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GEOLOGICAL SURVEY

# EXTENT AND FREQUENCY OF FLOODS IN THE VICINITY OF EASTON, PA.-PHILLIPSBURG, N.J.

By

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Prepared in cooperation with

Delaware River Basin Commission

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Open-file report

## PREFACE

This is the first of two reports on flood inundation along the Delaware River. This report presents data on the extent, depth, and frequency of flooding along the Delaware River in vicinity of Easton, Pa.-Phillipsburg, N.J. The second report is under preparation and will extend the coverage of this report upstream along the Delaware River to about three miles above Belvidere, N.J.

This flood inundation study is part of an investigative program financed through a cooperative agreement between the U.S. Geological Survey, Water Resources Division, and the Delaware River Basin Commission. The report was prepared under the direction of J. E. McCall, District Engineer, U.S. Geological Survey, Trenton, N.J. Technical guidance was furnished by J. A. Bettendorf, Hydraulic Engineer, Trenton, N.J.

Similar studies and reports on flood inundation elsewhere in the Delaware River basin are planned or in progress. Specific information as to location and status of these studies may be obtained from the Delaware River Basin Commission, Trenton, N.J.

The streamflow data for the Delaware River have been collected by the U.S. Geological Survey since 1906. Since 1921 this work has been conducted by the Survey in cooperation with the New Jersey Department of Conservation and Economic Development and its predecessor agencies. The streamflow data for the Lehigh River were collected by the Survey in cooperation with the Pennsylvania Department of Forests and Waters and were furnished by the Harrisburg, Pa. office of the Survey. Additional data were obtained from the Corps of Engineers, U.S. Army; U.S. Weather

Bureau; Delaware River Joint Toll Bridge Commission; City of Easton, Pa.; Town of Phillipsburg, N.J.; Pennsylvania Railroad Co.; and many local utilities, industrial firms, and residents. Photographs were furnished by the Easton Express of Easton, Pa.

CONTENTS

# ILLUSTRATIONS

[Plates are in pocket]

## ILLUSTRATIONS



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## TABLES

# EXTENT AND FREQUENCY OF FLOODS IN THE VICINITY OF EASTON, PA.-PHILLIPSBURG, N.J.

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## INTRODUCTION

### Purpose and Scope

The Delaware River has flooded many times in the past and, most certainly, will continue to do so in the future. Such floods inundate large areas resulting in heavy property damage, business losses, rescue and emergency costs, and possible loss of life. An evaluation of flood conditions is necessary for planning of the optimum economic development of the river valley consistent with the flood risk. Basic data on the regimen of the streams, particularly the magnitude of floods to be expected, the frequency of their occurrence, and the areas inundated, are essential for planning the development of flood-prone areas.

This report presents information relative to the extent, depth, and frequency of floods on the Delaware River and its tributaries in the vicinity of Easton, Pa.-Phillipsburg, N.J. With the exception of the Lehigh River, the report covers flooding on the tributaries due only to backwater from the Delaware River. Flood conditions on the Lehigh River are discussed separately because flooding may be due to floods primarily

on the Lehigh River, backwater from the Delaware River, or a combination of the two. Data are given for the area under study for several past floods, emphasis being given to the August 19, 1955, flood, the May 24, 1942, flood, and a hypothetical flood based on the August 19, 1955, flood modified by existing and planned flood-control works. With these data the extent, depth, and frequency of flooding at any site along the reach of the Delaware River considered in the report can be estimated. Evaluation of flood data are presented so local and regional agencies, organizations and individuals may have a technical basis for making decisions on usage of flood-prone areas.

No recommendations for land use, or suggestions for limitation of land use, are made in the report. Criteria and recommendations for land use planning can be found in Dola (1961); White (1961); American Society of Civil Engineers Task Force on Flood Plain Regulations (1962); and Goddard (1963). The responsibility for planning for the optimum land use in the flood plain and the implementation of flood-plain regulations to achieve such optimum use rests with the state and local interests. The preparation of this report was undertaken after consultation with representatives of the Lehigh-Northampton Counties, Pennsylvania, Joint Planning Commission; and the Warren County, New Jersey, Regional Planning Board; and after both had demonstrated their need for flood-plain information and their willingness to consider flood-plain regulations.

## Location and Extent of Area

The area covered by this report consists of the Delaware River and its flood plain and is situated in Northampton County, Pa. and Warren

County, N.J. (pl. 1). Included in the study is the extent of flooding on the tributaries due to backwater from the Delaware River. The total length of stream channel covered in the report for the August 19, 1955, flood is 21.9 miles with 12.6 miles on the main stem of the Delaware River. Included in the 9.3 miles of tributary stream channel are 3.6 miles of the Lehigh River and 1.9 miles of the Bushkill Creek. Two large urban areas, Easton, Pa. and Phillipsburg, N.J., are on the Delaware River at the mouth of the Lehigh River. The area under study can be found on the U.S. Geological Survey 7½-minute topographic quadrangles Easton, N.J.-Pa. and Riegelsville, Pa.-N.J. The southern terminus for this report is the Northampton-Bucks County line. The northern terminus is latitude 40°45', the top of the Easton, N.J.-Pa. 7½-minute topographic quadrangle, which is four miles north of the Northampton Street Bridge in Easton, Pa.-Phillipsburg, N.J.

Studies are in progress for a second report to cover the reach of the Delaware River immediately upstream from the area of this report. The northern terminus for the second report will be latitude 40°52'30", the top of the Belvidere, N.J.-Pa. 7½-minute topographic quadrangle, which is three miles north of the Belvidere, N.J.-Riverton, Pa. bridge.

## The Flood Plain

The Delaware River reach under study is almost entirely in the Reading Prong extension of the New England physiographic province (Fenneman, 1938). The stream flows through an area of low mountains, and in many places the steep valley walls limit the extent of the flood plain.

The Delaware River in the reach under study is "trenched below the surrounding terrain" (Hoyt and Langbein, 1955, p. 17). Man's development along the River is mainly on the old flood plain formed in the geologic past by a much larger stream. In this region there is little or no flood plain for the present Delaware River. The old flood plain forms a terrace along the present Delaware River.

In the reach of the Delaware River under study, pre-Wisconsin glaciation had little or no effect on the flood plain. Remnants of fluvial-glacial deposits of Wisconsin age in the form of a valley train make up part of the flood plain in several locations, mainly along inside bends of the Delaware River (Salisbury, 1902). Several gravel pits have been developed along the reach. A limited area of the flood plain is used for farmland, but since the flood plain is narrow, development of the flood plain pertains mainly to building sites and highways. Concentrated industrial development on the flood plain exists almost solely in the Easton, Pa.-Phillipsburg, N.J. metropolitan area.

The Lehigh River flood plain in the vicinity of Easton, Pa. is bounded by railroad embankments on both sides. These embankments, situated in part near the bottom of cliffs and hills, limit the areal extent of flooding. Industrial development of the Lehigh River flood plain occurs mainly on the left (north) bank in the reach under study.

## METHOD OF ANALYSIS

The method of analysis used is, in part, similar to "Phase I" methods explained in U.S. Geological Survey Water-Supply Paper 1526 (Wiitala,

Jetter, and Sommerville, 1961). The initial step was to prepare flood-frequency curves (figs. 1, 2, and 3) for three sites on the Delaware River based on a regional flood-frequency study by Tice (1958). Then stage-discharge relations for floods were defined for these three locations. Next, high-water profiles for selected floods were plotted (fig. 4). The projected water surface of the August 19, 1955, flood, modified by the effect of flood prevention improvements planned or constructed prior to the date of this report, was furnished by the Corps of Engineers (fig. 4). (The major flood prevention improvements are the Tocks Island, Francis E. Walter, Beltzville, General Edgar Jadwin, Prompton, Aquashicola, and Trexler Reservoirs.) The final step was the preparation of a flood-inundation map (pl. 1), delineating the area inundated by the August 19, 1955, flood and the May 24, 1942, flood. The flood-inundation map was prepared on the basis of high-water profiles (fig. 4), field surveys, and information supplied by local residents.

## Data Available

Streamflow data have been systematically collected for a long period of time at three U.S. Geological Survey gaging stations in the vicinity of the study area. They are: Delaware River at Belvidere, N.J.; Lehigh River at Bethlehem, Pa.; and Delaware River

at Riegelsville, N.J. Well-defined stage-discharge relations are available for each of these locations. In addition, peak-stage readings from a wire-weight gage on the Northampton Street Bridge at Easton, Pa., maintained by the Delaware River Joint Toll Bridge Commission since 1936, were furnished by the Bridge Commission. The maximum annual flood discharges and/or stages, as recorded at these locations, are listed in tables 1, 2, 4, and 5. The annual peaks in the tables are based on a water year which begins on October 1 and ends on September 30. Elevations of peaks at gages can be converted to gage heights by subtracting the appropriate datum of gage listed in the tables. Flood stage, as used by the U.S. Weather Bureau for the gage at Northampton Street Bridge, is at an elevation of 177.2 feet.

Historic floods were recorded for many localities on the Delaware River. The most extensive record was collected in the Easton, Pa.-Phillipsburg, N.J. area where flood-crest elevations are available for historic floods back to Revolutionary times (table 3). However, several problems exist with these flood-crest elevations which make it impossible to establish an accurate long-term record of the historic floods on the Delaware River for a site in Easton, Pa. or Phillipsburg, N.J. The first problem is discrepancies in the data. Inconsistencies were due to: (1) difference in datums used to tie in various high-water marks; (2) bench-mark elevations used to determine flood-crest elevation were published in error; and (3) location of high-water marks not adequately described.

Another difficulty in obtaining an accurate long-term record for a site on the Delaware River is the variable backwater above the mouth of the Lehigh River. The relation between stage and discharge at Northampton Street Bridge is affected by backwater to varying degrees during different floods.

No precise determination could be made to convert flood-crest data obtained at a site below the mouth of the Lehigh River (table 3) to a site at the Northampton Street Bridge. However, it was possible to establish a relative magnitude of historic floods at the Northampton Street Bridge in Easton, Pa.-Phillipsburg, N.J.

The maximum known flood on the Delaware River in the Easton, Pa.-Phillipsburg, N.J. vicinity since colonial times occurred on August 19, 1955. The August 19, 1955, flood was about 5½ feet higher at the Northampton Street Bridge in Easton, Pa. than the flood of October 10, 1903, which was the second highest flood since colonial times. Other floods of large magnitude are: (1) the historical floods of January 8, 1841; June 5, 1862; December 16, 1901; and March 2, 1902; and (2) a flood of recent times, the March 19, 1936, flood. The erratic distribution of flood events is illustrated by the above dates and by figure 5, which shows the highest floods of record and the 1841 flood at Riegelsville, N.J.

Flood-crest elevations for the August 19, 1955, and October 10, 1903, floods, and the lesser floods of March 19, 1936, and May 24, 1942, were obtained from field surveys and published and unpublished records from several sources. The March 19, 1936, and the May 24, 1942, floods were included in figure 4, because both were floods of large magnitude occurring in recent times for which accurate data are available.

Photographs (figs. 6-10) indicate the extent of the flood of August 19, 1955, in the Easton, Pa.-Phillipsburg, N.J. metropolitan area. The first four photographs (figs. 6-9) were taken prior to peak stage of the flood. Figure 10 was taken on August 20, 1955, as the river was receding.

Table 6 gives information on bridges across the Delaware River in the

Easton, Pa.-Phillipsburg, N.J. area. All bridges in the area were either inundated or their approaches flooded by the 1955 flood. The center portion of the Northampton Street Bridge was destroyed by the flood of 1955 (fig. 10).

U.S. Geological Survey 7½-minute topographic maps, at a scale of 1:24,000, were used as a base to show areal extent of flooding and provide planimetric control. Vertical control used in obtaining flood elevations and cross sections was supplied by the U.S. Coast and Geodetic Survey, U.S. Geological Survey, City of Easton, Pa., Town of Phillipsburg, N.J., and the Pennsylvania Railroad Co. Bench marks used for vertical control are listed in table 7. Elevations in this report are referenced to sea-level datum of 1929.

Delaware River mileage used in this report conforms with the mileage system adopted by the Delaware River Basin Commission. The origin or zero mile is at the mouth of Delaware Bay. An exact location of the origin is the intersection of a line between Cape May Light in New Jersey and the tip of Cape Henlopen, Delaware, with the centerline of the navigation channel. Mileages for the tributaries of the Delaware River are measured from the mouth of the respective tributary.

## Magnitude and Frequency of Floods

Regionalized flood-frequency curves were defined for three locations on the Delaware River (figs. 1, 2, and 3). The relations, based on Tice's "Delaware River Basin Flood Frequency" (1958) open-file report and converted to partial-duration series, were derived by procedures explained by Dalrymple (1960). Regional frequency relations for the Delaware River were developed by Tice (1958) using a base period of 1913-55 and historical record extending

back to 1692. Observed streamflow data for gaging stations were used to develop regional relations. Figures 1 and 3 are flood-frequency curves defined for gaging stations with a well-defined stage-discharge relation. Figure 2, "Frequency of floods on Delaware River at Easton, Pa. below mouth of Lehigh River" is a flood-frequency curve for an ungaged site. A stage-discharge relation for floods above 50,000 cubic feet per second was developed from observed and historical streamflow data for the Delaware River at Riegelsville, N.J. gaging station and correlated to the stage at Northampton Street Bridge. This relation was used to define the flood-frequency curve in figure 2. Recurrence interval, as applied to flood events, is the number of years on the average within which a given flood will be equaled or exceeded once.

Magnitude and frequency relations (figs. 1 and 2) can be used for the Delaware River and its tributaries in the study area with few exceptions. Magnitude and frequency relations for all tributaries except the Lehigh River pertain only to flooding due to backwater. Flooding on the 3.6-mile reach of the Lehigh River included in this report may be due to the following conditions: (1) backwater from the Delaware River; (2) floods primarily on the Lehigh River; and (3) a combination of (1) and (2). It is therefore suggested that magnitude and frequency relations in this report not be used for the Lehigh River beyond one mile above its mouth. Another exception, detailed below, is for the reach of the Delaware River above the city of Easton, Pa.

