



FEMA

**Technical Support Data Notebook**

**DFIRM Update for Fort Bend County, Texas, Part 2**

**Tasks 45 and 47**

**Hydraulic Analyses and Floodplain Mapping**

**Brazos River**

**Prepared by**



**Riverine Flood Insurance Studies Throughout FEMA Region VI**

**Contract No. EMT-2002-CO-0049**

**Task Order 022**

**September 2009**

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## **I. TASK SUMMARY**

### **A. Report Introduction**

The Comprehensive Flood Risk Resources & Response Joint Venture (hereinafter referred to as CF3R, a joint venture) has completed the hydraulic analyses and floodplain mapping in accordance with Task Order 022, Task 45 and Task 47, for Fort Bend County, Texas. The hydraulic analysis consists of developing the flood profiles and floodway limits for Brazos River. Flood elevation data was then used to map the floodplain for the 1% and 0.2% events. Details of both tasks are discussed in this report.

### **B. Project Work Statement (Task 45 and Task 47)**

The Statement of Work for Task 45 and Task 47 is provided below:

Task 45 Scope Hydraulic analyses shall be completed for an approximate reach of flooding sources identified in the contract task order. The modeling shall include the annual chance events based on peak discharges computed under Task 42 of this SOW (recurrence intervals shall be identified in contract task order). The hydraulic methods used for this analysis shall be identified in each contract task order. Cross sections and field data collected under Task 39 of this SOW shall be used to prepare the hydraulic analyses. The hydraulic analyses shall be used to establish flood elevations, and if required floodways, for the subject flooding sources. In addition, the Contractor shall address all concerns or questions regarding this task raised during the QASP review.

If GIS-based modeling is performed, automated data processing and modeling algorithms for GIS-based modeling shall be documented and provided to FEMA to ensure they are consistent with the standards outlined in the ***Guidelines and Specifications for Flood Hazard Mapping Partners, as amended***. Digital data sets shall be documented and provided to FEMA for approval prior to performing the analyses to ensure they meet minimum requirements. If non-commercial (i.e. custom-developed) software is used for the analysis, then full user documentation, technical algorithm documentation, and the software shall be provided to FEMA for review prior to performing the scope of work.

#### Task Order J024 Specific Task Scope:

- Perform hydraulic analysis for about 87.17 miles of the Brazos River, using HEC-RAS and HEC-GeoRAS to develop profiles for the 10-, 2-, 1- and 0.2-percent annual chance storm events based on the peak discharges computed in Task 42.
- Estimate the Manning's n-values and establish the starting water surface elevations for each hydraulic model.
- Incorporate the field surveyed section, hydraulic structure and terrain data collected in Task 39 and 40.
- Establish base flood elevations and regulatory floodways.
- Prepare the Floodway Data Table.
- Prepare acquired data in a format consistent with FEMA DCS guidelines and upload it to the MIP once it becomes available. This service is based on the Draft DCS with the assumption that uploading will be a simple transmission process.
- Perform QA/QC in accordance with the approved QAP and prepare the appropriate QAP certification

Standards: All work conducted under this task shall conform to the standards specified for this task in Section 5, "Applicable Standards" of this SOW. In the event of any contradictions between the SOW and the standards, the standards shall control.

Deliverables: Upon completion of Task 45 and 47, the Study Contractor shall submit a TSDN report document in the Region VI hydraulic and workmap submittal outline format with required digital files delivered via CD or DVD. Additionally, the digital data shall either be uploaded to the MIP or developed on the MIP.

The Region VI hydraulics and work map submittal outline was developed in accordance with the Technical Support Data Notebook (TSDN) format described in Appendix M of *Guidelines and Specifications for Flood Hazard Mapping Partners*. At a minimum the submittal shall include, but is not limited to:

- Digital profiles of the 10-, 2-, 1- and 0.2-percent-annual-chance water-surface elevations representing existing conditions;
- Floodway Data Table(s) for each subject flooding source;
- Digital copies of all hydraulic modeling (input and output) files;
- All backup or supplemental information used in the analysis shall be provided for the QASP.
- For GIS-based modeling, deliverables include all input and output data, intermediate data processing products, GIS data layers, and final products in the format of the DFIRM database structure.
- A QA/QC report that includes a description and the results of all automated or manual QA/QC steps taken during the Hydraulic Analyses. This report shall be certified in accordance with contractor's QAP Plan.
- NSP Format Hydraulic Database or Intermediate Data Delivery consistent with the NSP Data Capture Standards and Guidelines.

The Data Capture Standards and Guidelines can be downloaded from [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm).

**Task 47 Scope:** : Digital floodplain boundaries and floodway boundaries (if required) shall be delineated for the flooding sources listed in Tasks 42, 43 and 45 of this SOW. The mapping shall incorporate all revised modeling and newly acquired topographic information. The floodplain boundaries for the recurrence intervals (identified in the contract task order) and a floodway (if required) shall be delineated on a digital work map based on topographic data developed under Task 40 of this SOW. In addition, the Contractor shall address all concerns or questions regarding this task raised during the QASP review.

**Task Order J024 Specific Task Scope:**

- Based on the hydraulic profiles calculated in Task 45, delineate the 1- and 0.2-percent annual chance boundaries for each flooding source on the topo data from Task 40.
- Prepare the floodway hydraulic model and delineate the regulatory floodway boundaries (if required).
- Include the cross sections, Base Flood Elevations, and flood insurance risk zone designation labels.
- Incorporate the results of all effective Letters of Map Change as appropriate.
- Prepare acquired data in a format consistent with FEMA DCS guidelines and upload it to the MIP once it becomes available. This service is based on the Draft DCS with the assumption that uploading will be a simple transmission process.
- Perform QA/QC in accordance with the approved QAP and prepare the appropriate QAP certification.

**Standards:** All work conducted under this task shall conform to the standards specified for this task in Section 5, "Applicable Standards" of this SOW. In the event of any contradictions between the SOW and the standards, the standards shall control.

**Deliverables:** Upon completion of Task 45 and 47, the Study Contractor shall submit a TSDN report document in the Region VI hydraulic and workmap submittal outline format with required digital files delivered via CD or DVD. Additionally, the digital data shall either be uploaded to the MIP or developed on the MIP.

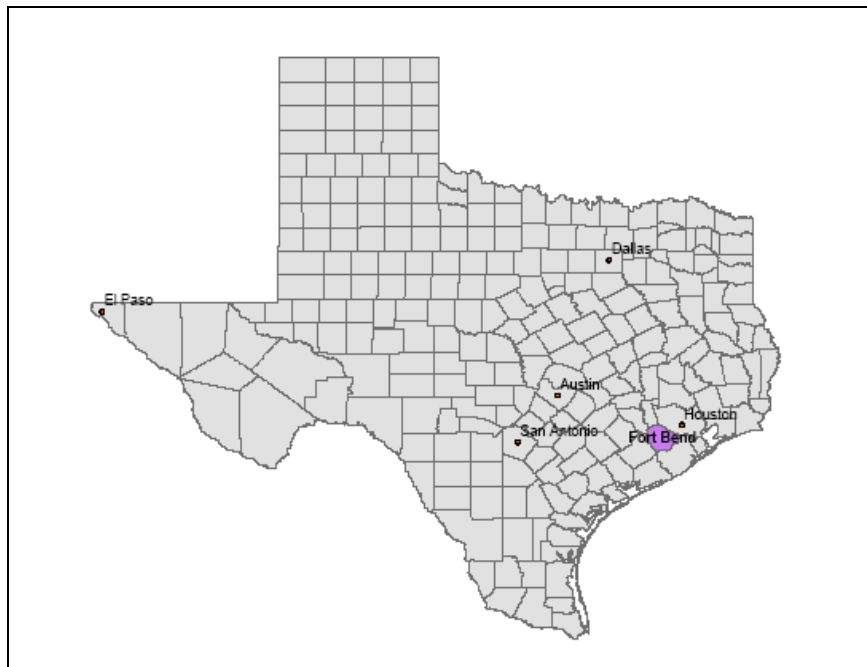
The Region VI hydraulics and work map submittal outline was developed in accordance with the Technical Support Data Notebook (TSDN) format described in Appendix M of *Guidelines and Specifications for Flood Hazard Mapping Partners*. At a minimum the submittal shall include, but is not limited to:

- Digital work maps with the 1- and 0.2-percent-annual chance floodplain boundaries and floodway boundaries (if required) delineated. These maps should also include cross sections, Base Flood Elevations (BFE's), and flood insurance risk zone designation labels.
- For Coastal Areas (if included in contract task order) the digital work map with the Coastal High Hazard (V Zone) delineated along identified shorelines. These maps should include transect locations, BFE's, and flood insurance risk zone designation labels.
- A QA/QC report that includes a description and the results of all automated or manual QA/QC steps taken during the preparation of the work maps. One QA/QC report shall be submitted for tasks 47, 47A and 47B.
- Any backup or supplemental information used in the mapping required for the government QASP review shall be included. This report shall be certified in accordance with contractor's QAP Plan.
- Intermediate Format Mapping Database or Intermediate Data Delivery consistent with the NSP Data Capture Standards and Guidelines.

The Data Capture Standards and Guidelines can be downloaded from [http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm).

### C. Location and General Description

Fort Bend County is located in the southeastern portion of Texas, as shown in **Figure 1**. It is bordered by Waller County to the north, Wharton County to the south and west, Harris County to the north and east, Brazoria County to the south and east, and Austin County to the west. The county is approximately 886 square miles in size and had a population of 419,772 people at the time of the 2003 census. Richmond is the county seat and is located in the central part of the county approximately twenty-eight miles west-southwest of Houston. Sugar Land, located in the northeastern region of the county, is the largest city.

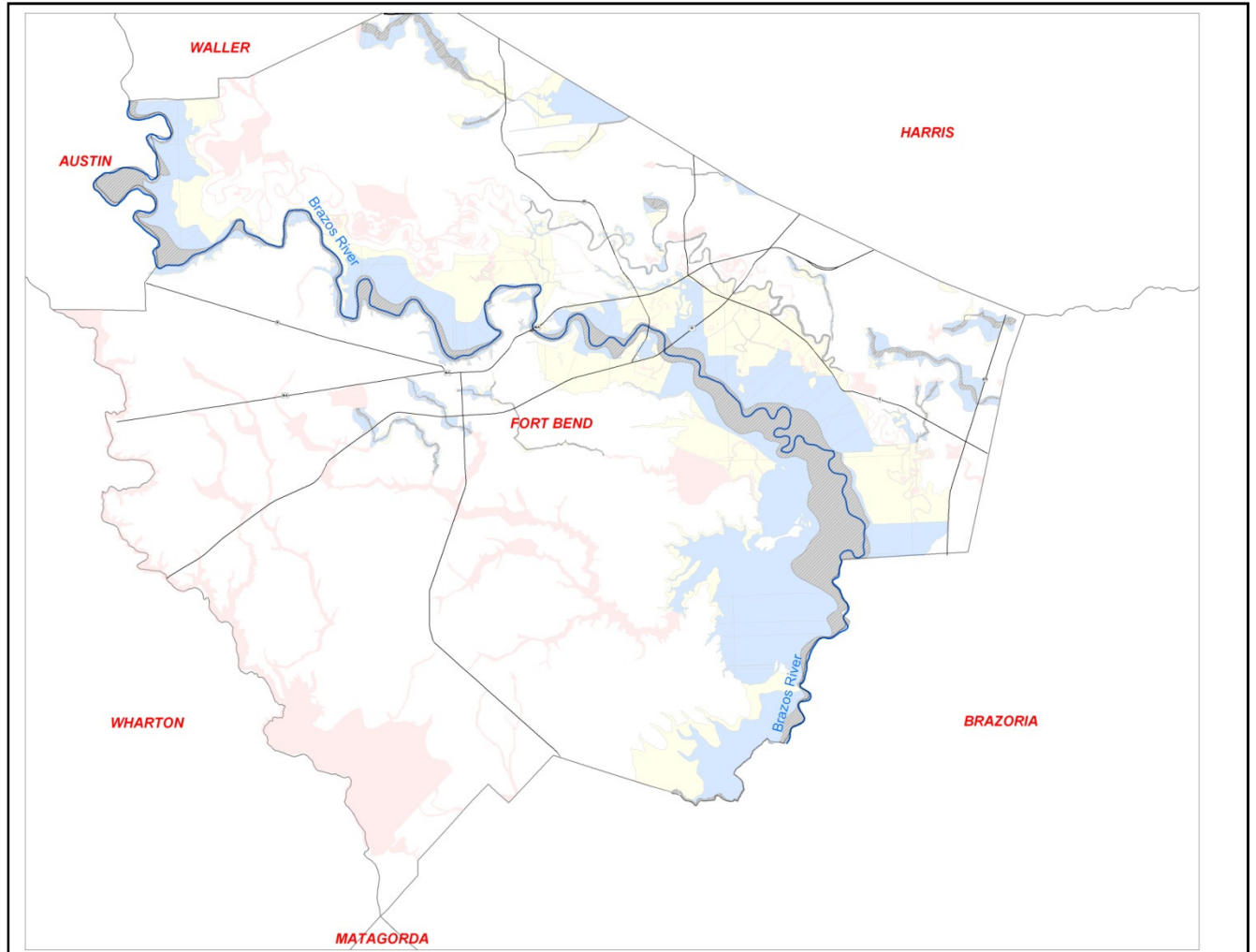


**Figure 1: Fort Bend County**

The **Brazos River** is the 11th longest river in the United States at 1280 miles, beginning at Blackwater Draw, Curry County, New Mexico and flowing 840 miles through the middle of Texas to the Gulf of Mexico. The Brazos River begins at the confluence of its Salt Fork and Double Mountain Fork near the eastern boundary of Stonewall County and runs 840 miles across Texas to its mouth on the Gulf of

Mexico, two miles south of Freeport in Brazoria County. The two forks emerge from the Caprock 150 miles above the confluence, thus forming a continuous watershed 1,050 miles long, which extends from New Mexico to the Gulf of Mexico and comprises 44,620 square miles, 42,000 of which are in Texas.

Approximately 87 miles of Brazos River runs through Fort Bend County from north to south boundary as shown in **Figure 2** below. Brazos River is primarily important today as a source of water for power and irrigation. The water is administered by the Brazos River Authority.



**Figure 2: Brazos River Detailed Study Stream**

## **II. METHODOLOGY**

### **A. Processing**

a. Summary of Methodology: The Brazos River study limits are approximately 87-mile length from northwest boundary of Fort Bend and Waller County to the confluence location between Cow Creek and Brazos River, southeast boundary of Fort Bend and Brazoria County. Brazos River is the main drainage outfall for the developments of Fort Bend County. The study limits are described in **Table 1**.

**Table 1 – Brazos River Study Limits**

Stream	Length	Upstream Location	Downstream Location
Brazos River	Approximately 87 miles, which is the entire length within the Fort Bend County	Waller and Fort Bend boundary	Confluence between Cow Creek and Brazos River

The HEC-RAS version 3.1.3 and Geo-RAS version 4.2.92 from the Hydrologic Engineering Center (HEC), US Army Corps of Engineers (Reference 1, 2), were used as the main hydraulics tools to compute the floodplain elevations and generate the floodplain maps. Fifty five (55) valley cross-section channels were field surveyed (Reference 1). The overbank topography data was based on the LiDAR topography data collected (Reference 2). All structures (10 hydraulics structures and 5 levee cross sections) along the stream were also surveyed and modeled. Most of the 14 structures along Brazos River were modeled as single structures except for the multiple bridges at FM 1093. The hydraulic model was calibrated against the 1991 flooding event and validated against the 2007 high flow events.

b. Technical Review Committee and QA/QC Process: Since Fort Bend County is a CTP to this project, the county has set up a Technical Review Committee to review study results. Regular meetings at various study stages were held to discuss hydraulic issues, especially channel Manning’s n values, ineffective flow areas, and overflow zone mapping. The draft hydraulic model and floodplain mapping were reviewed and accepted by the review committee in December 2008. This study was also reviewed by the CF3R JV’s QAP review process and also reviewed and approved by the National Service Provider (NSP) Denton Regional Management Center (RMC), who managed this study for FEMA. Review documents are provided in Appendix D-2.

**B. Previous Studies**

a. Flood Insurance Study (FIS) – Fort Bend County, Texas and Incorporated Areas – Revised November 7, 2001: The hydrologic and hydraulics analyses for the Brazos River were completed by Espey, Huston & Associates, Inc. (EHA) for the Federal Emergency Management Agency (FEMA) in May 1985. The 2001 FIS provided 100-year floodplain data, which include a grouping of the 10-, 50-, 100-, and 500-year flood elevations; delineations of the 100-year and 500-year floodplains; and 100-year floodway. This information is displayed on the FIRM and in flood profiles, floodway data tables and summary of discharges tables in the FIS report (Reference 3).

b. FIS – Brazoria County, Texas and Incorporated Areas – Revised September 22, 1999: The hydrologic analysis for the Brazos River was prepared by EHA for FEMA in December 1985, and was used in the hydraulic analysis prepared by Woodward-Clyde Consultants. The 1999 FIS provided 100-year floodplain data, which include a grouping of the 10-, 50-, 100-, and 500-year flood elevations; delineations of the 100-year and 500-year floodplains; and 100-year floodway. This information is displayed on the FIRM and in flood profiles, floodway data tables and summary of discharges tables in the FIS report (Reference 4).

c. LOMR – Case No: 98-06-863P – Effective April 22, 1998, Panels affected: 48157C0230 J, 0235 J, 0240 J, and 0245 J, the FIRM panels were revised to show the effects of improvement within LID No. 10

d. LOMR – Case No: 98-06-784P – Effective May 08, 1998, Panels affected: 48157C0235 J, 0245 J, 0255 J, and 0265 J, the FIRM panels were revised to show the effects of a new levee associated with LID No. 14 along the northern floodway fringe of the Brazos River from approximately 16,600 feet downstream to approximately 8,700 feet downstream of U.S. Highway 59.

e. LOMR – Case No: 99-06-1722P – Effective November 05, 1999, Panel affected 48157C0245 J, the FIRM panel was revised to show the effects of construction of a levee (MUD 121) along the Brazos River from approximately 7,000 feet upstream to approximately 10,250 feet upstream of Agnes Road; a

levee (eastern levee) approximately 4,900 feet west of and parallel to Agnes Road between the Brazos River and Rabbs Bayou; a levee along Rabbs Bayou that connects the eastern levee and an existing levee approximately 8,100 feet west of and parallel to Agnes Road; associated with the Greatwood East development

f. LOMR – Case No: 02-06-266P – Effective August 22, 2002, Panels affected 48157C0270 J, 0265 J, the FIRM panels were revised to show the effects of construction of the Sienna Plantation Levee along the Brazos River from approximately 1,100 feet downstream of the Atchison Topeka and Sante Fe Railroad to approximately 400 feet upstream of the confluence with Rabbs Bayou.

g. LOMR – Case No: 03-06-449P – Effective March 15, 2004, Panels affected 48157C0230 J, 0240 J, the FIRM panels were revised to show the effects of construction of the Fort Bend County Municipal Utility District No. 121 Levee along the Brazos River from a portion of the Brazos River with Horseshoe Lake to the northwest, U.S Route 90 to the north, and Ransom Road to the southwest.

h. LOMR – Case No: 04-06-248P – Effective February 10, 2004, Reissuance of LOMR Case number 98-06-784P, dated May 8, 1998. There was no revision to the flood insurance study

### **C. Concurrent Studies and LOMRs**

a. Brazos River Flood Frequency Analysis – LJA Engineering & Surveying, Inc (LJA) - October 2006: The hydrologic analysis for the Brazos River was completed by LJA for CF3R JV in October 2006. The proposed discharges for the Brazos River are as following:

Event	Effective flow	Proposed flow
10%	101,000	103,000
2%	157,000	147,000
1%	181,000	164,000
0.2%	242,000	202,000

The LJA report was discussed in detailed in the Brazos River Hydrologic Analysis Report (Task 42) (Reference 5).

b. Fort Bend County Levee Rehabilitation and Improvement Projects : A large percentage of development occurred along the Brazos River within the 1% chance floodplain. These developments are protected from the 1% chance flood by levees constructed and maintained by several Levee Improvement Districts (LIDs) and Municipal Utility Districts (MUDs). Due to the revised base flood elevations from this study and FEMA reemphasis on levee recertification through Procedure Memorandums 32 and 34, Fort Bend County has spearheaded a parallel program to raise the levee systems to bring them into compliance with FEMA recertification requirements. Several of the levee systems are interconnected, with the outer perimeter levees providing primary protection and the interior levees providing secondary layers of protection. On the north side of the River, LIDs 2, 14, 15, 19, First Colony LID and LID 2 and MUD 46 cooperated on raising the perimeter system which connects their districts. On the south side of the River, LIDs 10, 11 and MUD 121 along with the newly created LID 6, cooperated on raising the existing levees and building two new segments of levee to connect these districts with a perimeter system. The remaining districts (LID 17, LID 7) undertook individual projects to raise their respective levees. Except for LID 7, those projects have been completed and re-certifications have been submitted to FEMA for processing. Pecan Grove Levee improvement is under design at the completion of this study.

c. New Levees Addition. During the study, three new levee districts were created. These districts have submitted CLOMR/LOMR applications based on the effective FIS and models. The status of each of these applications is described in the following paragraphs:



1. LID 6 - CLOMR Application – Case No: 09-06-2928P (Approved CLOMR Case No. 08-06-1154R) – Currently under review by FEMA – Panels affected 48157C0210 J, 0230 J, the FIRM panels were revised to show the effects of construction of the LID 6 Levee along the Brazos River from River Station 205029 to 177611.

2. LID 19 - LOMR Application – Case No: 09-06-0987P (Approved CLOMR Case No. 07-06 1409R) - Currently under review by FEMA – Panels affected 48157C0265 J and 0270J, the FIRM panels were revised to show the effects of construction of the LID 19 levee along the Brazos River between River Stations 123453 and 110698.

3. LID 15 - LOMR (Approved 12/16/08, Effective Date 4/24/09) – Case No: 07-06-2682P – Panels affected 48157C0245 J, 0255 J and 0265 J, the FIRM panels were revised to show the effects of construction of the LID 15 levee along the Brazos River between River Stations 147311 and 123453.

d. City of Sugar Land West Wastewater Treatment Plant Levee - LOMR Case No: 09-06-1532P - Under reviewed by FEMA – Panel affected 48157C0230 J, the FIRM panel was revised to show the effects of a new levee surrounding the West Wastewater Treatment Plant (WWTP) on the south side of LID 07. The levee, constructed by the City of Sugar Land, is located west of Highway 99, south of Highway 90A, and north of the Brazos River.

**D. Hydraulic Analysis**

a. Datum Adjustments: All elevations in this analysis were in 2001 datum adjustments. There is no correction in elevations along Brazos River stream between 1973 (2001 FIS study) and 2001 datum adjustments.

b. Preliminary HEC-RAS model: The HEC-RAS model includes 115 cross-sections, in which 78 cross-sections were field surveyed; 10 bridges and 14 levee structures to present the existing condition of Brazos River along the Fort Bend County in 2008 (see **Exhibit 1** and **Exhibit 2** for locations of cross sections, bridges, and levees)

i. Starting Water Surface Elevations: The water surface elevations at the confluence of Cow Creek and Brazos River from the Brazoria County Flood Insurance Study (FIS) (dated September 22, 1999) were used as starting water surface elevations for Brazos River hydraulics analysis (see **Table 2**)

**Table 2: Starting Water Surface Elevations (in feet)**

Location	10% Event	2% Event	1% Event	0.2% Event
Confluence of Cow Creek and Brazos River	50.2	50.7	50.7	51.0

ii. Cross-Section Layout: Due to the limitation of the budget, only 78 surveyed cross sections were included in this 87-mile long Brazos River study. Some reach lengths between cross sections are more than 2000 feet. The cross sections for some structures do not reflect the bridge expansion and contraction. The cross sections do not cover the beginning and the end of the levees. Therefore, approximately thirty (30) interpolated cross-sections were added to the HEC-RAS models. LiDAR data were used for the over banks for added cross sections and the interpolated survey data for the channel sections.

iii. Bridge Structures: Ten bridges included in the HEC-RAS are FM 1093, FM 1489, FM 723, ATSF Railroads (two bridges), SH 90A Southbound, SH 90A Northbound, SH 99, SH 59, and FM 1462. Bridges at SH 99 and FM 1469 are not in the effective HEC-2 model. Also, two improved Texas Department of Transportation (TxDOT) bridges and channels at SH 59 and FM 723 were added to the HEC-RAS model.

iv. **Levee Structures:** Fourteen levees are included in the HEC-RAS, in which 9 levees are in the effective HEC-2 model. Due to the increases of the 1% water surface elevations from the preliminary Brazos River HEC-RAS model, most of the existing levees have rehabilitated and improved in the levee certification processes. **Table 3** shows all levees included in the hydraulics study.

