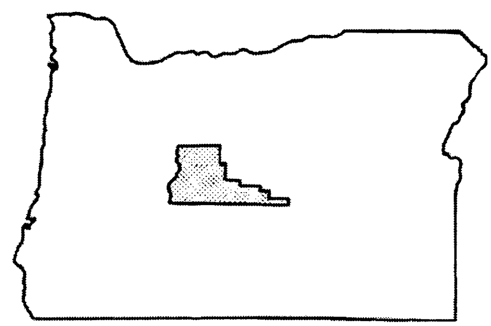
FLOOD INSURANCE STUDY

DESCHUTES COUNTY, OREGON AND INCORPORATED AREAS



COMMUNITY NAME	COMMUNITY NUMBER
BEND, CITY OF	410056
LA PINE, CITY OF	410057
DESCHUTES COUNTY, UNINCORPORATED AREAS	410055
*REDMOND, CITY OF	410015
SISTERS, CITY OF	410058

* NON-FLOOD PRONE

REVISED:
SEPTEMBER 28, 2007

Federal Emergency Management Agency

Flood Insurance Study Number
41017CV000A

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.

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

Old Zone	New Zone
A1 through A30	AE
V1 through V30	VE
B	X
C	X

Part or all of this FIS may be revised and republished at any time. In addition, part of this FIS may be revised by a 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 report components.

This publication incorporates revisions to the original Flood Insurance Study. These revisions are presented in Section 10.0.

Initial Countywide FIS Effective Date: August 16, 1988

Revised Countywide FIS Dates: June 8, 1998

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FLOOD INSURANCE STUDY

DESCHUTES COUNTY, OREGON AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) investigates the existence and severity of flood hazards in the geographic area of Deschutes County, Oregon, including the incorporated Cities of Bend, LaPine, Redmond, and Sisters and the unincorporated areas of Deschutes County (hereinafter referred to collectively as Deschutes 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 and to assist the community in its efforts to promote sound 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.

Please note that the City of Redmond is non-floodprone.

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.

1.2 Authority and Acknowledgements

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

The hydrologic and hydraulic analyses for this study were performed by the U.S. Army Corps of Engineers (COE), Portland District, for the Federal Emergency Management Agency (FEMA), under Interagency Agreement No. IAA-EMW-E-1153, Project Order No. 1, Amendment No. 29. This study was completed in July 1985.

1.3 Coordination

The initial coordination and precontract meeting was held on July 11, 1983, for the incorporated areas of Deschutes County. The meeting was attended by representatives from FEMA, the COE's Portland District, and the County. The intent of the meeting was: first, to inform the county of their status in the NFIP, second, to gather all available pertinent data on flooding in the county and finally, to reach an agreement on areas to be studied.

On November 14, 1983, public announcements of the proposed Flood Insurance Study were made available to the local news agencies and the communities in Deschutes County. The announcements informed residents of the study, and requested information that would help identify flood hazard areas and possible high water marks. Coordination continued throughout the processing of this study. In November and December 1983, letters were sent to the Department of Interior-U.S. Bureau of Reclamation, U.S. Geological Survey (USGS), U.S. Soil Conservation Service (SCS), Oregon Water Resources Department, Oregon Department of Transportation, and the State Director of the Bureau of Land Management in order to gather available flood information and pertinent flood data.

On February 27, 1986, an Intermediate Coordination Meeting was held in the courthouse annex; county planning personnel, representatives of the COE's Portland District, and FEMA officials were present. The work maps showing flooded areas, floodways, and base flood elevations were reviewed by the county.

On July 27, 1987, the results of the study were reviewed at the final meeting attended by representatives of the community, FEMA, and the study contractor. The study was acceptable to the community.

The results of this new county wide study were reviewed at the final CCO meeting held on December 12, 2006, and attended by representatives of Deschutes County, the City of Sisters, Oregon State Department of Land Conservation and Development, and FEMA. All problems raised at that meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Deschutes County, Oregon, including the incorporated communities listed in Section 1.1. The following streams were studied by detailed methods and were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through July 1990:

1. Deschutes River in four separate reaches (25.27 miles)
    a. Vicinity of Tumalo, River Mile (RM) 156 to 158 (2 miles)
    b. Vicinity of Bend, RM 162 to 169.5 (7.5 miles)
    c. Vicinity of Sunriver, RM 185.57 to 195.24 (9.67 miles)
    d. Vicinity of D.R. Recreational Homesites, RM 201 to 207.1 (6.1 miles)
2. Little Deschutes River (45.2 miles)

    From its confluence with Deschutes River to the Klamath County line.
3. Whychus Creek (18.6 miles)

    From the Jefferson County Line upstream to the USGS stream gage at RM 26.6.

Portions of some of the above-mentioned reaches lie within the corporate limits of Bend and Sisters.

Approximate analyses were used to study the following streams having a low development potential or minimal flood hazards:

1. Deschutes River in four separate reaches (14.3 miles total)
    a. Between Tumalo and Bend, RM 158-162 (4 miles)
    b. Upstream of Bend to Meadow Camp Ground, RM 169.5-173.7 (4.2 miles)
    c. Vicinity of General Patch Bridge, RM 195.5-201 (5.5 miles)
    d. Vicinity of Pringle Falls (0.6 miles)
2. Paulina Creek from its confluence with Little Deschutes River upstream (6.2 miles)
3. Spring River from its confluence with Deschutes River upstream (1.1 miles)
4. Tributary to Little Deschutes at La Pine from confluence upstream (1.5 miles)

An additional flood hazard was identified as a result of the potential Moraine Dam failure of Carver Lake near Sisters, Oregon, based on the USGS report entitled "Hydrologic Hazards along Squaw Creek from a Hypothetical Failure of the Glacier Moraine Impounding Carver Lake near Sister, Oregon" (Reference 2). This information was incorporated for advisory purposes only because of the high, but uncertain, estimate of failure probability for this natural dam.

The scope and methods of study were proposed to and agreed upon by representatives FEMA and Deschutes County.

2.2 Community Description

Deschutes County is located in central Oregon with Jefferson County bordering the north; Crook County bordering the east; Lake and Klamath Counties bordering the south; the Cascade Mountain Range, Lane, and Linn Counties bordering the west.

Located in the heart of the state, Deschutes County encompasses the snow-capped Cascades and the fertile valley, range, and forest lands of the "high country" – or central Oregon plateau. It experienced the most rapid growth of any county in the state during the mid-1970s to mid-1980s, mostly due to its invigorating climate (Reference 3).

The county was established December 13, 1916, from a part of Crook County and covers a total area of 3,055 square miles. The Cities of Bend, Sisters, and Redmond are the only incorporated communities in Deschutes County. The City of Bend is located near the center, the City of Sisters is located in the northwestern portion, and the City of Redmond is located in the northeastern portion of the county. The population of Deschutes County in 2004 was 134,479, which was an increase of 16.57% from the 2000 census (Reference 24). In 2003 the populations for the Cities of Bend, Sisters, and Redmond were 59,779, 16,822, and 1,156, respectively (Reference 24).

The climate is mild with an average January temperature of 31° F and an average July temperature of 63° F at Bend. The annual precipitation is 11.5 inches at Bend (Reference 3), but varies greatly across the county, exceeding 100 inches at the western edge near the Three Sisters Mountains and is less than 10 inches at Redmond, about 16 miles northeast of Bend (Reference 4).

The southwestern part of the county, delineated by a line running northwest to southeast through Sisters and just south of Bend, contains pumice sand underlain by highly permeable basalt. These very porous soils of volcanic origin contain a very large volume of water in subsurface storage. The area to the northeast of that imaginary line is not quite as porous but still holds a moderate to large volume of water in subsurface storage (Reference 5).

This large amount of subsurface storage has a dampening effect on floodflows, and Deschutes River in Deschutes County has some of the lowest discharge rates per square mile of any comparable size basin in the state.

The Cascade Mountain Range lies along the western edge of the county and is covered with evergreen forests consisting of Douglas fir at the higher elevations changing to Ponderosa pine and Lodgepole pine at the lower elevations as one moves eastward.

Of the nearly 2 million acres in Deschutes County, 1.75 million acres are in the Deschutes River Basin; and of that amount, just under 340,000 acres are in farm or ranch land with over 80 percent of it being pasture land (Reference 5).

Irrigation forms the largest water use in the basin with the majority of the irrigation rights held by irrigation districts in the area encompassing Bend, Redmond, and Sisters. These districts receive water from the direct flow of Deschutes River, Tumalo Creek, and Whychus Creek and from storage in Crescent Lake, Crane Prairie Reservoir and Wickiup Reservoir (Reference 5).

2.3 Principal Flood Problems

Obstructions to floodflows increase flood heights, causing more extensive flooding than would otherwise occur. Natural obstructions include trees, brush, or other vegetation growing along the streambanks in the floodway areas. Ice jams are also a potential obstruction to floodflows along the streams. Manmade obstructions include diversion dams, bridges, and road embankments.

Floods in the study area may occur several times during a single flood season. Snowmelt floods occur in the spring and early summer when temperatures rise rapidly, causing rapid melting of accumulated snow. During the winter, storms move inland from the Pacific Ocean bringing periods of intense rainfall over the Pacific Northwest. Winter flood are usually caused when the weather suddenly warms while the ground is still frozen, and rainfall melts the snowpack. When flooding occurs during a winter thaw, ice may obstruct floodflows by lodging against bridges or other obstructions along the streams.

The canyon reach upstream of the former log pond formed by Shevlin Dam is conducive to forming frazil ice, which is generated in turbulent open-water areas of a river during critical temperature and velocity conditions. This frazil ice has caused some flooding problems downstream in Bend in the vicinity of Mirror Pond several times since 1973, when the stored logs were removed. Presumably, frazil ice and ice-jams formed upstream of the log pond prior to 1973 but were prevented from moving downstream by the stored logs.

The annual flood season for the Deschutes River extends from November through July, with a majority of the larger floods downstream from Little Deschutes River occurring in November and December. Some high water levels result from snowmelt that occurs in late spring or from irrigation releases that occur in June and July. Floods are a possibility whenever the rainfall is abnormally intense or prolonged, especially if the rain falls on an existing snowpack in the surrounding mountains.

The flood of record (recorded since June 1938) on the Deschutes River above the Little Deschutes River occurred July 30, 1956. This was a regulated release from Wickiup Reservoir of 2,280 cubic feet per second (cfs) (approximately a 40-year event). The flood of record on Deschutes River below the Little Deschutes River confluence occurred November 27, 1909, with a discharge of 5,000 cfs at the Benham Falls Stream gage and of 4,820 cfs at the gage below Bend. A natural frequency curve has not been developed for the Deschutes main stem because of the operations of Crane Prairie Reservoir, Crescent Lake, and Wickiup Reservoir, which began in 1922 and 1942, respectively; therefore, no frequency has been assigned to the November 27, 1909, flood. Since 1909 the largest flood below the Little Deschutes River occurred in December 1964, with a discharge of 3,470 cfs at the gage near Benham Falls (RM 181.4). This was approximately a 175-year flood event.

The most significant high water discharge on Deschutes River in the past 15 years upstream of the irrigation diversion dam at RM 164.8 occurred July 23-24, 1976. The release from Wickiup Reservoir (RM 226.8) was 2,140 cfs, and the Benham Falls gage (RM 181.4) recorded 2,780 cfs. The Wickiup Reservoir release was approximately a 7-year frequency discharge, and the Benham Falls discharge was approximately a 3-year frequency discharge.

The most significant high water in the past 15 years downstream of Bend, Oregon, was 1,820 cfs at RM 164.4 (the Deschutes River below Bend gage station). It occurred March 20, 1972, and was approximately an 8-year flood.

The annual flood season for the Little Deschutes River extends from October through June, with a majority of the floods occurring during the period from April through June. Little Deschutes River generally remains above bankfull stage for 2 to 3 days during winter flood and 6 to 7 days during spring snowmelt floods.

The largest flood known to have occurred on Little Deschutes River was that of December 1964, with a peak discharge of 3,660 cfs at the gaging station at RM 28.1, about 1.5 miles north of La Pine. That flood caused considerable nuisance flooding to the ranches along the floodplain and damaged the Stearns Ranch

Bridge at RM 28.1. It should be noted that this event was greater than a 0.2-percent-annual-chance flood. The next two largest floods on Little Deschutes River occurred in June 1950 and May 1956, with discharges of 1,320 cfs, which have an average recurrence interval of 25 years. Both floods peaked about 0.7 feet lower than the December 1964 flood at the gaging station near La Pine. Flood damages from those floods, including the severe December 1964 flood, were minor due to the undeveloped character of the Little Deschutes River floodplain.

There are 10 bridges crossing Little Deschutes River in the study reach in Deschutes County. Pertinent information on the under-clearance of those bridges indicates that the only bridge in the study reach that would be overtopped by the 1-percent-annual-chance flood is the Ranch Bridge at RM 15.1. A 0.2-percent-annual-chance flood, however, would overtop the Vandervert Ranch Bridge at RM 3.1, Lazy River South Ranch Bridge at RM 16.6, Stearns Ranch Bridge at RM 28.1, and the Masten Bridge at RM 39.9. The approaches to those bridges may also be subject to flooding during periods of high water.

The annual flood season for Whychus Creek extends from November through April, with all of the larger floods occurring in November and December.

The largest flood known to have occurred on Whychus Creek since records have been kept caused considerable flooding in the study area and occurred December 25, 1980, with a discharge of 2,000 cfs at the USGS stream gage station at RM 26.6. The return interval for the flood was 80 years. The next largest food known to have occurred on Whychus Creek was that of December 1964, with a peak discharge of 1,980 cfs. This flood also had an average recurrence interval of 80 years. Debris deposition on agricultural land damaged irrigation diversion works; the flood also caused extensive personal property damage in Sisters and extensive bank erosion. The third largest flood on Whychus Creek occurred in November 1968, with a peak discharge of 1,840 cfs and an average recurrence interval of 60 years.

There are 12 bridges crossing Whychus Creek in the study reach. The only bridges in the study reach that would be overtopped by the 1-percent-annual-chance flood are the Ranch Bridge at RM 16.3 and the Elm Street Bridge in Sisters at RM 21.8. A 0.2-percent-annual-chance flood, however, would also overtop the Ranch Bridges at RM 19.3 and RM 19.4. The approaches to all the bridges in the study reach are subject to overtopping.

The Whychus Creek study reach also contains four irrigation diversion structures; three of which are presently in use. They are located at RM 21.7, RM 23.0, and RM 24.8. High velocity channel flow can deposit heavy accumulations of debris, gravel, and cobbles against these structures prior to a flood crest. This sudden partial blockage of the floodflow could result in increased water levels as far as 1,500 feet upstream of the structure.

In the stream corridor of Whychus Creek, obstructions to floodflows present an additional hazard. The unconsolidated volcanic deposits that make up the streambed and its banks offer little resistance to erosion. During flooding, any large debris accumulation in the channel can divert the flow sufficiently to erode one or both streambanks. If the areas beyond the streambanks are at the same or lower elevations than the streambank, much larger areas become susceptible to flooding.

An additional flood hazard along Whychus Creek results from the potential Moraine Dam failure of Carver Lake near Sisters, Oregon. As compared to other lakes in the Three Sister area in Central Oregon, Carver Lake is large and deep, and contains approximately 740 acre feet of water. Carver Lake Moraine Dam failure can occur in numerous ways, such as avalanches of rock and ice that could cause the lake to overtop; the material in the Carver Lake Moraine Dam generally consists of sand and gravel size particles that are loosely consolidated and thus unstable; and the possibility of seismic activities exists, which increases the probability for avalanches to occur. Three Carver Lake Moraine Dam failures have been observed in the Three Sisters area during the last 50 years.

The Summary of Elevations for the Carver Lake Moraine Dam Failure is described in Table 1.

Table 1. Summary of Elevations
Carver Lake Moraine Dam Failure

FIS Cross Sections[1]	Distance[2] (Miles)	Elevations[3] (Feet NAVD)
G	9.8	2,675
S	14.0	2,856
AI	18.8	3,073
AP	20.1	3,129
AR	20.8	3,157
AT	21.3	3,180
AV	21.5	3,188
AY	22.0	3,207
BC	22.8	3,253
BD	23.0	3,262
BL	24.8	3,382
BM	24.9	3,393
BQ	26.6	3,517

[1]Cross section lettering corresponds to that shown in the Floodway Data Table (Table 4) for Whychus Creek

[2]Stream distance in miles above mouth

[3]Elevations due to possible Carver Lake Moraine Dam failure. For the stream studied by approximate methods, only the 1-percent-annual-chance floodplain boundary is shown on the Flood Insurance Rate Map (FIRM).

2.4 Flood Protection Measures

There are three water storage reservoirs in the upper Deschutes basin (i.e., Crane Prairie, Wickiup, and Crescent Lake) that are operated by the U.S. Bureau of Reclamation. Although there is no flood control storage authorized for these three reservoirs, the large amount of irrigation storage available does, in fact, reduce winter and spring flows downstream.

There are a series of irrigation diversion structures located on the Deschutes River and Whychus Creek. The structures are used to divert some of the flow for irrigation purposes. Although the total flow is reduced, they are not considered to be recognized flood control devices.

In November 1984, the City of Bend built a log and chain ice boom across the Deschutes River about 300 feet upstream of the Colorado Avenue Bridge and Shevlin Dam, near RM 167.62. The purpose was to intercept and hold frazil ice floes, preventing them from reaching Mirror Pond downstream of Shevlin Dam where they could form an ice jam and cause significant overbank flooding in residential areas as occurred in December 1983.

The COE has determined that this log and chain ice boom would be structurally inadequate to resist the estimated force from a major ice jam and consequently recommended, under its small project authority, the construction of a stronger ice boom at RM 168.15, about 0.5 miles upstream of the city's log boom. Construction was completed in December 1987. The maps and profiles show the floodplain boundaries and elevations expected with the ice boom in place and functioning. There are no existing levees or other flood control projects which would reduce flooding on Deschutes River, Little Deschutes River, or Whychus Creek.

Nonstructural measures, however, are being used to aid in the prevention of future flood damage. These are in the form of an ordinance (Number PL-15) adopted by the County in May 1979, authorizing the County to control future development or redevelopment within the flood hazard zone outside the urban growth area (UGA) of all incorporated jurisdictions. Each city has its own UGA ordinance that the County administers. The County requires building permits for construction and reviews those permits to assure that sites are reasonably safe from flooding.

3.0 <u>ENGINEERING METHODS</u>

For all 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 which 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 which equals or exceeds the 100-year flood (1-percent-chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and 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 peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

The upper Deschutes sub-basin, including all of the Deschutes watershed above the stream gage below Bend, contains 1,899 square miles, which is about 18 percent of the total area of the Deschutes Basin.

The sub-basin is bounded on the west by the Cascade Range, on the south by the divide between the Deschutes and Klamath Basins, on the east by the Walker Rim, Crater Buttes, and Paulina Mountains, and on the north by the arbitrary divide which extends from the Paulina Mountains through Bend to the Three Sisters in the Cascades (Reference 5).

In general, the Deschutes River is subject to high water levels due to spring snowmelt. In only two years, 1944 and 1964, out of the 42 years since the river has been regulated by all three storage projects (Wickiup [1942], Crane Prairie [1922], and Crescent Lake [1922]), was the peak discharge caused primarily by rainfall. Because there were only two significant rain-on-snow events, it was determined that a reliable rain-on-snow discharge-frequency curve could not be derived.

The three reservoirs regulate approximately 540 square miles, or 33 percent, of the area of the Deschutes and Little Deschutes Rivers above their confluence (Reference 6). For this reason and because of numerous irrigation withdrawals, it was determined that frequency curves based on observed data best represent present-day conditions. These curves were developed in May 1984 using the "Guidelines for Determining Flood Flow Frequency" (Reference 7) and computed probability, unless otherwise described herein.

For the Deschutes River area downstream of Wickiup Dam, an irrigation water-storage reservoir operating since 1943, analysis of the outflow from Wickiup Dam revealed only non-winter annual peak flood events. A frequency curve was plotted (by using Weibull plotting position method). The 10-, 2-, 1-, and 0.2-percent-annual-chance discharges at Wickiup Dam outflow were used for the Deschutes River reach downstream to the confluence with Fall River. No adjustment for increased drainage area was made since these are irrigation releases and not discharges from storm events.

For Deschutes River in the vicinity of Deschutes River Recreation Homesites (above Little Deschutes River and below Fall Creek) Wickiup Reservoir releases were amplified by mean daily flow in Fall Creek. RM 204.7 is the confluence point between the Deschutes and Fall Rivers (D.A. = 45.1). The discharges used downstream of this confluence were determined from a frequency curve developed by using the Wickiup Dam outflow frequency curve and adding the mean daily flow from Fall River for each of the days of the six largest observed peaks from Wickiup Dam. A graphical analysis was used to draw the frequency curve through these points. Because only 10- to 0.2-percent-annual-chance discharges were of interest, only observed peaks greater than the 12.5-percent-annual chance (8-year) discharge frequency were used. These discharges were used throughout the reach of RM 204.7 to RM 192.5, the confluence with Little Deschutes River.

For Deschutes River downstream of the Little Deschutes River to RM 164.8, frequency discharges from the USGS stream gage station near Benham Falls were used. The frequency curve for the Benham Falls gage was developed in February 1978 for Flood Plain Information purposes using U.S. Water Resources Council Bulletin No. 17, "Guidelines for Determining Flood Flow Frequency," published in March 1976 (Reference 8). It was observed that the 1978 curve is still an accurate representation of the flows at Benham Falls when it was compared to a new curve developed for all the flows through 1982.

Three major irrigation diversions are located at RM 164.8 in Bend. Therefore, the discharges used as the frequency flows for the reach from RM 164.8 to RM 162, were determined from the USGS stream gage (RM 164.4) on the Deschutes River below Bend.

For the reach of Deschutes River downstream of the City of Bend, and Tumalo Creek, the frequency curve was developed first, by using USGS stream gage data for the Deschutes River below Bend, to develop a frequency curve (of regulated flows), and second, by taking the five highest peak discharges at Bend and adding the mean daily flow in Tumalo Creek for each of those days. Graphical analysis was used to scribe a curve through the points to develop the frequency curve. Only observed peaks of greater than 12.5-percent-annual-chance (8-year) discharge frequency were used, because of interest only in the 10- to 0.2-percent-annual-chance discharges.

The peak flows for Little Deschutes River were developed in August and November 1976 from a statistical analysis of streamflow, precipitation records, and runoff characteristics for the general region of the study area (Reference 8). Fifty years of continuous streamflow records on Little Deschutes River near La Pine (1925-1974) were used to accomplish this analysis.

Hydrologic analysis for Whychus Creek was carried out in December 1976 to establish peak discharge-frequency relationships for the USGS Gage No. 14075000, Whychus Creek near Sisters, Oregon. The period of record from 1926 to 1975 (50 years) was used in the derivations of a fall and winter curve and a spring and summer curve (Reference 8). Data from 1906 to 1920 were available but not used due to the uncertainty and discontinuity of these data.

Frequencies for these discharges were taken from the fall and winter discharge-frequency curve. The largest floods occur during the fall and winter period.

The probability of failure for Carver Lake was estimated by the USGS to be 1 to 5 percent for any given year and would be expected to occur from June to October (Reference 2). A dam-break computer model was used to simulate a hypothetical failure of the Carver Lake Moraine Dam. In the most extreme case, an initial peak discharge of 180,000 cfs would result from total displacement of the lake water by avalanche material.

For the hypothetical scenario, it was assumed that the flow would bulk up to a sediment concentration of 50 percent by volume (hyperconcentration) in the section between the breach and the end of the steeply sloping canyons, a distance of 8 miles. Debulking of the flood was assumed to occur in overflow sections of valley and debris-fan segments. Initial flood hydrographs were routed downstream using a one-dimensional unsteady-state streamflow model that incorporated field determinations of Manning's "n" coefficients to allow for hyperconcentrated flow. In the vicinity of the USGS gage (15.4 miles downstream from the lake), routing of the scenarios simulated estimated flood peak discharge of 21,000 cfs. In comparison, all simulated flood peak discharges were greater than that of a 1-percent-annual-chance flood from high precipitation or snowmelt. The 1-percent-annual-chance flood is used for comparison of peak magnitude only; the probability of occurrence is from a different statistical population.

