FLOOD INSURANCE STUDY

KENAI PENINSULA BOROUGH, ALASKA

AND INCORPORATED AREAS

Volume 1 of 2

COMMUNITY NAME	COMMUNITY NUMBER
HOMER, CITY OF	020107
*KACHEMAK, CITY OF	020109
**KENAI, CITY OF	020114
KENAI PENINSULA, BOROUGH OF	020012
SELDOVIA, CITY OF	020120
SEWARD, CITY OF	020113
**SOLDOTNA, CITY OF	020014

*No Special Flood Hazard Areas Identified
**Not a NFIP Community

PRELIMINARY:
JUNE 13, 2014

Federal Emergency Management Agency
FLOOD INSURANCE STUDY NUMBER
02122CV001B

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) report may not contain all data available within the Community Map Repository. Please contact the Community Map Repository for any additional data.

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

This FIS report was revised on TBD. Users should refer to Section 10.0, Revisions Description, for further information. Section 10.0 is intended to present the most up-to-date information for specific portions of this FIS report. Therefore, users of this report should be aware that the information presented in Section 10.0 supersedes information in Sections 1.0 through 9.0 of this FIS report.

Selected Flood Insurance Rate Map panels for this community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways, cross sections). In addition, former flood hazard zone designations have been changed for the area in and bordering the city of Seward (Section 10.2) as follows:

Old Zones	New Zones
Al through A30	AE
V1 through V30	VE
B	X
C	X

Revised Date:

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FLOOD INSURANCE STUDY
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AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Kenai Peninsula Borough, including the Cities of Kenai, Homer, Seward, Soldotna, and Seldovia; and the unincorporated areas of Anchor Point, Cooper Landing, English Bay, Hope, Moose Pass, Nikishka, Ninilchik, and Port Graham (referred to collectively herein as Kenai Peninsula Borough), 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 on the effective date of this study, the City of Kachemak has no Special Flood Hazard Areas (SFHA). This does not preclude future determinations of SFHAs that could be necessitated by changed conditions affecting the community (i.e. annexation of new lands) of the availability of new scientific or technical data about flood hazards.

The Digital Flood Insurance Rate Map (DFIRM) and FIS report for portions of this countywide study have been produced in digital format. Flood hazard information was converted to meet the Federal Emergency Management Agency (FEMA) DFIRM database specifications and Geographic Information System (GIS) format requirements. The flood hazard information was created and is provided in a digital format so that it can be incorporated into a local GIS and be accessed more easily by the community.

1.2 Authority and Acknowledgments

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

Information on the authority and acknowledgements for each jurisdiction included in this borough-wide FIS, as compiled from their previously printed FIS reports, is shown below:

Kenai Peninsula Borough (Incorporated and Unincorporated Areas)	The hydrologic and hydraulic analyses for the 1981 FIS report were performed by the U.S. Army Corps of Engineers (USACE), for FEMA, under Interagency Agreement No. IAA-H-7-76, Project Order No. 25, and IAA-H-10-77, Project Order No. 2. This work, which was completed in January 1978, covered all significant flooding sources affecting the Kenai Peninsula Borough. The hydrologic and hydraulic analyses for the Kenai River were updated for the 1999 FIS report. The restudy was performed by the USACE, Alaska District, for FEMA under Interagency Agreement No. EMW-96-IA-0195, Project Order No. 9. This work was completed in December 1997 (Reference 1).
Homer, City of	The hydrologic and hydraulic analysis for original June 16, 1999 study were performed by the USACE Anchorage District, for FEMA, under Interagency Agreement No. EMW-95-4759, Project Order No. 7. This study was completed in October 1996 (Reference 2). The redelineation for the September 25, 2009 revision was performed by Northwest Hydraulic Consultants (NHC) for FEMA, under IDIQ Contract EMS-2001-CO-0067 Task No. 21. This work was completed by NHC in August 2008. (Reference 2). For the 2013 revision, coastal hazard analysis was performed by the Strategic Alliance for Risk Reduction (STARR) (a joint venture between CDM, Stantec and Atkins) for the FEMA Region X, under Contract No. HSFEHQ-09-D-0370, Task Order HSFE10-10-J-0106. Work on this revision was completed by STARR in June 2011. (Reference 2).

The hydrologic and hydraulic analyses for the September 27, 2013 borough-wide FIS was performed by Northwest Hydraulic Consultants, Inc., for FEMA, under Contract No. EMS-2001-CO-0067, Project Order No. 28. The update included detailed studies of Bear Creek, Grouse Creek, Kwechak River, Resurrection River, Salmon Creek, Salmon Creek/Resurrection River Split, Salmon Creek Overflow and Salmon Creek Split within the City of Seward and surrounding Unincorporated Areas. The work was completed in December 2009 (Reference 1).

Base map information shown on the DFIRM was derived from the U.S. Geological Survey (USGS), the Kenai Peninsula Borough, and the Alaska Department of Natural Resources produced at a scale of between 1:2,400 to 1:63,360 depending on the data source, data dated 1989 or later. The projection used in the preparation of this map is Transverse Mercator, and the horizontal datum used is North American Datum of 1983.

The digital base map information for the City of Homer was provided by the City of Homer and developed by the U.S. Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS), National Geodetic Survey (NGS), Remote Sensing Division. This information was compiled at a scale of 1:6,000 in 2008. The coordinate system used for the production of the FIRM is Universal Transverse Mercator Zone 5, North American Datum of 1983 (NAD83), CLARKE1866. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the community boundaries. These differences do not affect the accuracy of information shown on this FIRM.

For this revised FIS, new hydrologic and hydraulic analyses were performed for Anchor River and Kenai River; as well as the hydrologic analyses for the Ninilchik River by STARR for FEMA Region X, under Contract No. HSFEHQ-09-D-0370, Task Order HSFE10-11-J-0001. Work on this revision was completed on March 27, 2014. The hydraulic analysis for the Ninilchik River and North Fork Chakok River were performed by the USACE and completed in January 2014. A new coastal engineering analysis was performed for selected areas in Cook Inlet and Resurrection Bay by STARR and was completed in March 2014.

STARR completed the base mapping activities for Kenai Peninsula Borough, AK. The base map data consists of spatial coverages collected from Kenai Peninsula Borough. Vector data is referenced to the following Geographic Coordinate System; NAD83, State Plane Alaska Zone 4, FIPS 5004 feet. Spatial data processing was performed using ESRI's ArcGIS 10.0 suite of GIS software. Light Detection and Ranging (LiDAR) data was acquired from the Kenai Peninsula Borough GIS Division. The native projection of the data is NAD83Alaska State Plane Zone 4, with horizontal and vertical datums: NAD83 and North American Vertical Datum of 1988 (NAVD88), respectively. Vertical and Horizontal units are in feet. The total flown area covers Nikiski, Kenai, Ninilchik, Happy Valley, Homer, and immediate surrounding areas. Data was acquired on May 26, 2009.

1.3 Coordination

An initial meeting is held with representatives from FEMA, the community, and the study contractor to explain the nature and purpose of a FIS, and to identify the streams to be studied or restudied. A final meeting is held with representatives from FEMA, the community, and the study contractor to review the results of the study.

The initial and final meeting dates for previous FIS reports for Kenai Peninsula Borough and its communities are listed in the following table:

Community	FIS Date	Initial Meeting	Final Meeting
Kenai Peninsula Borough	May 19, 1981	January 28 - 30, 1976	March 3 - 4, 1980
	December 6, 1999	N/A	December 2, 1998

The results of the September 25, 2009 revision for the City of Homer were reviewed at the final CCO meeting held on December 11, 2008, and attended by representatives of FEMA and the City of Homer. All problems raised at that meeting have been addressed.

The initial meeting for the 2010 FIS update was held on May 2, 2007, and attended by representatives of FEMA, City of Seward, Kenai Peninsula Borough, Seward/Bear Creek Flood Service Area, Alaska Department of Commerce, and Northwest Hydraulic Consultants, Inc.

The results of the study were reviewed at the final meeting held on June 16, 2010, and attended by representatives of FEMA, State of Alaska, and Kenai Peninsula Borough. All problems raised at that meeting have been addressed.

For the 2013 revision for the City of Homer FIS, the final CCO meeting was held on July, 26, 2012, and attended by representatives of the City of Homer, STARR, and FEMA. All problems raised at that meeting have been addressed.

The initial meeting for this revised 2014 borough-wide study was held on October 18, 2011 and attended by representatives of USACE, FEMA, officials of Kenai Peninsula Borough and of the community of Anchor Point, STARR, and the general public. The final CCO meeting was held on mm/dd/yy.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of the Kenai Peninsula Borough, Alaska, including the incorporated communities listed in Section 1.1. The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction through 1983.

2009 City of Homer FIS:

For the September 25, 2009 revised FIS, previously issued Letters of Map Revision (LOMRs) were incorporated, SFHAs were changed, corporate limits were updated, map format was updated, roads and road names were updated, and elevations were converted to the NAVD88. The method of conversion was digital capture of effective flooding and redelineation utilizing new topography data. NHC used five foot contour topography developed by the City of Homer to redelineate coastal flooding extents within the City and to add Beluga Lake to the SFHA.

2013 Borough-wide FIS:

The areas studied consisted of Kenai River Valley; Kasil of River Valley; Resurrection River Valley; North Kenai lakes area; the areas encompassing the cities of Kenai, Homer, Seward, Soldotna, and Seldovia; and the unincorporated areas of Port Graham, English Bay, Nikishka, Ninilchik, Anchor Point, Moose Pass, Cooper Landing, and Hope. Wind-driven-wave patterns in coastal areas adjacent to these areas were studied in order to delineate coastal flooding. Areas not studied consist of the Chugach National Forest, the Kenai National Moose Range, and areas with little or no development potential.

The following streams are studied by detailed methods in the 2013 FIS report:

Bear Creek	Kwechak River	Salmon Creek Overflow
Grouse Creek	Resurrection River	Salmon Creek Split
Kenai River	Salmon Creek	Sawmill Creek
Kasilof River	Salmon Creek/Resurrection River Split	

Cook Inlet, Katchemak Bay, and Resurrection Bay were also studied in detail. The watercourses and water bodies studied were chosen after giving consideration to existing and potential development along each of the streams and to the predicted flood flows and flood widths of each. These streams constitute the principal drainages, which have potential for flood damage, within the study area.

The limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2). Bear Creek, Grouse Creek, Resurrection River, Salmon Creek, Salmon Creek/Resurrection River Split, Salmon Creek Overflow, Salmon Creek Split, and Sawmill Creek are new or updated reaches for 2010 FIS revision.

Portions of Kenai River and Cook Inlet were studied by approximate methods. In addition, numerous streams and lakes were studied by approximate methods. Approximate analyses were used to study those areas having low development potential or minimal flood hazards. The effective approximate area boundaries for Clear Creek, Japp Creek, Lowell Creek, and Marathon Creek were adjusted for the 2010 FIS revision based on updated topographic data.

The FIS report and FIRM were converted to countywide format, and the flooding information for the entire county, including both incorporated and unincorporated areas, is shown. Also, the vertical datum was converted from the National Geodetic Vertical Datum of 1929 (NGVD29) to the NAVD88. In addition, the Transverse Mercator, State Plane coordinates, previously referenced to the North American Datum of 1927 (NAD27), are now referenced to the NAD83.

2013 Revised City of Homer FIS:

For the 2013 revision, STARR conducted 8 miles of revised Coastal Hazard Analysis that included computing wave runup. STARR utilized 25 transects in this study.

No LOMRs were recorded for this study.

For this 2014 Borough-wide Study:

The portions of the Anchor River studied were approximately 2.4 miles of the main stem from its mouth to the confluence of the north and south forks of the river, approximately 0.3 miles of the north fork extending just upstream of its crossing of the Sterling Highway, and 5.0 miles of the south fork extending just upstream of its crossing the Sterling Highway.

The portion of the Kenai River studied were approximately 4.8 miles of the Kenai River starting at the outlet of Kenai Lake, extending through the community of Cooper Landing, and terminating in the Kenai National Wildlife Refuge.

The portion of the Ninilchik River studied was approximately 1.3 miles from its mouth at Cook Inlet extending to just upstream of its crossing with the Sterling Highway.

The portion of the North Fork Chakok River studied was approximately 550 feet from it's confluence with Anchor River to Interstate A1

The coastal engineering analysis was performed for selected areas in Cook Inlet and Resurrection Bay. The detailed portions of this coastal engineering analysis were located specifically near the City of Kenai and the City of Homer.

List of shorelines and floodways studied

Community	Study Type	Length (miles)	Area
Ninilchik	Detailed coastal	2.2	Cook Inlet
Homer	Detailed coastal	8.5	Cook Inlet
Kenai/Nikiski	Detailed coastal	8.2	Cook Inlet
Kenai/Nikiski	Limited coastal	12.4	Cook Inlet
Happy Valley	Limited coastal	5.9	Cook Inlet
Homer (Beluga Lake)	Updated BFE	2.5	Cook Inlet
Seward	Detailed coastal	10.0	Resurrection Bay

No LOMRs were incorporated as part of this study.

2.2 Community Description

Anchor Point is a small fishing community and recreation area on Cook Inlet, at the mouth of Anchor River 20 miles south of Ninilchik and 15 miles northwest of Homer. It is subject to coastal and riverine flooding as is Ninilchik. Both Ninilchik and Anchor Rivers flow through narrow valleys with little or no development except at their mouths. There is little flood danger except in the developed areas.

Cooper Landing is a small community on the banks of Kenai River near the outlet of Kenai Lake 48 air miles east of Kenai. Kenai River periodically floods this area, due to both heavy runoff and Snow Lake dumping.

English Bay, a small village near the tip of Kenai Peninsula, is exposed to Cook Inlet and its storm waves. Buildings were relocated to higher ground on the steep slopes of the mountain after earlier flooding. A runway on a spit below the village could be overtopped, but no flood damage should result from storm waves. A more serious threat is the danger of tsunami, since English Bay is directly across Cook Inlet from Mt. Augustine, an active volcano on Augustine Island.

The City of Homer is located approximately 230 road miles to the south of Anchorage, at the mouth of Kachemak Bay on the east side of Cook Inlet. The City itself is on high ground above the bay, but its distinguishing feature is its spit, which extends for 4.5 miles into Kachemak Bay.

The City of Homer is primarily a fishing, fish-processing, and trade center, and enjoys a considerable seasonal tourist industry. During the summer months, the population of the City of Homer, approximately 4,000, swells with the influx of students and others seeking cannery or fishery employment. Tourism has grown considerably, with visitors coming to enjoy the scenery, hiking, or fishing. The city has also become a haven for a large number of artists as evidenced by the number of art festivals held during the summer months.

Hope is a small village on the coast of Turnagain Arm, the north coast of the Kenai Peninsula. It is approximately 20 air miles southeast of Anchorage at the mouth of Resurrection Creek. It is, therefore, subject to coastal as well as riverine flooding.

Kenai Peninsula Borough, in the third Judicial District in south-central Alaska, governs an area of more than 25,600 square miles. Kenai Peninsula is surrounded by the Greater Anchorage Area Borough to the north, Cook Inlet to the west, and the Gulf of Alaska to the south and east. The 2010 population of the Kenai Peninsula Borough is 55,400.

Japp Creek, which was studied by approximate methods, flows into Resurrection River from the east. The creek is a flood threat to the housing development below it.

Kenai, Kasilof, Resurrection Rivers, and Sawmill Creek flow from the mountains into coastal waters. Bear, Grouse, and Kwechak Creeks are tributaries to Salmon Creek. Salmon Creek is a tributary to the Resurrection River. The Salmon Creek/Resurrection River Split is a side channel connection between Salmon Creek and the Resurrection River. Salmon Creek Overflow and Salmon Creek Split are Salmon Creek side channels. The streams and detailed study areas are described in the following text.

The source of Kenai River is Kenai Lake, which is formed from the runoff from glacial rivers and lakes in steep mountainous terrain. After emerging from the lake, the river flows westerly for approximately 75 miles through the Kenai National Moose Range and privately owned land (near the communities of Sterling and Soldotna) to its outlet in Cook Inlet at Kenai. The entire watershed of the river lies within the Kenai Peninsula Borough. Most of the area is wilderness under Federal control, in either the Chugach National Forest or the Kenai National Moose Range. The eastern portion of the watershed consists predominantly of steep mountain slopes and many glaciers and icefields. Elevations rise to more than 6,000 feet. From west of the mountains to Cook Inlet, the watershed consists of rolling land and numerous lakes and muskegs. Kenai River is also fed by Beaver Creek, Funny River, Killey River, Moose River, Soldotna Creek, and Slikok Creek.

The floodplain of Kenai River in the study area is, for the most part, very narrow, and development in the area is relatively insignificant. There is ample high ground on each side of the river to provide safe building sites; however, consideration must be given to potential erosion problems. The area is growing rapidly as a recreational area; therefore, greatly increased development can be expected.

Kasilof River, which starts at Tustumena Lake, winds westerly through undeveloped wilderness and emerges at the village of Kasilof on Cook Inlet. The upper portion of the river flows through a narrow canyon and has several rapids due to the steep descent. The lower portion of the river has steep banks and flows through a narrow floodplain. The area is expected to grow rapidly as a recreational area, and the high valley banks and adjacent areas will provide ample ground for safe building sites.

Resurrection River, which has a drainage area of approximately 170 square miles, has its origin near Upper Russian Lake in the Chugach Mountains. From its headwaters, the river flows southeasterly for 22 miles, through the Chugach National Forest and privately owned land, to its outlet in Resurrection Bay at Seward. Unlike Kenai and Kasilof Rivers, Resurrection River has a braided channel and a steep gradient (60 feet in 3 miles). It has a channel bottom of silt, sand, gravel, and boulders; and the overbank areas are heavily covered with timber and brush. The portion of Resurrection River included in this study is from the mouth to a point approximately 3 miles upstream.

Salmon Creek, a tributary of Resurrection River, originates at the terminus of Bear Lake Glacier and flows adjacent to the Seward Highway for approximately 7 miles, generally southerly, to its confluence with Resurrection River. The creek is a glacier-fed stream which traverses a broad alluvial floodplain. Heavy debris and gravel bars cause numerous channel changes. The portion of Salmon Creek studied (approximately 6.5 miles of the stream) is from the mouth to a point just above its confluence with Lost Creek.

Salmon Creek Overflow is a side channel of Salmon Creek. If flows on the west side of the river near the confluence with Kwechak Creek. Salmon Creek Split is an overflow of Salmon Creek and flows along the east side of the Alaska Railroad and rejoins Salmon Creek downstream.

Development in the Resurrection River-Salmon Creek area has greatly increased, as the City of Seward can expand only in the direction of these streams because the mountains and Resurrection Bay surround the city on the other three sides.

There is ample high ground on both sides of these streams to provide safe building sites.

The North Kenai lakes area, an area protruding into Cook Inlet just north of the City of Kenai, consists of approximately 100 square miles of lakes and lowlands. The area is surrounded by Cook Inlet to the north and west, Kenai to the south, and the Kenai National Moose Range to the east. It is rapidly being developed as a recreational and residential area. There are no major streams in the area, but interconnecting creeks between the numerous lakes constitute a possible flood threat.

Seldovia is a fishing village 140 air miles southwest of Anchorage, near the southern end of the Kenai Peninsula, across Kachemak Bay from Homer. The storm-wave study encompasses most of the eastern shore of Seldovia Bay (including the lagoon), which constitutes the only flood threat to the city. No rivers or significant streams are within the corporate limits of Seldovia; therefore, riverine flooding is not a problem.

Port Graham is a small village on Port Graham Inlet, an inlet off Cook Inlet 22 air miles southwest of Homer. The village is sheltered from the brunt of the storms on Cook Inlet, but it will receive storm-driven waves. The buildings have been constructed on higher ground in order to avoid this type of flooding. Small streams and drainage ditches are present, but they do not cause flood problems.

Nikishka is a fuel tanker terminal on Cook Inlet, 10 miles north of Kenai. Several docks are subject to severe storm waves. The refineries are on top of steep cliffs and are not in danger from flooding. Ninilchik, a village on Cook Inlet 38 air miles south of Kenai, is at the mouth of Ninilchik River, and therefore, it is subject to both coastal and river flooding. A narrow spit affords some protection against storm waves and also shelters a small boat basin.

Moose Pass, a small community 25 miles north of Seward, is subject to flooding due to its location on Trail Lake, which periodically floods. Numerous streams feed Trail Lake; therefore, the water surface can rise rapidly. In addition, Snow Lake, when blocked by ice, periodically releases a large volume of water which can enter Trail Lake from Moose and Trail Creeks. Wave action on Trail Lake also can cause erosion.

Portions of the Seward and Sterling Highways, primarily consisting of the portions on each side of Moose Pass and Cooper Landing, are included in the study where development is expected and streams cross the highways.

The coastal areas adjacent to some of the cities consist of natural beaches ranging from gradually sloped sand or mud flats to natural rock revetments.

Mean annual precipitation on the Kenai Borough Peninsula varies from a low on the northwest side increasing towards the Gulf of Alaska. Most precipitation on the peninsula occurs during September and October. Snow begins to fall in October and stops in April or early May.

The average annual temperatures, average annual total precipitation, and average annual snowfall at Homer, Kasilof, Kenai, and Seward are listed below. Data reported are from the National Climatic Data Center (NCDC) Station 503665, at the Homer Airport, for the period 1932 to 2009; NCDC Station 504425 in Kasilof, for the period 1931 to 1997; NCDC Station 504546, at the Kenai Airport, for the period 1949 to 2009; and at NCDC Station 508371, in Seward, for the period 1949 to 2008. These coastal climatological data stations are at an elevation of 100 feet or less.

Station	Average Annual Temperature (Fahrenheit)	Average Annual Precipitation (inches)	Average Annual Snowfall (inches)
Homer	38	24	55
Kasilof	43	17	52
Kenai	34	19	61
Seward	40	69	84

2.3 Principal Flood Problems

The principal flood problem in the Anchor River study area is the threat to three road crossings that constrict the river. The Sterling Highway crossing of the north fork of the Anchor River is an earth fill structure with four 8 feet diameter corrugated metal pipe culverts that may be subject to hydraulic seepage due to water elevations on the upstream side of the road. The Sterling Highway crossing of the south fork of the Anchor River is a concrete span bridge. Although its bridge abutments are well armored, the crossing is subject to erosion due to high velocities of flood flows and the Sterling Highway could potentially be overtopped. Both of these river crossings are critical to the region as the Sterling Highway is the only road access to a significant portion of the Kenai Peninsula. The third river crossing is a trestle bridge on a secondary highway over the main stem of the river.

In October 2002, the bridge approach of the Sterling Highway was washed out. The Nikolaevsk Village was also isolated because of bridge failure on the North Fork of the Anchor River. Less damage occurred during the November 2002 flood, but road access 5 to the lower Kenai Peninsula was cut off for a second time when bridge approaches washed out on the Anchor River crossings on the Sterling Highway and Old Sterling Highway (Reference 3).

Flooding in October and November 2002 also occurred at the state campgrounds downstream of the Old Sterling Highway bridge crossing, inundating the entire area and damaging several cabins.

According to the National Weather Service (NWS), highways in the area begin to experience flooding at one foot below the flood stage.

Floods on the Kenai Peninsula can occur as a result of a combination of factors, which include heavy snowpack and snowmelt, high tides, and heavy precipitation.

High winds when combined with high tide create storm surge and wave runup, which flood coastal areas. Spring floods on streams may result when an above normal snowfall during the winter is followed by an unusually warm spring and a rapid snowmelt. Summer and autumn floods usually result from intense precipitation.

In addition, two other situations causing flooding can occur on Kenai River. The first, known as jokulhlaup, occurs when a glacier-dammed lake is suddenly released (Reference 4). When this happens during the winter, the sudden increase in flow raises the ice cover and attempts to move it downstream. Ice jams result and flooding to depths far greater than either the 1- or 0.2-percent-annual-chance flood can occur. The second, ice jams, occurs during spring break up, and it can also cause flooding to depths greater than either the 1- or 0.2-percent-annual-chance year flood. The severe nature of Alaskan winters lends itself to these unusual types of flooding. When there is a heavy ice cover on the river, untimely breakups (or jokulhlaups) can cause the ice to jam. Ice jams usually occur at natural restrictions or bends in the river and can cause water to back up and flood low areas.

Floods resulting from the sudden release of glacier-dammed lakes have occurred on the Kenai River in past years. This type of flooding was first recorded in December 1911 and on numerous other occasions up to September 1974. These floods originate from lakes formed either by Snow Glacier, at the head of Snow River, or by Skilak Glacier.

Future floods from most glacier-dammed lakes cannot be estimated reliably by using standard statistical procedures because the hydrologic characteristics of the drainage basin may change suddenly and discontinuously and glacier-dammed lakes which have no previous record of dumping may abruptly begin to do so. In addition, the flood sequence may change drastically, or the reservoir may cease filling due to changes in the glacier. Therefore, peak flows during a flood of this type have not been assigned a frequency nor have jokulhlaups been considered in the development of the maps and flood profiles in this study. As a means of comparison, however, the September 1974 jokulhlaup attained a peak discharge of 26,800 cubic feet per second (cfs) at Soldotna, and the 1-percent-annual-chance flood, as determined by means of conventional storm-runoff computations, would reach 37,500 cfs at the same location.

Kenai Peninsula is in a zone which has a relatively high probability of strong earthquakes. The most heavily populated part of the coast is directly across Cook Inlet from Mt. Augustine, an active volcano on Augustine Island. Local tsunamis, where discussed in this study, are defined as locally generated waves resulting from massive earth or rock slides (either above or below water), ice falls, seiches, and similar phenomena. Earthquakes may or may not be associated with this type of tsunami, and warning would not be possible. A teleseismic tsunami is defined as a tsunami resulting from an earthquake and is usually caused by displacement of the ocean floor. It generally occurs as a series of waves from the open sea. Local tsunami are an ever-present threat to many communities in Kenai Peninsula Borough. However, there is no way that a frequency can be assigned to an unpredictable event in Alaska due to the relatively short period of record. Tsunami are therefore, not included as elevation figures in this study. Local tsunami should always, however, be a consideration before beginning any construction in the coastal areas.

The frequency of the 1964 teleseismic tsunami has been studied by the USACE Waterways Experiment Station in Vicksburg, Mississippi, and has been determined to exceed the 0.2-percent-annual-chance event. The Waterways Experiment Station determined the 1- and 0.2-percent-annual-chance teleseismic tsunami waves for Seward, Homer, and Seldovia (Reference 5). The 0.2-percent-annual-chance level of inundation by a teleseismic tsunami at all three locations was calculated to be below the 1-percent-annual-chance storm event.

As is typical of most of Alaska, there is little information available concerning historical floods on the Kenai Peninsula. There is no record of a major flood with known discharge and documented water levels. Public agencies and longtime residents, however, can verify that floods have occurred. Information concerning historical floods was obtained primarily from interviews with residents in the area.

Resurrection River and Salmon Creek have overflowed their banks several times and have caused flood damages to the developed areas near their mouths.

Past floods and an analysis of conditions resulting from floods are shown in Table 1 (Floods of Record on the Kenai Peninsula). Factors aggravating flooding are natural obstructions such as trees and vegetation along the banks; manmade obstructions such as bridges and boat docks; ice jams; the accumulation along and within the streambed of brush and debris which can be carried downstream by high water; and blocked bridge openings, inadequately sized culverts, or other constrictions. As mentioned previously, there are several catastrophic situations which can occur in Kenai Peninsula Borough. These include jokulhlaups, ice jams, and local tsunami. All of these problems can not readily be assigned a frequency in Alaska, and are, therefore, not site-specifically evaluated in this study. However, they are a threat and should always be considered when planning development in threatened areas.

Table 1 - Floods of Record on the Kenai Peninsula

Year	Location	Flooding Conditions
1902	English Bay	St. Augustine eruption caused waves 20 to 30 feet on low tide; minor damage (Reference 6).
1946	Resurrection River	First recorded flood in vicinity of airport; 400 acres inundated.
1947	Cooper Landing	A few basements flooded; water over Sterling Highway in places.
1947	Anchor Point	November rains caused river to top banks, but there were no buildings at that time.
1949	Salmon Creek	Salmon Creek overflowed at approximately River Mile 4; flooded railroad and threatened railroad bridge; floodwaters surrounded Metcalf Country Store.
1951	Resurrection River	Floodwaters rose unexpectedly at night from heavy snowmelt in mountains due to warm weather; wells polluted by surface water; 5 feet of water in Clear Creek area.
1957	Resurrection River	River eroded easterly into Clear Creek drainage and head-water area; old car bodies were dumped in an attempt to halt the erosion.
1957	Moose Pass	Water reached the school and topped the railroad tracks, flooding railroad station.
1960	Resurrection River	River overflowed; heavy floodflows caused bank erosion along the east bank above the highway.
1961	Salmon Creek and Resurrection River	Flooded 8000 feet of highway on Nash Road; 500 feet of airport runway eroded; private homes damaged.
1962	Resurrection River	Heavy floodflows spread out over east side of floodplain; severe bank erosion above and below highway; washed out Airport Road bridge.
1964	Seldovia	15-foot teleseismic tsunami wave (Reference 7).
1964	Homer	20-foot teleseismic tsunami wave; 4 feet over end of spit (Reference 4).
1964	Kenai River	Ice-jam flooding caused five families to evacuate their homes on Ciechanski Road and Rebel Run (Reference 7).
1964	Seward	30- to 40-foot tsunami waves with runup to 49.3 feet (Reference 7).
1964	English Bay	30-foot tsunami wave (Reference 7).
1964	Port Graham	10- to 20-foot tsunami wave (Reference 7).
1967	Kenai River	Ice-jam flooding caused 22 families (81 people) to evacuate their homes; docks, seaplanes, and many homes and businesses damaged; several trailer homes washed away.
1969	Kenai River	Winter jokulhlaup caused ice jams with extensive flooding and damage.
1974	Kenai River	Ice-jam flooding washed out docks and boats and flooded several homes; during autumn, jokulhlaup caused flooding and minor damage.
1974	Salmon Creek	Overbank flows and minor bank erosion; some minor property damage in vicinity of Nash Road crossing.
1976	Cooper Landing	Floodwaters reached top of dock at Post Office.
1976	Port Graham	Cannery flooded by coastal storm.
1976	English Bay	Airport runway partially flooded by coastal storm.
1976	Moose Pass	Water flooded sewer system, closing school.
1976	Salmon Creek	Overbank flows and minor bank erosion. Some minor property damage in vicinity of Nash Road crossing.

Table 1 - Floods of Record on the Kenai Peninsula

1977	Kenai River	Heavy snowmelt caused a 20-year flood in August; glacier lake dumping caused a 20-year flood in September; both resulted in moderate flooding in Salmon Run Acres.
1983	Anchor River	Flooding washed out two portions of the Old Sterling Highway; erosion occurred along the south bank of the lower river, particularly along the Old Sterling Highway bridge and public campground.
1984	Anchor River	May/June-High water washed away bridge, flooded private property, and caused significant erosion at the Anchor River State Recreation Area.
1985	Bradley Lake, Homer, Ninilchik, Anchor River	Heavy peninsula-wide rains caused minor erosion damage to Bradley Lake, Homer, and along the Anchor River. Other damage included mud slides at the Ninilchik boat harbor.
1986	Kenai River	Heavy rains on October 10-12 caused flooding damage to a culvert at Beaver Creek and the Spur Highway as well as major bank sloughing along the bluff in Kenai.
1986	Seward	Heavy rains on October 10-12 caused severe damage to bridges, bridge approaches, railroad and highway embankments, and numerous homes and businesses.
1989	Seward	Heavy rains on August 25-27 caused over $1 million in damage to homes, roads, bridges, etc. Other areas of the Peninsula reported flooding, but sustained less damage.
1989	Kenai River	September-Flooding observed along the South River Bank in the Riverside Lane area (River Mile 15.5). Some homes and trailers affected; up to 1 foot of water on the ground. A half dozen cabins inundated with 1 to 1.5 feet of water in the Castaway Cove Area (River Mile 14.5 and 14.7).
1992	Anchor River	Flooding damage to one home was reported due to an ice jam on the North Fork of the Anchor River.
1993	Seward	Heavy rains on August 26 caused Salmon Creek, Clear Creek, and the Resurrection River to flood. Three homes and one business incurred damage. The railroad tracks at the upper end of Kenai Lake were damaged, and parts of Primrose Road were submerged.
1993	Cooper Landing	Jokulhlaup flooding occurred from the release of water from Snow River Glacial Lake. Yards and docks along the river were submerged.
1994	Homer	Storm undercut ½ mile of newly paved Homer Spit road.
1994	Seldovia	Storm damaged a park in Seldovia and wiped out the runway in Nanwalek.
1995	Kenai Peninsula Borough	Heavy rains from a continuous series of storms caused extensive flooding across South central Alaska. Borough-wide damage estimates exceeded $5 million. This included extensive damage to public facilities, commercial property and private residences.
1995	Kenai River	In November the lower portion of the Kenai River experienced a flood event that approximated the 1-percent-annual-chance flood discharge figure used in the 1980 Flood Insurance Study.
1995	Seward	Heavy rains associated with a series of storm fronts caused severe flooding in the Seward area. Area roads, bridges, the airport, harbor and many homes and businesses incurred serious flood damage. Road and utility repairs alone were estimated at $3.5 million.
2002	Kenai Peninsula Borough	Record-setting precipitation and unusually warm temperatures produced widespread flooding in the fall of 2002. Significant floods occurred in October and again in November.
2006	Kenai Peninsula Borough	An October storm brought record-breaking precipitation and high winds over a widespread area.

2.4 Flood Protection Measures

In 1945, the USACE diverted Lowell Creek (which formerly flowed through the center of Seward) via a tunnel through the mountains. The previous annual flooding has, therefore, been eliminated (Reference 8).

At the southern end of the spit, near the State Ferry Terminal, the State has constructed a reinforced earthen and timber wall to protect the ferry terminal building (Reference 2). The USACE has constructed several rock revetments at the southern tip to protect buildings and surrounding roads (Reference 6).

In several of the coastal areas, rock revetments and breakwaters have been constructed to protect boat harbors. Most improvements along the coast are at higher elevations and are well above potential flooding.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent-annual-chance (100-year) flood in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

2013 Borough-wide Study:

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community. The analyses included a review of all flood-frequency data for the area and the use of analytical techniques that were best suited to the specific stream data.

Peak discharges were determined by use of the USGS stream gaging records for Kenai River at Cooper Landing (1947-1978), Kenai River at Soldotna (1965-1978), and Kasilof River at Sterling Highway (1949-1974). All of the streams were evaluated on a regional frequency basis; however, the final analysis of each gaged stream was made based on an annual series. Statistical analyses were conducted in accordance with the Water Resources Council guidelines for determining flood-flow using the Stream flow Synthesis and Reservoir Regulations computer program developed by the USACE (Reference 9). Log-Pearson Type III frequency distribution with a 0.7 recommended skew coefficient was used (Reference 10).

Peak discharge quantiles were updated for several rivers and creeks in or near the City of Seward for this 2010 FIS update. The following watercourses were studied: Bear Creek, Grouse Creek, Kwechak Creek, Resurrection River, Salmon Creek, and Sawmill Creek. Discharge quantiles were initially estimated using regional regression equations developed by the USGS (Reference 11). These data were evaluated against observations of extreme peak discharges resulting from surge-release floods (i.e. debris dam failures) or other anomalous events and appropriate adjustments were then made to the peak flows (Reference 12).

For the City of Homer, the stillwater elevation for the base flood was determined by considering the effects from tide and storm surges (Reference 7). The annual tide curve follows an 18.6-year cycle, with high-tide elevations for any 1 year closely approximating that for the 18.6-year cycle. In determining the stillwater elevation, the probability of the simultaneous occurrence of a high tide and a storm event was first determined. The design condition is based on the probability of a high tide and major storm occurring simultaneously. The probabilities of these two independent events are combined so that there is a 1-percent chance of occurrence in a given year (base flood event). For this analysis, it was assumed that storms are independent of tides. A storm is also assumed to last 12 hours, thereby capturing a high-tide event. This is a conservative assumption based on wave records collected at the site. The analysis can be modeled as a Binomial Distribution Function, in which one storm of three will combine with a tide exceeding the critical tide. The critical tide is defined as the tide stage with a 0.4-percent chance of being exceeded and was determined based on tide records collected at Homer Spit. The critical tide corresponds to 18.7 feet NAVD88. Note that because the tide data are observed, storm surge is included in the tide record.

Storm-surge data for the City of Homer were not found. However, the report entitled "Storm Surge Climatology and Forecasting in Alaska," published by the Arctic Environmental Information and Data Center, and dated August 1981 (Reference 8), estimates that the highest surge would be less than 3 feet near the City of Homer because the hydrographic and topographic conditions are not conducive to high surges. Because the tide data also incorporate storm surge, a 1-foot surge was added to the computed tide level as a conservative assumption, to produce a stillwater elevation of 19.7 feet NAVD88.

Peak discharge-drainage area relationships for each flooding source studied in detail are shown in Table 2, "Summary of Discharges".

For this 2014 Revised Borough-wide Study:

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

The general approach taken in this analysis was to follow the guidelines presented in "Guidelines for Determining Flood Flow Frequency," Bulletin #17B by the Interagency Advisory Committee on Water Data, dated March 1982; "Guidelines and Specifications (G&S) for Flood Hazard Mapping Partners," Appendix C: Guidance for Riverine Flooding Analysis and Mapping, dated April 2003, by FEMA and USACE EM-1110-2-1415, Hydrologic Frequency Analysis, dated March 1993.

The computer program HEC-SSP Statistical Software Package, dated August 2008, developed by the USACE, was used to calculate the flood flow frequency estimates for this study. This program follows the guidelines in Bulletin #17B.

Daily discharge records for the Anchor River show distinct high runoff periods, one in the spring from April to mid-June (snowmelt) and one in the fall from September to November, which is predominately rainfall. The average annual mean discharge for Anchor River near Anchor Point (USGS #15239900, 1966-1992) is 201 cfs. The highest annual mean was 354 cfs and lowest was 119 cfs. The average annual mean discharge for Anchor River at Anchor Point (USGS #15240000, 1955-1966) is 303 cfs. The highest annual mean was 394 cfs and the lowest was 208 cfs.

The frequency data developed for the Anchor River at Anchor Point was used for the reach that runs from the gage to tidewater. The frequency curve developed from the data recorded at the Anchor River near Anchor Point was used for the South Fork of the study area. The assumption was made that the difference between the peak flows for the same exceedance probability at each gage entered the main channel from sub basins between the two gages. The assumption was also made that the intervening flow magnitudes were proportional to the area of those sub basins.

Annual peak flow data from the USGS stream gauge Kenai River at Cooper Landing, USGS # 15258000, was used to calculate the peak flow frequencies presented in this analysis. The period of record is from May 1947 to September 2004, a period of 56 years, using a continuous stage recording gauge. The average annual mean discharge for the Kenai River at Cooper Landing for the period of record is 2,840 cfs. The highest annual mean discharge was 4,500 cfs, the lowest was 2,100 cfs.

The flows for each population of peak events were fitted to the Log-Pearson Type III frequency distribution. The station skews for each population of annual peaks were weighted by a regional skew from a regional analysis done by the USGS in 2003 (WRI Report 03-4188). The frequency curve for each population was plotted on probability paper so that discharges for each type of flood event could be related to a frequency. The expected probability adjustment was not made to the frequency curves as FEMA does not recommend using this refinement in the analysis. The Probability of Union was used to combine the frequency curves for the two separate populations of flood events affecting the watershed. The USGS gauge has sufficient period of record (56 years) to calculate an estimate of the flood flow frequency for the area to be mapped.

Annual peak flow data from the USGS stream gauge Ninilchik River at Ninilchik (USGS # 15241600) was used to calculate the peak flow frequencies presented in this analysis. The period of record is from April 1963 to September 1985 using a wire weight gauge and from October 1998 to October 2003 using a continuous stage recording.

Daily discharge records for the Ninilchik River show distinct high runoff periods—one in the spring from April to mid-June (snowmelt) and one in the fall from September to November, which is predominantly rainfall. The average annual mean discharge for the Ninilchik River at Ninilchik (USGS gauge number 15241600) is 106 cfs. The highest annual mean was 151 cfs and the lowest was 55 cfs.

The USGS gauge data was analyzed for different populations of annual peak flows. The Ninilchik River is subject to a mixed population of flood events. Observed discharge data shows high flows during the spring mainly due to snowmelt and high flows again in the fall due to rainfall. The basin is not well covered by climatic stations, but those stations near the edges of the basin show that there may have been one or two rain on snow events during the period of record for the gauge.

The gauge data along with precipitation and temperature data from nearby climatic stations were used to identify the main hydrologic inputs to the annual peaks. There are 19 annual peaks attributed to snowmelt and 9 annual peaks attributed to rainfall. Rainfall caused peaks were found to occur from August to November. Snowmelt peaks were found to occur from April to May. Average daily flows were the only data available for some snowmelt peaks. Regression analysis was used to develop a relationship between average daily and peak flows. The regression coefficient was excellent for all cases (R2 = 0.98). The regression equations were used to calculate the missing instantaneous peak flows from the recorded average daily flows. The annual instantaneous peak flows were assembled for snowmelt and rainfall peaks for the Ninilchik River.

Peak discharge-drainage area relationships for each flooding source studied in detail 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 recurrence intervals along each stream studied in the borough. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data Table in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS report in conjunction with the data shown on the FIRM.

Water-surface elevations were computed for all streams studied by detailed methods by use of the HEC-2 or HEC-RAS computerized water-surface profile program (Reference 13 and Reference 14). These programs compute the water-surface profile for stream channels at any cross-section for subcritical, critical, or supercritical flow conditions and considers the effects of various structures such as bridges, culverts, weirs, and embankments. These programs apply Bernoulli's theorem for the local energy at each cross section and Manning's formula for the friction slope for a reach between two cross sections as determined in terms of the average of the conveyances at the two ends of the reach. Other losses are computed using one of several standard methods. Critical water-surface elevations, corresponding to the minimum specific energy, are computed using an iterative process.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the FIRM (Exhibit 2).

Table 2 - Summary of Discharges

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cfs) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Anchor River[1]					
North Fork	*	1,400	2,100	2,400	3,200
South Fork at gage #15239900	35.1	2,640	5,280	7,340	16,540
South Fork at confluence with North Fork	36.1	2,650	5,170	7,120	15,730
Main Stem at gage #15240000					
Bear Creek[2]					
At upstream study limit	6.6	440	610	690	880
Cook Inlet					
At Homer, West End	*	26.6	*	32.4	*
At Homer, Fronting Beluga Lake	*	28.1	*	33.7	*
At West Base of Homer Spit	*	27.8	*	33.6	*
At Homer Spit	*	26.8	*	32.5	*
Kachemak Bay					
At East Base of Homer Spit	*	19.8	*	22.5	*
At Homer, East End	*	18.4	*	20.0	*
Grouse Creek[2]					
At upstream study limit	6.1	740	1,020	1,140	1,450
Kasilof River					
At Cross Section M	738	10,810	13,700	15,035	18,200
Kenai River					
At Cooper Landing[1]	634	17,000	24,000	27,000	35,000
At Juneau Creek[1]	*	19,000	26,800	30,200	39,000
At outlet of Skilak Lake	1,257	22,100	28,600	31,500	39,400
Downstream of Killey River	1,484	23,800	30,600	33,700	43,700
Downstream of Moose River	1,748	25,600	32,700	35,900	44,300
Below Funny River	1,905	26,600	33,800	36,800	45,300
At mouth	2.162	28.000	37.300	38.300	47.000
At Soldotna gaging station[3]	2,010	28,000	38,500	44,000	58,000
Kwechak Creek[1]					
At Salmon Creek confluence	6.9	1,190	2,140	2,780	5,160
Ninilchik River					
At Ninilchik gage	131	1,190	2,140	2,780	5,160
Resurrection River[2]					
At upstream study limit	161	16,700	22,720	25,280	31,670
Downstream of Box Canyon	173	19,040	25,930	28,870	36,190
To Seward Highway	180	19,230	26,190	29,160	36,570

[1]New or updated data from the 2014 revised borough-wide study
[2]New or updated data in 2007 (Reference 9)
[3]Data based on additional gage records from 1980 through 1997
*Data not available

Table 2 - Summary of Discharges

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cfs) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Salmon Creek[1]					
Upstream of Kwechak Creek	24.1	1,860	4,310	6,340	15,900
Downstream of Grouse Creek	14.7	1,370	2,910	4,250	11,480
Upstream of Bear Creek	16.9	1,630	3,430	5,000	13,530
Downstream of Kwechak Creek	31.0	2,340	4,910	6,930	16,080
Upstream of Clear Creek	34.0	2,530	4,950	6,790	14,970
Downstream of Clear Creek	35.1	2,640	5,280	7,340	16,540
To Nash Road	36.1	2,650	5,170	7,120	15,730
Sawmill Creek[1]					
At upstream study limit	10.1	1,490	2,440	3,010	4,930
At Resurrection Bay[2]	11.0	1,460	2,350	2,860	4,590

[1]New or updated data in 2007 (Reference 9)
[2]Sawmill Creek discharges decrease in a downstream direction due to floodplain storage

For the Kasilof and Kenai Rivers, cross section data were obtained from field survey notes, field reconnaissance, photographs, topographic maps (References 15 - 25), and previous reports (References 26 - 28). Roughness factors (Manning's "n") were generally assigned on the basis of field inspection of floodplain areas together with computer determination of "n" with normal flows and standard published factors for pipe and corrugated metal culverts. For Kenai River, roughness factors were taken from a previous report (Reference 26). For Kasil of River, the "n" value for the channel was determined by performing a backwater analysis with known elevations and flow rates at the Sterling Highway Bridge. The overbank "n" values were determined by observation of the area and comparison with similar areas for which the roughness factors are known. The Manning's "n" values for all detailed studied streams are listed in the following Table 3 - Manning's "n" Values:

Table 3 - Manning's "n" Values

Stream	Channel "n"	Overbank "n"
Bear Creek	0.040	0.065 – 0.085
Grouse Creek	0.050	0.100
Kasilof River	0.029 – 0.039	0.035 – 0.100
Kenai River	0.029 – 0.031	0.035 – 0.100
Kwechak Creek	0.005 – 0.065	0.065 – 0.080
Resurrection River	0.035 – 0.040	0.035 – 0.100
Salmon Creek (including side channels)	0.045 – 0.080	0.045 – 0.120
Sawmill Creek	0.050	0.085

Starting water-surface elevations for the Kasilof and Kenai Rivers were based on a reasonable high tide which could occur during a month that flooding would be likely to occur.

Kenai River, at an elevation of 190 feet at the upstream limit of the study drops to sea level in Cook Inlet 47 miles downstream. Two large lakes upstream from the study area regulate the flow. The overbank areas vary from mudflats to dense tree cover. As the mean tide range is nearly 20 feet on Cook Inlet, considerable backwater would be expected at the mouth of the river during a high tide. However, the Kenai River's mouth is more than 1 mile wide and can accommodate high tides. The 1-percent-annual-chance coastal storm would cause the water surface to reach a peak at the coast and gradually recede upstream to a level of less than the 1-percent-annual-chance tide. This tide would then control until the river flooding reached a higher level. This would occur at cross section W. The two bridges over Kenai River in the study area, are high enough to avoid overtopping. However, numerous docks and gravel pads, which extend out into the river, impede flow. Several rivers and creeks that flow into Kenai River were studied by approximate methods. Both the 1- and 0.2-percent-annual-chance floods would cause only moderate flooding.

Beaver Creek enters Kenai River at river station 53,000. It actually flows in a side channel of the river between this station and River Station 59,000, but the flow in this channel is minimal as compared with the main channel flow. Therefore, the side channel was not considered in the backwater computations. Due to the broad floodplains in some overbank areas, shallow flooding results. Elevations for these areas of shallow flooding were computed by using field-surveyed cross sections and the HEC-2 computer program (Reference 13).

