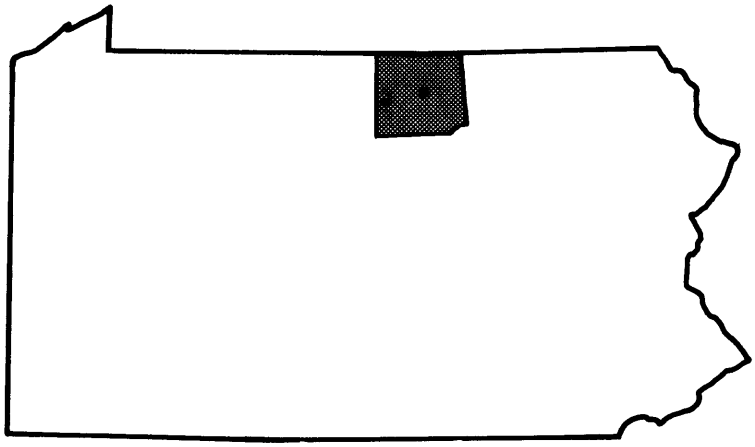
FLOOD INSURANCE STUDY

BOROUGH OF WELLSBORO, PENNSYLVANIA
TIOGA COUNTY



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Hoover Brook	Panels 21P-28P
Boyden Brook	Panels 29P-31P

Exhibit 2 - Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map

FLOOD INSURANCE STUDY
BOROUGH OF WELLSBORO, PENNSYLVANIA

1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this Flood Insurance Study is to investigate the existence and severity of flood hazards in the Borough of Wellsboro, Tioga County, Pennsylvania, and to aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of this information will be to convert the Borough of Wellsboro to the regular program of flood insurance by the Federal Insurance Administration (FIA). Further use of the information will be made by local and regional planners in their efforts to promote sound land use and flood plain development.

1.2 Coordination

The identification of streams requiring detailed study was done at a Consultation and Coordination Officer's (CCO) meeting attended by personnel of Gannett, Fleming, Corddry and Carpenter, Inc. (the study contractor), the FIA, and representatives of the community in March 1975. Study areas were finalized at a CCO meeting in November 1975. On August 23, 1978, the results of the study were reviewed at a final CCO meeting attended by personnel of the study contractor, the FIA, and community officials.

1.3 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended.

The hydrologic and hydraulic analyses for this study were performed by Gannett, Fleming, Corddry and Carpenter, Inc., for the Federal Insurance Administration, under Contract No. H-3813. This work, which was completed in July 1977, covered all significant flooding sources in the Borough of Wellsboro.

All survey work was done by, or under the direction of, Aero Services, under subcontract to Gannett, Fleming, Corddry and Carpenter, Inc.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated areas of the Borough of Wellsboro, Tioga County, Pennsylvania. The area of study is shown on the Vicinity Map (Figure 1).

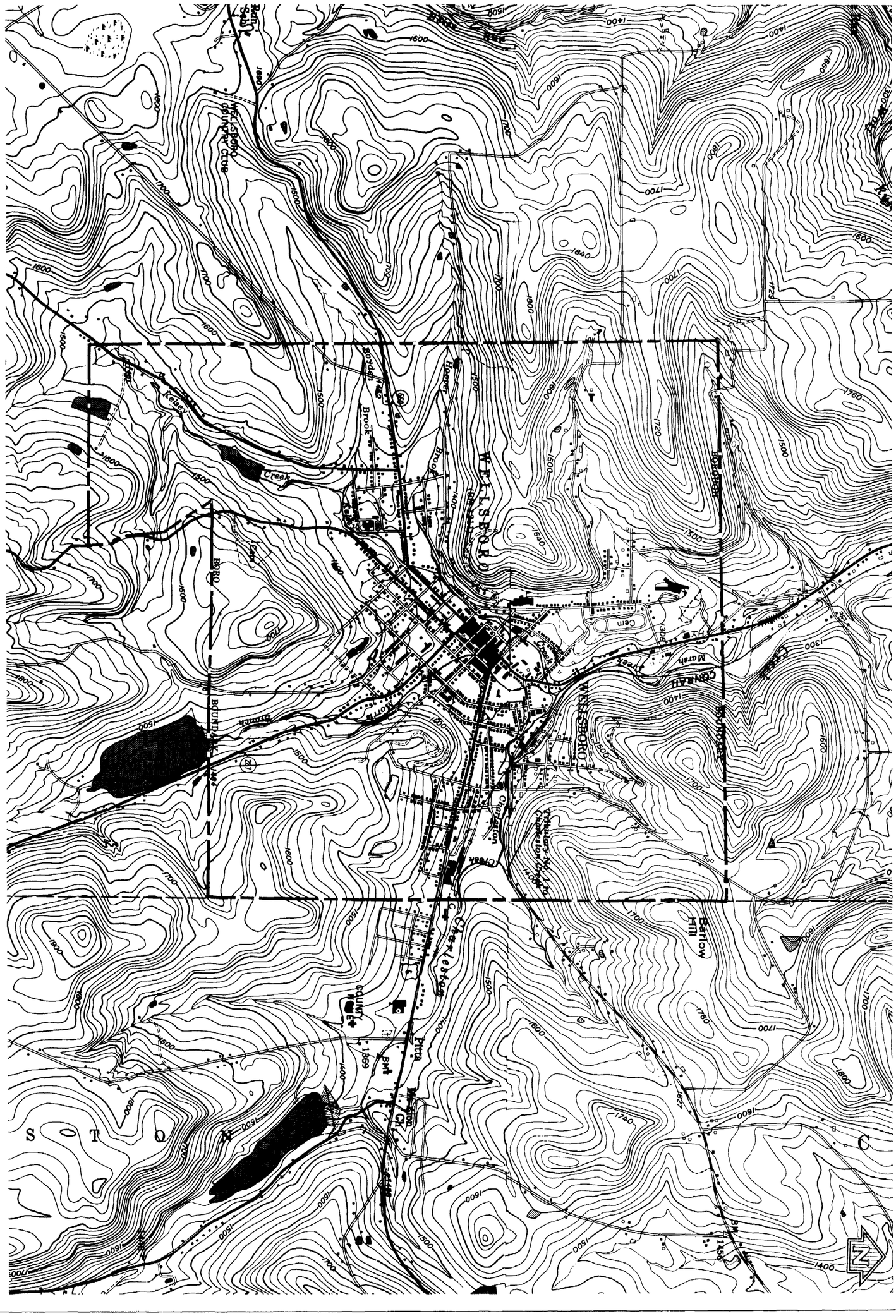


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

APPROXIMATE SCALE
2000 0 2000 4000 6000 FEET

VICINITY MAP

Floods caused by overflow of Marsh Creek, Charleston Creek, Tributary No. 1 to Charleston Creek, Morris Branch, Kelsey Creek, Boyden Brook and Hoover Brook were studied in detail.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction for the next five years, through July 1982.

2.2 Community Description

The Borough of Wellsboro is located in central Tioga County, 45 miles west of Towanda, Pennsylvania and 35 miles southwest of Elmira, New York. Wellsboro is bounded by Charleston Township to the east and Delmar Township to the north, south and west. Located within the Appalachian Plateau Province of Pennsylvania, the area has the characteristics of a dissected plateau. The bedrock has been disturbed only slightly from its original height and lies nearly horizontal in most places. The area has been covered with glaciers two or possibly three times, however, prominent glacial characteristics such as lakes, marshes, etc. are not very evident in the uplands of the county. In the valleys, however, effects of glaciation can be observed. The soil within the Borough has an average level of permeability, while the vegetation of the region varies considerably (Reference 1).

The climate of the study area is classified as humid continental. Summer and winter temperatures average 66.8 degrees Fahrenheit (°F) and 24.7°F, respectively. Annual average precipitation of the region is 37.1 inches, including an average annual snowfall totals 39.9 inches (Reference 2).

Early settlements in the area that is now Wellsboro began around 1800. Settlers from Virginia, Maryland, Delaware and Philadelphia were attracted to the area by the abundance of animals, fish, and forested land. Wellsboro was actually laid out in 1809 by Benjamin Morris, who named the town after his wife Mary Wells. Prior to 1870, when the boundaries were enlarged, the borough grew slowly. However, after this expansion and the prospering of the lumber and railroad industries occurred, the town grew rapidly. Tioga County was created in 1804 from part of Lycoming County and Wellsboro was incorporated as a borough in 1830 (Reference 3). Today Wellsboro is an active community whose population has stabilized at approximately 4,000 inhabitants. The population decreased from 4,369 in 1960 to 4,003 in 1970 (Reference 4). Virtually all the population is located in the central portion of the community.

Marsh Creek is a tributary of Pine Creek. Originating 8 miles southeast of Wellsboro, it flows 12.5 miles before emptying its waters into Pine Creek, near Ansonia. The drainage area totals 82.72 square miles.

Charleston Creek, 8.5 miles in length, and Kelsey Creek, 3.7 miles long, are both tributaries of Marsh Creek. Charleston Creek begins southeast of Wellsboro in Duncan Township, while Kelsey Creek originates south of the borough in Delmar Township. The drainage areas encompass 12.8 and 8.05 square miles, respectively.

Morris Branch, Boyden Brook, and Hoover Creek are all tributaries of Kelsey Creek. Their respective lengths are 3.2, 1.1, and 1.6 miles. Morris Branch originates south of the borough while Boyden Brook and Hoover Creek begin west of Wellsboro, all in Delmar Township. The drainage areas are 2.33, 1.03, and 0.9 square miles respectively.

2.3 Principal Flood Problems

Since the completion of three Soil Conservation Service (SCS) dams in 1968 there has been no flood damage within the Borough of Wellsboro. Prior to the completion of these dams, the most destructive floods occurred in 1889 and 1919. The flood of 1889 was the result of steady rain and caused $100,000.00 in damage. In 1919, a sudden downpour resulted in Main Street being inundated by floodwaters, causing an estimated $300,000.00 in damage, the worst flood to affect the community (Reference 3).

2.4 Flood Protection Measures

There are a number of dams and reservoirs within the Marsh Creek watershed that aid in alleviating potential flooding. Presently existing are three SCS Dams, and their effects have been included in the hydrologic analyses conducted for this study. All three of the dams, PA-600, PA-601, and PA-602, are multiple-purpose structures which provide flood protection, recreational, and water supply functions. The floodwater storage capacity afforded by these structures is 470 acre-feet, 260 acre-feet, and 1,355 acre-feet, respectively (Reference 5).

There are also non-structural measures being utilized to aid in the prevention of future flood damage. These are in the form of local land-use regulations, adopted from the Code of Federal Regulations, Title 24, Chapter 10, FIA, Parts 1910.3A and 1910.3B, which control building within areas that have a high risk of flooding (Reference 6).

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Floods having recurrence intervals of 10, 50, 100, and 500 years have been selected as having special significance for flood plain management and for flood insurance premium rates. The analyses reported here reflect current conditions in the watersheds of the streams.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail in the community.

For all of the streams studied by detailed methods, the hydrologic analyses followed the SCS Condition III procedure, which relates basin characteristics to streamflow characteristics (References 7 and 8).

However, for the detailed-study streams of Kelsey Creek, Morris Branch, Marsh Creek and Charleston Creek the hydrologic analyses was modified to account for the flood control dams along these streams. Flood routing was performed on the streams through their respective dams thus causing a reduction in discharges downstream from the dams.

Rainfall data were calculated using the United States Department of Commerce, Technical Paper No. 40, Rainfall Frequency Atlas of the United States, prepared in 1961. These data were combined with basin characteristics such as drainage area, stream slope, vegetation, soil cover and land-use characteristics to estimate the resulting discharge values considering a time lapse to the peak discharge calculated by empirical equations (Reference 9).

Peak discharges for floods of the selected recurrence intervals for the streams studied in detail are presented in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
*MARSH CREEK					
At downstream corporate limits	20.8	3,300	4,850	5,350	7,300
*CHARLESTON CREEK					
At confluence with Marsh Creek	12.7	1,850	2,700	2,950	4,200
Downstream of Tributary No. 1 to Charleston Creek	12.0	1,550	2,250	2,500	3,550
TRIBUTARY No. 1 TO CHARLESTON CREEK					
At confluence with Charleston Creek	0.7	550	800	900	1,250
*MORRIS BRANCH					
At confluence of Charleston Creek	2.3	600	900	1,000	1,400
At Pennsylvania Route 287 Bridge	1.9	250	450	500	700
*KELSEY CREEK					
At confluence with Morris Branch	5.5	1,350	2,000	2,150	3,100
At upstream confluence with Boyden Creek	3.3	250	350	350	700
HOOVER BROOK					
At confluence with Kelsey Creek	0.8	550	800	900	1,250
At upstream corporate limits	0.4	300	450	500	750
BOYDEN BROOK					
At confluence with Kelsey Creek	0.9	650	950	1,000	1,500
At upstream corporate limits	0.7	450	700	750	1,050

*NOTE: Discharges modified due to the flood control dams along each one of these streams.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the flooding sources studied in detail in the community were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of these flooding sources.

Composite cross sections for the backwater analyses of the streams studied in detail were obtained from aerial photographs flown in April 1975, at a negative scale of 1 inch equals 1,200 feet; the below-water sections were obtained by field measurement. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross-section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and based on field observations of the streams and flood plain areas. Roughness values for the main channels of the detailed study streams range from 0.014 to 0.075, with flood plain roughness values ranging from 0.040 to 0.100 for all floods. The acceptability of all assumed hydraulic factors, cross sections, and hydraulic structure data was checked by computations that duplicated historic floodwater profiles.

Flood water-surface profiles, determined for the detailed stream study, were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals. Flood water-surface elevations of the selected recurrence intervals were computed through the use of the Corps of Engineers' HEC-2 step-backwater computer program (References 10 and 11). Starting elevations for Marsh Creek were calculated using the slope-area method. Starting elevations for Charleston Creek, Morris Branch, and Kelsey Creek were taken from the Marsh Creek profiles. Starting elevations for Tributary No. 1 to Charleston Creek were taken from the Charleston Creek profiles. Starting elevations for Hoover Brook and Boyden Brook were taken from the Kelsey Creek profiles.

All elevations are referenced from the National Geodetic Vertical Datum of 1929 (NGVD), formerly referred to as Sea Level Datum of 1929. Locations of the elevation reference marks used in the study are shown on the maps.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are thus considered valid only if hydraulic structures in general remain unobstructed and do not fail.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage state and local governments to adopt sound flood plain management programs. Each Flood Insurance Study, therefore, includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FIA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100- and 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using topographic maps enlarged to a scale of 1 inch equals 800 feet with a contour interval of 20 feet (Reference 12). In cases where the 100- and 500-year flood boundaries are close together, only the 100-year boundary has been shown.

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2). Small areas within the flood boundaries may lie above the flood elevations and, therefore, may not be subject to flooding. Owing to limitations of the map scale or lack of detailed topographic data, such areas are not shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and floodway fringe.

The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood can be carried without substantial increases in flood heights. Minimum standards of the FIA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this report are presented to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plains. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 2).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

5.0 INSURANCE APPLICATIONS

In order to establish actuarial insurance rates, the FIA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHFs), and flood insurance zone designations for each flooding source affecting the Borough of Wellsboro.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
Marsh Creek								
A	- 25[1]	58[3]	486	11.0	1,245.1	1,245.1	1,245.6	0.5
B	295[1]	133	755	7.1	1,250.6	1,250.6	1,250.6	0.0
C	745[1]	176	670	8.0	1,254.4	1,254.4	1,254.4	0.0
D	1,735[1]	52	471	11.4	1,265.6	1,265.6	1,266.4	0.8
E	2,795[1]	61	554	9.7	1,275.6	1,275.6	1,276.4	0.8
F	3,305[1]	39	440	12.2	1,277.9	1,277.9	1,278.8	0.9
G	3,945[1]	54	569	9.4	1,282.2	1,282.2	1,282.4	0.2
Charleston Creek								
A	820[2]	31	210	14.0	1,286.7	1,286.7	1,287.0	0.3
B	1,600[2]	59	463	6.4	1,295.3	1,295.3	1,296.3	1.0
C	2,400[2]	43	376	7.8	1,303.2	1,303.2	1,304.1	0.9
D	3,370[2]	36	247	10.1	1,308.2	1,308.2	1,308.9	0.7
E	3,735[2]	35	291	8.6	1,311.3	1,311.3	1,312.2	0.9
F	4,605[2]	45	306	6.5	1,316.2	1,316.2	1,316.8	0.6
G	4,945[2]	59	371	5.4	1,317.6	1,317.6	1,318.6	1.0

[1] Feet from corporate limits
[2] Feet above confluence with Marsh Creek
[3] This width extends beyond corporate limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

FLOODWAY DATA

MARSH CREEK AND CHARLESTON CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
Tributary No. 1 to Charleston Creek								
A	285	16	100	8.5	1,327.0	1,327.0	1,328.0	1.0
B	925	33	103	8.3	1,341.3	1,341.3	1,341.4	0.1
Morris Branch								
A	950	61	195	5.1	1,289.7	1,289.7	1,290.6	0.9
B	1,320	88	184	5.4	1,293.6	1,293.6	1,294.5	0.9
C	1,830	40	167	5.2	1,300.7	1,300.7	1,301.5	0.8
D	2,360	*	47	9.5	1,307.8	1,307.8	1,307.8	0.0
E	2,600	*	53	11.7	1,310.3	1,310.3	1,310.3	0.0
F	3,095	*	39	11.7	1,318.2	1,318.2	1,318.2	0.0
G	3,435	*	59	12.7	1,324.7	1,324.7	1,324.7	0.0
H	4,270	*	60	10.4	1,340.9	1,340.9	1,341.0	0.1
I	4,790	*	59	10.6	1,353.7	1,353.7	1,353.8	0.1
J	5,265	*	54	9.3	1,363.1	1,363.1	1,364.0	0.9
K	6,070	*	56	8.9	1,382.0	1,382.0	1,382.0	0.0
L	6,665	*	49	10.2	1,394.1	1,394.1	1,394.9	0.8
M	7,595	*	23	5.4	1,411.6	1,411.6	1,412.1	0.5

