MARVIN GAYE
RECREATION CENTER & TRAIL

Conditional Letter of Map Revision (CLOMR)
Submittal for
Watts Branch
Washington, D.C. FIRM 1100010043C

Case#: 16-03-0096R

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APPENDICES

1. INTRODUCTION

1.1 Purpose of Study

Marvin Gaye Recreation Center and Trail at 6201 Banks Place NE is being expanded and some proposed improvement work is expected to occur adjacent to the exiting FEMA designated Floodway & Floodplain of Watts Branch Tributary in Washington, District of Columbia. The project includes the demolition of an existing one-story recreation center and the construction of a new LEED Gold recreation center (~15,000 sf), landscaping, construction of a community garden, site improvements for basketball courts, seating areas, stage and a boardwalk for site circulation. The existing playground, football and basketball fields will remain in place on the site. The estimated disturbed area (project limits) is approximately 1.5 acres. See Figure 2. Location Map. To assess impacts to the existing floodplain (FIRM 1100010043C) from proposed development, floodplain modeling is required and has involved obtaining, reviewing and revising existing effective models and then incorporating proposed improvements into a revised proposed model to determine impacts on the hydrology and hydraulics of Watts Branch Stream.

This Report is in support of a Conditional Letter or Map Revision (CLOMR) for the segment of Watts Branch that is effected due to the proposed development. This Report provides engineering calculations, which if accepted, will modify and supersede the existing FIS study of Watts Branch between Southern Avenue N.E. and 61st Street N.E.

1.2 Authority and Acknowledgments

The hydrologic and hydraulic analyses for this study were performed by A. Morton Thomas and Associates, Inc. (AMT). The Washington, D.C. Department of Energy & Environment (DOEE) is an active participant and providing guidance and review of the of the map update. The hydraulic analysis work was completed in August 2015. The most current effective HEC-RAS model (September 27, 2010) was obtained from FEMA Project Library was used in analyzing the proposed changes on the existing floodplain.

1.3 Coordination

The following meetings were held with DOEE. A representative from AMT is participating in the following meetings.

Date	Location	Meeting Topic
Spring 2015	DOEE Office Washington, D.C.	Review problems with the effective maps. Discuss preliminary study results and discuss the FEMA LOMR process.
TBD	DOEE Office Washington, D.C.	Review of the final study results.

Figure 1. Vicinity Map

Figure 2. Location Map

The government agencies and consulting firms contacted for information relevant to this study include:

Agency / Consulting Firm	Information Provided
District Department of Environment (DOEE)	Coordination, review and direction
AMT, LLC Survey	New channel surveys (bathymetry)
FEMA Library	Current Effective HEC-RAS floodplain model
A. Morton Thomas and Associates, INC	Revisions and development of Proposed HEC-RAS models

2. AREA STUDIED

2.1 Study Reach

This report describes an investigation of the potential impacts to the existing FEMA Floodplain on the Watts Branch within the Washington, D.C. The effective HEC-RAS model extends approximately 10 miles downstream from the Southern Avenue Bridge to the railroad crossing parallel to Kenilworth Avenue (see Figure 1). The proposed project lies within the upper 1/4 mile of the Watts Branch between Southern Avenue and 61st Street, NE. This section of Watts Branch was updated with new topography and bathymetry for the proposed analysis. Refer to the Figure 2 Location Map. The Effective FEMA HEC-RAS cross-section locations were used to match results to the effective FIS.

2.2 Stream / Floodplain

As a result of upstream regulation, there have been very few large flow events in the last 40+ years. The largest flows during that time period occurred in 1996, first in January-February, then in the November-December timeframe. These events caused no significant damage along the study reach. The reach was recently modified in a stream restoration project.

Almost the entire site of the proposed recreation center is within the 100-yr flood zone (Zone AE). Portions of the site are also within Zone X defined flood areas. As such, permitting coordinated with DOEE's floodplain manager is required and is being conducted. Based on meetings and discussions to date with DOEE, approval from FEMA will be needed since work is proposed within the floodplain.

2.3 Flood Protection Measures

The major design parameters for structures and construction within the floodplain are building the structure above the 100-year flood elevation, securing ("floodproofing") of buildings and mitigating flood impacts on adjacent properties. For new buildings, FEMA requires the finished floor elevation to be 1 foot above the 100-year flood elevation, however 18" above the 100-yr base flood elevation (BFE) is recommended. An ongoing CLOMR by FEMA will require careful coordination with respect to the BFE. The initial site grading and layout design intent was to keep all work (especially structures) out of floodway and maintain the BFE impacts to adjacent properties (requiring impacted property owner approval) to reduce permitting timelines and the concerns of the applicable federal and local agencies/authorities.

No structural berms, levees, or other flood protection structures were observed within the study reach. It is also noted that this reach of Watts Branch between Southern Avenue, NE and 61st Street, NE recently completed a stream restoration with bank grading and in-stream structures to stabilize the stream and improve conveyance. These improvements were not a part of the current effective model obtained from the FEMA Library.

3. ENGINEERING METHODS

3.1 Hydrologic Analysis

Flows used herein are the same as the most current effective HEC-RAS model provided by FEMA. Because this is a CLOMR, rather than a detailed restudy, it was unnecessary to undertake a present hydrologic analysis. With respect to the proposed Marvin Gaye Recreation center project, the contributing watershed and local drainage areas remain the same, so no hydrologic analysis for increase in peak discharges was needed or performed for the proposed conditions model. The discharges used in the effective model are summarized in Table 3.1. These discharges are maintained throughout the entire model. The effective flood insurance study (FIS# 110001V00A) is referenced in this report as Appendix H and is included in the electronic submittal of the report.

Table 3.1: Summary of Discharges

Storm Event	Annual Chance	Discharge, CFS
10-Year	10%	2545
50-Year	2%	3368
100-Year	1%	3872
500-Year	0.2%	4800

3.2 Hydraulic Analysis

The HEC-RAS model provided by FEMA Library was analyzed and run as the existing base model and is considered as the “Existing Effective” model. The “Existing Effective” model was then updated to incorporate the topographic survey that was performed between Southern Avenue and 61st Street to reflect any changes in topography that might have occurred since the “Existing Effective” model, including the recent stream restoration, and assess the hydraulic characteristics along that reach of Watts Branch. Additional cross sections were added to this model and it is termed as the “Corrected Effective” model. The “Corrected Effective” model also serves as the “Existing Conditions” model. The “Existing Conditions” model was updated for the proposed conditions analysis incorporating proposed development structures to assess floodplain impacts. This is termed as the “Proposed Condition” model. The updated models were used to compute water surface profiles for the 10-, 50-, 100-, and 500-year floods, floodplain inundation limits for the 100- and 500-year events, and floodway boundaries for the 100-year flood. Additionally, a fourth model termed “Proposed Conditions For Basketball Court Only” was developed to demonstrate that the court construction, although encroaching in the floodway does not affect flood heights and results in a No-Rise scenario. Development of these models is described in the following sections and hydraulic model output provided in appendices D, E, F, and G, respectively.

3.2.1 *Channel and Floodplain Topography*

Between cross-section 3.0765 just downstream of the Southern Avenue NE bridge and cross-section 2.9747 upstream of the 61st Street NE bridge, which essentially spans the reach where the proposed Marvin Gaye Recreation Center will be situated alongside the channel, four existing cross-section from the FEMA “Existing Effective” model were updated and eight new cross-sections were added in the “Corrected Effective” model. These additional cross-sections account for changes in topography and proposed structures along the floodplain, and help to better define the channel. The cross-section numbering is consistent with the cross-sectional numbering included with the FEMA Library obtained HEC-RAS model. There were no changes to the FEMA “Existing Effective” model downstream of cross-section 2.9747 which corresponds to cross section “W” in the FIS. Appendix D, E, F and G show cross-section geometry of the “Existing Effective”, “Corrected Effective”, “Proposed Condition” and “Corrected Effective For Basketball Court Only” models respectively. The new cross-sections follow the same numeric nomenclature in the model input. Cross section 3.0546 corresponds to cross-section “X” in the FIS. Reach lengths between the “Existing Effective and “Proposed” models do not change. Table 3.2 gives a summary of the updated, new, and unchanged cross section along with the channel reach length in the different models.

Floodplain topography for the updated cross-sections was provided by AMT Survey, LLC in the form of AutoCAD topographic data and 1-ft contours from the year 2014. These were merged together by AMT into a new topographic surface used to updated existing cross-section and cut new cross-sections that were imported into the HEC-RAS models.

The final HEC-RAS model created for the CLOMR begins at cross-section 3.1105 just upstream from the Southern Avenue Bridge and ends at cross-section 2.9747. The 100-year water surfaces converge at cross-section 2.9873 and no change in water surface for the 100-year is observed downstream of this cross-section.

3.2.2 *Hydraulic Structures*

There are two existing structures within the extents of the proposed study reach. The 61st Street, NE culvert crossing, which is the downstream boundary of the proposed study reach, and a footbridge crossing at River Station 3.03 upstream of 61st Street. There were no changes made to the existing structures from the FEMA “Existing Effective” model.

3.2.3 *Boundary Conditions & Starting water Surface Elevation*

Since the proposed study reach is on the upstream side of the model run the downstream boundary conditions were not updated for the proposed study from the FEMA “Existing Effective” model. The boundary conditions of the HEC-RAS model assumes normal depth for all profiles at a normal depth slope of 0.0023 ft/ft.

3.2.4 *Model Calibration*

No high water marks were available nor investigated to re-calibrate the model.

3.2.5 *Manning's Roughness Coefficients "n"*

The Manning's roughness coefficients for the channel and overbanks used in the hydraulic computations were taken directly from the FEMA "Existing Effective" model. Based upon experience and our engineering judgment, the roughness factors are reasonable. The channel "n" values range from 0.10 to 0.06 in the overbanks and 0.045 to 0.030 in the main channel. Ineffective flow areas in the "Corrected Effective" and "Proposed Conditions" models are slightly adjusted to incorporate the changes in the topography.

3.2.6 *Flood Profiles*

Proposed conditions flood profiles for the 10-, 50-, 100-, and 500-year events for the study reach generated using the HEC-RAS model are provided in Appendix F.

3.2.7 *Floodway*

A floodway analysis was performed on the proposed model in HEC-RAS. The encroachment stations did not change from the existing effective model due to the proposed development. The rises in the floodway water surface elevations did not exceed the maximum allowable one (1) foot limit. Table 3.3 shows the rises in floodway water surface elevations compared to the 100-year floodplain water surface elevations due to encroached conditions.

Table 3.2: Summary of Channel Reach Length for Unchanged, Updated and New Cross Sections

		Models		
River Station	**FIS Cross Section No.**	**FEMA Existing Effective**	**Corrected Effective**	**Proposed**
3.1105		103.02	103.02	103.02
3.091		76.68	76.68	76.68
3.083		**SOUTHERN AVE., NE**		
3.0765		115.25	87.29	87.29
3.0612			35.06	35.06
3.0546 X	X	114.85	52.68	52.68
3.0446		22.05	35.97	35.97
3.0378			26.20	26.20
3.0329			22.05	22.05
3.03		**FOOTBRIDGE**		
3.0287		285.09	33.45	33.45
3.022			36.07	36.07
3.016			56.12	56.12
3.005			50.5	50.5
2.995			42.96	42.96
2.9873			66.43	66.43
2.9747 W	W	29.66	29.66	29.66
2.9691		65	65	65
2.9628		**61ST STREET, NE**		
2.9565		83.31	83.31	83.31
2.9411 V	V	123.45	123.45	123.45
2.9178		16.64	16.64	16.64
TO				
0.0480 A	A	253.59	253.59	253.59

(green)	Unchanged
(blue)	Updated
(pink)	New

Table3.3: Summary of Floodway Water Surface Elevation Impact From Floodway Encroachment Analysis.

		100-Year	Floodway	Difference
River Sta	Q Total	W.S. Elev	W.S. Elev	W.S. Elev
	(cfs)	(ft)	(ft)	
3.1105	3872	92.79	93.36	0.57
3.091	3872	92.21	93.01	0.80
3.083	SOUTHERN AVE. CULVERT			
3.0765	3872	88.51	88.83	0.32
3.0612	3872	88.96	89.19	0.23
3.0546 X	3872	88.68	88.90	0.22
3.0446	3872	88.43	88.52	0.09
3.0378	3872	88.37	88.51	0.14
3.0329	3872	87.89	88.32	0.43
3.03	FOOTBRIDGE			
3.0287	3872	87.42	88.11	0.69
3.022	3872	87.72	88.33	0.61
3.016	3872	87.61	88.24	0.63
3.005	3872	87.52	88.15	0.63
2.995	3872	87.14	87.80	0.66
2.9873	3872	87.00	87.65	0.65
2.9747 W	3872	87.27	87.68	0.41
2.9691	3872	86.40	87.40	1.00
2.9628	61st ST. CULVERT			

3.3 Vertical Datum

The effective maps and profiles are in Maryland State Plane Coordinate system horizontally reference to North American Datum 1983 (NAD83) and vertically referenced to North American Vertical Datum of 1988 (NAVD88). All the results presented herein are also with reference to the same horizontal and vertical datum.

3.4 No-Rise Effect From Construction in Floodway

The proposed site development generates the least impact on the floodplain and floodway that is possible to meet the goals of the program. Every effort was taken to fill on ineffective areas of the floodplain and developing structures or grading in the floodway was avoided wherever possible. The only exception is the proposed NBA standard basketball court, at elevations very close to existing elevations, and the removal an existing building considered a safety hazard. The building is not in the “effective model” so has no impact on the BFE. The basketball court is the local resident’s most desired component of the project and there is no other location to place a basketball court to these dimensions and still meet the requirements of the program. In order to evaluate flood hazard impacts from construction of the basketball court, a hydraulic model termed

"Proposed Conditions For Basketball Court Only" was developed. Modeling results shown in Appendix G and summarized in Table 3.4, show a No-Rise effect on flood heights. Therefore, the work in the floodway should not be considered as an encroachment. It is the intent of this section and the additional hydraulic modeling performed to support a No-Rise Certification and therefore be exempt from the requirements of Section 65.12 of the NFIP regulations.

Table 3.4: Floodway Encroachment No-Rise effect on 100-Year Water Surface Elevations

		Corrected Effective	Corrected Eff. w/ Basketball Court	Difference
River Sta	Q Total	W.S. Elev	W.S. Elev	W.S. Elev
	(cfs)	(ft)	(ft)	
3.1105	3872	92.79	92.77	-0.02
3.091	3872	92.22	92.19	-0.03
3.083	SOUTHERN AVE. CULVERT			
3.0765	3872	88.53	88.52	-0.01
3.0612	3872	88.95	88.95	0
3.0546 X	3872	88.44	88.44	0
3.0446	3872	88.34	88.34	0
3.0378	3872	88.30	88.30	0
3.0329	3872	88.36	88.36	0
3.03	FOOTBRIDGE			
3.0287	3872	87.54	87.54	0
3.022	3872	87.75	87.75	0
3.016	3872	87.63	87.63	0
3.005	3872	87.57	87.57	0
2.995	3872	87.19	87.19	0
2.9873	3872	87.04	87.04	0
2.9747 W	3872	87.31	87.31	0
2.9691	3872	86.45	86.45	0
2.9628	61st ST. CULVERT			
2.9565	3872	81.05	81.05	0
2.9411 V	3872	81.15	81.15	0
2.9178	3872	80.78	80.78	0
2.9162	FOOTBRIDGE			
2.9146	3872	78.78	78.78	0
2.8312 U	3872	77.80	77.80	0
2.7217 T	3872	75.43	75.43	0
2.7094	3872	75.36	75.36	0
2.7023	58TH ST., NE			

4. RESULTS AND DISCUSSION

The proposed development affects the study reach between Southern Avenue NE and 61st Street NE modeled between cross-sections 3.0765 and 2.9747. Cross-sections downstream of cross-section 2.9747 are not affected by the proposed development. The 100-year water surfaces in all models converge at cross-section 2.9873 and do not result in any changes in water surface elevations downstream. The FEMA "Existing Effective" model was updated with recent survey topography and additional cross-sections as the "Corrected Effective" model to reflect any change in the topography since the "Existing Effective" model was developed and for comparison with the Proposed Condition model. A comparison of the 100-year water surface elevations between the "Existing Effective" and "Corrected Effective" models is summarized in Table 4.1.

Corresponding cross-sections in the "Existing Effective" and "Corrected Effective" models were compared to check for any raises in the 100-year water surface elevations. As can be seen in Table 4.1 there are raises in the 100-year water surface elevations between the two models, this is mainly a result of the change in topography since the "Existing Effective" model was developed and the detailed survey obtained for the study reach. However, the raises in the water surface elevations are not greater than one (1) foot. A maximum raise of 0.73 feet is observed at cross-section 3.0765 followed by 0.54 feet at cross-section 3.0329, cross-section "X" in the FIS.

The Proposed Conditions model was developed to reflect the changes in the topography due to proposed development and was compared with the "Corrected Effective" model. Table 4.2 gives a comparison of the changes in the 100-year water surface elevations between the proposed conditions and the "Corrected Effective" models.

A comparison of the "Proposed Condition" and "Corrected Effective" models show that there are some raises in the 100-year water surface elevations due the proposed development. The raises are less than one (1) foot. The 0.24 foot maximum raise in the 100-year water surface elevation of is seen at cross-section 3.0546, cross-section "X" in the FIS. The second greatest rise of 0.09 feet is seen at cross-section 3.0446. All the other raises are less than 0.1 feet. The raises in the water surface elevations in the proposed conditions are not expected to adversely affect any private property. As a result of this analysis, it is clear that the recent stream restoration project and other improvements along this reach of Watts Branch have created a greater change in the 100-year water surface elevations shown in the "Existing Effective" model. The effective FEMA model should be upgraded to the "Corrected Effective" model included in this report. The proposed improvements along this reach, as a result of the Marvin Gaye Recreation Center project are minor when compared to the "Corrected Effective" model and are well within the acceptable limits of a CLOMR application that has being submitted during this reporting process.

Minor construction to remove a safety hazard building and to reuse a flat portion of land as a basketball court are proposed to occur in the floodway. Modeling of these project components show a No-Rise effect on flood heights and support a No-Rise Certification showing the project exempt from the requirements of Section 65.12 of the NFIP regulations.

Since there is no work proposed at the downstream end of Watts Branch at its confluence with Anacostia River, the downstream boundary conditions have remained the same as in the "Existing Effective" model.

Table 4.1: 100-Year Water Surface Elevation Comparison Between "Existing Effective" And "Corrected Effective" Models.

		Existing Effective	Corrected Effective	Difference	
River Sta	Q Total	W.S. Elev	W.S. Elev	W.S. Elev	
	(cfs)	(ft)	(ft)		
3.1105	3872	92.67	92.79	0.12	
3.091	3872	92.06	92.22	0.16	
3.083	SOUTHERN AVE. CULVERT				
3.0765	3872	87.80	88.53	0.73	
3.0612	3872		88.95		
3.0546 X	3872	87.92	88.44	0.52	
3.0446	3872		88.34		
3.0378	3872		88.30		
3.0329	3872	87.82	88.36	0.54	
3.03	FOOTBRIDGE				
3.0287	3872	87.61	87.54	-0.07	
3.022	3872		87.75		
3.016	3872		87.63		
3.005	3872		87.57		
2.995	3872		87.19		
2.9873	3872		87.04		
2.9747 W	3872	87.31	87.31	0	
2.9691	3872	86.44	86.45	0.01	
2.9628	61st STREET N.E. CULVERT				
2.9565	3872	81.05	81.05	0	NO CHANGE
2.9411 V	3872	81.15	81.15	0	
2.9178	3872	80.78	80.78	0	
2.9162	FOOTBRIDGE				
2.9146	3872	78.78	78.78	0	
2.8312 U	3872	77.80	77.80	0	
2.7217 T	3872	75.43	75.43	0	
2.7094	3872	75.36	75.36	0	
2.7023	58TH STREET NE				

Table 4.2: 100-Year Water Surface Elevation Comparison Between "Corrected Effective" And "Proposed Conditions" Models.

		Corrected Effective	Proposed	Difference	
River Sta	Q Total	W.S. Elev	W.S. Elev	W.S. Elev	
	(cfs)	(ft)	(ft)		
3.1105	3872	92.79	92.79	0	
3.091	3872	92.22	92.21	-0.01	
3.083	SOUTHERN AVE. CULVERT				
3.0765	3872	88.53	88.5	-0.03	
3.0612	3872	88.95	88.94	-0.01	
3.0546 X	3872	88.44	88.68	0.24	
3.0446	3872	88.34	88.43	0.09	
3.0378	3872	88.30	88.37	0.07	
3.0329	3872	88.36	87.89	-0.47	
3.03	FOOTBRIDGE				
3.0287	3872	87.54	87.42	-0.12	
3.022	3872	87.75	87.72	-0.03	
3.016	3872	87.63	87.61	-0.02	
3.005	3872	87.57	87.52	-0.05	
2.995	3872	87.19	87.14	-0.05	
2.9873	3872	87.04	87.00	-0.04	
2.9747 W	3872	87.31	87.27	-0.04	
2.9691	3872	86.45	86.40	-0.05	
2.9628	61st STREET NE CULVERT				
2.9565	3872	81.05	81.05	0	NO CHANGE
2.9411 V	3872	81.15	81.15	0	
2.9178	3872	80.78	80.78	0	
2.9162	FOOTBRIDGE				
2.9146	3872	78.78	78.78	0	
2.8312 U	3872	77.80	77.80	0	
2.7217 T	3872	75.43	75.43	0	
2.7094	3872	75.36	75.36	0	
2.7023	58TH STREET NE				

CLOMR MT-2 Forms are Included in Appendix A. Appendix B provides a written response from the DOEE confirming non-existence of rare, threatened, and endangered species in the project area. Proposed conditions floodplain map and profiles are included in Appendix C. HEC-RAS outputs for the "Existing Effective", "Corrected Effective", "Proposed Conditions", and "Corrected Effective, Basketball Court Only" models are provided in Appendices D, E, F and G respectively. Since the original model did not change downstream of cross-section 2.9747, HEC-RAS output results for cross-sections downstream of cross-section 2.9747 are not provided in the appendices. FEMA Flood Insurance Study (FIS) #110001V000A is provided in electronic format as Appendix H.

5.0 BIBLIOGRAPHY AND REFERENCES

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APPENDIX A

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

MT-2 Forms

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

MT-2 Forms 1

Overview & Concurrence

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

MT-2 Forms 2

Riverine Hydrology & Hydraulics

U.S. DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

OVERVIEW & CONCURRENCE FORM

O.M.B No. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 1 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless it displays a valid OMB control number. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington, VA 20958-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

PRINCIPAL PURPOSE(S): This information is being collected for the purpose of determining an applicant's eligibility to request changes to National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRM).

ROUTINE USE(S): The information on this form may be disclosed as generally permitted under 5 U.S.C § 552a(b) of the Privacy Act of 1974, as amended. This includes using this information as necessary and authorized by the routine uses published in DHS/FEMA/NFIP/LOMA-1 National Flood Insurance Program (NFIP); Letter of Map Amendment (LOMA) February 15, 2006, 71 FR 7990.

DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a (NFIP) Flood Insurance Rate Maps (FIRM).

A. REQUESTED RESPONSE FROM DHS-FEMA

This request is for a (check one):

☒ CLOMR: A letter from DHS-FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision, or proposed hydrology changes (See 44 CFR Ch. 1, Parts 60, 65 & 72).

☐ LOMR: A letter from DHS-FEMA officially revising the current NFIP map to show the changes to floodplains, regulatory floodway or flood elevations. (See 44 CFR Ch. 1, Parts 60, 65 & 72)

B. OVERVIEW

1. The NFIP map panel(s) affected for all impacted communities is (are):

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Example: 480301 480287	City of Katy Harris County	TX TX	48473C 48201C	0005D 0220G	02/08/83 09/28/90
110001	District of Columbia	DC	110001	0043C	09/27/10

2. a. Flooding Source: Watts Branch

   b. Types of Flooding: ☒ Riverine ☐ Coastal ☐ Shallow Flooding (e.g., Zones AO and AH)

   ☐ Alluvial fan ☐ Lakes ☐ Other (Attach Description)

3. Project Name/Identifier: Marvin Gaye Recreation Center

4. FEMA zone designations affected: AE, X (choices: A, AH, AO, A1-A30, A99, AE, AR, V, V1-V30, VE, B, C, D, X)

5. Basis for Request and Type of Revision:

   a. The basis for this revision request is (check all that apply)

   ☐ Physical Change ☐ Improved Methodology/Data ☐ Regulatory Floodway Revision ☐ Base Map Changes

   ☐ Coastal Analysis ☒ Hydraulic Analysis ☐ Hydrologic Analysis ☐ Corrections

   ☐ Weir-Dam Changes ☐ Levee Certification ☐ Alluvial Fan Analysis ☐ Natural Changes

   ☒ New Topographic Data ☐ Other (Attach Description)

   Note: A photograph and narrative description of the area of concern is not required, but is very helpful during review.

b. The area of revision encompasses the following structures (check all that apply)

Structures: ☐ Channelization ☐ Levee/Floodwall ☐ Bridge/Culvert

☐ Dam ☐ Fill ☐ Other (Attach Description)

6. ☒ Documentation of ESA compliance is submitted (required to initiate CLOMR review). Please refer to the instructions for more information.

C. REVIEW FEE

Has the review fee for the appropriate request category been included? ☒ Yes Fee amount: $6,750.00

☐ No, Attach Explanation

Please see the DHS-FEMA Web site at http://www.fema.gov/plan/prevent/fhm/frm_fees.shtm **for Fee Amounts and Exemptions.**

D. SIGNATURE

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name: Gregory Fox	Company: A. Morton Thomas and Assoc.	
Mailing Address: 800 King Farm Blvd., 4th Floor Rockville, MD 20850	Daytime Telephone No.: 301-881-2545	Fax No.: 301-881-0814
	E-Mail Address: gfox@amtengineering.com	
Signature of Requester (required):	Date: 04/06/2016	

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirements for when fill is placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. For Conditional LOMR requests, the applicant has documented Endangered Species Act (ESA) compliance to FEMA prior to FEMA's review of the Conditional LOMR application. For LOMR requests, I acknowledge that compliance with Sections 9 and 10 of the ESA has been achieved independently of FEMA's process. For actions authorized, funded, or being carried out by Federal or State agencies, documentation from the agency showing its compliance with Section 7(a)(2) of the ESA will be submitted. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title: Phetmano Phannavong, Environmental Engineer	Community Name: District of Columbia	
Mailing Address: 1200 First Street NE, 5th Floor Washington, DC 20002	Daytime Telephone No.: 202-535-2977	Fax No.: 202-535-1364
	E-Mail Address: phetmano.phannavong@dc.gov	
Community Official's Signature (required): P. Phannavong	Date: 6/13/2016	

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.2(b) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: Gregory Fox	License No.: DC PE906004	Expiration Date: 08/31/2018
Company Name: A. Morton Thomas and Assoc.	Telephone No.: 301-881-2545	Fax No.: 301-881-0814
Signature:	Date: 04/06/16	E-Mail Address: gfox@amtengineering.com

Ensure the forms that are appropriate to your revision request are included in your submittal.

Form Name and (Number)	Required if ...
☒ Riverine Hydrology and Hydraulics Form (Form 2)	New or revised discharges or water-surface elevations
☐ Riverine Structures Form (Form 3)	Channel is modified, addition/revision of bridge/culverts, addition/revision of levee/floodwall, addition/revision of dam
☐ Coastal Analysis Form (Form 4)	New or revised coastal elevations
☐ Coastal Structures Form (Form 5)	Addition/revision of coastal structure
☐ Alluvial Fan Flooding Form (Form 6)	Flood control measures on alluvial fans

Seal (Optional)

U.S. DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY & HYDRAULICS FORM

O.M.B No. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 3.5 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington VA 20958-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

PRINCIPAL PURPOSE(S): This information is being collected for the purpose of determining an applicant's eligibility to request changes to National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRM).

ROUTINE USE(S): The information on this form may be disclosed as generally permitted under 5 U.S.C § 552a(b) of the Privacy Act of 1974, as amended. This includes using this information as necessary and authorized by the routine uses published in DHS/FEMA/NFIP/LOMA-1 National Flood Insurance Program (NFIP); Letter of Map Amendment (LOMA) February 15, 2006, 71 FR 7990.

DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a NFIP Flood Insurance Rate Maps (FIRM).

Flooding Source: Watts Branch

Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

☒ Not revised (skip to section B) ☐ No existing analysis ☐ Improved data
☐ Alternative methodology ☐ Proposed Conditions (CLOMR) ☐ Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	Effective/FIS (cfs)	Revised (cfs)

3. Methodology for New Hydrologic Analysis (check all that apply)

☐ Statistical Analysis of Gage Records ☐ Precipitation/Runoff Model → Specify Model: ______
☐ Regional Regression Equations ☐ Other (please attach description)

Please enclose all relevant models in digital format, maps, computations (including computation of parameters), and documentation to support the new analysis.

4. Review/Approval of Analysis

If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

Is the hydrology for the revised flooding source(s) affected by sediment transport? ☐ Yes ☐ No

If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation..

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.) Effective	Proposed/Revised
Downstream Limit*	Culvert at 61st St, NE.	2.9876	87.04	87.04
Upstream Limit*	Culvert at Southern Ave, NE	3.1105	92.78	92.78

*Proposed/Revised elevations must tie-into the Effective elevations within 0.5 foot at the downstream and upstream limits of revision.

2. Hydraulic Method/Model Used: HEC-RAS

3. Pre-Submittal Review of Hydraulic Models*

DHS-FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS.

4.

Models Submitted	**Natural Run** File Name:	Plan Name:	**Floodway Run** File Name:	Plan Name:	**Datum**
Duplicate Effective Model*	File Name:	Plan Name:	File Name:	Plan Name:	
Corrected Effective Model*	File Name: Watts Branch	Plan Name: Corrected Effective	File Name:	Plan Name:	NAD83
Existing or Pre-Project Conditions Model	File Name: Watts Branch	Plan Name: FEMA Effective	File Name:	Plan Name:	
Revised or Post-Project Conditions Model	File Name: Watts Branch	Plan Name: Proposed	File Name:	Plan Name:	NAD83
Other - (attach description)	File Name:	Plan Name:	File Name:	Plan Name:	

* For details, refer to the corresponding section of the instructions.

☒ Digital Models Submitted? (Required)

C. MAPPING REQUIREMENTS

A **certified topographic work map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

☒ Digital Mapping (GIS/CADD) Data Submitted (preferred)

Topographic Information: ______

Source: ______ Date: ______

Accuracy: ______

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM**, at the same scale as the original, annotated to show the boundaries of the revised 1%-and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%-and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area on revision.

☒ Annotated FIRM and/or FBFM (Required)

D. COMMON REGULATORY REQUIREMENTS*

1. For LOMR/CLOMR requests, do Base Flood Elevations (BFEs) increase? ☒ Yes ☐ No

   a. For CLOMR requests, if either of the following is true, please submit **evidence of compliance with Section 65.12 of the NFIP regulations**:

      - The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot compared to pre-project conditions.
      - The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot compared to pre-project conditions.

   b. Does this LOMR request cause increase in the BFE and/or SFHA compared with the effective BFEs and/or SFHA? ☐ Yes ☒ No

      If Yes, please attach **proof of property owner notification and acceptance (if available)**. Elements of and examples of property owner notifications can be found in the MT-2 Form 2 Instructions.

2. Does the request involve the placement or proposed placement of fill? ☒ Yes ☐ No

   If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(A)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR requests, is the regulatory floodway being revised? ☐ Yes ☒ No

   If Yes, attach **evidence of regulatory floodway revision notification**. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being established. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For CLOMR requests, please submit documentation to FEMA and the community to show that you have complied with Sections 9 and 10 of the Endangered Species Act (ESA).

For actions authorized, funded, or being carried out by Federal or State agencies, please submit documentation from the agency showing its compliance with Section 7(a)(2) of the ESA. Please see the MT-2 instructions for more detail.

* Not inclusive of all applicable regulatory requirements. For details, see 44 CFR parts 60 and 65.

March 11, 2016

Mr. Kenneth Brown
800 King Farm Blvd, 4th Floor
Rockville, MD 20850

Re: **Section 7 Consultation, Marvin Gaye Recreation Center**

Dear Mr. Brown:

The Department of Energy and Environment (the Department) has reviewed A. Morton Thomas & Associates, Inc.'s request for information regarding the presence of rare, threatened, and endangered species that may be located in the area of its proposed Marvin Gaye Recreation Center project. The response to this request is written below. Please be advised that this response is not an assessment of potential impacts.

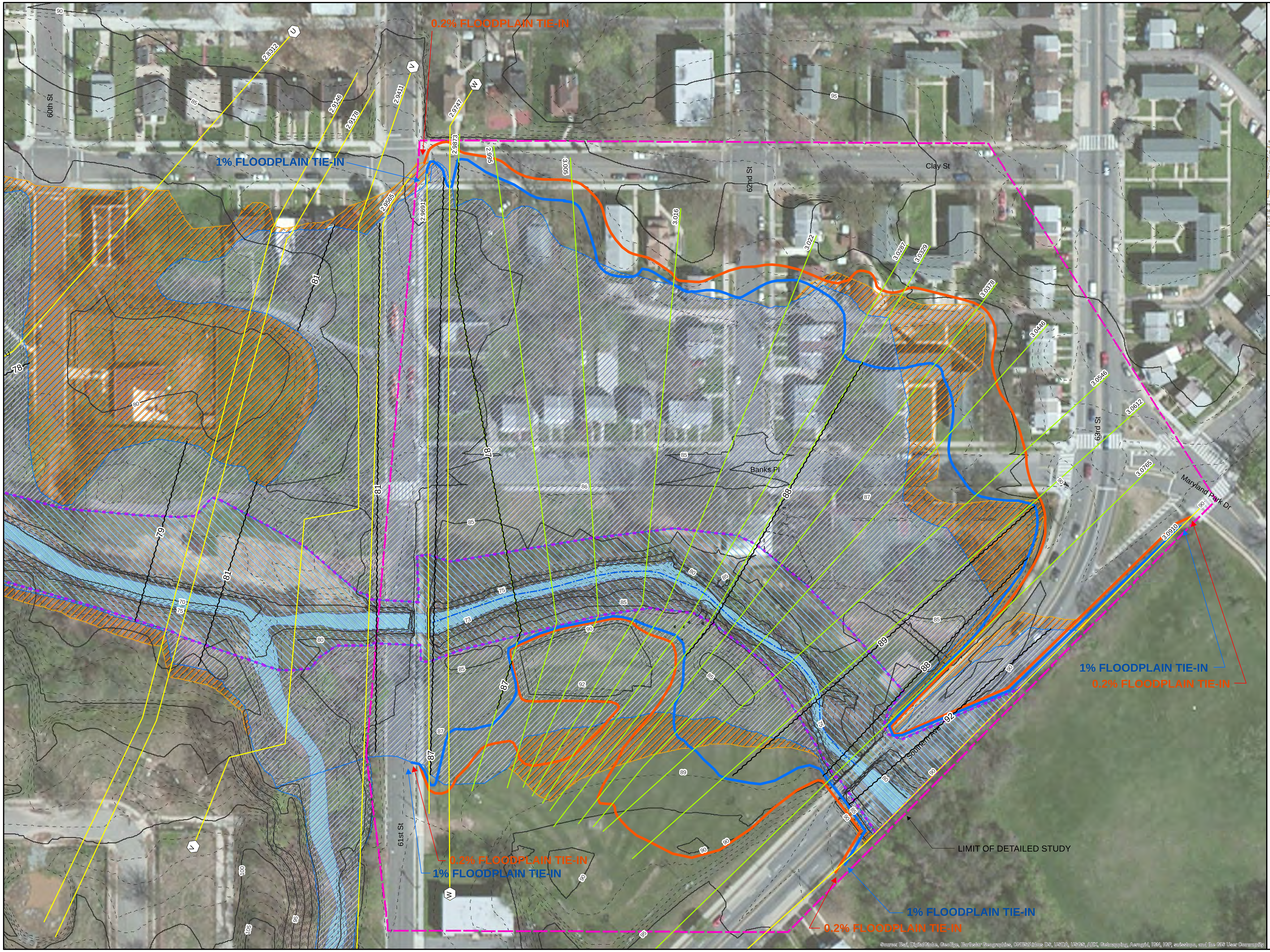
In response to this request the Department finds that according to current observations, surveys, and data derived from the District's *Wildlife Action Plan*, the proposed project area does not harbor any species listed by the federal Endangered Species Act (ESA) that may require protection in the District of Columbia. Please monitor the proposed and surrounding project areas regularly. Should any of these parameters change, please notify the Department immediately. Additionally, this response does not characterize nor quantify the presence of more common species that may be federally protected, nor species and habitats that may be considered important or valuable. Moreover, unless otherwise permitted by law, all District of Columbia and federal laws pertaining to fish and wildlife shall remain in effect for the duration of the project.

Finally, this correspondence in no way circumvents or nullifies any other permits or processes that may be required in connection with this project. For more information please contact me by phone at (202) 997-9607 or via email at bryan.king@dc.gov.

Sincerely,

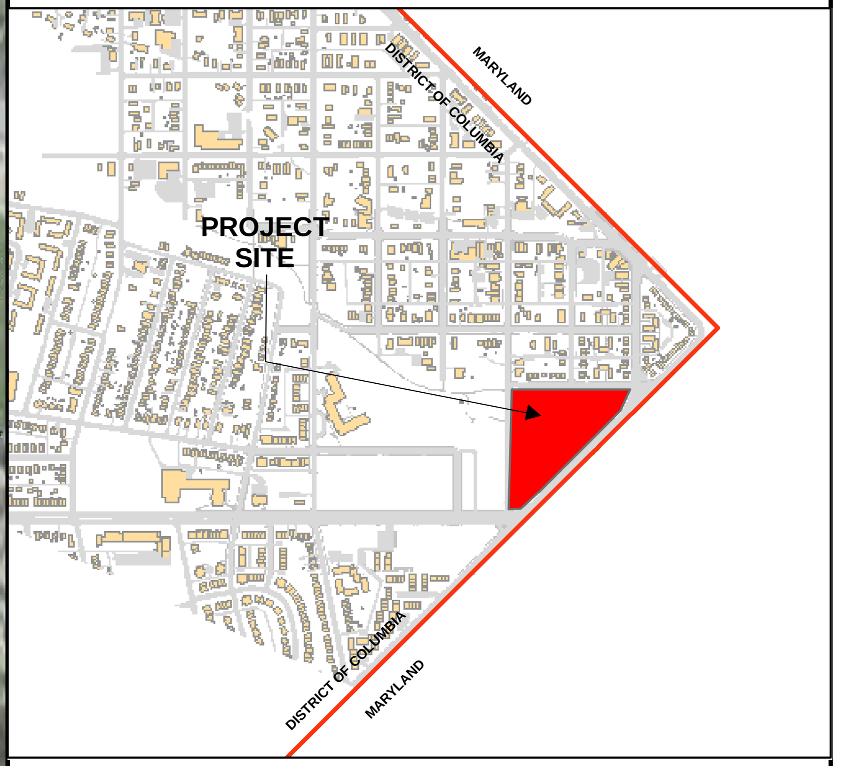
Bryan D. King

Bryan D. King
Associate Director



WASHINGTON, DISTRICT OF COLUMBIA

APPLICATION FOR CLOMR



Legend

- Proposed Base Flood Elevation (BFE)
- Proposed Cross Section
- Existing Cross Section
- Proposed 0.2% Annual Chance Flood Hazard
- Proposed 1% Annual Chance Flood Hazard
- Proposed Floodway*
- Proposed Area of Revision
- Major Contour
- Minor Contour
- Effective 0.2% Annual Chance Flood Hazard
- Effective 1% Annual Chance Flood Hazard
- Effective Floodway
- Watts Branch
- Flow Line

N

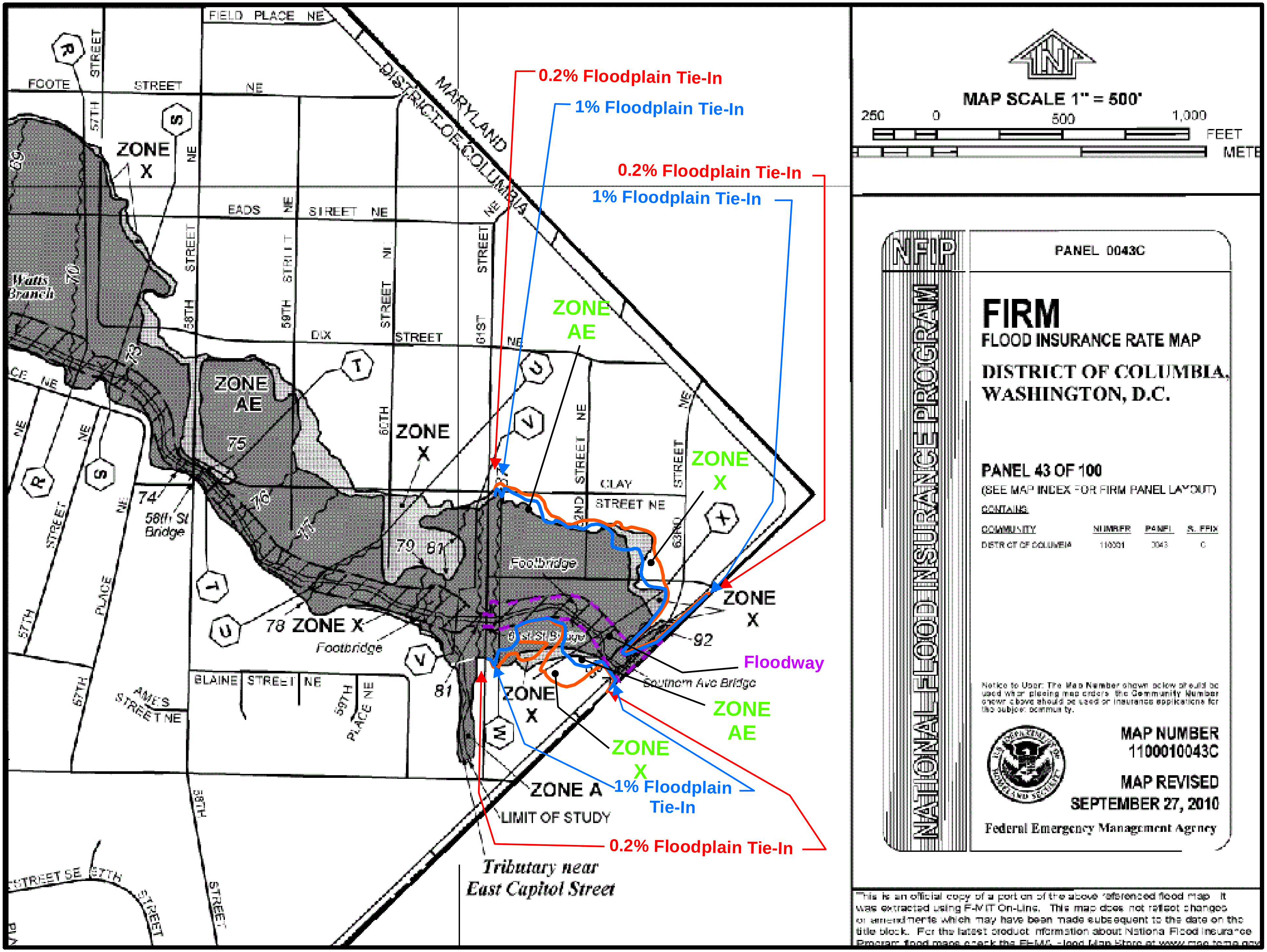
*** Floodway Not Revised**

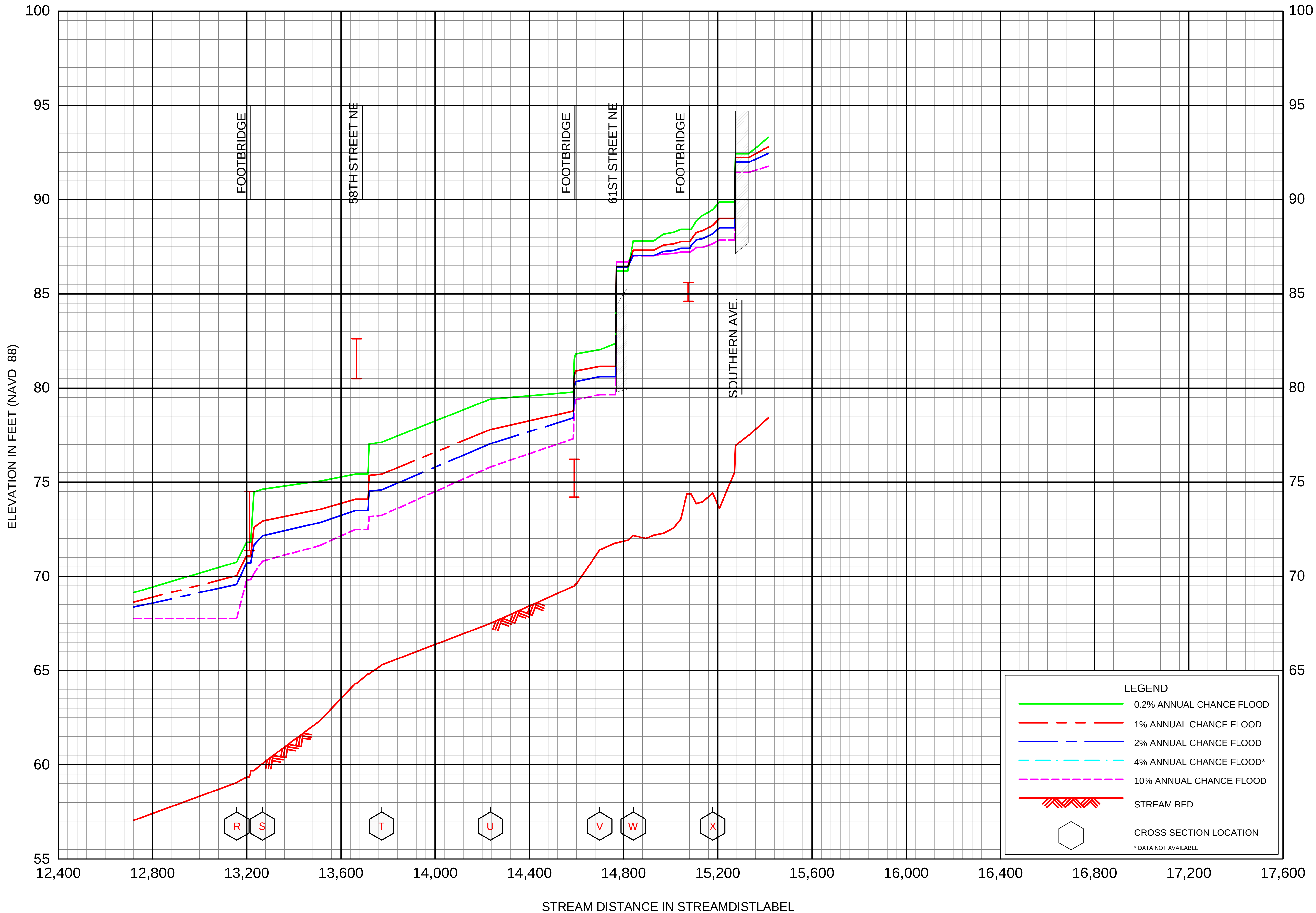
1 in = 50 ft

Vertical Datum: NAVD88

DISTRICT OF COLUMBIA
GREGORY W. FOX
PE906004
CIVIL
PROFESSIONAL ENGINEER
5-2-16

AMT
CONSULTING ENGINEERS


0.2% Floodplain Tie-In
1% Floodplain Tie-In
0.2% Floodplain Tie-In
1% Floodplain Tie-In
ZONE AE
ZONE X
ZONE AE
ZONE X
ZONE X
ZONE X
ZONE X
ZONE AE
ZONE X
ZONE A
Floodway
Footbridge
Footbridge
56th St Bridge
61st St Bridge
Southern Ave Bridge
LIMIT OF STUDY
1% Floodplain Tie-In
0.2% Floodplain Tie-In
Tributary near East Capitol Street
Watts Branch
FOOTE STREET NE
EADS STREET NE
DIX STREET NE
CLAY STREET NE
BLAINE STREET NE
AMES STREET NE
FIELD PLACE NE
DISTRICT OF COLUMBIA
MARYLAND
MAP SCALE 1" = 500'
250 0 500 1,000
FEET
NFIP
NATIONAL FLOOD INSURANCE PROGRAM
PANEL 0043C
FIRM
FLOOD INSURANCE RATE MAP
DISTRICT OF COLUMBIA, WASHINGTON, D.C.
PANEL 43 OF 100
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
DISTRICT OF COLUMBIA 110001 0043 C
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.
MAP NUMBER
1100010043C
MAP REVISED
SEPTEMBER 27, 2010
Federal Emergency Management Agency
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



FLOOD PROFILES

WATTS BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON, D.C.

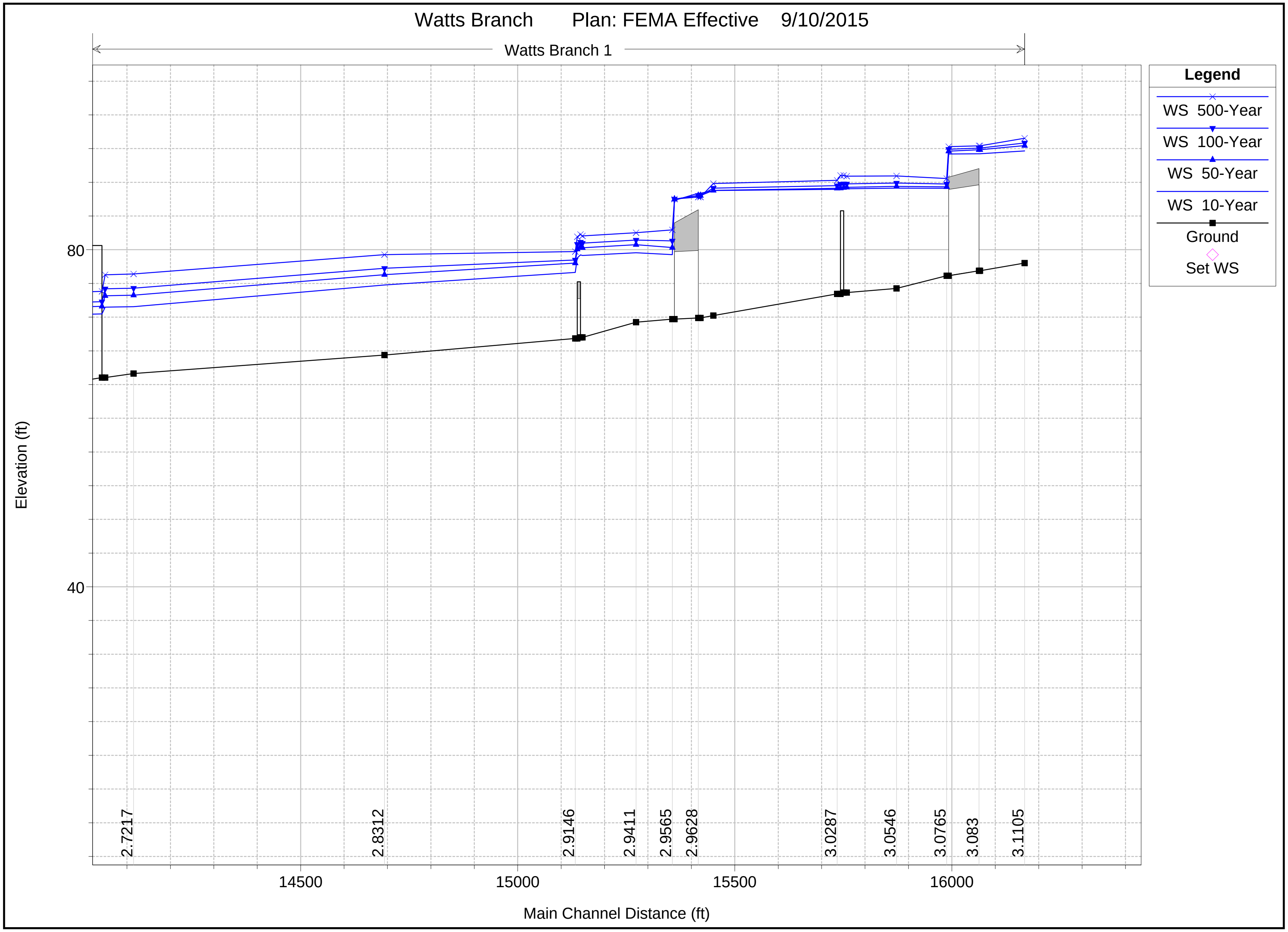
APPENDIX D

"EXISTING EFFECTIVE" MODEL

OUTPUTS

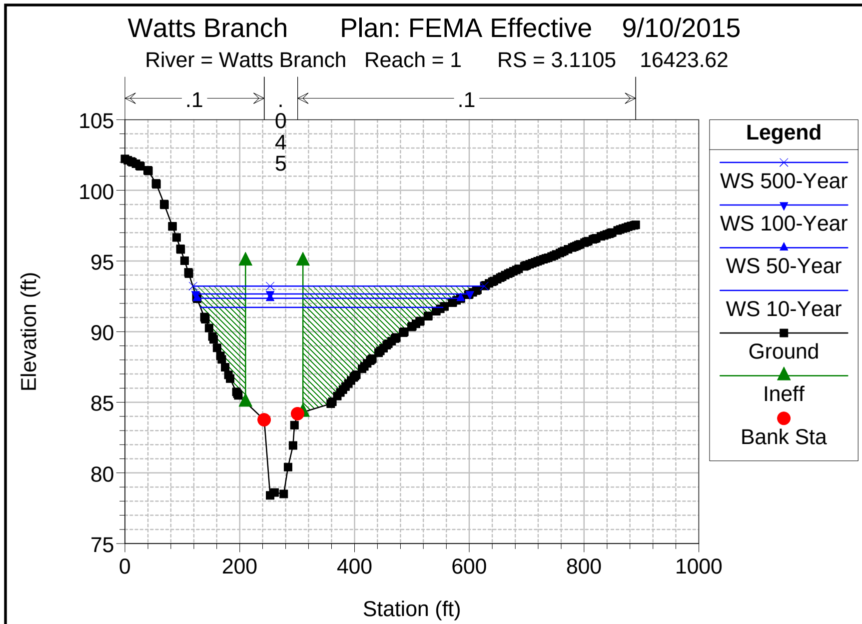
“EXISTING EFFECTIVE” MODEL

PROFILE

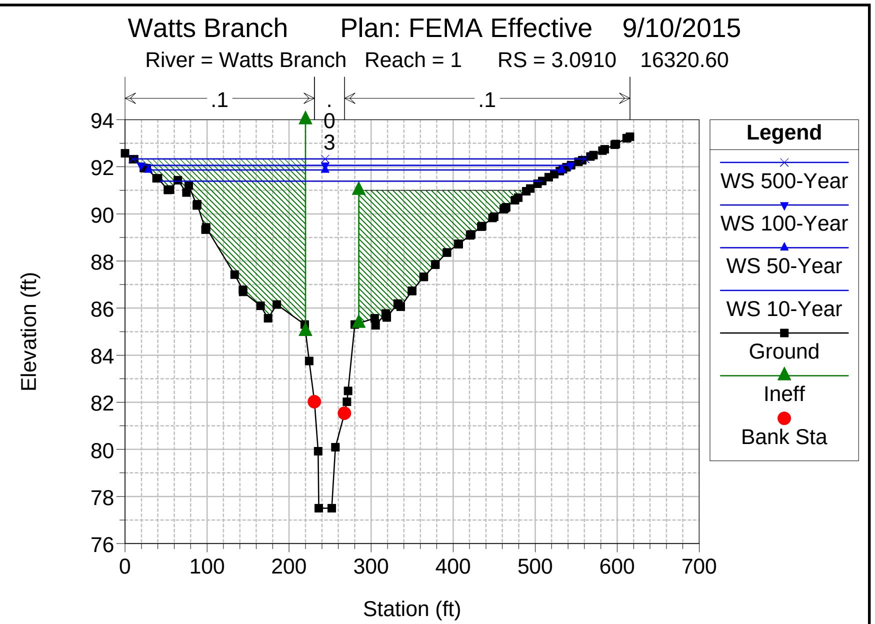

Watts Branch Plan: FEMA Effective 9/10/2015
Watts Branch 1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Set WS
Elevation (ft)
80
40
2.7217
2.8312
2.9146
2.9411
2.9565
2.9628
3.0287
3.0546
3.0765
3.083
3.1105
14500
15000
15500
16000
Main Channel Distance (ft)

“EXISTING EFFECTIVE” MODEL

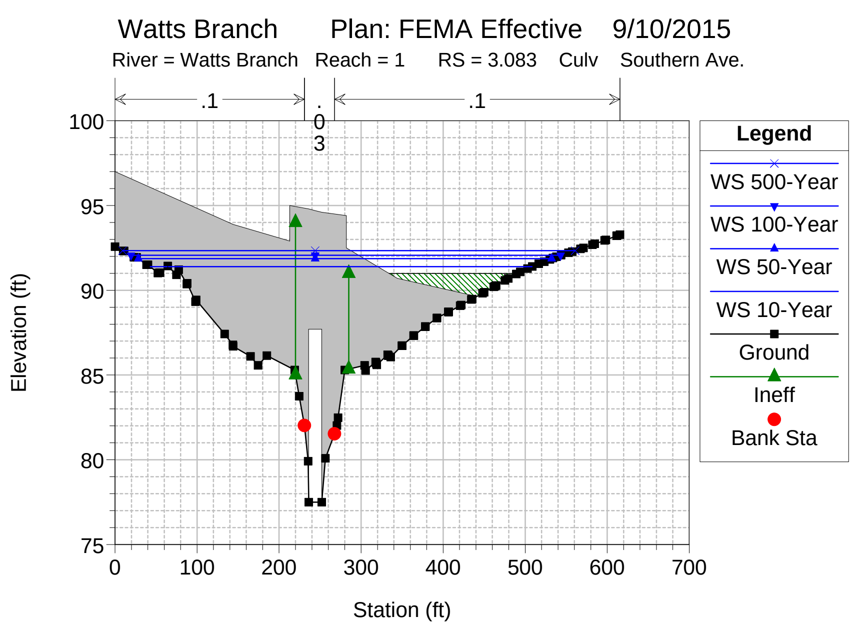
CROSS SECTIONS



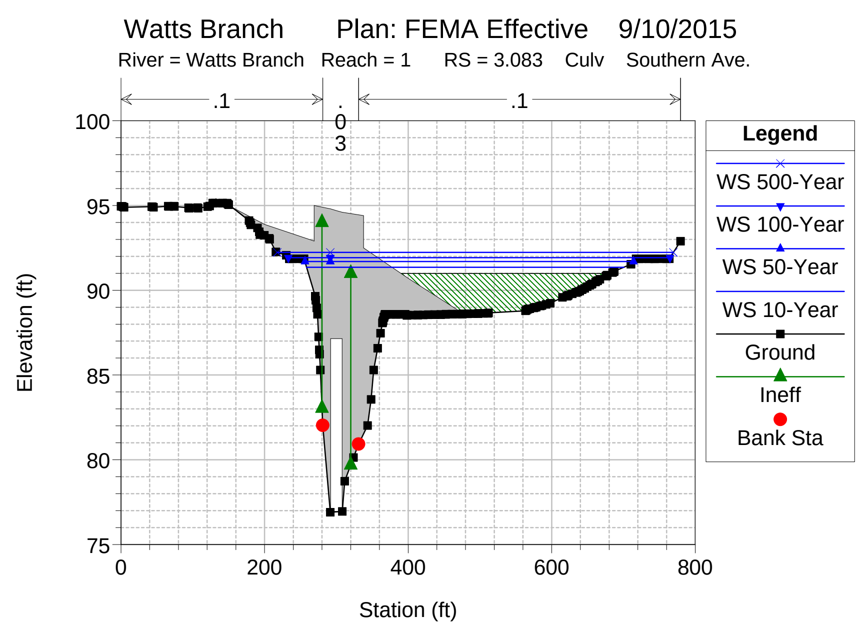
Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 3.1105 16423.62
.1
.045
.1
Elevation (ft)
Station (ft)
105
100
95
90
85
80
75
0
200
400
600
800
1000
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta



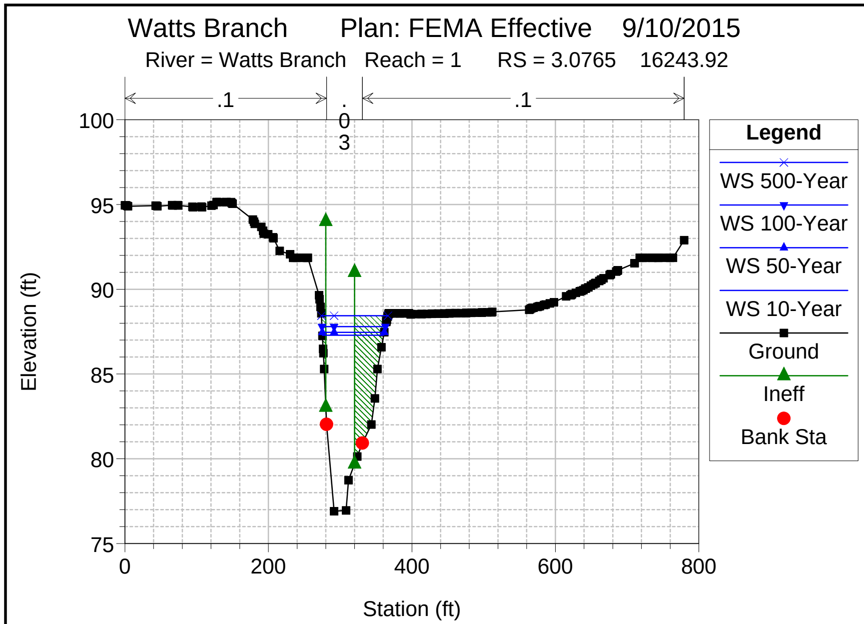
Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 3.0910 16320.60
.1
.03
.1
Elevation (ft)
Station (ft)
94
92
90
88
86
84
82
80
78
76
0
100
200
300
400
500
600
700
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta



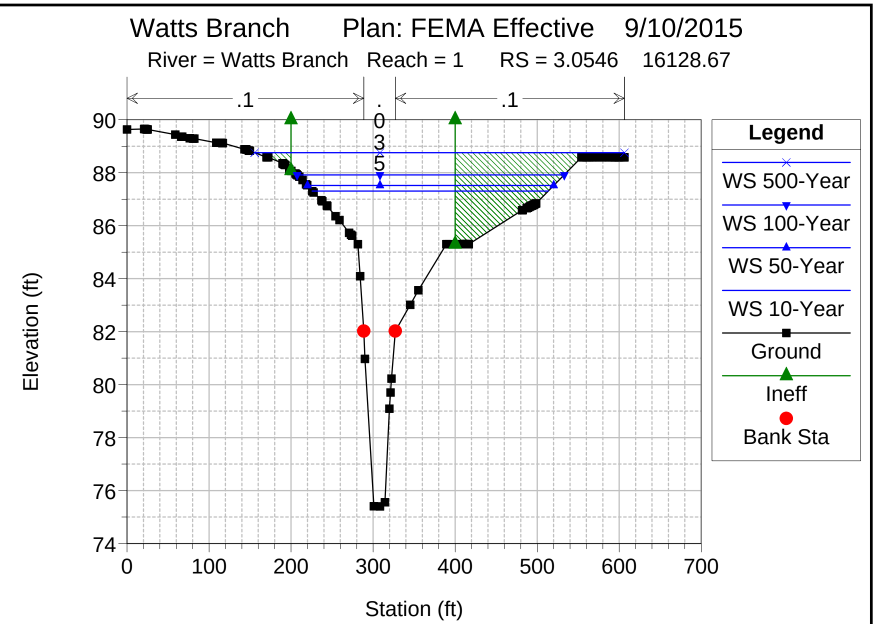
Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 3.083 Culv Southern Ave.
.1
.03
.1
Elevation (ft)
Station (ft)
100
95
90
85
80
75
0
100
200
300
400
500
600
700
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta



Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 3.083 Culv Southern Ave.
.1
.03
.1
Elevation (ft)
Station (ft)
100
95
90
85
80
75
0
200
400
600
800
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta



Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 3.0765 16243.92
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta



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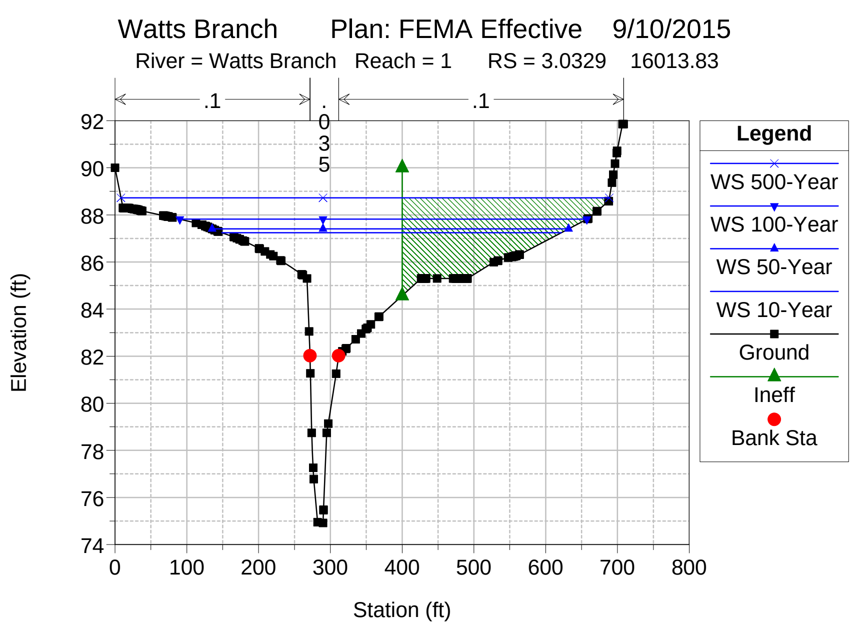
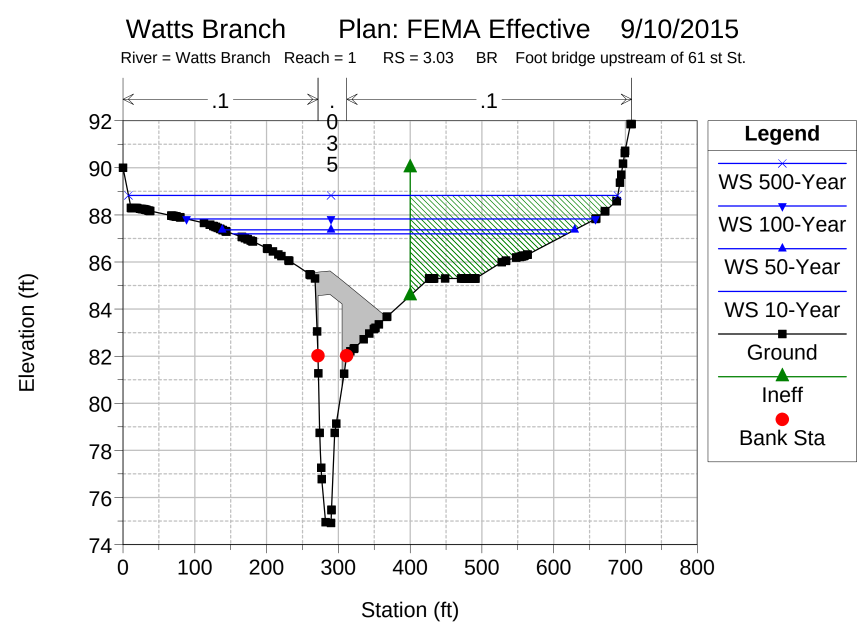
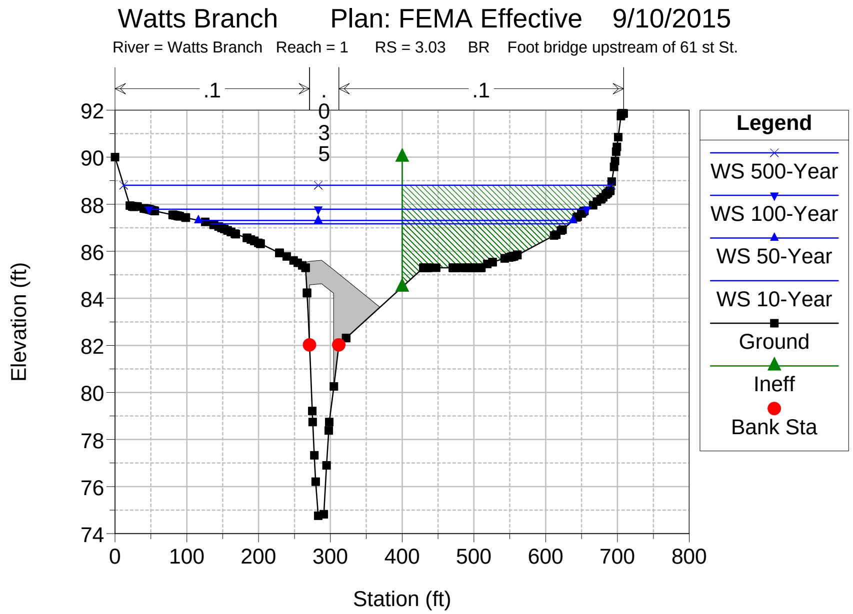
River = Watts Branch Reach = 1 RS = 3.0546 16128.67
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

