regulator And Analyze Severity Of Flood.
3. Carry Out Special Instructions Recommended By Basin Regulator.

PHASE III

FLOOD RECESSION

1. STORM ABATED.
2. RIVER STAGE FALLING AT ALL STATIONS.

DUTIES OF DAMTENDER

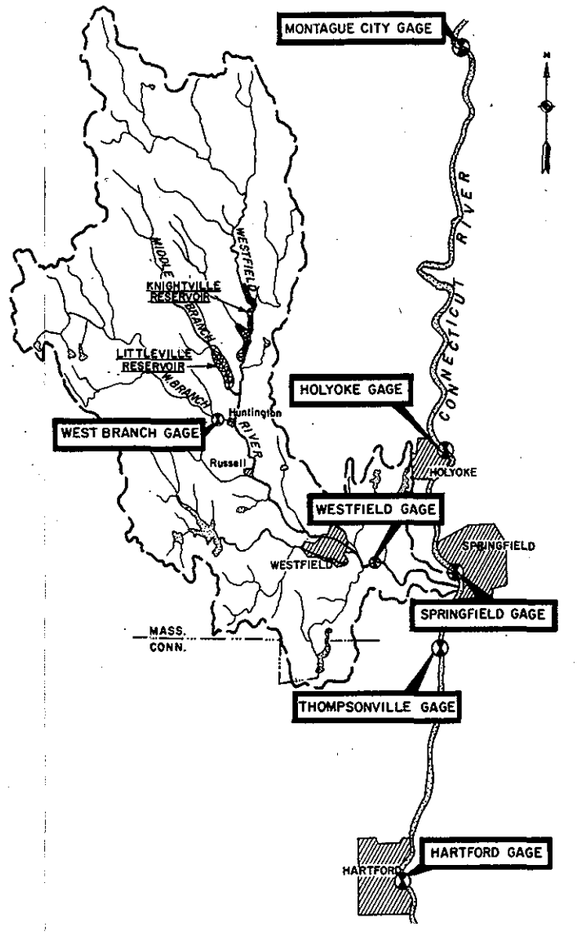
1. See Phase II Step No. 3
2. Reconnoiter Flood Plain and Note Conditions.
3. Report To R.R.S. For Further Instructions.
4. Submit Report of Collected Miscellaneous Data and Pertinent Information To R.R.S.

DUTIES OF REGULATOR

1. Collect Data From F.C.D.O.
2. Check Guide Curves For Allowable Releases.
3. Consult With Basin Regulator.
4. Relay Instructions To F.C.D.O.
5. Compile And Evaluate Flood Data And Review Regulation Procedures.
6. Revise Procedures If Evaluation Indicates The Need.

POST FLOOD

1. RIVER STAGES AT ALL STATIONS BELOW FIRST ALERT STAGE.
2. RESERVOIRS EMPTIED.



EMERGENCY OPERATION PROCEDURE DURING COMMUNICATION FAILURE

CONDITIONS NECESSITATING GATE CLOSURE

RAINFALL: THREE INCHES OF RAINFALL WITHIN THE WESTFIELD BASIN.

RIVER STAGE:

WESTFIELD RIVER	
1. WEST BRANCH	5.0'
2. WESTFIELD RIVER	9.0'
CONNECTICUT RIVER	
1. MONTAGUE CITY	28.0'
2. HARTFORD	20.0'

GENERAL INFORMATION

1. THE LITTLEVILLE OPERATOR IS IN CHARGE OF THE REGULATION OF BOTH RESERVOIRS DURING LOSS OF CONTACT WITH R.R.S.
2. *EACH OPERATOR IS RESPONSIBLE FOR REGULATION OF HIS RESPECTIVE DAM WHEN CONTACT IS* LOST BETWEEN DAMS.
3. DAM TENDERS WILL OPERATE ACCORDING TO PHASE I GUIDE CURVES WHEN CONDITIONS DO NOT NECESSITATE COMPLETE CLOSURE OF GATES.
4. NO RELEASES WILL BE MADE FROM RESERVOIR STORAGE UNTIL CONTACT HAS BEEN MADE WITH R.R.S.

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY G.M.D. | CK. BY

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

CHIEF,

CONNECTICUT RIVER FLOOD CONTROL

OPERATION PROCEDURES
KNIGHTVILLE & LITTLEVILLE RESERVOIRS
WESTFIELD RIVER BASIN

WESTFIELD RIVER MASSACHUSETTS

APPROVED: DATE JUNE 1967

CHIEF, ENGINEERING DIVISION

SCALE:

