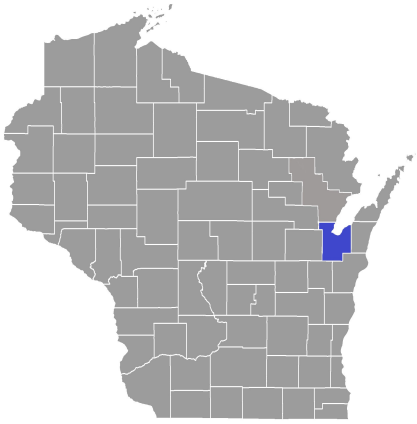
FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 4



BROWN COUNTY, WISCONSIN

AND INCORPORATED AREAS

COMMUNITY NAME	NUMBER
ALLOUEZ, VILLAGE OF	550612
ASHWAUBENON, VILLAGE OF	550600
BELLEVUE, VILLAGE OF	550627
BROWN COUNTY, UNINCORPORATED AREAS	550020
DE PERE, CITY OF	550021
DENMARK, VILLAGE OF*	550616
GREEN BAY, CITY OF	550022
HOBART, VILLAGE OF	550626
HOWARD, VILLAGE OF	550023
PULASKI, VILLAGE OF	550024
SUAMICO, VILLAGE OF	550660
WRIGHTSTOWN, VILLAGE OF	550025

*No Special Flood Hazard Areas Identified

TRIBAL NATION	NUMBER
THE ONEIDA NATION OF WISCONSIN	550379

FEMA

REVISED:
May 9, 2023

FLOOD INSURANCE STUDY NUMBER
55009CV001C

Version Number 2.4.3.5

TABLE OF CONTENTS
Volume 1

		Page
SECTION 1.0 – INTRODUCTION		**1**
1.1	The National Flood Insurance Program	1
1.2	Purpose of this Flood Insurance Study Report	2
1.3	Jurisdictions Included in the Flood Insurance Study Project	2
1.4	Considerations for using this Flood Insurance Study Report	6
SECTION 2.0 – FLOODPLAIN MANAGEMENT APPLICATIONS		**16**
2.1	Floodplain Boundaries	16
2.2	Floodways	31
2.3	Base Flood Elevations	32
2.4	Non-Encroachment Zones	32
2.5	Coastal Flood Hazard Areas	32
2.5.1	Water Elevations and the Effects of Waves	33
2.5.2	Floodplain Boundaries and BFEs for Coastal Areas	35
2.5.3	Coastal High Hazard Areas	36
2.5.4	Limit of Moderate Wave Action	37
SECTION 3.0 – INSURANCE APPLICATIONS		**38**
3.1	National Flood Insurance Program Insurance Zones	38
SECTION 4.0 – AREA STUDIED		**39**
4.1	Basin Description	39
4.2	Principal Flood Problems	40
4.3	Non-Levee Flood Protection Measures	41
4.4	Levees	42
SECTION 5.0 – ENGINEERING METHODS		**42**
5.1	Hydrologic Analyses	42
5.2	Hydraulic Analyses	52
5.3	Coastal Analyses	72
5.3.1	Total Stillwater Elevations	73
5.3.2	Waves	74
5.3.3	Coastal Erosion	75
5.3.4	Wave Hazard Analyses	75
5.4	Alluvial Fan Analyses	80
SECTION 6.0 – MAPPING METHODS		**80**
6.1	Vertical and Horizontal Control	80
6.2	Base Map	81
6.3	Floodplain and Floodway Delineation	82

TABLE OF CONTENTS
Volume 1 *(continued)*

Figures

	Page
Figure 1: FIRM Index	8
Figure 2: FIRM Notes to Users	9
Figure 3: Map Legend for FIRM	12
Figure 4: Floodway Schematic	31
Figure 5a: Wave Runup Transect Schematic	34
Figure 5b: Wave Overtopping Schematic	34
Figure 6a: Coastal Transect Schematic (Wave Runup and Overtopping)	36
Figure 6b: Coastal Transect Schematic (Overland Wave Propagation)	37
Figure 7: Frequency Discharge-Drainage Area Curves	51
Figure 8: 1-Percent-Annual-Chance Stillwater Elevations for Coastal Areas	73
Figure 9: Transect Location Map	79

Tables

	Page
Table 1: Listing of NFIP Jurisdictions	3
Table 2: Flooding Sources Included in this FIS Report	17
Table 3: Flood Zone Designations by Community	39
Table 4: Basin Characteristics	40
Table 5: Principal Flood Problems	41
Table 6: Historic Flooding Elevations	41
Table 7: Non-Levee Flood Protection Measures	41
Table 8: Levees	42
Table 9: Summary of Discharges	43
Table 10: Summary of Non-Coastal Stillwater Elevations	51
Table 11: Stream Gage Information used to Determine Discharges	52
Table 12: Summary of Hydrologic and Hydraulic Analyses	53
Table 13: Roughness Coefficients	72
Table 14: Summary of Coastal Analyses	72
Table 15: Water Level Station Analysis Specifics	74
Table 16: Coastal Transect Parameters	77
Table 17: Summary of Alluvial Fan Analyses	80
Table 18: Results of Alluvial Fan Analyses	80
Table 19: Countywide Vertical Datum Conversion	81
Table 20: Stream-Based Vertical Datum Conversion	81
Table 21: Base Map Sources	82
Table 22: Summary of Topographic Elevation Data used in Mapping	83
Table 23: Floodway Data	84

Volume 2

	Page
SECTION 6.0 – MAPPING METHODS *(continued)*	**159**
6.4 Coastal Flood Hazard Mapping	159
6.5 FIRM Revisions	161
6.5.1 Letters of Map Amendment	161
6.5.2 Letters of Map Revision Based on Fill	161
6.5.3 Letters of Map Revision	162
6.5.4 Physical Map Revisions	162
6.5.5 Contracted Restudies	163
6.5.6 Community Map History	163

TABLE OF CONTENTS
Volume 2 *(continued)*

Page

SECTION 7.0 – CONTRACTED STUDIES AND COMMUNITY COORDINATION 164
7.1 Contracted Studies 164
7.2 Community Meetings 173

SECTION 8.0 – ADDITIONAL INFORMATION 176

SECTION 9.0 – BIBLIOGRAPHY AND REFERENCES 178

Tables *(continued)*

Page

Table 23: Floodway Data *(continued)* 92
Table 24: Flood Hazard and Non-Encroachment Data for Selected Streams 159
Table 25: Summary of Coastal Transect Mapping Considerations 160
Table 26: Incorporated Letters of Map Change 162
Table 27: Community Map History 164
Table 28: Summary of Contracted Studies Included in this FIS Report 165
Table 29: Community Meetings 174
Table 30: Map Repositories 176
Table 31: Additional Information 177
Table 32: Bibliography and References 179

Volume 3
Exhibits

Flood Profiles Panel

Ash Street Tributary to Lancaster Creek 01 P
Ashwaubenon Creek 02-05 P
Ashwaubenon Creek (Middle) 06-07 P
Ashwaubenon Creek (Upper) 08 P
Baird Creek 09-15 P
Baird Creek Tributary 16-17 P
Baird Creek Tributary 6 18 P
Bakers Creek 19 P
Bakers Creek Tributary 20 P
Barina Creek 21 P
Beaver Dam Creek 22-27 P
Bower Creek 28-32 P
Bower Creek Tributary 33 P
Bower Creek Tributary A 34 P
Bower Creek Tributary B 35 P
Bower Creek Tributary 1 36-37 P
Bower Creek Tributary 2 38-40 P
Branch of Plum Creek 41 P
Branch of Plum Creek – Lower Tributary 42-43 P
Branch of Plum Creek – Upper Tributary 44 P
Branch River 45-46 P
Duck Creek 47-52 P
Duck Creek Tributary – Stream 11 53 P
Duck Creek Tributary 12 54 P
Dutchman Creek 55-57 P

TABLE OF CONTENTS
Volume 3 *(continued)*

Exhibits *(continued)*

Flood Profiles *(continued)*	Panel
Dutchman Creek North Tributary	58-59 P
Dutchman Creek South Tributary	60 P
Dutchman Creek Southeast Tributary	61 P
Dutchman Creek Southwest Tributary	62-63 P
East River	64-68 P
East River Tributary	69 P
East River Tributary A	70-71 P
East River Tributary B	72 P

Volume 4

Exhibits *(continued)*

	Panel
East Verlin North Tributary to Willow Creek	73 P
East Verlin Tributary to Willow Creek	74-75 P
Ellis Creek	76 P
Fox River	77-80 P
Lancaster Creek	81-82 P
Lancaster Creek Tributary	83 P
Mahon Creek	84-86 P
Middle Branch Little Suamico River	87 P
Neshota River	88-89 P
North Branch Ashwaubenon Creek	90-91 P
North Branch Bakers Creek	92 P
North Branch Willow Creek	93-94 P
North Tributary South Branch Ashwaubenon Creek	95 P
Oneida Creek	96 P
Pioneer Tributary to Duck Creek	97 P
Plum Creek	98-100 P
Sorensons Creek	101-102 P
Sorensons Creek Tributary	103-105 P
South Branch Ashwaubenon Creek	106-107 P
South Branch Little Suamico River	108-109 P
South Tributary to Willow Creek	110 P
Spring Creek	111-114 P
Spring Creek Tributary A	115-116 P
Spring Creek Tributary A Ditch	117 P
Spring Creek Tributary B	118 P
Suamico River	119-122 P
Tributary 1 to Dutchman Creek Southwest Tributary	123 P

TABLE OF CONTENTS
Volume 4 *(continued)*

Exhibits *(continued)*

Flood Profiles *(continued)*	Panel
Tributary 2 to Dutchman Creek Southwest Tributary	124 P
Tributary 3 to Dutchman Creek Southwest Tributary	125 P
Trout Creek	126-129 P
Unnamed Tributary to Green Bay	130 P
Vanguard Way Tributary to Lancaster Creek	131 P
West Verlin Tributary to Willow Creek	132 P
Willow Creek	133-138 P

Published Separately

Flood Insurance Rate Map Index
Flood Insurance Rate Map (FIRM)

SECTION 1.0 – INTRODUCTION

1.1 The National Flood Insurance Program

The National Flood Insurance Program (NFIP) is a voluntary Federal program that enables property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods.

For decades, the national response to flood disasters was generally limited to constructing flood-control works such as dams, levees, sea-walls, and the like, and providing disaster relief to flood victims. This approach did not reduce losses nor did it discourage unwise development. In some instances, it may have actually encouraged additional development. To compound the problem, the public generally could not buy flood coverage from insurance companies, and building techniques to reduce flood damage were often overlooked.

In the face of mounting flood losses and escalating costs of disaster relief to the general taxpayers, the U.S. Congress created the NFIP. The intent was to reduce future flood damage through community floodplain management ordinances, and provide protection for property owners against potential losses through an insurance mechanism that requires a premium to be paid for the protection.

The U.S. Congress established the NFIP on August 1, 1968, with the passage of the National Flood Insurance Act of 1968. The NFIP was broadened and modified with the passage of the Flood Disaster Protection Act of 1973 and other legislative measures. It was further modified by the National Flood Insurance Reform Act of 1994 and the Flood Insurance Reform Act of 2004. The NFIP is administered by the Federal Emergency Management Agency (FEMA), which is a component of the Department of Homeland Security (DHS).

Participation in the NFIP is based on an agreement between local communities and the Federal Government. If a community adopts and enforces floodplain management regulations to reduce future flood risks to new construction and substantially improved structures in Special Flood Hazard Areas (SFHAs), the Federal Government will make flood insurance available within the community as a financial protection against flood losses. The community's floodplain management regulations must meet or exceed criteria established in accordance with Title 44 Code of Federal Regulations (CFR) Part 60, *Criteria for Land Management and Use*.

SFHAs are delineated on the community's Flood Insurance Rate Maps (FIRMs). Under the NFIP, buildings that were built before the flood hazard was identified on the community's FIRMs are generally referred to as "Pre-FIRM" buildings. When the NFIP was created, the U.S. Congress recognized that insurance for Pre-FIRM buildings would be prohibitively expensive if the premiums were not subsidized by the Federal

Government. Congress also recognized that most of these floodprone buildings were built by individuals who did not have sufficient knowledge of the flood hazard to make informed decisions. The NFIP requires that full actuarial rates reflecting the complete flood risk be charged on all buildings constructed or substantially improved on or after the effective date of the initial FIRM for the community or after December 31, 1974, whichever is later. These buildings are generally referred to as “Post-FIRM” buildings.

1.2 Purpose of this Flood Insurance Study Report

This Flood Insurance Study (FIS) Report revises and updates information on the existence and severity of flood hazards for the study area. The studies described in this report developed flood hazard data that will be used to establish actuarial flood insurance rates and to assist communities in efforts to implement sound floodplain management.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive than the minimum Federal requirements. Contact your State NFIP Coordinator to ensure that any higher State standards are included in the community’s regulations.

1.3 Jurisdictions Included in the Flood Insurance Study Project

This FIS Report covers the entire geographic area of Brown County, Wisconsin.

The jurisdictions that are included in this project area, along with the Community Identification Number (CID) for each community and the United States Geological Survey (USGS) 8-digit Hydrologic Unit Code (HUC-8) sub-basins affecting each, are shown in Table 1. The FIRM panel numbers that affect each community are listed. If the flood hazard data for the community is not included in this FIS Report, the location of that data is identified.

The location of flood hazard data for participating communities in multiple jurisdictions is also indicated in the table.

Jurisdictions that have no identified SFHAs as of the effective date of this study are indicated in the table. Changed conditions in these communities (such as urbanization or annexation) or the availability of new scientific or technical data about flood hazards could make it necessary to determine SFHAs in these jurisdictions in the future.

Table 1: Listing of NFIP Jurisdictions

Community/Tribal Nation	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Allouez, Village of	550612	04030204	55009C0256G, 55009C0257G, 55009C0258G, 55009C0259F, 55009C0276G	
Ashwaubenon, Village of	550600	04030204	55009C0144G, 55009C0163F, 55009C0164F, 55009C0168G, 55009C0232F[1], 55009C0234F, 55009C0251F, 55009C0252F, 55009C0253F, 55009C0254G, 55009C0256G, 55009C0258G	
Bellevue, Village of	550627	04030101, 04030204	55009C0257G, 55009C0259F, 55009C0276G, 55009C0277F, 55009C0278F, 55009C0279F, 55009C0281F, 55009C0282F, 55009C0283F, 55009C0284F, 55009C0286F	
Brown County, Unincorporated Areas	550020	04030101, 04030102, 04030103, 04030204, 04190000	55009C0036F, 55009C0040F, 55009C0045F, 55009C0114G, 55009C0118G, 55009C0119G, 55009C0130F, 55009C0135G, 55009C0182G, 55009C0183G, 55009C0184G, 55009C0191G, 55009C0192F[1], 55009C0194F, 55009C0201G, 55009C0202G, 55009C0203F[1], 55009C0204F[1], 55009C0210F[1], 55009C0215F, 55009C0220F[1], 55009C0232F[1], 55009C0234F, 55009C0239F, 55009C0241F[1], 55009C0242F, 55009C0243F, 55009C0244F, 55009C0251F, 55009C0253F, 55009C0254G, 55009C0258G, 55009C0259F, 55009C0261F, 55009C0262F, 55009C0263F, 55009C0264F, 55009C0266F, 55009C0267F, 55009C0268F, 55009C0269F[1], 55009C0278F, 55009C0279F, 55009C0282F, 55009C0283F, 55009C0284F, 55009C0286F, 55009C0287F, 55009C0290F[1], 55009C0295F, 55009C0305F, 55009C0310F[1], 55009C0315F, 55009C0320F,	

[1] Panel Not Printed

Table 1: Listing of NFIP Jurisdictions *(continued)*

Community/Tribal Nation	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Brown County, Unincorporated Areas *(continued)*	550020	04030101, 04030102, 04030103, 04030204, 04190000	55009C0327F[1], 55009C0329F, 55009C0331F, 55009C0332F, 55009C0333F, 55009C0334F, 55009C0340F[1], 55009C0341F, 55009C0345F, 55009C0351F, 55009C0352F, 55009C0353F, 55009C0354F, 55009C0360F, 55009C0365F, 55009C0370F, 55009C0380F, 55009C0385F[1], 55009C0387F, 55009C0389F, 55009C0390F[1], 55009C0391F[1], 55009C0392F[1], 55009C0393F, 55009C0394F[1], 55009C0405F, 55009C0406F, 55009C0407F, 55009C0408F, 55009C0409F, 55009C0430F[1], 55009C0435F, 55009C0455F, 55009C0460F[1] 55009C0480F[1], 55009C0485F	
De Pere, City of	550021	04030204	55009C0242F, 55009C0244F, 55009C0253F, 55009C0254G, 55009C0258G, 55009C0259F, 55009C0261F, 55009C0262F, 55009C0263F, 55009C0264F, 55009C0266F, 55009C0267F, 55009C0268F	
Denmark, Village of[2]	550616	04030101	55009C0405F, 55009C0406F	
Green Bay, City of	550022	04030204, 04190000	55009C0142G, 55009C0144G, 55009C0161F, 55009C0162F, 55009C0163F, 55009C0164F, 55009C0166G, 55009C0167G, 55009C0168G, 55009C0169G, 55009C0183G, 55009C0184G, 55009C0186G, 55009C0187G, 55009C0188G, 55009C0189G, 55009C0191G, 55009C0192F[1], 55009C0193G, 55009C0194F, 55009C0215F, 55009C0232F[1], 55009C0251F, 55009C0252F, 55009C0256G, 55009C0257G, 55009C0276G, 55009C0277F, 55009C0281F, 55009C0282F	

[1] Panel Not Printed
[2] No Special Flood Hazards Identified

Table 1: Listing of NFIP Jurisdictions *(continued)*

Community/Tribal Nation	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Hobart, Village of	550626	04030103, 04030204	55009C0130F, 55009C0135G, 55009C0140F, 55009C0141G, 55009C0142G, 55009C0143G, 55009C0144G, 55009C0161F, 55009C0227F, 55009C0229F[1], 55009C0231F, 55009C0232F[1], 55009C0233F, 55009C0234F, 55009C0237F[1], 55009C0239F, 55009C0241F[1], 55009C0242F, 55009C0243F, 55009C0251F, 55009C0253F	
Howard, Village of	550023	04030103, 04030204, 04190000	55009C0130F, 55009C0135G, 55009C0142G, 55009C0152F, 55009C0153F, 55009C0154G, 55009C0158G, 55009C0159G, 55009C0161F, 55009C0162F, 55009C0164F, 55009C0166G	
The Oneida Nation of Wisconsin	550379	04030103, 04030204	55009C0130F, 55009C0135G, 55009C0140F, 55009C0141G, 55009C0142G, 55009C0143G, 55009C0144G, 55009C0161F, 55009C0163F, 55009C0164F, 55009C0227F, 55009C0231F, 55009C0232F[1], 55009C0233F, 55009C0234F, 55009C0241F[1], 55009C0251F, 55009C0253F	
Pulaski, Village of	550024	04030103	55009C0017F, 55009C0036F, 55009C0040F	
Suamico, Village of	550660	04030103, 04030204, 04190000	55009C0045F, 55009C0063F, 55009C0064F, 55009C0065F, 55009C0066F[1], 55009C0067G, 55009C0068F, 55009C0069G, 55009C0086G, 55009C0088G, 55009C0135G, 55009C0151F, 55009C0152F, 55009C0153F, 55009C0154G, 55009C0156F[1], 55009C0157G, 55009C0158G, 55009C0159G, 55009C0176G, 55009C0178G	

[1] Panel Not Printed

Table 1: Listing of NFIP Jurisdictions *(continued)*

Community/Tribal Nation	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Wrightstown, Village of	550025	04030204	55009C0329F, 55009C0332F, 55009C0333F, 55009C0334F, 55009C0341F, 55009C0345F	

[1] Panel Not Printed

1.4 Considerations for using this Flood Insurance Study Report

The NFIP encourages State and local governments to implement sound floodplain management programs. To assist in this endeavor, each FIS Report provides floodplain data, which may include a combination of the following: 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance flood elevations (the 1-percent-annual-chance flood elevation is also referred to as the Base Flood Elevation (BFE)); delineations of the 1-percent-annual-chance and 0.2-percent-annual-chance floodplains; and 1-percent-annual-chance floodway. This information is presented on the FIRM and/or in many components of the FIS Report, including Flood Profiles, Floodway Data tables, Summary of Non-Coastal Stillwater Elevations tables, and Coastal Transect Parameters tables (not all components may be provided for a specific FIS).

