FLOODFLOW CHARACTERISTICS AT PROPOSED CHANNEL-RELOCATION SITE ON MOHAWK RIVER NEAR ROME, NEW YORK

U.S. GEOLOGICAL SURVEY

Open-File Report 77-328

Prepared in cooperation with the

New York State Department of Transportation

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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CONVERSION FACTORS AND ABBREVIATIONS

The following factors may be used to convert English units to the International System of Units (SI)

Multiply English units	By	To obtain SI Units
	Length	
inches (in.)	2.540	centimeters (cm)
feet (ft)	0.3048	meters (m)
miles (mi)	1.609	kilometers (km)
	Area	
square miles (mi^2)	2.590	square kilometers (km^2)
	Flow	
cubic feet per second (ft^3/s)	.02832	cubic meters per second (m^3/s)
feet per second (ft/s)	.3048	meters per second (m/s)

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ABSTRACT

A flow-distribution analysis showed that magnitude of 50- and 100-year flood discharges in the old 3.3-mile-long Mohawk River channel near Rome, N.Y. would be small compared with that in the section of Erie (Barge) Canal that intercepts it. Under present channel conditions, the old channel receives flow only from Wheelers Creek, a tributary that enters at the southwest corner of the old channel. During a 50- or 100-year flood, inflow from Wheelers Creek would be divided; part would flow east and the remainder would flow north into the Canal over a weir.

Analyses were made of the effect that (1) three proposed channel-relocation schemes within the old channel, and (2) removal of an 8-foot culvert upstream from the relocation sites, would have on the 50- and 100-year flood profiles in the old channel. Channelization with the culvert retained would have a minor effect on flow distribution and flood-stage profiles; the 50- and 100-year flood stage would not be increased by more than 0.2 and 0.3 feet, respectively. Channel relocation with the culvert removed would significantly affect flow distribution and the water-surface profiles in the old channel. During the 50- and 100-year floods, all inflow from Wheelers Creek would be eastward, and the reach north of the mouth of Wheelers Creek to the Canal would have essentially ponded conditions during the 50-year flood but would receive southward flow out of the Canal over the weir during the 100-year flood. The maximum increase in flood stage resulting from channel relocation and removal of the culvert during the 50- and 100-year flood would be 1.4 and 1.6 feet, respectively.

INTRODUCTION

To expand the arterial system near the city of Rome, N.Y., the New York State Department of Transportation (NYSDOT) plans to construct two ramps across Mohawk River and Erie (Barge) Canal and to relocate the part of the Mohawk River that the ramps will cross. As part of a cooperative program of water-resources investigations with the State of New York, the U.S. Geological Survey analyzed the effects that three alternative channelization schemes and removal of an 8-ft culvert from the channel would have on 50- and 100-year flood profiles.

The channelization schemes proposed by NYSDOT are:

Scheme 1: A 3,000-ft-long channel with an open-span bridge for each ramp.

Scheme 2: A 1,500-ft-long channel with a multiplate arch culvert for each ramp.

Scheme 3: A 3,000-ft-long channel with one multiplate arch culvert for both ramps.

This report provides information on magnitude and frequency of flooding in the study area and an analysis of the effects that the three channel-relocation schemes and removal of the culvert from the channel would have on the profiles of 50- and 100-year floods in the old channel.

Data available

Hydrologic information for Mohawk River in this report is based primarily on flood data collected by the Geological Survey at the gaging station 01336000 at Delta Dam, 6.4 mi upstream from the study area. River cross sections, a plan drawing, and historic information were furnished by NYSDOT. Water-surface-elevation data from a U.S. Army Corps of Engineers report (1975) were also used. Roughness coefficients were based on field inspection.

All elevations are referred to mean sea level, datum of 1929.

Site Description

The study area, general location of the proposed channel-relocation schemes, and reference points are shown in figure 1. For the remainder of this report, all references to points A through G pertain to figure 1.

