FLOOD INSURANCE STUDY

VOLUME 1 of 6

LUZERNE COUNTY, PENNSYLVANIA
(ALL JURISDICTIONS)

COMMUNITY NAME	COMMUNITY NUMBER
ASHLEY, BOROUGH OF	420596
AVOCA, BOROUGH OF	420597
BEAR CREEK VILLAGE, BOROUGH OF	422756
BEAR CREEK, TOWNSHIP OF	421136
BLACK CREEK, TOWNSHIP OF	420598
BUCK, TOWNSHIP OF	421824
BUTLER, TOWNSHIP OF	420599
CONYNGHAM, BOROUGH OF	420992
CONYNGHAM, TOWNSHIP OF	420600
COURTDALE, BOROUGH OF	420601
DALLAS, BOROUGH OF	421825
DALLAS, TOWNSHIP OF	420602
DENNISON, TOWNSHIP OF	422271
DORRANCE, TOWNSHIP OF	421826
DUPONT, BOROUGH OF	422250
DURYEA, BOROUGH OF	420603
EDWARDSVILLE, BOROUGH OF	420604
EXETER, BOROUGH OF	420605
EXETER, TOWNSHIP OF	420606
FAIRMOUNT, TOWNSHIP OF	421827
FAIRVIEW, TOWNSHIP OF	420993
FORTY FORT, BOROUGH OF	420607
FOSTER, TOWNSHIP OF	421828
FRANKLIN, TOWNSHIP OF	421829
FREELAND, BOROUGH OF*	422637
HANOVER, TOWNSHIP OF	420608
HARVEYS LAKE, BOROUGH OF	420609
HAZLE, TOWNSHIP OF	421830
HAZLETON, CITY OF*	421203
HOLLENBACK, TOWNSHIP OF	421831
HUGHESTOWN, BOROUGH OF*	422626
HUNLOCK, TOWNSHIP OF	420994
HUNTINGTON, TOWNSHIP OF	421832
JACKSON, TOWNSHIP OF	420610
JEDDO, BOROUGH OF*	422269
JENKINS, TOWNSHIP OF	420611
KINGSTON, BOROUGH OF	420612
KINGSTON, TOWNSHIP OF	420613
LAFLIN, BOROUGH OF	420995
LAKE, TOWNSHIP OF	421833
LARKSVILLE, BOROUGH OF	420614
LAUREL RUN, BOROUGH OF	421818
LEHMAN, TOWNSHIP OF	420615
LUZERNE, BOROUGH OF	420616
NANTICOKE, CITY OF	420617
NESCOPECK, BOROUGH OF	420618
NESCOPECK, TOWNSHIP OF	420619
NEW COLUMBUS, BOROUGH OF	421819
NEWPORT, TOWNSHIP OF	421822
NUANGOLA, BOROUGH OF	422272
PENN LAKE PARK, BOROUGH OF	422645
PITTSTON, CITY OF	420620
PITTSTON, TOWNSHIP OF	421834
PLAINS, TOWNSHIP OF	420621
PLYMOUTH, BOROUGH OF	420622
PLYMOUTH, TOWNSHIP OF	420623
PRINGLE, BOROUGH OF	420624
RICE, TOWNSHIP OF	420996
ROSS, TOWNSHIP OF	421835
SALEM, TOWNSHIP OF	420625
SHICKSHINNY, BOROUGH OF	420626
SLOCUM, TOWNSHIP OF	422712
SUGAR NOTCH, BOROUGH OF*	421820
SUGARLOAF, TOWNSHIP OF	420997
SWOYERSVILLE, BOROUGH OF	420627
UNION, TOWNSHIP OF	421836
WARRIOR RUN, BOROUGH OF*	422270
WEST HAZLETON, BOROUGH OF	421821
WEST PITTSTON, BOROUGH OF	420628
WEST WYOMING, BOROUGH OF	420629
WHITE HAVEN, BOROUGH OF	420630
WILKES-BARRE, CITY OF	420631
WILKES-BARRE, TOWNSHIP OF	421823
WRIGHT, TOWNSHIP OF	420632
WYOMING, BOROUGH OF	420633
YATESVILLE, BOROUGH OF*	420634

***** No special flood hazard areas identified

EFFECTIVE DATE: NOVEMBER 2, 2012

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
42079CV001A

NOTICE TO
FLOOD INSURANCE STUDY USERS

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

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

Selected Flood Insurance Rate Map panels for the community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g. floodway boundaries, cross sections). In addition, former flood hazard zone designations have been changed as shown:

Old Zone	New Zone
A1 through A30	AE
B	X
C	X

Initial Countywide FIS Effective Date: November 2, 2012

TABLE OF CONTENTS – Volume 1 – November 2, 2012

FIGURES

TABLES

TABLES - continued

TABLE OF CONTENTS – Volume 3

EXHIBITS – continued

Exhibit 1 – Flood Profiles

TABLE OF CONTENTS – Volume 4

EXHIBITS – continued

Exhibit 1 – Flood Profiles – continued

TABLE OF CONTENTS – Volume 5

EXHIBITS – continued

Exhibit 1 – Flood Profiles – continued

TABLE OF CONTENTS – Volume 6

EXHIBITS – continued

Exhibit 1 – Flood Profiles – continued

FLOOD INSURANCE STUDY
LUZERNE COUNTY, PENNSYLVANIA (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 Luzerne County, Pennsylvania, including the Cities of Hazleton, Nanticoke, Pittston and Wilkes-Barre, the Boroughs of Ashley, Avoca, Bear Creek Village, Conyngham, Courtdale, Dallas, Dupont, Duryea, Edwardsville, Exeter, Forty Fort, Freeland, Harveys Lake, Hughestown, Jeddo, Kingston, Laflin, Larksville, Laurel Run, Luzerne, Nescopeck, New Columbus, Nuangola, Penn Lake Park, Plymouth, Pringle, Shickshinny, Sugar Notch, Swoyersville, Warrior Run, West Hazleton, West Pittston, West Wyoming, White Haven, Wyoming and Yatesville; and the Townships of Bear Creek, Black Creek, Buck, Butler, Conyngham, Dallas, Dennison, Dorrance, Exeter, Fairmount, Fairview, Foster, Franklin, Hanover, Hazle, Hollenback, Hunlock, Huntington, Jackson, Jenkins, Kingston, Lake, Lehman, Nescopeck, Newport, Pittston, Plains, Plymouth, Rice, Ross, Salem, Slocum, Sugarloaf, Union, Wilkes-Barre and Wright (referred to collectively herein as Luzerne 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 county that will establish actuarial flood insurance rates and to assist the county in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

Please note that on the effective date of this study, the Boroughs of Freeland, Hughestown, Jeddo, Sugar Notch, Warrior Run and Yatesville; and the City of Hazleton have no mapped Special Flood Hazard Areas (SFHA). This does not preclude future determinations of SFHA that could be necessitated by changed conditions affecting the community (i.e. annexation of new lands) or the availability of new scientific or technical data about flood hazards.

In some states and 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 takes precedence and the State (or other jurisdictional agency) will be able to explain them.

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

1.2 Authority and Acknowledgments

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

This FIS was prepared to include all jurisdictions within Luzerne County in a countywide format. Information on the authority and acknowledgements for each jurisdiction included in this countywide FIS, as complied from their previously printed FIS reports is shown below.

Ashley, Borough of:	For the FIS dated March 1980 and the Flood Insurance Rate Map (FIRM) dated September 30, 1980, the hydrologic and hydraulic analyses were performed by Yule, Jordan and Associates for the Federal Insurance Administration (FIA), under Contract No. H-4764. This work was completed in July 1979 (Reference 1).
Avoca, Borough of:	For the FIS dated January 16, 1981 and the FIRM dated July 16, 1981, the hydrologic and hydraulic analyses were prepared by Yule, Jordan and Associates for the FIA, under Contract No. H-4764. This work was completed in October 1979 (Reference 2).
Bear Creek, Township of:	For the FIS dated March 1978 and the FIRM dated September 29, 1978, the hydrologic and hydraulic analyses were performed by Gannett, Fleming, Corddry, and Carpenter, Inc., for the FIA, under Contract No. H-3813. The work was completed in June 1977. All survey work was done by, or under the direction of Quinn and Associates, Inc. of Horsham, Pennsylvania (Reference 3).
Black Creek, Township of:	For the FIS dated March 1980 and the FIRM dated September 3, 1980, the hydrologic and hydraulic analyses were prepared by Yule, Jordan and Associates, for the FIA, under Contract No. H-4764. This work was completed in December 1978 (Reference 4).
Buck, Township of:	For the FIS dated October 15, 1980 and the FIRM dated April 15, 1981, the hydrologic and hydraulic analyses were prepared by Gilbert Associates, Inc., for the FIA, under Contract No. H-4817. This work was completed in August 1979 (Reference 5).
Butler, Township of:	For the FIS dated June 1980 and the FIRM dated December 16, 1980, the hydrologic and hydraulic analyses were performed by Yule, Jordan and Associates for the FIA, under Contract No. H-4764. This work was completed in February 1979 (Reference 6).

Conyngham, Borough of:	For the FIS dated January 1980 and the FIRM dated July 16, 1980, the hydrologic and hydraulic analyses were performed by Yule, Jordan and Associates for the FIA, under Contract No. H-4764. This work was completed in January 1979 (Reference 7).
Conyngham, Township of:	For the FIS dated August 1976 and the FIRM dated February 16, 1977, the hydrologic and hydraulic analyses were performed by the Susquehanna River Basin Commission (SRBC) for the FIA, under Contract No. H-3496 (Reference 8).
Courtdale, Borough of:	For the original FIS and FIRM dated June 1, 1979, the hydrologic and hydraulic analyses were performed by Gilbert Associates, Inc., for the FEMA, under Contract No. H-4817. This work was completed in December 1978 (Reference 9). For the revision of the FIS dated July 20, 1981 and the FIRM dated January 20, 1982, the hydrologic and hydraulic analyses were performed by Gilbert Associates, Inc for FEMA (Reference 10).
Dallas, Borough of:	For the FIS dated July 2, 1980 and the FIRM dated January 2, 1981, the hydrologic and hydraulic analyses were performed by Yule, Jordan and Associates for the FIA, under Contract No. H-4764. This work was completed in June 1979 (Reference 11).
Dennison, Township of:	For the FIS dated October 15, 1980 and the FIRM dated April 15, 1981, the hydrologic and hydraulic analyses were performed by Gilbert Associates, Inc., for the FIA under Contract No. H-4817. This work was completed in August 1979 (Reference 12).
Dorrance, Township of:	For the FIS dated February 1980 and the FIRM dated August 15, 1980, the hydrologic and hydraulic analyses were performed by Yule, Jordan and Associates for the FIA, under Contract No. H-4764. This work was completed in March 1979 (Reference 13).
Dupont, Borough of:	For the FIS dated December 15, 1980 and the FIRM dated June 15, 1981, the hydrologic and hydraulic analyses were prepared by Yule, Jordan and Associates, for the FIA, under Contract No. H-4764. This work was completed in October 1979 (Reference 14).

Duryea, Borough of:	For the FIS dated December 1979 and the FIRM dated June 18, 1980, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3824. This work was completed in April 1978. The hydrologic and hydraulic analyses were conducted by Michael Baker, Jr., Inc., under subcontract to the SRBC (Reference 15).
Edwardsville, Borough of:	For the FIS dated October 1976 and the FIRM dated April 15, 1977, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496. Work maps were compiled by Quinn and Associates. Profiles and floodways were computed and flood boundaries delineated by Century Engineering under subcontract to the SRBC (Reference 16).
Exeter, Borough of:	For the FIS dated November 1976 and the FIRM dated May 16, 1977, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496. Work maps were compiled by Quinn and Associates. Profiles and floodways were computed and flood boundaries delineated by Century Engineering, under subcontract to the SRBC (Reference 17).
Exeter, Township of:	For the FIS dated March 15, 1983 and the FIRM dated September 15, 1983, the hydrologic and hydraulic analyses were prepared by the SRBC for FEMA, under Contract No. H-3824. This work was completed in July 1978 (Reference 18).
Fairmount, Township of:	For the FIS dated October 1980 and the FIRM dated April 1, 1981, the hydrologic and hydraulic analyses were prepared by Gilbert Associates, Inc., for the FIA, under Contract No. H-4817. This work was completed in September 1979 (Reference 19).
Fairview, Township of:	For the FIS dated July 20, 1981 and the FIRM dated January 20, 1982, the hydrologic and hydraulic analyses were performed by Gilbert Associates, Inc., for FEMA, under Contract No. H-4817. This work was completed in December 1978 (Reference 20).
Forty Fort, Borough of:	For the FIS dated October 1976 and the FIRM dated July 3 1981, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496. Work maps were compiled by Quinn and Associates. Profiles and floodways were computed and flood boundaries delineated by Century Engineering, under subcontract to the SRBC (Reference 21).

Foster, Township of:	For the FIS dated October 1, 1980 and the FIRM dated April 1, 1981, the hydrologic and hydraulic analyses were prepared by Gilbert Associates, Inc., for the FIA, under contract No. H-4817. This work was completed in August 1979 (Reference 22).
Franklin, Township of:	For the FIS dated November 19, 1980 and the FIRM dated May 19, 1981, the hydrologic and hydraulic analyses were prepared by Gilbert Associates, Inc., for the FIA under Contract No. H-4817. This work was completed in August 1979 (Reference 23).
Hanover, Township of:	For the FIS dated January 1981 and the FIRM dated January 2, 1981, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496. Work maps were compiled by Quinn and Associates. Profiles and floodways were computed and flood boundaries delineated by Century Engineering, under subcontract to the SRBC (Reference 24).
Harveys Lake, Borough of:	For the FIS dated June 1980 and the FIRM dated December 2, 1980, the hydrologic and hydraulic analyses were performed by Yule, Jordan and Associates, for the FIA, under Contract No. H-4764. This work was completed in September 1978 (Reference 25).
Hazle, Township of:	For the FIS dated October 1, 1980 and the FIRM dated April 1, 1981, the hydrologic and hydraulic analyses were prepared by Gilbert Associates, Inc., for the FIA, under Contract No. H-4817. This work was completed in August 1979 (Reference 26).
Hollenback, Township of:	For the FIS dated March 1980 and the FIRM dated September 17, 1980, the hydrologic and hydraulic analyses were performed by Yule, Jordan and Associates, for the FIA, under Contract No. H-4764. This work was completed in February 1979 (Reference 27).
Hunlock, Township of:	For the FIS dated October 1979 and the FIRM dated April 1, 1980, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA under Contract No. H-3824. This work was completed in March 1978. Compilation or computation of work maps, water-surface profiles, and floodway and flood boundary delineations were performed by Michael Baker Jr., Inc., under subcontract to the SRBC (Reference 28).

Huntington, Township of:	For the FIS dated October 15, 1980 and the FIRM dated April 15, 1981, the hydrologic and hydraulic analyses were prepared by Gilbert Associates, Inc., for the FIA, under Contract No. H-4817. This work was completed in September 1979 (Reference 29).
Jackson, Township of:	For the FIS dated March 1980 and the FIRM dated September 17, 1980, the hydrologic and hydraulic analyses were performed by Yule, Jordan and Associates for the FIA, under Contract No. H-4764. This work was completed in May 1979 (Reference 30).
Jenkins, Township of:	For the FIS dated November 1976 and the FIRM dated May 16, 1979, the hydrologic and hydraulic analyses were performed by the SRBC for the FIA, under Contract No. H-3496. Work maps were compiled by Quinn and Associates. Profiles and floodways were computed and flood boundaries delineated by Century Engineering, under subcontract to the SRBC (Reference 31).
Kingston, Borough of:	For the FIS dated December 1976 and the FIRM dated June 1, 1977, the hydrologic and hydraulic analyses were performed by the SRBC for the FIA, under Contract No. H-3496. Work maps for this study were compiled by Quinn and Associates. Profiles and floodways were computed and flood boundaries delineated by Century Engineering, under subcontract to the SRBC (Reference 32).
Kingston, Township of:	For the FIS dated July 2, 1980 and the FIRM dated March 12, 1982, the hydrologic and hydraulic analyses were prepared by Yule, Jordan and Associates, for the FIA, under Contract No. H-4764. This work was completed in August 1979 (Reference 33).
Laflin, Borough of:	For the FIS dated June 1980 and the FIRM dated December 2, 1980, the hydrologic and hydraulic analyses were performed by Yule, Jordan and Associates, for the FIA, under Contract No. H-4764. This work was completed in September 1978 (Reference 34).
Lake, Township of:	For the FIS dated March 1980 and the FIRM dated September 3, 1980, the hydrologic and hydraulic analyses were performed by Gilbert Associates, Inc., for the FIA, under Contract No. H-4817. This work was completed in May 1979 (Reference 35).

Larksville, Borough of:	For the FIS dated October 1976 and the FIRM dated April 1, 1977, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496 (Reference 36).
Lehman, Township of:	For the FIS dated June 1980 and the FIRM dated December 2, 1980, the hydrologic and hydraulic analyses were performed by Yule, Jordan and Associates for the FIA, under Contract No. H-4764. This work was completed in September 1978 (Reference 37).
Luzerne, Borough of:	For the FIS dated October 1976 and the FIRM dated April 15, 1977, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496 (Reference 38).
Nanticoke, City of:	For the FIS dated October 1976 and the FIRM dated April 15, 1977, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496 (Reference 39).
Nescopeck, Borough of:	For the FIS dated August 1979 and the FIRM dated February 1, 1980, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3824. This work was completed in February 1978. Compilation or computation of work maps, water-surface profiles and flood boundary delineations was performed by Michael Baker, Jr., Inc., under subcontract to the SRBC (Reference 40).
Nescopeck, Township of:	For the FIS dated February 1980 and the FIRM dated August 1, 1980, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA under Contract No. H-3824. This work was completed in March 1978. Compilation or computation of work maps, water-surface profiles, and floodway and flood boundary delineations were performed by Michael Baker, Jr., Inc., under subcontract to the SRBC (Reference 41).
New Columbus, Borough of:	For the FIS dated September 16, 1980 and the FIRM dated March 16, 1981, the hydrologic and hydraulic analyses were prepared by Gilbert Associates, Inc., for the FIA, under Contract No. H-4817. This work was completed in September 1979 (Reference 42).
Newport, Township of:	For the FIS dated June 1980 and the FIRM dated December 2, 1980, the hydrologic and hydraulic analyses were performed by Yule, Jordan and Associates for the FIA, under Contract No. H-4764. This work was completed in September 1978 (Reference 43).

Nuangola, Borough of: For the FIS dated July 20, 1981 and the FIRM dated January 20, 1982, the hydrologic and hydraulic analyses were performed by Gilbert Associates, Inc., for FEMA, under Contract No. H-4817. This work was completed in December 1978 (Reference 44).

Pittston, City of: For the FIS dated November 1976 and the FIRM dated May 2, 1977, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496. Work maps were compiled by Quinn and Associates. Profiles and floodways were computed and flood boundaries delineated by Century Engineering, under subcontract to the SRBC (Reference 45).

Pittston, Township of: For the FIS dated December 15, 1980 and the FIRM dated June 15, 1981, the hydrologic and hydraulic analyses were prepared by Yule, Jordan and Associates, for the FIA, under Contract No. H-4764. This work was completed in September 1979 (Reference 46).

Plains, Township of: For the original FIS dated November 16, 1976 and the FIRM dated May 16, 1976, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496 (Reference 47).

For the FIS and FIRM revision dated April 6, 1998, the hydrologic and hydraulic analyses were prepared by U.S. Geological Survey (USGS) for FEMA, under Inter-Agency Agreement No. FEMA-DR-1093. This work was completed March 20, 1996 (Reference 48).

Plymouth, Borough of: For the FIS dated October 1976 and the FIRM dated April 1, 1977, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496 (Reference 49).

Plymouth, Township of: For the FIS dated October 1976 and the FIRM dated April 15, 1977, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496 (Reference 50).

Pringle, Borough of: For the FIS dated October 1976 and the FIRM dated May 2, 1977, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496. Work maps were compiled by Quinn and Associates. Profiles and floodways were computed and flood boundaries delineated by Century Engineering, under subcontract to the SRBC (Reference 51).

Rice, Township of:	For the FIS dated July 2, 1980 and the FIRM dated January 2, 1981, the hydrologic and hydraulic analyses were prepared by Yule, Jordan and Associates for the FIA, under Contract No. H-4764. This work was completed in March 1979 (Reference 52).
Ross, Township of:	For the FIS dated October 15, 1980 and the FIRM dated April 15, 1981, the hydrologic and hydraulic analyses were prepared by Gilbert Associates, Inc., for the FIA, under Contract No. H-4817. This study was completed in September 1979 (Reference 53).
Salem, Township of:	For the FIS dated September 1979 and the FIRM dated March 18, 1980, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under contract No. H-3824. This work was completed in March 1978. Compilation or computation of work maps, water-surface profiles, floodway and flood boundary delineations were performed by Michael Baker, Jr., Inc., under subcontract to the SRBC (Reference 54).
Shickshinny, Borough of:	For the FIS dated January 1976 and the FIRM dated December 31 1976, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496. The topographic base maps used in this study were compiled from aerial photographs by Berger and Associates, Inc (Reference 55).
Sugarloaf, Township of:	For the FIS dated January 1980 and the FIRM dated July 2, 1980, the hydrologic and hydraulic analyses were performed by Yule, Jordan and Associates for the FIA, under Contract No. H-4764. This work was completed in January 1979 (Reference 56).
Swoyersville, Borough of:	For the FIS dated November 1982 and the FIRM dated November 5, 1982, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496. Work maps were compiled by Quinn and Associates. Profiles and floodways were computed and flood boundaries delineated by Century Engineering, under subcontract to the SRBC (Reference 57).
Union, Township of:	For the FIS dated March 1980 and the FIRM dated September 30, 1980, the hydrologic and hydraulic analyses were performed by Yule, Jordan and Associates for the FIA, under Contract No. H-4764. This work was completed in June 1979 (Reference 58).

West Pittston, Borough of:	For the FIS dated October 1976 and FIRM dated April 15, 1977, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496 (Reference 59).
West Wyoming, Borough of:	For the FIS and FIRM dated September 15, 1983, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496 (Reference 60).
White Haven, Borough of:	For the FIS dated October 15, 1980 and the FIRM dated April 15, 1981, the hydrologic and hydraulic analyses represent a revision of the original analyses by the Delaware River Basin Commission for the FIA, under Contract No. H-3747. The updated version was prepared by Gilbert Associates, Inc., for the FIA, under Contract No. H-4817. This work was completed in August 1979 (Reference 61).
Wilkes-Barre, City of:	For the original FIRM dated September 30, 1977, the hydrologic and hydraulic analyses for the original study were prepared by the SRBC for FEMA, under Contract No. H-3496 (Reference 62). For the revision of the FIS dated April 15, 1981 and the FIRM dated October 15, 1981, the hydrologic and hydraulic analyses were revised by Yule, Jordan and Associates. That work was completed in December 1979 (Reference 63). For the FIS and FIRM revision dated March 16, 1992, the hydrologic and hydraulic analyses for Mill Creek, Laurel Run, and Coal Brook were prepared by STV/Sanders & Thomas; and for the Susquehanna River by the SRBC. This work was completed in December 1990 (Reference 64).
Wright, Township of:	For the FIS dated July 16, 1980 and the FIRM dated January 16, 1981, the hydrologic and hydraulic analyses were performed by Yule, Jordan and Associates for the FIA, under Contract No. H-4764. This work was completed in April 1979 (Reference 65).
Wyoming, Borough of:	For the FIS dated November 1977 and the FIRM dated November 16, 1977, the hydrologic and hydraulic analyses were prepared by the SRBC for the FIA, under Contract No. H-3496 (Reference 66).

