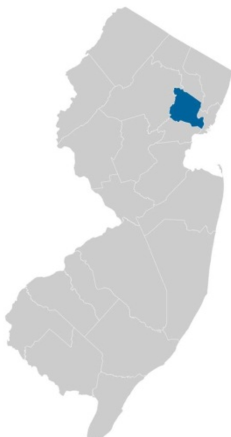
FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 3



ESSEX COUNTY, NEW JERSEY

(ALL JURISDICTIONS)

COMMUNITY NAME	NUMBER	COMMUNITY NAME	NUMBER
BOROUGH OF CALDWELL	340584	TOWNSHIP OF FAIRFIELD	345295
BOROUGH OF ESSEX FELLS	340575	TOWNSHIP OF IRVINGTON	340184
BOROUGH OF GLEN RIDGE	340183	TOWNSHIP OF LIVINGSTON	340185
BOROUGH OF NORTH		TOWNSHIP OF MAPLEWOOD	340186
CALDWELL	340190	TOWNSHIP OF MILLBURN	340187
BOROUGH OF ROSELAND	340193	TOWNSHIP OF MONTCLAIR	340188
CITY OF EAST ORANGE	340181	TOWNSHIP OF NUTLEY	340191
CITY OF NEWARK	340189	TOWNSHIP OF SOUTH	
CITY OF ORANGE TOWNSHIP	340192	ORANGE VILLAGE	340194
TOWNSHIP OF BELLEVILLE	340177	TOWNSHIP OF VERONA	340195
TOWNSHIP OF BLOOMFIELD	340178	TOWNSHIP OF WEST CALDWELL	340196
TOWNSHIP OF CEDAR GROVE	340180	TOWNSHIP OF WEST ORANGE	340197

REVISED:

PRELIMINARY

May 30, 2014

FLOOD INSURANCE STUDY NUMBER
34013CV001B

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

Initial County FIS Effective Date: June 4, 2007

Revised Countywide FIS Date: TBD - To add Base Flood Elevations and Special Flood Hazard Areas; to change Base Flood Elevations, Special Flood Hazard Areas, and zone designations; to updated roads and road names; and to reflect updated topographic information.

TABLE OF CONTENTS – VOLUME 1

1.0 INTRODUCTION 1

1.1 Purpose of Study 1

1.2 Authority and Acknowledgments 1

1.3 Coordination 7

2.0 AREA STUDIED 8

2.1 Scope of Study 8

2.2 Community Description 18

2.3 Principal Flood Problems 30

2.4 Flood Protection Measures 40

3.0 ENGINEERING METHODS 43

3.1 Hydrologic Analyses 44

3.2 Hydraulic Analyses 68

3.3 Coastal Analyses 77

3.4 Vertical Datum 82

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS 83

4.1 Floodplain Boundaries 83

4.2 Floodways 84

5.0 INSURANCE APPLICATION 127

6.0 FLOOD INSURANCE RATE MAP 128

7.0 OTHER STUDIES 131

8.0 LOCATION OF DATA 131

9.0 BIBLIOGRAPHY AND REFERENCES 131

TABLE OF CONTENTS – VOLUME 1 (Cont'd)

FIGURES

Figure 1 – Frequency Discharge, Drainage Area Curves....61
Figure 2 – Transect Location Map....79
Figure 3 – Transect Schematic....82
Figure 4 – Floodway Schematic....85

TABLES

Table 1 – CCO Meeting Dates For Precountywide FISs....7
Table 2 – Streams Studied By Detailed Methods....9
Table 3 – Streams Studied By Approximate Methods....15
Table 4 – June 4, 2007, Scope of Revision....17
Table 5 – [TBD], Scope of Revision....18
Table 6 – Summary of Discharges....54
Table 7 – Manning's "n" Values....75
Table 8 – Transect Data....80
Table 9 – Floodway Data....86
Table 10 – Community Map History....129

TABLE OF CONTENTS – VOLUME 2

EXHIBITS

Exhibit 1 - Flood Profiles

Bear Brook	Panels 01P-04P
Canoe Brook	Panels 05P-19P
Canoe Brook Tributary No. 1 (Downstream)	Panels 20P-21P
Canoe Brook Tributary No. 1 (Upstream)	Panels 22P-23P
Canoe Brook Tributary No. 2	Panels 24P-29P
Canoe Brook Tributary No. 3	Panels 30P-34P
Crooked Brook	Panels 35P-36P
Crystal Lake Branch	Panels 37P-38P
Cub Brook	Panels 39P-44P
Deepavaal Brook	Panels 45P-47P
Elizabeth River	Panels 48P-52P
Foulerton's Brook	Panels 53P-58P
Foulerton's Brook (Upstream)	Panel 59P
North Branch Foulerton's Brook	Panels 60P-64P
Green Brook	Panels 65P-69P
Green Brook Tributary	Panels 70P-73P
Kane Brook	Panels 74P-77P
Lightning Brook	Panels 78P-80P
Nishuane Brook	Panels 81P-84P
Passaic River (Upstream)	Panels 85P-96P
Passaic River Tributary	Panels 97P-99P

TABLE OF CONTENTS – VOLUME 3

EXHIBITS (Cont'd)

Exhibit 1 - Flood Profiles (Cont'd)

Peckman River	Panels	100P-111P
Peckman River Tributary	Panel	112P
Pine Brook	Panels	113P-121P
East Branch Rahway River	Panels	122P-130P
East Fork of East Branch Rahway River	Panels	131P-134P
West Branch Rahway River (Downstream)	Panels	135P-140P
West Branch Rahway River	Panels	141P-143P
Second River	Panels	144P-157P
Second River Tributary	Panels	158P-166P
North Branch Wigwam Brook	Panels	167P-170P
Branch of North Branch Wigwam Brook	Panel	171P
South Branch Wigwam Brook	Panels	172P-173P
St. Pauls Branch	Panels	174P-177P
Slough Brook	Panels	178P-180P
Slough Brook Tributary	Panels	181P-182P
Taylor Brook	Panels	183P-184P
Third River	Panels	185P-193P
Third River Tributary	Panels	194P-198P
Third River Tributary No. 1	Panel	199P
Turtle Brook	Panels	200P-201P
Van Winkles Brook	Panels	202P-204P
Yantacaw Brook	Panels	205P-207P

Exhibit 2 - Flood Insurance Rate Map Index
Flood Insurance Rate Map

FLOOD INSURANCE STUDY
ESSEX COUNTY, NEW JERSEY (ALL JURISDICTIONS)

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Essex County, including the Boroughs of Caldwell, Essex Fells, Glen Ridge, North Caldwell, and Roseland; the Cities of East Orange, Newark, and Orange Township; and the Townships of Belleville, Bloomfield, Cedar Grove, Fairfield, Irvington, Livingston, Maplewood, Millburn, Montclair, Nutley, South Orange Village, Verona, West Caldwell and West Orange (hereinafter referred to collectively as Essex County).

This FIS 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 Essex County 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 Acknowledgments

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

Information on the authority and acknowledgments for each jurisdiction with a previously printed FIS report included in this countywide FIS is shown on the following pages.

Belleville, Township of: The hydrologic and hydraulic analysis for the September 4, 1987, FIS revision for the Township of Belleville was a revision to the original analysis prepared by the New Jersey Department of Environmental Protection (NJDEP) for the Federal Emergency Management Agency (FEMA), under Contract No. H-3855. This work was completed in September 1977. The hydrologic and hydraulic analysis for the original study were conducted by Tippetts-Abbett-McCarthy-Stratton, Engineers and Architects, under subcontract with the NJDEP, Division of Water Resources, Bureau of Flood Protection Management. The hydrologic and hydraulic analysis for the Second River study was prepared by the NJDEP for FEMA. This work was completed in May 1986.

Bloomfield, Township of: The hydrologic and hydraulic analysis for the September 4, 1987, FIS was a revision to the original analysis prepared by McPhee, Smith, Rosenstein Engineers for FEMA, under Contract No. H-3723. This work was completed in January 1976. The Third River, the Third River Tributary No. 1, Second River, and the Second River Tributary were revised based on new hydrologic and hydraulic data provided by the NJDEP. This work was completed in March 1986.

Cedar Grove, Township of: The hydrologic and hydraulic analysis for the August 1979 FIS were performed by the NJDEP, for the FEMA, formerly the Federal Insurance Administration (FIA), under Contract No. H-3855. This work was completed in November 1977 and covered all significant flooding sources affecting the Township of Cedar Grove.

East Orange, City of: The hydrologic and hydraulic analysis in the February 4, 1988, FIS represent a revision of the original analysis prepared by Pfisterer, Tor, and Associates for FEMA, under Contract No. H-3737. The hydrologic and hydraulic analysis of Second River Tributary and Nishuane Brook was prepared by the NJDEP, Division of Water Resources, Bureau of Floodplain Management. This work was completed in November 1985.

Essex Fells, Borough of: The hydrologic and hydraulic analysis for the July 1979 FIS was prepared by the NJDEP, Division of Water Resources, Bureau of Floodplain Management, for the FEMA, formerly FIA, under Contract No. H-3959. Updated hydrologic and hydraulic analysis was performed by Harris Toups Associates for the NJDEP under Subcontract No. Ag7073. All survey and cross-sectional data for this study was collected and compiled by George de Benedicity Associates, Wharton, New Jersey, for Harris Toups Associates. This work was completed in October 1977 and covered all significant flooding sources affecting the Borough of Essex Fells.

Fairfield, Township of: The hydrologic and hydraulic analysis in the June 1986 study was a revision to the original analysis by the Soil Conservation Service. The updated version was prepared by the NJDEP for FEMA, under Contract No. H-3959. The hydrologic and hydraulic analysis in the updated study was computed by O'Brien & Gere Engineers, Inc., under subcontract to the NJDEP. This work was completed in December 1983.

Glen Ridge, Borough of: The hydrologic and hydraulic analysis for the October 3, 1983, FIS was prepared by the NJDEP for FEMA, under Contract No. H-4546. URS Corporation, Inc., updated the hydrologic and hydraulic analysis under subcontract to the NJDEP. This work was completed in December 1980.

Irvington, Township of: The hydrologic and hydraulic analysis for the June 1979 FIS were prepared by the NJDEP, Division of Water Resources for the FEMA, formerly FIA, under Contract No. H-3855. The updated hydrologic and hydraulic analysis was conducted by McPhee, Smith and Rosenstein Engineers, under subcontract to the NJDEP, Division of Water Resources. This work was completed in June 1977 and covered all significant flooding sources in the Township of Irvington.

Livingston, Township of: For the original March 15, 1977, FIS, the hydrologic and hydraulic analysis was performed by McPhee, Smith, Rosenstein Engineers, for FEMA, formerly FIA, under Contract No. H-3723.

For the December 17, 1987, FIS, the hydrologic and hydraulic analysis for Canoe Brook was prepared by the NJDEP. This work was completed in April 1987.

For the June 20, 2001, FIS, the hydrologic and hydraulic analysis for the Passaic River was prepared by Leonard Jackson Associates for FEMA, under Contract No. EMN-96-C0-0026.

Maplewood, Township of: The hydrologic and hydraulic analysis for the August 1977 FIS, was performed by McPhee, Smith, Rosenstein Engineers for the FIA, under Contract No. H-3723. This work was completed in February 1976 and covered all flooding sources affecting the Township of Maplewood.

Millburn, Township of: For the original August 1, 1979, FIRM and February 1979 FIS, the hydrologic and hydraulic analysis was prepared by the U.S. Army Corps of Engineers (USACE), New York District, for FEMA, under Inter-Agency Agreement No. IAA-H-2-73, Project Order No.4. This work was completed in March 1974.

For the February 17, 1988, FIS, the hydrologic and hydraulic analysis for the East and West Branches of the Rahway River was performed by Elson T. Killam Associates, Inc. This work was completed in March 1976. The hydrologic and hydraulic analysis for Van Winkles Brook was performed by Richard Brown Associates during the preparation of the FIS for the Township of Springfield. This work was completed in May 1979. The hydrologic and hydraulic analysis for Canoe Brook Tributary No. 1 was performed by McPhee, Smith, and Rosenstein Engineers during the preparation of the FIS for the Township of Livingston.

For the March 17, 2002, FIS, the hydrologic and hydraulic analysis for the Passaic River was prepared by Leonard Jackson Associates for FEMA, under Contract No. EMN-96-C0-0026. This work was completed in November 1998.

Montclair, Township of: The hydrologic and hydraulic analysis for the August 4, 1987, FIS, was a revision to the original analysis prepared by McPhee, Smith & Rosenstein, Engineers, for FEMA, under Contract No. H-3723. The original work was completed in July 1975. The hydrologic and hydraulic analysis for the Third River, the Second River, and Nishuane Brook was revised by the NJDEP. This work was completed in May 1986.

Newark, City of: For the original September 1979 FIS, the hydrologic and hydraulic analysis was prepared by USACE, New York District, for the FEMA, formerly FIA, under Inter-Agency Agreement Nos. lAA-H-19-74 and IAA-H-16-75, Project Order Nos. 17 and 6, respectively. This work was completed in February 1978.

For the January 19, 1996, FIS, flood elevations for Newark Bay were taken from the FIS for the City of Elizabeth, New Jersey.

North Caldwell, Borough of: The hydrologic and hydraulic analysis for the October 3, 1984, FIS were prepared by the NJDEP, Division of Water Resources, for FEMA, under Contract No. H-4546. The hydrologic and hydraulic analysis for this study were conducted by URS Corporation, Inc., under subcontract to the NJDEP. This work was completed in August 1981.

Nutley, Township of: The hydrologic and hydraulic analysis for the June 18, 1987, FIS, was a revision to the original analysis prepared by McPhee, Smith, Rosenstein Engineers, for

FEMA, under Contract No. H-3723. The work for the original study was completed in February 1976. The updated hydraulic analysis for the Third River and St. Pauls Branch (formerly called Third River Tributary) was prepared using the NJDEP supplemental report for the Third River, which was completed in June 1980.

Orange Township, City of: The hydrologic and hydraulic analysis for the December 15, 1983, FIS were prepared by the NJDEP for FEMA, under Contract No. H-4546. The hydrologic and hydraulic analysis was performed by URS Corporation, Inc., under subcontract to the NJDEP. This work was completed in February 1981.

Roseland, Borough of: For the original March 2, 1981, FIS report and September 2, 1981, FIRM (hereinafter referred to as the 1981 FIS), the hydrologic and hydraulic analysis was prepared by NJDEP for FEMA, under Contract No. H-3959. This work was completed in August 1978.

For the December 20, 2001, the hydrologic and hydraulic analysis for the Passaic River were prepared by Leonard Jackson Associates for FEMA, under Contract No. EMN-96-C0-0026. This work was completed in November 1998.

The planimetric base mapping information was provided in digital format by the New Jersey Department of Transportation (NJDT) and the NJDEP. These files were compiled at a scale of 1:24,000 from USGS 7.5-Minute Series Topographic Maps.

Additional information in and around the floodplains was added from data provided by Leonard Jackson Associates for the Passaic River for the December 20, 2001, digital Flood Insurance Rate Map (FIRM).

South Orange Village,

Township of: The hydrologic and hydraulic analysis for the January 1977 FIS, was performed by McPhee, Smith & Rosenstein Engineers for FEMA, formerly FIA, under Contract No. H-3723. This work was completed in August 1976, covered all flooding sources affecting the Township of South Orange Village, with the exception of Mountain House Brook.

Verona, Township of: The hydrologic and hydraulic analysis for the August 1979 FIS, were performed by the NJDEP, for FEMA, formerly FIA, under Contract No. H-3855. This work was completed in October 1977 and covered all significant flooding sources affecting the Township of Verona.

West Caldwell, Township of: The hydrologic and hydraulic analysis for the October 1979 FIS, was performed by the NJDEP for the FIA, under Contract No. H-3855. This work was completed in March 1977 and covered all significant flooding sources affecting the Township of West Caldwell.

West Orange, Township of: The hydrologic and hydraulic analysis for the October 1976 FIS, was performed by Pfisterer, Tor, and Associates for FEMA, formerly FIA, under Contract No. H-3737. This work was completed in March 1976 and covered all flooding sources affecting the Township of West Orange.

The precountywide authority and acknowledgements for the Borough of Caldwell are not available because no FIS report was published for the community.

The June 4, 2007, countywide FIS, was prepared to include all jurisdictions within Essex County into a single countywide format FIS. New hydrologic and hydraulic analysis for Crystal Lake Branch, Peckman River, East Branch Rahway River, and West Branch Rahway River were performed by Leonard Jackson Associates, for FEMA, under Contract No. EMN-96-C0-0026. This work was completed August 9, 2005.

For the June 4, 2007, countywide FIS, base map information was provided in digital orthophoto format by the State of New Jersey. This orthophotography of New Jersey is in State Plane North American Datum of 1983 (NAD 83) Coordinates, U.S. Survey Feet and was produced at a scale of 1:2400 (1"=200') with a 1-foot pixel resolution. Aerial photography of the entire State of New Jersey was captured during February-April 2002.

For the [date] countywide FIS revision, new detailed riverine hydrologic and hydraulic analysis was done for the Passaic River (upstream and downstream reaches) and for the Third River. For the upstream portion of the Passaic River, new detailed riverine analysis was completed from approximately 2,000 ft downstream of the confluence with Deepavall Brook to Interstate 280 in the Borough of Roseland. For the downstream portion of the Passaic River, new detailed riverine analysis was completed from the confluence with the Second River to the Essex county boundary with Bergen and Passaic counties. Please note: the updated coastal analysis conducted as part of this countywide FIS revision supersedes the detailed riverine analysis along the downstream reach of Passaic River in the Lower Passaic Basin. The Third River new detailed riverine analysis was done for its entirety in Essex County. This work was prepared by the Risk Assessment Mapping and Planning Partners (RAMPP) for FEMA under FEMA Contract No. HSFEHQ-09-B-0369, Task Order No. HSFE02-09-J-0001 and completed in September 2012.

It should be noted that the new hydrologic and hydraulic analysis for the Passaic River in Essex County, New Jersey was part of a larger study that included hydrologic modeling for the Passaic River watershed and a 41.2-mile long hydraulic study spanning

Bergen, Essex, Hudson, Passaic and Morris counties in the State of New Jersey. Approximately 29.6 miles of the 41.2-mile long study are contained within Essex County. For a detailed copy of the Passaic River Watershed study, please contact the FEMA Engineering Library for the "*Hydrologic and Hydraulic Analysis Technical Support Data Notebook: Task Order HSFE02-09-J-0001 for Passaic River Watershed Hydrologic and Hydraulic Study, New Jersey*", dated September 2012.

Additionally, for the [date] countywide FIS revision, new coastal analysis for Newark Bay and the downstream reach of the Passaic River, from Newark Bay to the Essex county boundary with Bergen and Passaic counties, was prepared by RAMPP for FEMA under Contract No. HSFEHQ-09-D-0369, Task Order No. HSFE03-10-J-0023. This work was completed in August 2013.

For the [date] countywide FIS revision, base map information is from New Jersey Office of Information Technology (NJOIT), Office of Geographic Information Systems (OGIS). This information was derived from digital orthophotos produced at a scale of 1:2400 (1"=200') with a 1 foot pixel resolution from photography dated 2012.

For the [date] countywide FIS revision, the projection system and horizontal datum used for the production of the FIRM is the UTM, NAD 83 Zone 18. Differences in datum, spheroid, projection, or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdictional boundaries. These differences do not affect the accuracy of this FIRM.

1.3 Coordination

Consultation Coordination Officer's (CCO) meetings may be held for each jurisdiction in this countywide FIS. 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.

The dates of the initial and final CCO meetings held for Essex County and the incorporated communities within its boundaries are shown in Table 1, "CCO Meeting Dates for Precountywide FISs".

Table 1 – CCO Meeting Dates For Precountywide FISs

Community Name	Initial CCO Date	Final CCO Date
Belleville, Township of	May 16, 1975	September 17, 1976
Bloomfield, Township of	June 7, 1974	May 9, 1975 July 2, 1975 October 9, 1975
Cedar Grove, Township of	May 16, 1975	June 8, 1976

Table 1 – CCO Meeting Dates for Precountywide FISs (Continued)

Community Name	Initial CCO Date	Final CCO Date
East Orange, City of	May 1975	*
Essex Fells, Borough of	May 1975	*
Fairfield, Township of	March 11, 1976	*
Glen Ridge, Borough of	May 26, 1977	*
Irvington, Township of	December 2, 1976	September 22, 1978
Livingston, Township of	October 7, 1975 April 5, 1999**	*
Maplewood, Township of	September 10, 1975	*
Millburn, Township of	*	*
Montclair, Township of	*	*
Newark, City of	June 6, 1975	*
North Caldwell, Borough of	June 2, 1977	*
Nutley, Township of	January 30, 1975	June 10, 1975
Orange Township, City of	May 26, 1977	*
Roseland, Borough of	May 19, 1976 April 5, 1999**	*
South Orange Village, Township of		*
Verona, Township of	May 16, 1975	June 8, 1976
West Caldwell, Township of	May 9, 1975	July 20, 1976
West Orange, Township of	*	*

*Date not available

**Notified by letter

For the June 4, 2007, countywide FIS, final CCO meetings were held on November 28, 2005. These meetings were attended by representatives of the Study Contractors, the communities, the State of New Jersey, and FEMA.

For the [date] countywide FIS revision, a request for additional data letter was sent to the affected communities December 9, 2012. The Flood Risk Review (FRR) meeting was held on February 19, 2013, and attended by representatives of local officials from the communities of [will insert the specific communities that attended], NJDEP, FEMA, and RAMPP.

The results of the [date] countywide FIS revision, were reviewed at the final CCO meeting held on [date], and attended by representatives of [insert attendee list]. All of the concerns and/or issues raised at that meeting have been addressed.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS report covers the geographic area of Essex County, New Jersey.

All or portions of the flooding sources listed in Table 2, "Streams Studied by Detailed Methods," were studied by detailed methods. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

For streams studied by approximate methods, see Table 3, "Streams Studied by Approximate Methods."

For the June 4, 2007, countywide FIS, see Table 4, "June 4, 2007, Scope of Revision" for the streams studied by detailed methods for that revision. The June 4, 2007, countywide FIS, also incorporated the determinations of letters issued by FEMA resulting in map changes (Letter of Map Revision (LOMR), and Letter of Map Revision Based on Fill (LOMR-F)).

For the [date], countywide FIS revision, see Table 5, "[TBD], Scope of Revision" for the limits of the new detailed analysis for the Passaic River, the Third River and Newark Bay. The [date], countywide FIS revision, also incorporates the following LOMRs which are listed below:

Case Number	Effective Date	Project Identifier/Flooding Source
09-02-0153P	11/24/2008	Zone X Labeling Update: Ponding Area between Ampere Parkway and County Route 506, north of Chester Avenue, Township of Bloomfield

The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction through Essex County.

Approximate analysis was used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon, by FEMA and representatives of Essex County.

Table 2 – Streams Studied By Detailed Methods

Stream Name	Description of Study Reaches
Bear Brook	At Livingston, Township of Entire length within the community
Canoe Brook	At Livingston, Township of Entire length within the community
	At Roseland, Borough of Entire length within the community

Table 2 – Streams Studied By Detailed Methods (Continued)

Stream Name	Description of Study Reaches
Canoe Brook Tributary No.1	At Livingston, Township of Entire length within the community
	At Millburn, Township of From Downstream corporate limits to approximately 950 feet upstream
Canoe Brook Tributary No.2	At Livingston, Township of Entire length within the community
Canoe Brook Tributary No.3	At Livingston, Township of Entire length within the community
Crooked Brook	At Maplewood, Township of Entire length within the community
Cub Brook	At Livingston, Township of Entire length within the community
Elizabeth River	At Irvington, Township of Entire length within the community At Newark, City of Entire length within the community
Foulerton's Brook	At Roseland, Borough of Entire length within the community
North Branch Foulerton's Brook	At Roseland, Borough of Entire length within the community
Fullerton Brook	At Livingston, Township of Entire length within the community
Deepavaal Brook	At Fairfield, Township of Entire length within the community

Table 2 – Streams Studied By Detailed Methods (Continued)

Stream Name	Description of Study Reaches
Green Brook	At Fairfield, Township of Entire length within the community
	North Caldwell, Borough of From downstream corporate limits to the dam just upstream of Mountain Avenue.
	At West Caldwell, Township of Entire length within the community
Kane Brook	At West Caldwell, Township of Entire length within the community
Lightning Brook	At Maplewood, Township of Entire length within the community
Lake No. 1	North Caldwell, Borough of Entire length within the community
Newark Bay	At Newark, City of Entire length within the community
Nishuane Brook	East Orange, City of Entire length within the community
	At Montclair, Township of From downstream corporate limits to Elm Street
Passaic River	Its entirety within Essex County
Passaic River Tributary	At Livingston, Township of Entire length within the community
	At Millburn, Township of Entire length within the community

Table 2 – Streams Studied By Detailed Methods (Continued)

Stream Name	Description of Study Reaches
Peckman River	At Cedar Grove, Township of Entire length within the community
	At Verona, Borough of Entire length within the community
	At West Orange, Township of From Verona, Township of Corporate Limits to Prospect Avenue
Peckman River Tributary	At Cedar Grove, Township of Entire length within the community
Pine Brook	At Essex Fells, Borough of Entire length within the community
	At West Caldwell, Borough of Entire length within the community
East Branch Rahway River	At Maplewood, Township of Entire length within the community
East Branch Rahway River	At Millburn, Township of Entire length within the community
	At Orange Township, City of Entire length within the community
	South Orange Village, Township of Entire length within the community

Table 2 – Streams Studied By Detailed Methods (Continued)

Stream Name	Description of Study Reaches
East Fork of East Branch Rahway River	At Orange Township, City of From confluence with East Branch Rahway River to a point approximately 320 feet downstream of Freeman Street
	At West Orange, Township of From upstream of Joyce Street to Northfield Avenue.
West Fork of East Branch Rahway River	At West Orange, Township of Between Forest Hill Road and Montrose Street
Tributary to East Branch Rahway River	At Maplewood, Township of Entire length within the community
West Branch Rahway River	At Millburn, Township of From approximately 100 feet downstream of the downstream corporate limits to Glen Avenue
	At West Orange, Township of From the corporate limits to Hoover Avenue
Branch of West Branch Rahway River	At West Orange, Township of From the confluence with Branch Rahway River to a point just downstream of Interstate 280
	At Belleville, Township of From Confluence with Passaic River to the corporate limits with Bloomfield Township Also revised from approximately 2,000 feet upstream of Franklin Avenue to the corporate limits with Bloomfield Township.

Table 2 – Stream Studied By Detailed Methods (Continued)

Stream Name	Description of Study Reaches
Branch of West Branch Rahway River (continued)	At Bloomfield, Township of Entire length within the community
Second River (also known as Wigwam Brook)	East Orange, City of Entire length within the community
	At Montclair, Township of From downstream corporate limits to Godfrey Road
	At Newark, City of Entire length within the community
	At Orange Township, City of Entire length within the community (Wigwam)
Slough Brook	At Livingston, Township of Entire length within the community
Slough Brook Tributary	At Livingston, Township of Entire length within the community
St. Paul Branch	At Nutley, Township of Entire length within the community
Taylor Brook	At Cedar Grove, Township of Entire length within the community
Third River	In its entirety within Essex County
Third River Tributary No. 1	At Bloomfield, Township of From confluence with Third River Tributary to a point approximately 2,000 feet upstream of confluence.

Table 2 – Stream Studied By Detailed Methods (Continued)

Stream Name	Description of Study Reaches
Third River Tributary No. 1 (continued)	At Montclair, Township of Entire length within the community
Turtle Brook	At West Orange, Township of From the confluence with West Branch Rahway River to a point about 2,100 feet upstream of St. Cloud Avenue
Van Winkles Brook	At Millburn, Township of From Downstream corporate limits to Millburn Avenue
North Branch Wigwam Brook	At West Orange, Township of From Corporate Limits with City of Orange Township to Harrison Avenue.
Branch to North Branch Wigwam Brook	At West Orange, Township of From Confluence with North Branch Wigwam Brook to Bloomfield Way
South Branch Wigwam Brook	At West Orange, Township of From Wildwood Road to the confluence with North Branch Wigwam Brook
Branch to South Branch Wigwam Brook	At West Orange, Township of Between Wildwood Road and Main Street
Yantacaw Brook	At Montclair, Township of From downstream corporate limits to Club Road

Table 3 – Streams Studied By Approximate Methods

Stream Name	Description of Study Reaches
Branch Brook	At Newark, City of Entire length within the community

Table 3 – Streams Studied By Approximate Methods (Continued)

Stream Name	Description of Study Reaches
Branch of Bear Brook	At West Orange, Township of Vicinity of Dogwood Road and Northfield Avenue
Canoe Brook	At Livingston, Township of Portions
	At Millburn, Township of Portions
Canoe Brook Branches	At West Orange, Township of Vicinity of Morris Road, Eagle Rock Avenue and Oval Road
Canoe Brook Tributary No. 1	At Millburn, Township of Portions
Great Hills Brook	At Millburn, Township of Portions
Greek Brook	North Caldwell, Borough of Portions
Greek Brook Tributary No. 1	North Caldwell, Borough of Portions
Greek Brook Tributary No. 2	North Caldwell, Borough of Portions
West Branch Rahway River	At Millburn, Township of Portions
Lightning Brook	At Irvington, Township of Entire length within the community
Nishuane Brook	At Glen Ridge, Borough of From at the southwest corner of the community
	At Orange Township, City of Entire length within the community
North Branch Foulerton's Brook	At Essex Fells Entire length within the community
	At Roseland, Borough of Entire length within the community

Table 3 – Streams Studied By Approximate Methods (Continued)

Stream Name	Description of Study Reaches
Branch of Peckman River	At West Orange, Township of Vicinity of Mayfair Drive, Midro Way, and Nestro Road
Peckman River Tributary	At Verona, Township of Entire length within the community
Taylor Brook	At Millburn, Township of Portions
Weequahic Lake	At Newark, City of Entire length within the community

The following areas for the Township of West Orange were studied by approximated methods:

- The area in the vicinity of Valley Road, south of Northfield Avenue
- The area in the vicinity of Main Street, north of Mt. Pleasant Avenue
- The area in the vicinity of Ashland Avenue between Park Avenue and White Street
- The area in the vicinity of Ashland Avenue between Park Avenue and Lakeside Avenue, Watchung Avenue between Lakeside Avenue and Washington Street, and the area adjoining these two areas
- The area in the vicinity of Main Street, Eagle Rock Avenue, and Harrison Avenue

Table 4 – June 4, 2007, Scope of Revision

Stream Name	Limits of Revised or New Detailed Study
Bear Brook	From the confluence with Canoe Brook to approximately 1,800 feet upstream of East Cedar Street
Canoe Brook	From approximately 1,500 feet downstream of South Orange Avenue to the confluence of Bear Brook
Canoe Brook Tributary No. 1	From the confluence of Canoe Brook to approximately 1,200 feet upstream of White Oak Ridge Road
Crystal Lake Branch	In its entirety
East Branch Rahway River	From approximately 200 feet downstream of Millburn Avenue to just upstream of Valley Road

Table 4 – June 4, 2007, Scope of Revision (Continued)

Stream Name	Limits of Revised or New Detailed Study
Peckman River	From the confluence with Passaic River (outside of Essex County) to approximately 80 feet downstream of Prospect Avenue (Route 577)
Slough Brook	From just downstream of Personage Hill Rd to a point approximately 200 feet upstream of Irving Avenue
West Branch Rahway River	From approximately 1,300 feet upstream of West Palm Avenue to just upstream of Hooper Avenue

Table 5 – [TBD], Scope of Revision

Stream Name	Limits of Revised or New Detailed Study
Newark Bay	Its entirety within Essex County
Passaic River (Downstream)	From Newark Bay to Essex County boundary with Bergen and Passaic Counties
Passaic River (Upstream)	From approximately 2,000 feet downstream of the confluence with Deepavall Brook to Interstate 280 in the Borough of Roseland
Third River	Its entirety within Essex County

2.2 Community Description

Essex County is located in northeastern New Jersey. Essex County is comprised of 22 incorporated communities. To the north, Essex County is bordered by Passaic County, to the west, Morris County, to the East, Bergen and Hudson Counties, and to the South, Union County. Essex County has a total population of 783,969 with the City of Newark having the largest population of 277,140 people (U.S. Census Bureau, 2010). The climate is characteristic of the Middle Atlantic seaboard. On average, Newark's warmest month is July with an average high of 82 degrees Fahrenheit (°F) and the coolest month is January with an average high of 24 °F. Precipitation is moderate, approximately 46 inches of rainfall annually, and is well distributed throughout the year (U.S. Climate Data, 2014).

