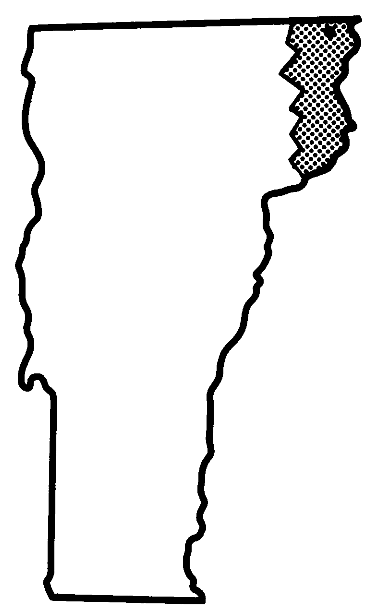
FLOOD INSURANCE STUDY

TOWN OF CANAAN, VERMONT

ESSEX COUNTY



MARCH 1980

federal emergency management agency

federal insurance administration

COMMUNITY NUMBER - 500046

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

FIGURES

TABLES

EXHIBITS

FLOOD INSURANCE STUDY

TOWN OF CANAAN,
ESSEX COUNTY, VERMONT

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Town of Canaan, Essex County, Vermont, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert the Town of Canaan to the regular program of flood insurance by the Federal Insurance Administration (FIA). Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these Federally-supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 24 CFR, 1910.1 (d). In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by DuBois & King, Inc., for the Federal Insurance Administration, under Contract No. H-4577. Approximate flood boundaries for some streams were determined in March 1977, by Michael Baker Jr., Inc., under contract to the Federal Insurance Administration. This study was completed in March 1977.

1.3 Coordination

Streams to be studied by detailed or approximate methods were identified at an initial time and cost meeting on June 30, 1977. A meeting was held on November 21, 1978, with representatives of the Study Contractor and the Town of Canaan to discuss the study. Flood elevations, flood boundaries, and floodway delineations were coordinated with the FIA, the Study Contractor, the U.S. Geological Survey (USGS), and the Town of Canaan.

On September 7, 1979, the results of the work by the Study Contractor were reviewed and accepted at a final coordination meeting attended by representatives of the FIA, the Study Contractor, and the community.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the Town of Canaan. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas, and areas of projected development or proposed construction through January 1984. The scope and methods of study were proposed to and agreed upon by the FIA and the Town of Canaan.

The flooding sources studied by detailed methods are listed below:

a. the Connecticut River, from the southeast corporate limit to the northeast corporate limit;

b. Willard Stream, from its mouth at the Connecticut River to the southern corporate limit;

c. Morrill Brook, from its mouth at Leach Creek to 0.3 mile upstream of its mouth;

d. Leach Creek, from its mouth at the Connecticut River to the United States - Canadian boundary, and from its mouth at Wallace Pond to 0.23 mile upstream of its confluence with Morrill Brook;

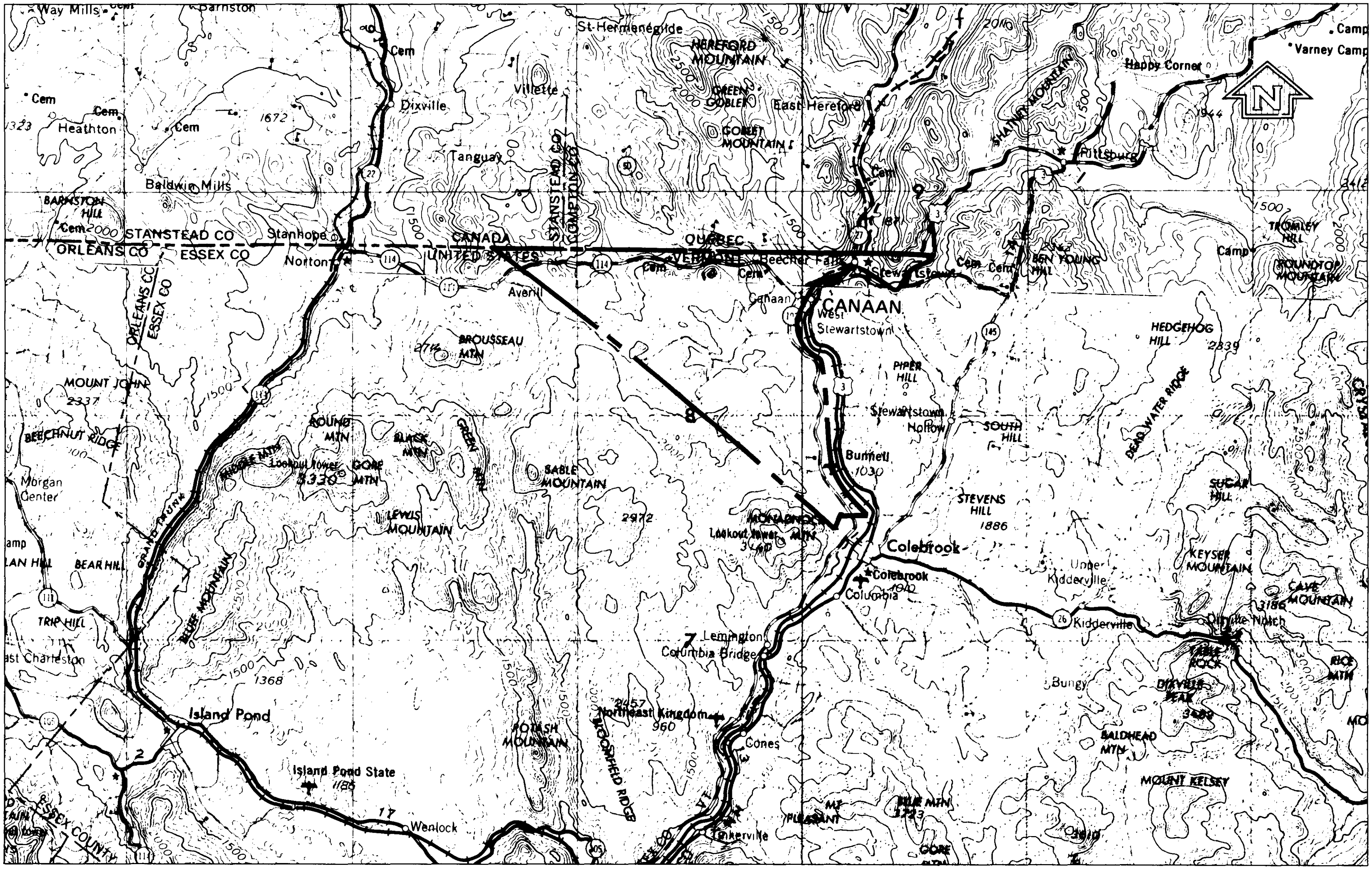
e. Halls Stream, from its mouth at the Connecticut River to the United States - Canadian boundary;

f. Capon Brook, from its mouth at the Connecticut River to 0.44 miles upstream of State Route 102; and

g. Wallace Pond, along the shoreline to the United States-Canadian boundary.

2.2 Community Description

The Town of Canaan is located in the northeastern corner of Vermont, in northeastern Essex County. The total land area contained within the town limits is 32.8 square miles. Communities surrounding the Town of Canaan are the towns of Averill to the southwest; Lemington to the south; Colebrook, New Hampshire, to the southeast; Stewartstown, New



FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

FIGURE 1

Hampshire, to the east; Clarksville and Pittsburg, New Hampshire, to the northeast; and Quebec, Canada, to the north. The population was 949 according to the 1970 Census (Reference 1). The present population is stable and little, if any, growth is expected.

The climate of Canaan is characterized by temperatures that can go well below -20 degrees Celsius (C.). Normal summer temperatures are in the low 20's (C). Annual precipitation over the area averages 40 inches (Reference 2).

The topography is characterized as gently sloping to moderately steep. Soils are generally loamy and are moderately well-drained. Soils along the streams are the same for slope and drainage but are more silty, sandy, and gravelly (Reference 3).

Capon Brook, a tributary of the Connecticut River, flows in a southeasterly direction near the Canaan - Lemington town line to its confluence. The brook has a total drainage area of 4.43 square miles and an average channel slope of 78 feet per mile.

The Connecticut River, the largest river in New England, forms the eastern border between Canaan, Vermont and New Hampshire and flows in a southerly direction. Its drainage area at the downstream limit of the study area, the Canaan - Lemington town line, is 488 square miles. The average channel slope of the river through the town is 8.3 feet per mile.

Halls Stream, a tributary of the Connecticut River, flows in a southwesterly direction forming the boundary between New Hampshire and Quebec. It continues to flow in a southerly direction through Canaan to its confluence with the Connecticut River at Beecher Falls. The stream has a total drainage area of 90.2 square miles and an average channel slope through Canaan of 6.6 feet per mile.

Leach Creek, also a tributary of the Connecticut River, flows in a northeasterly direction near the western end of Canaan where it discharges into Wallace Pond. The drainage area at this location is 15.0 square miles with an average channel slope of 36 feet per mile. From Wallace Pond, Leach Creek flows into Quebec before turning back into Canaan and flowing in a southerly direction to its mouth. The stream has a total drainage area of 59.3 square miles and average channel slope of 6 feet per mile through the downstream reach in Canaan.

Morrill Brook, a tributary of Leach Creek, flows in a northerly direction to its confluence slightly upstream of Wallace Pond. The brook has a total drainage area of 4.65 square miles and an average channel slope of 27 feet per mile.

Willard Stream, a tributary of the Connecticut River, flows in an easterly direction through Lemington then flows northeast to its mouth near the southern tip of Canaan. The stream has a total drainage area of 15.4 square miles and an average channel slope of 64 feet per mile.

Wallace Pond is situated on Leach Creek on the United States - Canadian border. Approximately 20 percent of the pond is located in the United States. The pond is predominantly fed by Leach Creek as well as several smaller tributaries in both countries. Leach Creek is also the outlet of the pond in Canada. At the outlet, Wallace Pond has a drainage area of 28.4 square miles.

As in much of Vermont, development has taken place on the flatland adjacent to rivers. Flood plains in the Town of Canaan are principally developed for agriculture with concentrations of residential and commerical development in the unincorporated Villages of Canaan and Beecher Falls.

2.3 Principal Flood Problems

In general, floods in the area are caused by heavy rains. In springtime, these rains are often associated with snowmelt. A winter thaw, accompanied by rain, often leads to ice jams which also cause flooding. Hurricanes traveling up the east coast of the country produce occasional flooding situations.

