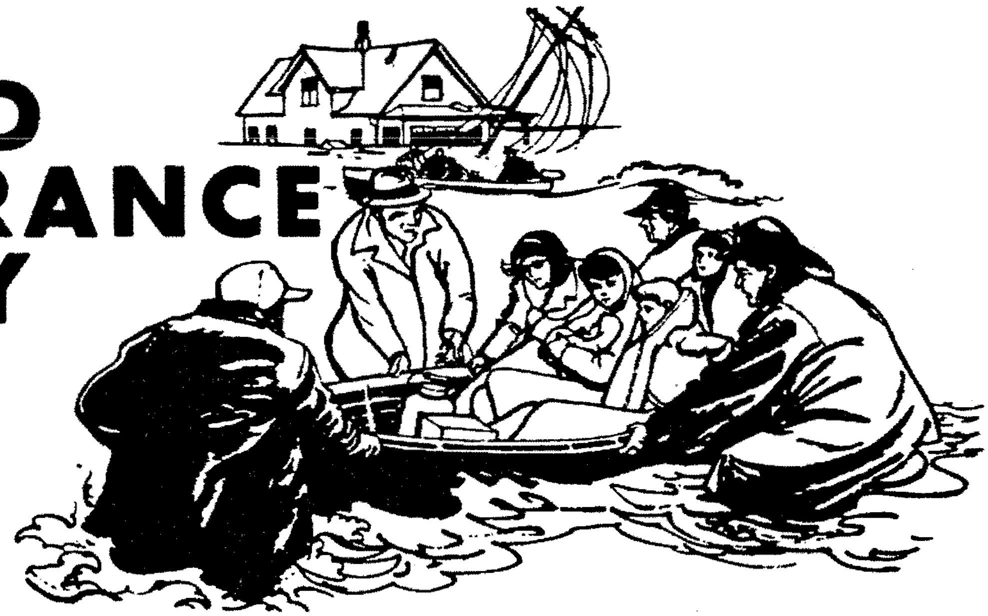
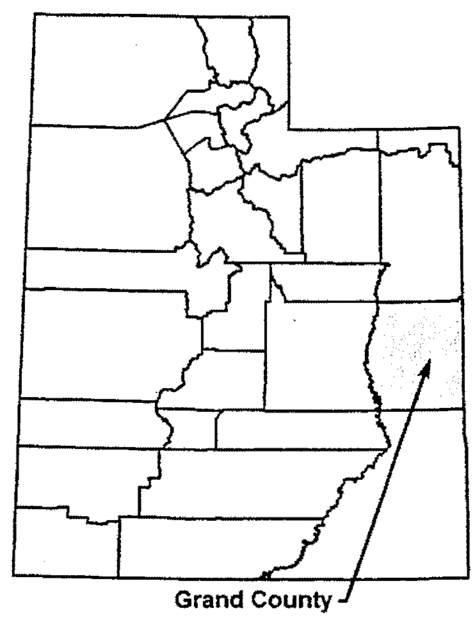
FLOOD INSURANCE STUDY



GRAND COUNTY, UTAH
AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
* Castle Valley, Town of	490110
Grand County (Unincorporated areas)	490232
Moab, City of	490072

* NON-FLOODPRONE



EFFECTIVE:
APRIL 2, 2009

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
49019CV000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program (NFIP) have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the Community Map Repository. It is advisable to contact the community repository for any additional data.

The Federal Emergency Management Agency (FEMA) may revise and republish part or all of this FIS report at any time. In addition, FEMA may revise part of this FIS report by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS report. Therefore, users should consult with community officials and check the Community Map Repository to obtain the most current FIS report components.

Selected Flood Insurance Rate Map panels for this community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways and cross sections). In addition, former flood insurance risk zone designations have been changed as follows.

Old Zone(s)	New Zone
A1-A30	AE
B	X
C	X

Initial FIS Effective Date: April 2, 2009

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FLOOD INSURANCE STUDY
GRAND COUNTY, UTAH, AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and supercedes the FIS report and Flood Insurance Rate Maps (FIRMs) and Flood Boundary and Floodway Maps in the geographic area of the City of Moab, and portions of Grand County, Utah, in the vicinity of the City of Moab (see Flood Insurance Rate Map Index), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates. This information will also be used by community officials to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local planners to further promote sound land use and floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

The Digital Flood Insurance Rate Map (DFIRM) and FIS Report for the area in the vicinity of the City of Moab have been produced in digital format. Flood hazard information was converted to meet the FEMA DFIRM database specifications and Geographic Information System (GIS) format requirements. The flood hazard information was created and is provided in a digital format so that it can be incorporated into a local GIS and be accessed more easily by the community.

The City of Green River is not included in this study. It should also be noted that the Town of Castle Valley in non-floodprone.

1.2 Authority and Acknowledgements

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

The detailed hydrologic and hydraulic analyses for this study were performed by Bowen, Collins & Associates. The hydrologic analyses for Mill Creek and Pack Creek and the hydraulic analyses for Mill Creek were performed for a

Pack Creek and the hydraulic analyses for Mill Creek were performed for a Letter of Map Revision sponsored by the City of Moab in February 2006. The hydraulic analyses for Pack Creek and the Colorado River and the conversion of the Mill Creek analyses to digital format were completed by Bowen, Collins & Associates in association with AMEC for the Utah Office of Emergency Services, a Federal Emergency Management Agency (FEMA) Cooperating Technical Partner (CTP), under Utah State Contract Number 066016. This work was completed in September 2006.

The base mapping for most of the study area consists of digital orthographic aerial photography prepared in natural color 1-meter resolution by the National Agricultural Imagery Program (NAIP) dated 2004. All base map and topographic mapping was acquired and/or converted to Utah State Plane, South, survey feet coordinates, North American Vertical Datum of 1988 (NAVD 88). The final DFIRM production was converted to UTM projection in meters in accordance with FEMA Guidelines & Specifications. All base mapping for the study, including the aerials, streets, landmarks and other features, was compiled and provided by:

Utah Automated Geographic Reference Center (AGRC)
State Office Building, Room 5130
Salt Lake City, UT 84114
801-538-3665, www.agrc.utah.gov

Use of the base mapping for this project is subject to the terms and conditions of the original source, which may be obtained from the AGRC.

1.3 Coordination

The Initial Consultation Coordination Officer (CCO) conference telephone call was held on June 8, 2005, with representative participants from the study contractor, the State of Utah Office of Emergency Services, FEMA, and the City of Moab.

Coordination with City officials and Federal and State agencies produced information pertaining to floodplain regulations, community maps, flood history, and other hydrologic data.

Another CCO meeting was held in Moab City on May 31, 2006, and attended by personnel from Moab City, FEMA, and the Utah Office of Emergency Services, and the study contractor. The purpose of this meeting was to review and discuss the preliminary results of the study to the community.

The results of this study were reviewed at the final CCO meeting held on March 27, 2007. Attending the meeting were representatives of Moab City, FEMA, the Utah Office of Emergency Services, and the study contractor. All problems raised at that meeting have been addressed.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area in the vicinity of the City of Moab, Grand County, Utah. The study was prepared in a countywide format, not limited by municipal jurisdictional boundaries, but was limited in scope to the flooding sources in the vicinity of Moab that are in areas experiencing or anticipating high population growth and development pressure. Moab City is the only community included in the FIS update because it is the only community in Grand County that was participating in the NFIP when this study was completed.

Flooding associated with Mill Creek and Pack Creek was evaluated using detailed study methods. Flooding associated with the Colorado River was studied using approximate study methods. Shallow flooding resulting from runoff from the slickrock (sandstone cliffs) area east of the city and from the mountains southeast of the city was digitized from the 1979 FIRM at the direction of FEMA personnel. The flood boundaries of these shallow flooding sources were defined in a Soil Conservation Service Flood Hazard Analysis Study in December 1975 (Reference 3).

Those areas studied by detailed methods were chosen with consideration given to all proposed construction and forecasted development through 2006.

2.2 Community Description

The City of Moab is located in southern Grand County, in east central Utah. Moab is approximately 235 miles southeast of Salt Lake City. The population of Moab was 4779 in 2000 (Reference 1). The Utah U.S. Census Bureau estimated the 2005 population to be 4810 (Reference 1).

The economy of Moab is based on tourism, mineral development, and industry. Moab is near Arches National Park, Canyonlands National Park, and other scenic attractions. The city is the historic center of a uranium mining district, with a uranium processing mill and tailings site just north of the city. Much of the residential area and part of the commercial area of Moab are located within the flood plains of Mill and Pack Creeks.

Mill Creek and Pack Creek flow northwesterly through Moab to their confluence on the west side of the city. From there, Mill Creek flows westerly to the Colorado River, approximately 0.4 mile west of the corporate limits.

Moab lies in the northwest end of a narrow fault valley bounded by steep, colorful, sandstone cliffs. The soils are Quaternary alluvium, consisting of silty, fine sand; gravel; cobbles; and boulders. A terrace of silty, fine sand and gravel with few cobbles is located on the east side of the city (Reference 3).

Temperatures in Moab range from an average low of 18.2°F to an average high of 42.4°F in the January, and from an average low of 62.8°F to an average high of 98.1°F in the July (Reference 4). The average annual precipitation in Moab is 9.01 inches (Reference 4).

Vegetation in the city is varied, with most of-the land covered with scattered brush and grass. Deciduous trees are found along watercourses or in irrigated residential areas.

2.3 Principal Flood Problems

The City of Moab is subject to flooding from Mill Creek and Pack Creek due to summer cloudburst storms. These streams originate in the La Sal Mountains southeast of Moab. The summer storms are generally intense and of short duration. It is not uncommon to experience flooding on Mill Creek and/or Pack Creek without experiencing any precipitation in Moab.

Cloudburst storms in Moab can produce short-duration floods originating on nearby sandstone cliffs. These floods create areas of shallow flooding as the runoff flows toward Mill Creek, Pack Creek, or the Colorado River.

