

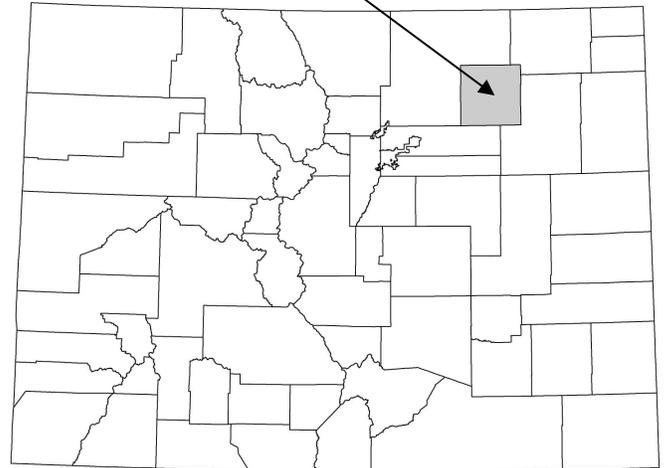
FLOOD INSURANCE STUDY



MORGAN COUNTY COLORADO, AND INCORPORATED AREAS

VOLUME 1 OF 1

Morgan County



COMMUNITY NAME	COMMUNITY NUMBER
BRUSH, CITY OF	080130
FORT MORGAN, CITY OF	080131
LOG LANE VILLAGE, TOWN OF	080217
MORGAN COUNTY (UNINCORPORATED AREAS)	080129
WIGGINS, TOWN OF	080204

Preliminary



Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
08087CV000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program 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 repository. It is advisable to contact the community repository for any additional data.

Part or all of this FIS may be revised and republished at any time. In addition, part of this FIS may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS components.

Effective FIS Date:	February 1977	City of Brush, Colorado
	August 1978	Town of Wiggins, Colorado
	September 29, 1989	Morgan County, Colorado

Initial Countywide FIS Report Effective Date: TBD

ATTENTION: On FIRM panels 08087C0552D, 08087C0555D, and 08087C0575D, the Kiowa Creek levee system, which is assumed to include a portion of Interstate 76, has not been demonstrated by the Town of Wiggins, Morgan County, or the levee owner(s) to meet the requirements of Section 65.10 of the NFIP regulations in 44 CFR as it relates to the levee's capacity to provide 1-percent annual chance flood protection. The subject areas are identified on FIRM panels (with notes and bounding lines) and in the FIS as potential areas of flood hazard data changes based on further review.

FEMA has updated the levee analysis and mapping procedures for non-accredited levees. Until such time as FEMA is able to initiate a new flood risk project to apply the new procedures, the flood hazard information on the three aforementioned FIRM panels that are affected by the Kiowa Creek levee system is being added as a snapshot of the prior previously effective information presented on the FIRMs and FIS reports dated as follows:

- February 15, 1979 (Town of Wiggins, Colorado Floodway – Flood Boundary and Floodway Map and Town of Wiggins, Colorado Flood Insurance Rate Map – only two (2) panels printed)
- August 1978 (Town of Wiggins, Colorado, Flood Insurance Study)
- September 29, 1989 (Morgan County, Colorado, Unincorporated Areas, Community-Panel No. 080129 0175 C – one (1) panel)

September 29, 1989 (Morgan County, Colorado, Unincorporated Areas, Flood Insurance Study)

It should be noted that the three aforementioned, effective FIRM panels were revised via a Letter of Map Revision (Case No. 89-08-18P), which became effective December 5, 1989. However, because of funding constraints at the time, the three panels were not republished to reflect the proposed modifications and the Flood Insurance Study for the Town of Wiggins, Colorado was not revised. The information presented in the LOMR, however, is reflected on the three current FIRM panels and is part of the initial Countywide FIS for Morgan County. As indicated above, it is expected that affected flood hazard data within the subject area could be significantly revised. This may result in floodplain boundary changes, 1-percent annual chance flood elevation changes, and/or changes to flood hazard zone designations.

The effective FIRM panels (and the FIS report) will again be revised at a later date to update the flood hazard information associated with the Kiowa Creek levee system when FEMA is able to initiate and complete a new flood risk project to apply the updated levee analysis and mapping procedures.

TABLE OF CONTENTS

Volume 1 – [TBD]

	<u>Page</u>
1.0 <u>INTRODUCTION</u>	1
1.1 Purpose of Study	1
1.2 Authority and Acknowledgments	2
1.3 Coordination	3
2.0 <u>AREA STUDIED</u>	4
2.1 Scope of Study	4
2.2 Community Description	6
2.3 Principal Flood Problems	9
2.4 Flood Protection Measures	15
3.0 <u>ENGINEERING METHODS</u>	16
3.1 Hydrologic Analyses	17
3.2 Hydraulic Analyses	19
3.3 Vertical Datum	21
4.0 <u>FLOODPLAIN MANAGEMENT APPLICATIONS</u>	22
4.1 Floodplain Boundaries	22
4.2 Floodways	24
5.0 <u>INSURANCE APPLICATIONS</u>	27
6.0 <u>FLOOD INSURANCE RATE MAP</u>	29
7.0 <u>OTHER STUDIES</u>	29
8.0 <u>LOCATION OF DATA</u>	31
9.0 <u>BIBLIOGRAPHY AND REFERENCES</u>	31

TABLE OF CONTENTS - continued

Volume 1 – continued – [TBD]

	<u>Page</u>
<u>FIGURES</u>	
Figure 1 – Floodway Schematic	27

<u>TABLES</u>	
Table 1 – Incorporated Letters of Map Change	6
Table 2 – Summary of Discharges	18
Table 3 – Floodway Data Tables	25 – 26
Table 4 – Community Map History	30

<u>EXHIBITS</u>	
Exhibit 1 - Flood Profiles	
Beaver Creek	Panel 01P – 05P
Beaver Creek Spill	Panel 06P
Exhibit 2 - Flood Insurance Rate Map Index	
Flood Insurance Rate Maps	

FLOOD INSURANCE STUDY
MORGAN COUNTY, COLORADO, AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and supersedes the FIS reports and/or Flood Insurance Rate Maps (FIRMs) [Flood Boundary and Floodway Maps] in the geographic area of Morgan County, Colorado, including the Cities of Brush and Fort Morgan, the Town of Wiggins, and unincorporated areas of Morgan County (hereinafter referred to collectively as Morgan County), 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 Morgan County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

This Countywide FIS was prepared by compiling pertinent information for the flood hazard areas in both the incorporated and unincorporated areas of Morgan County, Colorado, from existing technical and/or scientific data, and from new studies. This existing and new data was reviewed by the Federal Emergency Management Agency (FEMA) prior to its use in the development of this FIS to ensure compliance with NFIP regulations.

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.

Please also note that FEMA has identified one or more levees in the Town of Wiggins and Morgan County that have not been demonstrated by the community or levee owner(s) to meet the requirements of 44 CFR Section 65.10 of the NFIP regulations (44CFR65.10) as it relates to the levee's capacity to provide 1-percent annual chance flood protection. As such, temporary actions are being taken until such time as FEMA is able to initiate a new flood risk project to apply new levee analysis and mapping procedures. Please refer to the Notice to Flood Insurance Study Users pages at the front of this FIS for more information.

1.2 Authority and Acknowledgments

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

The initial hydrologic and hydraulic analyses for this study were performed by Gingery Associates, Inc., of Englewood, Colorado, as reported in “Floodplain Information Report, Beaver Creek, Brush, Colorado” (Gingery Associates, Inc., April 1976), and the U.S. Army Corps of Engineers (COE), Omaha District, as reported in “Special Flood Hazard Information Report, South Platte River, Volume II” (U.S. Army Corps of Engineers, Omaha District, May 1977). The initial portion of the first study was completed in April 1976 and covered all flooding sources affecting the City of Brush. A subsequent portion of the first study was completed in July 1977 and covered all significant flooding sources affecting the Town of Wiggins. The first study was performed by Gingery Associates, Inc., for the Federal Insurance Administration, under Contract No. H-4017. The second study was performed by the U.S. Army Corps of Engineers, Omaha District, for Morgan County, Washington County, and the Colorado Water Conservation Board (CWCB).

As part of the Morgan Countywide Digital Flood Insurance Rate Map (DFIRM) revision initiated in 2009, the South Platte River within the Morgan County limits was re-studied using approximate methods (Anderson Consulting Engineers, Inc., 2010). The work was completed under contract to the CWCB. Beaver Creek within Morgan County and the City of Brush was re-studied by AECOM Technical Services, Inc. under contract to the Colorado Department of Transportation (CDOT) and the CWCB (AECOM, 2012).

Except as noted below, the vector base map for Morgan County was provided by Anderson Consulting Engineers, Inc. (ACE), the Morgan County DFIRM study contractor. Specifically, the Morgan County data was provided in 2010 by Anderson Consulting Engineers, Inc., 375 East Horsetooth Road, Building 5, Fort Collins, CO, Phone (970) 226-0120. The base map data consists of a series of shape files based on the NAD83 horizontal datum, using the UTM Zone 13 projection and includes the following:

- (a) Transportation coverage – Included in this information is the road centerline and airport information within the county. These data were obtained from CDOT and were aligned by ACE to the roads visible on the 2005 National Agriculture Imagery Project (NAIP) aerial photo of the county, which was obtained from the United States Department of Agriculture (USDA, 2005);
- (b) Political boundaries – These data include all incorporated community, military and Federal facility, National Forest, and State Park boundaries. These data were obtained from CDOT and were aligned by ACE to the Public Land Survey System (PLSS) lines for the County;

- (c) Public Land Survey System - These data were obtained from the Bureau of Land Management (BLM) and include all section, township, and range information for the County;
- (d) Hydrography - These data were obtained from CDOT and were aligned by ACE to coincide with the stream centerlines visible on the 2005 NAIP aerial photograph. For areas where new studies were conducted for the DFIRM conversion project the stream centerline was replaced with the profile baseline utilized in the respective hydraulic study;
- (e) National Geodetic Survey (NGS) benchmarks – The NGS benchmarks were downloaded from the National Geodetic Survey/National Oceanic and Atmospheric Administration website;
- (f) United States Geological Survey (USGS) Quad map index – These data were obtained from the USGS and include the outline of all quad maps encompassed by the County boundary; and
- (g) New FIRM panel boundaries – These data were created by ACE, and display the outlines of the new DFIRM panels for the county.