Kasilof River, which drops from an elevation of 108 feet to sea level in 15 miles, winds through dense wilderness to Cook Inlet. Like the Kenai River mouth, the Kasilof River mouth is wide and accommodating to high tides. The 1-percent- annual-chance coastal storm-water surface level is higher than stream flooding up to cross section K. Since the Kasilof River originates in Tustumena Lake, it is self-regulating, and there is little danger of ice-jam flooding. The Sterling Highway Bridge is the only bridge across the river, and it is high enough to avoid overtopping. However, some docks extend into the river and constrict flow.

Two parallel bridges, Seward Highway and Alaska Railroad, cross Resurrection River near the mouth. Three openings through the bridge system divide the flow into thirds. Although the bridges greatly constrict the flow, the 0.2-percent- annual-chance flood would not top them. Considerable backwater upstream causes moderate flooding and is a serious hazard to development near the river. There is little development, however, because of the frequent flooding. Coastal flooding governs up to cross section F on Resurrection River.

Resurrection River is gradually changing its course by eroding easterly into the Clear Creek area. As the area's material can be easily eroded, a dangerous situation can develop. The river can readily change its course during flooding and cause new areas to be flooded.

The primary factor contributing to flooding on Resurrection River is the heavy accumulation of brush and debris along and within the streambed. During floods, vegetation on the floodplain impedes flood flows, thereby creating backwater and increased flood heights. Trees and other debris may be washed away and carried downstream. Increased flooding and other damage results when this debris collects at bridge abutments or other obstructions. Since it was impossible to predict the amount of accumulation of debris, it was assumed that there would be no accumulation.

Salmon Creek, a glacier-fed stream, traverses a broad alluvial flood plain where heavy debris and gravel bars cause frequent channel changes. A railroad embankment crosses the Salmon Creek drainage basin and acts as a levee. At high flow the creek divides into a side channel running along the eastern side of the railroad.

Further information on the Resurrection River and Salmon Creek are provided in Section 10.2. Updated detailed studies for these two rivers, along with new detailed studies of Bear, Grouse, Kwechak, and Sawmill Creeks, were completed in 2009.

The 1-percent-annual-chance flood levels for all streams studied by approximate methods were based on field examinations, historical information, map reconnaissance, and engineering judgment. Japp Creek, which was studied by approximate methods, was found to cause only moderate flooding. Calculations showed that the creek would remain within its banks at the critical point upstream above Forest Acres Subdivision. However; it would top its banks near the gravel pit and flood the alluvial fan, thereby causing damage to the few homes between the gravel pit and Resurrection River.

The profile baselines depicted on the FIRM represent the hydraulic modeling baselines that match the flood profiles on this FIS report. As a result of improved topographic data, the profile baseline, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA. Profile baselines were used on along the Resurrection River and Salmon Creek due to the meandering nature of the stream channels.

For this 2014 Revised Borough-wide Study:

The hydraulic model used for this study was the USACE HEC-RAS version 4.1. HEC-RAS models were developed for the 10-, 4-, 1-, and 0.2-percent-annual- chance flood events for the detailed models.

Cross sections for the HEC-RAS model were placed manually during review of base mapping features, including topographic contours, orthoimagery, etc. Cross sections were placed immediately upstream and downstream of road and railroad crossings, dams, and other hydraulic structures. Channel cross section data were obtained from field surveys, field reconnaissance, photos and topographic maps.

Structures across floodplains require special attention as they often create abrupt contraction or expansion of flow. The prediction of the energy losses in the contraction reach upstream from a structure and the expansion reach downstream from a structure in HEC-RAS requires an increase in the contraction and expansion coefficients as specified in the cross section data editor. Typical values for contraction and expansion coefficients used for structures are 0.3 and 0.5, respectively. In some cases, contraction and expansion coefficients for abrupt transitions in effective cross section area were set to 0.5 and 0.7, respectively.

Water surface elevations for the selected recurrence intervals for all streams studied by detailed methods in Kenai Peninsula Borough were calculated using HEC-RAS V. 4.1 USACE computer program (Reference 29).

The starting water surface elevations (WSELs) for all profiles of Kenai River and North Fork Chakok River were calculated using the normal depth method. Starting WSELs for all profiles of Anchor River and Ninilchik River were determined using the Mean Higher High Water (MHHW) tidal datum.

Maximum channel and floodplain n-values were developed using the USGS Water-supply Paper 2339 by starting with a base n-value and adding factors as described in the paper. Table 3, "Manning's "n" Values" shows the channel and overbank "n" values for the streams studied by detailed methods.

Table 3 – Manning's "n" Values - continued

Stream	Channel	Overbank
Anchor River	0.028-0.037	0.055-0.085
Kenai River	0.060	0.035-0.100
Ninilchik River	0.039-0.078	0.026-0.069
North Fork Chakok River	0.031	0.075

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 Wave Height Analysis

A detailed coastal study was performed so that an estimate of coastal flooding at specific sites could be made. Analyses of storm surge, wave setup, and wave runup were performed in accordance with the design criteria in the Shore Protection Manual of 1973, written by the USACE Coastal Engineering Research Center (Reference 30). The under-water and above-water topography were determined by the use of maps, U.S. Coast and Geodetic Survey navigation charts (Reference 31), and by visual inspection. Wind data are sparse, but some data are available in the vicinity of each site. Therefore, wind data used for a specific site are representative of the general wind conditions. By use of the available wind data (Reference 32), wind frequency curves were derived for the specific sites.

Tide frequency curves were derived by use of the frequency distribution functions developed by the USACE Coastal Engineering Research Center for the tide reference stations in Alaska (Reference 33). The tide frequency curves and wind frequency curves were used in conjunction in order to determine the 1-percent-annual-chance event. These calculations yielded three tide/wind combinations; a 1-percent-annual-chance tide event with a low wind velocity, a 1-percent-annual-chance wind event with a lower high tide, and a tide/wind combination between the two events. The combination yielding the highest elevation was used as the 1-percent-annual-chance elevation. The 10-percent-annual-chance event was computed similarly. FEMA did not require that the 2-percent-annual-chance and 0.2-percent-annual-chance elevations be computed for the tidal areas.

Field reconnaissance and surveys were made of key structures. Significant ponding could cause overtopping and eventual failure of roads. However, ponding was not considered in this study because failure would normally reduce the predicted flood levels. All bridges were considered to have remained intact during flooding.

Wave setup, runup, and surge were calculated for all three tide/wind combinations, and the maximum flood elevation was plotted. The computed surge is the result of wind setup only and does not take into account the surge caused by pressure differences on the open coast. Most locations in this study are substantially away from the open coast. Seward, however, is subject to the pressure-caused surges in the Gulf of Alaska as it is only separated from the gulf by the relatively small Resurrection Bay. The only way to predict these surges and their effect on Seward is through the use of hydrodynamic equations. The data for development of these equations are not available; therefore, the open-sea surge was not considered in this study. In order to determine the flood elevations, allowances were made for the irregularity of the coastline, the changes in beach slope, and the variation of beach materials. The calculated flood levels compared favorably with the observations of local residents and with previous high-water marks. Areas specified for approximate study were compared with areas of detailed study, and the approximate flood elevations were derived. Detailed coastal studies were made for Homer, Seward, Seldovia, Port Graham, English Bay, Kenai, and Nikishka.

Port Graham, English Bay, Kenai, and Nikishka have had little flooding from coastal storms because the banks along their coasts are steep, and development has occurred at higher elevations.

Stillwater elevations for the detailed coastal studies are shown in Table 4, "Summary of Stillwater Elevations – September 27, 2013". All elevations are referenced to the NGVD29 except for Resurrection Bay which was converted to the NAVD88 as part of an update in 2009 (Section 10.2). The original survey work for Seldovia was referenced to mean lower low water level (MLLW), which is 9.3 feet below the NGVD29. The original survey work for both English Bay and Port Graham was based on an assumed datum with the zero contour lines equal to 16.5 MLLW and 15.5 MLLW, respectively. Elevation reference marks used in the study are shown on the maps.

Table 4 - Summary of Stillwater Elevations – September 27, 2013

	Water Surface Elevations (Feet)			
Flooding Source	10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Cook Inlet[1]				
At Nikishka	15.4	n/a	17.1	n/a
At Homer, West End	26.6	n/a	32.4	n/a
At Homer, Fronting Beluga Lake	28.1	n/a	33.7	n/a
At West Base of Homer Spit	27.8	n/a	33.6	n/a
At Homer Spit	26.8	n/a	32.5	n/a
At Seldovia, South of Gray Cliff	10.5	n/a	18.7	n/a
At Seldovia, Northeast of Gray Cliff	15.1	n/a	24.4	n/a
At Port Graham	28.1	n/a	31.1	n/a
At Port Graham	28.8	n/a	32.7	n/a
At Port Graham	27.8	n/a	31.1	n/a
At Port Graham	28.0	n/a	30.5	n/a
At Port Graham	28.0	n/a	30.9	n/a
At English Bay, North	50.2	n/a	50.7	n/a
At English Bay, South	56.5	n/a	57.2	n/a
At Kasilof River	15.3	n/a	16.9	n/a
At Kasilof River	14.4	n/a	16.0	n/a
At Kasilof River	13.4	n/a	15.0	n/a
At Kasilof River	11.9	n/a	13.5	n/a
At Kasilof River	12.0	n/a	13.5	n/a
Kachemak Bay[1]				
At East Base of Homer Spit	19.8	n/a	22.5	n/a
At Homer, East End	18.4	n/a	20.0	n/a
Resurrection Bay[2]				
At Seward	14.6	n/a	16.1	n/a
At Seward	14.0	n/a	15.2	n/a
At Seward	14.3	n/a	16.2	n/a
At Seward	14.2	n/a	17.2	n/a

[1]National Geodetic Vertical Datum of 1929
[2]North American Vertical Datum of 1988 (converted from NGVD by adding 6.2 feet)

For this 2014 Revised Borough-wide Study:

Due to the vast distances between the areas of interest within the Kenai Peninsula Borough, the coastal engineering analysis was separated into two different analyses: Cook Inlet and Resurrection Bay. These two locations were modeled separately to account for local storm events, tides, and bathymetry. For both analyses, peaks-over-threshold (POT) analyses were performed on flood elevations (i.e., total water levels, TWLs) resulting from flood-producing events occurring over the period.

Flooding in the Kenai Peninsula Borough is governed by a combination of different physical processes. The severity of flooding experienced is dependent on the characteristics of waves arriving at the shoreline from distant storms, the magnitude of local storm winds, the tidal elevations coincident with storm conditions, et cetera. Flooding may also be driven by water level anomalies resulting from large freshwater flows or climate extremes due to global climate oscillations such as El Niño.

For the above reasons, it not always possible to tell a priori which meteorological or hydrological event produces the largest TWLs. The draft Pacific G&S recommends hindcasting a large number of events, carefully selected so that all major historic flooding events are captured. For both Cook Inlet and Resurrection Bay, sensitivity analysis showed that long period swell wave energy was dissipated at the inlets and was not a significant contributor in terms of wave run-up extremes at the shorelines of interest. Therefore, only locally generated waves were considered in the analysis. A time series of concurrent wind speed, direction and water levels (defined hourly) was compiled for both study areas. Waves were hindcast for all hourly wind speeds above a high threshold (~10 m/s) (Reference 34). Wave height, wave period, and wave direction triplets were saved at each transect for all wave events. At each hourly time-step, wave run-up was computed and saved at each transect. In Cook Inlet, the generalized extreme value distribution (GEV) coupled with the annual maxima approach was used to infer wave run-up return periods at each transect, while in Resurrection Bay, the generalized Pareto distribution (GPA) coupled with peaks-over-threshold analysis was used to infer wave-run-up return periods. The choice of statistical approach was driven by the number of years for which data was available – the peaks-over-threshold method uses data efficiently but also requires more effort in threshold selection.

STARR used of the NOAA data buoys or the Wave Information Study (WIS) buoys from the USACE as sources for offshore wave data. Then, STARR completed statistical analyses on the wave data to determine the 1-percent-annual-chance offshore wave climate. As the long term wave information necessary to develop flood hazard estimates is not available for sheltered waters, a 2D spectral wave model (SWAN) was used. The SWAN wave model was run for each of these events. Each event simulation covered 6 hours of record before and after the peak of the event. The primary inputs at each time step were: water level, wind speed, and wind direction. Model outputs (significant wave height, spectral wave period, mean wave direction, etc.) were saved at points along each transect.

Wave setup was determined based on the Direct Integration Method (DIM), as outlined

Advisory Committee for Water Retaining Structures (TAW) method or the runup on vertical structures method, as described in the G&S, depending on the steepness of the nearshore slopes.

For each wave runup calculation, the wave conditions were transformed to the equivalent deepwater wave conditions or the appropriate location in the surf zone (e.g., toe of structure), depending on the profile slope. For steep profiles which did not have a clearly defined toe, the toe of structures was assumed to be at the breaking wave location. Failed conditions for engineered structure slopes were not considered in Seward as the structures were not likely to fail and the intact condition was expected to be a more conservative estimate. The Joint North Sea Wave Project (JONSWAP) peakedness parameter (γ), for the open coast transects, was computed from the deepwater wave spectra as outlined in the G&S. Dynamic wave setup was not considered due to the lack of swell energy penetration.

The wave conditions saved at each transect, in conjunction with the water level coincident with the wave conditions, were used to compute wave runup on the transects. TWLs were computed at hourly intervals over the duration of each event. The definition of event duration was limited to 6 hours before and after the peak of the event. The maximum TWLs for each storm event were saved at each transect.

Evaluation of storm-induced erosion had been determined to be negligible for the entire study area because the shorelines in these areas are typically either made up of mudflats or non-erodible bluffs; estimation therefore is not part of the study.

Figure 1 is a profile for a hypothetical transect showing the effects of energy dissipation on a wave as it moves inland. This figure shows the wave elevations being decreased by obstructions, such as buildings, vegetation, and rising ground elevations and being increased by open, unobstructed wind fetches. Actual wave conditions may not necessarily include all of the situations shown in Figure 1.

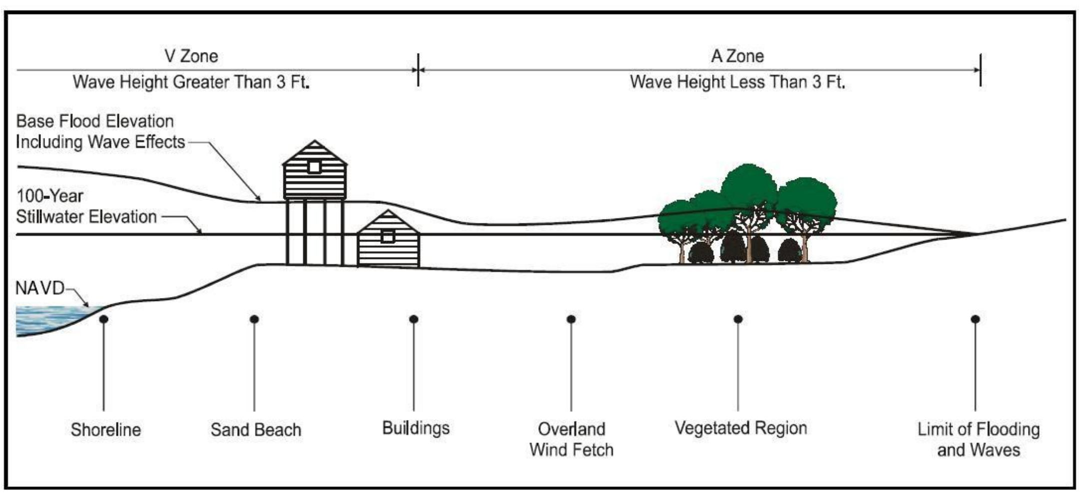

Figure 1 - Transect Schematic

After field reconnaissance, the locations of transects used in nearshore hydraulic computations (i.e., wave setup, runup, overtopping, and erosion, where applicable) were finalized (Figure 2 and Figure 3). A total of 14 transects were selected for the Cook Inlet communities and a 9 transects were selected for Resurrection Bay. The locations of transects were chosen so as to be reasonably representative of the bathymetric, topographic, and land-use characteristics of segments of the coastline. Transect spacing is denser in areas with considerable alongshore variation in bathymetry, topography, or cultural characteristics. Transects were placed perpendicular to the mean shoreline or parallel to the mean direction of wave propagation. Transect profiles were generated by sampling the USGS combined topographic and bathymetric data set at five meter intervals. This interval matches the resolution of the dataset.

In Cook Inlet, a 50 meter resolution unstructured grid was created. The grid covers the entire inlet out to the open ocean boundaries at the Shelikof Strait and the Kennedy and Stevenson Entrances. A time series of concurrent wind speed, direction, and water levels (defined hourly) was compiled Seward Area. Using SWAN, waves were hindcast for all hourly wind speeds above a high threshold (~10 m/s). The primary inputs at each time step were: water level, wind speed, and wind direction. Wave height, wave period, and wave direction triplets were saved at each transect for all wave events.

In Seward, a 50 meter resolution Cartesian grid was created. The grid covers Resurrection Bay. A total of 72 potential flooding events, selected based on wind speed and direction, were simulated. The SWAN wave model was run for each of these events. A time series of concurrent wind speed, direction, and water levels (defined hourly) was compiled for Kenai and Homer area. Waves were hindcast for all hourly wind speeds above a high threshold (~10 m/s). The primary inputs at each time step were: water level, wind speed, and wind direction. Wave height, wave period, and wave direction triplets were saved at each transect for all wave events.

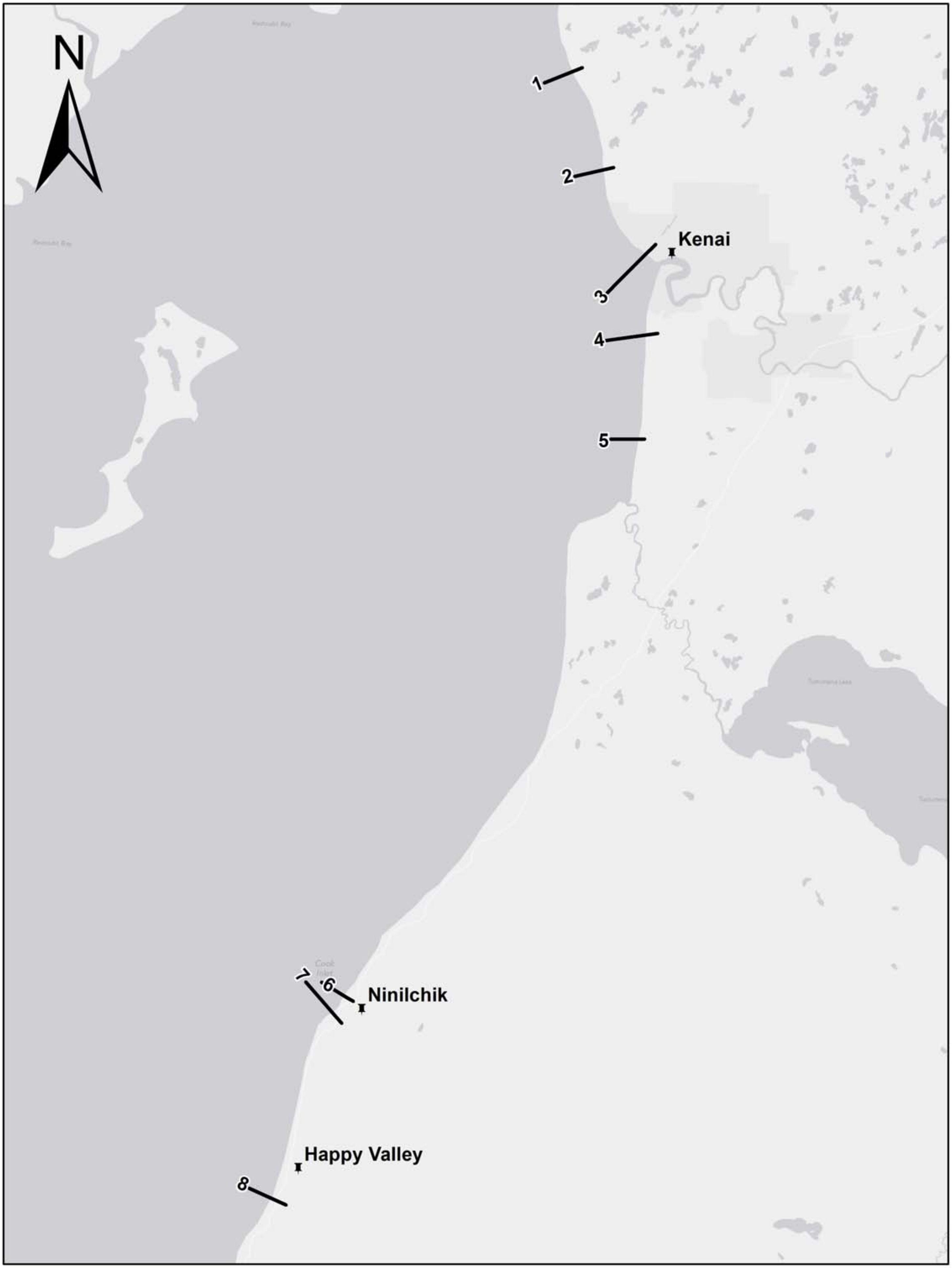

Figure 2 - Transect Locations for Cook Inlet

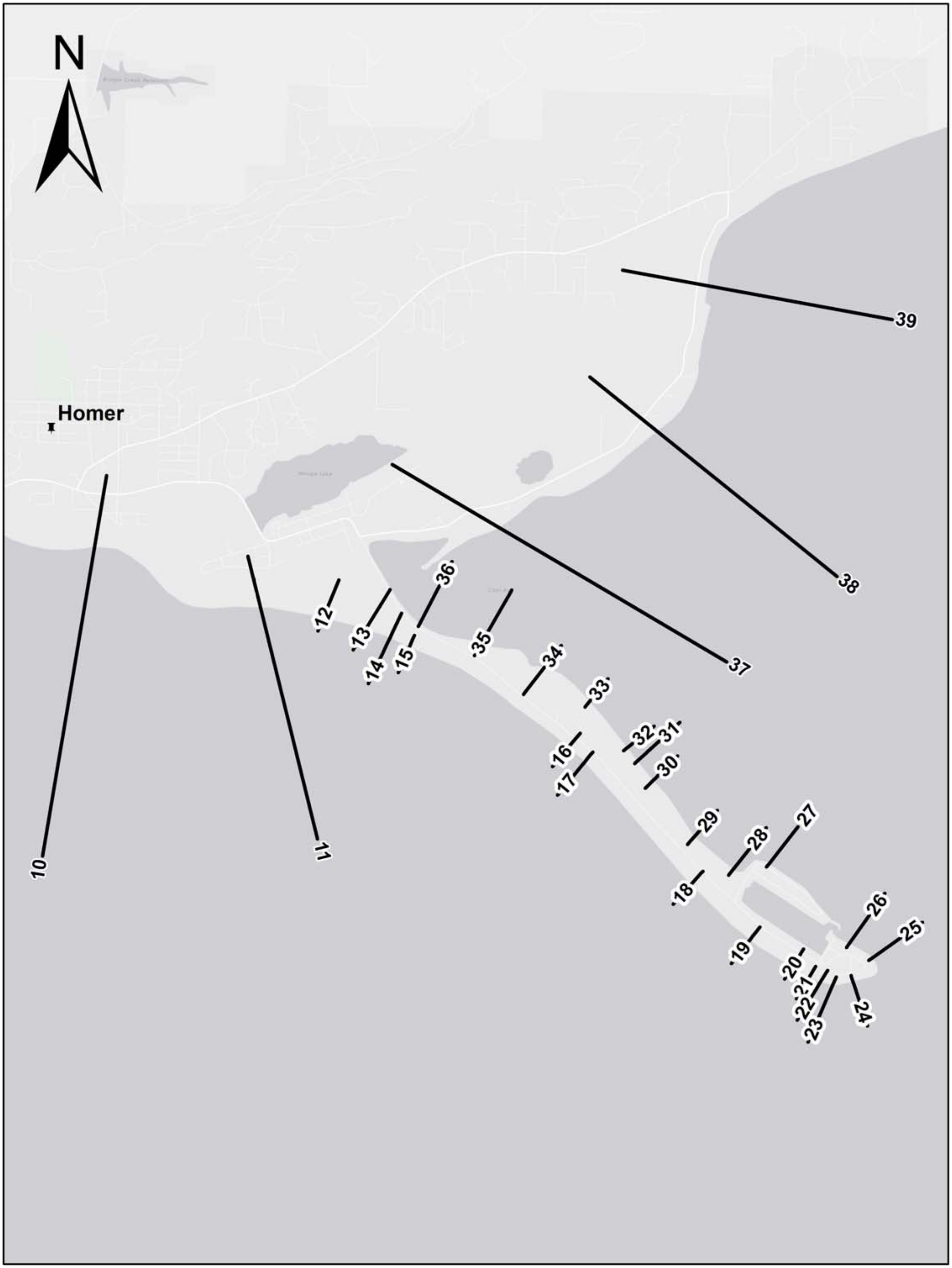

Figure 3- Transect Locations for Kachemak Bay

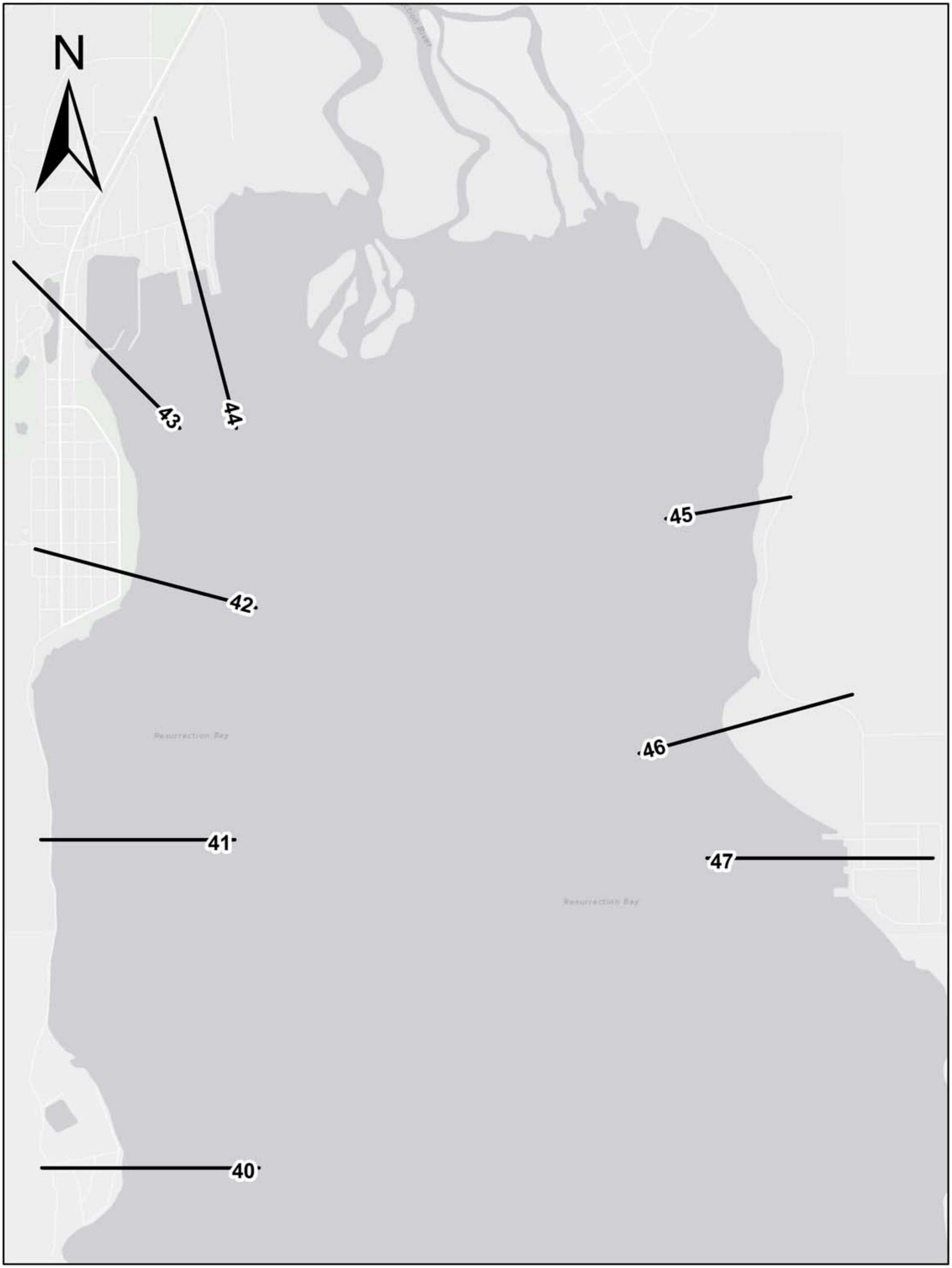

Figure 4 - Transect Locations for Resurrection Bay

Stillwater elevations for the detailed coastal studies are shown in Table 5, "Summary of Stillwater Elevations – 2014 Revision".

Table 5 - Summary of Stillwater Elevations - 2014 Revision

	Water Surface Elevations (feet NAVD88)			
Flooding Source	10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Cook Inlet				
At Kenai	16.2	17.8	18.1	18.6
At Ninilchik	16.2	17.8	18.1	18.6
At Happy Valley	16.2	17.8	18.1	18.6
At Homer, Fronting Beluga Lake	16.2	17.8	18.1	18.6
At Homer Spit	*	*	19.7	*
Kachemak Bay				
At Homer, East End	16.2	17.8	18.1	18.6
At Homer Spit	*	*	19.7	*
Resurrection Bay				
At Seward	14.1	14.6	14.9	15.4

*Data not available

Table 6, "Transect Descriptions," provides a listing of the transect locations, stillwater elevations, and maximum wave crest (or wave runup) elevations along the shoreline. Transects have been re-numbered to conform to countywide standard.

Along each transect, WHAFIS computes wave heights and wave crest elevations taking into account the combined effects of changes in ground elevation, vegetation, and other obstructions. Wave heights are calculated to the nearest 0.1 foot, and wave crest elevations are computed at whole-foot intervals. The calculations are carried inland along the transect until the wave crest elevation is permanently less than 0.5 foot above the SWEL or until the coastal flooding meets another flood source (e.g., a riverine flood source). The results of this analysis are summarized in Table 7, "Transect Data."

Table 6: Transect Descriptions - Kenai

Transect	Location	1-Percent-Annual-Chance Flood Elevation (Feet NAVD88) Stillwater	Maximum Wave[1,2]
1	Starts at the Cook Inlet shoreline approximately 2,300 feet west of the intersection of Kenai Spur Highway and Miller Loop Road.	18.1	23
2	Southwest of Lower Salamat of Lake, Starts at the Cook Inlet shoreline approximately 1,500 feet west of the intersection of Kenai Spur Highway and Railway Avenue.	18.1	31
3	Starts at the Cook Inlet shoreline approximately 2,400 feet southwest of the intersection of Kenai Spur Highway and South Forest Drive.	18.1	21
4	Starts at the Cook Inlet shoreline approximately 1,400 feet southwest of the intersection of Kalifornsky Beach Road and Karluk Avenue.	18.1	21
5	Starts at the Cook Inlet shoreline approximately 1,700 feet northwest of the intersection of Kalifornsky Beach Road and Lottie Drive.	18.1	25
6	Near Ninilchik River Delta, Starts at the Cook Inlet shoreline approximately 2,400 feet northeast of the intersection of Sterling Highway and Mission Avenue.	18.1	26
7	South of Ninilchik River Delta, Starts at the Cook Inlet shoreline approximately 1,600 feet west of the intersection of Sterling Highway and Oilwell Road.	18.1	29
8	Starts at the Cook Inlet shoreline approximately 1,500 feet southwest of the intersection of Sterling Highway and Royce Drive.	18.1	25
9	Starts at the Kachemak Bay shoreline approximately 2,700 feet west of the intersection of Sterling Highway and West Hill Road.	18.1	27

Table 6: Transect Descriptions – Kenai (continued)

Transect	Location	1-Percent-Annual-Chance Flood Elevation (Feet NAVD88) Stillwater	Maximum Wave[1,2]
10	Starts at the Kachemak Bay shoreline approximately 1,500 feet southwest of the intersection of Sterling Highway and Main Street.	18.1	19
11	Southwest of Beluga Lake, Starts at the Kachemak Bay shoreline approximately 1,700 feet south of the intersection of Ocean Drive and Lake Street.	18.1	24
12	Mariner Park Lagoon; approximately 1,000 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	25
13	Mariner Park, NW; approximately 2,200 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	33
14	Mariner Park, SE; approximately 2,900 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	25
15	Right of gazebo at tsunami warning signal; approximately 3,600 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	44
16	Approximately 9,900 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	29
17	Southeast of Houseboat; approximately 10,600 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	27
18	At pole left of Log Cabin; approximately 15,900 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	26
19	Right side of Lucky Pierre Charters; approximately18,500 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	27

Table 6: Transect Descriptions – Kenai (continued)

Transect	Location	1-Percent-Annual-Chance Flood Elevation (Feet NAVD88) Stillwater	Maximum Wave[1,2]
20	Salty Dawg Saloon lighthouse; approximately 20,100 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	29
21	Seafarer's Memorial; approximately 20,700 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	27
22	Homer Spit Campground; approximately 21,000 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	23
23	Lodges at Land's End condominiums, left; approximately 21,100 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	37
24	Lodges at Land's End condominiums, right; approximately 22,300 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	30
25	Behind Land's End Restaurant; approximately 22,500 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	25
26	Ferry Terminal; approximately 21,800 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	28
27	Port of Homer; approximately 17,300 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	34
28	Pier One Theater; approximately 16,600 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	23

Table 6: Transect Descriptions – Kenai (continued)

Transect	Location	1-Percent-Annual-Chance Flood Elevation (Feet NAVD88) Stillwater	Maximum Wave[1,2]
29	Heritage RV Park; approximately 14,900 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	25
30	North Star Terminal & Stevedore Co LLC (2); approximately 12,600 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	31
31	North Star Terminal & Stevedore Co LLC (1); approximately 11,800 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	33
32	Kevin Bell Ice Arena; approximately 11,200 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	23
33	Embayment labeled "Coal Bay" in effective FIRM; approximately 9,500 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	35
34	2664 Homer Spit Rd; approximately 7,700 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	21
35	South of 2170 Homer Spit Rd; approximately 5,600 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	34
36	North of Tsunami Warning Signal (Bayside); approximately 3,500 feet from the intersection of Homer Spit Road and Kachemak Drive.	19.7	27
37	South of Homer Airport, Starts at the Coal Bay shoreline approximately 6,000 feet east of the intersection of Homer Spit Road and Kachemak Drive.	18.1	22

Table 6: Transect Descriptions - Kenai

Transect	Location	1-Percent-Annual-Chance Flood Elevation (Feet NAVD88) Stillwater	Maximum Wave[1,2]
38	South of Homer Airport, Starts at the Coal Bay shoreline approximately 10,500 feet west of the intersection of Homer Spit Road and Kachemak Drive.	18.1	24
39	Starts at the Kachemak Bay shoreline approximately 3,300 feet south of the intersection of East End Road and Kachemak Bay Drive.	18.1	24
40	Near Spruce Creek, Starts at the Resurrection Bay shoreline approximately 1,450 feet east of the intersection of Lowell Point Road and Border Avenue.	14.9	15
41	Starts at the Resurrection Bay shoreline approximately 4,100 feet south of the intersection of 3rd Avenue and Railway Avenue.	14.9	26
42	Starts at the Resurrection Bay shoreline approximately 300 feet south of the intersection of Ballaine Boulevard and Adams Street.	14.9	17
43	Near Alaska Fjord Charters, Starts at the Resurrection Bay shoreline approximately 1,100 feet northeast of the intersection of Seward Highway and Port Avenue.	14.9	17
44	Near Alaska Fjord Charters, Starts at the Resurrection Bay shoreline approximately 2,600 feet southeast of the intersection of Seward Highway and Rebecca Lane.	14.9	21
45	Starts at the Resurrection Bay shoreline approximately 5,200 feet northwest of the intersection of Nash Road and Bette Cato Avenue.	14.9	20

Table 6: Transect Descriptions – Kenai (continued)

Transect	Location	1-Percent-Annual-Chance Flood Elevation (Feet NAVD88) Stillwater	Maximum Wave[1,2]
47	Starts at the Resurrection Bay shoreline approximately 400 feet northwest of the intersection of Nash Road and Morris Avenue.	14.9	20

[1]Due to map scale limitations, the maximum wave elevation is not shown on the Flood Insurance Rate Map
[2]Maximum wave runup elevation

Table 7: Transect Data – Kenai

Flooding Source	10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance	Base Flood Elevation (Feet NAVD)
Cook Inlet					
Transect 1		16.2	17.8		18.1
Transect 2		16.2	17.8		18.1
Transect 3		16.2	17.8		18.1
Transect 4		16.2	17.8		18.1
Transect 5		16.2	17.8		18.1
Transect 6		16.2	17.8		18.1
Transect 7		16.2	17.8		18.1
Transect 8		16.2	17.8		18.1
Transect 9		16.2	17.8		18.1
Transect 10		16.2	17.8		18.1
Transect 11		16.2	17.8		18.1
Transect 12					19.7
Transect 13					19.7
Transect 14					19.7
Transect 15					19.7
Transect 16					19.7
Transect 17					19.7
Transect 18					19.7
Transect 19					19.7
Transect 20					19.7
Transect 21					19.7
Transect 22					19.7
Transect 23					19.7
Transect 24					19.7
Kachemak Bay					
Transect 25					19.7
Transect 26					19.7
Transect 27					19.7
Transect 28					19.7
Transect 29					19.7
Transect 30					19.7
Transect 31					19.7
Transect 32					19.7
Transect 33					19.7
Transect 34					19.7

Table 7: Transect Data – Kenai (continued)

Flooding Source	10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance	Base Flood Elevation (Feet NAVD)
Transect 35			19.7		VE 21
Transect 36			19.7		VE 21
Transect 37	16.2	17.8	18.1	18.6	VE 22.2
Transect 38	16.2	17.8	18.1	18.6	VE 23.8
Transect 39	16.2	17.8	18.1	18.6	VE 23.5
Resurrection Bay					
Transect 40	14.1	14.6	14.9	15.4	VE 14.9
Transect 41	14.1	14.6	14.9	15.4	VE 25.7
Transect 42	14.1	14.6	14.9	15.4	VE 17.2
Transect 43	14.1	14.6	14.9	15.4	VE 16.8
Transect 44	14.1	14.6	14.9	15.4	VE 20.5
Transect 45	14.1	14.6	14.9	15.4	VE 20.2
Transect 46	14.1	14.6	14.9	15.4	VE 14.9
Transect 47	14.1	14.6	14.9	15.4	VE 20.1

3.4 Vertical Datum

2013 Borough-wide Study:

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FIS reports and FIRMs was NGVD29. With the finalization of NAVD88, many FIS reports and FIRMs are being prepared using NAVD88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NGVD29 except for the areas in and around the city of Seward which are referenced to NAVD88.

Stillwater elevations for Resurrection Bay were taken from the prior effective FIS and adjusted to NAVD88. The average conversion factor that was used to convert these data were from National Geodetic Survey (NGS) benchmarks and computed from Kenai Peninsula Borough (KPB) benchmarks using the GEOID99 ellipsoid model (Reference 34). The data points used to determine the conversion are listed in Table 8, "Vertical Datum Conversion".

Table 8 - Vertical Datum Conversion

NGS or KPB Station	Location	NGVD29 (feet)	NAVD88 (feet)	Conversion from NGVD29 to NAVD88 (feet)
BM X-74	Seward Airport	26.45	32.64	6.19
BM E-76	Mile 7 Seward Highway	208.35	214.63	6.18
BM B-76	Mile 4 Seward Highway	64.28	70.48	6.20
KPB BM-3	Nash Road & Seward Highway	28.57	34.76	6.19
KPB BM-7	Bruno Road	151.39	157.58	6.19
			Average:	6.19

2013 Revised City of Homer FIS

For the Revised City of Homer 2013 FIS report and FIRM, elevations were converted from NGVD29 to NAVD88 by adding 5.7 feet to the NGVD29 elevations. All of the flood elevations in the city of Homer are referenced to NAVD88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum.

NAVD88 = NGVD29 + conversion factor

To convert elevations referenced to MLLW to the NAVD88, subtract 4.90 feet. This conversion was derived from information on the "Datums" sheet for NOAA tide gage no. 9455557, "Homer, AK." Verified data for this station is available for the period May

1, 1964 through Dec 31, 1967. Local residents may be accustomed to referencing the Seldovia tide gage (NOAA station no. 9455500) datum. Unfortunately, the datum sheet for this tide gage does not include the NAVD88 datum.

However, as a first approximation, for nontechnical purposes, the change of 4.90 feet could be applied to Seldovia's datum.

For this 2014 Revised Borough-wide Study:

For this borough-wide revision, the beginning portions of the Kenai River, and Kadilof River were updated and are now referenced in NAVD88.

For additional information regarding conversion between NGVD29 and NAVD88, visit the NGS website at www.ngs.noaa.gov, or contact the NGS at the following address:

Vertical Network Branch, N/CG13
National Geodetic Survey, NOAA Silver Spring
Metro Center 3
1315 East-West Highway Silver Spring, Maryland
20910 (301) 713-3191

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 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each FIS provides 1-percent-annual-chance (100-year) flood elevations and delineations of the 1- and 0.2-percent-annual-chance (500-year) floodplain boundaries and 1-percent-annual-chance floodway to assist communities in developing floodplain management measures. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data Table, and Summary of Stillwater Elevations Table. Users should reference the data presented in the FIS report as well as additional information that may be available at the local map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent- annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community.

For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:2,400 with contour intervals of 5 and 10 feet (Reference 15); 1:2,400, with contour intervals of 2 and 10 feet (Reference 16); 1:2,400, with contour interval of 2 feet (Reference 17); 1:4,800, with contour intervals of 2 and 10 feet (Reference 18); 1:4,800, with contour interval of 5 feet (Reference 22); 1:12,000, with contour intervals of 10 feet (Reference 20); 1:4,800, with contour interval of 5 feet (Reference 21); 1:12,000, no contours available (Reference 22); 1:63,360, with contour interval of 100 feet (Reference 23); 1: 63,360, with contour intervals of 50 feet (Reference 24); and 1:2,400, with contour interval of 5 feet (Reference 25).

2013 Revised City of Homer FIS

During the September 25, 2009 revised FIS, NHC used five foot contour topography developed by the City of Homer to redelineate coastal flooding extents within the City and to add Beluga Lake to the SFHA. Flood levels within Kachemak Bay/Beluga Slough (Zone VE) are at an elevation of 34ft. Because it would be unreasonable to assume that the 34 feet elevation would continue in Beluga Lake, the decision was made to show the lake as an Approximate A Zone. Topographic data show that Lake Street, which separates Beluga Lake from Beluga Slough, is at an elevation lower than 25 feet, thus there is nothing to stop flood water from entering the lake across Lake Street from Beluga Slough. Beluga Lake was added to the SFHA and delineated at the 25 feet. contour. Clearly, however, a detailed study is required to refine this elevation.

The primary intent of the 2013 revision was to re-delineate existing flood levels on the new topographic data. However, NHC agreed to take a qualitative look at the VE Zone flood elevations within Beluga Slough to determine if they could or should be refined. Based upon the review, it is recommended that at some point in the future, re-mapping the entire coastline using the new Pacific Coast procedures should be considered. There was not enough evidence to suggest that the mapped elevation within Beluga Slough is either right or wrong and the only way to determine this would be through a new study.

For areas of coastal and showing flooding, boundaries for the 1-percent-annual- chance flood were delineated on the maps reference previously by using the computed elevations.

For stream studied by approximate methods, the 1-percent-annual-chance flood boundary was delineated on these same maps by using the estimated elevations and only the 1-percent-annual-chance floodplain boundary is shown on the FIRM (Exhibit 2).

For this 2014 Revised Borough-wide Study:

STARR performed coastal flood hazard analysis for the study area that included the collection of storm surge (coastal hydrology) data and conducting overland wave height analysis (coastal hydraulics). Storm surge or stillwater elevations were based on the statistical analysis from long-term water level gage records.

Overland wave height analysis was performed using the Coastal Hazard Analysis for Mapping Program (CHAMP). CHAMP is a transect based model, therefore the allocation and placement of transects is critical to the success of the coastal FIS. Results of the overland wave height analysis were transferred to topographic work maps. There were no PFD's located in Kenai Peninsula Borough, AK.

After the wave models were reviewed, the model outputs were imported into ArcMap and zone point shapefiles were generated. The zone point shapefiles delineate the change in BFEs along the transect and can be used to map the BFE changes. The BFEs were separated by drawing gutter lines which connect the zone point breaks between transects.

STARR delineated the 1- and 0.2-percent-annual-chance floodplain boundaries for Kenai Peninsula Borough using standard GIS utilities. The STARR team manually drew the floodplain boundaries on the on 2-foot topographic contours derived from the terrain model. Aerial imagery and land use data assisted in the development of these features.

Zone VE (high wave velocity action area) was assigned to areas where the wave height is at least 3 feet. Since the wave crest is 70 percent of the controlling wave height above the stillwater plus setup surface, the wave crest in Zone VE is at least 2.1 feet higher than the stillwater plus wave setup elevation. Zone AE was assigned to areas where the total wave height is less than 3 feet and the wave crest is less than 2 feet above the stillwater plus wave setup elevation. Any zone width that is less than 0.2 times the FIRM scale was merged into the adjacent higher elevation zone. In the case of Kenai Peninsula Borough, the FIRM scales are 1 inch equals 500 feet, so zone widths of less than 100 feet were usually merged to the adjacent higher zone.

In March 2007, FEMA developed the guidance on the identification and mapping of the LiMWA. The mapping was conducted by identifying the LiMWA location(s) along each transect using the WHAFIS output and connecting those points between transects using gutter lines. In areas where runup elevations dominate over WHAFIS wave height, such as areas with steeply sloping beaches or high bluffs, there is no need to delineate the LiMWA. To retain continuous LiMWA lines in runup areas, the LiMWA was placed immediately landward of the mapped VE/AE Zone boundary and coincident with the 1-percent-annual-chance floodplain boundary in areas without an AE zone.

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AH, AO, A99, V, and VE), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 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 FIS report and on the FIRM 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 have been tabulated for selected cross sections (Table 9). 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.

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 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 4.

