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THE NEW YORK STATE FLOOD OF JULY 1935

BY

HOLLISTER JOHNSON

Prepared in cooperation with the Water Power and Control Commission of the Conservation Department and the Department of Public Works, State of New York

Contributions to the hydrology of the United States, 1936
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THE NEW YORK STATE FLOOD OF JULY 1935

By Hollister Johnson

INTRODUCTION

A vivid impression of the tragic flood that swept over southern and central New York July 7 and 8, 1935, is furnished in the following quotation from the Albany Evening News for December 26, 1935, in which the outstanding news items of the year were summarized:

> Floods leading Empire State news during 1935
>
> As headlines that flashed across front pages in 1935 recede into memory with the passing year, one New York State news story stands out above all others--the disastrous July flood in the Southern Tier. Greatest news event of the year, it also was one of the biggest stories in Empire State history.
>
> On Sunday, July 7, sullen clouds hovered motionless above a populace mindful only of vacation plans and escape from oppressive heat. Without warning came torrents of rain--sheets of flowing water down grassy hillsides.
>
> Governor Lehman began a tour of the flood zone the following Thursday. The water had receded and he found:
>
> Dead, 43; homeless, hundreds; estimated damage, $25,000,000; devastated, a farm belt 200 miles long, from Hornell to the Catskill Mountains, 50 to 75 miles wide, from Pennsylvania border to the Mohawk Valley.
>
> State and local health officials quickly controlled a mosquito plague in the wake of the flood; prevented a dreaded outbreak of disease. Trying to undo the damage presented a problem that still remains for 1936 to solve--rich farm lands in Southern Tier counties buried under rock and gravel, highways ruined, homes destroyed.

The Geological Survey has no means of checking the accuracy of the item of estimated damage, but it is evident that this and the other recorded results mark this flood as a major disaster. Such a disaster can probably never be completely prevented, but by appropriate control and protective measures the resulting losses can be greatly reduced. This report records information about the very unusual precipitation and the consequent flood discharges, which were the most intense in the history of the State. The record of rates of flood discharge actually attained should furnish a basis for more intelligently determining the magnitude of floods to be guarded against, both in the region in which these floods occurred and in other regions where the information may be applicable, and thus tend to reduce flood losses.

A flood-control survey of the flood areas in southern and central New York has been made under the direction of the Corps of Engineers, U. S. Army, and it is expected that their findings and recommendations on the problem of flood control in these areas will be presented soon for the consideration of Congress.

ACKNOWLEDGMENTS

This report was prepared as a part of the regular stream-gaging work in New York, which is conducted under the direction of Arthur W. Harrington, district engineer, Albany, N. Y., and in cooperation with the Water Power and Control Commission of the Conservation Department, Lithgow Osborne, chairman, and Friend P. Williams, secretary, and the Department of Public Works, Frederick Stuart Greene, superintendent.

The writer was in immediate charge of the collection of field data, office computations, and the preparation of this report and was assisted by the members of the district office of the United States Geological Survey at Albany. The final preparation of the data for the report was made with the advice and guidance of R. W. Davenport, chief of the division of water utilization.

Field assistants were furnished by the Flood Control Survey, Corps of Engineers, U. S. Army, Capt. Lester W. Rhodes, in charge, and the New York State Department of Public Works, Hornell division, W. O. Dempster, division engineer.

The chapter on the causes of the storm was written by C. L. Mitchell, principal meteorologist, United States Weather Bureau, Washington, D. C.

The discussion of the general features of the storm was written by John C. Fisher, meteorologist, United States Weather Bureau, Ithaca.

The section on storms and floods in the Susquehanna River Basin in the vicinity of Binghamton was abstracted from an unpublished article by T. E. Reed, meteorologist in charge, and H. K. Gold, observer, United States Weather Bureau, Binghamton.

Wherever special data have been used, individual acknowledgments are given at appropriate places in the report.

RAINFALL

Causes

By C. L. Mitchell

The heavy rains were due, not to any single cause, but to a combination of causes. At 8 p.m. July 3 a well-defined disturbance was moving eastward over the Hudson Bay region, and an ill-defined, slow-moving disturbance over the Rocky Mountain region and the Plains States. At the same time a mass of polar air had begun to move southward over northern Canada. During the next 24 hours the northern disturbance had moved rapidly east-southeastward to the lower St. Lawrence Valley, the western disturbance had assumed more definite form and was central over South Dakota, and the polar continental air had overspread the Hudson Bay region. By the morning of July 5 the center of the northeastern disturbance was over the Gulf of St. Lawrence and the Dakota disturbance was over Minnesota and extreme western Ontario, moving northeastward. However, its further advance in that direction was blocked by a wedge of the polar continental air that had by this time pushed southeastward over James Bay and northern Ontario. With the center of the northern high-pressure area still west of Hudson Bay, the disturbance was not merely blocked in its northeastward movement but was carried along by the general drift of the upper air toward the east-southeast until the morning of July 7, when the center was near Buffalo, N. Y. Meanwhile the front of the polar continental air mass, which had reached northern New England and extreme northern New York by the evening of the 5th, pushed southward and southwestward, and at 8 p.m. of the 7th this cold front extended from a point a short distance south of New Haven, Conn., northwestward to Lake Ontario, through or very close to the area over which excessive rain was then falling and continued to fall through the night. For the second time the disturbance was blocked, and it made no further eastward progress; but its center drifted slowly southward during the next 24 hours and merged with another disturbance that moved northeastward from Georgia to the New Jersey coast, where it was centered the evening of July 8. Owing to this unusual meteorologic situation a mass of warm and very moist tropical maritime air moved north-northwestward over eastern and central New York, while at the same time a mass of polar continental air was moving southeastward over the Lake region and its front had reached eastern Lake Erie by 8 p.m. of the 7th. The inevitable result was that for a period of many hours, by the physical processes of convergence and forced convection, the continuous stream of tropical maritime air was lifted rapidly; and heavy and prolonged rainfall occurred over a considerable area, of which Cortland appeared to be the center. Wherever the tropical maritime air mass was forced to rise over elevated areas the rainfall was naturally even heavier than over other sections where the wind was not up-slope.

General features

By John C. Fisher

Past records show that the maximum 1-, 2-, and 3-day rainfalls for stations in south-central New York have been rather evenly divided between those caused by general fall storms and those caused by summer thunderstorms.

During the period July 6 to 9, 1935, heavy thunderstorms occurred over an area extending from northern Steuben County eastward to northern Delaware County, and previous records for 24-, 48-, and 72-hour precipitation were exceeded at all stations.

The records of the Weather Bureau station at Ithaca indicate that two thunderstorms were observed on the 6th, seven on the 7th, and two on the 8th. Commonly but one heavy thunderstorm passes over a given locality during a rain period; occasionally a second storm follows closely the course of the first, before run-off has taken place, and then local damage frequently occurs. But when a succession of storms continues for many hours, then great destruction is a foregone conclusion.

As indicated by the isohyetal map, the distribution of rainfall was unusually uniform for thunderstorm precipitation, but naturally there was considerable variation in amount. Observations throughout this area indicate that although a few sections escaped serious damage, in others the rainfall was undoubtedly much heavier than recorded by any of the standard gages.

The only tipping-bucket rain gage in the area of maximum rainfall is located at Ithaca. The record of this gage, which shows the time of fall of each 0.01 inch, is therefore of considerable interest.

Previous records of severe thunderstorms show greater intensities for all periods from 5 minutes to 2 hours; if this record is indicative of conditions throughout the area, the rainfalls were not of the type commonly characterized as "cloudbursts"; in other words, although the amount of precipitation falling in 24 hours, 48 hours, and 72 hours exceeded all previous records, the rate of fall was at no time unprecedented.

Comparison of greatest recorded precipitation, in inches, for 24-, 48-, and 72-hour periods, at stations in south-central New York

(Prepared by U. S. Weather Bureau, Ithaca, N. Y.)

Station	Length of record (years)	24-hour		48-hour		72-hour	
		1935	Previous	1935	Previous	1935	Previous
Ithaca	77	7.90	4.70	9.25	5.88	9.50	5.96
Cortland	57	7.67	5.80	10.58	6.47	11.15	7.82
Norwich	29	6.10	4.04	9.07	4.94	9.56	5.25
Delhi	22	8.52	5.71	8.68	6.44	9.43	6.49
Haskinville	36	3.35	2.80	6.70	3.61	6.76	4.25
Oneonta	41	5.24	5.09	6.71	5.18	6.94	5.26
Burdett	3	8.50	-	10.50	-	11.10	-
Ovid	3	7.61	-	9.84	-	10.61	-
Hammondsport	3	6.10	-	8.00	-	8.47	-

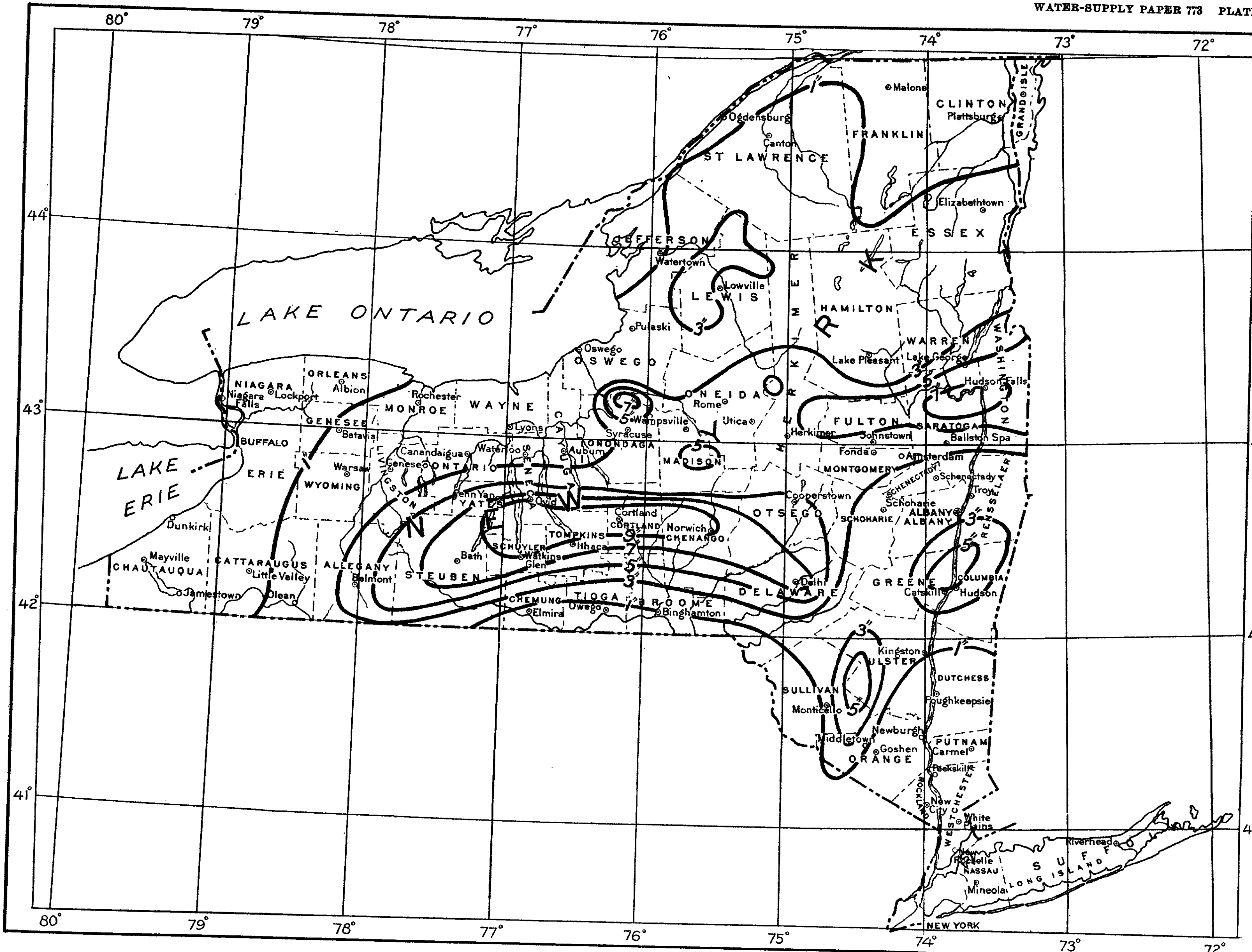
Rainfall records

The daily weather maps of the United States Weather Bureau are available for those who may wish to study carefully the development and progress of the July storm. In this report rainfall is the only meteorologic feature of the storm that will be presented. The information contained herein has been compiled from sources that are believed to be reliable, and it is assembled as a means of preserving a record of this outstanding storm.

No official records were made of the greatest and most intense rainfall that occurred. The heaviest rainfall was apparently centered along an approximately east-west line extending from a point near Hornell, in Steuben County, to a point near Delhi, in Delaware County. There were also heavy rains in other more or less isolated sections of the State, as in the Mohawk Valley; near Chaumont, Jefferson County; near Glens Falls; and in certain portions of the Catskill Mountains.

Records of precipitation have been obtained from the United States Weather Bureau and other indicated sources and are shown in the table of "Daily and maximum 2-day rainfall, in inches." The figures are the amounts as reported by the observers and are not strictly comparable, as the times of the observations at the various stations were not simultaneous. The amount as recorded usually represents the rainfall for the 24-hour period preceding the time of observation. Rainfall measured in the morning may be recorded under the date of measurement or under the date of the preceding day. Rainfall occurring during the daylight hours will probably be recorded under the date of occurrence at a station where observations are made in the late afternoon but may be recorded under the date of occurrence or under the date of the following day at a station where observations are made in the early morning.

The records at the stations having automatic rain gages indicate that most of the precipitation that caused the flood occurred during a 24-hour period commencing generally in the late afternoon of July 7. Because of variations in the methods of the observers in recording their measurements, and the fact that the period of the storm covered parts of two observation periods, it is believed that the recorded maximum 2-day rainfall represents very closely the rainfall which generally caused the flood and a large part of which probably occurred within a period of about 24 hours. The isohyetal map on plate 22, prepared by John C. Fisher, meteorologist, United States Weather Bureau, Ithaca, shows the total rainfall recorded under the dates of July 7 and 8 at stations reporting to the United States Weather Bureau at Ithaca. Supplemental measurements of the rainfall made after the storm indicate that a much heavier precipitation than that shown on the map probably occurred over a large area.



ISOHYETAL MAP OF NEW YORK STATE SHOWING TOTAL RAINFALL OBSERVED FOR JULY 7-8, 1935.

