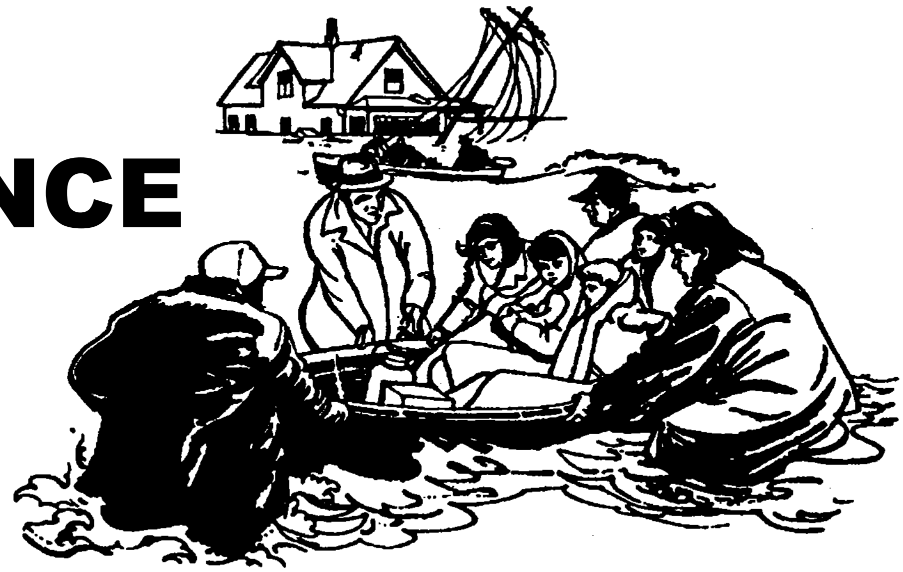
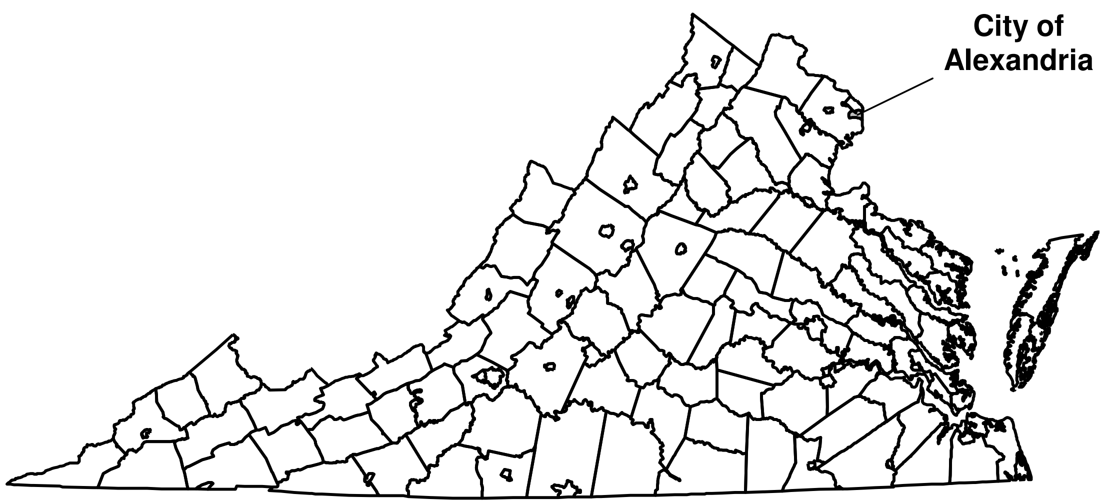
FLOOD INSURANCE STUDY



CITY OF ALEXANDRIA, VIRGINIA (INDEPENDENT CITY)



JUNE 16, 2011

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
515519V000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

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

Initial FIS Date: June 16, 2011

TABLE OF CONTENTS

TABLE OF CONTENTS - continued

FLOOD INSURANCE STUDY
CITY OF ALEXANDRIA, VIRGINIA (INDEPENDENT CITY)

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) investigates the existence and severity of flood hazards in, or revises and updates previous FISs / Flood Insurance Rate Maps (FIRMs) in the geographic area of the City of Alexandria.

This FIS aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This FIS 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 the City of Alexandria to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and will also be used 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) shall be able to explain them.

1.2 Authority and Acknowledgments

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

The original flood hazard analysis was prepared by the Baltimore District of the U.S. Army Corps of Engineers (USACE) in 1970. It was funded by the Federal Insurance Administration of the Department of Housing and Urban Development. The FIRMs have since been revised several times, but a FIS report was not previously published for the City of Alexandria.

For this initial FIS, a detailed report titled *Hydrologic and Hydraulic Analysis for the Cameron Run Watershed* was prepared by the USACE, Baltimore District in May 2007 and has been incorporated into this report. The investigation was conducted by the Planning Division of the USACE, Baltimore District, under Interagency Agreement No. HSFE03-06-X-0028. The work for the investigation was completed in March 2007. Fairfax County Department of Stormwater Planning, Virginia Department of Transportation (VDOT), and FEMA provided hydraulic data for several of the flooding sources in this investigation (Reference 4). In June 2009, the

Baltimore Corps District provided a follow-up study to the aforementioned report titled *Overland Flood Analysis for Hooffs Run, City of Alexandria, Virginia* which provided a more detailed hydrologic and hydraulic analysis for Hooffs Run. This analysis was used to generate flood profiles and floodplain boundaries for Hooffs Run (Reference 9).

In addition, tidal flood hazards for the Potomac River were updated according to a cursory-level frequency-of-occurrence storm surge analysis performed by the USACE Engineer Research and Development Center (ERDC) Coastal and Hydraulics Laboratory (CHL) (Reference 7). This analysis was completed on April 3, 2008 and the results were used to develop a unified storm surge profile for the Potomac River. The final Potomac unified profile is provided in a report titled *Unified Storm Surge Profile Methodology – For the Tidal Portions of the Potomac River*, Version 1.1, August 6, 2008. This document, prepared by the Michael Baker Corporation Regional Management Center 3 (RMC3), was considered the best available data for mapping the Potomac River at the time of this restudy (Reference 8).

Planimetric base map information is provided in digital format for all FIRM panels. These files were provided by the City of Alexandria and were compiled at a scale of 1" = 100' from aerial photography dated 2004. Users of this FIRM should be aware that minor adjustments may have been made to specific base map features.

The coordinate system used for the production of this FIRM is Universal Transverse Mercator (UTM), Zone 18 North, North American Datum of 1983 (NAD 83), GRS 80 spheroid. Corner coordinates shown on the FIRM are in latitude and longitude referenced to the UTM projection, NAD 83. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on the FIRM.

The Digital Flood Insurance Rate Map (DFIRM) production for this study was performed by AMEC, Earth & Environmental, Inc. for FEMA, under Contract No. EMP-2001-CO-2411, Task Order 0023.

1.3 Coordination

An initial CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to explain the nature and purpose of a FIS and to identify the streams to be studied by detailed methods. A final CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to review the results of the study.

For this FIS, an initial CCO meeting was held July 21, 2005. This meeting was attended by representatives of FEMA, the study contractors, and the City of Alexandria. A final CCO meeting was held on September 29, 2009, to discuss the results of this study. This meeting was attended by representatives from FEMA, the study contractors, and the City of Alexandria.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of the Independent City of Alexandria, Virginia.

All or portions of the flooding sources listed in Table 1 "Flooding Sources Studied by Detailed Methods" were studied by detailed methods. Limits of detailed study are indicated on the FIRMs (Exhibit 1).

TABLE 1 – FLOODING SOURCES STUDIED BY DETAILED METHODS

Backlick Run
Cameron Run
Four Mile Run
Holmes Run
Hooffs Run
Hooffs Run Overland Flow
South Lucky Run
Old Cameron Run Channel
Potomac River
Strawberry Run
Taylor Run
Timber Branch
Tributary 1 to Cameron Run
Tributary 1 to Taylor Run
Tributary 2 to Taylor Run

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction at the time of the original study.

No Letters of Map Revision (LOMRs) were recorded for this study.

For this revision, new hydrologic and hydraulic analyses were performed for the flooding sources identified in Table 2, "Studied Stream Reaches". As mentioned previously, new data was provided in three separate reports.

TABLE 2 – STUDIED STREAM REACHES

Flooding Source	Community(ies)	Study Start Point (Downstream)	Study End Point (Upstream)
Backlick Run	City of Alexandria and Fairfax County	Confluence with Holmes Run	Near Springfield Interchange
Cameron Run	City of Alexandria and Fairfax County	Confluence with Potomac River	Confluence of Backlick Run and Holmes Run
Holmes Run	City of Alexandria and Fairfax County	Confluence with Backlick Run	U.S. Route 66
Hooffs Run	City of Alexandria	Confluence with Cameron Run	Linden Street
Old Cameron Run Channel	City of Alexandria	Confluence with Hooffs Run	Culvert at Mill Road
Potomac River	City of Alexandria	Confluence of Cameron Run	Confluence of Four Mile Run
Strawberry Run	City of Alexandria	Culvert at Early Street	Saylor Place
Taylor Run	City of Alexandria	Confluence with Cameron Run	Near intersection of Scroggins Road and King Street
Tributary 1 to Cameron Run	City of Alexandria	Confluence with Cameron Run	0.45 miles upstream of confluence with Cameron Run
Tributary 1 to Taylor Run	City of Alexandria	Confluence with Taylor Run	Downstream of Railroad
Tributary 2 to Taylor Run	City of Alexandria	Confluence with Taylor Run	Culvert at Key Drive
Timber Branch	City of Alexandria	Culvert at Glendale Avenue	Culvert at Valley Drive

2.2 Community Description

The City of Alexandria is located in the northeastern tip of Virginia on the banks of the Potomac River across from Washington, D.C, which lies to the east. The city is bounded by the Capital Beltway (I-495) to the south and Washington National Airport to the north. Fairfax County and Falls Church lie to the west and south and Arlington County is located to the north.

The population of the city was estimated at 128,283 in 2000 and experienced a 6.8% rate of growth over the next 6 years resulting in a 2006 estimate of 136,974 (Reference 1).

Since the late 1980s, Alexandria has experienced unprecedented commercial development. Today the Old Town historic district is known for its array of museums, architecture, special events, fine restaurants and hotels, and other attractions that draw more than 1.5 million international and domestic visitors to it each year. More than two million square feet of new office complexes have been constructed. With this development, the

City has become a mecca for divisional, regional, national, and multinational headquarters for operations ranging from research and development to high technology, associations, and professional services. According to the City profile as part of the Virginia Economic Development Partnership, Alexandria claims the fourth largest concentration of professional associates and trade associations in the country, behind only New York City, Washington, D.C. and Chicago (Reference 2).

The average annual precipitation consists of approximately 40 inches of rainfall and approximately 17 inches of snowfall. The climate of the city is pleasant except for short periods of weather extremes. It has warm, humid summers, while winters are generally mild but wet. Average temperatures for January and July are 36 degrees Fahrenheit (°F) and 79°F, respectively (Reference 3).

The topography of Alexandria is mainly rolling hills with a maximum elevation of approximately 280 feet and a minimum elevation of 3 feet above sea level.

2.3 Principal Flood Problems

In general, three types of storms historically cause flooding (non-tidal) in the City of Alexandria: thunderstorms, tropical systems, and frontal storms. The summer thunderstorms, with high intensity-short duration rainfall, are the major cause of flooding. The three largest flood events on record, which included record rainfall over long duration (i.e. 24 hours), was primarily caused by short duration, high intensity bursts of rainfall (i.e. 6 hours or less) during the larger storm duration (Reference 4).

The city experiences nuisance flooding due to an overtaxed stormwater system and owing to the high levels of development described above. Also, its proximity to the tidally influenced Potomac River and low-lying developed areas, both residential and commercial, make parts of the City susceptible to significant flood related damage. It has been included in several disaster declarations, most recently due to severe storms in June of 2006 and as a result of Hurricane Isabel in 2003. Extensive damage due to storm surge and riverine flooding occurred during both of these events.

The highest recorded flows determined by an analysis of two USGS gaging stations located in Alexandria (along Four Mile Run and Cameron Run) occurred in 2006 and 1972, respectively. The gage height at Four Mile Run was 20.20 feet with a streamflow of 18,100 cfs, due to high levels of rainfall which fell across the Potomac River basin area in late June of 2006, resulting in several homes being flooded within the community. The gage height at Cameron Run was 18.14 feet with a streamflow of 19,900 cfs on June 22, 1972, associated with Hurricane Agnes (Reference 5).

The most recent widespread flooding in the City Alexandria occurred in June 2006. Several roadways, including Telegraph Road and U.S. Interstate Highway 495/95 (Capital Beltway) were overtopped; commercial and residential structures in the City of Alexandria reported significant flooding; stormwater infrastructure was inundated with larger than design flows causing deep ponding of water on roadways; and the Huntington area in Fairfax County, on the southern bank of Cameron Run, received significant flood damages. News reports estimated damages in Huntington near $10 million (Reference 10).

. On September 23, 2003, the USGS gaging station (01653000) at Cameron Run in Alexandria recorded a peak streamflow of 9,330 cfs with a gage height of 11.29 feet as a result of Hurricane Isabel (Reference 5). The hurricane's eye tracked well west of the Chesapeake Bay, but the storm's 40 to 60 mph sustained winds pushed a bulge of water northward up the bay and its tributaries producing a record storm surge. The Virginia western shore counties of the Chesapeake Bay and the tidal tributaries of the Potomac, Rappahannock and other smaller rivers, experienced a storm surge which reached 5 to 9 feet above normal tides. In many locations, Isabel's surge was higher than the previous record storm known as the Chesapeake-Potomac Hurricane of 1933. Impact on the commonwealth of Virginia as a whole is staggering with $1.6 billion in damages with over 1,186 homes and 77 businesses destroyed, 9,110 homes and 333 businesses with major damage and 107,908 homes and over 1,000 businesses affected or impacted with minor damage. An estimated 660,000 dump trucks of debris was generated. At least 10 people were directly killed by the storm with hundreds injured. Almost 2 million electrical customers found themselves without power. Crop losses were calculated to be $59.3 million with another $57.6 million in damages to fences, farm buildings and equipment. Cost to Virginia's Dominion Power were $128 million, Red Cross outlays $6 million, military bases $283 million, private property $732 million, National Park Service $123 million, and public property $270 million (Reference 6).

2.4 Flood Protection Measures

Floodplain management measures in Alexandria are described in the Virginia Uniform Statewide Building Code (Commonwealth of Virginia, 1975). This building code was adopted and is enforced by the city building inspector. The code states that, where a structure is located in the 1-percent annual chance flood plain, the lowest floor must be built at or above the 1-percent annual chance flood elevation, except for non-residential structures which may be flood-proofed to that level.

A flood control channel was constructed in the 1970's along Cameron Run between the Capital Beltway and the railroad bridge. At Cameron Station, a concrete-lined flood control channel was constructed on Backlick Run to protect residential areas from flooding (Reference 4).

The USACE constructed a flood protection project on Four Mile Run from Interstate 395 to a point 1,050 feet downstream of South Arlington Ridge Road. The project, which impacts both Arlington County and the City of Alexandria, consists of 11,850 feet of improved channel, approximately 4,700 linear feet of floodwalls, bridge improvements, drop structures and other appropriate hydraulic modifications to carry the design flow. Although the project was initially designed to protect against the 1-percent annual chance flooding event, it currently is not certified to provide this level of protection (Reference 28).