This section presents important considerations for using the information contained in this FIS Report and the FIRM, including changes in format and content. Figures 1, 2, and 3 present information that applies to using the FIRM with the FIS Report.

- Part or all of this FIS Report may be revised and republished at any time. In addition, part of this FIS Report may be revised by a Letter of Map Revision (LOMR), which does not involve republication or redistribution of the FIS Report. Refer to Section 6.5 of this FIS Report for information about the process to revise the FIS Report and/or FIRM.

  It is, therefore, the responsibility of the user to consult with community officials by contacting the community repository to obtain the most current FIS Report components. Communities participating in the NFIP have established repositories of flood hazard data for floodplain management and flood insurance purposes. Community map repository addresses are provided in Table 30, "Map Repositories," within this FIS Report.

- New FIS Reports are frequently developed for multiple communities, such as entire counties. A countywide FIS Report incorporates previous FIS Reports for individual communities and the unincorporated area of the county (if not jurisdictional) into a single document and supersedes those documents for the purposes of the NFIP.

  The initial Countywide FIS Report for Brown County became effective on August 18, 2009. Refer to Table 27 for information about subsequent revisions to the FIRMs.

- Selected FIRM panels for the community may contain information (such as floodways and cross sections) that was previously shown separately on the corresponding Flood Boundary and Floodway Map (FBFM) panels. In addition, former flood hazard zone designations have been changed as follows:

Old Zone	New Zone
A1 through A30	AE
V1 through V30	VE
B	X (shaded)
C	X (unshaded)

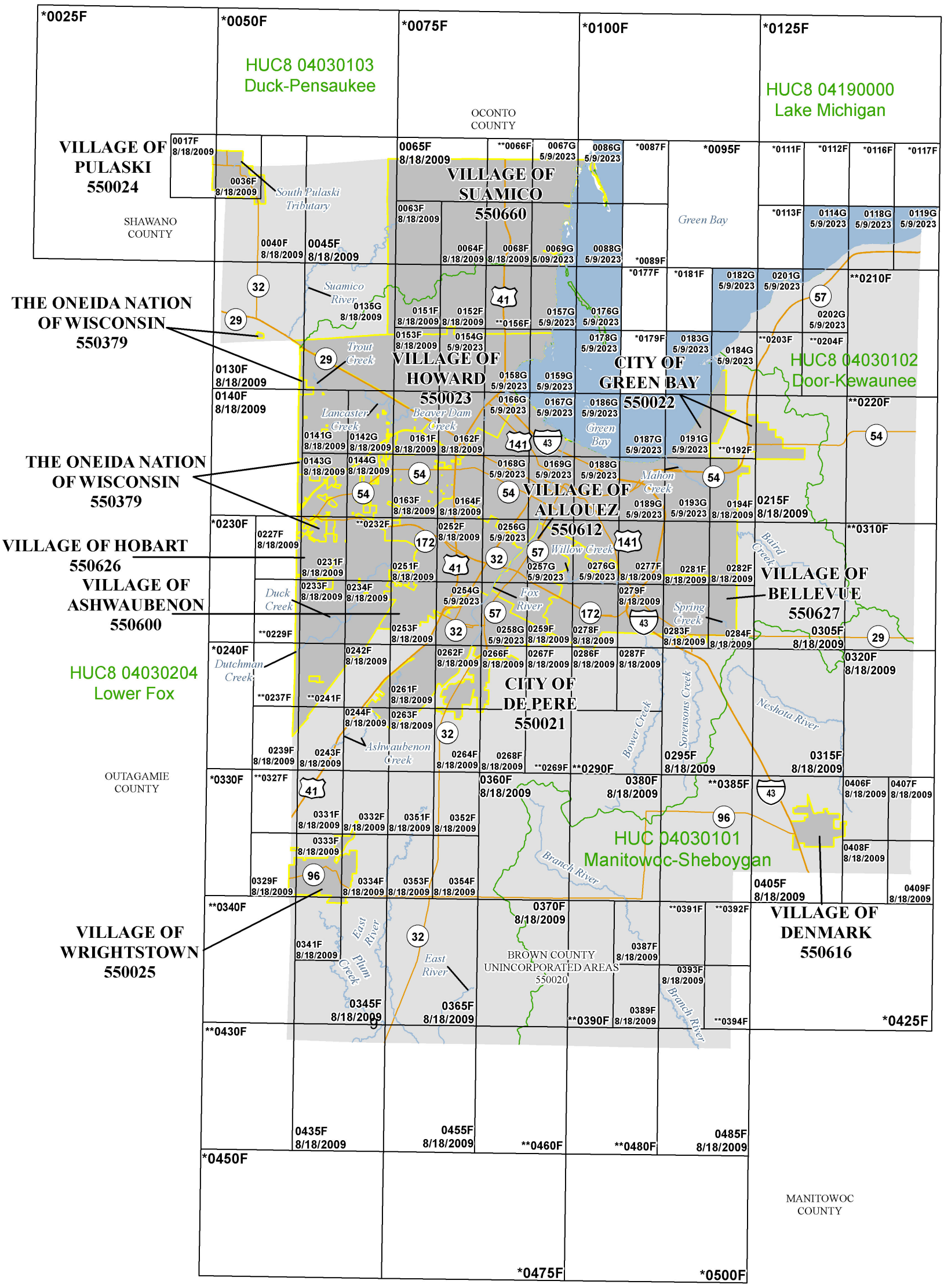
- FEMA does not impose floodplain management requirements or special insurance ratings based on Limit of Moderate Wave Action (LiMWA) delineations at this time. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. If the LiMWA is shown on the FIRM, it is being provided by FEMA as information only. For communities that do adopt Zone VE building standards in the area defined by the LiMWA, additional Community Rating System (CRS) credits are available. Refer to Section 2.5.4 for additional information about the LiMWA.

  The CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Visit the FEMA Web site at https://www.fema.gov/national-flood-insurance-program-community-rating-system or contact your appropriate FEMA Regional Office for more information about this program.

- FEMA has developed a *Guide to Flood Maps* (FEMA 258) and online tutorials to assist users in accessing the information contained on the FIRM. These include how to read panels and step-by-step instructions to obtain specific information. To obtain this guide and other assistance in using the FIRM, visit the FEMA Web site at https://www.fema.gov/online-tutorials.

The FIRM Index in Figure 1 shows the overall FIRM panel layout within Brown County, and also displays the panel number and effective date for each FIRM panel in the county. Other information shown on the FIRM Index includes community boundaries, flooding sources, watershed boundaries, and USGS HUC-8 codes.

Figure 1: FIRM Index



ATTENTION: The corporate limits shown on this FIRM Index are based on the best information available at the time of publication. As such, they may be more current than those shown on FIRM panels issued before April 19, 2023.

1 inch = 4 miles 1:240,000

0 1 2 4 6 8 miles

Map Projection:
Universal Transverse Mercator Zone 16 North;
North American Datum 1983

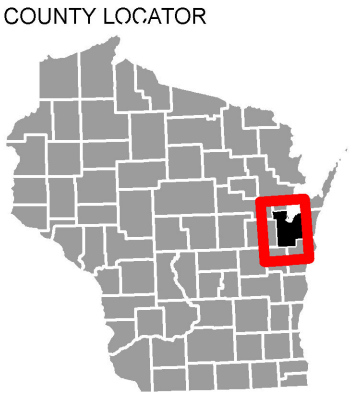
THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTPS://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION

* PANEL NOT PRINTED - AREA OUTSIDE COUNTY BOUNDARY
** PANEL NOT PRINTED - NO SPECIAL FLOOD HAZARD AREAS

COUNTY LOCATOR



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX

BROWN COUNTY, WISCONSIN and Incorporated Areas

PANELS PRINTED:

0017, 0036, 0040, 0045, 0063, 0064, 0065, 0067, 0068, 0069, 0086, 0088, 0114, 0118, 0119, 0130, 0135, 0140, 0141, 0142, 0143, 0144, 0151, 0152, 0153, 0154, 0157, 0158, 0159, 0161, 0162, 0163, 0164, 0166, 0167, 0168, 0169, 0176, 0178, 0182, 0183, 0184, 0186, 0187, 0188, 0189, 0191, 0193, 0194, 0201, 0202, 0215, 0227, 0231, 0233, 0234, 0239, 0242, 0243, 0244, 0251, 0252, 0253, 0254, 0256, 0257, 0258, 0259, 0261, 0262, 0263, 0264, 0266, 0267, 0268, 0276, 0277, 0278, 0279, 0281, 0282, 0283, 0284, 0286, 0287, 0295, 0305, 0315, 0320, 0329, 0331, 0332, 0333, 0334, 0341, 0345, 0351, 0352, 0353, 0354, 0360, 0365, 0370, 0380, 0387, 0389, 0393, 0405, 0406, 0407, 0408, 0409, 0435, 0455, 0485

FEMA

MAP NUMBER
55009CIND0B

MAP REVISED
May 9, 2023

Each FIRM panel may contain specific notes to the user that provide additional information regarding the flood hazard data shown on that map. However, the FIRM panel does not contain enough space to show all the notes that may be relevant in helping to better understand the information on the panel. Figure 2 contains the full list of these notes.

Figure 2: FIRM Notes to Users

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products, or the National Flood Insurance Program in general, please call the FEMA Mapping and Insurance eXchange at 1-877-FEMA-MAP (1- 877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Flood Map Service Center website or by calling the FEMA Mapping and Insurance eXchange.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates, refer to Table 27 in this FIS Report.

To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

The map is for use in administering the NFIP. It may not identify all areas subject to flooding, particularly from local drainage sources of small size. Consult the community map repository to find updated or additional flood hazard information.

BASE FLOOD ELEVATIONS: For more detailed information in areas where Base Flood Elevations (BFEs) and/or floodways have been determined, consult the Flood Profiles and Floodway Data and/or Summary of Non-Coastal Stillwater Elevations tables within this FIS Report. Use the flood elevation data within the FIS Report in conjunction with the FIRM for construction and/or floodplain management.

Coastal Base Flood Elevations shown on the map apply only landward of the zero elevation referenced to Low Water Datum of Lake Michigan, administratively established by the National Oceanic and Atmospheric Administration at 176.0 meters (577.5 feet) above zero point International Great Lakes Datum of 1985. This elevation is generally accepted to be equal to an elevation of 577.6 feet North American Vertical Datum of 1988 (NAVD88). Coastal flood elevations are also provided in the Coastal Transect Parameters table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Coastal Transect Parameters table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on the FIRM.

Figure 2. FIRM Notes to Users *(continued)*

FLOODWAY INFORMATION: Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the FIS Report for this jurisdiction.

FLOOD CONTROL STRUCTURE INFORMATION: Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 4.3 "Non-Levee Flood Protection Measures" of this FIS Report for information on flood control structures for this jurisdiction.

PROJECTION INFORMATION: The projection used in the preparation of the map was Universal Transverse Mercator (UTM) Zone 16. The horizontal datum was the North American Datum of 1983 NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

ELEVATION DATUM: Flood elevations on the FIRM are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at www.ngs.noaa.gov.

Local vertical monuments may have been used to create the map. To obtain current monument information, please contact the appropriate local community listed in Table 30 of this FIS Report.

BASE MAP INFORMATION: Base map information shown on the FIRM was provided by various sources. For information about base maps, refer to Section 6.2 “Base Map” in this FIS Report.

The map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map.

Corporate limits shown on the map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after the map was published, map users should contact appropriate community officials to verify current corporate limit locations.

NOTES FOR FIRM INDEX

REVISIONS TO INDEX: As new studies are performed and FIRM panels are updated within Brown County, Wisconsin, corresponding revisions to the FIRM Index will be incorporated within the FIS Report to reflect the effective dates of those panels. Please refer to Table 27 of this FIS Report to determine the most recent FIRM revision date for each community. The most recent FIRM panel effective date will correspond to the most recent index date.

SPECIAL NOTES FOR SPECIFIC FIRM PANELS

This Notes to Users section was created specifically for Brown County, Wisconsin, effective May 9, 2023.

LIMIT OF MODERATE WAVE ACTION: Zone AE areas subject to overland wave propagation (refer to Table 25 for applicable transects) have been divided by a Limit of Moderate Wave Action (LiMWA). The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. The effects of wave hazards between Zone VE and the LiMWA (or between the shoreline and the LiMWA for areas where Zone VE is not identified) will be similar to, but less severe than, those in Zone VE.

Figure 2. FIRM Notes to Users *(continued)*

FLOOD RISK REPORT: A Flood Risk Report (FRR) may be available for many of the flooding sources and communities referenced in this FIS Report. The FRR is provided to increase public awareness of flood risk by helping communities identify the areas within their jurisdictions that have the greatest risks. Although non-regulatory, the information provided within the FRR can assist communities in assessing and evaluating mitigation opportunities to reduce these risks. It can also be used by communities developing or updating flood risk mitigation plans. These plans allow communities to identify and evaluate opportunities to reduce potential loss of life and property. However, the FRR is not intended to be the final authoritative source of all flood risk data for a project area; rather, it should be used with other data sources to paint a comprehensive picture of flood risk.

Each FIRM panel contains an abbreviated legend for the features shown on the maps. However, the FIRM panel does not contain enough space to show the legend for all map features. Figure 3 shows the full legend of all map features. Note that not all of these features may appear on the FIRM panels in Brown County.

Figure 3: Map Legend for FIRM

SPECIAL FLOOD HAZARD AREAS: *The 1-percent-annual-chance flood, also known as the base flood or 100-year flood, has a 1-percent chance of happening or being exceeded each year. Special Flood Hazard Areas are subject to flooding by the 1-percent-annual-chance flood. The Base Flood Elevation is the water surface elevation of the 1-percent-annual-chance flood. 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. See note for specific types. If the floodway is too narrow to be shown, a*

	Special Flood Hazard Areas subject to inundation by the 1-percent-annual-chance flood (Zones A, AE, AH, AO, AR, A99, V and VE)
Zone A	The flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains. No base (1-percent annual chance) flood elevations (BFEs) or depths are shown within this zone.
Zone AE	The flood insurance rate zone that corresponds to the 1-percent-annual -chance floodplains. Base flood elevations derived from the hydraulic analyses are shown within this zone.
Zone AH	The flood insurance rate zone that corresponds to the areas of 1-percent -annual-chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the hydraulic analyses are shown at selected intervals within this zone.
Zone AO	The flood insurance rate 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 depths derived from the hydraulic analyses are shown within this zone.
Zone AR	The flood insurance rate zone that corresponds to areas that were formerly protected from the 1-percent-annual-chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1-percent-annual-chance or greater flood.
Zone A99	The flood insurance rate zone that corresponds to areas of the 1-percent -annual-chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or flood depths are shown within this zone.

Figure 3: Map Legend for FIRM *(continued)*

Zone V	The flood insurance rate zone that corresponds to the 1-percent-annual -chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations are not shown within this
Zone VE	Zone VE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations derived from the coastal analyses are shown within this zone as static whole-foot elevations that apply throughout the zone.
	Regulatory Floodway determined in Zone AE.
OTHER AREAS OF FLOOD HAZARD	
	Shaded Zone X: Areas of 0.2-percent-annual-chance flood hazards and areas of 1-percent-annual-chance flood hazards with average depths of less than 1 foot or with drainage areas less than 1 square mile.
	Future Conditions 1-Percent-Annual-Chance Flood Hazard – Zone X: The flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined based on future-conditions hydrology. No base flood elevations or flood depths are shown within this zone.
	Area with Reduced Flood Risk due to Levee: Areas where an accredited levee, dike, or other flood control structure has reduced the flood risk from the 1-percent-annual-chance flood. See Notes to Users for important information.
	Area with Flood Risk due to Levee: Areas where a non-accredited levee, dike, or other flood control structure is shown as providing protection to less than the 1-percent-annual-chance flood.

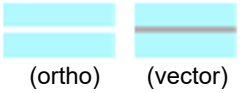
Figure 3: Map Legend for FIRM *(continued)*

OTHER AREAS

Zone D (Areas of Undetermined Flood Hazard): The flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

Unshaded Zone X: Areas of minimal flood hazard.

FLOOD HAZARD AND OTHER BOUNDARY LINES



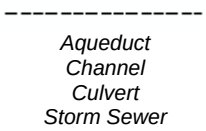
Flood Zone Boundary (white line on ortho-photography-based mapping; gray line on vector-based mapping)

Limit of Study

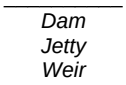
Jurisdiction Boundary

Limit of Moderate Wave Action (LiMWA): Indicates the inland limit of the area affected by waves greater than 1.5 feet

GENERAL STRUCTURES

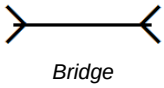


Channel, Culvert, Aqueduct, or Storm Sewer



Dam, Jetty, Weir

Levee, Dike, or Floodwall

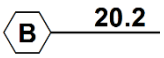


Bridge

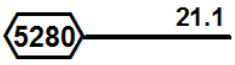
REFERENCE MARKERS

River mile Markers

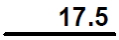
CROSS SECTION & TRANSECT INFORMATION



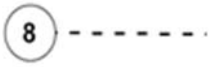
Lettered Cross Section with Regulatory Water Surface Elevation (BFE)



Numbered Cross Section with Regulatory Water Surface Elevation (BFE)



Unlettered Cross Section with Regulatory Water Surface Elevation (BFE)



Coastal Transect

Figure 3: Map Legend for FIRM *(continued)*

	Profile Baseline: Indicates the modeled flow path of a stream and is shown on FIRM panels for all valid studies with profiles or otherwise established base flood elevation.
	Coastal Transect Baseline: Used in the coastal flood hazard model to represent the 0.0-foot elevation contour and the starting point for the transect and the measuring point for the coastal mapping.
513	Base Flood Elevation Line
ZONE AE (EL 16)	Static Base Flood Elevation value (shown under zone label)
ZONE AO (DEPTH 2)	Zone designation with Depth
ZONE AO (DEPTH 2) (VEL 15 FPS)	Zone designation with Depth and Velocity
BASE MAP FEATURES	
Missouri Creek	River, Stream or Other Hydrographic Feature
234	Interstate Highway
234	U.S. Highway
234	State Highway
234	County Highway
MAPLE LANE	Street, Road, Avenue Name, or Private Drive if shown on Flood Profile
RAILROAD	Railroad
	Horizontal Reference Grid Line
	Horizontal Reference Grid Ticks
+	Secondary Grid Crosshairs
Land Grant	Name of Land Grant
7	Section Number
R. 43 W. T. 22 N.	Range, Township Number
$^{42}76^{000m}$E	Horizontal Reference Grid Coordinates (UTM)
365000 FT	Horizontal Reference Grid Coordinates (State Plane)
80° 16’ 52.5”	Corner Coordinates (Latitude, Longitude)

SECTION 2.0 – FLOODPLAIN MANAGEMENT APPLICATIONS

2.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance (500-year) flood is employed to indicate additional areas of flood hazard in the community.