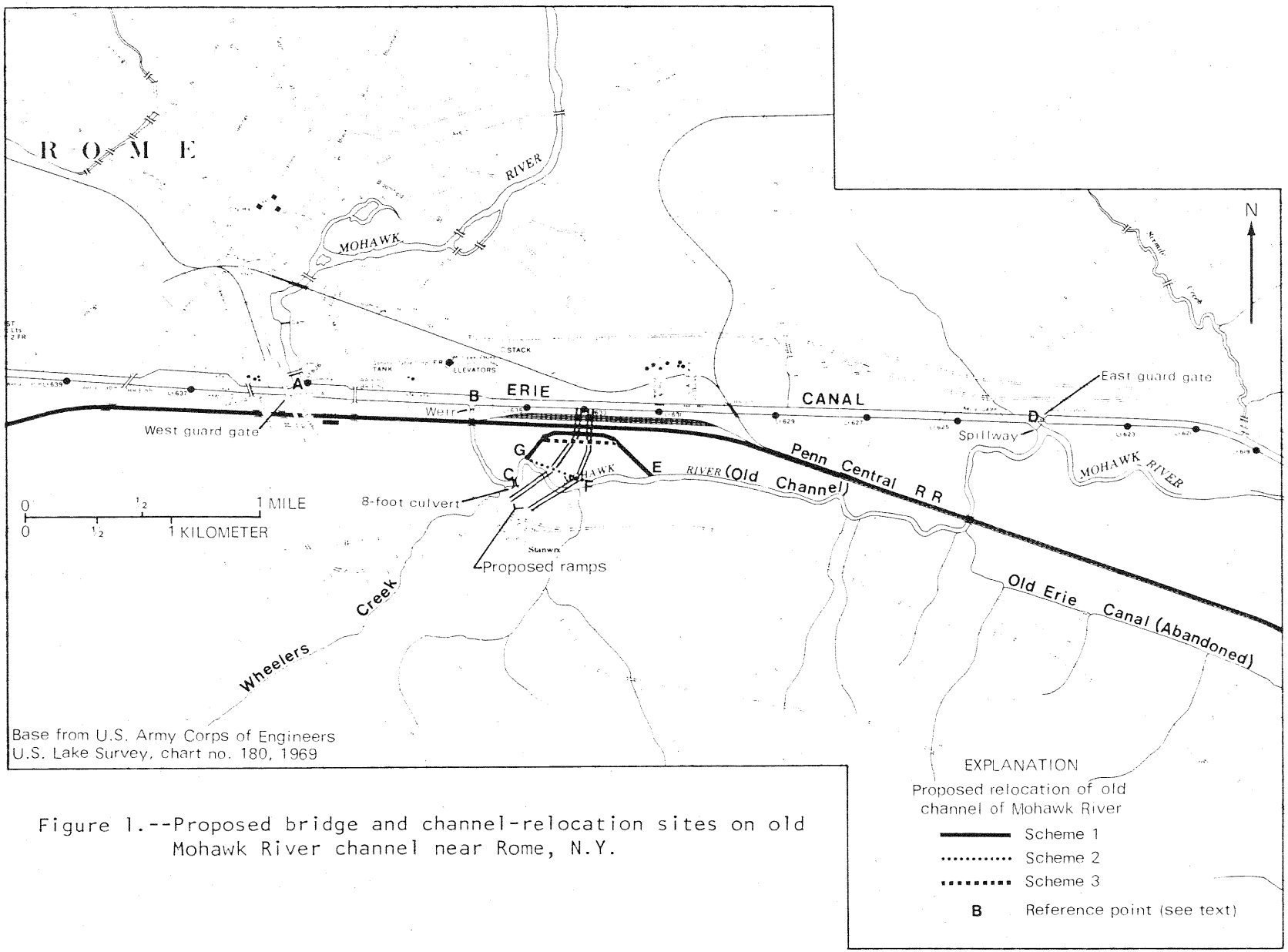

Figure 1.--Proposed bridge and channel-relocation sites on old Mohawk River channel near Rome, N.Y.

Mohawk River empties into the summit-level section of Erie (Barge) Canal at Rome from the north at A, from where it flows east and west to maintain a normal canal-pool elevation of 418.8 ft. The drainage area of the Mohawk River at A is 156 mi^2. The water level in the Canal east of A is maintained by a 225-ft-long spillway (elevation 418.8 ft) at D, approximately 3.2 mi east of the river-canal junction (A).

The old Mohawk River channel is south of the Canal, beginning at an 85-ft-long weir (elevation 418.8 ft) at B, approximately 0.7 mi east of the river-canal junction (A). Length of the old channel between B and D is 3.3 mi.

Wheelers Creek enters the old Mohawk River channel 2,000 ft south of the weir at C. The drainage area of Wheelers Creek is 16.2 mi^2.

The streambed of the old Mohawk River channel consists of gravel and cobbles. The channel is basically trapezoidal, and its fairly heavily vegetated banks range from 6 to 12 ft in height. The adjacent flood plains are generally flat pasture or fields except where the channel is bounded by the old (abandoned) Erie Canal or the Penn Central Railroad embankment (fig. 1). The old channel and the Erie (Barge) Canal are effectively separated, even during high flows, by the Penn Central Railroad embankment and the Barge Canal berm.

At present, two railroad bridges span the old channel, and an 8-ft-diameter culvert is immediately east of the mouth of Wheelers Creek. The openings of the railroad bridges are large enough to have little effect on flood profiles, but the culvert severely restricts floodflows.

The three channel-relocation schemes call for trapezoidal channels with bottom widths of 30 ft and side slopes of 1 (vertical) on 2 (horizontal). Elevations of the channel invert and the top of banks are 417 ft and 429 ft, respectively.

Scheme 1, which begins at G, calls for a channel approximately 3,000 ft long between G and E. The proposed highway crossings consist of open-span bridges.

Scheme 2 calls for a channel approximately 1,500 ft long between G and F. Two 20.6-ft x 13.2-ft multiplate arch culverts would be in the channel; one for each of the ramps.

Scheme 3 calls for a channel approximately 3,000 ft long between G and E. The apex of the channel curve would be approximately 50 ft south of scheme 1, and one 24.7-ft x 16.2-ft multiplate arch culvert would be in the channel.

PRESENT FLOOD SITUATION

Erie (Barge) Canal

Two canal guard gates are in the study area--one immediately west of A and one immediately east of D. The guard gates are closed to protect the Canal during periods of extremely high water. NYSDOT procedure is to close each gate when the gages on the Canal read 421.3 ft. The gage for the west guard gate is at the gate; the gage for the east gate is at Lock 20, 15.8 mi east of the east gate. Between the east gate and Lock 20, the river receives flow from the Canal over two additional spillways, both at an elevation of 418.8 ft. Records collected by NYSDOT during past floods indicate that the guard gates are not closed at the same time and that the relief provided by the two spillways east of D may attenuate some peaks to the point that only the west gate need be closed. Thus, the water level attained in the Canal depends on the cause, magnitude, and duration of flooding and at what time the guard gates are closed.

For example, the flood of record at the Delta Dam gaging station 6.4 mi upstream from A was on October 2, 1945 and had a discharge 8,560 ft^3/sec. Rain falling on already saturated ground in the Mohawk River basin on October 1 and 2 exceeded 4 in. at some precipitation stations. During this flood, a maximum stage of 423.1 ft was recorded at the west guard gate, and the east gate was not closed at any time.