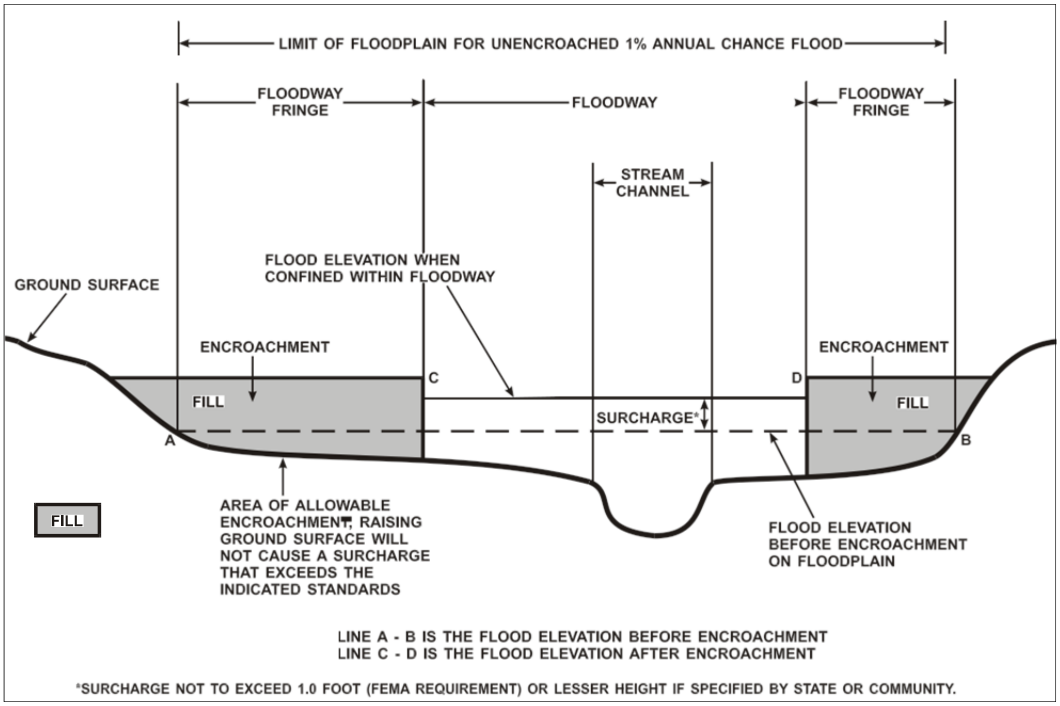

Figure 4 - Floodway Schematic

4.3 Base Flood Elevations

Areas within the community studied by detailed engineering methods have BFEs established in AE and VE Zones. These are the elevations of the 1-percent-annual-chance (base flood) relative to NAVD88. In coastal areas affected by wave action, BFEs are generally maximum at the normal open shoreline. These elevations generally decrease in a landward direction at a rate dependent on the presence of obstructions capable of dissipating the wave energy. Where possible, changes in BFEs have been shown in 1-foot increments on the FIRM. However, where the scale did not permit, 2- or 3-foot increments were sometimes used. BFEs shown in the wave action areas represent the average elevation within the zone. Current program regulations generally require that all new construction be elevated such that the first floor, including basement, is elevated to or above the BFE in AE and VE Zones.

4.4 Velocity Zones

The USACE has established the 3-foot wave height as the criterion for identifying coastal high hazard zones (Reference 31). This was based on a study of wave action effects on structures. This criterion has been adopted by FEMA for the determination of VE zones. Because of the additional hazards associated with high-energy waves, the NFIP regulations require much more stringent floodplain management measures in these areas, such as elevating structures on piles or piers. In addition, insurance rates in VE zones are higher than those in AE zones.

The location of the VE zone is determined by the 3-foot wave as discussed previously. The detailed analysis of wave heights performed in this study allowed a much more accurate location of the VE zone to be established. The VE zone generally extends inland to the point where the 1-percent-annual-chance stillwater flood depth is insufficient to support a 3-foot wave.

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD88)	WITHOUT FLOODWAY (FEET NAVD88)	WITH FLOODWAY (FEET NAVD88)	INCREASE (FEET)
Anchor River								
A	1,474	190	2,301	6.6	18.3	18.3	18.3	0.0
B	3,282	280	3,296	5.0	19.3	19.3	19.3	0.0
C	5,931	730	5,397	4.4	19.8	19.8	20.0	0.2
D	7,075	640	3,441	7.2	20.0	20.0	20.5	0.5
E	9,051	730	2,185	11.3	25.2	25.2	25.3	0.1
F	11,371	145	1,102	14.0	32.5	32.5	32.6	0.1
G	12,229	220	2,718	5.7	39.3	39.3	39.5	0.2
H	13,281	400	1,455	12.3	42.7	42.7	43.1	0.4
I	15,023	450	1,739	12.8	49.8	49.8	50.1	0.3
J	17,166	450	2,163	11.7	61.2	61.2	61.7	0.5
K	20,382	520	2,007	11.0	75.6	75.6	75.8	0.2
L	25,013	500	1,897	10.5	97.0	97.0	97.2	0.2
M	27,205	430	2,002	9.7	107.5	107.5	107.5	0.0
N	29,311	270	1,520	11.3	116.9	116.9	117.8	0.9
O	31,293	100	672	13.4	128.7	128.7	128.7	0.0
P	32,549	380	1,835	5.3	134.8	134.8	134.8	0.0
Q	34,899	390	1,340	12.2	148.6	148.6	148.5	0.0
R	36,185	260	1,327	6.8	154.0	154.0	154.5	0.5
S	37,680	310	816	12.2	162.9	162.9	162.9	0.0
T	38,366	83	670	13.0	168.9	168.9	169.0	0.1

[1]Feet above Confluence with Cook Inlet

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS

FLOODWAY DATA

ANCHOR RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Bear Creek								
A	114.9	37.4	118.7	5.8	167.3[2]	167.3	167.6	0.3
B	327.0	35.0	122.5	5.6	170.2	170.2	170.7	0.5
C	597.8	33.6	106.5	6.5	174.3	174.3	174.9	0.6
D	855.4	36.4	130.1	5.3	178.8	178.8	178.9	0.1
E	1116.2	26.3	108.5	6.4	183.7	183.7	184.0	0.3
F	1501.8	28.3	110.4	6.3	188.8	188.8	189.7	0.9
G	1868.8	29.2	105.9	6.5	195.2	195.2	195.4	0.2
H	2307.7	32.0	110.2	6.3	202.2	202.2	203.1	0.9
I	2993.2	37.4	98.1	7.0	217.9	217.9	218.0	0.1
J	3479.4	39.1	110.3	6.3	229.5	229.5	230.2	0.7
K	3847.7	24.0	97.8	7.1	237.6	237.6	237.6	0.0
L	4178.5	20.5	85.2	8.1	243.3	243.3	244.0	0.7
M	4372.8	25.4	202.5	3.4	253.5	253.5	254.1	0.6
N	4600.0	53.3	405.8	1.7	253.7	253.7	254.3	0.6
O	5083.9	51.0	350.1	2.0	253.8	253.8	254.4	0.6
P	5528.2	45.0	290.2	2.4	253.9	253.9	254.5	0.6
Q	5984.4	45.3	217.1	3.2	254.2	254.2	254.8	0.6
R	6388.9	21.8	95.4	7.2	254.6	254.6	255.3	0.7

[1]Feet Above Confluence with Salmon Creek
[2]Elevations Computed Without Consideration of Flooding Effects From Salmon Creek

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

BEAR CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET)	WITHOUT FLOODWAY (FEET)	WITH FLOODWAY (FEET)	INCREASE (FEET)
Kasilof River								
A	0	*	10,588	1.8	18.0[2]	9.0[2,4]	9.0[2]	0.0
B	2,890	*	7,972	2.4	18.0[2]	9.1[2,4]	9.1[2]	0.0
C	6,590	*	6,562	2.9	18.0[2]	9.3[2,4]	9.3[2]	0.0
D	9,560	*	6,386	2.9	18.0[2]	9.5[2,4]	9.5[2]	0.0
E	13,370	*	7,146	2.6	18.0[2]	9.8[2,4]	9.8[2]	0.0
F	16,975	*	5,906	3.2	18.0[2]	10.1[2,4]	10.1[2]	0.0
G	19,065	*	5,355	3.5	13.5[3]	10.3[2,4]	10.3[2]	0.0
H	21,365	*	6,168	2.8	13.5[3]	10.7[2,4]	10.7[2]	0.0
I	23,875	*	9,885	1.8	13.5[3]	10.9[2,4]	10.9[2]	0.0
J	26,265	*	4,878	3.6	13.5[3]	11.1[2,4]	11.1[2]	0.0
K	28,205	*	2,714	6.4	13.5[3]	12.4[2,4]	12.4[2]	0.1
L	30,665	925	5,375	3.2	15.7[3]	15.7[3]	15.7[3]	0.4
M	34,130	230	2,145	7.0	19.6[3]	19.6[3]	20.6[3]	1.0
N	37,070	187	2,054	7.3	24.9[3]	24.9[3]	25.6[3]	0.7
O	39,990	301	2,252	6.7	30.8[3]	30.8[3]	31.3[3]	0.5
P	40,160	214	1,753	8.6	30.8[3]	30.8[3]	31.8[3]	1.0
Q	41,960	245	2,542	5.9	35.3[3]	35.3[3]	35.6[3]	0.3
R	43,770	257	2,002	7.5	37.9[3]	37.9[3]	38.4[3]	0.5
S	46,490	637	3,221	4.7	44.3[3]	44.3[3]	44.9[3]	0.6

[1]Feet Above Cross Section A
[2]NAVD88
[3]NGVD29
[4]Elevations Computed Without Consideration of Backwater Effects From Cook Inlet
*Floodway Width Was Not Computed

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK
AND INCORPORATED AREAS

FLOODWAY DATA

KASILOF RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD29)	WITHOUT FLOODWAY (FEET NGVD29)	WITH FLOODWAY (FEET NGVD29)	INCREASE (FEET)
Kasilof River (continued)								
T	49,220	760	3,853	3.9	49.0	49.0	49.4	0.4
U	52,860	200	1,869	8.0	54.6	54.6	55.2	0.6
V	56,440	315	2,661	5.6	61.3	61.3	62.0	0.7
W	58,730	250	1,447	10.4	67.1	67.1	67.1	0.0
X	60,670	342	2,574	5.8	73.5	73.5	73.5	0.7
Y	62,270	390	1,856	8.1	78.4	78.4	78.4	0.0
Z	64,000	248	1,954	7.7	84.7	84.7	84.7	0.1
AA	66,300	247	1,935	7.8	91.0	91.0	91.0	0.0
AB	68,420	212	2,048	7.3	95.8	95.8	95.8	0.1
AC	71,740	302	2,416	6.2	102.0	102.0	102.0	0.1
AD	75,380	212	2,293	6.5	107.4	107.4	107.4	0.1

[1]Feet Above Cross Section A

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS

FLOODWAY DATA

KASILOF RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET)	WITHOUT FLOODWAY (FEET)[5]	WITH FLOODWAY (FEET)[5]	INCREASE (FEET)
Kenai River								
A	0	*	26,200	1.5	13.5[3]	9.0[3]	9.0[3]	0.0
B	3,380	*	38,750	1.0	13.5[3]	9.1[3]	9.1[3]	0.0
C	6,440	*	34,746	1.1	13.5[3]	9.1[3]	9.1[3]	0.0
D	9,840	*	29,073	1.3	13.5[3]	9.1[3]	9.1[3]	0.0
E	13,030	*	28,620	1.3	13.5[3]	9.1[3]	9.1[3]	0.0
F	16,270	*	24,083	1.6	13.5[3]	9.2[3]	9.2[3]	0.0
G	19,460	*	18,531	2.1	13.5[3]	9.3[3]	9.3[3]	0.0
H	22,700	*	21,076	1.8	13.5[3]	9.4[3]	9.4[3]	0.0
I	25,460	*	15,249	2.5	13.5[3]	9.4[3]	9.4[3]	0.0
J	25,880	*	15,604	2.5	13.5[4]	9.5[4]	10.5[4]	1.0
K	29,430	*	13,168	2.9	13.5[4]	9.7[4]	10.7[4]	1.0
L	31,430	*	10,073	3.8	13.5[4]	9.8[4]	10.7[4]	0.9
M	33,370	603[2]	9,895	3.9	13.5[4]	10.1[4]	11.0[4]	0.9
N	36,000	747[2]	12,739	3.0	13.5[4]	10.6[4]	11.4[4]	0.8
O	38,765	758[2]	13,024	2.9	13.5[4]	10.8[4]	11.6[4]	0.8
P	41,495	564[2]	10,559	3.6	13.5[4]	11.0[4]	11.8[4]	0.8
Q	44,215	481[2]	8,959	4.3	13.5[4]	11.3[4]	12.0[4]	0.7
R	46,980	770[2]	10,869	3.5	13.5[4]	11.9[4]	12.6[4]	0.7
S	49,975	1,120[2]	20,287	1.9	13.5[4]	12.3[4]	12.9[4]	0.6
T	52,835	440[2]	6,994	5.5	13.5[4]	12.3[4]	12.9[4]	0.6
U	54,435	880[2]	13,379	2.8	13.5[4]	12.8[4]	13.4[4]	0.6
V	55,915	450[2]	6,202	6.1	13.5[4]	12.8[4]	13.4[4]	0.6

[1]Feet Above Cross Section A
[2]Width Affected by Tidal Influences
[3]NAVD88
[4]NGVD29
[5]Elevations Computed Without Consideration of Backwater Effects From Cook Inlet
*Floodway Width Was Not Computed

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK
AND INCORPORATED AREAS

FLOODWAY DATA

KENAI RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
Kenai River (continued)								
W	58,000	1,049	12,437	3.0	13.7	13.7	14.2	0.5
X	59,705	2,250	14,922	2.5	13.9	13.9	14.4	0.5
Y	62,640	1,210	6,842	5.5	14.6	14.6	15.0	0.4
Z	65,485	850	8,840	4.3	16.0	16.0	16.5	0.5
AA	65,905	850	8,107	4.7	16.1	16.1	16.6	0.5
AB	68,750	663	7,795	5.6	18.3	18.3	19.3	1.0
AC	71,410	855	7,005	6.3	20.1	20.1	20.8	0.7
AD	74,030	628	7,878	5.6	22.3	22.3	22.7	0.4
AE	76,880	1,374	8,954	4.9	23.2	23.2	23.5	0.3
AF	78,520	972	8,572	5.1	24.9	24.9	25.2	0.3
AG	81,310	1,612	12,630	3.5	27.5	27.5	27.7	0.2
AH	83,025	1,904	14,424	3.1	28.0	28.0	28.3	0.3
AI	84,915	2,004	14,171	3.1	28.4	28.4	28.7	0.3
AJ	87,540	1,651	9,588	4.6	29.1	29.1	29.5	0.4
AK	90,160	1,301	7,630	5.8	31.3	31.3	31.5	0.2
AL	93,060	706	6,807	6.5	33.8	33.8	33.9	0.1
AM	95,185	615	6,637	6.6	35.6	35.6	35.7	0.1
AN	96,995	513	5,049	7.5	41.2	41.2	41.6	0.4
AO	99,555	485	7,342	5.2	43.1	43.1	43.4	0.3
AP	101,915	450	6,064	6.2	44.0	44.0	44.5	0.5
AQ	103,805	387	5,729	6.5	44.9	44.9	45.4	0.5
AR	106,875	547	6,504	5.8	46.4	46.4	46.9	0.5

[1]Feet Above Cross Section A
[2]Width Affected by Tidal Influences
[3]Elevations Computed Without Consideration of Backwater Effects From Cook Inlet

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

KENAI RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
Kenai River (continued)								
AS	109,555	526	5,845	6.4	47.9	47.9	48.3	0.4
AT	112,155	331	3,354	11.2	50.4	50.4	50.5	0.1
AU	112,495	388	4,560	8.2	52.4	52.4	53.1	0.7
AV	113,995	299	4,435	8.5	54.2	54.2	54.6	0.4
AW	115,745	435	5,518	6.8	56.1	56.1	56.4	0.3
AX	117,665	511	5,141	7.3	57.7	57.7	57.9	0.2
AY	119,985	502	6,183	6.0	59.9	59.9	60.0	0.1
AZ	122,575	540	5,387	6.8	61.6	61.6	61.7	0.1
BA	125,040	542	4,762	7.7	64.4	64.4	64.5	0.1
BB	127,650	443	4,215	8.7	68.3	68.3	68.3	0.0
BC	130,525	425	4,318	8.5	72.8	72.8	72.8	0.0
BD	132,035	522	5,293	7.0	75.0	75.0	75.0	0.0
BE	139,995	526	4,354	8.5	85.2	85.2	85.2	0.0
BF	148,475	392	4,040	9.1	99.8	99.8	99.8	0.0
BG	150,475	390	4,210	8.7	103.0	103.0	103.0	0.0
BH	151,675	514	4,780	7.7	104.8	104.8	105.0	0.2
BI	154,035	383	4,256	8.6	107.9	107.9	108.0	0.1
BJ	154,765	334	3,989	9.2	108.8	108.8	108.9	0.1
BK	156,815	406	4,393	8.4	111.8	111.8	111.9	0.1
BL	162,995	530	5,259	7.0	120.3	120.3	120.4	0.1
BM	163,545	450	4,520	7.9	121.0	121.0	121.0	0.0
BN	165,745	380	4,640	7.7	123.4	123.4	123.5	0.1

[1]Feet Above Cross Section A
[2]Width Affected by Tidal Influences
[3]Elevations Computed Without Consideration of Backwater Effects From Cook Inlet

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

KENAI RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
Kenai River (continued)								
BO	167,995	312	4,327	8.3	125.2	125.2	125.6	0.4
BP	171,215	410	4,851	7.4	128.1	128.1	128.8	0.7
BQ	172,755	377	4,964	7.2	129.6	129.6	130.1	0.5
BR	174,595	426	6,013	6.0	131.1	131.1	131.5	0.4
BS	176,795	765	7,439	4.8	132.3	132.3	132.7	0.4
BT	180,435	437	4,814	7.5	134.7	134.7	134.9	0.2
BU	181,675	385	4,683	7.7	135.9	135.9	136.0	0.1
BV	184,275	479	3,962	9.1	139.2	139.2	139.3	0.1
BW	189,075	278	4,106	8.7	145.9	145.9	146.2	0.3
BX	193,315	400	5,861	6.1	149.2	149.2	149.7	0.5
BY	194,110	552	7,979	4.2	149.9	149.9	150.3	0.4
BZ	196,255	381	5,299	6.4	150.3	150.3	150.8	0.5
CA	198,625	630	6,898	4.9	151.9	151.9	152.3	0.4
CB	201,260	356	4,282	7.9	153.4	153.4	153.6	0.2
CC	203,835	300	3,705	9.1	156.1	156.1	156.4	0.3
CD	206,800	277	3,539	9.5	160.2	160.2	160.4	0.2
CE	211,110	338	3,307	10.2	167.6	167.6	167.7	0.1
CF	211,830	680	4,752	7.1	170.1	170.1	170.3	0.2
CG	213,615	875	6,303	5.3	172.0	172.0	172.8	0.8
CH	215,125	519	4,686	7.2	173.8	173.8	174.1	0.3
CI	218,125	810	7,710	4.4	176.4	176.4	176.8	0.4
CJ	220,920	469	5,528	6.1	177.5	177.5	178.3	0.8

[1]Feet Above Cross Section A
[2]Width Affected by Tidal Influences
[3]Elevations Computed Without Consideration of Backwater Effects From Cook Inlet

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

KENAI RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET)	WITHOUT FLOODWAY (FEET)	WITH FLOODWAY (FEET)	INCREASE (FEET)
Kenai River (continued)								
CK	224,220	1,212	9,031	3.7	179.7[2]	179.7[2]	180.3[2]	0.6
CL	226,200	1,370	11,274	3.0	180.8[2]	180.8[2]	181.7[2]	0.9
CM	229,245	710	5,720	5.9	181.9[2]	181.9[2]	182.9[2]	1.0
CN	235,075	800	7,521	4.5	185.8[2]	185.8[2]	186.4[2]	0.6
CO	235,865	713	6,714	4.7	186.0[2]	186.0[2]	186.7[2]	0.7
CP	239,985	406	4,733	6.7	188.3[2]	188.3[2]	189.2[2]	0.9
CQ	245,255	410	5,466	5.8	191.6[2]	191.6[2]	192.3[2]	0.7
CR	246,415	580	6,553	4.8	192.4[2]	192.4[2]	193.0[2]	0.6
CS	247,890	470	6,012	5.2	192.7[2]	192.7[2]	193.6[2]	0.9
CT	417,979	385	3,223	9.5	419.8[3]	419.8[3]	419.8[3]	0.0
CU	420,204	325	3,503	8.9	426.1[3]	426.1[3]	426.5[3]	0.4
CV	422,116	490	3,309	9.3	429.6[3]	429.6[3]	429.8[3]	0.2
CW	423,896	428	3,729	7.3	433.3[3]	433.3[3]	433.4[3]	0.1
CX	425,453	315	2,758	9.9	435.5[3]	435.5[3]	435.6[3]	0.1
CY	428,068	308	3,460	7.8	440.8[3]	440.8[3]	440.8[3]	0.0
CZ	430,630	335	4,903	5.6	443.5[3]	443.5[3]	443.5[3]	0.0
DA	432,514	550	6,889	4.0	444.1[3]	444.1[3]	444.1[3]	0.0
DB	435,440	375	4,632	6.0	444.3[3]	444.3[3]	444.3[3]	0.0
DC	437,804	905	30,325	0.9	445.0[3]	445.0[3]	445.1[3]	0.1
DD	440,788	1,740	148,594	0.2	445.1[3]	445.1[3]	445.1[3]	0.0

[1]Feet Above Cross Section A
[2]NGVD29
[3]NAVD88

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK
AND INCORPORATED AREAS

FLOODWAY DATA

KENAI RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Kwechak Creek								
A[2]	144.2	400.0	1304.4	6.5	136.1	136.1	136.1	0.0
B[2]	556.3	620.0	2903.7	5.9	142.8	142.8	142.9	0.1
C	1231.5	337.0	541.8	5.1	152.1	152.1	152.8	0.7
D	1778.3	203.0	424.6	6.6	161.8	161.8	162.0	0.2
E	2348.6	76.0	321.6	8.7	170.3	170.3	170.4	0.1
F	2880.2	95.0	289.6	9.6	179.5	179.5	179.7	0.2
G	3299.4	76.0	337.7	8.2	187.0	187.0	187.3	0.3
H	3546.7	66.0	297.3	9.4	190.1	190.1	190.4	0.3
I	3952.4	100.8	393.5	7.1	196.3	196.3	196.9	0.6
J	4254.9	86.8	295.7	9.4	200.7	200.7	200.7	0.0
K	4771.1	118.4	425.6	6.5	207.8	207.8	208.5	0.7
L	5507.2	97.6	286.0	9.7	220.1	220.1	220.3	0.2
M	6241.9	92.6	334.1	8.6	234.3	234.3	235.3	1.0
N	6852.3	95.9	301.9	9.3	245.4	245.4	246.2	0.8
O	7513.5	75.1	271.5	10.2	260.0	260.0	260.9	0.9
P	8163.6	109.6	359.1	7.7	273.4	273.4	273.6	0.2
Q	8645.3	76.9	276.2	10.1	281.6	281.6	281.8	0.2
R	9380.1	52.5	237.6	11.7	298.1	298.1	298.6	0.5
S	10124.5	133.7	364.6	7.6	314.7	314.7	315.3	0.6
T	10890.0	44.8	220.8	12.6	335.6	335.6	336.6	1.0

[1]Feet Above Confluence with Salmon Creek
[2]Shared Floodway with Salmon Creek

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

KWECHAK CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD88)	WITHOUT FLOODWAY (FEET NAVD88)	WITH FLOODWAY (FEET NAVD88)	INCREASE (FEET)
Ninilchik River								
A	575	139	2,780	1.5	18.0	17.5[2]	17.5	0.0
B	2,209	147	1,462	2.8	18.0	17.9[2]	17.9	0.0
C	3,182	191	1,118	3.8	18.2	18.2	18.3	0.1
D	4,304	43	514	8.2	28.5	28.7	28.7	0.2
E	4,725	136	782	5.4	30.1	30.4	30.4	0.3
F	5,840	104	668	6.3	35.1	36.0	36.0	0.9
G	6,416	73	535	7.9	38.1	38.1	38.5	0.4
H	6,469	56	523	8.0	38.6	38.6	38.9	0.3

[1] Feet above Confluence with Cook Inlet
[2] Elevations Computed Without Consideration of Backwater Effects From Cook Inlet

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS

FLOODWAY DATA

NINILCHIK RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD88)	WITHOUT FLOODWAY (FEET NAVD88)	WITH FLOODWAY (FEET NAVD88)	INCREASE (FEET)
North Fork Chakok River								
A	1,041	55	275	9.0	42.3	41.6	42.2	0.6
B	1,226	73	751	3.8	48.3	48.3	48.3	0.0
C	1,670	230	707	6.0	48.3	48.3	48.4	0.1

[1] Feet above confluence with Anchor River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS

FLOODWAY DATA

NORTH FORK CHAKOK RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Resurrection River								
A	144.0	3060.0	10014.7	2.9	16.2	12.3[2]	13.0[2]	0.7
B	698.2	3010.0	11189.3	2.6	16.2	12.8[2]	13.5[2]	0.7
C	1336.0	2900.0	10767.5	2.7	16.2	13.3[2]	14.0[2]	0.7
D	1790.7	2800.0	9670.6	3.0	16.2	13.6[2]	14.4[2]	0.8
E	2431.9	2443.5	7453.1	3.9	16.2	14.3[2]	15.1[2]	0.8
F	3093.5	2127.4	6729.8	4.3	16.2	15.7[2]	16.6[2]	0.9
G	3589.0	1844.5	6055.8	4.8	17.8	17.8	18.1	0.3
H	3950.0	1750.0	5710.6	5.1	19.3	19.3	19.6	0.3
I	4459.9	1650.0	5861.5	5.0	21.5	21.5	21.8	0.3
J	4993.6	1485.1	6302.6	4.6	23.4	23.4	23.9	0.5
K	5408.3	1293.9	4548.5	6.4	25.1	25.1	25.6	0.5
L	6068.0	1523.5	4988.7	5.9	28.1	28.1	29.0	0.9
M	6545.5	1494.5	4520.4	6.5	30.2	30.2	31.2	1.0
N	7066.7	1340.0	5515.5	5.3	33.1	33.1	33.7	0.6
O	7482.1	1320.0	5857.4	5.0	34.5	34.5	35.0	0.5
P	8147.1	1840.0	5916.0	4.9	37.3	37.3	37.4	0.1
Q	8636.7	2255.0	7887.7	3.7	38.7	38.7	38.8	0.1
R	9199.1	2474.3	7939.0	3.7	40.1	40.1	40.1	0.0
S	9719.2	2350.0	6918.8	4.2	42.0	42.0	42.2	0.2
T	10134.2	2300.0	7989.5	3.6	43.6	43.6	44.1	0.5
U	10775.2	2200.0	5962.0	4.8	45.8	45.8	46.4	0.6
V	11233.3	2275.0	6838.7	4.2	48.2	48.2	48.9	0.7

[1]Feet Above Resurrection Bay
[2]Elevations Computed Without Consideration of Coastal Flooding Effects From Resurrection Bay

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

RESURRECTION RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Resurrection River (Continued)								
W	11995.4	2110.0	5975.7	4.8	51.9	51.9	52.9	1.0
X	12752.7	1650.0	4881.1	5.9	56.2	56.2	56.9	0.7
Y	13272.9	1100.0	3826.8	6.6	58.3	58.3	58.8	0.5
Z	13758.8	1000.0	3721.0	6.8	60.6	60.6	60.7	0.1
AA	14248.8	1213.9	3476.6	7.3	62.8	62.8	63.0	0.2
AB	14769.3	1215.0	4081.6	6.2	65.6	65.6	65.8	0.2
AC	15261.1	1125.0	3146.4	8.0	68.2	68.2	68.4	0.2
AD	15760.6	870.0	3387.1	7.5	71.8	71.8	71.8	0.0
AE	16456.8	765.0	3298.0	7.7	74.8	74.8	75.2	0.4

[1]Feet Above Resurrection Bay

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

RESURRECTION RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Salmon Creek								
A	0.0	868.9	2096.9	2.2	16.2	13.2[2]	13.3[2]	0.1
B	933.7	1134.7	2491.3	1.9	16.2	14.4[2]	14.7[2]	0.3
C	1814.9	1264.3	2590.7	1.8	16.2	15.6[2]	16.0[2]	0.4
D	2702.3	1680.4	2595.0	1.8	17.6	17.6	18.0	0.4
E	3504.6	1293.1	2459.5	1.9	20.3	20.3	20.8	0.5
F	4419.0	350.0	1333.1	3.5	23.1	23.1	23.5	0.4
G	5107.3	630.0	2248.4	2.1	24.2	24.2	24.9	0.7
H	5635.9	705.3	2335.9	2.0	24.7	24.7	25.5	0.8
I	6021.3	830.0	2319.1	2.0	25.2	25.2	25.9	0.7
J	6364.7	804.6	1933.7	2.4	25.9	25.9	26.5	0.6
K	7254.7	116.0	603.3	7.7	29.2	29.2	29.6	0.4
L	7422.2	108.0	700.9	6.6	30.6	30.6	31.0	0.4
M	7775.5	820.0	4225.7	1.1	31.5	31.5	32.0	0.5
N	8574.2	1050.0	3595.6	1.3	31.8	31.8	32.2	0.4
O	9125.6	1125.0	2269.6	2.0	32.2	32.2	32.7	0.5
P	9540.8	1243.3	1297.0	3.6	33.6	33.6	34.2	0.6
Q	10268.0	986.0	1968.7	2.5	35.7	35.7	36.7	1.0
R	10597.6	933.5	1217.6	4.0	37.7	37.7	38.0	0.3
S	10834.2	439.6	1373.8	5.6	39.4	39.4	39.7	0.3
T	11115.5	886.7	6106.8	1.7	43.4	43.4	43.9	0.5
U	11738.2	1017.2	4444.0	1.8	43.7	43.7	44.2	0.5
V	12193.0	930.0	3896.1	1.7	44.1	44.1	44.7	0.6

[1]Feet Above Resurrection Bay
[2]Elevations Computed Without Consideration of Backwater Effects From Resurrection Bay

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

SALMON CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Salmon Cr. (Continued)								
W	12573.7	953.8	2594.4	2.5	45.0	45.0	45.7	0.7
X	13178.6	835.0	2310.0	2.8	48.7	48.7	49.1	0.4
Y	13607.2	1081.0[2]	3524.0	1.7	51.5	51.5	51.7	0.2
Z	14045.8	1377.0[2]	3764.0	1.6	53.8	53.8	54.2	0.4
AA	14431.3	1380.0[2]	3457.3	1.7	57.3	57.3	57.4	0.1
AB	14640.0	1336.0[2]	3671.3	1.6	58.8	58.8	58.9	0.1
AC	14856.7	1221.0[2]	3592.4	1.7	60.3	60.3	60.3	0.0
AD	15102.4	1055.0[2]	3186.4	1.9	61.8	61.8	61.9	0.1
AE	15581.9	1130.0[2]	3567.3	1.7	64.9	64.9	65.0	0.1
AF	16294.3	1177.0[2]	2475.9	2.4	67.5	67.5	67.7	0.2
AG	17103.6	817.6	659.7	7.5	73.0	73.0	73.5	0.5
AH	17545.9	560.0	1788.7	2.8	76.4	76.4	77.4	1.0
AI	17970.5	345.1	720.1	6.9	78.1	78.1	78.9	0.8
AJ	18417.3	130.5	730.3	6.8	83.3	83.3	83.9	0.6
AK	18708.8	130.0	638.6	7.8	85.3	85.3	85.7	0.4
AL	18935.9	80.0	444.9	11.2	87.3	87.3	87.8	0.5
AM	19076.7	108.3	763.9	6.5	90.3	90.3	90.3	0.0
AN	19448.1	107.9	632.9	8.3	91.7	91.7	91.8	0.1
AO	19858.5	541.7	1380.6	4.3	93.6	93.6	94.6	1.0
AP	20120.5	620.0	1957.7	3.0	95.4	95.4	95.8	0.4
AQ	20384.5	700.0	1681.2	3.5	96.5	96.5	97.4	0.9
AR	20789.2	655.0	2083.2	2.8	101.0	101.0	101.6	0.6

[1]Feet Above Resurrection Bay
[2]Floodway Width Includes Dry Land

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

SALMON CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Salmon Cr. (Continued)								
AS	21295.0	540.0	2002.7	3.0	105.0	105.0	105.7	0.7
AT	21674.3	624.0	2147.2	2.8	108.0	108.0	108.6	0.6
AU	22110.7	753.5	1104.3	5.4	112.1	112.1	113.0	0.9
AV	22534.3	895.0	1763.5	3.4	116.6	116.6	117.5	0.9
AW	22885.5	698.9	1163.4	5.1	119.6	119.6	120.4	0.8
AX	23316.7	281.0	900.7	6.6	125.5	125.5	126.0	0.5
AY	23747.3	250.0	932.5	6.3	132.1	132.1	133.1	1.0
AZ[2]	24119.2	400.0	1480.5	3.6	136.4	136.4	137.2	0.8
BA[2]	24482.2	620.0	1225.9	4.3	139.5	139.5	139.7	0.2
BB	24929.7	292.0	874.9	6.1	143.3	143.3	143.6	0.3
BC	25217.7	215.0	863.0	6.2	145.1	145.1	145.4	0.3
BD	25528.2	273.0	1304.5	4.1	146.8	146.8	147.1	0.3
BE	25689.5	156.6	797.7	6.7	147.2	147.2	147.4	0.2
BF	25869.8	122.4	956.1	5.6	149.0	149.0	149.0	0.0
BG	26005.6	358.3	1655.4	3.5	149.5	149.5	149.6	0.1
BH	26449.5	135.0	592.4	10.7	150.6	150.6	151.0	0.4
BI	26912.0	180.0	1224.9	5.2	154.4	154.4	155.4	1.0
BJ	27443.5	142.5	608.5	10.4	157.3	157.3	157.3	0.0
BK	27897.6	105.0	956.2	6.6	160.4	160.4	160.9	0.5
BL	28456.2	135.0	946.3	6.7	162.0	162.0	162.3	0.3
BM	29068.7	69.3	520.3	12.2	163.7	163.7	164.6	0.9
BN	29625.9	162.2	1245.9	5.1	168.6	168.6	168.6	0.0

[1]Feet Above Resurrection Bay
[2]Shared Floodway with Kwechak Creek

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

SALMON CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Salmon Cr. (Continued)								
BO	30971.1	217.8	922.1	5.4	171.6	171.6	171.7	0.1
BP	31569.1	120.0	457.7	10.9	175.6	175.6	176.3	0.7
BQ	32112.8	191.2	807.5	6.2	183.6	183.6	184.2	0.6
BR	32150.3	214.4	1675.6	2.5	184.8	184.8	185.2	0.4
BS	32693.7	200.9	806.0	5.3	185.8	185.8	186.1	0.3
BT	33134.6	300.0	828.8	5.1	189.0	189.0	189.7	0.7

[1]Feet Above Resurrection Bay

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

SALMON CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Salmon Creek Overflow								
A	979.1	115.1	157.6	6.5	71.5	71.5	71.6	0.1
B	1482.0	97.5	344.0	3.0	77.4	77.4	77.6	0.2
C	1760.7	66.0	220.2	4.6	79.2	79.2	79.4	0.2
D	2151.8	149.3	462.2	2.2	81.7	81.7	81.9	0.2
E	2421.6	209.5	583.2	1.8	82.3	82.3	82.7	0.4
F	2719.8	236.7	507.4	2.0	83.1	83.1	83.6	0.5
G	3074.1	177.0	383.3	2.7	85.5	85.5	85.5	0.0
H	3524.9	117.3	247.1	4.1	90.3	90.3	90.5	0.2
I	3686.7	32.9	149.9	13.4	95.1	95.1	95.2	0.1
J	3773.0	180.3	1396.6	0.8	98.1	98.1	99.0	0.9
K	3925.9	156.0	1263.4	0.8	98.1	98.1	99.0	0.9
L	4295.4	80.0	465.7	2.2	98.2	98.2	99.0	0.8
M	4637.5	43.4	113.4	9.0	104.5	104.5	104.6	0.1
N	4856.4	59.8	205.6	5.0	108.7	108.7	108.8	0.1
O	5149.0	87.9	322.7	3.2	110.8	110.8	110.9	0.1
P	5506.5	245.3	458.8	2.2	112.7	112.7	113.0	0.3
Q	5891.9	245.7	271.0	3.8	117.4	117.4	117.7	0.3
R	6201.3	262.9	444.6	2.3	122.3	122.3	122.3	0.0
S	6578.5	170.4	276.9	3.7	126.4	126.4	126.7	0.3
T	6963.7	158.3	375.6	2.7	130.9	130.9	131.7	0.8
U	7365.0	125.4	279.3	3.7	135.1	135.1	135.9	0.8
V	7798.7	134.5	353.7	2.9	140.0	140.0	140.1	0.1

[1]Feet Above Confluence with Salmon Creek

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

SALMON CREEK OVERFLOW

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Salmon Creek Overflow (Continued)								
W	8220.7	158.1	309.7	3.3	143.6	143.6	144.0	0.4
X	8522.7	158.8	409.8	2.5	146.1	146.1	146.4	0.3
Y	8758.7	173.5	409.4	2.5	147.6	147.6	147.7	0.1
Z	8821.6	251.1	365.5	0.0	147.8	147.8	147.9	0.1

[1]Feet Above Confluence with Salmon Creek

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

SALMON CREEK OVERFLOW

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Salmon Creek / Resurrection River Split								
A[2]	24.1	449.9	750.7	3.3	37.5	35.0[3]	36.0	1.0
B[2]	307.1	435.0	1042.8	2.4	37.9	36.3[3]	37.3	1.0
C	537.3	375.0	780.6	3.2	38.1	37.4[3]	38.3	0.9
D	788.0	360.0	1048.6	2.4	38.5	38.5	39.5	1.0
E	990.7	330.0	1412.0	1.8	38.8	38.8	39.7	1.0
F	1213.0	285.0	1204.0	2.1	38.9	38.9	39.9	0.9
G	1615.0	145.8	225.2	0.0	39.3	39.3	40.2	0.9

[1]Feet Above Confluence with Resurrection River
[2]Shared Floodway with Resurrection River
[3]Elevations computed without backwater effects from Resurrection River

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

SALMON RESURRECTION SPLIT

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Salmon Creek Split								
A	856.4	128.9	373.3	2.1	43.0	43.0	43.2	0.2
B	1557.0	113.9	165.1	4.8	46.3	46.3	46.5	0.2
C	1900.8	62.5	195.0	4.0	50.0	50.0	50.2	0.2
D	2195.5	70.8	154.7	5.1	52.6	52.6	53.1	0.5
E	2507.4	140.7	303.1	2.6	55.7	55.7	56.0	0.3
F	3003.6	142.0	192.3	4.1	60.1	60.1	60.3	0.2
G	3457.2	150.0	271.6	2.9	65.7	65.7	66.6	0.9
H	3850.5	205.0	273.0	2.9	69.5	69.5	69.7	0.2
I	4344.8	152.4	211.0	3.7	73.4	73.4	74.2	0.8
J	4867.0	164.2	361.4	2.2	77.2	77.2	77.9	0.7
K	5317.9	148.4	297.5	2.7	78.8	78.8	79.7	0.9
L	5662.5	165.0	398.3	2.0	79.4	79.4	80.4	1.0
M	6042.8	296.8	168.9	4.7	84.8	84.8	84.8	0.0
N	6295.8	57.0	208.7	3.8	87.2	87.2	87.5	0.3
O	6343.9	100.0	409.6	1.9	87.4	87.4	87.8	0.4
P	6391.9	185.5	566.6	1.4	87.5	87.5	87.9	0.4

[1] Feet Above the Confluence with Salmon Creek

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

FLOODWAY DATA

SALMON CREEK SPLIT

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD88)	WITHOUT FLOODWAY (FEET NAVD88)	WITH FLOODWAY (FEET NAVD88)	INCREASE (FEET)
Sawmill Creek Split								
A	279.0	73.5	119.4	3.9	16.2[2]	12.7[3]	12.7[3]	0.0
B	724.0	86.8	223.8	2.1	16.2[2]	14.1[3]	14.2[3]	0.1
C	1038.0	116.5	451.4	5.5	16.2[2]	14.5[3]	14.6[3]	0.1
D	1178.0	116.5	332.0	4.7	17.6	17.6	17.6	0.0
E	1732.0	52.8	76.8	4.9	20.4	20.4	20.4	0.0
F	2075.0	66.0	120.6	3.4	23.6	23.6	23.6	0.0
G	2529.0	87.0	205.4	2.3	25.0	25.0	25.1	0.1
H	2969.0	98.7	80.3	5.8	31.1	31.1	31.1	0.0
I	3502.0	137.7	49.3	0.0	41.8	41.8	41.8	0.0

[1]Feet upstream from Resurrection Bay

[2]Backwater Effects From Resurrection Bay

[3]Elevations Computed Without Consideration of Backwater Effects From Resurrection Bay

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS

FLOODWAY DATA

SAWMILL CREEK SPILT

5.0 INSURANCE APPLICATIONS

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

Zone A

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

Zone AE

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

Zone AH

Zone AH is the flood insurance risk zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

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

Zone V

Zone V is the flood insurance risk zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no BFEs are shown within this zone.

Zone VE

Zone VE is the flood insurance risk zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

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

Zone D

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

6.0 FLOOD INSURANCE RATE MAP

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

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

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

Historical data relating to the maps prepared for each community are presented in Table 10, “Community Map History”.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
Homer, City of	May 19, 1981	None	June 16, 1999	September 25, 2009
*Kachemak, City of	N/A	None	N/A	September 27, 2013
[1]Kenai, City of	May 19, 1981	None	May 19, 1981	July 5, 1983 June 3, 1988 December 6, 1999
Kenai Peninsula, Borough of	May 19, 1981	None	May 19, 1981	
Seldovia, City of	N/A	None	N/A	
Seward, City of	May 19, 1981	None	May 19, 1981	September 27, 2013
[1]Soldotna, City of	December 6, 1999	None	December 6, 1999	September 27, 2013

*No special flood hazard areas identified
[1]Not a NFIP Community

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

Flood Insurance Studies have been performed for Seward, Soldotna, and Seldovia (References 32, 33, and 34, respectively). For Seldovia, in the 1999 FIS, the study area was increased to include the area where Trene Lake flows out to Kachemak Bay. Except for this area, the Coastal High Hazard runups to elevations of 37.3 feet (28 feet MLLW) and 34.3 feet (23 feet MLLW), in areas sheltered from runup but subject to tidal influence, were used from the previous study. The actual flood boundary differs from the March 1974 study at Seldovia due to the new mapping. The 1974 study mapping had no contour lines; thus, flood lines were not exact. Another change is the designation of the flood zone in Seldovia Bay. It was called Zone A in 1974 but is Zone V under the later coastal criteria guidelines. The original flood boundary at Seward (Reference 32) added the surge and runup to the highest observed tide. For the 1999 FIS, surge and runup were added to a calculated 1-percent-annual-chance tide which is less than reported previously.

There are several floodplain information reports for Kenai River (References 29, 30, and 31). This study generally agrees with those reports.

This study is also in general agreement with previously published Flood Hazard Boundary Maps for the Cities of Soldotna and Kenai (References 40 and 41, respectively).

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

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting FEMA, Federal Insurance and Mitigation Division, Federal Regional Center, 130 228th Street Southwest, Bothell, WA 98021-8627.

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39. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of Seldovia, Kenai Peninsula Borough, Alaska, unpublished.

40. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Soldotna, Kenai Peninsula Borough, Alaska, 1974.

41. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Kenai, Kenai Peninsula Borough, Alaska, 1974.

42. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, HEC-RAS River Analysis System Computer Program, Davis, California, April 1997.

43. U.S. Department of the Army, Corps of Engineers, Topographic Map, Scale 1:12,000, Contour Interval 2 feet, Kenai Peninsula Borough, Alaska, January 1997

10.0 REVISIONS DESCRIPTION

This section has been added to provide information regarding significant revisions made since the original FIS and FIRM were printed. Future revisions may be made that do not result in the republishing of the FIS report. All users are advised to contact the Community Map Repository at the address below to obtain the most up-to-date flood hazard data.

Donald E. Gilman River Center
514 Funny River Road
Soldotna, AK 99669

10.1 First Revision (Revised December 6, 1999)

This study was revised on December 6, 1999, to reflect corrections made to the topographic mapping on which the original hydraulic model was based. This is a restudy of approximately 5 miles of the Kenai River from approximately 4,500 feet downstream of the confluence with Shikok Creek to approximately 6.1 miles downstream of the confluence with Shikok Creek. This area is commonly referred to as Big Eddy. The Kenai River is within the boundaries of the Kenai Peninsula Borough.

The hydrologic and hydraulic analyses for the restudy were performed by the USACE, Alaska District, for the Federal Emergency Management Agency, under Interagency Agreement No. EMW-96- IA-0195, Project Order No. 9. This work was completed in December 1997.

In November 1995, the lower portion of the Kenai River experienced a flood event that approximated the 1-percent-annual-chance flood discharge figure used in the original study. While the water levels in the Big Eddy area were well below the 1-percent-annual-chance floodplain elevations identified in the original study, significant flooding occurred, inundating land identified as being above the 1-percent-annual-chance flood event. Subsequent investigations indicated an error in a portion of the topographic mapping on which the hydraulic model was based, necessitating the restudy.

The results of this restudy were reviewed at a final CCO meeting held on December 2, 1998, and attended by representatives of Kenai Peninsula Borough, USACE, Alaska Department of Community and Regional Affairs, and FEMA. All problems raised at that meeting have been addressed in this restudy.

A hydrologic analysis was done to establish peak discharge-frequency relationships for the Kenai River. Peak discharges were determined using USGS stream-gaging records for the Kenai River at Cooper Landing (1947 to 1996) and the Kenai River at Soldotna (1965 to 1996). Peak discharges for the glacier dam releases or "Jokulhlaups" were obtained from the National Weather Service river forecast office.

Water-surface elevations for the Kenai River were computed using the USACE HEC-RAS computer program (Reference 42).

The hydraulic analysis was performed using the USACE HEC-RAS computer program (Reference 42). The re-study model was calibrated against the November 1995 flood, the elevation of which had been surveyed in detail shortly after the flood. The restudy identified a new 1-percent-annual-chance discharge of 42,300 cfs, which is based on additional years of gaging records. This flow is higher than the 1-percent-annual-chance discharge determined by the original study. However, the new 1-percent-annual-chance discharge and resultant flood profile are applicable only to the restudy area.

Cross sections for the Kenai River were determined using topographic maps at a scale of 1:12,000, with a contour interval of 2 feet (Reference 43), supplemented by field surveys and actual flood watermarks placed by many residents during the flood. All waterway-opening and invert elevations through bridges and culverts were obtained through field surveys.

Manning's "n" roughness values were established based on field observations and engineering judgment. Channel roughness values along the Kenai River were 0.040. Overbank roughness values ranged from 0.040 - 0.080.

Starting water-surface elevations for the Kenai River were computed using the slope-area method.

Table 1, "Floods of Record on the Kenai Peninsula", Table 2, "Summary of Discharges", Table 5, "Floodway Data", and Exhibit 1, "Flood Profiles", were revised to reflect changes as a result of the restudy.

10.2 Second Revision (Revised September 27, 2013)

Bear Creek, Grouse Creek, Kwechak Creek, Resurrection River, Salmon Creek, and Sawmill Creek were modeled and mapped for FEMA Flood Insurance Studies within the City of Seward, Alaska and adjacent Borough lands. Northwest Hydraulic Consultants, Inc. (NHC) completed this work in December 2009. The work was conducted under IDIQ Contract EMS-2001-CO-0067 Task #28.

Peak discharge quantiles were updated for these six detailed study reaches. Discharge quantiles were initially estimated using regional regression equations developed by the USGS (Reference 11). These data were evaluated against observations of extreme peak discharges resulting from surge-release floods (i.e. debris dam failures) or other anomalous events and appropriate adjustments were then made to the peak flows (Reference 12).

The USACE HEC-RAS Version 4.0 was used for hydraulic modeling of the reaches. Cross sections for these models were cut from 2-foot contours provided by the Kenai Peninsula Borough, and augmented with in-stream survey and bridge soundings completed during the period of October to December 2007. Manning's "n" roughness values were selected based on professional judgment and comparing channel characteristics observed at the site to photographs of channels with computed "n" values. Each of the six study reaches are detailed in the following paragraphs.

Bear Creek

Bear Creek is a detailed study covering the 1 mile reach from Bear Lake to Salmon Creek. A Manning's "n" value of 0.04 was used within channel banks, 0.065 in the overbanks, and 0.085 in wooded overbanks upstream of the Bear Creek Road Culvert. The Bear Creek Fish weir and the fish hatchery were represented as physical features in the modeling. Both the 1- percent and 0.2-percent-annual-chance floodplain boundaries are completely contained within the incised channel corridor between Seward Highway and Bear Creek Road crossing. The floodway and floodplain are also coincident within this reach. For all other portions of Beer Creek, floodways were encroached to the channel banks without exceeding a 1-foot rise.