Daily and maximum 2-day rainfall, in inches

Station	County	July 6	July 7	July 8	July 9	July 10	Maximum 2-day
Western Plateau							
Alfred	Allegany	-	0.16	5.58	0.24	0.66	5.82
Allegany State Park	Cattaraugus	-	.80	.11	-	-	.91
Andover	Allegany	0.02	3.38	2.69	.28	.51	6.07
Angelica	Allegany	.26	.72	3.39	1.69	-	5.08
Arnot (a)	Schuyler	-	.40	1.98	1.14	.47	3.12
Caneadea Dam	Allegany	-	.24	.87	.75	.07	1.62
Elmira	Chemung	.30	.10	.56	1.00	.11	1.56
Franklinville	Cattaraugus	-	.97	.33	.10	.28	1.30
Haskinville	Steuben	.06	*	6.70	-	.95	6.70
Lost Nation Brook (b)	Allegany	-	1.19	.08	.28	.02	1.28
Olean	Cattaraugus	-	-	1.93	.09	.24	2.02
Scio	Allegany	-	.10	3.85	.69	-	4.54
Woodhull	Steuben	-	.42	1.55	.38	.11	1.97
Great Lakes							
Brockport	Monroe	-	.17	.04	-	-	.21
Buffalo	Erie	T	-	.28	-	-	.28
Fredonia	Chautauqua	-	-	.09	-	-	.09
Herrings	Jefferson	.40	1.70	.12	.35	.01	2.10
Jamestown	Chautauqua	-	-	.33	T	-	.33
Lewiston	Niagara	-	.20	.02	T	-	.22
Linden (c)	Genesee	-	1.25	1.08	-	-	2.33
Lockport	Niagara	-	.38	.12	.01	-	.50
Oswego	Oswego	.31	.55	.63	.58	-	1.21
Rochester	Monroe	.13	2.13	.08	.08	-	2.34
South Wales	Erie	-	.35	-	.08	-	.35
Stafford	Genesee	-	.73	.91	-	-	1.64
Watertown	Jefferson	.47	.84	.09	.15	.24	1.31
Central Lakes							
Auburn	Cayuga	.15	.44	.90	.29	.01	1.34
Avon	Livingston	T	.25	.05	.15	1.87	2.02
Baldwinsville (c)	Onondaga	-	.12	2.90	.35	.07	3.25
Brewerton (c)	Onondaga	-	.21	6.82	.46	.06	7.28
Bristol Springs (d)	Ontario	-	1.29	3.70	1.20	.04	4.99
Burdett (d)	Schuyler	.60	2.00	8.50	.60	-	10.50
Canastota (d)	Madison	.22	1.79	1.14	.42	.05	2.93
Cayuga (c)	Cayuga	-	.08	.98	1.23	.22	2.21
Cleveland (c)	Oswego	.06	2.30	.48	.12	-	2.78
Clyde (c)	Wayne	-	.14	1.18	.74	.76	1.92
Dansville	Livingston	1.11	1.00	3.69	.68	-	4.69
Fulton (c)	Oswego	-	.09	2.80	.15	.12	2.95
Geneva	Ontario	.16	.82	1.41	.07	.22	2.23
Hammondsport (d)	Steuben	-	1.90	6.10	.47	.28	8.00
Hemlock	Livingston	-	.75	.38	.07	.02	1.13
Ithaca	Tompkins	1.12	3.62	4.60	.26	.04	8.22
Letchworth Park	Wyoming	-	.25	.51	1.30	.15	1.81
Locke (d)	Cayuga	-	1.23	3.47	.78	.60	4.70
Macedon (c)	Wayne	-	2.30	.70	-	.04	3.00
Mays Point (c)	Seneca	-	.16	.87	.70	.26	1.57
Newark (c)	Wayne	.02	.98	1.09	.20	.01	2.07
New London (c)	Oneida	-	.60	3.05	1.42	.20	4.47
Ovid (d)	Seneca	-	2.23	7.61	.77	.23	9.84
Penn Yan	Yates	-	1.25	4.08	-	.10	5.33
Shortsville	Ontario	-	2.00	.64	2.18	.03	2.82
Skaneateles	Onondaga	.20	.84	.63	1.36	.01	1.99
Syracuse	Onondaga	.19	2.05	1.25	.13	T	3.30
Waterloo (c)	Seneca	-	.25	1.54	.85	.04	2.39
Williamstown (d)	Oswego	-	.27	1.73	.29	.09	2.02

a Record furnished by U. S. Soil Conservation Service.
b Record furnished by U. S. Geological Survey.
c Record furnished by New York State Department of Public Works.
d Record furnished by Oswego River Watershed Co.

Daily and maximum 2-day rainfall, in inches--Continued

Station	County	July					Maximum 2-day
		6	7	8	9	10	
Eastern Plateau							
Bainbridge	Chenango	-	-	4.10	1.25	0.21	5.35
Binghamton	Broome	0.27	0.07	1.02	.31	.22	1.38
Cold Spring Brook (b)	Delaware	.07	1.48	1.70	.57	.02	3.59
Cooperstown	Otsego	-	.84	4.49	.13	1.06	5.33
Cortland	Cortland	-	1.70	7.67	1.78	.39	9.45
Delhi	Delaware	T	-	8.52	.16	.75	8.68
DeRuyter (c)	Madison	-	.98	2.25	.86	-	3.23
Franklin (e)	Delaware	T	.69	6.50	1.27	.37	7.77
Honk Falls	Ulster	-	5.10	1.00	.31	.05	6.10
Jeffersonville	Sullivan	-	.04	.53	.86	.42	1.39
Leonardsville (b)	Madison	-	.69	2.05	1.31	.51	3.36
Matamoras, Pa.	Pike	-	-	.08	2.86	.28	3.14
Morrisville	Madison	.02	3.04	2.50	.17	.43	5.54
Norwich	Chenango	.11	2.97	6.10	.49	.11	9.07
Oneonta	Otsego	-	1.47	5.24	.23	.18	6.71
Port Jervis	Orange	.25	.40	2.29	.75	.06	3.04
Roxbury	Delaware	.09	.87	1.85	.34	.53	2.72
Sage Brook (b)	Chenango	.31	2.12	4.55	.22	.09	6.80
Shackham Brook (b)	Cortland	1.39	2.25	2.10	.46	.08	4.94
Sharon Springs (2)	Schoharie	.22	2.50	1.65	.09	.74	4.15
Sherburne	Chenango	-	.32	3.56	1.02	.19	4.58
Susquehanna, Pa.	Susquehanna	-	-	.58	2.22	.40	2.80
Warwick	Orange	-	.11	-	.19	.11	.30
Mohawk Valley							
Canajoharie (c)	Montgomery	-	.59	2.42	.40	-	3.01
Delta	Oneida	-	.25	3.15	2.10	.21	5.25
Dolgeville	Herkimer	-	.80	4.87	1.62	-	6.49
Ephratah (f)	Fulton	-	.37	2.76	.11	.19	3.13
Frankfort (c)	Herkimer	-	.62	2.65	.82	.29	3.47
Gloversville	Fulton	T	1.90	2.10	.16	.31	4.00
Hinckley (c)	Oneida	-	.74	1.60	.96	.59	2.56
Inghams Mills (f)	Herkimer	-	.31	4.23	1.58	.26	5.81
Jacksonburg (c)	Herkimer	-	.21	2.84	.90	.29	3.74
Little Falls (1)	Herkimer	-	.82	3.35	.20	.52	4.17
Little Falls (2)	Herkimer	-	.21	4.02	1.90	.33	5.92
Pecks Pond (f)	Fulton	-	-	5.99	.18	.14	6.17
Salisbury	Herkimer	-	2.05	3.20	.16	.34	5.25
Schenectady (g)	Schenectady	-	.49	2.01	.56	.34	2.57
Scotia (c)	Schenectady	-	2.50	T	.59	.36	2.50
Sharon Springs (1)	Schoharie	.12	3.21	.96	.07	.67	4.29
Sprite (f)	Fulton	-	.53	4.10	1.37	.13	5.47
Stewart's Landing (f)	Fulton	-	.79	5.96	3.03	.17	8.99
Taberg	Oneida	.02	.01	2.50	.30	.18	2.80
Trenton Falls	Oneida	.46	1.85	1.45	.22	.12	3.30
Tribes Hill	Montgomery	-	.96	3.63	.30	.20	4.59
Utica	Oneida	-	.06	3.28	.15	.04	3.43
Verf Kill((h)	Schenectady	.38	1.80	.64	.16	-	2.44
Northern Plateau							
Beaver Falls	Lewis	-	1.25	1.00	.16	.03	2.25
Bennett's Bridge (i)	Oswego	-	1.40	.61	.12	1.61	2.01
Big Moose	Herkimer	.41	.80	.76	.36	-	1.56
Bonaparte	Lewis	-	.64	2.05	.51	-	2.69
Boonville	Oneida	-	.25	1.85	.55	.30	2.40
Colton	St. Lawrence	.05	.01	1.90	.65	.37	2.55
Copenhagen	Lewis	-	4.02	.17	.07	-	4.19
Eagle Falls	Lewis	T	2.13	1.19	.20	.49	3.32

b Record furnished by U. S. Geological Survey
c Record furnished by New York State Department of Public Works.
e Record furnished by Arthur Bennett
f Record furnished by New York Light and Power Co.
g Record furnished by Sanitary Engineer, City of Schenectady, N. Y.
h Record furnished by Malcolm L. Fisher, Scotia, N. Y.
i Record furnished by Niagara-Hudson Corporation.

Daily and maximum 2-day rainfall, in inches--Continued

Station	County	July					Maximum 2-day
		6	7	8	9	10	
Northern Plateau-Cont.							
Gabriels	Franklin	-	0.09	0.14	0.27	0.11	0.41
Hoffmeister	Hamilton	-	2.32	1.00	1.14	.24	3.32
Hope	Hamilton	-	.58	2.30	1.09	.18	3.39
Indian Lake	Hamilton	1.00	.54	1.03	1.30	.14	2.33
Lake Placid Club	Essex	.10	.52	.70	.11	-	1.22
Lowville	Lewis	.50	1.82	.06	.26	.06	2.32
Lyons Falls	Lewis	-	1.19	1.81	.28	.45	3.00
McKeever	Herkimer	-	.58	1.46	.94	.45	2.40
North Lake	Herkimer	.10	.96	1.37	.13	.33	2.33
Raquette Lake	Hamilton	.20	.50	.70	.12	.18	1.20
Sabattis	Hamilton	-	.36	.60	.33	-	.96
South Edwards	St. Lawrence	1.20	2.79	.01	.50	-	3.99
Sperryville	Lewis	-	.77	1.82	.10	1.16	2.59
Stillwater Reservoir	Herkimer	-	1.29	.90	.23	.21	2.19
Tupper Lake	Franklin	.61	.80	.13	.33	.03	1.41
Wanakena	St. Lawrence	.48	1.21	.13	.12	.05	1.69
Hudson Valley							
Adams, Mass. (f)	Berkshire	.01	1.03	2.59	.05	.06	3.62
Albany	Albany	T	2.08	.59	.06	.46	2.67
Bedford Hills	Westchester	-	-	.38	.32	.47	.79
Boyd's Corners	Putnam	.40	.42	.17	.48	.06	.82
Cairo	Greene	-	2.48	3.52	.28	.05	6.00
Carmel	Putnam	.28	.18	.18	.28	.01	.46
Conklingville	Saratoga	-	4.73	.70	.15	-	5.43
Feeder Dam (f)	Saratoga	1.61	1.37	5.00	1.57	.19	6.57
Glenham	Dutchess	-	-	.10	.22	.30	.52
Greenfield Center	Saratoga	-	2.80	2.00	.05	.30	4.80
High Falls	Ulster	-	1.95	.20	.10	-	2.15
Johnsonville (f)	Rensselaer	-	1.37	1.74	-	.06	3.11
Mechanicville	Saratoga	-	.95	1.89	.27	.29	2.84
Mohonk Lake	Ulster	-	.30	.58	.43	.01	1.01
Mount McGregor	Saratoga	.43	4.70	2.87	.85	.42	7.57
North Creek (f)	Warren	-	.98	1.00	1.33	.17	2.33
Oak Hill (b)	Greene	-	2.35	.35	.95	.12	2.70
Poughkeepsie	Dutchess	-	.33	.25	.23	-	.58
Rifton	Ulster	-	.40	.34	.10	.07	.74
Schaghticoke (f)	Rennsselaer	-	1.50	1.67	-	.10	3.17
Schuylerville (c)	Saratoga	.06	4.53	.24	.08	T	4.77
Southeast Reservoir	Putnam	-	.16	.35	.25	.04	.60
Spier Falls	Saratoga	.36	5.10	2.95	.24	.34	8.05
Voorheesville	Albany	-	-	2.39	.55	.32	2.94
Walden	Orange	1.45	.06	.25	.21	-	1.51
Wappingers Falls	Dutchess	T	.01	.09	.36	T	.45
Warrensburg (f)	Warren	-	3.40	3.53	2.02	.15	6.93
West Point	Orange	.05	T	.24	.30	.28	.58
Atlantic Coast							
Bridgehampton	Suffolk	-	-	.01	.88	T	.89
Cutchogue	Suffolk	-	-	.01	1.25	-	1.26
Flushing	Queens	-	T	-	.36	.12	.48
Hicksville	Nassau	-	-	-	.18	.19	.37
Mount Vernon	Westchester	-	-	.12	.48	.43	.91
New York City	New York	-	T	.03	.62	.30	.92
Scarsdale	Westchester	-	-	.05	.26	.37	.63
Setauket	Suffolk	-	-	.02	.60	-	.62

b Record furnished by U. S. Geological Survey.
c Record furnished by New York State Department of Public Works.
f Record furnished by New York Light and Power Co.

Daily and maximum 2-day rainfall, in inches--Continued

Station	County	July					Maximum 2-day
		6	7	8	9	10	
Champlain Valley							
Ashley (f)	Washington	0.40	0.68	3.42	0.23	0.12	4.10
Chazy	Clinton	-	-	.05	.34	T	.39
Dannemora	Clinton	-	-	.35	.30	.05	.65
Port Henry (f)	Essex	-	.10	.93	.68	.64	1.61
Smith's Basin (c)	Washington	1.11	4.09	1.58	.02	-	5.67
Whitehall (c)	Washington	.95	3.72	.23	.05	-	4.67
Willsboro	Essex	-	.13	1.07	.08	.13	1.20
St. Lawrence Valley							
Alexandria Bay	Jefferson	-	1.08	.03	.26	1.18	1.44
Canton	St. Lawrence	-	1.32	.41	.49	T	1.73
Chasm Falls	Franklin	.04	.60	.20	.02	.35	.80
Lawrenceville	St. Lawrence	-	1.36	.08	.32	.02	1.44
Ogdensburg	St. Lawrence	-	.64	.18	.23	.18	.82

c Record furnished by New York State Department of Public Works.
f Record furnished by New York Light and Power Co.