[1] Feet above confluence with Charleston Creek

*Floodway coincident with channel banks

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

FLOODWAY DATA

TRIBUTARY NO. 1 TO CHARLESTON CREEK AND MORRIS BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
Morris Branch (continued)								
N	8,380 [1]	*	18	6.9	1,425.1	1,425.1	1,425.1	0.0
O	8,485 [1]	*	23	5.4	1,426.8	1,426.8	1,427.1	0.3
Kelsey Creek								
A	615 [2]	146	442	4.9	1,288.9	1,288.9	1,289.9	1.0
B	1,470 [2]	95	488	4.4	1,297.6	1,297.6	1,298.2	0.6
C	1,905 [2]	30	244	8.8	1,301.3	1,301.3	1,301.5	0.2
D	2,445 [2]	41	284	7.2	1,306.0	1,306.0	1,307.0	1.0
E	2,615 [2]	57	356	5.8	1,309.8	1,309.8	1,310.0	0.2
F	3,220 [2]	24	184	11.1	1,314.8	1,314.8	1,314.8	0.0
G	3,530 [2]	33	191	10.7	1,316.6	1,316.6	1,316.7	0.1
H	3,805 [2]	34	211	7.6	1,319.4	1,319.4	1,320.4	1.0
I	4,010 [2]	*	127	12.6	1,321.4	1,321.4	1,321.4	0.0
J	4,080 [2]	*	162	9.9	1,321.7	1,321.7	1,322.7	1.0
K	4,455 [2]	*	240	6.7	1,328.6	1,328.6	1,329.4	0.8
L	4,955 [2]	*	143	10.1	1,331.1	1,331.1	1,332.0	0.9
M	5,300 [2]	19	139	10.4	1,335.9	1,335.9	1,336.6	0.7
N	5,555 [2]	27	180	8.1	1,339.1	1,339.1	1,339.7	0.6

[1] Feet above confluence with Charleston Creek
[2] Feet above confluence with Morris Branch
*Floodway coincident with channel banks

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

FLOODWAY DATA

MORRIS BRANCH AND KELSEY CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
Kelsey Creek (continued)								
O	6,045[1]	27	124	11.7	1,344.5	1,344.5	1,344.5	0.0
P	6,570[1]	28	149	9.7	1,353.1	1,353.1	1,354.1	1.0
Q	6,865[1]	17	88	4.0	1,358.2	1,358.2	1,359.2	1.0
R	7,390[1]	14	39	9.0	1,364.8	1,364.8	1,364.9	0.1
S	8,155[1]	13	42	8.3	1,378.4	1,378.4	1,379.4	1.0
Hoover Brook								
A	290[2]	31	134	6.7	1,326.8	1,326.8	1,327.7	0.9
B	760[2]	110	360	2.5	1,334.0	1,334.0	1,335.0	1.0
C	905[2]	70	115	7.8	1,337.4	1,337.4	1,337.4	0.0
D	1,025[2]	81	211	4.3	1,338.5	1,338.5	1,339.4	0.9
E	1,265[2]	37	118	7.6	1,341.6	1,341.6	1,341.6	0.0
F	1,775[2]	78	181	5.0	1,349.1	1,349.1	1,350.1	1.0
G	2,210[2]	50	162	5.6	1,358.3	1,358.3	1,359.3	1.0
H	2,465[2]	19	88	8.0	1,363.1	1,363.1	1,364.1	1.0
I	2,885[2]	27	80	8.8	1,371.3	1,371.3	1,372.3	1.0
J	3,475[2]	12	69	10.1	1,386.7	1,386.7	1,387.7	1.0

[1] Feet above confluence with Morris Branch
[2] Feet above confluence with Kelsey Creek

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

FLOODWAY DATA

KELSEY CREEK AND HOOVER BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
Boyden Brook								
A	240	13	83	12.0	1,362.1	1,362.1	1,363.1	1.0
B	810	20	105	9.5	1,376.7	1,376.7	1,377.4	0.7
C	1,105	68	151	5.6	1,385.4	1,385.4	1,385.4	0.0
D	1,575	42	114	7.5	1,397.7	1,397.7	1,397.7	0.0
E	2,110	23	102	8.3	1,407.9	1,407.9	1,408.1	0.2
F	2,750	19	89	9.6	1,424.2	1,424.2	1,424.2	0.0

[1] Feet above confluence with Kelsey Creek

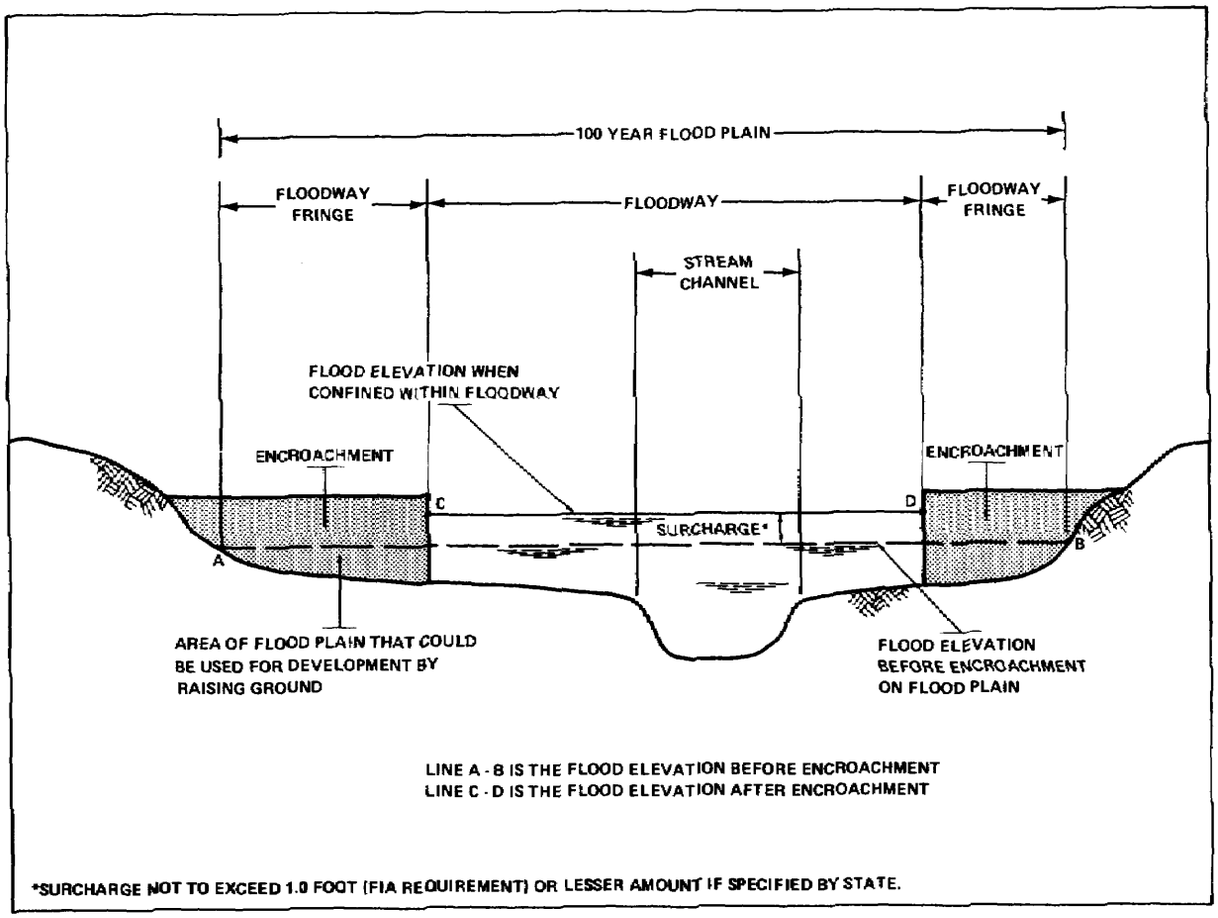
TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

FLOODWAY DATA

BOYDEN BROOK



FLOODWAY SCHEMATIC

Figure 2

difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot

Twelve reaches meeting the above criteria were required for the flooding sources of Wellsboro. Five are along Morris Branch, one is along Boyden Brook, one is along Kelsey Creek, one is along Hoover Brook, one is along Marsh Creek, two are along Charleston Creek and one is along Tributary No. 1 to Charleston Creek. The locations of the reaches determined for the flooding sources of the Borough of Wellsboro are shown on the Flood Profiles (Exhibit 1) and are summarized in the Flood Insurance Zone Data Table (Table 3).

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Marsh Creek							
Reach 1	05	-2.3	-0.5	+1.8	025	A5	Varies
Charleston Creek							
Reach 1	05	-2.3	-0.5	+1.8	025	A5	Varies
Reach 2	05	-2.0	-0.5	+1.6	020	A4	Varies
Tributary No. 1 to Charleston Creek							
Reach 1	05	-1.3	-0.5	+0.8	015	A3	Varies
Morris Branch							
Reach 1	05	-2.5	-0.4	+0.8	025	A5	Varies
Reach 2	05	-0.2	-0.1	+0.2	005	A1	Varies
Reach 3	05	-3.9	-0.8	+4.7	040	A8	Varies
Reach 4	05	-1.2	-0.3	+0.9	010	A2	Varies
Reach 5	05	-0.2	-0.0	+1.1	005	A1	Varies
Kelsey Creek							
Reach 1	05	-2.0	-0.5	+1.4	020	A4	Varies

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

FLOOD INSURANCE ZONE DATA

MARSH CREEK, CHARLESTON CREEK, TRIBUTARY NO. 1, MORRIS BRANCH AND KELSEY CREEK

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Hoover Brook Reach 1	05	-0.8	-0.3	+0.6	010	A2	Varies
Boyden Brook Reach 1	05	-1.2	-0.3	+2.0	010	A2	Varies

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

FLOOD INSURANCE ZONE DATA

HOOVER BROOK AND BOYDEN BROOK

5.2 Flood Hazard Factors

The FHF is the FIA device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire area of the Borough of Wellsboro was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zones A1, A2, A3, A4, A5, A8	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; also areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of Minimal Flooding; including areas that are protected from the 100- and 500-year floods by dike, levee, or other water control structure; not subdivided.

Table 3, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Borough of Wellsboro is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the FIA.

6.0 OTHER STUDIES

Presently, no other Flood Insurance Study or similar such investigation is being conducted or has been conducted in the Borough of Wellsboro or the immediately adjacent communities.

This study is authoritative for purposes of the Flood Insurance Program and the data presented here either supersede or are compatible with previous determinations.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic, and other pertinent data used in this study can be obtained by contacting the office of the Insurance and Mitigation Division of the Federal Emergency Management Agency, Regional Director, Curtis Building, Sixth and Walnut Streets, Philadelphia, Pennsylvania 19106.

8.0 BIBLIOGRAPHY AND REFERENCES

1. Stanley W. Lohman, Groundwater in North-Central Pennsylvania, Department of Internal Affairs, Commonwealth of Pennsylvania, Harrisburg, Pennsylvania, 1939.

2. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service, Monthly Averages of Temperature and Precipitation for State Climatic Divisions, (Pennsylvania), Washington, D. C., 1941-1970.

3. Wellsboro Chamber of Commerce, Historical Highlights of Wellsboro, Press of Wellsboro Gazette, Wellsboro, Pennsylvania, 1930.

4. U. S. Department of Commerce, Bureau of the Census, 1970 Census of Population, Number of Inhabitants, Pennsylvania, Government Printing Office, Washington, D. C., 1971.

5. Department of Forests and Waters, Commonwealth of Pennsylvania, Dams, Reservoirs, and Natural Lakes, Water Resources Bulletin No. 5, Harrisburg, Pennsylvania, 1970.

6. U. S. Department of Housing and Urban Development, Code of Federal Regulations, Government Printing Office, Washington, D. C., April 1, 1973.

7. U. S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, Washington, D. C., 1964.

8. U. S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, Washington, D. C., 1973.

9. U. S. Department of Commerce, Weather Bureau, Technical Paper No. 40, Rainfall Frequency Atlas of the United States, Washington, D. C., 1961.

10. U. S. Army Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A, HEC-2 Water-Surface Profiles, Davis, California, October 1973.

11. U. S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water-Surface Profiles Users' Manual, Davis, California, October 1973.

12. U. S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 20 feet: Antrim, Pennsylvania, 1971; Keeneyville, Pennsylvania 1969.

Chow, Ven T., Handbook of Applied Hydrology, New York, McGraw-Hill, 1964.

Chow, Ven T., Open-Channel Hydraulics, New York, McGraw-Hill, 1959.

Department of Environmental Resources, Commonwealth of Pennsylvania, Hydrologic Data of the June 1972 Flood in Pennsylvania, Water Resources Bulletin No. 9, August 1974.

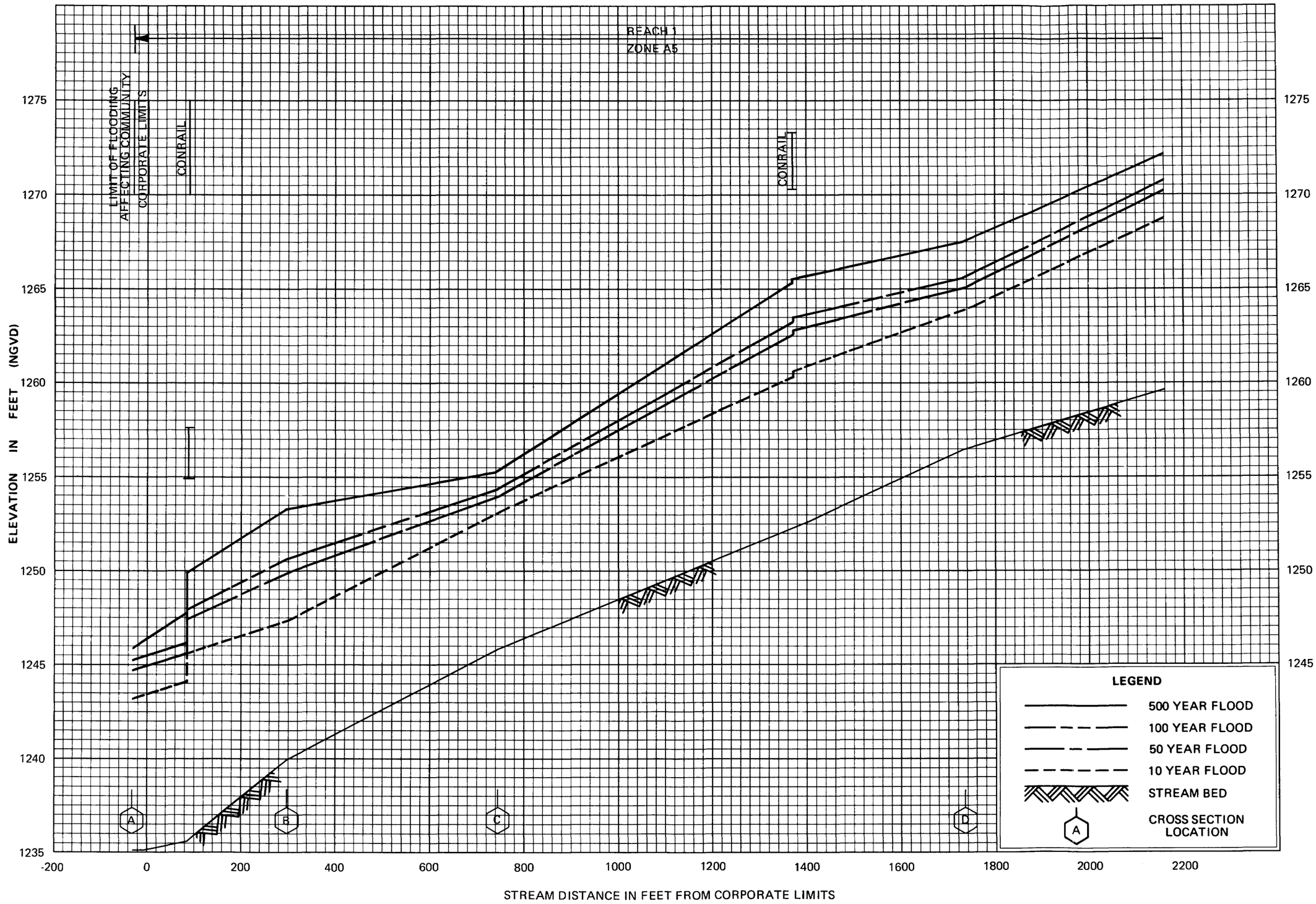
Department of Forests and Waters, Commonwealth of Pennsylvania, Pennsylvania Gazetteer of Streams, Part 1, Water Resources Bulletin No. 6, Harrisburg, Pennsylvania, December 1970.

King, H. W., and E. F. Brater, King's Handbook of Hydraulics, 5th Edition, New York, McGraw-Hill, 1963.

Department of Environmental Resources, Commonwealth of Pennsylvania, Tropical Storm Agnes - Flood Damage Inventory for the Commonwealth of Pennsylvania, Harrisburg, Pennsylvania, December 1974.

Reich, B. M., B. M. McGinnis, and R. L. Kerr, Design Procedures for Rainfall-Duration-Frequency in Pennsylvania, Department of Forests and Waters, Commonwealth of Pennsylvania, University Park, Pennsylvania, August 1970.