**TABLE 3: LEVEES IN THE BRAZOS RIVER HYDRAULICS STUDY**

LEVEES	NOTE
Pecan Grove MUD	Included in the effective HEC-2 Model
Fort Bend LID 07	Included in the effective HEC-2 Model
Fort Bend LID 10	Included in the effective HEC-2 Model
Fort Bend LID 02	Included in the effective HEC-2 Model
First Colony LID 01	Included in the effective HEC-2 Model
First Colony LID 02	Included in the effective HEC-2 Model
Fort Bend MUD 46	Included in the effective HEC-2 Model
Fort Bend MUD 49	Included in the effective HEC-2 Model
Sienna Plantation LID	Included in the effective HEC-2 Model
Fort Bend MUD 121	Added from the LOMR Case #03-06-449P
Fort Bend LID 6	Added from the LOMR Case #08-06-1154R
Fort Bend LID 11	Added from the LOMR Case #099-06-1722P
Fort Bend LID 14	Added from the LOMR Case #98-06-784P
Fort Bend LID 15	Added from the LOMR Case #07-06-2682P
Fort Bend LID 17	Added from the LOMR Case #06-06-BD92P
North Sienna Plantation LID	Added from the LOMR Case #02-06-266P

v. **Manning’s Values:** The Manning’s values in the channel were calculated through the calibration process. The Manning’s values over banks were estimated based on field investigations, field pictures, and aerial photography. The n-values and expansion and contraction coefficients followed recommendations set forth in the HEC-RAS Hydraulic Reference Manual (Reference 6). Table 4 shows the comparisons of the ranges of the Manning’s values used in the HEC-RAS model between the effective HEC-2 and preliminary HEC-RAS models.

**Table 4 – Manning’s Values’ Comparisons**

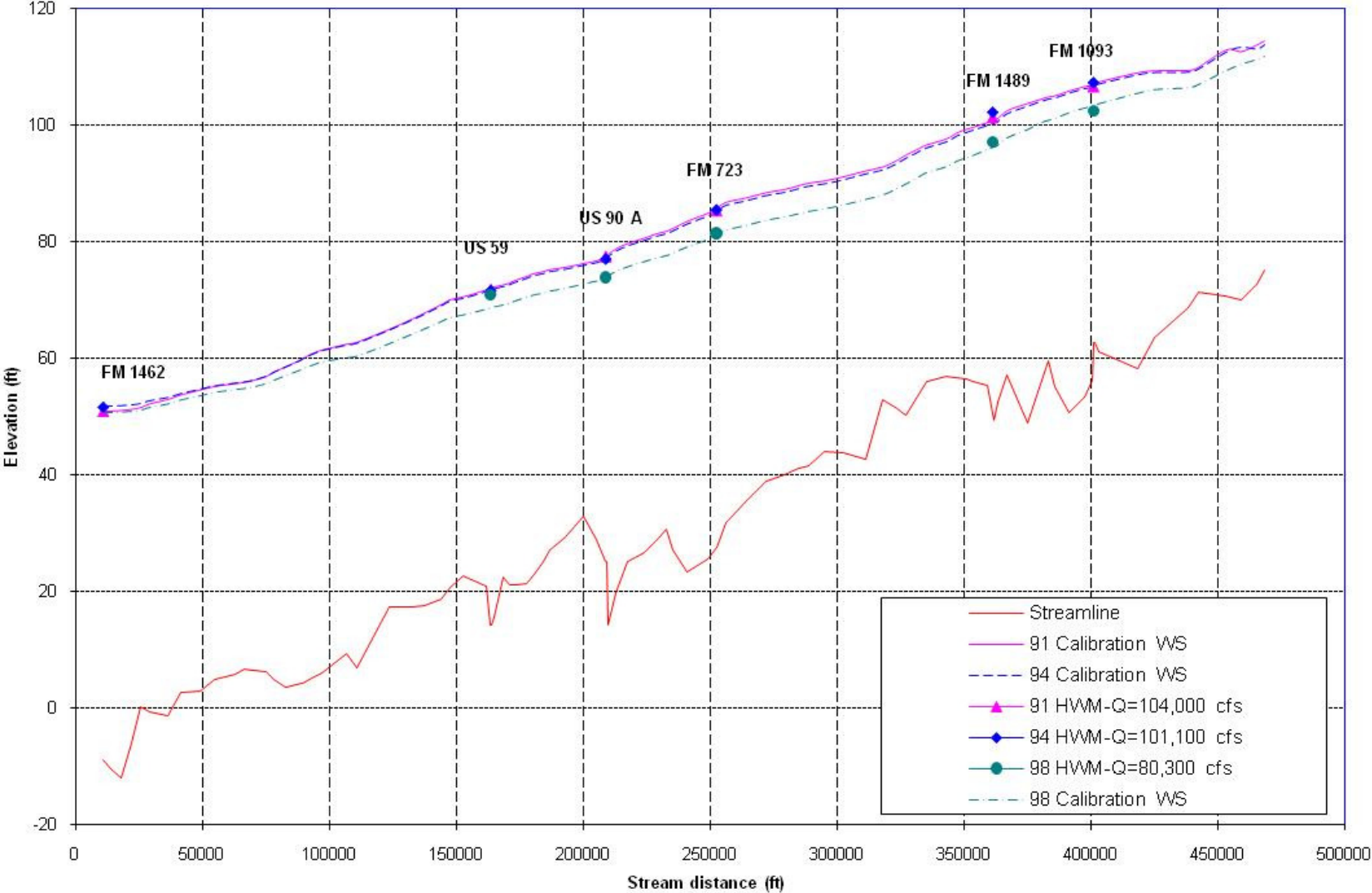
Hydraulic Model	Left Over-bank	Channel	Right Over-Bank
Effective HEC-2	0.05 - 0.12	0.025	0.05 - 0.12
Preliminary HEC-RAS	0.05 – 0.12	0.030 – 0.044	0.05 – 0.12

vi. **Ineffective Areas:** The placements of the ineffective flow areas were established to reflect the flow path of the floodplain.

c. **Calibration Process:**

i. **“USGS Rating Curve Revision” Report:** On November 2007, Mr. Dunbar issued the report entitled “Recommended Revision to USGS Rating Curve for Brazos River at Richmond for Use in Updating FIS in Fort Bend County, Texas” that recommended revisions to the 1991 and 1994 events peak flows from 94,000 cfs to 104,000 cfs and 91,000 cfs to 101,000 cfs respectively (see the attached report

Figure 3: Calibration Water Surface Elevation Profiles



- d. Verification with the 2007 High Flow Events: During 2007, several high flow events occurred in Fort Bend County (see **Table 10**). FBCDD collected HWM for these events and provided them to Baker to validate the model. The preliminary Brazos River HEC-RAS model was verified against these HWMs as shown in **Table 11** and in **Figure 4**. While the model compared reasonably acceptable with the July 5 and July 20 HWMs, the computed WSEL were 4-5 ft higher during the Jan 19 event.

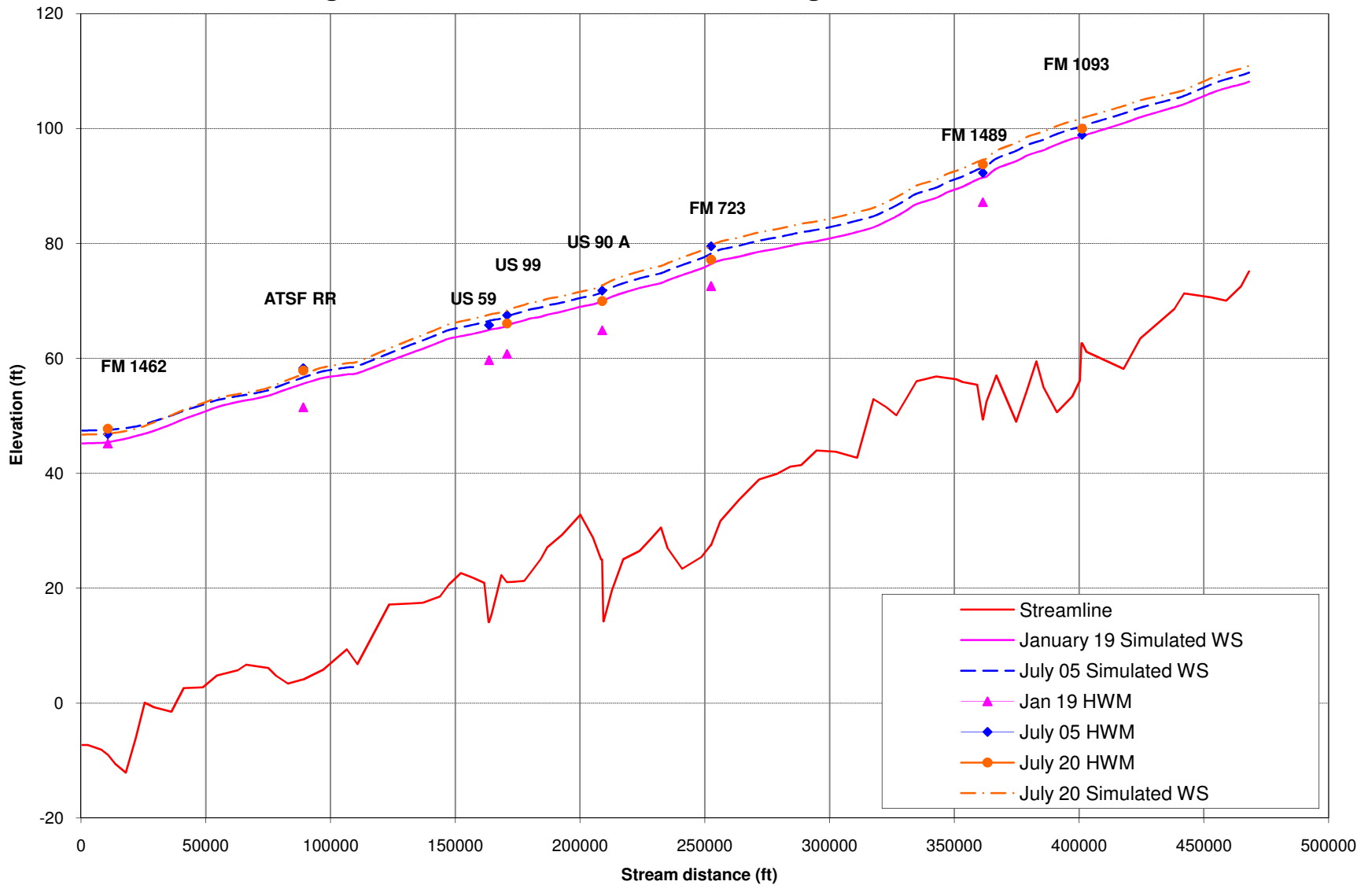
**Table 10: Brazos River Peak Flows in 2007 High Flow Events**

USGS Gage	January 19 Event	July 5 Event	July 20 Event
Richmond	59,200 cfs	66,300 cfs	72,100 cfs
Rosharon	53,500 cfs	66,500 cfs	64,700 cfs

**Table 11: Verifications with 2007 high flow events**

Location	January 19 Event			July 5 Event			July 20 Event		
	HWM	Computed WSEL	Diff.	HWM	Computed WSEL	Diff.	HWM	Computed WSEL	Diff.
FM 1093	N/A	N/A	N/A	98.9	100.53	1.63	100	101.87	1.87
FM 1489	87.2	91.5	4.3	92.3	93.26	0.96	93.8	94.61	0.81
FM 723	72.6	76.45	3.85	77.7	78.29	0.59	79.5	79.65	0.15
HW 90A	64.9	69.91	5.01	70.0	71.49	1.49	71.8	72.62	0.82
US 99	60.8	65.68	4.88	66.1	67.28	1.18	67.5	68.37	0.87
US 59	59.7	64.97	5.27	65.8	66.56	0.76	N/A	N/A	N/A
ATSF RR	51.5	55.61	4.11	57.9	56.72	-1.18	58.3	57.31	-0.99
FM 1462	45.2	45.37	0.17	47.5	47.57	0.07	46.8	46.9	0.1

Figure 4: Veification with the 2007 High Flow Events



- e. Tie-in condition at Brazoria County: In 1986, the U.S. Army Corps of Engineers (USACE) study for the Brazoria County FIS determined that due to a lower topography to the east, high flows from the Brazos River along the Fort Bend / Brazoria County line overflowed in an easterly direction. Due to the overflow, the 1% flow of Brazos River (in the effective Brazoria FIS report) is reduced from 181,000 cfs at Brazoria/Fort Bend County line to 103,189 cfs at the confluence of Brazos River with Cow Creek. Based on the flow distribution of the effective Brazos River HEC-2 model from the Brazoria County, the 1% flow distribution for the Brazos River HEC-RAS model was adjusted to reflect the gradual flow drop from 162,000 cfs at the Brazoria/Fort Bend County line (Station 62793) to 103,189 cfs at the confluence of Cow Creek and Brazos River (Station 431).
- f. Flow Distribution for the Preliminary Brazos River HEC-RAS model: For the flow distribution of 1% storm, the Hempstead flow hydrograph is increased by an attenuation factor and was routed from the Waller/Fort Bend county line to the confluence of the Cow Creek and Brazos River location. The attenuation factor is adjusted until the Richmond computed flow is equal to the proposed value of 164,000 cfs. **Table 12** shows the flow distribution along the Brazos River within Fort Bend County.

**TABLE 12: FLOW DISTRIBUTION FOR BRAZOS RIVER**

<b>Location</b>	HEC-RAS Station (ft)	10% Flow	2% Flow	1% Flow	0.2% Flow
Waller/Fort Bend County	468115	105500	154400	172200	216322
Upstream of FM 1093	417909	103800	151100	168600	211800
Upstream of FM 723	302479	103000	148500	165700	208100
Richmond USGS Gage	208514	103000	147000	164000	206000
Brazoria/Fort Bend County Line	62793	103000	145000	162000	204000
	54416	103000	143000	160000	202000
	48774	103000	140844	155643	192430
	41067	103000	133570	145769	176356
	36123	103000	124521	133487	164898
	29208	103000	114541	119939	134357
	25409	103000	108000	112000	124000
	21940	103000	105100	108200	116000
	17870	103000	104524	107380	114464
	13523	103000	103328	105676	111275
	10664	96100	102545	104561	109187
	8169	96100	102487	104475	109031
	2630	96100	101722	103500	107200
Cow Creek and Brazos River	431	96100	101722	103189	106591

**E. Floodplain and Floodway Mapping:**

The floodway analysis was conducted by first using Method 4 of HEC-RAS which allows the specification of the maximum permissible surcharge of one (1) foot. After obtaining the approximate location of the encroachment stations, the floodway limits were refined manually using the Method 1 in HEC-RAS with user entered right and left encroachment stations. The effective floodway width was maintained where ever possible.

The computed water surface elevations for the 1-percent and 0.2-percent chance flood events, and the floodway limits were mapped using HEC-GeoRAS.

**F. Mapping Issues:**

Overflow issues were identified in the floodplain mapping of the Brazos River. It will take some detailed modeling to determine the actual overflow issues. CF3R was not tasked to resolve the overflow problems. Future analyses are required for the overflow mapping for Brazos River.

- a. Brazos River overflow at US 90A and FM 359 adjacent to Pecan Grove Levee: the Brazos River study identified a potential overflow at the North of US 90A, near FM 359, where the water exits the river bank and flow overland in the southeasterly direction across the Pecan Grove MUD Levee and re-enter the river at West of the Fort Bend County LID 7. Two analyses of the overflow at US 90A (from Costello and Jones & Carter) were submitted to CF3R for review and usage in the overflow mapping. Without the determination of peak overflow, both analyses were not considered. The overflow area was mapped using the interpolated BFE from the two cross sections upstream and downstream of Pecan Grover MUD Levee.
- b. Brazos River overflow from the Fort Bend and Brazoria County line at the South Texas Water Company Canal to the confluence location between Cow Creek and Brazos River: an overflow (AO) zone was shown on the Brazoria County effective FIRM (dated September 22, 1999) to reflect the overflow conditions between the Brazos River and Oyster Creek. The overflow analysis in Brazoria County was prepared by the USACE in 1986. CF3R used the USACE results in the flow distributions of the Brazos River HEC-RAS model along the Brazoria/Fort Bend county line. CF3R found no record for the USACE model of the overflow analysis in the USACE Galveston District.
- c. Brazos River and Oyster Creek overflow mapping at Flat Bank Creek and Sienna Plantation Diversion Channel: backwater from the Brazos River in the extreme event will raise the water surface elevations of the Oyster Creek several feet and most likely flood numerous structures. The floodplain mapping shown on the 2001 (effective) study did not consider the interaction between the two flooding sources. CF3R used the back water elevations of Brazos River and current (2001) data for the overflow mapping at Flat Bank Creek and Sienna Plantation and Diversion Channel.

**III. EXCEPTIONS**

There were no deviations from the Performance Work Statement or FEMA’s Guidelines and Specifications.

**IV. RESULTS AND CONCLUSIONS**

**Table 13** shows the proposed water surface elevations of the 10%- , 2%, 1%-, and 0.2%-storm events at specific locations. **Figure 7** shows the water surface elevation profiles of the multi storm events.

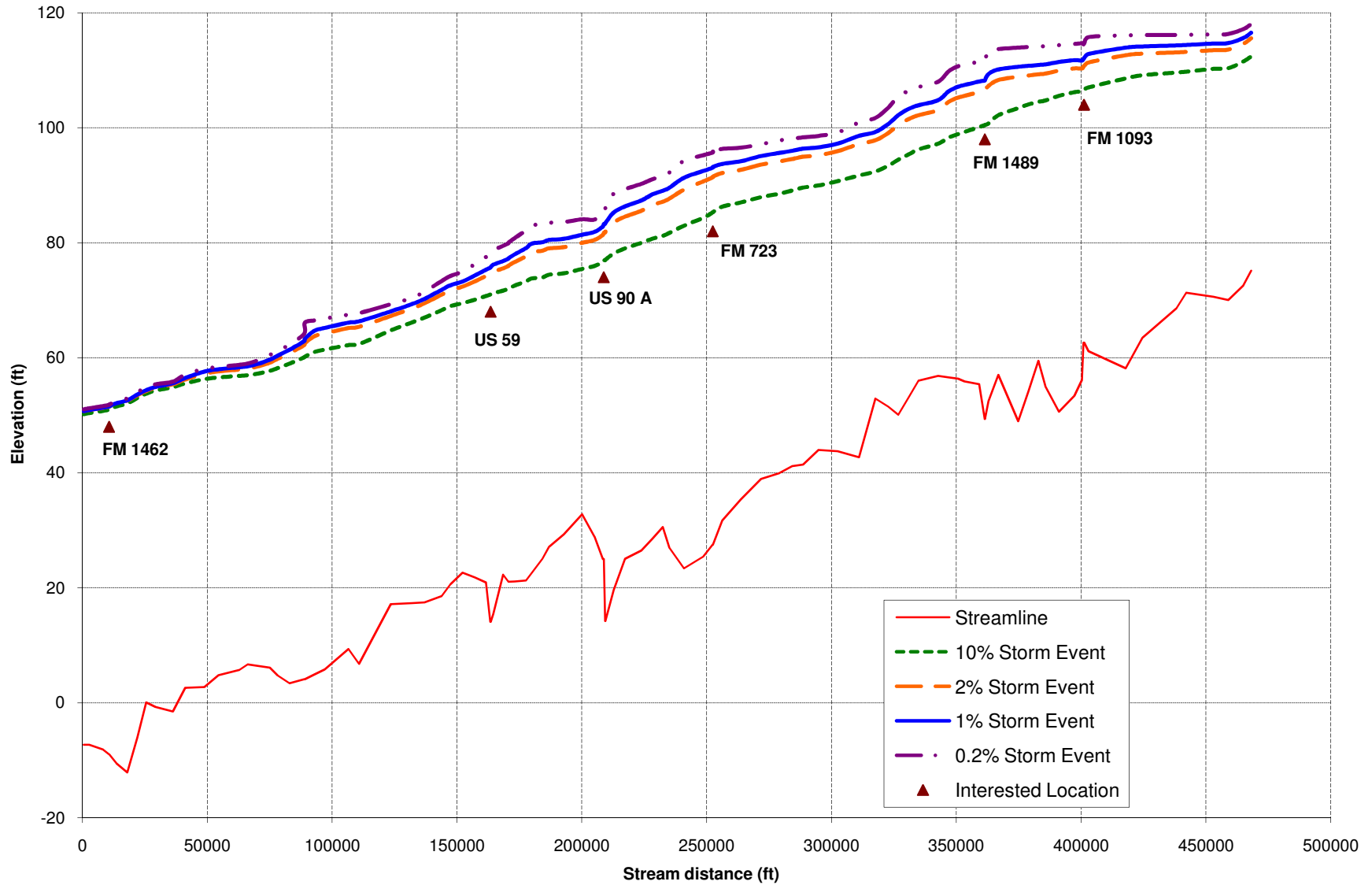
**Table 13 – Proposed Water Surface Elevations (All Elevations in Ft)**

Location	HEC-RAS Station (ft)	10% WSEL	2% WSEL	1% WSEL	0.2% WSEL
Waller/Fort Bend County	468115.5	112.42	115.56	116.53	118.04

Upstream of FM 1093	402954.8	107.03	111.35	112.83	115.78
Upstream of FM 1489	361438.6	100.5	106.49	108.28	111.61
Upstream of FM 723	252497.4	85.34	91.51	93.19	95.84
Richmond Gage (SH 90A)	208514.5	76.73	81.44	82.92	85.36
Upstream of SH 99	170696.7	72.07	76.04	77.33	80.04
Upstream of US 59	163504.4	71.00	74.52	75.64	77.91
MUD 46	123453.2	64.77	67.26	68.06	69.31
Brazoria/Fort Bend County	66083.94	56.98	58.09	58.5	58.99
Upstream of FM 1462	17870.4	52.05	52.53	52.59	52.91



**Figure 5: Multi Storm Event Water Surface Elevation Profiles**

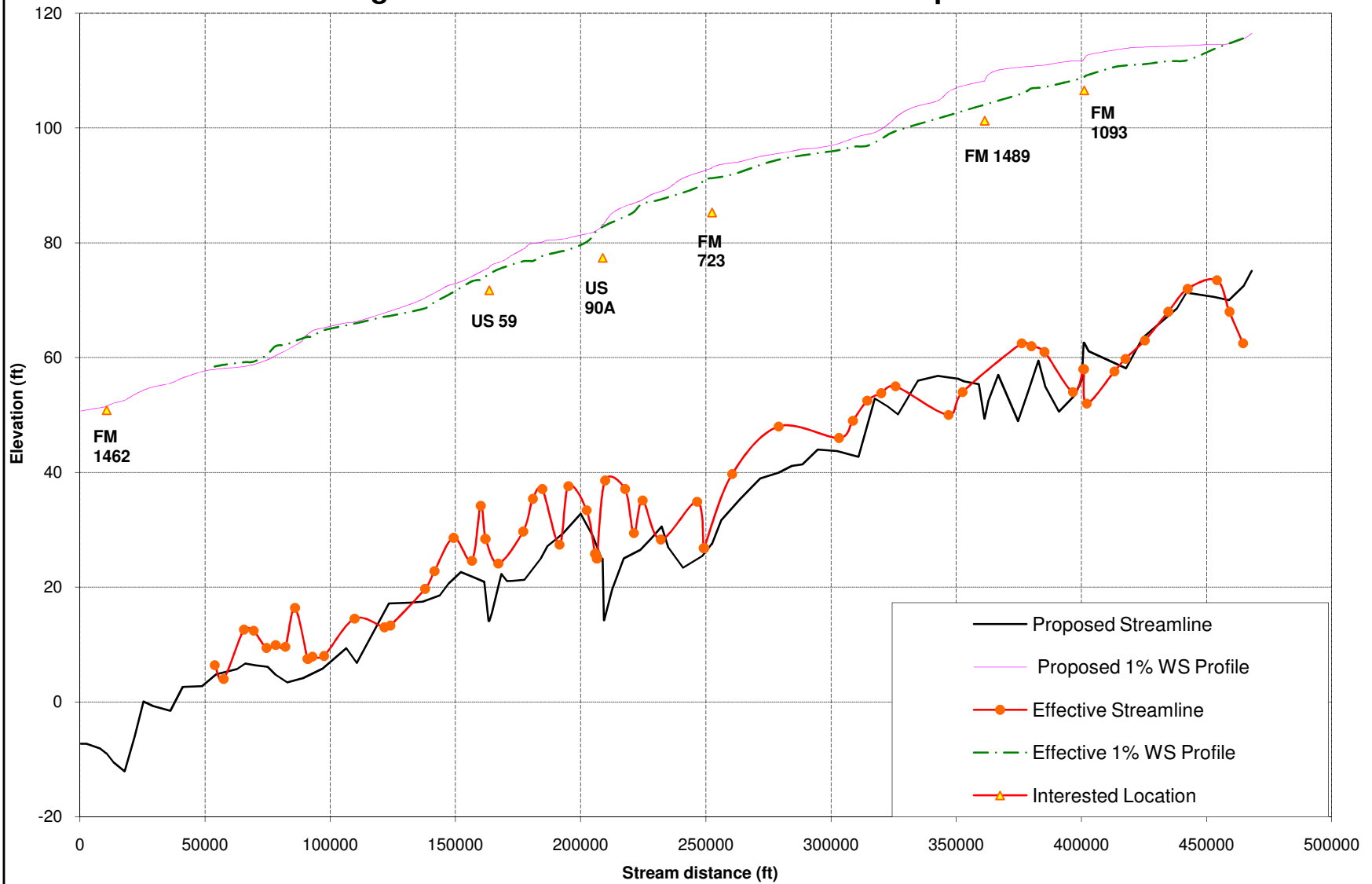


**Table 14** shows the comparisons of the proposed and effective of water surface elevations and floodway width in the 1% storm event. **Figure 8** shows the comparisons of the proposed and effective 1% water surface elevation profiles.