Since 1881, over 100 cloudburst floods have been recorded in the Moab area. Damages have included erosion of channels, water and sediment damages to residential areas, deposition of debris, and severe damage to irrigation diversions, bridges, roads, buried water pipelines, and structures near Mill Creek and Pack Creek.

The largest Mill Creek flood of record occurred on August 21, 1953. The peak discharge of that flood was 5110 cubic feet per second (cfs). The largest gaged flood on record for the Colorado River, 76,800 cfs, occurred on June 19, 1917. The most recent large flood of 70,300 cfs on the Colorado River occurred on May 27, 1984.

2.4 Flood Protection Measures

Numerous flood control measures in the Moab area have been implemented and many more have been recommended (Reference 3). In the slickrock area to the east of the city, 107 rock-wire check dams have been built. These check dams and a debris basin at the mouth of Tusher Canyon reduce flooding from this area. Additionally, several small dams have been constructed in drainages at the foot of the rock cliffs along the east side of the city to create detention facilities to attenuate large runoff peaks from the slickrock area. These detention facilities were designed to control the 100-year flood.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods 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 that are expected to be equaled 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 floodplain management and for flood insurance 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 equaled 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 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent- annual-chance flood in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein 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 the major streams in the community (Reference 19 and 20).

A flood frequency analysis was performed using an annual series of peak flood discharges for Mill Creek for the period of record from USGS gage 0918400. The period of record included in this analysis was 1915 to 1917, and 1975 to 1993. The Mill Creek streamflow gage was abandoned in 1993. The flood frequency analysis was performed using the HEC-FFA Flood Frequency Analysis computer program developed by the U.S. Army Corps of Engineers. A generalized skew factor of 0.1, obtained from a recent Utah Department of Transportation study (Reference 12) was used in the analysis.

Bulletin 17B, Guidelines for Determining Flood Flow Frequency (References 6 and 7) recommends performing a sensitivity analysis to test if the upper tail of the flood frequency curve is sensitive to low flows. A sensitivity analysis was performed using different threshold values. The final analysis used a threshold value of 300 cfs to reduce the effects of the low flow "non-flood" events on the upper portion of the flood frequency curve. No historic discharge data were used in the analysis.

Stream gage records for Pack Creek exist only for the years 1955 to 1959 and are inadequate for development of flood frequency estimates using statistical methods. Therefore, the methods described in the National Flood Frequency

Program – Methods for Estimating Flood Magnitude and Frequency in Rural Areas in Utah (References 10 and 11) were used develop flood frequency discharges for Mill Creek using regional regression equations. Version 3 of the NFF computer program was used to apply the appropriate regional regression equation in computing flood frequency discharges, but the results were area weighted with the statistical analyses from Mill Creek to refine the results. A similar procedure was used to develop the flood frequency discharges for Mill Creek below the Pack Creek confluence. A more detailed summary of the hydrologic analysis is presented in a hydrology report that is included in the Technical Support Data Notebook on file in the FEMA archives and at the Community Map Repository.

Although not studied using details methods, a flood frequency analysis was also completed for the Colorado River using annual peak discharges from USGS gage 09180500. The period of record for the analysis was 1914 to 1917, and 1923 to 2005. Due to the length of record, no generalized skew was used. No historic discharge data were used in the analysis. The FFA computer program and the procedures outlined in Bulletin 17 B were utilized in performing the analysis.

Peak discharge-drainage area relationships for the Colorado River, Mill Creek and Pack Creek are shown in Table 1.

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-Percent Annual-Chance	2-Percent Annual-Chance	1-Percent Annual-Chance	0.2-Percent Annual-Chance
COLORADO RIVER, Near Cisco, Utah	24,100	59,000	78,500	86,000	100,000
MILL CREEK					
Below Pack Creek confluence	132.3	3,580	7,660	9,940	16,650
3.5 miles upstream from the mouth of Mill Creek at confluence with Colorado River	74.9	2,910	6,250	8,670	15,400
PACK CREEK At Mill Creek Drive	57.4	2,560	5,480	7,120	11,920

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals (Reference 21). Users should be aware that flood elevations shown on the Flood Insurance Rate Map (FIRM) represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data table in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS report in conjunction with the data shown on the FIRM.

Channel cross sections for the backwater analyses of Mill Creek and Pack Creek were field surveyed when there was little to no flow in the streams. Elevation data for the floodplain areas outside the main channels were taken from 1991 aerial topographic mapping obtained from the City of Moab. All hydraulic structures were field surveyed to obtain elevation data and structural geometry for modeling purposes.

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 FIRM (Exhibit 2).

Water-surface profiles for Mill Creek and Pack Creek were computed using version 3.1.3 of the U.S. Army Corps of Engineers HEC-RAS step-backwater computer program (Reference 8). Profiles were computed for the 10-, 50-, 100-, and 500-year floods. Starting water surface elevations for both river models were computed using normal depth routines.

Roughness coefficients (Manning's "n") were estimated for Mill Creek and Pack Creek by field investigation and supplemented with engineering judgment. Roughness coefficients-ranged from 0.045 to 0.050 in the main channels and from 0.05 to 0.17 in the overbank areas.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Areas of shallow flooding caused by bank overtopping at several locations along Mill Creek and Pack Creek were estimated using normal depth analysis. Hydraulic computations for Mill Creek predict that the 100- and 500-year floods will overtop the north bank immediately upstream of the 400 East bridge. This hydraulic restriction is due to sediment deposition under the bridge and a narrow channel section just downstream of the bridge. Computations also predict that Mill Creek will overflow its banks immediately upstream of the 300 East bridge during the 50-, 100-, and 500-year floods due to capacity restrictions of the existing bridge opening. The north bank of Mill Creek may also overtop during the 100- and 500-year floods between Main Street and 300 South due to the height of the bank in that area. Some Mill Creek overtopping is also predicted upstream of the Main Street bridge during the 100- and 500-year floods due to sediment deposition in the area. Hydraulic computations for Pack Creek predict that the Main Street bridge will overtop during the 50-, 100-, and 500-year floods due to sediment deposition in the bridge culverts and thick vegetation in the existing channel. The banks upstream of the 400 East bridge on Pack Creek will also overtop during the 500-year event. Since most of these capacity problems and the related shallow flooding can be easily mitigated for the 100-year event, the base flood elevations for Mill Creek and Pack Creek were computed assuming the entire 100-year discharge would remain in the channel and routed downstream rather than subtracting the over bank flows upstream. This is believed to be prudent and conservative, and the approach is supported by community officials for managing development in or near the floodplains. The extent of the shallow flooding areas caused by channel overtopping were developed assuming the capacity restrictions remain unchanged during a flood.

The areas of 100-year shallow flooding associated with surface runoff originating in the slickrock area, along the east side of the city, was determined using a normal depth analysis and previous U.S. Soil-Conservation Service calculations (Reference 3). In the southwestern portion of Moab, 500-year flood boundaries were determined using U.S. Soil Conservation Service calculations (Reference 3). The results were verified by local residents.

The approximate flood boundaries associated with the 100-year flood on the Colorado River in the vicinity of Moab were developed from information provided by the USGS in association with USGS Scientific Investigations Report 2005-5022 (Reference 5). That study utilized the USGS Multi-Dimensional Surface Water Modeling System (MD_SWMS) to evaluate hydraulic characteristics of the section of the Colorado River near Moab. USGS personnel utilized their model with the 100-year discharge listed in Table 1 to develop the approximate floodplain boundary shown on the FIRM.

3.3 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD). With the completion of the North American Vertical Datum of 1988 (NAVD), many FIS reports and FIRMs are now prepared using NAVD as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. It is important to note that the 1991 base map used to delineate the floodplain boundaries was developed on the NGVD29 datum. The flood boundaries and elevations were developed using the NGVD29 datum and mapping, then converted to NAVD88 for publishing. The conversion was made by adding 3.32 feet to the NGVD29 elevations provided by field survey and topographic mapping. For information regarding conversion between the NGVD and NAVD, visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

Spatial Reference System Division
NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each FIS provides 1-percent-annual-chance flood elevations and delineations of the 1- and 0.2-percent-annual-chance floodplain boundaries and 1-percent-annual-chance floodway to assist communities in developing floodplain management measures. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data table and Summary of Stillwater Elevations Table. Users should reference the data presented in the FIS report as well as additional information that may be available at the local map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using digital topographic maps with a contour interval of 2 feet (Reference 16). Shallow flooding boundaries associated with Mill Creek and Pack Creek were delineated using the same digital topographic maps. Shallow flooding boundaries associated with flooding from the slickrock area and the surrounding mountains were digitized from the effective FIRM's.

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, V, and VE); and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

The streams studied by approximate methods, only the 1-percent-annual-chance floodplain boundary, are shown on the FIRMs (Exhibit 2).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-

percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodway presented in this FIS report and on the FIRM was computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations have been tabulated for selected cross sections and are presented in Table 2. In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mill Creek								
A	805	595	3,527	2.8	3,971.5	3,971.5	3972.4	0.9
B	1,618	605	4,185	2.4	3,974.6	3,974.6	3975.5	0.9
C	2,358	444	3,256	3.1	3,977.9	3,977.9	3978.4	0.5
D	2,764	370	2,132	4.7	3,979.7	3,979.7	3980.1	0.5
E	3,400	350	2,092	4.8	3,985.9	3,985.9	3986.5	0.6
F	4,242	472	3,004	5.4	3,991.7	3,991.7	3991.8	0.2
G	4,366	397	2,547	4.9	3,994.8	3,994.8	3995.0	0.2
H	4,515	409	3,072	3.2	3,996.5	3,996.5	3997.2	0.7
I	5,207	384	2,633	3.8	4,002.2	4,002.2	4003.2	1.0
J	5,638	467	2,488	4.0	4,006.4	4,006.4	4007.1	0.7
K	6,048	423[2]	1,688	5.9	4,010.4	4,010.4	4010.8	0.3
L	6,487	742[2]	2,027	4.9	4,016.0	4,016.0	4016.4	0.4
M	7,023	282	1,412	6.1	4,025.0	4,025.0	4025.1	0.1
N	7,265	167	1,117	7.8	4,030.3	4,030.3	4031.0	0.7
O	7,600	115	1,257	6.9	4,034.3	4,034.3	4035.3	1.0
P	7,780	74	724	12.0	4,037.0	4,037.0	4037.2	0.2
Q	7,913	130	931	9.3	4,039.5	4,039.5	4040.0	0.5
R	8,074	157	816	10.6	4,041.6	4,041.6	4041.8	0.2
S	8,213	220	1,219	7.1	4,043.7	4,043.7	4044.4	0.7
T	8,330	195	965	9.0	4,044.7	4,044.7	4045.4	0.7
U	8,834	183	1,035	8.4	4,052.4	4,052.4	4053.2	0.8
V	9,100	130	841	10.3	4,057.1	4,057.1	4057.4	0.4
W	9,849	176	966	9.0	4,066.3	4,066.3	4066.8	0.5
X	10,149	155	856	10.1	4,071.5	4,071.5	4071.9	0.3
Y	10,442	157	788	11.0	4,076.7	4,076.7	4077.3	0.6
Z	10,786	287	2,264	3.8	4,087.4	4,087.4	4088.1	0.8