U. S. Army Corps of Engineers, North Atlantic Division, Hydrologic Study, Tropical Storm Agnes, New York, December 1975.



FLOOD PROFILES

MARSH CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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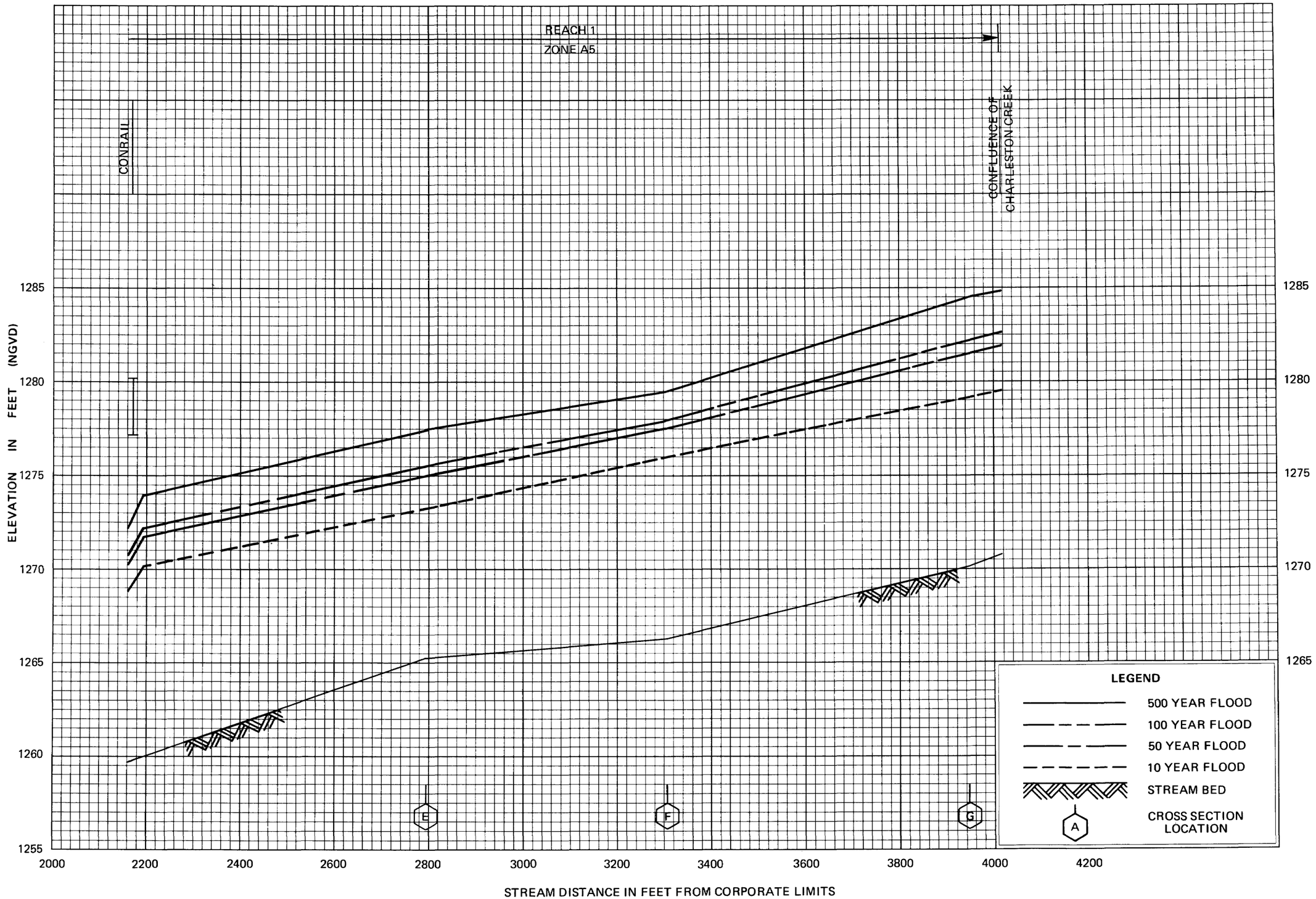

FLOOD PROFILES

MARSH CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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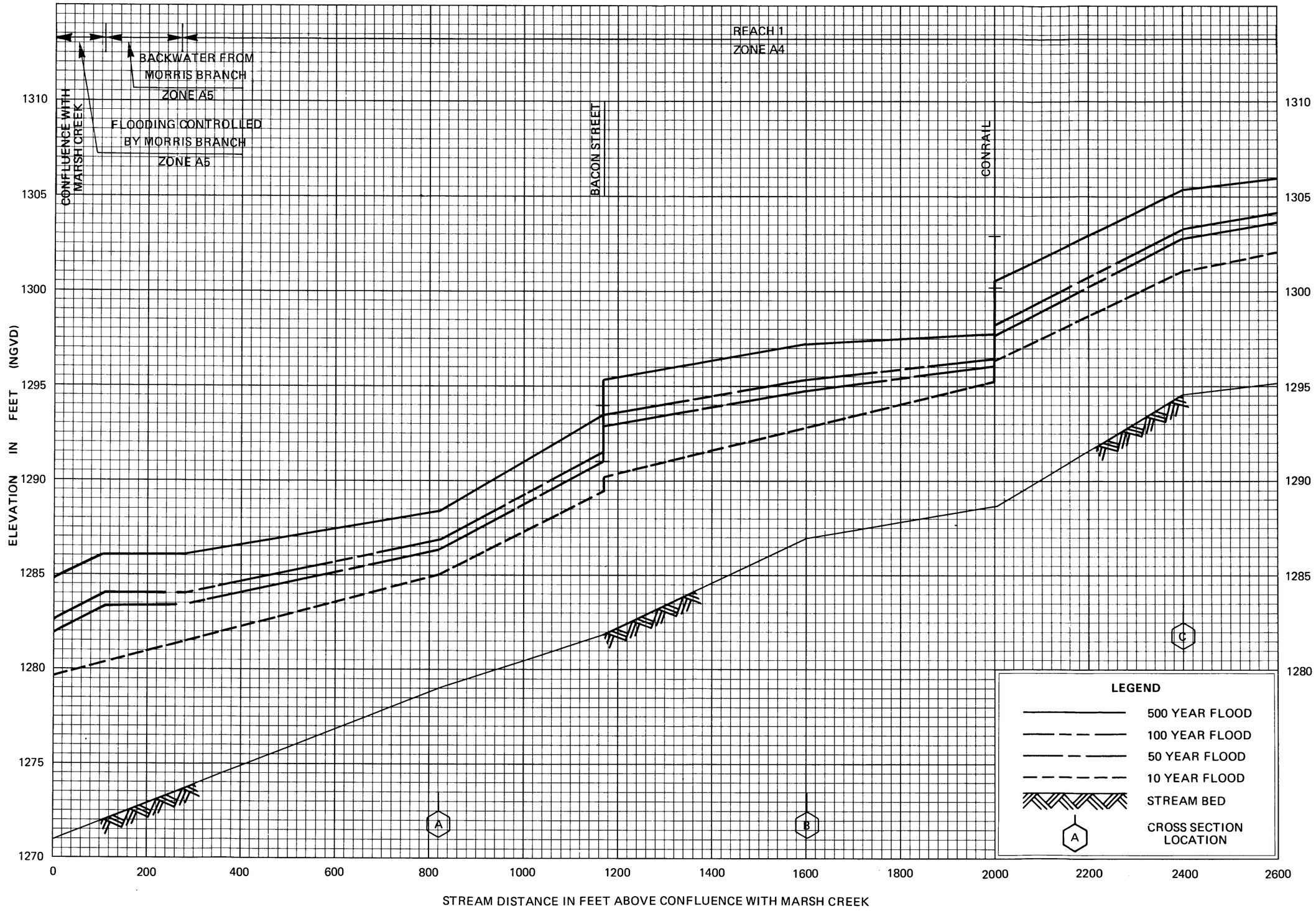

FLOOD PROFILES

CHARLESTON CREEK

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Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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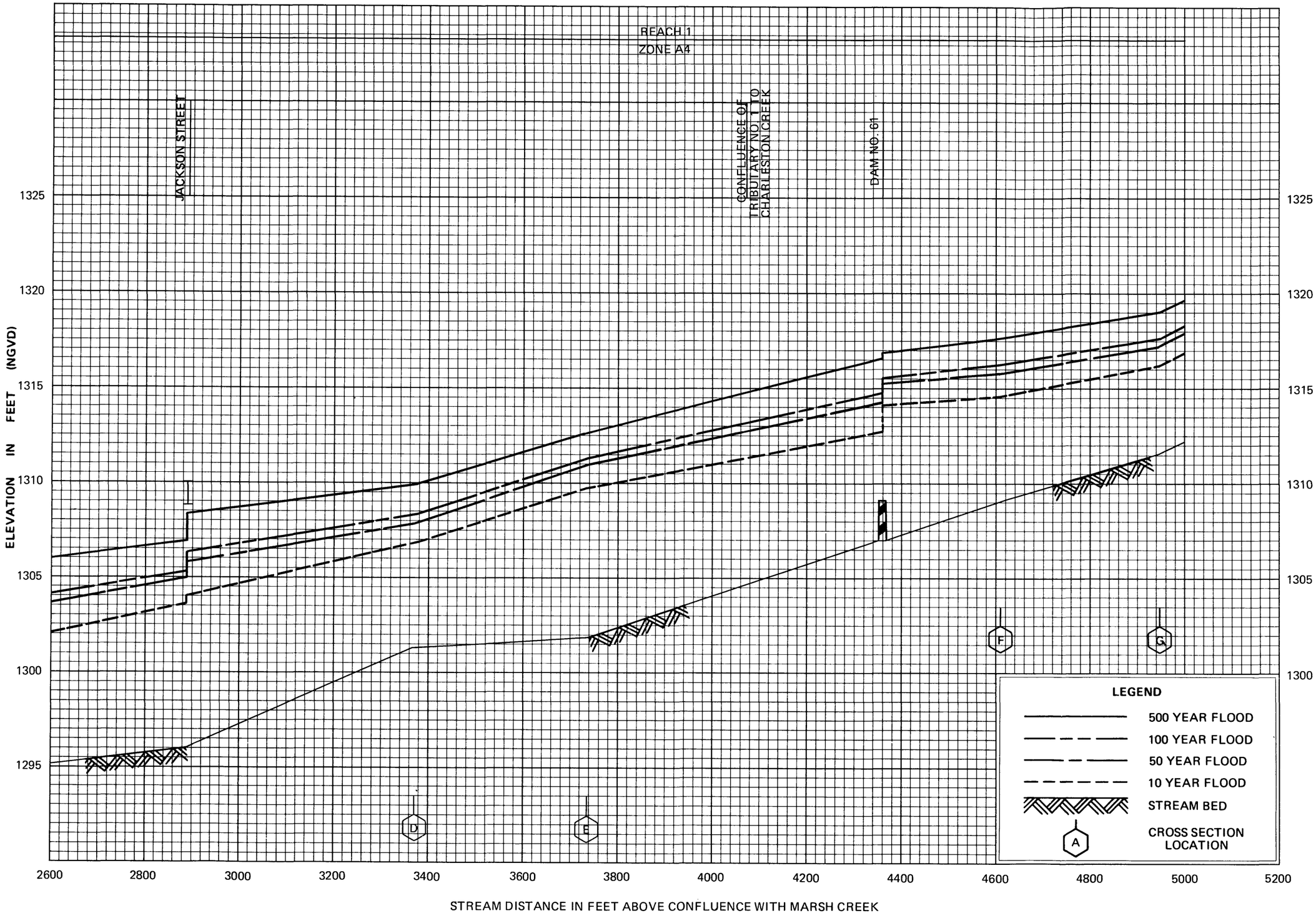

FLOOD PROFILES

CHARLESTON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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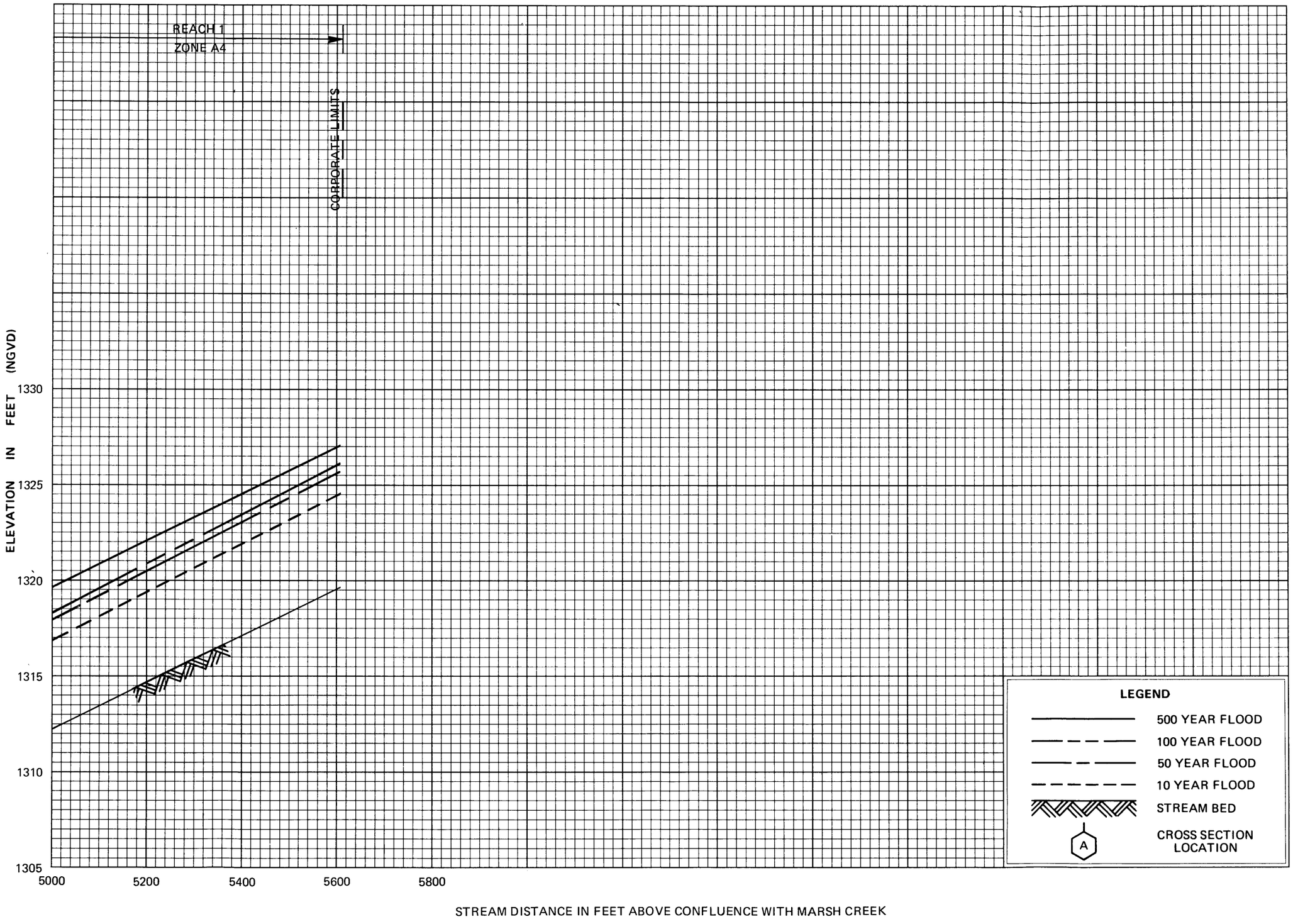

FLOOD PROFILES

CHARLESTON CREEK

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(TIOGA CO.)

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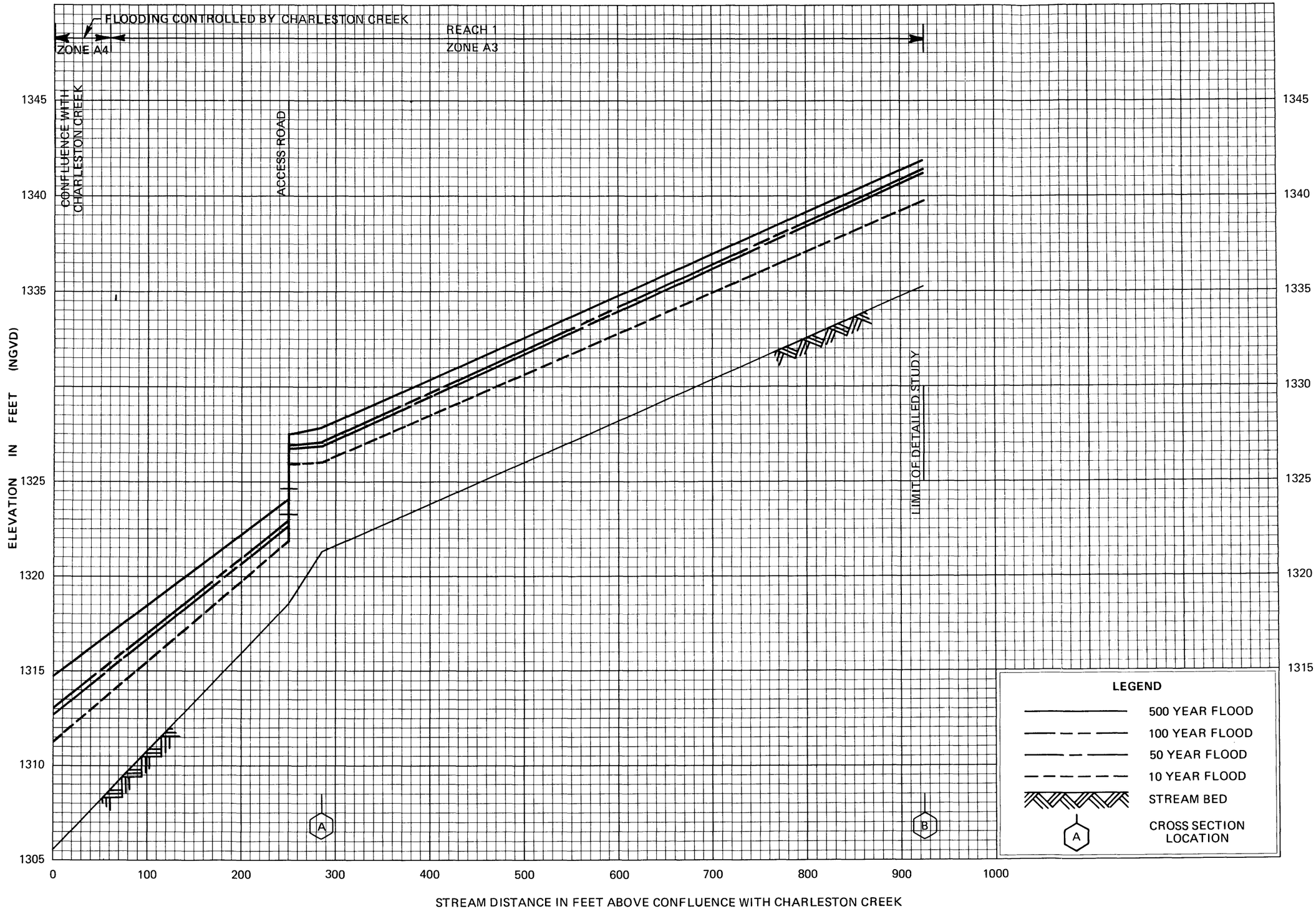