The flood of August 19, 1955, was the greatest on the Delaware River since colonial times and has an estimated recurrence interval of more than 150 years. For most of the reach under study, the October 10, 1903; March 19, 1936; and the May 24, 1942, floods have estimated recurrence intervals of 130 years, 40 years, and 11 years, respectively. The frequency relations given

for the above floods are the average of the recurrence intervals obtained from figures 1 and 2 and are to be used for the reach from the Bucks-Northampton County line (mile 175.8) to the northern city limits of Easton, Pa. (mile 185.1), which is the approximate head of backwater from the Lehigh River. For the reach from the Easton city limits (mile 185.1) to the top of the quadrangle (mile 188.4) the following recurrence intervals should be used: October 10, 1903, 124 years; March 19, 1936, 32 years; and May 24, 1942, 9 years. These recurrence intervals are a weighted average determined from figures 1, 2, and 3, with figure 3 being given greater weight.

Existing and planned flood-control works in the Delaware River basin would reduce future floods significantly. According to the Corps of Engineers, Philadelphia District, the latest designs for these works would reduce the depth of flooding of a hypothetical August 1955 flood by about 14 feet at Easton, Pa. and about 10 feet at Riegelsville, N.J. The flood-control works will decrease significantly the frequency of flooding but will not completely eliminate the flood threat.

Magnitude and frequency of any past or future flood can be estimated by use of the frequency curves. Information concerning the use and interpretation of frequency curves can be found in several published reports; for example, Dalrymple, (1960); Gumbel, (1945); and Langbein, (1949).

Magnitude and frequency relations used for practical applications should be based on elevations referenced to sea-level datum of 1929. A list of bench marks and their elevations as used in this report is presented in table 7 to aid any subsequent study and field surveys.

## Flood Profiles

Flood profiles of the Delaware River (fig. 4) were constructed for the August 19, 1955; October 10, 1903; March 19, 1936; and May 24, 1942, floods and are based on known flood-crest elevations at many points. By use of flood profiles, flood-frequency data can be extended to all sites along the reach. The flood-crest elevations were procured by two methods. In the summer of 1964, field investigations located high-water marks supplied by local residents and industrial firms, and elevations of these marks were obtained by levels to bench marks. In addition, flood-crest elevations were obtained from publications and various agency records. All flood-crest elevations, as well as low-water elevations, used in the profiles are listed in table 8.

The profile for the hypothetical flood based on the August 19, 1955, flood modified by existing and planned flood-control projects was furnished by the Corps of Engineers (fig. 4). This modified August 19, 1955, flood profile is approximately equivalent to the May 24, 1942, flood profile.

The low-water profile of September 3, 1964, and thalweg profile are shown for comparison with flood profiles (fig. 4). Data for the low-water profile were obtained by field survey. The thalweg, a line connecting the lowest points in the stream channel, was obtained from cross sections furnished by the Corps of Engineers. The profile showing approximate elevation of top of bank is a line connecting the lowest points on either the right and/or left bank where inundation will begin. It is based on cross sections and is interpolated between cross sections

by reference to a topographic map.

Flood profiles of the Lehigh River are shown in figure 11. A low-water profile is given for comparison. Flood profiles in figure 11 should not be used to extend flood-frequency relations for reasons given on page 9.

## USE OF FREQUENCY AND PROFILE RELATIONS

Frequency and profile relations can be used to: (1) estimate the frequency of the lowest flood that would inundate a specific site; (2) estimate the depth of flooding at a specific site by a flood of a given frequency; (3) delineate areas subject to a specific frequency of flooding. For all three cases frequency of floods can be estimated by determining the proper proportion between two given profiles in figure 4.

To determine the frequency of flooding for the lowest flood that would inundate a specific site, the ground elevation and river stationing must be known. The ground elevation for the site can be obtained from a topographic map (pl. 1) or, preferably, from ground surveys. River stationing can be secured from plate 1. The frequency of the lowest flood that would inundate the site can then be estimated by use of figure 4. For example, consider a specific site at mile 182.5. The elevation of the specific location determined by ground survey is 185 feet above mean sea level. Using proportions between two profiles in figure 4, the frequency of recurrence of the lowest flood that would inundate the specific site is approximately 90 years.

Depth of flooding at a specific site by a flood of a given frequency

can be determined by use of river stationing and ground elevation. The elevation of the flood of the selected frequency is obtained from figure 4 at the site indicated by stationing. Depth of flooding is determined by substracting the ground elevation from the flood elevation. For example, the elevation of a 130-year flood, determined from figure 4, for a site at mile 182.5 is 187 feet above mean sea level. To obtain the depth of flooding subtract the ground elevation (185 feet) from the flood elevation (187 feet). Therefore, the depth of flooding is approximately 2 feet. Conversely, the frequency of a flood of a given depth at a specific site can be estimated. The ground elevation is added to the given depth of flooding to obtain the elevation of the flood at the site. Figure 4 can then be used to estimate frequency. Consider the same site at mile 182.5 with a ground elevation of 185 feet above mean sea level. Add the ground elevation to a depth of flooding being considered to obtain the flood elevation. If the depth of flooding under consideration is one foot, the flood elevation would therefore be 186 feet above mean sea level. Using proportions between two profiles in figure 4 the frequency of recurrence of a flood elevation of 186 feet at mile 182.5 is approximately 105 years.

Delineation of areas subject to a specific frequency of flooding can be determined by the following procedure. Draw a line proportionally spaced between two profiles shown on figure 4 nearest to the selected frequency. Elevations from the drawn profile used in conjunction with river stationing will locate the boundary of flooding on the ground or on plate 1.

## Areal Extent of Flooding

The areal extent of flooding is, in large measure, restricted owing to the confining valley walls for many miles of the reach of the Delaware River. Plates 1 and 2 show the areal extent of the August 19, 1955, flood and the May 24, 1942, flood. Field investigations supplemented by an analysis of profile data were used to delineate the August 19, 1955, flood on 1:24,000 scale U.S. Geological Survey topographic maps. The extent of historic floods of a specific frequency can be estimated by means described above. Flooding on tributaries to the Delaware River, as shown in plates 1 and 2, is primarily due to backwater from the Delaware River. Local storms on the tributary basin would have a different frequency and profile.

In the August 19, 1955, flood the Pennsylvania Canal was completely inundated. For smaller floods the Pennsylvania Canal may or may not be flooded. Flooding of the Canal is dependent on the elevation of the top of the Canal's bank at the river's edge and, to a lesser degree, on the stage at the mouth of the Lehigh River.

The hypothetical August 19, 1955, flood modified by existing and planned flood-control projects is approximately equivalent to the May 24, 1942, flood (fig. 4). Therefore the May 24, 1942, flood delineated in plates 1 and 2 approximates the areal extent of inundation for this modified August 19, 1955, flood for the Delaware River and its tributaries, with the exception of the Lehigh River.

The areal extent of inundation for three floods was computed for the reach under study. Included in the computations were all tributaries with the exception of the Lehigh River above the Third Street Bridge. The May 24, 1942, flood, having a recurrence interval of 11 years, inundated an

area of 0.88 square mile. A flood of a much larger magnitude, the October 10, 1903, flood, having a recurrence interval of 130 years, flooded an area of 1.29 square miles which was only 45 percent greater than the area inundated by the May 24, 1942, flood. The August 19, 1955, flood, greatest known flood on the Delaware River since colonial times, inundated an area of 2.07 square miles. This area is 60 percent greater than the area inundated by the October 1903 flood and 135 percent greater than the area inundated by the May 1942 flood. A relation consisting of a small increase in areal extent of flooding with an increase of recurrence interval is apparent, at least in the Easton, Pa.-Phillipsburg, N.J. area.

## Depth of Flooding

The more significant aspect of flooding in the study reach is the depth of flooding. Depth of flooding for any specific recurrence interval can be estimated for any site by subtracting the ground elevation from the water-surface elevation, obtained from the profile (fig. 4) for the appropriate river mileage. Thirteen cross sections (figs. 12-17) are given in this report to illustrate the depth of flooding at these sites for the floods of August 19, 1955; October 10, 1903; March 19, 1936; and May 24, 1942. These cross sections, furnished by the Corps of Engineers, are based upon field surveys of September 1964. Cross section at mile 179.1 was extended in May 1965 by the Geological

Survey to include the gravel pit. Flood elevations were determined from figure 4.

## LIMITATIONS

Procedures recommended in this report should be used with full knowledge of the limitations involved. Correct evaluation of results obtained is essential.

The term "recurrence interval" does not imply that a flood will recur at a specific or equal length of time. A flood having a recurrence interval of 25 years indicates only the probability that a flood of that magnitude will be equaled or exceeded on the average 4 times in 100 years.

The flood-frequency curves (figs. 1, 2, and 3) are based on a regionalized relation defined by Tice (1958) from procedures explained by Dalrymple (1960). It must be recognized that hydrologic conditions are not constant. Any geomorphologic changes in the stream that would upset the present hydrologic conditions to a perceptible degree may reflect a change of the flood-frequency relation. Changes such as stream dredging, straightening, filling, and building of flood walls or reservoirs upstream could alter the flood-frequency relation. Planned and existing flood-control works would modify the August 19, 1955,

flood. Figure 4 shows this modification, computed by the Corps of Engineers, based on latest designs for the projects.

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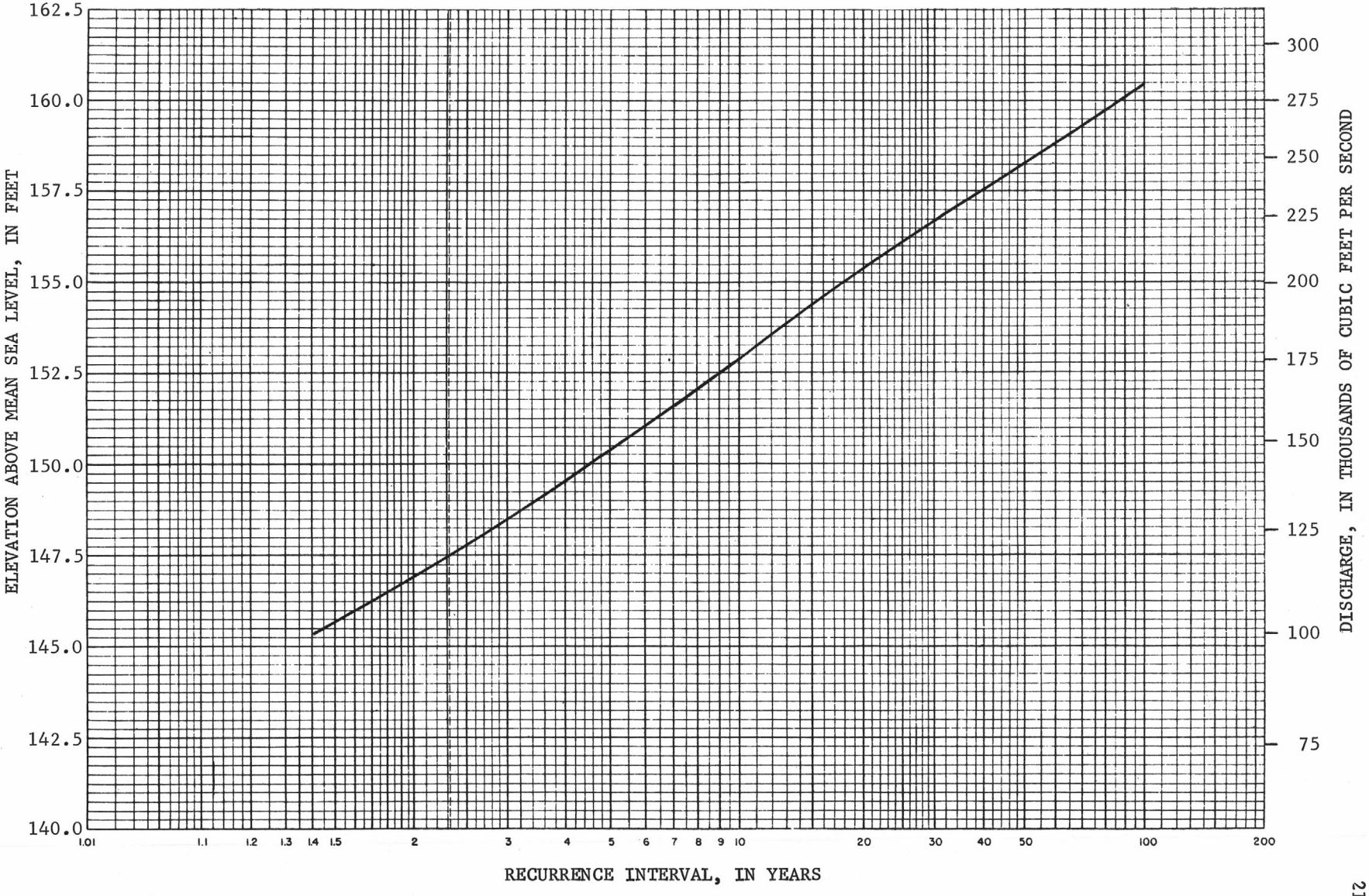


Figure 1.--Frequency of floods on Delaware River at Riegelsville, N.J.