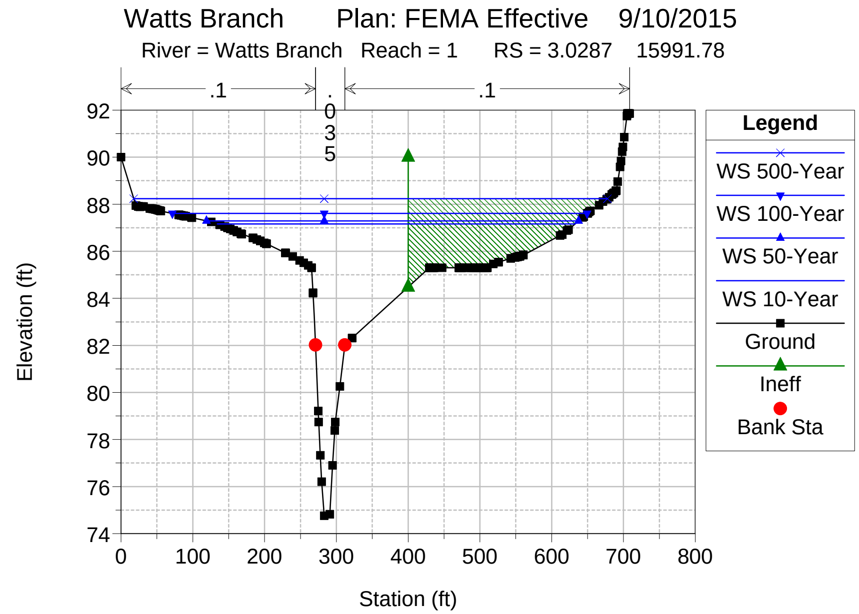


Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 3.0329 16013.83
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta



Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 3.03 BR Foot bridge upstream of 61 st St.
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 3.03 BR Foot bridge upstream of 61 st St.
.1
.035
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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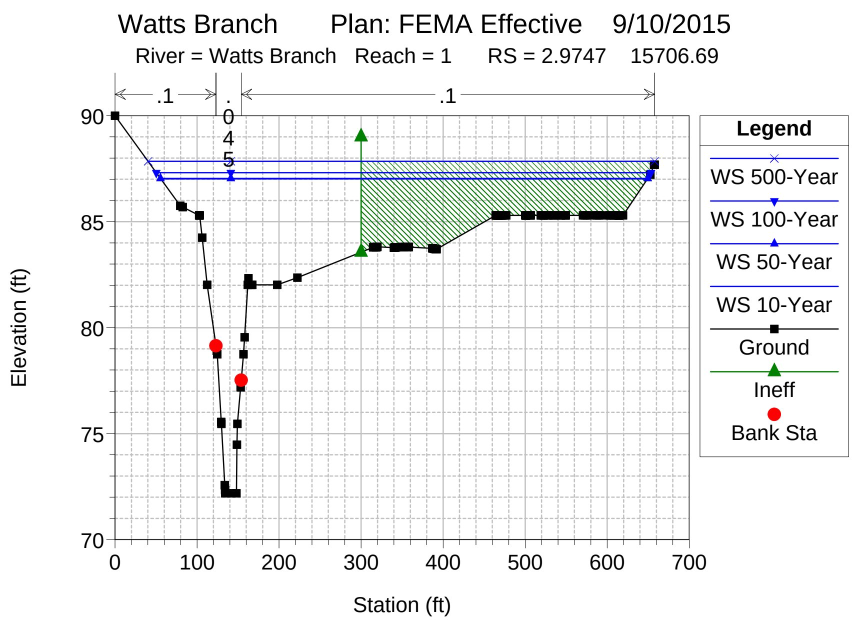
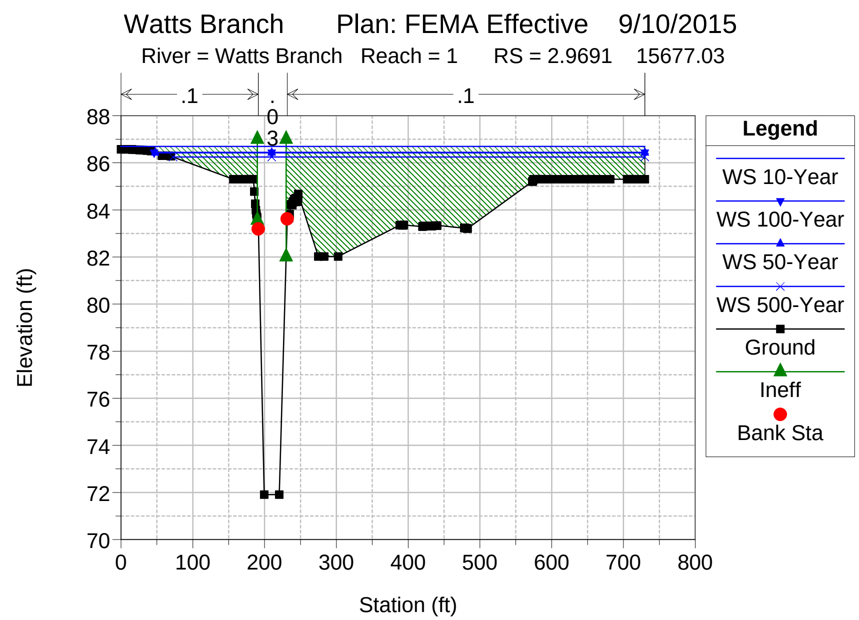
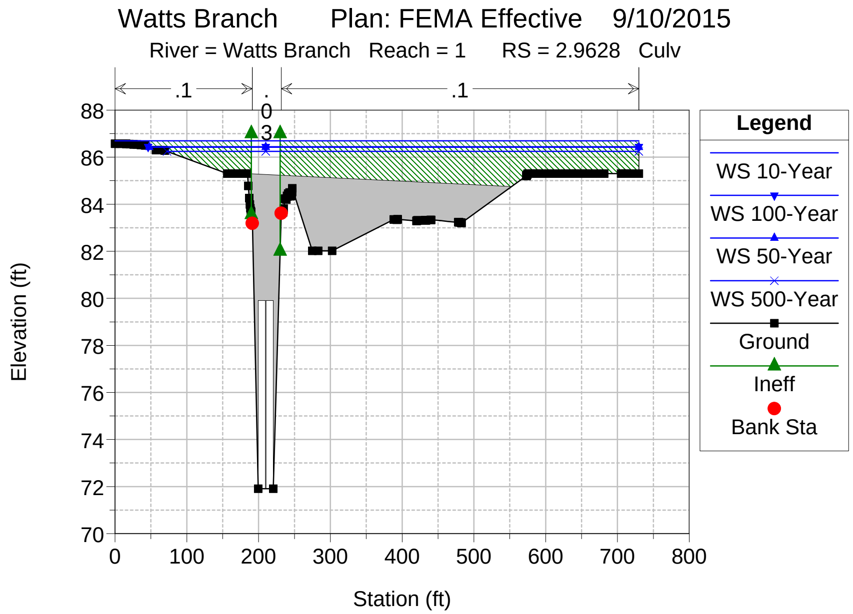
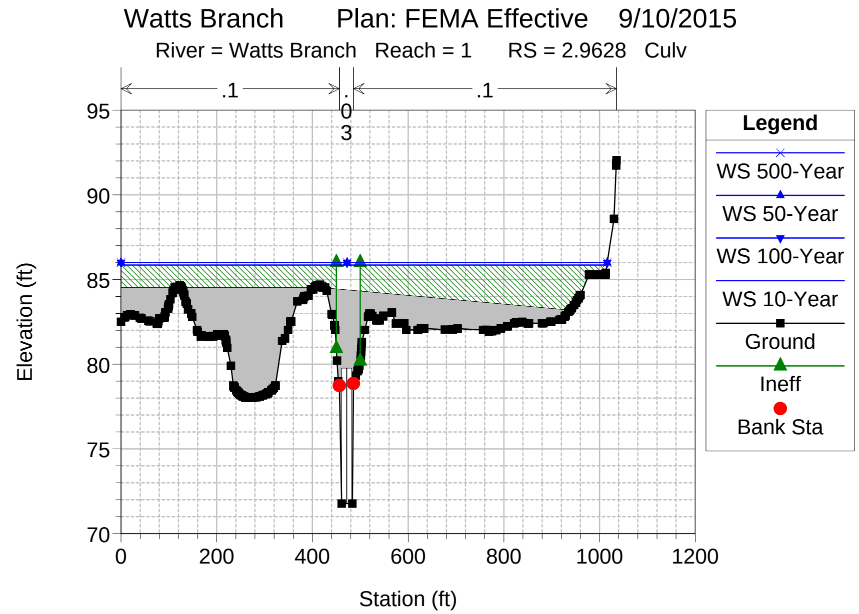
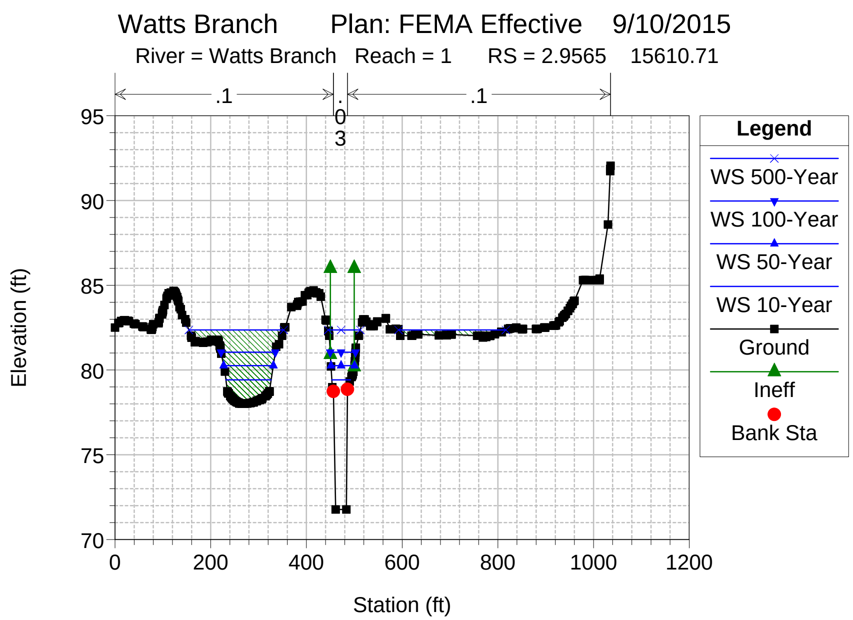
River = Watts Branch Reach = 1 RS = 3.0287 15991.78
.1
.035
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

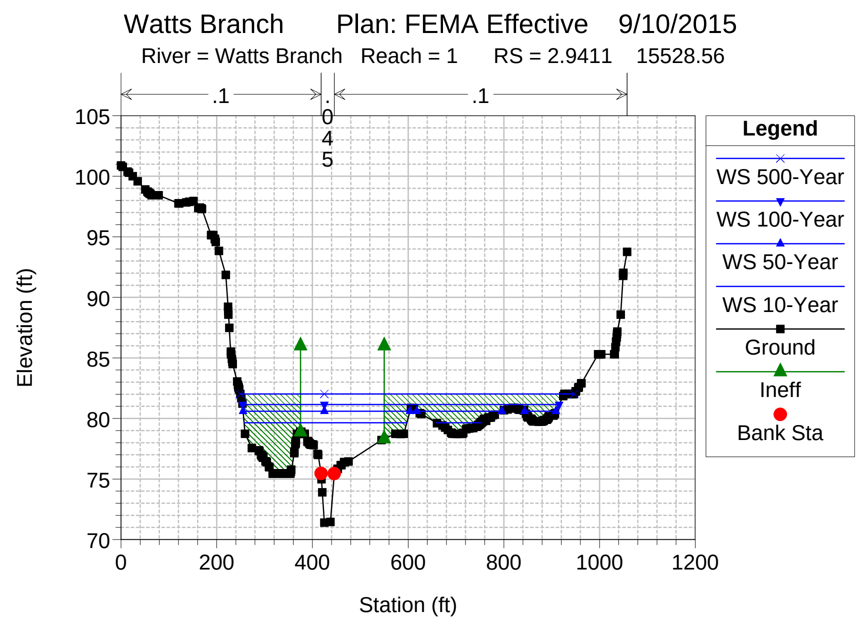

Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 2.9747 15706.69
.1
.045
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

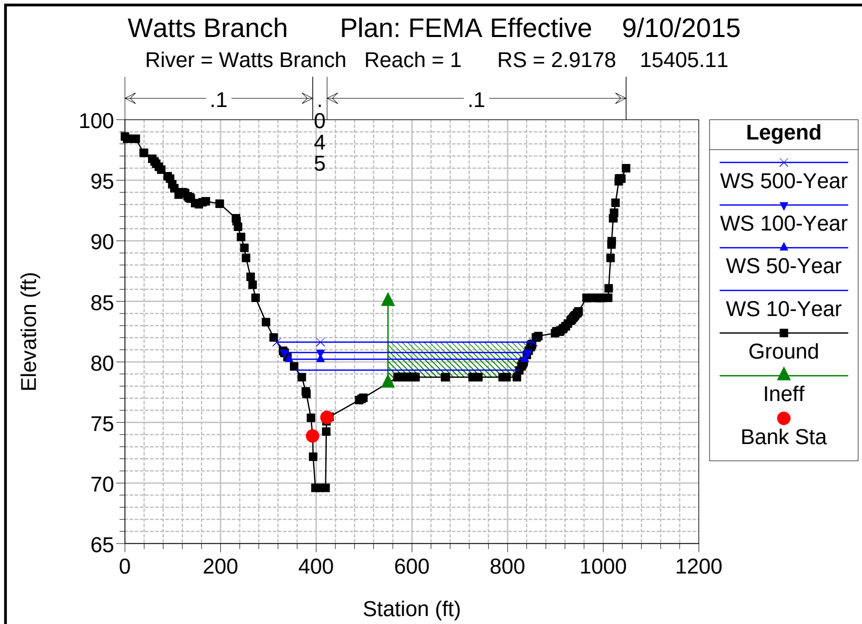

Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 2.9691 15677.03
.1
.03
.1
Legend
WS 10-Year
WS 100-Year
WS 50-Year
WS 500-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

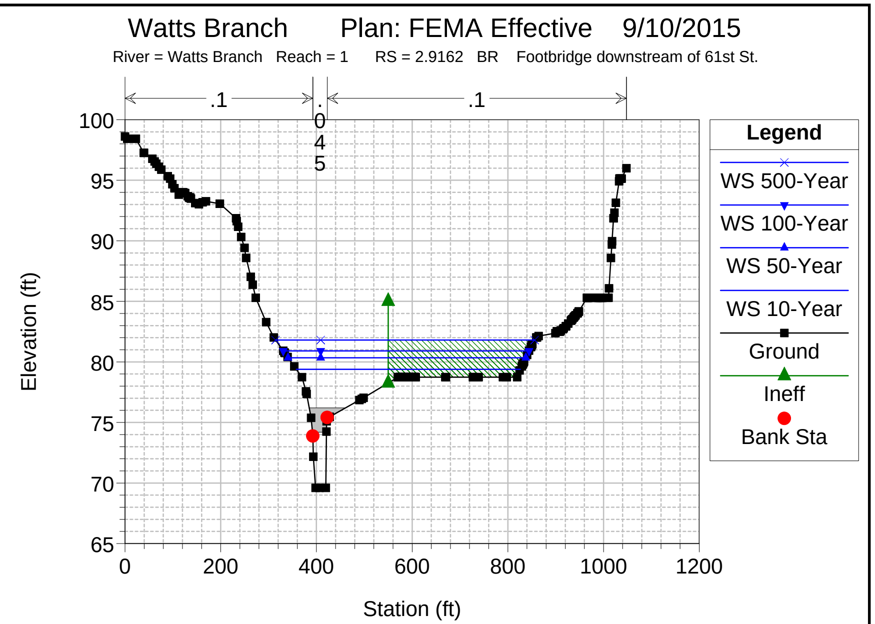

Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 2.9628 Culv
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 10-Year
WS 100-Year
WS 50-Year
WS 500-Year
Ground
Ineff
Bank Sta

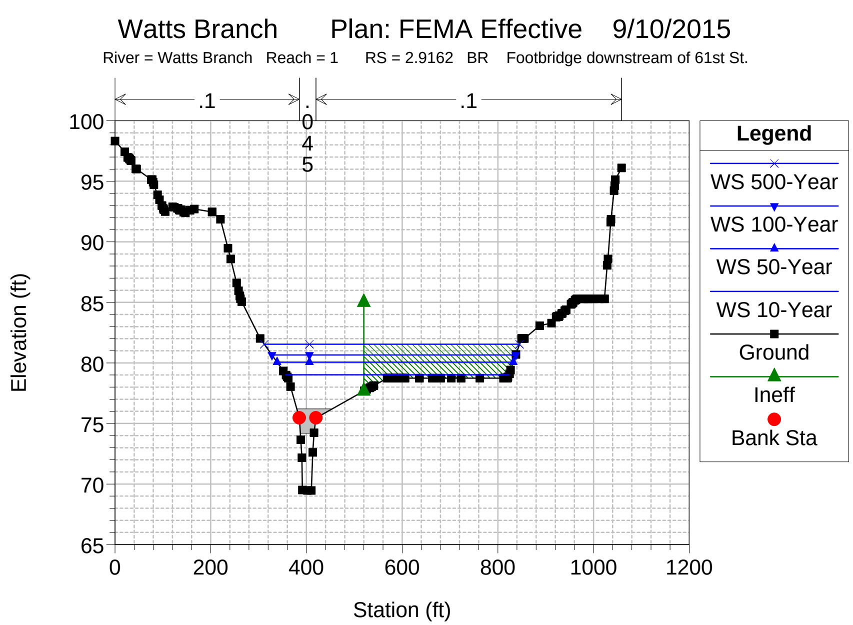

Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 2.9628 Culv
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 50-Year
WS 100-Year
WS 10-Year
Ground
Ineff
Bank Sta

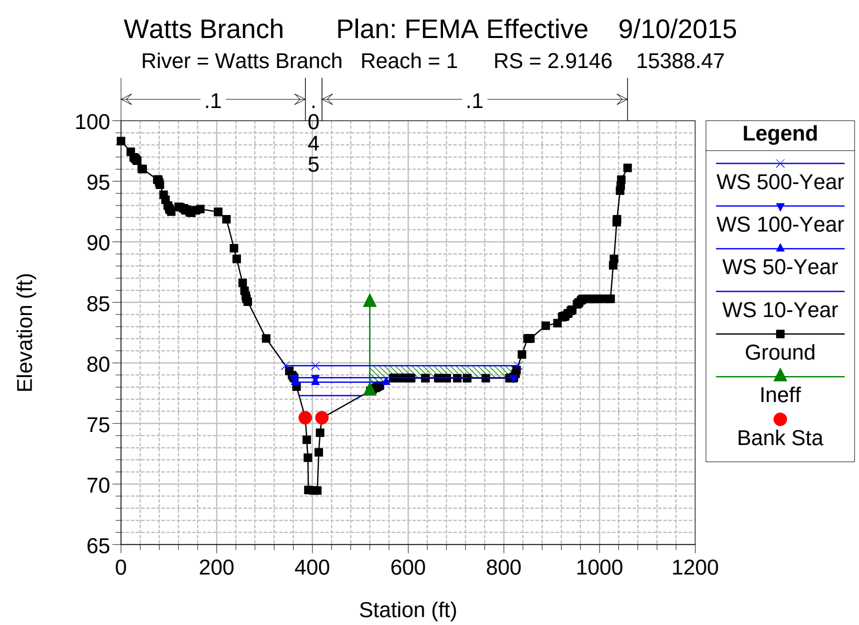

Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 2.9565 15610.71
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

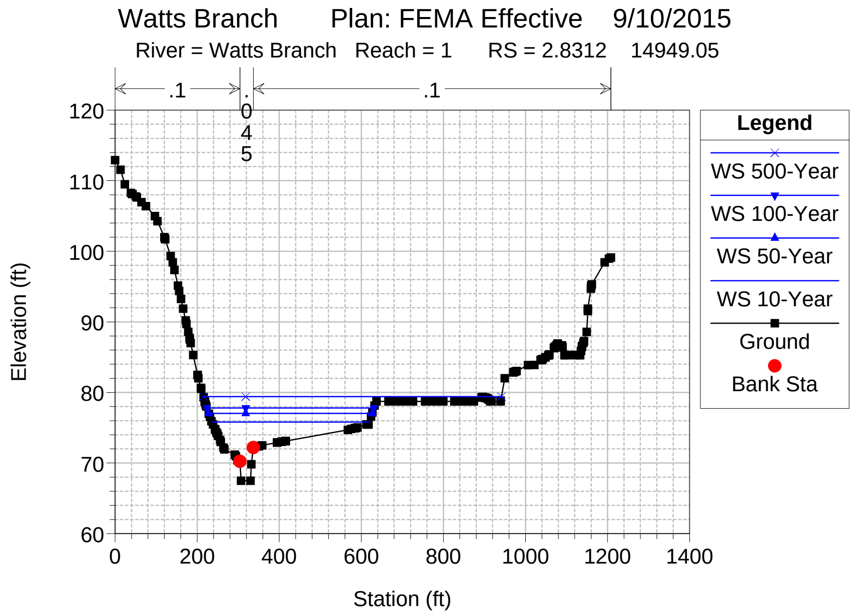

Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 2.9411 15528.56
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

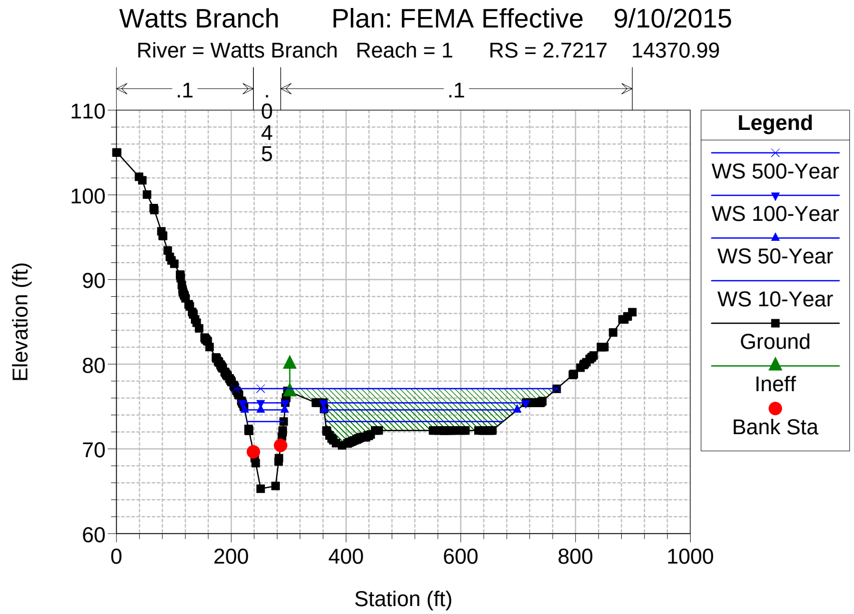

Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 2.9178 15405.11
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 2.9162 BR Footbridge downstream of 61st St.
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 2.9162 BR Footbridge downstream of 61st St.
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 2.9146 15388.47
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 2.8312 14949.05
.1
.045
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Bank Sta
Elevation (ft)
Station (ft)


Watts Branch Plan: FEMA Effective 9/10/2015
River = Watts Branch Reach = 1 RS = 2.7217 14370.99
.1
.045
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

“EXISTING EFFECTIVE” MODEL

STANDARD OUTPUT TABLE

HEC-RAS Plan: FEMA Effective Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Watts Branch	1	3.1105	10-Year	2545.00	78.41	91.72	84.08	91.86	0.000396	3.28	979.26	422.07	0.17
Watts Branch	1	3.1105	50-Year	3368.00	78.41	92.36	85.10	92.58	0.000572	4.08	1043.12	459.58	0.21
Watts Branch	1	3.1105	100-Year	3872.00	78.41	92.67	85.56	92.95	0.000691	4.56	1074.49	478.00	0.23
Watts Branch	1	3.1105	500-Year	4880.00	78.41	93.23	86.35	93.63	0.000939	5.47	1130.12	507.39	0.27
Watts Branch	1	3.0910	10-Year	2545.00	77.50	91.39	84.46	91.80	0.000446	5.27	751.94	463.40	0.27
Watts Branch	1	3.0910	50-Year	3368.00	77.50	91.87	85.65	92.48	0.000659	6.57	894.56	503.86	0.32
Watts Branch	1	3.0910	100-Year	3872.00	77.50	92.06	86.22	92.83	0.000811	7.37	956.65	523.69	0.36
Watts Branch	1	3.0910	500-Year	4880.00	77.50	92.34	87.26	93.45	0.001168	8.96	1047.49	551.43	0.43
Watts Branch	1	3.083		Culvert									
Watts Branch	1	3.0765	10-Year	2545.00	76.91	87.29	83.26	88.08	0.001164	7.16	359.56	85.48	0.42
Watts Branch	1	3.0765	50-Year	3368.00	76.91	87.46	84.34	88.80	0.001917	9.30	366.34	86.43	0.54
Watts Branch	1	3.0765	100-Year	3872.00	76.91	87.80	84.91	89.44	0.002246	10.31	379.93	88.38	0.59
Watts Branch	1	3.0765	500-Year	4880.00	76.91	88.44	86.05	90.74	0.002872	12.18	405.72	92.67	0.67
Watts Branch	1	3.0546	10-Year	2545.00	75.40	87.31	82.92	87.80	0.001095	6.01	695.38	287.91	0.34
Watts Branch	1	3.0546	50-Year	3368.00	75.40	87.51	84.12	88.32	0.001750	7.71	732.09	300.17	0.43
Watts Branch	1	3.0546	100-Year	3872.00	75.40	87.92	84.80	88.84	0.001943	8.35	807.27	325.73	0.46
Watts Branch	1	3.0546	500-Year	4880.00	75.40	88.76	86.19	89.85	0.002162	9.28	974.52	450.73	0.49
Watts Branch	1	3.0329	10-Year	2545.00	74.92	87.24	83.31	87.65	0.001066	5.67	827.17	472.79	0.33
Watts Branch	1	3.0329	50-Year	3368.00	74.92	87.41	84.68	88.08	0.001721	7.29	869.83	496.52	0.42
Watts Branch	1	3.0329	100-Year	3872.00	74.92	87.82	85.16	88.57	0.001867	7.82	986.84	567.12	0.44
Watts Branch	1	3.0329	500-Year	4880.00	74.92	88.72	86.10	89.53	0.001907	8.38	1318.17	680.33	0.45
Watts Branch	1	3.03		Bridge									
Watts Branch	1	3.0287	10-Year	2545.00	74.76	87.16	83.02	87.56	0.000978	5.54	852.29	498.58	0.32
Watts Branch	1	3.0287	50-Year	3368.00	74.76	87.29	84.25	87.95	0.001608	7.17	887.92	518.51	0.41
Watts Branch	1	3.0287	100-Year	3872.00	74.76	87.61	84.96	88.37	0.001830	7.82	983.22	577.92	0.44
Watts Branch	1	3.0287	500-Year	4880.00	74.76	88.23	85.88	89.16	0.002132	8.80	1211.90	660.03	0.48
Watts Branch	1	2.9747	10-Year	2545.00	72.18	87.02	80.35	87.23	0.000716	4.37	1213.08	593.21	0.22
Watts Branch	1	2.9747	50-Year	3368.00	72.18	87.04	81.64	87.40	0.001243	5.77	1218.14	593.96	0.28
Watts Branch	1	2.9747	100-Year	3872.00	72.18	87.31	82.32	87.73	0.001465	6.35	1284.84	603.00	0.31
Watts Branch	1	2.9747	500-Year	4880.00	72.18	87.85	84.60	88.40	0.001864	7.36	1422.14	617.56	0.35
Watts Branch	1	2.9691	10-Year	2545.00	71.91	86.70	78.89	87.14	0.000552	5.31	482.23	729.74	0.27
Watts Branch	1	2.9691	50-Year	3368.00	71.91	86.43	80.14	87.23	0.001041	7.19	471.35	682.14	0.37

HEC-RAS Plan: FEMA Effective Locations: User Defined (Continued)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Watts Branch	1	2.9691	100-Year	3872.00	71.91	86.44	80.87	87.50	0.001369	8.26	472.08	683.51	0.42
Watts Branch	1	2.9691	500-Year	4880.00	71.91	86.25	82.16	87.98	0.002300	10.58	464.11	657.33	0.54
Watts Branch	1	2.9628		Culvert									
Watts Branch	1	2.9565	10-Year	2545.00	71.77	79.42	78.78	81.94	0.007280	12.74	202.92	133.17	0.86
Watts Branch	1	2.9565	50-Year	3368.00	71.77	80.26	80.26	83.70	0.008546	14.92	240.62	152.72	0.95
Watts Branch	1	2.9565	100-Year	3872.00	71.77	81.05	81.05	84.69	0.007996	15.41	279.65	166.29	0.94
Watts Branch	1	2.9565	500-Year	4880.00	71.77	82.36	82.36	86.48	0.007583	16.53	345.22	489.13	0.93
Watts Branch	1	2.9411	10-Year	2545.00	71.40	79.64	79.12	80.59	0.006204	9.20	547.31	432.55	0.61
Watts Branch	1	2.9411	50-Year	3368.00	71.40	80.60	79.76	81.53	0.005688	9.58	714.83	592.11	0.59
Watts Branch	1	2.9411	100-Year	3872.00	71.40	81.15	80.09	82.08	0.005411	9.76	811.06	661.51	0.58
Watts Branch	1	2.9411	500-Year	4880.00	71.40	82.02	80.69	83.02	0.005364	10.36	964.74	697.24	0.59
Watts Branch	1	2.9178	10-Year	2545.00	69.60	79.32	77.08	79.96	0.003241	7.25	653.50	465.58	0.43
Watts Branch	1	2.9178	50-Year	3368.00	69.60	80.22	78.53	80.93	0.003424	7.94	833.45	493.22	0.45
Watts Branch	1	2.9178	100-Year	3872.00	69.60	80.78	78.90	81.50	0.003395	8.20	950.31	509.30	0.45
Watts Branch	1	2.9178	500-Year	4880.00	69.60	81.64	79.67	82.42	0.003546	8.84	1144.04	535.80	0.46
Watts Branch	1	2.9162		Bridge									
Watts Branch	1	2.9146	10-Year	2545.00	69.47	77.31	77.31	79.21	0.012802	11.39	300.65	131.44	0.82
Watts Branch	1	2.9146	50-Year	3368.00	69.47	78.41	78.41	80.20	0.010544	11.56	465.15	189.71	0.76
Watts Branch	1	2.9146	100-Year	3872.00	69.47	78.78	78.78	80.71	0.011002	12.21	522.85	458.95	0.78
Watts Branch	1	2.9146	500-Year	4880.00	69.47	79.78	79.56	81.64	0.009714	12.46	690.14	486.11	0.75
Watts Branch	1	2.8312	10-Year	2545.00	67.50	75.81	74.11	76.15	0.002470	5.99	1051.53	383.73	0.38
Watts Branch	1	2.8312	50-Year	3368.00	67.50	77.04	74.86	77.29	0.001750	5.58	1533.28	398.57	0.33
Watts Branch	1	2.8312	100-Year	3872.00	67.50	77.80	75.22	78.01	0.001444	5.35	1837.03	406.96	0.30
Watts Branch	1	2.8312	500-Year	4880.00	67.50	79.41	75.75	79.62	0.001254	5.53	2696.47	726.21	0.29
Watts Branch	1	2.7217	10-Year	2545.00	65.31	73.24	70.99	74.18	0.004666	7.84	347.82	373.41	0.53
Watts Branch	1	2.7217	50-Year	3368.00	65.31	74.60	71.93	75.70	0.004318	8.53	438.78	406.16	0.53
Watts Branch	1	2.7217	100-Year	3872.00	65.31	75.43	72.48	76.60	0.004062	8.83	498.69	427.69	0.52
Watts Branch	1	2.7217	500-Year	4880.00	65.31	77.13	73.47	78.38	0.003511	9.21	640.19	560.08	0.50

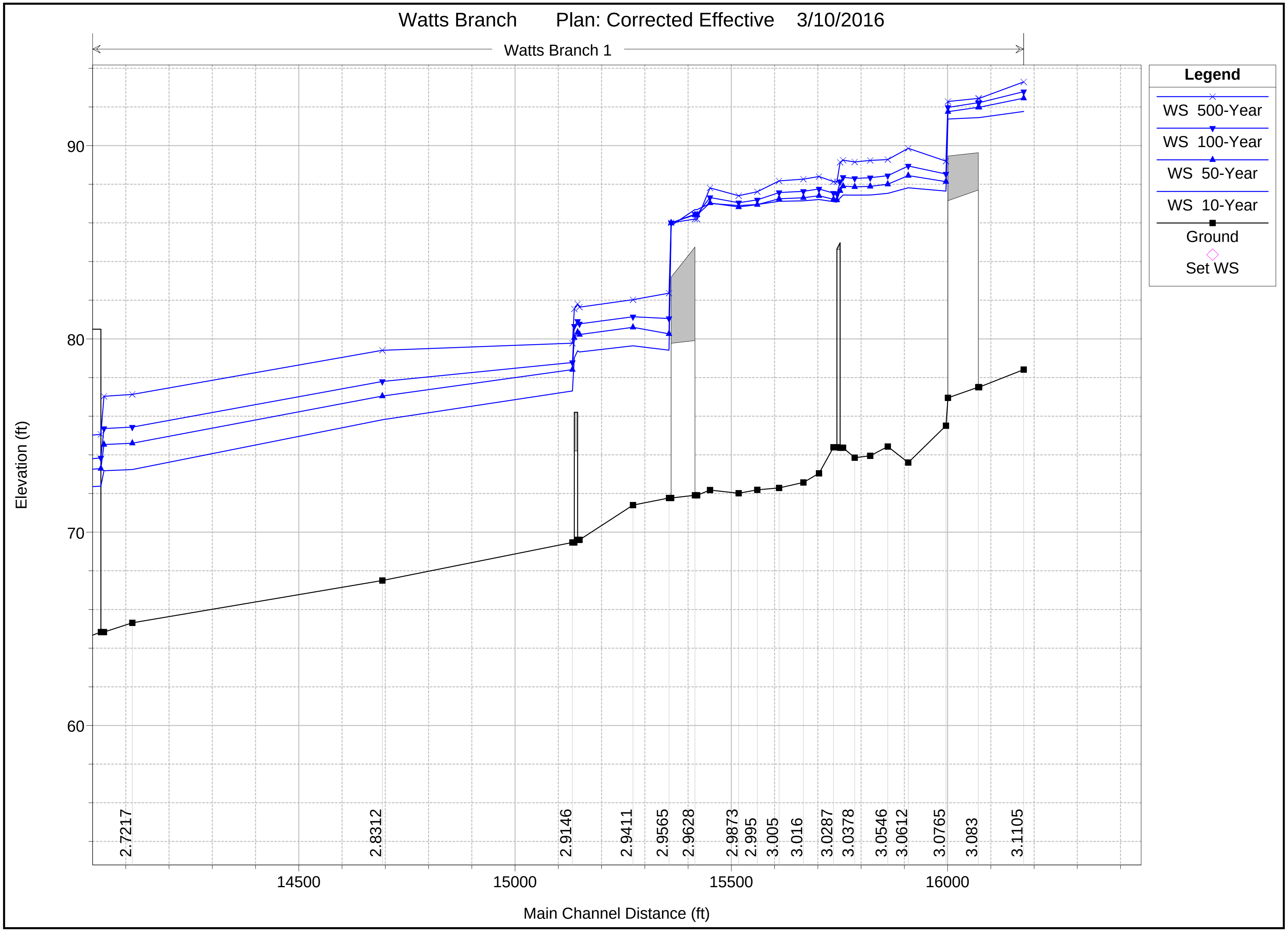
APPENDIX E

"CORRECTED EFFECTIVE" MODEL

OUTPUTS

“CORRECTED EFFECTIVE” MODEL

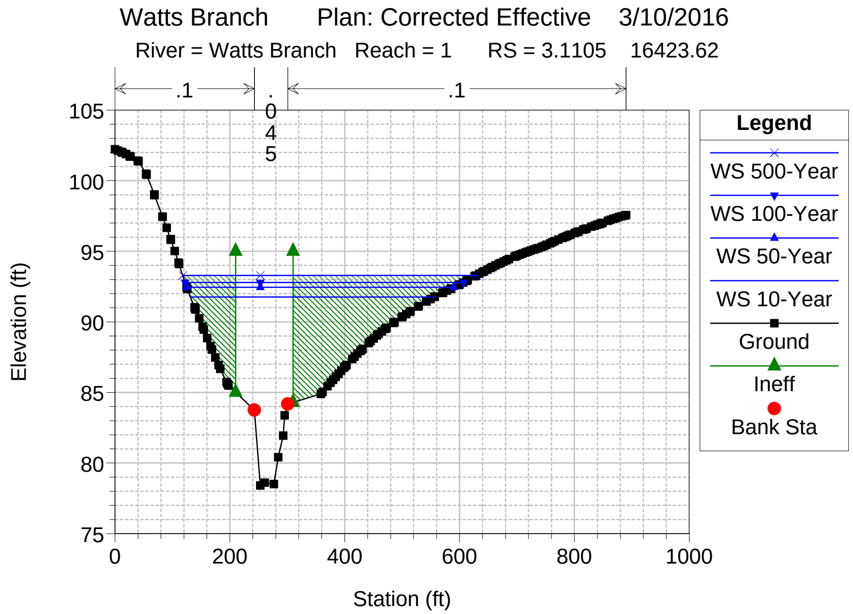
PROFILE

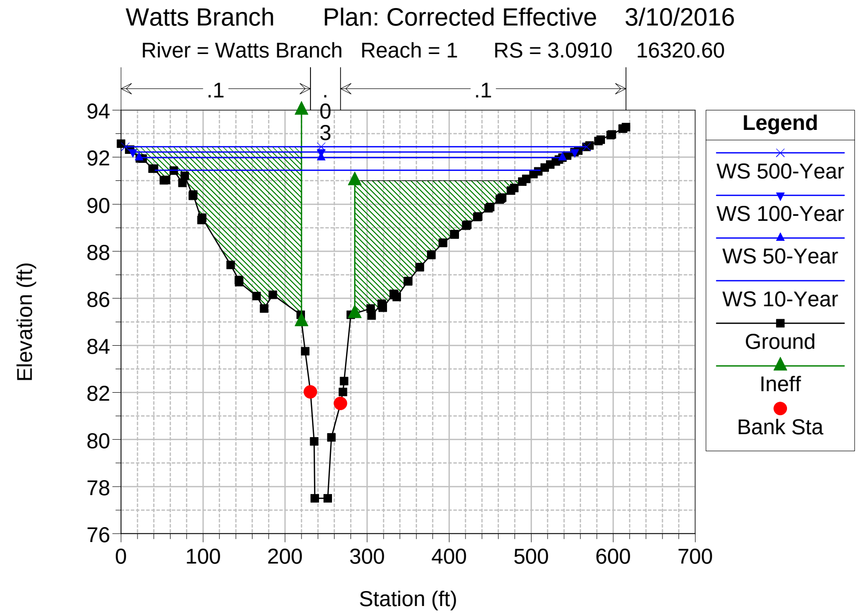


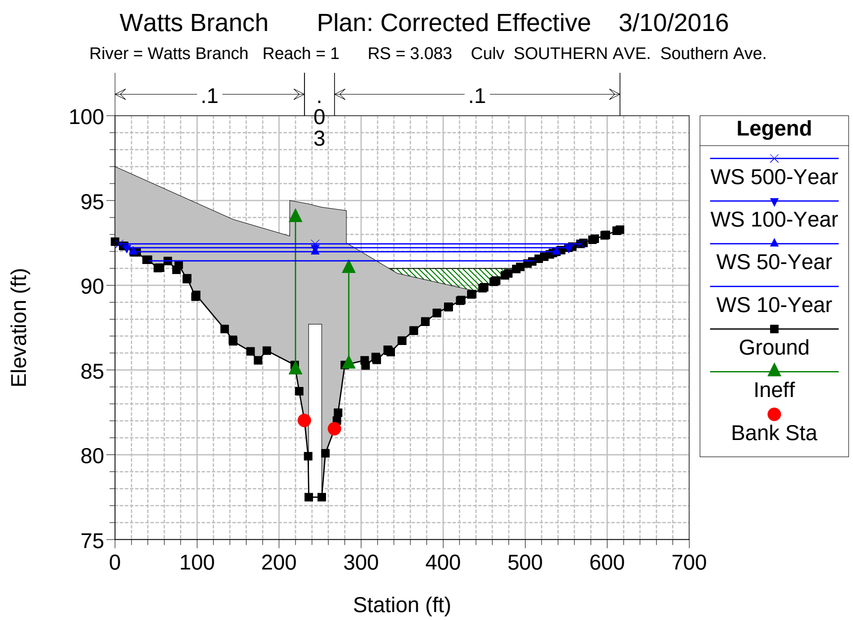
Watts Branch Plan: Corrected Effective 3/10/2016
Watts Branch 1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Set WS
Elevation (ft)
90
80
70
60
2.7217
2.8312
2.9146
2.9411
2.9565
2.9628
2.9873
2.995
3.005
3.016
3.0287
3.0378
3.0546
3.0612
3.0765
3.083
3.1105
14500
15000
15500
16000
Main Channel Distance (ft)

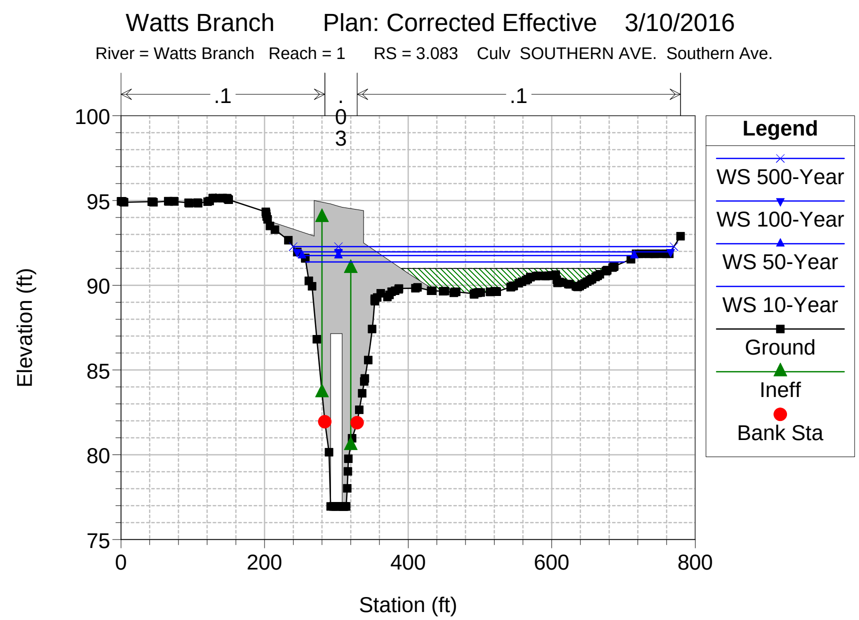
“CORRECTED EFFECTIVE” MODEL

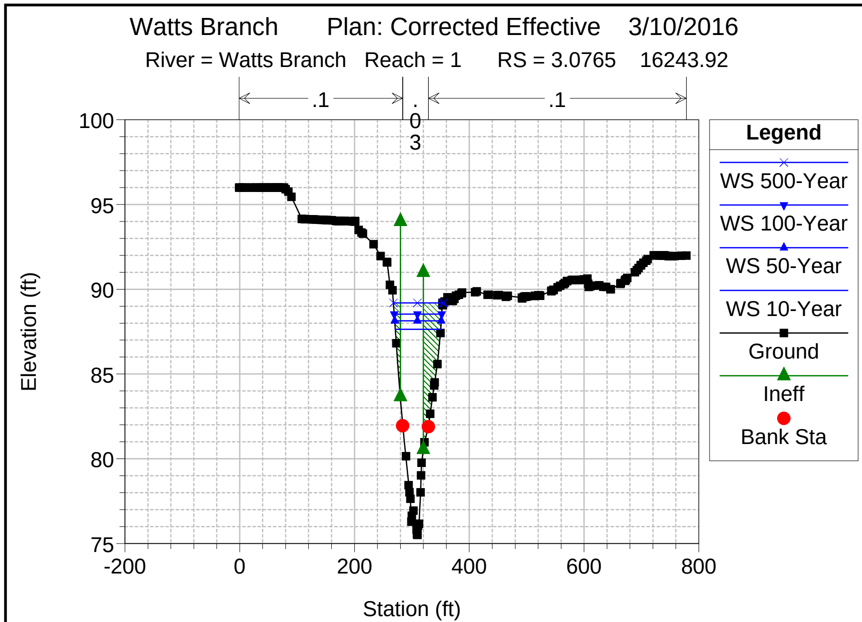
CROSS SECTIONS

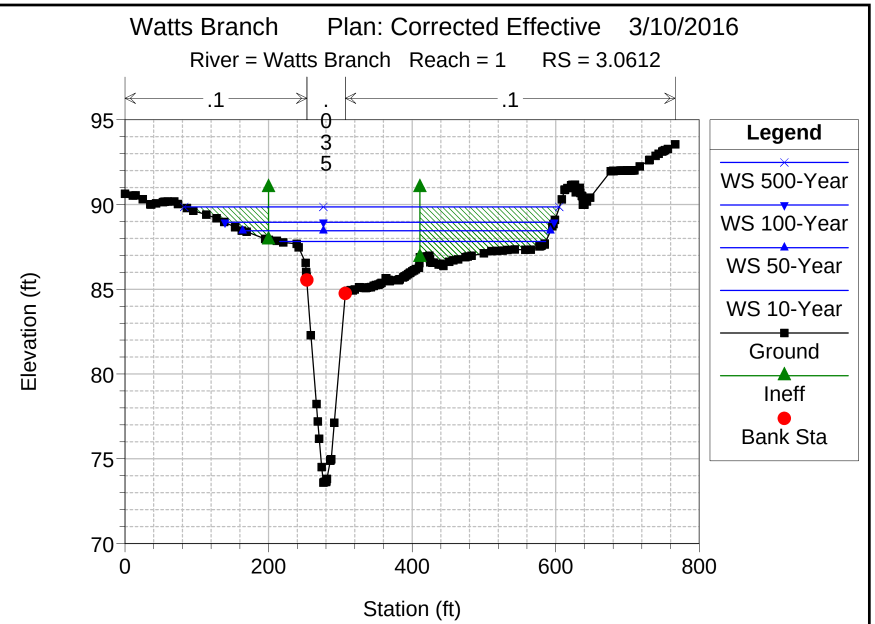

Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.1105 16423.62
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

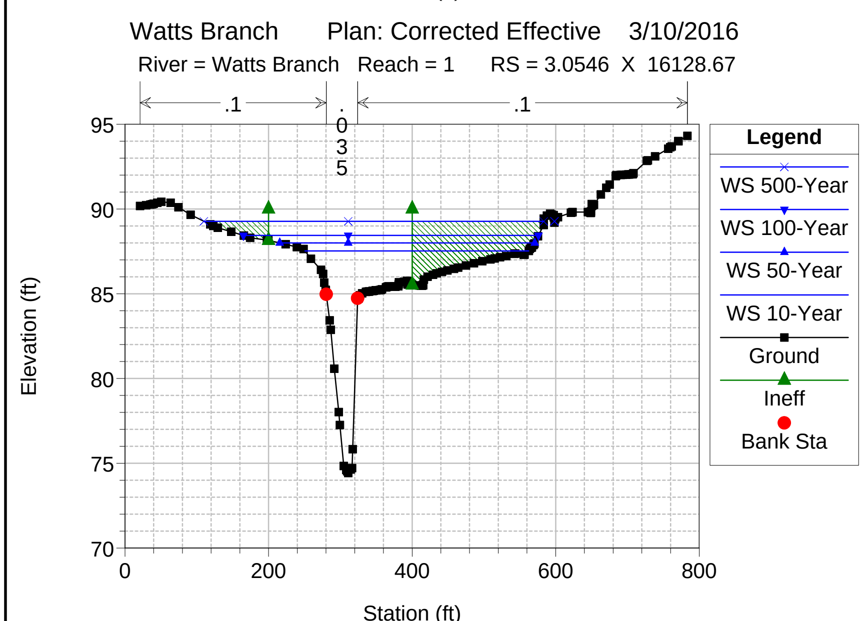

Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.0910 16320.60
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

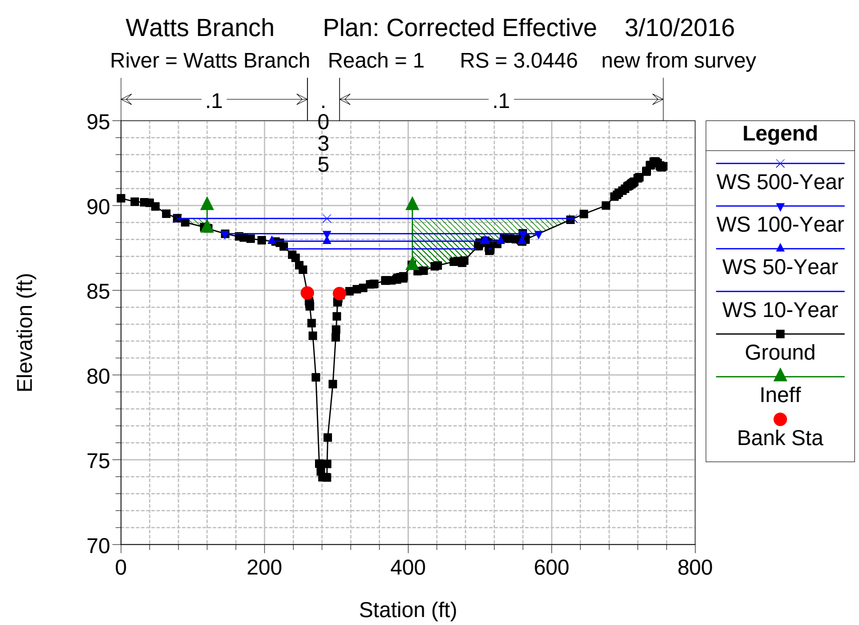

Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.083 Culv SOUTHERN AVE. Southern Ave.
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

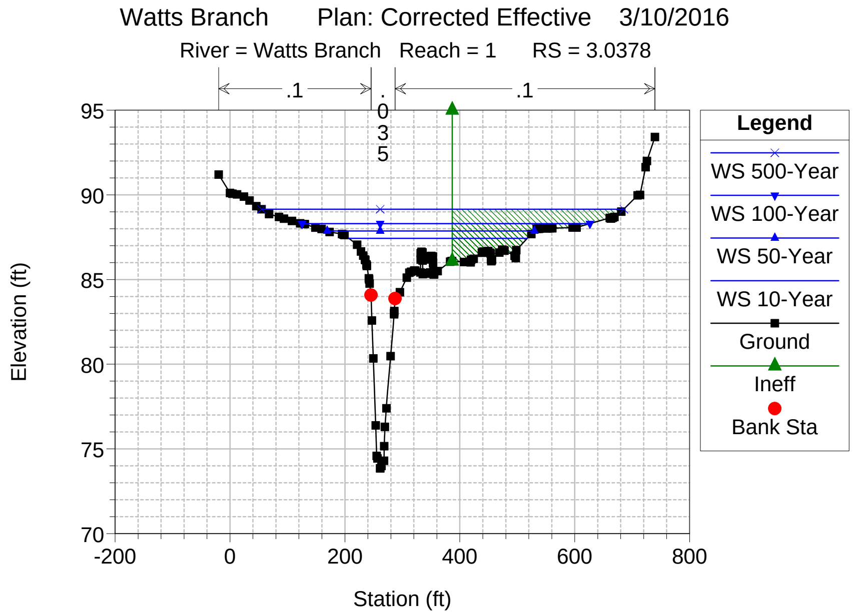

Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.083 Culv SOUTHERN AVE. Southern Ave.
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.0765 16243.92
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

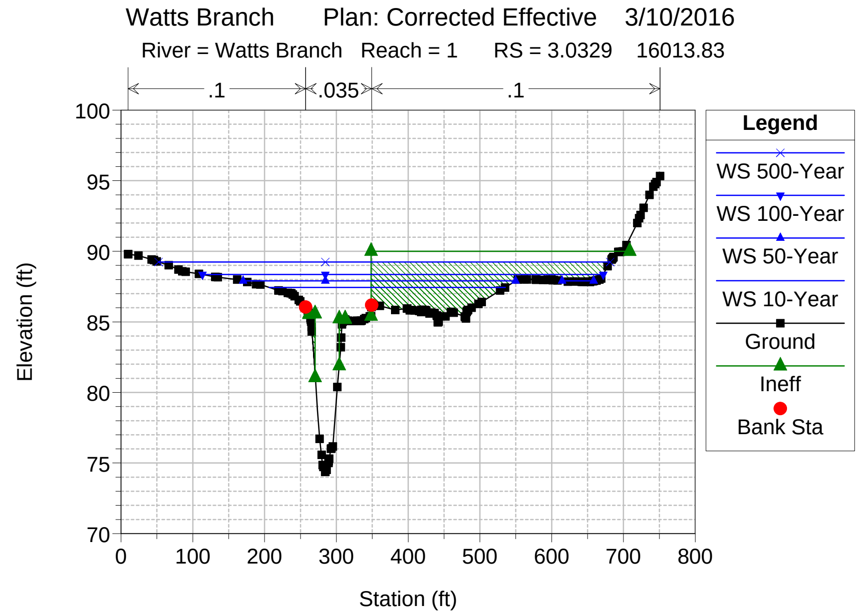

Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.0612
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.0546 X 16128.67
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

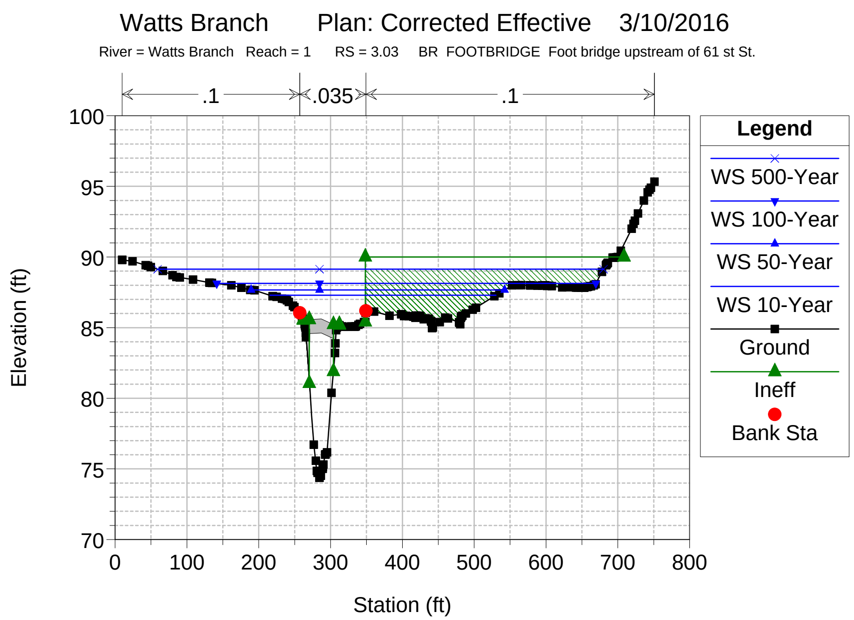

Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.0446 new from survey
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta



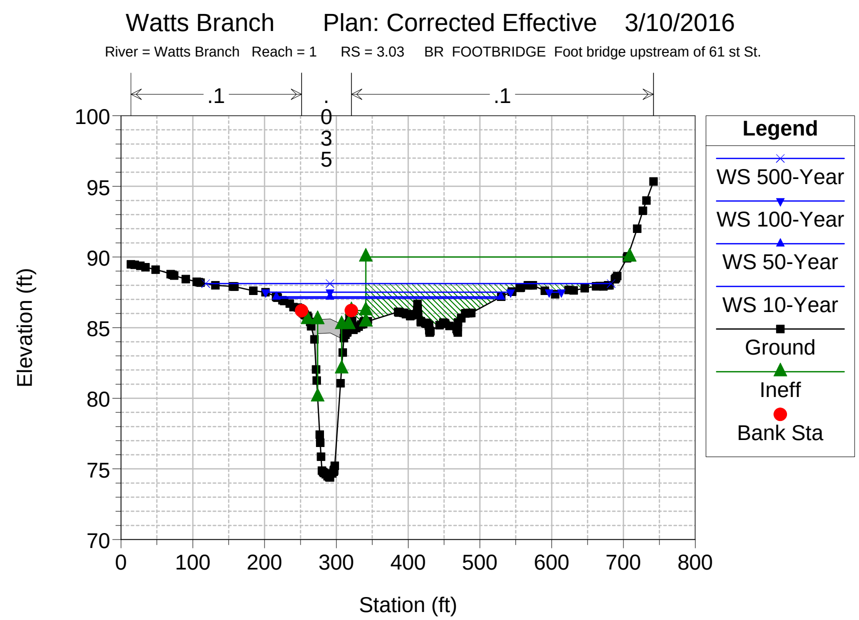
Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.0378
.1
.035
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



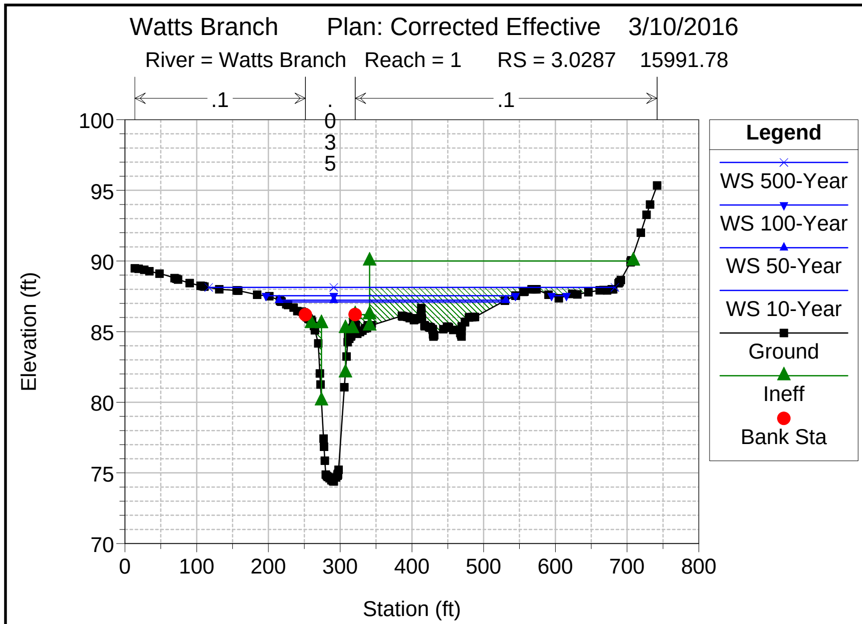
Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.0329 16013.83
.1
.035
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

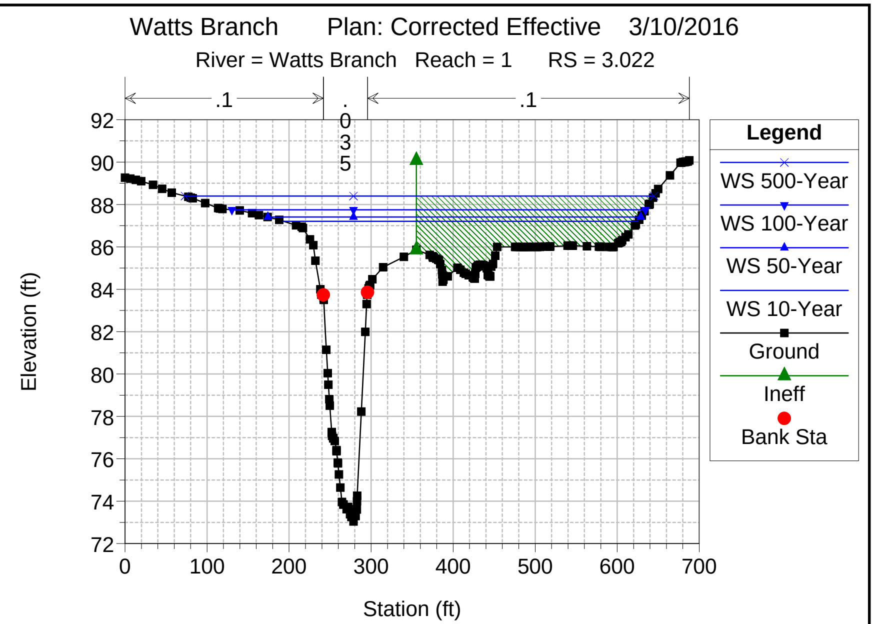


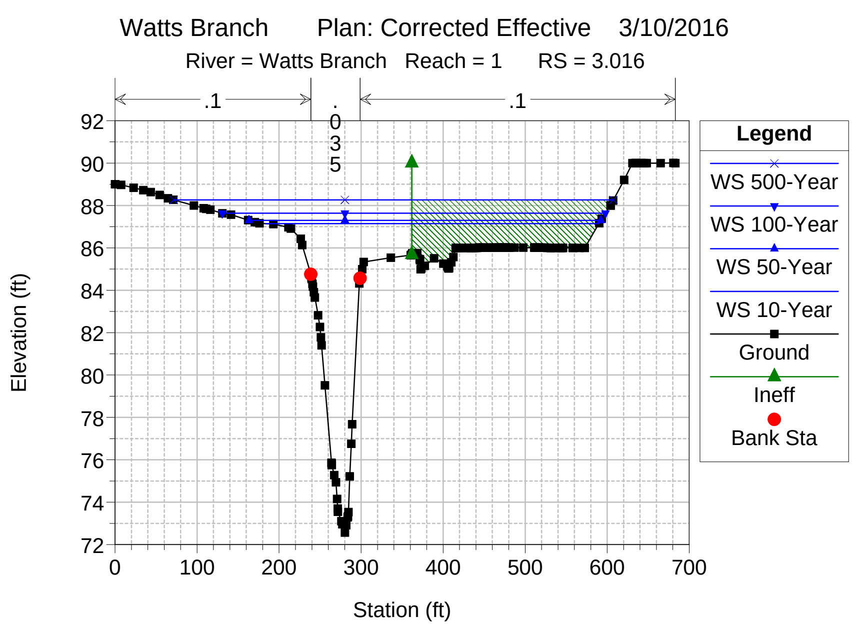
Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.03 BR FOOTBRIDGE Foot bridge upstream of 61 st St.
.1
.035
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

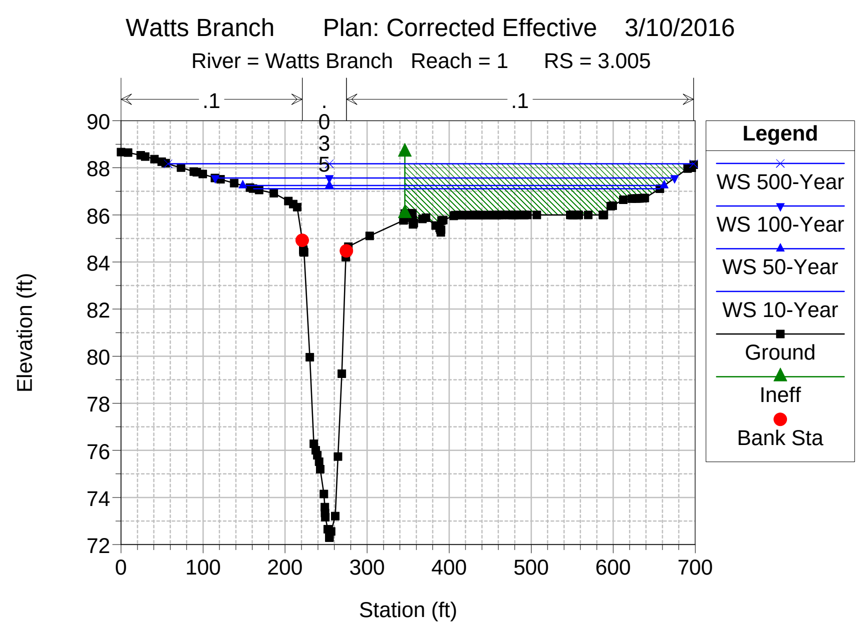


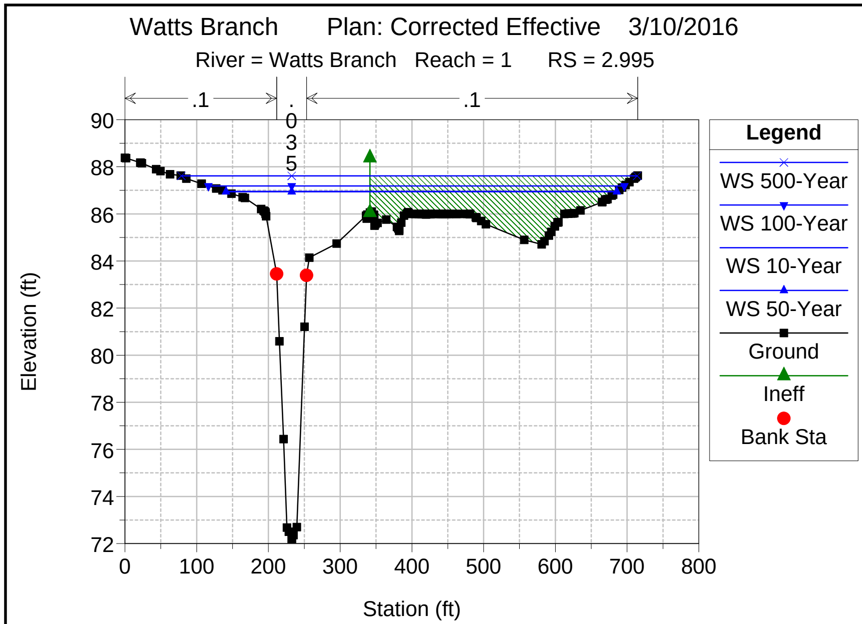
Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.03 BR FOOTBRIDGE Foot bridge upstream of 61 st St.
.1
.035
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

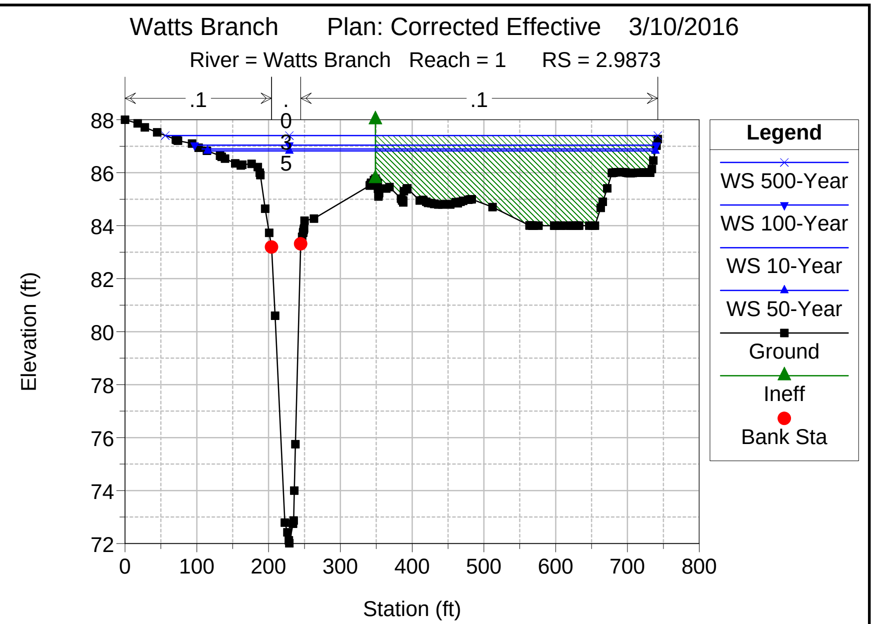

Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.0287 15991.78
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

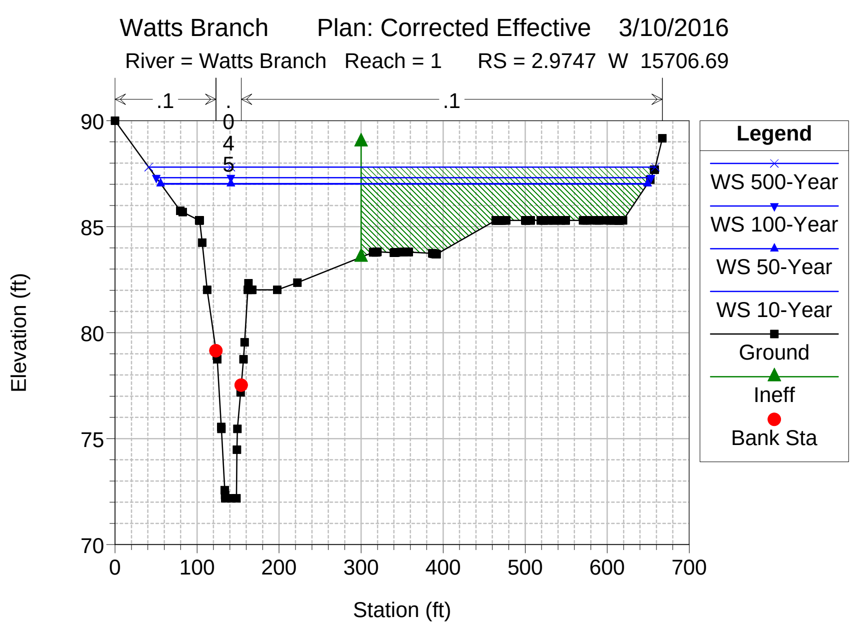

Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.022
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