Three potential channels of flow were defined for the alluvial fan where the community of Sisters is located. Flow could occur almost anywhere on the alluvial fan because of channel shifting that accompanies local scour and damming. It was assumed that about 75 percent of the total flow would be diverted in the main channel of Whychus Creek towards Sisters. The hypothetical-flood scenario resulted in estimated discharges of 9,800 cfs, at RM 20.5 in Sisters along the main channel. In the remaining channels about 3,000 and 1,000 cfs respectively, would start to flow down Whychus Creek Ditch, an abandoned channel (now used as a ditch), and down Whychus Creek Canal; but these flows probably would attenuate rapidly.

The community of Sisters would begin to experience rising flood water about 1.8 hours after the dam breach; the flood peak would arrive about 30 minutes later. In Sisters, locally high velocities, damming, erosion, and sediment deposition could cause considerable property damage and possible loss of life. The stream would be especially dangerous at road crossings where bridges may fail or sections wash away.

Frazil ice, which has caused flooding problems on Deschutes River, is generated in turbulent open-water areas of a river having velocities in excess of 2.0 to 2.5 feet per second, when water temperatures are a few hundredths of a degree below the freezing point. Prolonged cold spells of below 0° temperatures, low relative humidity, and high wind velocity can supercool water to below its feezing point. Frazil ice consists of small discoid shaped crystals of ice which are adhesive and readily attach to objects in the channel such as rocks and logs. Frazil ice that does not become attached to objects flocculates and rises to the surface. In slower moving reaches and the calm water of ponds, these "flocs" freeze together and form clumps of slush ice which then form ice pans. These ice pans grow large enough to be considered as ice floes. This moving layer of the mixture of floes, slush, and water may develop into a continuous ice cover if initiated by the formation of an ice bridge at an artificial obstacle such as a dam or an ice boom. The water will continue to move beneath the ice cover until the leading edge progresses upstream to a point where the channel becomes shallow enough and the velocity fast enough that the incoming ice floes are forced under the ice cover. This "thickening" of the ice cover can continue until an ice jam occurs.

Elevations from the December 1983 ice jam flood on Deschutes River were used to help determine which flow rate to use for ice jam flooding. Pictures and level surveys in the right overbank at approximate RM 167.4 indicated an elevation of 3,603.1 feet North American Vertical Datum (NAVD) for the 1983 ice jam flood. Mean monthly flows for December and January at Benham Falls, the nearest gage upstream from Bend, have ranged between 560 and 1,540 cfs for the past 12 years. It was thought that flows in Deschutes River during the December 1983 ice jam flood were about 1,000 cfs. However, this flow rate gave a flood elevation lower than the 1983 event. The flow rate of 1,540 cfs, therefore, was used to determine the level of ice at the time of ice jam formation, then was used again to determine the level of floodwater over the ice cover for an assumed jammed condition. This produced an elevation at RM 167.44 within 0.1 foot of the 1983 high water mark.

Both a lack of records on ice jam flooding, other than the December 1983 event, and limited stream gage records of ice jam formation (12 years) make the assigning of a frequency to icing conditions impractical.

Peak discharge-drainage area relationships for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods of each flooding source studied by detailed methods in the community are shown in Table 2.

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 exceedance probabilities. 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 tables in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance ratings purposes. For construction and/or floodplain purposes, users are cautioned to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments where a floodway was

Table 2. Summary of Discharges

Flooding Source and Location	River Mile	Drainage Area (square miles)	Peak Discharges (cubic feet per second)			
			10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
DESCHUTES RIVER						
Vicinity of Tumalo						
(Downstream of Tumalo Creek)	156.0	1,990	2,050	2,630	2,890	3,450
Vicinity of City of Bend						
(Downstream of Diversion Dam)	164.4	1,899	1,920	2,460	2,685	3,200
Vicinity of Sunriver						
(Downstream of Little Deschutes)	192.5	1,660	3,070	3,320	3,400	3,560
(Upstream of Little Deschutes)	192.5	640	2,400	2,550	2,600	2,720
Vicinity of Deschutes River Recreation Homesites						
(Downstream of Fall River)	204.7	595	2,400	2,550	2,600	2,720
(Upstream of Fall River)	204.7	538	2,200	2,400	2,480	2,620
LITTLE DESCHUTES RIVER						
At mouth	0.0	1,020	1,330	2,110	2,620	4,100
Upstream of Paulina Creek	15.4	974	1,290	2,030	2,530	3,960
USGS Station No. 14063000 (Near La Pine)	28.1	859	1,170	1,850	2,300	3,600
At Deschutes-Klamath County Line	45.2	620	920	1,450	1,810	2,830
WHYCHUS CREEK						
At Deschutes-Jefferson County Line	9.3	106	2,130	3,740	4,630	7,100
Downstream of Indian Ford Creek	20.8	93	1,930	3,390	4,200	6,440
Upstream of Indian Ford Creek	20.8	51	1,140	2,000	2,480	3,800
USGS Station No. 14075000 (Near Sisters)	26.6	44	1,020	1,790	2,210	3,390

computed (Section 4.2), selected cross section locations are also shown on the FIRM.

Orthophoto topographic maps were developed from aerial photography and field control. Cross sections of the channel and overbank areas for all the streams were determined by a combination of field survey and photogrammetry methods. Field surveys were taken of the channel area and at least fifty feet to each side of the channel. These field surveys were conducted in November 1975 for Little Deschutes River, with some supplemental bridge surveys taken in February 1977. Cross sections for Deschutes River were surveyed in July and August 1984. Cross sections for Whychus Creek were surveyed in November 1976 and were extended 100 feet to each side of the channel.

Bridges and dams were field surveyed where no "as built" drawings existed. Where "as built" drawings were available, their elevation datum was checked by field survey.

The approximate analyses were done using Normal Depth Calculation with cross sections spaced farther apart than detailed cross sections.

Hydraulic analyses for Deschutes River, Little Deschutes River, and Whychus Creek were performed using the COE HEC-2 step-backwater computer program (References 9).

The models were calibrated using engineering judgment and information about past flooding events from local officials and residents along the three streams.

Roughness factors (Mannings "n") used in the hydraulic computations were chosen by engineering judgment and field observations of the stream and floodplain areas. Roughness values for the main channel of Whychus Creek ranged from 0.037 to 0.048, while the floodplain roughness values ranged from 0.05 to 0.12 for all floods. For Little Deschutes River, those "n" values varied from 0.030 to 0.055 for the channel and 0.042 to 0.15 for the overbanks. The "n" values generally increase going upstream. For Deschutes River, a channel roughness coefficient of 0.043 was generally used, while most overbank areas were assigned a value of 0.12 due to heavy brush or existing structures. In the Deschutes River Recreation Homesites area, the channel "n" was increased to 0.048 due to the pronounced and more severe meanders.

Starting water-surface elevations were determined by slope area method where the starting slope was estimated from a combination of field notes, topographical maps, and the use of dummy cross sections downstream of the first surveyed cross section. For Little Deschutes River, three dummy cross sections with the same configurations as the first surveyed section and set on a slope equal to that between the first two surveyed sections were used. The starting water-surface elevation was considered satisfactory when the water depths for the various floods were the same at the first surveyed sections as for the dummy sections.

Since it was probable that the ice boom proposed by the COE would be constructed within 12 months after the submission of this study, the effect of that ice boom was considered in determining the flood elevations upstream of its location at RM 168.15. The discharge of 1,540 cfs estimated for the December 1983 ice jam condition (see Section 3.1) was used to first calculate the water level during icing conditions and then to determine the flood water level on top of an ice cover after the ice jam forms farther upstream, assumed to occur at about RM 169.4.

The hydraulic analysis for the Carver Lake Moraine Dam failure was based on the most extreme failure scenario simulated by the USGS using a dam break computer model (Reference 2). The proposed dam failure flood profile and floodplain boundary delineations along Whychus Creek are provided for advisory purposes only; no additional flood insurance or floodplain management measures are associated with this information.

With the experience of ice jam flooding on Deschutes River, 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.

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 (NGVD29). With the completion of the North American Vertical Datum of 1988 (NAVD88), many FIS reports and FIRMs are now prepared using NAVD88 as the referenced vertical datum.

To accurately convert flood elevations for Deschutes River, Little Deschutes River, and Whychus Creek from the current NGVD29 datum to the newer NAVD88 datum, the following procedure was implemented. Locations at the upstream and downstream ends of each flooding source, as well as at an intermediate location between these two end points, were evaluated using the COE CORPSCON (Reference 23) vertical datum conversion software. At each of the three points CORPSCON calculated the difference between the NGVD29 and NAVD88 elevations. These three conversion factors were averaged to develop an average conversion factor for each flooding source. The final NAVD88 elevations reported herein were computed by adding the calculated average conversion factor to the existing NGVD29 data (Reference 23). Table 3 shows the conversion factor for each stream studied in detail.

Table 3. Datum Conversion Factors

Stream Name	Conversion from NGVD29 to NAVD88 (ft) Minimum Conversion	Maximum Conversion	Average Conversion[1]	Maximum Offset
Deschutes River	3.79	3.99	3.90	0.11
Little Deschutes River	3.92	4.08	4.01	0.09
Whychus Creek	3.66	3.88	3.76	0.12

[1]Used to convert elevation data from NGVD29 to NAVD88

Flood elevations shown in this FIS report and on the FIRM are referenced to the NAVD88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the NGVD29 and NAVD88, visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242
(301) 713-4172 (fax)

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.

To obtain current elevation, description, and/or location information for benchmarks shown on this map, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their website at www.ngs.noaa.gov.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The NFIP encourages state and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 10-, 2-, 1, and 0.2-percent-annual-chance flood elevations; delineations of the 1- and 0.2-percent-annual-chance floodplains; and a 1-percent-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles and Floodway Data 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 flood was 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 for Deschutes River were interpolated using FIS work maps at a scale of 1:4,800, with a contour interval of 4 feet, except in the City of Bend. For the Deschutes River in the City of Bend, the boundaries of the 1-percent-chance-flood were redelineated using contours at a scale of 1:1,200 and an interval of 2 feet. For Little Deschutes River and Whychus Creek, the boundaries were interpolated using orthophoto topographic maps at a scale of 1:6,000, with a contour interval of 5 feet (References 10, 11, and 12).

The cross sections for approximate flooding were interpolated using topographic maps at a scale of 1:24,000 prepared from the same aerial photography (Reference 13).

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM. On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE); 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.

For the streams studied by approximate methods, only the 1-percent-annual-chance floodplain boundary is shown on the FIRM.

The floodplain boundary delineations representing the proposed Carver Lake Moraine Dam failure along Whychus Creek were based on the USGS open file report 87-41 (Reference 2) and orthophoto topographic maps at a scale of 1:6,000, with a contour interval of 5 feet (Reference 12). The RM stations and corresponding elevations as shown in Table 1 identified in the USGS report were correlated to the appropriate cross sections from the detailed study of Whychus Creek. Between cross sections, the Carver Lake Moraine Dam failure delineations were interpolated using the above-referenced orthophoto topography maps. In areas where the Carver Lake Moraine Dam failure delineation corresponded to either the 1- or 0.2-percent-annual-chance floodplain boundaries, only the 1-percent-annual-chance floodplain boundaries were shown.

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 base 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 floodways presented in this study were 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 are tabulated at selected cross sections (Table 4). The large number of cross sections on Deschutes River with a zero or small rise in water surface is caused by several factors. In the reaches downstream (just north) of and upstream (just south) of Bend, the 1-percent-annual-chance floodplain is narrow, and the floodway limits are at the tops of banks which generally do not exceed the 1-percent-annual-chance floodplain width. This is also the situation at the downstream part of the Tumalo reach. In the reach at Deschutes River Recreation Homesites area, the floodway was not restricted any more in order to maintain efficient flow lines between the outside of channel's meander lines. This was based upon engineering judgment.

For Whychus Creek, the many cross sections with zero or small rise in water surface, sometimes alternating with large rises, resulted because critical or supercritical depth occurred, and the energy grade line was used as the limiting factor.

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.

In some areas along the Deschutes River, Little Deschutes River, or Whychus Creek the stream has moved significantly, causing the existing floodplain boundary configuration to no longer fit the stream location as shown on 2005 ortho imagery. In these areas the existing floodway boundaries were adjusted to fit the current stream. The regulatory floodway boundary configuration relative to the current stream data was maintained, wherever possible. In this manner, the regulatory floodway contains the current stream.

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
DESCHUTES RIVER								
A	155.94	64	272	10.6	3,140.8	3,140.8	3,140.8	0.0
B	156.07	134	353	8.2	3,152.5	3,152.5	3,152.5	0.0
C	156.16	161	660	4.4	3,156.1	3,156.1	3,156.2	0.1
D	156.25	114	386	7.5	3,158.0	3,158.0	3,158.1	0.1
E	156.34	122	606	4.8	3,160.6	3,160.6	3,160.8	0.2
F	156.41	150	669	4.3	3,161.7	3,161.7	3,161.9	0.2
G	156.51	86	280	10.3	3,164.0	3,164.0	3,164.0	0.0
H	156.59	94	585	5.4	3,167.2	3,167.2	3,167.9	0.7
I	156.68	87	595	5.4	3,168.0	3,168.0	3,169.0	1.0
J	156.82	152	831	3.5	3,169.6	3,169.6	3,170.5	0.9
K	156.94	77	493	5.9	3,171.0	3,171.0	3,171.5	0.5
L	157.10	164	819	4.8	3,173.2	3,173.2	3,173.9	0.7
M	157.19	232	913	4.8	3,174.1	3,174.1	3,175.0	0.9
N	157.34	219	1029	4.0	3,175.8	3,175.8	3,176.6	0.8
O	157.46	64	523	5.5	3,176.7	3,176.7	3,177.4	0.7
P	157.56	176	654	6.5	3,178.0	3,178.0	3,178.7	0.7
Q	157.75	78	486	6.8	3,181.4	3,181.4	3,182.3	0.9
R	157.87	106	626	5.5	3,183.6	3,183.6	3,184.1	0.5
S	158.03	119	697	4.2	3,185.1	3,185.1	3,186.0	0.9
T	161.96	60	243	12.5	3,350.7	3,350.7	3,350.7	0.0
U	162.34	45	227	11.8	3,381.7	3,381.7	3,381.7	0.0
V	162.51	42	240	11.2	3,394.3	3,394.3	3,394.5	0.2
W	162.77	134	301	8.9	3,422.8	3,422.8	3,423.0	0.2
X	162.90	81	254	10.6	3,436.6	3,436.6	3,436.6	0.0
Y	162.99	37	222	12.1	3,444.1	3,444.1	3,444.1	0.0
Z	163.10	88	265	10.1	3,461.8	3,461.8	3,461.8	0.0

[1]Miles above mouth

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

DESCHUTES RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
DESCHUTES RIVER								
AA	163.21	49	221	12.2	3,466.7	3,466.7	3,466.7	0.0
AB	163.32	52	225	11.9	3,479.6	3,479.6	3,479.6	0.0
AC	163.37	124	497	5.4	3,489.0	3,489.0	3,489.0	0.0
AD	163.52	55	371	7.2	3,494.9	3,494.9	3,495.8	0.9
AE	163.72	96	560	5.5	3,497.9	3,497.9	3,498.6	0.7
AF	163.88	68	248	12.0	3,500.2	3,500.2	3,500.2	0.0
AG	163.98	172	516	7.7	3,507.8	3,507.8	3,507.8	0.0
AH	164.01	226	697	5.1	3,510.2	3,510.2	3,510.2	0.0
AI	164.21	120	810	3.3	3,512.0	3,512.0	3,512.1	0.1
AJ	164.38	52	237	11.3	3,512.6	3,512.6	3,512.7	0.1
AK	164.53	50	294	9.1	3,522.2	3,522.2	3,522.6	0.4
AL	164.63	58	535	5.0	3,525.1	3,525.1	3,525.6	0.5
AM	164.77	45	214	12.6	3,528.4	3,528.4	3,528.4	0.0
AN	164.85	293	2,802	1.2	3,564.3	3,564.3	3,564.4	0.1
AO	165.06	140	1,656	2.1	3,564.4	3,564.4	3,564.5	0.1
AP	165.34	155	1,287	2.6	3,564.6	3,564.6	3,564.8	0.2
AQ	165.54	150	1,044	3.3	3,565.0	3,565.0	3,565.2	0.2
AR	165.66	88	314	10.8	3,568.3	3,568.3	3,568.3	0.0
AS	165.79	152	602	5.7	3,574.4	3,574.4	3,574.4	0.0
AT	165.81	202	1,978	1.7	3,582.8	3,582.8	3,582.8	0.0
AU	165.92	185	2,056	1.7	3,582.9	3,582.9	3,582.9	0.0
AV	166.30	367	2,894	1.2	3,598.6	3,598.6	3,598.6	0.0
AW	166.46	121	1,099	3.1	3,598.7	3,598.7	3,598.7	0.0
AX	166.61	234	1,984	1.7	3,599.0	3,599.0	3,599.0	0.0
AY	166.77	321	2,335	1.5	3,599.2	3,599.2	3,599.2	0.0
AZ	166.90	471	2,527	1.4	3,599.3	3,599.3	3,599.3	0.0

[1]Miles above mouth

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

DESCHUTES RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
DESCHUTES RIVER								
BA	167.02	107	1,091	3.1	3,599.4	3,599.4	3,599.4	0.0
BB	167.13	184	958	3.6	3,599.8	3,599.8	3,599.8	0.0
BC	167.31	131	1,412	2.4	3,600.7	3,600.7	3,600.7	0.0
BD	167.44	246	1,421	2.4	3,600.9	3,600.9	3,600.9	0.0
BE	167.61	452	2,424	1.4	3,608.7	3,608.7	3,608.7	0.0
BF	167.75	365	1,924	1.8	3,608.8	3,608.8	3,608.8	0.0
BG	167.97	138	1,118	3.0	3,609.2	3,609.2	3,609.2	0.0
BH	168.09	106	824	4.1	3,609.5	3,609.5	3,609.5	0.0
BI	168.23	355	2,291	1.5	3,611.5[2]	3,605.0	3,605.0	0.0
BJ	168.40	289	1,688	2.0	3,611.7[2]	3,610.1	3,610.2	0.1
BK	168.67	254	1,713	2.0	3,612.6[2]	3,610.9	3,610.9	0.0
BL	168.83	218	1,791	1.9	3,612.9[2]	3,611.1	3,611.1	0.0
BM	169.02	194	1,202	7.8	3,613.3[2]	3,611.3	3,611.4	0.1
BN	169.28	180	1,109	3.1	3,613.9[2]	3,612.2	3,612.2	0.0
BO	169.42	97	327	10.4	3,614.6[2]	3,613.9	3,613.9	0.0
BP	169.58	111	544	6.3	3,622.1[2]	3,620.9	3,620.9	0.0
BQ	185.57	141	1,490	2.3	4,155.5	4,155.5	4,155.9	0.4
BR	185.72	221	2,060	1.7	4,155.7	4,155.7	4,156.1	0.4
BS	185.93	154	1,505	2.3	4,155.9	4,155.9	4,156.2	0.3
BT	186.10	394	2,858	1.3	4,156.0	4,156.0	4,156.4	0.4
BU	186.47	1,065	2,947	1.5	4,156.2	4,156.2	4,156.6	0.4
BV	186.80	283	2,347	1.5	4,156.4	4,156.4	4,156.7	0.3
BW	187.02	213	1,570	2.2	4,156.5	4,156.5	4,156.8	0.3
BX	187.27	880	2,878	2.0	4,156.8	4,156.8	4,157.1	0.3
BY	187.51	520	2,644	1.8	4,157.1	4,157.1	4,157.3	0.2
BZ	187.77	265	2,100	1.6	4,157.3	4,157.3	4,157.5	0.2

[1]Miles above mouth

[2]1-percent-annual-chance flood elevation established assuming ice-jam conditions due to 1987 ice boom

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

DESCHUTES RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
DESCHUTES RIVER								
CA	188.02	1,163	3,555	1.6	4,157.6	4,157.6	4,157.7	0.1
CB	188.32	226	1,743	2.0	4,157.9	4,157.9	4,158.0	0.1
CC	188.68	379	1,681	2.0	4,158.5	4,158.5	4,158.6	0.1
CD	188.84	242	2,078	1.6	4,158.7	4,158.7	4,158.9	0.2
CE	189.48	2,054	4,842	1.4	4,159.2	4,159.2	4,159.4	0.2
CF	189.93	456	2,045	2.2	4,159.7	4,159.7	4,159.8	0.1
CG	190.32	260	1,338	2.7	4,160.3	4,160.3	4,160.5	0.2
CH	190.54	185	1,544	2.4	4,160.7	4,160.7	4,160.9	0.2
CI	190.73	258	1,380	2.7	4,161.0	4,161.0	4,161.2	0.2
CJ	190.97	246	1,797	2.3	4,161.4	4,161.4	4,161.6	0.2
CK	191.25	229	1,711	2.4	4,161.7	4,161.7	4,161.9	0.2
CL	191.68	140	1,442	2.4	4,162.2	4,162.2	4,162.4	0.2
CM	191.71	177	1,548	2.2	4,162.2	4,162.2	4,162.5	0.3
CN	192.00	149	1,824	1.9	4,162.5	4,162.5	4,162.7	0.2
CO	192.47	620	2,765	1.8	4,162.7	4,162.7	4,163.1	0.4
CP	192.72	140	1,472	1.7	4,162.9	4,162.9	4,163.3	0.4
CQ	193.05	114	1,298	2.0	4,163.1	4,163.1	4,163.5	0.4
CR	193.30	132	1,432	1.8	4,163.3	4,163.3	4,163.7	0.4
CS	193.74	135	1,328	2.0	4,163.6	4,163.6	4,164.0	0.4
CT	194.01	127	1,193	2.2	4,163.9	4,163.9	4,164.3	0.4
CU	194.31	124	1,382	1.9	4,164.2	4,164.2	4,164.6	0.4
CV	194.86	131	1,295	2.0	4,164.5	4,164.5	4,165.1	0.6
CW	195.05	114	1,228	2.1	4,164.7	4,164.7	4,165.2	0.5
CX	195.24	134	1,287	2.0	4,164.9	4,164.9	4,165.5	0.6
CY	195.45	165	1,403	1.9	4,165.1	4,165.1	4,165.6	0.5
CZ	195.85	245	1,883	1.4	4,165.5	4,165.5	4,166.0	0.5

[1] Miles above mouth

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

DESCHUTES RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
DESCHUTES RIVER								
DA	196.25	166	1,586	1.6	4,165.8	4,165.8	4,166.3	0.5
DB	196.55	120	1,304	2.0	4,166.1	4,166.1	4,166.6	0.5
DC	197.21	294	2,072	1.3	4,166.6	4,166.6	4,167.1	0.5
DD	197.63	145	1,430	1.8	4,166.9	4,166.9	4,167.5	0.6
DE	198.02	160	1,396	1.9	4,167.2	4,167.2	4,167.9	0.7
DF	198.45	164	1,477	1.8	4,167.4	4,167.4	4,168.3	0.9
DG	198.74	162	1,575	1.7	4,167.7	4,167.7	4,168.7	1.0
DH	199.10	145	1,464	1.8	4,167.9	4,167.9	4,168.9	1.0
DI	199.14	149	1,289	2.0	4,167.9	4,167.9	4,168.9	1.0
DJ	199.24	174	1,565	1.7	4,168.1	4,168.1	4,169.0	0.9
DK	199.42	227	1,937	1.3	4,168.3	4,168.3	4,169.2	0.9
DL	199.60	177	1,672	1.6	4,168.5	4,168.5	4,169.4	0.9
DM	199.78	119	1,161	2.2	4,168.6	4,168.6	4,169.5	0.9
DN	200.13	207	1,779	1.5	4,169.0	4,169.0	4,169.9	0.9
DO	200.37	129	1,247	2.1	4,169.3	4,169.3	4,170.1	0.8
DP	200.61	159	1,566	1.7	4,169.5	4,169.5	4,170.3	0.8
DQ	200.90	139	1,352	1.9	4,169.7	4,169.7	4,170.5	0.8
DR	200.94	139	1,373	1.9	4,170.1	4,170.1	4,170.7	0.6
DS	201.05	128	1,232	2.1	4,170.2	4,170.2	4,170.8	0.6
DT	201.32	165	1,406	1.9	4,170.6	4,170.6	4,171.2	0.6
DU	201.50	184	1,514	1.7	4,170.8	4,170.8	4,171.4	0.6
DV	201.67	276	1,809	1.9	4,171.0	4,171.0	4,171.6	0.6
DW	201.92	913	3,104	0.8	4,171.2	4,171.2	4,171.8	0.6
DX	202.25	610	3,359	0.8	4,171.4	4,171.4	4,171.9	0.5
DY	202.57	938	2,778	0.9	4,171.5	4,171.5	4,172.0	0.5
DZ	203.03	1,653	4,247	0.6	4,171.8	4,171.8	4,172.3	0.5