There are no previous FIS reports or FIRMs published for the Boroughs Freeland, Hughestown, Jeddo, Penn Lake Park, Sugar Notch, Warrior Run, and Yatesville; the City of Hazleton; and the Township of Slocum. There are no previous FIS reports

published for the Boroughs of Bear Creek Village, Laurel Run, and West Hazleton; and the Townships of Dallas, and Wilkes-Barre; therefore the previous authority and acknowledgment information for these communities are not included in this FIS. These communities may not appear in the Community Map History table (Section 6).

For this countywide FIS, and the countywide DFIRM database and mapping were prepared for FEMA by GG3, a joint venture between Gannett Fleming, Inc., Camp Hill, Pennsylvania, and Greenhorne & O'Mara, Inc., Laurel, Maryland under Joint Venture Contract No. EMP-2003-CO-2606, Task Order No. 13. New detailed hydrologic and hydraulic analyses were conducted along a portion of Big Wapwallopen Creek, Lattimer Creek, and Susquehanna River; redelineation was performed along the remaining detailed study stream reaches; limited detail analyses were conducted along Big Wapwallopen Creek, Bow Creek, Bow Creek Tributary A, Browns Creek, and Watering Run; and finally new approximate analyses were conducted along approximately 600 stream miles throughout the County. This work was completed in October 2009.

The orthophotography base mapping was provided by the PAMAP Program, Pennsylvania Department of Conservation and Natural Resources, Bureau of Topographic and Geologic Survey. This information was photogrammetrically compiled at a scale of 1:2,400 from aerial photography dated April 2005. The digital countywide FIRM was produced in Pennsylvania State Plane North Zone (FIPS Zone 3701), units in feet, and referenced to the North American Datum of 1983 (NAD83), Geodetic Reference System 1980 (GRS80) spheroid. Differences in datum and spheroid used in the production of the FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on this FIRM.

1.3 Coordination

An initial Consultation Coordination Officer's (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 streams to be studied by detailed methods.

The initial and final meeting dates for the previous FIS reports for Luzerne County and its communities are listed in Table 1, "Initial and Final CCO Meetings."

TABLE 1 – INITIAL AND FINAL CCO MEETINGS

Community Name	Initial Meeting	Final Meeting
Borough of Ashley	April 11, 1978	November 28, 1979
Borough of Avoca	April 12, 1978	August 25, 1980
Township of Bear Creek	December 1975	September 14, 1977
Township of Black Creek	April 10, 1978	August 22, 1979
Township of Buck	May 17, 1979	April 23, 1980
Township of Butler	April 1978	July 16, 1979

TABLE 1 – INITIAL AND FINAL CCO MEETINGS - continued

Community Name	Initial Meeting	Final Meeting
Borough of Conyngham	April 1978	July 16, 1979
Township of Conyngham	*	*
Borough of Courtdale	May 15, 1978	*
Borough of Dallas	April 12, 1978	February 21, 1980
Township of Dennison	May 17, 1978	April 23, 1980
Township of Dorrance	April 1978	August 22, 1979
Borough of Dupont	April 12, 1978	June 30, 1980
Borough of Duryea	June 24, 1975	May 17, 1979
Borough of Edwardsville	*	September 30, 1975
Borough of Exeter	*	October 24, 1975
Township of Exeter	June 24, 1975	December 20, 1978
Township of Fairmount	May 16, 1978	April 2, 1980
Township of Fairview	May 17, 1978	*
Borough of Forty Fort	*	October 23, 1975
Township of Foster	May 17, 1978	March 29, 1980
Township of Franklin	May 15, 1978	April 1 1980
Township of Hanover	*	October 23, 1975
Borough of Harveys Lake	April 1978	*
Township of Hazle	May 18, 1978	March 29, 1980
Township of Hollenback	April 1978	October 23, 1979
Township of Hunlock	June 17, 1975	October 5, 1978
Township of Huntington	May 16, 1978	April 2, 1980
Township of Jackson	April 11, 1978	October 24, 1979
Township of Jenkins	*	September 9, 1975
Borough of Kingston	*	September 30, 1975
Township of Kingston	April 11, 1978	February 21, 1980
Borough of Laflin	April 1978	*
Township of Lake	May 16, 1978	September 28, 1979
Borough of Larksville	*	July 22, 1975
Township of Lehman	April 1978	*
Borough of Luzerne	*	October 23, 1975
City of Nanticoke	July 21, 1975	*
Borough of Nescopeck	June 17, 1975	August 17, 1978
Township of Nescopeck	June 17, 1975	October 5, 1978
Borough of New Columbus	May 16, 1978	April 2, 1980
Township of Newport	April 1978	*

* Data Not Available

TABLE 1 – INITIAL AND FINAL CCO MEETINGS - continued

Community Name	Initial Meeting	Final Meeting
Borough of Nuangola	May 30, 1978	*
City of Pittston	*	July 21, 1975
Township of Pittston	April 12, 1978	June 30 1980
Township of Plains	*	July 30, 1975
Borough of Plymouth	*	July 21, 1975
Township of Plymouth	*	July 23, 1975
Borough of Pringle	*	*
Township of Rice	April 1978	September 27, 1978
Township of Ross	May 16, 1978	April 22, 1980
Township of Salem	June 17, 1975	October 5, 1978
Borough of Shickshinny	*	*
Township of Sugarloaf	April 1978	July 16, 1979
Borough of Swoyersville	*	October 23, 1975
Township of Union	April 11, 1978	November 28, 1979
Borough of West Pittston	*	July 22, 1975
Borough of West Wyoming	*	October 23, 1975
Borough of White Haven	April 23, 1980	April 23, 1980
City of Wilkes-Barre	*	August 25, 1980
Township of Wright	April 1978	October 3, 1979
Borough of Wyoming	*	October 23, 1975

* Data Not Available

For this countywide FIS, the final CCO meeting was held on February 23rd and 24th, 2010, and attended by representatives of FEMA, the study contractor, Luzerne County; the Boroughs of Bear Creek Village, Conyngham, Dallas, Dorrance, Dupont, Edwardsville, Harveys Lake, Larksville, Luzerne, Nescopeck, Penn Lake Park, Plymouth, Shickshinny, West Pittston, West Wyoming and Wyoming; and the Townships of, Buck, Butler, Dallas, Dennison, Fairmount, Foster, Franklin, Hanover, Hazle, Lake, Lehman, Nescopeck, Plains, Rice, and Salem, as well as from the Cities of Hazleton, Nanticoke, Pittston, and Wilkes-Barre. All problems raised at that meeting has been addressed.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Luzerne County, Pennsylvania, including the communities listed in Section 1.1.

All or portions of the streams 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).

TABLE 2 – STREAMS STUDIED BY DETAILED METHODS

Abrahams Creek
Abrahams Creek of Forty Fort
Balliet Run
Bear Creek
Beaver Run
Big Wapwallopen Creek
Big Wapwallopen Creek Tributary E
Big Wapwallopen Creek Tributary H
Black Creek
Harveys Creek
Hunlock Creek
Huntington Creek
Huntsville Creek
Kitchen Creek
Lackawanna River
Lattimer Creek
Laurel Run No. 1
Lehigh River
Lidy Creek
Little Nescopeck Creek No. 1
Little Nescopeck Creek No. 2
Little Nescopeck Creek No. 2 Tributary C
Little Wapwallopen Creek
Mill Creek No. 1
Mill Creek No. 2
Mud Swamp Creek
Nescopeck Creek
Newport Creek
Phillips Creek
Pikes Creek
Pine Creek No. 1
Pine Creek No. 2
Pond Creek
Bow Creek
Bow Creek Tributary A
Cider Run
Coal Brook
Collins Creek
Drakes Creek
East Fork Harveys Creek
Fades Creek
Geneceda Creek
Reyburn Creek
Salem Creek
Sandy Run
Shickshinny Creek
Snake Creek
Solomon Creek
South Branch Newport Creek
Spring Run
Sugarnotch Run
Susquehanna River
Sutton Creek
Tenmile Run
Toby Creek
Tributary A to Toby Creek
Tributary C to Abrahams Creek
Tributary No. 1 to Hunlock Creek
Tributary No. 1 to Tributary No. 2 to Hunlock Creek
Tributary No. 2 to Hunlock Creek
Tributary No. 17 to Susquehanna River
Tributary to Black Creek
Unnamed Tributary to Mill Creek No. 1
Walker Run
Wright Creek

Limited detail analyses were used to study those areas having low development or minimal flood hazards. For this countywide study, limits of limited detail studies for newly studied or revised streams are shown below in Table 3, "Streams Studied by Limited Detailed Methods."

TABLE 3 – STREAMS STUDIED BY LIMITED DETAILED METHODS

Flooding Source	Limits of Study
Browns Creek	From its confluence with Huntsville Creek to approximately 1,400 feet upstream of Chase Road.
Big Wapwallopen Creek	From approximately 750 feet downstream of Hobbie Wapwallopen Road to approximately 1,700 feet downstream of the confluence of Bow Creek. Also, from approximately 5,250 feet upstream of Nuangola Road to approximately 500 feet upstream of Dale Drive.
Bow Creek	From approximately 1,250 feet upstream of State Route 309, South Mountain Boulevard, to approximately 4,050 feet upstream of Black Walnut Drive.
Bow Creek Tributary A	From approximately 500 feet downstream of Wilkes Lane to approximately 1,900 feet upstream of Shady Tree Drive.
Watering Run	From its confluence with Big Wapwallopen Creek to 3,160 feet upstream of State Route 309, South Mountain Boulevard.

Numerous flooding sources in the county were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards.

Streams that have names in this countywide FIS other than those used in the previously printed FIS reports for the communities in which they area located are shown in Table 4, "Stream Name Changes."

TABLE 4 – STREAM NAME CHANGES

Community	Old Name	New Name
Borough of Avoca	Mill Creek	Mill Creek No. 2
Township of Bear Creek	Pine Creek	Pine Creek No. 1
Township of Butler	Little Nescopeck Creek	Little Nescopeck Creek No. 2
Borough of Conyngham	Little Nescopeck Creek	Little Nescopeck Creek No. 2
Borough of Conyngham	Tributary A	Little Nescopeck Creek No. 2 Tributary C
Township of Conyngham	Little Nescopeck Creek	Little Nescopeck Creek No. 1
Township of Dennison	Tributary A	Big Wapwallopen Creek Tributary E
Township of Dorrance	Mill Creek	Mill Creek No. 2
Borough of Dupont	Mill Creek	Mill Creek No. 2
Township of Hollennback	Tributary C	Big Wapwallopen Creek Tributary H
Township of Hollenback	Pine Creek	Pine Creek No. 2
Township of Huntington	Pine Creek	Pine Creek No. 2
Township of Huntington	Wapwallopen Creek	Big Wapwallopen Creek
Township of Nescopeck	Little Nescopeck Creek	Little Nescopeck Creek No. 1

TABLE 4 – STREAM NAME CHANGES – continued

Community	Old Name	New Name
Borough of New Columbus	Pine Creek	Pine Creek No. 2
Township of Pittston	Mill Creek	Mill Creek No. 2
Township of Plains	Mill Creek	Mill Creek No. 1
Township of Plains	Unnamed Tributary to Mill Creek	Unnamed Tributary to Mill Creek No. 1
Township of Sugarloaf	Little Nescopeck Creek	Little Nescopeck Creek No. 2
Township of Sugarloaf	Tributary G	Little Nescopeck Creek No. 2 Tributary C
City of Wilkes-Barre	Laurel Run	Laurel Run No. 1
City of Wilkes-Barre	Mill Creek	Mill Creek No. 1
Township of Wright	Tributary A	Bow Creek Tributary A

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

There are no Letters of Map Change (LOMCs) incorporated into this countywide study.

2.2 Community Description

Luzerne County is bordered by Wyoming County in the north, Lackawanna County in the northeast, Monroe County in the east, Carbon County in the southeast, Schuylkill County in the south, Columbia County in the west, and Sullivan County in the northwest. The population of Luzerne County is 319,250 as of the year 2000 (Reference 67) and has a land area of 907 square miles.

Luzerne County is located in northeast Pennsylvania. It is located in four physiographic regions: the Glaciated Low Plateau Section, the Susquehanna Lowland Section, the Anthracite Upland Section and the Anthracite Valley Section. The Glaciated Low Plateau Section is characterized by red-green-gray sedimentary rocks of the Catskill Formation. The Susquehanna Lowland Section is characterized by ridges which are parallel to the streams that drain the area. The Anthracite Upland Sections is characterized by mountains and steep-sided valleys. Coal, shale, sandstone and conglomerate make up this region. The Anthracite Valley Section is a valley with sharp mountain ridges on either side of the valley. Approximately half of the valley (the southwestern end) is noted for its deposits of anthracite.

The climate in the study area is generally continental in nature, modified by the effects of the Atlantic Ocean and the Gulf of Mexico. Moderately warm summers, with temperatures occasionally rising above 85 degrees Fahrenheit (°F), and cool winters, with temperatures occasionally dropping below 20°F, characterize the climate. Summer and winter mean temperatures range from 72°F to 26°F, respectively. Temperature extremes range from -21°F (January 1994) to a sultry

101°F (June 1899, September 1953 and July 1988). The annual precipitation averages 37.6 inches (Reference 68).

2.3 Principal Flood Problems

The history of flooding along the streams within Luzerne County indicates that floods may occur in any season of the year; however, the possibility of flooding is greatly reduced during the winter months. Although most severe floods are attributable to rainfall alone, the spring floods can be compounded by snowmelt and moving ice. The major floods in the late summer and fall are associated with tropical storms moving up the Atlantic coastline. The following paragraphs summarize the principal flooding problems within Luzerne County.

Major floods in Luzerne County during this century occurred in March 1936, May 1946, August 1955, March 1964, June 1972 and September 1975 (References 69, 70 and 71).

Abrahams Creek is the principal source of flooding in the Boroughs of Forty Fort, Swoyersville and West Wyoming. Wade Run is an additional source of flooding in the Borough of Swoyersville. Extensive areas in the eastern and central portions of the Borough of Swoyersville are inundated by the 1-percent-annual-chance flood event on Abrahams Creek and Wade Run. Much of this inundation is a result of channel overflow into natural ponding areas. All types of land uses are located within these areas.

Major floods occurred in the Borough of West Wyoming in 1865, 1902, 1904, 1936, 1940, 1946, 1960 and 1970 causing extensive damage to buildings and property (Reference 71). Due to the level topography of parts of the Borough of West Wyoming, there are two shallow flooding areas that create problems. Sheet flooding occurs when Abrahams Creek breaches Eighth Street. This sheet flooding, flows southwest across the borough and into the channel of an unnamed tributary.

Bear Creek, Geneceda Creek, Pine Creek No. 1 and Tenmile Run are the principal sources of flooding in the Township of Bear Creek. According to local information, flood damage has occurred in 1942 and during Tropical Storm Agnes in 1972. Flood damage incurred during the 1972 flood was estimated at $30,220 in 1972 dollars by the PADEP, formerly known as the Pennsylvania Department of Environmental Resources (Reference 72). No discharge records were available, thus the return periods of these storms could not be determined.

Beaver Run, Fades Creek, Harveys Creek and Pikes Creek are the primary sources of flooding in the Township of Lake. Due to the rather undeveloped nature of the township, flood damage in the past along these streams has been minimal.

Big Wapwallopen Creek is the primary source of flooding in the Townships of Rice and Wright, and one of the primary sources of flooding in the Townships of Conyngham, Dorrance, Fairview, Hollenback and Nescopeck. Big Wapwallopen Creek Tributary H is one of the principal sources of flooding in the Township of Hollenback.

During the 1-percent-annual-chance flood in the Township of Conyngham, Big Wapwallopen Creek causes flooding in only a small area in the southwest corner of the township. This area is undeveloped.

In the Townships of Dorrance, Hollenback and Nescopeck the two largest floods occurred in August 1955 and June 1972 floods. The discharges recorded at USGS Gaging Station No. 01538000, which is located on Big Wapwallopen Creek immediately above the Hobbie Road bridge in the Township of Hollenback, were 3,140 and 5,410 cubic feet per second (cfs), respectively, with corresponding gage heights of 9.23 feet and 11.04 feet, respectively. In the Township of Conyngham these floods have estimated recurrence intervals of 3.33- and 0.33-percent-annual-chance floods, respectively. In the Township of Hollenback these floods have estimated recurrence intervals of 4- and 0.5-percent-annual-chance floods, respectively. Other storms producing severe flooding in the Township of Fairview occurred on September 29-30, 1924, October 18, 1975, and October 9, 1976.

In June 1972, floodwaters from Big Wapwallopen Creek in the Township of Hollenback reached a depth of 18 to 24 inches over Hobbie Road and were up to the first floor of homes adjacent to the creek along Valley Road and along Oak Road near Camp Keller. Floodwaters from Big Wapwallopen Creek Tributary H at Hobbie Road were 6 to 8 inches over the road at the firehouse. No other flooding of developed areas is known to have occurred during past major storms in the Township of Hollenback.

The floods of 1955 and 1972 had estimated discharges of 1,660 cfs and 2,850 cfs in the Townships of Rice and Wright, and estimated recurrence intervals of 3.33- and 0.33-percent-annual-chance floods, respectively. Floodwaters from Big Wapwallopen Creek were approximately 18 inches over the roadway on Nuangola Road, in the Township of Rice, near Wech Corners, during the March 1936 flood. This was apparently due to an insufficient waterway opening in the bridge, which has since been replaced. No flooding in developed areas in the Township of Wright is known to have occurred during major storms except in June 1972 when floodwaters from Watering Run reached a depth of 12 inches over Alberdeen Road at the Village of Alberts Corner.

Black Creek is one of the principal sources of flooding in the Townships of Black Creek and Hazle. Racoon Creek and Tributaries to Black Creek are additional sources of flooding in the Township of Black Creek. Lattimer Creek, Dreck Creek, and their tributaries are additional sources of flooding in the Township of Hazle. The largest flood in these townships occurred in June 1972. The recurrence interval for this flood in the Township of Black Creek is estimated as an 0.33-percent-annual-chance flood. Other storms producing severe flooding along streams in the Township of Hazle occurred in 1924, 1940, 1950, 1952 and August 1955 (Hurricanes Connie and Diane).

Floodwaters from Black Creek covered the road to a depth of 1-foot at several places between Fern Glen and Rock Glen and at the confluence with Nescopeck Creek, located in the Township of Black Creek. Tributaries to Black Creek, Rock Glen, and Racoon Creek at Weston flowed out of their banks. Roads and adjacent properties at these locations in the Township of Black Creek were flooded.

The upstream portions of Black Creek, Drakes Creek and Lattimer Creek have been heavily strip mined. The bared land has resulted in an increase in stormwater runoff and sediment disposition in the streams. New development in and near the floodplains of Black Creek and Lattimer Creek, where the Township of Hazle joins the City of Hazleton and the Borough of West Hazleton, has also increased stormwater runoff. These conditions have resulted in an increase in flooding problems along these streams in the recent years.

Bow Creek and Bow Creek Tributary A, located in the Township of Fairview, Bowman Creek and its tributaries located in the Township of Ross, and Cider Run and Sutton Creek located in the Township of Franklin have flooded from time to time. However, due to the relatively undeveloped nature of the floodplains in the township, only a minimal amount of flood damage has occurred. Other storms producing severe flooding along streams in the Township of Hazle occurred in 1924, 1940, 1950, 1952 and August 1955 (Hurricanes Connie and Diane).

Gardner Creek is the principal source of flooding in the Borough of Laflin. The flood of August 1955, which had a recurrence interval of approximately 2-percent-annual-chance flood, inundated areas along Market Street and Main Street to a depth of 1-foot (Reference 73). There has been no flooding of comparable magnitude since that time.

Huntington Creek is one of the principal sources of flooding in the Townships of Fairmount, Huntington and Ross. Kitchen Creek and Phillips Creek are also principal sources of flooding in the Township of Fairmount. According to local accounts, recent flooding occurred along the streams in the Township of Fairmount in 1972 and 1975. Blaine Pond has also presented some flood problems during severe storms. In June 1972, Tropical Storm Agnes resulted in the worst natural disaster to hit the region, with record flooding along streams in the area. Other storms producing severe flooding in the region occurred on September 29-30, 1955, on October 18, 1975 and October 9, 1976.

There is substantial flooding on the flatlands along Huntington Creek in the Township of Huntington during the spring of each year. The floods of 1972 and 1975 caused considerable damage to the township along Huntington Creek. Some of the areas most frequently flooded in the township are adjacent to Cann Road, Everetts Corner Road, Lundevist Road, Williams Road and Townhill Road. Also, the area along Huntington Creek, from the downstream corporate boundary upstream to Huntington Mills, experiences considerable flooding. Undersized bridge openings and several locations in the stream channels where debris and fallen trees restrict the flow of the water contribute to the severity of the flooding. In June 1978 several homes in the Village of Register experienced severe flood damage because the bridge opening on State Route 239 could not pass the flood flows.

Huntsville Creek is the principal source of flooding in the Township of Jackson. The largest flood in the township occurred in 1972, had an estimated 2.5-percent-annual-chance flood recurrence interval and a discharge of 1,650 cfs on Huntsville Creek at the eastern boundary of the township. Floodwaters from Huntsville Creek reached a depth of one foot over Chase Road above the confluence of Browns Creek.

Lehigh River is the principal source of flooding in the Borough of White Haven and the Township of Buck, and one of the principal sources of flooding in the Townships of Dennison and Foster. Pond Creek and Sandy Run are additional sources of flooding in the Township of Foster. Flood damages in the Townships of Buck and Foster have been minimal because of the undeveloped nature of the townships along the river and the deep valley the river flows through. The most serious flood of record was due to Hurricanes Connie and Diane in August 1955, with a peak flow of 31,900 cfs at the Stoddartsville gaging station, and an 0.5-percent-annual-chance flood recurrence interval (Reference 74). Other storms which caused flooding occurred in 1942 and December 1950, with peak flows of 15,700 cfs and 7,250 cfs, and 2.5- and 10-percent-annual-chance flood recurrence intervals, respectively. The flood of 1972 was much less severe in the Upper Lehigh River drainage basin than in the adjoining Susuqehanna River basin. At the Stoddartsville gaging station, Tropical Storm Agnes produced a peak flow of 3,210 cfs, with a recurrence interval of 33.3-percent-annual-chance flood.

The Lehigh River flows through the Borough of White Haven in a broad rocky bed with steep banks. The tributaries in the borough are subject to a variation in flow; the flood flows are caused by the rapid runoff from surrounding mountain slopes. According to local information, large magnitude floods occurred in the Borough of White Haven on the Lehigh River in 1902, 1955 and 1956. The flood of 1902 destroyed sawmills which were located along the river. Hurricane Diane, in August 1955, resulted in record flooding along streams in the Lehigh River basin in the area. According to surface water records, this storm was estimated at approximately 55,000 cfs on the Lehigh River at the Borough of White Haven and the Township of Dennison (Reference 75). Other storms producing serious flooding occurred in September 1924 and May 1942. Since February 1961, the flow on the Lehigh River has been controlled by the Francis E. Walter Dam and no serious flooding has occurred. Some local flooding due to surface drainage inadequacies has occurred in the past, but current information indicates that the problems have been corrected by re-routing some of the surface drainage into more adequate channels.