The table of "Hourly rainfall, in inches" shows the rainfall as recorded by automatic rain gages at nine stations in or near the main storm area. Unfortunately, none of these gages were within the area of the most intense precipitation, and therefore they did not furnish information on what actually took place in that area. That at least 12 to 14 inches of rain fell in 12 to 16 hours is indicated by the amounts of rainfall measured in open receptacles after the storm.

Hourly rainfall, in inches

Recording gage station	County	July	A.M.												P.M.											
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Arnot, N. Y.	Schuyler	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.09	0.01	-	-	-	-	-	0.22	0.06
U. S. Soil Conservation Service		7	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.61	0.05	-	0.17	-	0.19	.18	.02
		8	.10	0.21	0.03	0.03	0.03	0.25	0.11	-	-	-	0.15	0.15	-	-	-	.01	.01	.47	0.11	.03	-	-	-	.02
		9	.01	.01	.03	.06	-	-	.02	0.10	-	0.02	.16	-	0.01	-	0.02	.02	-	.01	.01	.03	0.05	-	-	-
Binghamton, N. Y.	Broome	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	T	.27
U. S. Weather Bureau		7	.05	T	-	-	-	-	-	-	-	-	-	-	-	T	T	T	T	T	.01	.01	T	-	-	-
		8	-	-	-	.01	T	T	.06	.04	0.18	.02	-	.14	T	-	-	T	T	T	.07	.13	.09	.11	.12	.05
		9	.03	.01	T	T	T	.01	.01	.02	.04	.03	T	.02	T	T	.01	.02	.07	.02	.02	T	-	-	-	-
Cold Spring Brook	Delaware	6	-	-	-	-	-	-	-	-	-	-	.02	.02	-	0.01	-	-	-	-	-	.02	-	-	-	-
China, N. Y.		7	-	-	-	-	-	-	-	-	-	-	-	-	-	.28	-	-	-	-	-	.82	.38	-	-	-
U. S. Geol. Survey		8	-	-	-	.39	-	-	.01	.10	.38	.02	.06	.12	.10	-	-	-	-	-	-	.01	-	.04	.30	.17
		9	.17	.01	.03	-	.02	.03	.02	.04	.05	.02	.01	.01	-	.01	-	.05	.02	.04	.04	-	-	-	-	-
Ithaca, N. Y.	Tompkins	6	-	-	-	-	-	-	-	-	-	-	-	-	-	T	.08	.01	-	-	-	-	-	.55	.41	.07
U. S. Weather Bureau		7	T	-	-	-	-	-	-	-	-	-	-	-	-	T	T	-	.54	.91	T	.23	.50	.63	.17	.64
		8	1.20	1.12	.45	.25	.32	.04	.01	-	-	.15	.24	.14	.03	.17	T	.16	T	.12	.12	.07	.01	-	-	-
		9	.01	T	.01	T	T	.03	.01	.01	T	T	.12	T	T	.01	T	T	.01	.01	.03	T	T	T	T	.01
Lost Nation Brook	Allegany	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Centerville, N. Y.		7	-	-	-	-	-	-	-	-	-	-	.45	.70	.02	.02	-	-	-	-	-	-	-	-	-	-
U. S. Geol. Survey		8	-	.01	-	-	-	-	-	-	-	.01	.01	-	-	-	-	-	.05	-	-	-	-	-	-	-
		9	-	-	-	-	-	-	-	-	-	.01	-	-	-	-	-	-	-	.13	-	-	-	.14	-	-
Rochester, N. Y.	Monroe	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	T	.13
U. S. Weather Bureau		7	.01	T	T	.01	-	-	-	-	-	-	-	.02	2.09	T	-	-	-	-	-	-	-	-	-	-
		8	-	T	.08	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		9	-	-	-	-	-	-	-	-	-	-	0.07	.01	-	-	-	-	-	-	-	-	-	-	-	-
Sage Brook	Chenango	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.31
South New Berlin, N.Y.		7	.04	-	-	-	-	-	.01	.01	-	-	-	-	-	-	-	-	-	.06	*.17	*.23	*.23	*.23	*.24	*.90
U. S. Geol. Survey		8	*.81	*.80	*.66	.24	.26	-	.04	.02	.26	.12	.05	.05	.07	*.24	*.56	-	-	-	-	-	-	.03	.16	.18
		9	.08	-	-	-	-	.01	.01	-	-	.02	-	-	-	-	-	-	.04	.02	.03	-	-	.01	-	-
Shackham Brook	Cortland	6	-	-	-	-	-	-	-	.01	.01	-	-	-	-	.06	.01	.57	-	-	-	-	-	.06	*.33	*.34
Truxton, N. Y.		7	*.04	*.03	*.05	*.03	*.03	*.03	*.03	*.02	-	-	-	-	-	-	-	.25	*.16	*.12	*.06	*.28	*.28	*.28	*.28	*.28
U. S. Geol. Survey		8	.12	.12	.08	.08	.12	.08	.03	.02	-	-	.05	.24	.04	.06	.04	.06	.40	.20	.06	.10	.06	.04	.06	.04
		9	.03	.03	.03	.02	.02	.01	.02	.02	.03	.03	.04	.04	-	-	-	.03	.02	.03	.01	.01	.01	.01	.01	.01
Syracuse, N. Y.	Onondaga	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	T	.15	.04
U. S. Weather Bureau		7	-	-	-	-	-	-	-	-	.01	T	-	-	.03	.64	.25	.97	.07	.01	-	T	T	T	T	.07
		8	.10	.07	.06	.10	.04	.04	.01	.02	.01	.03	-	.02	.10	T	.03	T	.03	.17	.18	.10	.08	.04	.02	T
		9	.02	.03	-	-	-	-	T	T	T	T	-	-	T	T	T	T	.01	.02	.01	.01	.01	.01	.01	T

* Estimated, gage sticking. Total catch during estimated periods is correct.

Field observations of results of erosion and washouts indicate that amounts of rainfall as great as those indicated in the following table, if not greater, may have occurred over a considerably larger area than is covered by these all too few but very significant measurements.

Rainfall measured in open receptacles after the storm

(Furnished by U. S. Soil Conservation Service, Bath, N. Y.)

Location			Rainfall, July 7-8, 1935	
Latitude	Longitude	Resident's name	Inches	Time (hours)
42°31'00"	77°28'20"	J. Schultz	7	14
42°18'30"	77°30'40"	Mrs. McKinley	8.2	12
42°18'30"	77°25'18"	Herbert Ford	12±	12
42°21'30"	77°29'20"	Mr. Wagner	8±	36
42°22'45"	77°17'00"	New York State Fish Hatchery	9.5	16
42°21'45"	77°18'45"	H. W. Hobbs	6.1±	14½
42°33'45"	77°22'30"	J. F. Cleland	8±	16
42°31'30"	77°21'25"	B. F. Edmonds	7.0	16
42°19'00"	77°24'45"	S. Dobbin	14±	12
42°25'20"	77°34'00"	Haskinville Station, W. G. Collins	6.7	16
42°30'15"	77°29'30"	Soil Conservation Warehouse, Cohocton	6.7	16
42°38'00"	77°33'20"	Mr. Bailey	8	24
42°36'00"	77°31'30"	Mr. Gibson	6.5	24
42°24'45"	77°13'30"	Hammondsport	8.0	16
42°30'00"	77°31'45"	B. Van Vlake	9	12
42°21'30"	77°23'45"	Mr. Chamberlain	9.5	16
42°18'15"	77°23'30"	R. Dobbins	12±	16
42°17'30"	77°24'00"	T. W. Miller	11±	16
42°17'34"	77°22'55"	Ed Fenton	14±	16

The measurements in the above table were all made in the vicinity of Bath. The following few miscellaneous measurements of precipitation in open receptacles indicate that the storm was probably equally intense in other localities.

Hector, N. Y. - "The total fall observed from 5 p.m. Saturday, July 6, to 7 a.m. Monday, July 8, was 14.23 inches. Ten inches of this amount fell during the 12-hour period ending at 7 a.m. Monday, July 8. *** About a mile east of Hector and at an elevation of about 300 to 400 feet higher I found a reliable farmer who was astonished to find that more than 10 inches of rain was contained in his chicken-feed pail, which he was accustomed to set out on the ground in an open spot between the barn and house after feeding in the evening just before dark. This was on the morning of Monday, July 8." This quotation is from a letter by T. E. Reed, meteorologist, United States Weather Bureau, Binghamton, who was spending his vacation at Hector at the time of the storm.

Watkins Glen, N. Y. - About 6 miles northwest, near Hall's Corners, a farmer left a straight-sided cream pail in an open place in his yard about noon on Sunday, July 7, and on Monday morning he noted that it was filled with water up to the rivets fastening the handles on the pail. The writer measured this depth to be 7 inches, which the farmer stated was caught between noon July 7 and 9 a.m. July 8.

Ithaca, N. Y. - "At one place about 6 miles west and 3 miles north from Ithaca a can with straight sides showed a rainfall of approximately 9 inches for the Sunday night rain previous to the peak of the flood. At a point about a mile west of the south end of Cayuta Lake a farmer told me that a 10-quart pail which was empty the night before was full and overflowing the next morning. Near Odessa another man had a milk bottle out which was full of water." From letter of J. P. Wells, consulting engineer, Rochester, N. Y.

Freeville, N. Y. - Albert B. Genung states that a straight-sided 5-gallon paint pail used to water his flowers was left empty in the garden on Sunday and found overflowing on Monday morning.

Rochester was the only automatic rain-gage station to have record-breaking intensities for periods less than 2 hours. In the hour ending at 1 p.m. July 7 the gage recorded 0.91 inch in 10 minutes, 1.25 inches in 15 minutes and 1.98 inches in 30 minutes. The maximum amounts previously recorded were 0.78 inch in 10 minutes, 0.99 inch in 15 minutes, and 1.70 inches in 30 minutes.

The following notes extracted from reports of cooperative observers of the United States Weather Bureau tell in the observers' own words the unusual intensity of this storm:

Alfred, N. Y. - J. Nelson Norwood, president Alfred University: "The terrific rain (indicated 5.58 inches) came during the night of July 7 and the morning of July 8. *** The heaviest came between midnight and 7 o'clock in the morning, with intervals of little or no rain. Between 8 o'clock on Sunday evening and 8 o'clock on Monday morning the rain had amounted to 5.2 inches. The heaviest rains previously recorded here were in July 1920, when in the course of a regular tornado 3¼ inches of rain came in 4 hours, and the other was in 1890, when a 24-hour rain amounted to 4.34 inches. The streams at this height in the foothills of the Allegheny Mountains are mere creeks and most of the time have little or no water in them. They simply overflowed their banks and did terrific damage in the lower levels."

Cortland, N. Y. - Fred H. Crook: "Heaviest single shower in Cortland Monday, July 8, at 4:30, brought 1½ inches in less than 30 minutes."

Delhi, N. Y. - H. L. Smith: "6 p.m. Sunday, July 7, until 4 a.m. Monday morning 8.1 inches of rain fell. It came down in torrents. I never experienced such a downpour in my life."

Ovid, N. Y. - "For the week before July 6 there had been very little rainfall. Saturday night, July 6, about 8 p.m. a heavy rain began and lasted about 1 hour, during which time 2.23 inches fell. Sunday, July 7, in the afternoon there were several thundershowers, the main parts of which went around us. Sunday night, July 7, there were thundershowers all night. The greatest amount of rain fell between 3:00 a.m. and 7:00 a.m. of Monday. During this time about 6 inches fell. Between 3:00 a.m. and 4:00 a.m. the rain fell in virtual sheets--a cloudburst. I would estimate that during this hour about 3 inches fell."

Sharon Springs, N. Y. - W. M. Kling: "Fury of storm so great Sunday that rain dashing horizontally makes it certain that rainfall much greater than measurement." 3.21 inches of rainfall was recorded between 6:30 and 7:20 p.m. on Sunday, July 7.

FLOOD DISCHARGES

General features

A series of extraordinarily severe thunderstorms during the night of July 7 and the morning of July 8, 1935, speedily brought many small streams to destructive heights before the inhabitants could realize the seriousness of the situation in which they were caught. Consequently, many people were drowned or narrowly escaped with their lives, and there was generally no time for the protection of property, where that would have been possible.

The most intense run-off occurred along an east-west line extending from Hornell, on the Canisteo River, to Oxford, on the Chenango River, or generally along the boundary between the Susquehanna River Basin and the Finger Lakes or Oswego River Basin. There were notable floods of less intensity near Chaumont, Jefferson County; in certain portions of the Mohawk Valley; on upper Schoharie Creek; on the Saw Kill near Kingston; on upper Esopus Creek; on the West Branch of the Delaware River near Delhi and Walton; and on Ouleout Creek in Delaware County.

Fortunately, the storm was confined to a comparatively narrow strip, which cut generally across the upper sources of main streams instead of extending longitudinally along any of them, as seemingly might have been possible. Had the latter occurred it is a matter of conjecture as to what greater heights the main streams might have reached. The additional damage would undoubtedly have been enormous.

The precipitous hillsides characteristic of many drainage basins, the steep slopes of the small streams, the narrowness of the valleys, the inability of the soil to absorb and store the rainfall, and the severity of the thunderstorms all contributed to the very rapid concentration and intensity of the run-off and to the severity of the destruction wrought by the small streams. Evidence of the almost incredible force of the rushing waters of these smaller streams is shown in plate 23,A.

On the larger streams the flatter slopes and broader valleys caused the flood waters to assume less destructive velocities and to overflow the banks, thus causing less spectacular but very real loss by inundation as shown in plate 23,B.

Figures 20 and 21 show the flood hydrographs based upon records of stage at principal gaging stations in the flood area.

A. SALMON CREEK AT MYERS, N. Y., SHOWING FORCE OF THE FLOOD WATERS.
Courtesy of "The News, New York's picture newspaper."