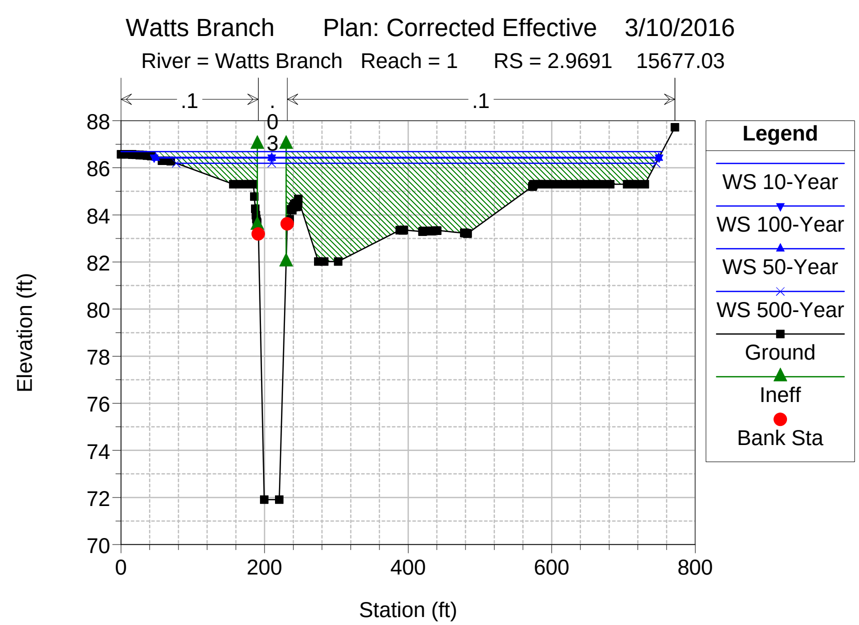

Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.016
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

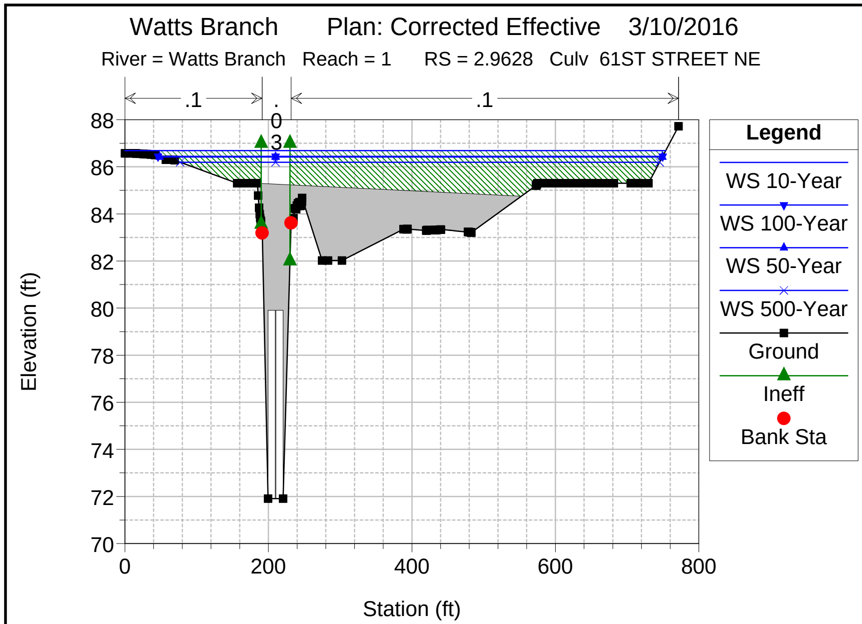

Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 3.005
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 2.995
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 10-Year
WS 50-Year
Ground
Ineff
Bank Sta

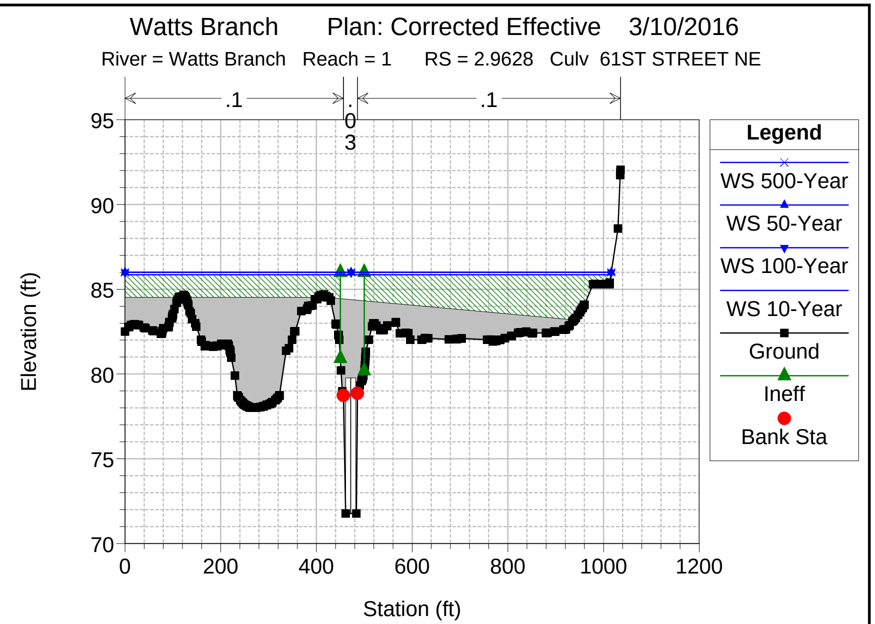

Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 2.9873
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 10-Year
WS 50-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 2.9747 W 15706.69
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

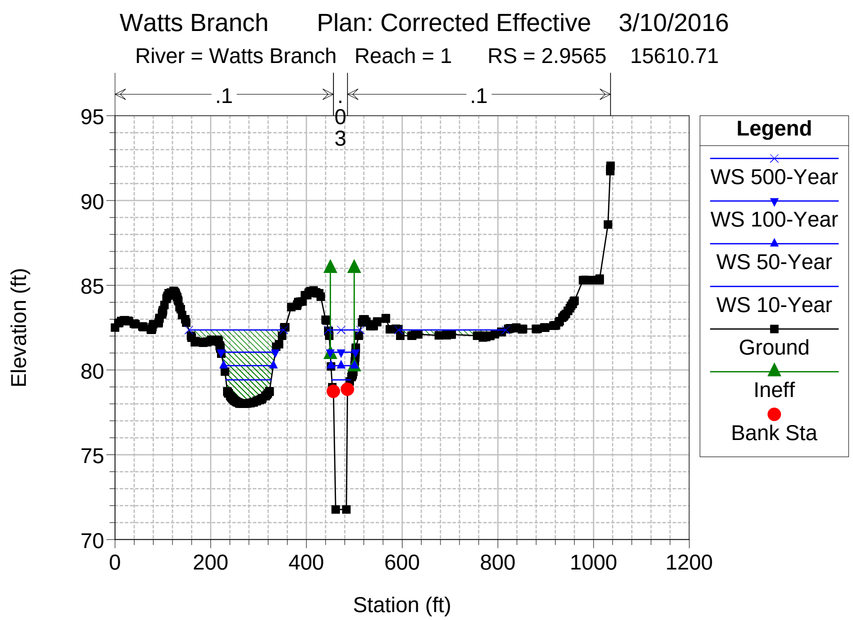

Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 2.9691 15677.03
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 10-Year
WS 100-Year
WS 50-Year
WS 500-Year
Ground
Ineff
Bank Sta



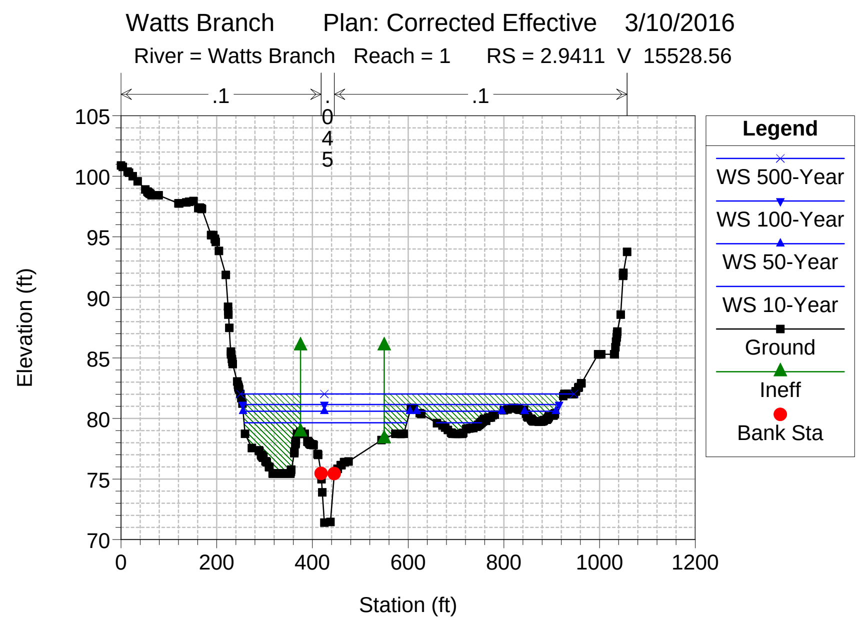
Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 2.9628 Culv 61ST STREET NE
.1
.03
.1
Elevation (ft)
Station (ft)
88
86
84
82
80
78
76
74
72
70
0
200
400
600
800
Legend
WS 10-Year
WS 100-Year
WS 50-Year
WS 500-Year
Ground
Ineff
Bank Sta



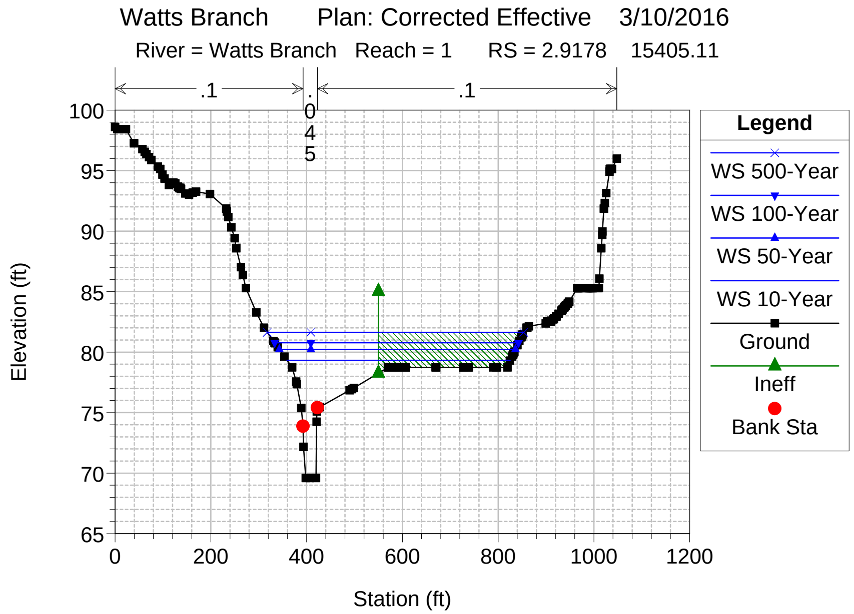
Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 2.9628 Culv 61ST STREET NE
.1
.03
.1
Elevation (ft)
Station (ft)
95
90
85
80
75
70
0
200
400
600
800
1000
1200
Legend
WS 500-Year
WS 50-Year
WS 100-Year
WS 10-Year
Ground
Ineff
Bank Sta

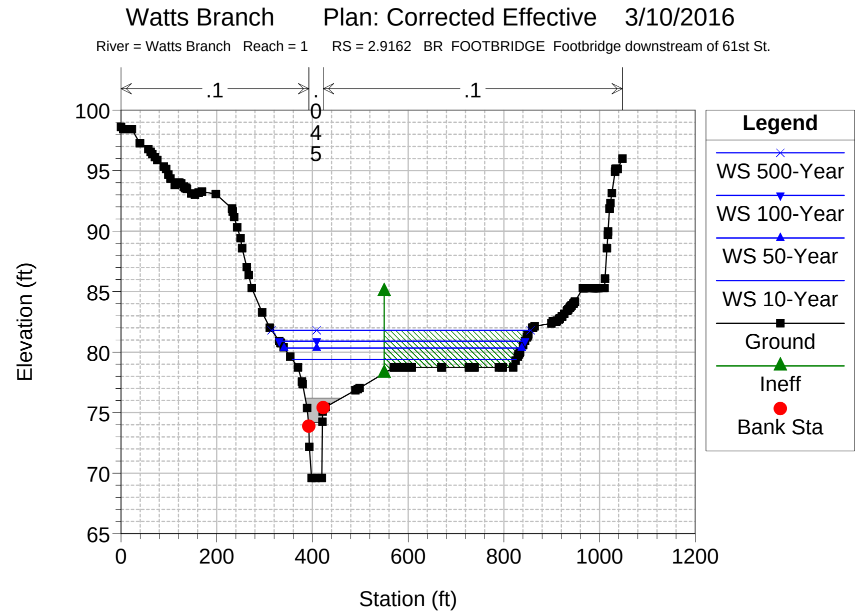


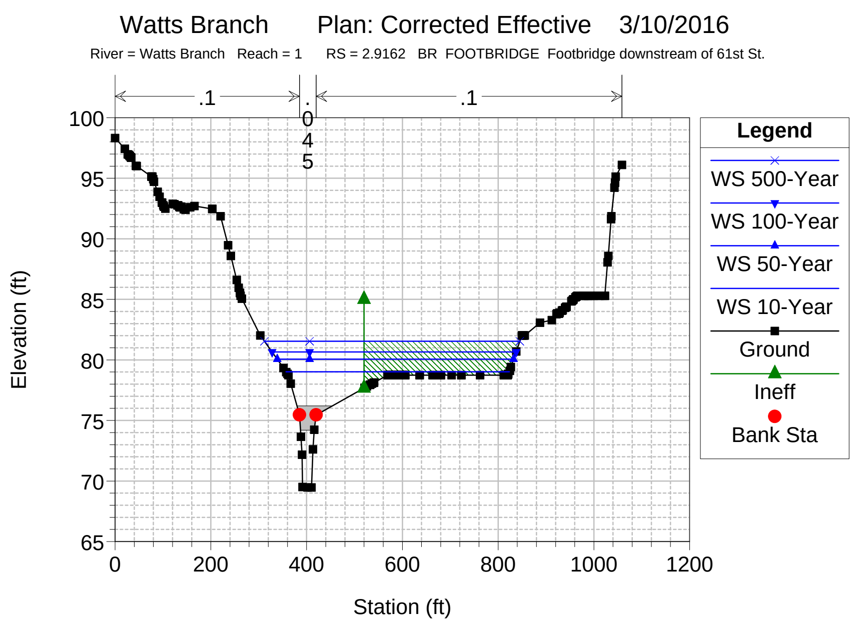
Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 2.9565 15610.71
.1
.03
.1
Elevation (ft)
Station (ft)
95
90
85
80
75
70
0
200
400
600
800
1000
1200
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

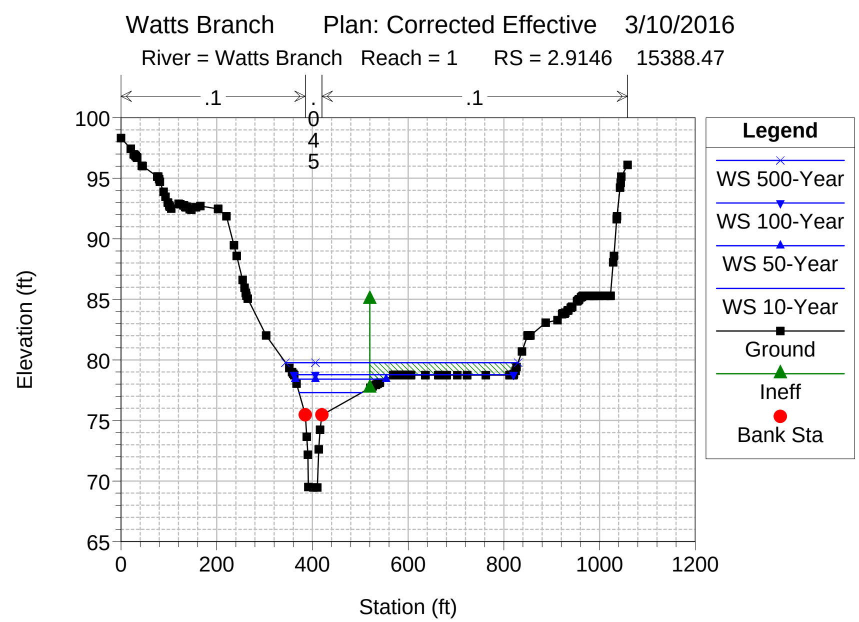


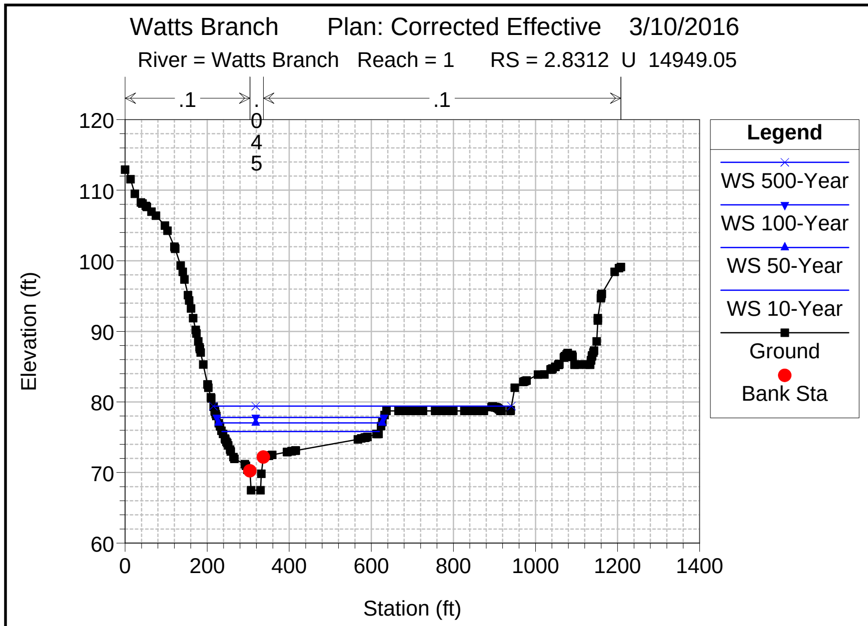
Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 2.9411 V 15528.56
.1
.045
.1
Elevation (ft)
Station (ft)
105
100
95
90
85
80
75
70
0
200
400
600
800
1000
1200
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 2.9178 15405.11
.1
.045
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

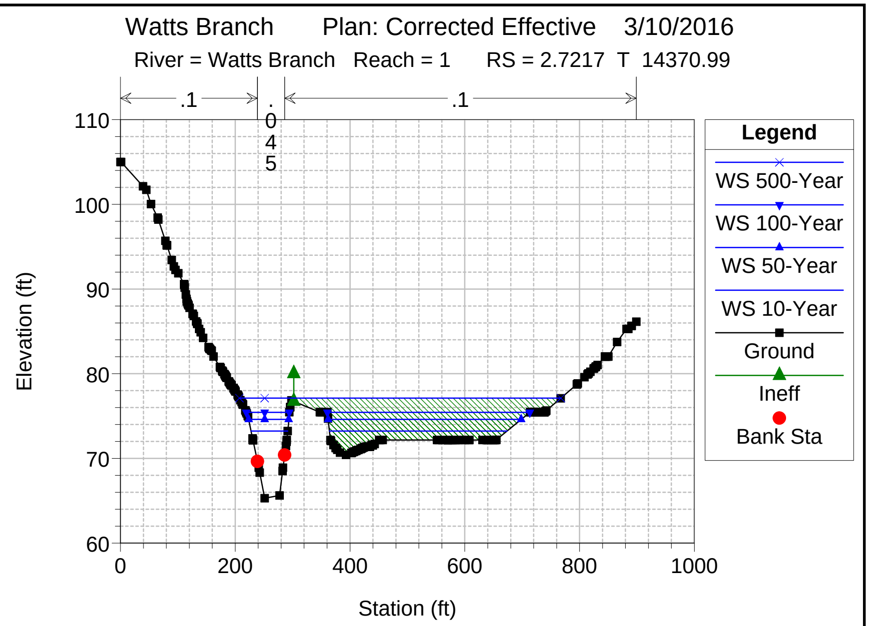

Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 2.9162 BR FOOTBRIDGE Footbridge downstream of 61st St.
.1
.045
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 2.9162 BR FOOTBRIDGE Footbridge downstream of 61st St.
.1
.045
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 2.9146 15388.47
.1
.045
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 2.8312 U 14949.05
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Bank Sta



Watts Branch Plan: Corrected Effective 3/10/2016
River = Watts Branch Reach = 1 RS = 2.7217 T 14370.99
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

“CORRECTED EFFECTIVE” MODEL

STANDARD OUTPUT TABLE

HEC-RAS Plan: Ex Corrected Eff Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Watts Branch	1	3.1105	10-Year	2545.00	78.41	91.76	84.08	91.91	0.000391	3.26	984.01	424.50	0.17
Watts Branch	1	3.1105	50-Year	3368.00	78.41	92.45	85.10	92.67	0.000557	4.05	1052.49	465.14	0.20
Watts Branch	1	3.1105	100-Year	3872.00	78.41	92.79	85.56	93.07	0.000667	4.51	1086.46	484.40	0.22
Watts Branch	1	3.1105	500-Year	4880.00	78.41	93.29	86.35	93.69	0.000922	5.44	1136.89	511.05	0.26
Watts Branch	1	3.0910	10-Year	2545.00	77.50	91.44	84.46	91.84	0.000438	5.24	767.44	469.03	0.26
Watts Branch	1	3.0910	50-Year	3368.00	77.50	91.98	85.65	92.57	0.000632	6.47	930.75	516.00	0.32
Watts Branch	1	3.0910	100-Year	3872.00	77.50	92.22	86.22	92.95	0.000767	7.22	1007.68	538.69	0.35
Watts Branch	1	3.0910	500-Year	4880.00	77.50	92.44	87.26	93.52	0.001125	8.84	1083.92	562.30	0.43
Watts Branch	1	3.083 SOUTHERN AVE.		Culvert									
Watts Branch	1	3.0765	10-Year	2545.00	75.51	87.64	83.51	88.47	0.001215	7.34	361.96	79.14	0.42
Watts Branch	1	3.0765	50-Year	3368.00	75.51	88.13	84.62	89.44	0.001795	9.23	381.65	81.19	0.51
Watts Branch	1	3.0765	100-Year	3872.00	75.51	88.53	85.21	90.13	0.002081	10.20	397.48	82.85	0.56
Watts Branch	1	3.0765	500-Year	4880.00	75.51	89.20	86.40	91.43	0.002680	12.06	424.21	88.03	0.64
Watts Branch	1	3.0546 X	10-Year	2545.00	74.43	87.53	82.83	88.07	0.001357	6.10	582.55	311.71	0.36
Watts Branch	1	3.0546 X	50-Year	3368.00	74.43	88.00	84.14	88.81	0.001932	7.53	659.09	355.28	0.43
Watts Branch	1	3.0546 X	100-Year	3872.00	74.43	88.44	84.84	89.35	0.002099	8.09	745.91	410.94	0.45
Watts Branch	1	3.0546 X	500-Year	4880.00	74.43	89.27	86.54	90.35	0.002323	8.99	912.66	473.94	0.48
Watts Branch	1	3.0329	10-Year	2545.00	74.37	87.44	82.61	87.88	0.001899	5.33	500.58	329.06	0.41
Watts Branch	1	3.0329	50-Year	3368.00	74.37	87.90	83.77	88.54	0.002487	6.45	573.53	423.47	0.48
Watts Branch	1	3.0329	100-Year	3872.00	74.37	88.36	86.05	89.06	0.002499	6.81	667.53	558.39	0.48
Watts Branch	1	3.0329	500-Year	4880.00	74.37	89.25	86.71	90.03	0.002373	7.26	908.39	629.08	0.48
Watts Branch	1	3.03 FOOTBRIDGE		Bridge									
Watts Branch	1	3.0287	10-Year	2545.00	74.39	87.10	81.90	87.67	0.002142	6.07	448.27	307.33	0.44
Watts Branch	1	3.0287	50-Year	3368.00	74.39	87.22	83.08	88.17	0.003496	7.86	463.38	315.95	0.56
Watts Branch	1	3.0287	100-Year	3872.00	74.39	87.54	83.74	88.66	0.003869	8.55	505.79	368.58	0.59
Watts Branch	1	3.0287	500-Year	4880.00	74.39	88.14	86.53	89.57	0.004458	9.74	614.73	566.27	0.65
Watts Branch	1	2.9747 W	10-Year	2545.00	72.18	87.01	80.35	87.21	0.000720	4.38	1209.88	592.73	0.22
Watts Branch	1	2.9747 W	50-Year	3368.00	72.18	87.03	81.64	87.39	0.001249	5.78	1215.73	593.60	0.29
Watts Branch	1	2.9747 W	100-Year	3872.00	72.18	87.31	82.32	87.73	0.001465	6.35	1284.92	603.01	0.31
Watts Branch	1	2.9747 W	500-Year	4880.00	72.18	87.81	84.60	88.37	0.001895	7.41	1411.52	617.55	0.36
Watts Branch	1	2.9691	10-Year	2545.00	71.91	86.69	78.89	87.12	0.000554	5.32	481.71	753.81	0.27
Watts Branch	1	2.9691	50-Year	3368.00	71.91	86.42	80.14	87.22	0.001044	7.20	470.95	700.79	0.37
Watts Branch	1	2.9691	100-Year	3872.00	71.91	86.45	80.87	87.50	0.001369	8.26	472.09	703.43	0.42
Watts Branch	1	2.9691	500-Year	4880.00	71.91	86.20	82.16	87.95	0.002332	10.63	462.11	668.43	0.54
Watts Branch	1	2.9628 61ST STREET NE		Culvert									

HEC-RAS Plan: Ex Corrected Eff Locations: User Defined (Continued)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Watts Branch	1	2.9565	10-Year	2545.00	71.77	79.42	78.78	81.94	0.007280	12.74	202.92	133.17	0.86
Watts Branch	1	2.9565	50-Year	3368.00	71.77	80.26	80.26	83.70	0.008546	14.92	240.62	152.72	0.95
Watts Branch	1	2.9565	100-Year	3872.00	71.77	81.05	81.05	84.69	0.007996	15.41	279.65	166.29	0.94
Watts Branch	1	2.9565	500-Year	4880.00	71.77	82.36	82.36	86.48	0.007583	16.53	345.22	489.13	0.93
Watts Branch	1	2.9411 V	10-Year	2545.00	71.40	79.64	79.12	80.59	0.006204	9.20	547.31	432.55	0.61
Watts Branch	1	2.9411 V	50-Year	3368.00	71.40	80.60	79.76	81.53	0.005688	9.58	714.83	592.11	0.59
Watts Branch	1	2.9411 V	100-Year	3872.00	71.40	81.15	80.09	82.08	0.005411	9.76	811.06	661.51	0.58
Watts Branch	1	2.9411 V	500-Year	4880.00	71.40	82.02	80.69	83.02	0.005364	10.36	964.74	697.24	0.59
Watts Branch	1	2.9178	10-Year	2545.00	69.60	79.32	77.08	79.96	0.003241	7.25	653.50	465.58	0.43
Watts Branch	1	2.9178	50-Year	3368.00	69.60	80.22	78.53	80.93	0.003424	7.94	833.45	493.22	0.45
Watts Branch	1	2.9178	100-Year	3872.00	69.60	80.78	78.90	81.50	0.003395	8.20	950.31	509.30	0.45
Watts Branch	1	2.9178	500-Year	4880.00	69.60	81.64	79.67	82.42	0.003546	8.84	1144.04	535.80	0.46
Watts Branch	1	2.9162 FOOTBRIDGE		Bridge									
Watts Branch	1	2.9146	10-Year	2545.00	69.47	77.31	77.31	79.21	0.012802	11.39	300.65	131.44	0.82
Watts Branch	1	2.9146	50-Year	3368.00	69.47	78.41	78.41	80.20	0.010544	11.56	465.15	189.71	0.76
Watts Branch	1	2.9146	100-Year	3872.00	69.47	78.78	78.78	80.71	0.011002	12.21	522.85	458.95	0.78
Watts Branch	1	2.9146	500-Year	4880.00	69.47	79.78	79.56	81.64	0.009714	12.46	690.14	486.11	0.75
Watts Branch	1	2.8312 U	10-Year	2545.00	67.50	75.81	74.11	76.15	0.002470	5.99	1051.53	383.73	0.38
Watts Branch	1	2.8312 U	50-Year	3368.00	67.50	77.04	74.86	77.29	0.001750	5.58	1533.28	398.57	0.33
Watts Branch	1	2.8312 U	100-Year	3872.00	67.50	77.80	75.22	78.01	0.001444	5.35	1837.03	406.96	0.30
Watts Branch	1	2.8312 U	500-Year	4880.00	67.50	79.41	75.75	79.62	0.001254	5.53	2696.47	726.21	0.29
Watts Branch	1	2.7217 T	10-Year	2545.00	65.31	73.24	70.99	74.18	0.004666	7.84	347.82	373.41	0.53
Watts Branch	1	2.7217 T	50-Year	3368.00	65.31	74.60	71.93	75.70	0.004318	8.53	438.78	406.16	0.53
Watts Branch	1	2.7217 T	100-Year	3872.00	65.31	75.43	72.48	76.60	0.004062	8.83	498.69	427.69	0.52
Watts Branch	1	2.7217 T	500-Year	4880.00	65.31	77.13	73.47	78.38	0.003511	9.21	640.19	560.08	0.50

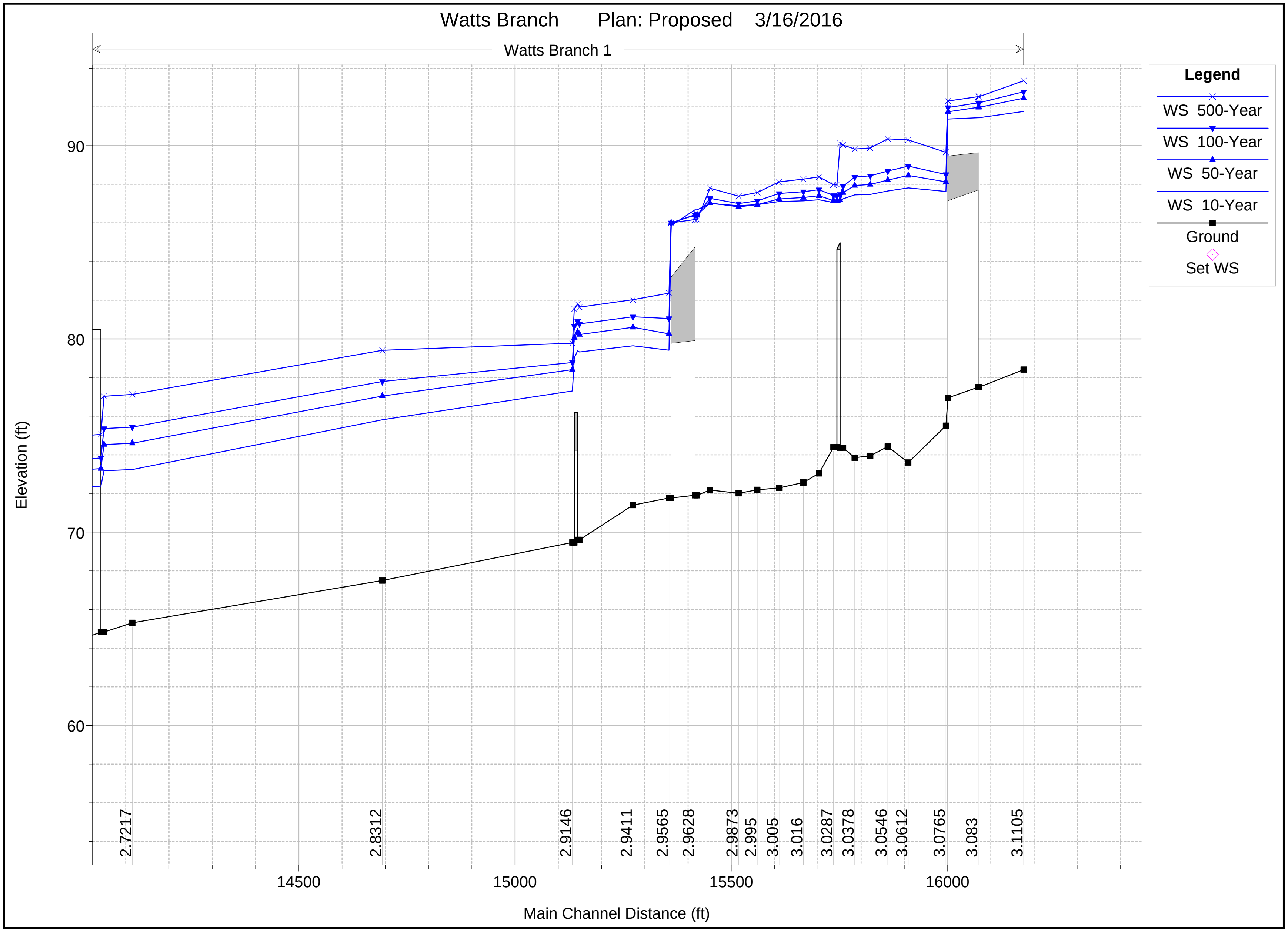
APPENDIX F

“PROPOSED CONDITIONS” MODEL

OUTPUTS

“PROPOSED CONDITIONS” MODEL

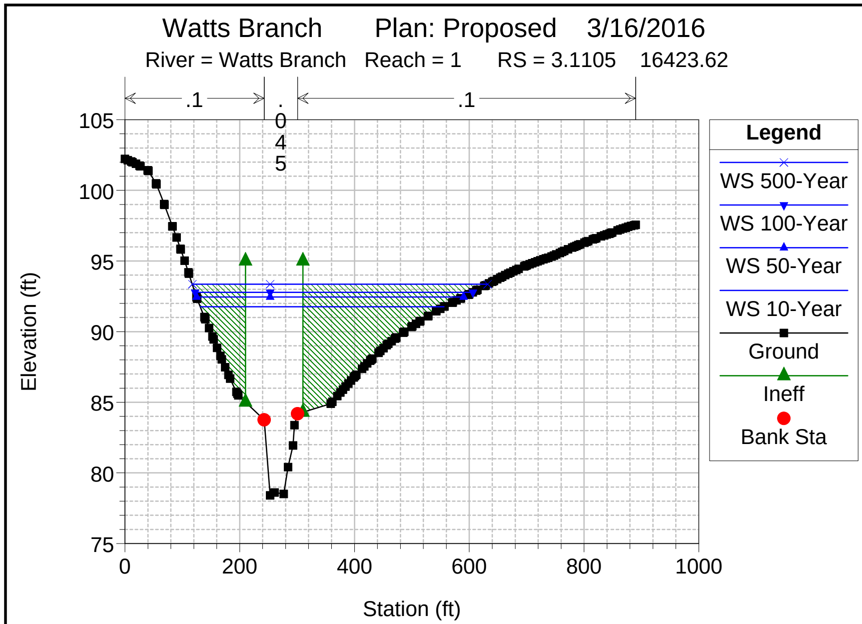
PROFILE

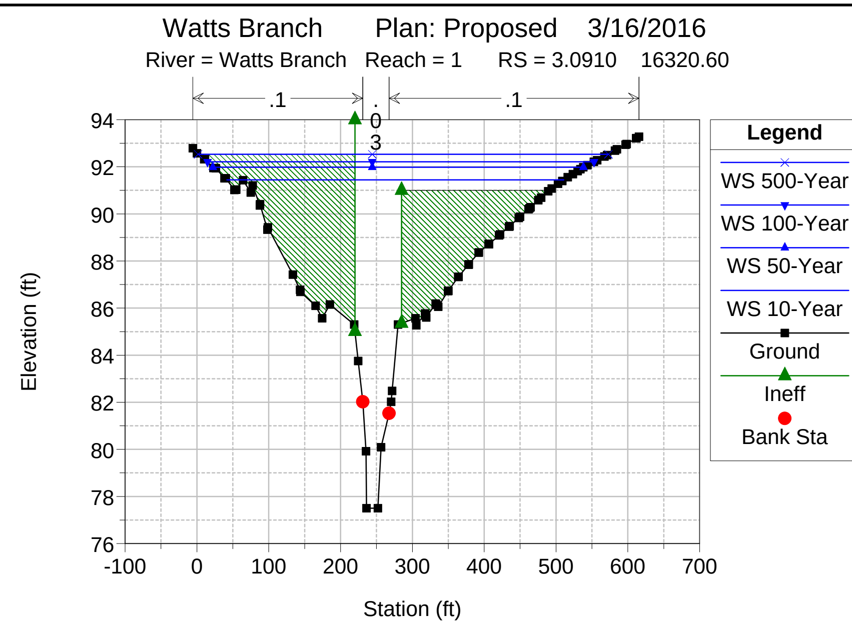


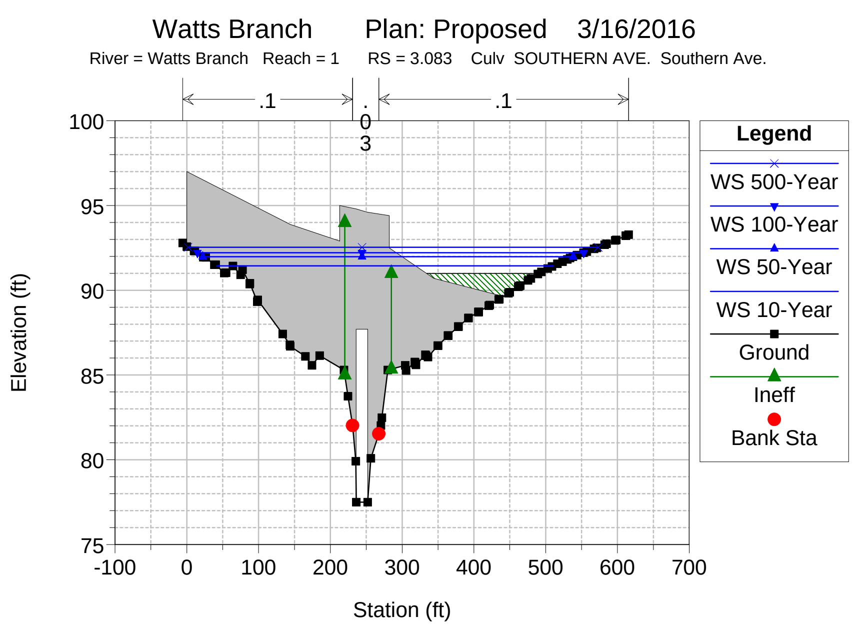
Watts Branch Plan: Proposed 3/16/2016
Watts Branch 1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Set WS
Elevation (ft)
90
80
70
60
2.7217
2.8312
2.9146
2.9411
2.9565
2.9628
2.9873
2.995
3.005
3.016
3.0287
3.0378
3.0546
3.0612
3.0765
3.083
3.1105
14500
15000
15500
16000
Main Channel Distance (ft)

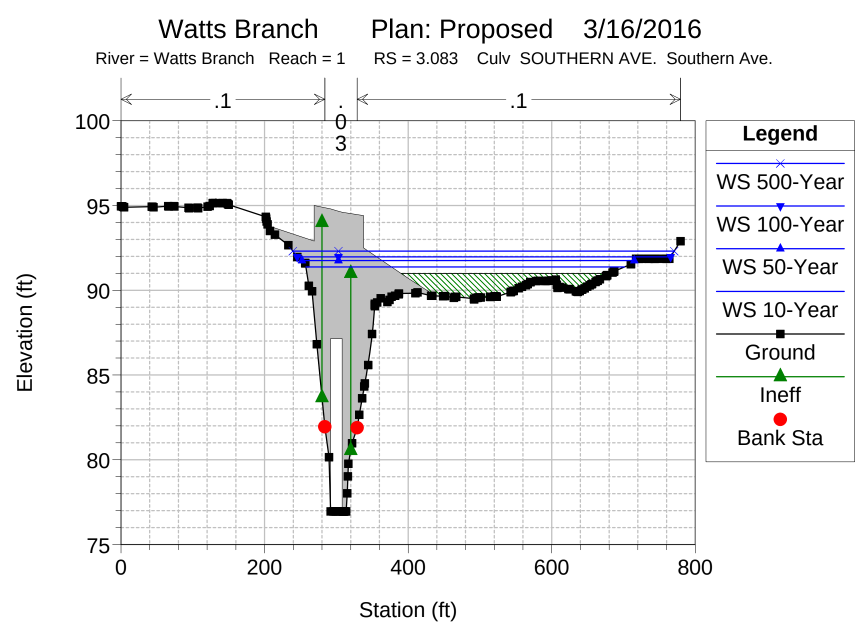
“PROPOSED CONDITIONS” MODEL

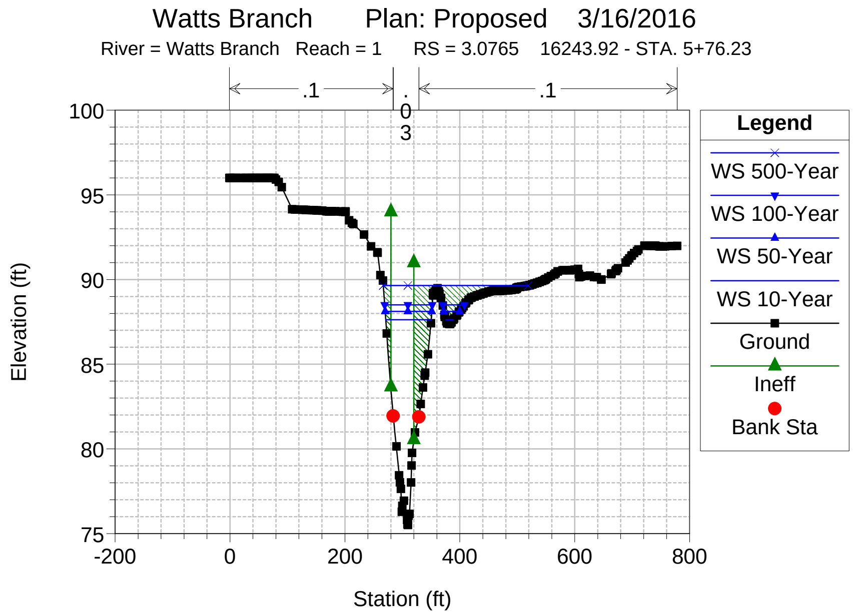
CROSS SECTIONS


Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.1105 16423.62
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

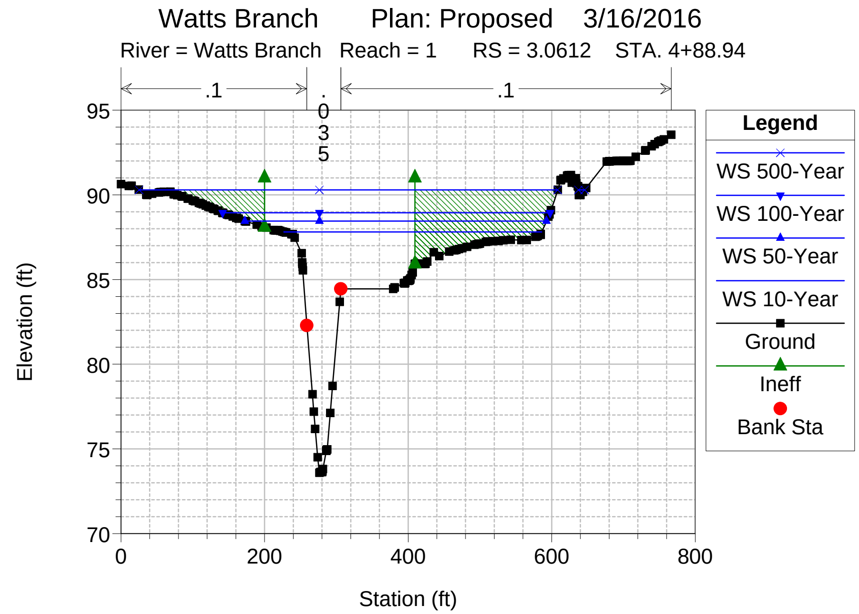

Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0910 16320.60
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.083 Culv SOUTHERN AVE. Southern Ave.
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

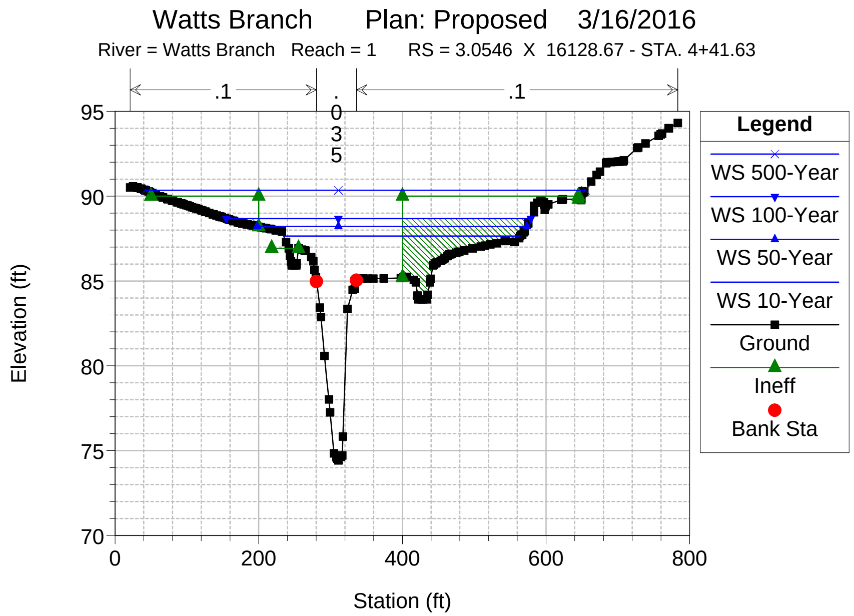

Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.083 Culv SOUTHERN AVE. Southern Ave.
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta



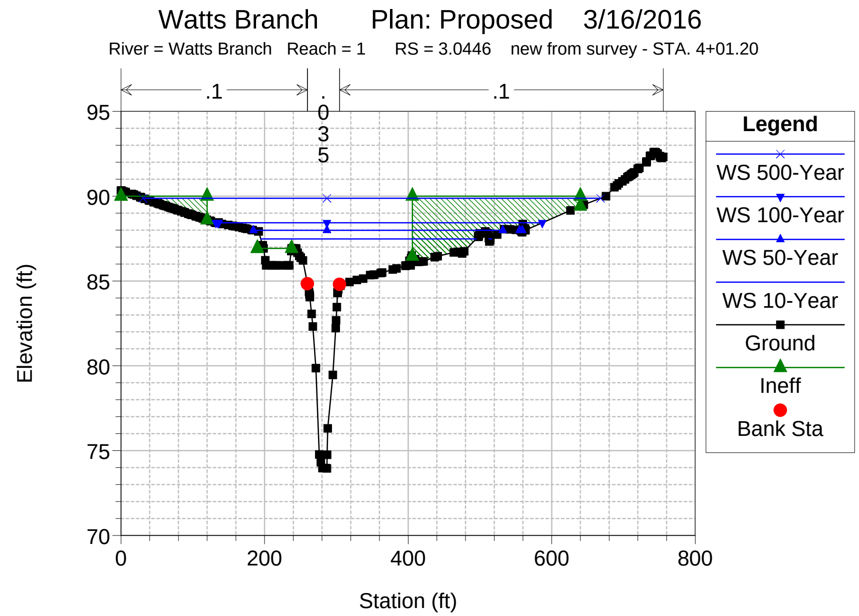
Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0765 16243.92 - STA. 5+76.23
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta



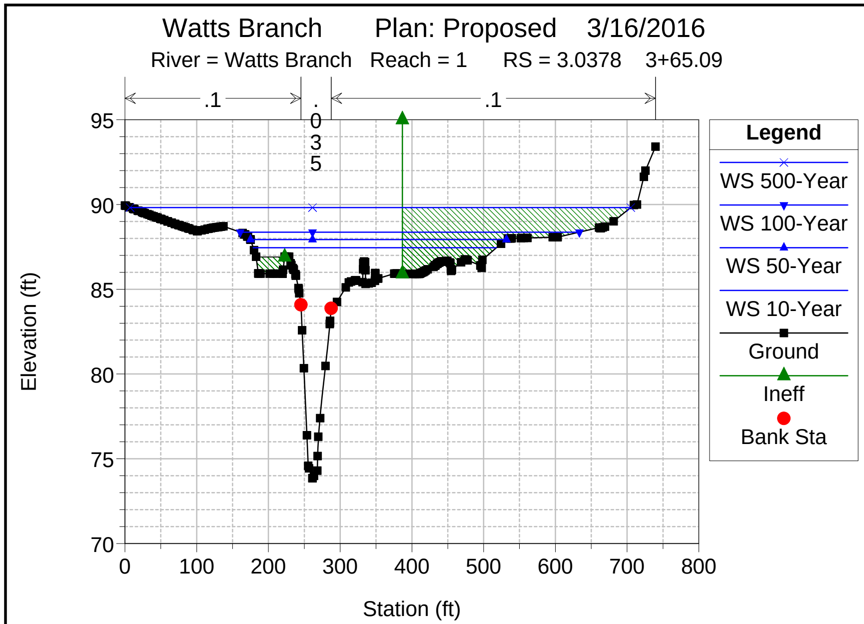
Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0612 STA. 4+88.94
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta



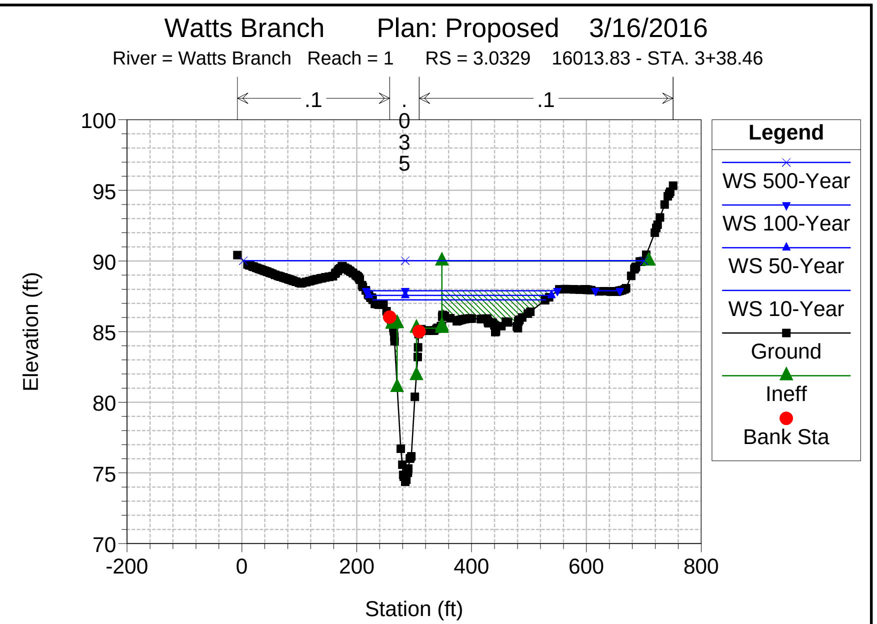
Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0546 X 16128.67 - STA. 4+41.63
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta



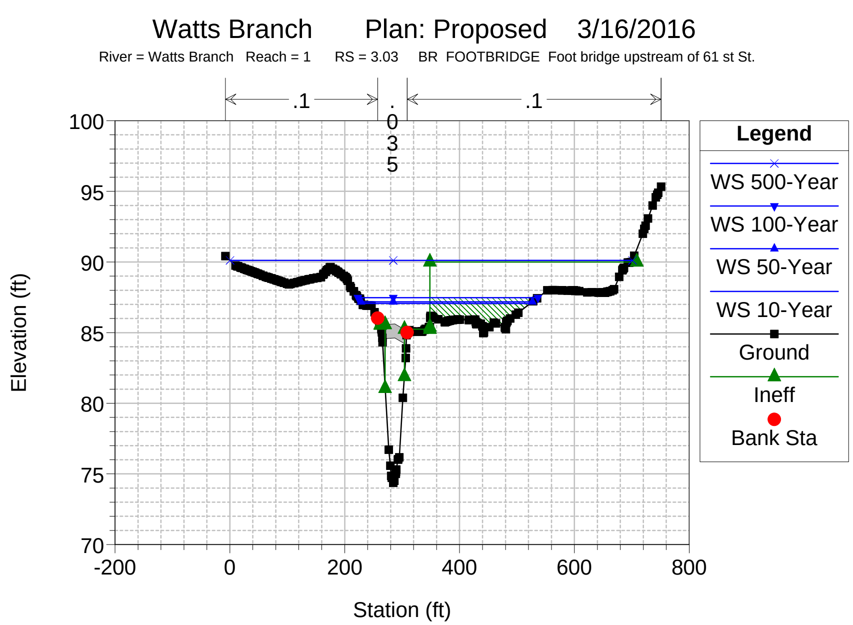
Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0446 new from survey - STA. 4+01.20
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta



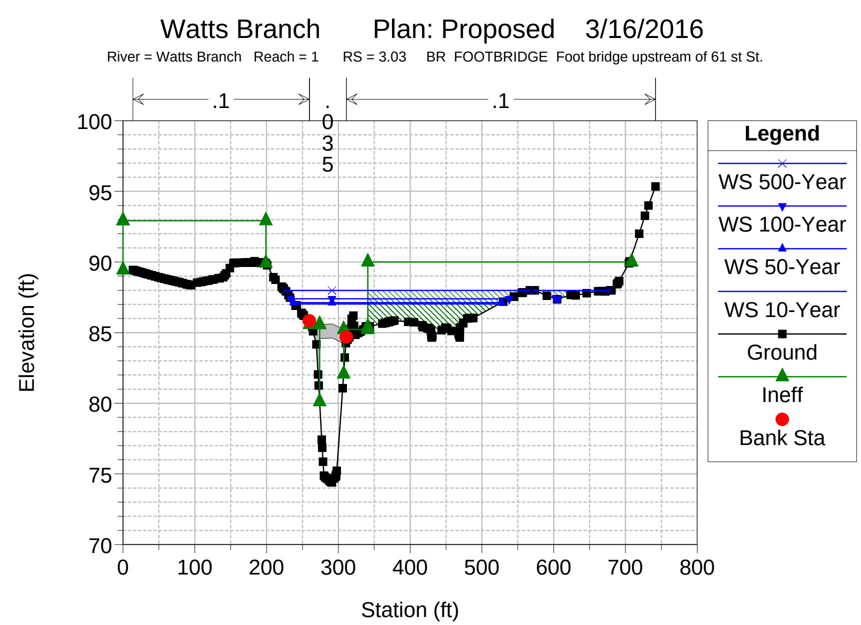
Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0378 3+65.09
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta



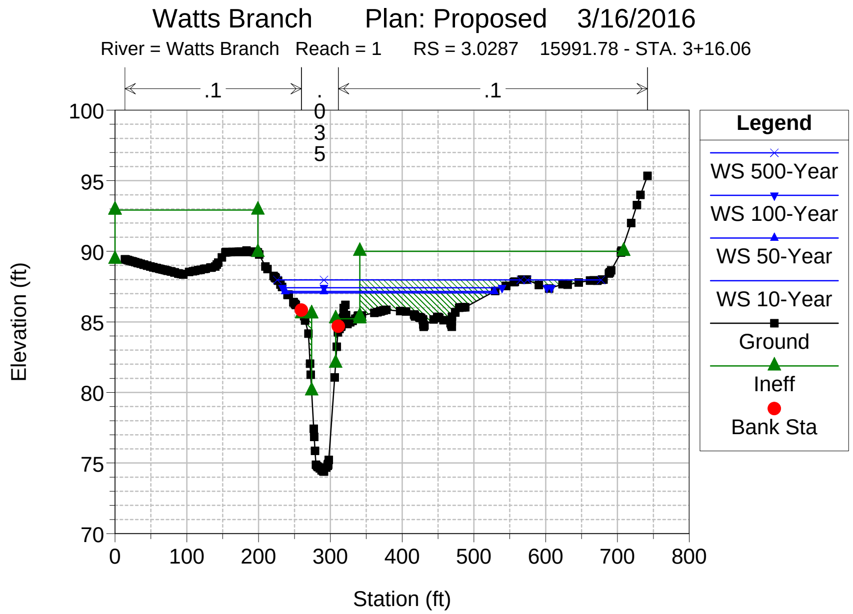
Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0329 16013.83 - STA. 3+38.46
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

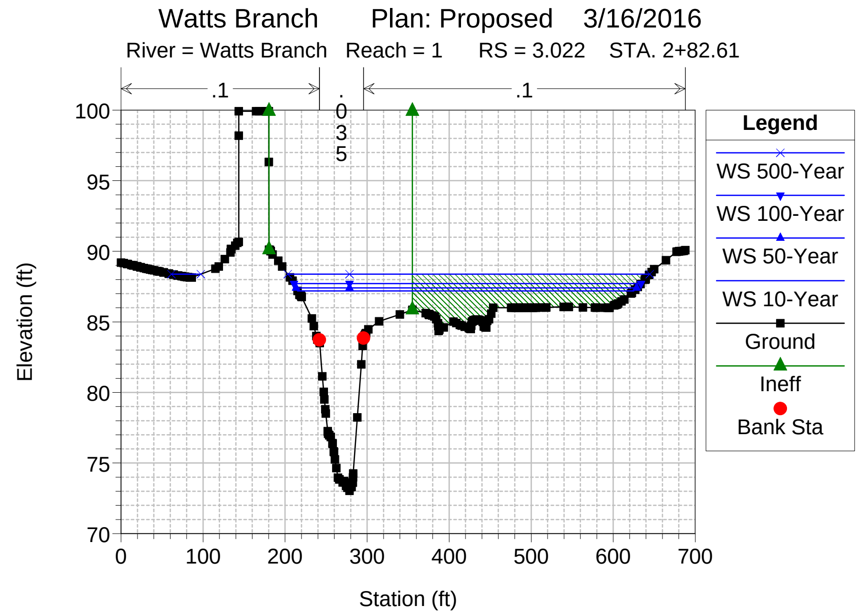


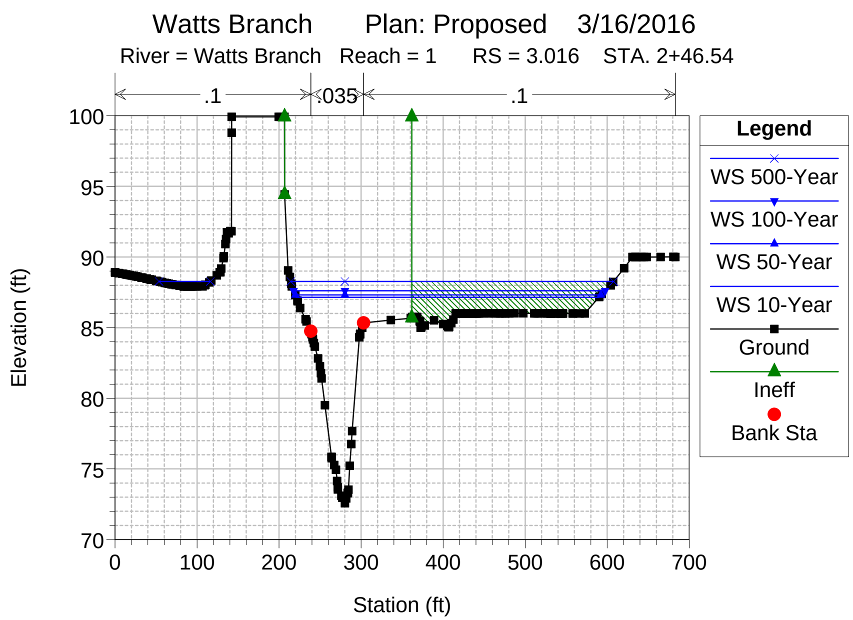
Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.03 BR FOOTBRIDGE Foot bridge upstream of 61 st St.
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

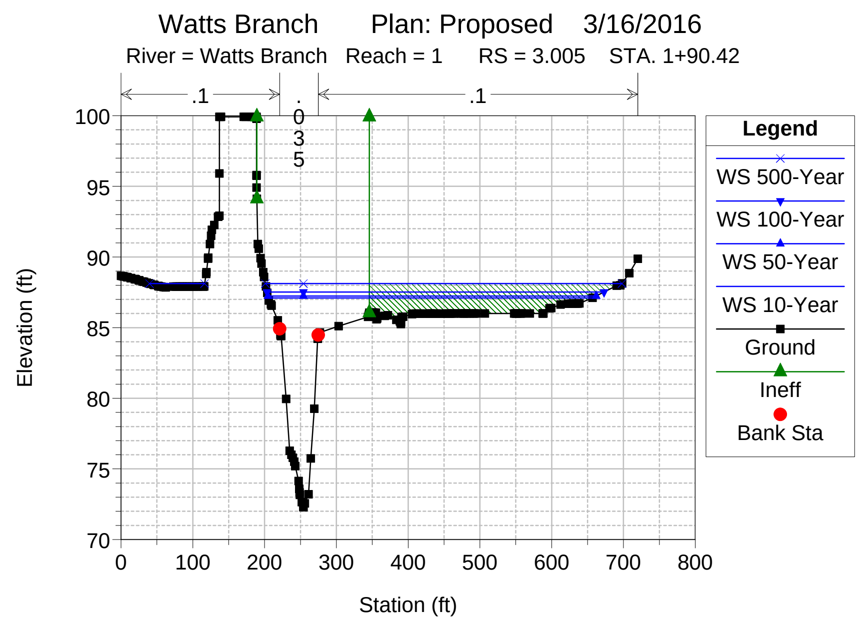


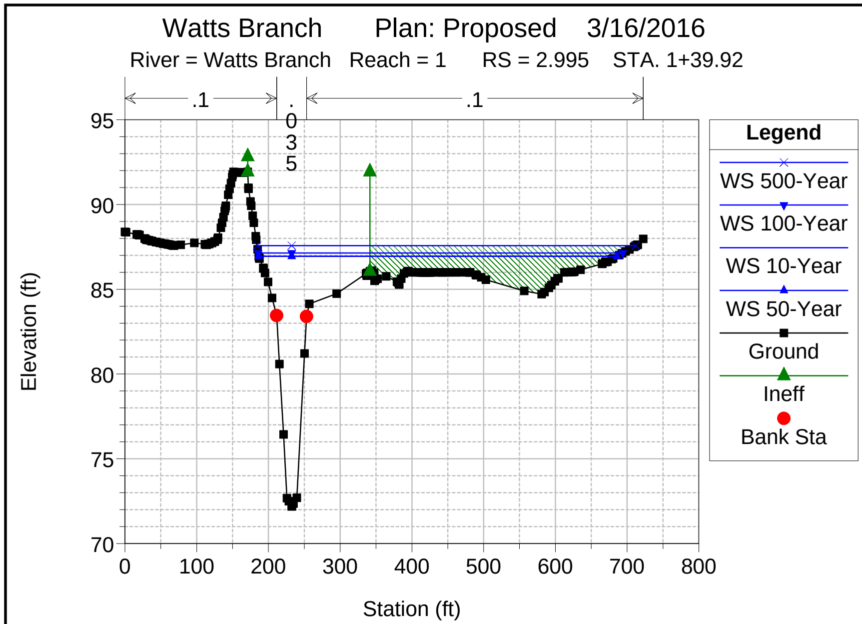
Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.03 BR FOOTBRIDGE Foot bridge upstream of 61 st St.
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

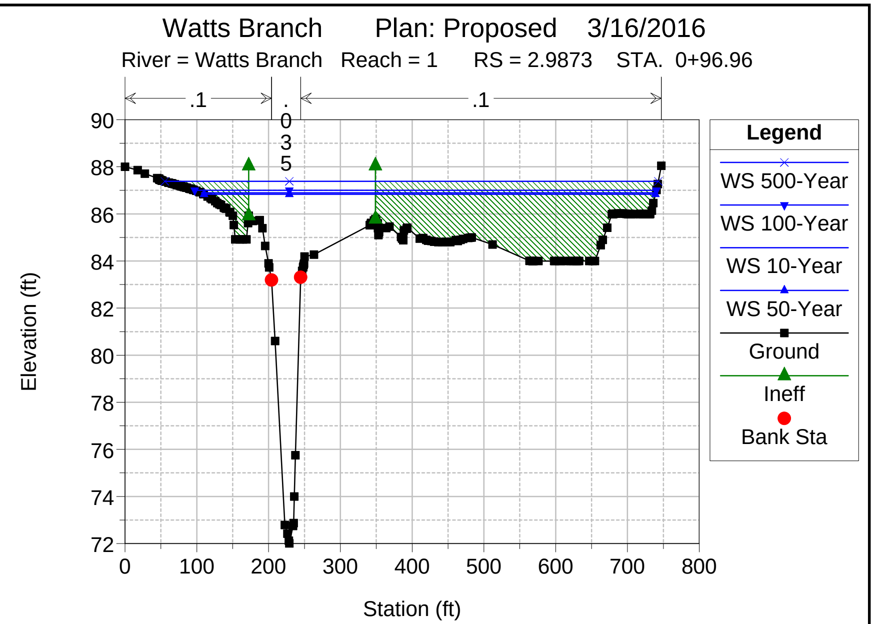

Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0287 15991.78 - STA. 3+16.06
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

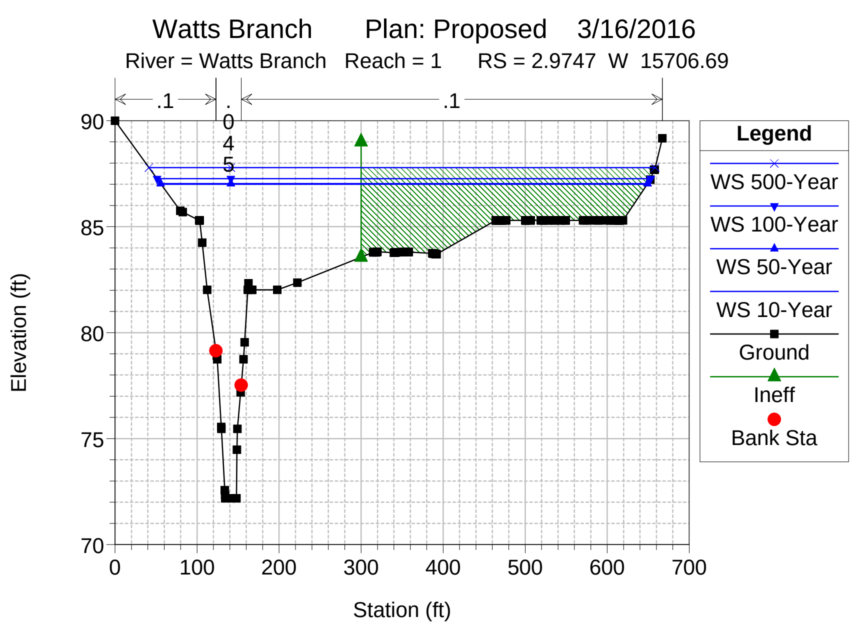

Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.022 STA. 2+82.61
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

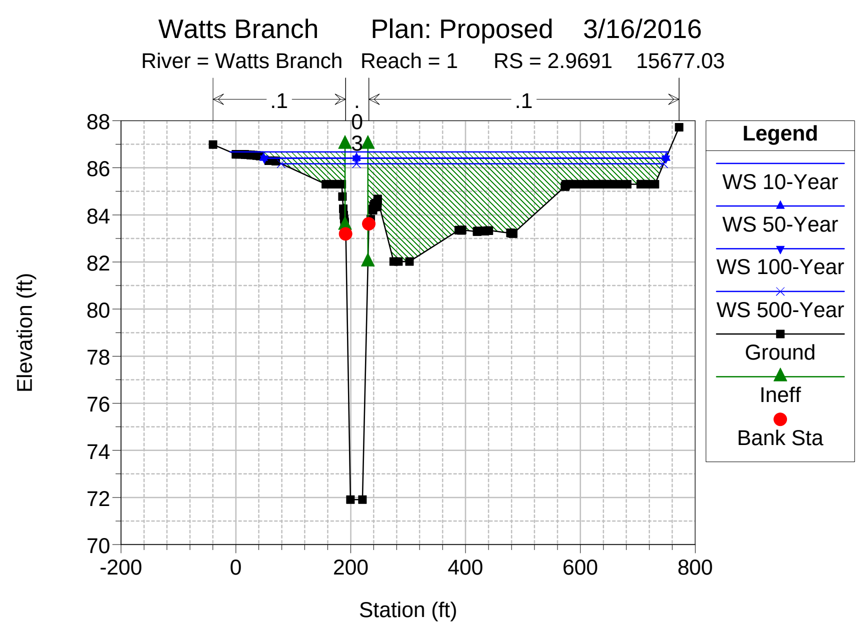

Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.016 STA. 2+46.54
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

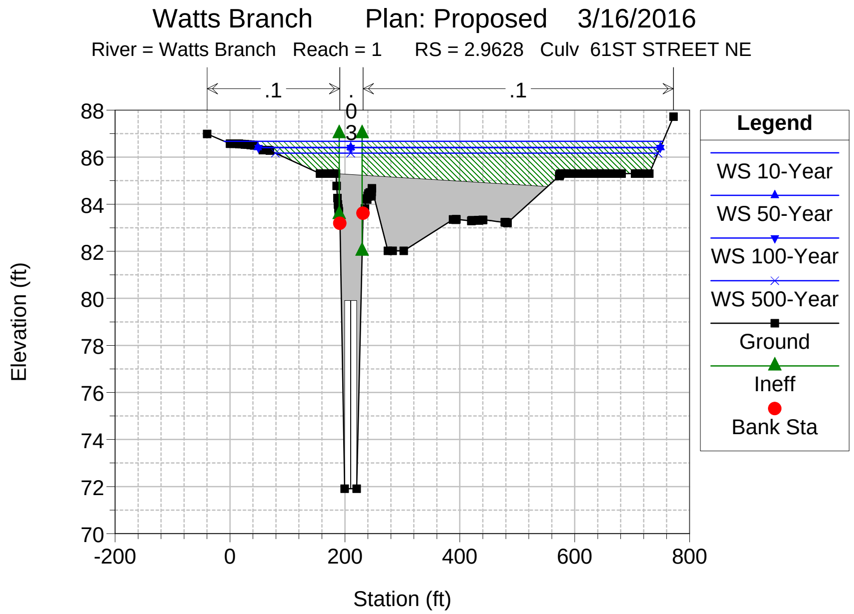

Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 3.005 STA. 1+90.42
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

