FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 3

MONROE COUNTY, MICHIGAN

(ALL JURISDICTIONS)

COMMUNITY NAME	NUMBER	COMMUNITY NAME	NUMBER
ASH, TOWNSHIP OF	260141	LONDON, TOWNSHIP OF	260149
BEDFORD, TOWNSHIP OF	260142	LUNA PIER, CITY OF	260150
BERLIN, CHARTER TOWNSHIP OF	260143	MAYBEE, VILLAGE OF *	260954
CARLETON, VILLAGE OF *	260953	MILAN, TOWNSHIP OF	260152
DUNDEE, TOWNSHIP OF	260144	MONROE, CHARTER TOWNSHIP OF	260154
DUNDEE, VILLAGE OF	260313	MONROE, CITY OF	260153
ERIE, TOWNSHIP OF	260145	PETERSBURG, CITY OF	260288
ESTRAL BEACH, VILLAGE OF	260261	RAISINVILLE, TOWNSHIP OF	260155
EXETER, TOWNSHIP OF *	260586	SOUTH ROCKWOOD, VILLAGE OF	260320
FRENCHTOWN, CHARTER TOWNSHIP OF	260146	SUMMERFIELD, TOWNSHIP OF	260156
IDA, TOWNSHIP OF	260147	WHITEFORD, TOWNSHIP OF	260157
LASALLE, TOWNSHIP OF	260148		

* No Special Flood Hazard Areas Identified

REVISED:

JUNE 19, 2020

FLOOD INSURANCE STUDY NUMBER

26115CV001B

Version Number 2.3.2.4

U.S. DEPARTMENT OF HOMELAND SECURITY

FEMA

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Volume 3

Exhibits

Flood Profiles — Panel

Flood Profiles	Panel
Bancroft Noles Drain	01-04 P
Bay Creek	05-07 P
Bragden Ditch	08-10 P
Flat Creek	11-13 P
Halfway Creek	14-18 P
Huron River	19-22 P
Huron River Diversion Channel	23 P
Indian Creek	24-26 P
Kelly Doty Drain	27-28 P
Laudenschlager Drain	29-30 P
Mouillee Creek	31 P
North Branch Swan Creek	32-33 P
North Ten Mile Creek	34 P
Otter Creek	35-36 P
Plum Creek	37-39 P
River Raisin	40-48 P
Saline River	49-50 P
Salter Drain	51 P
Sandy Creek	52-53 P
Silver Creek	54 P
Spring Brook	55-57 P
Stony Creek	58-61 P
Swan Creek	62-66 P

Published Separately

Flood Insurance Rate Map (FIRM)

FLOOD INSURANCE STUDY REPORT
MONROE COUNTY, MICHIGAN (ALL JURISDICTIONS)

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 insurance 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 60.3, *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 Monroe County, Michigan.

The jurisdictions that are included in this project area, along with the Community Identification Number (CID) for each community and the 8-digit Hydrologic Unit Codes (HUC-8) sub-basins affecting each, are shown in Table 1. The Flood Insurance Rate Map (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	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Ash, Township of	260141	04090005, 04100001	26115C0083E, 26115C0084E, 26115C0085E, 26115C0091E, 26115C0092E, 26115C0093E, 26115C0094E, 26115C0103E, 26115C0104E, 26115C0105E[2], 26115C0108E, 26115C0110E, 26115C0111E, 26115C0112E, 26115C0113E, 26115C0114E, 26115C0116E, 26115C0118E	
Bedford, Township of	260142	04100001	26115C0335E, 26115C0344E, 26115C0345E, 26115C0355E, 26115C0360E, 26115C0361E[2], 26115C0362E, 26115C0363E, 26115C0364E, 26115C0366E, 26115C0367E, 26115C0368E, 26115C0369E, 26115C0457E, 26115C0476E, 26115C0477E, 26115C0481E, 26115C0482F	
Berlin, Charter Township of	260143	04090005, 04100001, 04120200	26115C0108E, 26115C0109E, 26115C0110E, 26115C0114E, 26115C0116E, 26115C0117E, 26115C0118E, 26115C0119F, 26115C0136F, 26115C0137F, 26115C0138F, 26115C0139F, 26115C0145F, 26115C0252E, 26115C0256F, 26115C0257F, 26115C0276F, 26115C0277F	
Carleton, Village of [1]	260953	04100001	26115C0084E, 26115C0092E	

[1] No Special Flood Hazard Areas Identified

[2] Panel Not Printed

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

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Dundee, Township of	260144	04100001, 04100002	26115C0160E, 26115C0170E, 26115C0180E, 26115C0183E, 26115C0184E, 26115C0185E, 26115C0190E, 26115C0195E, 26115C0201E, 26115C0203E, 26115C0215E	
Dundee, Village of	260313	04100001, 04100002	26115C0180E, 26115C0183E, 26115C0184E, 26115C0185E	
Erie, Township of	260145	04100001, 04120200	26115C0360E, 26115C0367E, 26115C0369E, 26115C0378E, 26115C0379F, 26115C0383F, 26115C0386F, 26115C0387F, 26115C0388F, 26115C0389F, 26115C0395F, 26115C0482F, 26115C0501F, 26115C0502F, 26115C0525F	
Estral Beach, Village of	260261	04100001, 04120200	26115C0276F	
Exeter, Township of [1]	260586	04100001	26115C0070E[2], 26115C0075E[2], 26115C0080E[2], 26115C0083E, 26115C0090E[2], 26115C0091E, 26115C0093E, 26115C0206E, 26115C0207E[2], 26115C0230E[2]	
Frenchtown, Charter Township of	260146	04100001, 04100002, 04120200	26115C0093E, 26115C0094E, 26115C0113E, 26115C0114E, 26115C0229E, 26115C0230E[2], 26115C0231E[2], 26115C0232E, 26115C0233E[2], 26115C0234E, 26115C0237E, 26115C0241E, 26115C0242F, 26115C0251E, 26115C0252E, 26115C0253E, 26115C0254F, 26115C0256F, 26115C0257F, 26115C0258F, 26115C0259F, 26115C0261F, 26115C0262F, 26115C0270F, 26115C0276F	

[1] No Special Flood Hazard Areas Identified

[2] Panel Not Printed

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

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Ida, Township of	260147	04100001	26115C0195E, 26115C0215E, 26115C0220E, 26115C0335E, 26115C0355E, 26115C0360E	
LaSalle, Township of	260148	04100001, 04120200	26115C0220E, 26115C0238E, 26115C0239E, 26115C0360E, 26115C0376E, 26115C0377F, 26115C0378E, 26115C0379F, 26115C0381F, 26115C0382F, 26115C0383F, 26115C0384F	
London, Township of	260149	04100001, 04100002	26115C0033E, 26115C0034E, 26115C0045E, 26115C0065E, 26115C0070E[2], 26115C0075E[2], 26115C0185E, 26115C0201E, 26115C0202E, 26115C0206E	
Luna Pier, City of	260150	04100001, 04120200	26115C0379F, 26115C0383F, 26115C0387F	
Maybee, Village of [1]	260954	04100001	26115C0070E[2], 26115C0207E[2]	
Milan, City of	260151	04100001, 04100002	N/A	Washtenaw County, Michigan FIS Report, April 3, 2012
Milan, Township of	260152	04100001, 04100002	26115C0010E, 26115C0020E, 26115C0030E, 26115C0033E, 26115C0034E, 26115C0040E, 26115C0045E, 26115C0160E, 26115C0180E, 26115C0185E	
Monroe, Charter Township of	260154	04100001, 04100002, 04120200	26115C0236E, 26115C0237E, 26115C0238E, 26115C0239E, 26115C0241E, 26115C0242F, 26115C0243F, 26115C0244F, 26115C0263F, 26115C0264F, 26115C0377F, 26115C0381F, 26115C0382F, 26115C0425F	

[1] No Special Flood Hazard Areas Identified

[2] Panel Not Printed

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

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Monroe, City of	260153	04100001, 04100002, 04120200	26115C0233E[2], 26115C0234E, 26115C0237E, 26115C0241E, 26115C0242F, 26115C0244F, 26115C0253E, 26115C0261F, 26115C0262F, 26115C0263F, 26115C0264F	
Petersburg, City of	260288	04100002	26115C0190E	
Raisinville, Township of	260155	04100001, 04100002	26115C0090E[2], 26115C0093E, 26115C0201E, 26115C0202E, 26115C0203E, 26115C0204E, 26115C0206E, 26115C0207E[2], 26115C0208E, 26115C0209E, 26115C0215E, 26115C0220E, 26115C0228E, 26115C0229E, 26115C0230E[2], 26115C0231E[2], 26115C0236E, 26115C0237E 26115C0238E	
South Rockwood, Village of	260320	04090005, 04100001	26115C0108E, 26115C0109E, 26115C0116E, 26115C0117E, 26115C0128E, 26115C0136F	
Summerfield, Township of	260156	04100001, 04100002	26115C0170E, 26115C0190E, 26115C0195E, 26115C0310E[2], 26115C0330E, 26115C0335E	
Whiteford, Township of	260157	04100001, 04100002	26115C0310E[2], 26115C0320E, 26115C0330E, 26115C0335E, 26115C0340E, 26115C0344E, 26115C0345E, 26115C0435E, 26115C0451E, 26115C0452E, 26115C0456E, 26115C0457E	

[1] No Special Flood Hazard Areas Identified

[2] 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 31, "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 Monroe County became effective on April 20, 2000. Refer to Table 28 for information about subsequent revisions to the FIRMs.

- 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 www.fema.gov/national-flood-insurance-program-community-rating-system or contact your appropriate FEMA Regional Office for more information about this program.

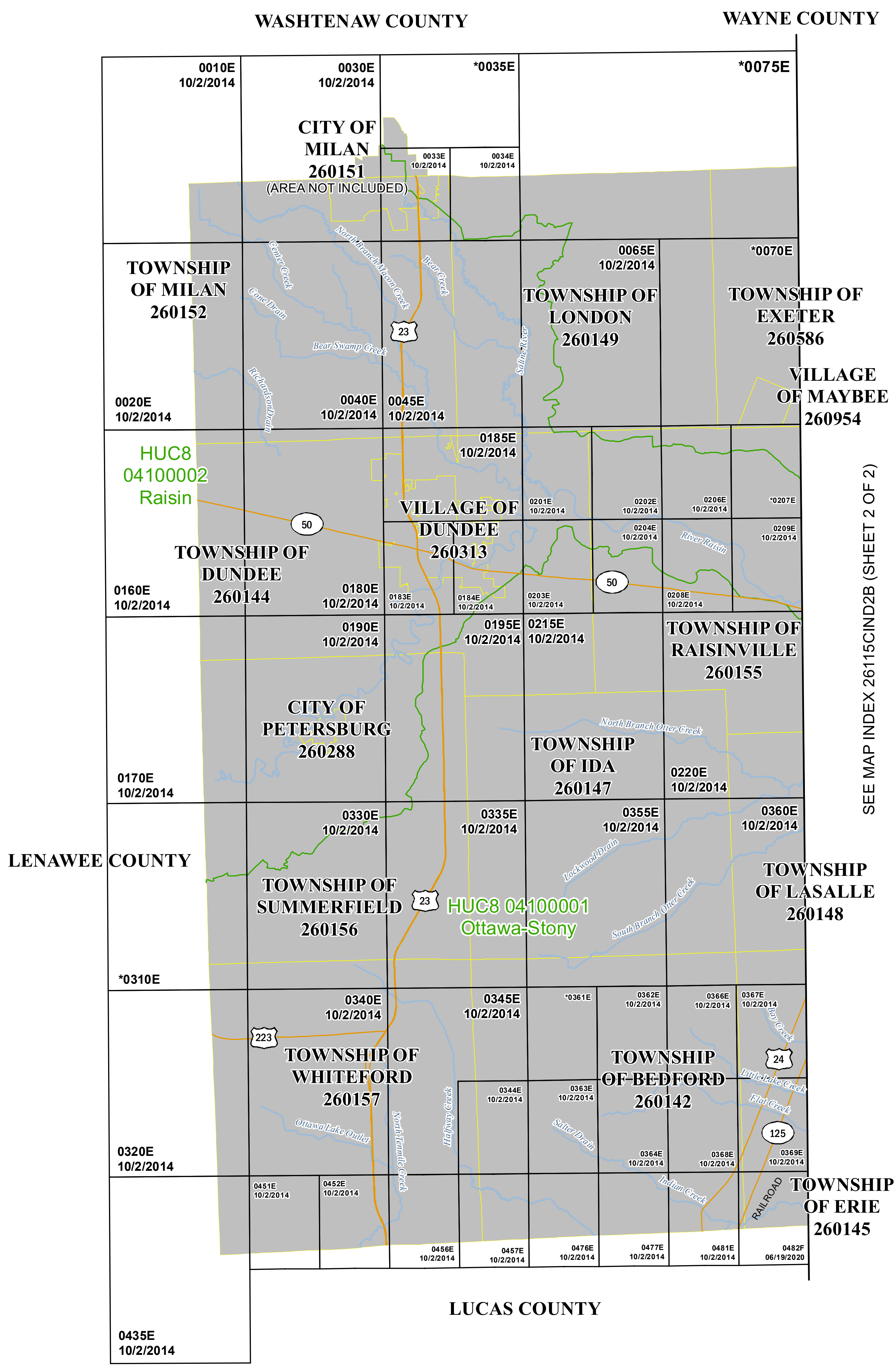
- Previous FIS Reports and FIRMs may have included levees that were accredited as reducing the risk associated with the 1-percent-annual-chance flood based on the information available and the mapping standards of the NFIP at that time. For FEMA to continue to accredit the identified levees, the levees must meet the criteria of the Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10), titled "Mapping of Areas Protected by Levee Systems."

- Since the status of levees is subject to change at any time, the user should contact the appropriate agency for the latest information regarding levees presented in Table 9 of this FIS Report. For levees owned or operated by the U.S. Army Corps of Engineers (USACE), information may be obtained from the USACE National Levee Database (nld.usace.army.mil). For all other levees, the user is encouraged to contact the appropriate local community.

- 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 www.fema.gov/online-tutorials.

The FIRM Index in Figure 1 shows the overall FIRM panel layout within Monroe 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



1 inch = 14,000 feet 1:168,000

0 3,550 7,100 14,200 21,300 28,400 feet

Map Projection:
State Plane Michigan South, FIPS 2113;
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 - NO SPECIAL FLOOD HAZARD AREAS

COUNTY LOCATOR

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX (1 of 2)

MONROE COUNTY, MICHIGAN (All Jurisdictions)

PANELS PRINTED:

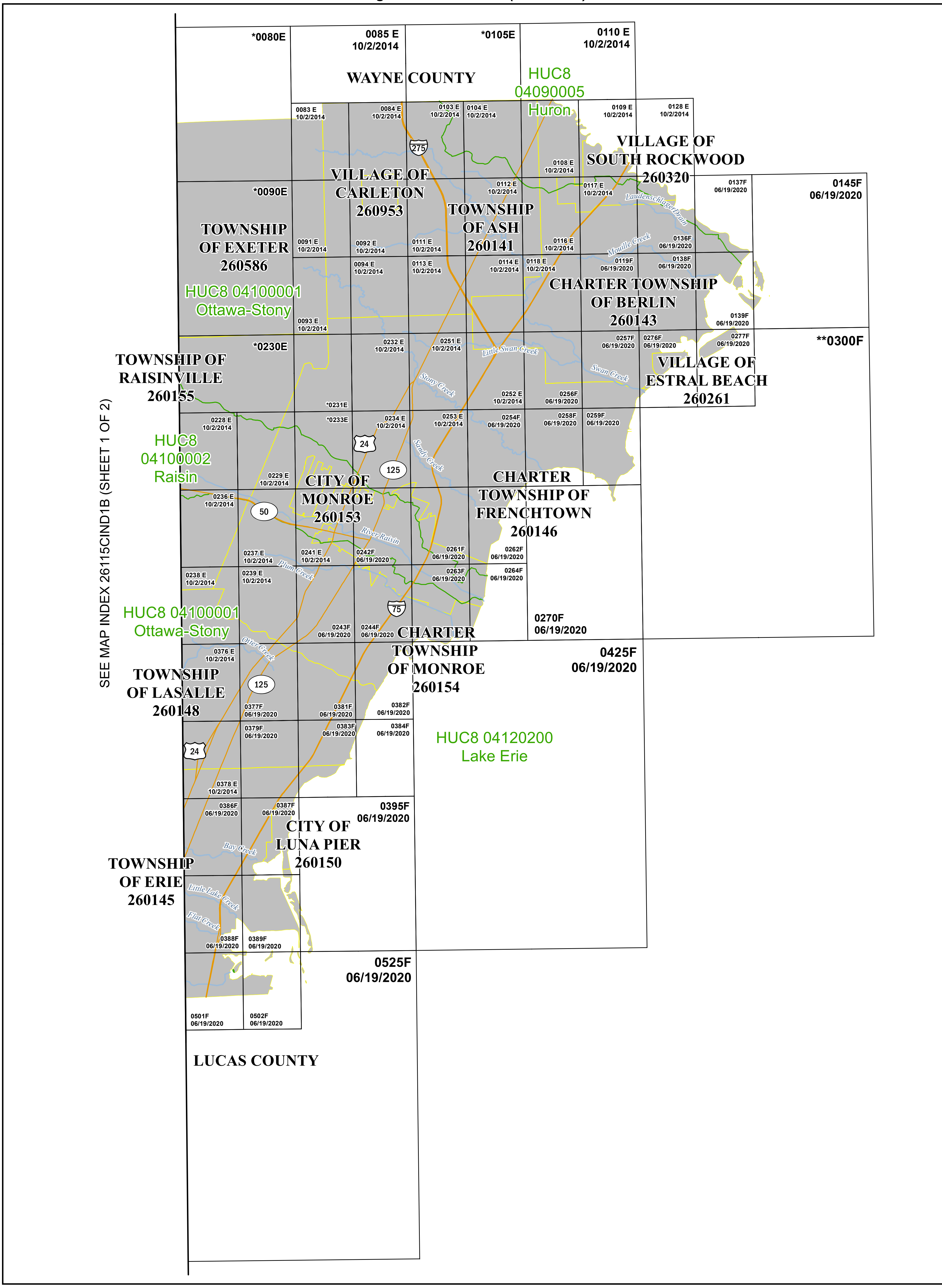
0010, 0020, 0030, 0033, 0034, 0040, 0045, 0065, 0160, 0170, 0180, 0183, 0184, 0185, 0190, 0195, 0201, 0202, 0203, 0204, 0206, 0208, 0209, 0215, 0220, 0320, 0330, 0335, 0340, 0344, 0345, 0355, 0360, 0362, 0363, 0364, 0366, 0367, 0368, 0369, 0435, 0451, 0452, 0456, 0457, 0476, 0477, 0481, 0482