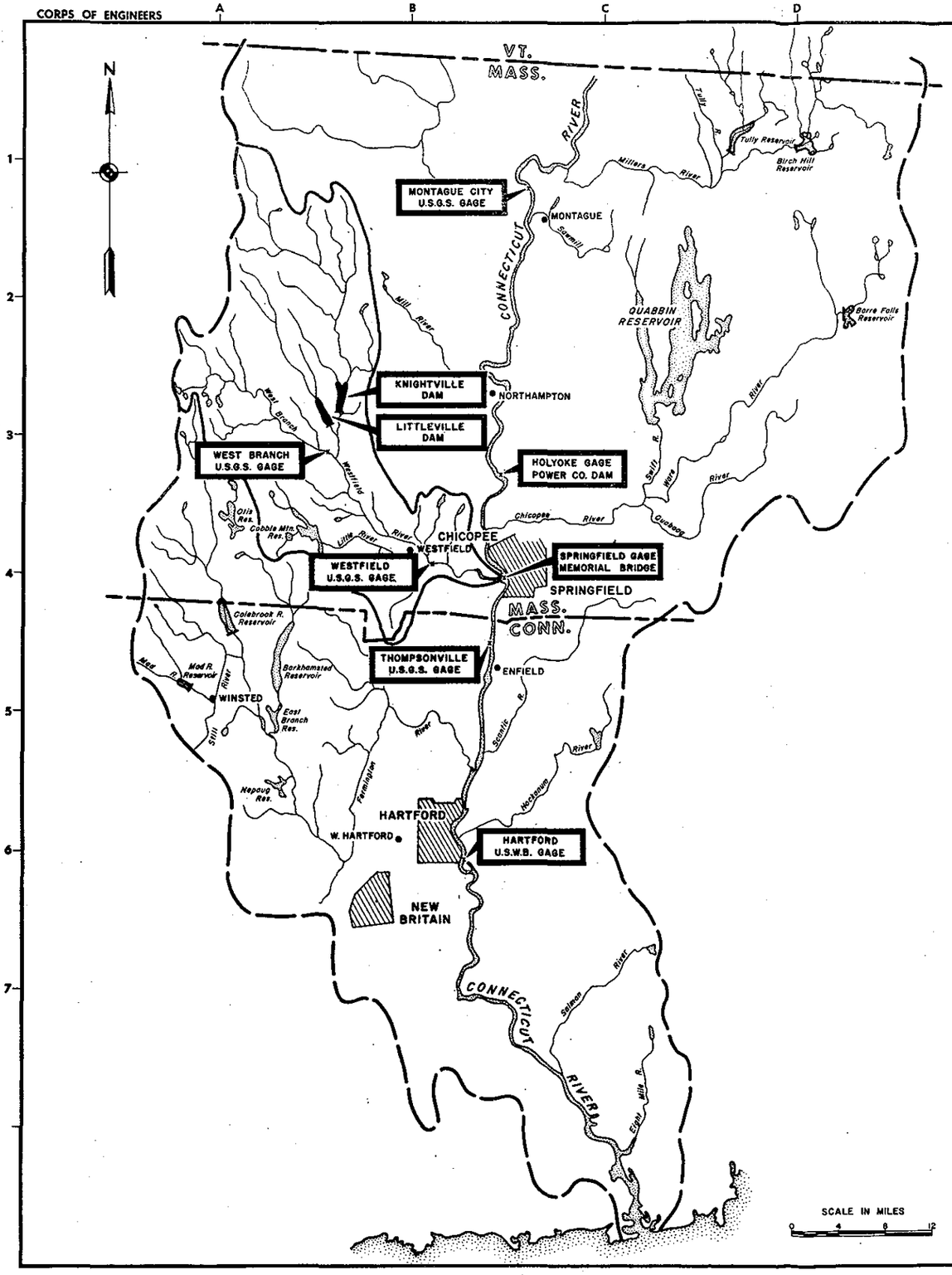
DRAWING NUMBER

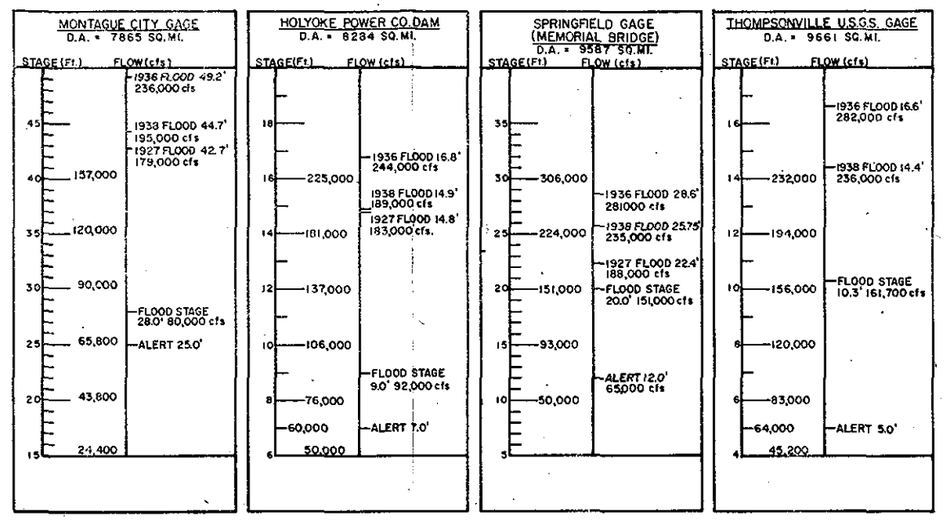
SHEET

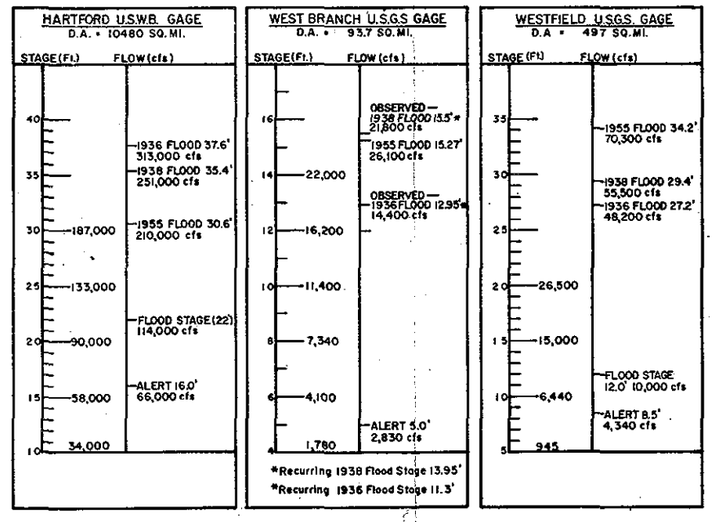
PLATE NO. H-1-2

CORPS OF ENGINEERS

U. S. ARMY







REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY | CK. BY

PROJECT ENGINEER

CHIEF, HYD & HYD. SECTION

CHIEF, PLANN. & REP. BRANCH

CONNECTICUT RIVER FLOOD CONTROL

WESTFIELD RIVER RESERVOIRS

GUIDE CHART FOR RESERVOIR REGULATION

WESTFIELD RIVER BASIN

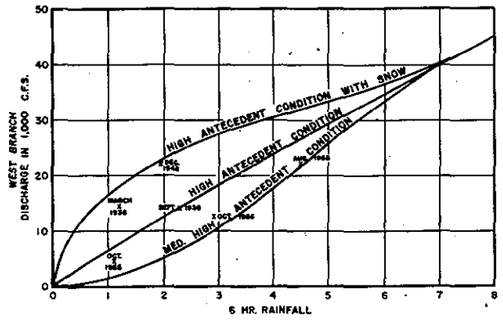
APPROVED DATE

CHIEF, ENGINEERING DIVISION

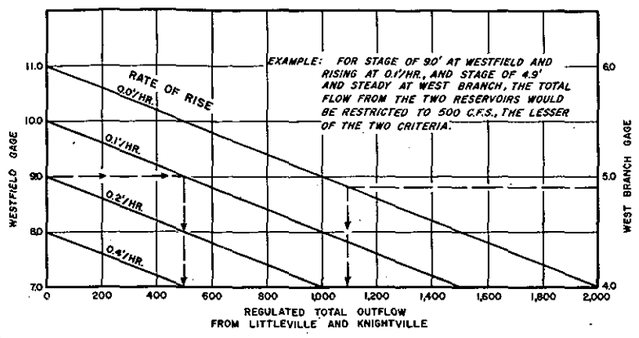
SCALE

DRAWING NUMBER

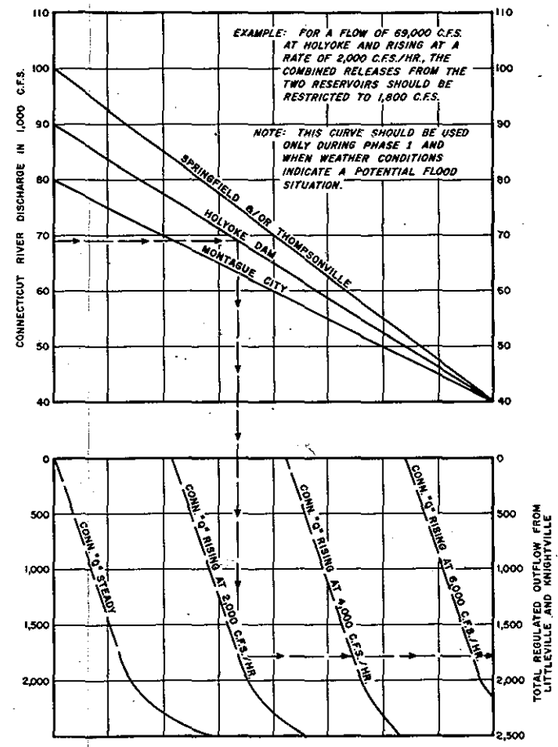
PLATE H-I-3



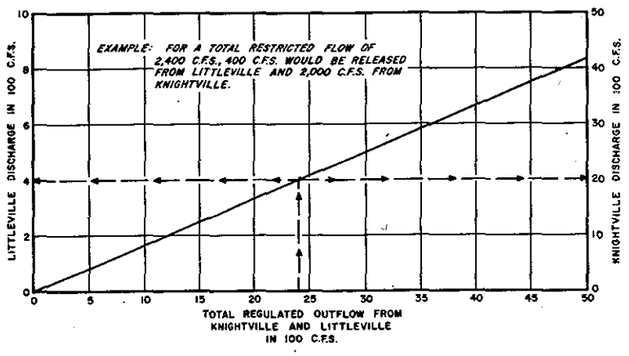
GUIDE CURVE NO. 1 - PHASE I
ESTIMATING WEST BRANCH DISCHARGE FROM MAX. 6-HOUR RAINFALL



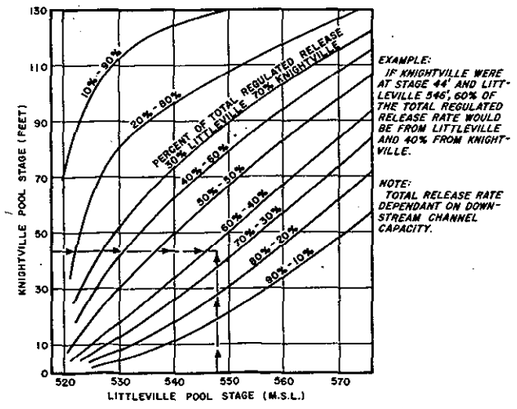
GUIDE CURVE NO. 2 - PHASE I
REGULATION FOR STAGES ON WESTFIELD RIVER



GUIDE CURVE NO. 3 - PHASE I
REGULATION FOR CONNECTICUT RIVER DISCHARGES



GUIDE CURVE NO. 4 - PHASE I
PROPORTIONING RESTRICTED FLOWS FROM THE TWO RESERVOIRS



GUIDE CURVE NO. 5 - PHASE III
PROPORTIONING RELEASES FROM THE TWO RESERVOIRS

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY | CK. BY

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

CHIEF, PLANS & BFTS. BRANCH

CONNECTICUT RIVER FLOOD CONTROL
WESTFIELD RIVER RESERVOIRS
REGULATION GUIDE CURVES FOR FLOOD CONTROL
WESTFIELD RIVER BASIN

APPROVED

DATE

CHIEF, ENGINEERING DIVISION

SCALE

DRAWING NUMBER

SHEET

PLATE H-I-4

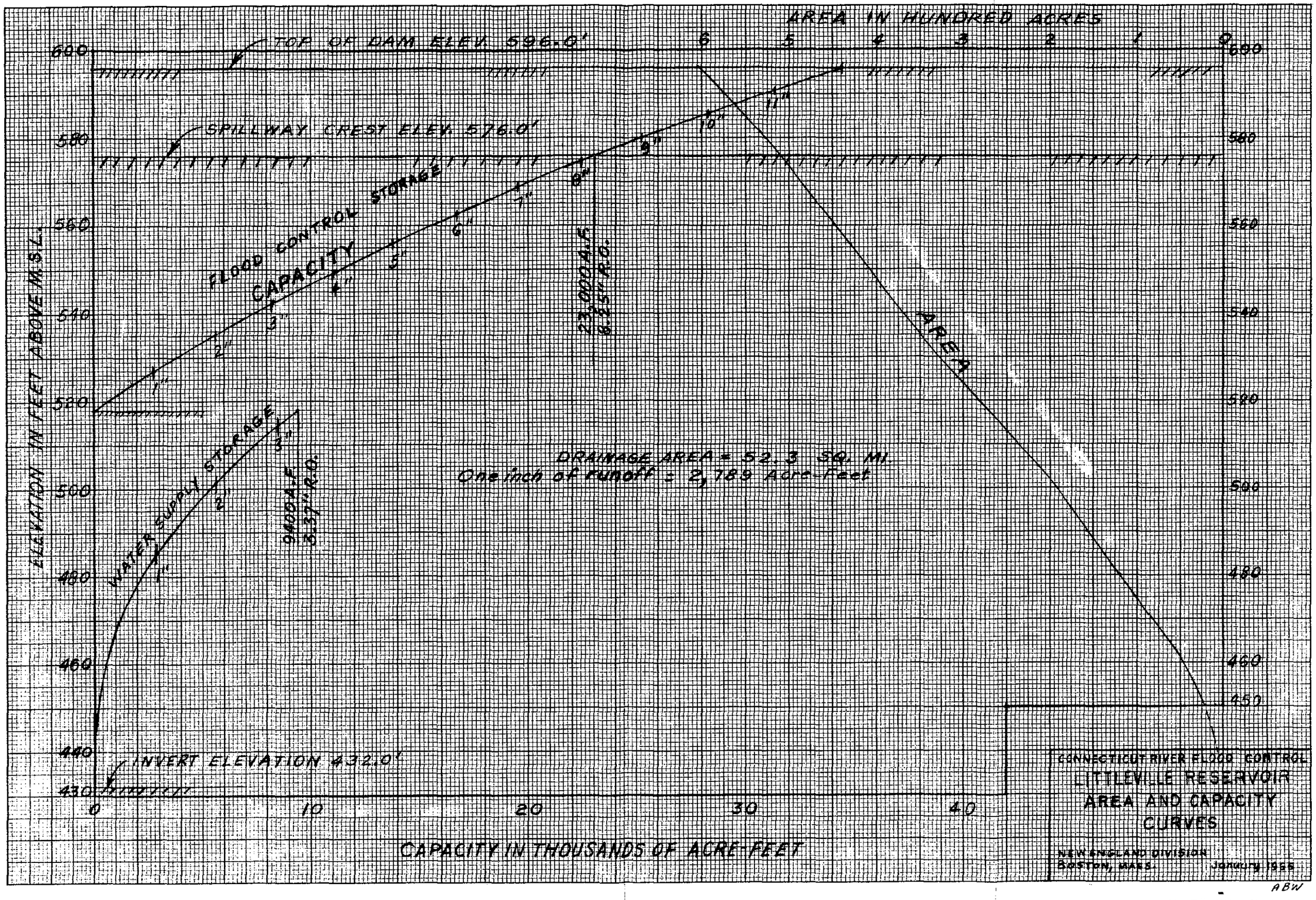
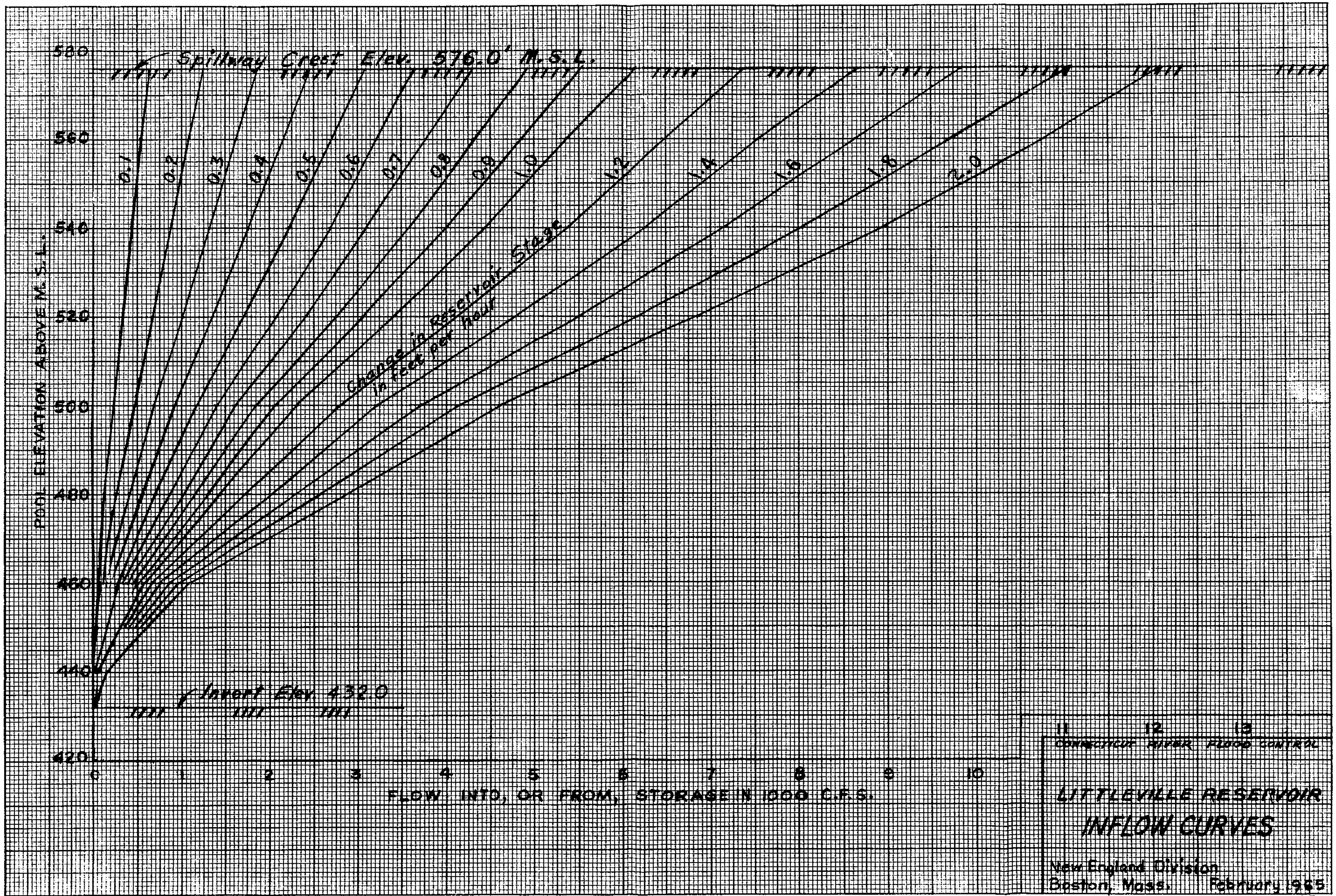
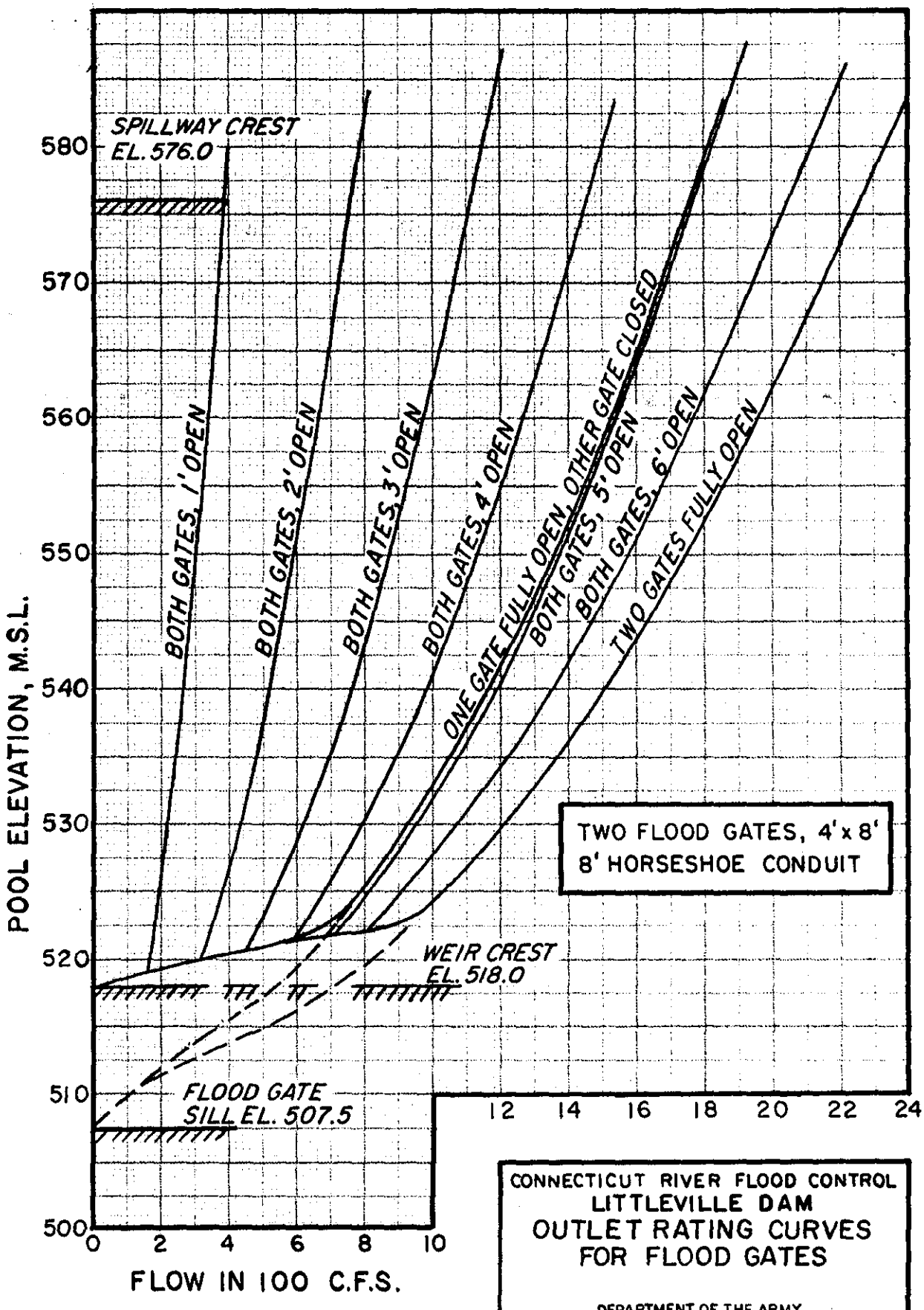