Low-lying areas of Canaan are subject to periodic flooding caused by overflow of the Connecticut River and its tributaries. The most frequent flooding occurs in early spring as a result of snowmelt and heavy rains, but flooding historically has occurred as a result of ice jams and debris collection but these effects are not reflected in this study. Notable floods in this area occurred in 1906, 1924, 1927, 1936, 1943, 1954 and 1972. No information is available on the floods of 1906, 1924, and 1927; however, it is estimated that the 1927 flood is the largest flood to have affected the area. The 4 latter notable floods of record, 1936, 1943, 1954, and 1972, have estimated return periods of 50, 50, 8, and 8 years, respectively. These return periods are based on the frequency curve developed from the gage records of the USGS gage on the Connecticut River at North Stratford, New Hamsphire.

The flood of June 1943 caused severe damage in the Canaan area. Property damages totaled over $300,000 with additional high agricultural losses along the Connecticut River. Extensive highway and bridge destruction intensified the impact of the flood on the area. Halls Stream, which joins the Connecticut River at Beecher Falls, contributed a peak flow of 21,000 cubic feet per second (cfs) to the flood and was the principle cause of the 1943 flood in Canaan (Reference 4).

Due to the short period of gage records available for Halls Stream, no accurate estimate of the recurrence interval for the 1943 flood can be made. However, statistically, it is an event even rarer than a 500-year flood. Figure 2 shows flooding in the community. There are no recorded high water elevations available in the Town of Canaan.

2.4 Flood Protection Measures

There are three storage reservoirs operated on the Connecticut River above Canaan: First Connecticut Lake, Second Connecticut Lake, and Lake Francis.

HALL'S STREAM AT BEECHER FALLS MFG. CO., DURING FLOOD, JUNE, 194[illegible]

FIGURE 2 - Flood damage in the upper valley of the Connecticut River.

The artificial storage capacity of these 3 reservoirs amounts to 187,500 acre feet: 99,500 acre feet in Lake Francis and 88,000 acre feet in First and Second Connecticut Lakes combined. All 3 reservoirs are located northeast of Canaan in New Hampshire on the Connecticut River. First Connecticut and Second Connecticut Lakes are operated as a unit for storage of water for power and are used for recreation. However, they do afford some small degree of flood control. Lake Francis at Pittsburg, New Hampshire, is used for both storage of water for power and for flood control. There are no other structural flood protection measures planned for the town. The town does discourage building in the flood plain which is enforced through its zoning bylaws.

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. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one percent chance of annual occurrence) in any 50-year period is about 40 percent (four in ten), and for any 90-year period, the risk increases to about 60 percent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

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 affecting the community.

The flood discharges for the Connecticut River and Halls Stream were determined by a log-Pearson Type III analysis as outlined by the U.S. Water Resources Council (Reference 5).

The flood discharges for Capon Brook, Leach Creek, Morrill Brook, and Willard Stream were determined using methods for ungaged streams. Methods used included those developed by the USGS and the U.S. Bureau of Public Roads (References 6 and 7).

The Johnson and Tasker method is a multiple regression technique used to define the relation between flood peaks, collected at a network of gaging stations maintained by the USGS, and a set of basin characteristics which include drainage area, average season snowfall, area of lakes and ponds, and a maximum 24-hour rainfall having a recurrence of 2 years. Potters method is an imperical method based on geological location in Vermont which includes the drainage area and the slope of the drainage area.

Wallace Pond, which has a surface area of approximately 510 acres, provides no appreciable storage on Leach Creek (Reference 4). Therefore, it was studied assuming inflow equaling outflow. The outflow occurs over a dam's spillway which acts as a controlling section. The hydrology was determined using that developed for Leach Creek as previously stated.

One anomalous condition in the hydrology occurred for the Halls Stream log-Pearson Type III analysis. The historical flood of 1943, with an estimated discharge of 21,000 cfs, was not included in the analysis by a historical adjustment. This is because it was impossible to assign a period of historical return to the flood.

The USGS gages used in this study include: the gage (no. 01129200) on the Connecticut River below Indian Stream, with a period of record of 20 years; the gage (no. 01129500) on the Connecticut River at North Stratford, New Hampshire, with a period of record of 46 years; and the international gaging station (no. 01129300) on Halls Stream near East Hereford, Quebec, which has a period of record of 15 years (References 8 and 9).

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in the community are shown in Table 1.

3.2 Hydraulic Analyses

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

Cross sections and dimensions of structures were obtained by field survey.

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 was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Roughness coefficients (Manning's "n") were determined using methods outlined in Open Channel Hydraulics (Reference 10). Roughness coefficients for the streams studied in detail are listed below:

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA SQ MILES	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
CAPON BROOK					
At Confluence with Connecticut River	4.43	672	952	1,087	1,414
CONNECTICUT RIVER					
At downstream corporate limits	488.0	10,700	14,900	17,250	22,500
Just upstream of Leach Creek	377.0	7,300	10,600	12,400	17,000
Just upstream of Halls Stream	285.0	5,050	7,500	8,900	12,400
HALLS STREAM					
At Confluence with Connecticut River	90.2	4,514	5,443	5,827	6,714
LEACH CREEK					
At Confluence with Connecticut River	59.3	4,095	5,735	6,458	8,356
Just downstream of Wallace Pond	28.4	2,410	3,375	3,801	4,918
Just upstream of Wallace Pond	15.0	1,518	2,132	2,415	3,125
Just upstream of Morrill Brook	10.2	1,150	1,615	1,829	2,367
MORRILL BROOK					
At Confluence with Leach Creek	4.65	656	915	1,041	1,345
WILLARD STREAM					
At Confluence with Connecticut River	15.4	1,503	2,161	2,503	3,338

Stream	Range of "n" Values	Area
Capon Brook	0.024-0.045	Channel
	0.035-0.100	Overbank
Connecticut River	0.030-0.050	Channel
	0.025-0.080	Overbank
Halls Stream	0.033-0.049	Channel
	0.050-0.200	Overbank
Leach Creek	0.025-0.055	Channel
	0.035-0.080	Overbank
Morrill Brook	0.050	Channel
	0.070	Overbank
Willard Stream	0.035-0.056	Channel
	0.035-0.075	Overbank

All backwater computations for riverine flooding were started at normal depth, except for the upper reach of the Connecticut River, which was started at critical depth over the dam above the Village of Canaan and Morrill Brook, a tributary of Leach Creek, which was started at the coincident flood elevation of Leach Creek since coincident 100-year floods are likely. For each length of riverine flooding sources, water-surface elevations were determined using the HEC-2 method (Reference 11). Water-surface elevations for Wallace Pond were determined by developing a rating curve for the outlet structure using U.S. Army Corps of Engineers (COE) guidelines (Reference 12). The water-surface elevations were then determined using the flow rates developed for the pond. The water-surface elevations determined from the rating curve were assumed to be the pond elevations for the respective flood frequency; no attempt was made at establishing a water-surface gradient for the pond due to small surface areas. Elevations on Wallace Pond are shown in Table 2.

TABLE 2 - SUMMARY OF ELEVATIONS

LOCATION	ELEVATIONS (NGVD) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
WALLACE POND				
At Canaan, Vermont	1,294.9	1,295.8	1,296.2	1,297.2

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1).

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are, therefore, considered valid only if hydraulic structures, in general, remain unobstructed and if channel and overbank conditions remain essentially the same as ascertained during this study.

All elevations are referenced from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study 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-year and the 500-year floods have been delineated using the elevations determined at each cross section; between cross sections the boundaries were interpolated using topographic maps enlarged to a scale of 1:2400, with a contour interval of 20 feet (Reference 13). Approximate flood boundaries were delineated from the Flood Hazard Boundary Map (Reference 14) and verified by field inspection and engineering judgment.

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, not be subject to flooding; owing to lack of detailed topographical information or to limitations of the map scale, such areas are not shown. In cases where the 100-year and the 500-year flood boundaries are close together, only the 100-year boundary has been 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 National 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 a 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 may 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.

Floodways were determined using methods available in the HEC-2 computer program (Reference 11). The floodways were determined so as not to produce more than a 1.0-foot rise in the energy grade line. The floodways were computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 3). No floodway was determined for Wallace Pond since the floodway concept is not applicable.

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries 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 the 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 3.

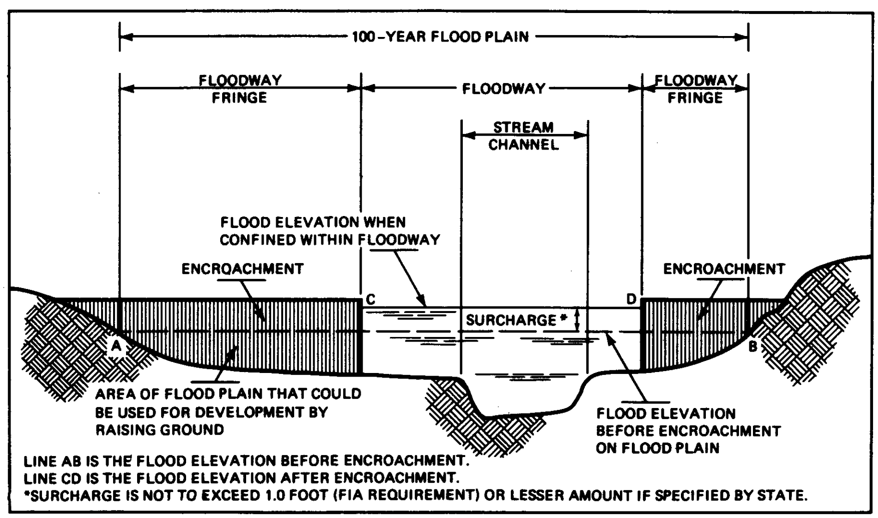


FIGURE 3 - Floodway Schematic

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
CONNECTICUT RIVER								
A	361.52	1826	12,185	1.4	1010.7	1010.7	1011.7	1.0
B	361.91	212	2988	5.8	1010.7	1010.7	1011.6	0.9
C	362.33	287	4440	3.9	1011.6	1011.6	1012.5	0.9
D	363.14	478	4939	3.5	1012.6	1012.6	1013.5	0.9
E	363.91	1769	14,537	1.2	1013.0	1013.0	1014.0	1.0
F	364.72	1041	8149	2.1	1013.2	1013.2	1014.2	1.0
G	365.47	1682	11,968	1.4	1013.7	1013.7	1014.7	1.0
H	365.78	450	4322	4.0	1014.0	1014.0	1014.8	0.8
I	366.87	2018	15,301	1.1	1015.0	1015.0	1016.0	1.0
J	367.19	1023	6416	2.7	1015.2	1015.2	1016.1	0.9
K	367.75	1125	6753	2.6	1016.0	1016.0	1017.0	1.0
L	368.59	1228	6817	2.5	1017.7	1017.7	1018.6	0.9
M	369.20	200	1928	6.4	1018.9	1018.9	1019.9	1.0
N	369.63	203	1505	8.2	1025.2	1025.2	1025.2	0.0
O	369.69	245	1987	6.2	1026.7	1026.7	1026.7	0.0
P	369.80	151	893	13.9	1027.2	1027.2	1027.2	0.0
Q	369.96	270	1079	11.5	1041.3	1041.3	1041.3	0.0
R	369.97	241	1020	12.2	1056.9	1056.9	1056.9	0.0
S	370.02	250	3437	3.6	1059.7	1059.7	1059.7	0.0
T	370.14	250	2999	4.1	1059.8	1059.8	1059.8	0.0
U	370.33	188	2353	5.3	1060.1	1060.1	1060.1	0.0
V	370.81	146	1311	9.5	1062.4	1062.4	1062.4	0.0
W	371.21	103	785	15.8	1072.1	1072.1	1072.1	0.0
X	371.27	181	1853	6.7	1076.5	1076.5	1076.5	0.0
Y	371.31	151	1252	9.9	1076.8	1076.8	1076.8	0.0
Z	371.56	145	1808	4.9	1079.4	1079.4	1079.7	0.3