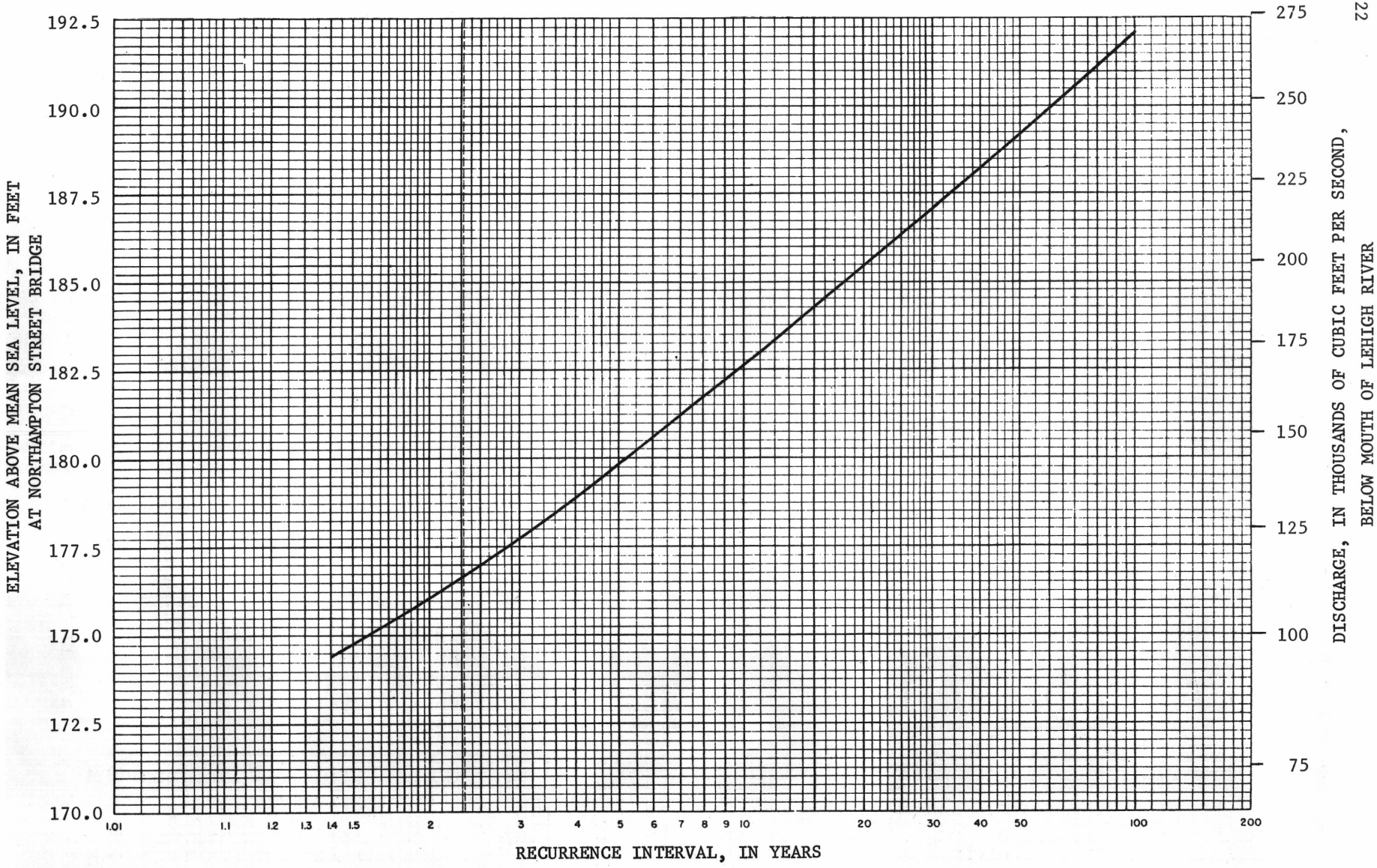


Figure 2.--Frequency of floods on Delaware River at Easton, Pa. below mouth of Lehigh River.

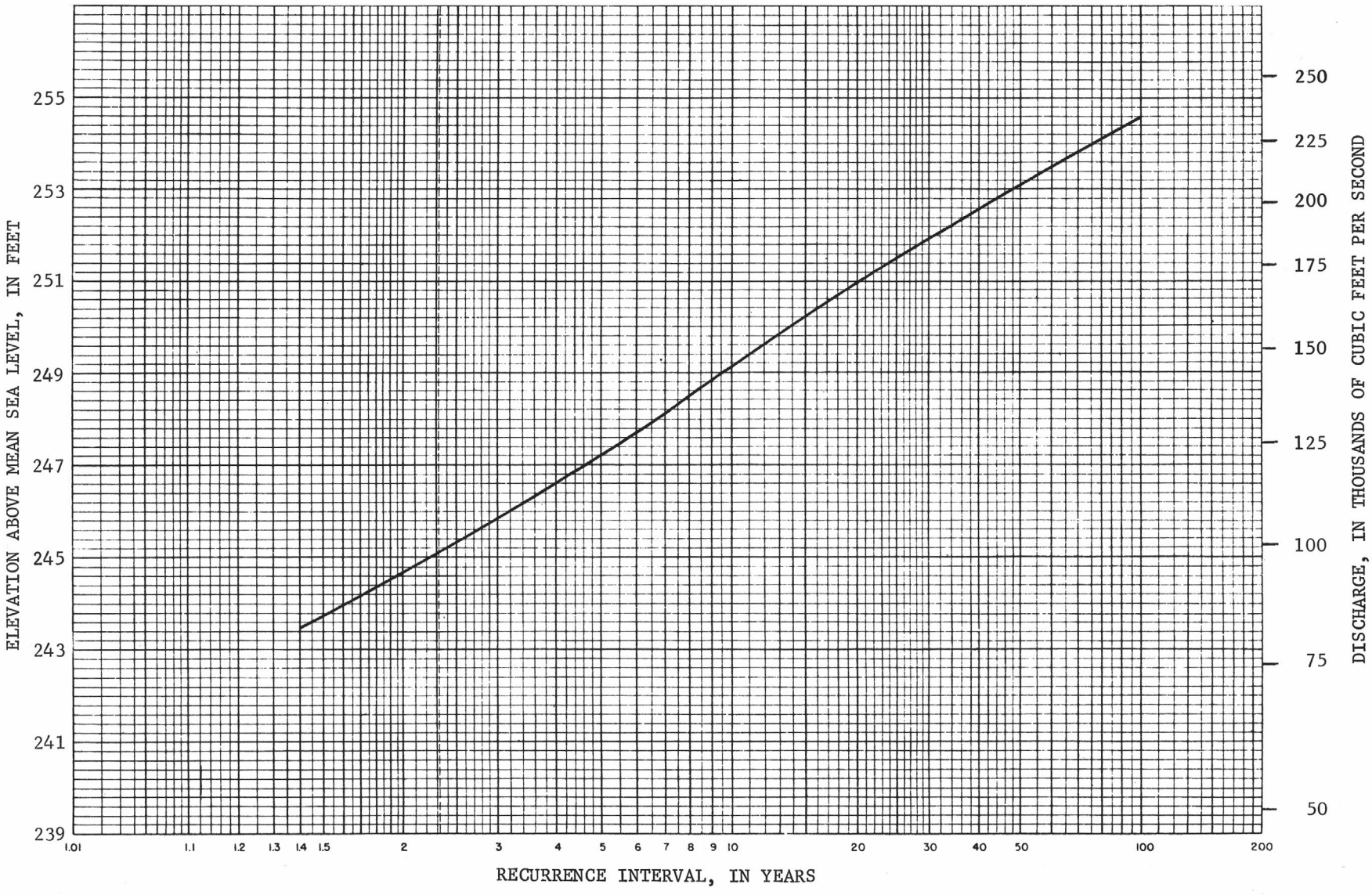


Figure 3.--Frequency of floods on Delaware River at Belvidere, N.J.

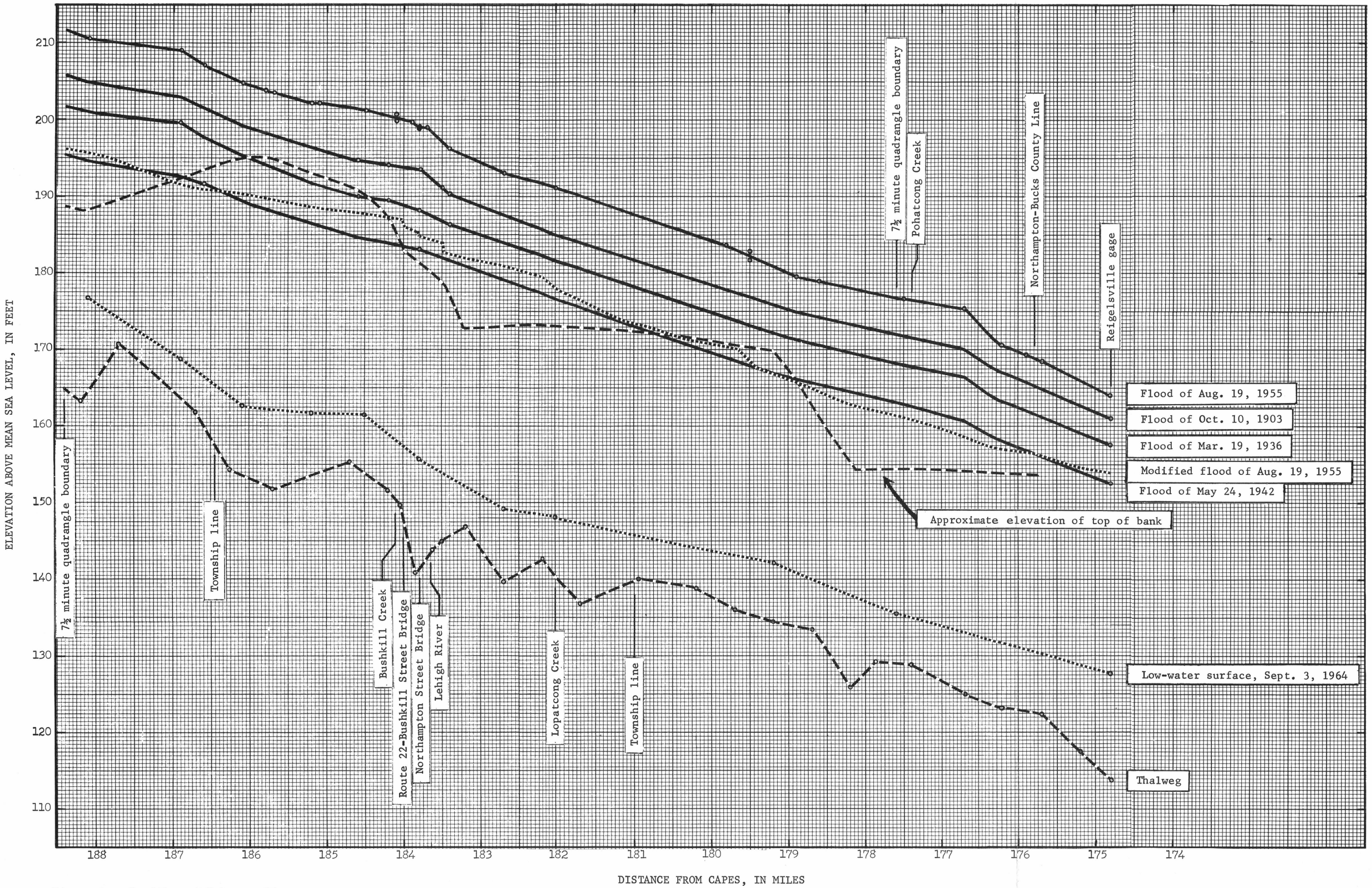


Figure 4.-- Profiles of Delaware River.

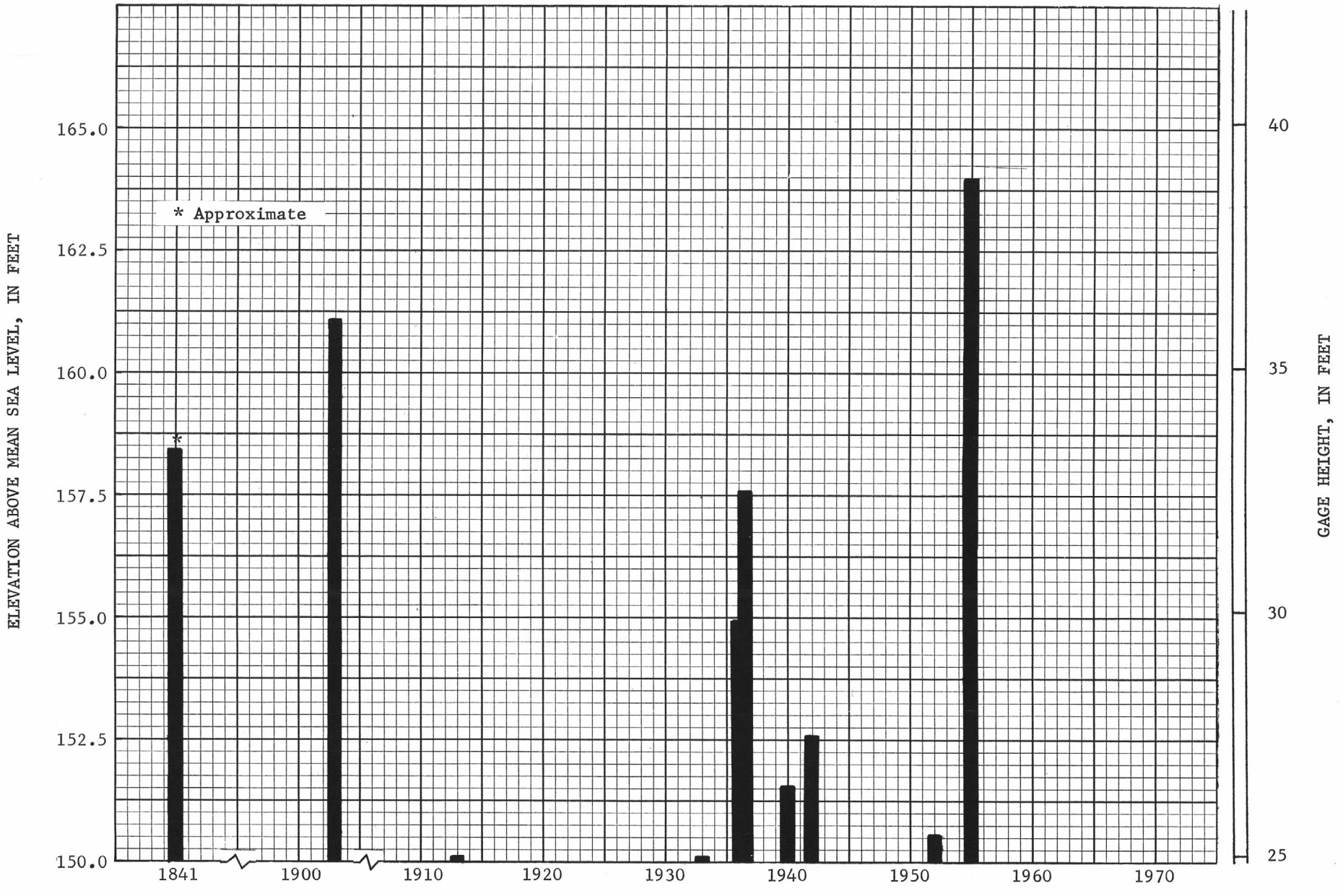


Figure 5.--Floods above 150.0-foot elevation, Delaware River at Riegelsville, N.J., 1907-1964, and floods of 1841 and 1903.