**Table 14 – Comparisons of the Proposed and Effective Water Surface Elevations and Floodway Widths in 1% Storm Event**

Location	Water Surface Elevation (ft)			Floodway Width (ft)		
	Proposed	Effective	Difference	Proposed	Effective	Difference
Waller/FB County Line	116.53	116.8	-0.27	1783	1783	0
FM 1093	112.10	109.04	3.06	1305	1297	8
FM 723	93.04	91.25	1.79	4904	2254	2650
HW 90A	82.81	81.96	0.85	1012	749	263
US 59	75.64	74.39	1.25	3384	3339	45
Brazoria/FB County Line	58.34	59.37	-1.03	1904	1904	0

**Figure 6: 1% Water Surface Elevation Comparisons**



It was concluded that the floodplain and floodway boundaries of the Brazos River are reasonable to use for the Fort Bend Flood Insurance Study.

## **V. REFERENCES**

1. HEC-RAS model Version 3.1.3, US Army Corps of Engineers, Hydrologic Engineering Center, Davis, CA., 2005
2. HEC-GeoRAS Tools (Version 4.1), US Army Corps of Engineers, Hydrologic Engineering Center, Davis, CA, 2006.
3. Fort Bend County Flood Insurance Study, Federal Emergency Management Agency, Revised November 2001
4. Brazoria County Flood Insurance Study, Federal Emergency Management Agency, Revised September 22, 1999
5. "DFIRM Update for Fort Bend County Texas, Part 2 Task 42 Hydrology Analyses Brazos River" Technical Support Data Notebook, May 31, 2009.
6. HEC-RAS Hydraulic Reference Manual, US Army Corps of Engineers, Hydrologic Engineering Center, Davis, CA, November 2002.
7. Fort Bend County Drainage Criteria Manual, Fort Bend County Drainage District, Revised April 1999

**APPENDIX A-6**

**Key to Cross-Section Labeling**

<b>KEY TO CROSS-SECTION LABELING</b>		
Community Name:	Fort Bend County	State: Texas
Community ID No.	48157C	
Compiled By:	CF3R Joint Venture	
Date TSDN Submitted:	June 2009	
Prepared By:	CF3R Joint Venture	
Flooding Source:	Brazos River	
Run Date:	09/2009	
Field Survey Section No.	Cross-Section Letter in FIS Report	Computer Stationing
	A	430.71
	B	10583.06
	C	10664.39
	D	21940.01
	E	29208.63
05	F	41067.94
06	G	48774.81
	H	62793.19
	I	70125.67
	J	78171.67
10	K	82824.19
	L	88739.93
	M	89012.58
	N	92834.65
12	O	106462.70
13	P	110697.60
14	Q	123453.20
	R	131800.00
15	S	136966.10
16	T	143791.40
	U	147311.30
17	V	152184.50
	W	157172.40
18	X	161567.80
	Y	163253.20
	Z	163504.40
	AA	164543.70
	AB	170554.20
	AC	170696.70
	AD	173078.30
	AE	179826.00
21	AF	184222.10
23	AG	200097.90
	AH	208418.20
	AI	208514.50

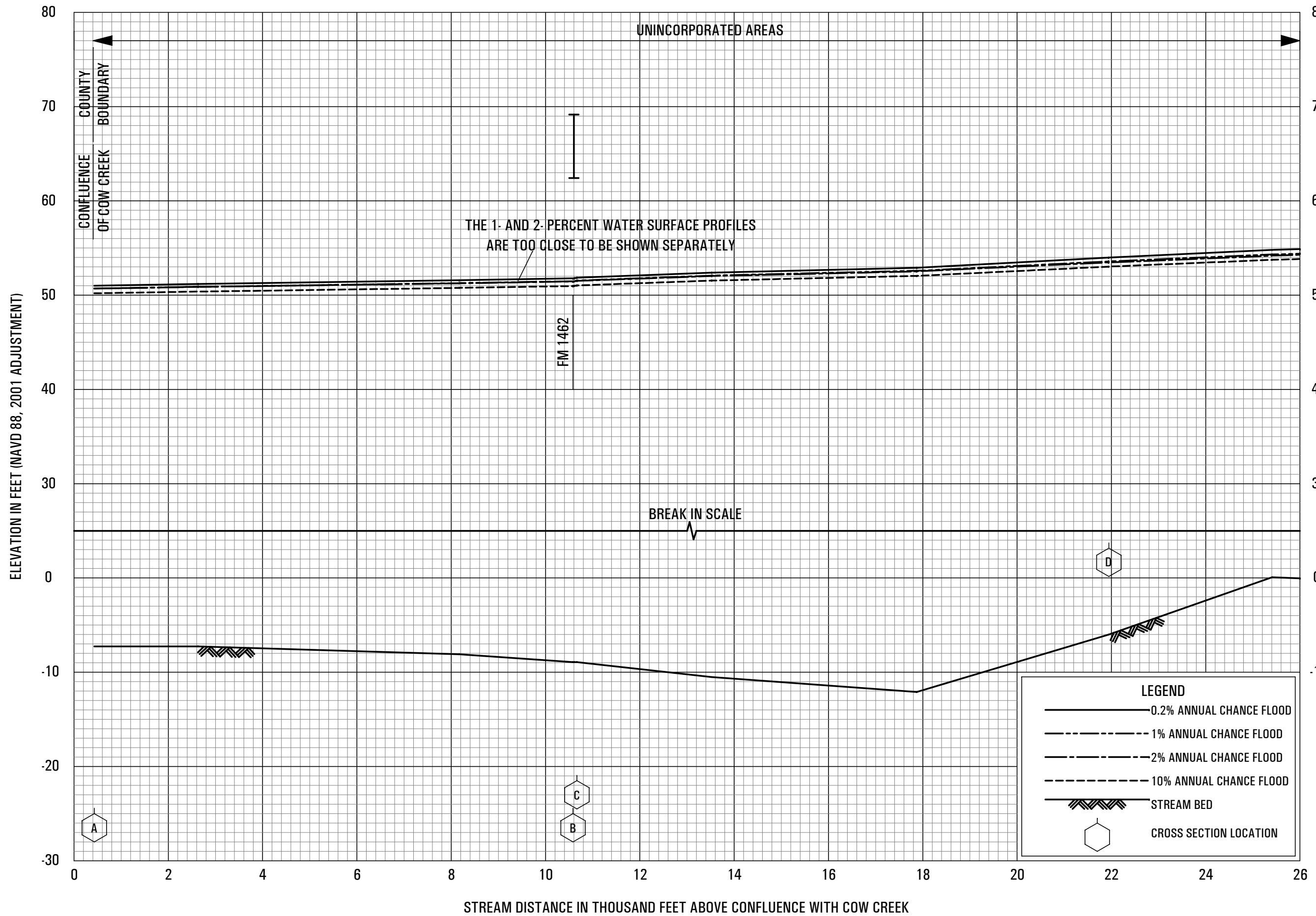
	AL	212681.10
25	AM	223871.80
26	AN	232403.30
27	AO	240899.40
	AP	248699.70
	AQ	252397.70
	AR	252497.40
29	AS	263690.50
31	AT	279087.80
35	AU	302479.40
	AV	322762.30
38	AW	326774.90
	AX	330773.70
40	AY	342702.20
	AZ	361344.30
	BA	361438.60
	BB	362916.00
43	BC	366825.80
45	BD	382895.20
	BE	397240.90
	BF	400910.60
	BG	401182.60
50	BH	424652.60
53	BI	453026.10
	BJ	465002.60
55	BK	468115.50

## **APPENDIX B-1**

### **FIS Profiles**

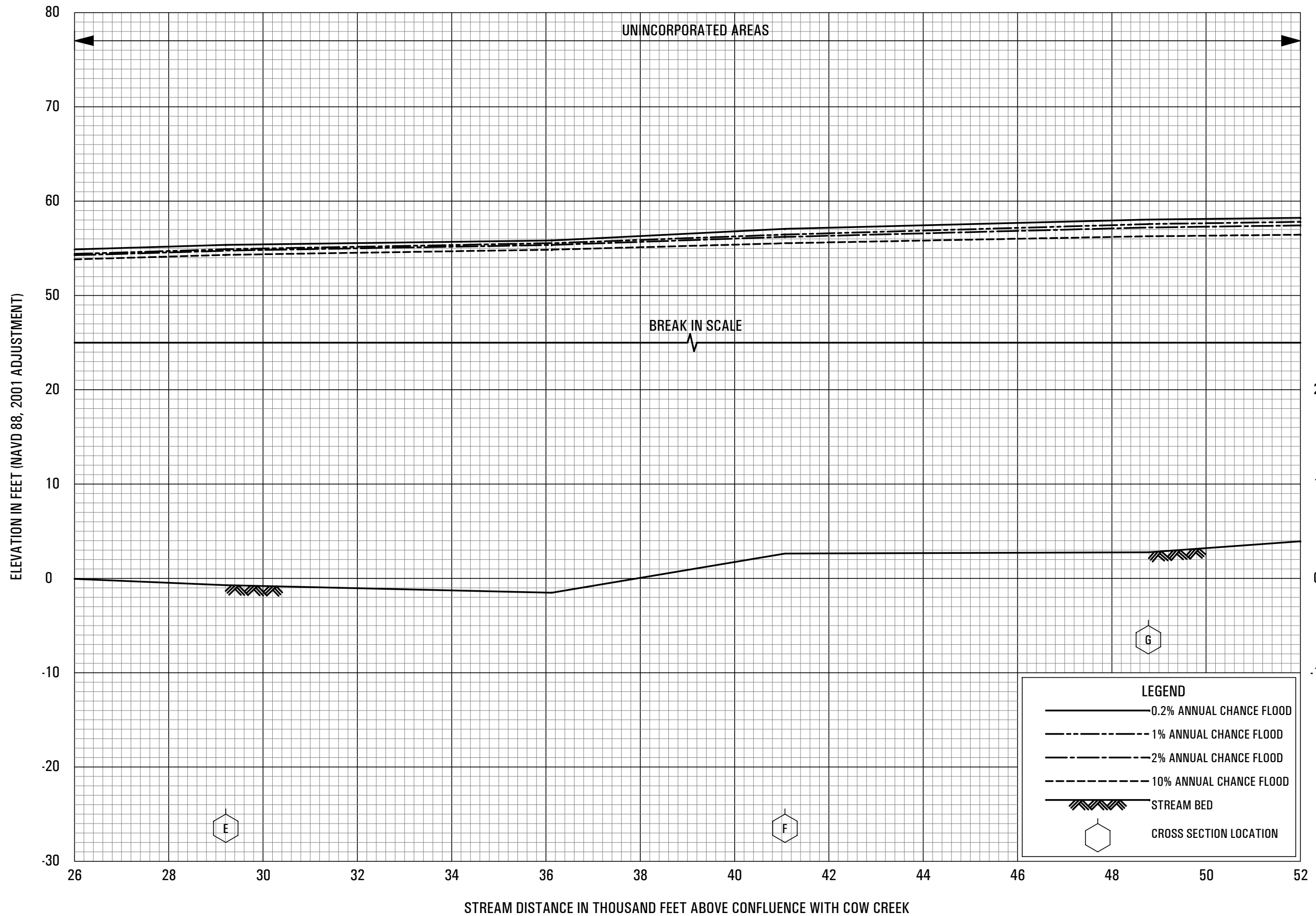
FIS Profiles are included in the Profiles folder.





**FLOOD PROFILES**  
BRAZOS RIVER

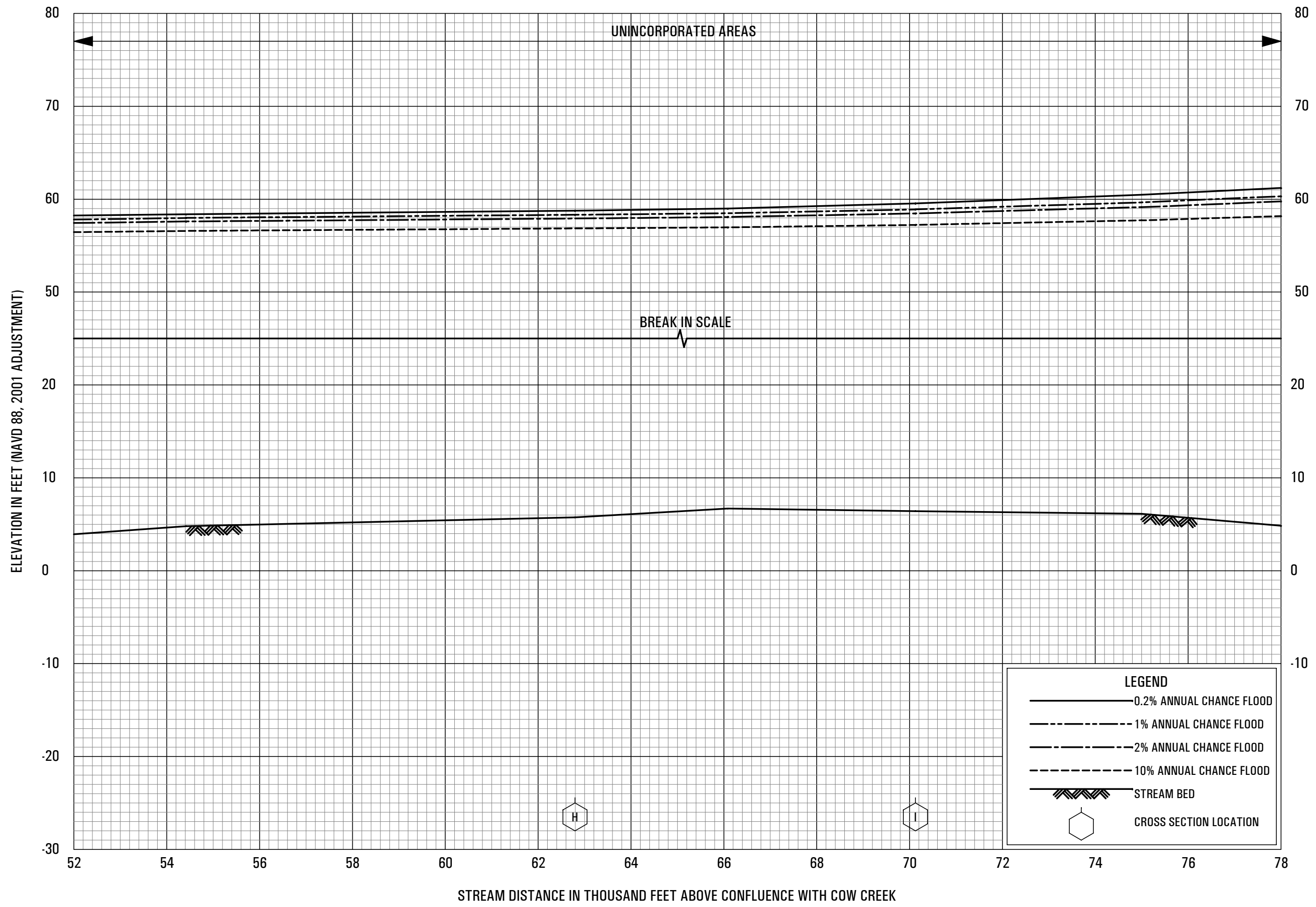
FEDERAL EMERGENCY MANAGEMENT AGENCY  
FORT BEND COUNTY, TX  
AND INCORPORATED AREA



FLOOD PROFILES

BRAZOS RIVER

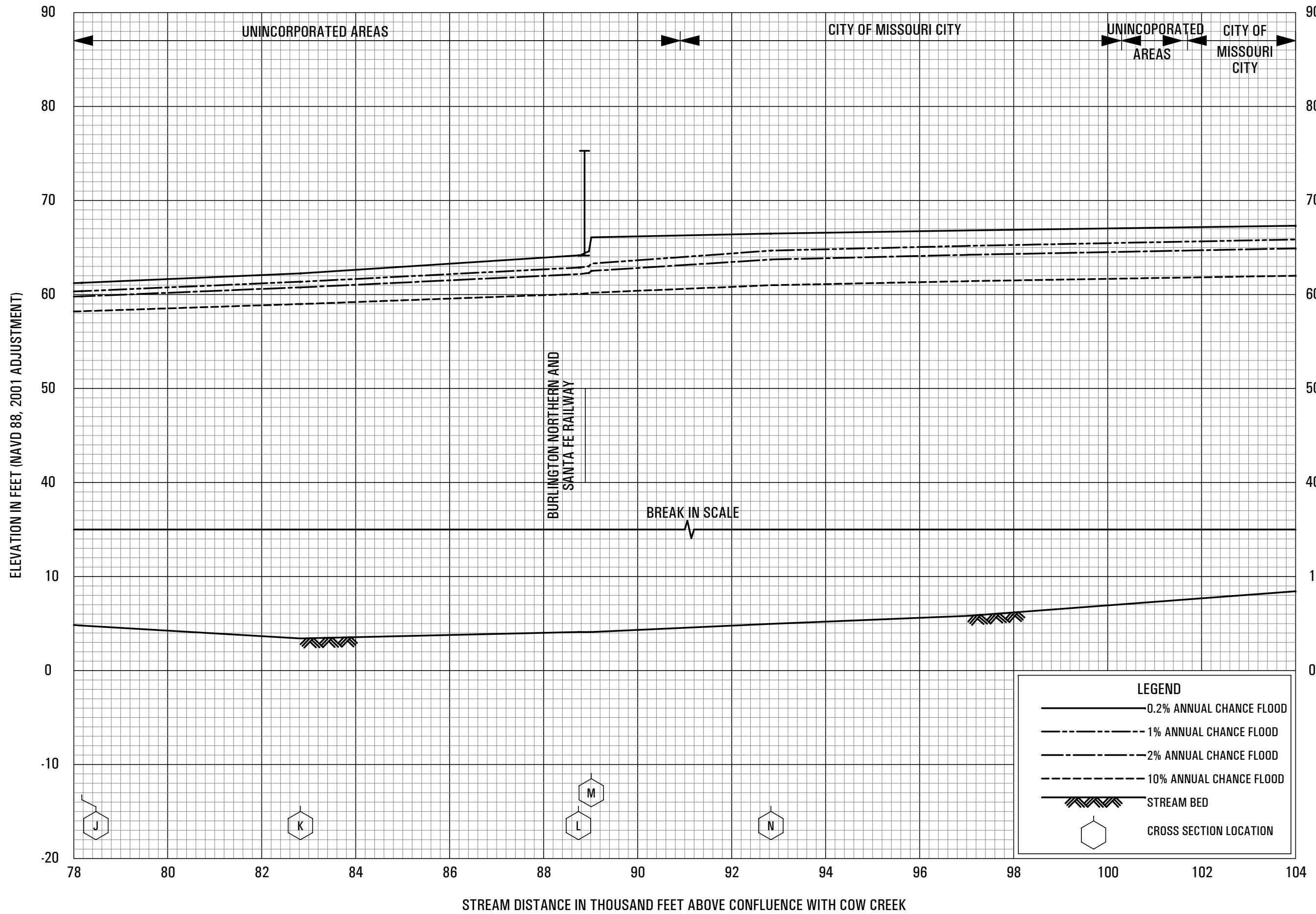
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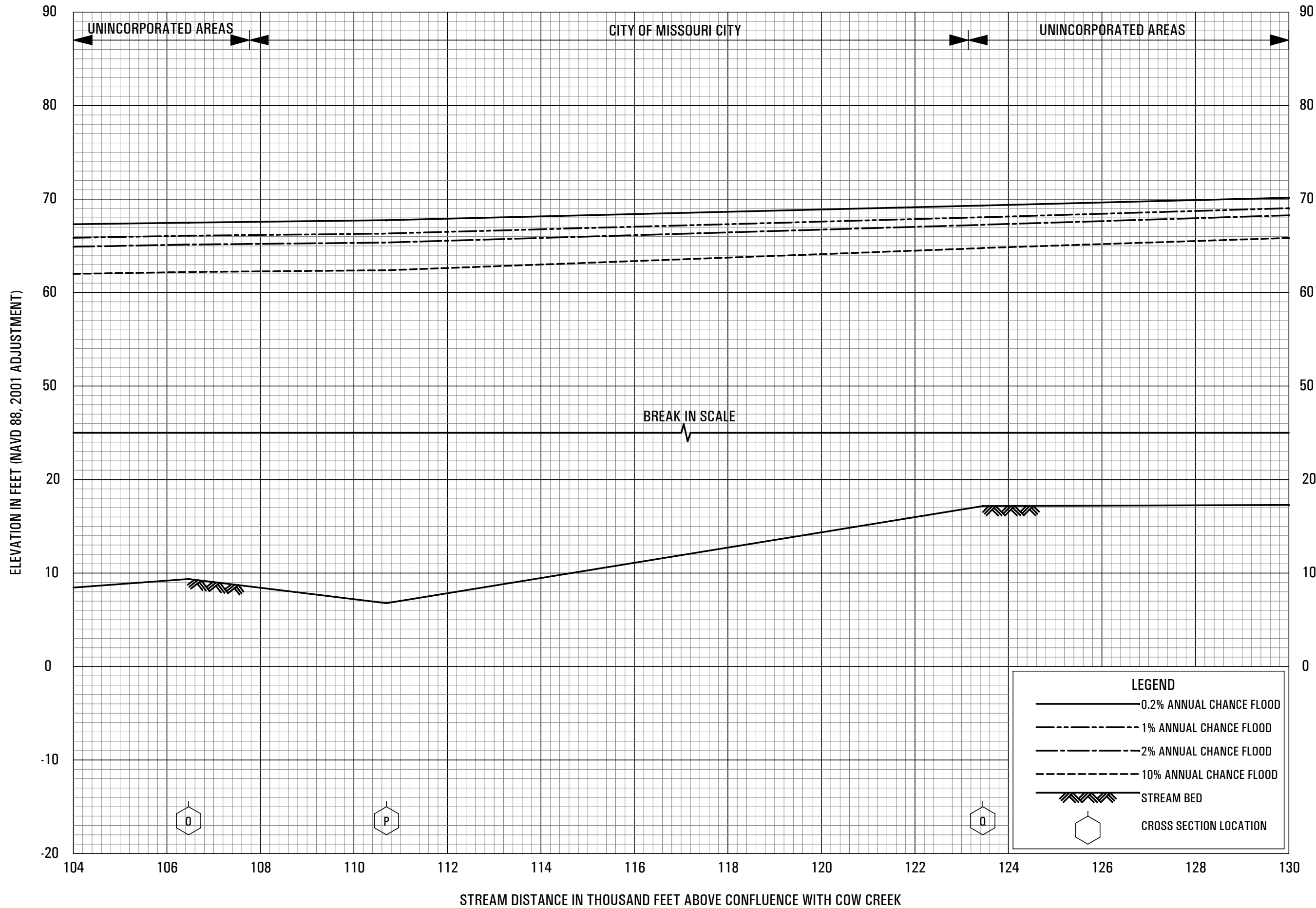