The hydraulic structure layer, including bridges and culverts within the extents of the effective hydraulic models, along with dams, weirs, and levees that are present within the county were obtained from the respective hydraulic studies. Dams, weirs, and levees along with the bridges and culverts in the effective hydraulic models that were visible on the 2005 aerial photograph were digitized by ACE.

The coordinate system used for the production of the DFIRM is Universal Transverse Mercator referenced to the North American Datum of 1983 and the GRS 80 spheroid, Western Hemisphere.

1.3 Coordination

An initial coordination meeting was held on July 12, 1976, with officials from the City of Brush and representatives from the Colorado Water Conservation Board, the Federal Insurance Administration, and Gingery Associates, Inc. At this meeting, the results of a Flood Plain Study of Beaver Creek prepared by Gingery Associates, Inc., for the Colorado Water Conservation Board and the City of Brush were presented and explained. There were no objections to the study and therefore the data developed for it were used for the 1977 Flood Insurance Study for the City of Brush.

A presentation and explanation of floodways by Gingery Associates, Inc., was accomplished during a public meeting with the City of Brush on October 11, 1976. The city later sent a letter on November 16, 1976, regarding the type of floodway to be developed for the 1977 FIS.

The final community coordination meeting for the 1977 FIS was held on January 10, 1977, and was attended by representatives of the Federal Insurance Administration, the study contractor, and the City Council. No problems were encountered during this meeting.

Streams requiring detailed study were identified at an initial public meeting attended by personnel of Gingery Associates, Inc., and the Federal Insurance Administration, and officials of the Town of Wiggins on June 29, 1976. This was the initial coordination meeting held as part of developing the 1978 FIS for the Town of Wiggins.

The U.S. Army Corps of Engineers, the Soil Conservation Service, and officials from the Town of Wiggins were contacted during the course of the 1978 FIS.

The final community coordination meeting for the 1978 FIS was held on August 24, 1977, and was attended by personnel of Gingery Associates, Inc., the Federal Insurance Administration, and officials of the Town of Wiggins. Problems resulting from this meeting have since been corrected.

On November 29, 1988, the results of the study associated with the 1989 FIS for unincorporated areas of Morgan County were reviewed and accepted at a final coordination meeting attended by representatives of the community and FEMA.

A pre-scoping meeting for the Morgan County Countywide DFIRM conversion project was conducted on January 31, 2008 at the Morgan County Administration Building in Fort Morgan, Colorado. The meeting was attended by representatives of Morgan County, Fort Morgan, Brush, Wiggins, FEMA, CWCB, and Anderson Consulting Engineers, Inc., (ACE), the DFIRM study contractor.

On TBD, the results of the Morgan County DFIRM Conversion project were presented and reviewed at a final community coordination meeting attended by representatives of FEMA, CWCB, Morgan County, the Cities of Brush and Fort Morgan, and the Towns of Hillrose, Log Lane Village, and Wiggins. All concerns raised during this meeting have been resolved.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the geographic area of Morgan County, Colorado, including the incorporated communities of Brush, Fort Morgan, Hillrose, Log Lane Village, and Wiggins.

The flooding in the City of Brush is from Beaver Creek, which was studied in detail as part of the 1977 FIS report for the City of Brush. Other sources of possible flooding in Brush include the Brush Lateral Canal and Badger Creek

overflows. Both of these flood sources were inspected and evaluated to ascertain the extent and possibility of diverting floodwaters into the city. The study contractor's (Gingery Associates, Inc.) final conclusion regarding Badger Creek and Brush Lateral Canal was that neither will flood the City of Brush.

The area studied in detail as part of the 1977 FIS was chosen with consideration given to all forecasted development and proposed construction until 1981.

Floods caused by the overflow of Kiowa Creek were studied in detail as part of the 1978 FIS report for the Town of Wiggins. Kiowa Creek is the only flooding source for the Town of Wiggins.

Those areas studied by detailed methods as part of the 1978 FIS were chosen with consideration given to all forecasted development and proposed construction through 1982.

Beaver Creek was studied by detailed methods as part of the 1989 FIS report for unincorporated areas of Morgan County from Interstate 76 to a point approximately 11,130 feet upstream from its confluence with Upper Platte and Beaver Canal, a reach of approximately 7.4 miles.

The South Platte River was studied by approximate methods as part of the 1989 FIS from a point approximately 900 feet downstream of the county road at Balzac to the Weld County line, a reach of approximately 47 miles.

The areas studied by detailed methods as part of the 1989 FIS were selected based on the extent and validity of available existing hydrologic and hydraulic data.

Approximate methods of analysis as part of the 1989 FIS were used to study all the remaining areas having a potential flood hazard that did not have available detailed scientific or technical data.

As part of the countywide DFIRM Conversion Project in 2009, Zone A flood hazard information was mapped along the South Platte River from the eastern county boundary at Washington County to the western county boundary at Weld County, a distance of approximately 49 river miles. Water-surface elevations for the 100-year Zone A floodplain on the South Platte River were computed using the Hydrologic Engineering Center - River Analysis System (HEC-RAS), Version 4.0.0 (U.S. Army Corps of Engineers, March 2008).

For the South Platte River study in 2009, topographic maps with 5-foot contour intervals were acquired by ACE in April 2009. These maps were generated from photogrammetric DTM and aerial LiDAR data acquired in March 2009. Detailed structure surveys were conducted at all stream crossings for the South Platte River, and the survey data was used to supplement the aforementioned topographic data.

As part of the countywide DFIRM Conversion Project in 2012, Beaver Creek was studied by detailed methods from County Road “T” (approximately 0.6 miles north of Interstate 76) upstream approximately 5.8 river miles to County Road “P”, including approximately 0.7 miles of split flow paths (AECOM Technical Services, Inc., July 2012).

This Countywide FIS also incorporates the determination of letters issued by FEMA resulting in map changes (Letter of Map Revision [LOMR], Special Response [SR], Letter of Map Amendment [LOMA], as shown in Table 1.

Table 1 Incorporated Letters of Map Change

<u>Community</u>	<u>Flooding Source(s) and Project Identifier</u>	<u>Case Number</u>	<u>Effective Date</u>	<u>Type</u>
Town of Wiggins, CO	Kiowa Creek	89-08-18P	December 5, 1989	LOMR
Town of Wiggins, CO	Kiowa Creek	199105476FIA	December 5, 1989	102
Town of Wiggins, CO	Kiowa Creek	199535193MBJ	December 5, 1989	102A

2.2 Community Description

City of Brush

The City of Brush is located in Morgan County, in northeastern Colorado, approximately 90 miles northeast of Denver. Adjacent areas include mostly unincorporated areas of Morgan County. The normal annual precipitation in the Beaver Creek and Brush area is approximately 17.5 inches per year. Included as part of the precipitation is snowfall of 38 inches per year. The mean annual temperature in the area is 48.0°F.

Vegetation in the area consists of farmland crops in the lower reaches and prairie grasses in the upper reaches. The predominant soils in the basin consist of sand and sandy loam soils and, to a lesser extent, silt and clay loam. The topography adjoining Beaver Creek is very flat to the west, which includes the area of Brush, but quite steep to the east.

The Burlington Northern Railroad, directly east of Brush, and County Road “R” (Old DLD Road), 0.5 mile south of town, significantly affect flood flows within the Beaver Creek flood plain. In addition to the road and railroad crossings within the flood plain, the City of Brush is located in the flood plain area. The road and railroad embankments, as well as the buildings and streets in town, serve as obstructions to the orderly passage of flood flows through this portion of Beaver Creek. Through the Beaver Creek study area, the main channel is small,

inadequate, and restricted by the natural vegetation, thus limiting the effectiveness of the channel.

City of Fort Morgan

The City of Fort Morgan, the county seat, is located in central Morgan County and is approximately 82 miles northeast of Denver and 8 miles west of the City of Brush. The area of Fort Morgan is approximately 2.8 square miles and the 2013 population was 11,407 (U.S. Census Bureau, 2013).

The mean annual temperature for Fort Morgan is approximately 48°F, with an average high temperature in July of 89°F and an average low temperature in January of 10°F. The average annual precipitation in Fort Morgan is approximately 14.2 inches, with an average annual snowfall of 24 inches.

A majority of the City of Fort Morgan is situated south of Interstate 76, as well as the South Platte River. The South Platte River appears to be the only major flooding source affecting the Fort Morgan City limits, with most of the effective Zone A floodplain mapping depicted north of Interstate 76 in a largely undeveloped area.

Town of Hillrose

The Town of Hillrose is located in east-central Morgan County approximately 98 miles northeast of Denver and 8 miles northeast of the City of Brush. The area of Hillrose is 128 acres and the 2013 population was 250 (U.S. Census Bureau, 2013).

The mean annual temperature for Hillrose is approximately 50°F, with an average high temperature in July of 90°F and an average low temperature in January of 10°F. The average annual precipitation in Hillrose is approximately 13 inches, with an average annual snowfall of 21.8 inches.

The flooding source closest to the Town of Hillrose is Beaver Creek, located approximately 1.5 miles to the west. Effective Zone A floodplain mapping in the area, however, indicates the Town of Hillrose is not affected by flooding from Beaver Creek or any other flooding source.

Town of Log Lane Village

The Town of Log Lane Village is located immediately northwest of the City of Fort Morgan. The area of Log Lane Village is 128 acres and the 2013 population was 869 (U.S. Census Bureau, 2013).

The mean annual temperature for Log Lane Village is approximately 50°F, with an average high temperature in July of 90°F and an average low temperature in January of 10°F. The average annual precipitation in Log Lane Village is approximately 13 inches, with an average annual snowfall of 21.8 inches.

A majority of the Town of Log Lane Village is situated south of the Upper Platte and Beaver Canal, and is in close proximity to the South Platte River. The South Platte River appears to be the only major flooding source affecting the Log Lane Village Town limits, with most of the effective Zone A and Zone X floodplain mapping depicted north of the Upper Platte and Beaver Canal and the corporate limits.