[1]MILES ABOVE MOUTH
[2]THIS WIDTH EXTENDS BEYOND CORPORATE LIMITS

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

FLOODWAY DATA

CONNECTICUT RIVER

TABLE 2

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
CONNECTICUT RIVER								
AA	372.07	144[3]	1615	5.5	1080.1	1080.1	1081.1	1.0
AB	372.50	438[3]	2258	3.9	1082.3	1082.3	1083.2	0.9
AC	373.17	226[3]	1417	6.3	1087.3	1087.3	1087.9	0.6
AD	373.56	232[3]	1350	6.6	1094.8	1094.8	1094.8	0.0
LEACH CREEK								
A	0.25	263	850	7.6	1018.0	1016.1[4]	1016.3	0.2
B	0.43	79	613	10.5	1019.2	1019.2	1020.0	0.8
C	0.49	91	851	7.6	1021.8	1021.8	1021.9	0.1
D	0.83	523	3059	2.1	1023.0	1023.0	1023.8	0.8
E	0.98	632	2946	2.2	1023.1	1023.1	1023.9	0.8
F	1.44	87	864	7.5	1024.7	1024.7	1025.0	0.3
G	1.55	582	3832	1.7	1026.0	1026.0	1026.2	0.2
H	1.96	259	1111	5.8	1026 0	1026.0	1026.4	0.4
I	2.41	266	1665	3.9	1028.4	1028.4	1029.2	0.8
J	2.94	115	652	9.9	1031.2	1031.2	1031.7	0.5
K	0.15[2]	650	2187	1.1	1297.5	1297.5	1298.5	1.0
L	0.33[2]	160	723	3.3	1297.9	1297.9	1298.6	0.7
M	0.49[2]	83	258	9.3	1300.8	1300.8	1300.9	0.1
N	0.52[2]	110	579	4.2	1305.0	1305.0	1305.1	0.1
O	0.60[2]	97	394	6.1	1305.7	1305.7	1306.2	0.5
P	0.85[2]	36	157	11.7	1323.9	1323.9	1324.0	0.1

[1]MILES ABOVE MOUTH
[2]MILES ABOVE MOUTH AT WALLACE POND
[3]THIS WIDTH EXTENDS BEYOND CORPORATE LIMITS
[4]ELEVATIONS WITHOUT CONSIDERING BACKWATER EFFECT FROM CONNECTICUT RIVER

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

FLOODWAY DATA

CONNECTICUT RIVER - LEACH CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
CAPON BROOK								
A	0.11	190	607	1.8	1012.6	1009.5[2]	1010.5	1.0
B	0.19	43	140	7.8	1012.6	1010.1[2]	1010.7	0.6
C	0.22	37	305	3.6	1021.0	1021.0	1021.0	0.0
D	0.34	42	119	9.2	1027.8	1027.8	1028.1	0.3
E	0.50	51	175	6.2	1038.0	1038.0	1038.6	0.6
F	0.64	37	110	9.9	1059.0	1059.0	1059.1	0.1
MORRILL BROOK								
A	0.23	38	148	7.0	1309.3	1309.3	1310.3	1.0
B	0.31	57	212	4.9	1313.4	1313.4	1314.0	0.6
HALLS STREAM								
A	0.03	162	2013	2.9	1080.1	1080.1	1080.5	0.4
B	0.30	108	1311	4.4	1080.2	1080.2	1080.9	0.7
WILLARD STREAM								
A	0.22	226	1079	2.3	1012.1	1008.6[2]	1009.6	1.0
B	0.45	202	732	3.4	1012.1	1009.2[2]	1010.1	0.9
C	0.74	65	233	10.8	1013.6	1013.6	1013.6	0.0
D	0.77	146	1013	2.5	1018.5	1018.5	1018.5	0.0
E	0.90	93	261	9.6	1019.9	1019.9	1019.9	0.0
F	1.16	175	622	4.0	1028.6	1028.6	1029.5	0.9

[1]MILES ABOVE MOUTH
[2]ELEVATIONS WITHOUT CONSIDERING BACKWATER EFFECT FROM CONNECTICUT RIVER

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

FLOODWAY DATA

CAPON BROOK - MORRILL BROOK - HALLS STREAM - WILLARD STREAM

5.0 INSURANCE APPLICATION

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 (FHF), and flood insurance zone designations for each flooding source affecting the Town of Canaan.

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 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
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the Town of Canaan are shown on the Flood Profiles (Exhibit 1) and are summarized in the Flood Insurance Zone Data(Table 4).

5.2 Flood Hazard Factors

The FHF is 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 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 Town of Canaan was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations are shown or FHFs determined.
Zones A2-A4:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations are shown, and zones subdivided according to FHF.
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; or 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.

Table 4, "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 Town of Canaan 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

There have been no other detailed studies performed in or around the Town of Canaan.

A Flood Hazard Boundary Map has been published by the Federal Insurance Administration (Reference 14). The differences between the Flood Hazard Boundary Map and this study are justified due to the more detailed nature of this Flood Insurance Study.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
CONNECTICUT RIVER							
REACH 1	0010,0015	–2.1	–0.7	1.2	020	A4	VARIES–SEE MAP
LEACH CREEK							
REACH 1	0005,0010	–1.5	–0.4	1.1	015	A3	VARIES–SEE MAP
REACH 2	0005	–1.1	–0.3	0.6	010	A2	VARIES–SEE MAP
CAPON BROOK							
REACH 1	0015	–0.9	–0.3	0.7	010	A2	VARIES–SEE MAP
MORRILL BROOK							
REACH 1	0005	–0.8	–0.2	0.6	010	A2	VARIES–SEE MAP
HALLS STREAM							
REACH 1	0010	–1.3	–0.4	0.5	015	A3	VARIES–SEE MAP
WILLARD STREAM							
REACH 1	0015	–0.8	–0.3	0.6	010	A2	VARIES–SEE MAP
WALLACE POND							
REACH 1	0005	–1.3	–0.4	1.0	015	A3	1296

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

FLOOD INSURANCE ZONE DATA

CONNECTICUT RIVER - LEACH CREEK - CAPON BROOK - MORRILL BROOK - HALLS STREAM - WILLARD STREAM - WALLACE POND

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic and other pertinent data used in this study can be obtained by contacting the Insurance and Mitigation Division, Federal Emergency Management Agency, The J.W. McCormack Post Office and Courthouse Building, Room 462, Boston, Massachusetts 02109.

8.0 REFERENCES AND BIBLIOGRAPHY

1. Henneberger, John D., editor, Vermont Year Book, National Survey, Chester, Vermont, 1978.

2. State of Vermont, Water and Related Land Resources of Vermont, June 1974.

3. U.S. Department of Agriculture, Soil Conservation Service, General Soil Map, Essex County Vermont, December 1974.

4. State of Vermont, Report to the General Assembly of 1947 by the Commission (Act No. 195, 1945) to Investigate Flood Damage in the Upper Valley of the Connecticut River, 1947.

5. U.S. Water Resources Council, Bulletin No. 17A, Guidelines for Determining Flood Flow Frequencies, November 1977.

6. U.S. Geological Survey, Flood Magnitude and Frequency of Vermont Streams, Johnson and Tasker, 1974.

7. U.S. Bureau of Public Roads, Peak Rates of Runoff from Small Watersheds, W.D. Potter, 1961.

8. U.S. Geological Survey, Water Supply Paper 1301, 1954; and Water Supply Paper 1721, 1964.

9. --------------------, Water Resources Data for New Hampshire and Vermont, 1961-1976.