[1] Feet above corporate limits

[2] Reflects combined widths of Pack and Mill Creeks

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRAND COUNTY, UT AND INCORPORATED AREAS

FLOODWAY DATA

MILL CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mill Creek (continued)								
AA	11,000	369	2,152	4.0	4,087.7	4,087.7	4088.5	0.8
AB	11,233	157	824	10.5	4,089.9	4,089.9	4089.9	0.0
AC	11,800	178	918	9.5	4,101.3	4,101.3	4101.3	0.0
AD	12,221	122	760	11.4	4,106.4	4,106.4	4106.4	0.0
AE	12,910	87	823	10.5	4,118.8	4,118.8	4119.2	0.5
AF	13,288	110	811	10.7	4,124.3	4,124.3	4124.6	0.3
AG	13,825	94	748	11.6	4,132.4	4,132.4	4132.4	0.0
AH	14,269	84	834	10.4	4,139.2	4,139.2	4139.5	0.3
AI	14,821	121	1,099	7.9	4,145.1	4,145.1	4146.0	0.9
AJ	14,900	205	907	9.6	4,150.5	4,150.5	4150.5	0.0
AK	15,012	210	1,168	7.4	4,152.2	4,152.2	4153.2	1.0
AL	15,639	230	1,225	7.1	4,161.6	4,161.6	4161.6	0.0
AM	16,200	150	911	9.5	4,166.8	4,166.8	4167.8	0.9
AN	17,050	53	503	17.3	4,179.2	4,179.2	4179.4	0.2
AO	17,503	62	521	16.6	4,190.7	4,190.7	4190.7	0.0

[1] Feet above corporate limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRAND COUNTY, UT AND INCORPORATED AREAS

FLOODWAY DATA

MILL CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Pack Creek								
A	1,721	307	2,101	3.4	4,030.4	4,030.4	4,030.6	0.2
B	2,312	293	1,809	3.9	4,036.8	4,036.8	4,036.9	0.2
C	2,716	250	1,829	3.9	4,042.1	4,042.1	4,042.2	0.0
D	2,950	223	1,300	5.5	4,045.3	4,045.3	4,045.3	0.0
E	3,094	207	1,647	4.3	4,048.3	4,048.3	4,048.3	0.0
F	3,523	153	965	7.4	4,053.4	4,053.4	4,053.4	0.0
G	4,071	124	1,006	7.1	4,064.0	4,064.0	4,064.3	0.3
H	4,250	156	1,445	4.9	4,067.5	4,067.5	4,067.9	0.4
I	4,448	173	1,915	3.7	4,069.9	4,069.9	4,070.9	1.0
J	4,771	133	1,280	5.6	4,072.7	4,072.7	4,073.6	1.0
K	5,052	199	2,087	3.4	4,075.1	4,075.1	4,075.6	0.5
L	5,589	153	1,198	5.9	4,078.6	4,078.6	4,078.7	0.1
M	6,058	145	1,422	5.3	4,087.4	4,087.4	4,087.7	0.4
N	6,536	183	918	7.8	4,094.9	4,094.9	4,095.2	0.3
O	6,691	91	638	11.2	4,097.9	4,097.9	4,098.1	0.2
P	7,057	210	1,647	4.3	4,103.6	4,103.6	4,103.9	0.3
Q	7,518	360	1,885	3.8	4,106.1	4,106.1	4,106.2	0.1
R	7,778	418	1,797	4.0	4,108.1	4,108.1	4,108.1	0.0
S	8,004	346	1,342	5.3	4,115.3	4,115.3	4,115.3	0.0
T	8,223	303	1,451	4.9	4,118.8	4,118.8	4,118.8	0.0
U	8,667	214	1,168	6.1	4,126.3	4,126.3	4,126.3	0.0
V	8,792	199	1,027	6.9	4,127.0	4,127.0	4,127.0	0.0
W	9,333	195	1,314	5.4	4,136.8	4,136.8	4,136.8	0.0
X	9,849	242	742	9.6	4,144.1	4,144.1	4,144.1	0.0
Y	10,248	269	1,752	4.1	4,152.7	4,152.7	4,152.7	0.0
Z	10,843	144	1,056	6.7	4,166.5	4,166.5	4,166.9	0.4

[1] Feet above confluence with Mill Creek
[2] Reflects combined widths of Pack and Mill Creek
[3] Elevations computed without consideration of influence from Mill Creek
[4] Width/width within corporate limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRAND COUNTY, UT AND INCORPORATED AREAS

FLOODWAY DATA

PACK CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Pack Creek								
AA	11,515	161	1,047	6.8	4,177.7	4,177.7	4,178.1	0.3
AB	12,114	98	820	8.7	4,188.5	4,188.5	4,189.1	0.6
AC	12,581	173	1,409	5.1	4,194.5	4,194.5	4,195.2	0.7
AD	12,706	111	854	8.3	4,195.4	4,195.4	4,195.9	0.5
AE	12,895	154	1,358	5.2	4,199.4	4,199.4	4,199.5	0.1

[1] Feet above confluence with Mill Creek
[2] Reflects combined widths of Pack and Mill Creek
[3] Elevations computed without consideration of influence from Mill Creek
[4] Width/width within corporate limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRAND COUNTY, UT AND INCORPORATED AREAS

FLOODWAY DATA

PACK CREEK

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent-annual-chance flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1.

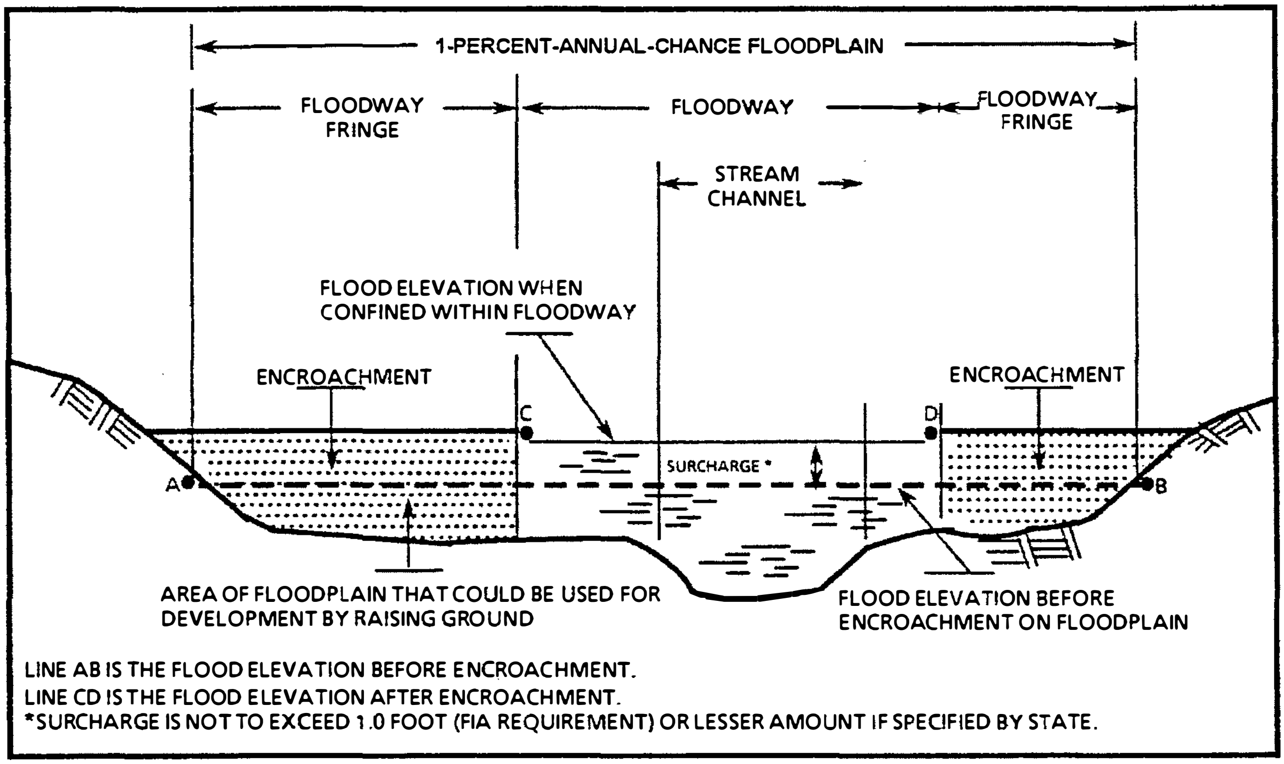

FIGURE 1 - FLOODWAY SCHEMATIC

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs or base flood depths are shown within this zone.

Zone AE

Zone AE is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance risk zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot base flood depths derived from the detailed hydraulic analyses are shown within this zone.