Township of Belleville

The Township of Belleville is located in east-central Essex County and in the northeastern part of New Jersey. Belleville is bordered by the Township of Nutley to the north, the Township of Lyndhurst to the east, the City of Newark to the south, and the Township of Bloomfield to the west. Across the Passaic River from North Arlington, Belleville lies approximately 6 mi. north of Newark Airport and approximately 10 mi. west of New York City. It is part of the New York-New Jersey metropolitan area.

Belleville was first settled by the Dutch in the late 17th century. In later years, the English established their roots in this area and adopted the name of Belleville in 1793. The township was incorporated in 1839 (Cummingham, 1953). Belleville is both a residential and an industrial community.

The floodplain of the Passaic River, the Second River and the Third River contain commercial, industrial, recreational and residential developments, and public utilities. Numerous city streets and highways cross the floodplains. There is little vacant land in the township and pressure to continue economic development within the area is expected to increase the use of the floodplains.

The Passaic River generally flows in a southern direction along the eastern boundary of the township to its confluence with Newark Bay. The Second River flows in an eastern direction along the southern boundary of the township to its confluence with the Passaic River. For approximately 3,000 feet (ft.), the Third River flows in an east-northeastern direction through the northwestern part of Belleville.

Diversified topography prevails in the region. Belleville consists of step-like waves or ridges of land running north and south, parallel to the Passaic River. Vegetation consists of planted lawns, trees, and shrubbery, which are typical of residential and commercial areas.

Township of Bloomfield

The Township of Bloomfield is located in the northeastern portion of Essex County, approximately 4 mi. north of Newark, New Jersey. The township lies in the Lower Passaic River Valley. It is bounded on the south by the City of East Orange; the west by the Borough of Glen Ridge and the Township of Montclair; the north by the City of Clifton; and the east by the Townships of Nutley and Belleville, and the City of Newark.

Bloomfield was settled over 300 years ago as one of the three original wards of Newark. In its early days, Bloomfield was primarily a farming community but its location on several rivers and streams led to industrial development accompanied by increasing wealth and population. In 1796, Bloomfield seceded from Newark and in 1912 was incorporated as a township under an act of the New Jersey State Legislature.

Land use in the township consists of residential, commercial and industrial development, public and semi-public land, parks and playgrounds, and vacant land. The floodplain in the township is predominantly residential with a substantial number of commercial, industrial, and public enterprises. Numerous city streets, state highways, and rail lines cross the floodplain.

The Third River originates in the Township of Montclair and flows in a southern direction. The Third River Tributary No. 1 lies in the northeastern part of the Township of Montclair and flows in a generally southern direction. The Second River drains the southern portion of the Township of Bloomfield and flows in a generally eastern direction. The Second River Tributary originates in the City of Orange Township and flows in a northeastern direction.

The soil is generally unstratified and stratified drift with fluvial deposits. It is underlain with bedrock varying from basalt and diabase traprock to gray and red sandstone and shale. Vegetation consists primarily of sycamore, red maple, black oak, and poplar.

Borough of Caldwell

No previous study was completed for the Borough of Caldwell.

Township of Cedar Grove

The Township of Cedar Grove is located in northeastern Essex County, in northeastern New Jersey. It is approximately 9 mi. north of Newark and approximately 15 mi. west of New York City. The township is bounded on the north by the Township of Little Falls, on the east by the Township of Montclair, on the south by the Township of Verona, and on the west by the Borough of North Caldwell.

Created in 1787, the area known as modern day Cedar Grove was originally part of Caldwell Township. In 1891, the State legislature separated Verona from the Township of Caldwell, with Cedar Grove forming the northern portion of Verona. In 1907, Cedar Grove broke away from Verona and in 1908 was incorporated as a separate township. Industrial development commenced in 1814, utilizing the power resources of the Peckman River. At that time, most of the land was occupied by large truck farms, a number of smaller farms and wooded areas. Now, housing developments have mushroomed throughout the township.

City of East Orange

The City of East Orange is located in Essex County approximately 47 mi. northeast of Trenton and adjacent to Newark, New Jersey. It is bordered by the City of Orange Township to the west, the Borough of Glen Ridge and the Township of Bloomfield to the north, the City of Newark to the east and south, and the Township of South Orange Village to the southwest.

The area was first settled in the late 1600's when a group of 30 families came by boat from New Haven, Connecticut, and settled along the Passaic River. East Orange was part of Newark until l806, when they separated. In 1863, East Orange became a separate township; and in 1900 it was incorporated as a city.

The Second River Tributary is part of the Passaic River Basin and enters East Orange from the City of Orange Township in the vicinity of Springdale Avenue. The Second River Tributary flows in an eastern direction. As the stream crosses the railroad, it turns in a northeastern direction, crosses Dodd Street, and enters Watsessing Park. The stream passes into the Township of Bloomfield by way of Watsessing Park. The headwaters of Second River Tributary are in the Township of West Orange, where the stream has several branches and is called Wigwam Brook.

Nishuane Brook is a tributary to the Second River Tributary with its confluence point in the vicinity of Kearny and North Park Streets. The stream has headwaters in Montclair to the north of the city. Nishuane Brook then flows in a southern direction in Montclair, crosses briefly into Orange, and enters the City of East Orange near Thomas Boulevard. From this point, it flows southward parallel to Long Street, crossing the corporate limits of Orange and East Orange several times before its confluence with Second River Tributary.

The City of East Orange lies east of the First Watchung Mountain slope where the headwaters of the tributaries of the Second River within East Orange are formed. The general drainage patterns are in a north-south direction between the foot hill ridges, even with the general topography tending to slope downward to the east. The southern portion of the City of East Orange drains southward into the Elizabeth River basin and is completely sewered, with no open stream channels remaining. The northern portion of the city, generally to the north of Interstate Route 280, drains northward into the Second River and its tributaries. In the northern area, only Second River Tributary and Nishuane Brook remain as open channels; the rest of the natural drainage courses have been placed in pipe sewers or culverts.

Borough of Essex Fells

The Borough of Essex Fells is located in western Essex County, in the northeastern part of New Jersey, about 10 mi. northwest of Newark. It is a well-established, highly developed, residential suburban community. The Boroughs of Caldwell, West Caldwell and North Caldwell border the community to the north.

Township of Fairfield

The Township of Fairfield is located in the extreme northwestern portion of Essex County in northern New Jersey. It is bordered by the Borough of Lincoln Park to the north, the Township of Wayne to the east, the Borough of North Caldwell and the Townships of West Caldwell and East Hanover to the south, and the Township of Montville to the west.

The township lies within the area known as the central basin of the Triassic Lowlands Province. This area has a relatively flat topography.

The Passaic River flows in a clockwise direction as it forms the western and northern boundaries of Fairfield. Deepavaal Brook flows northeast, drains most of the township's industrial area, and discharges into the Passaic River near the eastern tip of the township. Green Brook, a tributary to Deepavaal Brook, flows to the northwest.

Fairfield was formed as a township from the Township of Caldwell by referendum on November 5, 1963. In June 1964, the Township of Fairfield became the Borough of Fairfield (New Jersey, 1696), however, in 1976, Fairfield returned to the title of a township.

Borough of Glen Ridge

The Borough of Glen Ridge is located in the central portion of Essex County in northeast

New Jersey, approximately 5 mi. northwest of the City of Newark. The Township of Bloomfield borders to the north and east, the Township of Montclair to the west, and the City of East Orange to the south of Glen Ridge.

The Borough of Glen Ridge was incorporated in 1895, but it dates back to Puritan settlers from Connecticut 300 years ago. The borough was originally a rural settlement, turning industrial in the 1800's. Today, the Borough of Glen Ridge is almost exclusively single-family residential. The sidewalks are lined with large shade trees, and gas lamps still light the township. Bloomfield Avenue contains the one percent of the total land area that is commercial.

Bloomfield Avenue, Washington Avenue, Bellevue Avenue, Bay Avenue, and Ridgewood Avenue are the major transportation routes within the township. Numerous bus lines and railroads also serve the township.

The Borough of Glen Ridge lies on a narrow trap-ridge, which is one of the easternmost spurs of the Watchung Mountains. The township has set most of the land traversed by Toneys Brook/Second River aside as parkland.

Township of Irvington

The Township of Irvington is located in the extreme south-central portion of Essex County in northeastern New Jersey, approximately 15 mi. southwest of New York City. It is bordered by the communities of Maplewood to the west, Hillside and Union to the south and Newark to the north and east.

In the early 1700s, Irvington was known as the Village of West Farms. The Camp family settled there between 1725 and 1730 and was of such prominence that the Village of West Farms became known as Camptown. Camptown's name was changed to Irvington on November 2, 1852, and the Township of Irvington was incorporated in 1898. Irvington included the Village of West Farms and a portion of Clinton Township south of Chancellor Avenue. The growth of Irvington was somewhat leisurely until the period between 1890 and 1930 when the township experienced a building boom. This era brought the electric streetcar, water systems, paved roads and the establishment of commercial business areas within the town. These commercial business areas are generally concentrated along Irvington's main arteries of transportation such as Springfield Avenue. However, Irvington remains primarily a residential township of single-family dwellings.

Irvington's main avenues of transportation include Springfield Avenue, Clinton Avenue and Grove Street. The Garden State Parkway serves the community, having been constructed in this area between 1950 and 1955. The Lehigh Valley Railroad also traverses the township.

The Elizabeth River flows roughly through the center of the township in a southerly direction. Lightning Brook also flows in a southerly direction and forms a portion of the western boundary.

The Township of Irvington lies in the Piedmont Physiographic Province. The Brunswick Formation, the most common rock type found in northeastern New Jersey, underlies almost the entire area between the Palisades and the Watchung Mountains. The topography of the area started developing from the Schooley peneplain at the beginning of the Tertiary Period, about 70 million years ago. During Triassic times, sandstones, shales, argillite lake deposits and basalt lava flows were deposited, peneplaned and subsequently buried under several hundred feet of cretaceous sands, clays, and marls. The present day landscape is the product of continuous erosion (Widmer, 1964).

Since Irvington is a rather densely populated, primarily residential community, vegetative cover is generally composed of lawns and native trees.

Development in the floodplain of the Elizabeth River is mainly residential, except around Clinton and Nye Avenues, where some commercial establishments exist.

Township of Livingston

The Township of Livingston is located in the southwestern portion of Essex County, approximately 21 mi. west of New York City. It is bordered by the Borough of Roseland to the north, the Township of West Orange to the east, the Township of Millburn to the south, and the Borough of Florham Park and the Township of East Hanover to the west. The Passaic River, which forms the western corporate limits of the Township, drains the western portion of the Township and flows in a southerly to northerly direction.

The bedrock underlying the township consists of Brunswick Formation and Watchung Basalt, which are units of the Newark Group of the late Triassic Age. Overlying these rocks in places are unconsolidated surficial sediments consisting of clay, sand, and gravel, some of which were deposited during the Pleistocene glacial periods, and others that are of more recent origin.

Township of Maplewood

The Township of Maplewood is located in the south central portion of Essex County, New Jersey, about 20 mi. west of New York City. It is bordered by the municipalities of South Orange and West Orange on the north, Newark and Irvington on the east, Union on the south, and Millburn on the west.

It was incorporated in 1904 as the Township of South Orange after separating from the Township of South Orange Village, and in 1922 its name was changed to the Township of Maplewood. Statistics showed a population of 1,600 at the beginning of the 20th Century. The community experiences very little growth since there is little vacant land remaining that could be developed. It is primarily a residential community with retail business and some minor, light industry.

The East Branch Rahway River bisects the township; the terrain becomes topographically higher to the east, toward the Township of Irvington, and to the west toward the South Mountain Reservation.

Red shales and sandstones of the Newark Group of the Triassic Age underlie the soil. Any overburden in the basin generally consists of till.

Local parklands and a golf course encompass the largest part of the floodplain. A small section of the floodplain in the Township of Maplewood is predominantly residential, with some commercial, industrial, and public enterprises. Numerous city streets and rail lines cross the floodplain.

Approximately three-quarters of Maplewood on the western side lie in the Rahway River Basin. The major stream in this area, the East Branch Rahway River, approximately 7 mi. long, with a drainage area of 9.1 sq. mi., flows through Maplewood in a southerly direction, and discharges into the Rahway River. Crooked Brook, a tributary to East Branch Rahway River, flows in a southerly direction and empties into East Branch Rahway River upstream from Baker Street.

The remaining one-quarter of Maplewood on the eastern side lies within the Elizabeth River Basin. Lightning Brook is the main stream, and a tributary to the Elizabeth River. Lightning Brook flows along the eastern border of the township.

Township of Millburn

The Township of Millburn is located approximately 7 mi. west of Newark in northeastern New Jersey. Millburn is bordered by the Township of Livingston to the north, the Township of West Orange to the northeast, the Township of Maplewood to the east, the Township of Union to the southeast, the Township of Springfield to the south, the City of Summit to the southwest, and the Boroughs of Chatham and Florham Park to the west.

The Passaic River forms the northwest corporate limits of Millburn, and the East Branch and West Branch Rahway River flow through the southeastern area of the township, where the East Branch Rahway River forms the southeastern corporate limits. Several other streams flow through the township. Glen Avenue Brook, East Branch Taylor Brook, Canoe Brook, and Great Hills Brook are located in the northwest section of the township, Van Winkles Brook in the south-central area, and Taylor Brook in the northern area. These streams pass through the highly developed commercial area in the southeastern portion of the township and through the various highly developed residential areas.

The bedrock underlying the township consists of Brunswick Formation and Watchung Basalt, which are units of the Newark Group of the late Triassic Age. Overlying these rocks in places are unconsolidated surficial sediments consisting of clay, sand, and gravel, some of which were deposited during the Pleistocene glacial periods, and others that are of more recent origin.

Township of Montclair

The Township of Montclair is located in the northeast portion of Essex County, approximately 4 mi. north of Newark, in the northeast portion of New Jersey. The township consists of a strip of land 1.4 mi. wide and 4.5 mi. long. It is bordered by the Township of West Orange and the City of Orange Township to the south, the Township of Verona and the Township of Cedar Grove to the west, the Township of Little Falls and the City of Clifton to the north, and the Township of Bloomfield and the Borough of Glen Ridge to the east.

The Township of Montclair was formerly a part of Newark, New Jersey, founded in 1660.

From 1812 until 1868, the Township of Bloomfield governed Montclair. Primarily a quiet woodland and farm area, the first settlers obtained land from the Native Americans by treaties and payments. The southern part of Montclair, Cranetown, was named after Jasper Crane's son, who built the first dwelling there. Dutch farmers came from Hackensack to the northern part of Montclair, naming the area Speertown. Cranetown and Speertown are symbolized in the seal of Montclair by a crane and spear held by a Native American. In the late eighteenth century, Speertown Road, now known as Valley Road, connected Cranetown and Speertown. The Township of Montclair reflects the living habits brought by newcomers of many nationalities. A number of the original families remained throughout the years, with succeeding generations continuing the life of the township.

The floodplains in the township are predominantly residential, with a few industrial enterprises that are small in size and have minor influence on the economy of the township. Numerous city streets and rail lines cross the floodplain.

The soil is generally unstratified and stratified drift with fluvial deposits, underlain with bedrock varying from basalt and diabase traprock to gray and red sandstone and shale. Vegetation consists primarily of sycamore, red maple, black oak, and poplar trees.

City of Newark

The City of Newark is the largest city in New Jersey. The city is located in southeastern Essex County, in northern New Jersey, 10 mi. west of New York City. The Second River and the Township of Belleville form the city's northern corporate limits, while the Passaic River and Newark Bay form its eastern corporate limits. The city is bordered by the City of Elizabeth on the south, by the City of Bayonne on the southeast, the Town of Hillside on the southwest, the Town of Harrison on the north, the Township of Irvington on the northwest, the City of Jersey City on the east, and the City of East Orange, the Township of Maplewood, and the Township of South Orange Village on the west.

The Passaic River and Newark Bay form 50-percent of Newark's corporate limits. These waters were instrumental in the city's founding and have been a prime factor in much of the city's growth.

Water transport is still highly significant, as demonstrated by the extremely rapid growth of Port Newark. Much of the tidal lands along the river and bay have been filled and developed for industry, commerce, and transportation. The once green hills above the meadows have been covered with dense residential and commercial development. Commercial and industrial growth continues in the lowland areas even today.

The Passaic River generally flows southerly along the eastern corporate limits to its confluence with Newark Bay. The Second River flows easterly along the northern corporate limits to its confluence with the Passaic River. Both the Elizabeth River in the western corporate limits, and the Branch Brook in north Newark, flow southwesterly.

Borough of North Caldwell

The Borough of North Caldwell is located in the northwestern portion of Essex County in northeast New Jersey, approximately 10 mi. from the City of Newark. North Caldwell is bordered by the Township of Little Falls and the Township of Fairfield to the north, the Township of Cedar Grove and the Township of Verona to the east, the Borough of Essex Fells and the Township of Caldwell to the south, and the Borough of West Caldwell to the west.

The history and development of the borough are closely linked to West Essex. The history is a mix of Robert Treat's English settlers from Connecticut, and Dutch settlers from the Passaic Valley. Development came slowly to the area because of the steep terrain of the First Mountain in the Watchung Mountains. The land developed as small farms and led to the present day residential style of the community, which consists mainly of low-density residential units. Large homes and new residential developments are scattered throughout the borough.

There are no major thoroughfares in the Borough of North Caldwell; however, Mountain Avenue and Greenbrook Road provide access to nearby State Route 23 and Passaic Avenue. Although some land has been paved, there still remains a vegetative cover typical of the area. There are green areas, due in part to a golf course and the County Sanitarium, and naturally wooded areas with oak, maple, and pine trees. Green Brook bisects the borough in an east-west direction.

North Caldwell lies within the Triassic lowlands of the Piedmont Physiographic Province. The bedrock is of the Stockton sandstone Brunswick shale sequence. The shale is extremely thick, covering the valleys and ridges of the First and Second Watchung Mountains. Soils covering the area are of the Urban Land-Boonton-Riverhead association, consisting of sloping to steep, moderately well-draining soils.

Township of Nutley

The Township of Nutley is located in the northeast corner of Essex County, approximately 5 mi. north of Newark, New Jersey. The City of Clifton to the north, the Township of Lyndhurst to the east, the Township of Belleville to the south, and the Township of Bloomfield to the south border it. The Passaic River borders Nutley on its eastern boundary.

Nutley was settled over 300 years ago, in 1660, with the arrival of 30 Puritan families from Connecticut seeking civil and religious freedom. It was one of the three original wards of Newark and was known as "Wardsesson," an area of approximately 20.5 sq. mi. that included what is now Nutley, Glen Ridge, Belleville, and part of Newark. In its early days, the township was primarily farmland. Due to its low-lying location and the rivers and streams situated in the area, industrial development brought increased wealth and population. In 1902, the Township of Franklin, operating since 1874, officially became the Township of Nutley.

The Passaic River flows in a southern direction and empties into Newark Bay in New Jersey. The Passaic River is affected by tides from Newark Bay.

The soil within the area is generally unstratified and stratified drift with glacial and fluvial deposits, underlain with bedrock varying from basalt and diabase traprock to gray and red sandstone and shale. Vegetation consists primarily of sycamore, red maple, black oak, and poplar.

City of Orange Township

The City of Orange Township is located in the central portion of Essex County in northeast New Jersey. It is bordered by the Township of Montclair and the Borough of Glen Ridge to the north, the City of East Orange to the east, the Township of South Orange Village to the south, and the Township of West Orange to the west.

The area was first settled by farmers who left the Newark colony to settle in what was known as the Newark Mountains. In 1806, Orange was incorporated as Orange Township (Snyder, 1969). In 1982, the Town of Orange changed its name to the City of Orange Township. Orange was prosperous throughout the late 1800s and early 1900s, with many industries within the small municipality including Orange (Rheingold) Breweries, Monroe Calculators, and several major hat manufacturers; however, over the years, industry has left the area. Many rehabilitation projects are currently underway in an effort to reverse the decline of the city from a once prosperous residential and industrial community.

Since the city is highly developed, most land cover in the area is impervious, although there are some lawn areas typical of single-family residences. A large park is located in an area that was formerly a swamp, between Harrison Street and Center Street.

The streets in the City of Orange Township almost form a grid system. There are several major roads including Scotland Avenue, Center Street, Central Avenue, Main Street, and Park Avenue. In addition, Interstate 280 divides the city into northern and southern portions. Numerous bus routes and railroads also serve the city.

The City of Orange Township is situated in a valley running north and south that is formed by the Watchung Mountains on the west and a drainage divide on the east, running along Berkeley Avenue. The East Branch Rahway River and the East Fork of East Branch Rahway River flow north to south, collect the drainage which enters the valley, and feed it south into the Rahway River. In the northern section of the city, Wigwam Brook flows west to east, picks up drainage north of Interstate Route 280, and feeds it into the Passaic River.

The City of Orange Township lies within the Triassic lowlands of the Piedmont Physiographic Province. The Brunswick Formation, the most common rock type found in northeastern New Jersey, underlies almost the entire area between the palisades and the Watchung Mountains. The formation usually is soft red shale with occasional interbedded sandstone. The City of Orange Township is in the urban land category, and soils are generally of the Boonton and Riverhead association.

Borough of Roseland

Roseland is in western Essex County, in northeastern New Jersey. It is approximately 18 mi. northwest of New York City. Roseland is bordered by the Borough of Essex Fells on the north, the Townships of West Caldwell and West Orange on the east, the Township of Livingston on the south, and the Township of East Hanover of Morris County on the west.

The region, which now includes Roseland, Essex Fells, Livingston, Caldwell, and West

Caldwell, was known as Horseneck following its purchase from local Native Americans in 1702. Livingston Township was formed in 1813 from the original Horseneck tract. Roseland was a part of Livingston Township and was known then as Centerville.

The floodplains of Passaic River, Foulerton's Brook, North Branch Foulerton's Brook, and Canoe Brook are occupied by residential, industrial, and commercial buildings, parkland, and undeveloped lands. The Passaic River forms the western corporate limits of Roseland and drains the entire borough through its tributaries. Foulerton's Brook originates in Livingston and flows northwesterly to its confluence with Passaic River in the vicinity of Interstate Highway 280. North Branch Foulerton's Brook originates in Essex Fells and flows southwesterly into Roseland. It continues in this direction while draining the northern half of the borough. The brook changes direction in the vicinity of Livingston Avenue and the Prudential property and then flows westerly before joining Foulerton's Brook near Interstate Highway 280. Canoe Brook originates in West Orange and flows southwesterly through Roseland, draining the southeastern portion of the community.

The soil in the borough is predominately silt over clay and gravel, except in the western area, which is poorly drained and consists of recent alluvium.

Township of South Orange Village

The Township of South Orange Village is located in the south central portion of Essex County, adjacent to the City of Newark, about 20 mi. west of New York City.

The community is experiencing very little growth since there is little vacant land remaining to be developed. The village is an older, established community, having been chartered in 1869. South Orange is primarily a residential community with retail business and some minor light industry.

Most of the community lies within the East Branch Rahway River Valley, with a gently sloping rise to the east and a steeper sloping rise to the west.

The soil is generally underlain by red shales and sandstones of the Newark Group of Triassic Age. Overburden in the basin consists generally of till. In the lower portions of the basin, this till resembles glacial drift in character.

The East Branch Rahway River flows in a southerly direction for approximately 7 mi. before discharging into the Rahway River at Springfield, New Jersey.

Township of Verona

The Township of Verona, located in southern Essex County, in northeast New Jersey, is approximately 8 mi. northwest of Newark and approximately 14 mi. west of New York City. It is part of the New York-New Jersey metropolitan area. The borough is bounded on the north by the Cedar Grove, on the east by Montclair, on the south by West Orange, and on the west by Caldwell.

The Dutch settled Verona in the early 17th century. At that time, it was part of Newark. In 1798, it separated from Newark and became the Township of Caldwell. At various times during the next 100 years, issues arose which caused dissatisfaction between the Caldwell and Verona areas, resulting in a separation. The Township of Verona, including Cedar Grove, was approved by the State legislature in 1892, and was incorporated as a Borough on May 13, 1907.

The Peckman River flows south through Verona, Cedar Grove, Little Falls, and West Paterson and joins the Passaic River approximately 1 mi. downstream of the U.S. Geological Survey (USGS) gage.

Township of West Caldwell

The Township of West Caldwell in Essex County is located approximately 10 mi. west of Newark, New Jersey, and 17 mi. west of New York City. It is part of the New York-New Jersey Metropolitan Area. West Caldwell shares common boundaries with the community of Fairfield to the north, North Caldwell to the northeast, Caldwell to the east, Essex Fells to the southeast, Roseland to the south, East Hanover to the southwest, and Montville to the west.

Township of West Orange

The Township of West Orange is situated in Central Essex County approximately 47 mi. northeast of Trenton, New Jersey, and approximately 7 mi. northeast of Newark, New Jersey.

A substantial area of the community is devoted to golf and country club use. There are also two large reservation areas, the South Mountain area in the southern part of the township containing Orange Reservoir, and the Eagle Rock Reservation in the northern part of the township. The First and Second Watchung Mountains run through the township in a northeast- southwest direction forming drainage divides. The west slope of the Second Watchung Mountain forms the headwaters of the several branches of Canoe and Bear Brooks, which are part of the Passaic River drainage basin system. The valley between the two mountains is drained by West Branch Rahway River in the southern part, draining in a southerly direction, and by Peckman River in the northern part, draining northerly toward the Passaic River. The eastern slope of the First Watchung Mountains is the source of the two Forks of East Branch Rahway River, which flow generally southward. It is also the source of the two Branches of Wigwam Brook, which drain generally eastward into Second and Passaic Rivers.

West Orange is primarily a residential township, with a large proportion of single family housing. There are a few existing multi-unit residential buildings, and future development is expected to be of this type. Many of the remaining undeveloped areas zoned for residential use are most suitable for low-density, cluster-type housing.

The commercial and business district is centered along both Main Street and Prospect Avenue in the vicinity of Interstate 280. The industrial area is in the Watchung Avenue and Valley Road areas.

2.3 Principal Flood Problems

For the [date] countywide FIS revision, special consideration was given to storms which caused damages to the area in recent years, including Hurricane Sandy in 2012 and Hurricane Irene in 2011 (FEMA, 2013).

Hurricane Sandy ("Superstorm Sandy") came ashore as an immense tropical storm in Brigantine, New Jersey, on October 29, 2012. On October 30, 2012, President Obama approved a Major Disaster Declaration (FEMA-4086-DR-NJ) for the State of New Jersey. Rainfall amounts associated with Hurricane Sandy in New Jersey were between 2 to 4 inches, while the storm produced almost a foot of rain in states to the south. A full moon made the high tides 20 percent higher than normal and amplified the storm surge. The New Jersey shore suffered the most damage, battered by 14-foot waves at the shoreline, while 32-foot waves were recorded at NOAA Buoy 44065, and wind gusts up to 88 miles per hour. Governor Chris Christy declared a state of emergency on October 31, 2013. The New Jersey shore suffered the most damage. Some barrier island communities suffered severe "wash over" including the creation of two temporary inlets. Seaside communities were damaged and destroyed along the coastline. Approximately 2.7 million households had lost power. In Essex County, residents coped with downed power lines, trees and flooding as Hurricane Sandy hit the area. Flooding was severe along the Passaic River, particularly affecting the East Ward in the City of Newark where five feet of water covered the area making it impossible for emergency vehicles to pass through (Eustachewich, 2012). The several-story county jail on Doremus Avenue was surrounded by water, with backup generators close to being flooded during the storm (Dinges, 2012).

Having earlier been downgraded to a tropical storm, Hurricane Irene came ashore at Little Egg Inlet in southern New Jersey; on August 28, 2011. In anticipation of the storm, Governor Chris Christy declared a state of emergency on August 25, 2011. On August 27, 2011, President Obama approved a Major Disaster Declaration (FEMA-4021-DR-NJ) for the counties of Bergen, Essex, Morris, Passaic, and Somerset in the State of New Jersey making federal aid available to supplement state and local recovery efforts. Mandatory evacuations were ordered throughout the State of New Jersey. Wind Speeds were recorded at 75 mph and rain totals reached over 10 inches in many parts of the state. 1.46 million customers lost power during the storm. Overall damage estimates, for the State of New Jersey, came to over $1 billion dollars (in 2011 dollars); with over 200,000 homes and buildings being damaged.

For the June 4, 2007, countywide FIS, special consideration was given to the heavy rainfall that began along the eastern United States coastline as a result of Hurricane Floyd which made landfall on September 15, 1999, and which brought flooding as far north as New Jersey. Hurricane Floyd has been recorded as the single most costly disaster to affect the State of New Jersey. With more than one quarter of a billion dollars in damage and over half of the population affected, Floyd's rainfall and subsequent flooding underscored the importance of accurate flood hazard data for proper risk assessment/insurance, emergency assistance, and disaster mitigation efforts. Hurricane Floyd set more than 35 new peaks of record for stream discharges throughout central and northern New Jersey. The restudied area predominantly reflects impacted streams for which Hurricane Floyd set a new maximum peak recorded discharge. These streams were identified because the flooding demonstrated that the existing hydrologic analysis was no longer adequate. For more information regarding Hurricane Floyd history, please 'refer to the "Preliminary Report Hurricane Floyd 7-17 September, 1999," prepared by Richard J. Pasch, Todd B. Kimberlain and Stacy R. Stewart of the National Hurricane Center, dated November 18, 1999 at http://www.nhc.noaa.gov/1999floyd.html.

For the precountywide FISs, historic floods in the Passaic River basin occurred in November 1810, July 1865, September 1882, March 1902, October 1903, March 1936, September 1938, July 1945, August 1955, October 1955, and May 1968. Flooding in the Passaic River basin resulting in declared disasters also occurred in 1972, 1973, 1975, 1984, 1992, 1999, 2001, and 2005.

Early reports of heavy rainfall in New Jersey indicated a record of 15 inches on August 1843, an estimated 4 to 5 inches in October 1869, and precipitation of 17.9 inches on September 21-23, 1882 (New Jersey, 1887). The storm of October 1903 was centered over Paterson, where a total of 15.5 inches of rainfall was recorded. In the Maplewood area, 10.48 inches fell on October 8, 1903. The 1903 flood has an estimated peak discharge of 39,800 cubic feet per second (cfs) and an estimated 100-year (1-percent-annual-chance) frequency at the confluence of the Passaic River with Newark Bay. The Passaic River crested at 12.9 feet at Little Falls; New Jersey (USGS 01389500 Passaic River at Little Falls NJ) on October 10, 1903, flood stage for this gage is 7.0 feet and recorded a peak discharge of approximately 31,700 cfs due to the failure of Beattie’s Dam (USGS, 1904). The storm of July 30-August 2, 1927, had a maximum precipitation of 4.24 inches. The storm of March 1936, which was a transcontinental type storm, resulted in intense rainfall on March 11 to 12 and again from March 16 to 19. The rain fell on a heavy snow cover resulting in damaging floods throughout the northeastern states. The average precipitation over the Passaic River Basin was 11.1 inches. During the period July 17-25, 1938, an irregular series of showers and thunderstorms resulted in widely varying precipitation over the eastern seaboard. At Plainfield, immediately west of the Rahway River Basin, precipitation reached a total of 11.32 inches for the storm period. The storm of July 1945 was a tropical storm that was widespread over most of the northeastern states. An average of 8.5 inches of rain fell on the Passaic River Basin. Hurricane Connie passed over central Pennsylvania and moved to New Jersey on August 13, 1955, producing 8.10 inches of rainfall.

The storm of May 28 to 29, 1968, was the result of a low pressure disturbance that originally formed along the Atlantic Coast, south of Cape Hatteras, North Carolina, and later reorganized into a low pressure center near the mouth of the Delaware Bay. Rainfall over the Passaic River Basin averaged approximately 6.0 inches. Tropical Storm Doria moved across New Jersey in August 1971, causing river stages to rise rapidly and flash flooding to occur, especially along the small streams and brooks. During the heavy flooding over northeastern New Jersey on September 12 to 14, 1971, Tropical Storm Heidi moved north-northeast, producing flooding in the general area.

The heavy flooding over northeastern New Jersey on September 12-14, 1971, was caused by the tropical storm Heidi, moving north-northeastward and producing flooding in the general area (USGS, 1972a). Heidi caused damages throughout Essex County.

Township of Belleville

The Township of Belleville is subject to flooding from the Passaic River, the Second River, and the Third River. All three flooding sources flow in well-defined channels with flooding occurring in adjacent low-lying areas. Flooding is generally the result of heavy rainfall produced by hurricanes moving up the coast, large frontal storms from the west and south, and local thunderstorms. Historic floods occurred in 1902, 1903, 1936, and 1945. The 1903 flood has an estimated peak discharge of 39,800 cfs and an estimated 100-year (1-percent-annual-chance) frequency at the confluence of the Passaic River at Newark Bay. The floods inundated large areas, causing damage to buildings and disruption of transportation and utility lines (USACE, 1972b). The 1903 flood crested at approximately 13.5 ft. in the vicinity of Belleville Turnpike in Belleville. Frequent flooding is also known to occur along the Third River between Fairway Avenue and Joralemon Street.