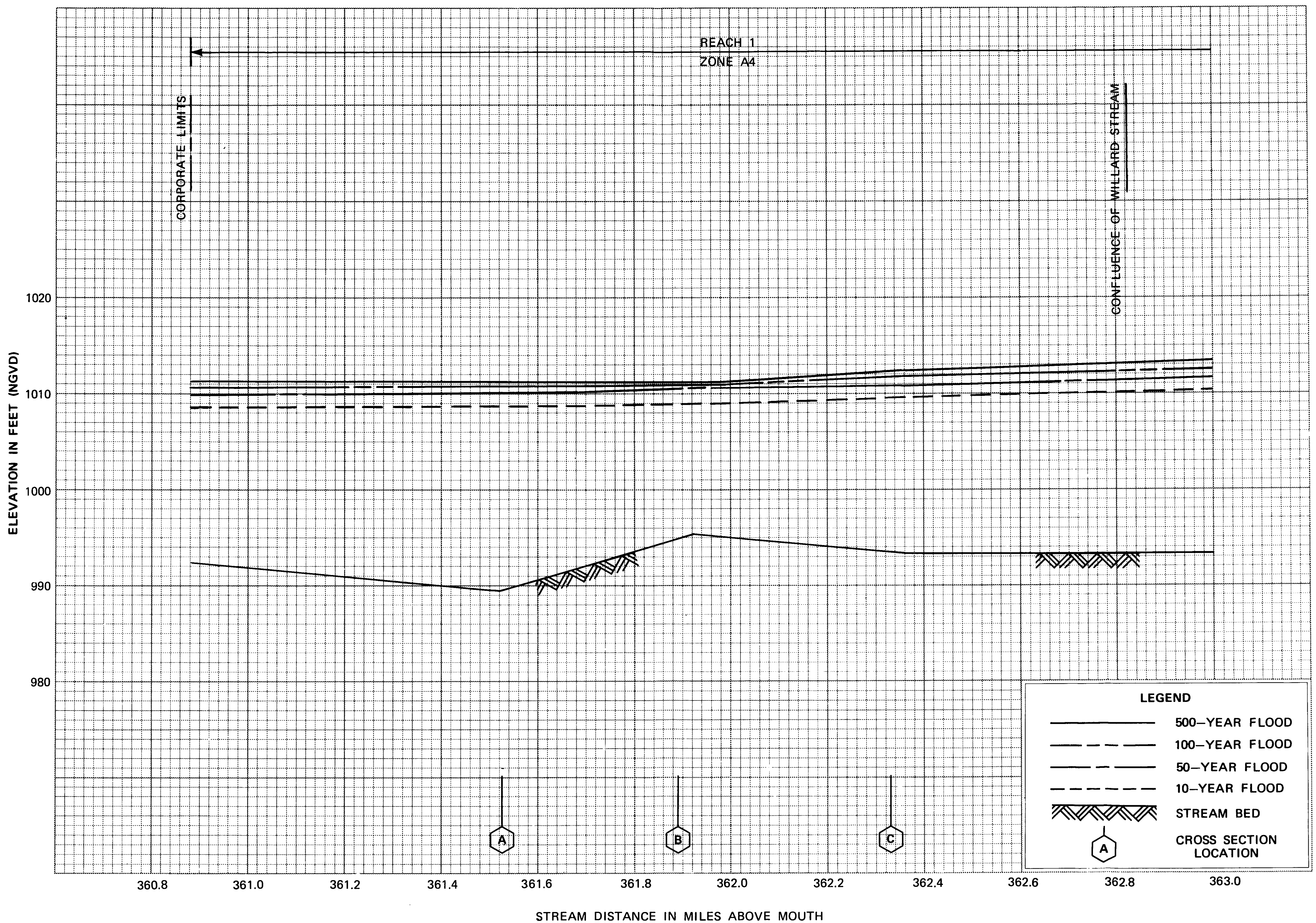
10. Chow, Ven Te, Open Channel Hydraulics. New York: McGraw-Hill Book Company, Inc., 1959.

11. U.S. Army Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A, HEC-2 Water-Surface Profiles, Davis, California, November 1976, (updated) August 1977.

12. --------------------, "Hydraulic Design of Spillways," EM 1110-2-1603, March 1965.

13. U.S. Geological Survey, 15 Minute Series Togographic Maps, Scale 1:62500, Contour Interval 20 feet: Averill, Vermont-New Hampshire, 1953; Dixville, New Hampshire, 1930; Indian Stream, New Hampshire-Vermont; 1926.

14. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Town of Canaan, Vermont, March 1977.