Zone X

Zone X is the flood insurance risk zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by levees. No BFEs or base flood depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance risk zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use the zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent-annual-chance floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

The current FIRM presents flooding information for the city of Moab and surrounding area. Historical data relating to the maps prepared for Moab City and Grand County are presented in Table 3.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
* Castle Valley, Town of	N/A	N/A	N/A	N/A
Grand County	October 6, 1981	N/A	April 2, 2009	None
Moab, City of	June 21, 1974	December 26, 1975 May 31, 1977	June 4, 1980	None

* No Special Flood Hazard Areas

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRAND COUNTY, UT
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

The USGS published Scientific Investigations Report 2005-5022 (Reference 5), which summarizes the results of a study that evaluated the water surface elevations, shear stress, and distribution of two-dimensional velocities in the reach of the Colorado River in the vicinity of Moab, Utah. The primary purpose of that study was to evaluate the stability of the Moab uranium mill tailings adjacent to the Colorado River at the north end of the Moab Valley. The flood frequency analysis documented in that report estimated a 100-year discharge of 97,600 cfs, but that analysis utilized a historic discharge estimate of 125,000 cfs for a flood in 1884. The Study Contractor discussed the difference in the results of the flood frequency analyses performed by the USGS and this FIS, and USGS personnel agreed that their analysis was conservative because of the concern with the uranium tailings. USGS personnel developed the approximate floodplain included on the FIRM by utilizing the 86,000 cfs 100-year discharge and the USGS Multi-Dimensional Surface Water Modeling System (MD_SWMS) model that was utilized in the 2005 USGS study.

During 1975, the U.S. Soil Conservation.Service conducted a flood hazard analysis for Moab (Reference 3). That report summarizes data associated with delineating the 100-year flood profiles and flood plain for Mill Creek, Pack Creek, and shallow flooding in Moab due to runoff from the slickrock drainage areas. The hydrologic data presented in the 1975 U.S. Soil Conservation Service report associated with Mill Creek and Pack Creek have been superceded by this FIS. However, the shallow flood hazard boundaries created by runoff originating in the slickrock areas and the mountain southwest of Moab were digitized as part of this FIS.

This FIS report either supersedes or is compatible with all previous studies on streams studied in this report and should be considered authoritative for purposes of the NFIP.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Federal Insurance and Mitigation Division, Federal Emergency Management Agency, FEMA Region VIII, Denver Federal Center, Building 710, P.O. Box 25267, Denver, Colorado 80225-0267.

9.0 BIBLIOGRAPHY AND REFERENCES

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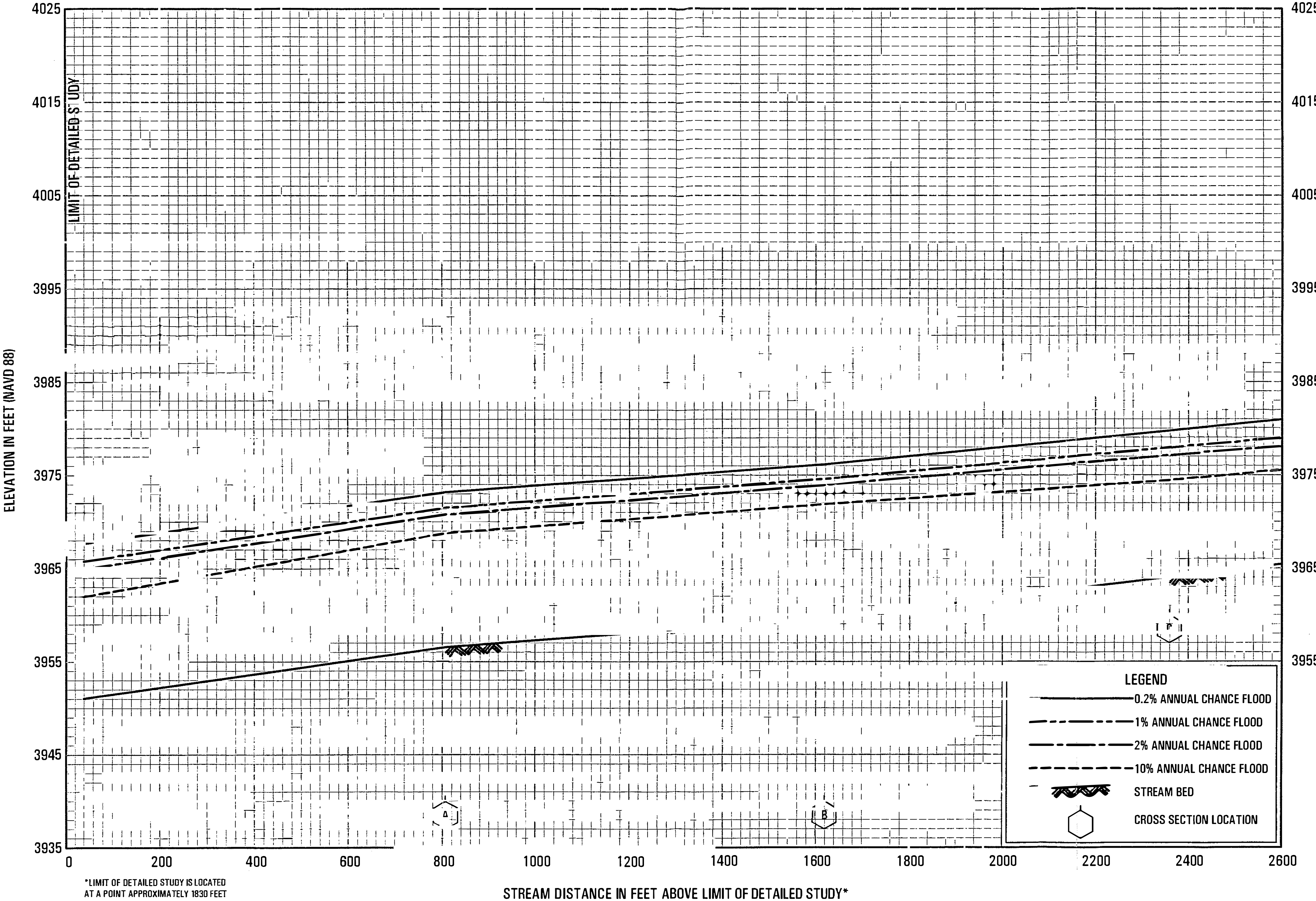
10.0 REVISIONS DESCRIPTIONS

This section has been added to provide information regarding significant revisions made since the original Flood Insurance Study was printed. Future revisions may be made that do not result in the republishing of the FIS report. To assure that any user is aware of all revisions, it is advisable to contact the local community repositories for flood hazard data at the locations noted below:

Table 4
Local Community Repositories for Flood Hazard Data

Community Name	Flood Hazard Data Repository
Moab, City of	Moab City Planning Department, 217 East Center Street, Moab, Utah 84532
Grand County (Unincorporated Areas)	Grand County Courthouse, 125 East Center Street, Moab, Utah 84532



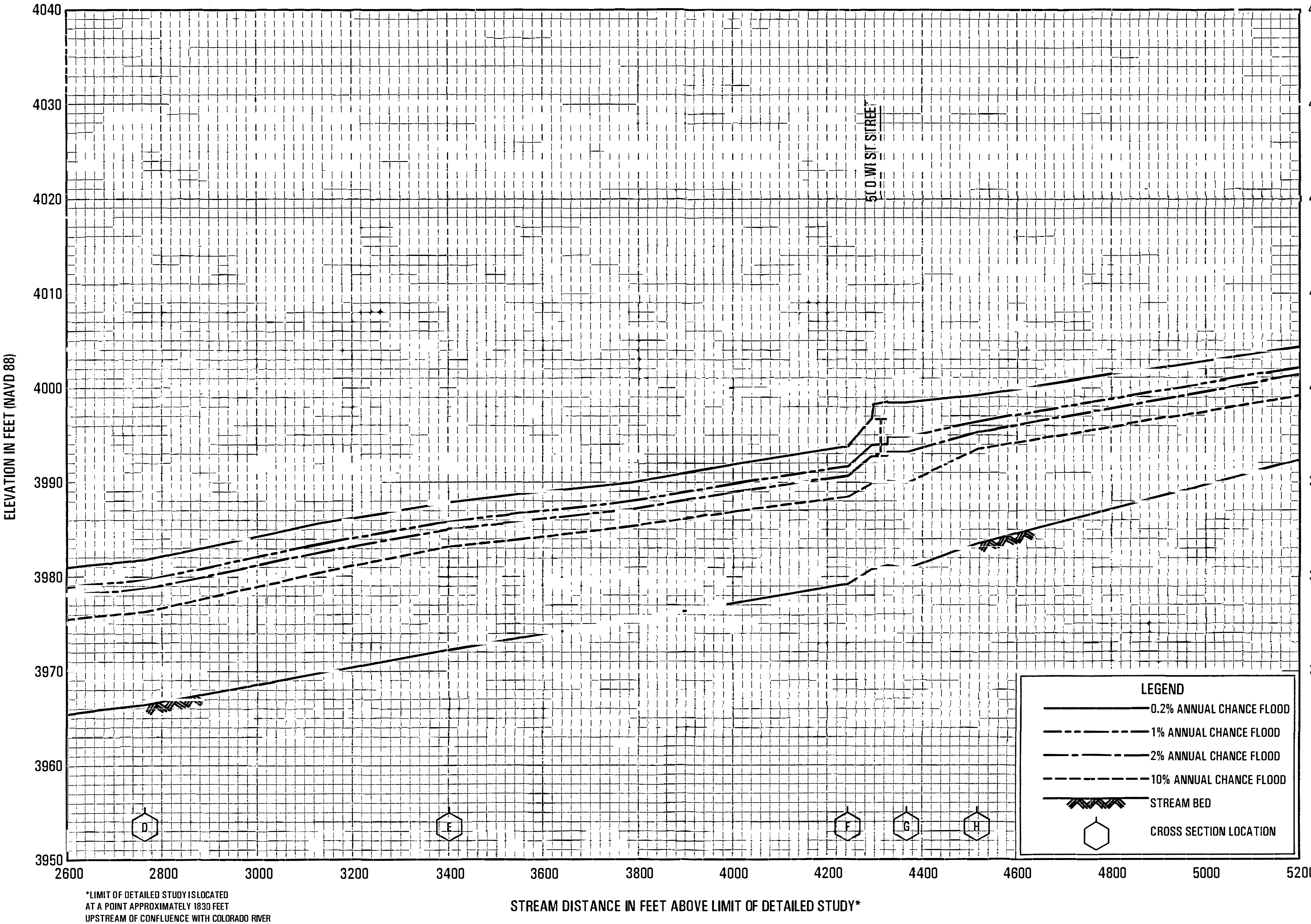
*LIMIT OF DETAILED STUDY IS LOCATED AT A POINT APPROXIMATELY 1830 FEET UPSTREAM OF CONFLUENCE WITH COLORADO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRAND COUNTY, UT
AND INCORPORATED AREAS