Each flooding source included in the project scope has been studied and mapped using professional engineering and mapping methodologies that were agreed upon by FEMA and Brown County as appropriate to the risk level. Flood risk is evaluated based on factors such as known flood hazards and projected impact on the built environment. Engineering analyses were performed for each studied flooding source to calculate its 1-percent-annual-chance flood elevations; elevations corresponding to other floods (e.g. 10-, 4-, 2-, 0.2-percent-annual-chance, etc.) may have also been computed for certain flooding sources. Engineering models and methods are described in detail in Section 5.0 of this FIS Report. The modeled elevations at cross sections were used to delineate the floodplain boundaries on the FIRM; between cross sections, the boundaries were interpolated using elevation data from various sources. More information on specific mapping methods is provided in Section 6.0 of this FIS Report.

Depending on the accuracy of available topographic data (Table 22), study methodologies employed (Section 5.0), and flood risk, certain flooding sources may be mapped to show both the 1- and 0.2-percent-annual-chance floodplain boundaries, regulatory water surface elevations (BFEs),and/or a regulatory floodway. Similarly, other flooding sources may be mapped to show only the 1-percent-annual-chance floodplain boundary on the FIRM, without published water surface elevations. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent- annual-chance floodplain boundary is shown on the FIRM. Figure 3, “Map Legend for FIRM”, describes the flood zones that are used on the FIRMs to account for the varying levels of flood risk that exist along flooding sources within the project area. Table 2 and Table 3 indicate the flood zone designations for each flooding source and each community within Brown County, respectively.

Table 2, “Flooding Sources Included in this FIS Report,” lists each flooding source, including its study limits, affected communities, mapped zone on the FIRM, and the completion date of its engineering analysis from which the flood elevations on the FIRM and in the FIS Report were derived. Descriptions and dates for the latest hydrologic and hydraulic analyses of the flooding sources are shown in Table 12. Floodplain boundaries for these flooding sources are shown on the FIRM (published separately) using the symbology described in Figure 3. On the map, the 1-percent-annual-chance floodplain corresponds to the SFHAs. The 0.2-percent annual chance floodplain shows areas that, although out of the regulatory floodplain, are still subject to flood hazards.

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. The procedures to remove these areas from the SFHA are described in Section 6.5 of this FIS Report.

Table 2: Flooding Sources Included in this FIS Report

Flooding Source	Community/ Tribal Nation	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Apple Creek	Brown County, Unincorporated Areas	At confluence with Fox River	At upstream limit of approximate study	04030204			N	A	2006
Ash Street Tributary to Lancaster Creek	Howard, Village of	Approximately 500 feet downstream of Ash Street	Approximately 150 feet upstream of Ash Street	04030204	0.1		Y	AE	2006
Ashwaubenon Creek	Ashwaubenon, Village of; Brown County, Unincorporated Areas; De Pere, City of	Mouth at Fox River	Just upstream of confluence of Hemlock Creek	04030204	3.2		Y	AE	2006
		Just upstream of confluence of Hemlock Creek	Just upstream of Southbridge Road	04030204			N	A	2006
Ashwaubenon Creek (Middle)	Brown County, Unincorporated Areas; De Pere, City of	Just upstream of Southbridge Road	At Brown County/City of De Pere Corporate Limits	04030204	2.2		Y	AE	2006
Ashwaubenon Creek (Upper)	Brown County, Unincorporated Areas	At Brown County/City of De Pere Corporate Limits	Approximately 170 feet downstream of Williams Grant Drive	04030204			N	A	2006
		Approximately 170 feet downstream of Williams Grant Drive	At convergence of North Branch and South Branch of Ashwaubenon Creek	04030204	0.1		Y	AE	2006
Baird Creek	Green Bay, City of	Mouth at East River	At 7th Street	04030204	7.9		Y	AE	2006
Baird Creek Tributary	Green Bay, City of	Mouth at Baird Creek	Approximately 0.3 mile upstream of Finger Road	04030204	2.0		Y	AE	2006

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community/ Tribal Nation	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Baird Creek Tributary 6	Green Bay, City of	Mouth at Baird Creek	Approximately 0.2 mile upstream from Railroad	04030204	0.3		Y	AE	2006
Bakers Creek	Howard, Village of	Approximately 250 feet downstream of Belmont Road	Approximately 0.2 mile upstream of Hillcrest Heights	04030103	0.6		Y	AE	2006
Bakers Creek Tributary	Howard, Village of	At Velp Avenue	Approximately 0.5 mile upstream of Velp Avenue	04030103	0.5		Y	AE	2006
Barina Creek	Green Bay, City of	Approximately 375 feet downstream of Church Road	Approximately 0.3 mile upstream of Church Road	04030204	0.4		Y	AE	2006
Beaver Dam Creek	Green Bay, City of; Howard, Village of	At confluence with Duck Creek	Approximately 0.3 mile upstream of Packerland Drive	04030204	6.7		Y	AE	2006
Bower Creek	Bellevue, Village of; Brown County, Unincorporated Areas	Mouth at East River	Approximately 0.6 mile upstream of Golf Course Bridge	04030204	5.8		Y	AE	2006
		Approximately 0.6 mile upstream of Golf Course Bridge	At upstream limit of study	04030204			N	A	2006
Bower Creek Tributary	Brown County, Unincorporated Areas	Approximately 515 feet downstream of Pine Grove Road	Approximately 105 feet upstream from Dickinson Road	04030204	0.3		Y	AE	2006
		At confluence of Bower Creek	At upstream limit of approximate study	04030204			N	A	2006
Bower Creek Tributary 1	Bellevue, Village of; Brown County, Unincorporated Areas	Approximately 45 feet downstream of Monroe Road	Approximately 1.2 miles upstream of Bower Creek Road	04030204	2.1		Y	AE	2006

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community/ Tribal Nation	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Bower Creek Tributary 2	Bellevue, Village of; Brown County, Unincorporated Areas	Approximately 110 feet downstream of Bower Creek Road	Approximately 0.6 mile upstream of Meadow Sound Drive	04030204	1.8		Y	AE	2006
Bower Creek Tributary A	Bellevue, Village of; Brown County, Unincorporated Areas	At confluence of Bower Creek	Approximately 0.2 mile upstream of Golf Course Bridge	04030204	1.0		Y	AE	2006
		Approximately 0.2 mile upstream of Golf Course Bridge	At upstream limit of approximate study	04030204			N	A	2006
Bower Creek Tributary B	Bellevue, Village of; Brown County, Unincorporated Areas	At confluence of Bower Creek	Approximately 0.2 mile upstream of Driveway	04030204	0.5		Y	AE	2006
		Approximately 0.2 mile upstream of Driveway	At upstream limit of approximate study	04030204			N	A	2006
Branch of Plum Creek	Brown County, Unincorporated Areas	Approximately 405 feet downstream of confluence of Branch of Plum Creek Upper Tributary	Approximately 0.1 mile upstream of confluence of Branch of Plum Creek Lower Tributary	04030204	0.6		Y	AE	2006
Branch of Plum Creek Lower Tributary	Brown County, Unincorporated Areas	At confluence with Plum Creek	At Brown County/ Manitowoc County Boundary	04030204	0.3		Y	AE	2006
Branch of Plum Creek Upper Tributary	Brown County, Unincorporated Areas	At confluence with Branch of Plum Creek	Approximately 0.3 mile upstream of confluence with Branch of Plum Creek	04030204	0.3		Y	AE	2006

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community/ Tribal Nation	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Branch of Plum Creek Upper Tributary *(continued)*	Brown County, Unincorporated Areas	Approximately 0.3 mile upstream of confluence with Branch of Plum Creek	At upstream limit of approximate study	04030204			N	A	2006
Branch River	Brown County, Unincorporated Areas	Approximately 100 feet downstream of Hill Road	Approximately 0.8 mile upstream of Park Bridge	04030101	3.1		Y	AE	2006
Branch River Downstream	Brown County, Unincorporated Areas	At Brown County/ Manitowoc County Boundary	Approximately 100 feet downstream of Hill Road	04030101			N	A	2006
Branch River Upstream	Brown County, Unincorporated Areas	Approximately 0.8 mile upstream of Park bridge	At upstream limit of approximate study	04030101			N	A	2006
Duck Creek	Green Bay, City of; Hobart and Howard, Villages of; The Oneida Nation of Wisconsin	Mouth of Green Bay	At Brown County/ Outagamie County Boundary	04030204	14.5		Y	AE	2006
Duck Creek Tributary Stream 11	Green Bay, City of; The Oneida Nation of Wisconsin	Mouth at Duck Creek	Approximately 0.2 mile upstream of Open Gate Trail	04030204	0.9		Y	AE	2006
Duck Creek Tributary 12	Green Bay, City of; Hobart, Village of; The Oneida Nation of Wisconsin	At confluence with Duck Creek	Approximately 0.4 mile upstream of West Mason Street	04030204	0.5		Y	AE	2006
Dutchman Creek	Allouez, Ashwaubenon, and Hobart, Villages of	At confluence with Fox River	Approximately 0.3 mile upstream of Packerland Drive Culvert	04030204	5.0		Y	AE	1989
Dutchman Creek North Tributary	Ashwaubenon, Village of	At confluence with Dutchman Creek	Approximately 120 feet upstream of North Road	04030204	2.2		Y	AE	2006

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community/ Tribal Nation	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Dutchman Creek SouthTributary	Ashwaubenon, Village of	At confluence with Dutchman Creek	Approximately 0.1 mile upstream of North Road	04030204	0.9		Y	AE	2006
Dutchman Creek Southeast Tributary	Ashwaubenon, Village of	At confluence with Dutchman Creek	Approximately 0.1 mile upstream of Sand Acres Drive	04030204	1.3		Y	AE	2006
Dutchman Creek Southwest Tributary	Ashwaubenon, Village of	At confluence with Dutchman Creek	Approximately 0.2 mile upstream of confluence of Tributary 3 Dutchman Creek Southwest Tributary	04030204	1.7		Y	AE	2006
		Approximately 0.2 mile upstream of confluence of Tributary 3 Dutchman Creek Southwest Tributary	At upstream limit of approximate study	04030204			N	A	2006
East River	Allouez and Bellevue, Villages of; Brown County, Unincorporated Areas; De Pere and Green Bay, Cities of	At confluence with Fox River	At Wrightstown Road	04030204	23.5		Y	AE	1990
	Brown County, Unincorporated Areas	At Wrightstown Road	At upstream limit of approximate study	04030204			N	A	1990
East River Tributary	Brown County, Unincorporated Areas	Approximately 60 feet downstream of Monroe Road	Approximately 70 feet upstream of Dickinson Road	04030204	0.6		Y	AE	2006

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community/ Tribal Nation	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
East River Tributary A	Brown County, Unincorporated Areas; De Pere, City of	At confluence with East River	Approximately 0.1 mile upstream of Heritage Road	04030204	1.7		Y	AE	1994
East River Tributary B	Brown County, Unincorporated Areas	At confluence with East River Tributary A	Approximately 0.3 mile upstream of East River Tributary A	04030204	0.3		Y	AE	1994
East River Tributary C	Brown County, Unincorporated Areas	At confluence with East River	At upstream limit of approximate study	04030204			N	A	2006
East River Tributary D	Brown County, Unincorporated Areas	At confluence with East River	At upstream limit of approximate study	04030204			N	A	2006
East River Tributary D2	Brown County, Unincorporated Areas	At confluence with East River Tributary D	At upstream limit of approximate study	04030204			N	A	2006
East River Tributary E	Brown County, Unincorporated Areas	At confluence with East River	At upstream limit of approximate study	04030204			N	A	2006
East River Tributary E2	Brown County, Unincorporated Areas	At confluence with East River Tributary E	At upstream limit of approximate study	04030204			N	A	2006
East River Tributary F	Brown County, Unincorporated Areas	At confluence with East River	At upstream limit of approximate study	04030204			N	A	2006
East River Tributary F2	Brown County, Unincorporated Areas	At confluence with East River Tributary F	At upstream limit of approximate study	04030204			N	A	2006
East River Tributary G	Brown County, Unincorporated Areas	At confluence with East River	At upstream limit of approximate study	04030204			N	A	2006

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community/ Tribal Nation	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
East River Tributary G2	Brown County, Unincorporated Areas	At confluence with East River Tributary G	At upstream limit of approximate study	04030204			N	A	2006
East River Tributary H	Brown County, Unincorporated Areas	At confluence with East River	At upstream limit of approximate study	04030204			N	A	2006
East River Tributary I	Brown County, Unincorporated Areas	At confluence with East River	At upstream limit of approximate study	04030204			N	A	2006
East River Tributary J	Brown County, Unincorporated Areas	At confluence with East River	At upstream limit of approximate study	04030204			N	A	2006
East River Tributary J2	Brown County, Unincorporated Areas	At confluence with East River Tributary J	At upstream limit of approximate study	04030204			N	A	2006
East River Tributary J3	Brown County, Unincorporated Areas	At confluence with East River Tributary J	At upstream limit of approximate study	04030204			N	A	2006
East Verlin North Tributary to Willow Creek	Bellevue, Village of	Mouth at East Verlin Tributary to Willow Creek	Approximately 15 feet upstream of Railroad	04030204	0.1		Y	AE	2006
East Verlin Tributary to Willow Creek	Bellevue, Village of; Green Bay, City of	At confluence with Willow Creek	Approximately 0.4 mile upstream of confluence of East Verlin North Tributary to Willow Creek	04030204	1.3		Y	AE	2006
Ellis Creek	Green Bay, City of	Approximately 0.5 mile downstream of Edgewood Drive	Approximately 0.5 mile upstream of Edgewood Drive	04030204	1.0		Y	AE	2006

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community/ Tribal Nation	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
ERT Overflow 1	Brown County, Unincorporated Areas	At confluence with East River Tributary	At upstream limit of detailed study	04030204	0.2		Y	AE	2006
ERT Overflow 2	Brown County, Unincorporated Areas	At confluence with East River Tributary	At upstream limit of detailed study	04030204	0.2		Y	AE	2006
Fox River	Allouez, Ashwaubenon, and Wrightstown, Villages of; Brown County, Unincorporated Areas; De Pere and Green Bay, Cities of	Approximately 0.5 mile downstream of Interstate 43	At Brown County/ Outagamie County Boundary	04030204 04060200	19.5		Y	AE	2016*
Green Bay/Lake Michigan	Brown County, Unincorporated Areas; Green Bay, City of; Howard and Suamico, Villages of	Entire shoreline within Brown County	Entire shoreline within Brown County	04030102 04030103 04030204	33.3		N	AE, VE	2017
Haller Creek	Suamico, Village of	At confluence with Suamico River	At Brown County/ Oconto County Boundary	04030103			N	A	2006
Hemlock Creek	Brown County, Unincorporated Areas; De Pere, City of	At confluence with Ashwaubenon Creek	At Quarry Park Drive	04030204	0.2		N	A	2006
Lancaster Creek	Howard, Village of	At confluence with Duck Creek at Riverview Drive	Approximately 0.7 mile upstream of Shawano Avenue	04030204	3.9		Y	AE	1991
		Approximately 0.7 mile upstream of Shawano Avenue	At upstream limit of approximate study	04030204			N	A	1991
Lancaster Creek Tributary	Howard, Village of	At Rockwell Road	Approximately 0.3 mile upstream of Rockwell Road	04030103	0.3		Y	AE	2006

*WDNR, 2016

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community/ Tribal Nation	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Mahon Creek	Green Bay, City of	Mouth at Green Bay	Approximately 0.3 mile upstream of Spartan Road	04030204	3.3		Y	AE	2006
Middle Branch Little Suamico River	Pulaski, Village of	At Brown County/Oconto County Boundary	Approximately 40 feet downstream of Summit Street	04030103			N	A	2006
		Approximately 40 feet downstream of Summit Street	At Brown County/ Shawano County Boundary	04030103	1.0		Y	AE	2006
Moose Creek	Suamico, Village of	Just downstream of Rainbow Drive	Approximately 0.1 mile upstream of Northwood Road	04030103			N	A	2006
Neshota River	Brown County, Unincorporated Areas	At Brown County/ Manitowoc County Boundary	Approximately 55 feet upstream of Bridge in Section 22 and 23 T22N R22E	04030101	3.6		Y	AE	2006
		Approximately 55 feet upstream of Bridge Section 22 and 23 T22N R22E	At upstream limit of approximate study	04030101			N	A	2006
North Branch Ashwaubenon Creek	Brown County, Unincorporated Areas; Hobart, Village of	At confluence with South Branch Ashwaubenon Creek	North County Line Road at Brown County/Outagamie County Boundary	04030204	2.5		Y	AE	2006
North Branch Bakers Creek	Howard, Village of	At confluence with Bakers Creek	Approximately 0.4 mile upstream of confluence with Bakers Creek	04030103	0.4		Y	AE	2006
North Branch Suamico River	Brown County, Unincorporated Areas	At confluence with Suamico River	At Brown County/ Oconto County Boundary	04030103			N	A	2006

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community/ Tribal Nation	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
North Branch Wequiock Creek	Brown County, Unincorporated Areas	Just downstream of Nicolet Drive	At upstream limit of approximate study	04030102	0.5		N	A	2006
North Branch Willow Creek	Bellevue, Village of; Green Bay, City of	At confluence with Willow Creek	Approximately 1.8 miles upstream of Manitowoc Road	04030204	2.3		Y	AE	2006
North Pulaski Tributary	Pulaski, Village of	At Brown County/ Shawano County Boundary	At Brown County/ Oconto County Boundary	04030103			N	A	2006
North Tributary South Branch Ashwaubenon Creek	Brown County, Unincorporated Areas	At confluence with South Branch Ashwaubenon Creek	Approximately 0.4 mile upstream of confluence with South Branch Ashwaubenon Creek	04030204	0.4		Y	AE	2006
Oneida Creek	Green Bay, City of; The Oneida Nation of Wisconsin	At confluence with Duck Creek	Approximately 0.9 mile upstream of Country Club Court	04030103	1.1		Y	AE	2006
Pioneer Tributary to Duck Creek	Howard, Village of	At confluence with Duck Creek	Approximately 150 feet upstream of Cardinal Lane	04030204	0.2		Y	AE	2006
Plum Creek	Brown County, Unincorporated Areas; Wrightstown, Village of	At confluence with Fox River	Approximately 3.0 miles upstream of confluence with Fox River	04030204	2.9		Y	AE	2006
		Approximately 3.0 miles upstream of confluence with Fox River	At upstream limit of detailed study	04030204			N	A	2006
Plum Creek Tributary 1	Brown County, Unincorporated Areas	At confluence with Plum Creek	At upstream limit of approximate study	04030204			N	A	2006

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community/ Tribal Nation	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Plum Creek Tributary 2	Brown County, Unincorporated Areas	At confluence with Plum Creek Tributary 1	At upstream limit of approximate study	04030204			N	A	2006
Plum Creek Tributary 3	Brown County, Unincorporated Areas	At confluence with Plum Creek	At Brown County/ Manitowoc County Boundary	04030204			N	A	2006
Plum Creek Tributary 4	Brown County, Unincorporated Areas	At confluence with Plum Creek	At Brown County/ Manitowoc County Boundary	04030204			N	A	2006
Potter Creek	Brown County, Unincorporated Areas	At confluence with Suamico River	At Brown County/ Shawano County Boundary	04030103			N	A	2006
Sorensons Creek	Bellevue, Village of	At confluence with Spring Creek	Approximately 70 feet upstream of Big Creek Road	04030204	3.7		Y	AE	2006
	Bellevue, Village of; Brown County, Unincorporated Areas	Approximately 70 feet upstream of Big Creek Road	At upstream limit of approximate study	04030204			N	A	2006
Sorensons Creek Tributary	Bellevue, Village of	At confluence with Sorensons Creek	Approximately 0.6 mile upstream of Manitowoc Road	04030204	2.8		Y	AE	2006
South Branch Ashwaubenon Creek	Brown County, Unincorporated Areas	At confluence of Ashwaubenon Creek Upper	Approximately 0.2 mile upstream of Freedom Road	04030204	2.3		Y	AE	2006
South Branch Little Suamico River	Brown County, Unincorporated Areas; Pulaski, Village of	At Corporate Way	At Brown County/ Shawano County Boundary	04030103	2.0		Y	AE	2006
South Tributary to Willow Creek	Bellevue, Village of	Mouth at Willow Creek	Approximately 0.1 mile upstream of Limekiln Road	04030204	1.1		Y	AE	2006