Township of Bloomfield

The Township of Bloomfield is subject to flooding from the Passaic River and the Second River. The flooding along the streams within the corporate limits is attributed mainly to backwater created by inadequate storm drains and culverts, clogged bridges or shallow stream beds. Most of the land adjacent to the rivers in Bloomfield is affected by flooding. The exception is the Third River section between John F. Kennedy Drive and Maple Street where natural high riverbanks combined with natural high grounds confine floodwater to the channel. There are several other areas scattered throughout Bloomfield that experience flooding due to inadequate storm drainage systems.

The Township of Bloomfield has sustained flood damages; the historic floods occurred during May 1968, August and September 1971, and February 1973.

Severe flooding in the Township of Bloomfield was experienced on September 12-14, 1971, during Tropical Storm Heidi. Flooding also occurred on February 2, 1973, causing some damages, and on July 13 and 14, 1975.

Township of Cedar Grove

The Township of Cedar Grove is subject to flooding from the Peckman River and its tributaries. All flooding sources flow in well-defined channels with flooding occurring in adjacent low-lying areas. Flooding occurs along the Peckman River and its tributaries during times of excessive and prolonged rainfall, particularly in residential areas having steep slopes. This flooding is the result of high runoff combined with insufficient carrying capacity of bridge openings and culverts.

City of East Orange

The flooding problem along the channel of the Second River Tributary in the City of East Orange has long been recognized and studied. The first comprehensive report on flooding problems of Second River Tributary in 1940 was stimulated by the 1938 flood (Essex County Highway Department, 1940). This report contained a master plan for the improvement of Second River Tributary, setting channel slopes and improvements capable of carrying design flows with an expected frequency of 30 years. For current information regarding the master plan and drainage improvements, please visit the City of East Orange website at http://www.eastorange-nj.gov/.

Nishuane Brook has some reported flooding problems at the Dodd Street and Thomas Boulevard crossings. Flood damages during the August 1971 storm (Hurricane Doria) consisted of damage to approximately a dozen homes between Dodd Street and Lake Street along Second River Tributary. No specific damages were reported for East Orange for the flood of August 1973, even though the reported magnitude of this flood was on the same order as that of the 1971 flood in East Orange.

In addition to the problems outlined above, there is local flooding in East Orange caused by poor pipe drainage facilities along Summit Street and Melmore Gardens west of North Clinton Street, and at the street crossing at the railroad and Fourth Avenue.

Borough of Essex Fells

Flooding within the Borough of Essex Fells usually occurs as a result of heavy rainfall from localized thunderstorms and hurricanes during the summer and fall months. Because of the low permeability of certain soils, the high degree of development, and the borough's inadequate storm sewers, some areas are subject to frequent flooding and ponding of surface water.

The basements of five houses along Devon Road and one house along Hawthorne Road in Essex Fells suffered considerable damage from flooding during Tropical Storm Doria in August 1971. The flood of August 2, 1973, had a 83-year recurrence interval measured at the nearest upstream gage (No. 01379500) to confluence with Passaic River, and had a less than 10-year recurrence interval measured at the nearest downstream gage (No. 01381900) at Pine Brook. The length of record of the upstream gage is from 1903 to 1911, and 1937 to the present, and the latter is from 1966 to the present. The flood of April 6-7, 1984, measured with the aforementioned gages, had a less than a 10-year recurrence interval upstream and a 44-year recurrence interval downstream. Floodwaters resulting from Hurricane Irene on August 29-30, 2011, measured at the same gages, had a recurrence interval of 16 years upstream and 22 years downstream.

Township of Fairfield

The low-lying area of the wide floodplain of the Passaic River comprises much of the Township of Fairfield and forms a large natural storage area. Floodwaters from the Pompton River enter this storage area from the north near the Two Bridges area. During large floods, Beatties Dam, which is located above Little Falls, constricts the river section enough to cause floodwaters from the Pompton River to enter the Passaic River, flowing in both an upstream and downstream direction at the point where the two rivers join (Richard P. Browne Associates, 1975 and 1976). The storage area thus contains flows from the Passaic River and the Pompton River.

The flood peaks from the Pompton River are reduced and retarded somewhat due to the lake and reservoir storage on the northern upland tributaries and the valley storage between Pompton Lakes and Two Bridges. According to a USACE analysis, the Pompton River peak reaches the Passaic River approximately 12 to 18 hours before the Passaic River peaks (USACE, 1972a). The southern upland tributaries of the Passaic

River are as precipitous as the northern tributaries, but they join the Passaic River at widely separated points which results in desynchronization of their peaks. They are greatly affected by the large valley storage in the lower reaches and are, therefore, low flood producers into the Passaic River floodplains.

Borough of Glen Ridge

Toneys Brook is contained in a deep gorge formed by the railroad embankment and Bloomfield Avenue. The gorge runs from a point upstream of Hillside Avenue to a point behind the Parkway Apartments. Downstream of Hillside Avenue, a limited amount of homes and businesses have experienced minor flooding.

Township of Irvington

The two major sources of flooding in the Township of Irvington are the Elizabeth River and inadequate internal drainage. During the August 2, 1973, (40-year recurrence interval, based upon frequency discharge curve for the Elizabeth River at Hillside) storm there was severe flooding throughout the township with many streets being impassable. During the August 17, 1974, (10-percent-annual-chance recurrence interval, based upon frequency discharge curve for the Elizabeth River at Hillside) storm and during Hurricane Doria (2-percent-annual-chance recurrence interval, based upon frequency discharge curve for the Elizabeth River at Hillside) in 1971, the township was declared a flood disaster area.

Additional flooding due to inadequate internal drainage has occurred in several areas of Irvington located in the vicinity of Durand Place and Wagner Place, Isabella Avenue and Delmar Place, Augusta Street and Ball Street, and Chestnut Avenue.

A sewer master plan for the Township of Irvington was prepared and details inadequate storm sewers and areas of internal flooding (New Jersey, 1977). For current information regarding the master plan and drainage improvements, please visit the Township of Irvington website at https://www.irvington.net/.

Township of Livingston

The Livingston area is subject to frequent rainfalls of great intensity and varying origin. The rainfall may be from local thunderstorms, hurricanes, storms originating over the Atlantic Ocean, or storms coming from the mainland. High intensity, short duration storms tend to cause flooding of the smaller drainage basins of the Township. Lower intensity, longer duration storms are more troublesome to the waterways with larger tributary areas, such as Canoe Brook and the Passaic River.

The Township of Livingston is highly developed, with buildings and paved areas covering a significant portion of the land area and effectively reducing the amount of land available to absorb precipitation. Throughout most of the Township, the surface soil has a relatively low permeability, although there are a few local deposits of sand and gravel. In general, the slope of the terrain varies from 1 percent to 10 percent throughout most of the Township. The low permeability of the soil, the steep slope of the terrain, and the high degree of development in Livingston all contribute to relatively high amounts of runoff, especially from the high intensity storms experienced on the east coast of the

United States. The runoff is carried in open waterways to the Passaic River. The present problems due to storm water runoff are principally related to high velocity flow, channel erosion (particularly in upstream areas), and subsequent depositions of rock and silt in the downstream portions of the brooks.

Local flooding in Livingston is generally due to inadequate storm sewers, high-water elevations in the streams to which the storm sewers discharge, or blockages, such as silting of the stream channel at the point of discharge from a storm sewer. In addition to causing silting and blockage of the stream channel, the erosion caused by the high velocities also undermines the embankments of the streams and affects the adjacent land area. This type of damage is caused not only by severe floods but also by the cumulative effects of lesser, but more frequent storms.

The downstream portions of Canoe Brook and Slough Brook, as well as the land area bordering the Passaic River, are greatly influenced by high-water levels in the Passaic River. A historic flood in Livingston in the Passaic River Basin occurred during October 1903; however, because of the low level of development at that time, damages were not too severe. The storm of October 1903 was centered over Paterson, where a total of 15.5 inches of rainfall was recorded.

A review of the great storms which have occurred in the northeastern states reveals that the Rahway River and its tributaries are located in the North Atlantic storm belt. Under extremely intensive and prolonged rains, the East Branch Rahway River; its tributary, Crooked Brook; and Lightning Brook, a tributary of the Elizabeth River, overflow their banks in the Township of Maplewood. Also some bridges over East Branch Rahway River are topped by floodwaters, thus making roads impassable.

Township of Maplewood

At the time the FIS for the Township of Maplewood was published, local flooding was due mainly to poor drainage. The storm sewer system was originally designed for 5- to 10-percent-annual-chance storms and the storm sewer could not accommodate rainfall resulting from the 1-percent-annual-chance storm. For current information regarding the master plan and drainage improvements, please visit the Township of Maplewood website at http://www.twp.maplewood.nj.us/.

The Township of Maplewood has sustained damages from floods that have occurred in the past, with the historic floods occurring during July 1901, February 1902, October 1903, August 1927, July 1938, August 1955, September 1971, and August 2, 1973 (New Jersey, 1974 and USGS, 1972). The damaging storms occurred in Maplewood during the floods of August 2, 1973, and July 1938. The historic flooding occurred during the storm of October 1903; however, because of the absence of development in the community, damages were not as great as those caused by the August 2, 1973 flood.

Township of Millburn

Stream bank overflow along the East Branch and West Branch Rahway River, the Passaic River, Canoe Brook, Taylor Brook, and Great Hills Brook is the principal flood problem within the township of Millburn. Such flooding along the East Branch and West Branch Rahway River has caused damage to some homes and a number of commercial establishments. Flooding along the brooks primarily affects private residences and property in Millburn.

Township of Montclair

Flooding along the streams within the Township of Montclair is mainly caused by backwater that is created by inadequate pipes, box culverts, and bridges clogged by deposits of silt and debris. Shallow, rocky streambeds and heavy brush cover on overbanks also limit effective flow areas.

The adjacent land area for the streams studied in detail in Montclair is affected by heavy rainfall, with the exception of a few areas where the channel is relatively wide and the banks are well stabilized. There are several other areas in the township, which, although not adjacent to a body of water, experience flooding due to an inadequate storm water drainage system.

Montclair has sustained damages from past floods. The significant floods occurred during May 1968, August and September 1971, and on February 2, 1973. Floodwaters caused disruption in traffic, inundation of streets, interruption of businesses, danger to life, and flooding of homes.

City of Newark

The City of Newark is subject to tidal flooding from the Passaic River and Newark Bay. Most of the flood problems occur in the south and eastwardly (Ironbound Section) adjacent to U.S. Route 22 and Frelinghuysen Avenue. Flooding always occurs when an annual peak rainfall coincides with a high tide in Newark Bay. This area is susceptible to flooding because of its flat topography and low elevations.

A historic tide record was obtained in Newark during the October 1903 flood. The largest flood on record occurred August 28, 1971, with a peak discharge of approximately 6,500 cfs recorded at the USGS Second River at Belleville gage (no. 1392500). Due to drastic changes in urbanization over the gaging period a meaningful statistical return period could not be computed.

Borough of North Caldwell

Due to the steep terrain through which it passes, the floodplain of Green Brook is confined and causes no major flood problems for the Borough of North Caldwell.

Township of Nutley

Flooding along the streams within the Township of Nutley is mainly attributable to backwater created by inadequate storm drains and culverts. Flooding that occurs from the culvert between Elm Street and Hillside Avenue on St. Pauls Branch is of particular concern to the township. The narrow, rocky channel and flat overbanks with heavy vegetation also contribute to the flooding problem. Even though some storms may last only a short period of time, heavy rainfall affects most of the adjacent land area along the streams within the community. Certain areas of River Road, which are parallel to the

Passaic River, are subject to flooding during a rainstorm of high intensity.

There are several other areas within the Township of Nutley that, although not adjacent to a body of water, experience flooding because the storm water drainage system is inadequate. Problems also occur due to flooding conditions in the Third River and St. Pauls Branch, causing backwater in the storm drainage system. Another source of flooding is sanitary sewer backup due to excessive infiltration of the storm waters into the sanitary sewer system.

City of Orange Township

The floodplains of Wigwam Brook, the East Branch Rahway River, and the East Fork of East Branch Rahway River in the City of Orange Township have been encroached upon to the point where most of them are developed. This encroachment has caused flood problems and damage from storms with recurrence intervals of less than one year.

The principal flood problems in the City of Orange Township are due to a combination of urbanization in the floodplain, manmade restrictions within the streams, and inadequate storm drainage. In a report prepared for the City of Orange Township and the Township of West Orange, it was determined that the approximate capacity of the East Fork of East Branch Rahway River between Forest Street and Central Avenue is only 90 cfs (Elson T. Killman Associates, Inc., 1977). The 1-percent-annual-chance flood at this location produces a flow of 560 cfs.

A significant flood along the East Fork of East Branch Rahway River occurred on August 28-29, 1971 (Tropical Storm Doria), and produced a discharge of 385 cfs at Mitchell Street (USACE, 1973). This discharge is equivalent to a flood with a recurrence interval of approximately 30 years. Flooding along Wigwam Brook is rather extensive throughout its length within the City of Orange Township corporate limits. Due to its highly developed floodplain, even minor flooding produces damage to residential and commercial structures.

Borough of Roseland

Flooding within the Borough of Roseland occurs as a consequence of heavy rains usually resulting from localized thunderstorms and hurricanes during the summer and fall months. Due to the low permeability of certain soils, the high degree of development and less than adequate storm sewers in the borough, some areas are subject to frequent flooding and ponding of surface water. A damaging storm occurred on August 2, 1973, creating considerable overbank flooding along Passaic River, Foulerton's Brook, North Branch Foulerton's Brook, and Canoe Brook. This flood on Passaic River had an estimated return period of 83 years. Flooding associated with this storm caused traffic interruptions, property damage, siltation of streambeds, and erosion of embankments. Hurricane Irene on August 29-30, 2011, caused flooding on Passaic River and was estimated to have a 16-year return period.

Problem flooding locations in Roseland identified at various times include area along Foulerton's Brook at Locust, Second, Third, and Fourth Avenues, all of which have experienced flooding during severe rainstorms. There are other areas along North Branch Foulerton's Brook at Gates, Mitchell, and Godfrey Avenues, Plymouth Place, Freeman

Street, and Condit Court where overbank erosion occurred during the August 1973 storm.

Township of South Orange Village

Because of the topography of the East Branch Rahway River, and the Township of South Orange Village's proximity to the headwaters of the river, flood peaks occur rapidly. The flood cycle usually lasts a matter of hours, and, in most cases, lasts less than a day. Local drainage area flooding in Township of South Orange Village follows the same pattern. The major flood damage has occurred in the business community, where the flood waters have entered first-floor levels of retail and service type establishments and businesses; in addition, flood damage has occurred to the basements of residences. Because the village is highly congested even minor flooding causes damage to both public and private property and creates traffic hazards.

The Rahway River and its tributaries are located in the North Atlantic Storm Belt and flooding of the East Branch Rahway River in South Orange occurs frequently. Overflow of the East Branch Rahway River causes a flood problem in the Township of South Orange Village, between the northern and southern boundaries of the village, for residential, commercial, industrial, and public facilities. The principal cause of the flooding is the inability of the existing channel to accommodate the precipitation runoff. This is partly due to bridge constrictions and low channel capacities caused by encroaching development.

The Township of South Orange Village has sustained damages from floods; the historic floods occurred during July 1901, February 1902, October 1903, August 1927, July 1938, August 1955, May 1968, September 1971, and August 1973. The damaging storms on record occurred in South Orange during the floods of July 1938. The historic flooding occurred during the storm of October 1903; however, because of the absence of development in the community, damages were not as great as those that occurred during the August 1973 flood.

Township of Verona

The Township of Verona is subject to flooding from the Peckman River and its tributaries. All flooding sources flow in well-defined channels, within adjacent low-lying areas. Flooding occurs during times of excessive and prolonged rainfall, particularly in residential areas having steep slopes. The flooding is a result of high runoff combined with insufficient carrying capacity of bridge openings and culverts.

Township of West Caldwell

Flooding in West Caldwell is a result of heavy rainfall produced by hurricanes moving up the coast, large frontal storms from the west and south, and local thunderstorms. Historic floods affecting the Township of West Caldwell occurred in 1902, 1903, 1936, and 1945. The 1903 flood, with an estimated peak discharge of 39,800 cfs at the confluence of the Passaic River and Newark Bay, inundated large areas, causing damage to buildings and disruption of transportation and utility lines (New Jersey, 1974). A storm similar to the one which caused the flood of 1903 would result today in a significantly larger area of inundation and greater discharges, due to the increased percentage of impervious areas (New Jersey, 1973). Flooding has occurred in 1968 and 1971, resulting in estimated damages in excess of 1 million dollars in this locality.

The Passaic River flows along the western boundary of West Caldwell. The low areas in West Caldwell, adjacent to the Passaic River, are subject to flooding. Areas subject to inundation include residential, commercial, and park lands. The low flat areas adjacent to Pine, Green, and Kane Brooks in the lower reaches are also subject to flooding.

Township of West Orange

The Township of West Orange has been affected by flooding in most of the low-lying areas located along the numerous open stream courses within its boundaries. Several other areas are also affected by flooding due to poor drainage. In 2010, the Township of West Orange passed 2274-10 An Ordinance Amending and Supplementing Chapter 25 Section 28 of the General Ordinances of the Town of West Orange, Entitled “Steep Slope and Natural Features Ordinance” which amended the steep slope ordinance by placing additional restrictions of State open waters, wetlands, wetland transition areas, flood hazard areas, floodways and riparian zones. This amendment was warranted to prevent flooding, protect water quality, and preserve wildlife and aquatic habitat. For current information regarding the master plan and drainage improvements, please visit the Township of West Orange website at http://www.westorange.org/ or contact the designated Construction Official.

1. A major flood area exists along the East Fork of the East Branch Rahway River in West Orange, east of Valley Road between Freeman Street and Kingsley Street. The flooding problem there, which is due to inadequate channel capacity, has been studied by the USACE (USACE, 1973). The upper portions of this stream are steeply sloped but as of the publication of the [date] countywide FIS report, requests have been made to the USACE and NJDEP to assess whether there is flood storage potential at golf courses and other open spaces as a part of the larger study underway to study flood mitigation alternatives in the Rahway River Basin.

2. North Branch Wigwam Brook has had serious flooding problems in the vicinity of Harrison and Mississippi Avenues, and along most downstream parts of the improved channel. This is due to excessive velocity and lack of channel capacity, notably at Ashwood Terrace, Whittelsey Avenue, Watson Avenue, and Washington Avenue. South Branch Wigwam Brook has had serious flooding reported in the vicinity of Watchung Avenue, Lakeside Avenue, Standish Avenue, and Ashland Avenue.

3. West Branch Rahway River has had flooding problems along its entire length from Northfield Avenue to Lake Vincent, although parts of this river flow through undeveloped or country club areas.

4. Along Peckman River, flooding has occurred between Nicholas Avenue and Kenz Terrace.

5. An area on the western boundary of the Township of West Orange known as the Merklin District is subject to frequent flooding due to inadequate pipe sewers and insufficient capacity of the existing storm water pumping station. The area

flooded is centered between Hunterdon and Morris Roads and Westover and Tappan Terraces. The Mayfair District centered on Mayfair Drive in the north central part of the township is one such location plagued by flooding related to drainage issues. In this location flooding is caused by an inadequate storm water ejector system (Elson T. Killman Associates, Inc., 1972). The Township of West Orange has been moving forward with plans to undertake storm sewer improvements and in 2011 awarded construction contracts to begin the improvements to help alleviated flooding projects on several streets including Nestro Road, Midro Way, Mayfair Drive and Rosemont Terrace and Rosemont Drive. This project has been financed by a grant from the NJDEP and a loan from the New Jersey Environmental Infrastructure Trust.

2.4 Flood Protection Measures

The Township of Belleville, in cooperation with Essex County, participates in cleaning and removing debris from the Second and the Third Rivers. The Township of Belleville has also been granted funds through the Hazard Mitigation Grant Program (HMGP) to fund the installation of a system of values within the existing 17 outfalls from Main Street to the Passaic River (Belleville Times, 2014). For additional information on ordinances and flood protection measures, please visit the Township of Belleville website at http://www.bellevillenj.org.

Other than normal cleaning and removal of silt and debris from various bridges, there has been no major channel improvement work completed on the Third or Second Rivers in the Township of Bloomfield. Interior drainage improvements such as repairs and maintenance have been made to reduce localized flooding conditions in the Township of Bloomfield. For additional information on ordinances and flood protection measures, please visit the Township of Belleville website at http://www.bloomfieldtwpnj.com.

The Township of Cedar Grove's flood prevention program includes cleaning brooks, streams, and tributaries to the Peckman River. Catch basins and storm sewers are checked during heavy rains to prevent debris from entering watercourses. On an annual basis, the Peckman River is cleared of trees, large debris and shoal material. For additional information on ordinances and flood protection measures, please visit the Township of Cedar Grove website at http://www.cedargrovenj.org/site.

Flood protection measures for the City of East Orange are described in the Master Plan. For additional information on ordinances and flood protection measures, please visit the City of East Orange website at http://www.eastorange-nj.gov.

Almost the entire length of Nishuane Brook in the City of East Orange was constructed to include concrete sidewalls and inverts. Culverts have also been installed at all the street crossings. These improvements, designed to contain the 2-percent-annual-chance flood, were not enough to prevent some local flooding during the August 1973 storm.

The Borough of Essex Fells recognized the need for flood plain management and, in April 1977, a preliminary ordinance was adopted at a Planning Board meeting. This ordinance defines the flood hazard area as specified on the Special Flood Hazard Area Map prepared by FEMA. Chapter 141: Flood Damage Prevention was adopted by the Mayor and Council of the Borough of Essex Fells, December 18, 1979, by Ordinance No.

79-455 (Ch. 15.16 of the 1992 Code) and amended in its entirety June 5, 2007, by Ordinance No. 2007-829. In July 2013, the Planning Board imitated Master Plan updates, which include incorporating the current environmental and stormwater management elements into the Master Plan. For additional information on ordinances and flood protection measures, please visit the Borough of Essex Fells website at http://www.essexfellsboro.com.

In the Township of Fairfield, there are no flood protection structures on streams. The township ordinance restricts construction in flood plain areas in accordance with FEMA's land-use regulation requirements. With approximately 70% of property and structures in the Township of Fairfield located in SHFAs the community encourages residents to explore flood protection measures such as drainage maintenance and improvements, wet and dry flood proofing and elevating. For additional information on ordinances and flood protection measures, please visit the Township of Fairfield website at http://www.fairfieldnj.org/index.html.

There are no flood protection measures existing within the Borough of Glen Ridge. For additional information on ordinances and flood protection measures, please visit the Borough of Glen Ridge website at http://www.glenridgenj.org/index.html.

The Township of Irvington has few flood protection measures implemented. Previous improvements include a flume constructed in 1933 along the Elizabeth River. The flume varies from 6 to 10 ft. deep with widths from 20 to 30ft. A double culvert was built to accommodate the Garden State Parkway. For additional information on ordinances and flood protection measures, please visit the Township of Irvington website at https://www.irvington.net.

The Township of Livingston established regulations to prevent flooding problems along the Passaic River. For additional information on ordinances and flood protection measures, please visit the Township of Livingston website at http://www.livingstonnj.org.

Improvements by the Township of Livingston along Canoe Brook, including a new concrete lined channel to improve flow conditions and prevent bank erosion upstream of Cedar Street, were constructed in 1972. In the section between Serbrooke Parkway and East Mount Pleasant Avenue (State Route 10), a concrete lining was created to prevent erosion of the bank slopes, and concrete grade beams were placed across the bottom of the channel to reduce erosion of the streambed. Upstream of Slough Brook, along West Northfield Road, a channel was protected from erosion by lining the bank slopes with riprap.

During the early 1930s, the Works Progress Administration constructed mortar rubble masonry walls along the East Branch of the Rahway River, from the Jefferson Avenue Bridge to a point approximately 750ft. downstream from the Baker Street Bridge in the Township of Maplewood. The purpose of this work was to protect the banks of the river and to prevent erosion. For additional information on ordinances and flood protection measures, please visit the Township of Livingston website at http://www.livingstonnj.org.

No structures built solely for flood protection exist in the Township of Millburn. Some of the brooks have paved or piped sections that may aid in reducing channel obstructions. Also, a section of the West Branch Rahway River is channelized. For additional information on ordinances and flood protection measures, please visit the Township of Millburn website at http://twp.millburn.nj.us.

The Memorial Park Retention Basin on the Second River in the Township of Montclair was modified around 1950 to provide storage for approximately 357,000 cubic ft. of floodwater. For information on ordinances and additional flood protection measures, please visit the Township of Montclair website at http://www.montclairnjusa.org.

The inhabitants of the City of Newark depend on the usual warnings issued through radio, television, and local newspapers for information concerning possible flooding conditions. Flood warnings and predicted flood peaks are issued by NOAA's Flood Forecasting Center, located at Mount Holly, New Jersey. For information on ordinances and additional flood protection measures, please visit the City of Newark website at http://www.ci.newark.nj.us.

There are no existing flood protection facilities located along Green Brook in the Borough of North Caldwell, nor are any expected. Most of the land adjacent to Green Brook is owned by the borough and the Green Brook Country Club. There has been limited development in the flood plain to date. There are five small dams along Green Brook that fall within the limits of detailed study, but none provide flood protection. For information on ordinances and additional flood protection measures, please visit the Borough of North Caldwell website at http://northcaldwell.org.

The dam on St. Pauls Branch in the Township of Nutley, located approximately 600 ft. upstream from the Erie-Lackawanna Railroad, does not provide any flood protection. For information on ordinances and additional flood protection measures, please visit the Township of Nutley’s website at http://www.nutleynj.org.

The Borough of Roseland has no formal structural measures designed specifically for flood protection. Roseland has recognized the need for proper floodplain management, and the community adopted a resolution on April 15, 1975. This resolution established land use and control measures to reduce all new construction or substantial improvements, including prefabricated and mobile homes. Any new construction or substantial improvements are to be made reasonably safe from flooding and to be located so as to minimize flood damage. For additional information on ordinances and flood protection measures, please visit the Borough of Roseland’s website at http://www.roselandnj.org.

An overall Rahway River Flood Control Project was authorized by the Flood Control Act of October 27, 1965, in accordance with the recommendations of the Chief of Army Engineers in House Document No. 67, 89th Congress, First Session. A General Design Memorandum, detailing the work to be accomplished by the USACE, New York District, was completed in September 1969. This study includes the authorized flood control improvement along the East Branch Rahway River at Township of South Orange Village, New Jersey.

The flood area for which protection is being provided consists of approximately 70 acres on the left and right banks of the East Branch Rahway River. The improvement is designed to protect the area against an overflow of the East Branch Rahway River with a frequency of occurrence of once in 100 years. The improvement is essentially a channel enlargement project, which provides for clearing and excavation for a length of about 7,000 ft. Generally, the project consists of concrete walls, levees, a flume, drainage structures, replacement of four bridges, and miscellaneous changes to existing utilities. The upstream limit of the project is the upstream corporate limits of the Township of South Orange Village and the downstream limit is approximately 800 ft. upstream of the Erie-Lackawanna Railroad spur, about 1,400 ft. below Third Street.

The area around the Township of South Orange Village water-pumping plant and the service building has been previously flooded and will still be susceptible to future flooding when the upstream channel is completed. Installing flashboards at the doors and windows has temporarily protected the pumping station, and valuable equipment within the service building has been raised above flood levels. For additional information on ordinances and flood protection measures, please visit the Township of South Orange Village's website at http://www.southorange.org.

To prevent flooding, the Township of Verona regularly cleans brooks, streams, and tributaries to the Peckman River. Catch basins and storm sewers are checked during heavy rains to prevent debris from entering watercourses. On an annual basis, Peckman River is cleared of trees, large debris, and shoal material as needed. For information on ordinances and additional flood protection measures, please visit the Township of Verona's website at http://www.veronanj.org.

There have been numerous attempts to solve some of the flooding problems along various streams in the Township of West Orange. The East and West Forks of East Branch Rahway River have had channel improvements along substantial lengths. For information on ordinances and additional flood protection measures, please visit the Township of West Orange's website at http://www.westorange.org.

Essex County has no levee type structure that would require analysis of levee failure and removal under Section D.2.10.3.4.1 of the Draft Atlantic Ocean and Gulf of Mexico Coastal Guidelines update.

In alignment with standard practice used in other FEMA studies, all coastal armoring structures and beach stabilization structures have been included in the analysis without adjusting the analysis to remove the structure or reduce the effects of the structure.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood-hazard data required for this study. Flood events of a magnitude 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 analysis 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

For the June 4, 2007, countywide FIS, hydrologic analysis was carried out to establish peak discharge-frequency relationships for each flooding source affecting the community that was studied by detailed methods as described by each community on the following pages.

Township of Belleville

The discharge-frequency analysis for the Second River in Belleville were determined by the USACE using Water Resources Council (WRC) Bulletin 15 (WRC, 1967). The discharge- frequency relationship was based on discharge data recorded at Belleville, New Jersey. Discharge records for this reach of the Second River date back to 1936. The hydrologic analysis for the Second River upstream of Franklin Avenue was revised based on an updated USGS gage analysis.

Township of Bloomfield

Hydrologic analysis was carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail and affecting the Township of Bloomfield. Discharges for the Third River Tributary No. 1 in Bloomfield, which has a drainage area less than 1 sq. mi., were computed by the rational method.

The Second River flood flow frequency data for Bloomfield were obtained from the USGS. The 1-percent-annual-chance discharges were based on a log-Pearson statistical analysis of the stage-discharge records at the Belleville gaging station (New Jersey, 1974). USGS transfer coefficients were used to determine the discharges for points along the Second River and Second River Tributary.

The USGS, in cooperation with the NJDEP, Division of Water Resources, developed a regional equation method, which was applied to determine discharges for the Second River in Bloomfield. A comparison with this method indicated differences of 10 percent in flood discharges of the same frequency. As a result, the data obtained by statistical analysis was used.

City of Cedar Grove

For the August 1979 FIS, hydrologic analysis was carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each stream studied in detail in the community. Peak discharge-drainage area relationships for the 10-, 2-, and 1-percent-annual-chance floods were determined by use of an empirical formula that utilizes drainage area, slope, an impervious factor, urbanization, and the amount of surface storage in the basin. The peak discharge-drainage area relationship for the 0.2-percent-annual-chance flood was extrapolated from the lower recurrence interval discharges.

For the June 4, 2007, countywide FIS, peak discharges for the various recurrence intervals were determined for Peckman River using Log-Pearson Type III analysis of gage data at Ozone Avenue in the Township of Verona. This gage has a period of records of 24 years of historic peaks discharges that includes the July 23, 1945, peak discharge of 3,800 cfs and the September 16, 1999, Hurricane Floyd peak discharge of 3,500 cfs with a gage height of 6.57 ft. Drainage area transposition was then performed to obtain flows at other points of interest along the Peckman River.

City of East Orange

For the February 4, 1988 revision, for Second River Tributary and Nishuane Brook in the City of East Orange, the 1-percent-annual-chance frequency data were based on a log-Pearson Type III statistical analysis of stage-discharge records at gaging stations operated by the USGS at Belleville, New Jersey (New Jersey 1970 and 1974). It is to be noted that this gage had been operated as a continuous record station up to 1964 and as a partial record crest stage station since that time, recording the annual maximum gage height that has been correlated to a corresponding maximum annual discharge. A log-Pearson Type III analysis of frequency discharges has been prepared at the gage location (USACE, 1975b). This relationship has been used in the East Orange study.

Borough of Essex Fells

The peak discharges for Pine Brook in the Borough of Essex Fells were determined by use of the frequency-discharge relationship described in Special Report 38, prepared by the USGS, in cooperation with the NJDEP, Division of Water Resources (New Jersey, 1974). Discharges of 0.2-percent-annual-chance floods for this stream were estimated by straight-line extrapolation of a log probability graph for flood discharges prepared up to and including 1-percent-annual-chance frequencies. For areas studied by approximate methods, the depth-discharge frequency relationship developed by the USGS was utilized to delineate flooding boundaries (USGS, 1972a).

Township of Fairfield

For the portion of Deepavaal Brook upstream of the confluence of Green Brook in Fairfield, discharges were determined using unpublished USACE data developed in 1983. The USACE data included hydrographs and rating curves developed for the Passaic River near the upstream Fairfield corporate limits. This analysis incorporates a diversion of flows from the Passaic River into Deepavaal Brook. Discharges from Green Brook and the upstream portion of Deepavaal Brook were combined to obtain the discharges for the downstream portion of Deepavaal Brook.