FEMA

MAP NUMBER
26115CIND1B

MAP REVISED
JUNE 19, 2020

Figure 1: FIRM Index *(continued)*



1 inch = 14,000 feet 1:168,000

0 3,550 7,100 14,200 21,300 28,400 feet

Map Projection:
State Plane Michigan South, FIPS 2113;
North American Datum 1983

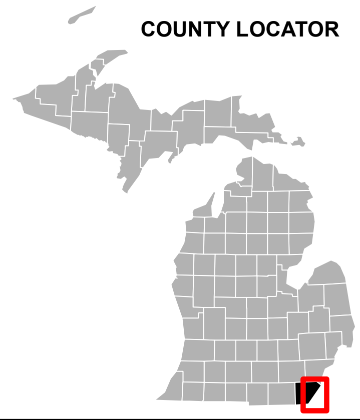
THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTPS://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION

* PANEL NOT PRINTED - NO SPECIAL FLOOD HAZARD AREAS
** PANEL NOT PRINTED - AREA ALL WITHIN ZONE AE (EL 578)

COUNTY LOCATOR



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX (2 of 2)

MONROE COUNTY, MICHIGAN (All Jurisdictions)

PANELS PRINTED:

0083, 0084, 0085, 0091, 0092, 0093, 0094, 0103, 0104, 0108, 0109, 0110, 0111, 0112, 0113, 0114, 0116, 0117, 0118, 0119, 0128, 0136, 0137, 0138, 0139, 0145, 0228, 0229, 0232, 0234, 0236, 0237, 0238, 0239, 0241, 0242, 0243, 0244, 0251, 0252, 0253, 0254, 0256, 0257, 0258, 0259, 0261, 0262, 0263, 0264, 0270, 0276, 0277, 0376, 0377, 0378, 0379, 0381, 0382, 0383, 0384, 0386, 0387, 0388, 0389, 0395, 0425, 0501, 0502, 0525

FEMA

MAP NUMBER
26115CIND2B

MAP REVISED
JUNE 19, 2020

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 Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA 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 Map Service Center website or by calling the FEMA Map Information 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 Map Service Center at the number listed above.

For community and countywide map dates, refer to Table 28 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.

<u>BASE FLOOD ELEVATIONS</u>: 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 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 Erie, administratively established by the National Oceanic and Atmospheric Administration at 173.5 meters (569.2 feet) above zero point International Great Lakes Datum of 1985. This elevation is generally accepted to be equal to an elevation of 569.4 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.

<u>FLOODWAY INFORMATION</u>: 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.

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

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 State Plane Michigan South, FIPS 2113. The horizontal datum was 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 31 of this FIS Report.

BASE MAP INFORMATION: Base map information shown on the FIRM was derived from multiple sources including Monroe County, USFWS, and the USDA. 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.

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

NOTES FOR FIRM INDEX

REVISIONS TO INDEX: As new studies are performed and FIRM panels are updated within Monroe County, Michigan, 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 28 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 Monroe County, Michigan, effective June 19, 2020.

COASTAL BARRIER RESOURCES (CBRS): Coastal Barrier Resources System (CBRS) areas and “otherwise protected areas” (OPAs) are no longer shown on this map panel, but still may be present in this community. Current information on these areas is provided by the U.S. Fish & Wildlife Service (FWS). NFIP flood insurance is not available within CBRS areas for structures that are built or substantially improved on or after the dates indicated by FWS. Users should reference the most up-to-date information provided by FWS to determine NFIP insurance eligibility. The official maps and additional information regarding CBRS areas are provided on the FWS website at: www.fws.gov/cbra. FEMA also includes the official boundaries from FWS on our interactive and dynamic flood maps available through the FEMA Map Service Center.

LIMIT OF MODERATE WAVE ACTION: Zone AE has 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.

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 Monroe 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 note is shown.*

	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, either at cross section locations or as static whole-foot elevations that apply throughout the 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.
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.
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.

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

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.
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
NO SCREEN	Unshaded Zone X: Areas of minimal flood hazard.
FLOOD HAZARD AND OTHER BOUNDARY LINES	
(ortho) (vector)	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

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

GENERAL STRUCTURES	
Aqueduct *Channel* *Culvert* *Storm Sewer*	Channel, Culvert, Aqueduct, or Storm Sewer
Dam *Jetty* *Weir*	Dam, Jetty, Weir
	Levee, Dike, or Floodwall
Bridge	Bridge
REFERENCE MARKERS	
22.0	River mile Markers
CROSS SECTION & TRANSECT INFORMATION	
B 20.2	Lettered Cross Section with Regulatory Water Surface Elevation (BFE)
5280 21.1	Numbered Cross Section with Regulatory Water Surface Elevation (BFE)
17.5	Unlettered Cross Section with Regulatory Water Surface Elevation (BFE)
8	Coastal Transect
	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 (shown for flooding sources for which no cross sections or profile are available)
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

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

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 Monroe 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 23), study methodologies employed (Section 5.0), and flood risk, certain flooding sources may be mapped to show both the 1-percent 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-percent 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 Monroe 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 13. 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	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
Bancroft Noles Drain	South Rockwood, Village of	Confluence with Huron River	Village of South Rockwood / Charter Township of Berlin corporate limits	04090005	1.6		Y	AE	August 1981
Bay Creek	Erie, Township of	Mouth at Lake Erie	Cemetery Road	04100001	3.6		Y	AE	July 1977
Bragden Ditch	Bedford, Township of	Confluence with Indian Creek	A point approximately 1,425 feet upstream of Bernard Street	04100001	2.6		Y	AE	December 1979
Dally Drain	Whiteford, Township of	Confluence with North Ten Mile Creek	A point approximately 1,000 feet down stream of Sterns Road	04100001	2.9		N	A	April 2012
Flat Creek	Bedford, Township of	Minx Road	The footbridge located approximately 170 feet downstream of the confluence with North River	04100001	2.8		Y	AE	December 1979

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

Flooding Source	Community	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
Halfway Creek	Bedford, Township of; Whiteford, Township of	Township of Erie / Township of Bedford corporate limits	A point approximately 485 feet upstream of the Monroe County / Ohio state boundary	04100001	0.6		Y	AE	December 1979
Halfway Creek	Erie, Township of	A point approximately 0.9 miles downstream of Township of Erie / Township of Bedford corporate limits	Township of Erie / Township of Bedford corporate limits	04100001	0.9		N	A	April 2012
Halfway Creek	Bedford, Township of; Whiteford, Township of	A point approximately 250 feet downstream of the Ohio / Michigan state boundary	A point approximately 450 feet upstream of Sterns Road	04100001	3.8		Y	AE	December 1979
Halfway Creek	Whiteford, Township of	A point approximately 450 feet upstream of Sterns Road	Confluence with Sink Creek	04100001	3.1		N	A	April 2012
Huron River	Berlin, Charter Township of	Mouth at Lake Erie And Approximately 2.3 miles upstream of Interstate 75	Approximately 2.4 miles downstream of Interstate 75 And Telegraph Road (U.S. Highway 24)	04090005	6.2		Y	AE	February 1981

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

Flooding Source	Community	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
Huron River	South Rockwood, Village of	Approximately 2.4 miles downstream of Interstate 75	Approximately 2.3 miles upstream of Interstate 75	04090005	4.7		Y	AE	August 1981
Huron River Diversion Channel	South Rockwood, Village of	Divergence from Port Creek	Confluence with Bancroft Noles Drain	04090005	0.8		N	AE	August 1981
Indian Creek	Bedford, Township of	Confluence with Halfway Creek	Temperance Road	04100001	5.7		Y	AE	December 1979
Kelly Doty Drain	Bedford, Township of	Township of Erie / Township of Bedford corporate limits	A point approximately 0.6 mile upstream of Sterns Road	04100001	1.4		Y	AE	December 1979
Lake Erie	Berlin, Charter Township of; Erie, Township of; Estral Beach, Village of; Frenchtown, Charter Township of; LaSalle, Township of; Luna Pier, City of; Monroe, Charter Township of; Monroe, City of	Ohio / Michigan state boundary	Monroe County/ Wayne County boundary	04120200	31		N	VE, AE, AO	November 2016
Laudenschlager Drain	Berlin, Charter Township of	A point approximately 0.6 mile downstream of Haggerman Road	Haggerman Road	04100001	0.6		Y	AE	February 1981

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

Flooding Source	Community	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
Laudenschlager Drain	South Rockwood, Village of	Haggerman Road	A point just downstream of North Dixie Highway	04100001	2.1		Y	AE	August 1981
Little River Raisin	Dundee, Township of	Confluence with River Raisin	A point approximately 0.8 miles upstream of Davis Road	04100002	1.0		N	A	April 2012
Mouillee Creek	Berlin, Charter Township of	Mouth at Lake Erie	A point just upstream of Haggerman Road	04100001	2.9		Y	AE	February 1981
North Branch Otter Creek	Dundee, Township of; Ida, Township of; LaSalle, Township of	Confluence with South Branch Otter Creek	Wells Road	04100001	10.6		N	A	April 2012
North Branch Swan Creek	Ash, Township of	Confluence with Swan Creek	Oakville Waltz Road	04100001	1.9		Y	AE	April 1981
North Ten Mile Creek	Whiteford, Township of	A point approximately 100 feet upstream of northbound U.S. Highway 23	Confluence of Bischoff and Glen Drains	04100001	4.5		N	A	April 2012
North Ten Mile Creek	Whiteford, Township of	Ohio / Michigan state boundary	A point approximately 100 feet upstream of northbound U.S. Highway 23	04100001	0.9		Y	AE	November 1979
Otter Creek	Lasalle, Township of	Approximately 0.3 mile downstream of State Highway 125	Confluence of South Branch Otter Creek	04100001	2.2		N	A	April 2012

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

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi²) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Otter Creek	Lasalle, Township of	Mouth at Lake Erie	South Dixie Highway (M-125)	04100001	3.9		Y	AE	March 1976
Plum Creek	Monroe, Charter Township of; Monroe, City of	Mouth at Lake Erie	South Raisinville Road	04100001	5.7		Y	AE	November 1974 September 1976
River Raisin	Dundee, Township of; Dundee, Village of; Petersburg, City of; Summerfield, Township of	A point approximately 0.5 mile upstream of Dundee Dam	Monroe / Lenawee County Boundary	04100002	17.5		N	A	April 2012
River Raisin	Dundee, Village of	A point approximately 1 mile downstream of State Highway 50	A point approximately 0.5 mile upstream of Dundee Dam	04100002	1.5		Y	AE	January 1981
River Raisin	Dundee, Township of	Township of Raisinville / Township of Dundee corporate limits	A point approximately 1 mile downstream of State Highway 50	04100002	5.7		N	A	April 2012
River Raisin	Raisinville, Township of	Charter Township of Frenchtown / Township of Raisinville corporate limits	Township of Raisinville / Township of Dundee corporate limits	04100002	9.0		Y	AE	December 1980

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

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi²) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
River Raisin	Frenchtown, Charter Township of; Monroe, Charter Township of	Downstream of North Telegraph Road (U.S. Highway 24)	Charter Township of Frenchtown / Township of Raisinville corporate limits	04100002	2.7		Y	AE	September 1976
River Raisin	Monroe, City of	Mouth at Lake Erie	Downstream of North Telegraph Road (U.S. Highway 24)	04100002	4.8		Y	AE	November 1974
Saline River	London, Township of; Milan, Township of	Township of London / Township of Milan corporate limits	A point approximately 0.6 mile upstream of southbound U.S. Highway 23	04100002	2.0		Y	AE	August 1981
Salter Drain	Bedford, Township of	A point approximately 1,900 feet upstream of Jackman Road	A point approximately 600 feet downstream of Brians Court	04100001	1.8		N	A	April 2012
Salter Drain	Bedford, Township of	Confluence with Salter Creek	A point approximately 1,900 feet upstream of Jackman Road	04100001	0.6		Y	AE	December 1979
Sandy Creek	Frenchtown, Charter Township of	Mouth at Lake Erie	North Monroe Street (U.S. Highway 125)	04100001	3.5		Y	AE	August 1976
Silver Creek	Erie, Township of	Michigan / Ohio state line	Approximately 2,087 feet above Michigan / Ohio State line	04100001	0.4		Y	AE	May 2014

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

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi²) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Spring Brook	Bedford, Township of	Confluence with Halfway Creek	A point approximately 1,380 feet upstream of Monroe Road	04100001	2.6		Y	AE	December 1979
Stony Creek	Ash, Township of	Charter Township of Frenchtown / Township of Ash corporate limits	Exeter Road	04100001	3.7		N	A	April 2012
Stony Creek	Frenchtown, Charter Township of	Mouth at Lake Erie	Charter Township of Frenchtown / Township of Ash corporate limits	04100001	8.9		Y	AE	August 1976
Swan Creek	Ash, Township of	Grafton Road	Exeter Road	04100001	2.6		N	A	April 2012
Swan Creek	Ash, Township of	East Labo Road	Grafton Road	04100001	7.0		Y	AE	April 1981
Swan Creek	Ash, Township of; Berlin, Charter Township of	A point approximately 380 feet upstream of southbound Interstate 75	East Labo Road	04100001	1.7		N	A	April 2012
Swan Creek	Berlin, Charter Township of	Mouth at Lake Erie	A point approximately 380 feet upstream of southbound Interstate 75	04100001	1.5		Y	AE	February 1981
Zone A Streams	Varies	Varies	Varies	04100001, 04100002	Varies		N	A	April 2012

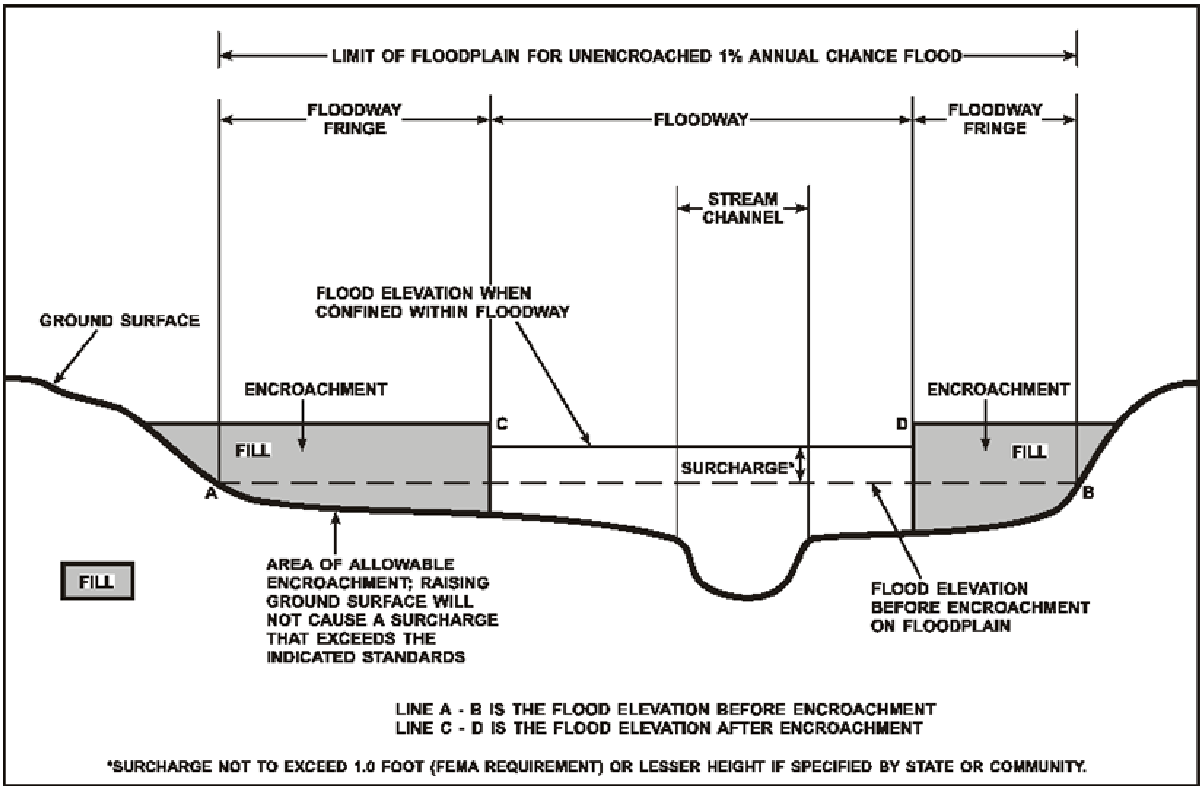
2.2 Floodways

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. Regulations for Michigan under Act 245, Public Acts of 1929, as amended by Act 167, Public Acts of 1968, encroachment in the floodplain is limited to that which will cause only insignificant increases in flood heights. Thus, at the recommendation of the Michigan Department of Natural Resources, Land and Water Management Division, floodways having no more than a 0.1-foot surcharge have been delineated for this study. 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 24, "Floodway Data."