[1]Miles above mouth

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

DESCHUTES RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
DESCHUTES RIVER								
EA	203.44	1,930	3,929	1.9	4,172.1	4,172.1	4,172.5	0.4
EB	203.80	1,118	2,906	0.9	4,172.7	4,172.7	4,173.0	0.3
EC	204.06	1,180	3,354	0.8	4,173.1	4,173.1	4,173.3	0.2
ED	204.59	1,180	3,121	0.8	4,173.7	4,173.7	4,173.9	0.2
EE	204.94	1,375	3,823	0.7	4,174.1	4,174.1	4,174.2	0.1
EF	205.15	1,312	3,457	0.7	4,174.3	4,174.3	4,174.4	0.1
EG	205.26	1,130	3,140	0.8	4,174.3	4,174.3	4,174.5	0.2
EH	205.42	921	1,933	1.3	4,174.5	4,174.5	4,174.6	0.1
EI	205.49	1,310	3,583	0.8	4,174.6	4,174.6	4,174.8	0.2
EJ	205.87	700	2,393	1.0	4,174.9	4,174.9	4,175.1	0.2
EK	206.06	215	1,342	1.9	4,175.1	4,175.1	4,175.3	0.2
EL	206.20	136	908	2.7	4,175.4	4,175.4	4,175.6	0.2
EM	206.24	117	902	2.8	4,175.5	4,175.5	4,175.7	0.2
EN	206.39	755	2,016	1.2	4,176.0	4,176.0	4,176.2	0.2
EO	206.47	667	2,094	1.2	4,176.2	4,176.2	4,176.3	0.1
EP	206.58	121	987	2.5	4,176.4	4,176.4	4,176.5	0.1
EQ	206.84	517	1,779	1.4	4,176.9	4,176.9	4,177.1	0.2
ER	207.03	130	1,026	2.4	4,177.3	4,177.3	4,177.5	0.2
ES	207.13	132	991	2.5	4,177.5	4,177.5	4,177.7	0.2

[1]Miles above mouth

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

DESCHUTES RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
LITTLE DESCHUTES RIVER								
A	0.06	546	1,536	1.7	4,163.1[2]	4,161.4	4,161.7	0.3
B	0.81	458	885	3.0	4,163.1	4,163.1	4,163.3	0.2
C	1.02	165	543	4.8	4,163.9	4,163.9	4,163.9	0.0
D	1.84	530	2,411	1.1	4,165.1	4,165.1	4,165.5	0.4
E	3.06	561	2,040	1.3	4,166.4	4,166.4	4,166.7	0.3
F	3.75	672	1,692	1.5	4,167.6	4,167.6	4,167.7	0.1
G	4.57	650	2,231	1.2	4,168.9	4,168.9	4,169.0	0.1
H	5.23	495	1,494	1.8	4,169.3	4,169.3	4,169.8	0.5
I	5.58	850	798	3.3	4,169.7	4,169.7	4,170.6	0.9
J	6.59	667	2,199	1.2	4,171.7	4,171.7	4,172.2	0.5
K	7.33	210	964	2.7	4,172.6	4,172.6	4,173.2	0.6
L	8.08	523	2,330	1.1	4,173.8	4,173.8	4,174.5	0.7
M	8.75	196	823	3.1	4,174.9	4,174.9	4,175.6	0.7
N	9.42	548	1,661	1.6	4,176.8	4,176.8	4,177.3	0.5
O	10.16	540	1,883	1.4	4,177.9	4,177.9	4,178.3	0.4
P	10.95	460	785	3.3	4,179.7	4,179.7	4,180.2	0.5
Q	12.09	395	2,102	1.2	4,181.8	4,181.8	4,182.4	0.6
R	12.83	781	2,929	0.9	4,182.6	4,182.6	4,183.0	0.4
S	14.15	151	981	2.6	4,184.5	4,184.5	4,184.6	0.1
T	15.07	594	2,591	1.0	4,185.4	4,185.4	4,185.5	0.1
U	15.71	556	2,056	1.2	4,186.0	4,186.0	4,186.1	0.1
V	16.60	603	2,535	1.0	4,188.7	4,188.7	4,188.8	0.1
W	17.17	268	2,080	1.2	4,189.7	4,189.7	4,189.8	0.1
X	18.18	531	2,181	1.2	4,190.9	4,190.9	4,191.0	0.1
Y	19.19	690	2,341	1.1	4,191.9	4,191.9	4,192.0	0.1
Z	19.83	250	1,748	1.4	4,192.8	4,192.8	4,192.8	0.0

[1]Stream distance in miles above confluence with Deschutes River

[2]Backwater from Deschutes River

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

LITTLE DESCHUTES RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
LITTLE DESCHUTES RIVER								
AA	20.92	600	1,692	1.5	4,194.5	4,194.5	4,194.7	0.2
AB	21.78	740	2,867	0.8	4,195.2	4,195.2	4,195.4	0.2
AC	22.76	785	2,654	0.9	4,195.6	4,195.6	4,195.8	0.2
AD	23.80	824	1,664	1.5	4,196.4	4,196.4	4,196.8	0.4
AE	24.75	818	2,031	1.2	4,197.5	4,197.5	4,198.1	0.6
AF	25.94	98	603	4.0	4,200.0	4,200.0	4,200.9	0.9
AG	26.93	706	2,037	1.2	4,202.8	4,202.8	4,203.3	0.5
AH	28.11	70	543	4.2	4,205.1	4,205.1	4,205.5	0.4
AI	28.52	713	2,177	1.1	4,206.0	4,206.0	4,206.5	0.5
AJ	29.41	837	1,585	1.5	4,207.1	4,207.1	4,207.4	0.3
AK	30.36	772	1,819	1.3	4,208.3	4,208.3	4,208.6	0.3
AL	31.37	800	1,853	1.2	4,209.7	4,209.7	4,210.0	0.3
AM	32.39	800	1,913	1.1	4,210.9	4,210.9	4,211.3	0.4
AN	33.03	389	657	3.3	4,212.6	4,212.6	4,213.6	1.0
AO	33.85	286	438	1.5	4,218.4	4,218.4	4,219.0	0.6
AP	35.03	508	1,951	1.1	4,221.5	4,221.5	4,222.1	0.6
AQ	36.05	451	1,457	1.5	4,223.8	4,223.8	4,224.3	0.5
AR	36.75	574	1,799	1.1	4,225.8	4,225.8	4,226.4	0.6
AS	37.52	384	1,193	1.7	4,228.4	4,228.4	4,229.4	1.0
AT	38.33	137	1,449	1.4	4,233.9	4,233.9	4,234.3	0.4
AU	38.97	173	1,332	1.5	4,237.9	4,237.9	4,238.0	0.1
AV	39.88	100	710	2.9	4,242.8	4,242.8	4,242.9	0.1
AW	40.70	319	1,596	1.2	4,245.5	4,245.5	4,245.6	0.1
AX	41.66	657	1,502	1.3	4,247.6	4,247.6	4,247.7	0.1
AY	42.76	340	808	2.4	4,250.2	4,250.2	4,250.3	0.1
AZ	43.22	626	1,712	1.1	4,252.2	4,252.2	4,252.4	0.2

[1]Stream distance in miles above confluence with Deschutes River

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

LITTLE DESCHUTES RIVER

TABLE 4

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
LITTLE DESCHUTES RIVER								
BA	44.02	187	681	2.8	4,255.4	4,255.4	4,255.5	0.1
BB	44.71	187	1,044	1.8	4,259.1	4,259.1	4,259.3	0.2
BC	45.22	238	1,502	1.2	4,262.3	4,262.3	4,262.3	0.0

[1]Stream distance in miles above confluence with Deschutes River

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

LITTLE DESCHUTES RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
WHYCHUS CREEK								
A	8.02	67	525	8.8	2,590.5	2,590.5	2,591.5	1.0
B	8.35	127	608	7.6	2,605.7	2,605.7	2,606.4	0.7
C	8.69	181	780	5.9	2,621.3	2,621.3	2,622.3	1.0
D	9.03	214	951	4.9	2,635.7	2,635.7	2,636.3	0.6
E	9.27	171	670	6.9	2,645.0	2,645.0	2,646.0	1.0
F	9.54	129	572	8.1	2,658.1	2,658.1	2,658.7	0.6
G	9.82	133	551	8.4	2,674.0	2,674.0	2,674.7	0.7
H	10.19	242	1,189	3.9	2,688.0	2,688.0	2,688.8	0.8
I	10.51	134	486	9.5	2,702.2	2,702.2	2,702.3	0.1
J	10.86	208	801	5.8	2,721.6	2,721.6	2,722.6	1.0
K	11.21	111	536	8.6	2,738.6	2,738.6	2,738.6	0.0
L	11.50	116	746	6.2	2,751.7	2,751.7	2,752.7	1.0
M	11.85	81	459	10.1	2,767.6	2,767.6	2,767.6	0.0
N	12.18	169	857	5.4	2,782.3	2,782.3	2,783.3	1.0
O	12.53	71	533	8.7	2,794.4	2,794.4	2,794.4	0.0
P	12.92	226	925	5.0	2,810.5	2,810.5	2,811.5	1.0
Q	13.25	134	660	7.0	2,826.1	2,826.1	2,826.5	0.4
R	13.61	192	935	5.0	2,839.4	2,839.4	2,840.4	1.0
S	13.99	163	660	7.0	2,856.5	2,856.5	2,856.9	0.4
T	14.47	190	845	5.5	2,880.1	2,880.1	2,881.0	0.9
U	14.87	125	745	6.2	2,897.7	2,897.7	2,898.2	0.5
V	15.23	134	808	5.7	2,910.8	2,910.8	2,911.8	1.0
W	15.60	124	669	6.9	2,926.9	2,926.9	2,927.7	0.8
X	15.92	218	933	5.0	2,940.8	2,940.8	2,941.8	1.0
Y	16.25	227	749	6.2	2,955.3	2,955.3	2,955.8	0.5
Z	16.59	251	658	7.0	2,970.8	2,970.8	2,971.0	0.2

[1]Miles above mouth

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

WHYCHUS CREEK

TABLE 4

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
WHYCHUS CREEK								
AA	16.88	185	386	12.0	2,985.6	2,985.6	2,986.2	0.6
AB	17.00	317	767	6.0	2,995.2	2,995.2	2,995.8	0.6
AC	17.14	155	663	7.0	3,001.3	3,001.3	3,001.7	0.4
AD	17.38	311	1,057	4.4	3,011.3	3,011.3	3,012.1	0.8
AE	17.69	188	606	7.6	3,023.9	3,023.9	3,024.2	0.3
AF	17.96	158	622	7.4	3,038.4	3,038.4	3,038.6	0.2
AG	18.27	291	916	5.1	3,048.7	3,048.7	3,049.7	1.0
AH	18.58	273	708	6.5	3,062.7	3,062.7	3,062.7	0.0
AI	18.78	508	915	5.1	3,071.8	3,071.8	3,072.7	0.9
AJ	18.99	125	458	10.1	3,083.1	3,083.1	3,083.4	0.3
AK	19.30	280	1,086	4.3	3,097.6	3,097.6	3,097.8	0.2
AL	19.40	263	751	6.2	3,100.7	3,100.7	3,100.7	0.0
AM	19.51	237	1,328	3.5	3,103.9	3,103.9	3,104.2	0.3
AN	19.84	172	462	10.0	3,116.4	3,116.4	3,116.4	0.0
AO	19.95	284	782	5.9	3,124.5	3,124.5	3,125.2	0.7
AP	20.06	178	984	4.3	3,127.7	3,127.7	3,128.4	0.7
AQ	20.46	127	280	8.8	3,139.0	3,139.0	3,139.4	0.4
AR	20.79	80	368	6.7	3,154.0	3,154.0	3,154.6	0.6
AS	21.16	131	330	7.5	3,168.8	3,168.8	3,168.9	0.1
AT	21.29	51	261	9.5	3,175.7	3,175.7	3,175.7	0.0
AU	21.37	45	288	8.6	3,178.3	3,178.3	3,178.6	0.3
AV	21.54	48	252	9.8	3,184.3	3,184.3	3,184.8	0.5
AW	21.73	109	279	8.9	3,193.4	3,193.4	3,193.4	0.0
AX	21.84	77	262	9.5	3,201.3	3,201.3	3,201.3	0.0
AY	21.96	128	645	3.8	3,205.2	3,205.2	3,206.1	0.9
AZ	22.19	74	265	9.4	3,216.1	3,216.1	3,216.1	0.0

[1]Miles above mouth

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR

AND INCORPORATED AREAS

FLOODWAY DATA

WHYCHUS CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ.FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
WHYCHUS CREEK								
BA	22.33	125	633	3.9	3,221.7	3,221.7	3,222.5	0.8
BB	22.56	91	275	9.0	3,233.4	3,233.4	3,233.4	0.0
BC	22.78	82	433	5.7	3,248.4	3,248.4	3,248.4	0.0
BD	23.01	304[2]	680	3.6	3,257.6	3,257.6	3,257.8	0.2
BE	23.51	356[2]	399	6.2	3,281.2	3,281.2	3,281.5	0.3
BF	23.94	127	452	5.5	3,313.2	3,313.2	3,313.5	0.3
BG	24.04	133	376	6.6	3,320.8	3,320.8	3,320.9	0.1
BH	24.19	109	421	5.9	3,329.9	3,329.9	3,330.8	0.9
BI	24.46	151	307	8.1	3,350.0	3,350.0	3,350.1	0.1
BJ	24.69	220	366	6.8	3,371.4	3,371.4	3,371.5	0.1
BK	24.75	157	412	6.0	3,377.1	3,377.1	3,377.3	0.2
BL	24.79	58	281	8.8	3,378.0	3,378.0	3,378.3	0.3
BM	24.91	63	274	9.1	3,384.8	3,384.8	3,385.2	0.4
BN	25.43	55	207	10.7	3,424.4	3,424.4	3,424.4	0.0
BO	25.87	45	240	9.2	3,455.2	3,455.2	3,455.9	0.7
BP	26.39	64	214	10.3	3,492.2	3,492.2	3,492.3	0.1
BQ	26.64	48	261	8.5	3,509.4	3,509.4	3,510.2	0.8

[1]Miles above mouth
[2]Split floodway

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY
DESCHUTES COUNTY, OR
AND INCORPORATED AREAS

FLOODWAY DATA

WHYCHUS 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.

Approximate 1-percent-annual-chance floodplain boundaries in some portions of the study area were taken directly from the Flood Hazard Boundary Map (Reference 14).

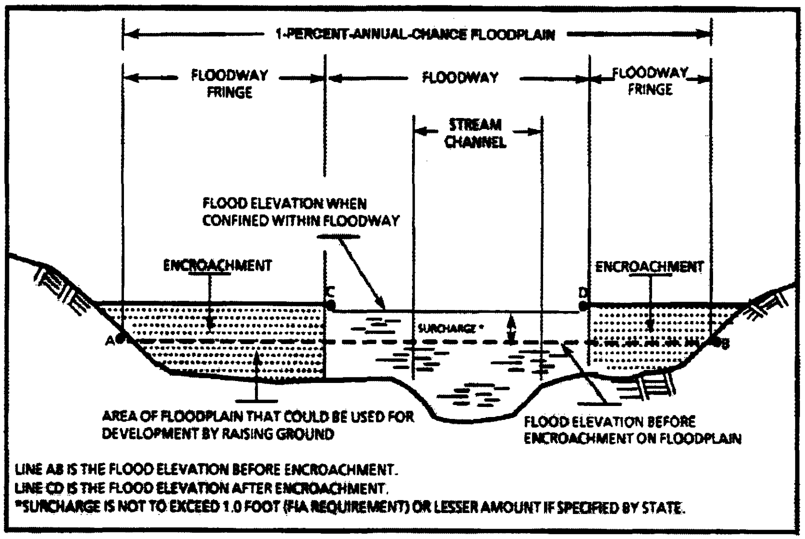

Figure 1. Floodway Schematic

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 rate 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 base (1-percent-annual-chance) flood elevations (BFEs) or depths are shown within this zone. This approximate flood zone is present in the City of Bend and the unincorporated areas of Deschutes County.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by detailed methods.

Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. This flood zone is present in the Cities of Bend and Sisters and the unincorporated areas of Deschutes County.

Zone X

Zone X is the flood insurance rate 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 depths are shown within this zone. This flood zone is present in the Cities of Bend and Sisters and the unincorporated areas of Deschutes County.

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 rate 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 base flood elevations or average depths. Insurance agents use the zones and base flood elevations 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 countywide FIRM presents flooding information for the entire geographic area of Deschutes County. Previously, FIRMs were prepared for each incorporated community and the unincorporated areas of the County identified as flood-prone. This countywide FIRM also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community are presented in Table 5, "Community Map History."

7.0 OTHER STUDIES

The COE prepared Flood Insurance Studies for Crook and Jefferson Counties, which border Deschutes County on the east and north, respectively (References 15 and 16). The results of this study are in agreement with those Flood Insurance Studies. This study incorporates the Flood Insurance Study of the Cities of Sisters and Bend (References 1 and 17).

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE(S)
Bend, City of	June 28, 1974	August 8, 1975	September 4, 1987	June 8, 1998
La Pine, City of	N/A	N/A	N/A	–
Sisters, City of	December 7, 1973	April 23, 1976	September 29, 1986	June 8, 1998
Redmond, City of[1]	N/A	N/A	N/A	–
Unincorporated Areas	January 17, 1975	September 6, 1977	August 16, 1988	June 8, 1998

[1]Non-Flood Prone

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR

AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

TABLE 5

The results of two Portland District Flood Plain Information Reports for Little Deschutes River and Whychus Creek were used in this FIS, including water-surface profiles and floodplain areas (References 18 and 19). The reaches of Little Deschutes River and Whychus Creek, covered in those reports, were also shown on COE orthophoto plan-profile sheets (References 12 and 20).

The advisory data presented for the Carver Lake Moraine Dam failure, in Sisters, Oregon, including water-surface profiles, Summary of Elevation (Table 1), and floodplain delineations, were taken from USGS open file report 87-41 (Reference 20).

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

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting Federal Insurance and Mitigation Division, FEMA Region X, Federal Regional Center, 130 228th Street, SW, Bothell, Washington 98021-9796.

9.0 BIBLIOGRAPHY AND REFERENCES

1. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of Bend, Oregon, June 8, 1988.
2. U.S. Geological Survey, Hydrologic Hazards Along Squaw Creek from a Hypothetical Failure of the Glacial Moraine Impounding Carver Lake Near Sisters, Oregon, Open File Report 87-41, 1987.
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8. U.S. Water Resources Council, "Guidelines for Determining Flood Flow Frequency," Bulletin 17, March 1976.
9. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water-Surface Profiles, Generalized Computer Program, Davis, California, November 1976, updated May 1982.

10. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Insurance Study Work Maps – Deschutes River, Contour Interval 4 feet, Scale 1:4,800. Date of Photography July 27, 1984, Sheets 2 to 3 and 5 to 9 of 10.

11. U.S. Department of the Army, Corps of Engineers, Portland District, Orthophoto Topography Maps, Little Deschutes River, Vicinity of LaPine, Oregon, Scale 1:6,000, Contour Interval 5 feet, October 1975.

12. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Plain Information, Orthophotographic Topography, Squaw Creek, Oregon, Scale 1:6,000, Contour Interval 5 feet, November 1976.

13. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Insurance Study Work Maps – Deschutes River and Little Deschutes River, Scale 1"=2,000'. Dates of Photography July 27, 1984 and October 1975, Sheet 10 of 10.

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17. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of Sisters, Oregon, September 29, 1986.

18. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Plain Information, Little Deschutes River, LaPine, Oregon, December 1977.

19. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Plain Information, Squaw Creek, Sisters, Oregon, August 1978.

20. U.S. Department of the Army, Corps of Engineers, Portland District, Flood Plain Information, Little Deschutes River at LaPine, Oregon, Flooded Areas and Water-Surface Profiles, December 1977.

21. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water-Surface Profiles, Generalized Computer Program, Davis, California, September 1990.

22. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Deschutes County, Oregon and Incorporated Areas, August 16, 1988.

23. U.S. Army Corps of Engineers, Engineer Research and Development Center, CORPSCON-Coordinate Conversion Software, Version 5.11, www.erdc.usace.army.mil.

24. E-Podunk web site, Deschutes County, OR County Profile, http://www.epodunk.com, 2006.

10.0 REVISION 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 Flood Insurance Study report. To ensure that any user is aware of all revisions, it is advisable to contact the community repository of flood hazard data located at the Deschutes County Planning Section, 1130 Northwest Harriman, Bend, Oregon 97701.

10.1 First Revision

This study was revised in January 1996 to study by detailed methods the unincorporated areas of Sunriver in Deschutes County, Oregon, located between RMs 195.2 and 200.9 on the Deschutes River.

For the restudy, the initial Consultation Coordination Officer (CCO) meeting was held on August 17, 1994, with representatives of the Deschutes County Planning Department, FEMA, and the study contractor. The Deschutes County Water Resources Department and the Bureau of Land Reclamation were also contacted for historical data.

The results of the study were reviewed at the final CCO meeting held on April 10, 1997, and attended by representatives of FEMA, Deschutes County, and the study contractor. All problems raised at that meeting have been addressed in this study.

The effective hydrology was used for this restudy.

The hydraulic analysis used in this revision was performed by Ogden Beeman & Associates, Inc., under Contract No. EMW-95-C-4729.

This update combined the FIRMs and FIS reports for Deschutes County and incorporated communities into the countywide format. Under the countywide format, FIRM panels have been produced using a single-layout format for the entire area within the County instead of separate layout formats for each community. The single-layout format facilitates the matching of adjacent panels and depicts the flood-hazard area within the entire panel border, even in areas beyond a community's corporate boundary line. In addition, under the countywide format, this single FIS report provides all FIS information and data for the entire County area.

Cross sections were developed for the reach of the Deschutes River by studying aerial photographs and determining the appropriate spacing to represent the meanders in the river. The surveying of the cross sections was performed by David Evans & Associates, Inc. The exceptions are the furthest downstream section, 195.24, and the furthest upstream section, 200.94, which were not resurveyed but rather taken from the survey data of the previous study.

The dimensions of the two bridges in the reach, the General Patch Bridge and the pedestrian footbridge, were both surveyed by David Evans & Associates, Inc. For the Deschutes River (General Patch) bridge section, State of Oregon, Department of Transportation, State Highway Division, plans were also referenced.

Channel roughness factors (Manning's "n") were 0.120 for the overbanks and 0.048 for the channel based on the field observations. In addition, the roughness values selected correspond to the values used in the effective study in the upstream reach.

The hydraulic analysis for the Deschutes River was performed using the COE HEC-2 computer program (Reference 21) to provide the water-surface elevations along the study reach. The starting water-surface elevation was taken from the downstream study's results for section 195.24.

The survey data is referenced to the NGVD of 1929/1947.

The floodways presented in this restudy were computed on the basis of equal-conveyance reduction from each side of the floodplain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed and are presented in Table 4, "Floodway Data."

In addition, in reviewing the effective downstream study (Reference 22) for the initial starting water-surface elevations, a problem was noted. In the floodway run, the flows were not adjusted from the storm events run at section 192.72. Consequently, the 1-percent-annual-chance flood base condition was assigned the 10-percent-annual-chance flood flow and the 1-percent-annual-chance floodway was given the 2-percent-annual-chance flood flow. The study contractor re-ran the HEC-2 model for the downstream floodway conditions with the corrected discharges. The results indicated that overall, seven sections (CR through CX) had elevation increases on the order of 0.1 to 0.2 foot; however, no floodway rises were greater than the 1-foot limit. The minor changes in elevation do not affect the plotted floodway boundaries on the effective maps.