For Green Brook in Fairfield, hydrologic analysis was based on the method for estimating flood-peak magnitudes developed in Special Report 38 (New Jersey, 1974). This method is based on a multiple regression analysis used to develop mathematical relationships between flood discharges at the various recurrence intervals (2, 10, 50, and 100 years) obtained from gaging station data and hydrologic characteristics. Flood information from 103 sites was used in performing the analysis. Hydrologic parameters included stream drainage area, main channel slope, surface storage area, and an index of manmade impervious cover based on basin population and development conditions. The 0.2-percent-annual-chance discharge was extrapolated from the lower frequency floods.

Borough of Glen Ridge

The hydrologic analysis in the Glen Ridge study was based on records at the USGS gaging station (No. 0392500) on the Second River near Belleville, New Jersey. To obtain values of the 10-, 2-, 1-, and 0.2-percent-annual-chance discharges, a statistical analysis of the frequency-discharge relationships was performed using a log-Pearson Type III flood-frequency analysis and employing station skew as outlined in the WRC guidelines (USGS, 1978 and WRC, 1967).

The developed discharges for the drainage area above Belleville were applied to Toneys Brook/Second River in Glen Ridge using the following drainage area-drainage ratio formula:

$$Q_1/Q_2 = (A_1/A_2)^n$$

where Q_1 and Q_2 are the discharges at specific locations, and A_1 and A_2 are the drainage areas at these locations. The exponent "n" varies from 0.070 to 0.080.

Township of Irvington

The discharge-frequency relationships for the Elizabeth River in Irvington had been determined for the FIS of Union Township prepared by the consulting engineering firm of Pfisterer, Tor and Associates (FEMA, 1978). These peak discharges were obtained by log-Pearson Type III analysis of data from the Elizabeth River gaging station at Elizabeth, New Jersey, covering a 38-year period as furnished by the USACE (USACE, 1975a). This gaging station was originally located 85 ft. upstream from the Westfield Avenue Bridge in Elizabeth. On December 27, 1972, a new gaging station was established at Ursino Lake, Hillside, 75 ft. upstream from the Trotters Lane Bridge. Peak discharge records for 1973-1974 at the new gaging station at Ursino Lake were adjusted by the USACE to correlate with the records from the old gaging station site. The discharges associated with Irvington were then computed by assuming that flows would vary according to the relationship (A1/A2)0.75, where A1 is the drainage area at the Elizabeth gage and A2 is the drainage area at the Hillside gage.

Township of Livingston

For Livingston streams besides the Passaic River studied in detail, two methods of determining peak frequency-discharge relationships were employed. For streams or sections of streams where the drainage basins are approximately 1 sq. mi. or larger, Special Report 38, prepared by the USGS in cooperation with the NJDEP Division of Water Resources, was used to determine peak discharges (New Jersey, 1974). For the remainder of the streams where the drainage basins were less than 1 sq. mi. in area, the rational method was used to determine discharges. The rational method is based on determination of the intensity of rainfall (i), the runoff coefficient (C), and the drainage area (A). This is equated to discharge by use of the formula:

$$Q=CiA$$

As a result of the criteria set forth above, Canoe Brook, Slough Brook, Bear Brook, Foulerton Brook, and the downstream portion of Canoe Brook Tributary No. 1, peak discharges were determined by the use of Special Report 38 (New Jersey, 1974). The other Canoe Brook tributaries, Cub Brook, Passaic River Tributary, and Slough Brook Tributary have peak discharges determined by the rational method.

For the June 4, 2007, countywide FIS, peak discharges for the selected recurrence intervals along Canoe Brook Tributary No. 1 were determined using regression equations and procedures outlined in Special Report 38 (New Jersey, 1974), published by the NJDEP. Peak discharges for Canoe Brook, Bear Brook, and Slough Brook did not change from the previous effective FIS report.

Township of Maplewood

For the August 1977, hydrologic analysis was carried out to establish the peak discharge-frequency relationship for floods of the selected recurrence intervals to each stream studied in detail in the Township of Maplewood.

For East Branch Rahway River in Maplewood, flood flow frequency data were obtained from the East Branch Rahway River, General Design Memorandum prepared by the USACE, New York District, (USGS, 1972a). The frequency data were developed in accordance with the methods of frequency analysis contained in Statistical Methods in Hydrology (USGS 1962).

Because there are no discharge data available for East Branch Rahway River, frequencies were developed by the above method on the basis of available discharge data at the gaging station on West Branch Rahway River at Millburn (drainage area of 7.1 sq. mi.), covering an 11-year period, adjusted by correlation with a long-term station on the Passaic River at Paterson having a period of study of 82 years (FEMA, 1984).

Frequency-discharge data for Lightning Brook in Maplewood were based on USACE analysis of the stage-discharge records at the gaging station on the Elizabeth River at Elizabeth (drainage area of 18.0 sq. mi.), covering a 53-year period at the gaging station operated by the USGS (FEMA, 1984).

Discharges for Crooked Brook in Maplewood, which has a drainage area of less than 1 sq. mi., were computed by the rational method. The rational method is based on determination of the intensity of rainfall (i), the runoff coefficient (C), and the drainage area (A). This is equated to discharge by use of the formula:

$$Q = CiA$$

For the June 4, 2007, countywide FIS, peak discharges for the selected recurrence intervals along East Branch Rahway River were determined using regression equations and procedures outlined in Special Report 38 (New Jersey, 1974), published by the NJDEP.

Township of Millburn

Frequency-discharge data for the flooding sources in the Township of Millburn were developed through the use of statistical methods and analysis of drainage basins. Small drainage basins were compared with drainage basins having similar characteristics and known frequency-discharge relationships. From this information, synthetic unit hydrographs and frequency-discharge relationships were computed.

For the February 17, 1988, Millburn FIS, hydrologic information for the West and East Branches of the Rahway Rivers were obtained from Flood Plain Delineation Program for East and West Branches of the Rahway River (Elson T. Killam Associates, Inc., 1976). The hydrologic analysis for Van Winkles Brook was taken from the FIS for the Township of Springfield (FEMA, 1982). The hydrologic analysis for Canoe Brook Tributary No. 1 was taken from the FIS for the Township of Livingston (FEMA, 2001).

For the June 4, 2007, countywide FIS, peak discharges for the selected recurrence intervals along Canoe Brook Tributary No. 1 were determined using regression equations and procedures outlined in Special Report 38 (New Jersey, 1974), published by the NJDEP.

Township of Montclair

The frequency-discharge data for the Second River were obtained from the USGS and developed using log-Pearson Type III distribution, which required the use of the statistical analysis of discharge records covering a 28-year period at the gaging station operated by the USGS at Belleville, New Jersey.

Frequency-discharge data for Nishuane Brook in Montclair were developed by correlation with the Second River, which has similar drainage basin characteristics, at Belleville, New Jersey. Discharges for small tributaries having a drainage area less than 1.0 sq. mi. were computed by the rational method.

The USGS, in cooperation with the NJDEP, Division of Water Resources, developed a series of regional equations, which were applied to determine discharges for streams in Montclair having a drainage area of more than 1.0 sq. mi. (New Jersey, 1974). A comparison with this and the aforementioned method indicated differences in flood discharges of the same frequency of approximately 15 percent. Discharges for Third River Tributary and Yantacaw Brook (having areas less than or equal to 1 sq. mi.) were determined using the rational method.

City of Newark

Peak flow data for the Second River in the City of Newark were obtained from records of the USGS Belleville gage, which has a period of record from 1936 to 1961, and from 1963 to 1977 (FEMA, 1984). The peak discharge versus frequency relationships for the selected recurrence intervals at the gage were determined by a log-Pearson Type III statistical analysis of the peak flows (WRC, 1976). Peak discharge-frequency values were obtained for the mouth of the river by transposing the values at the gage by a power of 0.75. Peak flow data for the Elizabeth River were determined by a log-Pearson Type III statistical analysis of peak discharges (WRC, 1976). Data for the Elizabeth River were taken from the Irvington, New Jersey FIS (FEMA, 1980c).

Borough of North Caldwell

For Green Brook in North Caldwell, peak discharges of the 10-, 50-, and 1-percent-annual-chance floods were developed using Special Report 38 (New Jersey, 1974). Peak discharges for the 0.2-percent-annual-chance flood were determined using an equation derived by the USGS similar to the equations in Special Report 38. These discharges were compared to those determined by the extrapolation of the log graph of the above discharges calculated by Special Report 38, and were found to be similar.

Township of Nutley

Frequency-discharge data for St. Pauls Branch in Nutley were developed by comparison with the Second River at Belleville, New Jersey, which has similar drainage basin characteristics. The USGS, in cooperation with NJDEP, developed a regional equation that was applied to check the discharges for St. Pauls Branch (New Jersey, 1974). A comparison with this method indicated differences in flood discharges of the same frequency of approximately 10 percent.

City of Orange Township

For Wigwam Brook in the City of Orange Township, a regional transfer equation was used to transfer discharges from the USGS gaging station (No. 01392500) located on the Second River at Belleville, New Jersey. The USGS gaged flows were converted into frequency-discharge values using the log-Pearson Type III method in accordance with WRC Bulletin 17A (USGS, 1978). Discharges were determined using the following drainage area- discharge regional transfer equation:

$$Q_1/Q_2 = (A_1/A_2)^n$$

where Q_1 is the discharge at a specific location, A_1 is the drainage area at that point, Q_2 is the discharge at the gage, A_2 is the drainage area at the gage, and "n" is the transfer exponent. A value of 0.75 was used for "n".

The hydrology for the East Branch Rahway River and the East Fork of East Branch Rahway River in Orange was obtained from the FIS for Township of West Orange (FEMA, 1976).

Borough of Roseland

For the 1981 Roseland FIS, the peak discharges for Foulerton's Brook, North Branch Foulerton's Brook, and Canoe Brook were determined by use of the frequency-discharge relationship described in Special Report 38, prepared by the USGS (New Jersey, 1974) in cooperation with the NJDEP. This analysis takes into consideration drainage area, main-channel slope, surface storage, and manmade impervious land cover. It was developed from a regression analysis of 103 stream-gauging stations throughout New Jersey. Discharges for the 0.2-percent-annual-chance flood events for these streams were estimated by straight line extrapolation on log-probability paper of the discharges computed for flood frequencies up to100 years.

For North Branch Foulerton's Brook above Livingston Avenue, the design discharges were determined by using Special Report 38 (New Jersey, 1974) and the rational method.

For the December 15, 1983 revision, the hydrology was determined using log-Pearson Type III analysis based on USGS gage data at Pine Brook.

For the June 4, 2007, countywide FIS, peak discharges for the selected recurrence intervals along East Branch Rahway River were determined using regression equations and procedures outlined in Special Report 38 (New Jersey, 1974), published by the NJDEP.

Township of South Orange Village

For the January 1977 revision, hydrologic analysis was carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for the East Branch Rahway River in the Village of South Orange.

For the East Branch Rahway River in South Orange, flood flow-frequency data were obtained from the East Branch Rahway River, General Design Memorandum (USACE, 1969). Discharge frequencies were developed in accordance with the methods of frequency analysis contained in a USACE report (USACE, 1962). These analysis was based on stage-discharge records of the gaging station on the West Branch Rahway River at Millburn, New Jersey (drainage area 7.9 sq. mi.), adjusted by correlation with a long-term station on the Passaic River at Paterson, New Jersey, having a period of record of 86 years (FEMA, 1984).

For the June 4, 2007, countywide FIS, peak discharges for the selected recurrence intervals along East Branch Rahway River were determined using regression equations and procedures outlined in Special Report 38 (New Jersey, 1974), published by the NJDEP.

Township of Verona

For the August 1979 revision, peak discharge-frequency relationships for the Peckman River in the Borough of Verona were estimated by procedures outlined in New Jersey Special Report 38 (New Jersey, 1974). This report provides the equation that relates basin size, channel slope, surface storage, and an index of manmade impervious cover.

For June 4, 2007, countywide FIS, peak discharges for the various recurrence intervals were determined for Peckman River using Log-Pearson Type III analysis of gage data at Ozone Avenue in the Borough of Verona (USGS gage no. 01389534). This gage has a period of records of 24 years of historic peaks that includes the July 23, 1945, peak discharge of 3,800 cfs and the September 16, 1999, Hurricane Floyd peak discharge of 3,500 cfs with a gage height of 6.57 ft. Drainage area transposition was then performed to obtain flows at other points of interest along the Peckman River.

Township of West Caldwell

For Pine, Green, and Kane Brooks in the Township of West Caldwell, peak discharges for floods of the 10-, 2-, and 1-percent-annual-chance recurrence intervals were developed by using Special Report 38 (New Jersey, 1974). On these streams, when the drainage area was less than 1 sq. mi., the rational method was used.

Special Report 38 presents regional flow equations, which relate basin characteristics to peak flood discharges. The characteristics are basin size, channel slope, surface storage, and impervious cover. These parameters were determined from USGS topographic maps (USGS, 1970).

Discharges for the 0.2-percent-annual-chance floods of Green Brook Tributary, Kane Brook, and Pine Brook in West Caldwell were determined by straight-line extrapolation of a single-log graph of flood discharges computed for frequencies up to 100 years.

Township of West Orange

For the May 2, 1977 revision, the discharge-frequency relationships for West Branch Rahway River above the corporate limits in West Orange (Drainage Area 4.6 sq. mi.) were based on analysis made by the USACE, New York District. Due to the short period of record at the nearest gaging station on the Rahway River at Millburn (Drainage Area 7.1 sq. mi. period of record 1938, 1940-1950), the USACE has developed a study using the log-Pearson Type III analysis (WRC, 1967) for Millburn by correlating data with Ringwood Creek near Wanaque (drainage area 19.1 sq. mi.) (USACE, date unknown).

Discharge values for locations upstream from Millburn were determined by applying factors to the log-Pearson III values at Millburn. These factors were based upon ratios of discharges obtained by the method in Special Report No. 38 (New Jersey, 1974).

For the East Branch Rahway River in West Orange the discharge-frequency relationships for the East Fork (Drainage Area 0.94 sq. mi.) and the West Fork (Drainage Area 0.50 sq. mi.), were based on log-Pearson Type III analysis using statistical parameters developed by the USACE, New York District.

The discharges along East Branch Rahway River at the downstream corporate limits (Drainage Area 2.13 sq. mi.) were based on adjustment of values obtained by the USACE at a location downstream at the southern limits of South Orange Village (Drainage Area 4.26 sq. mi.). The adjustment in flows was based on applying a ratio of drainage areas with an exponent of 0.75 in accordance with the practice of the USACE.

For Wigwam Brook (Second River Tributary) in West Orange the frequency-discharge relationships were based on those developed for the City of East Orange and the Township of Bloomfield FISs (FEMA, 1975a; 1975b). Discharges were obtained along Second River at the confluence with Tony's Brook by McPhee, Smith & Rosenstein (FEMA, 1977b; 1987a; 2001). They used the relationship (A/A)0.75 in conjunction with the log-Pearson Type III analysis based on data obtained at the USGS gaging station on Second River at Belleville (Drainage Area 11.6 sq. mi.).

The discharges for Wigwam Brook (Drainage Area 0.28 sq. mi.), North Branch Wigwam Brook (Drainage Area 1.26 sq. mi.), and South Branch Wigwam Brook (Drainage Area 0.82 sq. mi.) were computed by applying an $(A/A)^X$ factor to frequency-discharge relationships derived at Tony's Brook confluence point along Second River (Drainage Area 6.66 sq. mi.). The exponents X in the $(A/A)^X$ factor were as follows: for the 10-

percent-annual-chance flood the exponent was 0.65; for the other frequencies the exponent was 0.5. These exponents were chosen because of the change in the physical characteristic upstream.

For June 4, 2007, countywide FIS, peak discharges for the various recurrence intervals were determined for Peckman River using Log-Pearson Type III analysis of gage data at Ozone Avenue in the Borough of Verona. This gage has a period of records of 24 years of historic peaks that includes the July 23, 1945 peak of 3,800 cfs and the September 16, 1999 Hurricane Floyd peak of 3,500 cfs with gage height of 6.57 ft. Drainage area transposition was then performed to obtain flows at other points of interest along the Peckman River.

Peak discharges for the selected recurrence intervals on the East Branch Rahway River, West Branch Rahway River, and Crystal Lake Branch were determined using regression equations and procedures outlined in Special Report 38 (New Jersey, 1974), published by the NJDEP. The 0.2-percent-annual-chance discharges for West Branch Rahway River were determined by extrapolating the discharge by plotting the relationship between frequency and the log of the discharge for other recurrence intervals.

Frequency-Discharge Drainage Area curves for the East Branch Rahway River, West Branch Rahway River, North Branch Wigwam Brook, South Branch Wigwam Brook, Peckman River, St. Pauls Branch, Lightning Brook, and Crooked Brook are shown in Figure 1, "Frequency Discharge, Drainage Area Curves."

For the [date] countywide FIS revision, new detailed hydrologic analysis was carried out to establish peak discharge-frequency relationships for four frequencies for Passaic River and Third River. The updated coastal analysis conducted as part of this countywide FIS revision supersedes the detailed riverine analysis along the downstream reach of Passaic River in the Lower Passaic Basin.

The new hydrologic and hydraulic analysis for the Passaic River in Essex County, New Jersey was part of a larger study that included hydrologic modeling for the Passaic River watershed and a 41.2-mile long hydraulic study spanning Bergen, Essex, Hudson, Passaic and Morris counties in the State of New Jersey. Approximately 29.6 miles of the 41.2-mile long study are contained within Essex County. For a detailed copy of the Passaic River Watershed study, please contact the FEMA Engineering Library for the "*Hydrologic and Hydraulic Analysis Technical Support Data Notebook: Task Order HSFE02-09-J-0001 for Passaic River Watershed Hydrologic and Hydraulic Study, New Jersey*", dated September 2012.

Special Report 38 was used to determine the discharges for Third River, using a correlation of data developed by the USGS for Second River in Belleville, New Jersey.

Hypothetical rainfall data (frequency storm) are used to develop peak flow hydrographs for the four return intervals scoped for the project. The frequencies considered for this study are 10-Year (10-percent), 50-Year (2-percent), 100-Year (1-percent) and 500-Year (0.2-percent) for detailed streams. In addition, the New Jersey Flood Hazard Area Design Flood (NJFHADF) was computed for the USGS gaging stations and the additional flow locations. The NJFHADF is equal to the 1-percent-annual-chance flood plus an additional 25-percent in flow, and not to exceed the 0.2-percent-annual-chance flood. NJFHADF boundary is to regulate disturbance to the land and vegetation within flood hazard area of a water body. This regulation is set forth by the State of New Jersey Flood Hazard Area Control Act Rules N.J.A.C. 7:13, and is administered.

Flood flow frequencies for Passaic River were developed using a calibrated rainfall-runoff model of Central Passaic Watershed. The model was developed following the criteria outlined in Appendix C (FEMA, 2009). The Rainfall-Runoff model was developed using USACE Hydrologic Engineering Center's (HEC) HEC-HMS 3.5 computer model (HEC, 2010b). Hydrologic losses were based on NRCS's Curve Number method, rainfall-runoff transformations were based on NRCS (unit hydrograph) procedures. There is no hydrologic channel or reservoir routing in the Central Passaic Basin model. All HEC-HMS subbasins connect directly to unsteady HEC-RAS models for routing purposes, which were also used for model calibration and verification.

USGS rating curve, observed flow, and stage hydrograph data are used to develop peak flow hydrographs for the four return intervals scoped for the project. The frequencies considered for this study are 10-Year (10-percent), 50-Year (2-percent), 100-Year (1-percent) and 500-Year (0.2-percent) for detailed streams. The hypothetical rainfall used in this study was based on NOAA Atlas 14 data. The duration chosen for the frequency storm is 96-hour and the type of distribution chosen is Frequency Storm. Areal adjustment factors were applied to individual HEC-HMS basin models to better simulate a uniformly distributed precipitation event, and to match updated Log-Pearson Type III peak flow frequency gage data.

It should be noted there is a flow reversal that occurs on the upper portion of the Passaic River in Essex County during high flows upstream of its confluence with the Pompton River. This flow reversal affects the USGS gages at both Two Bridges (No. 01389005, drainage area of 740 sq. mi.) and Pine Brook (No. 01381900, drainage area of 349 sq. mi.). This backwater effect results in conditions where the same discharge can occur at two different stages or looped rating curves. For a detailed copy of the Passaic River Watershed study, please contact the FEMA Engineering Library for the "*Hydrologic and Hydraulic Analysis Technical Support Data Notebook: Task Order HSFE02-09-J-0001 for Passaic River Watershed Hydrologic and Hydraulic Study, New Jersey*", dated September 2012.

A summary of the drainage area-peak discharge relationships for all the streams studied by detailed methods is shown in Table 6 - "Summary of Discharges."

Table 6 – Summary of Discharges

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
BEAR BROOK					
At confluence with Canoe Brook	2.3	720	1,140	1,400	2,100
CANOE BROOK					
At John F. Kennedy Parkway	7.1	1,380	2,150	2,580	3,700
At Livingston and Roseland corporate limits	1.54	325	545	675	920
CANOE BROOK TRIBUTARY NO. 1					
At Millburn Township and Livingston Corporate Limits	1.3	430	710	870	1,250
At confluence with Canoe Brook	1.0	265	435	535	805
CANOE BROOK TRIBUTARY NO.2					
At confluence with Canoe Brook	0.7	380	560	680	900
CANOE BROOK TRIBUTARY NO. 3					
At confluence with Canoe Brook	0.5	290	440	520	700
CROOKED BROOK	*	*	*	*	*
CRYSTAL LAKE BRANCH					
At confluence with West Branch Rahway River	0.2	80	140	170	300
CUB BROOK					
At confluence with Bear Brook	0.6	320	460	540	720

* Data not available

Table 6 – Summary of Discharges (Continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
DEEPAVAAL BROOK					
At confluence with Passaic River	6.85	1,000	1,540	1,860	2,570
Upstream of confluence with Green Brook	1.26	340	470	550	690
ELIZABETH RIVER					
At approximately 300 feet downstream of Mill Road	5.21	1,238	1,900	2,190	2,972
At Springfield Avenue	3.9	932	1,465	1,665	2,297
FOULERTON'S BROOK					
At confluence with Passaic River	3.91	475	775	945	1,360
At Eagle Rock Avenue	1.69	410	670	825	1,180
At the Roseland and Livingston Corporate Limits	1.3	400	670	820	1,360
KANE BROOK					
At confluence with Unnamed Tributary	0.9	257	428	530	731
At Central Avenue	0.4	221	276	311	370
LIGHTNING BROOK	*	*	*	*	*
NORTH BRANCH FOULERTON'S BROOK					
At Eisenhower Parkway	1.9	480	780	975	1,420
At Morristown and Erie Railroad	1.58	435	710	870	1,250
GREEN BROOK					
At confluence with Deepavaal Brook	3.97	660	1,070	1,310	1,880
At confluence with Kane Brook	1.9	363	604	747	1,037
At Fairfield and North Caldwell Corporate Limits	1.47	465	750	920	1,370

* Data not available

Table 6 – Summary of Discharges (Continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
GREEN BROOK (continued)					
Upstream of confluence of Tributary 1	1.18	370	600	740	1,250
At Central Avenue	0.8	321	423	467	507
NISHUANE BROOK					
At confluence with Second River Tributary	*	*	*	1,489	*
Approximately 450 feet downstream of Orange Road	*	*	*	1,213	*
PASSAIC RIVER (DOWNSTREAM)					
Above confluence with Second River	906	17,746	23,900	30,772/ 38,465[1]	43,185
PASSAIC RIVER (UPSTREAM)					
Upstream of confluence of Pompton River	361	7,335	10,660	12,612/ 15,765[1]	16,345
Downstream of confluence of Rockaway River	345	6,612	9,482	10,845/ 13, 545[1]	13,545
PASSAIC RIVER TRIBUTARY					
At confluence with Passaic River	10.2	3,070	3,725	4,175	5,515
Upstream of confluence with Great Notch Brook	8.9	2,700	3,150	3,458	4,485
Upstream of Diversion to Passaic River	8.8	3,340	5,255	6,265	9,200
Upstream of confluence with Unnamed Tributary	8.0	3,085	4,850	5,780	8,490

[1] Peak discharge calculated for New Jersey Flood Hazard Area Design Flood (NJFHADF) is equal to the 1-percent annual chance flow plus an additional 25-percent in flow, and not to exceed the 0.2-percent annual chance flow.
* Data not available

Table 6 – Summary of Discharges (Continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
PECKMAN RIVER					
Just upstream of confluence of Peckman River Tributary	6.9	2,765	4,350	5,185	7,615
Just upstream of confluence with Taylor Brook	5.0	2,185	3,435	4,095	6,015
Just upstream of Ozone Avenue	4.5	1,990	3,130	3,730	5,480
Just upstream of Linden Avenue	3.6	1,680	2,640	3,150	4,625
Just upstream of confluence with Tributary to Peckman River	2.2	1,165	1,835	2,185	3,210
Just upstream of inlet to Verona Lake	1.5	900	1,410	1,685	2,475
PECKMAN RIVER TRIBUTARY					
At confluence with Peckman River	0.37	200	320	380	530
PINE BROOK					
(West Caldwell)	3.0	715	1,145	1,400	2,000
At approximately 300 feet upstream of Eagle Rock Avenue	2.5	570	1,070	1,290	1,800
EAST BRANCH RAHWAY RIVER					
Just upstream of Millburn Avenue	6.7	1,340	2,090	2,455	3,530
Just upstream of Pierson Road	6.4	1,330	2,040	2,440	3,510
Just upstream of Baker Street	5.0	1,125	1,735	2,080	3,005
Just upstream of Erie Lackawanna Railroad culvert	4.5	1,115	1,720	2,070	2,980
Just upstream of Orange Avenue	3.7	1,040	1,605	1,930	2,780
Just downstream of Montrose Avenue	2.2	780	1,215	1,470	2,215
Just upstream of Meeker Avenue	1.8	670	1,050	1,275	1,850

Table 6 – Summary of Discharges (Continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
EAST BRANCH RAHWAY RIVER (continued)					
Just upstream of confluence with East Fork of East Branch Rahway River	1.5	670	955	1,165	1,696
EAST FORK OF EAST BRANCH RAHWAY RIVER	*	*	*	*	*
TRIBUTARY TO EAST BRANCH RAHWAY RIVER	*	*	*	*	*
WEST FORK OF EAST BRANCH RAHWAY RIVER	*	*	*	*	*
WEST BRANCH RAHWAY RIVER					
At approximately 1,300 feet upstream of West Palmer Avenue	4.5	600	980	1,190	1,860
Just upstream of Orange Reservoir Dam	3.9	700	1,203	1,500	2,500
Just upstream of confluence with Turtle Brook	1.9	570	910	1,110	1,700
SECOND RIVER					
At confluence with Passaic River	15.7	3,790	5,250	5,890	7,530
At Franklyn Avenue	11.6	2,910	3,900	4,355	5,625
At Willet Street	10.4	*	*	5,750	*
At approximately 900 feet upstream of Washington Street (Toneys Brook)	2.65	1,277	1,925	2,256	3,137
At Glenwood Avenue	*	*	*	2,256	*
At Brighton Avenue	*	*	*	3,658	*
At Prospect Glenwood Avenue	*	*	*	4,360	*

* Data not available

Table 6 – Summary of Discharges (Continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
SECOND RIVER (continued)					
At Glen Ridge and Montclair Corporate Limits	2.5	*	*	1,914	*
At Glen Ridge Avenue	*	*	*	1,454	*
SECOND RIVER TRIBUTARY					
At East Orange and Orange Corporate Limits (Wigwam Brook)	3.68	1,495	2,345	2,795	4,070
NORTH BRANCH WIGWAM BRANCH	*	*	*	*	*
BRANCH OF NORTH BRANCH WIGWAM BROOK	*	*	*	*	*
SLOUGH BROOK					
At Parsonage Hill Road	1.7	400	600	810	1,200
SLOUGH BROOK TRIBUTARY					
At Parsonage Hill Road	0.3	140	200	240	320
ST. PAUL BRANCH	*	*	*	*	*
TAYLOR BROOK					
At confluence with Peckman River	1.4	380	610	720	1,030
THIRD RIVER					
At Joralemon Street	9.0	2,180	2,775	3,020/ 3,775[1]	4,075
At confluence with Third River Tributary No. 1	5.84	1,275	1,913	2,300/ 2,875[1]	3,080

[1] Peak discharge calculated for New Jersey Flood Hazard Area Design Flood (NJFHADF) is equal to the 1-percent annual chance flow plus an additional 25-percent in flow, and not to exceed the 0.2-percent annual chance flow.

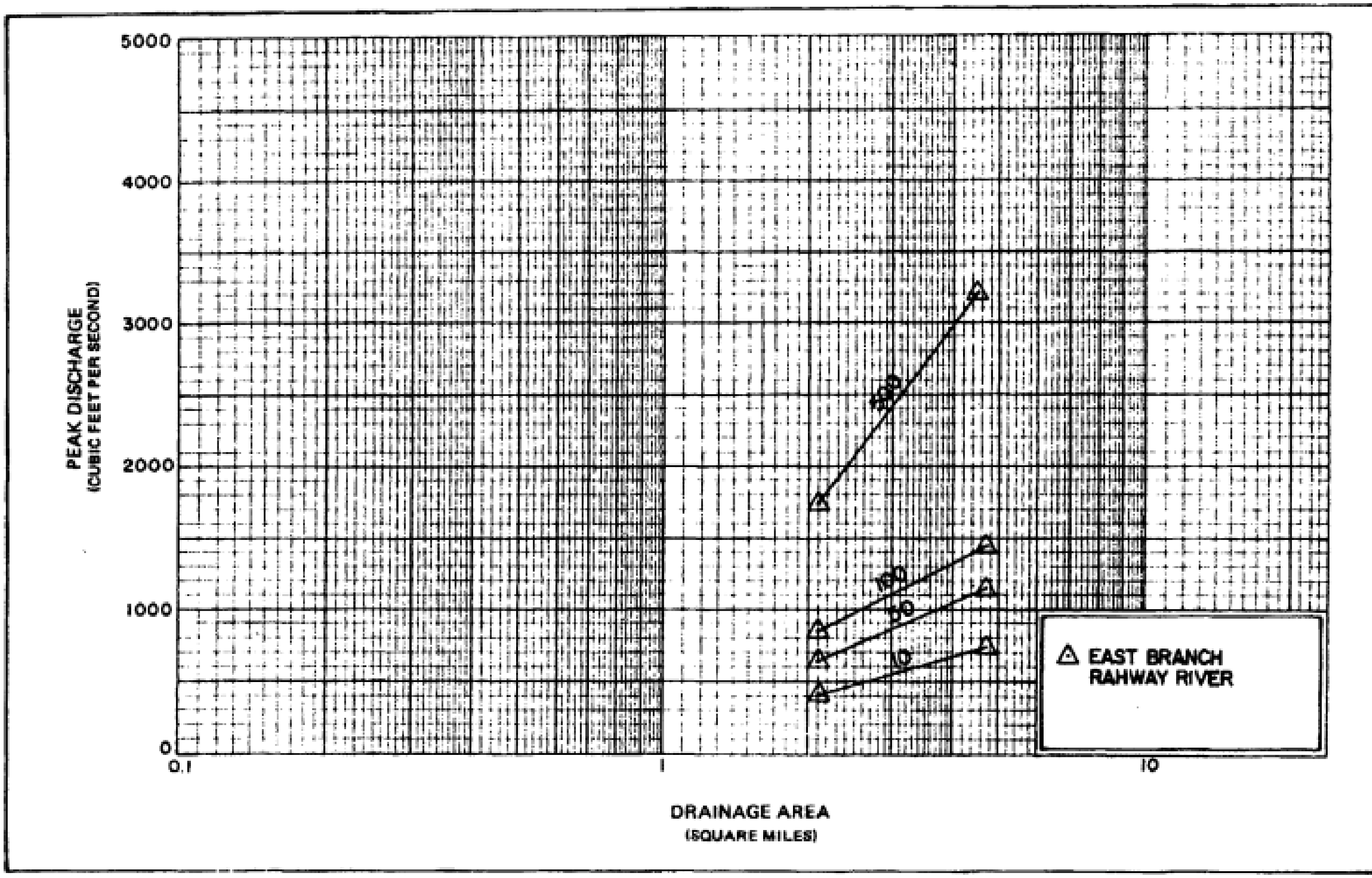
* Data not available

Table 6 – Summary of Discharges (Continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
THIRD RIVER (continued)					
At the Garden State Parkway	3.0	1,010	1,290	1,400/ 1,750[1]	1,880
At the Montclair Corporate Limits	3.0	630	948	1,295/ 1,458[1]	1,458
THIRD RIVER TRIBUTARY NO. 1					
At Glen Ridge and Montclair Corporate Limits	1.0	415	630	720	950
At confluence with Third River	0.6	*	*	550	*
TURTLE BROOK	*	*	*	*	*
VAN WINKLES BROOK					
At Millburn Avenue	1.2	410	670	860	1,230
YANTACAW BROOK					
At Bloomfield and Montclair Corporate Limits	0.5	275	430	630	*

[1] Peak discharge calculated for New Jersey Flood Hazard Area Design Flood (NJFHADF) is equal to the 1-percent annual chance flow plus an additional 25-percent in flow, and not to exceed the 0.2-percent annual chance flow.