**FLOOD PROFILES**  
BRAZOS RIVER

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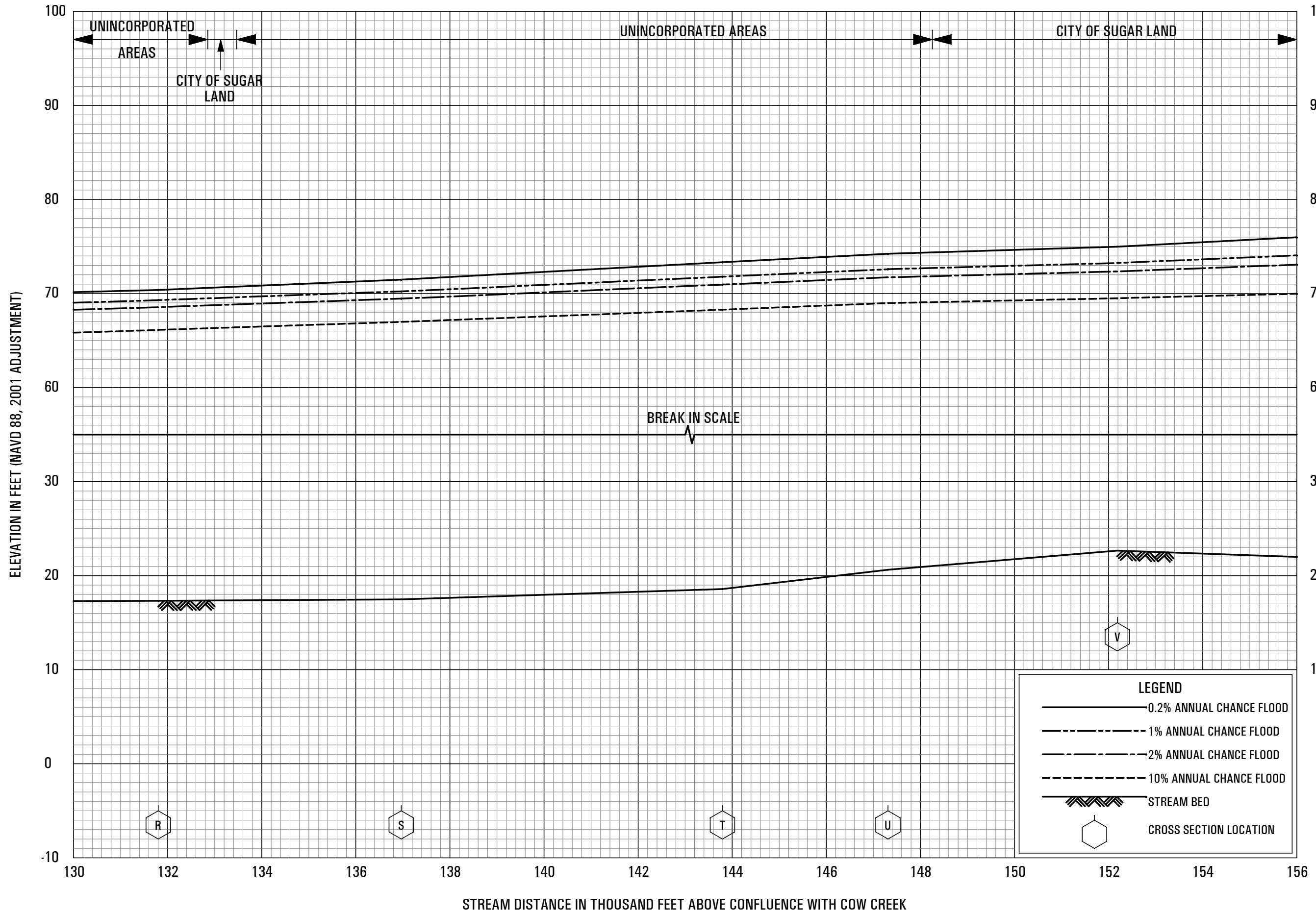




**FLOOD PROFILES**  
BRAZOS RIVER

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**FORT BEND COUNTY, TX**  
AND INCORPORATED AREA

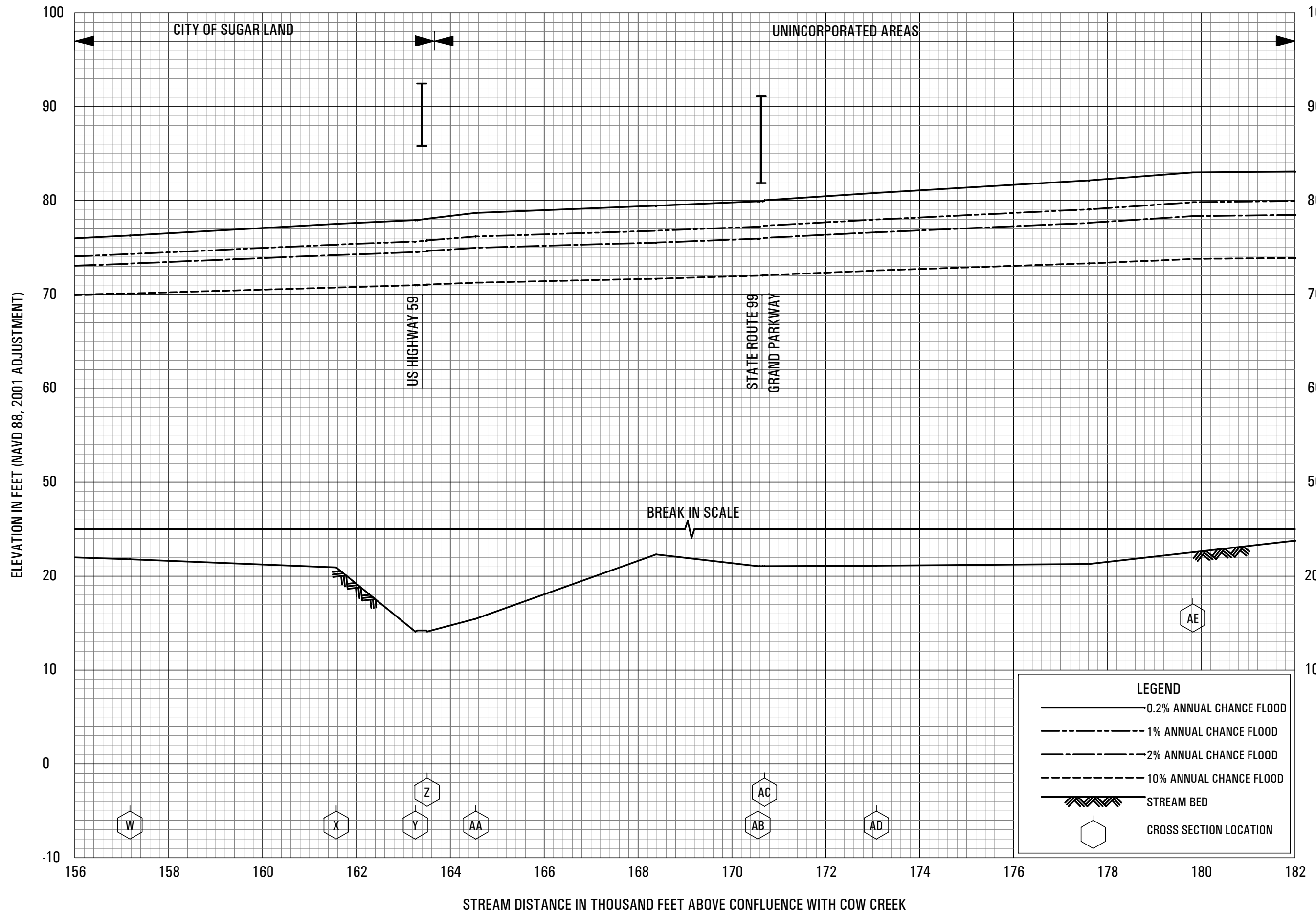
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**FLOOD PROFILES**

**BRAZOS RIVER**

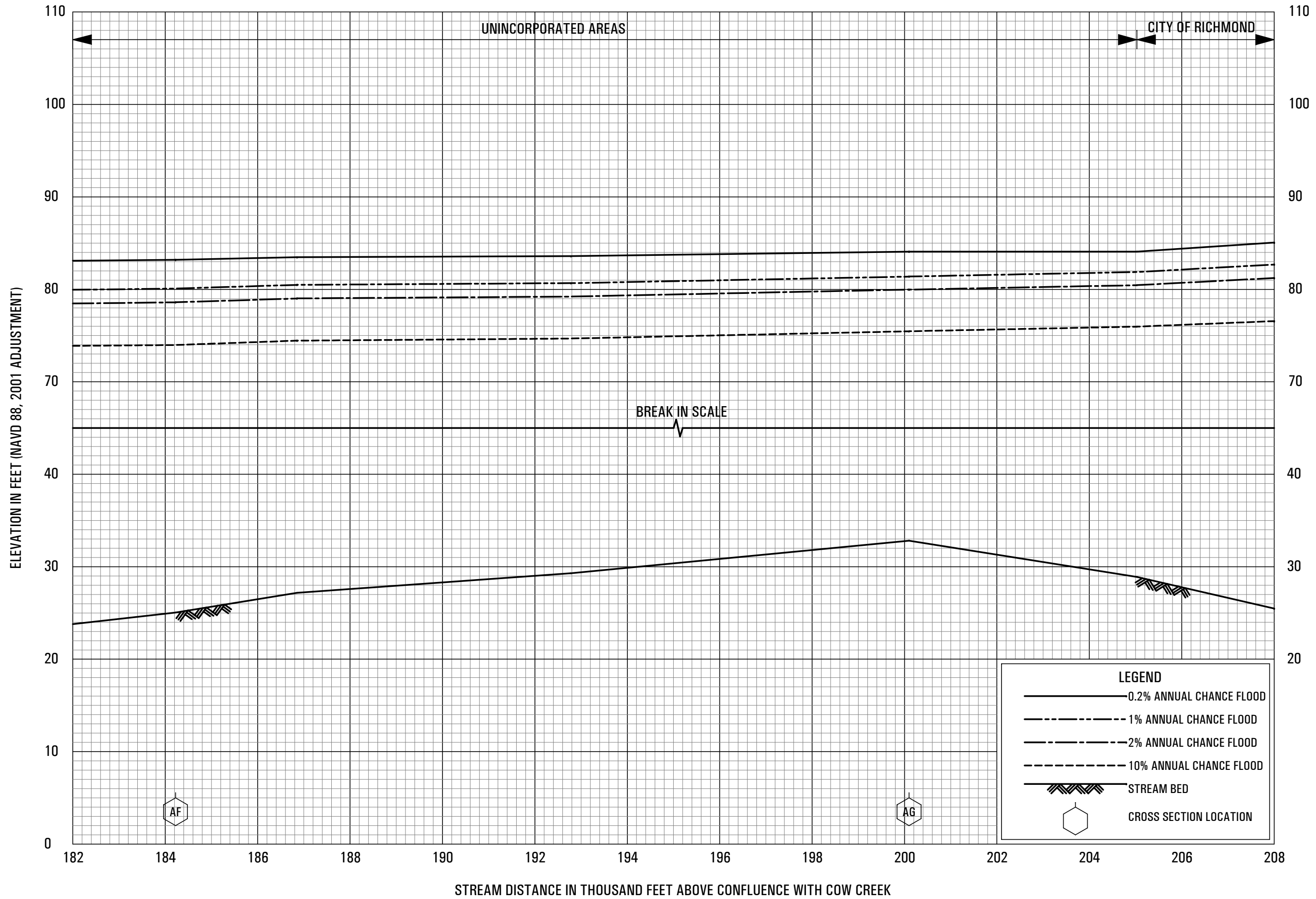
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**FLOOD PROFILES**

**BRAZOS RIVER**

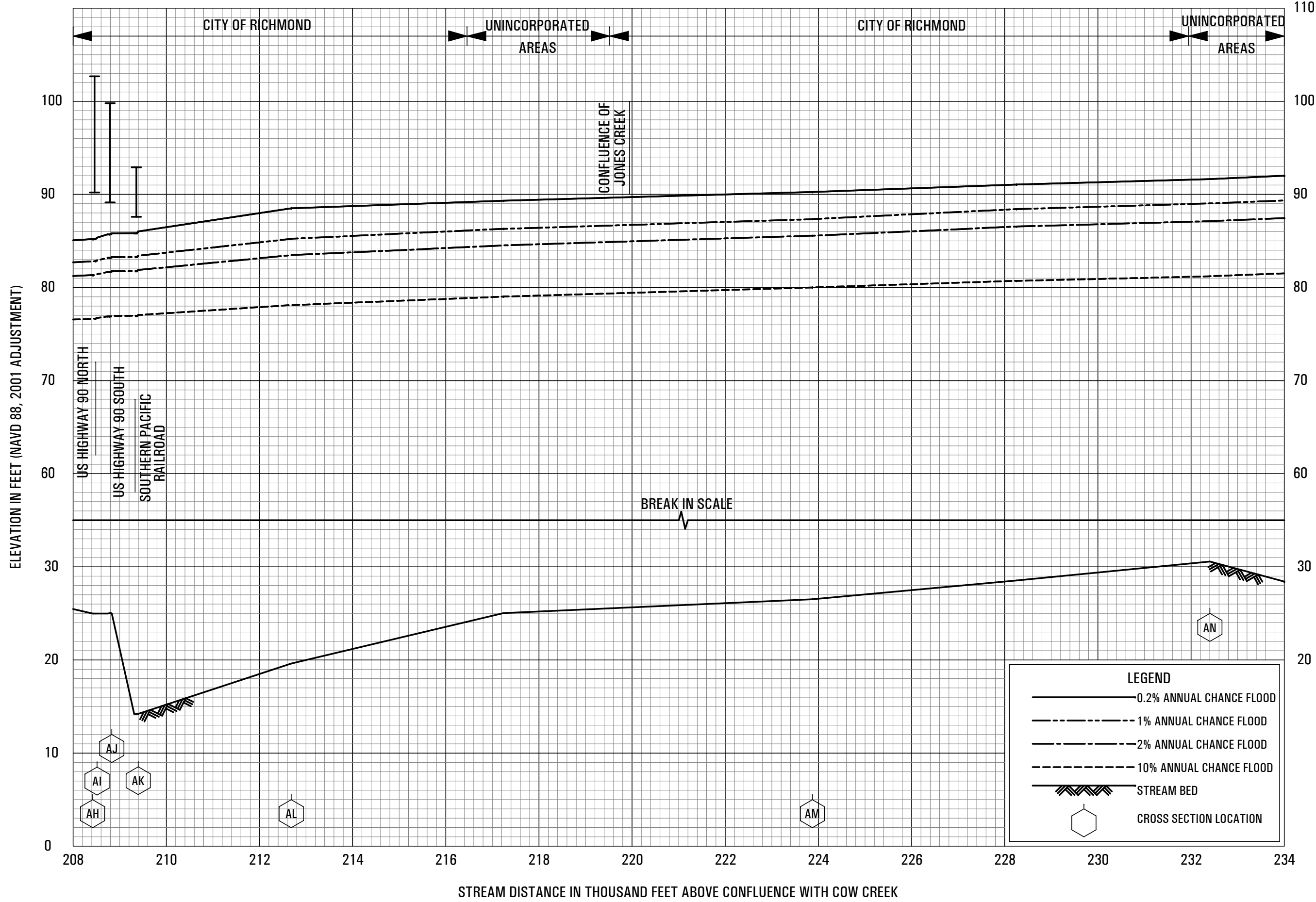
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**FLOOD PROFILES**  
BRAZOS RIVER

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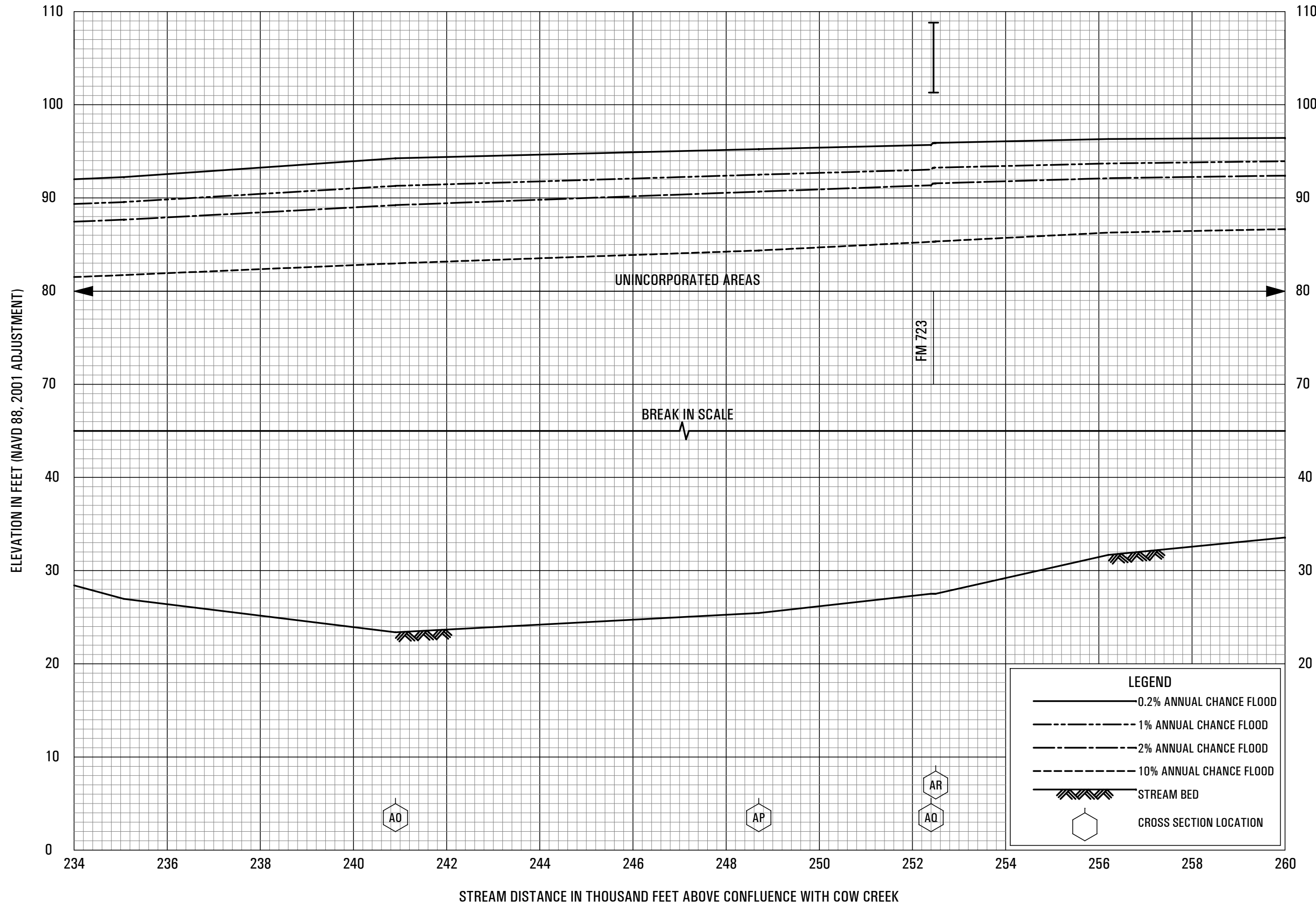




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**BRAZOS RIVER**

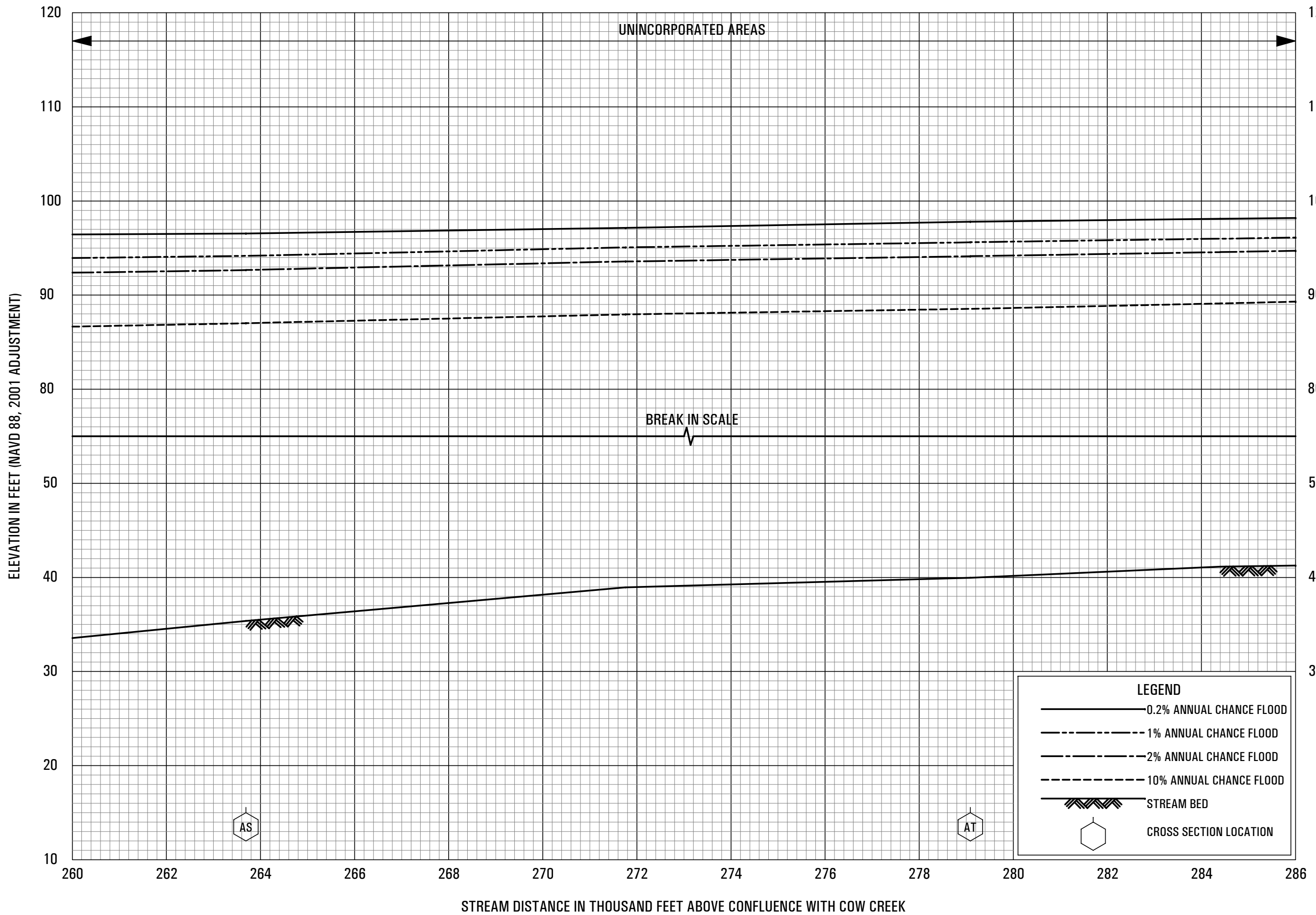
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FLOOD PROFILES

