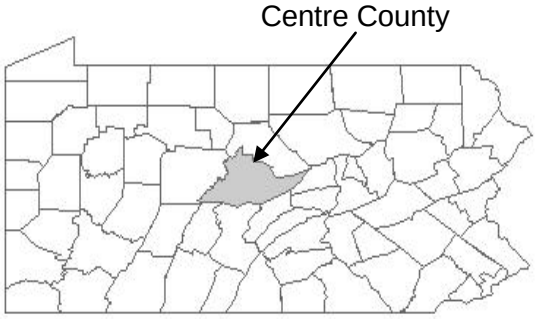
FLOOD INSURANCE STUDY

VOLUME 1 OF 2

This Preliminary FIS report includes only revised Flood Profiles and Floodway Data tables. See "Notice to Flood Insurance Study Users" page for additional details.



CENTRE COUNTY, PENNSYLVANIA

(ALL JURISDICTIONS)

COMMUNITY NAME	COMMUNITY NUMBER	COMMUNITY NAME	COMMUNITY NUMBER
BELLEFONTE, BOROUGH OF	420257	MILESBURG, BOROUGH OF	420264
BENNER, TOWNSHIP OF	421460	MILLHEIM, BOROUGH OF	420265
BOGGS, TOWNSHIP OF	421193	PATTON, TOWNSHIP OF	420266
BURNSIDE, TOWNSHIP OF	421461	PENN, TOWNSHIP OF	421466
*CENTRE HALL, BOROUGH OF	420258	PHILIPSBURG, BOROUGH OF	420267
COLLEGE, TOWNSHIP OF	420259	PORT MATILDA, BOROUGH OF	420268
CURTIN, TOWNSHIP OF	421462	POTTER, TOWNSHIP OF	421467
FERGUSON, TOWNSHIP OF	420260	RUSH, TOWNSHIP OF	421468
GREGG, TOWNSHIP OF	421194	SNOW SHOE, BOROUGH OF	421459
HAINES, TOWNSHIP OF	420261	SNOW SHOE, TOWNSHIP OF	421198
HALFMOON, TOWNSHIP OF	421463	SPRING, TOWNSHIP OF	420269
HARRIS, TOWNSHIP OF	420262	STATE COLLEGE, BOROUGH OF	420270
HOWARD, BOROUGH OF	420263	TAYLOR, TOWNSHIP OF	421469
HOWARD, TOWNSHIP OF	421464	UNION, TOWNSHIP OF	421470
HUSTON, TOWNSHIP OF	421195	UNIONVILLE, BOROUGH OF	420272
LIBERTY, TOWNSHIP OF	421196	WALKER, TOWNSHIP OF	421471
MARION, TOWNSHIP OF	421465	WORTH, TOWNSHIP OF	421472
MILES, TOWNSHIP OF	421197		

*NO SPECIAL FLOOD HAZARD AREAS IDENTIFIED

PRELIMINARY:
AUGUST 16, 2013

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
42027CV001B

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

Initial Countywide FIS Effective Date: May 4, 2009
Revised FIS Effective Date: TBD

This Preliminary FIS report does not include unrevised Floodway Data Tables or unrevised Flood Profiles. These unrevised components will appear in the final FIS report.

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FLOOD INSURANCE STUDY
CENTRE 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 Centre County, including the Boroughs of Bellefonte, Howard, Milesburg, Millheim, Philipsburg, Port Matilda, Snow Shoe, State College, and Unionville; and the Townships of Benner, Boggs, Burnside, College, Curtin, Ferguson, Gregg, Haines, Halfmoon, Harris, Howard, Huston, Liberty, Marion, Miles, Patton, Penn, Potter, Rush, Snow Shoe, Spring, Taylor, Union, Walker and Worth (referred to collectively herein as Centre County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community 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 Borough of Centre Hall, has no identified Special Flood Hazard Areas (SFHA). This does not preclude future determinations of SFHAs 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.

Please also note that the Borough of South Philipsburg was annexed by the Township of Rush on January 1, 2007, and all references to it in this report are for historical purposes only.

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

1.2 Authority and Acknowledgments

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

Information on the authority and acknowledgements for each of the previously printed FISs and FIRMs for communities within Centre County was compiled, and is shown below.

Borough of Bellefonte: The Flood Insurance Study was conducted by Susquehanna River Bain Commission at the request of the Federal Insurance

Administration, U.S. Department of Housing and Urban Development. The source of authority for the study is the National Flood Insurance Act of 1968, as amended. Authority and financing is contained in Contract No. H-3496 between the contractor and the Federal Insurance Administration (FIA).

Township of Benner: The hydrologic and hydraulic analyses for this study were prepared by the U.S. Geological Survey (USGS) for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in March 1987.

For this revision, the Spring Creek Levee System is de-accredited and re-mapped to show 1-percent-annual-chance conditions behind the levee. This work was performed under FEMA Contract No. HSFEHQ-09-D-0369, Task Order No. HSFE03-10-J-0025.

Township of Boggs: The hydrologic and hydraulic analyses for this study represent a revision of the original analysis prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. That work was completed in May 1987. The hydrologic and hydraulic analyses for Spring Creek and Moose Run in this revision were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-89-E-2997, Task Letter No. 89-3. This work was completed in June 1989.

Township of College: For the original July 4, 1989, FIS, the hydrologic and hydraulic analyses for this study represent a revision of the original analysis prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. The work for the original study was completed in May 1987. For Slab Cabin Run, Thompson Run, and Walnut Run in the January 2, 1992, revision, the hydrologic and hydraulic analyses were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-89-E-2997. The work for that revision was completed in October 1989. Additional work associated with that revision was completed in November 1990.

For the December 16, 2003, revision, the hydrologic and hydraulic analyses for the portion of Cedar Run No. 2 located within the township corporate limits were prepared by GKY and Associates, Inc., for FEMA, under contract number EMP-1999-CO-2225 as specified in the Limited Map Maintenance Program Task Letter #99-4. This work was completed in June 2001.

Township of Curtin: The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in May 1987.

Township of Ferguson: For the original July 17, 1989, FIS, the hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in June 1987.

For the December 17, 1991, FIS, the hydrologic and hydraulic analyses for Slab Cabin Run and Big Hollow Run were prepared by the USGS for FEMA. The analysis for Slab Cabin Run was completed in September 1989. The analyses for Big Hollow Run were completed in July 1990.

For the January 5, 1996, FIS, the determinations of seven Letters of Map Revision (LOMRs) issued by FEMA were incorporated.

For the December 16, 2003, revision, numerous approximate 100-year floodplains (Zone A) were revised based on new analyses that were prepared by the Water Resources Department of Dewberry & Davis LLC for FEMA. This work was completed on March 2001. Three LOMRs issued by FEMA have also been incorporated into the FIS.

Township of Haines: The hydrologic and hydraulic analyses for this study were performed by Gannett, Fleming, Corddry and Carpenter, Inc., for the FIA, under Contract No. H-3813. This work, which was completed in March 1977, covered all

significant flooding sources in Haines Township. All survey work was done by, or under the direction of Aero Services, Philadelphia, Pennsylvania.

Township of Harris: For the original June 1989 FIS, the hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in June 1987.

For the December 16, 2003, revision, the hydrologic and hydraulic analysis for Cedar Run No. 2 and part of Mackey's Run were prepared by GKY and Associates, Inc. for FEMA, under Contract No. EMP-1999-CO-2225 as specified in the Limited Map Maintenance Program Task Letter #99-4. This work was completed in June 2001.

Additional hydrologic and hydraulic analyses for Slab Cabin Run were prepared by the USGS for FEMA. These analyses were completed in September 1989, and included in the January 5, 1996, FIS for the Township of Ferguson.

Borough of Howard: The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in March 1987.
For this revision the Howard Levee System has been updated to remove Provisional status and to be accredited, under FEMA Contract No. HSFEHQ-09-D-0369, Task Order No. HSFE03-10-J-0025

Township of Howard: The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in March 1987.
For this revision the Howard Levee System has been updated to remove Provisional status and to be accredited, under FEMA Contract No. HSFEHQ-09-D-0369, Task Order No. HSFE03-10-J-0025

Township of Huston:	The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in May 1987.
Township of Liberty:	The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in March 1987.
Borough of Milesburg:	The study was conducted by the Susquehanna River Basin Commission at the request of the FIA, U.S. Department of Housing and Urban Development. The source of authority for the study is the National Flood Insurance Act of 1968, as amended. Authority and financing is contained in Contract No. H-3496 between the contractor and the FIA.
Borough of Millheim:	The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in June 1987.
Township of Penn:	The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in June 1987.
Borough of Philipsburg:	The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in March 1987.
Borough of Port Matilda:	The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in May 1987.
Township of Rush:	The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in March 1987.

Township of Snow Shoe:	The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in March 1987.
Borough of South Philipsburg:	The hydrologic and hydraulic analyses for this study prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in March 1987.
Township of Spring:	The hydrologic and hydraulic analyses in this study represent a revision of the original analyses by the Susquehanna River Basin Commission for FEMA. The updated version was prepared by Buchart-Horn, Inc., Consulting Engineers and Planners, for FEMA, under Contract No. H-4819. This work was completed in April 1982.
Borough of State College:	In this study, the hydrologic and hydraulic analyses for Slab Cabin Run were prepared by the USGS for FEMA, under the Inter-Agency Agreement No. EMW-90-E-3287, Project Order No. 1. The work for this study was completed in November 1990.
Township of Union:	The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in May 1987.
Borough of Unionville:	The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in May 1987.
Township of Walker:	The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. The hydrologic and hydraulic analyses for Nittany Creek in the August 15, 1990, revision were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-88-E-2704, Task Letter No. 88-12. This work was completed in February 1987.

Township of Worth: The hydrologic and hydraulic analyses for this study were prepared by the USGS for FEMA, under Inter-Agency Agreement No. EMW-85-E-1823, Project Order No. 17. This work was completed in May 1987.

1.3 Coordination

Borough of Bellefonte: The Centre County Planning Commission was contracted for information on local flooding problems. A consultation and coordination meeting was help with borough officials to present the findings of this study. Flood discharge information was coordinated with the U.S. Army Corps of Engineers (USACE) and the USGS.

Township of Benner: The initial Consultation Coordination Office (CCO) meeting was held on March 6, 1985, and attended by representatives of FEMA, the township, and the USGS. The purpose of an initial CCO meeting is to discuss the scope of the FIS.

The results of the study were reviewed at the final CCO meeting held on June 30, 1988, and attended by representatives of FEMA, the township, and the USGS. All problems raised at that meeting have been addressed.

Township of Boggs: The initial CCO meeting was held on March 6, 1985, and attended by representatives of FEMA, the township, and the USGS.

The results of the study were reviewed at the final CCO meeting held on June 16, 1988, and attended by representatives of FEMA, the township, and the USGS. All problems raised at that meeting have been addressed.

Township of College: For the January 1992, FIS, an initial CCO meeting was held on March 5, 1985, and a final CCO meeting was held on June 16, 1988. Both of these meetings were attended by representatives of FEMA, the township, and the study contractor.

For the December 16, 2003, revision, the township was notified by FEMA in a letter dated September 28, 2001, that its FIS would

be revised using the analyses prepared by GKY and Associates, Inc.

A final CCO meeting was held on May 24, 2002, and was attended by representatives of the township, the State, and FEMA.

Township of Curtin: The initial CCO meeting was held on March 6, 1985, and attended by representatives of FEMA, the township, and the USGS.

The results of the study were reviewed at the final CCO meeting held on June 16, 1988, and attended by representatives of FEMA, the township, and the USGS. All problems raised at that meeting have been addressed.

Township of Ferguson: For the July 17, 1989, FIS, and initial CCO meeting was held on March 5, 1985, and a final CCO meeting was held on July 1, 1988. Both of these meetings were attended by representatives of FEMA, the township, and the USGS.

For the January 5, 1996, revision, the township was notified by FEMA in a letter dated October 14, 1994, of the incorporation of the aforementioned LOMRs.

For the December 16, 2003, revision, the community was notified by FEMA in a letter dated May 14, 2002, that its FIS would be revised using the analyses prepared by Dewberry & Davis LLC, Water Resources Department. A final CCO meeting was held on January 8, 2003, and was attended by representatives from the township, Dewberry & Davis LLC, and FEMA.

Township of Haines: The initial CCO meeting was held in March 1975, and attended by representatives of the FIA, the township, and Gannett, Fleming, Corddry and Carpenter, Inc. (the study contractor). Study areas were finalized at a CCO meeting in November 1975. The results of the study were reviewed at the final CCO meeting held on May 4, 1977, and attended by representatives of the FIA, the township, and the study contractor. All problems raised at that meeting have been addressed.

Township of Harris:	For the June 1989 FIS, and initial CCO meeting was held on March 5, 1985, and a final CCO meeting was held on June 16, 1988. Both of these meetings were attended by representatives of the USGS, the township, and FEMA. For the December 16, 2003, revision, the Township of Harris was notified by FEMA in a letter dated September 28, 2001, that its FIS would be revised using the analyses prepared by GKY and Associates, Inc. A final CCO meeting was held on May 24, 2002, and was attended by representatives of the township, Dewberry & Davis LLC, GKY & Associates, Inc., the State, and FEMA.
Borough of Howard:	The initial CCO meeting was held on March 6, 1985, and attended by representatives of FEMA, the borough, and the USGS. The results of the study were reviewed at the final CCO meeting held on August 16, 1988, and attended by representatives of FEMA, the borough, and the USGS. All problems raised at that meeting have been addressed.
Township of Howard:	The initial CCO meeting was held on March 6, 1985, and attended by representatives of FEMA, the township, and the USGS. The results of the study were reviewed at the final CCO meeting held on August 16, 1988, and attended by representatives of FEMA, the township, and the USGS. All problems raised at that meeting have been addressed.
Township of Huston:	The initial Consultation Coordination Office (CCO) meeting was held on March 5, 1985, and attended by representatives of FEMA, the township, and the USGS. The results of the study were reviewed at the final CCO meeting held on June 16, 1988, and attended by representatives of FEMA, the township, and the USGS. All problems raised at that meeting have been addressed.
Township of Liberty:	The initial CCO meeting was held on March 6, 1985, and attended by representatives of FEMA, the township, and the USGS. The results of the study were reviewed at the final CCO meeting held on June 16, 1988, and

attended by representatives of FEMA, the township, and the USGS. All problems raised at that meeting have been addressed.