10.2 Second Revision

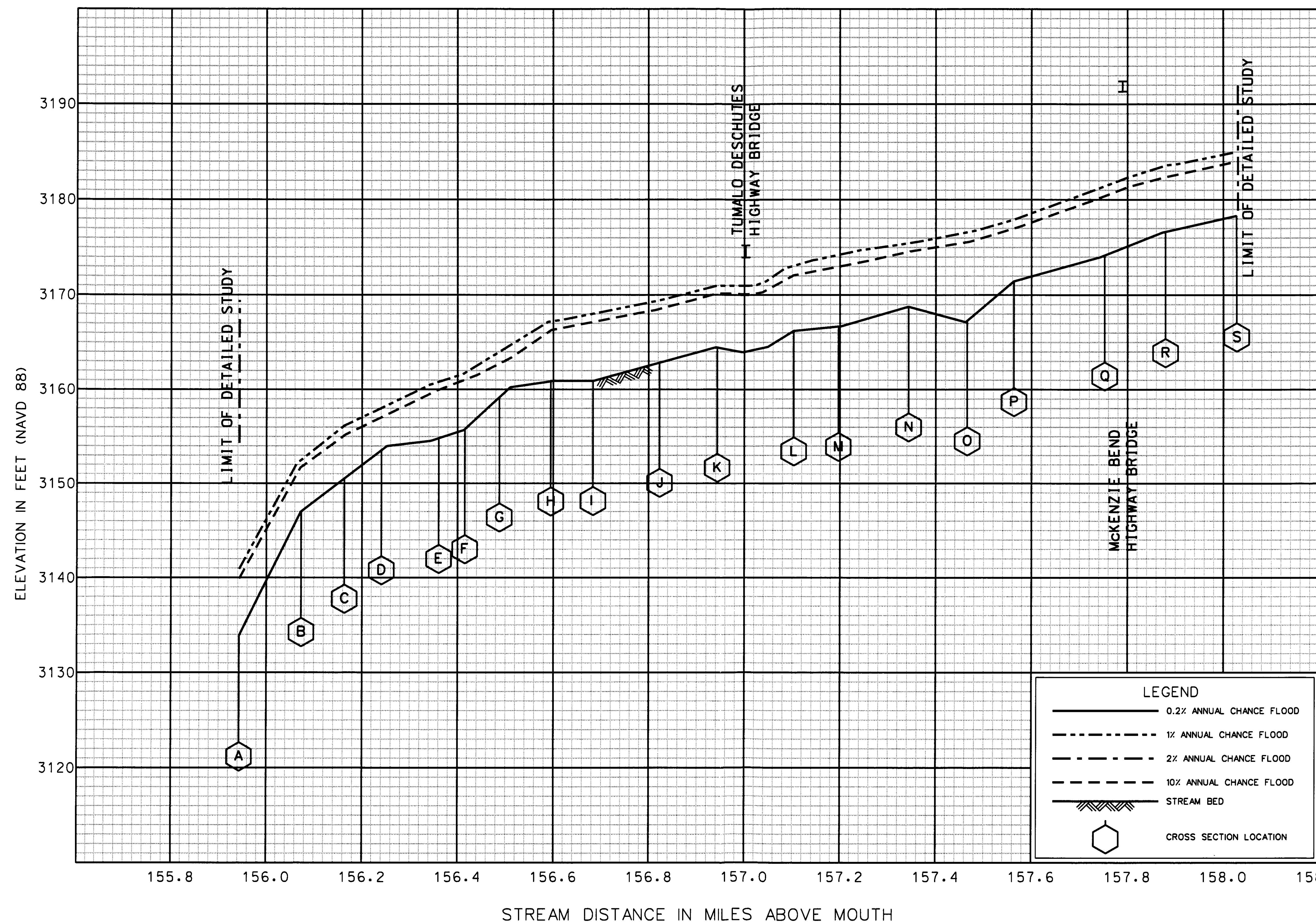
Squaw Creek was renamed to Whychus Creek in 2005. All mention of Squaw Creek has been changed to Whychus Creek in this FIS report and on the FIRM panels. References to Squaw Creek in the section 9.0 remain unchanged.

The City of Bend provided contour data in digital format. The files were compiled at a scale of 1:1,200 from aerial photographs dated 2004. This information was used to redelineate the existing Zone AE boundaries in the City of Bend.

The County of Deschutes provided 1-meter resolution ortho imagery from the National Agriculture Imagery Program for use as the FIRM base map. The imagery was published in 2005.

The mapping for the countywide conversion has been prepared using digital data. Previously published FIRM data produced manually have been converted to vector digital data by a digitizing process. These vector data were fit to raster digital images of the USGS quadrangle maps of the County area to provide horizontal positioning.

All vertical datum elevations in this report have been converted from NGVD29 to NAVD88. Refer to section 3.3 for a more specific explanation about the datum conversion for Deschutes County.



FLOOD PROFILES

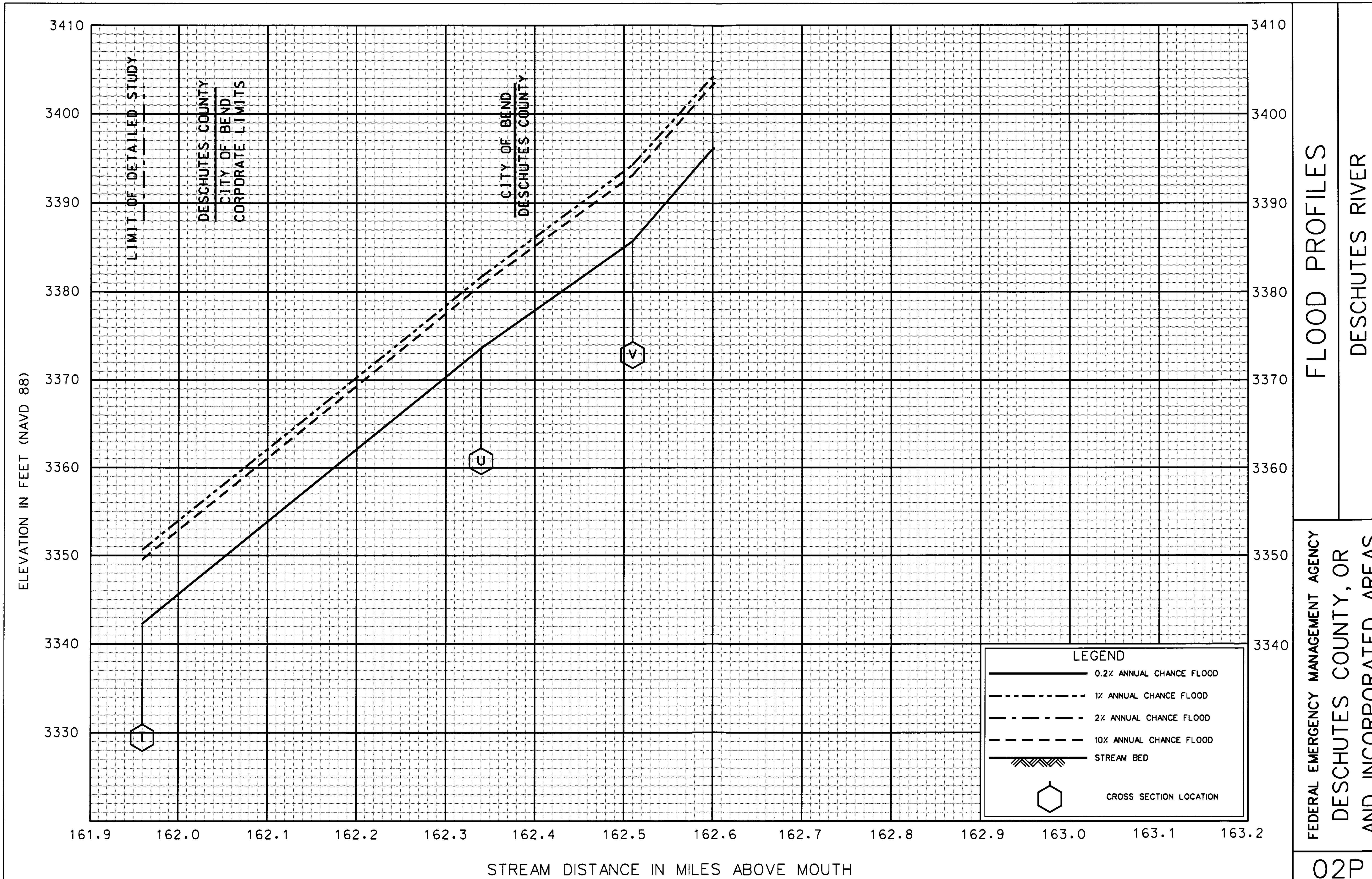
DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR

AND INCORPORATED AREAS

01P



FLOOD PROFILES
DESCHUTES RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
DESCHUTES COUNTY, OR
AND INCORPORATED AREAS
02P
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN MILES ABOVE MOUTH
LIMIT OF DETAILED STUDY
DESCHUTES COUNTY
CITY OF BEND
CORPORATE LIMITS
CITY OF BEND
DESCHUTES COUNTY
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
T
U
V
3410
3400
3390
3380
3370
3360
3350
3340
3330
161.9
162.0
162.1
162.2
162.3
162.4
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162.7
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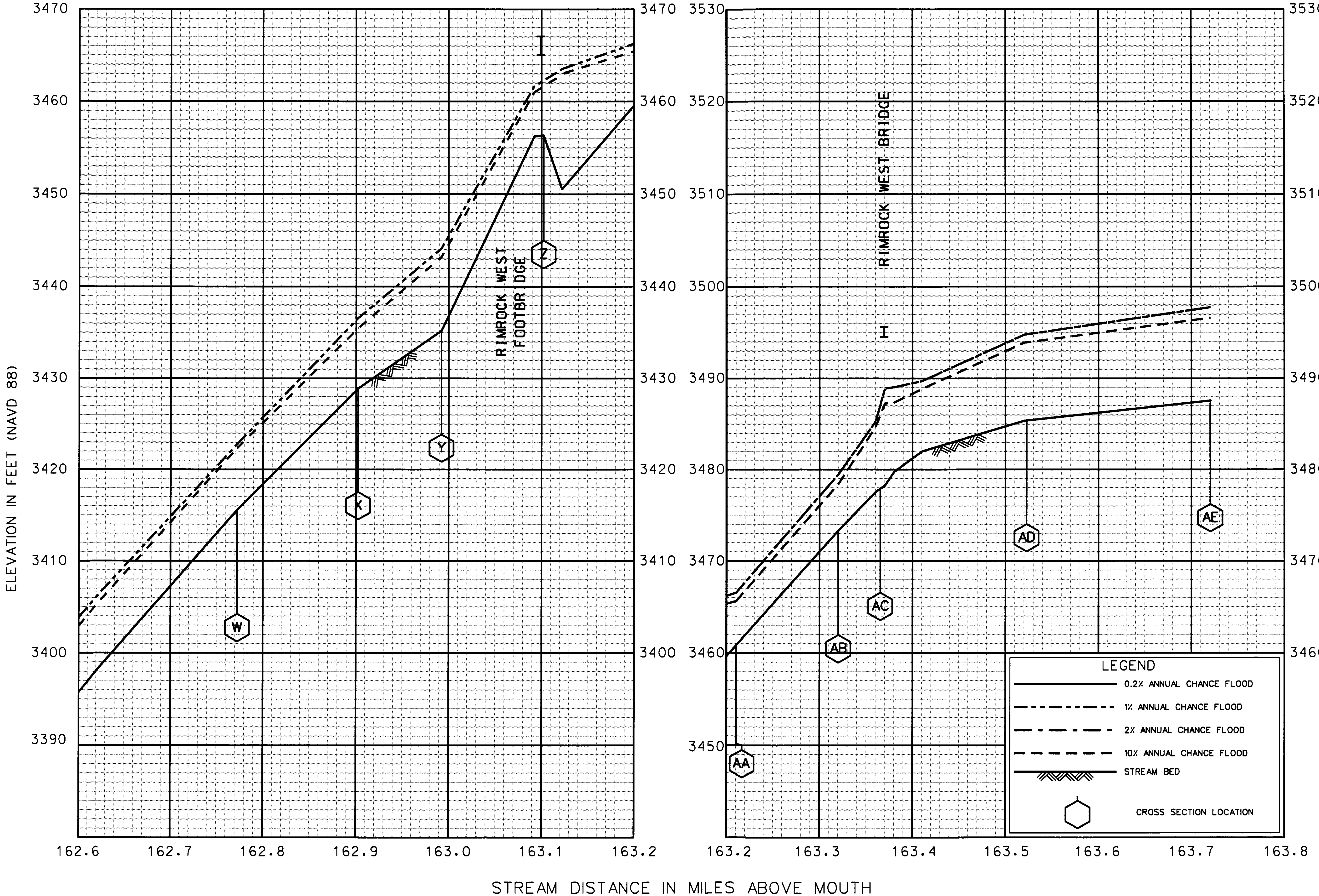
163.0
163.1
163.2



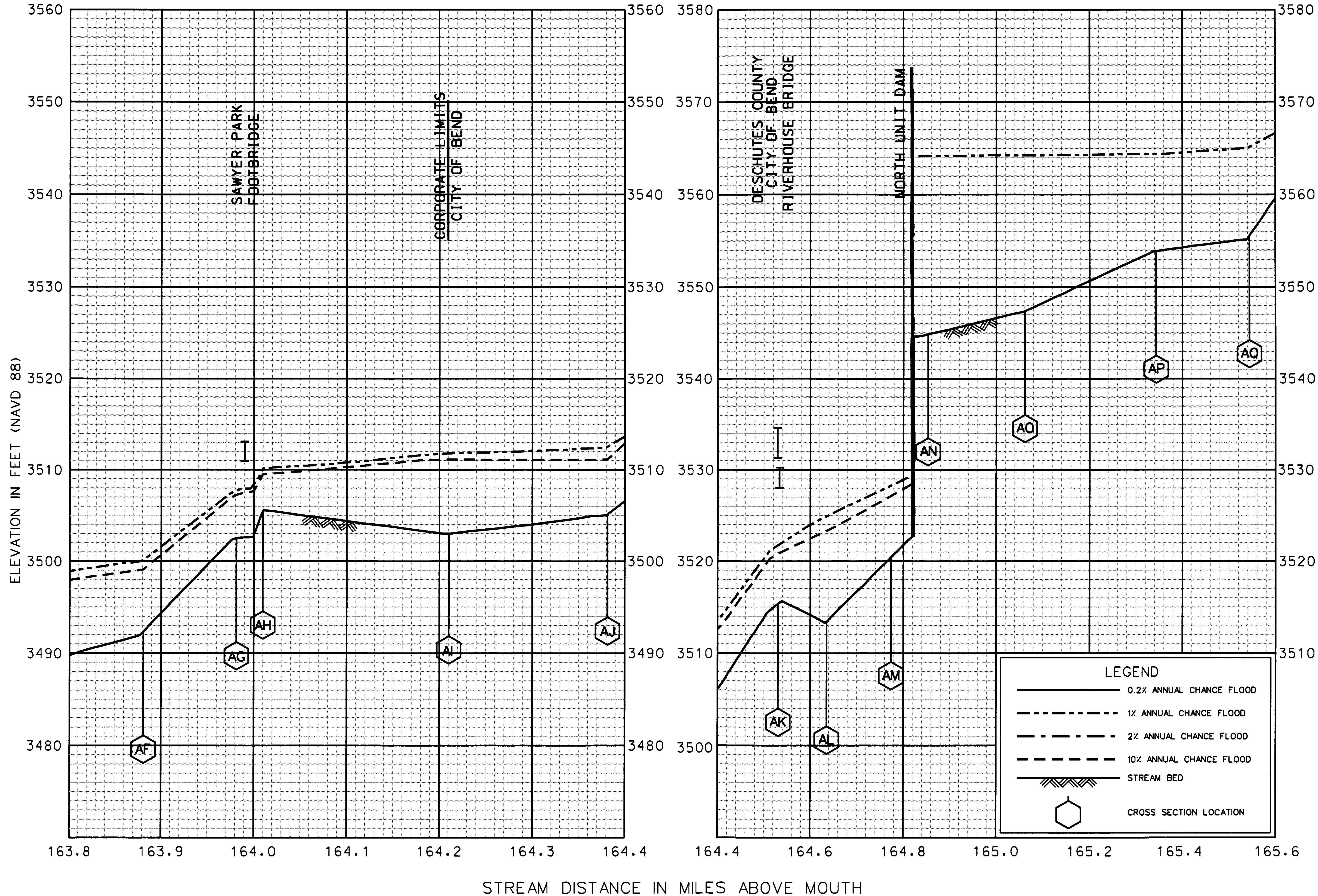
FLOOD PROFILES

DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

03P



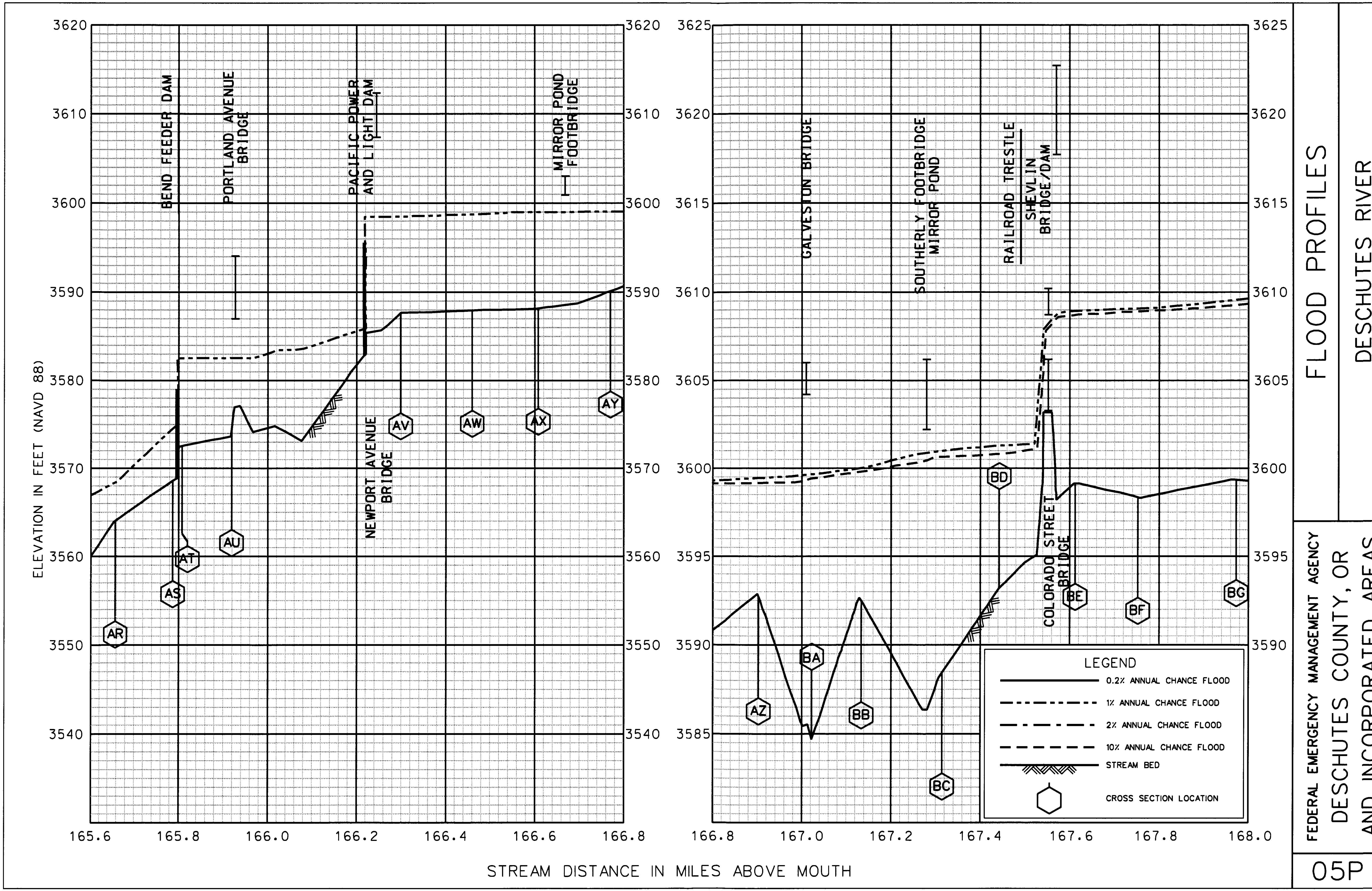
FLOOD PROFILES

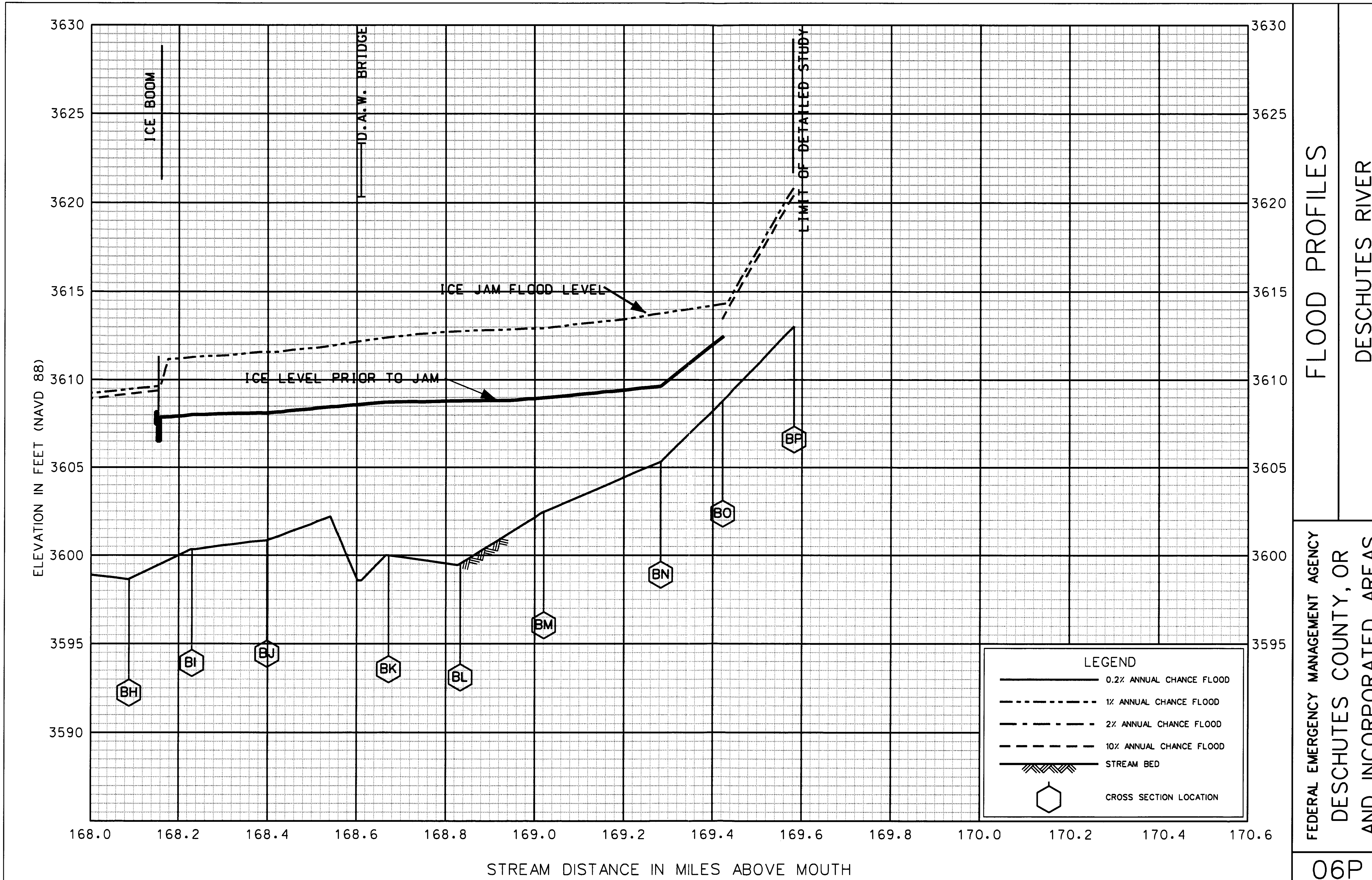
DESCHUTES RIVER

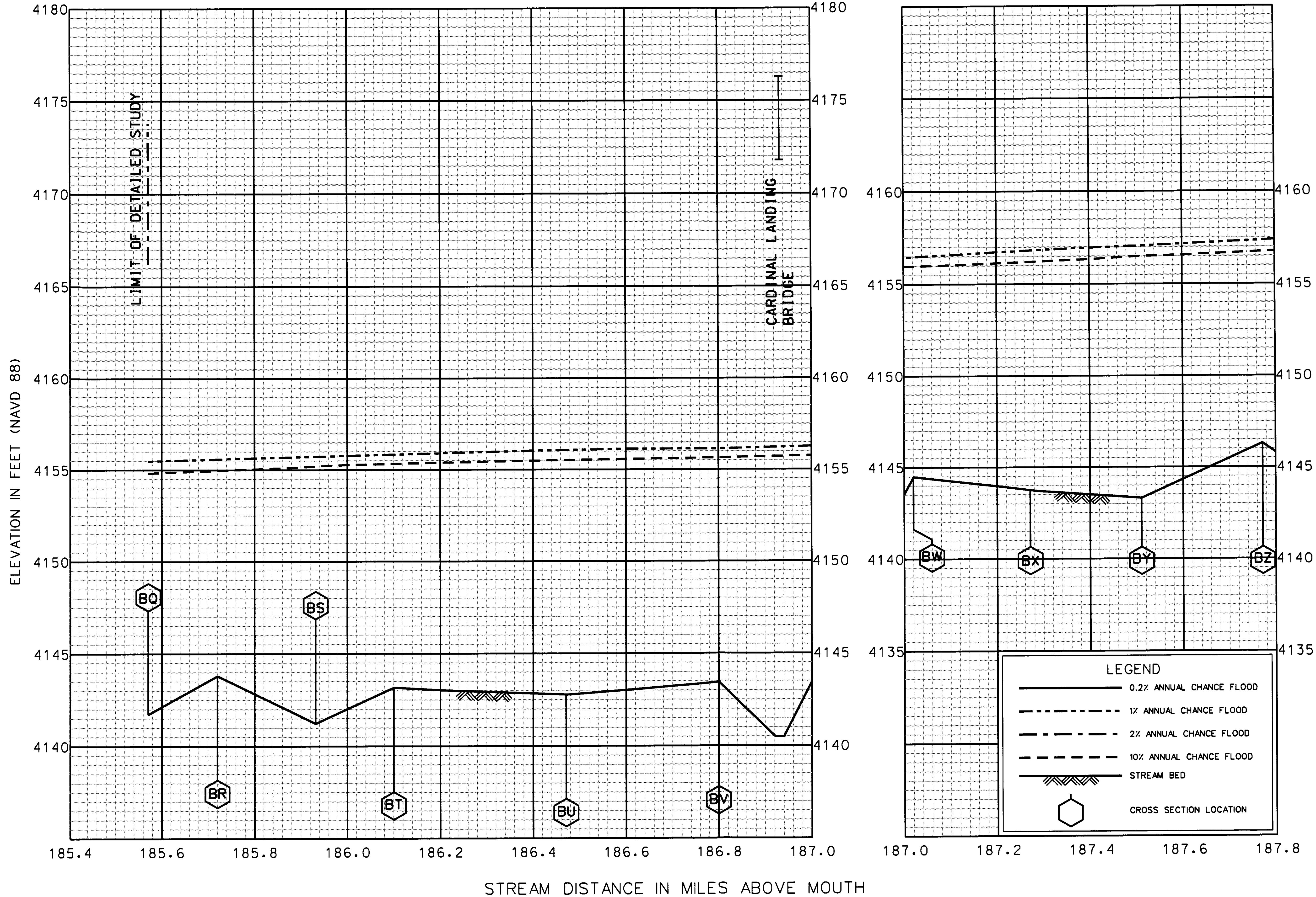
FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