3.0 ENGINEERING METHODS

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

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the county. Detailed hydrologic information was unavailable for South Lucky Run, one of two flooding sources that were not restudied as part of this revision.

Since Four Mile Run forms the corporate boundary between the City of Alexandria and Arlington County, hydrologic information for Four Mile Run was obtained from the effective FIS for Arlington County, dated November 3, 1981. The hydrologic analysis for Four Mile Run was a modification of the work presented by the USGS in their Water-Supply Paper, *Effects of Urban Development on Floods in Northern Virginia*, which relates basin characteristics to stream flow characteristics (Reference 15). This analysis followed the standard log-Pearson Type III method as outlined by the Water Resources Council (Reference 26).

Using a multiple linear regression discharges at the selected recurrence intervals were then related to basin characteristics (Reference 27). Those regression equations were then used to determine discharges on the ungaged portions of Four Mile Run (Reference 28).

To determine the existing peak flows for the 10-, 2-, 1-, and 0.2-percent annual chance flood events for all remaining flooding sources with the exception of the Potomac River, the U.S. Army Corps of Engineers Hydrologic Modeling System (HMS), version 3.1.0, was used. HEC-HMS is a public domain software package for hydrologic analysis developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center (HEC). HEC-HMS is designed to simulate the precipitation-runoff process in dendritic watershed systems. It is designed to be applicable in a wide range of geographic areas for solving the widest possible range of problems (Reference 19). It is widely used and is an approved model for FEMA's mapping partners.

Although the watershed contains a streamflow gage operated by the USGS, with 50+ years of record, the project scope specifically outlined the use of a rainfall-runoff model, such as HEC-HMS, to perform the analysis. This is due to the theory that the data record at the USGS gage is not homogeneous due to increasing levels of watershed development throughout the period of record. USACE Engineering Regulation 1110-2-1464 states that a rainfall-runoff model is desirable where urbanization has changed the runoff response during the gaging record (Reference 20). FEMA guidelines and specifications state that rainfall-runoff models should be used in lieu of a gage analysis where the data is non-homogeneous (Reference 21)

The calibrated and verified HEC-HMS basin model was used to determine peak flows for the 10-, 2-, 1-, and 0.2-percent annual chance synthetic storm events (Reference 4).

Because of the complex nature of the Hooff's Run flooding conditions, the USACE- Baltimore District performed an overland flow flooding analysis of Hooffs Run in the City of Alexandria. Significant overland flooding occurs between East Maple Street and Jamieson Avenue due to a lack of capacity of the local stormwater infrastructure. An analysis of this level of detail was outside of the scope of the initial May 2007 USACE Cameron Run Watershed study. For the supplemental analysis, more detail was placed on simulating the hydrology specifically of the Hoofs Run watershed and overland flooding area, thus leading to minor refinements in the original HEC-HMS model (Reference 9).

A summary of the drainage area-peak discharge relationships for detailed studied streams is shown in Table 3, "Summary of Discharges."

TABLE 3 – SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) ANNUAL CHANCE 10%	2%	1%	0.2%
BACKLICK RUN					
Confluence with Holmes Run	13.18	6,304	11,484	13,948	19,896
Downstream of Confluence with Turkeycock Run	12.05	6,259	11,422	13,858	19,756
Downstream of Confluence with Indian Run	8.56	4,921	8,330	9,999	14,129
At US. Route 495 (Capital Beltway)	3.81	1,600	2,799	3,405	4,797
Upstream of Henry Shirley Memorial Highway	2.72	1,455	2,348	2,940	4,171
At Leesville Boulevard	2.04	1,337	2,071	2,493	3,605
Upstream of Braddock Road	1.08	789	1,187	1,398	1,889
Downstream of Carmine Street	0.54	704	1,067	1,233	1,610
CAMERON RUN					
Upstream of U.S. Route 1 Interchange	44.49	11,203	20,400	25,414	39,189
At Telegraph Road (and Huntington Area)	39.14	10,820	20,400	25,398	39,056
At Confluence with Strawberry Run	36,03	10,814	20,397	25,350	38,372
At Railroad Bridge	33.96	10,434	19,555	24,275	36,650
At USGS Gage	32.62	9,922	18,498	22,944	34,657
FOUR MILE RUN					
At the confluence with Long Branch (upstream of corporate limits)	17.3	*	*	26,000	42,000
HOLMES RUN					
At confluence with Backlick Run	19.04	4,424	8,232	10,195	15,875
Upstream of Duke Street	18.73	4,393	8,166	10,095	15,712
At Henry Shirley Memorial Highway	17.56	4,254	7,887	9,741	15,138
Upstream of Beauregard Street	16.74	4,100	7,560	9,315	14,438
Below Lake Barcroft Dam	14.7	3,770	6,914	8,486	13,088

* Data not available

TABLE 3 – SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) ANNUAL CHANCE 10%	2%	1%	0.2%
HOOFFS RUN					
At U.S. Route 495	2.80	1,901	2,443	2,727	3,006
At Jamieson Avenue	2.37	1,559	2,094	2,338	3,032
Overland Flood Area	1.77	628	1,311	1,627	2,324
Upstream of Linden Street	1.77	1,885	2,574	2,882	3,595
OLD CAMERON RUN CHANNEL					
At Truesdale Drive	0.29	410	570	641	805
STRAWBERRY RUN					
Upstream of Eisenhower Avenue	0.74	509	806	949	1,310
At Early Street	0.37	256	449	535	744
At Duke Street	0.3	196	357	435	610
Upstream of Fort Williams Parkway	0.08	67	123	150	217
TAYLOR RUN					
Upstream of Telegraph Road	1.69	996	1,629	1,932	2,654
At Duke Street	1.2	553	917	1,104	1,594
At Janney's Lane	0.94	343	538	672	817
Near Intersection of Quincy Street and King Street	0.48	252	445	540	781
TIMBER BRANCH					
At Glendale Avenue Culvert	0.56	671	995	1,141	1,480
At Timber Branch Parkway	0.41	581	851	969	1,237
At Braddock Road	0.26	408	591	669	852
TRIBUTARY 1 TO CAMERON RUN					
Confluence with Cameron Run	1.3	946	1,480	1,730	2,347
TRIBUTARY 1 TO TAYLOR RUN					
At confluence with Taylor Run	0.38	391	588	676	889

TABLE 3 – SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) ANNUAL CHANCE 10%	2%	1%	0.2%
TRIBUTARY 2 TO TAYLOR RUN					
At Francis Hammond Parkway	0.26	118	224	277	412
Downstream of Key Drive	0.14	61	119	148	223

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.

Table 4 below summarizes the method of floodplain boundary determination for all detailed flooding sources.

TABLE 4 – SUMMARY OF FLOOD BOUNDARY DETERMINATION

FLOODING SOURCE	CLASSIFICATION
Backlick Run	New study
Cameron Run	New study
Four Mile Run	Redelineated (based on Arlington County BFEs)
Holmes Run	New study
Hooffs Run	New study
South Lucky Run	Redelineated
Old Cameron Run	New study
Potomac River	Revised study
Taylor Run	New study
Timber Branch	New study
Tributary 1 to Cameron Run	New study
Tributary to 1 Taylor Run	New study
Tributary 2 to Taylor Run	New study

The redelineated flooding sources were remapped using the BFEs on the previously effective FIRMs and the 2’ contour interval topographic data provided by the City of Alexandria. For Four Mile Run, BFEs were taken from the Arlington County FIS since this information was more detailed and up-to-date than the plotted BFEs shown on the previous effective Alexandria DFIRM, dated May 15, 1991. Elevations were adjusted according to the vertical datum conversion listed in section 3.3. Flood hazards may be altered significantly from the previous delineation based on major changes in base mapping and/or topography.

USACE ERDC CHL performed a cursory-level frequency-of-occurrence analysis of the storm surge for the tidally influenced reach of the Potomac River. This reach extends from the Potomac’s confluence with the Chesapeake Bay to Washington D.C. The 1-percent annual chance storm surge elevation along the lower Potomac was estimated using the Advanced CIRCulation (ADCIRC) numerical model. In order to estimate the 1-percent annual chance storm surge elevation, an event emulating Hurricane Isabel was dynamically simulated. This model was calibrated to replicate the 1-percent annual chance storm surge elevation at the Washington, DC National Ocean Service gauge no. 8594900 (Haines Point) (Reference 7). The results of this analysis were compiled into a unified storm surge profile and published in a report titled *Unified Storm Surge Profile Methodology – For the Tidal Portions of the Potomac River*, Version 1.1, August 6, 2008. The water-surface elevations provided in this document, prepared by the Baker Regional Management Center 3 (RMC3), were utilized to delineate the revised floodplain boundaries for the Potomac River (Reference 8).

With the exception the Hooff’s Run reach between East Maple Street and Jamieson Avenue, the U.S. Army Corps of Engineers HEC-RAS (River Analysis System), version 3.1.1, was used to calculate flood elevations for the 10-, 2-, 1-, and 0.2-percent annual chance storm events for newly studied reaches. All HEC-RAS hydraulic modeling was performed by the USACE – Baltimore District as part of the Cameron Run Watershed Study (May 2007).

The Hooff’s Run Overland Flow analysis between East Maple Street and Jamieson Avenue was performed by the USACE-Baltimore District utilizing FLO-2D two dimensional flood routing software (June 2009). This level of analysis was performed due to the complex nature of the sheet flow occurring as a result of the lack of stormwater infrastructure capacity in this area. The FLO-2D model for Hooff’s Run was developed based on a 1 meter digital elevation model (DEM) developed by the U.S. Army Geospatial Center (AGC) developed from flights performed in October 2003. Floodplain delineations for the overland flow area between East Maple Street and Jamieson Avenue were also based on the AGC 1 meter DEM. Flooding depths of less than 1-foot in this overland flow area are depicted as 0.2-percent annual chance (Shaded Zone X) floodplain.

Cross section geometries were obtained from a variety of sources and methodologies, as specified in the previously referenced USACE reports.

Roughness factors (Manning's "n") used in the hydraulic computations for all flooding sources were chosen based upon engineering judgment, land use, aerial photography, and field observations. Several flooding sources in the watershed contain concrete lined channels. A summary of the roughness values used in this investigation is shown in Table 5.

TABLE 5 – MANNING'S "N" VALUES

Flooding Source	Channel "n"	Overbank "n"
Backlick Run	.015 (concrete-lined) .035-050 (natural)	.015-.120
Cameron Run	.030-.040	.015-.120
Four Mile Run	.030-.050	.040-.080
Holmes Run	.045-.070	.015-.120
Hooffs Run FLO-2D values (Overland Flooding Area)	.015 (concrete-lined) .035 (natural) .020 (concrete) 0.20 (average grass cover)	.015-.100
Old Cameron Run Channel	.035	.015-.100
Strawberry Run	.020 (concrete-lined) .035-.045(natural)	
Taylor Run	.035-.050	.015-.100
Timber Branch	.015 (concrete-lined) .030-.045 (natural)	.015-.100
Tributary 1 to Cameron Run	.045	.015-.120
Tributary 1 to Taylor Run	.035	.015-.070
Tributary 2 to Taylor Run	.035-.040	.015-.100

FEMA guidelines and specifications (Reference 21) state that the starting water-surface elevations chosen for profile computations are to be based upon normal depth (slope-area) unless known water surface elevations are available from other sources. For tributaries, normal depth is also to be used unless a coincident peak situation is assumed. The assumption of coincident peak may be appropriate if the following are true:

- The ratio of drainage areas lies between 0.6 and 1.4;
- The times of peak flow are similar for the two combining watersheds; and
- The likelihood of both watersheds being covered by the same storm being modeled is high.

The third criterion is met as the total area of the entire Cameron Run watershed is less than 50 square miles. However, other than the Backlick

Run-Holmes Run confluence, none of the other flooding sources meet the drainage area ratio criteria. However, the results of the HEC-HMS model can be used to determine if the times of peak are similar for the combining watersheds. The results of the HEC-HMS model were used as a guideline for whether to model a flooding source with a downstream boundary condition of normal depth, or backwater (coincident peaks). If the peak for the tributary was more than 30 minutes before or after the peak of the main flooding source, the tributary was modeled as a backwater (coincident peak) condition. If the peak for the tributary was 30 minutes before or after the peak of the main flooding source, normal depth was used as the downstream boundary condition.

Normal depth was used as the downstream boundary condition for the following flooding sources: Cameron Run; Tributary 1 to Cameron Run; Hooffs Run; Strawberry Run; Taylor Run; and Timber Branch. Cameron Run empties into the Potomac River and the probability that the Potomac River will be at flood stage (riverine or tidal) at the same moment as the Cameron Run peak is extremely low. For Timber Branch, the downstream boundary condition is controlled by a culvert, and the slope of the pipe was used as the normal depth slope.

Backwater (coincident peaks) was used as the downstream boundary condition for the following flooding sources: Backlick Run; Holmes Run; and Old Cameron Run Channel. The downstream end or these flooding sources were modeled as junctions in HEC-RAS.

The hydraulic analysis for this study was based on unobstructed flow. The flood elevations computed thus are considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Flooding for Timber Branch in the City of Alexandria continues beyond the downstream limit of the study area. Floodwaters overtop the culvert headwall and enter a drainage swale in a residential area. During the June 2006 flood event city staff observed that the floodwaters continue in this swale and eventually enter the sub-surface stormwater infrastructure at the next downstream stormwater inlet. This dynamic was not modeled in the original USACE study (2007); however, it is clear that the homes near this swale are affected by floodwaters.

For the Timber Branch culvert, it was determined using HEC-RAS that the culvert capacity is 450 cfs. This culvert was identified as a reach, using lag routing, in the original HEC-HMS model. For the revised model, this reach was converted to a diversion that can convey 450 cfs. All flow entering the culvert above 450 cfs was placed into a new reach where the overland flow occurs. A FLO-2D model was developed for the Timber Branch area using the same process, methods, and assumptions used for the Hooffs Run overland flood model (Reference 9). Because average flood depths for the overland flow portion of Timber Branch were less than 1 ft, this area was designated as 0.2-percent annual chance floodplain.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals. Locations of the selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1).

All qualifying benchmarks within a given jurisdiction that are catalogued by the National Geodetic Survey (NGS) and entered into the National Spatial Reference System (NSRS) as First or Second Order Vertical and have a vertical stability classification of A, B or C are shown and labeled on the FIRM with their 6-character NSRS Permanent Identifier.

Benchmarks catalogued by the NGS and entered into the NSRS vary widely in vertical stability classification. NSRS vertical stability classifications are as follows:

- Stability A: Monuments of the most reliable nature, expected to hold position/elevation (e.g., mounted in bedrock)
- Stability B: Monuments which generally hold their position/elevation (e.g., concrete bridge abutment)
- Stability C: Monuments which may be affected by surface ground movements (e.g., concrete monument below frost line)
- Stability D: Mark of questionable or unknown vertical stability (e.g., concrete monument above frost line, or steel witness post)

In addition to NSRS benchmarks, the FIRM may also show vertical control monuments established by a local jurisdiction; these monuments will be shown on the FIRM with the appropriate designations. Local monuments will only be placed on the FIRM if the community has requested that they be included, and if the monuments meet the aforementioned NSRS inclusion criteria.

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

It is important to note that 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.