Borough of Milesburg: The Centre County Planning Commission was contacted for the information on local flooding problems. A consultation and coordination meeting was held with the Borough officials to present the findings of this study. Flood discharge information was coordinated with the Baltimore District, USACE, and Harrisburg District, USGS.

Borough of Millheim: The initial CCO meeting was held on March 6, 1985, and attended by representatives of FEMA, the borough, and the USGS. The results of the study were reviewed at the final CCO meeting held on June 16, 1988, and attended by representatives of FEMA, the borough, and the USGS. All problems raised at that meeting have been addressed.

Township of Penn: The initial CCO meeting was held on March 6, 1985, and attended by representatives of FEMA, the township, and the USGS. The results of the study were reviewed at the final CCO meeting held on September 15, 1988, and attended by representatives of FEMA, the township, and the USGS. All problems raised at that meeting have been addressed.

Borough of Philipsburg: The initial CCO meeting was held on March 5, 1985, and attended by representatives of FEMA, the borough, and the USGS. The results of the study were reviewed at the final CCO meeting held on August 24, 1989, and attended by representatives of FEMA, the borough, and the USGS. All problems raised at that meeting have been addressed.

Borough of Port Matilda: The initial CCO meeting was held on March 5, 1985, and attended by representatives of FEMA, the borough, and the USGS. The results of the study were reviewed at the final CCO meeting held on July 1, 1988, and attended by representatives of FEMA, the borough, and the USGS. All problems raised at that meeting have been addressed.

Township of Rush: The initial CCO meeting was held on March 5, 1985, and attended by representatives of

FEMA, the township, and the USGS. The results of the study were reviewed at the final CCO meeting held on December 20, 1989, and attended by representatives of FEMA, the township, and the study contractor. All problems raised at that meeting have been addressed.

Township of Snow Shoe: The initial CCO meeting was held on March 5, 1985, and attended by representatives of FEMA, the township, and the USGS. The results of the study were reviewed at the final CCO meeting held on June 30, 1988, and attended by representatives of FEMA, the township, and the USGS. All problems raised at that meeting have been addressed.

Borough of South Philipsburg: The initial CCO meeting was held on March 5, 1985, and attended by representatives of FEMA, the borough, and the USGS. The results of the study were reviewed at the final CCO meeting held on August 24, 1989, and attended by representatives of FEMA, the borough, and the USGS. All problems raised at that meeting have been addressed.

Township of Spring: On October 17-20, 1979, flooding sources were identified at an initial CCO meeting attended by representatives of FEMA, the Township of Spring, and Buchart-Horn, Inc. (the study contractor). During the course of the study, representatives of Spring were contacted for information concerning the history of flood problems and discussion of the study report. Local citizens were also contacted throughout the study for additional information used in this report. On November 23, 1982, the results of the study were reviewed at a final CCO meeting held with representatives of FEMA, the township, and the study contractor.

Borough of State College: The initial CCO meeting was held on May 30, 1990, and attended by representatives of FEMA, the community, and the USGS. On June 13, 1990, representatives from FEMA and the USGS met with the borough engineer to obtain background information on flooding in the community. The results of the study were reviewed at the final CCO meeting held on August 13, 1991, and attended by representatives of FEMA, the borough, and the

	USGS. All problems raised at that meeting have been addressed.
Township of Union:	The initial CCO meeting was held on March 6, 1985, and attended by representatives of FEMA, the township, and the USGS. The results of the study were reviewed at the final CCO meeting held on June 30, 1988, and attended by representatives of FEMA, the township, and the USGS. All problems raised at that meeting have been addressed.
Borough of Unionville:	The initial CCO meeting was held on March 6, 1985, and attended by representatives of FEMA, the borough, and the USGS. The results of the study were reviewed at the final CCO meeting held on September 15, 1988, and attended by representatives of FEMA, the borough, and the USGS. All problems raised at that meeting have been addressed.
Township of Walker:	The initial CCO meeting was held on March 6, 1985, and attended by representatives of FEMA, the township, and the USGS. The results of the study were reviewed at the final CCO meeting held on June 16, 1988, and attended by representatives of FEMA, the township, and the USGS. All problems raised at that meeting have been addressed.
Township of Worth:	The initial CCO meeting was held on March 5, 1985, and attended by representatives of FEMA, the township, and the USGS. The results of the study were reviewed at the final CCO meeting held on July 1, 1988, and attended by representatives of FEMA, the township, and the USGS. All problems raised at that meeting have been addressed.

The results of the May 4, 2009 countywide FIS were reviewed at the final CCO meeting held on March 5, 2008, and attended by representatives of the communities, Centre County, the State of Pennsylvania, FEMA, and Gannett Fleming Inc. All problems raised at that meeting have been addressed in that study.

For this revision, the levee along the Blanchard Reservoir has been accredited. In addition, the levee along Spring Creek at the Benner Spring State Fish Hatchery has been de-accredited. The resulting floodplain has been re-mapped as a result of this de-accreditation.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Centre County, Pennsylvania, including the incorporated communities listed in Section 1.1. The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction through Centre County. A list of streams studied by detailed methods along with the limits of study are shown in Table 1 – Streams Studied by Detailed Methods for the May 4, 2009 FIS.

Approximate analyses were used to study those areas having low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by FEMA and Centre County.

Table 1 - Stream Reaches Studied by Detailed Methods for the May 4, 2009 FIS

Stream	Limits of Detailed Study
Aaronsburg Tributary	From approximately 2,500 feet downstream from Rachel's Way to approximately 600 feet upstream of Culvert No. 2
Bald Eagle Creek	From approximately 750 feet downstream from US 220 and I-80 West to approximately 9,150 feet (1.73 miles) upstream of Chestnut Street
	From approximately 2,550 feet downstream from Furnace Street to approximately 2,375 feet upstream of Furnace Street
	From approximately 16,500 (3.125 miles) feet downstream from High Street to approximately 5,000 feet upstream of High Street
Beech Creek	From approximately 150 downstream from North Eagle Valley Road to approximately 9,150 feet (1.73 miles) upstream of Stoner Road
	From approximately 1,850 feet downstream from Main Street to approximately 1,900 feet upstream of Main Street

Table 1 - Stream Reaches Studied by Detailed Methods for the May 4, 2009 FIS (continued)

Stream	Limits of Detailed Study
Big Hollow Run	From approximately 3,250 feet downstream from US Business Route 322 (North Atherton Street) to approximately 425 feet upstream of Cherry Lane
	From approximately 700 feet downstream from Teaberry Lane to approximately 150 feet upstream of Science Park Road
Cedar Run No. 2	From the confluence with Spring Creek to approximately 100 feet upstream of Rock Hill Road
Cold Stream	From approximately 4,550 downstream from Pine Street to the dam
Dewitt Run	From approximately 400 feet downstream from Race Street to approximately 1,720 feet upstream of Eagle Valley Road (US 22)
Elk Creek	From approximately 1,400 feet downstream from Coburn Road to approximately 2,000 feet upstream of Park Road
Galbraith Gap Run	From approximately 1,400 feet downstream from Mount Nittany Expressway to approximately 3,650 feet upstream of Mount Nittany Expressway
Gap Run	From approximately 300 feet downstream from North Main Street to approximately 2,600 feet upstream of On the Hill Road
Laurel Run No.1	From approximately 1,550 feet downstream from Plank Road to approximately 8,150 feet upstream of Plank Road
Laurel Run No. 2	From approximately 1,200 feet downstream from Railroad Avenue to approximately 550 feet upstream of Eagle Valley Road
Lick Run	From approximately 500 feet downstream from Mill Street to approximately 800 feet upstream of Park Road

Table 1 - Stream Reaches Studied by Detailed Methods for the May 4, 2009 FIS (continued)

Stream	Limits of Detailed Study
Little Fishing Creek	From approximately 3,050 feet downstream from Wood Duck Lane to approximately 300 feet upstream of Wood Duck Lane
	From approximately 1,200 feet downstream from Hockman Road to approximately 400 feet upstream of Blue Ball Gap Road
Little Marsh Creek	From Yarnell Road to approximately 1,450 feet upstream of Circle Road
Little Sandy Run	From approximately 900 feet downstream from Clarence Road to approximately 1,000 feet upstream of Clarence Road
Logan Branch	From approximately 4,700 feet downstream from Epply White Road to approximately 3,650 feet upstream of Rishel Hill Road
Mackey's Run	From approximately 2,000 feet downstream from Rock Hill Road to approximately 1,000 feet upstream of Rock Hill Road
Marsh Creek	From approximately 50 feet upstream of North Eagle Valley to 50 feet upstream of Howard Divide Road
Moose Run	From approximately 100 feet downstream from Eagle Valley Road to approximately 1,200 feet upstream of Butler Road
Moshannon Creek	From approximately 1,400 feet downstream from Conrail to 3,500 feet upstream of Maple Street
Nittany Creek	From approximately 800 feet downstream from Benner Road to approximately 400 feet upstream of East College Avenue
North Fork Beech Creek	From approximately 2,500 feet downstream from Clarence Road to approximately 50 feet upstream of Hickory Road

Table 1 - Stream Reaches Studied by Detailed Methods for the May 4, 2009 FIS (continued)

Stream	Limits of Detailed Study
Oliver Run	From a point approximately 2,400 feet upstream of the confluence with Laurel Run No. 1 to approximately 3,350 feet upstream of that same point
Penns Creek	From approximately 3,200 feet downstream from Abandoned Railroad Bridge to approximately 3.3 miles upstream of an Abandoned Railroad Bridge
	From approximately 2,100 feet downstream from Main Street to approximately 1,950 feet upstream of Main Street
Pine Creek	From approximately 1,700 feet downstream from East Street to just downstream of Pine Creek Hollow Road
Piney Run	From approximately 225 feet downstream from Flatt Street to approximately 2,050 feet upstream of No. Ten Road
Roaring Run	From approximately 1,250 feet downstream from Nittany Valley Drive to approximately 1,050 feet upstream of Nittany Valley Drive
Slab Cabin Run	From approximately 1,100 feet downstream from Puddintown Road to approximately 9,500 feet (1.79 miles) upstream of Atherton Street
	From approximately 7,300 feet (1.38 miles) downstream from Scott Road to approximately 20 feet upstream of Pine Grove Road

Table 1 - Stream Reaches Studied by Detailed Methods for the May 4, 2009 FIS (continued)

Stream	Limits of Detailed Study
Spring Creek	From approximately 600 feet downstream from Commerical Street Bridge to approximately 1,300 feet upstream of Fish Hatchery Road From approximately 4,500 feet downstream from Trout Road to approximately 2,900 feet upstream of Houserville Road From approximately 1,100 feet downstream from Puddintown Road to approximately 4,250 feet upstream of Mount Nittany Expressway
Thompson Run	From approximately 2,300 feet downstream from College Avenue to approximately 900 feet upstream of Moses Thompson Avenue
Unnamed Tributary to Gap Run	From the confluence with Gap Run to approximately 1,380 feet upstream of the confluence with Gap Run.
Wallace Run	From approximately 1,050 feet downstream from Eagle Valley Road to approximately 550 feet upstream of Chestnut Grove Road
Walnut Run	From the confluence with Thompson Run to approximately 3,500 feet upstream of the confluence with Thompson Run

2.2 Community Description

Centre County is located in Central Pennsylvania. The climate in central Pennsylvania has the characteristics of being humid continental. Summer and winter temperatures average 70.6 degrees Fahrenheit (°F) and 28.7°F, respectively. Annual average precipitation of the region is 39.7 inches, while snowfall totals 17.3 inches (The Weather Channel, 2005). According to the 2010 Census, the population of Centre County was 153,990, and the land area approximately 1,110 square miles (U.S. Census Bureau, 2010).

Shawanese Indians were the first inhabitants of what is now Centre County. The first permanent settlers came to the area in 1775, being attracted by a good climate and fertile valleys needed for agriculture and plentiful supplies of timber, iron, ore, coal and limestone needed to begin manufacturing.

Aaronsburg was laid out as a town in 1786 and the first school was started three years later. Later in the century, blast furnaces began producing iron to supply the western portion of the state. In 1800, Centre County was created from sections of Mifflin, Northumberland, Lycoming and Huntingdon Counties. Haines Township was also created at this time and it was one of the original eight townships (Linn, 1925 and Maynard, 1877).

The Borough of Bellefonte is located in the central portion of Centre County, Pennsylvania. The total area of 1.9 square miles is included in the municipality. Bellefonte was settled in 1795 and incorporated as a borough in 1806 from a portion of Spring Township. The borough is a small community surrounded by a rural agricultural setting which is developing through the influence of the Pennsylvania State University located approximately 11 miles to the south. In 2000, Bellefonte had a population of 6,395 (U.S. Census, 2000). Bellefonte is situated in areas of gentle relief slightly southeast of very steep, ridge-like Balk Eagle Mountain.

The Township of Benner is located in the southern part of Centre County in central Pennsylvania, approximately 7 miles northeast of State College. It is bordered by the Township of Spring to the northeast, the township of Potter to the southeast, the Township of College to the south, the Township of Patton to the southwest and the Township of Union to the northwest.

The Township of Boggs is located in the central part of Centre County in central Pennsylvania, approximately 18 miles north of State College. It is bordered by the Township of Curtin to the northeast, the Township of Howard to the east, the Townships of Marion and Spring to the southeast, the Township of Union to the southwest, and the Township of Snow Show to the northwest.

The Township of Burnside is located in the northern part of Centre County in central Pennsylvania. It is bordered by the Township of Snow Shoe to the south and the Township of Curtin to the west.