FLOOD PROFILES

TRIBUTARY NO. 1 TO CHARLESTON CREEK

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BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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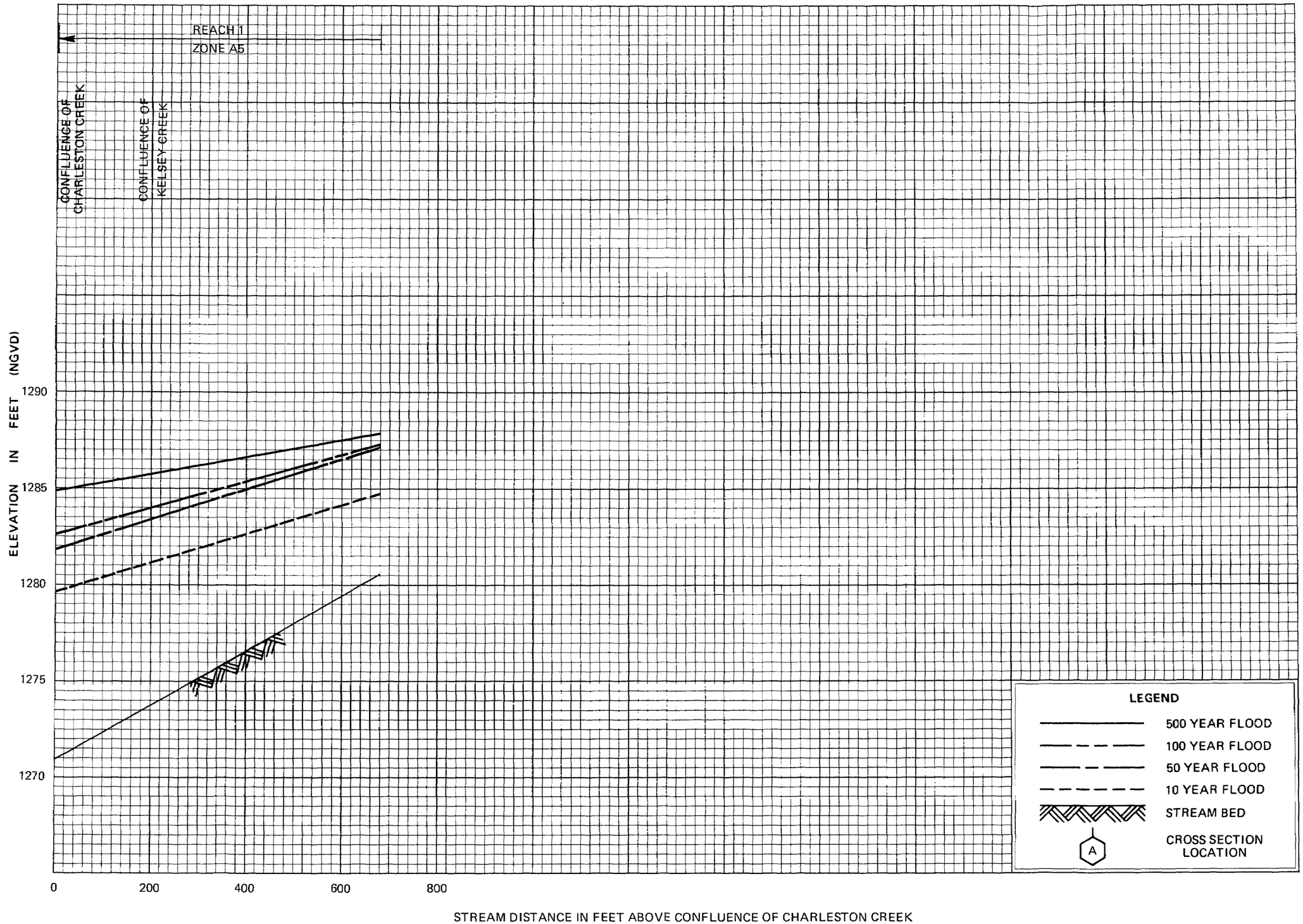

FLOOD PROFILES

MORRIS BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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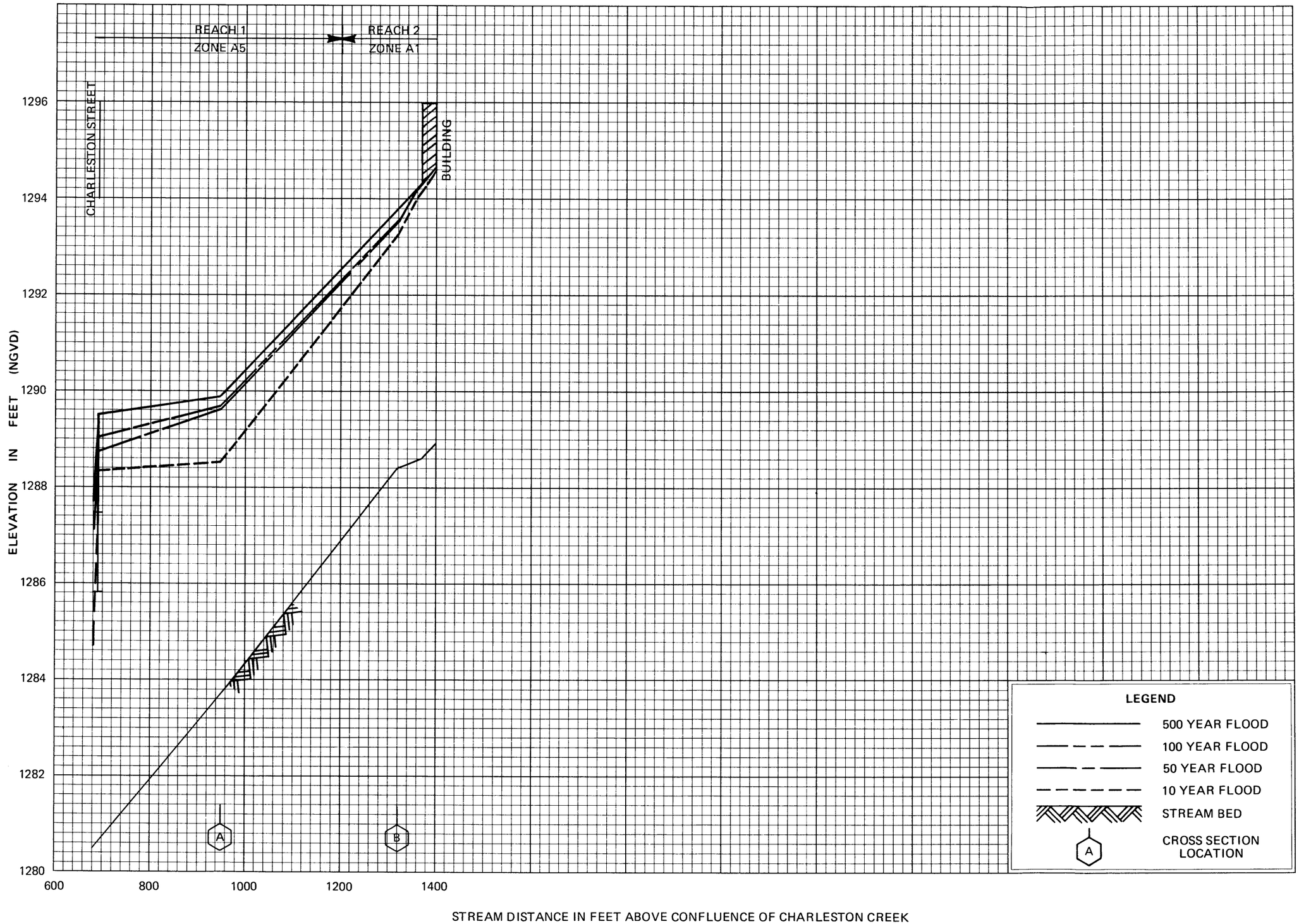

FLOOD PROFILES

MORRIS BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY
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BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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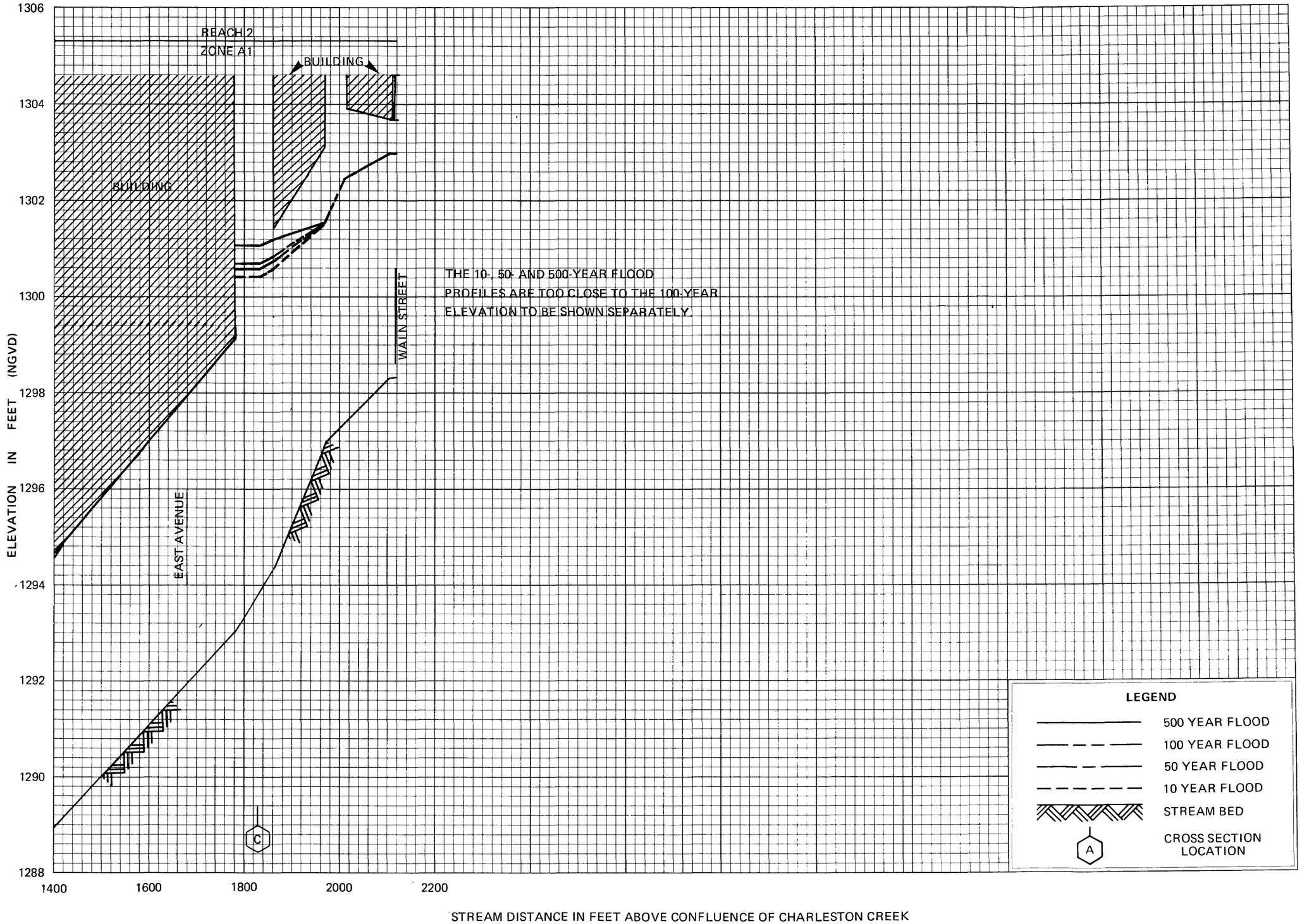

FLOOD PROFILES

MORRIS BRANCH

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BOROUGH OF WELLSBORO, PA
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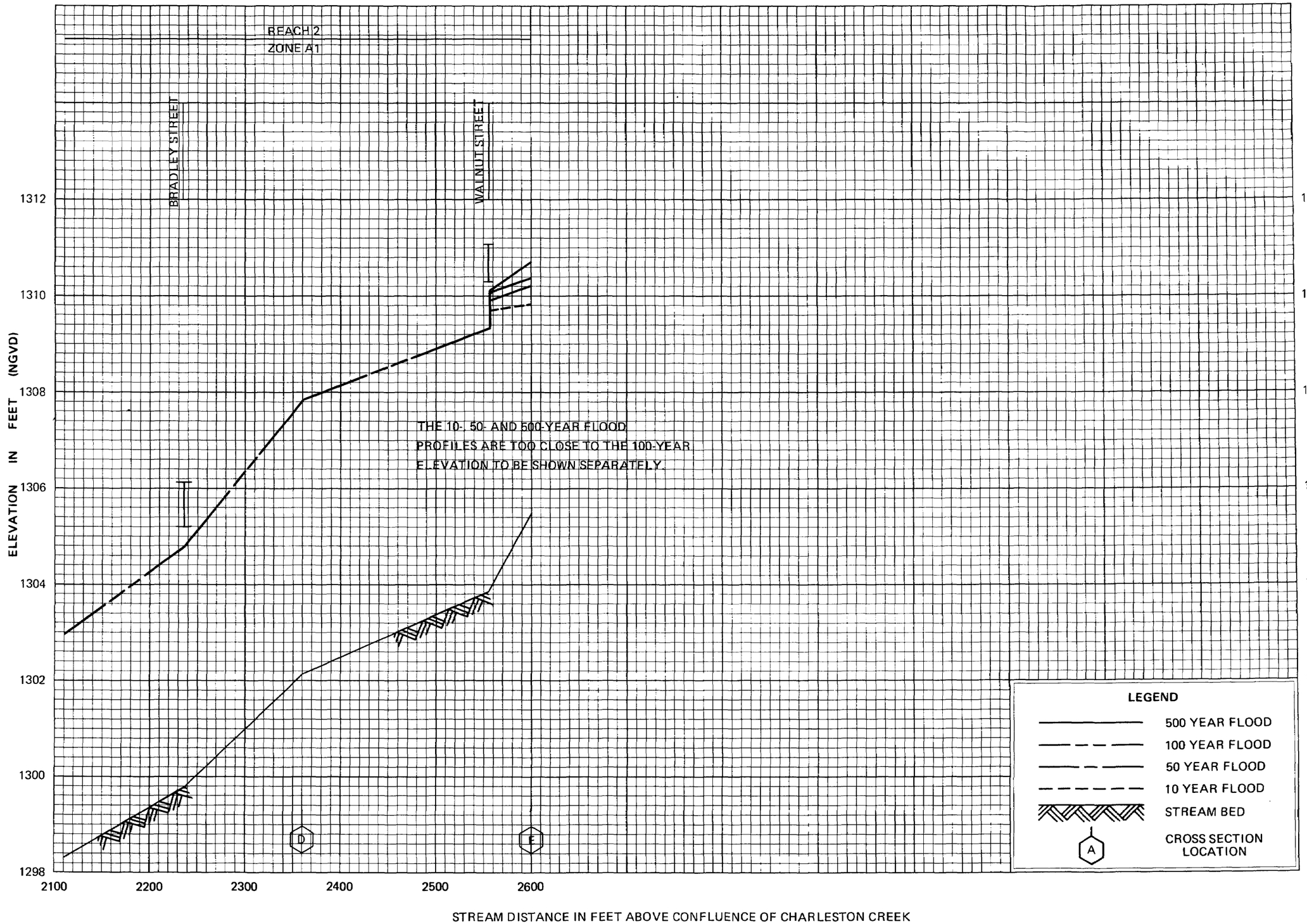

FLOOD PROFILES

MORRIS BRANCH

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BOROUGH OF WELLSBORO, PA
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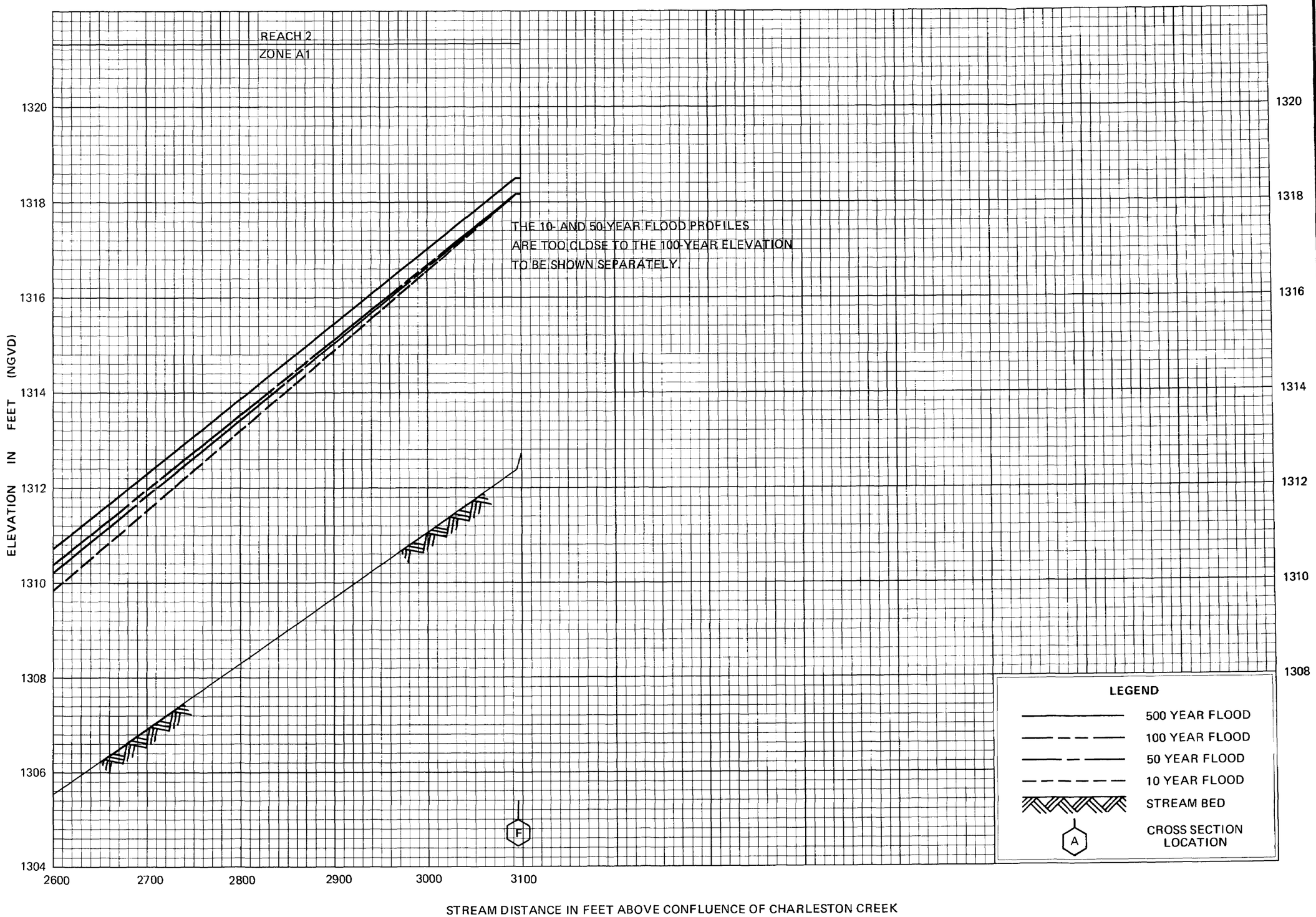

FLOOD PROFILES

MORRIS BRANCH

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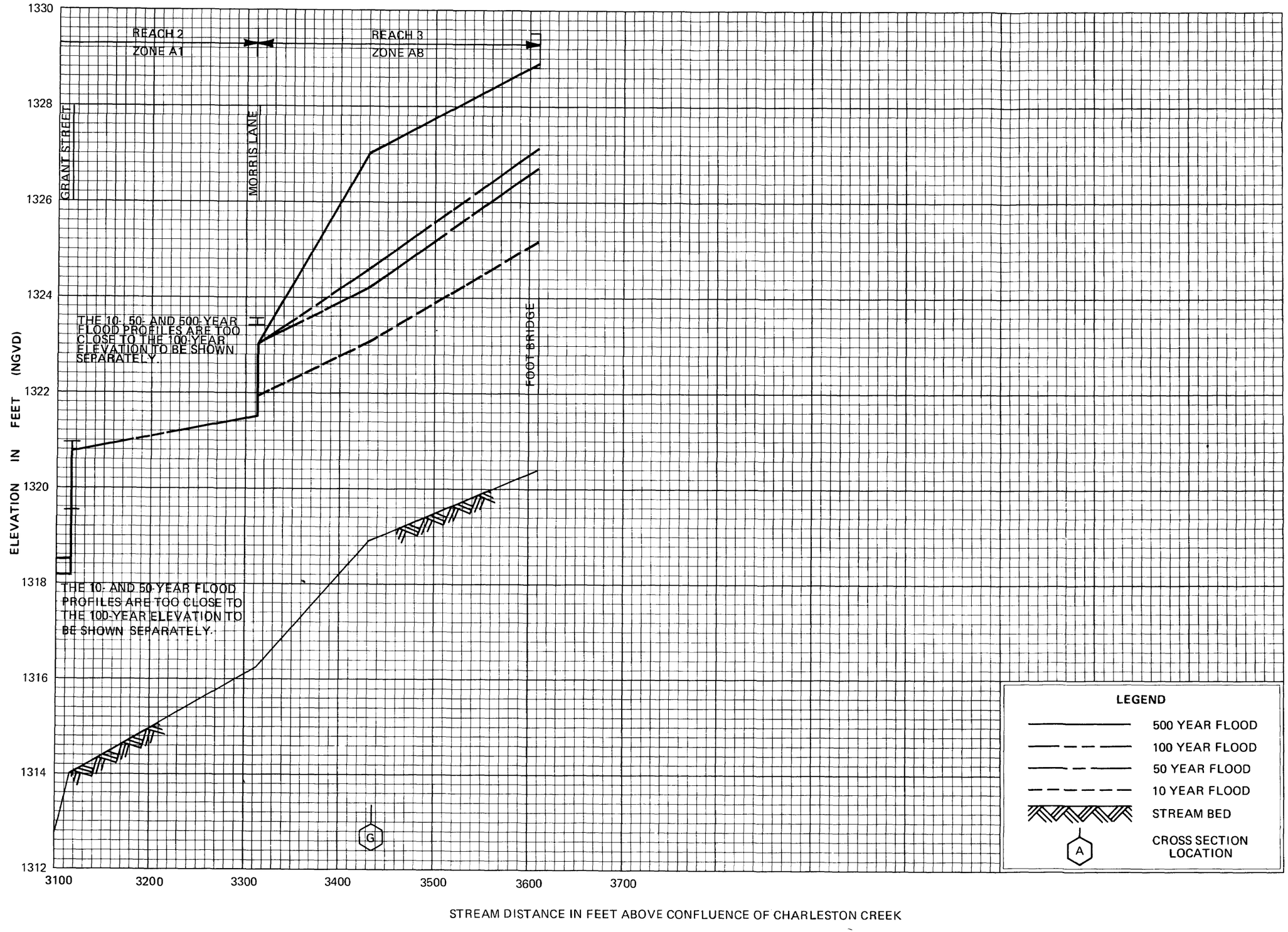

FLOOD PROFILES

MORRIS BRANCH

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(TIOGA CO.)