* Data not available

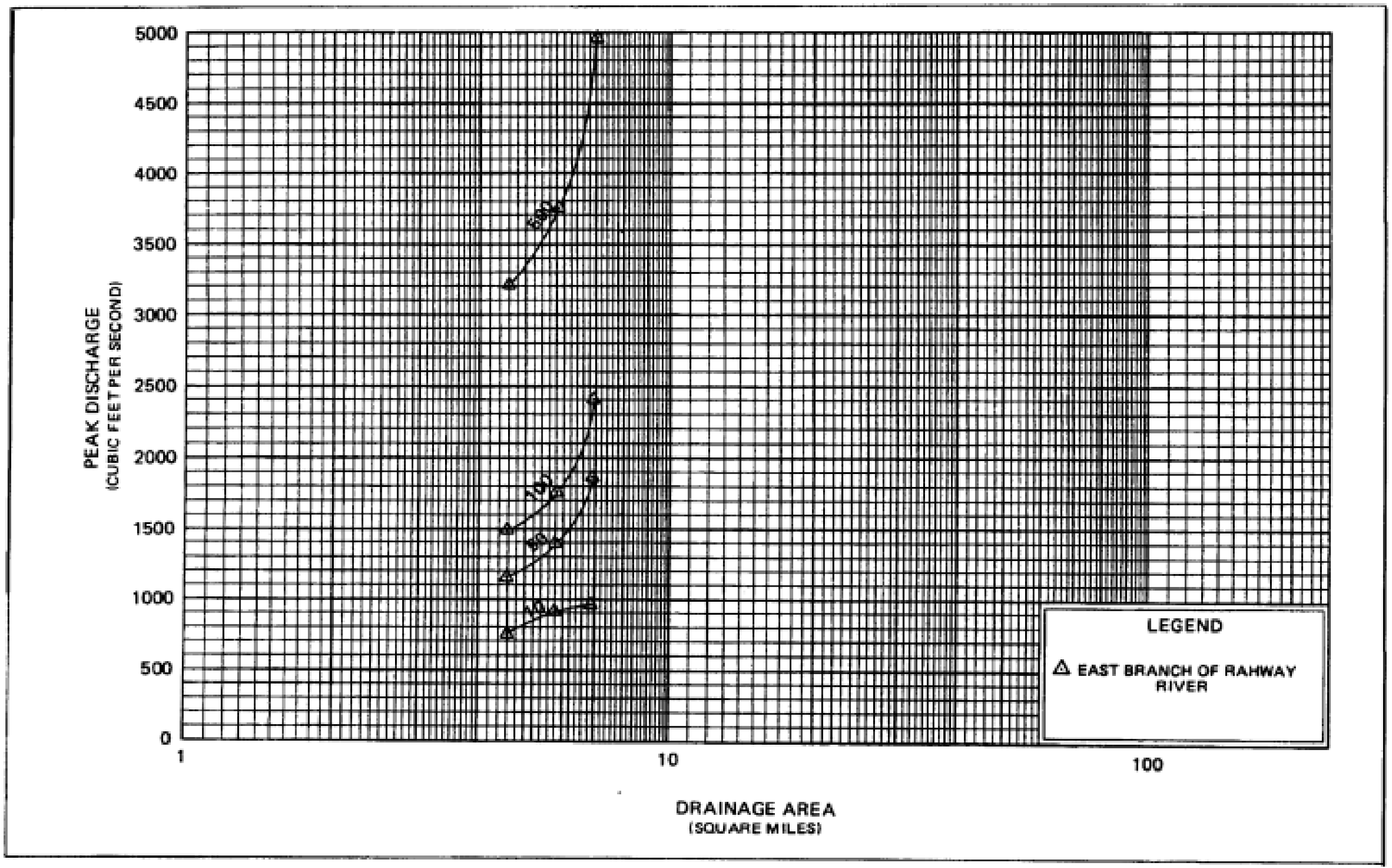


FEDERAL EMERGENCY MANAGEMENT AGENCY
ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

EAST BRANCH RAHWAY RIVER

FIGURE 1

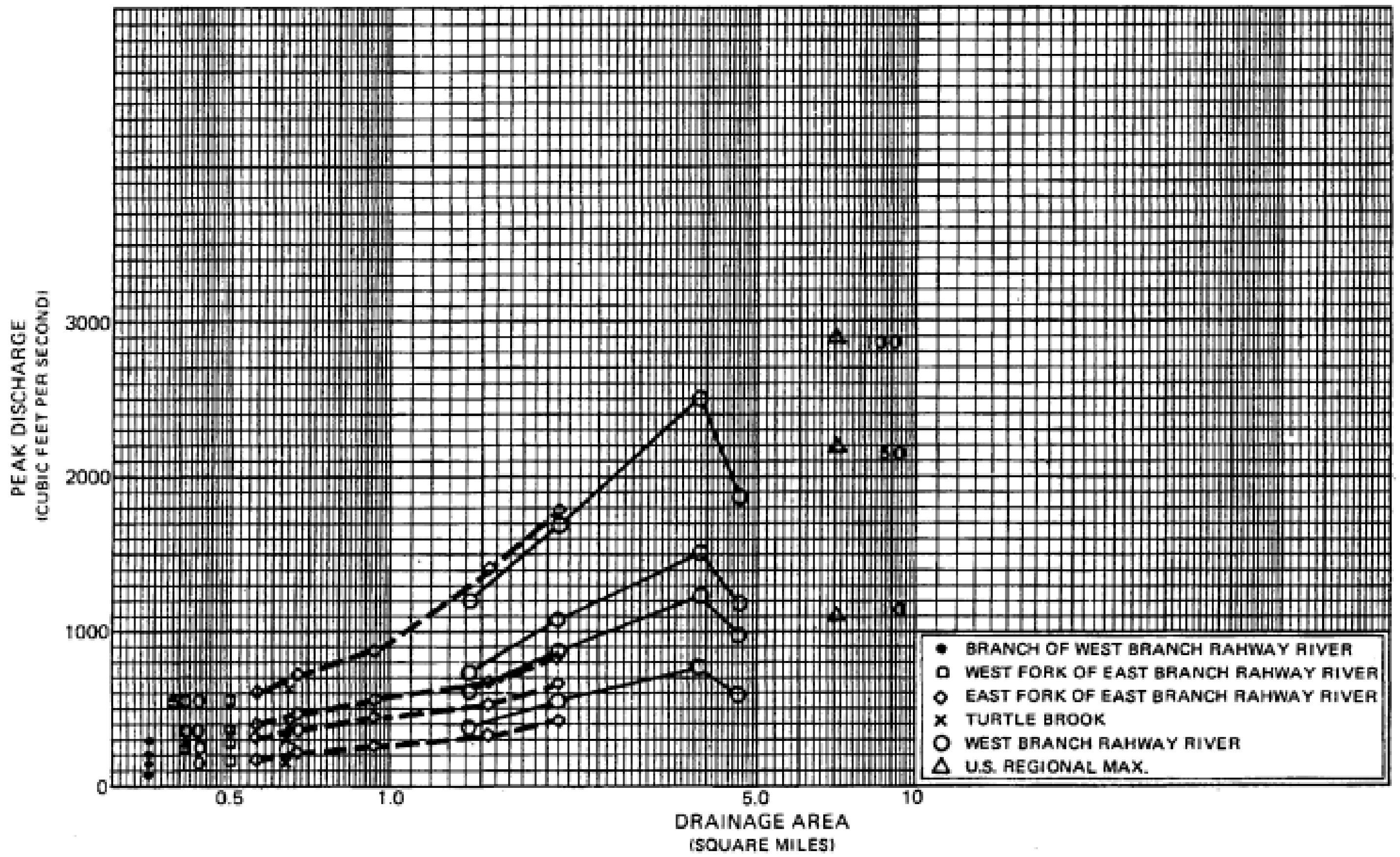


FEDERAL EMERGENCY MANAGEMENT AGENCY
ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

EAST BRANCH RAHWAY RIVER

FIGURE 1



FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ

(ALL JURISDICTIONS)

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

EAST AND WEST BRANCH RAHWAY RIVER AND TRIBUTARIES

FIGURE 1

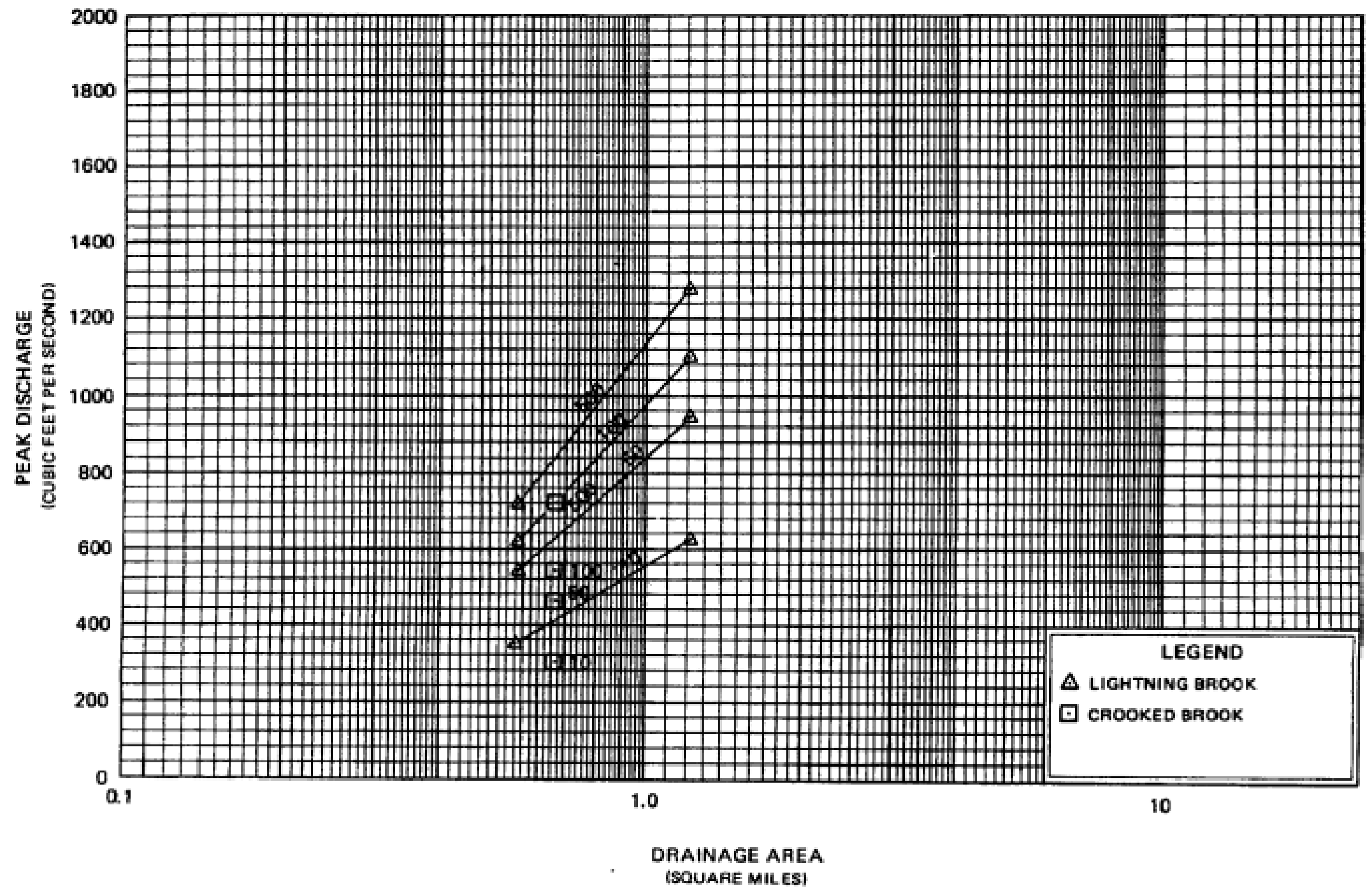
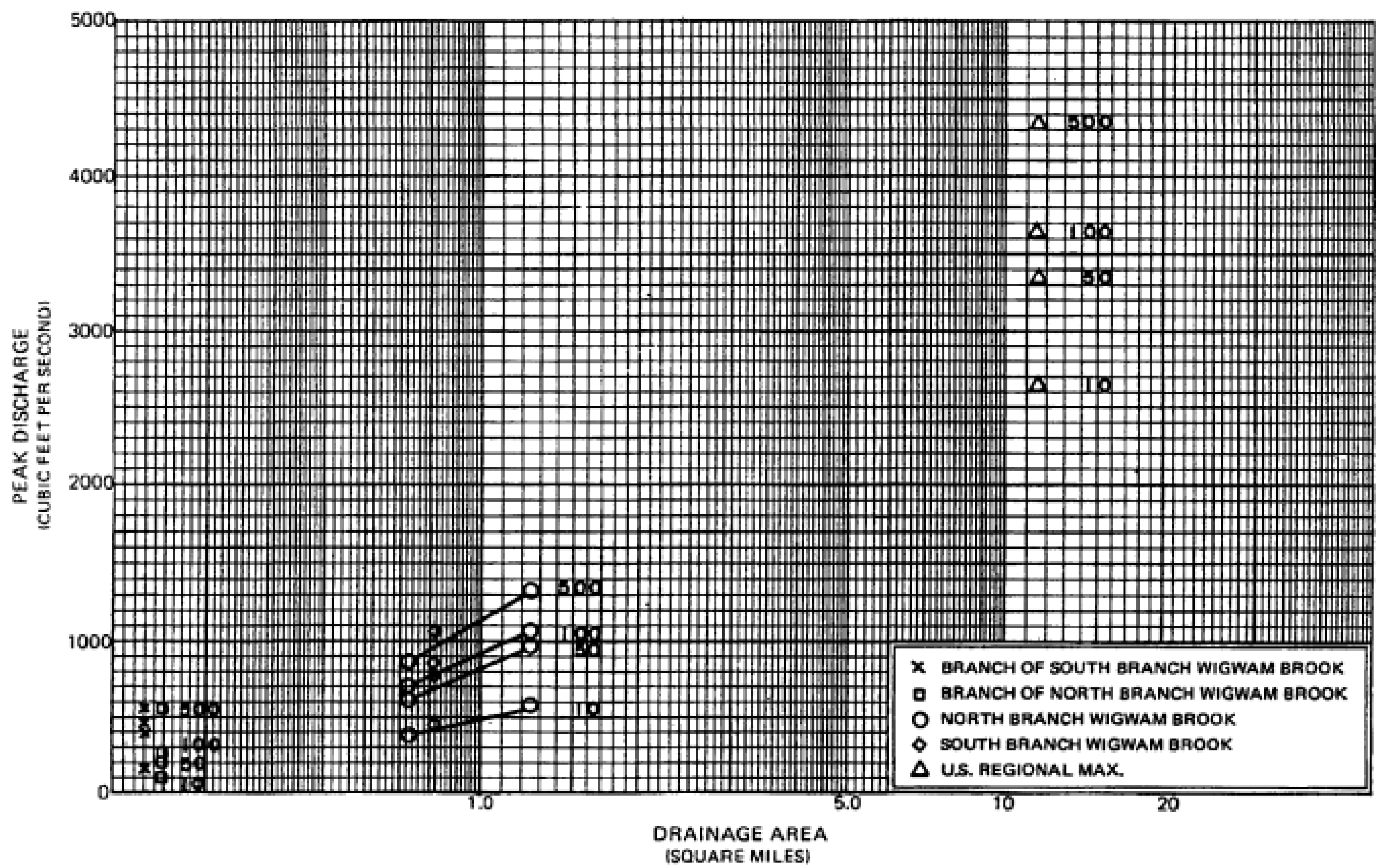


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY
ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

LIGHTNING BROOK-CROOKED BROOK



FEDERAL EMERGENCY MANAGEMENT AGENCY

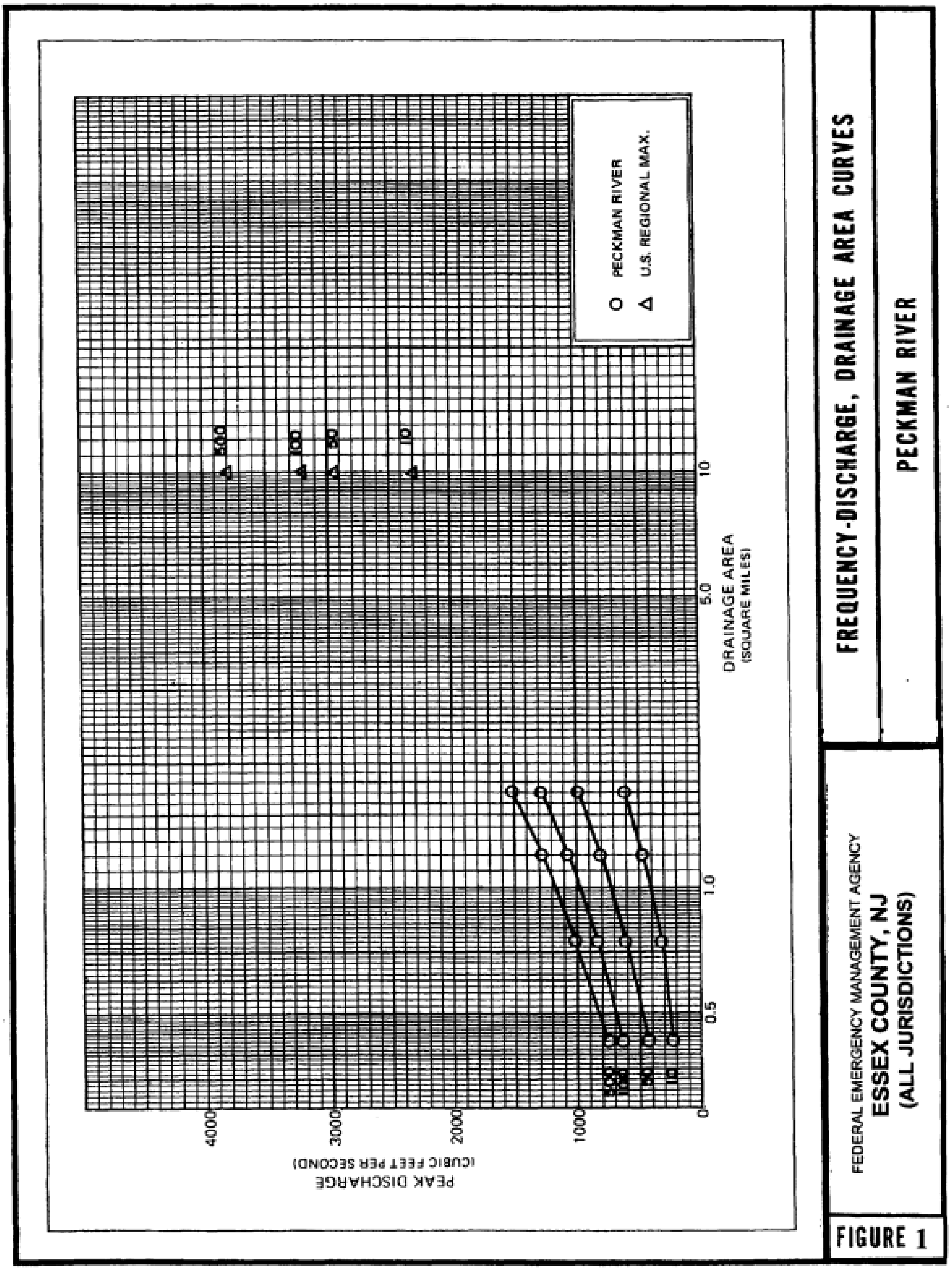
ESSEX COUNTY, NJ

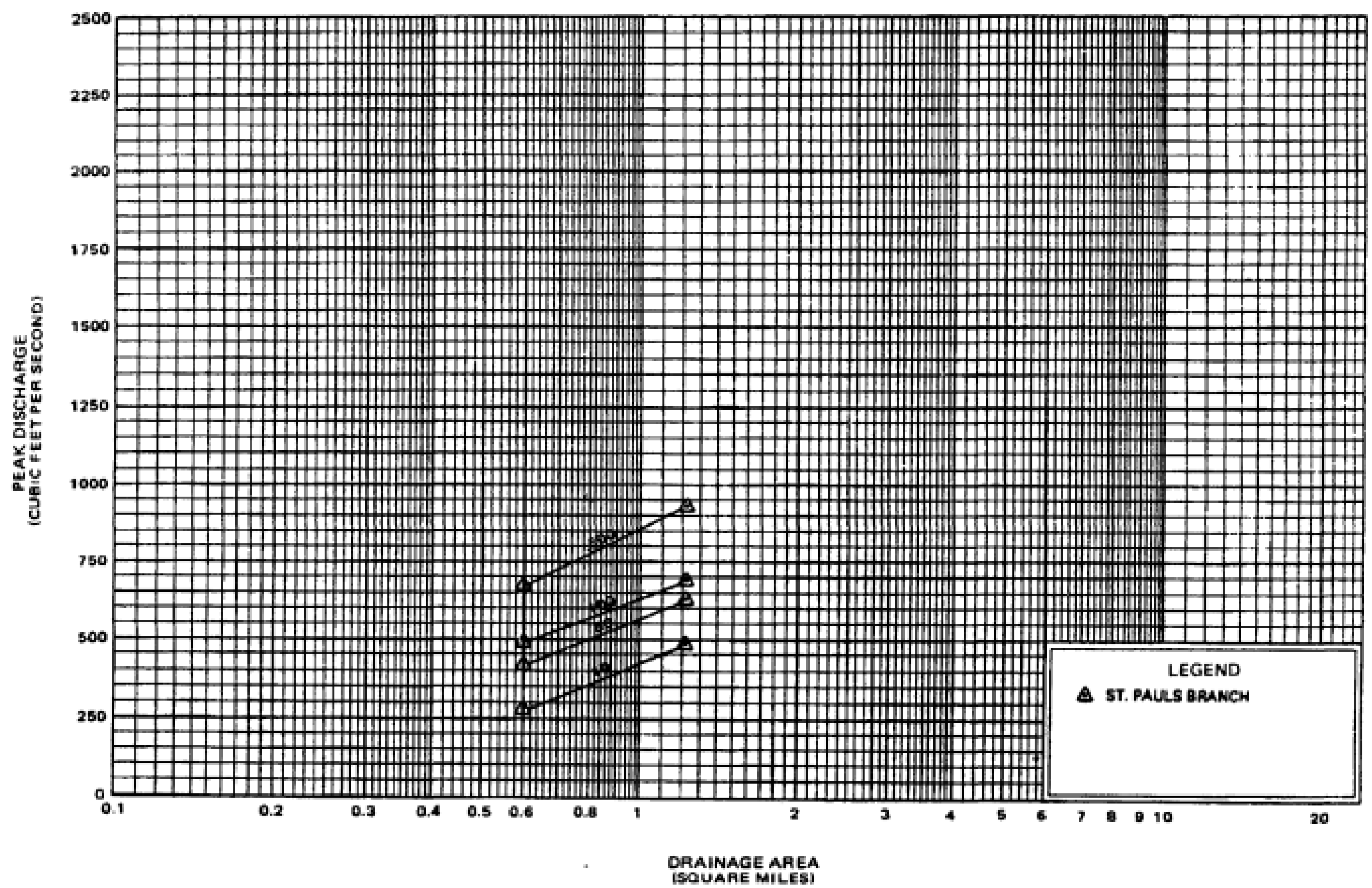
(ALL JURISDICTIONS)

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

NORTH AND SOUTH BRANCH WIGWAM BROOK AND TRIBUTARIES

FIGURE 1


PEAK DISCHARGE
(CUBIC FEET PER SECOND)
4000
3000
2000
1000
0
0.5
1.0
5.0
10
DRAINAGE AREA
(SQUARE MILES)
500
100
50
10
PECKMAN RIVER
U.S. REGIONAL MAX.
FEDERAL EMERGENCY MANAGEMENT AGENCY
ESSEX COUNTY, NJ
(ALL JURISDICTIONS)
FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES
PECKMAN RIVER
FIGURE 1



FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ

(ALL JURISDICTIONS)

FREQUENCY DISCHARGE, DRAINAGE AREA CURVES

ST. PAULS BRANCH

FIGURE 1

3.2 Hydraulic Analyses

Analysis 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 FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

Flood profiles were drawn showing computed water-surface elevations (WSELs) to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1). The locations of selected cross sections used in the hydraulic analysis are shown on these profiles as well. For stream segments for which a floodway was computed (Section 4.2), selected cross-section locations are also shown on the FIRM.

The hydraulic analysis 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.

Natural channel and overbank roughness factors (Manning's "n" values) were chosen by engineering judgment and based on field observations of the streams and floodplain areas. For a complete list of Manning's "n" factors used in this study, see Table 7, "Manning's "n" Values".

Prior to the June 4, 2007, countywide FIS, each community within Essex County, with the exception of the Borough of Caldwell, has a previously printed FIS report. The hydraulic analysis described in those reports have been compiled and are summarized.

WSELs for floods of the selected recurrence intervals for the streams studied by detailed methods were computed using the USACE HEC-2 step-backwater computer program (HEC, 1974; various dates).

For the Township of Belleville cross-section data for the backwater analysis was taken from the 1938 USACE Survey (USACE, 1938). This information was field checked and supplemented where appropriate with the 1935 Work Projects Administration Survey, a 1976 topographic survey, and data obtained from the Township Engineer (Works Project Administration, 1935; GEOD Aerial Mapping, Inc., Unpublished(a)). The cross sections were located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures in the highly urbanized areas.

Starting WSELs for the Second River in Belleville were taken from the FIS for the City of Newark (FEMA, 1980a).

For the Township of Cedar Grove cross sections for the backwater analysis of the Peckman River, Taylor Brook, and Peckman River Tributary were taken from field-surveyed channel data (GEOD Aerial Mapping, Inc., Unpublished(c)) and overbank areas taken from topographic maps.

Cross sections for the backwater analysis of Second River Tributary and Nishuane Brook for the City of East Orange were field surveyed and were located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures in urbanized areas.

Starting WSELs for Second River Tributary in East Orange were taken from a profile prepared for the FIS for the Township of Bloomfield (New Jersey, 1973). The starting WSELs for Nishuane Brook were determined using coincident peak with Second River Tributary.

The cross sections for the backwater analysis of Pine Brook in Essex Fells were determined by combining newly field-surveyed channel and bridge data with overbank data taken from aerial photographs (Essex County Department of Public Work, Unpublished). The computer model for Pine Brook was calibrated with the aid of known flood mark information obtained by interview with local residents. Starting WSELs for Pine Brook were obtained from the West Caldwell FIS (FEMA, 1979). For the stream studied by approximate methods, depth-discharge frequency relationships developed by the USGS were used (New Jersey, 1963). Boundaries for ponding areas caused by inadequate drainage were obtained from known high-water marks and from consultation with borough officials.

Cross-section data for the Township of Fairfield were obtained from aerial photographs (Robinson Aerial Surveys, 1964): below-water sections were obtained by field measurement. Starting WSELs for Deepavaal Brook and Green Brook were determined by the slope/area method.

Channel cross sections and partial overbank cross sections for the Borough of Glen Ridge were obtained from field surveys. The overbanks were extended using topographic maps compiled from aerial photographs (GEOD Aerial Mapping, Inc., 1977a). Cross sections were located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of those structures. All bridges and culverts were field surveyed to obtain elevation data and structural geometry. Starting WSELs for Toneys Brook in Glen Ridge were obtained from the Supplemental Flood Study I, Phase II, prepared for the Township of Bloomfield (New Jersey, Unpublished).

Channel cross sections and partial overbank cross sections for the Township of Irvington were obtained through field surveys. The overbanks were extended using topographic maps (GEOD Aerial Mapping, Inc., 1976).

Floods along Lightning Brook in Irvington were based upon depth, discharge-frequency relationships for riverine sites in New Jersey based upon the mean annual flood. This was supplemented with information from the municipal engineer and field investigations to delineate approximate boundaries. Floods in areas of inadequate drainage in the vicinity of Breakenridge Terrace, along Chestnut Avenue, along Franklin Terrace, in the vicinity of Stratford Place, and between Harding Terrace and Edmund Place were also based upon field investigation and information from the municipal engineer.

For the original March 15, 1977, Livingston FIS, WSELs for floods of the selected recurrence intervals were computed through use of the USACE HEC-2 computer program Water-Surface Profiles (HEC, various dates). Channel cross sections for the backwater analysis of all streams in the township were field surveyed and were located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures in highly urbanized areas. The overbanks were extended with the use of the Essex County Aerial Survey of Livingston dated April 1969 (Essex County Drainage Engineer, 1969). In areas where the aerial photographs did not indicate recent development, full cross sections of the streams were taken.

The Passaic River cross sections for Livingston were supplied by Dames & Moore. These cross sections were field surveyed with additional information added from the 2-foot contour interval map (Essex County Drainage Engineer, 1969).

For the December 17, 1987, Livingston FIS report, cross sections for the Passaic River were obtained from the Flood Insurance Studies for the Borough of Florham Park and the City of East Hanover (FEMA, 1986; USGS, 1975). The overbank was extended with the use of the Essex County Aerial Survey (Essex County Drainage Engineer, 1969). In areas where the aerial photographs did not indicate recent development, full cross sections of the streams were taken.

Starting elevations for East Branch Rahway River and Lightning Brook in the Township of Maplewood were developed by the slope-area method. Crooked Brook starting elevations were developed using a 1-year recurrence interval discharge, with the Rahway River peak backwater effects being the control. All elevations are measured from mean sea level datum; Elevation Reference Marks used in the study are shown on the maps.

The hydraulic analysis for Van Winkles Brook in the Township of Millburn was taken from the FIS for the Township of Springfield (FEMA, 1982). For Canoe Brook Tributary No. 1, the hydraulic analysis was taken from the FIS for the Township of Livingston (FEMA, 2001).

WSELs for the 1- and 0.2-percent-annual-chance floods along West and East Branch Rahway Rivers were taken from a report prepared by E.T. Killam for the Township of Millburn (Elson T. Killam Associates, Inc., 1976).

The starting WSELs for the Passaic River in Millburn were obtained from the effective FIS for the Township of Fairfield showing computed WSELs for floods of selected recurrence intervals. The starting WSELs for Van Winkles Brook were calculated using normal depth developed from slope/area calculations.

Cross sections for the Second River in the City of Newark were field surveyed and were located at close intervals above and below bridges and culverts to compute the significant backwater effects of these structures in the highly urbanized areas.

Starting WSELs for Newark were taken from the tide elevations of the Passaic River. Elevations for the detailed analysis of the Elizabeth River were taken from the Irvington, New Jersey FIS, and were computed through the use of the USACE HEC-2 step-backwater computer program (HEC, 1974 and various dates). No profiles were developed for Newark Bay and the Passaic River because flooding is tidal and elevations are constant.

The 1-percent-annual-chance water surface-elevation for Branch Brook and Weequahic Lake in Newark were determined by field inspection and using flood-prone area maps (USGS, 1973, 1972b).

For the approximate analysis of Tributary 1 in North Caldwell, the extent of the 1-percent-annual-chance flood was determined by the methods outlined in Techniques for Estimating Depth of 100-Year Floods in New Jersey (USGS, 1979). For the approximate analysis of Tributary 2 and Tributary 3, the extent of the 1-percent-annual-charice flood was determined by combining past flooding limits with engineering judgment. These limits were then compared to approximate limits of flooding determined using curves established for non-coastal plain sites in New Jersey. The curves use the mean annual flood discharge for a specific area to predict the depth of flow for a specific frequency.

Cross-section data for the backwater analysis for St. Pauls Branch was obtained from field surveys. Cross sections were located at close intervals above and below bridges and culverts in order to compute the significant backwater effect of those structures in highly urbanized areas.

WSELs of floods in Nutley of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (HEC, various dates). Flood profiles were drawn showing computed WSELs for floods of the selected recurrence intervals. Starting WSELs for St. Pauls Branch were developed by the slope/area methods.

Channel cross sections and partial overbank cross sections for the City of Orange Township were obtained through field surveys. The overbanks were extended using topographic maps compiled from aerial photographs (GEOD Aerial Mapping, Inc., 1977a). In areas where aerial photographs did not indicate the most recent development, full cross sections of the streams were taken.