3.3 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the completion of the North American Vertical Datum of 1988 (NAVD 88), many FIS reports and FIRMs are now prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are now referenced to NAVD 88. In order to perform this conversion, effective NGVD 29 elevation values were adjusted downward by 0.8 foot. Structure and ground elevations in the community must, therefore, be referenced to NAVD 88. It is important to note that adjacent communities may be referenced to NGVD 29. This may result in differences in base flood elevations across the corporate limits between the communities.

For more information on NAVD 88, see Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, FEMA Publication FIA-20/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
http://www.ngs.noaa.gov/

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report provides 1-percent annual chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent annual chance flood elevations; delineations of the 1-percent 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 county. For the streams studied in detail, the 1-percent and 0.2-percent annual chance floodplain boundaries have been determined at each cross section. The delineations are based on the best available topographic information.

Topographic data was provided by the City of Alexandria to support floodplain mapping efforts. The city provided 2-foot contour data developed from aerial topographic information in 2004. For Hooff's Run between East Maple Street and Jamieson Avenue, the AGC 1 meter DEM was used to delineate the overland flow floodplain boundary. This information was developed from flights performed in October 2003.

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

New floodplains were delineated based upon the USACE study (May 2007) for all streams in the Cameron Run watershed with the exception of Hooff's Run between East Maple Street and Jamieson Avenue. New floodplains in this area were delineated based on the USACE Hooff's Run Overland Flood Analysis (June 2009). The Potomac River floodplains were based on the Potomac Unified Storm Surge Profiles prepared by Baker RMC 3 (FEMA, 2008). Floodplain boundaries were redelineated for South Lucky Run and Four Mile Run in the City of Alexandria.

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

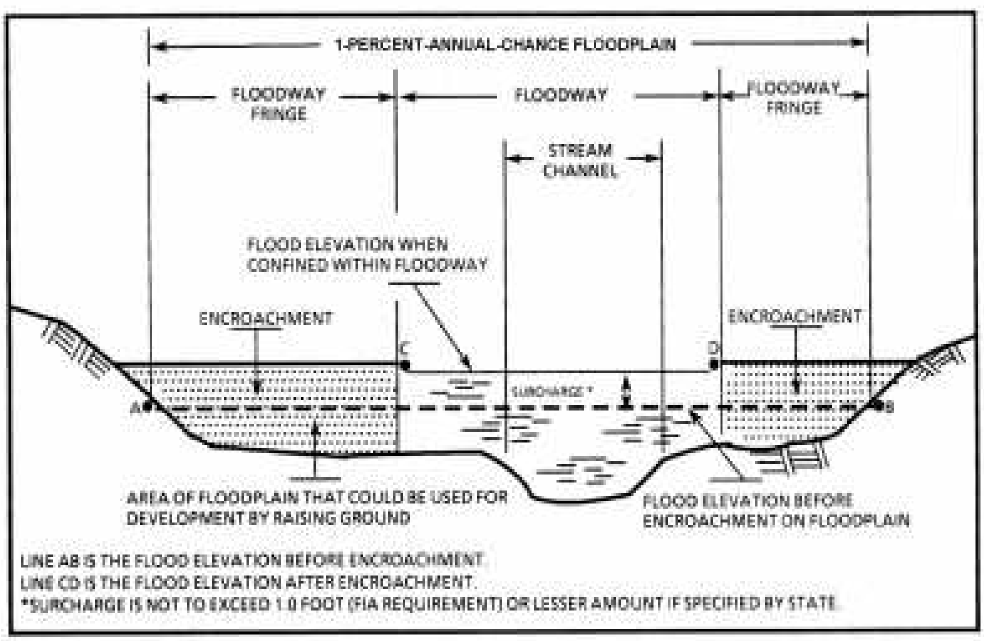
4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent annual chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent annual chance flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in an FIS are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

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

No floodways were shown on the previous FIRMs for the City of Alexandria, and no new floodways have been computed as part of this revision.

FIGURE 1: FLOODWAY SCHEMATIC



5.0 INSURANCE APPLICATIONS

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

Zone A

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

Zone AE

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

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent annual chance floodplain, areas within the 0.2-percent annual chance floodplain, and to 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 base flood elevations or 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 rate zones as described in Section 5.0. In the 1-percent annual chance floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

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

7.0 OTHER STUDIES

FISs have been prepared for jurisdictions neighboring the City of Alexandria. The Flood Insurance Study for Arlington County was prepared on November 3, 1981 and is currently being revised (References 28 and 32). The Flood Insurance Study for the Unincorporated Areas of Fairfax County, Virginia was prepared on September 17, 2010. The Flood Insurance Study for the City of Falls Church, Virginia (Independent City) was prepared on July 16, 2004 (reference 30).

Information pertaining to revised and unrevised flood hazards for the City of Alexandria has been compiled into this FIS. Therefore, this FIS supersedes all previously printed FIS Reports, FIRMs, FBFMs, and FHBMs for the City of Alexandria.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting Federal Insurance and Mitigation Division, Federal Emergency Management Agency, One Independence Mall, Sixth Floor, 615 Chestnut Street, Philadelphia, Pennsylvania 19106-4404.

9.0 BIBLIOGRAPHY AND REFERENCES

1. U.S. Department of Commerce, Census Bureau, State & County QuickFacts, 2006. http://quickfacts.census.gov/

2. Virginia Economic Development Partnership, Community Profiles, 2006. http://virginiascan.yesvirginia.org/Data_Center/Community_Profiles/Default.aspx

3. City of Alexandria, About Alexandria, 2006. http://alexandriava.gov

4. U.S. Army Corps of Engineers, Baltimore District, Hydrologic and Hydraulic Analysis for the Cameron Run Watershed in Northern Virginia, Final Report, Baltimore, Maryland, May 2007.

5. U. S. Geological Survey, Department of the Interior, Peak Streamflow, http://nwis.waterdata.usgs.gov/nwis/

6. National Climatic Data Center, National Environmental Satellite, Data, and Information Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Asheville, NC. http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

7. U.S. Army Corps of Engineers, Cursory-Level Analysis of the 100-Year Storm Surge Elevation for the Lower Potomac River, April 3, 2008.

8. Federal Emergency Management Agency, Baker Regional Management Center 3 (RMC3), Unified Storm Surge Profile Methodology for the Tidal Portions of the Potomac River, Version 1.1, August 6, 2008.

9. U.S. Army Corps of Engineers, Planning Division, Baltimore District, Overland Flood Analysis for Hooffs Run, City of Alexandria, Virginia, June 2009.

10. U.S. Army Corps of Engineers, Baltimore District, June 2006 Flood Investigation for Cameron Run, Fairfax County, Virginia, Final Report January 2007.

11. Fairfax County Stormwater Planning Division, Cameron Run Watershed Management Plan, prepared by Versar, Inc., Draft Final December 2006.

12. Federal Emergency Management Agency, Flood Insurance Study, Unincorporated Areas of Fairfax County, Virginia, March 5, 1990; revised in Countywide format (in press).

13. Lake Barcroft Watershed Improvement District, Report on the Response of Lake Barcroft Dam to Heavy Rains During the Period of June 23 through June 29, 2006, July 2006.

14. U.S. Army Corps of Engineers, Baltimore District, Alexandria, Virginia, Flood Insurance Study, December 1970.

15. U.S. Department of Interior, Geological Survey, Water Supply Paper 2001-C, Effects of Urban Development on Floods in Northern Virginia, by D.G. Anderson, Washington, D.C., 1970.

16. U.S. Department of Interior, Geological Survey, Open File Report 76-443, Flood-plain Delineation for Cameron Run Basin, Fairfax County-Alexandria City, Virginia, 1976.

17. Northern Virginia Regional Commission, Flood Frequency Analysis for Cameron Run at USGS Gaging Station 01653000 at Alexandria, Virginia, December 6, 2006.

18. Virginia Department of Transportation, Woodrow Wilson Bridge Project, Cameron Run Hydrologic and Hydraulic Study, Virginia, February 2002.

19. U.S. Army Corps of Engineers, Hydrologic Engineering Center, Hydrologic Modeling System HEC-HMS, User's Manual, Version 3.1, November 2006.

20. U.S. Army Corps of Engineers, Engineering Regulation 1110-2-1464, Hydrologic Analysis of Watershed Runoff, June 30, 1994.

21. Federal Emergency Management Agency, Guidelines and Specifications for Flood Hazard Mapping Partners, April 2003.

22. U.S. Army Corps of Engineers, Hydrologic Engineering Center, River Analysis System HEC-RAS, User's Manual, November 2006.

23. Federal Emergency Management Agency, Best Available Data Letter for Fairfax County, Virginia (Unincorporated Areas), September 23, 1991.

24. U.S. Army Corps of Engineers, Baltimore District, Floodplain Mapping for the Belle Haven Watershed, Fairfax County, Virginia, February 2006.

25. URS Group, Inc., City of Alexandria Holmes Run Maintenance Alternatives, June 2001.

26. Water Resources Council, "Guidelines for Determining Flood Flow Frequency," Bulletin 17, Washington, D. C., March 1976.

27. U. S. Army Corps of Engineers, Hydrologic Engineering Center, Computer Program 704-G1-12020, Multiple Linear Regression, Davis, California, 1968 with updates.

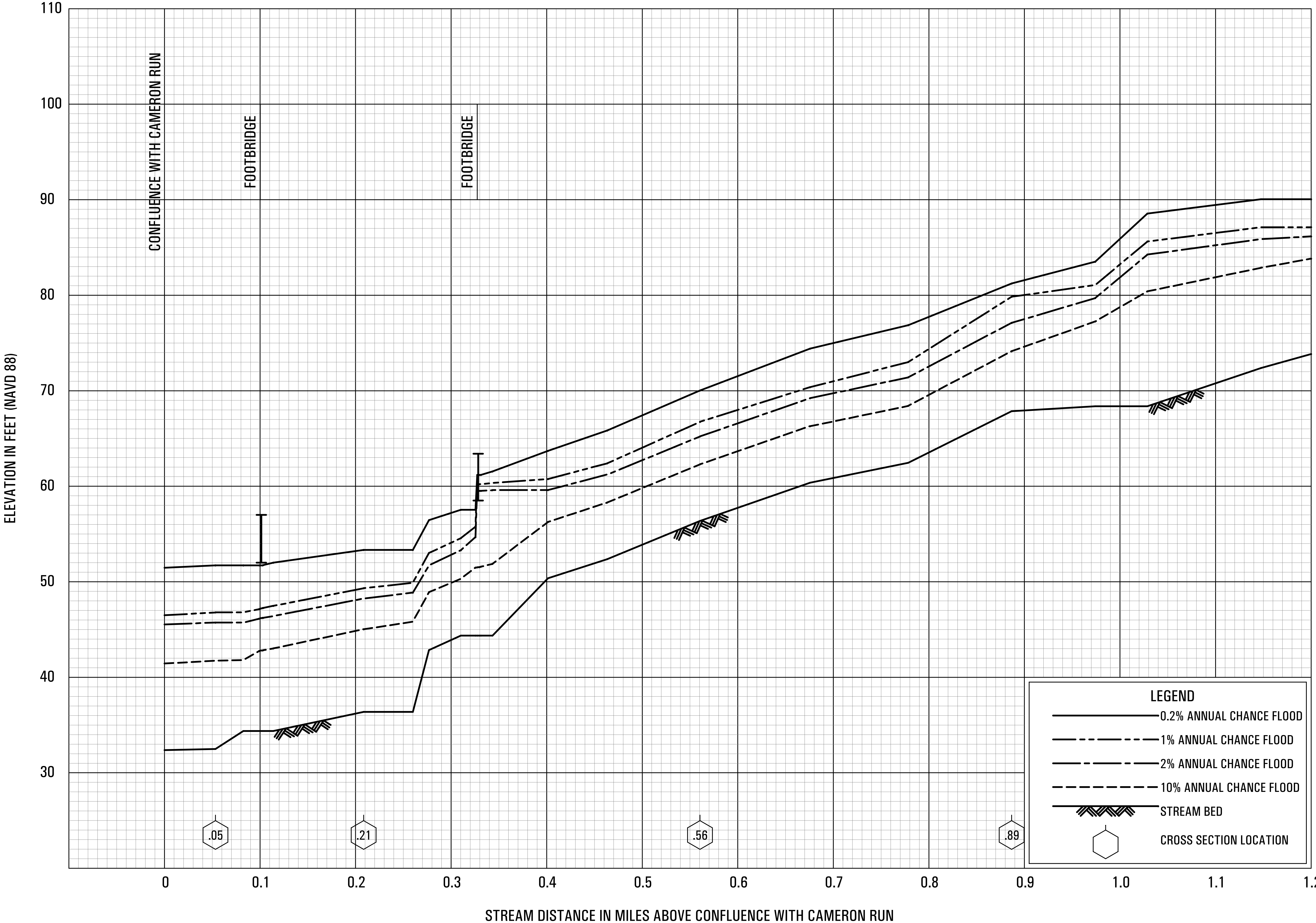
28. Federal Emergency Management Agency, Department of Homeland Security, Flood Insurance Study, Arlington County, Virginia, and Incorporated Areas, in press.

29. White, Kathleen D, Flick, Mark S. and Mark, David J. 2008. “Re-evaluation Study of Washington, D.C. Flood Insurance Study,” US Army Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, N.H. in press.

30. Federal Emergency Management Agency, Flood Insurance Study, City of Falls Church, Virginia (Independent City), July 16, 2004.

31. U.S. Department of Interior, Geological Survey, Open File Report 76-443, Floodplain Delineation for Cameron Run Basin, Fairfax County-Alexandria City, Virginia, 1976.

32. Federal Emergency Management Agency, Flood Insurance Study, Arlington County, Virginia, and Incorporated Areas, November 3, 1981.