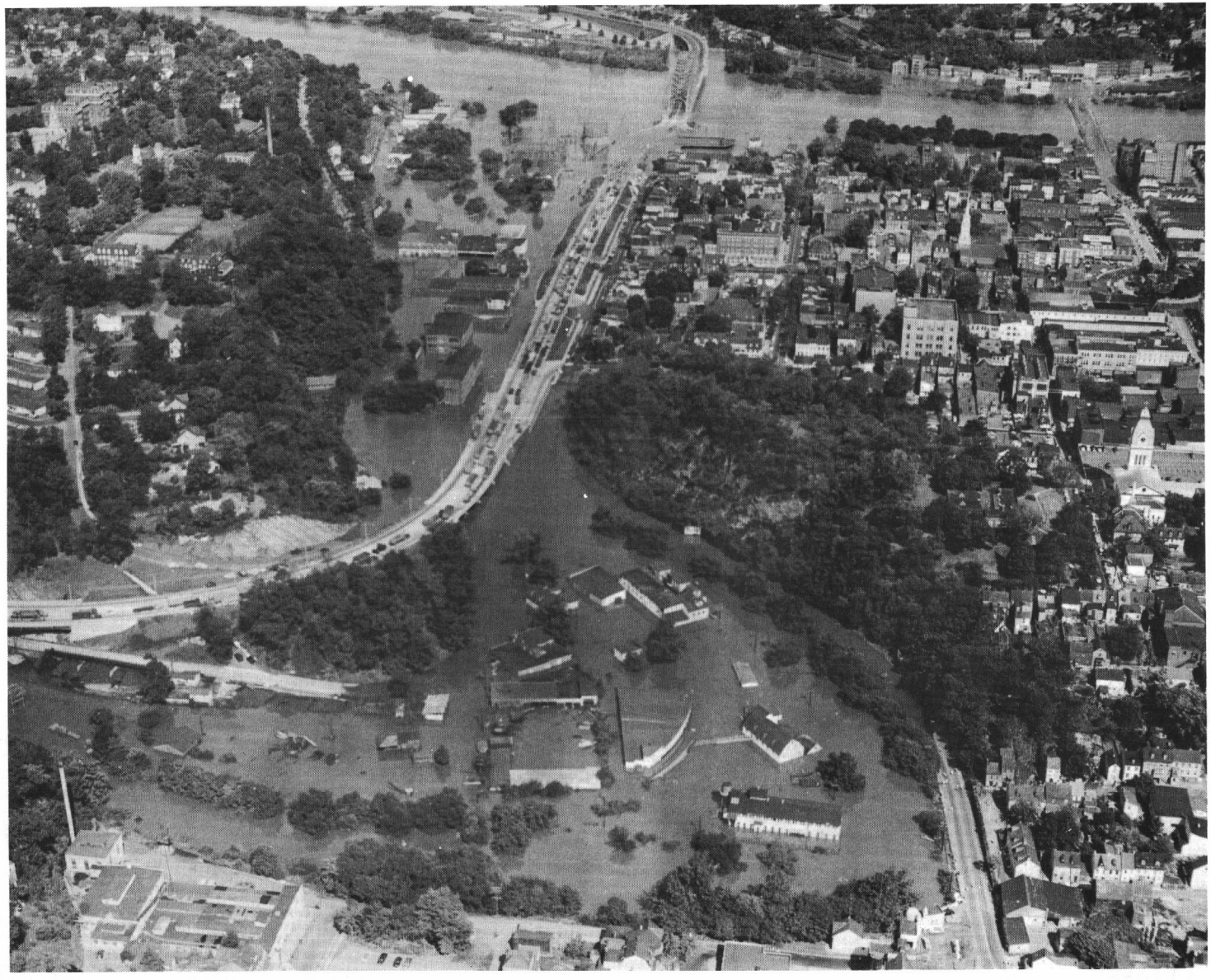

Figure 6.--Bushkill Creek at Easton, Pa., August 19, 1955. Extensive inundation along Bushkill Creek due to backwater from the Delaware River. Delaware River at top of photograph. Photograph by Easton Express.

Figure 7.--Delaware River at Easton, Pa.-Phillipsburg, N.J., August 19, 1955. Approaches of Route 22-Bushkill Street Bridge (upper right) and Northampton Street Bridge (lower left) under water. Photograph by Easton Express.


Figure 8.--Delaware River at Easton, Pa., August 19, 1955. Pennsylvania approach to Route 22-Bushkill Street Bridge under water. Photograph by Easton Express.

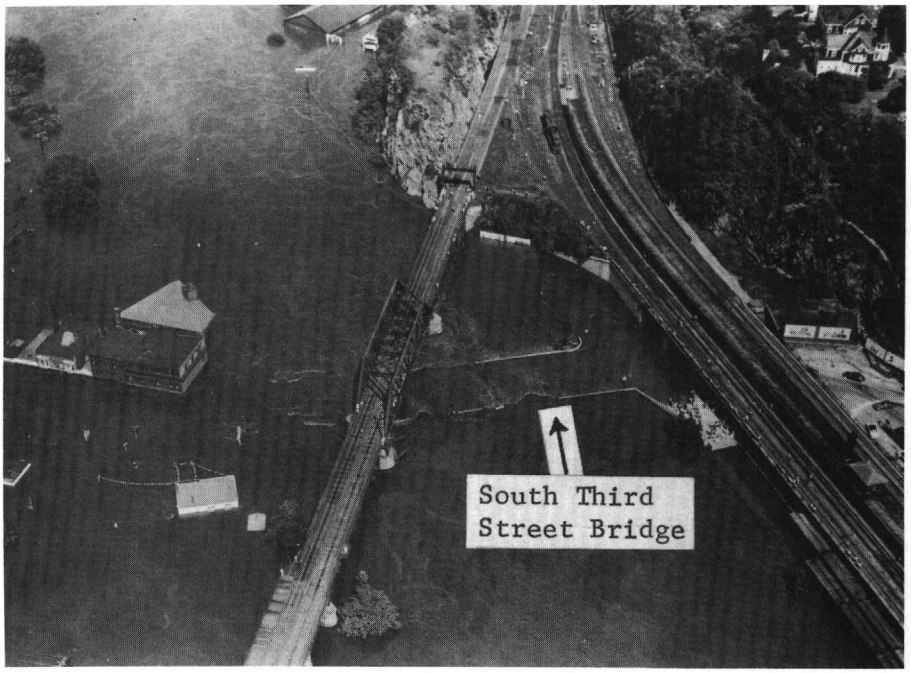


Figure 9.--Lehigh River at Easton, Pa., August 19, 1955. Handrail of South Third Street Bridge just above water surface in center of photograph. The Central Railroad of New Jersey Bridge crosses over the South Third Street Bridge in the center of photograph. Photograph by Easton Express.

Figure 10.--Delaware River at Easton, Pa.-Phillipsburg, N.J., August 20, 1955. River receding. Center of Northampton Street Bridge severed. Arrow (upper left) indicates high-water level. Photograph by Easton Express.

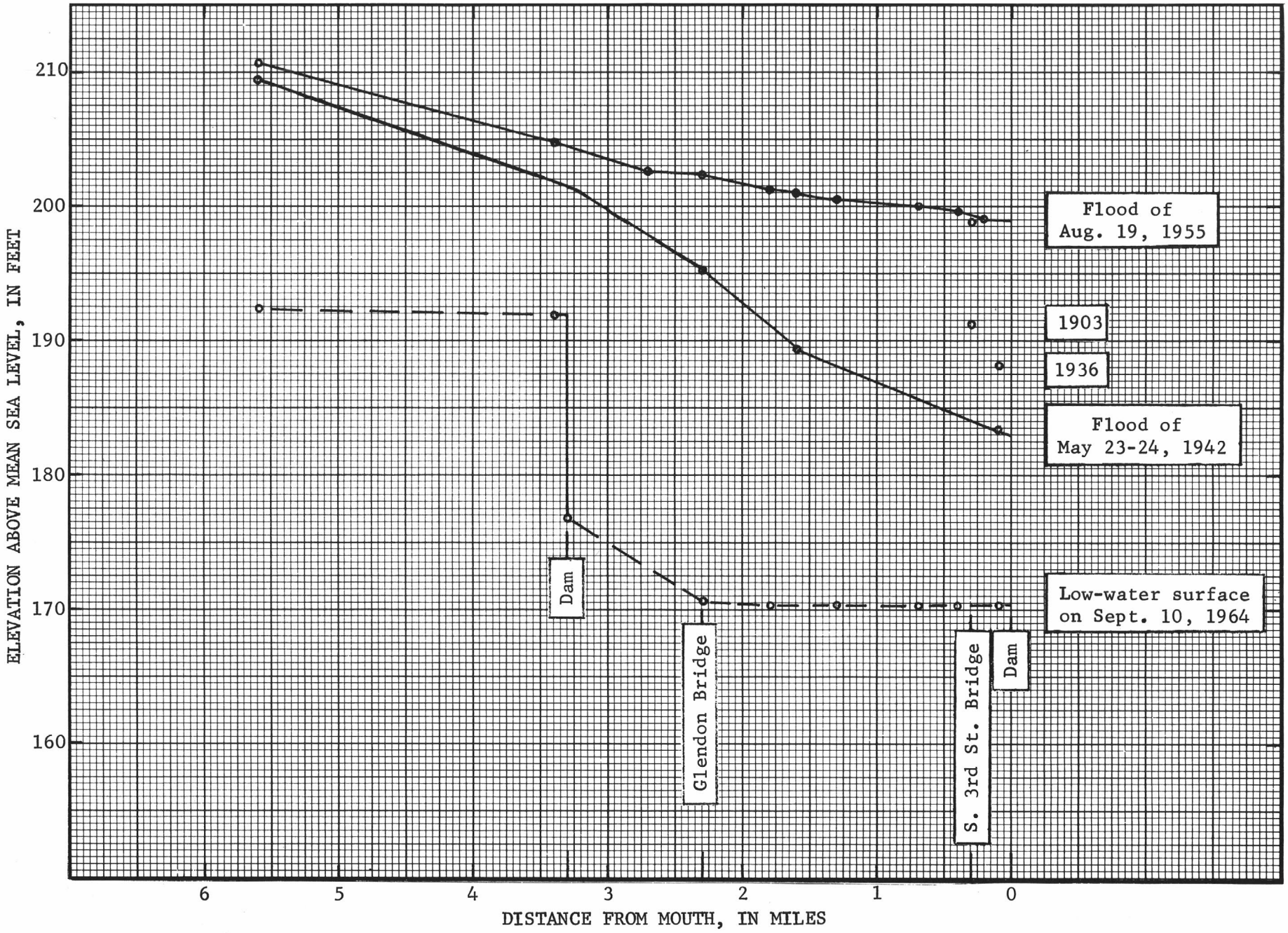


Figure 11.--Profiles of Lehigh River.

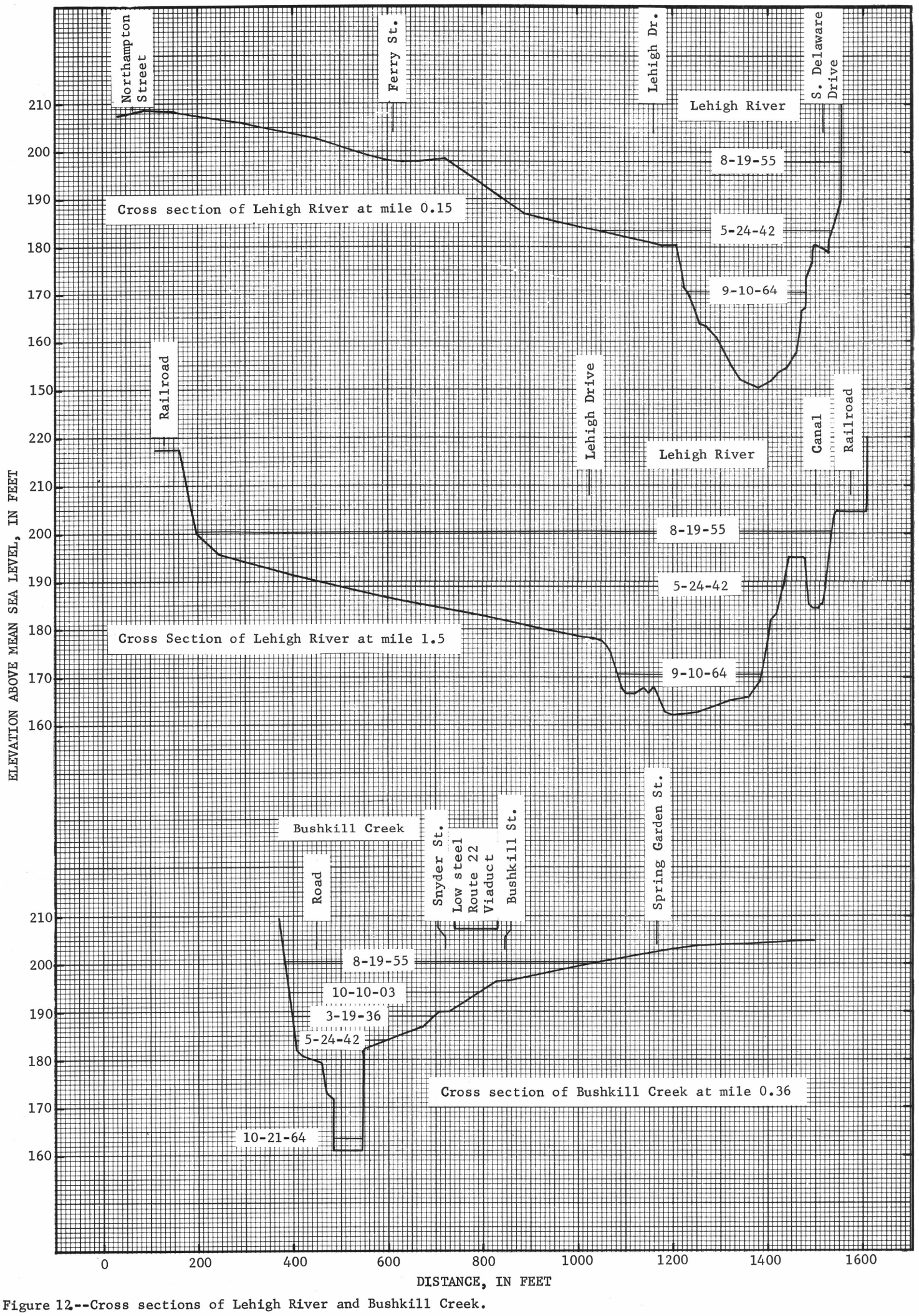


Figure 12.--Cross sections of Lehigh River and Bushkill Creek.