All floodways that were developed for this FIS project are shown on the FIRM using the symbology described in Figure 3. In cases where the floodway and l-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 Base Flood Elevation (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.

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. BFEs 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.

2.4 Non-Encroachment Zones

This section is not applicable to this FIS 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. Seiche influence and resulting oscillation is particularly dominant in Lake Erie, due to the lake's narrow east-west orientation and shallow depths.
- *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 effects of wave heights.

- *Wave setup* is the increase in stillwater elevation at the shoreline caused by the breaking 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 erosion that occurs over time and at a more constant rate.
- *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 total stillwater elevation intersects the land; see Figure 5a.
- *Wave overtopping* refers to the flooding runup that occurs when wave runup passes over the crest of a barrier; see Figure 5b.

Figure 5a: Wave Runup Transect Schematic

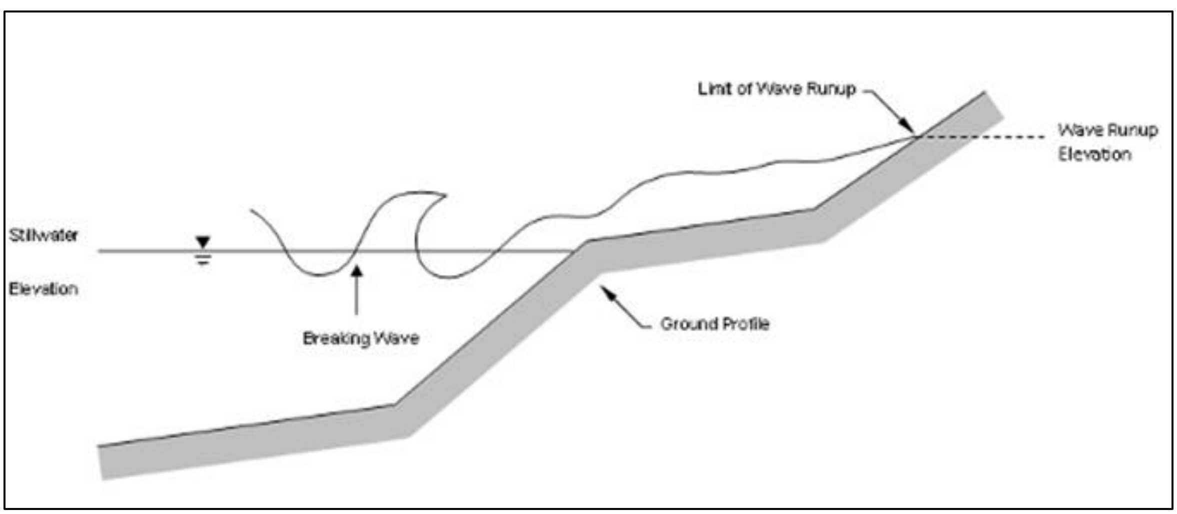
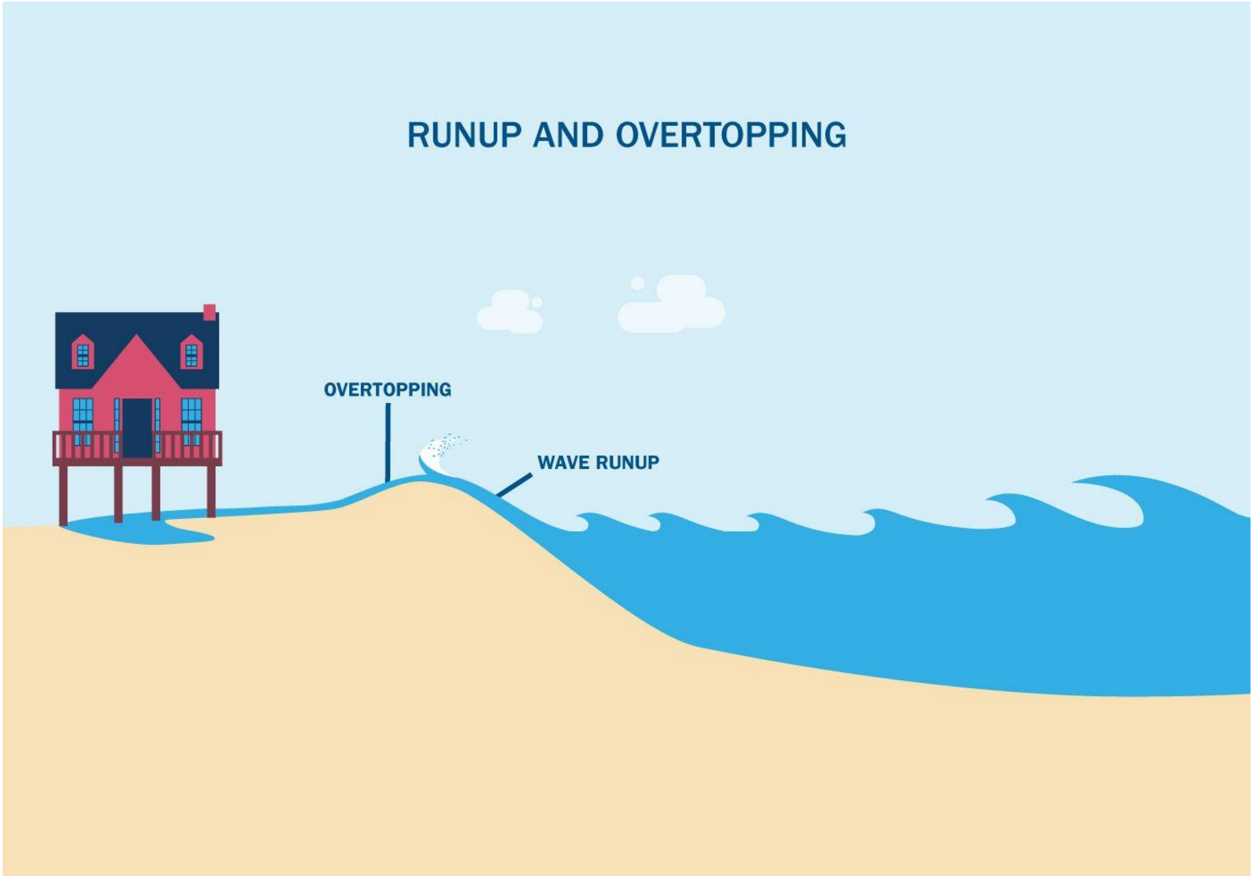


Figure 5b: Wave Overtopping Schematic



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 interact with factors such as topography 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 total stillwater elevation (stillwater elevation including storm surge plus wave setup) for the 1-percent-annual-chance storm. The methods that were used for calculation of total stillwater elevations for coastal areas 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 methods that were used for calculation of wave hazards are described in Section 5.3 of this FIS Report.

Table 26 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 total stillwater elevation for the 1-percent-annual-chance storm plus the additional flood hazard from overland wave effects (storm-induced erosion, 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 17, "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 Area (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.

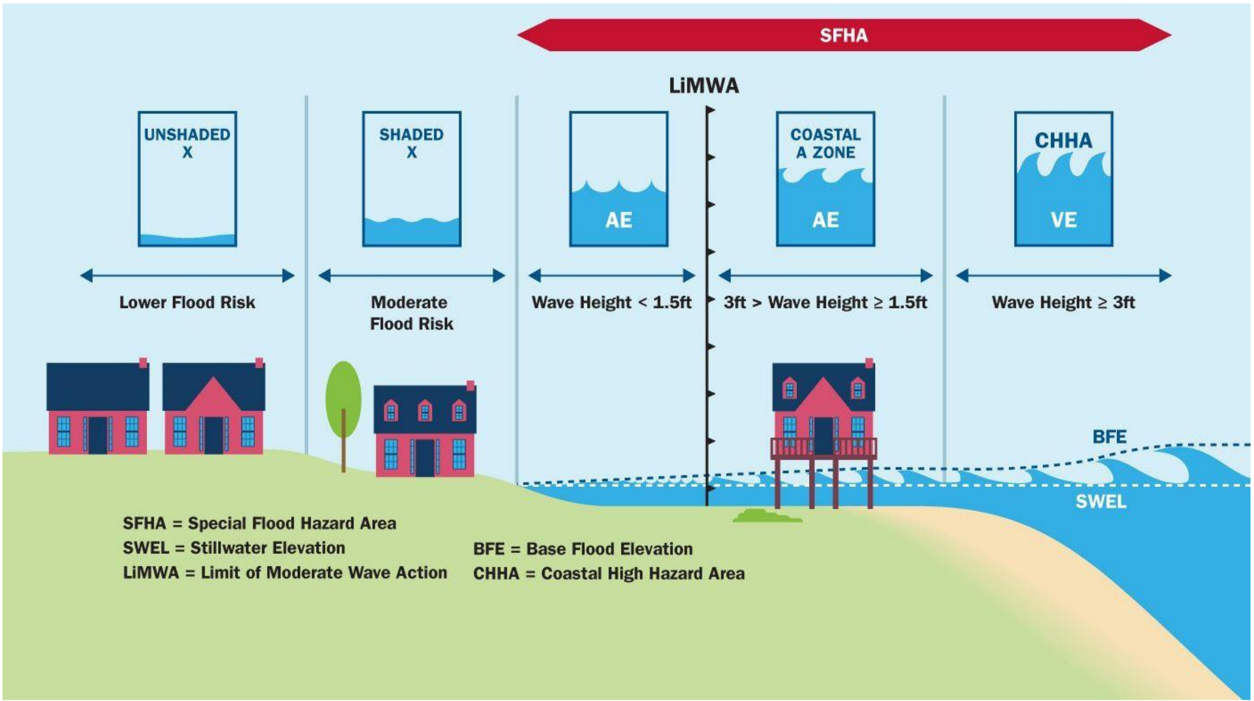
CHHAs are designated as "VE" zones (for "velocity wave zones") and are subject to more stringent regulatory requirements and a different flood insurance rate structure. Zone VE is further subdivided into elevation zones and shown with BFEs on the FIRM.

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. 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 6, "Coastal Transect Schematic," 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 areas in an area without a PFD subject to overland wave propagation. This figure also illustrates energy dissipation and regeneration of a wave as it moves inland.

Figure 6: Coastal Transect Schematic



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." In many cases, the BFE on the FIRM is higher than the stillwater elevations shown in Table 17 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, or 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 6.

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.

Where wave runup elevations dominate over wave heights, there is no evidence to date of significant damage to residential structures by runup depths less than 3 feet. Examples of runup dominated areas include areas with steeply sloped beaches, bluffs, or flood protection structures that lie parallel to the shore. In these areas, the FIRM does not show a LiMWA. Similarly, in areas where the Zone VE designation is based on the presence of a primary frontal dune 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 Monroe County.

Table 3: Flood Zone Designations by Community

Community	Flood Zone(s)
Ash, Township of	A, AE, X
Bedford, Township of	A, AE, X
Berlin, Charter Township of	A, AE, X
Carleton, Village of	X
Dundee, Township of	A, AE, X
Dundee, Village of	A, AE, X
Erie, Township of	A, AE, VE, X
Estral Beach, Village of	AE, AO, X
Exeter, Township of	X
Frenchtown, Charter Township of	A, AE, AO, VE, X
Ida, Township of	A, X
LaSalle, Township of	A, AE, AO, VE, X
London, Township of	A, AE, X

Table 3: Flood Zone Designations by Community *(continued)*

Community	Flood Zone(s)
Luna Pier, City of	AE, AO, VE, X
Maybee, Village of	X
Milan, Township of	A, AE, X
Monroe, Charter Township of	A, AE, AO, VE, X
Monroe, City of	AE, VE, X
Petersburg, City of	A, X
Raisinville, Township of	A, AE, X
South Rockwood, Village of	A, AE, X
Summerfield, Township of	A, AE, X
Whiteford, Township of	A, AE, X

3.2 Coastal Barrier Resources System

The Coastal Barrier Resources Act (CBRA) of 1982 was established by Congress to create areas along the Atlantic and Gulf coasts and the Great Lakes, where restrictions for Federal financial assistance including flood insurance are prohibited. In 1990, Congress passed the Coastal Barrier Improvement Act (CBIA), which increased the extent of areas established by the CBRA and added "Otherwise Protected Areas" (OPA) to the system. These areas are collectively referred to as the John H. Chafee Coastal Barrier Resources System (CBRS). The U.S. Fish and Wildlife Service (FWS) is responsible for maintaining and updating the official CBRS maps and the CBRS digital boundary data.

Historically, CBRS areas and OPAs were included on FIRMs. To address potential inconsistencies between published FIRMs and the official CBRS information maintained by the FWS, CBRS areas and OPAs are no longer shown on effective FIRMs as of February 15, 2019. The removal of the CBRS data from FIRMs does not affect the CBRS status of these areas or change the restrictions that apply in these areas. CBRS areas and OPAs still may be present in Monroe County. Current information on these areas and the official CBRS maps are available at www.fws.gov/cbra.

Table 4: Coastal Barrier Resources System Information

[Not Applicable to this Flood Risk Project]

SECTION 4.0 – AREA STUDIED

4.1 Basin Description

Table 5 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 5: Basin Characteristics

HUC-8 Sub-Basin Name	HUC-8 Sub-Basin Number	Primary Flooding Source	Description of Affected Area	Drainage Area (square miles)
Huron	04090005	Huron River	Begins at the Lake Erie shoreline, extends northwest, encompassing 2 percent of Monroe County	909
Lake Erie	04120200	Lake Erie	Encompasses the shoreline of Monroe County	4,810
Ottawa-Stony	04100001	Stony Creek	Largest watershed within Monroe County, encompassing 73 percent of Monroe County	689
Raisin	04100002	River Raisin	Begins at the Lake Erie shoreline, extending northwest through the center of Monroe County, encompassing 25 percent of Monroe County	1,070

4.2 Principal Flood Problems

Table 6 contains a description of the principal flood problems that have been noted for Monroe County by flooding source.

Table 6: Principal Flood Problems

Flooding Source	Description of Flood Problems
All sources	Winter and spring are the main flooding seasons in Monroe County, though flooding due to intense local thunderstorms has been recorded during summer months and may occur at any time. The most severe flooding has historically occurred along the Lake Erie shoreline and in areas around several inland waterways, including the Huron River, Plum Creek, and River Raisin and its tributaries. Urban flooding from runoff during heavy rainfall has also been noted to occur (FEMA 2000 and Bedford Township Planning Commission 2009).