04P


BEND FEEDER DAM
PORTLAND AVENUE BRIDGE
PACIFIC POWER AND LIGHT DAM
NEWPORT AVENUE BRIDGE
MIRROR POND FOOTBRIDGE
GALVESTON BRIDGE
SOUTHERLY FOOTBRIDGE MIRROR POND
RAILROAD TRESTLE
SHEVLIN BRIDGE/DAM
COLORADO STREET BRIDGE
AR
AS
AT
AU
AV
AW
AX
AY
AZ
BA
BB
BC
BD
BE
BF
BG
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN MILES ABOVE MOUTH
165.6 165.8 166.0 166.2 166.4 166.6 166.8
166.8 167.0 167.2 167.4 167.6 167.8 168.0
3540 3550 3560 3570 3580 3590 3600 3610 3620
3585 3590 3595 3600 3605 3610 3615 3620 3625
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
DESCHUTES RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
DESCHUTES COUNTY, OR
AND INCORPORATED AREAS
05P


ICE BOOM
D.A.W. BRIDGE
LIMIT OF DETAILED STUDY
ICE JAM FLOOD LEVEL
ICE LEVEL PRIOR TO JAM
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN MILES ABOVE MOUTH
3630
3625
3620
3615
3610
3605
3600
3595
3590
168.0
168.2
168.4
168.6
168.8
169.0
169.2
169.4
169.6
169.8
170.0
170.2
170.4
170.6
BH
BI
BJ
BK
BL
BM
BN
BO
BP
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
DESCHUTES RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
DESCHUTES COUNTY, OR
AND INCORPORATED AREAS
06P



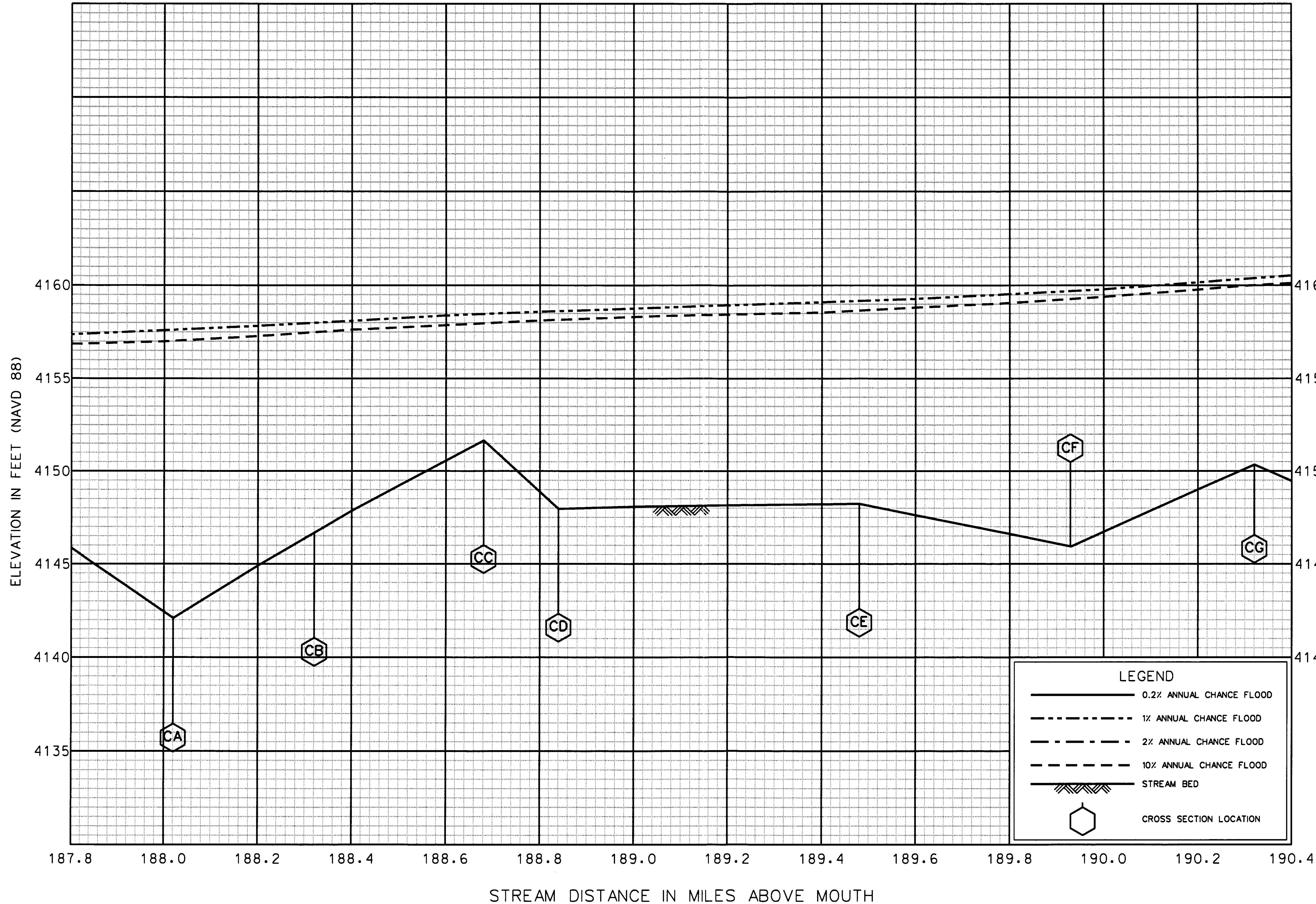
FLOOD PROFILES

DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

07P

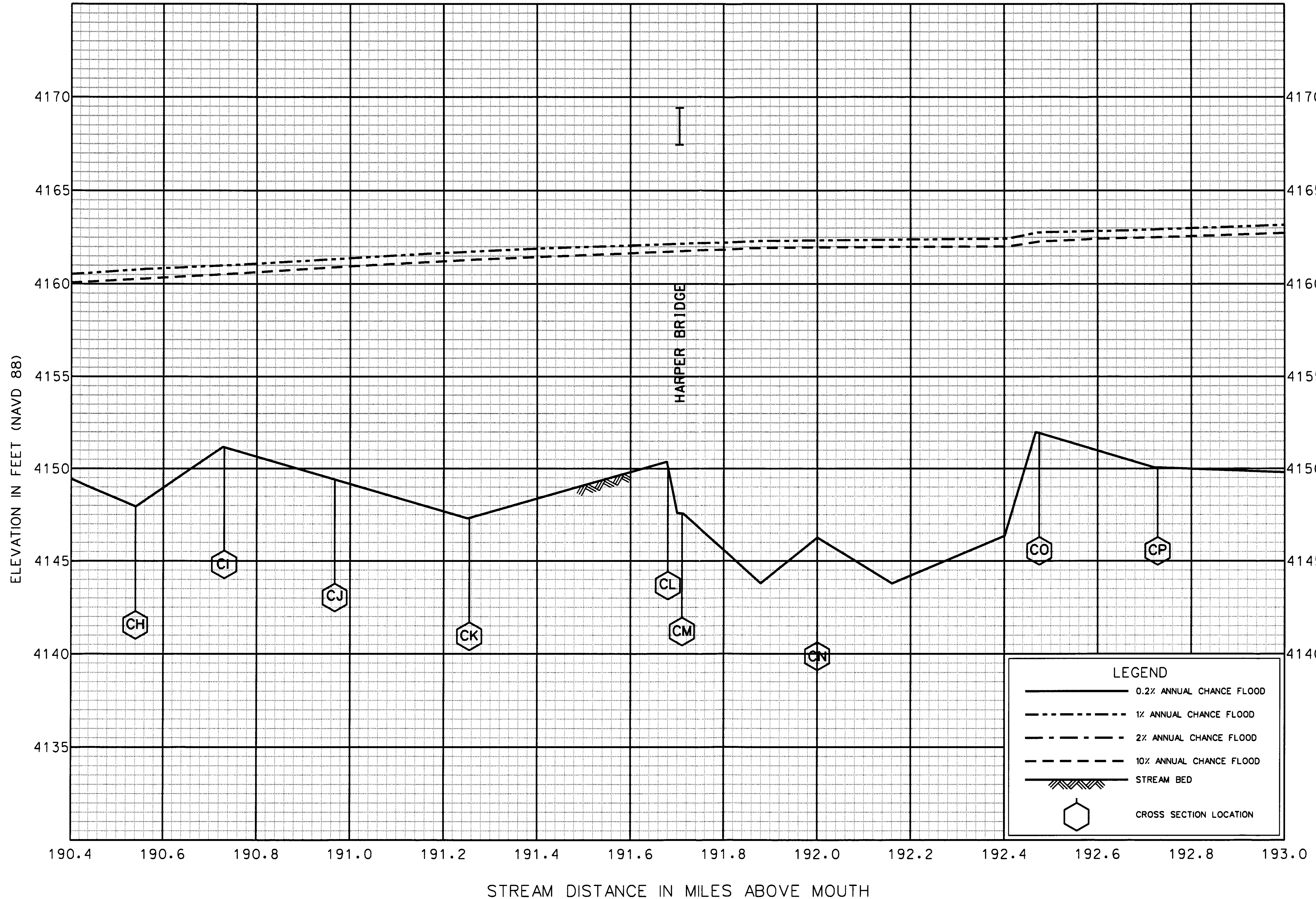


FLOOD PROFILES

DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

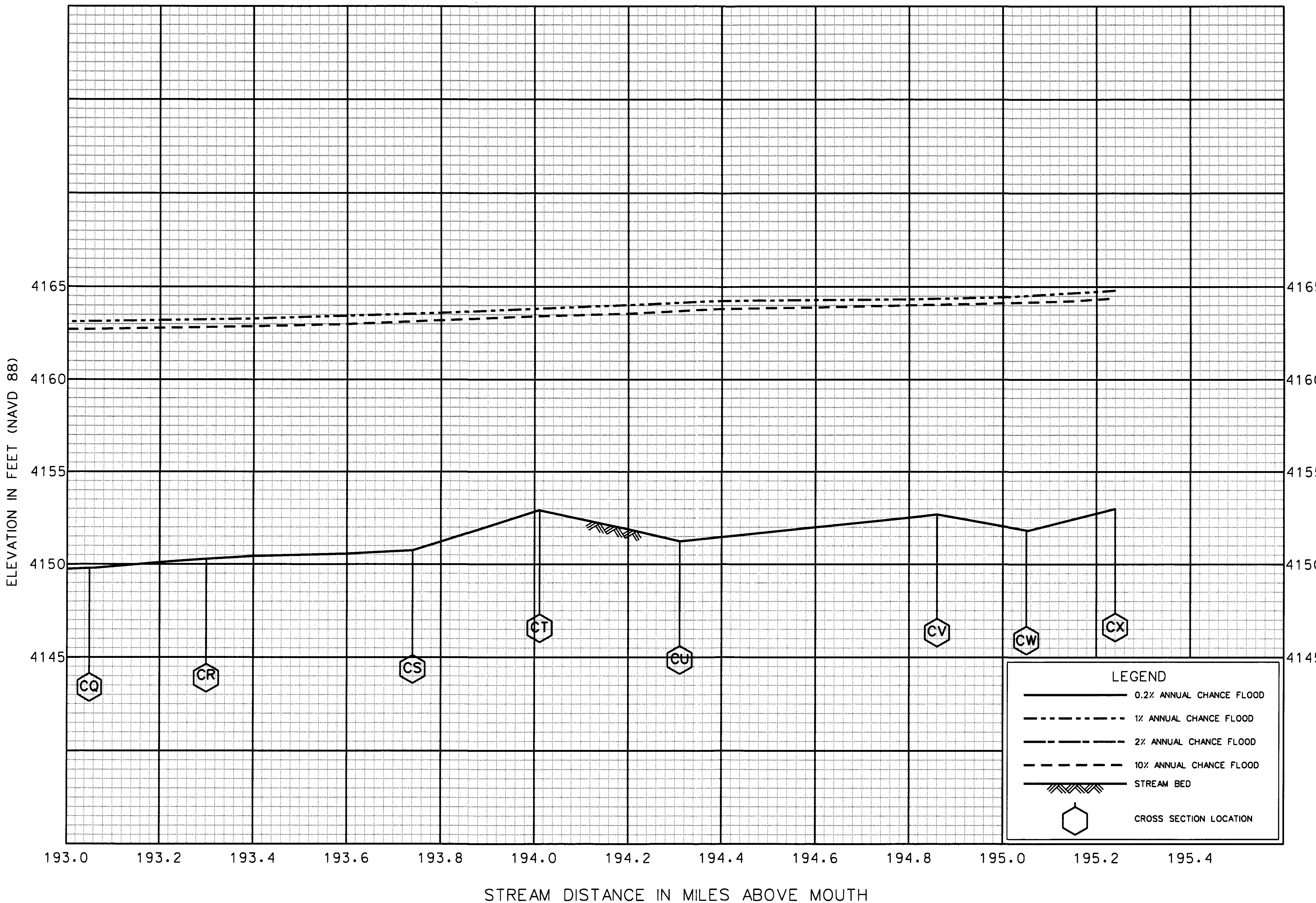


FLOOD PROFILES

DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS



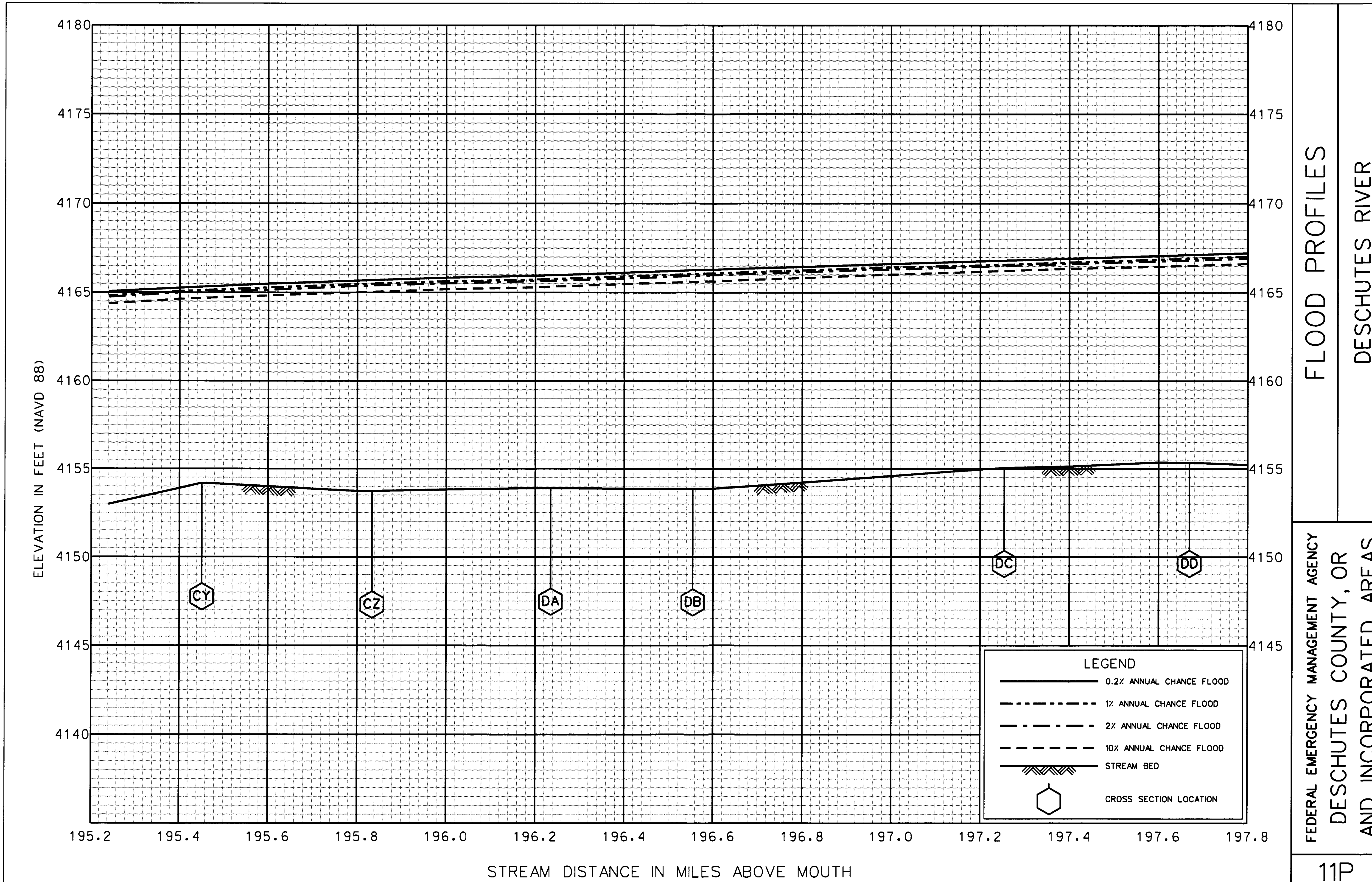
FLOOD PROFILES

DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR
AND INCORPORATED AREAS

10P



ELEVATION IN FEET (NAVD 88)
4180
4175
4170
4165
4160
4155
4150
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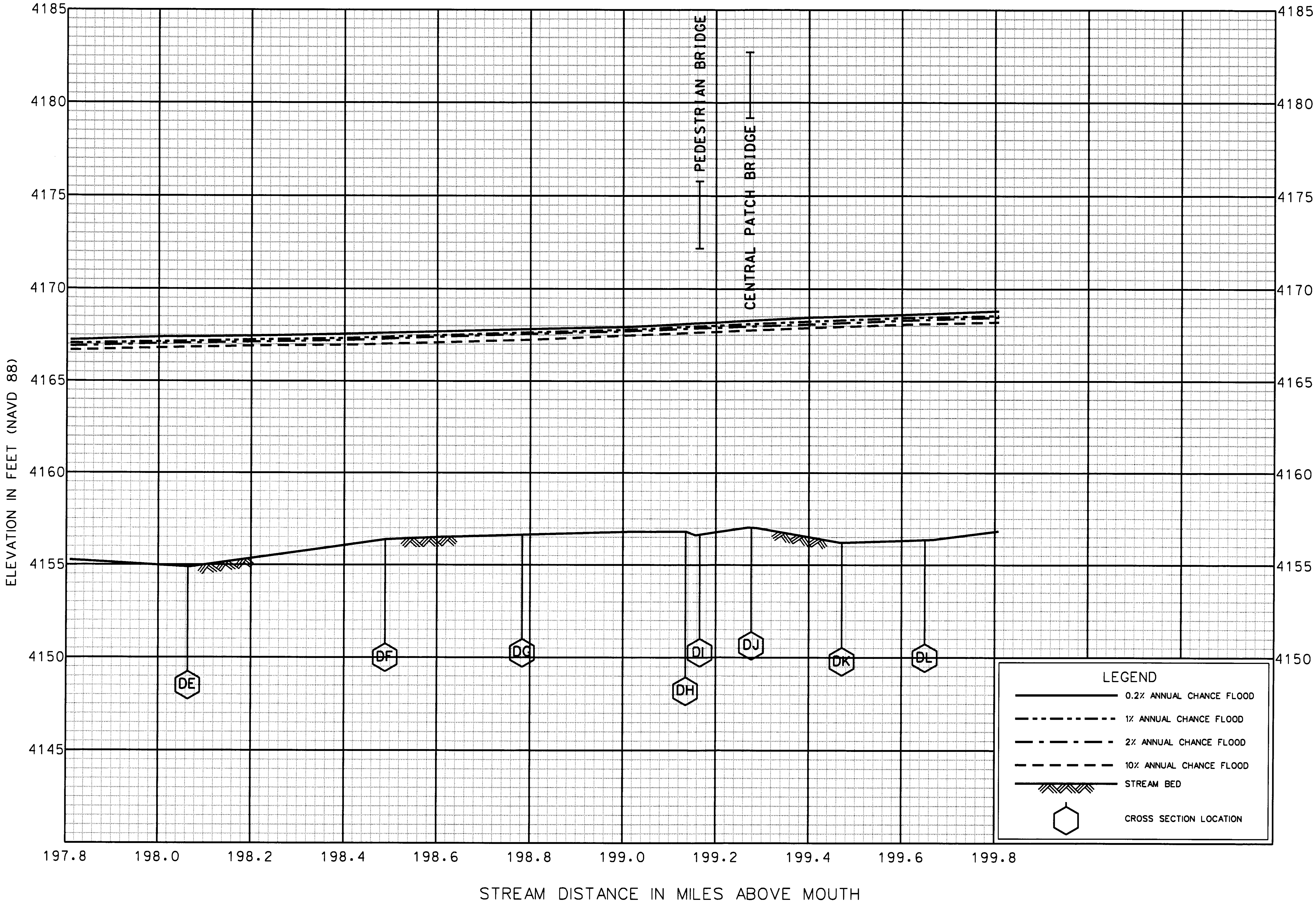
4140
195.2
195.4
195.6
195.8
196.0
196.2
196.4
196.6
196.8
197.0
197.2
197.4
197.6
197.8
STREAM DISTANCE IN MILES ABOVE MOUTH
CY
CZ
DA
DB
DC
DD
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
DESCHUTES RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
DESCHUTES COUNTY, OR
AND INCORPORATED AREAS
11P