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community/ Tribal Nation	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Spring Creek	Bellevue, Village of	Mouth at Bower Creek	Approximately 0.3 mile upstream of Willow Road	04030204	7.6		Y	AE	2006
Spring Creek Tributary A	Bellevue, Village of; Green Bay, City of	Mouth at Spring Creek	Approximately 160 feet upstream of Ontario Road	04030204	1.6		Y	AE	2006
		Approximately 160 feet upstream of Ontario Road	At upstream limit of detailed study	04030204			N	A	2006
Spring Creek Tributary A Ditch	Bellevue, Village of	At confluence with Spring Creek Tributary A	Approximately 0.1 mile upstream of confluencewith Spring Creek Tributary A	04030204	0.1		Y	AE	2006
Spring Creek Tributary B	Bellevue, Village of	Mouth at Spring Creek	Approximately 450 feet upstream of Cottage Road	04030204	0.6		Y	AE	2006
Suamico River	Brown County, Unincorporated Areas; Suamico, Village of	Mouth at Green Bay	At Flintville Lane	04030103 04060200	8.6		Y	AE	2006
		At Flintville Lane	At upstream limit of detailed study	04030103 04060200			N	A	2006
Tributary 1 to Dutchman Creek Southwest Tributary	Ashwaubenon and Hobart, Villages of	Mouth at Dutchman Creek Southwest Tributary	Approximately 475 feet upstream of South Packerland Drive	04030204	0.5		Y	AE	2006
Tributary 2 to Dutchman Creek Southwest Tributary	Ashwaubenon, Village of	Mouth at Dutchman Creek Southwest Tributary	Approximately 0.5 mile upstream of Mouth at Dutchman Creek Southwest Tributary	04030204	0.5		Y	AE	2006

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community/ Tribal Nation	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Tributary 3 to Dutchman Creek Southwest Tributary	Ashwaubenon, Village of	Mouth at Dutchman Creek Southwest Tributary	Approximately 0.4 mile upstream of Mouth at Dutchman Creek Southwest Tributary	04030204	0.4		Y	AE	2006
		Approximately 0.4 mile upstream of Mouth at Dutchman Creek Southwest Tributary	At upstream limit of detailed study	04030204			N	A	2006
Trout Creek	Green Bay, City of; Hobart, Village of; The Oneida Nation of Wisconsin	At confluence with Duck Creek	At Sunlit Drive	04030103	9.4		Y	AE	2012
Unnamed Tributary 1 to Duck Creek	Hobart, Village of; The Oneida Nation of Wisconsin	At confluence with Duck Creek	At upstream limit of approximate study	04030103			N	A	2006
Unnamed Tributary 1.1 to Duck Creek	Hobart, Village of; The Oneida Nation of Wisconsin	At confluence with Unnamed Tributary 1 to Duck Creek	At upstream limit of approximate study	04030103			N	A	2006
Unnamed Tributary 1.2 to Duck Creek	Hobart, Village of	At confluence with Unnamed Tributary 1 to Duck Creek	At upstream limit of approximate study	04030103			N	A	2006
Unnamed Tributary 1.2.1 to Duck Creek	Hobart, Village of; The Oneida Nation of Wisconsin	At confluence with Unnamed Tributary 1.2 to Duck Creek	At upstream limit of approximate study	04030103			N	A	2006
Unnamed Tributary 1 to Ashwaubenon Creek	Brown County, Unincorporated Areas	At confluence with Ashwaubenon Creek	At upstream limit of approximate study	04030204			N	A	2006
Unnamed Tributary 2 to Ashwaubenon Creek	Brown County, Unincorporated Areas	At confluence with Ashwaubenon Creek	At upstream limit of approximate study	04030204			N	A	2006
Unnamed Tributary to Bower Creek	Brown County, Unincorporated Areas	At confluence with Bower Creek	At upstream limit of approximate study	04030204			N	A	2006
Unnamed Tributary to Bower Creek Tributary B	Brown County, Unincorporated Areas	At confluence with Bower Creek Tributary B	At upstream limit of approximate study	04030204			N	A	2006

Table 2: Flooding Sources Included in this FIS Report *(continued)*

Flooding Source	Community/ Tribal Nation	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Unnamed Tributary to Green Bay	Green Bay, City of	At confluence with Green Bay	Approximately 0.3 mile upstream of Nicolet Drive	04030204	0.4		Y	AE	2006
Unnamed Tributary to Haller Creek	Suamico, Village of	At confluence with Haller Creek	At upstream limit of approximate study	04030103			N	A	2006
Unnamed Tributary to Plum Creek	Brown County, Unincorporated Areas	At confluence with Plum Creek	At upstream limit of approximate study	04030204			N	A	2006
Unnamed Tributary to the West Branch Suamico River	Brown County, Unincorporated Areas	At confluence with West Branch Suamico River	At Brown County/ Outagamie County Boundary	04030103			N	A	2006
Vanguard Way Tributary to Lancaster Creek	Howard, Village of	At confluence with Lancaster Creek	Approximately 0.1 mile upstream of confluence with Lancaster Creek	04030103	0.1		Y	AE	2006
Wequiock Creek	Brown County, Unincorporated Areas	At confluence with Green Bay	At convergence of North Branch Wequiock Creek and South Branch Wequiock Creek	04030102			N	A	2006
West Branch Suamico River	Brown County, Unincorporated Areas	At confluence with Suamico River	At Brown County/ Outagamie County Boundary	04030103			N	A	2006
West Verlin Tributary to Willow Creek	Allouez and Bellevue, Villages of; Green Bay, City of	At confluence with East River	At confluence of East Verlin Tributary to Willow Creek	04030204	7.9		Y	AE	2006
	Bellevue, Village of	Approximately 1,260 feet upstream of confluence with East River	At confluence of Willow Creek	04030204	0.2		Y	AE	2006
Willow Creek	Bellevue, Village of	Approximately 500 feet downstream of Allouez Avenue	Approximately 0.4 mile downstream of Bellevue Road	04030204	0.7		Y	AE	2006
	Bellevue, Village of	Approximately 0.4 mile downstream of Bellevue Road	Approximately 0.3 mile upstream of Bellevue Road	04030204	0.2		Y	AE	2017
	Bellevue, Village of; Green Bay, City of	Approximately 0.3 mile upstream of Bellevue Road	Approximately 0.3 mile upstream of Ontario Road	04030204	6.4		Y	AE	2006

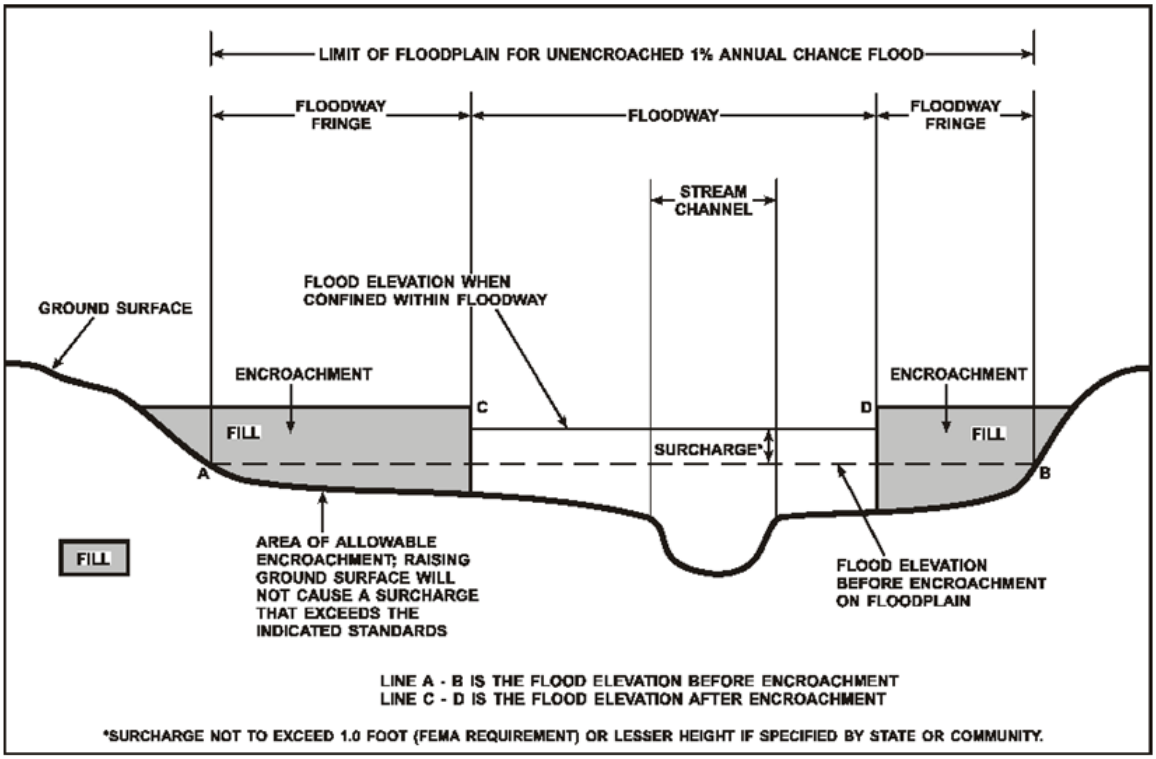
2.2 Floodways

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 balancing floodplain development against increasing flood hazard. With this approach, the area of the 1-percent-annual-chance floodplain on a river is divided into a floodway and a floodway fringe based on hydraulic modeling.The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment in order to carry the 1-percent-annual-chance flood. The floodway fringe is the area between the floodway and the 1-percent annual chance floodplain boundaries where encroachment is permitted. The floodway must be wide enough so that the floodway fringe 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 4.

To participate in the NFIP, Federal regulations require communities to limit increases caused by encroachment to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this project are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway projects.

Figure 4: Floodway Schematic



Floodway widths presented in this FIS Report and on the FIRM were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. For certain stream segments, floodways were adjusted so that the amount of floodwaters conveyed on each side of the floodplain would be reduced equally. The results of the floodway computations have been tabulated for selected cross sections and are shown in Table 23, “Floodway Data.”

All floodways that were developed for this Flood Risk Project are shown on the FIRM using the symbology described in Figure 3. 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 on the FIRM. For information about the delineation of floodways on the FIRM, refer to Section 6.3.

2.3 Base Flood Elevations

The hydraulic characteristics of flooding sources were analyzed to provide estimates of the elevations of floods of the selected recurrence intervals. The BFE is the elevation of the 1-percent-annual-chance flood. These BFEs are most commonly rounded to the whole foot, as shown on the FIRM, but in certain circumstances or locations they may be rounded to 0.1 foot. Cross section lines shown on the FIRM may also be labeled with the BFE rounded to 0.1 foot. Whole-foot BFEs derived from engineering analyses that apply to coastal areas, areas of ponding, or other static areas with little elevation change may also be shown at selected intervals on the FIRM.

BFEs are primarily intended for flood insurance rating purposes. Cross sections with BFEs shown on the FIRM correspond to the cross sections shown in the Floodway Data table and Flood Profiles in this FIS Report. 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. For example, the user may use the FIRM to determine the stream station of a location of interest and then use the profile to determine the 1-percent-annual-chance elevation at that location. Because only selected cross sections may be shown on the FIRM for riverine areas, the profile should be used to obtain the flood elevation between mapped cross sections. Additionally, for riverine areas, whole-foot elevations shown on the FIRM may not exactly reflect the elevations derived from the hydraulic analyses; therefore, elevations obtained from the profile may more accurately reflect the results of the hydraulic analysis.

2.4 Non-Encroachment Zones

This section is not applicable to this Flood Risk Project.

2.5 Coastal Flood Hazard Areas

For most areas along rivers, streams, and small lakes, BFEs and floodplain boundaries are based on the amount of water expected to enter the area during a 1-percent-annual-chance flood and the geometry of the floodplain. Floods in these areas are typically caused by runoff from storm events. However, for areas on, or near, the Great Lakes, ocean coasts, large rivers, or other large bodies of water, the BFE and floodplain boundaries may be based on additional components that include storm surge and wave dynamics.

Coastal flooding sources that are included in this Flood Risk Project are shown in Table 2.

2.5.1 Water Elevations and the Effects of Waves

Specific terminology is used in coastal analyses to indicate which components have been included in evaluating flood hazards.

The stillwater elevation (SWEL or still water level) is the surface of the water resulting from astronomical tides, storm surge, and freshwater inputs, but excluding wave setup contribution or the effects of waves.

- *Astronomical tides* are periodic rises and falls in large bodies of water caused by the rotation of the earth and by the gravitational forces exerted by the earth, moon and sun. Tidal-induced fluctuations in the Great Lakes are small and their presence is masked by the normal fluctuations due to atmospheric forcing. The Great Lakes can be treated as if no tidal signal exists, and this contribution to water levels is neglected.

- *Storm surge*, inclusive of wind setup and seiche-induced fluctuation, is the additional water depth that occurs during large storm events. These events can bring air pressure changes and strong winds that force water up against the shore. The most common cause of a large seiche in the Great Lakes is the oscillating water level after a storm that moves over the lake, with the downwind portion of the lake subject to wind setup as water piles up against the coast and the upwind portion subject to a decrease in water levels.

- *Freshwater inputs* include rainfall that falls directly on the body of water, runoff from surfaces and overland flow, and inputs from rivers.

The 1-percent-annual-chance stillwater elevation is the stillwater elevation that has been calculated for a storm surge from a 1-percent-annual-chance storm. The 1-percent-annual-chance storm surge can be determined from analyses of water level station records, statistical study of regional historical storms, or other modeling approaches. Stillwater elevations for storms of other frequencies can be developed using similar approaches.

The total stillwater elevation (also referred to as the mean water level) is the stillwater elevation plus wave setup contribution but excluding the other effects of waves, such as wave runup and overland wave propagation.

- *Wave setup* is the increase in stillwater elevation at the shoreline caused by the reduction of waves in shallow water. It occurs as breaking wave momentum is transferred to the water column.

Like the stillwater elevation, the total stillwater elevation is based on a storm of a particular frequency, such as the 1-percent-annual-chance storm. Wave setup is typically estimated using standard engineering practices or calculated using models, since water level stations are often located in areas sheltered from wave action and do not capture wave height or wave setup information.

Coastal analyses may examine the effects of overland waves by analyzing storm-induced erosion, overland wave propagation, wave runup, and/or wave overtopping.

- *Storm-induced erosion* is the modification of existing topography by erosion caused by a specific storm event, as opposed to long-term erosion that occurs over time.
- *Overland wave propagation* describes the combined effects of variation in ground elevation, vegetation, and physical features on wave characteristics as waves move onshore.
- *Wave runup* is the uprush of water from wave action on a shore barrier. It is a function of the roughness and geometry of the shoreline at the point where the stillwater elevation intersects the land as shown in Figure 5a.
- *Wave overtopping* refers to the flooding that occurs when wave runup passes over the crest of a barrier as shown in Figure 5b.

Figure 5a: Wave Runup Transect Schematic

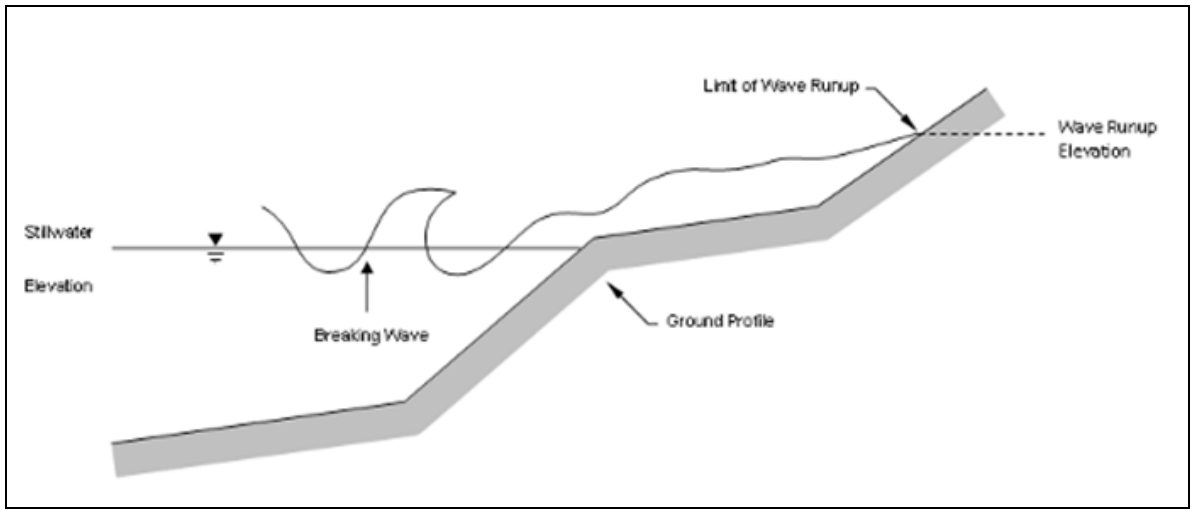


Figure 5b: Wave Overtopping Schematic

2.5.2 Floodplain Boundaries and BFEs for Coastal Areas

For coastal communities along the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, and the Caribbean Sea, flood hazards must take into account how storm surges, waves, and in some cases extreme tides or lake level variations interact with factors such as topography, structures, and vegetation. Storm surge and waves must also be considered in assessing flood risk for certain communities on rivers or large inland bodies of water.

Beyond areas that are affected by storm surge and waves, coastal communities can also have riverine floodplains with designated floodways, as described in previous sections.

Floodplain Boundaries

In many coastal areas, storm surge is the principle component of flooding. The extent of the 1-percent-annual-chance floodplain in these areas is derived from the stillwater elevation for the 1-percent-annual-chance storm. The methods used for calculation of stillwater elevations for coastal areas are described in Section 5.3 of this FIS Report.

In areas dominated by overland wave propagation, the coastal BFEs represent the wave dissipation and generation as the wave propagates landward from the shoreline. The landward extent of the 1-percent-annual-chance floodplain is determined by the stillwater elevation with the addition of wave setup, where applicable. The methods used for calculation of wave setup and overland wave propagation are described in Section 5.3 of this FIS Report.

In some areas, the 1-percent-annual-chance floodplain is determined based on the limit of wave runup or wave overtopping for the 1-percent-annual-chance storm surge. The Special Flood Hazard Area (SFHA) extent is determined based on the elevation of the land in relation to the wave runup elevation or the amount of wave overtopping. For areas dominated by wave runup, the coastal BFE can vary from reach to reach. Where wave runup exceeds the crest of a coastal feature, the SFHA extent is determined by the limit of the overtopping zone. The methods that were used for calculation of wave runup and overtopping hazards are described in Section 5.3 of this FIS Report.

Table 25 presents the types of coastal analyses that were used in mapping the 1-percent-annual-chance floodplain in coastal areas.

Coastal BFEs

Coastal BFEs are calculated as the stillwater elevation for the 1-percent-annual-chance storm plus the additional flood hazard from wave effects (storm-induced erosion, wave setup, overland wave propagation, wave runup, and wave overtopping).