FLOOD PROFILES

MILL CREEK



FLOOD PROFILES

MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRAND COUNTY, UT

AND INCORPORATED AREAS

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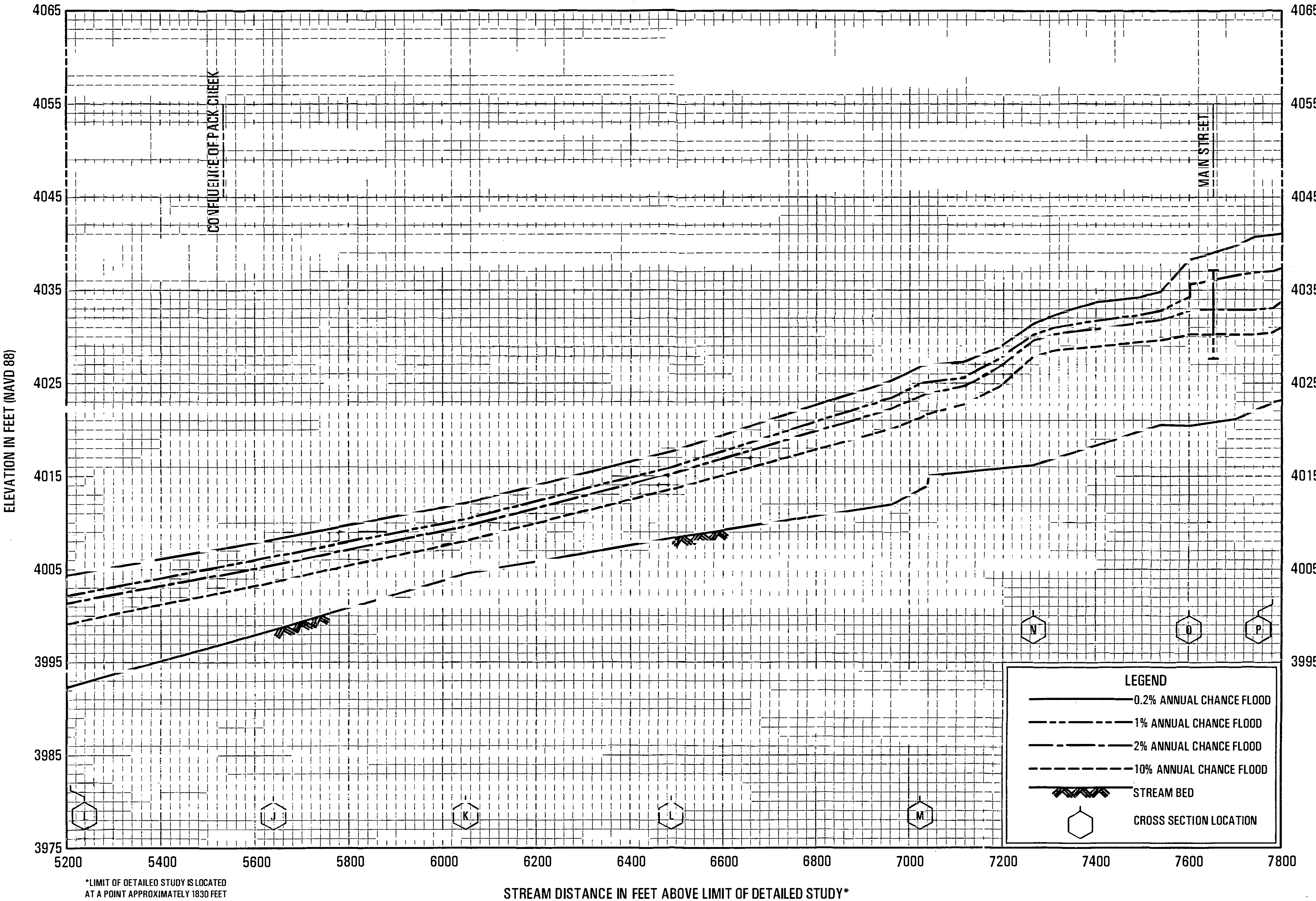

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FLOOD PROFILES

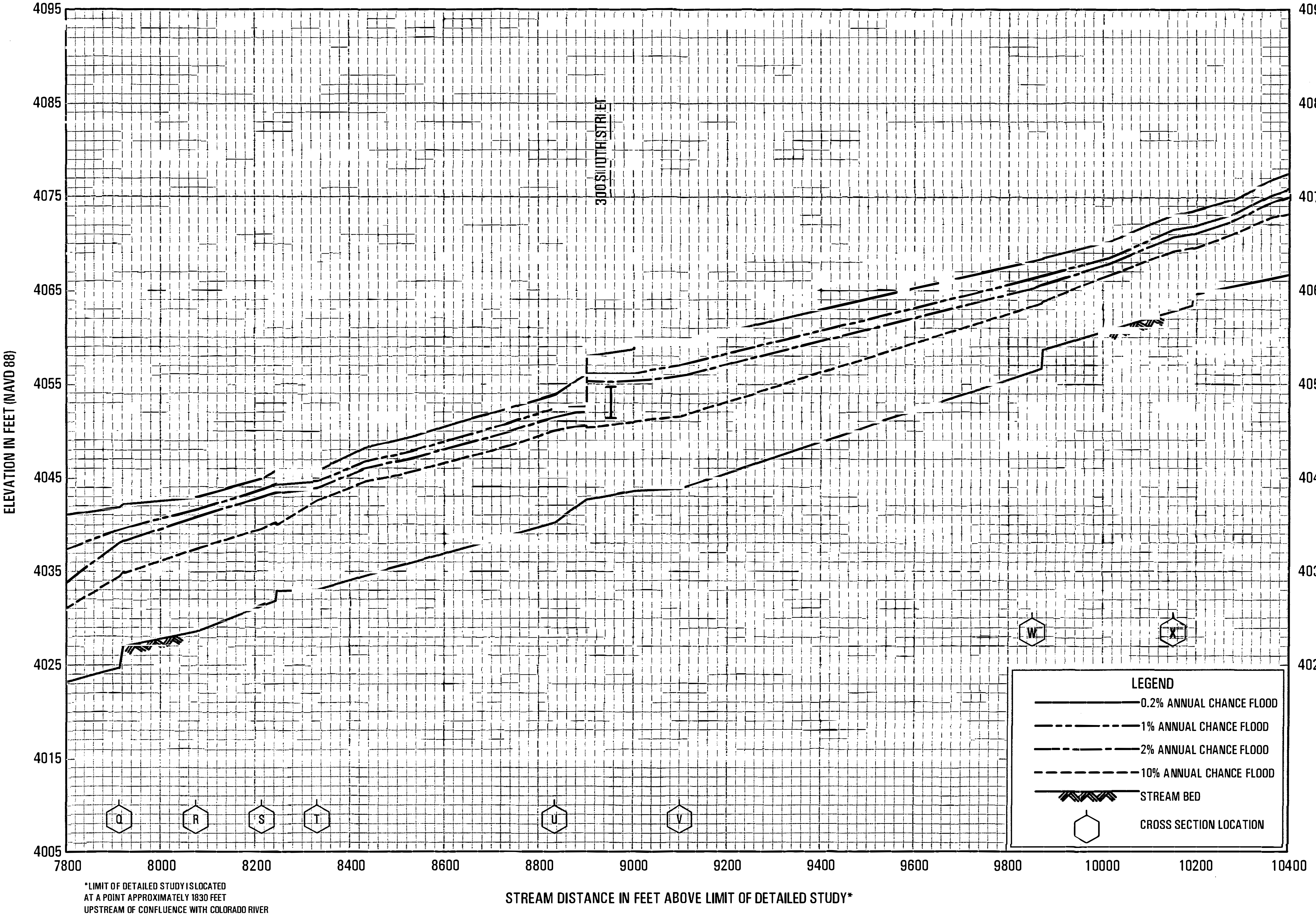
MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRAND COUNTY, UT

AND INCORPORATED AREAS

03P



FLOOD PROFILES

MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRAND COUNTY, UT
AND INCORPORATED AREAS