TOP OF DAM ELEV. 596.0'
SPILLWAY CREST ELEV. 576.0'
FLOOD CONTROL STORAGE
CAPACITY
INVERT ELEVATION 432.0'
ELEVATION IN FEET ABOVE M.S.L.
AREA IN HUNDRED ACRES
CAPACITY IN THOUSANDS OF ACRE-FEET
DRAINAGE AREA = 52.3 SQ. MI.
One inch of runoff = 2,789 Acre-Feet
CONNECTICUT RIVER FLOOD CONTROL
LITTLEVILLE RESERVOIR
AREA AND CAPACITY CURVES
NEW ENGLAND DIVISION
BOSTON, MASS.
January 1955
ABW

PLATE NO. H-1-5

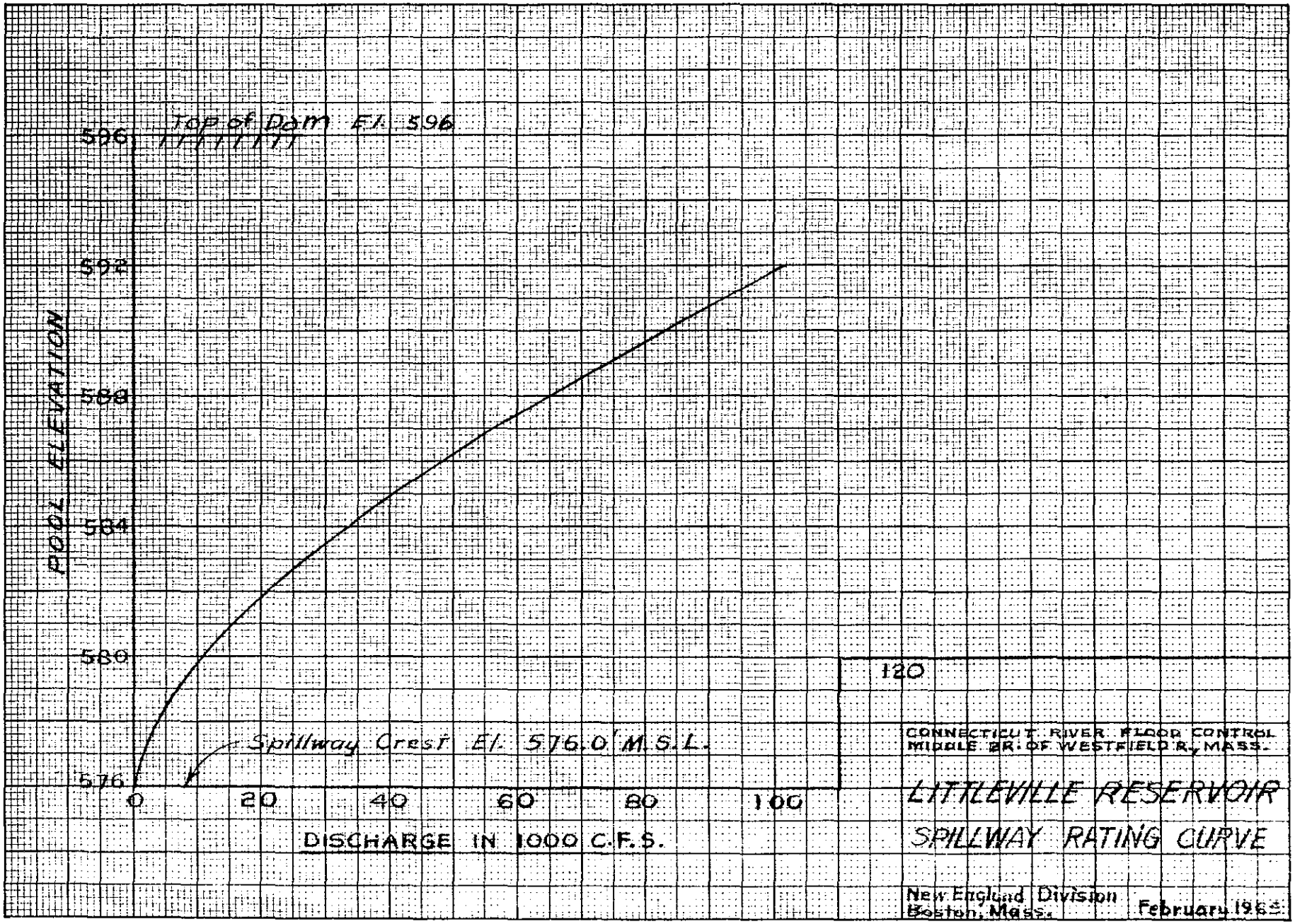

Spillway Crest Elev. 576.0' M.S.L.
Invert Elev. 432.0
POOL ELEVATION ABOVE M.S.L.
580
560
540
520
500
480
460
440
420
0
1
2
3
4
5
6
7
8
9
10
11
12
13
FLOW INTO, OR FROM, STORAGE IN 1000 C.F.S.
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.2
1.4
1.6
1.8
2.0
Change in Reservoir Stage
in feet per hour
CONNECTICUT RIVER FLOOD CONTROL
LITTLEVILLE RESERVOIR
INFLOW CURVES
New England Division
Boston, Mass.
February 1965
ABW



CONNECTICUT RIVER FLOOD CONTROL
LITTLEVILLE DAM
OUTLET RATING CURVES
FOR FLOOD GATES

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

PLATE NO. H-1-7



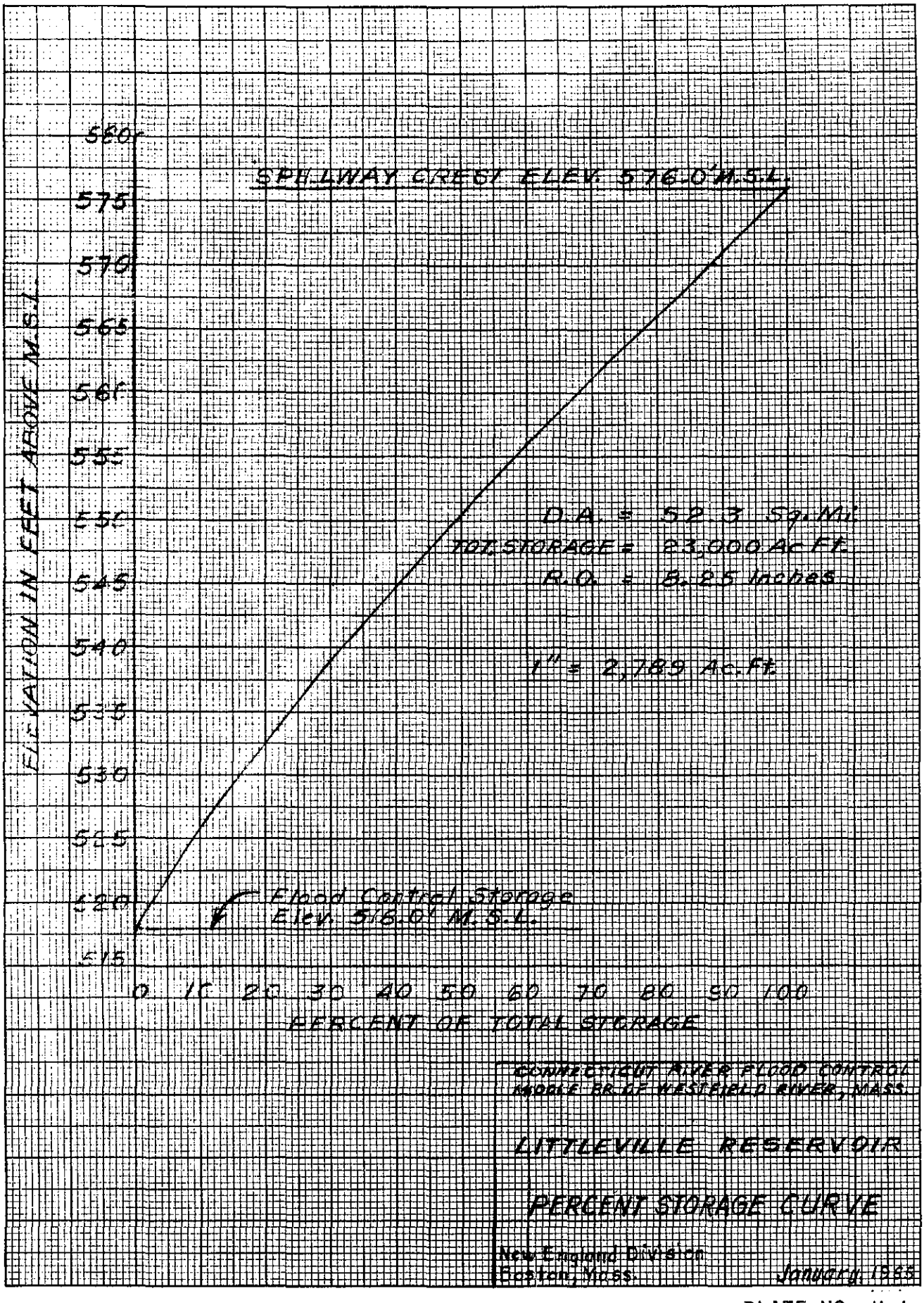
CONNECTICUT RIVER FLOOD CONTROL
MIDDLE BR. OF WESTFIELD R., MASS.