BRAZOS RIVER

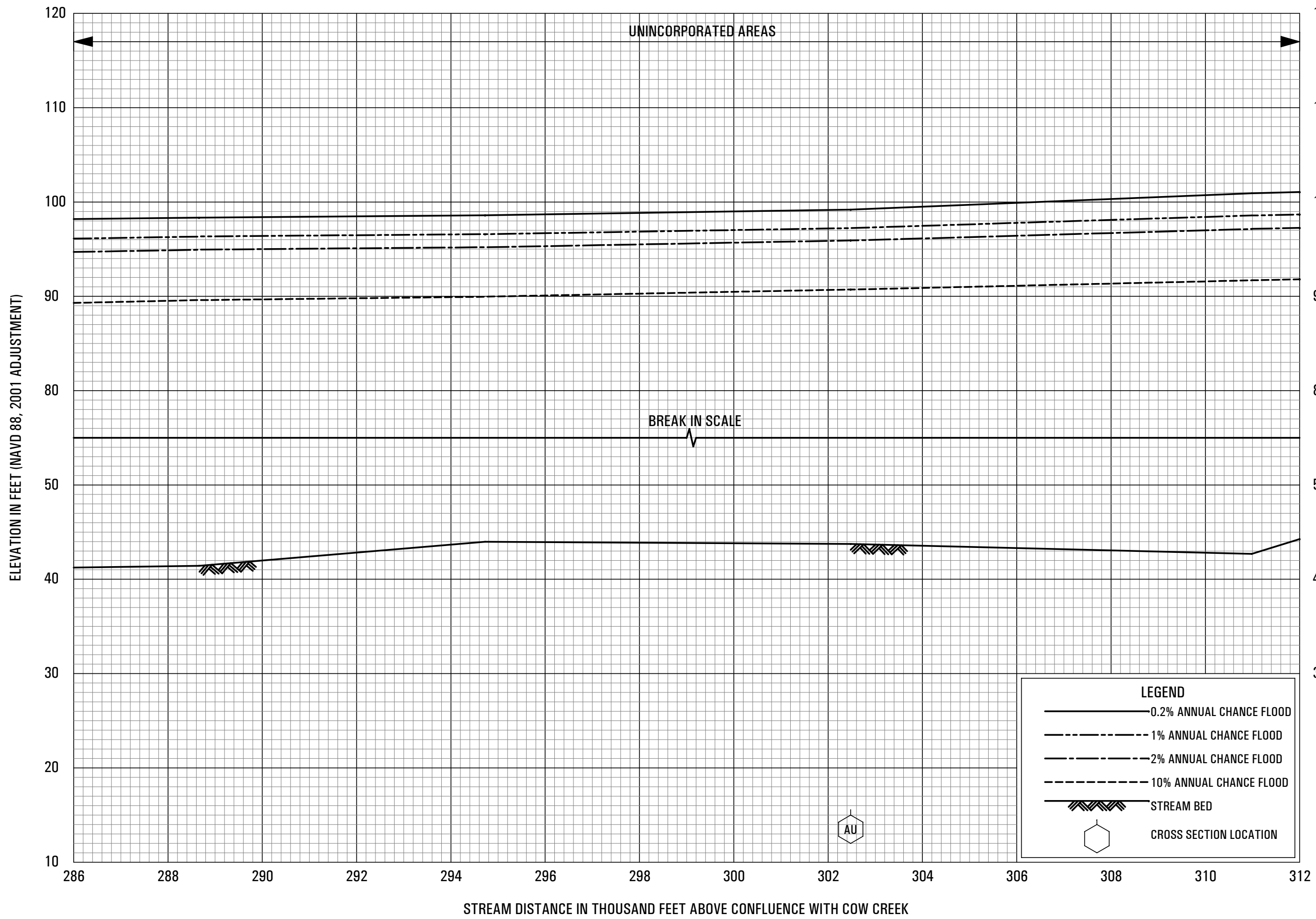
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 AND INCORPORATED AREA



**FLOOD PROFILES**

**BRAZOS RIVER**

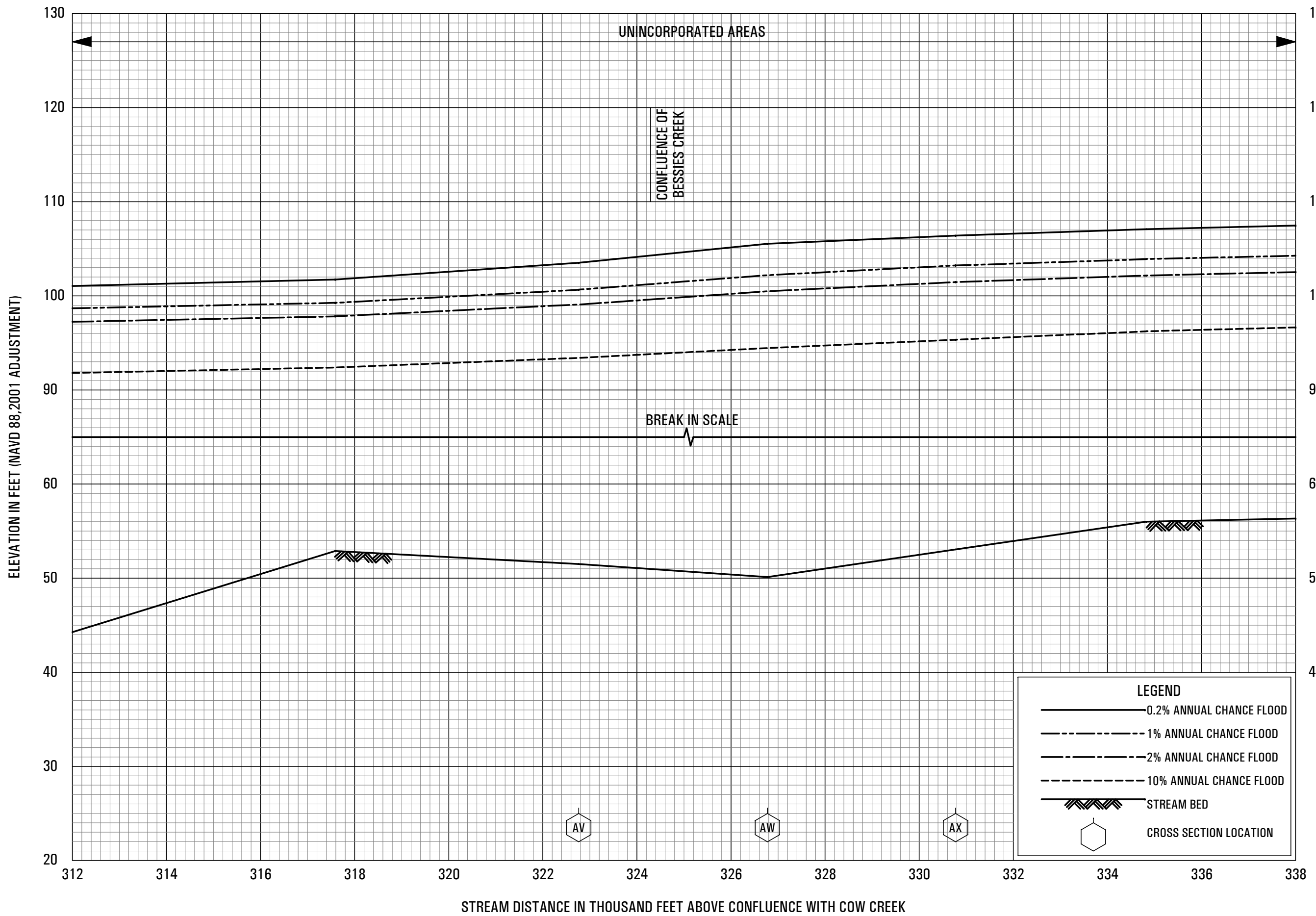
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AND INCORPORATED AREA**



**FLOOD PROFILES**

**BRAZOS RIVER**

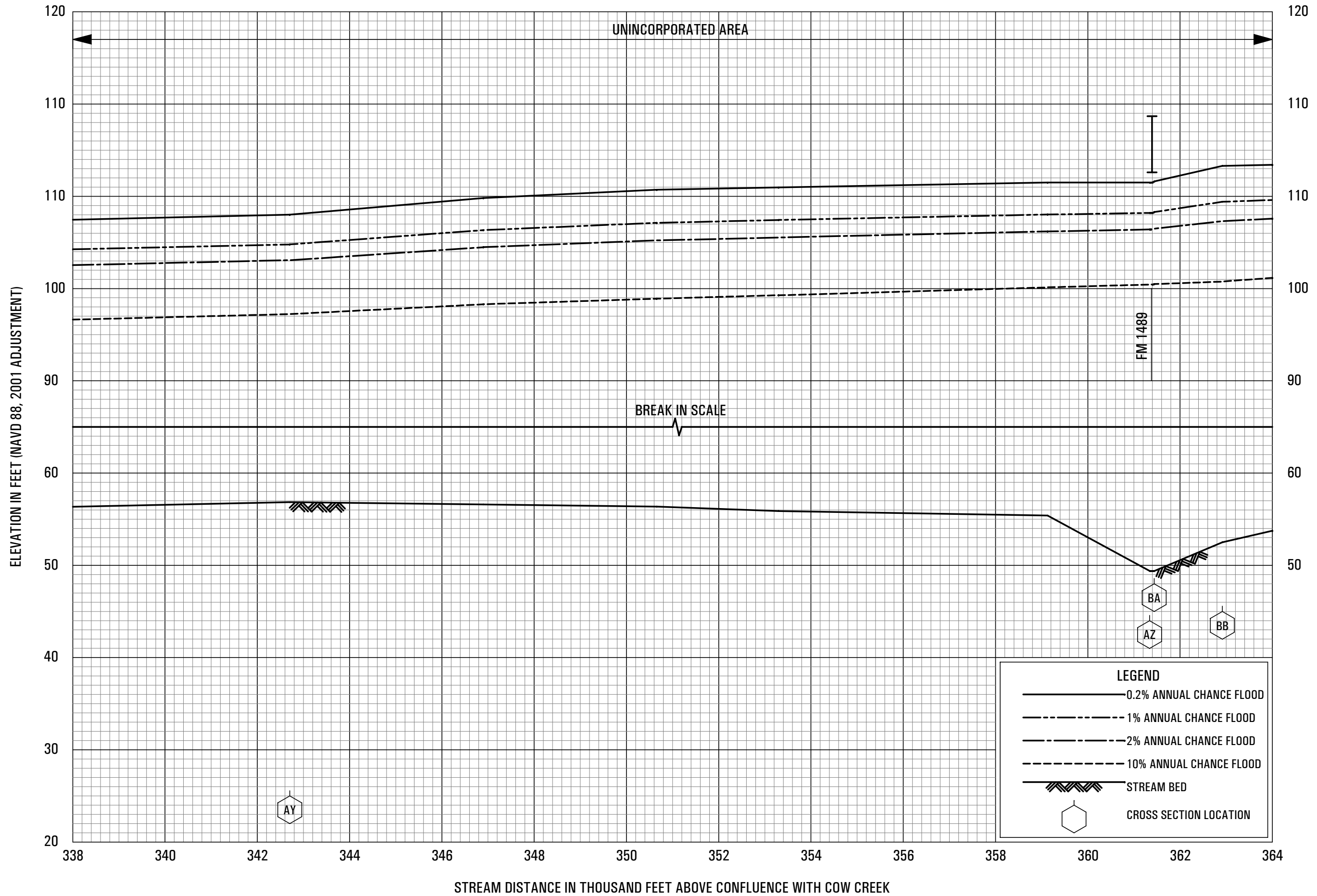
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AND INCORPORATED AREA**



FLOOD PROFILES

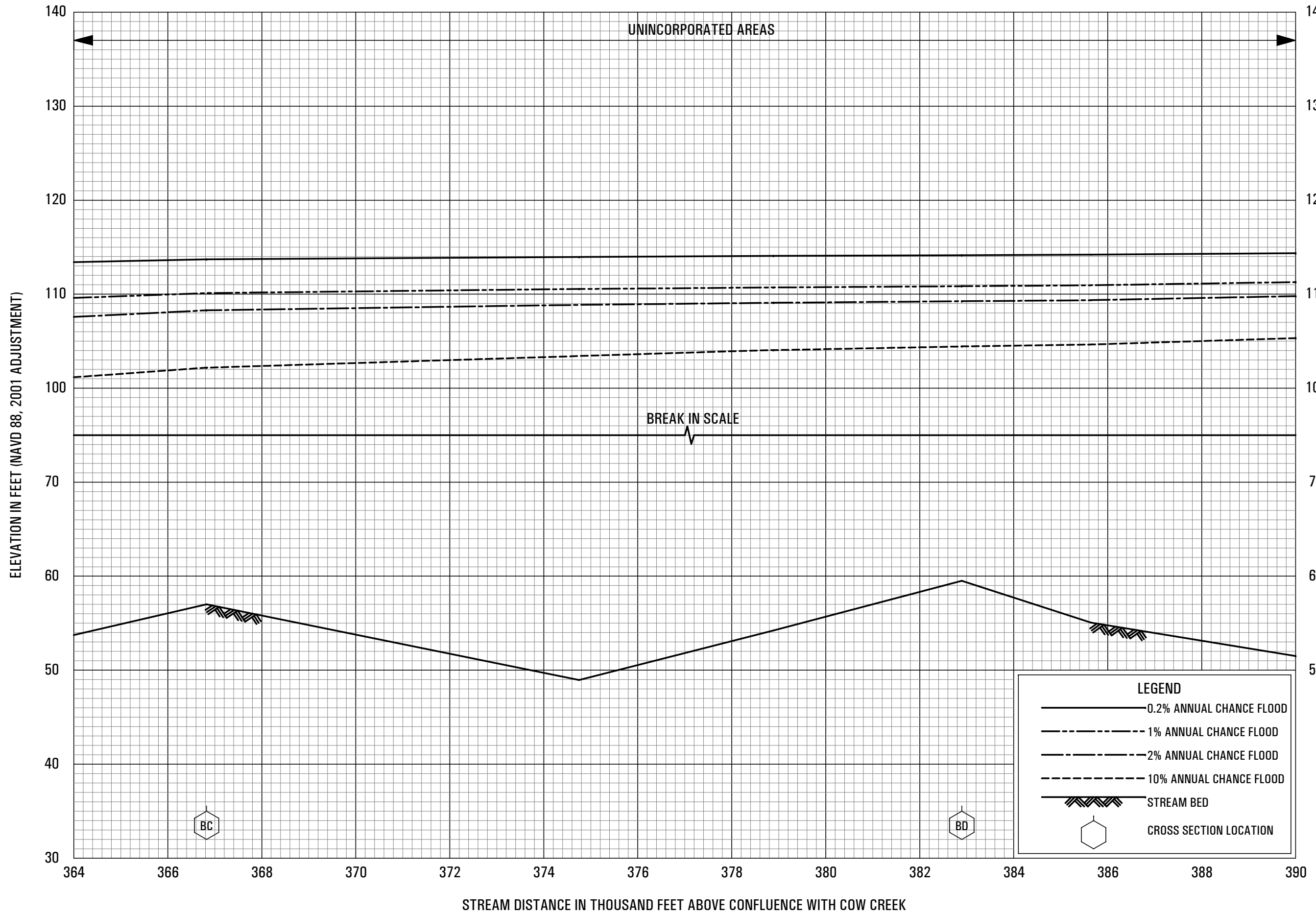
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 AND INCORPORATED AREA



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BRAZOS RIVER

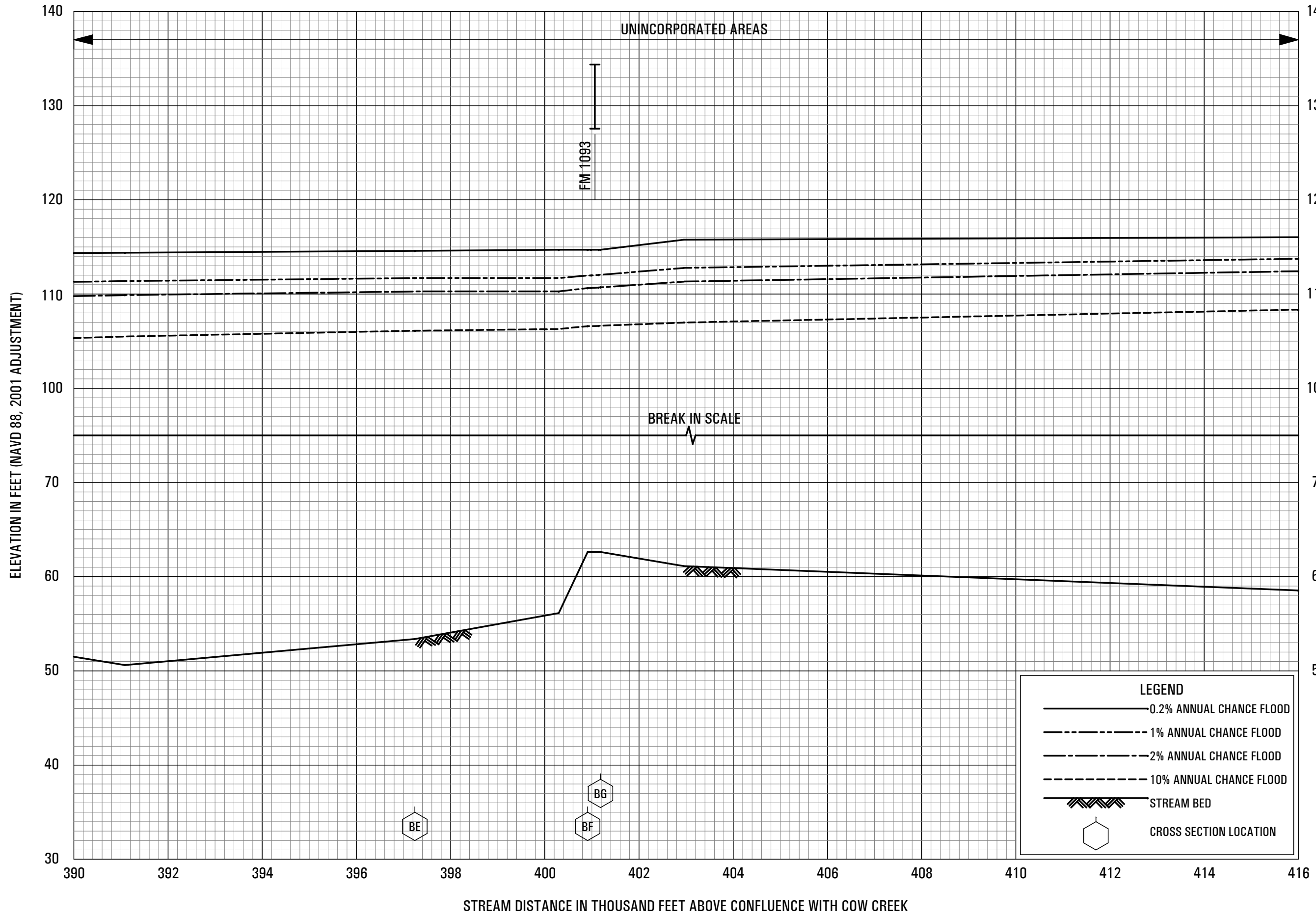
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**FLOOD PROFILES**

**BRAZOS RIVER**

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FORT BEND COUNTY, TX  
AND INCORPORATED AREA**