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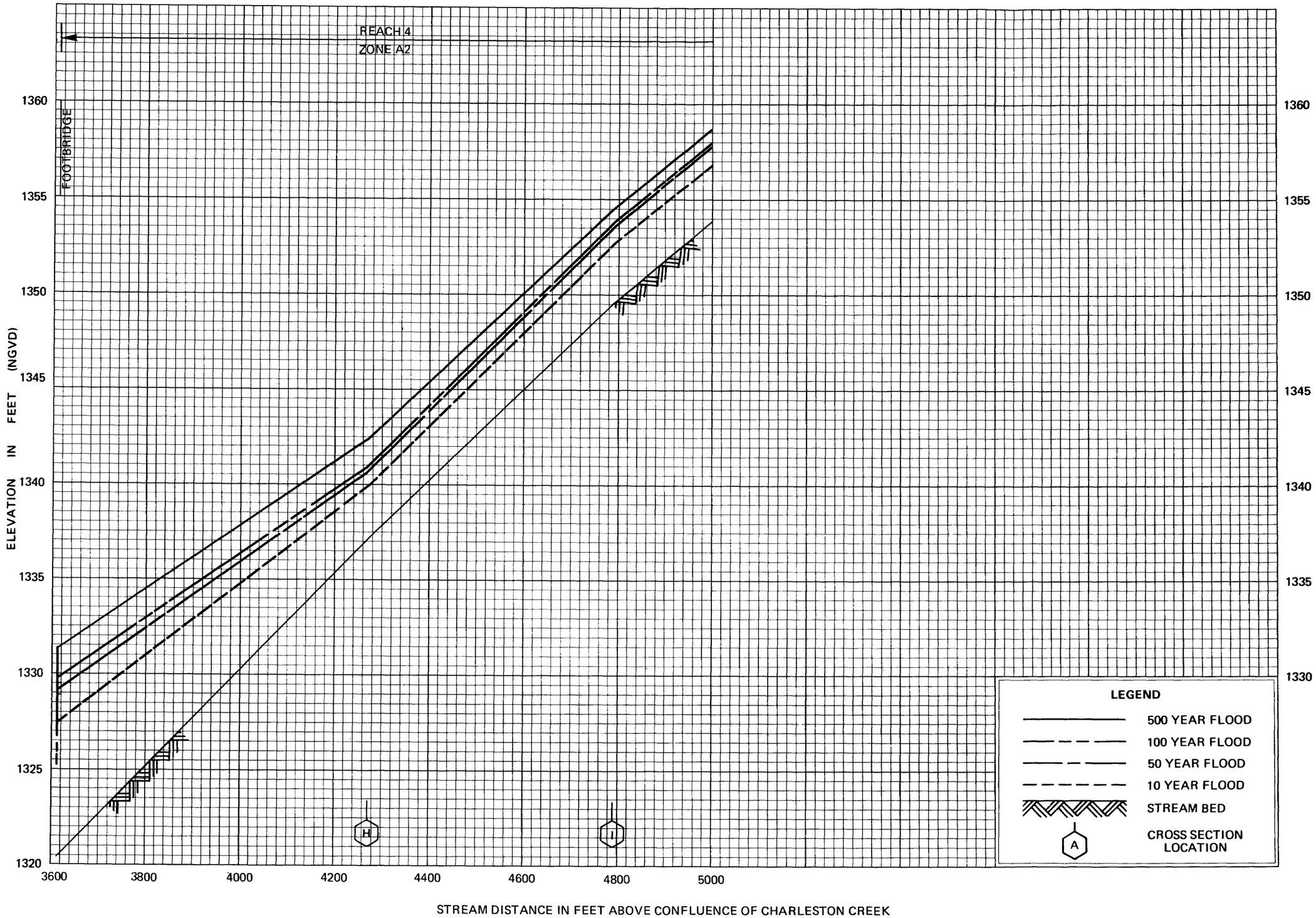

FLOOD PROFILES

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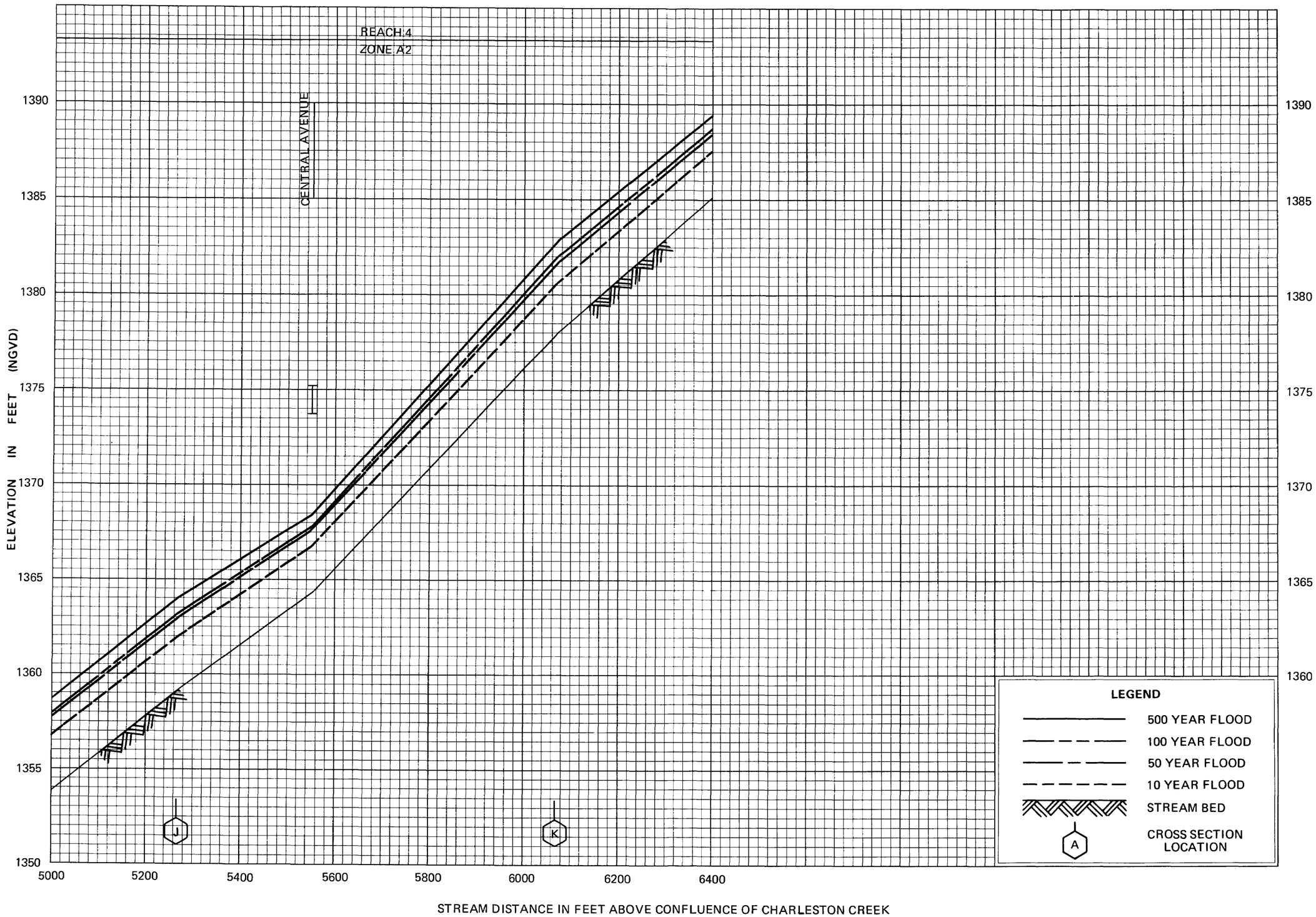

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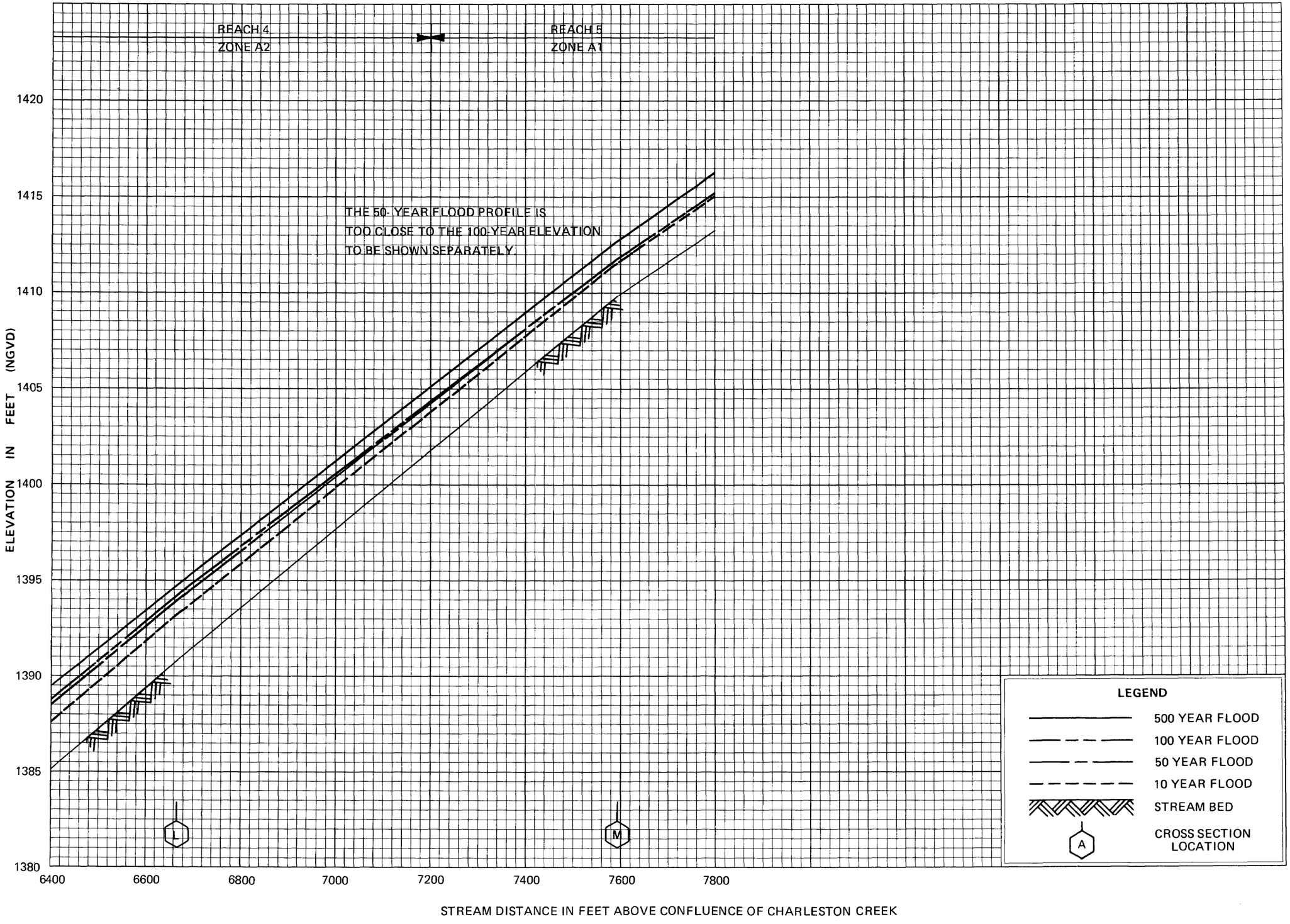

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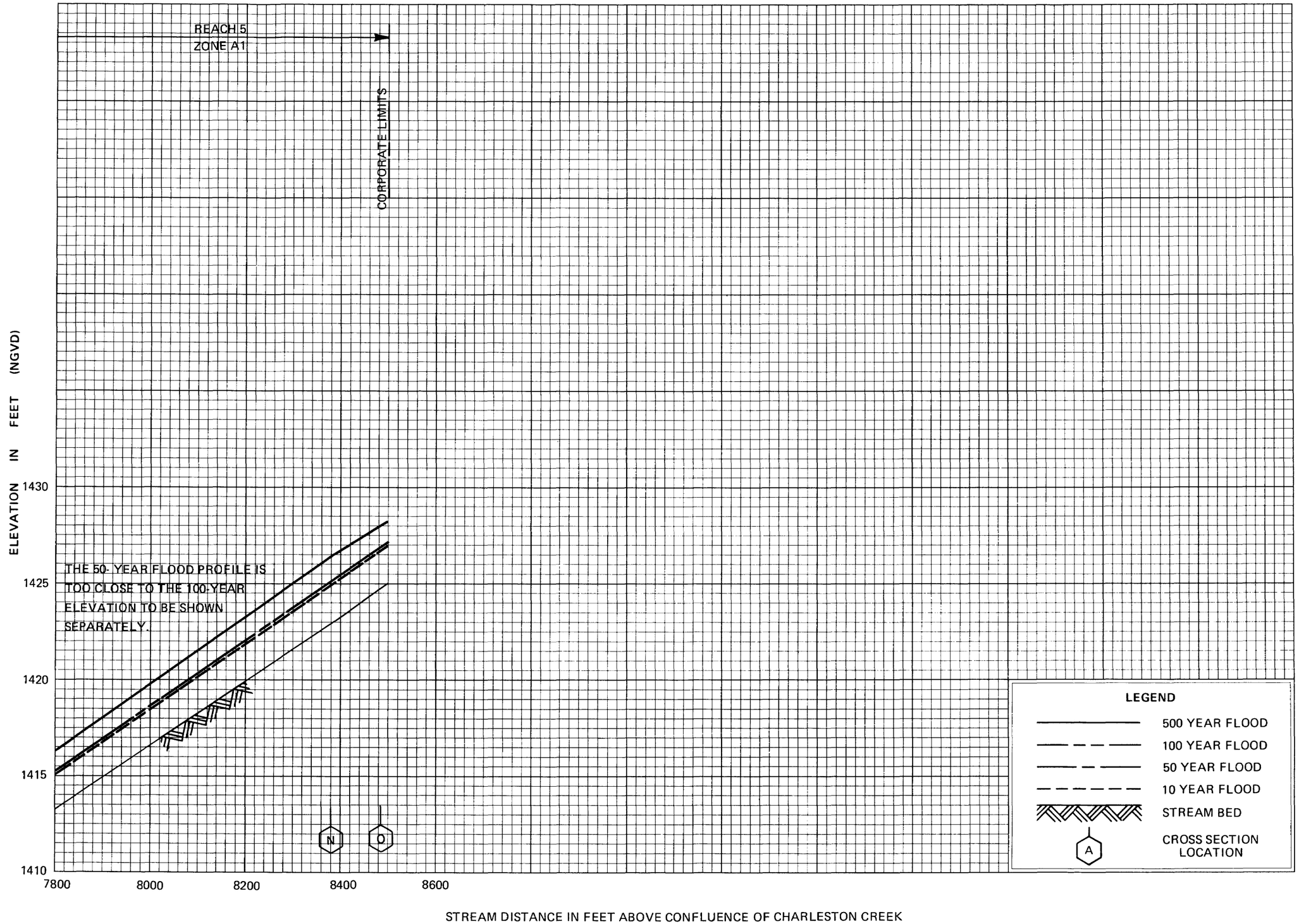