LITTLEVILLE RESERVOIR

SPILLWAY RATING CURVE

New England Division
Boston, Mass. February 1963

PLATE NO. H-1-8



CONNECTICUT RIVER FLOOD CONTROL
MIDDLE BRANCH WESTFIELD RIVER, MASS.

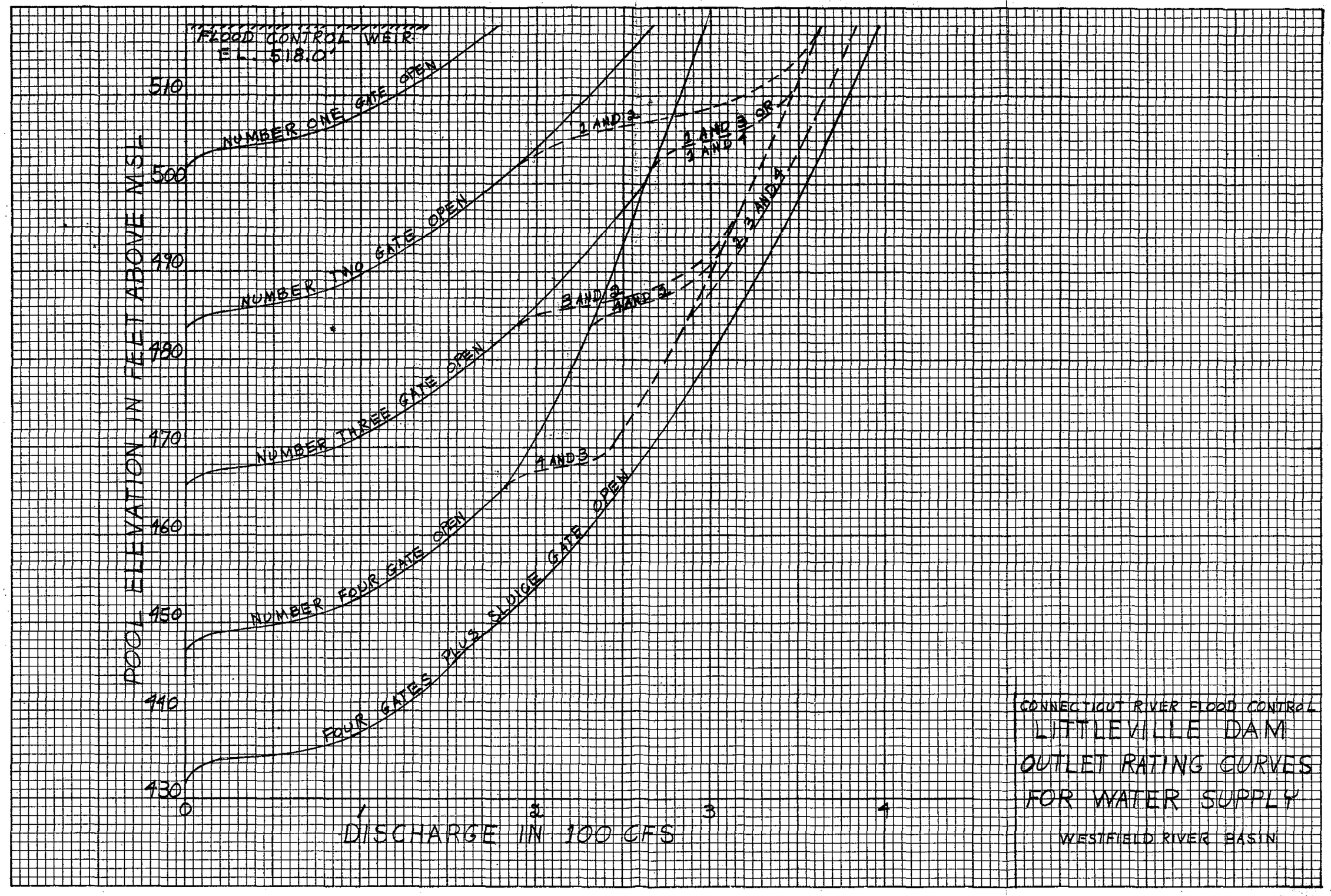
LITTLEVILLE RESERVOIR

PERCENT STORAGE CURVE

New England Division
Boston, Mass.

January 1955

PLATE NO. H-1-9



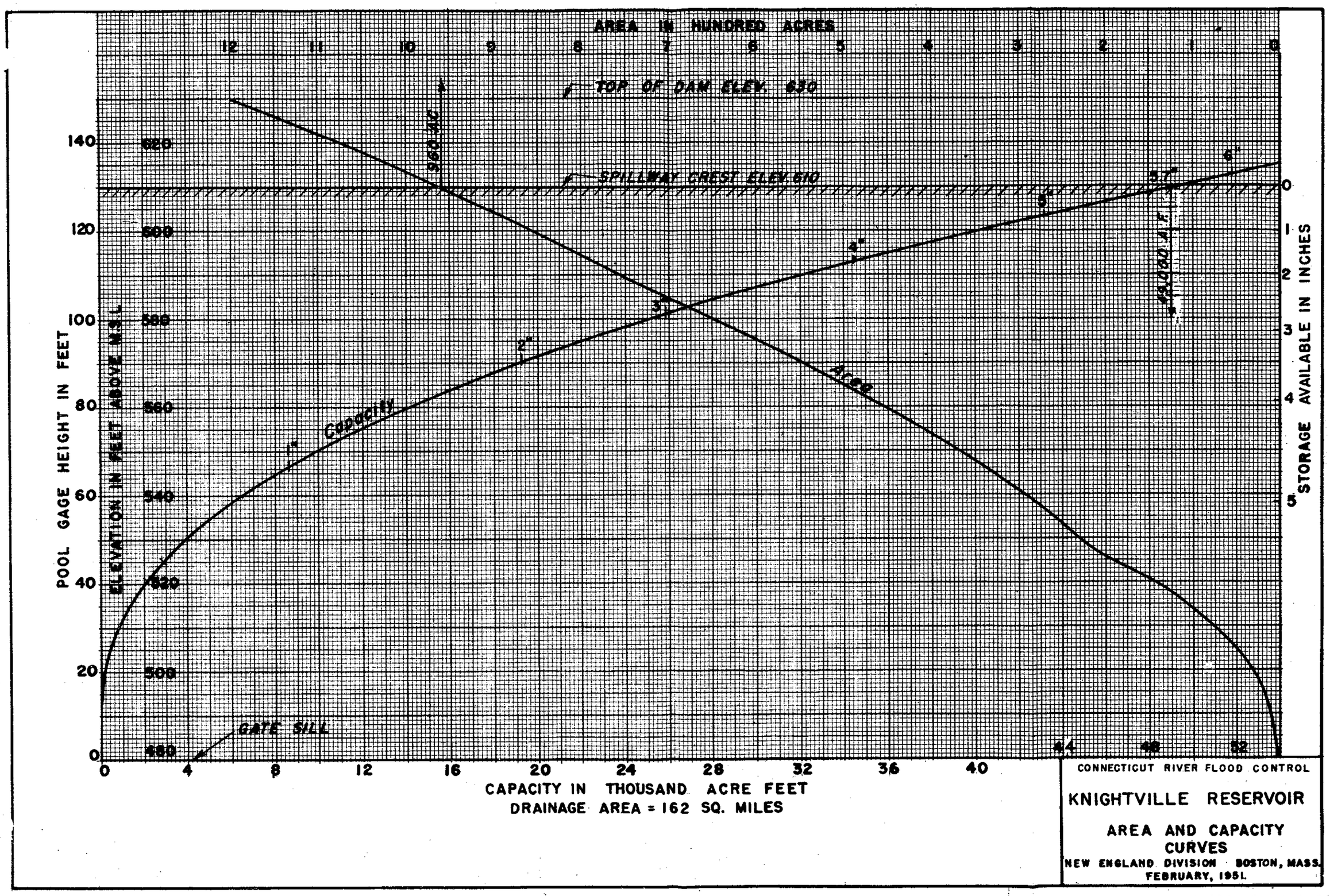
CONNECTICUT RIVER FLOOD CONTROL

LITTLEVILLE DAM

OUTLET RATING CURVES FOR WATER SUPPLY

WESTFIELD RIVER BASIN

PLATE NO. H-1-10



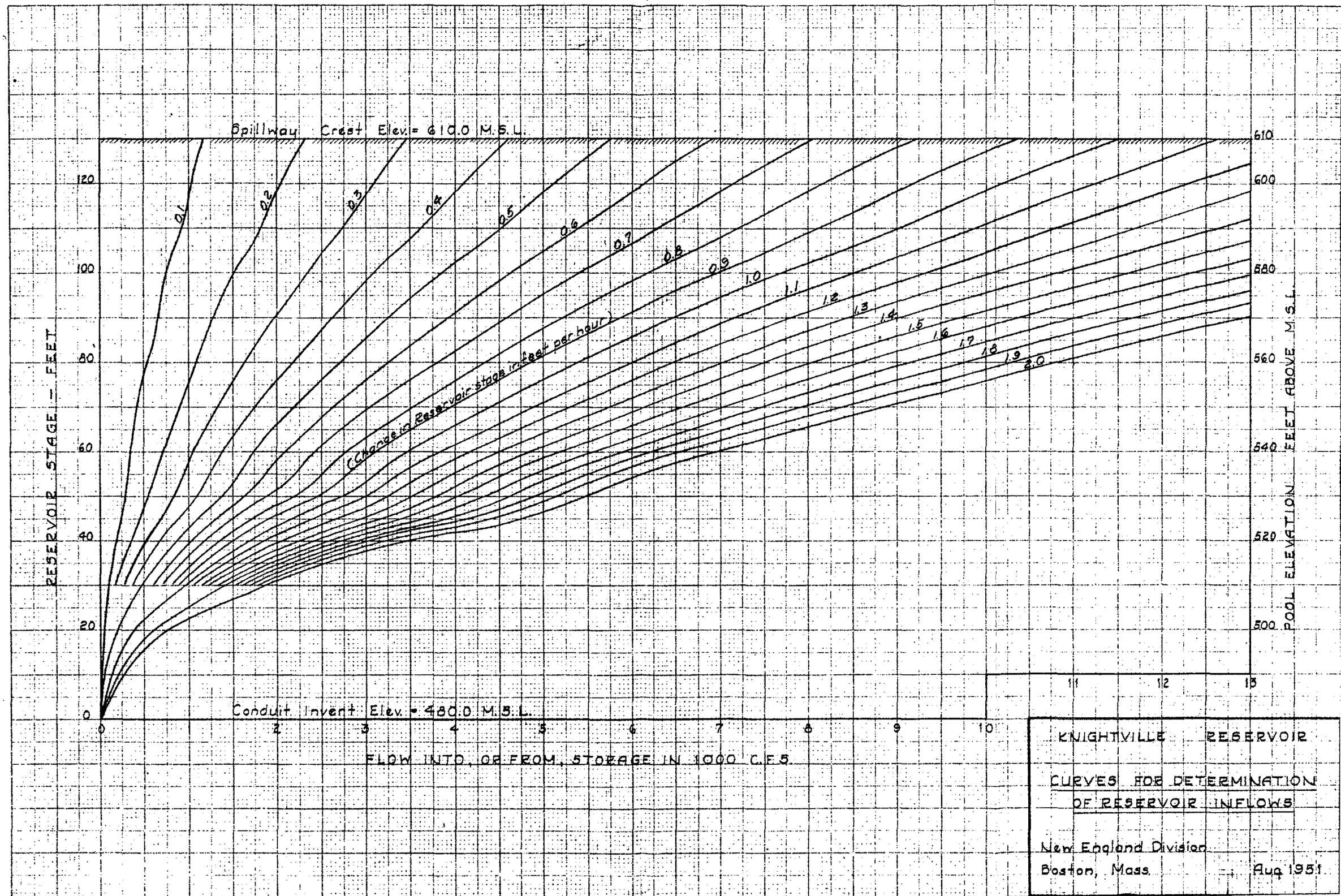
CONNECTICUT RIVER FLOOD CONTROL

KNIGHTVILLE RESERVOIR

AREA AND CAPACITY CURVES

NEW ENGLAND DIVISION BOSTON, MASS.
FEBRUARY, 1951.