The flood of July 3, 1974 was of a different nature. Severe thunderstorms in the early morning dropped more than 3 in. of rain in 3 hours over much of the Mohawk River basin. The peak discharge at the Delta Dam gaging station came that afternoon but was only 2,040 ft^3/sec. By this time, inflow (including that of Wheelers Creek) into the Canal between Rome and Lock 20 had raised the water level in the Canal sufficiently to require closing of both the west and east guard gates. With both gates closed, maximum stage attained (which was also the highest stage of record on the Canal), was 424.8 ft at the west gate. All inflow from Mohawk River into the Canal at A left the canal at D.

Old Mohawk River Channel

When the Canal is at normal pool elevation, part of Wheelers Creek's flow in the old channel is north into the Canal over the 85-ft-long weir, and the remainder is east. No water from the Canal enters the old channel at B; excess canal water that is not needed to maintain the normal canal elevation reenters Mohawk River at D.

During periods of high water, direction of flow in the old channel reach between B and C depends on the water-surface elevation in the Barge Canal and the magnitude of inflow from Wheelers Creek. During the July 1974 flood, part of the discharge of Wheelers Creek flowed north. During floods on Mohawk River attended by minor inflow from Wheelers Creek, the flow direction between B and C would be reversed--flow would be out of the canal over the 85-ft-long weir.

MAGNITUDE AND FREQUENCY OF FLOODS

The U.S. Geological Survey has maintained a gaging station on Mohawk River below Delta Dam near Rome, N.Y. (station 01336000), 6.4 mi upstream from the study area, since 1921. Continuous records at this station through 1960 are summarized in two U.S. Geological Survey reports (1960 and 1964). Since 1961, similar records have been released annually in Geological Survey reports, "Surface-Water Records." The drainage area at the gaging station is 150 mi^2.

No records have been collected for Wheelers Creek.

Flood Frequency

A log-Pearson Type III analysis was made of the annual peak discharges for Mohawk River at the Delta Dam gaging station. The resulting frequency curve was adjusted to reflect the larger drainage area of the River at the point where it enters the Barge Canal at the upstream end of the study area (A).

An analysis of the 50- and 100-year floods on Mohawk River in the study area necessarily includes an assessment of the flood situation on Wheelers Creek. Although the drainage area of Wheelers Creek is small compared with that of Mohawk River, and it is likely that floodwaters on the Creek would be receding by the time the River crests. Inflow from Wheelers Creek significantly affects flow in the old channel.

The drainage area of Wheelers Creek was added to that of Mohawk River at the upstream end of the study area, and the frequency curve for the Delta Dam gaging station was again adjusted to obtain the flood-frequency relationship on Mohawk River with Wheelers Creek included. For a flood of a given recurrence interval on Mohawk River, the difference between the two adjusted discharge values represents the contribution of Wheelers Creek.

The flood-frequency relationships on Mohawk River at the upstream and downstream ends of the study area are summarized in table 1.

Table 1.--Flood discharges on Mohawk River near Rome at upstream and downstream ends of study area with east and west guard gates closed

Recurrence interval (years)	Discharge, in ft^3/s	
	Upstream end of study area	Downstream end of study area
2	2,200	2,400
5	3,500	3,800
10	4,600	5,000
25	6,200	6,700
50	7,600	8,200
100	9,200	9,900

ANALYSIS OF HYDRAULIC CONDITIONS

Analyses were made on the old Mohawk River channel and the Barge Canal to determine the distribution of Wheelers Creek's flow and the total flow in the Canal. The standard step-backwater method was used to develop the water-surface profiles. As mentioned previously, the water level attained in the Canal during floods depends on when the gates are closed. Floods in the study area are most severe when both gates are closed, and the floodflow analyses were made assuming this condition.

The step-backwater analyses were started at the 225-ft-long spillway (D), where, during both the 50- and 100-year floods, the spillway is submerged so that the water-surface elevation in the old channel is the same as in the Canal. Starting elevations at the spillway were determined from a stage-discharge relationship developed from data given in U.S. Army Corps of Engineers (1975). The starting elevations were 423.6 ft and 424.1 ft for the 50- and 100-year floods, respectively.

In the analysis of present conditions, the 8-ft-diameter culvert at Wheelers Creek and its roadway embankment (at C) were retained, and schemes 1, 2, and 3 were evaluated for two possible situations; one with the culvert retained, the other with it removed.

The flow-distribution analysis showed that the Canal would carry most of the flow during a 50- or 100-year flood. Flow in the old channel would amount to less than 5 percent of the total floodflow at the downstream end of the study area, either under present flood conditions or if the culvert were retained upon implementation of scheme 1, 2, or 3. If the culvert were removed, the old channel would carry less than 10 percent of the total floodflow regardless of which scheme was in effect.

Results of the flow-distribution analysis are given for a 50-year flood in table 2 and figure 2, and for a 100-year flood in table 3 and figure 3, for the following situations[1]:

I. Present condition (original channel with culvert and no ramps).
II. Scheme 1 with culvert retained.
III. Scheme 2 with culvert retained.
IV. Scheme 3 with culvert retained.
V. Scheme 1 with culvert removed.
VI. Scheme 2 with culvert removed.
VII. Scheme 3 with culvert removed.

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[1] Scheme 1, 3,000-ft channel with open-span bridge for each bridge ramp.
Scheme 2, 1,500-ft channel with multiplate arch culvert for each bridge ramp.
Scheme 3, 3,000-ft channel with one multiplate arch culvert for both ramps.

Table 2.--Discharges, in cubic feet per second, during 50-year flood in selected reaches of study area under alternative conditions

[Location of B, C, D given in fig. 2]

Condition[1]	Old Mohawk River Channel		Barge Canal
	Between B and C[2]	Between C and D	Between B and D
I	250 (N)	350	7850
II	250 (N)	350	7850
III	250 (N)	350	7850
IV	260 (N)	340	7860
V	20 (S)	620	7580
VI	10 (N)	590	7610
VII	0	600	7600

[1] See descriptions in text.
[2] N, northward flow into Erie (Barge) Canal;
S, southward flow out of Erie (Barge) Canal.