Where they apply, coastal BFEs are calculated along transects extending from offshore to the limit of coastal flooding onshore. Results of these analyses are accurate until local topography, vegetation, or development type and density within the community undergoes major changes.

Parameters that were included in calculating coastal BFEs for each transect included in this FIS Report are presented in Table 16, “Coastal Transect Parameters.” The locations of transects are shown in Figure 9, “Transect Location Map.” More detailed information about the methods used in coastal analyses and the results of intermediate steps in the coastal analyses are presented in Section 5.3 of this FIS Report. Additional information on specific mapping methods is provided in Section 6.4 of this FIS Report.

2.5.3 Coastal High Hazard Areas

Certain areas along the open coast and other areas may have higher risk of experiencing structural damage caused by wave action and/or high-velocity water during the 1-percent-annual-chance flood. These areas will be identified on the FIRM as Coastal High Hazard Areas.

- *Coastal High Hazard Areas (CHHA)* is a SFHA extending from offshore to the inland limit of the primary frontal dune (PFD) or any other area subject to damages caused by wave action and/or high-velocity water during the 1-percent-annual-chance flood.
- *Primary Frontal Dune (PFD)* is a continuous or nearly continuous mound or ridge of sand with relatively steep slopes immediately landward and adjacent to the beach. The PFD is subject to erosion and overtopping from high tides and waves during major coastal storms.

The landward limit of the PFD occurs at a point where there is a distinct change from a relatively steep slope to a relatively mild slope; this point represents the landward extension of Zone VE.

No PFDs were identified within Brown County.

CHHAs are designated as "VE" zones (for "velocity wave zones") and are subject to more stringent regulatory requirements and a different flood insurance rate structure. BFEs are assigned to Zones VE on the FIRM. More detailed information about the identification and designation of Zone VE is presented in Section 6.4 of this FIS Report.

Areas that are not within the CHHA but are SFHAs may still be impacted by coastal flooding and damaging waves; these areas are shown as "AE" zones on the FIRM.

Figure 6a, "Coastal Transect Schematic (Wave Runup and Overtopping)," illustrates the relationship between the base flood elevation, the 1-percent-annual-chance stillwater elevation, and the ground profile as well as the location of the Zone VE and Zone AE/AO in areas subject to wave runup and overtopping.

Figure 6a: Coastal Transect Schematic (Wave Runup and Overtopping)

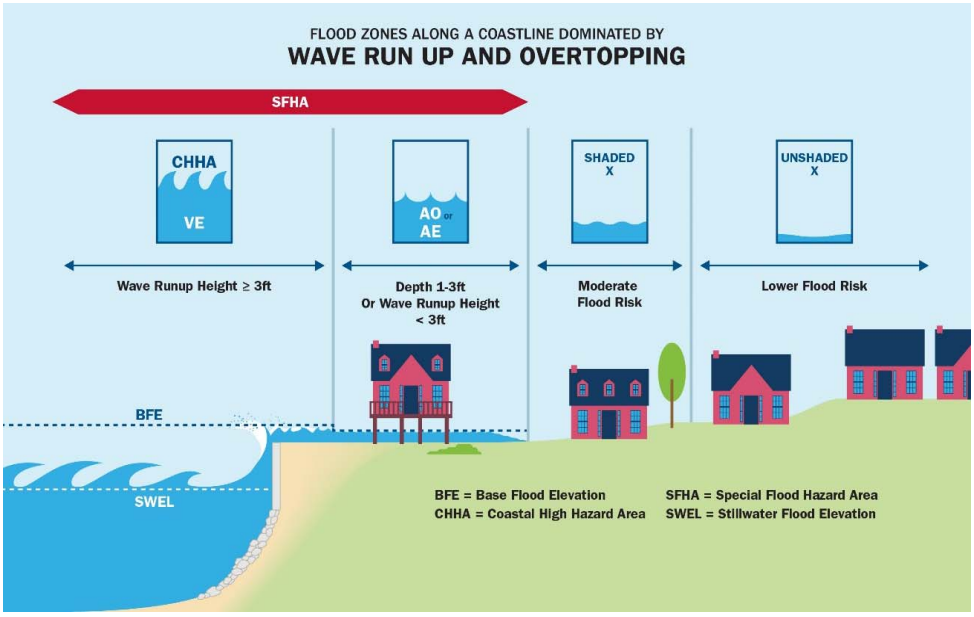
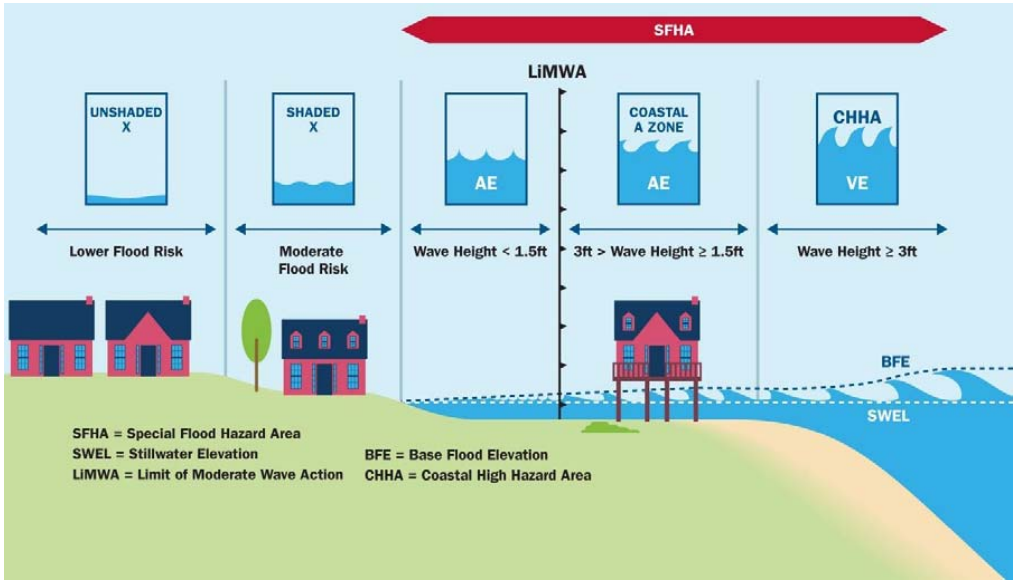


Figure 6b, “Coastal Transect Schematic (Overland Wave Propagation),” illustrates the relationship between the base flood elevation, the 1-percent annual chance stillwater elevation, and the ground profile as well as the location of the Zone VE and Zone AE in areas subject to overland wave propagation. This figure also illustrates energy dissipation and regeneration of a wave as it moves inland.

Figure 6b: Coastal Transect Schematic (Overland Wave Propagation)



Methods used in coastal analyses in this Flood Risk Project are presented in Section 5.3 and mapping methods are provided in Section 6.4 of this FIS Report.

Coastal floodplains are shown on the FIRM using the symbology described in Figure 3, “Map Legend for FIRM.” The BFE mapped on the FIRM at the shoreline is determined by the 1-percent annual chance total water elevation, which includes the stillwater elevation plus wave effects. The 1-percent annual chance total water elevations are included in Table 16, along with the statistical stillwater elevations. If the BFE on the FIRM is higher than the stillwater elevations shown in Table 16 due to the presence of wave effects, the higher elevation should be used for construction and/or floodplain management purposes.

2.5.4 Limit of Moderate Wave Action

Laboratory tests and field investigations have shown that wave heights as little as 1.5 feet can cause damage to and failure of typical Zone AE building construction. Wood-frame, light gage steel, and masonry walls on shallow footings or slabs are subject to damage when exposed to waves less than 3 feet in height. Other flood hazards associated with coastal waves (floating debris, high velocity flow, erosion, and scour) can also damage Zone AE construction.

Therefore, a LiMWA boundary may be shown on the FIRM as an informational layer to assist coastal communities in safe rebuilding practices. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. The location of the LiMWA relative to Zone VE and Zone AE is shown in Figure 6b.

The effects of wave hazards in Zone AE between Zone VE (or the shoreline where Zone VE is not identified) and the LiMWA boundary are similar to, but less severe than, those in Zone VE where 3-foot or greater breaking waves are projected to occur during the 1-percent-annual-chance flooding event. Communities are therefore encouraged to adopt and enforce more stringent floodplain management requirements than the minimum NFIP requirements in areas lakeward of the LiMWA. The NFIP Community Rating System provides credits for these actions.

In areas where wave runup elevations dominate over wave crest elevations (Figure 6a), the LiMWA should not be shown on the FIRM. Examples of runup dominated areas include shorelines with steeply sloped beaches, bluffs, or flood protection structures that lie parallel to the shore. Similarly, in areas where the Zone VE designation is based on the presence of a PFD or wave overtopping, the LiMWA is not shown on the FIRM.

SECTION 3.0 – INSURANCE APPLICATIONS

3.1 National Flood Insurance Program Insurance Zones

For flood insurance applications, the FIRM designates flood insurance rate zones as described in Figure 3, “Map Legend for FIRM.” Flood insurance zone designations are assigned to flooding sources based on the results of the hydraulic or coastal analyses. Insurance agents use the zones shown on the FIRM and depths and base flood elevations in this FIS Report in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

The 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (e.g. Zones A, AE, V, VE, etc.), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of additional flood hazards.

Table 3 lists the flood insurance zones in Brown County.

Table 3: Flood Zone Designations by Community

Community/Tribal Nation	Flood Zone(s)
Allouez, Village of	AE, X
Ashwaubenon, Village of	A, AE, X
Bellevue, Village of	A, AE, X
Brown County, Unincorporated Areas	A, AE, VE, X
De Pere, City of	A, AE, X
Denmark, Village of	X
Green Bay, City of	AE, AO, VE, X
Hobart, Village of	A, AE, X
Howard, Village of	AE, VE, X
The Oneida Nation of Wisconsin	A, AE, X
Pulaski, Village of	A, AE, X
Suamico, Village of	A, AE, VE, X
Wrightstown, Village of	AE, X

SECTION 4.0 – AREA STUDIED

4.1 Basin Description

Table 4 contains a description of the characteristics of the HUC-8 sub-basins within which each community falls. The table includes the main flooding sources within each basin, a brief description of the basin, and its drainage area.

Table 4: Basin Characteristics

HUC-8 Sub-Basin Name	HUC-8 Sub-Basin Number	Primary Flooding Source	Description of Affected Area	Drainage Area (square miles)
Door - Kewaunee	04030102	No Primary Flooding Source within Brown County	This sub-basin encompasses northeastern Brown County, the northern portion of Kewaunee County, and all of Door County	769
Duck-Pensaukee	04030103	Little Suamico and Pensaukee Rivers	Located in the southeastern portion of Oconto County, this relatively small sub-basin is also located in portions of Brown, Outagamie, and Shawano Counties	334
Lake Michigan	04190000	Lake Michigan	Entire surface water area of Lake Michigan	22,457
Lower Fox	04030204	Fox River	The Lower Fox River basin is located in northeastern Wisconsin and encompasses Brown, Calumet, Outagamie and Winnebago counties	650
Manitowoc-Sheboygan	04030101	Manitowoc River	This large sub-basin encompasses portions of Brown, Kewaunee, Calumet, Fond Du Lac, Sheboygan and Ozaukee counties, along with all of Manitowoc County	1,650

4.2 Principal Flood Problems

Table 5 contains a description of the principal flood problems that have been noted for Brown County by flooding source.

Table 5: Principal Flood Problems

Flooding Source	Description of Flood Problems
All Flooding Sources	For the streams studied, the majority of major floods have occurred in the early spring and summer due to the spring rains and snowmelt, however, the history of flooding in the region indicates that significant floods can occur throughout the year.
Apple Creek	A notable recent flooding occurred in July 2010. Heavy rainfall caused Apple Creek to rise about 2.5 feet above flood stage at the Apple Creek Campground. Brown County officials had to evacuate 28 people from the campground where water was up to 5 feet deep.
Fox River	According to the USGS gage in the City of Green Bay, the highest river levels have occurred in 1993, 2004, 2008, 2011, 2014, 2015, and 2019, with the flood of record occurring in June of 1990, when stream flow reached an all-time high of 33,800 cubic feet per second.
Green Bay	High stages of Green Bay are the primary source of flood problems, especially in the City of Green Bay, because of the city's relatively flat topography along the bay and between the mouths of the Fox River and Mahon Creek.
Lake Michigan	Flooding typically occurs along the shoreline of Lake Michigan and the mouths of its tributaries during high lake levels; the result of extended periods of above-normal precipitation combined with short-duration high winds from storm patterns. Some property damage and loss may occur during these events due to high water and erosion.
	Lake Michigan and the mouths of its tributaries can also be effected by seiches. Seiches are a weather phenomenon which are typically caused when strong winds and rapid changes in atmospheric pressure push water from one end of a body of water to the other. When the wind stops, the water rebounds to the other side of the enclosed area. The water then continues to oscillate back and forth for hours or even days. These sudden, extreme changes in water levels can cause severe flooding and damage to the lake shoreline and along tributary channels.

Table 6 contains information about historic flood elevations in the communities within Brown County.

Table 6: Historic Flooding Elevations

[Not Applicable to this Flood Risk Project]

4.3 Non-Levee Flood Protection Measures

This section is not applicable to this Flood Risk Project.

Table 7: Non-Levee Flood Protection Measures

[Not Applicable to this Flood Risk Project]

4.4 Levees

This section is not applicable to the Flood Risk Project.

Table 8: Levees

[Not applicable to this Flood Risk Project]

SECTION 5.0 – ENGINEERING METHODS

For the flooding sources 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 at least once on the average during any 10-, 25-, 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-, 25-, 50-, 100-, and 500-year floods, have a 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance, respectively, of being equaled or exceeded during any year.

Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1-percent chance of annual exceedance) during the term of a 30-year mortgage is approximately 26 percent (about 3 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.

5.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak elevation-frequency relationships for floods of the selected recurrence intervals for each flooding source studied. Hydrologic analyses are typically performed at the watershed level. Depending on factors such as watershed size and shape, land use and urbanization, and natural or man-made storage, various models or methodologies may be applied. A summary of the hydrologic methods applied to develop the discharges used in the hydraulic analyses for each stream is provided in Table 12. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

A summary of the discharges is provided in Table 9. A summary of stillwater elevations developed for non-coastal flooding sources is provided in Table 10. (Coastal stillwater elevations are discussed in Section 5.3 and shown in Table 16.) Stream gage information is provided in Table 11.

Table 9: Summary of Discharges

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)					
			10-Percent-Annual-Chance	4-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance Existing	1-Percent-Annual-Chance Future	0.2-Percent-Annual-Chance
Ash Street Tributary to Lancaster Creek	At U.S. Route 1	0.5	*	*	*	186	*	*
Ashwaubenon Creek	At mouth	28.1	2,000	*	2,625	2,900	*	3,540
	At County Trunk Highway F	24.3	1,800	*	2,475	2,650	*	3,240
Ashwaubenon Creek (Middle)	At Southridge Road	18.9	*	*	*	2,500	*	*
Ashwaubenon Creek (Upper)	At Williams Grant Drive	10.1	*	*	*	2,160	*	*
Baird Creek	At mouth	26.7	1,750	*	2,200	2,400	*	2,800
	At Danz Avenue	18.0	1,630	*	2,045	2,230	*	2,600
	At Green Bay and Western Railroad	16.9	1,330	*	1,670	1,825	*	2,130
	At Huron Road	12.5	*	*	*	1,500	*	*
	Northview Road	11.0	*	*	*	1,415	*	*
Baird Creek Tributary	At mouth	2.8	*	*	*	790	*	*
Bakers Creek	At Belmont Road	0.9	*	*	*	388	*	*
Bakers Creek Tributary	At Velp Avenue	1.0	*	*	*	245	*	*

*Data not available

Table 9: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)					
			10-Percent-Annual-Chance	4-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance Existing	1-Percent-Annual-Chance Future	0.2-Percent-Annual-Chance
Barina Creek	At Church Road	1.1	87	*	*	296	*	*
Beaver Dam Creek	At mouth	7.8	750	*	1,100	1,285	*	1,740
	Highway 54	3.2	590	*	790	960	*	1,300
Branch River	Project Limit Sect. 22 and 27	29.3	1,700	*	2,900	3,500	*	5,150
	CTH G Project Limit	18.7	1,400	*	2,400	2,850	*	4,200
Bower Creek	At mouth	41.8	*	*	*	8,272	*	*
	At CTH GV	34.2	*	*	*	5,000	*	*
	At Lime Kiln Road	19.6	*	*	*	4,737	*	*
Bower Creek Tributary 1	At Bower Creek Road	3.9	*	*	*	1,027	*	*
Bower Creek Tributary 2	At Bower Creek Road	0.2	*	*	*	280	*	*
Bower Creek Tributary A	At Tordeur Road	1.7	*	*	*	952	*	*
Bower Creek Tributary B	At mouth	1.1	*	*	*	683	*	*
Branch of Plum Creek	At CTH CE	3.3	*	*	*	900	*	*
Branch Plum Creek Lower Tributary	At mouth	0.3	*	*	*	279	*	*
Branch Plum Creek Upper Tributary	At mouth	0.3	*	*	*	138	*	*

* Data not available

Table 9: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)					
			10-Percent-Annual-Chance	4-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance Existing	1-Percent-Annual-Chance Future	0.2-Percent-Annual-Chance
Duck Creek	At mouth	151.0	4,200	*	5,800	6,500	*	9,200
	Vicinity of Howard	128.9	3,830	*	5,310	5,910	*	8,300
	Just upstream of confluence of Trout Creek	113.5	3,590	*	4,980	5,550	*	7,790
Duck Creek Tributary 11	At mouth	0.6	*	*	*	340	*	*
Duck Creek Tributary 12	At mouth	0.2	*	*	*	140	*	*
Dutchman Creek	At mouth	31.0	*	*	*	3,450	*	*
	At Oneida Street	*	*	*	*	3,300	*	*
Dutchman Creek	At Circle Drive	*	*	*	*	2,430	*	*
Dutchman Creek North Tributary	At mouth	2.8	*	*	*	1,150	*	*
Dutchman Creek South Tributary	At Waube Lane	4.0	*	*	*	1,290	*	*
Dutchman Creek Southeast Tributary	At Main Street	2.9	*	*	*	615	*	*
Dutchman Creek Southwest Tributary	At Main Street	2.2	*	*	*	805	*	*
East River	At mouth	147.0	5,000	*	7,000	7,900	*	10,000
	At confluence of Bower Creek	107.2	3,500	*	4,800	5,600	*	7,700

* Data not available

Table 9: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)					
			10-Percent-Annual-Chance	4-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance Existing	1-Percent-Annual-Chance Future	0.2-Percent-Annual-Chance
East River *(continued)*	At State Trunk Highway 32	53.7	1,250	*	2,250	2,700	*	3,750
	At County Trunk Highway ZZ	46.3	1,050	*	1,950	2,300	*	3,200
East River Tributary	At CTH GV	1.2	*	*	*	700	*	*
East River Tributary A	Approximately 240 feet upstream of mouth	1.2	*	*	*	836	*	*
East River Tributary B	Approximately 160 feet upstream of mouth	0.3	*	*	*	310	*	*
East Verlin North Tributary to Willow Creek	At mouth	0.1	*	*	*	20	*	*
East Verlin Tributary to Willow Creek	At mouth	0.9	*	*	*	1,685	*	*
Ellis Creek	At Van Beek Road	0.7	*	*	*	560	*	*
Fox River	At mouth	6,473	22,700	*	30,600	34,000	*	38,600
	At confluence of Dutchman Creek	6,317	22,790	*	28,050	30,990	*	35,500
	At confluence of Ashwaubenon Creek	6,285	22,400	*	27,500	30,340	*	35,000
	At De Pere Dam	6,253	22,500	*	27,550	29,950	*	34,550
	At Little Kaukauna Lock and Dam	6,244	22,500	*	27,500	29,900	*	34,500
	At confluence of Apple Creek	6,241	21,950	*	26,750	29,450	*	34,500