FLOOD PROFILES

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BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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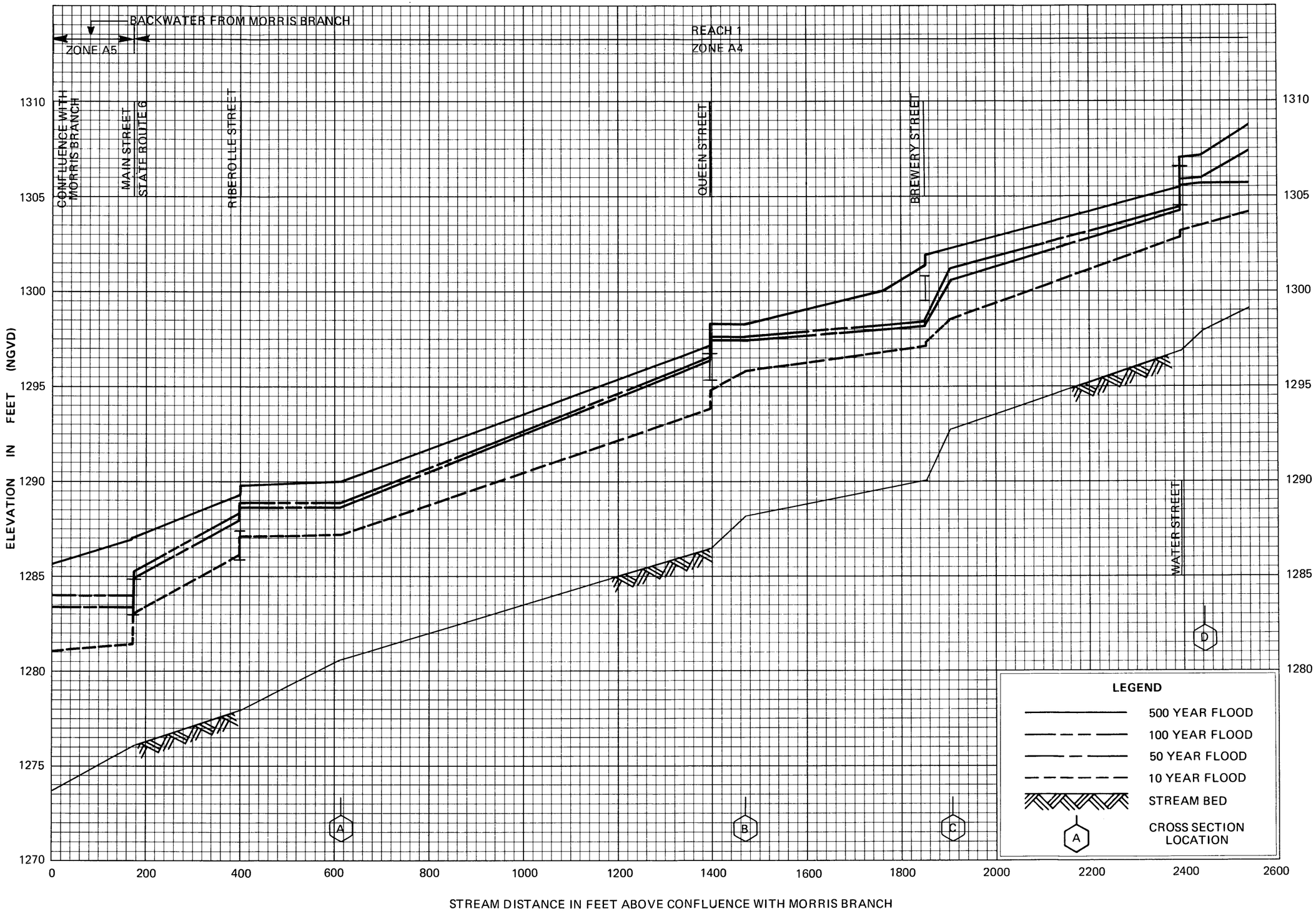

FLOOD PROFILES

KELSEY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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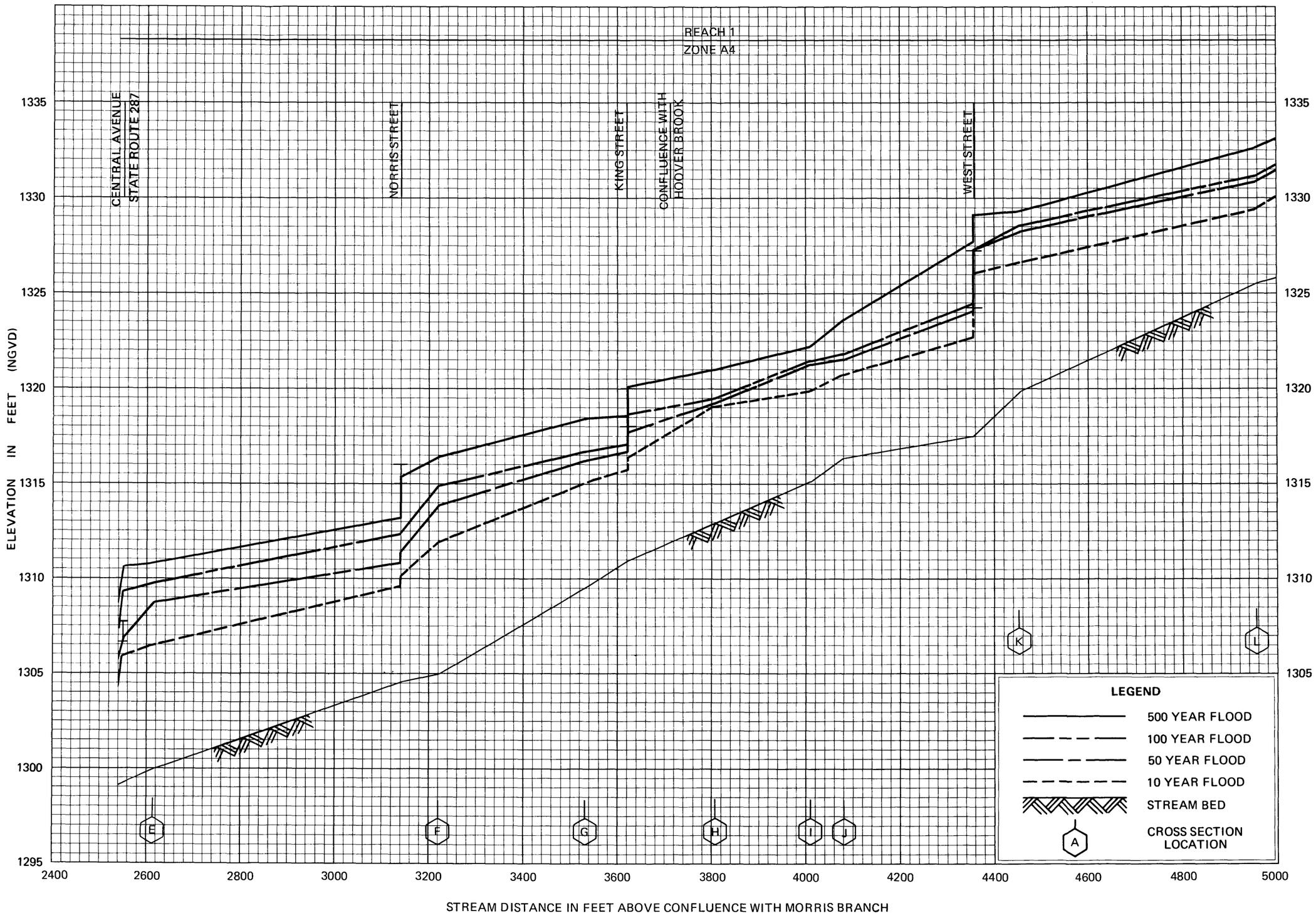

FLOOD PROFILES

KELSEY CREEK

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BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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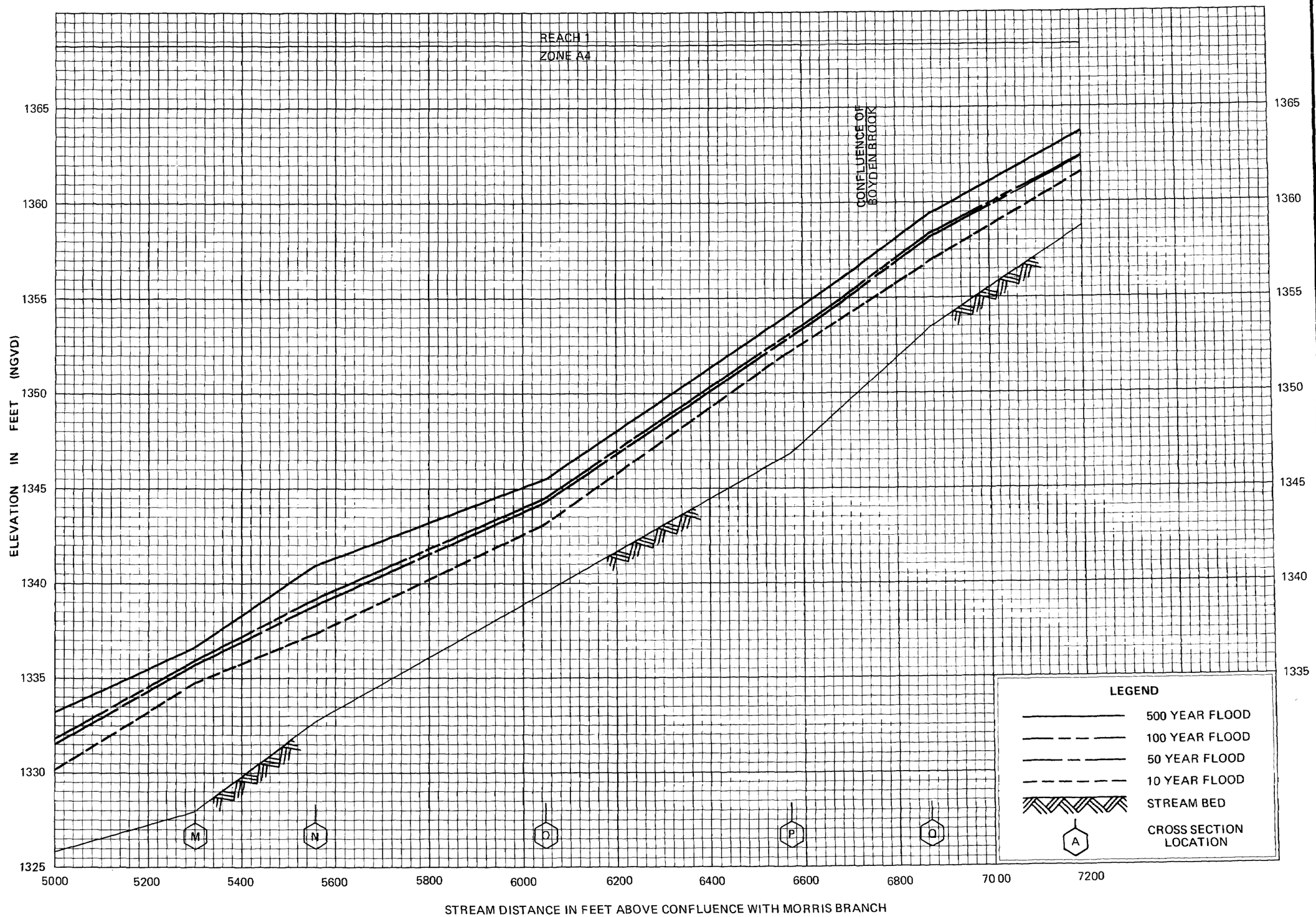

FLOOD PROFILES

KELSEY CREEK

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BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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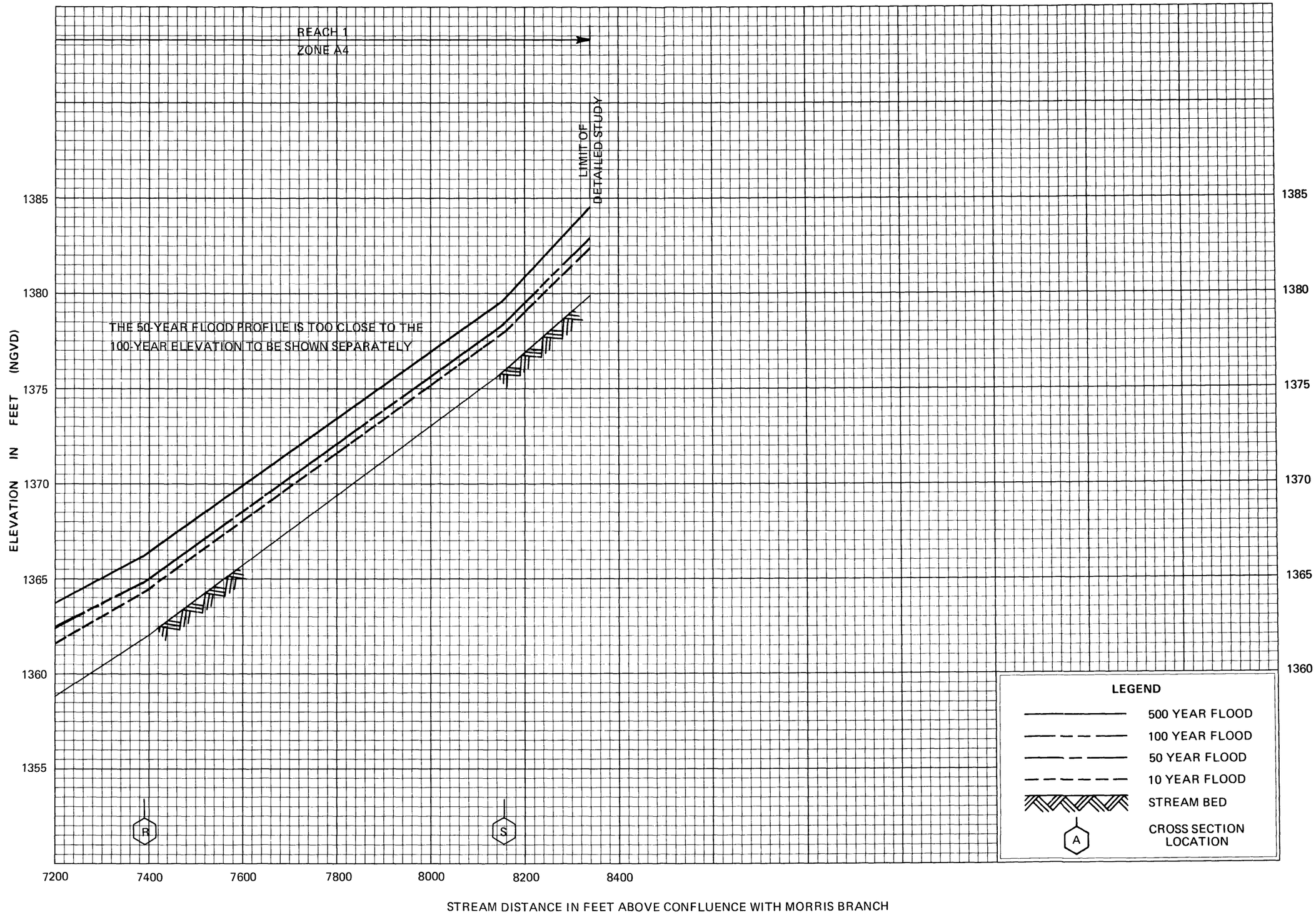

FLOOD PROFILES

KELSEY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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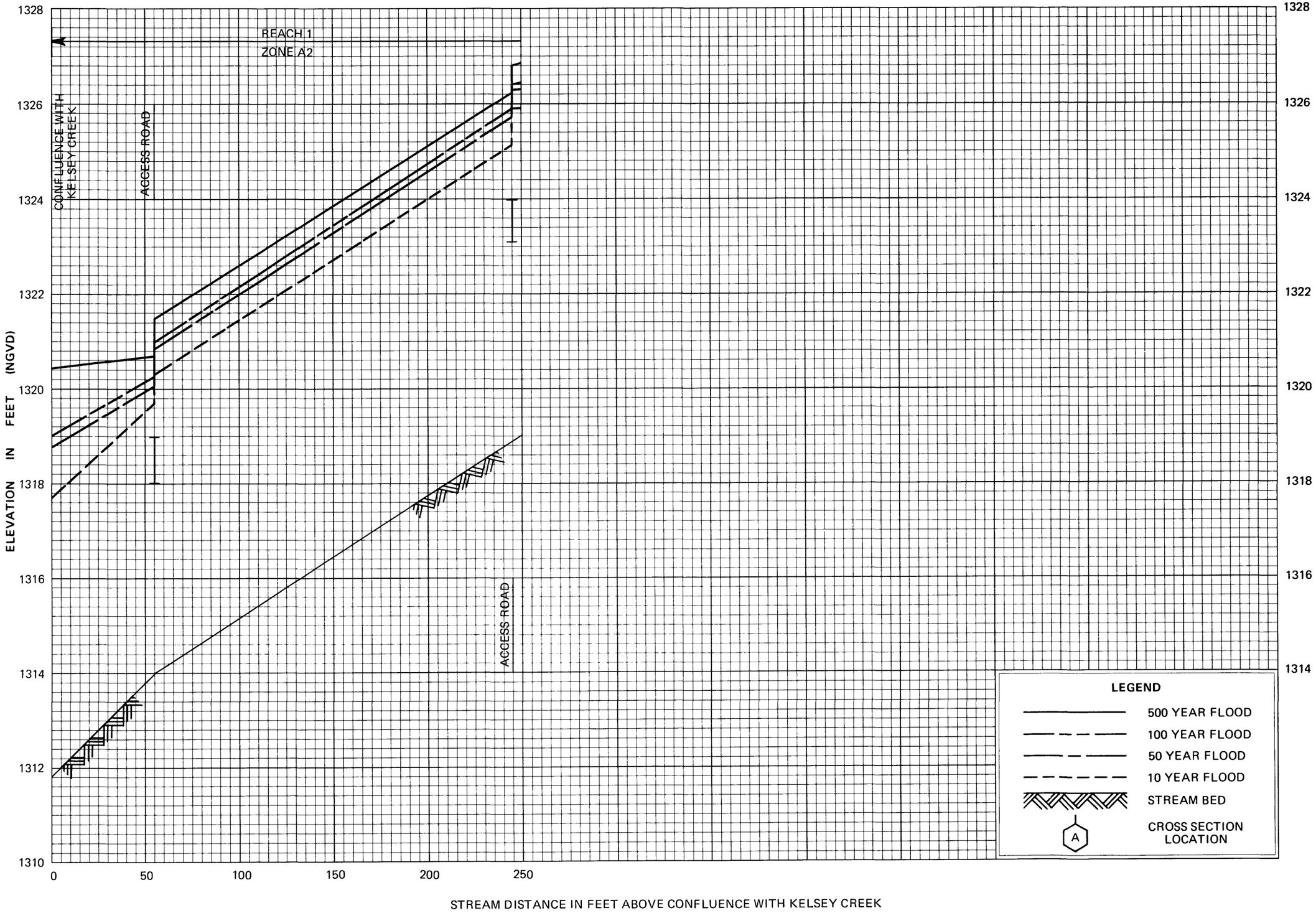