FLOOD PROFILES

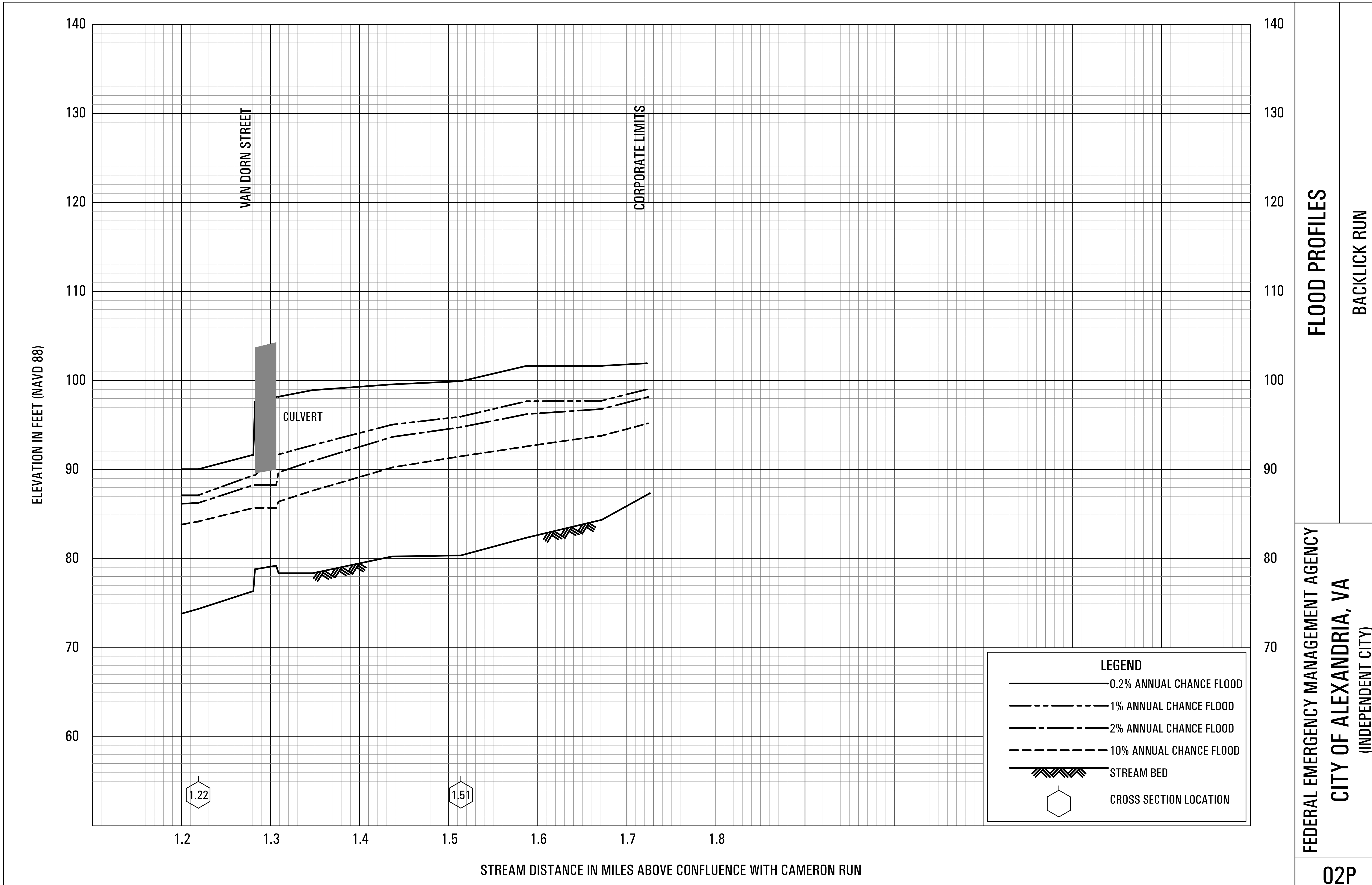
BACKLICK RUN

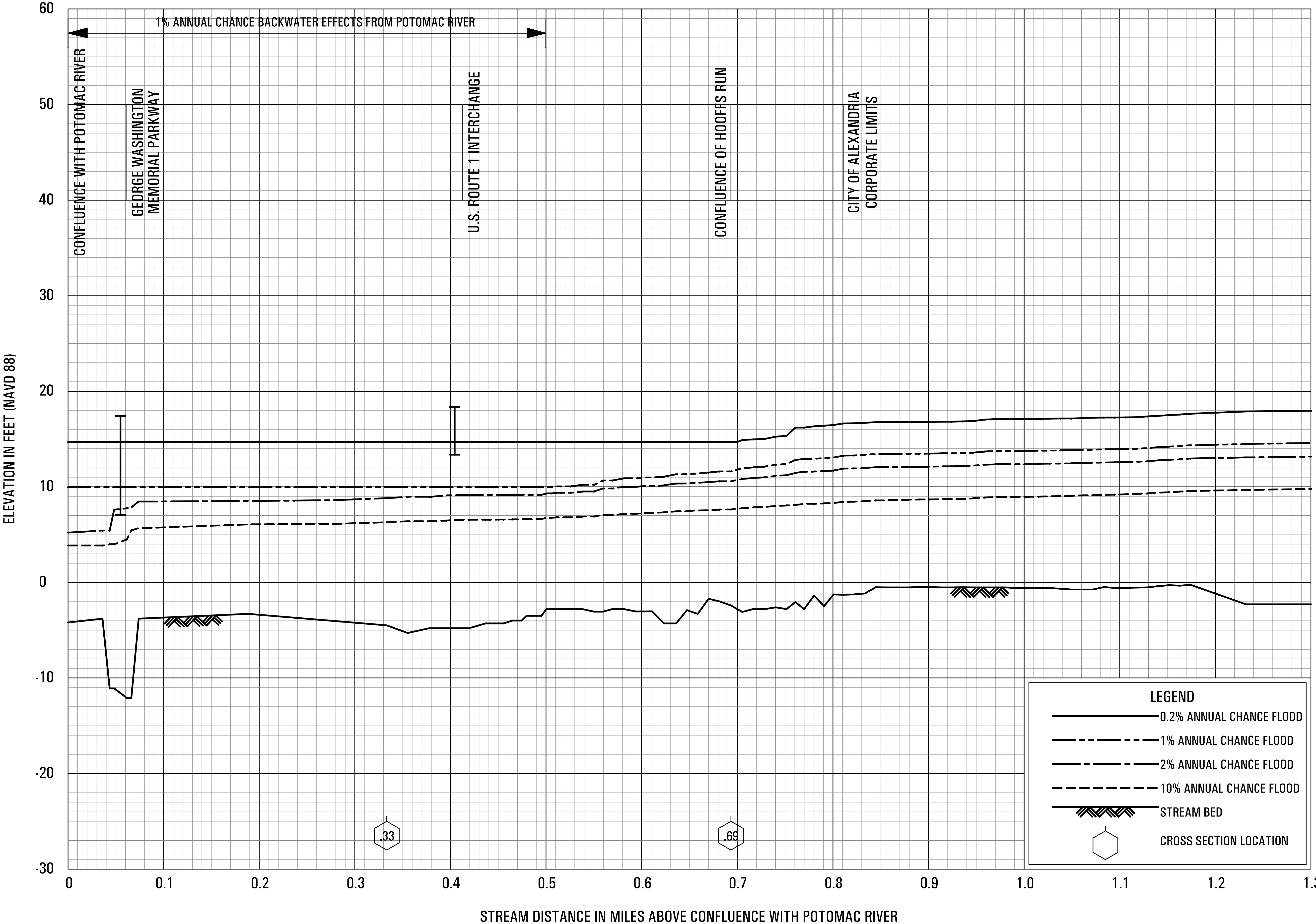
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA

(INDEPENDENT CITY)

01P


140
130
120
110
100
90
80
70
60
ELEVATION IN FEET (NAVD 88)
VAN DORN STREET
CORPORATE LIMITS
CULVERT
1.22
1.51
1.2
1.3
1.4
1.5
1.6
1.7
1.8
STREAM DISTANCE IN MILES ABOVE CONFLUENCE WITH CAMERON RUN
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
BACKLICK RUN
FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF ALEXANDRIA, VA
(INDEPENDENT CITY)



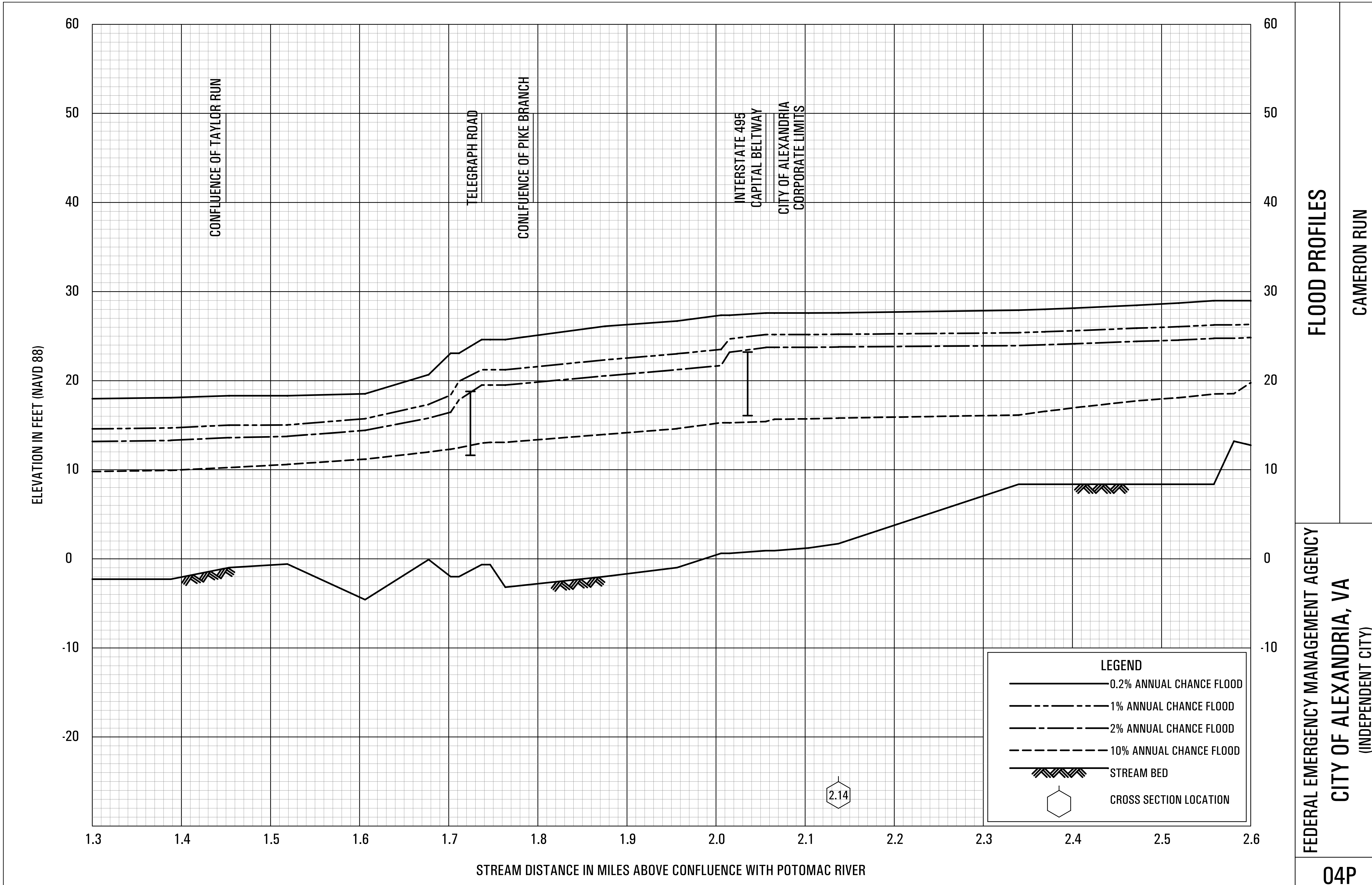
FLOOD PROFILES

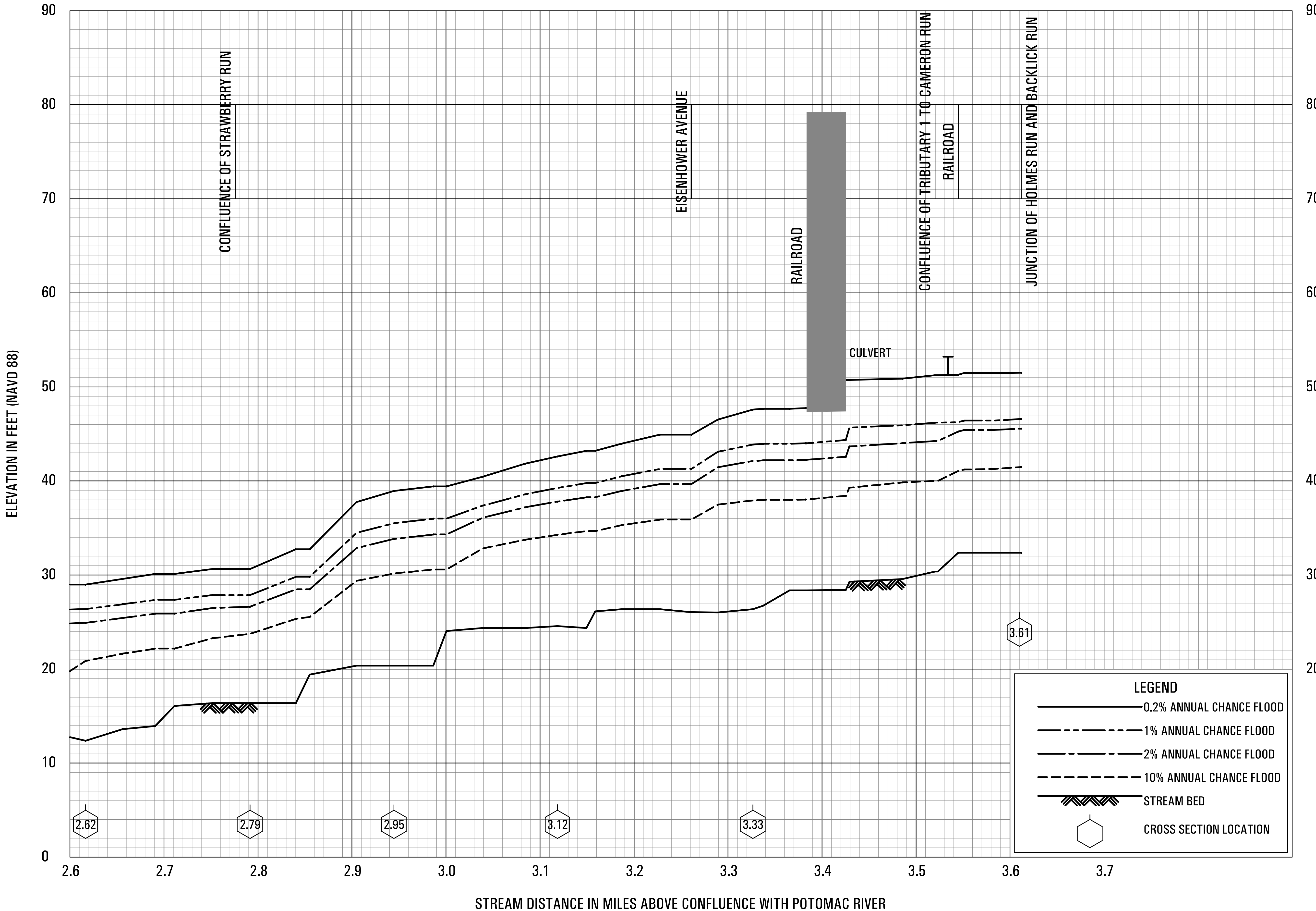
CAMERON RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA
(INDEPENDENT CITY)

03P


60
50
40
30
20
10
0
-10
-20
CONFLUENCE OF TAYLOR RUN
TELEGRAPH ROAD
CONFLUENCE OF PIKE BRANCH
INTERSTATE 495
CAPITAL BELTWAY
CITY OF ALEXANDRIA
CORPORATE LIMITS
ELEVATION IN FEET (NAVD 88)
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
2.6
STREAM DISTANCE IN MILES ABOVE CONFLUENCE WITH POTOMAC RIVER
2.14
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
CAMERON RUN
FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF ALEXANDRIA, VA
(INDEPENDENT CITY)
04P