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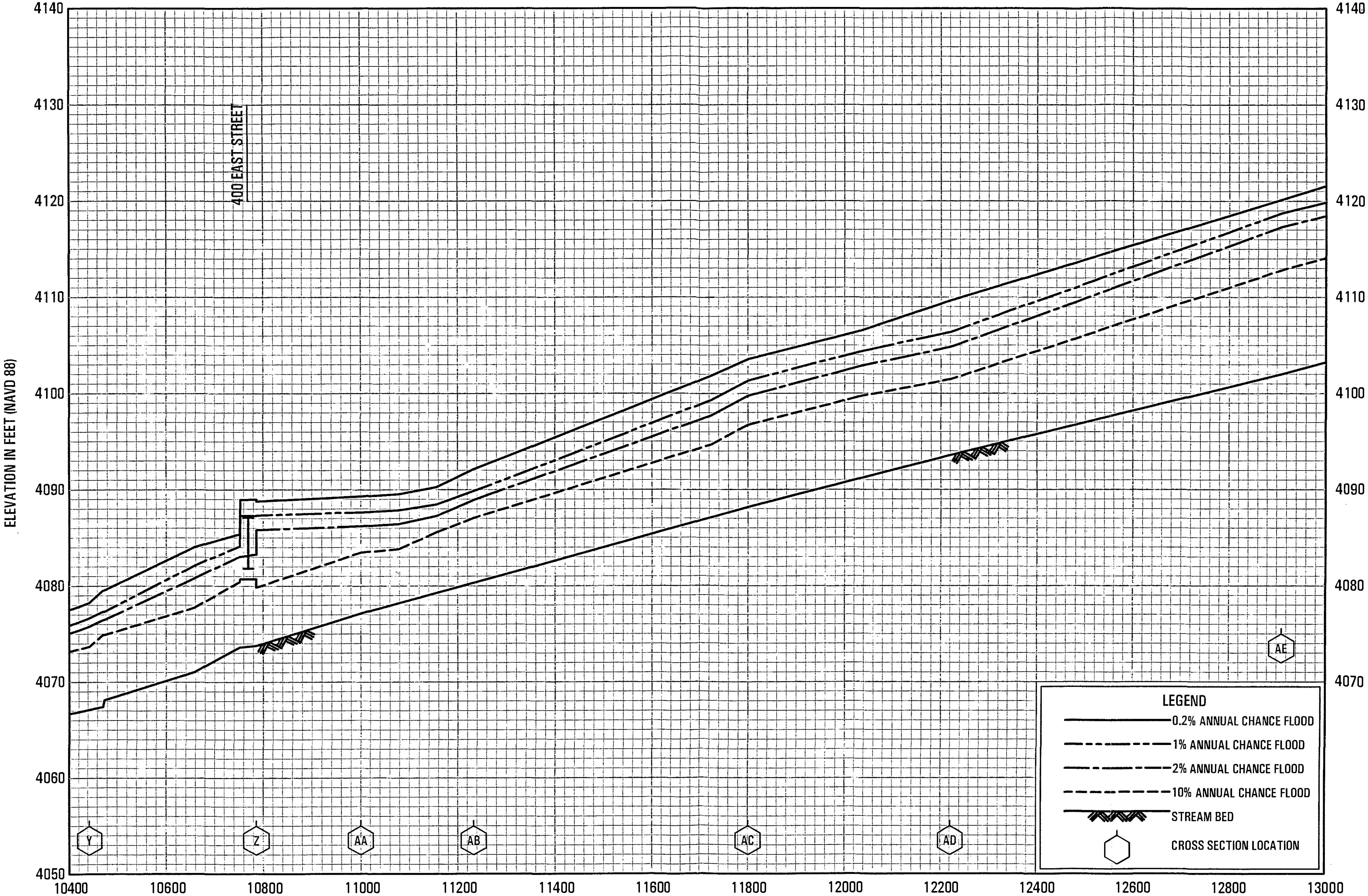

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FLOOD PROFILES

MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRAND COUNTY, UT AND INCORPORATED AREAS

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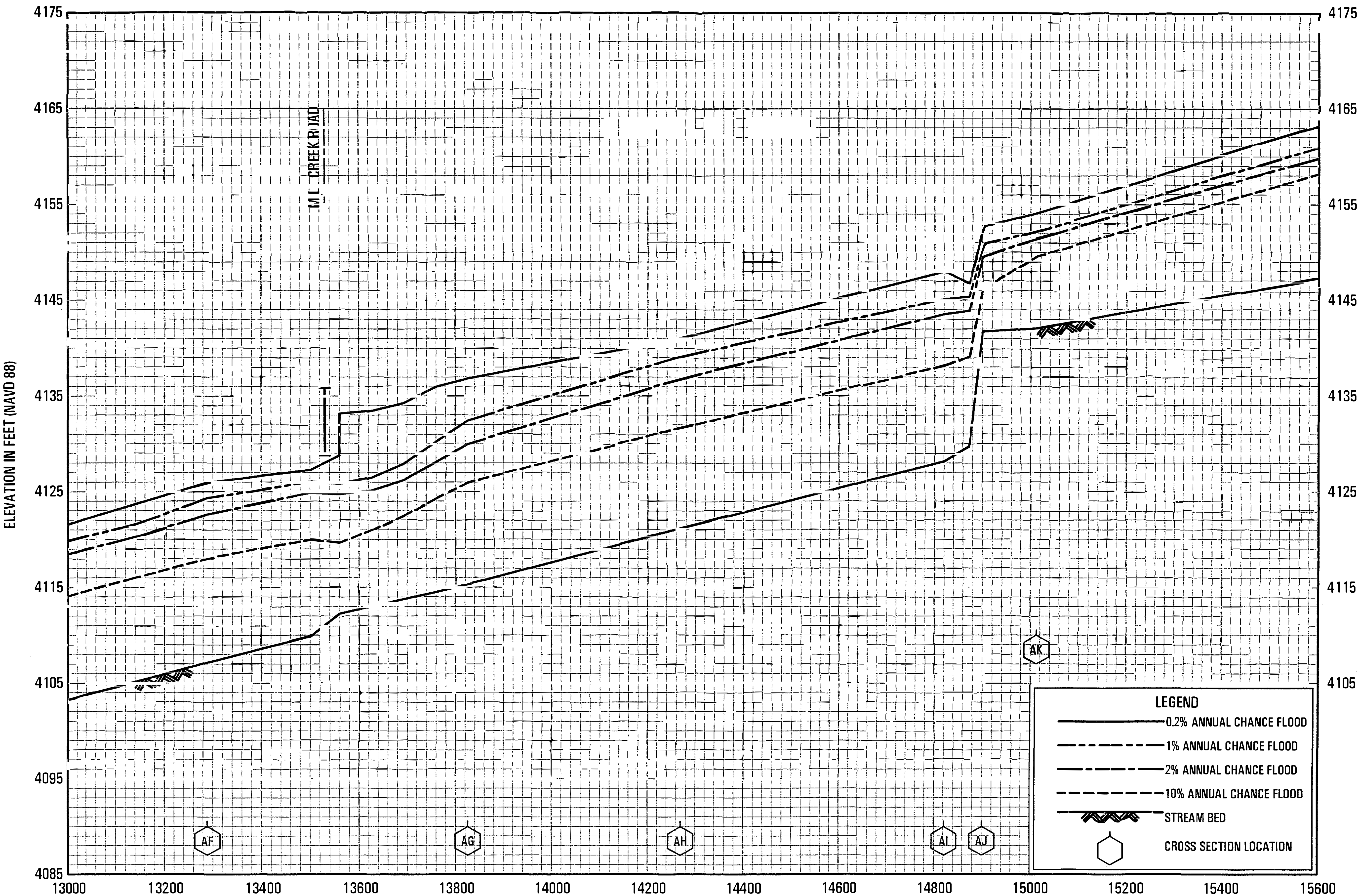

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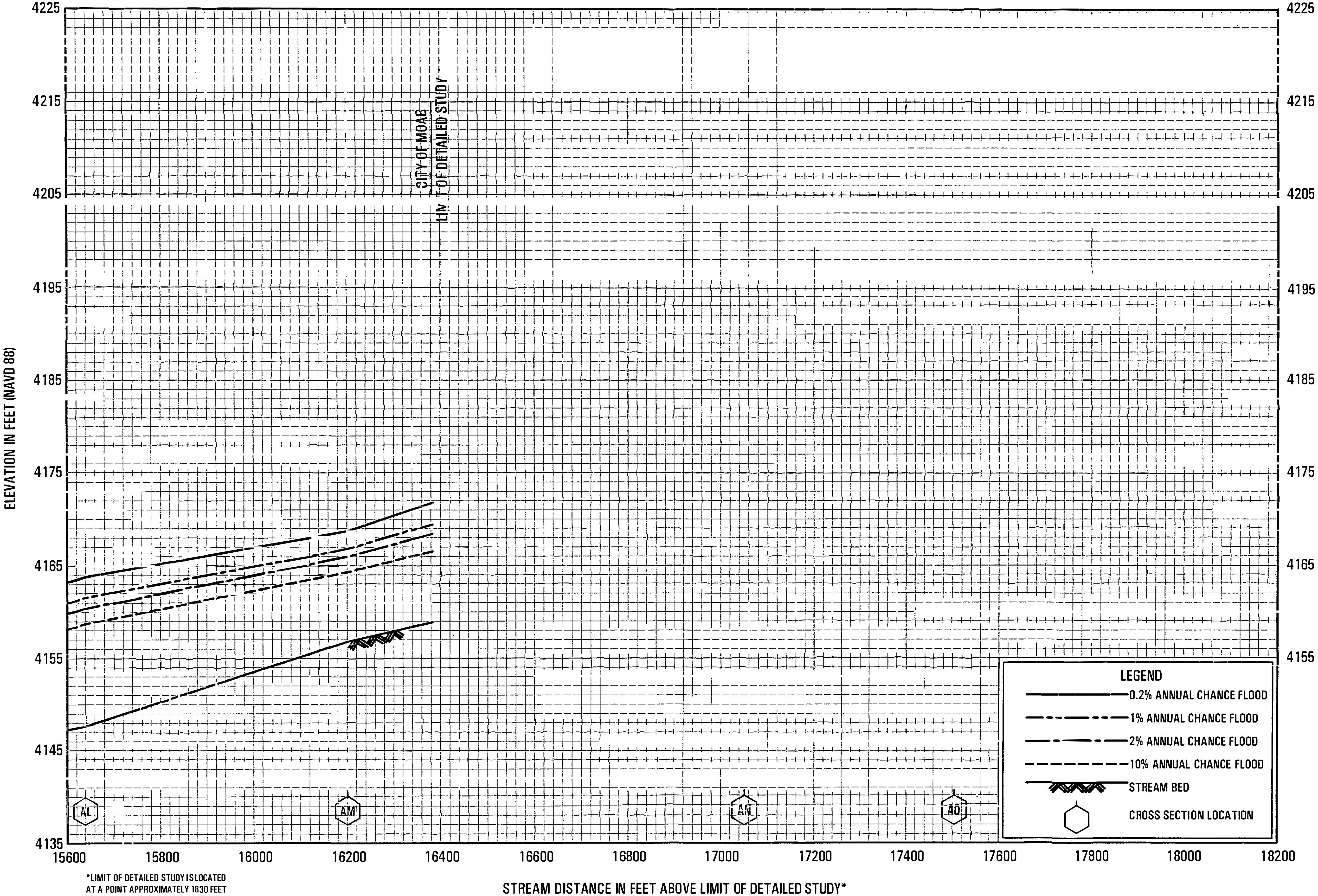
FLOOD PROFILES

MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRAND COUNTY, UT
AND INCORPORATED AREAS

06P



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FLOOD PROFILES

MILL CREEK

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GRAND COUNTY, UT

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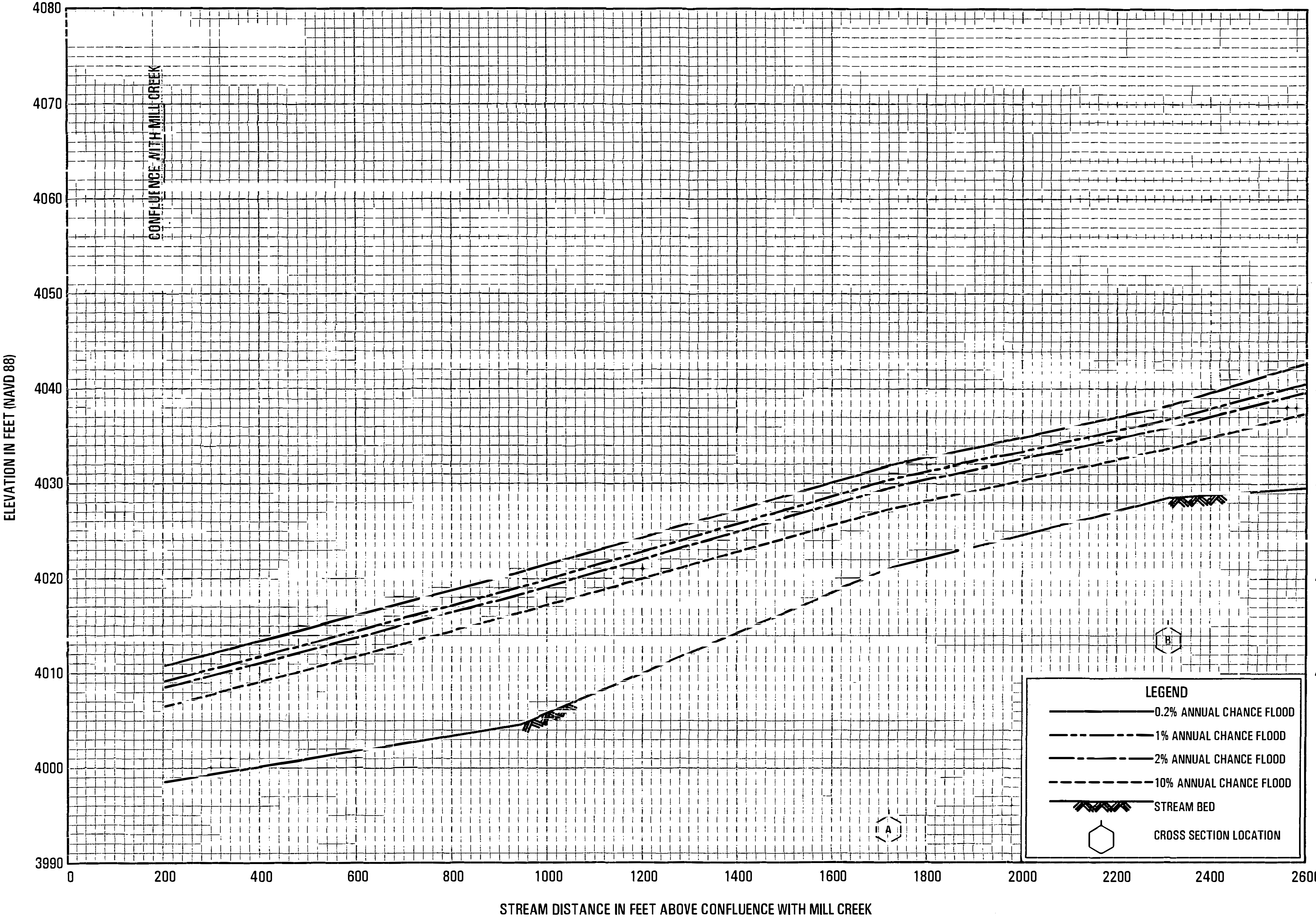


FLOOD PROFILES

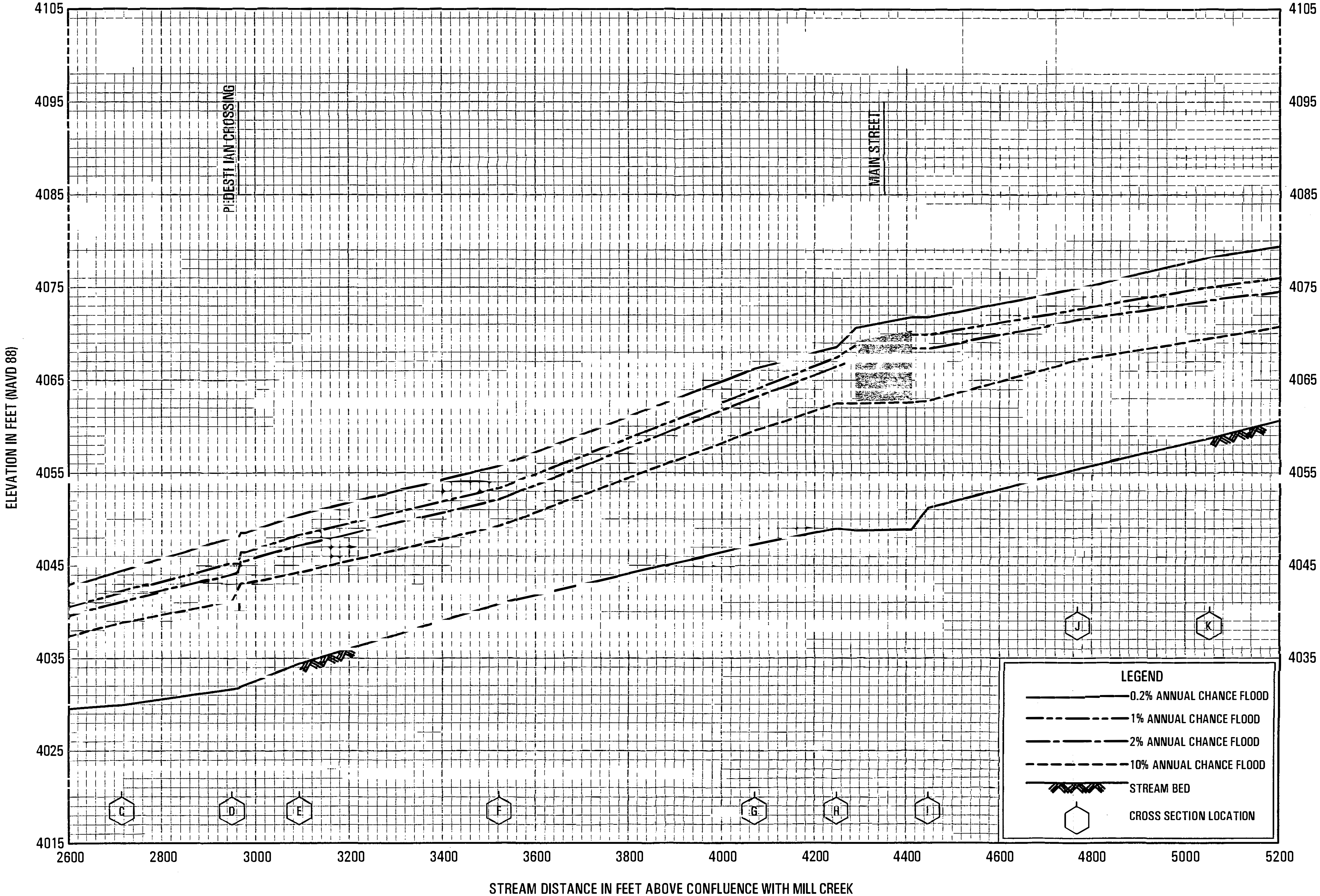
PACK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRAND COUNTY, UT