Grouse Creek

Grouse Creek is a limited detailed study extending approximately 0.6 mile from Grouse Lake to the confluence with Salmon Creek (where Grouse and Lost Creeks combine to become Salmon Creek). The downstream boundary conditions are based on assuming a coincident peak between Lost and Grouse Creeks because of similar drainage areas, 8.6 and 6 square miles, respectively (Table 2). The boundary condition elevations were taken from the upstream end of the Salmon Creek modeling. A check using a normal depth downstream boundary condition resulted in water surface elevations that are generally within a half a foot of those taken from the Salmon Creek modeling. Manning's roughness values of 0.05 and 0.1 were used for Grouse Creek in-channel and over bank areas, respectively. A floodway was not developed for Grouse Creek.

Kwechak Creek

Kwechak Creek is a detailed study extending approximately 2.5 upstream from the confluence with Salmon Creek. Manning's roughness values of 0.05 and 0.065 were used for Kwechak Creek in-channel and overbank areas, respectively. For the 0.2-percent annual chance event, a flow split was modeled starting upstream of the Bruno Street bridge and reconnecting with Kwechak Creek about 0.2 miles upstream of the confluence with Salmon Creek. Manning's roughness values of 0.065 and 0.085 were used in the split for the in-channel and overbank areas, respectively. The 1- percent-annual-chance and lower peak flows are not high enough to flow into this side channel. Cross-sections in the lower portion of the Kwechak Creek model are common with the Salmon Creek model. The lower part of the Kwechak Creek reach is perched, with earthen berms restricting flood water from reaching lower ground in the overbanks. Therefore, the final modeling results account for a "without levee" simulation that follow FEMA guidelines and assumes that these berms do not provide any flood protection for the 1-percent-annual-chance event. The without left levee failure of Kwechak Creek results in flows connecting with the left overbank of Salmon Creek (between river stations AU and BX). This flow is maintained in the overbank of Salmon Creek and intermittent high ground limits the flow from reaching the Salmon Creek main channel. Therefore, BFEs are different between the left overbank and main channel of Salmon Creek. This is reflected in the Salmon Creek Flood Profiles for the 1- percent-annual-chance flood. The floodway boundary encroaches to the banks of Kwechak Creek.

Resurrection River

Resurrection River is a detailed study extending approximately 3.0 miles upstream from Resurrection Bay. Manning's 'n' values of 0.035 to 0.1 in the overbanks, 0.035 to 0.04 in-channel were based on historical models, comparison of aerial photographs and channel characteristics observed onsite to photographs of channels with computed 'n' values, and professional judgment. A floodway analysis was completed to match effective floodway boundaries then adjusted as needed to produce up to a one-foot rise.

Salmon Creek

Salmon Creek is a detailed study covering the reach 6.5 miles upstream from Resurrection Bay. Manning's roughness values were selected based on field observations and comparison of channel photos. Manning's 'n'-values of 0.045 to 0.05 were used within main channel banks, with overbank 'n' values ranging from 0.055 to 0.12.

Three flow splits were also modeled; Salmon Creek Overflow, Salmon Creek Split, and Salmon Creek / Resurrection River Split.

The most upstream split, called Salmon Creek Overflow, occurs above Seward Highway. During high flows, water escapes the right bank and enters a swale running roughly parallel and to the west of the mainstem. Approximately 1 mile downstream, Salmon Creek Overflow passes through a pair of culverts in the Seward Highway. The side channel then continues roughly another 0.7 miles downstream before connecting back to the mainstem channel. Intermittent high ground between the Salmon Creek Overflow and Salmon Creek mainstem restricts flow passing between the two reaches. This results in different BFEs on the two reaches. Manning's 'n' values of 0.04 to 0.08 were used within main channel banks, with overbank 'n' values ranging from 0.08 to 0.10.

The second flow split, called Salmon Creek Split, occurs upstream of the railroad bridge (approximate 3.6 miles upstream of Resurrection Bay) where low ground allows flow to escape the left bank (to the south of the main channel). Salmon Creek Split runs roughly parallel to the railroad grade, and follows Salmon Creek Road, before reconnecting with the Salmon Creek mainstem approximately 1.4 miles upstream of Resurrection Bay where the Seward Highway and railroad grade crosses over Salmon Creek. Manning’s ‘n’ values of 0.065 and 0.08 were used within the main channel banks and overbank areas, respectively.

The third split, called Salmon Creek/Resurrection River Split, is located downstream of where water overtops the Seward Highway, on the right bank of Salmon Creek upstream of the Seward Highway and railroad grade bridge crossing over Salmon Creek. This split channel connects at the downstream end to the Resurrection River. The Seward Highway hinders, to some extent, the 1-percent-annual-chance event from flooding the downstream area. Because the roadway is not certified for flood protection the final modeling results account for a “without levee” simulation that follows FEMA guidelines and assumes that the roadway does not limit flow into the Salmon Creek/Resurrection River Split. Manning’s ‘n’ values used within the split reach range from 0.045 to 0.075.

A floodway was developed for Salmon Creek and the various split channels by starting with the effective floodway boundary and then making revisions to reflect newer topography and simulate up to a one-foot rise in the 1-percent-annual-chance peak flow.

<u>Sawmill Creek</u>

Sawmill Creek is a limited detailed study covering the reach 2 miles upstream from Resurrection Bay. Manning’s ‘n’ values of 0.05 were used within channel banks and 0.085 in the overbanks. Both the 1-percent and 0.2-percent-annual-chance floodplain boundaries are completely contained within the incised channel corridor in the upper reaches of Sawmill Creek.

The main branch of Sawmill Creek passes beneath the Nash Road Bridge and into Resurrection Bay through a channel confined on the right bank by an earthen berm. The final modeling results account for a “without levee” simulation that follow FEMA guidelines and assume that this berm does not provide any flood protection for the 1-percent-annual-chance event. Without the berm, flow inundates the right overbank area downstream of Nash Road. A floodway was not developed for Sawmill Creek.

A little more than half-a-mile upstream of Resurrection Bay, a low left bank allows an appreciable amount of flow to escape into a swale running along the north side of Nash Road. This flow split was modeled as a separate reach, referred to as Sawmill Creek Split, and passes through a series of culverts before ultimately emptying into Resurrection Bay.

The HEC-RAS model contains a lateral structure that allows for an interchange of flow between Sawmill Creek and the upstream cross sections of Sawmill Creek Split. A second lateral structure allows for flows in Sawmill Creek Split to short-circuit the normal reach length through a culvert under Nash Road.

The floodway was computed in HEC-RAS using the equal conveyance reduction methodology. Encroachment stations were computed at each cross section and the floodway boundaries were interpolated between cross sections.

Due to the lateral structure at the upstream end of Sawmill Creek Split, the encroachment at Cross Sections G through I results in a reduction of flow into Sawmill Creek Split, which, in turn, affects the downstream water surface elevations of both Sawmill Creek and Sawmill Creek Split. In order to minimize these impacts, the encroachment stations at these cross sections were set at the maximum cross section extents, and the regulatory floodway widths included in the Floodway Data Table are based on the 1-percent-annual-chance floodplain width. In addition, the floodway boundary between Cross Sections H and I was delineated to include the overflow area between the two streams to prevent encroachment into the overflow area resulting in adverse impacts to Sawmill Creek.

As part of this second revision, the format of the map panels has changed. Previously, flood-hazard information was shown on both the FIRM and Flood Boundary and Floodway Map. In the new format, all base flood elevations, cross sections, zone designations, and floodplain and floodway boundary delineations are shown on the Flood Insurance Rate Map and the Flood Boundary and Floodway Map has been eliminated. Some of the flood insurance zone designations were changed to reflect the new format. Areas previously shown as numbered Zone A were changed to Zone AE. Areas previously shown as Zone B were changed to Zone X (shaded). Areas previously shown as Zone C were changed to Zone X (unshaded). In addition, all Flood Insurance Zone Data Tables were removed from the FIS report and all zone designations and reach determinations were removed from the profile panels.

10.3 Third Revision (Revised November 06, 2013)

For this revision, STARR conducted 8 miles of revised Coastal Hazard Analysis that included computing wave runup. STARR utilized 25 transects in this study.

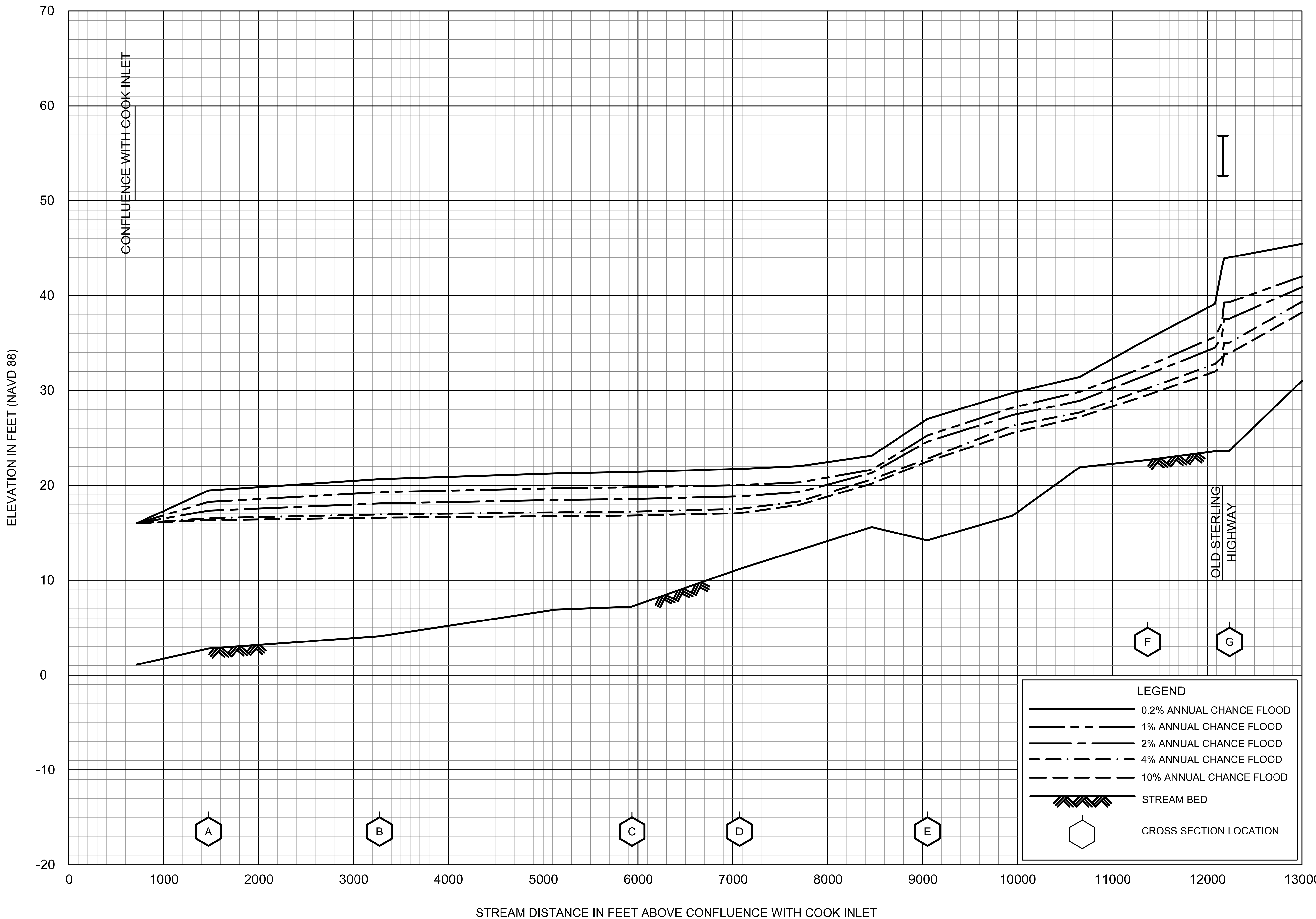
The wave climate for both Cook Inlet and Kachemak Bay was determined using methodology outlined in the 1984 version of the USACE "Shore Protection Manual (SPM)" (Reference 9). The under-water and above-water topography were determined using the National Geodetic Data Center Homer 1 arc-second DEM (Reference 10) and Light Detection And Ranging (LiDAR)-derived topography produced by Aero-Metric, Inc. (Reference 11). Because Cook Inlet and Kachemak Bay do not share the same storm exposure, an analysis of the wave climate was performed for each water body.

Wave conditions in Kachemak Bay are based on wind-generated waves traveling down the main axis of the bay. The wave growth is limited by the available fetch length. The wind data used to predict the wave conditions are taken from wind velocity-duration curves developed from 8 partial years of measurements at Homer Spit. Because the data sample is drawn from a short record, the velocity values were adjusted upwards by 10 percent. The 1-hour sustained wind speed having a 1-percent chance of being equaled or exceeded in any given year was used. Kachemak Bay is highly irregular in shape; therefore, the fetch length was developed using the restricted fetch methodology. The effective fetch length for the bay was determined to be approximately 8.5 miles. Using Figure 3-24 from the USACE SPM, in conjunction with the effective fetch length and 1-hour wind duration-wind speed, results in a wave height of 8.5 feet and an associate wave period of 5.25 seconds.

For Cook Inlet, extensive wind and deep-water wave analyses were performed by the USACE, Coastal Engineering Research Center (Reference 12). These analyses yielded a wave height of 30 feet associated with a wave having a 1-percent chance of being equaled or exceeded in any given year. These deep-water conditions cannot reach Homer Spit due to the shallowness of the area. This site is depth limited for extreme events. The largest wave that could reach the site is the breaking wave. The breaking-wave height depends on the wave period and depth. Field measurements and observations show that the wave period ranges from 7 to 9 seconds. A 10-second wave period was assumed to be the upper limit and was used in the wave-runup calculations.

Wave runup was computed for storms from both the Cook Inlet and Kachemak Bay sides of Homer Spit using the methodology outlined in the USACE SPM and the super-position principle. Transects along the spit were developed at which runup was calculated. A runup adjustment (Casco Bay method) was applied at the profile crest, where the slope becomes much more gradual. The transects were representative of the various reaches of the spit and included armored and natural beach areas. Five natural beach transects and eight armored sections were developed along the Cook Inlet side, and eight natural beach transects and four armored sections were developed along the Kachemak Bay side.

The primary intent of this revision was to re-delineate existing flood levels on the new topographic data. However, NHC agreed to take a qualitative look at the VE Zone flood elevations within Beluga Slough to determine if they could or should be refined. Based upon the review, it is recommended that at some point in the future, re-mapping the entire coastline using the new Pacific Coast procedures should be considered. There was not enough evidence to suggest that the mapped elevation within Beluga Slough is either right or wrong and the only way to determine this would be through a new study.



FLOOD PROFILES

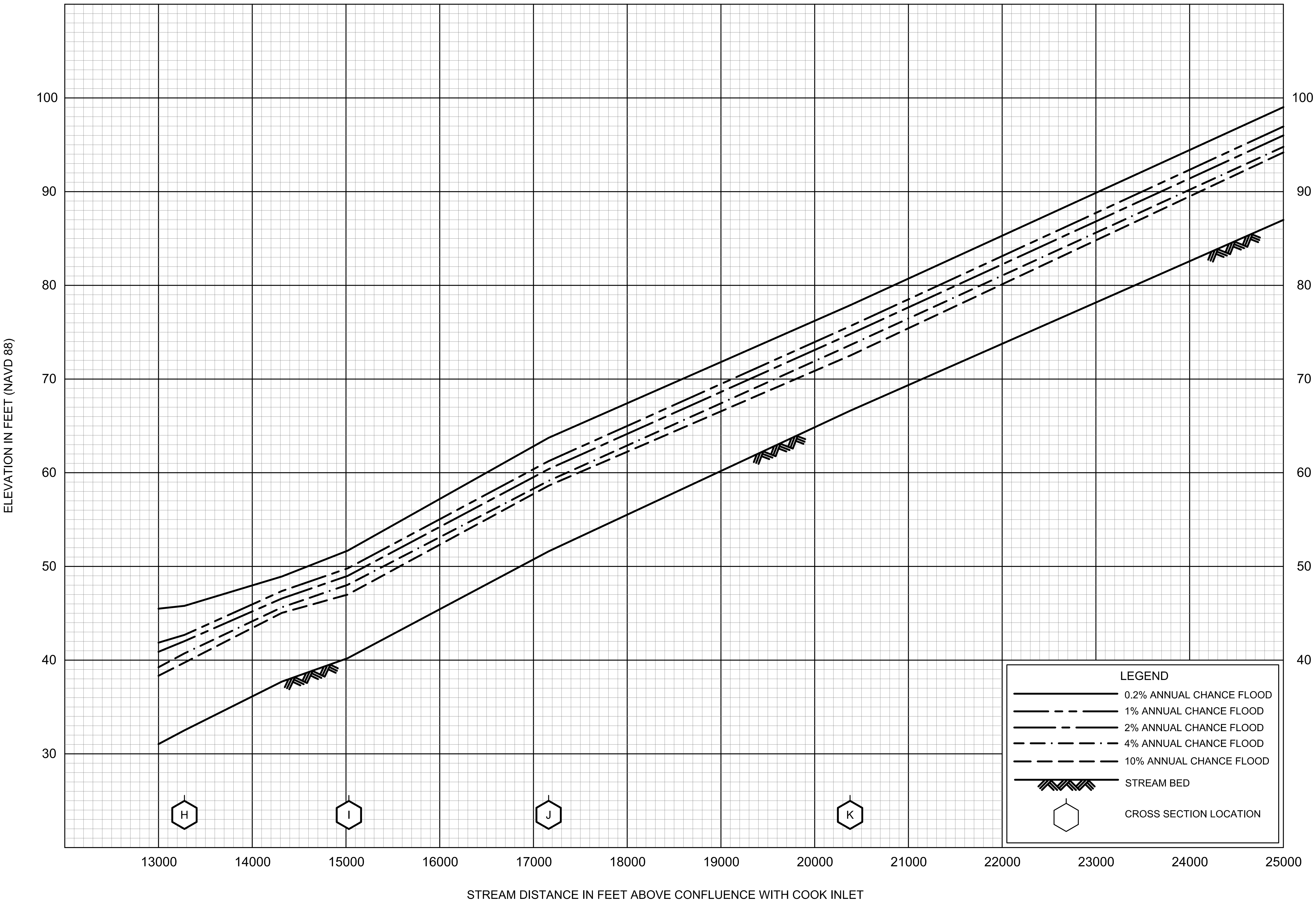
ANCHOR RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS

01P



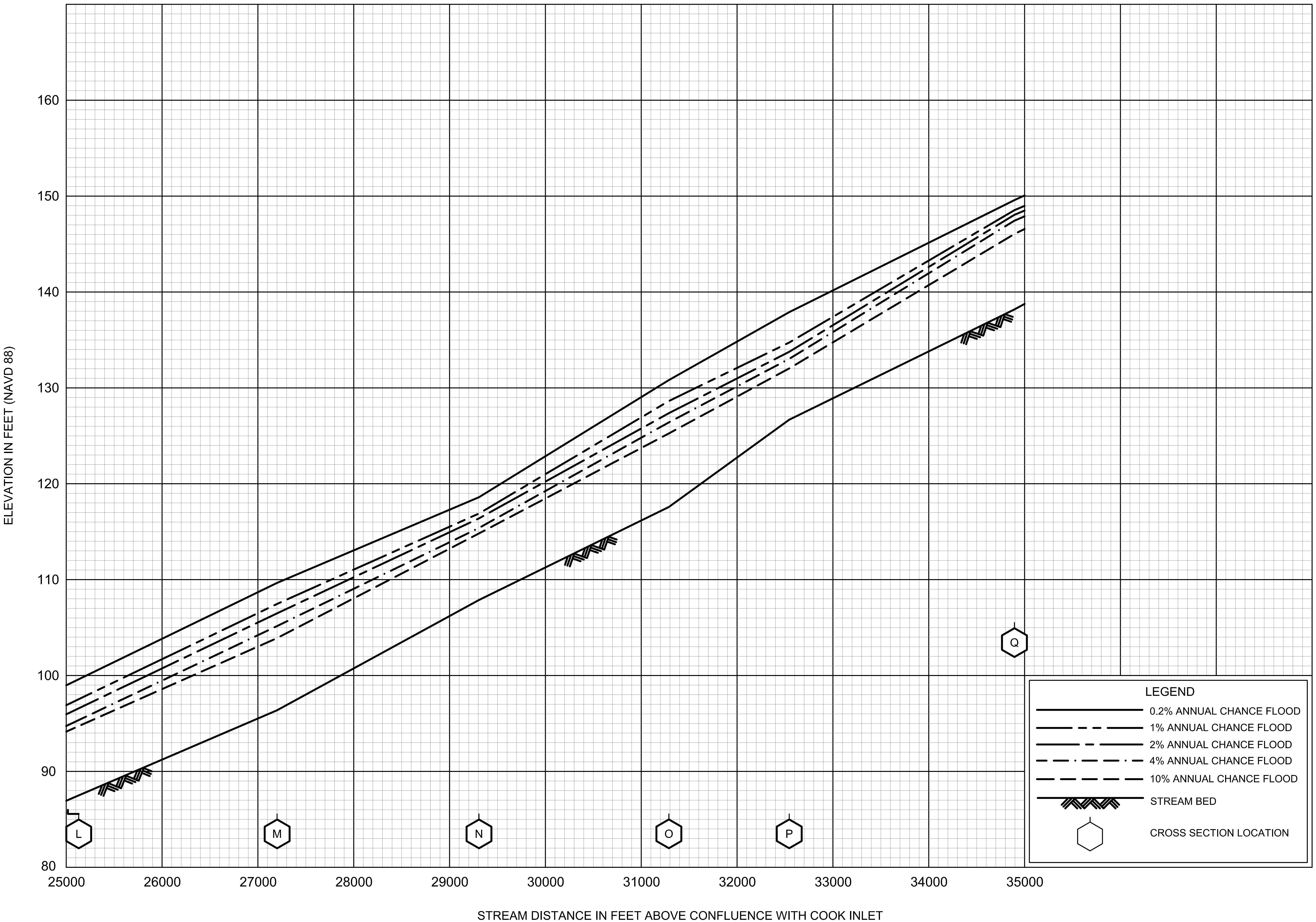
FLOOD PROFILES

ANCHOR RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS



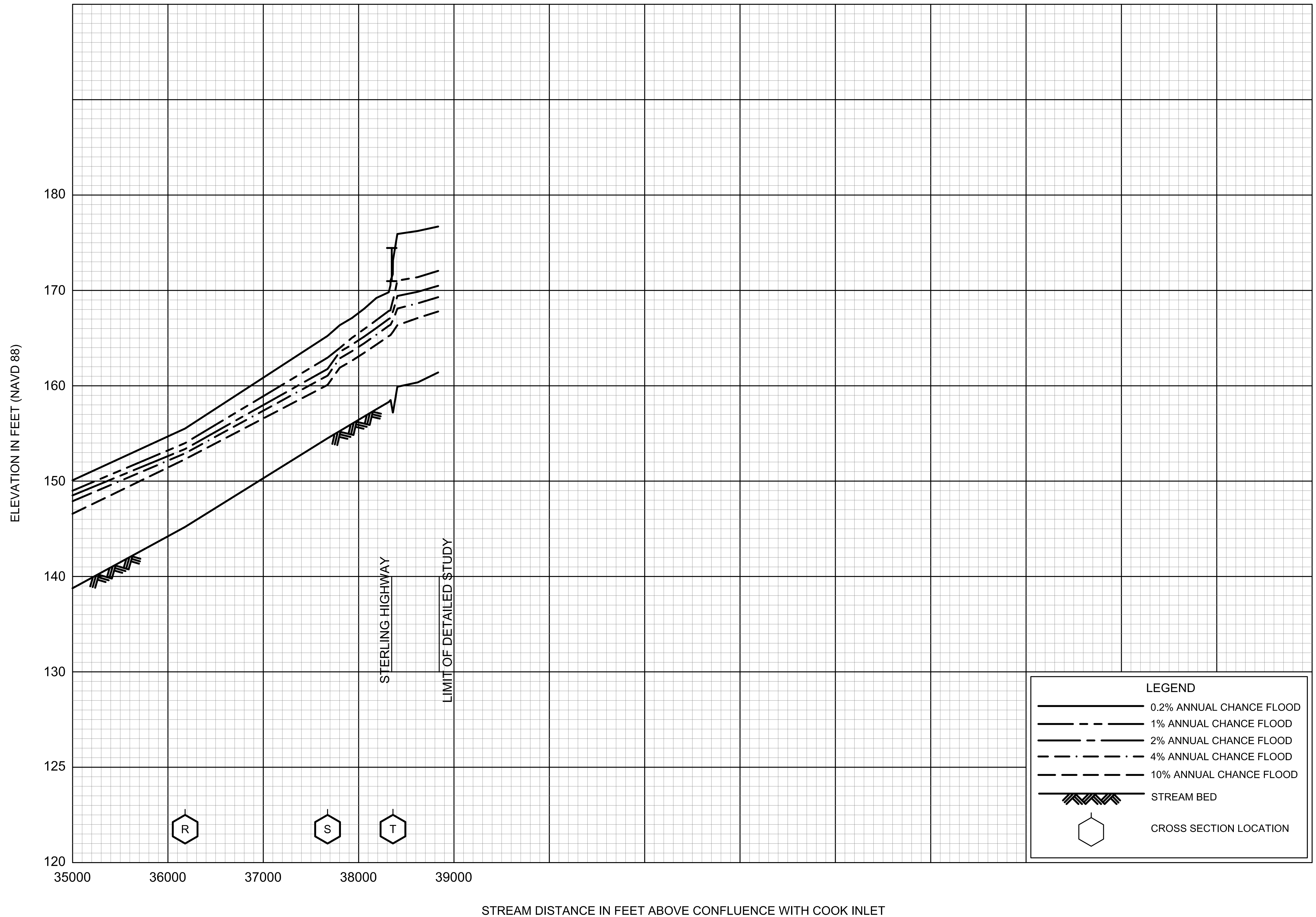
FLOOD PROFILES

ANCHOR RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS



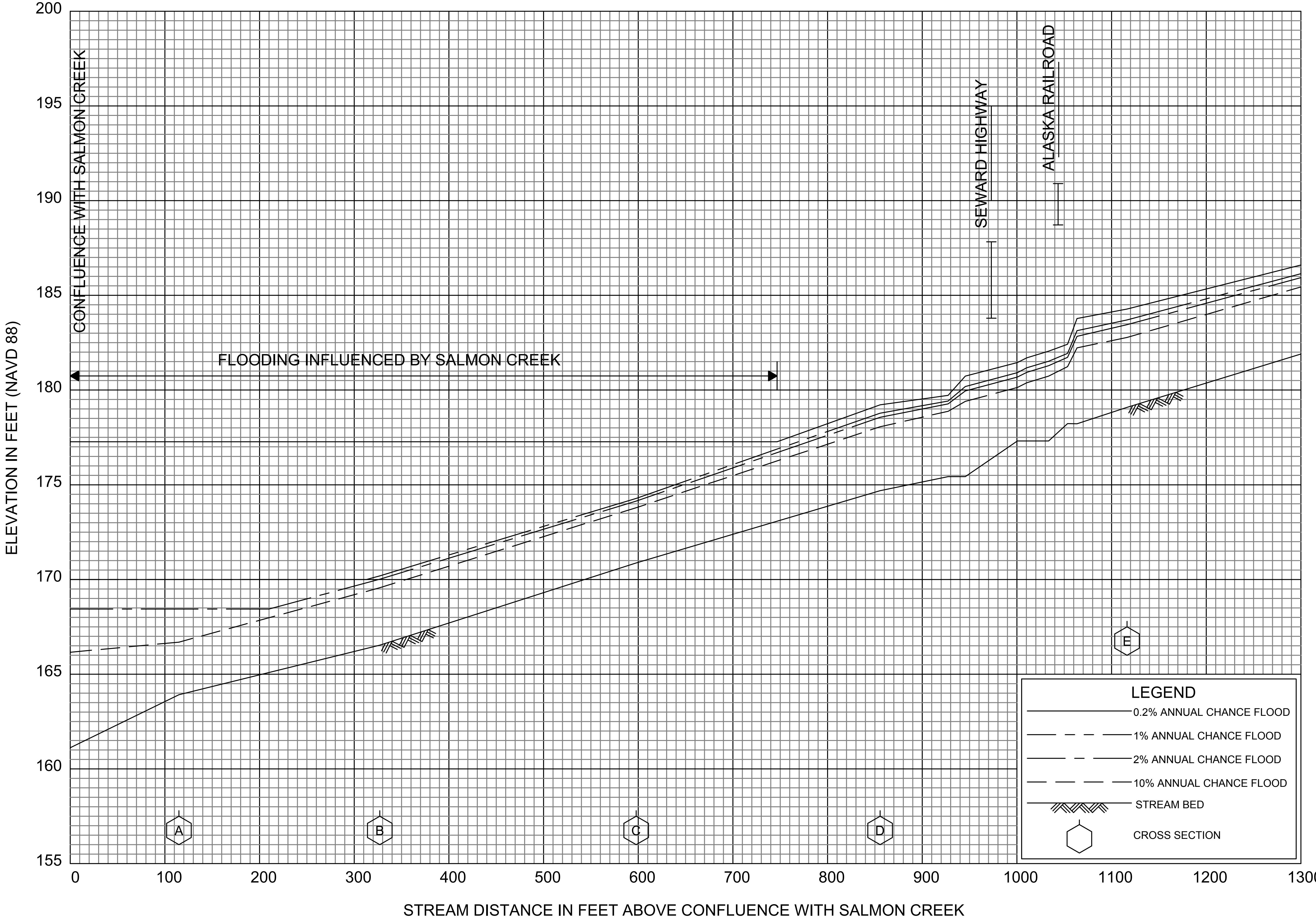
FLOOD PROFILES

ANCHOR RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS



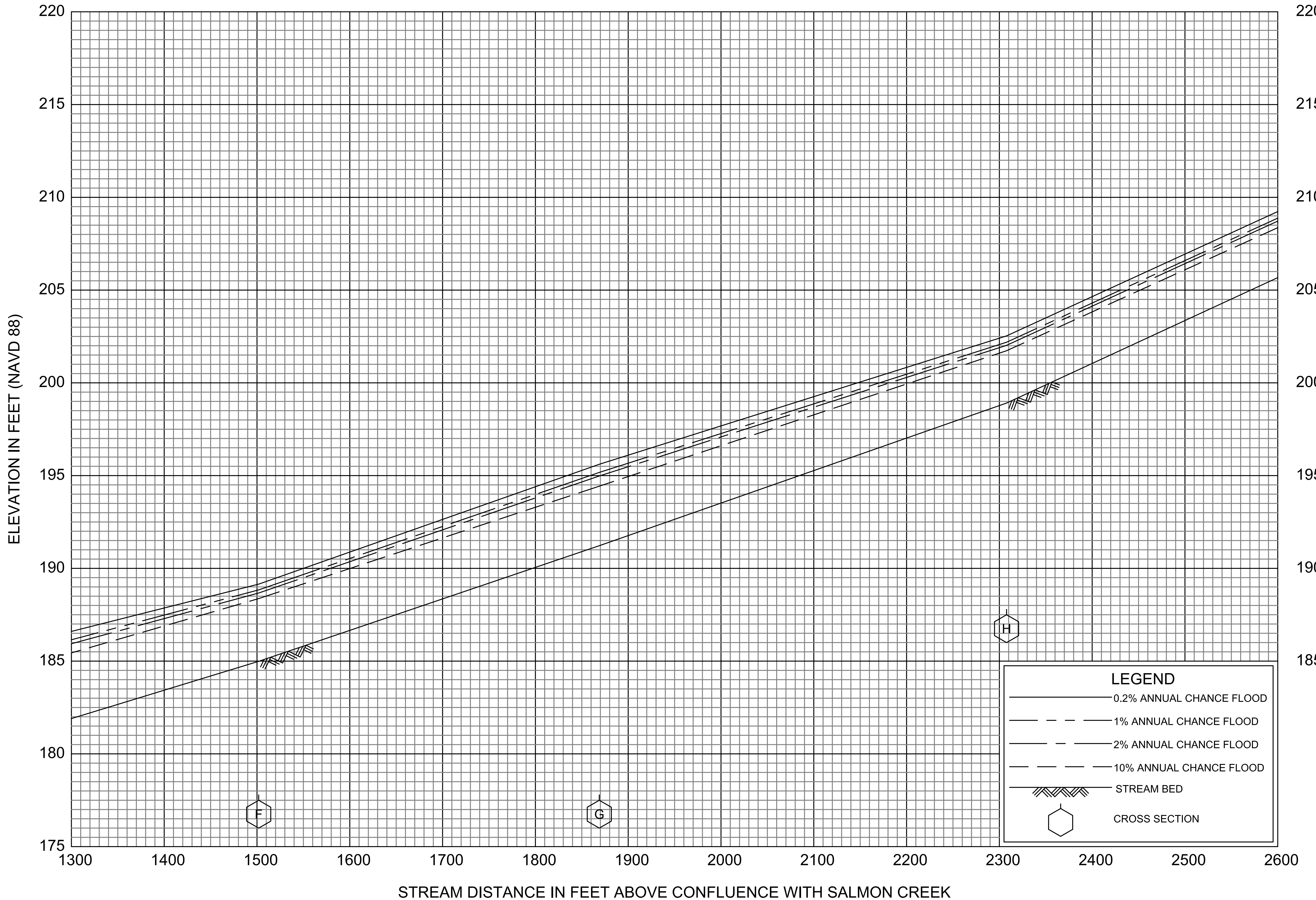
FLOOD PROFILES

BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

05P



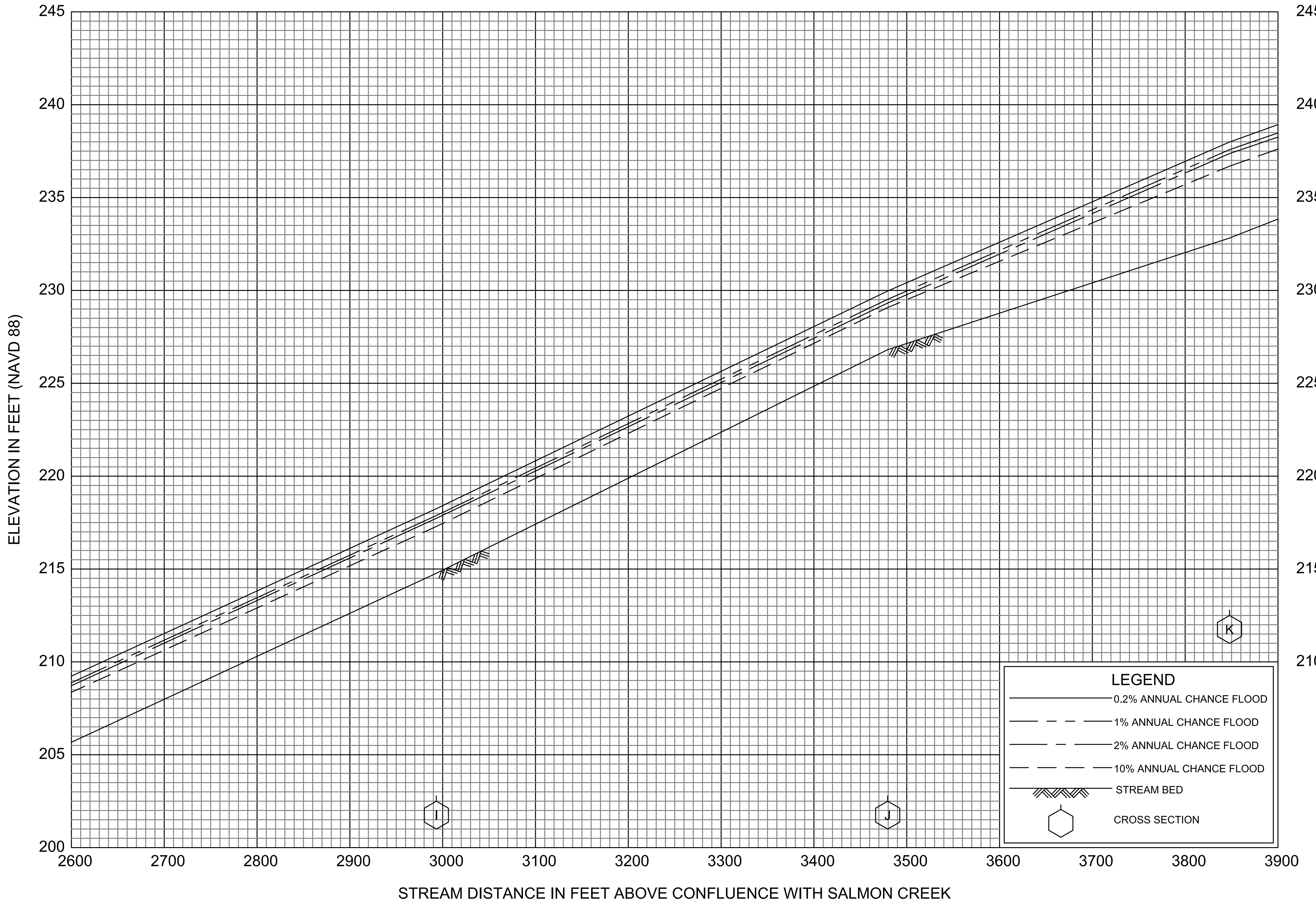
FLOOD PROFILES

BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

06P

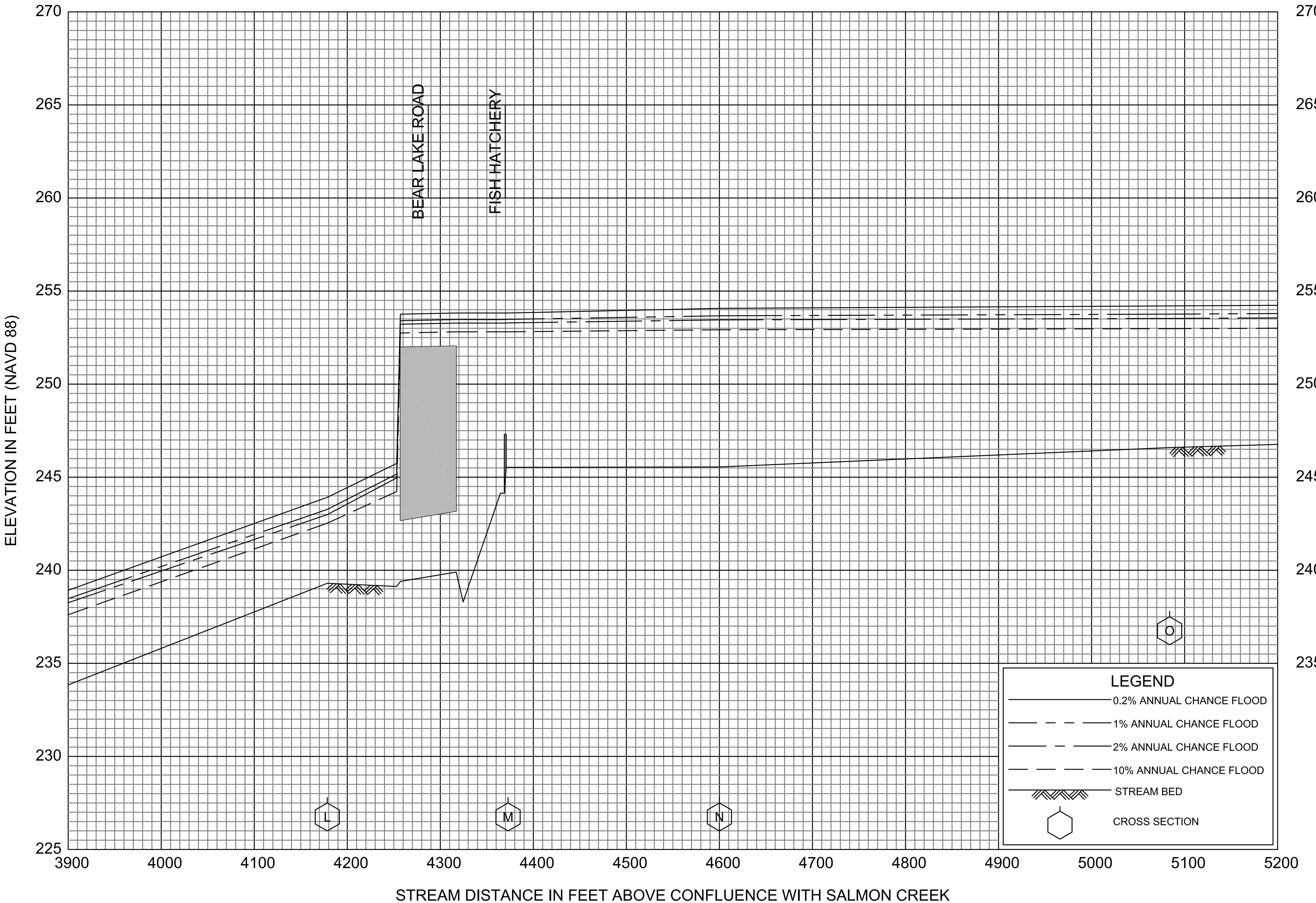


FLOOD PROFILES

BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS



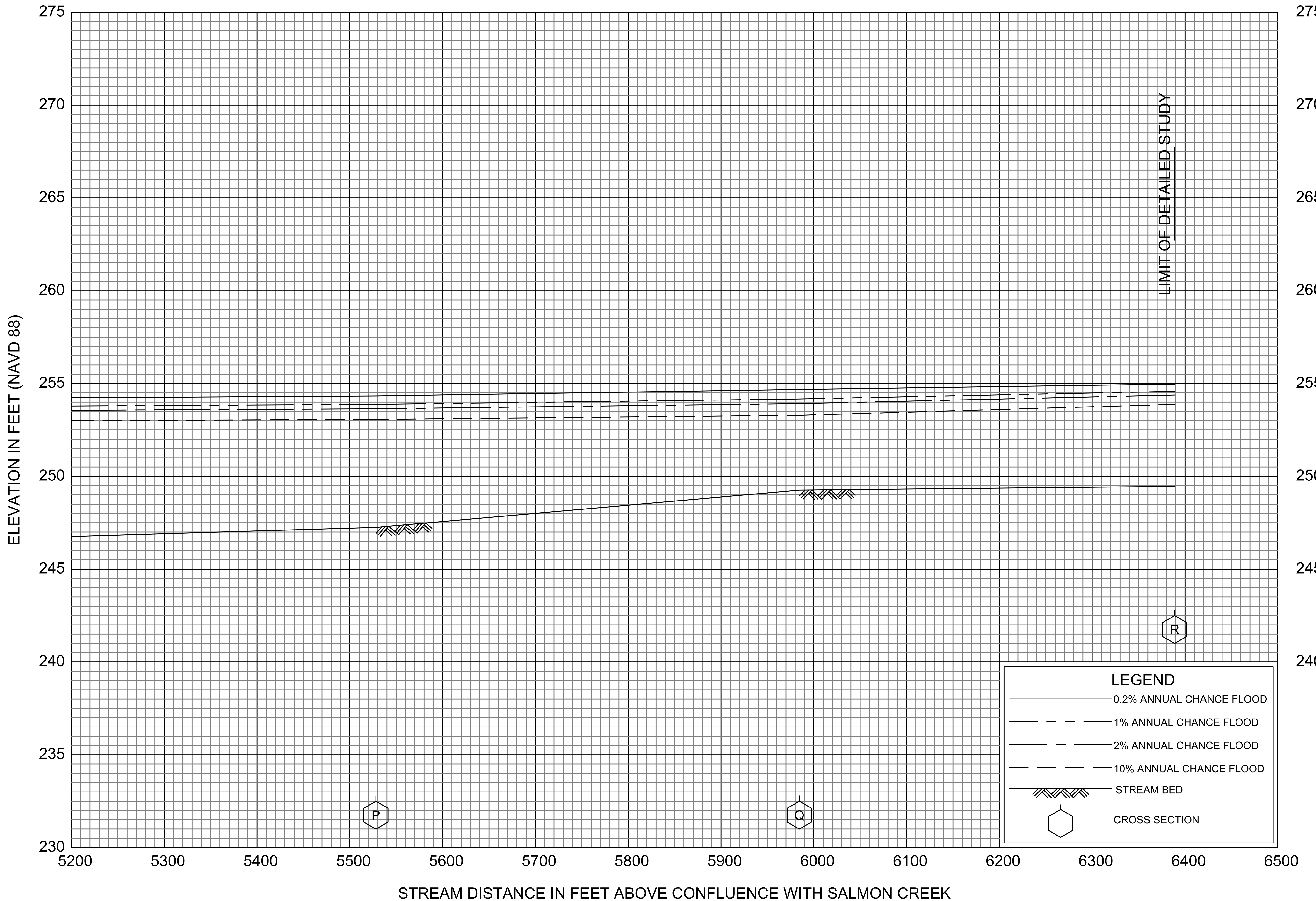
FLOOD PROFILES

BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

08P



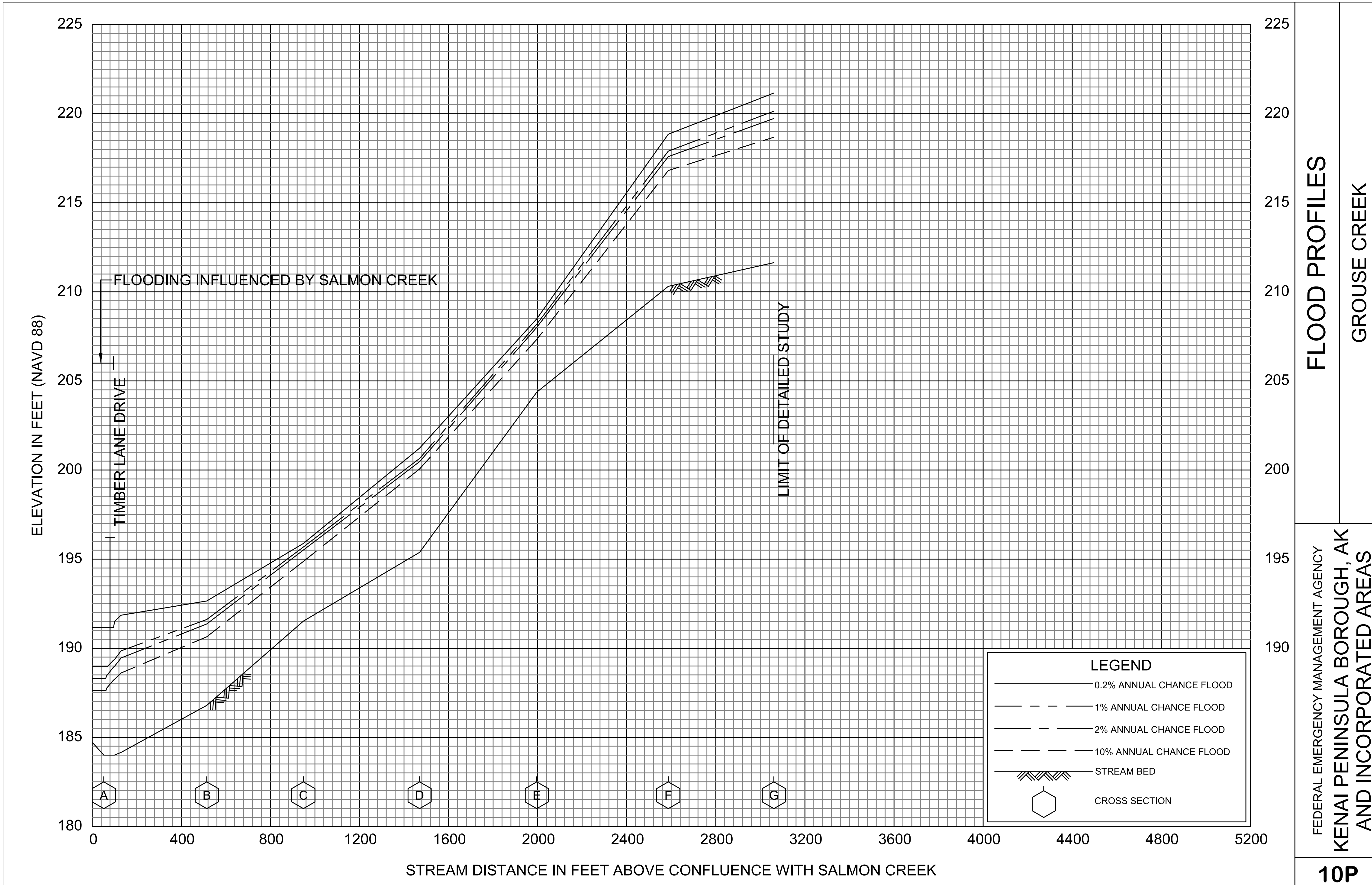
FLOOD PROFILES

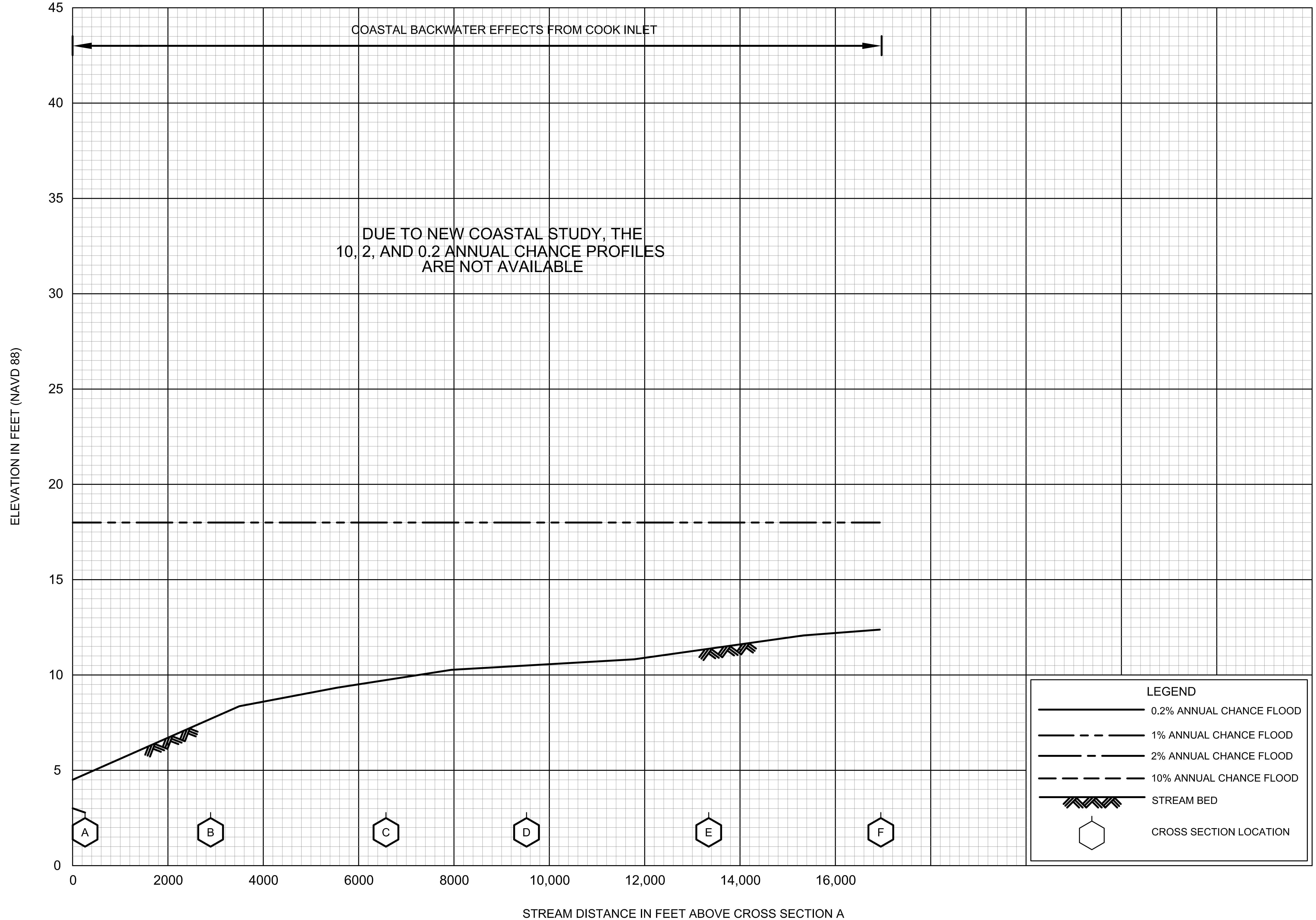
BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