Little Nescopeck Creek No. 1 is one of the primary sources of flooding in the Township of Dennison. In June 1972, Tropical Storm Agnes caused serious flooding on Little Nescopeck Creek No. 1 in the township. Other storms producing serious flooding occurred in September 1924 and May 1942.

Little Nescopeck Creek No. 2 and Little Nescopeck Creek No. 2 Tributary C are the primary sources of flooding in the Borough of Conyngham. The largest flood to occur in the Borough was in June 1972, which has an estimated 0.33-percent-annual-chance flood recurrence interval. During the flood, Little Nescopeck Creek No. 2 Tributary C flooded Main Street with two feet of water. In 1955, two men drowned when Little Nescopeck Creek No. 2 covered Butler Avenue to a depth of 4 to 5 feet.

Little Wapwallopen Creek is one of the principal sources of flooding in the Townships of Conyngham and Dorrance, and an additional source of flooding in the Township of Rice. Based upon historic data and information from the FIS for the Township of Conyngham, Little Wapwallopen Creek and the Susquehanna River are the major sources of flooding problems within the Township of Conyngham, with Big Wapwallopen Creek as an additional source (Reference 8). The river and major

stream floodplain areas are inundated periodically by major flooding events. Most notable of these have been the March 1936 and June 1972 floods which caused considerable damage to development on these floodplains. The June 1972 flood had an 0.33-percent-annual-chance flood recurrence interval. Little Wapwallopen Creek and Susquehanna River each inundate sizeable land areas during the 1-percent-annual-chance flood. Backwater flooding from the Susquehanna River and flooding from the Little Wapwallopen Creek combine to create an extensive 1-percent-annual-chance floodplain along the creek. This area is primarily in agricultural and woodland use, but includes a few scattered rural residences.

Little Wapwallopen Creek flooded over Hislop Road approximately 18 to 20 inches deep during one storm in the Township of Rice. A tributary of Little Wapwallopen Creek is flooded occasionally below Nuangola Road. A mobile home park near the township line of Blytheburn is flooded occasionally to a depth of 18 to 20 inches. No other flooding of developed areas in the Township of Rice is known to have occurred during the past major storms.

Floodwaters from Little Wapwallopen Creek have been over the roads in the Township of Dorrance several times during some of the major storms. During the 1972 flood the water was 2 feet deep on St. Mary's Road. No other flooding in developed areas of the township occurred during a major storm.

Mill Creek No. 1 is one of the primary sources of flooding in the City of Wilkes-Barre and the Township of Plains. Development located along Mill Creek No. 1 in the Township of Plains has suffered severe damage during past major floods, most notably in 1936, 1972 and 1996. The flood of 1996 caused stages on Mill Creek No. 1 that exceeded the 1-percent-annual-chance flood recurrence interval.

Mill Creek No. 2 is the primary source of flooding in the Boroughs of Avoca and Dupont, and one of the principal sources of flooding in the Township of Pittston. Collins Creek is also a source of flooding in the Township of Pittston. The largest flood in the Boroughs of Avoca and Dupont and the Township of Pittston occurred in August 1955. This flood was estimated to have a 2.5-percent-annual-chance flood recurrence interval. The peak discharge for a storm of this magnitude is estimated to be 2,600 cfs for the Borough of Avoca, 1,350 cfs for the Borough of Dupont, and 630 cfs for the Township of Pittston. When Mill Creek No. 2 overflows, flooding to depths of 6 feet usually results in the area between East McAlpine Street and the northern boundary of the borough. During the 1955 flood, the waters of Mill Creek No. 2 did not top the masonry walls through the Borough of Dupont, but it backed out of the drainage opening in the wall and flooded some of the streets, particularly Jackson Street. The waters from the 1955 storm were high on Mill Creek No. 2 and Collins Creek in the Township of Pittston; however, little or no flooding occurred in the township.

Nescopeck Creek is the principal source of flooding in the Townships of Butler and Sugarloaf, and one of the principal sources of flooding in the Borough of Nescopeck and the Townships of Dennison and Nescopeck. Wright Creek is an additional source of flooding in the Township of Dennison. The two largest floods occurred in 1955 and 1972. The recurrence intervals for these storms in the Townships of Butler and Sugarloaf were 3.33- and 0.33-percent-annual-chance floods, respectively, and the discharges were 8,000 cfs and 13,200 cfs, respectively. In June 1972, Nescopeck Creek was over its banks west of U.S. Route 309 in the Sleepy Hollow and St. John's

areas of the Township of Butler. East of U.S. Route 309, in the Township of Butler, the water was reportedly 10 feet deep on the Angela Park parking lot. In the Township of Sugarloaf, Nescopeck Creek flooded along Kellar Road east of State Route 93 and a tributary to Nescopeck Creek flooded the Cedar Head Road crossing.

In June 1972, Hurricane Agnes caused serious flooding on Nescopeck Creek in the Township of Dennison. Other storms producing serious flooding occurred in September 1924 and May 1942.

During the flood of 1972, high flows on Nescopeck Creek combined with backwater from the Susquehanna River to flood several residential and commercial properties in the Borough of Nescopeck, near the mouth of the creek. Although a few properties were damaged on the first floor level, most flooding was confined to basements. The 1975 Tropical Storm Eloise flood caused much less property damage than the flood of 1972. Only a small number of residential structures were affected, and damages to those structures were minimal.

In the Township of Nescopeck during the 1972 flood, floodwaters from Nescopeck Creek overran a number of house-trailers in low-lying sections just south of the Borough of Nescopeck. One or two of these trailers were destroyed. The 1975 flood resulted in similar damage, though on a much reduced scale.

Lake Nuangola is a natural lake, approximately 100 acres, in northern Luzerne County, that was formed as a result of a glacier. Currently, there is a natural spring that can be viewed on the mountainside of North End Road. This spring constantly flows into the wetlands that serve as a natural filter for the lake. The lake is utilized for swimming, fishing, boating and other recreational activities. There is a north inlet and a south outlet with a natural bog between them. This bog is a scrub-shrub wetland that occupies approximately ten acres along the southern end of Lake Nuangola. Boardwalks and a footbridge facilitate access through the bog. On the northern section, dominant species at this location include leather and cranberry. The southern section dominant species includes meadowsweet (Spiraea latifolia) and alder (Alnus rugosa). The change in the rising waters is a direct result of prolonged, heavy rain or snow and also related to other natural elements. These changes impact flooding conditions not only near the lake area, but also in areas of wetlands that exist throughout the Borough. When the Borough was incorporated in 1908, not very many homes existed. However, over the years, summer homes were built on the shores of the lake and these homes are now currently being converted to year round occupancies. There are approximately 116 homes situated on the lakefront from a total of approximately 418 structures. This does not include the homes that surround the lake area and outlying area. The homes that can be affected by flooding are those mainly around the lake but these are not the only homes that may be affected. North End Road actually gets flooded because the road elevation is very low and receives the flow down the mountain of a natural spring. Wetlands also adjoin the road. These homes are prone to flooding problems. Also there are homes in other areas of Nuangola Borough that are not in direct contact with the lake, but have been exposed to flooding in the past.

Pine Creek No. 2 is one of the principal sources of flooding in the Borough of New Columbus and the Township of Huntington. Little Pine Creek is an additional source of flooding in the Borough of New Columbus. There is substantial flooding in these municipalities, particularly along the flatlands and along Pine Creek No. 2 during the

spring of each year. Tropical Storms Agnes and Eloise caused considerable flooding along the stream in the Borough of New Columbus and considerable damage along the stream in the Township of Huntington. Adding to the severity of the flood problems in the Borough of New Columbus are bridge openings unable to pass flood flows, debris, and fallen trees in the stream channels.

Shickshinny Creek is the principal source of flooding in the Township of Union and one of the principal sources of flooding in the Borough of Shickshinny. The largest flood in the Township of Union was June 1972, with an estimated 0.33-percent-annual-chance recurrence interval and a discharge of 8,300 cfs on Shickshinny Creek at the southern boundary of the township. Floodwaters from Shickshinny Creek had a depth of two feet over McKendree Road at the bridge in Koonsville, located in the Township of Union, and several homes were evacuated in the area.

Solomon Creek and Sugarnotch Run are the principal sources of flooding in the Borough of Ashley. Solomon Creek is one of the principal sources of flooding in the City of Wilkes-Barre. Solomon Creek and Spring Run are additional sources of flooding in the Township of Hanover. The largest flood in the Borough of Ashely occurred in August 1972, which had an estimated 3.33-percent-annual-chance flood recurrence interval, and a discharge of 2,450 cfs was recorded at the USGS Gaging Station on Solomon Creek. Both Solomon Creek and Sugarnotch Run were out of their banks during this flood. Flood waters from Solomon Creek covered Manhattan Street and Hartford Street along an open drainage ditch. In the West Ashley Section, Fredericks Street and Preston Street were flooded by waters from Sugarnotch Run.

Susquehanna River is the principal source of flooding in the Boroughs of Exeter, Larksville, Plymouth, West Pittston, and Wyoming; the Cities of Nanticoke, Pittston and Wilkes-Barre; and the Townships of Exeter, Hanover, Hunlock, Jenkins, Nescopeck, Newport, Plains, Plymouth and Salem. It is one of the principal sources of flooding in the Boroughs of Duryea, Edwardsville, Forty Fort, Kingston, Nescopeck, Shickshinny and Swoyersville. On the Susquehanna River at USGS Gaging Station No. 01536500 in Wilkes-Barre, below the confluence with Lackawanna River, flood records exist since 1890. River stages, recorded discharges and recurrence intervals for the four recorded floods of greatest magnitude are as follows (References 69, 70, 71 and 73):

Date	Stage (feet)	Discharge (cfs)	Recurrence Interval
March 20, 1936	33.07	232,000	4-percent-annual-chance
March 10-11, 1964	30.15	228,000	4.3-percent-annual-chance
June 24, 1972	40.91	345,000	0.30-percent-annual-chance
September 27, 1975	35.06	251,000	2.63-percent-annual-chance

Peak flows of 250,000 cfs and 363,000 cfs were recorded for the 1936 and 1972 floods, respectively, at the gaging station on Susquehanna River located in Danville (Reference 75). Other large magnitude floods have occurred in March 1865, March 1902, March 1904, March 1936, April 1940 and May 1946. Approximately

12 inches of rainfall from Tropical Storm Agnes produced severe runoff conditions which resulted in high flows on all other local streams and tributaries.

Storms of tropical origin affect the Susquehanna River on an average of about one in three years. Their usual path is from the south and curving to the northeast, but a few have travelled from the southeast to the northwest. The tropical storm season runs from June to November (Reference 76).

Lackawanna River and Susquehanna River are the chief sources of flooding and damage in the Borough of Duryea and the City of Pittston. During the 1972 flood, water from the Susquehanna River backed up into the Lackawanna River, causing the overtopping of a section of levee and flooding an extensive portion of the commercial-residential center in the borough. Flood waters entered the first and, in some instances, the second floors of numerous homes and businesses. In addition to residential and commercial damage, flood waters overran two local farms, destroying crops and ruining farm equipment. A sewage treatment plant serving several local communities, located in the borough also received heavy damage. Tropical Storm Eloise, in 1975, brought a repetition of damages to some low-lying areas of the Borough of Duryea. Overall, however, the damage was on a much reduced scale when compared to the flood of 1972. Record flooding occurred on the Lackawanna River in 1942 and 1955 when flows of 20,900 cfs and 31,000 cfs were measured at the Old Forge gaging station. These floods had a return period of approximately 2.86- and 0.667-percent-annual-chance floods. Development located on the Lackawanna River and Susquehanna River floodplain areas has experienced severe damage during a number of past major floods.

In the Borough of Edwardsville the Susquehanna River flood waters across the river in the City of Wilkes-Barre crested at 40.91 feet, more than 18 feet above flood level at 7:00 p.m. Saturday, June 24, 1972. The 1936 flood crested at 33.07 feet. This was the second worst flood in the history of the Borough of Edwardsville (Reference 77).

During Tropical Storm Agnes, most of the serious property damage in the Township of Exeter occurred in the Susquehanna River floodplain along State Route 92. On Riverside Drive, floodwaters from the Susquehanna River engulfed a large residential area containing both homes and house trailers. A number of homes had water up to rooftop levels. One home and one house trailer were destroyed. There was similar residential damage in the Apple Tree Road area. A trailer court, situated near the Susquehanna River bank, was especially hard hit. Several trailers were ripped from their moorings and destroyed. Others required extensive repairs to restore them to a habitable condition.

Damaging floods have been reported in the Borough of Forty Fort as early as 1787. Several times since 1891, floodwaters from the Susquehanna River have exceeded bankful stage. Among these, the 1972 flood, with a recurrence interval of approximately 0.33-percent-annual-chance-flood, caused considerable damage throughout the Borough of Forty Fort and the Wyoming Valley area.

Hunlock Gardens, a small low-lying community located in the eastern corner of the Township of Hunlock between U.S. Route 11 and the Susquehanna River, was the main center of damage during the 1972 flood. Floodwaters from the river entered the basements and first floors of several residential and commercial structures in this

area. Elsewhere, there were only minor damages caused mainly by seepage of ground and surface water into basements.

Heavy flows on the smaller streams in the Township of Hunlock eroded sections of stream bank, clogging some stream segments with silt and other debris. Damage to the township road system was also extensive. According to one township official, the Pennsylvania Department of Community Affairs forwarded $3,000.00, in 1972 dollars, to the township for the purpose of road repairs. Aside from roads, no other public facilities in the township were seriously affected.

Tropical Storm Eloise created similar serious damages in the vulnerable Hunlock Gardens area of the Township of Hunlock. However, at the time Tropical Storm Eloise occurred, some of the residents in the township were protected by flood insurance.

Since 1891, floodwaters have exceeded bankful stage in the Borough of Larksville 57 times. Among these, the flood of 1972 caused considerable damage throughout the borough and the Wyoming Valley area.

During the 1972 flood, residential damages in the Township of Nescopeck were heaviest in the northern section of the township, just downstream from the Village of Wapwallopen. Floodwaters entered the basements and first floors of several homes located between the Susquehanna River and the railroad tracks. One such home was completely destroyed. Farmers in some sections of the township reported heavy soil and crop losses. Heavy flows on local streams gouged out portions of stream banks, clogging streams with silt and other debris. One county-owned bridge was swept away and the township road system required extensive repairs. Tropical Storm Eloise resulted in similar damages, though on a much smaller scale.

Damage from flooding in the Township of Newport has been limited to the Retreat State Hospital, the only developed area along the Susquehanna River. The bridge carrying the hospital access road over the river was inundated during the 1972 flood (Reference 78). There have been no major flood problems along the other streams in the Township of Newport.

High water from heavy rains caused the Susquehanna River to inundate some of the southeastern areas of the Borough of Pringle during Tropical Storm Agnes.

During the 1972 flood, floodwaters entered basements and first floors of many homes located near the river in the Township of Salem. Residential damages ran especially high at Beach Haven and Dogtown (Rocky Run). Similar problems developed during the 1975 flood, though damages were not nearly as severe.

Flash flooding on the many small streams which drain into the Susquehanna River has been a continuing problem for the Township of Salem. During the major storms of 1972 and 1975 and also during more recent cloud bursts, these streams were transformed into raging torrents. Many overflowed their banks flooding residential areas, washing out roads and eroding sections of stream bank.

In the event of a 0.2-percent-annual-chance flood, the majority of the Borough of Swoyersville would be inundated.

The greatest 24 hour rainfall occurred between September 29-30, 1924, when 5.09 inches fell in the area of the City of Wilkes-Barre, located approximately 3.4 miles downstream from the Borough of Wyoming (Reference 79).

There were five deaths attributed to the 1972 flood. The property damage in the City of Wilkes-Barre area was set at nearly 1 billion dollars, in 1972 dollars (Reference 79).

Toby Creek is the principal source of flooding in the Boroughs of Courtdale, Dallas, Luzerne and Pringle and the Township of Kingston, and one of the principal sources of flooding in the Borough of Kingston.

Due to the relatively undeveloped nature of the Toby Creek floodplain in the Borough of Courtdale, only a minimal amount of flood damage has been experienced. The steep terrain in the Borough of Courtdale adjoining the stream has prohibited any major development in that area and flood damage has therefore been minimal. Another condition which affects flooding in the borough is the absence of an effective storm water collection system. Surface drainage is transported via streets and overland flow. This condition often results in localized flooding during severe storms.

The two largest floods of record in the Toby Creek watershed occurred in December 1942 and June 1972. At USGS Gaging Station No. 01537000 located on Toby Creek in the Borough of Luzerne, peak discharges of 3,010 cfs were recorded on December 30, 1942 and 3,390 cfs on June 22, 1972. Their corresponding gage heights were 4.8 feet and 6.1 feet, respectively (References 69, 70 and 71). Discharges of these magnitudes have estimated recurrence intervals of 2.86- and 4-percent-annual-chance floods, respectively.

Flooding in the Township of Kingston during the 1972 flood was limited to the county bridge on Main Street in Shavertown over Toby Creek, and on tributaries to Toby Creek where a culvert was too small to carry the discharge. No other known flooding of developed areas in the Township of Kingston occurred during past major storms.

Since the streams in the Township of Lehman drain the area quickly, Lehman Township has experienced only minor flooding, usually of short duration. Flooding has been limited to wooded or pasture land, with occasional shallow flooding of roads.

2.4 Flood Protection Measures

At present, there are no flood protection structures located within the Boroughs of Ashley, Avoca, Conyngham, Courtdale, Dallas, Dupont, Larksville, Nescopeck, New Columbus, Nuangola, Shickshinny and West Pittston; the Cities of Nanticoke and Pittston; and the Townships of Black Creek, Buck, Butler, Conyngham, Dorrance, Fairmount, Fairview, Franklin, Hazle, Hollenback, Hunlock, Huntington, Jackson, Jenkins, Lake, Pittston, Plains, Rice, Ross, Salem, Sugarloaf and Wright. Residents of these municipalities rely on the usual warnings through radio, television, and the local newspapers for information concerning possible flood conditions.

The Boroughs of Ashley, Avoca, Conyngham, Courtdale, Dallas, Dupont, Harveys Lake, Laflin, New Columbus, Nuangola and White Haven; and the Townships of Bear Creek, Black Creek, Buck, Butler, Dennsion, Dorrance, Fairmount, Fairview, Foster, Franklin, Hazle, Hollenback, Huntington, Jackson, Kingston, Lehman, Newport, Pittston, Rice, Ross, Salem, Sugarloaf, Union and Wright utilize non-structural measures of flood protection to aid in the prevention of future flood damage. These measures are in the form of land-use regulations adopted from the Code of Federal Regulations, Title 24, Chapter 10, FIA, Parts 1910.3A and 1910.38, which control building within areas that have a high risk of flooding (Reference 80).

The Francis E. Walter Reservoir, located at the confluence of Bear Creek and the Lehigh River, is the only flood protection structure within the corporate limits of the Township of Bear Creek. This dam regulates flow from 288 square miles above the dam with 108,700 acre-feet of storage allocated to flood control, and controls 21-percent of the Lehigh River basin. This dam effectively reduces flooding problems in the Borough of White Haven and the Townships of Bear Creek and Dennison. Various other dams are located within the Township of Bear Creek, but due to their size and function are not considered flood protection structures (Reference 81).

There are five upstream reservoirs, one in Pennsylvania and four in New York, which contribute to a reduction of the flood hazard of the Susquehanna River within the Boroughs of Edwardsville, Exeter, Forty Fort, Kingston, Larksville, Luzerne, Plymouth, Pringle, Shickshinny, Swoyersville, Union, West Pittston, West Wyoming and Wyoming; the Cities of Nanticoke, Pittston and Wilkes-Barre; and the Townships of Conyngham, Hanover, Jenkins, Newport and Plymouth. The five upstream reservoirs include: East Sidney Lake, located approximately 8 miles east of Sidney, New York, on Ouleout Creek; Whitney Point Dam, located approximately 1 mile north of Whitney Point, New York, on the Ostelic River; Arkport Dam, located approximately 5 miles northeast of Hornell, New York, on the Canisteo River; Almond Dam, located approximately 2 miles northwest of Hornell, New York, on Canacadea Creek in the Chemung River Basin; and Stillwater Reservoir, located approximately 9 miles north of Carbondale, Pennsylvania on the Lackawanna River. The Tioga-Hammond Dam, located approximately 20 miles southwest of Elmira New York, on the Tioga River and Crooked Creek; and Cowanesque Lake, located on the Cowanesque River approximately 2 miles above the confluence with the Tioga River at Lawrenceville, Pennsylvania, along with the five upstream reservoirs listed previously are upstream from the Boroughs of Duryea and Nescopeck and the Townships of Exeter, Hunlock, Nescopeck, Plains and Salem. Of these upstream dams, the five existing in 1972 reduced flood stages on the Susquehanna River by approximately 0.6-foot during the Agnes flood.

Levees were erected along the Lackawanna River by the old Pennsylvania Department of Forests and Waters. A part of this levee was overtopped during the 1972 flood, allowing water to enter a large section of the commercial-residential center of the Borough of Duryea. The Pennsylvania Department of Environmental Protection completed plans to raise the height of the levee by three feet and borough officials are hopeful this will eliminate some of the danger of backwater flooding from the Susquehanna River.

A local flood protection project consisting of a levee along a section of the Susquehanna River and an impounding basin and pressure conduit on Toby Creek provide some reduction of the flood hazards to the Boroughs of Edwardsville, Forty Fort, Kingston, Luzerne, Plymouth, Pringle, Swoyersville and Wyoming; the City of Wilkes-Barre; and the Townships of Hanover and Plymouth. The project also reduces the drainage area of Abrahams Creek through the Borough of Forty Fort. The protective works consist of 18,429 feet of earthen levee on the right bank of the Susquehanna River located in the Boroughs of Edwardsville and Kingston, 3,900 feet of diversion of Abrahams Creek, and appurtenant drainage structures including three pumping stations and a concrete pressure culvert 16.5 feet in diameter and 6,659 feet long, with an impounding basin, levees and intake structure to carry the flow of Toby Creek. Also included are 1,080 feet of concrete interceptor sewer; and approximately 16,700 feet of electric transmission lines with two transformer substations. The improvements were designed to protect the communities against flood discharges equal to those which occurred in March 1936. The levee system is designated to contain a peak discharge of 232,000 cfs with 3.0 feet of freeboard. Tropical Storm Agnes, with a discharge of 345,000 cfs exceeded the project design discharges and caused heavy damages to the protective works and to the Borough of Edwardsville. Phase I emergency repairs were completed in January 1973 under a contract for remedial work throughout the Wyoming Valley Levee System. Phase II, permanent restoration, including the raising of the protective works, where required, was completed in April 1974 (Reference 78). This levee only protects a small portion of the Township of Plymouth, because most of the township is outside the levee, therefore the levee has a negligible effect on the township.