The Township of College is located in the southern part of Centre County in central Pennsylvania. It is bordered by the Township of Benner to the north, the Township of Harris to the south, the Borough of State College to the west, the Township of Ferguson to the southwest, and the Township of Patton to the northwest.

The Township of Curtin is located in the northern part of Centre County in central Pennsylvania, approximately 21 miles north-northeast of State College. It is bordered by the Township of Beech Creek to the north, the Township of Liberty to the east, the Township of Howard to the southeast, the Township of Boggs to the southwest, and the Townships of Snow Shoe and Burnside to the west.

The Township of Ferguson is located in the southwestern part of Centre County in central Pennsylvania. It is bordered by the Township of College and the Borough of State College to the northeast, the Township of Harris to the east, the Townships of Jackson and Baree to the southeast, the Townships of Franklin

and Warriors Mark to the southwest, the Township of Halfmoon to the west, and the Township of Patton to the northwest.

The Township of Gregg is located in southern Centre County in central Pennsylvania. The township is bordered by the Township of Walker to the north, the Townships of Miles and Penn to the east and the Township of Potter to the west.

Haines Township is located in eastern Centre County in central Pennsylvania, 30 miles west of Sunbury and 50 miles northwest of Harris, Pennsylvania. The township is bounded by Miles Township to the north, Armagh Township to the south, Hartley Township to the east, and Penn Township to the west. The total area within the township is 58.23 square miles. In 2000, the population of Haines Township was 1,479 persons (U.S. Census, 2000).

Penns Creek is a 55-mile long tributary of the Susquehanna River. Originating west of Haines Township in Green Township, the creek flows east through Centre and Union Counties before flowing south through Snyder County. The confluence of Penns Creek with the Susquehanna River is at Selinsgrove, Pennsylvania. The drainage area of Penns Creek encompasses 554 square miles at its mouth. Pine Creek is a tributary of Penns Creek. Its length of 17.2 miles is almost entirely within the Haines Township corporate limits. Originating in Hartley Township the creek flows west though Haines Township before joining Penns Creek at the community of Coburn in Penn Township. The drainage area totals 36.4 square miles. The small tributary south of Aaronsburg has a length of 2.5 miles. It flows in a southwesterly direction to Elk Run, south of Millheim; its drainage area is 2.35 square miles.

Much of the township land has been set aside for Bald Eagle State Park. Consequently, less than 5-percent of the township has been developed either residentially, commercially, or industrially. Residential development that has occurred is mainly concentrated within towns of Aaronsburg, Woodward and Ingleby. Scattered development is contained within the floodplains of the streams being studied within the township and this development has been inundated by flood waters in recent years.

The Township of Halfmoon is located in the southwestern portion of Centre County in central Pennsylvania. The township is bordered by the Township of Ferguson, to the south, the Township of Patton to the northeast, Township of Huston to the north, the Township of Worth to the northwest, and the Township of Taylor to the west.

The Township of Harris is located in the southern portion of Centre County in central Pennsylvania, approximate 5 miles southeast of State College. It is bordered by the Township of College to the north, the Township of Potter to the east, the Township of Jackson to the south, and the Township of Ferguson to the west.

The Borough of Howard is located in the northeastern part of Centre County in central Pennsylvania, approximately 23 miles northeast of State College. It is bordered by the Township of Howard on all sides.

The Township of Howard is located in the northeastern part of Centre County on central Pennsylvania, approximately 23 miles northeast of State College it is bordered by the Township of Liberty to the northeast, the Township of Marion to the south, the Township of Boggs to the west, and the Township of Curtin to the north. It surrounds the Borough of Howard.

The Township of Huston is located in the western part of Centre County in central Pennsylvania, approximately 10 miles northwest of State College. It is bordered by the Township of Union to the northeast, the Township of Patton to the southeast, the Township of Worth to the southwest, and the Township of Rush to the northwest.

The Township of Liberty is located in northeastern Centre County in central Pennsylvania, approximately 19 miles northeast of State College. It is bordered by the Township and Borough of Beech Creek to the north, the Township of Porter to the east, the Township of Marion to the south, the Township of Howard to the southwest, and the Township of Curtin to the west.

The Township of Marion is located in the northeastern portion of Centre County in central Pennsylvania. The township is bordered by Walker Township to the south and east, the Township of Spring to the southwest, the Township of Howard to the northwest and the Township of Liberty to the north and west.

The Township of Miles is located in the eastern part of Centre County, in central Pennsylvania. The township is bordered by the Township of Haines and Penn to the south, the Township of Gregg to the west, and the Township of Walker to the north and west.

The Borough of Milesburg is locate in the central portion of Centre County, Pennsylvania and covers a total area of 0.4 square miles. Milesburg Borough was incorporated in 1843 from portions of Boggs Township, which was settled in 1793. Milesburg Borough is a small community in a predominately rural area. The Borough population in 2000 was 1,187. The nearest community is the larger Borough of Bellefonte, located approximately 3 miles upstream on Spring Creek.

The Borough of Millheim is located in eastern Centre County in central Pennsylvania, approximately 28 miles northeast of State College. It is completely surrounded by the Township of Penn.

The Township of Patton is located in southern Centre County, in central Pennsylvania. It is bordered by the Township of Union to the north, the Township of Benner and College to the east, the Township of Ferguson to the south and east, the Townships of Halfmoon and Worth to west, and the Township of Huston to the north and west.

The Township of Penn is located in the eastern part of Centre County in central Pennsylvania, approximately 25 miles east of State College. It is bordered by the Township of Miles to the north, the Township of Haines to the east, the Township of Armagh to the south, and the Township of Gregg to the west.

The Borough of Philipsburg is located in the western portion of Centre County, in central Pennsylvania, approximately 25 miles northwest of State College. It is bordered by the Township of Rush to the north and east, the Borough of South Philipsburg to the south, and the Township of Decatur and the Borough of Chester Hill to the west.

The Borough of Port Matilda is located in the southwestern part of Centre County in central Pennsylvania, approximately 13 miles west of State College. It is surrounded by the Township of Worth.

The Township of Potter is located in the southern part of Centre County in central Pennsylvania. It is bordered by the Township of Walker to the north, the Township of Gregg to the north and east, the Township of Harris to the west, and the Townships of Benner and Spring to the north and west.

The Township of Rush is located in the southwest portion of Centre County in central Pennsylvania, approximately 20 miles west of State College. It is bordered by the Township of Snow Shoe to the northeast; the Township of Union to the east; the Townships of Huston, Worth, and Taylor to the southeast; the Township of Snyder to the south; and the Townships of Gulich, Woodward, Decatur, Morris, and Cooper, and the Boroughs of Osceola Mills and Chester Hill to the west. The Township of Rush completely surrounds the Boroughs of Philipsburg and South Philipsburg.

The Borough of Snow Shoe is located in northern Centre County in central Pennsylvania. It is completely contained within the Township of Snow Shoe.

The Township of Snow Shoe is located in the northern part of Centre County in central Pennsylvania, approximately 25 miles north of State College. It is bordered by the Township of Burnside to the north, the Township of Curtin to the northeast, the Township of Boggs to the southeast, the Township of Union to the south, the Township of Rush to the southwest, and the Township of Cooper to the west.

The Borough of South Philipsburg is located in the western portion of Centre County in central Pennsylvania, approximately 25 miles northwest of State College. It is bordered by the Township of Rush to the south and east, the Borough of Philipsburg to the north, and the Borough of Chester Hill to the west.

The Township of Spring is located within the central portion of Centre County, Pennsylvania, approximately 7 miles northeast of State College and 70 miles northwest of the City of Harrisburg. It is bordered by Township of Boggs to the north, the Township of Benner to the west, the Township of Potter to the south, and the Townships of Walker and Marion to the east. The total land area contained within Spring, is 26 square miles (Department of Commerce, 1981).

The Borough of State College is located in the southern part of Centre County in central Pennsylvania. It is bordered by the Township of College to the north and east; and by the Township of Ferguson to the south and west.

The Township of Taylor is located in the southwest part of Centre County in central Pennsylvania. It is bordered by the Township of Rush to the, and the Township of Worth to the northeast, and the Township of Halfmoon to the southeast.

The Township of Union is located in the western part of Centre County in central Pennsylvania, approximately 12 miles north of State College. It is bordered by the Township of Snow Shoe to the northwest, the Township of Boggs to the northeast, the Township of Benner to the southeast, the Township of Patton to the south, the Township of Huston to the southwest, and the Township of Rush to the west.

The Borough of Unionville is located in the central part of Centre County in central Pennsylvania, approximately 11 miles north of State College. It is surrounded by the Township of Union.

The Township of Walker is located in the northeastern part of Centre County in central Pennsylvania, approximately 21 miles northeast of State College. It is bordered by the Township of Marion to the north, the Township of Porter the northeast, the Townships of Miles and Logan to the east, the Township of Gregg to the south, and the Township of Spring to the southwest.

The Township of Worth is located in the southwestern part of Centre County in central Pennsylvania, approximately 12 miles west of State College. It is bordered by the Township of Rush to the north and west, the Township of Huston to the northwest, the Township of Halfmoon to the southeast, and the Township of Taylor to the southwest.

2.3 Principal Flood Problems

Spring Creek is the major source of flooding within Bellefonte. Buffalo Run and Logan Branch cause more localized flood problems. The 1-percent-annual chance floodplain areas consist of relatively narrow corridors. During past major floods, Bellefonte has experienced damage to industries, businesses, and residences located in the narrow stream corridors. Gage records for the years 1911 to 1919 were taken on Spring Creek approximately 0.5 mile north of Bellefonte. During this period, the maximum flood occurred on March 15, 1912, and had a recurrence of 25-years. The June 1972 flood, with an approximate recurrence interval of 50-years, caused considerable damage.

The Borough of Milesburg, located at the confluence of Spring Creek with Bald Eagle Creek, has experienced severe damage from a number of past floods, most notably those of March 1963 and June 1972. The June 1972 flood had a recurrence interval of approximately the 1-percent-annual-chance flood on Bald Eagle Creek. Bald Eagle Creek flows generally in an easterly direction through the central portion of the municipality, while Spring Creek flows north through the south-central portion of the Borough to Bald Eagle Creek. Based on historic data and information from this study, Bald Eagle Creek and Spring Creek constitute the major sources of flooding problems within the Borough of Milesburg. The 1-percent-annual-chance floodplain areas of these streams

cover extensive areas of the Borough. This area is primarily developed for low density housing. A generating plant site owned by West Penn Power Company is also included within the 1-percent-annual-chance floodplain. Several commercial establishments within the borough are subject to inundation by the 1-percent-annual- chance flood.

The worst floods within the Township of Spring occurred in March 1966 and June 1972 (Department of the Interior, 1980). The 1936 flood was the most severe, having an estimated recurrence interval of the 0.2-percent-annual-chance on Spring Creek near Axemann. Spring Creek crested on March 18, 1936, and had a discharge of 8,400 cubic feet per second (cfs) and a maximum stage of 8.6 feet (from information provided by local residents).

In October 1940, a USGS gaging station was established at Spring Creek 2.5 miles upstream of the confluence of Logan Branch. Since 1940, the maximum discharge recorded was 5,410 cfs on June 23, 1972, when Spring Creek reached an elevation of 796.28 feet. The estimated recurrence interval for this flood was approximately 2-percent-annual-chance flood (Department of the Interior, 1980).

During Tropical Storm Agnes in 1972, the Bellfonte Sewage Treatment Plant, located along Spring Creek north of Bellefonte, reportedly had 5 feet of water. Problems in the Pleasant Gap area are compounded by numerous sinkholes which are believed to affect flood elevations and boundaries in this area. As in the case of Gap Run, surface water empties into these sinkholes and is carried away by underground channels.

Due to the flooding caused by Tropical Strom Agnes, the capacity of the sinkholes has decreased significantly, and flooding now occurs even during minor storms. The large sinkhole which absorbs Gap Run overflows into a ditch that runs behind the residences along Harrison Road and then under State Route 26. A number of homes have suffered basement flooding in the area of Harrison Road-College Avenue intersection.

Major floods cause localized inundation of structures along Bald Eagle Creek, Beech Creek, Beaver Branch, Big Hollow Run, Black Moshannon Creek, Cedar Run No. 2, Cherry Run, Cold Stream, Council Run, Dewitt Run, Elk Creek, Galbraith Gap Run, Halfmoon Creek, Laurel Run, Lick Run, Little Fishing Creek, Little Marsh Creek, Little Sandy Run, Marsh Creek, Moose Run, Moshannon Creek, Nittany Creek, North Fork Beech Creek, Oliver Run, Penns Creek, Pine Creek, Piney Run, Roaring Run, Slab Cabin Run, South Fork Beech Creek, Spring Creek, Spruce Creek, Thompson Run, Wallace Run, Walnut Run, and Wolf Run. Historic flood information as been shown on the flood profiles for Spring Creek.

Another problem area is Phantom Lake, which is a hydrologic phenomenon. The lake is significant because of its unpredictability. Due to geologic faults in the lake basin, which is located on both sides of State Route 64 approximately 2.5 miles northeast of Pleasant Gap, water appears and disappears rapidly. The lake has known to fill to a depth of 35 feet (1936), remain that way for up to 4 months, then disappear within days. The lake is situated in a limestone aquifer

and occurs as a result of the Karst topography that characterizes Pennsylvania. Since it is located in an agricultural area, it does not present a hazard to developed areas. It does however; create problems for motorists, as State Route 64 is made impassable by waters which are reported to reach as high as the top of the guard rails at times.

2.4 Flood Protection Measures

FEMA specifies that all levees must have a minimum of 3 foot freeboard against 1-percent annual chance flooding to be considered a safe flood protection structure. The levee located along Foster Joseph Sayers Lake (Blanchard Reservoir), on Bald Eagle Creek, has 10 feet of freeboard above the 1-percent-annual chance flood elevation, which does meet FEMA's requirements.