Table 6: Principal Flood Problems *(continued)*

Flooding Source	Description of Flood Problems
Lake Erie	Flooding along the Lake Erie shoreline has historically occurred most often as a result of the combination of a high lake level and easterly winds. Fluctuations in the lake's water-surface elevations may subject the shoreline to flooding and erosion. Fluctuations in Lake Erie's level can be classified as long-term, seasonal, or short-term. Long-term fluctuations occur over periods of several years. These fluctuations are due to climatic variations, which are seen in changes in precipitation, evaporation, and temperature, and are not cyclical. Seasonal fluctuations reflect the annual hydrologic cycle. High volumes of runoff contribute to the lake in spring and early summer as a result of icemelt and rain falling on saturated soils. This is compounded by a low rate of evaporation to produce higher water levels. In fall and early winter, evaporation from the lake is the greatest and runoff volumes are the lowest, which leads to a decrease in water levels. Short-term fluctuations occur over periods of between several hours and several days due to meteorological conditions. These fluctuations are caused by sustained winds and differences in barometric pressures over the lake surface, which result in imbalances in water levels across the lake's surface. The effects of short-term fluctuations are more localized than the effects of long-term and seasonal fluctuations (FEMA 2000). Severe flooding along the shoreline of Lake Erie occurred in November 1972. Prior to this event, precipitation within the Lake Erie basin had been greater than average and the lake was two feet above its long-term average water level for November. A northeasterly wind reaching speeds up to 45 miles per hour began on November 13 and continued until late November 15. This wind forced water to pile up against and inundate extensive areas of the lake's southwest shore. Peak water levels reaching a height more than six feet higher than the long-term average for November were recorded in Toledo and waves up to 12 feet were generated. Areas along the shoreline were evacuated. Nine Michigan counties and seven Ohio counties were declared Federal Disaster Areas following this event (FEMA 2000; Buetler 1973; and Hushak and Zygmont 1988). A severe storm on April 9, 1973, caused flooding along the Lake Erie shoreline that resulted in an estimated $20 million in damage to residential and commercial properties. It was reported that approximately 140 homes in the Charter Township of Berlin and 400 homes in the City of Luna Pier were inundated. Many more in surrounding communities were also inundated (FEMA 2000). Flooding occurred again along the Lake Erie shoreline during the early hours of June 17, 1973, when a trough of low pressure over the western side of the lake and 11 mile per hour winds caused an eight-foot rise in water levels. Water levels reached nearly as high as they had during the April 1973 flood. Bolles Harbor and the City of Luna Pier were reported to have experienced the most severe flooding, with roads in Bolles Harbor being inundated by three and a half to four feet of water (Ludington 1973).

Table 6: Principal Flood Problems *(continued)*

Flooding Source	Description of Flood Problems
Lake Erie *(continued)*	On March 31, 1985, record high lake levels, combined with strong northeasterly winds, caused the worst flooding since 1973 to occur along the western shoreline of Lake Erie. The worst of this flooding occurred in the areas around the Charter Township of Frenchtown and the City of Luna Pier. At around 5 a.m., water was reported to have begun to overtop recently completed dikes in the City of Luna Pier. The evacuation of approximately 200 people from the community began about an hour later. Floodwaters in the city crested at around 1 p.m. at approximately five feet above flood stage and began receding at around 3:30 p.m. after the winds changed directions. Most of the homes in the Lakewood area of the City of Luna Pier were flooded. In the Charter Township of Frenchtown, more than 100 homes were flooded (Blade 1985).
Huron River	On May 3, 1983, heavy rainfall caused flooding along the Huron River in the Village of South Rockford. Eight families were evacuated during the flooding (Pollick 1983).
Plum Creek	Flooding in areas adjacent to Plum Creek in the Charter Townships of Frenchtown and Monroe and the City of Monroe has been noted to occur due to ice jams, particularly when the water level of Lake Erie is high (FEMA 2000).
River Raisin	Flooding in areas adjacent to the River Raisin in the Charter Townships of Frenchtown and Monroe and the City of Monroe has been noted to occur due to ice jams, particularly when the water level of Lake Erie is high (FEMA 2000). An ice jam on January 26, 1969, at the Winchester Street bridge in the City of Monroe caused River Raisin to rise seven feet above its normal level. Roads were closed in a 16-block area on both the north and south sides of the river and approximately 150 families were evacuated from their homes. On the north side, the flooding occurred over a 10-block area between roughly Monroe Street (M-125) on the west and the Penn Central railroad on the east. On the south side, a six-block residential area along Front Street between Macomb and Winchester Streets was inundated. City officials resorted to calling in demolition experts to blast a channel in the ice using dynamite (Richards 1969). In March 1978, floodwaters from River Raisin came within one-half foot of overtopping Monroe Street in the Village of Dundee. Approximately six buildings were reported to have sustained limited flood damage during this event. Stream flow records obtained from two stream gages—one approximately 0.9 mile downstream of Ida Maybee Road (USGS gage no. 04176500) and one at Academy Road in Lenawee County (USGS gage no. 04176000)—indicate that the magnitude of this flood was equal to approximately a 4-percent-annual-chance flood event (FEMA 2000). In March 1982, 1,100 people were evacuated due to flooding along River Raisin in Monroe County. In the Village of Dundee, the Monroe Street (M-50) and U.S. Highway 23 bridges crossing River Raisin were closed and lowland areas were inundated by at least four feet of water (Rice 1969). Monroe County encountered more flooding from Raisin River in late November and early December of 2011 and in June of 2015. In 2011, the flood waters spilled over the river's banks into the communities of Monroe and Dundee, inundating neighborhoods and businesses. The 2011 and 2015 flooding also forced the closure of the M-50 bridge in Dundee.

Table 7 contains information about historic flood elevations in the communities within Monroe County.

Table 7: Historic Flooding Elevations

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Lake Erie	Monroe, Michigan, at Fermi Power Plant (NOAA Station ID 9063090)	576.9	July 1969	*	NOAA Station
Lake Erie	Monroe, Michigan, at Fermi Power Plant (NOAA Station ID 9063090)	577.0	September 1969	*	NOAA Station
Lake Erie	Monroe, Michigan, at Fermi Power Plant (NOAA Station ID 9063090)	577.3	June 17, 1973	*	NOAA Station
Lake Erie	Toldeo, Ohio, at Maumee Bay (NOAA Station ID 9063085)	577.6	April 9, 1973	*	NOAA Station
Lake Erie	Toldeo, Ohio, at Maumee Bay (NOAA Station ID 9063085)	577.5	April 1974	*	NOAA Station
Lake Erie	Toldeo, Ohio, at Maumee Bay (NOAA Station ID 9063085)	577.4	March 1975	*	NOAA Station
Otter Creek	Just upstream of South Dixie Highway (USGS Gage No. 04176605)	581.3	February 23, 1990	*	USGS Gage

* Data not available

Table 7: Historic Flooding Elevations *(continued)*

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Otter Creek	Just upstream of South Dixie Highway (USGS Gage No. 04176605)	582.1	June 2, 1997	*	USGS Gage
Otter Creek	Just upstream of South Dixie Highway (USGS Gage No. 04176605)	581.4	February 18, 1998	*	USGS Gage
Otter Creek	Just upstream of South Dixie Highway (USGS Gage No. 04176605)	581.2	January 13, 2005	*	USGS Gage
Otter Creek	Just upstream of South Dixie Highway (USGS Gage No. 04176605)	581.7[1]	March 2, 2007	*	USGS Gage
River Raisin	Approximately 0.9 Miles downstream of Ida Maybee Road (USGS Gage No. 04176500)	625.5	February 19, 1976	*	USGS Gage
River Raisin	Approximately 0.9 Miles downstream of Ida Maybee Road (USGS Gage No. 04176500)	625.7	March 23, 1978	*	USGS Gage
River Raisin	Approximately 0.9 Miles downstream of Ida Maybee Road (USGS Gage No. 04176500)	625.9	September 6, 1981	*	USGS Gage

[1] Water-surface elevation affected by backwater

* Data not available

Table 7: Historic Flooding Elevations *(continued)*

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
River Raisin	Approximately 0.9 Miles downstream of Ida Maybee Road (USGS Gage No. 04176500)	626.9[1]	March 15, 1982	*	USGS Gage
River Raisin	Approximately 0.9 Miles downstream of Ida Maybee Road (USGS Gage No. 04176500)	626.1	March 16, 1982	*	USGS Gage
River Raisin	Approximately 0.9 Miles downstream of Ida Maybee Road (USGS Gage No. 04176500)	625.8	February 26, 1985	*	USGS Gage
Saline River	At Sherman Road	673.7	March 1979	*	*
Saline River	At U.S. Highway 23	679.0	March 1979	*	*

[1] Water-surface elevation affected by backwater

* Data not available

4.3 Non-Levee Flood Protection Measures

Table 8 contains information about non-levee flood protection measures within Monroe County such as dams, revetments, seawalls, and/or dikes. Levees are addressed in Section 4.4 of this FIS Report.

Table 8: Non-Levee Flood Protection Measures

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
Hooper Run and Rapideau Drain	N/A	Crib Dikes	In the Adeline subdivision, which is located just west of Interstate 75	Strengthening the 13-year-old dikes along Hooper Run and Rapideau Drain. This work involved encasing the 203 feet of existing cribs along Hooper Run Drain just east of Suder Road and the 170 feet of existing cribs on both the east and west sides of Suder Road with treated timber. East of Interstate 75 near the north end of Grodi Road, the USACE supervised a project to protect the Grodi Road neighborhood from flooding from Wells Drain. As part of this project, the drain was rerouted 200 feet to the north and a 650 foot long earth dike was constructed to prevent flooding on the southern side of the drain.
Lake Erie	N/A	37,740 feet of Earth Dike and Sand filled crib dikes	Along the lower reaches of Swan Creek and Blanchett Drain near Lake Erie and south of the Huron River near Lake Erie enclosing a small residential development	Constructed between November 1973 and January 1974 under Operation Foresight. These protective measures were intended to provide temporary flood protection and are now in need of repair or replacement. While the dikes provide some protection against wave action and minor flooding, their intermittent nature and earthen construction provide little protection against major floods (FEMA 2000).

Table 8: Non-Levee Flood Protection Measures *(continued)*

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
Lake Erie	N/A	Clay Dikes and Private Sea Walls	Village of Estral Beach	Some of the clay dikes have sand cribs built on top or are lined with rock gabions along their length. These structures provide some protection from wave action and minor flooding on Lake Erie, but do not provide protection from the 1- or 0.2-percent-annual-chance flood events (FEMA 2000).
Lake Erie	N/A	Concrete walls, Rock-filled Crib Dikes	In the City of Luna Pier	14,000 feet of temporary flood protection structures were built under Operation Foresight. However, concrete walls constructed along the Lake Erie shoreline as part of Operation Foresight are considered permanent structures for flood protection. These walls would be overtopped during a 1-percent-annual-chance flood, but do provide limited protection during flood events smaller than the 1-percent-annual-chance event. A six-foot-tall rock-filled crib dike constructed as part of Operation Foresight in 1973 was replaced in fall 1984 with a four-foot-tall dike after residents complained that the crib dike blocked their view of Lake Erie. This new dike consisted of precast reinforced concrete cylinders six-feet in diameter which were bolted together and filled with dirt, gravel, and rocks. The new dike was constructed on the water side of the old crib dike and stretches from the northernmost point of the Allens Cove peninsula south to La Pointe Drain at the southernmost edge of the community.

Table 8: Non-Levee Flood Protection Measures *(continued)*

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
Lake Erie	N/A	Sand filled wood crib dikes	These dikes were constructed in the areas of Lost Peninsula, between Hooper Run and Rapideau Drain near Interstate 75, and along Wells Drain east of Interstate 75.	Constructed under Operation Foresight to provide temporary protection from Lake Erie flooding. A system of flap gates was constructed under Interstate 75 on LaPointe, Rapideau, and Wells Drains on the lake side of the roadway to provide protection against flooding from Lake Erie. However, these gates may increase the potential for flooding due to surface runoff (FEMA 2000).
Lake Erie	N/A	Steel and Concrete Sea Walls	Much of the shoreline of the Township of LaSalle	Most of these were overtopped by floodwaters from Lake Erie in 1973. The sea walls primarily serve to protect the shoreline from erosion, though in some places they may hold out floodwaters from Lake Erie. However, flooding may still occur due to backwater from Lake Erie along the numerous small streams found in the community (FEMA 2000).

Table 8: Non-Levee Flood Protection Measures *(continued)*

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
Lake Erie	N/A	Wood, Steel and Concrete Seawalls	Much of the Shoreline of the Charter Township of Frenchtown	Constructed in 1972 and 1973 by the USACE as part of Operation Foresight. These seawalls were constructed to provide temporary flood protection and do not supply long-term protection against flooding from Lake Erie. In 2002, a comprehensive flood protection study was completed for the Resort District of the Charter Township of Frenchtown. In 2009, clay berms located at State Park Subdivision, Brest Bay Grove, Dewey's Subdivision, and Pointe aux Peaux Road near Superior Street, Avenue F, Shady Lane, and the woods were rebuilt. A wooden retainer wall along Shady Lane and Avenue F was constructed to replace a crib dike that was constructed under Operation Foresight and had since deteriorated beyond repair. As of summer 2009, plans were in place for additional shoreline flood protection measures extending from Detroit Beach north to the Fermi 2 nuclear power plant (FEMA 2000 and Cousino 2009).

Table 8: Non-Levee Flood Protection Measures *(continued)*

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
Lake Erie	N/A	Wood, steel and Concrete Seawalls	Charter Township of Monroe	The seawalls were constructed in 1972 and 1973 by the USACE as part of Operation Foresight. These seawalls were constructed to provide temporary flood protection and do not supply long-term protection against flooding from Lake Erie (FEMA 2000).
Lake Erie, Muddy Creek	N/A	Steel Pile Wall, Clay Dike	In the City of Luna Pier	In 1986, the community was awarded two grants through the Shoreline Community Protection Program administered by the Emergency Management Division of the Michigan State Police. The first was for $30,000 and was used to help the community finance the construction of a steel-pile wall along Muddy Creek. The second was for $10,000 and was used to partially finance the restoration of a 1,700-foot-long clay dike located north of the Allen Cove Road bridge that was washing away. The project also called for placing rocks underlain by a filter fabric on the west face of the dike to keep the clay from washing away.
River Raisin Watershed	N/A	Dams	Various	The numerous dam impoundments found in the River Raisin watershed upstream of the township provide substantial flood storage volumes and reduce peak flood discharges (FEMA 2000).

4.4 Levees

This section is not applicable to this FIS project.

Table 9: Levees

[Not Applicable to this FIS 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.

The engineering analyses described here incorporate the results of previously issued Letters of Map Change (LOMCs) listed in Table 27, "Incorporated Letters of Map Change", which include Letters of Map Revision (LOMRs). For more information about LOMRs, refer to Section 6.5, "FIRM Revisions."

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 13. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

A summary of the discharges is provided in Table 10. Frequency Discharge-Drainage Area Curves used to develop the hydrologic models may also be shown in Figure 7 for selected flooding sources. A summary of stillwater elevations developed for non-coastal flooding sources is provided in Table 11. (Coastal stillwater elevations are discussed in Section 5.3 and shown in Table 17.) Stream gage information is provided in Table 12.