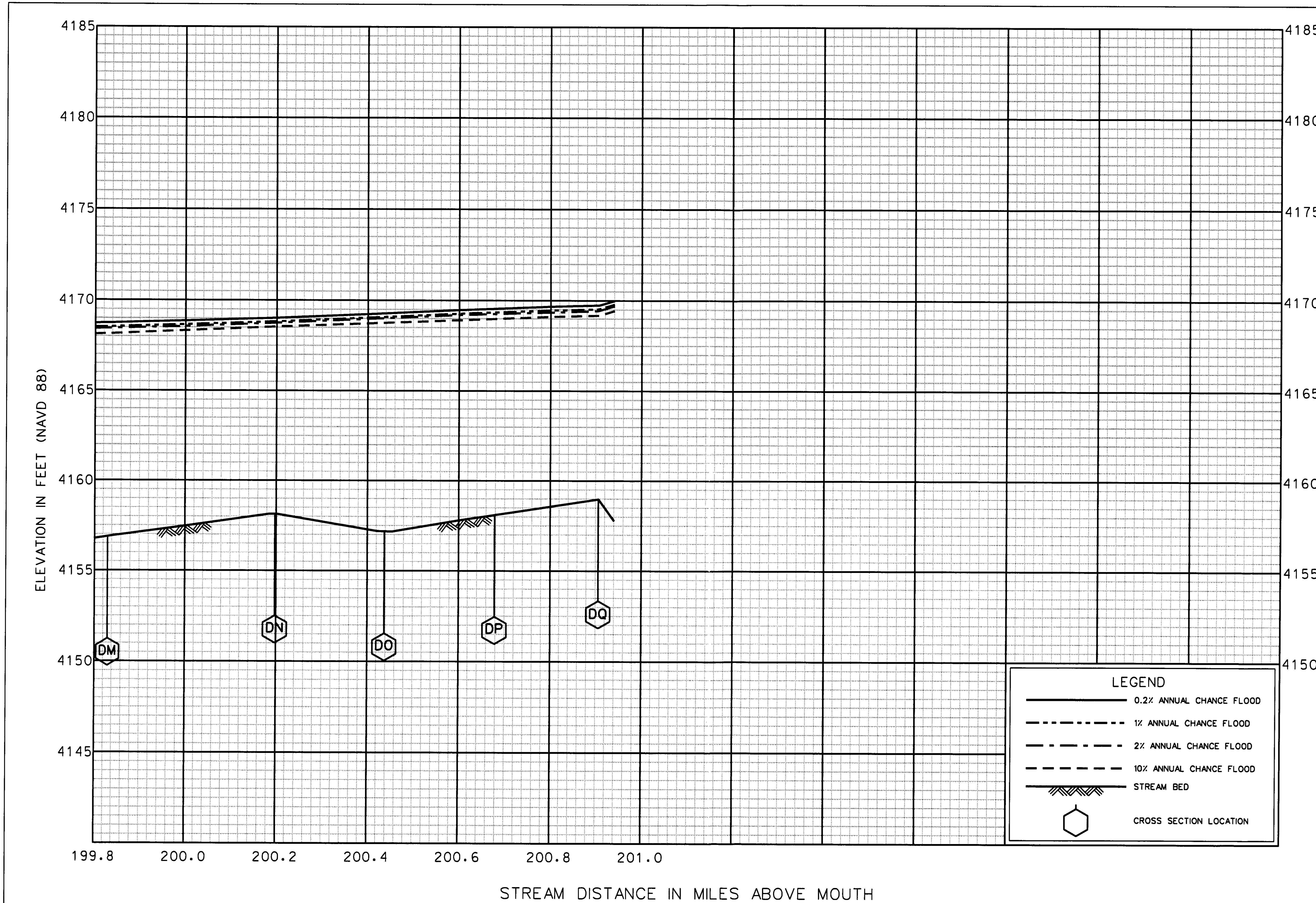
FLOOD PROFILES

DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

12P

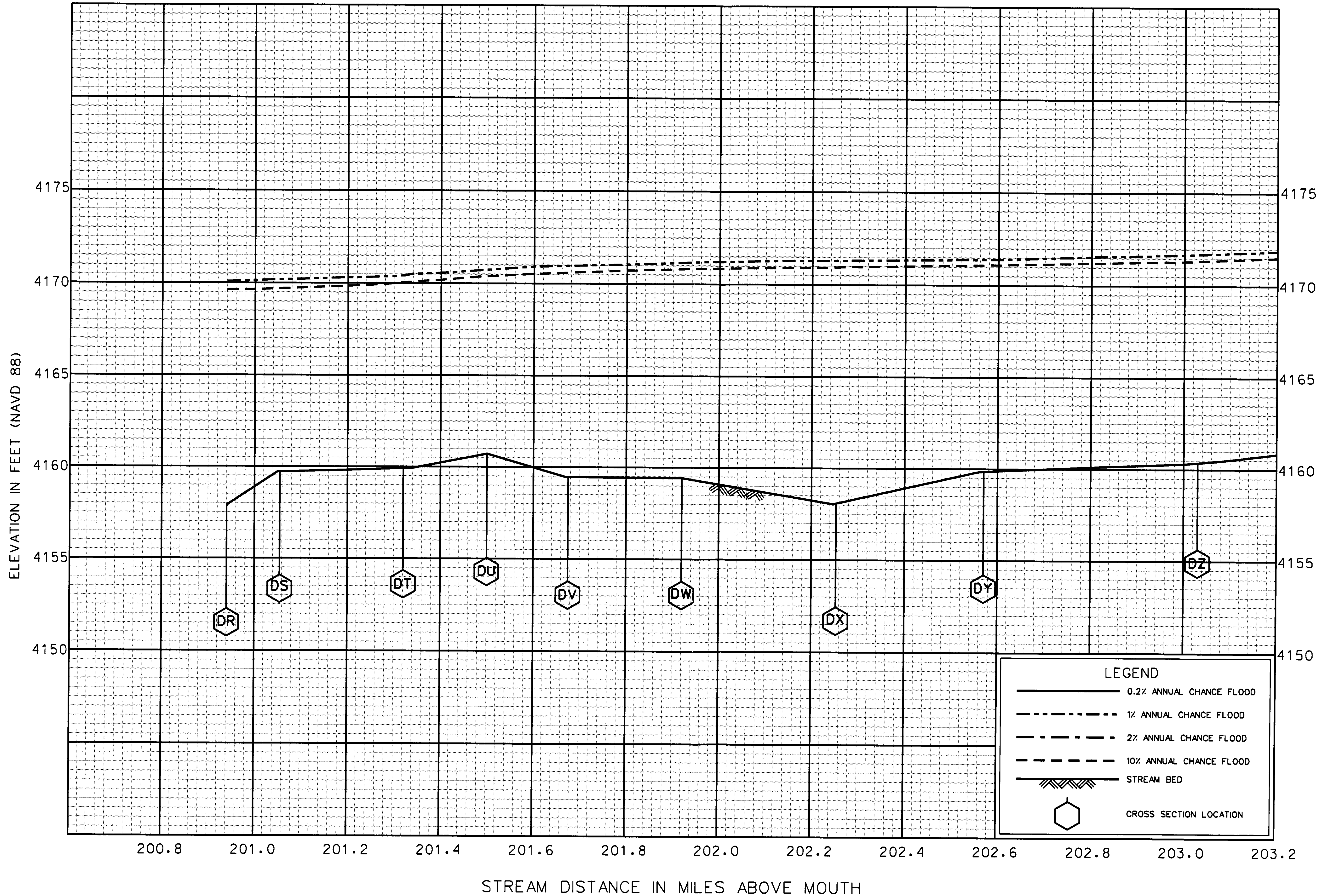


FLOOD PROFILES

DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

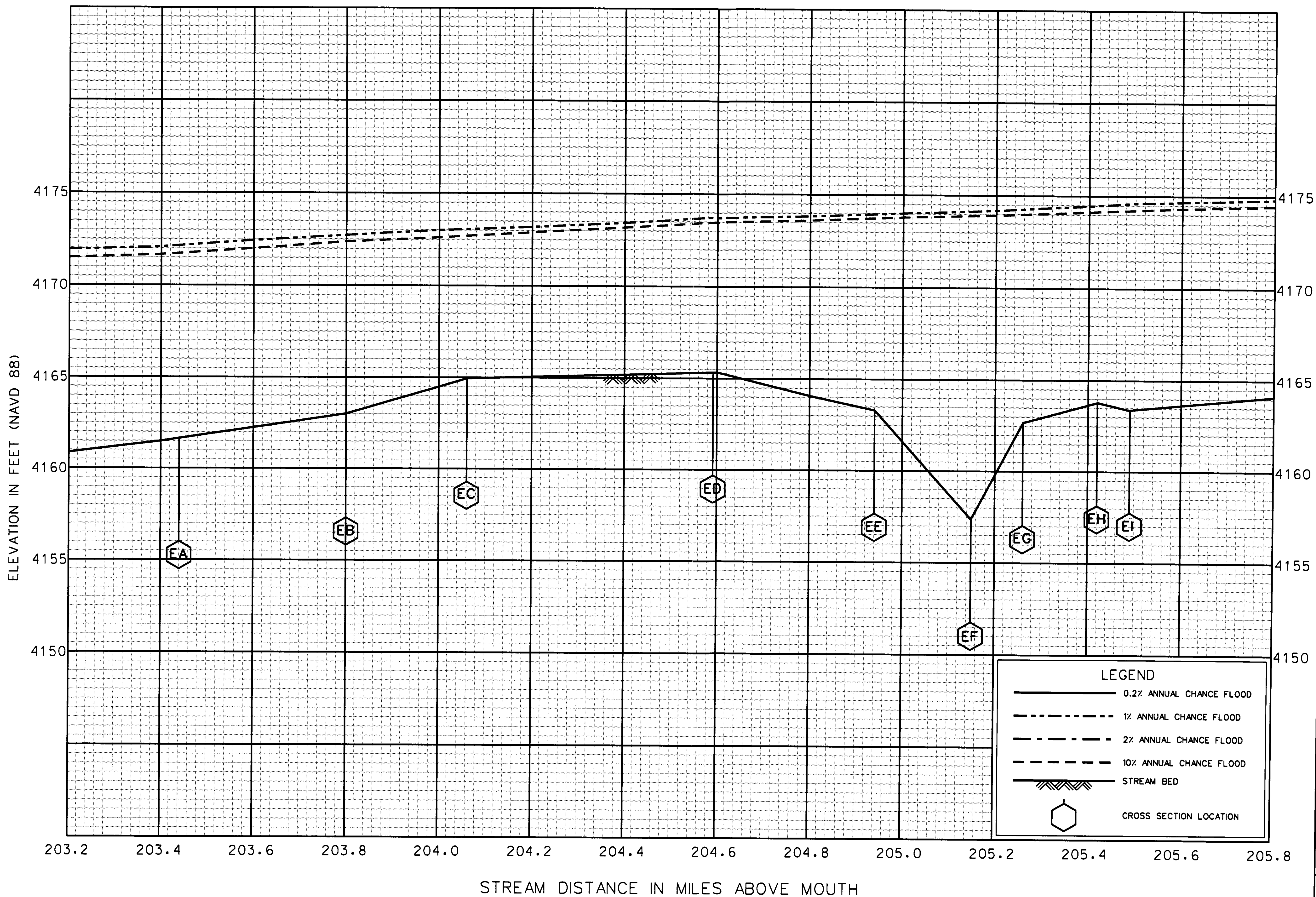


FLOOD PROFILES

DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

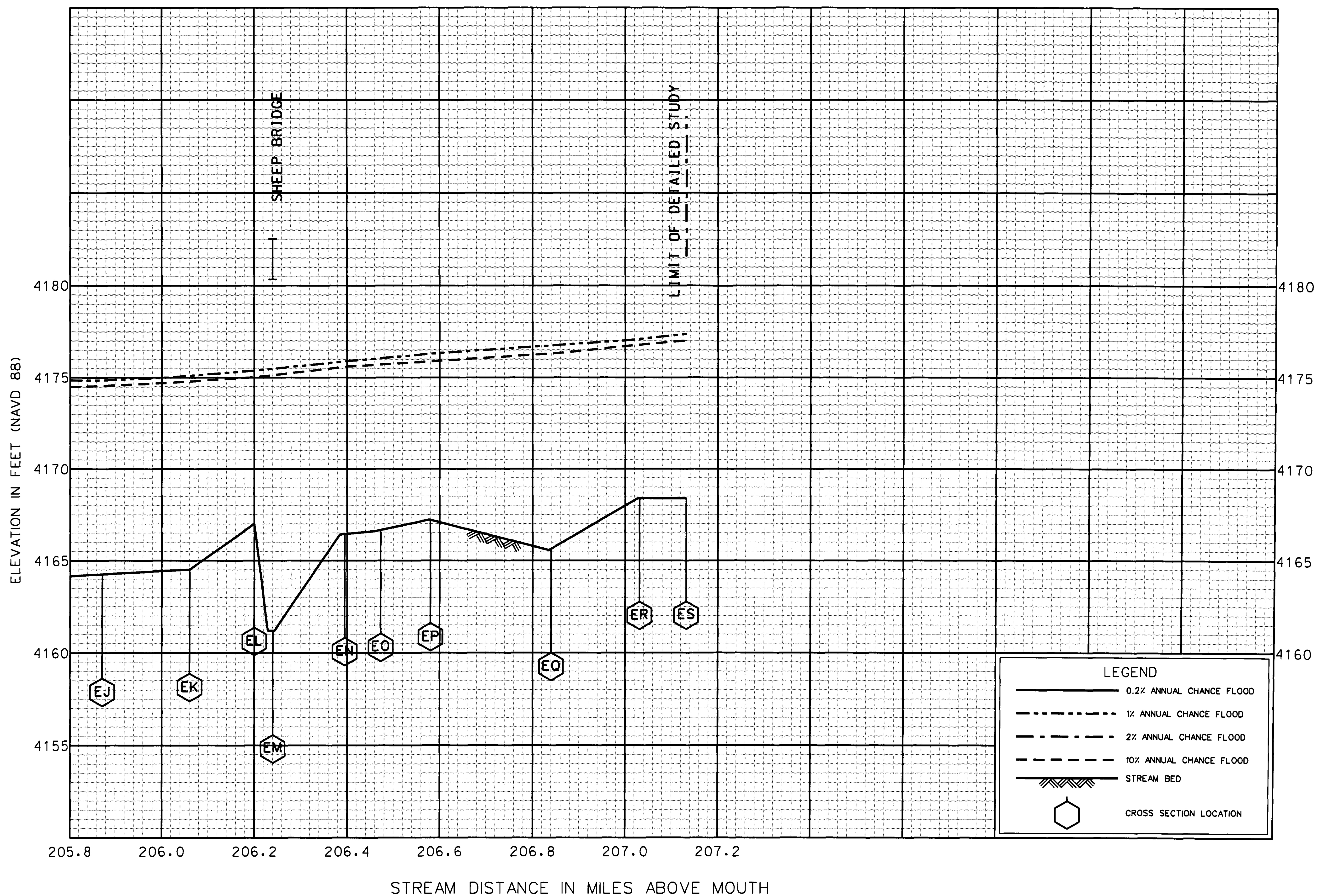


FLOOD PROFILES

DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

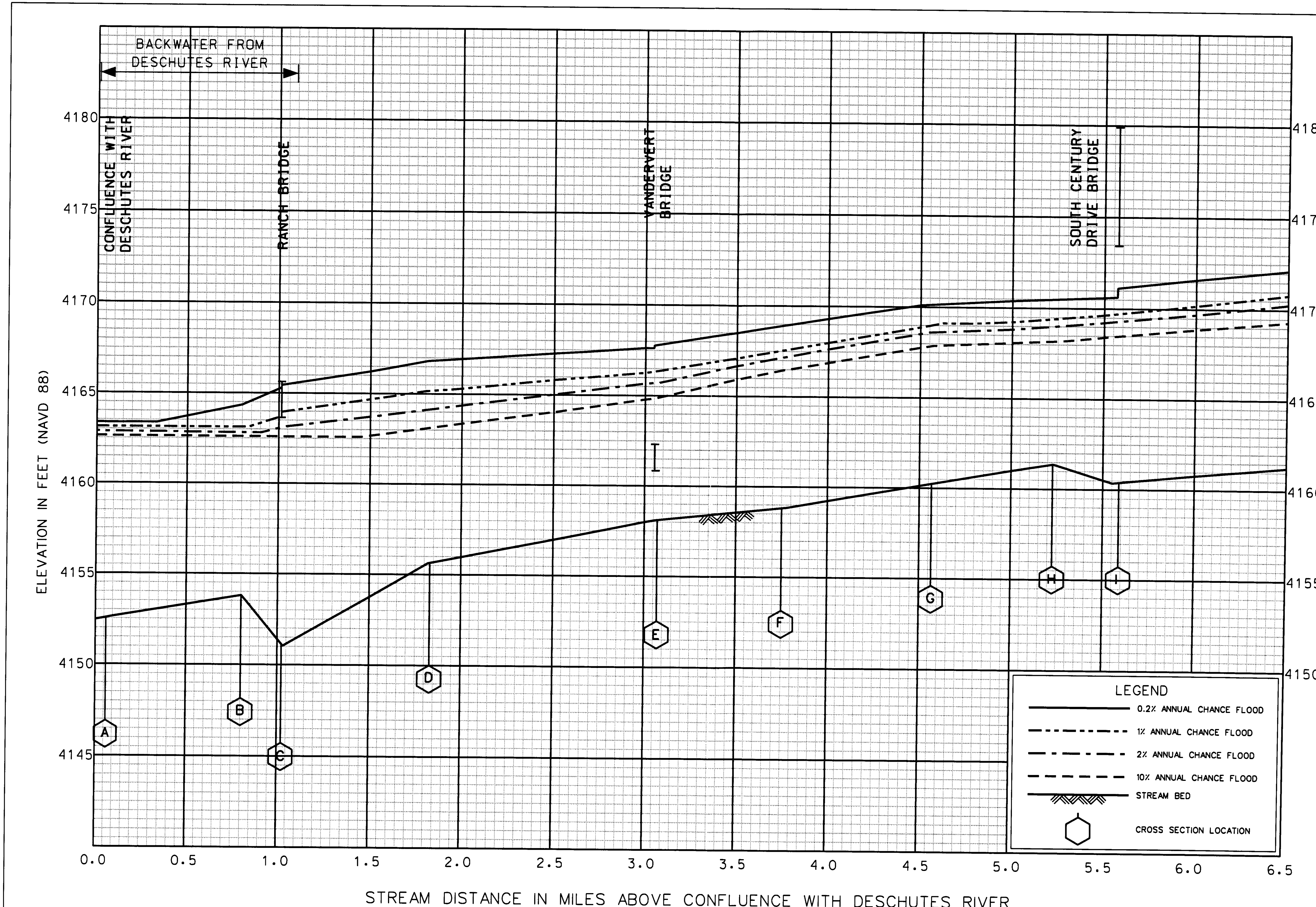


FLOOD PROFILES

DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS



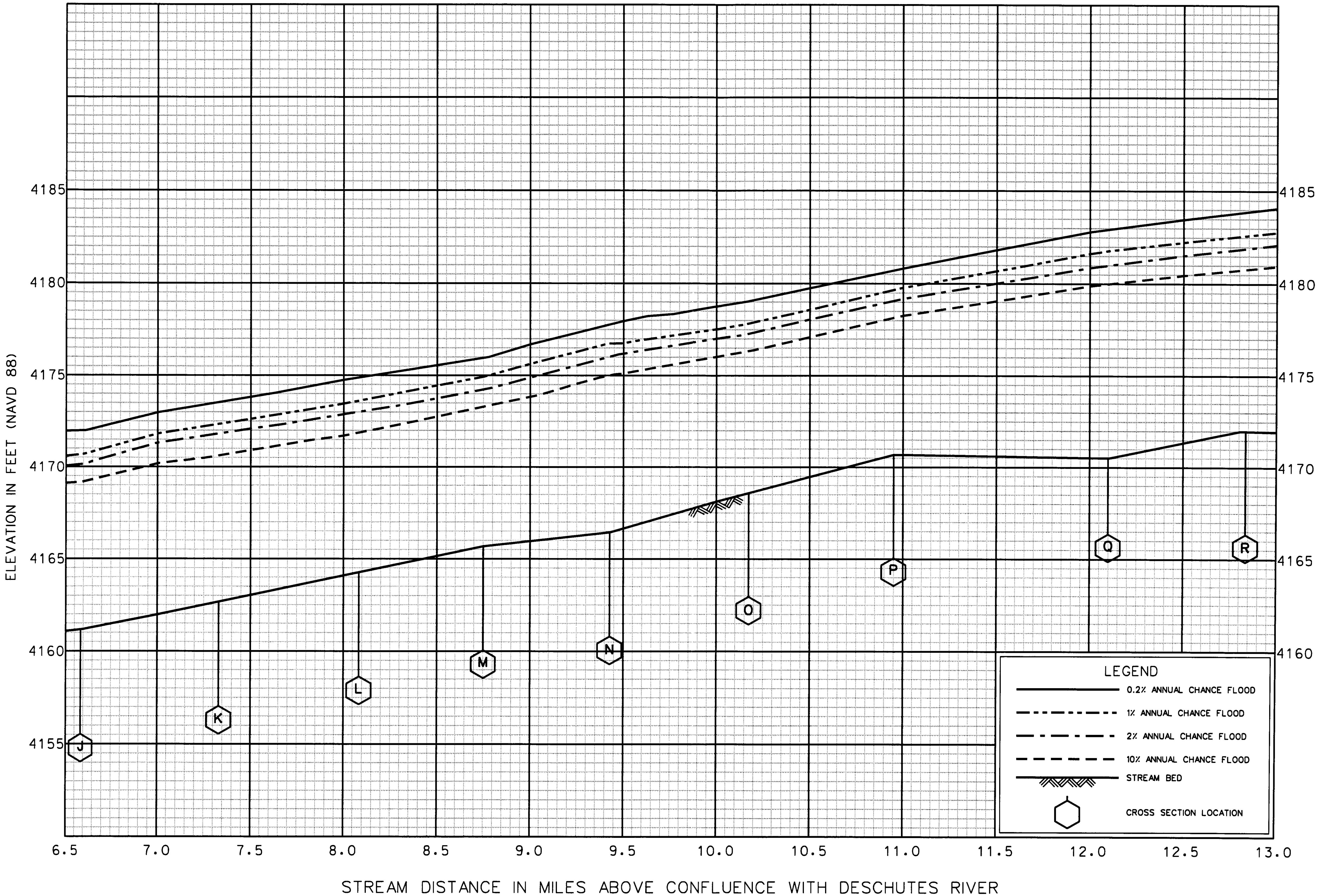
FLOOD PROFILES

LITTLE DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

17P

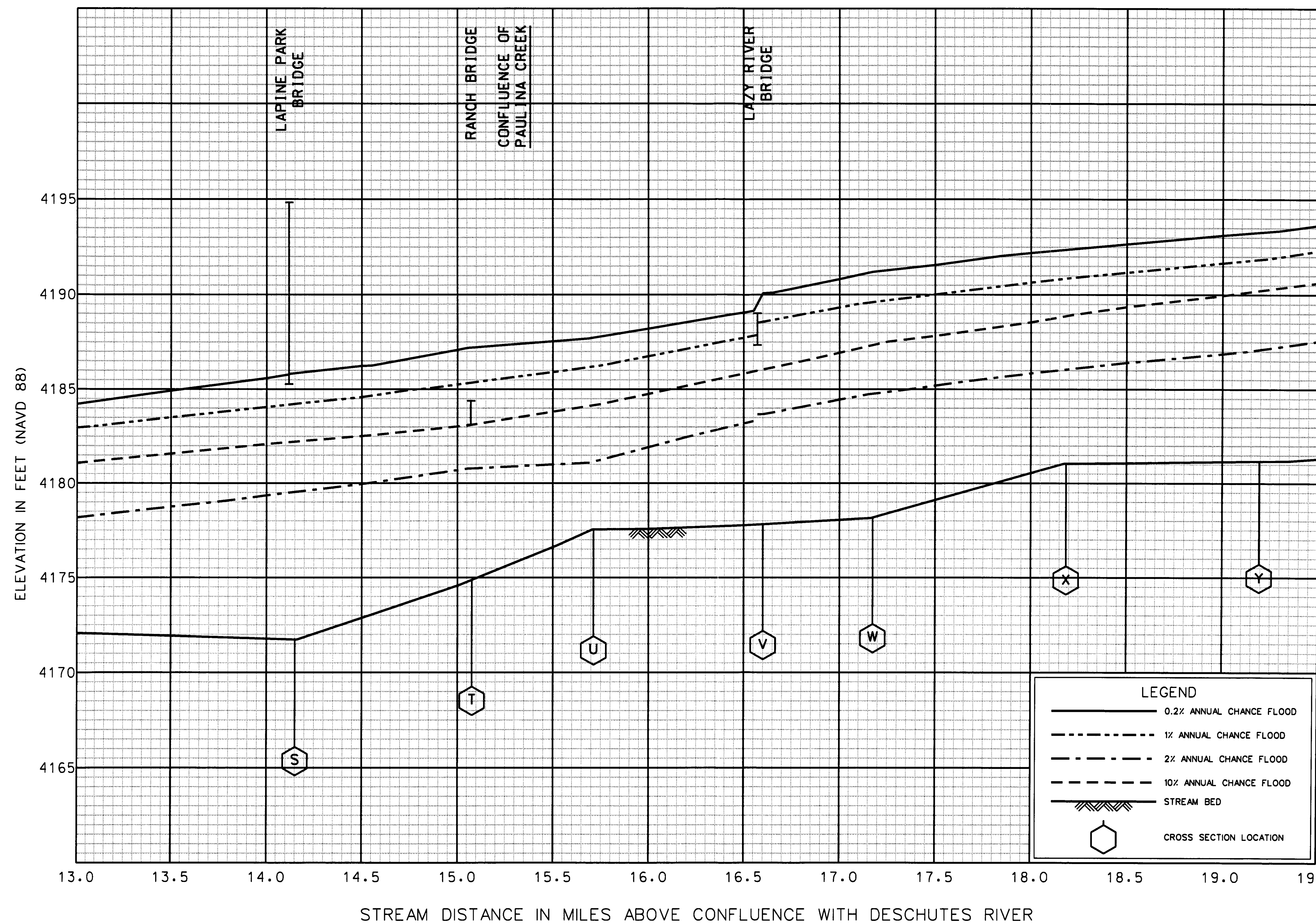


FLOOD PROFILES

LITTLE DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