The majority of the Borough of Forty Fort's floodplain area is protected up to the 1-percent-annual-chance flood by the levee system. Therefore, the 1-percent-annual-chance floodplain delineated by the FIS for the Borough of Forty Fort includes a narrow strip between the river and the levee and a larger unprotected area in the southern point of the borough (Reference 21). The levee system offers no flood protection from a flood with an 0.2-percent-annual-chance flood recurrence interval.

A local flood protection project consisting of walls and levees along Mill Creek No. 1 reduces the flood hazard to the Brookside area of the City of Wilkes-Barre.

An existing local flood protection project consisting of a levee at the mouth of Hicks Creek reduces the flood hazard of the Borough of Exeter.

The Redevelopment Authority of Luzerne County has initiated two state funded redevelopment projects in the Township of Exeter involving the relocation of residences in flood prone areas to higher ground. Meanwhile, the PADEP has initiated a creek restoration project aimed at clearing debris from stream beds and stabilizing banks.

Following the October 1975 flood, the stream channels of Huntington Creek and Kitchen Creek, located in the Township of Fairmount, were cleared of debris to increase their conveyance capacity.

Crystal Lake is a 494-acre reservoir located upstream of the Township of Fairview on Big Wapwallopen Creek. This dam is primarily for public water supply, and

although it is not regulated for flood control, its storage capacity should reduce peak flows on Big Wapwallopen Creek in the Township of Fairview.

The Swoyersville-Forty Fort levee extends from the vicinity of Fort Street in the Borough of Forty Fort to 800 feet beyond the Wyoming Valley Airport where it curves landward into the Borough of West Wyoming on the west bank. Construction began in 1953 and was completed in 1957. The levee was raised in 1960 and 1965 to offset mine subsidence (Reference 78).

Paper Mill Dam at Huntington Mills on Huntington Creek, located in the Township of Huntington, was the only watershed control project in the township, and was completely destroyed during Tropical Storm Eloise.

A river stage forecasting system exists for the entire Susquehanna River watershed, with the Office of Civil Defense of Luzerne County responsible for coordinating with the Township of Jenkins.

A minor flood control project, PADEP Project No. S40:94 was constructed on Toby Creek along Old State Route 309 below the sewage treatment plant in the Township of Kingston. The project consists of placing a rock blanket on a fill slope for erosion protection along the outside of a stream curve. A new bridge on Main Street in the Village of Shavertown, in the Township of Kingston, over Toby Creek was funded by Luzerne County. This project was constructed to reduce the overflow problem on Toby Creek.

Harveys Lake, a natural lake located upstream of the Township of Lake, in the Borough of Harveys Lake, has a substantial effect in reducing the peak flood flows on Harveys Creek downstream in the Township of Lake.

A concrete ditch and outlet structure drainage to Harveys Lake to control minor local road flooding in the Borough of Harveys Lake was constructed at Warden Place by the Commonwealth of Pennsylvania, Department of General Services.

In the City of Nanticoke, guidelines for floodplain development are set forth in the zoning ordinances. Areas within reach of the 10-percent-annual-chance flood are restricted to parks, playgrounds, or recreational development. Likewise, areas affected by a 1-percent-annual-chance flood are limited to the above users and other uses provided adequate flood proofing measures are enacted (Reference 78).

Buchart-Horn Consulting Engineers, in cooperation with Township of Salem officials implemented a study on the feasibility of diverting Mud Swamp Creek at East Berwick directly into the Susquehanna River via a system of underground culverts. It is unlikely, however, that the Township of Salem will undertake actual construction of the system unless federal or state funding can be obtained.

A local flood protection project has been constructed for Abrahams Creek through the Borough of West Wyoming. This project is designed to accommodate the 1-percent-annual-chance flood. Upstream of the Borough of West Wyoming, Slocum Dam reduces flood hazards from Abrahams Creek.

3.0 ENGINEERING METHODS

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

3.1 Hydrologic Analyses

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

Pre-countywide Analyses

Within Luzerne County, the Boroughs of Ashley, Avoca, Conyngham, Courtdale, Dallas, Dupont, Duryea, Edwardsville, Exeter, Forty Fort, Harveys Lake, Kingston, Laflin, Larksville, Luzerne, Nescopeck, New Columbus, Nuangola, Plymouth, Pringle, Shickshinny, Swoyersville, West Pittston, West Wyoming, White Haven and Wyoming; the Cities of Nanticoke, Pittston and Wilkes-Barre; and the Townships of Bear Creek, Black Creek, Buck, Butler, Conyngham, Dennison, Dorrance, Exeter, Fairmount, Fairview, Foster, Franklin, Hanover, Hazle, Hollenback, Hunlock, Huntington, Jackson, Jenkins, Kingston, Lake, Lehman, Nescopeck, Newport, Pittston, Plains, Plymouth, Rice, Ross, Salem, Sugarloaf, Union and Wright have a previously published FIS report. The hydrologic analyses described in those reports have been compiled and are summarized below.

Discharges for the reaches of Abrahams Creek located in the Boroughs of West Wyoming and Wyoming, the reach of Big Wapwallopen Creek located in the Township of Conyngham, Coal Brook, Laurel Run No. 1, the reach of Little Wapwallopen Creek located in the Township of Conyngham, Mill Creek No. 1, Newport Creek, Reyburn Creek, Shickshinny Creek, the reach of Solomon Creek above Spring Run located in the Township of Hanover, South Branch Newport Creek, Spring Run and Wade Run were obtained from the regional flood frequency method developed by the U.S. Army Corps of Engineers (USACE) (Reference 82). The coefficients for this method for the reaches of Abrahams Creek were adjusted to reflect the Toby Creek flood frequency data, and to correspond with discharges computed by the PADEP. A USGS gaging station on the Susquehanna River located

approximately 3.4 miles downstream from the Borough of West Wyoming at Wilkes-Barre was the principal source of data for determining defining discharge-frequency relationships for the river. The gage has been in operation since 1891. The outflow of Abrahams Creek from Slocum Dam was added to the peak flows for the uncontrolled area below the dam. Flood discharges into the area of shallow flooding in the Borough of West Wyoming were determined by applying standard weir formulas to the area of Eighth Street where Abrahams Creek overflows it channel banks. The regional mean for the unrevised portion of Mill Creek No. 1, Newport Creek, and South Branch Newport Creek were adjusted to account for the effect of mining on the flood peaks in accordance with the Solomon Creek data in Wilkes-Barre. All discharges for the reaches of Big Wapwallopen Creek and Little Wapwallopen Creek located in the Township of Conyngham, Newport Creek and South Branch Newport Creek were determined by the SRBC. The discharges for the reaches of Big Wapwallopen Creek and Little Wapwallopen Creek located in the Township of Conyngham were calculated using the regional flood frequency method developed by the USACE, but with the mean logarithm modified to agree with data for the USGS stream gage on Wapwallopen Creek.

The discharges for Abrahams Creek of Forty Fort and South Branch Abrahams Creek of Forty Fort were obtained from the modified PSU III method (Reference 83). These discharges were further modified for the effects of urbanization in order to correspond with the discharges computed by the PADEP. Hydrographs were computed for the mouth of Abrahams Creek and a portion of Abrahams Creek upstream from Wade Run. The triangular unit hydrograph method described in "Design of Small Dams" was used to obtain the hydrographs (Reference 84). A six hour design storm was used and the runoff curve number adjusted to match the peak. The design rainfall was obtained from Reich, McGinnis and Kerr and the storm distribution was determined as described by Kerr et al. (References 85 and 86). These hydrographs were used for the storage routing and ponding computations.

Discharges for Coal Brook, Laurel Run No. 1, Mill Creek No. 1, the reach of Solomon Creek above Spring Run located in the Township of Hanover, Spring Run, and Wade Run were obtained by applying a reduction factor to the discharges obtained from the regional flood frequency method (Reference 82). The reduction was computed as the ratio of station discharges to regional discharge, where both are evaluated as the antilog of the mean logarithm of discharge. This procedure for computing the reduction factor appears to be confirmed by the results obtained by Geo-Tech Services for the PADEP (Reference 87).

The mean value for the reach of Shickshinny Creek located in the Borough of Shickshinny was modified to correspond with the mean at nearby stations. The values for Shickshinny Creek were consistent with peak discharge values estimated using the method described in the USGS regional flood-flow frequency report (Reference 73). This method involves the development of regional regression equations that relate floods of selected probabilities of occurrence to readily measurable drainage basin characteristics. The published values were, therefore, used for the reach of Shickshinny Creek below the confluence with Reyburn Creek. Peak discharge values for Shickshinny Creek above the confluence with Reyburn Creek and for Reyburn Creek were estimated using the regional regression equations. Values for Shickshinny Creek above the confluence with Reyburn Creek were adjusted for storage in the impoundment behind the Shickshinny Lake Dam. The

dam was designed to store the runoff from a 1-percent-annual-chance storm before over-topping the emergency spillway. Normal discharge is provided by a 30-inch outlet pipe. The drainage area above the dam was, therefore, not included in the regional regression equations for peak discharges of 10-, 2- and 1-percent-annual-chance storms. The discharge of the 30-inch outlet pipe was added to values obtained from the equations. To obtain the peak discharge values of the 0.2-percent-annual-chance storm, which exceeds the 1-percent-annual-chance flood design capacity of the dam, the difference between the 0.2-and 1-percent-annual-chance flood discharges estimated using the regional regression equations was added to the 1-percent-annual-chance flood peak discharges adjusted for storage. The effect of storage below the confluence with Reyburn Creek was not significant and, therefore, no adjustment was made to the values obtained from the FIS for the Borough of Shickshinny (Reference 55).

The discharges for Wade Run were obtained from the rational method using a "c" factor of 0.3. The design rainfall was taken from the report by Reich, McGinnis and Kerr (Reference 86). The time of concentration was taken from the nomograph in Design of Small Dams (Reference 84).

The peak discharges for Balliet Run, Beaver Run, Big Wapwallopen Creek Tributary E, Big Wapwallopen Creek Tributary H, Black Creek, Bow Creek, Bow Creek Tributary A, Cider Run, East Fork Harveys Creek, Fades Creek, Harveys Creek, the reaches of Huntington Creek located in the Townships of Fairmount and Huntington, Huntsville Creek, Kitchen Creek, Little Nescopeck Creek No. 1, Little Nescopeck Creek No. 2, Little Nescopeck Creek No. 2 Tributary C, the reach of Little Wapwallopen Creek located in the Township of Dorrance, Phillips Creek, Pikes Creek, Pine Creek No. 2, Pond Creek, Sandy Run, the reach of Sutton Creek located in the Township of Franklin, the reach of Toby Creek below Tributary B at the Agway Company located in the Borough of Dallas, the reach of Toby Creek above the confluence with Huntsville Creek located in the Township of Kingston and Wright Creek were estimated by the use of regression models prepared by the USGS for the PADEP (Reference 73). This method involves the development of regional regression equations that relate floods of selected probabilities of occurrence to readily measurable drainage basin characteristics. By selecting the proper regression equation, the magnitude of a flood of a particular recurrence interval can be easily estimated. This method is particularly applicable for use on ungaged streams. When an upstream contributing tributary drainage area was less than 2 square miles (Bow Creek Tributary A), the transfer method was used to adapt the downstream data to the upstream location (Reference 88). The results of this method used on Balliet Run, Big Wapwallopen Creek Tributary E, Big Wapwallopen Creek Tributary H, Black Creek, Bow Creek, Bow Creek Tributary A, Browns Creek, Cider Run, East Fork Harveys Creek, the reaches of Huntington Creek located in the Townships of Fairmount and Huntington, Huntsville Creek, Kitchen Creek, Lattimer Creek, Little Nescopeck Creek No. 2, Little Nescopeck Creek No. 1, Little Nescopeck Creek No. 2 Tributary C, the reach of Little Wapwallopen Creek located in the Township of Dorrance, Phillips Creek, Pine Creek No. 2, Pond Creek, Sandy Run, the reach of Sutton Creek located in the Township of Franklin, the reach of Toby Creek below Tributary B at the Agway Company located in the borough of Dallas, Watering Run, and Wright Creek were compared to and found consistent with the values developed using two other regional methods (References 89 and 90). The results of this method for Snake Creek, the reach of Toby Creek above the confluence with Huntsville

Creek located in the Township of Kingston, and Tributary C to Abrahams Creek were compared to and found consistent with the values developed using the Pennsylvania State University Method and the Federal Highway Administration (FHWA) Method (References 83 and 89). The regression model for Flood Frequency Region 5 was used to estimate peak discharges for the reach of Huntington Creek located in the Township of Fairmount, Kitchen Creek, Little Nescopeck Creek No. 1, Phillips Creek, Pond Creek, Sandy Run, and Wright Creek. Regression Model 2 was used to estimate the peak discharges for Cider Run, the reach of Huntington Creek located in the Township of Huntington, Pine Creek No. 2, and the reach of Sutton Creek located in the Township of Franklin. The results for Little Nescopeck Creek No. 2 and Nescopeck Creek were also consistent with data obtained from the USGS for Big Wapwallopen Creek, a gaged stream (USGS Gaging Station No. 015380000 near Wapwallopen, Pennsylvania) having similar hydrological characteristics (References 83 and 88). The gage records for the station were for the 58-year period from 1920 to 1977. The peak discharge values for Little Nescopeck Creek No. 2 below the Jeddo Tunnel were adjusted upward to account for the mine drainage discharge. This discharge was estimated to be 155 cfs for the 1-percent-annual-chance flood frequency by the PADEP. The USGS Gaging Station No. 015370000 is located on Toby Creek five miles downstream from the Borough of Dallas. Flow at the gage, however, is attenuated by the Huntsville Reservoir, which discharges into Toby Creek below the Borough of Dallas. The effects of this regulation on flood-flow frequency has not been established. A regional analysis technique was therefore considered appropriate particularly since less than 15-percent of the area drained by the stream at the gage is above the Borough of Dallas.

The peak discharges for Harveys Creek were adjusted to account for the storage effects from Harveys Lake. To make this adjustment, flood flows for tributaries to Harveys Lake were first computed using the unit hydrograph method developed by the Natural Resource Conservation Service (NRCS), formerly known as the Soil Conservation Service (Reference 91). Flood flow routing was then computed through the lake using the USACE HEC-1 flood hydrograph computer model (References 92 and 93). The results of this analysis were added to the peak discharges determined using the regression equation for the drainage area between the lake and the study area.

The hydrologic analyses for detailed stream studies of Bear Creek, Pine Creek No. 1, and Tenmile Run were performed using regional methods, developed from regression analysis, relating drainage area, channel slope, percent area of storage, and an index of average annual excess precipitation through empirical equations (Reference 89).

The peak discharge values and the base frequency-discharge curve for USGS Gaging Station No. 01538000, which is along Hobbie Road on Big Wapwallopen Creek in the Township of Hollenback, were obtained from the USGS. The stream gage records were used for a 58-year period, from 1920 to 1977. As a test of the reliability of the frequency-discharge data for the gage, discharges for the various return periods were determined using three regional analysis techniques. These included the most recent USGS flood-flow frequency report, the Federal Highway Administration method, and the Pennsylvania Department of Transportation method (References 73, 89 and 90). The comparison of the results obtained using these methods with the gage data determined the adequacy of the gage information. The peak discharge values for the reach of Big Wapwallopen Creek located in the Township of Dorrance

were developed using a transfer method to adapt the gage data to locations in the Township of Dorrance (Reference 88). This method is based on the assumption that peak flows are highly correlated to the drainage area for streams having similar hydrologic characteristics and, therefore, gage data can be transferred upstream or downstream using an area adjustment to a given power.

For the reach of Big Wapwallopen Creek located in the Township of Nescopeck, a statistical analysis of peak-discharge records was made for the stream gage located approximately 2.6 miles upstream from the eastern boundary of the Township of Nescopeck. This gage has 53 years of record (Reference 75).

Discharges for Collins Creek, Hunlock Creek, the reach of Lackawanna River located in the Borough of Duryea, Lidy Creek, Mill Creek No. 2, Mud Swamp Creek, the reaches of Nescopeck Creek located in the Borough and Township of Nescopeck, the reaches of Solomon Creek located in the City of Wilkes-Barre and Township of Hanover, the reaches of Toby Creek located in the Boroughs of Edwardsville, Kingston, Luzerne and Pringle, Tributary No. 1 to Hunlock Creek, Tributary No. 1 to Tributary No. 2 to Hunlock Creek and Tributary No. 2 to Hunlock Creek were determined using the log-Pearson Type III method. The Water Resources Council recommended the log-Pearson Type III method for determination of such relationships for gaged sites (Reference 94). For such gaged sites, the flood-frequency data can be obtained directly from statistical analyses of flood peak discharge data. For an ungaged site, it is necessary to regionalize the flood-frequency data from two or more gaged sites. For Hunlock Creek, the reach of Lackawanna River located in the Borough of Duryea, Mill Creek No. 2, the reach of Nescopeck Creek located in the Township of Nescopeck, Salem Creek, the reach of Sutton Creek located in the Township of Exeter, Tributary No. 1 to Hunlock Creek, Tributary No. 17 to Susquehanna River, Tributary No. 2 to Hunlock Creek, and Walker Run which are ungaged sites, values of the 10-, 2-, 1-, and 0.2-percent-annual-chance floods at these stream gaging stations were plotted against the drainage area on logarithmic coordinates and the appropriate values for the study area determined from an extrapolation of the plot.

For Collins Creek, Lidy Creek, and Mill Creek No. 2, which are ungaged sites, the drainage area and C_m and C_s coefficient information was obtained from the regional flood-frequency procedure developed by the USACE (Reference 95). This regression method was developed from curves fitting the gaged data collected throughout the northeastern United States to provide a consistent evaluation of peak flow frequency after the occurrence of Tropical Storm Agnes. Both hurricane and non-hurricane events were considered in the development. The flood-frequency curves were modified for the effects of urbanization. The procedure used in adjusting for the effects of urbanization was developed from available data for these effects on flood frequency. The effect of mining was included in the analyses by reducing the drainage area by the amount of mining area which does not contribute runoff to the peak flow. The analysis considered the effects of storage in two ponding areas behind the railroad embankment located immediately north and south of the boundary between the Boroughs of Duryea and Avoca. These are noncontributing areas within the watershed where stormwater is either ponded or discharged from the basin due to the effects of urbanization and surface mining.

Peak discharge values for the reach of Drakes Creek located in the Township of Jackson were obtained using the FHWA method, which is appropriate for the small drainage area being considered at the downstream study limits, and by using a transfer method at the upstream study limits (References 88 and 89). The FHWA method utilizes a multiple regression approach to develop the predictive formulas. The dependent variable, discharge, is regressed against the independent variables of rainfall, erosivity, watershed area, and difference in elevation to predict the 10-percent-annual-chance flood discharge. Other return period discharges are determined as a function of the 10-percent-annual-chance flood event adjusted for storage. These methods were also compared with two other regional techniques for reasonableness (References 89 and 90).

For the reach of Lackawanna River located in the Borough of Duryea, the statistical analyses were performed by the USACE for stream gages at the Boroughs of Old Forge and Archbald. The stream gage at Old Forge is located approximately 0.6 mile upstream from the northeastern boundary of the Borough of Duryea and has 36 years of record. The stream gage located in the Borough of Archbald is located approximately 20.1 miles upstream from the northeastern boundary of the Borough of Duryea and has 35 years of record. The flood-frequency curves were adjusted for the effects of upstream reservoirs.

The discharge determination for the reaches of Solomon Creek located in the City of Wilkes-Barre and Township of Hanover was complicated due to the number of deep mines and strip mines and the mine drainage system. The peak discharge data for Solomon Creek was analyzed as recommended by the Water Resources Council, with a skew coefficient of +0.1 (Reference 94). These discharges were used for the reach of Solomon Creek from the mine drainage outlet at stream distance 9,735 feet to the mouth of Spring Run. This discharge was adjusted for the difference in drainage area between the gage and mine outlet using the ratio of drainage areas to the 0.75 power. The discharges at the mouth of Solomon Creek were obtained from the USACE regional flood frequency, with the idea that the effect of the mine was to cause the flows to be diverted past the gage.

Peak discharge values were previously developed for Solomon Creek for the FIS for the Township of Hanover using the regional flood-frequency method developed by the USACE with a reduction factor applied to the account for diversion of flows caused by mining operations (References 24 and 96). These discharges fell within the 50-percent confidence interval plotted from USGS gage data and were therefore, adapted for use on the reach of Solomon Creek located in the Borough of Ashley and Sugarnotch Run using a transfer technique (Reference 88). This method is based on the assumption that flood peaks can be considered proportional to a given power of the drainage areas of streams having similar hydrologic characteristics.

The discharges for the reaches of Toby Creek located in the Boroughs of Edwardsville, Kingston, Luzerne and Pringle were obtained through analysis of the flood peak discharge data for the Luzerne gage which is located approximately 0.6 mile upstream from the Borough of Kingston. The period of record from 1942 to 1993 was analyzed using the procedures recommended by the Water Resources Council (Reference 94).

The discharges for Tributary No. 1 to Tributary No. 2 to Hunlock Creek were obtained by the rational method, which states that the peak runoff, Q, due to a rainfall intensity, I, in in/hr over a drainage area, A, in acres, is given by Q=cIA where c is a coefficient based on soils and land use (Reference 97).

The log-Pearson Type III method requires the mean, M, and the standard deviation, S, and the skew coefficient. The method uses the following equations:

$$M = C_m + 0.75 \log(A)$$

$$S = C_s - 0.05 \log(A)$$

where A is the drainage area in square miles and C_m and C_s are coefficients, which are obtained from maps. The skew coefficient is also obtained from a map. The SRBC has made some modifications to the C_m and the skew coefficient maps used in these studies. This procedure is based on log-Pearson Type III analysis of a large number of station records in the Susquehanna River Basin through 1972. The procedure uses the upper curve for obtaining a factor to be applied to the natural discharges, based on the percentage of imperviousness of the watershed. The percentage of imperviousness is determined by the percentage of area covered by structures, streets, sidewalks, and parking lots as shown on aerial photos or obtained by field examination. Only existing conditions were considered.

Rainfall amounts were obtained from the rainfall duration frequency analysis prepared by Reich et al. (Reference 85). Rainfall time distribution was obtained from the study by Kerr et al. (Reference 86). A six hour storm duration and an average antecedent moisture condition (Antecedent Moisture Condition II) were assumed. The times of concentration for the watershed were obtained from the following equation (Reference 84):

$$T_c = \left(\frac{11.9L^3}{H} \right)^{0.385}$$

The time of concentration, T_c, is defined as the time, in hours, that is necessary for a drop of water to travel from the furthest point on the watershed to the point of interest. In the above equation, L is the length of the longest watercourse in miles, and H is the difference in elevation between the highest point on the water shed and the point of interest, in feet. The runoff curve number was adjusted in order to match the peaks obtained from the USACE regional flood frequency procedure, adjusted for urbanization at the mouth of Mill Creek No. 2. The resulting hydrographs were routed through the railroad culvert along Mill Creek No. 2 in the Borough of Avoca using the Puls method (Reference 98).