B. INUNDATION FROM CHENANGO RIVER, BINGHAMTON, N. Y.

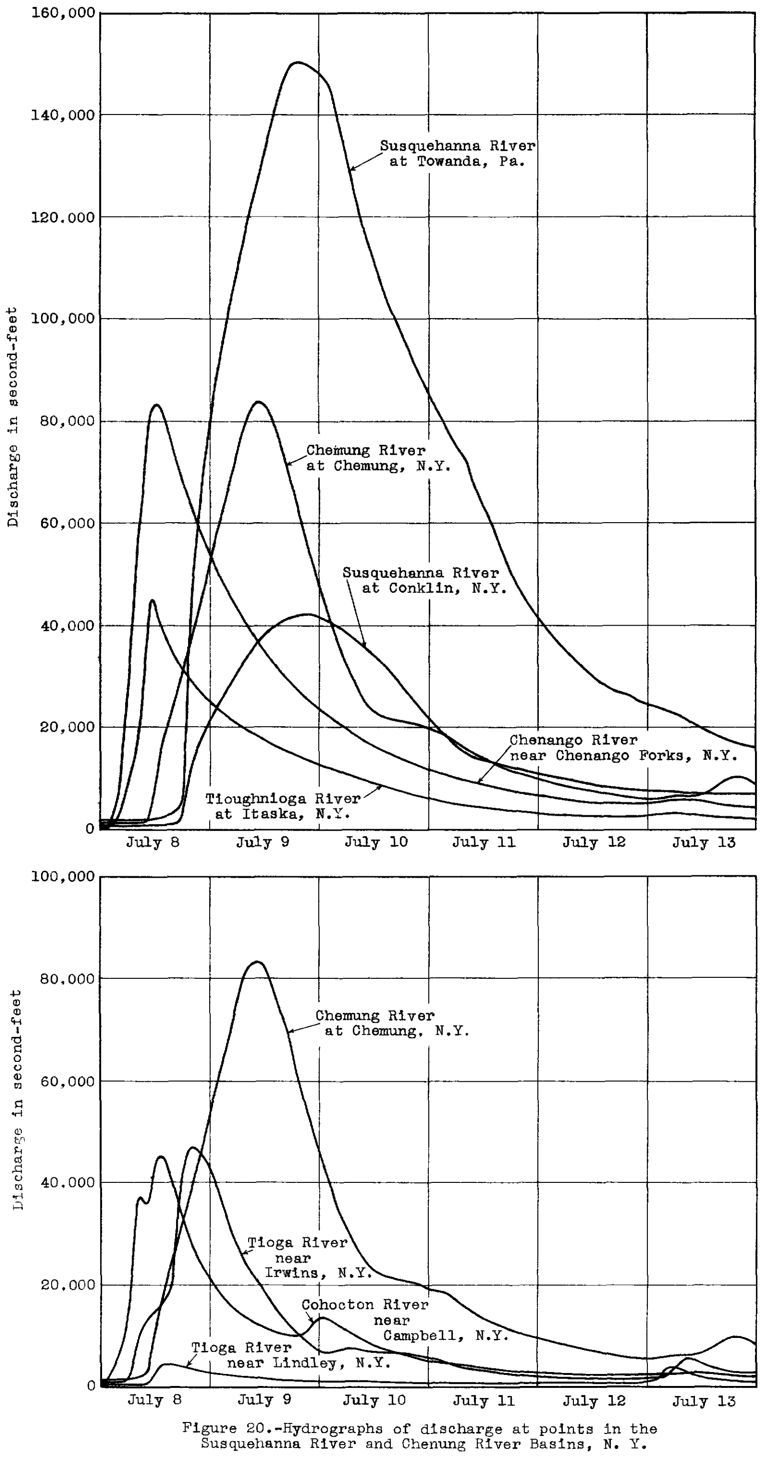


Figure 20.-Hydrographs of discharge at points in the Susquehanna River and Chenung River Basins, N. Y.

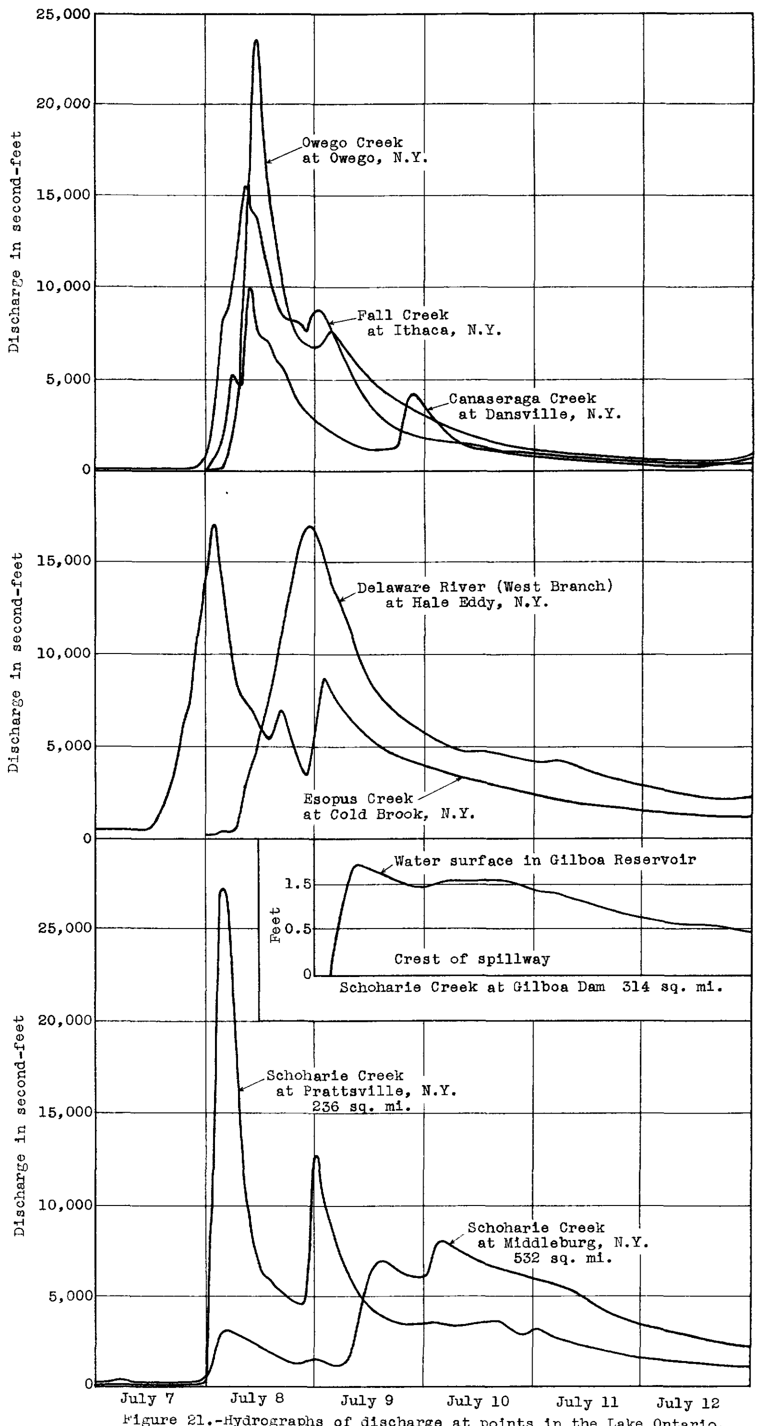


Figure 21.-Hydrographs of discharge at points in the Lake Ontario, Delaware River, Esopus Creek, and Schoharie Creek Basins, N. Y.

Unfortunately, within the areas of extraordinarily intense flood run-off there were no regular gaging stations at which intense discharges were recorded. Consequently, it has been necessary to obtain information of these discharges largely from special field surveys. The results obtained are valuable, but, no matter how painstakingly obtained in the field and how carefully interpreted, they cannot approach in accuracy and completeness the data that might have been obtained at regularly established stream-gaging stations.

As the most intense discharges occurred largely on the smaller streams in a widespread area, it was desirable to make many determinations of the flood discharges by the best available methods in order to insure comprehensive information over the flood area.

Field work

Obstacles met in obtaining funds for the work delayed the start of the field activity until September 18. The writer, with an official car, was detailed from the district office of the United States Geological Survey at Albany, N. Y., to the field work, which was completed November 1. Field assistants were furnished by the Flood Control Survey, Corps of Engineers, U. S. Army, and by the New York State Department of Public Works.

A thorough reconnaissance of the flood area was first made by driving over the roads, walking up and down the streams where necessary, and selecting places on the streams at which it was believed satisfactory determinations of the flood discharge could be made from the evidence of the stages of the water surface, slopes, and other pertinent data. Sufficient data were obtained in the field to allow the computation of the flood discharge by one or more methods dependent upon established hydraulic formulas and experience in their application. From these data were made 55 determinations of flood discharge--26 by the slope-area method, 22 over dams, 3 over falls, 1 through drops, and 3 through culverts.

In selecting a reach of channel at which a slope-area determination of discharge was to be made, the following factors were considered and the best possible selection made:

Straightness of channel.
Length of reach.
Uniformity of cross section and slope.
Absence of trees, brush, and other obstructions.
Permanence of channel during flood.
Approach and get-away conditions.
Quality and quantity of high-water marks.

At each site of a slope-area measurement a stadia survey was made, locating high-water marks on each bank for a considerable distance above and below the reach. Cross sections were taken across the flood channel at each end of the reach; on certain streams an additional cross section was taken near the center of the reach. Great care was exercised in the selection of the high-water marks, to insure that they represented the water surface and not an energy grade line of the stream, as indicated by the height to which waves had washed or drift had been thrown. For this reason high-water marks on the ground, where wave action and run-up were believed to be a minimum, were generally selected in preference to high-water marks on trees and bushes as defined by debris, which may have been carried up by wave action or by the velocity of the current to a level above the prevailing water surface.

In selecting dams, falls, drops, or culverts only those were considered whose crests, profiles, and cross sections were sufficiently regular to allow their characteristics of discharge to be satisfactorily defined by formulas and coefficients whose applicability to similar structures had been determined by previous investigations. At such sites sufficient high-water marks were taken nearby to define the head on the crests or openings. The structures were measured, and sufficient data were obtained for determining profiles and cross sections at the highest flood stage. The presence of possible backwater or submergence from below was investigated. Notes on conditions affecting the velocity of approach were made.

Photographs were generally taken at each point of measurement, and notes were made as to the character of the bed and banks of the channels and any other conditions that might be pertinent to a particular measurement.

Office preparation of field data

The data obtained in the field were plotted, and for most measurements the following sheets of data were made and checked:

1. A map or sketch to scale, showing layout of channels, structures, etc., with relative location of high-water marks.

2. A longitudinal profile showing the location of the high-water marks from which was determined the water-surface slope of the stream or the head on the structures.

3. Cross sections of the channels and of the structures through or over which the water flowed.

4. For the slope-area measurements, sheets with the computation of the area and hydraulic radius of each section.

Assumptions and computations

The application of formulas and coefficients used in the computation of the flood flows was made with a full appreciation of the limitations of scientific knowledge of the behavior of streams under unusually extreme conditions, such as those of the July flood, and is believed to be consistent with good engineering judgment. Many of the streams undoubtedly carried enormous quantities of debris. The effect of this debris upon the applicability of the laws and formulas generally accepted as governing the flow of water is problematic. The same statement applies to the effects of sediment, entrained air, turbulence, excessive slopes and velocities, and other factors, which occurred in a degree far outside the field of ordinary experiment and experience. In an unpublished manuscript Harold C. Troxell, associate engineer, United States Geological Survey, describes the enormous debris movement that occurred during the flood of January 1, 1934, in La Cañada Valley, near Los Angeles, Calif. There the debris apparently moved downstream in a succession of waves, at velocities much slower than the water velocities, first filling up the stream channel and then being scoured out, creating unstable channel conditions that made it almost impossible to determine the discharge of water with any degree of accuracy. The field investigations in the New York flood area disclosed no evidence that the debris movements during the flood of July 1935 were generally similar to those described by Mr. Troxell. Consequently it is believed that, through the reaches selected for the determination of flood discharge, the debris moved downstream in such a manner as to cause very little if any reduction in apparent area or water capacity of the channels. For the purposes of this report it has been assumed that the water surface of the streams was represented by the high-water marks indicated on the banks, that the channels as surveyed had remained substantially unchanged throughout the flood, and that the flow conformed to the laws of the flow of water expressed by the formulas selected for the determination of the particular flood discharge. The results thus obtained are believed to be in the most useful form and of such value in the planning of flood-