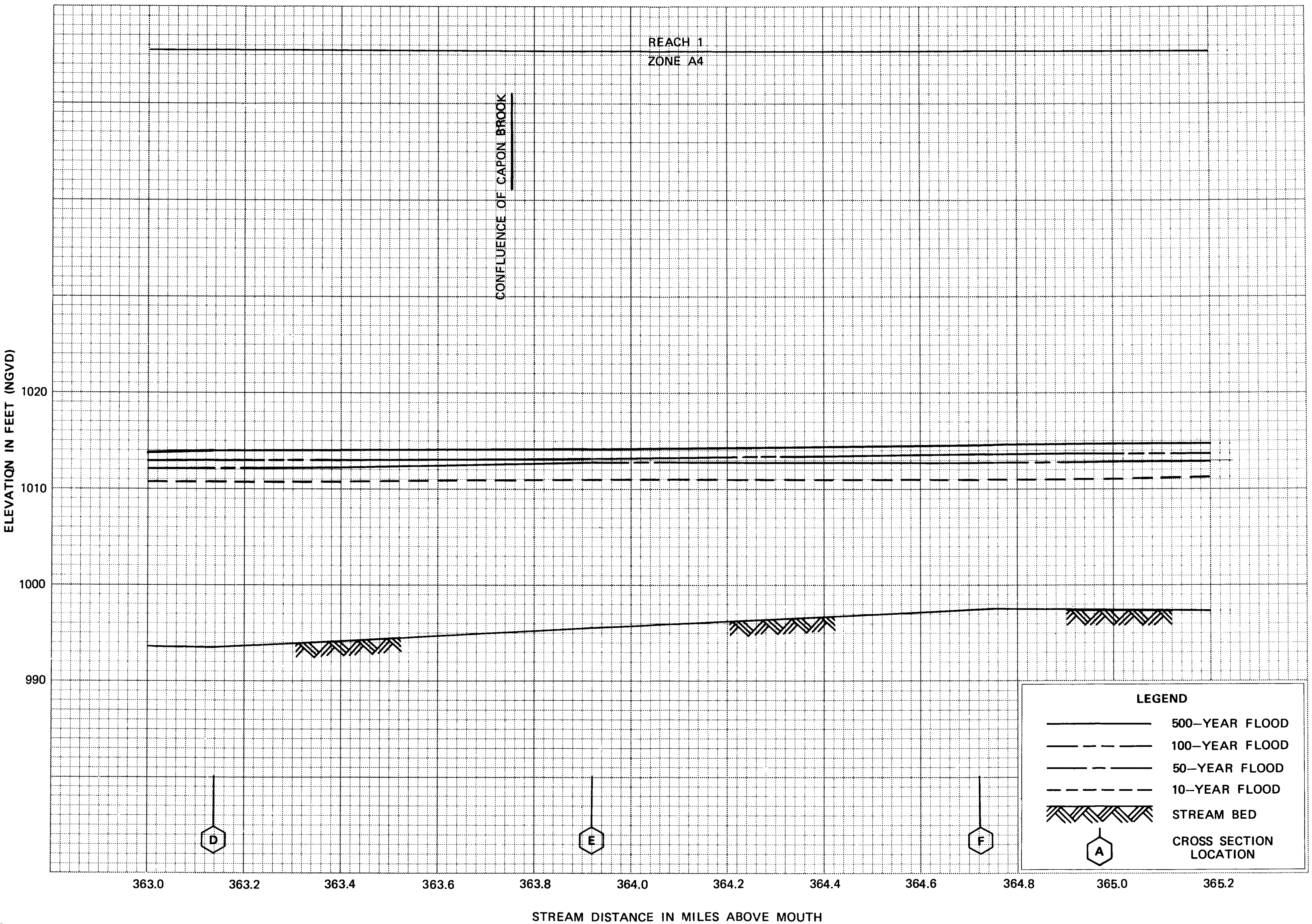
FLOOD PROFILES

CONNECTICUT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

01P



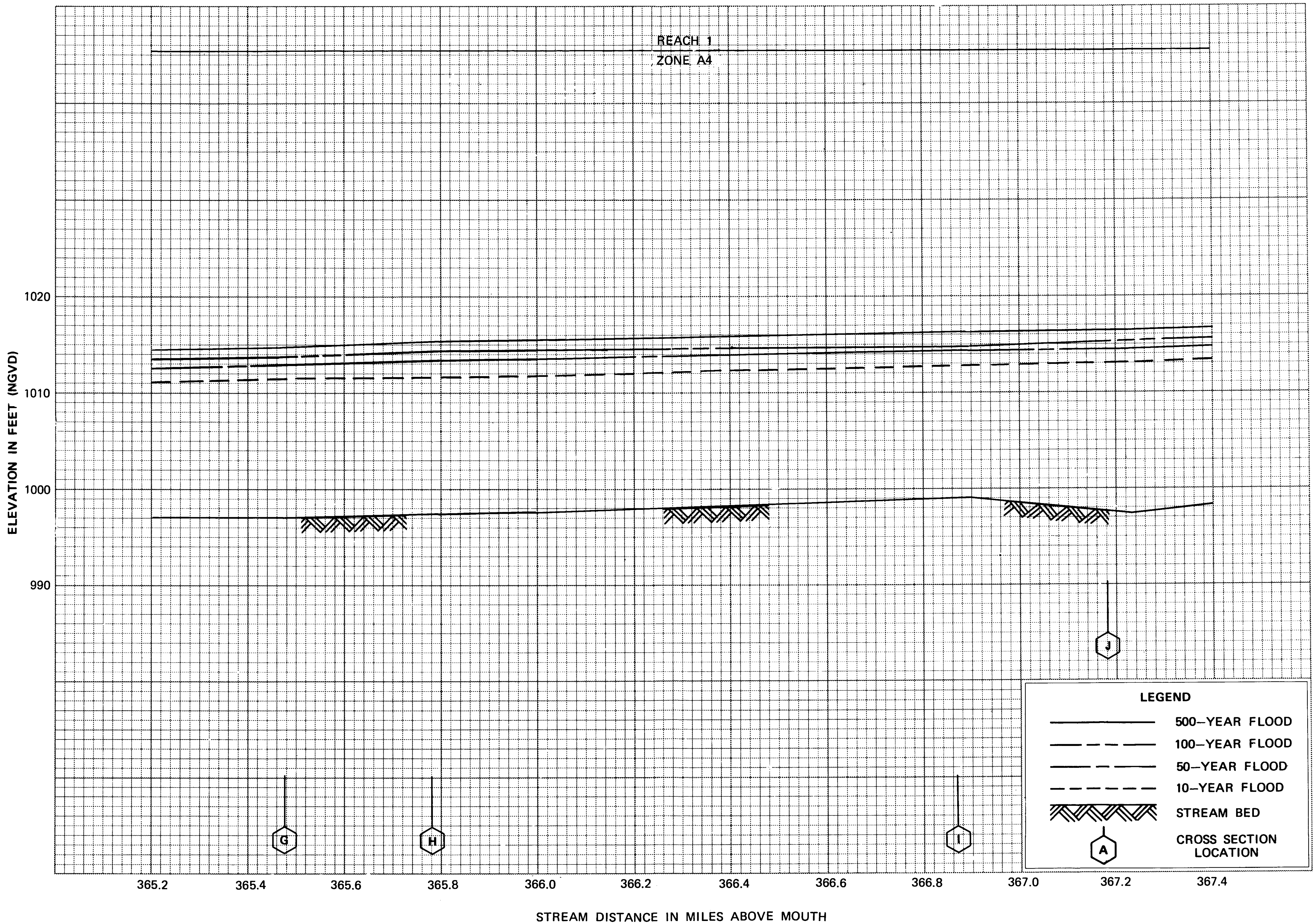
FLOOD PROFILES

CONNECTICUT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

02P



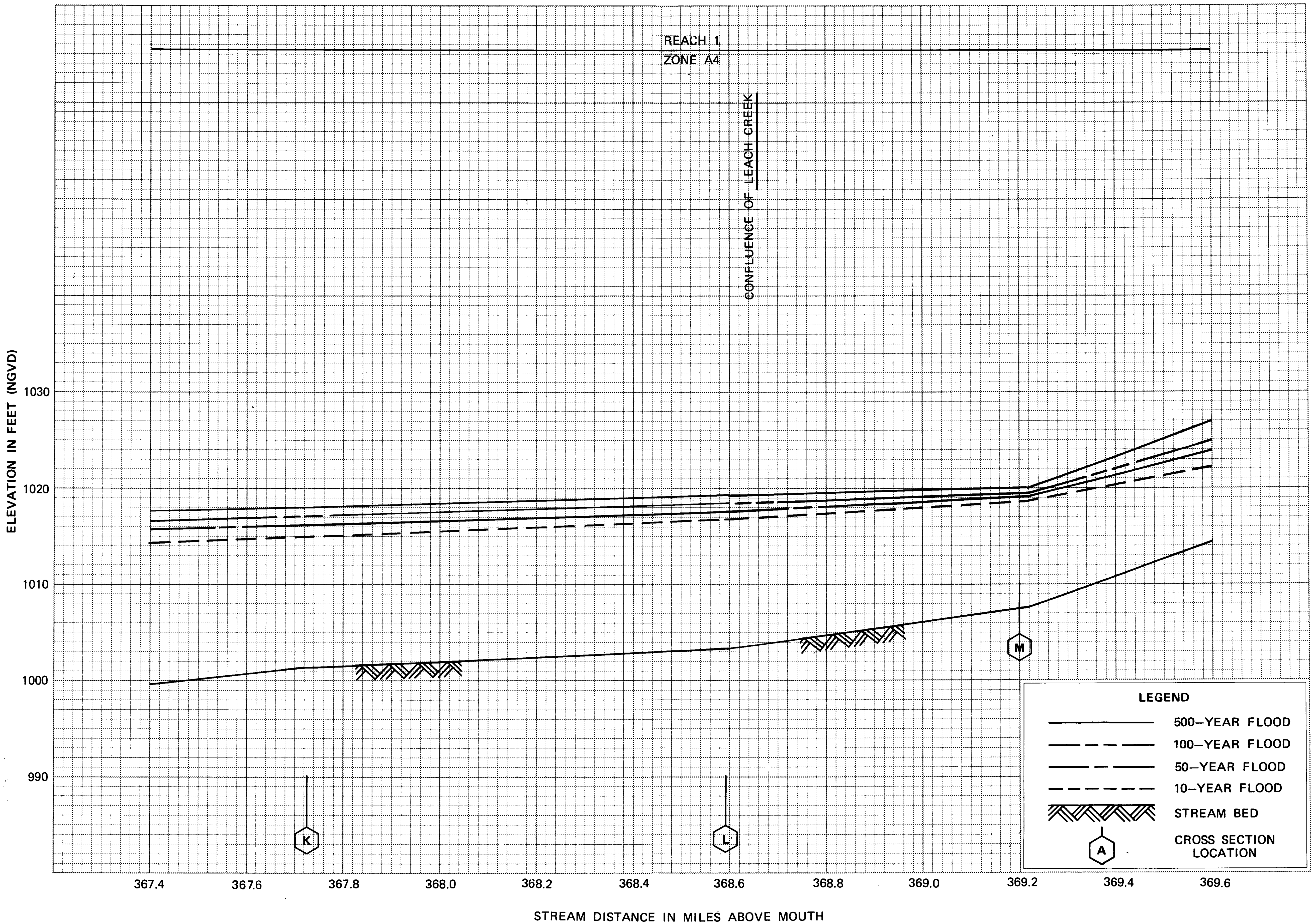
FLOOD PROFILES

CONNECTICUT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

03P



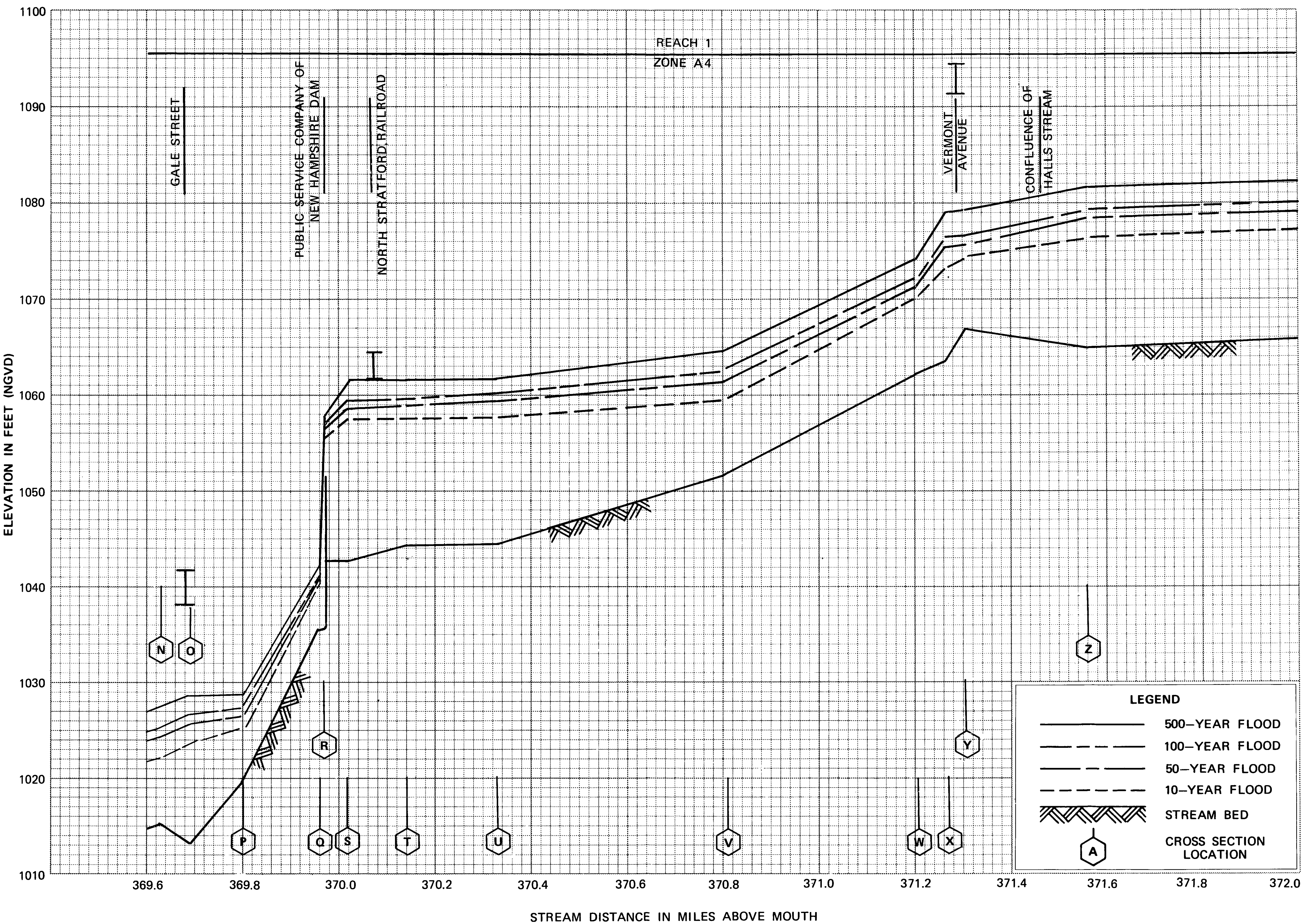