Table 10: Summary of Discharges

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance Existing	0.2% Annual Chance
Bancroft Noles Drain	Upstream of confluence with the Huron River	2.0	125	*	220	290	445
Bancroft Noles Drain	Upstream of Carlton Rockwood Road	1.7	110	*	205	270	420
Bay Creek	Upstream of Interstate 75	12.5	635	*	895	985	1,300
Bay Creek	Upstream of confluence with Cousino Drain	8.6	340	*	485	535	705
Bay Creek	Upstream of railroad crossing located downstream of Telegraph Road	7.9	315	*	450	495	660
Bay Creek	Upstream of Minx Road	6.6	275	*	375	440	590
Bragden Ditch	Upstream of confluence with Indian Creek	2.4	295	*	440	515	715
Bragden Ditch	At Jackman Road	1.9	255	*	380	450	620
Flat Creek	At Minx Road	3.3	350	*	400	450	550
Flat Creek	At Crabb Road	2.3	315	*	340	370	450
Flat Creek	At a point approximately 650 feet downstream of Corl Road	2.1	265	*	315	335	390
Flat Creek	At Lewis Avenue	1.3	160	*	240	280	390

*Not calculated for this FIS project

Table 10: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance Existing	0.2% Annual Chance
Halfway Creek	At Township of Erie/Township of Bedford corporate limits	32.2	1,450	*	2,150	2,500	3,250
Halfway Creek	Upstream of confluence with Indian Creek	22.6	1,290	*	1,900	2,200	2,900
Halfway Creek	Upstream of Michigan/Ohio state boundary	20.4	1,240	*	1,810	2,100	2,800
Halfway Creek	At Smith Road	19.4	1,080	*	1,570	1,900	2,500
Halfway Creek	Upstream of confluence with Spring Brook	16.4	740	*	1,060	1,270	1,670
Halfway Creek	At Secor Road	15.4	640	*	930	1,080	1,460
Huron River	At mouth at Lake Erie	901.2	7,230	*	10,590	11,980	14,800
Huron River	Upstream of confluence with Silver Creek	875.2	6,480	*	8,750	10,390	12,100
Huron River	At Township of Rockwood/Township of Flat Rock corporate limits (Wayne County)	864.0	6,490	*	9,390	10,610	13,080
Huron River Diversion Channel	At divergence from the Huron River	*	0	*	165	240	340
Indian Creek	Upstream of confluence with Halfway Creek	8.5	600	*	880	1,020	1,390

*Not calculated for this FIS project

Table 10: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance Existing	0.2% Annual Chance
Indian Creek	Upstream of confluence with Bragden Ditch	4.6	410	*	595	695	950
Indian Creek	Upstream of confluence with Salter Drain	2.7	290	*	420	490	685
Kelly Doty Drain	At Telegraph Road	2.3	265	*	395	465	650
Kelly Doty Drain	Upstream of confluence with unnamed tributary	1.2	195	*	295	355	495
Laudenschlager Drain	At Hagerman Road	2.6	55	*	75	85	120
Mouillee Creek	Upstream of mouth at Lake Erie	12.8	440	*	590	650	750
North Branch Swan Creek	Upstream of confluence with Swan Creek	21.2	565	*	855	960	1,170
North Ten Mile Creek	At Ohio/Michigan state boundary	36.6	1,050	*	1,530	1,780	2,380
Otter Creek	(location not published)	54.0	1,350	*	2,175	2,540	3,600
Plum Creek	Upstream of mouth at Lake Erie	34.0	900	*	1,400	1,650	2,200
Plum Creek	Upstream of confluence with Anweiler Drain	30.0	800	*	1,300	1,500	2,050
Plum Creek	Upstream of confluence with Pitts Creek	14.0	580	*	920	1,100	1,500

*Not calculated for this FIS project

Table 10: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance Existing	0.2% Annual Chance
River Raisin	Just downstream of Raisinville Road	1,056.0	10,200	*	14,400	16,500	22,000
River Raisin	At a point approximately 0.9 mile downstream of Ida Maybee Road (USGS gage no. 04176500)	1,042.0	10,500	*	14,400	16,400	22,000
River Raisin	At Dundee Dam	761.0	6,700	*	9,200	10,100	12,500
Saline River	At Township of Milan/City of Milan corporate limits	109.7	2,060	*	3,490	4,060	5,190
Salter Drain	Upstream of confluence with Indian Creek	1.1	160	*	240	280	395
Sandy Creek	(location not published)	23.2	915	*	1,410	1,635	2,150
Sandy Creek	(location not published)	10.4	575	*	895	1,010	1,420
Silver Creek	At mouth	15.9	*	*	*	2,050	*
Spring Brook	Upstream of confluence with Halfway Creek	2.4	345	*	510	600	835
Spring Brook	At Sterns Road	2.0	310	*	455	540	740
Spring Brook	At Secor Road	1.5	255	*	380	450	620
Stony Creek	(location not published)	123.5	1,940	*	2,860	3,680	4,835
Stony Creek	(location not published)	100.9	1,805	*	2,725	3,485	4,680
Swan Creek	Upstream of mouth at Lake Erie	103.0	2,450	*	3,650	4,090	4,950

*Not calculated for this FIS project

Table 10: Summary of Discharges *(continued)*

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance Existing	0.2% Annual Chance
Swan Creek	Upstream of confluence with Little Swan Creek No. 2	90.6	2,210	*	3,290	3,690	4,470
Swan Creek	At Labo Road	81.2	2,000	*	3,070	3,470	4,230
Swan Creek	Upstream of confluence with Little Swan Creek No. 1	63.0	1,670	*	2,575	2,910	3,555
Swan Creek	Upstream of confluence with Duff Drain	56.9	1,630	*	2,485	2,800	3,410
Swan Creek	Upstream of confluence with North Branch Swan Creek	35.7	1,060	*	1,630	1,840	2,240

*Not calculated for this FIS project

Figure 7: Frequency Discharge-Drainage Area Curves

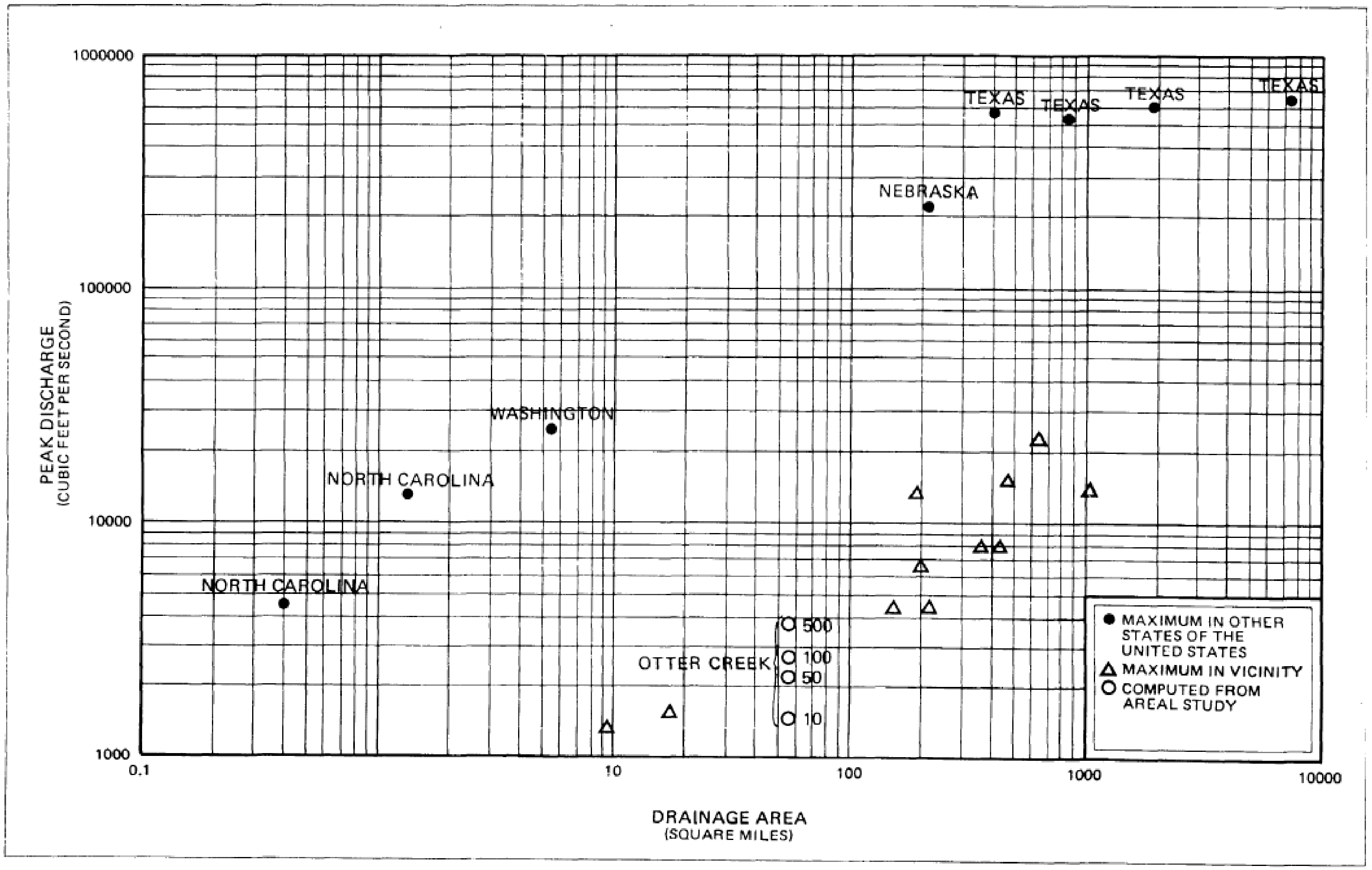


Figure 7: Frequency Discharge-Drainage Area Curves *(continued)*

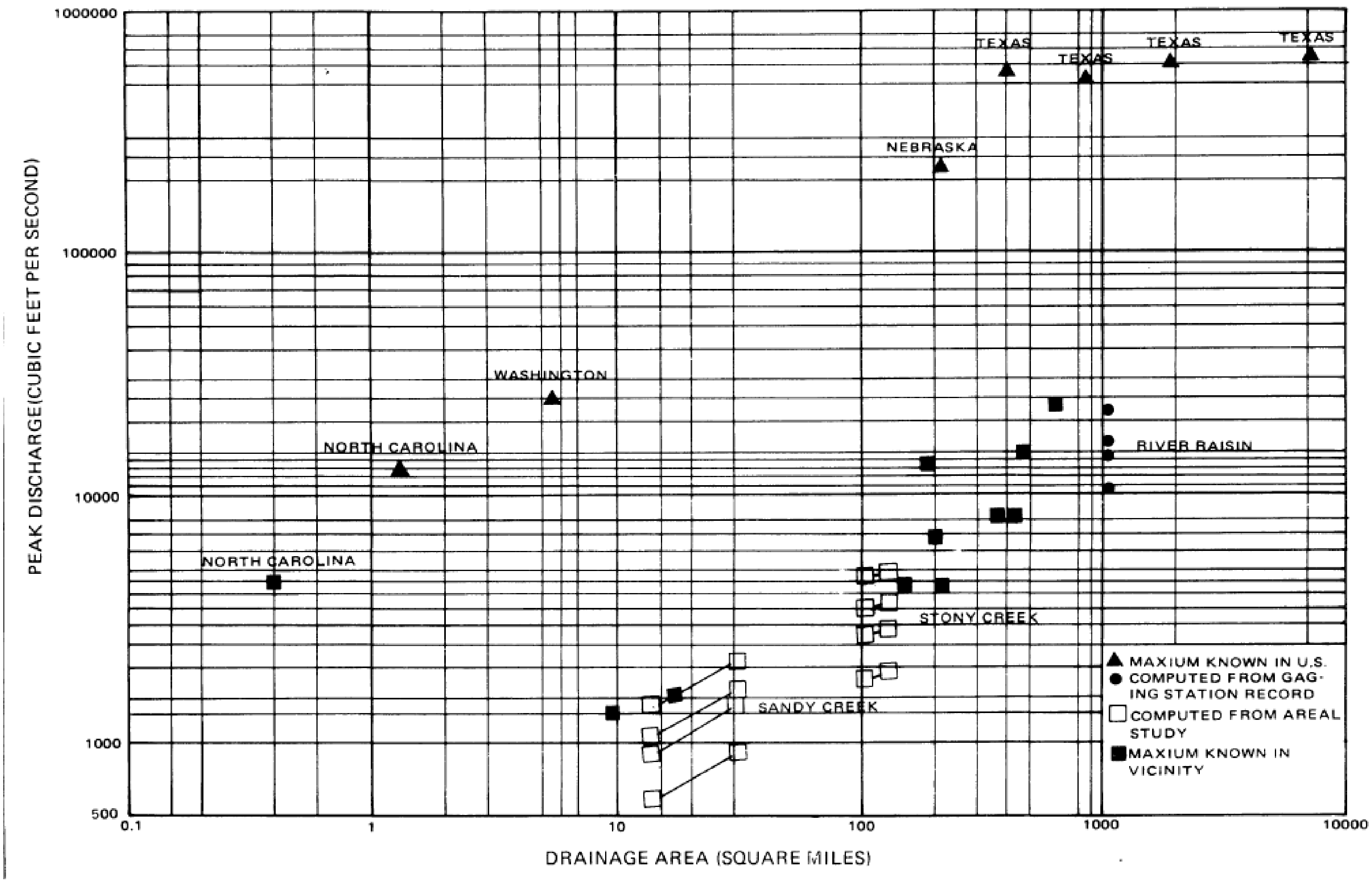


Figure 7: Frequency Discharge-Drainage Area Curves *(continued)*

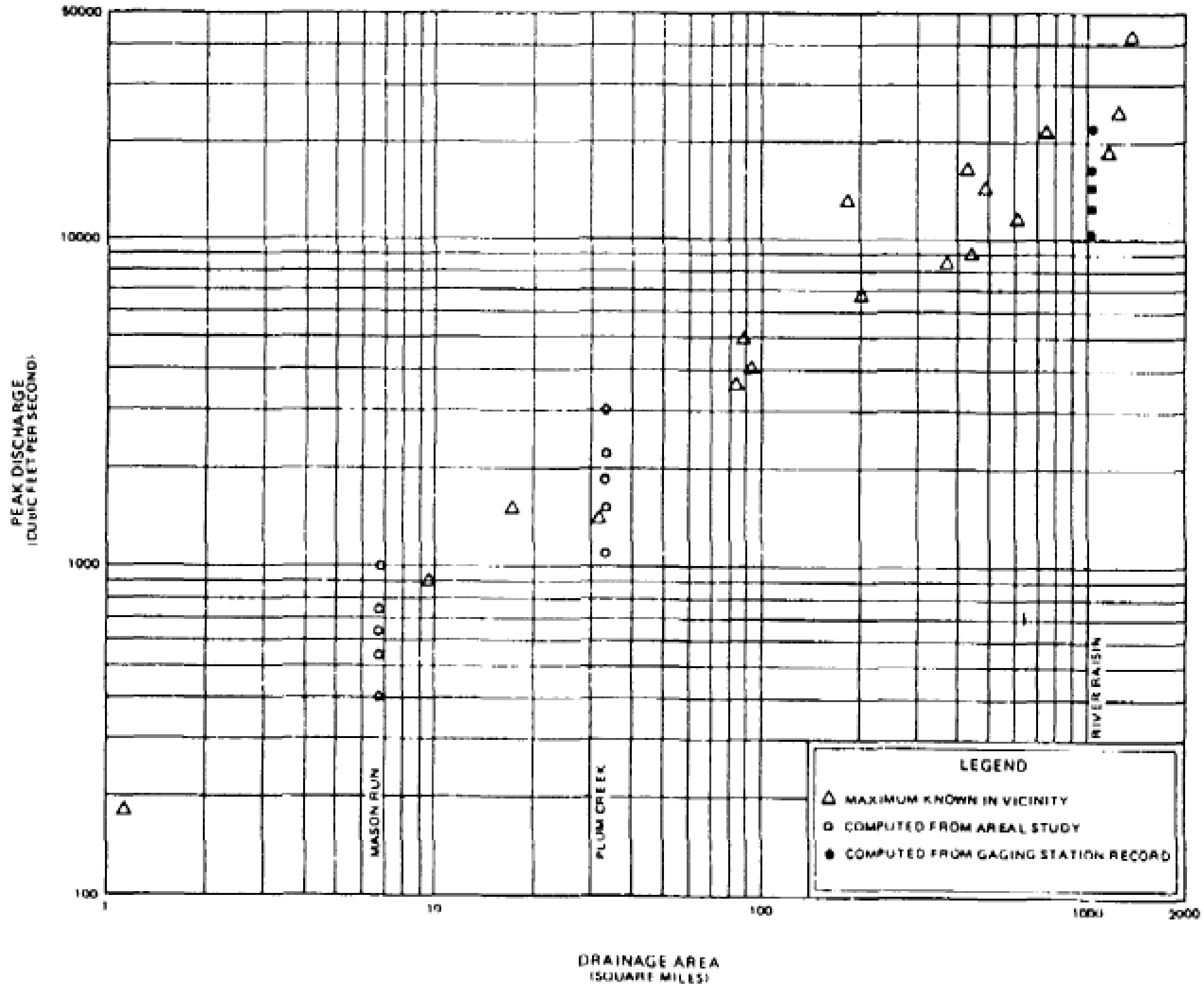


Table 11: Summary of Non-Coastal Stillwater Elevations

[Not Applicable to this Flood Risk Project]

Table 12: 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
River Raisin	04176500	USGS	River Raisin Near Monroe, MI	1,042	1937	1974
River Raisin	04176000	USGS	River Raisin Near Adrian, MI	463	1947	1979

Hydrologic calculations were performed using approximate methods for each of the Zone A streams listed in Table 13. Basins were delineated at various locations throughout each reach. The method of analysis used for each basin was selected based upon the size of the watershed and the availability of a systematic record of peak discharge data or previously published estimates of the 1-percent-annual-chance discharge.

For stream locations at which a gage is present and there is a systematic record of at least 10 years of peak discharge data available, flood frequency analyses were performed using the USGS PeakFQWin computer program (USGS 2006). PeakFQWin provides an estimate of the 1-percent-annual-chance discharge by fitting the log-Pearson Type III distribution to the annual peak discharges following the guidelines of Bulletin 17B. For stream locations at which no gage is present but one is present on the stream, the discharge estimate at the gaged site was weighted based on the ratio of the drainage areas of the gaged and ungaged sites. This gage weighting is performed when the ratio of the drainage areas is between 0.5 and 2.0. The equation used to weight the discharges is shown below.

$$Q_{100(UG)} = \left(\frac{A_u}{A_g}\right)^{0.89} Q_{100(G)}$$

In the equation above, Q100(UG) is the area-weighted estimate of the 1-percent-annual-chance discharge at the ungaged site; Q100(G) is the 1-percent-annual-chance discharge estimate at gaged site based on the systematic records; Au is the drainage area at ungaged site; and Ag is the drainage area at gaged site.