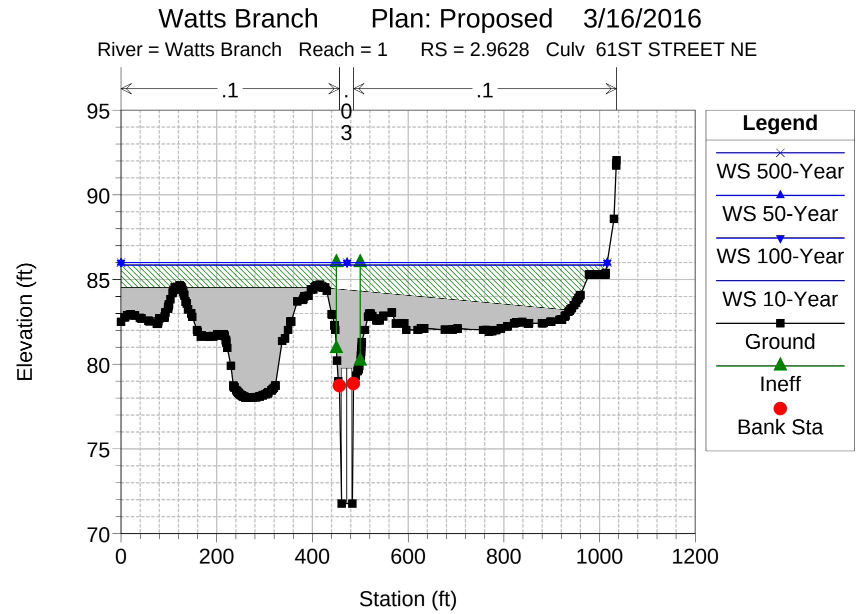

Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 2.995 STA. 1+39.92
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 10-Year
WS 50-Year
Ground
Ineff
Bank Sta

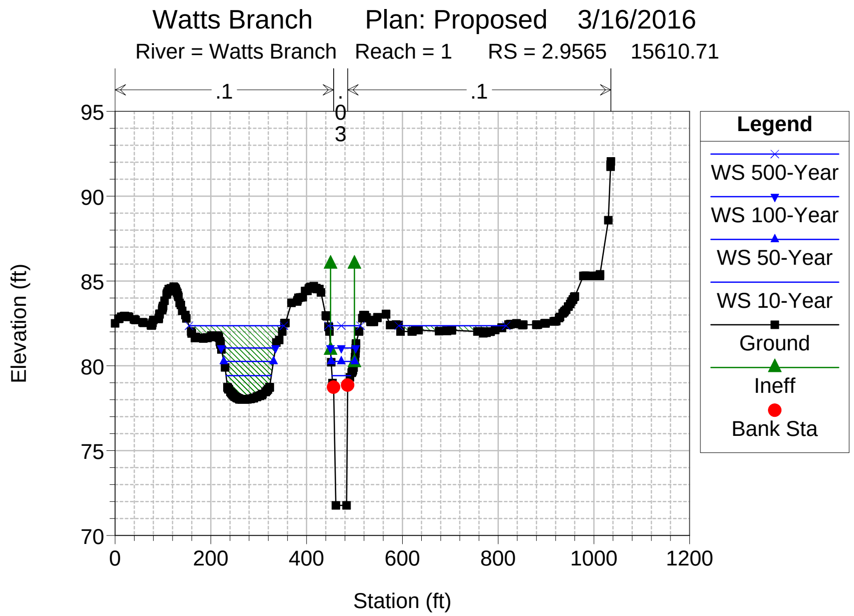

Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9873 STA. 0+96.96
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 10-Year
WS 50-Year
Ground
Ineff
Bank Sta

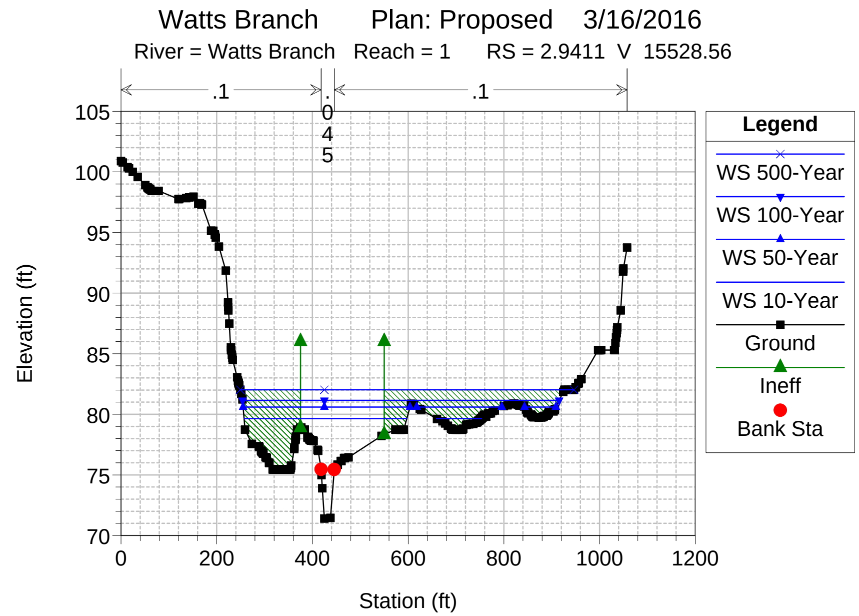

Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9747 W 15706.69
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

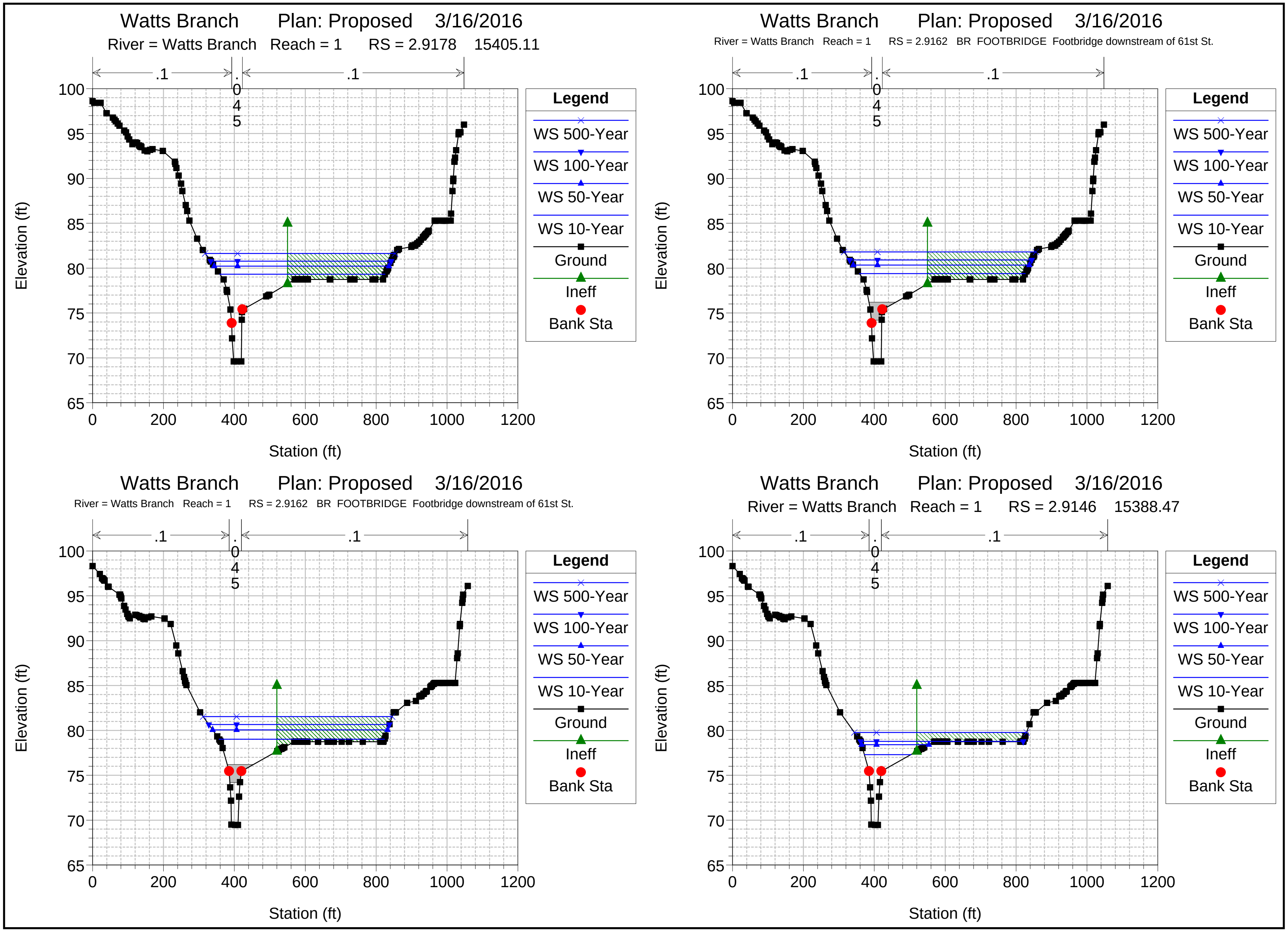

Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9691 15677.03
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 10-Year
WS 50-Year
WS 100-Year
WS 500-Year
Ground
Ineff
Bank Sta

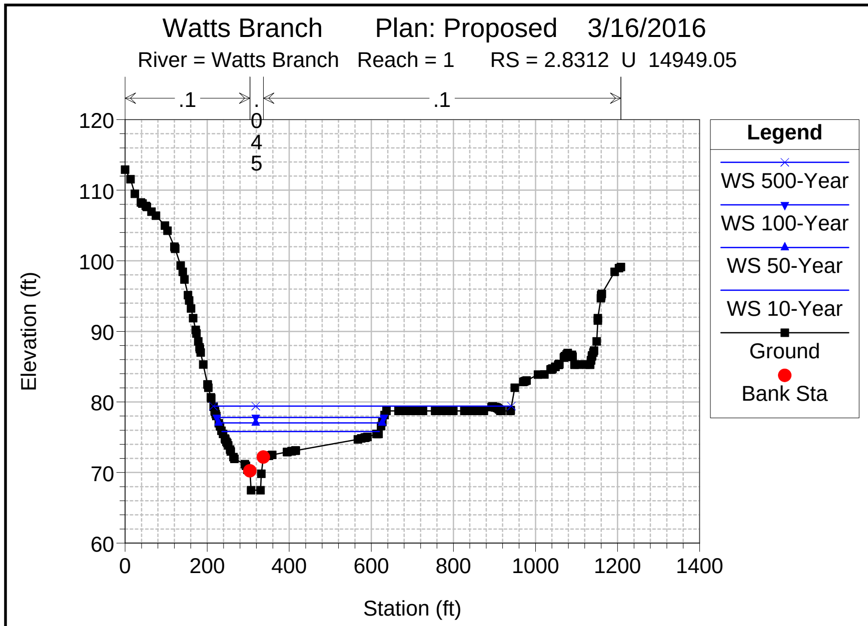

Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9628 Culv 61ST STREET NE
Elevation (ft)
Station (ft)
Legend
WS 10-Year
WS 50-Year
WS 100-Year
WS 500-Year
Ground
Ineff
Bank Sta

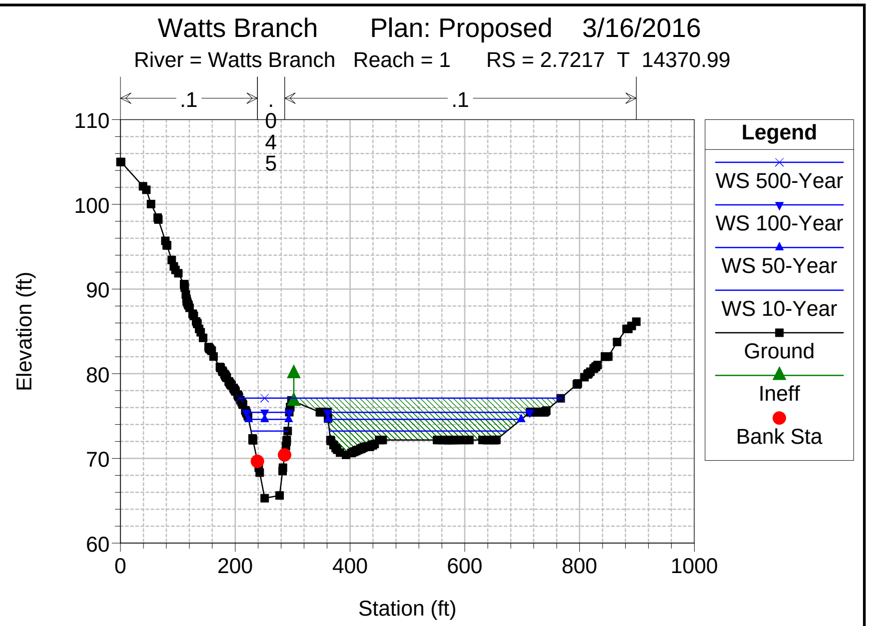

Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9628 Culv 61ST STREET NE
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 50-Year
WS 100-Year
WS 10-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9565 15610.71
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9411 V 15528.56
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9178 15405.11
.1
.045
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
100
95
90
85
80
75
70
65
0
200
400
600
800
1000
1200
Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9162 BR FOOTBRIDGE Footbridge downstream of 61st St.
Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9162 BR FOOTBRIDGE Footbridge downstream of 61st St.
Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9146 15388.47


Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 2.8312 U 14949.05
.1
.045
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Bank Sta
Elevation (ft)
Station (ft)


Watts Branch Plan: Proposed 3/16/2016
River = Watts Branch Reach = 1 RS = 2.7217 T 14370.99
.1
.045
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

“PROPOSED CONDITIONS” MODEL

STANDARD OUTPUT TABLE

HEC-RAS Plan: Proposed Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Watts Branch	1	3.1105	10-Year	2545.00	78.41	91.76	84.08	91.91	0.000391	3.26	983.83	424.41	0.17
Watts Branch	1	3.1105	50-Year	3368.00	78.41	92.45	85.10	92.67	0.000557	4.05	1052.49	465.14	0.20
Watts Branch	1	3.1105	100-Year	3872.00	78.41	92.79	85.56	93.06	0.000668	4.51	1086.04	484.17	0.22
Watts Branch	1	3.1105	500-Year	4880.00	78.41	93.35	86.35	93.75	0.000907	5.42	1142.79	514.21	0.26
Watts Branch	1	3.0910	10-Year	2545.00	77.50	91.44	84.46	91.84	0.000438	5.24	766.86	468.89	0.26
Watts Branch	1	3.0910	50-Year	3368.00	77.50	91.98	85.65	92.57	0.000632	6.47	930.74	516.00	0.32
Watts Branch	1	3.0910	100-Year	3872.00	77.50	92.21	86.22	92.94	0.000769	7.23	1005.86	538.15	0.35
Watts Branch	1	3.0910	500-Year	4880.00	77.50	92.53	87.26	93.58	0.001088	8.74	1115.62	571.35	0.42
Watts Branch	1	3.083 SOUTHERN AVE.		Culvert									
Watts Branch	1	3.0765	10-Year	2545.00	75.51	87.63	83.51	88.46	0.001221	7.35	361.37	92.21	0.42
Watts Branch	1	3.0765	50-Year	3368.00	75.51	88.12	84.62	89.43	0.001803	9.24	381.13	108.68	0.52
Watts Branch	1	3.0765	100-Year	3872.00	75.51	88.50	85.21	90.11	0.002099	10.22	396.41	120.56	0.56
Watts Branch	1	3.0765	500-Year	4880.00	75.51	89.65	86.40	91.71	0.002342	11.58	442.34	252.29	0.60
Watts Branch	1	3.0546 X	10-Year	2545.00	74.43	87.65	82.79	88.07	0.001180	5.38	651.07	329.21	0.34
Watts Branch	1	3.0546 X	50-Year	3368.00	74.43	88.21	84.30	88.82	0.001582	6.53	750.32	375.31	0.40
Watts Branch	1	3.0546 X	100-Year	3872.00	74.43	88.68	85.08	89.36	0.001686	6.98	855.06	423.86	0.41
Watts Branch	1	3.0546 X	500-Year	4880.00	74.43	90.35	86.36	90.74	0.000950	5.88	2106.79	612.66	0.32
Watts Branch	1	3.0329	10-Year	2545.00	74.37	87.25	82.61	87.89	0.001956	6.57	467.36	301.34	0.43
Watts Branch	1	3.0329	50-Year	3368.00	74.37	87.56	83.77	88.58	0.002928	8.26	506.27	317.82	0.53
Watts Branch	1	3.0329	100-Year	3872.00	74.37	87.89	84.43	89.09	0.003297	9.02	549.15	375.51	0.56
Watts Branch	1	3.0329	500-Year	4880.00	74.37	90.02	86.78	90.45	0.001194	6.35	2108.59	697.51	0.35
Watts Branch	1	3.03 FOOTBRIDGE		Bridge									
Watts Branch	1	3.0287	10-Year	2545.00	74.39	87.05	81.91	87.68	0.001822	6.42	453.20	286.16	0.41
Watts Branch	1	3.0287	50-Year	3368.00	74.39	87.16	83.07	88.22	0.003040	8.36	463.68	291.28	0.53
Watts Branch	1	3.0287	100-Year	3872.00	74.39	87.42	83.74	88.71	0.003559	9.25	491.10	312.23	0.58
Watts Branch	1	3.0287	500-Year	4880.00	74.39	87.98	86.26	89.71	0.004397	10.76	553.35	441.86	0.65
Watts Branch	1	2.9747 W	10-Year	2545.00	72.18	87.00	80.35	87.21	0.000723	4.39	1207.93	592.44	0.22
Watts Branch	1	2.9747 W	50-Year	3368.00	72.18	87.03	81.64	87.39	0.001247	5.78	1216.29	593.68	0.29
Watts Branch	1	2.9747 W	100-Year	3872.00	72.18	87.27	82.32	87.70	0.001492	6.40	1274.01	601.77	0.31
Watts Branch	1	2.9747 W	500-Year	4880.00	72.18	87.79	84.60	88.35	0.001910	7.43	1406.45	617.06	0.36
Watts Branch	1	2.9691	10-Year	2545.00	71.91	86.68	78.89	87.12	0.000555	5.32	481.39	763.84	0.27
Watts Branch	1	2.9691	50-Year	3368.00	71.91	86.42	80.14	87.22	0.001043	7.20	471.04	701.01	0.37
Watts Branch	1	2.9691	100-Year	3872.00	71.91	86.40	80.87	87.47	0.001387	8.29	470.27	699.22	0.42
Watts Branch	1	2.9691	500-Year	4880.00	71.91	86.17	82.16	87.93	0.002348	10.65	461.15	665.89	0.55
Watts Branch	1	2.9628 61ST STREET NE		Culvert									

HEC-RAS Plan: Proposed Locations: User Defined (Continued)

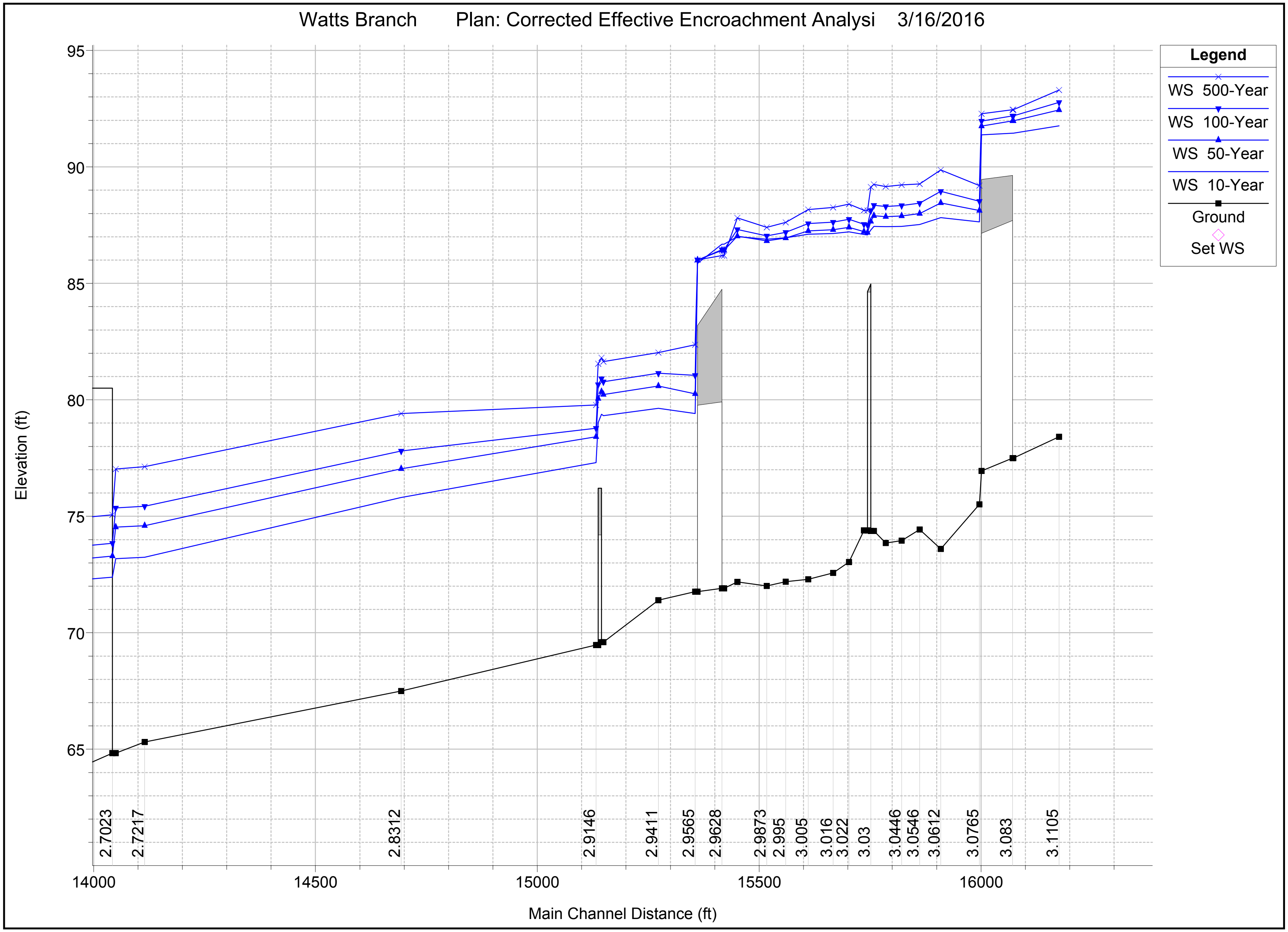
River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Watts Branch	1	2.9565	10-Year	2545.00	71.77	79.42	78.78	81.94	0.007280	12.74	202.92	133.17	0.86
Watts Branch	1	2.9565	50-Year	3368.00	71.77	80.26	80.26	83.70	0.008546	14.92	240.62	152.72	0.95
Watts Branch	1	2.9565	100-Year	3872.00	71.77	81.05	81.05	84.69	0.007996	15.41	279.65	166.29	0.94
Watts Branch	1	2.9565	500-Year	4880.00	71.77	82.36	82.36	86.48	0.007583	16.53	345.22	489.13	0.93
Watts Branch	1	2.9411 V	10-Year	2545.00	71.40	79.64	79.12	80.59	0.006204	9.20	547.31	432.55	0.61
Watts Branch	1	2.9411 V	50-Year	3368.00	71.40	80.60	79.76	81.53	0.005688	9.58	714.83	592.11	0.59
Watts Branch	1	2.9411 V	100-Year	3872.00	71.40	81.15	80.09	82.08	0.005411	9.76	811.06	661.51	0.58
Watts Branch	1	2.9411 V	500-Year	4880.00	71.40	82.02	80.69	83.02	0.005364	10.36	964.74	697.24	0.59
Watts Branch	1	2.9178	10-Year	2545.00	69.60	79.32	77.08	79.96	0.003241	7.25	653.50	465.58	0.43
Watts Branch	1	2.9178	50-Year	3368.00	69.60	80.22	78.53	80.93	0.003424	7.94	833.45	493.22	0.45
Watts Branch	1	2.9178	100-Year	3872.00	69.60	80.78	78.90	81.50	0.003395	8.20	950.31	509.30	0.45
Watts Branch	1	2.9178	500-Year	4880.00	69.60	81.64	79.67	82.42	0.003546	8.84	1144.04	535.80	0.46
Watts Branch	1	2.9162 FOOTBRIDGE		Bridge									
Watts Branch	1	2.9146	10-Year	2545.00	69.47	77.31	77.31	79.21	0.012802	11.39	300.65	131.44	0.82
Watts Branch	1	2.9146	50-Year	3368.00	69.47	78.41	78.41	80.20	0.010544	11.56	465.15	189.71	0.76
Watts Branch	1	2.9146	100-Year	3872.00	69.47	78.78	78.78	80.71	0.011002	12.21	522.85	458.95	0.78
Watts Branch	1	2.9146	500-Year	4880.00	69.47	79.78	79.56	81.64	0.009714	12.46	690.14	486.11	0.75
Watts Branch	1	2.8312 U	10-Year	2545.00	67.50	75.81	74.11	76.15	0.002470	5.99	1051.53	383.73	0.38
Watts Branch	1	2.8312 U	50-Year	3368.00	67.50	77.04	74.86	77.29	0.001750	5.58	1533.28	398.57	0.33
Watts Branch	1	2.8312 U	100-Year	3872.00	67.50	77.80	75.22	78.01	0.001444	5.35	1837.03	406.96	0.30
Watts Branch	1	2.8312 U	500-Year	4880.00	67.50	79.41	75.75	79.62	0.001254	5.53	2696.47	726.21	0.29
Watts Branch	1	2.7217 T	10-Year	2545.00	65.31	73.24	70.99	74.18	0.004666	7.84	347.82	373.41	0.53
Watts Branch	1	2.7217 T	50-Year	3368.00	65.31	74.60	71.93	75.70	0.004318	8.53	438.78	406.16	0.53
Watts Branch	1	2.7217 T	100-Year	3872.00	65.31	75.43	72.48	76.60	0.004062	8.83	498.69	427.69	0.52
Watts Branch	1	2.7217 T	500-Year	4880.00	65.31	77.13	73.47	78.38	0.003511	9.21	640.19	560.08	0.50

APPENDIX G

"PROPOSED CONDITIONS FOR BASKETBALL COURT ONLY" MODEL OUTPUTS

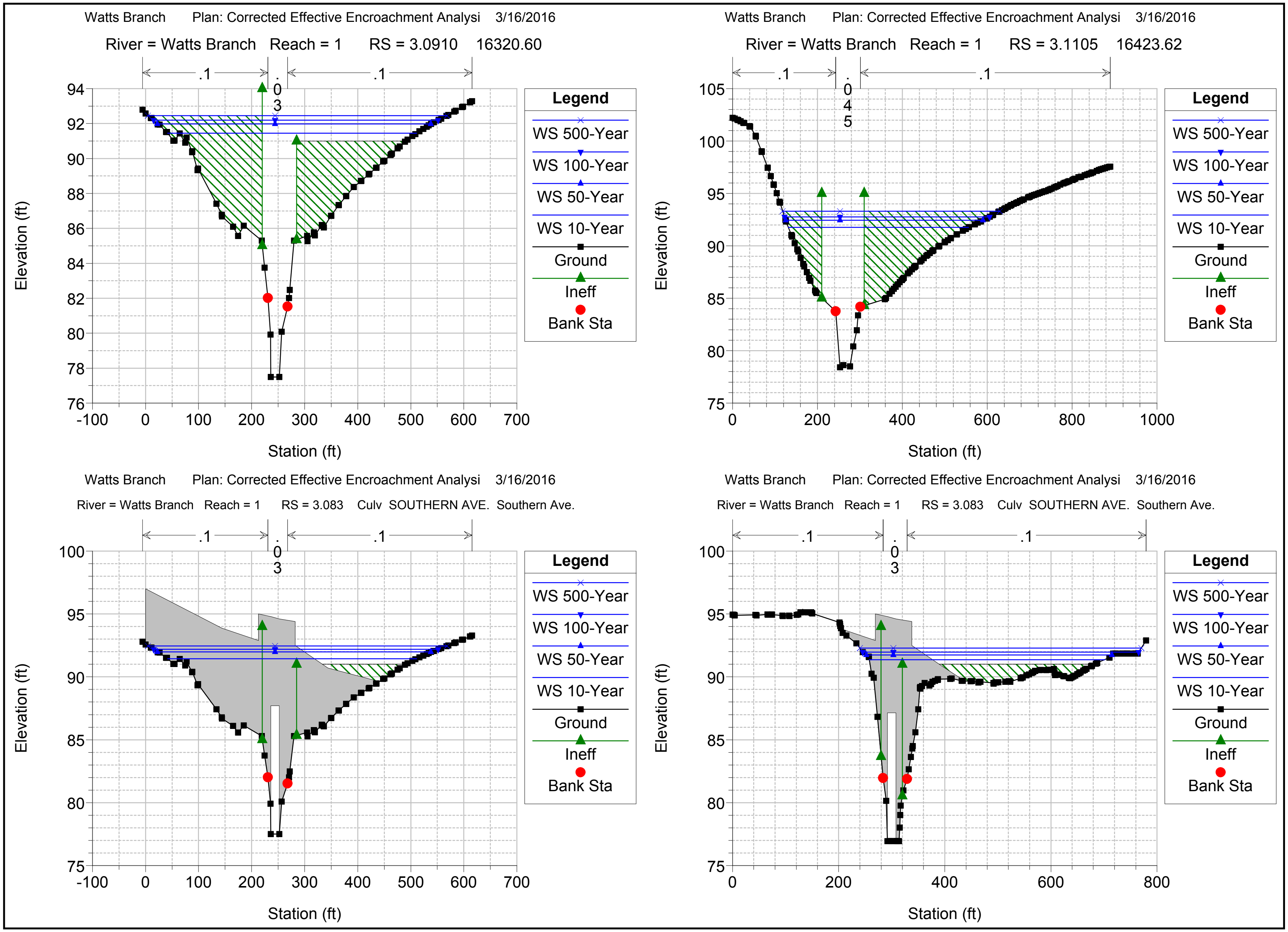
“PROPOSED CONDITIONS FOR BASKETBALL COURT ONLY” MODEL

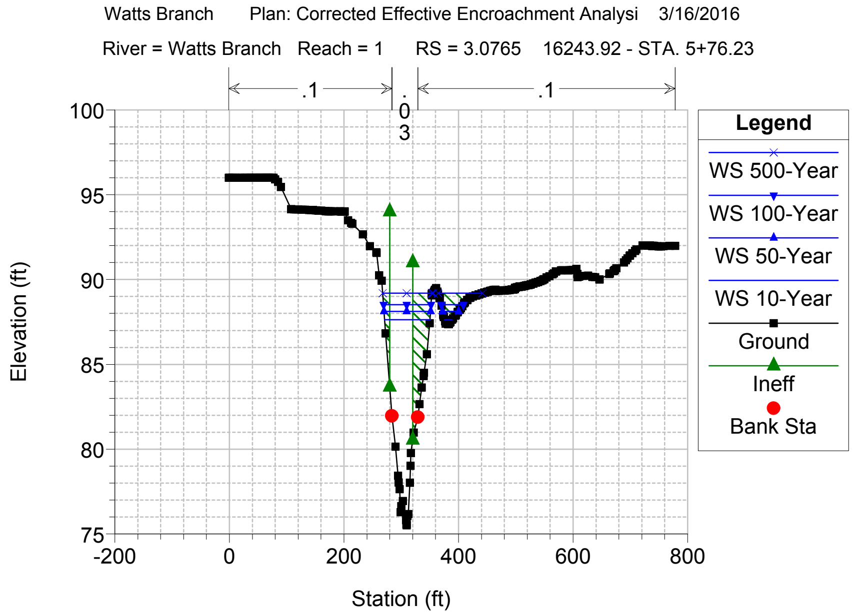
PROFILE


Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Set WS
Elevation (ft)
Main Channel Distance (ft)
95
90
85
80
75
70
65
14000
14500
15000
15500
16000
2.7023
2.7217
2.8312
2.9146
2.9411
2.9565
2.9628
2.9873
2.995
3.005
3.016
3.022
3.03
3.0446
3.0546
3.0612
3.0765
3.083
3.1105

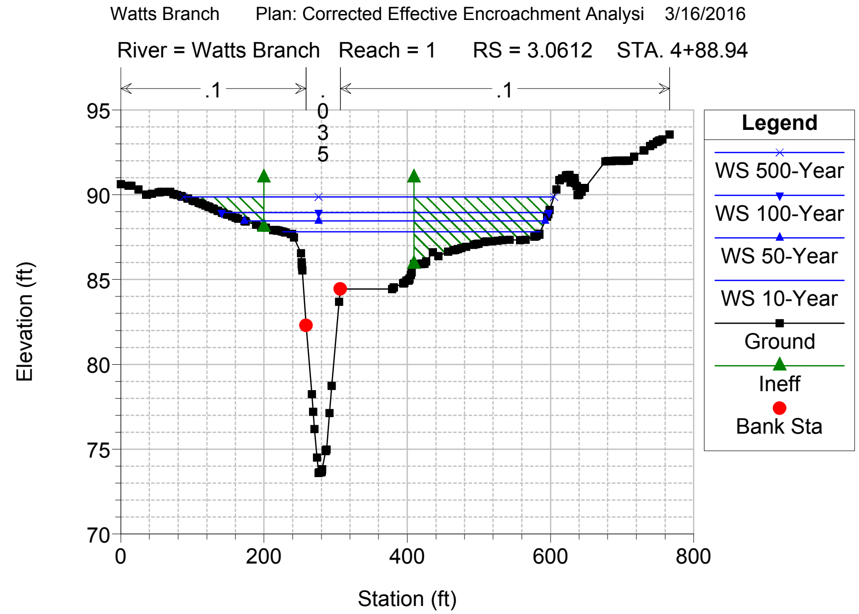
“PROPOSED CONDITIONS FOR BASKETBALL COURT ONLY” MODEL

CROSS SECTIONS

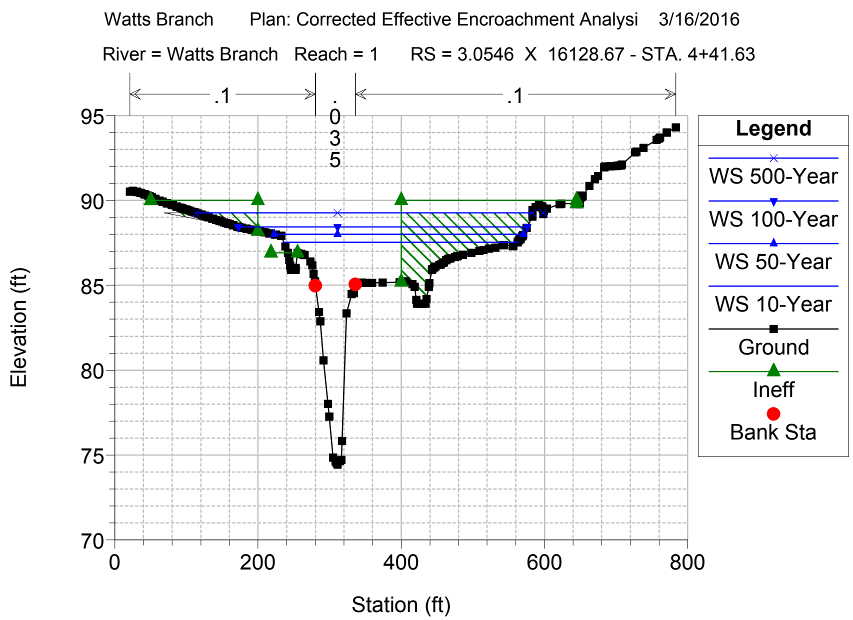

Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0910 16320.60
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.1105 16423.62
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.083 Culv SOUTHERN AVE. Southern Ave.
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.083 Culv SOUTHERN AVE. Southern Ave.
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta



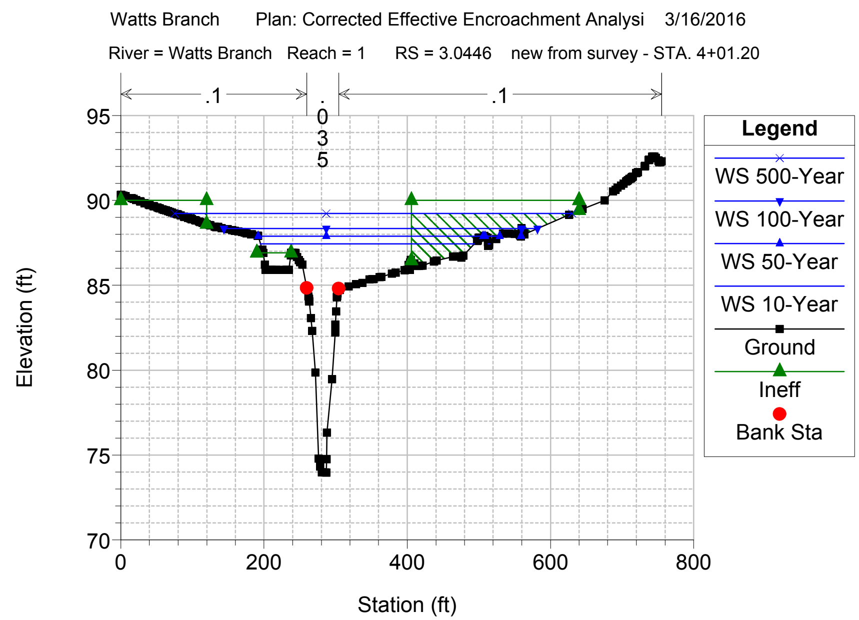
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0765 16243.92 - STA. 5+76.23
.1
.03
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



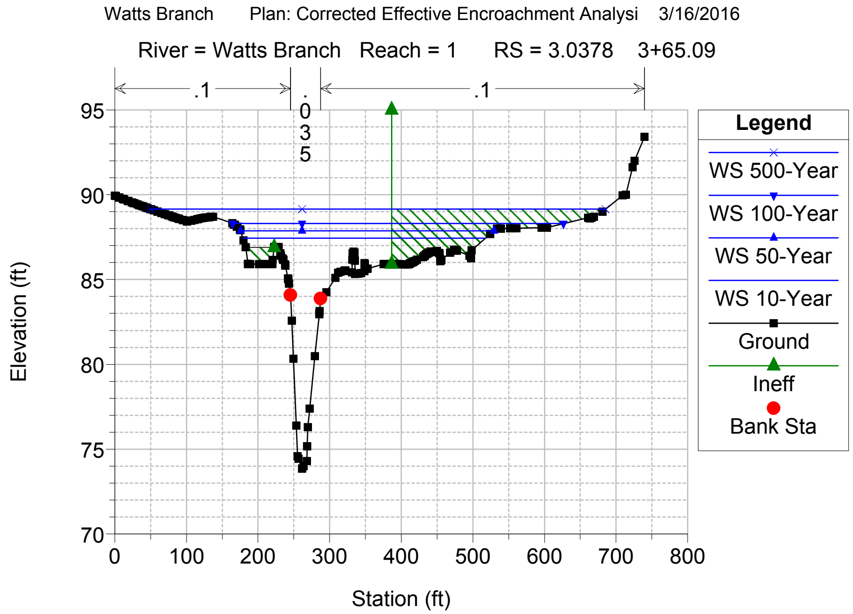
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0612 STA. 4+88.94
.1
.035
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



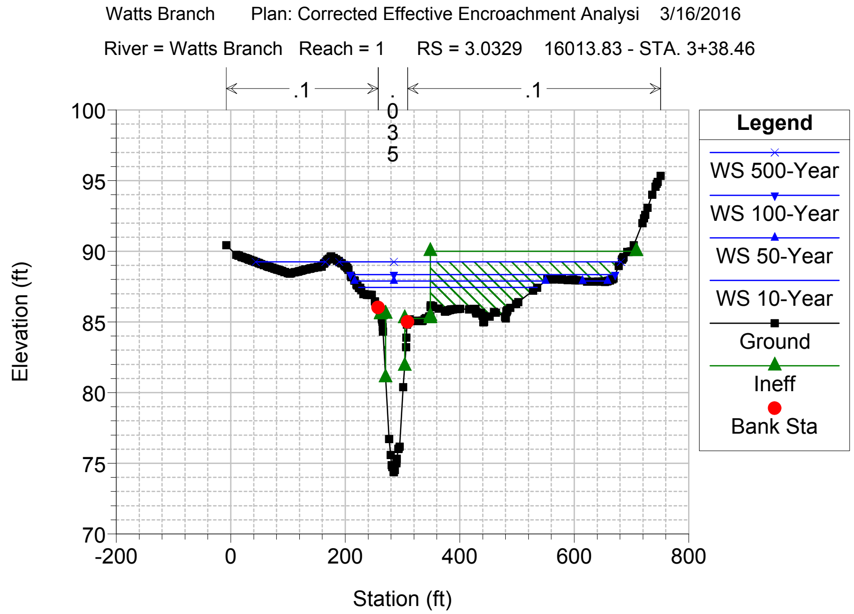
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0546 X 16128.67 - STA. 4+41.63
.1
.035
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



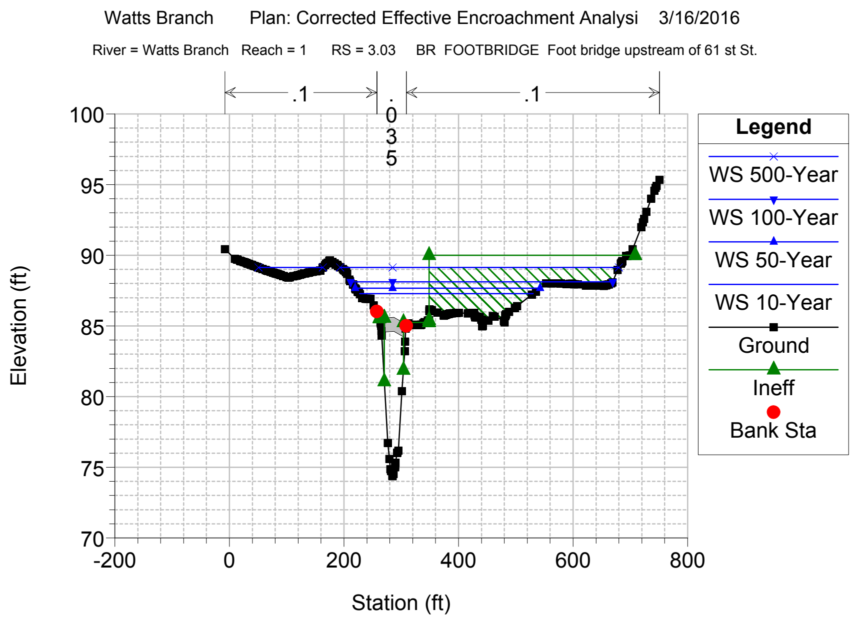
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0446 new from survey - STA. 4+01.20
.1
.035
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



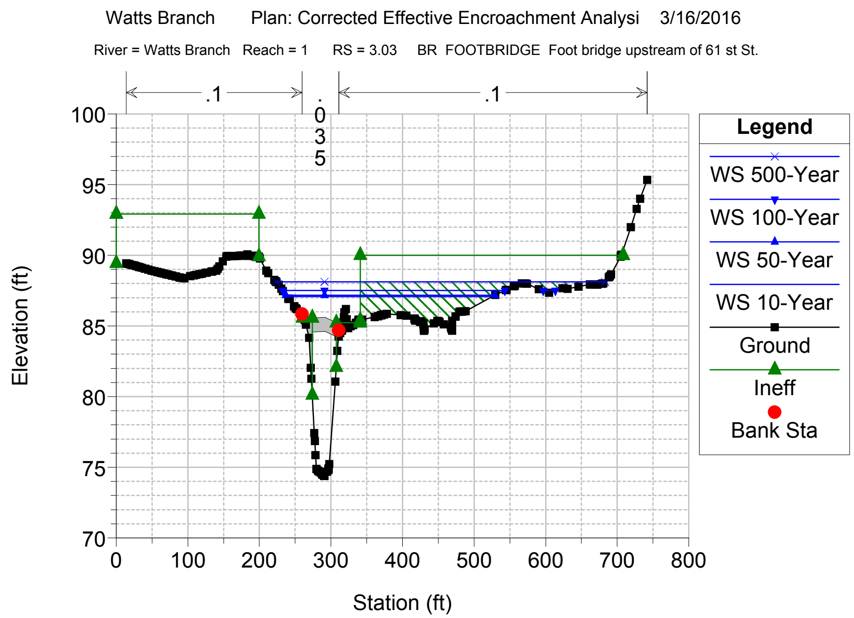
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0378 3+65.09
.1
.035
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



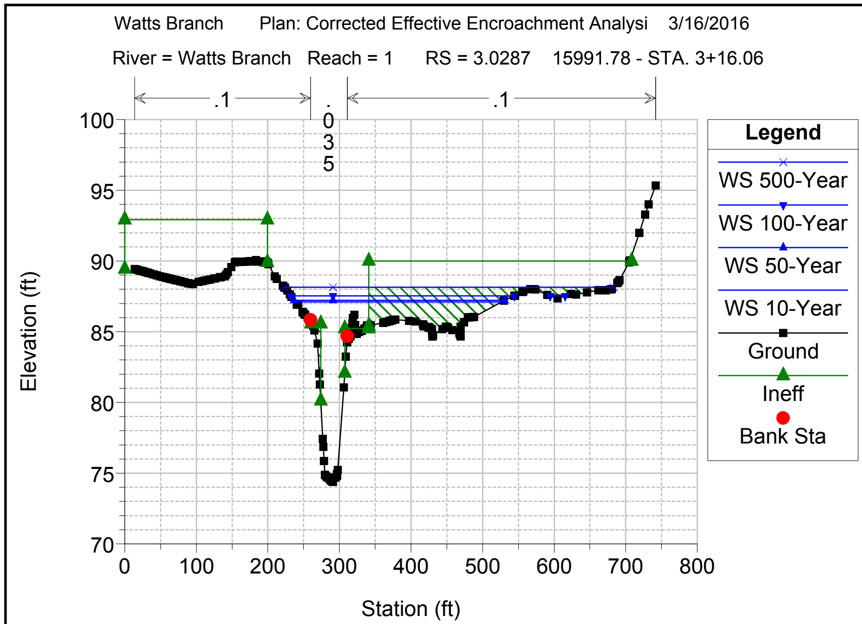
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0329 16013.83 - STA. 3+38.46
.1
.035
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

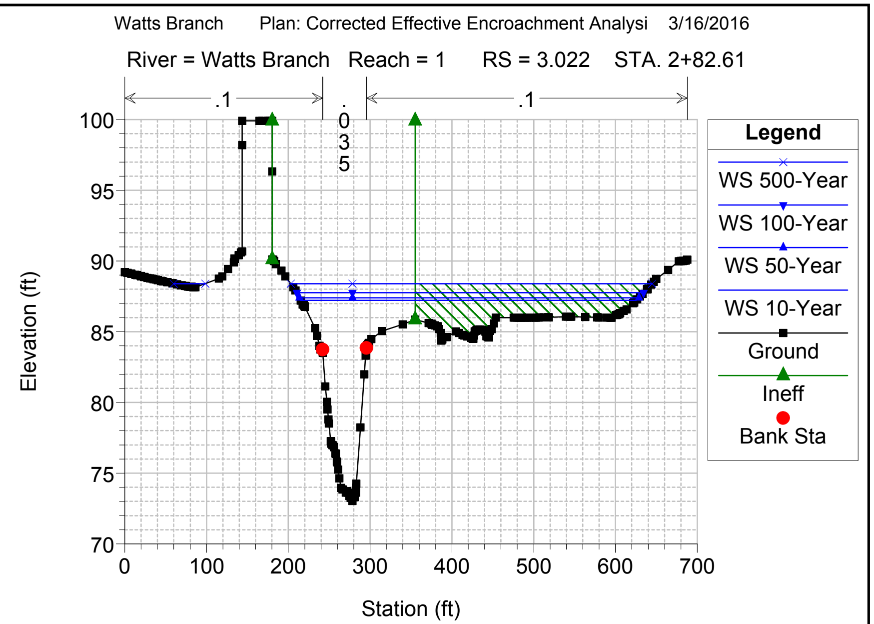


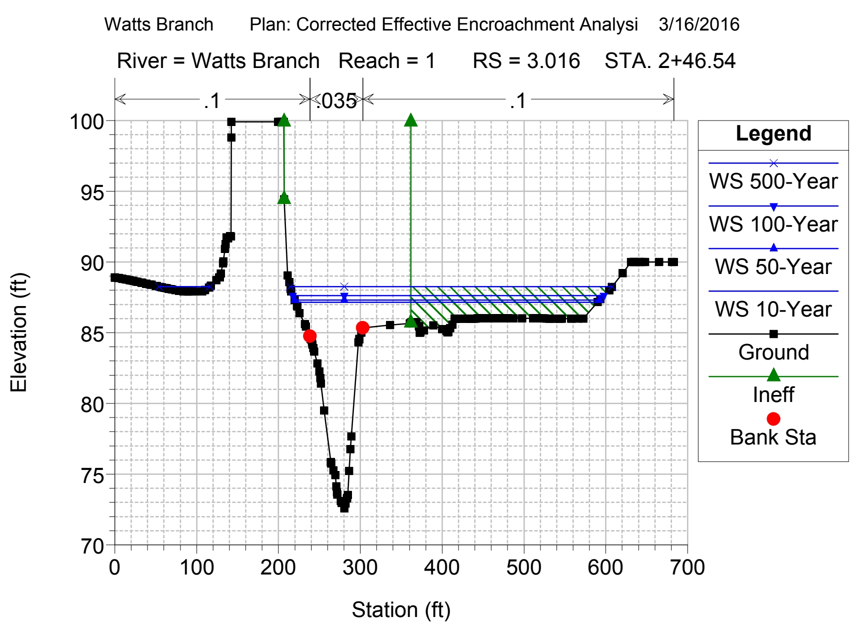
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.03 BR FOOTBRIDGE Foot bridge upstream of 61 st St.
.1
.035
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

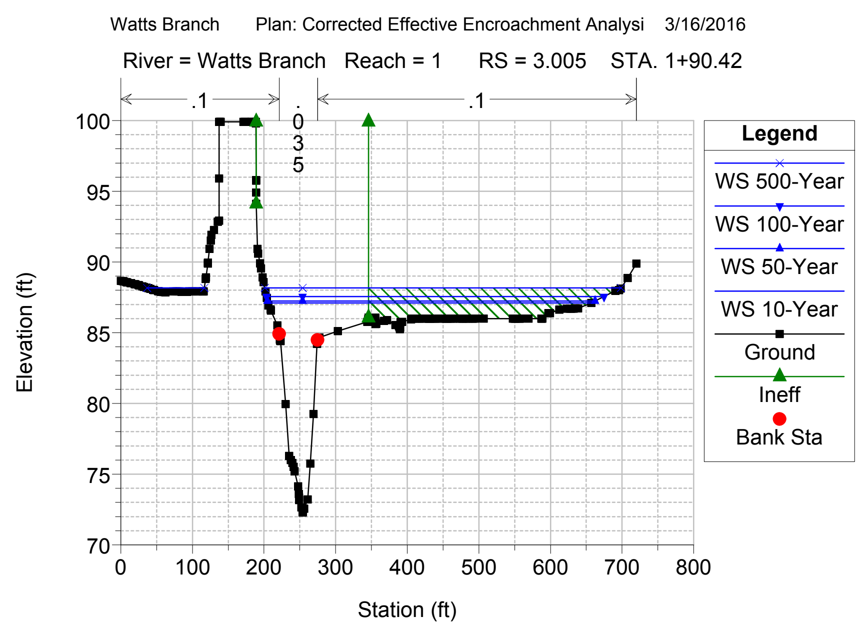


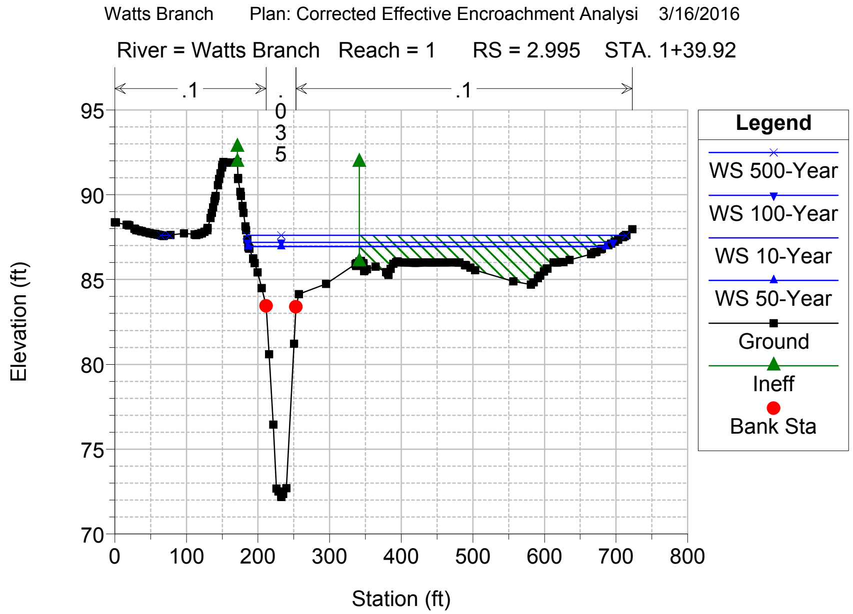
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.03 BR FOOTBRIDGE Foot bridge upstream of 61 st St.
.1
.035
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

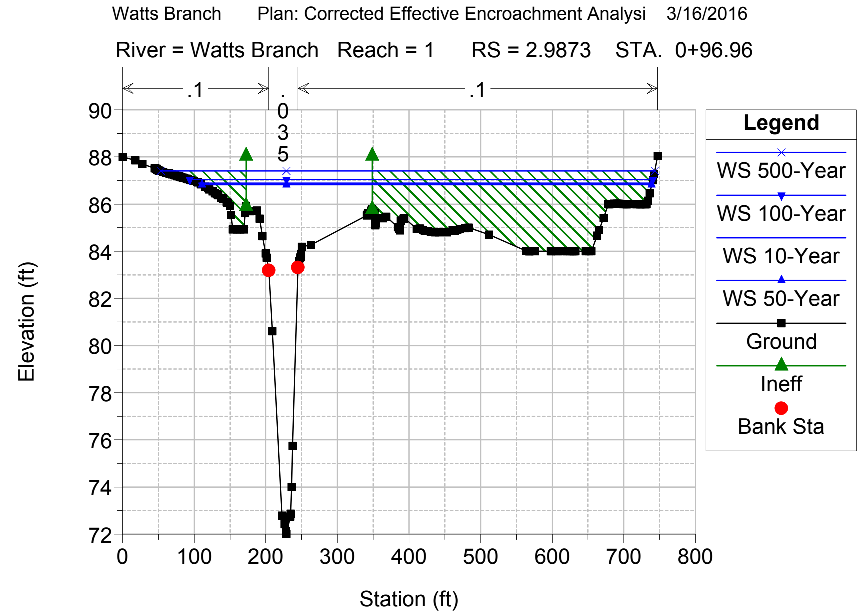

Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.0287 15991.78 - STA. 3+16.06
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

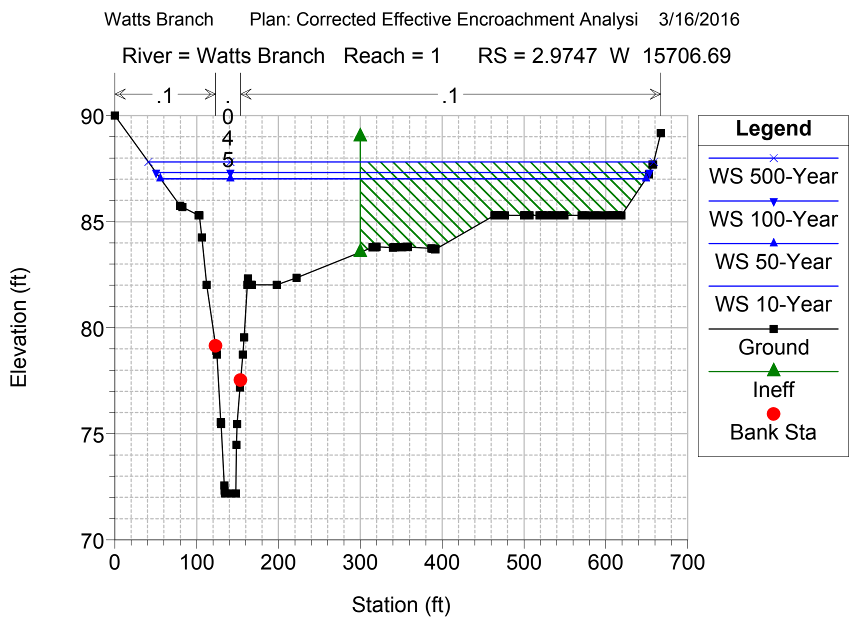

Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.022 STA. 2+82.61
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

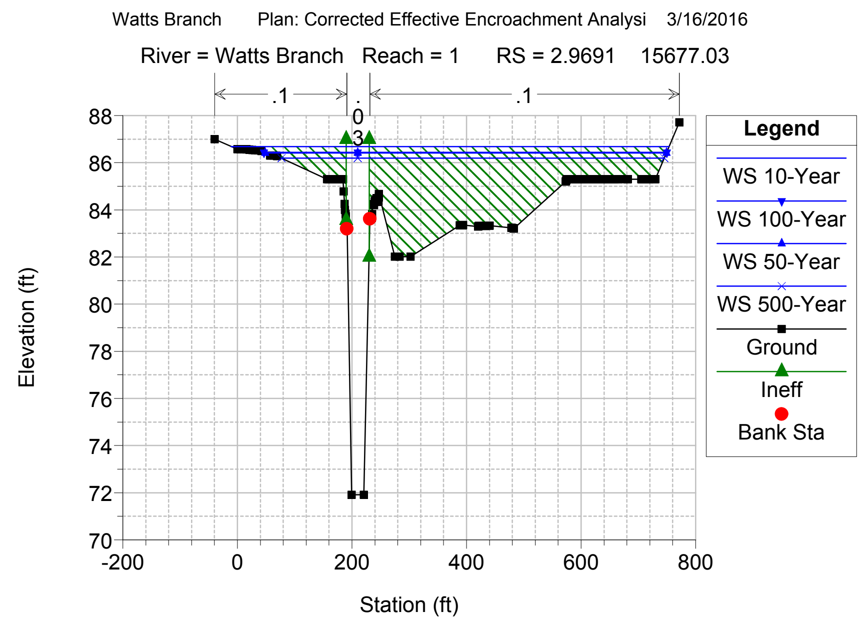

Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.016 STA. 2+46.54
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

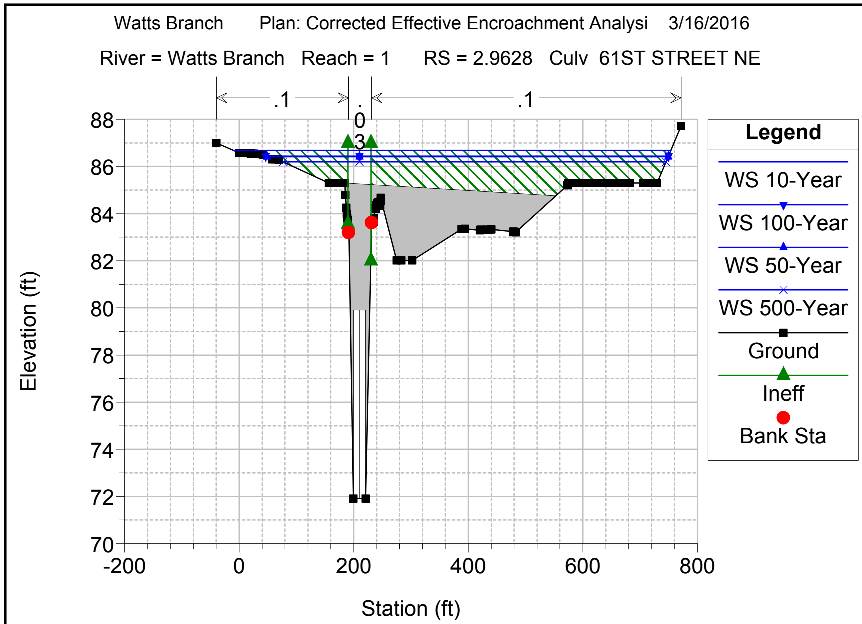

Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 3.005 STA. 1+90.42
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

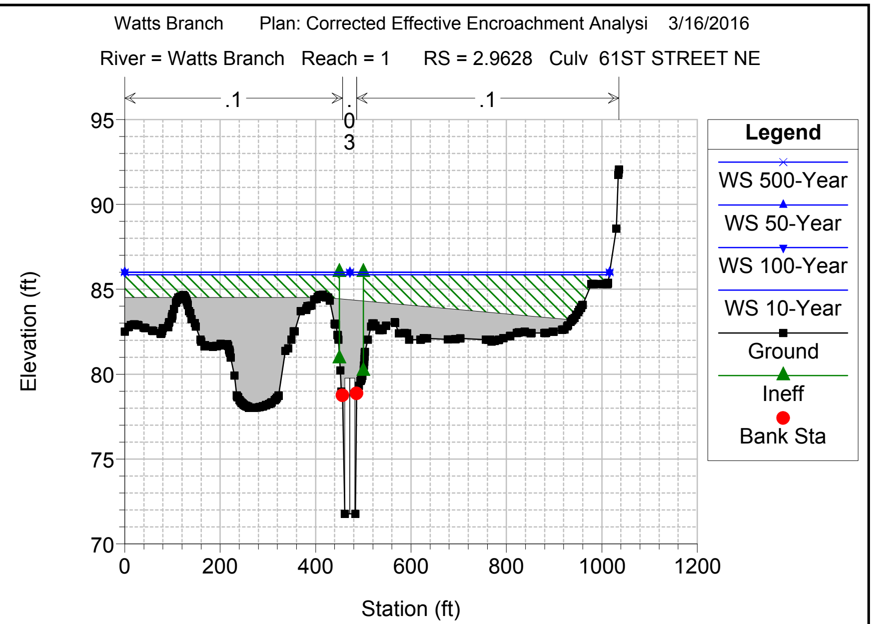

Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 2.995 STA. 1+39.92
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 10-Year
WS 50-Year
Ground
Ineff
Bank Sta

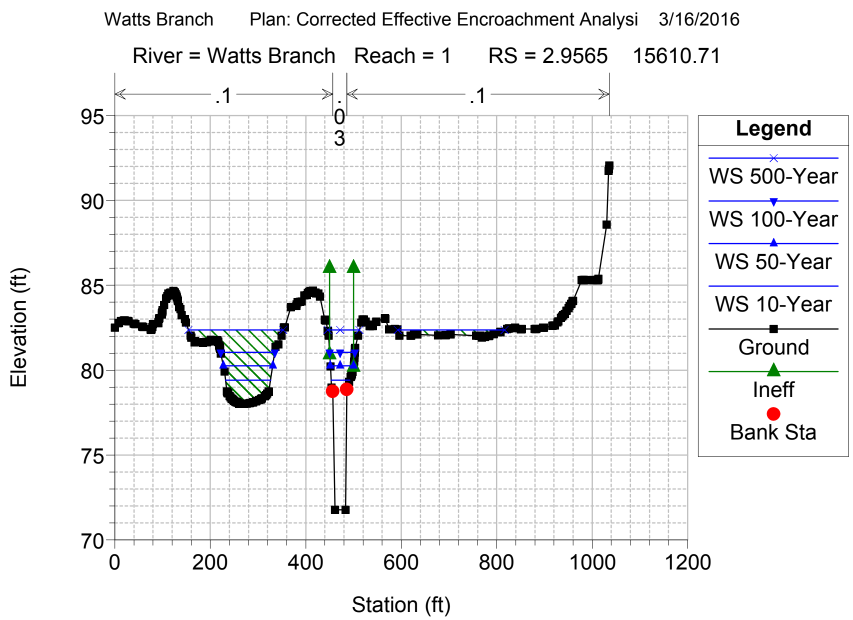

Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9873 STA. 0+96.96
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 10-Year
WS 50-Year
Ground
Ineff
Bank Sta

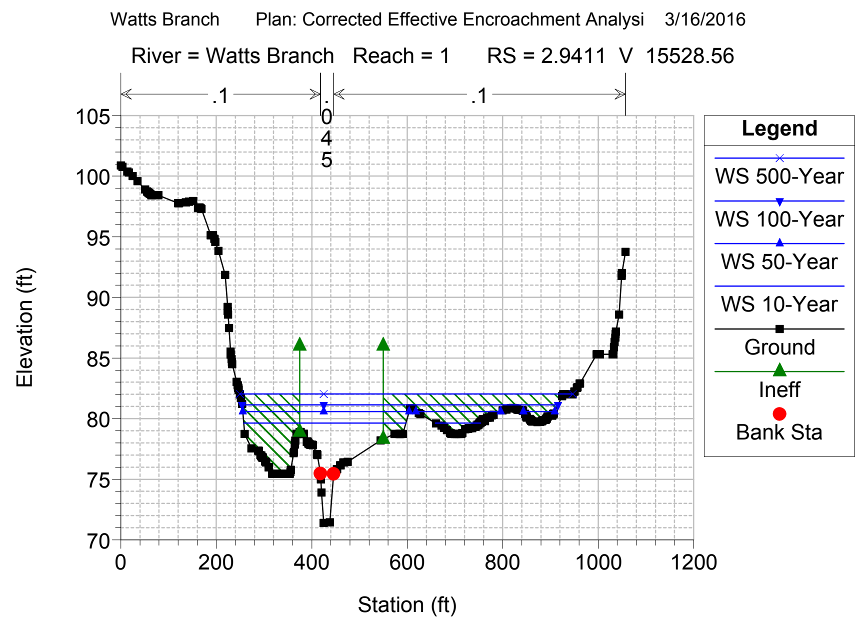

Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9747 W 15706.69
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9691 15677.03
.1
.03
.1
Elevation (ft)
Station (ft)
Legend
WS 10-Year
WS 100-Year
WS 50-Year
WS 500-Year
Ground
Ineff
Bank Sta


Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9628 Culv 61ST STREET NE
Legend
WS 10-Year
WS 100-Year
WS 50-Year
WS 500-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

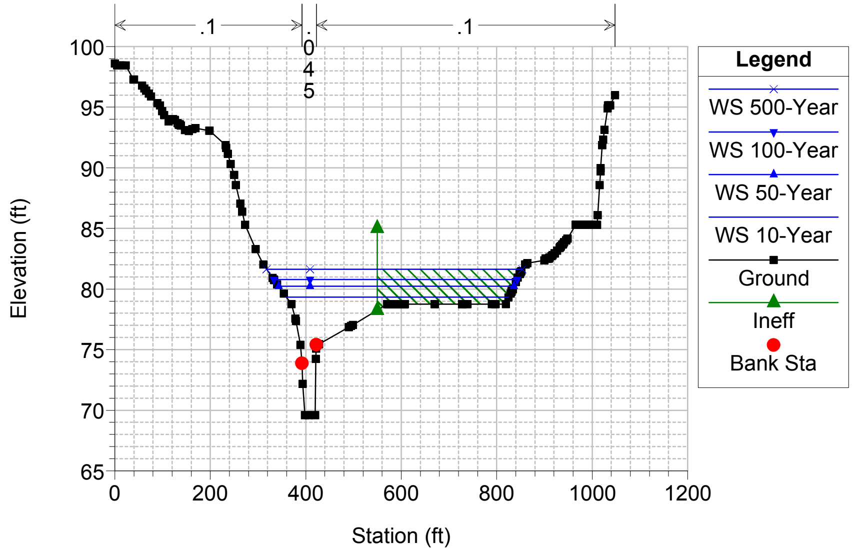

Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9628 Culv 61ST STREET NE
Legend
WS 500-Year
WS 50-Year
WS 100-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9565 15610.71
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 2.9411 V 15528.56
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

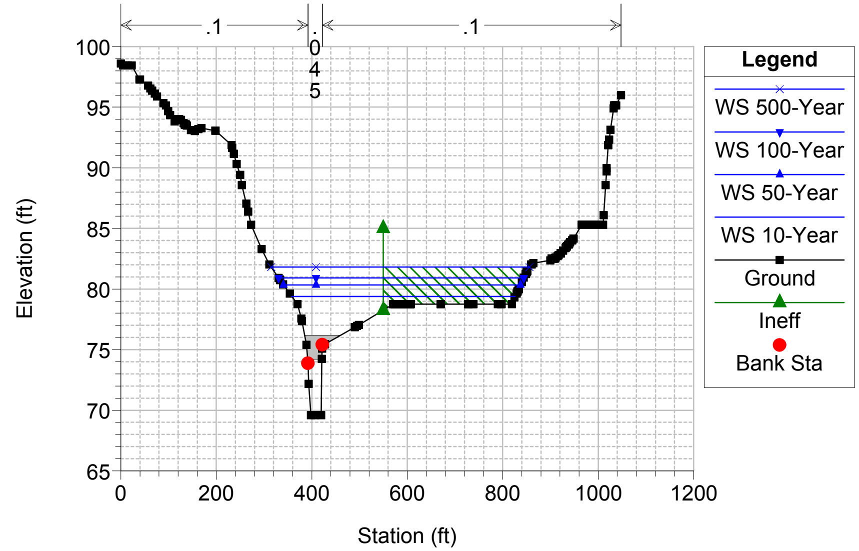
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016

River = Watts Branch Reach = 1 RS = 2.9178 15405.11



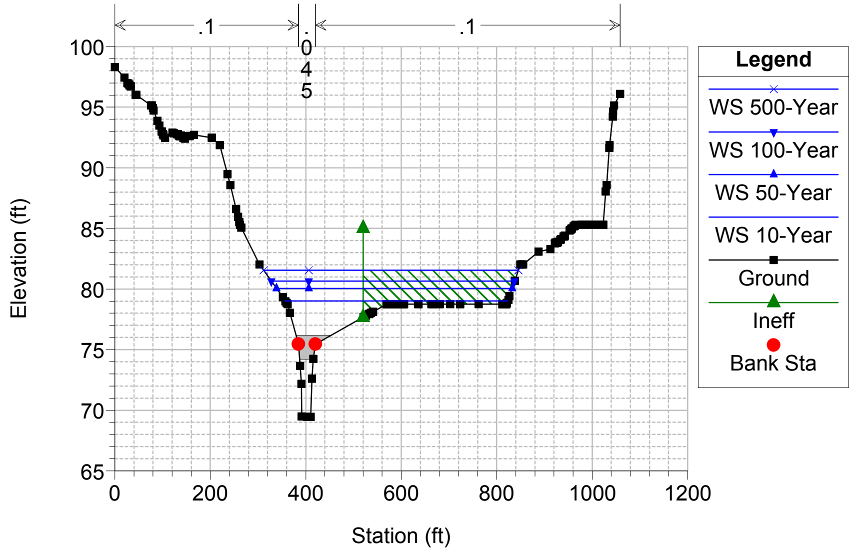
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016

River = Watts Branch Reach = 1 RS = 2.9162 BR FOOTBRIDGE Footbridge downstream of 61st St.