FLOOD PROFILES

CONNECTICUT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

04P



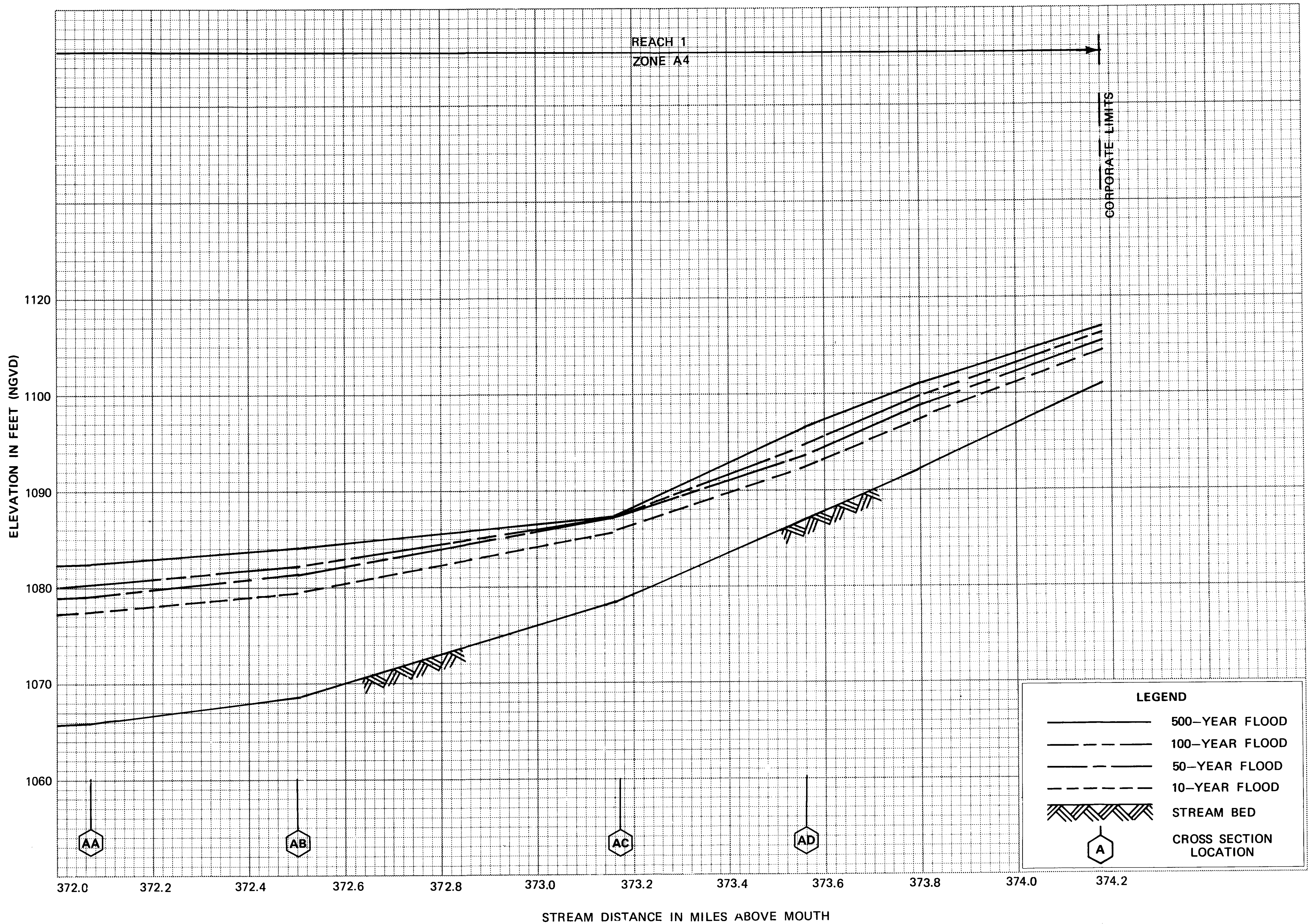
FLOOD PROFILES

CONNECTICUT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

05P



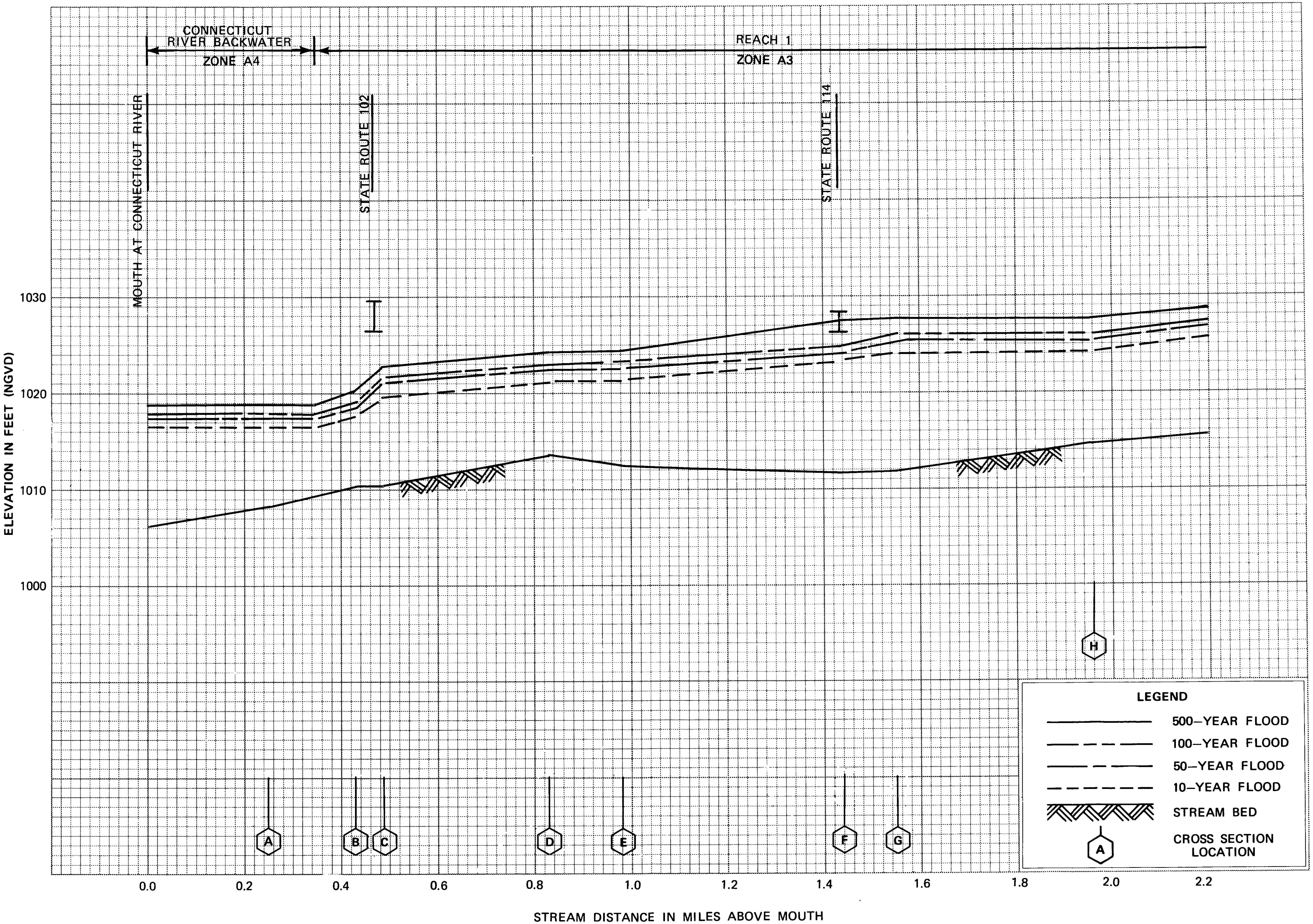
FLOOD PROFILES

CONNECTICUT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

06P



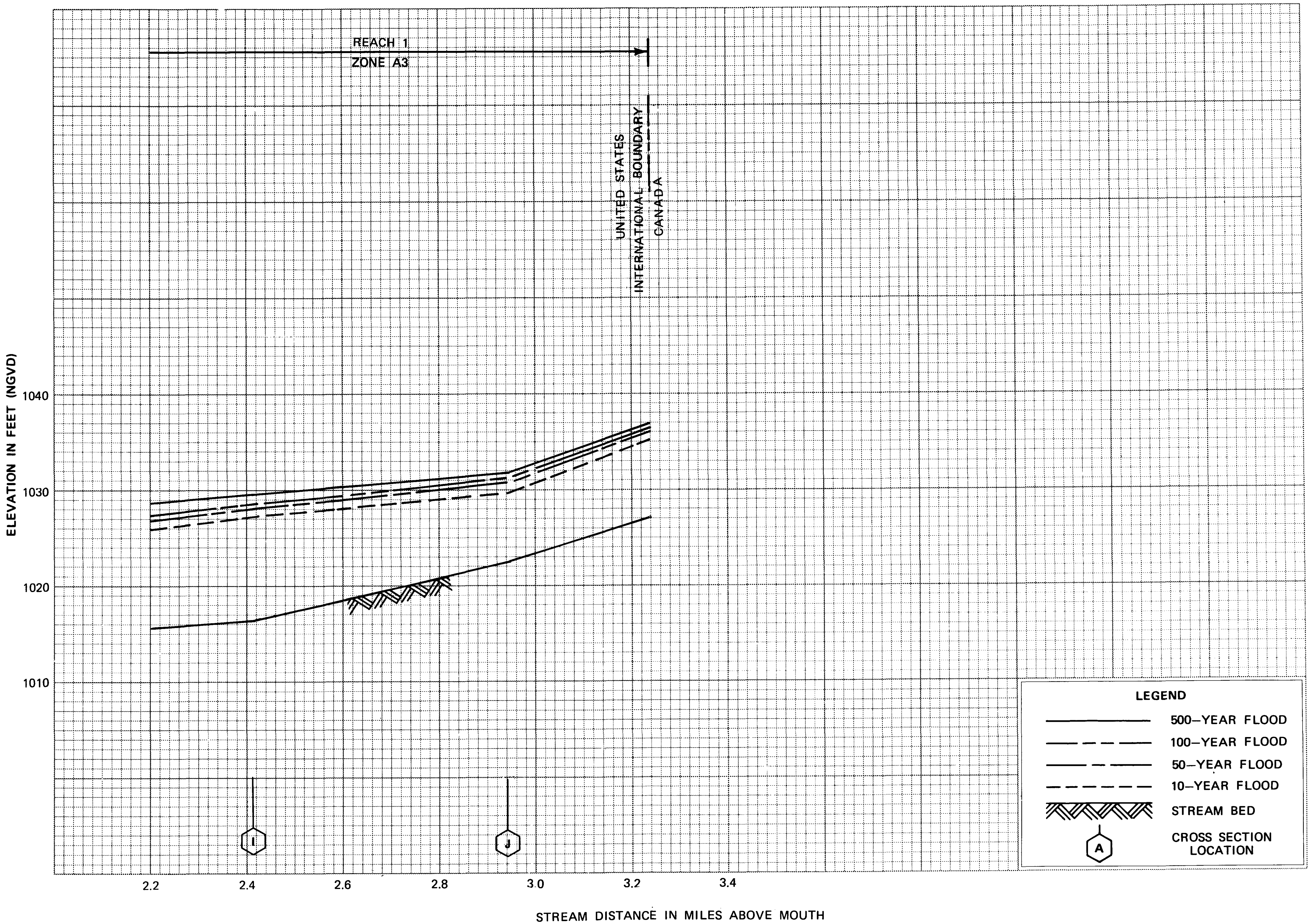
FLOOD PROFILES