The Township of Benner has two levees of note. A 2,300-foot levee exists on Spring Creek at Fisherman's Paradise. Upstream of this levee exists another levee on Spring Creek located at the Benner Spring State Fish Hatchery. However, this levee has been de-accredited because it does not meet the FEMA 3-foot freeboard requirement. A flood control levee and floodwall is located along the east bank of Moshannon Creek, from a point approximately 1,450 feet downstream of the downstream corporate limits of the Borough of Philipsburg, to Maple Street. This portion of the channel has been straightened; however, these flood control structures have not yet been approved by FEMA, therefore, their flood control effects have not been considered in this study. Also, minor channel improvements have been made along Bald Eagle Creek.

Within the Township of Haines, there is a levee which varies in height from 5 to 10 feet and extends 1,800 feet along the northern side of Pine Creek in the vicinity of Woodward Cave provides protection from the estimated 10-percent-annual-chance recurrence interval, however, it is overtopped by the 2-,1-,and 0.2-percent annual chance floods. The dam on Pine Creek is only for purposes of low-flow impoundment. There are also non-structural measures being utilized to aid in the prevention of future flood damage. These are in the form of local land use regulations adopted from the code of Federal Regulations, Title 24, Chapter 10, FIA, Parts 1910.3A and 1910.3B, which controls building within areas that hive a high risk of flooding.

Within the Township of Spring, there is a ditch located along the hillside south of Pleasant Gap which diverts runoff from the southern portion of Pleasant Gap. The ditch is approximately 2 feet deep and 10 feet wide and was built by a local mining company. It cuts across the hillside at an approximate 45-degree angle and diverts water to the abandoned railroad right-of-way that once served a nearby quarry.

Within the Township of Walker, there is a short levee on the west bank of Little Fishing Creek between Legislative Route 14027 and a dam located approximately 280 feet downstream. FEMA specifies that all levees must have a minimum of 3 foot freeboard against the 1-percent-annual-chance flooding to be considered a safe flood protection structure. This levee does not meet FEMA's three-foot freeboard requirements.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent-annual-chance (100-year) 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 peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

Pre-countywide Analyses

Information on the hydrologic analyses for each of the previously printed FISs for communities within Centre County was complied, and is shown below and listed in Table 2 – Summary of Discharges.

Borough of Bellefonte

The discharges for Spring Creek and Logan Branch were obtained from the regional flood frequency method developed by the USACE. For recurrence intervals of 10-, 2- and 1-percent annual chance years, the rainfall intensity over a 24-hour period is 4 inches, 5 inches, and 6 inches respectively (Weather Bureau, 1961). For Spring Creek, the skew coefficient was modified to provide a reasonable recurrence interval for the 1972 flood at Sayers Dam. The discharges for both streams were modified to reflect the effect of the underlying limestone on the runoff coefficient.

Township of Benner

The flood-frequency discharge values for Spring Creek were determined by application of the U.S. Water Resources Council procedures to the peak discharges of record for stream gage No. 01546500, near Axemann (U.S. Water Resources Council, 1982). The resultant estimate of the 1-percent-annual chance discharge was time-weighted with regional estimate, determined with the regional regression equation presented in Water Resources investigations 82-81

(U.S. Department of the Interior, 1982), on the basis of the number of years of gage record and the years-of-record equivalency of the regional estimate. Discharge values at sites other than at the gage were transferred from the gage site by multiplying the gage at value times the drainage-area ratio raised to the 0.82 power.

Township of Boggs

The flood-frequency discharge values for Bald Eagle Creek were determined from the FIS from the Borough of Milesburg, Pennsylvania, by multiplying the study discharge value times the drainage-area ratio raised to the 0.80 power (U.S. Department of Housing and Urban Development, 1977).

The flood-frequency discharge values for Wallace Run, Little Marsh Creek, and Moose Run were determined utilizing regional regression equations developed in USGS Water Resources Investigations 82-21 (U.S. Department of the Interior, 1982).

The flood-frequency discharge values for Spring Creek were taken from FIS for the Township of Spring (FEMA, 1983). This value was confirmed by the FIS for Borough of Milesburg (U.S. Department of Housing and Urban Development, 1977).

Township of College

For the July 1989 FIS, the flood frequency discharge values for Spring Creek were determined by application of Bulletin 17B to the peak discharge of record for stream gage No. 01546500 near Axemann. The resultant estimate of the 1-percent-annual-chance discharge was determined with the regional regression equation presented in the USGS Water Resources Investigations 82-21 on the basis of the number of years of gage record and the years-of-record equivalency of the regional estimate (U.S. Department of the Interior, 1982). Discharge values at ungaged sites were computed by multiplying the discharge at the gage by the ratio of the drainage areas raised to the 0.80 power.

For the January 1992 FIS, the 1-percent-annual-chance discharge values for Slab Cabin Run, Thompson Run, and Walnut Run were determined using the Pennsylvania State University PSU-IV method (The Pennsylvania State University for Research on the Land and Water Resources, 1981). This technique was developed for specific use in estimating peak flood flows for ungaged sites on small streams in Pennsylvania. These PSU-IV discharge values were adjusted downward to achieve hydrologic compatibility with the extreme floods of record and the discharge values determined for Spring Creek, as described above.

The 1-percent-annual-chance discharge value for the Walnut Run/Thompson Run overflow area, which is the shallow flooding area between Walnut Run and Thompson Run, was determined through normal depth rating curves. The 1-percent-annual-chance discharge calculated was 230 cubic feet per second (cfs).

For the December 16, 2003 revision, the flood-frequency discharge values for Cedar Run No. 2 were determined utilizing regional regression equations developed in USGS Water Resources Investigations Report 00-4189 (U.S. Department of the Interior, 2000). The hydrologic analysis for Big Hollow Run came from the Township of Ferguson, a community contiguous to the Township of College.

Township of Curtin

The flood-frequency discharge values for Beech Creek and Marsh Creek were determined by application of Bulletin 17B to the peak discharge of record for gage No. 0154950 at Monument and gage no 01547700 at Blanchard (U.S. Department of the Interior, 1981). The resultant estimate of the 1-percent-annual-chance discharge was time weighted with a regional estimate, determined with the regional regression equation presented in USGS Water Resources investigations 82-21 on the basis of the number of years of gage record and the years-of-record equivalency of the regional estimate (U.S. Department of the Interior, 1986). Discharge values at sites other than at the gage were transformed from the gage site by multiplying the gage value times the drainage-area ratio raised to the 0.80 power.

Township of Ferguson

For the July 17, 1989 FIS, the flood-frequency discharge for Slab Cabin Run were determined using the regional regression equations developed in USGS Water Resources Investigations 82-21 (U.S. Department of the Interior, 1982). The Pennsylvania State University PSU-IV method confirmed the determination (The Pennsylvania State University, 1981).

In the December 17, 1991, FIS, flood-frequency discharge values for Slab Cabin Run and Big Hollow Run were determined utilizing regional relations of the PSU-IV method (The Pennsylvania State University, 1981). This technique was developed for specific use in estimating peak flood flows for ungaged sites on small streams in Pennsylvania. Computed discharges for Slab Cabin Run were reduced for part of the study to account for approximate storage effects of the two sink holes. Computed discharges for Big Hollow Run were greatly reduced, on the basis of flood history, to approximately allow for losses of flood flows to numerous sink holes and generally high infiltration along the channel.

For the December 16, 2003, revision, hydrologic analyses for streams studied by approximate methods were based on methods outlined in Water Resources Investigations report 86-4195 (U.S. Department of the Interior, 1986).

Township of Haines

For the study of Pine Creek and the Aaronsburg Tributary the hydrologic analysis was a modification of the U.S. Department of Agriculture, Soil Conservation Service (SCS) procedure designated in this study as “McSparran Tp, condition III,” which relates basin characteristics to stream flow characteristics (USACE, 1968).

Rainfall data were calculated using the Pennsylvania State University's "Design Procedures for Rainfall-Duration-Frequency in Pennsylvania" as prepared in August 1970, for the Department of Forests and Waters (Reich, McGinnis, and Kerr, 1970). These data were combined with basin characteristics such as drainage area, stream slop, 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.

For the study of Penns Creek, the hydrologic analysis was performed using data presented in the Hydrologic Engineering Center (HEC), "Regional Frequency Study, Upper Delaware and Hudson River Basins, New York District," as prepared by the USACE in November 1974 (U.S. Department of Commerce, 1941-1970).

Township of Harris

For the June 1989 FIS, the flood-frequency discharge values for Spring Creek and Galbraith Gap Run were determined utilizing regional regression equations developed in USGS Water-Resources Investigations 82-21 (U.S. Department of Interior, 1986). The PSU-IV method confirmed the determination (PSU, 1981). This technique was developed for specific use on estimating peak flood flows for ungaged sites on small streams in Pennsylvania.

For the July 1989 FIS, the flood-frequency discharge values for Slab Cabin Run were also determined utilizing regional regression equations developed in USGS Water-Resources Investigations 82-21 (U.S. Department of the Interior, 1986). The Pennsylvania State University PSU-IV method confirmed the determination (PSU, 1981). Computed discharges for Slab Cabin Run were reduced for part of the study to account for approximate storage effects of two sink holes in the Township of Ferguson.

For the December 16, 2003, revision, the flood-frequency discharge values for Cedar Run No. 2 were determined utilizing regional regression equations developed in USGS Water-Resources Investigations Report 00-4189 (U.S. Department of the Interior, 2000). The flood-frequency discharge values for Mackey's Run were determined using the ratio of the drainage area to the Cedar Run No. 2 drainage area multiplied by the flows on Cedar Run No. 2. The flood-frequency discharge values for Slab Cabin Run from the Township of Ferguson were added to this study, but no new analyses were performed.

Borough of Howard

The flood-frequency discharge values for Lick Run were determined utilizing the regional regression equations developed in the USGS Water Resources Investigations 82-21 (U.S. Department of the Interior, 1982). The PSU-IV method confirmed the determination (PSU, 1981).

Township of Howard

The flood-frequency discharge values for Lick Run were determined utilizing the regional regression equations developed in the USGS Water Resources Investigations 82-21 (U.S. Department of the Interior, 1982). The PSU-IV method confirmed the determination (PSU, 1981).

Township of Huston

The flood-frequency discharge values for Bald Eagle Creek and Laurel Run were determined utilizing the regional regression equations developed in the USGS Water Resources Investigations 82-21 (U.S. Department of the Interior, 1982).

Township of Liberty

The flood-frequency discharge values for Beech Creek and Marsh Creek were determined by application of the USGS Bulletin 17B procedures to the peak discharge of record for the stream gage Nos. 01547950 and 05147700 at Monument and Blanchard, respectively (U.S Department of the Interior, 1981). The resultant estimate of the 1-percent-annual-chance discharge was determined with the regional regression equation presented in Water Resources Investigations 82-21 on the bases of the number of years of gage record and the years-of-record equivalency of the regional estimate (U.S. Department of the Interior, 1982). Discharge values at sites other than that at these gage sites were transformed from the gage site by multiplying the gage value times the drainage area ratio raised to the 0.80 power.

Borough of Milesburg

Hydrologic analyses were carried out to establish the peak discharge frequency relationships for floods of the selected recurrence intervals for the streams studied in detail in the Borough of Milesburg. All flood discharges and profile starting elevations were determined by the Susquehanna River Basin Commission.

The discharges for Bald Eagle Creek and Spring Creek were obtained from the regional flood frequency method developed by the USACE with a skew coefficient modified to provide a reasonable recurrence interval for the 1972 flood at Sayres Dam. The discharges for Spring Creek were modified to reflect the effect of the limestone geologic formation found in the area.

Borough of Millheim

The flood-frequency discharge values for Elk Creek were determined utilizing regional regression equations developed in USGS Water-Resources Investigations 82-21 (U.S. Department of the Interior, 1982).

Township of Penn

The flood-frequency discharge values for Elk Creek and Pine Creek were determined utilizing regional regression equations developed in USGS Water-Resources Investigations 82-21 (U.S. Department of the Interior, 1982).

The flood-frequency discharge values for Penns Creek were determined by application of the USGS Bulletin 17B procedures to the peak discharge of record for the stream gage No. 01555000 at Penns Creek, Pennsylvania (U.S Department of the Interior, 1981). The resultant estimate of the 1-percent-annual-chance discharge was time-weighted with a regional estimate. This estimate was determined with the regional regression equation presented in Water Resources Investigations 82-21 on the bases of the number of years of gage record and the years-of-record equivalency of the regional estimate (U.S. Department of the Interior, 1982). Discharge values at sites other than at the gage were transformed from the gage site by multiplying the gage value times the drainage-area ratio raised to the 0.80 power.

Borough of Philipsburg

The flood-frequency discharge values for Moshannon Creek were determined by application of the procedures outlined in USGS Bulletin 17B to the annual peak discharges of record for the stream gage No. 01542000 at Osceola Mills (U.S Department of the Interior, 1981). Discharge values at sites other than the gage site were transformed from the gage site by multiplying the gage value by the drainage-area ratio raised to the 0.727 power. The flood-frequency discharge values for Cold Stream were determined using the regional regression equations developed in Water Resources Investigations 82-21 (U.S. Department of the Interior, 1982).

Borough of Port Matilda

The flood-frequency discharge values for Bald Eagle Creek and Laurel Run were determined utilizing regional regression equations developed in Water Resources Investigations 82-21 (U.S. Department of the Interior, 1982).

Township of Rush

The flood-frequency discharge values for Moshannon Creek were determined through application of Water Resources Council methods to the peak discharges of record for the stream gage No. 01542000 at Osceola Mills (U.S Department of the Interior, 1981). Discharge values at sites other than the gage location were transformed from the gage site by multiplying the gage value by the drainage-area ratio raised to the 0.727 power. The flood-frequency discharge value for Cold Stream was determined using regional regression equations developed in Water Resources Investigations 82-21 (U.S. Department of the Interior, 1982).