For the detailed study of Geneceda Creek, the hydrologic analysis was a modification of the U.S. Department of Agriculture, NRCS procedure designed in this study as "Kirpich Tc Condition II," which relates basin characteristics to streamflow characteristics (Reference 91). Rainfall data was calculated and combined with basin characteristics such as drainage area, stream slope, vegetation, soil cover, and land use characteristics to estimate the resulting discharge values considering a time lapse to the peak discharge calculated by empirical equations (Reference 85).

Discharges for the reach of Huntington Creek located in the Township of Ross were taken from the log-Pearson Type III frequency curves, Water Resources Council adjusted for USGS Gaging Station No. 01538800 (Reference 99). This data was provided by the USGS. The gage is located where State Route 118 crosses Huntington Creek. Stage-discharge records for this gage for the period extending from 1960 through 1975 were used in this analysis.

Discharges for the reach of Lackawanna River located in the City of Pittston were obtained from the frequency discharge curves for the stream gage at Old Forge as published by the USACE. Old Forge is located approximately 7.2 miles upstream of the City of Pittston. The length of record for the USGS Gaging Station No. 01536000 located in Old Forge extends from 1938 to present. In both instances, gaged data were adjusted to reflect a difference in the drainage area at Pittston

Discharges for the reach of Lehigh River located in the Township of Buck, provided by the USGS, were determined from log-Pearson Type III flood frequency curves adjusted by the Water Resources Council for USGS Gaging Station No. 01447500 located near Stoddartsville (Reference 100). This gage is located 75 feet upstream of Pennsylvania Route 115. Stage discharge records for this gage for the period from 1942 through 1977 were used in this analysis.

A regional frequency study done by the USACE was used to compute the unregulated flows for the Lehigh River at the Francis E. Walter Dam site and at a point just north of the Borough of White Haven (Reference 101). The unregulated flows for the reaches of Lehigh River located in the Borough of White Haven and the Township of Dennsion were calculated according to a log-Pearson Type III distribution (References 99 and 102). The difference between the flows at these two points was taken to be the additional runoff added to the river between the dam and White Haven. The regulated river flows were determined by adding the additional runoff flows to the regulated flows released from the Francis E. Walter Dam provided by the USACE for various return intervals (Reference 103).

Discharges for the reach of Mill Creek No. 1, from Cleveland Street to a point approximately 1,000 feet upstream of State Route 315, located in the Township of Plains, and Unnamed Tributary to Mill Creek No. 1 were computed by the regional method developed by the USGS (Reference 104). The regional flood frequency method developed by the Pennsylvania State University was used to verify values computed using the USGS method (Reference 105).

Discharges for Mud Swamp Creek were obtained from a unit hydrograph routing and combining procedure. The NRCS triangular unit hydrograph and runoff curve number procedure was used (Reference 84). The soils analysis was based on the Land Resource Map of Pennsylvania (Reference 106). The subwatersheds were determined so as to best represent the effects of various tributaries. The convex method of flood routing was used (Reference 91).

Discharges for the reaches of Nescopeck Creek located in the Townships of Black Creek, Butler and Sugarloaf were interpolated in proportion to the drainage area between values developed for the FIS for the Township of Nescopeck and values developed by the NRCS in preparation of the Watershed Work Plan for the Nescopeck Creek Watershed (References 41 and 107). Values in the FIS for the Township of Nescopeck were obtained from the regional flood-frequency method developed by the USACE (Reference 97). The NRCS values were developed using

Technical Release No. 20, a computer program for hydrograph routing (Reference 108).

The drainage area above the Agway Company located in the Borough of Dallas is only 2 square miles. Therefore, discharges for the reach of Toby Creek located in the Borough of Dallas and Tributary A to Toby Creek near the upper boundary of the borough were computed using the FHWA method, which is appropriate for smaller drainage areas (Reference 89). The FHWA Method utilizes a multiple regression approach to develop the predictive formulas. The dependent variable discharge is regressed against the independent variables of similar erosivity, watershed area, and difference in elevation for predicting the 10-percent-annual-chance flood discharge. Other return period discharges are determined as a function of the storage adjusted 10-percent-annual-chance flood event.

Peak discharge values on Toby Creek, developed for the FIS for the Borough of Luzerne, were adopted for use on the reach of Toby Creek below the confluence with Huntsville Creek located in the Borough of Kingston utilizing the transfer technique (References 38 and 88). Above the confluence with Huntsville creek, attenuation by the Huntsville Reservoir does not affect discharges on Toby Creek.

Discharge values for Tributary to Black Creek were developed using the NRCS Technical Release No. 55 method (Reference 109). This graphical method is appropriate for small, steep, narrow watersheds such as the Tributary to Black Creek watershed. This method computes peak discharges from agricultural drainage areas of 1 to 2,000 acres and considers the general empirical relationships between drainage area, precipitation, hydrologic soil-cover complexes, and slope.

Countywide Analyses

For this countywide FIS, new hydrologic analyses were performed by GG3 along Big Wapwallopen Creek in the Townships of Dorrance, Fairview, Rice, and Wright; Bow Creek and Bow Creek Tributary A in the Township of Fairview; Browns Creek, Lattimer Creek and Watering Run. For these flooding sources, peak flood discharges were computed using USGS Regression Equations (Reference 110). In addition, new hydrologic analyses were conducted by the USACE, Baltimore District, along the Susquehanna River.

For the Susquehanna River, four USGS stream gages were analyzed along the main stem to determine the 10-, 2-, 1-, and 0.2-percent-annual-chance flood discharges. In order to determine a discharge frequency curve at each gage location, the Baltimore District of the USACE completed a hydrologic study as part of the Wyoming Valley Levee Raising Project in January 1995. This hydrologic study considered the effects of the many flood control reservoirs upstream of the project area on the Susquehanna River and West Branch Susquehanna River in addition to the hydraulic changes brought about by the alterations to the flood control projects being proposed at the time. At least eight reservoirs were in various stages of completion between 1940-1980. The Baltimore District study created a homogenous data set by altering the flow data since 1940 to reflect flows that would have occurred without reservoir regulation. This “natural conditions” data set for the period of record for each gage was then adjusted by average reduction factors consistent with the flood control reservoirs in place to determine an “existing conditions” data set. This “existing conditions” data set was then adjusted to include the effects of the levee raisings and “improved conditions” data set was created (Reference 111).

The result of this analysis provided a discharge frequency curve for each of the four USGS gages, or the “improved conditions” discharge frequency curve. In order to get more accurate flow transitions along the study area, changes in flow were generated at tributaries with greater than five square miles of contributing area using the incremental addition in contributing area technique.

Peak discharge-drainage area relationships for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods for each stream studied by detailed methods are presented in Table 5, “Summary of Discharges."

TABLE 5 – SUMMARY OF DISCHARGES

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
ABRAHAMS CREEK					
At U.S. Route 11/ Wyoming Avenue	7.60	1,200	2,250	2,900	5,050
At a point approximately 2,000 feet upstream of U.S. Route 11/ Wyoming Avenue	5.40	980	1,850	2,400	4,200
ABRAHAMS CREEK OF FORTY FORT					
At the confluence with Susquehanna River	3.55	950	1,650	1,950	2,600
BALLIET RUN					
At the confluence with Big Wapwallopen Creek	7.26	780	1,300	1,600	2,250
BEAR CREEK					
At a point approximately 1.1 miles downstream of State Route 115, the downstream Limit of Detailed Study	34.43	2,784	4,583	5,487	7,830
At a point approximately 3,825 feet upstream of the confluence of Tenmile Run, the upstream Limit of Detailed Study	21.79	1,941	3,239	3,892	5,550
BEAVER RUN					
At Greenbriar Road, the downstream Limit of Detailed Study	2.35	468	853	1,065	1,692
BIG WAPWALLOPEN CREEK					
At the confluence with Susquehanna River	53.20	3,350	6,550	8,400	15,000
At a point approximately 0.4 mile downstream of Hobbie Road	42.24	2,350	3,770	4,490	6,470
At a point 0.2 mile downstream of the confluence of Balliet Run	40.60	2,250	3,550	4,250	6,100
At the confluence of Balliet Run	32.74	1,900	3,050	3,600	5,200
At the corporate limit between the Townships of Dorrance and Hollenback	30.50	2,490	4,180	5,035	7,410

TABLE 5 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
BIG WAPWALLOPEN CREEK (continued)					
At Blue Ridge Trail	26.10	2,180	3,660	4,410	6,500
Just upstream of the confluence of Big Wapwallopen Creek Tributary E	18.70	1,580	2,670	3,230	4,790
Just upstream of the confluence of Watering Run	14.52	1,220	2,080	2,530	3,770
Just upstream of the confluence of Bow Creek	7.30	588	1,025	1,253	1,904
At the corporate limit between the Townships of Wright and Fairview	5.23	420	750	910	1,400
BIG WAPWALLOPEN CREEK TRIBUTARY E					
At the confluence with Big Wapwallopen Creek	3.61	450	780	925	1,400
At South Main Road	2.94	380	660	800	1,200
BIG WAPWALLOPEN CREEK TRIBUTARY H					
At the confluence with Big Wapwallopen Creek	3.40	430	740	890	1,320
At a point 0.23 mile downstream of Oak Drive	2.53	340	590	710	1,040
BLACK CREEK					
At Rock Glen Road	54.50	3,900	6,200	7,300	10,000
At the confluence of Tributary to Black Creek	51.30	3,675	5,900	6,975	9,900
At a point 2.59 miles upstream of Rock Glenn Road	46.00	3,400	5,450	6,500	9,500
At Interstate 81	34.41	2,977	5,076	6,161	9,600
Above the confluence of Stony Creek in the Borough of West Hazelton	21.31	2,040	3,528	4,299	6,500
Above the confluence of Lattimer Creek	12.45	1,335	2,346	2,871	4,500
BOW CREEK					
At the confluence with Big Wapwallopen Creek	4.74	550	920	1,100	1,600
At the confluence of Bow Creek Tributary A	2.46	352	560	675	1,000
At a point approximately 1,600 feet upstream of Black Walnut Drive	1.60	250	430	520	770

TABLE 5 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
BOW CREEK TRIBUTARY A					
At the confluence with Bow Creek	0.94	160	275	325	490
At a point approximately 850 feet upstream of Garden Avenue	0.32	70	120	145	215
BROWNS CREEK					
At the confluence with Huntsville Creek	3.80	500	850	1,030	1,520
CIDER RUN					
At the confluence with Sutton Creek	2.20	445	812	1,014	1,613
COAL BROOK					
At the confluence with Laurel Run	3.14	486	696	792	1,459
COLLINS CREEK					
At the confluence with Mill Creek No. 2	1.67	230	390	470	680
At the corporate limit between the Township of Pittston and the Borough of Dupont	1.36	200	340	400	580
DRAKES CREEK					
At a point 0.51 mile upstream of the confluence with East Fork Harveys Creek	1.78	260	420	510	700
Upstream of Pine Tree Road	1.35	200	320	380	550
EAST FORK HARVEYS CREEK					
At the confluence of Drakes Creek	5.07	850	1,520	1,890	2,750
FADES CREEK					
At the confluence with Pikes Creek	2.07	424	775	969	1,543
GENECEDA CREEK					
At the confluence with Tenmile Creek	1.92	530	1,202	1,525	2,700
At a point approximately 2,250 feet upstream of Trailwood Lake Road, the upstream Limit of Detailed Study	0.71	119	360	489	1,080

TABLE 5 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
HARVEYS CREEK					
At the corporate limit between the Townships of Lake and Lehman	14.24	1,133	2,017	2,494	3,909
Above the confluence of Paint Spring Run	10.72	710	1,291	1,607	2,553
HUNLOCK CREEK					
At the confluence with Susquehanna River	32.50	2,780	5,600	7,400	13,900
At the confluence of Tributary No. 1 to Hunlock Creek	22.00	2,100	4,300	5,650	10,800
At the confluence of Tributary No. 2 to Hunlock Creek	13.40	1,460	3,050	4,050	7,900
HUNTINGTON CREEK					
At the Luzerne - Columbia County boundary	80.00	7,386	12,196	14,695	21,912
Above the confluence of Rogers Creek	58.80	5,806	9,669	11,687	17,523
Above the confluence of Kitchen Creek	26.60	3,122	5,317	6,477	9,852
At State Route 118, USGS Gaging Station No. 01538800	4.94	792	1,427	1,780	2,842
HUNTSVILLE CREEK					
At the corporate limit between the Townships of Jackson and Kingston	14.30	1,050	1,850	2,300	3,850
At the confluence of Browns Creek	10.21	475	850	1,100	1,800
KITCHEN CREEK					
At the confluence with Huntington Creek	20.10	2,500	4,690	5,260	6,000
LACKAWANNA RIVER					
At the confluence with Susquehanna River	348.00	14,400	24,000	29,000	45,200
LATTIMER CREEK					
At the confluence with Black Creek	1.31	215	369	447	662
Just downstream of Church Street	1.15	193	331	401	594

TABLE 5 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
LAUREL RUN NO. 1					
At the confluence with Mill Creek No.1	12.80	1,240	2,210	2,800	4,420
LEHIGH RIVER					
At the corporate limit between the Township of Dennison and Borough of White Haven	310.00	9,500	12,500	19,600	55,800
At USGS Gaging Station No. 01447500, Stoddartsville, Pennsylvania	91.70	7,314	16,607	22,676	44,156
LIDY CREEK					
At the confluence with Mill Creek No. 2	1.68	230	390	470	680
LITTLE NESCOPECK CREEK NO. 1					
At the confluence with Nescopeck Creek	10.70	1,184	2,092	2,563	3,825
Above the confluence of Conety Run	7.30	876	1,565	1,923	2,950
LITTLE NESCOPECK CREEK NO. 2					
At County Road east of State Route 93	13.75	1,425	2,375	2,850	4,100
At the downstream corporate limit between the Borough of Conyngham and the Township of Sugarloaf	10.71	1,200	2,025	2,450	3,550
At the upstream corporate limit between the Borough of Conyngham and the Township of Sugarloaf	9.21	1,075	1,800	2,200	3,200
At the corporate limit between the Townships of Sugarloaf and Butler	7.18	925	1,575	1,900	2,800
At Interstate 81	5.85	772	1,308	1,571	2,312
At a point 0.3 mile upstream of Old Turnpike Road	4.11	518	910	1,108	1,700
At a point 0.27 mile downstream of Sams Road	3.09	414	733	894	1,300

TABLE 5 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
LITTLE NESCOPECK CREEK NO. 2 TRIBUTARY C					
At the confluence with Little Nescopeck Creek No. 2	2.36	350	600	725	1,075
At the downstream corporate limit between the Borough of Conyngham and Township of Sugarloaf	1.56	250	430	525	800
At the upstream corporate limit between the Borough of Conyngham and Township of Sugarloaf	1.44	200	375	450	675
At Rock Glen Road	1.09	185	330	400	600
LITTLE WAPWALLOPEN CREEK					
At the confluence with Susquehanna River	39.50	2,750	5,250	7,000	12,500
Upstream of the confluence of Pond Creek	29.30	2,150	4,400	5,900	10,400
At a point 0.6 mile downstream of Blue Ridge Trail	15.32	1,400	2,300	2,700	3,900
At a point 0.3 mile upstream of Blue Ridge Trail	13.34	1,250	2,070	2,470	3,550
MILL CREEK NO. 1					
At the confluence with Susquehanna River	36.60	2,440	4,230	5,200	7,930
At Cleveland Street	21.80	1,734	3,007	3,776	5,758
Above the confluence of Gardner Run	11.34	1,064	1,844	2,348	3,581
Above the confluence of Unnamed Tributary to Mill Creek No. 1	10.12	979	1,698	2,161	3,295
MILL CREEK NO. 2					
At the Luzerne - Lackawanna County boundary	10.60	840	1,140	1,320	1,780
At the corporate limit between the Boroughs of Dupont and Avoca	8.48	910	1,450	1,710	2,400
At the confluence of Lidy Creek	6.76	790	1,250	1,470	2,020
At the confluence of Collins Creek	4.47	500	830	980	1,400
Downstream of Pennsylvania Turnpike, Interstate 476	3.42	400	670	810	1,140

TABLE 5 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
MUD SWAMP CREEK					
At the Luzerne - Columbia County boundary	1.43	620	1,050	1,170	1,515
At the confluence of Tributary No. 1 to Mud Swamp Creek	0.40	175	300	330	430
NESCOPECK CREEK					
At the confluence with Susquehanna River	174.00	8,350	15,000	19,000	30,500
At Interstate 80	156.75	8,220	14,800	18,800	30,000
At the confluence of Black Creek	94.67	5,600	9,900	12,300	18,600
At the corporate limit of the Townships of Sugarloaf and Black Creek	90.55	5,450	9,500	11,700	17,800
Above the confluence of Little Nescopeck Creek	65.42	4,155	7,160	8,695	10,410
At State Route 93, Berwick-Hazelton Highway	79.33	4,900	8,600	10,400	15,600
At a point 0.7 mile upstream of the confluence of Little Nescopeck Creek	64.08	4,100	7,060	8,545	10,365
At a point 0.5 mile upstream of the corporate limit between the Townships of Butler and Sugarloaf	59.39	3,950	6,800	8,200	12,000
At the confluence of Long Run	56.21	3,820	6,550	7,900	11,400
At the confluence of Nescopeck Creek Tributary E, 0.53 mile west of State Route 309	50.11	3,500	5,950	7,100	10,200
NEWPORT CREEK					
At the confluence with Susquehanna River	10.40	1,150	2,150	2,700	4,100
Above the confluence with South Branch Newport Creek	7.10	760	1,450	1,825	3,050
PHILLIPS CREEK					
At the confluence with Huntington Creek	5.50	915	1,630	2,015	3,155

TABLE 5 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
PIKES CREEK					
At the corporate limit between the Townships of Lake and Lehman	5.00	845	1,508	1,868	2,927
Above the confluence of Fades Creek	2.93	556	1,008	1,225	1,986
PINE CREEK NO. 1					
At the Pennsylvania Turnpike, Interstate 476	3.09	415	735	898	1,370
At a point approximately 125 feet downstream of White Haven Road, the upstream Limit of Detailed Study	0.36	76	144	179	282
PINE CREEK NO. 2					
At the Luzerne - Columbia County boundary	21.09	2,604	4,463	5,450	8,324
Downstream of the confluence of Bell Creek	12.72	1,754	3,048	3,741	5,766
Upstream of the confluence of Bell Creek	7.32	1,138	2,010	2,480	3,861
POND CREEK					
At a point approximately 950 feet downstream of Hickory Hill Drive, the downstream Limit of Detailed Study	7.49	884	1,579	1,941	2,940
REYBURN CREEK					
At the confluence with Shickshinny Creek	9.60	1,410	2,465	3,035	4,580
Upstream of the tributary 0.15 mile north of Cragle Hill Road	5.16	865	1,545	1,910	2,950
At a point 0.25 mile downstream of Baer Road	3.52	640	1,155	1,440	2,200
SALEM CREEK					
At the confluence with Susquehanna River	3.77	640	1,480	2,010	4,300
SANDY RUN					
Above the confluence of Pond Creek	10.99	1,201	2,120	2,597	3,800

TABLE 5 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
SHICKSHINNY CREEK					
At the corporate limit between the Township of Union and the Borough of Shickshinny	24.97	2,500	4,800	6,200	10,800
Above the confluence of Reyburn Creek	11.97	1,270	2,030	2,440	4,160
Above the confluence of Tributary to Shickshinny Creek	7.61	650	950	1,120	2,390
SNAKE CREEK					
At the confluence with Toby Creek	3.14	590	1,060	1,320	2,030
SOLOMON CREEK					
At the confluence with Susquehanna River	18.20	2,200	2,950	4,900	7,800
At the corporate limit between the City of Wilkes-Barre and the Township of Hanover	16.75	1,390	2,575	3,780	5,250
Upstream of the confluence of Spring Run	11.00	1,020	1,880	2,370	3,800
Upstream of the confluence of Sugarnotch Run	8.15	800	1,490	1,890	3,020
SOUTH BRANCH ABRAHAMS CREEK OF FORTY FORT					
Upstream of the confluence of Wade Run	1.7	460	790	950	1,280
SOUTH BRANCH NEWPORT CREEK					
At the confluence with Newport Creek	5.80	640	1,230	1,550	2,550
SPRING RUN					
At the confluence with Solomon Creek	4.35	540	1,025	1,325	2,200
SUGARNOTCH RUN					
At a point 0.38 mile above the confluence with Solomon Creek, the downstream Limit of Detailed Study	2.85	350	640	810	1,300

TABLE 5 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
SUSQUEHANNA RIVER					
At the confluence with Nescopeck Creek	10,425.40	175,530	244,619	275,995	374,274
At the confluence with Wapwallopen Creek	10,251.40	172,281	237,526	268,378	358,551
At the confluence with Little Wapwallopen Creek	10,198.20	171,287	235,358	266,049	353,744
At the confluence with Shickshinny Creek	10,158.70	170,549	233,748	264,320	350,175
At the confluence with Hunlock Creek	10,123.70	169,896	232,321	262,788	347,012
At the confluence with Harvey Creek	10,091.10	169,289	230,996	261,365	344,075
At the confluence with Newport Creek	10,044.90	168,242	229,109	259,339	339,892
At the confluence with Nanticoke Creek	10,030.80	168,163	228,538	258,726	338,627
At the confluence with Solomon Creek	10,023.30	168,021	228,320	258,394	337,943
At the confluence with Toby Creek	10,051.10	167,682	227,488	257,598	336,298
At USGS Gaging Station located in Wilkes Barre	9,968.60	167,000	226,000	256,000	333,000
At the confluence with Abrahams Creek	9,932.00	166,387	225,170	255,060	331,777
At the confluence with Lackawanna River	9,914.60	166,095	224,776	254,613	331,196
At the confluence with Gardner Creek	9,566.60	160,265	216,886	245,676	319,571
At the confluence with Sutton Creek	9,548.50	159,962	216,476	245,212	318,967
SUTTON CREEK					
At the confluence with Susquehanna River	11.20	1,570	3,610	4,130	8,430
At the corporate limit between the Townships of Franklin and Exeter	7.78	1,194	2,104	2,595	4,035
Above the confluence of Cider Run	5.46	905	1,611	1,994	3,121
TENMILE RUN					
At the confluence with Bear Creek	7.07	797	1,378	1,671	2,450
Upstream of Pennsylvania Turnpike, Interstate 476	1.08	181	331	408	630

TABLE 5 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
TOBY CREEK					
At USGS Gaging Station No. 01537000	32.40	2,240	3,530	4,160	5,800
At the corporate limits between the Township of Kingston and Borough of Luzerne	32.10	2,233	3,504	4,129	5,756
At the confluence of Huntsville Creek	14.42	1,930	3,350	4,110	6,100
At the confluence of Snake Creek	11.16	1,580	2,760	3,390	5,050
Between State Route 309 and Center Street	10.44	1,500	2,630	3,230	4,925
At the corporate limit between the Borough of Dallas and the Township of Dallas	4.52	780	1,400	1,730	2,620
At the confluence of Tributary A to Toby Creek	2.01	280	460	545	790
TRIBUTARY A TO TOBY CREEK					
At the confluence with Toby Creek	1.37	200	320	385	530
TRIBUTARY C TO ABRAHAMS CREEK					
At the confluence with Abrahams Creek	2.57	500	910	1,140	1,730
TRIBUTARY NO. 1 TO HUNLOCK CREEK					
At the confluence with Hunlock Creek	7.90	1,060	2,350	3,160	6,400
TRIBUTARY NO. 1 TO TRIBUTARY NO. 2 TO HUNLOCK CREEK					
At the confluence with Tributary No. 2 to Hunlock Creek	0.91	380	530	590	720
TRIBUTARY NO. 2 TO HUNLOCK CREEK					
At the confluence with Hunlock Creek	7.38	980	2,130	2,900	6,000
Upstream of the confluence of Tributary No. 1 to Tributary No. 2 to Hunlock Creek	5.81	840	1,850	2,500	5,150

TABLE 5 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
TRIBUTARY NO. 17 TO SUSQUEHANNA RIVER					
At the confluence with Susquehanna River	1.87	405	940	1,300	2,800
TRIBUTARY TO BLACK CREEK					
At the confluence with Black Creek	2.90	575	925	1,100	1,500
At the old railroad grade approximately 500 feet upstream of Mountain Street	1.70	350	600	700	1,000
UNNAMED TRIBUTARY TO MILL CREEK NO. 1					
Just upstream of the confluence with Mill Creek No. 1	0.45	96	167	225	343
WADE RUN					
At the confluence with South Branch Abrahams Creek of Forty Fort	0.73	530	700	780	930
WALKER RUN					
At the confluence with Susquehanna River	3.96	660	1,600	2,200	3,790
Upstream of Denns Road	2.97	550	1,320	1,860	3,100
At a point approximately 1,00 feet downstream of the upstream North Market Street bridge crossing	2.46	480	1,180	1,640	3,600
WATERING RUN					
At the confluence with Big Wapwallopen Creek	3.42	480	820	990	1,450
At a point approximately 2,800 feet downstream of State Route 309	2.10	320	540	660	970
At a point approximately 1,300 feet upstream of State Route 309	1.23	210	355	430	635
WRIGHT CREEK					
At the confluence with Lehigh River	9.30	1,056	1,873	2,297	3,450

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that the 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. The flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are encouraged 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 to an accuracy of 0.5-foot for floods of the selected recurrence intervals. Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross-section locations are also shown on the FIRM (Exhibit 2).