AND INCORPORATED AREAS

08P



FLOOD PROFILES

PACK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

GRAND COUNTY, UT

AND INCORPORATED AREAS

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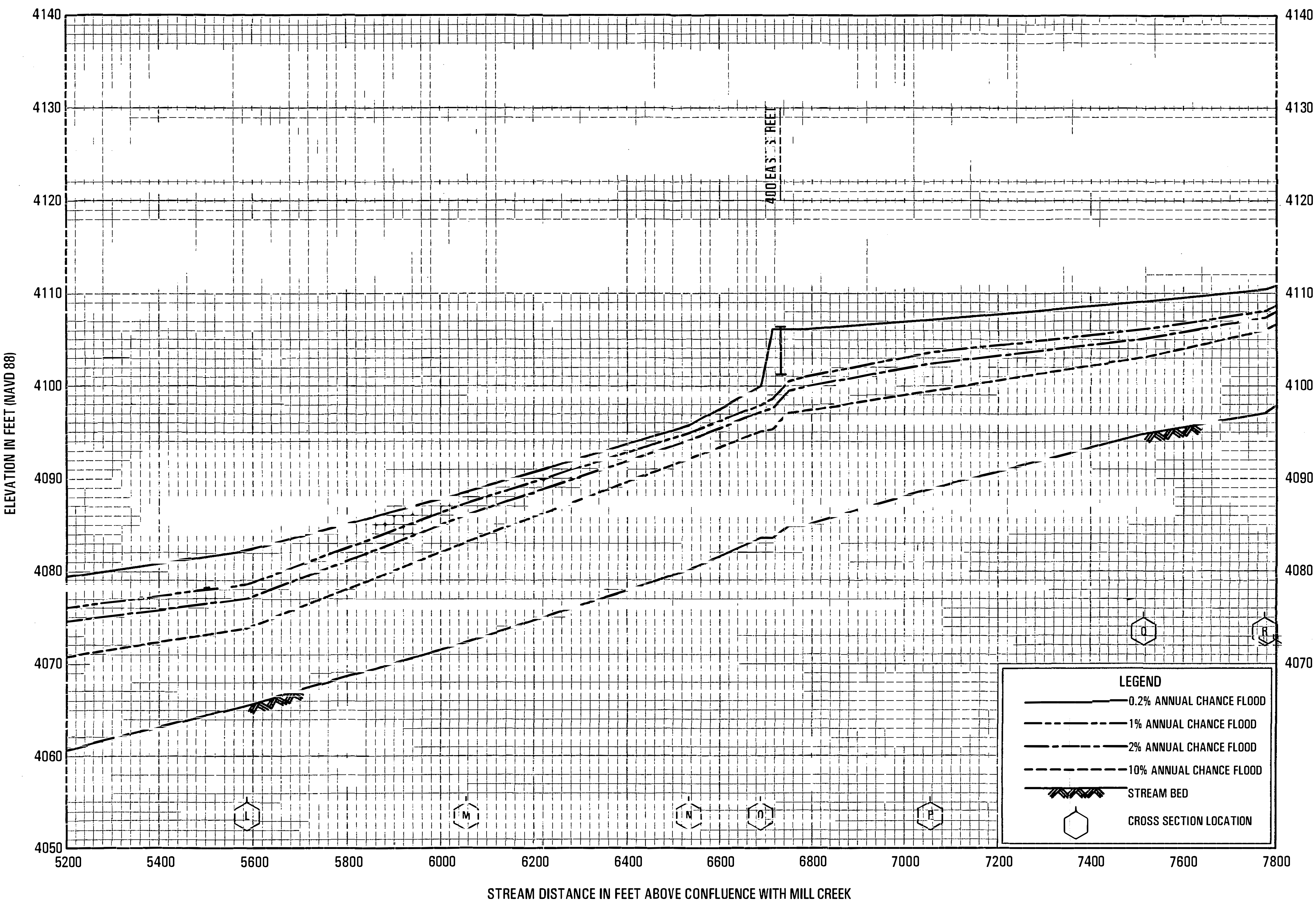

FLOOD PROFILES

PACK CREEK

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GRAND COUNTY, UT

AND INCORPORATED AREAS

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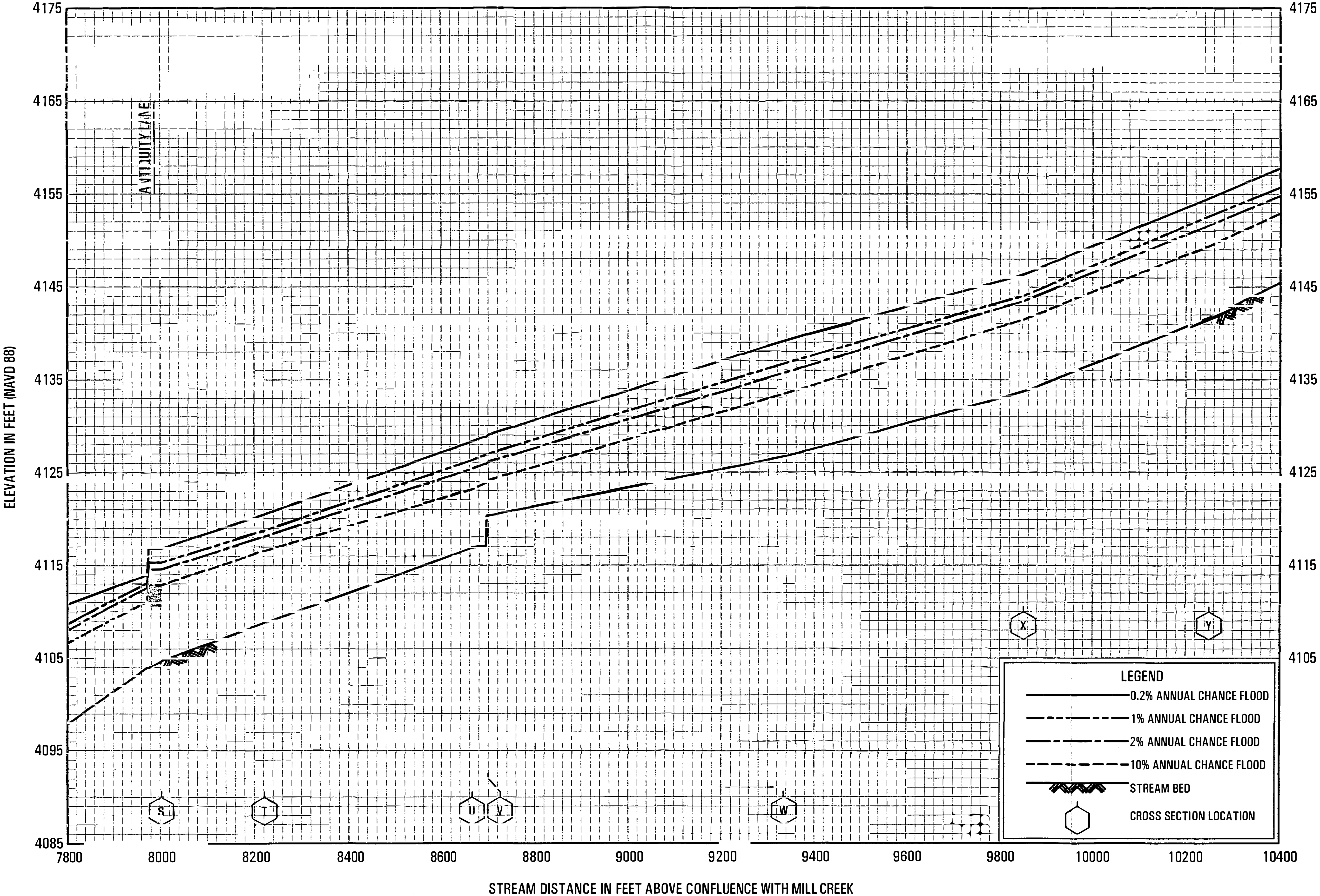

FLOOD PROFILES

PACK CREEK

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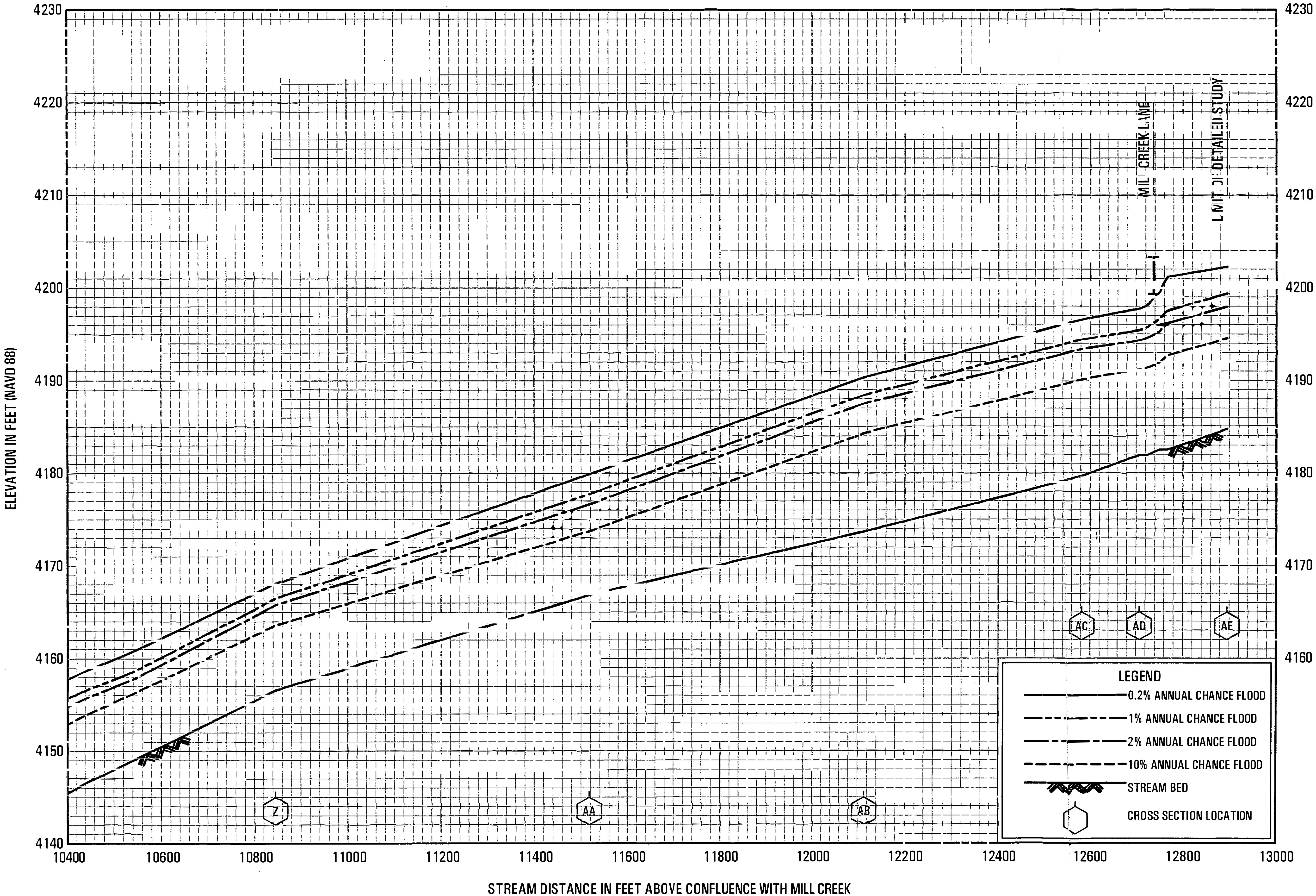

FLOOD PROFILES

PACK CREEK

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