PLATE NO. H-1-11

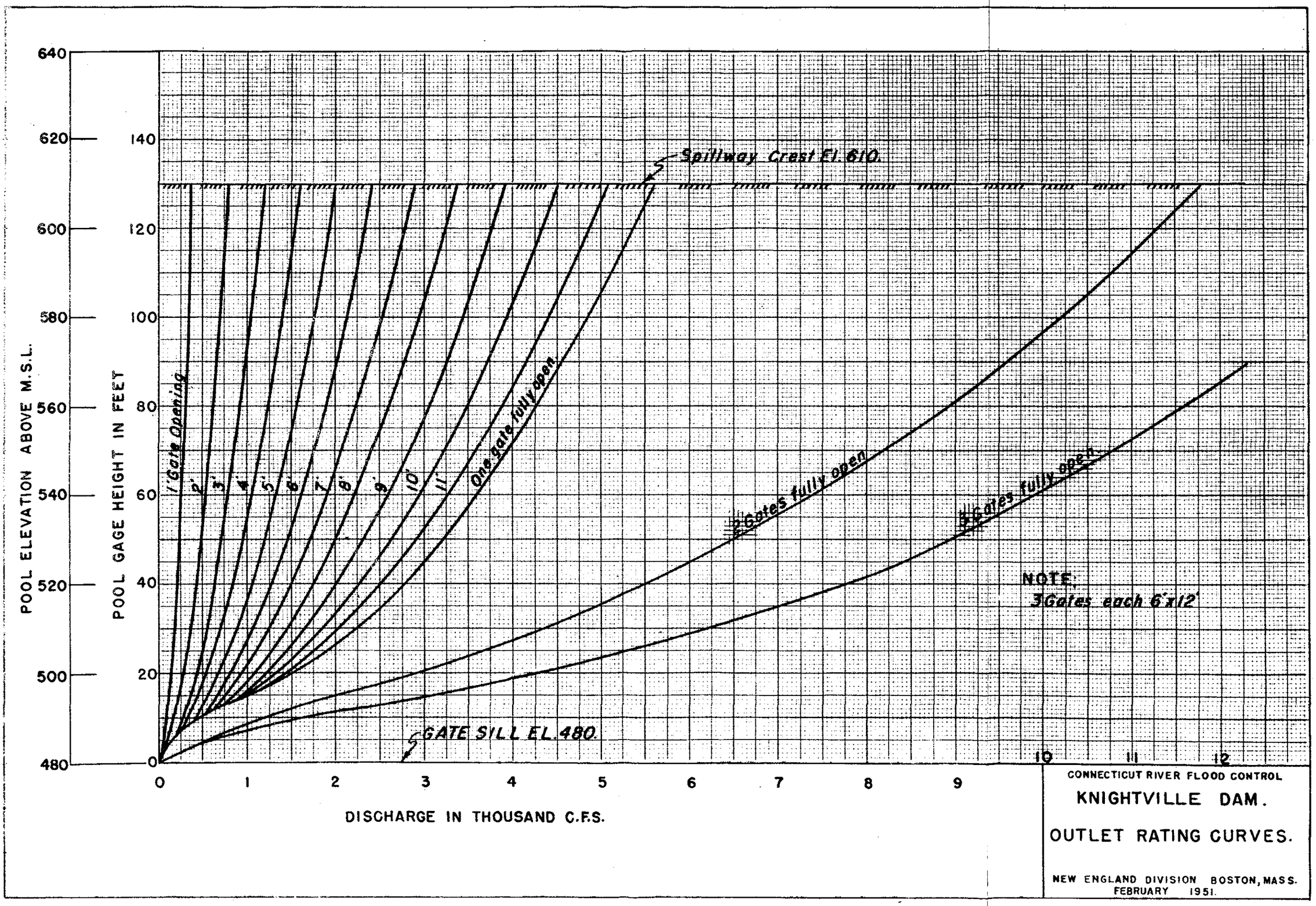


KNIGHTVILLE RESERVOIR

CURVES FOR DETERMINATION OF RESERVOIR INFLOWS

New England Division
Boston, Mass. Aug 1951

PLATE NO. H-1-12



CONNECTICUT RIVER FLOOD CONTROL

KNIGHTVILLE DAM.

OUTLET RATING CURVES.

NEW ENGLAND DIVISION BOSTON, MASS.
FEBRUARY 1951.