The hydraulic analyses for these studies were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

All elevations shown on the Flood Profiles and FIRM (Exhibits 1 and 2) are referenced to the North American Vertical Datum of 1988 (NAVD88).

Pre-countywide Analyses

Within Luzerne County, the Boroughs of Ashley, Avoca, Conyngham, Courtdale, Dallas, Dupont, Duryea, Edwardsville, Exeter, Forty Fort, Harveys Lake, Kingston, Laflin, Larksville, Luzerne, Nescopeck, New Columbus, Nuangola, Plymouth, Pringle, Shickshinny, Swoyersville, West Pittston, West Wyoming, White Haven and Wyoming; the Cities of Nanticoke, Pittston, and Wilkes-Barre; and the Townships of Bear Creek, Black Creek, Buck, Butler, Conyngham, Dennison, Dorrance, Exeter, Fairmount, Fairview, Foster, Franklin, Hanover, Hazle, Hollenback, Hunlock, Huntington, Jackson, Jenkins, Kingston, Lake, Lehman, Nescopeck, Newport, Pittston, Plains, Plymouth, Rice, Ross, Salem, Sugarloaf, Union and Wright have a previously published FIS report. The hydraulic analyses described in those reports have been compiled and are summarized below.

Water surface profiles for all streams studied by detailed methods were calculated using the USACE's HEC-2 step-backwater program (Reference 112).

The 1-percent-annual-chance flood elevations for Abrahams Creek from the vicinity of Shoemaker Avenue to the western boundary of the Borough of West Wyoming was defined at selected field surveyed cross sections using Manning's equation. The floodline was then interpolated between cross sections. Flood elevations in the areas of shallow flooding and ponding were determined by normal depth calculations at selected cross sections and by utilizing depth-storage curves for the affected areas.

Due to the level topography of parts of the Borough of West Wyoming, there are two shallow flooding areas that create problems. Sheet flooding occurs when Abrahams Creek breaches Eighth Street. This sheet flooding flows southwest across the Borough and into the channel of an unnamed tributary. After passing through a culvert, this water ponds into a depressed area. The B zone between the two AO zones is due to backwater flooding from Abrahams Creek in the Boroughs of Wyoming and Swoyersville.

The portion of Abrahams Creek of Forty Fort upstream from Wade Run is blocked by a dam which crosses the creek and which is intended to prevent backflow from Wade Run. As a result, Abrahams Creek ponds behind the dam. The backwater computations provided unrealistically high elevations for this area and so the entire area was treated as a ponding area, and the storage elevation determined by storage calculations. The average depth of the pond is designated as 3.0 feet.

For the reaches of Laurel Run No. 1 and Mill Run No. 1 located in the City of Wilkes-Barre it was not possible to verify the profile using known high water marks.

Due to the high embankment and inadequate culvert opening at the railroad crossing along Mill Creek No. 2 west of Spring Street located in the Borough Duryea, water from the 10-, 2-, 1-, and 0.2-percent-annual-chance floods is stored behind the embankment forming a pond. Since the runoff period is not long enough to inundate the floodplain to the top of the embankment, flood routing procedures were used to delineate the flooding in the area upstream of the railroad.

Within the Borough of Avoca, Mill Creek No. 2 flooding leaves the ponding area above the railroad culvert and flows westerly along the railroad. This overflow enters the Borough of Duryea and ponds in mining pits. The elevations are the maximum levels which could be reached during the 1- and 0.2-percent-annual-chance floods, and were used to delineate the flooding in the mining pits.

Within the Borough of Old Forge, Lackawanna County, St. Johns Creek 0.2-percent-annual-chance flooding leaves the channel, flows westerly through a low area along Connell Street, and enters the Borough of Duryea. This overflow merges with backwater flooding from the Lackawanna River at cross sections K and L.

For Solomon Creek, the 1-percent-annual-chance flood profile was greater than the elevation of the boundary ridge in the vicinity of South Main Street in the City of Wilkes-Barre. Thus, the water will flow overland through the City. The area inundated by the flow was determined by topographic information.

Hydraulic calculations for Tributary to Black Creek showed that the stream would overflow its banks in the vicinity of Mountain Street in the Township of Black Creek, and flow down the slope to Black Creek for storms of greater than a 10-percent-annual-chance flood frequency. From Mountain Street to the tributary's confluence with Black Creek, profiles for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods for Tributary to Black Creek will, therefore, coincide. The profile of the 10-percent-annual-chance flood was plotted within these limits as being a reasonable representative of profiles of all floods having a recurrence interval of 10 years or greater.

The hydraulic calculations for the reach of Toby Creek located in the Borough of Kingston showed that under present conditions Toby Creek will overflow in the vicinity of the Main Street bridge in the Borough of Luzerne, but will not overflow at the emergency spillway of the impounding basin in Pringle Borough. For the reach of Toby Creek located in the Borough of Pringle, the 2-, 1-, and 0.2-percent-annual-chance flood levels are shown as coincident. A 1-percent-annual-chance flood design hydrograph for Toby Creek was computed using the triangular unit hydrograph procedure described in "Design of Small Dams," with time of concentration and runoff curve number adjusted to produce a hydrograph peak which agreed with the 1-percent-annual-chance peak shown on the Floodway Data Table (Reference 84). The design rainfall was taken from the report by Reich et al. (Reference 85). Design storm time was computed as described by Kerr et al. This hydrograph was used to determine the elevation of ponded water in the impounding basin.

Cross sections for Abrahams Creek, Abrahams Creek of Forty Fort, the reaches of Big Wapwallopen Creek located in the Townships of Conyngham and Nescopeck, Coal Brook, Hunlock Creek, Lackawanna River, Laurel Run No. 1, the reach of Little Wapwallopen Creek located in the Township of Conyngham, the reach of Mill Creek No. 1 located in the City of Wilkes-Barre, the reach of Mill Creek No. 2 located in the Borough of Duryea, Mud Swamp Creek, the reaches of Nescopeck Creek located in the Borough and Township of Nescopeck, Newport Creek, Salem Creek, the reach of Shickshinny Creek located in the Borough of Shickshinny, the reaches of Solomon Creek located in the City of Wilkes-Barre and the Township of Hanover, South Branch Newport Creek, Spring Run, the reaches of Toby Creek located in the Boroughs of Edwardsville, Kingston, Luzerne and Pringle, Tributary No. 1 to Hunlock Creek, Tributary No. 1 to Tributary No. 2 to Hunlock Creek, Tributary No. 17 to Susquehanna River, Tributary No. 2 to Hunlock Creek, Wade Run, and Walker Run were located at regular intervals along the stream length and at significant changes in ground relief and land use or land cover. Ground elevations for the cross sections were photogrammetrically obtained as the 1:2,400 scale base maps were compiled (References 113, 114 and 115). Reach lengths for the channel were measured along the centerline of the channel between sections as scaled from the 1:2,400 scale mapping or stream bottom profiles. The overbank reach lengths were scaled from the 1:2,400 scale mapping measured along the approximate center line of the effective area.

A total of 11 cross sections were used to analyze the reach of Abrahams Creek through the Borough of Forty Fort, 10 cross sections were used to analyze the reach of Abrahams Creek through the Borough of West Wyoming, and 13 cross sections were used to analyze the reach of Abrahams Creek through the Borough of Wyoming. A total of 4 cross sections were used to analyze Abrahams Creek of Forty Fort. A total of 13 cross sections were used to analyze Big Wapwallopen Creek and Little Wapwallopen Creek through the Township of Conyngham. Four cross sections were used to analyze the Lackawanna River through the City of Pittston. Six cross sections were used to analyze the reach of Newport Creek located in the City of Nanticoke and the reach of Shickshinny Creek located in the Borough of Shickshinny. Two cross sections were used to analyze South Branch Newport Creek. Twenty-one cross sections were used to analyze the reach of Toby Creek located in the Borough of Luzerne. Seven cross sections were used to analyze Wade Run.

The channel bottom elevations for Abrahams Creek, Abrahams Creek of Forty Fort, the reach of Big Wapwallopen Creek located in the Township of Conyngham, Coal Brook, Laurel Run No. 1, the reach of Little Wapwallopen Creek located in the Township of Conyngham, the reach of Mill Creek No. 1 located in the City of Wilkes-Barre, the reach of Newport Creek located in the City of Nanticoke, the reach of Shickshinny Creek located in the Borough of Shickshinny, the reach of Solomon Creek located in the City of Wilkes-Barre, South Branch Newport Creek, and Wade Run were taken from field surveyed profiles of the bottom with an interval distance of not more than 1,500 feet.

The channel bottom elevations for the reach of Big Wapwallopen Creek located in the Township of Nescopeck, Hunlock Creek, Mud Swamp Creek, the reaches of Nescopeck Creek located in the Borough and Township of Nescopeck, Salem Creek, Tributary No. 1 to Hunlock Creek, Tributary No. 1 to Tributary No. 2 to Hunlock Creek, Tributary No. 17 to Susquehanna River, Tributary No. 2 to Hunlock Creek, and Walker Run were taken from field surveyed profiles of the bottom with an interval distance of not more than 1,000 feet.

The channel bottom elevations for the reach of Lackawanna River located in the City of Pittston were obtained from existing profiles.

The channel bottom elevations for the reaches of Toby Creek located in the Boroughs of Luzerne and Pringle were taken from field surveyed cross sections.

Cross sections for the reaches of Lackawanna River and Mill Creek No. 2 located in the Borough of Duryea were located at regular intervals along the stream length and at significant changes in ground relief and land use or land cover. Ground elevations for the cross sections were photogrammetrically obtained. The channel bottom elevations for the reaches of Lackawanna River and Mill Creek No. 2 located in the Borough of Duryea were taken from field surveyed cross sections at an interval distance of not more than 1,000 feet.

Cross section information for Balliet Run, the reaches of Big Wapwallopen Creek located in the Townships of Dorrance, Hollenback, Rice, and Wright, Big Wapwallopen Creek Tributary E, Big Wapwallopen Creek Tributary H, the reach of Black Creek located in the Township of Black Creek, Bow Creek, Bow Creek Tributary A, Collins Creek, Drakes Creek, East Fork Harveys Creek, Huntsville Creek, the reach of Lehigh River located in the Borough of White Haven, Lidy Creek, Little Nescopeck Creek No. 2, Little Nescopeck Creek No. 2 Tributary C, the reach of Little Wapwallopen Creek located in the Township of Dorrance, the reach of Mill Creek No. 1 located in the Township of Plains, the reaches of Mill Creek No. 2 located in the Boroughs of Avoca and Dupont and the Township of Pittston, the reaches of Nescopeck Creek located in the Townships of Black Creek, Butler and Sugarloaf, Reyburn Creek, the reach of Shickshinny Creek located in the Township of Union, Snake Creek, the reach of Solomon Creek located in the Borough of Ashley, Sugarnotch Creek, the reach of Sutton Creek located in the Township of Exeter, the reaches of Toby Creek located in the Boroughs of Dallas and the Township of Kingston, Tributary A to Toby Creek, Tributary C to Abrahams Creek, Tributary to Black Creek, and Unnamed Tributary to Mill Creek No. 1 were obtained from aerial photographs flow in April 1978 at a scale of 1:9,600 (References 116 through 120). The below water sections were obtained by field measurements. All

bridges, dams and culverts were field checked to obtain elevation data and structural geometry.

The geometric data for the structures carrying Interstate 81 over the reaches Big Wapwallopen Creek Tributary E located in the Township of Dorrance, the structures carrying Interstate 81 over the reaches of Collins Creek and Lidy Creek located in the Borough of Dupont, the structures carrying Interstate 81 over the reaches of Little Nescopeck Creek No. 2 and Nescopeck Creek in the Township of Butler, the structures carrying Interstate 80 over the reach of Nescopeck Creek in the Township of Black Creek, and the structures carrying Interstate 81 over the reach of Solomon Creek located in the Borough of Ashely were obtained from the Pennsylvania Department of Transportation (PennDOT).

For the reach of Solomon Creek located in the Borough of Ashley and Sugarnotch Run, one section, 0.05 mile above the borough, was scaled from orthophoto maps furnished by the PADEP. The below water sections were obtained by field measurement except for the below water section of the cross section above the borough which was based on the field comparison with the measured cross sections.

Cross section information for Bear Creek, Geneceda Creek, Pine Creek No. 1, and Tenmile Run were obtained from field surveys using third order leveling methods and standards of accuracy. All bridges, dams, and culverts were field checked to obtain elevation data and structural geometry in order to compute significant effects of these structures.

Cross sections Beaver Run, Fades Creek, Harveys Creek, and Pikes Creek were located at regular intervals along the stream length and at significant changes in ground relief and land use or land cover. The below water sections were obtained by field measurement. All bridges, dams, and culverts were field checked to obtain elevation data and structural geometry.

Cross section information for Black Creek, Cider Run, Huntington Creek, Kitchen Creek, the reaches of Lehigh River located in the Townships of Buck and Dennison, Little Nescopeck Creek No. 1, Phillips Creek, Pine Creek No. 2, Pond Creek, Sandy Run, the reach of Sutton Creek located in the Township of Franklin, and Wright Creek was field surveyed. Cross sections were located at close intervals above and below bridges, culverts and other hydraulic structures, in order to compute the significant backwater effects from these structures.

The starting water surface elevations for Balliet Run, Bear Creek, Big Wapwallopen Creek, Big Wapwallopen Creek Tributary E, Big Wapwallopen Creek Tributary H, Black Creek, Bow Creek, Browns Creek, Cider Run, Coal Brook, Collins Creek, Drakes Creek, East Fork Harveys Creek, Fades Creek, Geneceda Creek, Harveys Creek, the reaches of Huntington Creek located in the Townships of Fairmount and Huntington, Kitchen Creek, Lattimer Creek, Laurel Run No. 1, Lehigh River, Lidy Creek, Little Nescopeck Creek No. 1, Little Nescopeck Creek No. 2, Little Wapwallopen Creek, the reach of Mill Creek No.1 located in the City of Wilkes-Barre, the reaches of Nescopeck Creek located in the Townships of Black Creek, Butler and Sugarloaf, Phillips Creek, Pikes Creek, Pine Creek No. 1, Pine Creek No. 2, Pond Creek, Reyburn Creek, Sandy Run, Shickshinny Creek, Snake Creek, the reaches of Solomon Creek located in the Borough of Ashley and the City of Wilkes-

Barre, Sugarnotch Run, the reach of Sutton Creek located in the Township of Franklin, Tenmile Run, the reach of Toby Creek located in the Borough of Dallas, Tributary A to Toby Creek, Tributary C to Abrahams Creek, Tributary to Black Creek, Watering Run, and Wright Creek were calculated using the slope/area method or normal depth calculations. Cross sections for Little Nescopeck Creek No. 1, the reach of Lehigh River located in the Township of Dennison, and Wright Creek used the slope/area method to compute normal depth at cross sections, beginning approximately 2.5 miles downstream of the corporate limits and continuing upstream to the upstream corporate limits.

Starting water surface elevations along the reach of Abrahams Creek located in the Borough of Forty Fort, Abrahams Creek of Forty Fort, and Wade Run were determined by routing the 1-percent-annual-chance flood through the ponding area and the mouth of Abrahams Creek. The stage-storage curve was obtained from the 1:2,400 scale topographic map. The rating curve for the outlet under the levee was furnished by PADEP.

Starting water surface elevations along the reaches of Abrahams Creek located in the Boroughs of West Wyoming and Wyoming, the reach of Lackawanna River located in the City of Pittston, Newport Creek, the reach of Solomon Creek located in the Township of Hanover, South Branch Newport Creek, and Spring Run were started using a rating curve based on the USACE profiles.

Starting water surface elevations for Hunlock Creek, the reaches of Nescopeck Creek located in the Borough and Township of Nescopeck, Salem Creek, Tributary No. 17 to Susquehanna River, and Walker Run were started at their respective mouths using critical depth calculations developed by the SRBC. A section of Nescopeck Creek located in the Borough of Nescopeck was controlled by backwater from the Susquehanna River.

Starting water surface elevations for the reach of Huntington Creek located in the Township of Ross were determined from the stage-discharge curves for USGS Gaging Station No. 01538800 located at the downstream corporate boundary of the Township of Salem, where S.R. 118 crosses Huntington Creek.

A rating curve was developed for the dam at the dairy farm on Huntsville Creek below the downstream corporate limits of the Township of Jackson to establish the starting water surface elevations.

Starting water surface elevations for the reach of Lackawanna River located in the Borough of Duryea were started at the confluence with Susquehanna River using elevations developed by a rating curve and assumed flows on the Susquehanna River coincident with the Lackawanna River peak. A ponding area is shown north of the private road that parallels the Lackawanna River. This area is caused by seepage from the river through the porous base of the road. The ponding elevations in this area were assumed to be equal to the 1-percent-annual-chance flood elevations of the Lackawanna River.

Starting water surface elevations for Little Nescopeck Creek No. 2 Tributary C were established using the slope/area method for subcritical flow. This resulted in a higher

elevation for Little Nescopeck Creek and, therefore, represented the worst possible condition.

Starting water surface elevations for the reach of Mill Creek No. 1 located in the Borough of Plains and Unnamed Tributary to Mill Creek No. 1 were determined from established rating curves.

Starting water surface elevations for Mill Creek No. 2 were started at the confluence with the Lackawanna River using normal depths for all recurrence intervals.

Starting water surface elevations for Mud Swamp Creek were determined using a culvert rating curve developed for the downstream study of the Borough of Berwick, Columbia County, Pennsylvania.

Starting water surface elevations for the reach of Sutton Creek located in the Township of Exeter were started using the 10-percent-annual-chance flood backwater elevations on the Susquehanna River profile.

The volumetric flood routing method was used to analyze the reach of Toby Creek located in the Borough of Edwardsville upstream of the impounding basin located in the Borough of Pringle. The computations showed that the 1-percent-annual-chance flood on Toby Creek would be contained in the impounding basin but any changes in channel or bridge configuration upstream of the basin may cause emergency spillway flow from the basin into the Borough of Edwardsville.

Starting water surface elevations for the reaches of Toby Creek located in the Boroughs of Kingston, Luzerne and Pringle and the Township of Kingston were started at the inlet to the pressure conduit using a rating curve computed by the USACE.

Starting water surface elevations for Tributary No. 1 to Hunlock Creek, Tributary No. 1 to Tributary No. 2 to Hunlock Creek, and Tributary No. 2 to Hunlock Creek were started at the respective mouths of each creek using coincident conditions on the assumption that the streams will peak concurrently.

Roughness coefficients (Manning's “n” values) were estimated based on a field inspection of the individual streams supplemented by the use of aerial photography. Roughness coefficients were selected using engineering judgment based on tables published by Ven Te Chow (Reference 121) and channel conditions and overbank vegetation or land use. The Manning’s “n” values used for the reach of Lehigh River located in the Township of Buck were compared with recognized standard texts for reasonableness (References 121 and 122). The “n” values used for the reaches of Big Wapwallopen Creek and Little Wapwallopen Creek located in the Township of Conyngham were selected from the tables published by Ven Te Chow and the Bureau of Public Roads, based on channel conditions and overbank vegetation or land use (References 121 and 123). The “n” values were increased in the developed area to account for the effect of buildings.

The acceptability of all assumed hydraulic factors, cross sections and hydraulic structures data in the Boroughs of Ashley, Avoca, Conyngham, Dallas and Dupont; and the Townships of Black Creek, Butler, Dorrance, Hollenback, Jackson, Kingston,

Pittston, Rice, Sugarloaf, Union and Wright, could not be checked by computations that duplicated historic flood water profiles because there were no known highwater marks for floods of known discharge.

For the Boroughs of Edwardsville, Luzerne and New Columbus; and the Townships of Buck, Dennison, Fairmount, Foster, Franklin, Hazle, Huntington, Lake and Ross, the hydraulic models were tested and the "n" values adjusted within an acceptable range to best fit the Stoddartsville gaging station rating curve. When a satisfactory model was achieved, the water surface profiles were computed for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods.

The computed profiles for the Boroughs of Dallas and Edwardsville and the Township of Dorrance appeared consistent with data regarding the June 1972 flood.

The tabulation showing the channel and overbank Manning's "n" values for the streams studied by detailed methods can be found in Table 6, "Manning's "n" Values."