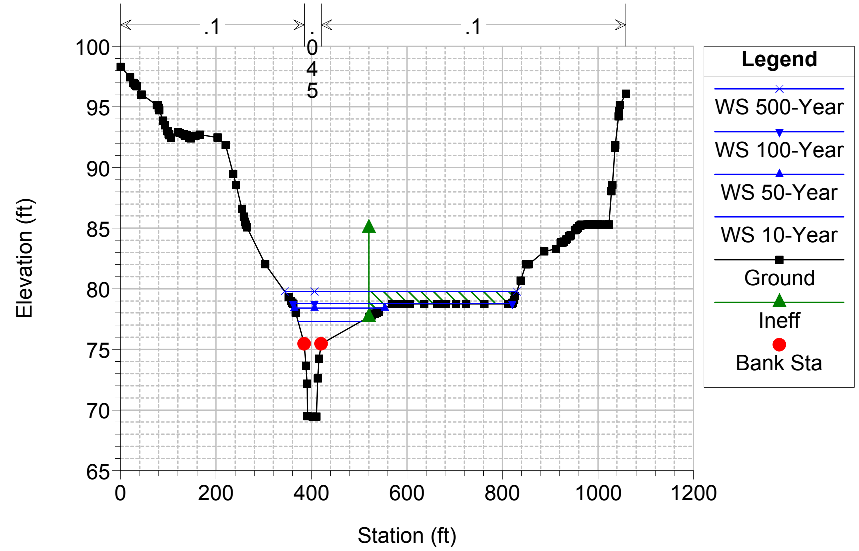
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016

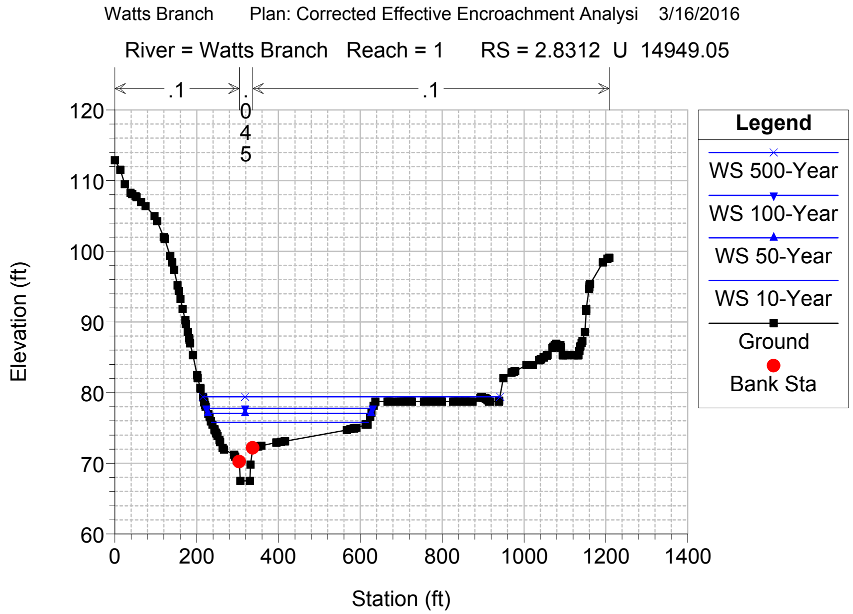
River = Watts Branch Reach = 1 RS = 2.9162 BR FOOTBRIDGE Footbridge downstream of 61st St.



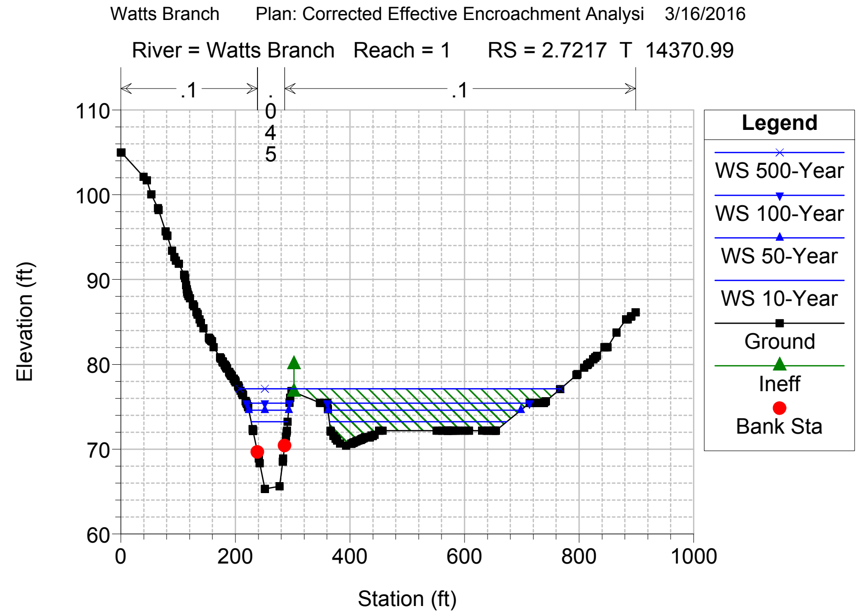
Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016

River = Watts Branch Reach = 1 RS = 2.9146 15388.47





Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 2.8312 U 14949.05
.1
.045
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Bank Sta
Elevation (ft)
Station (ft)



Watts Branch Plan: Corrected Effective Encroachment Analysi 3/16/2016
River = Watts Branch Reach = 1 RS = 2.7217 T 14370.99
.1
.045
.1
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

“PROPOSED CONDITIONS FOR BASKETBALL COURT ONLY” MODEL

STANDARD OUTPUT TABLE

HEC-RAS Plan: Corr Eff Encoach Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Watts Branch	1	3.1105	10-Year	2545.00	78.41	91.76	84.08	91.91	0.000391	3.26	983.97	424.48	0.17
Watts Branch	1	3.1105	50-Year	3368.00	78.41	92.45	85.10	92.67	0.000557	4.05	1052.26	465.00	0.20
Watts Branch	1	3.1105	100-Year	3872.00	78.41	92.77	85.56	93.05	0.000671	4.52	1084.60	483.39	0.22
Watts Branch	1	3.1105	500-Year	4880.00	78.41	93.30	86.35	93.70	0.000920	5.44	1137.67	511.47	0.26
Watts Branch	1	3.0910	10-Year	2545.00	77.50	91.44	84.46	91.84	0.000438	5.24	767.32	469.00	0.26
Watts Branch	1	3.0910	50-Year	3368.00	77.50	91.98	85.65	92.57	0.000633	6.48	929.85	515.75	0.32
Watts Branch	1	3.0910	100-Year	3872.00	77.50	92.19	86.22	92.93	0.000774	7.24	999.67	536.35	0.35
Watts Branch	1	3.0910	500-Year	4880.00	77.50	92.45	87.26	93.53	0.001120	8.83	1088.11	563.52	0.43
Watts Branch	1	3.083 SOUTHERN AVE.		Culvert									
Watts Branch	1	3.0765	10-Year	2545.00	75.51	87.64	83.51	88.47	0.001216	7.34	361.85	79.13	0.42
Watts Branch	1	3.0765	50-Year	3368.00	75.51	88.13	84.62	89.44	0.001797	9.23	381.47	81.17	0.51
Watts Branch	1	3.0765	100-Year	3872.00	75.51	88.52	85.21	90.12	0.002085	10.20	397.28	82.82	0.56
Watts Branch	1	3.0765	500-Year	4880.00	75.51	89.19	86.40	91.43	0.002686	12.07	423.96	87.89	0.64
Watts Branch	1	3.0546 X	10-Year	2545.00	74.43	87.53	82.83	88.07	0.001357	6.10	582.55	311.71	0.36
Watts Branch	1	3.0546 X	50-Year	3368.00	74.43	88.00	84.14	88.81	0.001932	7.53	659.09	355.28	0.43
Watts Branch	1	3.0546 X	100-Year	3872.00	74.43	88.44	84.84	89.35	0.002099	8.09	745.91	410.94	0.45
Watts Branch	1	3.0546 X	500-Year	4880.00	74.43	89.27	86.54	90.35	0.002323	8.99	912.66	473.94	0.48
Watts Branch	1	3.0329	10-Year	2545.00	74.37	87.44	82.61	87.88	0.001899	5.33	500.58	329.06	0.41
Watts Branch	1	3.0329	50-Year	3368.00	74.37	87.90	83.77	88.54	0.002487	6.45	573.53	423.47	0.48
Watts Branch	1	3.0329	100-Year	3872.00	74.37	88.36	86.05	89.06	0.002499	6.81	667.53	558.39	0.48
Watts Branch	1	3.0329	500-Year	4880.00	74.37	89.25	86.71	90.03	0.002373	7.26	908.39	629.08	0.48
Watts Branch	1	3.03 FOOTBRIDGE		Bridge									
Watts Branch	1	3.0287	10-Year	2545.00	74.39	87.10	81.90	87.67	0.002142	6.07	448.27	307.33	0.44
Watts Branch	1	3.0287	50-Year	3368.00	74.39	87.22	83.08	88.17	0.003496	7.86	463.38	315.95	0.56
Watts Branch	1	3.0287	100-Year	3872.00	74.39	87.54	83.74	88.66	0.003869	8.55	505.79	368.58	0.59
Watts Branch	1	3.0287	500-Year	4880.00	74.39	88.14	86.53	89.57	0.004458	9.74	614.73	566.27	0.65
Watts Branch	1	2.9747 W	10-Year	2545.00	72.18	87.01	80.35	87.21	0.000720	4.38	1209.88	592.73	0.22
Watts Branch	1	2.9747 W	50-Year	3368.00	72.18	87.03	81.64	87.39	0.001249	5.78	1215.73	593.60	0.29
Watts Branch	1	2.9747 W	100-Year	3872.00	72.18	87.31	82.32	87.73	0.001465	6.35	1284.92	603.01	0.31
Watts Branch	1	2.9747 W	500-Year	4880.00	72.18	87.81	84.60	88.37	0.001895	7.41	1411.52	617.55	0.36
Watts Branch	1	2.9691	10-Year	2545.00	71.91	86.69	78.89	87.12	0.000554	5.32	481.71	753.81	0.27
Watts Branch	1	2.9691	50-Year	3368.00	71.91	86.42	80.14	87.22	0.001044	7.20	470.95	700.79	0.37
Watts Branch	1	2.9691	100-Year	3872.00	71.91	86.45	80.87	87.50	0.001369	8.26	472.09	703.43	0.42
Watts Branch	1	2.9691	500-Year	4880.00	71.91	86.20	82.16	87.95	0.002332	10.63	462.11	668.43	0.54
Watts Branch	1	2.9628 61ST STREET NE		Culvert									

HEC-RAS Plan: Corr Eff Encoach Locations: User Defined (Continued)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Watts Branch	1	2.9565	10-Year	2545.00	71.77	79.42	78.78	81.94	0.007280	12.74	202.92	133.17	0.86
Watts Branch	1	2.9565	50-Year	3368.00	71.77	80.26	80.26	83.70	0.008546	14.92	240.62	152.72	0.95
Watts Branch	1	2.9565	100-Year	3872.00	71.77	81.05	81.05	84.69	0.007996	15.41	279.65	166.29	0.94
Watts Branch	1	2.9565	500-Year	4880.00	71.77	82.36	82.36	86.48	0.007583	16.53	345.22	489.13	0.93
Watts Branch	1	2.9411 V	10-Year	2545.00	71.40	79.64	79.12	80.59	0.006204	9.20	547.31	432.55	0.61
Watts Branch	1	2.9411 V	50-Year	3368.00	71.40	80.60	79.76	81.53	0.005688	9.58	714.83	592.11	0.59
Watts Branch	1	2.9411 V	100-Year	3872.00	71.40	81.15	80.09	82.08	0.005411	9.76	811.06	661.51	0.58
Watts Branch	1	2.9411 V	500-Year	4880.00	71.40	82.02	80.69	83.02	0.005364	10.36	964.74	697.24	0.59
Watts Branch	1	2.9178	10-Year	2545.00	69.60	79.32	77.08	79.96	0.003241	7.25	653.50	465.58	0.43
Watts Branch	1	2.9178	50-Year	3368.00	69.60	80.22	78.53	80.93	0.003424	7.94	833.45	493.22	0.45
Watts Branch	1	2.9178	100-Year	3872.00	69.60	80.78	78.90	81.50	0.003395	8.20	950.31	509.30	0.45
Watts Branch	1	2.9178	500-Year	4880.00	69.60	81.64	79.67	82.42	0.003546	8.84	1144.04	535.80	0.46
Watts Branch	1	2.9162 FOOTBRIDGE		Bridge									
Watts Branch	1	2.9146	10-Year	2545.00	69.47	77.31	77.31	79.21	0.012802	11.39	300.65	131.44	0.82
Watts Branch	1	2.9146	50-Year	3368.00	69.47	78.41	78.41	80.20	0.010544	11.56	465.15	189.71	0.76
Watts Branch	1	2.9146	100-Year	3872.00	69.47	78.78	78.78	80.71	0.011002	12.21	522.85	458.95	0.78
Watts Branch	1	2.9146	500-Year	4880.00	69.47	79.78	79.56	81.64	0.009714	12.46	690.14	486.11	0.75
Watts Branch	1	2.8312 U	10-Year	2545.00	67.50	75.81	74.11	76.15	0.002470	5.99	1051.53	383.73	0.38
Watts Branch	1	2.8312 U	50-Year	3368.00	67.50	77.04	74.86	77.29	0.001750	5.58	1533.28	398.57	0.33
Watts Branch	1	2.8312 U	100-Year	3872.00	67.50	77.80	75.22	78.01	0.001444	5.35	1837.03	406.96	0.30
Watts Branch	1	2.8312 U	500-Year	4880.00	67.50	79.41	75.75	79.62	0.001254	5.53	2696.47	726.21	0.29
Watts Branch	1	2.7217 T	10-Year	2545.00	65.31	73.24	70.99	74.18	0.004666	7.84	347.82	373.41	0.53
Watts Branch	1	2.7217 T	50-Year	3368.00	65.31	74.60	71.93	75.70	0.004318	8.53	438.78	406.16	0.53
Watts Branch	1	2.7217 T	100-Year	3872.00	65.31	75.43	72.48	76.60	0.004062	8.83	498.69	427.69	0.52
Watts Branch	1	2.7217 T	500-Year	4880.00	65.31	77.13	73.47	78.38	0.003511	9.21	640.19	560.08	0.50

APPENDIX H

FEDERAL EMERGENCY MANAGEMENT ACENCY (FEMA)

FLOOD INSURANCE STUDY (FIS)

DISTRICT OF COLUMBIA

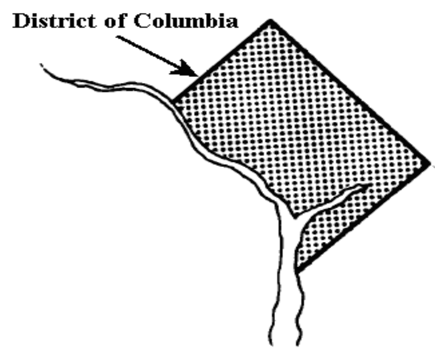
WASHINGTON, D.C.

SEPTEMBER 27, 2010

FIS #110001V000A

FLOOD INSURANCE STUDY

DISTRICT OF COLUMBIA
WASHINGTON, D.C.



REVISED: SEPTEMBER 27, 2010

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
110001V000A

NOTICE TO FLOOD INSURANCE STUDY USERS

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

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

Old Zone(s)	New Zone
A1 – A30	AE
V1 – V30	VE
B	X
C	X

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.

Initial FIS Effective Date: November 15, 1985

Revised FIS Date: September 27, 2010

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FLOOD INSURANCE STUDY
DISTRICT OF COLUMBIA
WASHINGTON, D.C.

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and supersedes the FIS reports and/or Flood Insurance Rate Maps (FIRMs) in the geographic area of the District of Columbia, Washington D.C. (hereinafter referred to as D.C.), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates. This information will also be used by D.C. to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

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

1.2 Authority and Acknowledgements

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

The hydrologic and hydraulic analyses for this study were performed by the U.S. Army Corps of Engineers (USACE) for the Federal Emergency Management Agency (FEMA) under Contract No. HSFE03-04-X-0016. The study was completed in December 2005. The November 15, 1985 FIS was prepared by Sheladia Associates, Inc., (SAI), under Contract No. H-6816. This study was completed in April 1983.

The base mapping for this study was obtained from the D.C.'s Office of the Chief Technology Officer (OCTO), which is responsible for implementing and managing the enterprise-wide geographic information system (GIS) for Washington D.C. These planimetrics were developed from aerial photography acquired in the spring of 1999, and originally published on June 10, 2002. The planimetrics used for this study was updated in December 2004. The data are in the Maryland State Plane Coordinate System and horizontally referenced to the North American Datum of 1983 (NAD83) and vertically to the North American

Vertical Datum of 1988 (NAVD88). OCTO is located at 441 4th Street, NW, Suite 9305 Washington, D.C. 20002.

1.3 Coordination

The initial Consultation Coordination Officer (CCO) meeting for the previous study was held in May 1979, and attended by representatives of FEMA**,** D.C., and the study contractor. The D.C. Department of Environmental Services (DES) served as the city coordinating agency for the previous study. Results of the hydrologic analyses were coordinated with the U.S. Geological Survey (USGS) and the DES. The results of the previous study were reviewed at the final meeting, on March 27, 1984, attended by representatives of the study contractor, FEMA, and the community. The study was acceptable to the community.

The initial CCO meeting for this study was held on February 10, 2005, and attended by representatives of FEMA**,** D.C., and USACE (Study Contractor for this study). The D.C. Emergency Management Agency (EMA) served as the city coordinating agency for this study.

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

The results of the study were reviewed at the final CCO meeting held on September 26, 2006, and attended by representatives of FEMA, the community, and the study contractor. The 90-day statutory process for appeals was initiated on October 5th, 2007.

2.0 <u>AREA STUDIED</u>

2.1 Scope of Study

This FIS covers the geographic area of D.C. The area of study is shown on the Vicinity Map (Figure 1).

USACE was contracted to perform detailed studies on the same streams studied with detailed methods in the effective FIS. The selection of streams for detailed study in the original FIS was made jointly with the community officials at the Time and Cost Meeting held in May 1979, with priority given to all known flood hazard areas and areas of projected development and proposed construction through May 1984. Rock Creek, a tributary of the Potomac River, was included in the original FIS as “an existing data study stream,” referring to a study by CH2MHill (1979). This study reevaluated the hydrology and hydraulics in detail for Rock Creek. Table 1 lists the rivers or streams studied in whole or in part by detailed methods in the study.

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA
WASHINGTON D.C.

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

USACE's detailed methodology included comparing existing condition hydrology calculations to the results used in the effective FIS (refer to Section 3.1). New georeferenced hydraulic models were created for each stream studied in detail, and the resulting GIS layers (floodplains, cross-sections, floodways) were used in the development of the updated FIS mapping (refer to Section 3.2).

Table 1- Names of streams and rivers studied in whole or partially by detailed methods

Anacostia River	Melvin Hazen Branch
Barnaby Run	Oxon Run
Broad Branch	Pinehurst Run
Creek along Normanstone Drive	Pope Branch
East Creek A	Potomac River
East Creek B	Rock Creek
Fenwick Branch	Tributary of Fenwick Branch
Fort Dupont Creek	Watts Branch

Flooding in parts of the community with low development potential or minimal flood hazard was studied by approximate methods. Table 2 lists the streams studied in whole or partially by approximate methods.

Table 2- Names of streams and rivers studied in whole or partially by approximate methods

Broad Branch[1]	Tributary near East Capitol Street
Hickey Run	Tributary near Gaging Station[2]
Melvin Hazen Branch	Tributary near Military Road
Pinehurst Run[3]	Tributary through Dumbarton Oaks Park
Piney Branch	Tributary through Dupont Park[2]
Tributary near Battle Kemble Park	Tributary through Klingle Park
Tributary near Dalecarlia Reservoir	Tributary through Soapstone Park

[1]- The reach of Broad Branch originally studied by approximate method was downstream of a portion of the same stream that had been studied in detail. As part of the study, USACE included the downstream portion in the hydraulic

model for Broad Branch. Because limited data were available for the downstream reach, the floodplain was left as a Zone A.

[2] - Tributary near Gaging Station and Tributary through Fort Dupont Park were listed in the effective FIS as streams studied via the approximate methodology, but a review of the effective Flood Insurance Rate Maps (FIRM) revealed that these streams had not been mapped. USACE was directed by FEMA Region III to not include them as part of the study because of their location within park lands.

[3] - The reach of Pinehurst Branch originally studied by approximate method was downstream of a portion of the same stream that had been studied in detail. As part of the study, USACE upgraded the downstream portion to a detailed study and included it in the hydraulic model for Pinehurst Run.

USACE's methodology for approximate method streams included developing the 1-percent annual chance discharge for the stream (refer to Section 3.1). New geo-referenced hydraulic models were created for each approximate method stream, and the resulting GIS layer for the 1-percent annual chance inundation area was used in the development of the updated FIS mapping.

This FIS incorporates Letter of Map Revision (LOMR) case number 07-03-1294P as issued by FEMA on August 31, 2007. This LOMR reflects more detailed topographic data along the Potomac River in the vicinity of Arnold Ave SW and Lackland Way SW.

2.2 Community Description

D.C., the capital of the nation, is located between the states of Maryland and Virginia and contains an area of about 69 square miles (44,160 acres). The District of Columbia is bounded by Montgomery and Prince George's Counties, Maryland, and the Potomac River, which separates D.C. from Virginia.

In 2004, D.C. was home to more than 553,500 people (Census 2005a). The number of housing units in 2002 was 272,636, of which 104,866 were in existence prior to 1939 (Census 2005c).

As befits the Nation's capital, D.C. is highly urbanized. Only about 19 percent of the D.C. area has been left relatively undisturbed (FEMA 1985). The majority of this area is found in the numerous parks, memorials, and national historic sites throughout the city, with 36 operated by the National Park Service alone. The largest parks are Rock Creek Park proper (over 1600 acres), Fort Dupont Park (376 acres), and the National Zoological Park (163 acres).

The topography of the District of Columbia is rolling with elevations ranging from sea level along the tidal portions of the Potomac and Anacostia Rivers, to as much as 414 feet North American Vertical Datum of 1988 (NAVD88) at Tenleytown. Interstream ridges are highest in the part of the Piedmont that makes up the northwestern part of the city. These ridges descend gradually to the coastal plains to the south and east, where hilltop elevations rarely exceed 230 feet NAVD88.

Topography indicates that much of the land drains toward Rock Creek and the Anacostia River. The D.C. Homeland Security Emergency Management Agency (DC HSEMA) reports that single family and multifamily residential flooding is limited because residential properties tend to rise quickly from the Anacostia and Potomac Rivers. Floodplain management following the preparation of the effective FIS (FEMA 1985) includes floodplain building code restrictions that also reduce exposure of residential and commercial development to flood damage.

D.C. is located in the Chesapeake Bay drainage basin, on the dividing line between the Piedmont and the Coastal Plain province (about 60 miles east of the Appalachian Mountain range and 100 miles west of the Atlantic Ocean). Its location between the coastal plain and the mountains results in three primary sources of moisture (Figure 2). According to the USGS (1991), these are air moving inland from the Atlantic Ocean, air of tropical origin in the Gulf of Mexico, and air containing moisture recycled form land surfaces, lakes, and reservoirs. National Climatic Data Center records indicate that the mean annual precipitation for the period 1963-2004 is about 41.6 inches.

Precipitation is distributed fairly evenly throughout the year, but can be higher in the summer due to short-duration, high-intensity storms. Summers are generally warm and humid, with the warmest temperatures in mid to late July, often above 80 degrees Fahrenheit. Winter is normally mild, with average daily low temperatures below 30 degrees Fahrenheit, and average daily high temperatures in the around 45 degrees Fahrenheit. The coldest winter weather usually occurs in late January and early February.

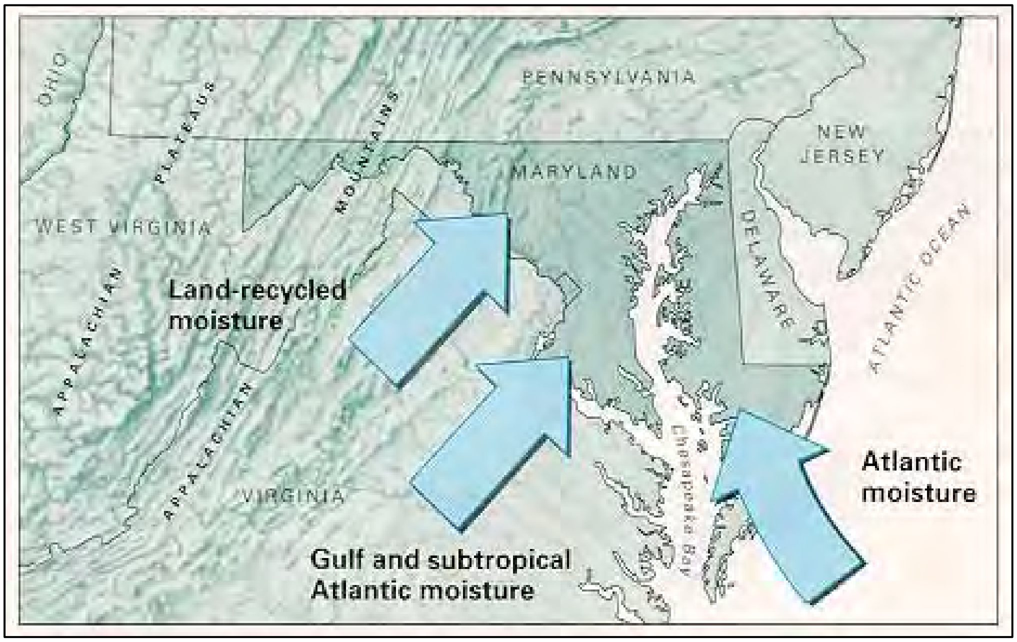

Figure 2. Major Sources of Moisture to the District of Columbia (from USGS 1991).

2.3 Principal Flood Problems

USGS (1991) identified damaging floods in the District of Columbia as being associated with severe thunderstorms, hurricanes, and intense rainfall on existing snowpack. They reported that the difference in the frequency between winter-spring flooding and summer-fall flooding is imperceptible. However, they do point out that loss of life from flooding caused by thunderstorms is more likely than from flooding caused by widespread winter-spring storms because of the flash flood nature of these storms. Floods along the Potomac and Anacostia Rivers generally result from a combination of tidal effects: storm surge along the river from Chesapeake Bay and fluvial flows. Table 3 lists major flood events in the District of Columbia, and a few of the more unusual events are described in more detail below. High water marks on the Potomac River at Great Falls, including the floods of 1936, 1942, 1972, and 1937 are shown in Figure 3.

The earliest large flood of record in D.C. was the flood of June 1-2, 1889 (USGS 1991, Frankenfeld 1924, Ambrose et al. 2002). This flood is very well described by an observer quoted by U.S. Signal Corps (1889):

> “The waters of the Potomac rose higher (June 2nd) than ever before known. At about noon the water had risen until the tide-gauges were hidden, and was fully three feet above the 1877 flood mark, and that was fully eleven feet above the spring-tide high water. The streets and reservations on the lower levels in the centre of the city and all the wharves and streets along the river front were under water. Toward evening the water had begun to recede … The flood caused great damage along the river front and on Rock Creek; the harbor improvements were injured and two spans

> of the Long Bridge were washed away. Serious, if not irreparable, damage was caused along the length of the Chesapeake and Ohio canal, which was rendered entirely unnavigable throughout its entire length …. Considerable damage was caused to the machinery plants and material in the Navy Yard."

Ambrose et al. (2002) report an unofficial crest of 11.5 ft above flood stage, or 19.5 ft above flood stage at Aqueduct Bridge. The Signal Corps, which was the predecessor to the Weather Bureau and the National Weather Service, had provided a flood warning on May 31, and suggested that damages would have been worse except that many people took advantage of the warning to protect against flood damage. Ambrose et al. (2002) reprint a number of Library of Congress photos of this event, showing floodwaters on Pennsylvania Avenue.

Other damaging floods associated with heavy rainfall are the floods of May 1924, October 1942, and June 1972. The May 12-15, 1924 flood in the Potomac basin occurred after several periods of rainfall, and once again, the banks of the Chesapeake and Ohio Canal were washed out for a distance (Frankenfeld 1924). Ambrose et al. (2002) report that this damage was the death knell for the Chesapeake and Ohio Canal. In October of 1942, extremely heavy rain in Virginia caused flooding in the Potomac River, resulting in a flood stage of 17.7 feet, 0.3 ft higher than the 1936 flood (Swenson 1942). DC HSEMA records indicate that this event flooded Washington Harbor, Wisconsin Avenue and K Streets in northwest Washington, and the waters approached the runway at Ronald Reagan Washington National Airport. Ambrose et al. (2002) report that the flood of 1942, with a crest of 10.7 ft above flood stage, is the official flood of record for Washington.

Flash-floods have been reported in D.C. on several occasions, including July 22, 1969, May 5, 1989, and August 11, 2001. Andrews (1969) reported that 9.02 inches of rain fell at National Airport between June 20 to 28, 1969, with over 4 inches (in.) on the 22^{nd}. He described the rates of fall on that day (1.03 in. in 10 min, 2.53 in. in 30 min, and 3.29 in. in 60 min) as being an all-time record. Ambrose et al. (2002) report that this rainfall led to substantial damages along Four Mile Run above its confluence with the Potomac River (on the Virginia side of the river). Other severe damages were reported in Maryland. The flood of June 21-23, 1972 resulted from heavy rainfall caused by Tropical Storm Agnes. Wagner (1972) reported that the flood crest probably would have been higher except that it coincided with low tide. In one case, according to DC HSEMA, up to five inches of rain fell in D.C. on May 5, 1989. Three people were killed, and hundreds of homes and businesses were destroyed. Ambrose et al. (2002) reported over seven inches of rain in northwest D.C. on August 11, 2001, following two inches of rain the previous day. Flood damage due to this flash flood event was described as "the worst in more than fifty years" and D.C. was declared a disaster area (Ambrose et al. 2002).

Table 3-Historical significant flood event summary for Washington, D.C.

Event Date	Type of Event	Recurrence Interval	Description
June 1-2, 1889	Flood, Potomac River Basin	50to>100 [1]	Flood of 1936. [1]
February 18, 1889	Ice Jam, Potomac River	-	55K damages in 1918 dollars. [2]
March 28-30, 1924	Snowmelt and intense rainfall runoff, Potomac River Basin	20 to> 100 [1]	5 Deaths, $4Million in Damage. [1]
May 12-14, 1924	Rainfall	-	Greatest Damage since flood of 1889. [3]
August 23, 1933	Tidal Surge	-	Chesapeake-Potomac Hurricane of 1933.
March 17-19, 1936	Thick Ice, Snowmelt and intense rainfall runoff, Potomac River Basin	20 to> 100 [1]	Greatest flood since 1889 .[1] Exceeded flood of May 1924. [4]
April 25-28, 1937	Rainfall	-	Third Largest flood after 1936 and 1889. Comparable to May 1924. [4]
October 13-17, 1942	Flood from extended rainfall	>100 [6]	Potomac River Stage at Washington 0.3 ft higher than in 1936. [5]
August 12-13, 1955	Flood, Rock Creek, Potomac, Anacostia River Basins	5 to 10 [1]	Hurricanes Connie and Diane.
June 21-23, 1972	Flood, Rock Creek	>100 [1]	Hurricane Agnes.
September 5-6, 1979	Flood Rock Creek	50 to >100 [1]	Hurricane David $374,000 in damage. [7]
November 4-7, 1985	Flood, Potomac River Basin	2 to>100 [1]	Hurricane Juan combined with stationary front. $9 million damage along C&O canal and $113 million along Potomac. [7]
May 5, 1989	Flood	-	Three people killed, hundreds of homes and businesses destroyed. [7]
January 19-21, 1996	Snowmelt Flood	-	Fifth highest flood on official record.
September 6-8, 1996	Flood, Potomac River	-	Hurricane Fran, flooding similar to Hurricane Juan. [6]
August 11, 2001	Flash Flood, Rock Creek	-	Rock Creek discharge at Sherrill Drive gage about 1.5 times the 100-yr discharge. [1]
September 18-19, 2003	Flood, Potomac, Anacostia River Basins	-	Hurricane Isabel. Caused a system malfunction in the 14th Street pumping station. The Incident closed 395 in both directions for 48-Hours. $125 million in property damages. [7]
June 22-23, 2006	Rainfall	-	Localized flooding throughout region damaged major Federal buildings. $10 million in damages. [7]

Symbol > = Greater Than.

[1] USGS (1991)
[2] Henry (1918)
[3] Frankenfield (1924)
[4] Swenson (1937)
[5] Swenson (1942)
[6] Source: Ambrose et al. (2002)
[7] Source: DC HSEMA

Figure 3. Potomac River high water marks at Overlook 2, Great Falls National Park (courtesy National Park Service)

River ice breakup was a feature of several notable floods in Washington, including February 1881; February 18, 1918; February 6, 1932; January and February, 1936; and February 16, 1948 (USACE 2005). According to Henry (1918), the ice jam flood of 1918 damaged all the house boats on the Potomac River (loss estimated at $1,500 in contemporary dollars), damaged all but three boat houses (loss estimated at $15,000 in contemporary dollars), and caused more than $38,000 (contemporary dollars) in damages to commercial interests along K Street.

The most severe ice-related flood was the flood of March 1936, which was the greatest flood experienced since the flood of 1889. Earlier freezing and thawing resulted in the formation of thick ice throughout the eastern U.S. comparable to 1918 (Moxom 1936a), and ice jams on the Potomac River were reported in January and February of 1936 (USACE 2005). Rainy weather in late February and early March caused floodwaters to rise again in early March, but it was the extremely heavy rain on March 15 (over five inches in less than 12 hours in the headwaters of the Potomac River falling on saturated and semi-frozen ground that resulted in the record flood of March 17, 1936 (Moxom 1936b). Swenson (1937) reports that the peak stage at Wisconsin Avenue was 17.2 ft during this event.

Winter floods in D.C. can also be associated with large snowpack. DC SHEMA reported that just two weeks after the Blizzard of 1996 dumped two to four feet of snow on the Washington area, 60-degree temperatures and heavy rain (two to five inches) led to rapid snowmelt. Flooding on the Potomac River damaged homes and businesses, and 80% of the paths and bridges in the C&O National Historic Park were wiped out. According to Ambrose et al. (2002), this flood was the fifth highest on record for the Potomac River (see high water mark of Figure 3).

Flooding associated with hurricanes has also resulted in damaging floods in D.C. Ambrose et al. (2002) report that five hurricanes made landfall along the Virginia, Maryland, and Delaware coasts from 1900 to 2000, and only the Chesapeake-Potomac hurricane of 1933 had winds greater than 100 miles per hour at landfall. This hurricane resulted in a tidal surge at D.C., with some areas of D.C. flooded to a depth of ten feet (Ambrose et al. 2002). Ten people died when a train crossing the Anacostia River was swept off the tracks by floodwaters (Ambrose et al. 2002).

Precipitation associated with Hurricane Able (September 1952) was reported as being about 3.47 inches (Ross 1952), which caused flooding along Rock Creek (Ambrose et al. 2002). The combined impact of Hurricanes Connie and Diane in August 1955 resulted in rainfall of 10.43 inches at Washington D.C., that caused major flooding in the Potomac River, according to Ambrose et al. (2002).

On September 5, 1979, Hurricane David resulted in five to six inches of rain north and northeast of D.C., which caused flooding along Rock Creek Parkway (USGS 1991), as well as funnel clouds and tornadoes throughout the city. According to DC HSEMA, $374,000 in damage was caused. USGS (1991) reported that the Rock Creek discharge at Sherrill Drive gage was about 1.5 times the 1-percent annual chance discharge during that event. Precipitation associated with the remnants of Hurricane Fran caused flooding along the Potomac River on the order of the 1985 flooding from Hurricane Juan (see Figure 3) (Ambrose et al. 2002). The most severe hurricane to impact D.C. in recent memory is Hurricane Isabel.

According to DC HSEMA, floods put the following areas and addresses at high risk: 3000 K Street, NW; 3030 K Street, NW; 3050 K Street, NW; 3524 K Street, NW; 3526 K Street, NW; 3528 K Street, NW; 1000 Potomac Street, NW; 3524 Water Street, NW; 3526 Water Street, NW; Polk Street and Anacostia Avenue, SE; North Extension, Shoemaker Street (near Tilden Street); North Side, Quebec and Williamsburg Streets; 27th and Q Streets, (North Side); C&O Canal and 29th Street, NW; Mayfair Terrace and Jay Street; G and 22nd Streets, (northeast side); South of Potomac Avenue and Half Street; South of Frederick Douglas Memorial Bridge; East Side Ft. Lincoln Subdivision; Washington Channel (Maine & 6th Streets); and Georgetown Waterfront (between Key Bridge and the mouth of Rock Creek).

A tropical weather pattern between June 19, 2006 and June 27, 2006 is responsible for considerable flooding in the interior of Washington DC affecting several Federal buildings, and the Smithsonian Institute. The system produced heavy downpours, with a total recorded accumulation on June 25, 2006 of 7.09 inches. Storm related floodwaters collected along Constitution Avenue, and forced the closure of the IRS Headquarters, the National Archives, the Department of Commerce and the Department of Justice Buildings, in addition to several of the Smithsonian buildings. The system also caused flooding alone Rock Creek, inundating several of the National Zoos parking areas, and closing the Rock Creek Parkway.

2.4 Flood Protection Measures

Flooding on the Potomac River at Washington, D.C. is caused by tidal flooding from Chesapeake Bay and flood flows on the Potomac River upstream of Washington, D.C. Flood flows combined with high tide elevations produced record flood flows of 484,000 cubic feet per second (cfs) in 1889 and 1936. As a result of the 1936 flood, the existing flood control project was authorized for construction by the Flood Control Act of 1936 and completed in 1939. In the Flood Control Act of 1946, Congress authorized the U.S. Army Corps of Engineers to modify the existing project to reduce the amount of emergency work required to close openings in the line of protection during a flood event. The National Park Service would be responsible for the emergency closures.

FEMA Region III received notification from the Baltimore District Corps of Engineers of inadequate maintenance and observed deficiencies for the three federally maintained levees within the District of Columbia by letters dated January 31, 2007. The structures no longer comply with NFIP Regulation 44CFR 65.10. The flood hazard mapping has been updated to reflect this non-compliance and shows increased inundation areas landward of the levees.

The following is a description of the project as completed for reference.

The project consisted of a levee between the Lincoln Memorial and the Washington Monument and a raised section of P Street, S.W., adjacent to Fort McNair. The project had three openings that were to be temporarily closed during a flood emergency. These openings were located at 23rd Street and Constitution Avenue, N.W.; 17th Street and Constitution Avenue, N.W.; and 2nd and P Streets, S.W. In order for the project to provide the design level of protection, sandbag closures would have had to been constructed in the openings at 23rd Street and Constitution Avenue and at 2nd and P Streets.

The project provided a design level of protection equal to a 575,000 cfs event with an estimated 1-percent annual chance (100-year) return interval. The project was authorized to have a top-of-protection equal to 700,000 cfs event with an estimated 185-year return interval. In October 1942, portions of Washington were flooded when a high tide coincided with the third highest flow of record (447,000 cfs) on the Potomac River. The resulting flood stage was the highest on record and caused an estimated $7,407,000 in damages.

The District Department of the Environment (DDOE) is the regulatory agency that is delegated the authority pursuant to D.C. Law 1-64 (the “District of Columbia Applications Insurance Implementation Act”), D.C. Code §§ 5-301 et seq., and Mayor’s Order 98-46 to review building permits to determine whether the building sites are at risk for flooding, ensure that construction is designed to minimize flood damage, ensure that public utilities and facilities are located, elevated and constructed to minimize flood damage, and generally implement and enforce the Act. The DDOE’s Watershed Protection Division coordinates the National Flood Insurance Program for DC and coordinates general floodplain management activities with DC HSEMA.

3.0 ENGINEERING METHODS

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

3.1 Hydrologic Analyses.

The effective Flood Insurance Study (FIS) for the District of Columbia (FEMA 1985) included hydrologic analyses for the areas studied in detail. The objectives of the hydrologic portions of the FIS update are to compare flows established for detailed study areas in the effective FIS to those obtained for current conditions and make recommendations for revision of flow values if necessary. The current FIS update has an additional objective, to establish 10-, 2-, 1-and 0.2-percent annual chance flows for streams identified within the effective FIS and Flood Insurance Rate Map approximate flood zones and previously unstudied areas. Methods and results of the updated hydrologic analyses are presented below.

Effective FIS Hydrology

For gaged watersheds, discharges for the selected exceedance probabilities used in the effective FIS were developed using the standard method developed by the Water Resources Council known as Bulletin 17 (Interagency Advisory Committee On Water Data (IACWD) 1976). According to the effective FIS, flood frequencies for the Anacostia River were based on a revision of a watershed modeling study undertaken by the Maryland National Capital Park and Planning Commission. No reference to this study was given in the effective FIS. Effective FIS stage-frequencies for the tidally influenced portions of the Potomac and Anacostia Rivers were developed by a frequency analysis of the measured water-surface elevations recorded by the tidal gage located at Haines Point, near the confluence of the two rivers. The effective FIS (FEMA 1985) reported that flood frequencies for ungaged watersheds were developed using rainfall-runoff relationships established through application of the Soil Conservation Service (SCS, now Natural Resources Conservation Service, NRCS) triangular hydrograph method (USDA 1972), the SCS Technical Report 55 (TR55) method (USDA 1975), or regression equations developed by the U.S. Geological Survey (USGS) for the Northern Virginia/Metropolitan Washington areas (Anderson 1970).

Potomac River

The Potomac River is affected by both riverine flows in the upper portion of the river within the District of Columbia and tidal and storm surge effects from Chesapeake Bay.

Riverine Hydrology

For the riverine portions of the Potomac River, the effective FIS is based on a flood frequency analysis of annual peak discharge data collected at USGS gage for the Potomac River near the Washington, D.C. Little Falls Pumping Station (USGS Station No. 01646500), which is not tidally influenced. The period of record was not given in the study, but is assumed to be 1931 to 1982 (based on the April 1983 date given for completion of the study). The effective FIS states that an adjusted skew coefficient was used to account for the short length of record at the gage but the value of the adjusted skew was not reported.

The current analysis is based on extension of the period of record to cover 1931 through 2003, including data from a historical peak on June 2, 1889. Flood frequencies were developed using the Corps of Engineers' Hydrologic Engineering Center (HEC) Flood Frequency Analysis (FFA) program (USACE 1992) and an updated version of the methods in *Bulletin 17*, given in *Bulletin 17B* (IACWD 1982). Like the method of *Bulletin 17*, this method assumes that a log-Pearson Type III distribution can adequately describe flood flows. This distribution is a three-parameter gamma function whose shape is proscribed by the mean, standard deviation, and skew of the base-10 logarithms of the data. Note that if skew=0, the log-Pearson Type III distribution becomes the log-normal distribution. Plate I of *Bulletin 17B* provides generalized skew coefficients for use in developing flood frequencies when detailed studies are not available.

In the case of large basins such as the Potomac River (11,560 mi^2 at the gage), the station skew computed from the peak annual discharge data can be used without weighting by the generalized skew. For the same reason, the skew proposed by USACE (1975) in a hydrology review of Tropical Storm Agnes (June 1972) was not applied since it was computed using much smaller basins. No adjustment in the computed station skew of 0.3 was made for length of record.

The results of the updated hydrologic analysis are shown in Table 4, along with the effective FIS discharges at the same location. The effective discharges are well within the 5 percent and 95 percent confidence limits of the updated discharges (Figure 4), therefore no revisions to the Potomac River riverine discharges are recommended for the selected exceedance probabilities.

Table 4 - Comparison of effective and updated peak discharges, Potomac River at Little Falls (USGS Station No. 01646500 - 11,560 m^2 drainage area)

Percent Chance Annual Exceedance	1985 FIS Discharge (cfs)	Revised Discharge (cfs)	Increase (cfs)
10	236, 000	240,000	4,000
2	381,000	395,000	14,000
1	457,000	475,000	18,000
0.2	658,000	698,000	40,000

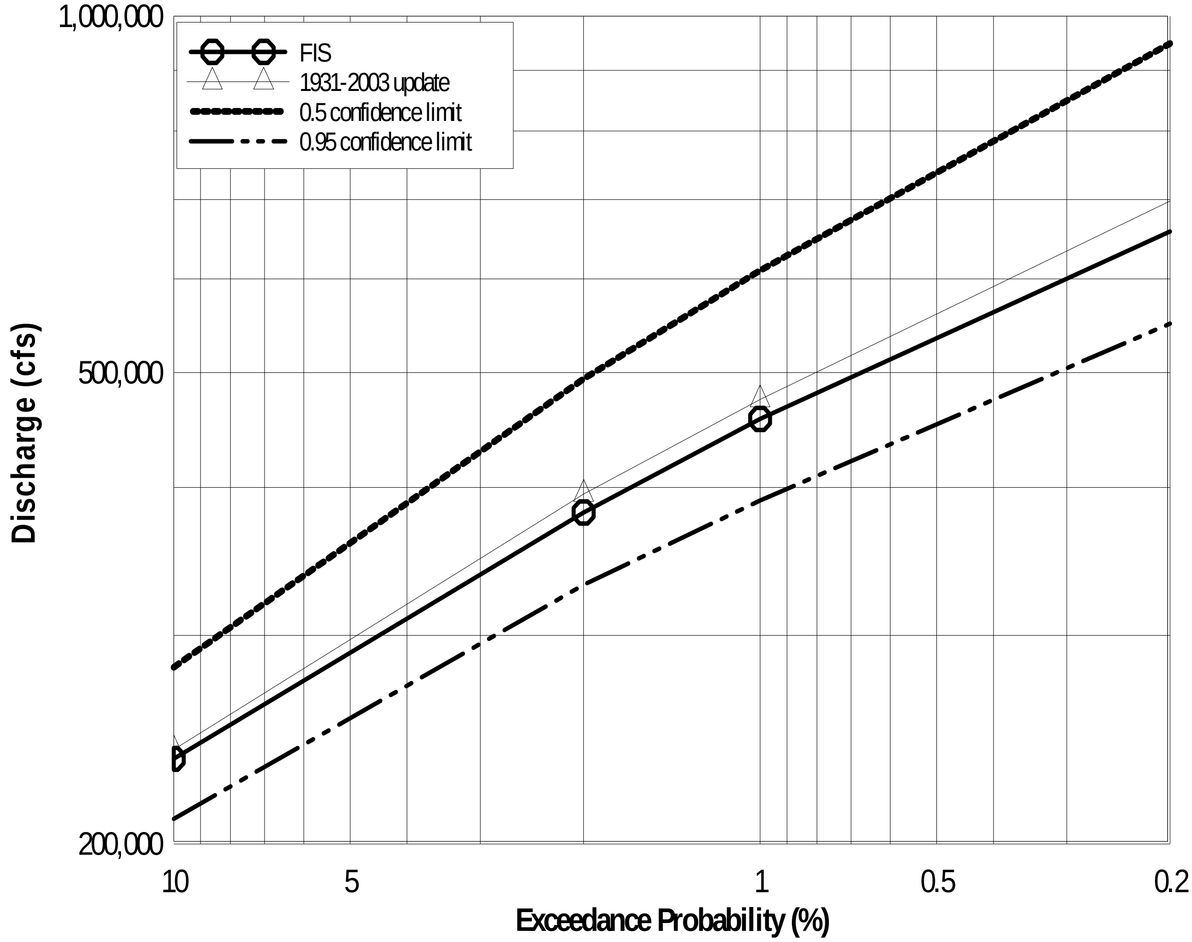

Figure 4. Frequency vs. Discharge curve for the Potomac River at Little Falls (USGS Station No. 01646500).

Tidal Hydrology

For the tidally-influenced portions of the Potomac River, the effective FIS is based on a stage-frequency analysis of measured water-surface elevations recorded at National Ocean Service (NOS) gage no. 8594900, which is located at Haines Point, near the confluence of the Potomac and Anacostia Rivers, for the period April 1931-April 1980. The log-Pearson Type III procedure was used in the analysis with data collected from 1 January 1932 through 31 December 2003. Table 5 presents the five highest water levels recorded at the Potomac River (Haines Point) tidal gage at Washington D.C.

The results of the updated tidal frequency analysis are shown in Table 6, along with the effective FIS stages at the same location. The effective FIS reported stage elevations relative to National Geodetic Vertical Datum of 1929 (NGVD29), which lies 0.94 ft below the mean-sea level datum for NOS gage 8595900 (Nook, USACE). Stages in this report are all converted to the North American Vertical Datum of 1988 (NAVD88). The effective stages are well within the 5 percent and 95 percent confidence limits of the updated stages (Figure 5), therefore no revisions to the Potomac River tidal stages are recommended for the selected exceedance probabilities.

Table 5- Highest Water-Surface Elevations Recorded at Potomac River (Haines Point) Tidal Gage, NOS #8595900, Washington, D.C. (1932-2003)

		Water-Surface Elevation	
Rank	Date	(ft mean sea level)	(ft NAVD88)
1	17 October 1942	9.50	9.65
2	20 March 1936	9.00	9.15
3	19 September 2003[1]	8.74	8.89
4	24 June 1937	7.10	7.25
5	9 September 1996[2]	6.60	6.75

[1] – Hurricane Isabel
[2] – Hurricane Fran

Table 6- Summary of Stage-Frequency Analysis for Potomac River (Haines Point) Tidal Gage NOS #8595900, Washington, D.C. (1932-2003)

Percent Chance Annual Exceedance	1985 FIS Water Surface Elevation (ft. NGVD)	1985 FIS Water Surface Elevation (ft. NAVD88)	Updated Stage-Frequency Analysis Water Surface Elevation (ft. NAVD88)
10	6.7	5.9	5.8
2	9.7	8.9	8.9
1	11.4	10.6	10.5
0.2	14.9	14.1	14.7

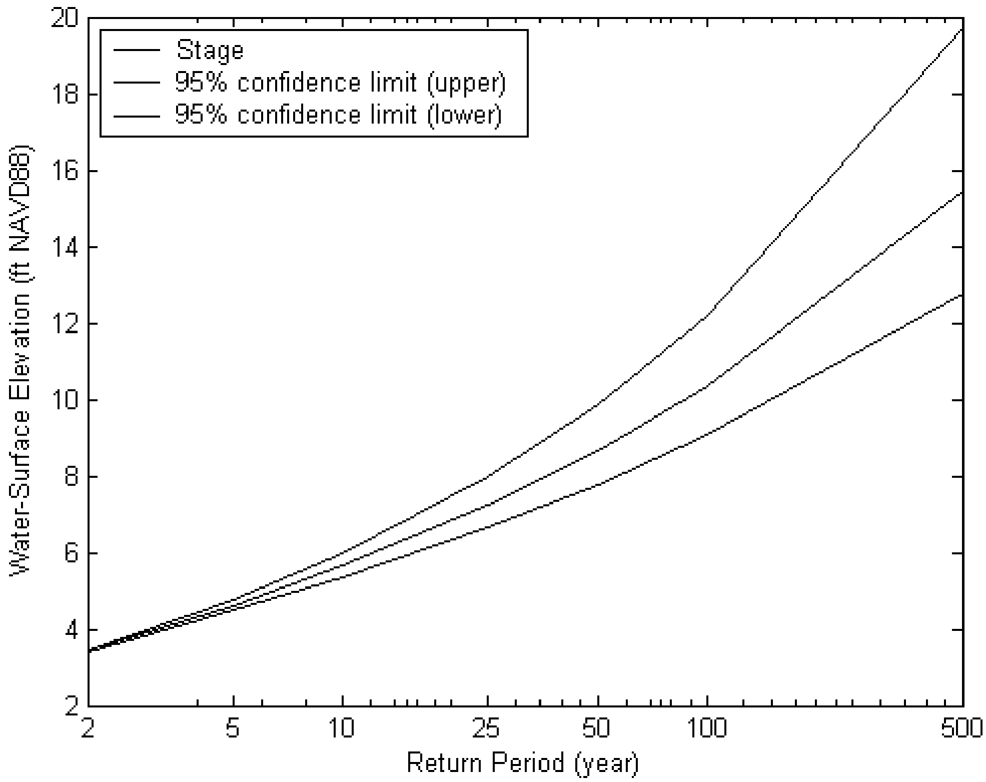

Figure 5. Water-surface elevation versus return period for Potomac River (Haines Point) Tidal Gage, NOS #8595900, Washington, D.C. (1932-2003).

<u>Watts Branch</u>

The effective FIS (FEMA 1985) reported that flood frequencies for ungaged watersheds were computed by either Soil Conservation Service rainfall-runoff methods (USDA 1972, 1975) or regression equations for the Northern Virginia/Metropolitan Washington areas (Anderson 1970). More recently, a gaging station (USGS 01651800 Watts Branch at Washington D.C.) was placed along Watts Branch within the District of Columbia corporate limits. Approximately 3.28 square miles of the total 3.7 square-mile drainage area is upstream of the gaging station. The period of record available at the gaging station at the time of this study is 1992 through 2003; however, the peak measured for 2003 is an estimate as of January 2005, the time of this analysis.

Application of Hydrologic Engineering Center's Flood Frequency Analysis (HEC-FFA) (USACE 1992) and the techniques of Bulletin 17B (IACWD 1982) to peak annual discharges for the period of record from 1992 to 2002, with a generalized skew of 0.7 from both Bulletin 17B and Figure 13 of USACE (1975), yield the estimated flood frequencies shown in Table 7. The station skew is computed as -0.006. The effective discharges fall outside of the confidence limits of the peak discharges computed based on the flood frequency analysis at the gage (Figure 6).

Table 7- Comparison of 1985 FIS and updated discharges, Watts Branch at Washington D.C. (USGS Station No. 01651800)

Percent Chance Annual Exceedance	1985 FIS Discharge (cfs)	Revised Discharge (cfs)	Decrease (cfs)
10	2,545	1,419	1,126
2	3,368	1,812	1,556
1	3,872	1,986	1,886
0.2	4,880	2,413	2,467

Because the record length of the gage is less than 25 years, a comparison of we compared the updated discharges to regional discharge estimates for similar watersheds per FEMA guidelines (FEMA 2003b) was done. For comparison purposes, the FIS 1-percent annual chance discharges for streams in Prince Georges County, Maryland, and the District of Columbia listed in Table 8 were examined. The FIS 1-percent annual chance discharges for streams in the neighboring watersheds were computed in previous flood studies using drainage area discharge curves developed by analyzing stream gage records for streams in and around Prince George's County, Maryland, and rainfall runoff methods or regression equations in the District of Columbia.

The regional 1-percent annual chance discharges were plotted logarithmically versus drainage area to establish linear relationships for the region (Figure 7). The Watts Branch 1-percent annual chance effective FIS discharge and the Watts Branch 1-percent annual chance discharge based on the flood frequency analysis of 10 years of record were also plotted for comparison. The comparison shows that the Prince George's County 1-percent annual chance discharge estimate relationship falls mid-way between the effective FIS 1-percent annual chance discharge and the updated gage analysis 100-year discharge for Watts Branch. The District of Columbia discharge estimate relationship agrees with the effective FIS 1-percent annual chance discharge for Watts Branch.

Given that the Watts Branch gage has only 10 years of record and the Watts Branch gage analysis 1-percent annual chance estimate appears low compared to both Prince George's County and District of Columbia FIS 1-percent annual chance discharges, it is recommended that the effective FIS discharges for Watts Branch as listed in the District of Columbia FIS report be used until additional Watts Branch gage data is available.

Table 8- 1985 FIS discharge estimates for regional watersheds similar to Watts Branch.

River Name/Location	Drainage Area (Mi.^{2})	Discharge for 1 percent Annual Chance Flood (cfs)
	Prince George's County, MD	
Paint Branch	31.07	11200
	17.64	7700
Indian Creek	29.2	10800
	25	8800
	10.4	5742
	2.6	2154
	1.9	1497
Beaverdam Creek	14.85	6900
	7.97	4600
	3.36	2550
	2.12	921
Burch Branch	3.78	2800
Bear Branch	2.79	1900
	1.04	1200
Little Paint Branch	10.39	5500
	7.78	4500
	4.17	3000
Slingo Creek	11.35	5800
	6.86	4200
Brier Ditch	7.52	4400
	3.81	2800
Long Branch	1.76	1650
Cabin Branch	3.43	2600
	2.25	1950
Ammendale Branch	2.2	1950
Muirkirk Branch	1.76	4470
	District of Columbia streams	
Normanstone Creek	0.344	980
East Creek A	0.41	788
East Creek B	0.086	292
Fort Dupont Creek	0.57	560
Broad Branch	1.7	3295
Melvin Hazen Branch	0.23	849
Fenwick Branch	1.4	3565
Barnaby Run	3.9	4384
Oxon Run	8.3	7545

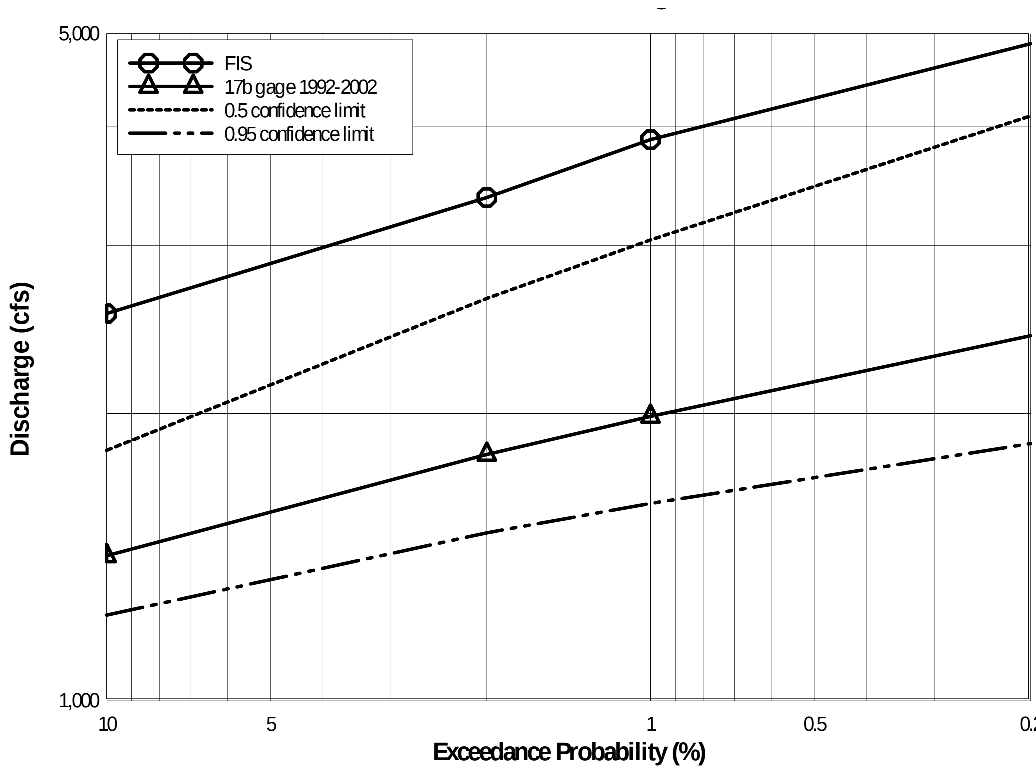

Figure 6. Frequency vs. Discharge curve for Watts Branch

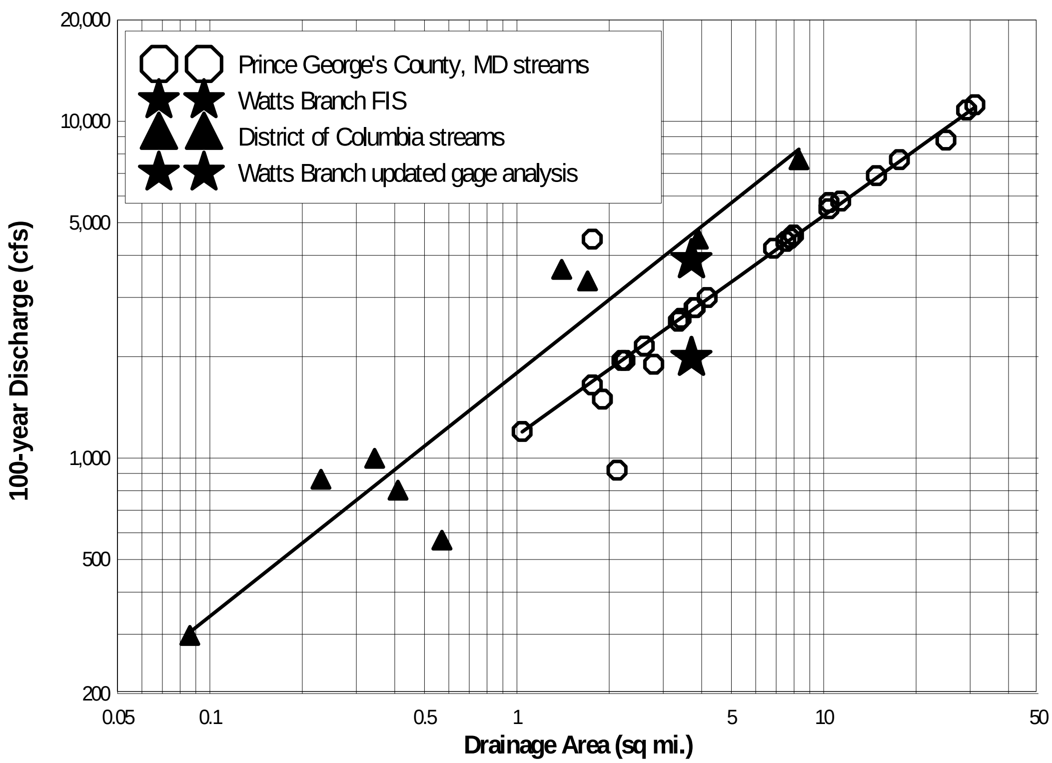

Figure 7. Drainage area vs. 1-percent-annual-chance discharge curve for Watts Branch

Anacostia River

Riverine Hydrology

The Anacostia River Reach of interest drains a watershed area of 163 square miles. Four USGS gages are located in the general area (Table 9). The upstream USGS Anacostia. The Northeast Branch of the Anacostia River at Riverdale, MD (USGS Gage # 01649500) records peak flows for approximately 72.8 square miles of this watershed. Since a significant portion of the study area is ungaged, the effective FIS discharges for the Anacostia River were obtained employing watershed model simulations of design storms obtained circa 1982 (FEMA 1985).

The presumption is that the hydrology portion of the effective FIS for the Anacostia River used all information available at the time, including gage records, for estimating and evaluating the watershed model simulated flow-frequency curve. Presumably, a restudy would be advisable if peak events have occurred since the study was performed which provides information for modeling that would significantly change the estimated curve. The influence of peaks occurring on flood frequency estimates during the intervening period since the effective FIS study was assessed by considering the record at the gages shown in Table 9. These gages were selected because: 1) the Northeast Branch Anacostia River gage at Riverdale, MD is located upstream of the study reach; 2) the Rock Creek gage is located immediately to the north; and 3) the Potomac River gage provides information on major regional events, because of its large drainage area, that might have bypassed by chance the smaller drainages areas served by the other gages; and, 4) all the gages have significant periods of record.

Table 10 presents the top five ranked peak annual flows in the period of record at these gages. As can be seen, the four largest peaks occurred prior to the completion of the current flood insurance study (circa 1982). Furthermore, the event of record (June 1972) at the North Branch Anacostia River and Rock Creek gages is significantly larger than the next largest event in the period of record. Consequently, it is unlikely that the additional period of record would increase flow-quantile estimates, particularly the 1 percent chance flood.

Table 9 - Gages near confluence of Potomac and Anacostia Rivers used for comparison of Anacostia River effective and updated hydrology.

Gage Name	USGS Gaging Station Number	Drainage Area (Mi^2)	Period of Record
Northeast Branch Anacostia River at Riverdale, MD	1649500	72.8	1933-2003
Rock Creek at Sherrill Drive, D.C.	1648000	62.2	1930-2003
Potomac River near Washington D.C., Little Falls Pump Station	1646500	11560	1931-2003

Table 10 - Top ranked peak annual events in gage record

Northeast Branch Anacostia River at Riverdale, MD		Rock Creek at Sherrill Drive, D.C.		Potomac River near Washington D.C., Little Falls Pump Station	
Date	Discharge (cfs)	Date	Discharge (cfs)	Date	Discharge (cfs)
6/22/1972	12,000	6/22/1972	12,500	3/19/1936	484,000
9/26/1975	10,800	9/6/1979	8,940	10/17/1942	447,000
8/23/1933	10,500	7/21/1956	7,220	6/24/1972	359,000

FEMA considers that a new estimate of a flow frequency curve is significantly different if the existing curve lies outside the most recently estimated curve's 90 percent confidence interval (FEMA 2003b). The period of record available at the North Branch Anacostia River gage was analyzed using Bulletin 17B (IACWD 1982) procedures to determine if there is a significant difference based on this criterion. A similar analysis for Rock Creek is discussed in detail in Section 3.2.5 below. These gages were selected because the gages provide a reasonable representation of the potential change that occurs due to the additional period of record.

The Bulletin 17B analysis was used to compute both a new estimate of the frequency curves at the gages, including confidence intervals, for the entire period of record; and, frequency curves obtained from the period used to establish the current FIRM map (circa 1982). The resulting frequency curves obtained by:

- assuming that the current FEMA FIRM maps are representative of a period of record up to water year 1980;
- assuming the data over the period of record is homogenous (effects of urbanization are minimal)
- using the information in the USGS data base for Rock Creek to give historic treatment to the 1933 event;
- noting that the regional skew provided in Bulletin 17B is not relevant to urban watersheds, and consequently, the adopted skew was set equal to the station skew.

The 1 percent exceedance computed flow values estimated for the period of record up to 1980 are contained within the 90 percent confidence interval obtained from the full period of record for both gages, as can be seen from Figure 8 for the Anacostia River at Riverdale and Figure 4 for the Potomac River at Little Falls. Consequently, the difference between estimates would not be considered significant based on the FEMA criterion.