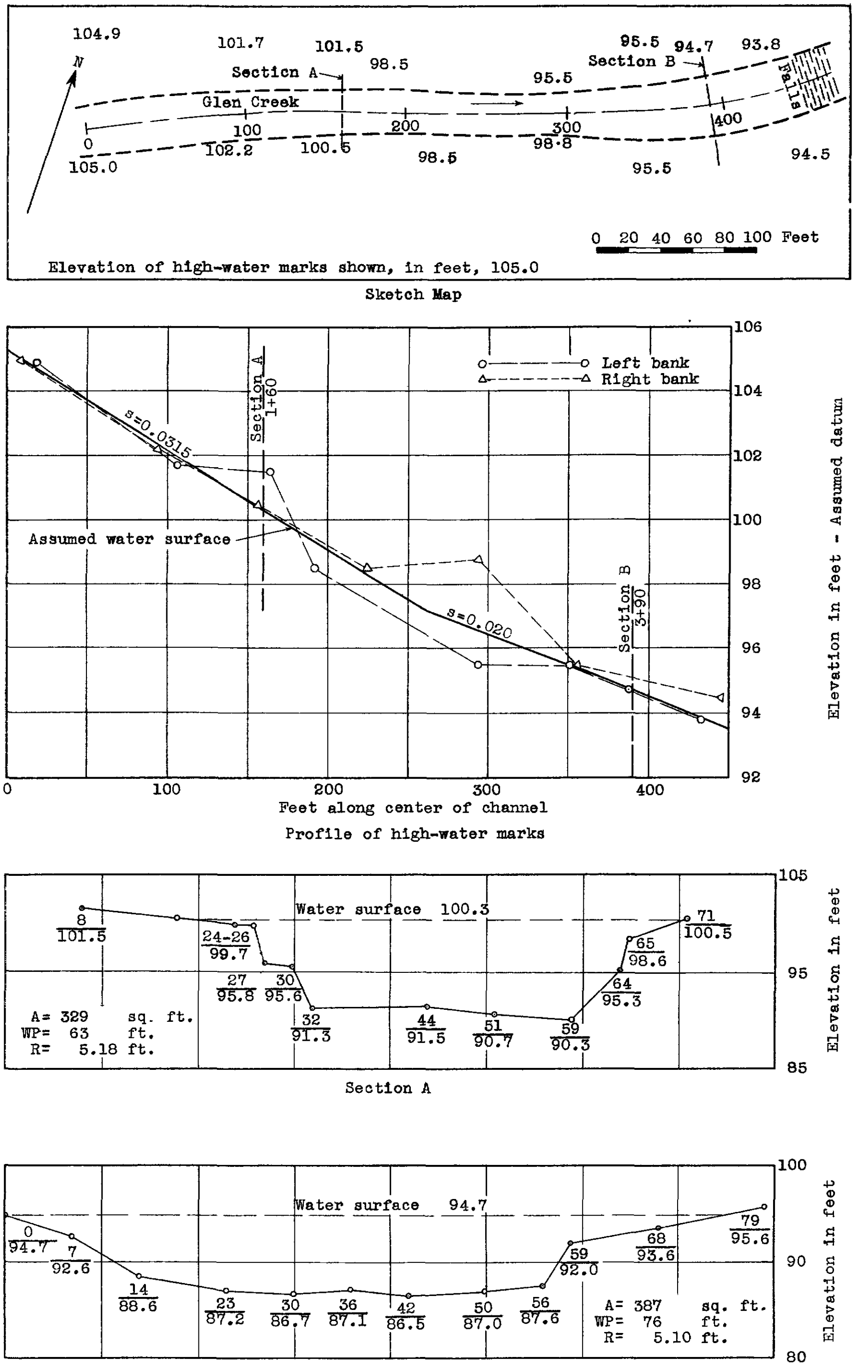


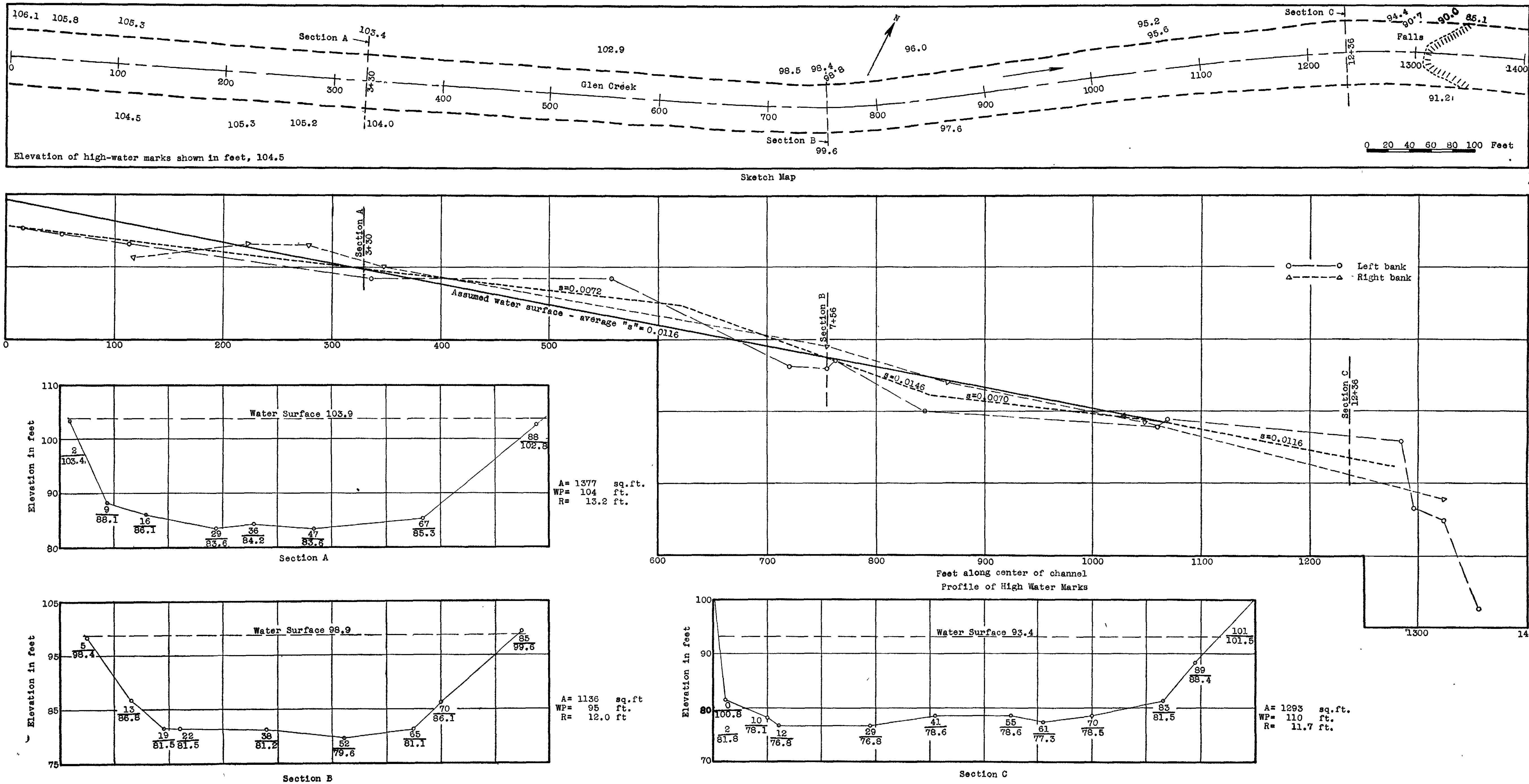
Figure 22.-Map, profile, and sections of slope-area reach on Glen Creek near Townsend, N. Y.

SLOPE-AREA REACH ON GLEN CREEK NEAR TOWNSEND, N. Y.

Looking upstream. Section B was taken about 50 feet above the falls, and section A was taken upstream, above the highway bridge. The bed of the creek at section A was composed chiefly of coarse gravel with a short section of ledge rock. At section B the bed of the creek was flat, smooth shale. The right bank of the creek was shale of fairly regular section. The left bank was coarse stone and dirt and fairly uniform. Both banks contained brush and trees, which were generally above the high-water line. The falls shown in the picture were 8 to 10 feet high and were not submerged from below during the flood. The channel through the section has a slight curvature to the left.

SLOPE-AREA REACH ON GLEN CREEK NEAR WATKINS GLEN, N. Y.

Looking downstream. Section A was taken in the foreground of the picture. Section B was taken at the bend where the man is standing. Section C was taken near the end of the bare rock showing on the right bank. The bed of the creek was smooth, flat shale covered in spots by medium-sized gravel. Both banks were rock, steep, and, although rough, relatively uniform. There were no trees below the high-water line. About 75 feet below section C there was a falls 10 to 12 feet high. There was no indication of submergence of the falls from below during the flood.



GLEN CREEK AT WATKINS GLEN, N. Y.
Lat. 42°-22.0' Long. 76°-54.4'

MAP, PROFILE, AND SECTIONS OF SLOPE-AREA REACH ON GLEN CREEK AT WATKINS GLEN, N. Y.

A.

B.

TYPICAL CHANNELS WITH "n" ASSUMED FOR EACH.

In *A* "n" assumed 0.30; reach extended from large elm on left bank to barn on right bank. In *B* "n" assumed 0.030 for main channel and overflow on right bank, 0.100 for wooded section on left bank.

A.

B

TYPICAL CHANNELS WITH "n" ASSUMED FOR EACH.

In *A* "n" assumed 0.035 for main channel, 0.100 for wooded flat shown at left of main channel. In *B* "n" assumed 0.040 to 0.045.

protection measures as to warrant their publication as the most reliable data that can be supplied. However, any user of the data is cautioned to keep in mind the method of derivation and to make such allowance therefor as may seem appropriate.

For the consideration of engineers who may wish to analyze critically the results showing outstandingly excessive rates of flow, there is shown on figure 22 and plates 24, 25, and 26 the basic information for two determinations of the flood flow of Glen Creek near Townsend and at Watkins Glen. Similar data for other determinations are on file and available to the public at the district office of the Geological Survey in Albany.

In computing the flood discharge by the slope-area method the average velocity was determined from the Manning equation

$$V = \frac{1.486}{n} r^{2/3} s^{1/2}$$

in which V = average velocity in the cross section

n = coefficient of roughness

r = hydraulic radius

s = surface slope

On plates 27 and 28 are shown pictures of typical channel sections with the assumed value of "n", the coefficient of roughness, for each. The values of "n" were selected and checked from the background of the Geological Survey's experience in such matters. Careful study was made of the pertinent data in a report by Ramser.* As the flow in most sections was not uniform, it was necessary to consider velocity head and to correct "s" to a value representing the energy grade line. Where there was a recovery of energy head, it was assumed that the actual recovery was 50 percent of the theoretical recovery. Where the flow was confined to one channel, the correction was easily made. Where a section was considered to be composed of two or more channels with different "n" and different "r", the weighted velocity head for the section was determined by an adaptation of the following equation given by O'Brien and Johnson**:

$$\alpha = \frac{\Sigma V^3 \, da}{V_m^3 \, A}$$

* Ramser, C. E., Flow of water in drainage channels; the results of experiments to determine the roughness coefficient "n" in Kutter's formula: U. S. Dept. Agr. Tech. Bull. 129, November 1929.

** O'Brien, M. P., and Johnson, J. W., Velocity head corrections for hydraulic flow: Eng. News-Record, August 16, 1935.

in which α = ratio of weighted velocity head to velocity head determined from the average velocity in the entire section.

V = average velocity in any channel into which the entire section may be subdivided.

da = area of any channel into which the entire section may be subdivided.

$\Sigma V^3 da$ = summation of the product of V^3 and da for the channels into which the entire section may be subdivided.

V_m = average velocity in the entire section.

A = area of the entire section.

The flow over dams was computed by the formula

$$Q = CLH^{3/2} \left(1 + 0.56 \frac{H^2}{d^2}\right)$$

in which C = coefficient depending largely on the shape of the crest. Values of C were selected from data in Horton, R. E., Weir experiments, coefficients, and formulas, 2d ed.: U. S. Geol. Survey Water-Supply Paper 200, 1907.

L = length, in feet, of the crest.

H = head, in feet, on the crest of the dam.

d = depth, in feet, of the approach channel.

Where necessary, allowance was made for submergence of the crest by water below the dam.

The flow over highway embankments was considered analogous to that over dams, and values for the coefficient C were selected from experimental data by Yarnell and Nagler.*

The flow over falls was computed by the following formula**:

$$Q = 5.67 \; LH^{1.5}$$

The results from this method were not very satisfactory. The steep slopes of the water surface in the channels above the falls caused velocities greater than the critical velocity at the falls section and thus made the fall section ineffective as a control.

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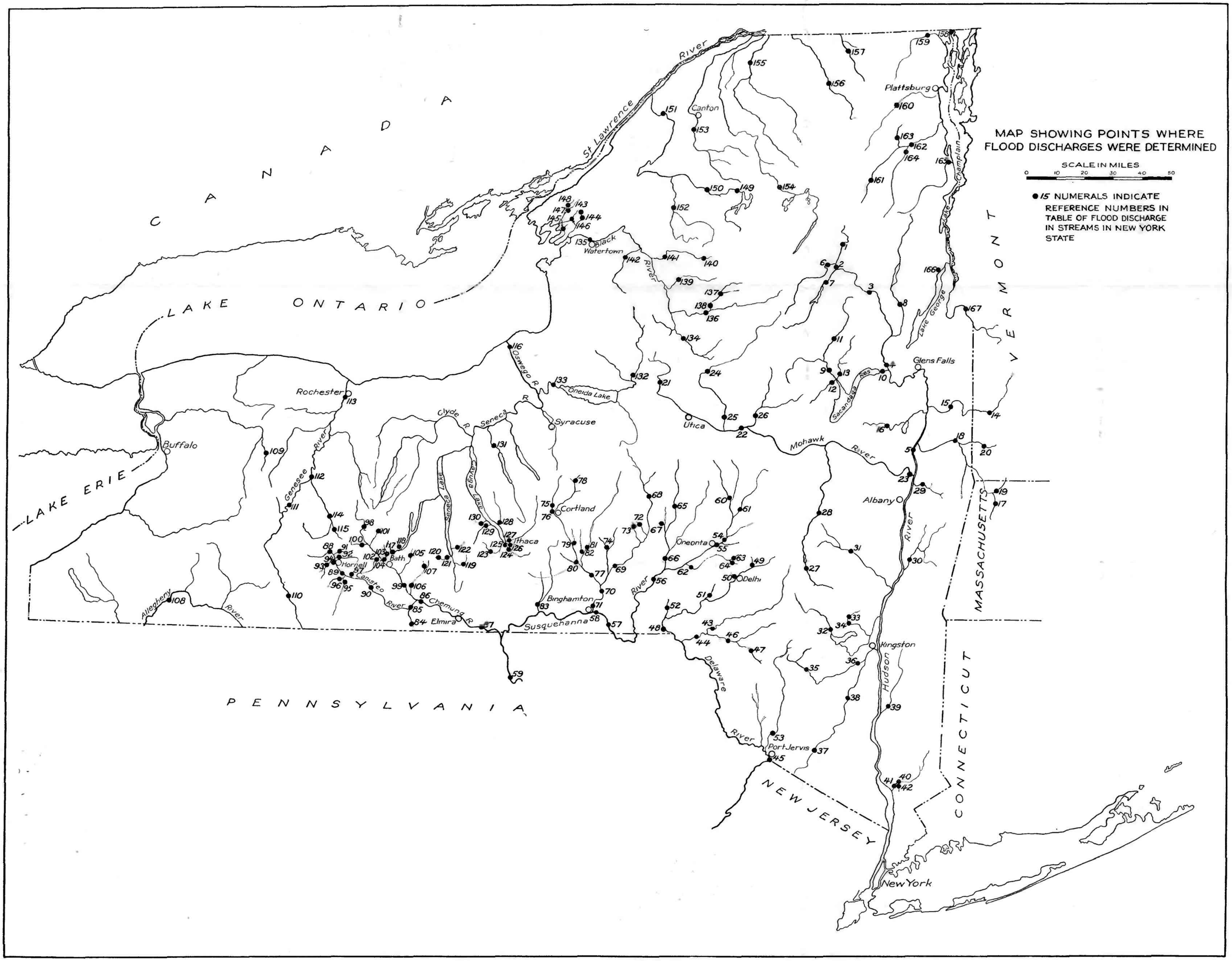
* Yarnell, D. L., and Nagler, F. A., Flow of flood water over railway and highway embankments: Public Roads, April 1930.
** King, H. W., Handbook of hydraulics, 2d ed., p. 333, 1929.



MAP OF NEW YORK STATE SHOWING LOCATION OF FLOOD DETERMINATIONS.