For Wigwam Brook, the East Branch Rahway River, and the upper portion of the East Fork of East Branch Rahway River in Orange, WSELs of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (HEC, various dates). For Wigwam Brook, the analysis was obtained from Supplemental Study No. IV (URS Corporation, Inc., Unpublished). The analysis for the East Branch Rahway River was obtained from Supplemental Study No. V (Leonard Jackson Associates, Unpublished) and the analysis for the East Fork of East Branch Rahway River were obtained from the FIS for the Township of West Orange (FEMA, 1976).

Starting WSELs for Wigwam Brook in the City of Orange Township were obtained from Supplemental Study No. IV (URS Corporation, Inc., Unpublished). Starting WSELs for the East Branch Rahway River were obtained from the FIS for the Township of Maplewood (FEMA, 1977a). Starting WSELs for the East Fork of East Branch Rahway River were determined by balancing weir and pressure flows at the upstream end of the culvert system.

Hand calculations were performed for the lower portion of the East Fork of East Branch Rahway River in Orange to determine the extent of shallow flooding. That portion of the stream, which is from the confluence with the East Branch Rahway River to a point approximately 320 ft. downstream of Freeman Street, consists of a combination of various- sized conduits and culverts. The hand calculations were based on computing losses starting at the crown of the "Brick Area" as it enters the East Branch Rahway River. A stage-discharge relationship was developed upstream of Forest Street based on a combination of pipe flow and weir flow down South Jefferson Street and Tompkins Street. WSELs from the rating curve were tied into the existing profiles as developed in the FIS for the Township of West Orange (FEMA, 1976).

WSELs of floods of the selected recurrence intervals for Canoe Brook, Foulerton's Brook,

Passaic River and North Branch Foulerton's Brook in the Borough of Roseland were computed using the USACE HEC-2 step-backwater computer program (HEC, various dates).

Starting WSELs for Foulerton's Brook in Roseland were determined using normal depth calculations. For North Branch Foulerton's Brook, starting WSELs were taken from the Foulerton's Brook confluence. Starting WSELs for Canoe Brook were obtained from the water-surface profiles developed for the detailed study of Canoe Brook in the downstream community of Livingston. Flood profiles were drawn showing computed WSELs for floods of the selected recurrence intervals.

For North Branch Foulerton's Brook above Livingston Avenue in Roseland, the depth discharge relationship developed by the USGS (New Jersey, 1964) was utilized to determine approximate 1-percent-annual-chance flood elevations.

Cross sections for the backwater analysis of the East Branch Rahway River in the Village of South Orange were obtained from the General Design Memorandum on the East Branch Rahway River at South Orange, New Jersey (USACE, 1969). The overbanks were field surveyed. Locations of representative cross sections used in the backwater analysis are shown on the Flood Boundary and Floodway Map.

Cross sections for the backwater analysis of the Peckman River in the Township of Verona were taken by combining field-surveyed channel data with overbank data taken from topographic survey (GEOD Aerial Mapping Inc., Unpublished(b)). Cross sections were located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures in the highly urbanized areas.

Starting WSELs for Verona were taken from the FIS of the Township of Cedar Grove, New Jersey (FEMA, 1980b). The limit of flooding in the approximate study area was based on the use of Flood Depth-Discharge-Frequency Relations for Non-Coastal Plain Sites in New Jersey, developed by the USGS (HEC, various dates). This method determines the difference in depth between the mean annual flood and the 1-percent-annual-chance flood.

For West Caldwell streams studied by approximate methods, the 1-percent-annual-chance flood was determined by the method described in <u>Flood Depth Frequency in New Jersey</u> (New Jersey, 1964). A tributary of Kane Brook was designated as Zone X (shaded) because its drainage area was less than 1 sq. mi. The remaining streams were designated Zone X, areas of minimal flooding, because their floodplains were less than 200 ft. wide.

Starting elevations on the West Branch Rahway River in the Township of West Orange downstream from Orange Reservoir were obtained by the slope-area method. The Orange Reservoir Spillway was used as a control for starting elevations upstream from it. Starting elevations for Turtle Brook in West Orange were obtained from the computer profile elevation at its confluence with West Branch Rahway River. Starting elevations for Peckman River were obtained from a control point at the spillway at Verona Lake in Verona, downstream from the West Orange corporate limits. Starting elevations for the West Fork of East Branch Rahway River were obtained from FIS profiles developed for the downstream community of South Orange Village (FEMA, 1977b; 1987a; 2001). Starting elevations for East Fork of East Branch Rahway River in West Orange were developed by computing a rating curve at the Freeman Street Bridge. Starting elevations for Wigwam Brook were derived from backwater analysis developed for the City of East Orange FIS (FEMA, 1987b) and extended to the West Orange corporate limits. Starting elevations for South Branch Wigwam Brook were taken from the computer profiles of North Branch Wigwam Brook at its confluence point.

For the June 4, 2007, countywide FIS, detailed studies were completed in 2005 for Bear Brook, Canoe Brook, Canoe Brook Tributary No. 1, Crystal Lake Branch, Peckman River, East Branch of the Rahway River, West Branch of the Rahway River, and Slough Brook. For limits of the revision refer to Table 4 - “June 4, 2007, Scope of Revision”.

New cross sections were defined and new HEC-RAS and HEC-2 computer models (Elson T. Killam Associates, Inc., 1972) were developed to account for bridges, culverts, weirs, channel relocation and improvements, areas of recent fill, and development in or near the floodplain that have occurred since the original FIS on the studied streams. Field surveying for this study included collection of overbank and underwater data as well as field surveying hydraulic structures to obtain elevation and structural geometry data. Topographic maps used were provided by the NJDEP and were at a scale of 1"=200', with contour intervals of 2 ft. Hydraulic analysis was conducted using the NGVD 29 for Bear Brook, Canoe Brook, Canoe Brook Tributary, Crystal Lake Branch, East Branch Rahway River, West Branch Rahway River and Slough Brook. Hydraulic analysis for Peckman River were conducted using NAVD 88.

Starting WSELs for the Canoe Brook, Canoe Brook Tributary No. 1, East Branch Rahway River, and Slough Brook were taken from known WSELs as defined by the effective FIS. Starting WSELs for the Crystal Lake Brach, West Branch Rahway River, and Peckman River were obtained utilizing slope-area method.

Due to an elevated road profile at the Route 46 Bridge in the Township of Little Falls, a diversion of flows occurs from the Peckman River to the Passaic River. This diversion reduces the flow which remains in the Peckman River downstream of the Route 46 Bridge.

For the [date], countywide FIS revision, new detailed hydraulic analysis was carried out for Passaic River and the Third River. It should be noted, the updated coastal analysis conducted for this countywide FIS revision supersedes the detailed riverine analysis along the downstream reach of Passaic River, from Newark Bay to the confluence with Second River at the corporate limits of the City of Newark and Township of Belleville.

The new hydrologic and hydraulic analysis for the Passaic River in Essex County, New Jersey was part of a larger study that included hydrologic modeling for the Passaic River watershed and a 41.2-mile long hydraulic study spanning Bergen, Essex, Hudson, Passaic and Morris counties in the State of New Jersey. Approximately 29.6 miles of the 41.2-mile long study are contained within Essex County. For a detailed copy of the Passaic River Watershed study, please contact the FEMA Engineering Library for the "*Hydrologic and Hydraulic Analysis Technical Support Data Notebook: Task Order HSFE02-09-J-0001 for Passaic River Watershed Hydrologic and Hydraulic Study, New Jersey*", dated September 2012.

For the [date], countywide FIS revision, the water surface elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance flood events, for Passaic River and the Third River were studied by detailed methods.

Water surface elevations for the NJFHADF were also computed. The NJFHADF is equal to the 100-year flood in tidal areas and the 100-year flood plus an added factor of safety in non-tidal areas (NJ flood hazard area design flood = 125-percent of 100-year discharge in non-tidal areas), not to exceed the 0.2-percent annual chance flood. The NJDEP is mandated to delineate and regulate flood hazard areas pursuant to N.J.S.A. 58:16A-50 et seq., the Flood Hazard Area Control Act. This Act authorizes the NJDEP to adopt land use regulations for development within the flood hazard areas, to control stream encroachments and to integrate the flood control activities of the municipal, county, State and Federal Governments.

For all FISs initiated in or after Fiscal Year (FY) 09, the NJFHADF floodplain boundary shall be delineated for all restudied and newly studied streams. The NJFHADF is not considered a future condition.

RAMPP used HEC-RAS version 4.1 (HEC, 2010a) for detail hydraulic models in Essex County, New Jersey. The hydraulic analysis for the Third River used a steady-state riverine analysis, and the hydraulic analysis for Passaic River used an unsteady-state riverine analysis. Both analysis included cross sections and field data collected during detailed field surveys.

Field survey information was collected along natural channel cross-sections for the channels of detailed studied streams. All structures (including dams) along Passaic River and Third River were field surveyed. Cross sections were placed at representative locations; usually no greater than 500 feet apart along the stream centerline. Field surveyed channel geometry was combined in overbank areas with Light Detection and Ranging (LiDAR) data collected in 2006 to complete the modeled cross-sectional geometry. In addition to the field survey cross-sections, non-surveyed or interpolated cross sections were also used to complete the hydraulic modeling along detailed study streams. Field surveyed cross sections were used to interpolate the channel geometry for non-surveyed cross section. All cross section overbank ground information were obtained from the LiDAR data collected in 2006.

The downstream boundary conditions for profiles along Passaic River and the Third River in the HEC-RAS models were calculated using the normal depth method. Using a normal depth method, the flow is assumed to be uniform so the energy slope was estimated by measuring the channel bed slope at the downstream end. For profiles along

Passaic River, runoff hydrographs from approximate unsteady HEC-RAS models and subbasins from the Central Passaic River HEC-HMS basin model were applied as hydrologic boundary conditions.

Manning's n-values for Passaic River were estimated based on survey field photos and 2007 aerial imagery, and along Third River were estimated based on field observation. The channel n-values were all between 0.03 and 0.043. It is typical for stream channels to have lower n-values than the overbanks. The n-values on the overbanks range between 0.03-0.140. Higher values were generally reserved for forested areas while more scattered trees, brush, or developed areas with significant obstructions due to buildings were generally assigned somewhat lower values. The differences in these assigned n-values from stream to stream are a result of slight differences in the terrain and engineering judgment. The n-values used in the HEC-RAS models are summarized in Table 7 - "Mannings "n" Values".

Table 7 – Manning's "n" Values

	Roughness Coefficients	
Flooding Source	Channel "n"	Overbank "n"
Bear Brook	0.035	0.090-0.150
Canoe Brook (Livingston)	0.015-0.040	0.015-0.100
Canoe Brook (Roseland)	0.020-0.040	0.060-0.200
Canoe Brook (Livingston)	0.035	0.15
Canoe Brook Tributary No. 1	0.035	0.15
Canoe Brook Tributary No. 2	*	*
Canoe Brook Tributary No. 2	*	*
Crystal Lake Branch	0.015-0.035	0.080
Cub Brook	*	*
Deepavaal Brook (Fairfield)	0.025-0.050	0.030-0.100
Elizabeth River (Irvington)	0.030-0.035	0.600-0.100
Elizabeth River (Newark)	0.020-0.035	0.060-0.090
Foulterton's Brook (Roseland)	0.020-0.040	0.060-0.200
North Branch Foulerton's Brook (Roseland)	0.020-0.040	0.060-0.200
Green Brook (Fairfield)	0.030-0.080	0.060-0.200
Green Brook (North Caldwell)	0.030-0.045	0.060-0.125
Green Brook Tributary	*	*
Kane Brook	*	*
Lightning Brook	*	*
Nishuane Brook (Montclair)	0.020-0.030	0.060-0.100
Passaic River (Fairfield)	0.030-0.043	0.035-0.14
Passaic River (West Caldwell)	0.035	0.035-0.14
Peckman River	0.030-0.045	0.020-0.100
Peckman River Tributary	*	*
Pine Brook	0.025-0.045	0.08
East Branch Rahway River	0.015-0.025	0.060-0.090
East Branch Rahway River (South Orange)	0.017-0.035	0.050-0.070
West Branch Rahway River	0.030-0.035	0.040-0.120
Slough Brook	0.035-0.060	0.060-0.150
Second River (Belleville)	0.030-0.035	0.050-0.070

*Data Not Available

Table 7 – Manning's "n" Values (continued)

Flooding Source	Roughness Coefficients Channel "n"	Overbank "n"
Second River (Glen Ridge)	0.020-0.035	0.060-0.100
Second River (Montclair)	0.018-0.035	0.020-0.150
Second River (Newark)	0.020-0.035	0.060-0.090
Second River Tributary (Wigwam Brook) (Orange)	0.013-0.021	0.055-0.080
North Branch Wigwam Brook	*	*
Branch of North Branch Wigwam Brook	*	*
St. Pauls Branch (Nutley)	0.035	0.090
Taylor Brook (Cedar Grove)	0.018-0.036	0.040-0.059
Third River (Belleville)	0.030-0.043	0.030-0.140
Third River (Montclair)	0.030-0.043	0.030-0.140
Third River Tributary No. 1(Montclair)	0.015-0.045	0.070-0.150
Van Winkles Brook (Millburn)	0.040	0.060
Yantacaw Brook (Montclair)	0.015-0.045	0.070-.0450

*Data Not Available

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

All elevations are referenced to the North American Vertical Datum of 1988 (NAVD 88).

All qualifying bench marks within a given jurisdiction that are cataloged 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.

Bench marks cataloged 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 well (e.g., mounted in bedrock)
- Stability B: Monuments which generally hold their position/elevation well (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 bench marks, 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 bench marks 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 (TSDN) associated with this FIS and FIRM. Interested individuals may contact FEMA to access this data.

3.3 Coastal Analyses

Coastal storm surge analyses were performed for the Passaic River and Newark Bay and all the bays and inlets within these areas.

The extent of coastal flooding due to hurricanes and northeasters is determined by three factors: 1) the nature of the storm with respect to intensity, duration, and path; 2) astronomical tide conditions at the time the storm-surge wave reaches the shore; and 3) the physical geometry and bathymetry of a particular area, which affects the time and passage of the surge wave.

The FEMA, Region II office, initiated a study in 2009 to update the coastal storm surge elevations within the states of New York and New Jersey including the Atlantic Ocean, the Barnegat Bay, the Raritan Bay, the Jamaica Bay, the Long Island Sound and their tributaries. The study replaces outdated coastal analysis as well as previously published storm surge stillwater elevations for all FIS Reports in the study area, including Essex County, New Jersey, and serves as the basis for updated FIRMs. The coastal study for the New Jersey Atlantic Ocean coast and New York City coast was conducted for FEMA by RAMPP under contract HSFEHQ-09-D-0369 task order HSFE02-09-J-0001.

The region wide, end-to-end storm surge modeling system includes the Advanced Circulation Model for Oceanic, Coastal and Estuarine Waters (ADCIRC) for simulation of 2-dimensional hydrodynamics. ADCIRC was dynamically coupled to the unstructured numerical wave model Simulating Waves Nearshore (unSWAN) to calculate the contribution of waves to total storm surge (FEMA, 2013). The resulting model system is typically referred to as SWAN+ADCIRC (FEMA, 2013). A seamless modeling grid was developed to support the storm surge modeling efforts. The modeling system validation consisted of a comprehensive tidal calibration followed by a validation using carefully reconstructed wind and pressure fields from five major flood events for the Region II domain: the 1938 hurricane, Hurricane Ethel, Hurricane Gloria, and two extra-tropical storms, from 1991 and 1992. Two of the more recent storm events, Hurricane Irene and Hurricane Sandy were not used in this study for validation. Both Hurricane Irene and Hurricane Sandy occurred during the study or after this storm surge was completed. Hurricane Irene was a major rainfall event and did not produce major coastal tidal flooding. The climatology of Hurricane Sandy, at this time, is not well studied.

Model skill was assessed by quantitative comparison of model output to wind, wave, and water level and high water mark observations. The model was then used to simulate 30 historical extra-tropical storms and 157 synthetic hurricanes to create a synthetic water elevation record from which the 10-, 2-, 1-, and 0.2- percent annual chance of exceedence elevations were determined.

Wave set up is the increase in mean water level above the still water level due to momentum transfer to the water column by waves that are breaking or otherwise dissipating their energy (Dean *et. al*., 2005). For the New York and New Jersey surge study, wave setup was determined directly from the coupled wave and storm surge model. The total stillwater elevation (SWEL) with wave setup was then used for the wave modeling.

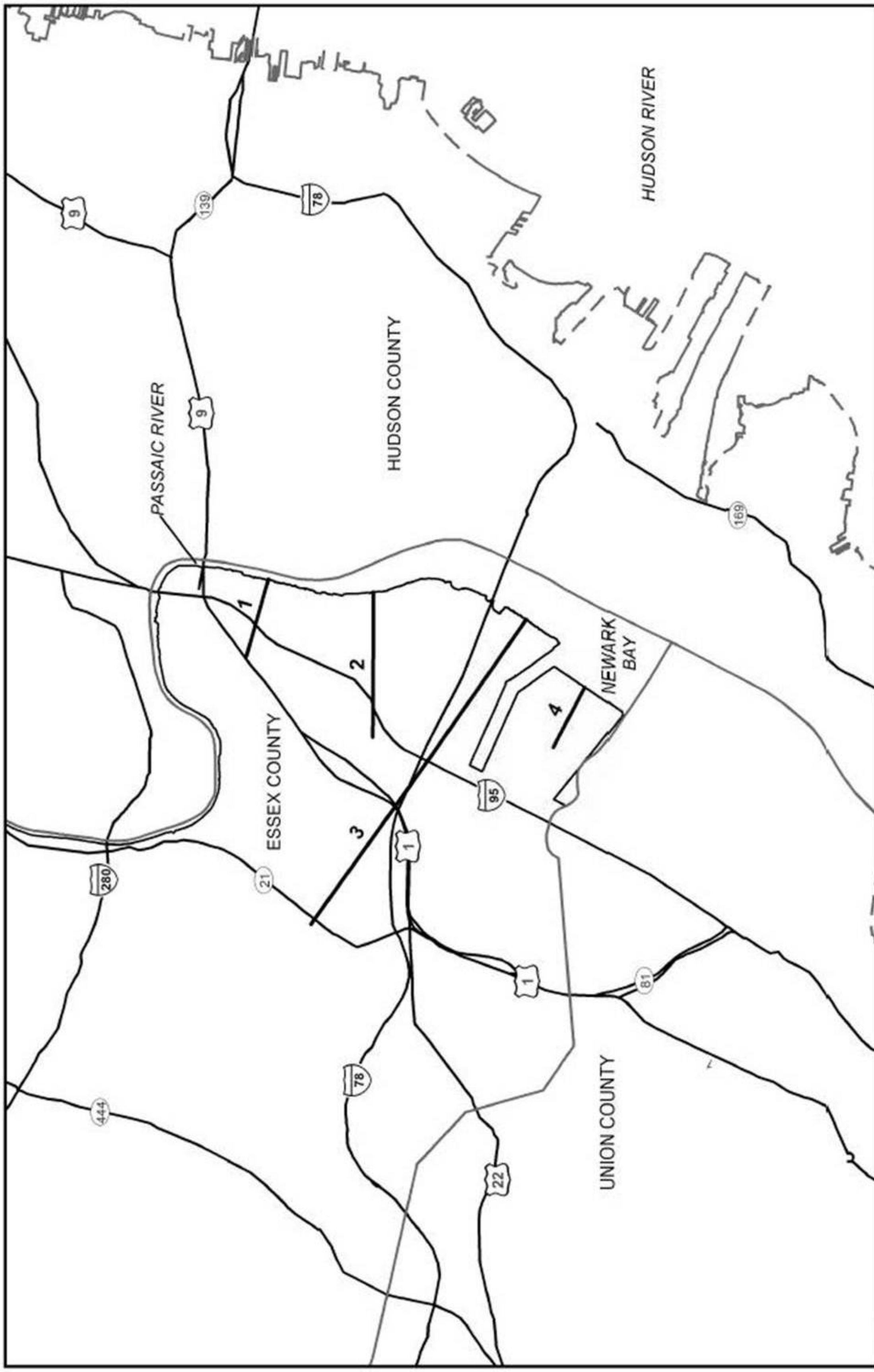
The stillwater elevations for the 10-, 2-, 1-, and 0.2- percent annual chance floods determined for the primary sources of flooding in Essex County: Passaic River and Newark Bay are shown in Table 8, "Transect Data". The analysis reported herein reflect the stillwater elevations due to tidal and wind setup effects. If the elevation on the FIRM is higher than the elevation shown in this table, a wave height, wave runup, and/or wave setup component likely exists, in which case, the higher elevation should be used for construction and/or floodplain management purposes.

The Newark Bay and Passaic River are the primary flooding sources in Essex County. Coastal flooding along Newark Bay and Passaic River in the southern and eastern parts of the county affects the City of Newark. In Essex County, the mildly sloped shoreline is comprised of industrial areas.

The tidal surge in the Newark Bay and Passaic River affects 14 mi. of Essex County coastline, and approximately 3.5 mi. of coastline were modeled for overland wave propagation. The fetch length across the Newark Bay varies from approximately 0.8 to 1.3 mi., and across the Passaic River varies from approximately 0.1 to 0.4 mi.

The coastal hydraulic analysis for this countywide FIS revision involved transect layout, field reconnaissance, and overland wave modeling including wave setup, wave height and wave run-up analysis.

Transects represent the locations where the overland wave height analysis was modeled and are placed with consideration given to topography, land use, shoreline features and orientation, and the available fetch distance. Each transect was placed to capture the dominant wave direction, typically perpendicular to the shoreline and extended inland to a point where coastal flooding ceased. Along each transect, wave heights were computed considering the combined effects of changes in ground elevation, obstructions, and wind contributions. Transects were placed along the shoreline along all sources of primary flooding in Essex County, as illustrated on the FIRMs and Figure 2 - "Transect Location Map". Transects also represent locations visited during field reconnaissance to assist in parameterizing obstructions and observing shore protection features.



Approximate Scale 0 1 2 4 6 8 Miles

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NEW JERSEY (ALL JURISDICTIONS)

TRANSECT LOCATION MAP

Figure 2

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in a report prepared by the National Academy of Sciences (NAS) (NAS, 1977). This method is based on three major concepts. First, depth-limited waves in shallow water reach maximum breaking height that is equal to 0.78 times the stillwater depth. The wave crest is 70-percent of the total wave height above the stillwater level. The second major concept is that wave height may be diminished by dissipation of energy due to the presence of obstructions, such as sand dunes, dikes and seawalls, buildings and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures prescribed in NAS Report. The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth.

Simulations of inland wave propagation were conducted using FEMA's Wave Height Analysis for Flood Insurance Studies (WHAFIS) model Version 4.0 (FEMA, 2007c). WHAFIS is a one-dimensional model that was applied to each transect in the study area. The model uses the total stillwater and starting wave information extracted from the coupled wave and storm surge model. In Table 8, "Transect Data," the 10-, 2-, 1-, and 0.2-percent annual chance stillwater elevations for each transect are provided along with the starting wave height and period. Simulations of wave transformations were then conducted with WHAFIS taking into account the storm-induced erosion and overland features of each transect. The model outputs the combined flood elevation from the total SWEL and wave height along each cross-shore transect allowing for the establishment of base flood elevations (BFEs) and flood zones from the shoreline to points inland within the study area. Wave heights were calculated to the nearest 0.1 foot, and BFEs were determined at whole-foot increments along the transects.

Table 8 – Transect Data

		Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (ft NAVD 88) Range of Stillwater Elevations*(ft NAVD 88)			
Flood Source	**Transect**	**Coordinates**	**Significant Wave Height H_s (ft)**	**Peak Wave Period T_p (sec)**	**10% Annual Chance**	**2% Annual Chance**	**1% Annual Chance**	**0.2% Annual Chance**
Passaic River	1	N 40.726587 W 74.120771	1.32	2.25	6.8	9.6 8.9 - 9.8	10.8 10.2 - 10.8	14 13.5 - 14
Newark Bay	2	N 40.712818 W 74.123033	2.75	3.22	6.9 6.9 - 7.5	9.6 8.4 - 9.8	10.8 10.2 - 10.9	14 13.5 - 14.3
Newark Bay	3	N 40.692723 W 74.127891	3.28	3.37	6.9 6.8 - 7.5	9.6 8 - 9.8	10.9 9.2 - 11	14 11.6 - 14.9
Newark Bay	4	N 40.685054 W 74.139672	3.21	3.20	6.9 6.9 - 7	9.7 9.1 - 9.8	10.9 10.6 - 10.9	14 13.8 - 14.1

*For transects with a constant stillwater elevation, only one number is provided to represent both the starting value and the range.

Wave runup is defined as the maximum vertical extent of wave uprush on a beach or structure. FEMA's 2007 Guidelines and Specifications require the 2-percent wave runup level be computed for the coastal feature being evaluated (cliff, coastal bluff, dune, or structure) (FEMA, 2007a). The 2-percent runup level is the highest 2-percent of wave runup affecting the shoreline during the 1-percent-annual-chance flood event. Each transect defined within the Region II study area was evaluated for the applicability of wave runup, and if necessary, the appropriate runup methodology was selected and applied to each transect. Runup elevations were then compared to WHAFIS results to determine the dominant process affecting BFEs and associated flood hazard levels. Based on wave runup rates, wave overtopping was computed following the FEMA 2007 Guidelines and Specifications.

The results of the overland wave height and runup calculations are accurate until local topography, vegetation, or cultural development within the community undergoes major changes. Consequently between transects, elevations were interpolated using topographic maps, land-use and land-cover data, and engineering judgment to determine the extent of coastal flood zones.

Areas of coastline subject to significant wave attack are referred to as coastal high hazard area. The USACE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard area. The 3-foot wave has been determined to be the minimum size wave capable of causing major damage to conventional wood frame of brick veneer structures. The one exception to the 3-foot wave criteria is where a primary frontal dune exists. The limit of the coastal high hazard area then becomes the landward toe of the primary frontal dune or where a 3-foot or greater breaking wave exists, whichever is most landward. The coastal high hazard zone is depicted on the FIRMs as Zone VE, where the delineated flood hazard includes wave heights equal to or greater than three feet. Zone AE is depicted on the FIRMs where the delineated flood hazard includes wave heights less than three feet. A depiction of how the Zones VE and AE are mapped is shown in Figure 3, "Transect Schematic".

Post-storm field visits and laboratory tests have confirmed that wave heights as small as 1.5 feet can cause significant damage to structures when constructed without consideration to the coastal hazards. Additional flood hazards associated with coastal waves include floating debris, high velocity flow, erosion, and scour which can cause damage to Zone AE-type construction in these coastal areas. To help community officials and property owners recognize this increased potential for damage due to wave action in the AE zone, FEMA issued guidance in December 2008 on identifying and mapping the 1.5-foot wave height line, referred to as the Limit of Moderate Wave Action (LiMWA). While FEMA does not impose floodplain management requirements based on the LiMWA, the LiMWA is provided to help communicate the higher risk that exists in that area (FEMA, 2008). Consequently, it is important to be aware of the area between this inland limit and the Zone VE boundary as it still poses a high risk, though not as high of a risk as Zone VE, see Figure 3, "Transect Schematic".

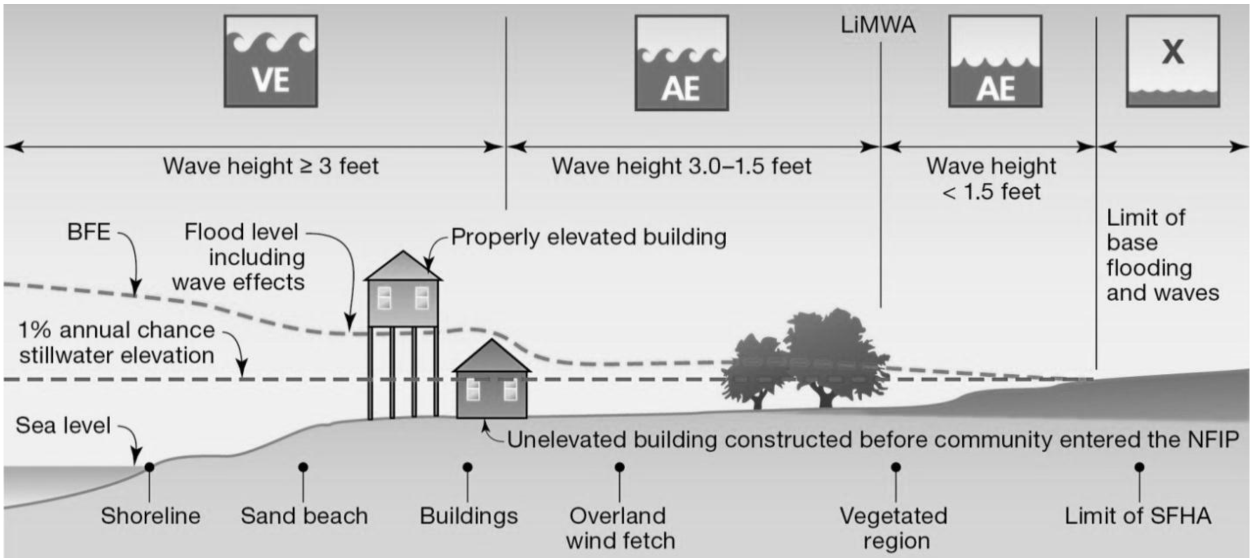


Figure 3 – Transect Schematic

3.4 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 NGVD 29. With the completion of the NAVD 88, many FIS reports and FIRMs are now prepared using NAVD 88 as the referenced vertical datum.

All of the flood elevations shown in this FIS report and on the FIRM are referenced to NAVD 88. 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.

As noted above, the elevations shown in this FIS report and on the FIRM for Essex County are referenced to NAVD 88. Ground, structure, and flood elevations may be compared and/or referenced to NGVD 29 by applying a standard conversion factor. The conversion factor to NGVD 29 is +1.0 foot. The conversion between datum may be expressed as an equation:

$$\text{NAVD 88} = \text{NGVD 29} - 1.0 \text{ foot}$$

The BFEs shown on the FIRM represent whole-foot rounded values. For example, a BFE of 102.4 will appear as 102 on the FIRM and 102.6 will appear as 103. Therefore, users that wish to convert the elevations in this FIS to NGVD 29 should apply the stated conversion factor to elevations shown on the Flood Profiles and supporting data tables in the FIS report, which are shown at a minimum to the nearest 0.1 foot.

For information regarding conversion between the NGVD 29 and NAVD 88, visit the National Geodetic Survey (NGS) website at www.ngs.noaa.gov, or contact the NGS at the following address:

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

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- 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 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 by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic and orthophoto topographic maps.

For the June 4, 2007, initial countywide FIS, floodplain boundaries along Bear Brook, Canoe Brook, Canoe Brook Tributary, Crystal Lake Branch, Peckman River East Branch Rahway River, West Branch Rahway River and Slough Brook, were delineated using topographic maps provided by the NJDEP. These topographic maps were at a scale of 1"=200', with contour intervals of 2 ft.

For the [date] countywide FIS revision, the floodplain boundaries were mapped using LiDAR data flown by Sanborn in 2006 and 2007 as part of the LiDAR acquisition initiative lead by the National Geospatial-Intelligence Agency (NGA) in 2006 for the metropolitan New Jersey area (NGA, 2006). Full details of the terrain development process can be found in the *Region II Coastal Terrain Processing Methodology*

Documentation Report included as part of the Region II NY/NJ Storm Surge Study TSDN (RAMPP, 2011).

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

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

New Jersey Flood Hazard Area Design Flood

For the Passaic River and Third River, the NJFHADF floodplain boundary was delineated in addition to the 1- and 0.2-percent-annual-chance boundaries.

The State of New Jersey, Department of Environmental Protection (the Department) is mandated to delineate and regulate flood hazard areas pursuant to N.J.S.A. 58:16A-50 et seq., the Flood Hazard Area Control Act. This Act authorizes the Department to adopt land use regulations for development within the flood hazard areas, to control stream encroachments and to integrate the flood control activities of the municipal, county, State and Federal Governments.

The State's Flood Hazard Area delineations are defined by the New Jersey Flood Hazard Area Design Flood. In 1974, the Water Policy and Supply Council passed a resolution stating that the New Jersey Flood Hazard Area Design Flood shall be equal to a design flood discharge 25-percent greater in flow than the 100 year or 1- percent annual chance flood. In addition, the floodway shall be based on encroachments that produce no more than a 0.2 foot water surface rise above the 100 year or 1-percent annual chance flood. These flood hazard area delineations must be adopted by NJDEP.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the base flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot and the State of New Jersey standards limit the increase to 0.2 feet, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed for certain stream segments on the basis of equal-conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (See Table 9, "Floodway Data"). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

Please note: NJDEP, Division of Land Use Regulation, currently enforces Floodway Limits along the Passaic River upstream from the junction with the Hackensack River.