* Data not available

Table 9: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)					
			10-Percent - Annual-Chance	4-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance Existing	1-Percent-Annual-Chance Future	0.2-Percent-Annual-Chance
Fox River *(continued)*	At confluence of Plum Creek	6,187	21,340	*	25,790	28,310	*	33,000
	At Rapide Croche Dam	6,150	20,200	*	25,100	27,500	*	31,000
Lancaster Creek	At mouth	12.4	715	*	1,290	1,500	*	2,200
	Approximately 0.4 mile downstream of Velp Street	11.4	505	*	990	1,180	*	1,850
	Approximately 400 feet upstream of Velp Street	10.9	400	*	890	1,070	*	1,700
	Approximately 500 feet upstream of Cardinal Lane	10.3	305	*	770	940	*	1,500
	Just downstream of Hillcrest	9.7	265	*	670	820	*	1,300
Lancaster Creek Tributary	At Rockwell Road	0.4	*	*	*	205	*	*
Mahon Creek	At Green Bay	3.0	*	*	*	1,300	*	*
	At STH 54	2.0	*	*	*	980	*	*
	At Spartan Road	0.9	*	*	*	530	*	*
Neshota River	At Brown-Manitowoc County Boundary	44.0	2,250	*	3,700	4,400	*	6,300
Neshota River	Project Limit	36.0	2,040	*	3,350	4,000	*	5,200

* Data not available

Table 9: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)					
			10-Percent-Annual-Chance	4-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance Existing	1-Percent-Annual-Chance Future	0.2-Percent-Annual-Chance
North Branch Ashwaubenon Creek	At mouth	4.4	*	*	*	870	*	*
North Branch Bakers Creek	At mouth	0.2	*	*	*	189	*	*
North Branch Willow Creek	At confluence with Willow Creek	1.2	*	*	*	770	*	*
	Manitiowoc Road bridge	1.1	*	*	*	717	*	*
	At a point approximately 2.3 miles upstream from the confluence with Willow Creek	0.7	*	*	*	512	*	*
North Tributary South Branch Ashwaubenon Creek	At mouth	1.0	*	*	*	350	*	*
Oneida Creek	At mouth	0.8	*	*	*	500	*	*
Pioneer Tributary to Duck Creek	At mouth	0.1	*	*	*	110	*	*
Plum Creek	At mouth	35.4	2,800	*	4,350	5,100	*	7,000
	Just upstream of tributary	22.9	2,000	*	3,100	3,600	*	4,950
Sorensons Creek	At mouth	7.8	*	*	*	1,777	*	*
	At Klondike Road	4.9	*	*	*	1,176	*	*
Sorensons Creek Tributary	At Klondike Road	2.3	*	*	*	1,442	*	*
South Branch Ashwaubenon Creek	At mouth	5.4	*	*	*	1,290	*	*

*Data not available

Table 9: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)					
			10-Percent-Annual-Chance	4-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance Existing	1-Percent-Annual-Chance Future	0.2-Percent-Annual-Chance
South Branch Little Suamico River	Just upstream of Town Road	3.1	340	*	500	625	*	850
South Tributary to Willow Creek	At Bellevue Street	0.4	*	*	*	438	*	*
Spring Creek	At Town Hall Road	5.8	*	*	*	4,737	*	*
	At Manitowoc Road	2.9	*	*	*	2,202	*	*
	At Huron Road	1.6	*	*	*	1,394	*	*
Spring Creek Tributary A	At Manitowoc Road	1.8	*	*	*	560	*	*
Spring Creek Tributary A Ditch	At Eaton Road	*	*	*	*	230	*	*
Spring Creek Tributary B	At mouth	0.4	*	*	*	295	*	*
Suamico River	At mouth	73.5	1,650	*	3,200	4,050	*	6,450
	Just upstream of Tributary at Suamico	62.8	1,500	*	2,850	3,650	*	5,800
	At County Trunk Highway M	55.0	1,350	*	2,600	3,300	*	5,250
Tributary 1 to Dutchman Creek Southwest Tributary	At mouth	0.3	*	*	*	140	*	*
Tributary 2 to Dutchman Creek Southwest Tributary	At mouth	0.2	*	*	*	154	*	*

*Data not available

Table 9: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)					
			10-Percent-Annual-Chance	4-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance Existing	1-Percent-Annual-Chance Future	0.2-Percent-Annual-Chance
Tributary 3 to Dutchman Creek Southwest Tributary	At mouth	0.1	*	*	*	236	*	*
Trout Creek	At mouth	12.7	700	*	1,300	1,600	*	2,450
	At East-West Road	11.4	650	*	1,200	1,500	*	2,300
	At North-SouthRoad	6.4	500	*	900	1,100	*	1,700
	Project Limit	2.7	300	*	550	700	*	1,050
Unnamed Tributary to Green Bay	At mouth	0.3	*	*	*	175	*	*
Vanguard Way Tributary to Lancaster Creek	At confluence with Lancaster Creek	0.1	*	*	*	185	*	*
Willow Creek	At confluence with East River	5.5	*	*	*	1,951	*	*
	Just upstream of confluence of First North Branch Willow Creek	3.9	*	*	*	1,707	*	*
	Hazen Road bridge	3.1	*	*	*	1,577	*	*

* Data not available

Table 9: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)					
			10-Percent-Annual-Chance	4-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance Existing	1-Percent-Annual-Chance Future	0.2-Percent-Annual-Chance
Willow Creek *(continued)*	Interstate 43 bridge	1.5	*	*	*	812	*	*
	Ontario Road bridge	0.7	*	*	*	362	*	*
West Verlin Tributary to Willow Creek	At mouth	0.1	*	*	*	310	*	*

*Data not available

Figure 7: Frequency Discharge-Drainage Area Curves

[Not applicable to this Flood Risk Project]

Table 10: Summary of Non-Coastal Stillwater Elevations

[Not Applicable to the Flood Risk Project]

Table 11: Stream Gage Information used to Determine Discharges

Flooding Source	Gage Identifier	Agency that Maintains Gage	Site Name	Drainage Area (Square Miles)	Period of Record	
					From	To
Fox River	040851385	USGS	Fox River at Oil tank Depot at Green Bay, WI	6,330	10/01/1988	09/01/2017

5.2 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. Base flood elevations on the FIRM represent the elevations shown on the Flood Profiles and in the Floodway Data tables in the FIS Report. Rounded whole-foot elevations may be shown on the FIRM in coastal areas, areas of ponding, and other areas with static base flood elevations. These whole-foot elevations may not exactly reflect the elevations derived from the hydraulic analyses. 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. The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

For streams for which hydraulic analyses were based on cross sections, locations of selected cross sections are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 6.3). selected cross sections are also listed in Table 23, “Floodway Data.”

A summary of the methods used in hydraulic analyses performed for this project is provided in Table 12. Roughness coefficients are provided in Table 13. Roughness coefficients are values representing the frictional resistance water experiences when passing overland or through a channel. They are used in the calculations to determine water surface elevations. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

Table 12: Summary of Hydrologic and Hydraulic Analyses

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Apple Creek	At confluence with Fox River	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Ash Street Tributary to Lancaster Creek	Approximately 500 feet downstream of Ash Street	Approximately 150 feet upstream of Ash Street	Wisconsin Department of Natural Resources (WDNR) Project Files	HEC-2	08/16/2006	AE with floodway	
Ashwaubenon Creek	Mouth at Fox River	Just upstream of confluence of Hemlock Creek	National Engineering Handbook - Section 4 (NEH 1972)	HEC-2	08/16/2006	AE with floodway	
	Just upstream of confluence of Hemlock Creek	Just upstream of Southbridge Road	National Engineering Handbook - Section 4	HEC-2	08/16/2006	A	
Ashwaubenon Creek (Middle)	Just upstream of Southbridge Road	At Brown County/City of De Pere Corporate Limits	National Engineering Handbook - Section 4	HEC-2	08/16/2006	AE with floodway	
Ashwaubenon Creek (Upper)	At Brown County/City of De Pere Corporate Limits	Approximately 170 feet downstream of Williams Grant Drive	National Engineering Handbook - Section 4	HEC-2	08/16/2006	A	

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Ashwaubenon Creek (Upper) *(continued)*	Approximately 170 feet downstream of Williams Grant Drive	At convergence of North Branch and South Branch of Ashwaubenon Creek	National Engineering Handbook - Section 4	HEC-2	08/16/2006	AE with floodway	
Baird Creek	Mouth at East River	At 7th Street	HEC-1	*	08/16/2006	AE with floodway	Hydraulic method was not listed in prior Flood Insurance Studies
Baird Creek Tributary	Mouth at Baird Creek	Approximately 0.3 mile upstream of Finger Road	HEC-1	*	08/16/2006	AE with floodway	Hydraulic method was not listed in prior Flood Insurance Studies
Baird Creek Tributary 6	Mouth at Baird Creek	Approximately 0.2 mile upstream from Railroad	HEC-1	*	08/16/2006	AE with floodway	Hydraulic method was not listed in prior Flood Insurance Studies
Bakers Creek	Approximately 250 feet downstream of Belmont Road	Approximately 0.2 mile upstream of Hillcrest Heights	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	
Bakers Creek Tributary	At Velp Avenue	Approximately 0.5 mile upstream of Velp Avenue	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	
Barina Creek	Approximately 375 feet downstream of Church Road	Approximately 0.3 mile upstream of Church Road	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	

*Unavailable

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Beaver Dam Creek	At confluence with Duck Creek	Approximately 0.3 mile upstream of Packerland Drive	National Engineering Handbook - Section 4	*	08/16/2006	AE with floodway	Hydraulic method was not listed in prior Flood Insurance Studies
Bower Creek	Mouth at East River	Approximately 0.6 mile upstream of Golf Course Bridge	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	
	Approximately 0.6 mile upstream of Golf Course Bridge	At upstream limit of study	WDNR Project Files	HEC-2	08/16/2006	A	
Bower Creek Tributary	Approximately 515 feet downstream of Pine Grove Road	Approximately 105 feet upstream from Dickinson Road	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	
	At confluence of Bower Creek	At upstream limit of approximate study	WDNR Project Files	HEC-2	08/16/2006	A	
Bower Creek Tributary 1	Approximately 45 feet downstream of Monroe Road	Approximately 1.2 miles upstream of Bower Creek Road	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	
Bower Creek Tributary 2	Approximately 110 feet downstream of Bower Creek Road	Approximately 0.6 mile upstream of Meadow Sound Drive	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	

*Unavailable

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bower Creek Tributary A	At confluence of Bower Creek	Approximately 0.2 mile upstream of Golf Course Bridge	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	
	Approximately 0.2 mile upstream of Golf Course Bridge	At upstream limit of approximate study	WDNR Project Files	HEC-2	08/16/2006	A	
Bower Creek Tributary B	At confluence of Bower Creek	Approximately 0.2 mile upstream of Driveway	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	
	Approximately 0.2 mile upstream of Driveway	At upstream limit of approximate study	WDNR Project Files	HEC-2	08/16/2006	A	
Branch of Plum Creek	Approximately 405 feet downstream of confluence of Branch of Plum Creek Upper Tributary	Approximately 0.1 mile upstream of confluence of Branch of Plum Creek Lower Tributary	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	
Branch of Plum Creek Lower Tributary	At confluence with Plum Creek	At Brown County/ Manitowoc County Boundary	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Branch of Plum Creek Upper Tributary	At confluence with Branch of Plum Creek	Approximately 0.3 mile upstream of confluence with Branch of Plum Creek	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	
	Approximately 0.3 mile upstream of confluence with Branch of Plum Creek	At upstream limit of approximate study	WDNR Project Files	HEC-2	08/16/2006	A	
Branch River	Approximately 100 feet downstream of Hill Road	Approximately 0.8 mile upstream of Park Bridge	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	
Branch River Downstream	At Brown County/ Manitowoc County Boundary	Approximately 100 feet downstream of Hill Road	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Branch River Upstream	Approximately 0.8 mile upstream of Park bridge	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Duck Creek	Mouth of Green Bay	At Brown County/ Outagamie County Boundary	WDNR Project Files	*	08/16/2006	AE with floodway	Hydraulic method was not listed in prior Flood Insurance Studies

*Unavailable

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Duck Creek Tributary Stream 11	Mouth at Duck Creek	Approximately 0.2 mile upstream of Open Gate Trail	WDNR Project Files	*	08/16/2006	AE with floodway	Hydraulic method was not listed in prior Flood Insurance Studies
Duck Creek Tributary 12	At confluence with Duck Creek	Approximately 0.4 mile upstream of West Mason Street	WDNR Project Files	*	08/16/2006	AE with floodway	Hydraulic method was not listed in prior Flood Insurance Studies
Dutchman Creek	At confluence with Fox River	Approximately 0.3 mile upstream of Packerland Drive Culvert	WDNR Project Files	HEC-2	09/29/1989	AE with floodway	
Dutchman Creek North Tributary	At confluence with Dutchman Creek	Approximately 120 feet upstream of North Road	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	
Dutchman Creek South Tributary	At confluence with Dutchman Creek	Approximately 0.1 mile upstream of North Road	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	
Dutchman Creek Southeast Tributary	At confluence with Dutchman Creek	Approximately 0.1 mile upstream of Sand Acres Drive	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	

*Unavailable

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Dutchman Creek Southwest Tributary	At confluence with Dutchman Creek	Approximately 0.2 mile upstream of confluence of Tributary 3 Dutchman Creek Southwest Tributary	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	
	Approximately 0.2 mile upstream of confluence of Tributary 3 Dutchman Creek Southwest Tributary	At upstream limit of approximate study	WDNR Project Files	HEC-2	08/16/2006	A	
East River	At confluence with Fox River	At Wrightstown Road	HEC-1	HEC-2	09/1990	AE with floodway	
	At Wrightstown Road	At upstream limit of approximate study	HEC-1	HEC-2	09/1990	A	
East River Tributary	Approximately 60 feet downstream of Monroe Road	Approximately 70 feet upstream of Dickinson Road	WDNR Project Files	HEC-2	08/16/2006	AE with floodway	
East River Tributary A	At confluence with East River	Approximately 0.1 mile upstream of Heritage Road	TR-55	*	06/1994	AE with floodway	Hydraulic method was not listed in prior Flood Insurance Studies

*Unavailable

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
East River Tributary B	At confluence with East River Tributary A	Approximately 0.3 mile upstream of East River Tributary A	TR-55	*	06/1994	AE with floodway	Hydraulic method was not listed in prior Flood Insurance Studies
East River Tributary C	At confluence with East River	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
East River Tributary D	At confluence with East River	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
East River Tributary D2	At confluence with East River Tributary D	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
East River Tributary E	At confluence with East River	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
East River Tributary E2	At confluence with East River Tributary E	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
East River Tributary F	At confluence with East River	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
East River Tributary F2	At confluence with East River Tributary F	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
East River Tributary G	At confluence with East River	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	

*Unavailable

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
East River Tributary G2	At confluence with East River Tributary G	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
East River Tributary H	At confluence with East River	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
East River Tributary I	At confluence with East River	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
East River Tributary J	At confluence with East River	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
East River Tributary J2	At confluence with East River Tributary J	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
East River Tributary J3	At confluence with East River Tributary J	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
East Verlin North Tributary to Willow Creek	Mouth at East Verlin Tributary to Willow Creek	Approximately 15 feet upstream of Railroad	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
East Verlin Tributary to Willow Creek	At confluence with Willow Creek	Approximately 0.4 mile upstream of confluence of East Verlin North Tributary to Willow Creek	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Ellis Creek	Approximately 0.5 mile downstream of Edgewood Drive	Approximately 0.5 mile upstream of Edgewood Drive	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
ERT Overflow 1	At confluence with East River Tributary	At upstream limit of detailed study	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
ERT Overflow 2	At confluence with East River Tributary	At upstream limit of detailed study	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
Fox River	Approximately 0.5 mile downstream of Interstate 43	At Brown County/ Outagamie County Boundary	log-Pearson Type III	*	2016	AE with Floodway	Hydraulic method was not listed in prior Flood Insurance Studies
Haller Creek	At confluence with Suamico River	At Brown County/Oconto County Boundary	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Hemlock Creek	At confluence with Ashwaubenon Creek	At Quarry Park Drive	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Lancaster Creek	At confluence with Duck Creek at Riverview Drive	Approximately 0.7 mile upstream of Shawano Avenue	TR-20	HEC-2	08/1991	AE with Floodway	

*Unavailable

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Lancaster Creek *(continued)*	Approximately 0.7 mile upstream of Shawano Avenue	At upstream limit of approximate study	TR-20	HEC-2	08/1991	A	
Lancaster Creek Tributary	At Rockwell Road	Approximately 0.3 mile upstream of Rockwell Road	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	AE with Floodway	
Mahon Creek	Mouth at Green Bay	Approximately 0.3 mile upstream of Spartan Road	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
Middle Branch Little Suamico River	At Brown County/Oconto County Boundary	Approximately 40 feet downstream of Summit Street	WDNR Project Files	*	08/16/2006	A	Hydraulic method was not listed in prior Flood Insurance Studies
	Approximately 40 feet downstream of Summit Street	At Brown County/ Shawano County Boundary	WDNR Project Files	*	08/16/2006	AE with Floodway	Hydraulic method was not listed in prior Flood Insurance Studies
Moose Creek	Just downstream of Rainbow Drive	Approximately 0.1 mile upstream of Northwood Road	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Neshota River	At Brown County/ Manitowoc County Boundary	Approximately 55 feet upstream of Bridge Section in 22 and 23 T22N R22E	National Engineering Handbook - Section 4	HEC-2	08/16/2006	AE with Floodway	

*Unavailable

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Neshota River *(continued)*	Approximately 55 feet upstream of Bridge Section 22 and 23 T22N R22E	At upstream limit of approximate study	National Engineering Handbook - Section 4	HEC-2	08/16/2006	A	
North Branch Ashwaubenon Creek	At confluence with South Branch Ashwaubenon Creek	North County Line Road at Brown County/ Outagamie County Boundary	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
North Branch Bakers Creek	At confluence with Bakers Creek	Approximately 0.4 mile upstream of confluence with Bakers Creek	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
North Branch Suamico River	At confluence with Suamico River	At Brown County/Oconto County Boundary	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
North Branch Wequiock Creek	Just downstream of Nicolet Drive	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
North Branch Willow Creek	At confluence with Willow Creek	Approximately 1.8 miles upstream of Manitowoc Road	TR-20	*	08/16/2006	AE with Floodway	Hydraulic method was not listed in prior Flood Insurance Studies
North Pulaski Tributary	At Brown County/ Shawano County Boundary	At Brown County/Oconto County Boundary	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	

*Unavailable

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
North Tributary South Branch Ashwaubenon Creek	At confluence with South Branch Ashwaubenon Creek	Approximately 0.4 mile upstream of confluence with South Branch Ashwaubenon Creek	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
Oneida Creek	At confluence with Duck Creek	Approximately 0.9 mile upstream of Country Club Court	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
Pioneer Tributary to Duck Creek	At confluence with Duck Creek	Approximately 150 feet upstream of Cardinal Lane	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
Plum Creek	At confluence with Fox River	Approximately 3.0 miles upstream of confluence with Fox River	National Engineering Handbook - Section 4	*	08/16/2006	AE with Floodway	Hydraulic method was not listed in prior Flood Insurance Studies
	Approximately 3.0 miles upstream of confluence with Fox River	At upstream limit of detailed study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Plum Creek Tributary 1	At confluence with Plum Creek	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	