The flow through drops was computed by the following formula*:

$$Q = 3.62 \, LH^{1.47} \left(1 + 0.44 \frac{a^2}{A^2}\right)$$

in which a = cross-sectional area of the drop or notch.

A = cross-sectional area of the approach channel.

The flow through culverts was computed by assuming that the available head was used in overcoming frictional losses in the culvert and in creating velocity.

All notes, photographs, plans, profiles, cross sections, and computations have been bound and are being kept as a permanent record.

Flood-discharge records

The table "Flood discharges of the streams in New York State" shows the results of the determination of the flood flows at the gaging stations and other points on streams. Previous maximum recorded floods are included, for comparison. The locations of the points at which these flood determinations were made are shown on plate 29 and may be identified by the corresponding number in the table. Many determinations are shown for streams that did not reach their previously recorded flood flows in July, in order to compare the unprecedented flood flows occurring at that time with the flood flows previously recorded throughout the State.

The time of occurrence of the maximum discharges is not shown for many of the determinations. Most people were too busy seeking safety or trying to protect their property to record the time of the occurrence except roughly as the night of July 7 or the morning of July 8.

*King, H. W., Handbook of hydraulics, 1st ed., p. 143, 1918.

Flood discharges of streams in New York State

No. on map	Stream	Point of measurement	County	Period of record	Maximum discharge previously recorded		Drainage area (square miles)	Maximum discharge during flood of July 1936			
					Date	Second-feet		Time	Second-feet Total	Second-feet Per sq. mi.	Method of determination
	Hudson River Basin										
1	Hudson River	Near Newcomb, N.Y.	Essex	1925-1935	Apr.9,1928	6,250	192	July 10,4am	970	5.0	Rating curve
2	Hudson River	Gooley, N.Y.	Essex	1916-1935	Apr.12,1922	13,900	419	July 9,11am	2,680	6.4	Rating curve
3	Hudson River	North Creek, N.Y.	Warren	1907-1935	Mar.27,1913	27,400	792	July 9,1pm	a6,920	8.7	Rating curve
4	Hudson River	Hadley, N.Y.	Saratoga	1921-1935	Apr.12,1922	33,100	1,664	July 9,2pm	a11,300	6.9	Rating curve
5	Hudson River	Mechanicville, N.Y.	Saratoga	1887-1935	Mar.28,1913	120,000	4,500	July 8,11am	a36,800	8.2	Rating curve
6	Cedar River	Near Indian Lake, N.Y.	Essex	1930-1935	Oct.7,1932	6,050	160	July 9,9am	1,650	10	Rating curve
7	Indian River	Near Indian Lake, N.Y.	Hamilton	1900-1935	Mar.28,1913	3,460	132	July 13,6pm	a989	7.5	Rating curve
8	Schroon River	Riverbank, N.Y.	Warren	1907-1935	Mar.28,1913	10,400	527	July 11,Noon	1,950	3.7	Rating curve
9	Sacandaga River	Near Hope, N.Y.	Hamilton	1911-1935	Mar.27,1913	32,000	491	July 9,4am	10,500	21	Rating curve
10	Sacandaga River	Conklingville, N.Y.	Saratoga	1932-1935	Dec.2,1932	6,700	1,044	July 12,7am	a7,650	7.3	Rating curve
11	Sacandaga River (E.Br.)	Griffin, N.Y.	Hamilton	1933-1935	Apr.17,1934	2,620	114	July 9,6am	3,310	29	Rating curve
12	West Stony Creek	Near Northville, N.Y.	Hamilton	1933-1935	Aug.24,1933	3,790	88	July 8,4am	5,060	58	Rating curve
13	East Stony Creek	Near Northville, N.Y.	Hamilton	1933-1935	Apr.17,1934	1,670	89	July 8,Noon	1,940	22	Rating curve
14	Battenkill	Arlington, Vt.	Bennington	1928-1935	Jan.10,1935	3,320	152	July 7,12:30pm	3,710	24	Rating curve
15	Battenkill	Battenville, N.Y.	Washington	1922-1935	Nov.4,1927	21,300	394	July 8,3pm	9,460	24	Rating curve
16	Kayaderosseras Creek	Near West Milton, N.Y.	Saratoga	1927-1935	Mar.16,1929	2,350	90	July 8,6am	2,730	30	Rating curve
17	Hoosic River	Adams, Mass.	Berkshire	1931-1935	Jan.9,1935	1,110	46	July 8,4am	975	21	Rating curve
18	Hoosic River	Near Eagle Bridge, N.Y.	Rensselaer	1910-1922 1923-1935	Nov.4,1927	29,800	510	July 8,6am	7,680	15	Rating curve
19	Hoosic River (N. Br.)	North Adams, Mass.	Berkshire	1931-1935	Nov.19,1932	2,720	39	July 8,4:30am	1,180	30	Rating curve
20	Walloomsac River	Near North Bennington, Vt.	Bennington	1931-1935	Nov.19,1932	3,460	111	July 7,10am	3,120	28	Rating curve

21	Mohawk River	Below Delta Dam, N.Y.	Oneida	b1919-1935	Mar.9,1921	c4,210	151	July 8-9	a4,030	27	Rating curve
22	Mohawk River	Near Little Falls, N.Y.	Herkimer	1927-1935	Mar.15,1929	21,300	1,348	July 8,8pm	a17,200	13	Rating curve
23	Mohawk River	Cohoes, N.Y.	Albany	1917-1935	Mar.16,1929	72,000	3,456	July 8,11:30am	a45,600	13	Rating curve
24	West Canada Creek	Hinckley, N.Y.	Oneida	1919-1935	Apr.12,1922	10,800	375	July 9,6pm	a5,380	14	Rating curve
25	West Canada Creek	Kast Bridge, N.Y.	Herkimer	b1905-1910 b1912-1913 b1920-1935	Mar.26,1913	23,300	556	July 8,4:30pm	a10,300	18	Rating curve
26	East Canada Creek	Dolgeville, N.Y.	Herkimer	b1898-1935	Mar.26,1913	c14,500	261	July 8,9pm	5,870	22	Rating curve
27	Schoharie Creek	Prattsville, N.Y.	Greene	d1902-1935	Nov.16,1926	d42,300	236	July 8,4am	d27,200	115	Rating curve
28	Schoharie Creek	Middleburg, N.Y.	Schoharie	b1906-1935	Feb.20,1909	c31,600	532	July 10,4am	a8,000	15	Rating curve
29	Poesten Kill	Near Troy, N.Y.	Rensselaer	1923-1935	Nov.4,1927	7,030	89	July 8,9am	519	5.8	Rating curve
30	Kinderhook Creek	Rossman, N.Y.	Columbia	1906-1914 1928-1935	Jan.22,1910	11,000	329	July 8,1:30pm	2,030	6.2	Rating curve
31	Catskill Creek	Oakhill, N.Y.	Greene	e1910-1935	Nov.9,1913	d12,300	98	July 10,3:30am	1,220	12	Rating curve
32	Esopus Creek	Coldbrook, N.Y.	Ulster	d1913-1935	Aug.24,1933	d55,000	192	July 8,2am	d17,100	89	Rating curve
33	Saw Kill	Near Shady, N.Y.	Ulster				d9.5		d9,180	966	Slope-area
34	Saw Kill	Near Bearsville, N.Y.	Ulster				d12.1		d9,980	825	Slope-area
35	Rondout Creek	Near Lackawack, N.Y.	Ulster	d1906-1935	Aug.26,1928	d26,715	100	July 9,2am	d2,120	21	Rating curve
36	Rondout Creek	Rosendale, N.Y.	Ulster	1901-1903 1906-1913 1926-1935	Aug.27,1928	27,300	386	July 8,3:30am	12,600	33	Rating curve
37	Wallkill River	Pellets Island Mountain, N.Y.	Orange	1919-1935	Mar.16,1920	8,350	385	July 13,10am	1,030	2.7	Rating curve
38	Wallkill River	Gardiner, N.Y.	Ulster	1924-1935	Sept.2,1927	12,900	711	July 11,5:30am	1,130	1.6	Rating curve
39	Wappinger Creek	Near Wappinger Falls, N.Y.	Dutchess	1928-1935	Mar.5,1934	5,950	182	July 9,5pm	75	0.4	Rating curve
40	Croton River	Cornell Dam near Croton, N.Y.	Westchester	1933-1935	Mar.5,1934	4,010	f378	July 10,3pm	a1.9	4.6	Rating curve
41	Croton River	Quaker Bridge, near Croton, N.Y.	Westchester	1933-1935	Mar.5,1934	3,940	g379	July 10,3pm	a3.2	1.9	Rating curve
42	Bird Brook	Quaker Bridge, near Croton, N.Y.	Westchester	1933-1935	May 3,1934	14	0.36	No peak	h	0.5	Rating curve

a Materially affected by storage or diversion.
b Combined record of New York State Engineer and Surveyor and U. S. Geol. Survey.
c Records of New York State Engineer and Surveyor.
d Record furnished by New York City Board of Water Supply.
e Combined record of New York City Board of Water Supply and U. S. Geol. Survey
f Effective drainage area 0.40 sq. mi.
g Effective drainage area 1.74 sq. mi.
h 0.19 second-foot on July 10, 3 pm

Flood discharges of streams in New York State--Continued

No. on map	Stream	Point of measurement	County	Period of record	Maximum discharge previously recorded		Drainage area (square miles)	Maximum discharge during flood of July 1935			
					Date	Second-feet		Time	Second-feet Total	Second-feet Per sq. mi.	Method of determination
	Delaware River Basin										
43	Delaware River (E. Br.)	Harvard, N.Y.	Delaware	1934-1935	Mar.6,1935	11,100	443	July 8,2pm	3,080	7.0	Rating curve
44	Delaware River (E. Br.)	Fishs Eddy, N.Y.	Delaware	1912-1935	Aug.24,1933	53,300	783	July 8,4pm	3,360	4.3	Rating curve
45	Delaware River	Port Jervis, N.Y.	Orange	1904-1935	Oct.10,1903	155,000	3,076	July 9,2pm	30,000	9.8	Rating curve
46	Beaver Kill	Cooks Falls, N.Y.	Delaware	1913-1935	Aug.24,1933	17,800	241	July 9,8am	640	2.6	Rating curve
47	Little Beaver Kill	Near Livingston Manor, N.Y.	Sullivan	1924-1935	Aug.26,1928	3,420	19.8	July 8, M	44	2.2	Rating curve
48	Delaware River (W. Br.)	Hale Eddy, N.Y.	Delaware	1912-1935	Oct.10,1903	46,000	593	July 8,11pm	17,000	29	Rating curve
49	Wright Brook	Bloomville, N.Y.	Delaware				11.2		2,370	212	Dam
50	Steele Brook	Near Delhi, N.Y.	Delaware				5.4		2,850	528	Dam
51	East Creek	Near Walton, N.Y.	Delaware				23.5		i2,790	119	Dam
52	Cold Spring Brook	China, N.Y.	Delaware				1.65	July 9,2am	28	17	Rating curve
53	Neversink River	Oakland Valley, N.Y.	Orange	1928-1935	Aug.24,1933	20,000	222	July 9,9am	1,830	8.2	Rating curve
	Susquehanna River Basin										
54	Susquehanna River	Colliersville, N.Y.	Otsego	1924-1935	Mar.16,1929	5,190	351	July 9,2am	a3,020	8.6	Rating curve
55	Susquehanna River	Oneonta, N.Y.	Otsego	1907-1935	Mar.27,1913	j19.9		July 8,8am	j15.7		
56	Susquehanna River	Bainbridge, N.Y.	Chenango	1907-1935	Mar.29,1914	j21.1		July 8,12:45pm	j18.7		
57	Susquehanna River	Conklin, N.Y.	Broome	1912-1935	Mar.28,1913	52,000	2,240	July 9,9pm	41,900	19	Rating curve
58	Susquehanna River	Binghamton, N.Y.	Broome	1902-1935	Mar.2,1902	jk19.74		July 9,3am	j17.7		
59	Susquehanna River	Towanda, Pa.	Bradford	1892-1935	Mar.17,1865	188,000	7,797	July 9,7pm	150,000	19	Rating curve
60	Oaks Creek	Index, N.Y.	Otsego	1929-1932	Apr.12,1932	1,060	103		458	4.4	Rating curve
61	Cherry Valley Creek	Near Westville, N.Y.	Otsego	1930-1931	Apr.11,1931	1,780	81		655	8.1	Rating curve
62	Ouleout Creek	East Sidney, N.Y.	Delaware				101		i16,700	165	Dam

63	Brook	Near Meridale, N.Y.	Delaware				0.52		170	327	Dam
64	Brook	Near Meredith, N.Y.	Delaware				0.44		156	355	Dam
65	Unadilla River	Near New Berlin, N.Y.	Chenango	1924-1935	Mar.15,1929	5,590	196	July 8,5pm	2,190	11	Rating curve
66	Unadilla River	Rockdale, N.Y.	Chenango	1929-1933	Oct.7,1932	10,400	518		9,810	19	Rating curve
67	Sage Brook	Near South New Berlin, N.Y.	Chenango	1932-1935	June 19,1934	23	0.69	July 8,2pm	201	291	Rating curve
68	Chenango River	Sherburne, N.Y.	Chenango	1907-1935	Unknown	j11.2		July 8,3pm	j7.6		
69	Chenango River	Greene, N.Y.	Chenango	1909-1929	1906	j14.0		July 8,3pm	1		
70	Chenango River	Near Chenango Forks, N.Y.	Broome	1912-1935	Mar.27,1913	35,500	1,492	July 8,Noon	82,800	56	Rating curve
71	Chenango River	Binghamton, N.Y.	Broome	1901-1911 j1933-1935	Mar.2,1902	m23.1		July 8,3pm	j24.8		
72	Gilmore Brook	Near Preston, N.Y.	Chenango				0.62		518	835	Culvert
73	Clear Brook	Preston, N.Y.	Chenango				1.34		449	335	Dam
74	Strongs Brook	Near Smithville Flats, N.Y.	Chenango				6.41		6,650	1,040	Slope-area
75	Tioughnioga River	Homer, N.Y.	Cortland				71.5		1,270	18	Dam
76	Tioughnioga River	Cortland, N.Y.	Cortland				100		1,460	15	Dam
77	Tioughnioga River	Itaska, N.Y.	Broome	1929-1935	Jan.9,1935	18,300	735	July 8,11am	44,700	61	Rating curve
78	Shackham Brook	Near Truxton, N.Y.	Cortland	1932-1935	Mar.31,1934	57	3.12	July 8,7pm	60	19	Rating curve
79	Willet Creek	Marathon, N.Y.	Cortland				11.0		6,430	585	Slope-area
80	Dudley Creek	Near Lisle, N.Y.	Broome				29.6		16,200	547	Slope-area
81	Otselic River	Near Upper Lisle, N.Y.	Cortland				214		15,400	72	Slope-area
82	Merrill Creek	Near Upper Lisle, N.Y.	Broome				20.8		15,100	726	Slope-area
83	Owego Creek	Near Owego, N.Y.	Tioga	1930-1935	Jan.9,1935	8,190	186	July 8,11am	23,500	126	Rating curve
84	Tioga River	Lindley, N.Y.	Steuben	1930-1935	Apr.1,1932 Aug.24,1933	15,800	770	July 8,2pm	4,640	6.0	Rating curve
85	Tioga River	Near Erwins, N.Y.	Steuben	1918-1935	May 22,1919	46,700	1,370	July 8,8pm	46,900	34	Rating curve
86	Chemung River	Corning, N.Y.	Steuben	1909-1935	Mar.14,1918	jn18.8		July 8,9pm	j20.15		

i Probable flow when dam failed.
j Gage height in feet from U. S. Weather Bureau Records.
k Equivalent gage height 23.5 feet, March 17, 1865.
l Former U. S. Weather Bureau observer reported water 4.2 feet higher than observed during period gage was in operation.
m Gage height in feet.
n Equivalent gage height 20.0 feet June 1, 1889.