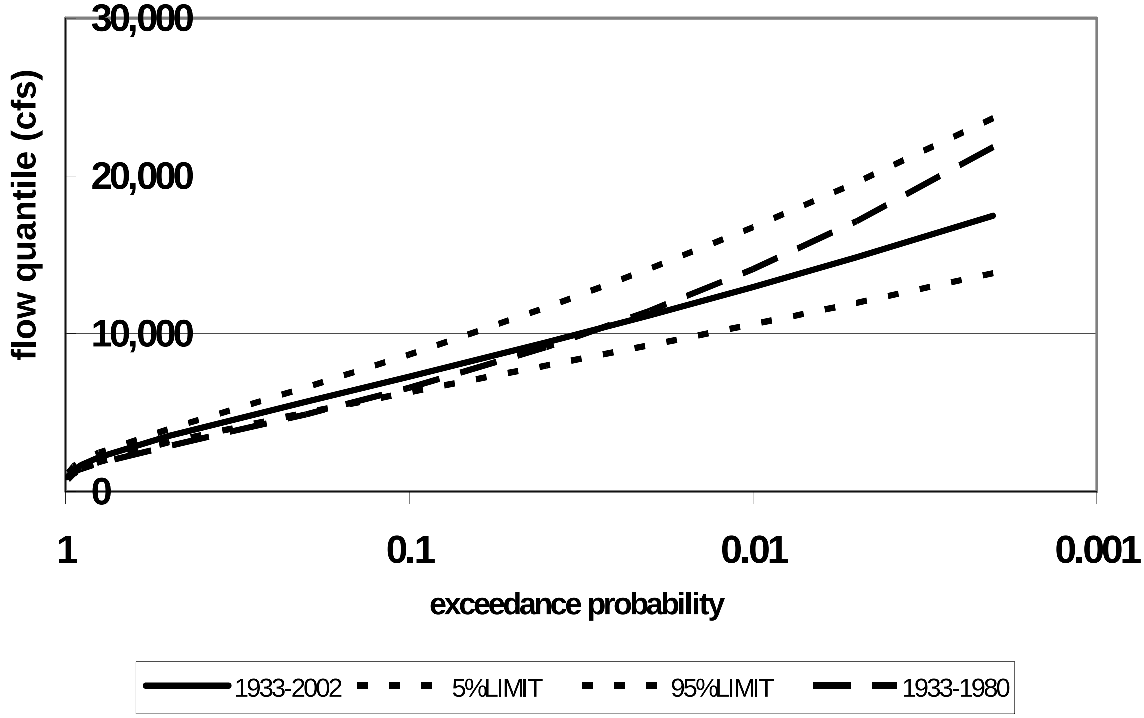

Figure 8: Northeast Branch Anacostia River frequency curves for approximate FEMA study period of record and current period of record.

The period of record gage information does not indicate that significant changes to the study reach frequency curve would occur because of the additional period of record since the last study performed to establish the effective FIS for the

Anacostia River. No significantly large events have occurred since 1980. Furthermore, an analysis of gages either upstream or in proximity of the study reach does not indicate that the additional period of record since the effective FIS was completed would significantly change the flow frequency curve based on the FEMA criterion. Consequently, it is not recommended to initiate any study to re-estimate the study area flow frequency curves because the additional period or record is not likely to make any significant difference.

Tidal Hydrology

For the tidally-influenced portions of the Anacostia River, the effective FIS is based on a stage-frequency analysis of measured water-surface elevations (WSELs) recorded at National Ocean Service (NOS) gage no. 8594900, which is located at Haines Point, near the confluence of the Potomac and Anacostia Rivers, for the period April 1931-April 1980. See Tidal Hydrology for the Potomac River.

Rock Creek

No frequency discharges or method of analysis is contained within the effective FIS (FEMA 1985) for Rock Creek, which was included in the FIS as an “existing data study stream.” CH2M Hill (1979) completed a study titled “Rock Creek Watershed Conservation Study” for the National Park Service in October 1979, which included hydrologic analyses. They reported that Rock Creek had undergone two significant changes prior to 1979. The first was the construction of two lakes, Lake Needwood and Lake Frank in 1966 and 1968, respectively. The second change was the urbanization of the watershed. The CH2MHill did not account for the regulation effects in their frequency curves from the dams in the upper Rock Creek. However, if this were to be considered, it would affect the lower portion of the frequency curve, with the impact of decreasing the discharges below the ten year return interval event. The upper frequencies are not likely to be impacted. According to KCI Technologies (2002), CH2MHill used the Anderson (1970) method to develop discharge rates, which would have accounted for urbanization effects.

More recently, in June 2002, KCI Technologies (2002) prepared a report as part of the Woodrow Wilson Bridge Project titled “Final Hydraulic Study of Fish Passage Improvements.” The KCI study, based on annual series gage data collected for the period 1930 to 1999 at the USGS gage located 200 feet downstream of Sherrill Drive on Rock Creek, used three different analyses to determine whether the discharges calculated for the earlier CH2M Hill study were still appropriate for Rock Creek in 2002. KCI performed Log-Pearson Type III analyses for the three periods 1930-1965, 1969-1999, and 1930-1999. The results showed quite a variation between the frequency curves developed for the three periods. However, in comparing the results to the analysis performed by CH2M Hill, they concluded CH2M Hill’s discharges still to be the best representation of frequency discharges for Rock Creek.

The discharges in Table 11 were determined by plotting values for the 2, 10 and 1-percent annual chance frequency events from KCI (2002) and best fitting graphical log plots based on drainage area changes in the Rock Creek watershed (Figure 9). The drainage areas shown in Table 11 were determined using a digital elevation model based on 100-foot cells; therefore, some small amount of difference is expected from the drainage areas reported in the effective FIS. Figure 10 provides the discharge-frequency curve comparison between CH2MHill (1979) and curves for three periods of record for USGS gage Rock Creek at Sherrill Drive.

Table 11- Rock Creek updated frequency analysis peak discharges

River Mile	Drainage Area (Mi^2)	10-percent Annual Chance Discharge (cfs)	2-percent Annual Chance Discharge (cfs)	1-percent Annual Chance Discharge (cfs)	0.2-percent Annual Chance Discharge (cfs)
0	78	8,400	14,200	16,700	22,200
0.9	77.5	8,400	14,100	16,600	22,100
4.05	73.3	8,000	13,500	16,000	21,500
4.83	68.6	7,600	12,900	15,200	20,400
6.5	65.4	7,100	12,200	14,400	19,400
7.5	63.6	6,900	11,800	13,900	18,800
9	62	6,400	11,000	13,000	18,000
9.01	60.4	5,800	10,000	12,000	16,500

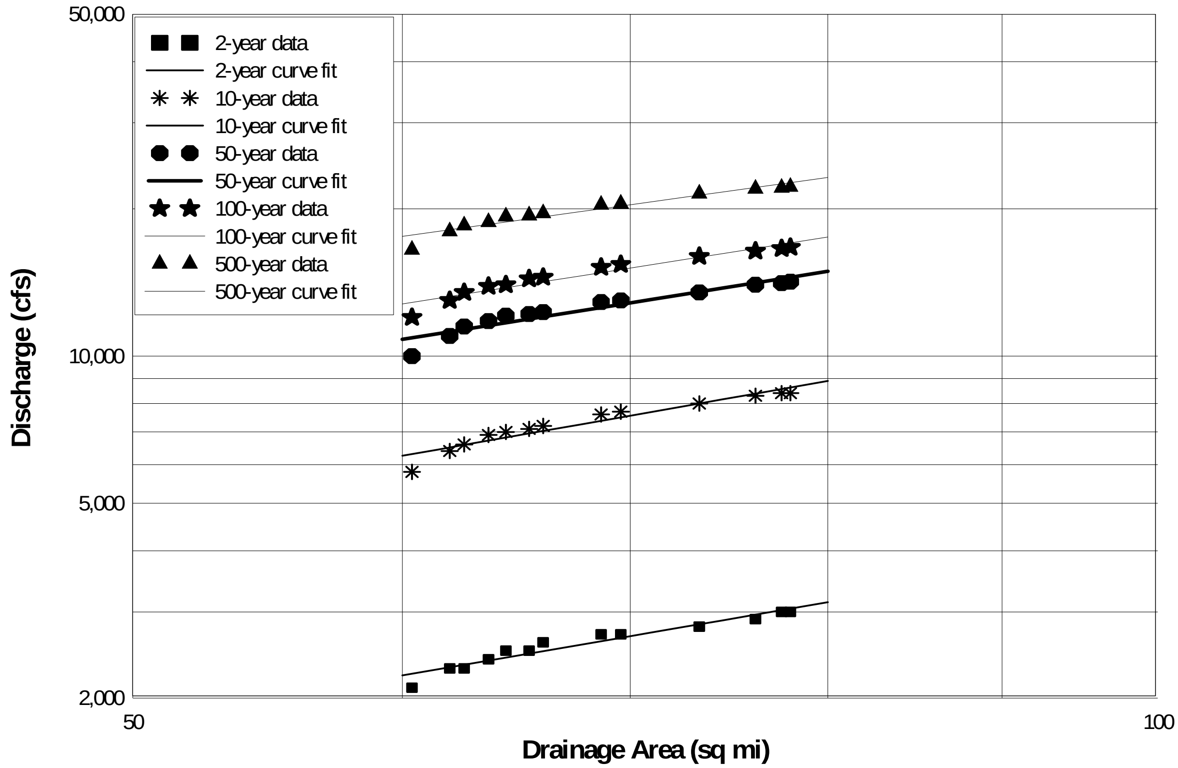

Figure 9. Drainage area vs. discharge curve for Rock Creek.

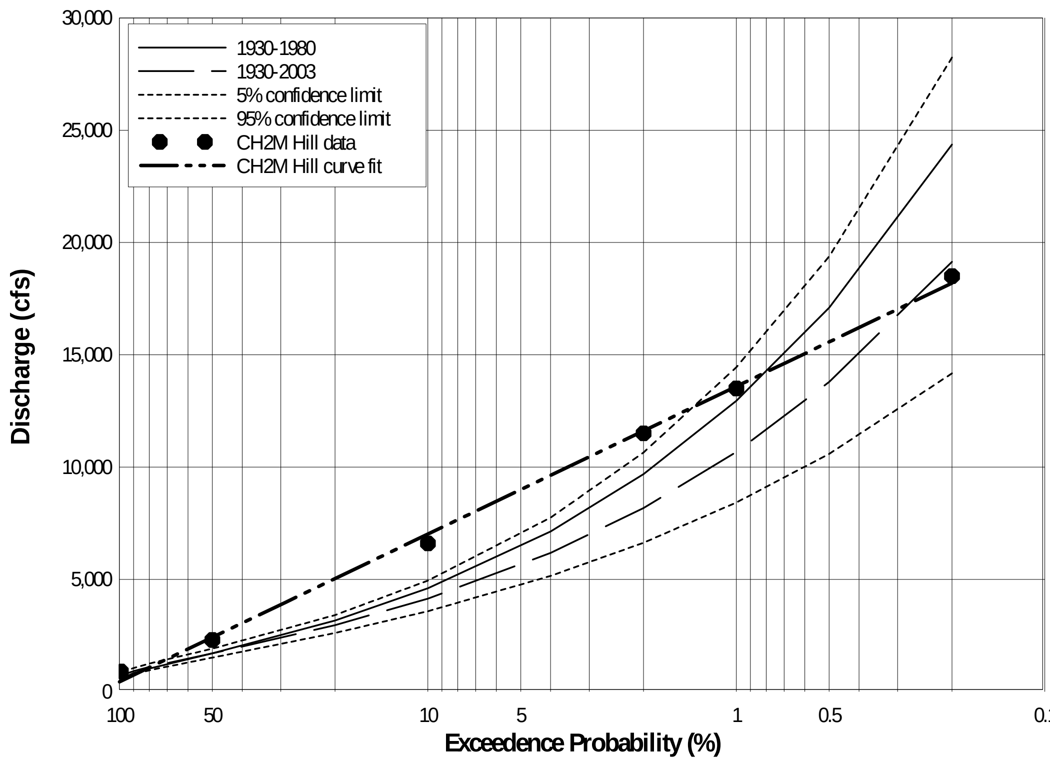

Figure 10. Comparison between CH2MHill (1979) discharge-frequency curve and curves for three periods of record for USGS gage Rock Creek at Sherrill Drive.

Hydrology Summary

FEMA considers that a new estimate of a flow frequency curve is significantly different if the existing curve lies outside the most recently estimated curve's 90 percent confidence interval (FEMA 2003b). Updated hydrological analyses for the Potomac River, Watts Branch, Anacostia River, and Rock Creek did not reveal significant differences between the discharges calculated for the effective FIS and those resulting from updated hydrological analyses. Therefore, the effective FIS discharges for these rivers shown in Table 12 are used in the current study. Table 12 also includes discharges for the other detailed study rivers in the current revision.

Table 12- Summary of Discharges

Flooding Source and Location	Drainage Area (Mi^2)	Exceedance Probability Discharge (cfs) 10 percent	2 percent	1 percent	0.2 percent
Potomac River at downstream city limits	11,560	23,6000	381,000	457,000	658,000
Anacostia River at confluence with Potomac River	163	24,884	34,241	39,462	50,000
Watts Branch at confluence with Potomac River	3.7	2,545	3,368	3,872	4,880
Creek along Normanstone Drive at confluence with Rock Creek	0.344	468	816	980	1,430
East Creek A at downstream city limits	0.41	366	652	788	1,200
East Creek B upstream of Glen Brook Road	0.086	136	242	292	505
Fort Dupont Creek upstream of Chessie System Railroad	0.57	231	450	560	895
Broad Branch at downstream limit of detailed study	1.7	2,100	2,840	3,295	4,230
Melvin Hazen Branch upstream of Connecticut Ave.	0.23	547	719	849	1,111
Fenwick Branch at confluence with Rock Creek	1.4	2,241	3,002	3,565	4,769
Fenwick Branch upstream of confluence with tributary of Fenwick Branch	0.76	853	1,456	1,738	2,550
Tributary of Fenwick Branch at confluence with Fenwick Branch	0.35	679	1,096	1,282	1,750
Pope Branch upstream of Fairlawn Ave.	0.39	433	755	902	1,300
Pinehurst Run upstream of Oregon Ave.	0.75	1,120	1,580	1,805	2,425
Barnaby Run at confluence with Oxon Run	3.9	2,808	3,779	4,384	5,598
Oxon Run at confluence with Anacostia River	8.3	4,795	6,490	7,545	9,660

3.2 Hydraulic Analyses

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

A triangulated irregular network (TIN), which is a 3-D model of a ground surface, was created from 1-meter contours and spot elevations provided by the Office of the Chief Technology Officer (OCTO). OCTO is responsible for implementing and managing the enterprise-wide geographic information system (GIS) for Washington D.C. The contours and spot elevations were compiled from aerial photography acquired in the spring of 1999. The elevations of the contours and spot elevations were converted to feet prior to the creation of the TIN. Cross sections for the backwater analyses were obtained from this TIN. The below-water portions of the cross sections were obtained from the effective hydraulic models, which were originally obtained by field survey or from sounding maps. Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

All bridges and culverts in the original hydraulic models were surveyed to obtain elevation data and structural geometry. In an effort to identify any bridges that had been modified since the original FIS had been conducted, USACE contacted the Washington D.C. Department of Transportation (DDOT) and the National Park Service (NPS) to acquire the most recent data on all bridges and culverts. The data from DDOT and NPS were compared to the effective hydraulic models and if a difference existed, the bridge data were replaced with the more recent information. There were several bridges and culverts for which DDOT or NPS did not have data. For these crossings, USACE conducted a field survey to acquire the data required to model the bridge or culvert. (NOTE: There are a few bridges and culverts that have been built since the previous study for which USACE could not obtain any information. No information on these new stream crossings was available from DDOT or NPS, and USACE could not gain access to the bridges or culverts due to fences around private property, or due to safety concerns. Notes have been added to the hydraulic models for any stream with this situation.)

Water-surface elevations for floods of the selected recurrence intervals were computed through use of the USACE Hydrologic Engineering Centers River Analysis System (HEC-RAS version 3.1.1) step-backwater computer program.

Starting water-surface elevations were calculated using the slope-area method for most detailed study streams. Where the detailed study began at an existing structure, the headwater elevation for each frequency flood was acquired from the effective FIS and used as the starting water surface elevation in the hydraulic analysis.

Channel and overbank roughness factors (Manning's "n" values) used in the original hydraulic computations were chosen by engineering judgment and were based on field observations of the stream and floodplain areas. Roughness values for the main channel of the Potomac and Anacostia Rivers ranged from 0.025 to 0.04, while floodplain roughness ranged from 0.035 to 0.08 for all floods. Roughness values for the main channels and overbanks of smaller streams ranged from 0.015 to 0.05 and 0.035 to 0.12 respectively.

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

3.3 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD29). With the finalization of the North American Vertical Datum of 1988 (NAVD88), many FIS reports and FIRMs are being prepared using NAVD88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD88. Structure and ground elevations in the community must, therefore, be referenced to NAVD88. It is important to note that adjacent communities may be referenced to NGVD29. This may result in differences in Base Flood Elevations (BFEs) across the corporate limits between the communities. The vertical datum conversion factor from NGVD29 to NAVD88 for Washington D.C. is –0.80 feet.

For more information on NAVD88, see the FEMA publication entitled Converting the National Flood Insurance Program to the North American Vertical Datum of 1988 (FEMA, June 1992), or contact the National Geodetic Survey at the following address: NGS Information Services, NOAA, N/NGS12, National Geodetic Survey, SSMC-3, #9202, 1315 East-West Highway, Silver Spring, Maryland 20910-3282, (301) 713-3242.

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the

Technical Support Data Notebook associated with the FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.

4.0 FLOODPLAIN MANAGMENT APPLICATIONS

The National Flood Insurance Program (NFIP) encourages state and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations; delineations of the 1- and 0.2-percent-annual-chance floodplains; and a 1-percent-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, 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 the triangulated irregular network discussed in Section 3.2.

Delineation in and around the DC mall area, including the Smithsonian, monument areas and Andrews Air force base was delineated using topography generated from DEMs. The DEMs used to delineate the floodplain were derived from LiDAR data that were developed by the Army. NGA processed this LiDAR in 2004 to remove trees and buildings to create DEMs that show “bare earth”. The heights shown in the DEMs are orthometric NAVD88 that have an accuracy of +/- .5 meter (NGA).

The 1- and 0.2-percent annual chance floodplain boundaries are shown on the Flood Insurance Rate Maps (Exhibit 2). In cases where the 1- and 0.2-percent annual chance floodplain boundaries are close together, only the 1-percent annual chance boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to the limitations of the map scale.

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

4.2 Floodways

Encroachment into the floodplain, such as by structure and fill placement, reduce the flood carrying capacity, increase the flood height and velocity, and increase 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 National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent annual chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1-percent annual chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced.

The following streams had floodway analyses conducted as part of the previous FIS: Barnaby Run, Broad Branch, Creek along Normanstone Drive, East Creek A, East Creek B, Fenwick Branch, Fort Dupont Creek, Melvin Hazen Branch, Oxon Run, Pinehurst Run, Pope Branch, Tributary of Fenwick Branch, and Watts Branch. The floodways presented in the effective FIS were computed on the basis of equal conveyance reduction from each side of the floodplain. The majority of the floodway analyses conducted during the previous study resulted in floodways within the stream channel. A few of the aforementioned streams are also located within National Park boundaries. Because floodways are typically only used for regulatory purposes, having floodways within the banks of a stream, or in a National Park where no development is likely to occur, it was decided during this update to reduce the number of streams with floodway analyses to only those that have a substantial floodway (in terms of width), and are not within a National Park.

For this update, USACE conducted floodway analyses on the following streams: Broad Branch, Fenwick Branch, Oxon Run, and Watts Branch. The objective of the floodway analyses was to replicate the same floodways on the aforesaid streams as those presented in the effective FIS. The floodway encroachments were set by matching the locations from on the effective Flood Insurance Rate Maps, and only adjusted if necessary to keep the increase in water-surface elevation compared to the 1-percent annual chance flood less than 1.0 foot. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed and are presented in Table 13.

As shown on the updated Flood Insurance Rate Maps (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 1-percent annual chance flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the 1-percent annual chance floodplain boundaries is termed the floodway fringe. The floodway fringe thus encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent annual chance flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 11.

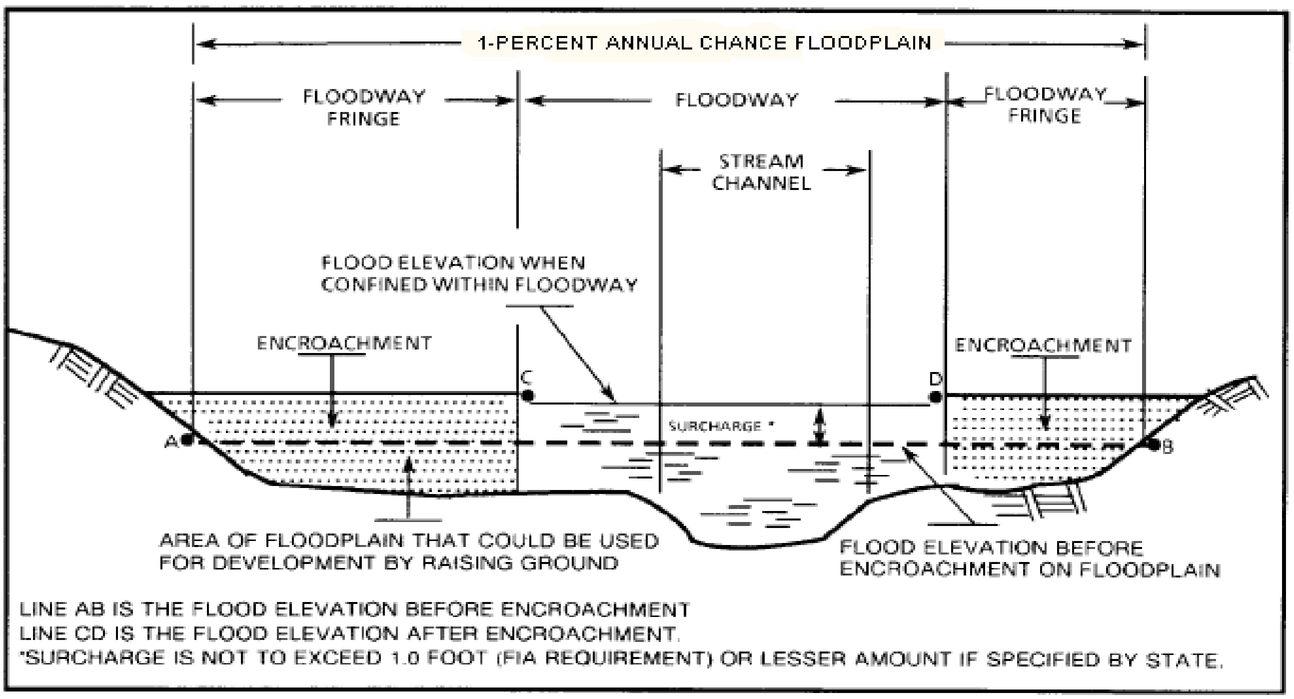

Figure 11. Floodway Schematic

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.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH[3] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY Feet (NAVD88)	WITHOUT FLOODWAY Feet (NAVD88)	WITH FLOODWAY Feet (NAVD88)	INCREASE (FEET)
BROAD BRANCH								
A	3,070 [1]	33	237	13.9	102.9	102.9	103.8	0.8
B	3,680 [1]	30	216	15.3	116.5	116.5	116.5	0.0
C	4,260 [1]	50	269	12.3	133.8	133.8	133.8	0.0
D	5,160 [1]	35	240	13.7	150.3	150.3	150.5	0.2
E	6,620 [1]	45	274	12.4	178.1	178.1	178.5	0.4
FENWICK BRANCH								
A	162 [2]	90	407	8.8	175.7	167.7 [4]	167.9	0.2
B	1,050 [2]	90	388	9.2	175.7	174.1 [4]	174.2	0.1
C	1,230 [2]	131	1,171	3.0	190.2	190.2	191.2	1.0
D	1,460 [2]	120	1,369	2.6	190.5	190.5	191.4	0.9
E	1,850 [2]	90	895	1.9	191.0	191.0	192.0	1.0
F	2,700 [2]	50	189	9.2	193.4	193.4	193.6	0.2
G	4,420 [2]	50	195	8.9	217.4	217.4	217.5	0.1
H	5,180 [2]	50	200	8.7	231.7	231.7	231.7	0.0
OXON RUN								
A	8,666 [3]	120	1,274	5.9	26.5	26.5	27.5	0.9
B	9,556 [3]	120	800	9.4	28.8	28.8	29.6	0.8
C	10,265 [3]	200	2,087	5.7	39.2	39.2	39.9	0.7
D	10,845 [3]	210	1,716	4.4	39.5	39.5	40.4	0.9
E	10,894 [3]	200	1,827	4.1	39.5	39.5	40.5	1.0
F	13,053 [3]	63	481	15.7	46.9	46.9	47.0	0.1

[1] Stream distance in feet above confluence with Rock Creek

[2] Stream distance in feet above confluence with Rock Creek

[3] Stream distance in feet above confluence with Potomac River

[4] Elevation computed without consideration of backwater effects from Rock Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

FLOODWAY DATA

BROAD BRANCH - FENWICK BRANCH - OXON RUN

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY Feet (NAVD88)	WITHOUT FLOODWAY Feet (NAVD88)	WITH FLOODWAY Feet (NAVD88)	INCREASE (FEET)
OXON RUN (continued)								
G	13,242 [1]	162	1,441	5.3	51.1	51.1	51.2	0.1
H	14,551 [1]	190	835	9.1	53.6	53.6	53.6	0.0
I	14,788 [1]	120	1,454	6.0	61.4	61.4	61.4	0.0
J	17,079 [1]	190	813	9.3	69.0	69.0	69.6	0.6
K	17,213 [1]	200	1,666	6.3	75.1	75.1	76.0	0.9
L	17,800 [1]	180	1,749	4.3	76.2	76.2	77.2	0.9
M	18,473 [1]	115	1,662	4.5	77.4	77.4	78.4	1.0
N	19,182 [1]	420	3,038	2.5	83.4	83.4	83.5	0.1
O	20,983 [1]	300	1,535	5.0	90.1	90.1	91.1	1.0
P	22,983 [1]	260	1,495	5.1	101.9	101.9	101.9	0.1
Q	24, 023 [1]	130	995	7.6	105.6	105.6	106.2	0.6
WATTS BRANCH								
A	253 [2]	65	478	8.1	14.5	4.5 [3]	5.0	0.5
B	991 [2]	88	620	6.2	14.5	11.0 [3]	11.0	0.0
C	1,662 [2]	170	690	5.6	14.5	11.7 [3]	11.6	0.0
D	2,567 [2]	95	579	6.7	14.5	13.1 [3]	13.2	0.1
E	3,389 [2]	205	1,106	3.5	14.6	14.6	14.7	0.1
F	4,796 [2]	85	508	7.6	17.6	17.6	18.0	0.4
G	5,136 [2]	67	348	12.3	19.1	19.1	19.1	0.0
H	5,696 [2]	77	797	4.9	29.6	29.6	29.6	0.0

[1] Stream distance in feet above confluence with Potomac River

[2] Stream distance in feet above confluence with Anacostia River

[3] Elevation computed without consideration of backwater effects from Anacostia River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

FLOODWAY DATA

OXON RUN - WATTS BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD			
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)
WATTS BRANCH (continued)								
I	6,218	145	812	4.8	30.6	30.6	30.6	0.0
J	6,796	100	1,051	3.7	34.2	34.2	34.5	0.3
K	7,441	114	982	3.9	36.1	36.1	36.7	0.6
L	8,200	120	957	4.1	37.3	37.3	37.7	0.4
M	8,999	66	549	7.1	40.5	40.5	40.7	0.2
N	11,212	40	359	10.8	55.0	55.0	55.9	0.9
O	11,451	65	693	5.6	59.9	59.9	60.3	0.4
P	11,947	75	544	7.1	60.8	60.8	61.3	0.5
Q	12,576	75	523	7.4	63.2	63.2	63.8	0.6
R	13,602	125	435	8.9	70.0	70.0	70.1	0.1
S	13,738	90	756	5.1	72.9	72.9	73.5	0.6
T	14,371	55	476	8.1	75.4	75.4	75.8	0.4
U	14,949	120	881	4.4	77.8	77.8	78.3	0.5
V	15,529	141	701	5.5	81.2	81.2	81.1	0.0
W	15,706	100	817	4.7	87.3	87.3	87.7	0.4
X	16,128	100	741	5.2	87.9	87.9	88.7	0.8

[1] Stream distance in feet above confluence with Anacostia River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY
DISTRICT OF COLUMBIA
WASHINGTON D.C.

FLOODWAY DATA

WATTS BRANCH

5.0 INSURANCE APPLICATION

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

Zone A:

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

Zone AE:

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

Zone X:

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

6.0 FLOOD INSURANCE RATE MAP

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

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

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

7.0 OTHER STUDIES

A Flood Insurance Study is being conducted for Prince Georges County, Maryland, which borders the D.C. on the northeast And Fairfax and Arlington Counties Virginia which border D.C on the West A Flood Insurance Study for Montgomery County was completed in 2006 (FEMA 2006). The results of these Flood Insurance Studies are in agreement. Results contained in the Flood Insurance Study for the City of Alexandria, Virginia (FEMA 1982), published in 1982, is at variance with the Potomac River flood elevations presented in this study.

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

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Flood Insurance and Mitigation Division, Federal Emergency Management Agency, One Independence Mall, 6th floor, 615 Chestnut Street, Philadelphia, PA 19106.

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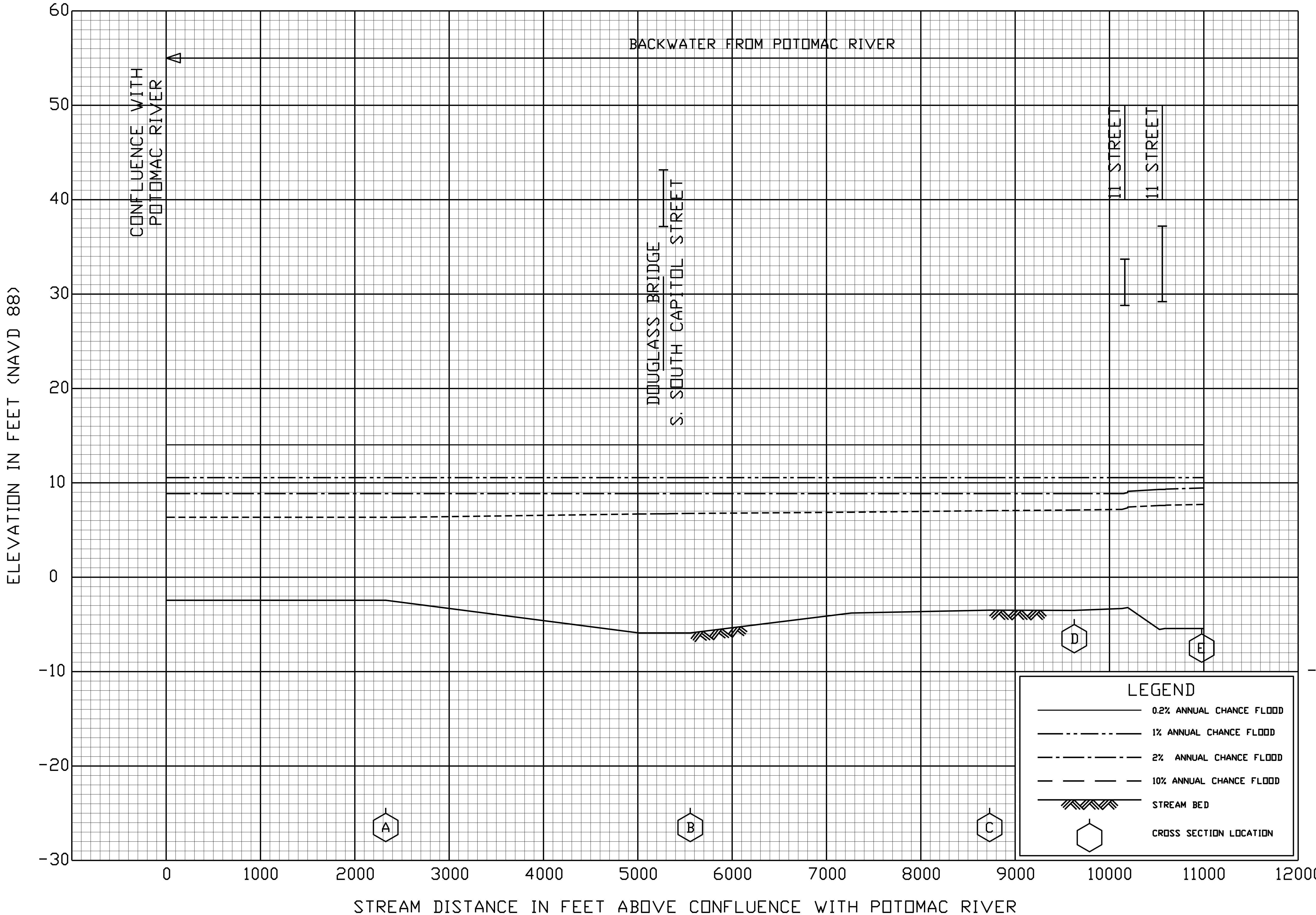


FLOOD PROFILES

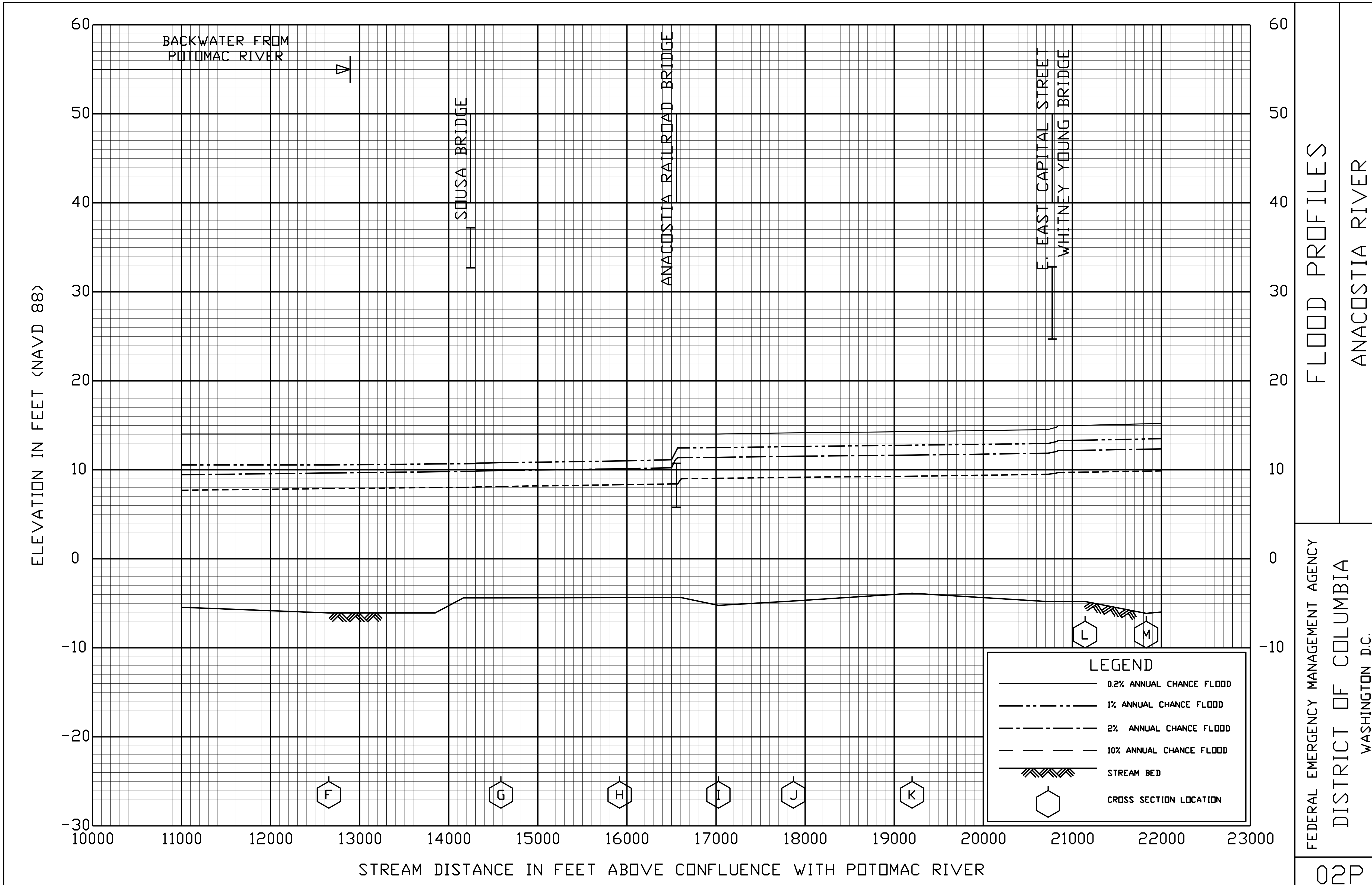
ANACOSTIA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

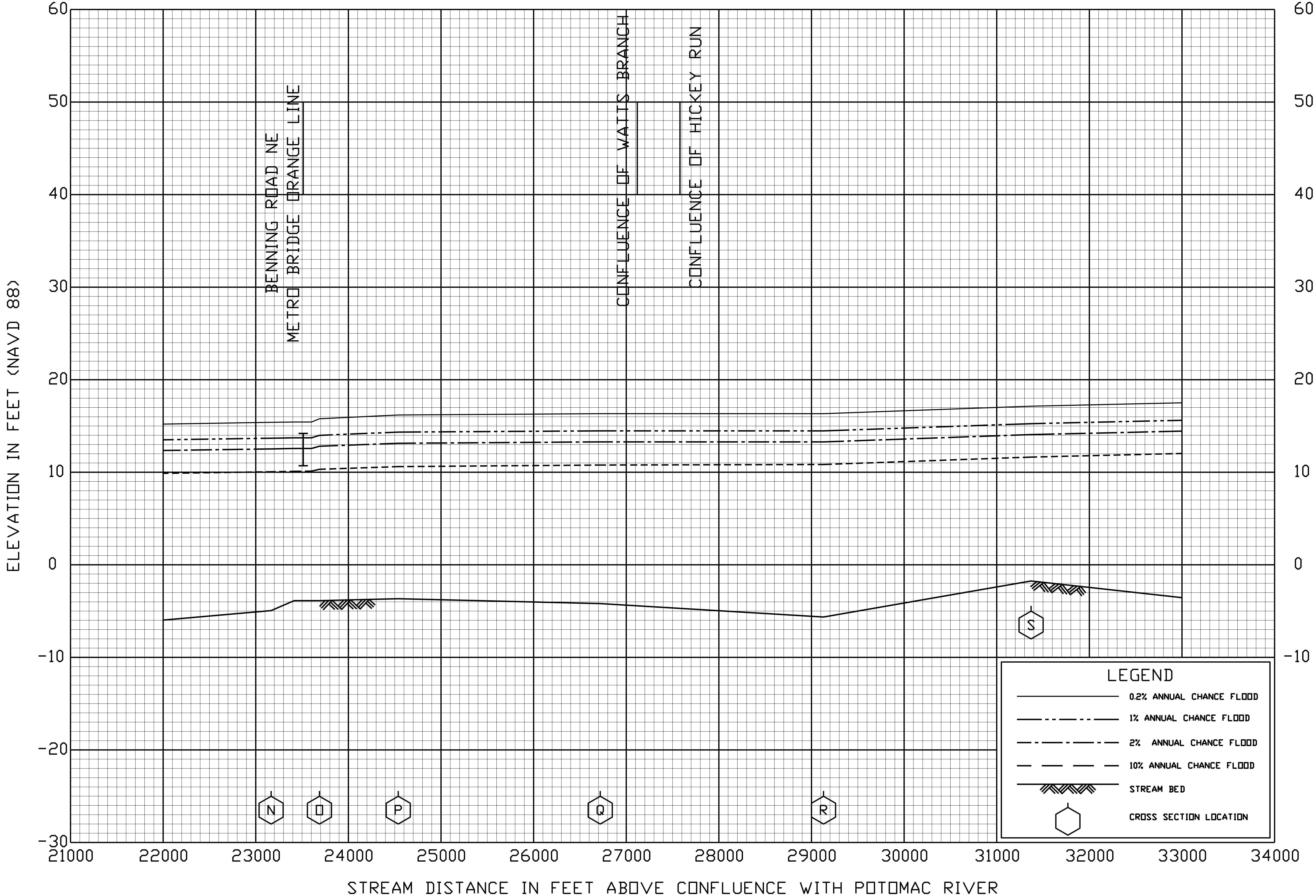
DISTRICT OF COLUMBIA

WASHINGTON D.C.

01P



BACKWATER FROM POTOMAC RIVER
SOUSA BRIDGE
ANACOSTIA RAILROAD BRIDGE
E. EAST CAPITAL STREET
WHITNEY YOUNG BRIDGE
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH POTOMAC RIVER
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
F
G
H
I
J
K
L
M
FLOOD PROFILES
ANACOSTIA RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
DISTRICT OF COLUMBIA
WASHINGTON D.C.
02P



FLOOD PROFILES

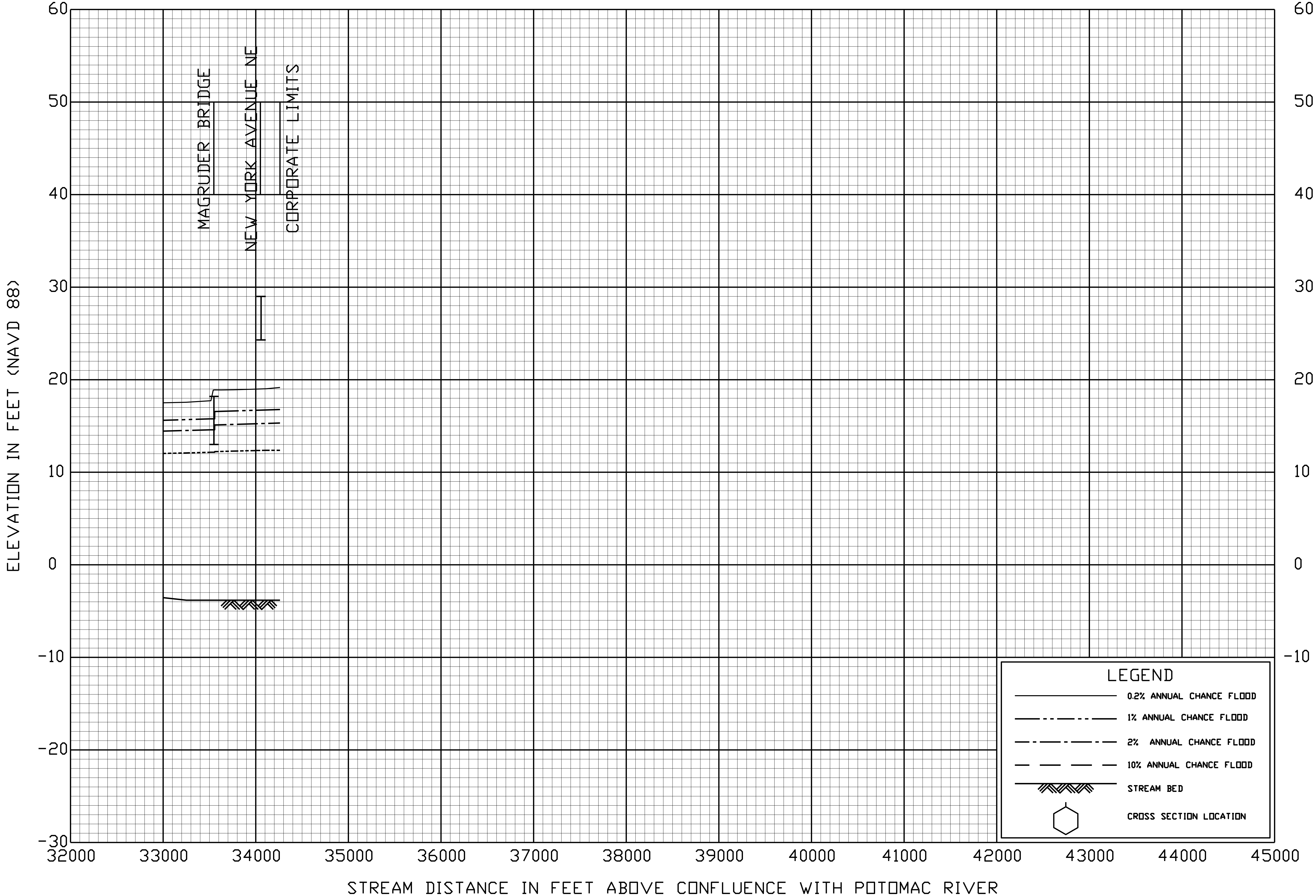
ANACOSTIA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

03P



FLOOD PROFILES

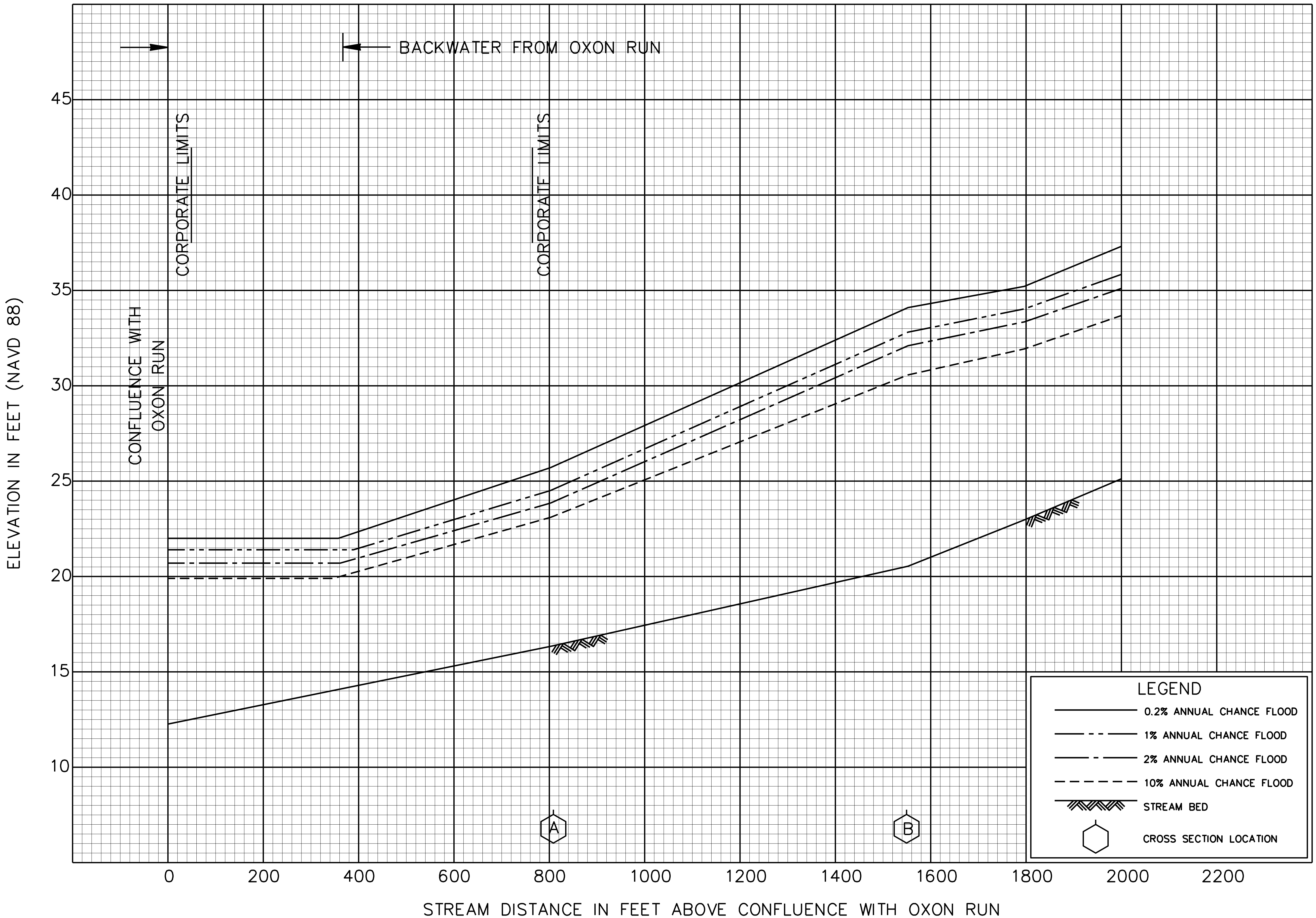
ANACOSTIA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

04P

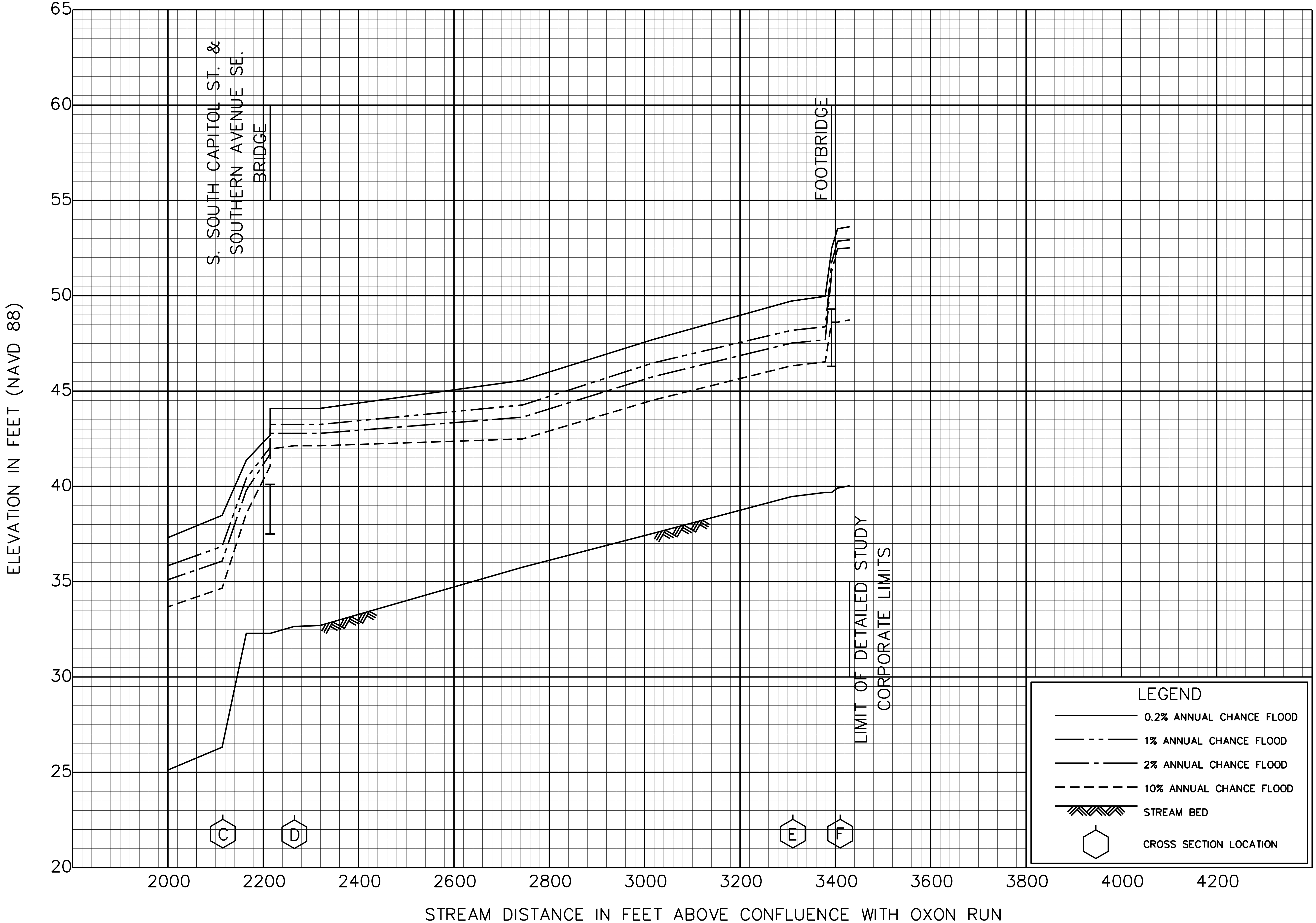


FLOOD PROFILES

BARNABY RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY
DISTRICT OF COLUMBIA
WASHINGTON D.C.

05P



FLOOD PROFILES

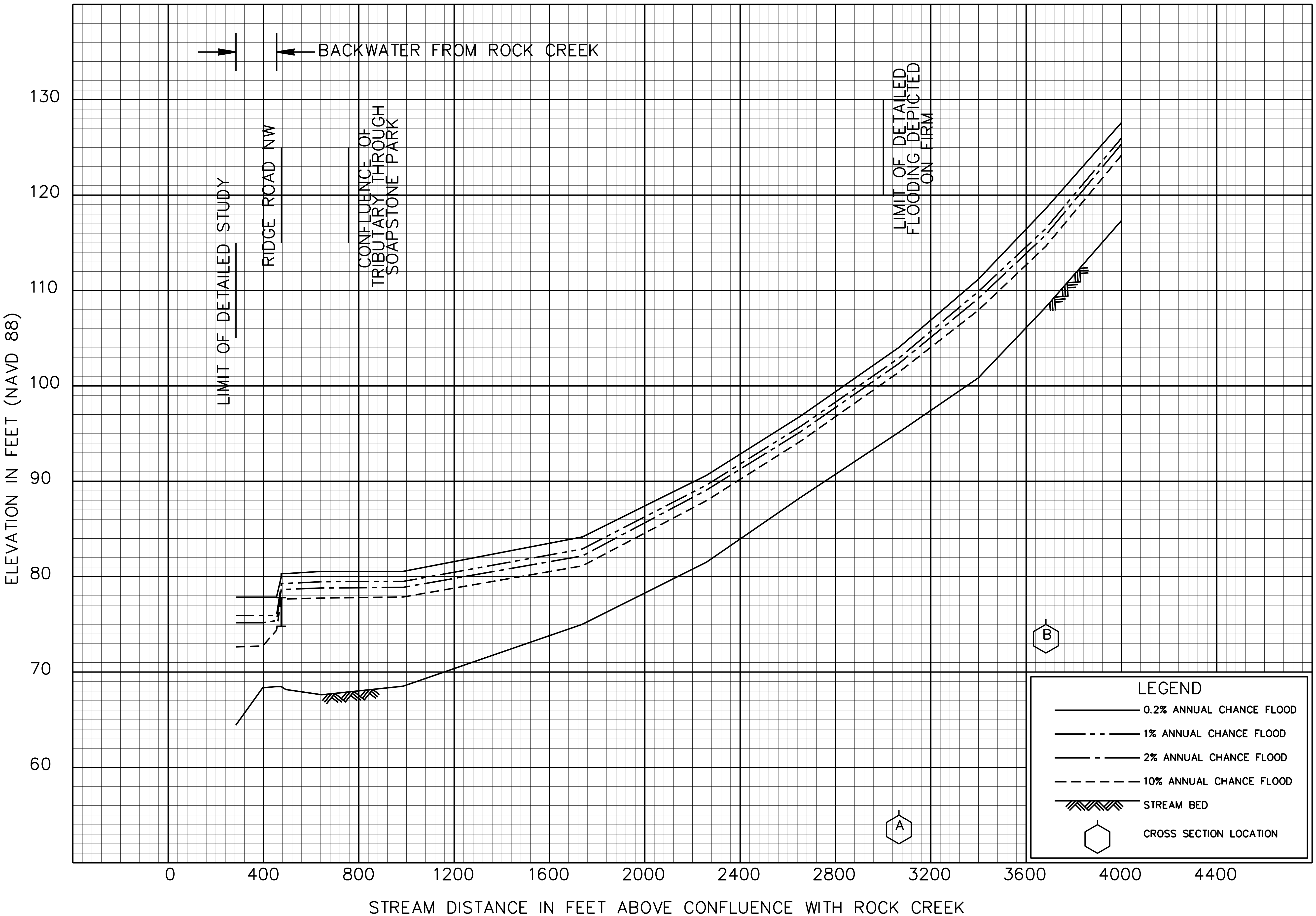
BARNABY RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

06P



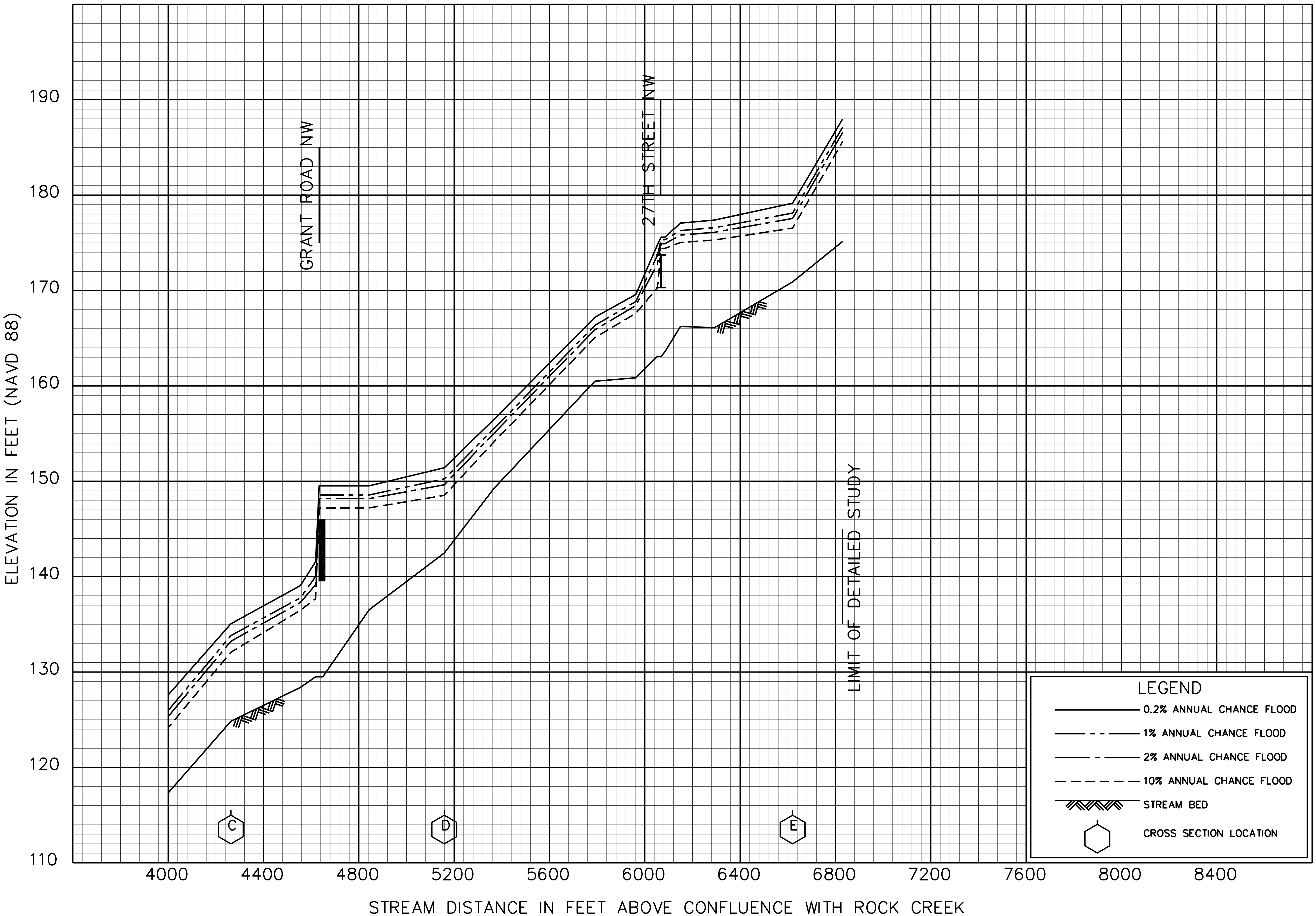
FLOOD PROFILES

BROAD BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA
WASHINGTON D.C.

07P



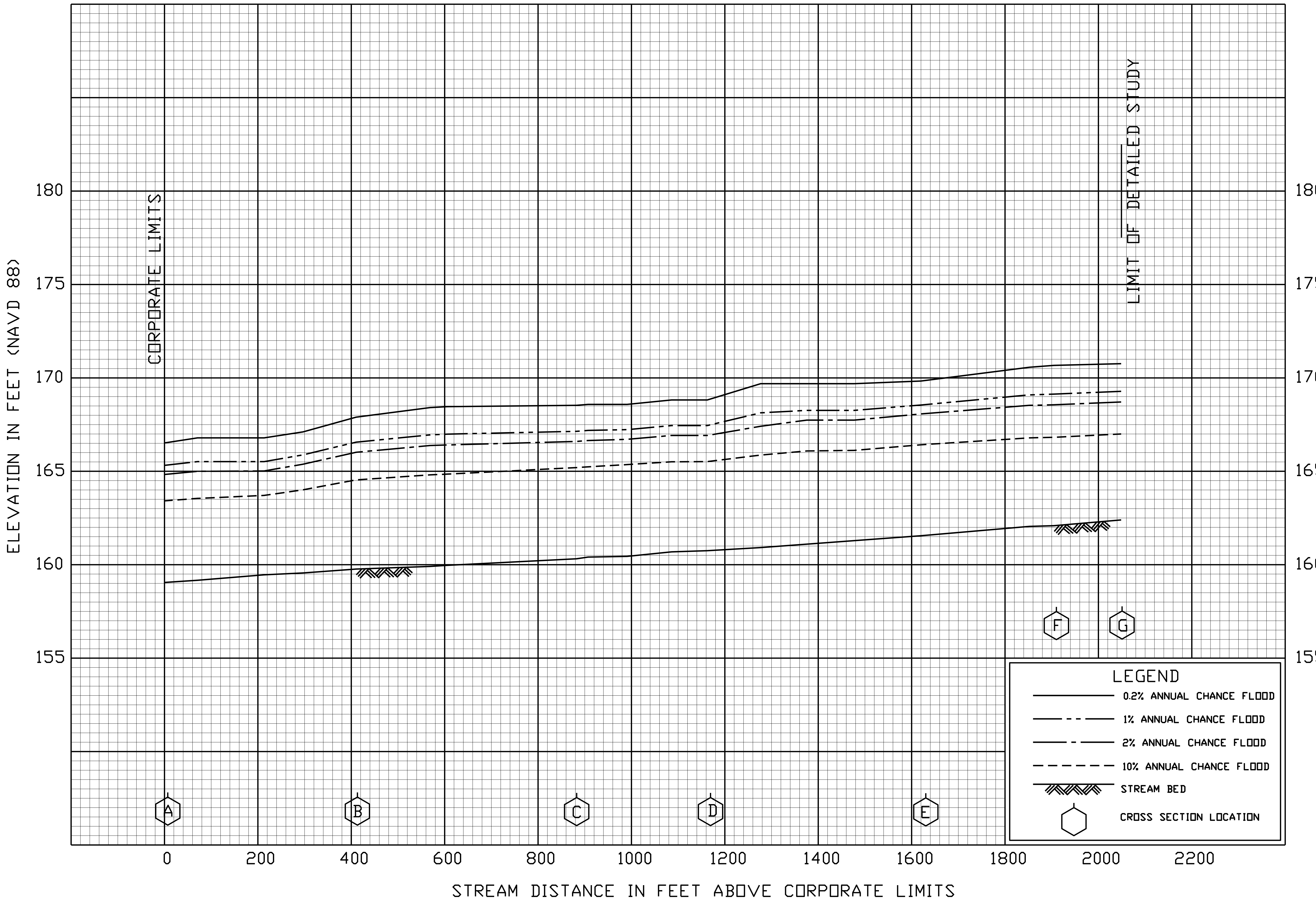
FLOOD PROFILES

BROAD BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA
WASHINGTON D.C.

08P



FLOOD PROFILES

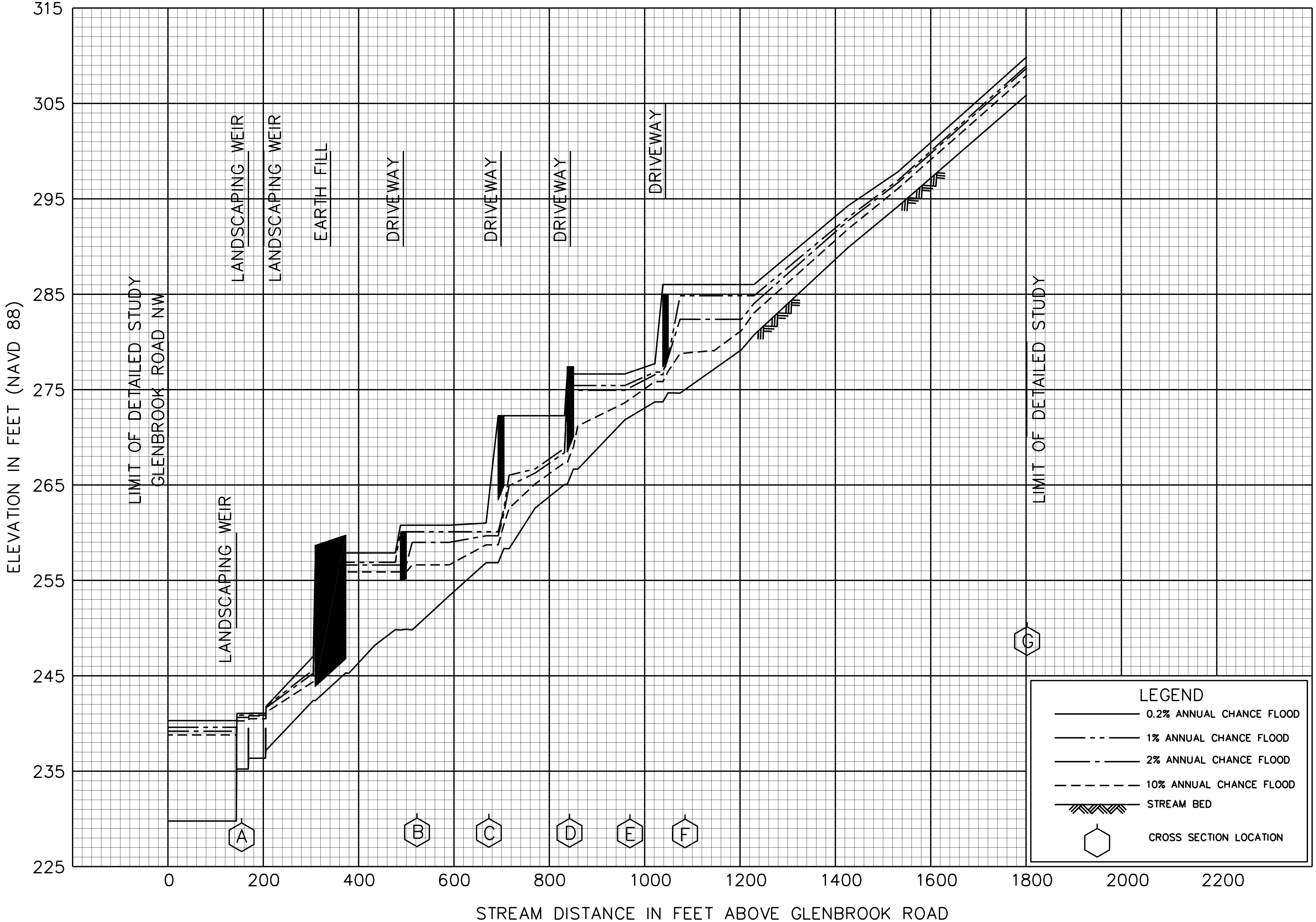
EAST CREEK A

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

09P



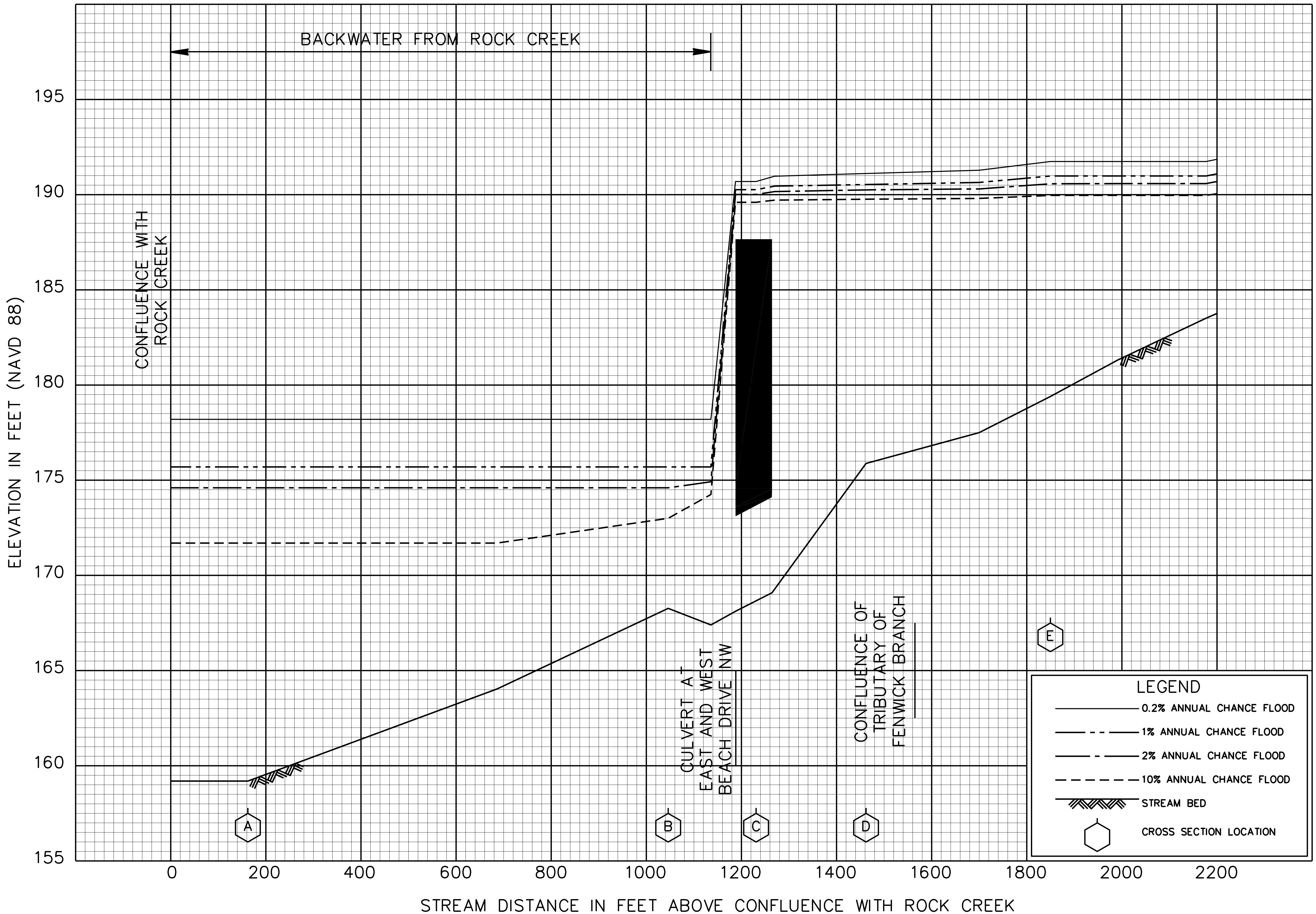
FLOOD PROFILES

EAST CREEK B

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA
WASHINGTON D.C.