Township of Snow Shoe

The flood-frequency discharge values for North Fork Beech Creek, Piney Run, and Little Sandy Run were determined utilizing regional regression equations developed in USGS Water-Resources Investigations 82-21 (U.S. Department of

the Interior, 1982). The Pennsylvania State University PSU-IV method confirmed the determination (PSU, 1981).

Borough of South Philipsburg

The flood-frequency discharge values for Moshannon Creek were determined through application of Water Resources Council methods to the peak discharges of record for the stream gage No. 01542000 at Osceola Mills (U.S Department of the Interior, 1981). Discharge values at sites other than the gage location were transformed from the gage site by multiplying the gage value by the drainage-area ratio raised to the 0.727 power.

Township of Spring

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

Flood discharges for Spring Creek were obtained from the original FIS for the Township of Spring (U.S. Department of Housing and Urban Development, 1977). The discharges were determined by the regional flood-flow frequency method developed by the USACE. This method is based on a multiple regression analysis using the mean standard deviation and mapped skew coefficient. The mean equation adopted by the USACE is:

$$\text{Log } Q_m = C_m + 0.75 \log (A)$$

Where log Q_m is the mean logarithm of annual flood peaks, A is the drainage area in square miles and C_m is the map coefficient for mean log of annual peaks.

The standard deviation equation adopted by the USACE is:

$$S = C_s + 0.75 \log (A)$$

Where S is the standard deviation of the logarithms of the annual peaks, C_s is a map coefficient for standard deviation and A is the drainage area in square miles.

The skew coefficient was modified to provide a reasonable recurrence interval for the 1972 flood at Sayers Dam, which is located downstream in the Townships of Liberty and Howard. Discharge values reflect the effect of the limestone geologic formation found in the area.

Hydrologic analyses for Logan Branch and Gap Run, both ungaged streams, followed the PSU III regional regression model (The Pennsylvania State University, 1981). The method was revised with factors derived from Tropical Strom Agnes data. A correction factor was also used to account for the underlying limestone which comprises more than 50 percent of the watershed.

Borough of State College

The flood-frequency discharge values for Slab Cabin Run were determined using the Pennsylvania State University PSU-IV method (The Pennsylvania State University, 1981). This technique was developed for specific use in estimating peak flood flows for ungaged sites on small streams in Pennsylvania. These PSU-IV discharge values were adjusted downward to achieve hydrologic compatibility with a peak discharge-frequency analyses for the downstream gage (No. 01546500) on Spring Creek at Axemann (U.S. Department of the Interior, 1981 and 1982).

Township of Union

The flood-frequency discharge values for Bald Eagle Creek were determined by transforming the discharge value from the FIS for the Borough of Milesburg by multiplying that discharge value time the drainage-area ratio raised to the 0.80 power (FEMA, 1976).

Confirmation of the derived flood-frequency discharge values for Bald Eagle Creek were determined utilizing regional regression equations developed in USGS Water Resource Investigations 82-21 (U.S. Department of the Interior, 1982).

Borough of Unionville

The flood-frequency discharge values for Bald Eagle Creek were determined by transforming the discharge value from the FIS for the Borough of Milesburg by multiplying that discharge value times the drainage-area ratio raised to the 0.80 power (FEMA, 1976). Confirmation of the derived flood-frequency discharge values for Bald Eagle Creek were determined utilizing regional equations developed in USGS Water Resource Investigations 82-21 (U.S. Department of the Interior, 1982).

The flood-frequency for Dewitt Run was determined utilizing regional regression equations developed in USGS Water Resource Investigations 82-21 (U.S. Department of the Interior, 1982).

Township of Walker

In the original study, the flood-frequency discharge values for Little Fishing Creek and Roaring Run were determined utilizing regional regression equations developed in USGS Water Resource Investigations 82-21 (U.S. Department of the Interior, 1982). The PSU-IV method confirmed the determinations (PSU, 1981). This technique was developed for specific use in estimating peak flood flows for ungaged sites on small streams in Pennsylvania. The flood-frequency discharge values for Nittany Creek in the August 1990 revision were determined using the PSU-IV method (PSU, 1981).

Township of Worth

The flood-frequency discharge values for Bald Eagle Creek were determined utilizing regional regression equations developed in Water Resources

Investigations 82-21 (U.S. Department of the Interior, 1982). Peak discharge-drainage area relationships for Centre County are shown in.

For this revision, no new hydrologic analyses were performed.

Table 2 – 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
AARONSBURG TRIBUTARY					
At upstream limit of detailed study	0.43	417	576	641	805
At downstream limit of detailed study	2.35	563	842	986	1,267
BALD EAGLE CREEK					
At Interstate Route 80, Borough of Milesburg	274	-	-	23,270	-
At downstream corporate limits of Borough of Milesburg	270	-	-	23,000	-
At upstream corporate limits of Milesburg	121	-	-	14,000	-
At upstream corporate limits of Township of Boggs	96.7	-	-	11,700	-
At downstream corporate limits of Borough of Unionville	84.3	-	-	10,480	-
At confluence of Dicks Run	79.9	-	-	10,000	-
At point approximately 3,750 feet upstream of confluence of Dicks Run	70.3	-	-	9,070	-
Immediately downstream of Laurel Run	65.0	-	-	8,660	-
At Township Route 568	56.7	-	-	7,800	-
At U.S. Route 322	38.7	-	-	7,000	-
At downstream corporate limits of Borough of Port Matilda	30.5	-	-	5,800	-
At upstream corporate limits of Borough of Port Matilda	20.6	-	-	4,300	-
BEECH CREEK					
At State Route 150	172.0	-	-	14,900	-
Immediately upstream of confluence of Bitner Run	166.0	-	-	14,500	-
At State Route 364	160.0	-	-	14,100	-

- Data Not Available

Table 2 – 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
BEECH CREEK (continued)					
At downstream limit of detailed study of Township of Curtin	108.0	-	-	11,700	-
At Township Route 489 at Village of Orviston	102.0	-	-	11,200	-
BIG HOLLOW RUN					
At downstream corporate limits of Township of College	6.50	-	-	250	-
At Cherry Lane	6.06	-	-	200	-
At Corl Street	2.69	-	-	160	-
At Science Park Road	0.87	-	-	100	-
CEDAR RUN NO. 2					
At confluence with Spring Creek	18.05	831	783	1,067	2,083
COLD STREAM					
At downstream corporate limits of Borough of Philipsburg	21.6	-	-	4,380	-
At upstream corporate limits of Borough of Philipsburg	20.0	-	-	4,150	-
DEWITT RUN					
At confluence with Bald Eagle Creek	4.37	-	-	1,130	-
ELK CREEK					
At downstream corporate limits of Borough of Millheim	48.6	-	-	6,990	-
At upstream corporate limits of Borough of Millheim	47.2	-	-	6,850	-

- Data Not Available

Table 2 – 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
GALBRAITH GAP RUN					
At confluence with Spring Creek	5.24	-	-	1,000	-
GAP RUN					
At the downstream corporate limits of Township of Spring	6.4	709	1,181	1,378	1,823
In the vicinity of the State Route 26 and State Route 144 intersection (excluding drainage area contributing to diversion ditch south of Pleasant Gap)	4.6	567	945	1,103	1,458
LAUREL RUN NO. 1					
At the confluence with Bald Eagle Creek	9.38	-	-	2,400	-
At downstream corporate limits of Borough of Port Matilda	8.9			4,800	
Downstream of U.S. Route 322	5.7			3,100	
LICK RUN					
At downstream corporate limits of Borough of Howard	12.4	-	-	2,200	-
At downstream corporate limits of Township of Howard	11.6	-	-	2,100	-
LITTLE FISHING CREEK					
At downstream corporate limits of Township of Walker	41.4	-	-	5,600	-
Above Roaring Run	26.7	-	-	4,000	-
At Mingoville	6.19	-	-	1,200	-

- Data Not Available

Table 2 – 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
LITTLE MARSH CREEK					
At Legislative Route 14009 at Village of Yarnell	2.49	-	-	740	-
LITTLE SANDY RUN					
At Legislative Route 14003 in Village of Clarence	5.75	-	-	1,200	-
LOGAN BRANCH					
At the upstream corporate limits with the Borough of Bellefonte	19.1	1,625	2,709	3,161	4,180
At the confluence of the unnamed tributary at Axemann	16.3	1,436	2,394	2,793	3,694
MACKEY'S RUN					
At confluence with Cedar Run No. 2	7.58	349	783	1,067	2,083
MARSH CREEK					
At USGS gage No. 01547700	44.1	-	-	6,000	-
Immediately upstream of confluence of Big Run	37.1	-	-	5,290	-
At downstream corporate limits of Township of Curtin	34.9	-	-	5,050	-
At Township Route 488 above Village of Romola	28.5	-	-	4,350	-
MOOSE RUN					
At lower corporate limits of Township of Boggs	2.25	-	-	686	-
Above Day Top Road	1.80	-	-	583	-

- Data Not Available

Table 2 – 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
MOSHANNON CREEK					
At L.R. 864, at Village of Casanova	147	-	-	10,150	-
At the confluence of Onemile Run	131	-	-	9,330	-
At Ninth Street	103.7	-	-	7,870	-
At downstream corporate limits of Borough of Philipsburg	81.3	-	-	6,620	-
At upstream corporate limits of Borough of Philipsburg	80.0	-	-	6,590	-
At upstream corporate limits of Borough of South Philipsburg	78.0	-	-	6,400	-
At stream gage No. 01542000	68.8	-	-	5,840	-
NITTANY CREEK					
At downstream corporate limits of Township of Walker	7.98	-	-	1,390	-
At State Route 1005	6.02	-	-	1,130	-
At State Route 550	2.36	-	-	530	-
At State Route 64	1.72	-	-	420	-
NORTH FORK BEECH CREEK					
At Clarence Road in Village of Clarence	15.7	-	-	3,000	-
At Township Route 706	7.3	-	-	1,500	-
OLIVER RUN					
Downstream of U.S. Route 322	5.1			1,700	
PENNS CREEK					
At downstream limit of Township of Haines	204.7	9,087	16,300	20,431	33,000
At upstream limit of Township of Haines	186.3	8,515	15,400	19,249	31,100

- Data Not Available

Table 2 – 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
PENNS CREEK (continued)					
Below confluence with Pine Creek	183	-	-	18,500	-
At Legislative Route 873	89.3	-	-	10,400	-
PINE CREEK					
At confluence with Penns Creek	93.6	-	-	10,500	-
At downstream limit of Township of Haines	36.4	4,269	6,327	7,253	9,387
At upstream limit of Township of Haines	13.0	2,312	3,650	4,155	5,493
PINEY RUN					
At confluence with North Fork Beech Creek	2.45	-	-	600	-
ROARING RUN					
At confluence with Little Fishing Creek	14.7	-	-	2,400	-
SLAB CABIN CREEK					
At confluence with Spring Creek	21.5	-	-	2,550	-
At downstream corporate limits of Borough of State College	16.1	-	-	1,740	-
Above confluence of Thompson Run	15.8	-	-	1,810	-
At corporate limits below U.S. Business Route 322	15.2	-	-	1,670	-
At upstream corporate limits of Borough of State College	14.7	-	-	1,620	-
At upstream corporate limits of Township of College	8.86	-	-	1,120	-
At downstream corporate limits of Township of Ferguson	5.44	-	-	910	-
At Scott Road	4.24	-	-	800	-

- Data Not Available

Table 2 – 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
SLAB CABIN CREEK (continued)					
At State Routes 45 and 26, approximately 1.1 miles downstream of Pine Grove Mills	2.30	-	-	600	-
Below sink hole, approximately 700 feet downstream of center of Pine Grove Mills	1.50	-	-	350	-
At State Routes 45 and 26, at center of Pine Grove Mills	1.45	-	-	450	-
SPRING CREEK					
At upper corporate limits of Township of Boggs	150	4,140	7,080	8,520	12,900
At the upstream corporate limits with the Borough of Bellefonte	89.0	2,940	5,100	6,300	9,660
At downstream corporate limits of Township of Benner	89.0	-	-	4,540	-
At USGS gaging station 01546500	87.2	-	-	4,460	-
At downstream corporate limits of Township of College	59.0	-	-	3,010	-
At State Route 26	34.6	-	-	2,020	-
At Boalsburg Road	30.6	-	-	1,900	-
At upstream corporate limits of Township of College	13.0	-	-	1,300	-
At Boalsburg Pike Road	9.87	-	-	1,100	-
Above confluence with Galbraith Gap Run	4.63	-	-	400	-
THOMPSON RUN					
At confluence with Slab Cabin Run	3.92	-	-	1,070	-
At State Route 26	3.82	-	-	980	-

- Data Not Available

Table 2 – 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
THOMPSON RUN (continued)					
Above Walnut Run/Thompson Run overflow area	1.52	-	-	500	-
WALNUT RUN					
At confluence with Thompson Run	2.28	-	-	250	-
Above Walnut Run/Thompson Run overflow area	2.15	-	-	530	-
At upstream corporate limits of Township of College	2.01	-	-	500	-
WALLACE RUN					
At confluence with Bald Eagle Creek	23.0	-	-	3,720	-
At Legislative Route 14009 at Village of Runville	17.7	-	-	3,070	-

- Data Not Available

3.2 Hydraulic Analyses

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

Borough of Bellefonte

Water surface elevations of floods of the selected recurrence intervals for Spring Creek were computed through the use of the Corps of Engineers HEC-2 step-backwater computer program (USACE, 1976). These computations were started

using elevations for coincident flows on Bald Eagle Creek 2.0 miles downstream from the Borough of Bellefonte.

Cross-sections were located at regular intervals along the stream length and at significant changes in ground relief and land use or land cover. A total of 8 cross sections were used to analyze Spring Creek through Bellefonte. Ground elevations for cross sections were photogrammetrically obtained as the 1"=200' scale base maps were compiled. The channel bottom elevations for Spring Creek were taken from field surveyed profiles of the bottom with an interval distance of not more then 1,500 feet.