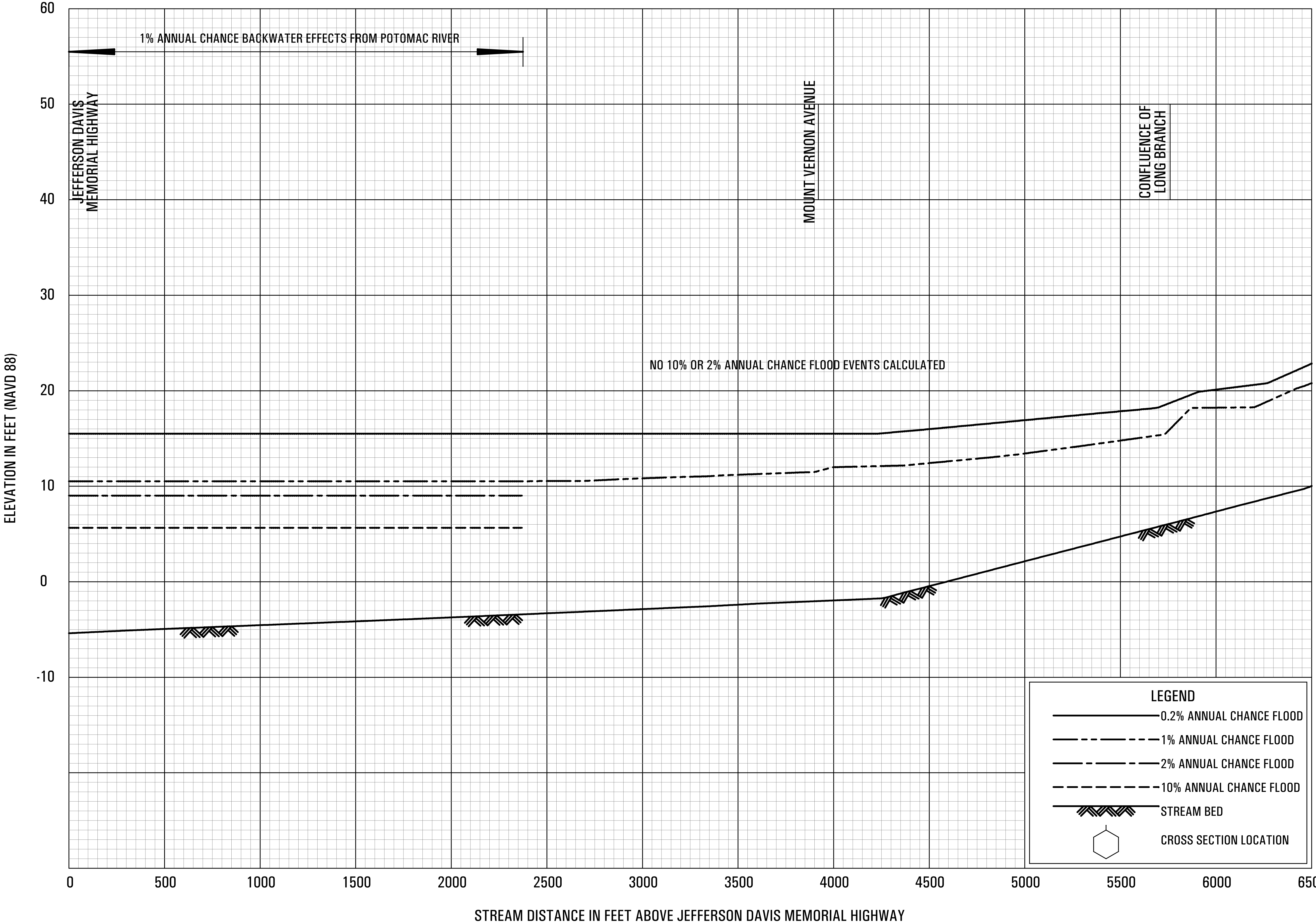
FLOOD PROFILES

CAMERON RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA
(INDEPENDENT CITY)

05P



FLOOD PROFILES

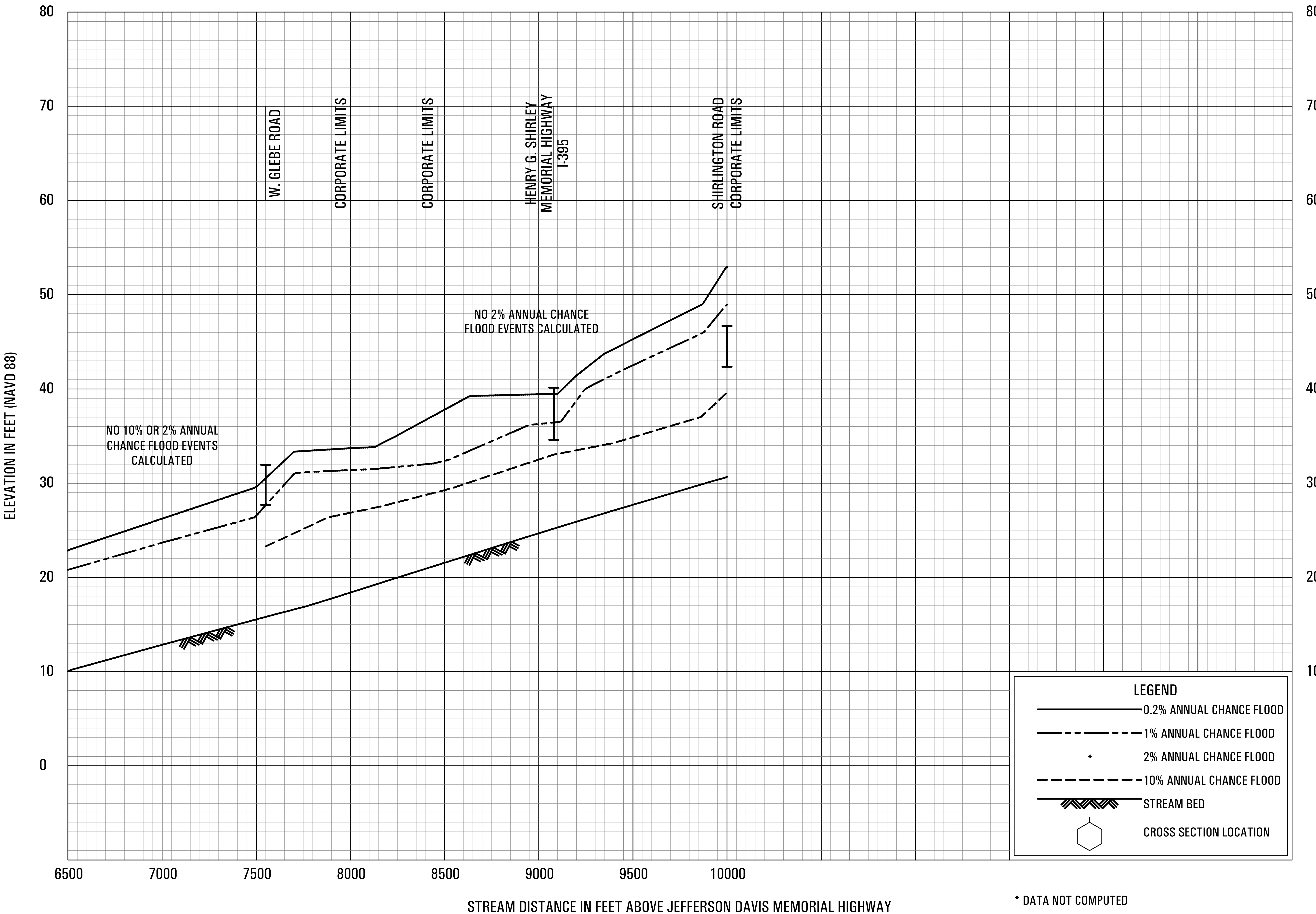
FOUR MILE RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA

(INDEPENDENT CITY)

06P



FLOOD PROFILES

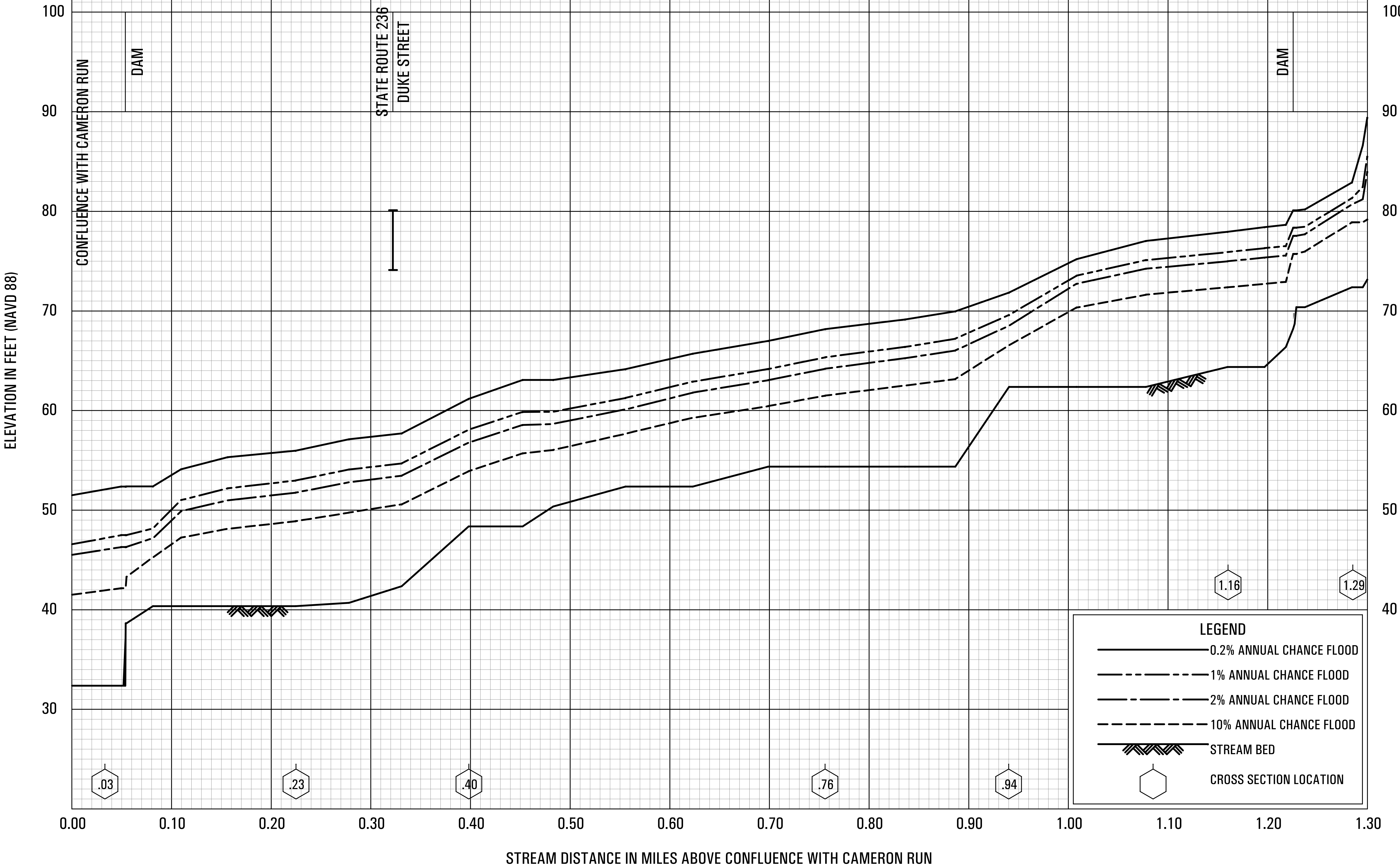
FOUR MILE RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA

(INDEPENDENT CITY)

07P



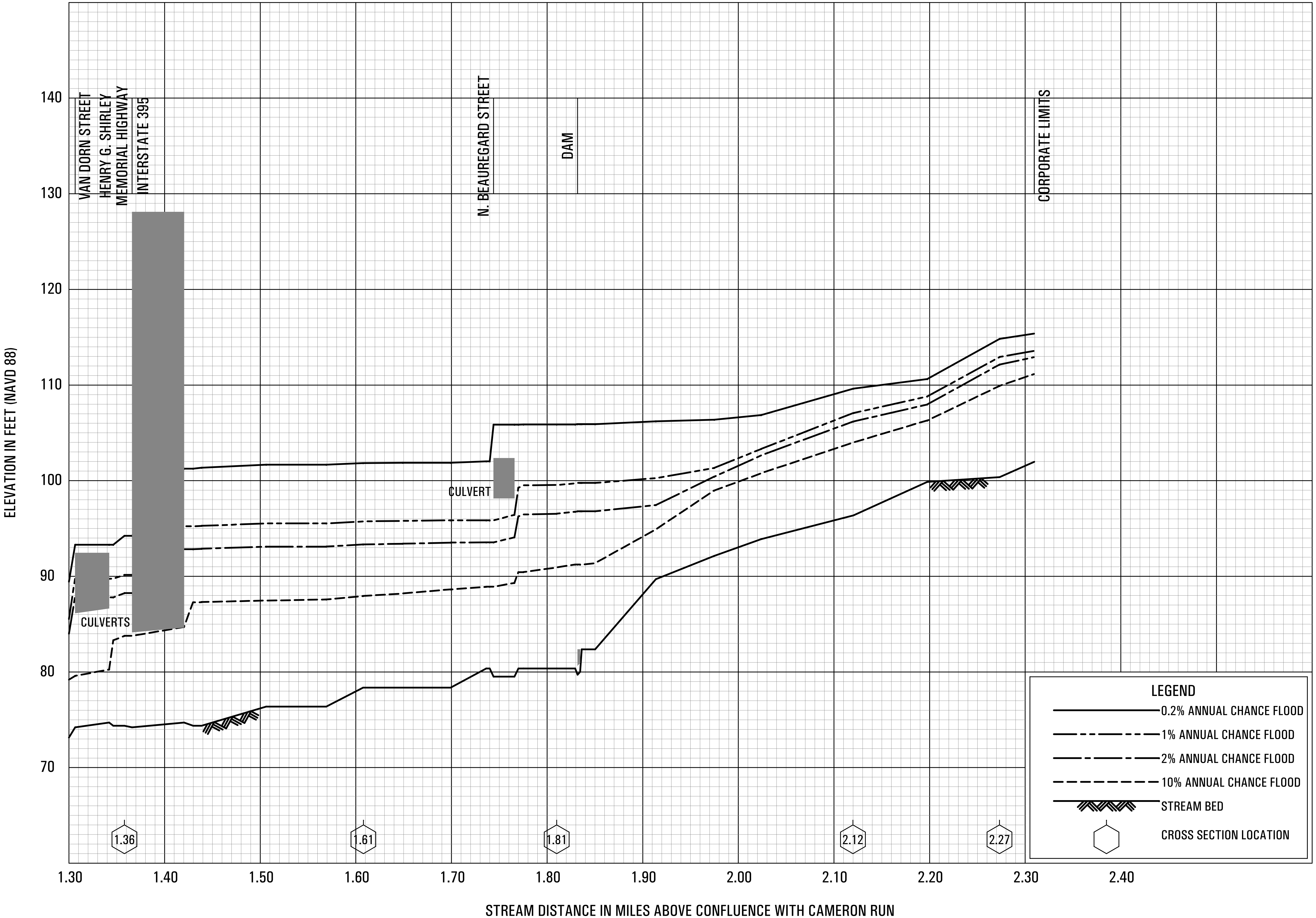
FLOOD PROFILES

HOLMES RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA

(INDEPENDENT CITY)