09P


FLOOD PROFILES
GROUSE CREEK
FEDERAL EMERGENCY MANAGEMENT AGENCY
KENAI PENINSULA BOROUGH, AK
AND INCORPORATED AREAS
10P
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH SALMON CREEK
FLOODING INFLUENCED BY SALMON CREEK
TIMBER LANE DRIVE
LIMIT OF DETAILED STUDY
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION
A
B
C
D
E
F
G
225
220
215
210
205
200
195
190
185
180
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
4400
4800
5200



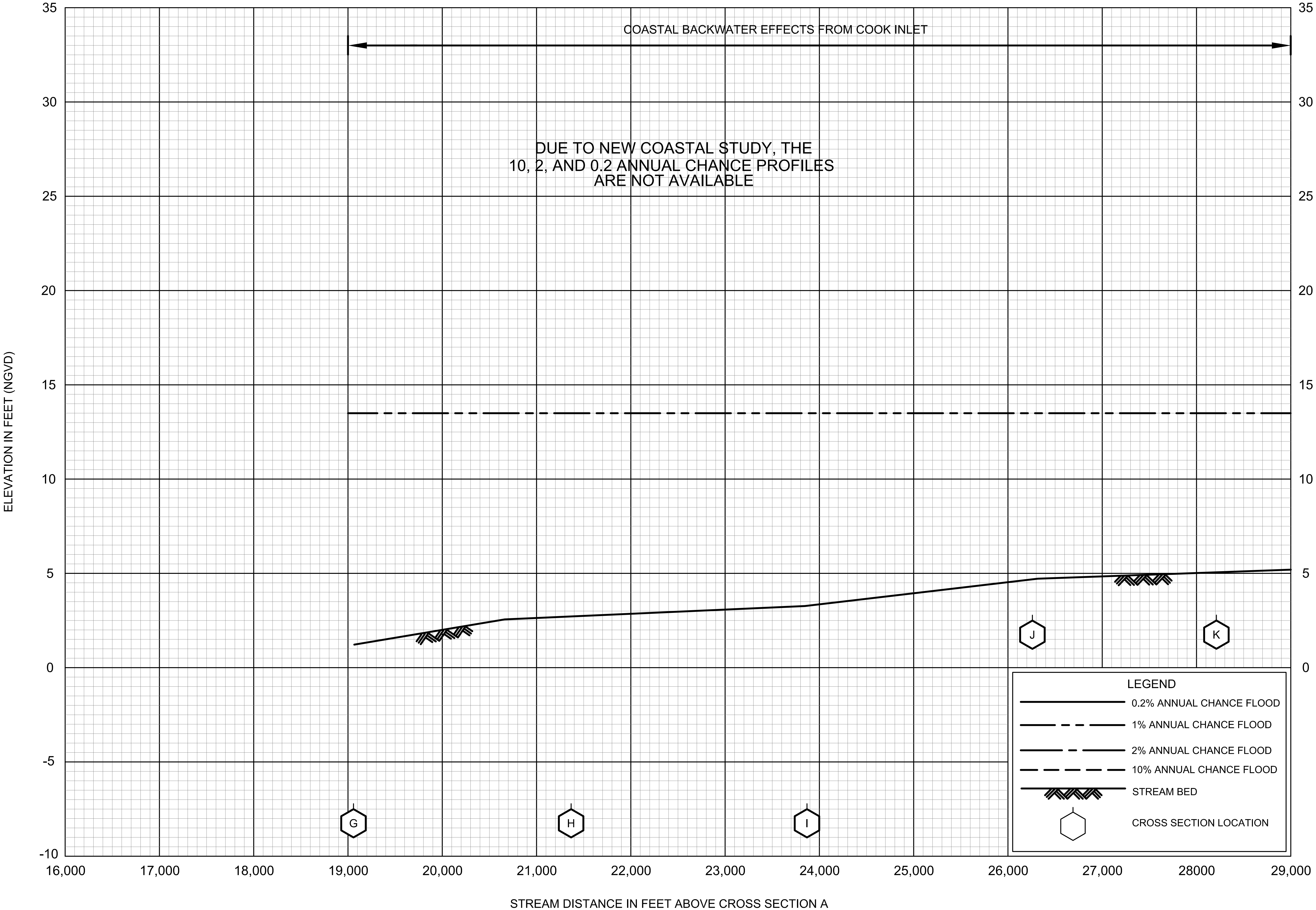
FLOOD PROFILES

KASILOF RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS



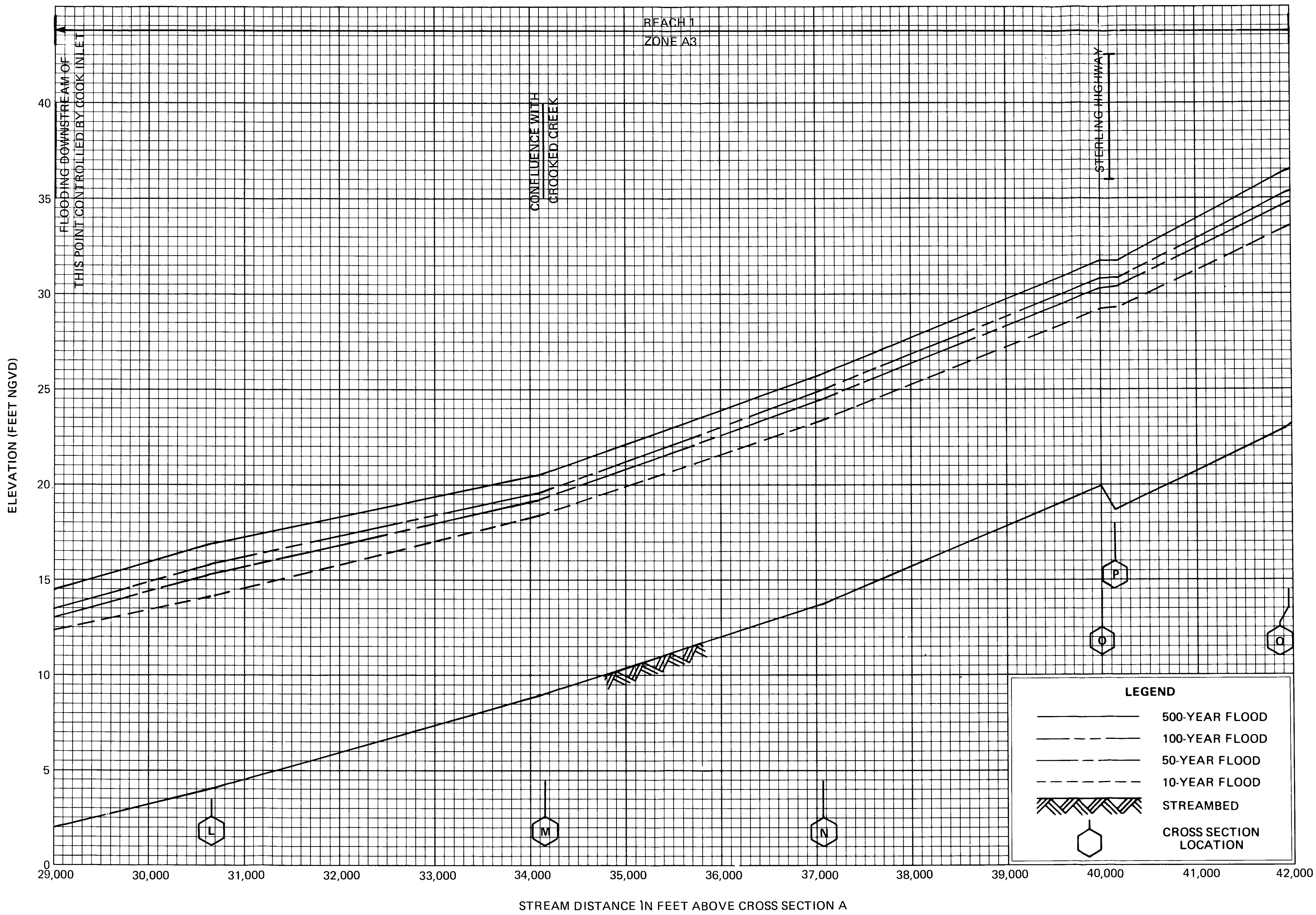
FLOOD PROFILES

KASILOF RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS

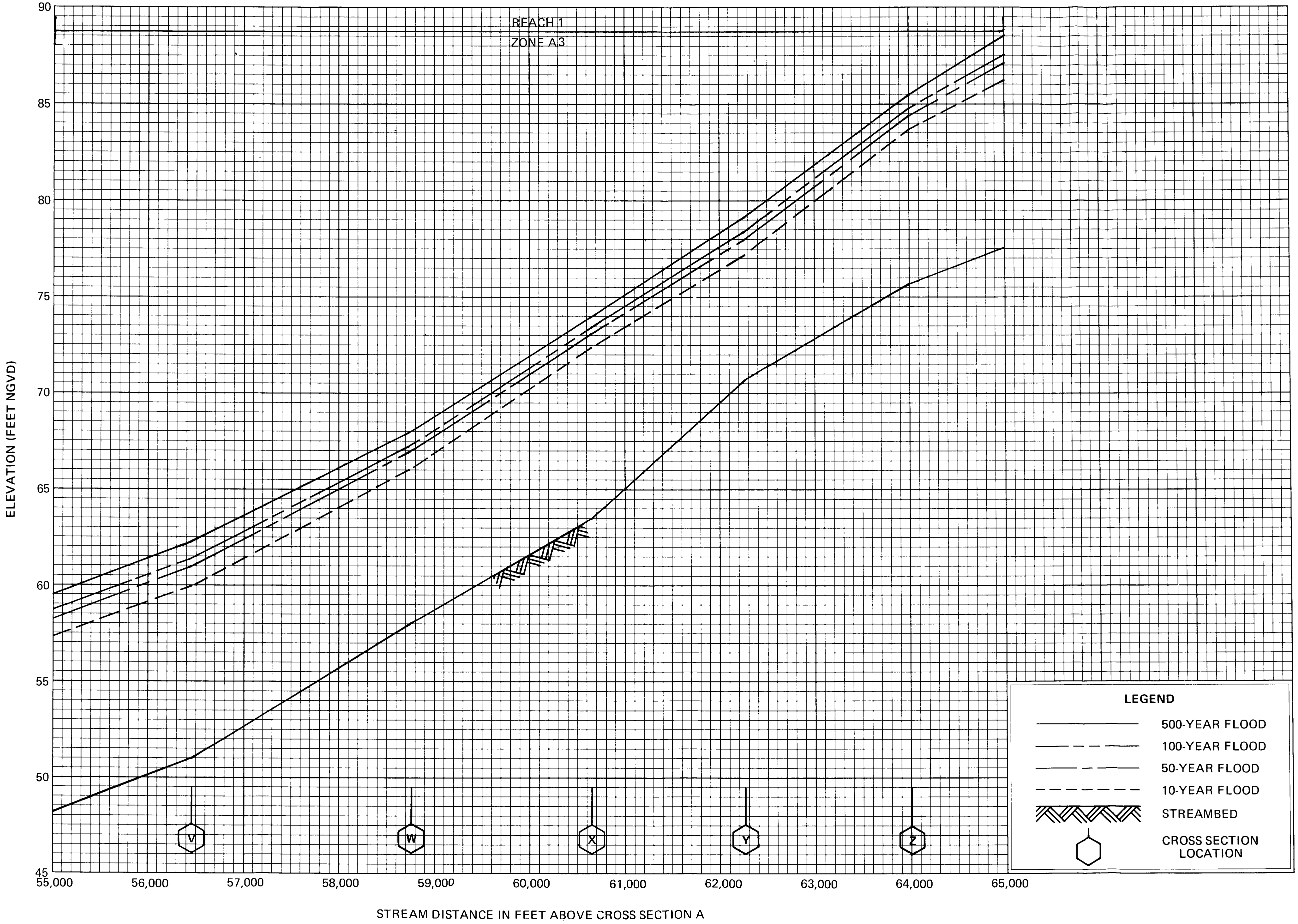


FLOOD PROFILES

KASILOF RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

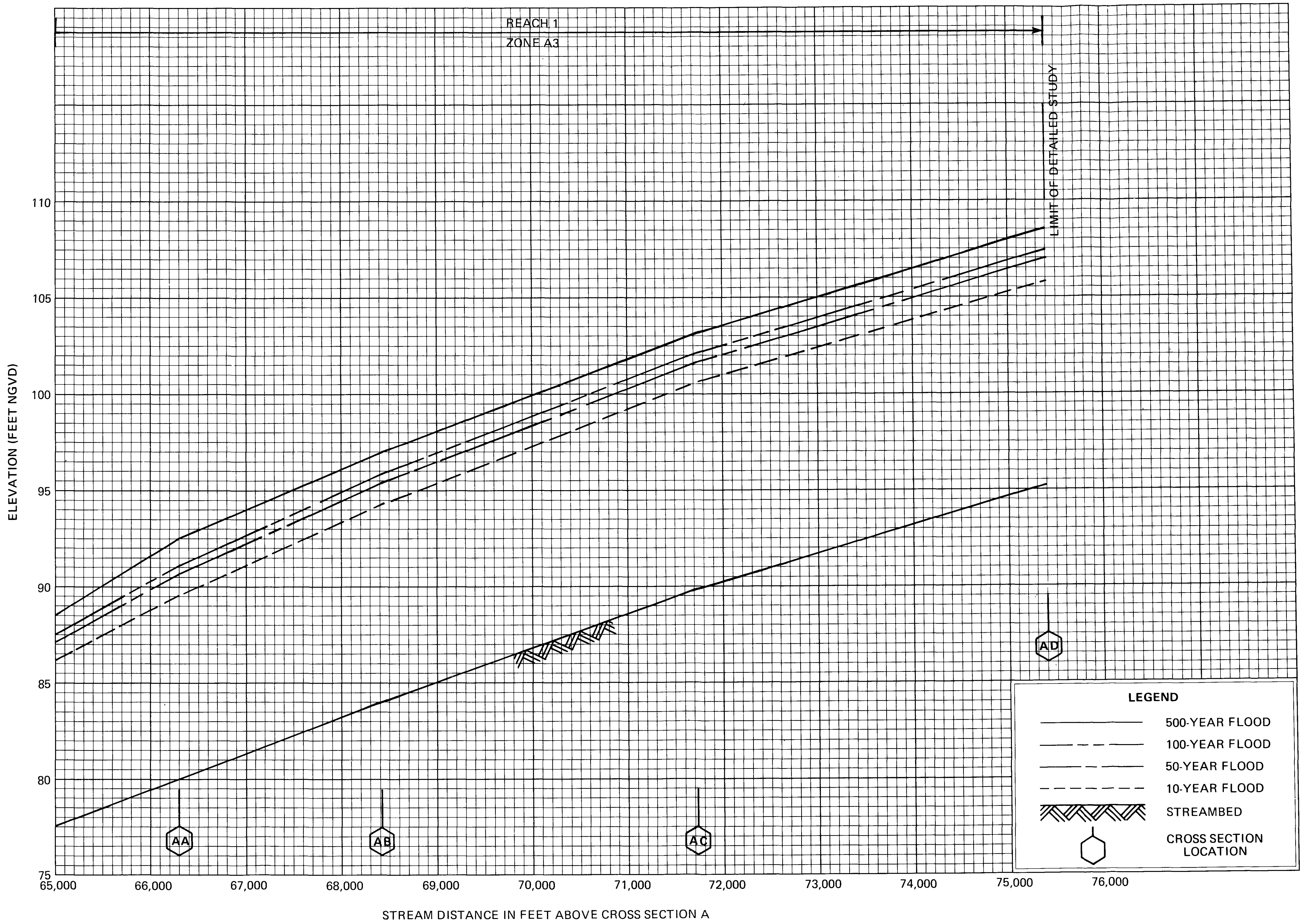


FLOOD PROFILES

KASILOF RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

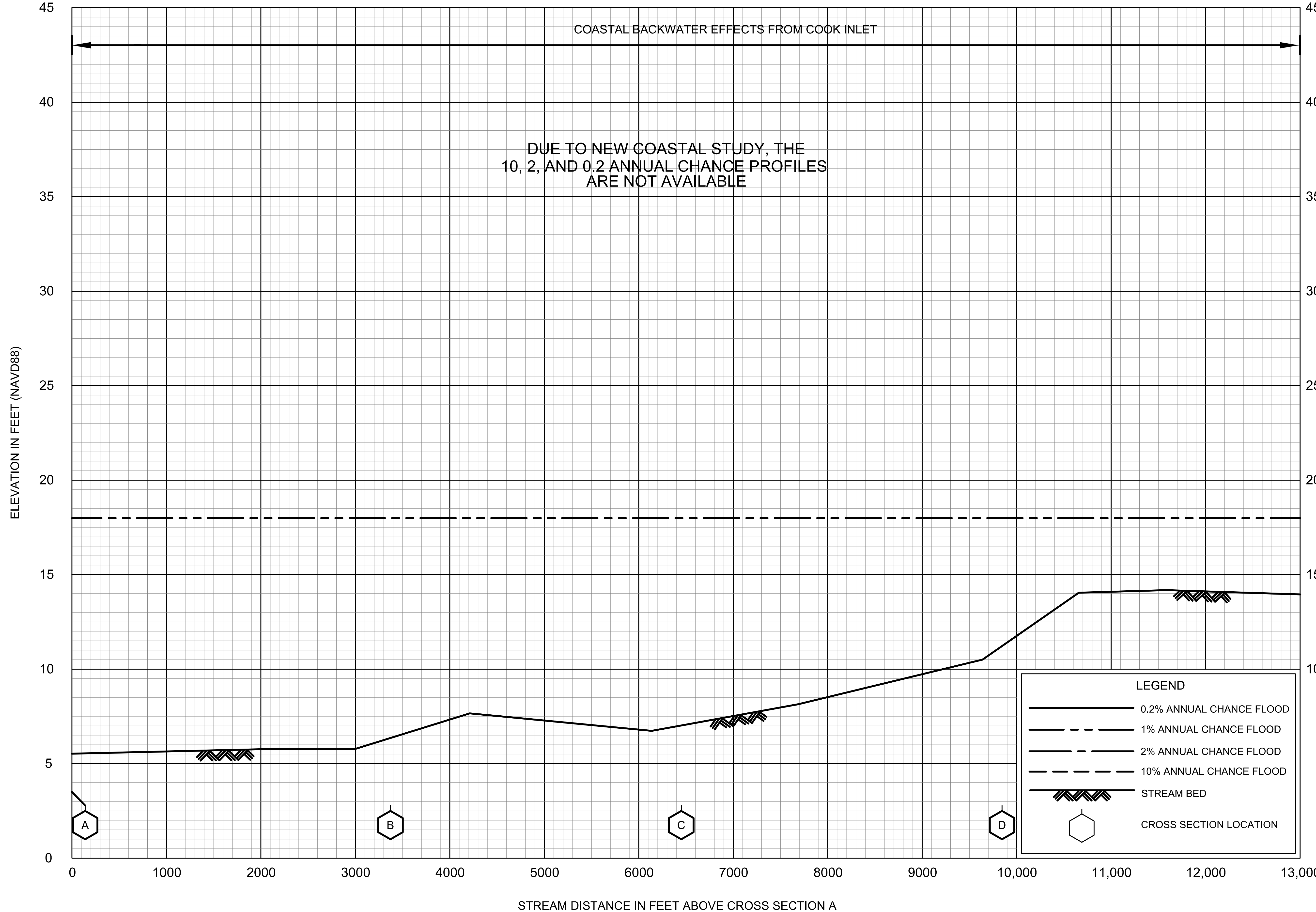


FLOOD PROFILES

KASILOF RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK



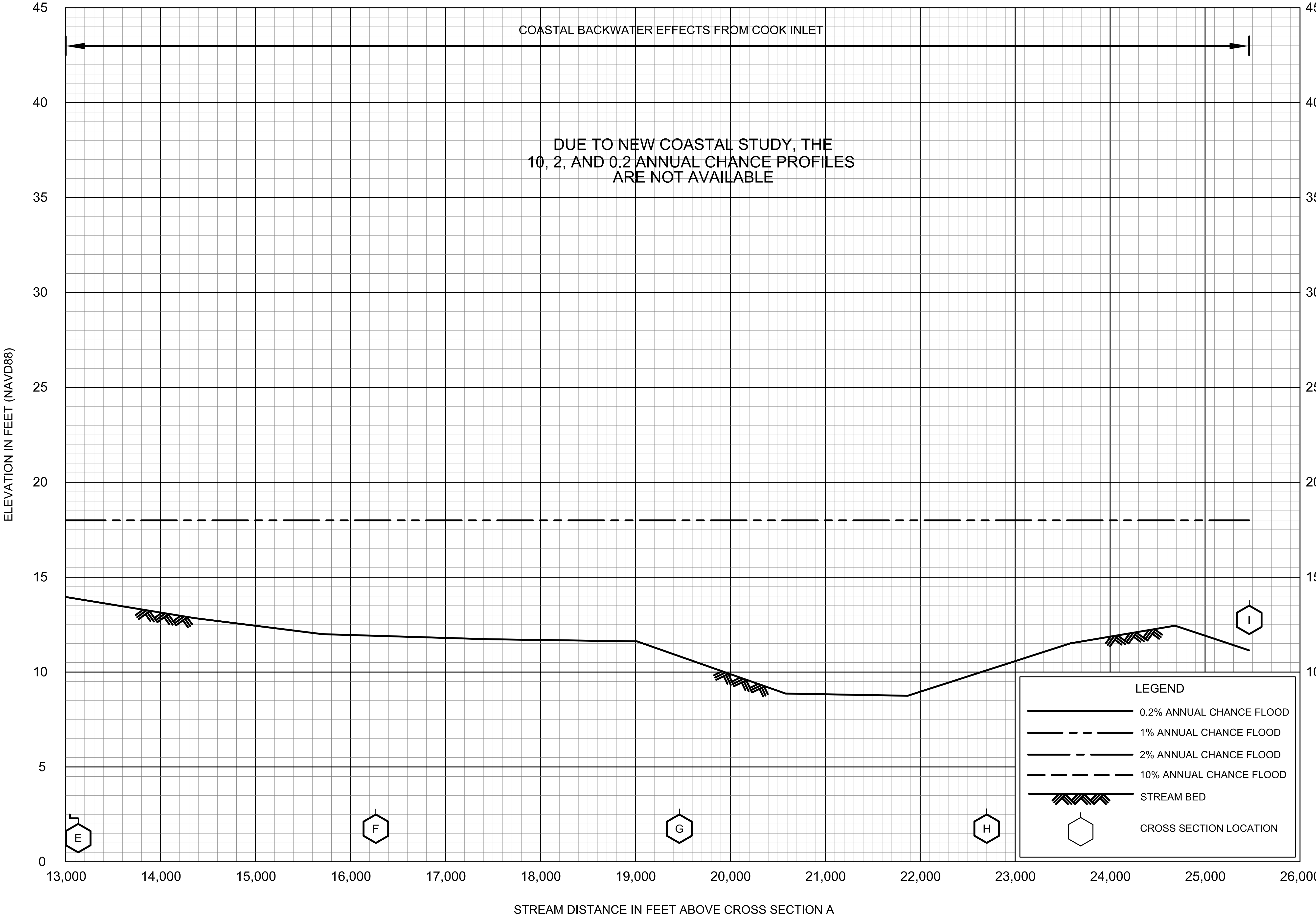
FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS



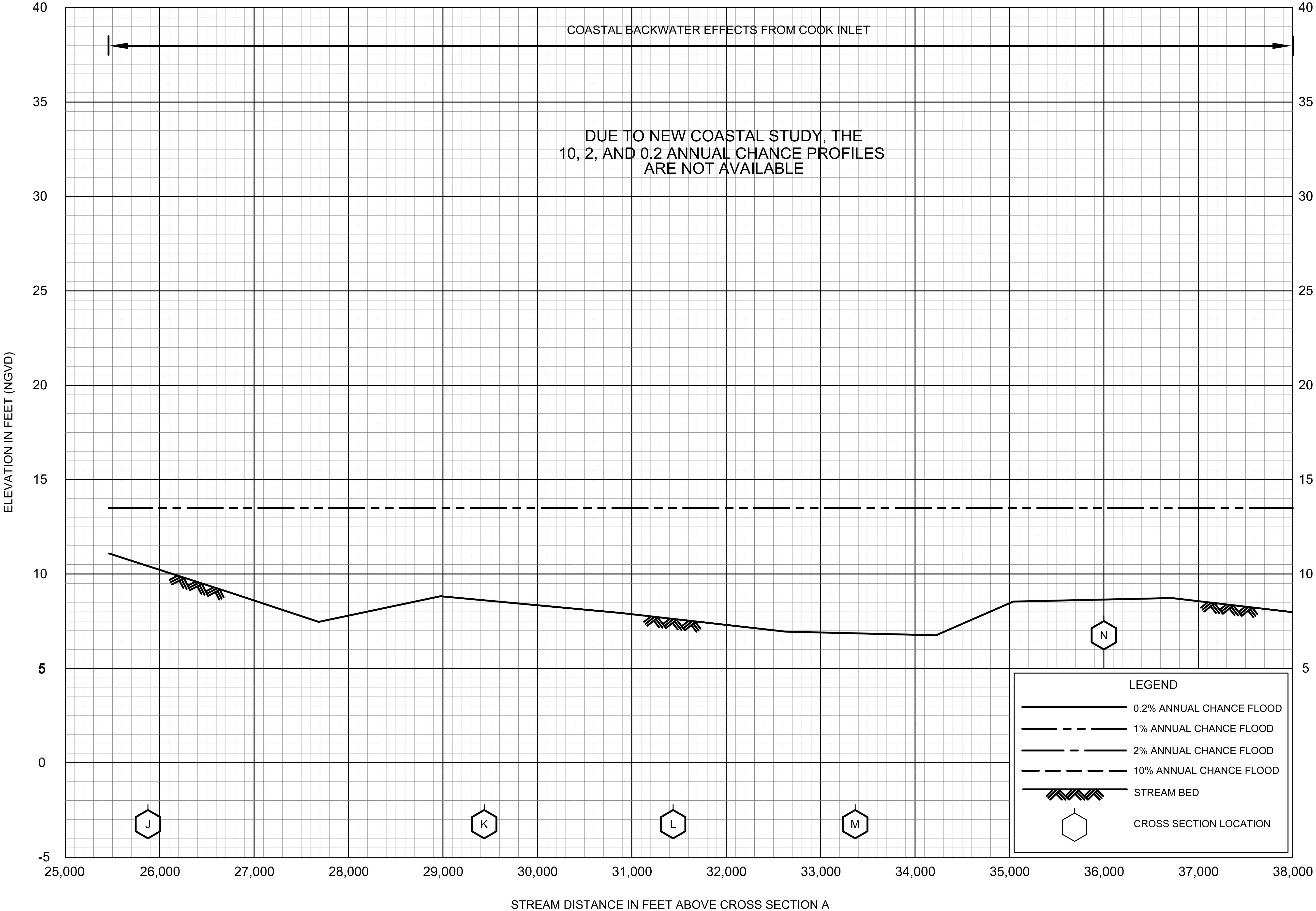
FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS



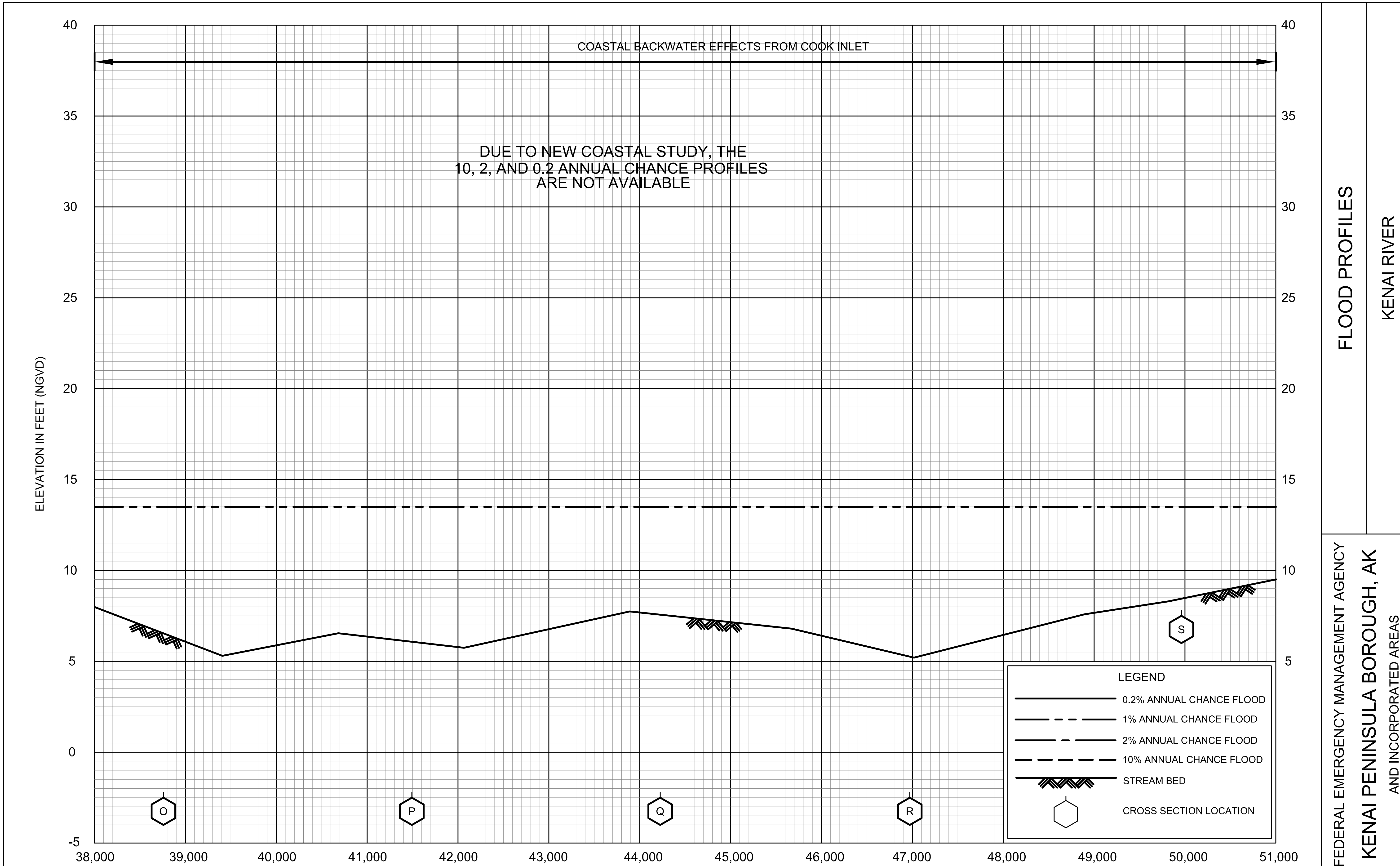
FLOOD PROFILES

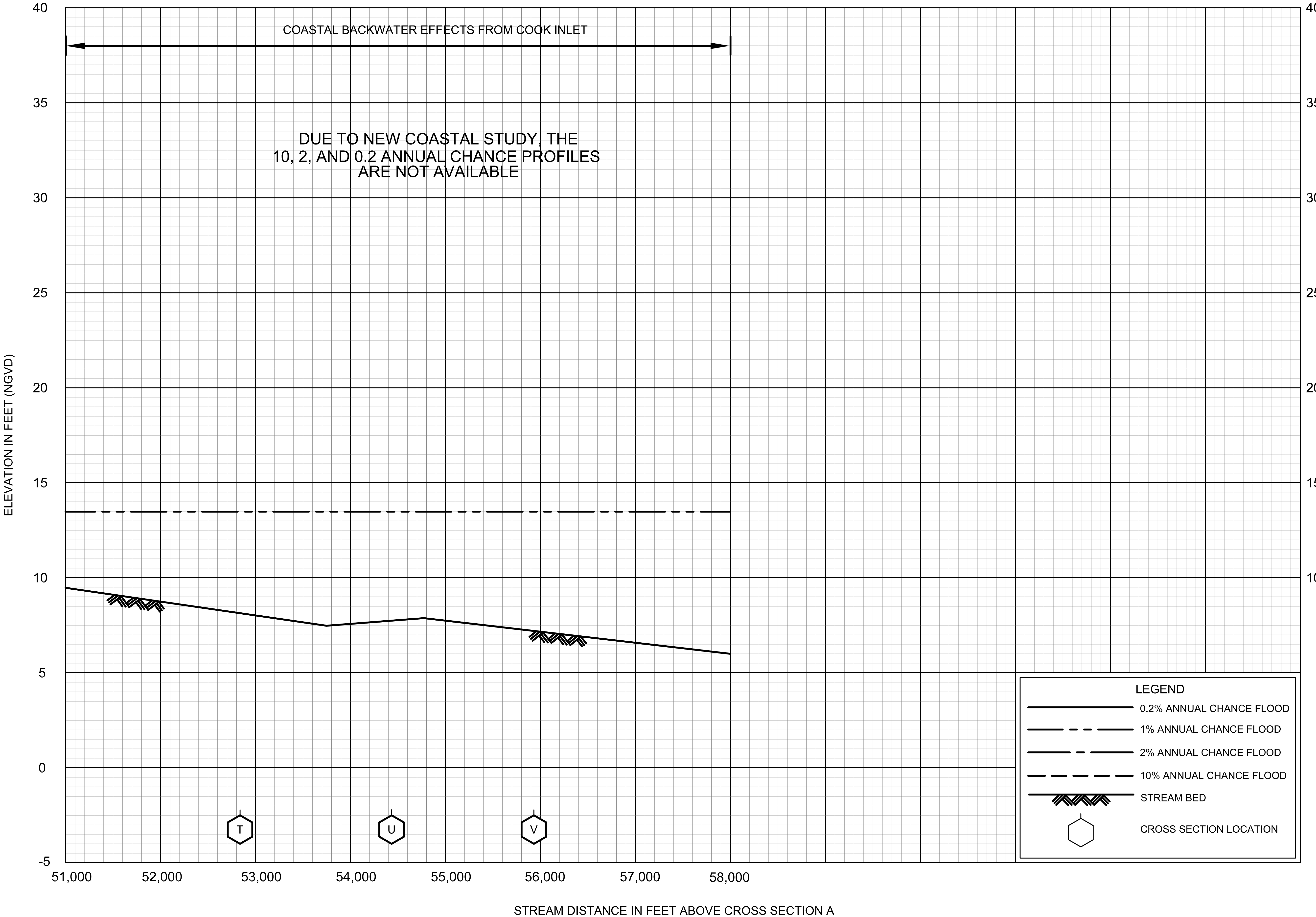
KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS


COASTAL BACKWATER EFFECTS FROM COOK INLET
DUE TO NEW COASTAL STUDY, THE
10, 2, AND 0.2 ANNUAL CHANCE PROFILES
ARE NOT AVAILABLE
ELEVATION IN FEET (NGVD)
STREAM DISTANCE IN FEET ABOVE CROSS SECTION A
40
35
30
25
20
15
10
5
0
-5
38,000
39,000
40,000
41,000
42,000
43,000
44,000
45,000
46,000
47,000
48,000
49,000
50,000
51,000
O
P
Q
R
S
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
KENAI RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
KENAI PENINSULA BOROUGH, AK
AND INCORPORATED AREAS



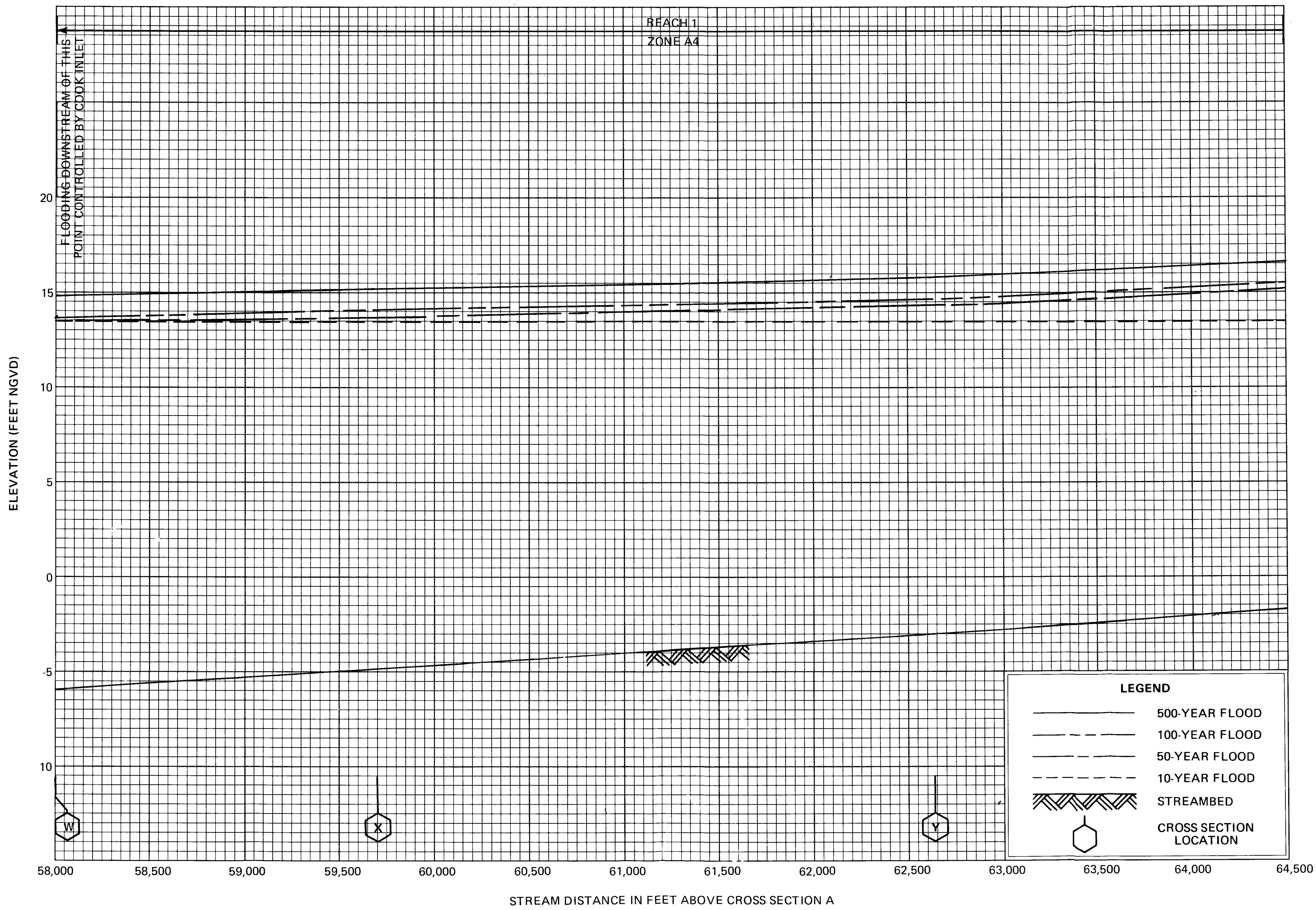
FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS

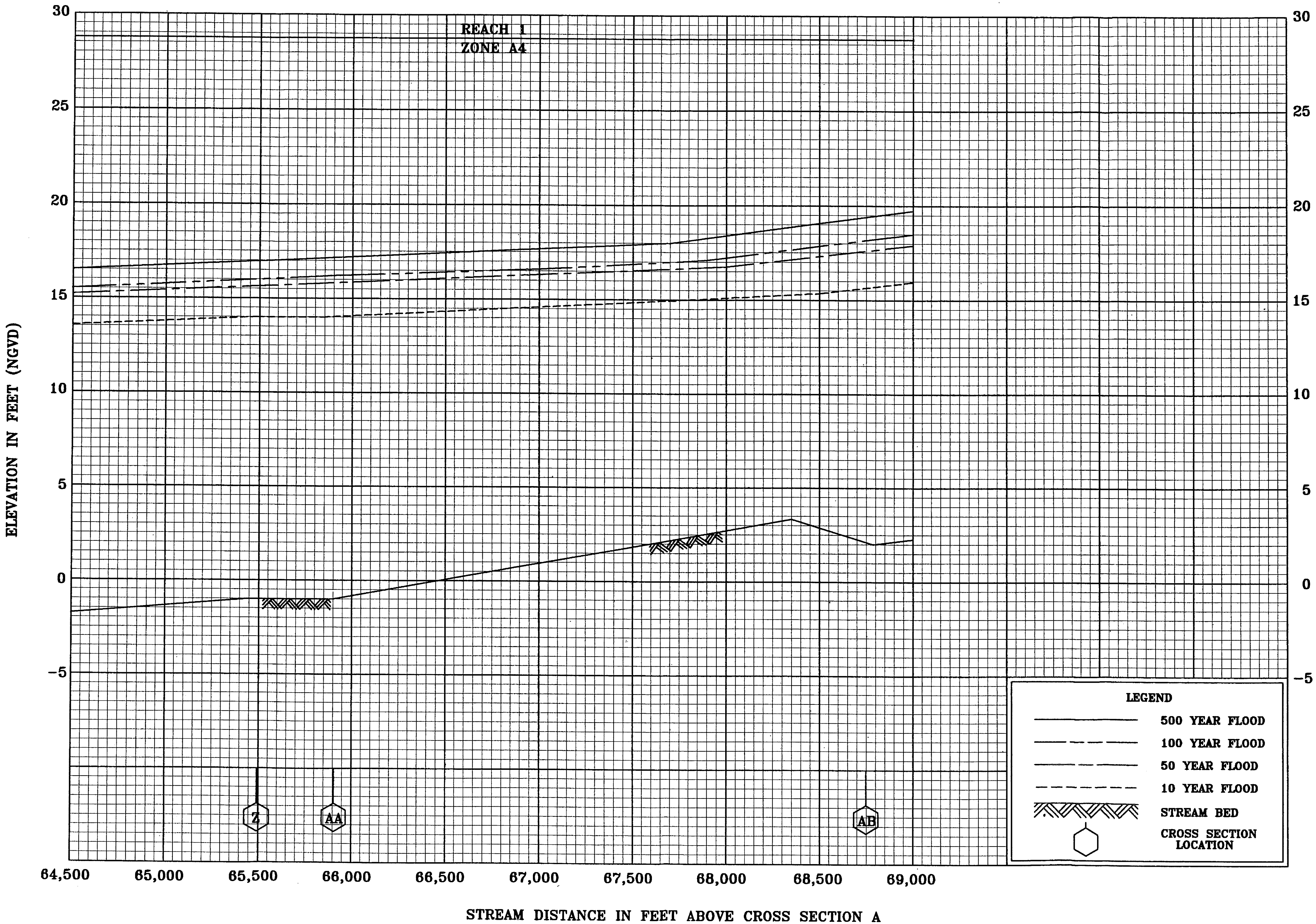


FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK



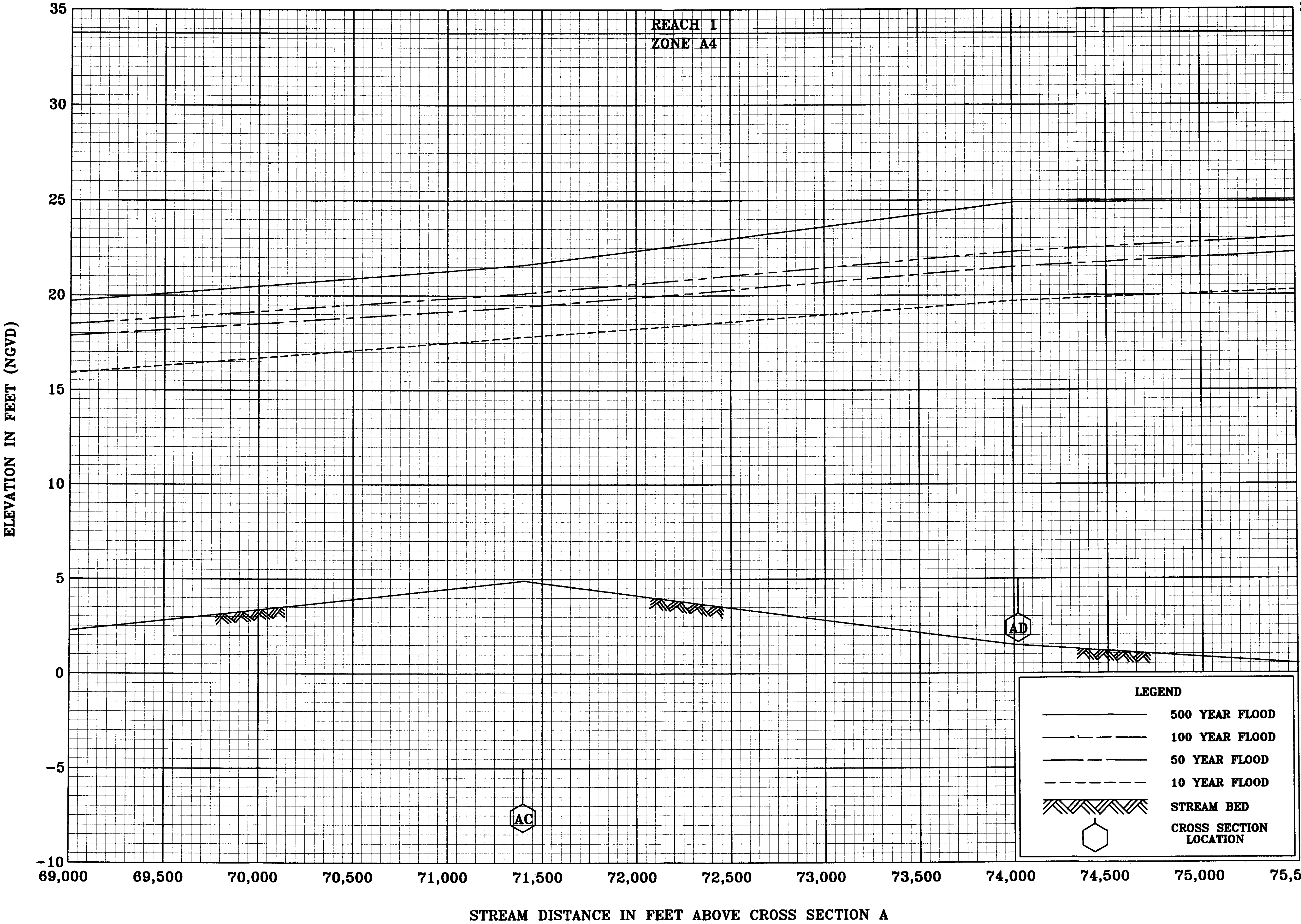
FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