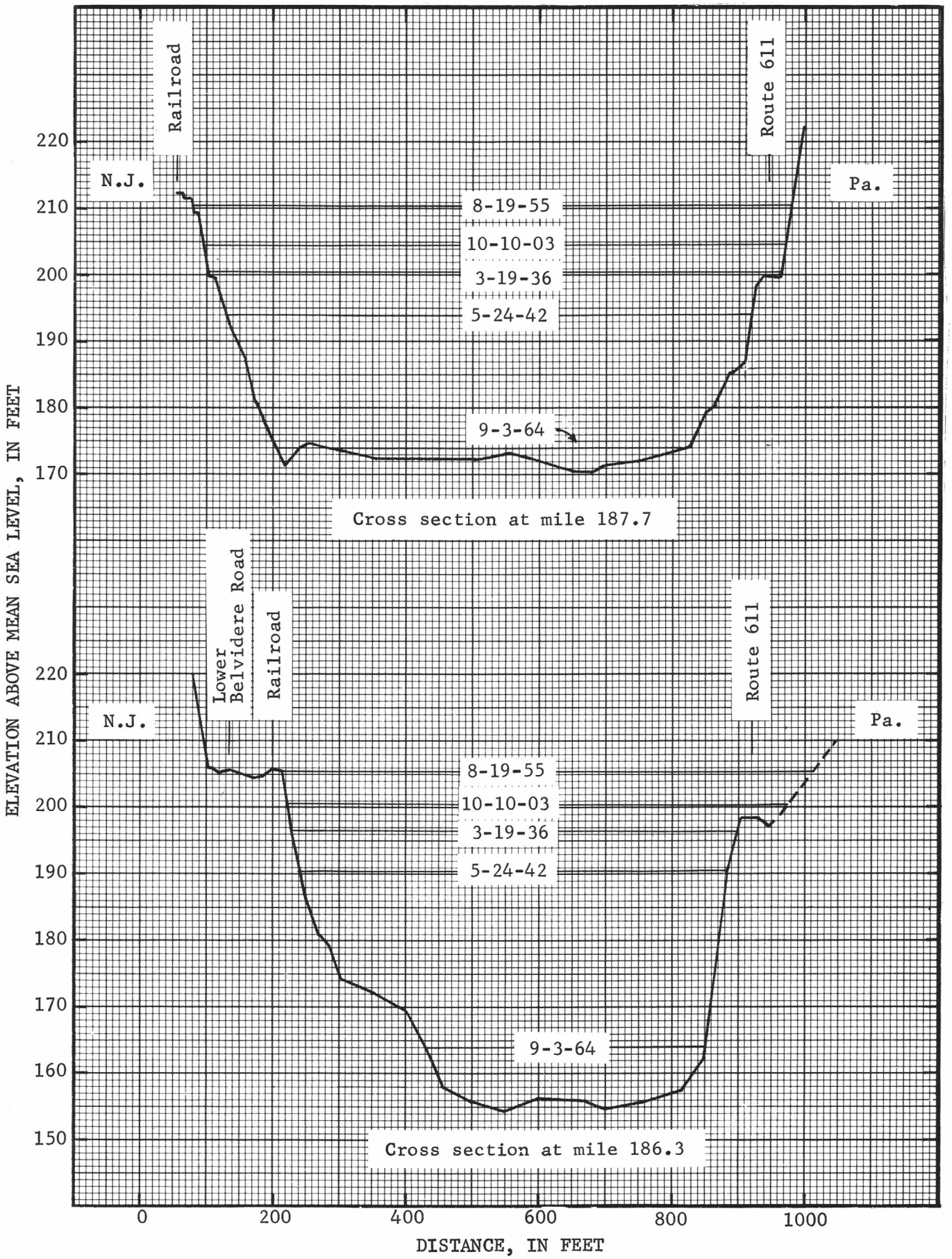


Figure 13.--Cross sections of Delaware River at miles 187.7 and 186.3.

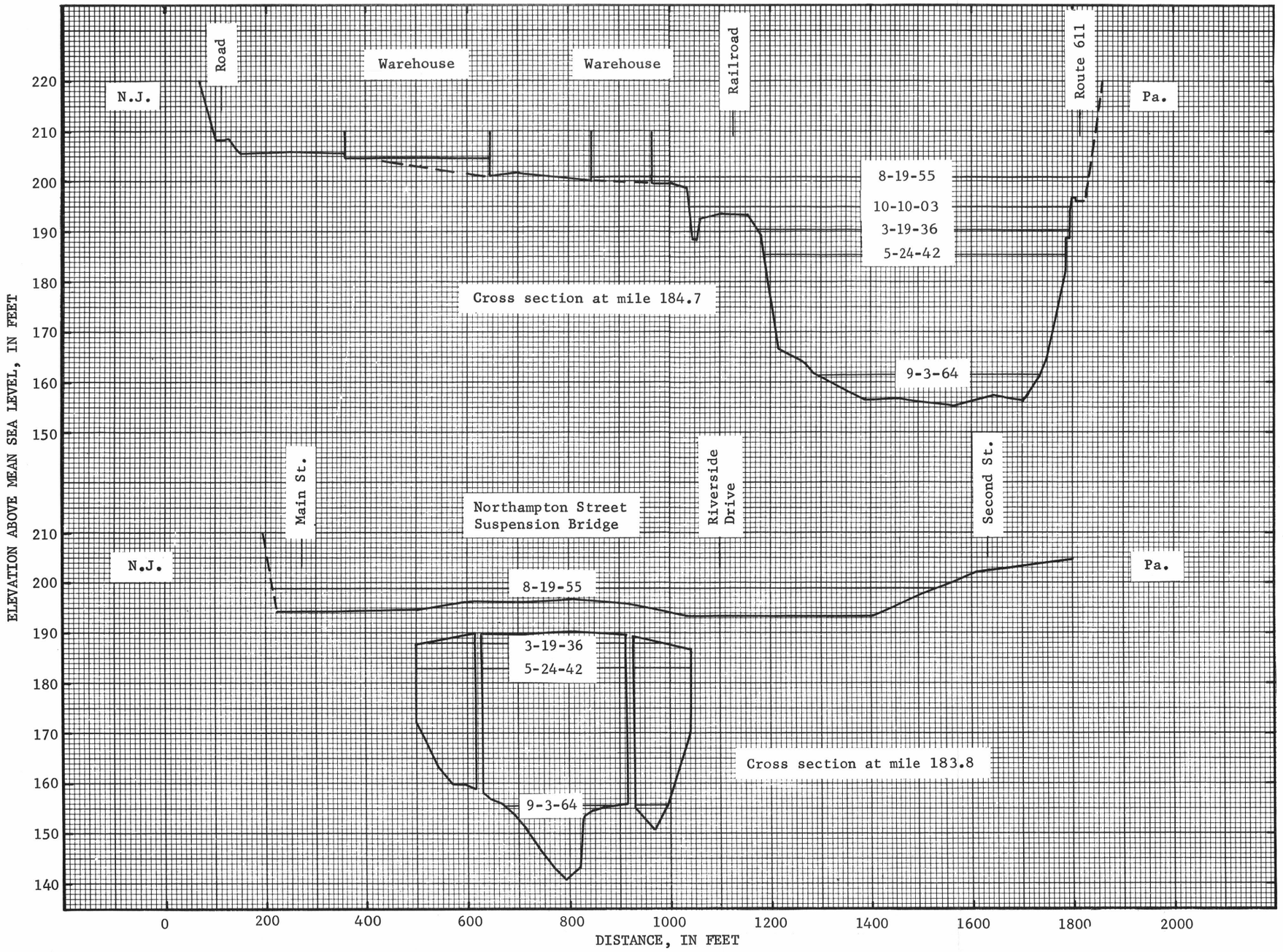


Figure 14.--Cross sections of Delaware River at miles 184.7 and 183.8.

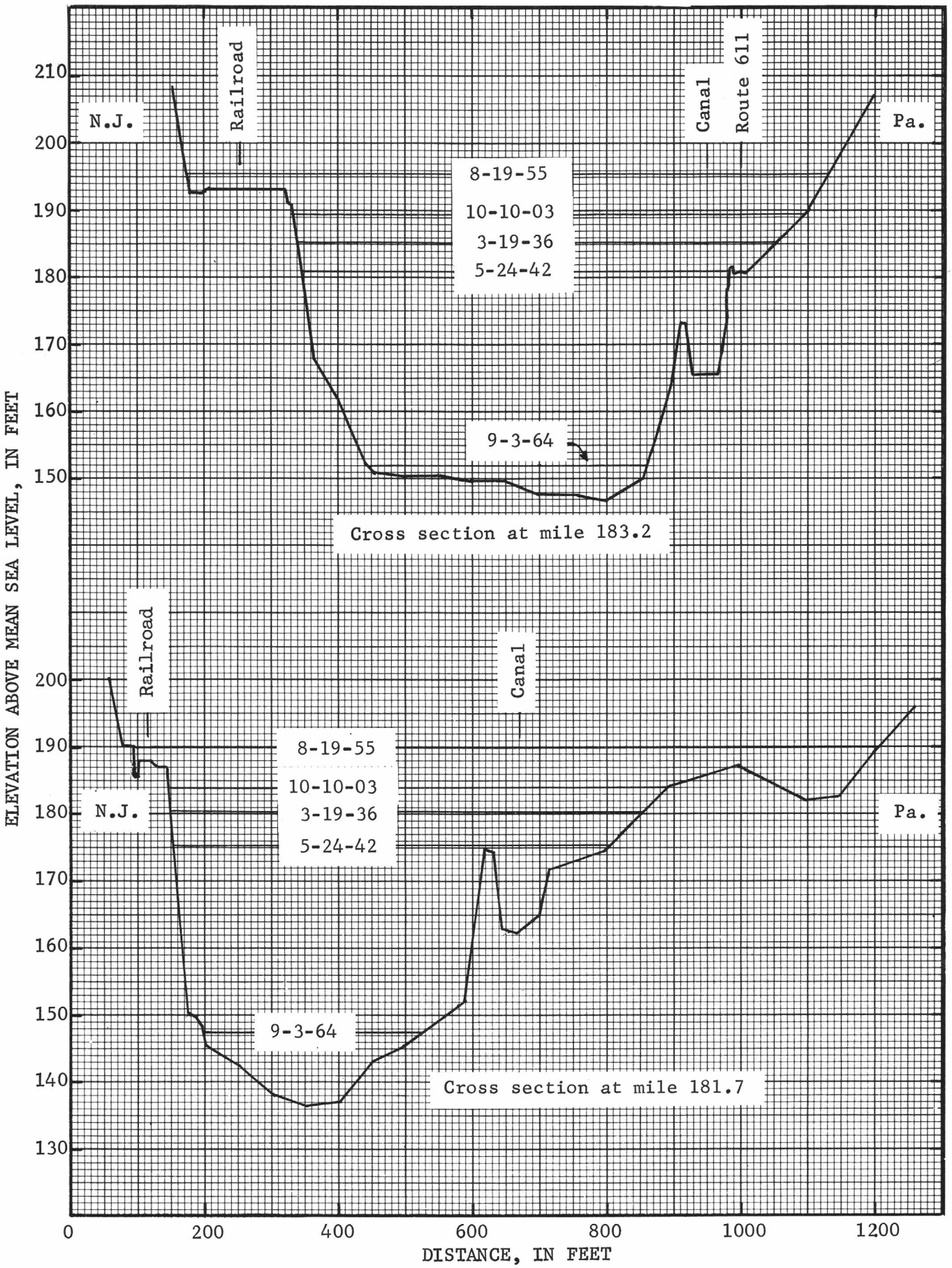


Figure 15.--Cross sections of Delaware River at miles 183.2 and 181.7.