Flood discharges of streams in New York State—Continued

No. on map	Stream	Point of measurement	County	Period of record	Maximum discharge previously recorded		Drainage area (square miles)	Maximum discharge during flood of July 1935			
					Date	Second-feet		Time	Second-feet		Method of determination
									Total	Per sq. mi.	
	Delaware River Basin-Cont.										
87	Chemung River	Chemung, N.Y.	Chemung	1903-1935	Mar.15,1918	67,000	2,530	July 9,10am	83,400	33	Rating curve
88	Canisteo River	Arkport, N.Y.	Steuben				30.4		4,820	159	Slope-area
89	Canisteo River	Canisteo, N.Y.	Steuben		1902	o9,570	185		o25,000	135	Slope-area
90	Canisteo River	West Cameron, N.Y.	Steuben	1930-1931	May 24,1931	4,000	344		35,000	102	Slope-area
91	Carrington Creek	Fremont Center, N.Y.	Steuben				p13.6		p3,750	276	Dam
92	Big Creek	Near North Hornell, N.Y.	Steuben				16.5		11,900	721	Slope-area
93	Canacadea Creek	Almond, N.Y.	Steuben				49.8		22,000	442	Slope-area
94	Canacadea Creek	Hornell, N.Y.	Steuben	1924-1929	Nov.30,1927	4,610	59.4		26,600	448	Slope-area
95	Bennett Creek	Near Canisteo, N.Y.	Steuben				71.5		o12,400	173	Slope-area
96	Purdy Creek	Near Canisteo, N.Y.	Steuben				21.2		o8,990	424	Slope-area
97	Stephens Creek	Near Carson, N.Y.	Steuben				7.04		6,700	952	Dam
98	Cohocton River	Near Cohocton, N.Y.	Steuben				44.0		891	20	Dam
99	Cohocton River	Near Campbell, N.Y.	Steuben	1918-1935	Dec.1,1927	12,900	472	July 8,1pm	45,400	96	Rating curve
100	Neil Creek	Bloomerville, N.Y.	Steuben				q20.8		q5,040	242	Slope-area
101	Tenmile Creek	Above West Creek, N.Y.	Steuben				q5.96		q1,510	253	Slope-area
102	Campbell Creek	Near Kanona, N.Y.	Steuben				q35.8		q14,000	391	Slope-area
103	Harrisburg Hollow	Near Hickory Hill, N.Y.	Steuben				2.02		2,220	1,100	Slope-area
104	Harrisburg Hollow	Near Hickory Hill, N.Y.	Steuben				2.49		2,810	1,130	Slope-area
105	Brook	Bradford, N.Y.	Steuben				1.68		1,940	1,150	Slope-area
106	Meads Creek	East Campbell, N.Y.	Steuben				46.1		30,300	657	Slope-area
107	Pine Creek	Near Monterey, N.Y.	Schuyler				5.00		3,270	654	Slope-area

	Allegheny River Basin										
108	Allegheny River	Red House, N.Y.	Cattaraugus	1903-1935	Mar.2,1910	41,000	1,690	July 10,4pm	3,710	2.2	Rating curve
	Streams tributary to Lake Ontario										
109	Little Tonawanda Creek	Linden, N.Y.	Genesee	1912-1935	Apr.22,1916	2,400	22	July 8,7am	261	12	Rating curve
110	Genesee River	Scio, N.Y.	Allegany	1916-1935	May 22,1919	10,600	309	July 8,1pm	8,560	28	Rating curve
111	Genesee River	St. Helena, N.Y.	Wyoming	1908-1935	May 17,1916	44,400	1,017	July 9,3:30am	17,400	17	Rating curve
112	Genesee River	Jones Bridge near Mount Morris, N.Y.	Livingston	1903-1906 1908-1913 1915-1935	May 17,1916	55,100	1,419	July 9,10am	14,500	10	Rating curve
113	Genesee River	Rochester, N.Y.	Monroe	1904-1935	Mar.30,1916	48,300	2,467	July 9,7:45pm	18,200	7.4	Rating curve
114	Canaseraga Creek	Near Dansville, N.Y.	Livingston	1910-1912 1915-1917 1919-1935	Nov.30,1927	6,900	153	July 8,10am	9,920	65	Rating curve
115	Stony Brook	Stony Brook Glen, N.Y.	Steuben				18.1		5,800	320	Drop and over road
116	Oswego River	Oswego, N.Y.	Oswego	1933-1935	Apr.15,1934	16,400	5,121	July 11,5:15pm	15,400	3.0	Rating curve
117	Softwater Creek	Near Cold Springs, N.Y.	Steuben				2.34		4,750	2,030	Slope-area
118	Glen Brook	Hammondsport, N.Y.	Steuben				4.96		4,990	1,010	Slope-area
119	Catlin Mill Creek	Odessa, N.Y.	Schuyler				7.33		3,600	491	Culvert-dam
120	Glen Creek	Near Townsend, N.Y.	Schuyler				2.91		7,330	2,520	Slope-area
121	Glen Creek	Watkins Glen, N.Y.	Schuyler				21.3		27,900	1,310	Slope-area
122	Creek	Burdett, N. Y.	Schuyler				12.6		4,600	365	Culvert
123	Five Mile Creek	Enfield, N. Y.	Tompkins				18.0		8,380	466	Dam
124	Six Mile Creek	Potters Falls, near Ithaca, N. Y.	Tompkins				45.5		4,330	95	Dam
125	Six Mile Creek	Van Attas Dam, Ithaca, N. Y.	Tompkins		June 21,1905	r8,500	47.8		4,920	103	Dam
126	Cascadilla Creek	East Ithaca, N.Y.	Tompkins				12.8		1,400	109	Dam
127	Fall Creek	Ithaca, N.Y.	Tompkins	1925-1935	Nov.16,1926	6,290	124	July 8,9am	15,500	125	Rating curve

o Record furnished by William S. Lozier, Inc., Consulting Engineers, Rochester, N.Y.
p Record furnished by Fretts, Tallamy & Senior, Consulting Engineers, Williamsville, N.Y.
q Record furnished by Soil Conservation Service, Bath, N. Y.
r U. S. Geol. Survey Water-Supply Paper 162.

Flood discharges of streams in New York State--Continued

No. on map	Stream	Point of measurement	County	Period of record	Maximum discharge previously recorded		Drainage area	Maximum discharge during flood of July 1935			
					Date	Second-feet	(square miles)	Time	Second-feet Total	Second-feet Per sq. mi.	Method of determination
	Streams tributary to Lake Ontario-Cont.										
128	Salmon Creek	Myers, N.Y.	Tompkins				89.2		18,500	207	Slope-area
129	Taughannock Creek	Near Halseyville, N.Y.	Tompkins				56.7		42,100	742	Slope-area
130	Trumansburg Creek	Trumansburg, N.Y.	Tompkins				11.5		17,800	1,550	Slope-area
131	Owasco Lake Outlet	Near Auburn, N.Y.	Cayuga	1912-1935	Mar.29,1913	2,750	208	July 13,4:30pm	a800	3.8	Rating curve
132	Fish Creek	Taberg, N.Y.	Oneida	1923-1935	Oct.6,1932	16,500	189	July 7,6:30pm	2,860	15	Rating curve
133	Oneida River	Caughdenoy, N.Y.	Oswego	1910-1935	Mar.30,1913	s11,100	1,377	July 11	st2,450	1.8	Rating curve
134	Black River	Near Boonville, N.Y.	Oneida	1911-1935	Mar.28,1913	10,000	295	July 9,2pm	a2,940	10	Rating curve
135	Black River	Watertown, N.Y.	Jefferson	1920-1935	Apr.9,1928	33,900	1,876	July 11,6:30am	a7,420	4.0	Rating curve
136	Moose River	McKeever, N.Y.	Oneida	1900-1935	Mar.27,1913	15,500	365	July 9,6:30pm	1,780	4.9	Rating curve
137	Moose River (Mid. Br.)	Old Forge, N.Y.	Herkimer	1911-1935	Mar.23,1921	862	52	July 9-13	a187	3.6	Rating curve
138	Moose River (Mid. Br.)	Near McKeever, N.Y.	Herkimer	1925-1935	Apr.27,1926	2,100	148	July 10,7pm	488	3.3	Rating curve
139	Independence River	Sperryville, N. Y.	Lewis	1927-1935	Oct.6,1932	4,700	85	July 8,5pm	525	6.2	Rating curve
140	Beaver River	Stillwater Dam, N.Y.	Herkimer	1908-1935	May 3,1926	3,700	172	July 8-9	a581	3.4	Rating curve
141	Beaver River	Croghan, N.Y.	Lewis	1930-1935	Apr.19,1933	3,390	294	July 9,3:30am	a1,400	4.8	Rating curve
142	Deer River	Copenhagen, N.Y.	Lewis	1929-1935	Jan.8,1930	4,500	89	July 7,7pm	1,200	14	Rating curve
143	Brook	Near Stone Mills, N.Y.	Jefferson				u1.7	July 7-8	u646	380	Culvert and over road
144	Brook	Stone Mills, N.Y.	Jefferson				u7.3	July 7-8	u2,460	337	Culvert and over road
145	Brook	Near Guffins Bay, N.Y.	Jefferson				u1.8	July 7-8	u460	256	Culvert and over road
146	Horse Creek	Near Depauville, N.Y.	Jefferson				u4.1	July 7-8	u1,950	476	Culvert and over road
147	Chaumont River	Depauville, N.Y.	Jefferson				u22.7	July 7-8	u4,500	198	Culvert
148	Brook	Near Depauville, N.Y.	Jefferson				u4.7	July 7-8	u1,020	217	Culvert

	Streams tributary to St. Lawrence River										
149	Oswegatchie River (E. Br.)	Cranberry Lake, N.Y.	St. Lawrence	1923-1935	Apr.1933	1,620	144	July 13-16	a230	1.6	Rating curve
150	Oswegatchie River (E. Br.)	Near Oswegatchie, N.Y.	St. Lawrence	1924-1935	Apr.6,1928	4,010	263	July 7,10pm	a1,760	6.7	Rating curve
151	Oswegatchie River	Near Heuvelton, N.Y.	St. Lawrence	1916-1935	Jan.11,1930	15,600	973	July 11,7am	4,270	4.4	Rating curve
152	Oswegatchie River (W. Br.)	Near Harrisville, N.Y.	St. Lawrence	1916-1935	Jan.9,1930	6,920	258	July 9,2am	1,780	6.9	Rating curve
153	Grass River	Pyrites, N.Y.	St. Lawrence	1924-1935	Nov.18,1927	8,300	335	July 9,4am	2,570	7.7	Rating curve
154	Raquette River	Piercefield, N.Y.	St. Lawrence	1908-1935	Apr.17,1922	7,580	722	July 10,1pm	1,330	1.8	Rating curve
155	St. Regis River	Brasher Center, N.Y.	St. Lawrence	1910-1917 1919-1935	Mar.27,1914	16,200	616	July 10,10am	3,010	4.9	Rating curve
156	Salmon River	Chasm Falls, N.Y.	Franklin	1925-1935	Apr.25,1926	2,890	132	July 8,9am	a156	1.2	Rating curve
157	Chateaugay River	Near Chateaugay, N.Y.	Franklin	1926-1935	Apr.8,1928	2,060	112	July 8,4pm	a162	1.4	Rating curve
158	Richelieu River	Rouses Point, N.Y.	Clinton	1871-1935	Apr.2,1903	m8.60	8,277	July 12	m3.61		
159	Great Chazy River	Perry Mills, N.Y.	Clinton	1928-1935	Mar.16,1929	5,810	247	July 9,2pm	182	0.7	Rating curve
160	Saranac River	Saranac, N.Y.	Clinton	1930-1935	Apr.17,1933	5,780	521	July 9,2am	936	1.8	Rating curve
161	Ausable River (W. Br.)	Near Newman, N.Y.	Essex	1916-1917 1919-1935	Oct.6,1932	6,200	116	July 9,6am	650	5.6	Rating curve
162	Ausable River	Near Ausable Forks, N.Y.	Clinton	1910-1935	Mar.27,1913	25,000	448	July 9,7am	3,440	7.7	Rating curve
163	Black Brook	Black Brook, N.Y.	Clinton	1924-1935	Apr.25,1926	720	49.4	July 10,7:30am	a82	1.7	Rating curve
164	Ausable River (E. Br.)	Ausable Forks, N.Y.	Essex	1924-1935	Oct.1,1924	11,000	198	July 9,6am	2,980	15	Rating curve
165	Bouquet River	Willsboro, N.Y.	Essex	1923-1935	Oct.1,1924	11,800	275	July 9,8pm	1,790	6.5	Rating curve
166	Lake George	Rogers Rock, N.Y.	Essex	1913-1935	Apr.18,1922	m5.07		July 12-13	m4.55		
167	Poultney River	Below Fair Haven, Vt.	Rutland	1928-1935	Nov.20,1932	3,870	187	July 8,12M	3,030	16	Rating curve

a Materially affected by storage or diversion.
m Gage height in feet.
s Record furnished by New York State Department of Public Works.
t Does not include flow through lock.
u Record furnished by Black River Regulating District, Watertown, N. Y.