(KENAI PENINSULA BOROUGH)



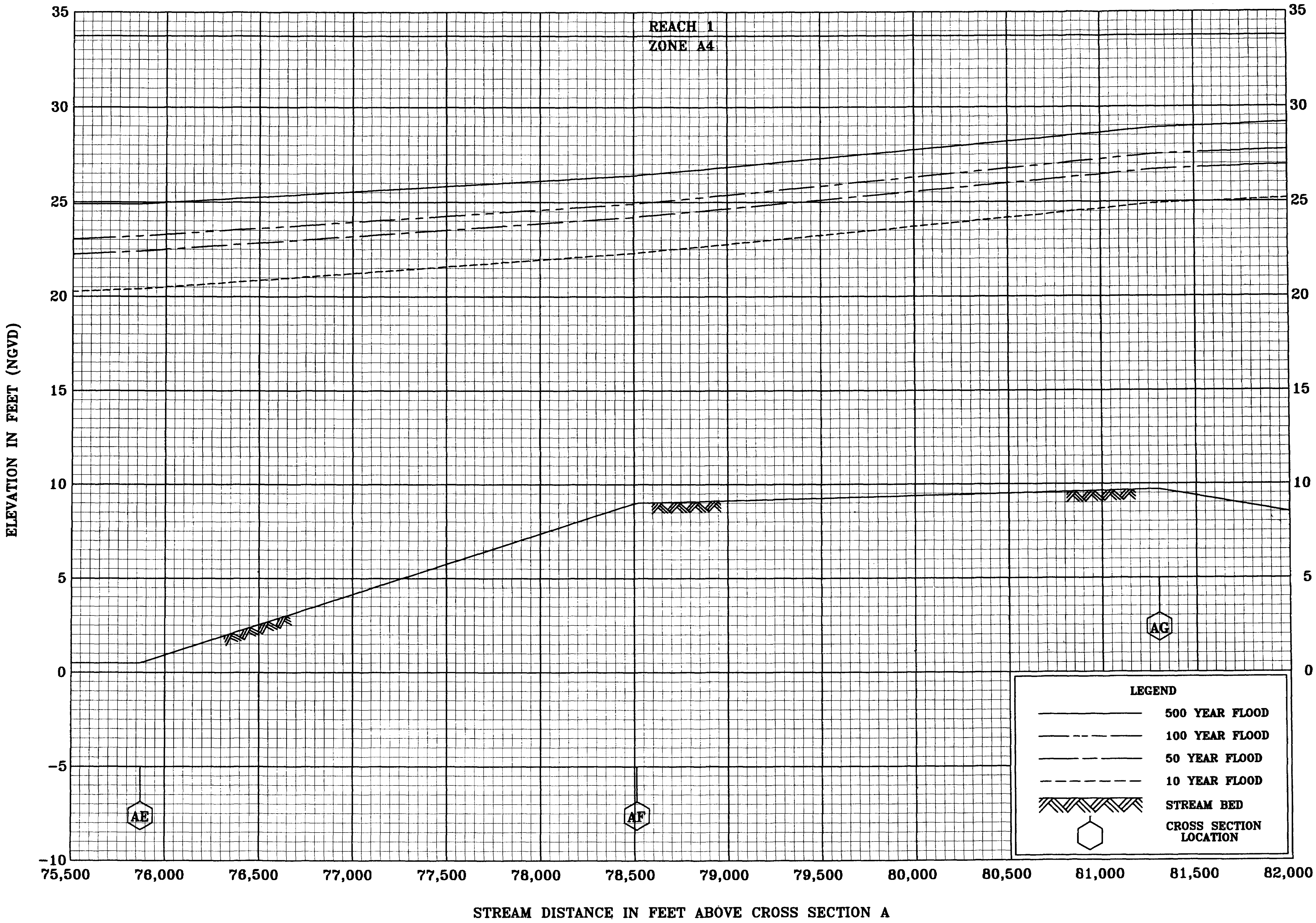
FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

(KENAI PENINSULA BOROUGH)



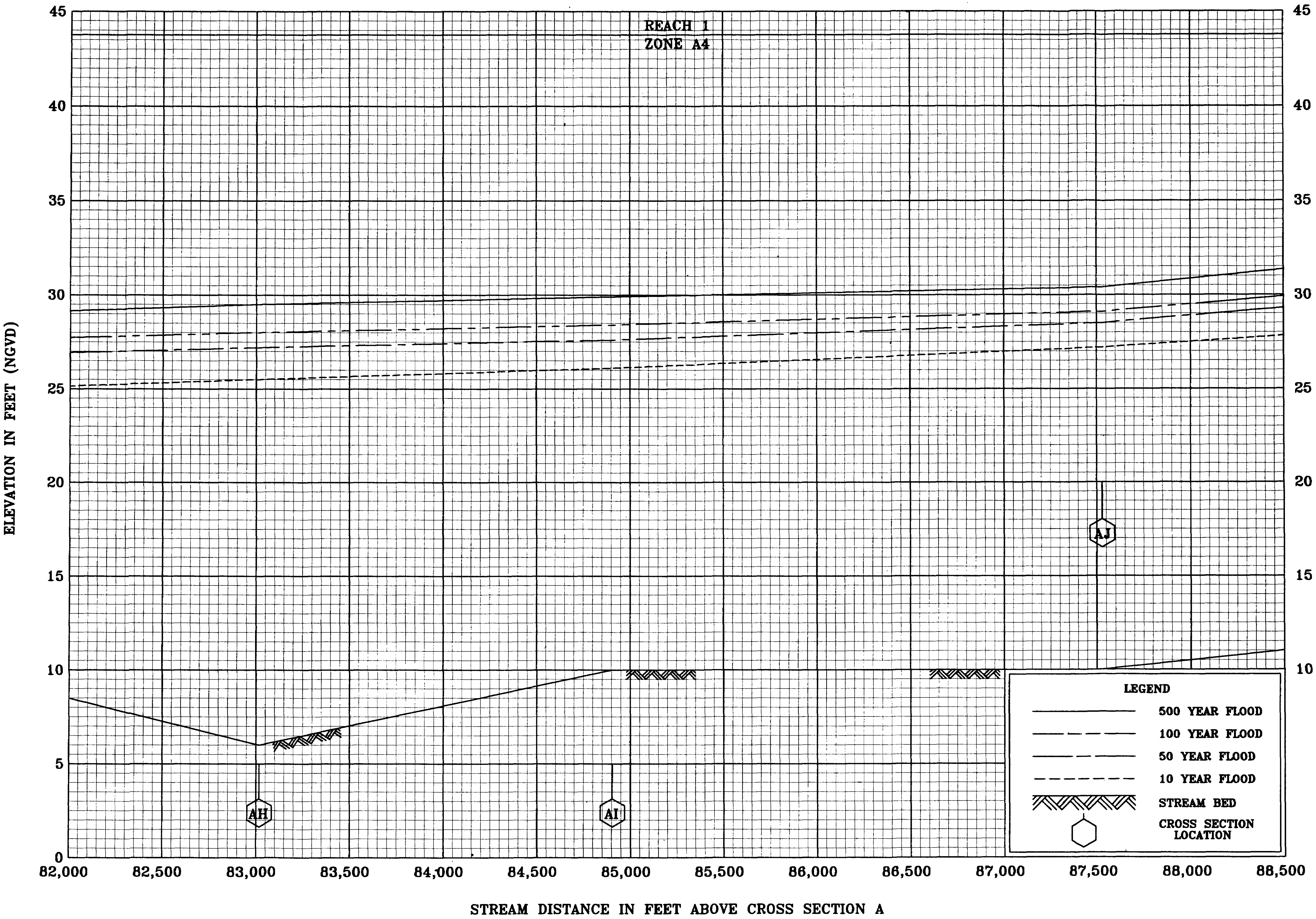
FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

(KENAI PENINSULA BOROUGH)

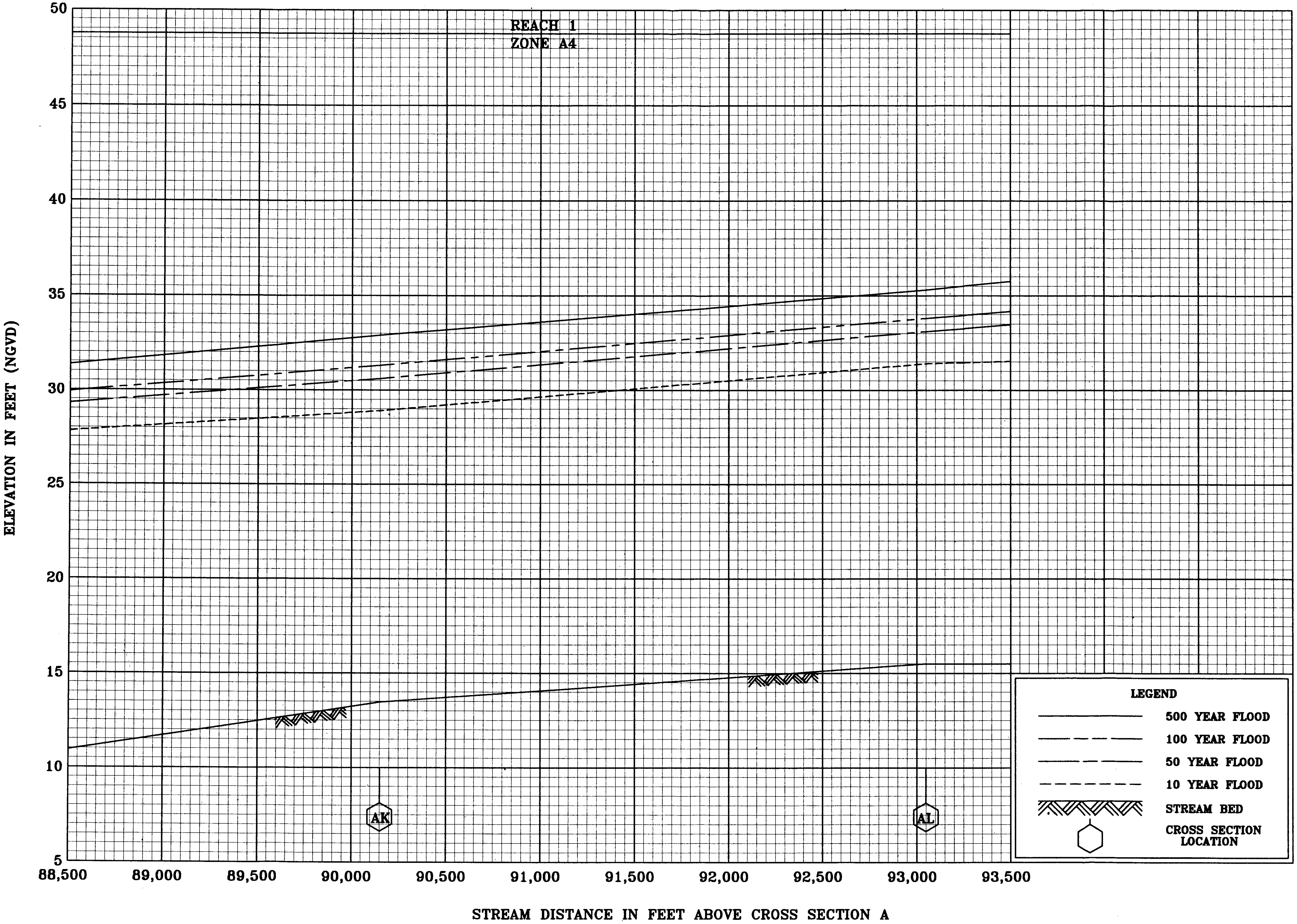


FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK
(KENAI PENINSULA BOROUGH)



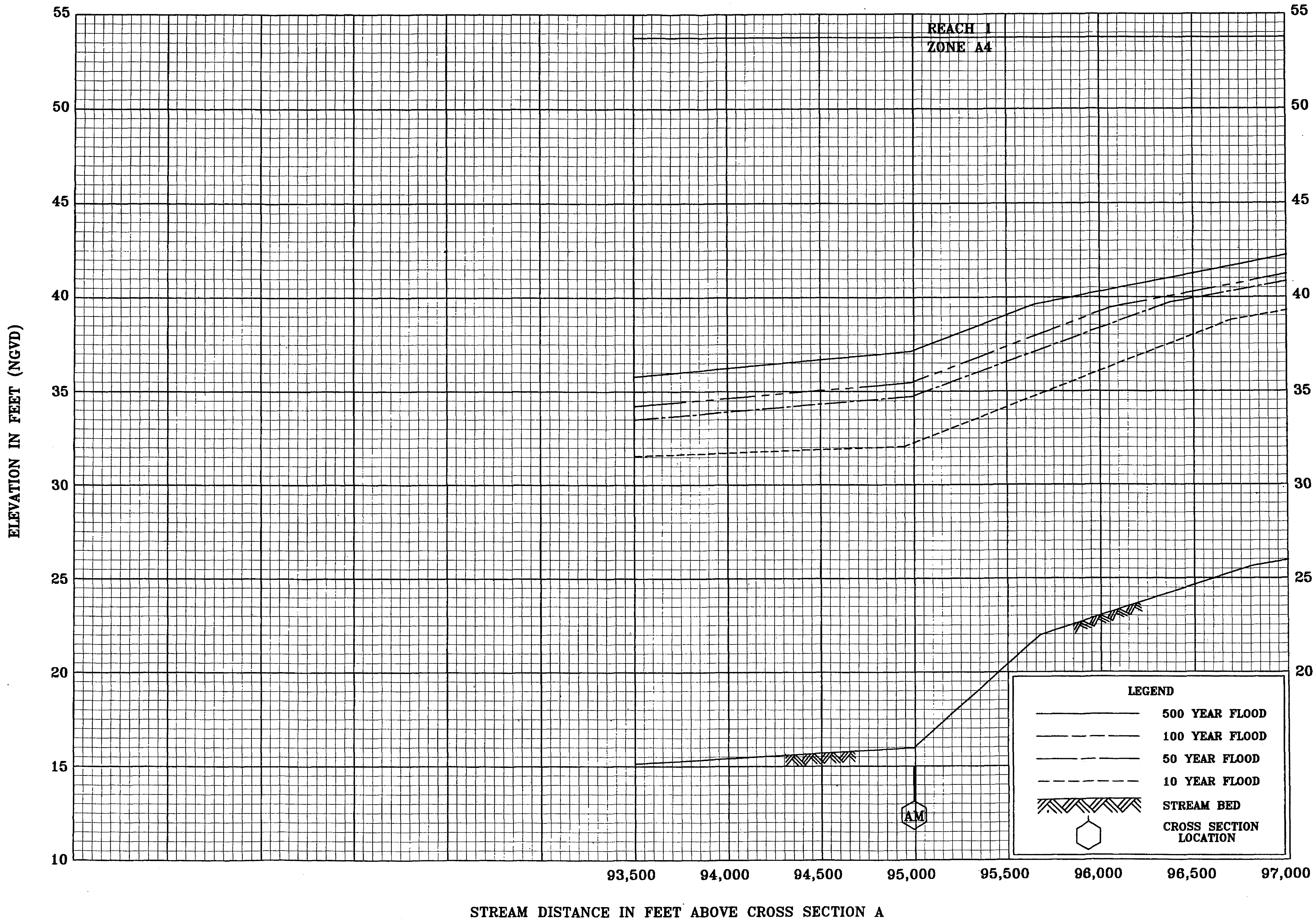
FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

(KENAI PENINSULA BOROUGH)



FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

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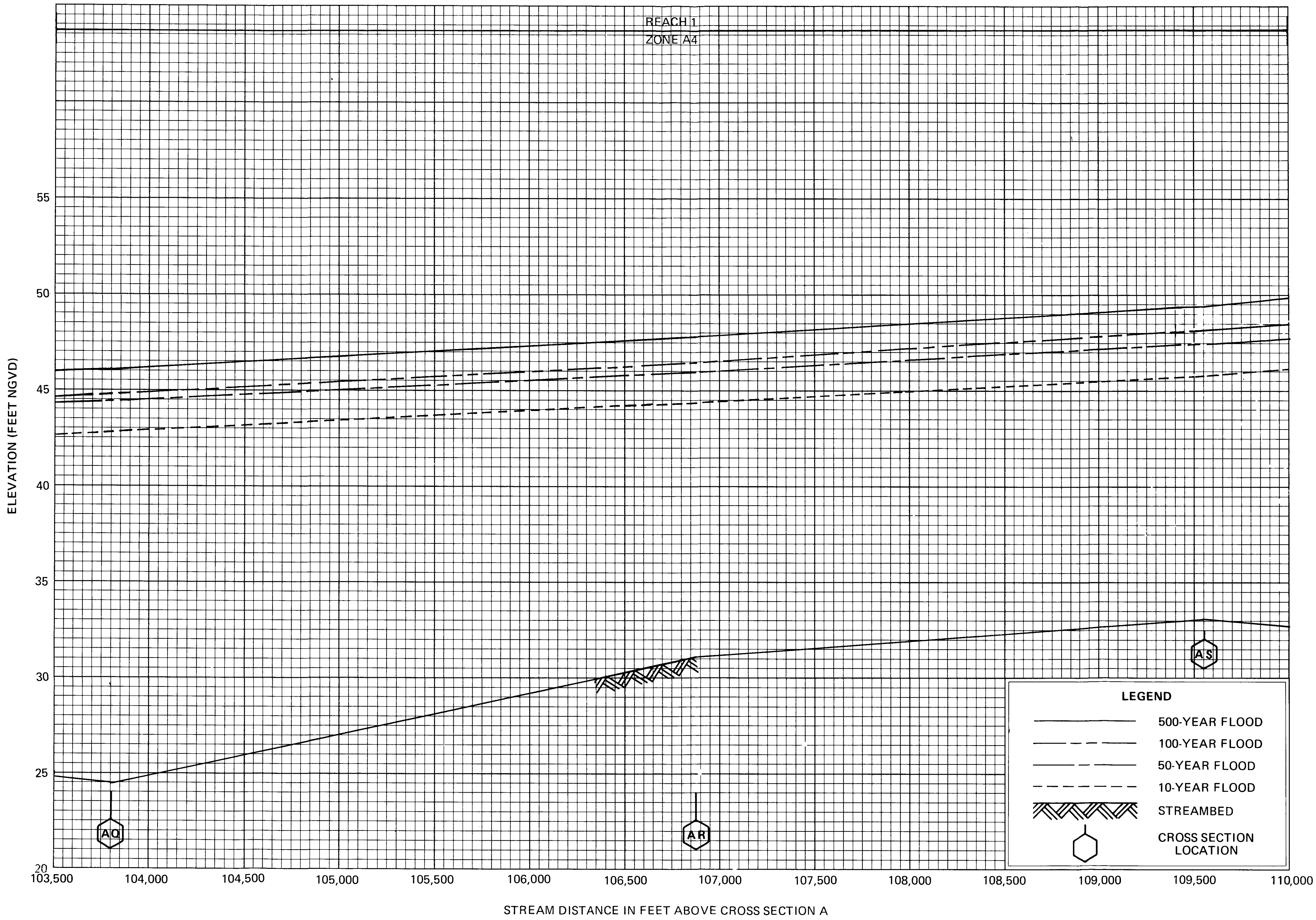
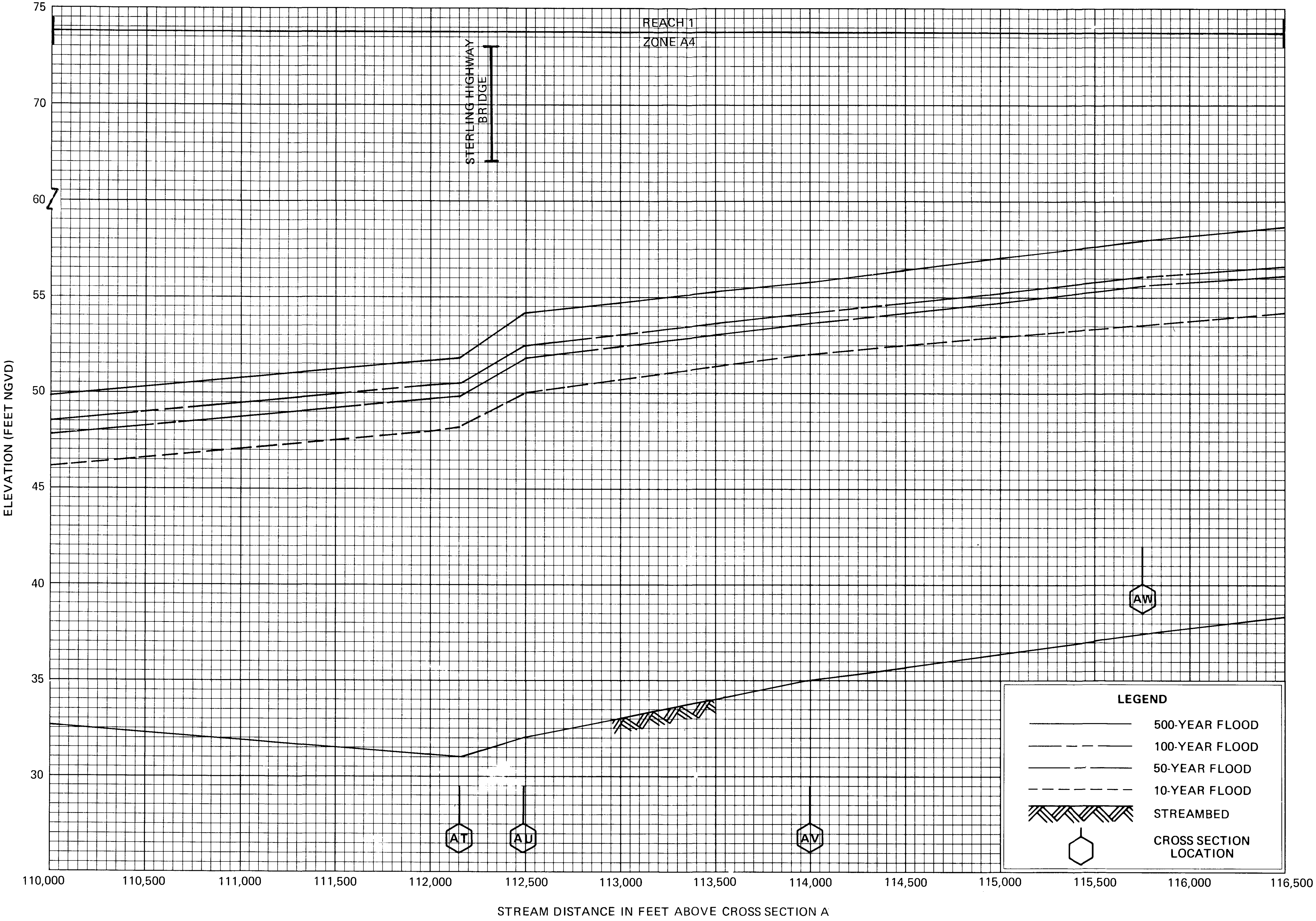


FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK



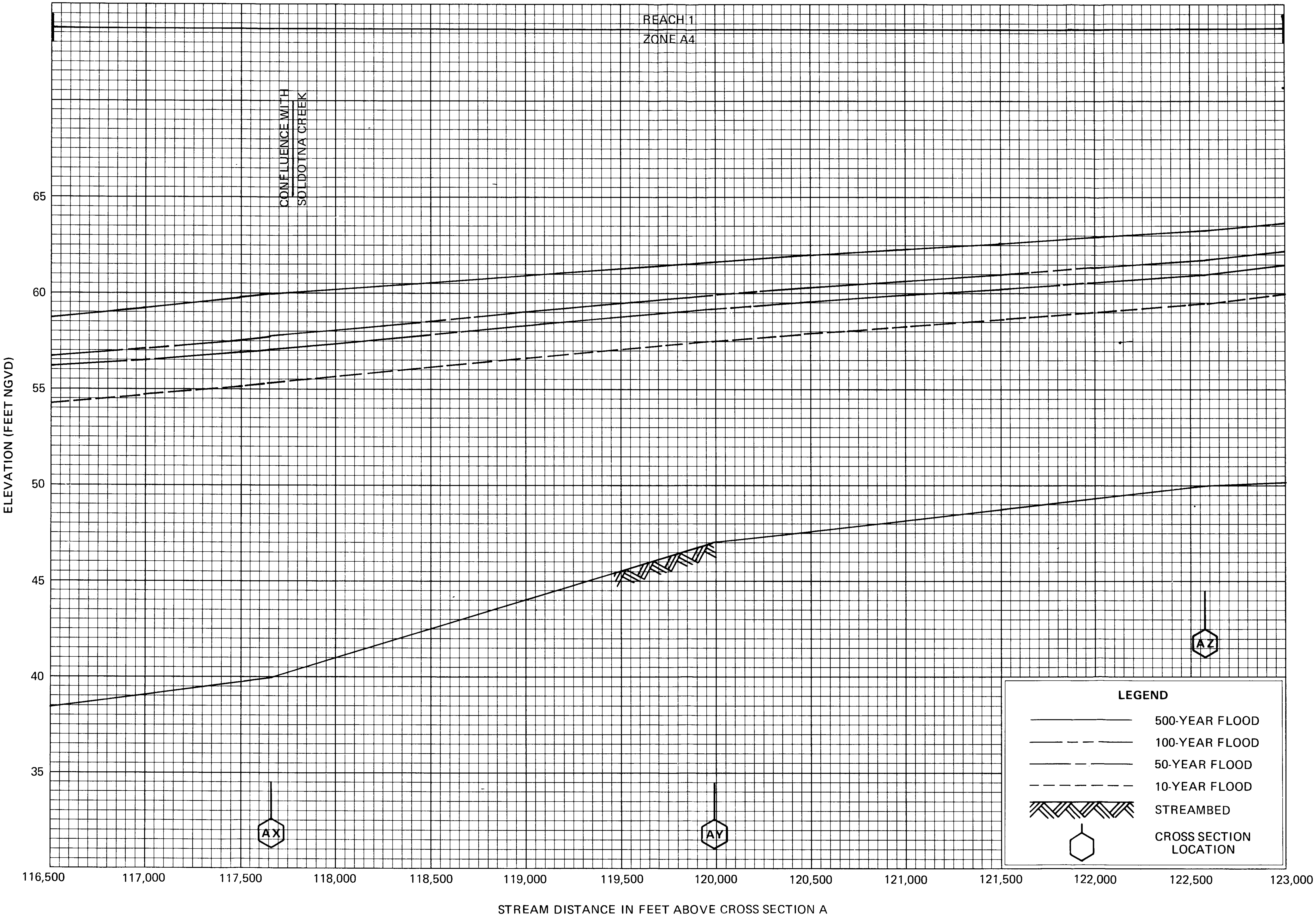
FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

29P

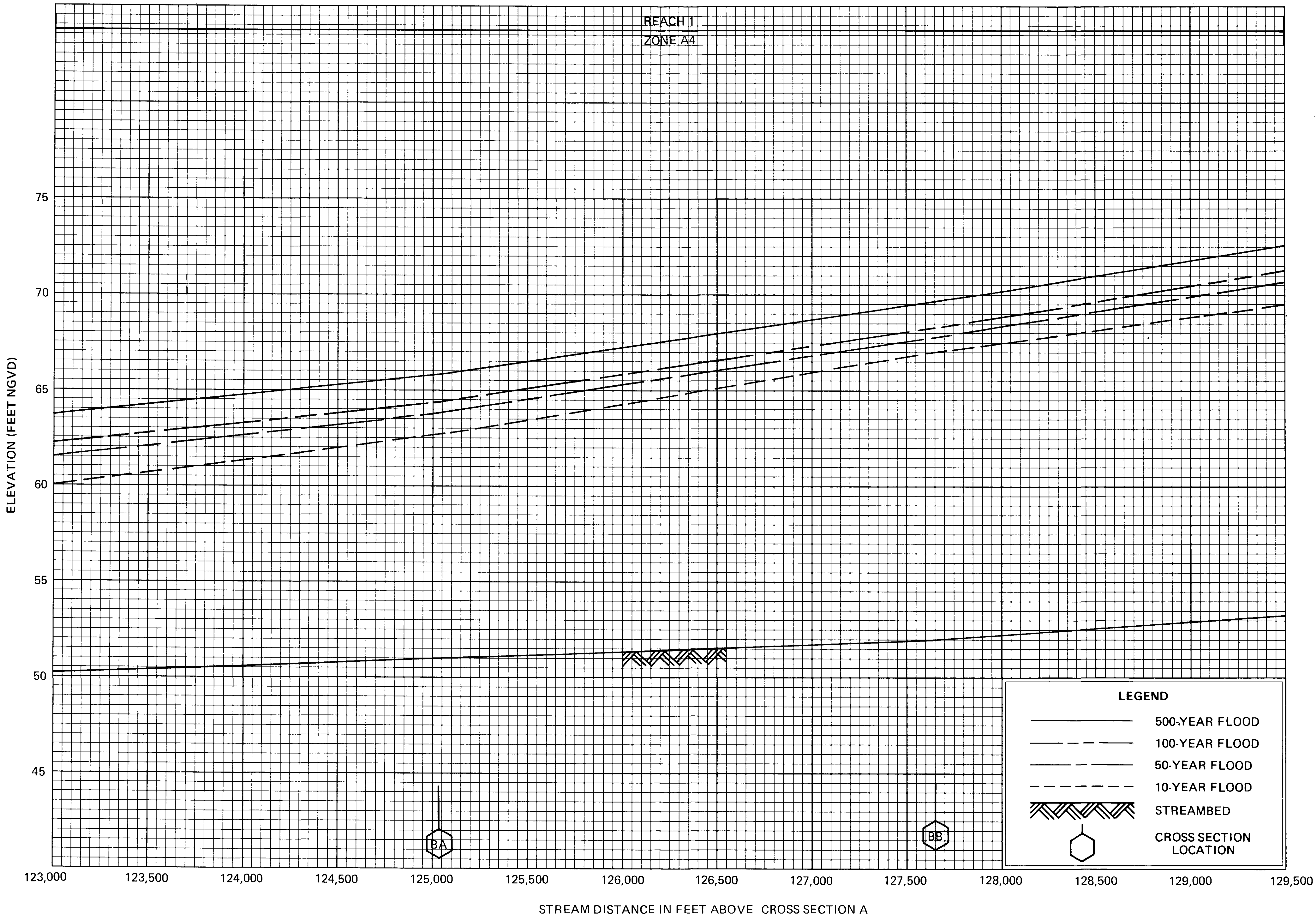


FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

FLOOD PROFILES

KENAI RIVER

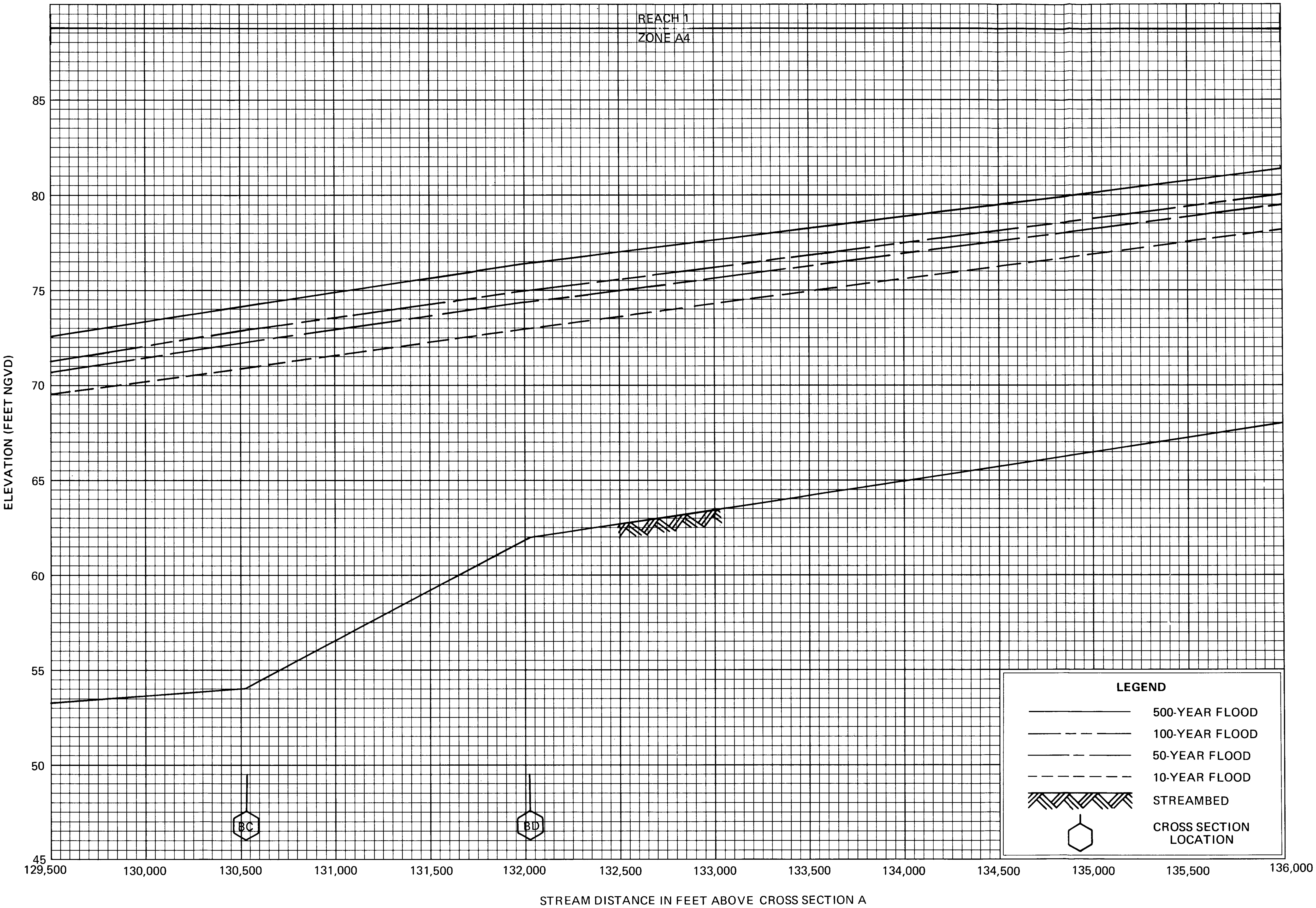


FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK



FLOOD PROFILES

KENAI RIVER

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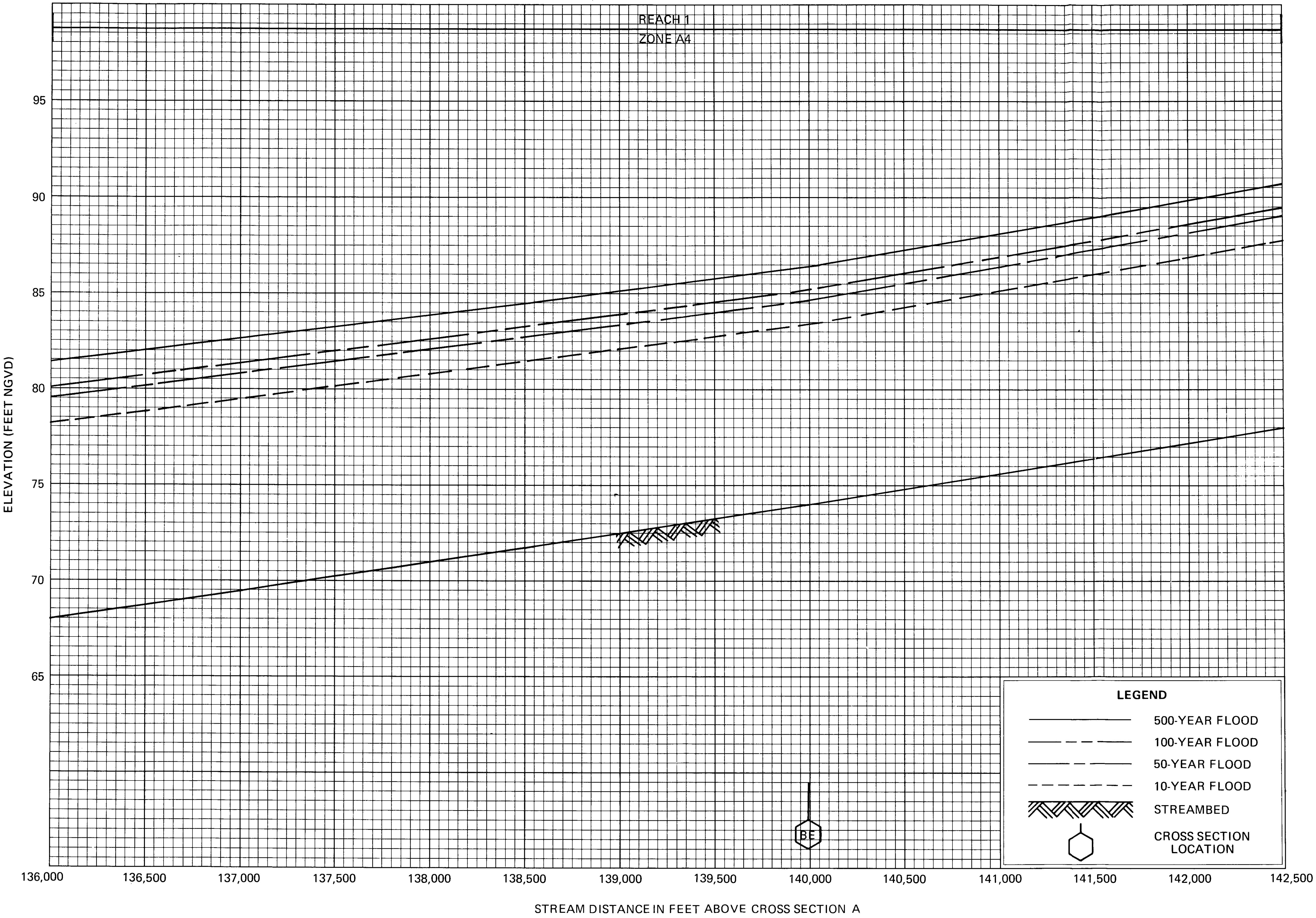

FLOOD PROFILES

KENAI RIVER

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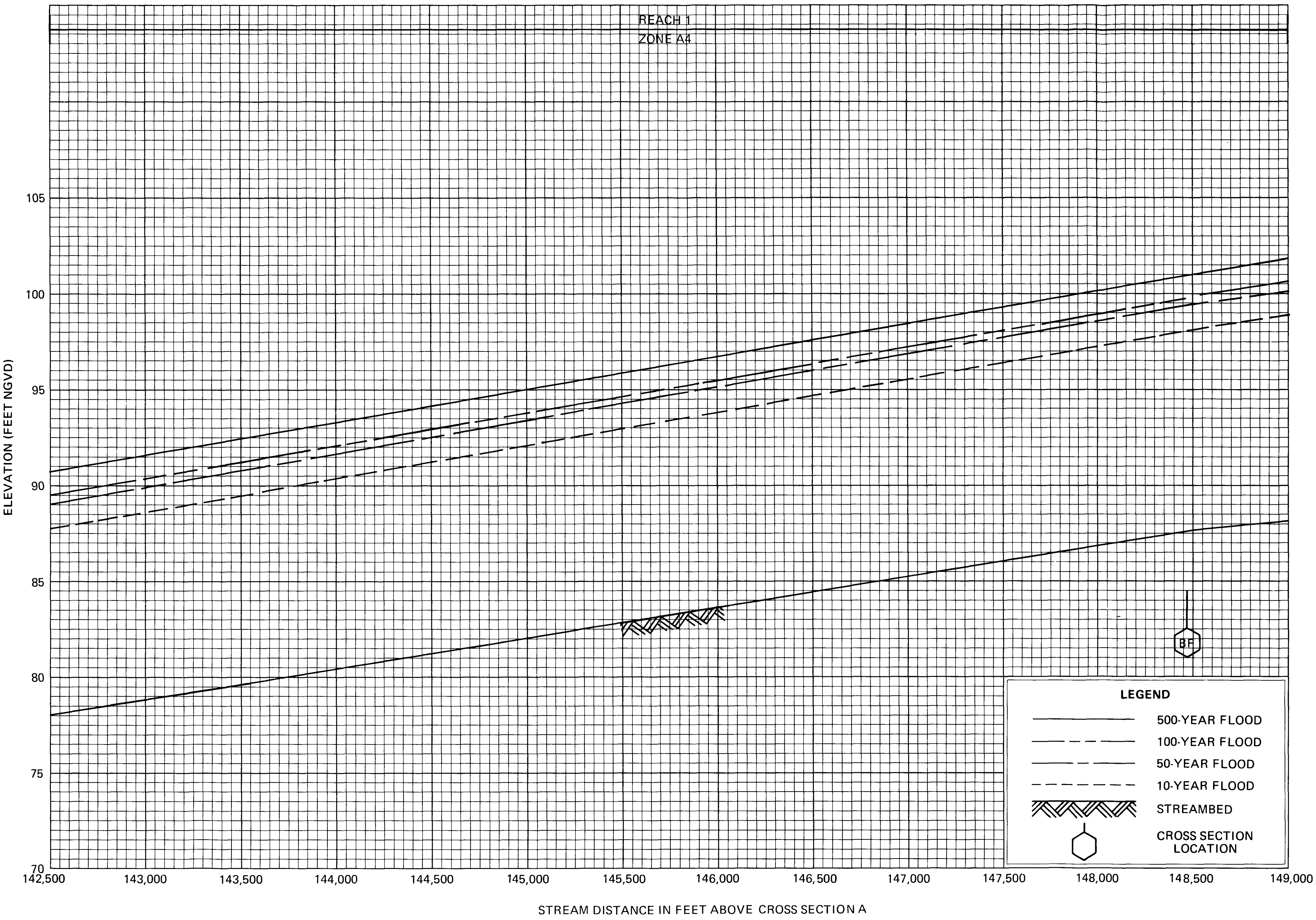

FLOOD PROFILES

KENAI RIVER

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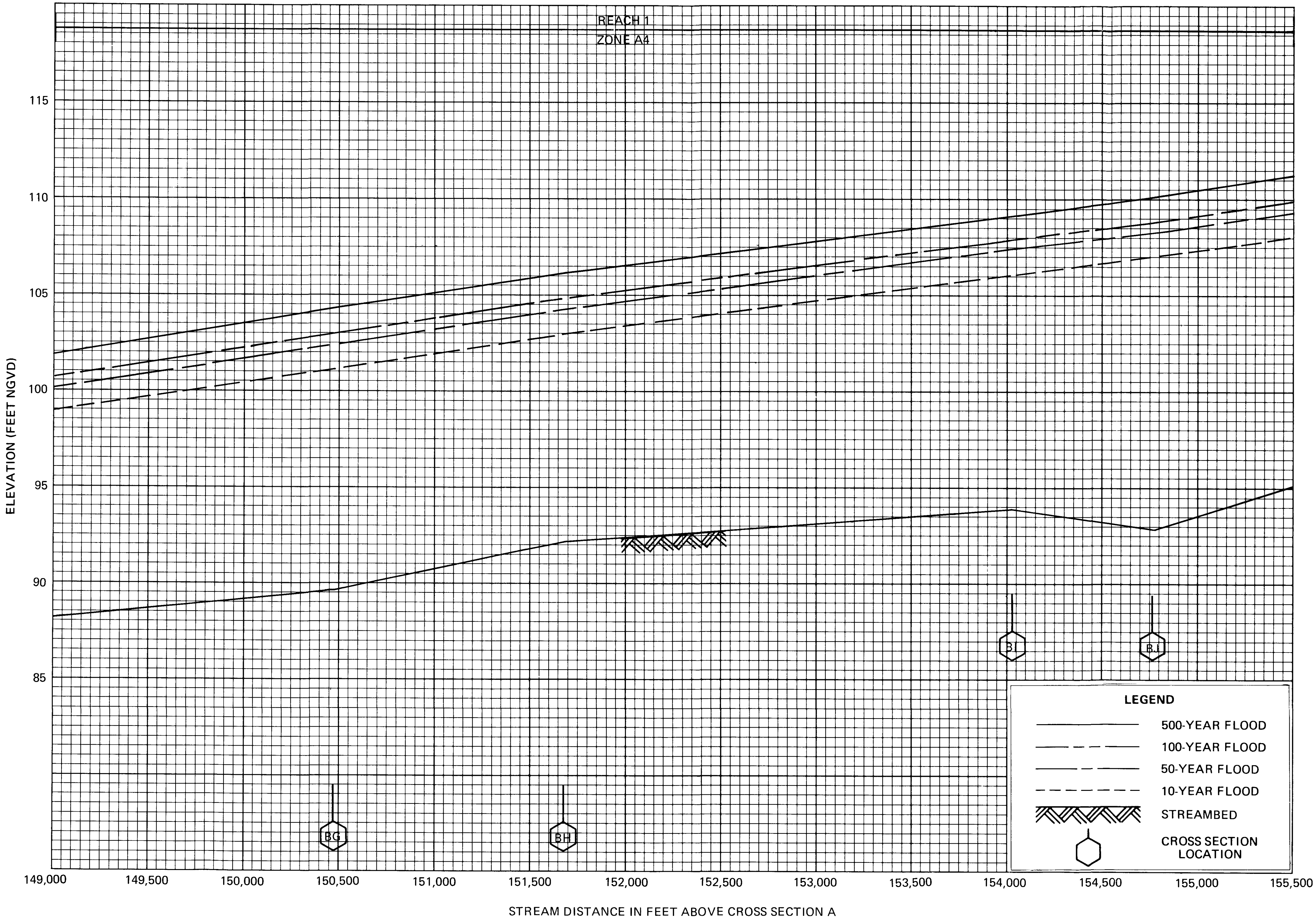