Town of Wiggins

The Town of Wiggins is located in the western part of Morgan County, in northeastern Colorado, approximately 59 miles northeast of Denver and 15 miles west of Fort Morgan. There are no communities adjacent to Wiggins. The population of Wiggins in 1975 was 530 (Colorado Municipal League, July 1976); according to the U.S. Census Bureau, the 2013 population increased to 900.

The flood plain development in Wiggins is primarily commercial and residential. Most new development is taking place on the higher ground in the eastern part of the community, although many businesses which already exist in the flood plain have expanded their physical plants.

Kiowa Creek flows northward through a wide, flat flood plain west of Wiggins. Most of the drainage basin is covered with well-drained, sandy soil. The vegetative cover is sparse, and consists of a few areas of irrigated crops and large areas of rangeland that are generally covered with short prairie grass (Soil Conservation Service, August 1968 and September 1972).

The climate in Wiggins is typical of the plains region east of the Rocky Mountains. The warmest month is July, with an average high temperature of 90.0°F, and the coldest month is January, with an average low temperature of 10.2°F. The average annual precipitation in Wiggins is 13.0 inches (Sperling's, 2015).

Morgan County (Unincorporated Areas)

Morgan County is located in the northeastern corner of Colorado; the City of Fort Morgan is the county seat. Morgan County borders Weld County on the west and north, Logan County on the northeast corner, Washington County on the east and southeast, and Adams County on the south.

According to the 1980 U.S. Bureau of the Census, Morgan County covers an area of 1,276 square miles and had a population of 22,513. This is a 12-percent increase from its 1970 population of 20,105 (U.S. Census Bureau, 1980). The estimated 2013 population of the county was 28,404 (U.S. Census Bureau, 2013).

The mean annual temperature for the county is 50.1°F; the warmest month is July, with an average daily high of 90°F. The average annual precipitation for the county is 13 inches, which includes an average of 21.8 inches of snowfall.

The South Platte River floodplain in Morgan County is used primarily for agriculture. Except for the areas adjacent to incorporated communities such as Fort Morgan, existing floodplain development consists mostly of farm and ranch buildings.

The vegetation in the area includes farm crops and prairie grasses. The predominant soils in the area consist of sand and sandy loam soils with smaller amounts of silt loam and clay loam (Gingery Associates, Inc., April 1976.).

2.3 Principal Flood Problems

Beaver Creek

City of Brush

The history of flooding on Beaver Creek in and around the City of Brush is vague and incomplete. Available records indicate major flood events occurred in 1935, 1955, and 1965.

Even though there are no published, formal flood records on Beaver Creek prior to 1935, it is certain that floods did occur. Colorado was settled in the late 1850's; but, before that time, travelers, hunters, and immigrants on the long trek to the far west recorded the occurrence of many flood events. The earliest floods recorded in Colorado were those on the Arkansas and Republican Rivers in 1826. Widespread flooding of major proportions occurred on the Arkansas River and, by interference, on the South Platte River and major eastern tributaries to the South Platte River in 1844 (U.S. Geological Survey, 1948).

Cloudburst rains in the (Kiowa Creek and) Beaver Creek basin(s) on May 30 and 31, 1935, caused the second largest flood ever recorded on the South Platte River. No frequency information was developed for any of these floods.

Newspaper accounts of the 1935 flood reported that many bridges and railroad crossings were washed out and many communities were isolated from rail and road transportation. Flood warnings were issued in the City of Brush as floodwaters on Beaver Creek approached the bridges in the eastern portion of town; however, few residents expected either high water or even the possibility of

seeing flood waters rushing through downtown streets. The Brush News Tribune, on June 6, 1935, reported that:

..... the creek channel narrows noticeably at the point just east of Brush which resulted in water backing along the railroad bridge as far as the depot, where it swept over the tracks, reaching more than two-foot depths in a short time.

The south side of Brush was under three to four feet of water, almost before residents could leave their houses. One or two houses were pushed off the foundation and several foundations crumbled under the pressure of the water.

On the north side of the tracks, the water reached an average depth of two feet. Some of the businesses were able to keep water off the ground floors, but all basements were filled to the top doing extensive damage to store merchandise stocks.

On the same date, the paper also reported that:

..... Beaver Creek has reached high waters and flood levels frequently in the past inflicting heavy damage to farmers and stockmen, but this time the destruction was infinitely greater than on previous occasions and marked the first time in the history of Brush that flood waters ever reached its streets. As one Brush man expressed it, 'Maybe the Indians have seen a flood like this, but no white man ever did.'

In 1965, when floodwaters again came down Beaver Creek threatening the City of Brush, the community was more prepared. The city constructed a 5-foot high dike around the southeast portion of town to protect that area against the onrushing floodwaters. The dike held as the floodwaters came within inches of overtopping the dike and again threatening the downtown area of Brush. Regardless, the business district had taken action to minimize flood damages. The merchants had not only sandbagged their places of business, but also had removed stock merchandise from their basements to higher and safer elevations.

In 1965, floodwaters took the U.S. Highway 6-34 Bridge (Business Route 76) out of service. Other bridges in the area were also washed out and closed for a period of 2 to 3 days until repairs could be completed.

The U.S. Geological Survey estimated the peak discharge of the 1965 flood at State Highway 71, crossing Beaver Creek south of Brush, to be 24,300 cubic feet per second. This flood was comparable to approximately a 25-year flood event (Water Supply No. 1850-B, 1969).

Unincorporated Morgan County

The normal low flow channel for Beaver Creek as studied for the 1989 FIS meanders through the study reach traversing approximately 7.4 miles through the 4-mile reach of the floodplain. The topography adjoining Beaver Creek is very flat to the west but quite steep to the east. Through the study reach, six major roads and railroads cross the creek. Two of these facilities, the Burlington Northern Railroad directly east of Brush, and County Road "R" (Old DLD Road), 0.5 mile south of town, significantly affect flood flows within the floodplain.

In addition to the road and railroad crossings within the floodplain, the City of Brush is located in the floodplain area. The road and railroad embankments as well as the buildings and streets in the city serve as obstructions to the orderly passage of flood flows through this portion of Beaver Creek. Through the study reach, the main channel is small, inadequate, and restricted by the natural vegetation, thus limiting the effectiveness of the channel.

The primary obstructions to flood flows through the study area are the brush and vegetation growing along the channel, roads, railroad embankments, and bridges in the floodplain. During periods of high water, these facilities tend to impede flood flows, thereby causing backwater conditions that increase flood heights upstream and flood velocities downstream. Debris that is washed downstream by floodwaters collects and obstructs downstream bridges and culverts, thus raising floodwaters in these areas. The accumulation of debris on the Burlington Northern Railroad Bridge would greatly increase the threat and severity of flooding within the City of Brush (Gingery Associates, Inc., April 1976).

Flood events on Beaver Creek are the result of intense thunderstorms occurring in the basin. Being subject to heavy rain events of cloudburst intensity, flooding in the upper part of the basin will characteristically have high peak discharges of short duration lasting only a few hours. As the flood event passes into the lower reaches of the creek near Brush, channel storage reduces the flood magnitude and the flood stages.

The 100-year flood is one with a peak flow magnitude that has a 1-percent chance of being equaled or exceeded in any given year and a frequency of occurrence of about once in 100 years on the long-term average. Similarly, the 10-year, 50-year, and 500-year floods have a 10-percent, 2-percent, and 0.2-percent chance, respectively, of being equaled or exceeded in any given year, and an average frequency of occurrence of about once in the number of years indicated.

The flows in Beaver Creek have been estimated based on recorded flood occurrences in the high plains area of eastern Colorado, western Kansas and southwestern Nebraska, and are typical of the Beaver Creek drainage area.

Typically, the flood events will move into the Brush community at a speed of 2 to 4 miles per hour (approximately 3 to 6 feet per second). Flood peaks may last for a duration of 2 to 10 hours while high flood stages may remain in the area for periods of 20 to 30 hours.

The flat topography of this reach of Beaver Creek tends to widen the floodplain area and reduce the depths and velocities of the flood flow as it passes through the area. In the reach of Beaver Creek between the Burlington Northern Railroad and Interstate 76, the average flow velocity in the main channel area for the 100-year flood event would be 3 to 4 feet per second. Average flow velocities in the floodplain west of the main channel, including the downtown area, would average between 1 to 3 feet per second. The floodplain east of the main channel would have average velocities ranging between 1 and 4 feet per second. Flood flow depths would be shallow throughout the reach, ranging from approximately 0.5 to 1-foot along the eastern edge of town to a maximum depth of 4 to 4.5 feet on Clayton Street.

Between County Road "R" (Old DLD Road) and the Burlington Northern Railroad, the average flow velocity for the 100-year flood event in the main channel would be approximately 2 to 3 feet per second. The fringe areas of floodplain would experience average velocities of 1 to 2 feet per second west of the main stream and approximately 0.7 to 1.2 feet per second east of the main stream. Flow depths in the wide floodplain area west of the creek would average between 1.5 to 2 feet.

From County Road "R" (Old DLD Road) to the upstream study limits, the main channel velocities are much higher, ranging from 6 to 10 feet per second. Through the same reach, the overbank or fringe area velocities average between 2.5 to 5 feet per second west of the Beaver Creek main channel and 2 to 4 feet per second east of the Beaver Creek main channel. The average flow depths on the agricultural areas within the floodplain on the west average between 0.5 and 2 feet.

Special note should be made of the potential hazardous flood velocities and depths in the downtown and residential areas of the city. Average velocities for the 100-year flood event were estimated to range between 1 to 3 feet per second; however, localized velocities on streets and around obstructions may be 2 or 3 times the average velocity. Velocities in excess of 2 to 4 feet per second and depths in excess of 2 to 3 feet are considered hazardous to human safety and welfare (Gingery Associates, Inc., April 1976).

Badger Creek

Other sources of possible flooding near Brush include the Brush Lateral Canal and Badger Creek overflows. Both of these flood sources were inspected and

evaluated as part of the 1989 FIS to ascertain an opinion on the extent and possibility for diverting flood waters into the City of Brush.