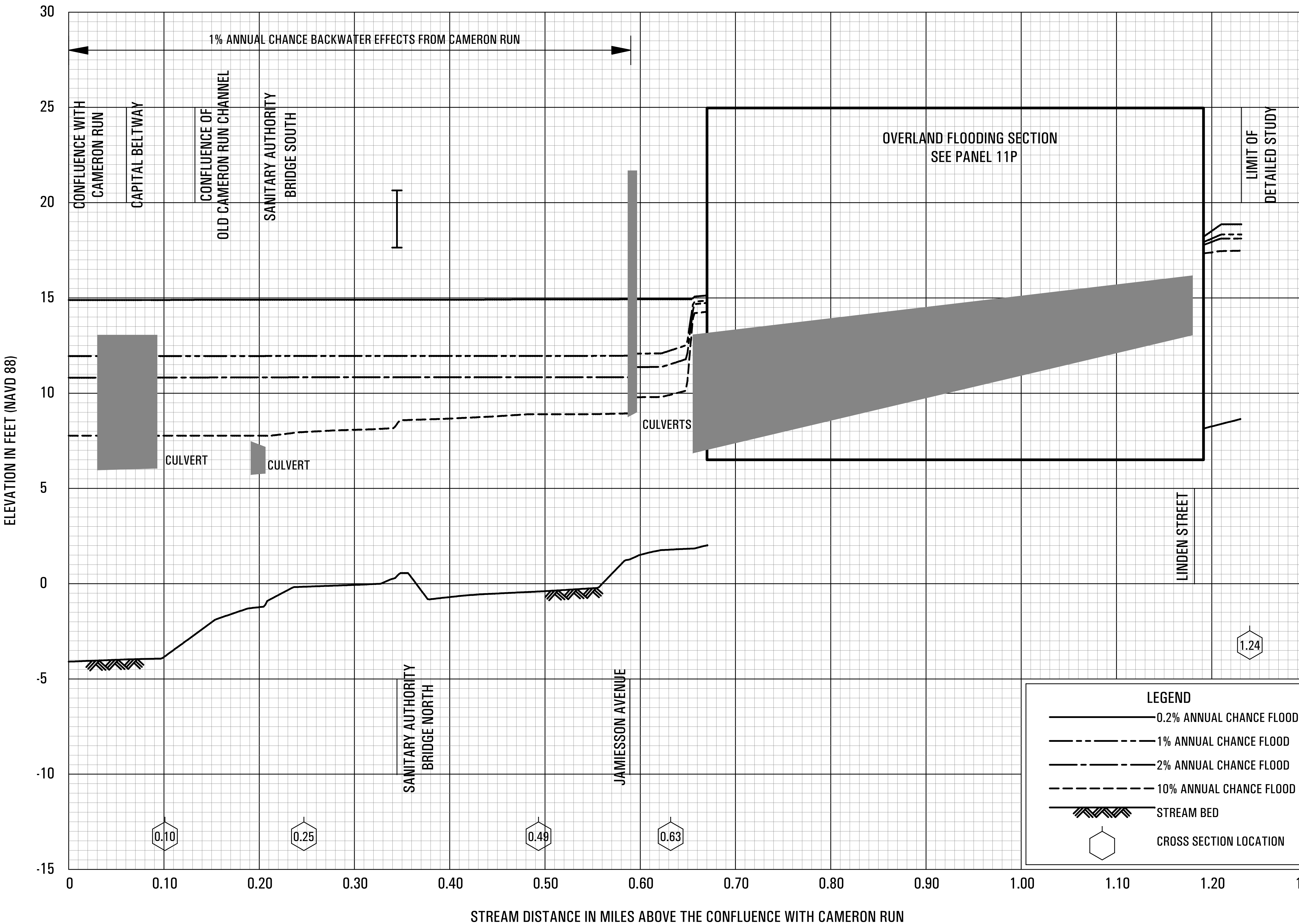


FLOOD PROFILES

HOLMES RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA
(INDEPENDENT CITY)



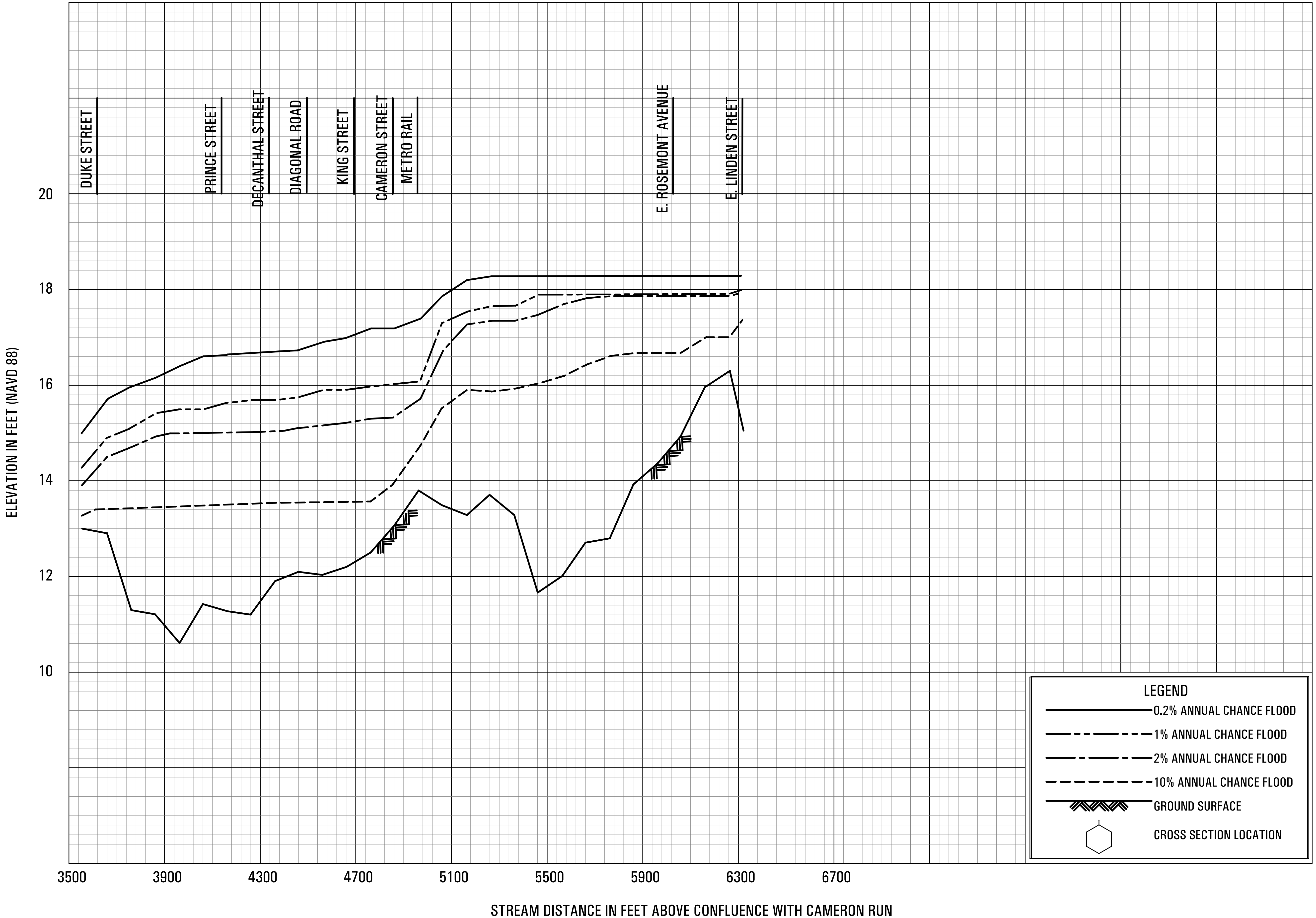
FLOOD PROFILES

HOOFFS RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA
(INDEPENDENT CITY)

10P

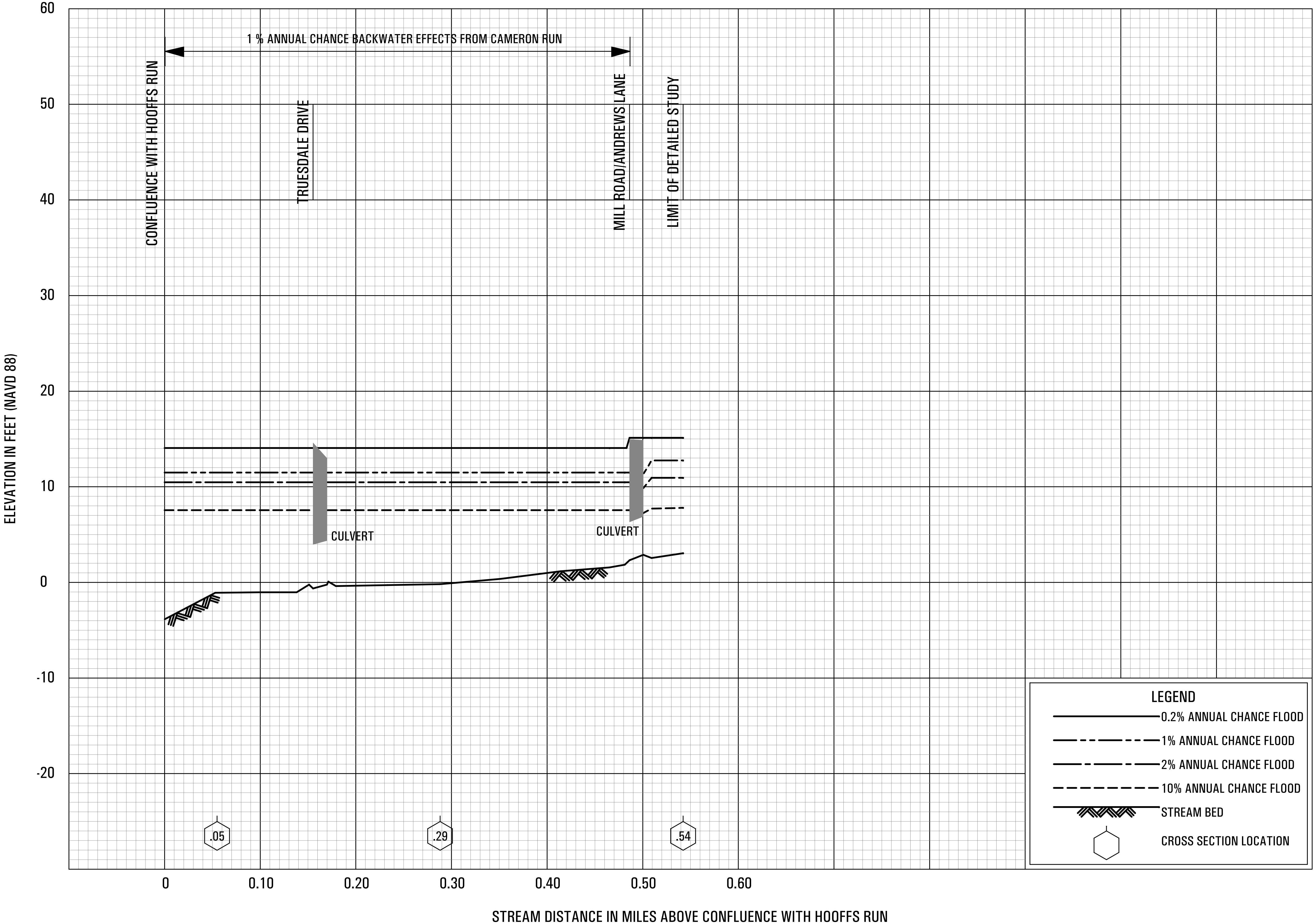


FLOOD PROFILES

HOOFFS RUN (OVERLAND FLOODING)

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA
(INDEPENDENT CITY)



FLOOD PROFILES

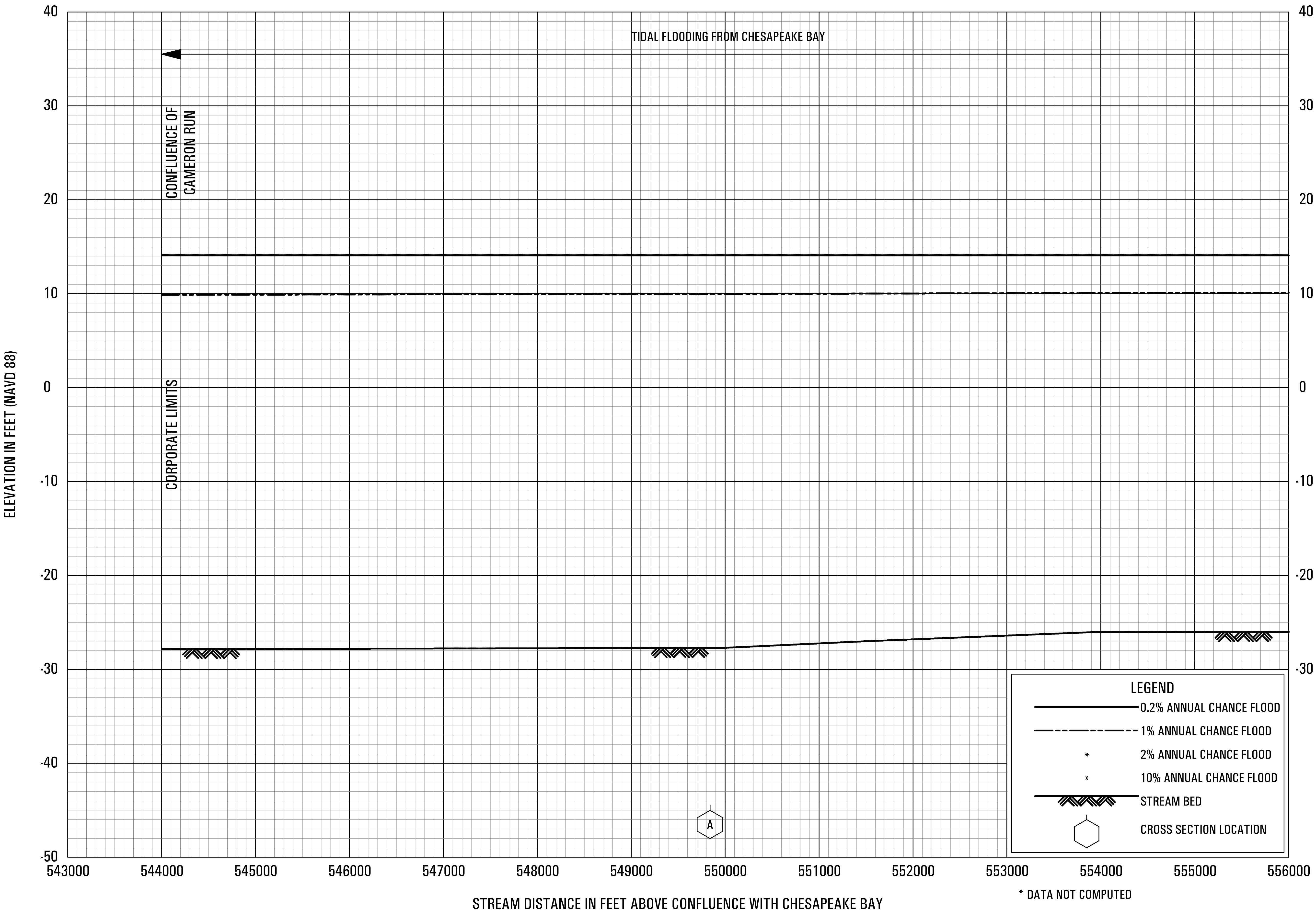
OLD CAMERON RUN CHANNEL

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA

(INDEPENDENT CITY)