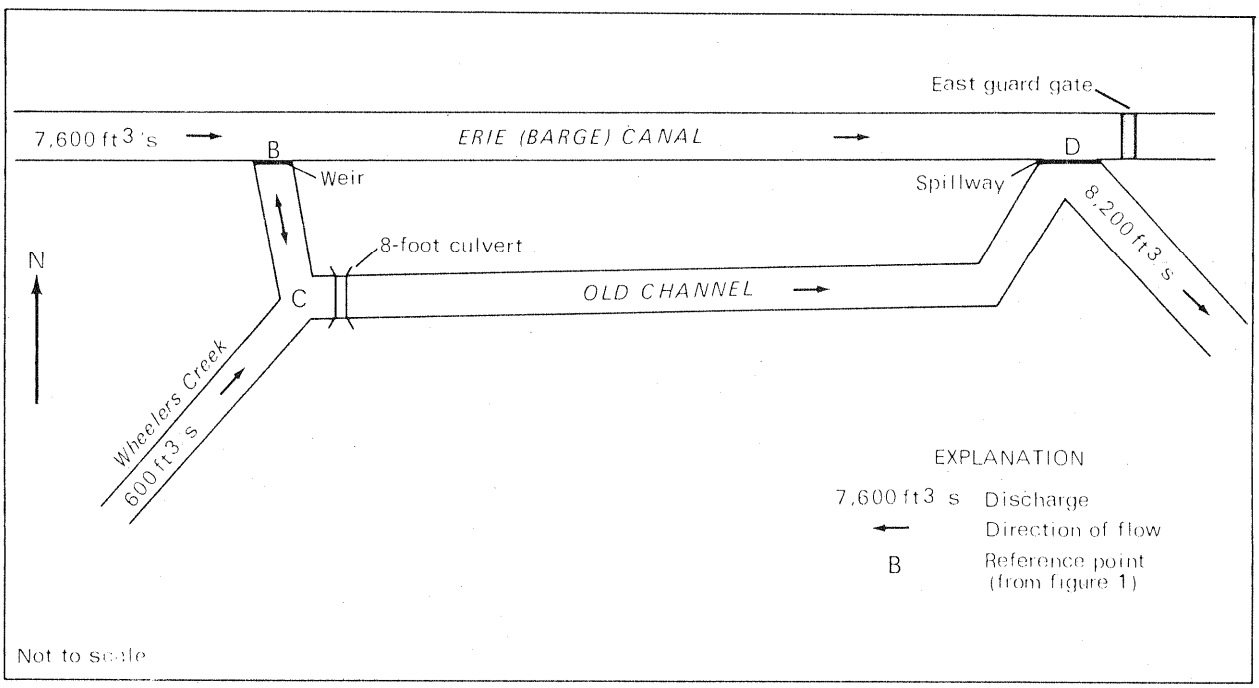

Figure 2.--Flow distribution during 50-year flood, Mohawk River near Rome, N.Y. Discharges in reaches between B and C, C and D, and B and D for conditions I-VII analyzed are given in table 2.

Table 3.--Discharges, in cubic feet per second, during 100-year flood in selected reaches of study area under alternative conditions

[Location of B, C, D given in fig. 3]

Condition[1]	Old Mohawk River Channel		Barge Canal
	Between B and C[2]	Between C and D	Between B and D
I	290 (N)	410	9490
II	290 (N)	410	9500
III	300 (N)	400	9500
IV	290 (N)	410	9490
V	90 (S)	790	9110
VI	0	700	9200
VII	80 (N)	780	9120

[1] See descriptions in text.
[2] N, northward flow into Erie (Barge) Canal;
S, southward flow out of Erie (Barge) Canal.