The Manning's "n" was evaluated from aerial and ground level photographs, topographic maps and on site field examinations. The "n" value was selected from tables published by Ven Te Chow (Chow, 1959) and the Bureau of Public Roads, based on channel conditions and overbank vegetation or land use. Within the Bellefonte Borough limits, the channel "n" value ranged between 0.044 and 0.052 and the overbank "n" value ranged between 0.050 and 0.090. The "n" values were increased in the downtown area to account for the effect of the buildings.

The effects of backwater flooding from Spring Creek were studied on Buffalo Run within Bellefonte, providing and extension of the 1- and 0.2-percent-annual chance floodplain boundaries into that area. The 1-percent-annual-chance flood elevations for Logan Branch were calculated at selected field surveyed cross sections using Manning's equation.

Township of Benner

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water surface elevations of floods of the selected recurrence intervals for Spring Creek were determined by adding 1-percent-annual-chance depths to streambed elevations. Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin area and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985).

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. The roughness coefficients for the channel range from 0.030 to 0.037, and for the overbank areas from 0.025 to 0.075.

Township of Boggs

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water Surface elevations of floods of the selected recurrence intervals for the reaches of detailed study on Bald Eagle Creek, Wallace Run, Little Marsh Creek, and Moose Run were determined by adding the 1-percent-annual-chance depths to streambed elevations. Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin area and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986 and National Technical Information Service, 1985).

For Spring Creek, the water-surface elevations at the corporate limits were taken directly from the FIS for the Borough of Milesburg and the Township of Spring (U.S. Department of Housing and Urban Development, 1977; FEMA, 1988). Flow over the dam elevations are a slight adjustment of the actual computations made after the flood of June 23, 1972. These minor adjustments were necessary to raise the discharge by approximately 5 percent in order to match the discharge used in adjacent studies.

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. The channel "n" values ranged from 0.031 to 0.037, and the overbank "n" values ranged from 0.035 to 0.085.

Township of College

Cross sections for flooding sources studied by detailed methods were obtained from field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

For the December 16, 2003, revision, cross sections along Cedar Run No. 2 were developed from community supplied topographic data with a contour interval of 5 feet in GIS format. A field survey was initiated to obtain bridge, culvert, and channel elevation data and structural geometry for Cedar Run No. 2, but was halted due to residential opposition. Therefore, most bridge, culvert, and channel data along Cedar Run No. 2 was estimated from field observations and pictures.

For the July 1989 and January 1992 revision, water-surface elevations of floods of the selected recurrence intervals for Spring Creek, from State Route 26 to a point approximately 7,935 feet upstream; Slab Cabin Run, from its confluence with Spring Creek to a point approximately 17,395 feet upstream; and Thompson Run, from its confluence with Slab Cabin Run to a point approximately 4,050

feet upstream were computed by modeling channel and bridge hydraulics with the USGS WSPRO step-backwater computer program (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985).

For Spring Creek, from the downstream corporate limits to a point approximately 2,880 feet upstream of Houserville Road from Puddintown Road to State Route 26, and from the abandoned CONRAIL bridge near the Village of Lemont to the upstream corporate limits; the remaining portions of Thompson Run; and the entire length of Walnut Run, normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from depths computed for adjoining reaches by step-backwater analyses and the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin area and 1-percent-annual-chance within channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985; U.S. Department of the Interior, 1968). Shallow flooding resulting from the overflow of Walnut Run to Thompson Run was computed using normal depth calculations.

For the December 16, 2003, revision, water surface elevations of floods of the selected recurrence intervals for Cedar Run No. 2 were computed using the USACE HEC-RAS step-backwater computer program (USACE, September 1998). Starting water surface elevations for Cedar Run No. 2 were calculated using the slope/area method. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. The following tabulations show the channel and overbank "n" values for the streams studied by detailed methods.

Table 3 – Manning's "n" Values for Township of College

Stream	Channel "n"	Overbank "n"
Spring Creek	0.030-0.036	0.025-0.150
Slab Cabin Run	0.020-0.041	0.042-0.150
Thompson Run	0.034-0.042	0.065-0.085
Cedar Run No. 2	0.04	0.035-0.12
Big Hollow Run	0.025-0.050	0.045
Walnut Run	0.034-0.042	0.065-0.085

Township of Curtin

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of

these structures. All bridges, dams and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence intervals for Beech Creek and Marsh Creek were determined by adding the 1-percent-annual-chance depths to streambed elevations. Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1981). This relationship was developed by means of regional regression analyses of basin area and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985).

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. For the streams studied in detailed methods, the channel "n" values ranged from 0.031 to 0.041, and the overbank "n" values ranged from 0.041 to 0.085.

Township of Ferguson

Cross sections for the flooding sources studied by detailed methods were obtained by field surveys and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water Surface elevations of floods of the selected recurrence intervals for Slab Cabin Run and Big Hollow Run were determined by adding the 1-percent-annual-chance depths to streambed elevations. Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin area and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985).

Roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. For Slab Cabin Run, the channel "n" values ranged from 0.032 to 0.044, and the overbank "n" values ranged from 0.032 to 0.063. For Big Hollow Run, the channel "n" values ranged from 0.025 to 0.050, and the overbank "n" value was 0.045.

For this revision, normal depth calculations for streams studied by approximate methods were based on methods outlined in Water Resources Investigations report 86-4195 (U.S. Department of the Interior, 1986). Cross section data used

to determine approximate floodplain boundaries was based on updated topographic maps (The Pennsylvania State University, 1995).

Township of Haines

Flood water surface elevations of the selected recurrence intervals were computed through use of the USACE HEC-2 step-backwater computer program (USACE, 1976). Composite cross sections for the backwater analyses of the three creeks were obtained from aerial photographs flown in April 1975, at a negative scale of 1:14,000 feet; the below-water sections were obtained by field measurement. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Channel roughness factors (Manning's "n"), used in the hydraulic computations, were chosen by engineering judgment and based on field observations of the streams and floodplain areas. Roughness values for the main channel of Pine Creek range from 0.025 to 0.045 with overbank roughness values ranging from 0.060 to 0.085 for all floods. Roughness values for the main channel of Penns Creek range from 0.025 to 0.045 with overbank roughness values ranging from 0.026 to 0.080 for all floods. Roughness values for both the main channel and the overbank of the Aaronsburg Tributary range from 0.060 to 0.080.

Those parts of Aaronsburg Tributary and Pine Creek not studied in detail as well as Tributaries Number 1 and Number 2 of Pine Run, Quarry Road Run Tributary and its tributary were studied by approximate method.

Township of Harris

Cross sections along Spring Creek and Galbraith Gap Run were obtained from field surveys. All bridges, dams, and culverts along Spring Creek and Galbraith Run were field surveyed to obtain elevation data and structural geometry.

Cross sections along Cedar Run No. 2 and Mackey's Run were developed from community supplied topographic data with a contour interval of 5 feet in GIS format. A field survey was initiated to obtain bridge, culvert, and channel-elevation data and structural geometry for Cedar Run No. 2 and Mackey's Run, but was never completed. Therefore, most bridge, culvert, and channel data along Cedar Run No. 2 and Mackey's Run was estimated from field observations and pictures.

For the June 1989 FIS water-surface elevations of floods of the selected recurrence intervals for Spring Creek and Galbraith Gap Run were determined by adding the 1-percent-annual-chance depths to streambed elevations. Normal depths of flooding for the 1-percent-anuual-chance recurrence interval were estimated from the regional relationship between drainage areas and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means on regional regression analyses of basin areas and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts

(U.S. Department of Transportation, 1986; National technical Information Service, 1985; U.S. Department of the Interior, 1968).

In the January 1996 FIS for the Township of Ferguson, water-surface elevations of floods of the selected recurrence intervals for Slab Cabin Run were also determined by adding 1-percent-annual-chance depths to streambed elevations. Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin areas and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Department of Transportation, 1986; National Technical Information Service, 1985; U.S. Department of the Interior, 1968).

For the December 16, 2003, revision, water-surface elevations of floods of the selected recurrence intervals for Cedar Run No. 2 and Mackey's Run were computed using USACE HEC-RAS step-backwater computer program (USACE, September, 1998). Starting water-surface elevations for Cedar Run were calculated using the slope/area method. Starting water-surface elevations for Mackey's Run were determined by the corresponding elevation of Cedar Run assuming coincident peak flooding. The water-surface elevations for the portion of Slab Cabin Run previously shown in the Township of Ferguson were added to the FIS, but no new analyses were performed. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and field inspection of the floodplain areas. The following tabulations shows the channel and overbank "n" values for the streams studied by detailed methods:

Table 4 – Manning's "n" Values for Township of Harris

Stream	Channel "n"	Overbank "n"
Spring Creek	0.031-0.036	0.031-0.067
Galbraith Gap Run	0.031-0.036	0.031-0.067
Cedar Run No. 2	0.04	0.035-0.12
Mackey's Run	0.04	0.035-0.12
Slab Cabin Run	0.032-0.044	0.032-0.063

Borough of Howard

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community ere surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence interval for Lick Run were computed by modeling channel and bridge hydraulics with the USGS WSPRO step-backwater computer program (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985). The starting water-surface elevation was determined from the normal depth of flooding for the 1-percent-annual-chance recurrence interval, which was estimated from the regional relationship between drainage area and flood depth prepared by means of regional regression analyses of basin areas and 1-percent-annual-chance within-channel depths observed at stream gages (U.S. Department of the Interior, 1986).

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of floodplain areas. The roughness coefficients for the channel range from 0.034 to 0.037, and for the overbank areas from 0.033 to 0.065.

Township of Howard

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence interval for Lick Run were determined by adding 1-percent-annual-chance depths to streambed elevations. The starting water-surface elevation was determined for the upstream corporate limits of the Borough of Howard.

Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin areas and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985).

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. The channel "n" values ranged from 0.033 to 0.035, and the overbank "n" values ranged from 0.035 to 0.045.

Township of Huston

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence interval for Bald Eagle Creek and Laurel Run were determined by adding 1-percent-annual chance depths to streambed elevations.

Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin areas and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985).

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. The channel "n" values ranged from 0.031 to 0.035, and the overbank "n" values ranged from 0.035 to 0.045.

Township of Liberty

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence interval for Beech Creek, from approximately 140 feet downstream of State Route 150 to a point approximately 1,545 feet upstream, were computed by modeling channel and bridge hydraulics with the USGS WSPRO step-backwater computer program (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985).

For Beech Creek, from approximately 10,960 to 36,620 feet above its confluence with Bald Eagle Creek, and for Marsh Creek from approximately 5,990 to 24,570 feet above its confluence with Bald Eagle Creek, normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin areas and 1-percent-annual-chance within-channel depth observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985).

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. For Beech and Marsh Creeks, the channel "n" values ranged from 0.030 to 0.038, and the overbank "n" values ranged from 0.035 to 0.090.

Borough of Milesburg

The flood profiles were calculated using the USACE HEC-2 water surface profiles computer program (USACE, 1973). Cross sections were located at regular intervals along the stream length and at significant changes in ground relief and land use or land cover. A total of seven cross sections were used to analyze Bald Eagle Creek and five cross sections were used to analyze Spring Creek through Milesburg. Ground elevations for the cross sections were photogrammetrically obtained as the 1”=200’ scale base maps were compiled. The channel bottom elevations for Bald Eagle Creek and Spring Creek were taken from field surveyed profiles of the bottom with and interval distance of not more than 1,500 feet.

Reach lengths for the channel were measured along the centerline of the channel between sections as scaled from the 1”=200’ scale mapping or stream bottom profiles. The overbank reach lengths were scaled from the 1”=200’ scale mapping measured along the approximate centerline of effective area.

Manning’s “n” was evaluated from aerial and ground level photographs, topographic maps, and on-site field examinations. The “n” value was selected from tables published by Ven Te Chow and the Bureau of Public Roads, (Chow, 1972) based on channel conditions and overbank vegetation or land use.

The backwater computations for Bald Eagle Creek were started using the slope-area method at the first stream section located about 1.2 miles downstream from Milesburg Borough. Within the Milesburg Borough limits, the channel “n” value ranged between 0.032 and 0.047 and the overbank “n” value ranged from 0.108 to 0.155. The “n” values were increased in the downstream area to account for the effect of the buildings.

The hydraulic model was tested and the “n” values adjusted within an acceptable range to best fit known highwater marks an/or elevations at gaging stations for the Bald Eagle Creek through Milesburg Borough. All gaging station elevations were determined by the Susquehanna River Basin Commission based on established rating curves. Highwater marks obtained by the USGS for the June 1972 flood were used. The 1972 flood has a recurrence interval of approximately 100 years for this section of Bald Eagle Creek.

When a satisfactory model was achieved, the water surface profiles were computed for floods with recurrence intervals of 10-, 2-, 1-, and 0.2-percent-annual chance flood.

The procedure for Spring Creek was essentially the same as described above. The entire creek from the mouth to the western boundary of Spring Township was studied. Profiles were started using elevations computed for Bald Eagle Creek. Channel “n” value was 0.042 and the overbank “n” values ranged between 0.055 and 0.077. The 1972 Spring Creek flood has a recurrence interval of approximately 50 years.

Borough of Millheim

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence interval for Elk Creek were determined by adding the 1-percent-annual-chance depths to streambed elevations.

Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin areas and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985).

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. For Elk Creek, the channel "n" values ranged from 0.030 to 0.045, and the overbank "n" values ranged from 0.040 to 0.052.

Township of Penn

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence interval for Elk Creek, Pine Creek, and Penns Creek were determined by adding the 1-percent-annual-chance depths to streambed elevations. Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin areas and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985).

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. The channel "n" values ranged from 0.030 to 0.045, and the overbank "n" values ranged from 0.040 to 0.052.

Borough of Philipsburg

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence interval for Moshannon Creek and Cold Stream were computed by modeling channel and bridge hydraulics with the USGS WSPRO step-backwater computer program by adding the 1-percent-annual-chance depths to streambed elevations (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985). Flood profiles were drawn showing the computed water-surface elevations for floods of the selected recurrence interval. The starting water-surface elevation for Moshannon Creek was determined by normal depth methods at a point approximately 23,000 feet downstream of the corporate limits (U.S. Department of the Interior, 1986). The starting water-surface elevation for Cold Stream was the backwater elevation for the 1-percent-annual-chance flood on Moshannon Creek, which was determined by the same methods.