For the [date] countywide FIS revision, no floodways were determined for Newark Bay or the Passaic River from the confluence with Newark Bay to the confluence with the Second River at the corporate limits of the City of Newark and the Township of Belleville.

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 WSEL of the base flood more than 0.2 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 4.

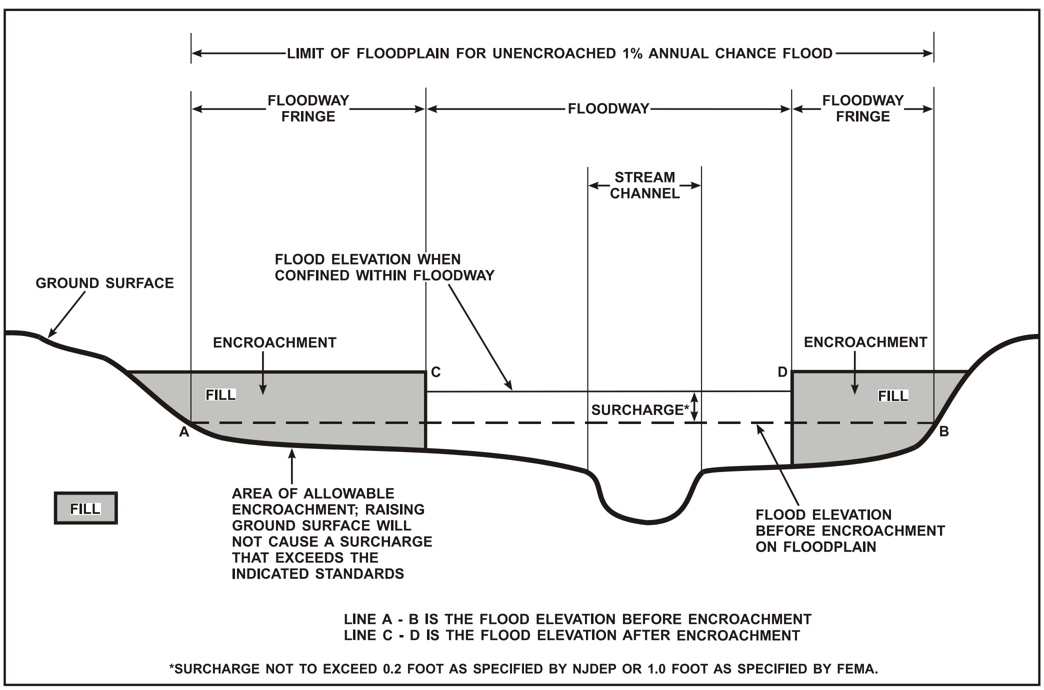


Figure 4 – Floodway Schematic

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Bear Brook								
A	800	62	190	7.4	223.7	223.7	223.8	0.1
B	1,710	380	668	2.1	234.1	234.1	234.3	0.2
C	2,630	38	140	7.2	242.1	242.1	242.1	0.0
D	2,742	20	88	11.6	242.4	242.4	242.5	0.1
E	4,020	28	103	9.9	256.2	256.2	256.3	0.1
F	5,615	20	91	11.1	285.5	285.5	285.5	0.0
G	6,631	274	557	1.8	309.5	309.5	309.7	0.2
H	7,605	36	98	10.3	322.0	322.0	322.0	0.0
I	8,040	28	95	10.6	328.5	328.5	328.5	0.0
J	8,610	90	154	4.4	340.8	340.8	341.0	0.2

[1] Stream distance in feet above confluence with Canoe Brook

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

BEAR BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Branch of West Branch Rahway River								
A	310	100	40	4.3	376.1	376.1	376.1	0.0
B	1,160	12	22	7.7	407.9	407.9	407.9	0.0
C	2,200	10	21	8.1	472.1	472.1	472.1	0.0
D	3,250	17	25	6.8	521.4	521.4	521.5	0.1

[1] Stream distance in feet above confluence with West Branch Rahway River

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

BRANCH OF WEST BRANCH RAHWAY RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Canoe Brook								
A	0	725	2,714	0.9	202.3	202.3	202.5	0.2
B	920	453	1,444	1.8	203.0	203.0	203.2	0.2
C	2,036	389	919	2.8	212.1	212.1	212.2	0.1
D	2,806	500	1,689	1.5	215.6	215.6	215.7	0.1
E	3,916	450	1,668	1.5	220.3	220.3	220.5	0.2
F	25,909	27	107	6.3	447.4	447.4	447.5	0.1
G	26,458	34	157	4.3	449.1	449.1	449.2	0.1
H	27,171	91	637	1.1	460.2	460.2	460.3	0.1
I	28,200	143	271	2.5	462.1	462.1	462.2	0.1
J	28,864	34	141	4.8	467.2	467.2	467.2	0.0

[1] Stream distance in feet above Millburn Township Corporate Limits

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

CANOE BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Canoe Brook Tributary No. 1 Downstream Portion								
	2,020[1]	29	63	8.5	209.6	209.6	209.6	0.0
A	2,325[1]	33	66	8.1	216.0	216.0	216.0	0.0
B	2,560[1]	30	64	8.3	224.0	224.0	224.0	0.0
C	3,670[1]	24	59	9.0	253.2	253.2	253.2	0.0
D								
Canoe Brook Tributary No. 1 Upstream Portion								
A	0[2]	22	37	6.2	388.6	388.6	388.8	0.2
B	750[2]	22	62	3.7	407.4	407.4	407.6	0.2
C	1,820[2]	24	34	6.8	416.8	416.8	416.8	0.0

[1] Feet above confluence with Canoe Brook
[2] Feet above Township of Livingston Corporate Limits

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

CANOE BROOK TRIBUTARY NO. 1 DOWNSTREAM PORTION - CANOE BROOK TRIBUTARY NO. 1 UPSTREAM PORTION

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Canoe Brook Tributary No. 2								
A	1,410	29	73	9.1	302.9	302.9	302.9	0.0
B	2,700	32	84	7.9	310.6	310.6	310.6	0.0
C	3,297	35	92	7.2	314.7	314.7	314.9	0.2
D	3,835	65	140	4.8	325.8	325.8	325.8	0.0
E	4,523	77	121	5.5	363.0	363.0	363.2	0.2
F	5,025	17	42	6.8	383.1	383.1	383.3	0.2
G	5,610	18	35	8.1	399.7	399.7	399.7	0.0
H	6,556	70	258	1.1	444.1	444.1	444.2	0.1
Canoe Brook Tributary No. 3								
A	670	68	83	6.3	392.8	392.8	392.8	0.0
B	1,620	22	56	9.3	440.7	440.7	440.7	0.0
C	2,460	30	63	8.3	484.6	484.6	484.6	0.0
D	2,830	34	66	7.9	502.3	502.3	502.3	0.0
E	3,370	12	48	10.8	517.2	517.2	517.2	0.0

[1] Stream distance in feet above confluence with Canoe Brook

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

CANOE BROOK TRIBUTARY NO.2
CANOE BROOK TRIBUTARY NO. 3

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Crooked Brook								
A	350[1]	18	91	5.9	108.3[2]	108.3[2]	108.4[2]	0.1
B	1,920[1]	31	203	2.7	139.5	139.5	139.5	0.0
C	2,660[1]	15	51	10.5	144.8	144.8	144.8	0.0
Crystal Lake Branch								
A	310[3]	22	32	5.3	372.0	372.0	372.0	0.0
B	1,530[3]	12	22	7.7	423.1	423.1	423.2	0.1
C	2,400[3]	13	24	7.0	481.8	481.8	481.9	0.1
D	2,700[3]	18	25	6.7	498.4	498.4	498.4	0.0
Cub Brook								
A	580[4]	22	60	8.9	251.7	251.7	251.7	0.0
B	1,700[4]	27	62	8.6	303.4	303.4	303.4	0.0
C	3,220[4]	27	62	8.6	364.3	364.3	364.3	0.0

[1] Stream distance in feet above confluence with East Branch Rahway River
[2] Elevation computed without consideration of Backwater from East Branch Rahway River
[3] Stream distance in feet above confluence with West Branch Rahway River
[4] Stream distance in feet above confluence with Bear Brook

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

CROOKED BROOK – CRYSTAL LAKE BRANCH – CUB BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Deepavaal Brook								
A	720	101	507	3.7	171.0	165.4[2]	165.6	0.2
B	1,845	335	1,307	1.4	171.2	165.9[2]	166.1	0.2
C	2,915	248	694	2.7	172.3	167.7[2]	167.8	0.1
D	3,565	483	1,993	0.9	172.6	168.0[2]	168.1	0.1
E	4,830	173	749	2.5	173.5	168.6[2]	168.8	0.2
F	6,056	513	2,497	0.7	174.3	169.5[2]	169.6	0.1
G	7,966	1,348	1,708	1.1	175.4	170.1[2]	170.2	0.1
H	10,436	681	2,985	0.6	175.4	170.8	170.9	0.1
I	11,711	530	1,802	1.0	175.4	171.1	171.2	0.1
J	14,351	1,067	3,376	0.2	175.4	171.8	171.9	0.1
K	15,601	1,068	3,846	0.1	175.4	171.8	171.9	0.1
L	16,839	700	3,221	0.2	175.4	171.8	171.9	0.1
M	17,626	624	2,903	0.2	175.4	171.8	171.9	0.1
N	18,634	199	801	0.7	175.4	171.9	172.0	0.1
O	19,439	200	632	0.9	175.4	171.9	172.1	0.2

[1] Stream distance in feet above confluence with Passaic River
[2] Elevation computed without consideration of backwater from Passaic River

TABLE 9	FEDERAL EMERGENCY MANAGEMENT AGENCY **ESSEX COUNTY, NJ** **(ALL JURISDICTIONS)**	**FLOODWAY DATA** **DEEPAVAAL BROOK**

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
East Branch Rahway River								
A-AC[2]								
AD	6,470	214	1,301	1.9	99.1	99.1	99.3	0.2
AE	8,340	262	1,031	2.4	101.4	101.4	101.6	0.2
AF	9,250	168	379	6.4	105.0	105.0	105.0	0.0
AG	10,340	243	814	2.6	110.7	110.7	110.7	0.0
AH	11,170	255	851	2.4	115.1	115.1	115.3	0.2
AI	12,120	125	348	6.0	119.5	119.5	119.5	0.0
AJ	13,200	67	304	6.8	129.9	129.9	129.9	0.0
AK	14,330	175	1,151	1.8	134.9	134.9	134.9	0.0
AL	15,340	96	723	2.9	135.1	135.1	135.3	0.2
AM	17,430	30	299	6.9	136.0	136.0	136.2	0.2
AN	18,210	60	552	3.5	139.0	139.0	139.1	0.1
AO	19,600	340	1,184	1.6	139.9	139.9	140.1	0.2
AP	20,710	45	306	6.3	141.3	141.3	141.5	0.2
AQ	21,830	26	196	9.8	142.6	142.6	142.8	0.2
AR	22,990	22	113	13.0	146.2	146.2	146.2	0.0
AS	24,030	18	138	9.2	150.4	150.4	150.4	0.0
AT	24,770	12	79	14.7	151.9	151.9	151.9	0.0
AU	25,735	154	696	1.7	166.7	166.7	167.7	0.0

[1] Stream distance in feet above confluence with West Branch Rahway River
[2] Data not available

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

EAST BRANCH RAHWAY RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
East Fork of East Branch Rahway River								
A	3,429	19	56	10.0	172.6	172.6	172.7	0.1
B	3,635	25	110	5.1	173.8	173.8	174.0	0.2
C	4,049	225	1,221	0.4	174.2	174.2	174.4	0.2
D	4,435	15	83	5.5	174.6	174.6	174.8	0.2
E	4,980	19	85	5.3	174.9	174.9	175.1	0.2
F	5,740	10	48	7.9	180.7	180.7	180.8	0.1
G	6,867	17	42	9.0	204.0	204.0	204.1	0.1

[1] Stream distance in feet above confluence with East Branch Rahway River

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

EAST FORK OF EAST BRANCH RAHWAY RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Elizabeth River								
A	41,200	32	227	9.7	83.9	83.9	84.1	0.2
B	41,941	31	209	10.5	94.1	94.1	94.2	0.1
C	43,302	31	237	9.2	101.6	101.6	101.8	0.2
D	43,872	28	272	8.1	107.0	107.0	107.1	0.1
E	44,533	38	263	8.3	109.6	109.6	109.8	0.2
F	44,950	32	322	6.8	113.1	113.1	113.2	0.1
G	45,453	106	547	4.0	117.4	117.4	117.6	0.2
H	46,192	140	530	4.1	121.4	121.4	121.5	0.1
I	46,303	25	222	9.9	121.4	121.4	121.5	0.1
J	46,651	23	208	8.0	123.8	123.8	124.0	0.2
K	47,278	35	232	7.2	127.9	127.9	128.0	0.1
L	48,731	35	254	6.6	139.1	139.1	139.2	0.1
M	49,306	23	225	7.4	140.4	140.4	140.6	0.2
N	49,794	25	285	5.8	143.2	143.2	143.4	0.2
O	50,914	55	453	3.7	145.3	145.3	145.5	0.2

[1] Stream distance in feet above mouth

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

ELIZABETH RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Foulertons Brook								
A	91[1]	96	299	3.2	175.7	168.9[4]	166.9	0.1
B	1,395[1]	563	968	1.0	175.7	169.9[4]	168.0	0.1
C	3,721[1]	24	87	10.9	183.2	183.2	183.2	0.0
D	4,209[1]	34	119	8.0	190.8	190.8	190.8	0.0
E	4,700[1]	53	155	6.1	204.8	204.8	204.9	0.1
F	4,880[1]	75	211	4.5	211.3	211.3	211.4	0.1
G	7,240[1]	28	137	6.0	248.6	248.6	248.8	0.2
Foulertons Brook (Upstream Portion)								
H	0[2]	32	129	6.4	265.4	265.4	265.4	0.2
I	925[2]	28	83	6.3	269.4	269.4	269.4	0.0
J	2,700[2]	14	35	6.3	282.4	282.4	282.6	0.2
North Branch Foulertons Brook								
A	3,560[3]	89	259	3.8	199.6	199.6	199.6	0.0
B	4,098[3]	27	92	10.6	206.8	206.8	206.8	0.0
C	6,543[3]	79	149	5.8	237.9	237.9	238.0	0.1
D	7,250[3]	105	176	4.9	247.3	247.3	247.4	0.1
E	10,455[3]	59	117	5.0	287.9	287.9	287.9	0.0

[1] Stream distance in feet above confluence with Passaic River
[2] Stream distance in feet above corporate limits
[3] Stream distance in feet above confluence with Foulertons Brook
[4] Elevation computed without consideration of backwater effects from Passaic River

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

FOULERTONS BROOK - FOULERTONS BROOK AT LIVINGSTON - NORTH BRANCH FOULERTONS BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Green Brook								
A	540	607	2,095	0.6	175.0	171.0[2]	171.2	0.2
B	1,380	423	1,152	1.1	175.0	171.1[2]	171.3	0.2
C	1,785	422	655	2.0	175.0	171.3[2]	171.5	0.2
D	2,760	463	524	2.5	175.0	172.2	172.4	0.2
E	4,670	77	314	4.2	175.5	175.5	175.7	0.2
F	5,780	48	136	9.6	186.9	186.9	186.9	0.0
G	6,880	76	159	8.2	214.6	214.6	214.6	0.0
H	7,470	16	75	12.3	234.8	234.8	235.0	0.2
I	7,935	30	92	10.0	251.7	251.7	251.7	0.0
J	9,585	61	126	5.9	313.1	313.1	313.3	0.2
K	10,845	90	163	4.5	362.6	362.6	362.6	0.0
L	11,745	35	88	8.4	384.6	384.6	384.6	0.0
M	12,245	64	206	3.6	389.2	389.2	389.4	0.2
N	13,440	264	330	2.2	402.2	402.2	402.4	0.2

[1] Stream distance in feet above confluence with Deepavaal Brook
[2] Elevation computed without consideration of backwater effects from Deepavaal Brook

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

GREEN BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Green Brook Tributary								
A	1,528	59	339	2.3	180.9	180.9	180.9	0.0
B	2,440	150	529	2.3	182.6	182.5	182.6	0.1
C	3,530	112	181	4.8	184.3	184.1	184.3	0.2
D	4,620	43	89	5.3	194.3	194.3	194.3	0.0
E	5,100	39	64	7.4	211.4	211.4	211.4	0.0
F	5,850	33	73	6.4	233.1	233.1	233.1	0.0
G	6,350	60	77	6.5	250.4	250.2	250.4	0.2

[1] Stream distance in feet above confluence with Green Brook

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

GREEN BROOK TRIBUTARY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Kane Brook								
A	1,034	40	50	6.5	195.6	195.6	195.7	0.1
B	1,266	15	35	8.8	202.9	202.9	202.9	0.0
C	1,765	17	37	8.4	219.8	219.8	219.8	0.0
D	2,570	14	39	7.9	241.6	241.6	241.7	0.1
E	2,875	15	35	8.7	248.6	248.6	248.7	0.1
F	3,200	13	34	9.2	262.4	262.4	262.4	0.0
G	3,500	18	38	8.3	279.8	279.8	279.8	0.0
H	3,750	12	48	6.5	294.2	294.2	294.2	0.0
I	4,540	15	36	8.8	309.1	309.1	309.2	0.1

[1] Stream distance in feet above confluence with Green Brook Tributary

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

KANE BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Lightning Brook								
A	190	30	168	6.5	116.9	116.9	117.1	0.2
B	850	40	308	3.6	124.7	124.7	124.9	0.2
C	1,125	56	149	7.3	129.4	129.4	129.6	0.2
D	2,200	29	101	10.8	140.6	140.6	140.6	0.0
E	3,100	28	101	10.8	157.9	157.9	157.9	0.0
F	4,460	22	64	9.7	177.4	177.4	177.4	0.0
G	4,984	10	49	12.7	187.6	187.6	187.6	0.0
H	5,540	20	61	10.2	192.5	192.5	192.5	0.0
I	6,008	8	49	12.7	196.6	196.6	196.7	0.1

[1] Stream distance in feet above Union County Boundary

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

LIGHTNING BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Nishuane Brook								
A	310	30	164	9.1	147.5	142.7[2]	142.7	0.0
B	825	54	392	3.8	147.8	147.8	148.0	0.2
C	1,680	57	253	5.9	148.1	148.1	148.3	0.2
D	2,070	47	217	6.9	149.5	149.5	149.7	0.2
E	2,545	90	241	5.0	153.0	153.0	153.2	0.2
F	2,920	92	245	4.9	159.3	159.3	159.4	0.1
G	3,465	118	357	3.4	169.3	169.3	169.5	0.2
H	4,075	26	105	11.5	174.1	174.1	174.1	0.0
I	4,815	46	277	4.4	190.8	190.8	190.8	0.0
J	5,280	70	180	6.7	194.4	194.4	194.4	0.0
K	4,857	116	329	3.7	207.5	207.5	207.7	0.2
L	6,521	99	210	5.8	217.7	217.7	217.7	0.0
M	6,685	150	410	3.0	219.6	219.6	219.7	0.1
N	6,695	150	429	2.8	220.0	220.0	220.0	0.0
O	7,300	182	361	3.4	233.4	233.4	233.4	0.0
P	7,580	45	169	7.2	235.8	235.8	235.8	0.0
Q	8,245	142	414	1.6	246.3	246.3	246.5	0.2
R	8,799	71	123	5.5	254.5	254.5	254.6	0.1
S	9,136	78	157	4.3	260.3	260.3	260.4	0.1
T	9,401	79	186	3.7	263.5	263.5	263.7	0.2

[1] Stream distance in feet above confluence with Second River Tributary
[2] Elevation computed without consideration of backwater from Second River Tributary

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

NISHUANE BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
North Branch Wigwam Brook								
A	40	38	223	4.7	161.5	158.7[3]	158.8	0.1
B	710	100	211	5.0	167.0	167.0	167.0	0.0
C	1,035	100	208	5.1	171.5	171.5	171.5	0.0
D	1,495	18	86	12.3	176.4	176.4	176.4	0.0
E	1,910	165	330	3.2	186.4	186.4	186.5	0.1
F	2,208	328	853	1.2	191.3	191.3	191.5	0.2
G	2,740	70	113	6.2	205.5	205.5	205.7	0.2
H	3,397	43	86	8.1	213.6	213.6	213.8	0.2
I	4,095	12	114	6.1	233.9	233.9	234.1	0.2
J	4,610	12	57	12.3	241.3	241.3	241.4	0.1
North Branch Wigwam Brook								
A	356[2]	28	36	7.7	262.3	262.3	262.3	0.0
B	514	30	43	6.4	264.0	264.0	264.1	0.1

[1] Stream distance in feet above corporate limits
[2] Stream distance in feet above confluence with North Branch Wigwam Brook
[3] Elevation computed without consideration of backwater effects from Second River Tributary

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

NORTH BRANCH WIGWAM BROOK - BRANCH OF NORTH BRANCH WIGWAM BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY[3]	WITH FLOODWAY[3]	INCREASE[3]
Passaic River (Downstream)								
A	2,927	355	5,143	6.0	*	4.1	4.1	0.0
B	8,311	324	6,389	4.8	*	6.9	6.9	0.0
C	15,459	410	6,926	4.4	*	8.7	8.7	0.0

[1] Stream distance in feet above Limit of Study (Limit of Study is approximately 730 feet downstream of confluence with Second River)
[2] Floodway width extends beyond corporate limits
[3] Riverine floodway data are provided for the purpose of a no-rise analysis in accordance with floodway determinations for development within the SFHA.
* Coastal flooding effects control NFIP regulatory Base Flood Elevations in this area.

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

PASSAIC RIVER (DOWNSTREAM)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Passaic River (Upstream)								
A	128,795	2,607	8,663	3.6	170.9	170.9	171.0	0.1
B	130,918	1,337	8,159	3.5	171.5	171.5	171.6	0.1
C	132,006	533	6,369	3.6	173.2	173.2	173.4	0.2
D	135,244	5,528	36,446	0.5	174.1	174.1	174.3	0.2
E	148,425	6,572	41,837	0.6	174.2	174.2	174.4	0.2
F	152,968	9,266	53,162	0.5	174.2	174.2	174.4	0.2
G	162,149	9,537	68,511	0.2	174.3	174.3	174.5	0.2
H	180,541	4,185	34,014	0.8	174.4	174.4	174.5	0.1
I	185,429	2,976	20,405	1.5	174.5	174.5	174.6	0.1
J	191,859	1,589	10,374	1.8	174.8	174.8	175.0	0.2
K	197,139	1,201	6,814	1.5	175.4	175.4	175.5	0.1
L	207,421	6,590	35,105	0.3	175.7	175.7	175.9	0.2
M	212,337	1,526	13,254	0.3	173.4*	173.4	173.6	0.2
N	214,222	1,061	7,689	0.6	173.5*	173.5	173.7	0.2
O	218,177	406	4,291	1.1	173.6*	173.6	173.8	0.2
P	221,122	1,404	7,689	0.6	173.8*	173.8	174.0	0.2
Q	224,102	1,780	13,066	0.4	173.8*	173.8	174.0	0.2
R	227,032	480	3,764	1.2	173.9*	173.9	174.1	0.2
S	230,342	1,200	10,395	0.4	174.6*	174.6	174.8	0.2
T	233,732	820	7,124	0.7	174.7*	174.7	174.9	0.2
U	237,252	970	6,960	0.7	174.9*	174.9	175.1	0.2

[1] Stream distance in feet above Limit of Study (Limit of Study is approximately 730 feet downstream of confluence with Second River)

[2] Floodway width extends beyond corporate limits

*Not studied as part of the [TBD] countywide FIS, a revised flood study will be completed in the future to resolve elevation differences

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

PASSAIC RIVER (UPSTREAM)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Passaic River (Upstream) (continued)								
V	239,322	1,665	14,827	0.3	175.1*	175.1	175.3	0.2
W	243,112	1,770	13,716	0.3	175.2*	175.2	175.4	0.2
X	249,152	2,700	15,447	0.3	175.3*	175.3	175.5	0.2
Y	252,682	1,640	11,174	0.4	175.4*	175.4	175.6	0.2
Z	255,842	910	6,565	0.7	176.4*	176.4	176.6	0.2
AA	258,522	432	3,411	1.4	176.6*	176.6	176.8	0.2
AB	260,042	624	4,142	1.1	176.9*	176.9	177.1	0.2
AC	262,992	960	4,336	1.1	177.2*	177.2	177.4	0.2

[1] Stream distance in feet above Limit of Study (Limit of Study is approximately 730 feet downstream of confluence with Second River)
[2] Floodway width extends beyond corporate limits
*Not studied as part of the [TBD] countywide FIS, a revised flood study will be completed in the future to resolve elevation differences

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

PASSAIC RIVER (UPSTREAM)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Passaic River Tributary								
A	2,700	443	9,224	0.1	175.7[3]	--[2]	--[2]	--[2]
B	3,730	138	5,303	0.1	175.7[3]	--[2]	--[2]	--[2]
C	5,650	202	342	1.9	179.8	179.8	180.0	0.2
D	6,820	138	445	1.4	193.0	193.0	193.2	0.2
E	7,300	16	127	5.0	193.2	193.2	193.4	0.2

[1] Stream distance in feet above confluence with Passaic River
[2] Data not available
[3] Backwater from Passaic River

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

PASSAIC RIVER TRIBUTARY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Peckman River								
A	11,150	71	513	11.3	181.8	181.8	182.0	0.2
B	11,850	74	478	12.1	187.3	187.3	187.3	0.0
C	12,286	56	386	15.0	192.6	192.6	192.6	0.0
D	12,700	102	667	8.7	197.2	197.2	197.3	0.1
E	13,300	63	475	12.2	203.8	203.8	203.8	0.0
F	13,900	60	396	14.6	208.0	208.0	208.0	0.0
G	14,600	68	473	12.2	214.2	214.2	214.4	0.2
H	15,350	138	686	7.6	220.8	220.8	220.8	0.0
I	16,100	102	476	10.9	225.9	225.9	225.9	0.0
J	17,000	50	346	15.0	237.9	237.9	237.9	0.0
K	17,320	61	390	13.3	251.0	251.0	251.2	0.2
L	17,490	57	362	14.3	268.0	268.0	268.2	0.2
M	18,100	47	337	15.4	279.6	279.6	279.6	0.0
N	18,800	114	813	6.4	284.2	284.2	284.4	0.2
O	19,150	61	423	9.7	285.9	285.9	286.1	0.2
P	19,700	176	490	8.4	293.2	293.2	293.2	0.0
Q	20,475	112	402	10.2	296.9	296.9	296.9	0.0
R	21,020	121	808	5.1	301.4	301.4	301.4	0.0
S	21,500	55	543	7.5	304.6	304.6	304.8	0.2
T	22,150	106	705	5.8	306.2	306.2	306.3	0.1
U	22,400	63	404	9.2	308.7	308.7	308.9	0.2

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

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

PECKMAN RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Peckman River (continued)								
V	22,800	39	288	13.0	310.5	310.5	310.7	0.2
W	23,800	45	310	12.0	317.9	317.9	318.0	0.1
X	24,700	47	368	10.1	323.7	323.7	323.9	0.2
Y	25,520	200	786	4.8	327.0	327.0	327.2	0.2
Z	26,050	94	487	7.7	328.3	328.3	328.5	0.2
AA	26,396	70	320	11.7	329.2	329.2	329.1	0.0
AB	26,770	212	1,431	2.2	333.5	333.5	333.7	0.2
AC	27,100	171	1,055	3.0	333.6	333.6	333.8	0.2
AD	27,750	68	310	10.2	334.1	334.1	334.3	0.2
AE	28,264	58	305	10.3	337.7	337.7	337.9	0.2
AF	28,840	164	1,200	1.8	347.2	347.2	347.3	0.1
AG	29,250	260	1,626	1.3	350.5	350.5	350.7	0.2
AH	30,175	210	1,653	1.3	350.5	350.5	350.7	0.2
AI	30,900	184	1,230	1.8	352.1	352.1	352.2	0.1
AJ	31,470	319	762	2.2	352.7	352.7	352.9	0.2
AK	31,940	307	557	3.0	353.2	353.2	353.4	0.2
AL	32,800	125	426	4.0	354.3	354.3	354.5	0.2
AM	33,605	145	488	3.5	356.0	356.0	356.2	0.2

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

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

PECKMAN RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Peckman River (continued)								
AN	34,350	34	167	10.1	360.8	360.8	360.9	0.1
AO	35,000	100	353	4.8	365.5	365.5	365.6	0.1
AP	35,475	215	545	3.1	367.1	367.1	367.3	0.2
AQ	36,120	68	304	5.5	374.4	374.4	374.6	0.2
AR	36,750	56	186	9.1	381.1	381.1	381.2	0.1
AS	37,375	21	75	10.7	394.5	394.5	394.5	0.0
AT	37,605	24	85	9.4	399.7	399.7	399.9	0.2
AU	37,875	45	103	7.8	408.7	408.7	408.7	0.0
AV	38,420	37	92	8.7	421.9	421.9	421.9	0.0
AW	38,870	52	115	6.9	435.3	435.3	435.5	0.2
AX	39,210	27	83	9.7	454.9	454.9	454.9	0.0
AY	39,690	24	77	10.3	466.3	466.3	466.3	0.0

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

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

PECKMAN RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Peckman River Tributary								
A	30	150	361	1.1	220.0	213.9[2]	214.1	0.2
B	175	34	98	3.9	220.0	219.0[2]	219.0	0.0
C	570	12	38	10.1	228.7	228.7	228.8	0.1
D	690	21	88	4.3	234.8	234.8	234.9	0.1
E	720	23	85	4.4	234.8	234.8	234.9	0.1
F	1,370	35	73	5.2	258.0	258.0	258.1	0.1
G	1,600	40	125	3.0	267.9	267.9	267.9	0.0

[1] Stream distance in feet above confluence with Peckman River
[2] Elevation computed without consideration of backwater effects from Peckman River

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

PECKMAN RIVER TRIBUTARY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Pine Brook								
A	5,639	170	310	4.5	175.7	174.4[2]	174.5	0.1
B	7,439	198	321	4.4	188.7	188.7	188.8	0.1
C	8,575	34	137	10.2	204.8	204.8	204.8	0.0
D	9,515	105	332	4.2	220.2	220.2	220.4	0.2
E	10,800	55	169	8.3	237.0	237.0	237.2	0.2
F	11,458	91	185	7.0	245.9	245.9	245.9	0.0
G	12,355	160	218	5.9	264.8	264.8	265.0	0.2
H	13,226	39	128	10.1	284.5	284.5	284.5	0.0
I	13,992	27	112	11.5	303.4	303.4	303.4	0.0
J	14,890	152	315	4.1	316.5	316.5	316.7	0.2

[1] Stream distance in feet above confluence with Passaic Creek
[2] Elevation computed without consideration of backwater effects from Passaic River

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

PINE BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Second River								
A-F[2]								
G	7,705	23	276	15.8	76.3	76.3	76.4	0.1
H	7,940	48	477	9.1	81.8	81.8	82.0	0.2
I	8,035	20	354	12.3	83.3	83.3	83.5	0.2
J	8,107	50	629	6.9	85.4	85.4	85.6	0.2
K	8,151	50	661	6.6	85.5	85.5	85.7	0.2
L	8,865	51	453	8.1	86.4	86.4	86.6	0.2
M	9,400	62	422	8.7	87.9	87.9	88.1	0.2
N	9,620	65	393	9.3	89.5	89.5	89.5	0.0
O	9,820	55	304	12.1	91.6	91.6	91.6	0.0
P	10,100	36	254	14.4	96.3	96.3	96.3	0.0
Q	10,500	37	326	11.2	101.4	101.4	101.4	0.0
R	10,600	37	529	10.9	102.7	102.7	102.9	0.2
S	11,553	208	1,183	4.9	106.8	106.8	106.9	0.1
T	12,700	195	1,584	3.6	110.7	110.7	110.8	0.1
U	13,080	71	816	7.0	111.1	111.1	111.2	0.1
V	13,650	158	1,415	4.1	112.6	112.6	112.8	0.2
W	14,319	120	1,344	4.3	114.2	114.2	114.4	0.2
X	15,211	158	1,756	3.3	116.1	116.1	116.3	0.2
Y	15,571	274	2,080	2.8	116.7	116.7	116.9	0.2
Z	15,986	245	1,850	3.1	117.1	117.1	117.3	0.2

[1] Stream distance in feet above confluence with Passaic River
[2] Floodway Contained in Channel