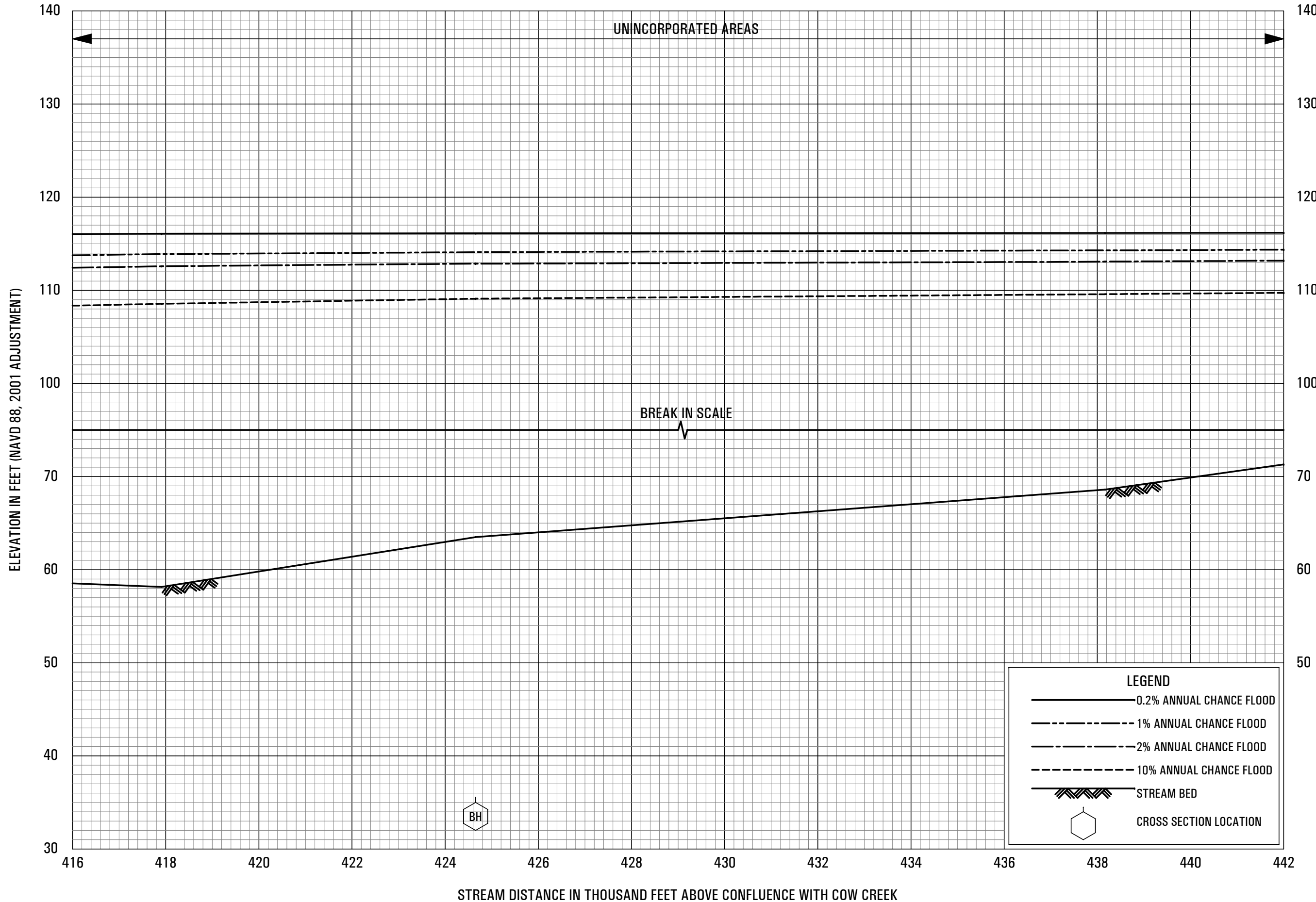


**FLOOD PROFILES**

**BRAZOS RIVER**

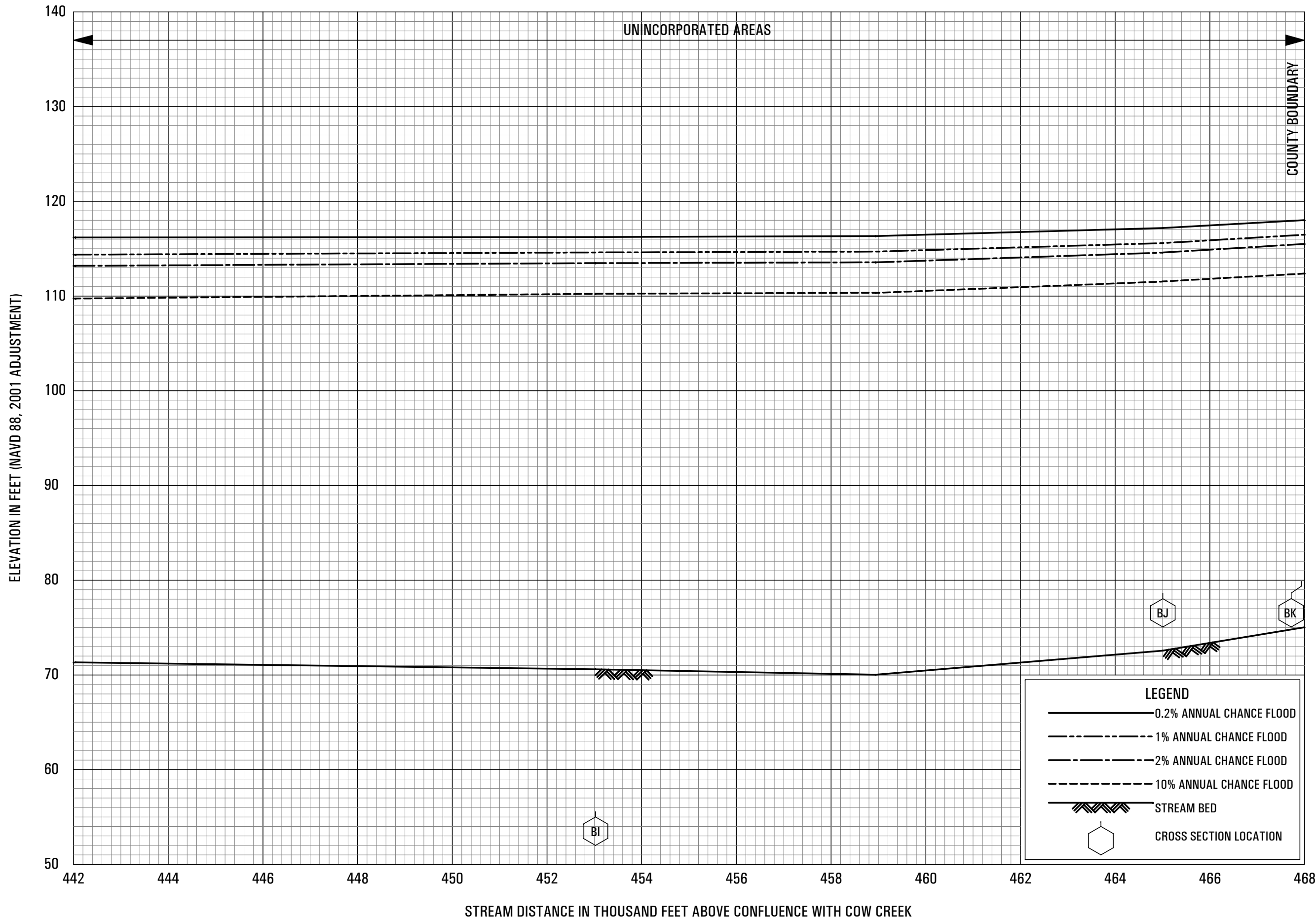
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FORT BEND COUNTY, TX  
AND INCORPORATED AREA**





**FLOOD PROFILES**  
**BRAZOS RIVER**

FEDERAL EMERGENCY MANAGEMENT AGENCY  
**FORT BEND COUNTY, TX**  
AND INCORPORATED AREA



**FLOOD PROFILES**  
BRAZOS RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY  
FORT BEND COUNTY, TX  
AND INCORPORATED AREA

## **APPENDIX B-2**

### **Floodway Data Tables**

Floodway Data Tables are included in the FWDT folder.

FLOODING SOURCE		FLOODWAY			BASE FLOOD			
CROSS SECTION	DISTANCE <sup>1</sup>	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Brazos River								
A	431	8,984/1,922 <sup>2</sup>	89,649	3.4	50.7	50.7	51.7	1.0
B	10,583	6,160/318 <sup>2</sup>	43,995	5.3	51.5	51.5	52.5	1.0
C	10,664	6,514/298 <sup>2</sup>	45,448	5.2	51.6	51.6	52.5	0.9
D	21,940	3,572/814 <sup>2</sup>	26,611	5.3	53.6	53.6	54.3	0.7
E	29,209	8,986/3,890 <sup>2</sup>	68,310	4.4	54.9	54.9	55.7	0.8
F	41,068	6,654/3,171 <sup>2</sup>	69,681	4.0	56.5	56.5	57.3	0.8
G	48,775	20,620/5,663 <sup>2</sup>	164,444	3.4	57.6	57.6	58.4	0.8
H	62,793	25,508	201,481	3.2	58.3	58.3	59.3	1.0
I	70,126	12,200	98,871	4.7	58.9	58.9	59.9	1.0
J	78,172	12,834	98,152	4.9	60.4	60.4	61.4	1.0
K	82,824	9,646	85,988	5.1	61.4	61.4	62.2	0.8
L	88,740	751	21,454	8.5	62.9	62.9	63.5	0.6
M	89,013	750	21,790	8.4	63.3	63.3	64.0	0.7
N	92,835	7,822	99,258	4.5	64.7	64.7	65.7	1.0
O	106,463	11,390	144,770	3.2	66.1	66.1	66.9	0.8
P	110,698	13,442	106,480	5.0	66.3	66.3	67.1	0.8
Q	123,453	12,948	96,782	5.2	68.1	68.1	68.7	0.6
R	131,800	10,037	80,754	5.9	69.3	69.3	70.0	0.7
S	136,966	7,472	74,747	6.0	70.2	70.2	71.2	1.0
T	143,791	8,586	83,432	6.0	71.8	71.8	72.8	1.0
U	147,311	7,502	88,692	4.5	72.6	72.6	73.6	1.0
V	152,185	3,587	59,075	5.6	73.3	73.3	74.2	0.9
W	157,172	3,983	60,243	5.7	74.3	74.3	75.2	0.9

<sup>1</sup> Feet above confluence with Intracoastal Waterway

<sup>2</sup> Total width / width within Fort Bend County

**TABLE 9**

**FEDERAL EMERGENCY MANAGEMENT AGENCY  
FORT BEND COUNTY, TEXAS  
AND INCORPORATED AREAS**

**FLOODWAY DATA**

**BRAZOS RIVER**

FLOODING SOURCE		FLOODWAY			BASE FLOOD			
CROSS SECTION	DISTANCE <sup>1</sup>	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Brazos River (continued)								
X	161,568	3,599	55,681	6.2	75.3	75.3	76.1	0.8
Y	163,253	1,294	31,158	6.6	75.6	75.6	76.4	0.8
Z	163,504	1,295	31,308	6.6	75.8	75.8	76.5	0.7
AA	164,544	3,066	56,875	5.8	76.2	76.2	76.9	0.7
AB	170,554	1,142	28,003	6.4	77.2	77.2	77.9	0.7
AC	170,697	1,143	28,107	6.4	77.3	77.3	78.0	0.7
AD	173,078	1,709	32,738	6.6	78.0	78.0	78.6	0.6
AE	179,826	4,990	91,221	4.0	79.8	79.8	80.3	0.5
AF	184,222	4,136	64,334	5.6	80.1	80.1	80.5	0.4
AG	200,098	2,632	59,282	5.1	81.4	81.4	82.4	1.0
AH	208,418	1,012	22,166	8.8	82.8	82.8	83.7	0.9
AI	208,515	1,012	22,269	8.8	82.9	82.9	83.8	0.9
AJ	208,830	864	22,911	8.2	83.3	83.3	84.1	0.8
AK	209,397	803	20,056	9.3	83.4	83.4	84.2	0.8
AL	212,681	781	26,574	7.2	85.2	85.2	85.8	0.6
AM	223,872	942	29,172	6.6	87.4	87.4	88.3	0.9
AN	232,403	1,181	39,414	4.6	89.0	89.0	89.9	0.9
AO	240,899	2,953	48,716	6.1	91.3	91.3	92.1	0.8
AP	248,700	4,951	54,009	6.1	92.5	92.5	93.3	0.8
AQ	252,398	4,905	57,427	7.0	93.0	93.0	93.9	0.9
AR	252,497	4,982	58,700	6.9	93.2	93.2	94.0	0.8
AS	263,691	4,438	54,193	5.4	94.2	94.2	95.2	1.0

<sup>1</sup> Feet above confluence with Intracoastal Waterway

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY  
**FORT BEND COUNTY, TEXAS  
AND INCORPORATED AREAS**

**FLOODWAY DATA**

**BRAZOS RIVER**

FLOODING SOURCE		FLOODWAY			BASE FLOOD			
CROSS SECTION	DISTANCE <sup>1</sup>	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Brazos River (continued)								
AT	279,088	6,632	71,363	5.2	95.6	95.6	96.6	1.0
AU	302,479	1,342	34,263	6.7	97.2	97.2	98.2	1.0
AV	322,762	1,000	20,869	9.2	100.7	100.7	101.5	0.8
AW	326,775	1,257	33,767	8.1	102.2	102.2	103.0	0.8
AX	330,774	2,351	43,432	7.0	103.2	103.2	104.1	0.9
AY	342,702	788	22,741	8.8	104.8	104.8	105.7	0.9
AZ	361,344	697	21,192	8.5	108.2	108.2	109.1	0.9
BA	361,439	697	21,248	8.4	108.3	108.3	109.2	0.9
BB	362,916	1,981	30,684	8.2	109.4	109.4	109.8	0.4
BC	366,826	6,634	83,385	5.0	110.1	110.1	111.1	1.0
BD	382,895	9,647/4,658 <sup>2</sup>	126,443	3.6	110.9	110.9	111.9	1.0
BE	397,241	5,881/3,555 <sup>2</sup>	77,758	4.4	111.8	111.8	112.7	0.9
BF	400,911	1,305/815 <sup>2</sup>	29,575	6.9	112.0	112.0	113.0	1.0
BG	401,183	1,305/1,071 <sup>2</sup>	29,689	6.8	112.1	112.1	113.1	1.0
BH	424,653	17,429/7,152 <sup>2</sup>	201,451	2.7	114.1	114.1	115.1	1.0
BI	453,026	16,980/437 <sup>2</sup>	187,999	2.9	114.6	114.6	115.6	1.0
BJ	465,003	8,449/1,857 <sup>2</sup>	58,215	6.8	115.6	115.6	116.6	0.9
BK	468,115	3,509/1,736 <sup>2</sup>	42,245	8.1	116.5	116.5	117.3	0.8

<sup>1</sup> Feet above confluence with Intracoastal Waterway

<sup>2</sup> Total width / width within Fort Bend County

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY  
**FORT BEND COUNTY, TEXAS  
AND INCORPORATED AREAS**

**FLOODWAY DATA**

**BRAZOS RIVER**

**APPENDIX B-3**

**HEC-RAS Multi Flow Plan Output**

HEC-RAS Plan: multi River: Brazos River Reach: Reach 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach 1	468115.5	10 %	105500.00	75.12	112.30	92.48	112.44	0.000102	3.93	70648.80	13495.60	0.13
Reach 1	468115.5	2%	154400.00	75.12	115.49	97.56	115.67	0.000125	4.65	100407.20	25841.03	0.15
Reach 1	468115.5	1%	172200.00	75.12	116.46	98.81	116.65	0.000130	4.84	111155.40	26458.64	0.15
Reach 1	468115.5	0.2%	216322.00	75.12	118.00	102.93	118.09	0.000082	3.97	207245.70	26463.50	0.12
Reach 1	465002.6	10 %	105500.00	72.57	111.41	90.09	111.94	0.000247	6.09	27158.39	10728.70	0.20
Reach 1	465002.6	2%	154400.00	72.57	114.52	94.03	115.09	0.000267	6.80	52014.01	25020.02	0.22
Reach 1	465002.6	1%	172200.00	72.57	115.54	95.33	116.06	0.000257	6.80	62970.83	27439.01	0.21
Reach 1	465002.6	0.2%	216322.00	72.57	117.14	99.25	117.64	0.000263	7.11	81930.06	28352.71	0.22
Reach 1	458943.6	10 %	105500.00	70.02	110.19	85.80	110.69	0.000188	5.88	28595.69	26356.88	0.18
Reach 1	458943.6	2%	154400.00	70.02	113.46	89.56	113.91	0.000186	6.22	58919.87	40088.63	0.18
Reach 1	458943.6	1%	172200.00	70.02	114.60	90.81	115.00	0.000171	6.09	73529.49	44035.11	0.18
Reach 1	458943.6	0.2%	216322.00	70.02	116.26	93.72	116.63	0.000174	6.33	97727.68	46987.89	0.18
Reach 1	453026.1	10 %	105500.00	70.60	110.07	89.20	110.12	0.000051	2.86	116811.70	31227.08	0.09
Reach 1	453026.1	2%	154400.00	70.60	113.36	93.60	113.40	0.000048	2.96	181090.60	40452.45	0.09
Reach 1	453026.1	1%	172200.00	70.60	114.52	96.11	114.56	0.000043	2.86	207826.70	41616.60	0.09
Reach 1	453026.1	0.2%	216322.00	70.60	116.17	101.55	116.20	0.000043	2.97	245875.70	45463.00	0.09
Reach 1	442044.3	10 %	105500.00	71.33	109.56	88.84	109.67	0.000083	3.75	88762.56	31792.11	0.12
Reach 1	442044.3	2%	154400.00	71.33	113.05	92.76	113.11	0.000052	3.19	161699.70	37817.14	0.10
Reach 1	442044.3	1%	172200.00	71.33	114.28	94.07	114.32	0.000043	2.95	188413.60	40031.55	0.09
Reach 1	442044.3	0.2%	216322.00	71.33	116.10	97.10	116.11	0.000009	1.44	448784.20	40705.06	0.04
Reach 1	438167	10 %	105500.00	68.60	109.40	86.48	109.46	0.000050	2.97	123145.10	32777.86	0.09
Reach 1	438167	2%	154400.00	68.60	112.95	90.67	112.99	0.000032	2.56	198913.60	39313.21	0.08
Reach 1	438167	1%	172200.00	68.60	114.19	92.03	114.22	0.000028	2.42	226223.90	40662.11	0.07
Reach 1	438167	0.2%	216322.00	68.60	116.08	95.14	116.09	0.000008	1.34	485924.70	43248.91	0.04
Reach 1	424652.6	10 %	105500.00	63.50	108.88	83.34	109.00	0.000070	3.85	93412.66	27248.90	0.11
Reach 1	424652.6	2%	154400.00	63.50	112.72	87.69	112.77	0.000042	3.19	168509.90	30292.37	0.09
Reach 1	424652.6	1%	172200.00	63.50	114.00	89.12	114.05	0.000036	3.03	194349.50	30294.78	0.08
Reach 1	424652.6	0.2%	216322.00	63.50	116.05	92.46	116.06	0.000010	1.62	403951.40	30306.60	0.04
Reach 1	417909.5	10 %	103800.00	58.15	108.26	85.05	108.53	0.000119	4.92	58585.48	23512.35	0.15
Reach 1	417909.5	2%	151100.00	58.15	112.42	89.51	112.55	0.000073	4.17	121504.20	27066.85	0.12
Reach 1	417909.5	1%	168600.00	58.15	113.77	90.97	113.87	0.000061	3.91	143617.10	27069.01	0.11
Reach 1	417909.5	0.2%	211800.00	58.15	116.01	94.38	116.02	0.000011	1.74	358538.10	27071.19	0.05
Reach 1	402954.8	10 %	103800.00	61.13	106.71	81.52	107.04	0.000116	4.79	36410.92	3930.49	0.15
Reach 1	402954.8	2%	151100.00	61.13	111.15	85.13	111.53	0.000127	5.46	61763.79	17859.13	0.16
Reach 1	402954.8	1%	168600.00	61.13	112.66	86.31	113.02	0.000123	5.51	73452.55	18417.55	0.16
Reach 1	402954.8	0.2%	211800.00	61.13	115.68	89.00	115.83	0.000069	4.33	176619.50	34380.66	0.12
Reach 1	401182.6	10 %	103800.00	62.62	106.41	77.81	106.82	0.000118	5.14	21377.13	1632.41	0.15
Reach 1	401182.6	2%	151100.00	62.62	110.59	81.41	111.25	0.000167	6.60	26483.46	11885.51	0.19
Reach 1	401182.6	1%	168600.00	62.62	111.97	82.62	112.73	0.000183	7.07	28265.72	13803.98	0.20
Reach 1	401182.6	0.2%	211800.00	62.62	114.55	85.39	115.57	0.000230	8.25	31742.71	14341.82	0.22
Reach 1	401142.6		Bridge									
Reach 1	400910.6	10 %	103800.00	62.62	106.36	77.81	106.77	0.000119	5.15	21322.49	1616.20	0.15
Reach 1	400910.6	2%	151100.00	62.62	110.51	81.41	111.18	0.000169	6.61	26384.76	11856.61	0.19
Reach 1	400910.6	1%	168600.00	62.62	111.88	82.62	112.65	0.000185	7.09	28153.18	13526.59	0.20
Reach 1	400910.6	0.2%	211800.00	62.62	114.44	85.39	115.47	0.000232	8.28	31579.44	13825.35	0.22
Reach 1	400296.9	10 %	103800.00	56.13	106.07	79.29	106.64	0.000174	6.14	20352.52	2592.23	0.19
Reach 1	400296.9	2%	151100.00	56.13	110.13	83.93	110.99	0.000236	7.70	29247.94	10613.34	0.22
Reach 1	400296.9	1%	168600.00	56.13	111.54	85.43	112.46	0.000246	8.07	34536.70	11760.20	0.23
Reach 1	400296.9	0.2%	211800.00	56.13	114.62	88.81	115.03	0.000141	6.42	101935.10	12926.03	0.17
Reach 1	397240.9	10 %	103800.00	53.38	105.92	78.93	106.17	0.000095	4.26	40351.66	7370.65	0.14
Reach 1	397240.9	2%	151100.00	53.38	110.18	83.19	110.42	0.000090	4.53	72039.55	11469.11	0.14
Reach 1	397240.9	1%	168600.00	53.38	111.65	84.52	111.87	0.000085	4.53	83256.90	12177.47	0.13
Reach 1	397240.9	0.2%	211800.00	53.38	114.54	87.48	114.69	0.000066	4.19	137545.60	12887.49	0.12
Reach 1	391085	10 %	103800.00	50.62	105.32	78.13	105.58	0.000117	4.46	49854.31	12245.04	0.15
Reach 1	391085	2%	151100.00	50.62	109.82	82.71	109.97	0.000079	4.05	97907.41	14522.53	0.12
Reach 1	391085	1%	168600.00	50.62	111.34	84.20	111.48	0.000070	3.91	114361.60	15386.51	0.12
Reach 1	391085	0.2%	211800.00	50.62	114.35	87.58	114.43	0.000047	3.41	185063.00	16418.25	0.10
Reach 1	385647.5	10 %	103800.00	55.06	104.52	78.62	104.90	0.000155	5.14	32452.34	9287.78	0.17
Reach 1	385647.5	2%	151100.00	55.06	109.30	83.09	109.57	0.000112	4.86	75335.98	15452.62	0.15
Reach 1	385647.5	1%	168600.00	55.06	110.94	84.60	111.15	0.000094	4.60	92535.52	15492.63	0.14
Reach 1	385647.5	0.2%	211800.00	55.06	114.18	87.92	114.27	0.000051	3.60	171973.10	15807.03	0.10
Reach 1	382895.2	10 %	103800.00	59.50	104.31	76.21	104.55	0.000088	4.44	56214.16	11258.76	0.13
Reach 1	382895.2	2%	151100.00	59.50	109.20	80.10	109.34	0.000057	3.89	117487.40	17900.15	0.11