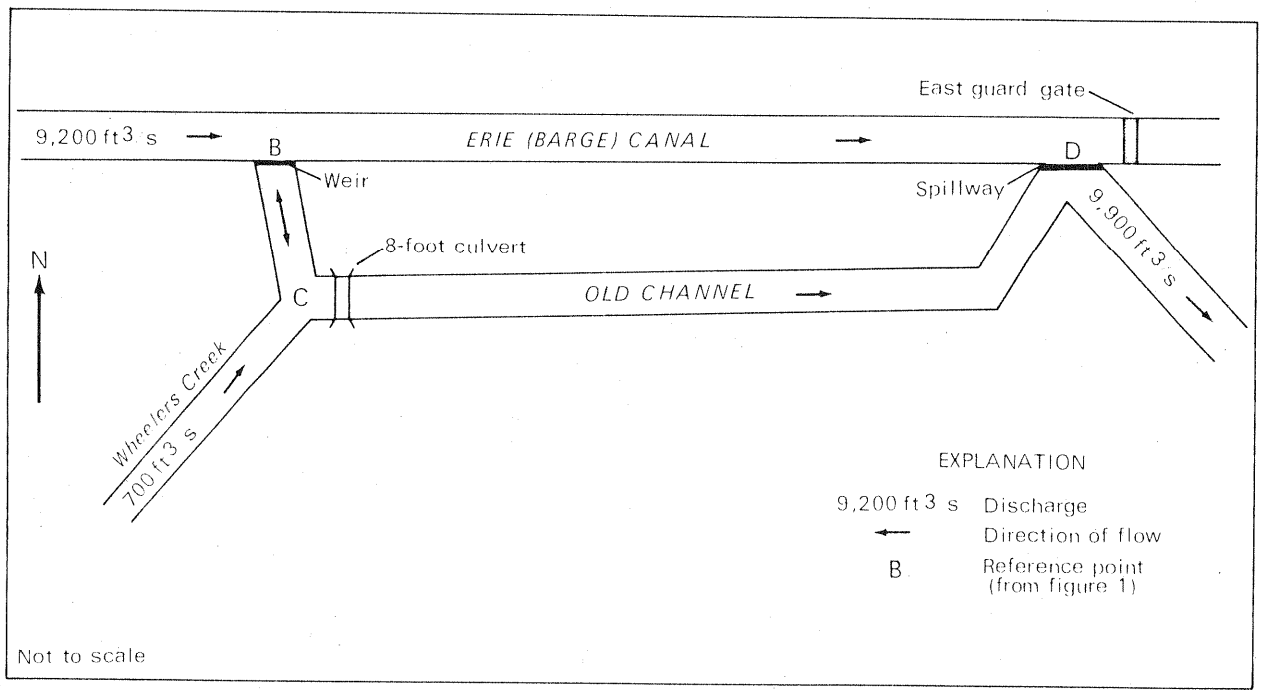

Figure 3.--Flow distribution during 100-year flood, Mohawk River near Rome, N.Y. Discharges in reaches between B and C, C and D, and B and D for conditions I-VII analyzed are given in table 3.

Water-surface profiles of the old channel between E and B were plotted for the 50- and 100-year floods.[2]

Figures 4 and 5 show comparisons of water-surface profiles during the 50- and 100-year floods, respectively, for the old channel under present conditions and for schemes 1, 2, and 3 with the culvert retained. Figures 6 and 7 show comparisons of water-surface profiles during the 50- and 100-year floods, but with the culvert removed upon implementation of either scheme 1, 2, or 3.

Under present conditions during a 50- or 100-year flood, discharge from Wheelers Creek would be divided upon entering the old channel.

Schemes 1, 2, and 3 with Culvert Retained

If the culvert were retained, none of the channelization schemes would alter the flow distribution in the old channel downstream from it. In the reach of the old channel between C and E, the greatest increase in flood stage would result from scheme 2. During a 50- and 100-year flood, maximum elevations in that reach would be 0.2 and 0.3 ft higher, respectively, than those during the same floods under present conditions. None of the schemes would change the water-surface profiles between B and C during the 50- or 100-year flood.

Schemes 1, 2, and 3 with Culvert Removed

If the culvert were removed, all inflow from Wheelers Creek would be eastward under present conditions and under any of the three channel-relocation schemes in either flood. Between B and C there would be no appreciable flow (an essentially ponded condition) with scheme 1, 2, or 3 during a 50-year flood, nor in scheme 2 during a 100-year flood; but if scheme 1 or 3 were implemented, there would be inflow from the Canal into the old channel southward across the weir during the 100-year flood. Water-surface profiles of each channelization scheme would be higher during either flood than those of the present channel between E and C. During a 50- or 100-year flood, scheme 1 would result in a maximum increase of flood levels of 1.1 and 1.6 ft, respectively; scheme 2 would result in a maximum increase in flood levels of 1.4 ft and 1.6 ft, respectively; and scheme 3 would result in a maximum increase in flood levels of 1.2 and 1.6 ft, respectively. Between B and C, the water-surface elevation during a 50- or 100-year flood with the culvert removed would be slightly higher than under present conditions.

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[2] The water-surface elevation in schemes 1 and 3 rises at a uniform slope. The length of the new channel for schemes 1 and 3 was compressed in figures 4-7 to conform with the length of the new channel for scheme 2 in order to allow comparison of the profiles. (The new channel for scheme 2 has approximately the same length as the old channel section it would replace.)