FLOOD PROFILES

HOOVER BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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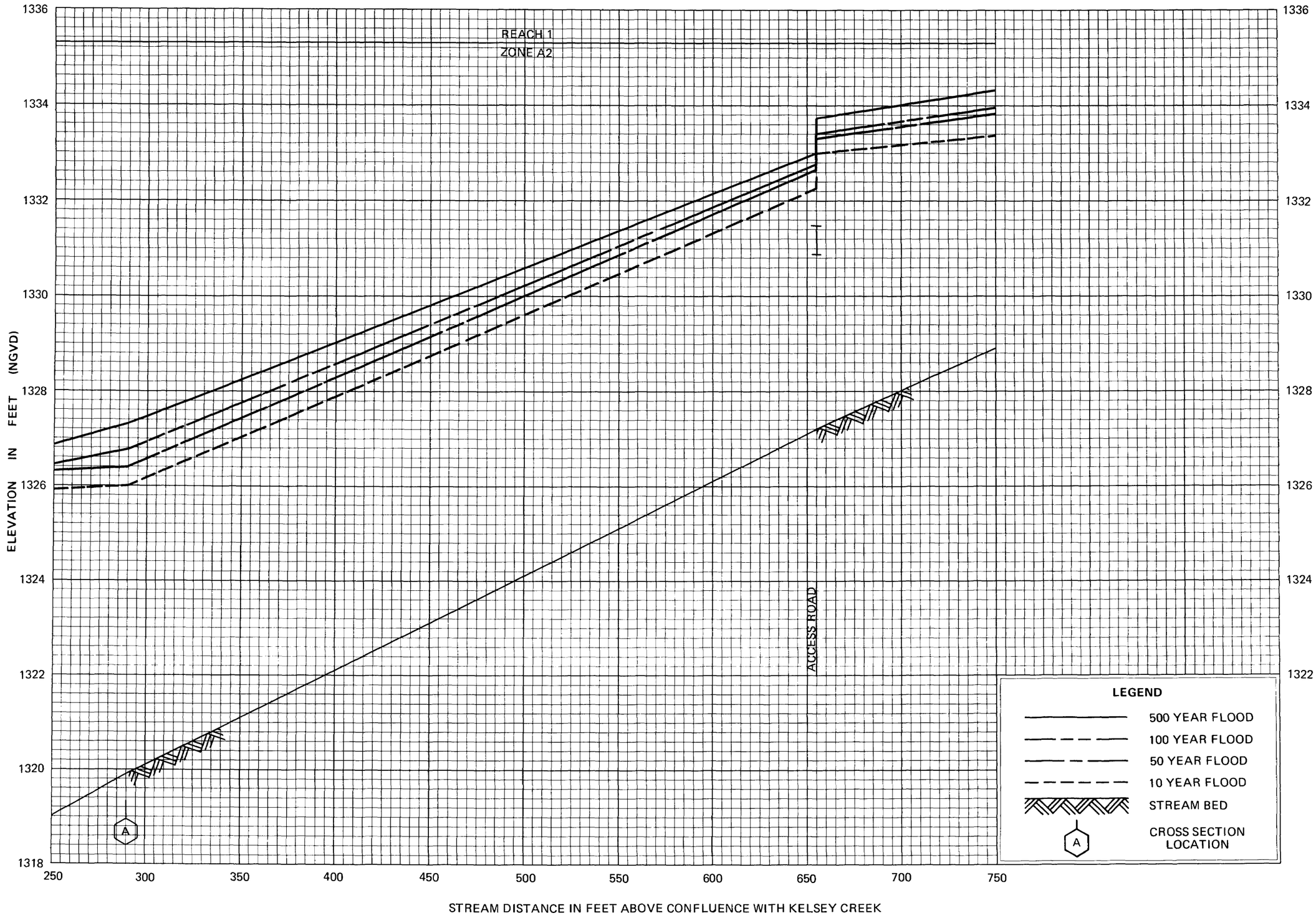

FLOOD PROFILES

HOOVER BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
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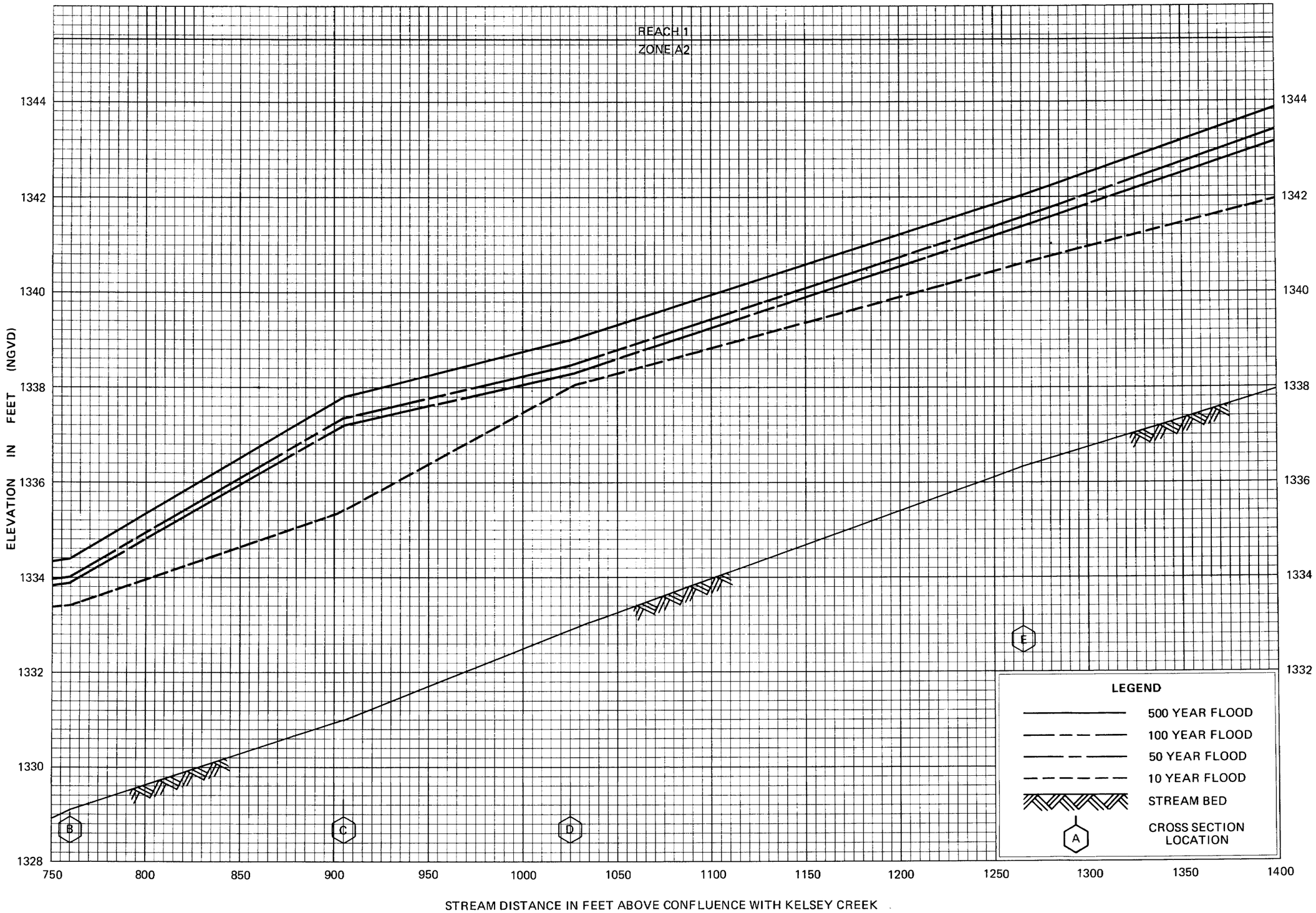

FLOOD PROFILES

HOOVER BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
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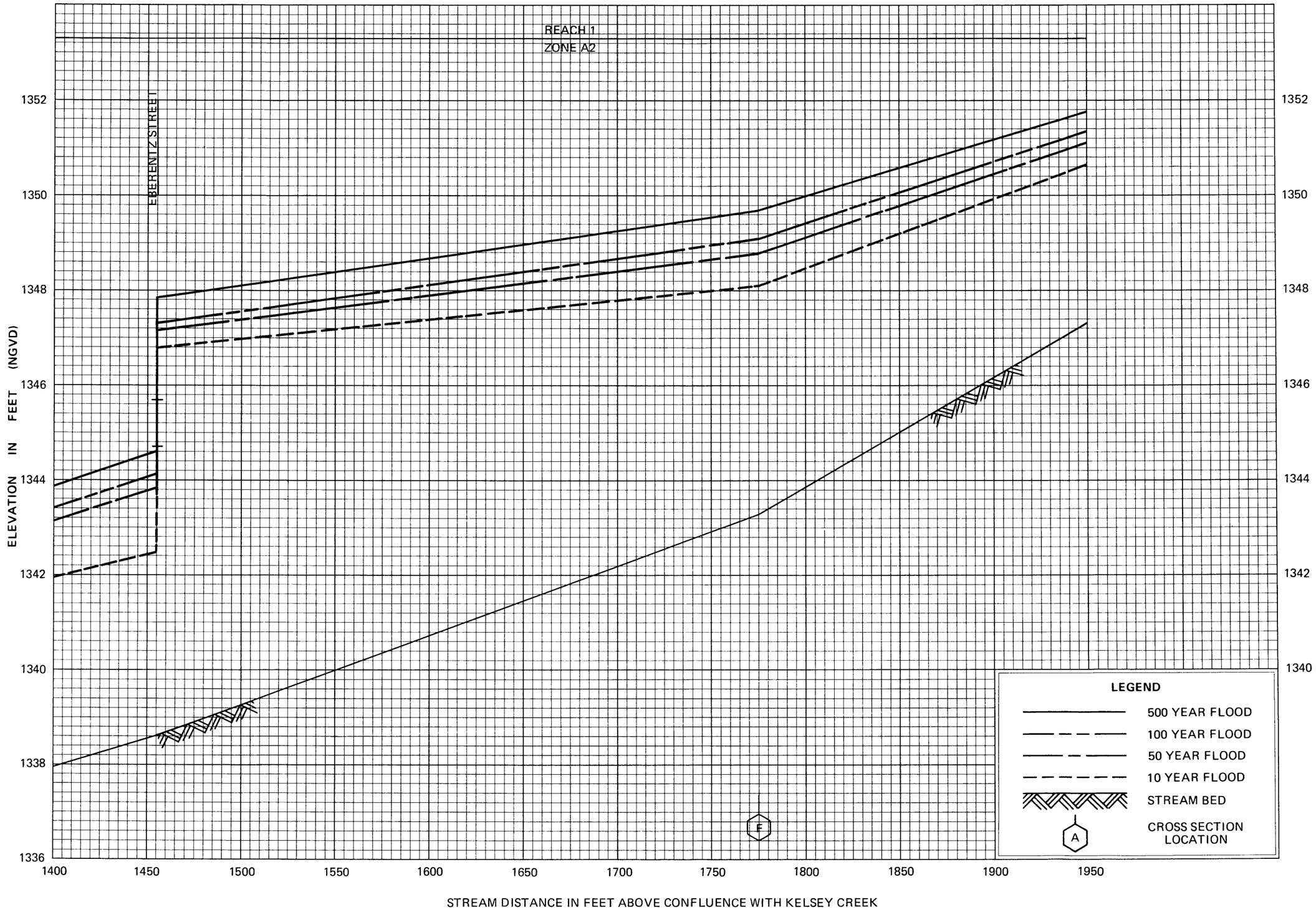

FLOOD PROFILES

HOOVER BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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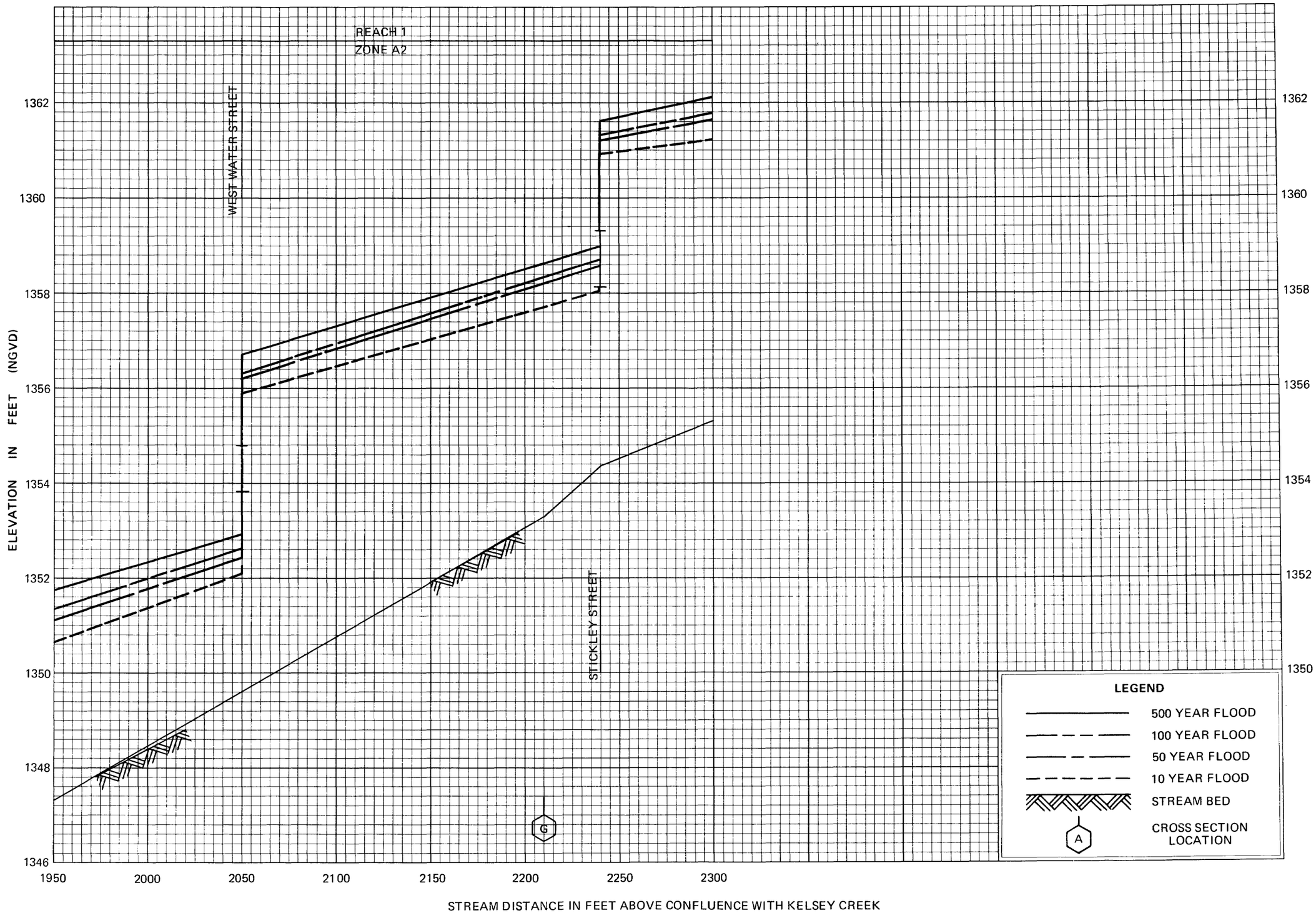

FLOOD PROFILES

HOOVER BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

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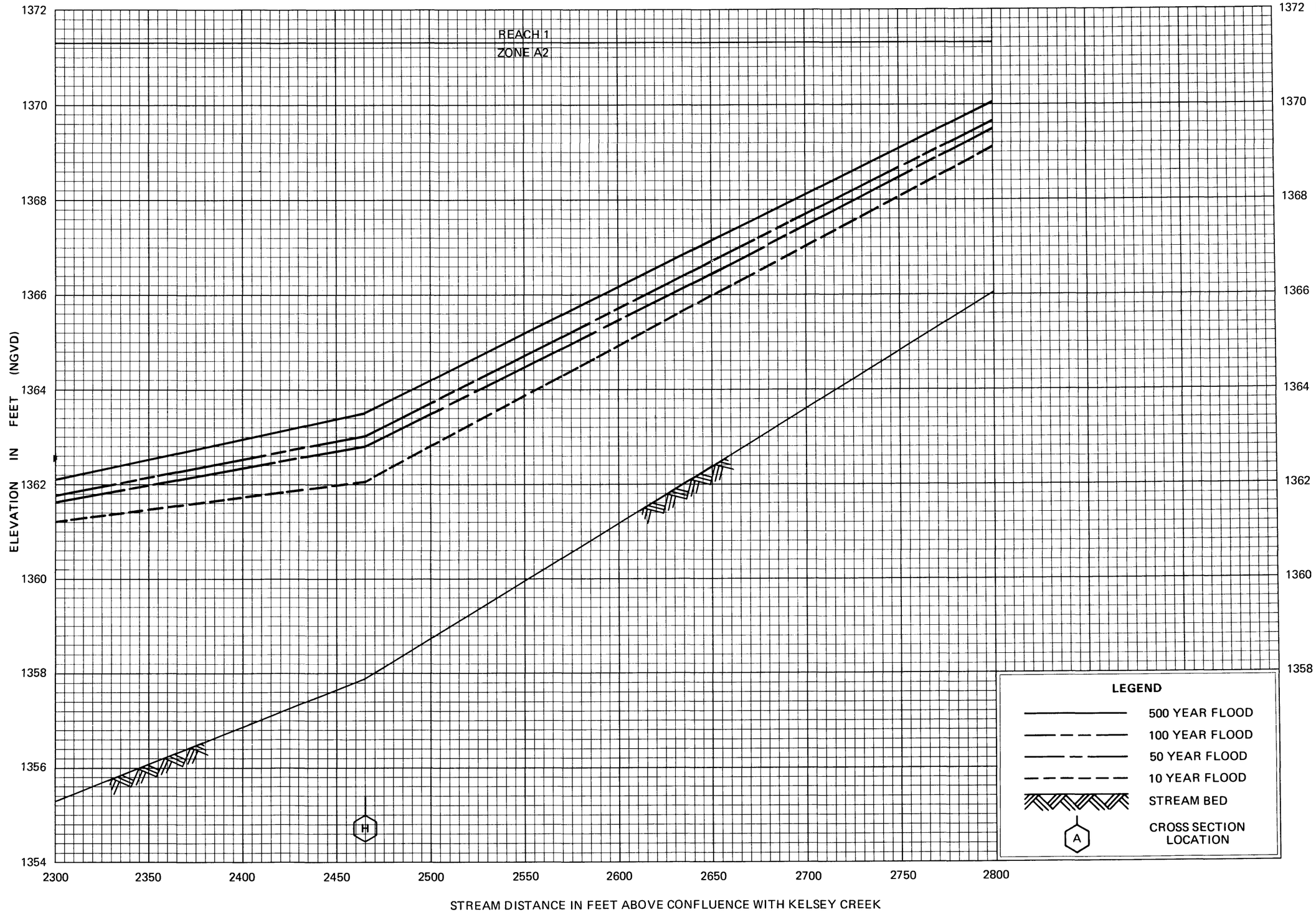
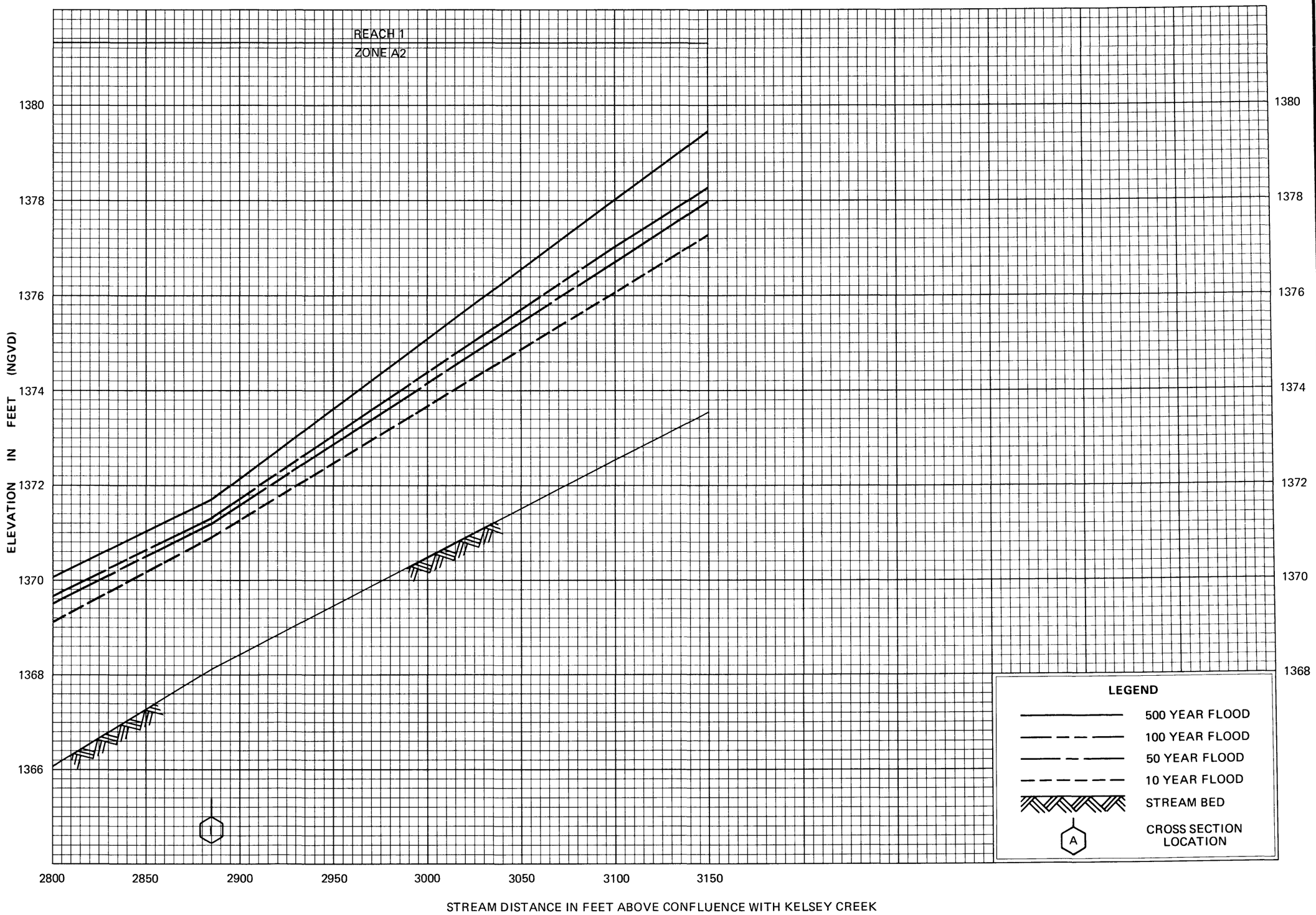