HEC-RAS Plan: multi River: Brazos River Reach: Reach 1 (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach 1	382895.2	1%	168600.00	59.50	110.86	81.41	110.96	0.000048	3.69	139992.30	17910.45	0.10
Reach 1	382895.2	0.2%	211800.00	59.50	114.12	84.39	114.18	0.000031	3.12	222996.80	17994.73	0.08
Reach 1	378885.8	10%	103800.00	54.23	103.86	78.93	104.17	0.000125	4.78	43829.02	12751.23	0.15
Reach 1	378885.8	2%	151100.00	54.23	109.01	83.65	109.15	0.000067	3.90	109412.80	16618.50	0.12
Reach 1	378885.8	1%	168600.00	54.23	110.70	84.82	110.81	0.000055	3.66	131441.30	16655.46	0.11
Reach 1	378885.8	0.2%	211800.00	54.23	114.04	87.55	114.09	0.000035	3.06	208888.60	16718.02	0.09
Reach 1	374749.9	10%	103800.00	48.96	103.22	74.62	103.63	0.000143	5.74	49397.34	12205.75	0.17
Reach 1	374749.9	2%	151100.00	48.96	108.80	79.93	108.93	0.000063	4.19	126032.30	14642.60	0.11
Reach 1	374749.9	1%	168600.00	48.96	110.54	81.67	110.64	0.000050	3.85	151167.20	14662.27	0.10
Reach 1	374749.9	0.2%	211800.00	48.96	113.93	85.58	113.99	0.000037	3.45	203444.50	14846.32	0.09
Reach 1	366825.8	10%	103800.00	57.01	102.06	74.45	102.56	0.000149	5.85	28315.50	6994.95	0.17
Reach 1	366825.8	2%	151100.00	57.01	108.21	78.55	108.50	0.000096	5.24	78644.97	12789.72	0.14
Reach 1	366825.8	1%	168600.00	57.01	110.08	79.95	110.31	0.000083	5.00	94990.07	15498.12	0.13
Reach 1	366825.8	0.2%	211800.00	57.01	113.66	83.12	113.80	0.000056	4.33	169094.00	16241.72	0.11
Reach 1	362916	10%	103800.00	52.49	100.75	81.18	101.65	0.000378	7.62	14637.23	1425.80	0.26
Reach 1	362916	2%	151100.00	52.49	107.25	86.23	107.91	0.000254	7.24	43968.63	8569.08	0.22
Reach 1	362916	1%	168600.00	52.49	109.32	87.82	109.83	0.000203	6.75	57392.07	11443.76	0.20
Reach 1	362916	0.2%	211800.00	52.49	113.27	91.29	113.51	0.000114	5.44	117247.50	13496.62	0.15
Reach 1	361438.6	10%	103800.00	49.38	100.50	71.38	101.17	0.000212	6.60	15722.57	607.72	0.20
Reach 1	361438.6	2%	151100.00	49.38	106.49	75.82	107.51	0.000257	8.12	19392.39	3967.63	0.23
Reach 1	361438.6	1%	168600.00	49.38	108.28	77.33	109.43	0.000274	8.64	20631.76	6988.61	0.24
Reach 1	361438.6	0.2%	211800.00	49.38	111.61	80.78	113.14	0.000330	9.98	22983.44	10669.12	0.26
Reach 1	361408.5		Bridge									
Reach 1	361344.3	10%	103800.00	49.38	100.44	71.38	101.12	0.000213	6.62	15694.51	606.41	0.20
Reach 1	361344.3	2%	151100.00	49.38	106.41	75.83	107.43	0.000259	8.14	19337.96	3870.39	0.23
Reach 1	361344.3	1%	168600.00	49.38	108.20	77.32	109.35	0.000276	8.66	20571.70	6973.55	0.24
Reach 1	361344.3	0.2%	211800.00	49.38	111.50	80.79	113.04	0.000333	10.01	22906.81	10415.79	0.26
Reach 1	359128.5	10%	103800.00	55.40	100.14	73.06	100.56	0.000179	5.27	23761.75	1635.04	0.18
Reach 1	359128.5	2%	151100.00	55.40	106.20	77.28	106.72	0.000178	6.00	36029.24	3497.68	0.19
Reach 1	359128.5	1%	168600.00	55.40	108.04	78.69	108.57	0.000175	6.15	41147.95	4452.79	0.19
Reach 1	359128.5	0.2%	211800.00	55.40	111.50	81.92	112.05	0.000171	6.49	67056.30	8339.77	0.19
Reach 1	353298.3	10%	103800.00	55.88	99.28	75.40	99.61	0.000145	4.84	33167.78	3605.21	0.16
Reach 1	353298.3	2%	151100.00	55.88	105.54	79.25	105.85	0.000118	5.01	59480.38	4852.27	0.15
Reach 1	353298.3	1%	168600.00	55.88	107.44	80.59	107.74	0.000110	5.02	68842.28	5832.22	0.15
Reach 1	353298.3	0.2%	211800.00	55.88	110.96	83.59	111.26	0.000104	5.20	94099.94	7827.44	0.15
Reach 1	350657.8	10%	103800.00	56.36	98.90	72.90	99.28	0.000120	5.22	36130.49	3689.15	0.16
Reach 1	350657.8	2%	151100.00	56.36	105.23	76.63	105.59	0.000106	5.47	59596.55	4859.91	0.15
Reach 1	350657.8	1%	168600.00	56.36	107.13	77.89	107.49	0.000104	5.59	66698.88	6447.38	0.15
Reach 1	350657.8	0.2%	211800.00	56.36	110.71	80.77	111.03	0.000096	5.66	100083.40	8569.65	0.15
Reach 1	346899.8	10%	103800.00	56.60	98.30	73.45	98.76	0.000153	5.55	22858.57	1618.82	0.17
Reach 1	346899.8	2%	151100.00	56.60	104.49	77.31	105.08	0.000161	6.43	32528.13	2543.35	0.18
Reach 1	346899.8	1%	168600.00	56.60	106.34	78.61	106.98	0.000166	6.73	35583.41	3152.38	0.19
Reach 1	346899.8	0.2%	211800.00	56.60	109.82	81.54	110.52	0.000175	7.31	56130.95	7048.38	0.20
Reach 1	342702.2	10%	103800.00	56.85	97.24	73.15	97.98	0.000218	6.92	16385.66	876.02	0.21
Reach 1	342702.2	2%	151100.00	56.85	103.08	77.17	104.17	0.000266	8.49	20677.85	1023.84	0.24
Reach 1	342702.2	1%	168600.00	56.85	104.79	78.53	106.02	0.000286	9.04	21991.56	2352.29	0.25
Reach 1	342702.2	0.2%	211800.00	56.85	108.02	81.66	109.48	0.000321	10.06	27991.33	5483.26	0.26
Reach 1	334827.8	10%	103800.00	56.00	96.24		96.58	0.000124	4.76	27792.31	2399.98	0.15
Reach 1	334827.8	2%	151100.00	56.00	102.17		102.57	0.000125	5.33	43690.73	2814.61	0.16
Reach 1	334827.8	1%	168600.00	56.00	103.91		104.32	0.000127	5.52	48592.77	2829.93	0.16
Reach 1	334827.8	0.2%	211800.00	56.00	107.09		107.57	0.000140	6.10	58742.76	4409.69	0.17
Reach 1	330773.7	10%	103800.00	53.06	95.35	74.15	95.92	0.000220	6.38	27018.81	3113.85	0.21
Reach 1	330773.7	2%	151100.00	53.06	101.47	78.38	101.99	0.000182	6.57	46471.58	4334.13	0.19
Reach 1	330773.7	1%	168600.00	53.06	103.24	79.80	103.76	0.000177	6.70	52257.39	4778.65	0.19
Reach 1	330773.7	0.2%	211800.00	53.06	106.40	82.95	106.98	0.000187	7.25	62846.11	6509.52	0.20
Reach 1	326774.9	10%	103800.00	50.12	94.47	70.69	95.10	0.000207	6.70	25829.49	2649.84	0.20
Reach 1	326774.9	2%	151100.00	50.12	100.50	74.89	101.24	0.000221	7.59	37371.73	2969.80	0.21
Reach 1	326774.9	1%	168600.00	50.12	102.20	76.31	103.00	0.000233	7.98	41314.09	3080.22	0.22
Reach 1	326774.9	0.2%	211800.00	50.12	105.53	79.65	106.25	0.000216	8.05	69356.04	4549.83	0.21
Reach 1	322762.3	10%	103800.00	51.50	93.42	69.44	94.20	0.000233	7.09	15837.22	1153.71	0.21
Reach 1	322762.3	2%	151100.00	51.50	99.09	73.50	100.20	0.000279	8.59	23157.39	3248.30	0.24
Reach 1	322762.3	1%	168600.00	51.50	100.66	74.87	101.89	0.000299	9.12	25605.60	4972.68	0.25
Reach 1	322762.3	0.2%	211800.00	51.50	103.51	78.05	105.06	0.000355	10.38	34935.25	6597.39	0.27

HEC-RAS Plan: multi River: Brazos River Reach: Reach 1 (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach 1	317588.5	10 %	103800.00	52.89	92.40	68.35	93.05	0.000198	6.62	19004.52	1152.33	0.20
Reach 1	317588.5	2%	151100.00	52.89	97.83	72.25	98.81	0.000247	8.15	23550.51	2007.45	0.23
Reach 1	317588.5	1%	168600.00	52.89	99.27	73.57	100.39	0.000271	8.73	24809.81	3412.68	0.24
Reach 1	317588.5	0.2%	211800.00	52.89	101.73	76.62	103.25	0.000346	10.25	27300.81	6816.61	0.27
Reach 1	310985.9	10 %	103800.00	42.71	91.71		92.05	0.000106	5.04	38330.68	2291.28	0.15
Reach 1	310985.9	2%	151100.00	42.71	97.15		97.58	0.000122	5.90	51673.11	2519.73	0.16
Reach 1	310985.9	1%	168600.00	42.71	98.58		99.04	0.000130	6.24	55267.25	2526.87	0.17
Reach 1	310985.9	0.2%	211800.00	42.71	100.93		101.54	0.000163	7.23	61880.35	2978.60	0.19
Reach 1	302479.4	10 %	103000.00	43.76	90.73		91.13	0.000110	5.16	25999.90	1817.00	0.15
Reach 1	302479.4	2%	148500.00	43.76	95.93		96.49	0.000134	6.23	36682.61	2220.25	0.17
Reach 1	302479.4	1%	165700.00	43.76	97.24		97.87	0.000147	6.65	39666.94	2326.65	0.18
Reach 1	302479.4	0.2%	208100.00	43.76	99.19		100.04	0.000191	7.81	44372.57	2544.64	0.20
Reach 1	294723.1	10 %	103000.00	43.99	89.97		90.35	0.000097	5.06	25864.47	2783.04	0.14
Reach 1	294723.1	2%	148500.00	43.99	95.21		95.63	0.000102	5.66	80950.21	14262.23	0.15
Reach 1	294723.1	1%	165700.00	43.99	96.59		96.98	0.000100	5.71	101551.10	15550.60	0.15
Reach 1	294723.1	0.2%	208100.00	43.99	98.59		98.99	0.000108	6.09	133009.60	15764.54	0.15
Reach 1	288659.1	10 %	103000.00	41.43	89.61		89.84	0.000068	4.02	46069.23	5169.49	0.12
Reach 1	288659.1	2%	148500.00	41.43	94.95		95.16	0.000063	4.24	92123.92	11152.10	0.12
Reach 1	288659.1	1%	165700.00	41.43	96.35		96.55	0.000061	4.26	107975.30	11467.27	0.11
Reach 1	288659.1	0.2%	208100.00	41.43	98.34		98.56	0.000067	4.63	131898.00	12546.26	0.12
Reach 1	284398.3	10 %	103000.00	41.15	89.12		89.51	0.000091	5.07	28992.95	5607.17	0.14
Reach 1	284398.3	2%	148500.00	41.15	94.57		94.88	0.000079	5.15	78812.65	15110.57	0.13
Reach 1	284398.3	1%	165700.00	41.15	96.00		96.29	0.000076	5.14	93410.45	15936.67	0.13
Reach 1	284398.3	0.2%	208100.00	41.15	98.11		98.31	0.000064	4.86	152161.30	16384.90	0.12
Reach 1	279087.8	10 %	103000.00	39.96	88.54		88.96	0.000119	5.24	23348.13	2337.02	0.15
Reach 1	279087.8	2%	148500.00	39.96	94.14		94.47	0.000096	5.18	68215.75	13299.25	0.14
Reach 1	279087.8	1%	165700.00	39.96	95.62		95.91	0.000089	5.11	81705.46	13722.21	0.14
Reach 1	279087.8	0.2%	208100.00	39.96	97.80		98.02	0.000076	4.87	133679.00	15624.53	0.13
Reach 1	271759.3	10 %	103000.00	38.95	87.95		88.21	0.000080	4.06	27486.06	2218.85	0.13
Reach 1	271759.3	2%	148500.00	38.95	93.58		93.87	0.000081	4.52	63164.37	12891.79	0.13
Reach 1	271759.3	1%	165700.00	38.95	95.08		95.36	0.000079	4.58	76974.66	13943.68	0.13
Reach 1	271759.3	0.2%	208100.00	38.95	97.15		97.49	0.000094	5.18	100456.90	14851.30	0.14
Reach 1	263690.5	10 %	103000.00	35.38	87.02		87.39	0.000131	4.88	24215.77	3012.50	0.16
Reach 1	263690.5	2%	148500.00	35.38	92.67		93.07	0.000125	5.34	49125.73	17008.27	0.16
Reach 1	263690.5	1%	165700.00	35.38	94.18		94.58	0.000123	5.46	59308.12	18373.93	0.16
Reach 1	263690.5	0.2%	208100.00	35.38	96.54		96.76	0.000084	4.71	136626.80	18521.21	0.13
Reach 1	256204	10 %	103000.00	31.69	86.29		86.62	0.000084	4.88	31188.06	7286.05	0.13
Reach 1	256204	2%	148500.00	31.69	92.12		92.39	0.000072	4.93	81205.33	24725.17	0.13
Reach 1	256204	1%	165700.00	31.69	93.70		93.94	0.000068	4.87	96032.71	25158.26	0.12
Reach 1	256204	0.2%	208100.00	31.69	96.33		96.42	0.000036	3.66	228927.70	25394.71	0.09
Reach 1	252497.4	10 %	103000.00	27.52	85.34		86.08	0.000272	7.02	17624.16	3385.72	0.19
Reach 1	252497.4	2%	148500.00	27.52	91.51		92.02	0.000205	6.66	62427.73	22812.70	0.17
Reach 1	252497.4	1%	165700.00	27.52	93.19		93.62	0.000185	6.46	76036.64	24527.10	0.16
Reach 1	252497.4	0.2%	208100.00	27.52	95.84		96.23	0.000179	6.58	97754.89	24747.38	0.16
Reach 1	252467.4		Bridge									
Reach 1	252397.7	10 %	103000.00	27.52	85.29		86.04	0.000274	7.03	17558.27	3111.03	0.19
Reach 1	252397.7	2%	148500.00	27.52	91.36		91.89	0.000211	6.75	61211.77	22554.40	0.17
Reach 1	252397.7	1%	165700.00	27.52	93.04		93.49	0.000190	6.54	74835.38	24511.88	0.16
Reach 1	252397.7	0.2%	208100.00	27.52	95.69		96.09	0.000184	6.65	96515.15	24745.55	0.16
Reach 1	248699.7	10 %	103000.00	25.45	84.36		84.97	0.000273	6.30	17702.55	776.08	0.18
Reach 1	248699.7	2%	148500.00	25.45	90.68		91.19	0.000228	6.39	47904.98	7369.95	0.17
Reach 1	248699.7	1%	165700.00	25.45	92.49		92.91	0.000193	6.05	61335.46	7418.41	0.16
Reach 1	248699.7	0.2%	208100.00	25.45	95.24		95.58	0.000174	5.98	81938.34	7707.71	0.15
Reach 1	240899.4	10 %	103000.00	23.38	82.98		83.35	0.000163	5.14	26592.66	1143.09	0.14
Reach 1	240899.4	2%	148500.00	23.38	89.23		89.74	0.000193	6.17	51047.39	8713.40	0.16
Reach 1	240899.4	1%	165700.00	23.38	91.30		91.73	0.000172	5.99	69946.35	9206.45	0.15
Reach 1	240899.4	0.2%	208100.00	23.38	94.26		94.63	0.000158	5.98	97510.21	9731.31	0.15
Reach 1	235070.8	10 %	103000.00	26.97	81.73		82.29	0.000219	6.08	19535.06	913.41	0.17
Reach 1	235070.8	2%	148500.00	26.97	87.67		88.48	0.000271	7.41	25965.41	1316.55	0.19
Reach 1	235070.8	1%	165700.00	26.97	89.57		90.51	0.000299	7.99	29203.53	2387.65	0.20
Reach 1	235070.8	0.2%	208100.00	26.97	92.24		93.42	0.000363	9.12	35777.41	2537.97	0.23
Reach 1	232403.3	10 %	103000.00	30.57	81.21		81.42	0.000396	3.83	29280.44	1142.38	0.12

HEC-RAS Plan: multi River: Brazos River Reach: Reach 1 (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach 1	232403.3	2%	148500.00	30.57	87.13	54.88	87.42	0.000454	4.54	36435.53	1823.19	0.13
Reach 1	232403.3	1%	165700.00	30.57	89.04	56.13	89.35	0.000468	4.75	39249.00	2123.91	0.13
Reach 1	232403.3	0.2%	208100.00	30.57	91.64	58.94	92.02	0.000555	5.39	47030.77	2432.95	0.14
Reach 1	228253.7	10%	103000.00	28.54	80.72	48.04	80.86	0.000066	3.22	42615.84	2508.19	0.09
Reach 1	228253.7	2%	148500.00	28.54	86.55	51.68	86.74	0.000080	3.92	52047.95	6867.06	0.10
Reach 1	228253.7	1%	165700.00	28.54	88.42	52.91	88.65	0.000086	4.16	56144.42	10010.96	0.11
Reach 1	228253.7	0.2%	208100.00	28.54	91.05	55.64	91.26	0.000085	4.31	110949.20	12431.72	0.11
Reach 1	223871.8	10%	103000.00	26.51	80.01	44.23	80.41	0.000159	5.08	21890.51	822.03	0.14
Reach 1	223871.8	2%	148500.00	26.51	85.57	48.28	86.16	0.000216	6.30	26651.45	7818.25	0.17
Reach 1	223871.8	1%	165700.00	26.51	87.35	49.69	88.02	0.000235	6.72	28323.25	12301.53	0.17
Reach 1	223871.8	0.2%	208100.00	26.51	90.26	52.93	90.70	0.000181	6.14	98969.45	15489.65	0.15
Reach 1	217239.6	10%	103000.00	25.03	79.03	42.80	79.28	0.000171	4.10	30947.50	1908.64	0.14
Reach 1	217239.6	2%	148500.00	25.03	84.53	47.30	84.83	0.000170	4.62	52732.45	9810.15	0.14
Reach 1	217239.6	1%	165700.00	25.03	86.31	48.86	86.63	0.000169	4.78	64321.43	10133.21	0.14
Reach 1	217239.6	0.2%	208100.00	25.03	89.32	52.80	89.59	0.000151	4.77	110259.50	13156.54	0.14
Reach 1	212681.1	10%	103000.00	19.62	78.12	44.25	78.52	0.000158	5.21	28094.93	2339.28	0.14
Reach 1	212681.1	2%	148500.00	19.62	83.49	48.77	84.00	0.000187	6.15	44314.59	9260.55	0.16
Reach 1	212681.1	1%	165700.00	19.62	85.23	50.30	85.78	0.000195	6.44	51561.40	10242.25	0.16
Reach 1	212681.1	0.2%	208100.00	19.62	88.51	53.76	88.89	0.000157	6.03	109059.60	10804.28	0.15
Reach 1	209396.9	10%	103000.00	14.22	77.05	46.04	77.81	0.000284	7.02	14978.00	643.46	0.20
Reach 1	209396.9	2%	148500.00	14.22	81.89	51.30	83.10	0.000385	8.87	18253.22	3442.89	0.24
Reach 1	209396.9	1%	165700.00	14.22	83.42	53.06	84.81	0.000422	9.52	19399.96	4455.21	0.26
Reach 1	209396.9	0.2%	208100.00	14.22	86.02	57.08	87.93	0.000540	11.19	21546.27	5504.70	0.29
Reach 1	209370.9		Bridge									
Reach 1	209310.1	10%	103000.00	14.22	76.97	46.04	77.74	0.000286	7.04	14928.27	642.41	0.21
Reach 1	209310.1	2%	148500.00	14.22	81.77	51.29	82.99	0.000389	8.90	18167.70	4954.38	0.24
Reach 1	209310.1	1%	165700.00	14.22	83.28	53.07	84.69	0.000427	9.55	19290.79	5428.29	0.26
Reach 1	209310.1	0.2%	208100.00	14.22	85.83	57.07	87.75	0.000548	11.25	21364.94	5842.51	0.29
Reach 1	208829.5	10%	103000.00	24.99	76.95	46.09	77.53	0.000202	6.14	17611.09	599.70	0.18
Reach 1	208829.5	2%	148500.00	24.99	81.75	50.32	82.69	0.000290	7.82	20890.77	4100.75	0.21
Reach 1	208829.5	1%	165700.00	24.99	83.27	51.78	84.35	0.000322	8.39	22192.51	4623.65	0.23
Reach 1	208829.5	0.2%	208100.00	24.99	85.82	55.13	87.30	0.000420	9.87	24403.31	5199.52	0.26
Reach 1	208809.5		Bridge									
Reach 1	208746	10%	103000.00	24.99	76.90	46.08	77.49	0.000203	6.15	17584.00	599.02	0.18
Reach 1	208746	2%	148500.00	24.99	81.68	50.33	82.63	0.000292	7.83	20836.99	4076.78	0.21
Reach 1	208746	1%	165700.00	24.99	83.20	51.79	84.28	0.000323	8.40	22129.66	4610.71	0.23
Reach 1	208746	0.2%	208100.00	24.99	85.72	55.13	87.21	0.000424	9.90	24313.31	5178.56	0.26
Reach 1	208514.5	10%	103000.00	24.99	76.73	47.09	77.41	0.000245	6.64	16446.23	579.43	0.19
Reach 1	208514.5	2%	147000.00	24.99	81.44	51.54	82.52	0.000340	8.38	19918.01	3547.39	0.23
Reach 1	208514.5	1%	164000.00	24.99	82.92	53.08	84.15	0.000375	8.98	21402.86	3954.44	0.24
Reach 1	208514.5	0.2%	206000.00	24.99	85.36	56.65	87.04	0.000488	10.57	23868.88	5308.51	0.28
Reach 1	208481.5		Bridge									
Reach 1	208418.2	10%	103000.00	24.99	76.65	47.09	77.34	0.000247	6.65	16404.09	578.78	0.19
Reach 1	208418.2	2%	147000.00	24.99	81.34	51.53	82.43	0.000343	8.40	19824.57	3459.80	0.23
Reach 1	208418.2	1%	164000.00	24.99	82.81	53.09	84.05	0.000379	9.00	21293.42	3949.19	0.24
Reach 1	208418.2	0.2%	206000.00	24.99	85.20	56.64	86.91	0.000494	10.61	23714.77	5296.73	0.28
Reach 1	205029.6	10%	103000.00	28.90	75.97	48.17	76.50	0.000206	5.88	18548.40	1088.18	0.18
Reach 1	205029.6	2%	147000.00	28.90	80.46	52.44	81.26	0.000269	7.29	24313.11	3396.79	0.21
Reach 1	205029.6	1%	164000.00	28.90	81.88	53.89	82.77	0.000290	7.74	26910.32	4372.97	0.21
Reach 1	205029.6	0.2%	206000.00	28.90	84.03	56.95	85.23	0.000372	9.07	31323.35	5568.58	0.24
Reach 1	200097.9	10%	103000.00	32.82	75.47	49.51	75.68	0.000125	4.37	42141.74	5445.35	0.13
Reach 1	200097.9	2%	147000.00	32.82	79.98	55.17	80.24	0.000140	5.05	53182.80	7675.45	0.15
Reach 1	200097.9	1%	164000.00	32.82	81.39	56.37	81.68	0.000149	5.33	56706.33	8932.87	0.15
Reach 1	200097.9	0.2%	206000.00	32.82	84.08	58.73	84.21	0.000090	4.34	132316.60	9728.24	0.12
Reach 1	192780.5	10%	103000.00	29.29	74.69	46.17	74.86	0.000102	3.86	47649.60	5026.71	0.12
Reach 1	192780.5	2%	147000.00	29.29	79.22	49.97	79.40	0.000100	4.19	76066.02	18124.43	0.12
Reach 1	192780.5	1%	164000.00	29.29	80.68	51.31	80.84	0.000093	4.14	87125.51	21724.46	0.12
Reach 1	192780.5	0.2%	206000.00	29.29	83.60	54.37	83.69	0.000062	3.56	187503.00	24301.65	0.10
Reach 1	186850.4	10%	103000.00	27.17	74.46	47.95	74.53	0.000045	2.57	79088.75	7007.53	0.08
Reach 1	186850.4	2%	147000.00	27.17	79.02	50.99	79.09	0.000045	2.82	124979.10	20422.52	0.08
Reach 1	186850.4	1%	164000.00	27.17	80.49	52.08	80.56	0.000042	2.81	143173.20	22896.48	0.08
Reach 1	186850.4	0.2%	206000.00	27.17	83.48	54.59	83.52	0.000031	2.52	243364.50	23664.90	0.07