For ungaged streams with drainage areas less than 20 square miles, 1-percent-annual-chance discharges were calculated using the methodology described in Computing Flood Discharges for Small Ungaged Watersheds (SORRELL 2008). The method detailed in this report is similar to the dimensionless unit hydrograph method developed by the SCS and described in “Section 4: Hydrology” of the National Engineering Handbook (SCS 1976). It utilizes contributing drainage area; curve numbers based on soil type and land use; times of concentration calculated based on the maximum flow path’s length, slope, and flow regime and the presence of ponds and swamps.

For ungaged streams with drainage areas greater than 20 square miles, 1-percent-annual-chance discharge estimates were calculated using regression equations described in “USGS Water-Resources Investigation Report 94-4002” (USGS 1994). These regression equations were developed from peak-discharge records available through 1982 from 185 gaging stations with 10 or more years of record. They are applicable to unregulated, rural streams draining less than 1,000 square miles and have standard errors of estimation ranging from 30 to 39 percent. The explanatory variables used in these equations are contributing drainage area; main-channel slope; percentage of the main-channel length that passes through swamp, lake, or pond; basin slenderness ratio; 100-year (1-percent-annual-chance) 24-hour rainfall depth; seven characteristics of surficial geologic material; and a regional factor.

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 on Table 24, “Floodway Data.”

A summary of the methods used in hydraulic analyses performed for this project is provided in Table 13. Roughness coefficients are provided in Table 14. 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 13: 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
Bancroft Noles Drain	Confluence with Huron River	Village of South Rockwood / Charter Township of Berlin corporate limits	TR-20	HEC-2	August 1981	AE w/ Floodway	Cross sections were obtained by field survey and supplemented by topographic maps with a scale of 1:24,000 (USGS 1966). The Starting water surface elevation was determined using the mean annual flood elevation of the Huron River at the confluence was used when modeling flooding due to runoff within the Bancroft Noles watershed. The 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations of the Huron River at the confluence were used when modeling flooding due to the diversion of flow from the Huron River.
Bay Creek	Mouth at Lake Erie	Cemetery Road	Runoff Curve Number Method, TR-20, And TR-55	HEC-2	July 1977	AE w/ Floodway	2017 Redelineation from a point 380 feet downstream of cross section G to a point 30 feet downstream of cross section J. Cross sections were obtained by photogrammetric techniques using aerial photographs published in April 1976 with a scale of 1:12,000 (Abrams 1976). The Starting water surface elevation was determined using the SCS TR-20 computer program (FEMA 1982) was used to compute the pool elevation for the area between the J.R. Whiting Generating Plant railroad spur bridge and Interstate 75 assuming the water-surface elevation of Lake Erie was at the mean (50-percent-annual-chance) flood level.
Bragden Ditch	Confluence with Indian Creek	A point approximately 1,425 feet upstream of Bernard Street	Barter's Unit Hydrograph	HEC-2	December 1979	AE w/ Floodway	Cross sections were obtained by field survey. The Starting water surface elevation was determined using the Slope-area method

Table 13: 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
Dally Drain	Confluence with North Ten Mile Creek	A point approximately 1,000 feet down stream of Sterns Road	MDEQ	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.
Flat Creek	Minx Road	The footbridge located approximately 170 feet downstream of the confluence with North River	HEC-1	HEC-2	December 1979	AE w/ Floodway	Significant volume of flood storage available upstream of the railroad crossing located north of Temperance Road in the Township of Bedford. Cross sections were obtained by field survey The Starting water surface elevation was determined using the Slope-area method
Halfway Creek	Township of Erie / Township of Bedford corporate limits	A point approximately 485 feet upstream of the Monroe County / Ohio state boundary	Barter's Unit Hydrograph	HEC-2	December 1979	AE w/ Floodway	Cross sections were obtained by field survey The Starting water surface elevation was determined using the Slope-area method
Halfway Creek	A point approximately 0.9 miles downstream of Township of Erie / Township of Bedford corporate limits	Township of Erie / Township of Bedford corporate limits	MDEQ & Brater's Unit Hydrograph	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.
Halfway Creek	A point approximately 250 feet downstream of the Ohio / Michigan state boundary	A point approximately 450 feet upstream of Sterns Road	Barter's Unit Hydrograph	HEC-2	December 1979	AE w/ Floodway	Cross sections were obtained by field survey The Starting water surface elevation was Obtained from the 1980 City of Toledo FIS (Bent 1970)

Table 13: 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
Halfway Creek	A point approximately 450 feet upstream of Sterns Road	Confluence with Sink Creek	MDEQ & Brater's Unit Hydrograph	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.
Huron River	Mouth at Lake Erie And approximately 2.3 miles upstream of Interstate 75	Approximately 2.4 miles downstream of Interstate 75 And Telegraph Road (U.S. Highway 24)	TR-20	HEC-2	February 1981	AE w/ Floodway	2017 Redelineation from cross section A to a point 1,150 feet downstream of cross section A. Upstream of the City of Flat Rock (Wayne County)/Village of Rockwood (Wayne County) corporate limits, cross sections were obtained from a study performed by the USACE, Detroit District (USACE Undated), and supplemented by USGS quadrangle maps with a scale of 1:24,000 (USGS 1973). Downstream, 16 valley and five bridge cross sections were obtained by field survey in April 1975 for the 1978 City of Rockwood FIS (FIA 1978). The Starting water surface elevation was assumed to be the mean (50-percent-annual-chance) flood elevation of Lake Erie
Huron River	Approximately 2.4 miles downstream of Interstate 75	Approximately 2.3 miles upstream of Interstate 75	TR-20	HEC-2	August 1981	AE w/ Floodway	Upstream of the City of Flat Rock (Wayne County)/Village of Rockwood (Wayne County) corporate limits, cross sections were obtained from a study performed by the USACE, Detroit District (USACE Undated), and supplemented by USGS quadrangle maps with a scale of 1:24,000 (USGS 1973). Downstream, 16 valley and five bridge cross sections were obtained by field survey in April 1975 for the 1978 City of Rockwood FIS (FIA 1978). The Starting water surface elevation was assumed to be the mean (50-percent-annual-chance) flood elevation of Lake Erie

Table 13: 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
Huron River Diversion Channel	Divergence from Port Creek	Confluence with Bancroft Noles Drain	N/A	HEC-2	August 1981	AE	Cross section source was not published. Water-surface elevations were estimated by calculating the diversion of flow from the Huron River. No starting water-surface elevations were calculated as a part of this analysis.
Indian Creek	Confluence with Halfway Creek	Temperance Road	Barter's Unit Hydrograph	HEC-2	December 1979	AE w/ Floodway	Cross sections were obtained by field survey. The Starting water surface elevation was determined using the Slope-area method
Indian Creek	A point approximately 1,450 feet downstream of the confluence with Bragden Ditch	The private drive located approximately 300 feet downstream of Lewis Avenue	Unknown	Unknown	Unknown	AE w/ Floodway	Revised by LOMR 05-05-0658P.
Kelly Doty Drain	Township of Erie/Township of Bedford corporate limits	A point approximately 0.6 mile upstream of Sterns Road	Barter's Unit Hydrograph	HEC-2	December 1979	AE w/ Floodway	Cross sections were obtained by field survey. The Starting water surface elevation was determined using the Slope-area method
Laudenschlager Drain	A point approximately 0.6 mile downstream of Haggerman Road	Haggerman Road	TR-20	HEC-2	February 1981	AE w/ Floodway	2017 Redelineation from a point 2,610 feet downstream of Haggerman Road to a point 2,350 feet downstream of Haggerman Road. Cross sections were obtained by field survey and supplemented by topographic maps with a scale of 1:24,000 (USGS 1966). The Starting water surface elevation was obtained from a convergence analysis performed between the downstream limit of study and cross section located approximately 3,450 feet downstream of the downstream study limit
Laudenschlager Drain	Haggerman Road	A point just downstream of North Dixie Highway	TR-20	HEC-2	August 1981	AE w/ Floodway	Cross sections were obtained by field survey and supplemented by topographic maps with a scale of 1:24,000 (USGS 1966).

Table 13: 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
Little River Raisin	Confluence with River Raisin	A point approximately 0.8 miles upstream of Davis Road	1993 National Regression Equations	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.
Mouillee Creek	Mouth at Lake Erie	A point just upstream of Haggerman Road	TR-20	HEC-2	February 1981	AE w/ Floodway	2017 Redelineation from a point 1,430 feet downstream of Haggerman Road to a point.60 feet upstream of Haggerman Road. Cross sections were obtained by field survey and photogrammetric techniques using aerial photographs flown in September and October 1979 with a scale of 1:4,800 (Northern 1979). The Starting water surface elevation was assumed to be 570.4 feet NAVD, the approximate mean monthly water-surface elevation of Lake Erie as reported by the USACE's Monthly Bulletin of Lake Levels for the Great Lakes (USACE Monthly)
North Branch Otter Creek	Confluence with South Branch Otter Creek	Wells Road	MDEQ, SCS, and 1993 National Regression Equations	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.
North Branch Swan Creek	Confluence with Swan Creek	Oakville Waltz Road	TR-20	HEC-2	April 1981	AE w/ Floodway	Cross sections were obtained by field survey and supplemented by topographic maps with a scale of 1:24,000 (USGS 1966). The Starting water surface elevation was assumed to be the 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations of Swan Creek at the confluence

Table 13: 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 Ten Mile Creek	A point approximately 100 feet upstream of northbound U.S. Highway 23	Confluence of Bischoff and Glen Drains	Area weighted Brater's Unit Hydrograph & SCS	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.
North Ten Mile Creek	Ohio / Michigan state boundary	A point approximately 100 feet upstream of northbound U.S. Highway 23	Barter's Unit Hydrograph	HEC-2	November 1979	AE w/ Floodway	Cross sections were obtained by field survey. The Starting water surface elevation was Developed from a rating curve based on the 1977 City of Sylvania, Ohio, FIS (FIA 1977)
Otter Creek	Approximately 0.3 mile downstream of State Highway 125	Confluence of South Branch Otter Creek	MDEQ Methods	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.
Otter Creek	Mouth at Lake Erie	South Dixie Highway (M-125)	Regional Relationships	HEC-2	March 1976	AE w/ Floodway	2017 Redelineation from a point 70 feet downstream of cross section M upstream to cross section R. Cross sections were obtained by photogrammetric techniques. The Starting water surface elevation was assumed to be the median elevation of Lake Erie
Plum Creek	Mouth at Lake Erie	South Raisinville Road	Regional Relationships	USGS E-431	November 1974 September 1976	AE w/ Floodway	Upstream of Herr Road, cross sections were obtained by field survey. Downstream, cross sections were obtained by photogrammetric techniques using aerial photographs published in April 1976 with scales of 1:6,000 and 1:9,200 (Kucera 1975).

Table 13: 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
River Raisin	A point approximately 0.5 mile upstream of Dundee Dam	Monroe / Lenawee County Boundary	Bulletin 17B frequency analysis	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010 A channel was added to the cross-section data where the LiDAR data did not extend below the water level of the channel. Channel geometry added to the Raisin River was estimated based on the profiles of adjacent detailed study reaches on the Raisin River. No structures were modeled.
River Raisin	A point approximately 1 mile downstream of State Highway 50	A point approximately 0.5 mile upstream of Dundee Dam	Log Pearson Type III Frequency Analysis	HEC-2	January 1981	AE w/ Floodway	Calibrated to match 1978 flood elevations at the Monroe Street Bridge Cross section source was not published. The Starting water surface elevation was determined using the Slope-area method
River Raisin	A point approximately 0.4 mile downstream of the confluence with Curtis Drain	A point 0.5 mile upstream of Dundee Dram	Log Pearson Type III Frequency Analysis	Unknown	Unknown	AE w/ Floodway	Revised by LOMR 07-05-0218P.
River Raisin	Township of Raisinville / Township of Dundee corporate limits	A point approximately 1 mile downstream of State Highway 50	Bulletin 17B frequency analysis	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010 A channel was added to the cross-section data where the LiDAR data did not extend below the water level of the channel. Channel geometry added to the Raisin River was estimated based on the profiles of adjacent detailed study reaches on the Raisin River. No structures were modeled.

Table 13: 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
River Raisin	Charter Township of Frenchtown / Township of Raisinville corporate limits	Township of Raisinville / Township of Dundee corporate limits	Log Pearson Type III Frequency Analysis	HEC-2	December 1980	AE w/ Floodway	Cross sections were obtained by field survey and photogrammetric techniques using aerial photographs published in April 1976 with scales of 1:6,000 and 1:9,200 (Kucera 1975).
River Raisin	Downstream of North Telegraph Road (U.S. Highway 24)	Charter Township of Frenchtown / Township of Raisinville corporate limits	Log Pearson Type III Frequency Analysis	USGS E-431	September 1976	AE w/ Floodway	Cross sections were obtained by field survey and photogrammetric techniques using aerial photographs published in April 1976 with scales of 1:6,000 and 1:9,200 (Kucera 1975).
River Raisin	Mouth at Lake Erie	Downstream of North Telegraph Road (U.S. Highway 24)	Log Pearson Type III Frequency Analysis	Standard Step-Backwater model	November 1974	AE w/ Floodway	2017 Redelineation from a point 100 feet upstream of cross section N, to cross section P. Cross sections were obtained by field survey and photogrammetric techniques using aerial photographs published in April 1976 with scales of 1:6,000 and 1:9,200 (Kucera 1975).
Saline River	Township of London/Township of Milan corporate limits	A point approximately 0.6 mile upstream of southbound U.S. Highway 23	TR-20	HEC-2	August 1981	AE w/ Floodway	Cross sections were obtained by field survey and supplemented by topographic maps with a scale of 1:24,000 (USGS 1966). The Starting water surface elevation was obtained from a convergence analysis performed between the downstream limit of study and a cross section located approximately one mile downstream of the downstream study limit
Salter Drain	Township of Bedford	A point approximately 1,900 feet upstream of Jackman Road	Brater's Unit Hydrograph	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.

Table 13: 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
Salter Drain	Confluence with Salter Creek	A point approximately 1,900 feet upstream of Jackman Road	Barter's Unit Hydrograph	HEC-2	December 1979	AE w/ Floodway	Cross sections were obtained by field survey The Starting water surface elevation was determined using the Slope-area method
Sandy Creek	Mouth at Lake Erie	North Monroe Street (U.S. Highway 125)	Regional Relationships	USGS E-431	August 1976	AE w/ Floodway	2017 Redelineation from a point 25 feet upstream of cross section C, to cross section D. Cross sections were obtained by field survey. The Starting water surface elevation was assumed to be the median water-surface elevation of Lake Erie.
Silver Creek	Michigan / Ohio state boundary	Michigan / Ohio state boundary near Meteor Avenue	Regression Equations (USGS 2006)	HEC-RAS 4.0	May 2014	AE w/ Floodway	Flooding source is located in Lucas County, Ohio, and is included in the Lucas County FIS. However, a portion of the stream has flooding effects in Monroe County, Michigan.
Spring Brook	Confluence with Halfway Creek	A point approximately 1,380 feet upstream of Monroe Road	Barter's Unit Hydrograph	HEC-2	December 1979	AE w/ Floodway	Cross sections were obtained by field survey. The starting water surface elevation was determined using the slope-area method.
Stony Creek	Approximately 1.6 miles downstream of North Stony Creek Road	Exeter Road	MDEQ Methods	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.
Stony Creek	Mouth at Lake Erie	Charter Township of Frenchtown / Township of Ash corporate limits	Regional Relationships	USGS E-431	August 1976	AE w/ Floodway	2017 Redelineation from a point 130 feet downstream of cross section E to a point 35 feet downstream of cross section F. Cross sections were obtained by field survey. The Starting water surface elevation was assumed to be the median water-surface elevation of Lake Erie

Table 13: 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
Swan Creek	Grafton Road	Exeter Road	TR-20	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.
Swan Creek	East Labo Road	Grafton Road	TR-20	HEC-2	February 1981	AE w/ Floodway	2017 Redelineation from a point 300 feet downstream of cross section A to a point 400 feet upstream of cross section A. Cross sections were obtained by field survey and supplemented by topographic maps with a scale of 1:24,000 (USGS 1966). The Starting water surface elevation was obtained from a convergence analysis performed between the downstream limit of study at Labo Road and a cross section located approximately 1.4 miles downstream at Interstate 75.
Swan Creek	A point approximately 380 feet upstream of southbound Interstate 75	East Labo Road	TR-20	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.
Swan Creek	Mouth at Lake Erie	A point approximately 380 feet upstream of southbound Interstate 75	TR-20	HEC-2	April 1981	AE w/ Floodway	Cross sections were obtained by field survey and photogrammetric techniques using aerial photographs flown in September and October 1979 with a scale of 1:4,800(Northern 1979). The Starting water surface elevation was assumed to be 570.4 feet NAVD, the approximate mean monthly water-surface elevation of Lake Erie as reported by the USACE's Monthly Bulletin of Lake Levels for the Great Lakes (USACE Monthly)

Table 13: 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
Zone A Streams: Hubbard and Clampitt Drain, Ottawa Lake Outlet	N/A	N/A	Brater's Unit Hydrograph & SCS	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.
Zone A Streams: Kelly Doty Drain, South Branch Otter Creek	N/A	N/A	MDEQ & SCS	HEC-RAS 4.1.0	April 2012	A	2017 Redelineation of Kelly Doty Drain from a point 2,640 feet upstream of Suder Road to a point 2,690 feet upstream of Suder Road. Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.
Zone A Streams: Bay Creek, Bear Swamp Creek, Colburn Drain, Hamilton Drain, Little Lake Drain, Lockwood Drain, Macon Creek, Mosquito Drain, North Branch Macon Creek Tributary 3, Saline River, Stony Creek	N/A	N/A	MDEQ Methods	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.