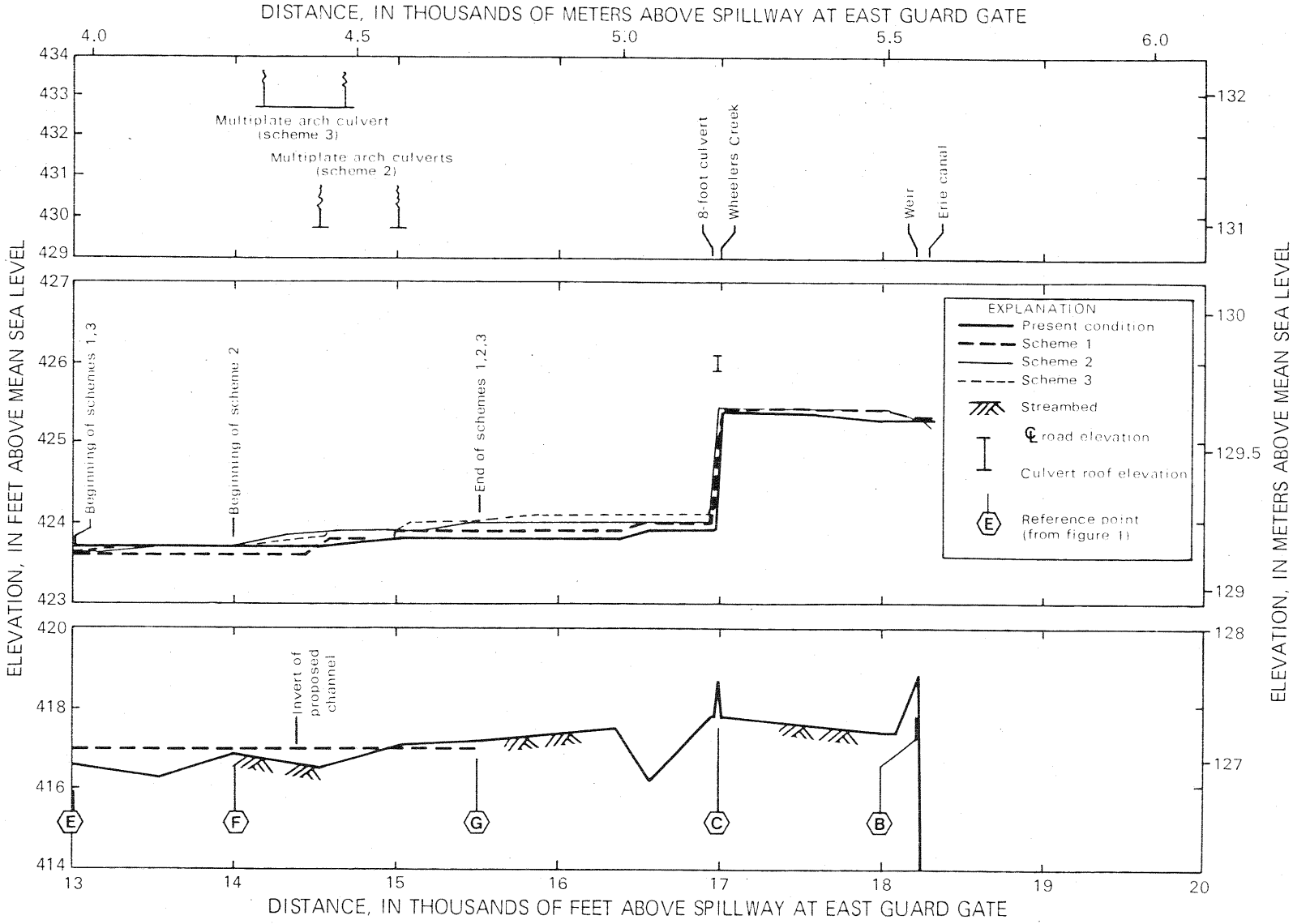

Figure 4.--Water-surface profiles for present condition and schemes 1, 2, and 3, during 50-year flood with 8-ft culvert retained, Mohawk River near Rome, N.Y.

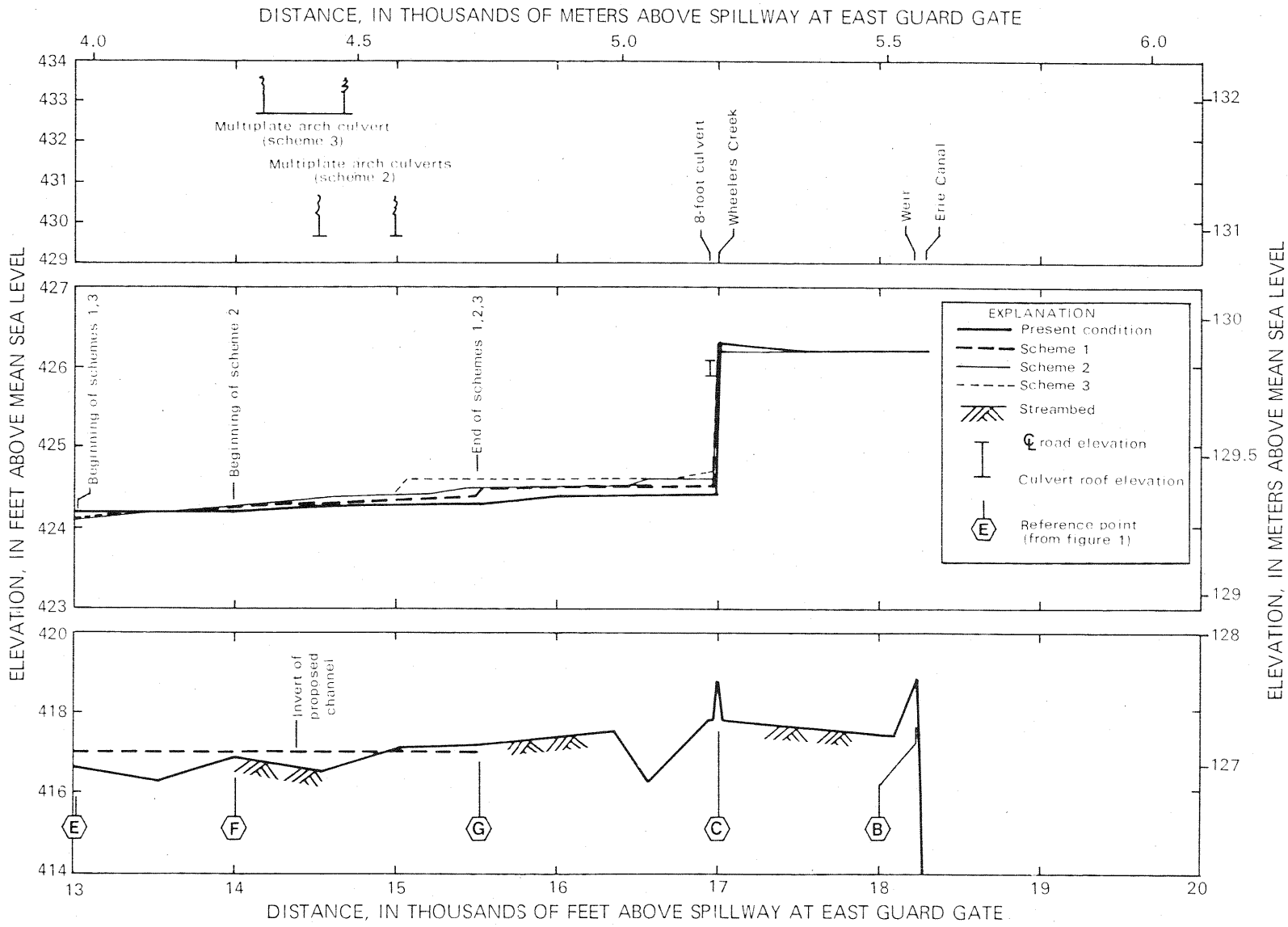

Figure 5.--Water-surface profiles for present condition and schemes 1, 2, and 3, during 100-year flood with 8-ft culvert retained, Mohawk River near Rome, N.Y.