FLOOD PROFILES

KENAI RIVER

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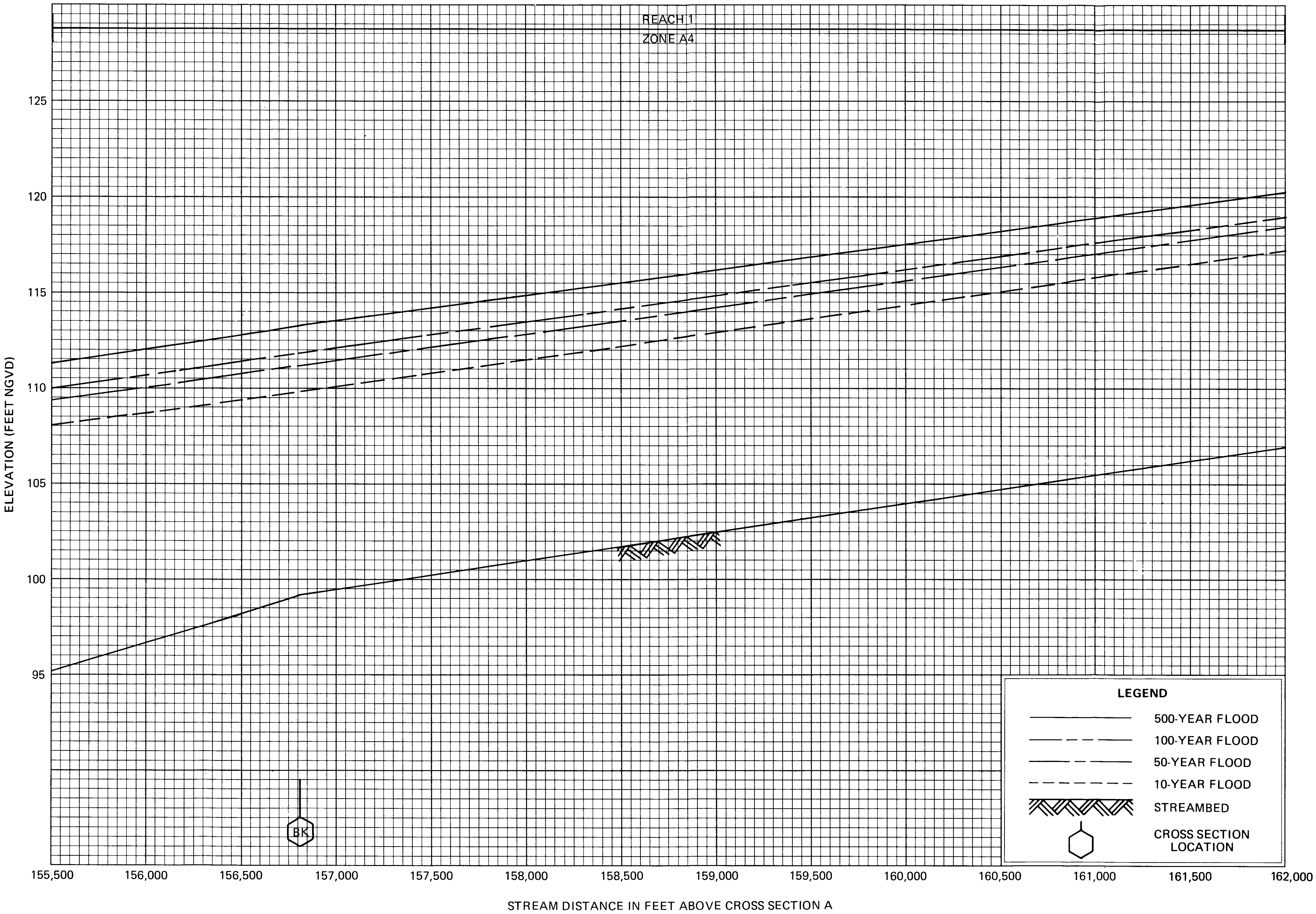

FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

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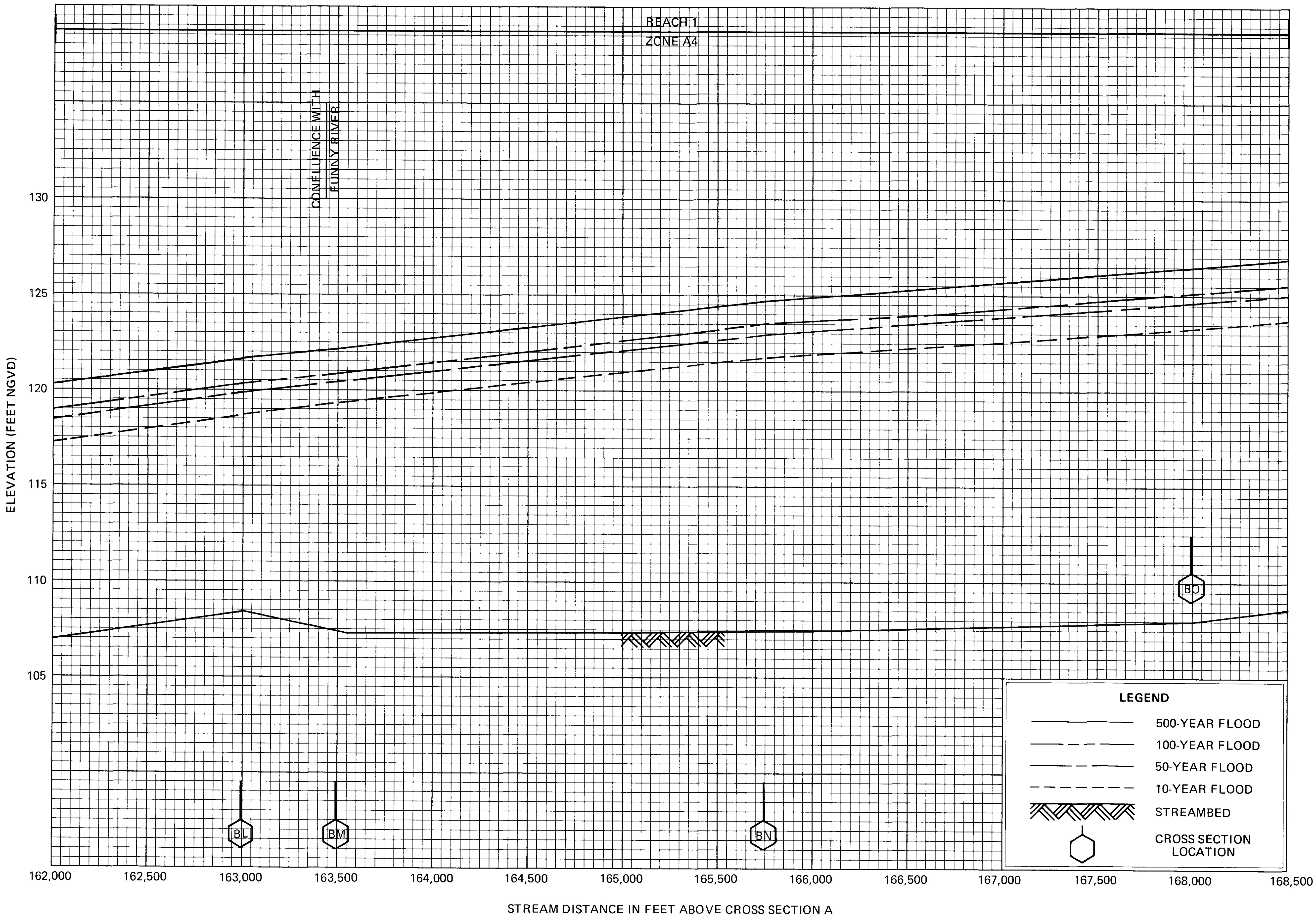
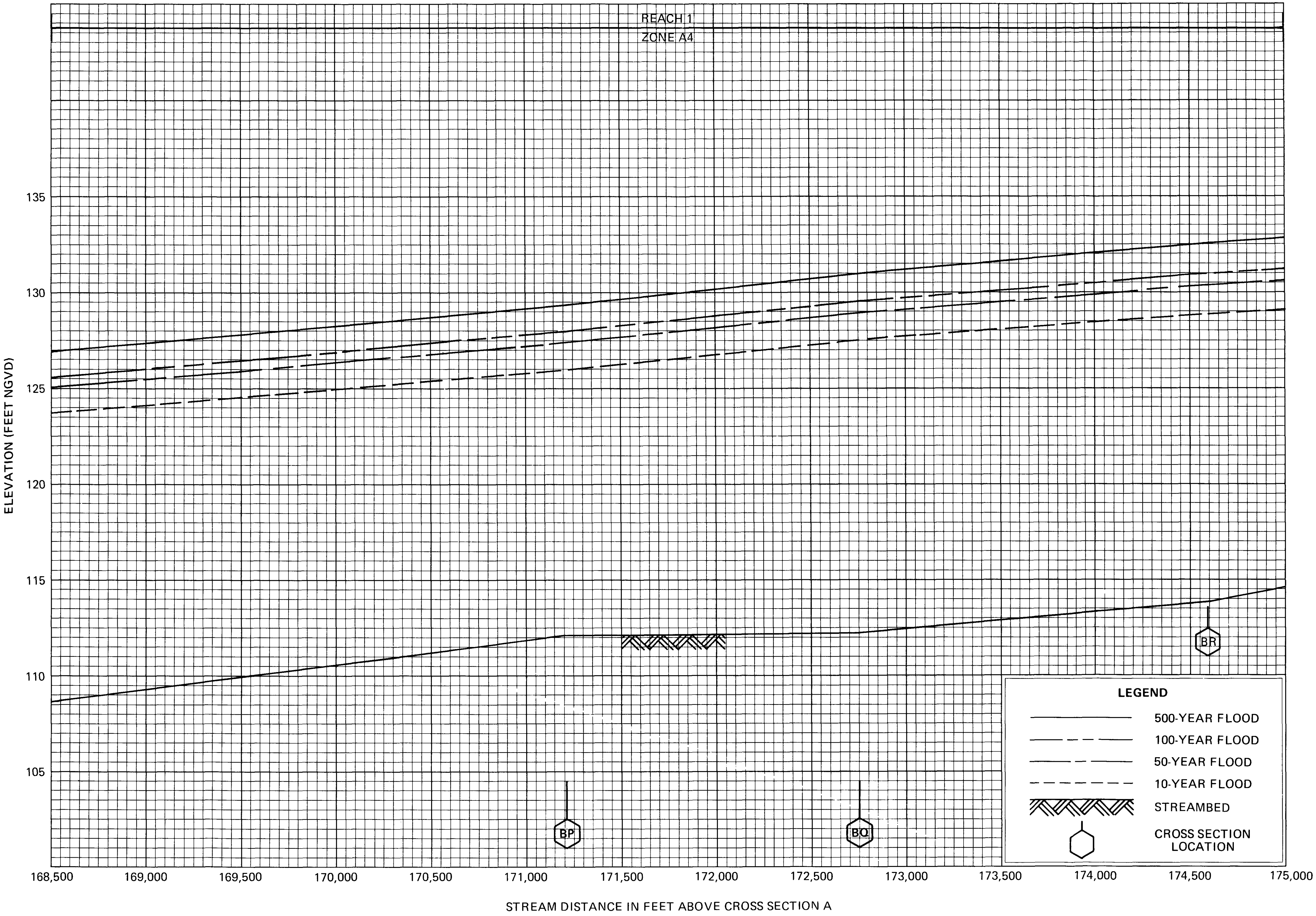


FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK



FLOOD PROFILES

KENAI RIVER

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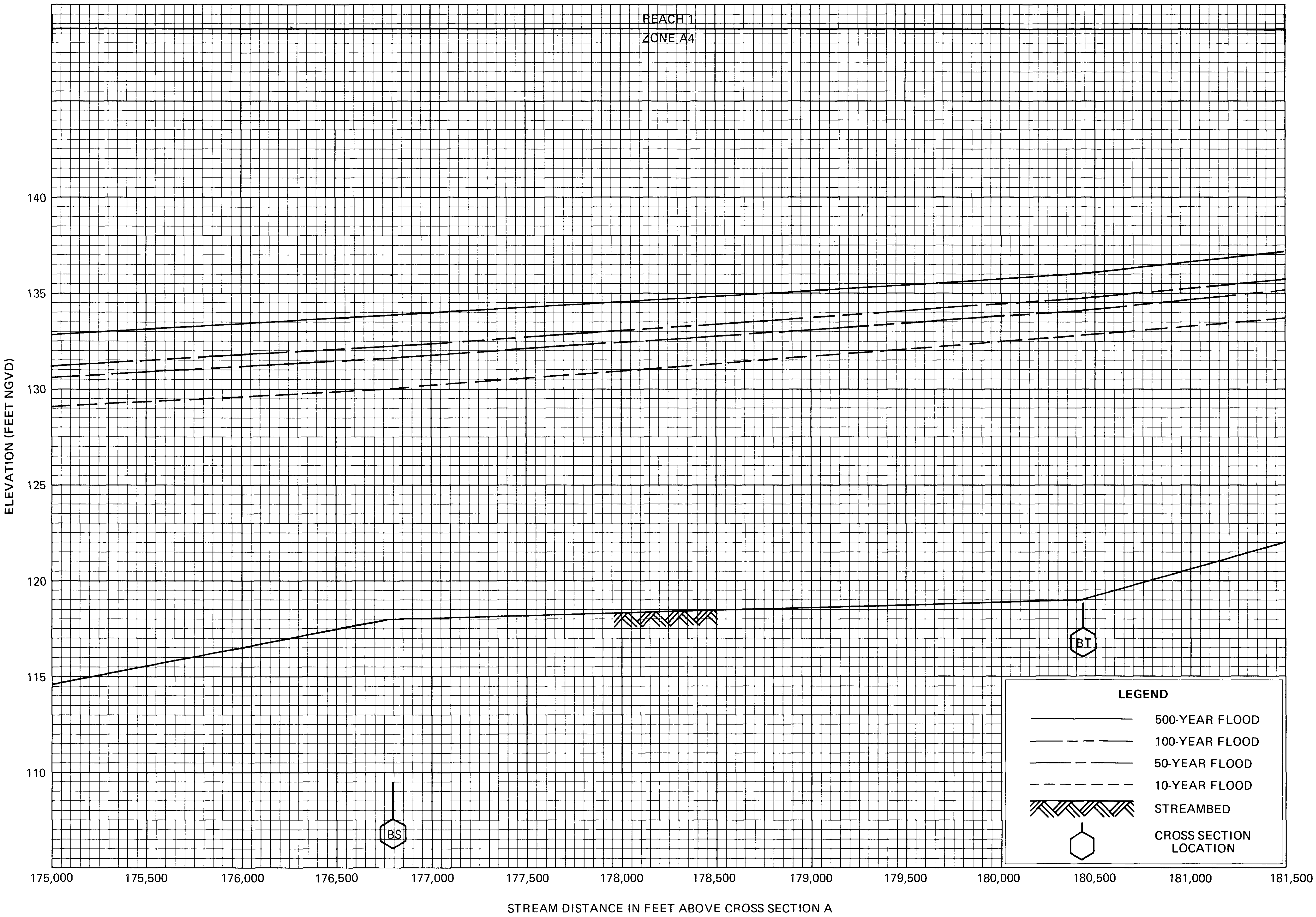

FLOOD PROFILES

KENAI RIVER

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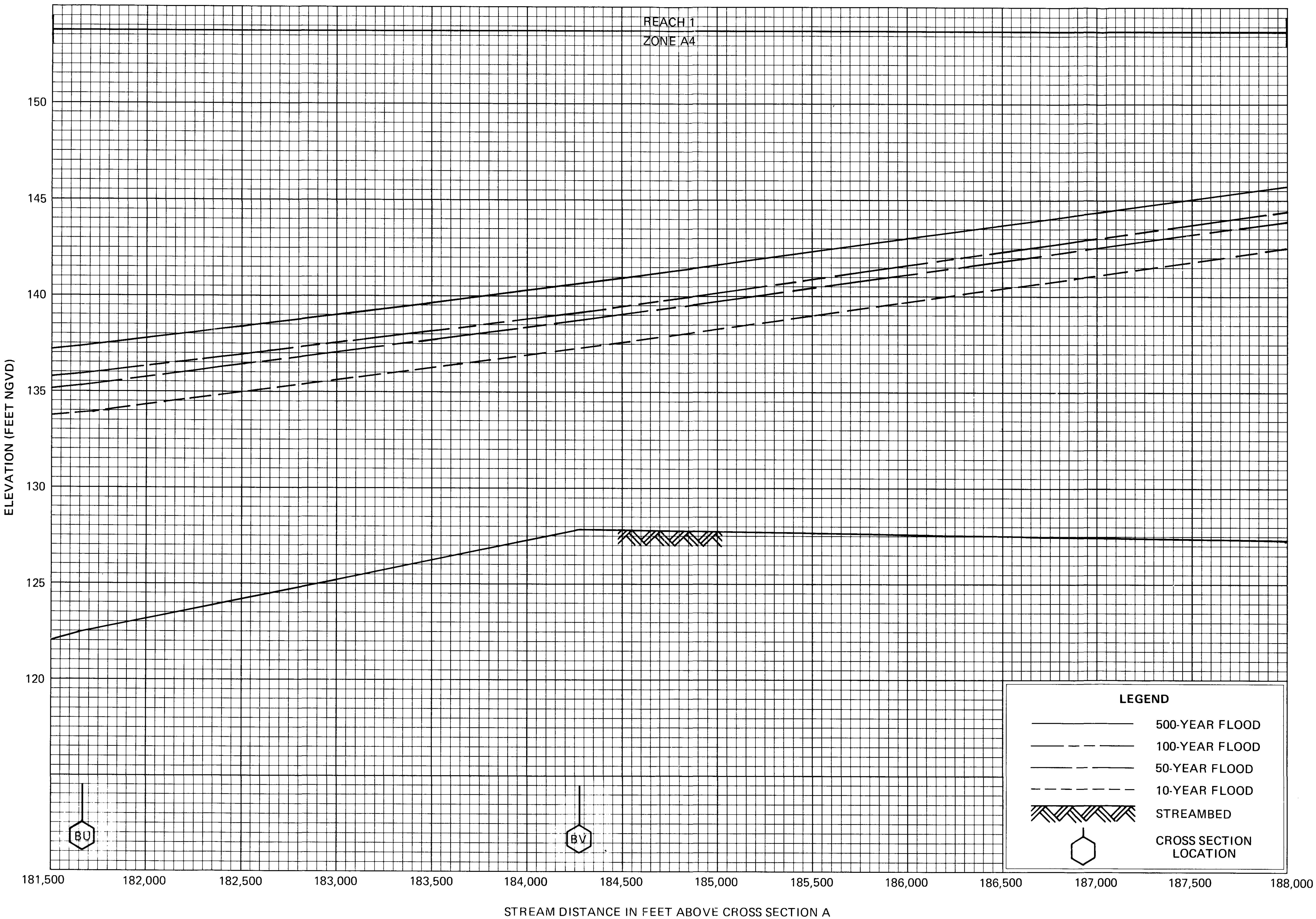

FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

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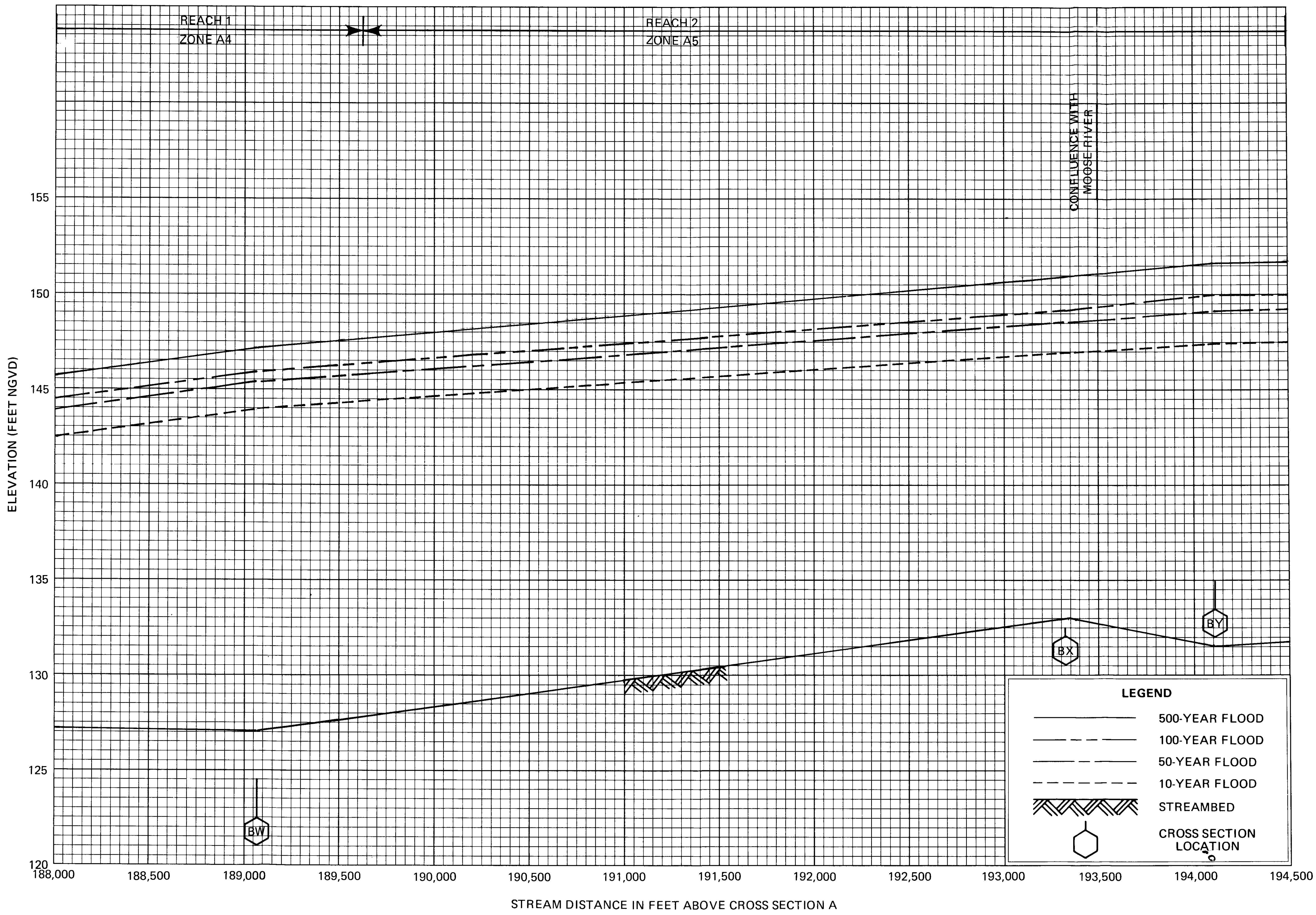

FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

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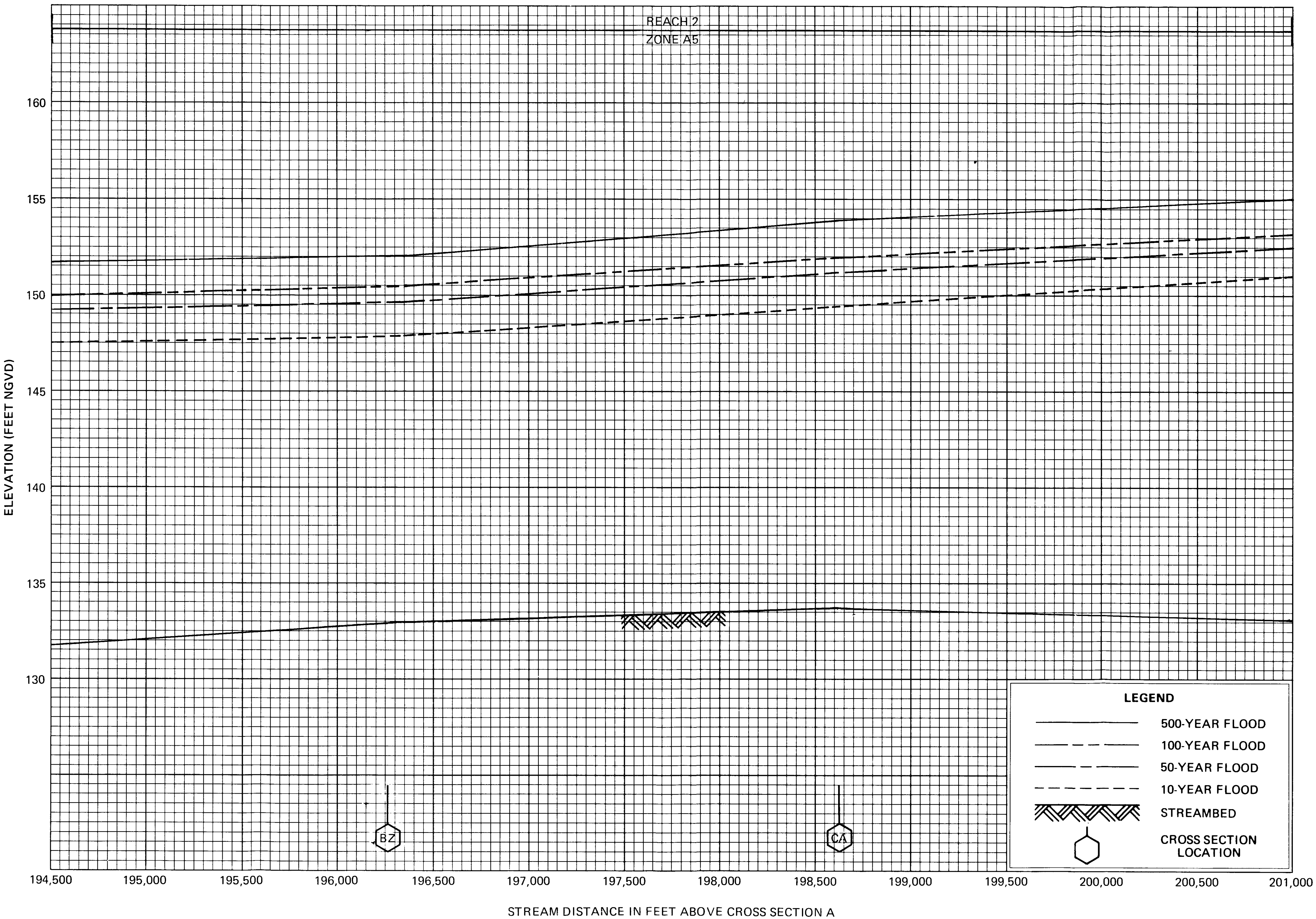
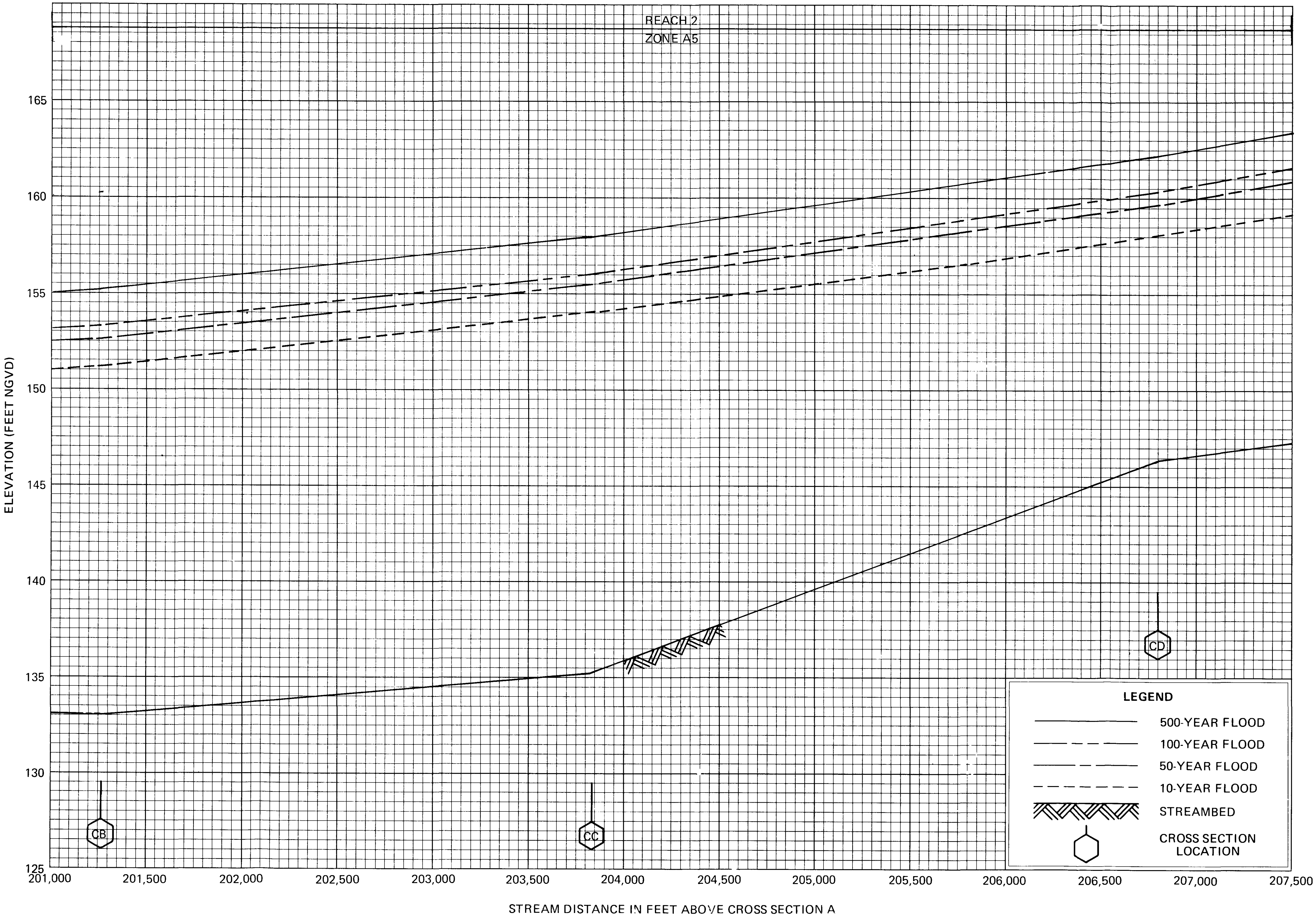


FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK



FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

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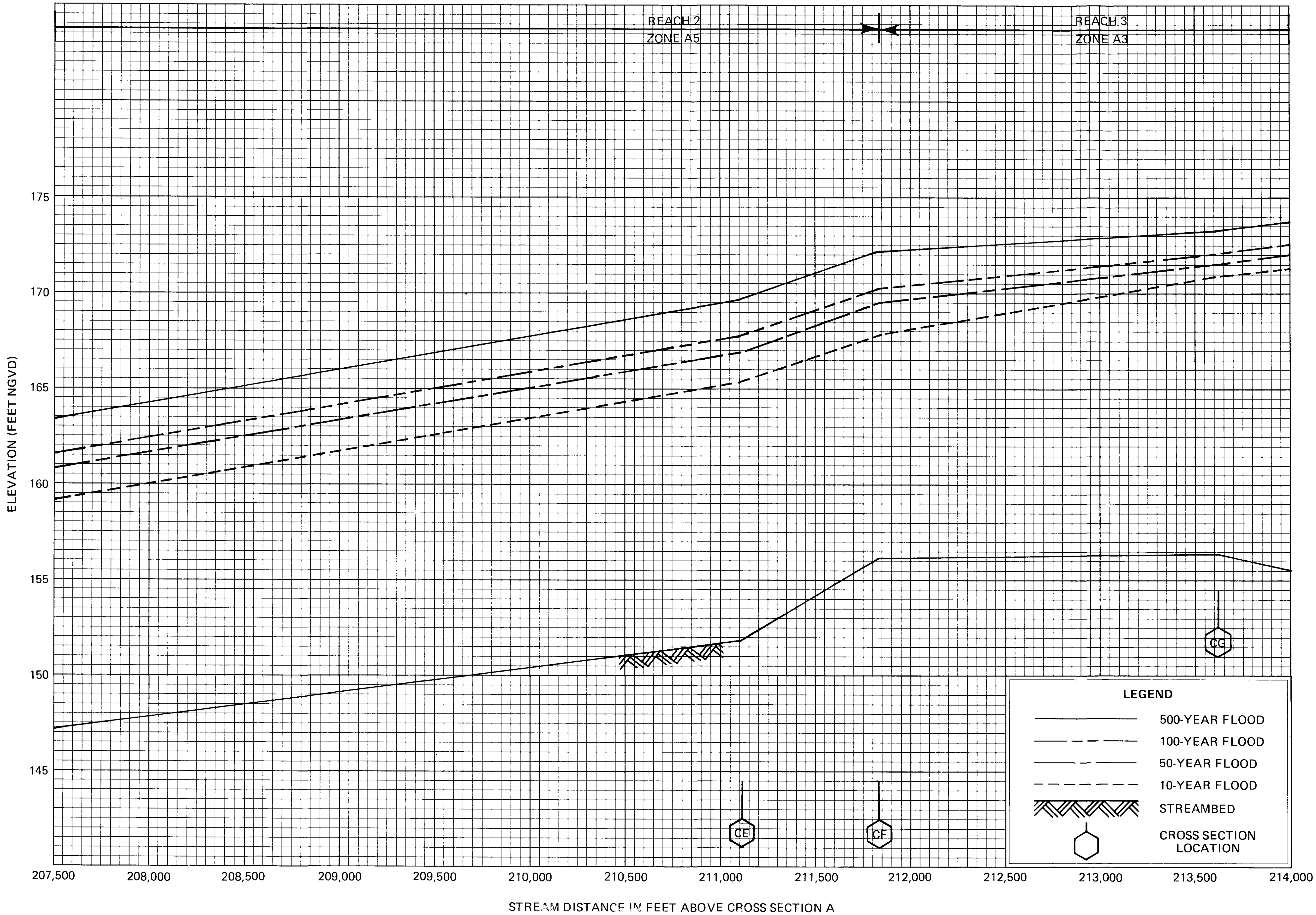
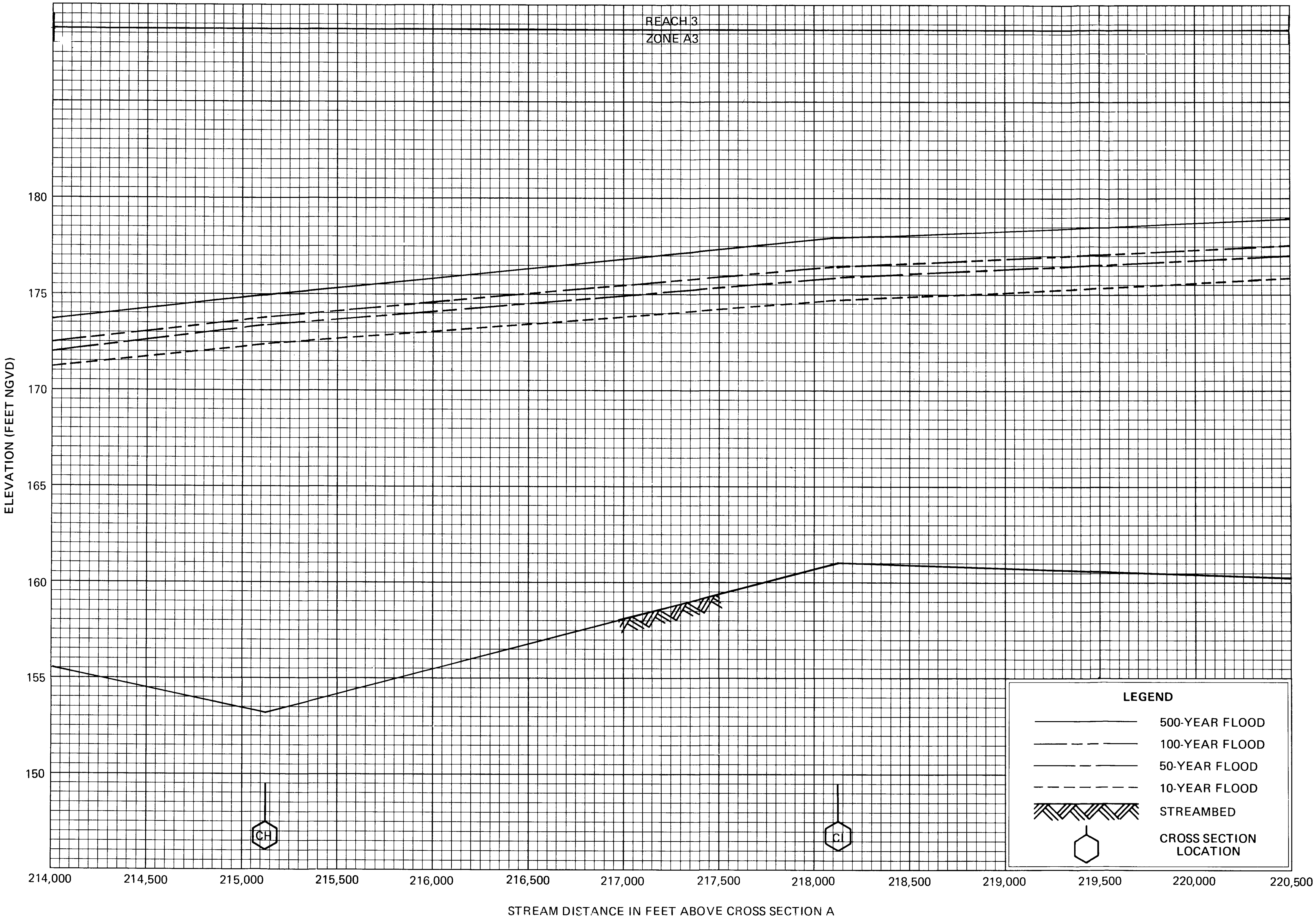


FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

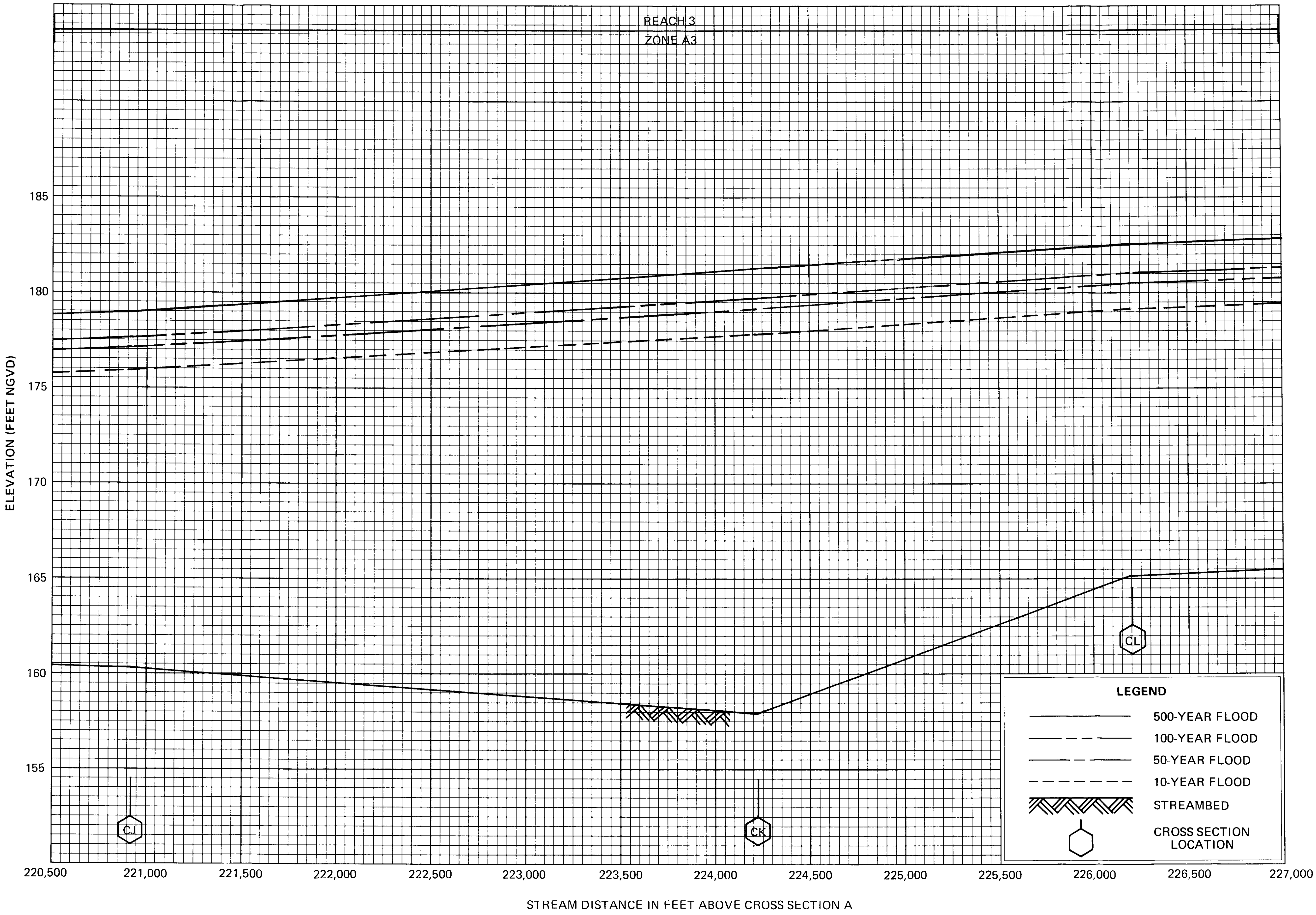


FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK



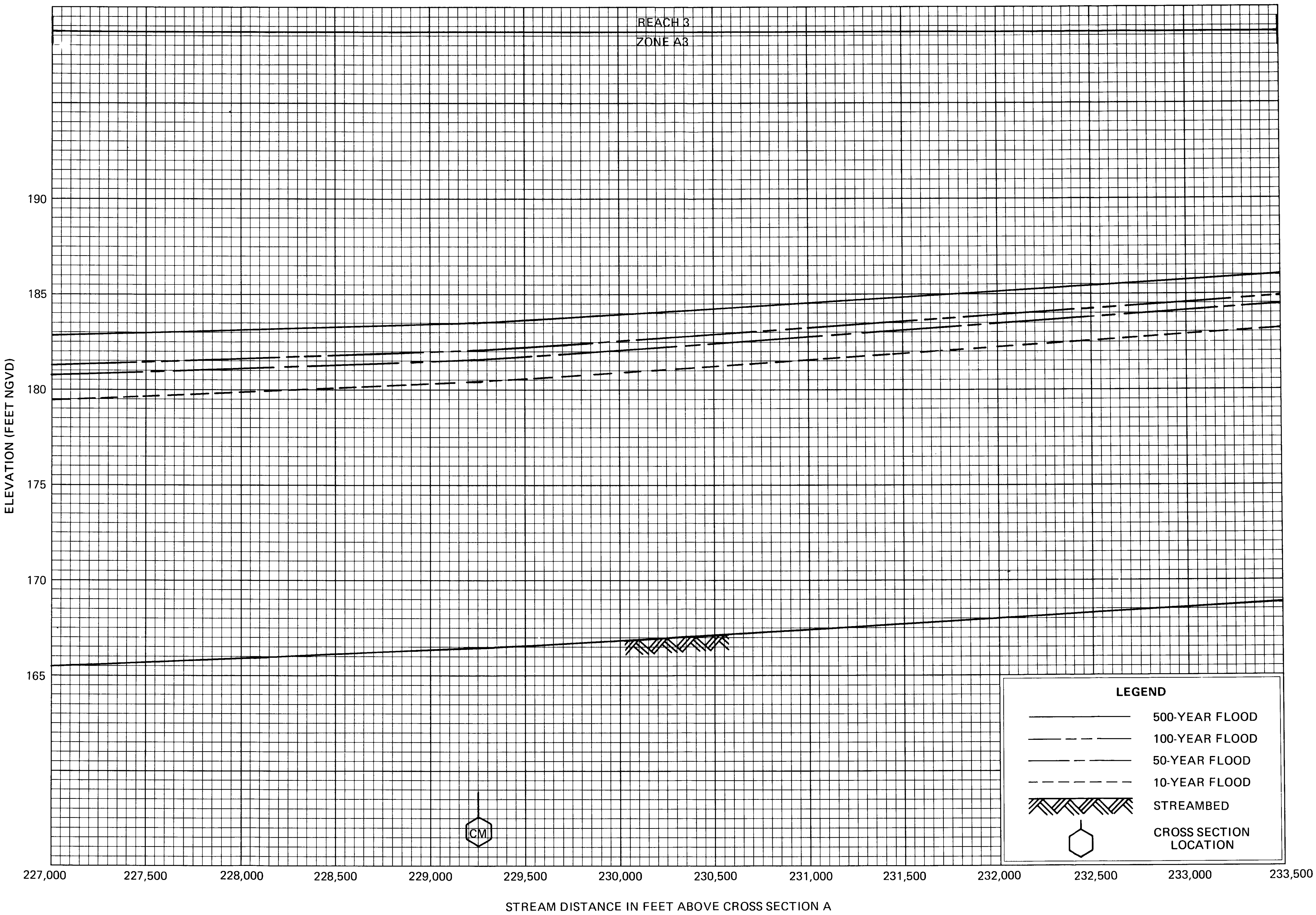
FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