TABLE 6 – MANNING'S "n" VALUES

Stream	Channel "n"	Overbank "n"
Abrahams Creek	0.032 – 0.050	0.027 – 0.085
Abrahams Creek of Forty Fort	0.041 – 0.054	0.048 – 0.090
Balliet Run	0.040	0.070
Bear Creek	0.020 – 0.040	0.060 – 0.090
Beaver Run	0.040	0.120
Big Wapwallopen Creek	0.024 – 0.065	0.035 – 0.180
Big Wapwallopen Creek Tributary E	0.040 – 0.050	0.050 – 0.100
Big Wapwallopen Creek Tributary H	0.030 – 0.040	0.035 – 0.060
Black Creek	0.038 – 0.045	0.020 – 0.120
Bow Creek	0.030 – 0.075	0.060 – 0.120
Bow Creek Tributary A	0.030 – 0.080	0.060 – 0.120
Browns Creek	0.060	0.060 – 0.110
Cider Run	0.035 – 0.047	0.075 – 0.090
Coal Brook	0.040	0.050
Collins Creek	0.035	0.030 – 0.080
Drakes Creek	0.040 – 0.045	0.050 – 0.070
East Fork Harveys Creek	0.037 – 0.045	0.060 – 0.070
Fades Creek	0.040	0.110
Geneceda Creek	0.020 – 0.040	0.055 – 0.090
Harveys Creek	0.060	0.100
Hunlock Creek	0.035 – 0.060	0.055 – 0.110
Huntingdon Creek	0.045	0.060 – 0.110
Huntsville Creek	0.030 – 0.037	0.040 – 0.070
Kitchen Creek	0.050	0.110
Lackawanna River	0.032 – 0.045	0.039 – 0.080
Lattimer Creek	0.025 – 0.038	0.045 – 0.120

TABLE 6 – MANNING'S "n" VALUES – continued

Stream	Channel "n"	Overbank "n"
Laurel Run No. 1	0.035 – 0.060	0.035 – 0.110
Lehigh River	0.042 – 0.050	0.085 – 0.120
Lidy Creek	0.035	0.035 – 0.060
Little Nescopeck Creek No. 1	0.050	0.110
Little Nescopeck Creek No. 2	0.035 – 0.045	0.030 – 0.090
Little Nescopeck Creek No. 2 Tributary C	0.035	0.030 – 0.090
Little Wapwallopen Creek	0.024 – 0.040	0.048 – 0.110
Mill Creek No. 1	0.032 – 0.040	0.030 – 0.095
Mill Creek No. 2	0.030 – 0.050	0.025 – 0.080
Mud Swamp Creek	0.050 – 0.060	0.040 – 0.100
Nescopeck Creek	0.035 – 0.060	0.030 – 0.100
Newport Creek	0.037 – 0.065	0.095 – 0.120
Phillips Creek	0.045	0.070 – 0.100
Pikes Creek	0.045	0.080
Pine Creek No. 1	0.020 – 0.040	0.060 – 0.090
Pine Creek No. 2	0.042	0.075 – 0.120
Pond Creek	0.024 – 0.043	0.100
Reyburn Creek	0.035 – 0.045	0.035 – 0.080
Salem Creek	0.035 – 0.057	0.050 – 0.110
Sandy Run	0.060	0.100
Shichshinny Creek	0.030 – 0.045	0.040 – 0.080
Snake Creek	0.037 – 0.040	0.050 – 0.100
Solomon Creek	0.040 – 0.085	0.025 – 0.110
South Branch Newport Creek	0.037 – 0.065	0.095 – 0.120
Spring Run	0.065	0.095 – 0.110
Sugarnotch Run	0.035	0.025 – 0.040
Susquehanna River	0.031 – 0.080	0.050 – 0.120
Sutton Creek	0.035 – 0.050	0.040 – 0.090
Tenmile Run	0.020 – 0.040	0.060 – 0.090
Toby Creek	0.030 – 0.040	0.040 – 0.070
Tributary A to Toby Creek	0.037 – 0.040	0.050 – 0.060
Tributary C to Abrahams Creek	0.040 – 0.043	0.050 – 0.075
Tributary No.1 to Hunlock Creek	0.040 – 0.055	0.060 – 0.080
Tributary No. 1 to Tributary No. 2 to Hunlock Creek	0.050 – 0.060	0.130
Tributary No. 2 to Hunlock Creek	0.050 – 0.060	0.060 – 0.090
Tributary No. 17 to Susquehanna River	0.025 – 0.055	0.070 – 0.085
Tributary to Black Creek	0.025 – 0.060	0.030 – 0.080
Unnamed Tributary to Mill Creek No. 1	0.032 – 0.040	0.041 – 0.095
Walker Run	0.035 – 0.055	0.050 – 0.110
Watering Run	0.070 – 0.075	0.060 – 0.120
Wright Creek	0.050	0.110

Countywide Analyses

No new detailed hydraulic analyses were conducted as part of this countywide FIS; however for flooding sources studied with approximate methods, the 1-percent-annual-chance flood elevations were determined using USGS Regression Equations (Reference 124) and the USACE HEC-RAS computer program (Reference 125). The peak flood discharges from the regression equations were input into a HEC-RAS model that included cross sections extracted from PAMAP LiDAR data collected in 2006. Because this cross section information was not supplemented with field survey data and the models did not include bridge and culvert information, the resulting floodplain boundaries are considered approximate. Approximately 500 stream miles in the County were analyzed using this approach.

As part of this countywide FIS, new detailed hydraulic analyses were performed along Big Wapwallopen Creek and Lattimer Creek by GG3, and the Susquehanna River by the USACE.

For Big Wapwallopen Creek and Lattimer Creek, water surface elevations were computed using the USACE HEC-RAS computer program (Reference 125). The HEC-RAS model developed by GG3 included cross section geometry generated using manual and semi-automated methods derived from GIS techniques and data.

The new detailed analyses along Big Wapwallopen Creek extended from a point approximately 1,700 feet downstream of the confluence of Bow Creek up to a point approximately 5,000 feet upstream of Nuangola Road. The analyses along Lattimer Creek extended from its confluence with Black Creek to a point approximately 750 feet upstream of Hillside Drive.

Cross section elevations for both streams were extracted from a Digital Terrain Model (DTM) developed from PAMAP LiDAR data and field surveyed channel geometry. The DTM was generated by combining overbank elevation data from LiDAR with data from traditional field survey of the stream channel and its immediate overbank areas. All bridges, culverts, dams, and other hydraulic obstructions were field surveyed to provide data on elevation, orientation, and structural geometry. All field survey data for structures and stream channels was provided by Gannett Fleming, Inc., Camp Hill, Pennsylvania.

The HEC-RAS computer program allows the use of an “ineffective flow” boundaries within a modeled cross section to distinguish areas of ponding or backwater from areas of active flow that contribute to the conveyance of flooding along the floodplain. As part of the modeling process, preliminary water-surface elevations calculated using HEC-RAS were delineated on the DTM using GIS software. This process helped identify natural areas of ineffective flow, which were defined as ineffective flow areas in subsequent runs of the HEC-RAS model.

The HEC-RAS models for both streams were not calibrated to historic events because high-water elevation information was not available.

A streamline was derived using PAMAP orthoimagery. This serves as a base line to define distances along the stream channel as indicated on the Flood Profile and the Floodway Data Tables. Selected cross sections used in the hydraulic analysis are

located on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2) relative to distances along this base line.

The detailed hydraulic analysis for the Susquehanna River was performed by the USACE, Philadelphia District, and Hydrologic Engineering Center (HEC).

The hydraulic characteristics of the Susquehanna River in Columbia, Luzerne, Montour, Northumberland and Snyder Counties were studied to determine the elevations of floodwaters for the 10-, 2-, 1- and 0.2-percent-annual-chance flood recurrence intervals.

The cross sections for the hydraulic analysis were obtained from the DTM, which was developed from aerial photography flown in April 1999 and April 2001 (Reference 126 and 127). The below water portion of the DTM was developed from new river surveys performed in Summer 2000 using CHANNEL, an ARC/INFO software application (Reference 128). Bridge geometry was obtained from as-built bridge drawings from the PennDOT and from field investigations.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if the hydraulic structures remain unobstructed, operate properly, and do not fail.

Water surface elevations for the selected recurrence intervals were computed using the HEC-RAS computer program (Reference 129). The HEC-RAS model was calibrated to five historic events and eight frequency based events at the gages. Comparisons were also made with high water marks collected during the flood of 1972 attributed to Tropical Storm Agnes using the best available bridge and levee data for 1972. These marks were modeled within acceptable limits.

Limited detail analyses were conducted by GG3 along portions of Big Wapwallopen Creek, Bow Creek, Bow Creek Tributary A, Browns Creek and Watering Run. These analyses included cross sections extracted from PAMAP LiDAR data, and field measurements of typical channel geometry, bridges and culverts. For flooding sources studied with limited detail methods, the 1-percent-annual-chance flood elevations were determined using USGS regression equations and the HEC-RAS computer program (References 110 and 129).

For flooding sources studied with approximate methods, the 1-percent-annual-chance flood elevations were determined using USGS regression equations and the HEC-RAS (References 110 and 129). The peak flood discharges from the regression equations were input into a HEC-RAS model that included cross sections extracted from PAMAP LiDAR data collected in 2006. Because this cross section information was not supplemented with field survey data and the models did not include bridge and culvert information, the resulting floodplain boundaries are considered approximate. Approximately 600 stream miles in the County were analyzed using this approach.

Qualifying bench marks within a given jurisdiction are cataloged by the National Geodetic Survey (NGS) and entered into the National Spatial Reference System (NSRS). First or Second Order Vertical bench marks that 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 abutments)

- Stability C: Monuments which may be affected by surface ground movements (e.g., concrete mounted 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 monument 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, 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 purposes of establishing local vertical control. Although these monuments are not shown on the DFIRM, they may be found in the Technical Support Data Notebook associated with this FIS and FIRM. Interested individuals may contact FEMA to access this data.

3.3 Vertical Datum

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

For this countywide FIS, all flood elevations shown in the FIS report and on the FIRM are referenced to NAVD88. Structure and ground elevations in the community must, therefore, be referenced to NAVD88. It is important to note that adjacent communities may be referenced to NGVD29. This may result in differences in base flood elevations across corporate limits between the communities.

As noted above, the elevations shown in the FIS report and on the FIRM for Luzerne County are referenced to NAVD88. Ground, structure, and flood elevations may be compared and/or referenced to NGVD29 by applying a standard conversion factor. The conversion factor from NGVD29 to NAVD88 for Luzerne County is **-0.643 foot**. The locations used to establish the conversion factor were USGS 7.5-minute topographic quadrangle corners that fell within the County, as well as those that were within 2.5 miles outside the County. The bench marks are referenced to NAVD88.

Conversion locations and values for Luzerne County are shown below in Table 7, "Vertical Datum Conversion Values."

TABLE 7 – VERTICAL DATUM CONVERSION VALUES

USGS 7.5-minute Quadrangle Name	Corner	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Conversion from NGVD29 to NAVD88 (feet)
Avoca	SE	41.250	-75.625	-0.586
Berwick	SE	41.000	-76.125	-0.682
Center Moreland	SE	41.375	-75.875	-0.683
Conyngham	SE	40.875	-76.000	-0.612
Dutch Mountain	SE	41.375	-76.125	-0.637
Freeland	SE	41.000	-75.875	-0.624
Harveys Lake	SE	41.250	-76.000	-0.673
Kingston	SE	41.250	-75.875	-0.627
Lopez	SE	41.375	-76.250	-0.563
Mifflinville	SE	41.000	-76.250	-0.673
Nanticoke	SE	41.125	-76.000	-0.639
Noxen	SE	41.375	-76.000	-0.655
Pittston	SE	41.250	-75.750	-0.544
Pleasant View Summit	SE	41.125	-75.625	-0.642
Ransom	SE	41.375	-75.750	-0.650
Red Rock	SE	41.250	-76.250	-0.673
Shickshinny	SE	41.125	-76.125	-0.696
Stillwater	SE	41.125	-76.250	-0.672
Sweet Valley	SE	41.250	-76.125	-0.691
Sybertsville	SE	41.000	-76.000	-0.647
White Haven	SE	41.000	-75.750	-0.713
Wilkes-Barre East	SE	41.125	-75.750	-0.605
Wilkes-Barre West	SE	41.125	-75.875	-0.597
			AVERAGE	**-0.643 feet**

NAVD88 = NGVD29 + conversion factor

The base floodplain elevations (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 NGVD29 should apply the conversion factor to elevations shown on the Flood Profiles and supporting data tables in this FIS report, which are shown at a minimum to the nearest 0.1-foot.

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

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

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.

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

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

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

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. For the streams studied in detail, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. The

boundaries were interpolated between cross sections using topographic maps and delineated in a GIS environment using digital terrain data collected by USACE in 1999 and 2001 and PAMAP LiDAR data collected in 2006 (References 113 – 120, 126, 127, and 131 – 134).

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the SFHAs (Zones A and AE), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- 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 (Exhibit 2).

4.2 Floodways

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

The floodways presented in this FIS 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 in Table 8, “Floodway Data Table.” The computed floodways are shown on the FIRM (Exhibit 2). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage, and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 8, “Floodway Data Table.” In order to reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development to areas outside the floodways.

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 9 for certain downstream cross sections of Abrahams Creek, Big Wapwallopen Creek, Big Wapwallopen Creek Tributary H, Bow Creek Tributary A, Hunlock Creek, Lackawanna River, Laurel Run No. 1, Little Wapwallopen Creek, Mill Creek No. 1, Nescopeck Creek, Newport Creek, Reyburn Creek, Salem Creek, Shickshinny Creek, Sutton Creek, Tributary No. 17 to Susquehanna River and Walker Run are lower than the regulatory flood elevations in that area, which must take into account the 1-percent-annual-chance flooding due to backwater from other sources.

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

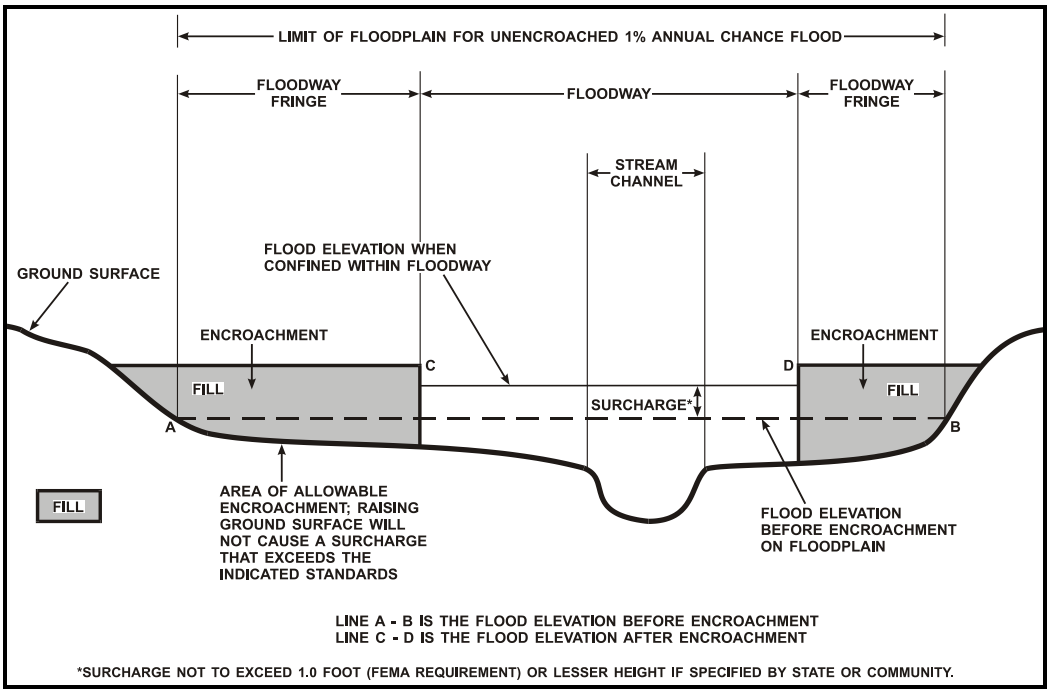

FIGURE 1 – FLOODWAY SCHEMATIC

No floodways were computed along Unnamed Tributary to Mill Creek No. 1 and for the stream reaches listed in Table 3, "Streams Studied by Limited Detailed Methods."

Along streams where floodways have not been computed, the community must ensure that the cumulative effect of development in the floodplains will not cause more than a 1.0-foot increase in the BFEs at any point within the community.

5.0 INSURANCE APPLICATIONS

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

Zone A

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

Zone AE

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

Zone AH

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

Zone AO

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

Zone AR

Zone AR is the flood insurance risk zone that corresponds to an area of special flood hazard formerly protected from the 1-percent-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 1-percent-annual-chance or greater flood event.

Zone A99

Zone A99 is the flood insurance risk zone that corresponds to areas of the 1-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 risk zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Because approximate

hydraulic analyses are performed for such areas, no BFEs are shown within this zone.

Zone VE

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

Zone X

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

Zone X (Future Base Flood)

Zone X (Future Base Flood) is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined based on future-conditions hydrology. No BFEs or base flood depths are shown within this zone.

Zone D

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

6.0 FLOOD INSURANCE RATE MAP

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

For flood insurance applications, the map designates flood insurance 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 base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

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

The current FIRM presents flooding information for the entire geographic area of Luzerne County. Previously, separate Flood Hazard Boundary Maps (FHBMs) and/or FIRMs were prepared for each incorporated community with identified flood hazard areas and the unincorporated areas of the County. Historical map dates relating to pre-countywide maps prepared for each community are presented in Table 9, “Community Map History.”

COMMUNITY NAME	INITIAL NFIP MAP DATE	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	INITIAL FIRM DATE	FIRM REVISIONS DATE
Ashley, Borough of	April 5, 1974	June 11, 1976	September 30, 1980	
Avoca, Borough of	July 19,1974	June 4, 1976	July 16, 1981	
Bear Creek, Township of	December 20, 1974	July 23, 1976	September 29, 1978	
Black Creek, Township of	May 31, 1974	May 14, 1976	September 3, 1980	
Buck, Township of	December 20, 1974	None	April 15, 1981	
Butler, Township of	May 31, 1974	April 30, 1976	December 16, 1980	
Conyngham, Borough of	May 10, 1974	October 22, 1976	July 16, 1980	
Conyngham, Township of	May 3, 1974	May 7, 1976	February 16, 1977	
Courtdale, Borough of	December 28, 1973	October 15, 1976	June 1, 1979	January 20, 1982
Dallas, Borough of	November 15, 1974	December 23, 1977	January 2, 1981	
Dallas, Township of	December 23, 1977	None	April 1, 1988	
Dennison, Township of	November 29, 1974	None	April 15, 1981	
Dorrance, Township of	January 24, 1975	None	August 15, 1980	
Dupont, Borough of	February 14, 1975	None	June 15, 1981	

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

LUZERNE COUNTY, PA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL NFIP MAP DATE	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	INITIAL FIRM DATE	FIRM REVISIONS DATE
Duryea, Borough of	December 28, 1973	December 3, 1976	June 18, 1980	
Edwardsville, Borough of	March 23, 1973	None	April 15, 1977	
Exeter, Borough of	June 15, 1973	July 9, 1976	May 16, 1977	
Exeter, Township of	June 28, 1974	May 21, 1976	September 15, 1983	
Fairmount, Township of	January 17, 1975	March 21, 1980	April 1, 1981	
Fairview, Township of	June 14, 1974	July 9, 1976	June 1, 1979	January 20, 1982
Forty Fort, Borough of	March 30, 1973	May 14, 1976	April 1, 1977	July 3, 1981
Foster, Township of	November 15, 1974	None	April 1, 1981	
Franklin, Township of	November 8, 1974	None	May 19, 1981	
Hanover, Township of	July 26, 1974	None	May 16, 1977	January 2, 1981
Harveys Lake, Borough of	December 28, 1973	November 12, 1976	December 2, 1980	
Hazle, Township of	November 8, 1974	None	April 1, 1981	
Hollenback, Township of	December 13, 1974	None	September 17, 1980	
Hunlock, Township of	March 22, 1974	None	April 1, 1980	

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

LUZERNE COUNTY, PA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL NFIP MAP DATE	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	INITIAL FIRM DATE	FIRM REVISIONS DATE
Huntington, Township of	January 3, 1975	None	April 15, 1981	
Jackson, Township of	December 28, 1973	June 10, 1977	September 17, 1980	
Jenkins, Township of	June 1, 1973	July 23, 1976	May 16, 1977	
Kingston, Borough of	February 2, 1973	None	June 1, 1977	
Kingston, Township of	July 19, 1974	May 28, 1976	January 2, 1981	March 12, 1982
Laflin, Borough of	November 19, 1976	None	December 2, 1980	
Lake, Township of	November 22, 1974	None	September 3, 1980	
Larksville, Borough of	July 6, 1973	May 28, 1976	April 1, 1977	
Laurel Run, Borough of	May 27, 1977	None	September 1, 1987	
Lehman, Township of	March 8, 1974	January 7, 1977	December 2, 1980	
Luzerne, Borough of	November 23, 1973	None	April 15, 1977	
Nanticoke, City of	August 24, 1973	December 14, 1973 October 3, 1975	April 15, 1977	
Nescopeck, Borough of	October 12, 1973	November 12, 1976	February 1, 1980	
Nescopeck, Township of	August 31, 1973	December 3, 1976	August 1, 1980	

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

LUZERNE COUNTY, PA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL NFIP MAP DATE	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	INITIAL FIRM DATE	FIRM REVISIONS DATE
New Columbus, Borough of	November 1, 1974	July 9, 1976	March 16, 1981	
Newport, Township of	December 27, 1974	None	December 2, 1980	
Nuangola, Borough of	December 20, 1974	None	September 28, 1979	January 20,1982
Penn Lake Park, Borough of	December 5, 1980	None	December 5, 1980	
Pittston, City of	August 31, 1973	June 4, 1976	May 2, 1977	
Pittston, Township of	January 24, 1975	February 15, 1980	June 15, 1981	
Plains, Township of	July 20, 1973	September 24, 1976	May 16, 1977	April 6, 1998
Plymouth, Borough of	March 30, 1973	March 29, 1974 May 7, 1976	April 1, 1977	
Plymouth, Township of	February 8, 1974	July 2, 1976	April 15, 1977	
Pringle, Borough of	July 13, 1973	August 6, 1976	May 2, 1977	
Rice, Township of	March 29, 1974	December 24, 1976	January 2, 1981	
Ross, Township of	January 24, 1975	None	April 15, 1981	
Salem, Township of	November 30, 1973	January 7, 1977	March 18, 1980	
Shickshinny, Borough of	March 30, 1973	May 14, 1976	December 31, 1976	

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

LUZERNE COUNTY, PA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL NFIP MAP DATE	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	INITIAL FIRM DATE	FIRM REVISIONS DATE
*Sugar Notch, Borough of	None	None	None	
Sugarloaf, Township of	May 3, 1974	June 18, 1976	July 2, 1980	
Swoyersville, Borough of	June 15, 1977	None	June 15, 1977	November 5, 1982
Union, Township of	January 17, 1975	None	September 30, 1980	
Warrior Run, Borough of	December 6, 1974	None	June 25, 1976	
**West Hazleton, Borough of	November 1, 1974	None	None	
West Pittston, Borough of	March 29, 1974	July 30, 1976	April 15, 1977	
West Wyoming, Borough of	April 15, 1977	None	April 15, 1977	July 22, 1977 September 15, 1983
White Haven, Borough of	October 26, 1973	None	August 1, 1977	April 15, 1981
Wilkes-Barre, City of	April 12, 1974	November 14, 1975	September 30, 1977	October 15, 1981 March 16, 1992
Wilkes-Barre, Township of	October 22, 1976	None	December 2, 1980	
Wright, Township of	March 8, 1974	October 1, 1976	January 16, 1981	

*Previous maps for this community have been rescinded on June 30, 1976

**Previous maps for this community have been rescinded on July 31, 1978

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

LUZERNE COUNTY, PA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL NFIP MAP DATE	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	INITIAL FIRM DATE	FIRM REVISIONS DATE
Wyoming, Borough of	February 9, 1973	March 22, 1974	November 16, 1977	July 3, 1981
*Yatesville, Borough of	None	None	None	

*Previous maps for this community have been rescinded on June 31, 1978

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

LUZERNE COUNTY, PA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Luzerne County has been compiled into this countywide FIS. Therefore, this FIS 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.