PLATE NO. H-I.-13

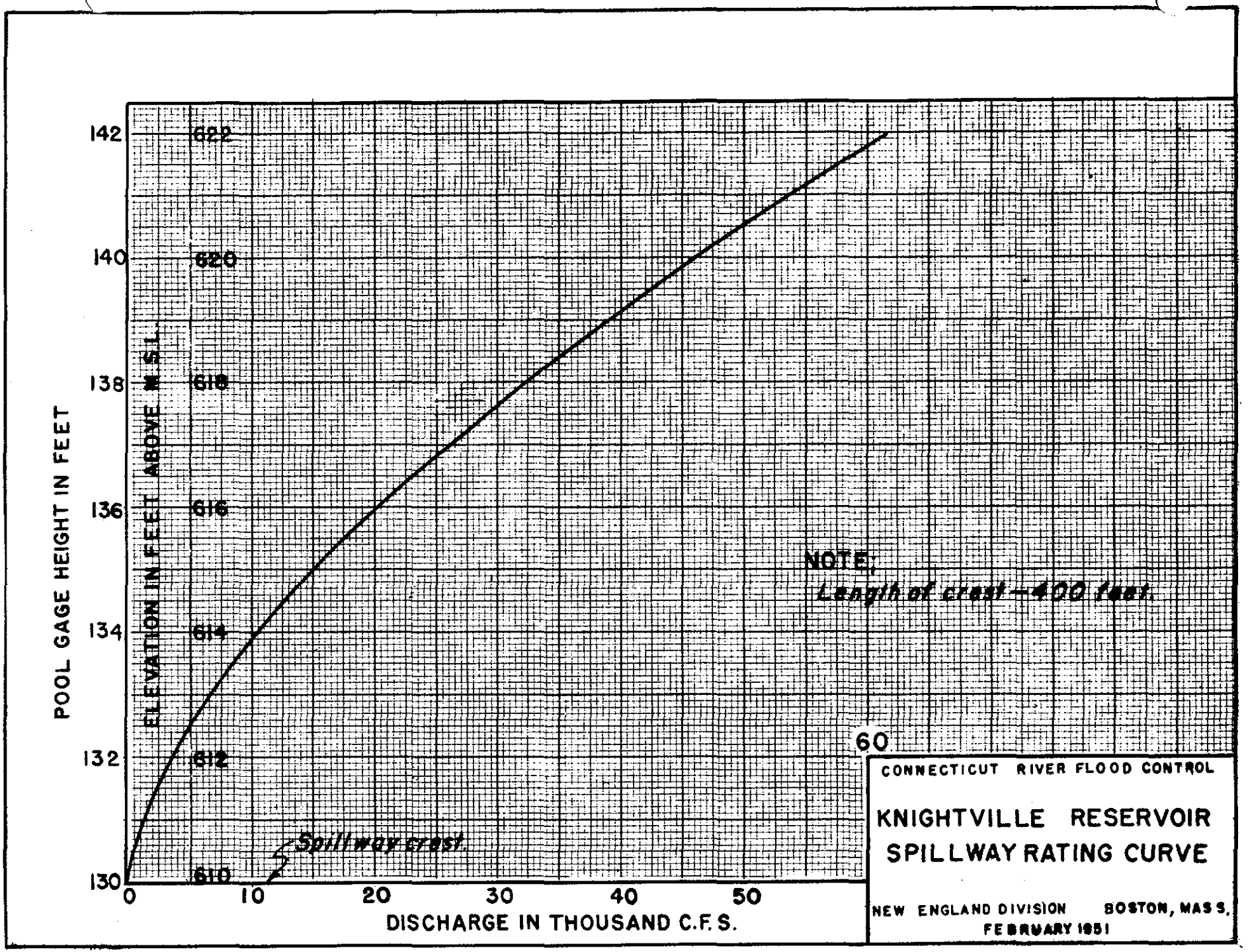


PLATE NO. H-1-14

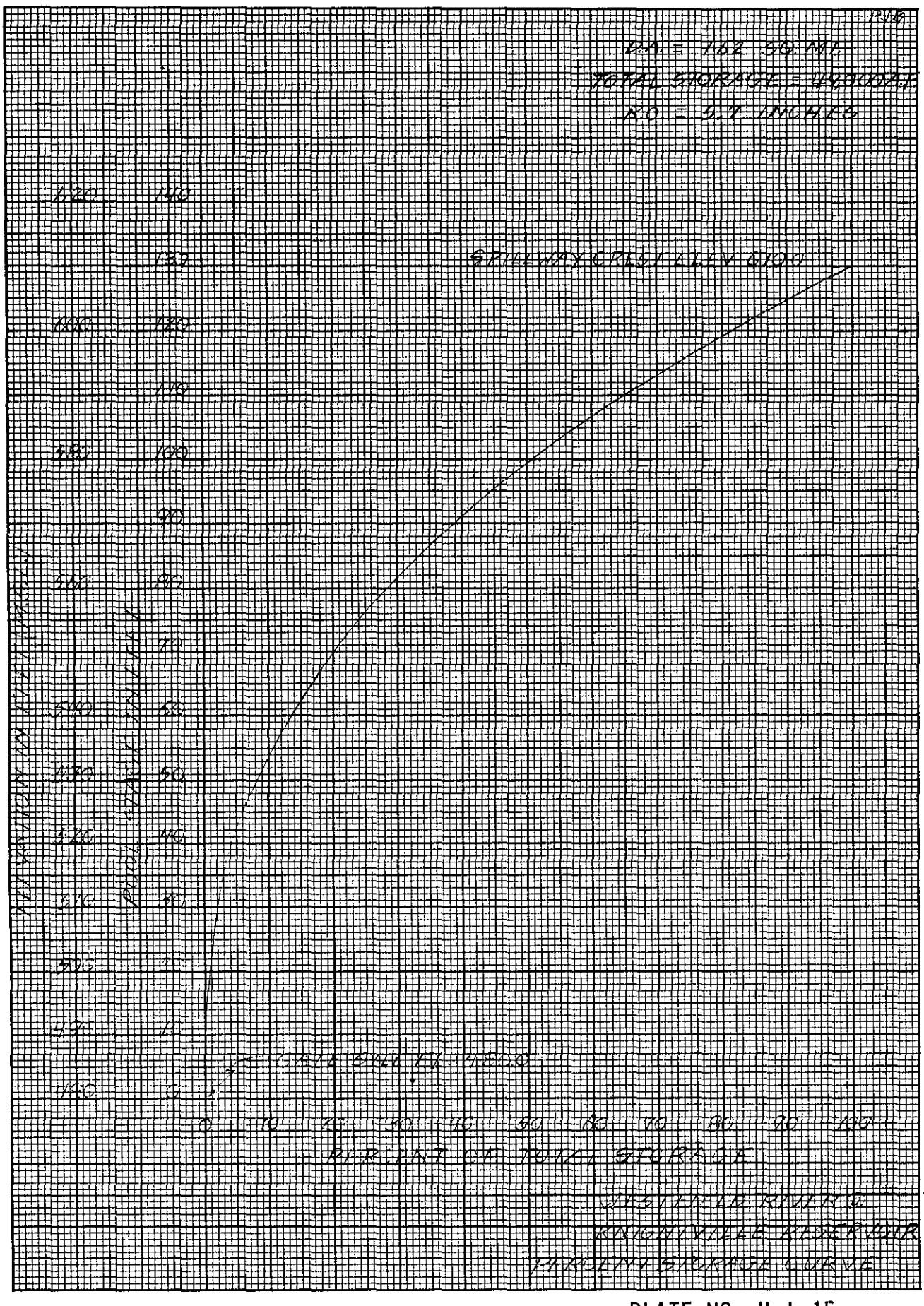
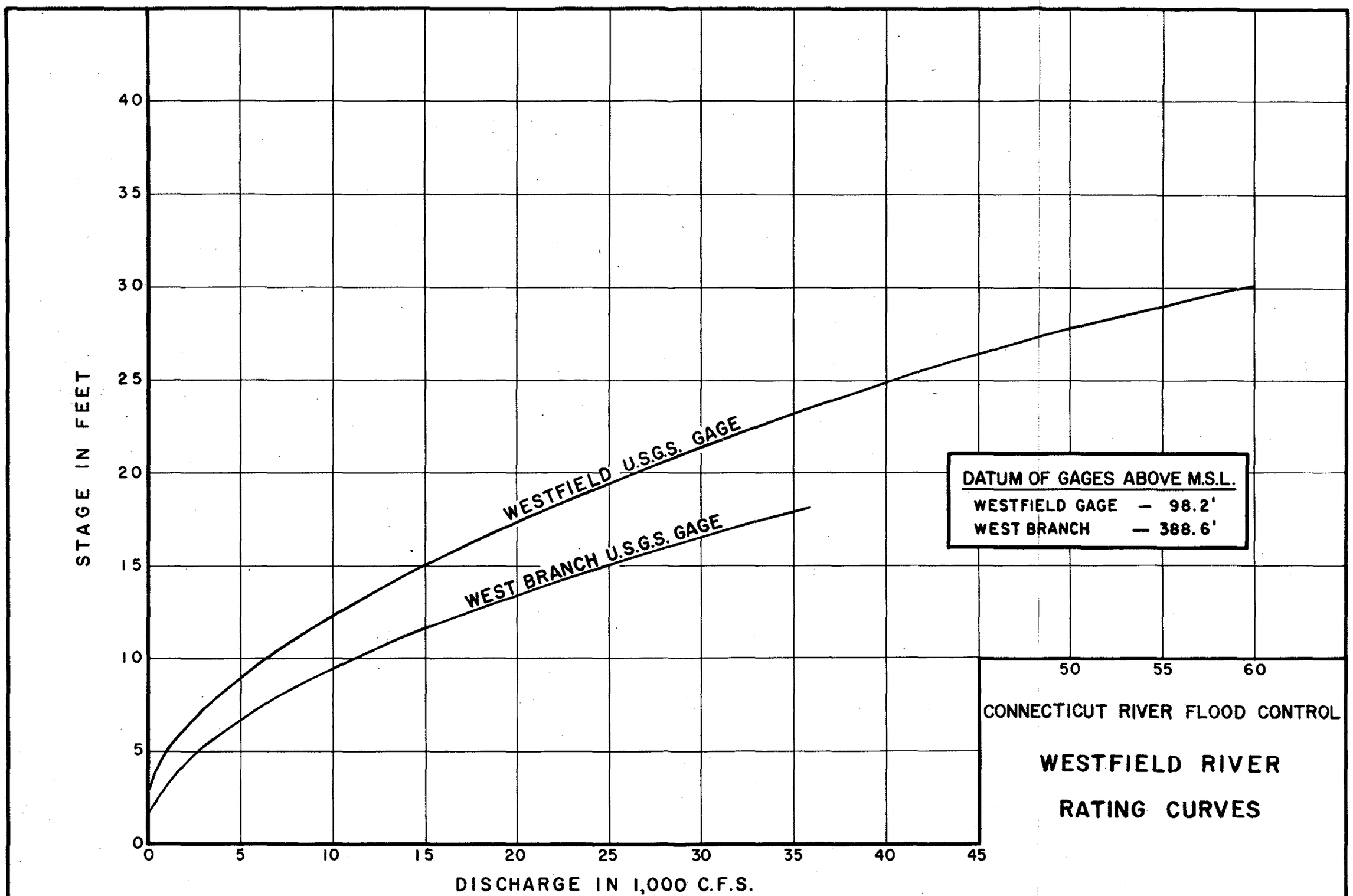


PLATE NO. H-I-15



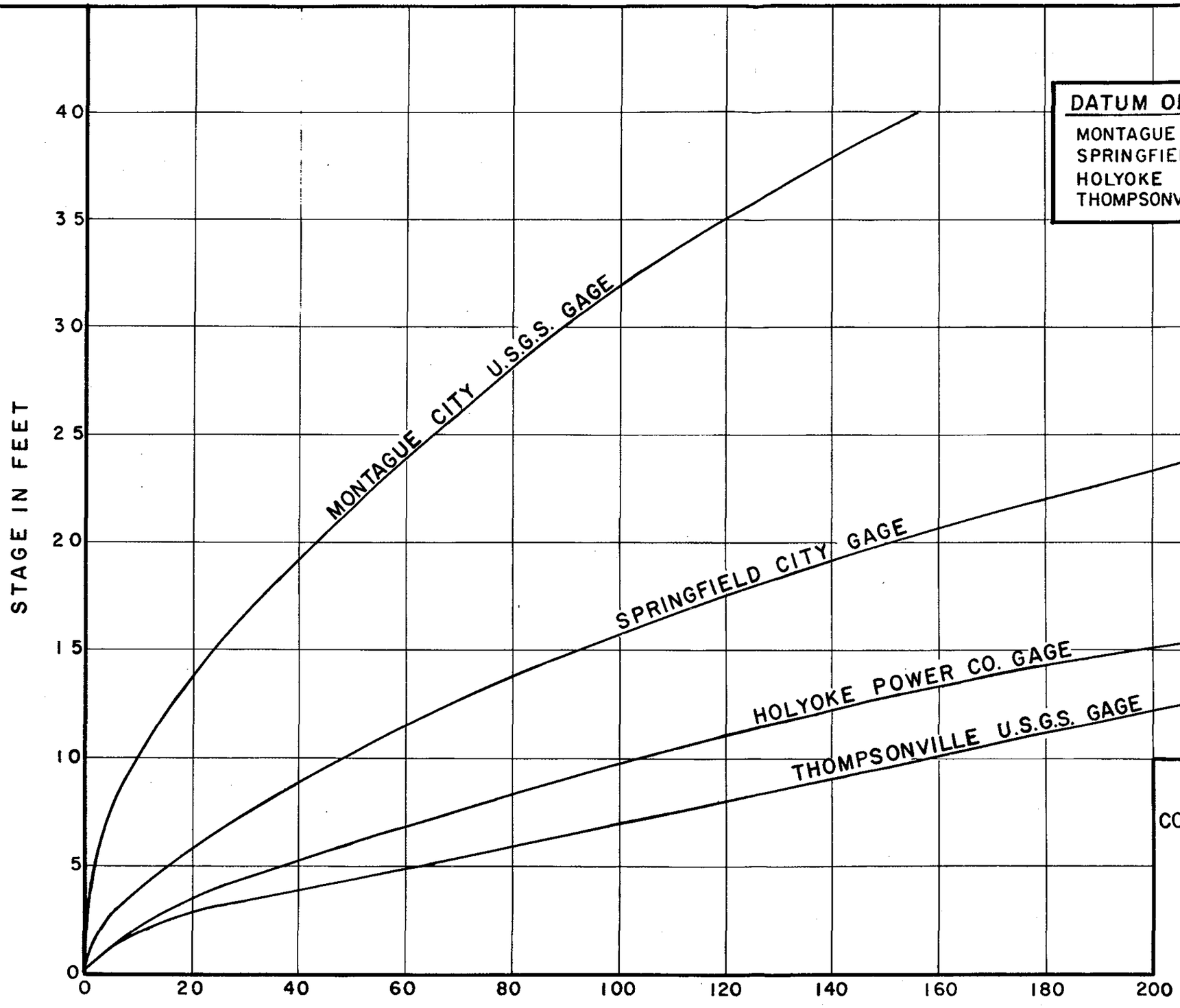
CONNECTICUT RIVER FLOOD CONTROL

WESTFIELD RIVER

RATING CURVES

PLATE H-I-16

DATUM OF GAGES ABOVE M.S.L.		
MONTAGUE CITY	-	99.9'
SPRINGFIELD	-	97.5'
HOLYOKE	-	37.3'
THOMPSONVILLE	-	38.5'



CONNECTICUT RIVER FLOOD CONTROL

CONNECTICUT RIVER RATING CURVES

PLATE H-I-17

9-210
(Sept. 1952)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

File No. Washington 14-1935.00
Field

Rating table for Westfield River near Westfield, Mass.

, from Apr. 7, 1957, to , 19

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
.00			4.00	420	42	6.00	1690	90	8.00	3720	120	10.00	6440	150
.10			.10	462	43	.10	1780		.10	3840		.10	6590	
.20			.20	505	45	.20	1870		.20	3960	120	.20	6740	
.30			.30	550	45	.30	1960		.30	4080	130	.30	6890	
.40			.40	595	50	.40	2050		.40	4210		.40	7040	
.50			.50	645	55	.50	2140		.50	4340		.50	7190	
.60	69	From curve	.60	700	60	.60	2230		.60	4470		.60	7340	150
.70	73	12	.70	760		.70	2320	90	.70	4600		.70	7490	160
.80	85	14	.80	820	60	.80	2410	100	.80	4730		.80	7650	
.90	99	16	.90	880	65	.90	2510		.90	4860	130	.90	7810	
3.00	115	18	5.00	945	65	7.00	2610		9.00	4990	140	11.00	7970	
.10	133	20	.10	1010	70	.10	2710	100	.10	5130		.10	8130	
.20	153	23	.20	1080		.20	2810	110	.20	5270		.20	8290	
.30	176	27	.30	1150		.30	2920		.30	5410		.30	8450	
.40	203	30	.40	1220	70	.40	3030		.40	5550	140	.40	8610	
.50	233	33	.50	1290	80	.50	3140		.50	5690	150	.50	8770	
.60	266	36	.60	1370		.60	3250	110	.60	5840		.60	8930	
.70	302	38	.70	1450		.70	3360	120	.70	5990		.70	9090	
.80	340	39	.80	1530		.80	3480		.80	6140		.80	9250	
.90	379	41	.90	1610	80	.90	3600	120	.90	6290	150	.90	9410	160

The above table is not applicable for ice or obstructed channel conditions. It is based on 10 discharge measurements made during 1957 (377-380), 1958 (381-384, 386, 387), is identical with rating 9-30-57 above 7.9 ft, and is well defined above 100 cfs and fairly well defined below.

Computed by JVB

Checked by RAG

Use hundredths throughout.