LEACH CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

07P

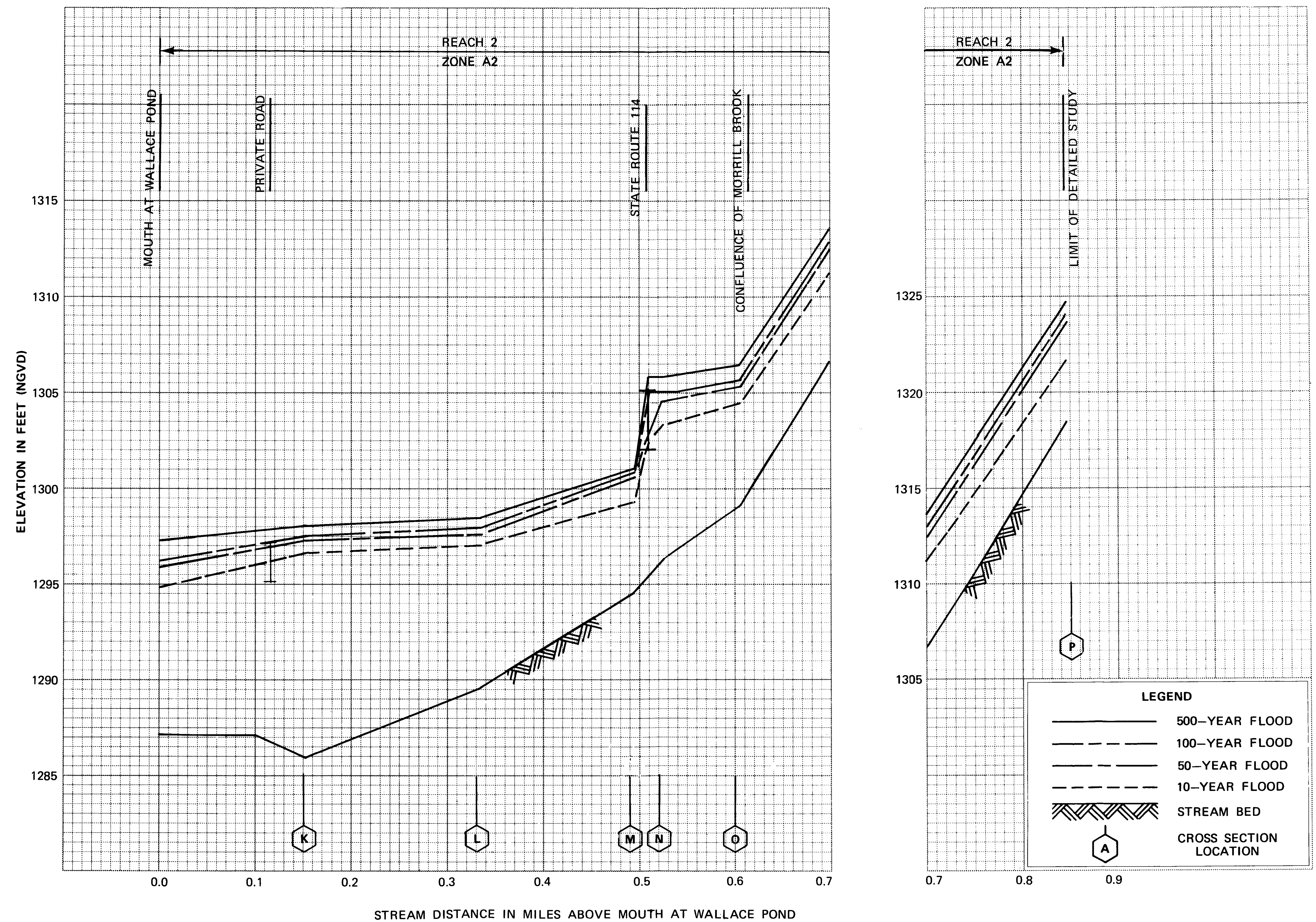


FLOOD PROFILES

LEACH CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)



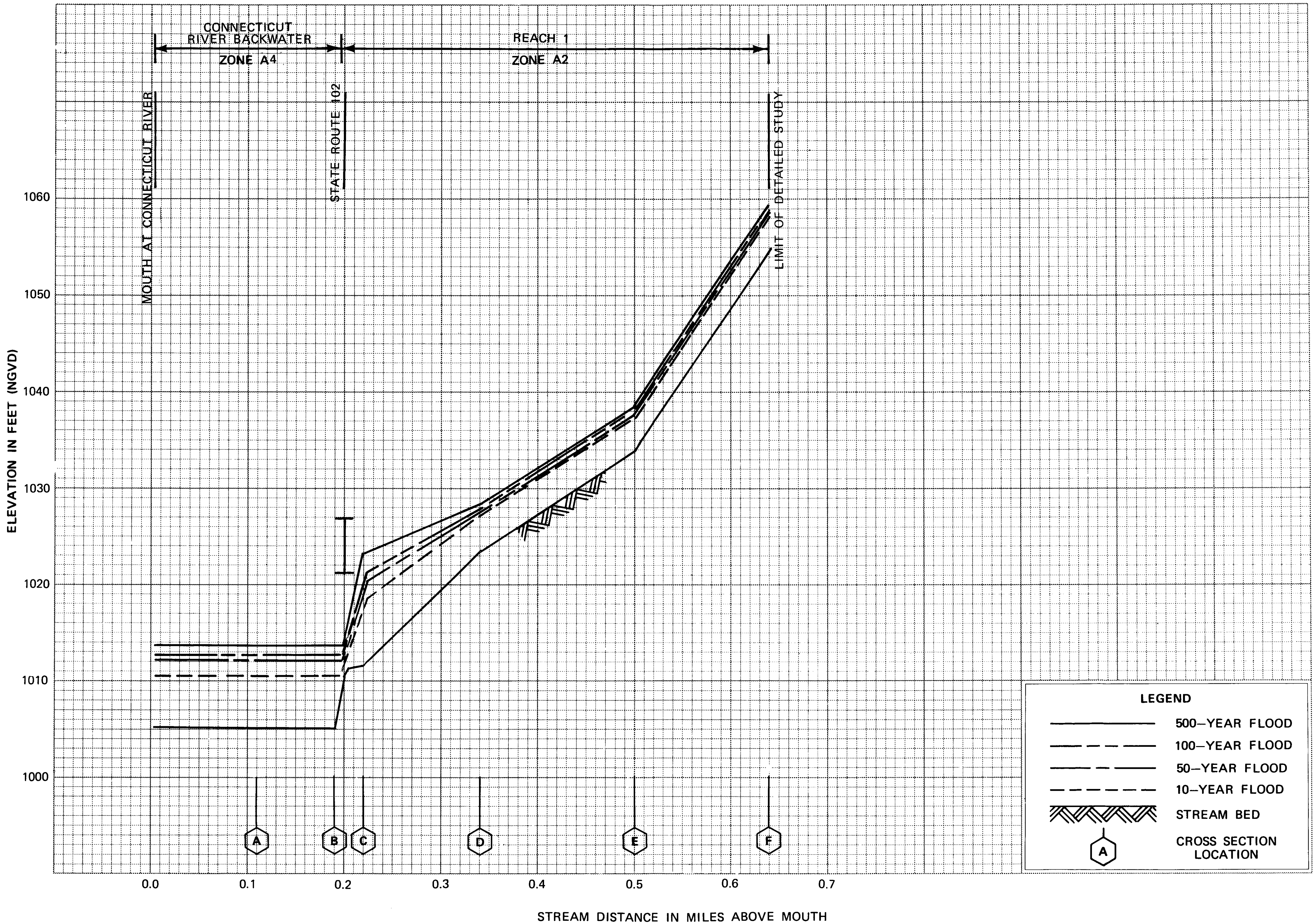
FLOOD PROFILES

LEACH CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

09P

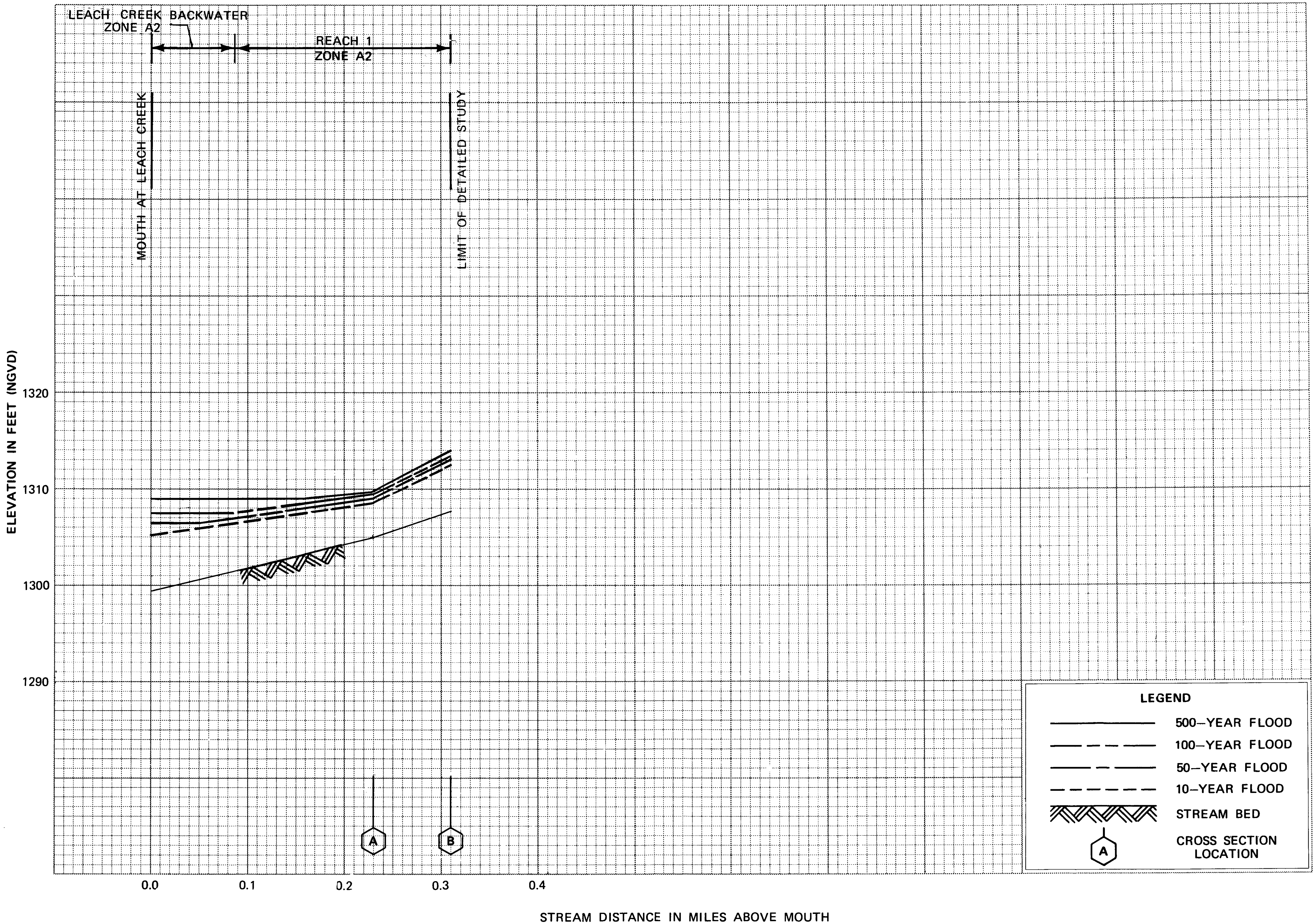


FLOOD PROFILES

CAPON BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)