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. The channel "n" values for the streams studied by detailed methods ranged from 0.030 to 0.036, and the overbank "n" values ranged from 0.036 to 0.120.

Borough of Port Matilda

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence interval for Bald Eagle Creek and Laurel Run were computed by adding the 1-percent-annual-chance depths to streambed elevations. Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin areas and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985).

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. For Bald Eagle Creek and Laurel Run, the channel "n" values ranged from 0.027 to 0.036, and the overbank "n" values ranged from 0.036 to 0.065.

Township of Rush

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence interval for Moshannon Creek, from a point approximately 13 miles upstream of the downstream corporate limits to the Borough of Philipsburg, and from a point approximately 24.8 miles upstream of the downstream corporate limits to a point approximately 1.0 mile upstream; and for Cold Stream, from a point approximately 0.4 mile upstream of its confluence with Moshannon Creek to a point approximately 0.9 mile upstream, were computed by modeling channel and bridge hydraulics with the USGS WSPRO step-backwater computer program (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985). Starting water-surface elevations were based on normal depths of flooding that were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin areas and 1-percent-annual-chance within-channel depths observed at stream gages. For Moshannon Creek, from a point approximately 7.8 miles upstream of the downstream corporate limits to a point approximately 1.3 miles upstream, and from a point approximately 24.2 miles upstream of the downstream corporate limits to a point approximately 0.6 mile upstream; and Cold Stream, from its confluence with Moshannon Creek to a point approximately 0.4 mile upstream, and from a point approximately 2.1 miles upstream of its confluence with Moshannon Creek to a point approximately 0.7 mile upstream, normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth (U.S. Department of the Interior, 1986). Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from bridges (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985). Flood Profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. For the streams studied in detailed methods, channel "n" values ranged from 0.030 to 0.045, and the overbank "n" values ranged from 0.045 to 0.100.

Township of Snow Shoe

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence interval for North Fork Beech Creek from a point approximately 2,500 feet downstream of Clarence Road to a point approximately 2,630 feet further upstream were computed by modeling channel and bridge hydraulics with USGS WSPRO step-backwater computer program (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985).

For the remaining detailed portion of North Fork Beech Creek, and Piney Run and Little Sandy Run, flood elevations were determined by adding 1-percent-annual-chance depths to streambed elevations. Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin areas and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985; U.S. Department of the Interior, 1968).

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. For the streams studied by detailed methods, the channel "n" values ranged from 0.028 to 0.043, and the overbank "n" values ranged from 0.037 to 0.095.

Borough of South Philipsburg

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence interval were computed by modeling channel and bridge hydraulics with USGS WSPRO step-backwater computer program (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence interval. The starting water-surface elevation for Moshannon Creek was taken from the FIS for the Borough of Philipsburg (FEMA, 1990). This elevation was determined for a point approximately 817 feet downstream of the Philipsburg-South Philipsburg corporate limits.

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. The channel "n" values ranged from 0.031 to 0.036, and the overbank "n" values ranged from 0.046 to 0.090.

Township of Spring

Cross sections for the backwater analyses were obtained from aerial photographs at a scale of 1”= 800’ and mapped on topographic maps at a scale of 1”= 400’ (Air Photographics, Inc., 1979; Pace Aerial Surveys, 1980). The below-water sections were obtained by field measurement. All bridges and culverts were field surveyed to obtain elevation data and structural geometry.

Channel roughness factors (Manning’s “n”) used in the hydraulic computations were chosen by engineering judgment and based on field observations of the stream and floodplain areas. The channel “n” values for Spring Creek ranged from 0.044 to 0.052, and the overbank “n” values ranged from 0.045 to 0.060. For Logan Branch, the channel “n” values ranged from 0.035 to 0.050, and the overbank “n: values ranged from 0.030 to 0.150. The channel “n” values for Gap Run ranged from 0.030 to 0.100, and the overbank “n” values ranged from 0.030 to 0.150.

Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (USACE, 1973). Starting water-surface elevations for Spring Creek were obtained from the previous FIS for the Township of Spring (U.S. Department of Housing and Urban Development, Federal Insurance Administration, 1977). Starting water-surface elevations for Logan Branch and Gap Run were determined using a known elevation just above the confluence with Spring Creek and Logan Branch, respectively. The known elevation was computed using a stage-discharge curve and Manning’s equation.

A profile base line was added to the portion of Gap Run where the stream flows underground and indicated where the HEC-2 program was modeled. Culverts along Main Street downstream of Conrail carry some of the flood flows, however, some flow does follow Main Street, and this is reflected by the profile base line.

Borough of State College

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence intervals were computed using the USGS WSPRO step-backwater computer program (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence interval. The starting water-surface elevation was taken from a similar hydraulic analysis for the FIS for the Township of College (FEMA, 1989).

Channel roughness factors (Manning’s “n”) used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the

floodplain areas. The channel "n" values ranged from 0.030 to 0.040, and the overbank "n" values ranged from 0.028 to 0.200.

Township of Union

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence intervals for Bald Eagle Creek were determined by adding the 1-percent-annual-chance depths to streambed elevations.

Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin areas and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985).

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. The channel "n" values ranged from 0.030 to 0.034, and the overbank "n" values ranged from 0.042 to 0.076.

Borough of Unionville

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence intervals for Bald Eagle Creek and Dewitt Run were computed by adding the 1-percent-annual-chance depths to streambed elevations. Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin areas and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985).

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. For Bald Eagle Creek and Dewitt Run, the channel "n" values

ranged from 0.030 to 0.035, and the overbank "n" values ranged from 0.038 to 0.076.

Township of Walker

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence intervals for Little Fishing Creek, Roaring Run, and Nittany Creek were determined by adding the 1-percent-annual-chance depths to streambed elevations. Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin areas and 1-percent-annual-chance within-channel depths observed at stream gages. Depths were adjusted on the basis of hydraulic calculations to account for increased depth due to backwater from hydraulic structures, such as bridges and culverts (U.S. Federal Highway Administration, 1986; National Technical Information Service, 1985; U.S. Department of the Interior, 1967). Starting water-surface elevations were determined using normal depth calculations.

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of engineering judgment and field inspection of the floodplain areas. The roughness coefficients for the channel ranged from 0.033 to 0.047, and the overbank "n" values ranged from 0.053 to 0.070.

Township of Worth

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the community were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence intervals for Bald Eagle Creek were computed by adding the 1-percent-annual-chance depths to streambed elevations. Normal depths of flooding for the 1-percent-annual-chance recurrence interval were estimated from the regional relationship between drainage area and flood depth prepared by the USGS (U.S. Department of the Interior, 1986). This relationship was developed by means of regional regression analyses of basin areas and 1-percent-annual-chance within-channel depths observed at stream gages.

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

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

For FIRM panels dated July 16, 2004, or later, qualifying bench marks within a given jurisdiction that are cataloged by the National Geodetic Survey (NGS) and entered into the National Spatial Reference System (NSRS) as First or Second Order Vertical and have a vertical stability classification of A, B, or C are shown and labeled on the FIRM with their 6-character NSRS Permanent Identifier.

Bench marks cataloged by the NGS and entered into the NSRS vary widely in vertical stability classification. NSRS vertical stability classifications are as follows:

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

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

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

For this revision, no new hydraulic analyses were performed.

3.3 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD). With the completion of the North American Vertical Datum of 1988 (NAVD), many FIS reports and FIRMs are now prepared using NAVD as the referenced vertical datum. The datum conversion factor from NGVD to NAVD in Centre County is -0.575 feet.

Flood elevations shown in this FIS report and on the FIRM are referenced to the NAVD. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the NGVD and NAVD, visit the National Geodetic Survey

website at 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 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, Floodway Data Table, and Summary of Stillwater Elevations 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 each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24,000, with a contour interval of 20 feet (U.S. Department of the Interior, 1971).

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the Flood Insurance Rate Map (Exhibit 2). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- 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 this revision, the 1-percent-annual-chance floodplain on the landward side of the de-accredited levee on Spring Creek was mapped using the effective 1-percent-annual-chance elevations to reflect the de-accreditation of the levee.

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 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this FIS report and on the FIRM 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 have been tabulated for selected cross sections (Table 5, Floodway Data Table). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

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

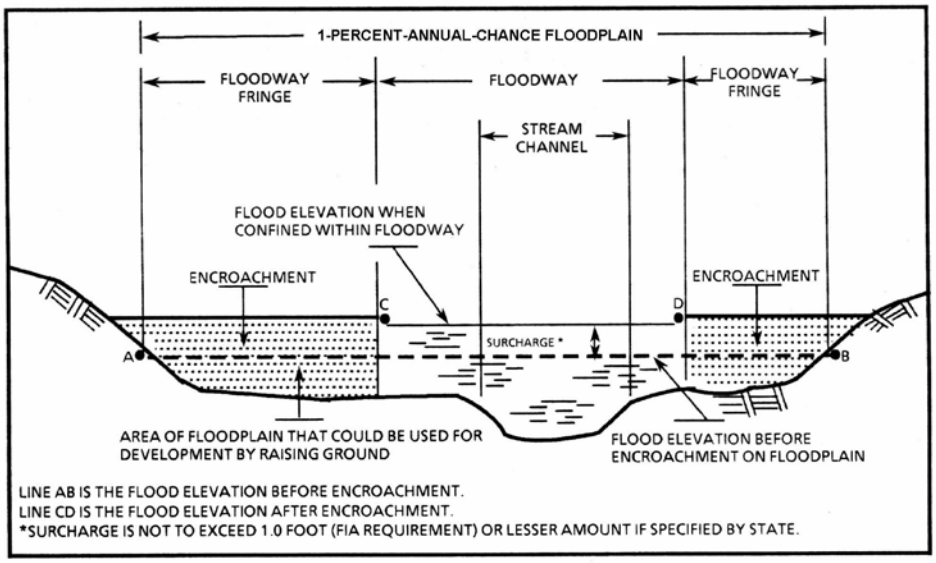

Figure 1 - Floodway Schematic

Table 2 – Floodway Data Table

Insert Table 3

5.0 INSURANCE APPLICATIONS

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

Zone A

Zone A is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base (1-percent-annual-chance) Flood Elevations (BFE) 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 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 X

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

6.0 FLOOD INSURANCE RATE MAP

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

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

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

The countywide FIRM presents flooding information for the entire geographic area of Centre County. Previously, FIRMs were prepared for each incorporated community of the County identified as flood-prone. This countywide FIRM also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps, where applicable. Historical data relating to the maps prepared for each community are presented in Table 6, Community Map History.

7.0 OTHER STUDIES

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

8.0 LOCATION OF DATA

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

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDAY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
Bellefonte, Borough of	June 7, 1974	None	February 2, 1977	None
Benner, Township of	November 1, 1974	August 1, 1980	June 5, 1989	None
Boggs, Township of	August 13, 1974	October 10, 1975	August 15, 1989	December 15, 1990
Burnside, Borough of	November 8, 1974	November 7,1980	January 17, 1986	None
Centre Hall, Borough of[1]	N/A	N/A	N/A	N/A
College, Township of	July 26, 1974	September 12, 1975	July 4, 1989	January 2, 1992 December 16, 2003
Curtin, Township of	December 20, 1974	July 9, 1976	June 5, 1989	None
Ferguson, Township of	July 26, 1974	October 15, 1976	July 17, 1989	December 17, 1991 January 5, 1996 December 16, 2003
Gregg, Township of	October 18, 1974	September 10, 1976	November 2, 1984	None
Haines, Township of	August 9, 1974	None	August 1, 1978	None
Halfmoon, Township of	January 24, 1975	None	October 13, 1978	None
Harris, Township of	June 28, 1974	December 12, 1975	June 5, 1989	December 16, 2003

[1] No Special Flood Hazard Areas Identified

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CENTRE COUNTY, PA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDAY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
Howard, Borough of	May 31, 1974	May 14, 1976 October 24, 1980	August 3, 1989	None
Howard, Township of	November 22, 1974	January 28, 1983	August 3, 1989	None
Huston, Township of	September 6, 1974	September 24, 1976	June 5, 1989	None
Liberty, Township of	September 13, 1974	None	June 5, 1989	None
Marion, Township of	November 8, 1974	None	November 2, 1984	None
Miles, Township of	September 13, 1974	June 25, 1976 October 24, 1980	December 4, 1985	None
Milesburg, Borough of	December 28, 1973	None	February 2, 1977	None
Millheim, Borough of	May 10, 1974	June 4, 1976	June 5, 1989	None
Patton, Township of	August 2, 1974	February 6, 1976	February 19, 1986	None
Penn, Township of	December 13, 1974	October 24, 1980	October 17, 1989	None
Philipsburg, Borough of	December 28, 1973	July 23, 1976	August 15, 1990	None

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CENTRE COUNTY, PA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDAY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
Port Matilda, Borough of	January 16, 1974	October 3, 1975 July 23, 1976	November 3, 1989	None
Potter, Township of	November 8, 1974	December 19, 1980	February 5, 1986	None
Rush, Township of	December 20, 1974	October 24, 1980	November 16, 1990	None
Snow Shoe, Borough of	November 8, 1974	None	August 10, 1979	None
Snow Shoe, Township of	September 13, 1974	August 13, 1976	June 19, 1989	None
Spring, Township of	June 21, 1974	June 25, 1976	April 15, 1977	October 18, 1983
State College, Borough of	June 14, 1974	February 20, 1976	June 30, 1976	September 30, 1992
Taylor, Township of	December 20, 1974	May 28, 1976	January 3, 1986	None
Union, Township of	November 8, 1974	November 14, 1980	July 17, 1989	None
Unionville, Borough of	August 9, 1974	July 30, 1976 April 4, 1984	November 3, 1989	None
Walker, Township of	November 15, 1974	None	July 17, 1989	August 15, 1990
Worth, Township of	December 27, 1974	July 4, 1980	August 15, 1989	None

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

CENTRE COUNTY, PA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

9.0 BIBLIOGRAPHY AND REFERENCES

Air Photographics, Inc. Aerial Photographs, Scale 1"=800': Township of Spring, Centre County, Pennsylvania, April 1979.