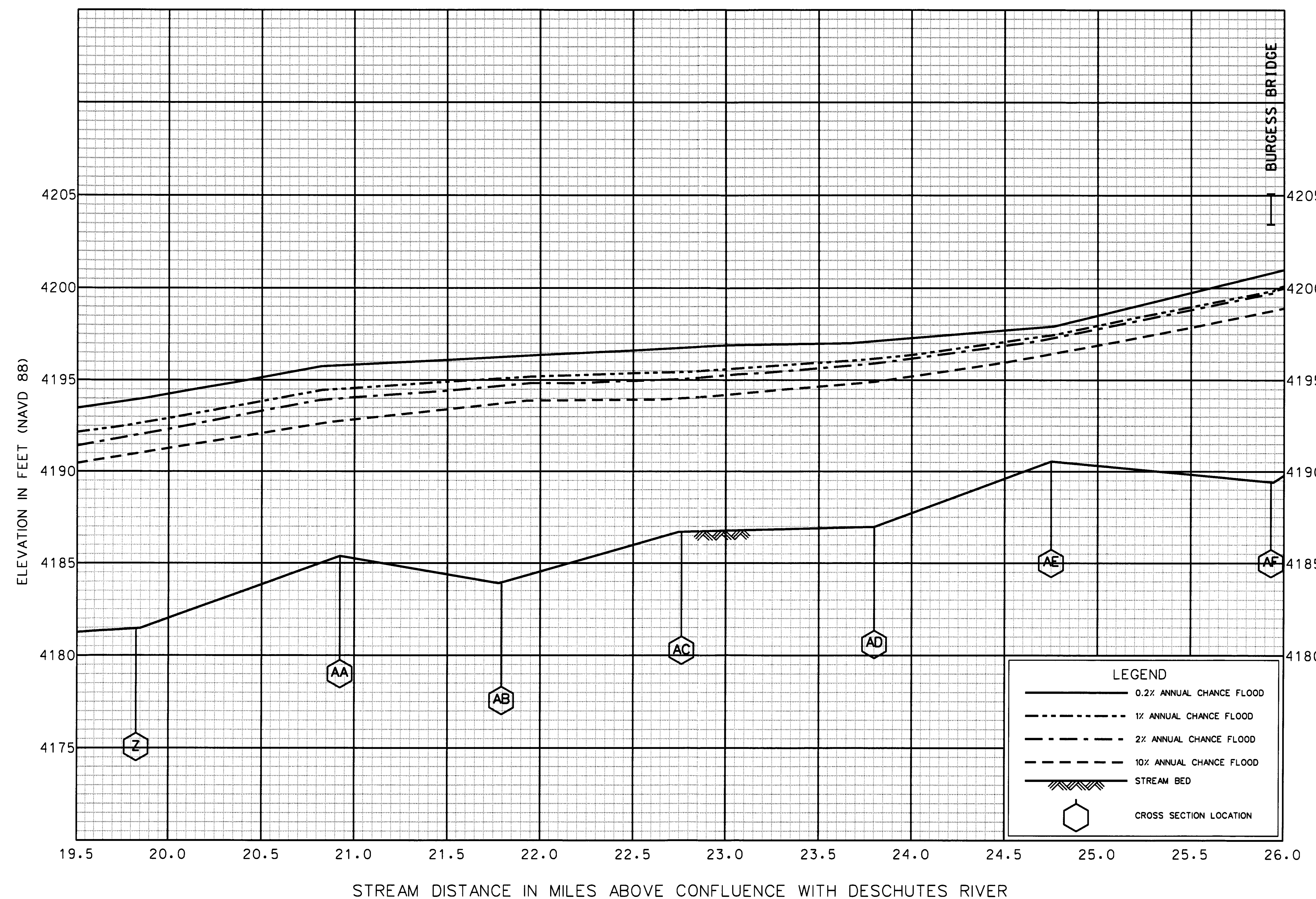


FLOOD PROFILES

LITTLE DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS



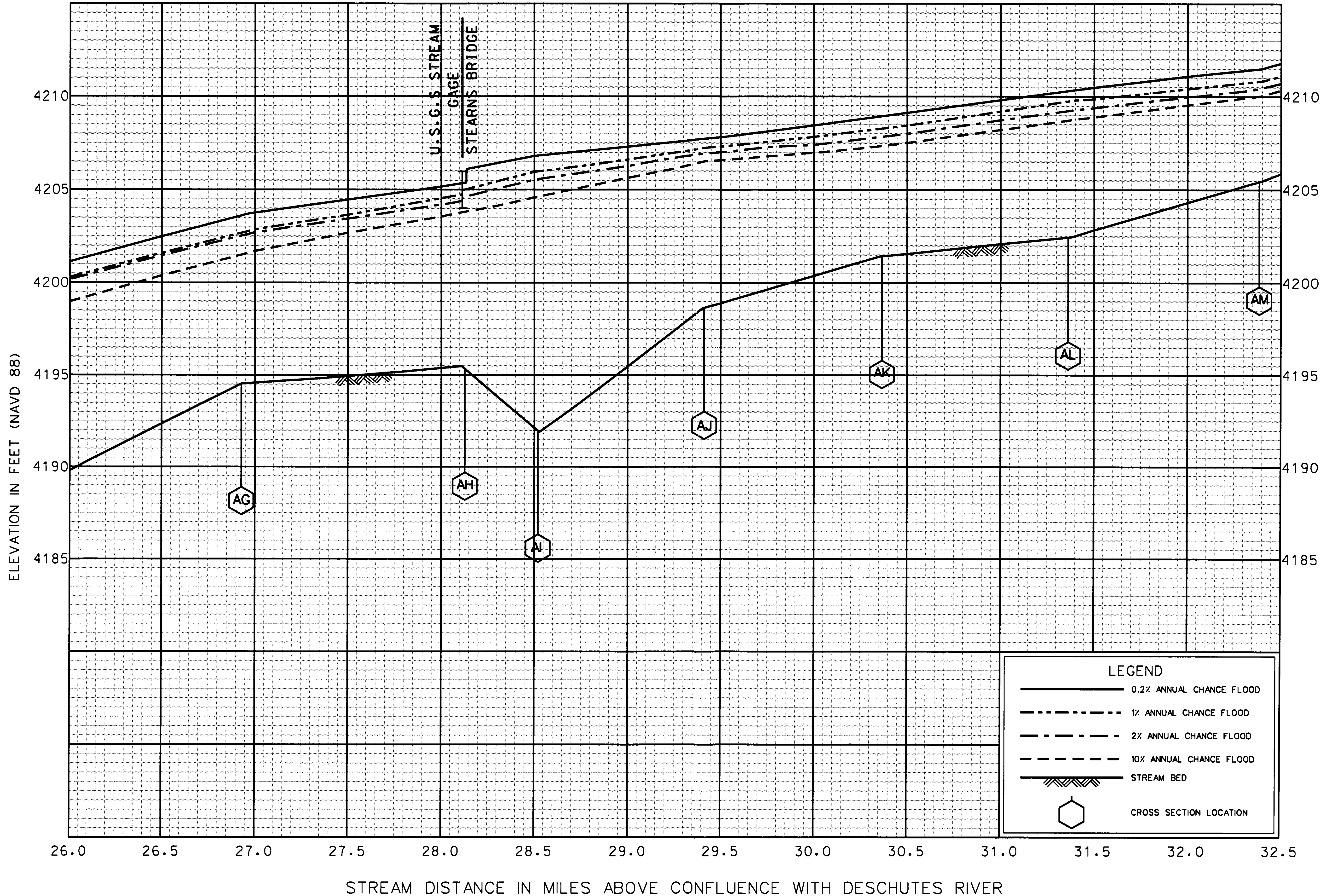
FLOOD PROFILES

LITTLE DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

20P



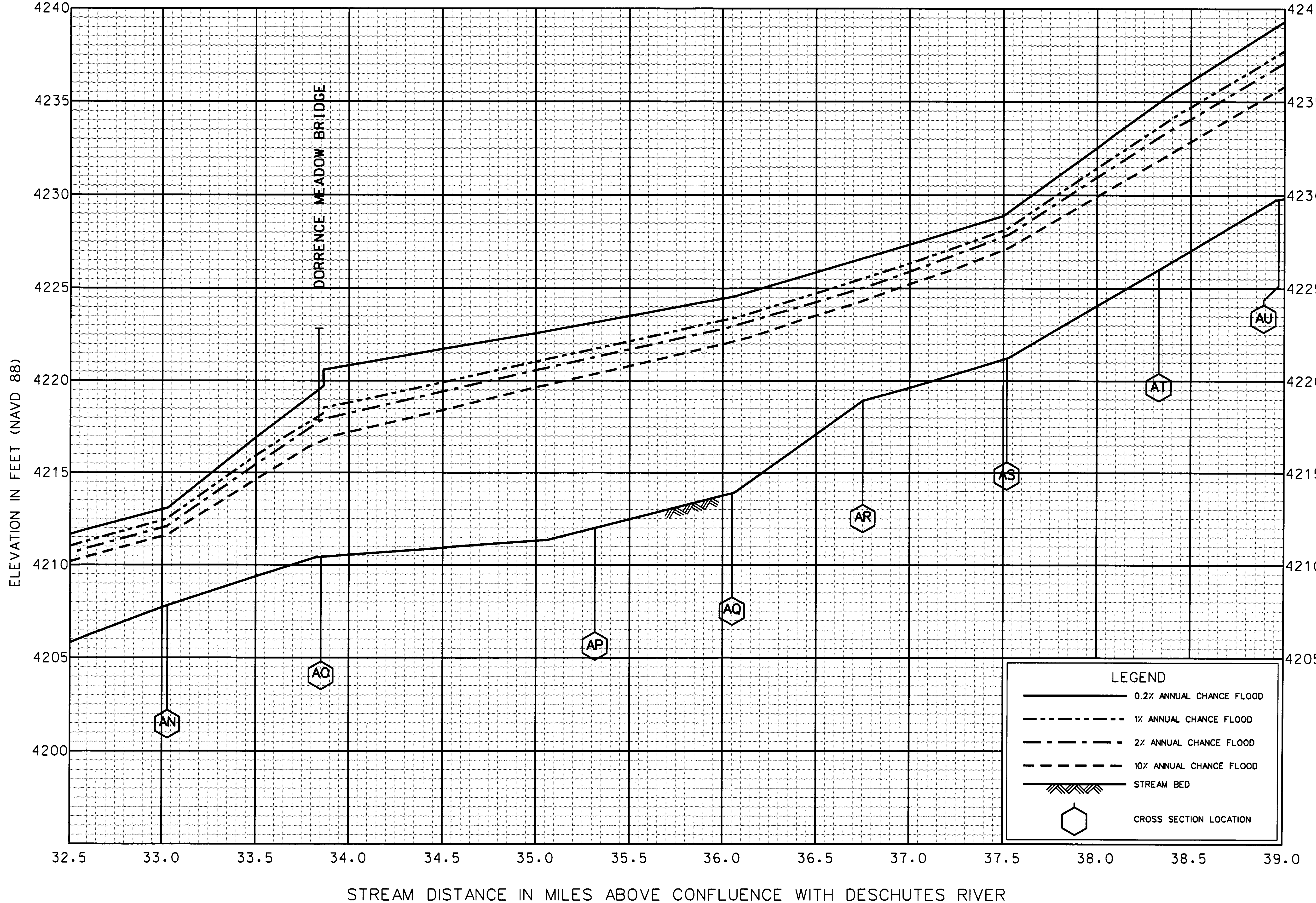
FLOOD PROFILES

LITTLE DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

21P



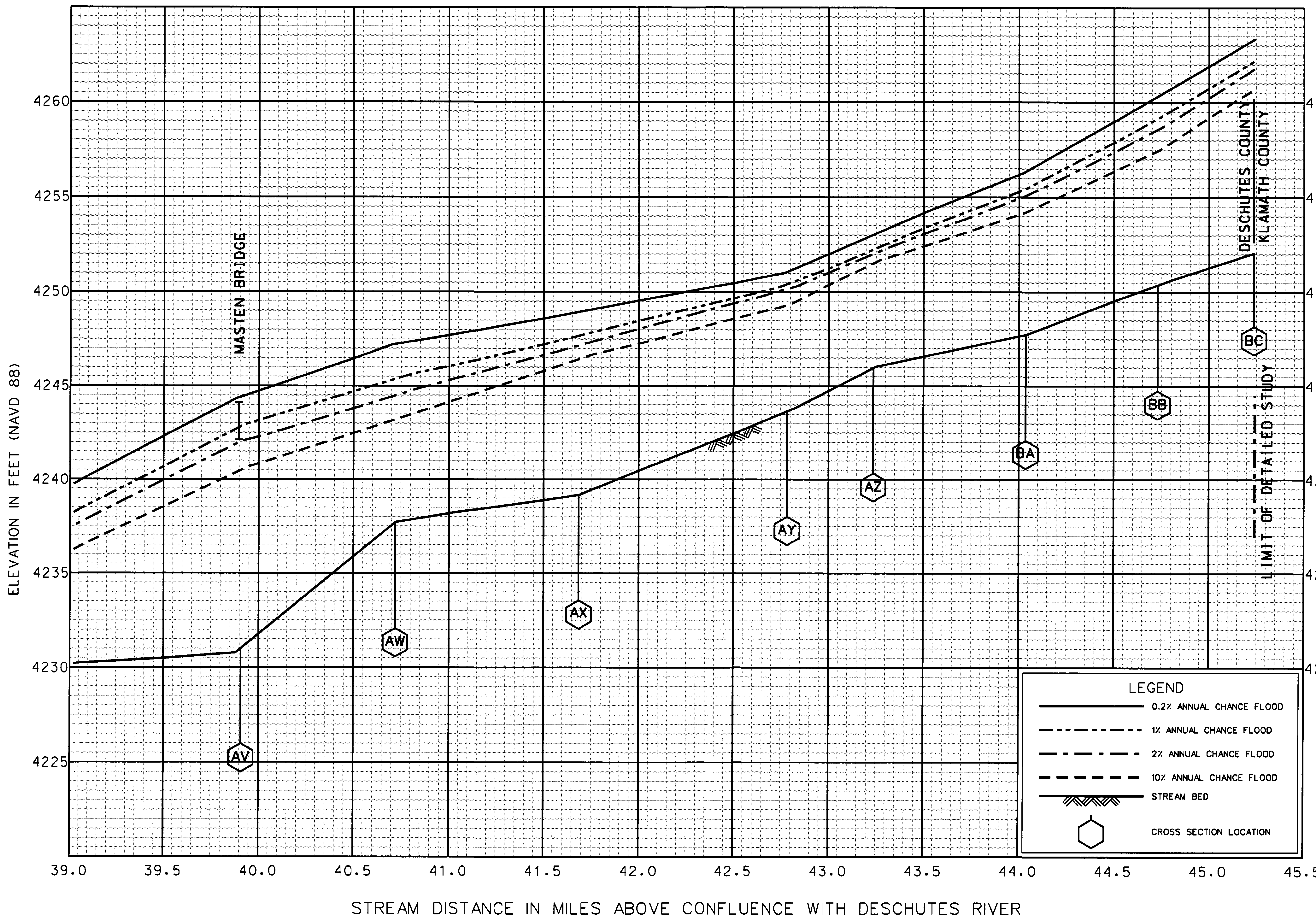
FLOOD PROFILES

LITTLE DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

22P



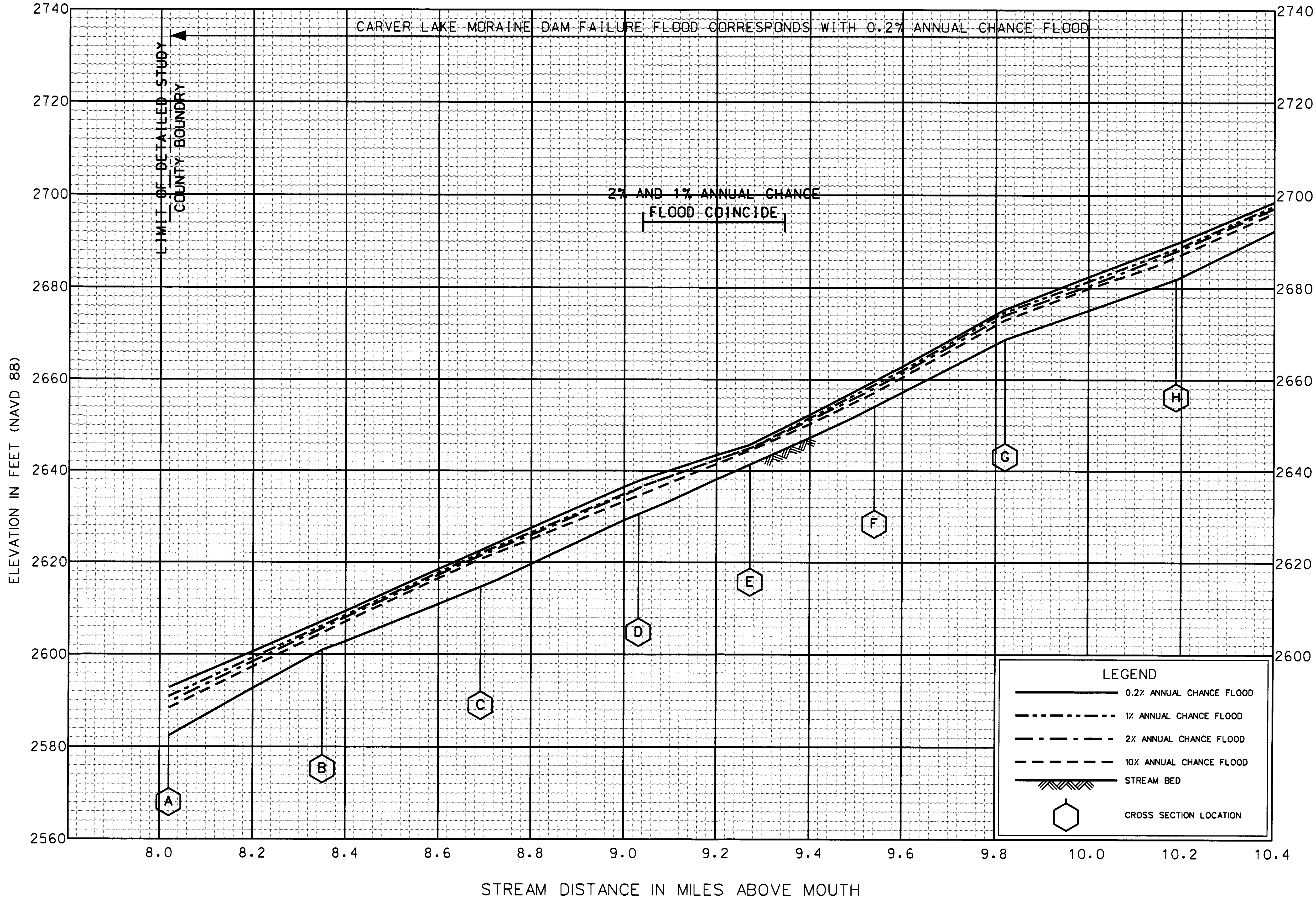
FLOOD PROFILES

LITTLE DESCHUTES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

23P

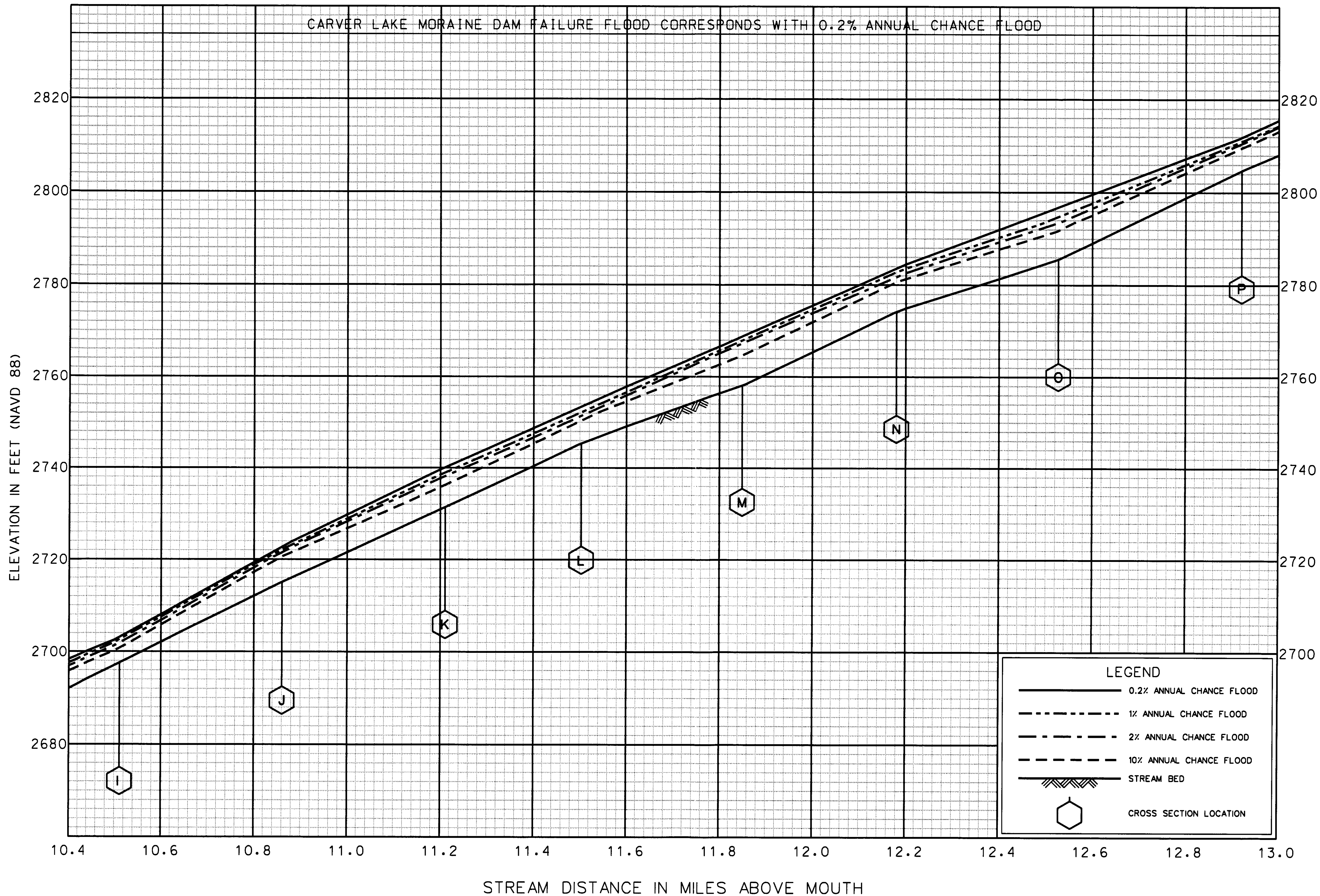


FLOOD PROFILES

WHYCHUS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS



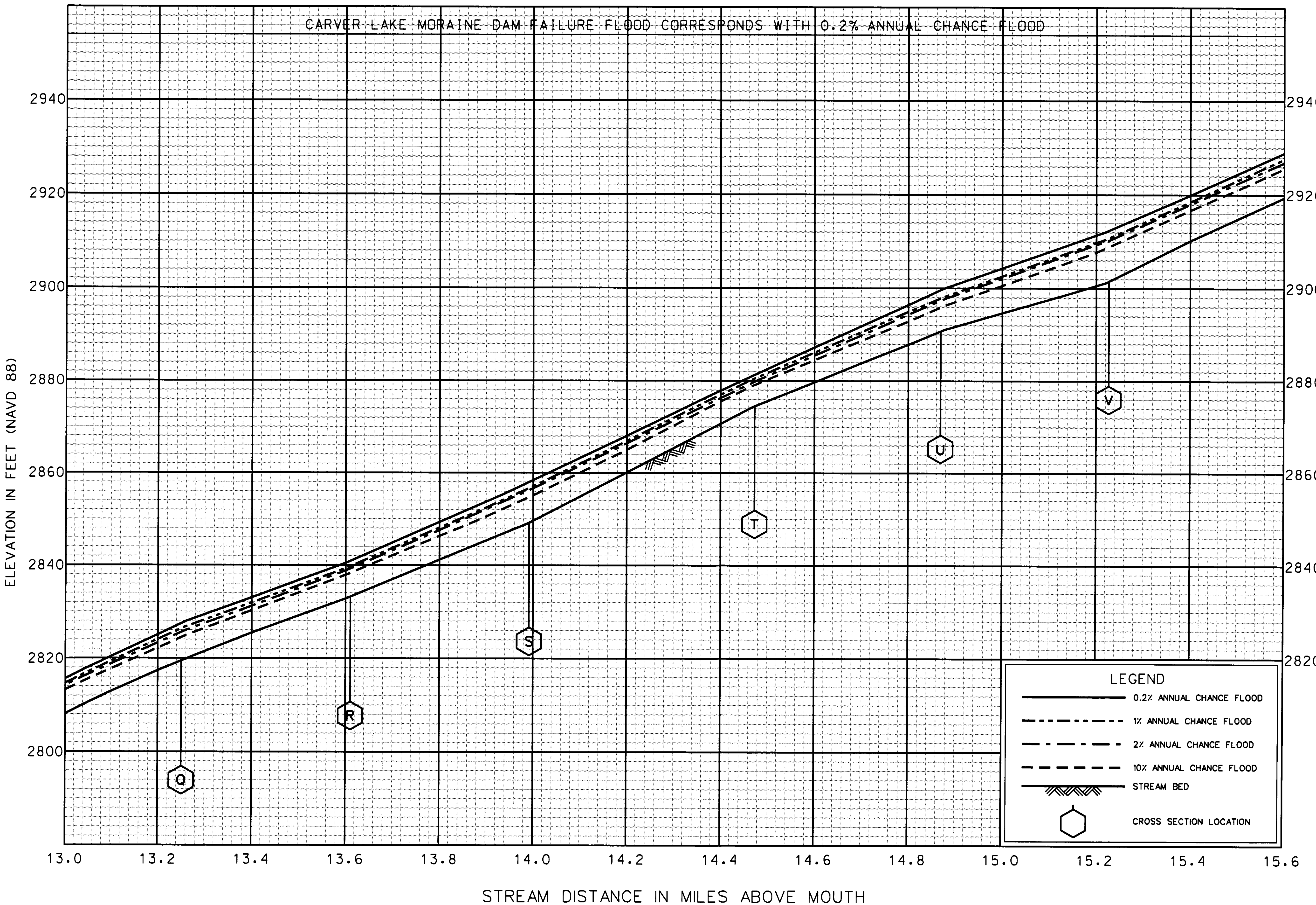
FLOOD PROFILES