The U.S. Geological Survey (USGS) quadrangle maps show the ground topography east of Badger Creek to slope towards the City of Brush, approximately 4.5 miles east. As a result, there is concern for the possibility of floodwaters overtopping the channel banks in Badger Creek at the Burlington Northern Railroad and State Highway 6-34 (Business Route 76) crossings and for the floodwaters to travel east to Brush.

Hydrologic calculations indicate the magnitude of the 100-year flood on Badger Creek to range between 25,000 cfs and 30,000 cfs. Hydraulic computations show that the backwater effect created by both the railroad and highway embankments is sufficient to overtop the channel banks. However, the depth of water overtopping the channel banks at either location is not sufficient to move the excess flood waters over the 4.5 miles of cultivated fields and irrigation laterals and embankments and into Brush. Still, flooding can be expected to occur for some distance east of Badger Creek along the railroad and highway. The worst situation is along the railroad because of the higher embankment and no provisions for flows to overtop the embankment.

Flooding has been experienced in Brush due to overflows from the Brush Lateral Canal traversing through the west and north portions of the city. During the 1935 flood, much water was diverted from Bijou Creek into the Upper Platte and Beaver Canal and thus into the Brush Lateral Canal, only to spill within the City of Brush, causing much damage and consternation.

South Platte River

The South Platte River in Morgan County generally flows easterly from the Weld-Morgan County line toward Fort Morgan where it gradually turns and flows in a northeasterly direction into Washington County. Throughout this reach, the South Platte River flows in a relatively well-defined channel. This channel is typically braided and is situated in a broad shallow valley ranging in width from about 1,500 feet to about 21,000 feet and is flanked by rolling plains. The streambed slope of the South Platte River in Morgan County is relatively uniform, generally ranging between 9 feet per mile and 5 feet per mile and averaging 6.5 feet per mile. The drainage area of the South Platte River in Morgan County varies considerably from the Weld-Morgan County line to the Washington-Morgan County line due mainly to the number of relatively large tributaries draining primarily the plains region located to the south of Morgan County.

Flooding along the South Platte River in Morgan County normally occurs from May through September with the most frequent flooding occurring during June. Annual peak discharges, however, have been

recorded from February through October. Floods in Morgan County normally occur under non-ice affected conditions. Ice jams, however, are possible even though their historical frequency of occurrence is rare.

Floodwaters on the South Platte River in Morgan County can result from intense localized rainfall or general rains, either of which may be augmented by snowmelt. The intense rainstorm floods result from intense rainfall over areas of relatively small areal extent. These storms can produce extremely rapid concentrations of floodwaters and ensuing rapid rises in stream levels. Because of the lack of warning time prior to streams attaining flood stages, this type of storm can produce floods which are extremely hazardous. This type of flood produces high peak discharge on tributaries in the general vicinity of the rainstorm. The discharge, however, attenuates rapidly on the South Platte River downstream from the contributing tributaries due to valley storage of the floodwater.

The general rainstorm floods result from rainfall over areas of large areal extent. Rainfall from this type of storm may occur over several days. Because of this time duration, the affected streams rise relatively slow; sometimes over a period of several days. The duration of the flood period also is sometimes of considerable length. Because of the large areal extent of rainfall, more tributaries contribute to the peak discharge on the South Platte River. This results in increasing discharge progressively downstream over a considerable length of the South Platte River. However, downstream from the contributing tributaries, the effects of valley storage cause flood discharge attenuation.

Erosive effects can be considerable in the event of any flood regardless of its origin. Floods resulting from intense rainstorms typically create severe erosion damages in a short period of time due to the relatively large peak discharge and high velocity of the floodwater. Erosion damages from snowmelt or general rainstorm floods usually result from prolonged exposure of the floodwater because of the long duration typical of these floods.

A 100-year flood or a 500-year flood on the South Platte River in Morgan County would result in the inundation of and subsequent damage to primarily agricultural properties and associated developments as well as public utilities and public roadways. Deep floodwater flowing at high velocity and carrying floating debris would create conditions hazardous to persons and vehicles attempting to cross flooded areas. In general, floodwater 3 or more feet deep and flowing at a velocity of 3 or more feet per second could easily sweep an adult person off his feet, thus creating definite danger of injury or drowning. Rapidly rising and swiftly flowing floodwater may trap persons in homes that are ultimately destroyed or in vehicles that are ultimately submerged or floated. Isolation of areas by floodwaters could create hazards in terms of medical, fire, or law enforcement emergencies (U.S. Army Corps of Engineers, Omaha District, May 1977).

Kiowa Creek

Town of Wiggins

A notable flood occurred on Kiowa Creek on May 21, 1878. It was reported that this flood washed away a railroad bridge crossing the creek shortly before a freight train arrived at the bridge. With the bridge gone, the freight train plunged into the saturated sand of the normally dry channel, never to be found or recovered. Widespread rains on June 2-7, 1921, caused flooding from the South Platte River Canyon above Denver to the Colorado-Nebraska State line. Cloudburst rains in the Kiowa Creek (and Beaver Creek) basin(s) on May 30 and 31, 1935, caused the second largest flood ever recorded on the South Platte River. No frequency information was developed for any of these floods.

Two recorded floods from Kiowa Creek did damage to the Town of Wiggins. These floods occurred in June 1935 and May 1973 (G.E. Ballinger, July 12, 1975). On Main Street, south of the Burlington Northern Railroad tracks, the 1935 flood reached a depth of 53 inches and the 1973 flood reached a depth of 41 inches. These flood depths were aggravated by the railroad tracks running through the town which acted as a dam once the water overran the bank. The 1935 flood is equivalent to the 100-year event analyzed as part of the 1978 FIS.

2.4 Flood Protection Measures

City of Brush

There are no existing or proposed flood control structures either in the study area itself or upstream of it that would tend to reduce the present flood hazard. Many small irrigation water storage facilities and farm stock ponds exist along Beaver Creek and within the Beaver Creek Basin; however, these facilities have little, if any, impact on regulating or controlling the impact of major floodwaters downstream.

Town of Wiggins

A right bank levee was constructed along Kiowa Creek in 1988 to protect approximately 5.5 square miles of property, including the majority of the Town of Wiggins and a portion of Morgan County from the 100-year flood event on Kiowa Creek. The levee consists of an earthen embankment that stretches from Interstate 76 south for a distance of approximately 2 miles. The levee is shown as providing protection from the 100-year flood event in the Letter of Map Revision (LOMR) 89-08-18P. The Town of Wiggins has certified, as reviewed and approved by FEMA, that the levee provides flood protection from the 100-year flood.

The portion of Interstate 76 that stretches from the levee northeast to the extent of the Kiowa Creek 1-percent annual chance floodplain is considered part of the Kiowa Creek levee system; however, within this jurisdiction, it has not been demonstrated by the community or levee owner(s) to meet the requirements of 44CFR65.10 of the NFIP regulations as it relates to the levee's capacity to provide 1-percent annual chance protection. Please refer to the Notice to Flood Insurance Study Users pages at the front of this FIS for more information.

Unincorporated Morgan County

The unincorporated area of Weldona, in the western portion of Morgan County, is flanked on the north and west by an earthen levee that protects the area from flood waters on Schaefer Draw. No flood hazard information is shown for Schaefer Draw in the vicinity of Weldona; therefore, the levee was not certified as showing 100-year flood protection.

Various road, railroad, and canal embankments along the South Platte River have the capacity to act as inadvertent levees in a 100-year event flood; however, as part of the 2010 floodplain study for the South Platte River, these embankments were not shown as providing flood protection.

A right bank levee was constructed along Kiowa Creek in 1988 to protect approximately 5.5 square miles of property, including the majority of the Town of Wiggins and a portion of Morgan County from the 100-year flood event on Kiowa Creek. The levee consists of an earthen embankment that stretches from Interstate 76 south for a distance of approximately 2 miles. The levee is shown as providing protection from the 100-year flood event in the Letter of Map Revision (LOMR) 89-08-18P. The Town of Wiggins has certified, as reviewed and approved by FEMA, that the levee provides flood protection from the 100-year flood.

The portion of Interstate 76 that stretches from the levee northeast to the extent of the Kiowa Creek 1-percent annual chance floodplain is considered part of the Kiowa Creek levee system; however, within this jurisdiction, it has not been demonstrated by the community or levee owner(s) to meet the requirements of 44CFR65.10 of the NFIP regulations as it relates to the levee's capacity to provide 1-percent annual chance protection. Please refer to the Notice to Flood Insurance Study Users pages at the front of this FIS for more information.

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 FIS. 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 one 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 FIS. Maps and flood elevations will be amended periodically to reflect future changes.

Note: Within the Town of Wiggins and Morgan County there are one or more levees that have not been demonstrated by the community or levee owner(s) to meet the requirements of 44CFR65.10 as it relates to the levee's capacity to provide 1-percent annual chance flood protection. Please refer to the Notice to Flood Insurance Study Users pages at the front of this FIS for more information.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

A hydrologic analysis was completed to estimate the peak discharge-frequency relationships for floods of 10-, 50-, 100-, and 500-year recurrence intervals for Beaver Creek. The flood peak estimates were based on a statistical analysis of recorded stream flow records for comparable drainage areas in the high plains area of eastern Colorado, western Kansas and southwestern Nebraska. The estimates prepared for the 1977 FIS for the City of Brush and the 1989 FIS for Morgan County were made utilizing the statistically analyzed data of the USGS (U.S Department of the Interior, Geological Survey, 1976), and are contained in this publication. The records are based on gaging records that ranged from 11 to 15 years, which were taken at various points on the rivers in the areas mentioned above.

The USGS study used the log-Pearson Type III method (Water Resources Council, 1967) for fitting a frequency curve to the gaging station data, and multiple regression techniques for regionalization (transferring the results to ungaged basins).

A considerable amount of historic stream gage data exists for the South Platte River that is pertinent to Morgan County. The USGS has published information collected at the South Platte River stream gages in Morgan County. Information from these gages was used in the hydrologic analysis conducted during the Beaver Creek study.

As a precursor to the Morgan County DFIRM Conversion Project, a hydrologic analysis was completed by PBS&J in 2008 to estimate the peak discharge-frequency relationships for floods of 10-, 50-, 100-, and 500-year recurrence intervals for the South Platte River. The flood peak estimates were based on a statistical analysis of recorded stream flow records for three stream gages on the South Platte River within Morgan County using the U.S. Geological Survey PeakFQ gage analysis program. The final discharges were determined from a gage located near Weldona, Colorado and included 25 peaks in the record.