*Unavailable

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Plum Creek Tributary 2	At confluence with Plum Creek Tributary 1	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Plum Creek Tributary 3	At confluence with Plum Creek	At Brown County/ Manitowoc County Boundary	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Plum Creek Tributary 4	At confluence with Plum Creek	At Brown County/ Manitowoc County Boundary	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Potter Creek	At confluence with Suamico River	At Brown County/ Shawano County Boundary	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Sorensons Creek	At confluence with Spring Creek	Approximately 70 feet upstream of Big Creek Road	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
	Approximately 70 feet upstream of Big Creek Road	At upstream limit of approximate study	WDNR Project Files	HEC-2	08/16/2006	A	
Sorensons Creek Tributary	At confluence with Sorensons Creek	Approximately 0.6 mile upstream of Manitowoc Road	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
South Branch Ashwaubenon Creek	At confluence of Ashwaubenon Creek Upper	Approximately 0.2 mile upstream of Freedom Road	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
South Branch Little Suamico River	At Corporate Way	At Brown County/Shawano County Boundary	National Engineering Handbook - Section 4	*	08/16/2006	AE with Floodway	Hydraulic method was not listed in prior Flood Insurance Studies
South Tributary to Willow Creek	Mouth at Willow Creek	Approximately 0.1 mile upstream of Limekiln Road	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
Spring Creek	Mouth at Bower Creek	Approximately 0.3 mile upstream of Willow Road	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
Spring Creek Tributary A	Mouth at Spring Creek	Approximately 160 feet upstream of Ontario Road	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
	Approximately 160 feet upstream of Ontario Road	At upstream limit of detailed study	WDNR Project Files	HEC-2	08/16/2006	A	
Spring Creek Tributary A Ditch	At confluence with Spring Creek Tributary A	Approximately 0.1 mile upstream of confluencewith Spring Creek Tributary A	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
Spring Creek Tributary B	Mouth at Spring Creek	Approximately 450 feet upstream of Cottage Road	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	

*Unavailable

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Suamico River	Mouth at Green Bay	At Flintville Lane	National Engineering Handbook - Section 4	*	08/16/2006	AE with Floodway	Hydraulic method was not listed in prior Flood Insurance Studies
	At Flintville Lane	At upstream limit of detailed study	National Engineering Handbook - Section 4	*	08/16/2006	A	Hydraulic method was not listed in prior Flood Insurance Studies
Tributary 1 to Dutchman Creek Southwest Tributary	Mouth at Dutchman Creek Southwest Tributary	Approximately 475 feet upstream of South Packerland Drive	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
Tributary 2 to Dutchman Creek Southwest Tributary	Mouth at Dutchman Creek Southwest Tributary	Approximately 0.5 mile upstream of Mouth at Dutchman Creek Southwest Tributary	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
Tributary 3 to Dutchman Creek Southwest Tributary	Mouth at Dutchman Creek Southwest Tributary	Approximately 0.4 mile upstream of Mouth at Dutchman Creek Southwest Tributary	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	

*Unavailable

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Tributary 3 to Dutchman Creek Southwest Tributary *(continued)*	Approximately 0.4 mile upstream of Mouth at Dutchman Creek Southwest Tributary	At upstream limit of detailed study	WDNR Project Files	HEC-2	08/16/2006	A	
Trout Creek	At confluence with Duck Creek	At Sunlit Drive	WDNR Project Files	HEC-2	10/2012	AE with Floodway	This stream was restudied as part of LOMR 10-05-4875
Unnamed Tributary 1 to Duck Creek	At confluence with Duck Creek	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Unnamed Tributary 1.1 to Duck Creek	At confluence with Unnamed Tributary 1 to Duck Creek	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Unnamed Tributary 1.2 to Duck Creek	At confluence with Unnamed Tributary 1 to Duck Creek	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Unnamed Tributary 1.2.1 to Duck Creek	At confluence with Unnamed Tributary 1.2 to Duck Creek	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Unnamed Tributary 1 to Ashwaubenon Creek	At confluence with Ashwaubenon Creek	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Unnamed Tributary 2 to Ashwaubenon Creek	At confluence with Ashwaubenon Creek	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Unnamed Tributary to Bower Creek	At confluence with Bower Creek	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Unnamed Tributary to Bower Creek Tributary B	At confluence with Bower Creek Tributary B	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Unnamed Tributary to Green Bay	At confluence with Green Bay	Approximately 0.3 mile upstream of Nicolet Drive	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
Unnamed Tributary to Haller Creek	At confluence with Haller Creek	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Unnamed Tributary to Plum Creek	At confluence with Plum Creek	At upstream limit of approximate study	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Unnamed Tributary to the West Branch Suamico River	At confluence with West Branch Saumico River	At Brown County/ Outagamie County Boundary	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
Vanguard Way Tributary to Lancaster Creek	At confluence with Lancaster Creek	Approximately 0.1 mile upstream of confluence with Lancaster Creek	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	

Table 12: Summary of Hydrologic and Hydraulic Analyses *(continued)*

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Wequiock Creek	At confluence with Green Bay	At convergence of North Branch Wequiock Creek and South Branch Wequiock Creek	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
West Branch Suamico River	At confluence with Suamico River	At Brown County/ Outgamie County Boundary	USGS Regression Equations	HEC-RAS 3.1.3	08/16/2006	A	
West Verlin Tributary to Willow Creek	At confluence with East River	At confluence of East Verlin Tributary to Willow Creek	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
	Approximately 1,260 feet upstream of confluence with East River	At confluence of Willow Creek	WDNR Project Files	HEC-2	08/16/2006	AE with Floodway	
Willow Creek	Approximately 500 feet downstream of Allouez Avenue	Approximately 0.4 mile downstream of Bellevue Road	TR-20	*	08/16/2006	AE with Floodway	Hydraulic method was not listed in prior Flood Insurance Studies
	Approximately 0.4 mile downstream of Bellevue Road	Approximately 0.3 mile upstream of Bellevue Road	TR-20	HEC-RAS 4.1.0	10/20/2017	AE with Floodway	Letter of Map Revision 17-05-2419P. No new hydrology was completed in 2017.
	Approximately 0.3 mile upstream of Bellevue Road	Approximately 0.3 mile upstream of Ontario Road	TR-20	*	08/16/2006	AE with Floodway	Hydraulic method was not listed in prior Flood Insurance Studies

*Unavailable

Table 13: Roughness Coefficients

Flooding Source	Channel "n"	Overbank "n"
All detailed flooding sources in Brown County	No data available	No data available

5.3 Coastal Analyses

For the areas of Brown County that are impacted by coastal flooding processes, coastal flood hazard analyses were performed to provide estimates of coastal BFEs. Coastal BFEs reflect the increase in water levels during a flood event due to storm surge as well as overland wave effects.

The following subsections provide summaries of how each coastal process was considered for this FIS Report. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation (STARR 2017). Table 14 summarizes the methods and/or models used for the coastal analyses. Refer to Section 2.5.1 for descriptions of the terms used in this section.

Table 14: Summary of Coastal Analyses

Flooding Source	Study Limits From	Study Limits To	Hazard Evaluated	Model or Method Used	Date Analysis was Completed
Lake Michigan/ Green Bay	Entire shoreline of Brown County from the Oconto County Line to the Kewaunee County Line	Entire shoreline of Brown County from the Oconto County Line to the Kewaunee County Line	Erosion	CSHORE	10/01/2017
			Overland Wave Propagation	WHAFIS	10/01/2017
			Statistical Analyses	Q-Q Optimization GPD	10/01/2017
			Storm Surge	ADCIRC	10/30/2016
			Wave Generation	SWAN	10/30/2016
			Wave Runup	Stockdon/van Gent/SPM[1]	10/01/2017
			Wave Setup	Direct Integration Method (DIM)	10/01/2017

[1] U.S. Army Corps of Engineers (USACE) Shore Protection Manual (SPM), 1984

5.3.1 Total Stillwater Elevations

The stillwater elevations for the 1-percent-annual-chance flood were determined for areas subject to coastal flooding. The models and methods that were used to determine storm surge and wave setup are listed in Table 14. The stillwater elevation that was used for each transect in the coastal analyses is shown in Table 16, “Coastal Transect Parameters. Figure 8 shows an example of the stillwater elevations for the 1-percent-annual-chance flood that was determined for this coastal analysis; wave setup is computed at each transect location and added to the stillwater elevation to determine a total stillwater elevation.

Stillwater elevations and starting wave conditions for Brown County were determined from the lake-wide wave and storm surge study conducted for Lake Michigan by FEMA and Strategic Alliance for Risk Reduction (STARR 2017). The study was performed using the coupled SWAN + ADCIRC hydrodynamic and wave model on a mesh of 1,045,141 nodes and validated using water levels and waves for six historical storms. The model was then used to simulate 150 selected historic storms based on historic peak water levels and peak wave heights. When available, ice coverage was accounted for in validation and production events. The modeled data were used to create a history of water elevation and wave height records from which the 10-, 2-, 1-, and 0.2-percent annual chance of exceedance elevations were calculated.

Figure 8: 1-Percent-Annual-Chance Stillwater Elevations for Coastal Areas

Storm Surge Statistics

Storm surge is modeled based on characteristics of actual storms responsible for significant coastal flooding. The characteristics of these storms are typically determined by statistical study of the regional historical record of storms or by statistical study of water level stations.

When historic records are used to calculate storm surge, characteristics such as the strength, size, track, etc., of storms are identified by site. Storm data was used in conjunction with numerical hydrodynamic models to determine the corresponding storm surge levels. An extreme value analysis was performed on the storm surge modeling results to determine a stillwater elevation for the 1-percent-annual-chance event.

In an oceanic environment water level stations can be used instead of historic records of storms when the available station record for the area represents both the astronomical tide component and the storm surge component. Great Lakes studies rely on water level stations to identify the highest water level storm events from the historic record. The selected storms are then used to simulate storm surge and wave heights across the study area. Table 15 provides the water level station name, managing agency, station type, station identifier, start date, end date, and statistical methodology applied to each station to determine the stillwater elevations.

Table 15: Water Level Station Analysis Specifics

Station Name	Managing Agency of Station	Station Type	Start Date[1]	End Date[1]	Statistical Methodology
Calumet Harbor, IL (9087044)	National Oceanic and Atmospheric Administration (NOAA)	Water Level	1960	2009	N/A
Green Bay, WI (9087079)	NOAA	Water Level	1960	2009	
Holland, MI (9087031)	NOAA	Water Level	1960	2009	
Kewaunee, WI (9087068)	NOAA	Water Level	1973	2009	
Ludington, MI (9087023)	NOAA	Water Level	1960	2009	
Mackinaw City, MI (9075080)	NOAA	Water Level	1960	2009	
Milwaukee, WI (9087057)	NOAA	Water Level	1960	2009	
Port Inland, MI (9087096)	NOAA	Water Level	1964	2009	
Sturgeon Bay, WI (9087072)	NOAA	Water Level	1960	2009	

[1] Available data within study period of record (1960-2009)

5.3.2 Waves

Starting wave heights and wave periods for Brown County were determined from the lake-wide wave and storm surge study conducted for Lake Michigan by FEMA and STARR as described in Section 5.3.1. The modeled data were used to create a history of wave height and wave period records which was used to determine starting wave conditions for the transect analysis.

Wave Setup Analysis

Wave setup was computed based on the wave and water level modeling results through the methods and models listed in Table 14. To adequately capture the complex hydrodynamics of wave-breaking across the surf zone, wave setup was calculated at each transect using the Direct Integration Method (DIM).

5.3.3 Coastal Erosion

A single storm episode can cause extensive erosion in coastal areas. Storm-induced erosion was evaluated using the methods listed in Table 14 to determine the modification to existing topography that is expected to be associated with coastal flooding events. The post-event eroded profile was used for the subsequent transect-based onshore wave hazard analyses.

5.3.4 Wave Hazard Analyses

Overland wave hazards were evaluated to determine the combined effects of ground elevation, vegetation, and physical features on overland wave propagation and wave runup. These analyses were performed at representative transects where waves are expected to be present during the floods of the selected recurrence intervals. The results of these analyses were used to determine elevations for the 1-percent annual chance flood. The transect analysis was performed with elevations in the vertical datum of IGLD85 and ultimately converted to NAVD88 for mapping.

Transect locations were chosen with consideration given to the physical land characteristics as well as development type and density so that they would closely represent conditions in their locality. Additional consideration was given to changes in the total stillwater elevation. Transects were spaced close together in areas of complex topography and dense development or where total stillwater elevations varied. In areas having more uniform characteristics, transects were spaced at larger intervals. Transects shown in Figure 9, “Transect Location Map,” are also depicted on the FIRM. Table 16 provides the location, stillwater elevations, and total water elevations for all coastal analysis transects. Starting wave conditions are also provided for each transect evaluated for overland wave hazards. In this table, “starting” indicates the parameter value at the beginning of the transect.

Wave Height Analysis

Wave height analyses were performed to determine wave heights and corresponding wave crest elevations for the areas inundated by coastal flooding and subject to overland wave propagation hazards. Refer to Figure 6b for a schematic of a coastal transect evaluated for overland wave propagation hazards.

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

Along each transect, wave heights and wave crest elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. The joint probability method (JPM) is used to compute five theoretical combinations of wave and water level conditions that have a joint 1-percent annual chance probability of occurrence. These theoretical combinations were simulated to determine the water levels, which include wave setup, and wave conditions at the shoreline. Wave heights and wave crest elevations were modeled using the methods and models listed in Table 14.

Wave Runup and Overtopping Analysis

Wave runup is the uprush of water caused by wave action on a shore barrier exceeding the total stillwater level. As part of the coastal study, an evaluation of wave runup is conducted to determine the total water elevation due to storm surge, wave setup, and wave runup, and whether that total water elevation is the dominant coastal flood hazard for an area. Wave runup is evaluated for areas having dune barrier systems, coastal bluffs, as well as sloped and vertical structures.

Wave runup elevations were calculated for each coastal transect using the methods and models listed in Table 14, which follow the FEMA Guidelines and Specifications. For gently sloping shorelines (slopes less than 1:10), the Stockdon equations were applied (Stockdon et al., 2006). For steeper (but non-vertical) sloping shorelines, the van Gent method was performed (van Gent, 2001). For vertical structures, runup elevations were determined using the guidance in Figure D-14 of the FEMA Guidelines and Specifications obtained from the SPM (USACE, 1984). The SPM results in a mean wave runup value, which was multiplied by 2.2 to obtain the 2-percent runup height.

Wave overtopping occurs when the potential wave runup elevation is greater than the topographic feature crest elevation. The overtopping rate will depend on the incident water level and wave conditions, the barrier geometry and roughness characteristics, and the upland slope. Overtopping rates were calculated using the methods and models listed in Table 14, which follow the FEMA Guidelines and Specifications.

Wave overtopping behavior is determined based on the slope landward of the barrier crest. Where the shoreline geometry is characterized by a low-crested bluff or structure backed by a positively-sloping, nearly level upland, the Plateau Method was applied to calculate an adjusted runup elevation and the inland extent of runup. Where the shoreline geometry is characterized by a negative slope landward of the barrier crest, the overtopping water will result in sheet flow on the negative slope and may propagate until it reaches another flooding source or ponding area.

Table 16: Coastal Transect Parameters

Flood Source	Coastal Transect	Starting Wave Conditions for the 1-Percent-Annual-Chance[1]		Starting Stillwater Elevations (ft NAVD88)					1-Percent-Annual-Chance Total Water Elevation[2] (ft NAVD88)
		Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10-Percent-Annual-Chance	4-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance	
Green Bay/ Lake Michigan	01^	5.3	6.31	583.3	*	584.0	584.1	584.4	587.1
	02	3.4	6.45	583.4	*	584.0	584.2	584.4	588.7
	03	2.8	6.07	583.5	*	584.1	584.2	584.4	589.2
	04^	6.0	5.41	583.5	*	584.1	584.2	584.4	588.1
	05^	6.1	5.80	583.5	*	584.1	584.3	584.5	588.3
	06	1.9	2.59	583.8	*	584.4	584.6	584.8	585.8
	07^	3.5	3.57	583.7	*	584.3	584.5	584.7	588.6
	08	3.5	6.24	583.8	*	584.4	584.5	584.7	588.9
	09^	3.7	3.74	583.8	*	584.4	584.5	584.7	588.4
	10	3.7	4.01	583.8	*	584.4	584.5	584.7	588.0
	11	5.0	4.12	583.8	*	584.4	584.5	584.7	587.9
	12	4.1	3.70	583.7	*	584.3	584.5	584.7	588.1

* Not calculated for this Flood Risk Project
[1] Wave data provided for WHAFIS-dominant transects only. The 1-percent starting wave parameters are not applicable for runup transects since a response-based approach is utilized.
[2] Includes wave action representative of 1-Percent Total Water Level (for wave runup and overtopping) or 1-Percent Wave Crest Elevation (for overland wave propagation)
^ Data provided for offshore shoreline only, where transect crosses multiple shorelines.

Table 16: Coastal Transect Parameters *(continued)*

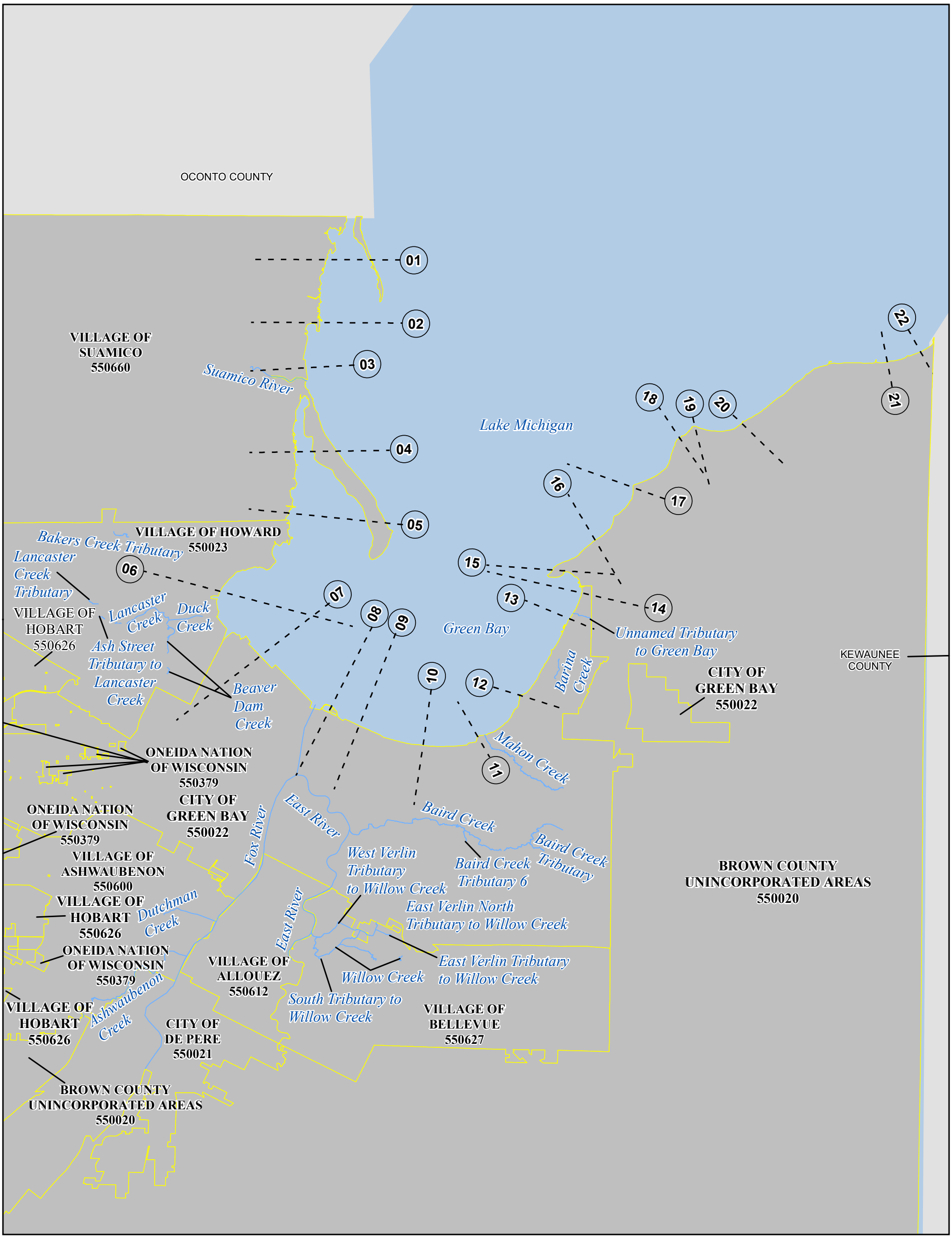
Flood Source	Coastal Transect	Starting Wave Conditions for the 1-Percent-Annual-Chance[1]		Starting Stillwater Elevations (ft NAVD88)					1-Percent-Annual-Chance Total Water Elevation[2] (ft NAVD88)
		Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10-Percent-Annual-Chance	4-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance	
Green Bay/ Lake Michigan	13	2.1	2.60	583.6	*	584.2	584.4	584.7	586.7
	14	1.5	2.82	583.3	*	584.1	584.3	584.7	587.7
	15	2.5	2.90	582.7	*	583.7	584.1	584.8	588.3
	16	4.4	6.73	583.4	*	584.1	584.3	584.6	587.8
	17	3.2	4.91	583.2	*	584.0	584.3	584.7	587.9
	18	6.4	6.53	583.2	*	583.9	584.1	584.4	588.1
	19	5.3	6.02	583.3	*	584.0	584.1	584.3	587.8
	20	4.7	4.80	583.2	*	584.0	584.2	584.5	587.9
	21	5.5	5.70	583.2	*	583.9	584.1	584.3	587.8
	22	4.9	6.30	583.2	*	583.9	584.1	584.4	587.3

* Not calculated for this Flood Risk Project

[1] Wave data provided for WHAFIS-dominant transects only. The 1-percent starting wave parameters are not applicable for runup transects since a response-based approach is utilized.