HEC-RAS Plan: multi River: Brazos River Reach: Reach 1 (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach 1	184222.1	10 %	103000.00	25.05	73.99	43.34	74.32	0.000139	5.00	39966.65	4543.34	0.14
Reach 1	184222.1	2%	147000.00	25.05	78.61	47.25	78.89	0.000125	5.11	76832.59	12016.69	0.14
Reach 1	184222.1	1%	164000.00	25.05	80.09	48.63	80.37	0.000124	5.23	92864.34	12281.15	0.14
Reach 1	184222.1	0.2%	206000.00	25.05	83.19	51.81	83.38	0.000097	4.84	135084.70	12281.15	0.13
Reach 1	179826	10 %	103000.00	22.55	73.79	41.95	73.91	0.000060	3.35	62047.62	4867.47	0.10
Reach 1	179826	2%	147000.00	22.55	78.35	47.63	78.50	0.000069	3.89	88715.41	13139.53	0.10
Reach 1	179826	1%	164000.00	22.55	79.83	48.73	79.98	0.000069	3.98	99908.50	13242.63	0.11
Reach 1	179826	0.2%	206000.00	22.55	83.01	51.27	83.10	0.000049	3.49	168658.40	13242.63	0.09
Reach 1	177610.8	10 %	103000.00	21.30	73.32	40.50	73.69	0.000140	5.44	35497.32	1885.08	0.15
Reach 1	177610.8	2%	147000.00	21.30	77.63	45.01	78.21	0.000198	6.87	46389.01	3208.83	0.18
Reach 1	177610.8	1%	164000.00	21.30	79.07	46.61	79.69	0.000208	7.19	51022.23	3222.65	0.18
Reach 1	177610.8	0.2%	206000.00	21.30	82.15	50.28	82.85	0.000232	7.90	60967.84	3231.90	0.19
Reach 1	173078.3	10 %	103000.00	21.12	72.56	45.52	72.96	0.000191	5.17	23277.06	1476.44	0.17
Reach 1	173078.3	2%	147000.00	21.12	76.64	50.19	77.24	0.000242	6.35	29573.08	1612.40	0.19
Reach 1	173078.3	1%	164000.00	21.12	77.98	51.67	78.65	0.000261	6.76	31762.61	1661.23	0.20
Reach 1	173078.3	0.2%	206000.00	21.12	80.81	55.07	81.66	0.000305	7.70	36642.64	1735.14	0.22
Reach 1	170696.7	10 %	103000.00	21.06	72.07	48.46	72.46	0.000231	5.00	21672.09	971.63	0.18
Reach 1	170696.7	2%	147000.00	21.06	76.04	52.61	76.61	0.000285	6.13	25947.13	1120.92	0.20
Reach 1	170696.7	1%	164000.00	21.06	77.33	54.03	77.98	0.000305	6.53	27404.58	1136.06	0.21
Reach 1	170696.7	0.2%	206000.00	21.06	80.04	59.11	80.88	0.000357	7.48	31421.86	1707.16	0.23
Reach 1	170662		Bridge									
Reach 1	170554.2	10 %	103000.00	21.06	72.01	48.46	72.40	0.000233	5.02	21608.29	971.19	0.18
Reach 1	170554.2	2%	147000.00	21.06	75.95	52.61	76.53	0.000288	6.15	25847.95	1119.88	0.20
Reach 1	170554.2	1%	164000.00	21.06	77.23	54.03	77.89	0.000309	6.55	27294.32	1134.92	0.21
Reach 1	170554.2	0.2%	206000.00	21.06	79.91	59.11	80.76	0.000362	7.51	31292.35	1707.40	0.23
Reach 1	168383.8	10 %	103000.00	22.31	71.68	43.54	71.95	0.000139	4.94	45390.50	2627.82	0.14
Reach 1	168383.8	2%	147000.00	22.31	75.53	48.62	75.94	0.000191	6.19	56620.01	3306.28	0.17
Reach 1	168383.8	1%	164000.00	22.31	76.80	51.62	77.24	0.000204	6.54	60877.65	3414.11	0.18
Reach 1	168383.8	0.2%	206000.00	22.31	79.45	55.92	79.97	0.000232	7.25	69973.98	3429.79	0.19
Reach 1	164543.7	10 %	103000.00	15.47	71.26	38.55	71.54	0.000098	4.50	39653.64	2970.44	0.12
Reach 1	164543.7	2%	147000.00	15.47	74.98	42.45	75.39	0.000134	5.58	50990.29	3065.82	0.15
Reach 1	164543.7	1%	164000.00	15.47	76.19	43.90	76.64	0.000147	5.95	54702.98	3066.38	0.15
Reach 1	164543.7	0.2%	206000.00	15.47	78.69	47.11	79.27	0.000180	6.83	62365.63	3066.38	0.17
Reach 1	163504.4	10 %	103000.00	14.10	71.07	37.27	71.41	0.000149	4.77	24694.93	1002.10	0.13
Reach 1	163504.4	2%	147000.00	14.10	74.63	41.18	75.20	0.000224	6.18	28909.96	1756.77	0.16
Reach 1	163504.4	1%	164000.00	14.10	75.77	42.53	76.43	0.000254	6.68	30377.05	2294.42	0.17
Reach 1	163504.4	0.2%	206000.00	14.10	78.07	45.62	79.00	0.000332	7.90	33372.54	2703.50	0.20
Reach 1	163492		Bridge									
Reach 1	163253.2	10 %	103000.00	14.10	71.00	37.28	71.34	0.000150	4.78	24624.49	1001.14	0.13
Reach 1	163253.2	2%	147000.00	14.10	74.52	41.17	75.09	0.000226	6.19	28771.85	2026.13	0.16
Reach 1	163253.2	1%	164000.00	14.10	75.64	42.53	76.32	0.000256	6.70	30218.28	2580.15	0.18
Reach 1	163253.2	0.2%	206000.00	14.10	77.91	45.62	78.84	0.000336	7.93	33156.68	2916.76	0.20
Reach 1	161567.8	10 %	103000.00	20.93	70.75	42.77	71.05	0.000168	4.84	38880.08	2665.68	0.14
Reach 1	161567.8	2%	147000.00	20.93	74.20	46.67	74.63	0.000229	5.99	49162.64	3336.01	0.17
Reach 1	161567.8	1%	164000.00	20.93	75.31	48.02	75.79	0.000250	6.37	52977.45	3551.66	0.17
Reach 1	161567.8	0.2%	206000.00	20.93	77.52	51.29	78.13	0.000307	7.31	60944.28	3609.70	0.19
Reach 1	157172.4	10 %	103000.00	21.80	70.12	41.72	70.37	0.000140	4.34	41250.92	2601.56	0.13
Reach 1	157172.4	2%	147000.00	21.80	73.29	45.76	73.69	0.000204	5.54	52799.56	3895.03	0.16
Reach 1	157172.4	1%	164000.00	21.80	74.31	47.25	74.75	0.000224	5.91	56839.86	3983.16	0.16
Reach 1	157172.4	0.2%	206000.00	21.80	76.29	50.37	76.86	0.000276	6.77	64757.74	3983.16	0.18
Reach 1	152184.5	10 %	103000.00	22.66	69.50	39.44	69.72	0.000121	4.08	45112.70	3330.40	0.12
Reach 1	152184.5	2%	147000.00	22.66	72.36	43.19	72.73	0.000186	5.32	56061.98	6901.59	0.15
Reach 1	152184.5	1%	164000.00	22.66	73.26	44.48	73.69	0.000213	5.78	60347.25	7277.73	0.16
Reach 1	152184.5	0.2%	206000.00	22.66	74.97	46.99	75.53	0.000273	6.73	69804.83	8172.89	0.18
Reach 1	147311.3	10 %	103000.00	20.62	68.99	40.82	69.17	0.000110	3.74	58765.57	8620.03	0.11
Reach 1	147311.3	2%	147000.00	20.62	71.73	44.44	71.95	0.000136	4.37	88493.78	11634.57	0.13
Reach 1	147311.3	1%	164000.00	20.62	72.60	45.65	72.82	0.000143	4.55	98698.42	11835.92	0.13
Reach 1	147311.3	0.2%	206000.00	20.62	74.22	48.19	74.47	0.000164	5.01	118006.40	11928.24	0.14
Reach 1	143791.4	10 %	103000.00	18.58	68.29	41.70	68.62	0.000212	5.21	52764.67	16489.95	0.15
Reach 1	143791.4	2%	147000.00	18.58	70.96	46.08	71.29	0.000232	5.72	81282.05	17801.84	0.16
Reach 1	143791.4	1%	164000.00	18.58	71.80	47.62	72.13	0.000240	5.91	90695.19	18333.09	0.17
Reach 1	143791.4	0.2%	206000.00	18.58	73.33	51.02	73.69	0.000266	6.39	108129.90	20087.43	0.18

HEC-RAS Plan: multi River: Brazos River Reach: Reach 1 (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach 1	136966.1	10 %	103000.00	17.48	66.99	38.54	67.25	0.000186	4.77	56859.25	23859.06	0.14
Reach 1	136966.1	2%	147000.00	17.48	69.46	42.87	69.75	0.000217	5.39	81026.38	24635.31	0.16
Reach 1	136966.1	1%	164000.00	17.48	70.23	44.36	70.52	0.000227	5.59	88578.22	24862.15	0.16
Reach 1	136966.1	0.2%	206000.00	17.48	71.48	47.79	71.83	0.000275	6.29	100991.00	25217.84	0.18
Reach 1	131800	10 %	103000.00	17.32	66.14	38.01	66.41	0.000179	4.69	60333.59	14047.36	0.14
Reach 1	131800	2%	147000.00	17.32	68.55	42.16	68.83	0.000206	5.26	90790.50	16723.96	0.15
Reach 1	131800	1%	164000.00	17.32	69.30	43.59	69.58	0.000213	5.43	100986.60	16747.37	0.16
Reach 1	131800	0.2%	206000.00	17.32	70.38	46.88	70.71	0.000259	6.10	115724.60	16779.71	0.17
Reach 1	123453.2	10 %	103000.00	17.16	64.77	38.80	65.06	0.000201	4.81	55878.66	16150.90	0.15
Reach 1	123453.2	2%	147000.00	17.16	67.26	42.88	67.53	0.000208	5.14	92333.72	18534.84	0.15
Reach 1	123453.2	1%	164000.00	17.16	68.06	44.26	68.31	0.000206	5.18	104527.60	18538.26	0.15
Reach 1	123453.2	0.2%	206000.00	17.16	69.31	47.44	69.49	0.000179	4.94	152412.30	18543.64	0.14
Reach 1	110697.6	10 %	103000.00	6.78	62.40	35.90	62.73	0.000226	5.21	49362.39	21207.51	0.16
Reach 1	110697.6	2%	147000.00	6.78	65.36	40.52	65.61	0.000200	5.19	92424.51	32871.30	0.15
Reach 1	110697.6	1%	164000.00	6.78	66.32	42.10	66.54	0.000189	5.13	107054.10	32888.99	0.15
Reach 1	110697.6	0.2%	206000.00	6.78	67.74	45.57	67.97	0.000203	5.44	128763.30	32901.71	0.15
Reach 1	106462.7	10 %	103000.00	9.36	62.21	30.82	62.29	0.000064	2.93	93205.68	17871.42	0.09
Reach 1	106462.7	2%	147000.00	9.36	65.15	34.86	65.23	0.000069	3.20	130918.90	19480.47	0.09
Reach 1	106462.7	1%	164000.00	9.36	66.10	36.45	66.18	0.000071	3.29	143313.70	19538.66	0.09
Reach 1	106462.7	0.2%	206000.00	9.36	67.48	41.16	67.58	0.000085	3.68	161260.10	19608.34	0.10
Reach 1	97022.76	10 %	103000.00	5.82	61.43	28.83	61.66	0.000126	4.39	54196.57	12627.12	0.12
Reach 1	97022.76	2%	147000.00	5.82	64.23	33.54	64.53	0.000174	5.37	76622.36	13792.24	0.14
Reach 1	97022.76	1%	164000.00	5.82	65.18	35.38	65.50	0.000180	5.55	84383.77	13795.77	0.15
Reach 1	97022.76	0.2%	206000.00	5.82	66.82	39.87	67.00	0.000135	4.91	144674.20	13805.09	0.13
Reach 1	92834.65	10 %	103000.00	4.96	61.00	28.36	61.18	0.000117	4.04	62954.16	12504.76	0.11
Reach 1	92834.65	2%	147000.00	4.96	63.73	33.03	63.94	0.000144	4.69	84038.89	13622.70	0.13
Reach 1	92834.65	1%	164000.00	4.96	64.68	34.70	64.89	0.000150	4.86	91415.98	13645.13	0.13
Reach 1	92834.65	0.2%	206000.00	4.96	66.49	40.29	66.63	0.000118	4.42	151991.40	13695.43	0.12
Reach 1	89012.58	10 %	103000.00	4.10	60.20	27.51	60.59	0.000230	5.34	27452.46	12335.67	0.16
Reach 1	89012.58	2%	147000.00	4.10	62.51	32.18	63.17	0.000361	6.98	31550.15	13641.16	0.20
Reach 1	89012.58	1%	164000.00	4.10	63.30	33.77	64.07	0.000414	7.57	33001.15	13704.86	0.22
Reach 1	89012.58	0.2%	206000.00	4.10	66.08	37.47	66.29	0.000168	5.06	142542.10	13721.56	0.14
Reach 1	88962		Bridge									
Reach 1	88739.93	10 %	103000.00	4.10	60.07	27.51	60.47	0.000234	5.37	27231.71	12287.05	0.16
Reach 1	88739.93	2%	147000.00	4.10	62.18	32.18	62.86	0.000376	7.07	30943.46	13616.57	0.20
Reach 1	88739.93	1%	164000.00	4.10	62.88	33.77	63.68	0.000431	7.67	32231.38	13681.41	0.22
Reach 1	88739.93	0.2%	206000.00	4.10	64.17	37.47	65.30	0.000592	9.19	34639.13	13710.29	0.26
Reach 1	82824.19	10 %	103000.00	3.42	58.99	32.02	59.23	0.000186	4.43	56377.78	17976.07	0.14
Reach 1	82824.19	2%	147000.00	3.42	60.77	38.56	61.05	0.000239	5.20	74017.73	21615.96	0.16
Reach 1	82824.19	1%	164000.00	3.42	61.37	39.66	61.67	0.000256	5.45	79981.55	22077.49	0.17
Reach 1	82824.19	0.2%	206000.00	3.42	62.25	42.29	62.62	0.000325	6.26	88775.59	22454.20	0.19
Reach 1	78171.67	10 %	103000.00	4.78	58.22	30.51	58.44	0.000172	4.28	65196.34	20487.36	0.14
Reach 1	78171.67	2%	147000.00	4.78	59.81	34.78	60.08	0.000220	5.01	87928.13	21613.32	0.16
Reach 1	78171.67	1%	164000.00	4.78	60.36	36.24	60.63	0.000234	5.22	95830.57	21647.69	0.16
Reach 1	78171.67	0.2%	206000.00	4.78	61.25	39.24	61.48	0.000228	5.25	144517.00	21716.25	0.16
Reach 1	75000.35	10 %	103000.00	6.13	57.73	27.17	57.94	0.000143	4.51	82411.17	21384.60	0.13
Reach 1	75000.35	2%	147000.00	6.13	59.15	31.63	59.42	0.000195	5.40	107043.10	22754.57	0.15
Reach 1	75000.35	1%	164000.00	6.13	59.66	33.21	59.93	0.000209	5.63	115950.70	22891.52	0.16
Reach 1	75000.35	0.2%	206000.00	6.13	60.48	36.84	60.75	0.000228	5.96	154537.80	23060.88	0.16
Reach 1	70125.67	10 %	103000.00	6.41	57.24	28.26	57.37	0.000111	3.54	83304.67	20899.85	0.11
Reach 1	70125.67	2%	147000.00	6.41	58.47	32.34	58.64	0.000160	4.36	102191.10	22166.56	0.13
Reach 1	70125.67	1%	164000.00	6.41	58.91	33.73	59.10	0.000177	4.62	109201.90	22644.41	0.14
Reach 1	70125.67	0.2%	206000.00	6.41	59.54	36.83	59.79	0.000236	5.40	119312.50	23333.71	0.16
Reach 1	66083.94	10 %	103000.00	6.70	56.98	26.80	57.04	0.000062	3.00	146675.90	35611.65	0.08
Reach 1	66083.94	2%	147000.00	6.70	58.09	31.25	58.17	0.000089	3.66	174034.80	39219.02	0.10
Reach 1	66083.94	1%	164000.00	6.70	58.50	32.80	58.58	0.000096	3.84	184361.50	39931.18	0.11
Reach 1	66083.94	0.2%	206000.00	6.70	58.99	37.19	59.10	0.000129	4.48	196730.70	40575.11	0.12
Reach 1	62793.19	10 %	103000.00	5.75	56.86	27.69	56.89	0.000051	2.45	188163.20	44655.07	0.07
Reach 1	62793.19	2%	145000.00	5.75	57.93	32.08	57.97	0.000067	2.88	223856.10	45767.74	0.09
Reach 1	62793.19	1%	162000.00	5.75	58.33	33.68	58.37	0.000072	3.02	237333.90	46350.28	0.09
Reach 1	62793.19	0.2%	204000.00	5.75	58.76	37.42	58.82	0.000098	3.55	251893.00	46510.00	0.10
Reach 1	54416.15	10 %	103000.00	4.80	56.59	28.48	56.64	0.000058	2.70	185149.50	41864.55	0.08

HEC-RAS Plan: multi River: Brazos River Reach: Reach 1 (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach 1	54416.15	2%	143000.00	4.80	57.61	32.74	57.67	0.000074	3.11	219867.30	44581.66	0.09
Reach 1	54416.15	1%	160000.00	4.80	57.99	34.36	58.05	0.000080	3.26	232866.00	44811.27	0.09
Reach 1	54416.15	0.2%	202000.00	4.80	58.38	37.90	58.43	0.000091	3.50	300608.00	45684.96	0.10
Reach 1	48774.81	10%	103000.00	2.76	56.29	27.29	56.33	0.000064	2.54	166363.10	39876.12	0.08
Reach 1	48774.81	2%	140844.00	2.76	57.22	31.20	57.28	0.000083	2.96	192718.10	40001.58	0.09
Reach 1	48774.81	1%	155643.00	2.76	57.58	32.58	57.63	0.000089	3.09	202671.00	40051.66	0.10
Reach 1	48774.81	0.2%	192430.00	2.76	58.05	35.67	58.08	0.000055	2.46	320148.50	40148.21	0.08
Reach 1	41067.94	10%	103000.00	2.64	55.55	26.75	55.67	0.000134	3.16	60857.44	15107.32	0.12
Reach 1	41067.94	2%	133570.00	2.64	56.22	29.78	56.39	0.000194	3.88	66059.99	16075.82	0.14
Reach 1	41067.94	1%	145769.00	2.64	56.47	30.88	56.67	0.000218	4.14	68096.63	16703.45	0.15
Reach 1	41067.94	0.2%	176356.00	2.64	57.06	33.46	57.32	0.000281	4.78	72897.20	17568.74	0.17
Reach 1	36123.57	10%	103000.00	-1.52	54.87	26.95	55.06	0.000156	4.49	76657.30	31384.48	0.13
Reach 1	36123.57	2%	124521.00	-1.52	55.36	29.53	55.60	0.000191	5.01	84514.68	31553.70	0.15
Reach 1	36123.57	1%	133487.00	-1.52	55.55	30.53	55.80	0.000205	5.22	87478.94	31624.93	0.15
Reach 1	36123.57	0.2%	164898.00	-1.52	55.83	33.84	56.16	0.000285	6.17	91803.91	31728.89	0.18
Reach 1	29208.63	10%	103000.00	-0.72	54.32	25.31	54.41	0.000089	3.21	109283.60	26843.76	0.10
Reach 1	29208.63	2%	114541.00	-0.72	54.76	26.59	54.85	0.000096	3.37	116462.60	27023.50	0.10
Reach 1	29208.63	1%	119939.00	-0.72	54.91	27.16	55.01	0.000100	3.45	119047.50	27061.67	0.10
Reach 1	29208.63	0.2%	134357.00	-0.72	55.37	28.59	55.42	0.000067	2.85	195676.30	27132.98	0.09
Reach 1	25409.74	10%	103000.00	0.08	53.75	22.31	53.99	0.000144	4.58	67808.13	23581.56	0.13
Reach 1	25409.74	2%	108000.00	0.08	54.20	22.79	54.43	0.000141	4.56	73681.50	23742.17	0.13
Reach 1	25409.74	1%	112000.00	0.08	54.33	23.18	54.58	0.000146	4.66	75494.63	23789.59	0.13
Reach 1	25409.74	0.2%	124000.00	0.08	54.80	24.30	55.06	0.000159	4.89	81701.34	24064.68	0.13
Reach 1	21940.01	10%	103000.00	-6.01	53.03	19.28	53.40	0.000194	5.01	32879.61	14977.29	0.15
Reach 1	21940.01	2%	105100.00	-6.01	53.48	19.51	53.84	0.000191	5.01	35603.18	15619.67	0.15
Reach 1	21940.01	1%	108200.00	-6.01	53.59	19.85	53.96	0.000199	5.12	36271.05	15692.51	0.15
Reach 1	21940.01	0.2%	116000.00	-6.01	53.99	20.68	54.40	0.000215	5.36	38875.73	15970.81	0.16
Reach 1	17870.4	10%	103000.00	-12.10	52.05		52.54	0.000224	5.70	24804.11	3503.63	0.16
Reach 1	17870.4	2%	104524.00	-12.10	52.53		53.01	0.000217	5.66	26517.38	3620.19	0.16
Reach 1	17870.4	1%	107380.00	-12.10	52.59		53.09	0.000227	5.79	26739.45	3625.59	0.16
Reach 1	17870.4	0.2%	114464.00	-12.10	52.91		53.45	0.000248	6.08	27883.91	3656.84	0.17
Reach 1	13523.62	10%	103000.00	-10.52	51.55	19.98	51.74	0.000136	4.01	61200.37	11291.47	0.12
Reach 1	13523.62	2%	103328.00	-10.52	52.04	20.01	52.23	0.000131	3.98	65394.83	12199.46	0.12
Reach 1	13523.62	1%	105676.00	-10.52	52.08	20.30	52.28	0.000136	4.05	65765.42	12264.77	0.12
Reach 1	13523.62	0.2%	111275.00	-10.52	52.38	20.93	52.58	0.000142	4.17	68293.97	13038.25	0.13
Reach 1	10664.39	10%	96100.00	-8.93	51.03	20.32	51.30	0.000218	4.83	53494.60	10980.24	0.15
Reach 1	10664.39	2%	102545.00	-8.93	51.52	21.08	51.80	0.000222	4.92	59172.97	11939.22	0.15
Reach 1	10664.39	1%	104561.00	-8.93	51.55	21.32	51.84	0.000229	5.00	59500.54	11963.91	0.16
Reach 1	10664.39	0.2%	109187.00	-8.93	51.85	21.85	52.13	0.000230	5.04	63102.80	12232.11	0.16
Reach 1	10615.39		Bridge									
Reach 1	10583.06	10%	96100.00	-8.93	50.97		51.27	0.000191	4.97	52652.88	10846.72	0.14
Reach 1	10583.06	2%	102545.00	-8.93	51.46		51.76	0.000196	5.08	58166.92	11834.71	0.15
Reach 1	10583.06	1%	104561.00	-8.93	51.49		51.80	0.000203	5.16	58464.94	11857.38	0.15
Reach 1	10583.06	0.2%	109187.00	-8.93	51.78		52.09	0.000204	5.21	62020.21	12124.45	0.15
Reach 1	8169.057	10%	96100.00	-8.10	50.78		50.88	0.000084	3.17	86217.34	13754.76	0.10
Reach 1	8169.057	2%	102487.00	-8.10	51.27		51.37	0.000083	3.19	92997.90	13913.77	0.10
Reach 1	8169.057	1%	104475.00	-8.10	51.29		51.39	0.000086	3.24	93251.77	13919.69	0.10
Reach 1	8169.057	0.2%	109031.00	-8.10	51.58		51.68	0.000086	3.27	97355.80	14015.02	0.10
Reach 1	2630.089	10%	96100.00	-7.27	50.39		50.49	0.000071	2.98	86168.98	16832.82	0.09
Reach 1	2630.089	2%	101722.00	-7.27	50.89		50.98	0.000070	2.98	94775.42	17803.84	0.09
Reach 1	2630.089	1%	103500.00	-7.27	50.89		50.99	0.000072	3.03	94870.72	17808.62	0.09
Reach 1	2630.089	0.2%	107200.00	-7.27	51.19		51.29	0.000071	3.02	100241.90	18167.47	0.09
Reach 1	430.7054	10%	96100.00	-7.27	50.20	13.27	50.32	0.000068	3.34	96474.05	14959.13	0.09
Reach 1	430.7054	2%	101722.00	-7.27	50.70	13.86	50.82	0.000068	3.36	104059.90	15496.85	0.09
Reach 1	430.7054	1%	103189.00	-7.27	50.70	14.01	50.82	0.000070	3.41	104059.90	15496.85	0.09
Reach 1	430.7054	0.2%	106591.00	-7.27	51.00	14.36	51.12	0.000069	3.41	108765.90	15965.55	0.09