As part of the Morgan County DFIRM Project, a hydrologic analysis was completed by AECOM Technical Services, Inc. in July 2012 to estimate the peak discharge-frequency relationships for floods of 10-, 50-, 100-, and 500-year recurrence intervals for Beaver Creek. The flood peak estimates were based on a hydrologic model developed using the U.S. Army Corps of Engineers' Hydrologic Modeling System, Version 3.2. The hydrologic analyses supersede the discharge estimates prepared for the 1977 FIS for the City of Brush and the 1989 FIS for Morgan County and are the new effective discharges for the current FIS.

The section of Kiowa Creek studied for the 1978 Town of Wiggins FIS was ungaged. Discharges were determined for Kiowa Creek using the section of the U.S. Geological Survey Technical Manual No. 1 dealing with ungaged streams (U.S. Department of the Interior, Geological Survey, 1976). The basin parameters needed to utilize this method, drainage area and basin slope, were measured from U.S. Geological Survey topographic maps at a scale of 1:250,000, with a contour interval of 200 feet (U.S. Department of the Interior, Geological Survey, 1953, 1954, 1961, 1963). Peak discharges were determined for the 10- and 100-year floods and plotted on log-probability paper. A straight line was drawn between these points to get the 50-year discharge, and this line was extrapolated to get the 500-year discharge. Peak discharge-drainage area relationships for Beaver Creek, Kiowa Creek, and the South Platte River are shown in Table 2.

Table 2 – Summary of Discharges

<u>Flooding Source and Location</u>	<u>Drainage Area</u> (square miles)	Peak Discharges (cubic feet per second)			
		10-Percent Annual Chance (10-year event)	2-Percent Annual Chance (50-year event)	1-Percent Annual Chance (100-year event)	0.2-Percent Annual Chance (500-year event)
Beaver Creek					
At Brush	1,089.0	14,700	30,300	38,400	69,700
Kiowa Creek					
At Interstate 76	709.2	14,237	36,000	49,346	96,000
South Platte River					
Near Weldona	13,190.0	12,000	22,130	27,570	43,240

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. 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.

Cross sections for the backwater analysis of Beaver Creek for the 1977 FIS for the City of Brush and for the 1989 FIS for Morgan County were taken from topographic maps (Gingery Associates, Inc., April 1976). Digitized cross sections were secured in the area south of County Road "R" (Old DLD Road).

Roughness coefficients (Manning's "n") used in the Beaver Creek computations for the 1977 and 1989 FISs were selected based on field inspection of the actual floodplain conditions. The roughness factors were 0.035 for the channel, 0.030 for the undeveloped overbank, and 0.050 for the developed overbank.

Water-surface profiles showing elevations of the 10-, 50-, 100-, and 500-year floods along Beaver Creek for the 1977 and 1989 FISs were developed using the U.S. Army Corps of Engineers' HEC-2 step-backwater computer program (U.S. Army Corps of Engineers, Hydrologic Engineering Center, 1973).

Starting water surface elevations for Beaver Creek for the 1977 and 1989 FISs were based on a statistical analysis of recorded stream flow records for comparable drainage areas in the high plains area of eastern Colorado, western Kansas, and southwestern Nebraska.

Flood profiles for the 1977 and 1989 FISs were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals. All elevations were referenced to the National Geodetic Vertical Datum (NGVD) of 1929. Elevation reference marks used in these studies were shown on the maps; descriptions of the marks were presented in Elevation Reference Marks.

Cross section data for Kiowa Creek near the study area for the 1978 FIS for the Town of Wiggins were obtained from field surveys. All bridges and backwater-producing structures were surveyed to obtain elevation data and structural geometry.

Roughness coefficients (Manning's "n") for Kiowa Creek for the 1978 FIS were estimated by field inspection. The channel "n" value used for Kiowa Creek was 0.030, and the overbank values ranged from 0.040 to 0.050.

Starting elevations for backwater computations along Kiowa Creek for the 1978 FIS were determined by using the slope area method. Water-surface profiles were computed for the 10-, 50-, 100-, and 500-year floods using the U.S. Army Corps of Engineers' HEC-2 computer program (U.S. Army Corps of Engineers, Hydrologic Engineering Center, December 1968).

Flood profiles for the 1978 FIS were drawn to an accuracy of 0.5 foot for floods of the selected recurrence intervals. All elevations were referenced to the National Geodetic Vertical Datum (NGVD) of 1929. Elevation reference marks used in these studies were shown on the maps; descriptions of the marks were presented in Elevation Reference Marks.

Water-surface elevation data for the South Platte River determined as part of the 1989 FIS for Morgan County were computed through the use of the U.S. Army Corps of Engineers' HEC-2 Water-Surface Profiles computer program. These computations were based upon channel and floodplain conditions as represented by surveys conducted in the spring of 1973.

As part of the Morgan County DFIRM Conversion Project, approximate Zone A hydraulic analyses were performed along the South Platte River for approximately 49 river miles throughout Morgan County using the U.S. Army Corps of Engineers' River Analysis System (HEC-RAS, Version 4.0). Starting water surface elevations for backwater computations along the South Platte River were determined by using the slope area method. Approximate 100-year Zone A (no Base Flood Elevations) and 500-year shaded Zone X floodplain limits were delineated along the entire reach within Morgan County.

As part of the Morgan County DFIRM Conversion Project, water surface elevations for the 10-, 50-, 100-, and 500-year floods for Beaver Creek were determined by AECOM Technical Services, Inc. in July 2012 using the U.S. Army Corps of Engineers' River Analysis System (HEC-RAS, Version 4.1). The analysis included approximately 5.8 river miles of Beaver Creek near the City of Brush and approximately 0.5 river miles of Beaver Creek split flow path in the City of Brush. Cross sections for this analysis were obtained from aerial mapping and 2-foot contours in April 2005. All bridge and culvert information was measured in the field to obtain elevation data and structural geometry. Starting water surface elevations for Beaver Creek were determined by normal depth.

Roughness coefficients (Manning's "n") for Beaver Creek as part of the 2012 AECOM study were determined by field inspection. Ground level photography aided in the selection of roughness factors and aerial photography was used to determine the limits of each roughness zone. Roughness values for the main channel of Beaver Creek ranged from 0.030 to 0.080, while overbank floodplain values ranged from 0.020 to 0.090.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). It should be noted that the Flood Profile for Kiowa Creek as depicted in the 1978 FIS for the Town of Wiggins has not been included in the current FIS; LOMR Case No. 89-08-18P, which became effective on December 5, 1989, eliminated flooding within the Town of Wiggins for all events up to and including the 1-percent annual chance event. For stream segments for which a floodway is computed (Section 4.2), selected cross section locations are also shown on the FIRM (Exhibit 2).

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.

Vertical control for the current study is based on the North American Vertical Datum of 1988 (NAVD). Elevation reference marks, or benchmarks, used in the current study are shown on the maps. Users seeking additional information on the benchmarks are directed on the FIRM panels to contact the National Geodetic Survey or visit the web site at <http://www.ngs.noaa.gov>.

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 in use for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD29). With the finalization of the North American Vertical Datum of 1988 (NAVD88), many FIS reports and FIRMs are being prepared using NAVD88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD88. Structure and ground elevations in the community must, therefore, be referenced to NAVD88. It is important to note that adjacent communities may be referenced to NGVD29. This may result in differences in Base Flood Elevations (BFEs) across the corporate limits between the communities.

As noted above, the elevations shown in the FIS report and on the FIRM for Morgan County and Incorporated Areas are referenced to NAVD88. Ground, structure, and flood elevations may be compared and/or referenced to NGVD29 by applying a standard conversion factor.

The conversion factor from NGVD29 to NAVD88 will vary for each detailed study reach in Morgan County. Beaver Creek was re-studied using detailed methods in NAVD88.

The Base Flood Elevations (BFEs) shown on the FIRM represent whole-foot rounded values. For example, a BFE of 4,220.4 will appear as 4,220 on the FIRM and 4,220.6 will appear as 4,221. Therefore, users that wish to convert the

elevations in this countywide study to NGVD29 should apply the stated conversion factor(s) to elevations shown on the Flood Profiles in the FIS report, which are shown to the nearest 0.5-foot.

For more information on NAVD88, see Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, FEMA Publication FIA-20, June 1992, or contact the Vertical Network Branch, National Geodetic Survey, Coast and Geodetic Survey, National Oceanic and Atmospheric Administration, Rockville, Maryland 20910 (Internet address <http://www.ngs.noaa.gov>).

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 Tables, and Summary of Stillwater Elevation Tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local community 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 (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance (500-year) 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.

For the 1977 FIS for the City of Brush, floodplain boundaries between cross sections on Beaver Creek were interpolated using topographic maps at a scale of 1:4800, with a contour interval of 2 feet (Gingery Associates, Inc., April 1976). For the 1989 FIS for Morgan County, floodplain boundaries between cross sections on Beaver Creek were interpolated using simple survey methods from the established markers or by scaling from physical features shown on the map.

For the 1978 FIS for the Town of Wiggins, floodplain boundaries between cross sections on Kiowa Creek were interpolated using topographic maps at a scale of 1:24,000, with a contour interval of 10 feet (U.S. Department of the Interior, Geological Survey, 1950, photorevised 1971).

For the 1989 FIS for Morgan County, floodplain boundaries for the South Platte River were interpolated by survey methods. USGS 7.5 Minute Quadrangle Maps were also used in this interpolation. Appropriate areas were plotted using existing Flood Hazard Boundary Maps (FHBMs) (Federal Insurance Administration, Federal Emergency Management Agency, May 12, 1981) and Flood Prone Quadrangle Maps (U.S. Department of the Interior, Geological Survey, 1950, 1951, 1963, 1965, 1970, 1973, 1974).

As part of the Morgan County DFIRM Conversion Project, floodplain boundaries were delineated along the South Platte River for approximately 49 river miles throughout Morgan County. Floodplain boundaries for the 1- and 0.2-percent-annual-chance floods were mapped on 5-foot interval contours and were interpolated manually in conjunction with the U.S. Army Corps of Engineers HEC-GeoRAS geospatial data processor based on a Triangulated Irregular Network or TIN (Anderson Consulting Engineers, 2010).