Date 8-22-58

Table 35

U. S. GOVERNMENT PRINTING OFFICE 16—87417

PLATE NO. H-I-18

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 1-1810.

Rating table for West Branch Westfield River at Huntington, Mass.

from Feb. 9, 1965, to , 19 . from , 19 , to , 19

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs	Feet	Cfs	Cfs
0.30	2.4		0.50	7.7		0.00			2.00	250	55	4.00	1840	100	6.00	4110	140	8.00	7340	180
.31	2.6		.51	8.1		.01			.01	305	60	.01	1940		.01	4250	140	.01	7520	
.32	2.8		.52	8.5		.02			.02	365	65	.02	2040		.02	4390	150	.02	7700	
.33	3.0	curve	.53	8.9	Curve	.03	2.4		.03	430	70	.03	2140		.03	4540		.03	7880	
.34	3.2		.54	9.3		.04	4.7		.04	500	70	.04	2240		.04	4690	150	.04	8060	180
.35	3.4		.55	9.7	smooth	.05	7.7	From	.05	570	80	.05	2340	100	.05	4840	160	.05	8240	200
.36	3.7		.56	10.1		.06	11.8	5.1	.06	650		.06	2440	110	.06	5000		.06	8440	
.37	3.9	from	.57	10.5	hyperbola	.07	16.9	5.7	.07	730		.07	2550		.07	5160		.07	8640	
.38	4.2		.58	10.9		.08	22.6	6.6	.08	810		.08	2660		.08	5320		.08	8840	
.39	4.4		.59	11.3		.09	29.2	7.3	.09	890		.09	2770		.09	5480		.09	9040	
0.40	4.7		0.60	11.8		1.00	36.5	8.0	3.00	970		5.00	2880		7.00	5640		9.00	9240	
.41	5.0					.01	44.5	9.5	.01	1050		.01	2990	110	.01	5800		.01	9440	200
.42	5.3					.02	54	11	.02	1130	80	.02	3100	120	.02	5960		.02	9640	220
.43	5.6					.03	65	14	.03	1210	90	.03	3220		.03	6120		.03	9860	
.44	5.9					.04	79	17	.04	1300		.04	3340		.04	6280	160	.04	10080	
.45	6.2					.05	96	20	.05	1390		.05	3460	120	.05	6440	180	.05	10300	
.46	6.5					.06	116	23	.06	1480		.06	3580	130	.06	6620		.06	10520	
.47	6.8					.07	139	29	.07	1570		.07	3710		.07	6800		.07	10740	
.48	7.1					.08	168	37	.08	1660		.08	3840	130	.08	6980		.08	10960	
.49	7.4					.09	205	45	.09	1750	90	.09	3970	140	.09	7160	180	.10	11180	220
																		.00	11400	

This table is applicable for open-channel conditions. It is based on 9 discharge measurements made during 1965(353-359), 1966(360, 361), is identical with rating 30 below 0.7 Ft and above 2.3 Ft, well defined. fair poor

Comp by GHS date 10/7/65

Ck'd by RAG date 11-9-65

Table No. 31

U. S. GOVERNMENT PRINTING OFFICE 1963 O—688 393

PLATE NO. H-I-19

9-210
(Rev. 5-63)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 1-1805.00

Rating table for Middle Branch Westfield River at Goss Heights, Mass

..., from Feb. 9, 1965, to ..., 19..., from ..., 19..., to ..., 19...

Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs	Gage height Feet	Discharge Cfs	Difference Cfs
* 0.00			2.00	78	17	4.00	840	70	6.00	3080	160	* 8.00	6640	200	10.00	10940	220	12.00	15720	240
.10			.10	95	19	.10	910	70	.10	3240		.10	6840		.10	11160	240	.10	15960	
.20			.20	114	22	.20	980	80	.20	3400		.20	7040		.20	11400		.20	16200	
.30			.30	136	23	.30	1060		.30	3560	160	.30	7240		.30	11640		.30	16440	240
.40			.40	159	25	.40	1140	80	.40	3720	170	.40	7440	200	.40	11880		.40	16680	
.50			.50	184	27	.50	1220	90	.50	3890		.50	7640	220	.50	12120		.50		
.60			.60	211	29	.60	1310	90	.60	4060		.60	7860		.60	12360		.60		
.75	0.10		.70	240	32	.70	1400	100	.70	4230		.70	8080		.70	12600		.70		
.80	.27	Values	.80	272	33	.80	1500	100	.80	4400	170	.80	8300		.80	12840		.80		
.90	.89		.90	305	35	.90	1600	110	.90	4570	180	.90	8520		.90	13080		.90		
1.00	2.08	of	3.00	340	35	5.00	1710	120	7.00	4750		9.00	8740		11.00	13320		.00		
.10	4.0	more	.10	375	40	.10	1830	120	.10	4930		.10	8960		.10	13560		.10		
.20	6.8	than	.20	415	40	.20	1950	130	.20	5110		.20	9180		.20	13800		.20		
.30	10.6	5.0	.30	455	45	.30	2080	130	.30	5290	180	.30	9400		.30	14040		.30		
.40	15.6	6.4	.40	500	50	.40	2210	140	.40	5470	170	.40	9620		.40	14280		.40		
.50	22	8	.50	550	50	.50	2350		.50	5660		.50	9840		.50	14520		.50		
.60	30	10	.60	606	55	.60	2490	140	.60	5850	190	.60	10060		.60	14760		.60		
.70	40	11	.70	655	55	.70	2630	150	.70	6040	200	.70	10280		.70	15000		.70		
.80	51	13	.80	710	60	.80	2780		.80	6240		.80	10500		.80	15240		.80		
.90	64	14	.90	770	70	.90	2930	150	.90	6440	200	.80	10720	220	.90	15480	240	.90		

This table is applicable for open-channel conditions. It is based on 8 discharge measurements made during 1965(555,556,558-562),1966(563)

is identical with rating 50 above 1.5 ft and is ... well defined. Comp by RAG date 11-12-65

Ckd by GHS date 11-22-65

* Datum changed from 400.30 ft to 399.30 ft above mean sea level, effective Oct. 1, 1964.

Table No. 51

U.S. GOVERNMENT PRINTING OFFICE 1963 O—688-399

PLATE NO. H-I-20

9-210
(Sept. 1962)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

File No. Washington 1A-1.79-5.00
Field

Rating table for Westfield River at Knightville, Mass.

..... from Oct. 1 ..... 1954 , to ..... , 19 .....

Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference	Gage height	Discharge	Difference
Feet	c.f.s.	c.f.s.	Feet	c.f.s.	c.f.s.	Feet	c.f.s.	c.f.s.	Feet	c.f.s.	c.f.s.	Feet	c.f.s.	c.f.s.
1.00			3.00	225	36	5.00	1810	130	7.00	5470	250	.00		
.10			.10	261	39	.10	1940	140	.10	5720	260	.10		
.20			.20	300	43	.20	2080	140	.20	5980	270	.20		
.30			.30	343	47	.30	2220	140	.30	6250	270	.30		
.40	0.5	Curve	.40	390	50	.40	2360	150	.40	6520	280	.40		
.50	1.7		.50	440	55	.50	2510	150	.50	6800		.50		
.60	3.7	from	.60	495	60	.60	2660	160	.60			.60		
.70	6.9		.70	555	65	.70	2820	160	.70			.70		
.80	11.4		.80	620	70	.80	2980	160	.80			.80		
.90	17.7		.90	690	75	.90	3140	170	.90			.90		
2.00	25.5	9.5	4.00	765	80	6.00	3310	180	.00			.00		
.10	35	11	.10	845	85	.10	3490	190	.10			.10		
.20	46	13	.20	930	90	.20	3680	200	.20			.20		
.30	59	16	.30	1020	100	.30	3880	210	.30			.30		
.40	75	18	.40	1120	100	.40	4090	210	.40			.40		
.50	93	21	.50	1220	110	.50	4300	220	.50			.50		
.60	114	24	.60	1330	110	.60	4520	230	.60			.60		
.70	138	26	.70	1440	120	.70	4750	230	.70			.70		
.80	164	29	.80	1560	120	.80	4980	240	.80			.80		
.90	193	32	.90	1680	130	.90	5220	250	.90			.90		

The above table is not applicable for ice or obstructed channel conditions. It is based on 13 discharge measurements made during 1953 (94,95), 1954 (103,105,106), 1955 (109-113,116,117), 1956 (118), is identical with rating 4-30-45 below 3.6 ft. and above 6.2 ft., and is well defined between 20 and 5,500 cfs.

Computed by RAB

Checked by WBG

Use hundredths throughout

Date 11-16-55

Table No. 22

U. S. GOVERNMENT PRINTING OFFICE 16—68317-2

PLATE NO. H-1-21

CONNECTICUT RIVER
RATING TABLES

MARCH 1964

STAGE (FT)	WELLS RIVER USGS GAGE	WHITE RIVER JCT USGS GAGE	NORTH WALPOLE USGS GAGE	MONTAGUE CITY USGS GAGE	HOLYOKE DAM FLOW IN C.F.S.	SPRINGFIELD CITY GAGE	THOMPSONVILLE USGS GAGE	HARTFORD USWB GAGE	BOOKIN ROCK USGS GAGE		WHITE RIVER USGS GAGE	DEERFIELD @ CHARLEMONT USGS GAGE	CHICOPEE R @ INDIAN ORCHARD USGS GAGE	FARMINGTON RIVER @ RAINBOW USGS GAGE
4.0	5030	1200	202	405	24000		42200				620	1980	170	2720
.5	6240	1780	488	695	31000		54200				970	2650	345	3390
5.0	7700	2480	930	1170	38000		63600				1390	3430	600	4080
.5	9200	3270	1510	1610	43000		73500				1870	4310	950	4850
6.0	10900	4180	2270	2260	50000		83000				2440	5210	1380	5680
.5	13050	5200	3160	2870	56000		92500				3110	6140	1830	6600
7.0	15300	6310	4230	3620	62000		102000				3890	7140	2310	7580
.5	17550	7500	5380	4410	68000		111000				4730	8240	2860	8620
8.0	19800	8780	6530	5300	74000		120000				5630	9380	3450	9730
.5	22050	10160	7780	6240	83000		129000				6500	10600	4070	10900
9.0	24300	11600	9080	7240	91000		138000				7300	11900	4720	12120
.5	26550	13100	10430	8340	98000		147000				8200	13200	5420	13300
10.0	28800	14600	11900	9500	106000		156000	34000	81000		9600	14600	6160	14710
.5	31050	16340	13450	10500	113000		165500	36000	86000		11050	16000	6950	16080
11.0	33300	17740	15200	12000	121000	57000	175000	38000	90000		12350	17500	7810	17500
.5	35550	19380	16950	13300	128000	61000	184500	40000	93000		13750	19000	8730	19000
12.0	37800	21080	18700	14800	137000	65000	194000	42500	97000		15150	20600	9710	20500
.5	40050	22880	20450	16300	144200	70000	203500	45000	100000		16650	22200	10760	22000
13.0	42300	24680	22200	17800	152000	74000	213000	47000	105000		18150	23900	11890	23500
.5	44550	26480	23950	19400		78000	222500	50000	109000		19750	25600	13100	25000
14.0	46800	28280	25700	21000		83000	232000	52000	114000		21350	27400	14360	
.5		30180	27600	22700		88000	241500	55000	118000		23100	29200	15680	
15.0		32080	29600	24400		93000	251000	58000	122000		24850	31100	17050	
.5		33980	31600	26200		98000	261000	60500	127000		26750	33100	18450	
16.0		35900	33600	28000		104000	271000	63500	130000		28650	35100	19900	
.5		37900	35600	29900		109000	281000	66500	136000		30700	37200	21400	
17.0		39900	37600	31400		114000		70000	140000			39300	22950	
.5		41900	39600	33700		120000		73000	146000			41500	24550	
18.0		43900	41600	35700		126000		76000	152000			43700	26200	
.5		45900	43600	37700		132000		80000	157000			46000	27850	
19.0		47900	45600	39700		138000		83000	162000			48300	29500	
.5		49500	47600	41700		143000		87000	167000			50700	31200	
20.0		52200	49600	43800		152000		90000	172000			53100	32900	
.5		54450	51600	45900		158000		94000	179000				34650	
21.0		56700	53600	48000		165000		98000	185000				36400	
.5		58950	55600	50200		173000		101000	190000				38200	
22.0		61200	57700	52400		180000		105000	195000				40000	
.5		63450	59950			187000		110000	200000					
23.0		65700	62200	56800		194000		114000	205000					
.5		68100	64450	59050		202000		118000	210000					
24.0		70800	66700	61300		210000		124000	215000					
.5		73400	68950	63550		218000		128000	223000					
25.0		76100	71200	65800		224000		133000	230000					
.5		78700	73450	68050		233000		138000	235000					
26.0		81400	75700	70300		240000		143000	242000					
.5		84200	77950	72650		249000		148000	247000					
27.0		86900	80200	75000		257000		153000	255000					
.5		89700	82750	77800		265000		159000	260000					
28.0		92400	85200	80000		273000		164000	266000					
.5		95200	87700	82500		282000		170000	272000					
29.0		98000	90200	85000		290000		176000	280000					
.5		101000	92700	87500		298000		181000	285000					
30.0		104000	95200	90000		304000		187000	295000					
.5		107000		92500		315000		193000	300000					
31.0		110000		95000		323000		200000	306000					
.5		113000		97750		332000		205000	311000					
32.0		116000		100500		340000		210000	320000					
.5		119000		103500		348000		217000	326000					
33.0		123000		106500		358000		223000	334000					
.5		126000		109750				230000	340000					
34.0		129000		113000				235000	350000					
.5		133000		116900				241000	356000					
35.0		136000		120000				247000	365000					
.5				123700				253000						
36.0				127000				259000						