Countywide FIS reports for the adjacent counties of Carbon County, Pennsylvania, Columbia County, Pennsylvania, Lackawanna County, Pennsylvania, Monroe County, Pennsylvania, Schuylkill County, Pennsylvania, Sullivan County, Pennsylvania, and Wyoming County, Pennsylvania are currently underway.

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 FIS can be obtained by contacting FEMA, Federal Insurance and Mitigation Division, One Independence Mall, Sixth Floor, 615 Chestnut Street, Philadelphia, Pennsylvania 19106-4404.

9.0 BIBLIOGRAPHY AND REFERENCES

1. Federal Emergency Management Agency, Flood Insurance Study, Borough of Ashley, Luzerne County, Pennsylvania, Washington D.C., March, 1980.

2. Federal Emergency Management Agency, Flood Insurance Study, Borough of Avoca, Luzerne County, Pennsylvania, Washington D.C., July 16, 1981.

3. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Township of Bear Creek, Luzerne County, Pennsylvania, Washington D.C., March 1978.

4. Federal Emergency Management Agency, Flood Insurance Study, Township of Black Creek, Luzerne County, Pennsylvania, Washington D.C., March 1980.

5. Federal Emergency Management Agency, Flood Insurance Study, Township of Buck, Luzerne County, Pennsylvania, Washington D.C., October 15, 1980.

6. Federal Emergency Management Agency, Flood Insurance Study, Township of Butler, Luzerne County, Pennsylvania, Washington D.C., June 1980.

7. Federal Emergency Management Agency, Flood Insurance Study, Borough of Conyngham, Luzerne County, Pennsylvania, Washington D.C., January 1980.

8. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Township of Conyngham, Luzerne County, Pennsylvania, Washington D.C., August 1976.

9. Federal Emergency Management Agency, Flood Insurance Study, Borough of Courtdale, Luzerne County, Pennsylvania, Washington D.C., June 1, 1979.

10. Federal Emergency Management Agency, Flood Insurance Study, Borough of Courtdale, Luzerne County, Pennsylvania, Washington D.C., July 20, 1981.

11. Federal Emergency Management Agency, Flood Insurance Study, Borough of Dallas, Luzerne County, Pennsylvania, Washington D.C., July 2, 1980.

12. Federal Emergency Management Agency, Flood Insurance Study, Township of Dennison, Luzerne County, Pennsylvania, Washington D.C., October 15, 1980.

13. Federal Emergency Management Agency, Flood Insurance Study, Township of Dorrance, Luzerne County, Pennsylvania, Washington D.C., February 1980.

14. Federal Emergency Management Agency, Flood Insurance Study, Borough of Dupont, Luzerne County, Pennsylvania, Washington D.C., December 15, 1980.

15. Federal Emergency Management Agency, Flood Insurance Study, Borough of Duryea, Luzerne County, Pennsylvania, Washington D.C., December 1979.

16. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of Edwardsville, Luzerne County, Pennsylvania, Washington D.C., October 1976.

17. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of Exeter, Luzerne County, Pennsylvania, Washington D.C., November 1976.

18. Federal Emergency Management Agency, Flood Insurance Study, Township of Exeter, Luzerne County, Pennsylvania, Washington D.C., March 15, 1983.

19. Federal Emergency Management Agency, Flood Insurance Study, Township of Fairmount, Luzerne County, Pennsylvania, Washington D.C., October 1980.

20. Federal Emergency Management Agency, Flood Insurance Study, Township of Fairview, Luzerne County, Pennsylvania, Washington D.C., July 20, 1981.

21. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of Forty Fort, Luzerne County, Pennsylvania, Washington D.C., October 1976.

22. Federal Emergency Management Agency, Flood Insurance Study, Township of Foster, Luzerne County, Pennsylvania, Washington D.C., October 1, 1980.

23. Federal Emergency Management Agency, Flood Insurance Study, Township of Franklin, Luzerne County, Pennsylvania, Washington D.C., November 19, 1980.

24. Federal Emergency Management Agency, Flood Insurance Study, Township of Hanover, Luzerne County, Pennsylvania, Washington D.C., January 1981.

25. Federal Emergency Management Agency, Flood Insurance Study, Borough of Harveys Lake, Luzerne County, Pennsylvania, Washington D.C., June 1980.

26. Federal Emergency Management Agency, Flood Insurance Study, Township of Hazle, Luzerne County, Pennsylvania, Washington D.C., October 1, 1980.

27. Federal Emergency Management Agency, Flood Insurance Study, Township of Hollenback, Luzerne County, Pennsylvania, Washington D.C., March 1980.

28. Federal Emergency Management Agency, Flood Insurance Study, Township of Hunlock, Luzerne County, Pennsylvania, Washington D.C., October 1979.

29. Federal Emergency Management Agency, Flood Insurance Study, Township of Huntington, Luzerne County, Pennsylvania, Washington D.C., October 15, 1980.

30. Federal Emergency Management Agency, Flood Insurance Study, Township of Jackson, Luzerne County, Pennsylvania, Washington D.C., March 1980.

31. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Township of Jenkins, Luzerne County, Pennsylvania, Washington D.C., November 1976.

32. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of Kingston, Luzerne County, Pennsylvania, Washington D.C., December 1976.

33. Federal Emergency Management Agency, Flood Insurance Study, Township of Kingston, Luzerne County, Pennsylvania, Washington D.C., July 2, 1980.

34. Federal Emergency Management Agency, Flood Insurance Study, Borough of Laflin, Luzerne County, Pennsylvania, Washington D.C., June 1980.

35. Federal Emergency Management Agency, Flood Insurance Study, Township of Lake, Luzerne County, Pennsylvania, Washington D.C., March 1980.

36. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of Larksville, Luzerne County, Pennsylvania, Washington D.C., October 1976.

37. Federal Emergency Management Agency, Flood Insurance Study, Township of Lehman, Luzerne County, Pennsylvania, Washington D.C., June 1980.

38. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of Luzerne, Luzerne County, Pennsylvania, Washington D.C., October 1976.

39. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, City of Nanticoke, Luzerne County, Pennsylvania, Washington D.C., October 1976.

40. Federal Emergency Management Agency, Flood Insurance Study, Borough of Nescopeck, Luzerne County, Pennsylvania, Washington D.C., August 1979.

41. Federal Emergency Management Agency, Flood Insurance Study, Township of Nescopeck, Luzerne County, Pennsylvania, Washington D.C., February 1980.

42. Federal Emergency Management Agency, Flood Insurance Study, Borough of New Columbus, Luzerne County, Pennsylvania, Washington D.C., September 16, 1980.

43. Federal Emergency Management Agency, Flood Insurance Study, Township of Newport, Luzerne County, Pennsylvania, Washington D.C., June 1980.

44. Federal Emergency Management Agency, Flood Insurance Study, Borough of Nuangola, Luzerne County, Pennsylvania, Washington D.C., July 20, 1981.

45. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, City of Pittston, Luzerne County, Pennsylvania, Washington D.C., November 1976.

46. Federal Emergency Management Agency, Flood Insurance Study, Township of Pittston, Luzerne County, Pennsylvania, Washington D.C., December 15, 1980.

47. Federal Emergency Management Agency, Flood Insurance Study, Township of Plains, Luzerne County, Pennsylvania, Washington D.C., November 16, 1976.

48. Federal Emergency Management Agency, Flood Insurance Study, Township of Plains, Luzerne County, Pennsylvania, Washington D.C., April 6, 1998.

49. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of Plymouth, Luzerne County, Pennsylvania, Washington D.C., October 1976.

50. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Township of Plymouth, Luzerne County, Pennsylvania, Washington D.C., October 1976.

51. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of Pringle, Luzerne County, Pennsylvania, Washington D.C., October 1976.

52. Federal Emergency Management Agency, Flood Insurance Study, Township of Rice, Luzerne County, Pennsylvania, Washington D.C., July 2, 1980.

53. Federal Emergency Management Agency, Flood Insurance Study, Township of Ross, Luzerne County, Pennsylvania, Washington D.C., October 15, 1980.

54. Federal Emergency Management Agency, Flood Insurance Study, Township of Salem, Luzerne County, Pennsylvania, Washington D.C., September 1979.

55. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of Shickshinny, Luzerne County, Pennsylvania, Washington D.C., January 1976.

56. Federal Emergency Management Agency, Flood Insurance Study, Township of Sugarloaf, Luzerne County, Pennsylvania, Washington D.C., January 1980.

57. Federal Emergency Management Agency, Flood Insurance Study, Borough of Swoyersville, Luzerne County, Pennsylvania, Washington D.C., November 1982.

58. Federal Emergency Management Agency, Flood Insurance Study, Township of Union, Luzerne County, Pennsylvania, Washington D.C., March 1980.

59. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of West Pittston, Luzerne County, Pennsylvania, Washington D.C., October 1976.

60. Federal Emergency Management Agency, Flood Insurance Study, Borough of West Wyoming, Luzerne County, Pennsylvania, Washington D.C., September 15, 1983.

61. Federal Emergency Management Agency, Flood Insurance Study, Borough of White Haven, Luzerne County, Pennsylvania, Washington D.C., October 15, 1980.

62. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, City of Wilkes-Barre, Luzerne County, Pennsylvania, Washington D.C., September 30, 1977.

63. Federal Emergency Management Agency, Flood Insurance Study, City of Wilkes-Barre, Luzerne County, Pennsylvania, Washington D.C., April 15, 1981.

64. Federal Emergency Management Agency, Flood Insurance Study, City of Wilkes-Barre, Luzerne County, Pennsylvania, Washington D.C., March 16, 1992.

65. Federal Emergency Management Agency, Flood Insurance Study, Township of Wright, Luzerne County, Pennsylvania, Washington D.C., July 16, 1980.

66. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of Wyoming, Luzerne County, Pennsylvania, Washington D.C., November 1977.

67. U.S. Census Bureau, State and County Quickfacts, http://quickfacts.census.gov, March 10, 2008.

68. The Weather Channel Interactive, Inc. Monthly Averages for Wilkes-Barre, Pennsylvania, www.weather.com, March 10, 2008.

69. U.S. Department of the Interior, Geological Survey, Water Resources Data for Pennsylvania, Water Years 1966 – 1977, Susquehanna and Potomac River Basins, Volume 2, Harrisburg, Pennsylvania, 1978.

70. U.S. Department of the Interior, Geological Survey, Water-Supply Paper 1903, Surface Water Supply of the United States, 1961 – 1965, Part I, North Atlantic Slope Basins, Maryland to York River, Volume 3, Washington D.C., 1970.

71. U.S. Department of the Interior, Geological Survey, Water Supply Paper 1672, Magnitude and Frequency of Floods in the United States, Part 1-B, North Atlantic Slope Basins, New York to York River by Richard H. Tice, Washington D.C., 1968.

72. Pennsylvania Department of Environmental Resources, Tropical Storm Agnes – Flood Damage Inventory for the Commonwealth of Pennsylvania, Harrisburg, Pennsylvania, December 1974.

73. Commonwealth of Pennsylvania, Department of Environmental Resources, in cooperation with the U.S. Geological Survey, Water Resources Bulletin No. 13, Floods in Pennsylvania, A Manual for Estimation of Their Magnitude and Frequency by Herbert J. Flippo, Jr., Harrisburg, Pennsylvania, October 1977.

74. U.S. Department of the Interior, Geological Survey, Log-Pearson Type III Flood Frequency Analysis, Lehigh River at Stoddartsville, Pennsylvania, 1942 – 1977, December 1, 1978.

75. U.S. Department of the Interior, Geological Survey, Water Resources Data for Pennsylvania, Part I, Surface Water Records, Harrisburg, Pennsylvania, Published Annually, 1961 – 1975.

76. Susquehanna River Basin Study, Appendix D – Hydrology, Susquehanna River Basin Study Coordinating Committee, June 1970.

77. Shank, William H., P.E., Great Floods of Pennsylvania, American Canal and Transportation Center, York, Pennsylvania, November 1974.

78. U.S. Army Corps of Engineers, Baltimore District, Floodplain Information, Susquehanna and Lackawanna Rivers, Luzerne County, Pennsylvania, Baltimore, Maryland, June 1974.

79. Local Climatological Data, Annual Summary with Comparative Data, Avoca, Pennsylvania, National Oceanic and Atmospheric Administration, Washington D.C., Revision 1976.

80. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Code of Federal Regulations, Title 24, Chapter 10, Parts 1910.3A and 3B, Federal Register, Volume 41, No. 207, Washington D.C., Revision 1976.

81. Department of Forests and Waters, Commonwealth of Pennsylvania, Water Resources Bulletin No. 5, Dams, Reservoirs, and Natural Lakes, 1970.

82. U.S. Army Corps of Engineers, Sacramento District, Statistical Methods in Hydrology by Leo R. Beard, Sacramento, California, January 1962.

83. The Pennsylvania State University, Institute for Research on Land and Water Resources, PSU III Flood Peak Frequency Design Manual by B.M. Reich, Y.P. King, and C.L. White, University Park, Pennsylvania, 1971.

84. Design of Small Dams, U.S. Government Printing Office, 1960, p. 47.

85. The Pennsylvania State University, Institute for Research on Land and Water Resources, Design Procedures for Rainfall Duration Frequency in Pennsylvania by B.M. Reich, R.L. Kerr, T.M. Rachford, June 1974.

86. Commonwealth of Pennsylvania, Department of Environmental Resources, Time Distribution of Storm Rainfall in Pennsylvania by R.L. Kerr, T.M. Rachford, B.M. Reich, B.H. Lee and K.H. Plummer, June 1974.

87. Geo-Tech Services, prepared for the Pennsylvania Department of Environmental Resources, Study of Acid Mine Drainage Abatement, Nanticoke, Warrior, and Solomon Creeks, draft report, November 1974.

88. American Water Resources Association, Water Resources Bulleting No. 2, Adoption of Flood Peaks and Design Hydrographs from Gaged and Nearby Ungaged Watersheds, Volume 14, April 1978.

89. Federal Highway Administration, Office of Research and Development, Method for Estimating Peak Rates of Runoff for Small Watersheds, Washington D.C., March 1978.

90. The Pennsylvania State University, Department of Civil Engineering, Final Report to the Pennsylvania Department of Transportation on Project 68-26, Flood Protection Methods for Pennsylvania Highway Crossings by B.M. Reich and D.R. Jackson, University Park, Pennsylvania, September 1971.

91. U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, U.S. Government Printing Office, Washington D.C., 1964.

92. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package, Computer Program, Davis, California, January 1973.

93. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package, Users Manual, Davis, California, October 1973.

94. Water Resources Council, A Uniform Technique for Determining Flood Flow Frequencies, Bulletin 15, Washington D.C., December 1967.

95. U.S. Army Corps of Engineers, North Atlantic Division, Hydrologic Study Tropical Storm Agnes, New York, October 1975.

96. U.S. Army Corps of Engineers, Hydrologic Engineering Center, Floodway Determination Using Computer Program HEC-2, Training Document No. 6, Davis, California, May 1974.

97. American Society of Civil Engineers Manual of Practice No. 37, Design and Construction of Sanitary and Storm Sewers, New York, New York, 1970.

98. Ven Te Chow, Handbook of Applied Hydrology, McGraw-Hill Book Company, Inc., New York, 1964, Section 25-II, p. 25-38.

99. Hardison, C.H., Generalized Skew Coefficients of Annual Floods in the United States and Their Application, Water Resources Research, V.10, No. 5, p. 745 - 752.

100. U.S. Department of the Interior, Geological Survey, Log-Pearson Type III Flood Frequency Analysis, Lehigh River at Stoddartsville, Pennsylvania, 1942 – 1977, December 1, 1978.

101. U.S. Army Corps of Engineers, Hydrologic Engineering Center, Regional Frequency Study, Upper Delaware and Hudson River Basins, New York District, Davis, California, March 1976.

102. U.S. Department of Agriculture, Soil Conservation Service, Technical Release No. 38, New Tables of Percentage Points for the Pearson Type III Distribution, Washington D.C., March 1976.

103. U.S. Army Corps of Engineers, Hydrologic Engineering Center, Hydrologic Study of Lehigh River Basin, Pennsylvania, Davis, California, April 1978.

104. U.S. Department of the Interior, Geological Survey, Water Resources Investigations 82-21, Evaluation of the Streamflow-Data Program in Pennsylvania, Herbert N. Flippo, Jr., Washington D.C., 1982.

105. The Pennsylvania State University, Department of Civil Engineering, Report No. FHWA/PA81-103, Procedure PSU-IV for Estimating Design/Flood Peaks in Ungaged Pennsylvania Watersheds, Gert Aron and David F. Kibler, University Park, Pennsylvania, 1981.

106. The Pennsylvania State University, Agriculture Experiment Station, Land Resource Map of Pennsylvania by H.W. Higbee, University Park, Pennsylvania, 1967.

107. U.S. Department of Agriculture, Soil Conservation Service, in cooperation with the Pennsylvania Department of Environmental Resources, Watershed Work Plan, Nescopeck Creek Watershed, Luzerne County, Pennsylvania, Washington D.C., November 1974.

108. U.S. Department of Agriculture, Soil Conservation Service, Technical Release No. 20, Computer Program, Project Formulation, Hydrology, Washington D.C., 1965.

109. U.S. Department of Agriculture, Soil Conservation Service, Technical Release No. 55, Urban Hydrology for Small Watersheds, Washington D.C., January 1975.

110. U. S. Department of the Interior, Geological Survey, Scientific Investigations Report 2008-5102, Regression Equations for Estimating Flood Flows at Selected Recurrence Intervals for Ungaged Streams in Pennsylvania, by Mark A. Roland and Marla H. Stuckey, Reston, Virginia, 2008.

111. U.S. Army Corps of Engineers, Baltimore District, Appendix I – Hydrology and Hydraulics – Final General Design Memorandum, Phase II, Wyoming Valley Levee Raising Project, Susquehanna River Basin, January 1995.

112. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Generalized Computer Program, Davis, California, October 1973.

113. Commonwealth of Pennsylvania, Department of Environmental Resources, Orthophoto maps compiled by photogrammetric methods from aerial photography, Scale 1:2,400, Contour Interval 5 Feet and 20 Feet: Anthracite Coal Region of Pennsylvania, 1967.

114. Quinn and Associates, Floodplain Map, compiled from aerial stereo photogrammetry flown in February 13, 1973, Horsham, Pennsylvania, October 31, 1973.

115. Tallamy, Van Kuren, Gertis and Thielman of Lanse, Pennsylvania, Topographic Maps compiled from aerial photography, Scale 1:9,600, Contour Interval 4 Feet: Borough of Conyngham and Townships of Butler, Dorrance, Hollenback, Rice, Sugarloaf, Union, and Wright, Luzerne County, Pennsylvania, flown in April 1978 (Unpublished).

116. Commonwealth of Pennsylvania, Department of Transportation, Topographic Maps, Scale 1:2,400, Contour Interval 5 Feet: Wilkes-Barre, Pennsylvania, 1973.

117. Michael Baker, Jr., Inc., Topographic Maps compiled from aerial photography, Scale 1:12,000, Beaver, Pennsylvania, April 1-11, 1975.

118. Michael Baker, Jr., Inc., Topographic Maps compiled from aerial photography, Scale 1:2,400, Contour Interval 5 Feet: Susquehanna River, Luzerne County, Pennsylvania, April 1975.

119. Pennsylvania Department of Transportation, Topographic Maps, Scale 1:2,400, Contour Interval 5 Feet: Wilkes-Barre, Pennsylvania, 1973.

120. Susquehanna River Basin Commission, Floodplain Maps, Wyoming Valley Reach, October 31, 1973.

121. Ven Te Chow, Open-Channel Hydraulics, New Luzerne, McGraw-Hill, 1959.

122. U.S. Department of the Interior, Geological Survey, Water-Supply Paper 1849, Roughness Characteristics of Natural Channels by Harry H. Barnes, Jr., Washington D.C., 1967.

123. Bureau of Public Roads, Hydraulic Design Series No. 2, Peak Rates of Runoff from Small Watersheds by W.D. Potter, Washington D.C., 1961.

124. U. S. Department of the Interior, Geological Survey, Scientific Investigations Report 2008-5102, Regression Equations for Estimating Flood Flows at Selected Recurrence Intervals for Ungaged Streams in Pennsylvania, by Mark A. Roland and Marla H. Stuckey, Reston, Virginia, 2008.

125. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-RAS, River Analysis System, Version 4.0.0, Davis, California, March 2008.

126. U.S. Army Corps of Engineers, Philadelphia District, Floodplain Management Services Branch, DTM: Columbia, Luzerne, Montour, Northumberland and Snyder Counties, Pennsylvania FIS, 2-foot contour accuracy, digital layers include: triangulated irregular network (TIN), transportation, hydrography, spot elevations, corporate limits, and orthophotography, developed by BAE Systems ADR., 1999 and 2001.

127. U.S. Army Corps of Engineers, Philadelphia District, Floodplain Management Services Branch, CROSS, Arc/Info software application, developed by Floodplain Management Services Branch, Philadelphia District, 1993.

128. U.S. Army Corps of Engineers, Philadelphia District, Floodplain Management Services Branch, CHANNEL, Arc/Info software application, developed by Floodplain Management Services Branch, Philadelphia District and Greenhorne & O'Mara, Inc., Greenbelt, MD, 1993.

129. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-RAS, River Analysis System, Version 3.1.1, Davis California, May 2003.

130. Federal Emergency Management Agency, Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, Washington D.C., 1992.

131. U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 20 Feet: Avoca, Pennsylvania, 1969; Center Moreland, Pennsylvania, 1946, Photorevised 1969; Conyngham, Pennsylvania, 1947, Photorevised 1969; Freeland, Pennsylvania, 1948, Photorevised 1969; Harveys Lake, Pennsylvania, 1946, Photorevised 1969; Kingston, Pennsylvania, 1946, Photorevised 1969; Nanticoke, Pennsylvania, Photorevised 1969; Pittston, Pennsylvania, 1947, Photorevised 1969; Pleasant View Summit, Pennsylvania, 1965, Photorevised 1973; Ransom, Pennsylvania, 1946, Photorevised 1969; Shickshinny, Pennsylvania, 1954, Photorevised 1969; Sweet Valley, Pennsylvania, 1946, Photorevised 1969; White Haven, Pennsylvania, 1947, Photorevised 1969; Wilkes-Barre East, Pennsylvania, 1947, Photorevised 1969; Wilkes-Barre West, Pennsylvania, Photorevised 1969.

132. Pennsylvania Department of Transportation, Scale 1:2,400, Contour Interval 5 Feet: 1973 Aerial Photograph Revision.

133. Commonwealth of Pennsylvania, Department of Transportation, Luzerne County, City of Wilkes-Barre, Route 309, Section 3, Scale 1:600, Contour Interval 1 Foot (Unpublished).

134. Pennsylvania Department of Conservation and Natural Resources, Bureau of Topographic and Geologic Survey, PAMAP Program, PAMAP Program LiDAR Processing/Contour Enhancement Lines of Pennsylvania, Middletown, Pennsylvania, April 2006.