The maximum intensity of discharge (presumably a momentary peak) as determined by measurements in the field, shown on figure 22 and plate 24, was 2,520 second-feet per square mile, from 2.91 square miles of the Glen Creek drainage basin near Townsend, N. Y., corresponding to a run-off rate of 3.90 inches per hour over the drainage basin. The run-off from 2.34 square miles of the Softwater Creek drainage basin near Cold Springs, N. Y., was 2,030 second-feet per square mile, or at the rate of 3.15 inches per hour over the drainage basin. From the indications of washout damage and other evidence it seems probable that there were numerous small streams whose intensities of discharge were equal to those thus determined, if not greater. Unfortunately, suitable locations for determinations of discharge were not found on these small streams. Other determinations of noteworthy intensities are given in the table.

Storage reservoirs

There are few storage reservoirs within the area of the most intense run-off. In general, at the beginning of the storm very little capacity was available for flood storage, with the result that most of the reservoirs quickly filled; but, though not exerting their maximum possible effect, they modified the flows considerably. On figure 21 it is shown that Gilboa Reservoir, on Schoharie Creek, absorbed practically all the flood flow and reduced the flow in the creek below the reservoir to a small portion of what it might have been. The dams at several small reservoirs and lakes in the central part of the State failed, and the value of these bodies of water as regulators of stream flow was destroyed or greatly diminished.

DAMAGE

No attempt has been made here to summarize the property losses and damages caused by the flood, as it is understood that such information is being obtained by the Flood Control Survey, Corps of Engineers, U. S. Army, and will be available in its report.

Farm lands suffered generally from gullying, from being buried under stones and gravel, and from inundation. On plate 30 is shown the character of the damage wrought by the small streams that washed tons of stones and gravel onto the farm lands.

A. CHARLES BECKWITH FARM, SOUTH OF OXFORD, N. Y., SHOWING TYPICAL DAMAGE BY STONES AND GRAVEL TRANSPORTED BY SMALL STREAMS.

B. STONE HOUSE FARM, NEAR NORWICH, N. Y., SHOWING TYPICAL DEBRIS CARRIED BY SMALL STREAMS.

A. WASHOUT OF ROADBED, LEHIGH VALLEY RAILROAD.

The wreck of a passenger train was narrowly averted at this point.

B. NEW YORK CENTRAL RAILROAD AT WATKINS GLEN, N. Y., SHOWING HIGH BRIDGE OVER GLEN CREEK DESTROYED DURING THE FLOOD.

Courtesy of International News Photos, Inc.

A. ERIE RAILROAD AT HORNELL, N. Y., SHOWING ROUNDHOUSE AND EQUIPMENT BURIED UNDER FLOOD WATERS

Courtesy of the Gannett Newspapers.

B. LACKAWANNA RAILROAD NEAR BATH, N. Y., SHOWING TYPICAL FLOOD CONDITIONS

A. TAUGHANNOCK FALLS STATE PARK, N. Y., *SHOWING DESTRUCTION OF ROAD* DUE TO INADEQUACY OF BRIDGE TO CARRY FLOOD WATERS.

B. DESTRUCTION WROUGHT BY FLOOD ALONG TAUGHANNOCK BOULEVARD, ITHACA, N. Y.

This scene was typical of many others.

A. CARS AND TRUCKS MAROONED AND ABANDONED ON FLOODED HIGHWAY, KANONA, N. Y.

B. ROAD DESTROYED BY GULLYING, NORWICH, N. Y.

A. CHENANGO FORKS, N. Y., AT JUNCTION OF TIOUGHNIOGA AND CHENANGO RIVERS, SHOWING INADEQUACY OF BRIDGE OVER TIOUGHNIOGA RIVER TO CARRY FLOOD WATERS.

B. INADEQUACY OF SENECA STREET BRIDGE OVER CANACADEA CREEK, HORNELL, N. Y., TO CARRY FLOOD DEBRIS.

A. O'DAY HOUSE ON FRONT STREET, BINGHAMTON, N. Y., TOPPLING INTO THE FLOOD WATERS OF CHENANGO RIVER.

Courtesy of the Binghamton Press.

B. TYPICAL SIGHT WHEREVER THE FLOOD STRUCK.

A. INUNDATION OF HOMES AND BUILDINGS, HORNELL, N. Y.
Courtesy of the Gannett Newspapers.

B. TELEPHONE POLE DRIVEN THROUGH SIDE WALL AND CEILING INTO THE SECOND FLOOR OF A HOME ON RIVER STREET, HORNELL, N. Y.

A. INOCULATION OF RESIDENTS AGAINST TYPHOID FEVER, HORNELL, N. Y.
Courtesy of the Gannett Newspapers.

B. HAZARDOUS SITUATION FROM WHICH THREE PEOPLE PROVIDENTIALLY ESCAPED, SMITHVILLE FLATS, N. Y.

Railroad operations were suspended by the destruction of roadbeds and bridges and inundation of property and equipment. Plates 31 and 32 show the type of damage to the railroads.

Miles of highways were rendered impassable by the destruction of the pavements, bridges, and culverts and by the inadequacy of the structures to pass the flood waters. Plates 33 to 35 show some of the various types of damages to the highways.

Buildings, automobiles, and private property of many kinds were destroyed, wrecked, buried, and inundated to the great loss of the owners. Plates 36 and 37 show some of the damages to private property.

A menace to health and life was created by the flood. Water supplies were contaminated and destroyed. People were caught and swept away by the flood waters. Plate 38 shows one of the steps taken to safeguard health by inoculation against typhoid fever and a hazardous situation from which three people providentially escaped with their lives.

STORMS AND FLOODS IN THE SUSQUEHANNA RIVER BASIN IN THE VICINITY OF BINGHAMTON, N. Y.

Considerable information regarding historic and recent floods in the vicinity of Binghamton, N. Y., has been collected in an unpublished article, "Floods in the Binghamton district of the Susquehanna River watershed", by Thomas E. Reed, meteorologist, and H. K. Gold, observer, United States Weather Bureau, Binghamton. The following notes on the storms and floods in this vicinity have been taken from their article:

Prior to about 1901 no systematic records were kept of the flood heights along the rivers, and the information of storms and floods has necessarily been derived largely from newspaper accounts of the events. The following quotations are extracts from current newspaper accounts:

August, 1794. "Pumpkin freshet. So called because it swept through tne fields of ripening grain and over the farm lands, ruining crops and carrying down hundreds of pumpkins. A famine threatened."

May 1833. "The late flood. Uncommonly destructive throughout the State." In the Chenango Valley "the smaller bridges generally gone, the banks of the streams cut up and torn away to a surprising extent, and the roads otherwise much injured. We have heard of no further loss of life. *** On the Chenango, several cattle were drowned. *** On the Susquehanna the fields of grain on the flats were much injured." Much damage was also done in Tioga County and to the Chemung Canal.

May 23, 1840. "A most violent storm of rain" lasted but an hour and did considerable damage in Windsor. "Not a bridge is left between Wood's (5 miles from this place) and the Susquehanna at Windsor Village."

February 3, 1842. "The freshet. Immense quantities of rain fell, and both the Chenango and Susquehanna Rivers rose higher than ever known before. *** From every direction we receive accounts of the ravages of the freshet. Never, within memory of that distinguished personage, 'the oldest inhabitant', have the streams risen to such an appalling degree."

March 14 (?), 1846. "Extraordinary freshet. The water here has seldom if ever been higher. It never came upon us so suddenly." Several days of "mild and serene" weather followed by "a heavy rain" of "12 or 14 hours" on the snow "still very deep on our adjacent hills" caused this "extremely disastrous" flood. "A sudden and most providential change in the weather" checked the flood, and "had the weather continued mild the loss must have been incalculably great." The damages were heavy in both the Chenango River and Susquehanna River valleys.

February 9, 1857. "The February thaw - great freshet in the Susquehanna and Chenango Rivers." Three days of warm weather "carried off the snow with extraordinary rapidity, sending the ice out of the rivers in 2:40 time" and raising the rivers "as high as they have been in several years." Damage, as reported, was chiefly to bridges on both the Chenango and Susquehanna Rivers.

March 17, 1865. Deep snows on the headwaters, "rapidly melting away in the face of the sun and south wind" and a severe rain, caused this great flood, "estimated as being from 4 to 8 feet higher than it had ever been known to be by white men. The Chenango River was considerably the highest, and its current was by far the most strong and raging." Houses in Binghamton were "in the water up to the first and second stories."

March 12, 1879. "The rivers are rising under the influence of melting snow, and the peaceful, slumbering ice is evidently preparing to gorge itself on bridges and mill property." Ice jams caused damage at Whitney Point, on the Tioughnioga River, and at Binghamton, on the Susquehanna River.

December 15, 1901. "Terrible rains caused flood. Binghamton was completely isolated from the outside world from Saturday night until early this morning (Monday) by the worst flood since 1865." The Chenango River at the Court Street Bridge reached a maximum observed stage of 20.4 feet, and the Susquehanna River at Washington Street Bridge a maximum observed stage of 14.9 feet. Great damage was done by inundation and washouts on the railroads and roads.

March 2, 1902. There was undoubtedly a heavy cover of snow over the upper portions of the drainage basin, which rapidly melted during the 5 or 6 days of unusually warm weather and light rains that preceded the flood. The Chenango River at Court Street Bridge rose to an observed stage of 23.1 feet. The Susquehanna River at Washington Street rose to an observed stage of 19.7 feet. Accounts of the flood state that the Susquehanna River reached a point 8 inches below the mark of the flood of 1865. "One of the most reliable marks of the flood of 1865 is afforded by two nails driven in the corner of the building at the corner of South and Carroll Streets, driven in the building in question at time of very highest, March 17, 1865." Much damage resulted from inundation and the destruction of highway and railroad structures.

1901-1935. At the Washington Street Bridge on the Susquehanna River at Binghamton, the United States Weather Bureau has daily observed the stage of the river since 1901. At the Court Street Bridge on the Chenango River the United States Geological Survey daily observed the stage of the river from 1901 to 1911, and after 1911 the United States Weather Bureau observed the stage occasionally at times of threatening floods and in 1933 resumed daily observations. The following table shows the date of occurrence and the maximum observed stage each year on the Susquehanna and Chenango Rivers:

Maximum observed river stages, in feet, at Binghamton, N. Y.

Year	Susquehanna River		Chenango River	
	Date	Feet	Date	Feet
1901*	Dec. 15	14.9	Dec. 15	20.4
1902	Mar. 2	19.7	Mar. 2	23.7
1903	Oct. 11	17.6	Oct. 11	20.3
1904	Mar. 27	17.8	Mar. 27	20.8
1905	Mar. 26	14.9	Mar. 26	18.7
1906	Mar. 29	9.9	Mar. 28	13.8
1907	Dec. 11	12.8	Jan. 5	13.8
1908	Feb. 16	14.0	Feb. 16	17.0
1909	Feb. 21	12.4	Feb. 21	15.7
1910	Mar. 2	17.7	Mar. 2	21.4
1911	Mar. 28	14.3	Mar. 28	18.1
1912	Apr. 3	14.5		
1913	Mar. 28	18.6	Mar. 28	22.3
1914	Mar. 29	18.5	Mar. 29	22.3
1915	July 9	15.2		
1916	Apr. 2	16.5	Apr. 2	20.1
1917	Mar. 28	13.9		
1918	Mar. 1	12.0		
1919	May 11	7.7		
1920	Mar. 28	14.6		
1921	Nov. 29	14.3		
1922	Mar. 8	12.8		
1923	Mar. 24	13.5		
1924	Oct. 1	17.2	Oct. 1	21.1
1925	Feb. 12	17.2	Feb. 12	20.7
1926	Nov. 17	14.4		
1927	Oct. 19	16.6		
1928	Mar. 27	11.5		
1929	Mar. 16	17.7		
1930	Jan. 26	9.5		
1931	Mar. 27	11.4		
1932	Oct. 7	12.2		
1933	Aug. 25	10.8		
1934	Mar. 5	17.7	Mar. 5	22.3
1935	Jan. 10	16.8	Jan. 10	21.4
1935	July 8	17.7	July 8	24.8

*Record starts in August 1901.

The flood of July 8, 1935, will long be remembered as the most sudden and most destructive flood that has ever occurred in the upper Susquehanna River Basin, particularly throughout the Chenango and Tioughnioga Valleys. Unprecedented rains that developed from severe and continuous thundershowers, popularly called "cloudbursts", occurred, particularly during the night of July 7-8, throughout Cortland and Chenango Counties, comprising the drainage areas of the upper basins, and to a lesser degree in northern Broome, Otsego, and Delaware Counties. While Cortland recorded a fall of 6.12 inches in 12 hours, from 5:00 p.m. July 7 to 5:00 a.m. July 8, there was but 0.10 inch recorded at the Binghamton station, only 40 miles distant. The greatest previous record for a 24-hour period at Cortland was 4.87 inches. The greatest record for a 24-hour period at Binghamton was 4.55 inches, on September 30, 1924.

The small streams and rivers were soon out of their banks, and a wall-like crest of water moved down the basins, converging at Binghamton, where the Susquehanna and Chenango Valleys meet. From a low stage of 1.3 feet at Binghamton the Chenango River rose above flood stage on the morning of July 8 within 4 hours and reached its crest of 24.80 feet 6 hours later, at 3:00 p.m. of that day. A number of lives were lost in the upper basins during the early morning hours of July 8. Hundreds of families were driven from their homes, particularly in the first ward of the city of Binghamton, which was badly flooded when the rising waters overflowed the west bank, and in that portion of Front Street north of the Ferry Street Bridge, which adjoins the first ward. A house at 208 Oak Street, in the first ward, bearing a crest mark of the great flood in that section of the city on March 17, 1865, shows that this height is 9 inches lower than the high-water mark of July 8, 1935.

The Susquehanna River at Binghamton did not rise as high as on previous occasions, the crest of 17.72 feet being recorded about 3:00 p.m. July 8. Both rivers continued in flood for about 50 hours.

Property damage of all kinds throughout the basins comprised in the district mounted upward to $8,000,000.

The record of former floods indicates the marked prevalence of winter and spring floods and the very rare occurrence of major summer floods in the Susquehanna River Basin in the vicinity of Binghamton. It is interesting to note that prior to July 1935 the highest observed stage of the Susquehanna River at Binghamton for each calendar month since the beginning of the record in 1901 has been as follows:

		Feet			Feet
January	1935	16.8	July	1915	15.2
February	1925	17.2	August	1903	11.0
March	1902	19.7	September	1924	15.3
April	1916	16.5	October	1903	17.6
May	1927	12.0	November	1926	14.4
June	1922	10.3	December	1901	14.9

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