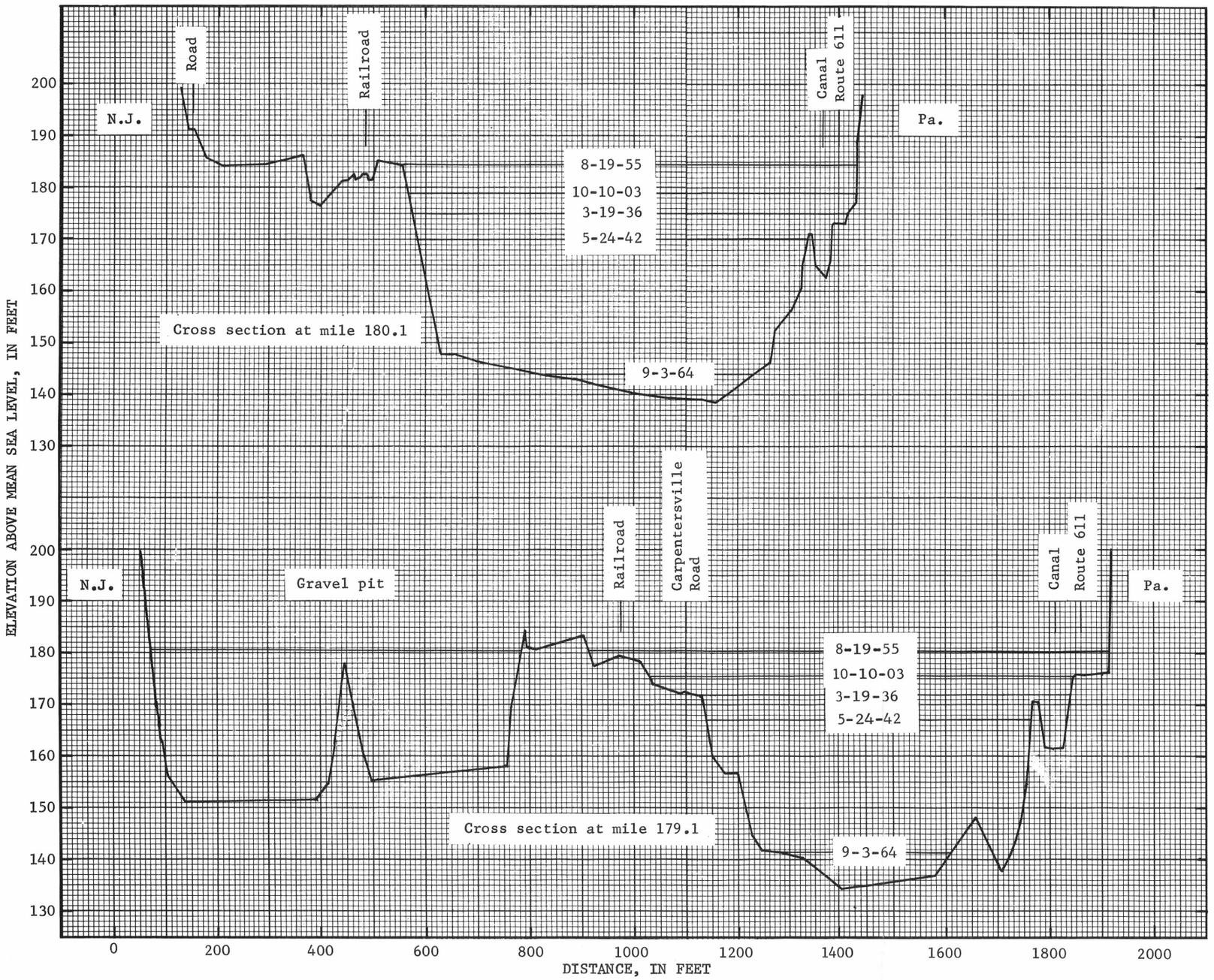


Figure 16.--Cross sections of Delaware River at miles 180.1 and 179.1.

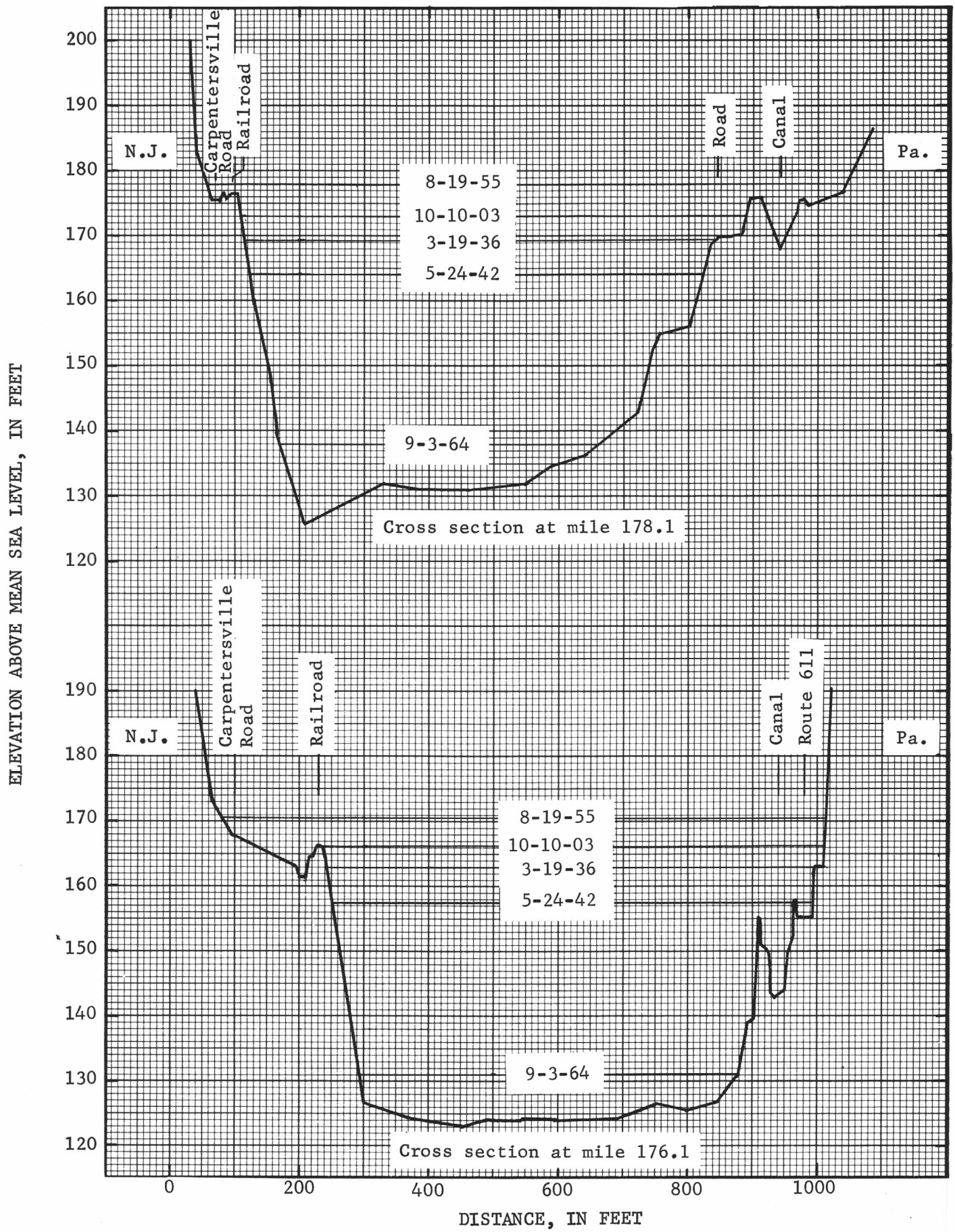


Figure 17.--Cross sections of Delaware River at miles 178.1 and 176.1.

Table 1.--Maximum annual floods, Delaware River at Belvidere, N.J., 1904, 1923-64

[197.7 miles above Capes. Drainage area, 4,535 square miles. Datum of gage is 226.43 feet above mean sea level, datum of 1929.]

| Water year | Date | Elevation (feet) | Discharge (cfs) | Water year | Date | Elevation (feet) | Discharge (cfs) |
|---|---|---|---|---|---|---|---|
| 1904 | Oct. 10, 1903 | 255.03 | 220,000 | 1944 | Nov. 10, 1943 | 240.48 | 63,100 |
| 1923 | Mar. 24, 1923 | 242.13 | 77,000 | 1945 | Mar. 18, 1945 | 241.08 | 68,700 |
| 1924 | Apr. 7, 1924 | 245.43 | 114,000 | 1946 | May 29, 1946 | 241.05 | 68,500 |
| 1925 | Oct. 1, 1924 | 245.73 | 118,000 | 1947 | Apr. 6, 1947 | 243.36 | 91,200 |
| 1926 | Apr. 10, 1926 | 238.45 | 43,800 | 1948 | Mar. 23, 1948 | 246.11 | 119,800 |
| 1927 | Nov. 17, 1926 | 244.93 | 108,000 | 1949 | Dec. 31, 1948 | 245.91 | 117,700 |
| 1928 | Oct. 20, 1927 | 243.23 | 84,400 | 1950 | Apr. 5, 1950 | 241.86 | 76,300 |
| 1929 | Mar. 15, 1929 | 242.33 | 79,000 | 1951 | Mar. 31, 1951 | 246.18 | 120,600 |
| 1930 | Mar. 9, 1930 | 237.73 | 38,400 | 1952 | July 10, 1952 | 242.96 | 87,200 |
| 1931 | Mar. 30, 1931 | 238.83 | 46,800 | 1953 | Dec. 12, 1952 | 246.43 | 122,000 |
| 1932 | Apr. 2, 1932 | 240.03 | 57,000 | 1954 | Feb. 18, 1954 | 237.43 | 38,000 |
| 1933 | Aug. 25, 1933 | 246.33 | 122,000 | 1955 | Aug. 19, 1955 | 256.64 | 273,000 |
| 1934 | Mar. 6, 1934 | 243.65 | 92,900 | 1956 | Oct. 16, 1955 | 244.56 | 93,300 |
| 1935 | Dec. 2, 1934 | 241.46 | 70,900 | 1957 | Apr. 7, 1957 | 240.33 | 55,700 |
| 1936 | Mar. 19, 1936 | 251.43 | 179,000 | 1958 | Dec. 22, 1957 | 242.12 | 70,300 |
| 1937 | Feb. 23, 1937 | 240.93 | 67,200 | 1959 | Jan. 23, 1959 | 243.91 | 86,800 |
| 1938 | Sept.22, 1938 | 245.70 | 116,000 | 1960 | Apr. 5, 1960 | 243.99 | 87,600 |
| 1939 | Dec. 7, 1938 | 242.31 | 81,000 | 1961 | Feb. 26, 1961 | 242.83 | 76,600 |
| 1940 | Apr. 1, 1940 | 247.83 | 138,300 | 1962 | Apr. 2, 1962 | 240.64 | 58,200 |
| 1941 | Dec. 31, 1940 | 239.08 | 50,900 | 1963 | Mar. 28, 1963 | 242.51 | 73,700 |
| 1942 | May 24, 1942 | 247.40 | 133,700 | 1964 | Mar. 11, 1964 | 242.13 | 70,400 |
| 1943 | Dec. 31, 1942 | 245.05 | 108,600 | | | | |

Table 2.--Maximum annual stages, Delaware River at Easton, Pa., 1904, 1936-64.

[183.8 miles above Capes. Drainage area, 4,717 square miles. Datum of gage is 100.21 feet above mean sea level, datum of 1929.]

| Water year | Date | Elevation (feet) | Discharge (cfs) | Water year | Date | Elevation (feet) | Discharge (cfs) |
|---|---|---|---|---|---|---|---|
| 1904 | Oct. 10, 1903 | [a]193.51 | --- | 1950 | Apr. 6, 1950 | 172.21 | --- |
| 1936 | Mar. 19, 1936 | 188.16 | --- | 1951 | Apr. 1, 1951 | 178.81 | --- |
| 1937 | Feb. 23, 1937 | 170.83 | --- | 1952 | July 11, 1952 | 175.27 | --- |
| 1938 | Sept.22, 1938 | 177.71 | --- | 1953 | Dec. 12, 1952 | 180.81 | --- |
| 1939 | Dec. 7, 1938 | 174.41 | --- | 1954 | Dec. 8, 1953 | 166.86 | --- |
| 1940 | Apr. 1, 1940 | 181.44 | --- | 1955 | Aug. 19, 1955 | 199.11 | --- |
| 1941 | Apr. 7, 1941 | 168.11 | --- | 1956 | Oct. 16, 1955 | 179.03 | --- |
| 1942 | May 24, 1942 | 183.21 | --- | 1957 | Apr. 7, 1957 | 171.80 | --- |
| 1943 | Dec. 31, 1942 | 177.71 | --- | 1958 | Dec. 22, 1957 | 177.06 | --- |
| 1944 | Nov. 10, 1943 | 171.96 | --- | 1959 | Jan. 23, 1959 | 175.61 | --- |
| 1945 | July 20, 1945 | 172.51 | --- | 1960 | Apr. 5, 1960 | 177.26 | --- |
| 1946 | May 29, 1946 | 172.56 | --- | 1961 | Feb. 27, 1961 | 174.66 | --- |
| 1947 | Apr. 6, 1947 | 174.24 | --- | 1962 | Apr. 2, 1962 | 169.88 | --- |
| 1948 | Mar. 23, 1948 | 177.81 | --- | 1963 | Mar 27-28,1963 | 173.26 | --- |
| 1949 | Dec. 31, 1948 | 179.31 | --- | 1964 | Mar. 11, 1964 | 172.30 | --- |

[a]From floodmark.

Table 3[1/].--Historic flood stages, Delaware River at Phillipsburg, N.J.

[Stages 20.0 feet and above. 183.5 miles above Capes. Drainage area, 6,081 square miles. Datum of gage is about 155 feet above mean sea level, datum of 1929.]

| Date | Stage (feet) | Date | Stage (feet) |
|---|---|---|---|
| 1781, May 9 | 21.0 | 1895, Apr. 9 | 23.5 |
| 1783, Feb. 28 | 20.0 | 1901, Dec. 16 | 31.1 |
| 1785, Mar. 17 | 23.0 | 1902, Mar. 2 | 29.5 |
| 1786, Oct. 4 | 21.0 | 1903, Oct. 10 | 35.9 |
| 1814, Apr. 1 | 20.0 | 1913, Mar. 28 | 22.2 |
| 1841, Jan. 8 | 28.5 | 1914, Mar. 29 | 21.0 |
| 1846, Mar. 16 | 24.0 | 1924, Oct. 1 | 22.0 |
| 1862, June 5[2/] | 28.5 | 1925, Feb. 12 | 21.0 |
| 1869, Oct. 15 | 24.5 | 1933, Aug. 25 | 25.0 |
| 1875, Apr. 9 | 23.5 | 1935, July 10 | 20.0 |
| 1878, Dec. 11 | 24.5 | 1936, Mar. 19 | 30.7 |

[1/]Table 3 from U.S. Geological Survey Water-Supply Paper 799, p. 367.

[2/]Date of Jan. 5, 1862, as given in U.S. Geological Survey Water-Supply Paper 799, p. 367, published in error.