FLOOD PROFILES

HOOVER BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

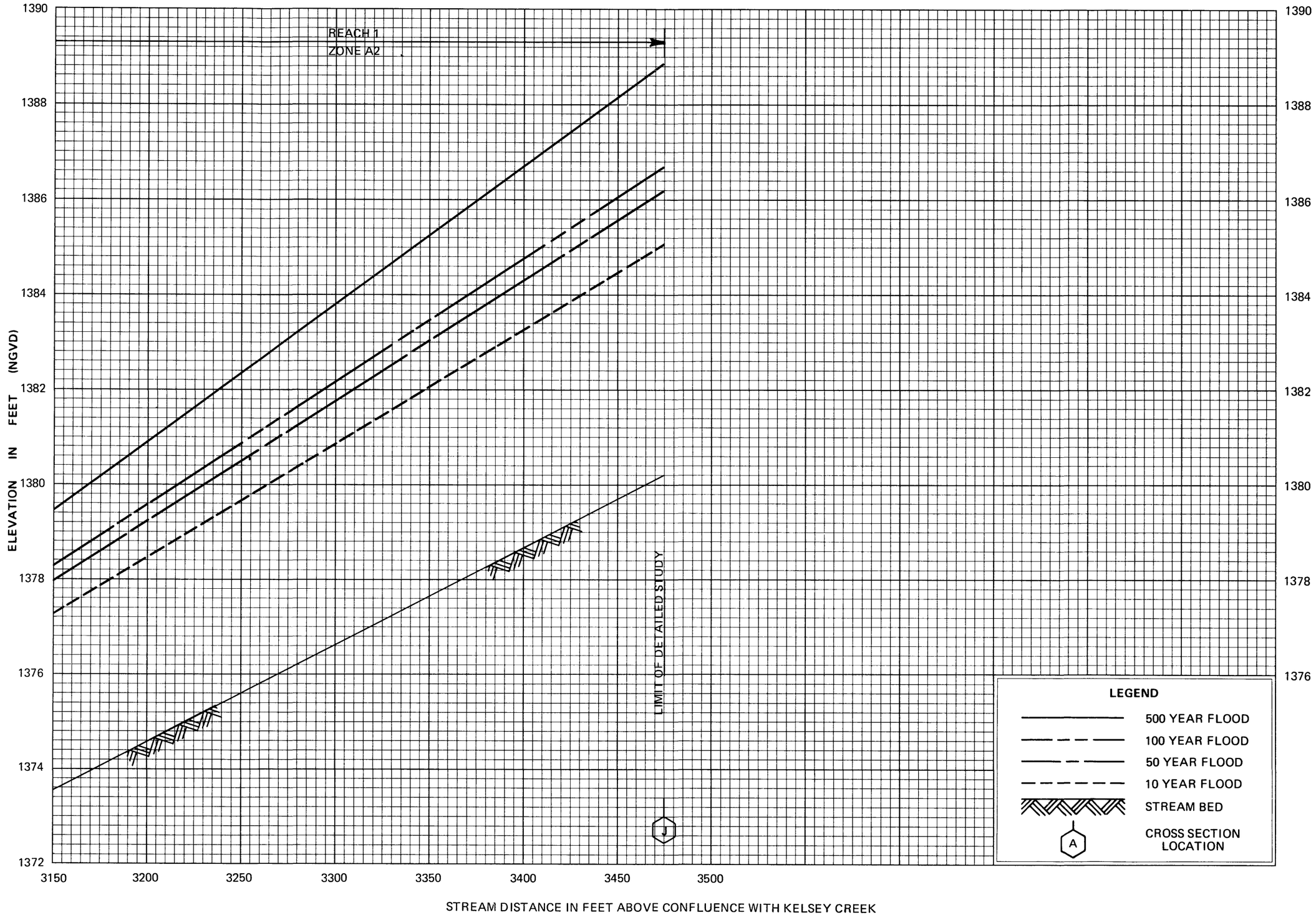


FLOOD PROFILES

HOOVER BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)

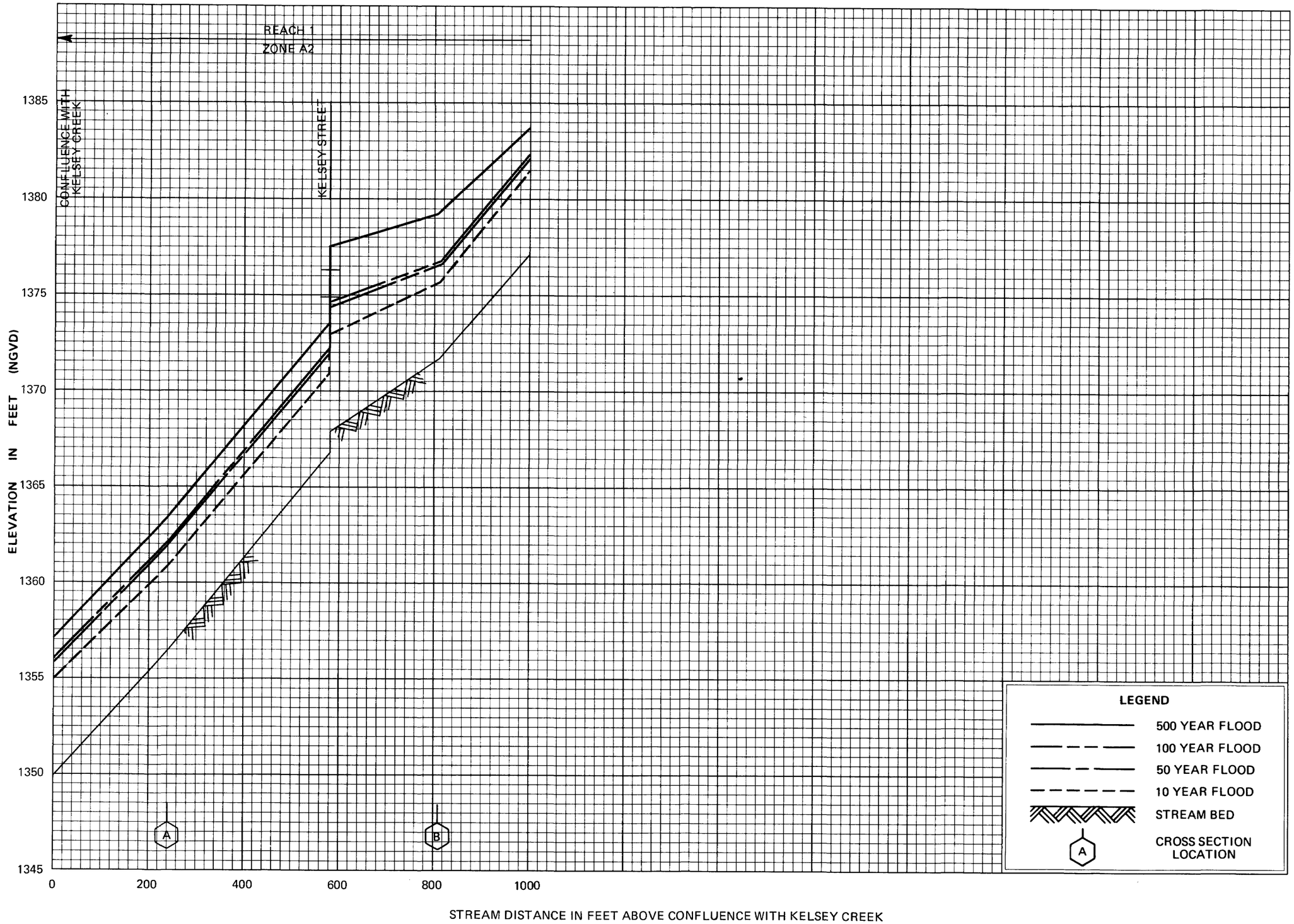


FLOOD PROFILES

HOOVER BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
(TIOGA CO.)



FLOOD PROFILES

BOYDEN BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

BOROUGH OF WELLSBORO, PA
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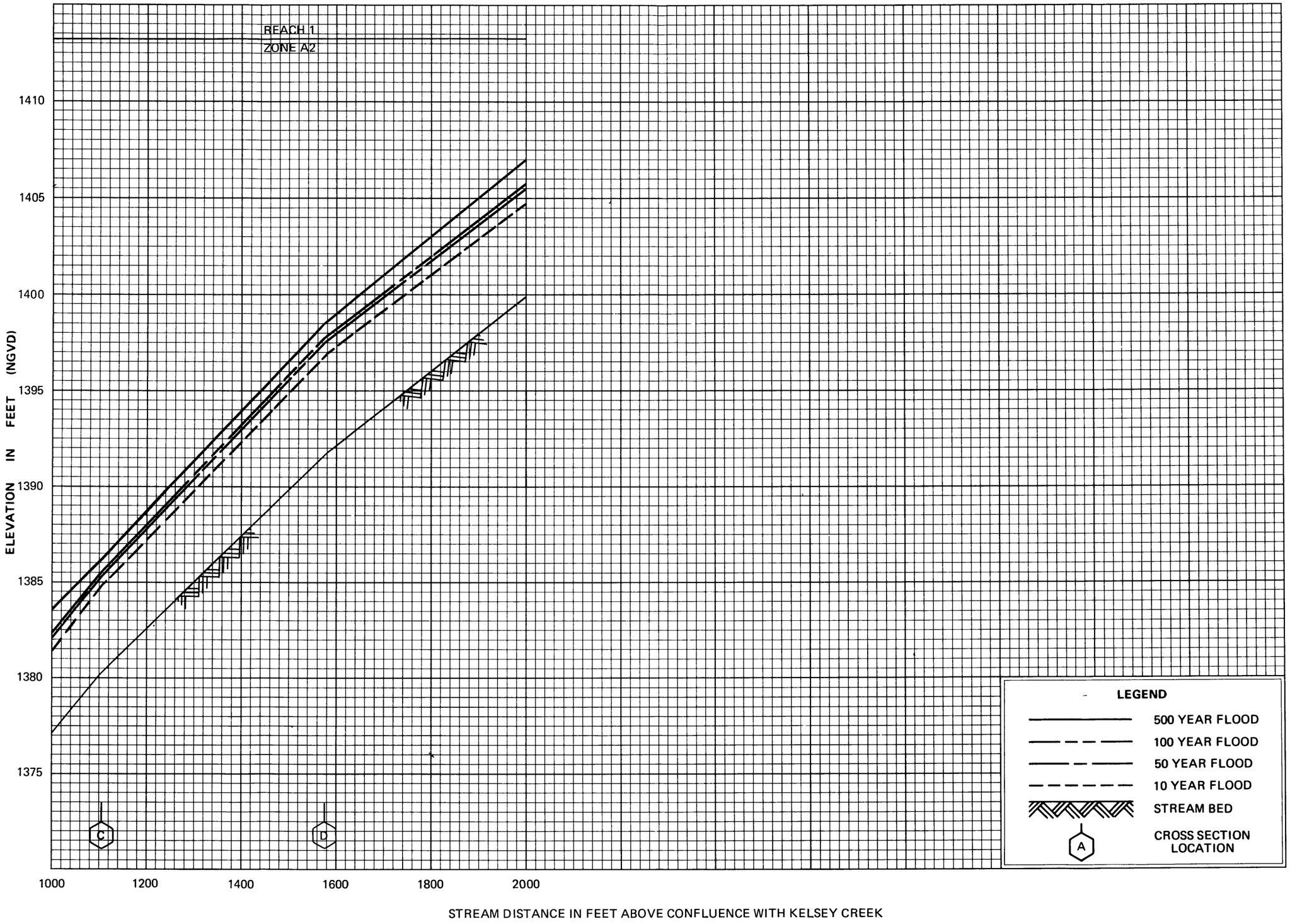

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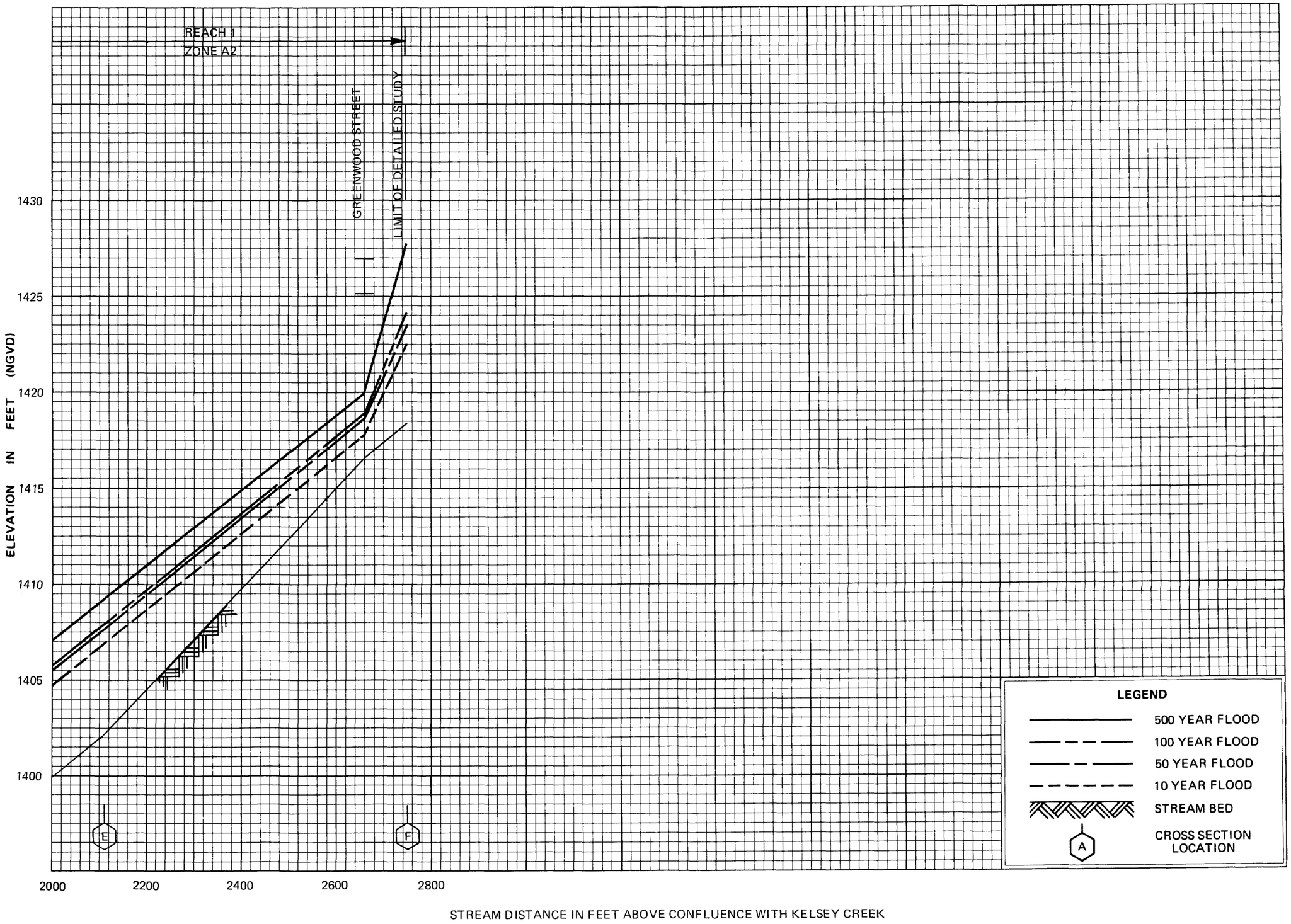

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