Table 13: 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
Zone A Streams: Center Creek, Flat Creek, Cousino-Martin Creek	N/A	N/A	MDEQ Methods & SCS	HEC-RAS 4.1.0	April 2012	A	2017 Redelineation of Flat Creek from a point 940 feet upstream of Suder Road to a point 1,090 feet upstream of Suder Road. 2017 Redelineation of Cousino Martin Creek from a point 30 feet downstream of Luna Pier Road to a point 980 feet upstream of Luna Pier Road. Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.

Table 13: 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
Zone A Streams: Albain Drain, Albert Johnson Drain, Alfen Drain, Barry Babcock and Baker Drain, Bear Creek, Beaver Meadow Drain, Beaverdam Drain, Bischoff Drain, Bragden Drain, Branch No. 1, Branch No. 2, Burgess Drain, Center Creek Tributary, Chapman Drain, Cone Drain, Cousino Drain, Cove Drain, Cox Drain, Coyle Drain, Coyle Drain, Coyle Drain Tributary, Cranberry Marsh Drain,	N/A	N/A	SCS	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.

Table 13: 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
Zone A Streams: Crandell Drain, Crubb Drain, Curtis Drain, Davis Swale, Dibble Drain, Duck Pond Drain, Dunlap Drain, Ellis Drain, Emmons Drain, Fishburn Drain, Fox Drain, Glenn Drain, Hall and Hanlon Drain, Harshman Drain, Henry Drain, Hitting Drain, Hoag and Auten Drain, Ida Drain, Ingraham Drain, Johnson Drain, Karns Drain, Kinney Drain, La Plaisance Creek, Labadie Drain, Lautz and Graft Drain, Lavoy Drain, Lavoy Drain Tributary, Leet Weidner Drain, Leonard Drain, Leppleman Drain, Little Lake Creek	N/A	N/A	SCS	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.

Table 13: 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
Zone A Streams: Little Lake Creek Tributary 1, Little Lake Creek Tributary 2, Little Swan Creek No. 1, Little Swan Creek No. 1 Tributary 1, Little Swan Creek No. 1 Tributary 2, Little Swan Creek No. 2, Macon and Milan Drain, McPeek Ditch, Middle Branch Otter Creek, Miller and Malosh Drain, Montri and Pomeroy Drain, Mouille Creek, Mouille Creek Tributary 2, Muddy Creek, No. 10 Drain, Nolan Engle Drain, North Branch Macon Creek, North Branch Macon Creek Tributary 1, North Branch Macon Creek Tributary 2, North Branch Winrick and Cousino Drain	N/A	N/A	SCS	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.

Table 13: 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
Zone A Streams: North River, Ottawa Lake Drain, Peters Drain, Pike Swale, Rapideau Drain, Rauch Drain, Reinhardt and Kettinger Drain, Rice Drain, Richardson Drain, Robert Drain, Root Drain, Saline River Tributary 1, Saline River Tributary 2, Saxton Drain, Schreiber Ditch, Sherman Wilson Drain, Shober No. 1 Drain, Sink Creek, Smith Ditch, Snober Drain, Southern Banch Mouille Creek, Spencer Drain, Streit Drain, Sugar Run Drain, Summerfield and Ida Drain, Swan Creek Tributary, Thomas and Richards Drain, Tracy Run, Uden Drain	N/A	N/A	MDEQ Methods & SCS	HEC-RAS 4.1.0	April 2012	A	2017 Redelineation of Rapideau Drain from a point 1,380 feet upstream of Suder Road to a point 1,980 feet upstream of Suder Road. 2017 Redelineation of Southern Branch Mouillee Creek from a point 2,170 feet downstream of Haggerman Road to a point 740 feet downstream of Haggerman Road. Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.

Table 13: 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
Zone A Streams: Unnamed Tributary 1 to Halfway Creek, Unnamed Tributary 2 to Halfway Creek, Unnamed Tributary 3 to Halfway Creek, Van Gunter Drain, Van Schoich Drain, Vanderventer Drain, Waffle Drain, Warner Drain, Warren Lewis Drain, Yarger Drain, Yetter Drain	N/A	N/A	SCS	HEC-RAS 4.1.0	April 2012	A	Cross-section geometry consisted of un-surveyed cross-sections developed from a Digital Elevation Model (DEM) generated using Monroe County LiDAR data. LiDAR data was obtained in the Spring 2010. No structures were modeled.

Table 14: Roughness Coefficients

Flooding Source	Channel "n"	Overbank "n"
All Base Studies	0.030 - 0.048	0.040 - 0.100
Bancroft Noles Drain	0.020 - 0.040	0.080 - 0.100
Bay Creek	0.030 - 0.045	0.020 - 0.100
Bragden Ditch	0.040 - 0.060	0.045 - 0.100
Flat Creek	0.040 - 0.060	0.045 - 0.100
Halfway Creek	0.035 - 0.060	0.040 - 0.100
Huron River	0.020 - 0.050	0.035 - 0.120
Huron River Diversion Channel	not available	not available
Indian Creek	0.040 - 0.060	0.045 - 0.100
Kelly Doty Drain	0.040 - 0.060	0.045 - 0.100
Laudenschlager Drain	0.020 - 0.040	0.080 - 0.100
Mouillee Creek	0.040	0.060 - 0.120
North Branch Swan Creek	0.020 - 0.035	0.060 - 0.120
North Ten Mile Creek	0.050 - 0.052	0.065
Otter Creek	not available	not available
Plum Creek	0.025 - 0.050	0.035 - 0.100
River Raisin	0.025 - 0.042	0.030 - 0.200
Saline River	0.045 - 0.065	0.060 - 0.150
Salter Drain	0.040 - 0.060	0.045 - 0.100
Sandy Creek	not available	0.040 - 0.120
Silver Creek	0.032 - 0.044	0.038 - 0.056
Spring Brook	0.040 - 0.060	0.045 - 0.100
Stony Creek	0.025 - 0.050	0.040 - 0.150
Swan Creek	0.020 - 0.040	0.055 - 0.120

5.3 Coastal Analyses

For the areas of Monroe 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. Table 15 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 15: Summary of Coastal Analyses

Flooding Source	Study Limits From	Study Limits To	Hazard Evaluated	Model or Method Used	Date Analysis was Completed
Lake Erie	Entire shoreline of Monroe County	Entire shoreline of Monroe County	Erosion	Cross-Shore Numerical Model (CSHORE)	1/1/2016
Lake Erie	Entire shoreline of Monroe County	Entire shoreline of Monroe County	Overland Wave Propagation	Wave Height Analysis for Flood Insurance Studies (WHAFIS)	1/1/2016
Lake Erie	Entire shoreline of Monroe County	Entire shoreline of Monroe County	Statistical Analysis	Peak Over Threshold / Generalized Pareto Distribution Joint Probability Method (JPM)	1/1/2016
Lake Erie	Entire shoreline of Monroe County	Entire shoreline of Monroe County	Storm Surge	Advanced Circulation Model (ADCIRC)	1/1/2016
Lake Erie	Entire shoreline of Monroe County	Entire shoreline of Monroe County	Wave Generation	Simulating Waves Nearshore Models (SWAN)	1/1/2016
Lake Erie	Entire shoreline of Monroe County	Entire shoreline of Monroe County	Wave Runup	CSHORE / Shore Protection Manual (SPM)	1/1/2016
Lake Erie	Entire shoreline of Monroe County	Entire shoreline of Monroe County	Wave Setup	SWAN	1/1/2016

5.3.1 Total Stillwater Elevations

The total stillwater elevations (stillwater including storm surge plus wave setup) 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 15. The stillwater elevation that was used for each transect in coastal analyses is shown in Figure 9, "Coastal Transect Parameters." Figure 8 shows the stillwater elevations for the 1-percent-annual-chance flood that was determined for this coastal analysis.

Stillwater elevations for Monroe County were determined from the lake-wide storm surge study conducted for Lake Erie by FEMA and Risk Assessment, Mapping, and Planning Partners (RAMPP) (FEMA 2012). The study was performed using the coupled SWAN + ADCIRC hydrodynamic and wave model on a mesh of 389,750 nodes validated using tides and 6 historical storms. The model was then used to simulate 155 selected historic storms based on historic peak water levels and peak wave heights. 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 created at each node.

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 16 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 16: Water Level Station Analysis Specifics

Station Name	Managing Agency of Station	Station Type	Start Date	End Date	Statistical Methodology
Buffalo, NY (9063020)	NOAA	Water Level	1860	2011	POT/GEV
Sturgeon Point, NY (9063028)	NOAA	Water Level	1989	2011	POT/GEV
Erie, PA (9063038)	NOAA	Water Level	1959	2011	POT/GEV
Fairport, OH (9063053)	NOAA	Water Level	1935	2011	POT/GEV
Cleveland, OH (9063063)	NOAA	Water Level	1860	2011	POT/GEV
Marblehead, OH (9063079)	NOAA	Water Level	1959	2011	POT/GEV
Toledo, OH (9063085)	NOAA	Water Level	1904	2011	POT/GEV
Fermi Power Plant, MI (9063090)	NOAA	Water Level	1963	2011	POT/GEV
Gibraltar, MI (9044020)	NOAA	Water Level	1989	2011	POT/GEV
Wyandotte, MI (9044030)	NOAA	Water Level	1930	2011	POT/GEV

Table 16: Water Level Station Analysis Specifics *(continued)*

Station Name	Managing Agency of Station	Station Type	Start Date	End Date	Statistical Methodology
Amherstburg, ON (11995)	Fisheries and Oceans, Canada	Water Level	1961	2011	POT/GEV
Bar Point, ON (12005)	Fisheries and Oceans, Canada	Water Level	1966	2011	POT/GEV
Kingsville, ON (12065)	Fisheries and Oceans, Canada	Water Level	1962	2011	POT/GEV
Erieau, ON (12250)	Fisheries and Oceans, Canada	Water Level	1962	2011	POT/GEV
Port Stanley, ON (12400)	Fisheries and Oceans, Canada	Water Level	1927	2011	POT/GEV
Port Dover, ON (12710)	Fisheries and Oceans, Canada	Water Level	1962	2011	POT/GEV
Port Colborne, ON (12865)	Fisheries and Oceans, Canada	Water Level	1962	2011	POT/GEV
Peace Bridge Below, ON (12954)	Fisheries and Oceans, Canada	Water Level	1999	2011	POT/GEV

For each return period, the stillwater elevation at each node was used to create a raster surface using ArcInfo geoprocessing tools. The storm surge modeling was performed with elevation data referenced to the long term mean lake level as the zero elevation. At the time of this study the mean lake level for Lake Erie was 571.6 feet NAVD88 or 571.4 feet IGLD 85. The node or point data was converted to the vertical datum of NAVD88.

Wave Setup Analysis

Wave setup was computed during the storm surge modeling through the methods and models listed in Table 15 and included in the frequency analysis for the determination of the total stillwater elevations.

5.3.2 Waves

Starting wave heights and wave periods for Monroe County were determined from the lake-wide storm surge study conducted for Lake Erie by FEMA and RAMPP (FEMA 2012) 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 as input to the transect analysis.

5.3.3 Coastal Erosion

A single storm episode can cause extensive erosion in coastal areas. Storm-induced erosion was evaluated to determine the modification to existing topography that is expected to be associated with flooding events. Erosion was evaluated using the methods listed in Table 15. 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 transect analysis was performed with elevations in the vertical datum of NAVD88. The results of these analyses were used to determine elevations for the 1-percent-annual-chance flood.

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 17 provides the location, stillwater elevations, and starting wave conditions 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 6 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 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.

Wave heights and wave crest elevations were modeled using the methods and models listed in Table 15, "Summary of Coastal Analyses".

Wave Runup 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 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 modeled using the methods and models listed in Table 15.

The FEMA Coastal Wave Runup and Overtopping Guidelines (FEMA 2018) includes several methodologies for evaluating wave runup for different slope scenarios and prevailing water/wave conditions. In the Great Lakes these methodologies include:

- Technical Advisory Committee for Water Retaining Structures Method, or TAW
- USACE Shore Protection Manual (SPM) for vertical structures

An alternate methodology to predict wave runup was investigated as a part of work being conducted by FEMA Region V for a coastal flood hazard study in the Great Lakes. USACE ERDC developed the report Wave Runup Prediction for Flood Hazard Assessment (USACE 2012) which proposes using the one-dimensional CSHORE model for evaluating wave runup. CSHORE was developed by Dr. Kobayashi and his graduate students at the University of Delaware (Kobayashi and Farhadzadeh 2008), and it provides an estimation of incident wave conditions by solving the nonlinear shallow water wave conditions along the cross-shore profile. CSHORE has been further tested and enhanced with close collaboration from the USACE in conducting FEMA's Great Lakes studies. The April 2014 version of CSHORE was used for this study.

CSHORE is a one-dimensional model that consists of a combined wave and current module based on time-averaged continuity, a sediment transport module to assess cross-shore profile change, empirical formulations for irregular wave runup, overtopping and seepage, as well as a module to assess over wash and structural damage. More details on the CSHORE model can be found in the User's Manual.

As part of its evaluation of wave runup methods for FEMA studies, the USACE provided recommended values for user-defined CSHORE input parameters including the runup wire height (RWH), for which they defined a value of 0.015 meters (0.049 feet) as being most appropriate based on the testing conducted.

CSHORE was applied on all transects that need runup evaluations. 155 storms were run for each transect and the maximum 2-percent runup for each valid run is adjusted by roughness reduction factors. The result is input to a Peak-Over-Threshold (POT) statistical analysis and used the Generalized Pareto Distribution (GPD) best fit to obtain the 1-percent-annual-chance runup value for each transect.

Wave overtopping occurs when a barrier crest height is lower than the potential wave runup level. Water will flow or splash over the barrier crest, typically to an elevation less than the potential runup height. The exact overtopping water surface elevation and overtopping rate will depend on the incident water level and wave conditions and on the barrier geometry and roughness characteristics.

Wave overtopping may be predicted by several different methods. The most widely used method is by using semi-empirical equations that have been fitted to hydraulic model tests using irregular waves for specific structure geometries. Overtopping cases are split into two geometry types: plateau and barrier. A plateau geometry is characterized by a positive slope inland of the barrier crest and a barrier geometry is characterized by a negative slope.

For plateau overtopping cases, the FEMA Coastal Wave Runup and Overtopping Guidelines (FEMA 2018) documents procedures that are used for estimation of adjusted runup elevation and inland extent of the overtopping. The procedure provides a graphical solution involving the potential runup elevation, barrier crest elevation, and the slope of the inland plateau.

For barrier overtopping cases, the FEMA Coastal Wave Runup and Overtopping Guidelines (FEMA 2018) provides equations for use in estimating an overtopping rate. As with plateau cases, the equations are a function of both hydraulic and barrier parameters including the significant wave height and period at the toe of the structure, the total stillwater elevation, the barrier crest elevation and slope. Interpretation of the estimated overtopping rate is complicated by a number of factors, including the projected duration of wave effects, the increased discharge possible under storm winds, the varying inland extent of water effects, and the specific topography and drainage landward of the barrier.