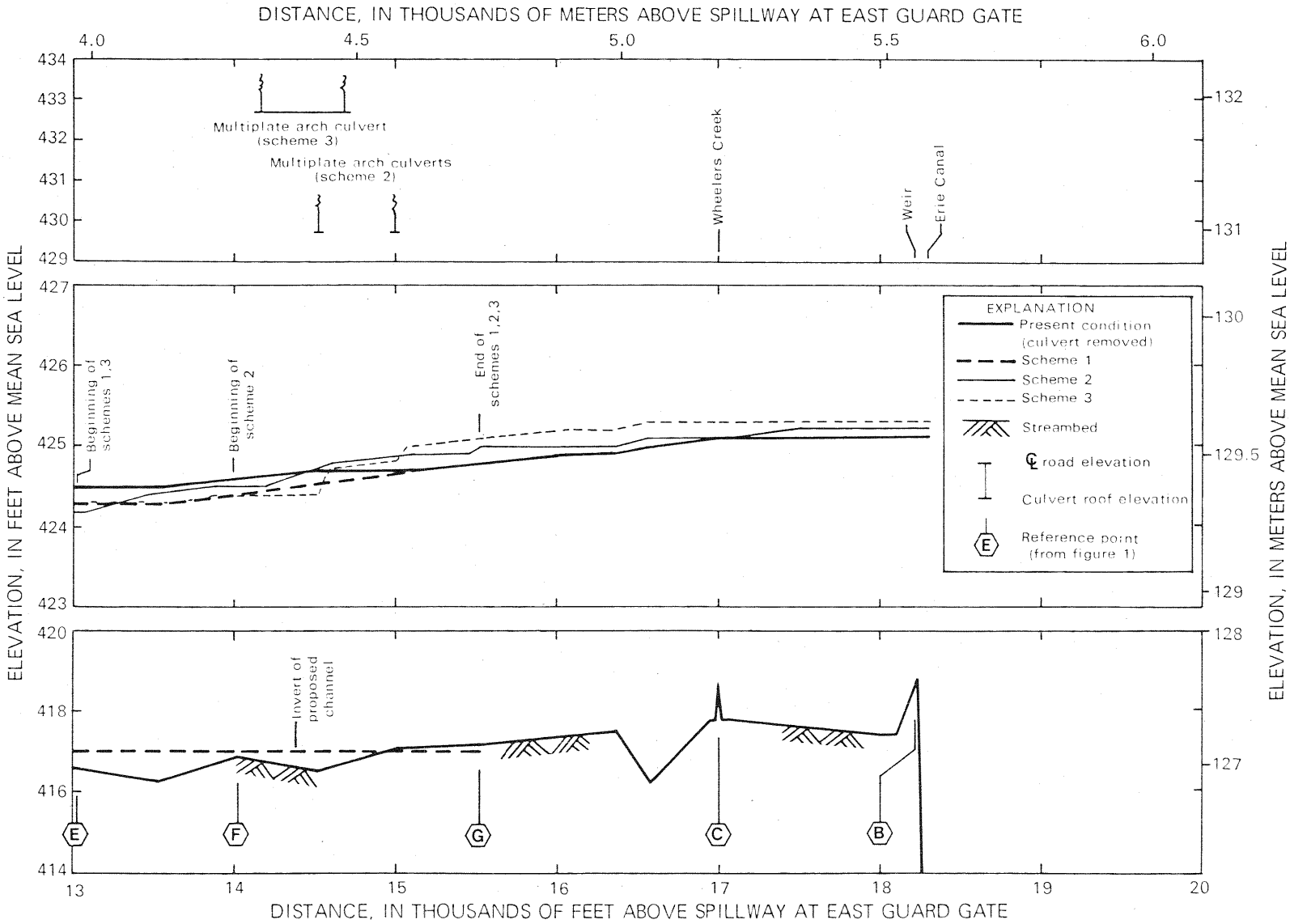

Figure 6.--Water-surface profiles for present condition and schemes 1, 2, and 3, during 50-year flood with 8-ft culvert removed, Mohawk River near Rome, N.Y.