Table 4.--Maximum annual floods, Lehigh River at Bethlehem, Pa., 1902-05, 1910-64

[11.0 miles above mouth. Drainage area, 1,279 square miles, includes that of Monacacy Creek. At site used prior to Oct. 1, 1928, 1,229 square miles. Datum of gage at present site is 210.94 ft above mean sea level, datum of 1929. Prior to Oct. 1, 1928, gage at same site and datum. Oct. 1, 1928 to Sept. 30, 1962, gage at site 4,250 ft downstream at datum 2.49 ft lower.]

| Water year | Date | Elevation (feet) | Discharge (cfs) | Water year | Date | Elevation (feet) | Discharge (cfs) |
|---|---|---|---|---|---|---|---|
| 1902 | Feb. 28, 1902 | 235.84 | 88,000 | 1936 | Mar. 12, 1936 | 225.49 | 55,700 |
| 1903 | Dec. 22, 1902 | --- | [a]26,800 | 1937 | Feb. 22, 1937 | 214.69 | 10,500 |
| 1904 | Oct. 10, 1903 | --- | [a]25,800 | 1938 | Oct. 23, 1937 | 217.82 | 22,400 |
| 1905 | Jan. 7, 1905 | --- | [a]19,600 | 1939 | Dec. 6, 1938 | 218.92 | 25,900 |
| 1910 | Jan. 22, 1910 | 224.72 | 32,200 | 1940 | Mar. 15, 1940 | 221.28 | 35,000 |
| 1911 | Aug. 31, 1911 | 218.71 | 12,700 | 1941 | Apr. 6, 1941 | 214.13 | 8,210 |
| 1912 | Mar. 15, 1912 | 222.54 | 24,800 | 1942 | May 23, 1942 | 231.92 | 92,000 |
| 1913 | Mar. 27, 1913 | 223.34 | 27,500 | 1943 | Dec. 31, 1942 | 218.47 | 24,000 |
| 1914 | Jan. 31, 1914 | 218.24 | 11,600 | 1944 | Nov. 9, 1943 | 220.00 | 30,000 |
| 1915 | Jan. 13, 1915 | 222.46 | 24,500 | 1945 | July 21, 1945 | 216.75 | 18,300 |
| 1916 | July 26, 1916 | 219.94 | 16,400 | 1946 | May 28, 1946 | 217.98 | 22,300 |
| 1917 | Mar. 28, 1917 | 220.44 | 17,900 | 1947 | July 8, 1947 | 217.93 | 22,300 |
| 1918 | Feb. 20, 1918 | 223.94 | 29,100 | 1948 | Apr. 15, 1948 | 215.47 | 13,100 |
| 1919 | Mar. 9, 1919 | 219.94 | 16,800 | 1949 | Dec. 31, 1948 | 219.22 | 26,900 |
| 1920 | Mar. 5, 1920 | 222.94 | 25,800 | 1950 | Mar. 29, 1950 | 215.72 | 14,400 |
| 1921 | Mar. 4, 1921 | 217.66 | 10,200 | 1951 | Dec. 5, 1950 | 223.76 | 46,900 |
| 1922 | Mar. 8, 1922 | 220.74 | 19,100 | 1952 | Mar. 12, 1952 | 219.76 | 31,000 |
| 1923 | Mar. 17, 1923 | 217.94 | 11,100 | 1953 | Nov. 22, 1952 | 222.20 | 41,200 |
| 1924 | Apr. 7, 1924 | 222.24 | 23,600 | 1954 | Dec. 7, 1953 | 216.18 | 16,600 |
| 1925 | Oct. 1, 1924 | 227.14 | 43,500 | 1955 | Aug. 19, 1955 | 231.83 | 91,300 |
| 1926 | Feb. 26, 1926 | 218.84 | 13,600 | 1956 | Oct. 16, 1955 | 219.93 | 30,900 |
| 1927 | Nov. 17, 1926 | 227.64 | 44,000 | 1957 | Apr. 6, 1957 | 218.20 | 23,800 |
| 1928 | June 30, 1928 | 224.34 | 30,700 | 1958 | Dec. 21, 1957 | 222.48 | 41,800 |
| 1929 | Mar. 6, 1929 | 216.25 | 16,600 | 1959 | Jan. 22, 1959 | 217.26 (ice jam) | --- |
| 1930 | Oct. 3, 1929 | 214.95 | 11,600 | | | | |
| 1931 | Feb. 18, 1931 | 214.18 | 8,820 | 1960 | Apr. 5, 1960 | 217.87 | 22,100 |
| 1932 | Apr. 1, 1932 | 215.01 | 12,000 | 1961 | Feb. 26 1961 | 217.26 | 19,700 |
| 1933 | Aug. 24, 1933 | 227.15 | 64,800 | 1962 | Mar. 12, 1962 | 215.59 | 15,800 |
| 1934 | Sept. 17, 1934 | 214.80 | 11,300 | 1963 | Mar. 31, 1963 | 218.80 | 13,200 |
| 1935 | July 10, 1935 | 226.98 | 63,700 | 1964 | Jan. 25, 1964 | 220.32 | 16,800 |

[a]Daily mean discharge; gage height unknown.

Table 5.--Maximum annual floods, Delaware River at Riegelsville, N.J., 1904, 1907-64

[174.8 miles above Capes. Drainage area 6,328 square miles. Datum of gage is 125.12 ft above mean sea level, datum of 1929.]

| Water year | Date | Elevation (feet) | Discharge (cfs) | Water year | Date | Elevation (feet) | Discharge (cfs) |
|---|---|---|---|---|---|---|---|
| 1841 | Jan. 8, 1841 | --- | [a]250,000 | 1935 | July 10, 1935 | 148.32 | 125,000 |
| 1904 | Oct. 10, 1903 | 161.02 | 275,000 | 1936 | Mar. 19, 1936 | 157.57 | 237,000 |
| 1907 | Jan. 1, 1907 | 139.52 | 61,000 | 1937 | Feb. 23, 1937 | 141.62 | 72,500 |
| 1908 | Dec. 11, 1907 | 147.62 | 120,000 | 1938 | Sept. 23, 1938 | 148.12 | 123,000 |
| 1909 | Feb. 21, 1909 | 145.02 | 102,000 | 1939 | Dec. 7, 1938 | 145.17 | 98,800 |
| 1910 | Mar. 1, 1910 | 145.92 | 109,000 | 1940 | Apr. 1, 1940 | 151.59 | 154,000 |
| 1911 | Mar. 28, 1911 | 141.12 | 72,600 | 1941 | Apr. 7, 1941 | 139.04 | 55,000 |
| 1912 | Mar. 17, 1912 | 143.32 | 89,000 | 1942 | May 24, 1942 | 152.62 | 164,000 |
| 1913 | Mar. 28, 1913 | 150.12 | 144,000 | 1943 | Dec. 31, 1942 | 148.00 | 122,800 |
| 1914 | Mar. 29, 1914 | 148.52 | 130,000 | 1944 | Nov. 10, 1943 | 142.70 | 80,300 |
| 1915 | Feb. 26, 1915 | 142.72 | 86,100 | 1945 | July 20, 1945 | 143.22 | 84,200 |
| 1916 | Apr. 3, 1916 | 144.42 | 97,700 | 1946 | May 29, 1946 | 143.37 | 81,600 |
| 1917 | Mar. 28, 1917 | 143.22 | 88,400 | 1947 | Apr. 6, 1947 | 145.17 | 95,100 |
| 1918 | Oct. 31, 1917 | 143.52 | 90,700 | 1948 | Mar. 23, 1948 | 148.40 | 121,300 |
| 1919 | Mar. 11, 1919 | 136.22 | 38,700 | 1949 | Dec. 31, 1948 | 149.62 | 131,900 |
| 1920 | Mar. 14, 1920 | 147.22 | 120,000 | 1950 | Apr. 6, 1950 | 143.16 | 80,100 |
| 1921 | Mar. 10, 1921 | 146.12 | 111,000 | 1951 | Apr. 1, 1951 | 149.15 | 127,800 |
| 1922 | Nov. 29, 1921 | 145.52 | 106,000 | 1952 | July 11, 1952 | 145.52 | 97,800 |
| 1923 | Mar. 24, 1923 | 142.92 | 86,100 | 1953 | Dec. 12, 1952 | 150.52 | 140,000 |
| 1924 | Apr. 8, 1924 | 148.22 | 122,000 | 1954 | Dec. 8, 1953 | 137.92 | 46,800 |
| 1925 | Oct. 1, 1924 | 149.32 | 132,000 | 1955 | Aug. 19, 1955 | 163.97 | 340,000 |
| 1926 | Apr. 10, 1926 | 138.17 | 47,100 | 1956 | Oct. 16, 1955 | 148.92 | 133,000 |
| 1927 | Nov. 17, 1926 | 147.72 | 118,000 | 1957 | Apr. 7, 1957 | 142.54 | 76,900 |
| 1928 | Oct. 20, 1927 | 146.42 | 107,000 | 1958 | Dec. 22, 1957 | 146.40 | 109,000 |
| 1929 | Mar. 16, 1929 | 143.42 | 83,100 | 1959 | Jan. 23, 1959 | 144.72 | 94,400 |
| 1930 | Mar. 9, 1930 | 137.52 | 43,300 | 1960 | Apr. 5, 1960 | 147.72 | 121,000 |
| 1931 | Mar. 30, 1931 | 139.52 | 57,000 | 1961 | Feb. 27, 1961 | 145.39 | 101,000 |
| 1932 | Apr. 2, 1932 | 140.88 | 66,600 | 1962 | Apr. 2, 1962 | 141.06 | 66,600 |
| 1933 | Aug. 25, 1933 | 150.12 | 141,000 | 1963 | Mar. 28, 1963 | 144.00 | 88,000 |
| 1934 | Mar. 6, 1934 | 143.32 | 84,100 | 1964 | Mar. 11, 1964 | 143.28 | 82,300 |

[a]Estimate for Center Bridge, 22.5 miles downstream.

Table 6.--Flood data for bridges across Delaware River in vicinity of Easton, Pa.-Phillipsburg, N.J.

| Miles above Capes | Bridge | Thalweg elevation, in feet | Floor elevation, in feet | Elevation of 1955 flood crest, in feet | Elevation of low steel, in feet | Depth of submergence of low steel by 1955 flood, in feet |
|---|---|---|---|---|---|---|
| 183.50 | Lehigh Valley Railroad.... | 145.0 | 218.6 | 197.2 | 186.9 | 10.3 |
| 183.53 | Central Railroad of New Jersey..... | 145.0 | 218.6 | 197.4 | 186.9 | 10.5 |
| 183.63 | Lehigh & Hudson Railroad.. | 143.9 | 195.3 | 198.2 | 190.1 | 8.1 |
| 183.81 | Northampton Street..... | 140.7 | 193.8 | 199.1 | 187.0 | 12.1 |
| 184.02 | Route 22-Bushkill Street.. | 149.7 | 203.6 | 200.1 | 193.2 | 6.9 |

Table 7.--Mean sea level reference points

| Miles above Capes | Description | Elevation above mean sea level, in feet |
|---|---|---|
| | Delaware River | |
| 177.6 | Pennsylvania Railroad B M 25. Bridge No. 44.63 (over Pohatcong Creek), copper bolt in east bridge seat, south abutment..... | 170.65 |
| 179.7 | USC&GS B M K 18. 4.0 miles southeast along the Pennsylvania Railroad from the station at Phillipsburg, Warren County, N.J., at the crossing of an asphalt road, 35 feet southwest of the centerline of the road, 20.6 feet southeast of the southeast rail, at a 4- by 4-foot concrete-box under the track, in the top of the southwest end of the southeast concrete headwall, 1 foot northeast of the southwest end of the headwall, and 1 foot below the level of the track. A standard disk, stamped "K 18 1935."..... | 181.781 |
| 180.8 | USGS B M T.T. Sta. No. 8 K 1929. Easton, Pa., 2.8 miles south of, 0.5 mile southwest of tourist camp, 30 feet north of point of curve, northwest side of road, in ledge; bronze tablet stamped "T.T. Sta. No. 8 K 1929."..... | 222.766 |
| 182.0 | USC&GS B M L 18 Reset. 1.7 miles southeast along the Pennsylvania Railroad from the station at Phillipsburg, Warren County, N.J., at a large bridge over a creek, in the top of the southwest end of the southeast concrete abutment, 8.2 feet southwest of the southwest rail of a sidetrack, and 1 foot below the level of the track. A standard disk..... | 191.450 |
| 183.0 | City of Easton, Pa. B M 114. North end doorsill of Easton Sewage Disposal Pumping Station, South Delaware Drive (Route 611)..... | 188.56 |

Table 7.--Mean sea level reference points--Continued

| Miles above Capes | Description | Elevation above mean sea level, in feet |
|---|---|---|
| | Delaware River--Continued | |
| 183.7 | USC&GS B M 197 (City of Easton). At Easton, Northampton County, Pa., at the northwest corner of Second and Ferry Streets, at the southeast corner of the post office, and on the top of the water table. A chiseled cross..... | 196.706 |
| 183.8 | USC&GS B M "EASTON." At Easton, Northampton County, Pa., at the intersection of Northampton and Third Streets, in Center Square, at the southwest corner of the monument, and in the top of a stone slab. A standard disk, stamped "213.175 Easton 1932."..... | 213.175 |
| 184.2 | Town of Phillipsburg, N.J. B M 192. Crosscut on catch basin, north side of Broad Street just east of Wire Alley..... | 198.371 |
| 184.5 | Town of Phillipsburg, N. J. B M 195. Crosscut on concrete step Leidy Electric Showroom, north side of Broad Street..... | 205.263 |
| 185.1 | City of Easton, Pa. B M 4. South end doorsill, City of Easton Water Filtration Plant on North Delaware Drive (Route 611)..... | 203.28 |
| 185.3 | City of Easton, Pa. B M 3. Northwest corner doorsill of City of Easton Lift Pump Station on North Delaware Drive (Route 611)..... | 201.31 |