12P

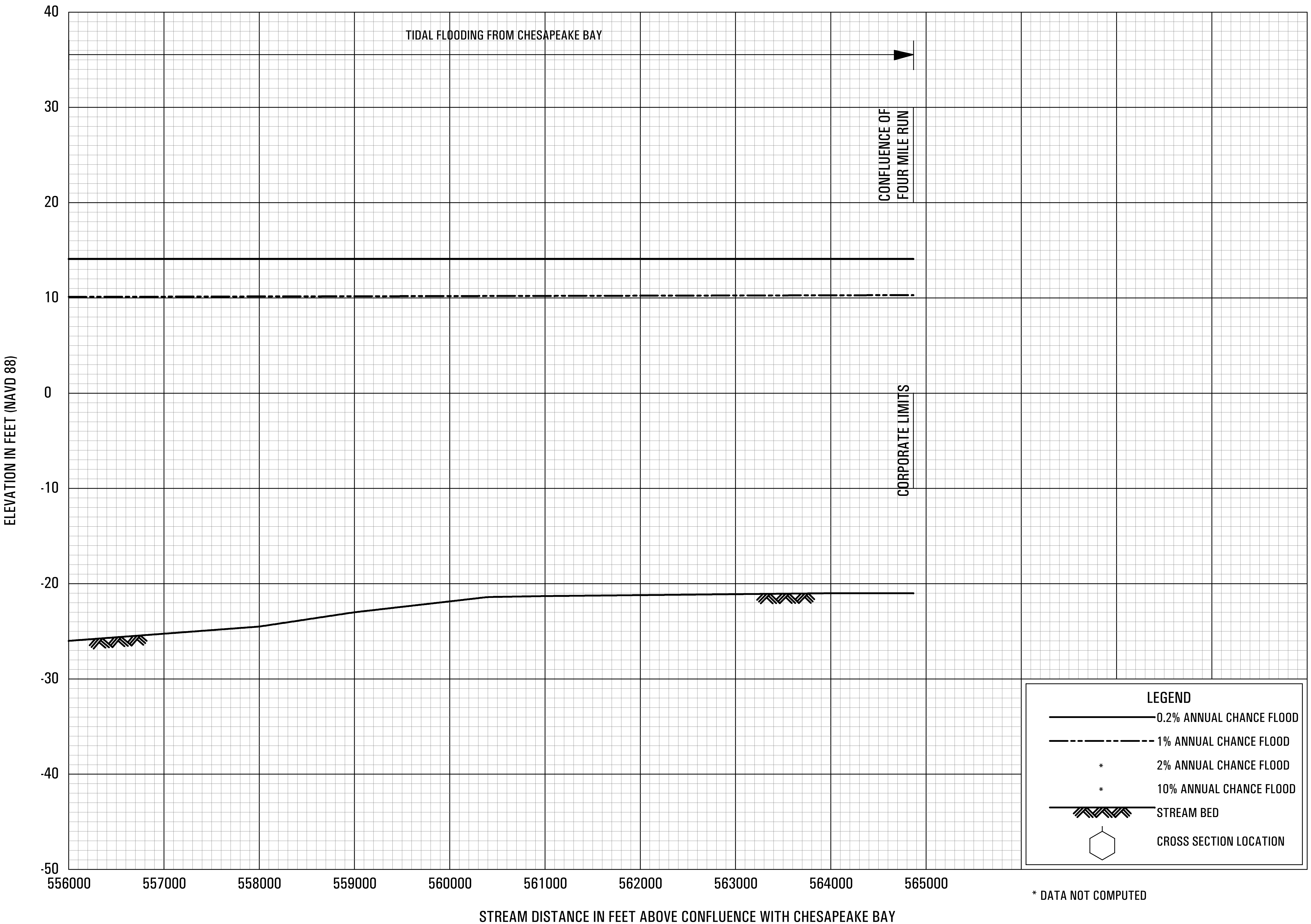


FLOOD PROFILES

POTOMAC RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA
(INDEPENDENT CITY)



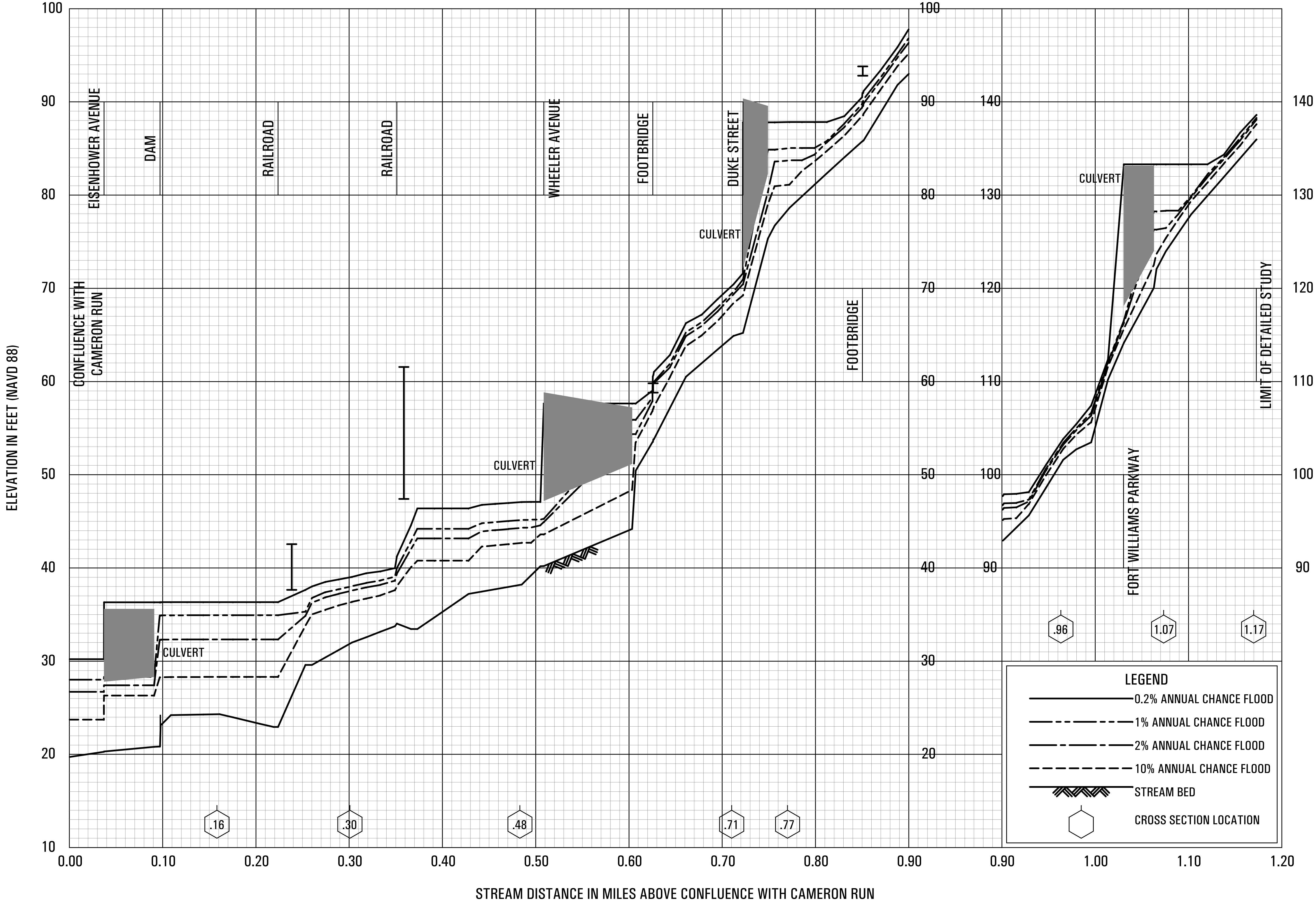
FLOOD PROFILES

POTOMAC RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA

(INDEPENDENT CITY)



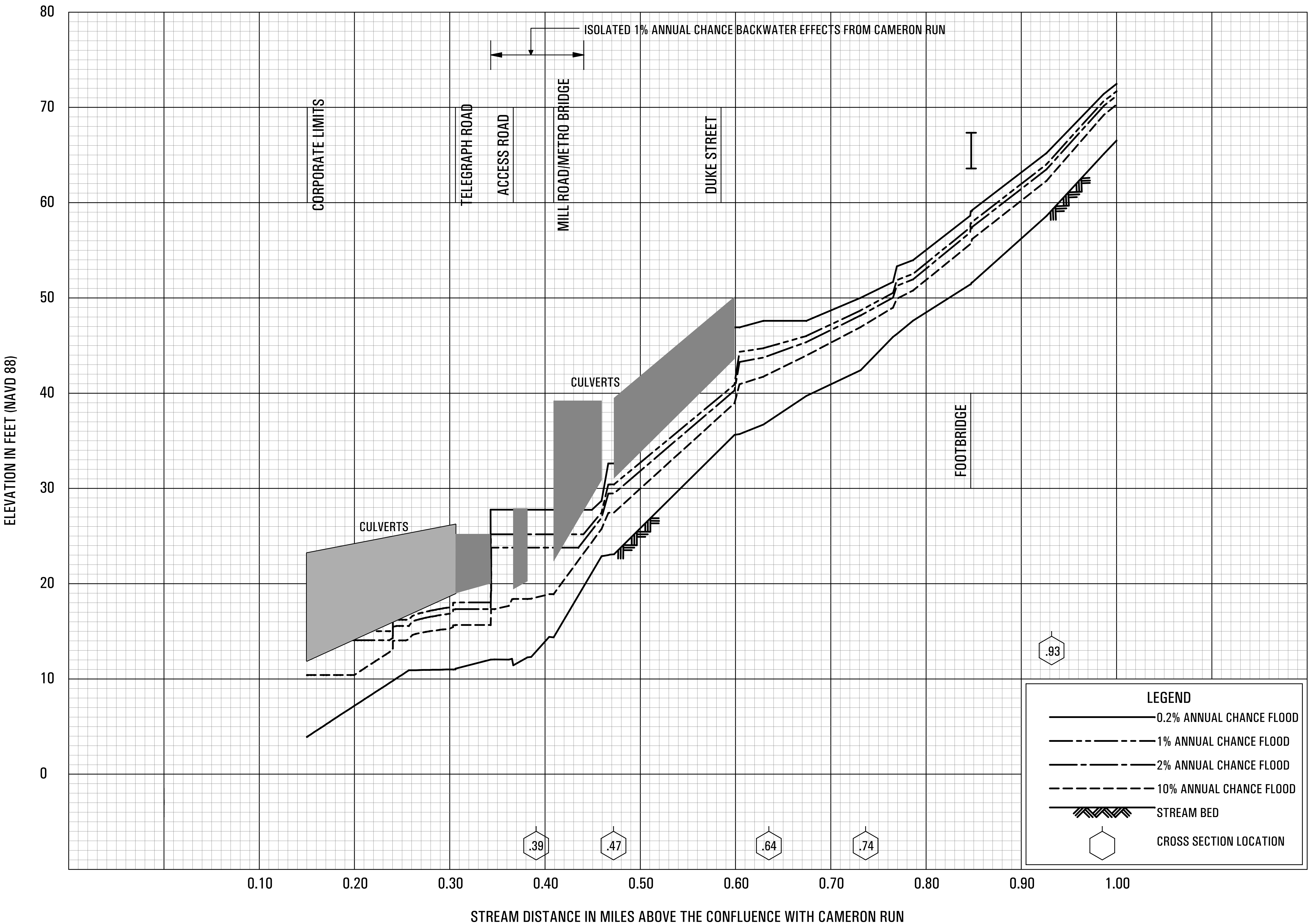
FLOOD PROFILES

STRAWBERRY RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA

(INDEPENDENT CITY)



FLOOD PROFILES

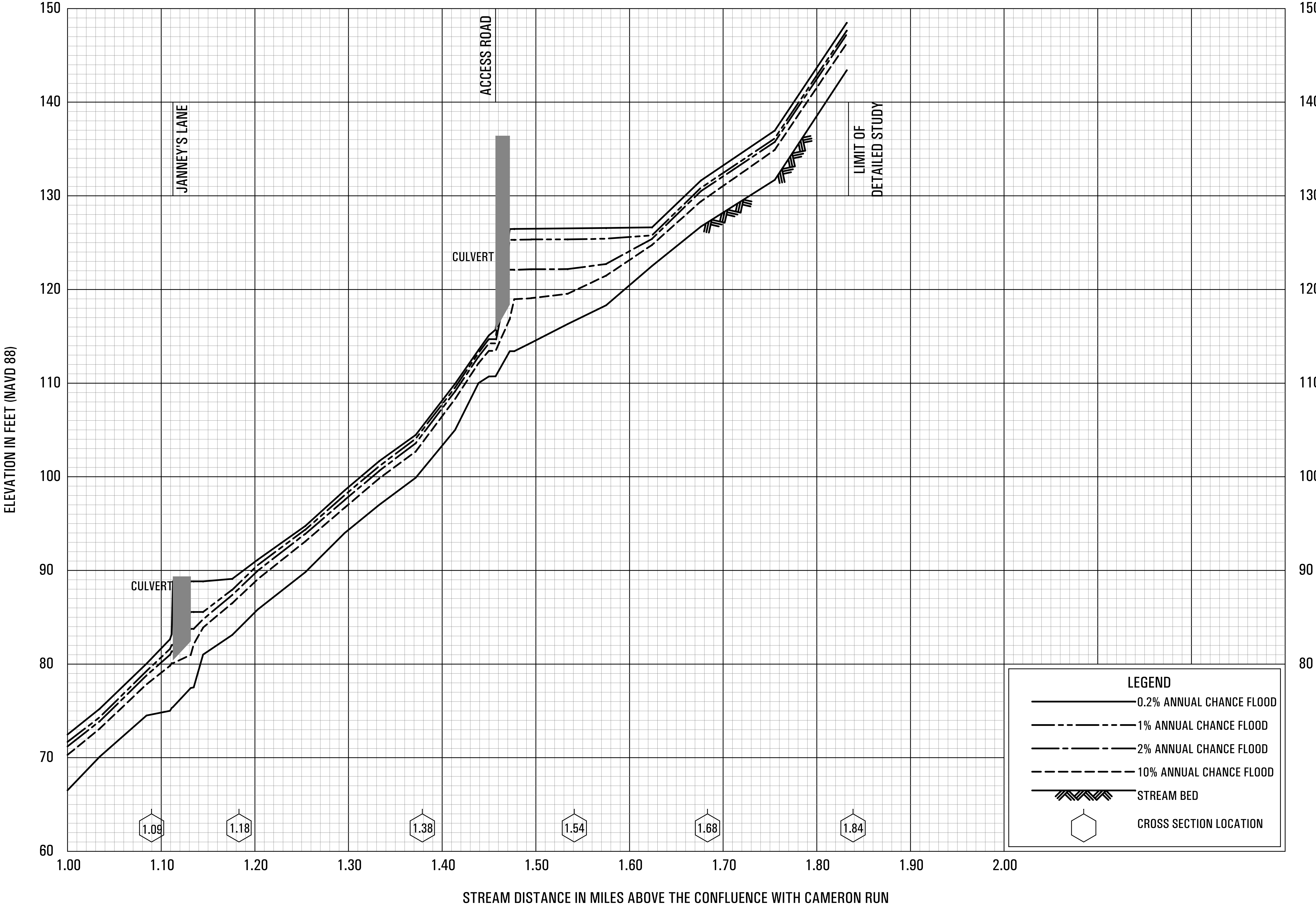
TAYLOR RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA

(INDEPENDENT CITY)