10P

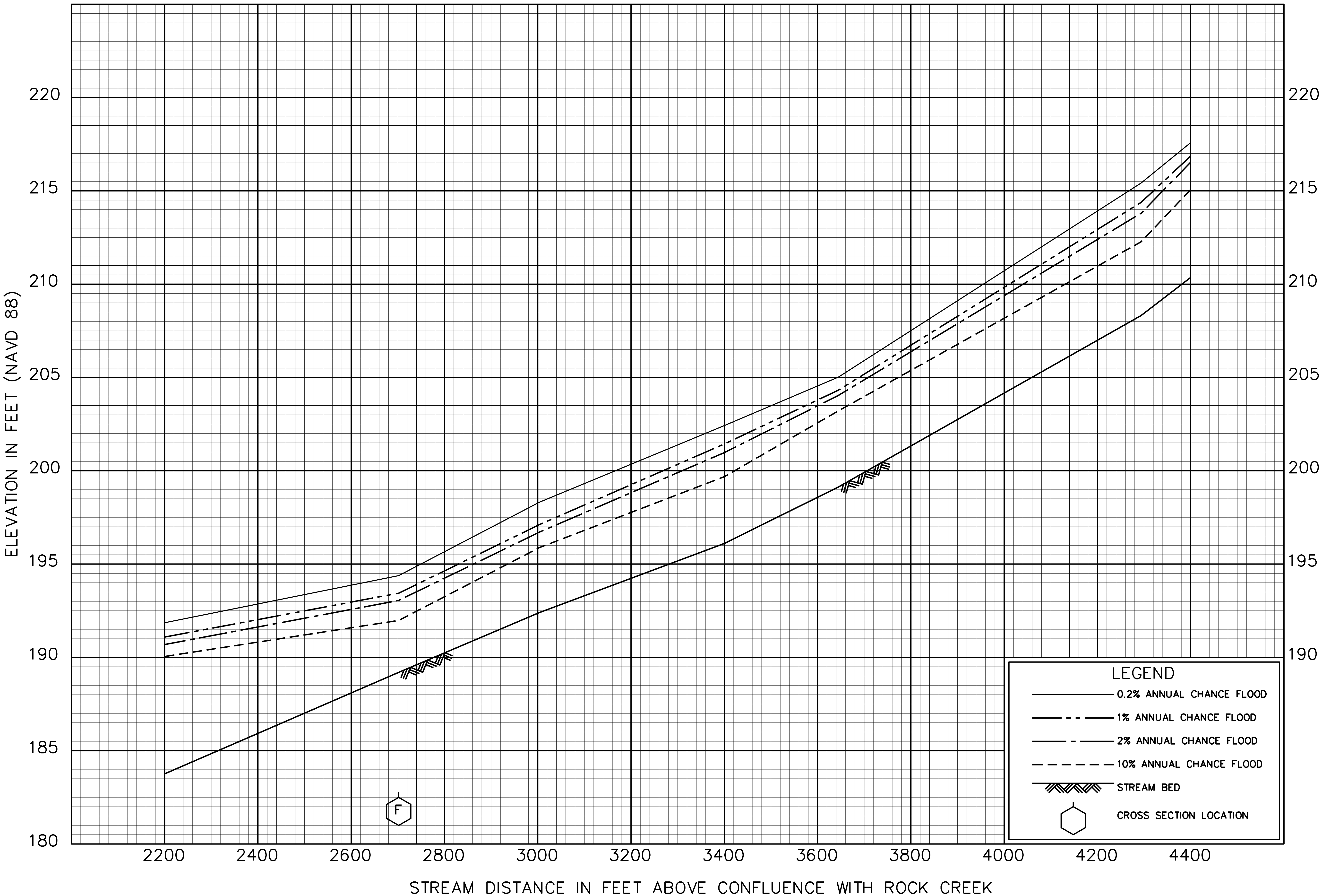


FLOOD PROFILES

FENWICK BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA
WASHINGTON D.C.



FLOOD PROFILES

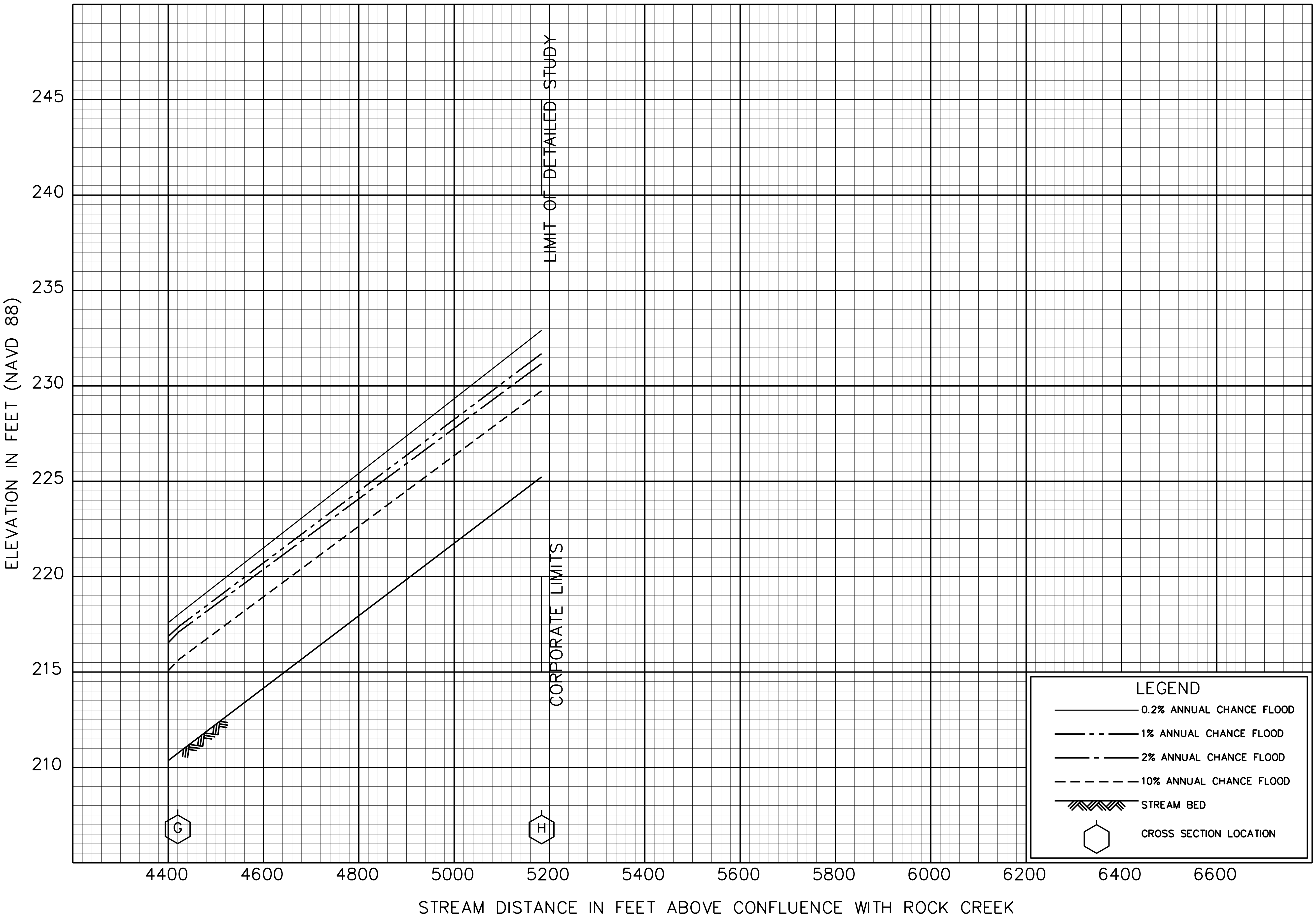
FENWICK BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

12P

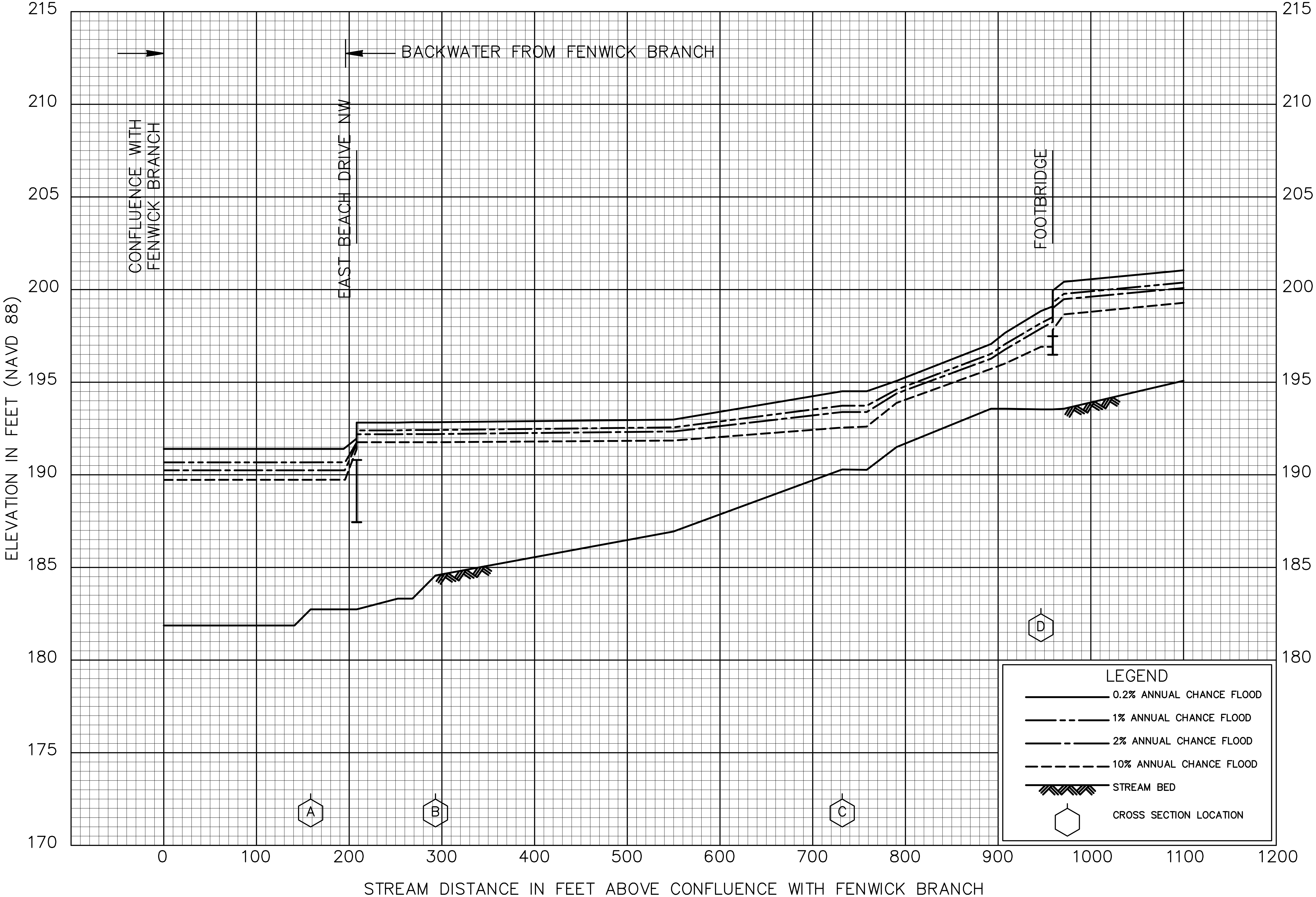


FLOOD PROFILES

FENWICK BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA
WASHINGTON D.C.



FLOOD PROFILES

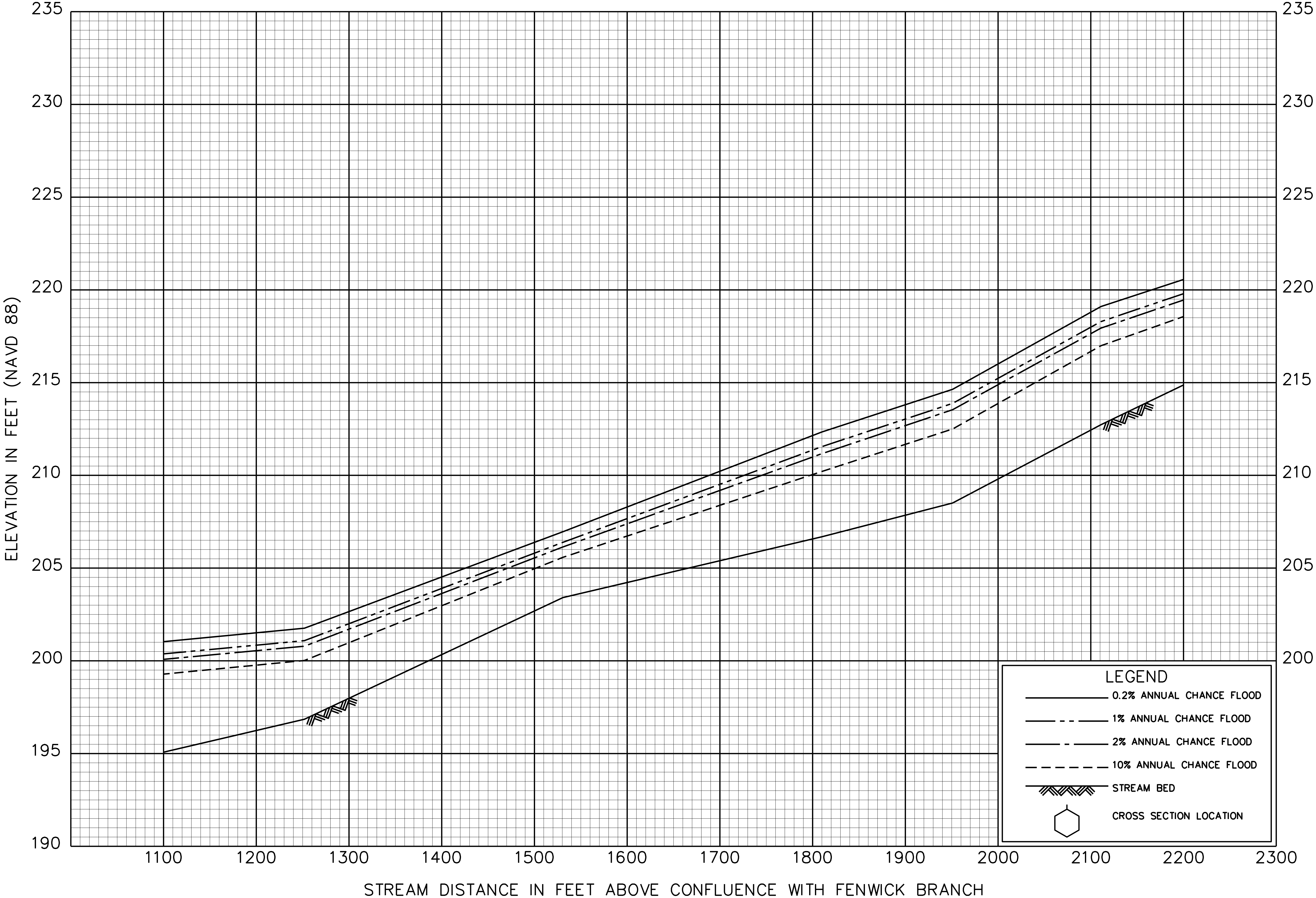
TRIBUTARY OF FENWICK BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

14P



FLOOD PROFILES

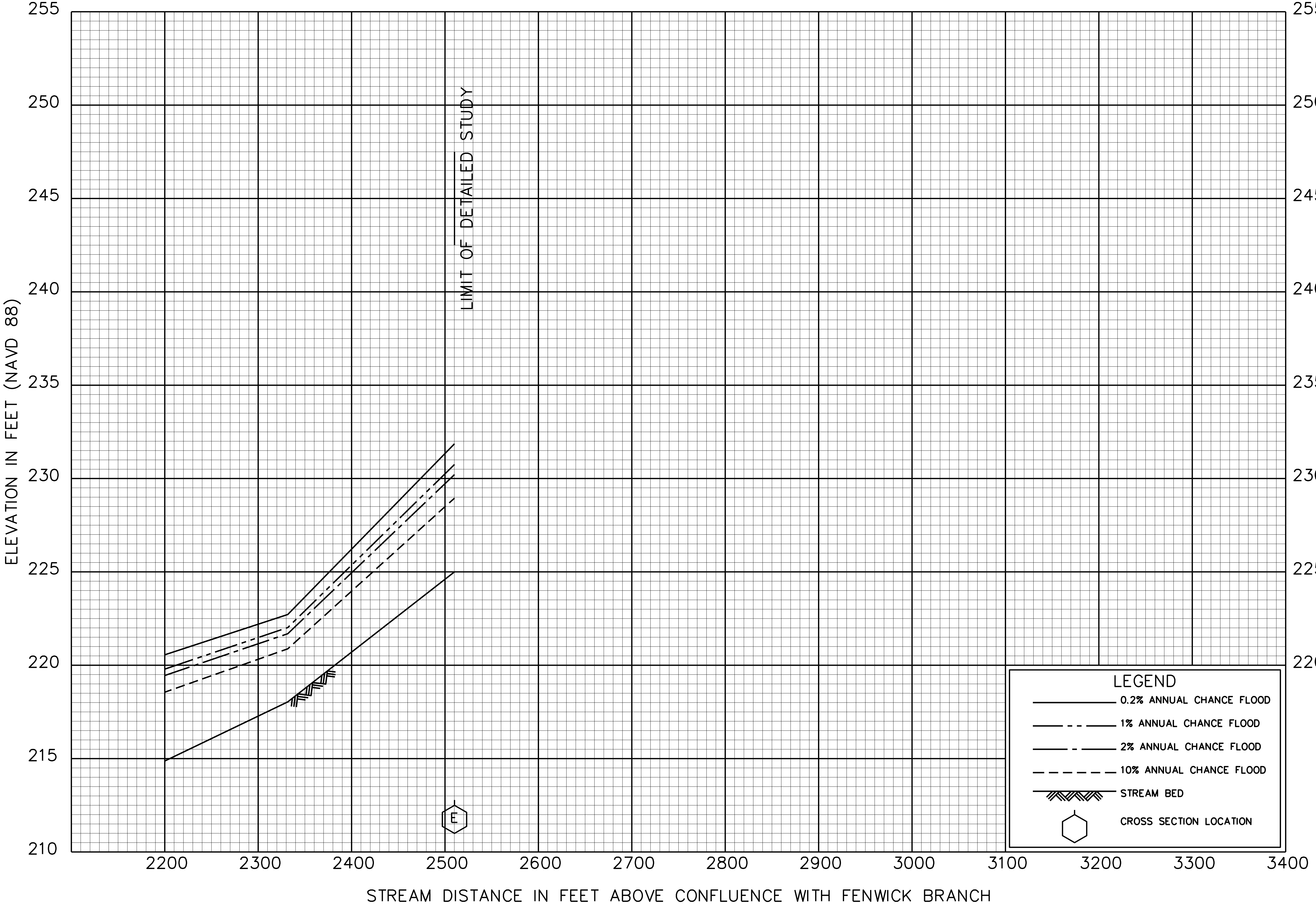
TRIBUTARY OF FENWICK BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

15P



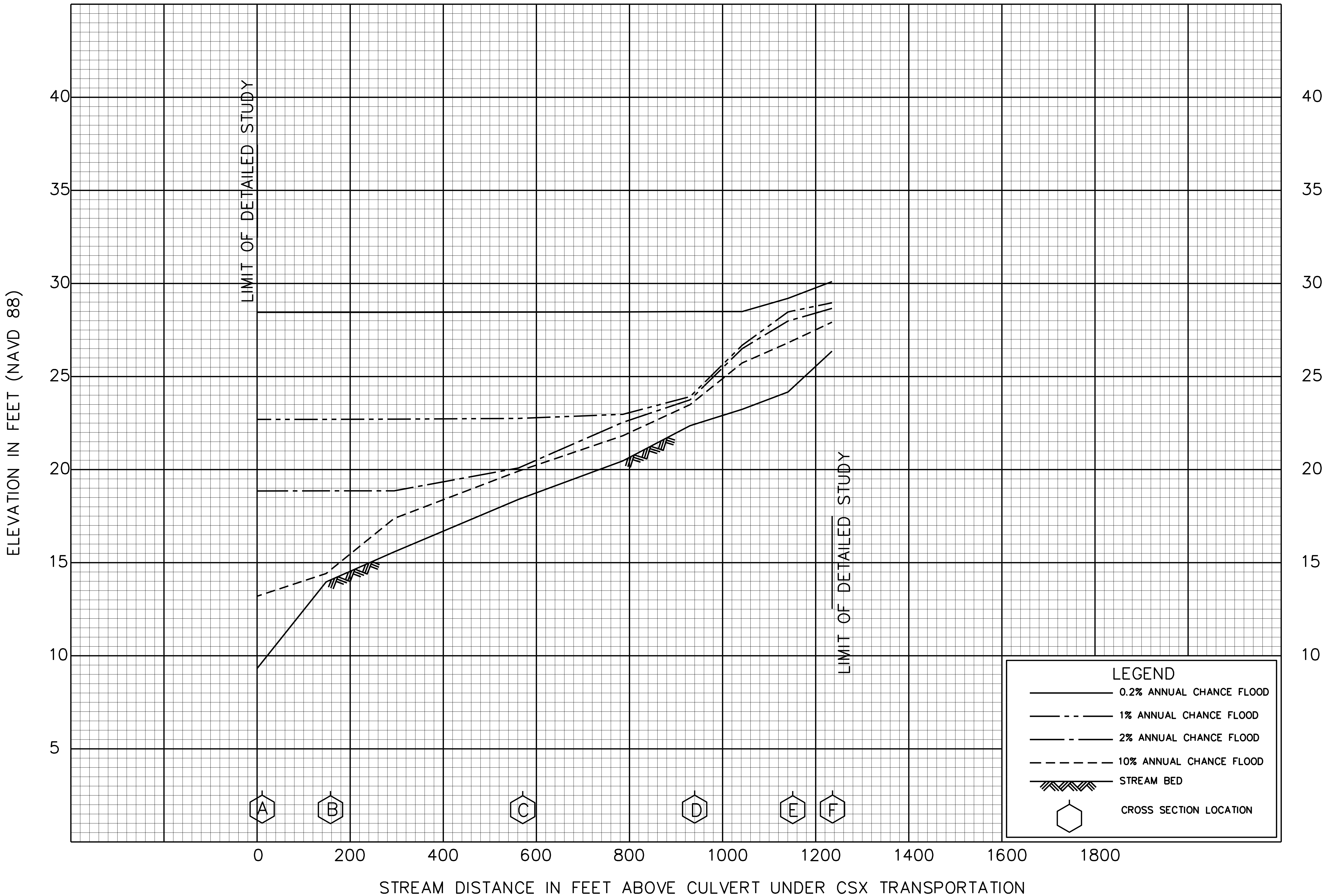
FLOOD PROFILES

TRIBUTARY OF FENWICK BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA
WASHINGTON D.C.

16P



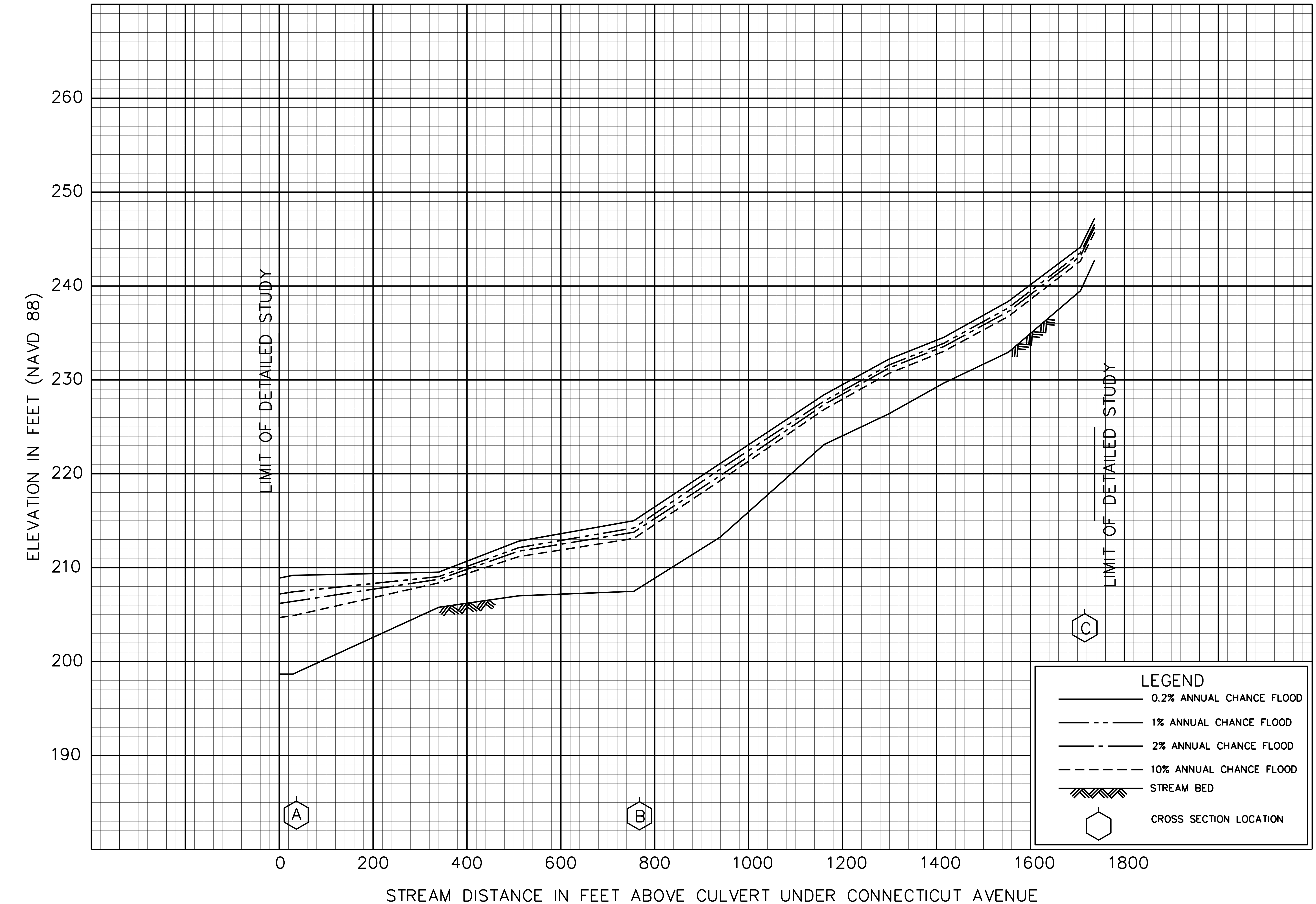
FLOOD PROFILES

FORT DUPONT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.



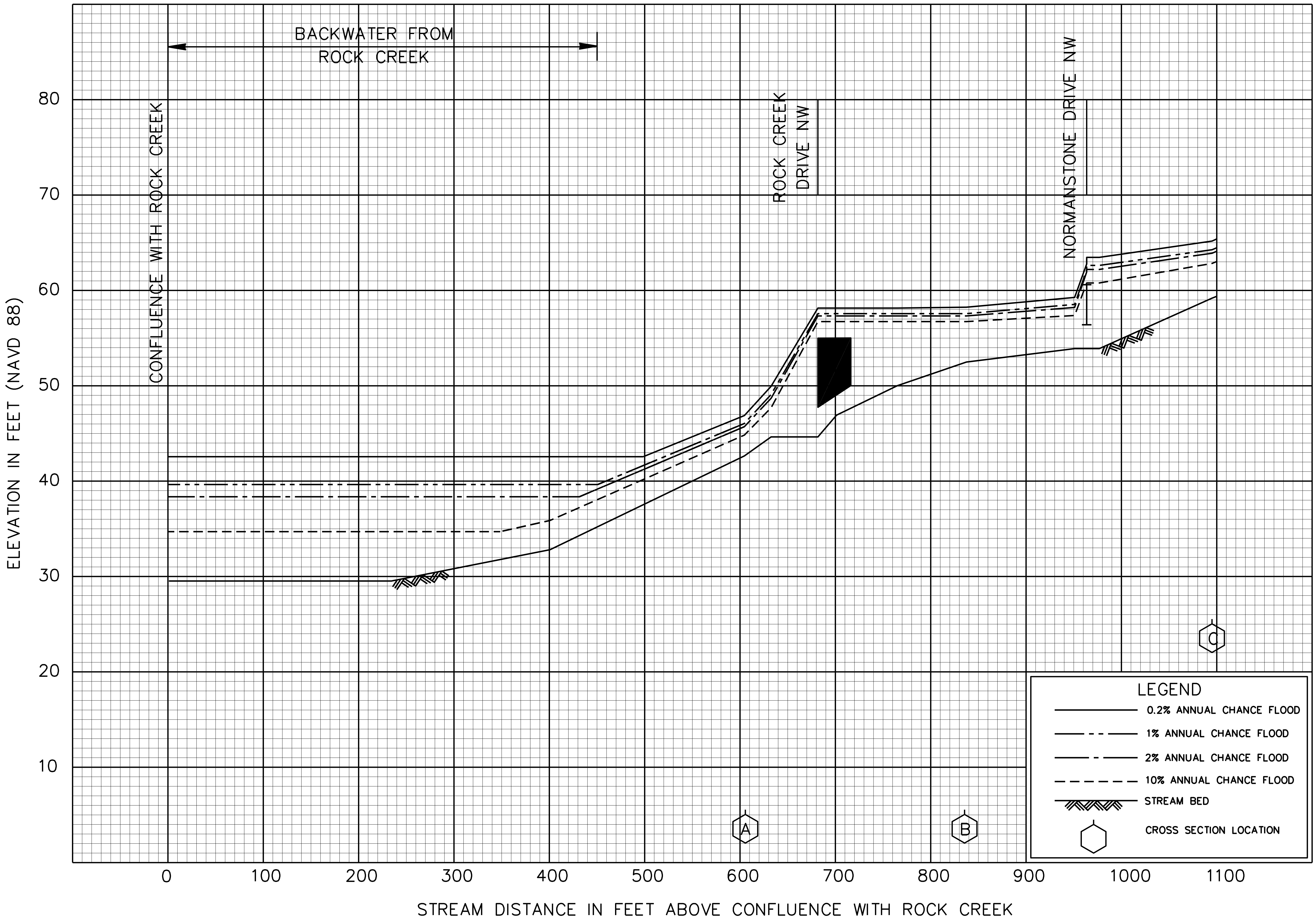
FLOOD PROFILES

MELVIN HAZEN BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.



FLOOD PROFILES

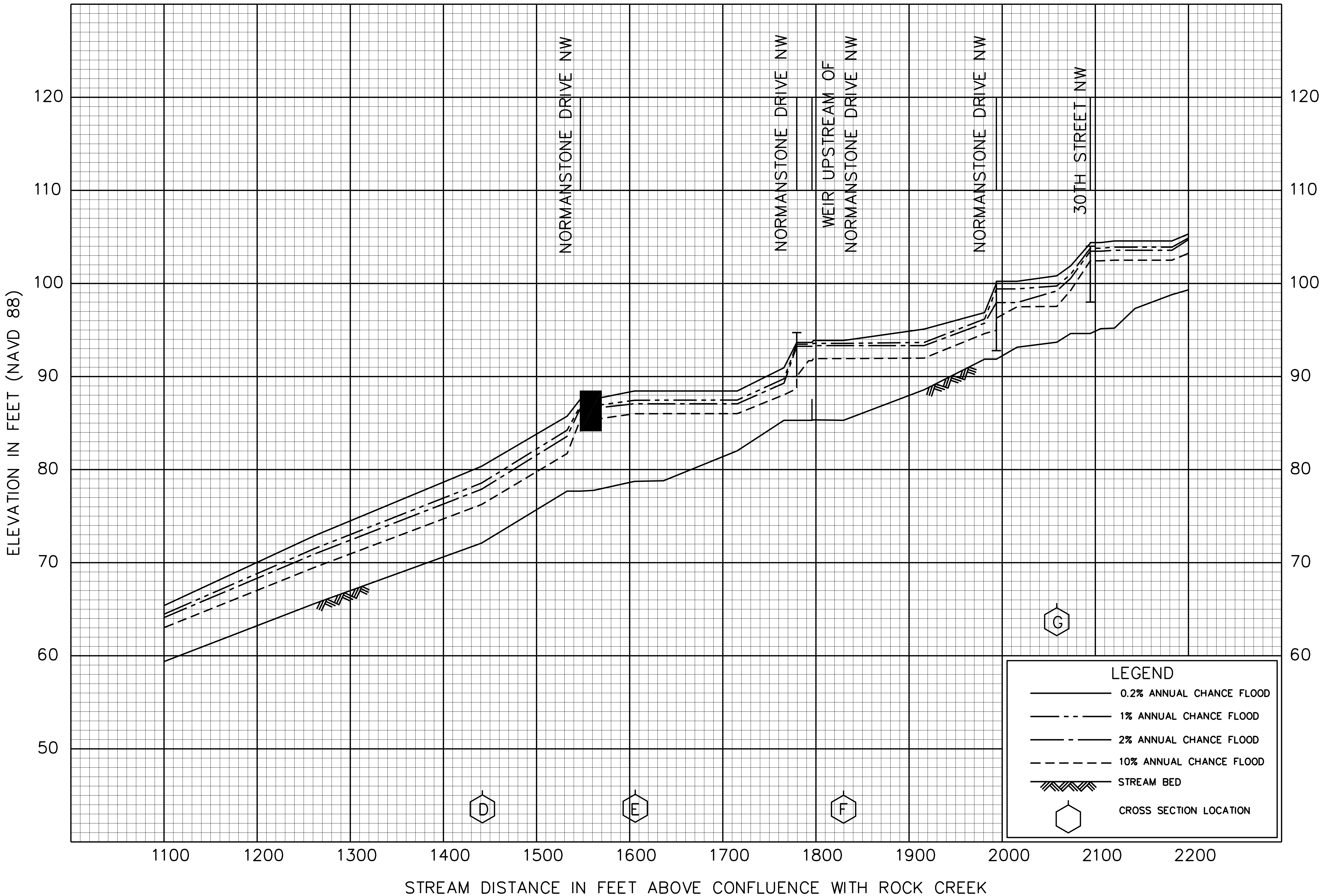
CREEK ALONG NORMANSTONE DRIVE

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

19P



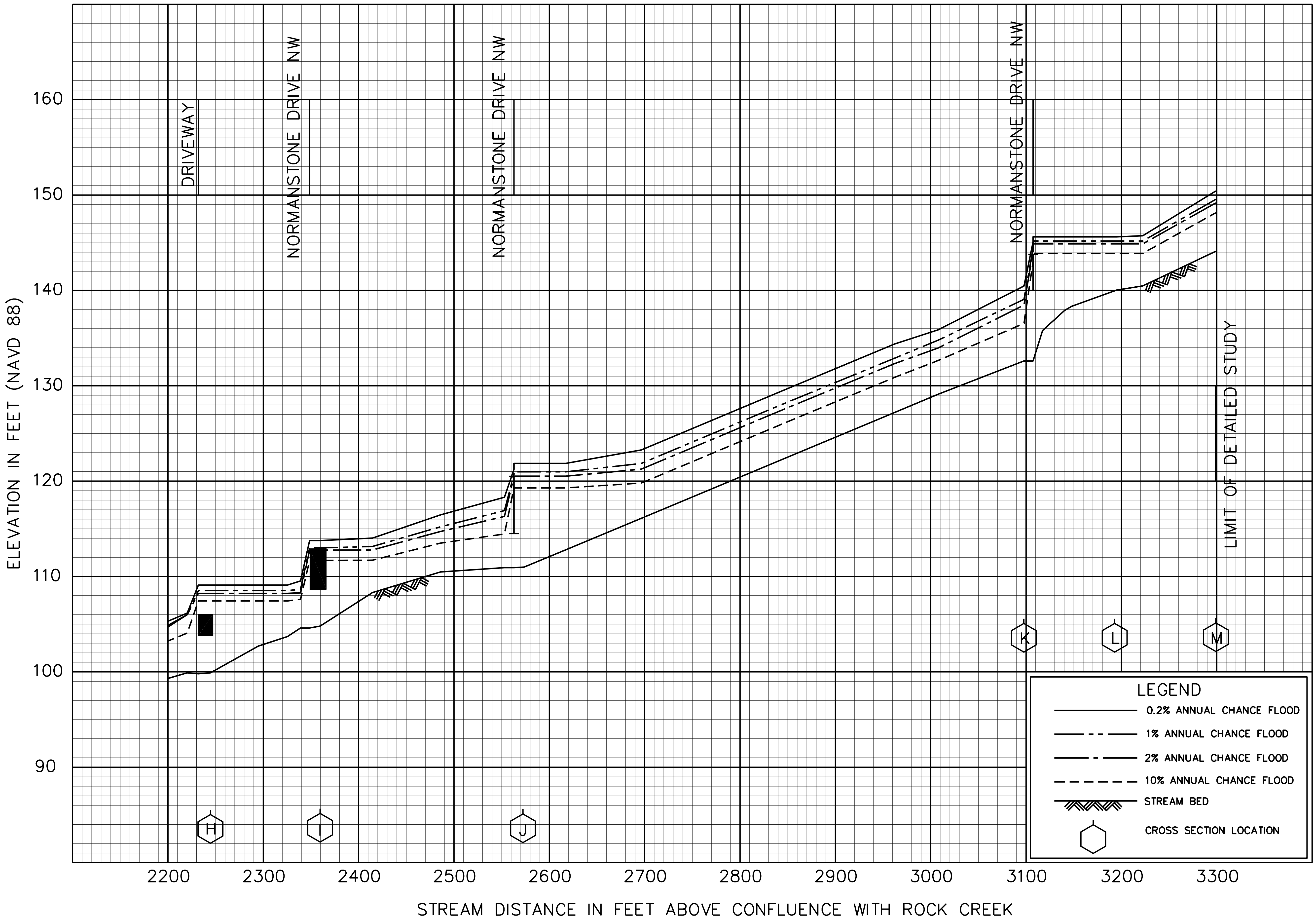
FLOOD PROFILES

CREEK ALONG NORMANSTONE DRIVE

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

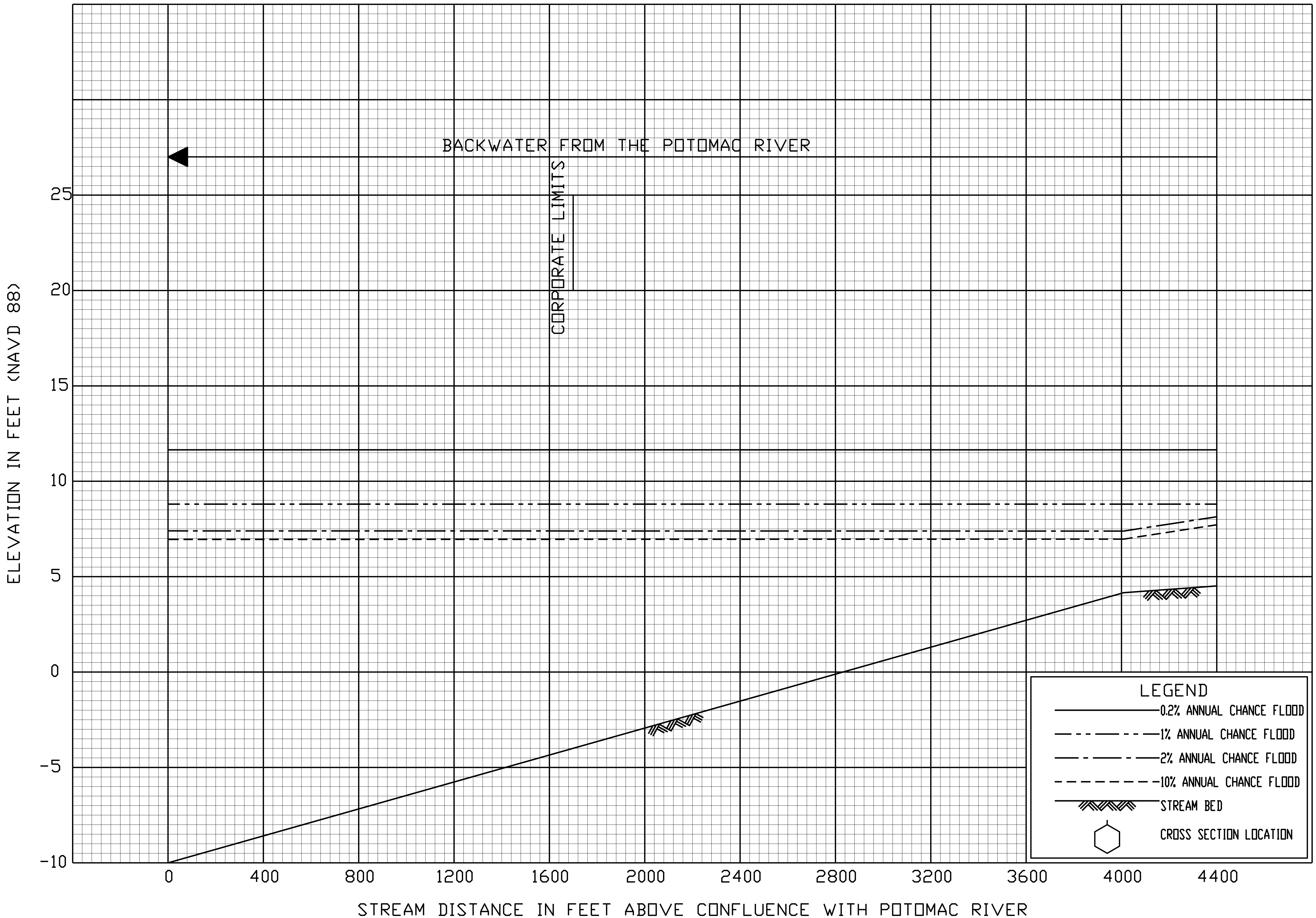


FLOOD PROFILES

CREEK ALONG NORMANSTONE DRIVE

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA
WASHINGTON D.C.



FLOOD PROFILES

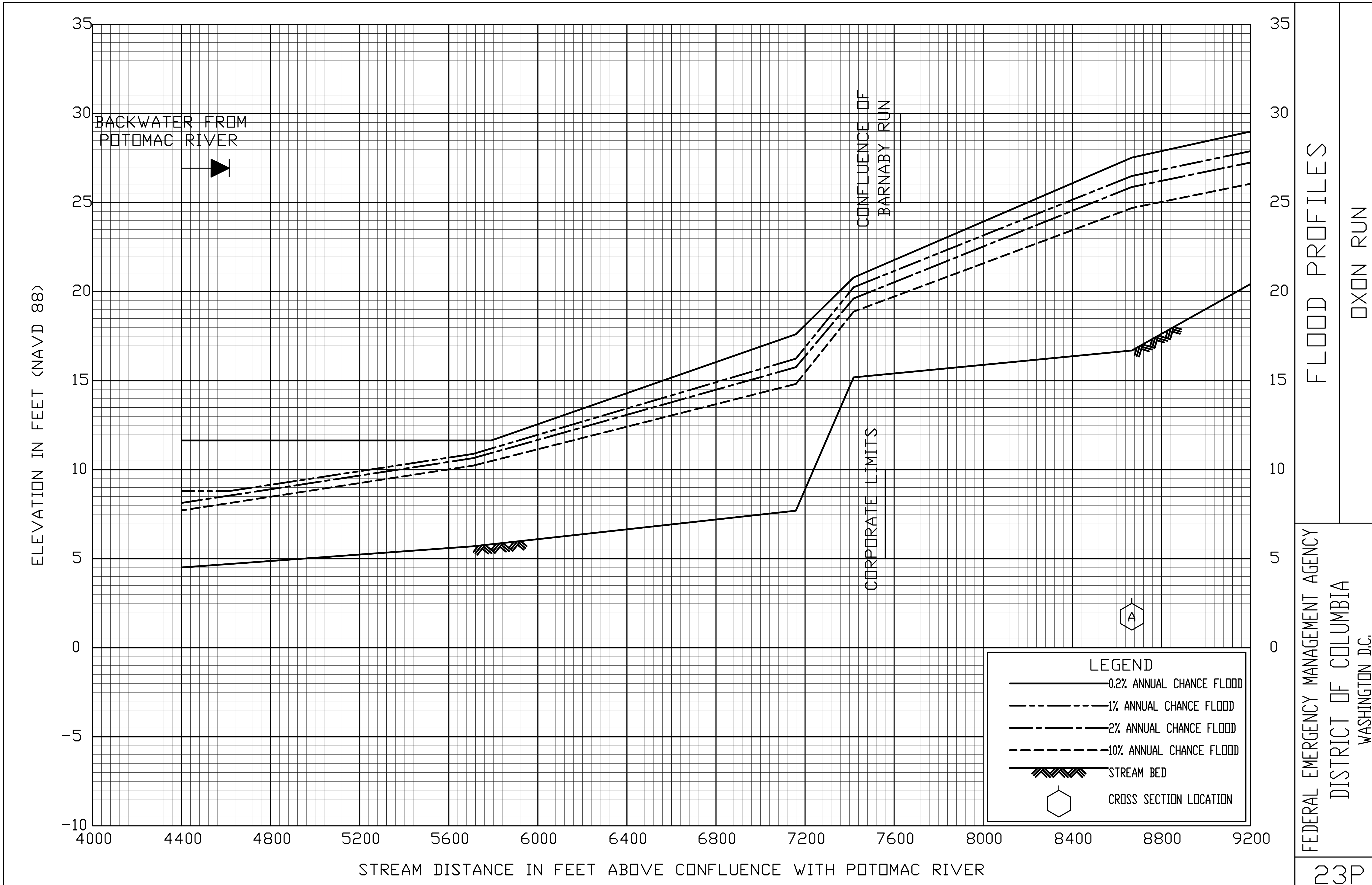
OXON RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

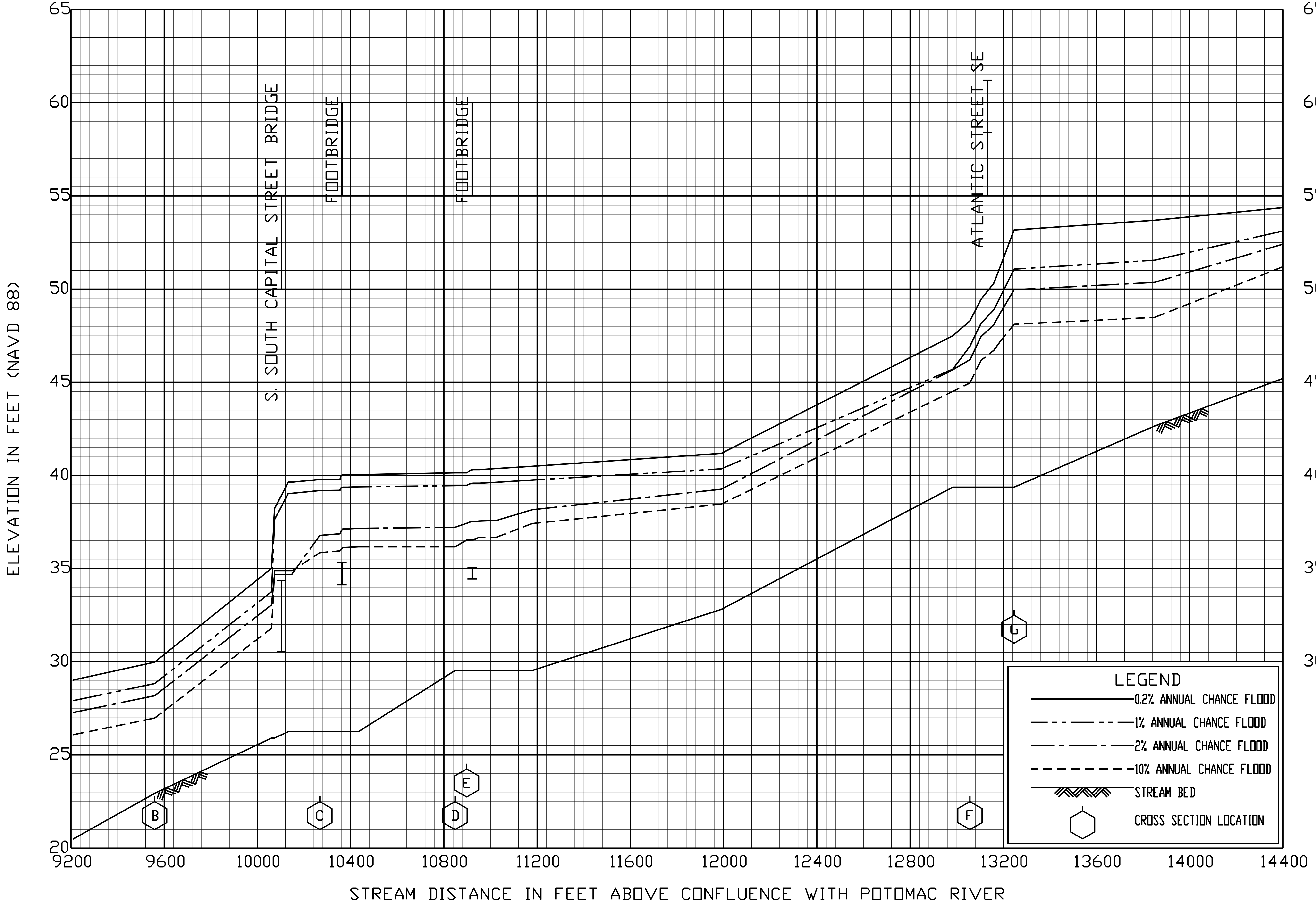
DISTRICT OF COLUMBIA

WASHINGTON D.C.

22P



BACKWATER FROM POTOMAC RIVER
CONFLUENCE OF BARNABY RUN
CORPORATE LIMITS
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH POTOMAC RIVER
35
30
25
20
15
10
5
0
-5
-10
4000
4400
4800
5200
5600
6000
6400
6800
7200
7600
8000
8400
8800
9200
A
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
OXON RUN
FEDERAL EMERGENCY MANAGEMENT AGENCY
DISTRICT OF COLUMBIA
WASHINGTON D.C.
23P



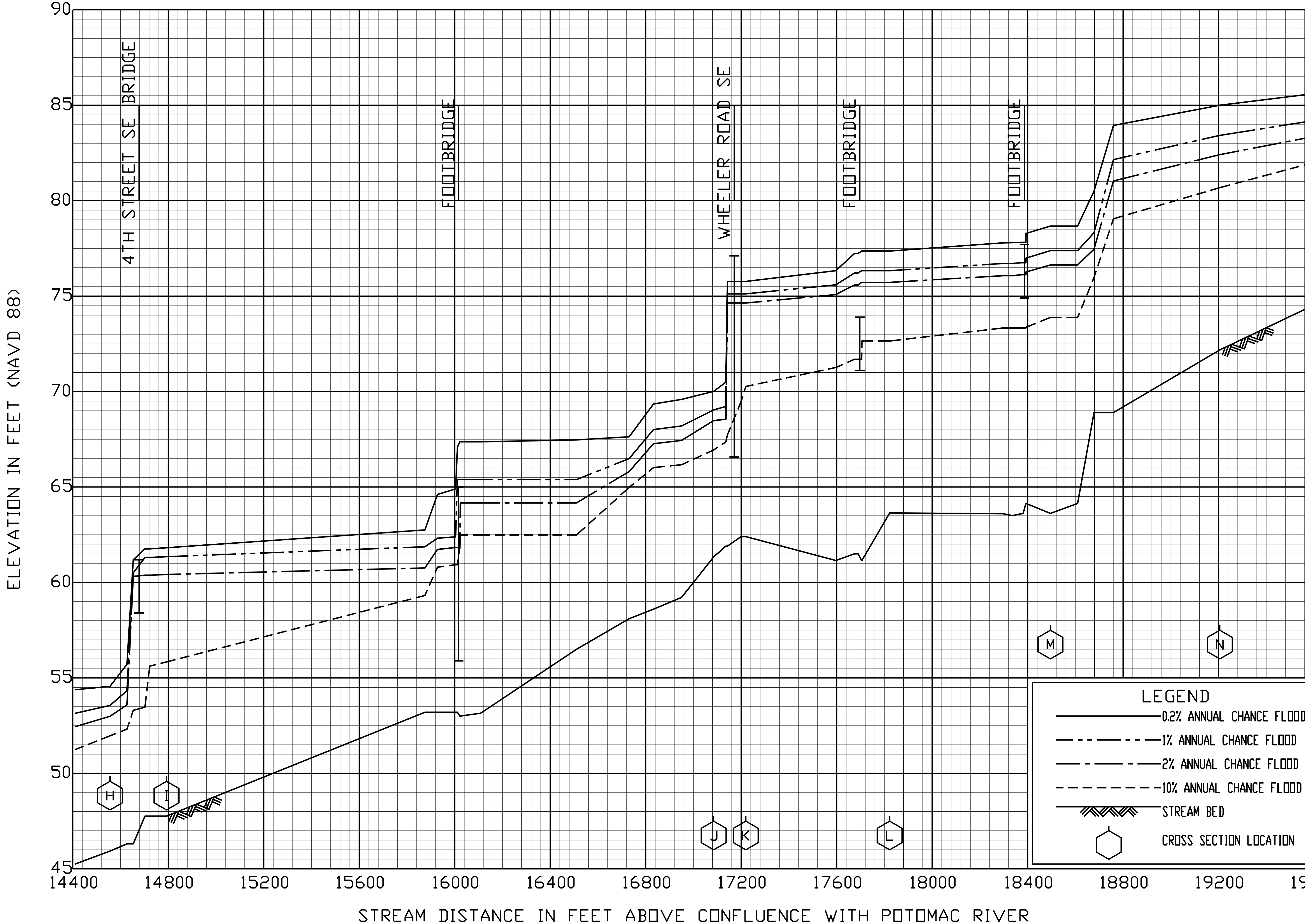
FLOOD PROFILES

OXON RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.



FLOOD PROFILES

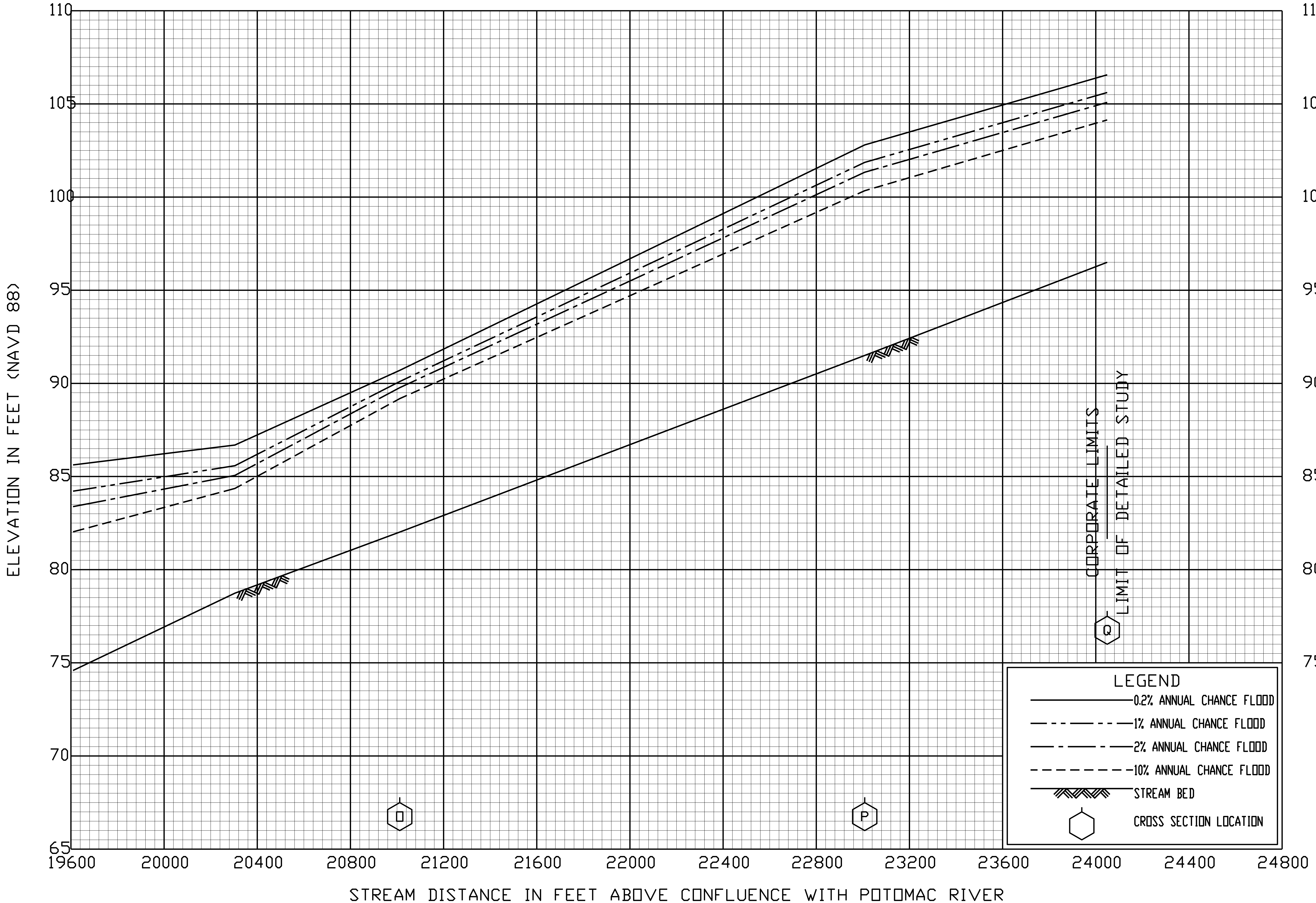
OXON RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

25P



FLOOD PROFILES

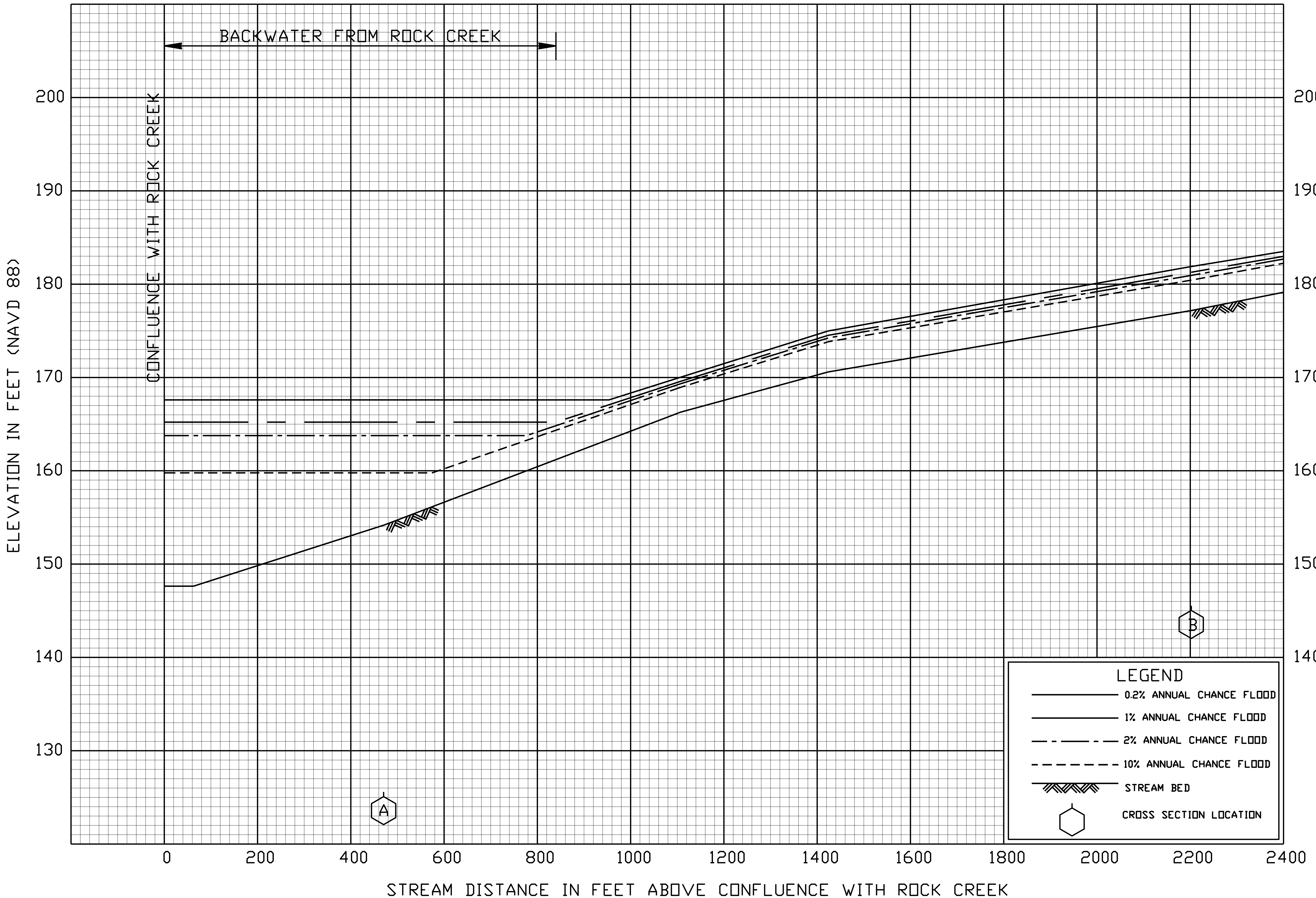
OXON RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

26P



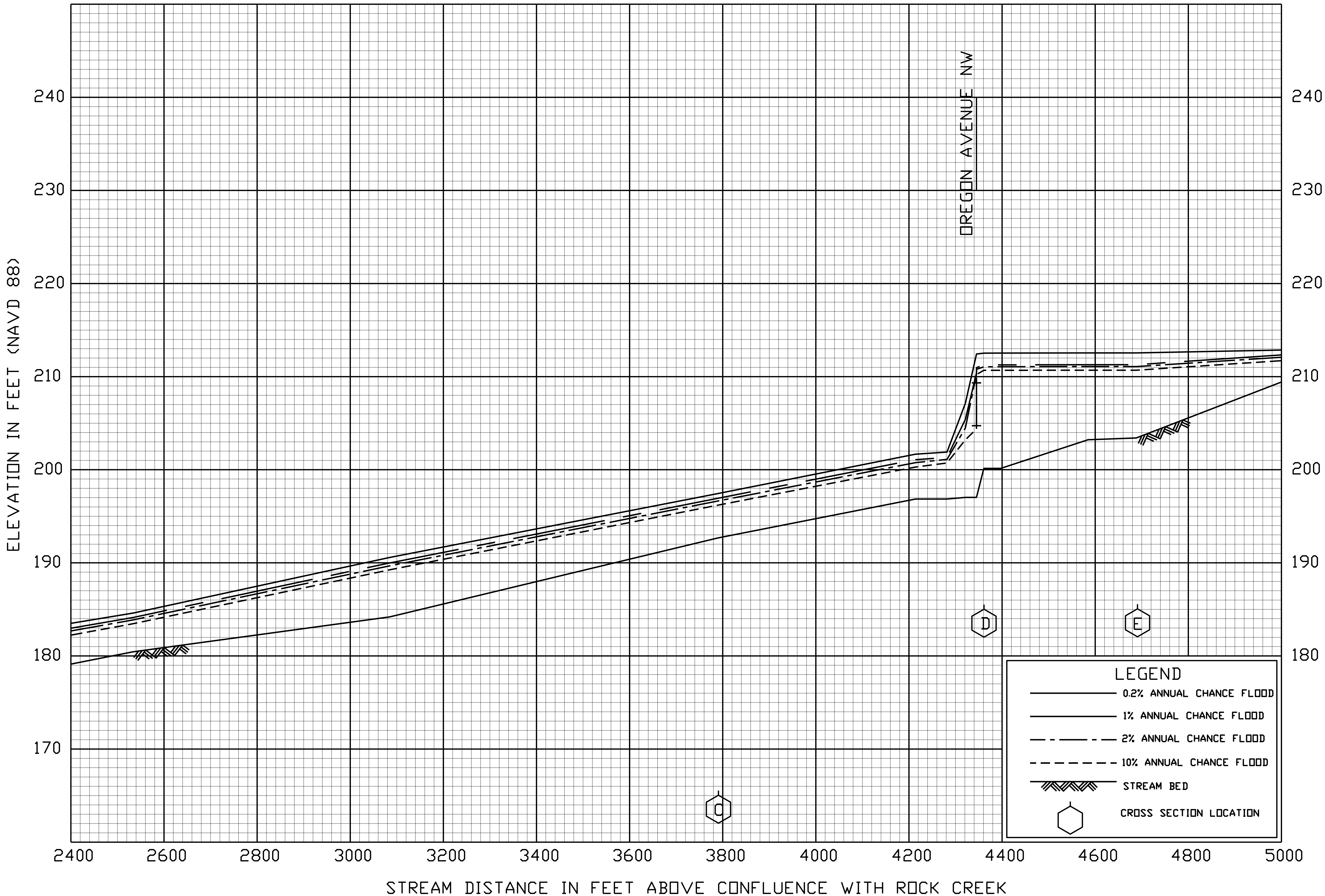
FLOOD PROFILES

PINEHURST RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.