Table 7.--Mean sea level reference points--Continued

| Miles above mouth | Description | Elevation above mean sea level, in feet |
|---|---|---|
| | Lehigh River | |
| 0.4 | USC&GS B M Easton 2.<br>At Easton, Northampton County, Pa., on the Central Railroad of New Jersey, directly across the track from the station, at a bridge over Lehigh River, in the top of the southwest wingwall of the masonry abutment, and about level with the track. A standard disk, stamped "Easton 2 1933." | 217.139 |
| 1.3 | City of Easton, Pa. B M 65.<br>Doorsill of Sarah Young Memorial Chapel, Lehigh Drive and Lynn Street | 187.36 |
| 2.4 | USGS B M T.T. Sta. No. 9 K 1929.<br>Glendon, Pa., 0.3 mile southwest of switch tower, 600 feet southwest of highway bridge over railroad, 12 feet northwest of northwest rail, on property line of Lehigh Valley R.R., in large boulder outcrop; letter "A" in word "MARK" highest point of bronze tablet set on steep angle stamped "T.T. Sta. No. 9 K 1929." | 205.350 |
| 5.7 | USC&GS B M Z 11.<br>2.7 miles southwest along the Central Railroad of New Jersey from West Easton, Northampton County, Pa., at Hope Crossing, about 300 yards southwest of milepost 78, at bridge 78/14 in the northeast dressed-stone wingwall, and in the third course below the top of the abutment. A standard disk, stamped "218.795 Z 11 1932." | 218.795 |

Table 7.--Mean sea level reference points--Continued

| Miles above mouth | Description | Elevation above mean sea level, in feet |
|---|---|---|
| | Bushkill Creek | |
| 0.3 | USC&GS B M "Gate." At Easton, Northampton County, Pa., at the north end of North Third Street at its junction with College Avenue, at the memorial entrance gate to Lafayette College, and in the west face of the east stone pillar. A standard disk, stamped "196.217 Gate 1932" and set vertically.... | 196.217 |
| 0.8 | City of Easton, Pa. B M 13. South end doorsill of Lehigh Valley Supply Co., 536 West Bushkill Drive..... | 192.94 |

Table 8.--Flood-crest elevations in the Easton, Pa.-Phillipsburg, N.J. vicinity

Delaware River

| Miles above Capes | Description | Flood elevations above mean sea level, in feet | | | | |
|---|---|---|---|---|---|---|
| | | Oct. 10, 1903 | Mar. 19, 1936 | May 24, 1942 | Aug. 19, 1955 | Low water Sept. 3, 1964 |
| 174.8 | Riegelsville, N.J., USGS gage, 20 ft upstream from suspension bridge, left bank.. | 161.0 | 157.6 | 152.6 | 164.0 | 127.5 |
| 175.7 | Riegelsville, N.J. (near)..... | | | | a168.5 | |
| 175.9 | Riegelsville, N.J. (near)..... | | | | a169.4 | |
| 176.2 | Riegelsville, N.J. (near)..... | | | | a170.5 | |
| 176.7 | Coffeetown, Pa., at residence of Mrs. Claude Golden, right bank..... | | | | b175.4 | |
| 177.5 | (1.1 miles above mouth, Pohatcong Creek) Carpentersville, N.J. (near), on house of Mr. James H. Halligan, right bank..... | | | | 176.6 | |
| 177.6 | Carpentersville, N.J. (near), left bank..... | | | | | 135.5 |
| 178.6 | Raubsville, Pa., on St. Paul's Lutheran Church, right bank..... | | | | b179.0 | |
| 178.9 | Carpentersville, N.J. (near), on office and garage of Houdaille Construction Co., left bank..... | | | | 179.5 | |
| 179.2 | Carpentersville, N.J. (near), at Budd's Beach, left bank..... | | | | | 142.2 |

Table 8.--Flood-crest elevations in the Easton, Pa.-Phillipsburg, N.J. vicinity--Continued

Delaware River--Continued

| Miles above Capes | Description | Flood elevations above mean sea level, in feet | | | | |
|---|---|---|---|---|---|---|
| | | Oct. 10, 1903 | Mar. 19, 1936 | May 24, 1942 | Aug. 19, 1955 | Low water Sept. 3, 1964 |
| 179.5 | Carpentersville, N.J. (near), on house of Mr. Louis Hajdu, left bank..... | | | | *c181.6 | |
| 179.5 | Raubsville, Pa. (near), on house of Mr. Frank Sofet, right bank..... | | | | 182.9 | |
| 179.8 | Raubsville, Pa. (near), on garage of Mr. C. M. Spang, right bank..... | | | | c183.6 | |
| 182.0 | Phillipsburg, N.J., N.J. Geodetic Control Survey 1955 flood crest disk on Phillipsburg Sewage Disposal Plant, left bank..... | | | | *de191.2 | 148.2 |
| 182.7 | Easton, Pa., on Easton Sewage Treatment Plant, South Delaware Drive, right bank.. | | | | *c193.0 | 149.2 |
| 183.4 | Easton, Pa., on wall of Keuber Brewery Co., right bank..... | h190.4 | h186.4 | | b196.2 | |
| 183.5 | Phillipsburg, N.J., 0.2 mile below mouth of Lehigh River, Central Railroad of N.J. Bridge, left bank..... | h191.2 | | | | |
| 183.7 | Easton, Pa., on Post Office, South 2nd and Ferry Streets, right bank..... | | | | *c199.0 | |

Table 8.--Flood-crest elevations in the Easton, Pa.-Phillipsburg, N.J. vicinity--Continued

Delaware River--Continued

| Miles above Capes | Description | Flood elevations above mean sea level, in feet | | | | |
|---|---|---|---|---|---|---|
| | | Oct. 10, 1903 | Mar. 19, 1936 | May 24, 1942 | Aug. 19, 1955 | Low water Sept. 3, 1964 |
| 183.8 | Easton, Pa., on Bennett's Hardware Store, 154 Northampton Street, right bank..... | | | | *c198.8 | |
| 183.8 | Easton, Pa., on Hotel Easton, Northampton and Green Streets, right bank..... | | | | *c198.9 | |
| 183.8 | Easton, Pa., on apartment bldg., 30 North Riverside Drive, right bank..... | | | | *c199.4 | |
| 183.8 | Phillipsburg, N.J., N.J. Geodetic Control Survey 1955 flood crest disk, Union Square, left bank..... | | | | *d199.0 | |
| 183.8 | Easton, Pa., Union Square, right bank..... | | | | b198.9 | |
| 183.8 | Easton, Pa., office of Delaware River Bridge Comm., upstream side of Northampton Street Bridge, right bank.... | | | | f199.1 | |
| 183.8 | Easton, Pa., wire-weight gage on Northampton Street Bridge, right bank.... | g193.5 | g188.2 | g183.2 | g199.1 | 155.6 |
| 183.9 | Easton, Pa., on apartment bldg., 122 Spring Garden Street, right bank..... | | | | 199.7 | |
| 184.1 | Phillipsburg, N.J., on garage of Trans Bridge Lines Inc., Broad Street Garage, left bank..... | | | | 199.9 | |

Table 8.--Flood-crest elevations in the Easton, Pa.-Phillipsburg, N.J. vicinity--Continued

Delaware River--Continued

| Miles above Capes | Description | Flood elevations above mean sea level, in feet | | | | |
|---|---|---|---|---|---|---|
| | | Oct. 10, 1903 | Mar. 19, 1936 | May 24, 1942 | Aug. 19, 1955 | Low water Sept. 3, 1964 |
| 184.1 | Easton, Pa., southwest corner of North Delaware Drive and North Front Street, right bank..... | | | | b200.8 | |
| 184.2 | Easton, Pa., on Wilson Bros. Mfg. Co., building, right bank..... | h194.3 | h189.5 | | | |
| 184.5 | Phillipsburg, N.J., on house of Mr. Alfred R. Bates, Broad Street and Judd Alley, left bank..... | | | | 201.2 | 161.5 |
| 184.6 | Easton, Pa., on old Easton Pumping Station, right bank..... | h194.8 | h190.0 | | | |
| 185.1 | Easton, Pa., on Water Filtration Plant, North Delaware Drive, right bank..... | | | | *c202.3 | |
| 185.2 | Easton, Pa., on Water Pumping Station, North Delaware Drive, right bank..... | | | | *c202.2 | 161.8 |
| 185.7 | Easton, Pa. (near), 1.7 miles north of mouth of Bushkill Creek and east side Route 611, right bank..... | | | | f203.6 | |
| 185.8 | Easton, Pa. (near), on garage of Mrs. Harold F. Rogers, right bank..... | | | | 203.9 | |

Table 8.--Flood-crest elevations in the Easton, Pa.-Phillipsburg, N.J. vicinity--Continued

Delaware River--Continued

| Miles above Capes | Description | Flood elevations above mean sea level, in feet | | | | |
|---|---|---|---|---|---|---|
| | | Oct. 10, 1903 | Mar. 19, 1936 | May 24, 1942 | Aug. 19, 1955 | Low water Sept. 3, 1964 |
| 186.1 | Easton, Pa. (near), on garage of Mr. William Tomino, right bank..... | | | | c204.9 | 162.6 |
| 186.6 | Easton, Pa. (near), on house of Mr. P. Carazel, right bank..... | | | | c207.1 | |
| 186.6 | Easton, Pa. (near), on house of Mr. Elwood Border, right bank..... | | | *c191.7 | | |
| 186.9 | Harmony Station, N.J. (near), on house of Mrs. Irma Miller, left bank..... | | *199.6 | | *209.1 | 168.8 |
| 188.1 | Harmony Station, N.J., on house of Mr. Earl S. Hayes, left bank..... | | | | c210.6 | 176.8 |

Table 8.--Flood-crest elevations in the Easton, Pa.-Phillipsburg, N.J. vicinity--Continued

Lehigh River

| Miles above mouth | Description | Flood elevations above mean sea level, in feet | | | | |
|---|---|---|---|---|---|---|
| | | Oct. 10, 1903 | Mar. 19, 1936 | May 23-24, 1942 | Aug. 19, 1955 | Low water Sept. 10, 1964 |
| 0.1 | Easton, Pa., on old Metropolitan Edison bldg., 2nd and Ferry Streets, left bank.. | | *c188.2 | *c183.4 | | 170.3 |
| 0.2 | Easton, Pa., on Gulf gas station, South 3rd and Lehigh Streets, left bank..... | | | | *c199.1 | |
| 0.3 | Easton, Pa., 87 ft downstream from South Third Street Bridge, right bank..... | f191.2 | | | b198.8 | |
| 0.3 | Easton, Pa., first pier on Central of New Jersey R.R. bridge, right bank of Delaware River..... | f191.2 | | | b197.0 | |
| 0.4 | Easton, Pa., on garage of Mr. Squire, Inc., 310 South 4th Street, left bank..... | | | | 199.6 | 170.3 |
| 0.7 | Easton, Pa., on Dock Street plant, Metropolitan Edison Co., Lehigh Drive, left bank..... | | | | 200.0 | 170.3 |
| 0.7 | Easton, Pa., H. N. Crowder, Jr. Co., bldg., Lehigh Drive, left bank..... | | | | f200.1 | |
| 1.3 | Easton, Pa., on Harmony Dye and Finishing Co. bldg., Peach and Lynn Streets, left bank..... | | | | c200.5 | 170.3 |

Table 8.--Flood-crest elevations in the Easton, Pa.-Phillipsburg, N.J. vicinity--Continued

Lehigh River--Continued

| Miles above mouth | Description | Flood elevations above mean sea level, in feet | | | | |
|---|---|---|---|---|---|---|
| | | Oct. 10, 1903 | Mar. 19, 1936 | May 23-24, 1942 | Aug. 19, 1955 | Low water Sept. 10, 1964 |
| 1.6 | Easton, Pa., Lehigh Foundry Co. on Lehigh Drive, left bank..... | | | f189.4 | b201.0 | |
| 1.8 | West Easton, Pa., on Ingersoll Rand bldg., Lehigh Drive, left bank..... | | | | b201.2 | 170.3 |
| 2.3 | Glendon, Pa., downstream side of highway bridge, left bank..... | | | f195.2 | b202.3 | 170.6 |
| 2.7 | Glendon, Pa., on garage of Mr. John Buttner, Lucy Crossing, right bank..... | | | | a202.6 | |
| 3.3 | Glendon, Pa., downstream of dam below Island Park, right bank..... | | | | | 176.8 |
| 3.4 | Glendon, Pa. (near), on Lehigh Valley Chemical Co. bldg., right bank..... | | | | c204.7 | 191.9 |
| 5.6 | Hope, Pa., upstream side of railroad underpass at lock 46, left bank..... | | | f209.5 | b210.7 | 192.2 |

Table 8.--Flood-crest elevations in the Easton, Pa.-Phillipsburg, N.J. vicinity--Continued

Bushkill Creek

| Miles above mouth | Description | Flood elevations above mean sea level, in feet | | | | |
|---|---|---|---|---|---|---|
| | | Oct. 10, 1903 | Mar. 19, 1936 | May 24, 1942 | Aug. 19, 1955 | Low water Oct. 21, 1964 |
| 0.1 | Easton, Pa., on garage of United Gas Improvement Co., 229 North Green Street, right bank | | | | *c200.6 | |
| 0.2 | Easton, Pa., on storage shed of Delaware River Joint Toll Bridge Comm. at Snyder and North 2nd Streets, right bank | | | | c200.6 | |
| 0.3 | Easton, Pa., on office and garage of Case's Tire Service, 219 North 3rd Street, right bank | | | | *c200.6 | |
| 0.4 | Easton, Pa., on Electric Sanitary Laundry, 214 North Bank Street, right bank | | | | 200.6 | 163.4 |
| 0.4 | Easton, Pa., on pillars of underpass of Route 22 at Bath Street, right bank | | | | 200.6 | |
| 0.8 | Easton, Pa., on Lehigh Plumbing Supply Co. bldg., 536 West Bushkill Drive, left bank | | | | c200.6 | |
| 0.8 | Easton, Pa., on Collins and Maxwell Construction Co. bldg., 600 Bushkill Drive, left bank | | | | c200.6 | |

Table 8.--Flood-crest elevations in the Easton, Pa.-Phillipsburg, N.J. vicinity--Continued

* Flood marker

Sources of data:

a Average flood elevation by USGS, Sept. 1955

b Water-Supply Paper 1420

c Local resident or industrial firm

d N.J. Geodetic Control Survey

e Elevation by USGS

f Corps of Engineers

g N.J. Department of Conservation and Economic Development Special Reports 9, 12, and 16

h Mangan, J. W., 1942, The floods of May 1942 in the Delaware and Lackawanna River basins

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