WHYCHUS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

25P

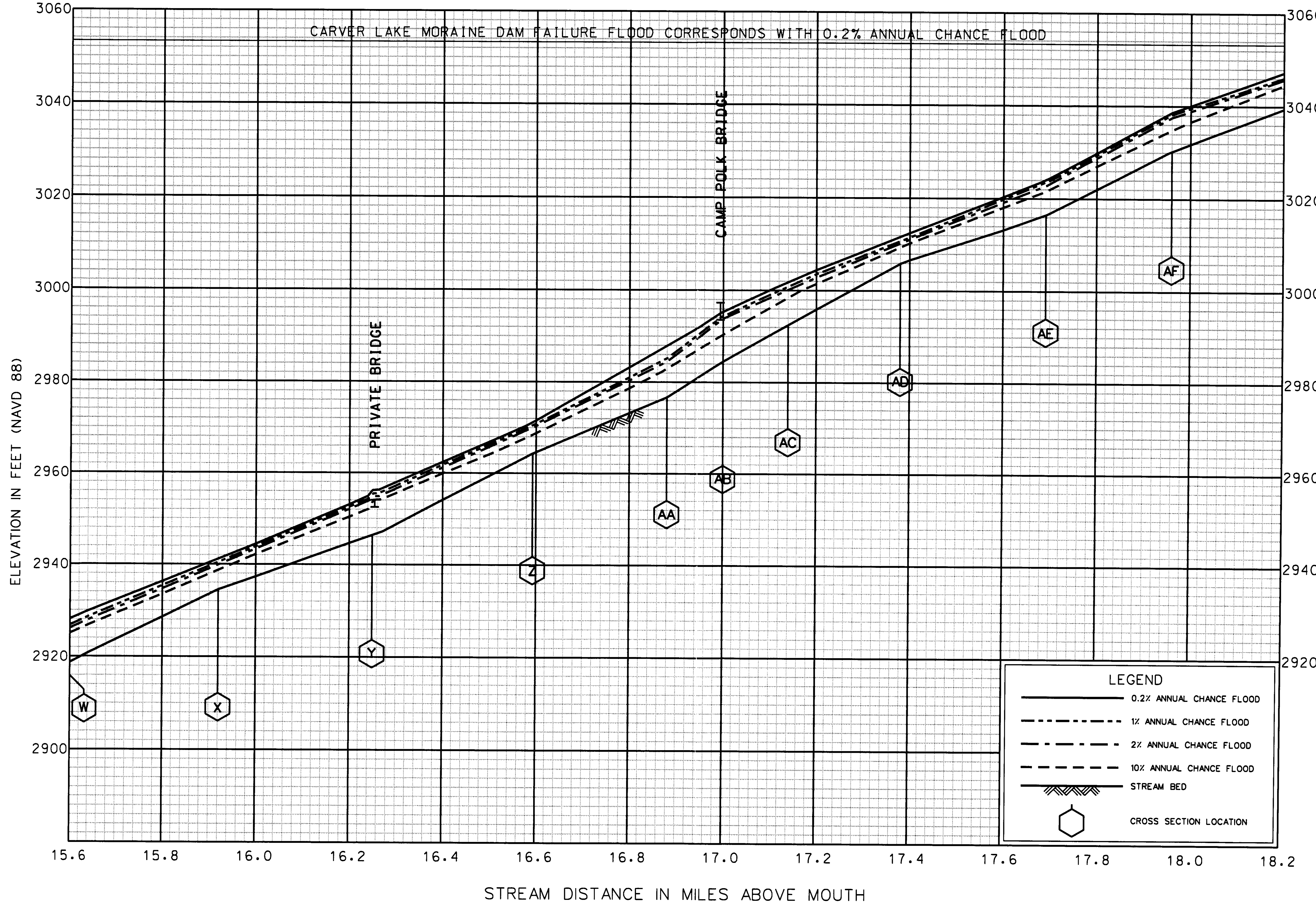


FLOOD PROFILES

WHYCHUS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

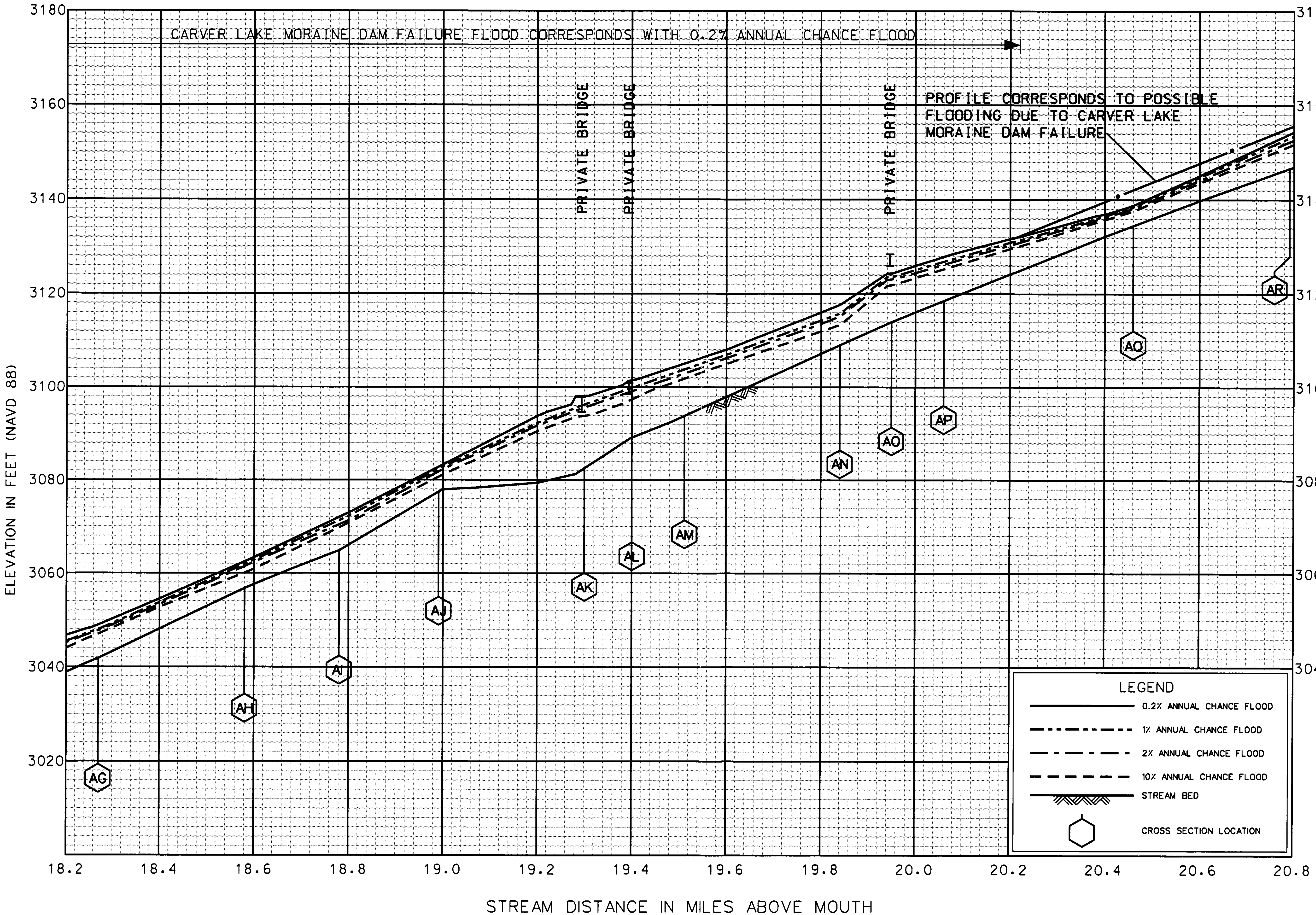


FLOOD PROFILES

WHYCHUS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS

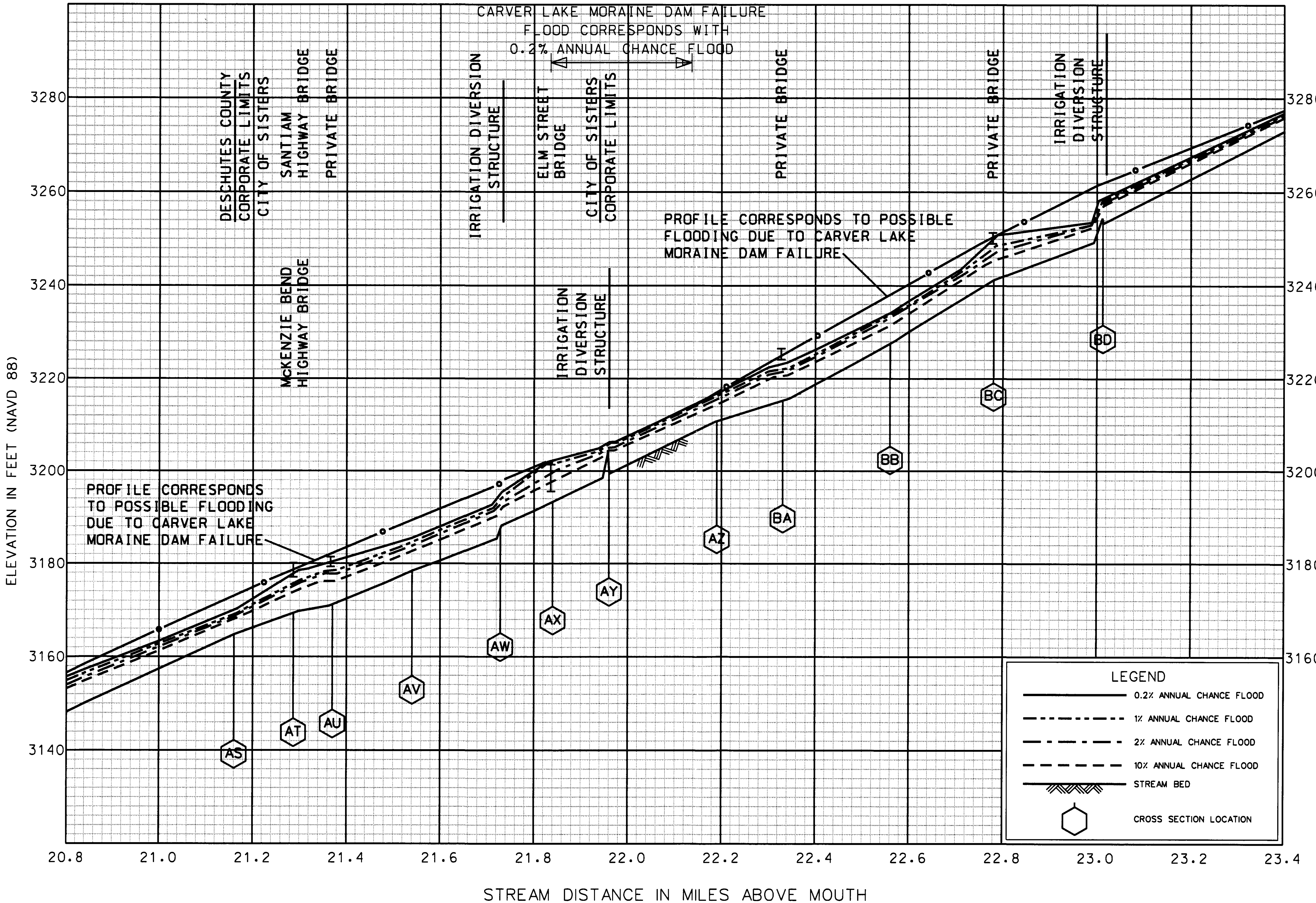


FLOOD PROFILES

WHYCHUS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS



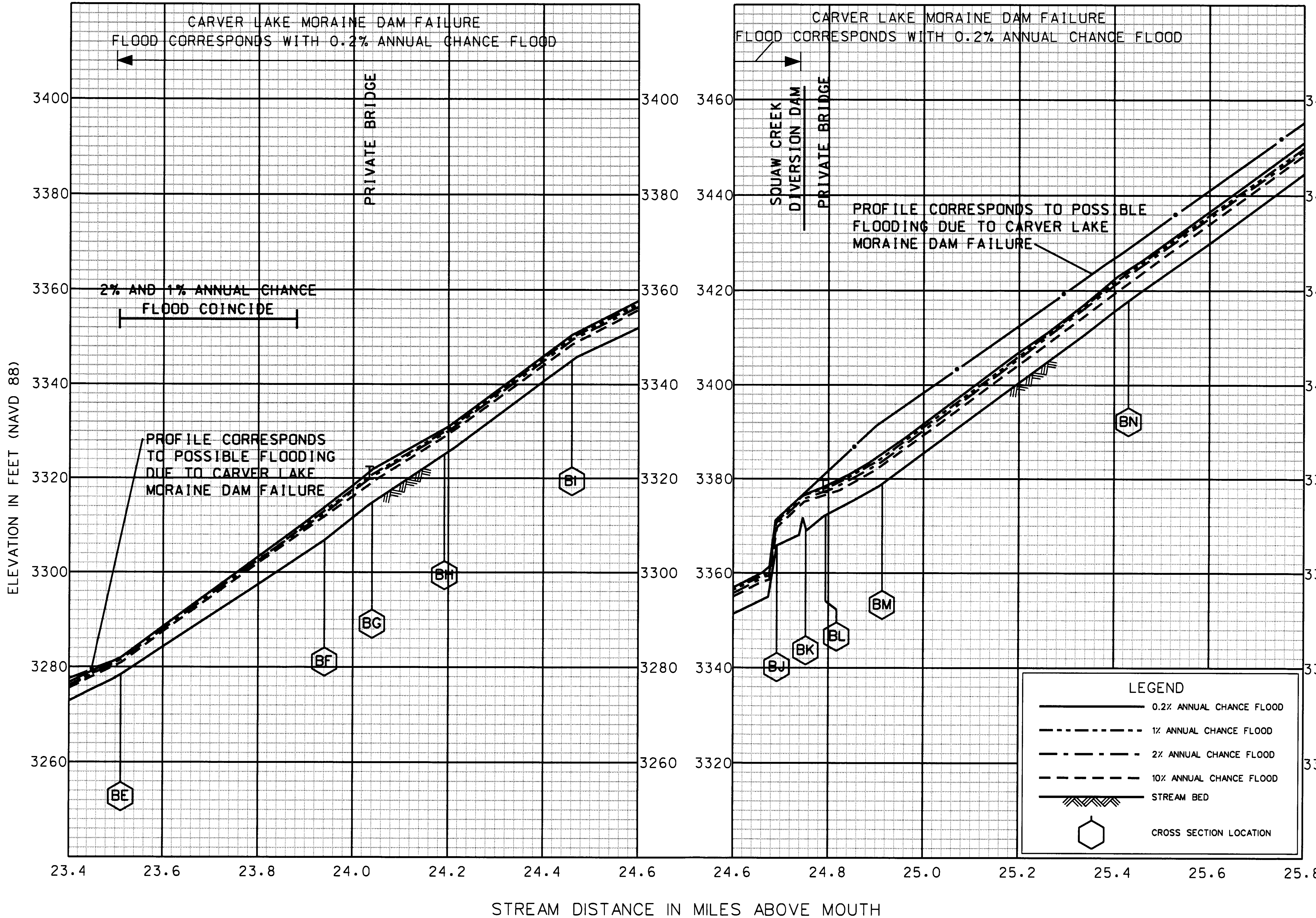
FLOOD PROFILES

WHYCHUS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR
AND INCORPORATED AREAS

29P

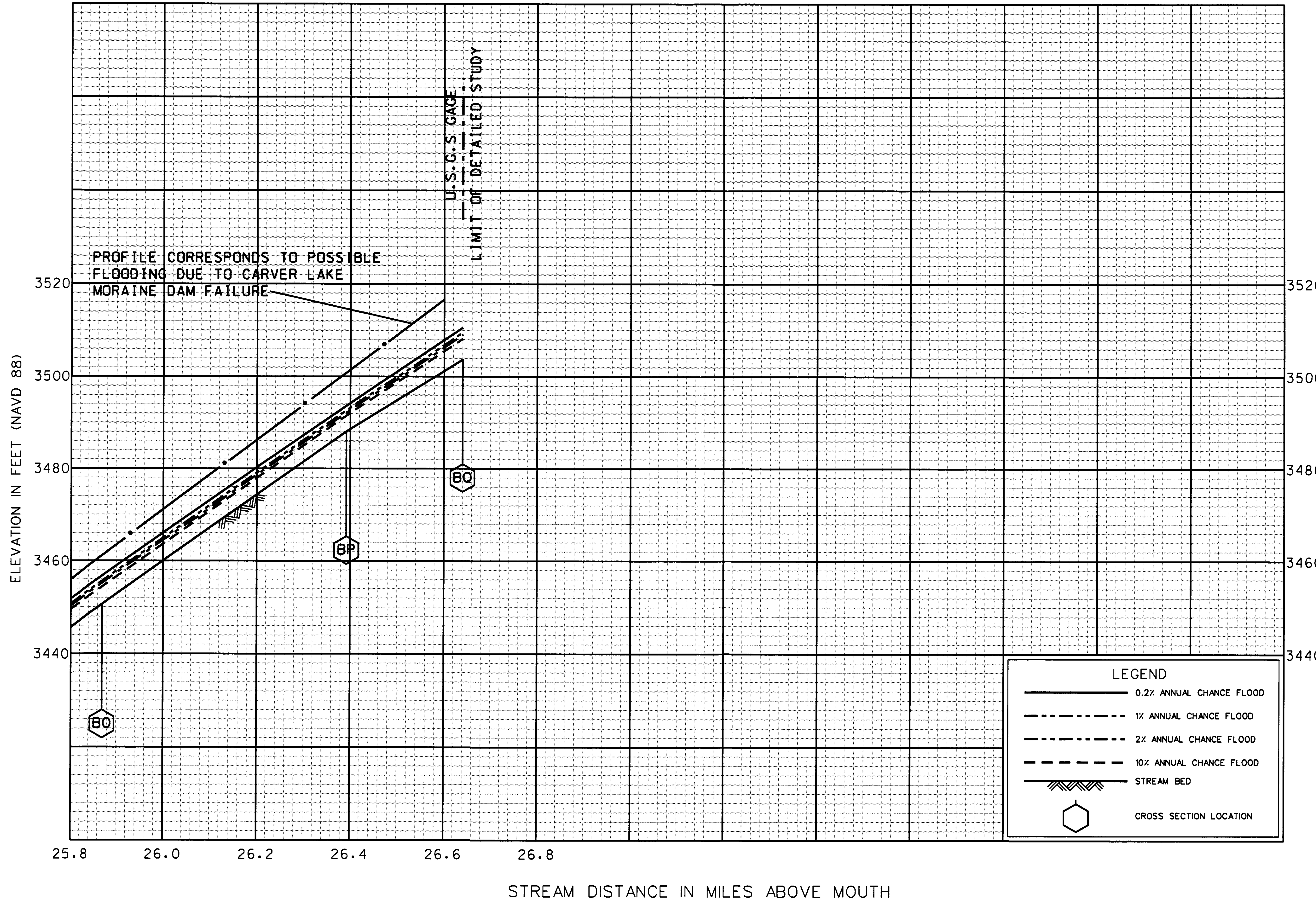


FLOOD PROFILES

WHYCHUS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR AND INCORPORATED AREAS



FLOOD PROFILES

WHYCHUS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DESCHUTES COUNTY, OR

AND INCORPORATED AREAS

31P