[2] Includes wave action representative of 1-Percent Total Water Level (for wave runup and overtopping) or 1-Percent Wave Crest Elevation (for overland wave propagation)

Figure 9: Transect Location Map



1 inch = 2 miles

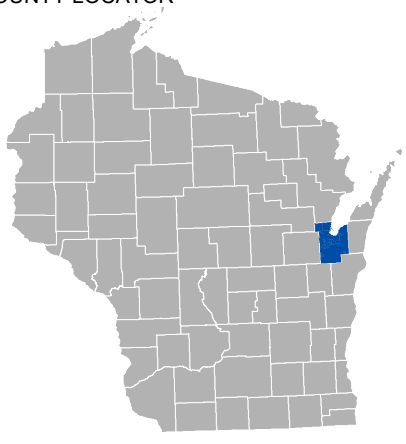
N

Miles

0 0.5 1 2

Map Projection:
Universal Transverse Mercator Zone 16N;
North American Datum 1983

COUNTY LOCATOR



NATIONAL FLOOD INSURANCE PROGRAM

Transect Locator Map

PANELS WITH TRANSECTS:
0067, 0069, 0086, 0088, 0113, 0118, 0119, 0154, 0157, 0158, 0159, 0166, 0167, 0169, 0176, 0178, 0179, 0181, 0182, 0183, 0184, 0186, 0187, 0188, 0189, 0191, 0193, 0201, 0202

FEMA

5.4 Alluvial Fan Analyses

This section is not applicable to this Flood Risk Project.

Table 17: Summary of Alluvial Fan Analyses

[Not applicable to this Flood Risk Project]

Table 18: Results of Alluvial Fan Analyses

[Not applicable to this Flood Risk Project]

SECTION 6.0 – MAPPING METHODS

6.1 Vertical and Horizontal Control

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 (NGVD29). With the completion of the North American Vertical Datum of 1988 (NAVD88), many FIS Reports and FIRMs are now prepared using NAVD88 as the referenced vertical datum.

Flood elevations shown in this FIS Report and on the FIRMs are referenced to NAVD88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between NGVD29 and NAVD88 or other datum conversion, visit the National Geodetic Survey website at www.ngs.noaa.gov.

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 archived project documentation associated with the FIS Report and the FIRMs for this community, Interested individuals may contact FEMA to access these data,

To obtain current elevation, description, and/or location information for benchmarks in the area, please visit the NGS website at www.ngs.noaa.gov.

The datum conversion locations and values that were calculated for Brown County are provided in Table 19.

Table 19: Countywide Vertical Datum Conversion

Quadrangle Name	Quadrangle Corner	Latitude	Longitude	Conversion from NGVD29 to NAVD88 (feet)
N/A	N/A	N/A	N/A	N/A
Average Conversion from NGVD29 to NAVD88 = -0.035 feet				

Table 20: Stream-Based Vertical Datum Conversion

[Not applicable to this Flood Risk Project]

6.2 Base Map

The FIRMs and FIS Report for this project have been produced in a digital format. The flood hazard information was converted to a Geographic Information System (GIS) format that meets FEMA's FIRM Database specifications and geographic information standards. This information is provided in a digital format so that it can be incorporated into a local GIS and be accessed more easily by the community. The FIRM Database includes most of the tabular information contained in the FIS Report in such a way that the data can be associated with pertinent spatial features. For example, the information contained in the Floodway Data table and Flood Profiles can be linked to the cross sections that are shown on the FIRMs. Additional information about the FIRM Database and its contents can be found in FEMA's *Guidelines and Standards for Flood Risk Analysis and Mapping*, https://www.fema.gov/guidelines-and-standards-flood-risk-analysis-and-mapping.

Base map information shown on the FIRM was derived from the sources described in Table 21.

Table 21: Base Map Sources

Data Type	Data Provider	Data Date	Data Scale	Data Description
2017 NAIP DOP Imagery	USDA FSA Aerial Photography Field Office	2017	1:12,000	Digital orthoimagery provided as countywide (USDA/FSA 2017)
Location of roads, railroads, bridges, streams and other physical features	FEMA	2004	1:12,000	Effective state and local road, stream, and railroad data (FEMA 2004)
PLSS and Municipal Boundary	Brown County Land Information Office	2008	1:12,000	Effective PLSS and municipal boundaries (BCLIO 2008)
Tiger Roads Data	U.S. Census Bureau	2018	1:6,000	State and local road railroad data (Census 2018)
USACE Structures	US Amy Corps of Engineers	2012	1:6,000	Digital structure data (USACE 2012)
Watershed Boundary Dataset (WBD), HUC8 Boundaries	USGS and USDA - NRCS	2017	1:12,000	Digital subbasin data (USGS/USDA 2017)
WIDNR	Wisconsin DNR	2018	1:6,000	Digital water area data (WIDNR 2018)

6.3 Floodplain and Floodway Delineation

The FIRM shows tints, screens, and symbols to indicate floodplains and floodways as well as the locations of selected cross sections used in the hydraulic analyses and floodway computations.

For riverine flooding sources, the mapped floodplain boundaries shown on the FIRM have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using the topographic elevation data described in Table 22. For each coastal flooding source studied as part of this FIS Report, the mapped floodplain boundaries on the FIRM have been delineated using the flood and wave elevations determined at each transect; between transects, boundaries were delineated using land use and land cover data, the topographic elevation data described in Table 22, and knowledge of coastal flood processes. In ponding areas, flood elevations were determined at each junction of the model; between junctions, boundaries were interpolated using the topographic elevation data described in Table 22.

In cases where the 1-percent and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

The floodway widths 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. Table 2 indicates the flooding sources for which floodways have been determined. The results of the floodway computations for those flooding sources have been tabulated for selected cross sections and are shown in Table 23, “Floodway Data.”

Table 22: Summary of Topographic Elevation Data used in Mapping

Community/Tribal Nation	Flooding Source	Source for Topographic Elevation Data			
		Description	Vertical Accuracy	Horizontal Accuracy	Citation
Brown County, Unincorporated Areas; Cities of De Pere, and Green Bay; Villages of Allouez, Ashwaubenon, Bellevue, Hobart, Howard, and Suamico	Ashwaubenon Creek, Baird Creek, Beaver Dam Creek, Duck Creek, Dutchman Creek, East River, Fox River, Lancaster Creek, South Tributary to Willow Creek, Suamico River, West Verlin Tributary to Willow Creek, Willow Creek	DEM	RMSE is 0.207(z) and the NSSDA is 0.405(z)	±0.5m (RMSE)	Brown 2010
Brown County, Unincorporated Areas; City of Green Bay; Villages of Howard, and Suamico	Barina Creek, Duck Creek, Fox River, Mahon Creek, Suamico River, Unnamed Tributary to Green Bay	LiDAR	±15cm (RMSE)	±0.5m (RMSE)	JALBTCX 2013

BFEs shown at cross sections on the FIRM represent the 1-percent-annual-chance water surface elevations shown on the Flood Profiles and in the Floodway Data tables in the FIS Report. Rounded whole foot elevations may be shown on the FIRM in coastal areas, areas of ponding, and other areas with static base flood elevations.

Table 23: Floodway Data

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Ash Street Tributary to Lancaster Creek								
A	104	144	121	1.5	602.5	602.5	602.5	0.0
B	466	39	70	2.7	605.8	605.8	605.8	0.0
C	686	29	36	5.1	608.3	608.3	608.3	0.0

[1] Feet above Limit of Detailed Study

* Limit of Detailed Study is approximately 500 feet downstream of Ash Street

TABLE 23

FEDERAL EMERGENCY MANAGEMENT AGENCY

BROWN COUNTY, WI AND INCORPORATED AREAS

FLOODWAY DATA

ASH STREET TRIBUTARY TO LANCASTER CREEK

Table 23: Floodway Data *(continued)*

FLOODING SOURCE		FLOODWAY				BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Ashwaubenon Creek									
A	1,464	322	1,792	1.6	10	585.7	584.7[2]	584.7	0.0
B	2,999	75	718	4.0	-73	585.7	584.8[2]	584.8	0.0
C	4,069	76	557	5.2	-33	585.7	585.3[2]	585.3	0.0
D	4,902	82	835	3.5	-48	586.0	586.0	586.0	0.0
E	5,299	134	1,372	2.1	0	589.7	589.7	589.7	0.0
F	6,557	117	1,363	2.1	-23	589.8	589.8	589.8	0.0
G	7,263	130	1,158	2.5	26	590.1	590.1	590.1	0.0
H	8,540	513	3,758	0.9	243	590.4	590.4	590.4	0.0
I	9,575	62	663	4.4	-30	590.4	590.4	590.4	0.0
J	11,483	140	2,223	2.3	-62	591.4	591.4	591.5	0.1
K	12,304	101	887	3.3	-71	592.1	592.1	592.2	0.1
L	13,974	498	2,033	1.4	231	593.0	593.0	593.1	0.1
M	15,529	317	689	4.2	84	593.9	594.0	594.0	0.1
N	20,739	449	1,471	1.8	75	598.2	598.2	598.2	0.0
O	24,307	62	603	4.4	-48	601.2	601.2	601.2	0.0
P	25,324	529	3,139	0.8	143	602.2	602.2	602.2	0.0
Q	28,684	389	1,959	1.4	-92	602.7	602.7	602.7	0.0
R	34,560	481	2,446	1.1	104	604.7	604.7	604.7	0.0
S	35,964	93	445	6.0	-136	605.2	605.2	605.2	0.0
T	36,666	50	470	5.6	-165	607.8	607.8	607.8	0.0
U	38,255	362	1,549	1.7	30	610.0	610.0	610.0	0.0
V	39,222	300	1,032	2.6	11	610.6	610.6	610.6	0.0
W	39,987	549	1,815	1.5	68	611.8	611.8	611.8	0.0
X	40,747	608	2,177	1.2	-240	612.5	612.5	612.5	0.0

[1]Feet above mouth
[2]Elevations computed without consideration of backwater effects from the Fox River

TABLE 23

FEDERAL EMERGENCY MANAGEMENT AGENCY

BROWN COUNTY, WI AND INCORPORATED AREAS

FLOODWAY DATA

ASHWAUBENON CREEK

Table 23: Floodway Data *(continued)*

FLOODING SOURCE		FLOODWAY				BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Ashwaubenon Creek (Middle)									
A	46,727	595	1,760	1.4	25	617.5	617.5	617.5	0.0
B	47,977	515	1,510	1.7	-7	618.7	618.7	618.7	0.0
C	49,217	466	1,226	2.0	41	620.7	620.7	620.7	0.0
D	50,177	636	2,725	0.9	-12	621.4	621.4	621.4	0.0
E	51,157	437	2,429	1.0	14	623.3	623.3	623.3	0.0
F	51,967	670	3,700	0.7	28	623.6	623.6	623.6	0.0
G	52,557	436	2,141	1.2	29	623.7	623.7	623.7	0.0
H	52,907	468	2,221	1.1	-11	623.8	623.8	623.8	0.0
I	54,907	573	2,510	1.0	0	625.5	625.5	625.5	0.0
J	55,087	474	1,926	1.3	60	625.6	625.6	625.6	0.0
K	56,546	398	1,635	1.5	5	626.6	626.6	626.6	0.0
L	57,687	380	1,704	1.5	-3	627.9	627.9	627.9	0.0
M	58,387	396	1,827	1.4	23	628.4	628.4	628.4	0.0

[1] Feet above mouth of Ashwaubenon Creek at the Fox River

TABLE 23

FEDERAL EMERGENCY MANAGEMENT AGENCY

BROWN COUNTY, WI AND INCORPORATED AREAS

FLOODWAY DATA

ASHWAUBENON CREEK (MIDDLE)

Table 23: Floodway Data *(continued)*

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Ashwaubenon Creek (Upper)								
A	81,950	172	1,520	2.5	651.7	651.7	651.7	0.0
B	82,355	276	3,626	0.8	661.0	661.0	661.0	0.0

[1] Feet above mouth of Ashwaubenon Creek at Fox River

Table 23: Floodway Data *(continued)*

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Baird Creek								
A	1,463	69	487	4.8	588.6	586.9[2]	586.9	0.0
B	2,271	151	800	2.9	588.6	588.2[2]	588.2	0.0
C	3,108	65	407	5.7	588.8	588.8	588.8	0.0
D	4,254	98	926	2.5	593.3	593.3	593.3	0.0
E	4,863	125	1,063	2.1	593.6	593.6	593.6	0.0
F	6,207	320	2,736	0.8	596.1	596.1	596.1	0.0
G	7,329	311	2,128	1.0	596.2	596.2	596.2	0.0
H	8,062	531	4,066	0.5	597.0	597.0	597.0	0.0
I	9,557	385	1,383	1.4	597.1	597.1	597.1	0.0
J	10,706	335	752	2.6	598.1	598.1	598.1	0.0
K	11,436	199	288	6.6	599.9	599.9	599.9	0.0
L	12,521	152	512	3.7	604.2	604.2	604.2	0.0
M	13,812	85	291	6.5	608.3	608.3	608.3	0.0
N	15,414	181	337	5.5	615.9	615.9	615.9	0.0
O	16,314	142	390	4.7	623.0	623.0	623.0	0.0
P	17,424	51	174	10.4	640.0	640.0	640.0	0.0
Q	18,924	62	274	6.5	667.2	667.2	667.2	0.0
R	19,140	88	349	5.4	669.5	669.5	669.5	0.0
S	19,868	128	578	3.3	674.2	674.2	674.2	0.0
T	20,870	141	710	3.5	678.4	678.4	678.4	0.0
U	21,762	147	370	5.1	681.8	681.8	681.8	0.0
V	22,651	207	483	3.7	687.2	687.2	687.2	0.0
W	23,768	105	430	4.1	691.9	691.9	691.9	0.0
X	24,670	98	295	5.9	694.2	694.2	694.2	0.0
Y	25,641	92	264	5.8	701.0	701.0	701.0	0.0
Z	26,749	284	553	2.7	707.1	707.1	707.1	0.0

[1]Feet above mouth
[2]Elevations computed without consideration of backwater effects from the East River

TABLE 23

FEDERAL EMERGENCY MANAGEMENT AGENCY

BROWN COUNTY, WI AND INCORPORATED AREAS

FLOODWAY DATA

BAIRD CREEK

Table 23: Floodway Data *(continued)*

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Baird Creek (continued)								
AA	27,818	334	696	2.2	713.2	713.2	713.2	0.0
AB	28,776	186	354	4.2	719.4	719.4	719.4	0.0
AC	29,459	100	342	4.4	723.8	723.8	723.8	0.0
AD	30,548	67	224	6.7	734.0	734.0	734.0	0.0
AE	31,504	44	348	6.8	741.9	741.9	741.9	0.0
AF	32,786	36	197	7.6	750.1	750.1	750.1	0.0
AG	33,802	42	210	7.0	756.5	756.5	756.5	0.0
AH	34,657	108	1,282	2.6	766.8	766.8	766.8	0.0
AI	35,621	92	571	2.6	767.7	767.7	767.7	0.0
AJ	36,589	242	765	1.9	769.8	769.8	769.8	0.0
AK	37,315	332	657	2.2	770.5	770.5	770.5	0.0
AL	38,070	417	773	1.9	771.3	771.3	771.3	0.0
AM	39,088	365	821	1.8	772.2	772.2	772.2	0.0
AN	39,896	556	1,476	1.0	772.7	772.7	772.7	0.0
AO	40,660	217	780	2.0	773.8	773.8	773.8	0.0
AP	41,748	236	886	1.7	775.3	775.3	775.3	0.0

[1]Feet above mouth

TABLE 23

FEDERAL EMERGENCY MANAGEMENT AGENCY

BROWN COUNTY, WI AND INCORPORATED AREAS

FLOODWAY DATA

BAIRD CREEK

Table 23: Floodway Data *(continued)*

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Baird Creek Tributary								
A	1,272	32	133	6.0	720.6	720.6	720.6	0.0
B	2,112	167	455	1.7	729.7	729.7	729.7	0.0
C	3,064	190	225	3.5	734.7	734.7	734.7	0.0
D	4,096	102	173	4.6	741.9	741.9	741.9	0.0
E	5,281	121	196	4.1	750.9	750.9	750.9	0.0
F	7,136	172	343	1.7	766.3	766.3	766.3	0.0
G	8,159	92	201	2.8	770.4	770.4	770.4	0.0
H	8,991	287	526	1.1	772.8	772.8	772.8	0.0
I	9,656	170	703	1.2	774.6	774.6	774.6	0.0
J	10,497	124	358	2.5	777.6	777.6	777.6	0.0

[1]Feet above mouth

TABLE 23

FEDERAL EMERGENCY MANAGEMENT AGENCY

BROWN COUNTY, WI AND INCORPORATED AREAS

FLOODWAY DATA

BAIRD CREEK TRIBUTARY

Table 23: Floodway Data *(continued)*

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Baird Creek Tributary 6								
A	197	109	68	2.4	620.8	620.8	620.8	0.0
B	766	12	19	7.3	647.2	647.2	647.2	0.0
C	1,358	9	18	8.0	672.9	672.9	672.9	0.0

[1]Feet above mouth

TABLE 23

FEDERAL EMERGENCY MANAGEMENT AGENCY

BROWN COUNTY, WI AND INCORPORATED AREAS

FLOODWAY DATA

BAIRD CREEK TRIBUTARY 6