16P



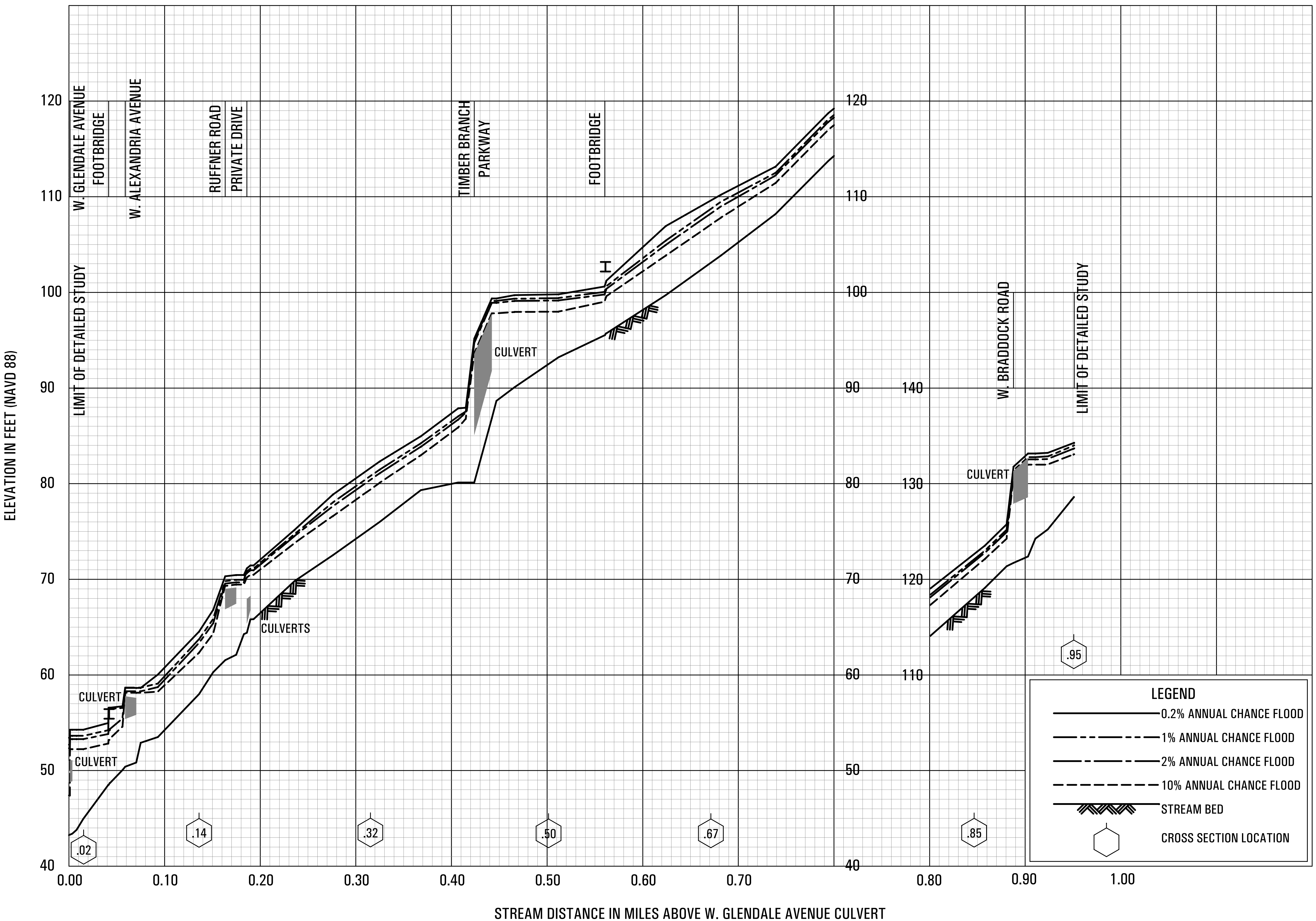
FLOOD PROFILES

TAYLOR RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA
(INDEPENDENT CITY)

17P

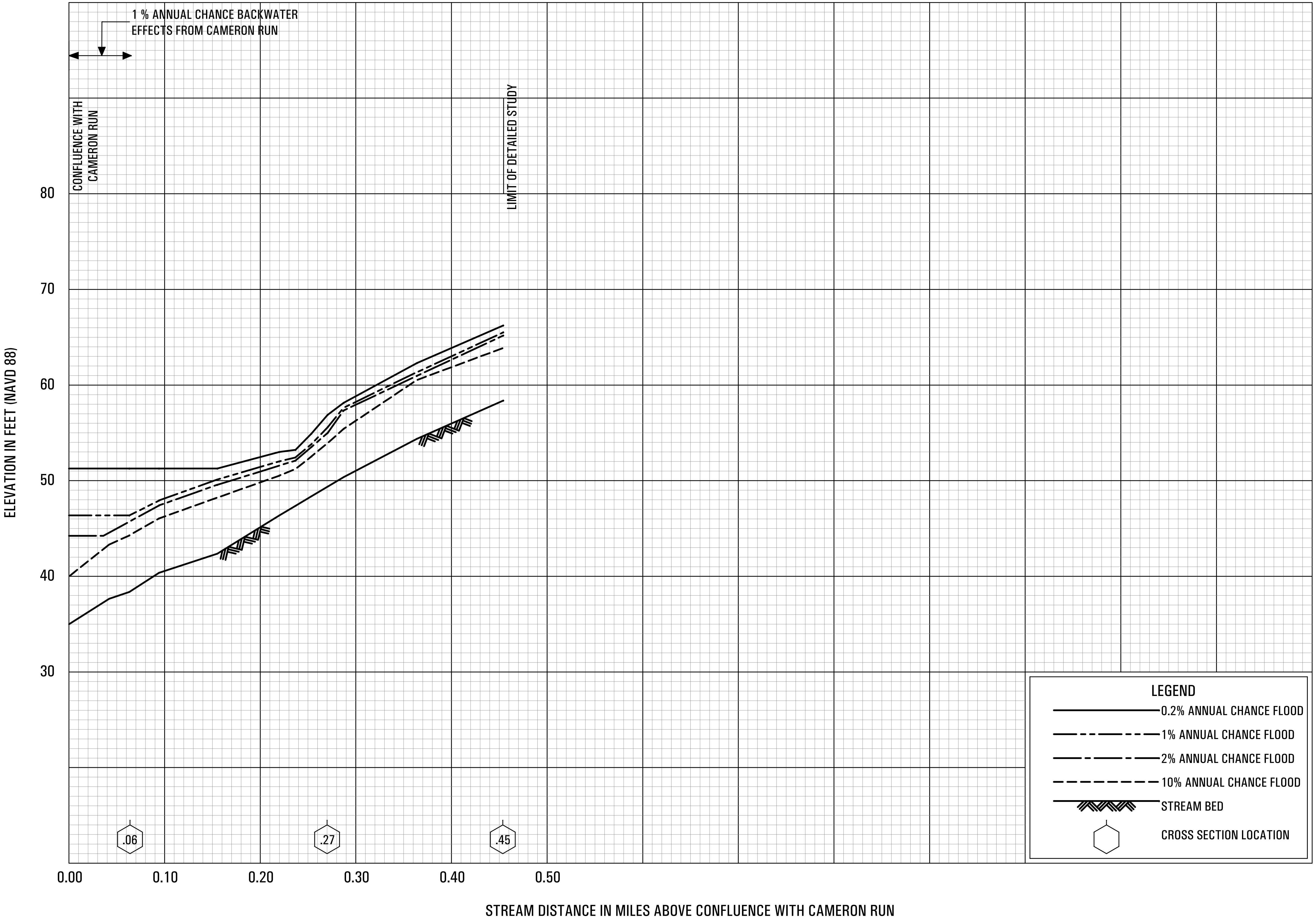


FLOOD PROFILES

TIMBER BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA
(INDEPENDENT CITY)



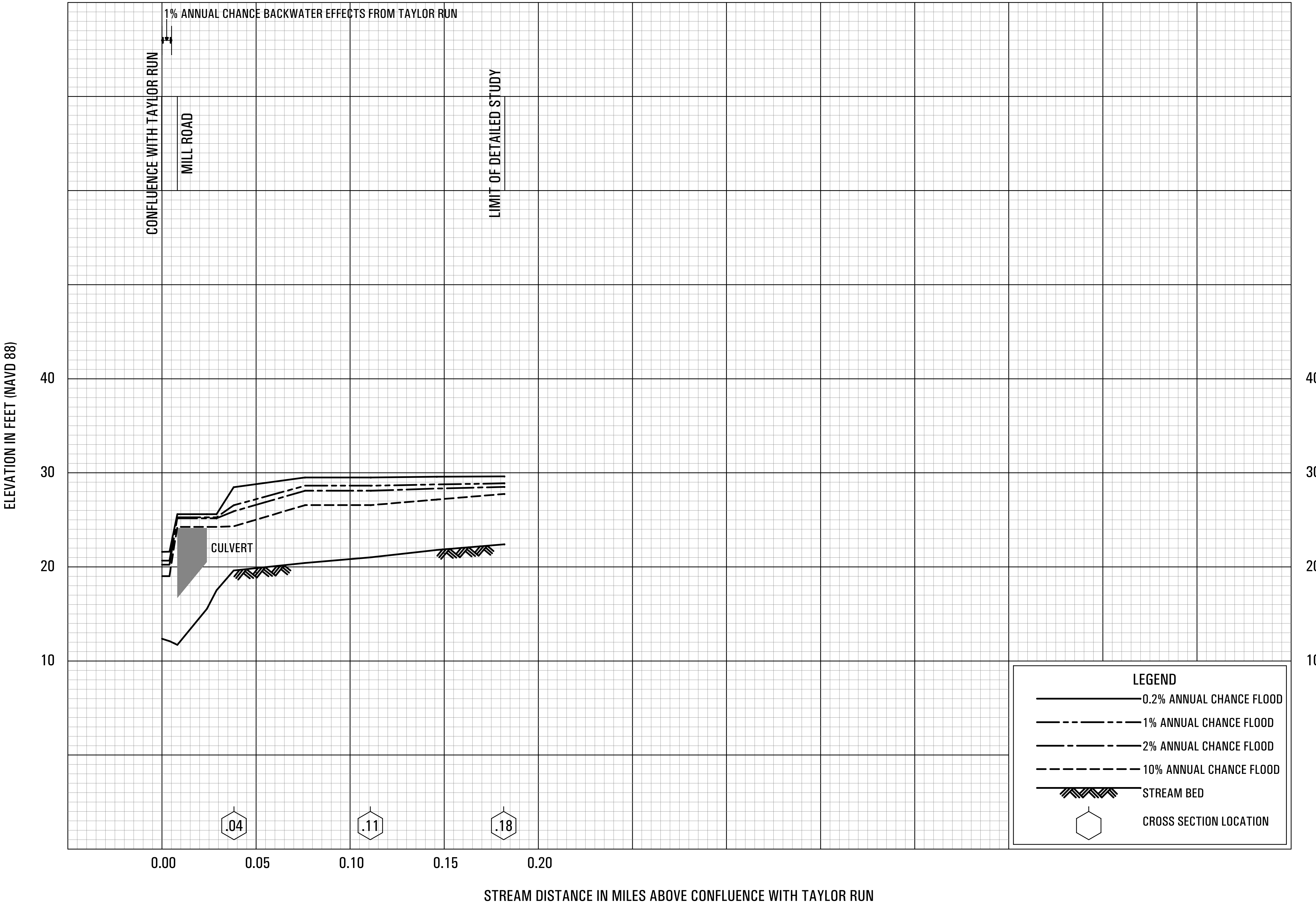
FLOOD PROFILES

TRIBUTARY 1 TO CAMERON RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA

(INDEPENDENT CITY)



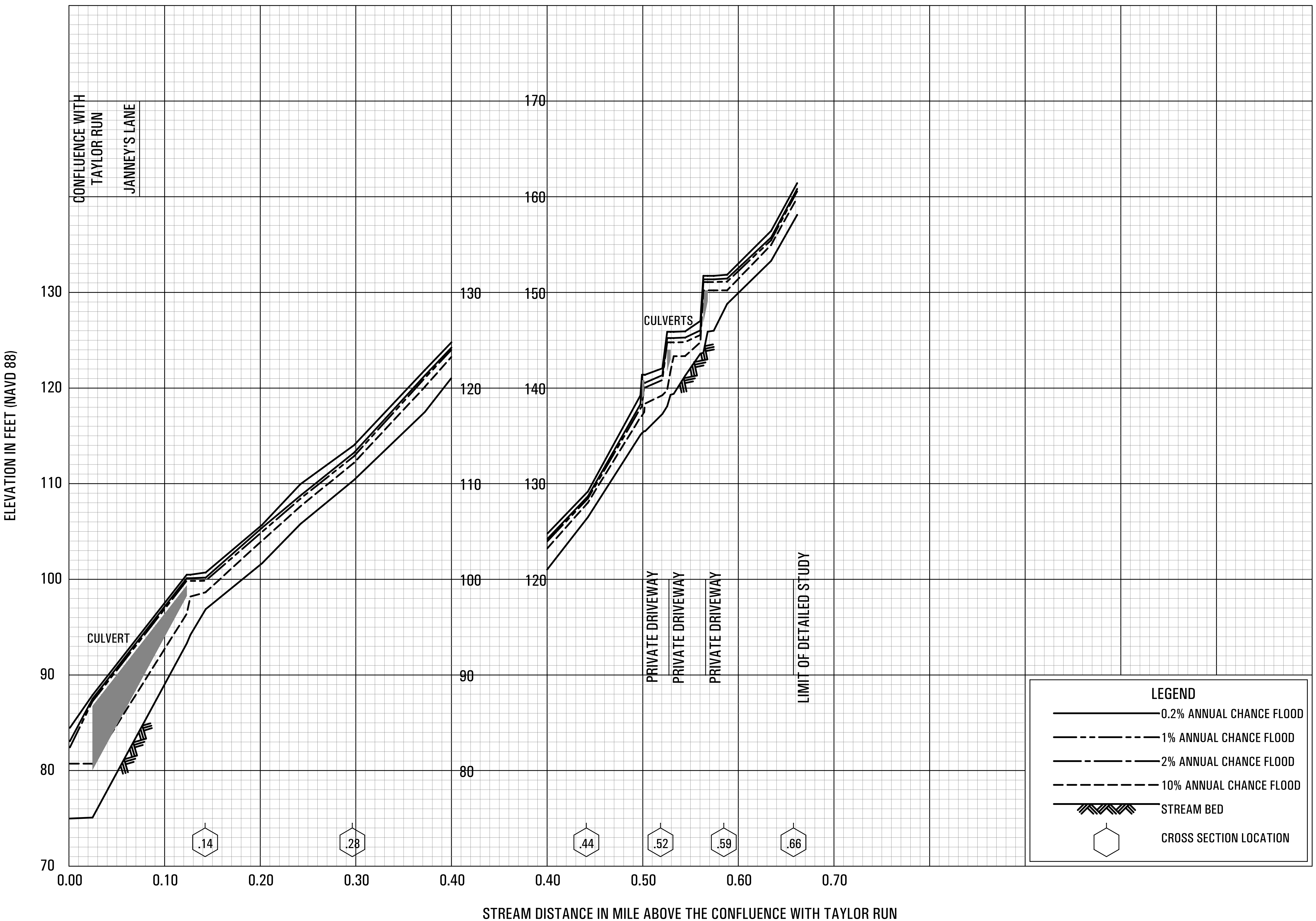
FLOOD PROFILES

TRIBUTARY 1 TO TAYLOR RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA

(INDEPENDENT CITY)



FLOOD PROFILES

TRIBUTARY 2 TO TAYLOR RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF ALEXANDRIA, VA
(INDEPENDENT CITY)