46P

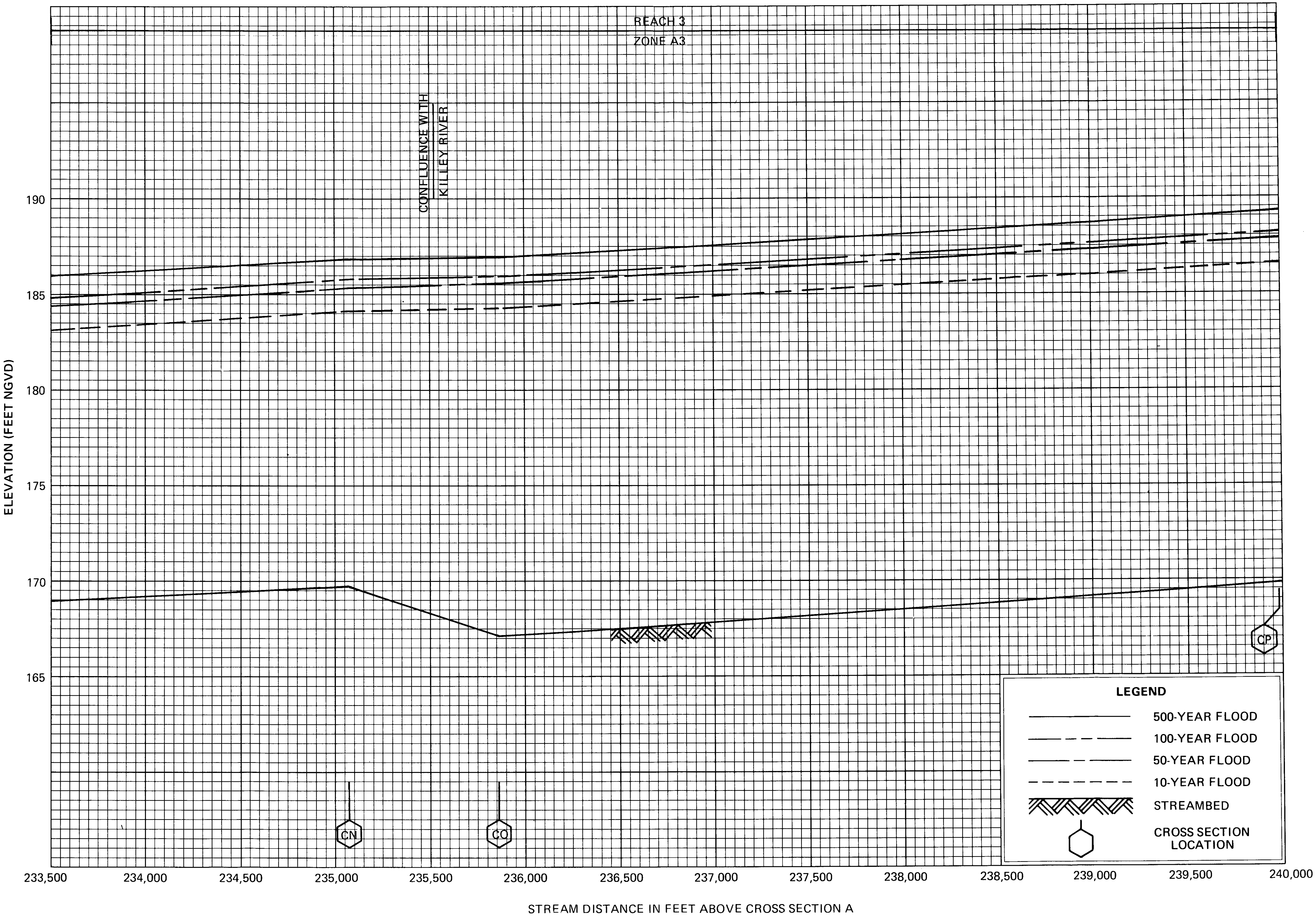


FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

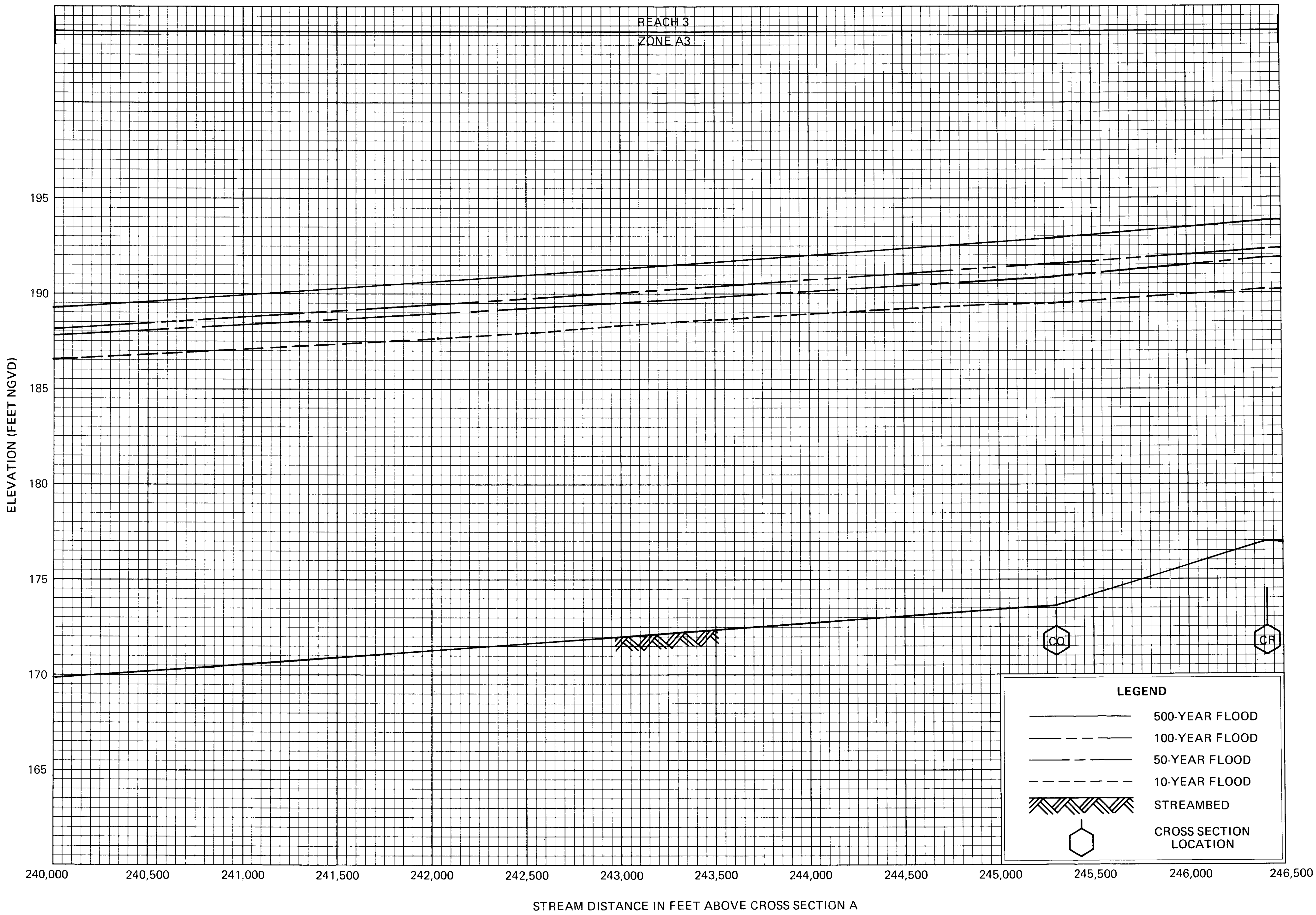


FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

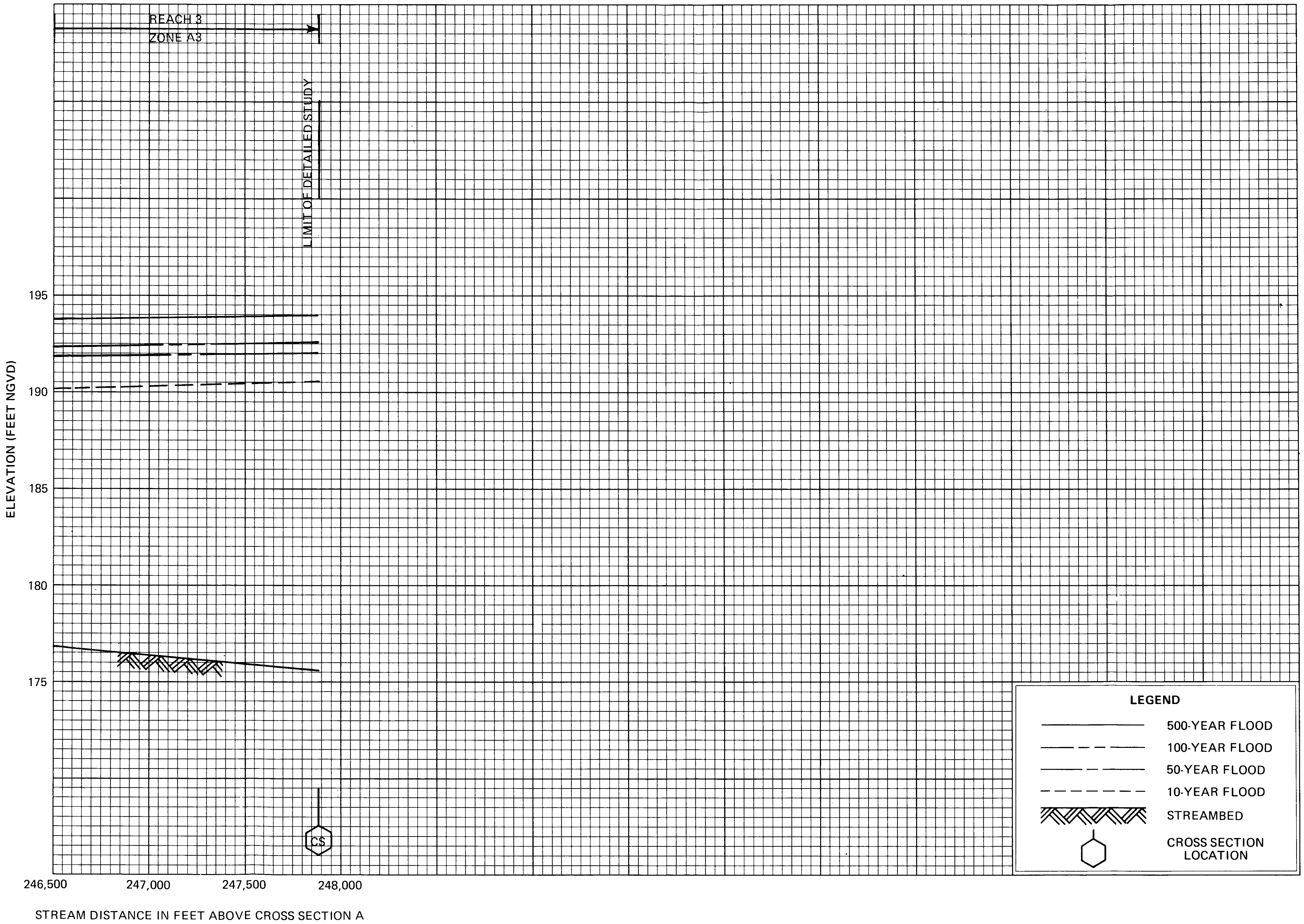


FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

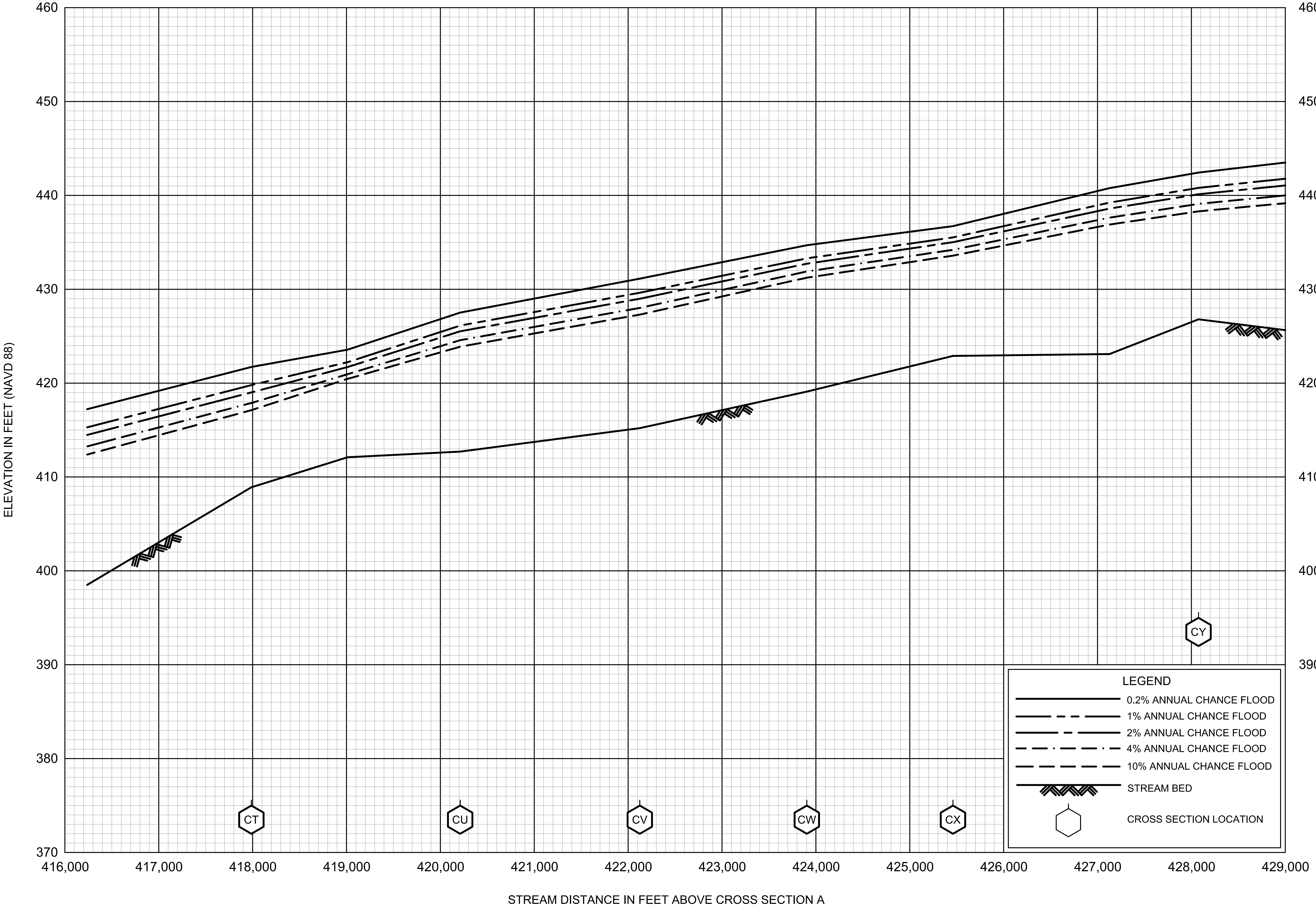


FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

FLOOD PROFILES

KENAI RIVER



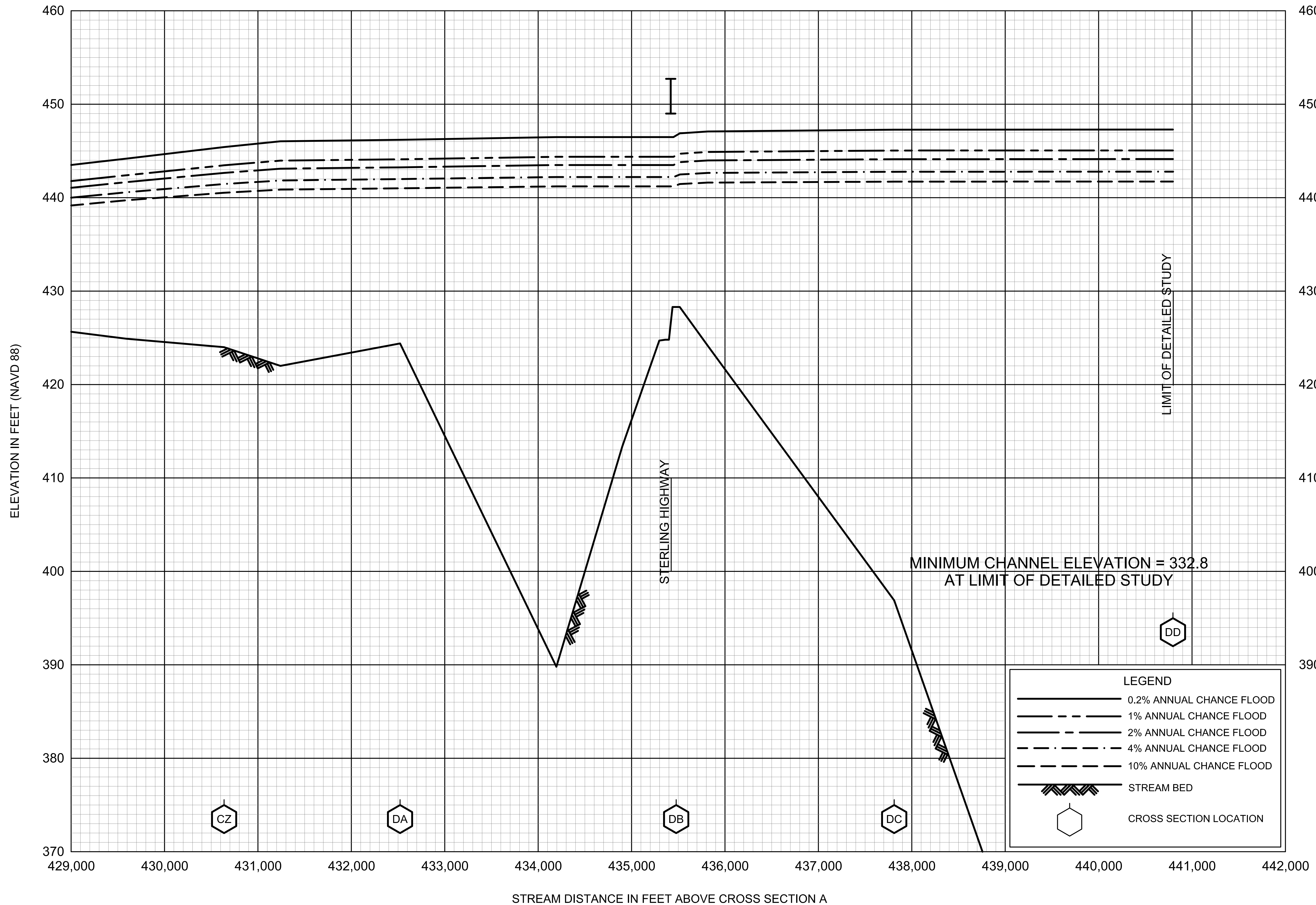
FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS



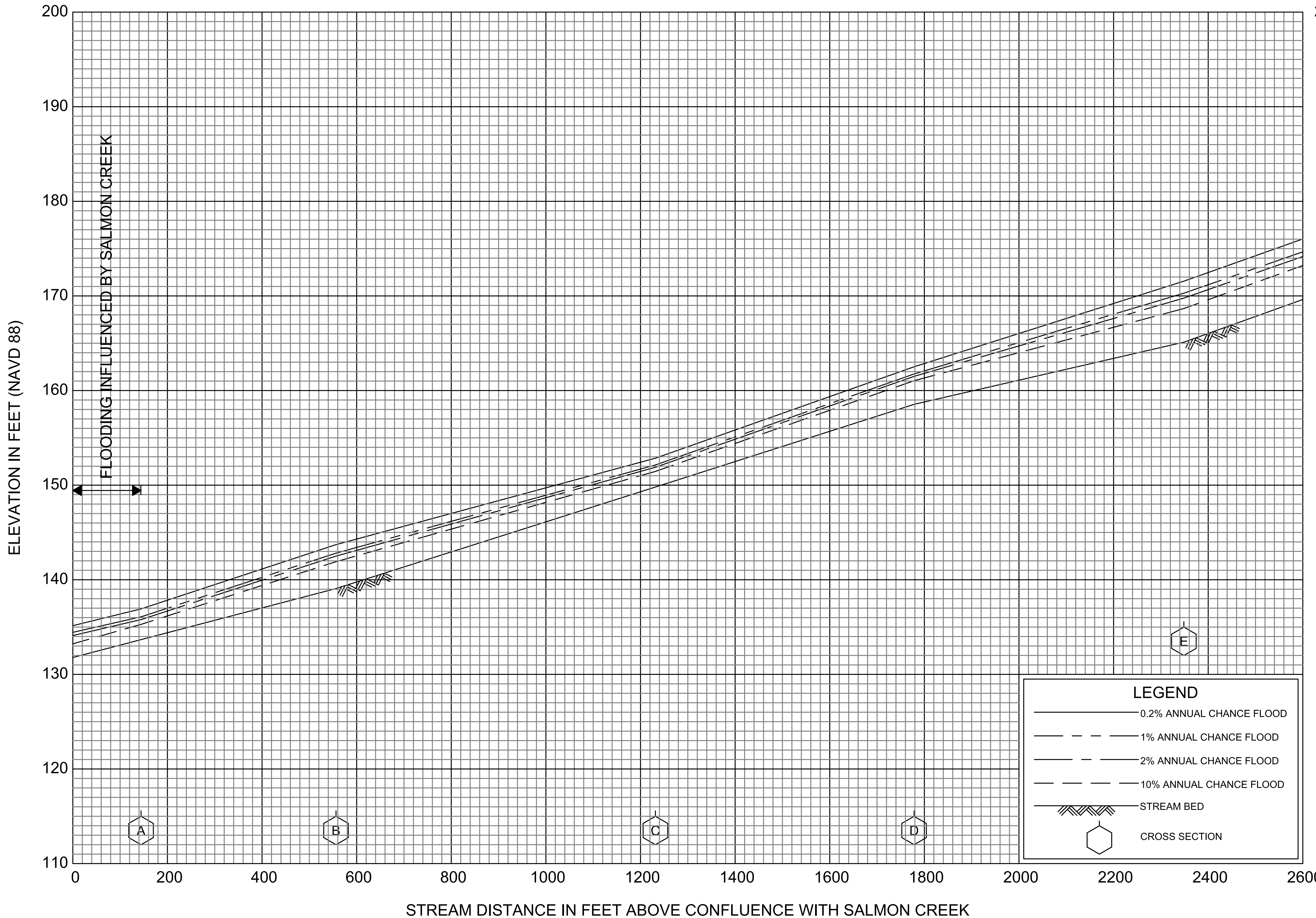
FLOOD PROFILES

KENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS



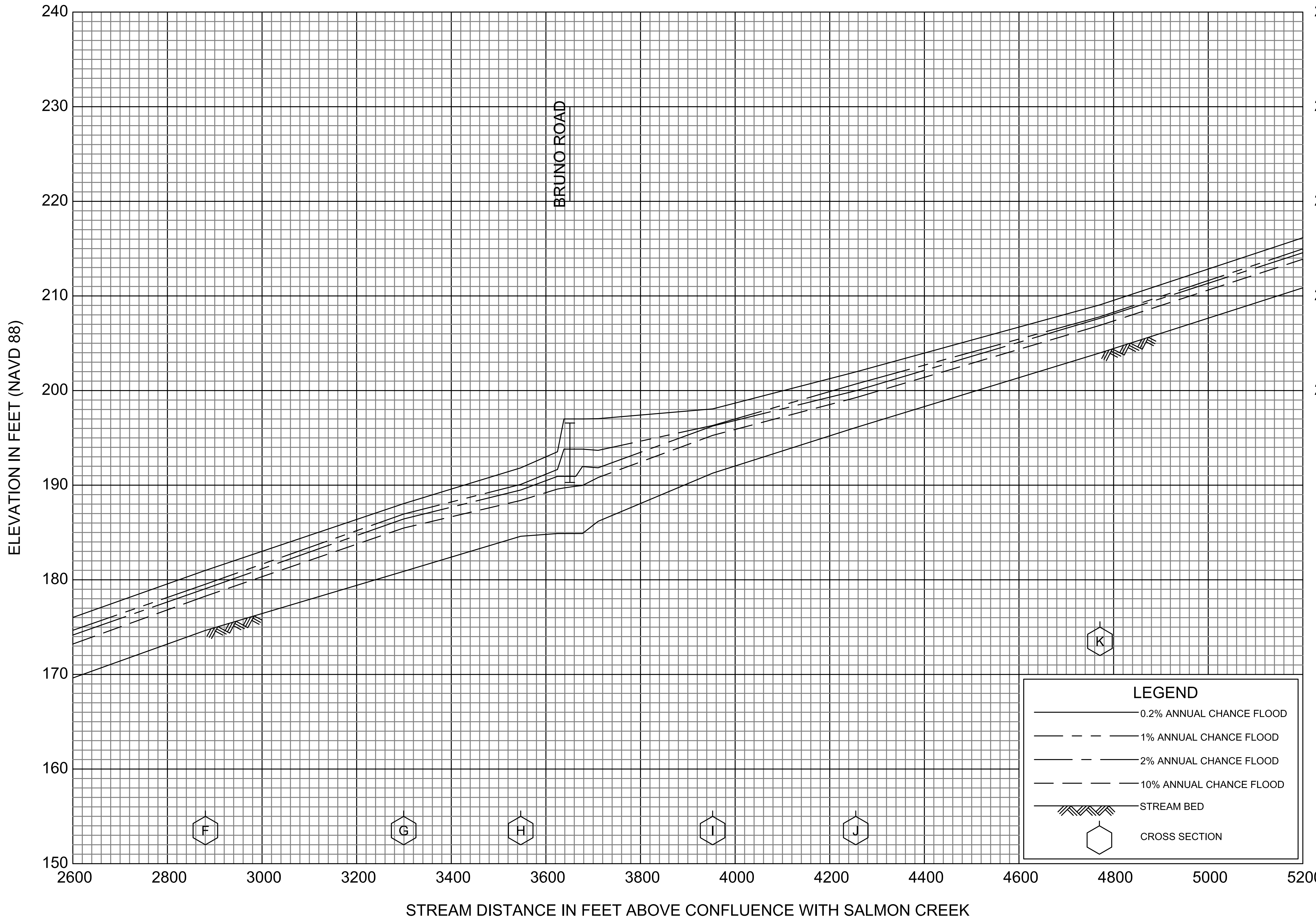
FLOOD PROFILES

KWECHAK CREEK (WITH LEVEES)

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

53P

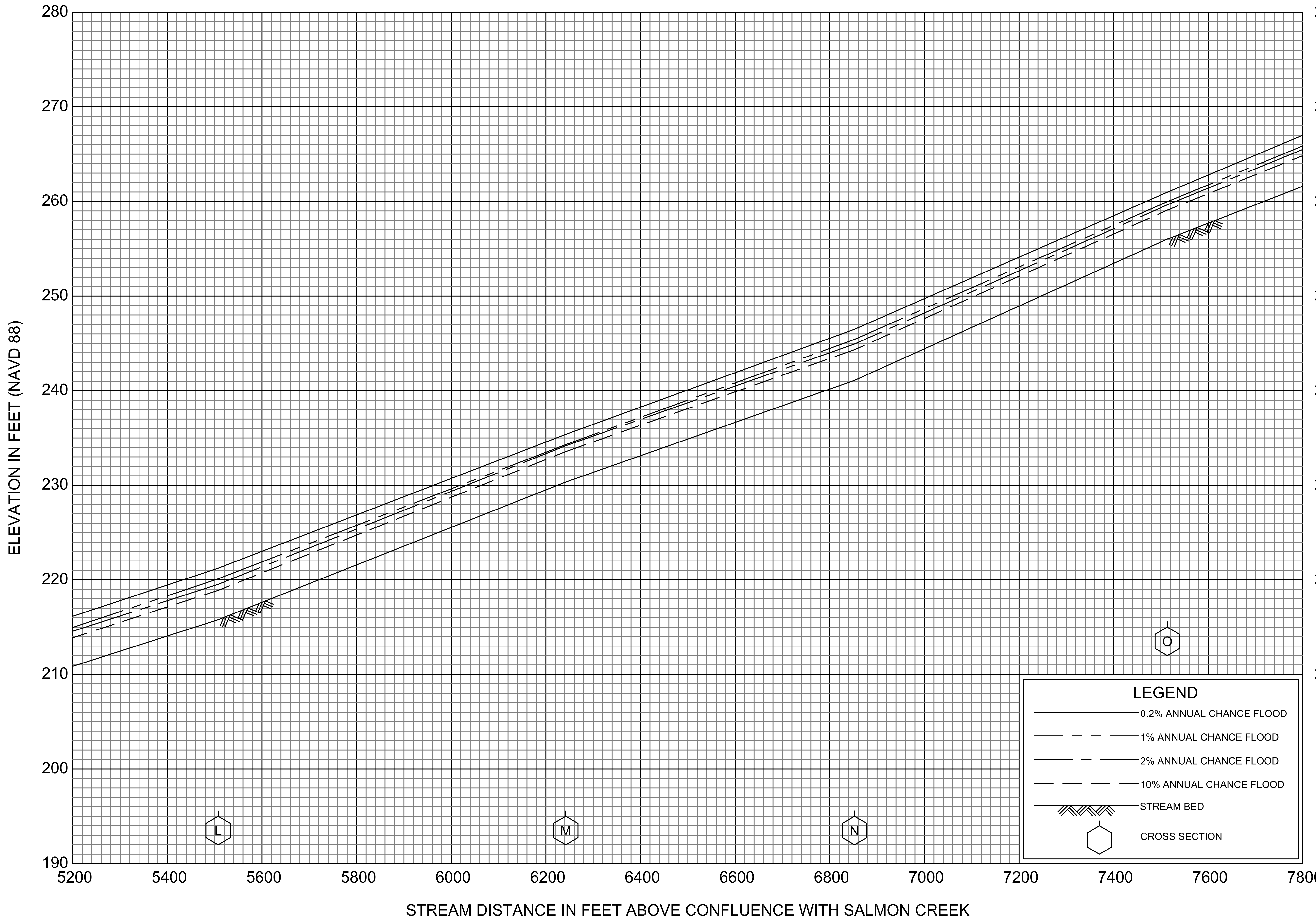


FLOOD PROFILES

KWECHAK CREEK (WITH LEVEES)

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

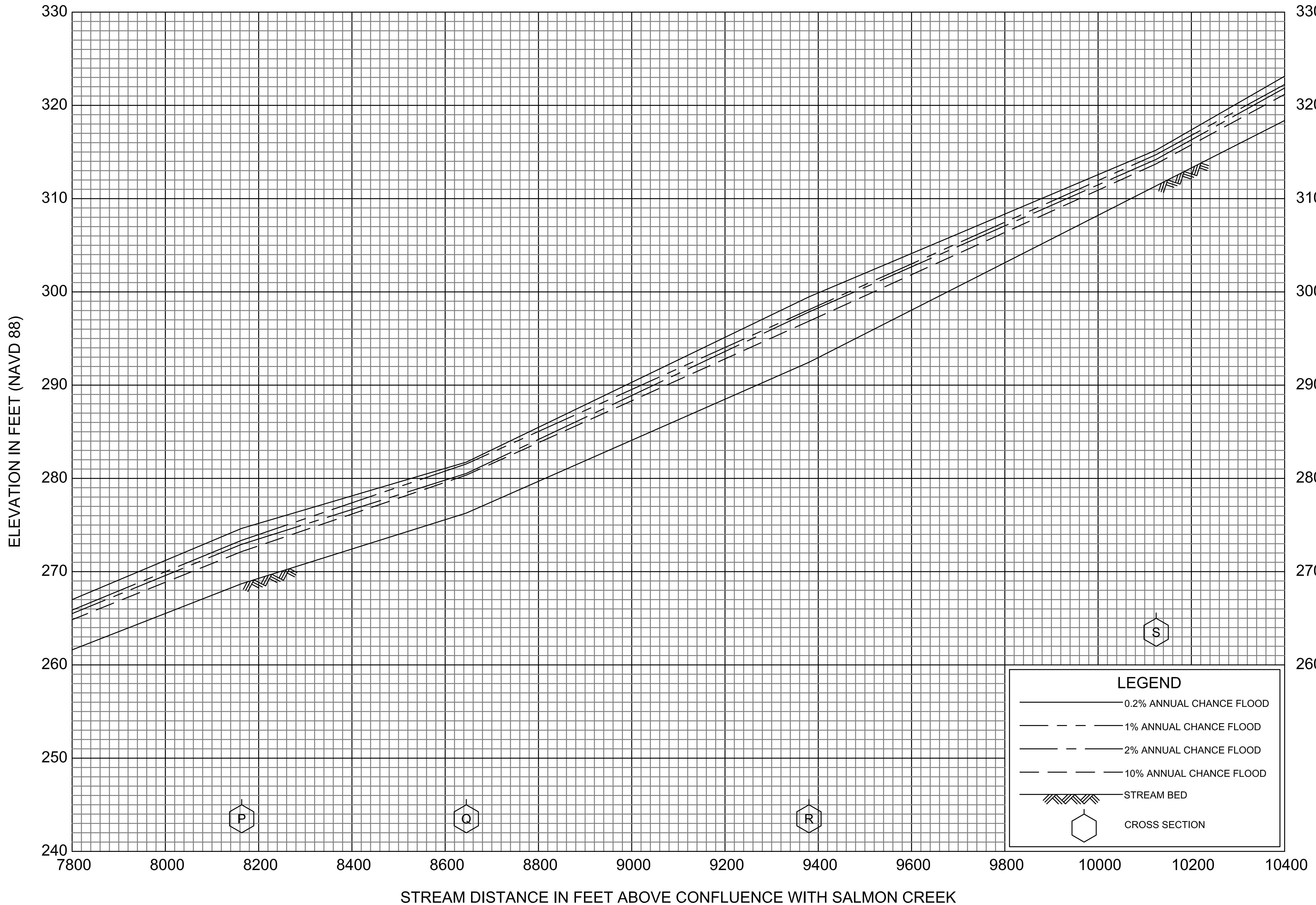


FLOOD PROFILES

KWECHAK CREEK (WITH LEVEES)

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

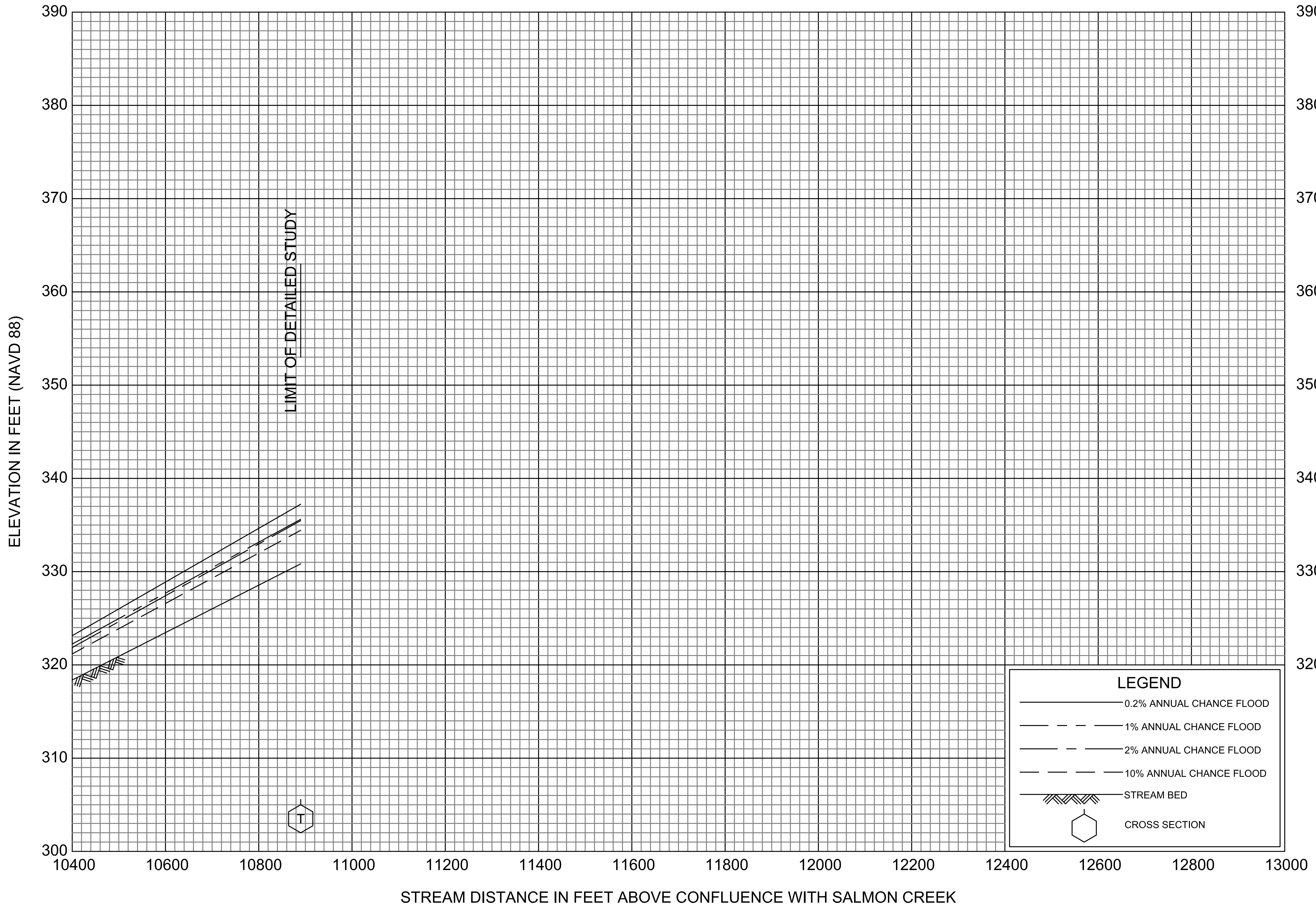


FLOOD PROFILES

KWECHAK CREEK (WITH LEVEES)

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

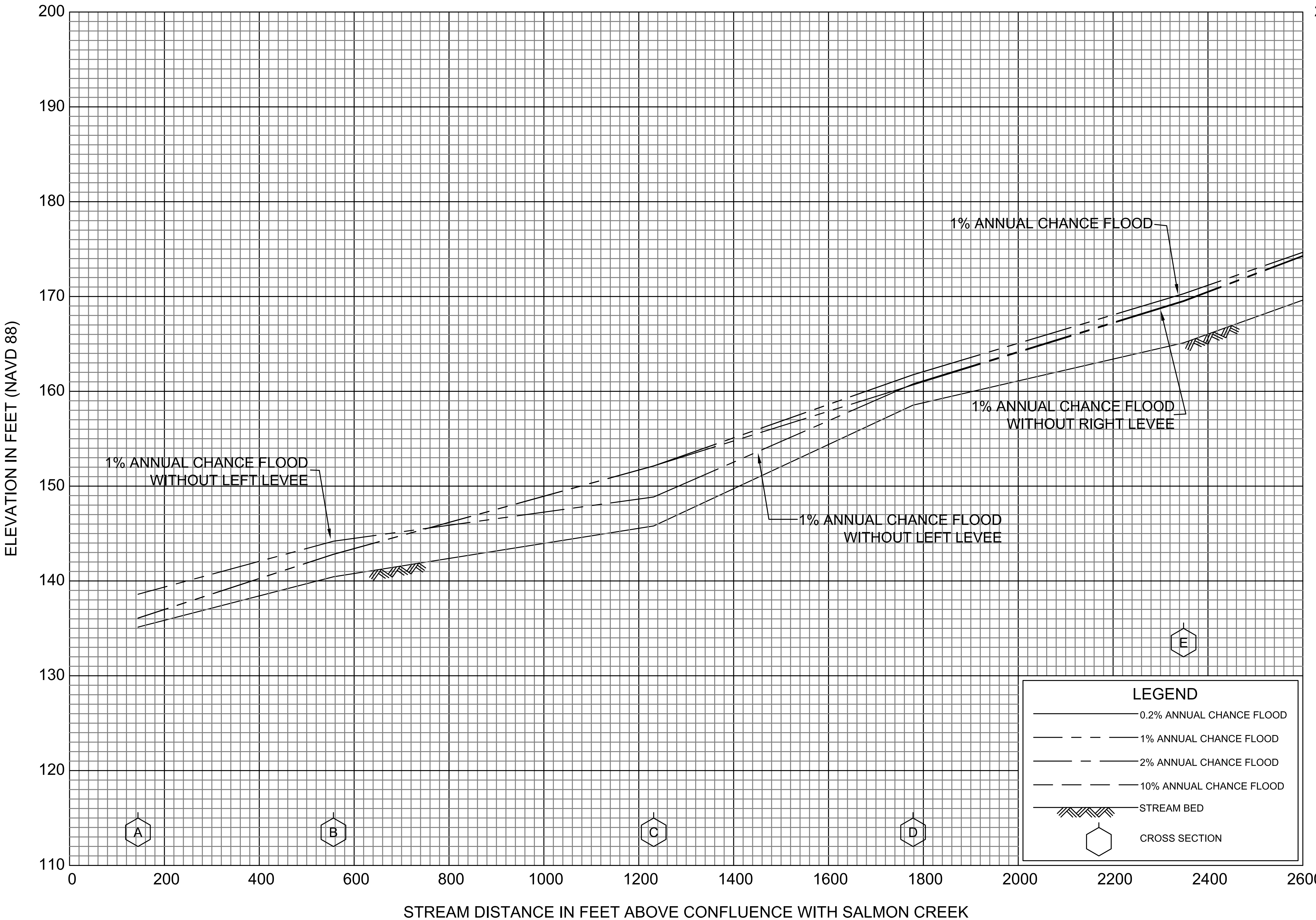


FLOOD PROFILES

KWECHAK CREEK (WITH LEVEES)

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

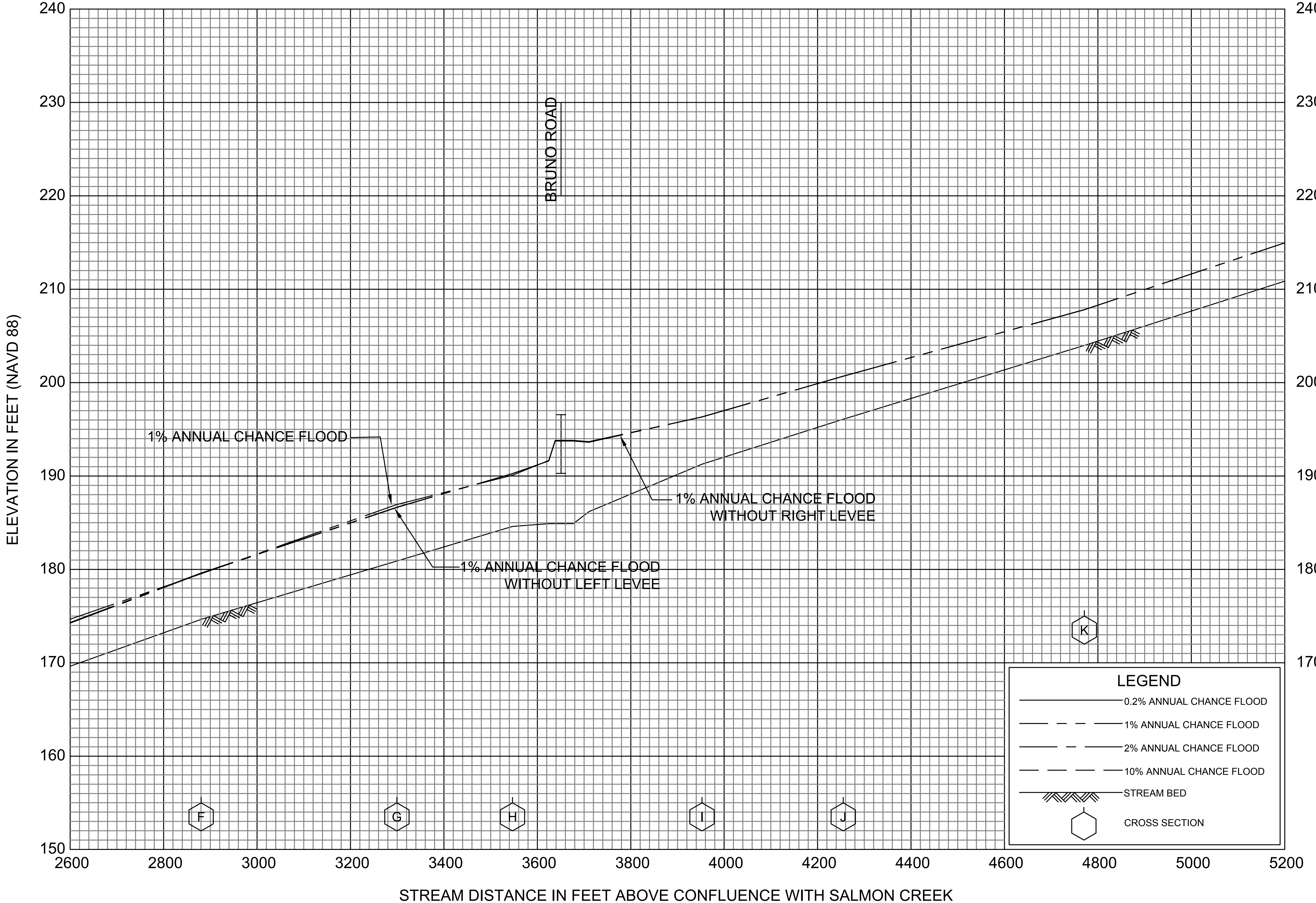


FLOOD PROFILES

KWECHAK CREEK (WITHOUT LEVEES)

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK AND INCORPORATED AREAS

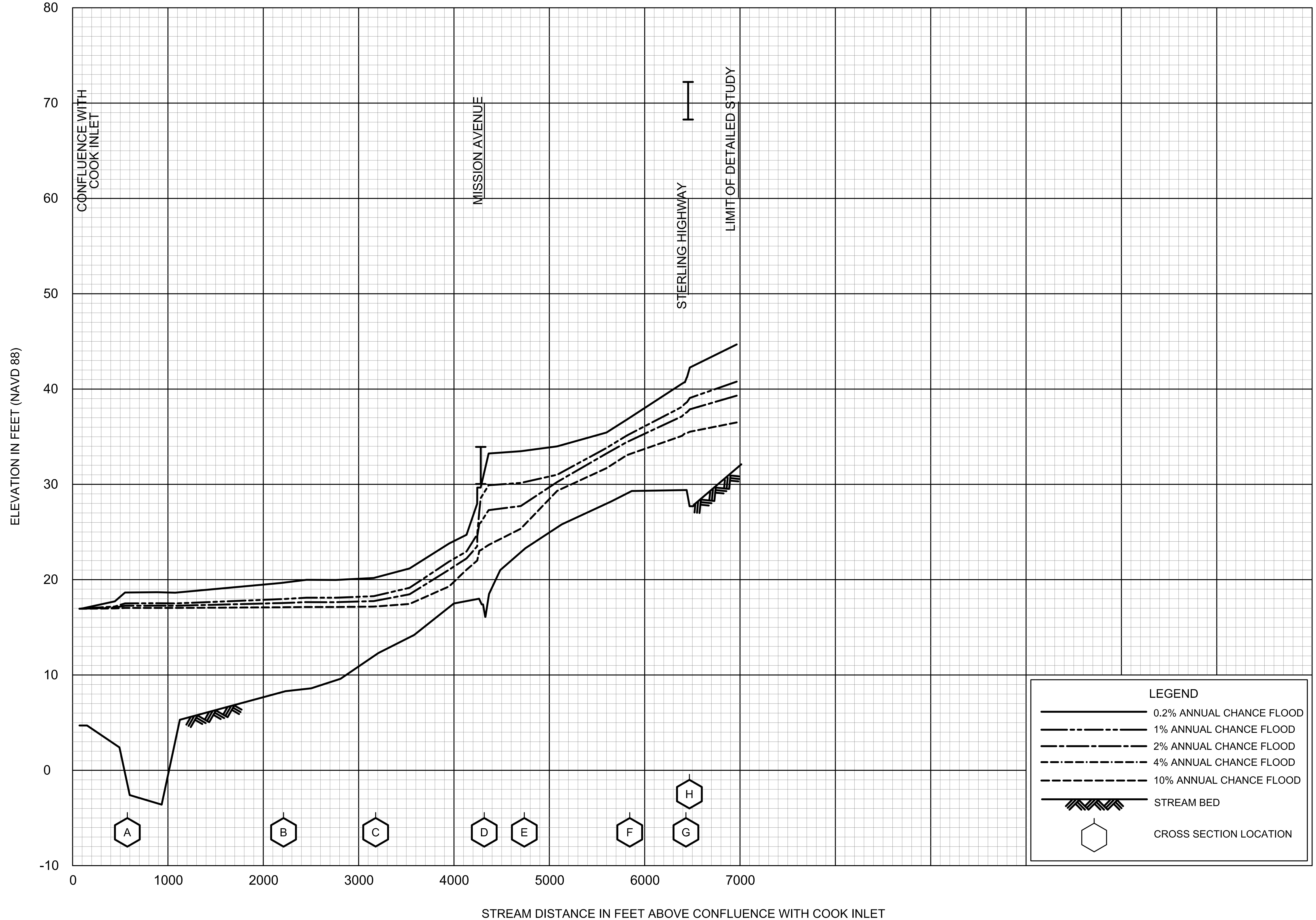


FLOOD PROFILES

KWECHAK CREEK (WITHOUT LEVEES)

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOUROUGH AND INCORPORATED AREAS



FLOOD PROFILES

NINILCHIK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KENAI PENINSULA BOROUGH, AK

AND INCORPORATED AREAS

60P