Beard, Leo. R., Statistical Methods in Hydrology, U.S. Army Corps of Engineers, Scaramento, California, January 1962.

Centre Regional Planning Agency, Centre Region Council of Governments. GIS map of Cedar Run drainage area, contour interval 5 feet. State College, Pennsylvania.

Chow, V. T., Handbook of Applied Hydrology, McGraw-Hill Book Company, 1964.

Chow, V. T., Open Channel Hydraulics, New York, New York, McGraw Hill Book Company, 1959.

Commonwealth of Pennsylvania, Department of Environmenal Resources, Bulletin No. 9, Hydrologic Data of the June 1972 Flood in Pennsylvania, Harrisburg, Pennsylvania, August 1974.

Department of Forests and Waters, Commonwealth of Pennsylvania, "Pennsylvania Gazetteer of Streams, Part 1, "Water Resources Bulletin No. 6, December 1970.

Department of Property and Supplies, Commonwealth of Pennsylvania, "Pennsylvania Manual 1970-71," Volume 100, 1971.

Federal Emergency Management Agency, Flood Insurance Administration, Flood Hazard Boundary Map, Township of Penn, Centre County, Pennsylvania, Washington D.C., October 24, 1980.

Federal Emergency Management Agency, Flood Insurance Study, Township of Benner, Centre County, Pennsylvania, Washington D.C., June 5, 1989.

Federal Emergency Management Agency, Flood Insurance Study, Township of Boggs, Centre County, Pennsylvania, Washington D.C., December 15, 1990.

Federal Emergency Management Agency, Flood Insurance Study, Township of College, Centre County, Pennsylvania, Washington D.C., December 16, 2003.

Federal Emergency Management Agency, Flood Insurance Study, Township of College, Centre County, Pennsylvania, Washington D.C., July 4, 1989.

Federal Emergency Management Agency, Flood Insurance Study, Township of Curtin, Centre County, Pennsylvania, Washington D.C., June 5, 1989.

Federal Emergency Management Agency, Flood Insurance Study, Township of Ferguson, Centre County, Pennsylvania, Washington D.C., December 16, 2003.

Federal Emergency Management Agency, Flood Insurance Study, Township of Harris, Centre County, Pennsylvania, Washington D.C., December 16, 2003.

Federal Emergency Management Agency, Flood Insurance Study, Borough of Howard, Centre County, Pennsylvania, Washington D.C., August 3, 1989.

Federal Emergency Management Agency, Flood Insurance Study, Township of Howard, Centre County, Pennsylvania, Washington D.C., August 3, 1989.

Federal Emergency Management Agency, Flood Insurance Study, Township of Huston, Centre County, Pennsylvania, Washington D.C., June 5, 1989.

Federal Emergency Management Agency, Flood Insurance Study, Township of Liberty, Centre County, Pennsylvania, Washington D.C., June 5, 1989.

Federal Emergency Management Agency, Flood Insurance Study, Borough of Millheim, Centre County, Pennsylvania, Washington D.C., June 5, 1989.

Federal Emergency Management Agency, Flood Insurance Study, Township of Penn, Centre County, Pennsylvania, Washington D.C., October 17, 1989.

Federal Emergency Management Agency, Flood Insurance Study, Borough of Philipsburg, Centre County, Pennsylvania, Washington D.C., August 15, 1990.

Federal Emergency Management Agency, Flood Insurance Study, Borough of Port Matilda, Centre County, Pennsylvania, Washington D.C., November 3, 1989.

Federal Emergency Management Agency, Flood Insurance Study, Township of Rush, Centre County, Pennsylvania, Washington D.C., November 16, 1990.

Federal Emergency Management Agency, Flood Insurance Study, Township of Snow Shoe, Centre County, Pennsylvania, Washington D.C., June 19, 1989.

Federal Emergency Management Agency, Flood Insurance Study, Borough South Philipsburg, Centre County, Pennsylvania, Washington D.C., September 5, 1990.

Federal Emergency Management Agency, Flood Insurance Study, Township of Spring, Centre County, Pennsylvania, Washington D.C., October 13, 1983.

Federal Emergency Management Agency, Flood Insurance Study, Borough of State College, Centre County, Pennsylvania, Washington D.C., September 30, 1992.

Federal Emergency Management Agency, Flood Insurance Study, Township of Union, Centre County, Pennsylvania, Washington D.C., July 17, 1989.

Federal Emergency Management Agency, Flood Insurance Study, Borough of Unionville, Centre County, Pennsylvania, Washington D.C., November 3, 1989.

Federal Emergency Management Agency, Flood Insurance Study, Borough of Walker, Centre County, Pennsylvania, Washington D.C., August 15, 1990.

Federal Emergency Management Agency, Flood Insurance Study, Borough of Worth, Centre County, Pennsylvania, Washington D.C., August 15, 1989.

John McSparren's Equations for Calculating Time to Peak, Tp, as described in ASCE Journal of the Hydraulics Division, July 1968, Pages 937-960, "Design Hydrographs for Pennsylvania Watersheds."

King, H. W. and Barter, E. F., King's Handbook of Hydraulics, 5th Edition, McGraw-Hill Book Company, 1963.

Linn, John Blair, History of Centre and Clinton Counties, J.B. Lippincott and Company, Philadelphia, 1925.

Maynard, D. S., Industries and Institutions of Centre County, Republican Job Printing House, 1877.

National Technical Information Service, Bridge Waterways Analysis Model/User's Instructions by J. O. Shearman, W. H. Kirby, and V. R. Schneider, Springfield, Virginia, 1985.

Ortho Map prepared from aerial photography flown April 18, 1971, by L. Robert Kimball, Consulting Engineers, Scale 1:2,400, Contour Interval 5 Feet. Ebensburg, Pennsylvania.

Pace Aerial Surveys, Topographic Maps compiled from aerial photographs, Scale 1"=400', Contour Interval 2 feet: Township of Spring, Centre County, Pennsylvania, October 1980.

Reisch, B. M., McGinnis, B. M. McGinnis and Kerr, R. L., Design Procedures for Rainfall-Duration-Frequency in Pennsylvania, Department of Forests and Waters, Commonwealth of Pennsylvania, August, 1970.

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

The Pennsylvania State University, Land Analysis Lab (LAL). (1995). Township of Ferguson Topographic Mapping, Scale 1:2,400, Contour Interval 5 Feet.

The Pennsylvania State University for Research on Land and Water Resources. Report FHWA/PA 81-013, Procedure PSU-IV for Estimating Design Peaks on Ungaged Pennsylvania Watersheds. G. Aron and D. F. Kibler, University Park, Pennsylvania, 1981.

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

U.S. Army Corps of Engineers, Hydrologic Engineering Center. HEC-RAS River Analysis System Users Manual and HEC-RAS River Analysis System Hydraulic Reference Manual, Version 2.2, September 1998.

U.S. Army Corps of Engineers, Hydrologic Engineering Center, Application of the HEC-2 Bridge Routines, Training Document No. 6, Davis California, June, 1974.

U.S. Army Corps of Engineers HEC-2 Computer Program 723-X6-L202A, Water Surface Profiles, Davis, California, 1976.

U.S. Army Corps of Engineers HEC-2 Water Surface Profiles, Users Manual, October 1973.

U.S. Army Corps of Engineers, Regional Frequency Study, Upper Delaware and Hudson River Basins, New York District, November 1974.

U.S. Army Corps of Engineers, North Atlantic Division, Hydrologic Study Tropical Storm Agnes , Report No. 2, New York October 1972.

U.S. Army Corps of Engineers, North Atlantic Division, Hydrologic Study, Tropical Strom Agnes, December 1975.

U.S. Army Corps of Engineers, North Atlantic Division, Hydrologic Study Tropical Storm Agnes (draft), New York, November 1973.

U.S. Department of Agriculture, Soil Conservation Service, Soil Survey Centre County, Pennsylvania, U.S. Government Printing Office, 1976.

U.S. Department of Agriculture, Soil Conservation, National Engineering Handbook, Section 4, "Hydrology," 1964.

U.S. Department of Commerce, U.S. Census Bureau (2010). State and County QuickFacts. http://quickfacts.census.gov/qfd/states/24/24005.html.

U.S. Department of Commerce, Design Charts for Open Channel Flow, Hydraulic Design Series No. 3, 1961.

U.S. Department of Commerce, National Oceanic an Atmospheric Administration, Environmental Data Service, Monthly Averages of temperatures and Precipitation for State (Pa.), Climatic Divisions, 1941-1970.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Township of Bellefonte, Centre County, Pennsylvania, August 1978.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Township of Benner, Centre County, Pennsylvania, August 1, 1980.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Township of Haines, Centre County, Pennsylvania, February 1978.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Township of Harris, Centre County, Pennsylvania, December 12, 1975.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Borough of Howard, Centre County, Pennsylvania, December 12, 1975.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Township of Howard, Centre County, Pennsylvania, January 28, 1983.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Township of Huston, Centre County, Pennsylvania, December 19, 1976.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Township of Liberty, Centre County, Pennsylvania, September 24, 1974.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Borough of Milesburg, Centre County, Pennsylvania, August, 1976.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Borough of Millheim, Centre County, Pennsylvania, June 4, 1976.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Township of Snow Shoe, Centre County, Pennsylvania, August 13, 1976.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of Bellefonte, Centre County, Pennsylvania, August 1976.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Township of Haines, Centre County, Pennsylvania, February 1978.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of Milesburg, Centre County, Pennsylvania, February 2, 1977.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Township of Rush, Centre County, Pennsylvania, February 2, 1977.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Township of Spring, Centre County, Pennsylvania, October 15, 1977.

U.S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, 1973.

U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 20 Feet: Bear Knob, Pennsylvania, 1962, Photorevised 1971; Beech Creek, Pennsylvania, 1967, Photorevised 1973; Bellefonte, Pennsylvania, 1962, Photorevised 1971; Black Moshannon, Pennsylvania 1959, Photorevised 1971; Centre Hall, Pennsylvania, 1966, Photorevised 1973; Coburn, Pennsylvania, 1963, Photorevised 1973; Franklinville, Pennsylvania, 1963, Photorevised 1972; Hartleton, Pennsylvania, 1973; Howard, Pennsylvania, 1967, Photorevised 1973; Houtzdale, Pennsylvania, 1944, Photorevised 1981; Julian, Pennsylvania, 1962, Photorevised 1971; Karthaus, Pennsylvania, 1959, Photorevised 1981; Madisonburg, Pennsylvania, 1966, Photorevised 1973; McAlevys

Fort, Pennsylvania, 1963, Photorevised; Millheim, Pennsylvania, 1973; Mingoville, Pennsylvania, 1966, Photorevised 1973; Philipsburg, Pennsylvania, 1959, Photorevised 1981; Pine Grove Mills, Pennsylvania, 1962, Photorevised, 1972; Port Matilda, Pennsylvania, 1959, Photorevised 1981; Sandy Ridge, Pennsylvania 1944, Photorevised 1981; Snow Shoe, Pennsylvania, 1960, Photorevised 1971; Snow Shoe NE, Pennsylvania, 1960, Photorevised 1971; Snow Shoe Southeast, Pennsylvania, 1960, Phorevised 1971; State College, Pennsylvania, 1962, Photorevised 1971; Weikert, Pennsylvania, 1973; Woodward, Pennsylvania, 1973.

U.S. Department of the Interior, Geological Survey, Water Resources Division, Annual Peak Flow Frequency Analysis, Harrisburg, Pennsylvania, 1980.

U.S. Department of the Interior, Geological Survey, Water Resources Data for Pennsylvania, Water Year 1979, Volume 2, Washington, D.C., 1980.

U.S. Department of the Interior, Geological Survey. Techniques of Water Resources Investigations, Measurement of Peak Discharge at Culverts by Indirect Methods. G.L. Bodhaine, Washington D.C., 1968.

U.S. Department of the Interior, Geological Survey. Techniques of Water Resources Investigations, Measurement of Peak Discharge at Dams by Indirect Methods. Harry Hulsing, Washington D.C., 1967.

U.S. Department of the Interior, Geological Survey, Office of Water Data Collection Interagency Advisory Committee on Water Data "Guidelines for Determining Flood Flow Frequency," Bulletin 17B, Reston, Virginia, September 1981.

U.S. Department of the Interior, Geological Survey, Water Resources Investigations 00-4189, Estimating Flood-Flow Frequencies in Pennsylvania. Marla H. Stuckey and Lloyd A. Reed, 2000.

U.S. Department of the Interior, Geological Survey, Water Resources Investigations 82-21, Evaluation of the Streamflow-Data Program in Pennsylvania by H.N. Flippo, Jr., Harrisburg, Pennsylvania, 1982.

U.S. Department of the Interior, Geological Survey, Water Resources Investigations 86-4195, Technique for Estimating Depths of 100-year Floods in Pennsylvania by H.N. Flippo, Jr., Harrisburg, Pennsylvania, 1986.

U.S. Federal Highway Administration, Report FHWA/RD-86/108, Bridge Waterways Analysis Model/Research Report by J. O. Shearman, W. H. Kirby, V.R. Schneider, and H.N. Flippo, Jr., Washington, D.C., 1986.

U.S. Geologic Survey, Water Supply Paper 1672, Magnitude and Frequency of Floods in the United States, Part 1B, North Atlantic Slope Basins, New York to York River.

U.S. Water Resources Council, Bulletin 17B, Guidelines for Determining Flood-Flow Frequency, Washington, D.C., 1981 (Revised 1982).

Weather Bureau, Technical Paper 40, Rainfall Atlas of the United States, May 1961.
The Weather Channel, www.weather.com, accessed August 30, 2005.