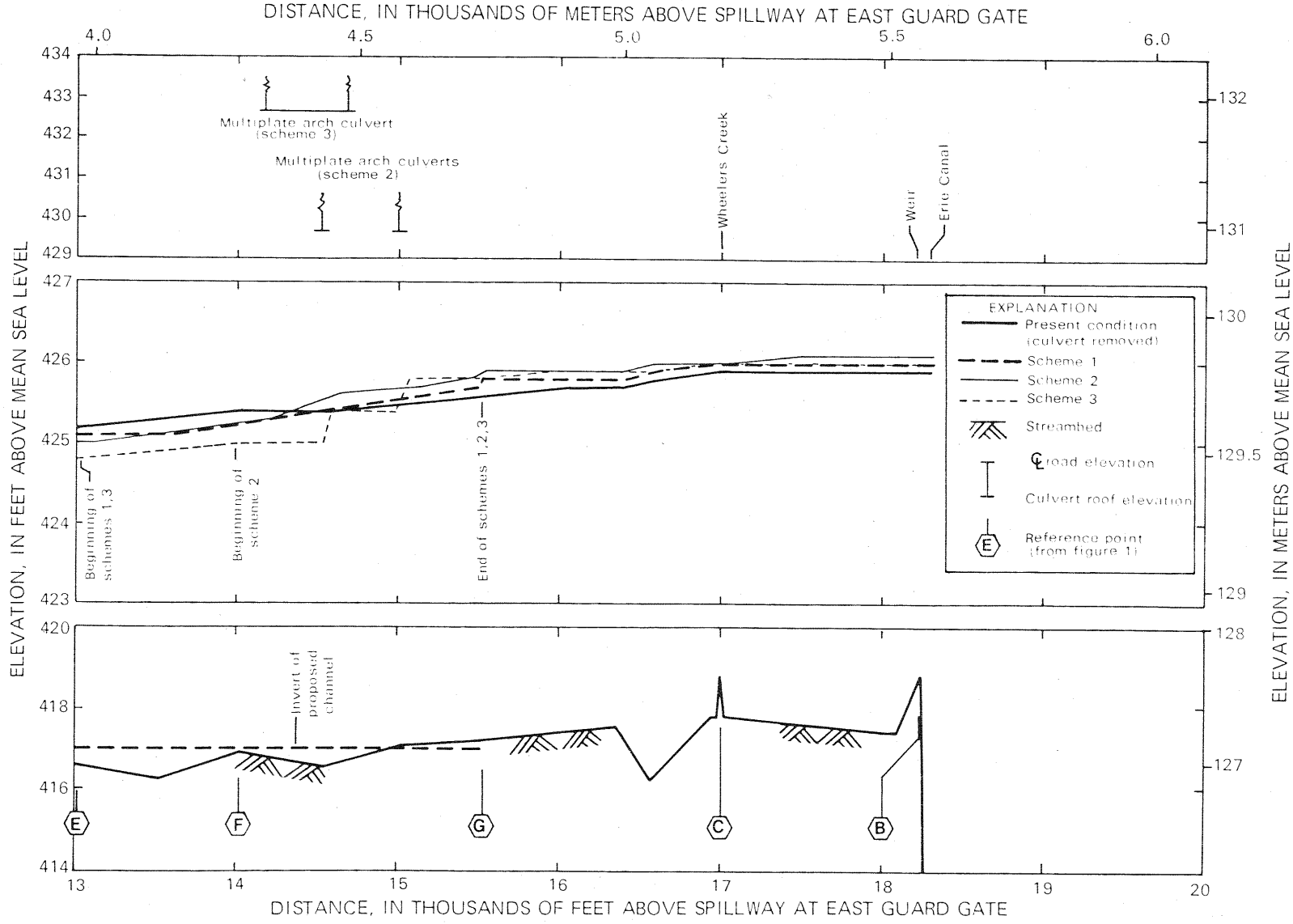

Figure 7.--Water-surface profiles for present condition and schemes 1, 2, and 3, during 100-year flood with 8-ft culvert removed, Mohawk River near Rome, N.Y.

Stream Velocity

The velocities for the different conditions analyzed in the old Mohawk River channel east of Wheeler's Creek are shown in table 4.

In the old channel north of Wheelers Creek, the maximum average velocity from Wheelers Creek under present conditions is 0.6 ft/s. During the 50-year flood on the Mohawk River, there is no flow in the old channel north of Wheelers Creek with any of the schemes, and during the 100-year flood with scheme 2 there is also no flow. During the 100-year flood with scheme 1 and 3, flow is southward from the Canal, and the velocity is 0.2 ft/s.

Table 4.--Maximum average velocities in old Mohawk River channel east of Wheelers Creek near Rome, N.Y.

[Velocities in feet per second]

	50-year flood	100-year flood
Present condition (with culvert and no channel relocation)	1.2	1.2
Scheme 1		
with 8-foot culvert		
retained	1.2	1.3
removed	1.9	2.2
Scheme 2		
In open channel		
with 8-foot culvert		
retained	1.2	1.2
removed	2.6	2.8
With multiplate arch culvert for each ramp		
with 8-foot culvert		
retained	1.8	1.9
removed	4.1	4.5
Scheme 3		
In open channel		
with 8-foot culvert		
retained	1.2	1.3
removed	1.9	2.1
With multiplate arch culvert		
with 8-foot culvert		
retained	2.3	2.6
removed	3.6	4.2

Scheme 1, 3,000-ft channel with open-span bridge for each ramp.
Scheme 2, 1,500-ft channel with multiplate arch culvert for each ramp.
Scheme 3, 3,000-ft channel with one multiplate arch culvert for both ramps.

CONCLUSIONS AND SUMMARY

Flow-distribution analyses show that during a 50- and 100-year flood, discharge in the old Mohawk River channel is small compared with that in the section of Erie (Barge) Canal that intercepts a 3.3 mi loop of the old channel. Whether under present conditions or with implementation of channelization schemes 1, 2, or 3, flow in the old channel would be less than 5 percent of the total flood discharge at the downstream end of the study area if the 8-ft-diameter culvert in the old channel is retained. Removal of the culvert would increase the old channel's capacity to carry floodwater, but flow in the channel would remain less than 10 percent of the total flood discharge.

Flow in the old channel during a 50- or 100-year flood is controlled in part by the 8-ft culvert. During those floods under present conditions, all flow in the old channel is from Wheelers Creek, a tributary that enters the old channel immediately upstream from the culvert. Inflow from Wheelers Creek is divided during either flood; part flows eastward, and the remainder flows northward into the canal over an 85-ft-long weir.

Channelization with retention of the culvert would have a minor effect on present floodflow distribution and water levels in the old channel. During a 50- and 100-year flood, it would cause not more than a 0.2- and 0.3-ft increase in water-surface elevation, respectively.

Removal of the culvert would alter the flow pattern in the old channel--all inflow from Wheelers Creek would be eastward. During a 50-year flood, there would be essentially ponded conditions in the old channel north of Wheelers Creek, regardless of what channel-relocation scheme was used. This also would be true with scheme 2 during a 100-year flood. If schemes 1 or 3 were implemented, flow in that reach would be southward, out of the canal, during a 100-year flood.

Channelization and removal of the culvert would cause a maximum increase in flood profiles of 1.4 and 1.6 ft during the 50- and 100-year flood, respectively, in the study reach.

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