As part of the Morgan County DFIRM Conversion Project, floodplain boundaries were delineated along Beaver Creek for approximately 5.8 river miles near the City of Brush and approximately 0.5 river miles of split flow path in the City of Brush. Floodplain boundaries for the 1- and 0.2-percent-annual-chance floods were mapped on 2- and 5-foot interval contours (AECOM Technical Services, Inc., July 2012).

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, AH, AO, and D), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards (shaded Zone X). 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.

Unless explicitly stated otherwise, for the streams studied by approximate methods, only the 1-percent-annual-chance floodplain boundary is shown on the Flood Insurance Rate Map (Exhibit 2).

Within the Town of Wiggins and Morgan County there are one or more levees that have not been demonstrated by the community or levee owner(s) to meet the requirements of 44CFR65.10 of the NFIP regulations as it relates to the levee's

capacity to provide 1-percent annual chance flood protection. As such, the floodplain boundaries in this area were taken directly from the previously effective FIRM (in this case, from LOMR Case No. 89-08-18P) and are subject to change. Please refer to the Notice to Flood Insurance Study Users pages at the front of this FIS for more information on how this may affect the floodplain boundaries shown on the FIRM.

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.

As part of the 1977 FIS for the City of Brush, the floodway for Beaver Creek was based on a surcharge limit of 0.5 foot, as recommended by the City of Brush in their November 16, 1976 letter.

As part of the 1978 FIS for the Town of Wiggins, the floodway for Kiowa Creek was based on a surcharge limit of 1.0 foot.

No floodways were computed for the 1989 FIS for Morgan County.

As part of the Morgan County DFIRM Conversion Project, a 0.5 foot rise floodway for Beaver Creek was computed.

The floodways presented in this FIS report and on the FIRM were computed 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 (Table 3). It should be noted that the Floodway Data Table for Kiowa Creek as depicted in the 1978 FIS for the Town of Wiggins has not been included in the current FIS; LOMR Case No. 89-08-18P, which became effective on December 5, 1989, eliminated the 1-foot rise floodway within the Town of Wiggins. 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			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Beaver Creek								
A	1,316	4,516	13,065	3.5	4221.2	4221.2	4221.7	0.5
B	3,622	5,651	16,292	6.9	4223.8	4223.8	4224.0	0.2
C	4,876	2,413	8,141	4.7	4232.4	4232.4	4232.8	0.4
D	5,414	6,879	54,122	1.6	4233.0	4233.0	4233.4	0.4
E	7,320	6,321	31,489	1.2	4233.2	4233.2	4233.6	0.4
F	10,122	2,400	17,975	1.4	4238.1	4238.1	4238.1	0.0
G	11,185	262	2,200	5.0	4238.3	4238.3	4238.4	0.1
H	12,353	449	3,389	5.8	4239.3	4239.3	4239.3	0.0
I	13,908	6,019	31,687	1.2	4241.3	4241.3	4241.4	0.1
J	16,939	4,476	26,248	1.5	4241.5	4241.5	4241.6	0.1
K	18,517	3,320	18,484	2.1	4241.9	4241.9	4242.0	0.1
L	20,378	3,484	13,742	10.0	4242.2	4242.2	4242.2	0.0
M	21,385	3,312	19,675	4.7	4244.9	4244.9	4245.2	0.3
N	24,197	2,529	12,465	3.1	4249.6	4249.6	4249.6	0.0
O	25,873	2,282	12,478	3.1	4250.6	4250.6	4250.6	0.0
P	28,944	2,601	8,401	4.6	4253.6	4253.6	4253.8	0.2
Q	31,916	2,826	19,016	3.2	4259.0	4259.0	4259.1	0.1

¹ Feet Above County Road T.

TABLE 3	FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOODWAY DATA
	MORGAN COUNTY, CO AND INCORPORATED AREAS	
		BEAVER CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Beaver Creek Spill								
A	1,087	5,574	12,993	1.5	4234.6	4234.6	4234.9	0.3
B	2,033	4,626	8,751	2.3	4235.1	4235.1	4235.3	0.2
C	2,964	4,970	12,798	2.4	4237.4	4237.4	4237.5	0.1
D	3,528	5,237	14,188	0.0	4238.5	4238.5	4238.8	0.3

¹ Feet Above Confluence with Beaver Creek.

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

**MORGAN COUNTY, CO
AND INCORPORATED AREAS**

FLOODWAY DATA

BEAVER CREEK SPILL

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 0.5 foot, in the case of Beaver Creek, at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1.

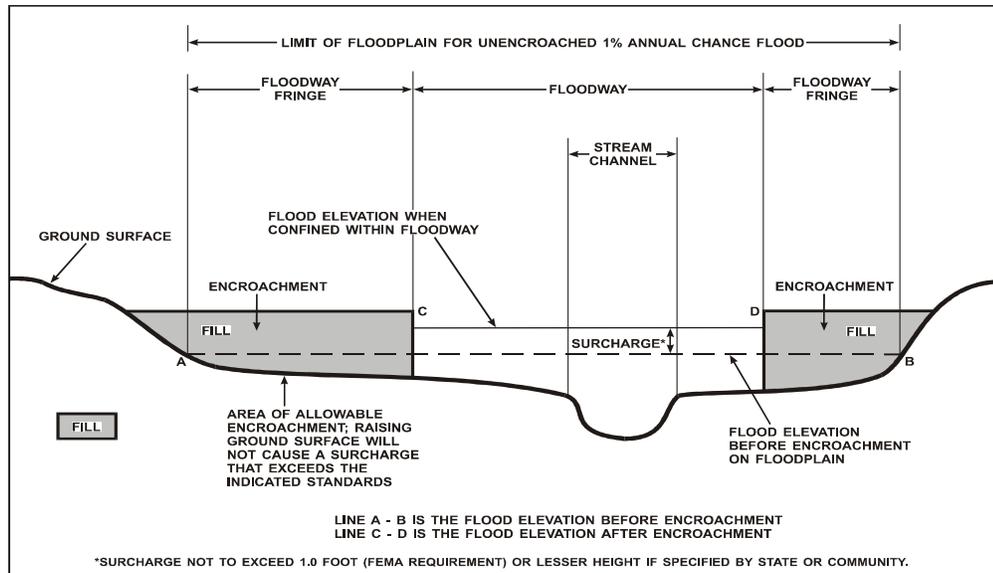


Figure 1 – Floodway Schematic

5.0 INSURANCE APPLICATIONS

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 AH

Zone AH is the flood insurance risk zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. 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 AR

Zone AR is the flood insurance risk zone that corresponds to an area of special flood hazard formerly protected from the 1-percent-annual-chance flood event by a flood-control system that was subsequently decertified. Zone AR indicates that the former flood-control system is being restored to provide protection from the 1-percent-annual-chance or greater flood event.

Zone A99

Zone A99 is the flood insurance risk zone that corresponds to the areas of the 1-percent-annual-chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No BFEs or depths 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.

Zone X (Future Base Flood)

Zone X (Future Base Flood) is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined based on future-conditions hydrology. No BFEs or base flood depths are shown within this zone.

Zone D

Zone D is the flood insurance risk zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

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 entire geographic area of Morgan County, Colorado. Previously, separate Flood Hazard Boundary Maps (FHBMs) and/or FIRMs were prepared for each identified flood prone incorporated community and for the unincorporated areas of the county. Historical data relating to the maps prepared for each flood prone community, prior to this Countywide FIS are presented in Table 4 “Community Map History.”

Within the Town of Wiggins and Morgan County there are one or more levees that have not been demonstrated by the community or levee owner(s) to meet the requirements of 44CFR65.10 of the NFIP regulations as it relates to the levee’s capacity to provide 1-percent annual chance flood protection. Please refer to the Notice to Flood Insurance Study Users pages at the front of this FIS for more information on how this may affect the FIRM.

7.0 OTHER STUDIES

For the 1977 FIS for the City of Brush, the only published report concerning the potential flood hazards on Beaver Creek in the area in and around Brush, Colorado was the Flood Plain Information Report, Beaver Creek, Brush, Colorado, prepared by Gingery Associates, Inc., April 1976. The information contained in the 1977 FIS report was based on the above mentioned report; therefore, they were in complete agreement.

For the 1978 FIS for the Town of Wiggins, the U.S. Army Corps of Engineers, Omaha District, completed a preliminary investigation to analyze the feasibility of a flood control project for Wiggins at the request of the Town of Wiggins after the 1973 flood (U.S. Army Corps of Engineers, 1976). The U.S. Army Corps of Engineers computed a preliminary 100-year discharge of 119,000 cubic feet per second, but felt it was not of

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Brush, City of	November 23, 1973	April 25, 1975	December 1, 1977	October 13, 1981
Fort Morgan, City of	October 29, 1976	February 6, 1979	February 5, 1986	N/A
Hillrose, Town of	N/A	N/A	N/A	N/A
Log Lane Village, Town of	N/A	N/A	N/A	N/A
Morgan County (Unincorporated Areas)	February 21, 1978	May 12, 1981	September 29, 1989	December 5, 1989
Wiggins, Town of	January 28, 1977	N/A	February 15, 1979	December 5, 1989

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY
**MORGAN COUNTY, CO
AND INCORPORATED AREAS**

COMMUNITY MAP HISTORY

sufficient detail to accurately define the flood peak discharges for use in completing the 1978 Flood Insurance Study.

The 1989 FIS for Morgan County was prepared by compiling existing hydrologic and hydraulic analyses and utilizing technical and scientific data prepared by other organizations originally for purposes other than those of the NFIP. The data was identified as the best available at the time of compilation of the 1989 FIS and depicted the general conditions of the flooding sources with relative accuracy. FEMA performed a cursory review and accepted the data as valid for purposes of the 1989 FIS and the NFIP. However, if better information is known to exist or has been developed since the date of this report, the information should be immediately forwarded to FEMA, Federal Insurance and Mitigation Division, Denver Federal Center, Building 710, Box 25267, Denver, Colorado 80225-0267 for consideration in revision of this FIS.