PLATE NO. H-1-22

LOG OF RADIO REPORTS - FLOOD CONTROL DAMS

OCT 22, 1967

Line	ITEM	LITTLEVILLE DAM		KNIGHTVILLE DAM										Line
1	Time of Observation	0800		0800										1
2	Precipitation (last 24 hours)	0.10		Trace										2
3	Form of Precipitation	Rain		Rain										3
4	Present Weather	Clear		Clear										4
5	Pool Stage	2.8		518.5										5
6	Tendency	Steady		Steady										6
7	Gate Openings	3'-3'		3'-3'-3'										7
8	Tailwater Gage	2.85'		2.80										8
9	Outflow	180		60										9
10	**INDEX POINTS**													10
11		4.6 (700)												11
12		West Branch												12
13		@ Huntington 1.5 (100)												13
14														14
15														15
	REMARKS													

EXAMPLE

NED FORM APR 61 477

SHEET NO. H-1-1

NED FORM MAR63 503

REGULATION OF LITTLEVILLE AND KNIGHTVILLE RESERVOIRS

LOG OF REPORTS AND INSTRUCTIONS

DATE AND TIME OF REPORT	LITTLEVILLE RES.												KNIGHTVILLE RES.								PRECIPITATION				West Branch RIVER AT Huntington			Westfield RIVER AT Westfield			RIVER AT					
	RES POOL		GATE OPENING								OUTFLOW		RES POOL		GATE OPENING			OUTFLOW																			
	HOUR	STAGE	1	2	3	4	5	6	7	8	T.W.	C.F.S.	HOUR	STAGE	1	2	3	T.W.	C.F.S.		LOCATION	HOUR	INCHES INC.	INCHES ACC.	HOUR	STAGE	C.F.S	HOUR	STAGE	C.F.S	HOUR	STAGE	C.F.S	HOUR	STAGE	C.F.S
10/30/67																																				
7:15PM	1900	520	3	3							1.8T	310	1900	8.0	3	3	3	3.75	700		Knightville	1900		1.0"	1900	3.1	1050									
							Weather Bureau						Forecasts		2"			along	Coast		and possibly 6" in Berk				shires in next 24 hours.						Call back at		2.0"			
10:00PM	2145	521	3	3							2.35	500	2145	11.0	3	3	3	4.10	850		Knightville 2.0" (Littleville 1.9")	2030			2030	4.1	1900	2030	7.9	3600						
											Call back with another report										at midnight															
Midnight	2330	521.5	3	3							2.55	600		13.0				4.30	1000						2330	4.9	2700	2330	8.0	3700						
											Close down gates at both Reservoirs and check stages every 2 hrs. during night																										
10/31/67											Call at 8:15 A.M. at office or										during night if necessary															
8:15AM	0200	524.5	0	0							0	0	0200	33.6	0	0	0		0						0200	5.65	3600	0200	10.0	6400						
	0400	525.0	0	0							0	0	0400	44.5	0	0	0		0						0400	5.40	3300	0400	11.5	8800						
	0600	525.6	0	0							0	0	0600	50.0	0	0	0		0						0600	5.00	2800	0600	12.25	10000						
	0800	526.2	0	0							0	0	0800	53.7	0	0	0		0		Knightville 2.75" (W. Cummington 3")				0800	4.50	2300	0800	11.5	8800						
																					(Storm over)															
											Stay as you are.										Call back at noon.															
12.30	1200	527.0	0	0							0	0	1200	59.4	0	0	0		0						1200	3.70	1500	1100	11.0	8000						
											Open Littleville to 450 cfs and Knightville to 1000 cfs in two steps.																									
							Now and at 4:00 pm., Call back at						0800																											
11/1/67																																				
0830	0800	527.5	2½	2½							2.30	480	0800	64.8	1.5	1.5	1.5	4.40	1100						0800	2.8	790	0800	8.3	4100						
											Open Littleville to 800 cfs and Knightville to 2500 cfs in																									
											Three steps, one every other hour														Call back in morning											
11/2/67																																				
0830	0800	525.0	5	5							2.90	800	0800	59.0	3	3	3	5.30	2250						0800	2.5	550	0800	8.1	3900						
											Open Knightville to 3000 cfs. Call back in morning																									
11/3/67																																				
0830	0800	522.0	5	5							2.75	700	0800	48.0	4	4	4	5.85	2850						0800	2.3	410	0800	8.1	3900						
											Stay as you are																										
											Empty Reservoirs and then go to normal gate settings																										
											Call in each morning until back To normal																										

EXAMPLE

GATE OPERATION RECORD

LITTLEVILLE RESERVOIR — OCTOBER MONTH 1967 YEAR

KNIGHTVILLE

DATE	HOUR	RES. STAGE Feet	GATE OPENING IN FEET*								OUTFLOW C.F.S.		REMARKS
			#1	#2	#3	#4	#5	#6	#7	#8	BEFORE	AFTER	
	LITTLEVILLE												
10/30	Mid-Night	521.5	3	3							600	600	
	0010	"	0	0							600	0	Start of Operation
10/31	1300	527.0	1	1							0	210	
	1600	527.0	2.5	2.5							210	480	
11/1/67	0900	527.5	3	3							480	550	
	1100	527.5	4	4							550	700	
	1300	527.4	4.5	4.5							700	800	
11/2/67	0600	525.0	5	5							750	800	
11/5/67	0900	520.0	3	3							300	300	End of Operation
	KNIGHTVILLE												
10/30	Mid-Night	13.0	3	3	3						1000	1000	
	0010	"	0	0	0						1000	0	Start of Operation
10/31	1300	59.4	1	0	1						0	480	
	1600	61.0	1	2	1						480	1000	
11/1/67	0900	64.8	2	2	2						1000	1560	
	1100	64.8	3	2	3						1560	2100	
	1300	64.4	3	3	3						2100	2500	
11/2/67	0900	59.0	4	4	4						2500	3000	
11/3/67	0900	48.0	4.5	4.5	4.5						2700	3000	
11/5/67	0900	8.0	3	3	3						900	900	End of Operation

EXAMPLE

*Indicate full opened gate by "F"

SIGNED _____
OPERATOR

DATE _____

NED FORM MAR 62 90 REPLACES EDITION OF FEB 60 WHICH IS OBSOLETE

SHEET NO. H-1-3

A T T A C H M E N T II

OPERATIONAL PROCEDURES AND MAINTENANCE

OF

HYDROLOGIC EQUIPMENT

AT

LITTLEVILLE AND KNIGHTVILLE RESERVOIRS

ATTACHMENT II

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ATTACHMENT II
OPERATIONAL PROCEDURES
AND MAINTENANCE OF
HYDROLOGIC EQUIPMENT

1. PRECIPITATION GAGE

An automatic recording precipitation gage is installed at Littleville and Knightville Dams which continuously records official precipitation readings for the U. S. Weather Bureau (USWB). The Flood Control Dam Operator (FCDO) should read the USWB rain gage daily and record the observations on WB Forms 1009-R and 612-24. While reading the gage, the operator should inspect the equipment to see if the clock is running correctly and the pen inking properly. Unless precipitation is falling at the time of observation, the pen of the recording gage should be raised to the next 0.25" line to avoid overlapping of the record. Rain gage charts (WB Form 1028c) should be changed each Monday and forwarded with WB Form 1009-R to the Reservoir Regulation Section (RRS). If additional charts, forms or other USWB supplies are needed, the FCDO should note it on the submitted WB Form 1009-R. Instructions on correct operation of precipitation gages and recording data are printed on the covers of each pad of USWB forms.

A Weather Bureau representative visits the dam several times each year to service the precipitation gage. Should a malfunction of the gage occur between visits, the FCDO should notify the RRS who will make arrangements with the USWB to repair the gage.

2. THERMOMETER

A maximum-minimum thermometer is located at Knightville Dam. The FCDO should adjust the maximum and minimum temperature levels daily. Whenever temperature data are requested by the RRS this information is transmitted via the NED radio network.

3. RESERVOIR STAGE RECORDER

The automatic water level recorders at Littleville and Knightville Dams trace the water level in the reservoirs at all times. The water-stage recorder is operated by a float. The recording instrument should

be checked each morning to assure that the clock is keeping correct time and that the pen is tracing properly. Any discrepancies in the record as evidenced by the pen time or gage height, should be noted on the chart and the instrument reset. During periods of reservoir storage, the outside tile or staff gage should be read to check the tape readings and chart record. The chart record should be changed the first working day of each month. At the beginning and ending of each monthly chart, the following information should be noted in ink on the chart.

a. Outside (tile) gage reading

b. Pen gage height reading

c. Watch time

d. Pen time

e. Date and name of dam

New charts for monthly recorders should be obtained from the NED warehouse.

4. TELEPHONE TRANSMITTER (TELEMARK)

A telephone transmitter (telemark) is in operation on the Westfield River at Westfield to obtain river stages to aid in regulating Littleville and Knightville Reservoirs. Presently telemarks are the most satisfactory method of river stage reporting, especially where it is essential to have 24-hour coverage of the index stations. Should the telemark become inoperative, the Littleville FCDO should visit the USGS gage to ascertain where the difficulty is. If the trouble cannot be determined at the gage, the telephone company should be requested to check out their circuits. The FCDO should be at the gage when the telephone company inspects their system. If the telemark still cannot be made operative, the RRS should be notified and NED and/or USGS personnel will inspect the telemark system. Telemark stations on the Connecticut River will not be the responsibility of the Littleville and Knightville Dam operators.

5. TAILWATER GAGING STATION

A tailwater gaging station is located downstream of each dam to provide a continuous official record of the discharge from the dam. It is essential that the equipment be checked frequently to assure a continuous

record. The tailwater gage readings included in the routine radio and telephone reports to the RRS on Fridays are used for calibration of the gates and as a ready reference of basin run-off conditions at the time of observation.

If inspection of the gage indicates a need for repair, the RRS should be notified immediately and arrangements will be made with the USGS to have the equipment repaired.

6. SNOW SAMPLING SET

A snow sampling set has been assigned to the FCDO. Procedures for obtaining snow survey data should follow instructions set forth in Snow-Survey Sampling Guide, Department of Agriculture Handbook No. 169. If given proper care, the only maintenance required would be occasional replacement of worn-out cutter heads.