Table 17: Coastal Transect Parameters

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (feet NAVD88) Range of Stillwater Elevations (feet NAVD88)				
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (second)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Lake Erie	1	1.6	2.8	576.7 576.7-576.7	577.0 577.0-577.0	577.2 577.2-577.2	577.1* 577.1-577.1	577.3 577.3-577.3
Lake Erie	2	1.4	2.5	576.8 576.8-576.8	577.1 577.1-577.1	577.2 577.2-577.2	577.1* 577.1-577.1	577.4 577.4-577.4
Lake Erie	3	1.2	2.3	576.8 576.8-576.8	577.1 577.1-577.1	577.2 577.2-577.2	577.1* 577.1-577.1	577.3 577.3-577.3
Lake Erie	4	1.2	2.1	576.7 576.7-576.7	577.0 577.0-577.0	577.1 577.1-577.1	577.1 577.1-577.1	577.3 577.3-577.3
Lake Erie	5	1.7	4.9	576.5 576.5-576.5	576.8 576.8-576.8	576.9 576.9-576.9	576.9 576.9-576.9	577.1 577.1-577.1
Lake Erie	6	2.1	4.1	576.5 576.5-576.5	576.8 576.8-576.8	576.9 576.9-576.9	576.9 576.9-576.9	577.1 577.1-577.1
Lake Erie	7	2.2	3.9	576.5 576.5-576.5	576.8 576.8-576.8	576.9 576.9-576.9	576.8* 576.8-576.8	577.0 577.0-577.0

*Water level may be different than WHAFIS forcing conditions as determined by Joint Probability Analysis

Table 17: Coastal Transect Parameters *(continued)*

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (feet NAVD88) Range of Stillwater Elevations (feet NAVD88)				
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (second)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Lake Erie	8	2.3	4.0	576.4 576.4-576.4	576.7 576.7-576.7	576.8 576.8-576.8	576.8 576.8-576.8	577.0 577.0-577.0
Lake Erie	9	1.9	3.5	576.4 576.4-576.4	576.7 576.7-576.7	576.8 576.8-576.8	576.8 576.8-576.8	577.0 577.0-577.0
Lake Erie	10	1.5	4.7	576.4 576.4-576.4	576.7 576.7-576.7	576.8 576.8-576.8	576.8 576.8-576.8	577.0 577.0-577.0
Lake Erie	11	2.5	4.1	576.4 576.4-576.4	576.6 576.6-576.6	576.7 576.7-576.7	576.7 576.7-576.7	576.9 576.9-576.9
Lake Erie	12	2.5	3.8	576.3 576.3-576.3	576.6 576.6-576.6	576.7 576.7-576.7	576.7 576.7-576.7	576.9 576.9-576.9
Lake Erie	13	2.5	3.9	576.3 576.3-576.3	576.6 576.6-576.6	576.7 576.7-576.7	576.6* 576.6-576.6	576.9 576.9-576.9
Lake Erie	14	2.3	4.3	576.3 576.3-576.3	576.6 576.6-576.6	576.7 576.7-576.7	576.6* 576.6-576.6	576.9 576.9-576.9

*Water level may be different than WHAFIS forcing conditions as determined by Joint Probability Analysis

Table 17: Coastal Transect Parameters *(continued)*

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (feet NAVD88) Range of Stillwater Elevations (feet NAVD88)				
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (second)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Lake Erie	15	2.0	4.0	576.3 576.3-576.3	576.5 576.5-576.5	576.7 576.7-576.7	576.5* 576.5-576.5	576.9 576.9-576.9
Lake Erie	16	1.8	3.5	576.3 576.3-576.3	576.5 576.5-576.5	576.7 576.7-576.7	576.7 576.7-576.7	576.8 576.8-576.8
Lake Erie	17	1.7	3.3	576.2 576.2-576.2	576.5 576.5-576.5	576.6 576.6-576.6	576.6 576.6-576.6	576.8 576.8-576.8
Lake Erie	18	1.9	3.8	576.2 576.2-576.2	576.5 576.5-576.5	576.6 576.6-576.6	576.5* 576.5-576.5	576.8 576.8-576.8
Lake Erie	19	1.7	3.4	576.2 576.2-576.2	576.5 576.5-576.5	576.6 576.6-576.6	576.6 576.6-576.6	576.8 576.8-576.8
Lake Erie	20	1.9	4.8	576.2 576.2-576.2	576.4 576.4-576.4	576.6 576.6-576.6	576.5* 576.5-576.5	576.8 576.8-576.8
Lake Erie	21	2.4	4.0	576.1 576.1-576.1	576.4 576.4-576.4	576.6 576.6-576.6	576.6 576.6-576.6	576.8 576.8-576.8

*Water level may be different than WHAFIS forcing conditions as determined by Joint Probability Analysis

Table 17: Coastal Transect Parameters *(continued)*

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (feet NAVD88) Range of Stillwater Elevations (feet NAVD88)				
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (second)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Lake Erie	22	2.3	4.0	576.1 576.1-576.1	576.4 576.4-576.4	576.6 576.6-576.6	576.5* 576.5-576.5	576.8 576.8-576.8
Lake Erie	23	2.1	3.5	576.1 576.1-576.1	576.4 576.4-576.4	576.6 576.6-576.6	576.5* 576.5-576.5	576.8 576.8-576.8
Lake Erie	24	2.5	3.5	576.1 576.1-576.1	576.4 576.4-576.4	576.5 576.5-576.5	576.5 576.5-576.5	576.7 576.7-576.7
Lake Erie	25	1.9	3.2	576.1 576.1-576.1	576.4 576.4-576.4	576.5 576.5-576.5	576.5 576.5-576.5	576.7 576.7-576.7
Lake Erie	26	2.1	3.3	576.1 576.1-576.1	576.4 576.4-576.4	576.5 576.5-576.5	576.5* 576.5-576.5	576.7 576.7-576.7
Lake Erie	27	1.9	3.1	576.0 576.0-576.0	576.4 576.4-576.4	576.5 576.5-576.5	576.5 576.5-576.5	576.7 576.7-576.7
Lake Erie	28	1.6	2.9	576.0 576.0-576.0	576.3 576.3-576.3	576.5 576.5-576.5	576.5 576.5-576.5	576.7 576.7-576.7

*Water level may be different than WHAFIS forcing conditions as determined by Joint Probability Analysis

Table 17: Coastal Transect Parameters *(continued)*

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (feet NAVD88) Range of Stillwater Elevations (feet NAVD88)				
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (second)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Lake Erie	29	1.6	3.4	576.0 576.0-576.0	576.3 576.3-576.3	576.5 576.5-576.5	576.5 576.5-576.5	576.7 576.7-576.7
Lake Erie	30	1.3	2.9	576.0 576.0-576.0	576.3 576.3-576.3	576.5 576.5-576.5	576.5 576.5-576.5	576.7 576.7-576.7
Lake Erie	31	1.4	3.2	576.0 576.0-576.0	576.3 576.3-576.3	576.5 576.5-576.5	576.5 576.5-576.5	576.7 576.7-576.7
Lake Erie	32	2.1	3.4	576.0 576.0-576.0	576.3 576.3-576.3	576.5 576.5-576.5	576.4* 576.4-576.4	576.7 576.7-576.7
Lake Erie	33	2.1	3.5	576.0 576.0-576.0	576.3 576.3-576.3	576.5 576.5-576.5	576.4* 576.4-576.4	576.7 576.7-576.7
Lake Erie	34	2.3	3.4	576.0 576.0-576.0	576.3 576.3-576.3	576.5 576.5-576.5	576.4* 576.4-576.4	576.7 576.7-576.7
Lake Erie	35	2.0	3.6	576.0 576.0-576.0	576.4 576.4-576.4	576.5* 576.5-576.5	576.5 576.5-576.5	576.7 576.7-576.7

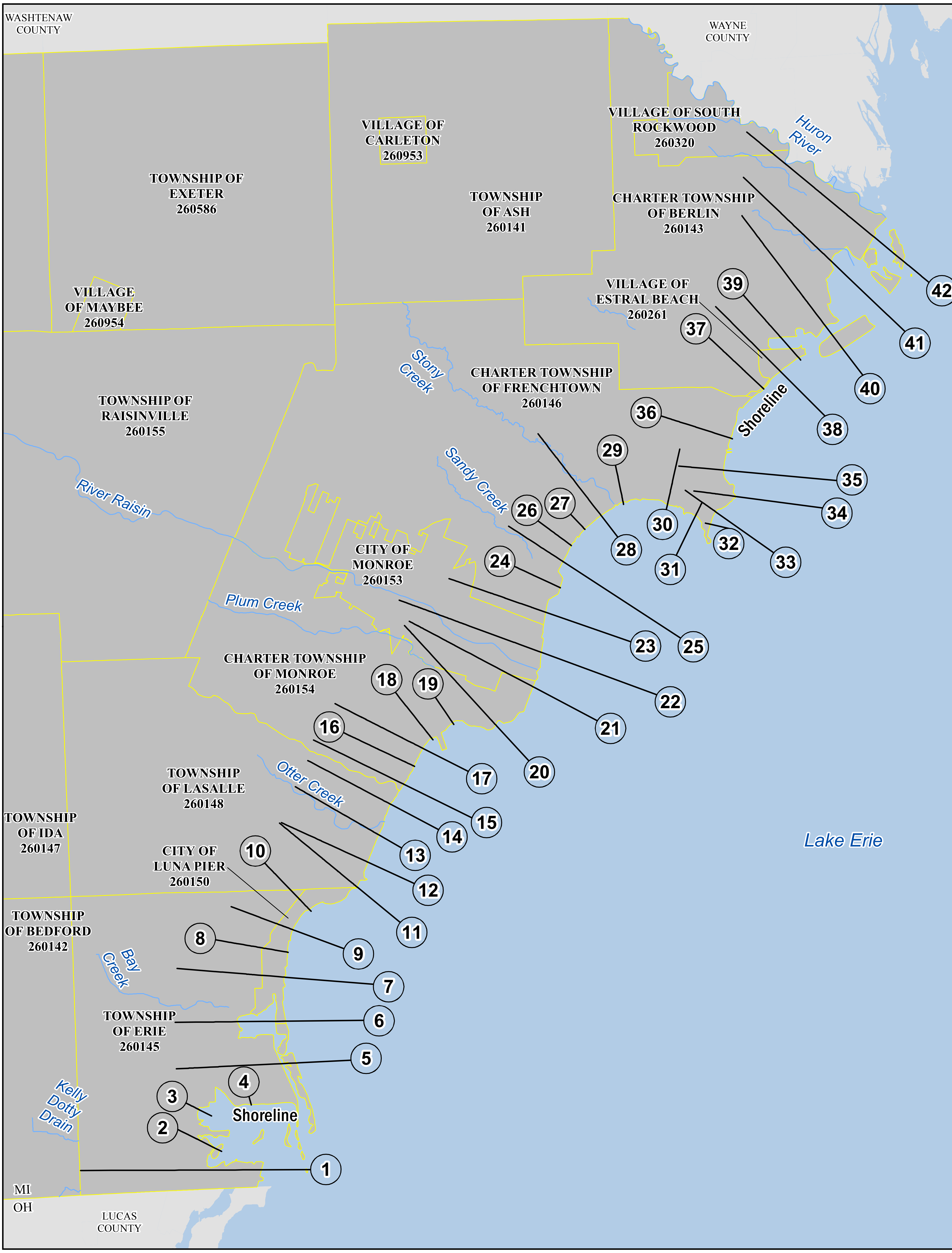
*Water level may be different than WHAFIS forcing conditions as determined by Joint Probability Analysis

Table 17: Coastal Transect Parameters *(continued)*

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (feet NAVD88) Range of Stillwater Elevations (feet NAVD88)				
		Significant Wave Height H_s (feet)	Peak Wave Period T_p (second)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Lake Erie	36	1.7	2.8	576.0 576.0-576.0	576.3 576.3-576.3	576.5 576.5-576.5	576.5 576.5-576.5	576.7 576.7-576.7
Lake Erie	37	1.7	3.1	576.0 576.0-576.0	576.3 576.3-576.3	576.4 576.4-576.4	576.4 576.4-576.4	576.7 576.7-576.7
Lake Erie	38	1.7	2.7	575.9 575.9-575.9	576.3 576.3-576.3	576.4 576.4-576.4	576.5 576.5-576.5	576.7 576.7-576.7
Lake Erie	39	1.7	2.8	575.9 575.9-575.9	576.2 576.2-576.2	576.4 576.4-576.4	576.4 576.4-576.4	576.7 576.7-576.7
Lake Erie	40	1.7	2.7	575.9 575.9-575.9	576.2 576.2-576.2	576.4 576.4-576.4	576.4 576.4-576.4	576.6 576.6-576.6
Lake Erie	41	1.8	4.0	575.9 575.9-575.9	576.2 576.2-576.2	576.4 576.4-576.4	576.4 576.4-576.4	576.6 576.6-576.6
Lake Erie	42	1.9	2.9	575.8 575.8-575.8	576.2 576.2-576.2	576.4 576.4-576.4	576.4 576.4-576.4	576.7 576.7-576.7

*Water level may be different than WHAFIS forcing conditions as determined by Joint Probability Analysis

Figure 9: Transect Location Map

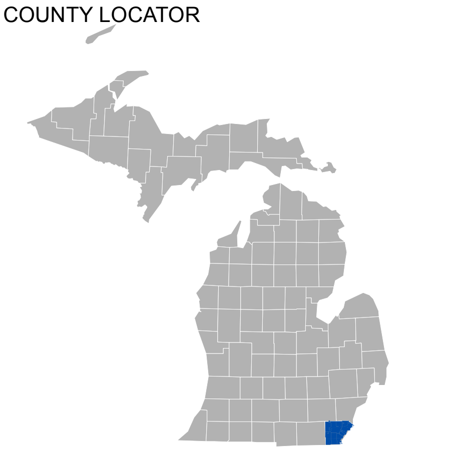


1 inch = 2.1 miles

0 0.5 1 2 3 Miles

Map Projection:
State Plane Michigan South, FIPS 2113;
North American Datum 1983

COUNTY LOCATOR



NATIONAL FLOOD INSURANCE PROGRAM

Transect Locator Map

PANELS WITH TRANSECTS:
0119, 0136, 0137, 0138, 0139, 0145, 0242, 0243, 0244, 0254, 0256, 0257, 0258, 0259, 0261, 0262, 0263, 0264, 0270, 0276, 0277, 0377, 0379, 0381, 0382, 0383, 0384, 0386, 0387, 0388, 0389, 0482, 0501, 0502

FEMA

5.4 Alluvial Fan Analyses

This section is not applicable to this Flood Risk Project.

Table 18: Summary of Alluvial Fan Analyses
[Not Applicable to this Flood Risk Project]

Table 19: 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. In the past, the standard vertical datum used for newly created or revised FIS Reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD29). All newly created or revised FIS reports and FIRMs are now prepared using the North American Vertical Datum of 1988 (NAVD88).

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 Monroe County are provided in Table 20.

Table 20: Countywide Vertical Datum Conversion

Quadrangle Name	Quadrangle Corner	Latitude	Longitude	Conversion from NGVD29 to NAVD88 (feet)
Belleville	SE	42.125	-83.375	-0.499
Blissfield	SE	41.750	-83.750	-0.564
Carleton	SE	42.000	-83.375	-0.528

Table 20: Countywide Vertical Datum Conversion *(continued)*

Quadrangle Name	Quadrangle Corner	Latitude	Longitude	Conversion from NGVD29 to NAVD88 (feet)
Deerfield	SE	41.875	-83.750	-0.515
Flat Rock	SE	42.000	-83.250	-0.564
Ida	SE	41.875	-83.500	-0.558
Ida	SW	41.875	-83.625	-0.528
Lambertville East	SE	41.750	-83.500	-0.594
Lambertville West	SE	41.750	-83.625	-0.577
Macon	SE	42.000	-83.750	-0.466
Maybee	SE	42.000	-83.500	-0.509
Milan	SE	42.000	-83.625	-0.486
Monroe	SE	41.875	-83.375	-0.571
Average Conversion from NGVD29 to NAVD88 = -0.535 feet				

Table 21: Stream-by-Stream 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*, 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 22.

Table 22: Base Map Sources

Data Type	Data Provider	Data Date	Data Scale	Data Description
Base Map for Monroe County	Michigan Center for Geographic Information	2007	N/A	PLSS data, water areas and lines, railroads
Base Map for Monroe County	Monroe County Planning Department	2008	N/A	Municipal and county boundaries, roads
Digital Ortho Mosaic	USDA FSA Aerial Photography Field Office	2016	1:12,000	Digital orthophoto for Monroe County, Michigan
Digital Orthophoto	Monroe County Planning Department	2010	N/A	Digital orthophoto for Monroe County, Michigan

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 23. 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 23, 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 23.

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 24, “Floodway Data.”

Table 23: Summary of Topographic Elevation Data used in Mapping

Community	Flooding Source	Source for Topographic Elevation Data			
		Description	Scale	Contour Interval	Citation
Monroe County	Lake Erie	2012 Light Detection and Ranging data (LiDAR)	20 cm RMSE	75 cm Root Mean Square Error (RMSE)	JALBTCX 2012
All Mapped Communities	All Flooding Sources	LiDAR	1:1,200	N/A	Woolpert 2010
Bedford, Township of	Kelly Dotty Drain	Topographic maps	1:24,000	5 and 10 ft	USGS Various
Bedford, Township of	Indian Creek	Topographic maps	1:24,000	5 and 10 ft	USGS Various
London, Township of; Milan, Township of	Saline River	Topographic maps	1:24,000	5 and 10 ft	USGS Various

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.