The 1989 FIS for Morgan County was in complete agreement with the existing Flood Insurance Rate Maps for the Cities of Fort Morgan and Brush, and the Town of Wiggins, Colorado, all of which lie in Morgan County (Federal Insurance Administration, Federal Emergency Management Agency, February 5, 1986, October 13, 1981, and February 15, 1979, respectively).

A Flood Hazard Boundary Map (FHBM) was published for Morgan County (Federal Insurance Administration, Federal Emergency Management Agency, May 12, 1981). The difference between the Flood Hazard Boundary Map and the current study are justified due to the more detailed nature of this Flood Insurance Study.

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 FEMA, Federal Insurance and Mitigation Division, Denver Federal Center, Building 710, Box 25267, Denver, Colorado 80225-0267.

9.0 BIBLIOGRAPHY AND REFERENCES

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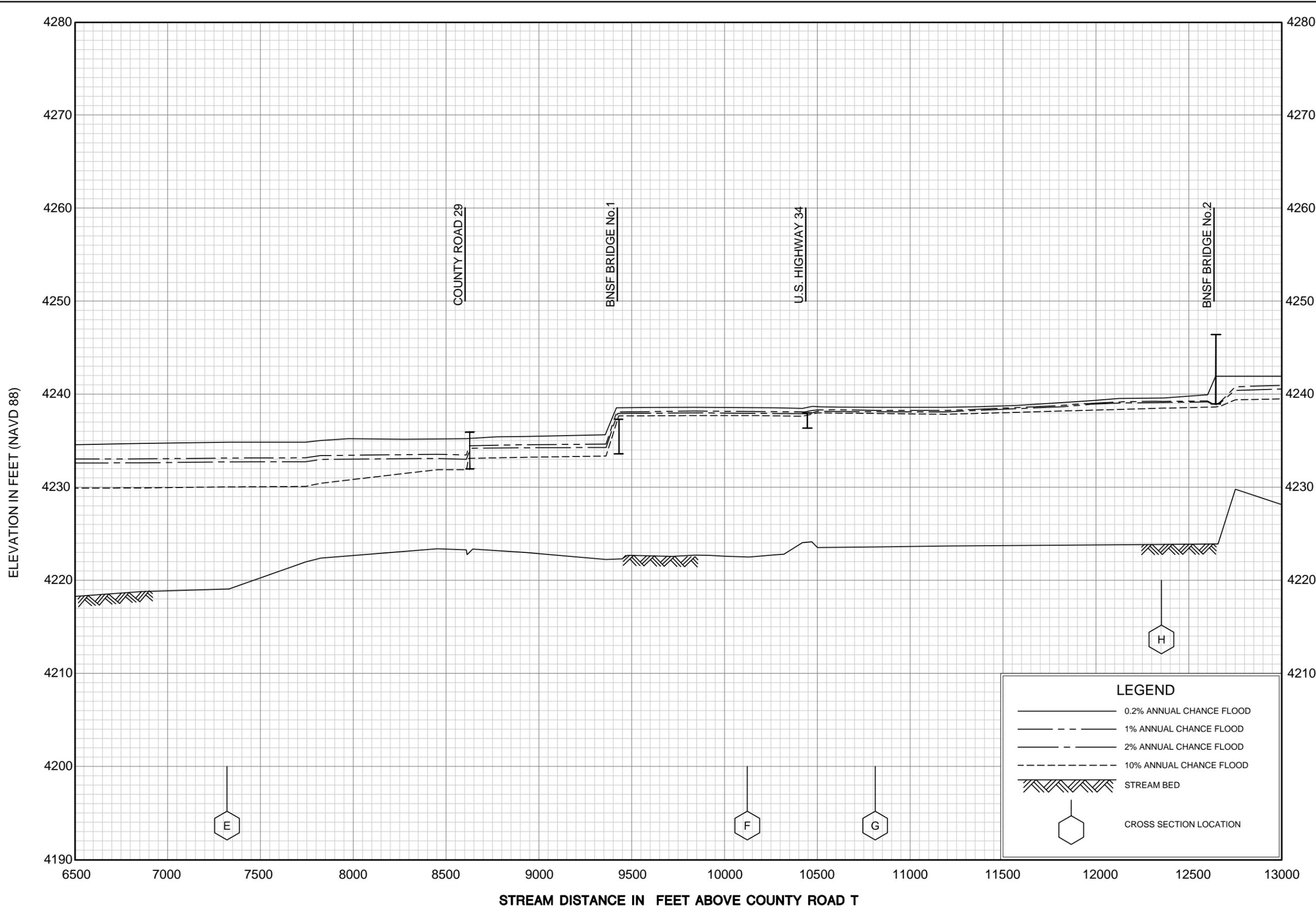
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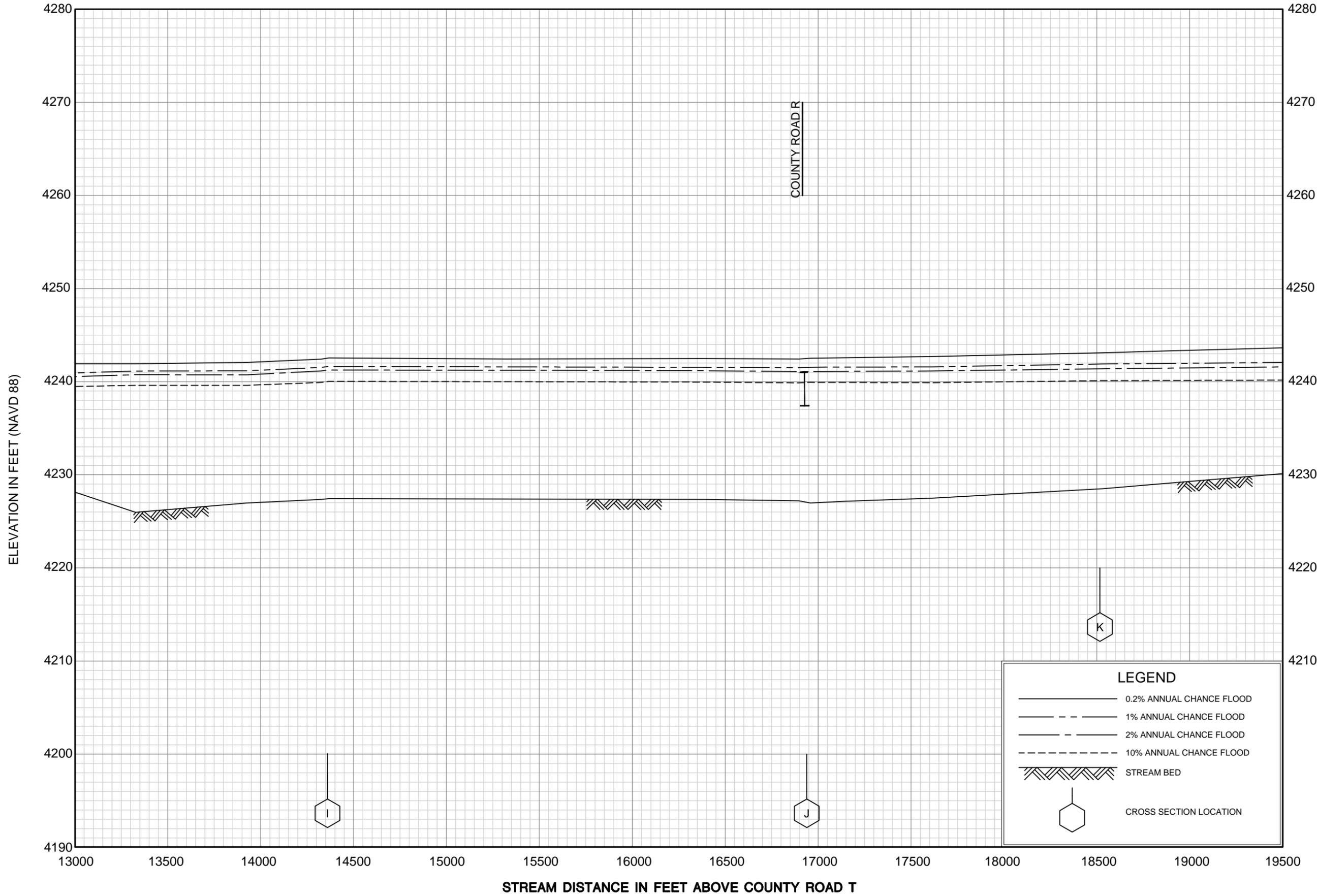
FLOOD PROFILES

BEAVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BRUSH, CO
MORGAN COUNTY

02P



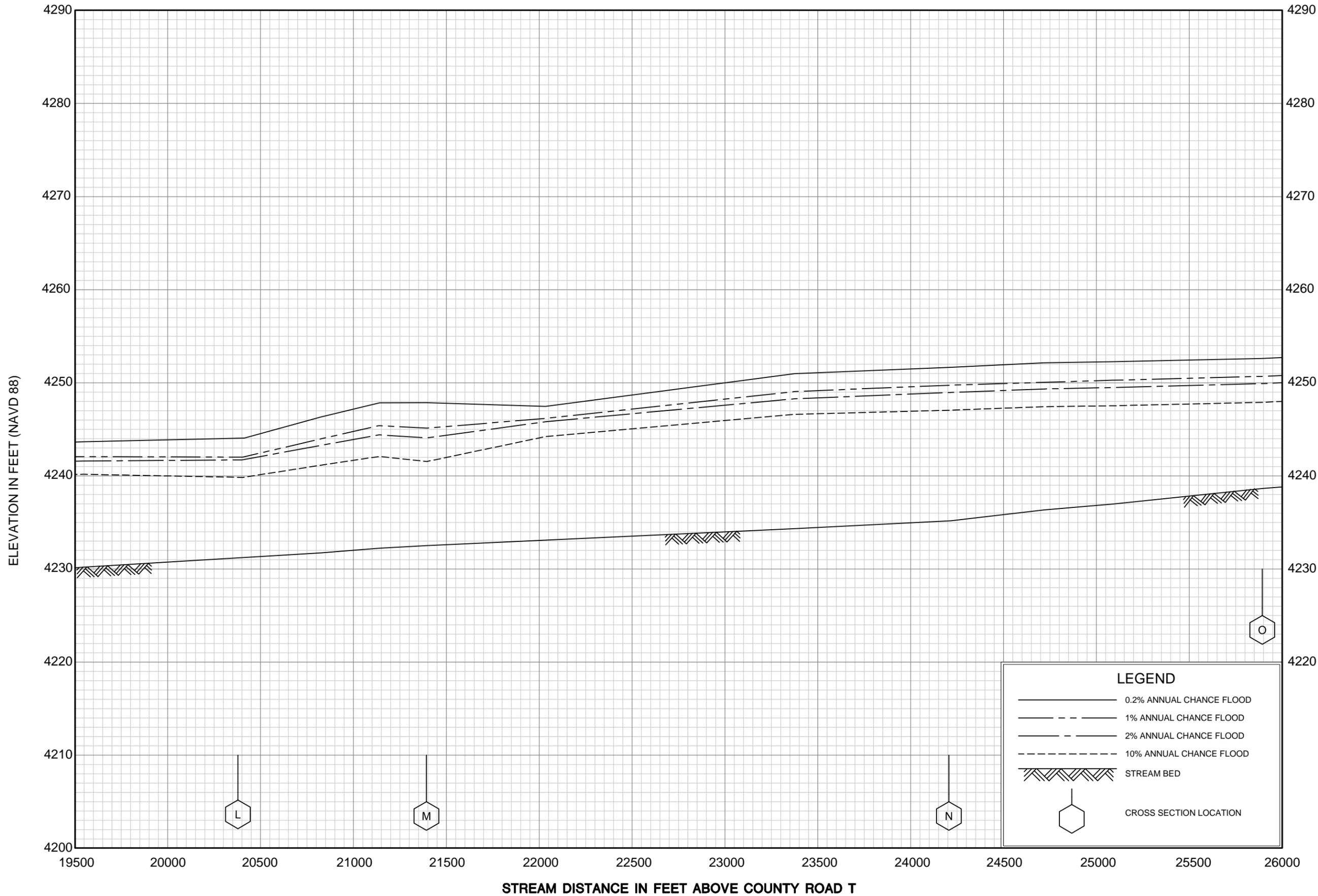
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MORGAN COUNTY

03P



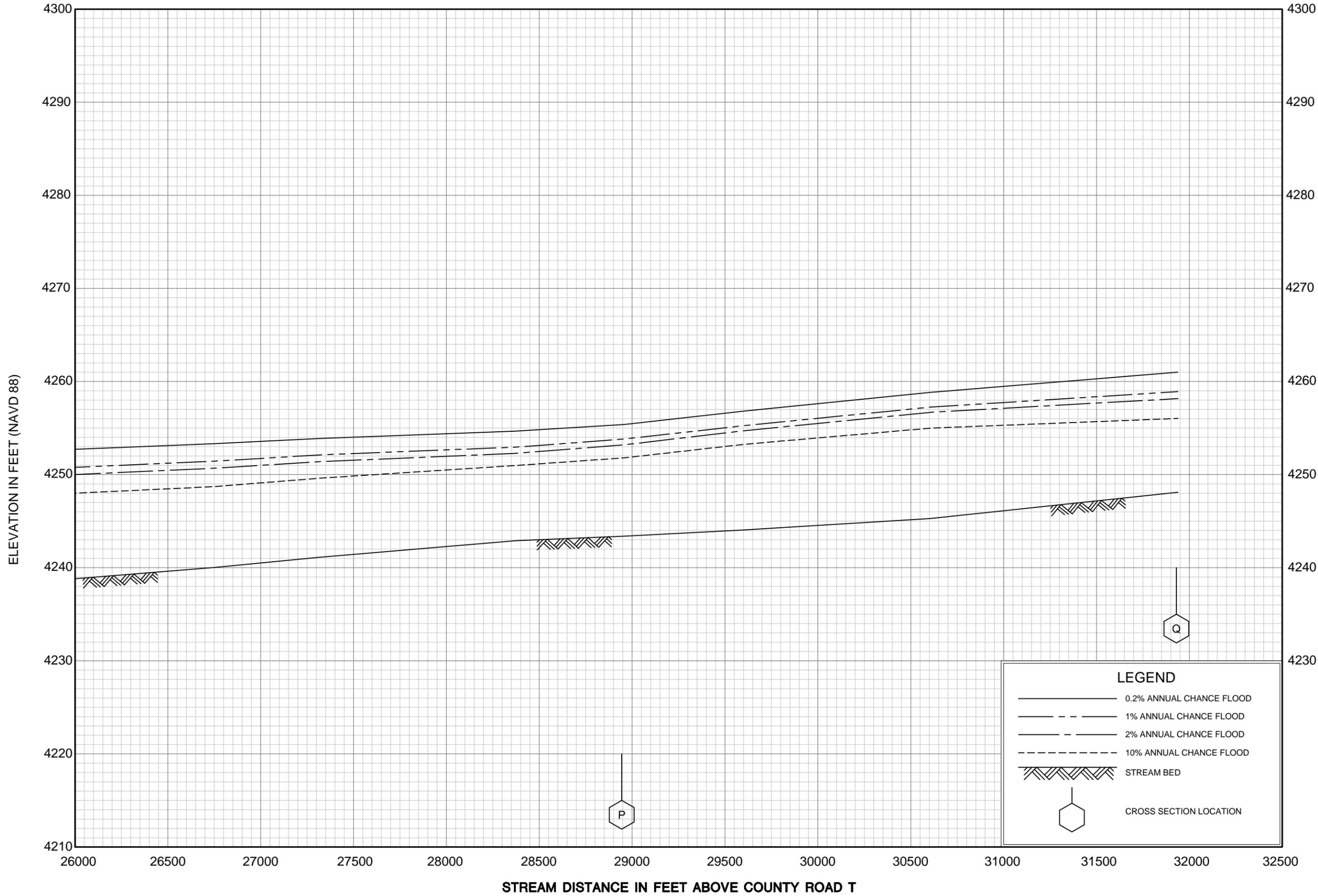
FLOOD PROFILES

BEAVER CREEK

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MORGAN COUNTY**

04P



FLOOD PROFILES

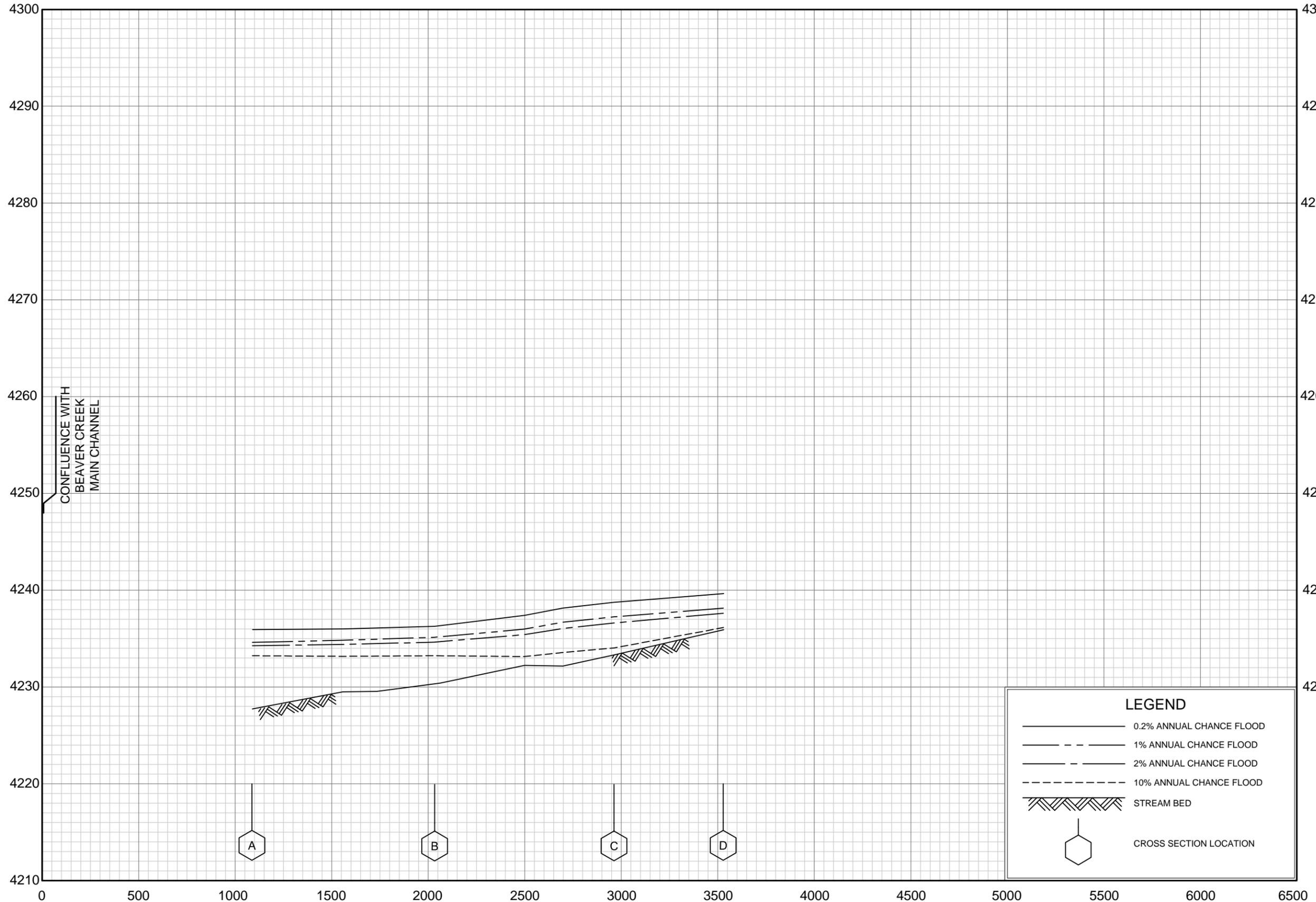
BEAVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BRUSH, CO
MORGAN COUNTY

05P

ELEVATION IN FEET (NAVD 88)



FLOOD PROFILES

BEAVER CREEK SPILL

FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF BRUSH, CO
MORGAN COUNTY