FLOOD PROFILES

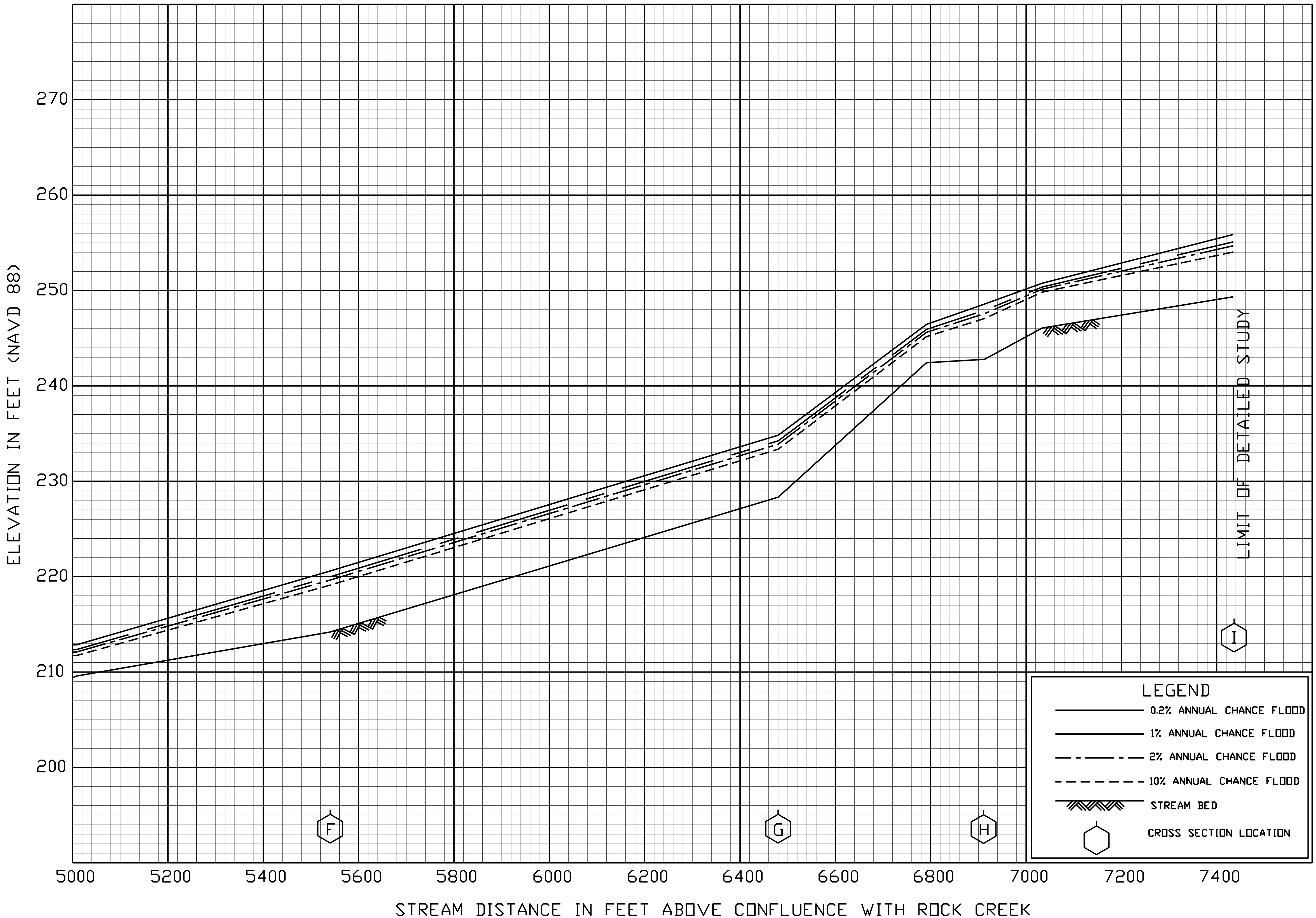
PINEHURST RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

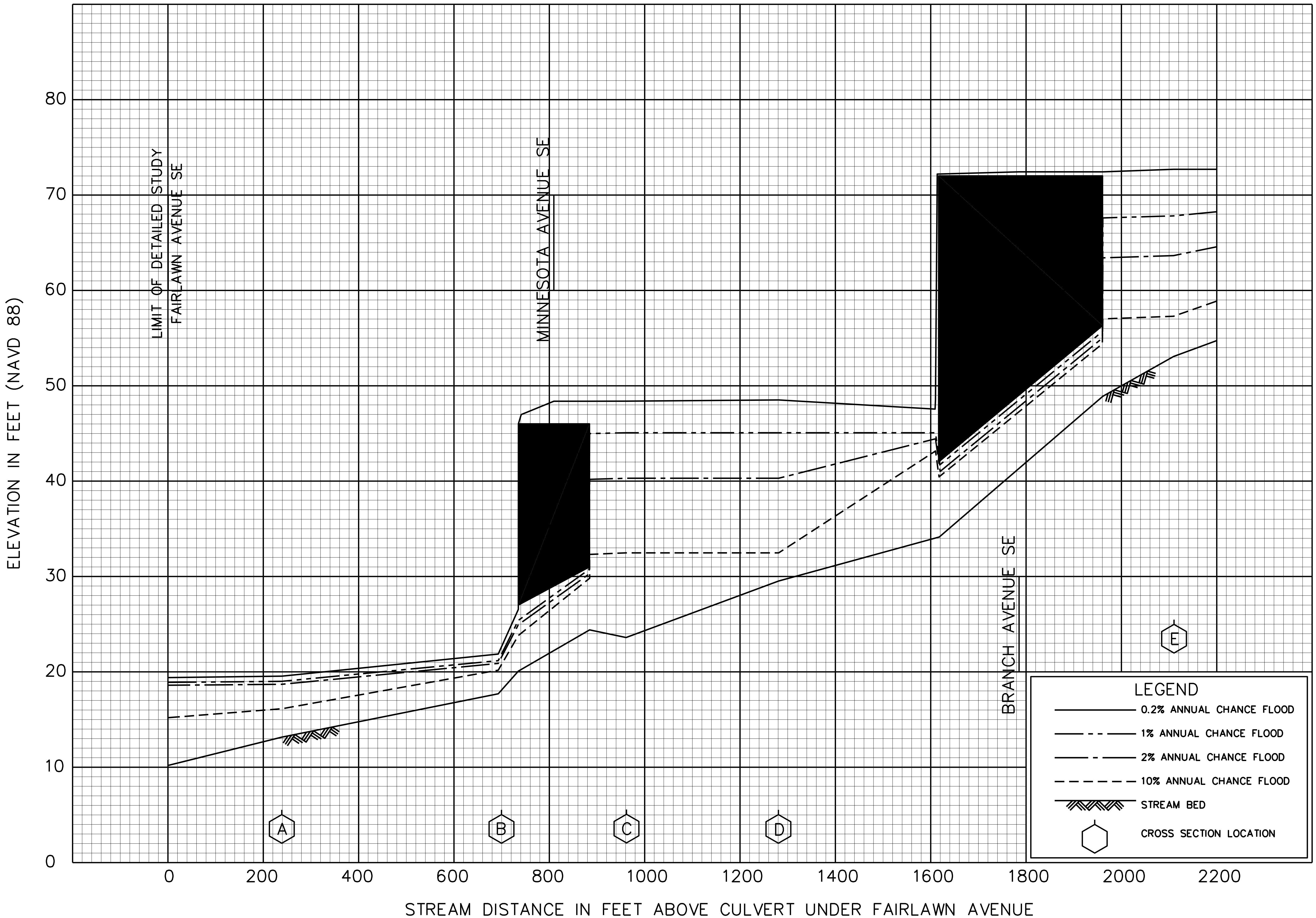
WASHINGTON D.C.

28P



FLOOD PROFILES
PINEHURST RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY
DISTRICT OF COLUMBIA
WASHINGTON D.C.

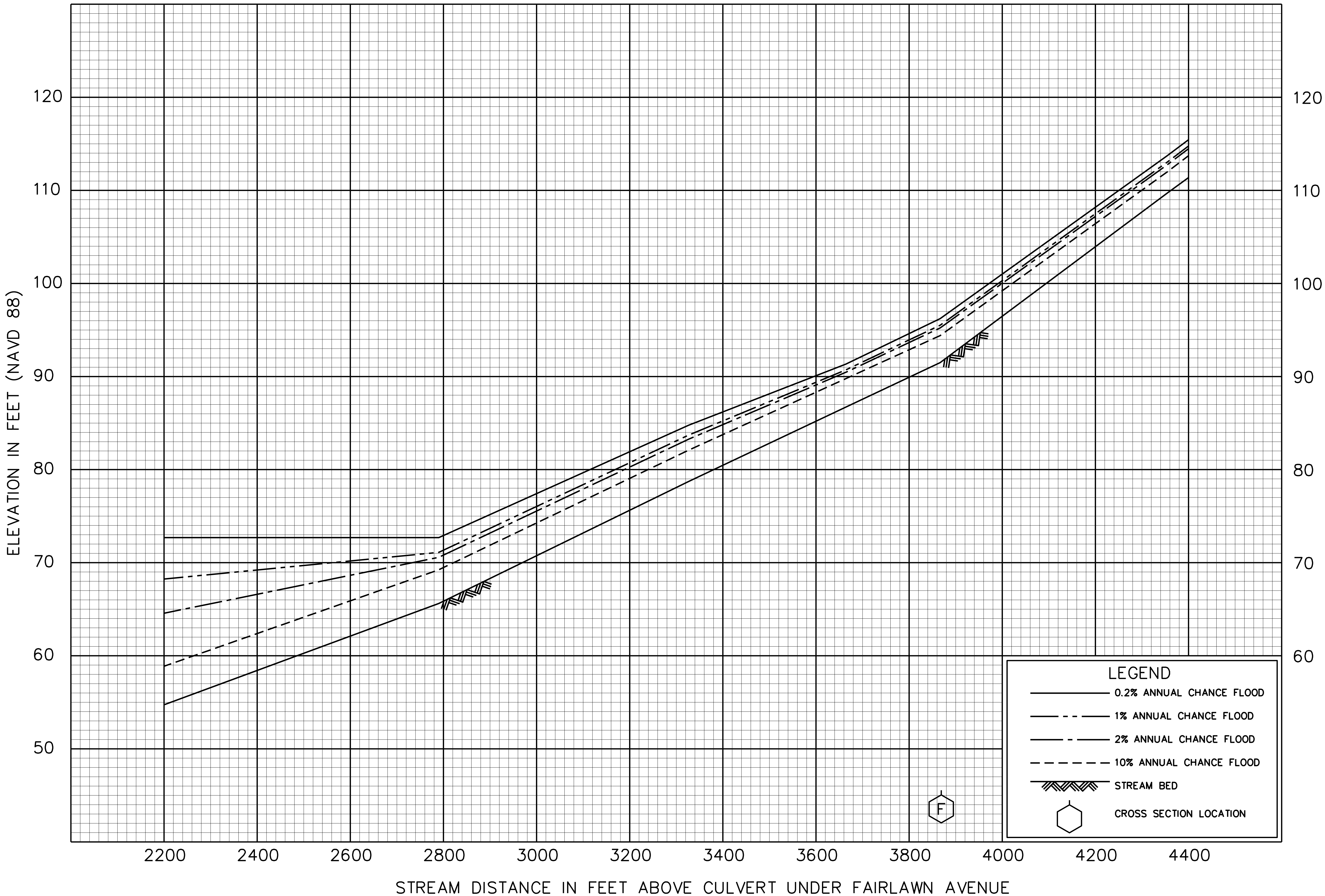


FLOOD PROFILES

POPE BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

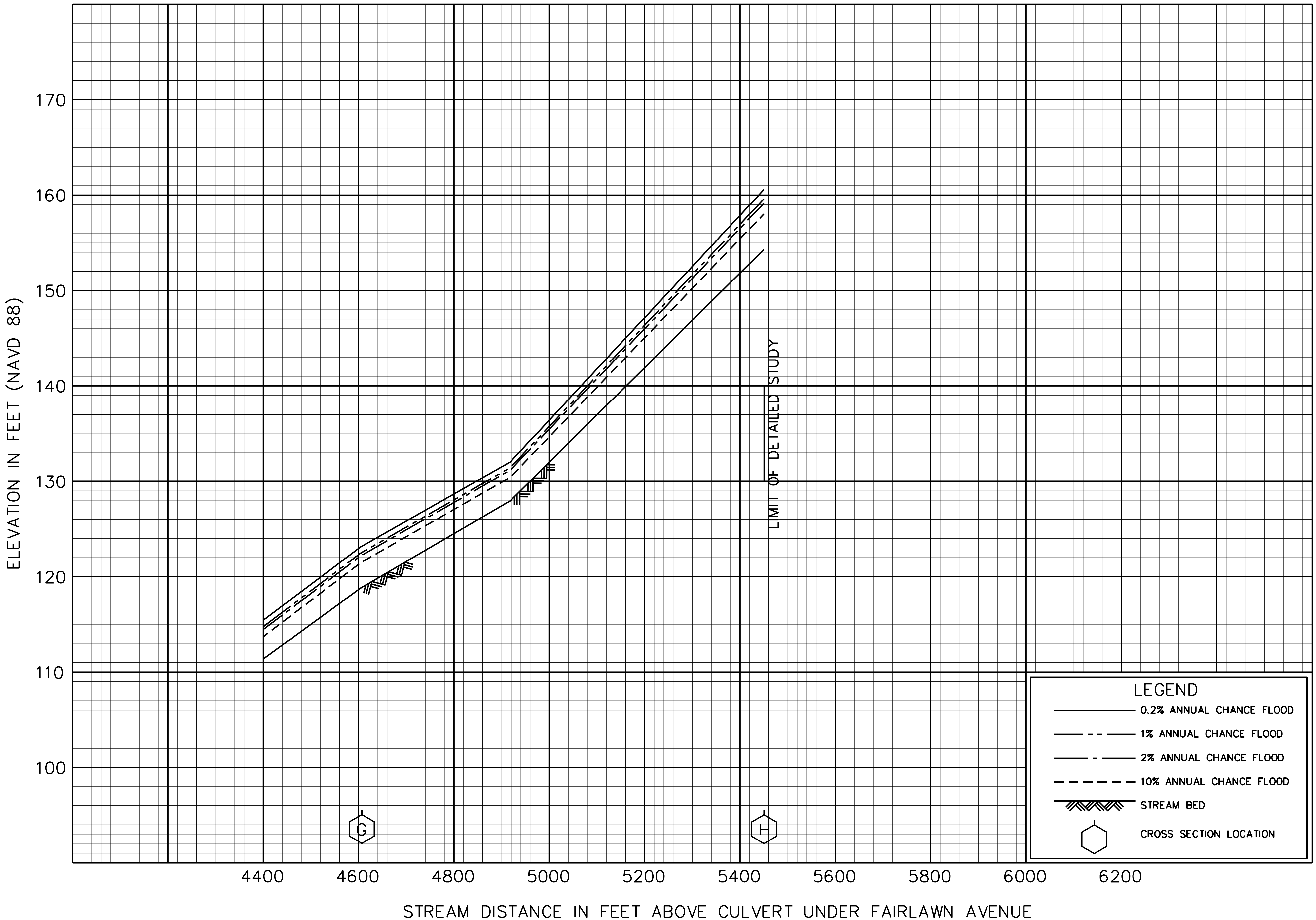
DISTRICT OF COLUMBIA
WASHINGTON D.C.



FLOOD PROFILES

POPE BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY
DISTRICT OF COLUMBIA
WASHINGTON D.C.

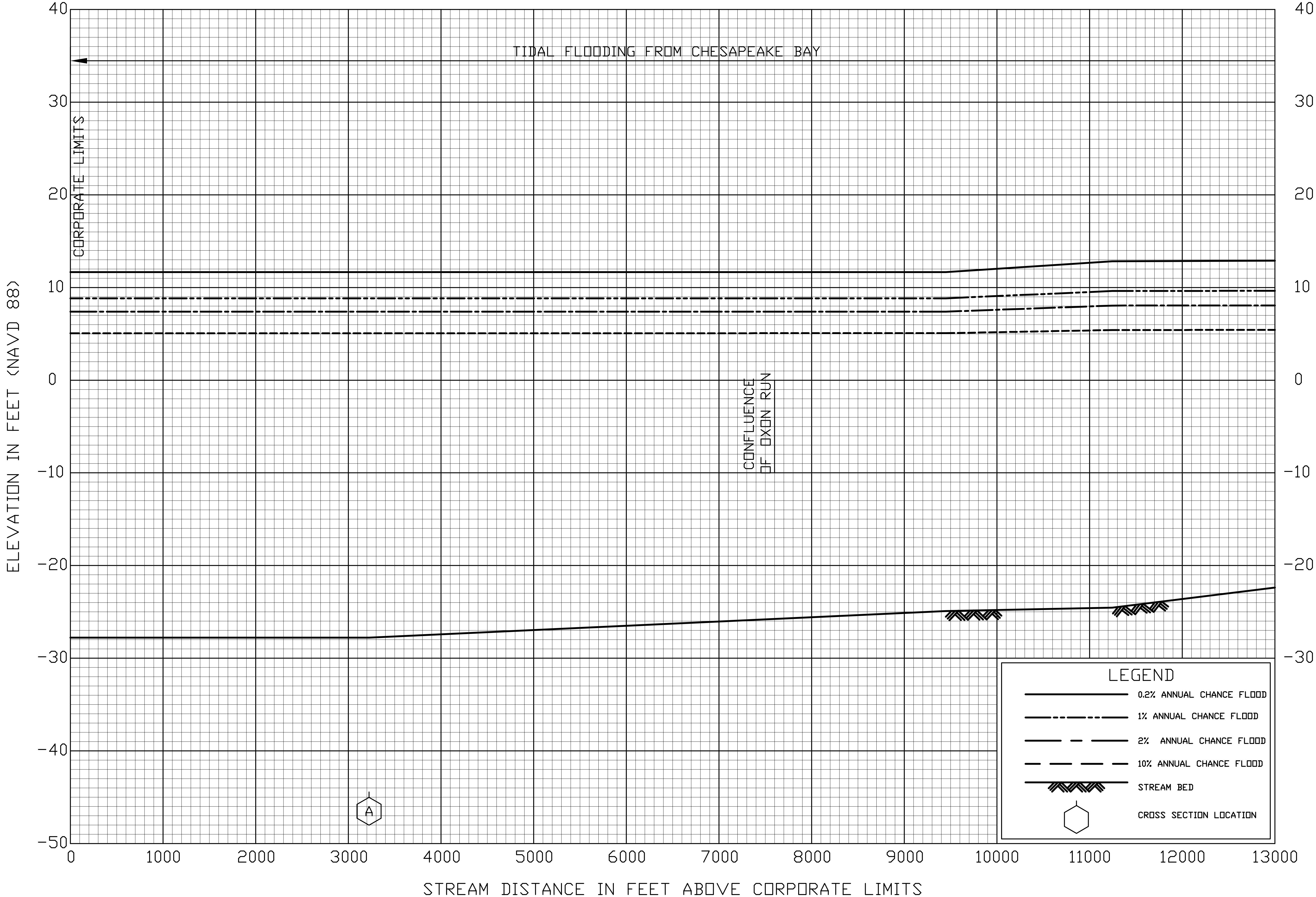


FLOOD PROFILES

POPE BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA
WASHINGTON D.C.



FLOOD PROFILES

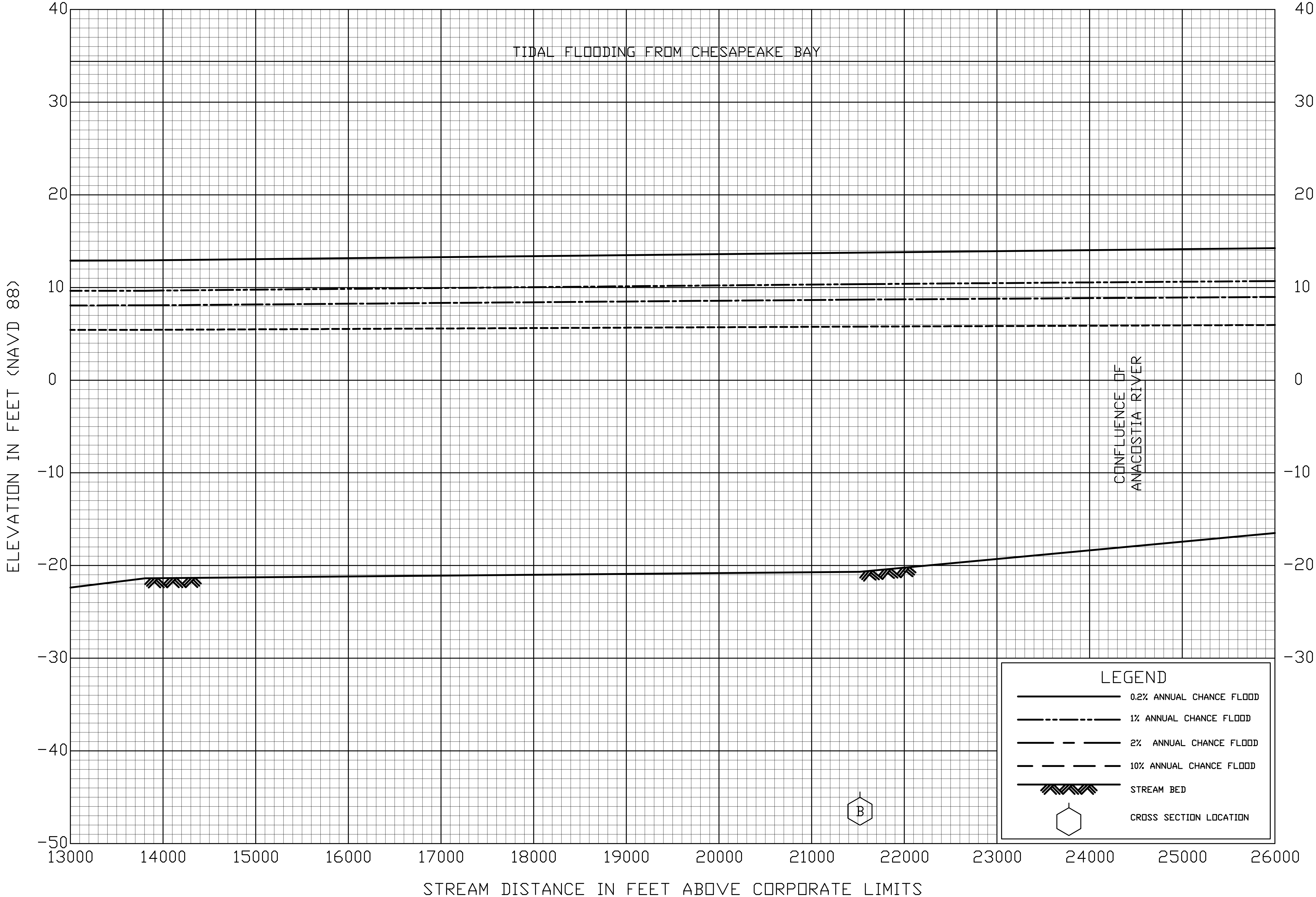
POTOMAC RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

33P



FLOOD PROFILES

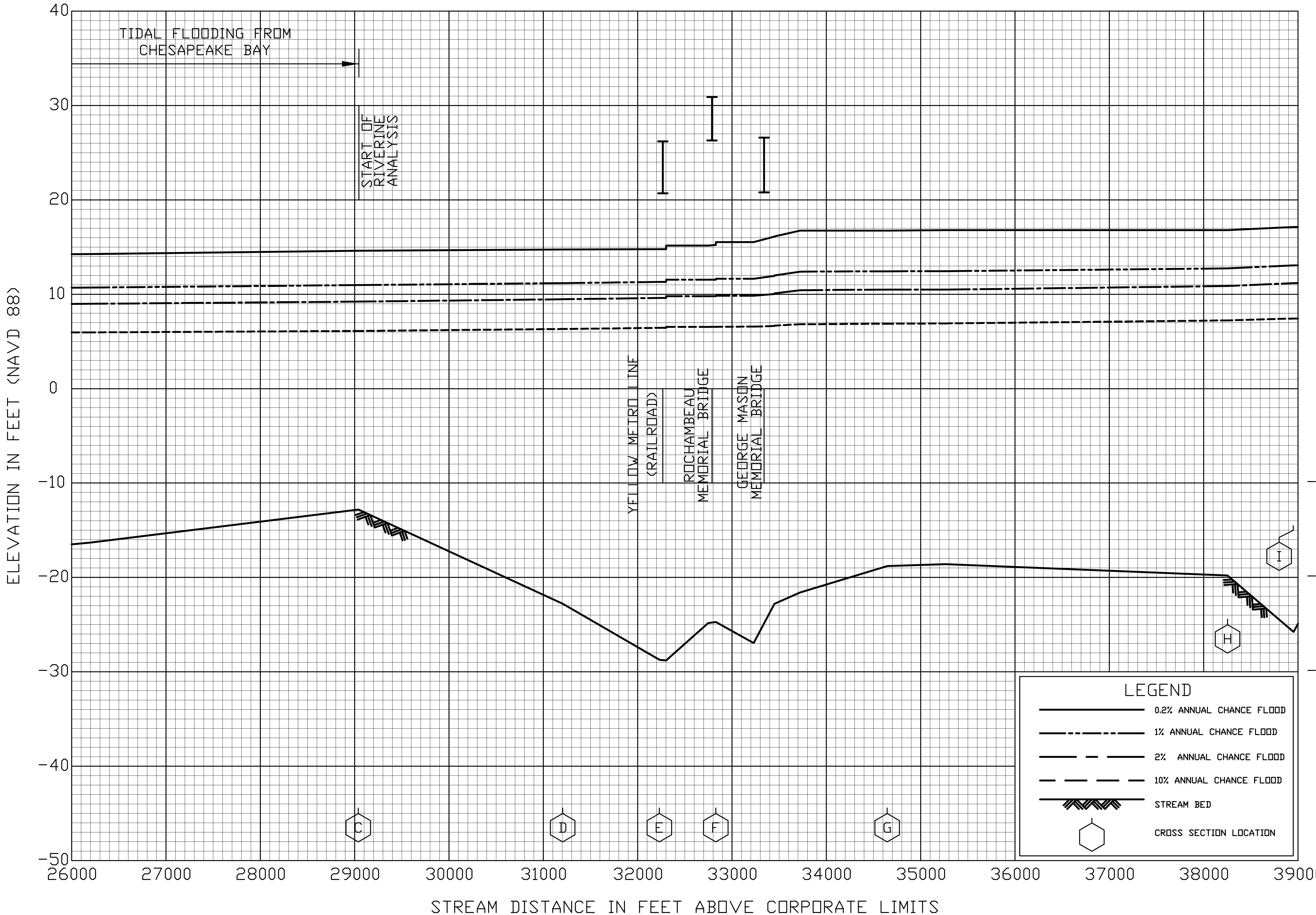
POTOMAC RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

34P



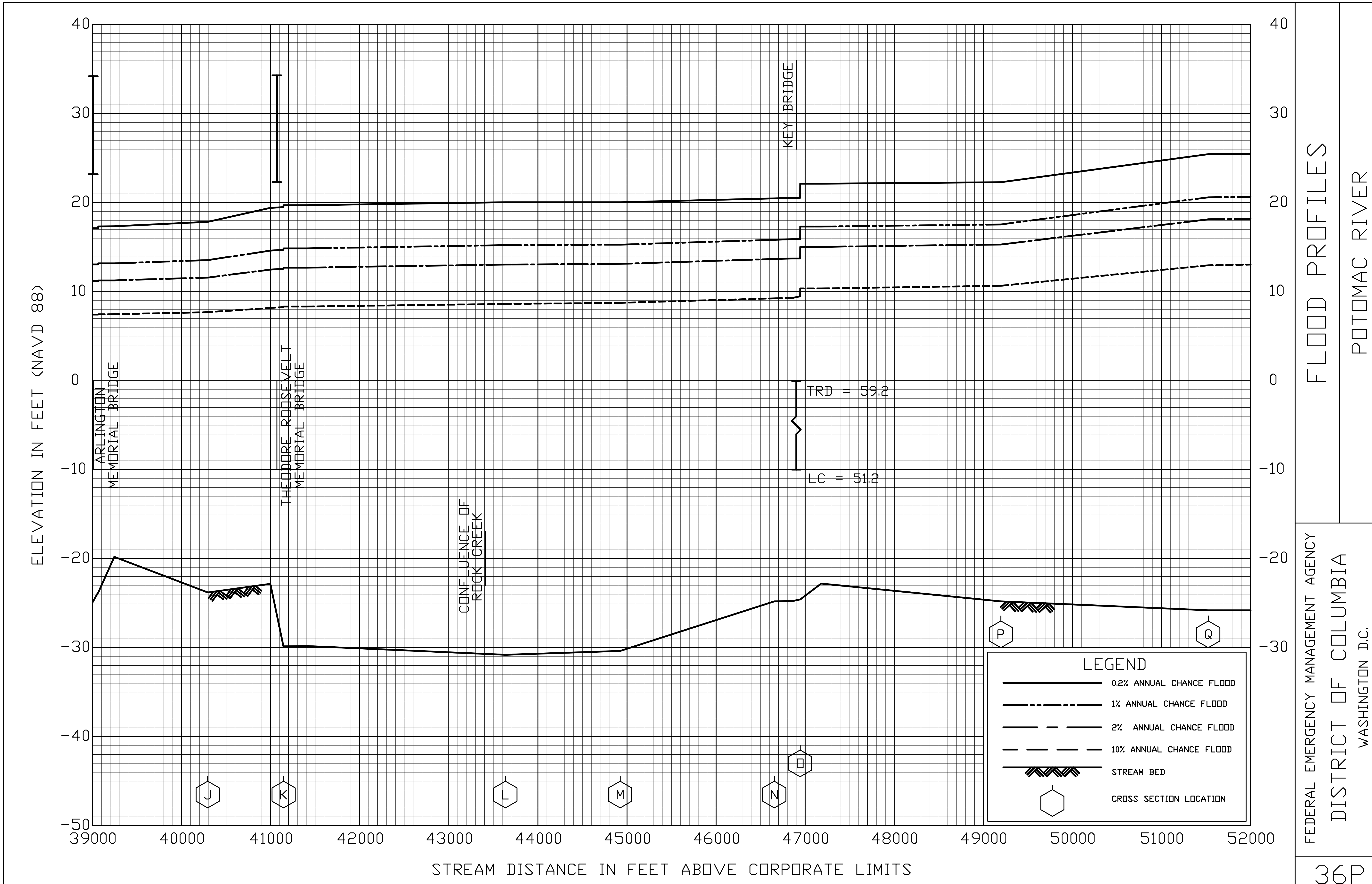
FLOOD PROFILES

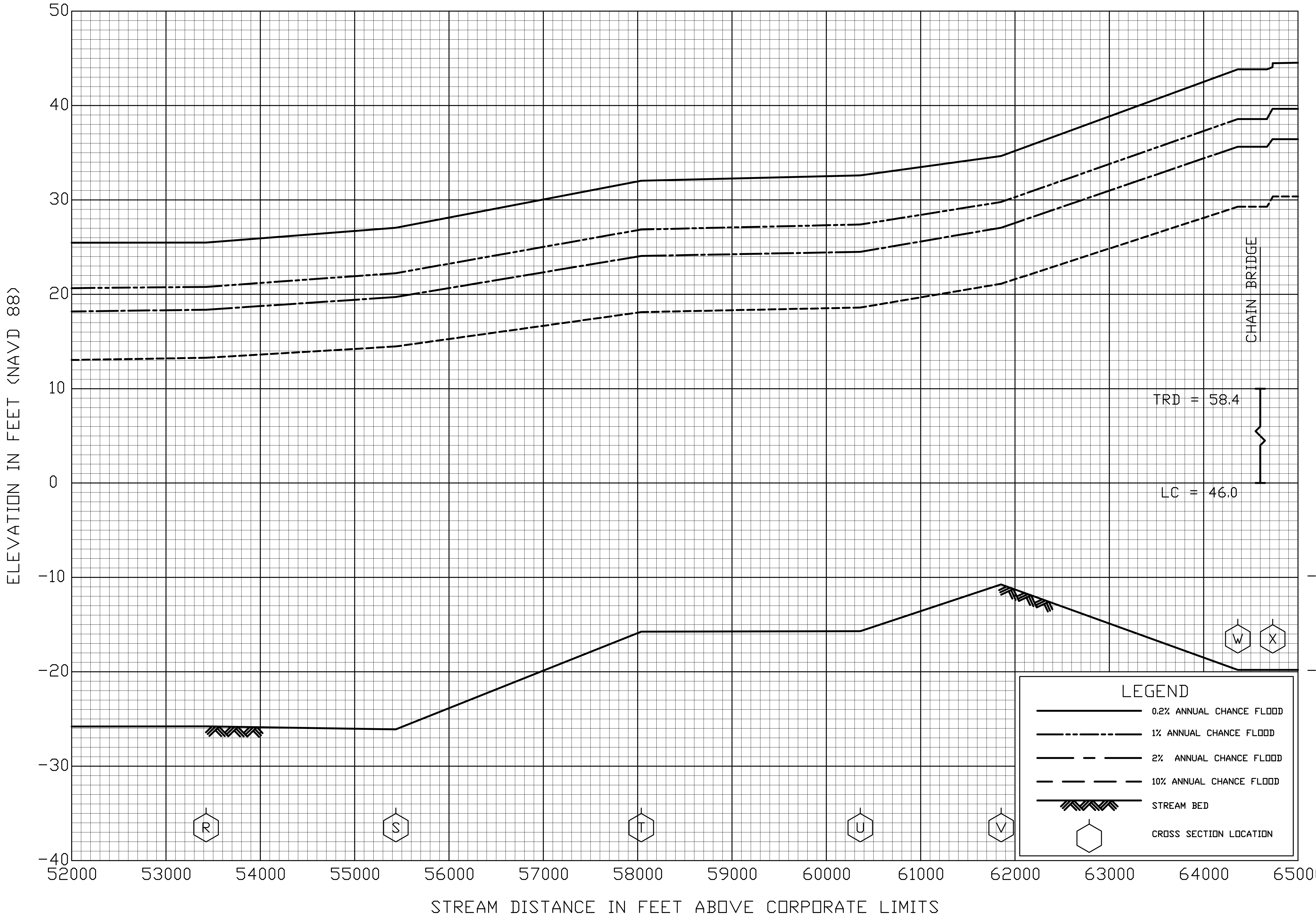
POTOMAC RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.


ELEVATION IN FEET (NAVD 88)
40
30
20
10
0
-10
-20
-30
-40
-50
STREAM DISTANCE IN FEET ABOVE CORPORATE LIMITS
39000
40000
41000
42000
43000
44000
45000
46000
47000
48000
49000
50000
51000
52000
ARLINGTON MEMORIAL BRIDGE
THEODORE ROOSEVELT MEMORIAL BRIDGE
CONFLUENCE OF ROCK CREEK
KEY BRIDGE
TRD = 59.2
LC = 51.2
J
K
L
M
N
O
P
Q
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
POTOMAC RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
DISTRICT OF COLUMBIA
WASHINGTON D.C.
36P



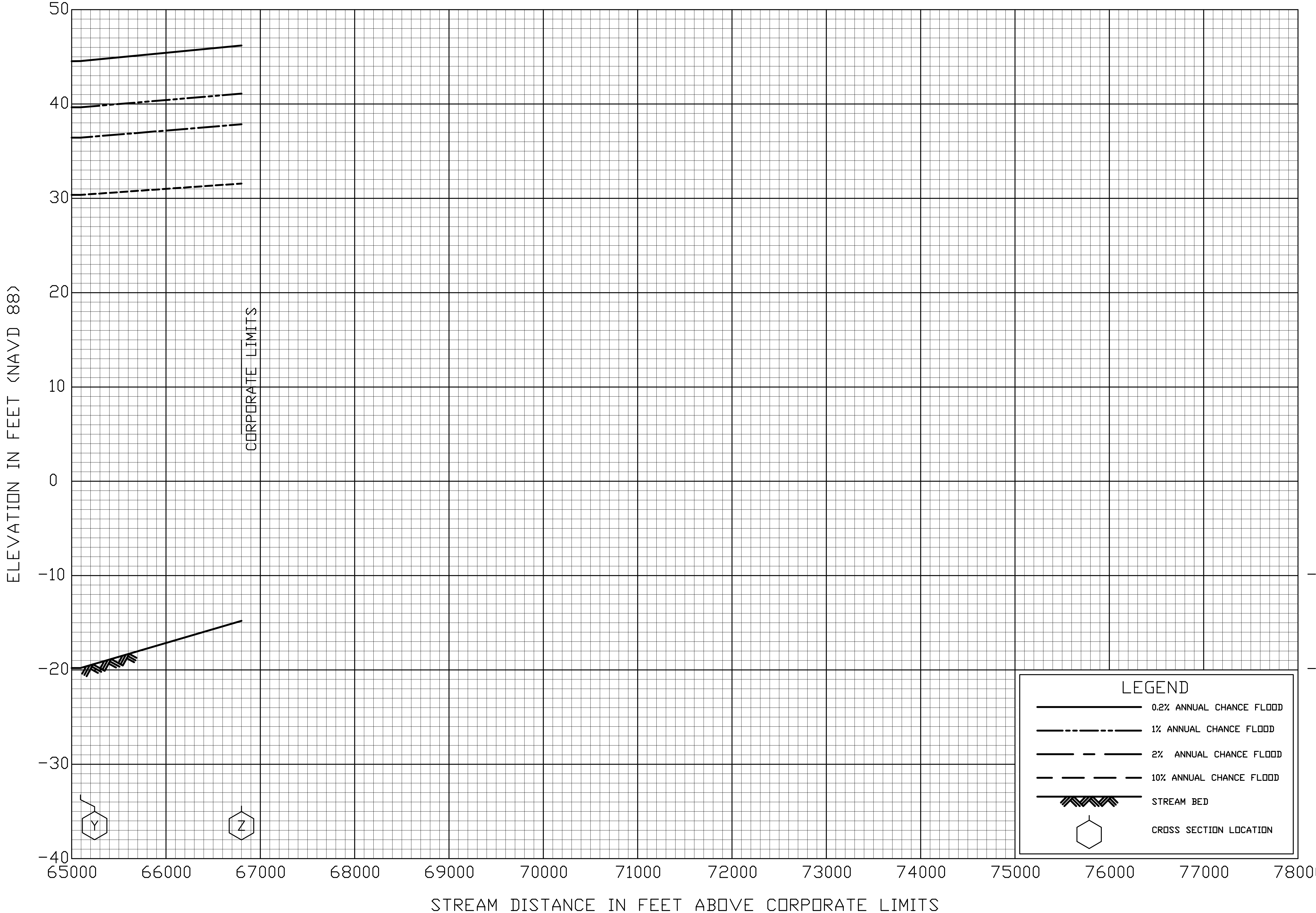
FLOOD PROFILES

POTOMAC RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.



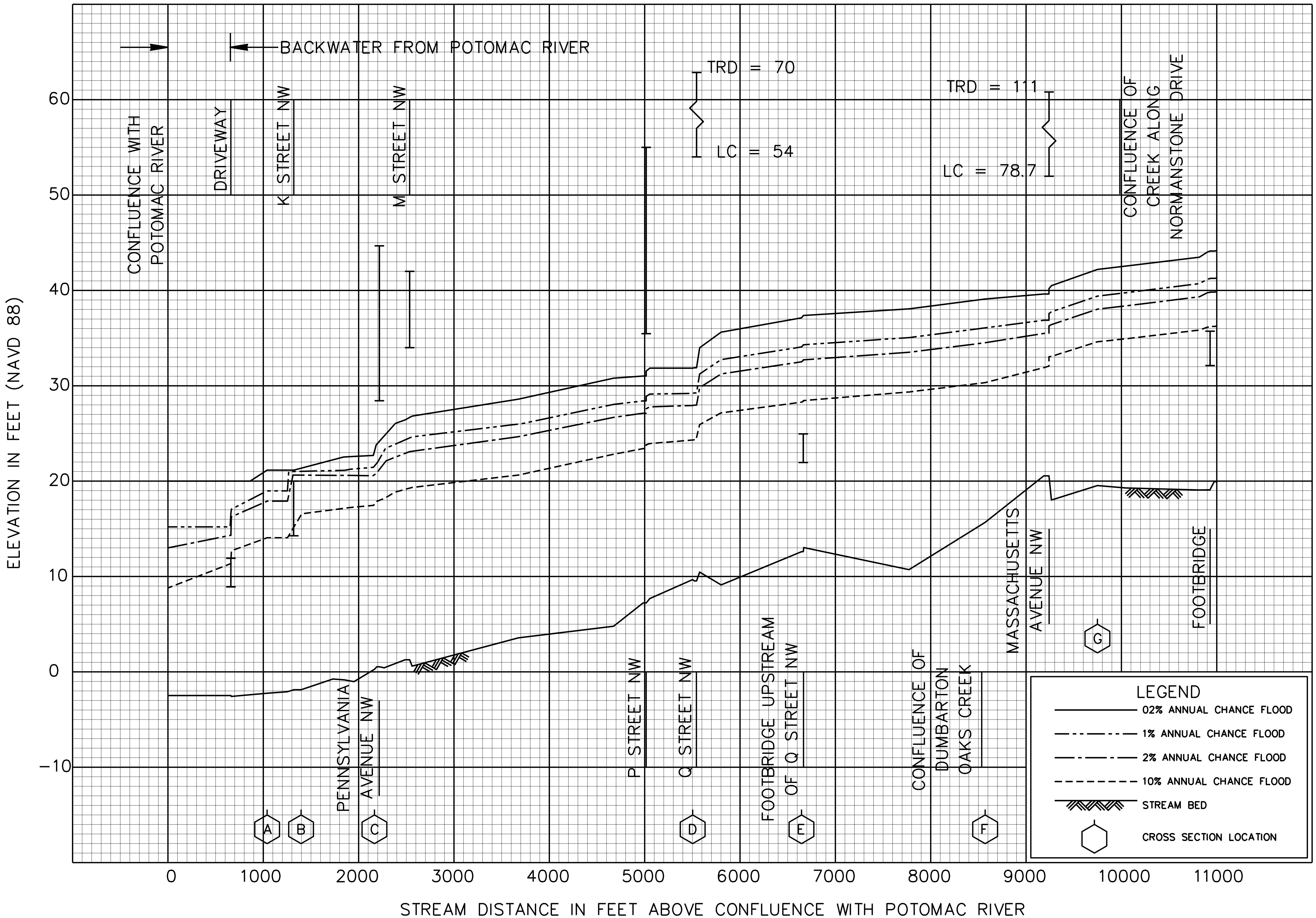
FLOOD PROFILES

POTOMAC RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

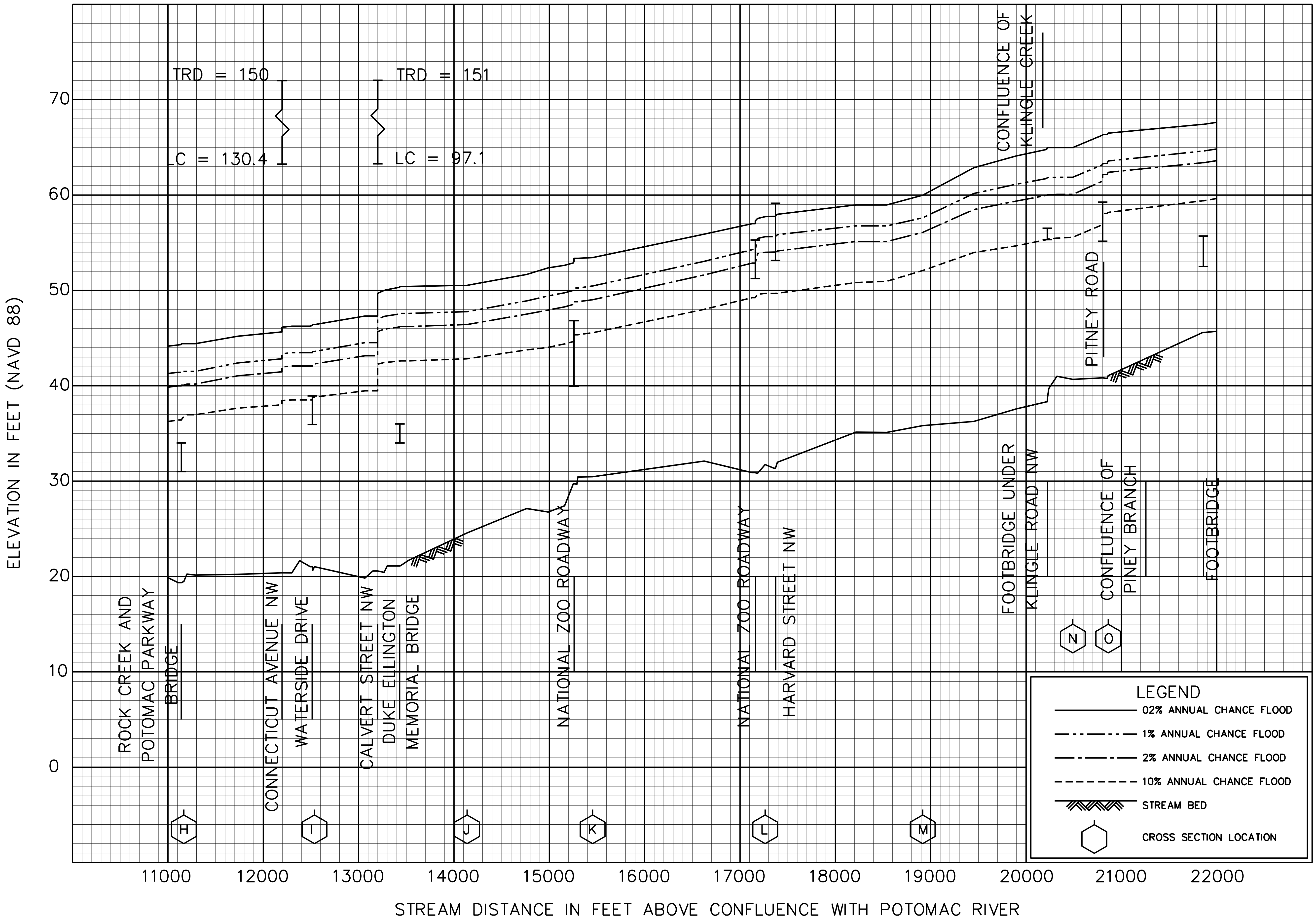
WASHINGTON D.C.



FLOOD PROFILES

ROCK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
DISTRICT OF COLUMBIA
WASHINGTON D.C.

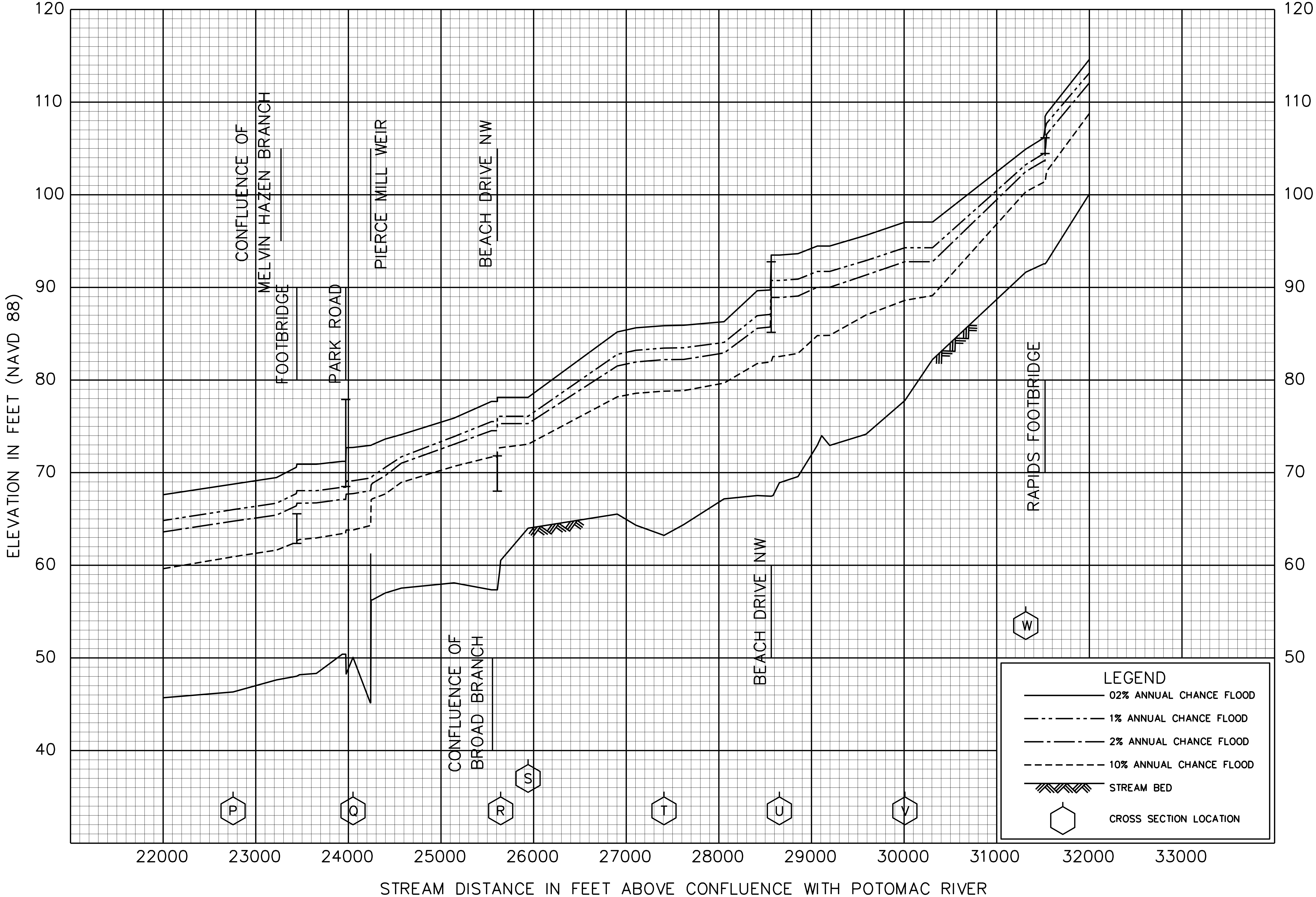


FLOOD PROFILES

ROCK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
DISTRICT OF COLUMBIA
WASHINGTON D.C.

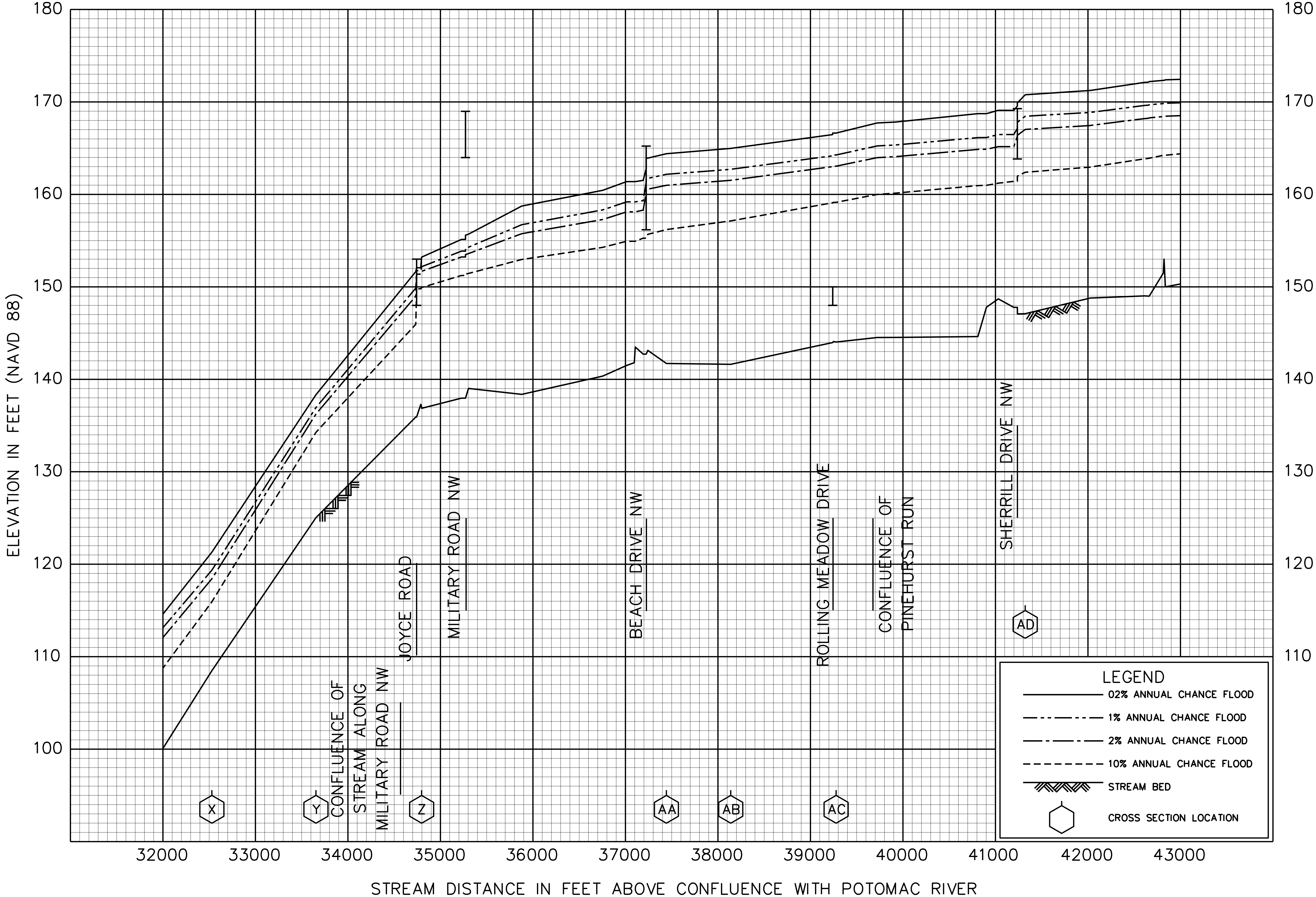
40P



FLOOD PROFILES

ROCK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
DISTRICT OF COLUMBIA
WASHINGTON D.C.



FLOOD PROFILES

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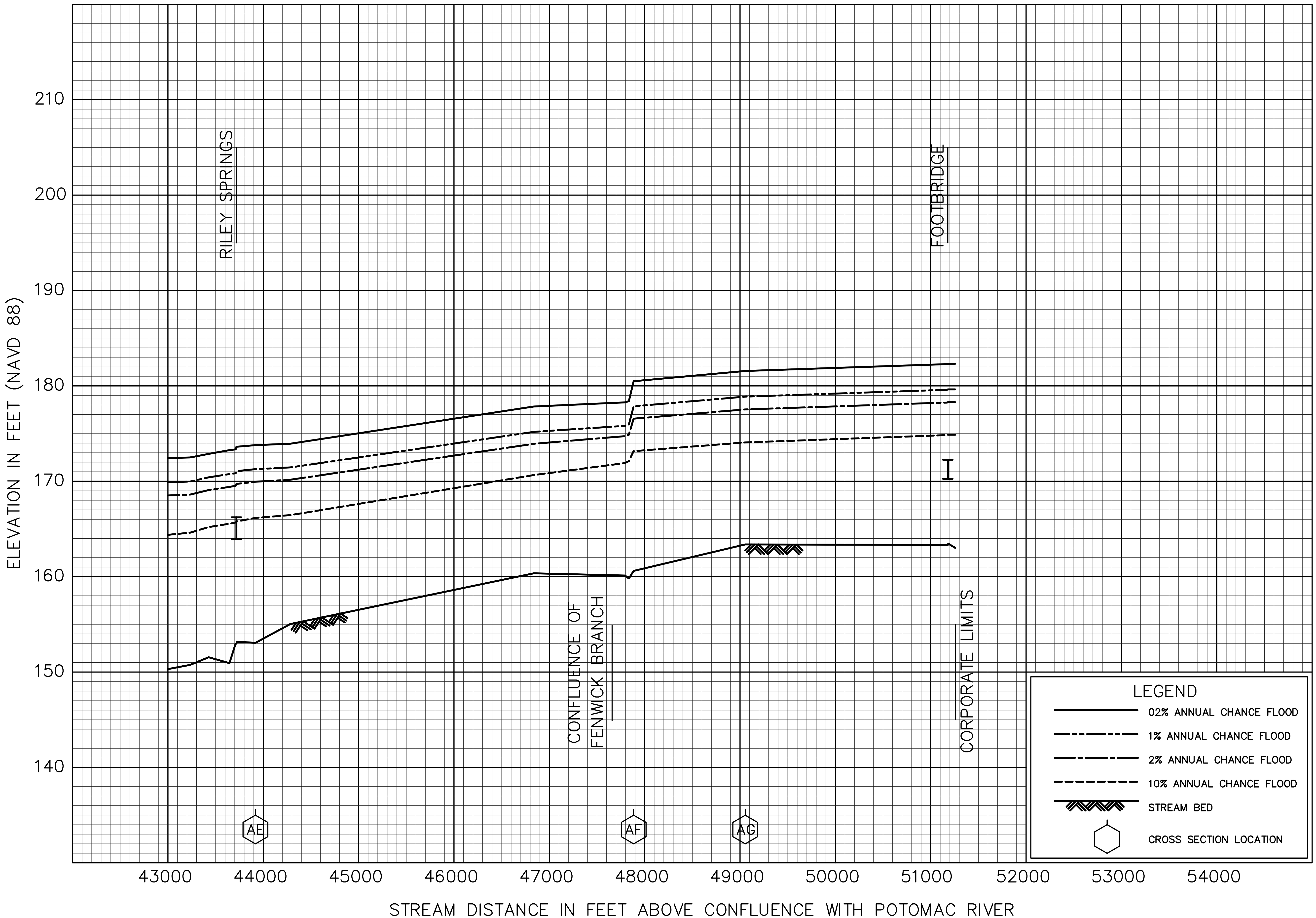

FLOOD PROFILES

ROCK CREEK

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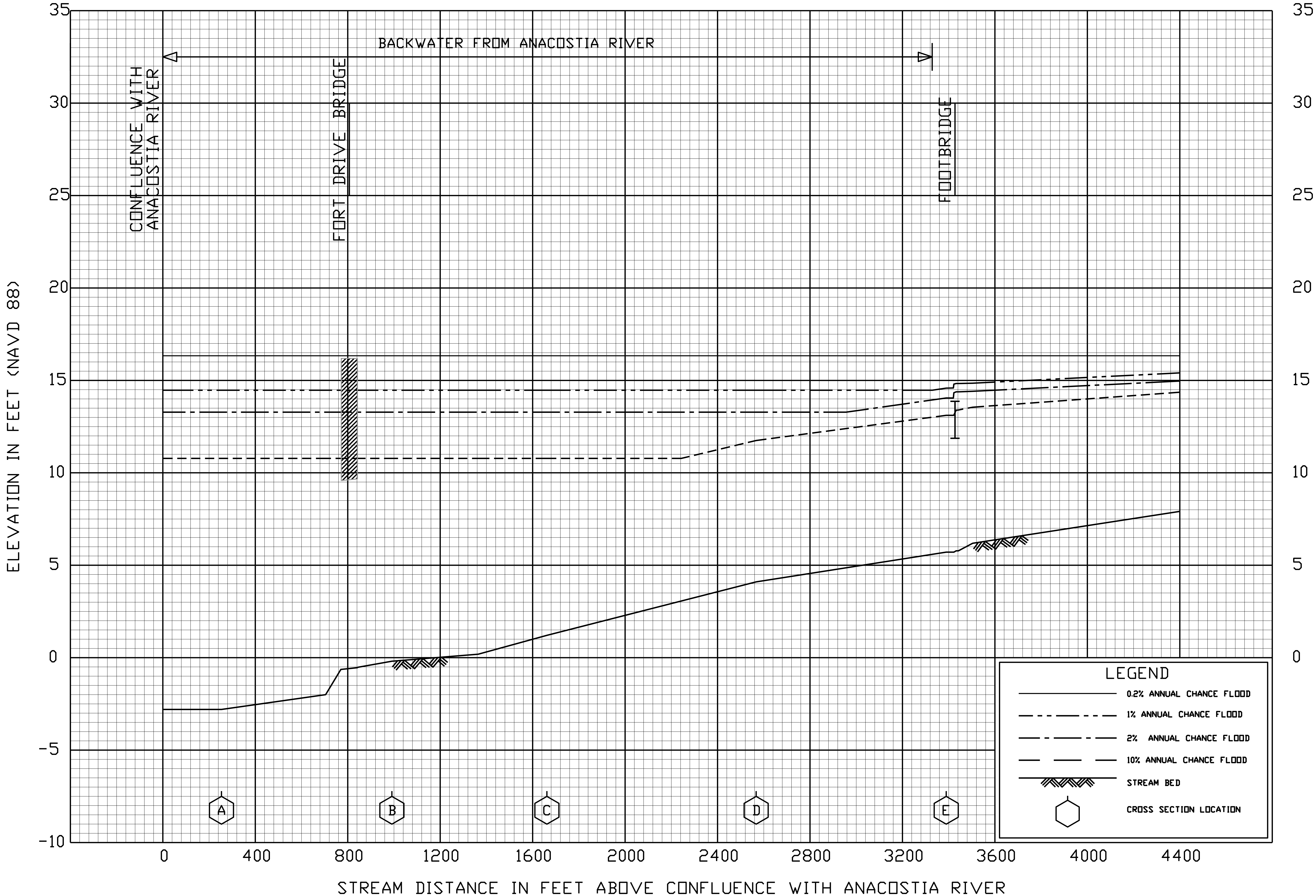


FLOOD PROFILES

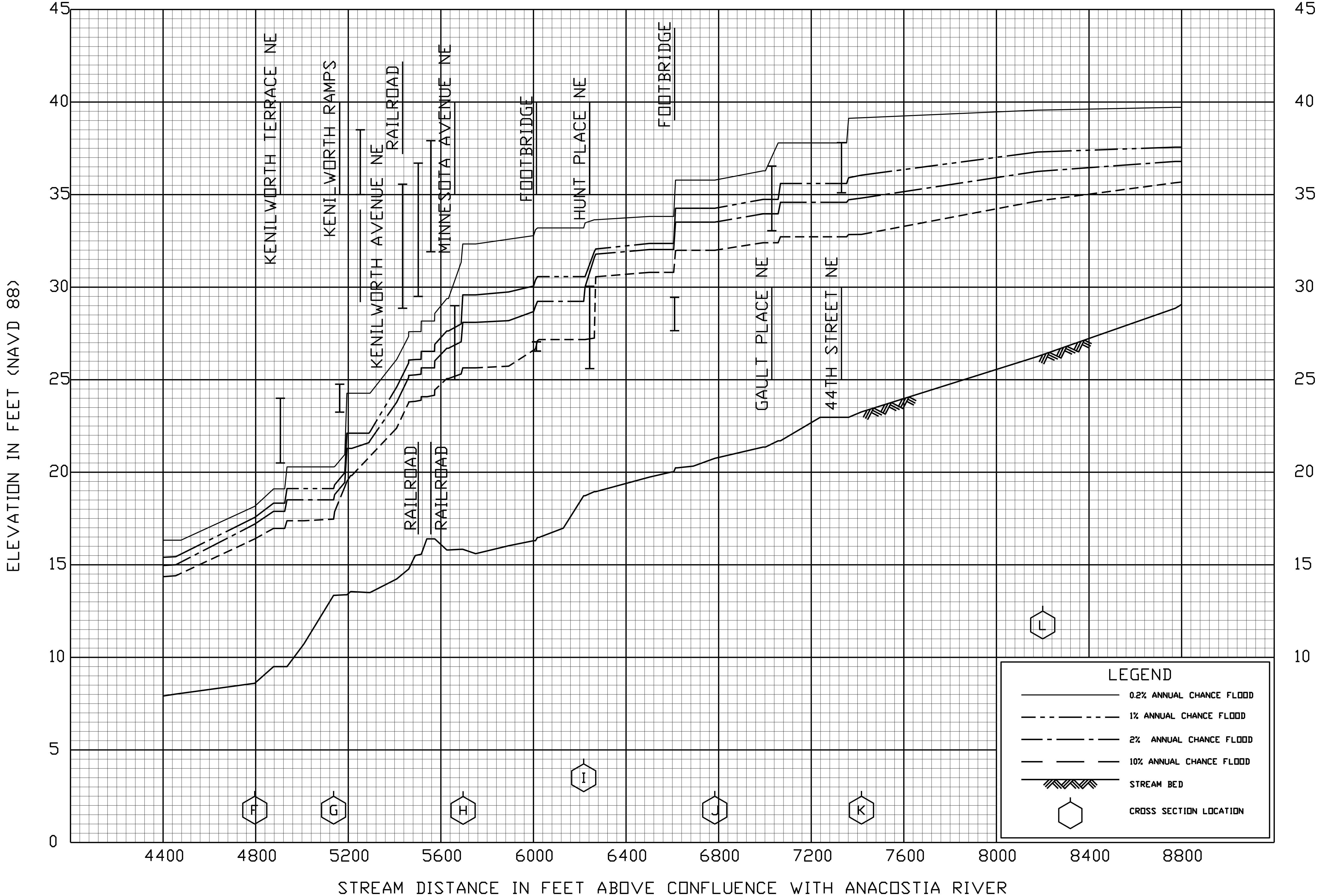
WATTS BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DISTRICT OF COLUMBIA

WASHINGTON D.C.

44P



FEDERAL EMERGENCY MANAGEMENT AGENCY

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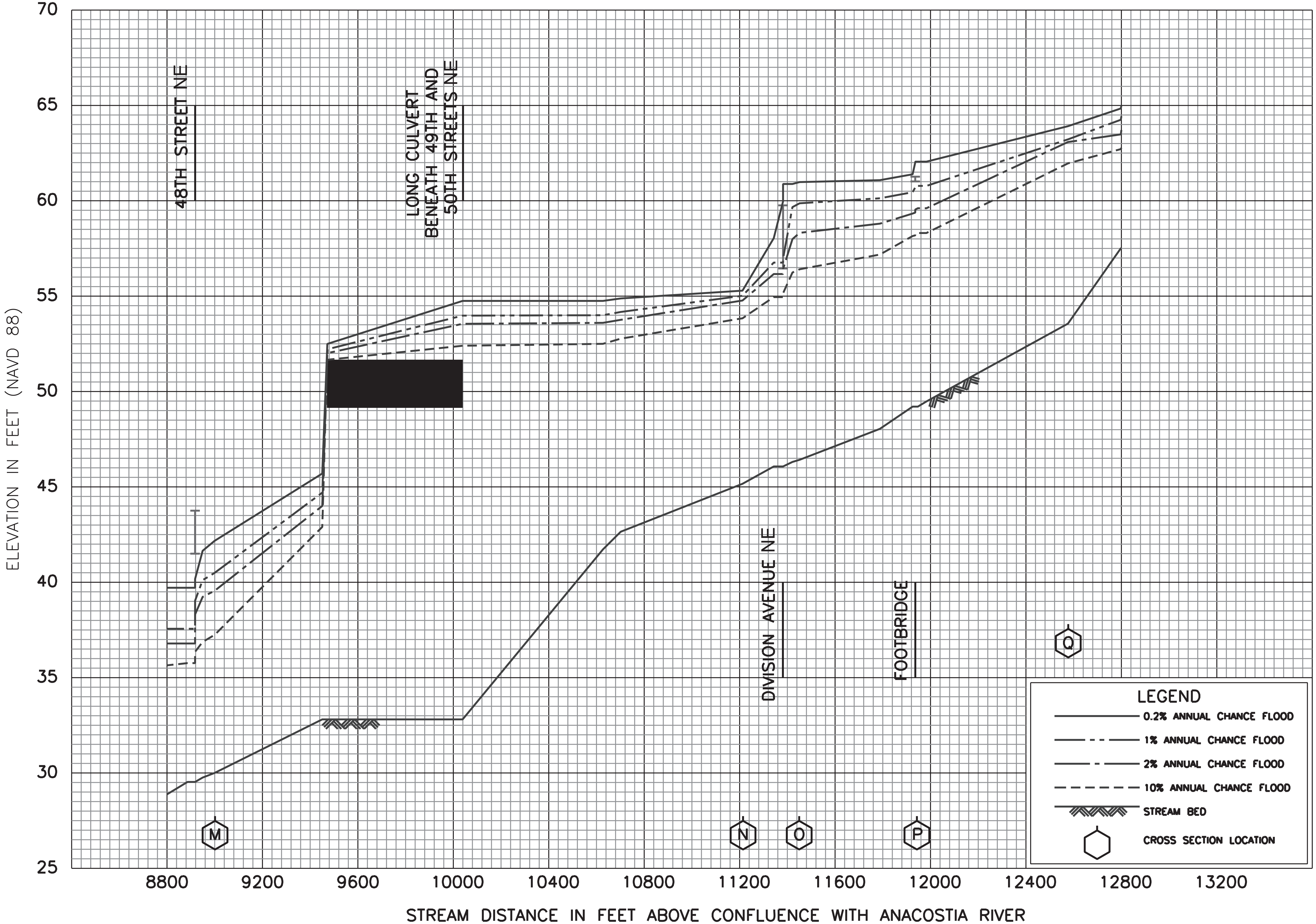
WASHINGTON D.C.

FLOOD PROFILES

WATTS BRANCH



FLOOD PROFILES

WATTS BRANCH

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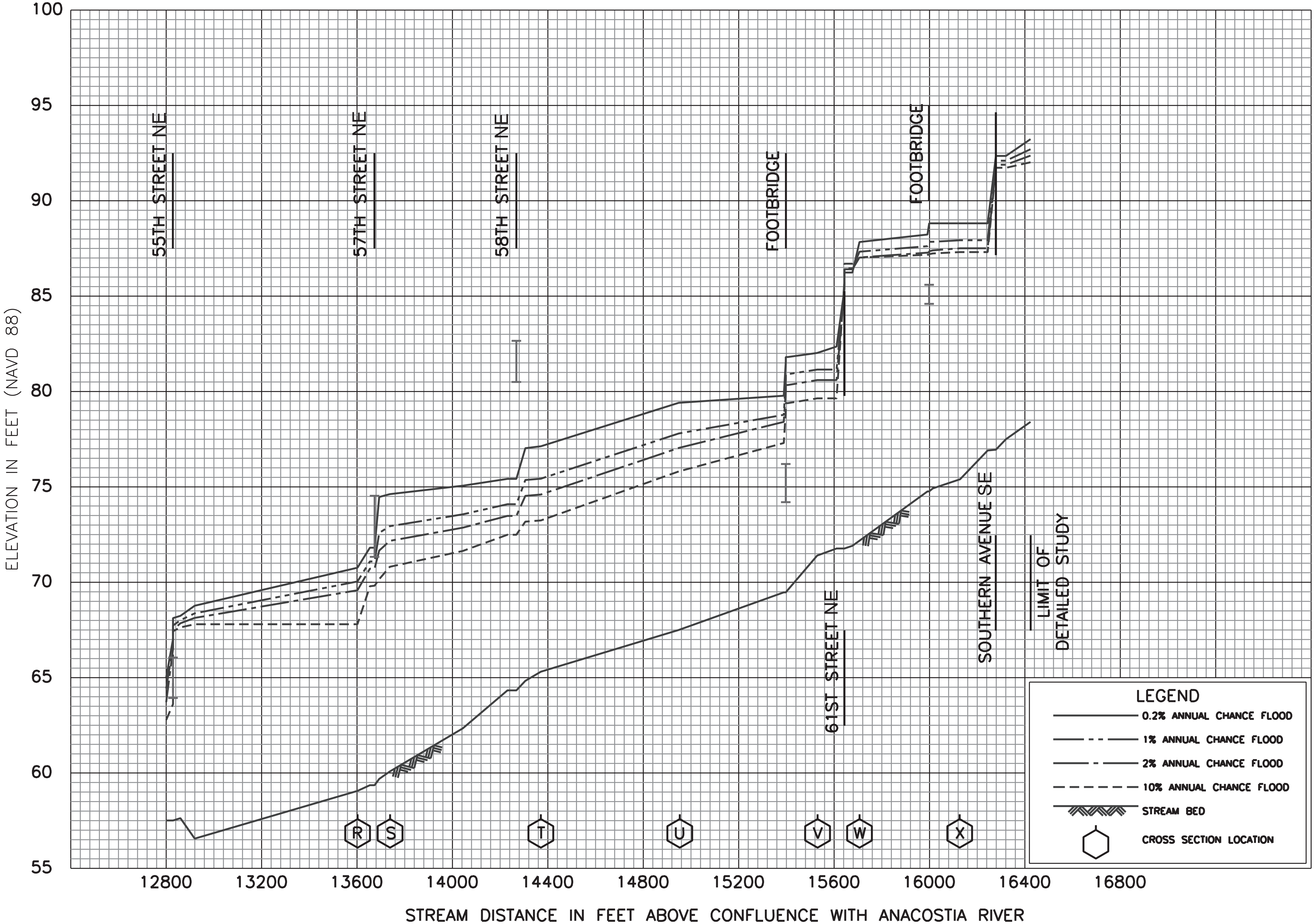

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