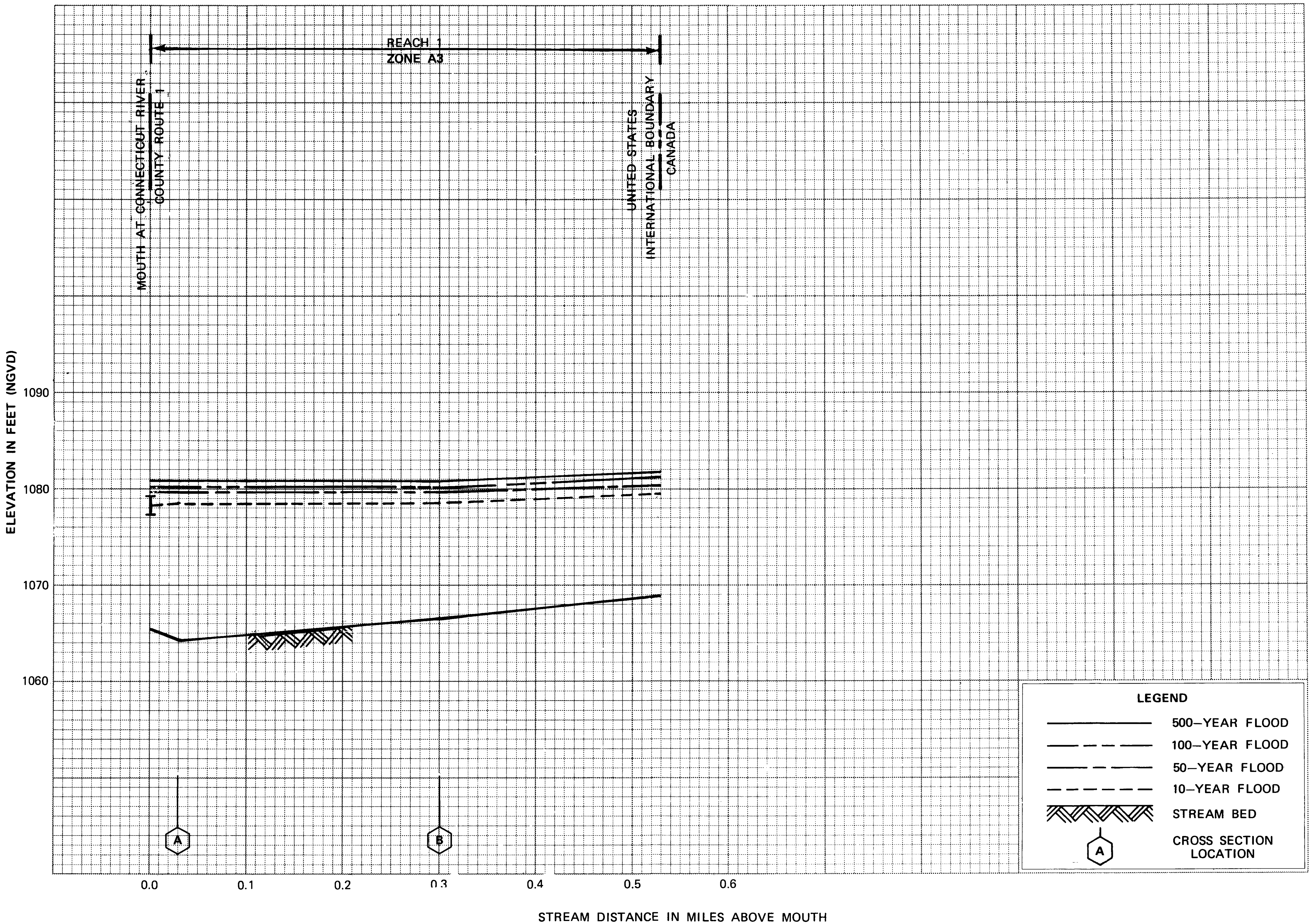
FLOOD PROFILES

MORRILL BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

11P



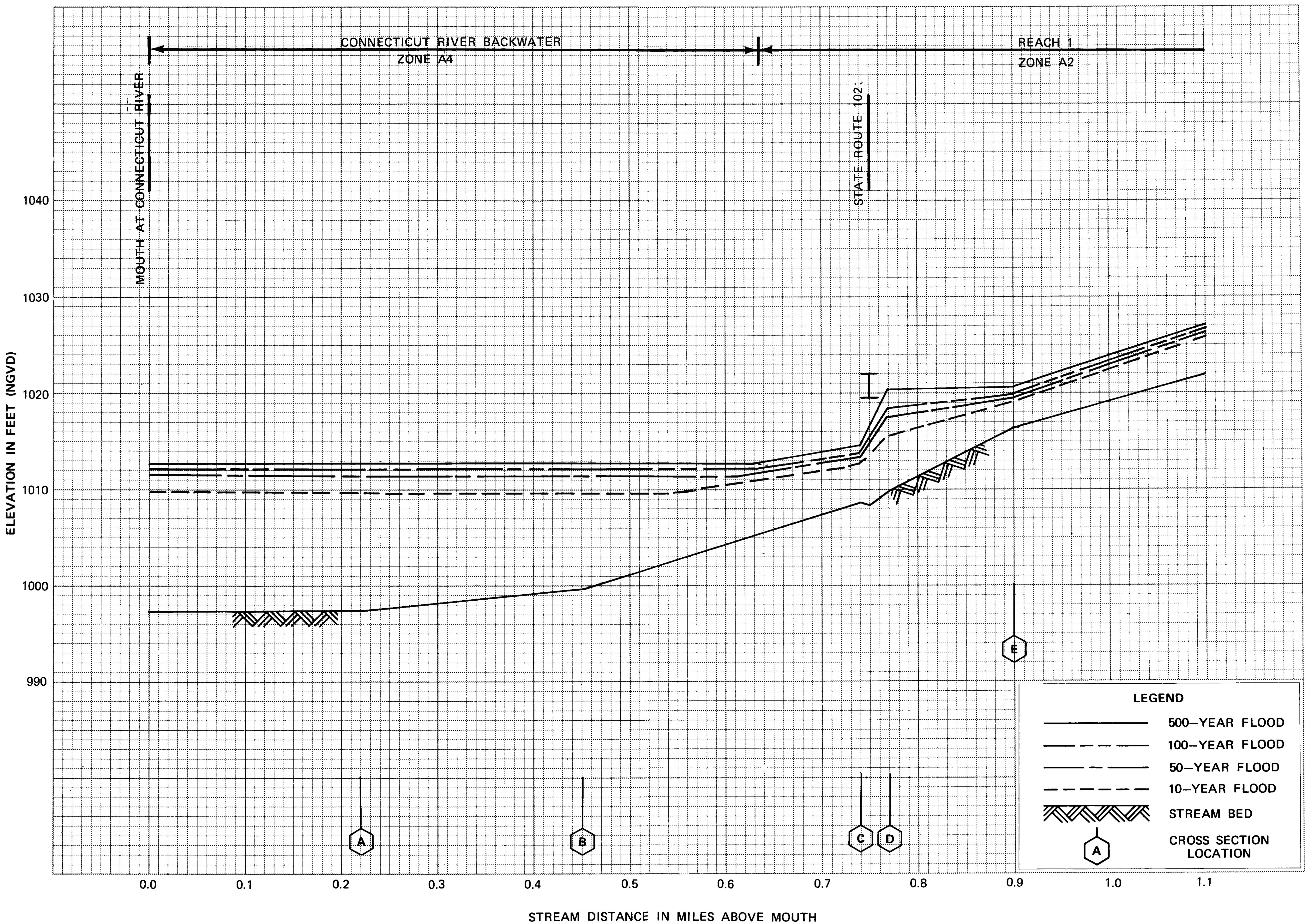
FLOOD PROFILES

HALLS STREAM

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)

12P

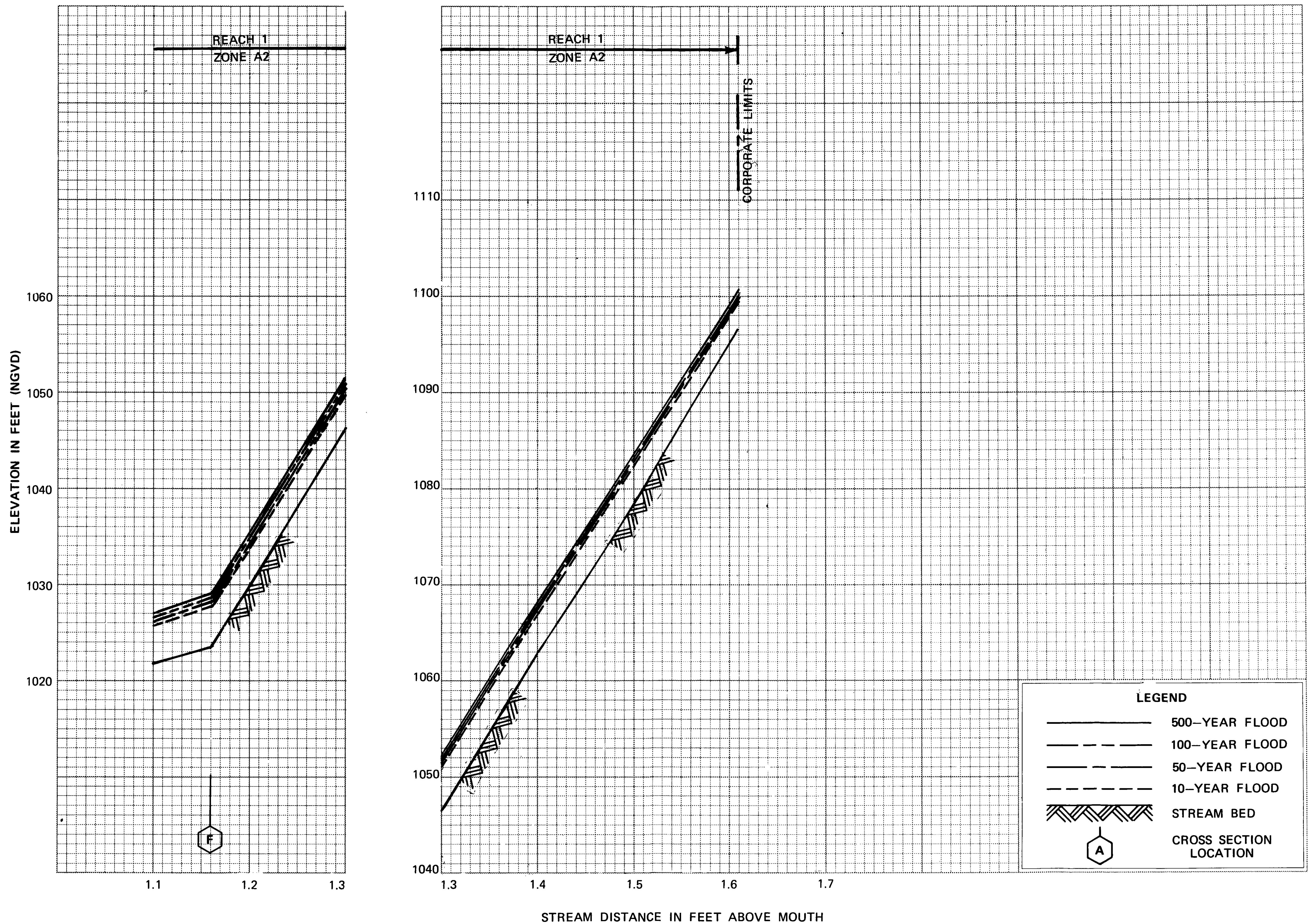


FLOOD PROFILES

WILLARD STREAM

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)



FLOOD PROFILES

WILLARD STREAM

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF CANAAN, VT
(ESSEX CO.)