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

SECOND RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Second River (continued)								
AA	16,741	233	2,215	1.0	121.3	121.3	121.4	0.1
AB	17,676	30	312	7.2	124.0	124.0	124.1	0.1
AC	19,630	30	329	6.9	128.8	128.8	129.0	0.2
AD	19,150	50	332	6.8	130.9	130.9	131.1	0.2
AE	19,310	45	178	12.7	132.1	132.1	132.1	0.0
AF	19,550	120	425	5.3	135.8	135.8	135.8	0.0
AG	19,935	43	322	7.0	141.9	141.9	141.9	0.0
AH	20,100	36	171	13.2	141.9	141.9	141.9	0.0
AI	23,385	42	234	8.2	192.8	192.8	192.8	0.0
AJ	23,740	27	182	10.5	194.7	194.7	194.8	0.1
AK	23,950	47	197	9.7	197.6	197.6	197.8	0.2
AL	24,670	41	225	8.5	211.7	211.7	211.7	0.0
AM	25,205	26	143	13.4	216.3	216.3	216.3	0.0
AN	26,055	20	131	14.6	224.1	224.1	224.1	0.0
AO	28,175	66	152	9.6	246.7	246.7	246.7	0.0
AP	29,149	14	97	14.9	254.5	254.5	254.5	0.0
AQ	29,500	15	107	13.6	257.5	257.5	257.5	0.0
AR	29,820	99	207	7.0	262.9	262.9	262.9	0.0
AS	30,188	85	253	5.7	269.4	269.4	269.5	0.1

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

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

SECOND RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Second River (continued)								
AT	30,570	154	934	1.6	276.8	276.8	276.9	0.1
AU	30,905	225	1,263	1.2	277.9	277.9	278.0	0.1
AV	31,410	88	419	2.1	280.4	280.4	280.4	0.0
AW	31,811	15	102	4.7	281.3	281.3	281.3	0.0
AX	32,341	20	52	9.2	284.6	284.6	284.6	0.0
AY	32,991	24	79	6.1	290.5	290.5	290.7	0.2
AZ	33,488	22	90	5.3	298.0	298.0	298.0	0.0
BA	33,903	97	308	1.6	303.9	303.9	303.9	0.0
BB	34,359	27	108	2.8	306.5	306.5	306.5	0.0
BC	34,941	25	74	4.1	307.0	307.0	307.0	0.0
BD	35,283	32	101	3.0	309.0	309.0	309.0	0.0
BE	35,523	31	111	2.7	309.3	309.3	309.3	0.0
BF	35,791	45	114	2.6	311.4	311.4	311.4	0.2
BG	36,271	13	44	6.8	313.4	313.4	313.0	0.2

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

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

SECOND RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Second River Tributary								
A	1,562	486	4,478	1.0	121.9	121.9	121.9	0.0
B	2,085	253	1,531	2.8	121.9	121.9	121.9	0.0
C	2,715	318	1,598	2.7	122.4	122.4	122.6	0.2
D	3,555	188	860	5.1	124.9	124.9	125.1	0.2
E	4,165	223	1,119	3.6	128.0	128.0	128.2	0.2
F	4,555	72	304	13.2	129.2	129.2	129.2	0.0
G	5,135	30	273	14.7	131.6	131.6	131.6	0.0
H	6,805	25	239	16.8	136.2	136.2	136.4	0.2
I	6,955	34	368	9.9	144.0	144.0	144.0	0.0
J	8,760	96	672	4.2	147.5	147.5	147.7	0.2
K	9,010	175	479	5.8	147.8	147.8	147.8	0.0
L	9,840	118	433	6.4	152.6	152.6	152.8	0.2
M	11,000	78	480	5.8	158.1	158.1	158.3	0.2

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

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

SECOND RIVER TRIBUTARY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Slough Brook								
A	2,850	14	69	11.8	176.1	176.1	176.3	0.2
B	5,190	76	126	6.4	185.7	185.7	185.7	0.0
C	6,750	184	622	1.3	195.4	195.4	195.4	0.0
D	7,970	29	84	9.6	206.9	206.9	206.9	0.0
E	9,012	34	97	8.3	218.5	218.5	218.5	0.0
F	10,475	210	307	2.6	225.4	225.4	225.6	0.2
G	12,235	140	394	2.1	229.9	229.9	230.1	0.2
H	12,810	29	83	9.7	236.6	236.6	236.6	0.0
I	14,160	45	98	6.0	243.0	243.0	243.2	0.2
J	15,255	22	88	6.6	254.0	254.0	254.0	0.0
K	16,006	25	64	9.2	261.6	261.6	261.6	0.0
L	17,490	27	130	3.1	272.7	272.7	272.7	0.0
M	18,680	40	143	2.8	274.0	274.0	274.1	0.0
N	19,470	49	106	2.5	275.3	275.3	275.4	0.1

[1] Stream distance in feet above Morris County Boundary

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

SLOUGH BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Slough Brook Tributary								
A	600[1]	232	158	1.5	176.3	176.3	176.5	0.2
B	1,040[1]	101	132	1.8	176.3	176.3	176.5	0.2
C	2,250[1]	39	44	5.3	183.8	183.8	183.8	0.0
D	2,600[1]	79	96	2.4	187.3	187.3	187.5	0.2
E	3,350[1]	107	113	2.1	194.6	194.6	194.7	0.1
F	4,120[1]	111	106	2.2	207.5	207.5	207.5	0.0
South Branch Wigwam Brook								
A	140[2]	270	652	1.3	160.5	160.5	160.7	0.2
B	472[2]	344	835	1.0	162.1	162.1	162.1	0.0
C	1,365[2]	117	323	2.6	165.3	165.3	165.5	0.2
D	1,580[2]	96	130	6.5	166.8	166.8	167.0	0.2

[1] Stream distance in feet above confluence with Slough Brook
[2] Stream distance in feet above confluence with North Branch Wigwam Brook

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

SLOUGH BROOK TRIBUTARY – SOUTH BRANCH WIGWAM BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
St. Pauls Branch								
A	594	19	66	10.4	51.5	51.5	51.5	0.0
B	1,654	12	56	12.3	61.8	61.8	61.8	0.0
C	3,210	50	188	3.6	96.8	96.8	96.8	0.0
D	4,244	186	416	1.7	106.0	106.0	106.2	0.2

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

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

ST. PAULS BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Taylor Brook								
A	100	20	71	10.1	284.0	284.0[2]	284.2	0.2
B	350	33	81	8.9	287.6	287.6	287.6	0.0
C	510	22	71	10.2	290.3	290.3	290.3	0.0
D	660	15	62	11.6	295.1	295.1	295.1	0.0
E	770	15	62	11.6	297.9	297.9	297.9	0.0
F	890	12	57	12.7	301.3	301.3	301.3	0.0
G	1,045	27	86	8.4	303.8	303.8	303.8	0.0
H	1,480	31	79	9.2	319.2	319.2	319.2	0.0
I	1,670	30	78	9.3	327.9	327.9	327.9	0.0
J	2,250	53	94	7.6	346.0	346.0	346.0	0.0
K	2,550	23	72	10.0	352.1	352.1	352.1	0.0
L	2,675	49	179	4.0	355.6	355.6	355.6	0.0
M	2,730	44	177	4.1	356.3	356.3	356.3	0.0

[1] Stream distance in feet above confluence with Peckman River
[2] Elevation computed without consideration of backwater from Peckman River

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

TAYLOR BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Third River								
A	545	184	913	4.5	44.6	44.6	44.7	0.1
B	2,394	249	1,350	3.0	50.3	50.3	50.4	0.1
C	3,114	260	1,515	2.7	51.7	51.7	51.9	0.2
D	4,186	279	1,207	3.4	56.4	56.4	56.5	0.1
E	5,900	145	773	5.3	60.4	60.4	60.5	0.1
F	7,086	180	1,129	3.6	68.1	68.1	68.2	0.1
G	8,545	168	1,713	2.4	70.8	70.8	70.9	0.1
H	9,096	226	1,889	2.2	71.0	71.0	71.1	0.1
I	9,987	450	2,372	1.7	72.3	72.3	72.3	0.0
J	10,736	380	2,128	1.9	72.9	72.9	73.1	0.2
K	12,045	460	1,844	2.2	74.3	74.3	74.5	0.2
L	12,545	200	805	5.1	74.5	74.5	74.6	0.1
M	14,045	55	566	7.3	80.8	80.8	80.9	0.1
N	14,424	487	1,868	2.2	82.2	82.2	82.3	0.1
O	16,045	396	2,365	1.3	82.7	82.7	82.9	0.2
P	17,775	67	536	5.6	88.8	88.8	88.8	0.0
Q	18,545	54	397	7.6	90.9	90.9	91.1	0.2
R	20,045	72	399	7.6	95.8	95.8	96.0	0.2
S	20,868	55	432	7.0	99.9	99.9	99.9	0.0
T	21,212	35	230	13.1	100.5	100.5	100.6	0.1
U	23,545	49	240	12.6	115.2	115.2	115.2	0.0
V	24,436	49	301	10.0	121.6	121.6	121.6	0.0
W	25,206	256	1,230	2.5	127.1	127.1	127.2	0.1

[1] Stream distance in feet above county boundary

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

THIRD RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Third River (continued)								
X	26,403	49	477	6.3	134.0	134.0	134.0	0.0
Y	27,545	133	606	5.0	138.2	138.2	138.2	0.0
Z	28,504	159	716	3.2	145.6	145.6	145.7	0.1
AA	29,295	165	1,116	2.1	146.5	146.5	146.5	0.0
AB	30,468	171	689	3.3	147.9	147.9	148.0	0.1
AC	32,644	358	2,102	1.1	154.1	154.1	154.3	0.2
AD	34,045	40	187	12.3	155.0	155.0	155.0	0.0
AE	34,456	231	667	3.5	159.8	159.8	159.9	0.1
AF	34,736	94	433	5.3	161.3	161.3	161.4	0.1
AG	36,045	90	639	3.6	163.0	163.0	163.2	0.2
AH	36,661	83	604	3.8	163.4	163.4	163.5	0.1
AI	37,545	88	630	3.7	165.6	165.6	165.6	0.0
AJ	38,630	255	1,377	1.7	171.4	171.4	171.5	0.1
AK	39,545	684	2,956	0.8	171.5	171.5	171.6	0.1
AL	41,329	318	846	2.7	180.3	180.3	180.4	0.1
AM	41,606	272	797	2.9	184.0	184.0	184.2	0.2

[1] Stream distance in feet above county boundary

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

THIRD RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Third River (continued)								
AN	53,000[1]	200	329	3.9	198.0	198.0	198.1	0.1
AO	54,500[1]	102	239	5.4	209.9	209.9	209.9	0.0
AP	55,500[1]	55	210	6.2	216.3	216.3	216.3	0.0
Third River Tributary								
A	325[2]	128	92	7.8	221.5	221.5	221.6	0.1
B	1,295[2]	158	281	2.6	248.1	248.1	248.2	0.1
C	1,670[2]	22	71	10.1	252.1	252.1	252.1	0.0
D	2,370[2]	18	66	10.9	276.4	276.4	276.4	0.0
E	2,874[2]	27	79	9.1	283.3	283.3	283.4	0.1
F	3,550[2]	36	57	8.4	303.9	303.9	303.9	0.0
G	3.980[2]	20	54	8.9	333.7	333.7	333.9	0.2
H	4,621[2]	102	198	1.2	358.0	358.0	358.2	0.2
I	5,590[2]	21	44	5.6	367.3	367.3	367.4	0.1
Third River Tributary No. 1								
A	510[2]	18	76	7.9	141.4	138.9[3]	138.9	0.0
B	1,500[2]	90	241	2.5	141.9	141.3	141.4	0.1
C	2,000[2]	124	150	4.0	143.0	143.0	143.1	0.1

[1] Stream distance in feet above confluence with Passaic River
[2] Stream distance in feet above confluence with Third River
[3] Elevation computed without consideration of backwater effects from Third River

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

THIRD RIVER – THIRD RIVER TRIBUTARY – THIRD RIVER TRIBUATARY NO. 1

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Turtle Brook								
A	650[1]	17	43	9.0	347.1	347.1	347.1	0.0
B	1,735[1]	19	44	8.8	408.8	408.8	408.8	0.0
C	2,210[1]	30	59	6.5	418.9	418.9	418.9	0.0
Van Winkles Brook								
A	-400[2]	150[3]	229	4.3	96.0	96.0	96.2	0.2
B	445[2]	40[3]	161	6.1	99.4	99.4	99.6	0.2
C	1,115[2]	39[3]	118	8.4	103.4	103.4	103.4	0.0
D	2,145[2]	29[3]	103	9.6	128.5	128.5	128.6	0.1
E	2,470[2]	20[3]	84	11.7	133.8	133.8	133.8	0.0

[1] Stream distance in feet above confluence with West Branch Rahway River
[2] Stream distance in feet above corporate limits
[3] Widths extend beyond corporate limits

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

TURTLE BROOK – VAN WINKLES BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
West Branch Rahway River								
A-BH[2]								
BI	21,790	150	250	4.8	298.3	298.3	298.3	0.0
BJ	24,420	800	11,573	0.1	334.0	334.0	334.0	0.0
BK	26,210	202	678	2.2	334.0	334.0	334.0	0.0
BL	26,870	81	404	3.7	336.9	336.9	336.9	0.0
BM	28,080	439	2,140	0.7	338.8	338.8	339.0	0.2
BN	29,205	174	532	2.8	339.8	339.8	340.0	0.2
BO	30,660	82	268	5.6	346.6	346.6	346.7	0.1
BP	31,705	95	233	6.4	353.6	353.6	353.6	0.0
BQ	32,800	205	624	2.4	359.9	359.9	360.0	0.1
BR	33,740	340	932	1.2	360.4	360.4	360.6	0.2
BS	34,765	212	285	3.9	360.9	360.9	361.0	0.1
BT	35,970	81	122	6.1	362.1	362.1	362.1	0.0
BU	37,380	70	316	2.3	367.0	367.0	367.0	0.0
BV	38,040	50	231	3.2	369.0	369.0	369.2	0.2
BW	39,680	55	364	2.0	372.3	372.3	372.4	0.1
BX	40,353	95	479	1.5	374.2	374.2	374.4	0.2

[1] Stream distance in feet above mouth
[2] Data not available

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

WEST BRANCH RAHWAY RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
West Fork East Branch Rahway River								
A	22,956	22	112	7.4	146.9	146.9	147.0	0.1
B	23,565	18	87	9.5	148.1	148.1	148.2	0.1
C	24,200	14	79	8.3	150.2	150.2	150.2	0.0
D	24,704	18	109	3.2	151.2	151.2	151.3	0.1
E	25,250	12	36	9.7	156.0	156.0	156.0	0.0
F	25,680	12	38	9.2	159.6	159.6	159.8	0.2
G	25,935	15	38	9.2	161.5	161.5	161.5	0.0

[1] Stream distance in feet above confluence with ?

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

WEST FORK TO EAST BRANCH RAHWAY RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Yantacaw Brook								
A	20	12	50	9.5	174.1	174.1	174.3	0.2
B	463	20	61	7.8	180.8	180.8	180.8	0.0
C	763	69	284	1.7	185.8	185.8	185.9	0.1
D	1,438	6	42	11.3	197.8	197.8	197.8	0.0

[1] Stream distance in feet above corporate limits

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

YANTACAW BROOK

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 analysis. The zones are as follows:

Zone A

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

Zone AE

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

Zone AH

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

Zone AO

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

Zone AR

Area of special flood hazard formerly protected from the one annual chance flood event by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the one percent annual chance or greater flood event.

Zone A99

Zone A99 is the flood insurance rate zone that corresponds to areas of the one percent annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No BFEs or depths are shown within this zone.

Zone V

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

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the one percent annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot BFEs derived from the detailed hydraulic analysis is 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 areas of one percent annual chance flooding where average depths are less than 1 foot, areas of one percent annual chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the one percent annual chance flood by levees. No BFEs or depths are shown within this zone.

Zone D

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

6.0 FLOOD INSURANCE RATE MAP

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

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use 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 analysis and floodway computations. The NJFHADF line is also shown for the Passaic River and Third River.

The countywide FIRM presents flooding information for the entire geographic area of Essex County. Previously, FIRMs were prepared for each community of Essex County identified as flood-prone. This countywide FIRM also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community are presented in Table 10, "Community Map History."

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISIONS DATE(S)
Belleville, Township of	January 9, 1974	June 4, 1976	September 28, 1979	September 4, 1987
Bloomfield, Township of	July 15, 1973	N/A	August 15, 1977	September 4, 1987
Caldwell, Borough of	N/A	N/A	N/A	N/A
Cedar Grove, Township of	February 8, 1974	N/A	February 1, 1980	N/A
East Orange, City of	February 13, 1976	N/A	February 2, 1977	February 4, 1988
Essex Fells, Borough of	December 3, 1976	N/A	January 2, 1980	N/A
Fairfield, Township of	June 15, 1973	N/A	June 15, 1973	July 1, 1974 July 16, 1976 September 15, 1983 March 1, 1984 June 3, 1986
Glen Ridge, Borough of	July 6, 1973	June 11, 1976	April 3, 1984	N/A
Irvington, Township of	December 28, 1973	September 28, 1975	December 4, 1979	November 14, 1980
Livingston, Township of	June 1, 1973	N/A	March 15, 1977	February 10, 1978 July 14, 1978 December 17, 1987 June 20, 2001
Maplewood, Township of	May 4, 1973	N/A	August 15, 1977	N/A
Millburn, Township of	April 27, 1973	September 24, 1976	August 1, 1979	February 17, 1988 January 3, 1997 March 17, 2002

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISIONS DATE
Montclair, Township of	March 9, 1973	N/A	September 15, 1977	August 4, 1987
Newark, City of	March 15, 1974	September 24, 1976	March 28, 1980	January 19, 1996
North Caldwell, Borough of	June 7, 1974	June 11, 1976	April 3, 1984	N/A
Nutley, Township of	May 23, 1973	N/A	April 15, 1977	May 12, 1978 June 18, 1987
Orange Township, City of	November 26, 1976	N/A	June 15, 1984	N/A
Roseland, Borough of	May 29, 1973	March 19, 1976	September 2, 1981	December 20, 2001
South Orange, Village	November 30, 1973	N/A	July 18, 1977	N/A
Verona, Township of	June 22, 1973	June 11, 1973	February 15, 1980	N/A
West Caldwell, Township of	June 15, 1973	August 20, 1976	April 16, 1979	December 20, 2001
West Orange, Township of	June 21, 1974	N/A	May 2, 1977	December 12, 1980

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, NJ
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

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

This is a multi-volume FIS. Each volume may be revised separately, in which case it supersedes the previously printed volume. Users should refer to the Table of Contents in Volume 1 for the current effective date of each volume; volumes bearing these dates contain the most up-to-date flood hazard data.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting FEMA, Federal Insurance and Mitigation Division, FEMA Region II, 26 Federal Plaza, Room 1351, New York, New York, 10278.

9.0 BIBLIOGRAPHY AND REFERENCES

Belleville Times, (2014, March 20), Belleville getting two flood mitigation grants, Retrieved April 8, 2014, from http://www.northjersey.com/towns/belleville-gets-help-with-flooding-1.746461.

Cunningham, John, T., This is New Jersey, Rutgers University Press, 1953.

Dean, R., Collins, I., Divoky, D., Hatheway, D. and Scheffner, N., FEMA Coastal Flood Hazard Analysis and Mapping Guidelines Focused Study Report: Wave Setup. 2005.

Dinges, T., (2012, October 30), Hurricane Sandy leaves Essex County a mess, Retrieved January 24, 2014, from http://www.nj.com/news/index.ssf/2012/10/hurricane_sandy_leaves_essex_c.html.

Elson T. Killam Associates, Inc., Flood Plain Delineation Program for East and West Branches of the Rahway River, Millburn, New Jersey, 1976.

Elson T. Killam Associates, Inc., Report Upon an Investigation of Improvements in the East Fork of East Branch Rahway River, Orange and West Orange, Essex County, New Jersey, Millburn, New Jersey, May 1977.

Elson T. Killam Associates, Inc., Report Upon Storm and Sanitary Facilities: Section I-Summary Report and Introduction, Section 4-Merklin District, Millburn, New Jersey, February 1972.

Essex County Department of Public Work, Aerial Photographs and Topographic Maps of Essex, Scale 1:1,200, Contour Interval 2 feet; Essex, April 1959, Unpublished.

Essex County Drainage Engineer, Essex County Aerial Survey, Scale 1:1,200, Contour Interval 2 feet, April 1969.

Essex County Highway Department, Engineering Committee, Report on Control of Floods on the Second River and Master Plan for Second River Improvement, Second River, Flood Control Conference, Scale 1:720 horizontal, 1:72 vertical, 1940.

Eustachewich, L. (2012, October 30), Sandy Outages, Passaic River Flooding in Essex, Retrieved January 24, 2014, from http://bloomfield.patch.com/groups/editors-picks/p/hurricane-sandy-power-outages-reported-in-essex-county.

Federal Emergency Management Agency, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update, Appendix D of Guidelines and Specifications for Flood Hazard Mapping Partners, 2007a.

Federal Emergency Management Agency, Guidance for Riverine Flooding Analyses and Mapping, Appendix C of Guidelines and Specifications for Flood Hazard Mapping Partners, November 2009.

Federal Emergency Management Agency, Flood Insurance Study, Borough of Florham Park, Morris County, New Jersey, March 1, 1984.

Federal Emergency Management Agency, Flood Insurance Study, Borough of West Caldwell, Essex County, New Jersey, April 16, 1979.

Federal Emergency Management Agency, Flood Insurance Study, City of Newark, Essex County, New Jersey, March 28, 1980a.

Federal Emergency Management Agency, Flood Insurance Study, City of East Orange, Essex County, New Jersey, May 1975a.

Federal Emergency Management Agency, Flood Insurance Study, Essex County, New Jersey (All Jurisdictions), January 7, 2007b.

Federal Emergency Management Agency, Flood Insurance Study, Township of Bloomfield, Essex County, New Jersey, July 1975b.

Federal Emergency Management Agency, Flood Insurance Study, Township of Irvington, Essex County, New Jersey, November 14, 1980c.

Federal Emergency Management Agency, Flood Insurance Study, Township of Montclair, Essex County, New Jersey, August 4, 1987a.

Federal Emergency Management Agency, Flood Insurance Study, Township of Nutley, Essex County, New Jersey, June 18, 1987b.

Federal Emergency Management Agency, Flood Insurance Study, Township of West Orange, Essex County, New Jersey, November 2, 1976.

Federal Emergency Management Agency, Flood Insurance Study, Township of Cedar Grove, Essex County, New Jersey, February 1, 1980b.

Federal Emergency Management Agency, Flood Insurance Study, Township of East Hanover, Morris County, New Jersey, January 17, 1986.

Federal Emergency Management Agency, Flood Insurance Study, Township of Livingston, Essex County, New Jersey, June 20, 2001.

Federal Emergency Management Agency, Flood Insurance Study, Township of Maplewood, Essex County, New Jersey, February 15, 1977a.

Federal Emergency Management Agency, Flood Insurance Study, Township of Springfield, Union County, New Jersey, February 2, 1982.

Federal Emergency Management Agency, Flood Insurance Study, Township of Union, Union County, New Jersey, August 1, 1978.

Federal Emergency Management Agency, Flood Insurance Study, Village of South Orange, Essex County, New Jersey, July 18, 1977b.

Federal Emergency Management Agency, Major Disaster Declarations, Disaster Declarations for New Jersey. Retrieved June 25, 2013, from https://www.Federal Emergency Management Agency.gov/ar/disasters/grid/state-tribal-government/37?field_disaster_type_term_tid_1=All

Federal Emergency Management Agency, Policy and Procedures for Identifying and Mapping Areas Subject to Wave Heights Greater than 1.5 feet as an Informational Layer on Flood Insurance Rate Maps (FIRMs), Procedure Memorandum No. 50, December 3, 2008.

Federal Emergency Management Agency, Region II Coastal Storm Surge Study Reports, Preliminary/Draft, December 2013.

Federal Emergency Management Agency, Supplementary WHAFIS Documentation, WHAFIS 4.0, Altanta, Georgia, 2007c.

GEOD Aerial Mapping, Inc., Field Brook and Cross Section Data, Topographic Maps, Scale 1:2,400, Contour Interval 5 feet: Belleville, New Jersey, 1976, Unpublished (a).

GEOD Aerial Mapping, Inc., Fieldbook and Cross Section Data for the Borough of Verona, New Jersey, Unpublished (b).

GEOD Aerial Mapping, Inc., Fieldbook and Cross Section Data for the Township of Cedar Grove, New Jersey, Unpublished (c).

GEOD Aerial Mapping, Inc., Topographic Maps, compiled from aerial photographs, Scale 1:2,400, Contour Interval 5 feet: Township of Glen Ridge Borough, Essex County, New Jersey, 1977a.

GEOD Aerial Mapping, Inc., Topographic Maps, compiled from aerial photographs, Scale 1:2,400, Contour Interval 5 feet: Orange, Essex County, New Jersey, 1977b.

GEOD Aerial Mapping, Inc., Topographic Maps, Scale 1:2,400, Contour Interval 5 feet: Irvington, New Jersey, March 1976.

Hydrologic Engineering Center, Floodway Determination Using Computer Program HEC-2, Training Document No. 5, U.S. Army Corp of Engineers, Davis, California, 1974.

Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Generalized Computer Program, U.S. Army Corp of Engineers, Davis, California, 1973; 1976; 1979; 1980; 1982; 1984; 1991 (various dates).

Hydrologic Engineering Center, HEC-RAS, River Analysis System, Version 4.1, U.S. Army Corps of Engineers, Davis, California, January 2010a.

Hydrologic Engineering Center, HEC-HMS, Hydrologic Modeling System, Version 3.5, U.S. Army Corps of Engineers, Davis, California, August 2010b.

Leonard Jackson Associates, prepared for the New Jersey Department of Environmental Protection, Supplemental Study No. V, Delineation of Floodway and Flood Hazard Area, East Rahway River, Station 140 + 00 to Station 204 + 50, Township of Maplewood, Township of West Orange, Village of South Orange, Essex County, New Jersey, Plate 3 of 3, Spring Valley, New York, Prepared April 1980, Unpublished.

National Academy of Sciences, Methodology for Calculating Wave Action Effects Associated with Storm Surges, 1977.

National Geospatial-Intelligence Agency, LiDAR, acquired by Sanborn, for Bergen, Hudson, Essex, Union, Middlesex, and Upper Monmouth County, New Jersey, 2006.

New Jersey, Department of Public Works, Division of Engineers, Sewer Master Plan for the Township of Irvington, Edwards and Kelcey, Inc., 1977.

New Jersey, Bureau of Geology and Topography, The Story of New Jersey's Civil Boundaries, 1606-1968, by John P. Snyder, Trenton, New Jersey, 1969.

New Jersey, Bureau of Water Control, Flood Hazard Area Delineation Based on Historic Data, Passaic River Basin, 1973.

New Jersey, Department of Environmental Protection, Division of Water Resources, in cooperation with the U.S. Geological Survey, Water Resources Circular 23, Statistical Summaries of New Jersey Streamflow Records, Trenton, New Jersey, 1970.

New Jersey, Department of Environmental Protection, Division of Water Resources, in cooperation with the U.S. Geological Survey, Special Report 38, Magnitude and Frequency Effects of Floods in New Jersey with Effects of Urbanization, by Stephen J. Stankowski, Trenton, New Jersey, 1974.

New Jersey, Department of Environmental Protection, Division of Water Resources, in corporation with the U.S. Geological Survey, Depth Discharge Frequency Relations for Non-Coastal Plain Sites in New Jersey, Water Resources Circular, No. 14, Trenton, New Jersey, 1964.

New Jersey, Department of Environmental Protection, Water Surface Profile, Supplemental Flood Study I, Phase II, Trenton, New Jersey, prepared June 1980, Unpublished.

New Jersey, Geological Survey, Annual Report of the State Geologist, for the Year 1887, Trenton, New Jersey, 1887.

Risk Analysis, Mapping, and Planning Partners, Region II Coastal Terrain Processing Methodology Documentation Report in Draft form, December 2011, Region II NY/NJ Storm Surge Study TSDN, Fairfax, Virginia, 2011.

Richard P. Browne Associates, Drainage Study, Passaic County, New Jersey, Volumes I and II, 1975; Volume III, 1976.

Robinson Aerial Surveys, Aerial Photographs, Scale 1”=100’: Essex County, New Jersey, 1964.

Snyder, John Parr., The story of New Jersey’s civil boundaries, 1606-1968, Bureau of Geology and Topography, Trenton, New Jersey, 1969.

URS Corporation, Inc., prepared for the New Jersey Department of Environmental Protection, Supplemental Study No. IV, Delineation of Floodway and Flood Hazard Area, Nishua Brook, Station 0 + 00 to Station 40 + 00, Second River Tributary, Station 50 + 00 to Station 86 + 00, City of Orange Township, City of East Orange, Borough of Glen Ridge, Township of Montclair, Essex County, New Jersey, Plate N-1 and Plate ST-2, Montavale, New Jersey, prepared June 1980, Unpublished.

U.S. Army Corps of Engineers, Discharges on Streams within the Rahway River Basin, New Jersey, New York District, New York, New York, July 1975.

U.S. Army Corps of Engineers, Feasibility Report for Flood Control for the East Fork of East Branch Rahway River at Orange and West Orange, West New Jersey, New York District, New York, New York, August 1973.

U.S. Army Corps of Engineering, Flood Control Survey, Passaic River, New Jersey, New York District, New York, New York, 1938.

U.S. Army Corps of Engineers, General Design Memorandum on the East Branch Rahway River at South Orange, New York District, New York, New York, September 1969.

U.S. Army Corps of Engineers, Hydrology Worksheets, West Branch of Rahway River, Peckman River, Second River, New York District, New York, New York, date unknown.

U.S. Army Corps of Engineers, Passaic River Basin, New Jersey and New York, Survey Report for Water Resources, New York District, New York, New York, 1972a.

U.S. Army Corps of Engineers, Passaic River Report, New York District, New York, New York, 1972b.

U.S. Army Corps of Engineers, Statistical Methods in Hydrology, ER 1110-2-1450, Sacramento District, by Leo R. Beard, October 1962.

U.S. Army Corps of Engineers, Work Sheets for log-Pearson Type III, Frequency-Discharge Data, Second River at Belleville, New York District, New York, New York, 1975b.

U.S. Census Bureau, American Fact Finder, Essex County, New Jersey, 2010. Retrieved February 5, 2014, from http://quickfacts.census.gov/qfd/states/34/34013.html.

U.S. Climate Data, Temperature-Precipitation-Sunshine-Snowfall, Climate Newark – New Jersey. Retrieved February 5, 2014, from http://www.usclimatedata.com/climate.php?location=USNJ0355.

U.S. Geological Survey, Floods of August and September 1971 in New Jersey, prepared in corporation with the New Jersey Department of Environmental Protection, Division of Water Resources, 1972a.

U.S. Geological Survey, Flood-Prone Area Map, Scale 1:24,000, Contour Interval 10 feet: Jersey City, New Jersey-New York, 1973; Elizabeth, New Jersey-New York, 1973.

U.S. Geological Survey, Flood-Prone Area Map, Scale 1:24,000, Contour Interval 20 feet: Orange, New Jersey, 1972b.

U.S. Geological Survey, Log-Pearson Type III Frequency Analysis, 1978.

U.S. Geological Survey, Techniques for Estimating Depth of 100-Year Floods In New Jersey, Anthony J. Velnich and Stanley L. Laskowski, Trenton, New Jersey, April 1979.

U.S. Geological Survey, The Passaic Flood of 1903, Water-Supply and Irrigation Paper No. 92, Series M, General Hydrographic Investigation, 8 by Marshall Ora Leighton, 1904.

U.S. Geological Survey, Water Resources Data for New Jersey, Part I, Surface Water Records, 1904 to 1974, prepared in cooperation with the New Jersey Department of Environmental Protection, Division of Water Resources, 1975.

U.S. Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Intervals 10 and 20 feet: Paterson, New Jeresy, 1955, Photorevised 1970; Caldwell, New Jersey, 1954, Photorevised 1970; Orange, New Jersey, 1955, Photorevised, 1970; Pompton Plains, New Jersey, 1955, Photorevised 1970.

Water Resources Council, Hydrology Committee, A Uniform Technique for Determining Flood Flow Frequency, Bulletin 15, December 1967.

Water Resources Council, Hydrology Committee, Guidelines for Determining Flood Flow Frequency, Bulletin 17, March 1976.

Widmer, Kemble., Geology and Geography of New Jersey, Volume 19, New Jersey Historical Series, Princeton, New Jersey, D. Von Nostrand Co., 1964.

Works Projects Administration, New Jersey Riparian Stream and Waterways Survey, Passaic River, 1935.